

NOVEMBER - DECEMBER 2019

ACCELERATE

ADVANCING HVAC&R SUSTAINABLY

MAGAZINE

The Global HFC
Phase-Down Plan

KIGALI

Is it
enough?

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Europe
METRO AG Store
Targets Net-Zero
Energy

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Reinventing The
Philippines' Food
Cold Chain

p.78



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ACCELERATE NEWS
ADVANCING HVAC&R SUSTAINABLY WORLDWIDE

A Quick Look

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Retailer **Publix** establishes CO₂ maintenance certification program with **Hillphoenix**. (Page 40) ... Kroger division **Quality Food Centers** retrofits glass doors without losing sales. (Page 44) ... **Makro** expands CO₂ installations in Latin America with new store in Colombia. (Page 46) ... Austrian **METRO** store is moving towards “net-zero” energy. (Page 48) ... **Carrefour** Poland retrofits 46 stores with CO₂. (Page 50) ... **Sainsbury’s** distribution center boosts efficiency with ammonia absorption system. (Page 52)

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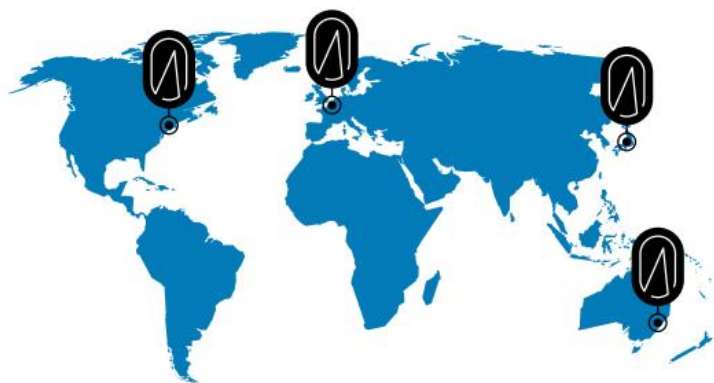
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ACCELERATE

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.news 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.

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November-December 2019
// Volume 1, Issue #105

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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

Cover Story:

HFOs: How Much is Too Much?

Print Distribution: FMI Energy & Store Development Conference (Dallas, September 8-11); ATMosphere Asia (Bangkok, Thailand, September 25)

// ISSUE #104

October 2019

Cover Story:

How Do We Cool a Warming World (Without Making It Warmer)?

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

// ISSUE #105

November/

December 2019

Cover Story:

Year One of Kigali: Is it enough?

Publication Date: November 19

// ISSUE #106

January 2020

Cover Story:

Women in Natural Refrigerants

Publication Date: January 14

Ad Deadline: January 7

Print Distribution:

AHR Expo (Orlando, Florida, February 3-5);

ATMosphere Japan (Tokyo, February 10)

// ISSUE #107

February 2020

Cover Story:

How are NatRefs transforming heating and cooling of buildings?

Publication Date: February 11

Ad Deadline: February 4

Print Distribution:

EuroShop (Düsseldorf, Germany, February 16-20); ATMosphere Cape Town (Cape Town, South Africa, March)

// ISSUE #108

March 2020

Cover Story:

Which NatRef is Best: CO₂, Ammonia or Hydrocarbons?

Publication Date: March 10

Ad Deadline: March 3

Print Distribution: IAR Natural

Refrigeration Conference and Heavy Equipment Expo (Orlando, Florida, March 15-18)

// ISSUE #109

April 2020

Cover Story:

How CO₂ heat pumps make electric cars go further

Publication Date: April 14

Ad Deadline: April 7

// ISSUE #110

May 2020

Cover Story:

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

Publication Date: May 12

Ad Deadline: May 5

Print Distribution:

ATMosphere Australia (Melbourne, May 17-18)

The editorial calendar is subject to change by the publisher.

Kigali: A Work in Progress

— by Michael Garry

Forging a global treaty with the cooperation of 197 countries is undoubtedly one of the hardest imaginable tasks. Yet that is what was accomplished in the realm of refrigerants with the Montreal Protocol in 1987, and most recently in 2016 with the Kigali Amendment to the Montreal Protocol

The Montreal Protocol, which has succeeded in putting the ozone layer on the road to recovery, is considered to be one of the most successful international treaties ever devised. Will the Kigali Amendment, with its planned phase down of HFCs, one day be similarly regarded? It will, if it can, as projected, slice up to 0.4°C (0.72°F) off the rise in global temperatures by 2100, a critical part of staying under the 2°C (3.6°F) increase that would cause catastrophic damage.

This month's cover story ([page 32](#)) takes stock of Kigali as it nears the close of its first official year. As with any new endeavor, the amendment has enjoyed some success, with 88 countries having ratified it as of this writing, but it's also going through some growing pains.

Unlike the Paris climate change accord, Kigali is legally binding for countries that ratify it. That is certainly a strength, but it also poses major challenges for developing countries that lack the technology and resources needed to transition from HFCs to climate-friendly natural refrigerants. It will ultimately be up to developed countries, working through the Multilateral Fund, to support developing countries in making this transition.

Developing countries will also need to educate their civil servants on the challenges and solutions associated with

an HFC phase down, as well as train technicians and contractors on proper installation and maintenance of the new technology.

With their greater resources, developed countries need to not only meet their Kigali responsibilities, but also try to exceed them. Given the urgency of the climate crisis, it can certainly be argued that the 49 developed countries (and advanced developing countries) should pursue an accelerated process that would lead to the complete phase out of HFCs by 2030. They can do this by fully embracing the adoption of natural refrigerant systems, which are available and cost-effective.

In fact, more than half of the developed nations — those belonging to the European Union — are already engaged in a much more ambitious plan than the Kigali Amendment, the F-Gas Regulation, which aims to reduce sales of F-gases to one-fifth of 2014 sales by 2030. The U.S. state of California, defying the do-nothing posture of the U.S. federal government, is also preparing to launch a plan that will incorporate Kigali but go well beyond it.

Needless to say, the U.S., the second largest user of HFCs after China, needs to ratify Kigali, though the Trump administration shows no inclination to send the amendment to the Senate for ratification, despite the urging of the HVAC&R industry.

The Kigali Amendment is, indeed, a work in progress, but one that needs to be embraced and expanded upon in the interests of healing the climate, just as the original Montreal Protocol is healing the ozone layer. ■ MG



Michael Garry
Editor in Chief

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Montreal Protocol Countries Make Key Decisions in Rome

At MOP 31, 171 nations grappled with improving enforcement, monitoring banned gases, financing the MLF, ensuring a sustainable cold chain, and more.

— By Avipsa Mahapatra

In his message to the 31st Meeting of the Parties to the Montreal Protocol (MOP 31), held from November 4 to 8, Pope Francis noted that the Montreal Protocol was an example of how cooperation can “achieve important outcomes, which make it simultaneously possible to safeguard creation.”

The meeting was held in the Food and Agriculture Organization (FAO) of the United Nations, Rome, an ideal location, not only because of the importance of the cooling sector in avoiding food waste and thereby addressing global hunger, but also because Italy is quite the hub of natural and efficient cooling technologies that do not use climate-warming hydrofluorocarbons (HFCs).

Delegates representing 171 countries negotiated a number of key issues, with the following salient points emerging during the meeting:

Significant new CFC-11 emissions show it is critical to ensure robust systems are in place to better enforce the Montreal Protocol.

Following scientific reports revealing that significant new global emissions of CFC-11, and a subsequent Environmental Investigation Agency (EIA) exposé pinpointing its illegal production and use to China, China reported stepping up law enforcement and putting in place systemic changes to prevent new CFC-11 production and use. An update from the Scientific Assessment Panel showed preliminary data indicating reductions in CFC-11 emissions in 2018 and 2019. Negotiators spent significant time discussing the scope of actions at the Montreal Protocol needed to discover and prevent illegal production or consumption of controlled substances.

There were differences of opinion on whether the contact group on this issue should be forward-looking and review institutional matters and processes, or

should it focus more on accountability and unanswered questions about the illegal production and emissions. Protracted discussions and negotiations covered gathering more information on the current situation, analyzing institutional processes to avoid similar situations in the future, impugning non-compliance and finding constructive ways forward.

Unfortunately, key conversations on how to undertake a comprehensive fitness check of the Montreal Protocol were not finished in Rome and are expected to continue next year. We hope that going forward countries take a serious look at the current monitoring, reporting, verification requirements, and procedures of the Montreal Protocol, which will be a key driver of sustained ozone and climate protection over the coming decade.

Continued financial and technical contributions are vital.

The Montreal Protocol relies heavily on inputs from its scientific and technical assessment panels to advise Parties on key areas that concern their decision making and priorities. This includes the replenishment of the Multilateral Fund

(MLF), the financial arm of the Montreal Protocol, which was also high on the agenda at MOP 31. Countries agreed on the terms of reference for the study to be carried out by the Technology and Economic Assessment Panel (TEAP) on the 2021-2023 replenishment of the MLF. The study will help guide determination on the overall contributions needing to be made to the MLF for the next three-year period for the implementation of the Montreal Protocol.

Additionally, countries made progress on requesting that the three Assessment Panels to the Montreal Protocol prepare quadrennial assessment reports that include existing and emerging challenges by the end of 2022.

These challenges include maintaining and enhancing energy efficiency, in light of the HFC phase down, while also looking at ozone layer depletion, interactions between ozone and climate, the effects of changes in the ozone layer to human health and ecosystems, as well as alternative technologies to the controlled substances.

Continued scientific and technical contributions, as well as a robust replenishment of the MLF, are imperative to ensure that control of synthetic gases harmful to our ozone and climate is actually implemented on the ground.

The Montreal Protocol and cooling sector must play an even greater role in broader climate change efforts.

About one-third of all food produced globally for human consumption is either lost or wasted, severely impacting farmers' incomes and food prices, wasting land, water and energy, as well as contributing to climate change. Recognizing this, the "Rome Declaration on the Contribution of the Montreal Protocol to Food Loss Reduction through Sustainable Cold Chain Management," called for "strengthening cooperation and coordination between Governments, the institutions of the Montreal Protocol,

the specialized agencies of the United Nations, existing private and public initiatives and all relevant stakeholders to exchange knowledge and promote innovation of energy-efficient solutions and technologies that reduce the use of substances controlled by the Montreal Protocol in the development of the cold chain, thereby contributing to the reduction of food loss and waste." This is a great opportunity for ensuring that the global cold chain uses future-proof sustainable technologies incorporating natural refrigerants.

In the margins of the negotiations, industry and NGOs outlined ways for the cooling sector to contribute further to climate mitigation. EIA released a new report – "Search, Reuse & Destroy: Initiating Global Discussion to Act on a 100 Billion Ton Climate Problem" – with action ideas on preventing emissions of rapidly growing super-pollutant fluorinated gases in "banks," which is the single greatest near-term strategy to achieve faster and deeper emission reductions: Recent findings on significant illegal production and use of CFC-11 further underscore the need to prevent new and existing banks from being emitted into the atmosphere.

The Kigali Amendment, which came into force on January 1, 2019, is expected to avoid 0.4°C of future global warming by the end of the century by cutting HFC by more than 80% over the next 30 years. It is unfortunate that only 88 parties (87 countries plus the EU) have ratified the Kigali Amendment to date, while youth around the world have been striking for climate action every Friday for months and current climate pledges and action are insufficient, by a wide margin, to address the worsening climate crisis and meet the global target of containing warming below 1.5 °C.

Countries must heed the clarion call from the Executive Director of the UN Environment Program, Inger Andersen, "Nothing short of universal ratification of the Kigali Amendment is acceptable."

■ AM



Avipsa Mahapatra is Climate Campaign Lead for the Environmental Investigation Agency (EIA), U.S., based in Washington, D.C.



Letters to the Editor

HIGHER R290 CHARGES NEEDED IN AUSTRALIA

For the past five years we have used propane (R290) refrigerant as per the maximum standard weight of 150g.

Unfortunately, these cabinets, both normal and low-temperature, are only very small in overall size/volume considering the power savings given to the customer. These units give the best output of refrigeration capacity compared to R134a and R404a, and, as these have been in the market for some time, we should be moving forward.

As more people are trained in propane refrigerant, the authorities need to look at moving forward and increase the actual volume that can be used in one application, including upright refrigeration cabinets and open-fronted cabinets.

We have seen multiple compressors used in open-fronted cabinets to comply with the refrigerant volume standard. However, this never operates correctly and technically the overall refrigerant volume is greater. There is no real power savings given the overall amperage is actually higher than using one compressor in a single system operating at the correct running pressures.

Some of the better manufacturers – Danfoss, Embraco and Emerson – have a vast range of compressors and condensing units to now suit all applications; a very wide capacity range with zero-ODP and low-GWP operations makes the systems easy to consider and operate.

Operating and repairing these cabinets is very simple given the training that is available in Australia from the refrigerant suppliers and our training institutions.

As with any refrigerant, there are always dangers, especially with propane. However, there are always general rules to follow, and install methods are available from the wide array of manufacturers with very good information; this includes printable manuals on using the refrigerant and wiring procedures to all relevant codes.

We have never retrofitted R290 as this is not the correct thing to do; you would be breaking the law and the refrigeration system would not actually perform correctly, and also can be very dangerous for the customer. We have seen this done and we have removed and refitted the appropriate refrigerant.

What I struggle to understand is that the industrial sections of our trade use ammonia and CO₂, which has quite large operating pressures and volumes; they also have to comply to plant-room requirements for leak detection and exhaust fans as R744 displaces oxygen. These are very high volumes of refrigerant, and yet we are limited to 150g because we use propane.

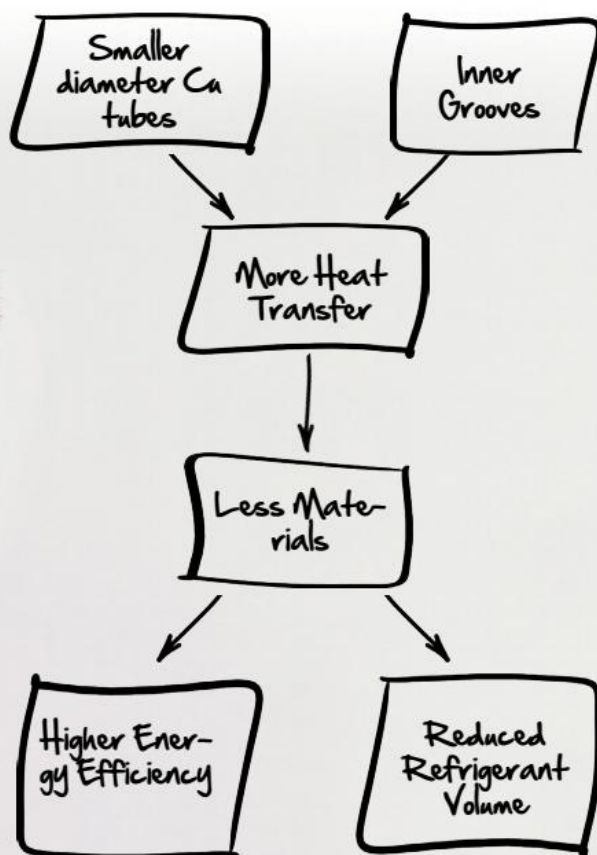
As we move forward, a higher charge limit will happen. However, we need to add more pressure to the authorities to get on board and actually do something, instead of talking about carbon footprints.

Peter Thatcher
Project Engineer
Cold Concepts Refrigeration
Campbellfield, 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.

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AMERICAS

November 27-29

ExpoFrioCalor Bolivia 2019, Santa Cruz de la Sierra, Bolivia

This is an international exhibition of air conditioning, heating, refrigeration and sanitary hot water. The exhibition, talks and activities are all taking place in parallel to inform visitors about sustainability, energy efficiency, alternative energy and environmental impact reduction.



www.expofriocalorbolivia.com/



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

December 7-10

HARDI Annual Conference, New Orleans, Louisiana, U.S.

The major four-day event for HARDI members brings together distributors, manufacturers and other vendors.



<http://bit.ly/35EYRF5>



@HARDInews

February 1-5, 2020

ASHRAE Winter Conference, Orlando, Florida, U.S.

Over 3,000 buildings-related engineers, architects, contractors, students, and other industry professionals will attend this five-day event packed with technical sessions, education, industry-advancing committee meetings and social events.



<http://bit.ly/35IUz4>



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February 5-5, 2020

AHR Expo, Orlando, Florida, U.S.

The AHR Expo says it is the world's largest HVAC&R event, attracting the most comprehensive gathering of industry professionals from around the globe each year.



<http://bit.ly/2IRXbyg>



@ahrexpo

February 25-26, 2020

NGA Show, San Diego, California, U.S.

This event offers over 60 specialized educational workshops led by retailers for retailers, and more than 400 companies on the expo floor showcasing products and solutions.



<http://bit.ly/2ISapUL>



@TheNGAShow



San Diego, California

EUROPE, MIDDLE EAST & AFRICA

November 27

Climate Control Awards, Dubai, United Arab Emirates

The purpose of the Climate Control Awards, the event says, "has been to persuade the HVAC&R industry to always be mindful of the bigger picture – of the need to serve society through looking beyond balance sheets."



<http://bit.ly/2qhqdAV>

November 28 - December 1

Bau + Energie Bern, Bern, Switzerland

Bau+Energie offers a fair alongside a congress on energy-efficient building and renovation, modern timber construction and renewable energies.



<http://bit.ly/2pl6905>



www.facebook.com/bauenergiebern



Bern, Switzerland

December 5-6

UNIDO Workshop on Uptake of Low-GWP Non-HFC Alternative Tech, Cape Town, South Africa

The South African government, in partnership with the United Nations Industrial Development Organization (UNIDO), is hosting a workshop focused on opportunities for the uptake of non-HFC refrigerants, energy efficiency, and safety standards while phasing down HFCs under the Kigali amendment.



<http://bit.ly/2NEXLCs>

February 11-14, 2020

Aquatherm Moscow, Moscow, Russia

Aquatherm Moscow says it is the largest and the most well-known event for HVAC, water supply, and pool equipment in Russia and Eastern Europe. As the first event in the construction season, it provides a platform for setting the industry trends, presenting novelties and meeting with new customers in the Russian market.



<http://bit.ly/2VW0udj>



www.facebook.com/aquatherm.moscow/

February 16-20, 2020

Euroshop, Düsseldorf, Germany

EuroShop says it is the world's largest trade fair for retail investment requirements. The trade fair presents itself in "eight retail dimensions with all the trends and topics that are moving the future."



<http://bit.ly/31pp5s5>



@EuroShop

November 21-23

REFCOLD India, Hyderabad, India

REFCOLD India covers all sections of the refrigeration and cold chain industry. It provides a platform to the global investment community to connect with stakeholders in the refrigeration and cold chain sector in India.



<https://bit.ly/2Jq3Zol>



@refcoldindia

December 2-4

Asia Cold Chain Show, Bangkok, Thailand

This event is focused on the cold chain industry. It features cold storage infrastructure, temperature controlling, IT solutions, material handling equipment and cold chain companies.



<http://bit.ly/31ju6Cl>



@AsiaColdChain

December 5

Renewable Heating and Cooling Forum, Canberra, Australia

This event looks at Australia's renewables heating and cooling sector, its current trends and where it's headed. The Renewable Heating and Cooling Forum is an opportunity for those interested in the renewable heating and cooling industry to not only attend the forum, but also take part in the Asia-Pacific Solar Research Conference and interact/network with its attendees.



<http://bit.ly/2oQx1hZ>



@AIRAHnews



Mumbai, India

December 4-6

India Cold Chain Show, Mumbai, India

The India Cold Chain Show is a business-to-business show catering to India's Cold Chain industry. The show says it's the sole trading voice for cold storage infrastructure, refrigeration, reefer transport, temperature controlling, IT solutions and data storage solutions.



<http://bit.ly/2BddOAn>



[www.facebook.com/
IndiaColdChainShow](http://www.facebook.com/IndiaColdChainShow)

February 10, 2020

ATMOsphere Japan, Tokyo, Japan

The 2020 edition of the conference will discuss and analyze the status of the market for natural refrigerants-based technologies and opportunities in the fast-growing market of Japan where competition is increasing.



<https://bit.ly/33VcuOZ>

AHR EXPO 2020 TO COVER NATREFS, ENERGY EFFICIENCY, AND MORE

Other topics include controls and connectivity, training and recruiting, and the cannabis market.

The 2020 AHR Expo, a leading trade show for the HVAC&R industry that will take place Feb 3-5 in Orlando, Florida (U.S.), has announced its full schedule of sessions for the 2020 Education Program, including more than 200 free seminars, new product and technology presentations, professional certifications and continuing education courses. Many sessions pertain to natural refrigerants, energy efficiency and enhanced controls.

In 2020, the AHR Expo will add a series of HVAC&R trend discussions led by members of the AHR Expo Expert Council.

"The development of our session schedule is ongoing, and we take careful consideration of discussions happening across the industry to identify pain points, opportunities, trends, etc. where we might offer support and solutions through dedicated sessions," said Mark Stevens, AHR Expo Show Manager.

AHR Expo is co-sponsored by trade bodies ASHRAE and AHRI, and is held concurrently with ASHRAE's Winter Conference.

The following is a list of sessions grouped by natural and low-GWP refrigerants, energy efficiency, controls and connectivity, training and recruiting, and more, linked to further information.

NATURAL AND LOW-GWP REFRIGERANTS

[Global Market and Policy Trends for CO₂, Hydrocarbons and Ammonia](#)

[Hydrocarbon Refrigerants](#)

[State-of-the-Art Refrigeration Technologies with Lower Environmental Impact, Part 1](#)

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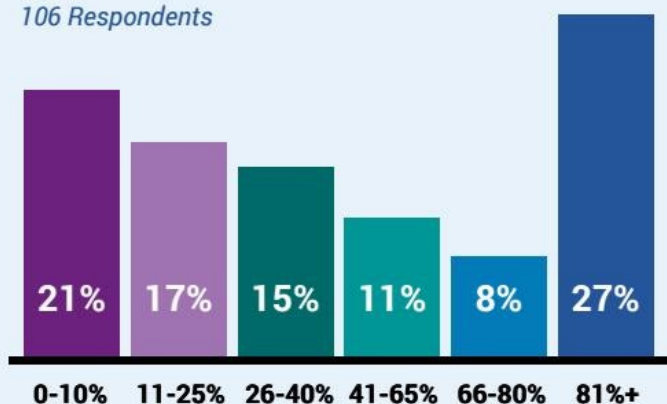
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Natural Refrigerants in Europe

What stakeholders are saying in the world's leading region for natural refrigerants.*

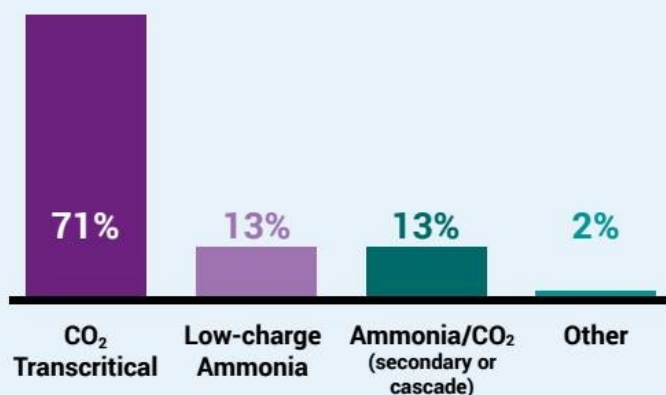
What is the share of natural refrigerant-based technology in your company today (percentage of products offered or installations)?

106 Respondents



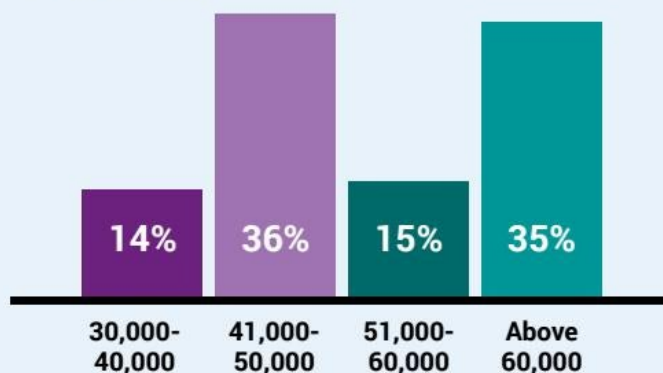
Which technology will see the highest growth rate in industrial refrigeration in the next five years in Europe?

52 Respondents



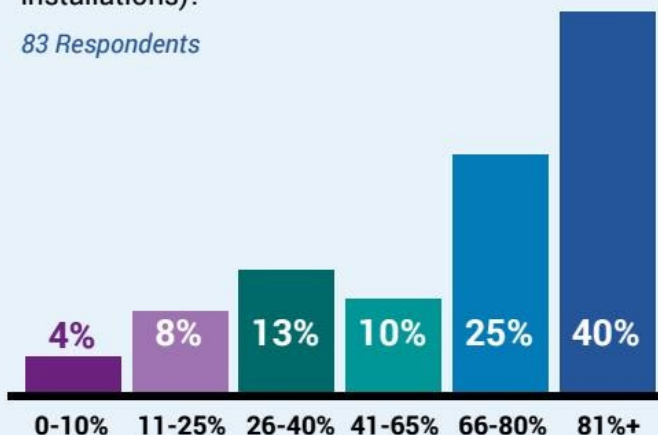
Today there are about 23,000 CO₂ transcritical installations in Europe. What do you think the number will be in 5 years?

66 Respondents



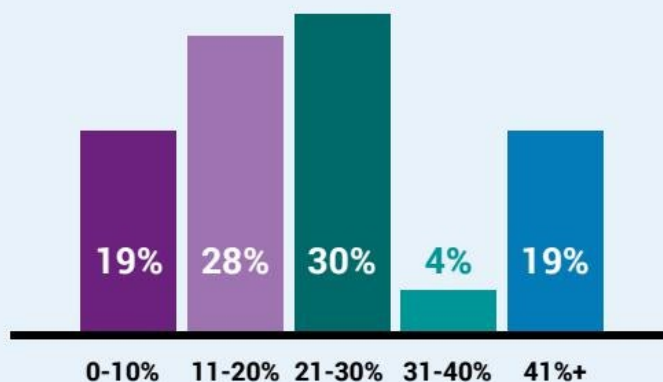
What do you think will be the share of natural refrigerant-based technology in your company in 5 years (by percentage of products offered or installations)?

83 Respondents



What is the percentage of refrigeration contractors and service technicians qualified to service natural refrigerants in Europe?

47 Respondents



* Based on questions posed to the audience at ATMosphere Europe, held in Warsaw, Poland, October 16-17, 2019.

**The Kigali amendment
may be quite new...**

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Kigali Update

Eighty-seven countries (plus the European Union) have accepted, ratified or approved the Kigali Amendment to the Montreal Protocol as of November 18, 2019.*

The countries that have done so since September 27 include: Bhutan, Vietnam, New Zealand, Mauritius, Lesotho, São Tomé and Príncipe, and Jordan.

The Kigali Amendment was enacted on October 15, 2016, by 197 countries (plus the EU) 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.

The 49 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 plus the EU have so far accepted, ratified or approved the Amendment.

The 148 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, 56 Article 5 countries (both groups) have accepted, ratified or approved the Amendment.

Here is a list of the 87 countries along with the EU that have accepted, ratified or approved the Kigali Amendment as of November 18.

* 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

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
New Zealand	Oct 3, 2019
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

Developing Countries (Article 5)

Participant	Acceptance(A), Ratification, Approval(AA)
Albania	Jan 18, 2019
Armenia	May 2, 2019 A
Barbados	Apr 19, 2018
Benin	Mar 19, 2018
Bhutan	September 27, 2019
Burkina Faso	Jul 26, 2018
Chad	Mar 26, 2019
Chile	Sep 19, 2017
Comoros	Nov 16, 2017
Cook Islands	Aug 22, 2019 A
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
Ghana	Aug 2, 2019
Grenada	May 29, 2018
Guinea-Bissau	Oct 22, 2018
Honduras	Jan 28, 2019
Jordan	Oct 16, 2019
Kiribati	Oct 26, 2018
Lao People's Democratic Republic	Nov 16, 2017 A
Lesotho	Oct 7, 2019
Malawi	Nov 21, 2017
Maldives	Nov 13, 2017
Mali	Mar 31, 2017 A
Marshall Islands	May 15, 2017
Mauritius	Oct 1, 2019
Mexico	Sep 25, 2018 A

Participant	Acceptance(A), Ratification, Approval(AA)
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
Palau	Aug 29, 2017
Panama	Sep 28, 2018
Paraguay	Nov 1, 2018 A
Peru	Aug 7, 2019
Rwanda	May 23, 2017
Samoa	Mar 23, 2018
São Tomé and Príncipe	Oct 1, 2019
Seychelles	Aug 20, 2019 A
Senegal	Aug 31, 2018
South Africa	Aug 1, 2019
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
Vietnam	September 27, 2019 AA

SOLARCHILL EXPANDS PROJECT FROM VACCINES TO FOOD

Solar-powered R600a food fridges for remote locations are being tested in Africa and South America, with an eye on commercialization.

— by Ilana Koegelenberg

SolarChill, a 19-year-old project that has brought solar-powered vaccine coolers with natural refrigerants (isobutane) to remote, off-the-grid locations, is poised to enter its next phase, providing food fridges.

Currently there are approximately 100,000 SolarChill A vaccine coolers installed in clinics around the world (including Africa, Asia, Latin America, and the Caribbean). One vaccine cooler can service up to 30,000 children.

SolarChill A units are also used in disaster areas such as war zones, earthquakes, and tsunamis. For example, Doctors Without Borders installed SolarChill units in refugee camps in Chad and Sudan, and United Nations Children's Fund (UNICEF) sent SolarChill units to earthquake-damaged zones in Haiti.

During the present phase of the project, 113 SolarChill A units have been installed in Colombia, Kenya and eSwatini (formerly Swaziland) for extensive field testing and monitoring. Through the project it was possible, for the first time, to field test and concurrently monitor online the performance of SolarChill appliances under a variety of ambient temperatures and use conditions over several months in the three countries.

The project is also successfully engaging in technology-transfer outreach to local

manufacturers. Manufacturers in eSwatini and Colombia have successfully adopted the SolarChill technology and are now placing the products on the market.

At the same time, 45 Solar Chill B food refrigerators are also being installed in Colombia, Kenya and eSwatini (15 in each one). The project's organizers are seeking funding and partnerships to support the production and commercialization of these units.

In regions without reliable electricity, a vast amount of vaccines are spoiled each year. The financial losses are set to increase with ever-more-expensive vaccines coming on the market. The lack of reliable electricity also impacts negatively on the preservation of food supplies. Refrigeration of food in many regions is simply unavailable, resulting in extensive spoilage.

"The SolarChill Project aims to tangibly improve the quality of our environment and human health by delivering affordable, climate-friendly, lead-battery-free, solar-powered vaccine cooling and food refrigeration to parts of the world that are without reliable electrical supply," explained Dr. Simon André Mischel of HEAT GmbH, Project Manager for the SolarChill project. The current project will be implemented until the end of 2019, although there is a possibility of extension until mid-2020, depending on the planned budget, he said.

CONCEIVED BY UNEP AND GREENPEACE

The SolarChill project was co-conceived in 2000 by the United Nations Environment Program (UNEP) and Greenpeace International during the 12th Meeting of the Parties to the Montreal Protocol in Ouagadougou, Burkina Faso. At the same time, the Danish Technological Institute showed interest in developing a solar powered, battery-free vaccine cooler. Other partner organizations were invited to join the project to provide much needed expertise in vaccine cooling and the use of solar technologies in developing countries.

The project was launched in early 2001. All in all, the project partners invested more than US\$500,000 seed capital for research and development. The current field testing and technology transfer phase of the SolarChill Project is enabled by funding from the Global Environment Facility.

"The SolarChill project partners have no commercial interest in the SolarChill technology itself," explained Mischel. Their sole mandate is to develop this public domain technology, make it freely available to interested manufacturers worldwide, and promote its uptake internationally."

There are five manufacturers of SolarChill A vaccine coolers in the world: Vestfrost (Denmark); Sure Chill (U.K.) which



Installing a SolarChill fridge at the Olasiti Health Care Facility in Tanzania.

licenses with Zero Appliances (South Africa) and Godrej (India); Haier (China); B Medical (formerly Dometic in Belgium); and Dulas (U.K.). The SolarChill team is collaborating with the Fridge Factory in eSwatini towards attaining the required WHO Performance Quality and Safety (PQS) certification for vaccine coolers.

The commercial SolarChill food fridges have not previously been widely commercialized, though a prototype at the Danish Technological Institute has been in operation for several years. The project has developed and published a production guideline for the development and manufacturing of SolarChill appliances.

"SolarChill B has a vast market potential as it can be used for domestic and small commercial applications in developing countries, as well as for off-the-grid recreational purposes in developed countries," said Mischel.

HOW DOES IT WORK?

In principle, the SolarChill technology is relatively simple, explains Mischel. Solar power from two or three 60W/80W solar panels run a direct-drive R600a compressor. The compressor runs the refrigerant cycle, which in turn produces an ice bank that maintains the required temperature in the cabinet. By using thermal storage, the system stores the power of the sun in an "ice battery." It is a solar version of the old-fashioned icebox.

A thermostat maintains the units at the required temperatures. For vaccines that is between 2-8°C (35.6-46.4°F), day and night. The optimum temperature range for perishable food storage is 3-5°C (37.4-41°F). In low-sun situations, or with power completely disrupted, the thick insulation of the cabinet maintains acceptable temperatures for up to five days.

There are two original models of SolarChill, a 50L (13.2 gal) unit for vaccine cooling and a 100L (26.4 gal) unit for food

refrigeration. Both models operate under the same principles. Larger SolarChill models are also available.

Working with hydrocarbons remains one of the challenges facing SolarChill, according to Mischel. "It is unlikely that existing appliance manufacturers that are not yet working with hydrocarbons in their general production line of refrigerators or freezers will be able to produce hydrocarbon SolarChill products," he said.

However, as the use of hydrocarbons in domestic and commercial refrigerator production increases worldwide, more appliance manufacturers acquire the infrastructure and the expertise to work with hydrocarbons. "The Montreal Protocol's Kigali Agreement for phasing down the use and production of HFCs will further stimulate the uptake of hydrocarbon refrigeration," said Mischel. ■ IK



NatRefs Expert Hafner Echoes Activist Greta Thunberg

At ATMOSphere Europe, he asks,
How dare you burn fossil fuel
when you can use a natural
refrigerants-based heat pump?

— by Tine Stausholm

In pointing out the advantages of natural refrigerants during his presentation on the latest industry technology trends at ATMOSphere Europe last month, Professor Armin Hafner questioned why anyone would choose not to use natural refrigerants to produce heat.

“How dare you make steam by burning fossil fuels, when you can use a heat pump?” Hafner said, echoing Swedish teenage climate activist Greta Thunberg’s speech at the United Nations Summit in New York in September, in which she excoriated world leaders for not acting more aggressively on climate change, demanding, “How dare you?”

Hafner, professor in refrigeration in the Department of Energy and Process Engineering at the Norwegian University of Science and Technology (NTNU), gave ATMOSphere Europe attendees a round-up of all the latest developments within hydrocarbons, ammonia and CO₂. The conference was held in Warsaw, Poland, October 16-17. (It was organized by shecco, publisher of *Accelerate Magazine*.)

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He stressed that low-GWP synthetics should only be used to keep existing systems going, never in a new system. New systems should “use a natural refrigerant, because they can do the job better and more energy efficient,” Hafner stated.

Hafner noted that there is a lot of waste heat out there “going to the crows” that should be utilized by replacing traditional boilers with heat pumps, while taking advantage of the cool side as well. This would give both primary energy savings and reduce CO₂ emissions, he said.

For industrial processes like pasteurization and drying, where already warm water needs heating up to 110°C (230°F) for steam production, hydrocarbons are the refrigerant of choice, Hafner said. For example, cascade systems with R290 (propane) and R600 (butane) would give a high internal temperature lift and great efficiency. “This is a combination you will see very much in the future for high-temperature-level heat pumps,” he said.

On the other hand, for high-performance buildings like hotels, schools and gyms, where colder water of perhaps 10°C (50°F) has to be heated up to 80°C (176°F), CO₂ would be the refrigerant of choice in the future, Hafner said.

Current research and development is focused on the performance of high-temperature heat pumps. Hafner described a current Norwegian R&D project, carried out in collaboration with an un-named European compressor manufacturer, to improve the heat management of R600 semi-hermetic compressors. Those compressors “have a challenge because the suction temperature of a high-temperature compressor is about 80°C [176°F], so the compressor has to be cooled with 80°C fluid.” He expressed optimism that the project would be able to solve this challenge by 2020.

Ammonia for district heating

Moving on to ammonia, and the new options it gives when combining it with water or CO₂, Hafner detailed ongoing work done by Japanese manufacturer Mayekawa. He praised Mayekawa’s development of a system providing 80°C (176°F) hot water for district heating, using only 100g of ammonia per kilowatt (12.25oz per TR), calling it a “good number.”

Another innovation “the market really needs,” according to Hafner, are semi-hermetic compressor arrangements for ammonia, which have the potential to save a “lot of space” and reduce maintenance, which is good for both the industry and end users. Part of the saved space can be used for fine separation of oil, and give the potential for oil-free evaporation and a smaller evaporator surface.

The last example of new ammonia developments presented by Hafner was the Osenbrück 4.0, a new type of heat-pump cycle (based on Osenbrück’s Process) where water and ammonia are used inside the closed loop of an absorption-compression heat pump.

This system contains a liquid-vapor separator, which separates water and ammonia gas. The liquid water is pumped around the system and the ammonia gas is sent into the compressor. When the two fluids combine again in the high-temperature absorber heat exchanger, heat is released (cold is generated by the desorber and evaporation of ammonia).

The temperature glide in the absorber enables higher outlet temperatures (up to 115°C/239°F) at lower pressures below 20 bar (290psi), compared to ammonia-only systems, said Hafner. Varying the composition of the water-ammonia mixture and the circulation ratios increases flexibility, and the process can be adapted to suit specific capacities. “That’s a nice development,” he said.

Chiller with CO₂ is possible

“Everybody said a CO₂ chiller is not possible; it is possible,” Hafner said. “And it is very energy efficient if you do it like this,” he added, referring to the new ECO₂ chiller and heat pump from Italian OEM enex.

The ECO₂ is compact and energy efficient, and it complies with the EU Ecodesign Directive. It can be used for both domestic hot water production and heating/cooling in the winter and summer, respectively. By utilizing an ejector, it is possible to unload the compressor and lift the suction pressure by “several bars” while also providing 7°C (44.6°F) water, Hafner said. “So no, no problem with [CO₂ chillers].”

■ TS

“Everybody said
a CO₂ chiller
is not possible;
it is possible.”

- Armin Hafner, NTNU



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Professor Peters: We Need to Reinvent the Cold Chain

In a keynote address, the U.K. clean-cold expert called for a system approach that will relieve exploding energy demands while meeting cooling needs for all.

— By Michael Garry

In a powerful demonstration of the vital role cooling plays in the global economy and the impact that the growing demand for cooling will have on the climate crisis, Professor Toby Peters of the University of Birmingham, U.K., issued a call for a new focus on improving both system efficiency and the cold chain in a keynote address at the 2019 ATMOSphere Europe conference in Warsaw, Poland.

"Global access to cooling underpins health, safe housing and workplaces; and it's essential for reducing post-harvest food loss," said Peters in a presentation called "Doing Cold Smarter." "If we want to solve these challenges, we have to solve the cold chain," he said.

An internationally-recognized expert in clean-cold technology, Peters described the need for sustainable cooling as sitting at the heart of the three big global agendas set by the United Nations: the Paris climate change accord, the Montreal Protocol (Kigali Amendment) and the SDGs (Sustainable Development Goals).

Peters, who this year released a groundbreaking report titled "A Cool World: Defining the Energy Conundrum of Cooling for All," kicked off the 10th ATMOSphere Europe conference with this powerful message. (See [Thought Leader Q&A, Accelerate Magazine, July-August 2019](#).) The conference was organized by shecco (publisher of *Accelerate Magazine*) and held on October 16-17. It attracted about 350 attendees.

While outlining the massive scope of the cooling challenge, Peters also offered a range of solutions, including changing agricultural pack houses in rural communities in India into integrated centers serving a wide range of cooling demands, including personal refrigeration lockers and comfort cooling for the elderly.

He also announced the launch of a Center for Sustainable Cooling later this year. The center is a partnership between the University of Birmingham and six to eight other U.K. universities, as well as others in Europe, the U.S., India, Japan, and "hopefully industry." The center will examine "how we can accelerate access to sustainable cooling for all who need it," he said. "It will look at the innovation pipeline and identify future skills and training needs and enable them to be met."

Peters praised the myriad stakeholders at ATMOSphere Europe as "the people who understand the need for sustainable cooling — the people focusing on natural refrigerants." He also urged them to recognize "the real opportunity to think about how we deliver clean sustainable cooling and address these challenges."

Data points

Peters began his keynote by listing data points that underscore the outsized importance and impact of cooling on society:

► In 2018, 104GW (gigawatts) of solar energy capacity was created, yet 115GW of energy was needed to support the new room air conditioners sold.

► Yet more than one billion people don't have access to cooling.

► Twenty percent of food is lost post-harvest due to the lack of a cold chain.

► More than 800 million people suffer from malnutrition.

► In India, 30% of patients are at health centers due to heat stress.

► The lack of a cold chain results in the death of 1.5 million people annually.

Peters also estimated the growth in cooling appliances and the impact that will have on energy demand:

► Nineteen pieces of cooling equipment will be deployed every second for the next 30 years.

► Current annual energy demand is 35,000TWh (terawatt-hours) but will grow to 95,000TWh by 2050 (particularly in developing markets). Moreover, if cooling is provided to the one billion people who lack it today, energy demand will increase to 19,000TWh. (Even with accelerated technology progress projections, the energy requirement is still 15,500TWh.)

► But to meet the 2°C (3.6°F) temperature-increase limit set by the Paris accord, annual energy use by cooling can only grow by 65,000TWh by 2050.



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

"These figures, when we get there, will be wrong, but they show us the size of the challenge facing us today," said Peters.

Expanded role for packing houses

Peters went through a number of ways to address the need for more efficient cooling and a better cold chain, including more efficient systems, the use of natural refrigerants, a reduction in demand through cool roofs, personal behavior change (such as temperature changes on ACs), thermal storage, and many other methods.

He is also one of the judges who will select the winner of the Global Cooling Prize, a competition seeking the development of a room air conditioners that are at least five times more efficient than current models.

But he cautioned that these interventions are not enough. "Delivering suitable cooling is about investing in radical reshaping of cooling at a system level." This includes not just looking at the amount of electricity needed, but to consider "what is the service we require, and how can we provide it in the least damaging way," he said.

In one example of a system approach, Peters noted that India is about to build about 23,000 agricultural packing houses, though "they will need 70,000 as they address the challenge of doubling farmer incomes and reduce food losses."

He suggested that these packing houses become "centers of cooling solutions, aggregated together, to suit a portfolio of needs in the most affordable way."

The packing house could, for example, also include food processing and veterinary vaccinations and serve as hubs for domestic refrigeration.

"The idea that rural communities can afford domestic fridges in every house is not viable when you look at the cost of fridges vs. income," he said. "But could we have personal refrigeration lockers accessible to home residents?"

He also envisions these "temperature-safe environments" as a place for the elderly on hot days, as well as a "lifeboat where you can store emergency supplies closer to the point of demand, because with climate change there will be more natural disasters. These are the areas we want to explore." ■ MG

World in Brief

NatRef Projects Shine in ASHRAE - UNEP Awards at MOP31

ASHRAE and the United Nations Environment Programme (UNEP) have announced the project selections for the 2019 OzonAction Lower-GWP Refrigeration and Air-Conditioning Innovation Awards. Out of the five winning projects, four included natural refrigerants.

The projects were recognized at an ASHRAE UNEP side event during the 31st Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (MOP31) in Rome, Italy, November 4-8.

This annual international award program recognizes people who have developed or implemented innovative refrigeration and air-conditioning application using low-GWP for developing countries.

"The projects selected represent long-term, global and energy-efficient solutions to lessen the impact of ozone-depleting substances," said

Sheila J. Hayter, ASHRAE President and co-chair of the judging committee.

The winning projects were:

► A low-charge ammonia vapor-compression refrigeration system for residential air-conditioning, implemented in India.

► An HFC-161 application for high-cooling-capacity household air conditioners, implemented in China.

► Packaged chillers with integrated air-handling units using R32 and R290, implemented in Saudi Arabia.

► The "crocodile project" CO₂ transcritical refrigeration system for a hot-and-humid region, implemented in Thailand.

► Low-charge propane chiller for a supermarket commercial-refrigeration system, implemented in Brazil.

■ IK

Carrier Expects to Sell 20,000th CO₂ Unit In Near Future

At ATMOSphere Europe in October, Pierre Boyer, Managing Director, Mechanical Systems for Carrier Commercial Refrigeration, was asked on stage how long it would take Carrier to deliver its 20,000th CO₂ transcritical system, following the announcement early this year that it had reached the 10,000-system mark.

"Not very long," answered Boyer. He attributes this rapidly accelerating adoption mostly to the commercial food retail industry in Europe.

Carrier installed its first transcritical CO₂ system in a Swiss supermarket in 2004. It took 10 years for Carrier reach 1,000 units, Boyer explained during the event's "Exclusive Interview" session, conducted by shecco CEO Marc Chasserot. Carrier hit the 13,000-unit mark in October, according to Boyer. ■ DY

Burger King Starts Roll Out of CO₂ in Spain

U.S. fast food chain Burger King has chosen Green & Cool's natural refrigerant CO₂Y system as condensing units for its restaurants in Spain. It marks the first time that Burger King has used CO₂.

"Over the last few months, we installed and tested 10 CO₂Y systems in our Spanish restaurants," confirmed Borja Hernández de Alba, General Director of Burger King Spain and Portugal. "We have been convinced by this new technology, which has a much lower environmental impact. This aligns with our sustainability values; thus we decided to order another 30 units that will be installed in the coming months in Spain."

Green & Cool is a part of U.S. HVAC provider Carrier. Its CO₂Y system is designed to be quiet and environmentally sustainable as a CO₂ transcritical condensing unit within a compact design, according to a recent press release from Carrier. "It is an ideal fit for providing high refrigeration output in small formats and even in a high-ambient country," stated Carrier. "For this reason, the CO₂Y solution is now the preferred condensing units for Burger King and will be implemented for new restaurants and restaurants remodeling in Spain." ■ IK

South Australian Academy Developing Virtual Reality Training for Hydrocarbons

The Technical and Further Education (TAFE) South Australia (SA) training academy has been working with local OEM AJ Baker & Sons to develop virtual reality (VR) content for a hydrocarbon refrigerant training module by year's end.

TAFE SA has been training on HC safety for several years and now is taking its training to the next level by employing a VR module that will assist in giving students the skills needed to safely service and install hydrocarbon equipment, explained Shannon Baldock, Electrical Lecturer at TAFE SA. The academy began working with VR in 2018. ■ IK

China's Second Transcritical CO₂ System 'Operating Successfully'

After more than a year of operation, China's second transcritical CO₂ system has been 'operating successfully', according to Li Li Du, Overseas Sales Director of system supplier Panasonic Appliances Refrigeration Systems in Dalian, China.

"The system has been running very reliably, there has been no leakage and the customer is very satisfied with the energy savings," said Du during a ChinaShop 2019 presentation about the project during the "Green Operations in China's Retailing Industry: Climate Change & Store Operation" seminar on the first day of ChinaShop 2019, held this year in Qingdao, China from November 7-9. ■ DY

U.S. Contractor Group Embraces NatRefs, Building Ammonia/CO₂ System

The Arcticom Group (TAG), a two-year-old private equity commercial-refrigeration consolidator that has acquired seven service-and-installation contractors in the Western U.S., is making its mark with natural refrigerants while raising its profile in the U.S. supermarket industry.

TAG's PMC Southwest division delivered an ammonia rack for an ammonia/CO₂ system in November to an under-construction Raley's supermarket in Sacramento, California (U.S.), the first to be installed by the 121-store chain. The store is expected to open next March.

The Raley's Sacramento outlet will be only the fifth U.S. store to deploy an

Canadian Contractor's CO₂ Rack Installations Exceed 60

Neelands Group Limited, a refrigeration contractor based in Burlington, Ontario, Canada, has done more than 60 transcritical CO₂ rack installations in the province of Ontario, according to Tom Quaglia, its senior manager, construction.

Among its food retailer customers, Longo's, a 35-store chain based in Vaughan, Ontario, has been a leading adopter of transcritical CO₂ systems, with 35% (12 stores) using the technology, "and this number continues to grow," said Quaglia.

In addition to Longo's, Neeland's has installed transcritical CO₂ systems for such retailers as Metro and Costco, as well as many independents, including Highland Farms, Greco's and Coppa's, said Quaglia. ■ MG

MOP 31: Reduce Food Waste Via Sustainable Cold Chain

The 31st Meeting of the Parties to the Montreal Protocol (MOP 31), held in Rome, Italy, discussed key cooling-related climate issues such as fostering sustainable cold chains, reducing food waste, and improving access to energy-efficient and low-GWP technologies for developing nations.

MOP 31 convened from November 4-8 at the headquarters of the United Nations (UN) Food and Agriculture Organization (FAO) in Rome. The preparatory segment met from November 4-6, followed by the high-level segment from November 7-8

In his opening remarks during the preparatory segment, Roberto Morassut, Italian Undersecretary of State, Ministry of the Environment, Land and Sea, stated that the Montreal Protocol is an "inspiration for a transition to a sustainable world."

René Castro-Salazar, Assistant Director-General, Climate, Biodiversity, Land, and Water Development of FAO, stressed the urgency for countries to work together to reduce food waste, noting it would be possible for "current food production to feed the entire world if waste were eliminated."

A summary of key topics covered at MOP 31 can be found at <https://bit.ly/36SqUBw>. ■ IK

ammonia/CO₂ system. Its unorthodox design employs DX ammonia; direct-drive Carlyle 5H ammonia compressors in a two-stage configuration; liquid-over-feed CO₂ for low- and medium-temperature cases and air conditioning (no CO₂ compressors); water-cooled condensing and heat reclaim with plate heat exchangers; and a total ammonia charge of 120lbs (54.5kg). Zero Zone built its two CO₂ skids.

TAG also recently announced that it has joined the North American Sustainable Refrigeration Council (NASRC) as a platinum member. ■ MG

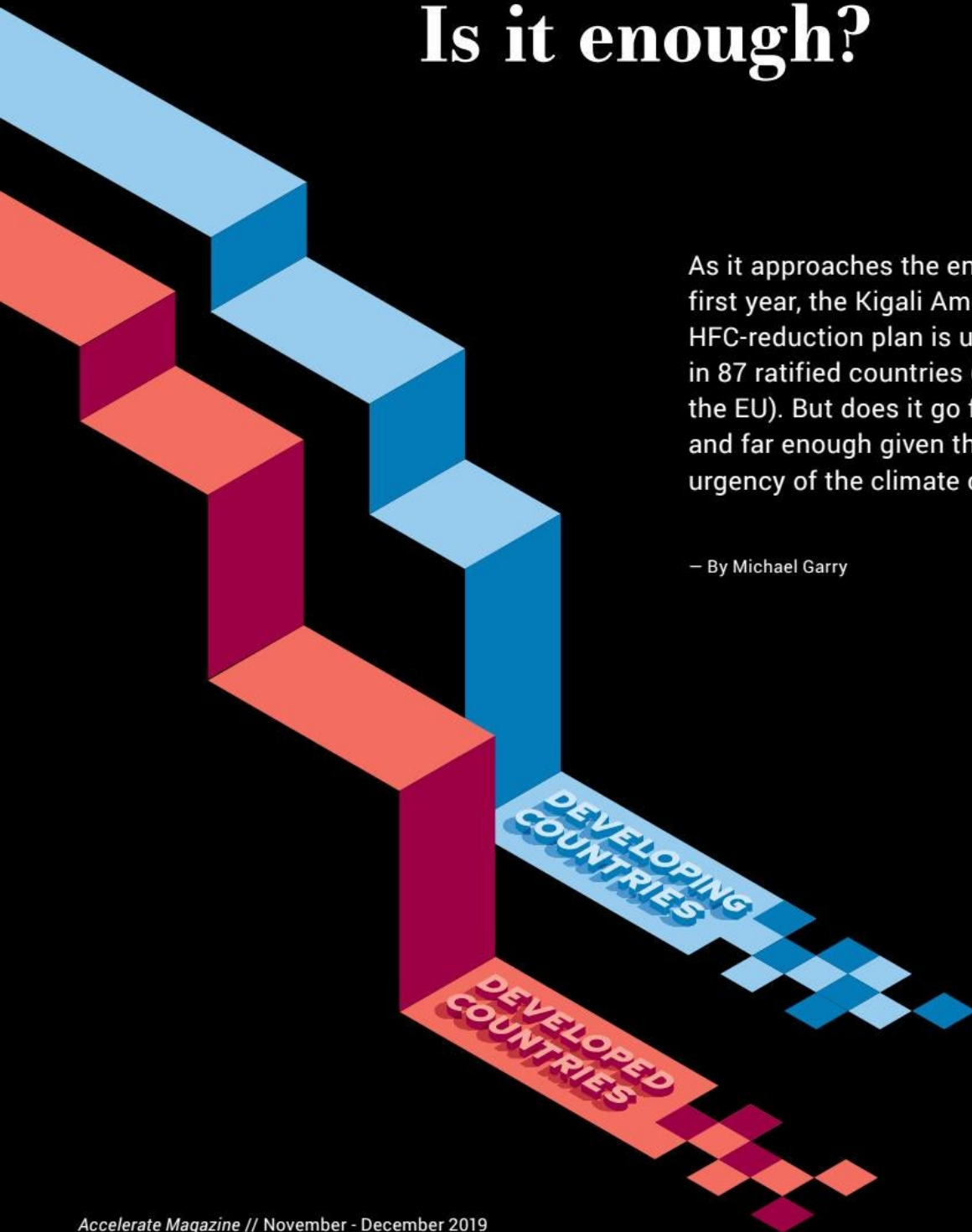
The Global HFC Phase-Down Plan

KIGALI

Is it enough?

As it approaches the end of its first year, the Kigali Amendment's HFC-reduction plan is underway in 87 ratified countries (and the EU). But does it go fast and far enough given the urgency of the climate crisis?

— By Michael Garry



On October 15, 2016, in Kigali, the capital of the African nation of Rwanda, the nations of the world came up with a plan to phase down hydrofluorocarbons (HFCs), the most powerful and fastest-growing greenhouse gas, mainly used as refrigerants in refrigerators and air conditioners.

The plan, known as the Kigali Amendment to the Montreal Protocol, was seven years in the making. It's a fitting extension to the original Montreal Protocol, created in 1987 to eliminate ozone-depleting CFC and HCFC gases. Kigali addresses the HFC gases that were designed to replace those ozone-depleting substances (ODS) but turned out to be environmentally damaging in their own way, thousands of times more powerful at warming the atmosphere than CO₂.

Kigali's planned phase-down of HFCs opens the door to the adoption of climate-friendly alternative technologies based on natural refrigerants. On the other hand, the chemical industry sees the phase down as an opportunity to market HFOs, its replacement for HFCs, though some HFOs produce trifluoroacetic acid (TFA) in the atmosphere. (See "[HFOs: How much is too much?](#)" *Accelerate America*, September 2019.)

The creation of the Kigali Amendment caught the eye of major media outlets, with the *New York Times* reporting, "Nations, Fighting Powerful Refrigerant that Warms Planet, Reach Landmark Deal." Coming almost a year after the Paris Agreement on climate change, the amendment was heralded as a key part of the global effort to reduce the proliferation of climate-warming gases that have precipitated what is now regarded as a climate emergency.

U.S. Secretary of State John Kerry, one of the negotiators in Kigali, called the amendment "likely the single most important step we could take at this moment to limit the warming of our planet and limit the warming for generations to come," according to the *New York Times*.

When fully implemented, the amendment is expected to avoid the creation of 80 Gt (billion metric tons) of CO₂e emissions by 2050. In addition, it is projected to reduce the rise in global temperatures by up to 0.4°C (0.72°F)

by 2100, helping achieve the Paris Agreement's goal of limiting the warming increase to well below 2.0°C (3.6°F) above pre-industrial levels. "That is a massive [reduction] considering that science tells us that we need to keep temperature rise below 1.5°C [2.7°F] to avoid full-scale climate catastrophe," said Janos Maté, senior policy consultant for Greenpeace International, which has been warning about HFCs since the early 1990s.

During the transition from HFCs to low-GWP alternative refrigerants, improvements in energy efficiency in refrigeration and air-conditioning equipment can potentially double the climate benefits of the HFC phasedown under the Kigali Amendment, according to "The Scientific Assessment of Ozone Depletion: 2018." (See "[How Do We Cool A Warming World \(Without Making it Warmer\)](#)," *Accelerate Magazine*, October 2019.)

Unlike the Paris accord, which is voluntary, the Kigali Amendment sets a legally binding timetable with specific HFC reduction targets, penalizes non-ratifying countries with trade restrictions, and requires developed (A2) nations to help finance developing (A5) countries' transition to alternative refrigerants.

While 197 countries and the European Union (EU) approved the amendment in 2016, it still requires ratification by individual nations to enter into force in those countries. The amendment as a whole took effect on January 1, 2019, because more than 20 countries (64 plus EU) had ratified it. The number of ratifications as of November 18, 2019, was 87 plus the EU, including 31 out of 49 developed countries and 56 out of 148 developing countries. (See [page 20](#) for a list of countries that have ratified.) Two of the largest consumers of HFCs, the U.S. and China, have yet to ratify.

With the first year of the Kigali Amendment almost over, a number of questions are on the table: Has it met expectations? When will more countries ratify? What challenges to implementation have emerged? Even at its best, some observers question whether the HFC-reduction process under Kigali is taking place quickly enough to adequately address the urgency of the climate crisis, and believe it should be a 100% phase out rather than a phase down that maxes out at an 85% reduction.

KIGALI AMENDMENT
TIMELINE

2016

Kigali Amendment to the Montreal Protocol adopted in Kigali, Rwanda.

2018

Plan launched to develop, within two years, guidelines for financing the phase down of HFCs.

2019

On January 1, Kigali Amendment enters into force, HFC import/export licensing required.

2019

87 countries plus EU have ratified the Kigali Amendment as of November 18, 2019.

2020

January 1 is cut-off date for MLF funding of HFC equipment in developing countries group 1.

2024

January 1 is cut-off date for MLF funding of HFC equipment in developing countries group 2.

2033

On January 1, HFCs trade with non-ratifying countries is banned.

2036

Developing countries reach the final step, 85% reduction of HFCs from baseline.

2045

Developing countries group 1 reach final step, 80% reduction of HFCs from baseline.

2047

Developing countries group 2 reach final step, 85% reduction of HFCs from baseline.

While less than half of 197 countries have ratified it, Alain Wilmart is confident that eventually "everybody will ratify." Wilmart is Ozone Layer and Fluor Gases Senior Policy Advisor at the Federal Ministry of the Environment in Belgium; he also serves as co-chair of the Open Ended Working Group of the Montreal Protocol, and participates in its Multilateral Fund (MLF), which channels financing from developed to developing countries. Wilmart spoke about the Kigali Amendment on October 17 at the ATMOSphere Europe conference in Warsaw, Poland. (The conference was organized by shecco, publisher of *Accelerate Magazine*.)

He pointed out that all of the previous amendments to the Montreal Protocol were ratified by all parties. However, if there are holdouts, Kigali has a clause barring trade in HFCs with non-parties to the amendment starting in 2033. It also behooves countries to ratify as soon as possible because they are obligated to meet the same timetable for reductions regardless of when they start.

A number of developing countries are on the cusp of ratification, according to reports at the 31st Meeting of the Parties to the Montreal Protocol (MOP 31), held November 7-8 in Rome, Italy. Armenia, Brazil, the Dominican Republic, Kenya, Sudan, Tanzania, Tunisia, and Zimbabwe said that their ratification is underway. Argentina, Guinea, Malaysia and Mozambique emphasized their intention to deposit instruments of ratification with the UN shortly. Separately, China's president, Xi Jinping, recently said China would ratify as soon as possible, according to the French Ministry for Europe and Foreign Affairs.

Out of 31 developed countries that have ratified the Kigali amendment, 24 of them are from the EU. The only EU countries that have not yet ratified are Italy, Spain, Romania and Malta. "The

only explanation for the delays is that the legal process for ratification can be complex," said Wilmart.

The EU itself has ratified the amendment, "just to show it is engaged in the same way," said Wilmart. Under Kigali, the EU ratification manages reduction steps and quotas, which are already defined by its F-Gas Regulation. But the EU does not control "purely national" steps, such as each country's contribution to the MLF, he noted.

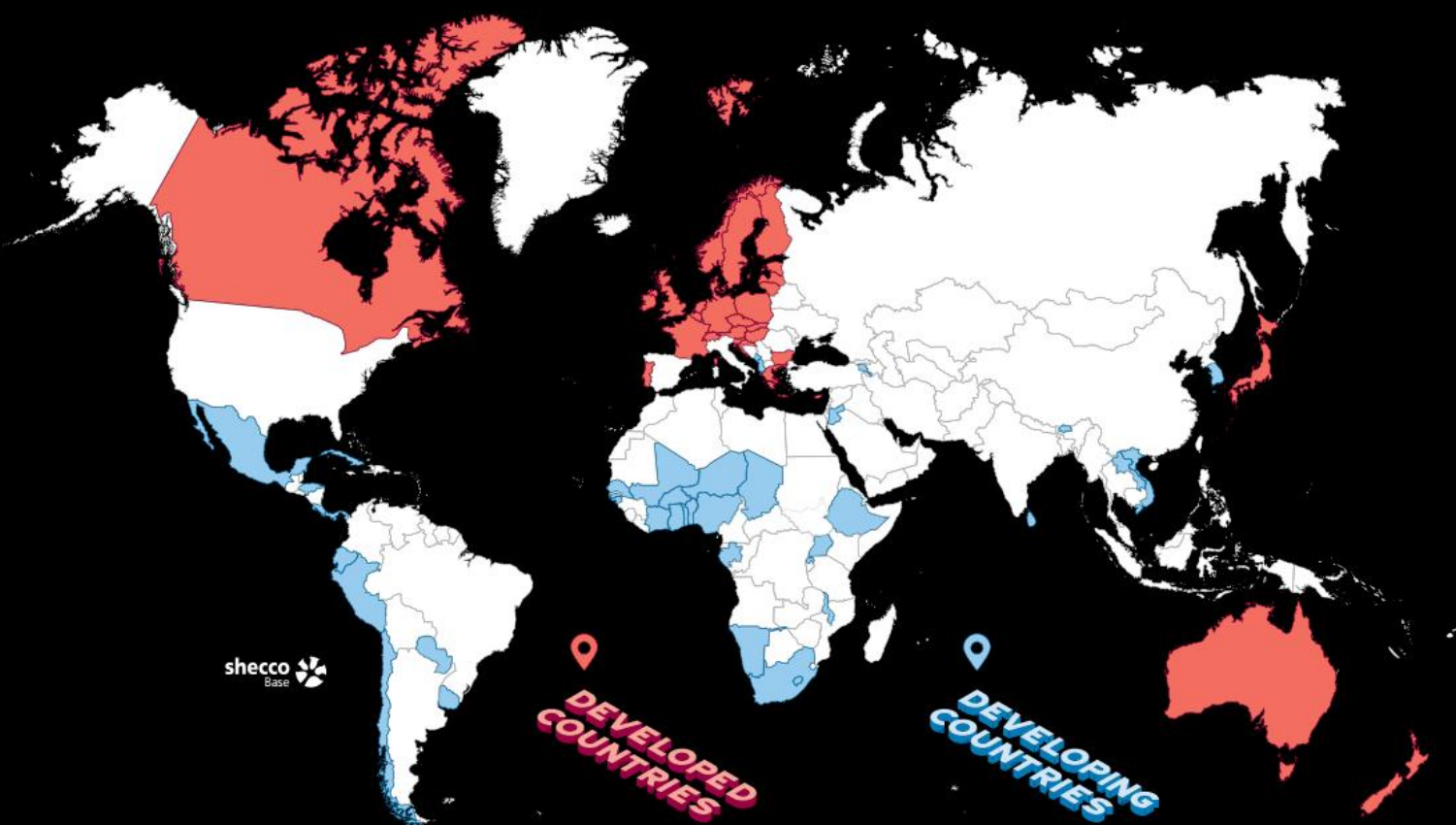
The fact that the U.S., where many major refrigeration and air-conditioning companies are located, has not ratified is "a bit annoying," said Wilmart. "But we know the situation in the U.S. with the administration." However, given the progress with new refrigeration technologies such as natural refrigerants in Europe and elsewhere, the U.S. will eventually "be forced to ratify," he said. "It's just rational to do that."

Are developed countries meeting their year-one 10%-reduction Kigali obligation? Since the EU's F-Gas Regulation is more ambitious than Kigali in its phase-down requirements, European countries are already ahead of the game. By 2020, EU countries are scheduled to cut baseline emissions (average demand during 2009-2012) by 37%.

Since 2015, HFC emissions in the EU have been declining, despite the influx of illegal HFC imports, said Bente Tranholm Schwarz, a Deputy Head in the European Commission's Director-General Climate Action, in a presentation at ATMOSphere Europe. Proof of that is that HFC prices in the EU are "four-to-six times higher than before the phase down," she said.

As a result, EU countries "have more margin to implement our [Kigali] regulations without any problem at the international level," said Wilmart.

COUNTRIES THAT HAVE RATIFIED THE KIGALI AMENDMENT



REPORTING PROTOCOLS NEEDED

Wilmart identified several challenges to the implementation of the Kigali Amendment, particularly for developing countries. The amendment calls for “market surveillance to assess the progress being made,” he said. This will enable the Kigali Amendment’s governing bodies to “spot the potential of a stronger path in the future if the parties decide to amend the Kigali Amendment and put in stronger rules.”

But this means that countries need to be able to have reporting protocols in place. “Not all have laws requesting access to data on production, imports, use and destruction of HFCs,” said Wilmart. “But if you want a phase down, you need to know the products and use, and countries need to report.” The amendment also calls for countries to employ an HFC licensing system to help prevent illegal movement of HFCs.

The first reporting requirement is the baseline amount of HFCs and HCFCs (or the best possible estimate), which countries must report to the UN’s Ozone Secretariat within three months of the date that Kigali takes effect in that country. That effective date is 90 days after ratification. Countries must then report annual production, imports and exports of HFCs and HCFCs, starting with the year that Kigali takes effect in each country. Countries have nine months after the end of the reporting year to submit data.

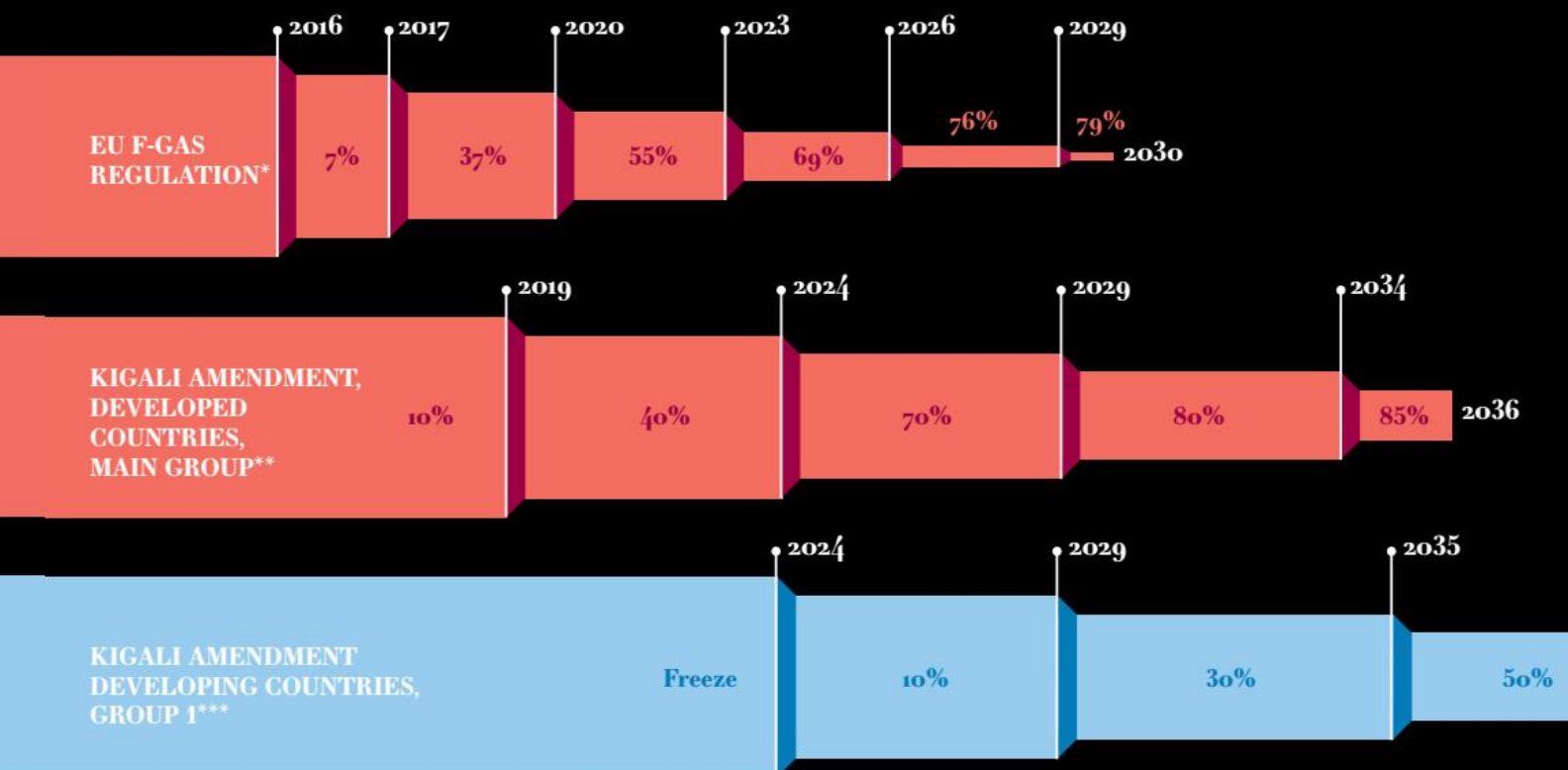
Countries are also asked to develop national strategies, including capacity building, which means training of civil servants and training/certification of technicians, architects and engineers.

To meet the various requirements of the amendment, ratified countries may need to “adopt legislation to modify the legal framework,” said Wilmart. He also advised countries to interact with bodies outside of the Montreal Protocol on efficiency and safety issues “to see how they can help in implementing the Kigali Amendment under their umbrella.”

The Multilateral Fund is still working on cost targets, said Wilmart. He pointed out that the MLF pays for the difference between “regular technology and the newest, most efficient one,” rather than the full cost of new technology.

Many developing countries have begun “enabling activities” (including national strategies) aimed at facilitating early adoption of the Kigali Amendment and preparing them for obligations under the

HFC PHASE-DOWN SCHEDULE (Percentage of baseline)



amendment, noted Natasha Kochova, a consultant with the Montreal Protocol Division, Department of the Environment, United Nations Industrial Development Organization (UNIDO), an implementing agency for Kigali.

"The Kigali Amendment is sensitive toward the situation countries are in, their needs and the challenges they are facing," Kochova said. "There is no 'one-fit-all' scenario; much of the work is done by custom tailoring and finding ways that are acceptable and appropriate."

At MOP 31, numerous developing countries asked for help in their transition to climate-friendly gases. Several presented a paper on "the risk of not being in a position to get access to the newest technologies based on low-to-zero GWP," said Wilmar. "They fear also

dumping of old and outdated technologies that will hamper the energy efficiency of equipment."

In particular, Malaysia and Uganda asked that alternatives to HFCs be made available at reasonable and competitive prices. Cambodia, Iran, Myanmar, and Nicaragua called for more financial and technical support for their ODS phase out while Argentina urged that the MLF complete the cost guidelines to fund the HFC phase down. Indonesia and Lebanon requested more support for capacity building and technological assistance in finding feasible alternative to HFCs.

Another challenge for Kigali are safety standards that block the adoption of HFC alternatives like hydrocarbons. In July, the Environmental Investigation Agency (EIA) issued a report calling for updates of these standards

The EIA report, "High-Stakes: Implementing and strengthening climate and ozone commitments under the Montreal Protocol," recognized the breakthrough that took place in May, when the IEC's 60335-2-89 standard was updated to increase the charge limit of flammable refrigerants in stand-alone cabinets in commercial refrigeration to 500 g (17.6oz) from 150 g (5.3oz). But the report recommends that countries rapidly update their national and regional standards to be aligned with the new IEC standard.

In addition, the EIA report says that an update of the hydrocarbon charge-limit standard for air conditioning equipment (IEC 60335-2-40) is needed to prevent the adoption of medium-GWP transitional refrigerants in ACs.

* Baseline = average HFCs demand 2009-2012

** Baseline = average production/consumption of HFCs 2011-2013 + 15% of HCFC baseline production/consumption.

***Baseline = average production/consumption of HFCs 2020-2022 + 65% of HCFC baseline production/consumption.

2040

80%

2045



Alain Wilmart,
Belgium Ministry of
the Environment

2030 PHASE-OUT PLAN

While the Kigali Amendment's HFC-reduction plan is widely regarded as an important step forward, it has been criticized for not going fast or far enough, and for not including HFOs in its phase-down plan. In particular, the NGO Greenpeace has advocated a global HFC phase out (rather than phase down that ends at an 85% reduction from baseline) "by no later than 2030, but if possible, sooner," said Greenpeace's Maté.

"A rapid global HFC phase out not only has climate benefits but would also make good business sense," added Maté. "It would immediately encourage developing countries to leapfrog HFCs and thus preempt having to have yet another phase-out scenario further down the road."

A 2017 report called "Climate Benefits of a Rapid Global HFC Phase-Out," prepared for Greenpeace by Öko-Recherche, a German environmental research group, estimated the additional climate benefits of a rapid HFC phase out, in contrast to the benefits offered by Kigali's phase-down schedule. Like Kigali, the Greenpeace report uses a 100-year standard for GWPs.

The report concludes that, while the Kigali HFC phase down will result in a cumulative reduction of 484Gt of CO₂e by 2021 (with 68 Gt remaining), a 2025 phase out would cut an additional 55Gt (with 13 Gt remaining), and a 2030 phase out would remove an additional 45Gt (with 23 Gt remaining). "An HFC phase out could strengthen international efforts to reach the long-term goals of the Paris Agreement," said the report.

Greenpeace also supports using a 20-year calculation of the GWP of HFCs, rather than the standard 100-year calculation. The 20-year metric "better reflects the true potency of HFCs during their actual time in the atmosphere," which averages out to 21.7 years, stated a paper

presented at the 2012 Gustav Lorentzen Conference by Maté and David Kanter, a Princeton Ph.D candidate in atmospheric science. The absolute annual HFC emissions weighted by GWP-20 are roughly twice as high as the absolute annual HFC emissions weighted by GWP-100, the report said.

The GWP-100 metric makes some HFCs "deceptively attractive," said the report. For example, R32, which has a GWP of 675 over 100 years, has a GWP of 2,330 over 20 years.

Another area where the Kigali agreement has been found lacking is in its focus on the production and consumption of HFCs. By contrast, California has opted to base its HFC-reduction goal on actual emissions, which it is required by state law to cut by 40% below a 2013 baseline by 2030.

Following the Kigali schedule alone would get California to only 37%-48% of that goal, according to a 2017 report by the California Air Resources Board (CARB). So CARB is preparing additional strategies to make up the gap, including a 150-GWP cap on refrigerants in new refrigeration equipment, 750-GWP cap for new stationary AC equipment, and a ban on all HFCs with GWPs above 1,500.

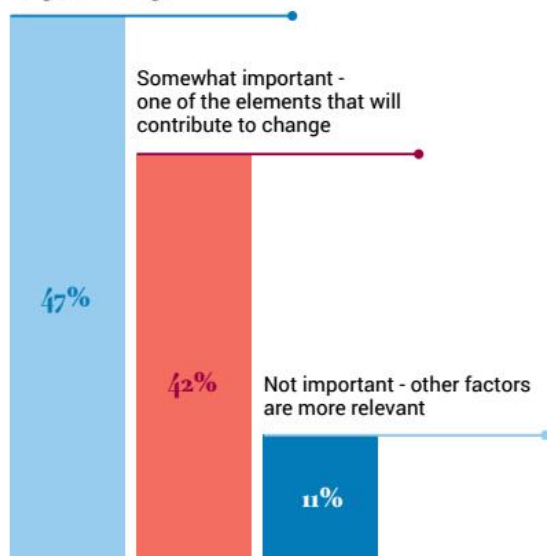
"Emissions tend to lag behind any phase down in the production of HFCs" due to the 10-20 year lifespan of equipment that continues to use and leak high-GWP HFCs, explained Glenn Gallagher, Air Pollution Specialist for the California Air Resources Board (CARB), who authored the 2017 report. That's what happened following the phase out of the HCFC R22, he said. "R22 has not been used in new air-conditioning units since January 1, 2010, yet we estimate that about 50% of all AC emissions are R22, and the other 50 percent is R410A. So R-22 'production' for new AC units is zero, yet the emissions are still half."



Janos Maté, Greenpeace

How important is the Kigali Amendment in accelerating adoption of natural refrigerants throughout the world?*

Very important - key factor for global change



*Question posed to the audience at ATMOSphere Europe, October 2019, Warsaw, Poland; 55 respondents

It would not be unusual for the Kigali Amendment to be adjusted to reflect these critiques. Since its adoption in 1987, the Montreal Protocol has been modified six times. "But the first step is to get as many [countries] as possible to ratify the Kigali Amendment," said Wilmart. ■ MG

GUIDELINES FOR REGULATING EFFICIENCY

The UN Environment's U4E (United for Efficiency) program and the Kigali Cooling Efficiency Program (K-CEP) recently published four "Model Regulation Guidelines" for accelerating the global adoption of energy-efficient and climate friendly refrigerators and air conditioners in developing countries.

The guidelines offer "voluntary guidance for governments in developing and emerging economies that are considering a regulatory or legislative framework" that requires new refrigerating or air-conditioning appliances to be energy-efficient and to use refrigerants with a lower global warming potential (GWP) than typical legacy refrigerants, and to ban the importation of used products. The guidelines – two for air conditioning and two for refrigerators – cover products commonly used in residential and light-commercial applications.

The guidelines urge the adoption of Minimum Energy Performance Standards (MEPS) and energy labels for air conditioners and refrigerators. If well-designed and implemented, MEPS and labels "are some of the fastest and most effective approaches to transition markets toward more energy-efficient products," the guidelines said.

The refrigerator guidelines can be found at <https://bit.ly/34XmGXL>, the air-conditioning guidelines at <https://bit.ly/202Kh2k>.

CALCULATING CO₂e EMISSIONS

The Kigali Amendment's HFC reductions are measured by CO₂e emissions of HFCs (in metric tons, with one metric ton equaling 1,000kg, or 2,205lbs). These emissions, in turn, are based on the amount of HFCs produced and consumed within a country during its baseline period. Determining how much in CO₂e emissions an HFC represents during that period (and how much needs to be cut at each milestone) is a matter of multiplying the mass of the gas produced and used (in metric tons) by its 100-year GWP. Thus the CO₂e of 10kg of R404A is 0.01 metric tons multiplied by the GWP of R404A (3,922), which equals 39.2 metric tons of CO₂e

Kigali bases GWPs on a list of 19 pure HFC gases (see chart, this page); the GWP of an HFC blend would be the weighted sum of the GWPs of its pure components. Thus the GWP of R404A is based on the GWPs of R125 (44%), R143a (52%) and R134a (4%).

Although pure HFOs, the latest generation of chemical refrigerants (such as R1234yf, with a GWP of 4) are not included in the Kigali phase down, HFO blends, which include an HFO and an HFC, are, since they contain an HFC component. Because HFO blends have a lower GWP than HFC blends, they may be targeted later, said Alain Wilmart, Ozone Layer and Fluor Gases Senior Policy Advisor at the Federal Ministry of the Environment in Belgium, and co-chair of the Open Ended Working Group of the Montreal Protocol.

Countries have to account for consumption and use of all of the HFCs on the Kigali list, noted Wilmart. "You cannot do cherry-picking; otherwise you could just take the highest GWP gases and forget the others."

The baseline period for developed countries is calculated as their average production/consumption of HFCs between 2011 and 2013, plus 15% of their HCFC baseline production/consumption (25% for select countries). On the other hand, the baseline for Group 1 developing countries (the vast majority) is based on their average production/consumption of HFCs between 2020 and 2022, plus 65% of their HCFC baseline production/consumption).

Because many developing countries are still in the process of phasing out HCFCs (notably R22) and replacing them with HFCs (with a deadline of 2030), Kigali decided to include 65% of HCFC production/consumption in their baseline. This allows those countries to replace HCFCs with HFCs before

phasing down HFCs, noted Wilmart. However, developing countries may be able to "leapfrog" HFCs and go directly to using alternatives like natural refrigerants, if the technology and training are available, he noted.

According to the phase-down schedule, in 2019 the Kigali Amendment requires most developed countries to cut their HFC emissions by a modest 10% from the baseline level. That figure jumps markedly to a 40% cut in HFC emissions by 2024, then to 70% in 2029, and finally to 85% in 2036. (See chart, [page 36](#).)

By contrast, developing (Article 5) countries have a much less demanding schedule. Group 1 has to freeze HFC emissions in 2024 at the baseline level. Their first reduction, 10%, comes in 2029, leading to a final 85% reduction in 2045.

HFCs IN KIGALI AMENDMENT PHASE DOWN

HFC	GWP (100-YEAR)
R134	1,100
R134a	1,430
R143	353
R245fa	1,030
R365mfc	794
R227ea	3,220
R236cb	1,340
R236ea	1,370
R236fa	9,810
R245ca	693
R43-10mee	1,640
R32	675
R125	3,500
R143a	4,470
R41	92
R152	53
R152a	124
R161	12
R23	14,800



Publix Establishes Certification Program for CO₂ Maintenance

Hillphoenix trains both contractors and technicians as Florida chain ramps up CO₂ installations.

— by Michael Garry

With a growing number of CO₂ refrigeration installations, Florida, U.S.-based Publix Super Markets has established an ambitious training and certification program for its contractors and technicians in concert with OEM Hillphoenix to ensure that its CO₂ systems are properly maintained.

"Many technicians don't have a comprehensive command of troubleshooting, diagnosing and creating a solution for some of this technology," said Doug Milu, Refrigeration and Energy Program Manager for Publix, who described the program in September at a session during the Food Marketing Institute (FMI) Energy & Store Development Conference in Dallas, Texas (U.S.). "The last thing we want is for somebody to stand in front of a machine and not know what to do."



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Milu stressed that the certification program is designed for both contractors and their technicians, as well as for Publix's own technicians, about 65 people who oversee the contractors. All participants have to pass a written test as well as engage in field training for each level of certification – bronze, gold and platinum. The curriculum is "tailored specifically to our systems," said Milu.

Publix, which operates 1,270 stores across seven southern U.S. states (nearly 800 in Florida), uses CO₂ systems in 17 stores, "with several more in the pipeline," said Milu. Those CO₂ systems include cascade and secondary configurations, some with glycol for medium temperature cases, some with CO₂ in liquid overfeed.

Publix plans to install its first transcritical booster CO₂ system in the third quarter of 2020 at a new store in Orlando, Florida; the system, to be supplied by Hillphoenix, will include an adiabatic gas cooler and ejectors. It is also pursuing plans to install an ammonia/CO₂ cascade system. "It's just a matter of time," Milu said.

In the certification program, Hillphoenix, based in Conyers, Georgia (U.S.), near Atlanta, has been providing training to Publix's contractors and technicians on CO₂ technology. The program began three and a half years ago but expanded to cover all five of Publix's divisions in January, said Rusty Walker, Hillphoenix's Senior Corporate Trainer, who participated with Milu in the FMI Energy Conference session, and is heavily involved in the Publix program. Walker described the program as "the first of its kind" for a food retail chain in the U.S.

"We took what Rusty was doing in Conyers [Hillphoenix's training center] out into the field," said Milu. "He travels to Miami, Atlanta, Jacksonville and the Florida panhandle for onsite training." The Miami training had about 170 technicians attending.

Each class takes a full day, with some being all day in the classroom, and others split between the classroom and a nearby store for the "hands-on portion," said Milu.



Doug Milu, Publix.

Photo from Food Marketing Institute

“

The last thing we want is for somebody to stand in front of a machine and not know what to do.

”

- Doug Milu, Publix

CYCLING BACK

Publix's bronze certification program encompasses glycol commissioning, case setting, and advanced electrical troubleshooting diagnostics. Contractors must renew their bronze certification every third year, and technicians also "cycle back through to make sure the training sticks," said Milu.

To achieve gold certification, contractors must certify that all service and lead installers have passed advanced electrical and troubleshooting. In addition, contractors and service personnel must pass cascade and booster CO₂ requirements; lead installers must pass an in-field set-up and installation class for CO₂ systems; start-up technicians must pass energy management and case controller training; service personnel must pass case maintenance, including proper cleaning of cases; and service technicians must pass open meat case set-up and commissioning.

For platinum certification, lead installers must take the Bitzer training class. In addition, service personnel and lead installers must complete a commissioning training class; lead installers must pass field-brazing training; service personnel must take case maintenance; and contractors must have quarterly diagnostics training in-house. Administrative personnel must be able to order parts online.

Contractors whose technicians go through the certification program gain "certain levels of accreditation" to work at Publix "so we understand what your capabilities are," said Milu. "It gives us insurance that you guys know what you're doing and your techs have been trained on our systems." ■ MG

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Kroger Division Invests in Glass-Door Retrofits, Without Losing Sales

Quality Food Centers has installed glass doors in more than half of its 62 stores.

— By Michael Garry

As part of a wide-ranging program to save energy, Quality Food Centers (QFC), a 62-store division of Kroger based in Bellevue, Washington (U.S.), has so far installed glass doors on existing medium-temperature display cases in more than half of its outlets, without adversely impacting sales.

"QFC is a trailblazer for glass-door retrofits," said Xinpei Li, Division Energy Manager for QFC, during a session called "Energy Efficiency Management in Supermarkets," at the Food Marketing Institute (FMI) Energy & Store Development Conference, held in Dallas, September 8-10.

The glass doors have been installed in beer, dairy, deli, and lunch-meat cases, but not in produce and fresh meat/seafood, Li said. Local utilities have offered rebates to reduce the cost of the doors.

Though some chains have reported losing sales after installing glass doors on open medium-temperature display cases, customer reaction to the doors has been positive at QFC, Li said. "When the doors are put on right and kept clean and are easy to open, customers get what they want."

In addition to saving energy, the glass doors keep aisles warmer, "which customers appreciate in winter," said Li. They also help protect products during a power outage.

Li recalled observing a shopper explaining to her young daughter that QFC was putting in glass doors to save energy. "I was touched," she said. "What we are doing in stores may have an impact on customers and their lifestyles. That's when I think, 'I love this industry.'"

QFC is also collaborating with its contractors to identify "energy maintenance opportunities," said Li. The retailer is also piloting retro-commissioning projects to improve HVAC&R efficiency and doing periodic audits "to make sure there is no ongoing waste of energy or water."

In 2017, QFC launched an "energy champion" program, assigning an energy leader in every store to oversee energy maintenance. A conference call for the leaders is held periodically to exchange findings and share best practices. The chain recognizes outstanding energy leaders.

New QFC stores are equipped with a range of energy-saving technologies, including LED lighting, motion and



Xinpei Li, Division Energy Manager for QFC.

Photo from Food Marketing Institute

occupancy sensors, distributed refrigeration systems, heat reclaim, case controls, digital scrolls, and variable-speed compressors.

KROGER'S INITIATIVES

Li also described some of the energy-saving initiatives that QFC's parent company, Kroger — which operates nearly 2,800 stores across 24 chains in 35 U.S. states — is undertaking. For example, in 2019, Kroger has launched a program to dramatically reduce its natural gas and electricity consumption, starting with 175 stores that will place glass doors on open refrigerated cases; the expected per-store energy reduction is up to 15%, she said.

Also, this year, Kroger is completing a retrofit of interior LED lighting throughout its chains, saving 350 million kWh of energy annually, said Li.

As of 2018, Kroger had installed enough solar and wind equipment to generate more than 14 million kWh of energy, as well as two anaerobic digesting facilities.

In 2019, the company offered electric vehicle charging stations at 100 stores, with more on the way. ■ MG

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Makro Continues CO₂ Installations in Latin America

A new store in Cali, Colombia, with TEKO's transcritical system, marks the growth of CO₂ technology in the region.

— By Pilar Aleu

Makro, a division of Dutch conglomerate SHV Holdings, has installed a transcritical CO₂ system from German OEM TEKO at its new Valle del Lili supermarket in Cali, Colombia — TEKO's fifth transcritical CO₂ installation in Latin America, two of which have been for Makro.

The use of CO₂ as a refrigerant in Latin America has been increasing in the past few years as retailers like SAIEP in Argentina, Cencosud in Chile, and Carrefour in Brazil have opted to use this natural refrigerant. Following the trend, Makro has increasingly been looking at reducing its GHG emissions and investing in transcritical CO₂ for its stores.

The supermarket in the south of Cali marks an important milestone for Makro as it features a new store concept.

With more than 3,400m² (36,597ft²) of sales space, the store has achieved Leadership in Energy and Environmental Design (LEED) certification thanks to the measures put in place to reduce water and energy.

The installation, carried out in the first quarter of 2019, features TEKO's ROXSTA2.0 transcritical CO₂ refrigeration system, complete with parallel compression. The cooling capacity is 130kW (37TR) on the medium-temperature side and 4kW (1.1TR) for low temperature.

As a special safety feature, the rack has been equipped with a controlled suction-gas super heater, which reduces the "oil throw" in the compressors and ensures the stable operation of the system, even if the cooling cabinets work under discontinued super heating.

In addition, the installation includes a gas cooler (cooling capacity: 254kW/72.2TR), electronic expansion valves, and self-service doors — all to maximize energy efficiency and to reduce the store's carbon footprint.

The installation was handled by a local company, Weston, with 57 years in refrigeration. Weston also supplied the evaporators, cold rooms and display cabinets.

There are plans for more such installations as TEKO partners with Makro Colombia, such as a CO₂ system for a new store in the city of Valledupar.

Makro's presence in South America includes: Brazil (68 stores), Argentina (23 stores), Perú (14 stores), Venezuela (37 stores) and Colombia (20 stores). ■ PA

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Austrian METRO Store on Its Way to 'Net-Zero' Energy

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

— by Ilana Koegelenberg

German food wholesale specialist METRO AG is one of the leading users of natural refrigerants in the world, with about 100 stores running transcritical CO₂ systems. One of those transcritical CO₂ stores, located in St. Pölten, lower Austria, has the further distinction of being METRO's first "net-zero" store, with a goal of using only renewable energy created on site with a 6,000m² (64,583ft²) photovoltaic system on the roof.

Opened in 2017, the 12,700m² (136,702ft²) St. Pölten store is part of the company's ambitious plan to reduce its CO₂ emissions by 50% in 2030 as compared to 2011 levels. As the store's energy profile is refined, it will be used as a model for optimizing efficiency in new stores, especially in Europe.

"New [METRO] stores opening today have to be much more competitive in terms of energy demand to reach our 2030 targets," explained Olaf Schulze, Director Energy Management at METRO AG, during ATMosphere Europe in Warsaw, Poland, on October 16.

St. Pölten is designed to realize a 60% reduction in energy demand as compared to the METRO worldwide average. Because of the time needed to optimize systems and the extreme temperatures of the past two summers,



Inside the METRO St. Pölten store.

this figure hasn't been realized yet, but Schulze said the store is well on track to achieving the designed efficiencies.

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

EFFICIENT TRANSCRITICAL SYSTEM

The St. Pölten store is equipped with a transcritical CO₂ booster system supplied by German OEM Teko, with a number of features designed to boost efficiency. Andreas Meier, Managing Director for Teko, was also at ATMosphere Europe to present alongside Schulze on the particulars of the refrigeration system his company supplied.

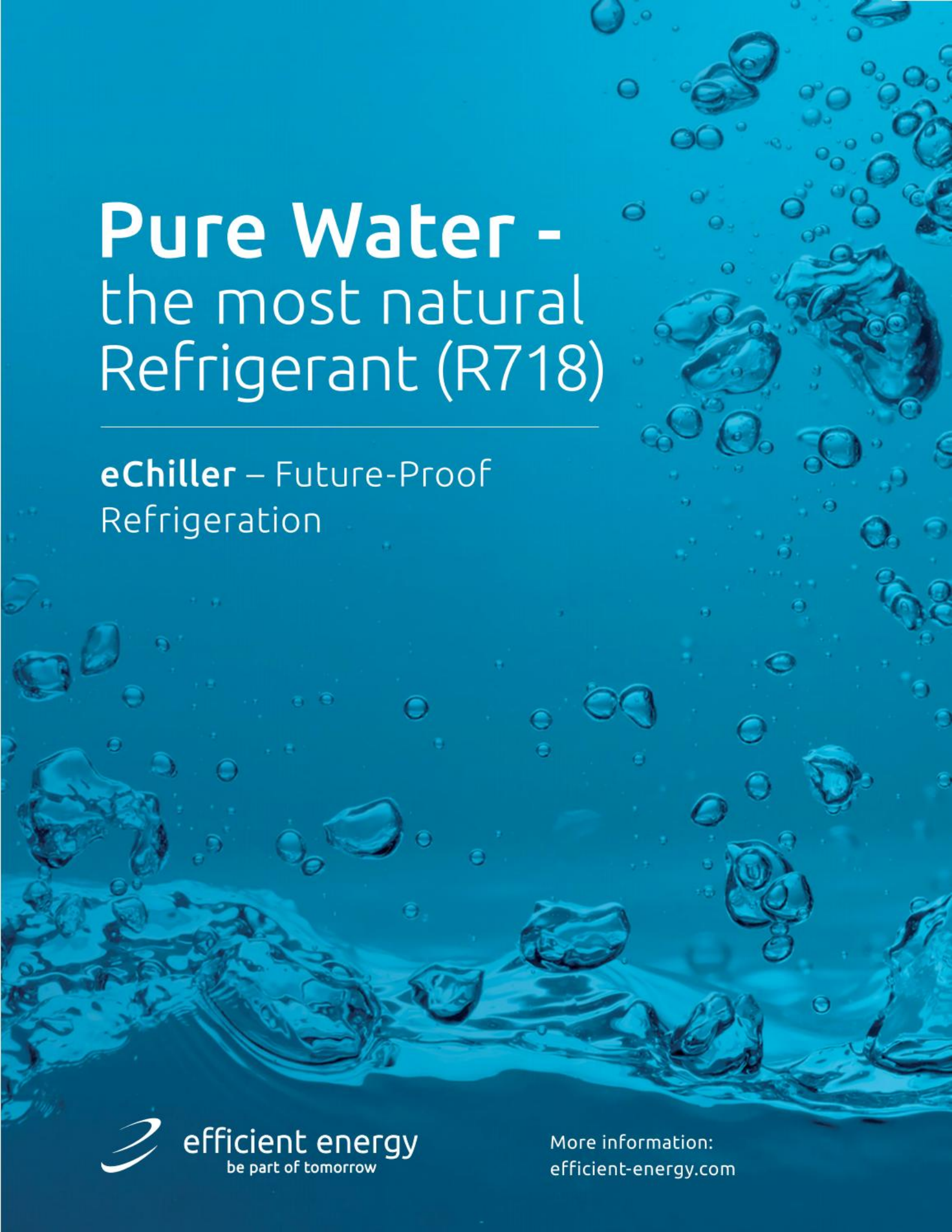
The refrigeration rack offers 290kW (82.5TR) on the medium-temperature

side and 93kW (26.4TR) on the low-temperature side, as well as full heat recovery (160kW/45.5TR) used to heat domestic hot water in the building. It also includes an Evalift suction heat-exchanger system to improve system efficiency, as well as parallel compression. Most of the building is cooled by natural ventilation, with 12kW (3.4TR) of air conditioning for the sales area also being supplied by the refrigeration rack.

Thanks to these features, the St. Pölten store's transcritical system is 20% more efficient than a standard transcritical CO₂ system, said Schulze. He expects the return of investment in the premium paid over a standard system to be less than five years.

Other energy-saving initiatives include capturing and using rainwater; using glass fronts to capitalize on natural light; adding doors to the cooling cabinets; and using "smart cooling" techniques to make sure products are kept at the right temperature and energy isn't wasted.

■ IK



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Carrefour Poland Retrofits 46 Stores with CO₂

Of these, 36 are transcritical CO₂ systems, including 11 with parallel compressors and two with ejectors.

— by Michael Garry

Jan Kroll, Carrefour Poland



In a notable transition from HFC refrigerants to CO₂ in existing stores, Carrefour Poland has converted 46 stores to energy-saving CO₂ systems since 2013, averaging six-to-eight retrofits per year, according to a presentation at ATMOSPHERE Europe in Warsaw, Poland.

Of its 46 CO₂ stores, 10 are cascade, 23 are transcritical booster, 11 are transcritical with parallel compression, and two are transcritical with a high-pressure gas ejector system and semi-flooded liquid ejector system (CALM). Danfoss was the supplier of the ejector systems.

"They followed the market and technology development for CO₂," said Andrzej Szymanik, Key Account Manager, Cooling for Danfoss Poland, during the ATMOSPHERE Europe presentation on October 16.

Szymanik shared the stage with Maciej Szymański, National Senior Manager, Maintenance Department for Carrefour Poland, and Jan Kroll, Senior Manager, Refrigeration and Air Conditioning for Carrefour Poland. Carrefour Poland is a division of French mega-retailer Carrefour.

Carrefour Poland, which operates 89 hypermarkets and more than 150 supermarkets, began the transition with both CO₂ cascade systems and CO₂ transcritical booster systems, but has installed only transcritical systems since 2017, noted Kroll.

CO₂ cascade systems, with their lower pressures, were initially viewed as mature and safer than transcritical CO₂. "But by 2016, the capex for both cascade and transcritical was the same, so we went

with only transcritical," said Kroll. "After two years, the [higher] refrigeration prices of HFCs convinced us it was the right decision." Moreover, by then, technicians got used to the higher pressures associated with transcritical systems, he added.

Carrefour Poland calculated that its CO₂ stores, which also included new cabinets, LED lights, new evaporators and controllers, saved on average 38% in energy costs compared to the HFC stores. The chain estimated that the CO₂ refrigeration alone cut energy costs by 20%. While the cascade system provided an estimated energy savings of 9%, the booster system and the booster system with parallel compression reduced energy by 17% and 29% respectively.

"Each step gave us more energy savings," said Szymański. "We're seeing a nice savings – higher than expected." He added that maintenance costs have been kept at a "reasonable level."

In its latest retrofit, completed in a 10,000m² (108,000 ft²) hypermarket in Warsaw in September, Carrefour Poland installed a transcritical CO₂ system with a high-pressure gas ejector system and semi-flooded liquid ejector system (CALM). "We are 100% convinced that the [energy] results will be even better than with parallel compression," said Kroll.

The CALM system allows for partially flooding the medium-temperature evaporator; some liquid leaving the evaporator is removed before it can reach the compressor.

"It was a very good decision to switch to CO₂," said Szymański. ■ MG

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SAINSBURY'S DISTRIBUTION CENTER BOOSTS EFFICIENCY WITH AMMONIA ABSORPTION

The Pineham DC uses exhaust waste heat from electrical generation to drive an ammonia-absorption refrigeration cycle, part of a flooded ammonia system.

— By Ilana Koegelenberg

Sainsbury's Supermarkets' new state-of-the-art Pineham Frozen National Distribution Center in Northampton, U.K., has gone through great lengths to optimize energy efficiency, including using the waste heat generated by its natural gas-powered engine to drive an ammonia-absorption refrigeration cycle that is part of the flooded ammonia refrigeration system.

This facility was completed last year and represents one of Europe's largest single-chamber cold storage facilities, with a total refrigerated volume of 380,000m³ (13,419,573ft³). All comfort cooling for the site and main electrical switch room is provided via the refrigeration system, primarily a flooded-ammonia type. Overall, a 9,900kg (21,825.8lbs) ammonia charge is used to generate a cooling capacity of approximately 3,000kW (853TR) at -32°C (-25.6°F); and 500kW (142TR) at 0°C (32°F).

"A flooded ammonia system is the most efficient and environmentally friendly refrigeration solution at these working conditions," explained Paul Arrowsmith, Refrigeration Engineering Manager at Sainsbury's Supermarkets.

The baseload electrical power for the facility is provided by a natural gas-powered combined heat and power (CHP) engine. The waste heat from this power generation serves two functions: the lower grade heat is used to provide heating and hot water within the distribution center offices and amenities, while the high-grade exhaust waste heat is used to drive an ammonia-absorption refrigeration cycle.

"The absorption plant has been uniquely integrated into the mechanical refrigeration system to maximize the overall cooling system efficiency," said Arrowsmith.

Normally, ammonia compression systems reject significant quantities of heat into the environment, reducing efficiencies. However, in the Sainsbury's system, the ammonia system rejects its heat into the common hybrid condensing system, which enables heat to be recovered for both underfloor heating and air cooler defrosting.

"This also considerably reduces other associated waste streams, such as cooling tower water, chemicals, effluent, and fan and pump power," said Arrowsmith.

Hybrid condensers operate wetted during the hotter and peak load times of the year and dry for the remaining. "The large surface area of this type of condenser enables a significant reduction in fan power and water consumption throughout the year," explained Arrowsmith.

A combination of inverter-driven reciprocating and screw compressors in a two-stage compression system are used in the mechanical refrigeration to maximize efficiency of the part-load condition. The control strategy of the compressors further ensures that the compressors are operating at their optimum efficiency point.

Various other energy-saving, energy-optimizing steps were taken. The cold storage envelope has been constructed within a developer's shell using industry-leading composite panel technology and the highest panel thicknesses available, including the underfloor insulation.

Also, all 25 cold storage air coolers incorporate heated motorized damper systems and fan socks to trap the heat from defrost, thereby reducing heat gain and moisture into the cold storage area and significantly reducing defrost number and duration. A bespoke defrost control system initiates defrosts only when required. ■ IK



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EC AND EIA CLASH ON ILLEGAL HFC IMPORTS IN EUROPE



Bente Tranholm Schwarz,
European Commission.



Clare Perry, EIA.

Both acknowledge the severity of the problem, but EIA points to insufficient custom enforcement and penalties.

— By Ilana Koegelenberg

The issue of illegal trade of HFC refrigerants in the European market was debated during a policy discussion at the ATMOsphere Europe conference, with representatives of the European Commission (EC) and the Environmental Investigation Agency (EIA) differing on the extent of the problem.

While noting that the HFC phase down in Europe under the F-Gas Regulation has been a huge success so far – with prices of HFCs going up and emissions coming down – Bente Tranholm Schwarz, a Deputy Head in the European Commission's Directorate-General Climate Action, acknowledged that illegal refrigerant trade in the form of smuggling across borders remained a drag on the regulation.

However, the amount of this illegal trade was hard to quantify. Because there is no longer a problem with huge discrepancies between HFC data declared at the borders and what is reported under the F-Gas Regulation, “the illegal trade we are experiencing is mainly in the form of [an unknown amount of] customs evasion,” she said during her ATMOsphere Europe presentation, which took place October 17 in Warsaw, Poland.

Tranholm Schwarz said that the commission would continue taking this issue of illegal trade “extremely seriously” and carry on taking action against it. “Just because we cannot estimate the level, does not mean we are saying it doesn’t exist and we’re not doing anything,” she said. “We are taking every possible measure to avoid illegal trade. It’s important to us because every kilo of HFCs that lands on our market illegally, is a kilo too many. It’s a kilo that has the potential to be emitted in the E.U.”

Among the actions the commission has been taking to try and tackle the smuggling issue is a workshop with customs officials to compile best practice guidelines on how to avoid illegal HFC trade and detect suspicious behavior at the borders.

Tranholm Schwarz also urged everyone present at ATMosphere Europe to help spread the message and bring down the demand for illegal HFCs. “It’s not okay to buy illegal HFC just because you can get it cheaper,” she said. “If it’s illegal, it’s illegal. Shame on you.”

EIA: DOORS WIDE OPEN

Clare Perry, Climate Campaign Leader at the EIA, offered a different perspective on the degree of the illegal trade problem at the policy session.

The EIA released its “Doors wide open” report in April, drawing the basic conclusion that there was an escalating illegal trade in Europe and a lot of it was coming through the “front door” as it was openly imported without a proper customs code or following the F-gas quota.

The EIA estimates that in 2018, 16.3 MtCO₂e of HFCs were placed on the EU market over and above the available quota of 101.2 MtCO₂e. This means that 16% of the quota was smuggled in – equivalent to the annual emissions of four coal-fired power stations, explained Perry.

She spoke about risk assessment and methods of smuggling, before spending some time on challenges to enforcement. Perry stressed that customs and the HFC registry are not connected and that there is no access to real-time quotas to allow for enforcement at the borders. Her list also included the lack of enforcement beyond the border, and lack of prosecutions and sufficient penalties. “In our experience, customs only pick up about 10% of [illegal imports] coming through,” she said.

Perry offered recommendations to improve implementation and enforcement. “We need to recognize the severity of the issue,” she said. “HFC illegal trade is a climate crime.” She suggested a per-shipment licensing system, greater transparency in the HFC registry, the removal of exceptions, a clear ban on disposable cylinders, increased minimum penalties and more frequent application of these penalties, training of customs and enforcement agencies, and funding destruction of seized HFCs, and more.

During the Q&A segment, Tranholm Schwarz disputed that a large number of refrigerants were “coming through the front door” as EIA said in its 2018 report, saying the EIA data was based on assumptions that were too aggressive and at odds with EC data that came later. “This 16.3 million ton difference is not there,” she said. “It’s not happening. We do not have open doors. That’s what our studies show, based on real data, not assumptions.”

Tranholm Schwarz did not disagree that illegal trade was a problem, only that it was because of reporting issues, she said later in the conference. “We have illegal trade but it’s happening in the form of smuggling – the same way that drugs and cigarettes get smuggled.” That’s why the EC is educating customs on best practices to help prevent the smuggling as much possible. “Every single kilo getting in illegally, we are trying to tackle.”

■ IK

CLAMPING DOWN ON ILLEGAL TRADE

International illegal trade in ozone depleting substances and HFCs pose a serious threat to the environment and human health, according to the United Nations Environment Program (UNEP) website (<http://bit.ly/2JxMvVM>).

“If left unchecked, illegal trade could jeopardize the success of the Montreal Protocol and the Kigali Amendment,” according to UNEP.

Unfortunately, the very policy that was meant to protect the market, has also created opportunity for smugglers. That’s why custom officials have had to step up their game. In recognition of the efforts of customs and enforcement officers in combating the illegal trade in environmentally sensitive commodities, UNEP’s OzonAction, the Ozone Secretariat, and the World Customs Organization have created the Montreal Protocol Customs Award.

Under the global customs award, 587 seizures were reported by 24 countries, and a total of 255,726kg (563,779lbs) of chemicals were seized, alongside numerous pieces of equipment.

According to UNEP, from 2020 onwards, the E.U. wants to introduce a Europe-wide electronic system that will allow an automatic check to see if an economic operator is registered, among other steps.

There is also ongoing training and educating of customs officials to try and enforce stricter control of illegal products coming in over the borders.

Database Offers Information on Flammable Refrigerant Leaks in Europe

LIFE FRONT is collecting data on leak sizes and concentrations from the marketplace to help improve the safety of hydrocarbon systems.

— by Ilana Koegeleberg

LIFE FRONT, a shecco-led, EU-funded project that aims to remove standards-related barriers to the use of flammable refrigerants, has launched an online database that includes market-based information in Europe associated with refrigerant leaks to help improve the safety of hydrocarbon systems. (shecco is publisher of *Accelerate Magazine*.)

The database (available at no cost at <https://bit.ly/2NLFdKE>) consists of two segments: the “refrigerant leak size database” and the “concentration database.”

The refrigerant leak size database provides a list of leak-hole sizes (in mm²) and corresponding mass-flow rates in refrigeration, heat pump, and air-conditioning equipment. It includes leaking component (such as evaporator or suction pipe), leak location, probable cause (such as corrosion or fatigue cracking), system capacity and refrigerant charge. It also shows, for the examples collected (251 on November 7), the probability of leak-hole size, and the probability of leak-flow rate (g/min).

The concentration database includes gas concentrations arising from refrigerant leaks in different parts of refrigeration, heat pump and AC systems. It includes



leak location, mass of refrigerant and mass flow rate, as well as leak-release height, direction and type.

Regarded as “Europe’s largest leakage size database,” this resource is the first of its kind and is projected to continue growing. It was officially launched on October 10 with a webinar where the LIFE FRONT project team, together with industry stakeholders who assisted with data collection, explained the benefits of collecting this kind of information. For one, the database is designed to inform safety standards, determining among other things, allowable refrigerant charge sizes and system design parameters.

“The objective of the databases is to show real data on refrigerant leakage to be used as a basis for the standard-making process, replacing the current assumptions that don’t necessarily rely on realistic scenarios,” said shecco’s Pauline Bruge, LIFE FRONT Project Coordinator.

“Correct determination of the hole size is essential for handling of flammable hydrocarbon refrigerants,” explained

U.K. Engineer and Project Consultant Daniel Colburn during his webinar presentation. “If it’s too small, you underestimate the potential hazard; too large and you over-engineer and over-price protective measures.”

“The database and the LIFE FRONT project can provide valuable inputs for changing product safety standards and increasing the allowable charge of flammable refrigerant in refrigeration, AC and heat pumps,” said Laure Meljac, Regional Manager for International Affairs for Swedish heat pump manufacturer NIBE, who took part in the project.

Equipment manufacturers are invited to contribute to the project with their own data, which will remain confidential. Project partners are hopeful that the database will increase with further contributions in the near future, given that knowing “leak rates is helpful for the improvement of products and services currently on the market,” said Werner Schwaiger, Head of Laboratory at Austrian refrigeration OEM AHT, which was involved with the data collection. ■ IK

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WATER-ONLY CHILLER GAINING MORE CUSTOMERS

Efficient Energy's eChiller, which can be significantly more energy efficient than standard chillers, is being used in industrial process cooling and IT-system cooling.

— by Tine Stausholm

Water (R718) has long been considered a natural refrigerant, but not many commercially successful chiller applications using only water have emerged. German company Efficient Energy GmbH is changing that.

The company's eChiller is a "future proof" system using only water for cooling processes with high chilled-water outlet temperatures. In the right conditions, it can be significantly more efficient than traditional chillers, said the company. In an installation for German printer Brune-Mettcker described at efficient-energy.de, the system achieved a 75% energy savings.

The eChiller is best equipped to produce chilled-water temperatures between 16°C (61°F) and 22°C (72°F), making it suitable for applications like data centers, industrial process cooling and high-temperature heat pumps.

The eChiller technology was introduced at the end of 2014, when the first prototypes were installed. The first commercial units were shipped in January 2018. Current applications are divided about 50/50 between industrial process cooling and IT system cooling, with big companies like Siemens and British Telecom among the early adopters. Efficient Energy also has several projects for comfort cooling.

The eChiller can also theoretically be used for sub-cooling of CO₂ systems in hot climates. Efficient Energy is currently



eChiller compressor impellers.

talking to potential customers, testing the feasibility of such applications. "From a theoretical side, we know this is working, and tests are ongoing," Bartmann said. "It is a very promising field; we are right now in the state of evaluation."

The company has two models available with cooling capacities of 35 and 45kW (10 and 12.8TR). The units can be combined and scaled up to 300kW (85TR). Efficient Energy is also developing larger models with a capacity of up to 125kW (35.5TR) each, also scalable. These will be launched by October 2020.

There are currently approximately 80 eChiller installations, mainly in Germany, but the larger capacity will enable Efficient Energy to target new application areas and markets, increasing sales expectations for 2020 and 2021, the company said.

The eChiller can be more expensive than imported chillers with synthetic refrigerants; Efficient Energy declined to say by how much. However, the price difference is reduced by subsidies for natural refrigerant equipment in countries such as Germany, France and Netherlands. Also,

being significantly more energy efficient than traditional chillers, the return of investment (ROI) on the capital cost is normally only between two and four years, according to Bartmann. "When compared to units that don't have any kind of free cooling, then it can even be paid back within one year," he said.

How does the eChiller work?

The essentials of the eChiller are like any other chiller that works on the principles of evaporation, compression and condensation. The big difference is the refrigerant used and the very low operating pressure.

The whole process happens in a near vacuum (water as a refrigerant only works that way). Operating with water vapor in a vacuum means that leakage tests and gas sensor maintenance isn't needed, explained Bartmann. Also, because there is no risk of leakages and the low operating pressures, the European EN378 Safety Standard is not applicable – another cost-saving benefit of the eChiller.

So, how does it actually work? Water enters the evaporator, where around 1% of the water evaporates, drawing energy from the remaining water and cooling it down. The pressure inside the evaporator is around 18mbar (0.26psi). This near-total vacuum is created by the rotating impeller in the unit's centrifugal compressor.

In the compressor, the pressure is then increased to 136mbar (1.97psi) and the temperature rises from 16°C (61°F) to 52°C (126°F). The water vapor is cooled down, condensed, and fed back into the evaporator through the expansion device.

The standard eChiller has two cooling modules and two heat exchangers. All units are also connected to a so-called recooling, usually placed on the roof of the building. This recooling can be an adiabatic cooler or a normal dry cooler, delivered by Efficient Energy, or



All eChiller units have the same dimensions; the capacity depends on the size and shape of the compressor impeller.

acquired separately by the customer. The two cooling modules, together with the recooling, gives the eChiller several operating modes and the potential for "free cooling."

Due to the nature of water – it freezes at temperatures at or below 0°C (32°F) – the standard eChiller unit has to be located indoors. However, solutions where the eChiller is put inside a frame or container are available, allowing for outdoor locations as well. To prevent freezing of the water in the recooling loop at very low ambient temperatures, it contains 30% glycol.

At high ambient temperatures like 35°C (95°F), the two modules work in cascade, cooling down the water from the recooling to, for example, the 18°C (64.5°F) chilled water that is typically required to cool a

server room. At these temperatures, the eChiller has an energy efficiency ratio (EER) of 3.4, which is "very similar to other chillers," according to Bartmann.

When the ambient temperature drops, the second module switches off, increasing the eChiller's efficiency. For example, at an ambient temperature of 21°C (70°F) the EER increases to 7.4.

When the ambient temperature drops enough that the cooling water from the recooling is at least 2°C (3.6°F) colder than the return water from the server room, the first stage also switches off. This allows the system to just send the water through the two heat exchangers, achieving "free cooling" and an EER of up to 125, the company said, adding that, in total, an annual coefficient of performance (COP) of up to 20 can be achieved. ■ TS

Accelerate Magazine/Europe Award Winners Named

Biedronka, Bofrost, Marek Zgliczynski, and Mirai were recognized at ATMOsphere Europe in Warsaw, Poland.

— By Michael Garry

Shecco, publisher of *Accelerate Magazine* and organizer of the ATMOsphere Europe conference, announced the winners of the 2019 *Accelerate Magazine/Europe* awards at ATMOsphere Europe in Warsaw, Poland, on October 17.

THE WINNERS ARE:

•Best in Sector/Food retail: **Biedronka**, part of Jeronimo Martins Group

•Best in Sector/Industrial: **Bofrost**

•Person of the Year: **Marek Zgliczynski**, Chair of the International Electrotechnical Commission (IEC) SC61C subcommittee and director of research and development for Brazilian compressor maker Embraco.

•Innovation of the Year: **Mirai's COLD 15 air-cycle refrigeration machine**

The *Accelerate Magazine Awards/Europe* program, now in its third year, recognizes people and organizations that excel in advancing natural-refrigerant technologies. The winners were selected by shecco, with the exception of the Innovation of the Year award, which was based on public vote leading up to the ATMOsphere Europe conference.



The runners-up for Innovation of the Year were: Area Cooling Solutions' iCool Max CO₂ refrigeration unit and Dorin's CD600 range of transcritical CO₂ compressors.

The *Accelerate Magazine Awards/Europe* were previously called the *Accelerate Europe Awards*. *Accelerate Europe* magazine was incorporated into *Accelerate Magazine* in June.

This year's winners were selected for the following accomplishments.

Biedronka has about 3,000 small-format stores in Poland, approximately one-third of which use small transcritical CO₂ systems from Advansor and Carrier. (About 20% of display cases use R290.)

In 2017, it started its ambitious plan of retrofits and new openings. So far, the rollout plan has converted 600 existing stores to transcritical CO₂ while adding 350 new stores with this technology. In 2020, 300 more stores will be retrofitted with CO₂, and the technology will be installed in 150 new stores. Biedronka is also converting its 16 distribution centers to CO₂ and by 2025, expects to use zero HFCs.

Bofrost has installed a transcritical CO₂ refrigeration system, supplied by Italian OEM Crea, at its existing cold-storage facility in Pordenone, Italy, replacing a system that employed HFCs. The system manages the cooling needs of the entire warehouse as well as a closed water circuit to air condition the offices.

Bofrost's facility is divided into three cold-storage rooms, one of which includes an automatic storage system that can't be stopped. Consequently, the addition of the CO₂ system had to be accomplished "without interfering with the normal activity," said Crea.

In addition, because of its position, "it was impossible to remove the old evaporators," Crea noted, and so the CO₂ evaporators "were mounted on dedicated supporting structures, in different positions from the previous ones, postponing the dismantling activity."

The CO₂ system consists of two medium-temperature/low-temperature booster systems, designed to supply more than 800kW (256TR). The refrigeration units are positioned outside the warehouse on a steel structure inside two separate containers. "After the first months of operation, there was a significant drop in energy consumption," said Crea.

Zgliczynski was the leader of the five-year effort that, on May 9 this year, resulted in the approval of an increase in the IEC's charge limit for A3 (flammable) refrigerants in self-contained commercial refrigeration display cases (under IEC's 60335-2-89 standard). That limit rose from 150g to 500g (5.3oz to 17.6oz), while the charge limit for A2 and A2L (low flammable) refrigerants increased to 1.2kg (2.6lbs) from 150g (5.3oz).

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

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 500g (17.6oz)-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



2 /

1 / The winners, from left: Tsyplakov Vladyslav, Mirai Intex; Umberto Defend, Bofrost; Fabio Roncadin, Bofrost; Stefano Tortorici, Crea; and Wojciech Polak, Biedronka.

2 / Marek Zgliczynski, IEC and Embraco

could be a significant rise in the number of hydrocarbon-based self-contained display cabinets.

"I want to thank shecco for this award," Zgliczynski said in a recorded message played for the audience at ATMOSphere Europe (he was in China on IEC business during the conference). "We were able, after many years, to approve this important standard for commercial refrigeration, raising the charge limit from 150g to 500g for hydrocarbons and 1.2kg for A2Ls. This is a very important step. Obviously, it's not finished yet. IEC is a global standard and we have now to adopt the standard, in Europe first of all, as an EN standard. The same movement is in place in the U.S. I think Japan will follow."

Mirai's COLD 15 air-cycle refrigeration machine is capable of cooling down to -130°C (-202°F), said Mirai, based in Brno-Tuřany, Czech Republic. Mirai describes the machine as "extremely reliable and

durable." (See, "Using Air as a Refrigerant," *Accelerate Magazine*, October 2019.)

The COLD 15 machine operates in an open-cycle (direct cooling by air) thanks to the reverse-joule air cycle. It uses ambient air, which is free, abundant, environmentally friendly, non-toxic and non-flammable, and there is no need for refilling.

The machine is "particularly efficient" at producing temperatures from -40°C (-40°F) to -110°C (166°F), said the company, adding that to reach these temperatures, traditional systems have to use liquid nitrogen or multiple cascades with HFC refrigerants.

The system features a turbo-expander and compressor located on the same shaft, which allows energy consumption reductions of up to 30%, the company said. ■ MG

NATURAL REFRIGERANT HEAT PUMPS TAKE CENTER STAGE AT BUSWORLD



This year's show highlighted an increasing shift towards electric buses, whose range can be extended with natural refrigerant heat pumps.

— By Pauline Bruge

Natural refrigerant products, especially heat pumps, had a strong presence at the Busworld conference, the annual meeting on buses and coaches that took place in Brussels, Belgium from October 18-23.

These products tie in well with the unofficial theme of this year's show, bus electrification, which is impacting vehicle design.

Today, e-buses represent 18% of all buses worldwide (compared to 7% in 2015), according to a BloombergNEF report published in May this year. According to the report, global sales for e-buses are expected to grow at a rate of 33.5% annually until 2025.

Most of these e-buses still use R134a for cooling, but as the drive towards phasing down HFCs intensifies globally, natural refrigerants such as R290 and CO₂ are becoming popular alternatives. Natural refrigerant heat pumps offer the ability to extend the driving range of electric vehicles.

As such, it was no surprise that natural refrigerant products, particularly heat pumps, had a strong presence at the show.

Even at the Busworld Awards, which took place on October 17, German GEA Bock's StarCO₂mpressor compressor for heat pumps was honored with an Innovation Label. According to GEA, the units offer "the industry's lowest overall height and the lowest weight."

Multiple innovations

Other than GEA's winning product, here are some other natural refrigerant product highlights from Busworld:

► Area Cooling Solutions (headquartered in Barcelona, Spain) presented its R744 Panasonic C-CV753L0U compressor for train passenger cabins, equipped with an inverter specific for e-bus applications.

► Italy-based Dorin showcased its brand-new transcritical CO₂ BOXÉR compressor range for mobile HVAC applications such as trains and e-buses. These units are compact and work in heat-pump mode to achieve high heating and cooling capacities, said Dorin.

► Germany-based Valeo presented its REVO-E HP R744 as a world first: an all-electric, zero emission HVAC unit specifically designed for buses with alternative drives. This electric rooftop

HVAC unit with a heat-pump function operates efficiently, under a wide range of ambient conditions, providing a large heating capacity with less energy consumption, said Valeo.

► Dutch HeaVac (part of the German Aurora Group) showcased its Roof Heat Pump Borealis 2.0 prototype using a 1.5kg (3.3lbs) R290 charge. This zero-emission hot/cold water module is also targeting e-mobility with a standard cooling capacity of 23kW (6.5TR) and a heating capacity of 16kW (4.5TR).

► The German company Konvekta introduced one of the first mobile heat-pump systems operating with CO₂ back in 2013, winning the Busworld Innovation Label in 2013 and 2015. This year, it displayed multiple variants of the Konvekta CO₂ heat-pump range.

► German-Dutch Waeco-Dometic displayed its first ASC 7400 G service unit for CO₂. It monitors the pressure conditions inside the service unit and HVAC system to eliminate potential dangers. It also automatically inspects the ambient air in the workshop to make sure it's breathable. ■ PB



Heat Pump Summit Issues Call to Action to Reduce GHGs

Speakers urged the industry to work towards higher energy efficiency and a greater use of natural refrigerants.

— by Tine Stausholm

The heat pump industry should play its part when it comes to reducing GHG emissions, while ensuring heating/cooling for all, according to several speakers at the 2019 Heat Pump Summit, which took place in Nuremberg, Germany on October 22-23.

"There are no passengers on spaceship Earth; we are all crew," said Peter Wegener from Business Development Holland, quoting Canadian philosopher Marshall McLuhan. The heat pump industry, he

added, must step up and become part of the climate-crisis solution rather than the problem if we are to avoid a temperature increase of more than 1.5°C (2.7°F).

"Our industry sector, and particularly heat pumps, can play a very important role," Andrea Voigt, Director General of the European Partnership for Energy and the Environment said, adding that: "We have to decrease the energy consumption by at least one-third by 2050, if we want to achieve the 1.5°C (2.7°F) goal, and double the use of renewable energy, and heat pumps are ideally placed to satisfy both requirements."

The summit included several presentations on energy efficiency, energy certification of heat pumps, and natural refrigerants.

Biagio Lamanna, R&D manager from Carel, spoke about CO₂ technology and its use in single-stage, cascade and

dual-stage cycles, detailing the evolution of its use in high-efficiency solutions like mechanical subcooling, parallel compression, and ejectors. Lamanna showed the audience how ejectors can improve the coefficient of performance (COP) by 12% and explained that while ejectors can be used with other refrigerants, the benefits are highest with CO₂.

Water as a refrigerant was also explored, by Jürgen Süss, Independent Consultant for Efficient Energy, who spoke about its use in traditional compression systems, but also touched upon its potential use in adsorption and absorption technologies.

The 2019 Heat Pump Summit took place at the Nuremberg Messe, in Nuremberg, Germany. It included more than 35 speakers with 260 attendees from more than 30 countries. The summit focused on industrial, commercial and municipal applications for heat pumps under the theme "Connecting Experts." ■ TS

Ammonia Training Center Plans Hub Where Artisans Can Train, Work and Live

The Skills City Africa project has German backing but seeks more help.

— By Ilana Koegelenberg

South Africa's Open Trade Training Centre (OTTC) for refrigeration artisans (aka student technicians) held a launch event on October 4 in Johannesburg to announce development plans for its Skills City Africa project, a novel concept that would be a major hub for training refrigeration technicians.

For the project, OTTC has bought a 7-hectare (17.3 acres) property adjacent to its current training center in Springs, Johannesburg, where it has been training ammonia technicians since 1993.

The dream is to, within the next five years, build an all-in-one hub for artisans to train, work, and live so that they can go into the industry ready to "put up shop," as Isolde Döbelin, OTTC Director, put it. "I want to train multi-skilled people who can go anywhere in the world and get a job," she explained at the launch, noting that other trades like plumbing and electrical would be taught as well.

One part of the new site will be developed as a training center while a section has been set aside to build factories that offer employment for students while they train. Each new student will get two decommissioned shipping containers — one to serve as living quarters and another that will be used as a personal workshop.

Once they have completed their training and become a qualified technician, they can simply take their containers and start a business anywhere on the continent. "Nobody should be unemployed," said Döbelin, who has been nurturing this idea since 2005. "There is so much work to be done in this country if we only had the right skills."

Natural refrigerant training

OTTC is well versed in natural refrigerant training. It was the first training facility in South Africa to offer a practical ammonia diploma, and nearly 400 students have graduated from its six-week hands-on course. It also recently finished construction of a state-of-the-art CO₂ system to enable practical training of students.

The Skills City Africa project will be run as a non-profit organization by a trust fund set up for this purpose, putting all money generated back into the project. Döbelin envisages an environmentally sustainable development complete with a racing track, hotel, conference center and an ice rink, even a crèche.

Döbelin so far has the backing of German training association BIV, which has been involved with OTTC for over 30 years, though Döbelin is asking for additional industry support to make her dream a reality.

To pledge its support, the head of the BIV, Heribert Baumeister, BIV's Federal Guild Master, came from Germany to attend the launch event and say a few encouraging words. He was accompanied by Karsten Beerman, Director of German training organization IKKE, who called the idea "wonderful" and echoed Döbelin's call for industry support. "I see a great future for this project," he said, vowing to do whatever he can to ensure its successful execution.

■ IK



A model of Skills City Africa built by students.

ATMOsphere Heads Back to South Africa in March 2020

This global conference for sustainable cooling and heating solutions is returning with ATMOsphere Cape Town.

— By Ilana Koegelenberg

Shecco's natural refrigerants conference, ATMOsphere, is heading back to South Africa in March next year for the first-ever ATMOsphere Cape Town.

The first African ATMOsphere event made its debut with the ATMOsphere Network FRIGAIR 2018 event, where more than 120 stakeholders from across the HVAC&R industry gathered to discuss natural refrigerants-based technologies. The conference speakers included Obed Baloyi of the South African Department of Environmental Affairs, Forestry and Fisheries; Alex Kuzma of Woolworths; and Malcolm Moore of food supplier In2Food, among others.

The second South African event is expected to welcome over 150 stakeholders, including policy-makers, manufacturers, end users, NGOs, contractors and academics.

The one-day conference will cover the latest market developments for natural refrigerants, provide updates on regulations and standards, feature end-user presentations, and showcase new technology innovations.

Companies working with natural refrigerants-based technologies are invited to support ATMOsphere Cape Town as a sponsor.

For more information and sponsorship benefits, contact Pilar Aleu, shecco Business Development Manager, at pilar.aleu@shecco.com.

More information about the conference will be available soon.

About ATMOsphere events

As global action against climate change accelerates, environmentally friendly solutions that are business-savvy and economical at the same time are of the utmost importance for the HVAC&R industry.

ATMOsphere conferences serve as a meeting point for all key stakeholders in the HVAC&R industry, and offer a program with knowledge and networking opportunities.

ATMOsphere helps technology end users cut costs – and help the environment – by serving as a platform to learn about the most energy-efficient and sustainable HVAC&R solutions through technology presentations and networking with leading businesses.

The event stresses using natural refrigerants to future-proof businesses against possible national and international regulations, given the fast-changing regulatory environment as global action against climate change accelerates. ■ IK

AUSTRALIA GETS ITS FIRST AMMONIA/CO₂ NEWTON SYSTEMS

Five of the Mayekawa low-charge packaged systems were installed in July at a new cold storage center in Western Sydney.

— By Devin Yoshimoto and Caroline Rham



The NewTon machines.

Five of Japanese OEM Mayekawa's "NewTon" ammonia/CO₂ industrial refrigeration systems were installed at a newly built cold storage and distribution center in Western Sydney, Australia, in July, by Tri Tech Refrigeration Australia, the installation contractor for the project.

These are the first NewTon systems to be installed in Australia.

The end user is a large multinational membership-based retailer that has been using third-party warehousing for refrigerated and non-refrigerated goods distributed to its retail outlets, explained Mack Hajjar, Projects Engineer for Tri Tech Refrigeration Australia. "Given the number of existing retail outlets that they have, with plans for more, the end user decided to build their own distribution center."

Basil McKinley Consulting prepared the project heat loads and specification while Mayekawa Japan managed the equipment selection and conceptual design. Tri Tech Refrigeration Australia

handled the detailed design, installation and commissioning.

Three medium temperature NewTon-C units supply 708kW (201.3TR) of cooling capacity at 2°C (35.6°F) for the chilled storage area of the facility, which measures around 28,975m³ (1,023,242ft³). In addition, two low temperature NewTon R6000 units supply 198kW (56.3TR) of cooling capacity at -24°C (-11.2°F) for the frozen storage area of the facility, which measures around 15,119m³ (533,922ft³).

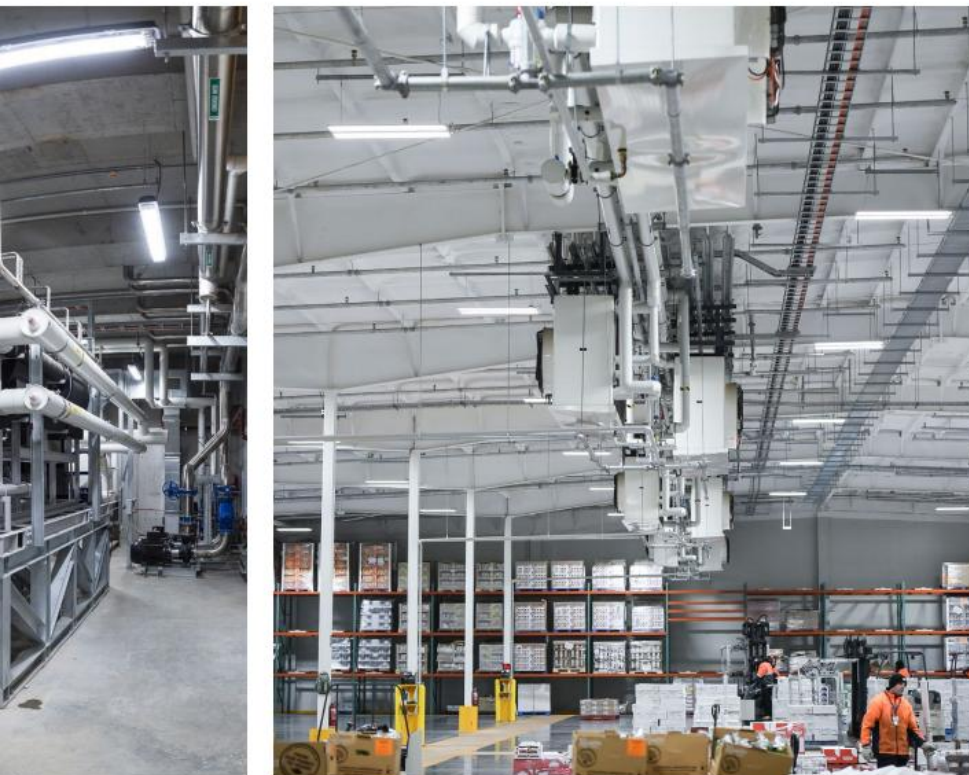
The decision to use the NewTons, Hajjar said, was motivated by the customer's requirements for safety and system redundancy.

One of the advantages of the NewTon system is that it employs CO₂ as a secondary refrigerant, reducing the overall ammonia charge and keeping it confined to the plant room. "The severity of an ammonia leak is further reduced because the total charge is distributed amongst several NewTon packages that in turn use semi-hermetic compressors which eliminates the risk of any shaft seal leaks," said Hajjar.

"These compressors are advanced; they have no shaft seal, no slide valve, are fully speed controlled, and use permanent magnet motors. It is good to see new technology like this come into the Australian market," he added.

There is a high level of redundancy built into the design as per the customer's requirements, explained Basil McKinley, the principal refrigeration consultant for the project. "One of the R6000 units provides 100% redundancy for the low-temperature system, as well as providing back-up for the medium-temperature system via a heat exchanger if required," he said.

"This also slows the CO₂ pressure rise in the medium-temperature system in the event of power failure by using the thermal mass of the freezer store," McKinley added. "The standby diesel generator only needs sufficient capacity to drive a low-temperature CO₂ pump and the fans of one freezer store evaporator to keep both CO₂ systems below design pressure during an extended power outage."



The newly built cold storage and distribution center in Western Sydney.

Compared to a traditional ammonia-pumped circulation system, the two NewTon R6000 units for the frozen storage area reduce the amount of ammonia from an estimated 1,900kg (4,189lbs) to 100kg (220lbs), according to Peter O'Neill, General Sales Manager for Mayekawa Australia, who spoke about the project during ATMOsphere Australia, held this past May in Melbourne. The CO₂ charge in this case is 1,300kg (2,866lbs).

First proposed over two years ago, the project entered its final installation stages in June and was commissioned in late July. Commissioning support was provided by Mayekawa Japan.

Regarding estimates on future energy performance, Hajjar said that "based on energy usage data obtained so far, overall typical compressor consumption is considerably lower than a conventional two-stage pumped ammonia plant servicing an industrial cold store of a similar size."

There were several challenges during installation and commissioning, Hajjar acknowledged, including providing elevation between the NewTon packages

and CO₂ pump stations; in this project that was done with structural steelwork. "Balancing water flows to optimize heat rejection/efficiency and maintaining adequate defrost temperatures were managed through commissioning and programming," Hajjar said.

Staging multiple NewTon units to maintain efficiency and part loading were also managed through commissioning and programming, added Hajjar.

Hajjar expects that, with regular preventative maintenance and ongoing manufacturer-recommended service, "the plant is expected to perform as designed for over 25 years, which is typical for industrial refrigeration plants."

Mayekawa expects to sell 330 sets of its NewTon ammonia/CO₂ cooling systems this fiscal year (April 2019 through March 2020), the company said in an interview conducted at its Moriya production facility in August. (The number of sets is equal to the number of compressors used; some NewTon units contain more than one compressor.) This would bring the total number of sets sold past 2,000 (95% in Japan) since the system was introduced in 2008. ■ DY & CR

INSTALLATION AT A GLANCE

Application: Cold storage and distribution center

Location: Western Sydney, New South Wales, Australia

Medium-temperature storage:

Temperature: +2°C (35.6°F)

Storage volume: 28,975m³ (1,023,242ft³)

Cooling capacity load: 708kW (201.3TR)

Refrigeration equipment: Three NewTon C units (plus one unit planned)

CO₂ vessel and pumps: One Mycom custom CO₂ vessel with two medium-temperature CO₂ pumps (duty and standby)

Evaporators: Eight 88.5kW (25.2TR) Thermofin CO₂ evaporators

ICF valve station: Danfoss

Low temperature storage:

Temperature: -24°C (-11.2°F)

Storage volume: 15,119m³ (533,922ft³)

Cooling capacity load: 198kW (56.3TR)

Refrigeration equipment: Two NewTon R6000 units

CO₂ vessel and pumps: One Mycom custom CO₂ vessel with two low-temperature CO₂ pumps (duty and standby)

Evaporators: Eight 24.8kW (7.1TR) Thermofin CO₂ evaporators

ICF valve station: Danfoss

Defrost: Pumped warm glycol (all evaporators fitted with interlaced glycol circuits with heat for warm glycol recovered from cooling tower water)

Condenser: Water-cooled closed loop outdoor cooling tower

Restaurants in Sydney's First Six-Star Luxury Hotel to Use Propane Equipment

The Crown Sydney Casino will be installing R290 commercial refrigeration cabinets, according to Australia-based OEM CyberChill.

— By Devin Yoshimoto

“

I've made a call that definitely by the end of this year, like it or not, we are going with R290.

— Craig Pickford, CyberChill

”

At least three of the main restaurants in Sydney, Australia's first six-star luxury hotel, the Crown Sydney Casino (currently under construction), will install R290 commercial refrigeration cabinets, according to Australia-based CyberChill Precision Refrigeration, manufacturers of this equipment.

"The first few cabinets have started being delivered this month and will be every month until the end of the first quarter in 2020," said Norma Pickford, Group Creative Director for CyberChill in October. The project is scheduled to be completed sometime in early 2021.

CyberChill supplies its refrigeration equipment to cafés, bars, hotels, restaurants, and production kitchens, among others. The company has manufacturing facilities in both England and China.

CyberChill has begun transitioning to R290 as a standard offering for its line of commercial refrigeration cabinets, and will finish by the end of this year, according to Craig Pickford, CyberChill's Managing Director.

Despite certain risks and challenges, Pickford said the move is motivated by a desire to be a leader in its sector over

the next few years. "In Australia, our challenge has been getting the technicians to become certified and accredited to work with R290, so we've simply remained with the traditional refrigerants like R134a and R404a," said Pickford. "But I've made a call that definitely by the end of this year, like it or not, we are going with R290," he said.

CyberChill mainly supplies its commercial refrigeration equipment to the higher end of Australia's hospitality and food service market. As such, Pickford said that he believes taking this leadership role adds significant value to the CyberChill brand and how it is perceived by others in the industry. "As a higher-end product, it is important that we lead," said Pickford. "Somebody has to lead and drag the rest of the industry with it, so that's the decision we took."

Pickford is encouraged by the progress he has seen in the industry and the effect CyberChill's actions have had on others. "We've moved along and progressed so much by now in the industry and I think there is far more acceptance of R290 equipment compared to before," said Pickford. "Our competitors are finally beginning to follow and have also started introducing R290, which can only be good for the industry." ■ DY

embraco

PLUG N' COOL

A NEW REFRIGERATION CONCEPT FOR CONVENIENCE STORES AND SUPERMARKETS



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Solution



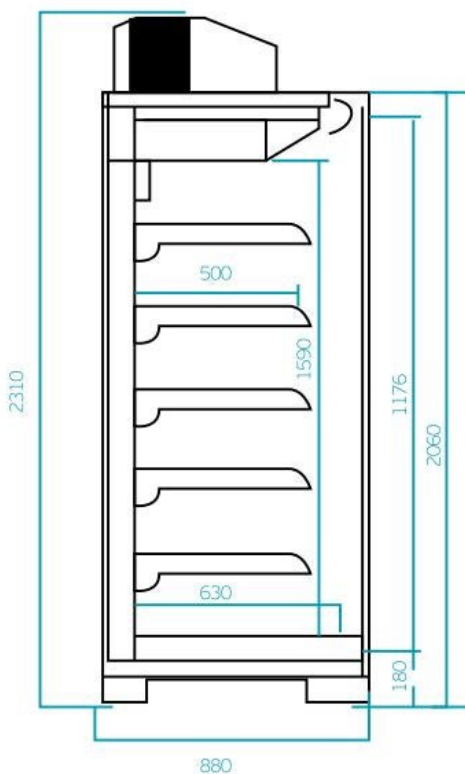
Variable Speed
Technology



Easy and Quick
Maintenance



Propane (R290)
Refrigerant



-34%

ENERGY
CONSUMPTION



-20%

TOTAL COST
IN 5 YEARS*

*COMPARED TO REMOTE R404A SCROLLS CU



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Skope Wins Best Hospitality Product Award for R290 Range

Its ReFlex fridges and freezers were recognized at the Fine Food Australia show.

— By Ilana Koegelenberg

OEM Skope Refrigeration, Christchurch, New Zealand, was recognized for its ReFlex range of propane (R290) hospitality fridges as the winner of the Foodservice Consultant Society International (FCSI)'s "Best New Hospitality Equipment Product" Award.

The award was presented on September 11 at the Fine Food Australia show in Melbourne, one of the best new product awards recognizing exciting and innovative products in the Australian marketplace.

"It's a great recognition of all the hard work the entire business has put into this product," said Nigel Chapman, Skope Design Manager. "We set out to develop a wide range of refrigeration solutions to a high watermark of innovation, and in a very ambitious time frame. The fact that this has been rewarded by an expert panel of judges means a great deal to the entire company."

The ReFlex range includes a variety of R290 fridges and freezers, both in under-bench as well as upright products. It combines well-built bodies (which include high-end features like food-grade 304 stainless steel, internal LED lighting and integrated locks) with Skope's app-based digital innovation, Skope-connect, the company says. This app allows owners to reduce energy use and food waste, while making it easier for them and their staff to monitor

food safety, Skope says, adding that the range boasts low electricity costs.

"ReFlex won because of its unique combination of strength and innovation that appealed to the Foodservice Consultant Society International's judges," said Chapman. "ReFlex wasn't designed in isolation; it was built on market knowledge and research of what the end user in food service requires."

PIONEERING NATURAL REFRIGERANTS

Skope has been pioneering natural refrigerants in Australia since the 2000 Sydney Olympics when it partnered with an international beverage brand to develop prototype natural refrigerant glass-door fridges. When that brand later converted its range from HFCs to CO₂ refrigerant, Skope was chosen to collaborate with experts from Creative Thermal Solutions to help other manufacturers transition away from synthetic refrigerants.

"From around 2012 onwards, we've led the industry charge to adopt natural refrigerants – long before the phase-down of HFCs began in Australian and New Zealand," said Chapman. This included helping customers embrace hydrocarbons and make the shift to R290.



The award-winning R290 Reflex range.



"Natural refrigerants aren't just being phased in, they're also just a really good idea," said Chapman. "They slash power costs for our customers and have virtually no impact on global warming or other forms of air pollution, and that's why we've always championed them."

The biggest challenge to the uptake of these natural refrigeration technologies in Australia is education, according to Chapman. That's why Skope has developed its own training modules and invests significant intellectual and practical resources in directly training service technicians. "We design our systems to be as safe and easy to service as possible; and this is more critical than ever with hydrocarbon natural refrigerants because of their flammability."

PUSHING THE ENVELOPE

According to Chapman, R&D is pivotal to Skope's long-term success. "With over 50 years in the industry, we wouldn't still be in this business if we couldn't push the envelope of what's possible," he said. "We care more about performance, quality, reliability, efficiency and user-friendly design than making a quick buck."

“ From around 2012 onwards, we've led the industry charge to adopt natural refrigerants – long before the phase-down of HFCs began in Australian and New Zealand. ”

– Nigel Chapman, Skope

Skope plans to roll out its Skope-connect software and natural refrigerants wherever it can "to create the green connected kitchen," said Chapman.

It isn't just about the environment though, as Skope wants its customers' experiences to be improved too, noted Chapman. "This isn't just about swapping gases; it's about always moving forward and being better than yesterday." ■ IK

Japan Stresses Safety As It Explores Hydrocarbons

After Japan cast a vote against a higher hydrocarbon charge, the trade group JRAIA is continuing to study flammability risks, with plans to issue new safety guidelines.

— By Tomoro Sato and Rena Okabe

When it comes to natural refrigerants, Japan has been decidedly in the CO₂ and ammonia camps, while casting a wary eye on hydrocarbons.

This year, its National Committee in the International Electrotechnical Commission (IEC) submitted one of eight negative votes on the question of whether to raise the charge limit for hydrocarbon refrigerants to 500g (17.6oz) from 150g (5.3oz) in self-contained commercial refrigeration cabinets under IEC standard 60335-2-89. Enough positive votes enabled the IEC to approve the increase in May.

But Japan is still open to the use of hydrocarbon refrigerants, as long as strict safety measures are in place. Japanese organizations are continuing to run safety tests and update a safety guideline to enable the safe and steady spread of hydrocarbon solutions in the country.

Japan was not opposed to the IEC's 500g (17.6oz) charge proposal itself, just the current safety standards, which it felt were not discussed enough, explained Kazuhiro Hasegawa, a member of the Engineering Department of the Japan Refrigeration and Air Conditioning Industry Association (JRAIA), in an interview with *Accelerate Japan* (sister publication to *Accelerate Magazine*).

"Japan voted against it, even though we knew the proposal would be approved, as an expression of warning against proceeding without clear safety standards," said Hasegawa. "We wanted to share the important message that we want to spread hydrocarbon technology safely and reliably."

"If any accidents happen under this international standard with 500g," he added, "we would need to revise the law which limits hydrocarbons use."



1 / Kazuhiro Hasegawa, JRAIA

2 / Yoshihisa Sakamoto, Sanden
Retail Systems

CREATING A GUIDELINE

JRAIA has been proceeding with a risk assessment for A2L and A3 refrigerants in collaboration with industry, government, and academia to ensure that safety is taken into consideration.

In an earlier project in 2016-2017 called the "Evaluation of Performance and Safety of Low-GWP Refrigerants," the New Energy and Industrial Technology Development Organization (NEDO), evaluated the safety of hydrocarbon refrigerants in cooperation with multiple universities. The study concluded that no major accidents were found if the charge limit was within 150g of the refrigerant charge, which was the international standard at the time.

NEDO's latest project – the "Development of the Optimization and Evaluation Methods for Next-Generation Refrigeration and Air-conditioning Technology that can Achieve Energy Savings and Low GWPs" – began last year and will continue to 2022. For this, NEDO is collecting data from simulations and experiments with hydrocarbon refrigerant leaks to review risks and other factors.

A draft guideline from the project has already been completed, said Yoshihisa Sakamoto, Chief of Built-in Refrigerated Display Cabinet Risk Assessment Working Group (WG) 3, as well as Product Engineer of Japanese OEM Sanden Retail Systems Corporation.

The final guideline will comprise not only information on the safe use of hydrocarbons but also contents on the entire refrigerant life cycle, including a manual for disposal procedures; it will be issued by March 2020, Sakamoto added.

JRAIA believes that hydrocarbons in small-sized refrigeration equipment will dominate, said Hasegawa. "I think that hydrocarbon technology will become a main option in Japan. The advantages of hydrocarbons in small equipment have been proven in the market."

While imported hydrocarbon showcases have started to be installed in Japanese stores, hydrocarbon use has been clouded by end user's concerns about safety. But Sakamoto believes that the upcoming hydrocarbon safe-use guideline will serve as a tailwind for the market penetration of hydrocarbon systems in Japan in the future.

■ TS & RO



“Japan voted against it, even though we knew the proposal would be approved, as an expression of warning against proceeding without clear safety standards.”

— Kazuhiro Hasegawa, JRAIA

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1 /

Transforming Thailand's Cooling Sector with NatRefs

The RAC NAMA project is moving the country towards energy-efficient refrigeration and air-conditioning products by using natural refrigerants like propane – and establishing a model for developing countries.

— By Devin Yoshimoto

2 /



1 / Dr. Kittisak Prukkanone, Thailand's Ministry of Natural Resources and Environment, at ATMosphere Asia 2019.

2 / Saijo Denki exhibiting its R290 air-to-water heat pump at Bangkok RHVAC 2019.

Thailand's climate is hot, and energy demand from the refrigeration and air conditioning (RAC) sector is rising fast.

Energy demand for household cooling in Thailand is projected to grow from around 1,000kWh per household in 2015 to 2,500kWh per household in 2030. There's also the rising number of refrigeration systems needed in the country's growing cold chain of convenience stores, supermarkets, refrigerated transport, cold storage warehouses, and food manufacturing facilities.

All of this contributes to Thailand's greenhouse-gas (GHG) emissions, which, under the Paris Agreement, the country is committed to reducing by 20%, as compared to business as usual (BAU) by 2030. A BAU scenario would elevate Thailand's GHG emissions to 555Mt (million metric tons) of CO₂e by 2030, which means the country needs to cut emissions by 111Mt of CO₂e before then, noted Dr. Kittisak Prukkanone, Director of the Measure and Mechanism Development Section of Thailand's Ministry of Natural Resources and Environment.

To address its growing cooling needs while also helping to meet its emissions goals, Thailand's five-year Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action (RAC NAMA) project was created in 2016. Its basic goal is to transition the country's RAC industry – one of the world's largest manufacturing hubs and exporters of RAC equipment – to the production of energy-efficient products that use natural refrigerants, notably propane (R290).

The RAC NAMA project, with European partners and funding of 320 million Baht (US\$10.6 million), affords Thailand an opportunity to kickstart a completely natural refrigerant-fueled path for sustainable growth in the next decade.

The RAC NAMA project's influence may well extend to the entire Association of Southeast Asian Nations (ASEAN) region and beyond, setting a precedent on how international cooperation can be used to accelerate a developing country's transition towards sustainability in the RAC sector. (Another Southeast Asia project with similar aims is being managed by UNIDO in the Philippines; [see page 78.](#))

R290 conversions

The RAC NAMA Fund's 320 million Baht (US\$10.6 million) in funding is targeted at three main stakeholder groups: local manufacturers, residential consumers, and small- to medium-sized commercial end users, as well as training and testing facilities.

Since the establishment of the fund in 2017, local Thai manufacturers have already shown interest, and production line conversions to R290 have begun taking place. Two examples are Thailand's Sanden Intercool Group (see "[Pushing Natural Refrigerants in Southeast Asia](#)," *Accelerate Magazine*, September 2019) and The Cool ([page 76](#)), which are two of the country's largest manufacturers of commercial refrigeration equipment. Several additional agreements are ongoing and others will take place in the next few months, according to GIZ, the project's implementer (see sidebar).

Most recently, on October 1, GIZ and Thai manufacturer Saijo Denki signed a Memorandum of Understanding (MoU). The MoU cemented collaboration in "the transfer of knowledge and the procurement of state-of-the-art equipment necessary for the manufacture of natural refrigerant-based technologies, which include air-to-water heat pump, chiller and monobloc air conditioner," according to a GIZ press release (<http://bit.ly/2JH2jFP>). "The MoU formalizes two years of ongoing cooperation and is part of Saijo Denki's internationalization and innovation strategy." ■ DY

RAC NAMA at a Glance

The RAC NAMA (Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action) project provides financial, technical, and policy support to Thailand's refrigeration and air conditioning industry stakeholders, focusing on four main RAC product types: domestic refrigerators, commercial refrigerators, room air conditioners, and chillers.

Considered the pioneering climate-finance project in Thailand, RAC NAMA was commissioned in 2016 by the NAMA Facility, a joint initiative between the German Ministry for the Environment, Nature Conservation, and Nuclear Safety and the U.K.'s Department for Business, Energy and Industrial Strategy that supports "developing and emerging economies to deliver on their Paris Agreement commitments," according to the NAMA Facility website.

The RAC NAMA project uses GIZ, Germany's international cooperation agency, as the main implementer. shecco (publisher of *Accelerate Magazine*) is a key executing partner for the project.

The project is being carried out in cooperation with the Thai Government, represented by the Office of Natural Resources and Environmental Policy and Planning (ONEP), the Department of Alternative Energy Development and Efficiency (DEDE), and the Electricity Generating Authority of Thailand (EGAT).

The RAC NAMA Fund is the main financial instrument for the project, with EGAT serving as the official Project Fund Manager. (For more information on the RAC NAMA Fund, see <http://bit.ly/2qb9E9X>.)

THE COOL SEES R290 AS THE FUTURE

With support from the Thailand RAC NAMA project, the Thai OEM is working to achieve full adoption over the next few years for its commercial refrigerators and freezers.

— By Devin Yoshimoto

At the ATMOsphere Asia 2019 conference, a representative from Thai OEM The Cool made a strong statement during his presentation in the "Innovative Refrigeration Solutions" session.

"In the near future, we are going to be 100% R290 and environmentally friendly," said Phurinat Sirirat, Assistant Chief Operating Officer, The Cool, at the conference, held in September in Bangkok, Thailand.

During Sirirat's presentation, he explained why The Cool sees R290-based technology as the future of its business, and outlined the steps it is taking now to achieve full adoption over the next few years.

Headquartered in Bangkok, The Cool manufactures, sells and services commercial plug-in and mobile vending refrigerators and freezers. It was founded in 2001 and is now active in Malaysia, Indonesia, Vietnam, the Philippines, and Myanmar.

A GLOBAL SHIFT

For The Cool, transitioning to R290 was not a recent decision. The company has been manufacturing R290 equipment on a limited scale for its large multinational clients since 2009. "It has been a global trend over the past 10 years for our clients such as Nestlé and Unilever to use R290 for their smaller sized freezers," said Sirirat. "All mobile vending ice cream cabinets and display freezers had to be 100% R290."

In Thailand, The Cool's leadership team recognized that this technology shift from its largest multinational clients was a signal of things to come. But the decision to invest in making the shift as well was not without its risks. "We had to invest in brand new [production] machines as well as in additional safety [measures] for our staff and in our facilities," said Sirirat. "And it was not immediately clear how many years it would take for us to get a return on our investment."

There were certain benefits, however. One of these was the fact that compared to R22 and R134a, using R290 resulted "in a 40% reduction in refrigerant charge," said Sirirat.

Although interest in the technology domestically was still low, Sirirat said that this has also been changing. "In the past three years, compared to five years ago, [interest] has been getting better and better," said Sirirat.

Ultimately, the benefits combined with the shifting global landscape outweighed the risks, and The Cool decided to pursue this direction seriously. "Our top management saw that this was a global trend and that we had to be leaders," said Sirirat.



Phurinat Sirirat, The Cool, at ATMOsphere Asia 2019.

THE RAC NAMA BOOST

Beginning in 2016, The Cool began participating in Thailand's RAC NAMA (Refrigeration and Air-Conditioning Nationally Appropriate Mitigation Action) project, an international initiative to help initiate a complete sector-wide transformation in Thailand towards more energy efficient and green cooling based on natural refrigerants. ([See page 74.](#))

The Cool, with its significant experience with R290, seemed to be a good match. With the help of RAC NAMA, R290 production lines were enhanced, equipment was improved, and safety standards were refreshed, according to Sirirat. With RAC NAMA's support going forward, The Cool seems set to significantly ramp up its sales activities for R290 in Thailand. ■ DY

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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Reinventing the Food Cold Chain in the Philippines

A UNIDO-led three-year initiative, which aims to bring energy-efficient refrigeration to the country, is seeking industry contributions for an innovation hub and demonstration projects.

— By Ilana Koegelenberg and Michael Garry



One of the most pressing issues in developing countries is a faulty food cold chain, which results in massive food waste and underserved communities. To address that problem in the Philippines, the United Nations Industrial Development Organization (UNIDO), together with the Department of Environment and Natural Resources of the Philippines (DENR), are spearheading a new initiative aimed at applying environmentally friendly, energy efficient refrigeration throughout the cold-chain – from farms to packing houses to cold-storage warehouses and finally stores – while advancing food safety and security.

The three-year project, which started implementation in October, is called the “Global Partnership for improving the Food Cold Chain in the Philippines.” It is funded by US\$2 million from the Global Environment Facility (GEF), with US\$25 million in co-financing (in-kind, grants and loans) contributed by other organizations. UNIDO is the implementing agency, working with the Department of Environment and Natural Resources of the Philippines (DENR), and shecco (publisher of *Accelerate Magazine*) as one of the key executing partners.

For the Philippines project UNIDO aims to “establish a global partnership” including national and international private-sector companies and financing institutions, said Franziska Menten, Project Coordinator, Department of the Environment, UNIDO, who spoke about the project on October 16 at ATMOSPHERE Europe in Warsaw, Poland, organized by shecco.

Jan Dusek,
shecco

The project plans in its first year to establish a Cold Chain Innovation (CCI) Hub (location to be determined by early December). This will be an “ecosystem of technical resources, research, knowledge sharing and stakeholder collaboration” supporting technology exhibitions and training, for which UNIDO is seeking industry contributions, said Menten.

In addition, UNIDO is calling for proposals from industry for business-case demonstration projects using low-GWP, energy efficient technology, supported by US\$800,000 in grants and incentives; the group is also seeking potential investment projects, financed by US\$22 million in loans from the Asia Development Bank (ADB) and local development banks.

“We have over US\$20 million to invest in the food cold chain in the Philippines, and the project aims to prepare companies to access all funding for their green projects,” said Menten.

The project’s first official Launching Ceremony & Technology Workshop is scheduled for early next year. A website and newsletter are under development, and a national project team is being recruited. Also planned is a technology and stakeholder workshop in the second quarter of 2020 and at ATMosphere Asia in 2020, as well as a report on the cold chain in the Philippines and the development of monitoring methodology for energy efficiency and CO₂e-reduction potential.

Jan Dusek, COO and Head of APAC, shecco, who spoke after Menten at ATMosphere Europe, described the CCI Hub as “an involvement opportunity for industry.” For training, industry stakeholders can share



The Cold Chain Innovation (CCI) Hub will support technology exhibitions and training.

“expertise on cold chain applications with natural refrigerants,” he said. Industry is also asked to donate natural refrigerant-based technologies such as smaller plug-in and remote systems while offering a “time-limited rental of larger systems.” In addition, UNIDO is seeking “hands-on experience with the latest environmentally friendly refrigerant technologies” for operation and maintenance at the CCI Hub,” said Dusek.

“It is the industry’s responsibility to help Southeast Asia move away from R22,” he said. To date, the region has made some progress with natural refrigerants, with thousands of propane (R290) plug-in cabinets installed, including a Royal Duty Free store in Manila using only R290 cabinets and a water-loop system. (See [“Royal Duty Free Is First in the Philippines With All-R290 Store,” Accelerate Magazine](#), June 2019.) Training on hydrocarbons and CO₂ systems have commenced in Southeast Asia, while at least five ammonia/CO₂ cascade systems have been installed in the Philippines and Malaysia, he said.

Three main components

The three main components of the project, said Menten, include: policy and regulatory assessment, awareness and capacity building, and technology transfer.

On the policy side, this means the adoption of regulatory, legal and voluntary measures to support the use of low-carbon and energy-efficient technology in the cold chain, Menten said. The project will also look at developing national standards for minimum energy efficiency and flammable refrigerants.

The project also seeks to foster awareness, knowledge and capacity in the use of energy-efficient, climate-friendly and safe refrigeration alternatives in the food cold chain. This includes monitoring and analyzing the efficiency and carbon impact of each link in the cold chain and identifying high-potential areas for improvement. It also includes education and training for 50 local engineers, as well as systems suppliers and end users, on cold chain technology.

For technology transfer, new technologies will be made available in the country and partnerships established between key stakeholders. ■ IK & MG

Researchers 'Do the Twist' for Refrigeration

A global research team has published a paper examining the potential for solid-state cooling via the twisting of rubber and other materials.

— By Ilana Koegelenberg

In a study published in the Oct 11 issue of the journal *Science*, an international team led by researchers at The University of Texas (UT) at Dallas and Nankai University in China has demonstrated “twistocaloric” refrigeration via twisting materials as diverse as natural rubber and ordinary fishing line.

“Compared with conventional vapor compression refrigerators, a solid that changes entropy when deformed could possibly provide higher efficiency; lower cost, weight, and volume; and more convenient miniaturization,” according to the study, entitled “Torsional refrigeration by twisted, coiled, and supercoiled fibers” by Wang *et al.*

For the past three years, Dr. Ray Baughman, Director of the Alan G. MacDiarmid NanoTech Institute at UT Dallas (Dallas, Texas, U.S.) has been working with Dr. Zunfeng Liu, a Professor in the State Key Lab of Medicinal Chemical Biology in the College of Pharmacy at Nankai University in Tianjin, China — and a team of 28 other researchers.

“Refrigeration contributes greatly to global warming, and the efficiency of refrigerators, after many decades of research, is only about 60%,” explained Baughman. “Yet in only three years, we’ve shown an efficiency of 67% by simply twisting rubber. It’s very promising.”

Baughman worked in industry for 31 years before becoming a professor. He currently holds over 99 patents in the U.S. alone and various other foreign ones as well.

He explained that a team member first observed twistocaloric cooling when building a platform in which a slender, coiled polymer-fiber artificial muscle lifted a person. His research teams previously developed artificial muscles made by tightly twisting and coiling fibers that range from carbon nanotube yarns to ordinary nylon thread and polyethylene fishing line.

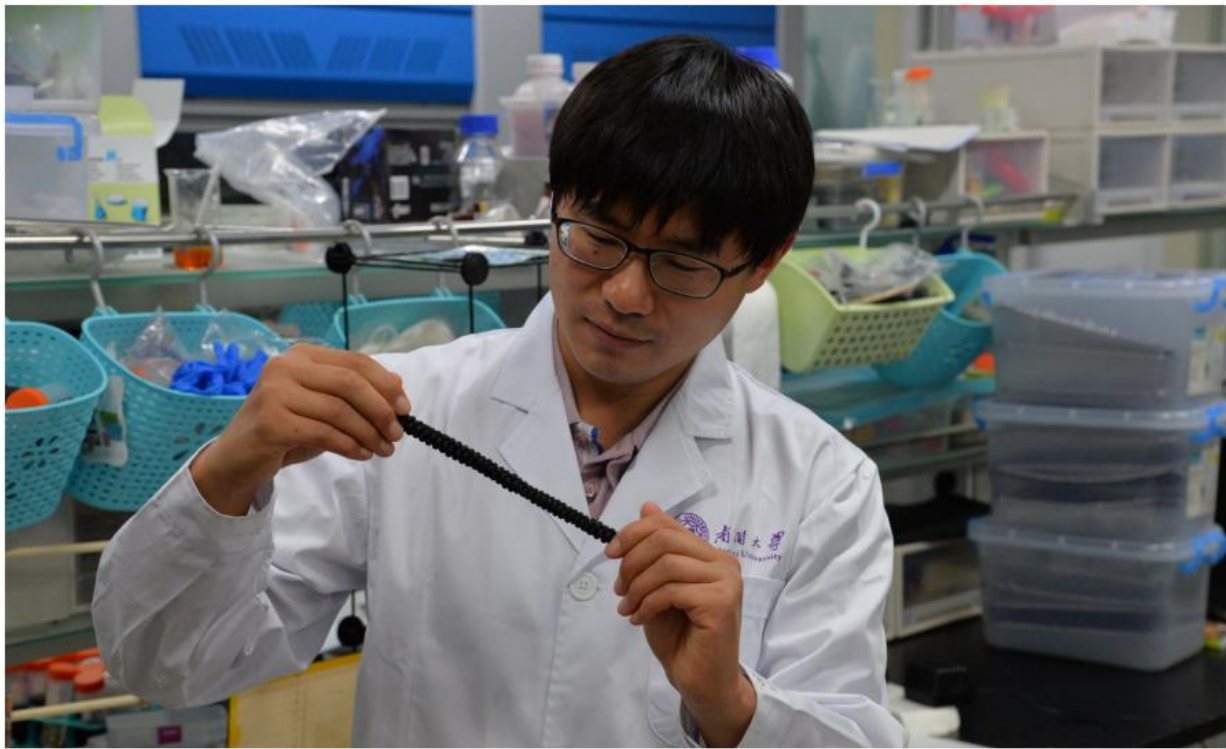
How does it work?

Stretching a rubber band heats the rubber and releasing the stretch cools it; this process is called elastocaloric cooling. Other solid substances that can be cooled include electrocaloric and magnetocaloric materials, which cool via changes in electric and magnetic fields, respectively. “This elastocaloric behavior of natural rubber has been known since the early 1800s. But to get high cooling from a rubber band, you have to release a very large stretch,” Baughman said. “With twistocaloric cooling, we found that all you have to do is release the twist.”

In the current work, the scientists stretched rubber fibers, then twisted them until they not only coiled, but also “supercoiled.” Fast release of just the twist resulted in surface temperature cooling of 15.5°C (27.9°F). Releasing both the twist and the stretch from the rubber produced even greater cooling of 16.4°C (29.5°F).

The twistocaloric cooling also worked for fishing line. The researchers inserted twist into nonelastic polymer fishing line until coils formed. Stretching the coiled fiber caused heating, while stretch release produced a maximum surface cooling of 5.1°C (9.2°F).

The best-performing material the team tested, Liu said, was nickel titanium (also known as nitinol) wire, an elastic alloy that’s been used in medical devices and implants. A single twisted nitinol wire could produce a cooling effect of 17.2°C (31°F); adding three more wires to the mix eked out a few more degrees of chill. In an experiment, the team bundled up three of these nitinol wires in a small chamber and flowed water over them. As the wires untwisted inside the tiny refrigerator — or “twist fridge,” as they called it — they cooled, bringing down the temperature of the surrounding fluid as well. This bundle of nitinol wires, weighing about 0.6g (0.02oz), lowered the temperature of a teaspoon or so of water by around 5.6°C (10°F) in a single, 30-second cycle, according to Liu.



Zunfeng Liu, one of the study authors, holding a super-coiled rubber fiber in his laboratory.

That's not much water, and the technology is still in its infancy. According to Baughman, the team has only scratched the surface of what is possible with this technology. "With more tinkering, our discovery could someday provide an alternative to traditional cooling systems, which, in addition to consuming fossil fuels, produce gobs of greenhouse gases and account for about 20% of global electricity consumption."

In another set of experiments, they coated different types of fibers with thermochromic paint, which changes color in response to temperature variations produced by twisting fibers or stretching coiled fibers. Such fibers could be used for remotely readable sensors of strain and twist, as well as for color-changing textiles for clothing.

But the timing for commercialization of the technology is still to be determined. "Many challenges and opportunities exist on the path from these initial discoveries to commercialization of twist fridges for diverse large- and small-scale applications," Baughman said. "Among the challenges are the need to demonstrate refined devices and materials that provide application-targeted cycle lifetimes and efficiencies by recovering part of the inputted mechanical energy." The opportunities include using performance-optimized twistocaloric materials, rather than the few presently studied commercially available candidates, he added.

A replacement for vapor compression ?

According to Baughman, this new technology has the potential to replace all vapor compression refrigeration systems, eliminating the need for refrigerant gases completely.

Interestingly, as part of Baughman's research on the artificial muscle, his team has also been looking at comfort-adjusting clothing that focuses on cooling the person, rather than the whole room.

According to Baughman, he and his team have been inundated with inquiries into the technology since the article in *Science* came out. He said that they are still trying to decide which direction to take this in – whether to start a consortium or to license the technology to a company (or two) for commercializing it.

The team will continue with this research, with the work at UT Dallas supported by the Air Force Office of Scientific Research, The Welch Foundation, and the National Science Foundation.

■ IK

Intelligent Pumping System Cuts Energy by 55% in Chillers

New Grundfos units use temperature sensors to regulate water flow.

— by Tine Stausholm

Danish pump manufacturer Grundfos has launched a new distributed pumping system (DPS) for commercial air-conditioning systems in Asia, aiming to help customers save up to 50% of energy consumption with intelligent pumps and temperature sensors.

The first installation of the DPS was made at Grundfos' own Singapore headquarters, which consists of an office and factory block. Between November 2016 and May 2017, the building achieved 55% pump-system energy savings.

The second installation was carried out at the Ngee Ann Polytechnic Environmental & Water Technology Centre of Innovation, also in Singapore. The building was already Platinum-certified in Singapore's Green Mark certification scheme. This project also achieved a 55% pump-system energy saving.

"With sustainability being a very key part of Grundfos' DNA, our DPS demonstrates our commitment to create cleaner and more energy-efficient technologies to enable our customers to reduce their energy consumption, and limit their impact on the environment," Anders Christiansen, Regional Business Director, Building Services for Grundfos Asia Pacific, said in a statement.

How does the DPS work?

Where traditional chiller systems often run at a constant speed, and over-pump to compensate for discrepancies between chilled water supply and return water temperatures, Grundfos' DPS is designed to operate optimally, said Grundfos.

The system achieves this by constantly regulating the water flow based on feedback from the temperature sensors, delivering the needed flow and matching the requirements of the different building zones. Apart from being energy-efficient and money-saving, this regulation also ensures consistent temperatures in the buildings and increased user comfort. Grundfos said.

Due to the self-regulating nature of the DPS, it doesn't require any control valves.

The core of the distributed pumping system are Grundfos' Magna3 and TPE3 pumps. Both series feature built-in sensors, variable-speed drives, controller and communications module and an IE5 motor.

The TPE3 pump is a dry-runner, vertical in-line pump, which is used as the primary pump. It is currently available in sizes up to 2.2kW, with a performance range of up to 25m (82ft) head and 80m³ (2,825ft³) per hour flow. The Magna3 is a wet-runner circulator, used as the secondary pump. It has a maximum twin of 18m (59ft) and a flow of up to 70m³ (2,472ft³) per hour.

"Cooling and ventilation has become a part of everyday life, and for the warm, tropical regions of Asia, it is especially pertinent in making cities habitable," Christiansen noted. ■ TS



Grundfos's TPE3 pump.

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Danish researchers have shown that reducing recirculation rate and evaporator-tube diameter can decrease refrigerant charge in overfeed systems, without sacrificing cooling capacity.

CUTTING AMMONIA CHARGE IN INDUSTRIAL SYSTEMS

— by Tine Stausholm

Ammonia as a refrigerant has been known for more than 150 years, but that doesn't mean the technology can't still be improved. Danish researchers have shown that, with a number of system design tweaks – notably reductions in recirculation rate and evaporator-tube diameter – a significant cut in refrigerant charge is possible for industrial systems, without compromising on cooling capacity.

The study, "Multi-objective optimisation of low charge liquid overfeed ammonia evaporators for industrial refrigeration," was carried out by researchers from the Technical University of Denmark and the Danish Technological Institute. It was published in Proceedings of the 8th Conference on Ammonia and CO₂ Refrigeration Technologies (<https://bit.ly/32CF32z>).

The research team of Martin R Kærn; Wiebke B Markussen; and Jóhannes

Kristófersson looked at how to minimize the required refrigerant charge and the heat-transfer area in liquid-overfeed evaporators, without compromising the required cooling capacity. The heat-transfer area was used as a measurement of the evaporator cost.

The evaporator used in the study was a traditional flooded inline finned evaporator, operated with pumped liquid circulation and rated to a 22kW (6.3TR) cooling capacity. The experiments were carried out with a -30°C (-22°F) evaporation temperature.

To find out what has the largest influence on the required refrigerant charge, the researchers looked at the interaction between parameters like the refrigerant recirculation ratio, the heat-exchange area (represented by longitudinal tube pitch and transverse tube pitch), tube diameter, and the number of tube circuits. The recirculation ratio is defined as the ratio between the refrigerant mass-flow

rate through the evaporator and the vaporized refrigerant mass-flow rate.

They found that the single biggest effect on the required refrigerant charge was a reduction of the recirculation rate, which reduced the charge significantly in all scenarios. They furthermore found that if the tube diameter is reduced, and the total number of tube circuits is increased at the same time, then the charge can be reduced even further. This is even possible with a decreased heat-exchanger size, thus saving cost.

In a previous study done by the same authors, they also found that the required charge could be reduced by a factor of two to three by reducing the recirculation ratio, the final reduction depending on the evaporation temperature. The researchers have also looked at a Danish cold-storage case study and found that the compressor power consumption can be reduced by 4.9% when the recirculation ratio is reduced from four to 1.5.

■ TS





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Taking Stock of the Japanese Market



Professor Kiyoshi Saito, chair of next year's Gustav Lorentzen Conference, is proud of Japan's pioneering role in the development of natural refrigerants, and expects further growth in CO₂ heat pumps and other applications.

— By Devin Yoshimoto

Japan played a key role in the early development of natural refrigerant-based technology, and that is something Professor Kiyoshi Saito is very proud of.

Saito, a leading authority on natural refrigerants in Asia, is a Professor in the Department of Applied Mechanics and Aerospace Engineering at Waseda University in Tokyo. He is also Director of the Waseda Saito Lab, where he conducts research and development in the field of system dynamics and control for HVAC&R systems such as heat pumps, desiccant systems, and absorption chillers.

He will serve as conference chair for the 14th IIR-Gustav Lorentzen Conference on Natural Refrigerants (GL2020), which will be held in December 2020 in Kyoto, Japan.

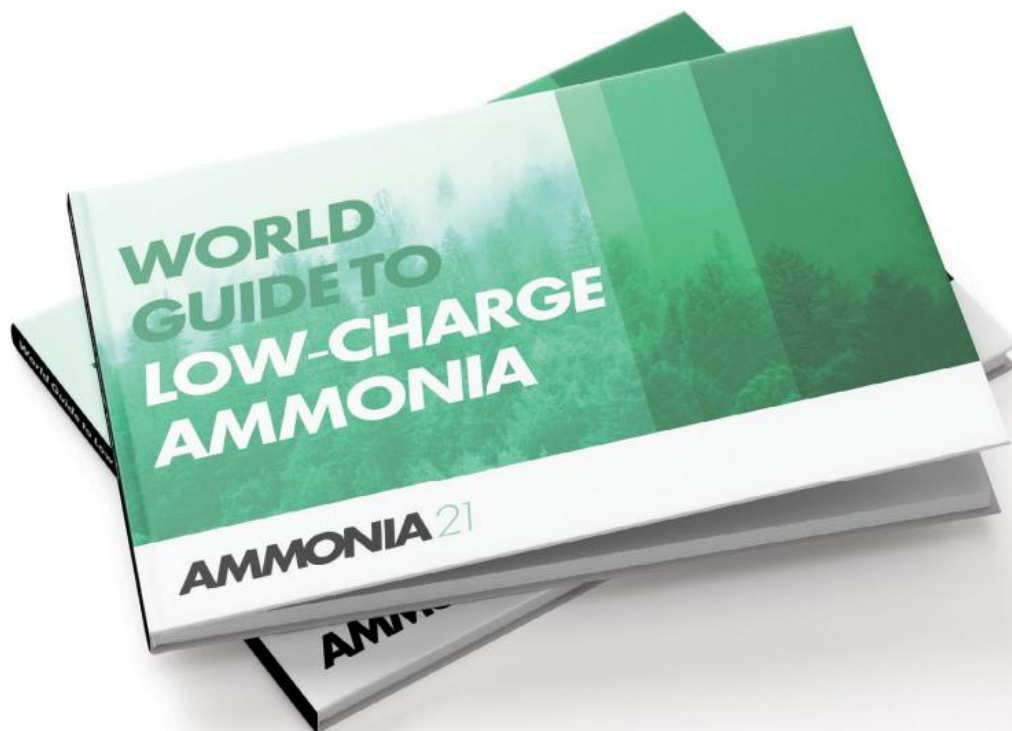
In this interview with *Accelerate Magazine*, Professor Saito offered his perspective on the current state of natural refrigerant technology in Japan and Asia, as well as what he is looking forward to at next year's GL2020 event.

// Accelerate Magazine: In which areas have you seen the most progress with natural refrigerant adoption in Japan over the past few years?



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► **Kiyoshi Saito:** Amid growing interest in global-warming countermeasures, in 2015, the Plan for Global Warming Countermeasures and the Fluorocarbon Emission Control Law was enacted, requiring equipment that uses refrigerants with low GWP for reducing CO₂ emissions.

In the following few years, the use of natural refrigerants in Japan is expected to be as follows:

► *Domestic heat pump water heaters (replacing gas water heaters):*

Domestic heat pump water heaters that use CO₂ as a refrigerant (such as EcoCute) are systems that can significantly reduce energy consumption in the field of hot water supply, which accounts for about one-third of the energy consumed at home. Since being commercialized for the first time in 2001, this system has experienced a large dissemination, and as of the end of June 2018, cumulative shipments exceeded 6 million units. Based on the long-term energy supply and demand outlook established in 2015, the goal is set to reach 14 million operative units by fiscal year 2030, while achieving further efficiency improvement and demonstration plants linking this technology with photovoltaic power generation (PV).

► *Commercial heat pump water heaters (replacing gas boilers):*

Since Itomic's first commercialization of commercial heat pump water heaters using CO₂ in 2002, Mitsubishi Electric and Mayekawa MFG, and other companies have been developing similar systems. Hybrid hot water supply systems with boilers have also been proposed.

► *CO₂ refrigerated display cabinets (replacing CFC refrigerant):*

Equipment using CO₂ as a refrigerant has been commercialized by Panasonic and Mitsubishi Heavy Industries Thermal Systems. Currently, there are several installations taking advantage of government subsidies. Further developments of this technology aim at reduction of the initial cost and efficiency improvement.

The widespread use of natural refrigerant equipment in the near future is also expected to be in vending machines, industrial heat pumps, and low-temperature refrigerators.

// **Accelerate Magazine:** With the higher IEC charge limit for hydrocarbons (500g/17.6oz), opportunities are opening up for hydrocarbon use in commercial refrigeration globally. What results do you expect to see in Japan regarding hydrocarbon use in the next few years?

Kiyoshi Saito: In Japan, the use of hydrocarbons is expected to become more common. However, in Japan, hydrocarbons are restricted by the High-Pressure Gas Safety Law, and there are restrictions on the amount of refrigerant that can be charged within the system. Even if the restriction on the refrigerant charge is loosened, it is still likely that systems using hydrocarbons would be required to undergo a risk assessment. (See page 72.)

Japan, which has released the world's highest quality and safest equipment, is presently promoting the use of these refrigerants upon the establishment of reliable risk assessment procedures. This is because people's safety comes first. Indeed, I am worried about the ease with which some systems may introduce hydrocarbons in other countries.

In Japan, this technology has already been introduced in refrigerators for domestic use and is also being adopted in hybrid heat pump water heaters. We believe that it will be integrated with refrigerated display cabinets as well.

// **Accelerate Magazine:** What are you most excited about for this upcoming GL2020 conference?

Kiyoshi Saito: I am very excited that we will have the GL2020 in the Kyoto (Japan) International Conference Center, where the Kyoto Protocol to counter global warming was adopted. We look forward to discussing the technology using natural refrigerants that has been implemented and presenting information about the deregulation of equipment using natural refrigerants. We want to discuss the scientific basis for the role of natural refrigerants in contributing to global-warming prevention.

// **Accelerate Magazine:** Is there anything special planned?

Kiyoshi Saito: I want to introduce the history of the conversion to natural refrigerants in Japan as the home of natural refrigerants. Also, we have planned a technical tour to showcase operative equipment using natural refrigerants. ■ DY



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