NORTH AMERICAN EDITION #7, JULY / AUGUST 2015

ACCELERATE

ADVANCING HVAC&R NATURALLY

MAGAZINE

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MAGAZINE

Editor's note
by Michael Garry

A GREAT GATHERING PLACE

In late June, I attended my first ATMOsphere America conference as editor of *Accelerate America*. It was an eye-opening experience.

Having served as editor of the magazine since its inception last November, I am familiar with the innovation and vibrancy of this space. But there's nothing like meeting and learning from the people who drive the market to appreciate its special genius.

These are the people, after all, who are working towards nothing less than changing the way North America uses refrigeration and HVAC – two of humankind's most important tools.

At ATMOsphere America, held this year in Atlanta, they all came together: end users – nine of them featured on the cover of this issue – OEMs, component manufacturers, contractors, utilities, consultants, regulators, standard groups, academics, and more. In this special issue of *Accelerate America*, you will learn about what many of them said, particularly companies who have installed and are using natural-refrigerant equipment. (If you were at the conference, this issue will help reinforce what you heard there!)

It was an honor for me to share the stage at ATMOsphere America with executives from four food retail companies – Delhaize America, Whole Foods, Lowe's Markets and Ahold USA – who participated in a panel discussion that I moderated. These companies represent a cross-section of the work being done with natural refrigerants at U.S. supermarkets; their stories start on page 24.

The main takeaway from this year's conference is that the North American market is at a tipping point; no longer neophytes in natural-refrigerant applications, many end users, like supermarkets, food service brands and industrial cold-storage operators, are starting to catch up with Europe and Japan in recognizing the need for, and benefits of, energy-efficient, environmentally benign refrigeration and HVAC systems.

With more and more companies successfully implementing natural-refrigerant systems, fence sitters – as we suggest on the cover – no longer have an excuse for inaction.

Next month, readers will have access to even more insights into the progress being made in North America when shecco (publisher of *Accelerate America* and organizer of ATMOsphere America) publishes "GUIDE to Natural Refrigerants in North America – State of the Industry 2015" as a supplement to the September issue of *Accelerate America*. We have a sneak preview to the GUIDE on page 18.

As end users and others continue to make strides over the next year, *Accelerate America* is planning to recognize three end-user companies and one individual with awards for doing exceptional work in driving adoption of natural refrigerant solutions. We will present these awards at next year's ATMOsphere America conference in June. For more on the awards program, turn to page 16.

I'm already looking forward to next year's conference! MG

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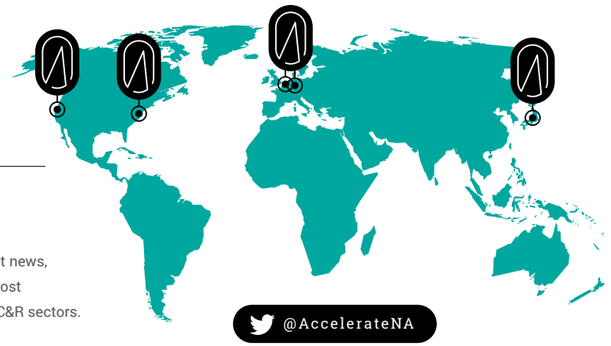

ABOUT ACCELERATE AMERICA

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

On cover, top row, from left: Tristam Coffin, Whole Foods Market; Roy Buchert, McDonald's; Paul Camera, Starbucks.

Middle row, from left: Harrison Horning, Delhaize America; Ken Welter, Baltic Trail Engineering (Ahold USA); Paige Dunn, Red Bull.

Bottom row, from left: Gerard von Dohlen, Newark Refrigerated Warehouse; Gary Cooper, Lowe's Markets; Antoine Azar, Coca-Cola

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Editor: Michael Garry, michael.garry@shecco.com, @mgarrywriter

Contributing Writers: James Knudsen, Jana Topley Lira, James Ranson, Robert Davidson, Elke Milner, Klara Skacanova

Events Coordinator: Silvia Scaldaferri

Advertising Manager: Franziska Menten

Graphic Designers: Mehdi Bouhjar, Patricia Ofuono, Charlotte Georis

Photographer: Scott Chasserot

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THE CHOICE

Users of HVAC&R equipment can continue to use chemical refrigerants with known environmental hazards, or make the investment in a long-term solution that is known, viable and safe

– By Jim Knudsen –

I had the good fortune to attend the ATMOsphere America 2015 conference on natural refrigerants in Atlanta, June 25-26. I am a long-term fan of this conference (four years) and this year was the best yet. ATMOsphere America 2015 serves as the forum for discussions about the business case for natural refrigerants in North and South America.

Natural refrigerants are compounds that occur more or less naturally in our environment and can be used in the refrigeration cycle. They are inexpensive and have little or no effect on the environment, but they do have other challenges. Natural refrigerants include carbon dioxide, ammonia, hydrocarbons (such as propane and isobutane) and, for special applications, water and air.

Currently the practice in refrigeration is to mostly use so-called "chemical" refrigerants. Chemical refrigerants are compounds specifically engineered to perform well in vapor/compression cycle refrigeration systems. These chemical refrigerants work very well but are very strong greenhouse gases, some as much as 4,000 times more potent than CO_2.

While new chemical refrigerants are being developed that have greatly reduced global warming potential (GWP), they are also mildly flammable and very expensive. In addition, these new chemical refrigerants raise questions about other environmental and health factors associated with their use.

NATURAL REFRIGERANT CHALLENGES

CO_2, the bubbles in your soft drink and the stuff that dry ice is made of, is a good refrigerant as well. Its effect on the environment, in the quantities used in refrigeration systems, is tiny compared to that of current chemical refrigerants. The challenge with CO_2 is that it requires very high pressures and the refrigeration

continued on p.10

systems get complicated in warm climates. This means that in order to use CO_2 as a refrigerant, the equipment can be expensive. On the other hand, CO_2 systems are also generally more energy efficient than chemical systems.

As discussed at the conference, the operational and component standards used to design CO_2 systems are in need of updating, particularly to harmonize them with European standards. On the plus side, UL (Underwriters Laboratories) is working toward harmonization of standards with the European Community under the banner of CANENA (Council for Harmonization of Electrotechnical Standardization of the Nations of the Americas). Additional federal regulations would also help drive systems designers and components manufacturers to invest in approval testing of components. But until then, U.S. components will continue to be substantially more expensive than their European counterparts.

Ammonia, that stinky stuff we use to clean with, is also a very good refrigerant. It is very efficient, cheap, and operates at reasonable pressures. The downside with ammonia is that, in its undiluted form, it is very toxic and can be flammable. Even with these limitations, ammonia is the most commonly used refrigerant in large refrigerated warehouses and some industrial applications. In these cases, safety standards are very strict and the systems are being constantly monitored. At the conference, new designs were presented for low-charge systems that provide the same refrigeration effect with a much smaller amount of ammonia (sometimes over 90% less).

Finally, hydrocarbons are great refrigerants, low pressure and non-toxic, but as you would expect, very flammable. Flammability in a refrigeration system can be a problem if it is not handled properly. In situations where we recognize the flammability of these gases, they can be used safely (think of your propane barbeque grill). Due to their flammability, hydrocarbons are generally used in very small quantities in self-contained systems like a refrigerator. In fact, in Europe it is common to have home refrigerators that utilize hydrocarbons as the refrigerant.

As the people at the ATMOsphere America conference work to promote the use of natural refrigerants to protect our environment and ensure the future viability of our refrigeration investments, they face roadblocks. The primary limitations to the wider use of natural refrigerants are equipment cost, unsupportive regulations, and, as noted, standards. Cost, regulations and standards and are all interwoven and it is fair to say that the U.S. is trailing Europe and perhaps the rest of the world in this regard. In fact, even the developing world, as recently represented by China, has set goals for the implementation of natural refrigerants.

While the regulations in the U.S. are lagging those in Europe, Canada, Australia, and others as well, there is progress. On July 3, the EPA issued a ruling on the accelerated phaseout of the very worst global warming potential refrigerants. While this is an incremental step, it is in the right direction.

Highlighted at the conference, the California Air Resources Board (CARB) regulators have proposed an aggressive phase-down of high global warming potential refrigerants. The U.S., Canada and Mexico have also sponsored a proposed amendment to the international treaty on atmospheric protection (originally only including ozone depletion) called the Montreal Protocol. This proposal includes an international phase-down, similar to Europe's, of the high global warming potential refrigerants.

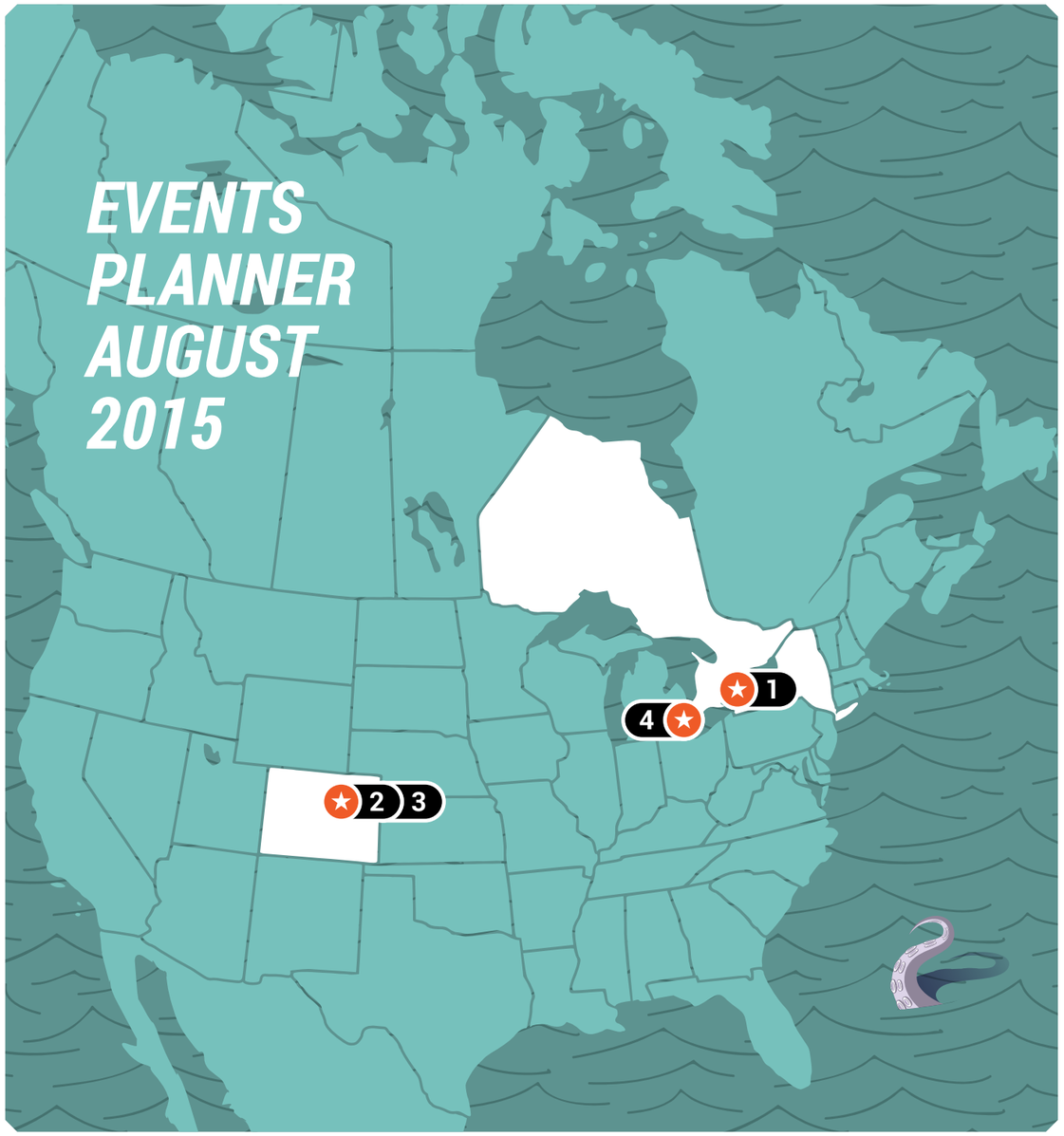
As the U.S. auto industry has learned with mileage and safety standards, it is always better for industry to get ahead and lead government, rather than to wait and be forced to follow unfavorable regulations.

The financial payback of these decisions cannot be ignored, but in most cases there are natural refrigerant solutions that have enough economic benefit in terms of energy efficiency to provide a payback. While the payback is sometimes longer than we would like, the technology is developing to provide better efficiencies all the time.

There are many aspects and nuances to the issues surrounding natural refrigerants that I have not discussed in this short article. But in essence the refrigeration industry and we as U.S. citizens have a choice: Continue to use the chemical refrigerants with their known environmental hazards, or make the investment in a future in which the long-term solution is known, viable and safe JK

Jim Knudsen, who lives in Columbus, Ga., is an experienced refrigeration executive, specializing in global marketing, business development and product strategy. He is the holder of five U.S. patents. His Strategic Leadership Blog is located at:

www.jamesknudsen.com

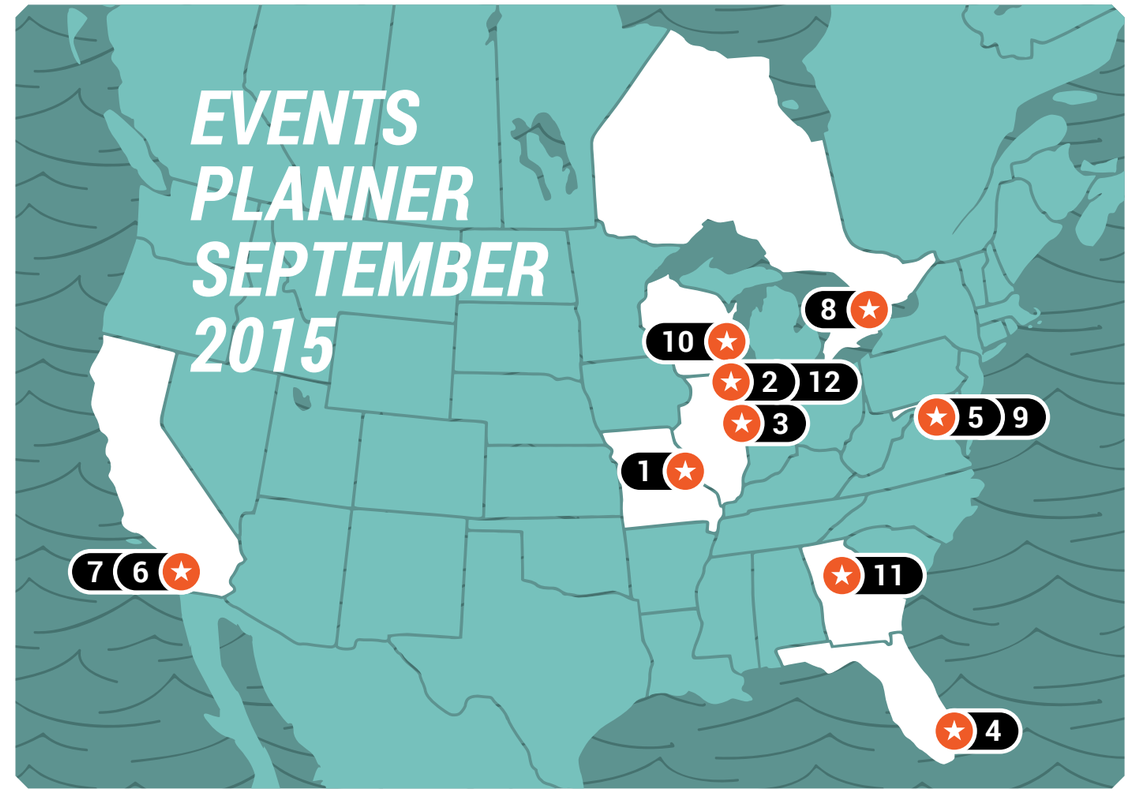


1. August 4-6,, Buffalo, NY
   ACEEE Summer Study on Energy Efficiency in Industry
   http://aceee.org/conferences/2015/ssi
   twitter : @ACEEEdc

2. August 19-21, Denver, CO
   Global Sustainability Summit
   http://fmi.org/forms/meeting/Microsite/2015TPASustainabilitySummit
   twitter : #FMIGMASummit / @FMI_ORG / @GroceryMakers

3. August 22- 25, Denver, CO
   NACDS Total Store Expo
   http://tse.nacds.org
   twitter : @nacds

4. August 26-28, Windsor, Ontario
   2015 HRAI Annual Meeting and Conference
   http://www.hrai.ca/agm/sponsors.html
   twitter : #HRAI_AGM_2015 / @HRAI_Canada



1. September 15-17, St. Louis, MO
   Comfortech 2015
   http://www.comfortechshow.com/ct15/public/enter.aspx
   twitter : #Comfortech2015 / @comfortechshow

2. September 15-18, Chicago, IL
   International Dairy Show 2015
   http://dairyshow.com/
   twitter: #DairyShow / @dairyshow

3. September 22-25, Urbana, IL
   CTS Training on Transcritical CO_2 Technology
   http://www.creativethermalsolutions.com/servicesandfacilities.html

4. September 20-22, Fort Lauderdale, FL
   IANA Intermodal Expo 2015
   http://www.intermodalexpo.com/index.php
   twitter: #IntermodalExpo / @IntermodalEXPO

5. September 20-23, National Harbor, MD
   Data Center World
   http://www.datacenterworld.com/fall/
   twitter: #datacenter / @DataCenterWorld

6. September 27-30, San Diego, CA
   2015 FMI Energy & Store Development Conference
   http://www.fmi.org/forms/meeting/Microsite/ESD2015,0
   twitter: #FoodRetail / @FMI_ORG

7. September 27-30, San Diego, CA
   CSCMP's 2015 Annual Conference
   https://cscmp.org/annual-conference
   twitter: #CSCMP2015 / @cscmp

8. September 28-29, Toronto, Canada
   Grocery Innovations Canada 2015
   http://www.groceryinnovations.com/closed.html
   twitter: @CFIGFCEI

9. September 29 - October 1, Washington, DC
   2015 AFFI Government Action Summit
   http://www.affi.org/events/2015-affi-government-action-summit

10. September 29 - October 2, Milwaukee, WI
    RETA 2015 National Conference
    http://reta.com/events/event_details.asp?id=644201&group=

11. September 30 - October 2, Atlanta, GA
    ASHRAE: Energy Modeling Conference
    https://www.ashrae.org/membership--conferences/conferences/ashrae-conferences/2015-ashrae-energy-modeling-conference
    @ashraenews

12. September 30 - October 3, Rosemont, IL
    78th Annual RSES Conference and HVACR Technology Expo
    http://www.rses.org/conference.aspx
    twitter: #RSES / @RSESHQ

1 October 5-9, Boston, MA
13th Cold Chain GDP & Temperature Management Logistics Global Forum
http://www.coldchainglobalforum.com/#ColdChain
twitter: #Logistics / @CCGlobalForum

2 October 10-13, Dallas, TX
NFRA Convention
http://nfraconvention.org/

3 October 11-14, Las Vegas, NV
NACS Show 2015
http://www.nacsonline.com/nacsshow/Pages/default.aspx
twitter: @NACSonline

4 October 20-22, Guadalajara, Mexico
2015 AHR Expo-Mexico
http://www.ahrexpomexico.com/sp/index.php
twitter: #AHRExpo / @ahrexpomexico

ACCELERATE AMERICA LAUNCHES AWARDS PROGRAM

— By Elke Miner

The awards will recognize end-user companies in food retail, food service and industrial refrigeration that are doing the most with natural-refrigerant solutions in North America; a person of the year will also be named

Any questions or comments about the awards program may be sent to michael.garry@shecco.com

Since its launch in November 2014, *Accelerate America* has been spotlighting the most progressive individuals and organizations working with natural refrigerants in HVAC&R applications in North America. To take that a step further, the magazine announced at ATMOsphere America 2015 a new awards program to recognize three end-user companies and one individual for doing the most to drive adoption of natural refrigerants.

The awards, which will be presented at the ATMOsphere America conference in June 2016, comprise two categories: Best in Sector and Person of the Year.

A Best in Sector award will go to one end-user company in each of three sectors — food retail, food service and industrial — that has gone above and beyond in advancing the adoption of natural refrigerant technologies in the previous 12 months in HVAC&R applications.

Companies will be recognized for natural-refrigerant technologies that are part of new builds or remodels completed between June 2015 and May 2016. Nominations may include system performance studies completed during this time period; the studies can refer to systems installed prior to June 2015 as well as those installed from June 2015 to May 2016.

Criteria for assessing systems and companies include:

- A reduction in energy consumption
- A reduction in greenhouse gas emissions
- Reproducibility
- A business case encompassing capital, installation, operation, maintenance and training, and a return on investment
- Commitment to future natural-refrigerant installations
- Industry leadership
- Innovation and perseverance

Complementing the Best in Sector Awards, the Person of the Year Award will honor a single individual who has done the most to advance the adoption of natural refrigerant technology in HVAC&R applications in North America between June 2015 and May 2016. This award is open to any individual, including end users, manufacturers, policy makers, academics and researchers.

Criteria for assessing individuals include:

- Impact on development and/or implementation of natural-refrigerant systems
- Leadership in organization as well as the industry
- Innovation and perseverance

"This will be someone who has driven the market," said Michael Garry, editor of *Accelerate America*. "It's going to be a difficult one to choose, but we want to single out and honor someone who's really done a special job."

The nominating process for the awards will open in January 2016 via a website to be announced, and continue through April. Nominations may be submitted by anyone involved with HVAC&R; companies and individuals may nominate themselves. From May to June 2016, a panel of experts, assembled by shecco, will review the nominations as well as others not nominated, and select winners.

During ATMOsphere America 2016, shecco will host a special ceremony honoring the *Accelerate America* award winners. The July 2016 issue of *Accelerate America* will profile the winning companies and individual. EM

GUIDE NORTH AMERICA PREVIEW

This new in-depth look at natural refrigerants in North America will provide the latest data and insights on applications in the light commercial, commercial and industrial sectors

– By Robert Davidson –

In early September, shecco will release "GUIDE to Natural Refrigerants in North America – State of the Industry 2015" as a supplement to the September issue of *Accelerate America*.

The GUIDE, a follow-up to a similar study published in 2013, paints a picture of the North American market for natural refrigerants through an in-depth examination of market trends, policy decisions, and the latest technological advancements in the use of these refrigerants in HVAC&R applications across three industry sectors (light commercial, commercial and industrial refrigeration). It is based on intelligence shecco has collected over the past two years through one-on-one interviews, intensive data-collection and a survey of hundreds of key stakeholders.

At ATMOsphere America 2015 in Atlanta, Nina Masson, shecco's deputy managing director, provided a sneak preview of some of the GUIDE's major insights into the progress and future prospects of natural refrigerants.

Masson explained how the light commercial refrigeration sector is driven by the efforts of large consumer brands, such as those that make up the Refrigerants, Naturally! advocacy group: Coca Cola, PepsiCo, Red Bull and Unilever, with Coke embracing CO_2 and the others incorporating hydrocarbons. Globally, these companies have installed 3.7 million pieces of natural refrigerant-based light commercial refrigeration equipment; in North America, the number stands at 205,000. Masson noted that this makes up nearly two-thirds of the current total (nearly 300,000), but with food service likely to see an influx of brands using hydrocarbon-based refrigeration equipment, the total should soon become larger.

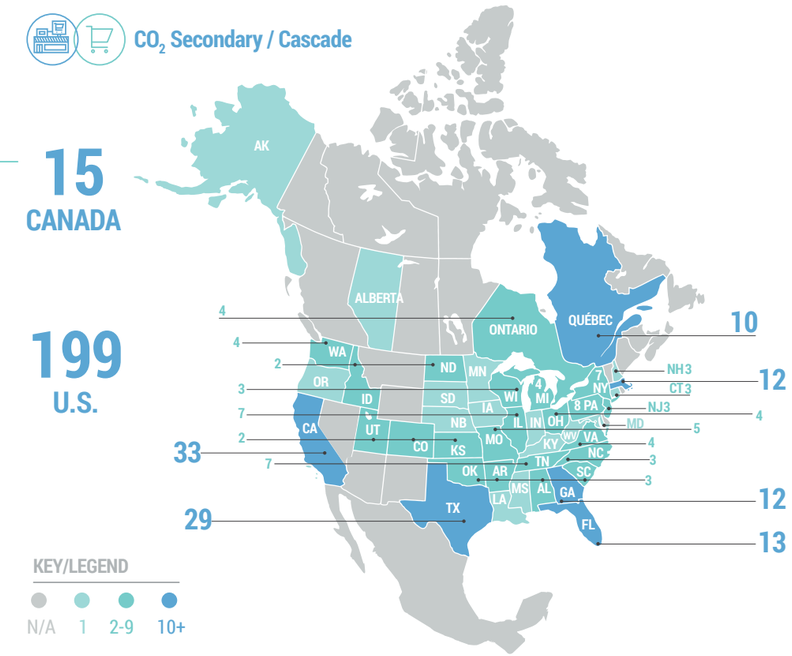
In commercial refrigeration, she noted, there are 105 CO_2 transcritical systems in Canada (including 70 in Quebec), compared to 24 two years ago. The United States now has 17 transcritical systems, up from two in the 2013 study. U.S. retailers have favored CO_2 secondary/cascade systems (with 199 installed vs. 15 in Canada) – especially in the south where higher ambient temperatures may undercut the efficiency of transcritical units.

In industrial refrigeration, Masson disclosed that 266 "next generation" installations were found in North America. Low-charge ammonia systems led the charge with 195 installations, including 54 in Quebec and 46 in Ontario. In addition, CO_2 transcritical systems have 27 installations across North America.

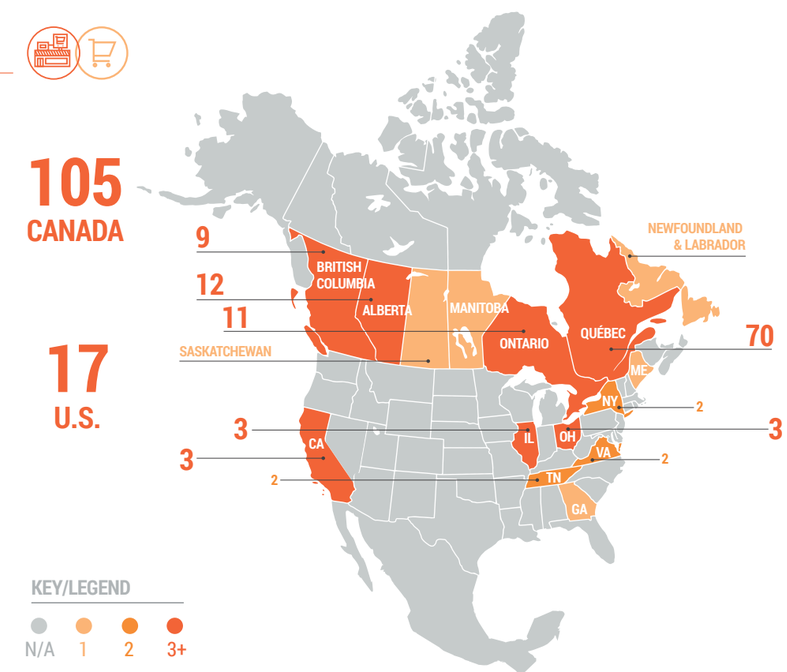
In addition to looking at today's market, the GUIDE will examine the future. Through the use of a "commercial availability" chart, readers will be able to understand what the growth potential of several more niche markets is likely to be, giving a head start to those looking to widen the range of natural refrigerants @ RD

The final version of the GUIDE will be updated with information gathered from ATMOsphere America 2015 and other sources.

Food Retail Installations of CO_2 Refrigeration, June 2015



CO_2 Transcritical



Source: shecco

THE STATE OF THE INDUSTRY: **A MARKET IN FLUX**

CO_2 got the most attention, but a panel of equipment manufacturers foresees an array of natural-refrigerant applications in a growing but fragmented marketplace

– By Robert Davidson –

The State of the Industry session on day one of ATMOsphere America 2015 conference in Atlanta shed light on the gradual growth of natural-refrigerant applications in North America from the perspective of major equipment manufacturers.

One speaker, Hussmann's Product Manager Quentin Crowe, forecast that within the next decade 15%-20% of the North American HVAC&R market will be based on natural refrigerant equipment.

This growth reflects the increasing fragmentation of a market traditionally dominated by harmful fluorinated gases. The fall-out from the global transition from F-gases has resulted in a North American market still finding its feet, as it becomes increasingly aware of the options available to it.

Dustan Atkinson, sales manager, supermarket systems for Heatcraft Worldwide Refrigeration, made the case that as HFCs become moribund, "a portfolio of solutions is now becoming the norm." Indeed, several presentations pointed out that all sizes and applications of refrigeration – from light commercial to commercial to industrial – are searching for the optimum refrigerant and system. This transition from fluorinated gases will be further accelerated by the EPA's final delisting of a group of high-GWP HFCs that came roughly a week after ATMOsphere America.

Panel moderator Nina Masson, shecco's deputy managing director, demonstrated the wide-ranging applications for natural refrigerants with data collected from the upcoming "GUIDE to Natural Refrigerants in North America — State of the Industry 2015." (The GUIDE is set for release in September 2015 as a supplement to *Accelerate America*.)

The data showed nearly 300,000 pieces of light-commercial equipment using CO_2 or hydrocarbons; 338 stores employing CO_2 transcritical, cascade or secondary systems; and more than 250 "next-generation" industrial installations of low-charge NH_3, cascade NH_3/CO_2 or CO_2 transcritical systems.

While these numbers were encouraging, concerns were raised about the infrastructure supporting natural refrigerants in North America, including the level of trained engineers and the availability of affordable components for natural refrigerant-based equipment.

Among natural refrigerants, CO_2 was still the one most frequently cited as showing the greatest potential in the North American market in light commercial, commercial and industrial refrigeration.

Scott Martin, Hillphoenix's director of sustainable technologies, discussed the importance of spreading the use of CO_2 transcritical refrigeration to the southern U.S., especially in supermarkets, with technology such as adiabatic gas coolers. He believes overall adoption of transcritical systems in the U.S. can be helped by the availability of components that are used in Europe, but not currently authorized in the U.S. With wider access to these components, he said, the price premium for CO_2 refrigeration will fade as it has in Europe, where the price premium of roughly 40% in 2006 fell to between zero and 8% for certain applications.

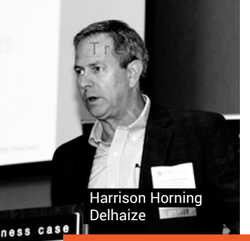
Meanwhile, noted Hussmann's Crowe, it is the manufacturers' responsibility to ensure that the virtues of transcritical systems are communicated effectively.

Marc-André Lesmerises, Carnot Refrigeration's CEO, emphasized the role of CO_2 transcritical in the future of refrigeration, observing, "CO_2 is good and not only for supermarkets." For example, he detailed the ability of CO_2 to satisfy demands in the cold storage, data center and ice rink industries. The growth of Carnot as a business is reflective of an industry moving to more and more sustainable technologies to meet refrigeration requirements.

With the rising demand for CO_2 systems, companies can maintain low emissions even in the midst of vast expansion, observed Andre Patenaude, director of CO_2 business development for Emerson Climate Technologies.

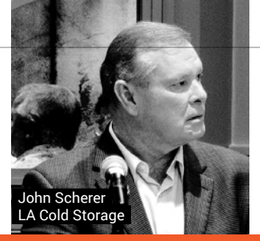
For all the talk about CO_2, other refrigerants will also play a key role in developing North American market. Lesmerises, for example, believes that "free cooling" – using cool outdoor air as a free cooling source -- will be the next "big thing" for the industry in terms of efficiency and uptake. Mark Tomooka, leader of Mayekawa's U.S. development team, and Joe Sanchez, engineering manager at Bitzer, made the case for both water and ammonia, adding that companies will need to improve in areas such as training.

With the prospects of increased demand in the next five years, Crowe is right to insist that manufacturers do all they can to inform end users about the qualities of natural refrigerants. But the industry must also strive to ensure that, when people begin to really listen, the natural refrigerants infrastructure is in place RD


Harrison Horning
Delhaize


Roy Buchert
McDonald's


Bruce Karas
Coca-Cola


John Scherer
LA Cold Storage


Ronald Domitrovic
EPRI

MARKET OPPORTUNITIES: THE BEST IS YET TO COME

End users from major industry sectors report on their ambitious plans for natural refrigerants and expectations for the marketplace

– By Robert Davidson

What are the opportunities for natural refrigerants in the food retail, food service and industrial marketplaces? On day one, ATMOsphere America 2015 brought together four end users from these sectors – including some of the most recognizable brands in the world – to outline their plans, which provided a sense of the considerable market potential for natural working fluids.

Harrison Horning, director of energy and facility services for the Hannaford Supermarkets division of Delhaize America, said the company has had "good luck" with CO_2-only transcritical refrigeration, which it has piloted for nearly two years at one store in Turner, Maine, and is set to test in a new store in North Berwick, Maine. "We're about ready to make it our standard in new stores," he said. Hannaford is also starting a test of self-contained coffin cases using small amounts of propane, and has replaced some HFC systems in its distribution centers with ammonia; it may also test an ammonia-CO_2 solution in its distribution centers.

Horning also sees a "big opportunity" for natural refrigerants in remodeled stores, which are far more common than new stores for Delhaize America. (This may change as Delhaize Group and Ahold announced a proposed merger in June.) Overall, he likened natural-refrigerant development to the U.S. moon mission in the 1960s, which resulted in the development of unexpected technologies. "We don't yet know all the opportunities ahead of us," he said.

Roy Buchert, McDonald's global energy director, spoke of the fast-food goliath's desire to replicate its mostly European roll-out of small hydrocarbon-based refrigeration equipment (more than 9,000 units) across the U.S. Buchert encouraged the same for the entire food service industry, which has nearly one million restaurants across the U.S., and could bring around a seismic shift that would distinguish the U.S. as a global leader in natural refrigerants.

Buchert stated that propane equipment has been released for McDonald's (mostly franchised) restaurants across the U.S. in light of the EPA delisting of certain fluorinated refrigerants, observing that "natural refrigerants make business sense, and it's the right thing to do for the environment."

Bruce Karas, vice president of environment & sustainability for Coca Cola North America, focused on the importance of the soft-drink giant's "point of sale" equipment and how the use of CO_2 as a refrigerant allows the company to spread its message of environmental responsibility. Natural refrigerants are becoming something of an industry standard, he noted, with fellow Refrigerants, Naturally! members Red Bull, PepsiCo and Unilever all utilizing them in the U.S. (albeit hydrocarbons rather than CO_2).

Karas urged regulators to be cognizant of the virtues of natural refrigerants as well as their implementation, "something that regulators sometimes aren't aware of." This represented a call-to-arms to legislators to improve the overall regulatory framework in advance of the large amount of natural refrigerant-based equipment set to dominate the light commercial refrigeration sector in the U.S. and eventually, worldwide.

John Scherer, manager of engineering at Los Angeles Cold Storage, (and president of low-charge-ammonia startup NXTCOLD) addressed the radical changes ongoing in the industrial refrigeration sector. He noted that the recent sweep of low-charge ammonia installations is set to soar further, estimating it to be a $400 million market. "Hundreds of NXTCOLD unit installations are planned and thousands are anticipated by 2020," he said.

The advent of low-charge ammonia systems, he added, means that many cooling applications traditionally addressed with HCFC or HFC refrigerants will move to ammonia. "A true divergence is occurring with unprecedented positive results for industry as well as the public," said Scherer. Cascade ammonia/CO_2 systems also have an important role to play in commercial and light commercial arenas as well as industrial.

One of the benefits of low-charge ammonia systems, he noted, is that they "alleviate concerns about locating them nearby public services and within neighborhoods."

The final speaker, Ronald Domitrovic, a program manager in the Power Delivery & Utilization Sector at EPRI (Electric Power Research Institute), explained EPRI's focus on testing new energy-saving technologies that can relieve the burden on electric utilities, such as transcritical and ammonia/CO_2 systems.

Domitrovic highlighted the refrigeration sector – and natural refrigerants, in particular – as one of the areas least visible to energy utilities. EPRI is working with utilities to educate them on the potential of natural refrigerants, and the value of offering energy incentives to end users of natural-refrigerant technology such as supermarkets and cold-storage warehouses RD

Food retail

FOOD RETAIL PANEL DISCUSSION

LEARNING FROM EXPERIENCE

Executives representing Hannaford Supermarkets, Whole Foods Market, Ahold USA and Lowe's Markets report on their progress with systems that use natural refrigerants, from CO_2 to propane to ammonia

By Michael Garry

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> "My sense is that with a northern climate, [transcritical refrigeration] can be a viable standard for our new stores."

HANNAFORD: CLOSE TO A STANDARD

In July 2013, a 35,000-square-foot Hannaford Supermarkets store in Turner, Maine, gained the distinction of becoming the first U.S. supermarket to feature a transcritical refrigeration system, which uses CO_2 as its sole refrigerant.

Thus, Harrison Horning, director of energy and facility services for the Hannaford Supermarkets division of Delhaize America, came to the food retail panel discussion at ATMOsphere America 2015 equipped with just under two years of experience with the system. (See, "Does Transcritical CO_2 Refrigeration Deliver," *Accelerate America*, Nov. 2014.)

His overall conclusion: "My sense is that with a northern climate, [transcritical refrigeration] can be a viable standard for our new stores."

From a total cost of ownership (TCO) perspective, he is satisfied that, for a new store, the transcritical system is at par with Hannaford's previous standard, a "premium [HFC] system optimized for a cold climate." He noted that while Hannaford does not factor a potential carbon tax into its TCO calculations, "we are assuming the price of HFC refrigerant will go up."

The ROI sought for Hannaford's a natural-refrigerant project is about 4.5 years. Horning declared the ROI thus far to be "good enough that we should at least feel good about piloting it and getting the data and getting comfortable with it."

Hannaford has designated the period 2015-2017 for piloting additional natural refrigerant systems, and is working on a five-year plan that takes it to 2020.

Already, Hannaford plans to open a new, 20,000-square-foot store in North Berwick, Maine, in August, that will serve as its second pilot for a transcritical system. The chain doesn't have any other store openings on the horizon, but if one comes along, Horning will propose that it get a transcritical system. "I think it would get approved," he said. "That would take us from a pilot phase to an actual standard."

Horning has been building a business case for transcritical technology based on the performance of the Turner store's system. At the panel discussion, he presented 11 months of energy consumption data (Oct. 2013-Aug. 2014) for both the Turner store's transcritical system and an HFC DX system used at a similar store in Bradford, Vt.

The overall energy performance of both systems was comparable; in the winter, the transcritical unit was more efficient, balancing out the summer months when it was less efficient.

Hannaford did another study comparing the overall energy use index (EUI), including electricity and propane (for heating), at both stores. The study covered 12 months, ending in April 2015. Again, the numbers were roughly the same, with the Turner store consuming 194 kBTU/square-foot/year, and the Bradford store using 190 kBTU/square-foot/year.

"It was nice to see the transcritical store on a par with our previous standard," said Horning, adding, "We expect reasonably good energy performance on all CO_2 transcritical pilot projects."

While Horning believes the transcritical system can serve as a standard for new stores, the jury remains out for remodels and retrofits. "We're going to pilot different systems to figure out what's the most cost effective to apply to existing stores," he said.

Horning pointed out that the much lower GWP of CO_2 compared with HFCs (one vs. up to 4,000) means that refrigerant leaks in the transcritical system will not contribute much in the way of greenhouse-gas emissions. Consequently, the Turner store's overall carbon footprint was found to be 18% lower than that of the Bradford store. "That's an additional benefit that doesn't really have a dollar value today, but perhaps someday it will," he said.

Hannaford is part of the Delhaize Group, a Brussels-based company that, as part of the Consumer Goods Forum, has committed to start phasing out HFCs in 2015. (In June, Delhaize Group and Ahold, another European company with a U.S. division, announced a proposed merger. Ahold is also a member of the Consumer Goods Forum.)

In August, Hannaford will begin testing its second natural refrigerant – propane – in eight self-contained, covered frozen coffin cases (each six feet long) in a store in Watertown, N.Y. (The cases are from Novum Commercial Refrigeration Technology.) "We had a store where the coffin cases were leaking all over the floor," said Horning. "We said, 'let's do that as a pilot site for some R290 air-cooled coffin cases." Hannaford has joined a growing number of U.S. food retailers exploring propane-based refrigerated cases, including H.E. Butt Grocery, Whole Foods Market and Lowe's Markets.

The propane cases are expected to yield low energy costs, said Horning. In addition, they employ "plug-and-play" refrigeration modules ("cassettes") that should incur low maintenance costs. "If there's any problem, the module unplugs and a new one plugs in," he said.

The cases provide other advantages, such as eliminating some under-slab piping and offering flexible movement in support of remerchandising or remodeling.

Hannaford has also started replacing some HFCs in its distribution centers with ammonia-based systems, and is considering CO_2 or NH_3-CO_2 hybrid systems for its DCs.

For further detail on the performance of the Turner store's transcritical refrigeration system, see this Department of Energy study: http://energy.gov/eere/buildings/downloads/case-study-transcritical-carbon-dioxide-supermarket-refrigeration-systems

Whole Foods Market

WHOLE FOODS: SILVER BUCKSHOT APPROACH

More than any other U.S. food retailer, Whole Foods Market has been testing a wide variety of natural refrigerant systems, from secondary and cascade to transcritical and ammonia/CO_2, along with propane self-contained cases.

The natural foods giant has not come to any firm conclusions yet. "There's no silver bullet with natural refrigerant systems; we have more of a silver buckshot approach, looking at a variety of designs in different climate zones and building types," said Tristam Coffin, sustainable facilities coordinator, Whole Foods Market, who participated in the food retail panel and the commercial refrigeration case studies session, co-presenting in the latter with Tom Wolgamot, principal, DC Engineering. (See "Whole Foods' Journey to Natural Refrigerants," *Accelerate America*, December 2014 - January 2015.

Still, Whole Foods' data is reflecting positively on transcritical technology. "We're at the point now with total cost of ownership, energy use and maintenance where we're looking at transcritical as being a very positive solution," close to cost parity with HFC systems, said Coffin. He attributed that to the influx of system manufacturers from Europe into the U.S., as well as to more U.S. OEMs "getting on board with natural refrigerants."

Whole Foods is "about a year" away from having enough data to make a total-cost-of-ownership decision on transcritical systems, said Coffin.

In terms of ROI, Coffin said Whole Foods generally seeks a 5-8 year payback on new building technologies. However, given the intangible factors that go into environmental initiatives, "we would consider one if it goes beyond 5-8 years."

Wolgamot and Coffin presented details on five of Whole Foods' natural refrigerant stores, as well as a baseline store in Fremont, Calif., that uses distributed R407A scroll units with hybrid condensers. One of the stores has a secondary system employing glycol, while another has a cascade system using CO_2 for both medium- and low-temperature cases. Two others (in Berkeley and San Jose, Calif.,) have transcritical and one with an ammonia/CO_2 system opened this year in Dublin, Calif. All are less than two years old, and three have been awarded GreenChill Platinum certification. (Whole Foods' first transcritical store – the first synthetic-refrigerant free supermarket in the U.S. – opened in Brooklyn, N.Y., in 2013.)

Whole Foods is also one of the few food retailers that has retrofitted an existing store – in Sacramento, Calif. – with a cascade, low-temperature CO_2 system, which replaced an HFC system. "We had an opportunity where all of the low-temperature cases were approaching end of life," said Coffin. "We wanted to see what a retrofit project would look like. It's been quite successful and something we'll be looking at for future projects as well." (The store qualified for energy incentives; see "Getting an Energy Rebate, the Whole Foods Way," *Accelerate America*, June 2015.)

Coffin noted that each Whole Foods store tends to be its own unique "snowflake," requiring a customized approach to refrigeration.

In terms of system and installation cost, the natural refrigerant stores were more expensive than the baseline store. The CO_2 cascade store (in the Castro section of San Francisco) was 10% more costly; the glycol store, 39%; one of the transcritical stores (in Berkeley), 61%; and the NH_3/CO_2 store, 101%.

"System costs are coming down, but installation costs are artificially high due to the lack of training among installing and service contractors," said Coffin. But he expects installation costs to drop as contractors gain familiarity with the systems.

In regard to training, Coffin alluded to the dearth of young people becoming refrigeration technicians. "As an industry we need to pull younger folks back to the refrigeration side," he said. "We need to make refrigeration sexy again."

Maintenance costs for natural refrigerant systems are comparable to those of HFC DX systems, though leak rates have been higher for naturals. However, with cheaper and environmentally benign gases, natural refrigerant leaks are far less consequential that HFC leaks.

The natural refrigerant stores were found to perform efficiently in many circumstances.

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In one energy comparison, the CO_2 cascade store outperformed the baseline store, while the glycol store underperformed baseline. The glycol system has changed for the better in recent months, said Wolgamot, though without visibility into the pumping mechanism it's hard to discern why. "Going forward, a fully integrated control system with the ability to see the operation of all components is extremely important," he said.

In another energy comparison, the transcritical systems' energy consumption was found to be less than that of the baseline. In terms of a whole-store energy comparison, the Berkeley transcritical store performs a little less efficiently than the San Jose transcritical store, which will be using a CHP (combined heat and power) system to subcool the transcritical system, making it still more efficient.

Whole Foods lacks enough energy data on the NH_3/CO_2 system (which is undergoing commissioning) to make a valid comparison.

> "Overall our experience with natural refrigerants has been extremely positive."

Coffin reported a number of lessons learned from Whole Foods' natural refrigerant explorations. One is that the commissioning agent, engineer of record, contractor and rack OEM must all work together and be assembled at the beginning of a project "so everyone knows what the expectations are." Another is that because high-grade CO_2 is not immediately available, "it is important to have a full charge on deck." Safety must always be prioritized, especially with the high pressures present in transcritical systems.

A major concern with natural refrigerant systems remains the expertise of maintenance contractors. At the San Jose transcritical store the contractor was found wanting when it came to troubleshooting problems. "When the contractor doesn't understand the system, it's a big issue," said Coffin. "If we don't see the service contractors keeping up, we'll put more pressure on OEMs to give us a full turn-key solution."

Whole Foods will continue to explore natural refrigerant technology. Transcritical systems remains a focus, but the chain will also keep studying cascade systems, especially the ammonia/CO_2 cascade system, said Coffin. In addition, the chain is testing several self-contained cases with hydrocarbons.

"Overall our experience with natural refrigerants has been extremely positive," said Coffin.

AHOLD USA: FIRST TRANSCRITICAL STORE

Ahold USA, parent company of Stop & Shop, Giant Food and other banners, has just started piloting its first transcritical CO_2 system, at a Giant store in Springfield, Va. Ken Welter, manager of refrigeration & design, Mid-Atlantic, for Baltic Trail Engineering (Ahold USA's refrigeration service provider), provided ATMOsphere America attendees insights into what led to this test.

In recent years, Ahold had settled on a three-rack DX system containing 3,000 pounds of HFC (2.56 lbs./MBH) as its refrigeration standard. However, the company decided to test alternative systems that would reduce "the refrigerant emissions component of our total carbon footprint," said Welter, who spent 25 years with Ahold USA before joining Baltic.

This led to a trial of a cascade CO_2 system that uses glycol as a secondary fluid and 1,200 pounds of an HFC (1.22 lbs./MBH) as the primary refrigerant. A second pilot looked at a cascade CO_2 system using DX HFC (1,200 pounds, or 1.25 lbs./MBH) for medium temperature loads. Both resulted in the same refrigerant charge, but the glycol system incurred energy penalties that left the cascade CO_2/DX medium temperature as the better option. However, that "still didn't get us where we wanted to go," said Welter.

So Ahold developed its current prototype – an HFC DX system with a single rack containing all three suction groups and a single liquid loop "that lets us get the [HFC] refrigerant charge [1,500 pounds, 1.11 lbs./MBH] down to about the same level, or lower, than a cascade system," he said. "But we wanted to still do better than that" in terms of reducing refrigerant emissions.

That led the company to its current trancritical trial, with a system provided by Carnot Refrigeration. The Springfield, Va., location wasn't Ahold's first choice but it was next in the development queue. However, since Springfield is in the southern most part of Ahold's operating territory, the energy performance there "only gets better" for the rest of the stores, said Welter.

Ahold decided to use "circuit piping" rather than loop piping for the transcritical system. "We felt we could reduce our piping costs by going to the dedicated circuits, which allowed us to keep all of our isolation and control valves at the rack and not have to put any out at the cases," said Welter. The retailer also chose hot-gas defrost over the more conventional electric defrost; he considers hot gas "more dependable."

Stop & Shop (Ahold USA)

Another big design decision was to use a dry gas cooler rather than an adiabatic unit with evaporative pre-cooling. The latter would seem to be a better fit for a southern climate like Virginia, Welter acknowledged, but in the end its additional cost made Ahold go with the dry gas cooler. "We'll see as we get into the summer if that was the right approach or not," he said. "We're not expecting it will operate at parity with our conventional DX design. But I don't think it's going to be too bad. We'll see."

In a first-cost comparison of the transcritical system with Ahold's DX HFC single-rack prototype, the cost of the stainless steel piping for the rack and gas cooler in the transcritical unit made that equipment 80% higher; the cost of cases, unit coolers and controls was 30% higher; but the costs of the refrigeration installation and electrical installation were 7% and 6% lower, respectively. In sum, the cost premium vs. the prototype for the transcritical system was $250,000, which was "in line with our budget," he said.

Like other retailers represented on the panel, Ahold USA allows a "more liberal payback" – five or six years – for energy and environmental initiatives than it would for others, noted Welter. Moreover, the company regards the cascade and transcritical tests as learning exercises and does not expect a financial return.

The Springfield store was the Ahold installer's first transcritical installation, though "he had done a CO_2 cascade job for us," said Welter. The installer spent time with Carnot learning the system, but most of the training came "on the fly" during the 7-8 day start-up with the assistance of the manufacturer.

Welter's one complaint about the installation: "I didn't think the case manufacturer was up to the task of properly installing the case controllers and electronic expansion valves. They have to do a better job." On the other hand, he found the compressor rack (three low-temp compressors, six medium temp) and gas cooler to be higher quality than typical HFC equipment – more akin to industrial quality.

On the whole, the start-up went well, Welter said, though the anxiety associated with any store "was a little heightened" because of the new technology and higher-pressure refrigerant.

Like many food retailers, Ahold, by testing a natural-refrigerant system, is trying to find a future-proof technology and avoid the need to keep replacing F-gas refrigerants with new versions such as HFOs. "If past is prologue, it won't be long before those refrigerants are on a hit list and we'll face pressure to reduce their environmental impact," said Welter.

LOWE'S MARKETS: SUCCESS WITH PROPANE

Texas is famous for many things. Now add to the list that it's a state featuring supermarkets that use some of the first refrigeration systems with hydrocarbon refrigerants.

In 2013, San Antonio-based H.E. Butt Grocery (HEB) became the first U.S. grocer to employ propane-based condensing units to provide refrigeration to an entire store's coolers and freezers. This year, Lowe's Markets similarly equipped a store in Lubbock with 35 propane-based condensing units (using Embraco compressors) for the store's 88-door Hussmann freezer units. (See, "Is Propane a Good Refrigerant for Supermarkets?" *Accelerate America*, March 2015.)

Charlie Wernette, director of engineering for HEB "was gracious enough to let

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HC

Hydrocarbon Plug-Ins Poised for U.S. Growth

—by Robert Davidson

Plug-in cases using hydrocarbon refrigerants are relatively new to U.S. supermarkets, but uptake of the units may well increase considering their cost and efficiency advantages.

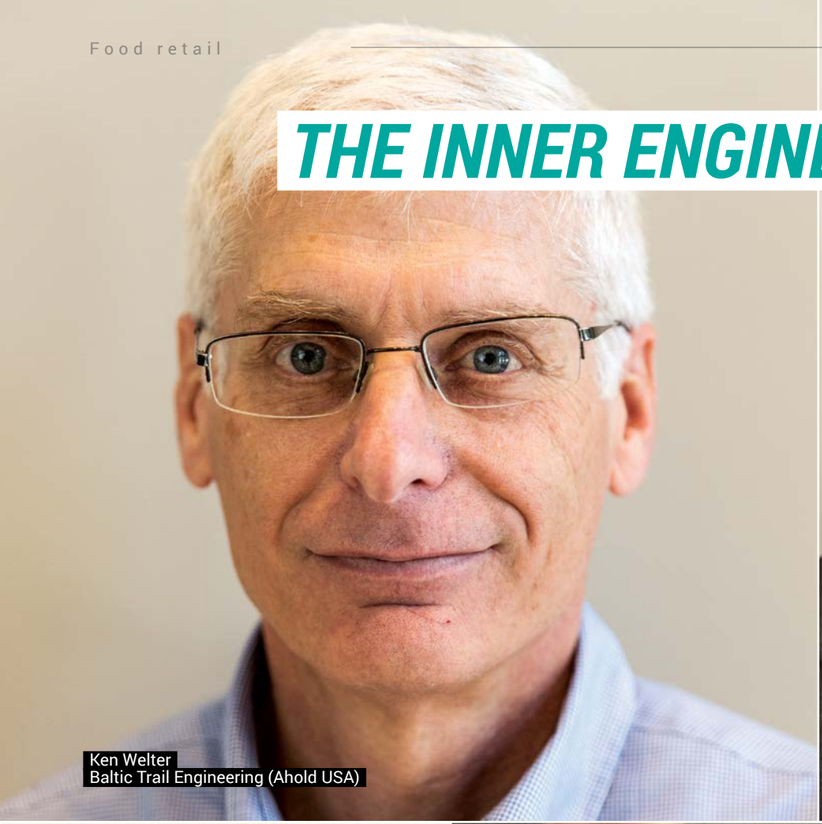
Drew Martin, sales representative for the U.S. branch of the German compressor maker Secop, delineated those advantages in a presentation at ATMOsphere America 2015.

Secop began its involvement with hydrocarbon plug-in cases about a decade ago when it partnered with cabinet manufacturer AHT and Aldi supermarkets. Since then, more than 600,000 plug-in units have been sold globally and more than 30,000 stores incorporate them, said Martin.

The hydrocarbon units now offer less than a one-year return on investment as well as an 80% reduction in the cost of refrigerant, he said. Martin noted that variable speed compressors are delivering the best efficiency gains for hydrocarbon plug-in units in supermarkets, cutting energy consumption by 39% compared with an on/off R404A compressor.

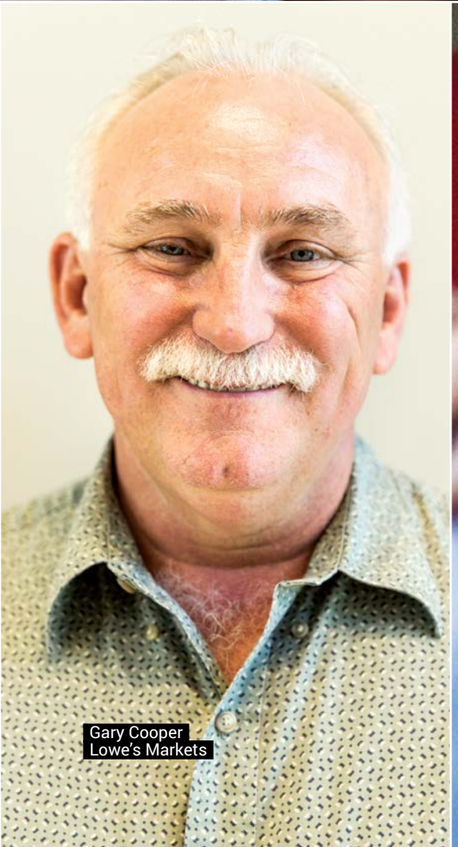
Martin identified a lack of trained maintenance personnel as the biggest barrier to the wider adoption of hydrocarbon plug-in units in supermarkets in North America. He hopes that the industry will learn from best practices in Europe and Asia to fully evaluate the risks and benefits of this technology RD

THE INNER ENGINEER



Ken Welter
Baltic Trail Engineering (Ahold USA)

Harrison Horning
Delhaize America



Gary Cooper
Lowe's Markets

Tristam Coffin
Whole Foods Market

During the food retail panel discussion, the four panelists were asked about their personal motivations for investigating climate-friendly natural refrigerants. Here's what they said:

Harrison Horning, director of energy and facility services for the Hannaford Supermarkets division of Delhaize America

I have a vested interest in the environment; I always have. I like to ski in the winter so I want to have cold snowy weather. I like to surf in the summer, and I want the great white sharks to stay south in warm water. At work, I take some pride in being able to buy in cost-effective ways and do the right thing for the environment.

Tristam Coffin, sustainable facilities coordinator, Whole Foods Market

I came from a sustainability background so to me [natural refrigerants are] an important transition to make from a climate perspective. That's why we pay very close attention to energy usage because if the energy goes up, the overall climate footprint doesn't make sense. What we're seeing overall is positive so I'm looking forward to moving toward natural refrigerants.

Ken Welter, manager of refrigeration & design, Mid-Atlantic, for Baltic Trail Engineering (Ahold USA's refrigeration service provider

We have a European parent company that is very much in tune with environmental issues. Some of the things they're doing won't provide a return but they do it because their customers value that. I'm more of a traditionalist; I look for the financial return. You'd like to do the right thing for the environment, but first and foremost it's got to be the right thing for the business.

Gary Cooper, director of refrigeration, Lowe's Markets

Everybody has a vested interest in taking care of the environment for our grandkids and great grandkids and what they're going to have to deal with. We've made several steps with CFCs and HFCs and we need to get to the end game. But as employees of supermarkets we have to keep in mind the utility bill; they don't fail to send it every month. You have to do right by the company and at the same time do right by the environment. You have to balance the two.

me see his store before we put ours in," said Gary Cooper, director of refrigeration, Lowe's Markets, during the food retail panel discussion. "That was invaluable, I learned a lot."

The condensing units at the Lowe's store each contain only five ounces of propane, per federal regulations, for a total of 170 ounces. (The rest of the store uses 700 pounds of R407F.) A 30-pound supply of propane (at $17 per pound) could "theoretically last you the life of the store," he said. Though flammable, the small amount of propane poses no danger, he said. "It's more perception than a problem."

The restrictions on propane charge limit the potential cooling loads, Cooper noted. He is hoping the charge maximums can be made higher.

The only connection between the engine room compressors and the Lowe's store's condensing units atop the freezer units is a copper loop containing glycol, used to remove heat from the condensing units. The units, which are extremely quiet, support a 250,000 BTU THR capacity.

The total cost of the fixtures and installation was higher than for conventional cases, though he expects the cost to drop with greater adoption of the technology. The copper increased the cost of the installation but "I sleep better at night knowing I've got copper up there," said Cooper.

Cooper called the installation of the cases "straightforward" and added that they are very simple to maintain. There is not much to track other than amperage and discharge-line temperatures. "We are working with Hussmann on trying to improve the capabilities of the [case controller] so we can get more data from it."

The energy consumption of the condensing units was found to be 25% less than that of condensing units using R407F. "The performance actually exceeded our expectations," Cooper said. He measured the energy by submetering components like the cases, the glycol pump station and the suction group that handles heat rejection.

Another plus is that the system allows lower discharge temperatures, extending the life of the compressors.

Overall, Cooper has found "enough good reasons" to pursue more installations of self-contained cases, whether with a hydrocarbon or another refrigerant. He particularly likes the sharp reduction in refrigerant charge. "That's what we're all trying to do – have less to leak," he said. "There are fewer places to leak from. That is the real benefit of this system."

Fortunately for Cooper, Lowe's does not have a strict ROI requirement for his tests of alternative refrigerants. "Our company is trying to be progressive" he said. "It's a cool place to be when your company let's you do things just to see if they'll work and help the industry move forward." MG

TRANSCRITICAL SYSTEM TAKING THE HEAT IN GEORGIA

In a Sprouts store, an all-CO_2 system is performing more efficiently than baseline HFC technology – By Michael Garry

One of the most closely watched stores in the supermarket industry is one operated by Sprouts Farmers Market in Dunwoody, Ga., a 29,000-square-foot facility opened in July 2014.

This is the first store in the U.S. to test whether an all-CO_2 transcritical refrigeration system can operate efficiently in a warm, southern climate, whose ambient temperatures often rise above 88°F. Above that "critical point" – known as supercritical mode – the CO_2 gas does not condense in the condenser (which instead serves as a gas cooler) and does not become a liquid until after the pressure is reduced.

At last year's ATMOsphere America conference, Newell presented an analysis of the expected energy consumption of the Dunwoody store's transcritical system compared with that of a DX R407A system at a comparable store. The transcritical system was projected to be 6.3% more efficient that the R407A system. With almost a year's worth of actual data, Newell demonstrated at this year's conference that the projected analysis was accurate – despite the warm climate, the transcritical system was more efficient, duplicating the performance of transcritical systems in northern climates.

"The 2014 theoretical comparison is correct; the energy consumed is less than the standard system," said Jeff Newel, director of research and development, Hillphoenix, during the commercial refrigeration case studies session at ATMOsphere America 2015. In fact, the actual energy consumption of the Dunwoody system is "at or below the values predicted."

The store's energy efficiency, combined with eliminating HFCs and reducing carbon footprint, earned it the EPA GreenChill program's platinum-level certification for two consecutive years.

Newel noted that it can be difficult to compare the power consumptions of two stores without measures of refrigerant mass flow. However, it's possible to come up with a reasonable estimate of energy consumption by using the previously calculated value "that you expect to see."

The Sprouts Dunwoody store compensates for the higher ambient temperature by employing an adiabatic condenser/gas cooler rather than a conventional condenser. "The lower you can get that temperature on the returning CO_2 from the gas cooler, the better," said Newel. "The adiabatic gas cooler gives you the ability to do that."

Newel explained that the adiabatic gas cooler operates dry in cooler weather, but in warmer weather fills with water, which evaporates and cools the air to about 50°F.

Hillphoenix is testing ejector and parallel compressor technologies that can also be used in transcritical systems to compensate for higher ambient temperatures. These technologies can "get the same or possibly better performance" than the adiabatic gas cooler, said Newel. The decision of which to choose will rest on first costs.

Following Newel's presentation, Reggie O'Donoghue, director of product management for Emerson Climate Technologies, explained the advantages of using electronic controls in CO_2 transcritical booster systems like the Sprouts store in Georgia, as opposed to mechanical controls.

Electronic controls are designed to manage the complexities of a transcritical CO_2 system as the gas cooler toggles between subcritical and supercritical mode. These controls "allow the use of algorithms that can optimize the system based on changing environmental conditions," O'Donoghue said. In particular, the electronics help manage flash tank pressure as well as COP, and allow system flexibility with remote supervision and control, including better leak control.

"It's a no brainer – electronic controls are better for transcritical CO_2," he said. "Mechanical controls won't be as efficient, especially in Georgia." MG

NH_3/CO_2 SYSTEM READY FOR TAKEOFF

Energy and maintenance savings expected for technology installed at a Texas Air Force Commissary

— By Robert Davidson

Ammonia (NH_3) has been an omnipresent refrigerant in the North American industrial sector for decades, but safety concerns have prevented it from being applied in populated environments like supermarkets.

However, as the supermarket industry continues to seek alternatives to ozone-depleting R22 and high-GWP HFCs, ammonia in small, controlled quantities has emerged as a potential option for a few pioneering retailers.

The first U.S. supermarket to test ammonia refrigeration was an Albertsons store (originally owned by Supervalu but now owned by Albertsons LLC) located in Carpinteria, Calif., which installed an NH_3/CO_2 cascade system in May 2012. This year, Whole Foods Market opened a store in Dublin, Calif., which also uses an NH_3/CO_2 cascade system.

One other notable example can be found in Texas, where a remodeled 117,000-square-foot commissary at the Lackland Air Force Base in San Antonio began operating the first phase of an NH_3/CO_2 cascade system last November; the system is now fully operational except for the part serving the produce department, which is still under renovation. The commissary is managed by the Defense Commissary Agency (DeCA), a global chain of supermarkets for the U.S. military, with 250 supermarkets currently running on military bases, generating approximately $6 billion in annual sales.

At ATMOsphere America 2015, Rob Arthur, principal/director of Refrigeration Engineering at CTA Architects Engineers, gave an overview of the commissary's NH_3/CO_2 refrigeration system.

DeCA has also had experience with natural refrigerant systems at three other locations, noted Arthur. These include two with transcritical CO_2 installations (commissaries in Spangdahelm, Germany and Newport, R.I.) and an NH_3/CO_2 secondary system at a DeCA distribution center in Kanto Plain, Japan

The Lackland project – which incorporated the Environmental Protection Agency, the Department of Energy and design consultants as partners - had strict requirements: a low-GWP or 100% natural refrigerants system, improved energy efficiency, serviceable equipment, no safety concerns, and a reasonable price.

Given these prerequisites, Arthur and his colleagues drew up a shortlist of potential systems, which included an HFC/CO_2 cascade system, a transcritical CO_2 system and an NH_3/CO_2 system. In the end, NH_3/CO_2 was chosen as the "only 100% natural refrigerant system at the time that could be used in this environment and still meet the goal of energy reduction," said Arthur.

The system, supplied by Hillphoenix, contains only 81 pounds of ammonia in nine chiller modules sequestered on the roof of the commissary; eighteen hundred pounds of CO_2 is used to chill cases via a low-temperature DX system and a medium-temperature pumped secondary system.

COST BREAKDOWN

The first-cost differential between the NH_3/CO_2 system and an R404A system proved less than expected -- $334,000, including equipment, installation, piping and refrigerant. Still, the estimated return on investment on this "demonstration project" is not favorable - 20 years. On the other hand, the NH_3/CO_2 system is projected to use 7.9% less energy compared to a four-rack R404A DX system, a savings of $3,100 annually. (Energy costs will be evaluated over the next year.) In addition, the annual maintenance cost savings, attributed to reduced refrigerant costs, are estimated to be $5,500 annually. The cost savings for "future proofing" against HFC regulations are also a key consideration, but difficult to determine.

To lessen unease about costs, the installation received Department of Energy funding while benefiting from the availability of equipment, which lowered prices.

Arthur detailed the barriers encountered during the course of this installation, such as concerns about safety of the ammonia system. A plume study coupled with town-hall-type meetings eventually mollified those concerns, but Arthur noted the need to change the perception of low-charge ammonia systems in the public at large.

There was also the industry-wide worry about whether the contractor was adequately trained on the installation and maintenance of an ammonia/CO_2 system. In the end, Arthur said, the installation was not difficult, though it did require an experienced person at the start-up. In addition, NH_3 screw compressors are not as readily available as typical HFC semi-hermetic compressors and Arthur recommended having an extra compressor on site in case of emergency. This shortage of components extended to the other ammonia-related components such as steel solenoid valves and shaft seals; they were also purchased in advance and placed on site.

Arthur also noted the need to work out electronic control strategies in advance. He advised not using separate control manufacturers for the ammonia system and CO_2 system for the sake of harmonious operations.

Despite these limitations, Arthur was bullish about these systems. "I believe the potential for low-charge ammonia/CO_2 systems in the United States is strong," he said. He pointed out their consistent performance regardless of climate, their energy efficiency improvements and their environmental neutrality.

With these qualities in mind, Arthur was steadfast in declaring that cost premiums will begin to dissipate with increasing demand – and that this is already happening.

A carbon-tax, he added, would eradicate the cost-premium vis-à-vis HFC systems and give momentum to natural refrigerants. RD

Rob Arthur, CTA Architects Engineers

SAVING ENERGY VIA SYSTEM INTEGRATION

Why transcritical CO_2 refrigeration should be tied to HVAC

— By Michael Garry & Robert Davidson


Paul Bevington, Carter Group

Transcritical CO_2 refrigeration systems are already seen in many quarters as a low-GWP, energy-efficient replacement for HFC DX systems. But they have the potential to go even further if integrated with HVAC applications, explained two refrigeration experts at ATMOSphere America 2015.

In a "desktop study" on CO_2 refrigeration in U.S. supermarkets, Australian engineer Klaas Visser, principal, KAV Consulting, showed that CO_2 transcritical technology offers the possibility of providing both cooling and heating from the same source, thereby saving considerable energy. "Because of the nature of the beast, it allows you to recover heat for most ordinary purposes."

Visser calculated that a typical 46,000-square-foot supermarket in Atlanta using R404A refrigerant generates nearly 6.7 million pounds in annual CO_2-equivalent emissions from total electrical energy usage (refrigeration, A/C and heating), natural gas consumption and refrigerant losses

The same Atlanta store that integrates heating (via heat reclaim) and cooling functions with a CO_2 transcritical system saves 690,000 kilowatts of energy annually, a reduction of 45%, along with a savings of about $13,000 in natural gas costs. Including refrigerant emissions, he calculated the reduction in total greenhouse gas emissions using the CO_2 system to be 4.5 million pounds, or 67%. The total reduction in annual costs (including electricity, gas and refrigerant) comes to more than $89,000, a 34% drop.

Heat reclaim from refrigeration systems used to be prevalent in U.S. grocery stores, but it has become less common with reductions in refrigerant charge, Visser noted. However, "to reduce energy usage and operating costs and to meet sustainability objectives, many grocery chains are again considering refrigerant heat recovery," he said, adding, "It's come full circle."

He also pointed out that in California, under the state's 2013 Building Energy Efficiency Standards, food retailers are required to use at least 25% of the heat from refrigeration for space heating in new stores.

Integrated HVAC&R

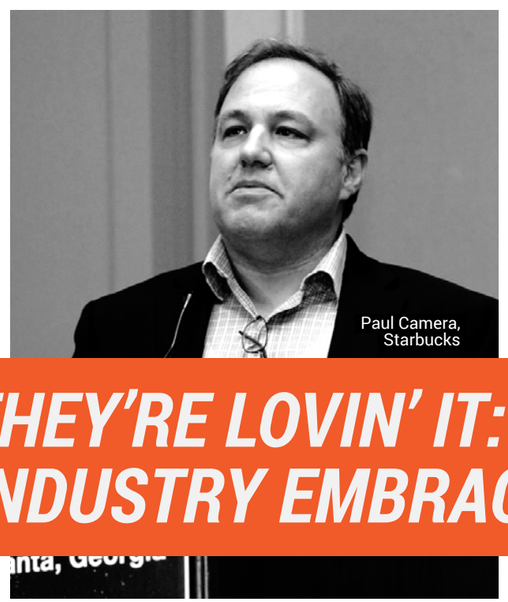
Paul Bevington, business development manager for U.K.- based Carter Group, also examined the advantages of integrating a transcritical refrigeration system with HVAC and the role integrated systems will play in the future of the U.S. commercial refrigeration market.

Bevington pointed out that integrated solutions allow retailers to use CO_2's high temperatures for massive heat recovery. Moreover, adding air conditioning to the refrigeration plant removes the need for heat pump-type solutions, reducing both the capital investment in HVAC systems as well as reducing the life-cycle investment for energy. One installation in Europe reduced energy use by 60%, he said.

Bevington also cited the Walgreens Net Zero store, near Chicago, which utilizes a ground-source heat pump solution on top of its CO_2 transcritical system. After running the store for 12 months, Walgreens was able to meet its net zero energy ambition. Through the use of integrated systems, Walgreens saw 60% energy savings on traditional heating and refrigeration solutions. Bevington said. MG & RD

Roy Buchert, McDonald's

Paige Dunn, Red Bull


Paul Camera, Starbucks


Charles Hon, True Manufacturing

THEY'RE LOVIN' IT: FOOD SERVICE INDUSTRY EMBRACES NATURALS

McDonald's, Starbucks and Red Bull are keen to refrigerate responsibly with hydrocarbons

– By Elke Milner –

MCDONALD'S INTRODUCES HYDROCARBON UNITS TO U.S.

Nearly everyone recognizes the iconic golden arches of a McDonald's restaurant, though not all may realize what goes on behind the scenes of this family favorite.

At ATMOsphere America 2015's food service panel discussion, Roy Buchert, McDonald's global energy director explained the company's ambitious plans to reduce its environmental impact, including moving toward the use of natural refrigerants, particularly hydrocarbons. This isn't just the right thing to do for the environment, but also makes long-term business sense, minimizing the number of refrigerant transitions and compensating for the delisting of HFCs, he said. (See, ""I'll Have Natural Refrigerants With That Equipment, Please," *Accelerate America*, March 2015.)

> "We're also launching new platforms and initiatives. We need multiple pathways to get the penetration that we want."

The fast-food giant has 35,000 restaurants in 119 countries, though 80% are operated by franchisees, who need to be persuaded of the merits of investing in natural refrigerants.

For a chain the likes of McDonald's, the conversion to natural refrigerants is no overnight project, encompassing some 700,000 pieces of equipment globally – everything from orange juice and cream dispensers to frozen fry dispensers and all manner of refrigeration.

It is not realistic from a cost perspective to suddenly make the switch to natural refrigerants in all HVAC&R equipment, so the company is focusing on replacing end-of-life equipment and installing green refrigeration solutions in new restaurants.

"We're also launching new platforms and initiatives," Buchert said. "We need multiple pathways to get the penetration that we want."

The company is already scaling up the use of small refrigeration equipment using 150 grams or less of propane, with more than 9,000 pieces deployed, primarily in Europe. This equipment, which includes 14 models, is proving 38% more energy efficient than conventional alternatives – meeting a key requirement for McDonald's.

McDonald's is also testing medium-size refrigeration systems (such as walk-ins and milkshake machines) using natural refrigerants in Europe, and ultimately plans to use naturals in large HVAC systems. In Denmark, McDonald's has even piloted an entirely HFC-free store.

The situation in the U.S. is different, with hydrocarbon-based, smaller equipment only recently released. However, the market for hydrocarbon equipment is expected to develop quickly.

"Things are moving much faster than we had thought," said Buchert. "We are still in a good position and we are eager to see things move forward."

While the HVAC&R market is certainly evolving in the U.S., Buchert addressed the lack of training, service infrastructure and available components, limited industry engagement, and local regulations as major challenges to the adoption of natural refrigerants in the food service industry.

"It's the trained service personnel who are going to be a challenge," Buchert said. "If something's wrong, I need to be able to get this thing fixed, and quickly."

Buchert added that higher initial costs of equipment could also be a deterrent to adoption of natural refrigerant solutions, despite the often-lower lifetime costs. But he believes the industry can pull together to drive the market in the right direction. "We need to work together to make this equipment more cost effective. It's going to be difficult to get them [franchises] to adopt, but we feel very confident that this is possible."

STARBUCKS VERIFIES ENERGY CLAIMS

Another big name in food service making the switch to naturals is Starbucks, the iconic Seattle-based coffee purveyor.

Making his first appearance at ATMOsphere America, Paul Camera, Starbuck's director of equipment and packaging development, Global Research & Development, emphasized the company's commitment to the environment, including water and energy conservation.

"We make conscious decisions as to what we're going to use in our stores," he said. "Obviously we recognize climate change, and as a company I'd say we're very socially responsible, and that continues to expand; we're seeing the impact of these new programs."

To save energy, Starbucks has put more than 4,000 stores on a heating/cooling energy-management system, installed new lighting technology, and invested in renewable energy. It is now addressing the energy usage of equipment, which is where natural refrigerants come in.

Starbucks' growth spurt in the 2000s has resulted in a significant number of refrigeration units reaching end of life, prompting its research and development team's strategy to implement natural refrigerants into front- and back-of-house refrigeration units. The plan is to transition more than 150,000 units to natural refrigerant systems, starting with propane for small equipment

"It all kind of hit us last fall that we need to start thinking about this," Camera said. "We really need to get moving: with training, manufacturing, everything. This is

continued on p.40

innovation, and as an innovative company, we need to get out there because this equipment is going to last a long time, and we don't want to be stuck behind the curve. "

Currently the company is conducting comprehensive testing and validation of natural-refrigerant equipment from multiple suppliers "to verify energy saving claims and ensure we choose the right equipment for our stores," he said. So

"We really need to get moving: with training, manufacturing, everything. This is innovation, and as an innovative company, we need to get out there because this equipment is going to last a long time, and we don't want to be stuck behind the curve."

far, energy savings have met or exceeded manufacturers' claims. The equipment is estimated to save energy beyond Energy Star 3.0 standards and address EPA 2017 program guidelines. "The financial benefit to the organization meets or exceeds required hurdle rates," he noted.

Overall, Starbucks is looking at the total lifecycle cost of natural-refrigerant equipment, including capital, service and operational efficiency. "Early test results are looking good, and it looks like the business plan is going to work out perfectly," Camera said. "When we talk about why we need to replace existing equipment, it's just costing us too much to run. There's no reason not to look into this."

Testing has also identified other areas of opportunity around equipment service, which can "help the business justification," he said.

Starbucks' next steps include finalizing the business model, extending the plan to Mexico and other markets, and developing a strategy for open or higher-charge refrigerant systems such as display cases, ice machines and HVAC systems.

RED BULL'S COOLERS SAVE RETAILERS MONEY

In just 28 years, Red Bull has become the leading maker of energy drinks, with annual sales of more than five billion cans.

Red Bull needs a lot of coolers to refrigerate those cans, about one million globally. To its great credit, the company wants those coolers to be HFC-free and is resolved that, where technically and legally feasible, 100% of the equipment it procures will use the hydrocarbon isobutane (R600a) for cooling. As of 2014, it was up to 65%. For this accomplishment, Red Bull received recognition from the White House Council on Environmental Quality.

"We support sustainability globally; we want to make sure we're transparent on that," said Paige Dunn, Red Bull North America's CSR and sustainability project lead, during the Food Service Panel at ATMOsphere America 2015.

She had this compelling message for retail users of Red Bull coolers: "We're saving you energy. We're saving you real money! We're constantly looking at ways to decrease energy usage and give our accounts actual financial savings."

The company's ECO Coolers use 45% less energy than standard coolers, thanks to energy-management devices, intelligent controllers, LED lighting, energy-efficient fans, insulated glass, night-mode devices, and R600a refrigerant.

"When it comes to energy performance, Red Bull's ECO Coolers really do check the box," Dunn said, adding that a single 100-watt light bulb uses the same amount of energy as seven Red Bull can coolers.

In *Accelerate America*'s March 2015 issue (see "Red Bull Charges Toward Sustainable Cooling"), Dunn described the process Red Bull underwent to bring R600a coolers to the North American market. While there was some bureaucratic red tap to wade through with the EPA, Dunn stressed at ATMOsphere America the positive side of the experience. "When the private sector and the government team up, we can get really cool results."

Dunn also emphasized the importance of safety, maintenance and training. "In order to ensure that we're properly managing this program, we have to make sure that our coolers are in good working condition. We're dedicated to fixing these coolers."

"We're saving you energy. We're saving you real money! We're constantly looking at ways to decrease energy usage and give our accounts actual financial savings."

To that end, Red Bull has partnered with system suppliers to train technicians. Unlike many end users of natural-refrigerant equipment, the company now regards training to be "a non-issue," said Dunn, pointing out the results that can be achieved when stakeholders work together to improve the market EM

COKE'S CONVINCED THAT CO_2 IS THE 'RIGHT BET'

Coca-Cola, the world's largest beverage company, has a long history of using carbon dioxide as the fizz in its soft drinks. Now CO_2 is also Coke's refrigerant of choice in its beverage coolers, vending machines and fountain equipment as it tries to achieve HFC-free status for all new cooling equipment.

– By Michael Garry –

After a decade and a half of seeking more environmentally friendly refrigeration technology, Coke has reached a critical juncture.

"We are reaching an inflection point in our HFC-free global system adoption," said Antoine Azar, global program director for Coca-Cola and chair of Brussels-based Refrigerants, Naturally!, a consortium of packaged goods companies advocating the replacement of HFC refrigerants. "We are at the phase where [CO_2] is the technology that fits our portfolio of equipment."

Azar made these comments at ATMOsphere America 2015 as part of a panel discussion on light-commercial technology that included several of Coke's equipment suppliers.

Coke's selection of CO_2 is the culmination of years of research into finding a natural-refrigerant replacement for HFCs – which it was urged to do by Greenpeace at the 2000 Olympics in Sydney, Australia. (See, "Coke's Quest to Reinvent Refrigeration,"


Antoine Azar,
The Coca-Cola Company

"I am confident that CO_2 is the future, for our applications at least."

Accelerate America, March 2015.) So far Coke has certified 244 CO_2 models, including 11 in 2015.

"I am confident that CO_2 is the future, for our applications at least," said Azar. "CO_2 is the only technology that has the safety, coverage, performance and cost we are looking for. We made the right bet."

Coke has installed 1.48 million HFC-free units globally as of quarter 1, 2015, an 80% improvement over Q1, 2014. While most of those units use CO_2, some equipment in Europe and Turkey still employ hydrocarbons as a refrigerant while transitioning to CO_2.

The beverage giant has aimed at being HFC-free by the end of 2015 in all new cooling equipment. Currently, about 4% of Coke's equipment portfolio lacks a CO_2 solution, though the company is working on closing that gap, Azar noted.

But in its commitment to CO_2, Coke remains an outlier among users of food service cooling equipment. For example, Refrigerants, Naturally!'s four members – Coke, PepsiCo, Red Bull and Unilever – have collectively deployed 3.7 million pieces of self-contained refrigeration equipment using natural refrigerants. (See, "Refrigerants, Naturally!: An Example to the World, *Accelerate America,* March 2015.) Coke is the only one of the four not using hydrocarbons as a refrigerant.

Azar acknowledged that Coke's status as one of the few users of standalone food service equipment choosing CO_2 rather than hydrocarbons. But he attributed that to "misperceptions" about CO_2, and pointed out that centralized CO_2 technology is catching on in the supermarket industry, and even some food service companies are approaching Coke's suppliers about CO_2. "We don't see any reason on earth to use hydrocarbons, we really don't," said Azar.

In his ATMOsphere America presentation, Azar addressed misperceptions about CO_2 technology regarding energy consumption and performance in high ambient temperatures. "Those may have been true 10 years ago, but not anymore."

For example, he stated that of the 244 certified CO_2 models, 40% are certified for "harsh ambient conditions," including Brazil, Mexico, North Africa and China.

He also pointed out that 75% of the CO_2 models are more energy efficient than comparable R134a equipment. Of the remaining 25%, some have no comparable R134a model. In addition, since there are many more R134a compressors than CO_2 compressors, it is easier to pick an R134a compressor "that fits your needs exactly."

While training and servicing often emerge as impediments to CO_2 system adoption, Azar emphasized that Coke is not facing any major issues in regard to servicing its CO_2 equipment. That's because its bottlers and third-party servicing companies receive "deep dive training" by equipment manufacturers, which make training material and tools available. Sanden Japan, Coke's main CO_2 compressor supplier, trains new suppliers.

And despite notions to the contrary, equipment cost is no longer an obstacle to Coke's CO_2 plans. There remains only a "low single-digit upcharge" for CO_2 units compared to HFC models – higher for small equipment and lower for large equipment.

There remain some obstacles to Coke's quest to have only CO_2 cooling equipment. One is the complexity of its portfolio. Azar presented a graph showing that 38 coolers represent about half of the company's equipment; the other 50% comprises "hundreds of others," including HFC-free and R134a units. "It's hard to convince some cooler suppliers to invest in CO_2 or any new technology," he said.

Also at the panel discussion, Bruce Karas, Coke's vice president, environmental sustainability, put Coke's natural-refrigerants program in the context of its overall commitment to the environment, which includes water conservation, recycling, sustainable sourcing and carbon footprint reduction.

Consumers are expecting companies to not only deliver the best products but to


Bruce Karas
The Coca-Cola Company

"We've got to deliver a cooler that doesn't raise the carbon footprint of the retailer."

do so with a "social purpose," said Karas. To that end, "we've got to deliver a cooler that doesn't raise the carbon footprint of the retailer."

Since 2000, Coke's overall focus on the efficiency of its equipment, which includes the installation of LED lighting and intelligent energy management devices, has saved its customers about $440 million in electricity consumption, said Karas.

SANDENVENDO SUPPLIES CO_2 VENDING MACHINES IN U.S.

Following the presentations by Azar and Karas, four of Coke's CO_2 equipment suppliers described their progress with CO_2 technology.

For example, Dallas-based SandenVendo America, a subsidiary of Sanden, has deployed 1,200 CO_2 vending machines in the U.S. to date, mostly for Coke, said Mike Weisser, vice president of sales and marketing, SandenVendo America. In Japan, the company has supplied thousands of CO_2 vending units. At ATMOsphere America, SandenVendo completed two orders for about 450 machines for companies in Brazil and Peru, he added.

Peru and Brazil are not thought of as good climates for CO_2 refrigeration, but that's not true, said Weisser. "They perform exceptionally well in these warmer climates up to 104°F."

The energy consumption of SandeVendo's CO_2 and R134a machines are currently about the same, with the former costing about 5% more than the latter, he noted.

In the near future, SandenVendo expects to deploy remote CO_2 condensing units in small retail formats like convenience stores in the U.S. "There's a big opportunity for natural refrigerants, particularly CO_2, to play a role in this market," said Weisser. The company has already installed 70 such systems in 7-Eleven stores in Japan.

SANDEN SEES CO_2 AS BEST CHOICE

Sanden Environmental Products Corp., another subsidiary of Sanden that makes compressors and other components, regards CO_2 as "the most flexible requirement" from low-temperature to high-temperature applications, and the "best choice," said Junya (Joe) Ichikawa president of the company.

While CO_2's critics say it's less efficient than R134a, Ichikawa presented data

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Junya (Joe) Ichikawa
Sanden Environmental Products

"This is the driver that pushes us to CO2,"

from Energy Star showing CO_2 to be more efficient than R134a across many cabinet volumes. He also pointed out that compared to R134a, CO_2 has a lower pressure drop, higher heat transfer efficiency at the evaporator and better evaporating latent heat.

He also presented data indicating that CO_2 cases are 20% to 25% more efficient than Freon cases. "This is the driver that pushes us to CO_2," he said.

The 70 CO_2 systems installed in Japanese 7-Eleven stores have an average energy savings of 23% compared to up-to-date R404A systems, Ichikawa said. "We expect a double or triple the demand for these systems this year." He also foresees its hermetic CO_2 compressor production volume to grow from one million in 2014 to 10 million in the coming years,

ISA'S GROWING CO_2 BUSINESS

Another Coke supplier represented on the panel was ISA, an Italian manufacturer of customized ice cream cabinets, pastry displays, and chilled display cases of various configurations as well as beverage cabinets. ISA has won the Coca-Cola Enterprises Award for Corporate Responsibility and Sustainability for its commitment to protecting the environment.

While ISA's products accommodate both hydrocarbons and CO_2, it considers CO_2 to be the "refrigerant of the future, because there are no charge limits," said Marco Giulietti, CEO of ISA.

ISA's CO_2 models include "blitz cassette units" and "Panda multideck units for supermarkets featuring "plug-in CO_2." The advantages of the plug-in CO_2 equipment, which has so far been deployed in Europe over the past two years, includes low-cost installation and maintenance, flexibility in layout and scalability.

Compared to hydrocarbon installation, ISA's CO_2 share has almost doubled in the past two years thanks to Coke and its retail customers. "CO_2 today is possible," said Giulietti.

IMBERA EXPERIENCES EVOLUTION OF CO_2 TECHNOLOGY

Imbera, a division of Mexico-based Femsa, the largest Coke bottler in the world, has the most CO_2 refrigerators in the Coca-Cola system worldwide.

"We have more than 100,000 CO_2 units in the field and we have a very good knowledge of the technology," said Andres Martinez-Negrete, technology and product development director for Imbera.

He is seeing an acceleration of CO_2 adoption, driven by Coke. "We are confident that more people will start choosing natural refrigerants in the next five years – two or three times what we have at this point."

All of its CO_2 models meet Energy Star 3.0 (October 2014) energy usage requirements, he said. In its flagship model, Imbera reduced energy consumption by 67% from 2009 to 2014. "Our CO_2 line is ready for DOE (U.S. Department of Energy) 2017 requirements."

While its CO_2 equipment originally came with a "big upcharge" compared to conventional models, "we are now finding some components that are cheaper," said Martinez-Negrete. Since 2009, the price gap between CO_2 and R134a has dropped from 35% to 5%.

He acknowledged that with 10 times the pressure, vibration had become an issue for Imbera's units. However, "we now have some coolers that have less decibels compared with R134a counterparts," he said. "We've come a long way, but there's still room for improvement."

There are other hurdles. One is the position of Coke as the primary driver of CO_2 refrigeration in food service applications. "If we had more customers pushing this forward, we would find more efficiencies," said Martinez-Negrete.

In addition, there is still not as much variety in CO_2 components like

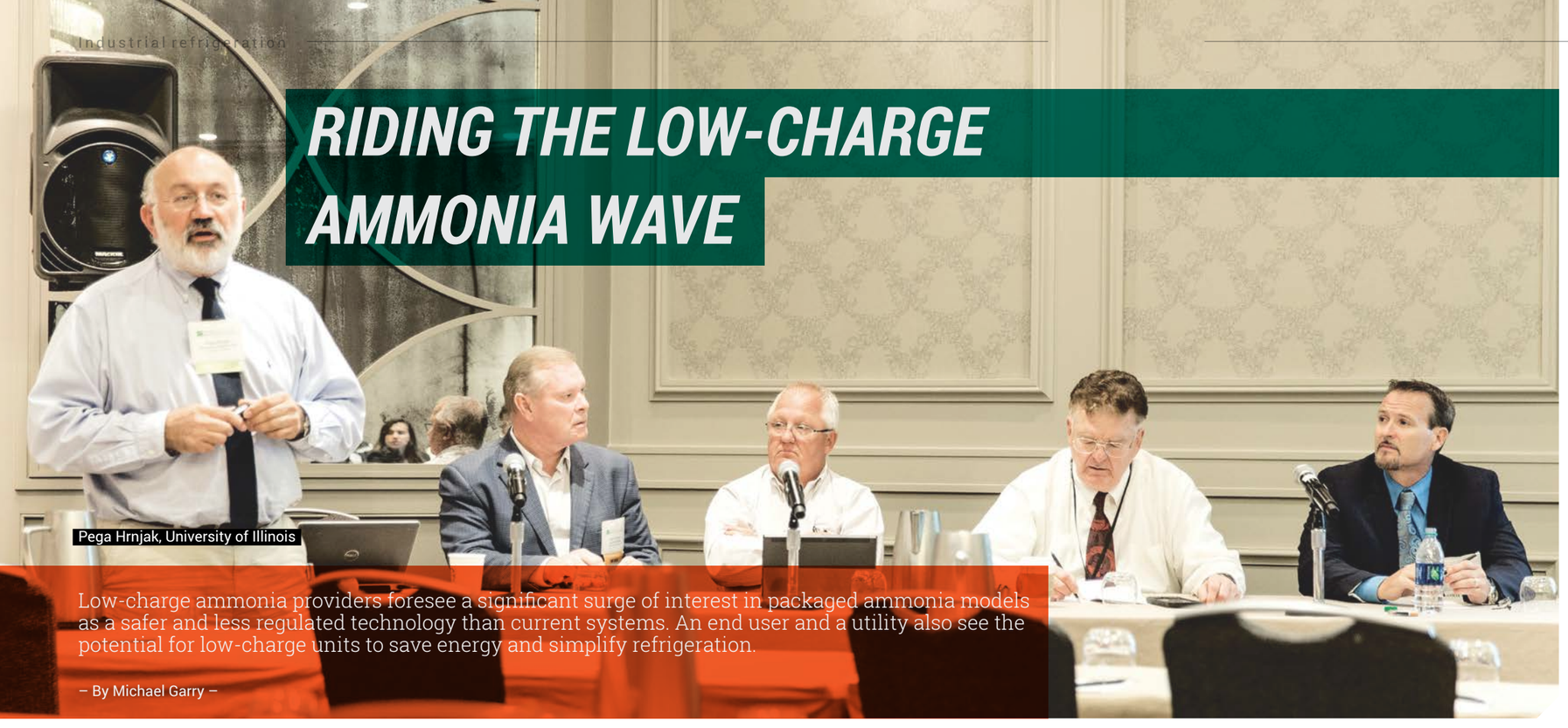

Andres Martinez-Negrete
Imbera

"A lot of customers are looking at CO2 as it was 10 years ago, not what we have at this point."

compressors compared with other refrigerants. That makes meeting the DOE's 2017 efficiency requirements challenging in some cases.

Moreover, some of Imbera's customers still harbor misperceptions about CO_2 as noisy, hard to maintain and expensive. "A lot of customers are looking at CO_2 as it was 10 years ago, not what we have at this point," he said MG

RIDING THE LOW-CHARGE AMMONIA WAVE



Pega Hrnjak, University of Illinois

Low-charge ammonia providers foresee a significant surge of interest in packaged ammonia models as a safer and less regulated technology than current systems. An end user and a utility also see the potential for low-charge units to save energy and simplify refrigeration.

– By Michael Garry –

"The future for refrigerated warehouses," said Gerard (Jerry) von Dohlen, president of Newark (N.J.) Refrigerated Warehouse, "is the packaged system.

"There's no question that virtually every public refrigerated warehouse in the country could use packaged systems," he continued. "And they are now, thank God, available."

Von Dohlen was referring to low-charge ammonia systems as he spoke to a panel discussion on the topic at ATMOsphere America 2015, moderated by ammonia expert Pega Hrnjak of the University of Illinois. Von Dohlen sees a role for other low-charge systems, including secondary and DX evaporators but was most bullish about packaged systems.

Low-charge ammonia systems have been the focus of great interest at industry conferences this year, such as the IIAR Conference and the IARW-WFLO Convention. With greater regulatory scrutiny on ammonia refrigeration, particularly equipment with more than

Gerard (Jerry) von Dohlen, Newark Refrigerated Warehouse

> "The future for refrigerated warehouses, is the packaged system, and they are now, thank God, available"

10,000 pounds of ammonia, operators have become amenable to systems that reduce the ammonia charge considerably. Von Dohlen himself is planning to convert to low-charge ammonia systems, one DX and one that uses brine and air as secondary coolants. (See, "Ammonia Returns to the Garden State," *Accelerate America*, June 2015.) Any cold-storage operator employing a central engine room will use CO_2 or other secondary fluids like brine or glycol, and retain ammonia in the engine room, he said. "To pump ammonia throughout a building in the modern world is just looking to aggravate OSHA and get hammered."

New Jersey cold storage operators are now in a position to consider low-charge systems, thanks to von Dohlen and former IIAR president Bruce Badger, who negotiated an exemption to the old state law requiring engineers on premises 24 hours a day at facilities that use ammonia. Operators can be exempt from that requirement if they use 5,200 pounds of ammonia or less, run a system that is IIAR-2 compliant and employ one full-time engineer certified by RETA (Refrigerating Engineers & Technicians Association).

Many New Jersey public refrigerated warehouses use central R22 systems in lieu of ammonia. But with the phaseout of R22, von Dohlen expects them to convert to packaged ammonia systems on the roof. He listed a number of advantages to packaged ammonia systems, including lower cost; easier fabrication, installation and maintenance; and standard leak detection.

However, von Dohlen foresees opposition to low-charge-ammonia packaged systems from contractors and design engineers who don't want to sacrifice the work inherent in traditional systems. But they will need to adjust to change or go out of business, he said, because he does not see the customization model for refrigeration systems as sustainable. "If we built cars that way, everybody would be a mechanic and the cars wouldn't run," he said, adding, "Henry Ford settled that issue. We've got to have standard packages."

Ideally, packaged ammonia systems would be similar to packaged air conditioning units, with the same outsourcing opportunity for financing, extended warranty and low-cost maintenance. He decried the fact that the money he now spends on refrigeration maintenance is more than what he spends on electric power. Rather than worry about refrigeration, von Dohlen wants to focus on his core competency – material handling.

Low-charge systems are still in dire need of trained technicians who can maintain them. To support the change in the New Jersey law, Essex College in Newark, the IIAR and RETA have launched a two-year associate program to train young people to become operating engineers in ammonia refrigeration plants. "I haven't been able to hire any [operating engineers]," he said. "New Jersey has none."

SLEEPING BETTER WITH LOW-CHARGE SYSTEMS

John Scherer, manager of engineering for Los Angeles Cold Storage, couldn't sleep well knowing that the company's three cold-storage warehouses adjacent to each other in downtown LA used 32,000 pounds of ammonia refrigerant.

An ammonia accident in such a densely populated area would be truly catastrophic.

So Scherer spent four years, working nights and weekends, to develop a low-charge packaged ammonia refrigeration system that typically uses less than 50 pounds of ammonia, or less than a pound per TR (ton of refrigeration). The system can work in facilities with capacities ranging from 5 TR to 150 TR, delivering temperatures from -60°F to 60°F.

He has installed one of those systems at LA Cold Storage, cutting the ammonia charge by 1,000 pounds, and removed another 7,000 pounds through other means. He is now marketing the system under the NXTCOLD brand to other cold storage operators. (See "Breaking with Tradition," *Accelerate America*, April 2015.)

"We can't afford in our warehouses to have the liabilities associated with large [ammonia-based] central systems," Scherer said at the low-charge-ammonia session at ATMOsphere America 2015. Over the past decade, he added, numerous companies have experienced big ammonia leaks, and about half of those companies have closed or been acquired.

The proliferation of accidents has also led to a huge uptick in government inspections of large ammonia facilities, a trend expected to continue. Even with his low-charge unit, Scherer needs to address regulatory issues. "The main thing is to meet with regulators and educate them."

NXTCOLD's low-charge ammonia units represent one way to achieve a safer, less regulated refrigerated warehouse. So far the company has installed four units, but another 46 units are due to be in place by August, and within the next 10 months Scherer expects to have about 100 units in the field, including many retrofits. He believes the low-charge units are applicable to many other kinds of end users, from farmers to supermarkets.

"We believe we will sell thousands of units over the next four to six years," said Scherer.

The NXTCOLD unit is able to use such a small amount of ammonia because of a patented electronic refrigerant injection control mechanism (ERIC), which senses the quality of the refrigerant in the evaporator and introduces only as much as necessary for a particular job. This maximizes the evaporator coils' heat transfer without the restrictions of superheat-based control.

John Scherer, LA Cold Storage

> "We believe we will sell thousands of units over the next four to six years"

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Kurt Liebendorfer
Evapco

> "They must be complied with regardless of the amount of ammonia. And all systems must understand the safety intent of PSM due to OSHA's general duty clause."

EVAPCO: GET READY TO RIDE LOW-CHARGE WAVE

"There is a wave coming for low-charge ammonia packaged solutions in the next 18 to 24 months," said Kurt Liebendorfer, vice president, Evapco, during the ATMOsphere America 2015 panel discussion on low-charge ammonia.

Besides cold-storage food warehouses, low-charge packaged units lend themselves to pharmaceutical and bioscience facilities, he said.

To safely ride that wave, he added, Evapco is addressing three key areas: code and regulatory compliance; research, development and testing; and reliable and repeatable manufacturing.

Large custom-designed ammonia systems need to comply with a variety of codes and regulations, including ASHRAE, IIAR, ASME, building codes, mechanical codes, and fire codes, as well as OSHA's PSM rule, EPA's RMP program, and local and state regulations. To date, low-charge ammonia systems, at least while they are relatively new, must run the same gauntlet of codes and regulations, despite containing much less ammonia and presenting much less risk. "They must be complied with regardless of the amount of ammonia," Liebendorfer said. "And all systems must understand the safety intent of PSM due to OSHA's general duty clause."

Panel moderator Pega Hrnjak of the University of Illinois observed that "we need to work together to try to open regulations in a direction that will support packaged systems and reduce requirements."

In support of its low-charge systems, Evapco is spending millions on research and development. "We have the only third-party low-temperature evaporator ammonia lab in the U.S.," said Liebendorfer.

Evapco has also invested in the manufacturing processes needed to turn out high volumes of low-cost product. Manufacturing low-charge ammonia systems as if they were air conditioners is "the end game," said Liebendorfer. "Then market adoption will spread like wild-fire."

And because of their standard design, low-charge systems are easier for technicians to understand and maintain, he noted.

Evapco's first entry into the low-charge marketplace is its Evolution 1 series, which encompasses 250 models, serves between 10 and 100 TR and delivers between -20°F and 50°F. It's in compliance with all major U.S. codes and provides ample room and safety features in its machine room.

Liebendorfer acknowledged that field-erected NH_3/CO_2 cascade systems, which have been on the market for the past decade, represent an alternative to low-charge packaged systems, though the latter are easier to install and use less energy. He suggested that NH_3/CO_2 could eventually emerge as a packaged solution.

TRYING TO IMPROVE THE ADOPTION CURVE

Electric utilities are increasingly recognizing that natural-refrigerant systems are capable of saving energy. As a result, they are rewarding end users of these systems with energy rebates that make the systems more affordable.

One of the utilities taking an active interest in natural refrigerant technology such as low-charge ammonia is Southern California Edison (SCE), one of the nation's largest utilities. "We're working with manufacturers, inventors and customers to look at the new technology and how it can help you with your business," said Paul Delaney, senior engineer, SCE, who also spoke at the low-charge ammonia session. "We're trying to improve the adoption curve for new technology." (See, "Southern California Edison Takes on Natural Refrigerants," *Accelerate America*, June 2015.)

Three years ago, SCE studied the energy efficiency of low-charge ammonia systems and estimated a 15-25% saving compared to HFC-based refrigeration and a 5%-10% saving compared to a large ammonia warehouse, as well as reduced peak demand.

More recently, at a Lineage Logistics cold-storage warehouse in Oxnard, Calif., SCE calculated a preliminary annual savings of 14% for using a NXTCOLD low-charge unit in lieu of a traditional ammonia system. SCE is also evaluating an Evapco low-charge, low-water-consumption unit as well as a low-charge, air-cooled Azane system.

SCE is working with the Electric Power Research Institute on several projects, including a packaged ammonia/CO_2 chiller at a food processing plant in Irvine, Calif., and a CO_2 transcritical ambient temperature evaluation at labs in Knoxville, Tenn.

SCE is also evaluating the energy efficiency of self-contained propane display cases. MG

CO_2: THE RIGHT INGREDIENT FOR INDIAN-FOODS WAREHOUSE

House of Spice chooses transcritical system for its Chicago-area facility, making it one of the first industrial sites in the U.S. to use CO_2-only refrigeration

– By James Ranson

The "American Dream" is a well-worn cliché, yet House of Spices (HOS), a major U.S. distributor of Indian food and ingredients, undoubtedly embodies it.

Its owner, G.L. Soni, arrived in the U.S. in 1964 with $200. By 1970, the lack of authentic Indian spices and ingredients in New York led the young entrepreneur to open a grocery store in Jackson Heights, N.Y., with the help of his wife, Sobhana, and younger brother Kumar. Soni sourced various South Asian spices and ingredients from Mumbai and dals (legumes) from Nairobi, Kenya.

In 1992, with the demand for Indian groceries growing, the family moved into what is still company headquarters in Flushing, N.Y. (a short walk to Citi Field, home of the N.Y. Mets) and began manufacturing the Laxmi brand of products, a wide range of vegetarian Indian fare that includes ingredients, snacks and sweets. The company's unofficial slogan: "If we don't have a product, you don't need it."

HOS's manufacturing and importing business has grown to encompass 11 warehouses throughout the U.S. and Canada, including New York, Houston, Chicago, San Francisco, Orlando, Boston, and Toronto. The company has exclusive partnerships with several popular Indian food brands and employs approximately 350 employees, including G.L.'s son Neil Soni as president and his daughter Amrapali Soni as treasurer.

A RARE CO_2 TRANSCRITICAL SYSTEM

HOS's newest warehouse, encompassing 130,000 square feet, opened on May 8, 2015 in Elk Grove Village, Ill. (near Chicago). For refrigeration, HOS applied its entrepreneurial flair, opting for a CO_2-only transcritical system from Hillphoenix, which made this one of the few industrial warehouses to use transcritical technology. HOS employees flew from in all over the country for the system's unveiling.

The warehouse's 15,000-square-foot refrigerated section chills produce, and soon, HOS's own line of ice cream and ghee (butter). The section currently holds 1,200 pallets, each containing 2,200 pounds of produce, or 2.2 million total pounds.

CO_2 (R744) is an environmentally sustainable alternative to the HFC (hydrofluorocarbon) refrigerants typically utilized in commercial refrigeration systems. Now, warehouses like HOS's are showing the application scope of CO_2.

The facility manager at the new warehouse, Justin Joy, acknowledged that he knew little about CO_2 as a refrigerant when the company conducted preliminary research, but is now glad he scratched beneath the surface. Cost, longevity, ease of installation and environmental impact were all factors that convinced HOS to opt for CO_2 over HFCs.

"One of the things that helped us make the decision to go with CO_2 was looking at the bigger picture," Joy said. "If we were just looking at that initial cost, then you can get caught out, because the initial cost might be slightly higher [than that of HFC systems]. But no one buys a giant freezer for one year; you install it for the long run."

Moreover, HOS found the cost of materials for transcritical to be much less than for conventional DX "because the pipes and everything else are much more compact," Joy said. In addition, the cost per pound of CO_2 is much less than that of Freon. Again, taking the long view, "we're not going to replace the freezer in five or 10 years; I'm going to keep it for 15 or 20 years, so when you add up that amount of time and all the maintenance involved, there will be significant savings."

In terms of the total cost of installation, including labor, Joy concluded there were few discernable differences from an HFC system. "If I remove all the common expenses -- the floor work, the building panels – the final cost becomes extremely close. The CO_2 system was less than 5% more to install."

Outside factors also figured into the decision. For example, as part of the Environmental Protection Agencies' (EPA) Significant New Alternatives Program (SNAP), HFCs with high global warming potential (GWP), such as R134a, are being phased out in favor of low-GWP alternatives like CO_2. "When you look at it that way the initial cost is negligible," Joy said. "If you go [with HFCs] then you're going to have more problems down the line."

Another major factor for HOS was its sustainability philosophy. "When we actually started doing the research on this, the difference in just the environmental impact of HFCs vs. CO_2, was very drastic," Joy noted. HFOs also came up for consideration, but HOS was far from convinced about their environmental viability. "Our local community is very pleased that we opted for CO_2."

CAPUTO'S SEALS THE DEAL

A turning point for Joy in his quest to find the right refrigeration system was a visit to Angelo Caputo's Fresh Market store/warehouse in nearby Carol Stream, Ill., in 2014. (See "In Love with CO_2," *Accelerate America*, June 2015.) Seeing the very same Hillphoenix rack installed in Caputo's 300,000 square-foot facility was enough to sell him on the idea. "The technician for the company said to us, 'If you're thinking about doing this – do it! It's one of the easiest things we've worked on; it's really simple and does the job so well.'

"We were actually standing next to the rack talking in a normal tone," added Joy. "He could hear me well and I could hear him perfectly well, which was such a big surprise because the systems using HFCs are loud."

HOS's preliminary research revealed only two or three companies like Caputo's in North America that had a CO_2 transcritical system installed in an industrial (warehouse) application. That made it difficult to source a local installation contractor once the decision to opt for Hillphoenix's CO_2 rack was made.

HOS finally found what it was looking for in New York-based contractor East Coast Refrigeration, which had done a previous installation of the same system. "We flew them in and they explained everything about the system," said Joy. "They straightaway said that the initial cost would be higher, but in the long run it would be so much better."

The rest is history. Hillphoenix ran a training course and equipped the technicians at HOS with the essentials in maintaining and running the system safely. The only concern for HOS was the high pressures CO_2 operates at. "That's one of the things that we asked in the beginning – 'Is it safe?' – and they [Hillphoenix] showed us how much they go out of their way to make sure it is," said Joy. "There is layer after layer of safety so that the high-pressure situation in not a problem."

HFCs are still used in HOS' 10 other facilities. But with huge growth expected in 2015, HOS has plans already in place to expand and renovate some of the company's warehouses. "We're in the process of doing that for four other warehouses – two in California, one in New York and another in Maryland, where we're growing substantially and need to move to bigger warehouses," said Joy. "After we run this freezer/cooler at our Chicago warehouse for a while, if it actually works for us how we're hoping and expecting it does, then there's a very high chance that we'll implement the same system in our other warehouses." JR

REGULATORS, STANDARD SETTERS RESHAPE THE LANDSCAPE FOR NATURALS

EPA, DOE, UL and the California Resources Board weigh in on the new rules and standards helping to pave the way for further natural refrigerant adoption

— By Robert Davidson and Michael Garry

From left, Gerald Wozniak, EPA; Antonio Bouza, DOE; Glenn Gallagher, CARB; Randall Haseman, UL; Klara Skacanova, shecco;

A PREVIEW OF EPA RULE CHANGES

Change was in the air during the regulations and standards session at ATMOsphere America 2015, in discussions of recent regulations, and intimations of regulations soon to come.

As Gerald Wozniak, environmental engineer for the EPA's Office of Atmospheric Programs, took the stage, the agency had already reeled off a series of actions via its SNAP (Significant New Alternatives Policy) program over the past year to find ozone-depleting-gas replacements such as natural refrigerants or get rid of high-GWP HFCs.

Examples include: a notice in Oct 2014 adding alternatives like CO_2 for refrigerated transport; a new rule last April allowing hydrocarbons in certain applications (such as propane in vending machines); and, most important, a proposal in August 2014 to delist a series of high-GWP refrigerants such as R404A and R507A in retail food refrigeration and vending machines, among other applications.

The delisting proposal elicited close to 8,000 comments, said Wozniak, one of several speakers in the regulations and standard sessions, which also included representatives of the Department of Energy, UL, California Resources Board and UL. He noted that the Office of Management and Budget was just a month away from finishing its interagency review, at which point the final rule would emerge.

As it happens, the OMB finished ahead of schedule. About a week after ATMOsphere America, the EPA announced the final delisting rule, and then posted it on the Federal Register July 20. (See story, page 55) Most notably, the EPA's final rule gives the HVAC&R industry more time to transition from the delisted HFCs than originally proposed.

The EPA estimates that the emissions prevented as a result of the delisting rule will range from 29 million to 38 million tons of carbon dioxide equivalent by 2020, and will increase from there, said Wozniak. This is significant because HFC emissions have been growing rapidly; left unchecked, they would double from current levels in the U.S. by 2020 and account for nearly 20% of global CO_2 emissions by 2050.

Wozniak also stated at ATMOsphere America that the EPA was "getting ready to come out with another acceptability notice" expanding the list of acceptable refrigerants under SNAP. And he proved correct, as the EPA on July 16 posted the notice on the Federal Register that a series of synthetic blends with GWPs ranging from 600 to 1,400 were allowed for certain applications. (See story, page 55.)

All of these changes were typical of SNAP, which Wozniak called a "continuing review program," with more delistings and approvals on their way. He emphasized that the EPA depends on feedback from stakeholders in different industries, including the attendees at ATMOsphere America, to see "where future transition is possible."

Wozniak clearly knows whereof he speaks. So his further prognostications were well worth noting, such as upcoming changes to the Clean Air Act's Section 608 regulations governing the handling and maintenance of ozone-depleting refrigerants. These changes would expand the regulation to include HFCs and simplify existing requirements. He said EPA would issue a "proposed rule in late 2015 and a final rule in 2016 after considering public comment."

Meanwhile, the Montreal Protocol has been looking at expanding its phasedown program from ozone-depleting gases to HFCs, based on amendments submitted by several countries, including the U.S. "The U.S. seeks the adoption of an amendment in 2015 that is acceptable to all parties," said Wozniak.

THE DOE'S RESEARCH CARROT

The EPA is not the only federal agency impacting the uptake of natural refrigerant technologies in the U.S. The Department of Energy (DOE) is playing a growing role, not only through enforcement (such as the more stringent energy standards for equipment coming in 2017), but also in research activities. The latter – described as the "carrot" rather than the "stick" -- were detailed in a presentation from Antonio Bouza, the DOE's technology development manager.

Among DOE's research efforts is its Building Technologies Office (BTO), whose mission is primarily to accelerate the development of near-term technologies that can save significant amounts of energy in commercial and residential buildings. For example, by 2020 the BTO seeks 10% energy savings in HVAC, 20% in water heating and 15% in appliances. Since Bouza took over the program in 2008, BTO has made refrigerants "a priority" in its investigations.

Over the long-term, he added, BTO wants to promote the development of next-generation technologies, such as non-vapor-compression systems, that may not require refrigerants. BTO, he noted, is "technology neutral."

But for the foreseeable future BTO is "set up to test commercial refrigeration and HVAC," Bouza said. "We leverage resources to get products into the marketplace. Unless you bring products into the marketplace, energy savings are not going to occur." He reports quarterly on BTO's progress as part of the Obama Administration's Climate Action Plan.

Bouza listed a number of projects involving refrigerants that were financed by the American Recovery & Reinvestment Act of 2009 (ARRA). These include the development of: lubricants for low-GWP/low-ozone-depleting refrigeration and air conditioning; a CO_2 scroll expander/compressor for supermarket refrigeration; a high-efficiency HVAC system using propane and CO_2; and a residential heat pump water heater using ammonia.

He also detailed a number of current energy-efficiency projects incorporating natural refrigerants, each funded with more than $1 million. One involves the Oak Ridge National Laboratory's cooperative R&D agreement with Hillphoenix, and focuses on the company's transcritical CO_2 system. The system was found to have 25% lower energy consumption than existing systems. Another Oak Ridge project is developing a CO_2 heat pump water heater "that fits the U.S. market for water heaters," he said.

A "higher risk" project with Xergy and GE appliances is developing a heat pump water heater using electrochemical compression technology. This technology allows water to be used as a refrigerant in a vapor compression cycle. "We'll be talking more about using water as a working fluid that creates opportunities not only for energy efficiency but in the global warming space too," Bouza said. Still another heat pump project for commercial applications uses air as the working fluid.

A project with Stone Mountain Technologies aims at developing a gas-fired absorption heat pump with ammonia as a refrigerant that works at very low ambient temperatures.

Bouza invited ATMOsphere America attendees to submit funding requests for natural refrigerant projects at BTO's website: http://energy.gov/eere/buildings/listings/funding-opportunities.

"It doesn't matter where ideas come from," as long they're viable in the U.S., said Bouza. "Nobody has a monopoly on good ideas."

NEW UL STANDARD FOR RAC

One of the key hurdles manufacturers of refrigeration and air conditioning equipment using natural refrigerants must overcome in the U.S. is getting their products certified by UL (Underwriters Laboratories), which is responsible for safety standards for many electrical products. Some natural refrigerant systems have passed muster with UL, but others still need the group's approval, as explained at ATMOsphere America by Randall Haseman, principal engineer, refrigeration and room air conditioning for UL.

As an executive committee member of UL's Joint Task Group on flammable refrigerants, Haseman focused his remarks on the Task Group's recent activities. Most notably, a Working Group on air conditioning recently changed the UL 284 standard for room air conditioners (RACs), reducing the amount of flammable refrigerant allowed to three times the lower flammability limit of the refrigerant (in kg/cubic meters) from the four times established in 2011. The change was made in part because "the Working Group couldn't be sure that [RACs] would be installed [by consumers] in rooms with sufficient area as marked on the product," said Haseman. For propane, the change limits the charge to 114 grams.

Heat pumps, dehumidifiers and other air conditioners, under the UL 60335-2-40 standard, are not allowed to have flammable refrigerants. However, requirements are being developed for small amounts of class A3 refrigerants and somewhat larger amounts of A2/A2L refrigerants for equipment that is non-ducted, factory charged and sealed. Class A2 and A3 requirements for the North American (U.S./Canada/Mexico) 60335-2-40 standard are also under development.

In regard to refrigeration systems, governed by UL 60335-2-24, no changes to the current A2 and A3 limits are anticipated, though the limits are being reviewed, said Haseman. A number of food retailers are eager to see the 150-gram limit for propane in commercial refrigerators/freezers increased to 500 grams, which is being considered by the IEC (International Electrotechnical Commission). "UL would look at that if it gets adopted by the IEC," said Haseman, adding that any propane charge over 150 grams would also have to be covered by the ASHRAE 15 installation standard.

Haseman also alluded to several UL standards, including UL 1995, which has been updated to include "better requirements" for CO_2-based HVAC and refrigeration equipment.

Several attendees of the session advocated for greater harmonization of standards between U.S. and other countries. Heatcraft Worldwide Refrigeration, for example, seeks ways to increase harmonization of design standards so that a common product design approach can be applied in its global markets, said Augusto Zimmermann, lead engineer for Heatcraft's Alternative Systems Center of Excellence, prior to the start of the regulations and standards session. "I'd like to challenge the industry to work together in unison to eliminate the burden that

continued on p.54

Policy Drives Adoption in Europe, Japan and China

For contrast to what is happening in the U.S., the regulations and standards session provided an update on refrigeration regulatory trends in Europe, Japan and China, courtesy of Klara Skacanova, shecco's deputy manager for market development.

In these regions, ambitious policy action "drives innovation and leads to increased availability, gradually reducing the cost of equipment using natural refrigerants," she said.

Europe has seen the most dynamic progress with respect to controlling HFC emissions with the EU's revised F-Gas Regulation. A combination of phase downs and bans of HFCs, the rules intend to reduce the average GWP of refrigerants from 2,000 currently to 400 in 2030. The regulations already take a hard line on R22, making it illegal to use even recycled or reclaimed R22 to service equipment as of this year.

There will be an opportunity to change the measures; for example, in mid-2017, reports will be due from EU member states on national codes, standards or legislation that are impeding the introduction of F-gas alternatives such as natural refrigerants, said Skacanova. On September 10, a Consultation Forum will take place to discuss these reports.

Japan has also made progress with a revised F-Gas law becoming effective as of April 2015. This revision targets the entire life cycle of F-gases from production to destruction, calls for reducing F-gas leakage, and promotes low-GWP/non-F-gas alternatives for designated products by a certain year. Starting in September, products with natural refrigerants will be labeled as such

In 2015 the Japanese Government has allocated $2.3 million for R&D into F-gas-free equipment, and $4.6 million for demonstrating energy-efficient products using natural refrigerants. It is also encouraging end-user investment by subsidizing natural refrigerant equipment.

In China, the government is recommending CO2, ammonia and hydrocarbons in a series of applications – and only one HFC -- as substitutes for HCFCs, which it is phasing out by 2030.

In March, the government created a low-GWP label for room air conditioners and heat pump water heaters using refrigerants with a GWP of less than 150.

In 2012, the government published national safety standards for flammable refrigerants like propane. China now manufactures 400,000 propane units annually.

→ North American natural refrigerant system design carries by not having harmonized standards with other global markets."

Scott Martin, director of sustainable technologies for Hillphoenix, pointed out that the company has been unable to incorporate components in its transcritical CO_2 refrigeration systems, like high-pressure copper to and from the gas cooler, because they have not been UL-approved in the U.S., even though those components have been widely and safely used in Europe for years.

Haseman replied that UL would "take a look at that data and most likely accept it."

CARB TARGETS SLCPs

Of the 50 U.S. states, California has been by far the most aggressive in dealing with climate change and its causes within its borders, passing a landmark greenhouse gas law (AB32) in 2006 that includes HFCs among its targets. In particular, the state has committed to reduce HFC emissions in new refrigeration and air conditioning equipment by 40% compared to 1990 levels by 2030, and 80% by 2050.

By the spring of 2016, the California Air Resources Board (CARB) is expected to have developed a strategic plan to reduce short-lived climate pollutants (SLCPs), including F-gases, methane and black carbon (soot), which last a few weeks to a few decades in the atmosphere; CO_2, by contrast, remains for up to 200 years. "If we can reduce [SLCPs], we get more return for our investment," said Glenn Gallagher, air pollution specialist for CARB at ATMOsphere America. He specializes in HFC remediation.

As part of the work on the SLCP plan, this year CARB has made a public a series of proposed measures it is considering to reduce HFC emissions; the agency welcomes industry feedback on these measures, which are:

» New stationary refrigeration (all sectors -- commercial, industrial, residential): A ban on refrigerants with GWP 150 or greater, starting on January 1, 2021 (with certain exceptions)

» New stationary air conditioning (all sectors): A ban on refrigerants with GWP 750 or greater, starting on January 1, 2022 (with certain exceptions)

» Very-high GWP refrigerants (2,500 or greater): A ban on sales/distribution, starting on January 1, 2020.

These proposals, Gallagher noted, stem from the European F-gas Regulations, though CARB's measures use a more aggressive timeline. CARB, he added, is technology neutral with respect to refrigerants, as long as they are EPA SNAP-approved and meet the low GWP threshold.

"The measures are trying to complement, not conflict with [EPA and DOE standards], but we will probably be a little more aggressive about our goals," he said.

For food retailers willing to be early adopters of low-GWP refrigeration systems, CARB is hoping to obtain incentive funding ranging between $50,000 and $250,000 per installation.

In September, CARB is publishing an initial draft of the SLCP strategic plan, and will present a second draft to the CARB board in the fall. It will present a final strategy to the board for approval in the spring of 2016, and then start the rulemaking process, said Gallagher. RD+MG

Those who would like to comment on the proposed CARB measures can do so at:
http://www.arb.ca.gov/cc/shortlived/shortlived.htm

EPA ANNOUNCES FINAL RULE FOR DELISTING OF HFCS

Reaction is mixed as the agency allows more time for transition to lower-GWP refrigerants, and expands list of allowable alternatives

– By Robert Davidson and Michael Garry

In a move that could impact the uptake of natural refrigerants, the U.S. Environmental Protection Agency (EPA) on July 20 posted in the Federal Register its final rule for the delisting of several high-GWP (global warming potential) refrigerants, giving the HVAC&R industry more time to transition from the delisted refrigerants than originally proposed.

The final rule, issued under EPA's Significant New Alternatives Policy (SNAP) program, changes the listings from acceptable to unacceptable for certain hydrofluorocarbons (HFCs) and HFC-blends in various end-uses in the refrigeration and air conditioning, aerosols and foam blowing sectors. In all cases, other refrigerant alternatives, such as natural refrigerants, were found to be available or potentially available that pose lower overall risk to human health and the environment.

The final rule takes effect Aug. 19.

The EPA also posted in the Federal Register a determination of acceptability on July 16, effective immediately, that expanded the list of acceptable substitutes for a variety of applications in the SNAP program. For new and retrofit supermarket systems, remote condensing units and low-temperature stand-alone equipment, approved refrigerants include R448A, R449A and R513A; for new vending machines, R450A and R513A; and for cold-storage warehouses, R513A. The GWP for these refrigerants ranges from 600 to 1,400.

DEADLINES POSTPONED

In its original delisting announcement in August 2014, EPA jarred the HVAR&R industry by proposing that the indicated refrigerants be phased out as early as January 2016. However, in its final rule, the agency moved those dates forward by at least one year for new equipment, and almost seven months for retrofit equipment.

For example, for retail food refrigeration applications, the use of HFCs R404A, R507A (with GWPs of 3,922 and 3,985, respectively) and other HFCs in new supermarket systems will be deemed unacceptable as of January 1, 2017. R404A, R507A and other HFCs will be delisted from use in new remote condensing units in supermarkets as of January 1, 2018.

In retrofit supermarket systems and remote condensing units, roughly the same refrigerants will become unacceptable July 20, 2016.

The rule also listed revised dates for a slew of refrigerants, including R134a (GWP 1,300), R404A, R407A (GWP 2,107) and R507A, in new stand-alone medium-temperature and low-temperature units in supermarkets. These refrigerants will be unacceptable as of January 1, 2020 for low-temperature units as well as medium-temperature units with a compressor capacity of at least 2,200 BTU/hour and medium temperature units containing a flooded evaporator.

The same refrigerants will be delisted as of January 1, 2019 in new medium-temperature units with a compressor capacity below 2,200 BTU/hour and those not containing a flooded evaporator. For retrofit stand-alone units, R404A and R507A will be unacceptable as of July 20, 2016.

The EPA designated January 1, 2019 as the date when refrigerants such as R134a, R404A, R507A and several others will be unacceptable in new vending machines. In retrofit vending machines, R404A and R507A will be unacceptable as of July 20, 2016.

In motor vehicle air conditioning, R134a will be unacceptable as of model year 2021, except where allowed under a narrowed use limit through model year 2025.

VARIED REACTION

Industry reaction to the final delisting rule was mixed.

"I think the industry will have ample time to adjust to the delisting of R404A and R507A in central systems," said Harrison Horning, director of energy and facility services for the Hannaford Supermarkets division of Delhaize America.

But Horning is concerned about the delisting of HFCs in stand-alone units. "Global experience is showing that stand-alone units can have very small charges and very tight systems, which suggests certain HFCs (R134a, R410A) could be applied with very low greenhouse gas emissions. I suppose some of the new HFO blends will warrant consideration as well. It remains to be seen whether propane can be cost-effective in a significant range of stand-alone units if the charge is limited to 150 grams."

Gary Cooper, director of refrigeration for Lowe's Markets in Texas, observed that the new rule "still seems like a tight timeline for OEMs, but it's an improvement."

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For Quentin Crowe, product manager for Hussmann, the postponement of deadlines will allow for a more effective transition. "I don't think it would be in anyone's benefit to do it sooner than decided, as there still needs to be training and design improvements to optimize equipment for these new lower-GWP refrigerants," he said. "With temperature glides of 10 degrees looking to be the new norm for new refrigerants, standards on setting up and commissioning equipment need to be established."

Will the delisting prompt greater interest in natural refrigerant alternatives? In the case of CO_2 transcritical systems in retail food refrigeration, "we don't think it will materially change [demand]," said an executive for a component manufacturer who asked not to be named. "There have been other options to R404A and R507 for years (R407A, C, and F), and the EPA's companion rule approving R448A, R449A, and R513A give the industry more choices. We feel the adoption of CO_2 stores overall will continue to increase, including transcritical, but will be more driven by technology and economics."

But Crowe thinks transcritical can directly benefit from the EPA rule. "I believe this is going to encourage some large retailers using R404A to consider transcritical CO_2 in applications where it can be proven financially feasible in northern regions," he said. "And this increased volume will help drive cost effective solutions so that transcritical can look more attractive in southern climates over the next couple years" RD+MG

For the complete posting of the final rule on delisting, see:
http://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf

EIA Issues HFC Reports

One report grades U.S. food retailers on HFC phaseouts while another guides federal employees to HFC-free equipment

— By James Ranson

In a follow-up to its 2013 report criticizing U.S. food retailers for failing to adequately address HFC refrigerants, the EIA (Environmental Investigation Agency) continued to find fault with 12 major U.S. supermarket chains for not doing enough to curb HFC leaks or phase out the gases altogether.

Released in June, the study, "Beyond the Dirty Dozen," essentially compiled a report card on HFC remediation steps taken by Albertsons, Ahold, Costco, Delhaize, HEB, Kroger, Meijer, Publix, Safeway, Target, Walmart, and Whole Foods.

For example, in discussing Walmart, the EIA, a UK-based environmental advocacy group, said that while the world's largest retailer operated more than 168 stores and two Sam's Clubs (as of 2014) that use hybrid systems containing glycol or CO2, the company has failed to install any HFC-free refrigeration systems. Walmart, the report noted, is among several retailers in the Consumer Goods Forum that pledged to begin phasing out HFCs in 2015

The EIA contrasted the efforts of U.S. retailers with their European, Japanese and Canadian counterparts, which are rolling out natural refrigerant-based stores or increasing maintenance on older fluorinated gas-based systems.

The EIA report included a "call to action" to all U.S. retailers to publicly commit to eliminating the use of HFCs in all new stores, and produce a plan to retrofit existing stores.

The EIA also recommended that the EPA continue rulemakings to ban the highest GWP HFCs, which it has begun to do.

For a free copy of the report, go to: http://eia-global.org/news-media/beyond-the-dirty-dozen.

HFC-FREE PROCUREMENT RESOURCE

The EIA (Environmental Investigation Agency) also released a report in June aiming to serve as a resource for U.S. government officials and procurement officers tasked with incorporating HFC-free equipment into federal facilities.

The report, "An Initial Guide to HFC-free Procurement and Refrigerant Management for the U.S. Government," is designed to fulfill a directive on governmental remediation of high-GWP HFCs included in President Obama's Climate Action Plan.

The report provides procurement officers with a comprehensive list of resources for procuring more sustainable alternatives to HFC-based technologies, including key sectors where HFC-free equipment and products are already available for purchase.

It also summarizes international HFC policies as well as domestic policies and agency initiatives that authorize HFC-free procurement.

The government's leadership in purchasing HFC-free equipment, the report said, will "incentivize the creation of needed infrastructure that will facilitate the adoption of HFC-free equipment and products throughout the U.S. market, leading to significant reductions in U.S. HFC emissions" JR

For a free copy of the report, go to:
http://eia-global.org/news-media/hfc-free-procurement-and-refrigerant-management

SHORT TAKES

by Michael Gary & Klara Skacanova

PepsiCo, Coke Join New White House Plan

In its latest climate-change initiative with private companies, the White House announced on July 27 the "American Business Act on Climate Pledge."

In the initiative, 13 major U.S. corporations, including Walmart, PepsiCo, Coca-Cola and Cargill, commit to reducing their greenhouse gas emissions.

PepsiCo, for example, said in a White House statement that it will "continue to implement hydrofluorocarbon(HFC)-free point-of-sale equipment (coolers, vending machines and fountain dispensers) to meet the goal that all of our new equipment in the U.S. will be HFC-free by 2020."

Coke pledged to reduce its greenhouse gas emissions by 25% by 2020, including changes to its refrigeration equipment. Walmart's commitment includes reducing total kWh-per-square foot energy intensity required to power its buildings by 20% by 2020 vs. its 2010 baseline MG

Cimco settles with Carnot over CO_2 ice-rink patents

Toronto-based Cimco Refrigeration, a division of Toromont Industries, announced an out-of-court settlement of several legal actions it took against Carnot Refrigeration for infringement of two Canadian patents related to CO_2 refrigeration systems for ice rinks. Cimco made the announcement on June 9 in a statement posted on its website, cimcorefrigeration.com.

One of the patents concerns a "CO_2 Refrigeration System for Ice-Playing Surfaces," and the other for a "CO_2 Refrigeration System." Cimco filed the suits after Carnot manufactured CO_2 systems that were installed - or scheduled to be installed - at various ice-rink locations in Quebec. Under the settlement, reached on June 4, Carnot has agreed to pay $1.8 million and a royalty to Cimco. Carnot has also agreed not to infringe any claim of the patents during their period of validity. Carnot acknowledged in the statement that the claims made by the patents are "valid and enforceable."

In addition, all other parties to the litigation have been released, and all municipalities named in the litigation are permitted to use CO_2 refrigeration systems installed in their facilities. Carnot has also agreed to discontinue separate legal actions.

The agreement applies to the following facilities and municipalities, which are located in Quebec: The Civic Centre, in Dollard-des-Ormeaux ; Stade de la Cite des Jeunes, in Riviere-du-Loop ; Centre Sportif Lacroix-Dutil, in Saint-Georges-de-Beauce; The Curling Club, in Roberval ; Arena Cynthia-Coull, in Longueuil ; and Centre Sportif Rosaire-Belanger, in Riviere-Bleue MG

No HFC Agreement at Montreal Protocol Meeting

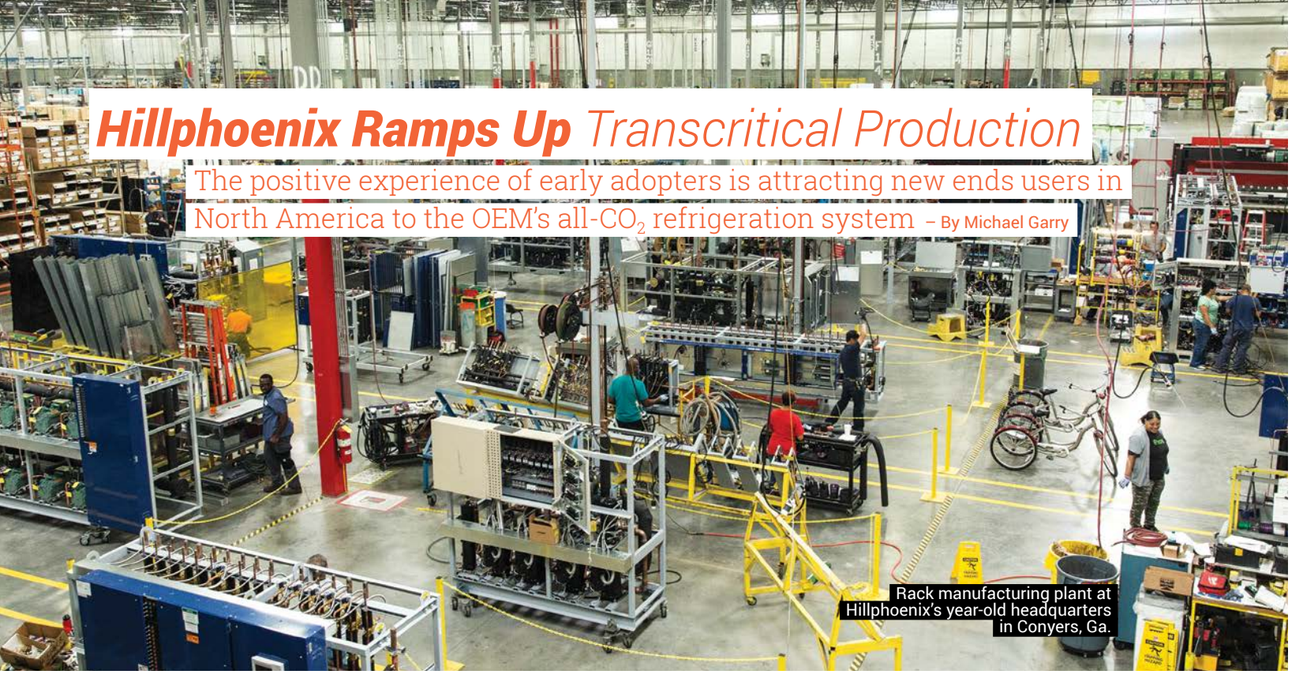
The latest attempt to phase down HFCs via the Montreal Protocol fell short at a meeting in Paris held July 20-24.

Four HFC phase-down amendments have been proposed in recent months by the North American countries, the European Union, the Pacific Islands and India. However, due to objections from Pakistan, participating countries at the Paris meeting – called the 36th Open-Ended Working Group (OEWG) meeting of the Parties to the Montreal Protocol – failed to agree on a mandate for a contact group that would formally negotiate ways of dealing with HFCs under the Montreal Protocol.

The parties did agree to hold further intersessional meetings on HFCs prior to the Meeting of the Parties to the Montreal Protocol in Dubai this November KS

Hillphoenix Ramps Up Transcritical Production

The positive experience of early adopters is attracting new ends users in North America to the OEM's all-CO_2 refrigeration system – By Michael Garry



Rack manufacturing plant at Hillphoenix's year-old headquarters in Conyers, Ga.

The tide is starting to turn in North America for HFC-free transcritical CO_2 refrigeration systems, said Eduardo Navarro de Andrade, vice president & general manager for Hillphoenix's Systems Division. And Hillphoenix has much to do with that.

Its all-natural-refrigerant system, called the Advansor by Hillphoenix CO_2 booster refrigeration system (Denmark-based Advansor was acquired by Hillphoenix in 2011), got its start in Europe, where more than 1,000 units have been installed in supermarket and light-industrial applications.

In North America, uptake of the technology has been slower – as of June there were 122 transcritical systems (from all manufacturers), 105 in Canada and 17 in the U.S., according to shecco research. But there are signs this year of significant growth.

For the North American market, Hillphoenix has already booked almost as many UL-certified transcritical racks in the first half of this year (56) as it built prior to 2015 (62). "We've had to [reconfigure] our plant and some of the assembly lines to accommodate the growth," said Navarro de Andrade, in an interview with *Accelerate America* in late June at Hillphoenix's year-old headquarters building in Conyers, Ga.

Part of what's driving the North American market now is the solid performance of the transcritical systems installed by early adopters, noted Navarro de Andrade. "CO_2 transcritical has been proven to deliver a

Eduardo Navarro de Andrade
Hillphoenix

2-5 year payback for typical applications, and will be dropping to 2-3 years for average climates. It's a viable economic solution, close to parity [with conventional systems]."

From an energy consumption point of view, transcritical systems have performed better than conventional DX systems in northern climates. By contrast, in southern climates, where higher ambient temperatures may drive the systems into supercritical mode, they are prone to operate less efficiently. However, Hillphoenix is demonstrating with a transcritical installation in Georgia that the system can still perform well in a southern climate. (See, "Transcritical System Taking the Heat in Georgia," page 32.)

The Georgia system, at a Sprouts Farmers Market store in the town of Dunwoody, is equipped with an adiabatic gas cooler that allows the system to run efficiently by keeping the CO_2 cool in warmer temperatures. Prior to installation, Hillphoenix projected that the transcritical system would be 6.3% more efficient than an R407A system at a comparable store. With almost a year's worth of performance data, the company determined that the transcritical system's efficiency has exceeded what was projected.

Hillphoenix has developed other technology – an ejector system and parallel compression – that can also maintain the efficiency of a transcritical CO_2 system. This year the company sold its first transcritical system with these components to a store in Europe. "We're probably a couple of years from commercializing ejector technology in the U.S.," said Navarro de Andrade.

Driving out the fear

The positive results obtained at the Georgia store and elsewhere help supermarkets and other end users overcome their apprehension about replacing traditional commercial refrigeration technology with a transcritical system, said Navarro de Andrade.

"We're driving out the fear by proving the performance, validating the reliability and support capability and making it bullet-proof," he said. "This starts getting more skeptical folks to understand that this is a real, viable solution."

Hillphoenix is helping to lower the cost of transcritical systems by incorporating new components. However, in some cases the company has been frustrated by its inability to get less costly components, widely used in Europe, UL-certified in the U.S. "We're working on that with component suppliers and the regulatory/certification agencies," said Navarro de Andrade.

At the same time, Hillphoenix is expanding its transcritical product portfolio. Prior to the ATMOsphere America 2015 conference in Atlanta in late June, the company provided a sneak preview at its headquarters of a new lower-cost system that "lends itself to smaller-format stores," he said. The modular unit, which will be released this year, has a narrower set of features than Hillphoenix's typical transcritical system.

Navarro de Andrade acknowledged that the skill level of contractors, technicians and designer engineers with respect to transcritical technology remains a challenge for the industry. "It's a new technology for most of them," he said.

> "Our studies show that CO_2 transcritical, in particular, should be the dominant choice for most of the segments across climates."

To meet this challenge, Hillphoenix has invested heavily in a Learning Center at its headquarters. In addition to a prepackaged curriculum, the company also creates a tailor-made program to meet the specific training needs of end users. In the nine years since it opened the Learning Center, Hillphoenix has trained more than 23,000 people, including end user customers, contractors and design engineers. Hillphoenix is also working with colleges and schools on training students. Its new technology requires new skills and is more disruptive of the status quo, making it potentially "more interesting for younger folks" as the industry tries to replace an aging workforce, said Navarro de Andrade.

Hillphoenix's Second Nature product line, which includes its CO_2 transcritical, cascade and secondary systems, represent close to 30% of its North American business. Navarro de Andrade doesn't expect it to become the largest part of the business for some time to come, but "at some point it will be."

Other natural refrigerant systems incorporating hydrocarbons and ammonia will also have a place in the portfolio, he added. "But our studies show that CO_2 transcritical, in particular, should be the dominant choice for most of the segments across climates. MG

Transcritical CO_2 by the Numbers

ADVANSOR/HILLPHOENIX TRANSCRITICAL SYSTEMS IN EUROPE	1,000+
TRANSCRITICAL SYSTEMS IN CANADA (ALL SUPPLIERS)	105
TRANSCTITICAL SYSTEMS IN U.S. (ALL SUPPLIERS)	17
HILLPHOENIX'S TRANSCRITICAL RACK BOOKINGS, FIRST HALF OF 2015	56
HILLPHOENIX'S TRANSCRITICAL RACK PRODUCTION, 2012-2014	62
PAYBACK FOR HILLPHOENIX TRANSCRITICAL SYSTEM IN TYPICAL APPLICATION	2-5 YEARS
EFFICIENCY OF HILLPHOENIX TRANSCRITICAL SYSTEM AT DUNWOODY, GA., STORE	6.3%+ HIGHER THAN THAT OF DX SYSTEM AT SIMILAR STORE
PERCENTAGE OF HILLPHOENIX'S NORTH AMERICAN BUSINESS REPRESENTED BY 2ND NATURE CO_2 SYSTEMS	ALMOST 30%

Source: Hillphoenix and shecco

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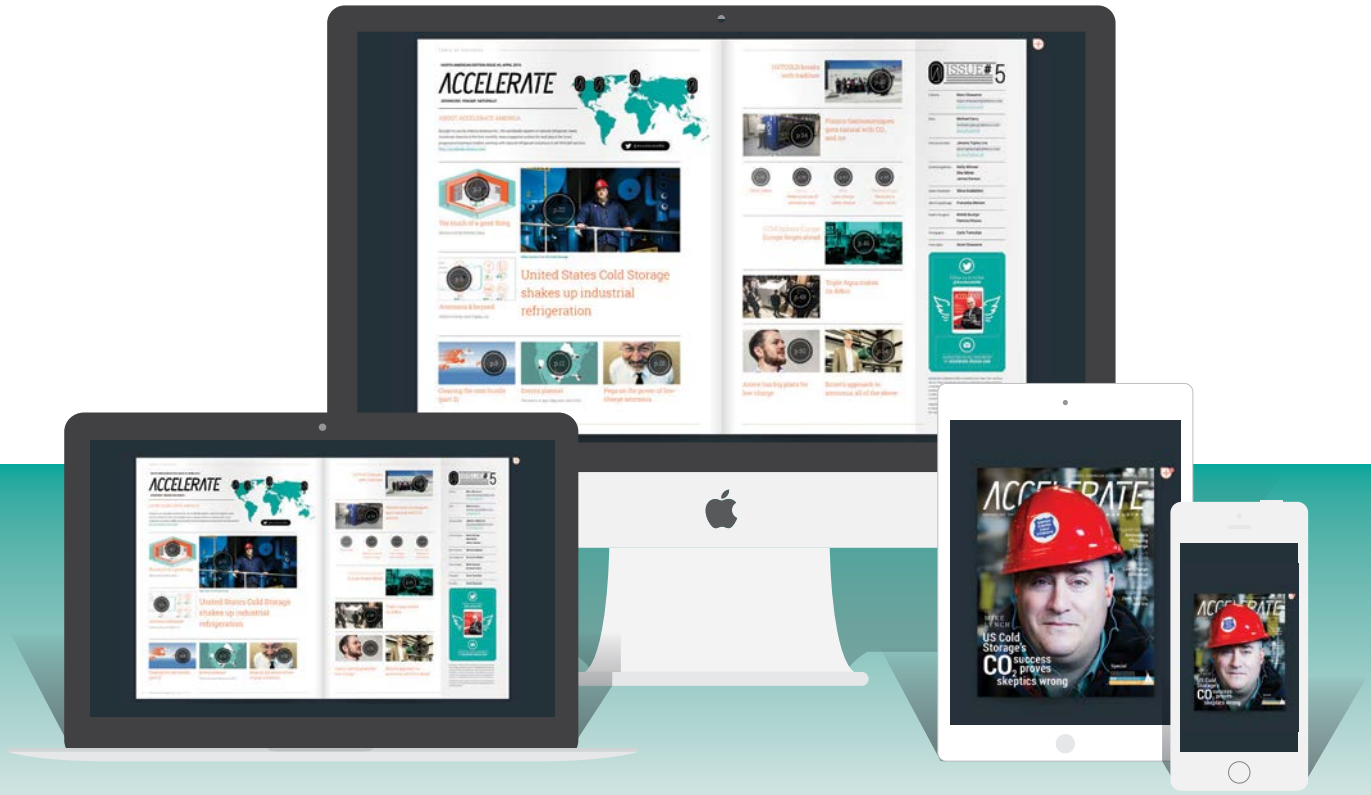

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