

JULY-AUGUST 2019

ACCELERATE

ADVANCING HVAC&R SUSTAINABLY

MAGAZINE

500 g

**How the new IEC charge limit for hydrocarbons
will shake up commercial refrigeration.**

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Headoffice:

Feldstrasse 30 / P.O. Box / 3073 Guemligen Bern / Switzerland

Phone +41 31 996 48 48 / info@frigoconsulting.com

ADVANCED NATURAL REFRIGERANT TECHNOLOGY RESULTS IN:

- Less energy consumption
- Reduced operating costs
- Improved eco-balance

OFFICES IN GERMANY / ROMANIA / POLAND

A Quick Look at This Issue

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Weis Markets reports “remarkable” reduction in energy use for its first transcritical system. ([Page 40](#)) ... **Migros Ticino** installs its first “total energy” integrated CO₂ system with provisions for refrigeration, heating and air-conditioning. ([Page 52](#)) ... **Food Lover’s Market** fits transcritical system into a space only a third the size of that used by the previous refrigeration system. ([Page 62](#)) ... **Logan City Council** bucks the trend in Australia and installs water-cooled ammonia chiller system for air conditioning. ([Page 64](#)) ... **Kokubu** finds that transcritical CO₂ or NH₃/CO₂ systems are the best options for its distribution centers. ([Page 72](#))

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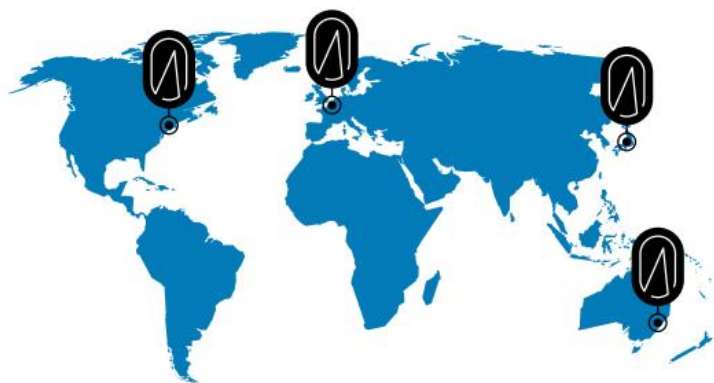
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ACCELERATE

ADVANCING HVAC&R SUSTAINABLY

MAGAZINE



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

About Accelerate Magazine

Brought to you by the worldwide experts in natural refrigerant news, *Accelerate Magazine* is the first global news magazine written for and about the most progressive business leaders working with natural refrigerant solutions in all HVAC&R sectors. It builds on the legacies of five regional magazines: *Accelerate America*, *Accelerate Europe*, *Accelerate Australia/New Zealand*, *Accelerate China* and *Accelerate Asia*, and is published in coordination with the Japanese language magazine, *Accelerate Japan*.

About Accelerate24.news

Accelerate24.news is a 24-hour global website providing up-to-the-minute news on sustainable cooling and heating, with a focus on natural refrigerant-based technologies. Leveraging the expertise of our journalists and analysts in North America, Europe and Japan, Accelerate24.com covers in one place what is found on R744.com, Hydrocarbons21.com and Ammonia21.com, the leading websites on CO₂, hydrocarbons and ammonia over the past decade.

WANT TO ADVERTISE?

/ Ad Coordinator

Silvia Scaldaferrì
silvia.scaldaferrì@shecco.com
+39 331 961 395

GOT A STORY IDEA?

/ Editor in Chief

Michael Garry
michael.garry@shecco.com
203-778-8770

July-August 2019
// Volume 1, Issue #102

Founder & Publisher

Marc Chasserot
marc.chasserot@shecco.com

Editor in Chief

Michael Garry
michael.garry@shecco.com

Associate Editor/Europe

Tine Stausholm

Associate Editor/Asia-Pacific

Devin Yoshimoto

Contributing Writers

Pilar Aleu
Marie Battesti
Jan Dusek
Eda Isaksson
Rena Okabe
Caroline Rham
Tomoro Sato
Klara Zolcer Skacanova

Ad Coordinator

Silvia Scaldaferrì

Art Director

Anna Salhofer

Graphic Designers

Juliana Gomez
Matjaž Krmelj

Photography Editor

Scott Chasserot

Photographers

Ben Beech
Tomoro Sato

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Editorial Calendar, 2019-2020, Volume 1

// ISSUE #101

June 2019

Cover Story:

NatRefs 101: Tracing the growth of natural refrigerants through the first 100 issues of *Accelerate* magazines from around the world.

Print distribution: ATMosphere America (Atlanta, June 17-18)

// ISSUE #102

July/August 2019

Cover Story:

Impact of IEC's new 500-g charge limit for hydrocarbons. What are the next steps?

// ISSUE #103

September 2019

FOCUS:

Cover Story:

HFOs: What Environmental Impact?

Publication Date: September 3

Ad Deadline: August 23

Print Distribution: FMI Energy & Store Development Conference (Dallas, September 8-11); ATMosphere Asia (Bangkok, Thailand, September 24)

// ISSUE #104

October 2019

Cover Story:

NatRefs: Are they making a difference? What is their potential?

Publication Date: October 2

Ad Deadline: September 20

Print Distribution: ATMosphere Europe (Warsaw, Poland, October 16-17)

// ISSUE #105

November/

December 2019

Cover Story:

Year One of Kigali: Where do we stand?

Publication Date: October 28

Ad Deadline: October 21

Print Distribution: The 31st Meeting of the Parties to the Montreal Protocol (Rome, November 4-8)

// ISSUE #106

January 2020

Cover Story:

How do NatRefs stack up in first cost, efficiency, maintenance – and TCO?

Publication Date: January 8

Ad Deadline: December 20

Print Distribution:

AHR Expo (Orlando, Fla., February 3-5)

// ISSUE #107

February 2020

Cover Story:

How are NatRefs transforming heating and cooling of buildings?

Publication Date: February 6

Ad Deadline: January 27

// ISSUE #108

March 2020

Cover Story:

Which NatRef is Best: CO₂, Ammonia or Hydrocarbons?

Publication Date: March 5

Ad Deadline: February 21

Print Distribution: IIR Natural Refrigeration Conference and Heavy Equipment Expo (Orlando, Fla., March 15-18)

// ISSUE #109

April 2020

Cover Story:

How CO₂ heat pumps make electric cars go further

Publication Date: April 8

Ad Deadline: March 27

// ISSUE #110

May 2020

Cover Story:

The Training Revolution: How IoT, AI, virtual reality and robotics will fill the technician void

Publication Date: May 6

Ad Deadline: April 24

The editorial calendar is subject to change by the publisher.

NEWS ON THE GO

– By Marc Chasserot

I am excited to tell you about a new website, Accelerate24.news, that we officially launched on July 1.

As its name attests, this is a 24-hour resource with news posted by our journalists in Europe, Tokyo and North America. It covers all natural refrigerants – CO₂, hydrocarbons, ammonia, water and air – in addition to other developments related to HVAC&R sustainability. And it carries the Accelerate brand, recognized in the industry as representing the leading magazines for natural refrigerant news.

Accelerate24.news's coverage will extend to all segments of the HVAC&R industry, from large industrial refrigeration to small residential applications, and everything in between. Like our new *Accelerate Magazine*, it will encompass all regions of the world, from North America to Europe to Asia Pacific and Australia, and more. It will leave no stones unturned, whether in technology, market trends, end-user adoption, energy efficiency or policy developments.

Most important, Accelerate24.news is designed to accommodate our readers – the decision-makers who are constantly on the move, in-between meetings or on a plane, with limited time to get their daily news digest. We have made it user-friendly so that it is accessible on any mobile device or tablet, making this website the place to go to stay up-to-date on natural refrigerant news.

We're also going to add many features to Accelerate24.news as we grow, including a weekly email alert curated by region. I encourage you to sign up for it now on the site.

Accelerate24.news builds on more than 10 years of news reporting and intelligence gathering on our three natural refrigerant-specific websites, R744.com, Ammonia21.com and Hydrocarbons21.com. These sites will continue to serve the industry with news and information on products, companies, events, and natural refrigerants, as well as other elements under development.

We intend to make Accelerate24.news the leading website for news and analysis on sustainable cooling and heating in the HVAC&R industry. Please let us know how we're doing! ■ MC

Watch my video announcement here:

<https://youtu.be/1TQcBkSoeUs>



Marc Chasserot
Publisher

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The Role of NatRefs in a Warming World

— By Michael Garry

Most people take refrigeration and air conditioning for granted, just another accommodation in the modern world.

But according to Professor Toby Peters of the University of Birmingham, U.K., 1.1 billion people, or 14.3% of the world's 7.7 billion population, lack access to adequate cooling for fresh food, safe medicines and protection from the heat.

The world, of course, is only getting warmer, making access to cooling even more essential to survival for everyone. To handle the global need for cooling — what Peters calls “cooling for all” — 15 billion cooling appliances of all stripes will be needed by 2050, he calculates, quite a jump from the 2.5 billion that exist today.

Even assuming all of these appliances are made available, what sort of burden will they place on the world's energy resources? Will it exacerbate the global warming caused by fossil fuels? How much of the renewable energy supplies will be taken up by soaring cooling demands?

Peters addresses these questions in an important new report, “A Cool World: Defining the Energy Conundrum of Cooling for All.” On [page 90](#), you will find an interview I conducted with him about the report.

Among the many strategies Peters suggests for tackling this energy conundrum is further accelerating the adoption of natural refrigerants to

help meet the HFC-reduction agenda of the Kigali Amendment to the Montreal Protocol.

But to accelerate the adoption of natural refrigerants, key obstacles need to be removed, such as standards and regulations that unduly restrict the use of natural refrigerant technologies. Our cover story this month ([page 32](#)) focuses on one such standard — the charge limit for hydrocarbons in self-contained commercial refrigeration display cases.

After years of discussion, considerable opposition, and a razor-thin vote by its National Committees, the International Electrotechnical Commission (IEC) finally in May approved an increase in the hydrocarbon charge limit to 500 g (17.6 oz) from 150 g (5.3 oz) in its IEC 60335-2-89 standard. Importantly, the IEC strengthened the safety requirements for higher-charge display cases.

This removes a major obstacle that had prevented wider adoption of hydrocarbons like propane and isobutane. But it remains for regional standard organization to follow suit and adopt some version of the IEC standard before real progress can be made.

Another application for which the hydrocarbon charge limit needs to be increased is air conditioning, which is proliferating across developing countries like India and China as global temperatures rise. The limit stands now at about 1 kg (2.2 lbs) for a direct inside system, and higher charges are under discussion.



Michael Garry
Editor in Chief

In a new report, “High-Stakes: Implementing and strengthening climate and ozone commitments under the Montreal Protocol,” the Environmental Investigation Agency (EIA) says that an update of the hydrocarbon charge-limit standard for air conditioning equipment is needed to limit the uptake of medium-GWP transitional refrigerants in ACs. This, it said, is key for a smooth implementation of the Kigali Amendment. ([See page 24.](#))

Natural refrigerants are clearly playing a key role in bringing about cooling for all in a warming world. ■ MG



Letters to the Editor

A GLOBAL VISION

I read the first issue of *Accelerate Magazine*, and I appreciate it very much, because natural refrigeration, environmental problems and global sustainability are matters involving the whole world and not confined in small regions!

With your new magazine, the reader can have a global vision of the most recent news about natural refrigeration in a very fast and smart way. For example, I read at the same time news from Japan and China (about the first transcritical plant in 2018, assembled, delivered and commissioned by our company) as well as from America and Europe.

Luca Rossi
Project Manager
Biaggini Frigoriferi
Cadenazzo, Switzerland

ACCELERATING U.S. SOLUTIONS

I really enjoy the new global format. I appreciate having the ability to learn about the natural refrigerant challenges and solutions being implemented around the world and gain new insights that may accelerate solutions here in the U.S.

Morgan Smith
Manager of Programs & Operations
North American Sustainable
Refrigeration Council
Webster, N.Y.

A WORLDWIDE PRIORITY

The new format of *Accelerate Magazine* is incredibly beneficial because it eliminates any confusion about industry trends, and also gives us a view into the direction other regions are going.

The concise format makes it easy to follow what is happening in the rest of the world. It is clear that natural refrigerants are becoming a priority worldwide.

Cara Godack
Marketing Manager
M&M Refrigeration
Federsburg, Md.

NATREFS AROUND THE WORLD

I like the layout of the new magazine better. It is great to hear and see what is happening around the world in natural refrigerants.

Ryan Welty
Vice President, Sales & Operations
South-Town Refrigeration & Mechanical
Minneapolis, Minn.

AMMONIA IN CHINA

In regard to "A Return to Ammonia in China" (*Accelerate Magazine*, June 2019), an example of a centralized low-charge ammonia installation addressing most, if not all, concerns of Chinese authorities has been in commercial operation in Dongguan for several years. The installation delivers superior energy efficiency compared with conventional liquid-overfeed systems with screw compressors.

To our knowledge this is the first system in the world with insulated coolers featuring automatic ambient air defrost.

In the event of an ammonia leak, the evaporators go into defrost mode. This isolates the evaporators from the freezer environment on the air side so that only very minimal amounts of NH₃, if any, enter the refrigerated space. The medium-temperature areas of this DC are serviced by a glycol loop, eliminating any NH₃ from those areas completely.

I can't say that I agree with the statement that China is "returning to ammonia." One of my colleagues attended the last refrigeration show in China and saw little evidence of that.

I heard recently that politicians/administrators in various Chinese jurisdictions had been told that an ammonia incident under their watch would mean the end of their careers.

Stefan Jensen
Managing Director
Scantec Refrigeration Technologies
Brisbane, Australia

LETTERS ARE WELCOMED!

Accelerate Magazine invites readers to submit letters to the editor to michael.garry@shecco.com. Letters may be edited for clarity or length.

Is CO₂ the Right Choice for E-mobility in Public Transport?

As a nonflammable refrigerant that provides ample heating and cooling in a heat pump, CO₂ makes a strong case for use in electric buses and trains

— By Marco Piovan

The fashion industry is not alone in evolving cyclically over decades with the same products. Even engineering at times brings back to light old things that perhaps had not been so successful in the past.

This is the case with CO₂, which attracted a great deal of attention in the early 20th century and, following a long break of roughly 50 years, has come back at the beginning of the 21st century as a promising new refrigerant. Following its use in refrigeration, with the development of highly efficient compressor rack solutions, it is now time for CO₂ to be employed for passenger comfort in transport.

The milestone was European Union Directive 2006/40/EC on “Mobile Air Conditioners,” or MACs, fitted in passenger cars (category M1 vehicles) and light commercial vehicles.

“To reduce emissions of fluorinated greenhouse gases from MACs, the European Directive introduces a gradual ban on these gases in passenger

cars,” the directive says. “Fluorinated greenhouse gases with a global warming potential (GPW) higher than 150 will no longer be used in MAC systems. By reducing these emissions, the Directive contributes to the EU’s strategy for climate action.”

The EU has not been mandating any one preferred gas for the transition to low-GWP refrigerants, but rather has left it to the automotive industry to develop solutions that meet the target set by the directive.

The automotive industry came out with R1234yf as the most likely and adaptable substitute to R134a. However, R1234yf is slightly flammable and thus requires further precautions for application in passenger cars and light commercial vehicles.

Modern cars typically employ a refrigerant charge of 200-300 g (7.1-10.6 oz), which is still manageable for an A2L-classified ASHRAE Standard 34 refrigerant such as R1234yf. This is not the case though for larger systems, such as buses and trains, where the refrigerant charge is typically above 5 kg (11 lbs).

Managing such quantities of a flammable refrigerant is quite complicated, and requires special care in the design and installation of the air-conditioning system aboard the vehicle.

CO₂'S CHALLENGES

It is clear that CO₂ air conditioners operate in transcritical mode, due to CO₂'s low critical temperature (31°C/88°F) compared to all other refrigerants. A transcritical cycle means the gas discharged by the compressor cannot be condensed by a heat exchanger.

Moreover, a transcritical CO₂ cycle reaches very high working pressures, i.e. more than 100 bar (1,450 psi), up to 10 times higher than the pressure in R1234yf systems. This means that components, such as the compressor and condenser (which for CO₂ is actually a gas cooler), need to be designed for high capacities and high pressures. This results in a much heavier unit compared to those operating on R134a or R1234yf.

By way of comparison, an R134a air-conditioning unit with a capacity of 20 kW (5.7 TR) – like those typically used on buses – weighs 100-150 kg (220.5-330.7 lbs), while the same unit running on CO₂ could weigh twice as much and require more complexity.

But the scenario for CO₂ is more favorable when it comes to electric mobility. Whereas in conventional vehicles heat is produced in massive amounts by the internal combustion engine, there is almost no heat supplied by an electric vehicle's engine. As a result, the vehicle's air-conditioning system also needs to provide heating, and is therefore upgraded to a reverse-cycle system (cooling and heating), namely a heat pump, in the transport sector.

This represents a clear advantage for CO₂ due to its intrinsic property of operating at very low temperatures (-20°C/-4°F) compared to R134a and R1234yf, which are limited to roughly 0°C (32°F). CO₂ thus adapts to a wider operating temperature range.

Despite the complications of building a heat pump to operate in transcritical mode – which is essential to obtain a decent level of efficiency, especially in warmer climates – these complications are still less intricate than the flammability issues that a refrigerant such as R1234yf would bring to system design.

As a class A1 refrigerant under ASHRAE Standard 34, CO₂ is certified as nonflammable and non-toxic in moderate concentrations.

In the EU, some governments have attempted measures to foster the adoption of e-mobility for public transport, and some manufacturers have followed by putting forward new-vehicle proposals on the market.

One of these, beginning in 2020, is the German "Blue Angel" eco-label (RAL-UZ 59b), which will be awarded only to buses with mobile air-conditioning using non-halogenated refrigerants such as CO₂.

In conclusion, CO₂ heat pumps are a viable solution for heating and cooling public transport using electric vehicles. Whether e-mobility will take over from conventional fuel-injection systems is another story; this will also depend on geopolitics (with the environment at stake). ■ MP



Marco Piovan is application manager - industrial HVAC, for Italian component manufacturer CAREL.

This article originally appeared in slightly different form as a blog post at www.carel.com.

AMERICAS

August 24-30

25th IIR International Congress of Refrigeration, Montreal, Canada

Held every four years, the ICR 2019 will have the theme "Refrigeration for human health and future prosperity." It will focus on energy saving and energy efficiency, food supply, health, reduction of global warming and the protection of the ozone layer.



<https://icr2019.org>



@IIFIIR

September 8-11

Energy & Store Development Conference, Dallas, Texas

The event covers store development and design, refrigeration, energy-efficiency and store maintenance.



<https://bit.ly/2MkUzb8>



@FMI_ORG

September 10-13

FEBRAVA 21st International Refrigeration, Air Conditioning, ventilation, Heating and Air Treatment Fair, Sao Paulo, Brazil

FEBRAVA showcases innovative products and launches for the entire HVAC&R chain.



<https://bit.ly/2YbNoMg>



<https://www.linkedin.com/showcase/febrava-br/>

October 1-4

National Association of Convenience Stores Show, Atlanta, Ga.

The NACS Show features thousands of products and services that convenience stores and fuel retailers sell and use.



<https://bit.ly/30wHrac>



@NACSONline

October 8-11

RETA National Conference, Las Vegas, Nev.

The Refrigerating Engineers & Technicians Association's National Conference offers hands-on training, workshops, technical presentations, networking events, and an exhibit hall.



<https://bit.ly/2xMyXQb>



@RETA_HQ



EUROPE,
MIDDLE EAST & AFRICA**September 9-11****11th International Conference
on Compressors and their
Systems,
London, United Kingdom**

The program will include a full session dedicated to industrial issues of a non-technical nature, in addition to the traditional keynote addresses, research and technical papers, podium papers and discussions.



<https://bit.ly/2JR3aDo>

September 25-25**TEKNO+HVAC 2019,
Abu Dhabi, United Arab Emirates**

The event, now in its second year, will showcase exhibitors in the HVAC industry as well as engineering and technology solutions.



<https://bit.ly/2xPm483>



@TEKNO_HVAC_ME

**October 2-5****ISK-SODEX Istanbul 2019,
Istanbul, Turkey**

This HVAC&R exhibition provides focus on products in the sector with the cooperation of associations, magazines and international exhibitors.



<https://bit.ly/2JDc2xt>



@ISK_Sodex

October 16-17**ATMOsphere Europe 2019,
Warsaw, Poland**

This is the European edition of the global ATMOsphere conference series dedicated to natural refrigerants-based technologies, and features tailored content in a multifaceted program.



<https://bit.ly/2LX8Qym>



@ATMOEvents

October 24-25**Sustainable Retail Summit,
Berlin, Germany**

This Consumer Goods Forum event showcases examples of today's leading retail industry challenges and how to overcome them. It covers the entire sustainability eco-system.



<https://bit.ly/2lwCVWJ>



@CGF_The_Forum

August 28-30

10th Shanghai International Frozen and Chilled Food Expo, Shanghai, China

The event is for trade negotiations and technical exchanges in the frozen and chilled food industry.



<https://bit.ly/2JJqHGa>

September 11-12

The Future of HVAC 2019, Brisbane, Australia

Organized by AIRAH, this is the sixth edition of an annual event for HVAC&R professionals, focused on where the industry is heading and how it's achieving its objectives.



<https://bit.ly/2GCNJh5>



<https://bit.ly/2GAVKmV>

September 25

ATMOsphere Asia 2019, Bangkok, Thailand

Coinciding with the Bangkok RHVAC trade show, ATMOsphere Asia will debate local/International f-gas policy, industrial refrigeration, market-ready solutions for food retail, and homegrown innovation.



<https://bit.ly/30ElciR>



@ATMOEvents

September 25-28

Bangkok RHVAC 2019, Bangkok, Thailand

The fair, the second largest exhibition in the Asia Pacific region, features buyers, importers, manufacturers, traders, distributors, wholesalers, retailers and department stores, and offers contact with end-users and local consumers on the public day.



<https://bit.ly/2u95XSQ>



<https://www.facebook.com/ditprhvac>

October 9-11

Refrigeration & HVAC Indonesia Jakarta, Jakarta, Indonesia

This event describes itself as the first and largest exhibition in Indonesia combining the areas of refrigeration and climate control.



<https://bit.ly/2XNpkQG>



@Messeninfo

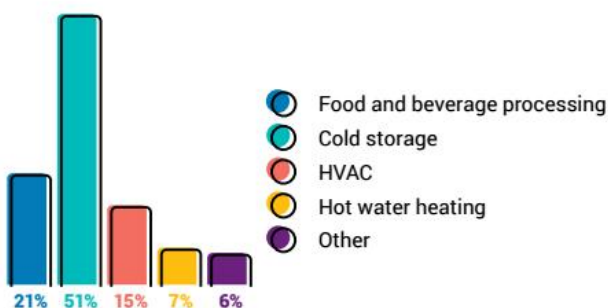


Natural Refrigerant Trends in North America

Attendees at ATMOsphere America, held in Atlanta, Ga., June 17-18, were asked about natural refrigerant uptake in North America. Here's what they said.

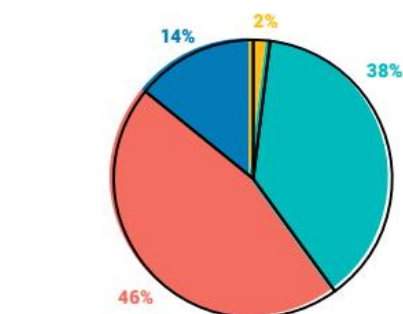
Besides supermarkets, in which application will natural refrigerants see the highest growth rate in the next five years in North America?

*143 respondents



What are the biggest challenges for retailers in adopting natural refrigerants in North America?

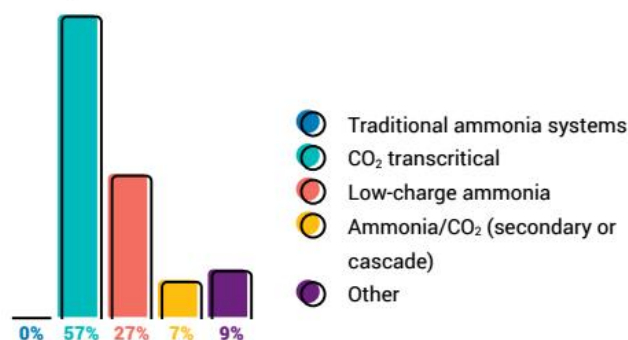
*85 respondents



- Lack of available technology
- Lack of trained installation & maintenance staff
- Initial cost of technology
- Awareness of natural refrigerant benefits

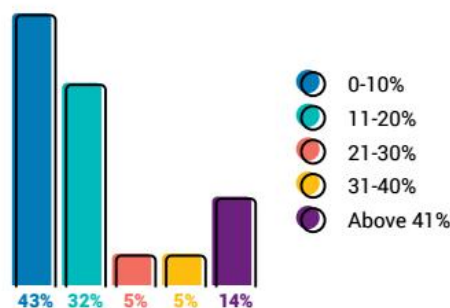
Which technology will see the highest growth rate for refrigerated warehousing in the next five years in North America?

*44 respondents



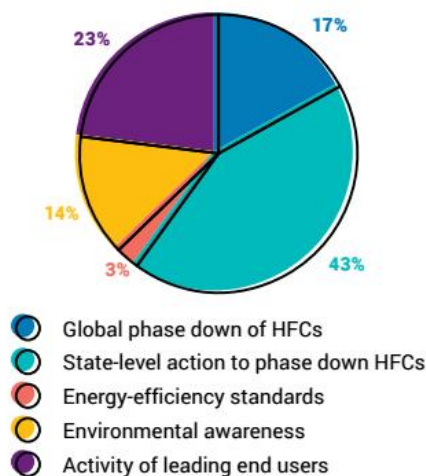
What do you think is the percentage of refrigeration contractors and service technicians who are qualified to service natural refrigerants in North America?

*37 respondents



What is currently driving the uptake of natural refrigerants in the U.S.?

*93 respondents





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Kigali Update

Seventy-five countries (including the European Union) have accepted, ratified or approved the Kigali Amendment to the Montreal Protocol as of July 29, 2019*

The Kigali Amendment to the Montreal Protocol was enacted on October 15, 2016 by 197 countries (parties) in Kigali, Rwanda; it took effect on January 1, 2019.

The Amendment calls for the phase down of the production and use of HFCs by developed and developing countries following the acceptance, ratification or approval of the amendment by each country.

Fifty developed (Non-Article 5) countries start with a 10% HFC phase down in 2019 (compared to a baseline of average HFC production/use in 2011-2013), except for Belarus, the Russian Federation, Kazakhstan, Tajikistan and Uzbekistan, which start with a 5% phase down in 2020. All developed countries end with an 85% HFC phase down by 2036. Thirty-one have so far accepted, ratified or approved the Amendment.

The 147 developing (Article 5) countries fall into two groups. The majority starts a freeze in 2024 at a baseline of average HFC production/use in 2020-2022; those countries end with an 80% HFC phase down by 2045. The other Article 5 countries (Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates) start a freeze in 2028 at a baseline of average HFC production/use in 2024-2026; those countries end with an 85% HFC phase down by 2047. So far 44 Article 5 countries (both groups) have accepted, ratified or approved the Amendment.

Here is a list of the 75 countries that have accepted, ratified or approved the Kigali Amendment as of July 29.

Developed (Non-Article 5) Countries

Participant	Acceptance(A), Ratification, Approval(AA)
Andorra	Jan 23, 2019 A
Australia	Oct 27, 2017 A
Austria	Sep 27, 2018
Belgium	Jun 4, 2018
Bulgaria	May 1, 2018
Canada	Nov 3, 2017
Croatia	Dec 6, 2018
Czech Republic	Sep 27, 2018 A
Cyprus	July 22, 2019
Denmark**	Dec 6, 2018 AA
Estonia	Sep 27, 2018
European Union	Sep 27, 2018 AA
Finland	Nov 14, 2017 A
France	Mar 29, 2018 AA
Germany	Nov 14, 2017 A
Greece	Oct 5, 2018
Hungary	Sep 14, 2018 AA
Ireland	Mar 12, 2018
Japan	Dec 18, 2018 A
Latvia	Aug 17, 2018
Lithuania	Jul 24, 2018
Luxembourg	Nov 16, 2017
Netherlands***	Feb 8, 2018 A
Norway	Sep 6, 2017
Poland	Jan 7, 2019
Portugal	Jul 17, 2018 AA
Slovakia	Nov 16, 2017
Slovenia	Dec 7, 2018
Sweden	Nov 17, 2017
Switzerland	Nov 7, 2018
United Kingdom of Great Britain and Northern Ireland	Nov 14, 2017

* Based on data from United Nations Treaty Collection (<https://bit.ly/2pg0sgF>)

** With territorial exclusion in respect of Greenland

*** For the European part of the Netherlands

Developing Countries

Participant	Acceptance(A), Ratification, Approval(AA)
Albania	Jan 18, 2019
Armenia	May 2, 2019 A
Barbados	Apr 19, 2018
Benin	Mar 19, 2018
Burkina Faso	Jul 26, 2018
Chile	Sep 19, 2017
Comoros	Nov 16, 2017
Costa Rica	May 23, 2018
Côte d'Ivoire	Nov 29, 2017 A
Cuba	June 20, 2019
Democratic People's Republic of Korea	Sep 21, 2017
Ecuador	Jan 22, 2018
Ethiopia	July 5, 2019
Gabon	Feb 28, 2018 A
Grenada	May 29, 2018
Guinea-Bissau	Oct 22, 2018
Honduras	Jan 28, 2019
Kiribati	Oct 26, 2018
Lao People's Democratic Republic	Nov 16, 2017 A
Malawi	Nov 21, 2017
Maldives	Nov 13, 2017
Mali	Mar 31, 2017 A
Marshall Islands	May 15, 2017
Mexico	Sep 25, 2018 A
Micronesia (Federated States of)	May 12, 2017
Montenegro	Apr 23, 2019
Namibia	May 16, 2019 A
Niger	Aug 29, 2018
Nigeria	Dec 20, 2018
Niue	Apr 24, 2018

Participant	Acceptance(A), Ratification, Approval(AA)
Palau	Aug 29, 2017
Panama	Sep 28, 2018
Paraguay	Nov 1, 2018 A
Rwanda	May 23, 2017
Samoa	Mar 23, 2018
Senegal	Aug 31, 2018
Sri Lanka	Sep 28, 2018
Togo	Mar 8, 2018 A
Tonga	Sep 17, 2018
Trinidad and Tobago	Nov 17, 2017
Tuvalu	Sep 21, 2017
Uganda	Jun 21, 2018
Uruguay	Sep 12, 2018
Vanuatu	Apr 20, 2018



'COOLEST DAY OF THE YEAR' OFF TO A GREAT START

The first annual World Refrigeration Day was celebrated in at least 153 countries, exceeding expectations for its creator, Stephen Gill

— By Tine Stausholm



Stephen Gill

The inaugural World Refrigeration Day (WRD), held on June 26 (Lord Kelvin's birthday), got off to a better start than even its organizers had hoped.

There were so many events held around the world – to raise awareness of the often overlooked HVAC&R industry – that volunteers behind the project are still working on a comprehensive list, but they believe that physical events took place in at least 153 countries. Many of these focused on natural refrigerants.

With only a tiny group of volunteers, the ambition for the first year was simply to establish the idea in the industry diary and gain support from national trade associations and professional bodies. However, according to longtime consultant Stephen Gill, former president of the Institute of Refrigeration (IOR) and the man behind the “coolest day of the year,” the response has been overwhelming and the goal was “more than achieved.”

Big trade groups like ASHRAE in the U.S., ISHRAE in India and AIRAH in Australia all supported WRD. The day before the event, Gill woke up to over 700 fresh emails in his inbox, and they kept coming in faster than he could reply.

Gill believes that the huge interest proves that the industry wants to tell the world what it does, and that “WRD was the opportunity that many had been waiting for.”

Despite the modest goal of the organizers, the event created quite a buzz on social media, with big international organizations like the World Bank and UN Environment tweeting about it. It also got picked up by HVAC&R trade publications and even some mainstream media outlets in the U.S., Asia and Europe.

When asked by *Accelerate Magazine* if there had been any negative experiences, or lessons learned, from the first version of WRD, Gill said that he had received some quite strong rejections when he first went out seeking support for his idea. These rejections had been demoralizing, but with the recent success in mind, the main takeaway for Gill has been “don’t give up, even if everyone doesn’t believe in your idea from day one.”

Luckily for Gill and his volunteers, the naysayers were a minority. By far the majority of people approached were positive, and several pledged financial support without hesitation, allowing the small team to recoup some of the expenses they’d already incurred, he said.

Sponsors and partners have also signed up for 2020 and plans for next year’s WRD will be revealed soon.

Many WRD events focused on natural refrigerants. Below are just a few examples.



June 26th every year

Behind the scenes at Woolworths

Two Woolworths supermarkets in Melbourne and Sydney, Australia, both using transcritical CO₂ systems for refrigeration, opened up their normally inaccessible plant rooms to the public; five one-hour walk-through sessions were held. Visitors were able to meet HVAC industry professionals and experience a day in the life of a refrigeration technician. The aim was to spread awareness about the refrigeration trade among especially young people and to showcase the latest technology.

Local industry associations like the Refrigeration and Air Conditioning Contractors Association (RACCA), Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH) and Royal Melbourne Institute of Technology (RMIT) all supported the event.

The events attracted almost 90 registrations, ranging from a 12-year-old student to a 72-year-old building services consultant, according to Dario Ferlin, refrigeration engineer, Woolworth Food Group, in a LinkedIn post. "One participant even took leave from work and paid his way to fly in from Cairns [Australia] over 2000 km [1.243 miles] away!"

Webinar on energy efficiency

shecco, publisher of *Accelerate Magazine*, held a webinar focusing on energy efficiency in HFC-free supermarkets. The webinar outlined key recommendations for end users, and included presentations from retailers sharing best practices, challenges and lessons learned. The webinar was part of a project funded by the Kigali Cooling Efficiency Program (K-CEP). ([See page 60.](#))



AHRAE celebrates at conference

Members of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) took time out during its annual conference, taking place from June 22-26, to celebrate WRD. Activities included distribution of "Refrigerants For Life" pocket guides from the United Nations Environment Program's OzonAction initiative, and photo ops giving participants the opportunity to tout their support on social media.

ASHRAE and OzonAction also held a webinar with the title "Refrigerants for life: How refrigerants affect modern life." The webinar aimed to capture a global image of current policies and usage trends for refrigerants in different applications, and included keynote speeches from (among others) Didier Coulomb, director general of IIR, and Andrea Voigt, director general of the European Partnership for Energy and the Environment. WRD founder Gill and ASHRAE EMEA Business Development Manager W. Stephen Comstock moderated the webinar. ■ TS



EIA: Updating HC Standards Is Key to Meeting Kigali Targets

Montreal Protocol's 41st Open-Ended Working Group of the Parties in Bangkok, Thailand

In a new report issued for the Montreal Protocol, the NGO calls for national approvals of IEC's new 500-g charge limit and an increase of the limit for ACs, while criticizing oversight of CFC-11

— By Marie Battesti

In a new wide-ranging report released at the Montreal Protocol's latest meeting, the Environmental Investigation Agency (EIA) calls updates on safety standards for hydrocarbon refrigerants "key to the implementation of the Kigali Amendment."

The NGO's report, "High-Stakes: Implementing and strengthening climate and ozone commitments under the Montreal Protocol" (<https://bit.ly/2GuLmwC>), was released at the 41st Open-Ended Working Group of the Parties in Bangkok, Thailand, held July 1-5.

Its main point is to call for better monitoring, reporting and verification requirements to combat illegal production and use of controlled refrigerants, in the light of the recent discovery of CFC-11 emissions in eastern China.

But the report also addressed a number of other areas, including the importance of updating hydrocarbon safety standards, energy efficiency in refrigeration and air-conditioning, the management and destruction of banks

of ozone-depleting substances (ODS) and HFCs, and the need to understand the long-term impact of trifluoroacetic acid (TFA) and other HFC and HFO breakdown products.

With the Kigali Amendment – which has established a global phase down of HFCs – coming into force at the beginning of 2019 for developed countries that have ratified it, EIA insists in its report on the need to update safety standards that have impeded the wider uptake of hydrocarbons.

EIA recognized the significant breakthrough that took place in May, when the IEC's 60335-2-89 standard was updated to increase the charge limit of flammable refrigerants to 500 g from 150 g in stand-alone cabinets in commercial refrigeration. ([See page 32.](#))

But the report recommends that Parties (countries) rapidly update their national and regional standards to be aligned with the new IEC standard. In addition, the report says that an update of the hydrocarbon charge-limit standard for air conditioning equipment is needed

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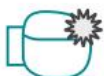
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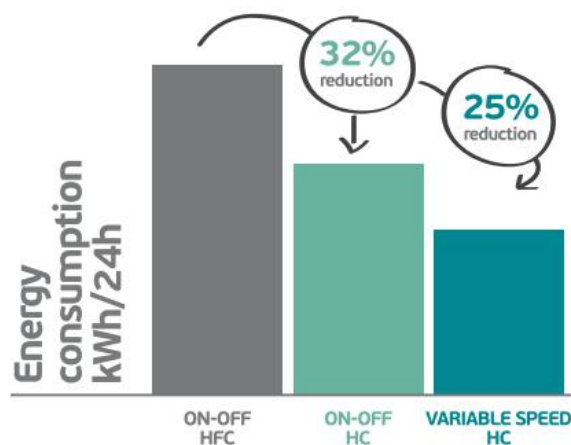
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“The huge and alarming CFC-11 spike must inevitably raise questions as to the fitness of the Montreal Protocol’s institutions and controls.”

— Avipsa Mahapatra, EIA

▶ to minimize the uptake of medium-GWP transitional refrigerants in ACs. This, it said, is key for a smooth implementation of the Kigali Amendment.

The NGO points out work is ongoing to allow higher charge limits for flammable refrigerants in air conditioning and heat pump equipment under IEC 60335-2-40. “The ‘Committee Draft for Vote’ (CDV) is anticipated by the end of 2019 and may result in publication of a new edition of the standard by 2021, provided it is approved in two rounds of voting,” the report says.

The current hydrocarbon charge limit for factory-made whole air conditioners and heat pumps is approximately 1 kg in a direct system inside, depending on room size, and 5 kg outside or in a special enclosure. Safety improvement measures that could support higher charges include improved leak tightness of the system, guaranteeing sufficient airflow in a room and the inclusion of leak-limiting valves, according to “International Safety Standards in Air Conditioning, Refrigeration and Heat Pump,” a 2018 report by GIZ (German Corporation for International Cooperation).

The EIA urges Parties to actively support the AC standard update, especially countries in the process of phasing out HCFCs so that they can bypass interim solutions and directly invest in energy efficient, low-GWP hydrocarbons for room air conditioning.

CFC-11 production in China

Through its report, the EIA issued a blistering criticism of the Montreal Protocol’s failure to oversee illegal production of outlawed refrigerants such as CFC-11.

“The huge and alarming CFC-11 spike must inevitably raise questions as to the fitness of the Montreal Protocol’s institutions and controls,” said Avipsa Mahapatra, EIA’s climate campaign lead based in Washington, D.C.

High emissions of CFC-11 were initially exposed by scientists in a letter to the journal *Nature*. EIA’s subsequent investigations identified illegal production and use of CFC-11 in China for the polyurethane (PU) foam insulation sector as the likely root cause.

A new study in May confirmed the findings, primarily in the northeastern provinces of Hebei and Shandong; 40% to 60% or more of the global emissions increase since 2012 can be attributed to this region.

China reported it has destroyed two illegal CFC-11 production facilities, seized 29.9 metric tons of illegally produced CFC-11 and has investigated 1,172 companies in China. But the EIA points out there are still knowledge gaps with regards to the production methodology, capacity and sales markets of those facilities, among others. ■ MB

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METRO AG TAKING CO₂ EJECTORS GLOBAL

The German retailer has installed transcritical ejector systems in China and throughout Europe

— By Devin Yoshimoto

German food retailer METRO AG continues to reach new milestones in its “F-Gas Exit Program,” which aims to phase out f-gases in all METRO Cash & Carry stores worldwide by 2030 through the deployment of CO₂ refrigeration systems.

Out of its 769 Cash & Carry (sometimes called Makro) stores in 26 countries, METRO has installed transcritical CO₂ systems in 95 and CO₂ cascade in 108 as of May 2019.

In recent months, the retailer has been improving the efficiency of its transcritical installations by including ejectors in 15 stores. “Our most preferred technology/type is [transcritical] CO₂ ejector plants,” said Olaf Schulze, director – energy, facility and resource management at METRO AG. “We believe that new [ejector] equipment can combine energy performance, customer added value and no (or low) emissions.”

In June, METRO China, which operates three transcritical stores, announced that it installed the country’s first transcritical CO₂ ejector system at its Chongqing store, which is located in China’s Nan’an district.

The store, which measures 15,536 m² (167,228 ft²), with a sales area of 8,597 m² (92,537 ft²), uses a transcritical CO₂ system from Carrier that replaced an R22 system.

“Due to the high temperature of Chongqing in the summer, we chose to use the ejector system as a solution for this store,” METRO China said in a statement. Energy savings compared to the R22 system is estimated to be 25%. Carbon emissions are expected to be reduced by around 917 metric tons of CO₂e per year.

The system has a low-temperature cooling capacity of around 140 kW (40 TR) and a medium-temperature cooling capacity of

around 350 kW (100 TR). In addition, the CO₂ system employs heat reclaim to provide hot water for the store’s daily use.

Also in June, METRO China retrofitted a store in Beijing with a transcritical CO₂ system from CREA that includes a parallel compression system. The retailer’s first transcritical system, at a new Beijing store opened in 2018, also uses parallel compression.

EJECTORS IN EUROPE

METRO AG has transcritical stores with ejectors operating in 14 stores in Europe, most of them installed this year.

In April, METRO AG opened its first CO₂ transcritical store Dubrovnik, Croatia; this system includes two Danfoss multi-ejectors, a high-pressure lift gas ejector, and a liquid ejector, as well as parallel compressors from Dorin.

In May, the company opened two stores with transcritical ejector systems in Poland – one in Opole and one in Czeszochowa. The latter system uses an ejector from Advansor and includes two booster racks for medium and low temperatures with a total cooling capacity of 184.3 kW (52.4 TR).

The retailer now has eight stores in Poland that use transcritical CO₂.

METRO AG has also installed transcritical ejector systems this year in Austria, France, Germany (one store each); Italy and Russia (two stores each); and in three stores in the Netherlands.

Later this year, METRO AG plans to implement transcritical CO₂ ejector systems at one store in Bulgaria (the second with ejectors), one store in Russia, seven in France and one in Belgium. ■ DY

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World in Brief

California Allocates \$1 Million For Green Refrigeration

In its final 2019-2020 budget bill approved on June 15, the California legislature allocated \$1 million to create an incentive program for adopting climate-friendly refrigerant technologies.

Governor Gavin Newsom signed the budget bill in late June.

The incentive program was established last year by the California Cooling Act (SB1013), which aims to reduce emissions of fluorinated greenhouse gases such as HFCs. The program also mandates consideration of energy efficiency and opportunities for increasing recovery, reclamation, and destruction of refrigerants at end-of-life.

The California Air Resources Board will oversee the program.
■ MG

PFAN, K-CEP Seek Efficient Cooling

The Private Financing Advisory Network (PFAN), a network of climate and clean energy financing experts, and the Kigali Cooling Efficiency Program (K-CEP), have launched a call for climate-friendly, energy-efficient cooling technologies.

PFAN aims to "bring projects to investment-ready status and then facilitate investor introductions." The network evaluates and selects projects on a quarterly basis.

Eligible regions include: Central, South and Southeast Asia, the Pacific Islands, Eastern Europe, the Caribbean and Central America, and Sub-Saharan Africa.

PFAN and K-CEP are looking for projects seeking investment of between \$1 million and \$50 million..
■ ZL

M&M Acquires Carnot

M&M Refrigeration, a major supplier of industrial ammonia/CO₂ cascade systems, on July 22 announced its acquisition of Carnot Refrigeration, a leading supplier of transcritical CO₂ systems to multiple business sectors.

Terms of the deal were not disclosed.

Based in Trois-Rivières, Québec, Canada, Carnot pioneered the use of CO₂ transcritical refrigeration in North America for commercial and industrial applications including data centers, food processing facilities, cold-storage warehouses, supermarkets and ice rinks.

M&M, based in Federalsburg, Md., designs, builds, manufactures and services industrial refrigeration equipment and control systems for cold storage, food processing and other industrial applications. A pioneer of ammonia/CO₂ cascade systems, it had installed them at more than 65 locations worldwide as of last year. In January 2018 M&M introduced a line of low-charge ammonia packaged systems called Pure Refrigeration.

In May 2018, M&M was acquired by Source Capital, an Atlanta-based private equity firm specializing in lower middle-market companies.

"We are thrilled to partner with M&M, and together pursue a future where eco-friendly refrigeration is the global standard," said Marc-André Lesmerises, CEO and founder of Carnot Refrigeration. "M&M's complementary market coverage and resources enhance our ability to service the growing demand for green refrigeration and heat pumps."

■ MG

Spanish Grocer Uses FTE System for CO₂

Consum, the largest grocery cooperative in the Spanish Mediterranean region, has chosen EPTA's CO₂ transcritical system, equipped with the Full Transcritical Efficiency (FTE) solution, for a new 1,100-m² (11,840 ft²) store in Alicante.

EPTA's FTE system is designed to improve the efficiency of transcritical CO₂ systems in warm climates. It uses flooded evaporation technology, supported by an intelligent liquid receiver, that allows the operating temperature of the cabinets to be increased.

FTE guarantees 10% continuous energy saving compared with a standard transcritical CO₂ booster rack, and 20%

lower installation and maintenance costs, according to EPTA.

The FTE system fits well with Consum, for which sustainability and efficiency are at the core of its activities. The chain operates 75% of its 730+ stores on renewable energy, with a goal of 100% in 2019, according to fiftybyfifty.org.

The new store in Alicante is designed to generating approximately 40% less emissions than a conventional store, thanks to the use of energy-efficient systems.

The installation includes Costan GranVista Next and GranBering cabinets for fresh and frozen products. ■ PA

Hillphoenix Installs 4th CO₂ System in Latin America

Hillphoenix's industrial division recently supplied a transcritical CO₂ booster system to one of the leading fruit processing companies in Peru, bringing the number of its natural refrigerant projects in Latin America up to seven, including four transcritical CO₂ installations.

Riopacking – an engineering and construction company specializing in food processing plants – was in charge of the installation, which took place in the city of Trujillo. The fruit-processing operator could not be identified without its permission.

The transcritical system serves 1,750 m² (18,837 ft²) of refrigerated storage, with a low-temperature capacity of 54 TR (190 kW), and a medium-temperature capacity of 21 TR (74 kW). The control package keeps the system's COP at maximum levels at all times.

"[The system] is very similar to a traditional HFC system – a common type of technology in this region – in terms of operation and maintenance," said Mauricio Baena, Hillphoenix's sales manager industrial in South America.

With this solution, the end user continues with its policy of using natural refrigerants – a decision that was made three years ago – to comply with international standards, and reduce the use of other refrigerants.

Including this project, Hillphoenix's industrial division has natural refrigerant installations in Mexico (2), Nicaragua (1), Costa Rica (2), Colombia (1), and Peru (1). ■ PA

Romanian NH₃ System Has 1.5-year ROI

Romanian installer Frigotehnica presented a case study showing a 1.5-year return on investment (ROI) for the purchase of an ammonia system rather than a traditional, HFC-based system.

The case study, presented during a conference in Bucharest, Romania, on June 6, showcased the installation of ammonia-based equipment in a poultry meat-processing facility. The end user decided to switch from an R404A system to an ammonia installation with a heat recovery system.

The single installation – which operates at maximum 460 kW (130.8 TR) – serves all cooling needs, including fast-freezing tunnels, water sprayers, chilled depositories, and glycol for cooling production and air conditioning. ■ MB

H-E-B Joins GreenChill

San Antonio, Texas-based grocer H.E. Butt Grocery Company (H-E-B), which operates 400 stores in Texas and Mexico, on July 19 announced that it has joined the Environmental Protection Agency's GreenChill Advanced Refrigeration Partnership.

"H-E-B is proud to join this cutting-edge partnership, which further signifies our commitment to be strong environmental stewards," said Winell Herron, H-E-B's group vice president of public affairs, diversity and environmental affairs.

To drive this commitment forward, H-E-B has appointed Keilly Witman as director of refrigerant management and sustainability. Witman helped launch the GreenChill Partnership in 2007, and she

SCMREF THAI Opens CO₂ Training Center

SCMREF THAI, a Thailand-based industrial and commercial refrigeration system manufacturer, opened a new CO₂ training center in Samut Prakan, just south of Bangkok, on June 13.

The company will be using the training center to train its internal engineers and sales people. "Right now, we are just focused on getting them familiar with the basics of working with CO₂, such as the operating pressure differences compared to traditional systems," said Varawut Kvankaew, managing director of SCMREF THAI.

"We hope that by educating people, we will boost the future CO₂ trend in Southeast Asia and that people will feel ready for the transition," Kvankaew added. ■ DY

managed it for six years as part of the EPA's Stratospheric Protection Division.

At H-E-B, Witman's task will be to lead the company's refrigerant strategies and ensure that it exceeds the partnership's standards.

Current GreenChill Manager Tom Land said, "H-E-B is a fantastic company to have join EPA's GreenChill Partnership because of their leadership in adopting advanced refrigeration technology."

The GreenChill program is a partnership between the U.S. Environmental Protection Agency and food retailers, aiming to reduce refrigerant emissions and decrease the industry's impact on the ozone layer and climate change. ■ TS

500 g

What does the new IEC hydrocarbon charge-limit standard for commercial cabinets mean for the natural refrigerant marketplace – and HFOs?

— By Michael Garry & Devin Yoshimoto

On May 9 of this year, in the culmination of a fierce, five-year debate over the amount of hydrocarbon refrigerant that can be safely used in commercial refrigeration, the International Electrotechnical Commission (IEC) approved an increase in the charge limit for A3 (flammable) refrigerants to 500 g (17.6 oz) from 150 g (5.3 oz) in self-contained commercial refrigeration display cases.

This change – as well as a rise in the charge limit for A2 and A2L (low flammable) refrigerants to 1.2 kg (2.6 lbs) from 150 g – was incorporated into IEC standard 60335-2-89, edition 3.0.

The effort to amend the 60335-2-89 standard with a higher charge limit for flammable refrigerants has been in the works since 2014, when the IEC's SC (subcommittee) 61C created a Working Group (WG4) for that purpose.

Notably, the new standard not only applies to commercial cabinets incorporating their own refrigeration unit but also commercial icemakers. Remote systems with more than 150 g of flammable refrigerant are excluded from the scope of the standard.

As the global organization establishing baseline standards for electrical equipment, the Geneva, Switzerland-based IEC has a huge influence on what systems, including those using natural refrigerants, will ultimately be adopted on a regional level. Thus, its approval of a 500-g charge limit for hydrocarbons like propane (R290) and isobutane (R600a), is one of the most important advances for natural refrigerants in recent years. It sets the stage for what could be a significant rise in the number of hydrocarbon-based self-contained display cabinets, already at 2.5 million globally, according to shecco, publisher of *Accelerate Magazine*.

"The safe application of flammable refrigerants like propane is fundamental to effective implementation of urgent climate legislation, namely the global HFC phase-down under the Montreal Protocol's Kigali Amendment and Europe's F-Gas Regulation," said Clare Perry, U.K. climate campaign leader for the Environmental Investigation Agency (EIA). "This standard will pave the way for the widespread

uptake of efficient and cost-effective climate-friendly commercial refrigeration, and sets the scene for a similar much-needed change to product standards for air-conditioning."

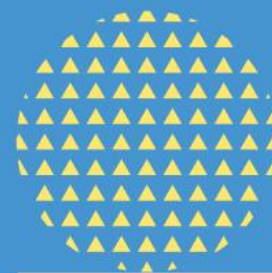
Daniel Colbourne, a U.K.-based consultant for GIZ Proklima, foresees the new charge limit having a substantial impact on the market for hydrocarbon systems. "Many companies have been waiting for this charge increase and so it surely will result in a huge shift," he said.

In particular, larger charge sizes will reduce the number of circuits needed to cool a large commercial case – in many instances down to one – thereby cutting costs for food retailers. "I believe the new IEC hydrocarbon charge limit (500 g) will reduce the overall CAPEX of a store relative to the 150-g limit, thereby making this architecture more attractive to those retailers comfortable with hydrocarbons in their stores," said Andre Patenaude, director food retail, growth strategy, Emerson Commercial & Residential Solutions.

But it almost didn't happen.

IEC standard changes are based on voting by National (country) Committees. The FDIS (Final Draft International Standard) – the final vote addressing the charge limit standard – initially fell just one-third of a vote short of being approved in the tally on April 12. Out of 35 total votes cast by National Committees, nine (25.7%) voted against; for the proposal to be enacted, the opposing votes could not exceed 25%. Some of the countries voting against raising the charge limit did so despite "not participating in the development of the standard," noted Marek Zgliczynski, chair of the IEC SC61C subcommittee as well as director of research and development for Brazilian refrigeration manufacturer Embraco.

However, it quickly became clear that the vote of the Malaysian National Committee was accompanied by comments flagged as "editorial" and as such had to be excluded from the vote count. According to IEC rules, negative votes must be accompanied by "technical" reasons to be counted. That reduced the negative vote total to eight, which enabled approval. (Final country-by-country voting is listed at <https://bit.ly/2UeBdZa>.)



Malaysia appealed the rejection of its vote but did not prevail. Another National Committee, Serbia's, was also found to have submitted a negative vote without technical justification.

"To my knowledge, this is the first time that such a situation has arisen in the long history of the IEC," which was formed in 1906, said F.W.P. Vreeswijk, IEC general manager and CEO.

On June 20, IEC published the newly updated version of 60335-2-89, officially completing the process. But in its wake a number of questions have already emerged about when the IEC standard will be adopted by regional standards bodies and what its impact will be on the uptake of hydrocarbons and other refrigerants like CO₂ and HFOs that are used in commercial refrigeration.

New safety requirements

In raising the amount of flammable refrigerants that could be used in commercial cases, the IEC had to make the case that it was not comprising safety. Indeed, some national committees, such as the U.S. and Japan, are said to have voted against raising the charge limit at least in part because of safety concerns.

Even in Europe, Arneg, the Italian self-contained cabinet manufacturer, is finding that its customers "are pushing us to maintain the 150-g charge" out of concerns about flammability, said Enrico Zambotto, its refrigeration director.

However, the IEC's risk assessments have shown that the revised rules for the higher charge limit made it even safer than the current 150-g charge limit, said Zgliczynski.

In a presentation at ATMosphere America in Atlanta, Ga., in June, Zgliczynski outlined the new safety requirements for flammable refrigerant charges above 150 g. (The conference was organized by shecco.)

Among the requirements: the refrigeration circuit has to be hermetically sealed; the appliance should be constructed not to cause excessive vibration or resonance; the appliance shall be marked with the minimum floor area in which it is permitted to be installed (with some exceptions); and the appliance shall be constructed to prevent flammable refrigerant concentration surrounding the appliance in case of a leak, as verified by the "Annex CC" test. Testing also includes a door/drawer opening test after a full charge release inside of a closed cabinet.

But it is still up to regional standards groups to decide whether to accept the IEC's safety guidance or come up with something different in order to justify larger hydrocarbon charges. Some OEMs are concerned "about the impact of additional safety regulations on their product development and sales strategies," said Robert Terry, director, global product management, variable speed platform, for U.S. compressor manufacturer Tecumseh.

In North America, CANENA, a standards harmonization body for the Americas, will develop the new hydrocarbon charge-limit standard for the U.S. and Canada. That will happen in the coming months "with some modification based on NFPA [National Fire Protection Association] and AHRTI [Air-Conditioning, Heating, and Refrigeration Technology Institute] studies," said Zgliczynski.

CANENA "has just started talking about moving on a standard," said Charles Hon, engineering manager for O'Fallon, Mo.-based commercial case maker True Manufacturing, who is a member of CANENA. "We haven't formed a committee yet but we're doing exploratory work on a proposal to start the process."

Participants in the CANENA effort include representatives of UL (Underwriters Laboratories), CSA (Canadian Standards Association) and AHRI (Air-Conditioning, Heating, and Refrigeration Institute), said Hon, adding that a binational CANENA standard would be accepted by UL and CSA.

Hon said he expects CANENA's hydrocarbon charge-limit standard to have "more safety controls than have been placed in the IEC standard." It's also possible, he added, that the standard will limit the hydrocarbon charge in upright commercial cabinets with doors – in which leaks could accumulate – to 250-300 g. (8.8-10.6 oz). But for other cabinets, a 500-g limit would apply. "That's the direction of some people," he said.



Hon believes that CANENA will act on a standard faster than it previously did for general rule changes, which took four years. "There are too many drivers here," he said. "There are people who want to have it done by the end of next year, but that to me is a very aggressive schedule."

In the U.S., ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) would also need to update its general safety standard, ASHRAE-15. The timing for that, noted Zgliczynski, is "unpredictable."

The U.S. Environmental Protection Agency (EPA), through its SNAP (Significant New Alternatives Policy) program also has to weigh in, usually by adopting the UL standard. Finally, the model code bodies that establish codes for buildings and fire safety would need to update their standards; with the 2021 codes already set, the next opportunity would be for 2024.

The adoption of the higher charge limit by building codes is "the piece that will enable us to do it in the U.S. without complication," said Geoff Amos, co-founder of NRMS Global, a U.K.-based design, manufacturing and consulting firm.

In Europe the revised IEC standard 60335-2-89 is going to be adopted by CENELEC (the European Committee for Electrotechnical Standardization) in EN 60335-2-89 "but not earlier than 2020 because of delays in the harmonization process with European directives," said Zgliczynski.

Colbourne is also uncertain about how quickly Europe will adopt the new IEC standard. He points to "problems with the harmonization of 60335-1, and that has a domino effect on all the others in the 60335-2-xx group."

On the other hand, even with a delay in CENELEC's incorporation of the standard, manufacturers, noted Colbourne, have another option: "They can demonstrate conformity to the so-called EHSRs (environmental health and safety requirements) from the [EU] directives, and these can be assigned to the relevant clauses in the IEC versions easily enough."

Next Up: Condensing Units and ACs

Having tackled hydrocarbon charge limits for self-contained commercial refrigeration units, the International Electrotechnical Commission (IEC) is looking at updating the standard for remote condensing units, which were excluded from the new IEC standard. The hurdle here is devising a proper test," explained Daniel Colbourne, U.K.-based consultant for GIZ Proklima.

The charges being discussed for remote condensing units vary, he said. "Some people here tell me 500 g is sufficient, while others tell me 1,500 g might just be enough! I think it all comes down to what equipment people are interested in."

The IEC is also working on updating the charge limit for hydrocarbons in air conditioning and heat pumps under IEC 60335-2-40. "We are hoping to issue a CDV (committee draft for vote), towards the end of this year," said Colbourne, referring to an interim vote by national committees. He expects considerable opposition from companies "with A2L interests."

According to the Environmental Investigation Agency (EIA), the 60335-2-40 CDV "may result in the publication of a new edition of the standard by 2021 provided it is approved in two rounds of voting." (See page 24.)

The current hydrocarbon charge limit for factory-made whole air conditioners and heat pumps is approximately 1 kg in a direct system inside, depending on room size, and 5 kg outside or in a special enclosure. Safety improvement measures that could support higher charges include improved leak tightness of the system, guaranteeing sufficient airflow in a room and the inclusion of leak-limiting valves, according to "International Safety Standards in Air Conditioning, Refrigeration and Heat Pump," a 2018 report by GIZ.

In support of the development of new hydrocarbon charge-limit standards, the LIFE FRONT project, funded by the EU LIFE Programme, is collecting field data on leak hole size, refrigerant mass flow rate, the causes of leaks and other parameters. The project is targeting standards such as EN 60335-2-40, EN 378 and ISO 5149, with a particular focus on domestic air conditioning and heat pumps. (shecco, publisher of *Accelerate Magazine*, is a participant in LIFE FRONT.)

Learning from Waitrose

Retailers interested in seeing how larger hydrocarbon charges work in the real world need look no further than what the U.K. grocery chain Waitrose has been doing for about a decade.

Waitrose now uses water-cooled hydrocarbon refrigeration in all refrigerated and frozen cases (including closed and open) and walk-in coolers at more than half of its 349 stores (the others use traditional DX systems), including new and retrofit locations, said Geoff Amos, co-founder of NRMS Global, a U.K.-based design, manufacturing and consulting firm, who has worked with Waitrose for a number of years. Most of Waitrose stores comprise 2,300 m² (25,000 ft²).

Waitrose's cases include between 300 g and 1,000 g of hydrocarbon charge per circuit, depending on the size and type of fixture, said Amos.

"It's been a success – no safety issues," he said, adding that the systems have been "practically leak-free."

Waitrose and other U.K. retailers have been able to use larger-than-150-g hydrocarbon charges by invoking the EN 378 (ISO 5149) general standard that allows charges up to 1.5 kg above ground (1.0 kg below ground) if rigorous safety precautions are taken.

The EN 378 safety rules are more stringent than those required for 500 g under the new IEC 60335-2-89 standard, noted Amos. In addition, EN 378 applies to "systems" while the IEC standard applies to "appliances." Waitrose's cases were defined as systems, said Amos.

In other parts of Europe, only a handful of stores have installed charges above 150 g per circuit in self-contained cabinets based on EN 378.

Waitrose employs propene (R1270) in most of its stores and propane on the rest, said Amos. The chain favors propene because it has a 5%-6% better capacity than propane and works better across medium- and low-temperature cases. It also emits an odor upon leaking, making it "self-alarming." While propene is widespread in the U.K., propane is the dominant hydrocarbon in the rest of Europe.

NRMS has worked with Waitrose on a shelf design that changes the airflow of open cases, enhancing the strength of air curtains, and improving the energy efficiency of the unit. Four stores have installed them. NRMS is testing variable-speed compressors that would further improve system efficiency, said Amos.

According to a 2017 Emerson study by the University of Birmingham, in stores converted to R1270 from remote systems using R404A, Waitrose saves 7% on electricity and 60% on gas (waste heat from the cooling loop is used for space heating). This reduces operating costs by £65,000 (\$81,283) per store per year. (The capital cost of each hydrocarbon system saves the company about £85,000/\$106,293.)

The Waitrose stores generally use water-loop systems in concert with the self-contained cases, with heat rejected by the water in a dry air cooler outside. Previous versions employed an R290 chiller.

Amos, who applied to the EPA for approval of 1,000 g of propane and propene, doesn't think propene will be accepted in the U.S. because it includes trace amounts of volatile organic compounds.

Waitrose's newest store opened in July in the Belgravia section of London, around the corner from Buckingham Palace. "High-charge hydrocarbons are OK for the Queen, right on her doorstep," said Amos.

In Japan, the use of flammable refrigerants is governed mainly by the High Pressure Gas Safety Act, administered by the High Pressure Safety Institute of Japan. Individual product standards are developed by Japanese Industrial Standards (JIS).

A guideline for a new hydrocarbon standard in Japan is expected to be published in the spring of 2020. That guideline will be based on a pending risk assessment by the Japan Refrigeration and Air-Conditioning Industry Association (JRAIA), supported by Japan's Ministry of Economy Trade and Industry (METI). The guideline would then influence the High Pressure Gas Safety Act and JIS, and subsequently codes in the Building Act and the Fire Service Act.

In Australia, the use of flammable refrigerants in commercial refrigeration is mainly guided by Standards Australia's AS/NZS 60335.2.89, according to the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) Flammable Refrigerants Safety Guide. It is not clear when this standard is set to be updated, though normal processes have shown that a higher charge could be approved in two to three years.



Thumbs up

The immediate reaction to the increase in the IEC charge limit to 500 g was positive throughout the world, from Australia to Europe to the U.S. (See [“Higher HC Charge Limit Gets Global Thumbs Up,” Accelerate Magazine](#), June 2019.)

NRMS Global's Amos expects more adoption of store-wide self-contained refrigeration with the higher hydrocarbon charge limit by retailers in continental Europe as more manufacturers convert to the new standard in their systems. “That’s still in the works but I’m pretty sure they will,” he said.

Once North America adopts higher charge limits for hydrocarbons, True’s Hon expects there to be an impact on the commercial marketplace, especially in states and regions that move to low-GWP maximums (such as 150) for commercial refrigeration.

In the U.S., the Hannaford chain in New England, a division of Ahold Delhaize, is testing full line-ups of water-cooled low-temperature R290 cases (using less than 150 g per circuit) in a few new stores, with an eye to using them in existing stores. (See, [“R290: The Future of Retail Refrigeration?” Accelerate America](#), January 2019.)

Harrison Horning, director of maintenance for Hannaford, said at the ATMosphere America conference in June that he is satisfied with 150 g or less of R290 charge, and doesn’t see much need for more than 150 g, “though the cost effectiveness might be better with a bigger charge.”

Two Texas retailers with several years of experience with R290 self-contained cases spoke favorably of them at the ATMosphere America conference. “Once you get it dialed in, it’s a robust system and works great,” said Gary Cooper, director of engineering for Lowe’s Markets, whose single-store R290 low-temperature units consume 25% less energy than a comparable HFC condensing unit in a lab. He said he would be open to a full-store implementation of R290 cases with a 500-g charge limit.

The efficiency advantage of hydrocarbon systems was demonstrated in a 2017 University of Birmingham study, “Retail Refrigeration – Making the Transition to Clean Cold.” It cited an Emerson study comparing the energy consumption and leaks of a self-contained R290 system to remote HFC, HFO and CO₂ booster systems in terms of CO₂e emissions generated. The hydrocarbon system generated the least power-related emissions; it also had the lowest TEWI (total equivalent warming impact), 50% less than R404A, 30% less than R448 and 12% less than CO₂. See chart, [page 38](#). (The study has not been independently tested, the report said.)

Charles Wernette, principal engineer for San Antonio, Texas-based H.E. Butt Grocery (H-E-B), said the IEC charge increase “makes the whole conversation about hydrocarbons much easier” in terms of price and maintenance. “We want to use as few compressors as possible,” he added. Wernette said he appreciates the simplicity of plug-in hydrocarbon systems, comparing them to home refrigerators.

TEWI Comparison of Supermarket Refrigeration Systems (in tons of CO₂e emissions)

Refrigerant	R404A	R448A	R744	R290
MT Power	1250	1240	1475	1256
LT Power	335	369	205	215
MT Leak	1075	395	0	0
LT Leak	260	93	0	0
TEWI	2920	2097	1680	1471

MT = Medium Temperature, LT = Low Temperature, TEWI = Total Equivalent Warming Impact (power + leaks).



Source: "Retail Refrigeration – Making the Transition to Clean Cold,"
University of Birmingham/Emerson

Japanese retailers, who typically employ CO₂ as a green refrigerant, have shown little interest in hydrocarbon equipment. What may change that is the outcome of JRAIA's hydrocarbon risk assessment.

Meanwhile, several Japanese technology suppliers and retailers are taking early steps to begin marketing and implementing hydrocarbon systems.

For example, Lithuania-based OEM Freor partnered with Japan-based OEM Nihon Netsugen Systems to exhibit its hydrocarbon water-loop technology in Japan for the first time at the Supermarket Tradeshow 2019 exhibition in Tokyo.

On the end user side, METRO Cash & Carry Japan is planning to replace its R404A freezer cabinets with R290 plug-in systems at three of its existing Japanese wholesale stores. And convenience store giant Lawson, a major user of CO₂ systems, announced it will be

conducting initial tests with Embraco's hydrocarbon-based Plug n' Cool system for small built-in display cases.

Not only in Japan, but throughout the world, questions are being asked about whether larger charges of hydrocarbons would take away market share from CO₂ systems. Colbourne doesn't think so. "R744 is much more suited to larger centralized systems, which hydrocarbons are not," he said.

Emerson's Patenaude says the impact of hydrocarbons on CO₂ will be "minimal."

But Amos thinks some retailers will choose hydrocarbons over CO₂ rack systems, depending on "where they are in the world and the skill set around." It's much easier for technicians to install and maintain hydrocarbon self-contained systems than remote CO₂ rack systems, he said.

Jurate Mizare, marketing manager for Freor believes the higher charge

size will "increase the attractiveness of hydrocarbon-based refrigeration systems versus CO₂ systems, especially for smaller stores."

How will the higher charge of hydrocarbons fare against 1.2 kg of A2L or A2 refrigerants (such as HFOs)? "A2L/A2s are only considered when there are no other options," said Colbourne. "There is a capacity band for commercial refrigeration where A2L/A2s are most viable, such as when several cabinets are multiplexed and remote systems, but the use of this approach is declining more and more so I can't imagine there will be so much interest over time."

Because of the greater efficiency of comparable hydrocarbon circuits, Amos does not see A2Ls, at least with a charge limit of 1.2 kg, as an option for self-contained cases. "A2Ls have a life, but not in that application," he said. "Maybe in DX systems in Europe where the GWP has to be below 150."

And True's Hon pointed out that propane would be far less costly than low-GWP HFOs that might compete with it. "HFO costs will be substantially higher even with large volume increases."

Anticipating these hurdles, A2L refrigerant manufacturers opposed the IEC's efforts to raise the charge limit for hydrocarbons, according to several sources interviewed by *Accelerate Magazine* who declined to be identified because of ongoing relationships with the manufacturers. One source said the companies are still trying to prevent regions from adopting the new IEC standard for the same reason. (Two HFO makers, Chemours and Honeywell, did not respond to a request for comment.)

The 1.2-kg charge limit for A2Ls and A2 refrigerants was selected to match the cooling capacity estimated for 500 g of propane (4 kW or 1.1 TR)), said Colbourne. (See "[Higher Hydrocarbon Charge Limits: A Long and Winding Road](#)," *Accelerate Magazine*, June 2019.) However, because of the drawbacks of 1.2 kg, A2L manufacturers are now preparing to seek a higher charge limit for A2Ls in the next update opportunity for the IEC standard in 2022, he said.

Manufacturers take stock

Meanwhile, equipment manufacturers are assessing their product portfolio in anticipation of higher hydrocarbon charge sizes. Some are already prepared, while others will be making updates.

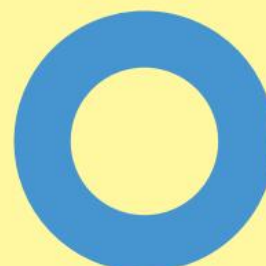
Italian component manufacturer Carel is already offering controls for plug-in and water-loop cabinets equipped with 500 g of hydrocarbons, said Diego Malimpensa, application manager for Carel. "Due to the fact 500 g will not be easily accepted in all countries, we have also comparable solutions with CO₂," he added.

Having provided cases with higher charges under EN 378 in Europe ([see page 36](#)), FREOR is ready for the 500-g limit in most of its cabinets and showcases, said Mizare. "We believe it will facilitate our expansion in the market."

Tecumseh's Terry said the company is "well-prepared to meet [higher hydrocarbon charges] with larger displacement R290 compressors and value-added systems in both fixed-speed and variable configurations."

Embraco currently makes HFC compressors serving larger than 150-g charges, and transitioning those to 500-g hydrocarbon units would "not be a big deal," said John Prall, applications engineer for Embraco North America.

U.S.-based Hussmann believes its microDS R290 system can accommodate retailers using up to 150 g of R290 for both open and closed cases, said CEO Tim Figge at the



ATMOsphere America conference in June. "We feel confident in our solution, but our portfolio continues to develop."

Thailand-based Sanden Intercool, one of Southeast Asia's largest manufacturers and exporters of commercial refrigeration equipment, has devised "a concise three-year plan to develop a complete range of green commercial, professional and retail refrigeration equipment for the beverage, dairy, ice cream, foodservice and retail store segments," said Alex Panas, commercial director, Sanden Intercool.

At the moment, all of Italian OEM Epta's self-contained units using propane as a refrigerant are at the limit of 150 g per circuit. "We are currently assessing the potential for products with higher charge limits, in order to plan new product developments according to market requests," said Francesco Mastrapasqua, advocacy & regulatory affairs manager.

"We consider the introduction of this new standard as an opportunity for a broader use of climate-friendly refrigerants worldwide, giving a significant contribution to the mitigation of climate change." ■ MG

Standards Organizations in Major Markets



Global:

IEC, ISO

1, North America:

CANENA, UL, ASHRAE, EPA

2, Europe:

CENELEC, CEN

3, Japan:

METI, JIS, High Pressure Safety Institute of Japan

4, Australia:

Standards Australia

AHRTI Report Challenges IEC Standards

A new report issued by the Air-Conditioning, Heating, and Refrigeration Technology Institute (AHRTI) makes a number of recommendations pertaining to the safe use of hydrocarbon (A3) refrigerants in commercial refrigeration and air conditioning, including some that challenge "either existing or proposed standards."

The AHRTI report, "Benchmarking Risk by Whole Room Scale Leaks and Ignitions Testing of A3 Refrigerants," focuses on single-door and three-door reach-in coolers in a convenience store, and PTAC and mini-split air conditioners in a motel room. (The report can be accessed here: <https://bit.ly/2M2my2V>). AHRTI is the research arm of the Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

The objective of the study was to conduct leak and ignition testing for R290

(propane) "under whole room scale conditions to develop data and insight into the risks associated with the use of Class A3 refrigerants and to generate technical data to support revisions of relevant safety standards."

AHRTI designed its testing scenario according to the existing or proposed requirements in the IEC (International Electrotechnical Commission) Standards IEC 60335-2-89 (for commercial refrigeration products) and 60335-2-40 (for air-conditioning products) and their equivalent North American version published by UL.

"Over the course of the project, the test results were presented to the working groups of the IEC SC61C/WG4 and IEC SC61D/WG16 while they were revising the contents related to using A3 refrigerants in the IEC 60335-2-89 and IEC 60335-2-40 respectively," the report says.



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Studies &
Technomercials

HVAC
Technomercials

Refrigeration Case
Studies &
Technomercials

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WEIS MARKETS REPORTS DRAMATIC ENERGY SAVINGS WITH TRANSCRITICAL CO₂

The chain's first transcritical system consumed less energy than three other store systems during an 8.5-month test

— By Michael Garry

O Remarkable," said Paul Burd, manager, refrigeration engineering for Weis Markets, a Mid-Atlantic chain of 204 grocery stores.

He was referring to a chart comparing the energy usage of four refrigeration systems used by Weis stores between August 2018 and May 2019, as he stood before about 400 attendees of the ATMOSphere America conference in Atlanta, Ga., in June. All four systems are located in stores of similar size and refrigeration load.

What was remarkable to Burd was the energy savings demonstrated by Weis's transcritical CO₂ refrigeration system, installed at a 54,000 ft² (5,017 m²) store in Randolph, N.J., in July 2018, the chain's first such system. Its energy usage during that period was 250,790 kWh, substantially below the energy consumed by the other systems, all based on HFC or HFO refrigerants: 32% less than a 1.5-year-old secondary glycol/DX system, 39% less than a seven-year-old distributed rack system, and 86% below a 23-year-old centralized DX system. (See [chart, page 44](#).)

The test period included August and September 2018, when high ambient temperatures, particularly during a two-week period, challenged the efficiency of a transcritical system. Yet Weis's unit consumed less energy during that period than the other systems.

The transcritical system, Burd said, "has really been a win for us."

He received some pushback on the energy savings from the ATMOSphere America audience, with one attendee questioning whether the three older systems represent a fair baseline. He responded by noting that Weis commissions its stores annually to ensure they are running optimally. "We take that very seriously," he said.

He acknowledged that the systems differ in the number of compressors used, and the older systems may have suffered an energy penalty by using hot-gas defrost rather than electric defrost, which the transcritical system employs. In the end Burd deferred to his data. "I'm just showing you the numbers," he said.

A system evolution

Burd went into the evolution of Sunbury, Pa.-based Weis's refrigeration technology, up to installing a transcritical CO₂ system. (See also "[Weis Markets' Journey to CO₂](#)," *Accelerate America*, September 2018.)

Weis began with central DX racks, then moved to distributed DX racks located near display cases. Its current design combines a low-temperature R448A



“The transcritical system has really been a win for us.”

— Paul Burd, Weis Markets

In the near future HFC refrigerants will be replaced by low environmental impact fluids. This scenario has prompted Modine to develop a complete range of CO₂ units for commercial and industrial applications.

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central DX rack with a medium-temperature R404A chiller using a pump to circulate secondary glycol to the cases.

Its transcritical CO₂ rack, an Advansor unit from Hillphoenix, employs three low-temperature and five medium-temperature compressors, with a CO₂ charge of 1,100 lbs (499 kg) and an adiabatic condenser from Baltimore Aircoil. It supplies a low-temperature capacity of 343.2 kBTU/hr at -24°F (-31°C), and a medium-temperature capacity of 1,137.3 kBTU/hr at 19°F (-7°C). The system includes heat reclaim for HVAC and water.

"We looked at transcritical for two to three years," said Burd. What held up a test was the unfamiliarity of Weis's in-house service technicians with servicing stainless steel piping. That changed with the release of Mueller's XHP copper-iron fittings, "which we could install ourselves," he said.

Still, launching its first transcritical system "was a big step for us," noted Burd. "It was hard for me to sell the idea."

But the company is now persuaded by the performance of the transcritical system. "It's a learning curve that we all need to be involved in," he said, adding, "It's been a great experience."

Burd had been concerned about the possibility of large CO₂ losses as a result of a power failure, so he installed a back-up 2-HP condensing unit to prevent pressure build up in the surge tank. However, leakage has been minimal, limited to some access points on the rack, he said.

Weis benefited from the CO₂ experience of its contractor, AAA Refrigeration, as well as from oversight and training offered by Hillphoenix and controller supplier Danfoss. "The last three weeks before the store opened, Hillphoenix and Danfoss were at the store every day," Burd said.

Hillphoenix spent 1.5 days training six of Weis technicians on the system. "They're very comfortable with it now," he said. "I can't say enough about Hillphoenix's training."

Energy Usage Comparison with Transcritical CO₂

(comparable store size and load)

SYSTEM	AGE (YEARS)	KWH USAGE 8/25/18- 5/6/19
5 DX racks, air-cooled condensers, individual system piping	23	466,693
6 distributed racks, loop piping, microchannel condensers, case controls	7	411,788
2 compressor racks (1 MT, 1 LT), MT secondary glycol, loop piping, case controls, adiabatic condensers	1.5	366,816
Transcritical CO ₂ rack, loop piping, case controls, adiabatic fluid coolers	0.5	250,790

Asked if Weis would now commit to using transcritical systems in future stores, Burd said the company is still monitoring the system during its first year of operation. Regarding costs, he said that while installation costs were comparable to its DX/secondary glycol system, there was still a "little upcharge" for the transcritical system, though Weis is working with Hillphoenix on design changes that could reduce the cost.

Weis has let shoppers at the Randolph, N.J., store know about the presence of a green refrigeration system. "We put signs throughout the store," Burd said. ■ MG



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Minibooster distributed CO₂ system

Distributed Systems Extend Hillphoenix's CO₂ Lineup

Minibooster and Tower units, imported from Europe, are designed for small stores and retrofits

— By Michael Garry

OEM Hillphoenix, a leading producer of transcritical CO₂ systems for the North American market, has introduced two distributed CO₂ rack systems designed for small retail outlets or retrofits and line extensions in conventional stores.

The systems – the Minibooster and the Tower – were displayed at Hillphoenix's Conyers, Ga., headquarters in June during a tour of its facilities for attendees of the ATMOSphere America conference. (The conference was organized by shecco, publisher of *Accelerate Magazine*.)

Both systems have been marketed in Europe by Danish OEM Advansor, a division of Hillphoenix.

Hillphoenix has sold more than 500 transcritical racks in North America, including full-size systems (called Advansor) and downsized units (called AdvansorFlex). The Minibooster and Tower units represent “a continuation of what we started in 2011 when we acquired Advansor,” said Subodh Sharma, director, product management systems, small format & self-contained for Hillphoenix.

“We are seeing more smaller stores with reduced loads so there is less need for a central system and more need to place systems closer to loads.”

— Subodh Sharma, Hillphoenix

Designed for the European market, the Tower and Minibooster are not yet available in the U.S., though “we are looking at adapting them to the U.S. market and seeing where changes need to be made for regulatory compliance,” said Sharma. Hillphoenix has a “couple of customers” interested in the Minibooster system.

The Tower unit offers a capacity of 283 KBTUs for medium-temperature cases and 68 KBTUs for low-temperature cases. The rack includes three medium-temperature and one low-temperature reciprocating Bitzer compressors. It is suited for a standard lineup of cases, said Sharma.

The Minibooster includes four medium-temperature and two low-temperature rotary Toshiba compressors (or comparable Bitzer compressors), producing a medium-temperature capacity of 137 KBTUs and a low-temperature capacity of 32 KBTUs. It is targeted for a lineup of small cases, he said.

Both units would need to be integrated with a condenser/gas cooler. The installed cost of each is approaching parity with that of similar-capacity HFC system, according to Hillphoenix.

TAKING OUT COSTS

Hillphoenix executives also spoke about aspects of their other CO₂ product offerings, including costs and product development.

As a large-scale producer of transcritical CO₂ racks, Hillphoenix has been able to “take costs out” of the manufacturing process, bringing down the installed cost of the equipment, said Derek Gosselin, manager of the technical product support team.

Michael May, director of R&D for Hillphoenix, said the company’s development efforts have driven the equipment and installation cost of transcritical racks down to where “we’re very close to parity” with comparable HFC systems, adding that “for certain applications we are at parity.”

To enhance the efficiency of transcritical systems in warm climates, Hillphoenix has invested in the development of gas and liquid ejectors. The company already has a gas ejector available, and is only a few months away from finishing work on a liquid ejector.

“We expect in the very near term to offer advanced CO₂ systems with a gas or liquid ejector or a combination of both,” said May. In fact, Hillphoenix is seeking retail partners to pilot gas ejectors, he added.

At the tour of its headquarters, Hillphoenix executives also discussed new microdistributed and distributed systems that employ HFCs and HFO blends. The company has two distributed units that include a condenser and receiver: the AdaptaPak launched two years ago for outdoor installation and the newly launched InviroPak for indoors (in both vertical and horizontal models).

“We are seeing more smaller stores with reduced loads so there is less need for a central system and more need to place systems closer to loads,” said Sharma.

The microchannel system, called SoloChill, is a complete-store solution that consists of a condensing unit in each case that uses less than seven lbs of R410A, R448A or R449A, and a water loop linked to a fluid cooler.

May said the company “is looking at developing a hydrocarbon version of the self-contained [SoloChill system] to go with HFOs, along with other options for self-contained as well.”

May described some innovative research Hillphoenix is conducting for transcritical technology. One involves using water for subcooling, and another is examining an innovative cooling approach as a supplement to transcritical CO₂ in order to “expand its efficiency and environmental application range,” he said.

Hillphoenix is also working with a supermarket chain on installing a CO₂ rack to integrate both refrigeration and HVAC. ■ MG

“We expect in the very near term to offer advanced CO₂ systems with a gas or liquid ejector or a combination of both.”

— Michael May, Hillphoenix



Tower distributed CO₂ system

US Climate Alliance Urges Industry to Support States' HFC Regulatory Efforts

At ATMOSphere America, Executive Director Julie Cerqueira offers the Alliance as a vehicle to provide information to 25 states

— By Michael Garry

Speaking on June 18 at the ATMOSphere America conference in Atlanta, Ga., Julie Cerqueira, executive director of the U.S. Climate Alliance, called upon the 400 HVAC&R industry attendees to “give us your best ideas and work with us to implement them.

“Some of our best ideas we have had because industry has brought them to my attention or has talked to our states,” she added.

Formed in 2017 in response to U.S. plans to withdraw from the Paris climate change accord, the U.S. Climate Alliance is a bipartisan group of 24 U.S. state governors as well as the governor of Puerto Rico.

Among its initiatives aimed at reducing greenhouse gas emissions in the absence of federal leadership, the Alliance is addressing short-term climate pollutants (SLCPs), including HFCs. ([See “States Coalition Making Progress on HFC Reduction,” Accelerate Magazine, June 2019.](#))

Julie Cerqueira,
U.S. Climate Alliance



“Some of our best ideas we have had because industry has brought them to my attention or has talked to our states.”

— Julie Cerqueira, U.S. Climate Alliance

Already several Alliance states, including California, Washington, Vermont, Connecticut, New York, Maryland and, most recently, Delaware (see sidebar, this page) have launched or are working on regulations to reduce HFCs and enable alternatives like natural refrigerants.

Cerqueira, who was named Person of the Year at the ATMOSphere America conference for her work at the Alliance, stressed that states in the Alliance recognize the need for consistent HFC regulations to avoid a “patchwork regulatory framework” across states.

EDUCATING LEGISLATORS

Cerqueira urged conference attendees to help the Alliance to educate state and federal legislators on the importance of reducing HFC emissions and supporting natural refrigerants

“For those of you who have partnered with an association, if you have a policy paper that outlines what you want, if you have a draft text that you want us to look at, if you have analysis you want us to share, [the Alliance] is a great way for you to talk to 25 states.”

At the state level, HFC reduction is an issue where there is general agreement among industry, the environmental community and other stakeholders, noted Cerqueira. Still, state legislators “need to hear from you that you support their taking action, so they can be courageous,” she said.

Educating the states and Congress is key to advancing HFC regulations given that “this is a pretty niche issue” compared to the contribution of energy consumption and transportation to climate change. But she pointed out that HFC reduction is “low-hanging fruit that they can tackle

easily. It should be an easy bipartisan decision.” The technology needed to support a transition from HFCs “is already available,” she added.

Cerqueira acknowledged that the preferred route on HFC regulation would be federal legislation in concert with ratification of the global HFC-reduction scheme under the Kigali Amendment to the Montreal Protocol.

“We all want a national framework,” she said. “That means encouraging Congress to put forward legislation and ratify the Kigali Amendment so we can join the community of nations that are moving in that direction.”

At the same time, Cerqueira emphasized the need for states to be able to set their own environmental regulations and not be preempted by the federal government. States can regulate HFCs but not energy efficiency requirements, which are set by Washington, D.C. “So preserving states’ rights while also encouraging a federal framework is critically important.”

Last year, the Alliance issued an “SLCP Challenge” urging national and subnational jurisdictions, business and other actors to bring SLCP-reduction plans to the Global Climate Action Summit in San Francisco, Calif., in September. That month, the Alliance issued its own SLCP “Challenge to Action” roadmap filled with recommendations on how to reduce SLCP emissions by 40% below 2013 levels by 2030. For HFC reduction, the plan suggested that states could adopt regulations, limit use of high-GWP refrigerants, and develop incentive programs for new low-GWP systems, among other measures. ■ MG

DELAWARE JOINS STATE EFFORTS TO CUT HFCs

Delaware Governor John Carney has directed the state’s Department of Natural Resources and Environmental Control (DNREC) to propose regulations by March 2020 that will eliminate the use of HFCs in Delaware.

Expressing the General Assembly’s support of regulating HFCs, State Representative Debra Heffernan, State Senator Nicole Poore, and State Senator Stephanie Hansen introduced House Concurrent Resolution (HCR) 60. It passed on June 30 and will take effect upon being signed by Carney.

“As Delaware continues our fight against climate change, my administration is moving toward eliminating hydrofluorocarbons (HFCs) as an increasingly harmful element to our state and our environment,” said Carney in a statement.

“HFCs are growing in the atmosphere at a rate of 8% a year and can be hundreds of times more potent than carbon dioxide in contributing to climate change,” he continued. “That’s why I have directed the Department of Natural Resources and Environmental Control to begin developing regulations that address HFC use in Delaware.”

Members of Delaware’s General Assembly applauded the governor’s move to regulate HFCs. “Man-made hydrofluorocarbons are damaging to our environment and quality of life, and they need to be regulated,” said Heffernan, the prime sponsor of HCR 60. “I’m proud to stand with Governor Carney and DNREC on this issue, and work toward guidelines to regulate the production and consumption of this extremely dangerous substance for the benefit of all Delawareans.”



Accelerate America Awards Presented at ATMOAmerica

Winners include Hannaford, Frialsa, South-Town Refrigeration, Hussmann and Julie Cerqueira.

— By Michael Garry

The winners of the 2019 *Accelerate America* Awards were announced June 17 at the ATMOsphere America conference in Atlanta.

THE WINNERS ARE:

- ▶ Hannaford (Best in Sector/Food Retail)
- ▶ Frialsa (Best in Sector/Industrial)
- ▶ South-Town Refrigeration & Mechanical/St. Cloud Refrigeration (Best Contractor)
- ▶ Hussmann's microDS R290 grocery merchandiser solution (Innovation of the Year)
- ▶ Julie Cerqueira, executive director, US Climate Alliance (Person of the Year)

Scarborough, Maine-based Hannaford, a division of Ahold Delhaize, was recognized for its pioneering efforts with natural refrigerants, including installing of the first transcritical CO₂ system in a U.S. supermarket in 2013; implementing one of the first transcritical CO₂ store retrofits in the U.S.; being among the first U.S. food retailers to explore large-scale in-store use of R290 water-loop display cases; and recently installing one of the first and largest transcritical CO₂ systems in a food retail distribution center.

Mexican cold-storage operator Frialsa was using ammonia/CO₂ systems in five of its facilities, including four new plants and one extension, as of 2017. Since then, the company has added new ammonia/CO₂ installations, including a 700 TR (2,462 kW) plant in Tijuana and a 640 TR (2,251 kW) facility in Lima, Peru, the first such plant in that country.

Minnesota-based South-Town Refrigeration & Mechanical/St. Cloud Refrigeration has distinguished itself by installing transcritical CO₂ systems for a variety of applications, including a food processor (Jack Link Beef Jerky), a supermarket (Lund & Byerlys) and an ice rink (first such installation in the "lower 48" states).

Hussmann's microDS system (Innovation of the Year) is a full-size grocery merchandiser solution using

150 g (5.3 oz) of propane (R290) refrigerant per circuit. It features full-sized 12-ft (3.7-m) open merchandisers and 5-door freezers; heat is rejected through a simple water-loop and dry fluid-cooler system.

Person of the Year Julie Cerqueira has overseen the growth of the US Climate Alliance, which now includes 24 state governors. (See page 48.) The Alliance is spearheading state action on HFC reduction in the absence of federal leadership, including efforts by California, Washington, New York, Maryland, Connecticut, Vermont and Delaware.

Last year, the Alliance issued an "SLCP Challenge" urging national and subnational jurisdictions, business and other actors to bring SLCP-reduction plans to the Global Climate Action Summit in San Francisco, Calif., in September. At the event, the Alliance issued its own SLCP "Challenge to Action" roadmap.

The *Accelerate America* awards program, in its fourth year, recognizes companies and individuals who are doing the most to drive adoption of natural refrigerants over the past year.

shecco is the organizer of ATMOsphere America and publisher of *Accelerate America*. ■ MG



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FMI ENERGY to Look at Future Refrigeration Architecture

The FMI Energy and Store Development Conference also includes GreenChill awards and regulatory update

— By Michael Garry

The Food Marketing Institute's annual Energy & Store Development Conference (E+SD), to be held September 8-11 at the Hilton Anatole in Dallas, Texas, will offer its usual blend of refrigeration, energy and store development workshops, a GreenChill awards ceremony and a regulations update geared to the food retail community.

Although natural refrigerants are not referred to specifically in the program, the conference includes workshops on current and future refrigeration architecture, and replacement strategies for equipment using R22.

Other refrigeration workshops include best practices for refrigeration contractors in installation and maintenance; best practices for improving refrigeration via HVAC and humidity management; and in-store system flexibility.

The U.S. Environmental Protection Agency (EPA) will host its annual GreenChill program's Achievement Recognition event. GreenChill is a voluntary EPA program in which participating retailers commit to cutting their emission rates; many retailers do this by adopting natural refrigerant systems. GreenChill retail partners represent approximately 30% of U.S. supermarkets.

The GreenChill awards include best emissions rate, exceptional leak goal achievement, and store certification excellence (GreenChill certifies individual stores that reach certain leak and charge levels). An award also goes to the best GreenChill certified store, which has typically employed a natural refrigerant system.

The event also features a refrigerants and energy regulations update, which will be given by two representatives of the Air-Conditioning, Heating and Refrigeration Institute (AHRI), Lauren MacGowens, sector lead, refrigeration technology, and Helen Walter-Terrinoni, vice president regulatory affairs.

The update will cover regulations on which refrigerants can be used in air conditioning and refrigeration, both at the federal and state levels.

Energy and design workshops

The conference's energy workshops include: energy-test case-study results; using software analytics to improve and maintain performance of refrigeration systems; energy procurement; sustainability scorecard; and energy efficiency and maintenance management in supermarkets.

The store development workshops encompass micro fulfillment, mixed-use urban design, experiential store

design, autonomous vehicles/robotics, and small platforms/design layout.

In addition, Michael Sansolo, retail food industry consultant and research director, Coca-Cola Retailing Research Councils of North and Latin America, will discuss findings from the Councils' two most recent studies on the risks supermarkets face from changing consumer habits, technology and emerging competition.

The event also offers, on two successive evenings, a manufacturer/retailer exchange in which retailers can meet with suppliers of energy management, HVAC, refrigeration, design, construction and lighting systems.

On the last day of the conference, facility and design tours will be held.

The conference co-chairs are John Lerch, director, energy and facilities, Weis Markets, and Brad Morris, senior manager, engineering and energy, Giant Eagle. ■ MG

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Migros store in Riazzino, Switzerland, with integrated CO₂ system

MIGROS TICINO INSTALLS ITS FIRST INTEGRATED CO₂ SYSTEM

Working with Biaggini Frigoriferi, the Swiss retailer has deployed a “total energy” system with provisions for refrigeration, heating and air-conditioning

— by Tine Stausholm

Migros Ticino, a cooperative that is part of Swiss retail giant Migros, has been at the forefront of the CO₂ revolution in HVAC&R since 2009, when it installed its first transcritical CO₂ system.

Now the company, which operates 33 grocery stores among other businesses, has taken its commitment to natural refrigerants one step further and installed its first fully integrated CO₂ system at a store in Riazzino, Switzerland, in the Italian-speaking section of the country.

Opened on February 28, 2019, the store is Migros Ticino's 21st to employ a transcritical CO₂ system; Migros Ticino is

aiming to have all of its stores converted to CO₂ refrigeration by 2025. (Migros as a whole had 302 transcritical CO₂ stores as of May 2019; it operates about 700 stores, divided into 10 cooperatives.)

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

The system's transcritical CO₂ compressor rack has subcooling, heat pump and chiller sections, and works with two separate water tanks providing the secondary fluid for the HVAC requirements. In two other Migros stores, Biaggini Frigoriferi has installed a compressor rack with a heat pump but not a chiller.

The integrated CO₂ system was conceived, designed and installed by Biaggini Frigoriferi, a 91-year-old OEM based in Cadenazzo, Switzerland. Eliwell by Schneider Electronic supplied the electronics and management software for the system, and Dorin the CO₂ compressors.

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

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

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

Auxiliary compressors

The Riazzino store has 1,200 m² (12,917 ft²) of sales area with 50 m (164 ft) of 2°C/4°C (35.6°F/39.2°F) medium-temperature cabinets and 20 m (66 ft) of -22°C (-7.6°F) low-temperature cabinets. The location also has 500 m² (5,382 ft²) of warehouse space, offices and technical rooms, including three medium-temperature and one low-temperature cold rooms.

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

Rossi noted that the heat pump and chillers use some of the same devices as the rack, such as a receiver and oil separator. Two auxiliary compressors are dedicated to the heat pump in the winter and the chiller in the summer, making the switch via a bypass system with automatic three-way valves. Two high-pressure CO₂ expansion valves (84 bar in the winter and 94 bar in the summer) are used with the heat pump's external air evaporator and the chiller's plate evaporator.

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

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

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

Free subcooling

The subcooling section of the rack, which optimizes the system in warm ambient temperatures, is capable of cooling down the outlet CO₂ mass flow from the gas cooler by more

System Specs

The Migros Ticino store in Riazzino, Switzerland, uses a transcritical CO₂/heat pump/chiller system with the following specifications:

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

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

Heat pump capacity:
55 kW (15.6 TR)

Chiller capacity:
70 kW (19.9 TR)

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

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

Heat pump temperature:
45°C (113°F)

Chiller temperature:
10°C (50°F)

OEM:
Biaggini Frigoriferi

Compressors:
Dorin

Electronics and management software:
Eliwell by Schneider Electric

Gas cooler/external evaporator:
LU-VE



From left: Luca Rossi, Biaggini Frigoriferi, and Andrea Skory, Migros Ticino, with CO₂ compressor rack at Migros store in Riazzino, Switzerland

than 10°C, without any additional energy consumption. In late June, when the temperature out of the gas cooler was 40.2°C (104.4°F), the temperature out of subcooling was 27°C (80.6°F).

Migros and Biaggini Frigoriferi declined to expand on how exactly this “free” subcooling is achieved, but Rossi stated that it was made possible by combining “the chiller working with the booster.”

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

Migros Ticino uses the annual consumption per linear meter of refrigerator cases as its parameter to compare energy efficiency between shops and different systems, but the chain hasn't yet got comparable data from the new store in Riazzino. However, the “trends are certainly positive” and it “equals the Migros Ticino standards,” said Migros Ticino's Skory, adding, “With the free subcooling, the

annual energy consumption will be certainly lower than the other installations.” As for the capital cost of the system, Rossi said it was lower than comparable refrigeration and HVAC systems.

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

Asked about whether Migros Ticino would adopt the system in the future, Skory stated that “at the moment, we don't have similar project in progress. though we are planning a large CO₂ air conditioning system.”

However, he added, “for all new stores this [total energy] system could become the new standard.”

■ TS



Deli case at Migros store in Riazzino, Switzerland

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NATURAL REFRIGERANTS HELP FOOTBALL GO GREEN

As football's worldwide popularity soars, teams in Europe are adopting CO₂ cooling at its arenas and air-based cryotherapy for its players.

— By Marie Battesti

The U.S. women's football (soccer) team captured the attention of the world as it brought home its fourth World Cup victory in France on July 7.

The enthusiasm for the women's World Cup — hosted by France from June 7 until July 7 — comes at a time of heightened focus on the environmental sustainability of football matches in Europe, including the use of natural refrigerants.

For example, Atlético Madrid's new state-of-the-art football stadium, the Wanda Metropolitano, is using

a CO₂ transcritical refrigeration system, equipped with parallel compressors and multi-ejectors, to serve up to 68,000 football fans.

The system provides cooling for a large kitchen serving several restaurants and VIP lounges. The installation includes cold rooms at 0°C/32°F (fresh food) and -20°C/-4°F (frozen foods), blast freezers at -30°C/-22°F, and kitchen rooms at 10°C/50°F.

"The heat recovery from the system is used for making hot water and heating the soccer

pitch [field]," said Albert Albert, in charge of the project at system manufacturer Pecomark.

A comparison study with a traditional R404A system (containing theoretical data, because the system was installed too recently to show results) concluded that the CO₂ system with parallel compressors and ejectors allows for an energy consumption reduction of 15%.

The growing popularity of cryotherapy for athletes – including football stars – also represents a market opportunity for natural refrigerants-based solutions in very low-temperature applications.

The practice involves exposing your body to extremely cold temperatures (as low as -110°C/-166°F) for a few minutes to speed up recovery, reduce injuries, increase energy and improve sleep. It has devout supporters among professional players such as Cristiano Ronaldo and retired star David Beckham.

European company Mirai Intex is now in touch with football clubs – mostly in Germany – to introduce "Refolution 1.0," a complete cryotherapy system, based on Mirai's COLD refrigeration system, which uses air as a refrigerant.

"We have managed to reduce significantly the energy consumption compared to a standard system," said Vladyslav Tsyplakov, development director at Mirai. "Our solution uses one single cascade system for the three chambers required in cryotherapy, while a traditional system uses three different cascade units."

Mirai is currently doing a comparative analysis to quantify the energy and operational cost savings Mirai's solution offers compared to a traditional system," he added.

Other initiatives

Football organizations have been involved in a number of other environmental initiatives in Europe this year. For example, the Union of European Football Associations (UEFA), and national football associations in Italy, Romania and Sweden, have announced their support for the new Life Tackle initiative, which is co-financed by the LIFE program of the European Commission.

The project aims to analyze how football matches can be organized and played as sustainably as possible. The LIFE program finances numerous projects in the EU, including the LIFE Front project to accelerate the use of hydrocarbon-based equipment in HVAC&R.

In addition, the French professional football governing body and the environmental NGO WWF (World Wildlife Fund) signed a partnership in April to reduce the ecological footprint of football clubs. Across the Channel, British football clubs claim they want to lead the way in reducing single-use plastics through the "Sky Ocean Rescue" initiative, led by Sky News and the Premier League. ■ MB

'Equal Pay for Equal Work'

The "European Sustainable Development Strategy" – the overarching framework setting the long-term objectives for EU member states – recognizes the interlinkages between environmental and social sustainability in Europe. It believes there is little chance for environmental progress without fair conditions for workers.

This became clear at the Women's World Cup last month.

Gianni Infantino, president of the International Federation of Football Association (FIFA), was greeted by ringing calls for "equal pay" as he walked onto the field to congratulate the U.S. team after it won the finals. According to the *New York Times*, the prize money for this year's Women's World Cup is \$30 million (approximately €27 million). By contrast, the 2018 World Cup for men offered \$400 million (approx. €356 million).

CNBC pointed out women's soccer games in the U.S. have generated more revenue than the men's over the past three years. From 2016 to 2018, women's games generated \$50.8 million (€45 million) in revenue, compared with \$49.9 million (€44 million) for the men's matches.

At the global level, FIFA says commercial revenues from the Women's World Cup cannot be separated out from other FIFA competitions, as rights are often sold as a package.

EUROPEAN RETAILERS COMBINE NATREFS AND EFFICIENCY TO CUT GHG EMISSIONS

METRO AG, Delhaize Belgium and Migros present carbon-reduction strategies during shecco/EIA webinar on World Refrigeration Day.

— By Marie Battesti

“Natural refrigerants are our default technology for new stores.”

— David Schalenbourg, Delhaize Belgium

European retailers Delhaize Belgium, METRO AG, and Migros are turning to a holistic approach encompassing HFC-free technology and energy-efficient solutions to lower their operations' carbon footprint, representatives of the companies said during a webinar organized by shecco (publisher of *Accelerate Magazine*) and the Environmental Investigation Agency (EIA) U.K.

The webinar was held on June 26, the first annual World Refrigeration Day. (See page 22.) A video of the webinar can be accessed at <https://bit.ly/32w4OTI>.

“To reap the highest rewards of HFC-free technology, a rigorous approach to equipment design [...] needs to be considered for the entire system of the store,” said Sophie Geoghegan, climate campaigner at EIA UK, an NGO based in London.

That design, she said, includes taking advantage of heat recovery and energy storage, ensuring good servicing and maintenance

throughout equipment lifetime, minimizing the heating and cooling loads, and investing in high-efficiency components.

METRO AG'S ENERGY REDUCTIONS

Olaf Schulze, director facility, energy & resource management for German retail giant METRO AG, presented the retailer's strategy to reduce its carbon footprint by 50% between 2011 to 2030. An F-gas exit program is part of the strategy. “We only install natural refrigerants in each new store opening and refurbished store,” he said. “Each new equipment is reducing dramatically the energy demand.”

In the Chinese cities of Chongqing and Beijing, where METRO AG is using transcritical CO₂ refrigeration, the chain estimates it can reduce energy demand by 25%, said Schulze. (See page 28.)

David Schalenbourg, director architecture, construction & maintenance for Delhaize Belgium (part of the Ahold Delhaize group), explained

that the Delhaize recently decided to adopt harmonized climate-science-based targets across countries where it operates in order to lower its CO₂ emissions by 30% and reach an average refrigerant GWP of 1,333.

“Natural refrigerants are our default technology for new stores,” said Schalenbourg, adding energy efficiency solutions such as adiabatic coolers, as well as leak management and preventive maintenance, were key for to further decrease Delhaize's carbon footprint.

Swiss retailer Migros in 2018 reduced its electricity consumption – in stores and logistics – by 9.8% and its greenhouse gas emissions by 22.4% compared to 2010, said Marina Escala, its energy monitoring specialist. As of May 2019, Migros operated 302 stores with transcritical CO₂, 149 with cascade CO₂ and about 20 with R290 water-loop systems. (See page 54.) ■ MB

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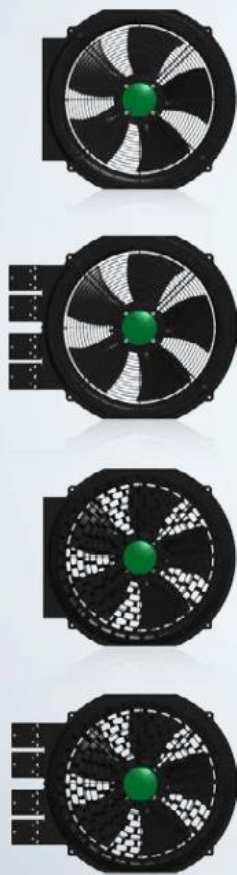
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Transcritical CO₂ rack in small room at Food Lover's Market in South Africa. Courtesy of RACA Journal

South African Grocer Does Workaround for First CO₂ System

Food Lover's Market installed the transcritical system on the third floor of repurposed building, using only a third of the space of a traditional system

— By Tine Stausholm

Food Lovers Market (FLM), a franchised supermarket and convenience store chain serving Southern Africa, recently installed its first transcritical CO₂ booster system in a new store in Ferndale, a suburb of Johannesburg — but not before overcoming an installation challenge.

Capetown, South Africa-based FLM, which franchises 120 grocery stores and 200 Fresh Stop convenience stores, decided to go with CO₂ because it is a “future proof solution” and a “cost effective option” fitting in with the chain's sustainability program, according to Jocelyn Kettle, business development coordinator with Commercial Refrigeration Services (CRS).

CRS, the South African OEM that designed and installed the new system, is the largest provider of CO₂ systems in South Africa, having installed 115 systems worldwide over the past 10 years (105 in South Africa). Yet this particular job offered a unique challenge.

The new Ferndale store, which opened on June 27, is located in a building formerly housing another retailer. The plant room, previously on the second floor, was moved to a much smaller space on the third (top) floor. That meant CRS had to design and install a new refrigeration system, including the compressor rack and condensers, to fit into a room only a third of the size previously used.

On top of this, CRS also had to work the piping around the ducting and electrics of an existing AC system. This they managed to do, creating a system that in terms of footprint is “very impressive,” according to Kettle.

Data easily collated

The transcritical system has a total capacity of 235 kW (66.8 TR), with 177 kW (50.3 TR) medium temperature and 58 kW (16.5 TR) low temperature. It has been designed for an ambient temperature of 32°C (89.6°F) and serves a store of 2,673 m² (28,772 ft²) located 1,700 m (5,577 ft) above sea level. The system also incorporates heat reclaim, and makes no use of electricity to generate hot water.

“The system is quiet, manageable from a central point, and all data can be easily collated,” said Arthur Woest, project manager for FLM. “Therefore, feedback collected can assist with preventing any potential liabilities that can result in stock loss.”

The Ferndale store has only been open since late June, so FLM and CRS have no data on its energy performance yet, but according to Kettle it “seems to be running under great performance.”

The initial costs of the system have been “slightly higher” than traditional HFC systems, but with “CO₂ being a cheaper gas, and it being a notably more energy efficient, it has potential to have a very high ROI,” Kettle said. ■ TS

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What About Ammonia for Air Conditioning?

Ammonia chillers have proven to be cost-effective for building air conditioning, but industry barriers continue to stand in the way of wider adoption

— By Devin Yoshimoto

Scantec Refrigeration Technologies, an industrial refrigeration system manufacturer and contractor in Australia, recently posted a video on LinkedIn highlighting a water-cooled ammonia chiller system providing air-conditioning at a government building in Queensland in 2011.

The video proved popular during the first month after its posting, receiving 44 "thumbs-up" reactions and 1,257 views. Yet the 2011 installation is one of the few ammonia-based air-conditioning systems in Australia. (The video can be accessed at <https://bit.ly/2K5MOGM>.)

Which begs the question: Why aren't there more ammonia chillers used for building and commercial air-conditioning? If the system in the video is any measure, it's not because of poor performance,

That system, consisting of two ammonia/water chillers, replaced an R22 system at the council administration center in Logan City, Australia, said Allan Wilson, facilities program leader, who was featured in the video. "During the eight years that the system has been installed, there's been no refrigerant loss and the system has been very reliable," he said.

Stefan Jensen, managing director of Scantec Refrigeration Technologies, which installed and has maintained the system, went into more detail.

"The original estimate for repairs and maintenance annually was in the order of \$50,000 a year," said Jensen. But this turned out to be "about 50% lower based on the service records of the last five years."

The reduction in energy consumption offered by the system was estimated to be from 900 to 1,400 MWh per year, ►



"I think the Australian air conditioning industry faces significant barriers, psychological, but also technical, with respect to being able to transition successfully to natural refrigerant-based technologies in air conditioning generally."

— Stefan Jensen,
Scantec Refrigeration Technologies

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Two ammonia-based chillers providing air conditioning for the Logan City council administration center in Queensland, Australia

Jensen added. This has resulted in a payback period calculated at five years — more than three years earlier than the estimated 8.5 years projected at the beginning of the project.

In fact, the Logan City council administration highlights the system's energy efficiency on its website, noting that it has a coefficient of performance of 5.79, "radically reducing energy costs."

The system was designed to address any safety concerns about an ammonia leak. It has a very low ammonia charge (0.03-0.05 kg/kW or .25-.39 lbs/TR), and the plant room is located on the roof, with significant ventilation, mitigating the risk of any major ammonia release.

Significant barriers

With ammonia chillers making such a compelling business case as a replacement for synthetic refrigerant-based systems used for air conditioning, has there been any increase in the number of ammonia chiller AC systems since 2011?

"Not to my knowledge," said Jensen.

His explanation: "I think the Australian air conditioning industry faces significant barriers, psychological, but also technical, with respect to being able to transition successfully to natural refrigerant-based technologies in air conditioning generally."

There were an estimated 22,600 large commercial chillers used for building air conditioning in Australia in 2016, according to "Cold Hard Facts 3," a research report compiled by Expert Group, an Australian consultancy.

The report states that HFO-1233zd is increasingly the refrigerant of choice for large centrifugal chillers, adding that several large chillers were installed in Australia in 2017 using that refrigerant.

Thus incumbent players, who stand to have something to lose, have stifled any further consideration of ammonia systems in building air-conditioning, noted Jensen.

"There is very limited encouragement from the large equipment suppliers to the AC industry with respect to expediting this transition," he said. "We have a recent

example where a mechanical services consultant categorically rejected NH₃ in favor of R134A-based chillers for air conditioning of a warehouse."

End-users of air conditioning systems are also affected by negative marketing from AC contractors and equipment suppliers, "who have a commercial interest in maintaining status quo for as long as possible," he said.

In March of this year, Iain Campbell, a senior fellow at the Rocky Mountain Institute, addressed this topic at the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH) Refrigeration 2019 conference in Melbourne. The Rocky Mountain Institute oversees the Global Cooling Prize, a competition to develop a climate-friendly cooling solution with a \$3 million prize for the winner.

"There are pockets of innovation, but even if you have a wonderful product, how do you get access to the market when the channels are owned by the biggest players? And how do you get to critical mass where you can be cost competitive," said Campbell. ■ DY

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T-Shirts and Training

With a sale of T-shirts to support an apprentice fund, and the opening up of an academy in Sydney, Kirby and Beijer Ref are stepping up training efforts in Australia

— By Devin Yoshimoto, Caroline Rham and Michael Garry



As the number of CO₂ systems in commercial refrigeration continues to expand in Australia, training efforts by technology suppliers and retailers are ramping up.

Some of these efforts took place on June 26, the first annual World Refrigeration Day. (See page 22.) For example, Woolworths opened up its plant room doors at two of its Australian supermarkets using transcritical CO₂ refrigeration, and saw significant participation among young people interested in the field, helping to reinforce the important role that natural refrigerant systems will play in the future of the industry.

Another initiative launched on World Refrigeration Day in Australia was the Kirby Apprentice Fund. It's

LEFT

Patrick Brennan, WorldSkills Australia Refrigeration and Air Conditioning "Skillaroo" 2019, wearing the Kirby Apprentice Fund T-shirt

the brainchild of Sydney-based Kirby, a major Australian wholesaler and manufacturer acquired as Heatcraft Australia by Swedish OEM Beijer Ref in 2018 and rebranded as Kirby this year.

The aim of the Kirby Apprentice Fund is to raise funds to support HVAC&R apprentices and "strengthen the technical skills of the HVAC&R industry," according to a website where apprentices can apply to maximize their opportunities from the fund (<http://www.kirbyhvacr.com.au/kirby-apprentice-fund-registration>).

"All proceeds raised by the Fund will be used to provide trade tools and skills development training to our industry apprentices," the website adds.

The website announced a few ways to contribute to the fund. One is to buy a T-shirt for \$10 from a local Kirby branch (there are more than 65 in Australia), with all profits directed to the fund. The T-shirts carry the message, "strengthening our trade" — the essence of the fund's purpose.

In addition, the website says, Kirby account customers will have the opportunity to contribute a "voluntary refrigerant levy" at the point-of-purchase to the fund, which will also be "fully invested back into the Fund for the provision of tools and training to apprentices."

Kirby has chosen award-winning apprentice Patrick Brennan to be the face of the Kirby Apprentice Fund (see sidebar, page 70).

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► New academy for natural refrigerants

Beijer Ref is also promoting training in more direct ways — especially for natural refrigerant-based systems. Notably, the company plans to open up a Beijer Ref Academy in Australia, said Inderpal Saund, business development manager APAC for Beijer Ref, at ATMOSphere Australia 2019, held in Melbourne in May.

"We will have that in Sydney where we will have a range of equipment to represent natural refrigerants," he said.

Saund also spoke about the company's two-day CO₂ training program launched in Australia in July 2018. The program covers topics such as CO₂ safety and handling, system design and benefits, control logic, and installation techniques. Held in classrooms and on site, training is targeted at not only contractors and consultants but end users as well.

The course takes groups of mechanics "through plant rooms and actually shares with them the reality of what is happening in the industry," said Saund. "We did this to give them a good aspect of what we were doing with CO₂ and where it is going."

In the first 10 months of the CO₂ training program, Beijer Ref and Kirby offered over 120 hours of courses, training 219 technicians from 60 companies.

Saund stressed that training is an ongoing need, especially with the advent of natural refrigerant technology. "We all need to contribute to this and to educate the industry on actually what is right and what is wrong," he said. "It's up to us as an industry; we need to do it." ■ DY, CR & MG

Australian 'Skillaroo' Technician to Compete in Russia

Patrick Brennan, a technician with Tony Stephens Refrigeration & Air Conditioning in Gympie, Australia, is a "Skillaroo."

That means he is one of 15 young people, ages 19-22, from a variety of skilled trades who have won a WorldSkills competition in Australia this year and will represent the country in a 60-nation WorldSkills competition August 22-27 in Kazan, Russia.

At the Australian event in April, Brennan won a gold medal in the Refrigeration and Air Conditioning category as well as the Best in Nation award covering all categories. He competed in installing and commissioning a glycol refrigeration system, fault-finding, and retrofitting an air conditioner.

WorldSkills International "promotes the benefits of and need for skilled professionals through grassroots community projects, skill competitions, and knowledge exchange through international cooperation and development between industry, government, organisations, and institutions," says its website (<https://worldskills.org>).

WorldSkills has set up a website (<https://www.worldskills.org.au/competitors/patrick-brennan/>) to solicit financial support for Brennan's trip to the Kazan competition.

Brennan is also supported by Australian wholesaler and manufacturer Kirby, a division of Beijer Ref, and is the face of the Kirby Apprentice Fund Initiative ([see main story, page 68](#)).

"I love my skill because it involves a lot of problem-solving," says Brennan on his WorldSkills website. "I'm always up for a challenge."





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Kokubu Group Concludes Natural Refrigerants Are Best for Its DCs

Akio Motohashi, Kokubu Group



Kokubu Group's West Tokyo distribution center

Distributor opts for either transcritical CO₂ or ammonia/CO₂ for new warehouses, depending on the location

— By Tomoro Sato and Rena Okabe

In February 2016, Kokubu Group, one of Japan's largest wholesale and distribution companies, opened its West Tokyo distribution center, located in Akishima City on the west side of Tokyo.

The facility was unique for a number of reasons.

First, it was the sixth facility to employ the company's "integrated three-temperature zone" concept, which it established four years prior.

Second, it was one of the company's largest distribution centers — approximately 58,000 m² (624,306 ft²), with 20,000 m² (215,278 ft²) of room temperature space, 7,600 m² (81,805 ft²) for refrigeration, and 9,000 m² (96,875 ft²) for freezing.

Finally, it was the first facility where Kokubu Group decided to use natural refrigerant technology — Mayekawa's NewTon ammonia/CO₂ system — for its refrigeration and freezing equipment.

Following the opening of the West Tokyo DC, Kokubu Group proceeded to use natural refrigerant systems at successive locations — transcritical CO₂ at the Kawaguchi and Funabashi Hinode distribution centers (opened in 2018) and the Obihiro distribution center (opened in June 2019). At these facilities, significant energy savings have been demonstrated compared to its traditional f-gas systems. (All of Kokubu's transcritical CO₂ systems are provided by Nihon Netsugen.)

Driven by these savings and long-term outlook, the company is now confident in moving forward with natural refrigerants at all of its new distribution centers, including transcritical CO₂ at the Kansai distribution center (planned for September 2019), and ammonia/CO₂ at the Okinawa Urasoe distribution center (the provisional name, and planned for January 2021).

"Choosing natural refrigerants for all new distribution centers is our company's policy at the moment," said Akio Motohashi, general manager of the logistics division for Kokubu Group.

The company's facilities in China, Vietnam, Myanmar, and Malaysia also represent an opportunity to phase out of their use of f-gases; however, it is not something the company is focused on currently due to the limited number of technology suppliers and the size of its distribution centers in each country, Motohashi explained.

Initial concerns

Up until the company decided to use natural refrigerants at its West Tokyo DC, Kokubu Group had been using mainly f-gases such as R410A in its refrigerating and freezing equipment.

"There were many internally within the company who were against the introduction of natural refrigerant equipment in the beginning," Motohashi said. "But after clarifying and explaining the advantages and disadvantages in a quantitative and qualitative way, the company decided to move forward with the installations."

The main causes for concern included the high initial cost of the systems and the safety risks for nearby residents in the case of an ammonia leak.

However, he added, "after comparing not just initial costs, but also utility and running costs such as maintenance from a long-term perspective, it was determined that there were benefits in making the investment."

To understand its operating costs using different refrigerants, Kokubu Group compared monthly electricity bills at three facilities with similar ambient temperatures: its Itabashi DC (which runs on R140A), its West Tokyo DC (NH₃/CO₂) and its Kawaguchi DC (transcritical CO₂).

The analysis also factored in the cost for water usage at the West Tokyo facility, which employs a water-cooled NH₃/CO₂ system.

The company found that the transcritical CO₂ system ran most efficiently during the cooler months in the winter, while the NH₃/CO₂ system was able to run very efficiently during the hot summer months.

Overall, however, "over the course of the year, we were able to achieve an energy savings of 30% annually



CO₂ unit coolers inside Kokubu's Kawaguchi distribution center

► compared to our refrigeration systems that used conventional fluorocarbon refrigerants" Motohashi said.

Since 2014, Japan's Ministry of the Environment (MOE) has provided subsidies to encourage Japan's shift to natural refrigerants, and Kokubu Group has taken advantage of them. "The increase in initial investment cost of the natural refrigerant systems can't be ignored," Motohashi said. "But they can be reduced using the subsidies provided by Japan's Ministry of the Environment."

The ministry's goal is to contribute to driving down the cost of natural refrigerant equipment to achieve cost parity with conventional f-gas equipment, and to accelerate the spread of the technology. Last December, the ministry confirmed that it had set the budget for natural refrigerant subsidies for fiscal year 2019 (April 2019 through March 2020) at ¥7.4 billion (\$68 million).

"Although initial costs are higher, with the use of subsidies, reduced maintenance and energy costs, along with the fact that the expected lifetimes of our natural refrigerant equipment are around 20-30 years, we came to the conclusion that there was a benefit to making the investment compared to freon-based refrigeration systems," said Motohashi.

In some cases, Kokubu Group was unable to obtain subsidies, yet moved ahead with the installations of natural refrigerant systems anyway.

"For the Obihiro distribution center, it did not meet the schedule for the subsidy application," Motohashi said. "We also applied for the subsidy

for the Kansai distribution center but it was not eligible." However, he added, "the Kokubu Group will continue to install natural refrigerant equipment as planned even if we do not receive subsidies."

Safety Considerations

While environmental and cost considerations factored heavily into the decision-making process at Kokubu Group, when deciding which natural refrigerant systems to use, safety was the number one factor.

"Some of Kokubu Group's distribution centers are located very close to the houses of nearby residents," Motohashi explained. "We came to the conclusion that, when the distribution centers were located near residential areas, we would choose to use CO₂-only systems."

As a result, after an NH₃/CO₂ system was installed at the West Tokyo facility, the company decided to install transcritical CO₂ systems at its Kawaguchi, Funabashi Hinode, and Obihiro DCs, and will install one at the Kansai DC.

On the other hand, for its Okinawa Urasoe DC, located in the southern Japanese island of Okinawa where temperatures are high year-round, the company selected an NH₃/CO₂ system, which remains consistently efficient in warm ambient conditions.

"In this way, we plan to select the appropriate natural refrigerant system depending on the location of the distribution center and its surrounding environment," said Motohashi. ■ TS & RO



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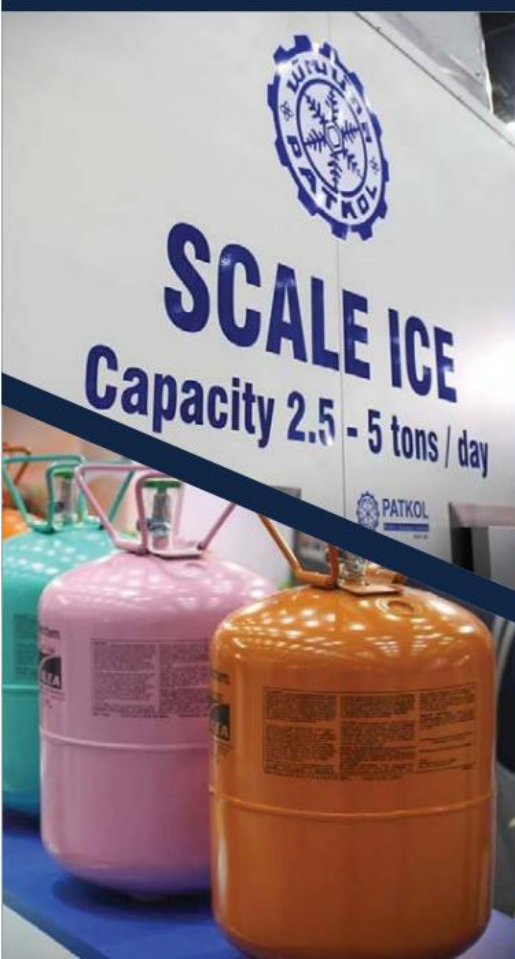
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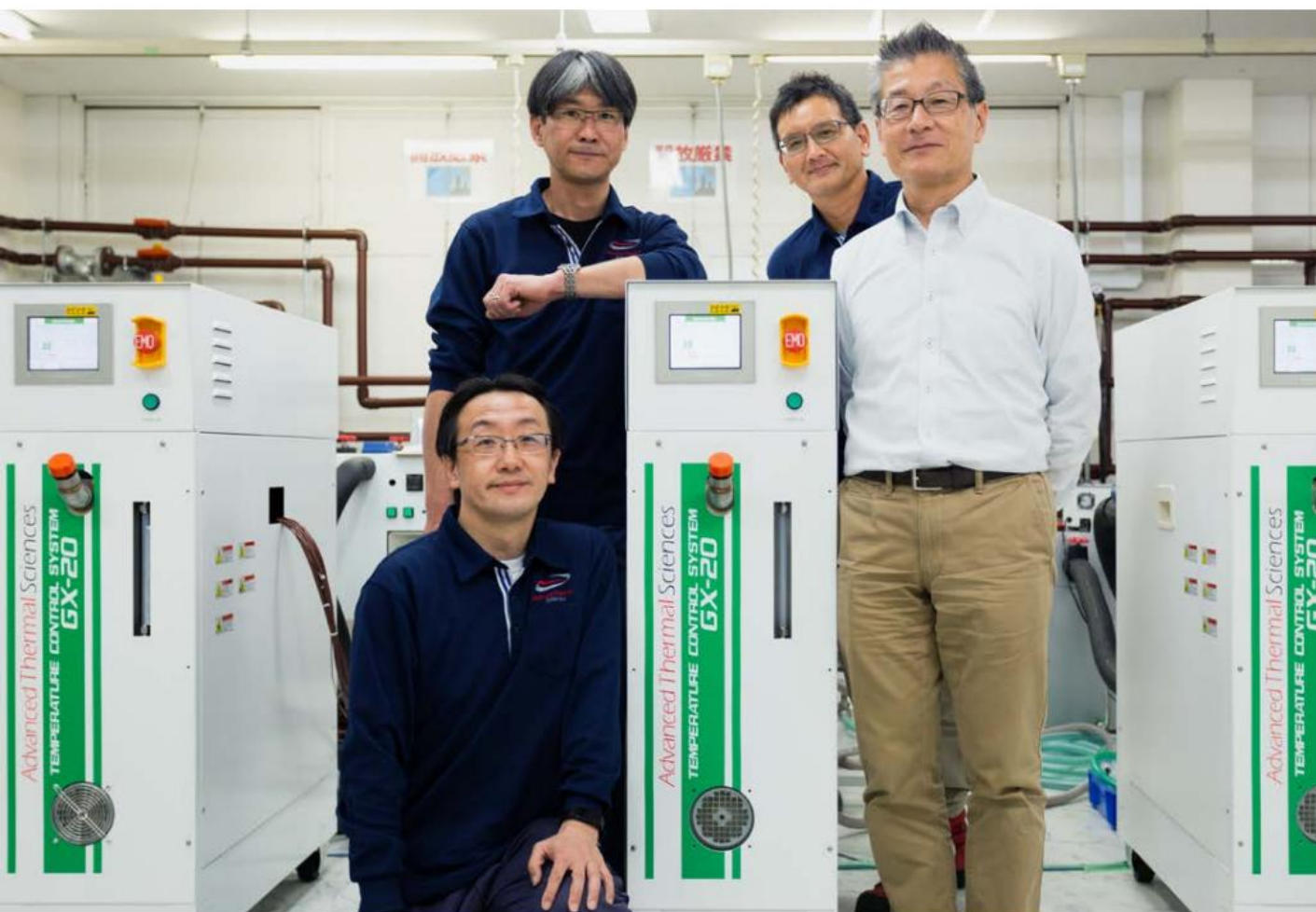
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NatRefs Meet Semiconductors



From left, standing around GX-20 chiller: Kazushige Shimizu, Tomoyuki Kariya and Toshihide Haruki; kneeling at left, Yasuhiro Fukami. All are with ATS Japan.

ATS Japan is first to market with a CO₂ chiller for the global semiconductor manufacturing industry, with an initial test at a German plant.

— By Tomoro Sato and Rena Okabe

In semiconductor manufacturing, for which precise temperature control is critically important, the chillers employed have traditionally used f-gas refrigerants.

In 2015, however, ATS Japan, a division of U.S.-based chiller manufacturer ATS, decided to begin moving towards the adoption of CO₂ refrigerant for its semiconductor chillers.

ATS Japan now has a chiller – Model GX-20 – which uses CO₂, and it is the first chiller in the semiconductor industry to use this refrigerant, according to the company.

The unit has already attracted attention as a next-generation chiller in Europe, with the company having begun a field trial of the system in June 2019 at a German semiconductor manufacturing company.

Founded in 2001, ATS Japan manufactures chillers for the semiconductor, solar cell, food, and medical device industries among others. Its decision in 2015 to develop a CO₂ chiller was driven in part by Japan's "Act on Rational Use and Proper Management of Fluorocarbons," which came into effect that year.

The company also noticed that this Japanese regulation on f-gas management was part of a larger environmental policy trend that was accelerating globally – especially in Europe, one of the company's main export markets.



Sachsen Kälte, ATS Japan's German service partner

"When I was visiting semiconductor factories in various locations throughout Europe, I would often meet local business people who were even more aware of the Kyoto Protocol than those in Japan," said Toshihide Haruki, sales and marketing manager for ATS Japan.

Haruki said that it was this general awareness, combined with the adoption of the EU F-gas Regulation, that ultimately drove the increase in demand that the company has been seeing in recent years for chillers using refrigerants with low GWPs.

The EU F-gas Regulation stipulates a ban on using certain HFCs (with GWPs greater than or equal to 150) in new centralized and plug-in commercial refrigeration equipment in Europe in 2022.

"We made a rough draft plan for the development of chillers that used CO₂ in 2015 as a response to the increasingly strict regulations and the demands of end users," Haruki said.

Following the announcement of this draft plan, the company began to coordinate internal resources and proceed to full-scale product development in 2017.

SUPPLIER COLLABORATION

Collaboration among suppliers of CO₂ components was key to overcoming ATS Japan's biggest challenge during development of its CO₂ system, said Tomoyuki Kariya, development department manager for ATS Japan.

"Once we began to develop the 'GX' series, I immediately understood why other companies did not start to develop any CO₂ refrigeration equipment," Kariya remarked.

The CO₂ parts and components that were needed were not readily available and it made development of the system very difficult.

Compressors, for example, were often only used by the manufacturers in their own products, and sales to outside companies were rare.



► This changed, however, after Panasonic announced its "CO₂ family" concept in 2018, where the company would actively make its technology available to outside companies in an effort to expand the CO₂ market in Japan.

As a result, ATS Japan was able to secure the use of Panasonic's 2-HP CO₂ compressor for its GX-20 CO₂ chiller.

Several other components, however, were still needed and required the cooperation of other companies such as Japan-based CO₂ component supplier Fujikoki for electronic expansion valves, and overseas suppliers such as Danfoss and Temprite.

The cooperation and openness among these component suppliers for CO₂ technology was the ultimate factor that made the development of the GX-20 successful.

Still, the options for CO₂ were very limited, said Kariya. Nevertheless, with the components currently available, ATS succeeded in ensuring the temperature accuracy of the chiller while considering the specific properties of CO₂, the exchange of temperature and pressure, and the responsiveness of the control valve, he said.

"But in order to achieve further temperature accuracy, the cooperation of parts manufacturers will continue to be needed," Kariya added.

FIELD TRIAL

After ensuring the safety level and optimal performance of the system with internal tests, the company delivered its first system to a German semiconductor manufacturing company to carry

out a field trial in June 2019. This was done in cooperation with ATS's German servicing partner Sachsen Kälte GmbH.

"This is the first CO₂ chiller for this industry, so our first priority was to put it into market after ensuring a sufficient level of safety and performance," said Kariya. "Due to the hard work of our team, we have finally been able to do it and advance the system to its final stage in June. We expect the field trial in Germany will be successful."

In addition, the company is continuing to investigate and optimize the performance of its system in Japan. The compressor used in the CO₂ chiller, which was tested internally in Japan up until May 2019, was sent to Panasonic for evaluation. The goal is to further reduce power consumption and evaluate the compressor's durability.

Kariya said that though the company has filed for a patent and finalized the system's basic configuration, more work still needs to be done.

"We are continuing to look towards improving the performance of the natural refrigerant chiller in various ways, such as improving energy efficiency, reducing water use, improving temperature response and applying our know-how cultivated from our expertise with f-gas chillers," said Kariya.

INTEREST RISING

Since ATS Japan first unveiled the concept for its CO₂ chiller at "Semicon Europe," a semiconductor technology exhibition, in Munich, Germany, in November of 2018, interest from end users has been steadily increasing.

"Because of the impact of the EU F-gas Regulation, more local companies than we expected have become aware of the fact that they will not be able to use their current chillers after 2022," said Haruki, who has visited Germany, France and other countries in Europe several times this year.

In fact, Haruki revealed, the field trial with the end user in Germany, which was originally scheduled to take two years, has been shortened to about eight months due to the pressing situation with the f-gas phase down in Europe.

Going forward, the company is aiming to secure a position as the top CO₂ chiller manufacturer in Europe.

Elsewhere, ATS Japan says that it is also seeing more interest than expected in North America, especially in California where regulations on f-gas use are becoming increasingly strict as well.

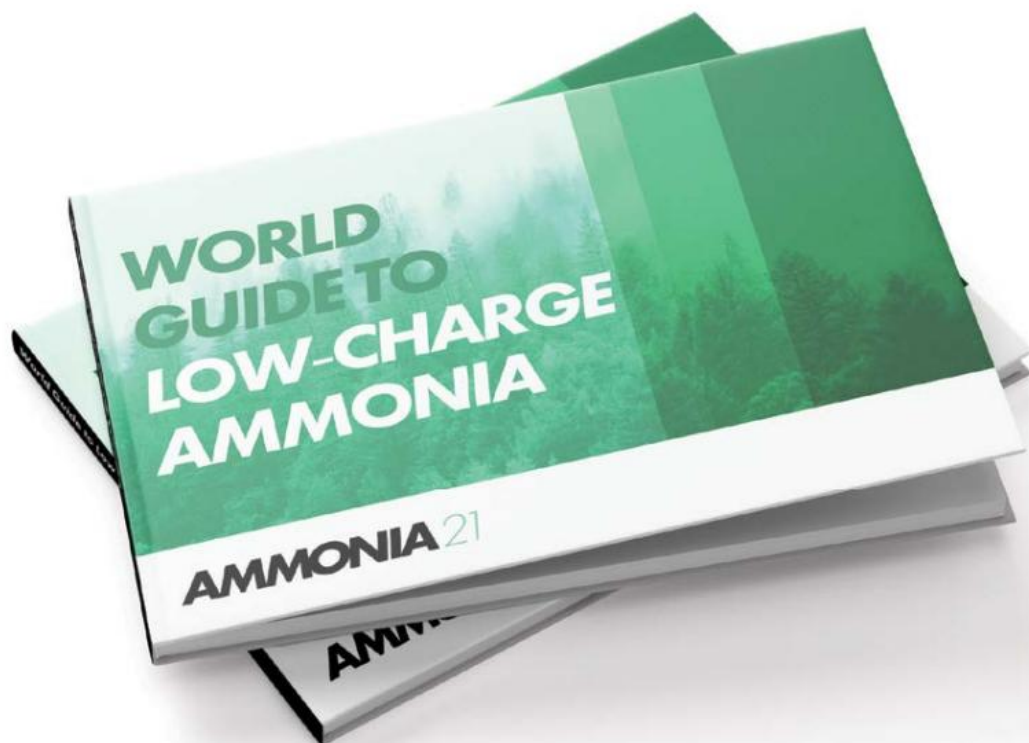
The company has, in fact, already anticipated this. "During the entire development period, we closely collaborated with our U.S. team to make sure the CO₂ chiller's standards and specifications would make it usable in America," said Kariya. "So we can bring the GX-20 to the North American market at anytime."

In Europe, ATS Japan says they plan to sell 30 units in its first year of sales.

The useful life of a semiconductor chiller is about 10 years. Considering the growing number of aging units with leak issues, ATS Japan estimates that the potential market for equipment replacements will be about 1,000 units per year. ■ TS & RO

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MHI'S CO₂ SALES DOUBLE IN JAPAN

ABOVE

MHI 10-HP CO₂ condensing units installed at Yokohama Reito's Haneda distribution center in Tokyo

As the January 1, 2020, deadline for the complete phase out of R22 looms, 68% of Japan's cold storage facilities still use the ozone-depleting refrigerant, according to data presented by Shigekatsu Koganemaru, a board member of the Japan Association of Refrigerated Warehouses, at ATMOsphere Japan 2018 (organized by shecco, publisher of *Accelerate Magazine*).

The scramble is on to replace R22, and in many cases natural refrigerants are the alternative, including CO₂ and low-charge ammonia.

Benefiting from this trend is Japanese OEM Mitsubishi Heavy Industries Air-Conditioning and Refrigeration (MHI). The company has already

Mitsubishi Heavy Industries has sold 160 CO₂ condensing units to cold-storage plants so far in its 2019 fiscal year, capitalizing on the need to replace R22 systems

— By Devin Yoshimoto, Rena Okabe and Tomoro Sato



sold 160 of its 10- and 20-HP C-Puzzle CO₂ condensing units in Japan in its 2019 fiscal year (April 2019 through March 2020), already doubling its sales (80) from its 2018 fiscal year.

The company revealed this information at the International Food Machinery & Technology Exhibition (FOOMA) Japan 2019 exhibition, which was held in Tokyo July 9-12.

MHI exhibited its 20-HP CO₂ unit at the event, which is one of the region's largest international exhibitions for food processing and manufacturing technologies.

"Although it is still a limited number of shipments, it is more than expected," said Taichi Kayama, a manager for MHI's low-temperature food sales and engineering division.

Regarding where the systems are being employed, Kayama said "almost 100% of the [CO₂] systems are being used in cold storage facilities at the moment."

In addition, Kayama noted that MHI is currently developing larger-capacity CO₂ systems, but did not offer details.

"Larger systems are mainstream right now," Kayama said, regarding the food manufacturing industry. "So 20-HP systems are not ideal."

"We are currently planning to develop [CO₂] equipment larger than 20 HP. In the future, when this capacity is increased, we would like to install our systems at food manufacturing freezer facilities."

Meanwhile, sales projections are on track for the company, as MHI exhibited the same 20-HP CO₂ condensing unit at last year's FOOMA Japan event, where the company said it expected to sell around 100 units in the coming year.

NEED FOR EFFICIENCY

MHI began selling the 20-HP unit in April 2018. "The need for products with high efficiency and reduced environmental burden [is] increasing, and we are expecting high demand for this 20-HP unit from warehouses and supermarkets," the company said in a statement last year. "CO₂ refrigerant has the strong advantage of not being affected by increasingly stringent refrigerant regulations."

MHI's 20-HP CO₂ condensing unit uses MHI's patented two-stage scroll-rotary compressor technology, with scroll on the high side and rotary on the low side of compression.

The same compressor technology is used in the company's 10-HP unit as well as MHI's Q-Ton CO₂ commercial heat pump water heater.

The system operates at temperatures of -45°C (-49°F) to -5°C (23°F) and is rated for operation in ambient temperatures of -15°C (5°F) up to 43°C (109.4°F).

The 20-HP system has a footprint that is the same as its 10-HP sibling, allowing the end user to save a significant amount of space, as well as modular side-by-side installation with additional units.

INSTALLATION AT YOKOHAMA REITO PLANT

In February 2018, Yokohama Reito Co. Ltd., a major Japanese refrigerated warehouse and food sales company, installed and commissioned MHI's CO₂ condensing units and NH₃/CO₂ cascade systems at its Haneda distribution center, one of its newest facilities in Tokyo.

The plant is located on Keihinjima island in Tokyo – Japan's largest freight hub – near both Tokyo harbor and Haneda airport. It is a three-story reinforced concrete structure with a floor area of 16,877 m² (181,662 ft²).

The facility features three MHI C-LTS NH₃/CO₂ cascade systems that cool about 8,190 m³ (289,227 ft³) of frozen low-temperature storage space at a temperature of -25°C (-13°F). In addition, two MHI 10-HP CO₂ condensing units cool 246 m³ (8,687 ft³) of refrigerated medium-temperature storage space at a temperature range of -10°C (14°F) to +10°C (50°F).

Yokohama Reito – which has been using only natural refrigerant-based technology for all of its new facilities since 2001 – continues to see these systems as a key part of its corporate social responsibility strategy.

For this latest installation, Yokohama Reito also utilized natural refrigerant subsidies provided by Japan's Ministry of the Environment.

■ DY, RO & TS

Japan Tightening HFC Recovery Regulations

A draft bill includes fines for venting gases and requires waste disposal firms to get HFC recovery certificates

— By Devin Yoshimoto and Rena Okabe

The Japanese government on May 29 passed a draft bill providing measures to tighten regulations on f-gas recovery in Japan, according to Japanese publication *Fukui Shimbun*.

The bill was first proposed at an advisory council of experts hosted jointly by Japan's Ministry of Environment (MOE) and Ministry of Economy, Trade and Industry (METI), in January 2019.

Implementation will begin in 2020 "after discussions with each prefecture [district governments]," *Fukui Shimbun* said.

The measures in the draft bill include "imposing a fine on every violation of

the law, and banning waste disposal firms from dealing with products without HFC recovery certificates," according to an editorial published by *The Asahi Shimbun*, another Japanese publication, in January.

"They would also empower prefectural governments to make on-the-spot inspections at building demolition work sites," it added.

The editorial, entitled, "Japan needs to heat up efforts to slash harmful emissions," referenced the January meeting and discussed the challenges with f-gas recovery in the country.

The total f-gas recovery rate per year has never exceeded 40% since 2002.

"Many of the businesses using fridges or involved in waste disposal do not recognize the importance of recovering the greenhouse gases and show no qualms about disposing of products containing them without taking the step," the editorial said. "That means huge amounts of HFCs are spewed into the atmosphere instead of being destroyed as they should be."

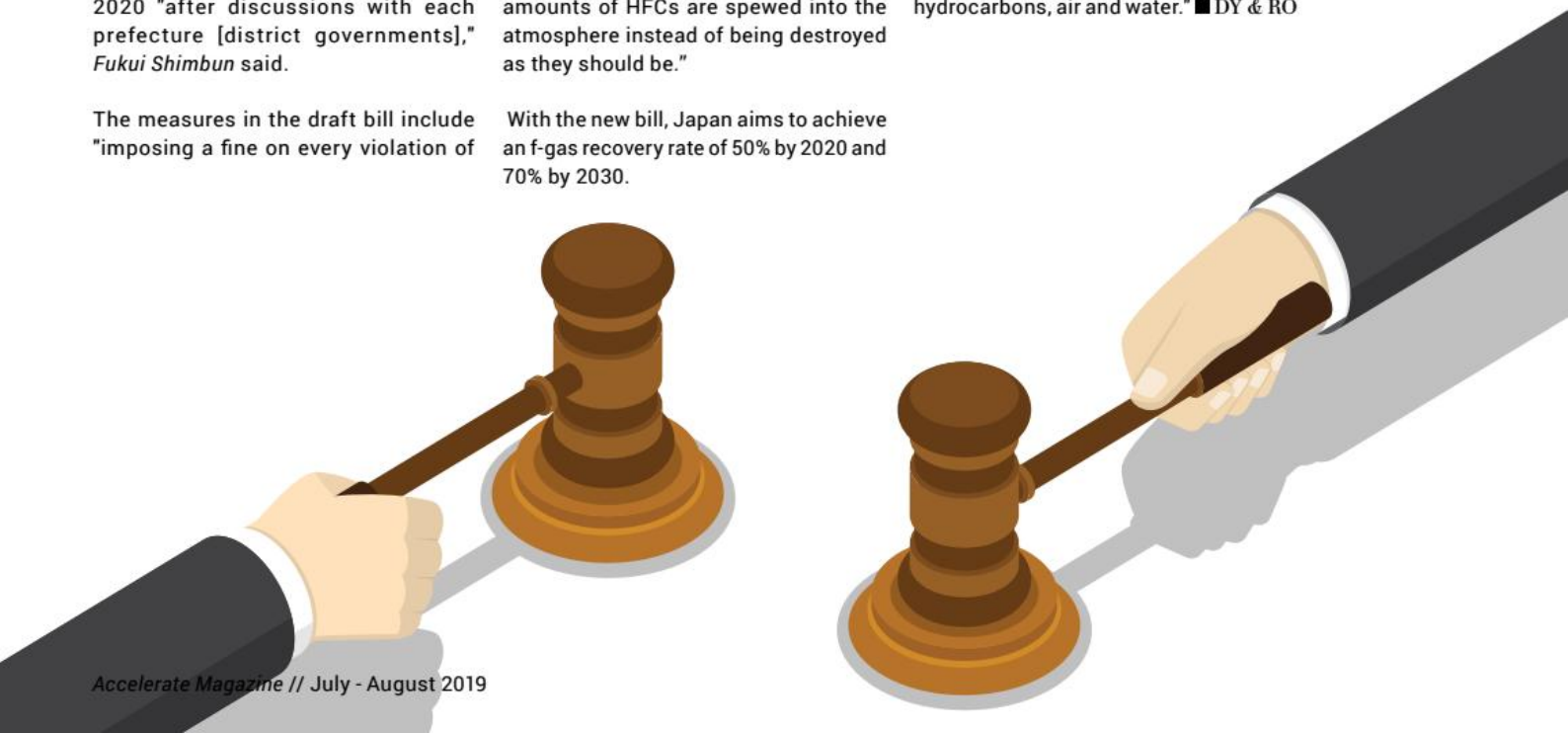
With the new bill, Japan aims to achieve an f-gas recovery rate of 50% by 2020 and 70% by 2030.

2018 Kigali acceptance

The Japanese government accepted the Kigali Amendment to the Montreal Protocol on December 18, 2018. As a developed country, it thereby committed to phasing down production and consumption of HFCs by 10% this year compared to the 2011-2013 average baseline level, leading up to an 85% reduction by 2036. The Kigali Amendment officially went into effect in January 2019.

The Asahi Shimbun editorial pointed out that refrigerant recovery and disposal can only partially contribute to achieving Japan's HFC phase-down targets — with natural refrigerants also playing a key role.

"Achieving the target of an 85% cut by 2036 requires replacing HFCs with climate-friendly alternatives," the editorial stated. "There are various natural refrigerants that are drawing growing attention as possible substitutes for HFCs, including ammonia, CO₂, hydrocarbons, air and water." ■ DY & RO



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BEIJING CHOOSES CO₂ FOR 2022 WINTER OLYMPICS



The event will use transcritical CO₂ refrigeration for six ice venues as China embraces CO₂ rinks for the first time

— By Devin Yoshimoto and Michael Garry

ABOVE

The 2018 Winter Olympics Opening Ceremony at the Olympics Stadium in PyeongChang, South Korea.

In a decision guided by the International Olympic Committee (IOC), the Beijing 2022 Organizing Committee in June announced that natural CO₂ refrigeration systems will be used in most of the ice venues at the Beijing, China, 2022 Winter Olympics.

It will be the first time the technology will be used for ice rinks in China and at the Olympic games, according to the Olympics.org website.

"This is a landmark decision which could potentially help address the issue of climate change, both in China and even globally," said Juan Antonio Samaranch, chair of the IOC Coordination Commission. "We are pleased to see that the IOC's close collaboration with Beijing 2022 has resulted in such an important outcome."

According to the Olympics.org website, CO₂ systems will be employed in the Beijing 2022 speed skating, figure skating and short track venues, as well as the ice hockey training venues. R449 will be used in the ice hockey and curling venues.

Ice rink expert Art Sutherland, who has worked as a consultant for the IOC for the last two Winter Olympics events, and is involved in the planning for Beijing 2022, provided some background on this decision at the ATMOSphere America conference, held June 17-18 in Atlanta, Ga. (The conference was organized by shecco, publisher of *Accelerate Magazine*.)

Sutherland, president and CEO of Accent Refrigeration Systems, Victoria, B.C., explained that five rinks under construction will use direct transcritical CO₂ systems (which circulate CO₂ under the ice) while four existing rinks, which were using R404A, opted for R449A, except for one that decided to switch to CO₂.

"Once those other four ice rinks saw that [the new rinks] were going with CO₂, one then then jumped on board," said Sutherland, who added that no vendor has been selected yet for the CO₂ systems.

Sutherland noted that during the 2018 Winter Olympics in Korea, all of the refrigerant used was R404A. "But [the IOC has] an environmental

committee and they wanted to have a green Olympics," Sutherland said. "And when they brought me to China to have a look at what's happening there, all the facilities were R404A again. It was quite a challenge to get that direction to change."

Sutherland first suggested several types of low-charge ammonia-based systems as a replacement for the R404A systems.

"First, out of the gate, I always go ammonia, but ammonia is just a non-starter in Beijing in public facilities."

Tipping point in China?

In addition to the six Olympic rinks, three private or municipal rinks plan to use

CO₂ systems, said Sutherland. "One year ago, there wasn't a single CO₂ rink in China. I have to give them credit for being very brave at biting the bullet now that we've got nine of them that are going in there. So it is good news."

Sutherland remarked that he is now going to China "every six weeks for the next three years."

Jin Ma, who serves as the deputy director of the Cold Storage and Cold Processing Committee at the Chinese Association of Refrigeration, as well as the chief engineer for the refrigeration system used at the national speed skating hall, said last December that he sees signs of a shifting mindset regarding the use of natural

refrigerants such as ammonia and CO₂ in China.

In an interview last fall (see ["Ice Rinks: Which Refrigerant Is Best?" Accelerate America, November-December 2018](#)), Sutherland strongly endorsed the use of natural refrigerants, including ammonia, CO₂ and ammonia/CO₂, in ice rink systems. "The whole world is going this way, moving away from [HCFCs] and HFCs, and now there's concern about HFOs and their acidic [by-products]," he said. "Ammonia and CO₂ are the best true green refrigerants."

CO₂ refrigeration is a relative newcomer to the ice rink market, with the first installation in 2010 at an arena in Saint Gédéon, Canada. But it is gaining

traction as a green alternative in the U.S. and especially in Canada, where there are more than 40 ice rinks systems, according to Quebec-based Carnot Refrigeration. CO₂ ice rinks are also being built in Europe, where early last year there were an estimated 20 installations, according to EKA (Energi & Kyranalys), a Swedish ice rink energy consultant.

An alternative to a direct transcritical CO₂ rink system is a transcritical CO₂/glycol secondary system that circulates glycol under the rink. The latter system is being used by St Michael-Albertville Arena, in Albertville, Minn. ■ DY & MG

“This is a landmark decision which could potentially help address the issue of climate change, both in China and even globally.”

— Juan Antonio Samaranch,
IOC Coordination Commission



Turning Heat Into Sound Into Cold



Herbert Berkhout,
SoundEnergy

Dutch start-up SoundEnergy uses thermoacoustics to change waste or solar heat into cooling, without refrigerants or vapor compression

— By Tine Stausholm

SoundEnergy, based in Enschede, the Netherlands, has developed a compressor- and refrigerant-free unit capable of delivering cold as low as -25°C (-13°F), using only waste heat, and requiring almost no energy input.

This might sound like a fairy tale, but the system, THEAC-25, works using long known principles of thermoacoustics and the Stirling Cycle. And it is already being deployed by several end users.

The device utilizes the fact that heating a gas leads to increased pressure, meaning that one can use a temperature differential to create a pressure differential. This can, in turn, be used to create a sound wave, which essentially is a wave of compression and rarefaction. This wave is then amplified and the resulting mechanical energy can be turned into cooling. The heat transfer has an efficiency of 40%-50%, the company said.

In a February 2019 article in *Forbes*, SoundEnergy CFO Roy Hamans explained the system as follows: "We take thermal energy ... [and] we transform this thermal energy into an acoustic wave. This wave travels through a pressurized infinite loop in which it continues to be amplified.

"This huge mechanical power," he continued, "will be transformed into a ΔT [lower temperature] down in the last two vessels [of the unit] by connecting them in reverse."

The complex process is only fully understood by "two or three dozen people globally, all experts in thermoacoustics," he added.



SoundEnergy's THEAC-25 thermoacoustic cooling system

The device can be used for air conditioning in a variety of building spaces, as well as cooling for packing and production processes, and for maritime projects like military vessels and even cruise ships.

According to *Forbes*, SoundEnergy began shipping THEAC-25 commercially in September 2018. One of the first customers was the government of Dubai, which bought a unit to cool a plant that condenses drinking water from the air. IKC Magenta, a child care center in Delden, the Netherlands, has installed the system for comfort cooling.

In 2019 SoundEnergy "got a lot of traction" in the food-and-beverage sector (such as bakeries and coffee roasting companies), heavy metal companies (die cast and metal hardeners), hydrogen production, off-grid applications like expeditionary compounds, and marine off-shore applications, SoundEnergy CEO Herbert Berkhout told *Accelerate Magazine*. "These amazing market segments show growth year-by-year and have a large cooling need."

Waste heat and sunshine

THEAC-25 can utilize waste heat such as that from a plant or production line. The minimum required heat-source temperature is 160°C (320°F), and the maximum input temperature is 300°C (572°F).

The minimum heat requirement means that normal solar panels don't work as a heat source, but vacuum solar collectors can provide the needed temperature, according to SoundEnergy's website (<https://www.soundenergy.nl>).

The company's prototype unit is 4-by-4 m wide (13-by-13 ft) and about 80 cm (31 in) high, and weighs 1,100 kg (2,425 lbs). It uses the noble gas argon to create the acoustic wave.

The prototype is capable of producing a 25-kW (7.1-TR) cold output, at a temperature as low as -25°C (-13°F). It does all this very silently, producing only around 70 dBA of noise.

Apart from providing cooling, THEAC-25 can also be used to generate heating and function as a heat transformer.

A device the size of the prototype will cost around \$50,000, but prices are expected to drop once production scales up, and lower prices are available to residential users. The system itself is scalable, both up and down in size. The company has created a demonstration unit that fits into a 20-ft shipping container.

The initial cost is partly offset by the fact that THEAC unit uses no electricity at all. It does, however, require three pumps to circulate the heat-bearing and cold-bearing fluids, a controller, and a dry cooling system. According to the SoundEnergy website, these use approximately 2 kW of electricity in total. The unit requires only an annual inspection.

THEAC has an expected lifespan of 20-30 years, and the systems pay for themselves, according to Hamans. "For commercial and industrial use we are talking about only a few years to five years payback time," he told *Forbes*. ■ TS



Viking Cold Solution's thermal storage cells at Dreisbach distribution center in Richmond, Calif.

Thermal Batteries Cut Cold-Storage Energy Costs

Viking Cold Solution's thermal-storage cells take over from refrigeration systems during peak demand hours

— by Devin Yoshimoto and Michael Garry

“The result were really wonderful.”

— Jason Dreisbach, Dreisbach Enterprises

One way to reduce the energy consumption of a refrigeration system is to use it at night when energy costs are low and lower ambient temperatures yield maximum mechanical and condensing efficiency.

But what about during the day? For energy-intensive industrial refrigeration plants, Viking Cold Solutions has a solution.

The Houston, Texas-based company has developed a thermal storage system (TES) that employs phase-change material, intelligent controls and cloud-based monitoring; the frozen material absorbs heat during costly peak-demand hours, partially melting, and allows the vapor-compression system to remain idle. During low-cost night hours, the refrigeration system takes over and refreezes the phase-change material.

Viking's phase-change material, a mix of water and salt formulated for each temperature target, is packaged in “passive

cells” — in effect, thermal batteries — and installed on elevated racks in the refrigerated space. It's managed by a control system installed on top of a facility's existing refrigeration control system. The material absorbs up to 85% of heat infiltration, which helps to stabilize temperatures in the facility, said Viking.

Though it has been marketing the thermal energy storage system for only about two-and-a-half years, Viking has already installed it at 33 locations in the U.S., mostly cold storage facilities, and in the walk-in freezer a few at supermarkets, including a Whole Foods Market outlet, said Collin Coker, Viking's vice president of sales and marketing. Coker spoke about the system in June at the Global Cold Chain Expo in Chicago, where Viking exhibited.

Also in June, Viking announced that it had successfully completed the



installation of eight thermal energy storage systems as a part of a utility-backed demand management program in Massachusetts. The systems store and facilitate the management of about 1.3 MW of energy at several cold storage facilities, including the Greater Boston Food Bank.

Some of Viking's installation have been at plants using ammonia refrigeration, though not at any using transcritical CO₂, still relatively new to the industrial refrigeration industry.

But Coker observed that the Viking system would help support the efficiency of a CO₂ system running in higher ambient temperatures in transcritical mode.

"We are an exceptional pair with that technology in markets that have more transcritical days," he said.

CASE STUDY IN CALIFORNIA

A measurement-and-verification case study on the thermal energy storage system describes an installation at a refrigerated distribution center in Richmond, Calif., run by Dreisbach Enterprises, a logistics company.

The Viking system was installed as a retrofit in the facility's 93,000-ft² (8,640 m²) freezer with a centralized ammonia refrigeration system. The facility also has medium-temperature storage, dry storage and office space.

The system kicks in as ambient temperatures increase during peak hours of the day and the heat rejection of the condenser is less efficient. The control algorithms reduce the run time of the refrigeration system, and allow fully charged, frozen thermal energy storage modules "to absorb the heat infiltration and maintain temperature stability inside the freezer," said the study.

This reduced the energy consumption of the freezer by 35%, according to the study; peak period energy consumption was cut by 43% while peak demand (for low-and medium temperature loads) fell 29% for 13 hours per day. Temperature stability improved by 50%.

"The result were really wonderful," said Jason Dreisbach, owner of Dreisbach Enterprises, in a video on Viking's website.

Viking's latest project is to install its thermal energy storage system with solar power generation at a food bank, further reducing energy costs.

■ DY & MG

THERMAL ENERGY STORAGE AROUND THE WORLD

Viking Cold Solution's thermal energy storage system is one of a growing number of thermal storage applications being used with natural refrigeration systems.

For example, in Japan, Yamato Co. Ltd. has developed a brine-ice thermal storage system that works with CO₂ condensing units. In Australia, Glaciem Cooling Technologies has devised a 100-kW thermal energy storage/CO₂ refrigeration system.

These systems are seeing significant adoption by end users around the world. Lawson, Japan's largest convenience store chain, is testing Yamato's system, while Glaciem Cooling Technologies' system was installed in April 2018 at The Bend Motorsport Park, a \$160-million motor racing circuit in South Australia.

In the U.S., Rebound Technologies has developed an on-demand ice storage system, IcePoint, that subcools liquid ammonia systems for food processing and cold storage operations.

IcePoint has been tested by Lineage Logistics, a U.S. cold-storage operator, at a facility in Oxnard, Calif., and will be installed at a Lineage plant in Unadilla, Ga., this fall. (See "[Lineage Logistics to Deploy On-Demand Subcooler at Ammonia Plant](#)," *Accelerate Magazine*, June 2019.)

Meeting the Demand for Cooling in a Warming World

Professor Toby Peters from the University of Birmingham explains the crucial need for cooling systems that serve everyone while not pushing the climate to the brink

— By Michael Garry

It is well known that, as the world warms because of climate change, the demand for cooling is expected to skyrocket, not just for air conditioning, but also in the cold chain and many other applications. What is not often understood is that, at the same time, there is insufficient cooling to serve humanity, even under current climate conditions.

consequences: poverty, malnutrition, spoiled medicines, and unsafe living and working environments.

In his groundbreaking new report, "A Cool World: Defining the Energy Conundrum of Cooling for All," Professor Toby Peters of the University of Birmingham, U.K., addresses the dual challenge of meeting the cooling needs of all people while also developing solutions for the huge spike in energy required to meet those demands. It is a complex dilemma calling for many approaches, including the accelerated adoption of natural refrigerants.

Professor Peters, an internationally recognized expert in clean cold technology, breaks down the issue in the following interview.

// Accelerate Magazine: What is the overall message of the 'Cooling For All' report?

Toby Peters: For the next 30 years, it is predicted that nineteen cooling appliances will be installed every second; however, even with this massive growth of the cooling sector, much of the world will still be without access to cooling in a warming world, suffering the

If we are to deliver on the societal, health and economic targets of the UN's Sustainable Development Goals (SDGs), cooling for all will be essential. But what would it mean for our renewable energy systems and overall climate change mitigation targets?

As a first step towards answering this question, we need to better understand the size of the problem. In "A Cool World – Defining the Energy Conundrum of Cooling for All," we set out to provide, for the first time, an initial indication of the scale of cooling for all in a warming world – a scenario that would see ubiquitous penetration of cooling from cold chains to AC units.

The conclusion is that we will not solve both the challenge of ensuring equitable access to cooling for all humans and mitigate its future energy and environmental impacts without step-change intervention.

// Accelerate Magazine: What role do natural refrigerants and the HFC phase down under the Kigali Amendment play in achieving the goals of the report?

Toby Peters: The Kigali amendment to the Montreal Protocol is crucial to reducing the HVAC&R sector's environmental footprint. But meeting the Kigali targets

could be very challenging if we strive to deliver access to cooling for all who need it and meet the UN's Sustainable Development Goals given the significant uplift in cooling equipment deployed. If we are to plan for a cooling for all goal, the analysis suggests that further accelerating the uptake of low-GWP and natural refrigerants would be necessary in order to meet the Kigali objectives.

// Accelerate Magazine: Is the use of natural refrigerants considered one of the energy-saving strategies as well as a way to reduce direct GHG emissions?

Toby Peters: We should absolutely ensure lowest GWP and highest energy efficiency from current technology choices. But as we migrate from fossil fuels to renewables, we require whole-system approaches to energy if we are to manage demand sustainably. This must include new, efficient strategies for cooling that cost-effectively meet demand, manage the thermal peaks so as to smooth intermittent renewable generation, as well as provide zero-emission temperature-controlled transport. Strategies should recognize the portfolio of available resources such as free and waste cold and heat; incorporate data connectivity and energy management; and consider the role of energy storage, as well as resource-pooling protocols.

// Accelerate Magazine: The report says that 14 billion appliances will be needed to provide cooling for all by 2050. Does this include only domestic cooling loads, or all cooling loads – domestic, commercial, industrial, and transport?

Toby Peters: All cooling demand

// Accelerate Magazine: How will cooling for all be financed?

Toby Peters: Access to financing remains a challenge for the adoption of sustainable cold-chain technology. There is no single silver bullet for the funding given that cooling has many different applications. Cooling for all



Professor Toby Peters, University of Birmingham, U.K.

will need a portfolio of novel financing solutions, both commercial and smart subsidies. These measures may include tax relief for cooperative solutions by farmer-producer organizations or reallocation of agricultural subsidies towards cold chains.

Within this, servitization of cooling – “cooling as a service” and “pay as you use” – must become increasingly important, especially, for example, to bring access to cooling and cold chain to small and marginal farmers or to drive energy efficiency into space cooling.

Also key is bringing cooling into the green financing agenda to ensure that we “think thermally,” not just electrically, as we finance renewables.

Other government policies, tailored for each market, might include:

- ▶ Undertaking a national cooling needs assessment to meet socio-economic goals and set total TEWI (total equivalent warming impact) and energy allowances to meet Paris Climate targets.
- ▶ Incentivizing technology efficiency and cooling-demand reduction (including shared reward).
- ▶ Using urban design to create “cool” spaces and mitigate cooling demand.
- ▶ Developing and enforcing building energy codes to mitigate cooling demand.

// Accelerate Magazine: How much energy savings in cooling will be needed by 2050 to offset the increase in cooling expected?

Toby Peters: As an indication of the impact of widespread global access to cooling – cooling for all – we developed a hypothetical scenario whereby refrigeration equipment penetrations globally converge by 2050 with those experienced in the developed world today (with the U.S. as the proxy); also in the model air conditioning is made available to all populations experiencing more than 2,000 cooling degree days per year. Without action beyond current technology progress and equipment efficiency gains, cooling related energy consumption could result in 19,600 TWh of energy consumption per year.

Using the International Energy Agency (IEA) dataset from the Energy Technology Perspectives 2017 publication (ETP2017), one can extract that this will more than triple the 6,300 TWh in IEA's implied "energy budget" for all cooling in its 2°C Scenario.

Although ultimately the actual detail of the numbers in a cooling for all scenario (penetration levels, energy consumption, solution choices, etc.) might have some statistical dispersion, given the size of the gap between current demand projections and those including cooling for all, the conclusions are highly likely to be correct.

// Accelerate Magazine: Will the growth in renewables keep up with the growing demand for cooling?

Toby Peters: The year 2017 set a record for global deployment of solar renewable at 94 GW of capacity added. In the same year the full-load power draw from all room air conditioners sold was 133 GW; of these approximately 20% were replacement units, with the remainder (about 106 GW) being incremental peak load demand added to the global grid.

Then 2018 was again a record year for global deployment of solar renewable at 104 GW of capacity added, while global room air-conditioner sales grew by about 9% year on year. The message is clear: the growth in solar renewables is not keeping up with the growth in demand from just the room air conditioners being sold each year.

Without step-change intervention, "greening" the volume of electricity required for cooling for all by 2050 could consume more than 68% of the projected total renewables capacity under the IEA 2°C Scenario, and more than 100% of the IEA Reference Technology Scenario's projected renewables capacity by 2050.

// Accelerate Magazine: What are the most important strategies for achieving energy reduction in cooling?

Toby Peters: How growing demand for cooling is managed will have enormous implications for our society, economy, energy demands and climate change. In order to achieve sustainable cooling that is affordable, financially sustainable and accessible to all who need it, a new needs-driven, integrated system-level approach is required that incorporates "thinking thermally" into energy strategies. It includes mitigating demand; understanding the size and location of the thermal, waste, natural and wrong-time energy resources; understanding novel energy vectors, thermal stores, clean-cooling technologies and new business models; and integrating these resources optimally with various cooling loads. Key actions have been identified to achieve this, although each country/community would select interventions based on an understanding of its own needs.

// Accelerate Magazine: How can we collaborate – industry, governments, academia and development institutions among others – to rapidly deploy these solutions?

Toby Peters: The question is "What is the service we require, and how can we provide it in the least damaging way?" rather than "How much electricity do I need to generate?"

Meeting the challenge needs integrated thinking applied not solely in the technological domain but across whole systems that include technology, social, economic, governance, policy, finance, business, energy, education and training.

Only through adopting such an approach will radical new fit-for-market interventions be developed, optimally integrated and

deployed in a commercially viable and technologically practical way.

The change required can only come about by breaking down sector-silo thinking and bringing the world's experts from across all relevant sectors together to deliver integrated systems thinking implemented at politically relevant scales that can ensure successful adoption and delivery of accelerated solutions. This can then drive government and industry cooperation, align policy and finance, shape academic research agendas, and accelerate the transition of innovation to market and widespread adoption at scale.

// Accelerate Magazine: How can the demand for cooling be reduced to make it more manageable?

Toby Peters: We have developed a merit order of intervention. This has to start with demand reduction. To deliver the required energy-demand reduction, interventions will need to include: influencing consumer behavior, urban planning and building design, and such interventions as cool roofs or doors on chillers as well as personal or product cooling vs. space cooling.

We also want to see how we can aggregate demand for matching with available sustainable energy supplies; much greater use of district or community-based cooling to harness free cooling (such as bodies of water), waste cooling and/or waste heat; and more radical technology and thermal energy storage innovations.

// Accelerate Magazine: What advances in installation, maintenance and training will be required to support the expansion in cooling?

Toby Peters: The efficiency and efficacy of cooling systems is dependent on the knowledge and skills of those installing, maintaining and operating cooling equipment. Poorly maintained equipment tends to work less effectively, leak more refrigerant and use more energy. Utilizing badly maintained systems at large scale can increase direct and indirect emissions across the sector by 10-30%. Therefore

knowledge and skills development is essential to ensure the best installation and use of cooling equipment, both in terms of existing stock and as demand for cooling grows.

This clearly represents a major knowledge and skills development challenge, but could also provide significant employment opportunities. Regulation and oversight will be required to ensure that equipment is installed and maintained by adequately trained professionals, and that the effect this has on total operating cost of equipment is minimized, in order to ensure compliance without compromising access.

// Accelerate Magazine: Why is meeting the cooling for all challenge so important to solving the climate change problem?

Toby Peters: Access to cooling is not a luxury; it is an issue of equity that requires fast action to protect the most vulnerable. Currently more than 1.1 billion people suffer the consequences of lack of access to cooling. Cooling delivers fresh food, safe medicines, protection from heat, and thermal comfort for a growing number of people who will live in a warming world. In more and more countries, air conditioning and refrigeration will be vital for economic productivity.

How the world meets this challenge and provides cooling services to a growing middle class and to the vulnerable poor in the coming decades will have important ramifications for our climate. Without innovations and targeted interventions the energy demand for cooling could increase more than five times by 2050; fast growing direct and indirect GHG emissions associated with cooling equipment can easily outpace all our attempts to reach the goals of the Paris Agreement and halt global warming. ■ MG



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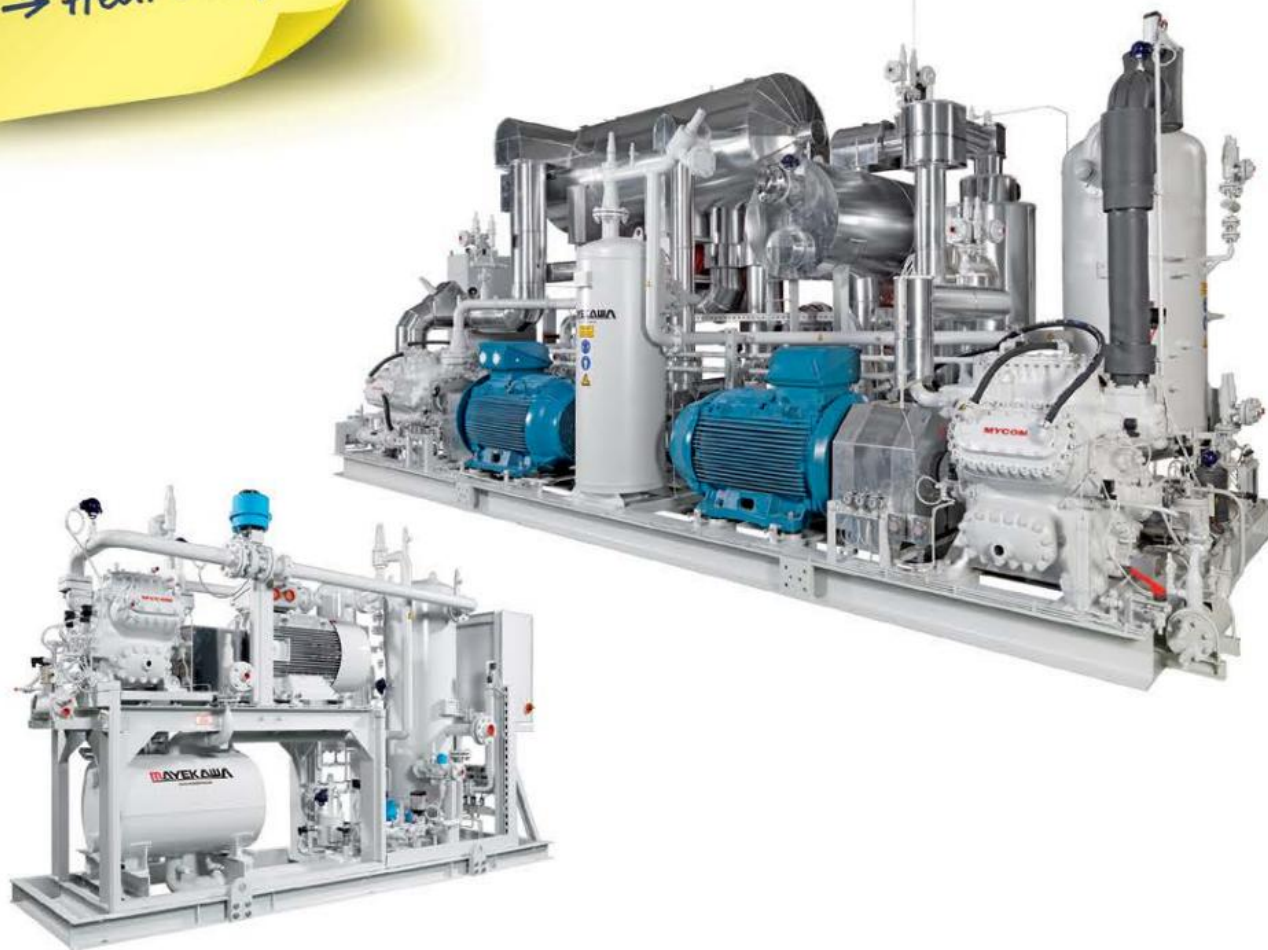
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