

JANUARY 2020

ACCELERATE

ADVANCING HVAC&R SUSTAINABLY

MAGAZINE

Profiles of 29
women around
the world working
with natural
refrigerants.

P. 28

WOMEN IN NATREFS



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R744.com, ammonia21.com and hydrocarbons21.com.

ACCELERATE NEWS
ADVANCING HVAC&R SUSTAINABLY WORLDWIDE

A Woman's Touch

— By Michael Garry

On November 27, 2007, I attended a meeting at the Washington, D.C., headquarters of the U.S. Environmental Protection Agency (EPA) to cover the launch of a new voluntary program for the supermarket industry called GreenChill.

At that time, I was a technology and environment reporter for *Supermarket News*, a national trade publication, where I had been writing about refrigeration used by food retailers for a number of years, including the first North American efforts to use natural refrigerants like CO₂. But I would cite that November meeting as the true start of my career covering the environmental side of refrigeration.

The EPA's GreenChill Partnership, in which food retailers would work with the agency to reduce their refrigerant leaks and charge while exploring new refrigeration options, sparked a new awareness in the supermarket industry about the environmental and business impact of the synthetic refrigerants that were leaking from their systems at an annual rate exceeding 25%.

Before long retail participation in the program soared. Many retailers were persuaded to seriously consider natural refrigerants for the first time.

Credit for the early success of the GreenChill program goes to Keilly Witman, its first manager who quickly became well-known to supermarket operators as someone at the EPA they could work with and not fear. During her five years in that job, leak rates at participating retailers (a significant slice of the industry) plummeted while interest in sustainable refrigeration options took off.

Keilly is one of the 29 women from around the world whom we have profiled in this issue ([page 28](#)), and she is a good example of the kind of impact that women, though vastly underrepresented in the HVAC&R industry, can have on the advancement of natural refrigerant technologies.

I have been fortunate to work with many other talented women in my career covering climate-friendly cooling and heating. At shecco, publisher of *Accelerate Magazine*, women have always held key positions in media, events and market research that support the development of the natural refrigerants industry ([see page 44](#)). Women who worked at shecco for many years and then moved on to positions elsewhere — such as Nina Masson and Franziska Menten — continue to support the advancement of these technologies in a big way.

While covering the natural refrigerants industry in the U.S., I see on a regular basis the amazing work being done by women like Danielle Wright and Morgan Smith at the North American Sustainable Refrigeration Council (NASRC) and Ali White at Energy Vermont. They are helping to clear the way for natural refrigerants to be used in the U.S. marketplace. Lois Stirewalt of RETA and GCCA is working on recruiting veterans to fill the technician jobs that are so badly needed.

Meanwhile, Avipsa Mahapatra and Christine Starr at the Environmental Investigation Agency are fighting the good fight to make sure that CFCs and HFCs are removed and natural refrigerants see the light of day.

Read more about these women and many others from across the globe who are breaking barriers, not only for natural refrigerants, but for their gender as well.



Michael Garry
Editor in Chief

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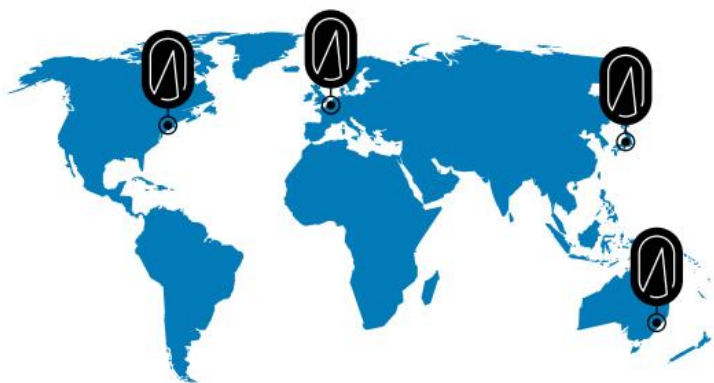
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ACCELERATE

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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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?

// ISSUE #106

January 2020

Cover Story:

Women in Natural Refrigerants

Print Distribution:

AHR Expo (Orlando, Florida, February 3-5); ATMosphere Japan (Tokyo, February 10)

// ISSUE #107

February 2020

Cover Story:

Focus on EuroShop and changes in retail refrigeration

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 are NatRefs transforming heating and cooling of buildings?

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.

Reshaping the Energy-Management Equation

How evolving demand response and smart optimization strategies can help reduce energy costs.

— By James Jackson

Energy cost reduction is a goal shared by most operators across the entire food retail spectrum. In recent decades, many supermarket, restaurant and convenience store chains have experimented with major energy retrofits, energy-service-company (ESCO) contracts, demand management and even on-site generation to help address rising electricity costs in individual stores and across their multi-site networks.

These strategies were intended to help building operators lower energy consumption and/or qualify them for rebates and incentives from participating utilities. But as the energy and utilities sectors continue to evolve, traditional approaches to energy efficiency and demand response must also adapt to this changing landscape.

In many regions of the U.S., increasing contributions from renewable sources are helping to reduce the need to offset

traditional peak demands. But these contributions aren't without their own challenges, as renewable power availability often changes or is unavailable when needed most.

At the same time, the widespread adoption of the internet of things (IoT) is enabling operators to leverage smart devices, systems and technologies to fine-tune energy consumption within building envelopes — all of which is helping to reshape the energy-efficiency equation.

Nowhere is this more applicable than in supermarkets, where chains are rife with energy optimization opportunities among their refrigeration, HVAC and lighting systems. The average 50,000ft² (4,665m²) store incurs \$200,000 in annual energy costs, resulting in 1,724 metric tons of CO₂e emissions — the equivalent of 360 vehicles — in one year. Of these costs, refrigeration and lighting account for more than 50% of total energy usage.

By utilizing automated energy management systems and control strategies, leaders in the retail space are uncovering previously hidden opportunities for seemingly small improvements — which when aggregated across a multi-site enterprise can add up to significant savings.

While these concepts may seem relatively straightforward in theory, implementing successful programs in today's challenging industry conditions can be far more complex in practice. Building

envelopes are rapidly changing with the transition to smaller store formats and the introduction of omnichannel business models (click-and-collect or direct-to-consumer delivery). Rebate programs can be complicated, requiring both coordination and clear communication between facilities and utilities, and the placement of automated control mechanisms to shift demand as required. In many cases, retailers lack the internal energy expertise to successfully drive these programs and benefit from them.

Fortunately, with advances in energy management systems (EMS) and controls technologies, retailers now have the ability to automate energy best practices across their enterprise networks for maximum efficiencies. These tools not only provide full building ecosystem optimization but also help operators capitalize on the potential for energy savings via utility energy incentives and available demand-management opportunities.

Navigating this complex landscape requires a strong understanding of the current state of energy markets. What follows are some of the key developments impacting food retailers.

Understanding “consumption” and “demand”

To help put energy trends into context, it's important to first have a basic understanding of the difference between electricity consumption and demand, and how each impacts your utility bill. Consumption is measured in kilowatt hours (kWh) and refers to the amount of energy used during a billing period. Depending on your geographic location, your specific rate plan and your utility's standard and time-of-use (TOU) rates, kWh prices can vary widely. Understanding these factors is essential to developing a smart energy management strategy that includes avoiding intensive consumption activities during peak TOU rate periods.

Demand represents the instantaneous energy load that a commercial customer (or building) places on the grid. Utilities use this as a measurement on which to base infrastructure planning and determine the total load requirements of the electrical system. As demand increases, utilities are forced to draw from additional power sources, often more expensive reserve sources like coal and other fossil fuels.

Utilities measure demand in kilowatts (kW) based upon the actual power a consumer draws. Because demand costs can be potentially higher than consumption rates — with charges ranging from a few to several dollars per kW — demand can account for a significant portion of your monthly bill. In a typical supermarket where refrigeration, HVAC and lighting systems are constantly in use to varying degrees, effectively managing demand costs is directly tied to how efficiently these systems are used and coordinated within a building.

Some food retailers may also be subject to utility-imposed demand ratchets, which allow utility companies to establish a minimum billing based on the highest instantaneous demand measured during a billing period. Essentially, utilities can lock customers who may have inconsistent or seasonal energy requirements into this high-demand rate to ensure they're able to cover the consumer's peak usage periods. This is very important to understand for both new and existing facility operators, because if you don't properly manage the demand in your building, it could result in a more costly, long-term rate structure.

The common denominator in all of this is that it can pay to implement energy-efficiency and demand optimization/coordination strategies at both individual retail sites and across enterprise networks.



James Jackson is Business Development Manager for Emerson.

Redefining traditional demand-response programs

One of the best places to look for the latest trends in the energy space is the state of California. With its progressive approach to sustainability, it is a fore-runner in the implementation of strategies, policies and regulations that often influence the direction that the rest of the country will follow on related matters. Researchers at the Lawrence Berkeley National Laboratory (LBNL) in California have recently turned their attention to evolving the state's approach to demand response.

Traditional demand response programs are comprised of voluntary agreements between participating utilities and their customers, whereby customers receive financial incentives for reducing their electricity loads during periods of high prices or when the reliability of the grid is threatened.

But in light of the rapid deployment of renewable generation, slow power plant retirement schedules and investments in California's grid, the state is now generating enough capacity to meet demand at peak times. This has offset the need for utilities to up their investments in demand-response infrastructures, and caused disruptions in the ways that consumers have participated in traditional demand-response programs.

LBNL evaluated California's energy dynamics and uncovered interesting findings that are also relevant to other states with similar energy profiles. The study drew from 200,000 customer-load profiles from the state's three major utilities and evaluated them against a model of California's evolving grid over the next 10 years. Like many states, California is benefiting from an increase in contribution from solar power and the continued shift of demand from midday to evening hours. The proliferation of

smart thermostats and controls in commercial and residential sectors is also helping the state optimize its energy consumption.

The LBNL study findings are helping researchers understand the amount of flexible customer load that is available and evaluate different methods for getting customers to change their energy consumption habits, such as TOU, peak-pricing programs, and day- and hour-ahead energy market plans. With these strategies in mind, the study recommends replacing California's traditional demand-response program with a four-pronged approach designed to incentivize consumers to adapt to the needs of the grid:

- **Shape:** Reshape load profiles through TOU prices/incentives and energy-efficiency programs.
- **Shift:** Move energy consumption from periods of high demand to those times when there is a surplus of renewable generation.
- **Shimmy:** Dynamically adjust to loads within minutes or seconds in response to grid disturbances or short-run ramps.
- **Shed:** Curtail loads to provide peak capacity and support the grid in emergency or contingency events (much like conventional demand response)

While utilities are likely to incentivize all of these strategies per a consumer's (or facility's) unique electricity requirements, the opportunity to shift demand is seen as the greatest contributor to future grid flexibility — and potentially one of the biggest opportunities for energy savings.

Self-generation via thermal and battery storage

In many regions, utility companies are also encouraging consumers to implement proven thermal- and battery-storage options to help shift demand from peak to off-peak hours. The concept of self-generation is relatively simple: thermal (ice) creation and battery charging take place during off-peak hours to store energy that can be used or discharged during peak hours to help utilities offset demand. Essentially, these options allow operators to augment their power portfolios and add flexibility to their energy-consumption strategies.

States and utility companies are taking notice. The California Public Utilities Commission (CPUC) created its Self-Generation Incentive Program (SGIP) to incentivize the use of existing, new and emerging distributed energy resources such as battery and thermal. The use of EMS energy dashboards helps operators demonstrate the effectiveness of their self-generation practices and qualify for available rebates.

As battery- and thermal-storage technologies continue to evolve, self-generation is likely to become a much more commonplace energy management strategy in the coming years. ■ JJ

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Letters to the Editor

CONTESTING ENERGY CLAIMS FOR NEWTON

The best specific energy consumption (SEC) in kWh/m³*a (a stands for annum) achieved by NewTon NH₃/CO₂ systems is approximately 35 kWh/m³*a for a distribution center with a refrigerated volume of 44,000 m³ (1,553,845 ft³). This is according to the paper "Actual Energy Conservations by Using NH₃/CO₂ Refrigeration System," proceedings of the 3rd International Conference of Saving Energy in Refrigeration and Air Conditioning ICSERA 2013, H. Asano and N. Mugabi, both with Mayekawa, figure 7.

According to ICR 2019 paper #466, "Real Energy Efficiency of DX NH₃ versus HFC," authored by yours truly, figure 8, a DX NH₃ two-stage system delivers a specific energy consumption of 20-24 kWh/m³*a when servicing a distribution center with a refrigerated volume of 44,000 m³.

Also, in the paper "Comparing Energy Consumption and Life Cycle Costs of Industrial Size Refrigeration Systems," authored by T. Lund, M. Skovrup and M. Holst of Danfoss, figure 1 shows that in all three jurisdictions investigated

(Rome, Frankfurt and Oslo) the R744/R717 (CO₂/NH₃) cascade system is less energy efficient than the equivalent dual-stage R717 system with liquid overfeed.

How then can the *Accelerate Magazine* article describing the recent NewTon installation completed by Tri Tech Refrigeration Australia in Sydney ("[Australia Gets Its First Ammonia/CO₂ NewTon Systems](#)," November-December 2019) claim that the NH₃/CO₂ system delivers significantly lower energy consumption than a conventional liquid-overfeed system, unless the contractor or the user of the NewTon system produces the SEC in kWh/m³*a to substantiate that claim?"

I have hereby provided the data to substantiate the claim that NH₃/CO₂ cascade systems are generally less efficient than conventional dual-stage R717 systems, and significantly less efficient than the centralized low-charge NH₃ systems described in ICR 2019 paper #466.

Stefan Jensen
Managing Director
Scantec Refrigeration Technologies
Brisbane, Australia

LETTERS ARE WELCOMED!

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

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AMERICAS

January 15-16

NASRC Low-GWP & Energy Efficiency Expo, Los Angeles, California, U.S.

The North American Sustainable Refrigeration Council (NASRC) and Southern California Edison will co-host this event, which will showcase the latest commercial refrigeration technologies and solutions that offer both low-GWP and energy-efficiency benefits in new and existing facilities.



<http://nasrc.org/energy-efficiency-expo>



@NatRefCouncil

February 1-5

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

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



<http://bit.ly/35lUz4>



@ashraenews

February 5-5

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/2lRXbyg>



@ahrexpo

Orlando, Florida

February 25-26

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/2lSapuL>



@TheNGAShow

March 15-18

IIAR Natural Refrigeration Conference & Heavy Equipment Expo, Orlando, Florida, U.S.

The IIAR 2020 show aims to create awareness of new ideas and trends that impact the future of the natural refrigeration industry. Attendees include design engineers, contractors, end users, academics, scientists, trainers, and government agencies.



<https://bit.ly/38HjSk7>



@iiarnews



EUROPE, MIDDLE EAST & AFRICA

February 11-14

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

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



Málaga, Spain

March 10

ATMOsphere Cape Town, Cape Town, South Africa

The first ATMOsphere Conference event in South Africa will promote the uptake of natural refrigerants in Cape Town and its surrounding areas. Topics will include: Global market trends, technology trends, policy, end-user panel and case-study presentations.



<https://bit.ly/2sl161m>



@ATMOEvents

March 17-20

Mostra Convegno, Milan, Italy

Mostra Convegno is a global marketplace where HVAC&R, renewable sources and energy-efficiency companies gather to showcase the latest technologies, solutions and systems for smart buildings in commercial, industrial and domestic residential sectors.



<https://bit.ly/38yKTWE>



@MCExpocomfort

March 31

ATMOsphere Ibérica, Málaga, Spain

ATMOsphere Ibérica moves south to Malaga, Spain. Participants will learn about the latest regulations and market trends, as well as technology innovations and end-user testimonials on CO₂, NH₃ and hydrocarbons solutions.



<https://bit.ly/2siLSK4>



@ATMOEvents

February 10**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>



@ATMOEvents

February 12-14**SMTS (Supermarket Trade Show)
2020,
Tokyo, Japan**

SMTS offers the latest information to the food distribution industry, focusing on supermarkets. It provides an opportunity to meet stakeholders from the retail, wholesale, ready-meal and foodservice industry.



<http://www.smts.jp/en/>

February 18-21**HCJ2020,
Tokyo, Japan**

HCJ says this is the biggest trade show for the Japanese hospitality industry. Three shows are held concurrently: Hoteres, for hotels and restaurants; Caterex for catering and food services; and the Food Service Equipment show for commercial kitchens and food services.



<https://www.jma.or.jp/hcj/en/>

Tokyo, Japan

March 19-20**Sydney Build Expo,
Sydney, Australia**

This is an event for the construction, architecture and infrastructure industry. It attracts 10,000-plus contractors, architects, specifiers, developers, government officials, designers, associations officials, house builders, engineers, suppliers and construction professionals.



<https://bit.ly/2sh266C>



@SydneyBuildExpo

March 25-24**AIRAH Refrigeration,
Melbourne, Australia**

AIRAH Refrigeration says it tackles both broad topics and granular details related to the refrigeration industry. The two-day event will feature sessions reviewing the latest developments in legislation and technology, as well as a multitude of case studies. The trade display will provide participants with the opportunity to interact with industry suppliers on their latest refrigeration technology offerings.



<https://bit.ly/35buDJc>



@AIRAHNews



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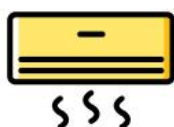
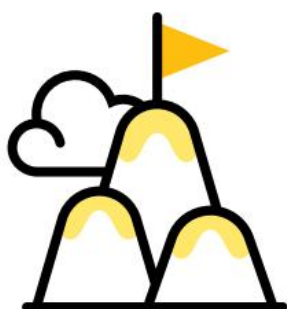
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CO R744

Connected Efficiency

The Impact of More Efficient Room Air Conditioners (RACs)

The Challenge:



4.5 Billion

The approximate number of RACs that will be used globally in 2050, up from 1.2 billion today.



3X/5X

The amount by which power demand for RACs will grow globally, and in developing countries, respectively.



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The amount of CO₂e emissions that can be avoided by 2050 by doubling the efficiency of new RACs in a de-carbonizing electricity system.*



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The potential increase in global temperatures that can be avoided by 2100 using the 2020 Global Cooling Prize-winning RAC.

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Base

Sources:
GlobalCoolingPrize.org;
* UN Environment Programme,
"Cooling in a warming world."

Ammonia Gas Detection

Model GG-NH3



Built for harsh environments. Designed to prevent false alarms.

- ◇ Operates in temperatures ranging from -50°F to +130°F (-45°C to +55°C)
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 - ◇ SafeCell technology continuously checks the cell's electrical viability
- ◇ The electrochemical sensor element is specific to Ammonia and does not react to other gases
 - ◇ Every detector passes rigorous testing and includes a 2-year warranty
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Kigali Update

Ninety countries (plus the European Union) have accepted, ratified or approved the Kigali Amendment to the Montreal Protocol as of January 13, 2020.*

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

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 started 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 will 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 will start a freeze in 2024 at a baseline of average HFC production/use in 2020-2022; those countries will 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) will start a freeze in 2028 at a baseline of average HFC production/use in 2024-2026; those countries will end with an 85% HFC phase down by 2047. So far, 59 Article 5 countries (both groups) have accepted, ratified or approved the Amendment.

Here is a list of the 90 countries along with the EU that have accepted, ratified or approved the Kigali Amendment as of January 13.

* 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
Argentina	Nov 22, 2019
Armenia	May 2, 2019 A
Barbados	Apr 19, 2018
Benin	Mar 19, 2018
Bhutan	Sep 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	Dec 5, 2019
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

Participant	Acceptance(A), Ratification, Approval(AA)
Mauritius	Oct 1, 2019
Mexico	Sep 25, 2018 A
Micronesia (Federated States of)	May 12, 2017
Montenegro	Apr 23, 2019
Namibia	May 16, 2019 A
Niger	Aug 29, 2018
Nigeria	Dec 20, 2018
Niue	Apr 24, 2018
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
Somalia	Nov 27, 2019
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	Sep 27, 2019 AA



James Newcomb, Rocky Mountain Institute

FINALISTS IN GLOBAL COOLING PRIZE INCORPORATE NATREFS

Two – and likely a third – use R290, while two employ water in design of highly efficient room air conditioners.

— By Michael Garry

Of the eight finalists competing in 2020 for a US\$1 million prize in the Global Cooling Prize competition, at least four have incorporated natural refrigerants in their design of a prototype room air conditioner (RAC) that will have at least five times lower climate impact than a baseline unit.

Two of the finalists (Godrej-Boyce and S&S Design Startup Solution Pvt. Ltd.) are incorporating propane (R290) in their systems, while another, Transeara, is using R32 but is “likely to transition to

R290 for the prototype build,” said Iain Campbell, senior fellow at the Rocky Mountain Institute.

Two others (Kraton Corporation and M2 Thermal Solutions) are employing water in their technologies. Barocal Ltd’s system utilizes an organic solid-state material (neopentylglycol), noted Campbell.

The other two finalists, Gree and Daikin, have selected HFC R152a and HFO R1234ze, respectively, for their systems.

The Government of India and Rocky Mountain Institute (RMI), two of the organizers of the program, announced the finalists on November 15 at a ceremony in New Delhi, India. The finalists were each awarded US\$200,000 to develop and ship their prototypes to India for testing in the summer of 2020. The winner of the Global Cooling Prize will be announced in November of 2020.

The following includes brief descriptions of the finalists and their systems; more details are available at <https://globalcoolingprize.org>.

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► S&S Design Startup Solution Pvt. Ltd., based in India, has developed a two-stage cooling system integrating a water loop and a traditional vapor compression system with natural, low-GWP refrigerant (R290).

► Godrej and Boyce Mfg. Co. Ltd., based in India, with partner A.T.E. Enterprises Private Limited, has designed an advanced (R290-based) vapor compression technology integrated with indirect evaporative cooling and solar PV.

► U.S.-based Transaera Inc. has developed vapor compression technology (using R32, and likely R290 later) with desiccant dehumidification.

► U.S.-based Kraton Corporation, with partners Porus Laboratories, IIT Bombay and Infosys, has designed evaporative cooling (via water) with membrane dehumidification using the electro-osmosis principle.

► U.S.-based M2 Thermal Solutions has devised evaporative cooling (via water) with membrane dehumidification using the capillary condensation principle.

► U.K.-based Barocal Ltd, a new spin-off from a University of Cambridge lab, offers solid state Barocaloric cooling technology (using neopentylglycol).

► Daikin Air Conditioning India Private Limited, with partners Daikin Industries Ltd and Nikken Sekkei Ltd., has devised a vapor compression technology with novel componentry and ultra-low GWP refrigerant (R1234ze).

► Gree Electric Appliances Inc. of Zhuhai, China, with partner Tsinghua University, has developed an advanced (R152-based) vapor compression technology integrated with evaporative cooling and solar PV.

The eight finalists were selected from 139 teams from 31 countries that submitted a full detailed technical application for the prize.

With the RAC industry set to quadruple in sales by 2050, a breakthrough RAC technology has the potential to prevent up to 75 gigatons (GT) of CO₂-equivalent emissions by 2050, while providing “affordable access to cooling in parts of the world where it is becoming a critical need,” said Rocky Mountain Institute Chief Executive Officer Jules Kortenhorst.

Energy and refrigerant

According to the Global Cooling Prize criteria, the winning cooling solution should have a five-times lower climate impact than that of a baseline AC unit, taking into account energy and refrigerant GWP (at an 80/20 weighting). The baseline RAC is a Volts 1.5TR (5.3kW) fixed-speed split AC unit that uses R22 refrigerant and has an energy efficiency ratio of 3.5 W/W.

The maximum power drawn by the solution from the electricity grid should not exceed 700W. Onsite water consumption should not exceed an annual average of 14 liters per day, with a daily maximum of 28 liters.

The solution should use a refrigerant that has zero ODP and is of lower toxicity (class A) and complies with IEC 60335-2-40 or ISO 5149.

When manufactured at a scale of 100,000 units, the winning solution should be no

more than twice the first cost of the baseline unit, with a payback period for the incremental cost of less than three years for the consumer.

The solution should be usable in existing homes, and the total volumetric size should not exceed 0.52m³ (18.4ft³), or twice the size of the baseline unit.

Global Cooling Prize administrators are committed to supporting finalists through the testing and prototyping phases as well as helping create market demand for the long-term commercial success of the winning solution. The Global Cooling Prize plans to work with countries that will see the largest adoption of RAC, such as India, China, Indonesia and Brazil, to ensure the deployment of the winning technology at scale; this could take place through government incentive programs and bulk procurement programs.

The Global Cooling Prize also plans to work with NGOs and multilateral agencies in order to secure commitments from other developing countries to scale the winning solution. “We will also be engaging the real estate development industry, other large buyers, investors, and venture capitalists to spur demand and open access to capital,” said the Global Cooling Prize’s website.

One idea being considered is a “pay-as-you-go” option to avoid the higher up-front cost of the winning unit, said Campbell. “We want to create an environment for the technology to scale.” ■ MG

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World in Brief

U.S. Report Includes HFC Cuts As Part of Decarbonization Plan

America's Pledge, a coalition of U.S. states, cities, businesses and other organizations committed to address climate change, has released a report that includes HFC-reduction among its decarbonization measures.

The report, "Accelerating America's Pledge: Going All-In to Build a Prosperous, Low-Carbon Economy for the United States," was released during the 2019 United Nations Climate Change Conference (COP25), which was held in Madrid, Spain, from December 2 to 13.

America's Pledge was formed in 2017 in response to the announcement by the Trump Administration that it would be withdrawing from the Paris climate accord, a process that formally began in November.

The report "offers a roadmap to reaching the nation's climate goals and sets the groundwork for a clean energy future for decades to come," said Michael Bloomberg, former Mayor of New York, and Edmund Brown Jr., former Governor of California, in an introduction letter. Bloomberg and Brown are the founders of America's Pledge.

The report outlines two scenarios for climate action in the U.S. – "bottom-up," drawing on the policies of the most successful states, cities and businesses; and "all-in," which combines bottom-up efforts with new federal engagement.

It also describes three main climate-remediation principles: accelerate toward 100% clean electricity and other energy supplies; decarbonize end users such as buildings, transportation and industry; and enhance ecosystems. ■ MG

Montreal Protocol Shown to Be Slowing Global Warming

New research carried out by scientists from the University of New South Wales (UNSW), Australia, has shown that the Montreal Protocol, designed to protect the ozone layer by phasing out CFCs, has reduced the global rise in temperatures even more than the Kyoto climate change agreement.

"By mass, CFCs are thousands of times more potent a greenhouse gas compared to CO₂, so the Montreal Protocol not only saved the ozone layer but it also mitigated a substantial fraction of global warming," Rishav Goyal, lead author of the paper, told the UNSW Newsroom website. The study was published in *Environmental Research Letters* in December 2019 (<https://bit.ly/36PruzP>).

The researchers found that, by mid-century, the measures in the Montreal Protocol will have avoided 1°C (1.8°F) of temperature change on a global average. In the Arctic, the effect is even greater, and the avoided temperature there will be as much as 3-4°C (5.4-7.2°F) come 2050. This corresponds to a 25% mitigation of global warming, according to the authors.

"Remarkably, the [Montreal] Protocol has had a far greater impact on global warming than the Kyoto Agreement, which was specifically designed to reduce greenhouse gases," Goyal added. ■ TS

Trawler Installs Compact CO₂ System

Global Seas, a private fisheries management company based in Seattle, Washington (U.S.), has installed a CO₂-based refrigeration system using recirculated seawater on its F/V Northern Defender trawler.

The system was chosen for its compactness and cost-effectiveness, according to a press release from GEA, which delivered the compressors for the system.

Highland Refrigeration, also based in Seattle, built the 500kW (142.2TR) recirculated seawater (RSW) system that had to fit into a space only 8m (26ft) long, 1m (3.3ft) wide, and 2m (6.6ft) high.

The installation of the system on the Northern Defender, and of follow-up orders, has been a positive experience, according to GEA, and Highland Refrigeration is now increasingly offering CO₂ systems for use on ships. ■ TS

Kirby, Beijer Ref to Open New Australian Facility

Natural refrigerant OEMs Kirby and Beijer Ref Australia have announced a commitment to a 10-year lease on a new AU\$48 million (US\$33 million) facility at Bankstown Airport in New South Wales.

"This new facility will help us deliver our business strategies and objectives in Australia, acting as our main manufacturing facility, distribution center and our corporate headquarters," said the Director of Operations at Kirby, Paul Campbell, according to a press release on December 3.

The facility is expected to be operational by November 2020. ■ DY

EC Green Deal May Include F-Gas Regulation

The European Commission (EC) on December 11 presented the European Green Deal, a wide-ranging set of sustainability goals that so far does not explicitly address F-gas reduction, though it may in the future, according to an EC official.

Anticipating the release of the Green Deal, Bente Tranholm Schwarz, Deputy Head in the EC's Directorate-General for Climate Action, addressed it on October 17 at the ATMOSphere Europe conference in Warsaw, Poland.

"What are the implications for F-gas policy? I don't know," Tranholm Schwarz said. But she added that one of the Green Deal's goals, which will be established by the summer of 2020, will be to cut 2030 greenhouse gas emissions by at least 50% under 1990 levels, and possibly 55%, as compared to the current 45% target. The EC "will have to look at all the possibilities we have to find this extra 10 percentage points," which could include "something for F-gas regulation," she said. The eventual goal of the European Green Deal is carbon neutrality by 2050.

The EU's F-Gas Regulation already calls for a 79% reduction of HFCs compared to average HFC demand between 2009 and 2012.

The EC's European Green Deal would have to be approved by the European Parliament and Council of the European Union before it would go into effect across the EU. ■ MG

VDE Verlag Publishes Textbook on Natural Refrigerants

German textbook publisher VDE Verlag has published *Natürliche Kältemittel – Anwendungen und Praxiserfahrungen* (Natural Refrigerant – Applications and Practical Experience), which it calls "so far, the only German-language book on natural refrigerants that systematically presents their properties and possible uses and compares them with each other."

The 304-page textbook is aimed at an audience of "planners, plant designers and operators of refrigeration and air conditioning systems, builders, architects, apprentices and students in the field of refrigeration and air conditioning," says VDE Verlag on the website where the book can be purchased (<https://bit.ly/37J-DrXy>); it is available in electronic form or print for €48 (US\$53.13).

Each chapter is written by an expert in the specific area. ■ IK

Panasonic: 600 CO₂ Condensing Units Sold in Europe

Since introducing outdoor CO₂ condensing units in Europe in 2017, Japanese OEM Panasonic has sold 600 as of October 2019, according to Gaku Shimada, Overseas Sales Manager for Panasonic's Refrigeration System Sales Department.

In marketing these units, Panasonic has targeted small-format stores, gas stations, fast food chains and restaurants, said Shimada during a presentation at ATMOSphere Europe, in Warsaw, Poland, on October 16. Europe is the world leader in transcritical CO₂ system installations with 23,000, though most of these are rack systems in supermarkets.

Australia Launches 'iHub'

The government of Australia has launched the Innovation Hub for Affordable Heating and Cooling (iHub) to facilitate the HVAC&R industry's transition to a low-emissions future, stimulate job growth, and showcase HVAC&R innovation.

Through the Australian Renewable Energy Agency, the government is providing AU\$6.5 million (US\$4.4 million) in funding to the three-year AU\$18 million (US\$12.2 million) iHub project, according to a press release from the Australian Government's Department of Environment and Energy.

Industry and academia are invited to submit iHub-funded proposals for the development of HVAC&R systems at the iHub website (<http://www.ihub.org.au>).

The objective of iHub is to support the broader HVAC&R industry with knowledge dissemination, skills-development and capacity-building, according to the iHub website. ■ IK

Panasonic initially sold 100 CO₂ condensing units in Europe in 2017; this grew to a cumulative total of 300 in 2018, reaching 600 this past October. The company has sold 10,000 CO₂ condensing units in Japan through 2019, along with 30 in Southeast Asia and 30 in Australia.

Shimada attributed the success of the CO₂ units to several factors, including ease of installation and reliability in high temperatures. "The most popular thing I hear from our installers is 'Gaku, this product is very, very easy to install,'" said Shimada. ■ DY

WOMEN IN NATURAL REFRIGERANTS



These 29 profiles reveal the extraordinary impact women are having in the male-dominated natural refrigerants industry.

— By Michael Garry, Tine Stausholm, Ilana Koegelenberg and Devin Yoshimoto



One thing that all of the HVAC&R trade shows around the world have in common is that the vast majority of attendees are men, reflecting the male domination of the cooling and heating industry.

But there are signs that women, by dint of their smarts, determination and grace, are becoming a powerful force in the industry.

Last year, the United Nations Environment Programme published a document, "Women in the Refrigeration and Air-conditioning Industry: Personal Experiences and Achievements," that contains more than 100 self-written profiles of female engineers, technicians, teachers and others working in HVAC&R throughout the world (<https://bit.ly/2s2wwty>). It's a powerful testament to the contributions women are making.

Inspired by these stories, *Accelerate Magazine* decided to profile 29 women in North America, Europe, Africa, Asia-Pacific and Australia who are making a difference in the natural refrigerants sector of the industry. These women are serving a number of roles – from design engineer and sales manager to project coordinator and energy consultant – for a wide spectrum of organizations, including manufacturers, end users, NGOs and trade associations.

We asked each woman to explain how they got involved with natural refrigerant systems, and to describe the work they have done and are doing with this technology. We also asked them to talk about the challenges associated with being a woman in a male-dominated field, and how they overcome them.

What you will find in reading these profiles is that the women – each in her own way – are advancing the global adoption of natural refrigerants. They are in many cases enabling this technology to gain a visibility and prominence it may not otherwise have attained. And they are doing this despite the obstacles and stereotypes that confront women in this field.

We hope these profiles will demonstrate the important role women are playing in the natural refrigerants marketplace – and inspire women and men to follow in their footsteps. ■ MG



DANIELLE WRIGHT

Executive Director,
North American Sustainable
Refrigeration Council (NASRC), U.S.

Key NatRef Accomplishment:
Gaining widespread support from the
food retail industry for NASRC.

Danielle Wright recalls exactly when she decided to get involved in promoting natural refrigerants in North America. It happened when she attended a workshop facilitated by Keilly Witman, a refrigerant management consultant who was the founding manager of the U.S. Environmental Protection Agency's GreenChill Partnership. (See page 31.)

"One presentation from her and I was hooked," said Wright.

That workshop would lead to the creation in September 2015 of the North American Sustainable Refrigeration Council (NASRC), a nonprofit of which Wright is Executive Director. NASRC is focused on removing the barriers to natural refrigerant adoption in the supermarket sector.

Prior to her role at NASRC, Wright oversaw the EnergySmart Grocer program, a third-party energy-efficiency program for the grocery sector in the Northern California (U.S.) territory served by the Pacific Gas & Electric (PG&E) utility.

"What I've always loved about working with the grocery sector is that any environmental initiative has to make good business sense," she said.

As the executive director of NASRC since March 2017, Wright, based in Mill Valley, California, aims to "remove the major pain points that are preventing grocers from choosing natural refrigerants," she said.

NASRC's biggest accomplishment "is gaining the support of all the major stakeholders in the [food retail] industry to drive forward action," she said. "Virtually every major supermarket chain across the country supports our efforts because they see this transition coming and understand the power of working together as a united force."

Wright acknowledged that "it takes a certain amount of grit" to work in the male-dominated retail refrigeration industry. "The biggest lesson I've learned is that by focusing too much on what others think, you are actually giving them the power to hold you back," she said. ■ MG



MORGAN SMITH

Manager of Programs & Operations,
North American Sustainable
Refrigeration Council (NASRC), U.S.

Key NatRef Accomplishment:
Partnering with utilities, leading industry
events, and accelerating training.

In April 2017, a global research initiative called Project Drawdown ranked refrigerant management as the No. 1 global climate-change mitigation solution.

That caught the attention of Morgan Smith, who managed landowner-outreach programs at the American Forest Foundation. The following January she joined the North American Sustainable Refrigeration Council (NASRC) as a project manager to help the nonprofit's work on advancing natural refrigerant adoption in the food retail industry.

"When I learned that refrigerant management was listed as the number-one global solution to climate change in Project Drawdown, I felt even more compelled to

contribute to NASRC's work," said Smith, now Manager of Programs & Operations at the NASRC.

Smith is engaged in such NASRC activities as partnering with utilities and other financing entities to deploy incentive programs; leading industry events and workshops; and accelerating training for contractors and service technicians.

Smith regards being a woman in a male-dominated field as an opportunity to bring a fresh perspective to the industry. "Advancing natural refrigerants is not easy, nor can it be accomplished alone," she said. "Having more perspectives represented increases our chances for success." ■ MG



KEILLY WITMAN

Director, Refrigerant Management and Sustainability, H-E-B, U.S.

Key NatRef Accomplishment: Creating a successful partnership between U.S. food retailers and the EPA via the GreenChill program; founding the North American Sustainable Refrigeration Council.

Before Keilly Witman became the first manager of the U.S. Environmental Protection Agency's (EPA's) GreenChill Partnership in 2007, the EPA had played a largely regulatory role in the U.S. supermarket industry.

But the aim of GreenChill was to offer food retailers an opportunity to voluntarily work with the EPA to reduce their leaks and consider alternative systems that use natural refrigerants. Witman became known as the "friendly face" of the EPA.

By the time Witman left the EPA five years later, GreenChill was a thriving program with the participation of a wide range of food retailers encompassing thousands of supermarkets. Many GreenChill retailers began installing systems that use natural refrigerants like CO₂ and hydrocarbons, which became a fast-track to the platinum-level award in the GreenChill store certification program that Witman created.

"It seemed obvious to me [at the EPA] that natural refrigerants were the answer to our industry's slow, stair-step approach of replacing one really bad refrigerant with a slightly less bad refrigerant," said Witman.

After leaving the EPA, Witman started her own consulting business, KW Refrigerant Management Strategy. She separately founded the North American Sustainable Refrigeration Council ([see page 30](#)) to overcome the hurdles that are standing in the way of broader adoption of natural refrigerants.

This past July, Witman joined H-E-B, a major regional food retailer in Texas (U.S.), as Director, Refrigerant Management and Sustainability. "We are probably most bullish about the use of propane self-contained cases, due to the energy efficiency of propane and the ability to use them to convert existing stores to natural refrigerants gradually," she said. ■ MG



LOIS STIREWALT

Natural Refrigeration Advocate and Workforce Development Program Director, RETA and GCCA, U.S.

Key NatRef Accomplishment: Recruiting former military personnel as refrigeration technicians, and helping to start a Women in Natural Refrigeration group.

When Lois Stirewalt applied to be Executive Director of the Ammonia Refrigeration Foundation (ARF) in 2016, she acknowledged that she knew nothing about natural refrigeration – but was willing and able to learn.

She got the job at ARF, and found she was fascinated by natural refrigeration. "It is something real. It is important. It is how we feed people and it is green," she said.

In her current role as Natural Refrigeration Advocate and Workforce Development Program Director for the Refrigerating Engineers & Technicians Association (RETA) and the Global Cold Chain Alliance (GCCA), Stirewalt has helped establish #REDWHITEandCOOL. This is a national initiative within the newly established RETA-Training Institute to recruit, train and hire transitioning military personnel for the natural refrigeration industry;

a test program will launch in 2020. "Our transitioning men and women in the armed forces have the skills and character that we are searching for in natural refrigeration," she said.

She has also helped organize within RETA a networking group for women called WiNR (Women in Natural Refrigeration), which held its first breakfast at RETA's conference in Texas in November 2018. WiNR is now a program/affinity group within the RETA-Training Institute, with plans to hold networking events at other trade shows.

WiNR is supporting the efforts and accomplishments of women in the natural refrigeration industry. "There are a great number of women who own their own businesses," noted Stirewalt. The group is encouraging an Alaskan female technician to become "the first woman ever" to become a RETA-Authorized Instructor (RAI). ■ MG



ALI WHITE

Energy Consultant,
Efficiency Vermont (U.S.), Vermont
Energy Investment Corp. (VEIC)

Key NatRef Accomplishment:
Securing utility incentive funding for
natural refrigerant installations.

Ali White's "North Star" has always been, "Where can I make the biggest impact?"

That credo has brought her to supporting the uptake of natural refrigerants as Energy Consultant for Efficiency Vermont (U.S.), an efficiency utility under the auspices of Vermont Energy Investment Corp. (VEIC).

"Both for my customers and for the planet. I am so grateful that it led me to NatRefs and the passionate, brilliant, dedicated people that I work alongside every day," she said.

Over the past two years, White has been instrumental in bringing a number of natural refrigeration installations to Vermont and Washington, D.C., and now to Delaware (U.S.). Her work has included securing utility incentive funding, incorporating energy efficiency improvements, calculating energy savings, conducting measurement and verification, and engaging with contractors and manufacturers.

White has also delivered natural refrigerant education to her "small but mighty state." In 2018, she worked with the North American Sustainable Refrigeration Council (see page 30) to co-host a Natural Refrigerant Workshop in Burlington, Vermont; in 2019 she coordinated with Refrigeration Service Engineers Society (RSES) to bring propane (R290) certification training to Vermont contractors.

And she's working with several manufacturers in Canada and Europe to remove barriers to bringing CO₂ condensing units into the U.S. market.

White acknowledges that there are "socially engrained stereotypes" about women that could cause people she meets to initially doubt her abilities. "Over time, I have trained myself to not take it personally. Instead, I engage and work to build relationships with folks; most of the time, preconceived notions dissolve fairly quickly." ■ MG

Lidia Perez was ranked top-five in her class at the Instituto Politecnico Nacional (National Polytechnic Institute of Mexico) in Mexico City – one of the largest public universities in Mexico – where she studied mechanical engineering and specialized in thermodynamics. She has continued to excel in her professional career, which includes 15 years in the refrigeration industry.

She has spent the past eight years at Kysor Warren (now Kysor Warren Epta U.S.) in Columbus, Georgia, working on natural refrigerant systems.

Perez participated in the design of one of the first cascade NH₃/CO₂ refrigeration systems used by a U.S. supermarket (a Piggly Wiggly store in Columbus, Georgia), and has helped in the design of the majority of the transcritical systems that Kysor Warren has manufactured.

She was also part of the team that designed the first CO₂ transcritical system for a supermarket (Casa Ley) in Mexico. "On this project I was one of the Kysor Warren presenters giving training to the installation, service and engineering teams," she said.

Last year, Kysor Warren Epta U.S. launched the CO₂ transcritical system with FTE (Full Transcritical Efficiency) for the North American market. Perez participated in the integration of the FTE technology into Kysor Warren's transcritical system design.

As a woman, Perez feels comfortable in the refrigeration field because of "my passion and positive attitude," she said. "I regularly try to go the extra mile on the work that I do by expanding my programming skills and applying them in the design processes. This extra mile has been greatly appreciated by my colleagues." ■ MG



LIDIA PEREZ

Mechanical Engineer IV,
Kysor Warren Epta U.S.

Key NatRef Accomplishment:
Participated in the design of the majority of the transcritical CO₂ systems manufactured by Kysor Warren.

When Omarly Acevedo entered the Technological University Of Pereira, in Pereira, Colombia, in 1997, she decided to study mechanical engineering, even though her family and friends warned her that it was a career for men. "That motivated me more to want to study it," she said. "This became a challenge."

It turned out to be the right decision, as Acevedo graduated with an honorable mention as one of the best in her class. She developed a particular interest in thermodynamics as well as refrigeration and air conditioning. She later earned a master's degree in mechanical engineering at the same university, writing her thesis on replacing R22 in commercial and industrial refrigeration and air conditioning.

Helping Colombia and other Latin American countries transition from R22 and HFCs to natural refrigerants,

particularly hydrocarbons, has been one of the primary focuses of Acevedo's career.

She is currently an International Consultant for the Montreal Protocol, implementing projects using low- or zero-GWP alternatives for refrigeration and air conditioning, and advising end users in the application of this technology. She also trains technicians in the safe handling of flammable refrigerants, and implements a certification program for technicians in the refrigeration and air conditioning sector.

Her clients include the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO) and the United Nations Development Program (UNDP).

"This is a sector where men predominate, but I want to tell my women colleagues that with passion and preparation, everything can be done," she said. ■ MG



OMARLY ACEVEDO

International Consultant,
Montreal Protocol, Colombia

Key NatRef Accomplishment:
Helping Latin American countries transition to natural refrigerants.



JENNIFER MONTEE

Project Developer,
Stellar, U.S.

Key NatRef Accomplishment:
Converting industrial refrigeration systems from freon to ammonia.

After almost a decade as an ammonia-focused refrigeration engineer, Jennifer Montee remembers the feeling she had completing one of her first major projects, the conversion of a system from freon to ammonia for a prominent dairy facility.

"I'll never forget being on site at 10 pm on a Friday to see the compressors fire up for the first time," she said. "Witnessing a system that I designed come to life was such a rewarding experience — and that still hasn't gotten old."

Now a California (U.S.)-based Project Developer for contractor Stellar, Montee continues to help industrial operators convert from freon to ammonia.

A recent job for alcoholic-beverage producer Constellation Brands involved converting four freon systems into one ammonia system, designed to be "more efficient and easier to maintain," she

said. "Replacing four systems in four different parts of the plant and tying them together is certainly a challenge, but it's a prime example of how we analyze what a client's goals are and find the optimal way to achieve them."

Prior to joining Stellar last year, one of Montee's positions was working in compliance for a PSM (process safety management) company (Resource Compliance, Inc.) "It made me look at things from a safety point of view rather than a purely functional view," she said.

Her advice to younger women breaking into the HVAC&R industry is to get hands-on experience outside of the office, and in the field, roles historically reserved for men. "Be bold and ask to take on some of those projects," she said. "If that doesn't work, perhaps it's time to move in another direction with a different company." ■ MG



AVIPSA MAHAPATRA

Climate Campaign Lead,
Environmental Investigation Agency, U.S.

Key NatRef Accomplishment: Exposing illegal production and trade in climate-damaging refrigerants, and working on modernizing obsolete safety standards.

Like Swedish teenage climate activist Greta Thunberg, Avipsa Mahapatra started as an enviro-activist in her teens.

"I represented young people at the UN climate talks, where it was clear that despite a climate emergency, decarbonizing our economy would take a long time," she said.

She joined the Environmental Investigation Agency's U.S. office in Washington, D.C., in 2012 "to rid the world of HFCs, as I view it as low-hanging fruit to buy us the time and climate space needed for large-scale global climate action."

As the EIA's Climate Campaign Lead, she spearheads an effort that includes exposing illegal production and trade in

climate-damaging refrigerants, working on modernizing obsolete safety standards and making a business case for natural refrigerants. She advocates for the use of sustainable cooling globally, from the U.S. to China and India.

Mahapatra works on overcoming bias by not hesitating to "speak up and fully participate, without worrying about trying to 'fit in,'" she said. "I've found that trusting my instincts, regardless of the mainstream view, is vital to enacting change over time."

Whether it is through encouraging diverse speakers at events and conferences, or not letting a female speaker be interrupted in a meeting, "I try my best to do my part in facilitating increased inclusiveness," she said. ■ MG



CHRISTINA STARR

Climate Policy Analyst,
Environmental Investigation Agency, U.S.

Key NatRef Accomplishment: Working with sub-national actors on HFC reduction.

As someone who wants to do something about climate change, Christina Starr was drawn to working on the phase down of HFCs "because of the opportunity it presents to avoid over half a degree Celsius of warming."

In her job as Climate Policy Analyst for the U.S. office of the Environmental Investigation Agency (EIA) in Washington, D.C., Starr focuses on research, policy analysis, and advocacy to support the phase down of HFCs and promote climate-friendly technologies like natural refrigerants, both internationally under the Montreal Protocol and domestically in the U.S.

As the leader of EIA's U.S. efforts, Starr has spent a lot of time over the past few years working with "sub-national actors," who are "playing a bigger and bigger role in continuing to reduce HFC emissions,

even in the absence of support from the federal government," she said. These entities include states and cities as well as companies like supermarkets.

In 2019, EIA launched a web platform called climatefriendlysupermarkets.org to highlight leadership by supermarkets on reducing HFCs. "We are also working [with them] to advance policies focused on improved refrigerant management and increasing recovery, reclamation and destruction of refrigerants at end-of-life," she said.

Starr's team at EIA consists mostly of women ([see Avipsa Mahapatra profile on this page](#)) and she has female role models in government as well as on the industry side. There are still challenges, but she thinks the key is "for women to expect and demand to be taken as seriously and respected as much as any man." ■ MG

EUROPE



VERONICA RIBAS IGNELZI

R&D Senior Manager,
Nidec Global Appliances, Slovakia

Key NatRef Accomplishment: Managing Nidec's compressor engineering R&D department, developing propane products.

"Doing something difficult and challenging fulfills me," said Veronica Ribas Ignelzi, who described engineering and technology as "difficult" yet "fantastic" at the same time. "To contribute to improving engineering and technology is to contribute to a better condition of life, and hopefully to a better world."

Ignelzi, who holds a Master's degree in mechanical engineering, with an undergraduate degree in electrical engineering, has worked for Nidec (and previously Embraco, now owned by Nidec) for nearly six years. She used to lead the Condensing Units Engineering Department, but now works as an R&D Senior Manager in the Compressor Engineering Division.

In both roles, she has had direct contact with natural refrigerants, as Nidec Global Appliance is actively moving in this direction by developing products that are

an alternative to those using high-GWP refrigerants, she explained. "In commercial applications, we are implementing a whole portfolio of models available with propane (R290)."

There are a number of challenges to being a woman in her position, according to Ignelzi. "Women may have to work harder than men in their engineering careers to be considered as competent as their male counterparts," she said. "Women sometimes receive less credit than men for doing the same work. There is also the family vs. career challenge that I believe is stronger for women."

When it comes to overcoming these challenges, Ignelzi believes that it is a process of understanding oneself and being honest with one's strengths and weaknesses. "No one is superwoman and understanding your limitations is a huge step to overcoming any challenge." ■ IK



MIRIAM SOLANA CIPRÉS

HVAC&R Engineer,
Carel, Italy

Key NatRef Accomplishment: Presenting, lobbying and training in support of natural refrigerants.

When Miriam Solana Ciprés witnessed the signing of the Kigali Amendment to the Montreal Protocol from her office in the U.S. in October 2016, it solidified her commitment to helping reduce greenhouse gas emissions via the phase out of HFCs and the adoption of natural refrigerants.

Solana Ciprés, who has a PhD in chemical engineering, had already joined Italian refrigeration manufacturer Carel in February 2016 as an HVAC&R Engineer for its HVAC/R Knowledge Center. In this capacity she is responsible for tracking refrigerant and energy-efficiency regulations and trends for the company, which makes controls, valves and other components for CO₂ and hydrocarbon systems.

Her work involves lobbying, training, and – what she enjoys most – the dissemination of knowledge. She has taken part in conferences and exhibitions around the

world, speaking about the use of natural refrigerants.

Solana Ciprés' first contact with CO₂ was not as a refrigerant, but rather as a fluid used to extract natural compounds from food – the subject of her PhD thesis.

She considers herself lucky to work with colleagues that have, since the beginning, appreciated her skills and work. "However, I would be lying if I said that nobody has ever made me feel different, solely by being a woman in a male-dominated field," she acknowledged. "In some contexts, it seems that you have to prove more than men to be taken into consideration."

"To overcome these challenges, it is important not to be afraid to fail, but rather to take every opportunity to try to do our best and demonstrate that our contribution is fundamental," she said.

■ IK



CELINE PEREZ

Commercial Manager
CTA, France

Key NatRef Accomplishment: Helping CTA sell more than 500 propane chillers to the European market, developing a propane heat pump range.

When French engineer Céline Perez worked in the R&D department at Dutch chemical company Dow Chemical in 2008-2009, she took an interest in chillers, which was one of the main causes of energy consumption and maintenance at the company.

In 2014, she got to combine that interest with her interest in green technology when she became Commercial Manager of French HVAC&R manufacturer CTA, a company that has produced natural refrigerant chillers for the Northern European market since 2007. Since her arrival, CTA has sold more than 500 propane (R290) chillers to the European market.

Perez has taken CTA's propane offerings further. "I clearly understood that propane had a cooling capacity as

good as R22 and that it was really easy to source," Perez said. "I decided to put all of my energy and time into a full-range development."

The result is that CTA has just launched a full propane heat pump range from 1.4 to 171TR (5 to 600kW), all of which comes with artificial intelligence (AI) controllers, as Perez believes that data-driven products are the future.

As for being a woman in HVAC&R, "It is hard but I like the challenge," Perez said. "I am sure that women are needed in this market because we have a different way of thinking. I would like to imagine that if you succeed in a male-dominated field, that means that you have something interesting to share." ■ TS

Franziska Menten learned about natural refrigerants at shecco (publisher of *Accelerate Magazine*), where she worked for five years with technology suppliers from around the globe that offer natural refrigerant-based solutions.

Three years ago, Menten joined the Montreal Protocol Division at the United Nations Industrial Development Organization (UNIDO) in Austria as Project Coordinator. In this role, she works with the governments of developing countries "to get the latest and most environmentally friendly solutions in their transition away from HCFCs and HFCs," she said.

One of the projects Menten is particularly pleased with is the installation of the Middle East's first transcritical CO₂ system in Amman, Jordan; the system includes multi-ejector technology and parallel compression. "The super-market owner and suppliers are very satisfied with the results of higher energy

efficiency, no food waste and extremely low maintenance costs," she said.

Menten is also working on a project to improve the food cold chain in the Philippines, with a focus on energy-efficient alternatives that incorporate natural refrigerants. In addition, she and her team just finished a project in The Gambia where "we trained 'super technicians' in the safe handling of hydrocarbon refrigerants and installed 200 R290 split AC units."

On the question of being a woman in a male-dominated field, Menten said, "The challenge is to be taken seriously and to be heard. It might be intimidating at first but this should not prevent any girl or woman from joining this exciting and very important field." She added, "I love my profession because I work with so many dedicated and inspiring women and men. We can bring innovation to developing countries and save the environment at the same time." ■ TS



FRANZISKA MENTEN

Project Coordinator,
Montreal Protocol Division,
UNIDO, Austria

Key NatRef Accomplishment: Bringing natural refrigerant technologies to developing countries.

Linda McVittie did not have a childhood dream of becoming an engineer, but instead chose to study business and languages. This paved her way into the refrigeration industry when she took a job as an export coordinator with Hussmann Craig-Nicol, a U.K. manufacturer of refrigerated display cases.

While employed at Hussmann Craig-Nicol, McVittie developed a keen interest in refrigeration, and ended up going back to school during the 1990s. She earned an engineering degree while still working four days a week and raising two young sons. She became a Chartered Engineer in 2004.

Her career includes 18 years with Star Refrigeration, where she sold bespoke refrigerant solutions; in 2013 she began working as a sales manager for Scotland at J&E Hall International.

During her career, McVittie has helped design, sell and install numerous ammonia refrigeration systems ranging from 57TR to 341TR (200kW to 1.2kW).

McVittie has "extolled the virtues" of natural refrigerants for many years, and now sees the EU F-Gas Regulation as "the biggest opportunity to promote the efficiency of these gases as the best refrigerants for refrigeration plants."

McVittie acknowledges that refrigeration has historically been a male-dominated industry, "But I wish I had known that it was an industry open or joining, whether male or female," she said. "The reality is that it is a very friendly industry where, if you are willing to apply yourself, you are supported and encouraged to learn."

"I would definitely encourage other women to come into this business," she added. "There are plenty of opportunities." ■ TS



LINDA MCVITTIE

Sales Manager for Scotland,
J&E Hall International

Key NatRef Accomplishment: Helped design, sell and install numerous ammonia refrigeration systems.



NINA STAN

Technical Director and Co-Owner,
Dar Food Solutions, Romania

Key NatRef Accomplishment:
Ammonia expertise, developing reefer containers that will use propane.

Romanian engineer Nina Stan has a special fondness for ammonia as a refrigerant. It's a love affair that began when she worked for a milk industrialization company from 1989 to 1997 – her first job – maintaining five large ammonia refrigeration systems.

In 1997, Stan changed track and became a service provider, rather than a client, working for a company where she designed, commissioned and installed refrigeration systems. She credits her success in this role to already knowing what clients wanted from such services, having herself been one.

In 2014, Stan decided it was time to start her own company, Dar Food Solutions, which includes an ecommerce site, www.frigmania.com; it provides commercial and industrial refrigeration systems as well as refrigerated containers (reefers). As Technical Director, she is involved in design and project management.

Since 2015, the company has been developing its own equipment, especially reefers, and is planning to equip them with propane units in the near future. She is also an active member of the General Association of Romanian Refrigeration Engineers.

Stan has countless examples of situations where she has been treated as subordinate to male colleagues, such as being asked to transfer calls to a man when clients bring up technical details. However, these prejudices and stereotypes amuse Stan rather than frustrate her.

"I can say, without being accused of a lack of modesty, that I am a good engineer," she said, "It really amuses me when I see a preconceived approach because I know I'll break it in a few seconds." ■ TS



RITA TEDESCO

Program Manager
ECOS, Belgium

Key NatRef Accomplishment: Working to reduce the barriers posed by standards to the uptake of natural refrigerants.

One of the key obstacles to the adoption of natural refrigerants is the use of outdated standards that don't reflect advances in natural refrigerant technology. Trying to overcome that obstacle is ECOS, a Brussels-based NGO that promotes environmental and climate interests in standardization and technical policies, both in Europe and globally.

"We want to reduce the barriers posed by standards to the uptake of natural refrigerants and ensure that standards support, not undermine, ambitious international and European policy efforts," explained Rita Tedesco Program Manager for ECOS.

ECOS and its national member organizations have been promoting natural refrigerants as climate-friendly alternatives to high-GWP options for more than seven years. "Together with our work on

energy systems, energy efficiency and circular economies, we want to improve the overall environmental performance of the heating and cooling sector," said Tedesco.

HVAC&R is an extremely male-dominated sector, especially in the standardization process, she noted. "In my case, the challenges of being a woman add to the ones of being a young professional representing environmental civil society in standardization, exactly the opposite of the typical standardizer."

This often translates into not being taken seriously by older, mostly male, industry representatives, she said. "The key to overcome this is to continue to show positive assertiveness and to believe in the added-value of one's work and the benefits for the climate." ■ IK



MONIKA WITT

Managing Director, TH. WITT GmbH,
Germany;
Chairperson, eurammon

Key NatRef Accomplishment: Leading eurammon, producing natural refrigerant components.

Monika Witt deals with natural refrigerants in both her family business, TH. WITT GmbH, and as chairperson for more than a decade of the German non-profit eurammon.

eurammon's mission is knowledge sharing about natural refrigerants, targeted at industry, politicians and the public, as well as technical consulting. "We support natural refrigerants wherever we can, as we consider it the only sustainable choice in the long term," she said.

Witt studied mechanical engineering with a focus on process engineering. She initially built air-separation systems as a project engineer, and then joined TH. WITT GmbH in 1996, taking over as Managing Director in 1998.

The company produces components for the industrial refrigeration industry,

such as refrigerant pumps, high-side float regulators, pressure-vessel units and more. "Natural refrigerants have always been the first choice at WITT, particularly ammonia, but also CO₂ and, in some cases, propane," said Witt. "I think we were the first to promote CO₂ refrigerant pumps back in 1996 and to offer entire cascade systems with ammonia/CO₂."

When it comes to being a woman in natural refrigerants, Witt sees more advantages than challenges. "When men recognize that women have a good understanding of what they are doing, they are very supportive," she said. "I have never really had bad experiences. Some men think they can pay less for a capable, educated woman, but then the woman should be strong enough to insist on equal pay." ■ IK



HAYLEY CATTELL

Northern Regional Sales Manager,
HRP (Beijer Ref), U.K.

Key NatRef Accomplishment:

Introducing the SCM Frigo
Cubo2Smart CO₂ condensing unit
into the U.K. and Ireland markets.

The Cubo2Smart CO₂ condensing unit by Italian system manufacturer SCM Frigo (parent company of Beijer Ref) won "Refrigeration Product of the Year" at the U.K.'s National ACR & Heat Pump Awards in 2019.

It was Hayley Cattell (formerly Billson), then Group Product Manager for Beijer Ref U.K. and Ireland, who introduced the Cubo2Smart CO₂ condensing unit into the U.K. and Ireland markets.

"This was the most exciting and rewarding project within my career to date," she said. "Since the initial launch in March 2018, the biggest task over the following 18-month period was dispelling any negativity surrounding the use of natural refrigerants."

Cattell started her career in the HVAC&R industry in 2011 as a Trainee Sales Engineer at Beijer Ref for the North of England. Her first milestone was gaining

National Vocational Qualification (NVQ) levels one and two in small commercial refrigeration that year. Over time, she progressed into branch management and later sales management, which included employing and coaching trainee sales engineers.

After successfully launching the Cubo2 Smart CO₂ condensing unit range, she returned to sales management as Northern Regional Sales Manager for Beijer Ref (represented by HRP in the U.K.), but continued to oversee the development of CO₂ products.

Being a woman in a male-dominated industry has not been an issue for Cattell. "Beijer Ref is a very modern company that actively promotes and supports women in industry," she said. The only real challenge has been moving refrigerant cylinders around during training, "which I soon overcame after a few gym sessions!" ■ IK



ŽELJKA VUKOVIĆ

Director,
Soko Engineering, Serbia

Key NatRef Accomplishment: Pioneering natural refrigeration projects in Serbia.

Mechanical engineer Željka Vuković has helped bring natural refrigerants to Serbia in the commercial and industrial sectors.

At Soko Engineering, where Vuković is now Director, she was involved in developing a cascade cooling system with R134a in the upper cascade and CO₂ in the lower cascade. Following that, she designed an ammonia refrigeration system for a distribution center with 236,806ft² (22,000m²) of refrigerated space.

"From the point of view of environmental protection, energy efficiency and investment value as an optimal solution, we chose an ammonia refrigeration system in cooperation with the investor," she said in a profile for "Women in the Refrigeration and Air-conditioning

Industry: Personal Experiences and Achievements," published last year by the United Nations Environment Programme. "After a long period of several decades, these were the first major projects in Serbia to involve ammonia refrigeration systems."

Last year, she helped Soko Engineering design its first three transcritical CO₂ cooling systems for supermarkets (the fourth is due for completion in January).

"At first, this job seemed like a man's job to me," Vuković said, "especially when you consider the noisy compressors in compressor rooms and the leakage of refrigerants; not to mention ammonia's strong odor. Today, I think this is a nice job for a woman because it allows us to do something good for the environment."

■ IK



CLARE PERRY

Climate Campaigns Leader,
Environmental Investigation Agency, U.K.



SOPHIE GEOGHEGAN

Climate Campaigner
Environmental Investigation Agency, U.K.

Key NatRef Accomplishments:

Advocating for natural refrigerants in the supermarket sector, and launching the Cool Technologies website.

The Environmental Investigation Agency (EIA), an NGO investigating and campaigning against environmental crime and abuse on four continents, has many committed women on their team. Two of them, based in the U.K., are Clare Perry and Sophie Geoghegan, both working on EIA's campaign to protect the ozone layer and promote natural refrigerants.

Perry has worked for EIA since 1998. With a degree in biology, she initially focused on ocean conservation issues, but since 2007 she's been the manager of the organization's ozone campaign. Geoghegan joined EIA two years ago, coming from a background in international development, and having previously worked for a renewable energy company.

Perry and Geoghegan work with stakeholders around the world on new legislation and business action to accelerate the move away from HFCs and towards energy efficiency and sustainable cooling.

A particular focus area for the EIA is the promotion of natural refrigerants in commercial refrigeration "where refrigerants like CO₂ and propane work very well," said Perry. As part of this, EIA works very closely with the supermarket sector, including the Consumer Goods Forum. Since 2008, the NGO has published a series of "Chilling Facts" reports documenting the use of HFCs and climate-friendly alternatives in European supermarkets.

To carry out her work, Perry travels a lot, attending meetings on the Montreal Protocol and the EU F-Gas Regulation, where she advocates for policies that can "ensure a level playing field for natural refrigerants," something that has not always been the case in the past, she said.

She is also a regular speaker at ATMOsphere conferences, having presented EIA's work at ATMOsphere Europe in 2018 and 2019. (ATMOsphere conferences are organized by shecco, publisher of *Accelerate Magazine*.)

Geoghegan engages with the HVAC&R industry to track progress on the uptake of natural refrigerants, identify barriers to this progress, and determine how these barriers can be overcome. A recent result of this work is the re-launch of the Cool Technologies website, (<https://cooltechnologies.org>), where EIA showcases HFC-free cooling alternatives in use around the globe. The website was hacked, and had to be taken off-line, in 2018, but is now back with a new and improved version.

Perry does not believe that being a woman has been a challenge in her work for EIA. "My major challenge has always been the level of technical know-how required to understand the application of the various different technologies," she said.

Geoghegan does not entirely agree. She calls the panels at various industry events "manels," and thinks the lack of diversity means that "new voices are not being heard and the industry remains stuck in the past."

"We are in a climate crisis and the cooling sector has a large role to play in avoiding the dire consequences of this, but it will require some thinking outside the box, for which we need all voices and ideas to be heard," Geoghegan said. ■ TS

AFRICA

"My passion to change the world was fueled by the fact that I would be working with natural refrigerants and would thus make a positive impact," said Samantha Bothma about getting into the HVAC&R industry. "Not only by using natural refrigerants, but also by the efficiencies of using CO₂."

Bothma (previously Ayres) started her career in the petrochemical industry after receiving a scholarship from Sasol, a South African energy and chemical company, to study mechanical engineering. She worked for Sasol for three years before being contacted about a position at South African manufacturer CRS (Sphere) in the refrigeration industry as a design engineer. "I always wanted to have a career involving thermodynamics and heat transfer, and so I jumped at the opportunity."

She has predominantly worked with CO₂ and has been involved in the design of transcritical CO₂ booster systems, heat pumps and chillers. She is currently working on industrial projects, taking CO₂ to the rest of the world as well as to areas where it has not been used before in South Africa.

Being a woman in HVAC&R is difficult at first because it always feels like you have to prove yourself, Bothma said. "But having a drive to learn anything and everything you can, and respecting people in all fields, allows them to open up and to help you," she advised. "There will always be people that believe you cannot do it, but it is up to you to prove them wrong."

"Always stay true to yourself and stand up for what you believe in," she added. "Just because you are a woman does not mean you have to be a pushover." ■ IK



SAMANTHA BOTHMA

Design Engineer,
CRS (Sphere), South Africa

Key NatRef Accomplishment: Designing transcritical CO₂ booster systems, heat pumps and chillers for the global market.



LAUREN GROENEWALD

Industrial Refrigeration Solutions Engineer,
Johnson Controls, South Africa

Key NatRef Accomplishment: Designing an industrial CO₂ liquefaction system and a brine chiller system, both using ammonia refrigeration.

Lauren Groenewald started her career as a process engineer at a South African mine before transitioning into the HVAC&R industry as a designer of heat exchangers and cooling towers for a small company in Johannesburg, South Africa.

For the past five years, she has been working at Johnson Controls where she gets to design industrial systems.

One of her notable projects has been a CO₂ liquefaction system for one of the world's largest gas manufacturers, using ammonia as the refrigerant to cool the CO₂ from a gas to a liquid. Another is a brine chiller system for South Africa's largest fertilizer manufacturer, with

ammonia used to chill to two different temperatures. Both projects were handled from the design phase through to successful commissioning.

When Groenewald was a young engineer at the start of her career, she often felt "marginalized and discriminated against," she said. "It was a few years into my career that I realized I did not need to act like a man to gain respect, but rather that my femininity was my greatest strength."

She quoted author William Golding: "I think women are foolish to pretend they are equal to men; they are far superior and always have been." ■ IK



LILI DU

Overseas Sales Director, Panasonic Appliances Refrigeration System Dalian, China

Key NatRef Accomplishment: Led the team that installed and commissioned China's second transcritical CO₂ system.

"I was exposed to CO₂ [refrigeration] for the first time in 2008," said Li Li Du, Overseas Sales Director for Panasonic Appliances Refrigeration System (PAPRSDL), based in Dalian, China. "From then on I started studying NatRefs. I am now in charge of the spread of our company's new NatRef technology."

Du helped lead the team that installed and commissioned China's second transcritical CO₂ commercial refrigeration system (and the first state-owned system) at a CSF Market store in Beijing in July 2018.

"The system has been running very reliably, there have been no leaks and the customer is very satisfied with the energy savings," Du said last November during a presentation about the project. "Now that my team and I have

successfully completed the first state-owned CO₂ transcritical supermarket design and installation, we are devoted to CO₂ systems."

Du joined Panasonic after graduating with a Master's degree in refrigeration, and has worked there in refrigeration technology system research and design for the past 11 years.

In her work, Du sees little difference between women and men. "I love my job — CO₂ technology especially," she said. But when it comes to family, support is important. "I'm the mother of a seven-year old. I travel a lot for work and I have no time for my son. So my parents and husband give me a lot of support and it lets me work very happily." ■ DY



HERLIN HERLIANKA

Consultant, Energy Conservation and Renewable Energy Sector, Indonesia

Key NatRef Accomplishment: Providing technical support and creating training materials for the handling of flammable refrigerants.

Herlin Herlianka was introduced to natural refrigerants in 1996 while working on a Montreal Protocol implementation project phasing out R12 in Indonesia.

"They taught us how to replace R12 with blended propane/isobutane (R290/R600a)," said Herlianka. "Since then, I have believed that NatRefs are the most sustainable refrigerants because they exist in nature and are not harmful to the environment."

Herlianka's 20-plus years in Indonesia's HVAC&R industry spans a variety of roles, from lecturing on air conditioning at Bandung State Polytechnic Institute and starting her own RAC contracting business, to being the first woman elected President of ASHRAE's Indonesia chapter in 2015.

In recent years, Herlianka's work has focused on consulting, technician training, and standards development, especially for hydrocarbons. In 2015, Herlianka served as a technical expert for the Green Chillers NAMA (Nationally Appropriate Mitigation Action) R290 chiller project, for which she provided support in developing comprehensive flammable-refrigerant safe-handling training materials, certification schemes and training centers.

As a woman working in the HVAC&R industry, Herlianka said people doubted her competency in the past. "I overcame this situation by showing everybody that I could do the so-called men's jobs like welding and brazing better than a man could."

"I was taught by my parents to always be as strong as a man and that is what I am today," she said. ■ DY



TAKAKO MOMOI

Climate Campaigner
Kiko Network, Japan

Key NatRef Accomplishment: Advocating for natural refrigerants in Japan through government-policy proposals and public-awareness campaigns.

For Takako Momoi, the issue of ozone-layer depletion kick-started her career in climate and energy policy. "As a student, I began to engage in activities to stop atmospheric emissions of chlorofluorocarbons," she said.

Eight years after she helped launch Japan's Save the Ozone Network, the country established its "Fluorocarbon Recovery and Destruction Law."

The results, however, were unsatisfactory, said Momoi. "Despite fluorocarbon collection becoming mandatory, Japan's recovery rate remained stagnant and I grew to think that it was important to move away from fluorocarbons and towards natural refrigerants instead."

Today, Momoi is in charge of fluorocarbon-related activities at Kiko Network, a Kyoto, Japan-based environmental NGO, where she works on making HFC-reduction and pro-natural refrigerant

policy proposals to Japanese government officials, and increasing public awareness of natural refrigerants through pamphlets and an animated video series, "In search of an f-gas free world." The series highlights hydrocarbon use in air conditioning (<https://bit.ly/2SYaz9Y>) and CO₂ use in convenience stores (<https://bit.ly/2sRfTRJ>).

Momoi regards the male domination of Japan's HVAC&R industry as having a negative effect on the country's sustainable development. "From the remote standpoint of an environmental NGO, I feel like Japan's environmental policy and the industry's environmental objectives are decided on in the context of a seniority-based patriarchal society," she said.

"I believe that this distorts the true nature of environmental policy and inhibits change based on new ideas and value judgments stemming from a future-oriented, long-term perspective." ■ DY



RAQUEL F. DUMAYAS

RAC Servicing Trainer,
General Santos National School
of Arts and Trades, The Philippines

Key NatRef Accomplishment: Training and developing natural refrigerant-based refrigeration and air-conditioning course curricula in the Philippines.

In Raquel Dumayas' 15-plus-year career as a refrigeration and air-conditioning (RAC) trainer in the Philippines, technological change has been rapid and constant. "I have experienced the use of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs) and today, hydrocarbons (HCs) known as natural refrigerants," Dumayas said.

Dumayas is an instructor at the General Santos National School of Arts and Trades in the southern Philippine region of Mindanao, where she develops training curricula and promotes the use of natural refrigerants in RAC equipment such as hydrocarbon-based split air conditioners.

Dumayas is deeply motivated by a sense of responsibility, not only to the environment, but also to other women who see opportunities for themselves in the RAC industry.

"While I was considering the topic of my [Master's] dissertation, I was especially driven to inspire and motivate women wishing to work in this field and I considered some of the difficulties women might encounter in this kind of career," Dumayas said in "Women in the Refrigeration and Air-conditioning Industry: Personal Experiences and Achievements," published last year by the United Nations Environment Programme.

While obtaining her Master's degree in Vocational Education, Dumayas proposed, successfully invented, and patented a new type of "snap-on hand type pinch-off tool" used to make pinching operations requiring tight seal pressure easier for women.

"I finished my Master's degree with a deep sense of fulfillment, knowing that in one way or another, in pursuing a career in the RAC industry, I had been able to inspire women," Dumayas said. ■ DY



LAURA GARBO

General Manager,
Arneg Oceania Pty Ltd, Australia

Key NatRef Accomplishment:
Supporting Australia's adoption of
commercial CO₂ refrigeration systems.

In 2007, Arneg supplied its first commercial transcritical CO₂ refrigeration system in Australia. Since that time, Australia's natural refrigerant culture has grown significantly, said Arneg Oceania's General Manager, Laura Garbo, who has been instrumental in that growth.

"I would say that 80% of low-temperature cabinets Arneg installed in the past few years have all been equipped for CO₂ applications," she said. "And we have seen a growing number of medium-temperature installations as well."

Independent retailers, in particular, have been very receptive to the new technology, Garbo said, "We have recently completed Michael's IGA Keysborough where all Arneg refrigeration is run by a fully transcritical CO₂ system, designed and installed by a local contractor, MB Refrigeration." (See page 62.)

While the adoption of CO₂ systems in Australia has progressed, Garbo said that safety standards have continued to hold back wider application of natural refrigerants in Australia. "At the international

level we have seen important steps taken, like the International Electrotechnical Commission's new charge limit for hydrocarbons; but the activity of regional standards groups has been very limited," she said.

As a woman, Garbo does not see an issue with being in Australia's largely male-dominated HVAC&R industry. "Refrigeration in Australia is managed nearly in its entirety by individuals that share a career, and therefore relationships are quite strong," she said. "Stereotypes and the lack of field experience are in my opinion more than counterbalanced by experience, academic knowledge and an open mind."

Garbo is also quick to acknowledge the support from her Arneg Oceania's team, especially the other female members. "I feel very fortunate to have technical teams around me, both in Australia and overseas," she said. "I am also glad to say that Arneg Oceania includes many exceptional women in the team, and each of them has contributed significantly to our incredible growth." ■ DY

THE WOMEN OF SHECCO

Since its inception as a market accelerator of natural refrigerants in 2007, shecco, based in Brussels, Belgium, has fielded a team of talented female employees in its media, events and market development divisions.

That tradition continues today, with the following women:

► **Pilar Aleu**, Business Development Manager, Europe and America

► **Caroline Rham**, Business Development Manager, Australia

► **Rena Okabe**, Sales & Marketing Deputy Manager, Japan; Editor of *Accelerate Japan*

► **Silvia Scaldaferri**, Partnership Coordinator

► **Florence Boivin**, Office Manager

► **Ilana Koegelenberg**, Deputy Manager, Market Development

► **Anna Salhofer**, Head of Design

► **Juliana Gómez**, Senior Graphic Designer

► **Tine Stausholm**, Associate Editor/ Europe

► **Pauline Bruge**, Project Coordinator, Market Development

► **Zita Laumen**, Market Analyst, Market Development

The women at shecco are all motivated to bring environmentally friendly cooling and heating solutions to the world, both to help companies improve their operations, and to contribute to solving the climate crisis.

"I am proud to contribute to making tomorrow a better world for the generations to follow!" said Rham, who joined shecco in 2017, and has been in the

HVAC&R industry since 2007. While previously working for gas supplier BOC, she helped launch CO₂ as a refrigerant in Australia and New Zealand.

Okabe, who started at shecco in 2015 as a writer and marketing assistant, sees the company contributing to environmental sustainability by advancing “not just eco-friendly solutions but energy-efficient and financially beneficial solutions that make sense business-wise as well.” Natural refrigerant technology, she added, “should be a part of the business plan for any HVAC&R industry stakeholder in order to survive and thrive in the future.”

Okabe hopes her work will help the acceleration of natural refrigerant technology “go faster” and will also “encourage all Japanese women to step up and make an impact with me in the HVAC&R industry.”

Koegelenberg joined shecco last September following nearly eight years as editor of South African trade publications *RACA Journal* and *Cold Link Africa*. Starting as Deputy Editor of *Accelerate Magazine*, she has transitioned to Deputy Manager for shecco’s Market Development division, while continuing to write for its media outlets.

“Working for shecco to help the uptake of natural refrigerants around the world is incredibly exciting,” said Koegelenberg, who plans to move to Brussels. “I used to always follow its various publications and stories from my office in South Africa and dreamed of one day being part of such a forward-thinking organization. And today that dream is a reality, and I am proud to be part of the team that will help the world accelerate towards a more sustainable future in HVAC&R.”

Koegelenberg replaced Klara Zolcer Skačanová, who left shecco in October after eight years at the company. “For me

it was important and rewarding to work in a field where one can contribute to a global change at such a crucial moment,” said Skačanová. “There are undoubtedly unprecedented opportunities to attract the younger generation, female and male, [to the HVAC&R industry] with the ongoing revolution towards future-proof low-carbon technologies.”

Nina Masson, who joined shecco in its first year, 2007, as its first female employee, spent a decade at the company in a variety of roles in market development and media, rising to become Chief Market Development Officer and a Co-Owner.

Building on her experience at shecco, Masson is now an independent consultant (Nina Masson Consulting) for international development projects, mainly focused on natural refrigerants and energy efficiency, as well as e-waste and ozone-depleting substances.

In her work for HEAT, a German sustainability consultancy, she is currently contributing to Refrigerants, Naturally! for LIFE, a European Union project – in which shecco is also a participant – to introduce natural refrigerants in small organic-food stores.

Masson also co-owns two companies. One, re-generate GmbH (www.re-generate.co), does projects on the potential of 3D printing in the HVAC&R industry. “Here I am currently involved in a project on defining use cases for miniature heat exchangers that could revolutionize HVAC&R applications in terms of flexibility,” she said.

The other is called Cyclic Design (www.cyclic.design), a design strategy company for sustainable packaging solutions, “where we developed an innovative shampoo bottle.” ■ MG



HANNAFORD PIONEERS TRANSCRITICAL CO₂ – AGAIN

The food retailer, which installed the first transcritical CO₂ system in a U.S. supermarket, is now deploying one of the first in a U.S. retail warehouse.

— By Michael Garry

Hannaford, a Scarborough, Maine (U.S.)-based division of Ahold Delhaize, has the distinction of installing the first transcritical CO₂ booster refrigeration in a U.S. supermarket, at a store in Turner, Maine, in July 2013.

Now, Hannaford is about to become one of the first U.S. grocers to employ a transcritical CO₂ system in a refrigerated warehouse. (The first known to do so was Angelo Caputo's Fresh Markets, which installed a transcritical system at a warehouse/commissary in Carol Stream, Illinois, U.S., also in July 2013; a store was later added to that facility; see ["In Love with CO₂," Accelerate America](#), June 2015.)

Hannaford's CO₂ warehouse, located in Shodack Landing, New York (U.S.) – 20 miles east of Albany, New York – also contains one of the world's largest refrigerated spaces (250,000ft²/23,226m²) to use a transcritical system, supplied by Quebec, Canada-based Carnot Refrigeration. The warehouse supplies 85 of Hannaford's approximately 190 stores in New York, New Hampshire, Vermont and Massachusetts.

Harrison Horning, Hannaford's Director of Energy & Facilities, who has overseen the installation of transcritical CO₂ systems at three Hannaford stores, including the first one in Turner, Maine, "helped steer us towards the [transcritical] system, probably four or five years ago," said Jim Baisley, Facility Manager at the Shodack Landing warehouse. "Then we just started talking with different manufacturers. And now it's coming to fruition."

Hannaford plans to complete the installation of the fourth and final transcritical rack, in what is a replacement of the warehouse's original, almost 30-year-old R22 system, by February 2020. Three of the racks are medium-temperature, two-stage, inter-cooled systems, while the low-temperature rack (the first installed) is single-stage, with ejector defrost.

All the racks use Bitzer compressors. Hannaford has two other warehouses – one dry, one refrigerated with ammonia – in Maine.

The timing is fortuitous; as of January 1, 2020, pure R22 can no longer be produced or imported into the U.S.

WHY CO₂?

Why did Hannaford opt for a CO₂ refrigeration at the warehouse, rather than one using ammonia, like its sister facility in Maine? One factor, which influenced the facility's original use of R22, is that the town of Shodack Landing doesn't like ammonia.

Another is that ammonia condensers generally need to be cooled by water, which is available to the facility in only limited quantities from wells, noted Baisley. "Air-cooling ammonia is just not all that feasible." The warehouse's transcritical system employs air-cooled gas coolers and evaporators, from Guentner.

The water limitation also precluded the use of an adiabatic gas cooler for the transcritical system, he noted, adding that "we hear less-than-positive things about the maintenance of adiabatic."

The CO₂ system "seemed to be the safer overall alternative," said Dave DeLong, director of distribution operations at the warehouse. Moreover, he added, the cost of the system wasn't too different from that of other systems, and the long-term costs looked attractive.

Transcritical CO₂ refrigeration is also part of Hannaford's involvement with the Environmental Protection Agency's voluntary GreenChill program, which supports leak reduction and the transition to environmentally friendly systems. "Environmentally, it's really hard to make any argument against CO₂ [refrigeration]," said Beasley.

Hannaford was sufficiently persuaded by the CO₂ system's "beneficial pieces" to install it at the Shodack Landing warehouse, said DeLong.

Still, noted Baisley, there are some "perceptions of CO₂" that can be problematic. "It operates at a higher pressure, so right away people become nervous of those numbers," he said. "But it's a relative number. Your forklift carries a lot more pressure just in the hydraulic system, and nobody's worried about that."

“

Environmentally, it's really hard to make any argument against CO₂ [refrigeration].

– Jim Baisley, Hannaford

”

Another issue, acknowledged DeLong, is the relative scarcity of technicians with CO₂ expertise, especially for a system as large and untested as the one at Shodack Landing. To address that, Hannaford has sent two of its in-house technicians for CO₂ training at the Industrial Refrigeration Technical College in Lyndhurst, Virginia (U.S.) while the rest will be trained at the warehouse by OEM Carnot, which has been "right there every step of the way," said Baisley. "One of the things that helped push us in this direction is their knowledge and their simple approach to it."

Mullally Bros., a Troy, New York (U.S.)-based contractor, which is the installer of the CO₂ equipment at the warehouse, has also been sending its technicians to school "to learn about the valves and controls," said Baisley.

Baisley himself toured some of Carnot's transcritical CO₂ projects in Quebec, including a cranberry plant and a cold-storage warehouse about the size of the Shodack Landing facility.

A SHIP IN A BOTTLE

In transitioning from to CO₂, Hannaford used the same two engine rooms occupied by the original R22 system, which consisted of a series of screw compressors that were removed a few at a time. "We needed to remove some of it to make room for the CO₂ system, but leave enough to keep our operations running," explained Beasley. "At times, I felt like I was building a ship in a bottle."

The process began last summer, when the transcritical rack for the freezer room was installed during one of the hottest weeks of the year, recalled DeLong. "It was handled well, but it was a little nerve-wracking to wind down one system and switch over to the new one. But we've had zero problems out of the freezer since."



Medium-temperature CO₂ rack at Hannaford warehouse.

Hannaford will need to wait until next summer before accumulating a year's worth of energy data on the transcritical system. However, a "huge savings" has been observed for the CO₂ freezer system, compared to the original system, said Baisley. "It's exceeded our expectations."

Baisley noted that the air-cooled gas coolers on the roof operate very efficiently, and the facility is running less compressor horsepower than it did in the past. In addition, all evaporators use EC (electronically commutated) fans and fan-speed control, while defrost is handled with an ejector and hot gas. "Everything is as efficient as it will ever be," he added.

"Overall, it's a promising start, for sure," said DeLong.

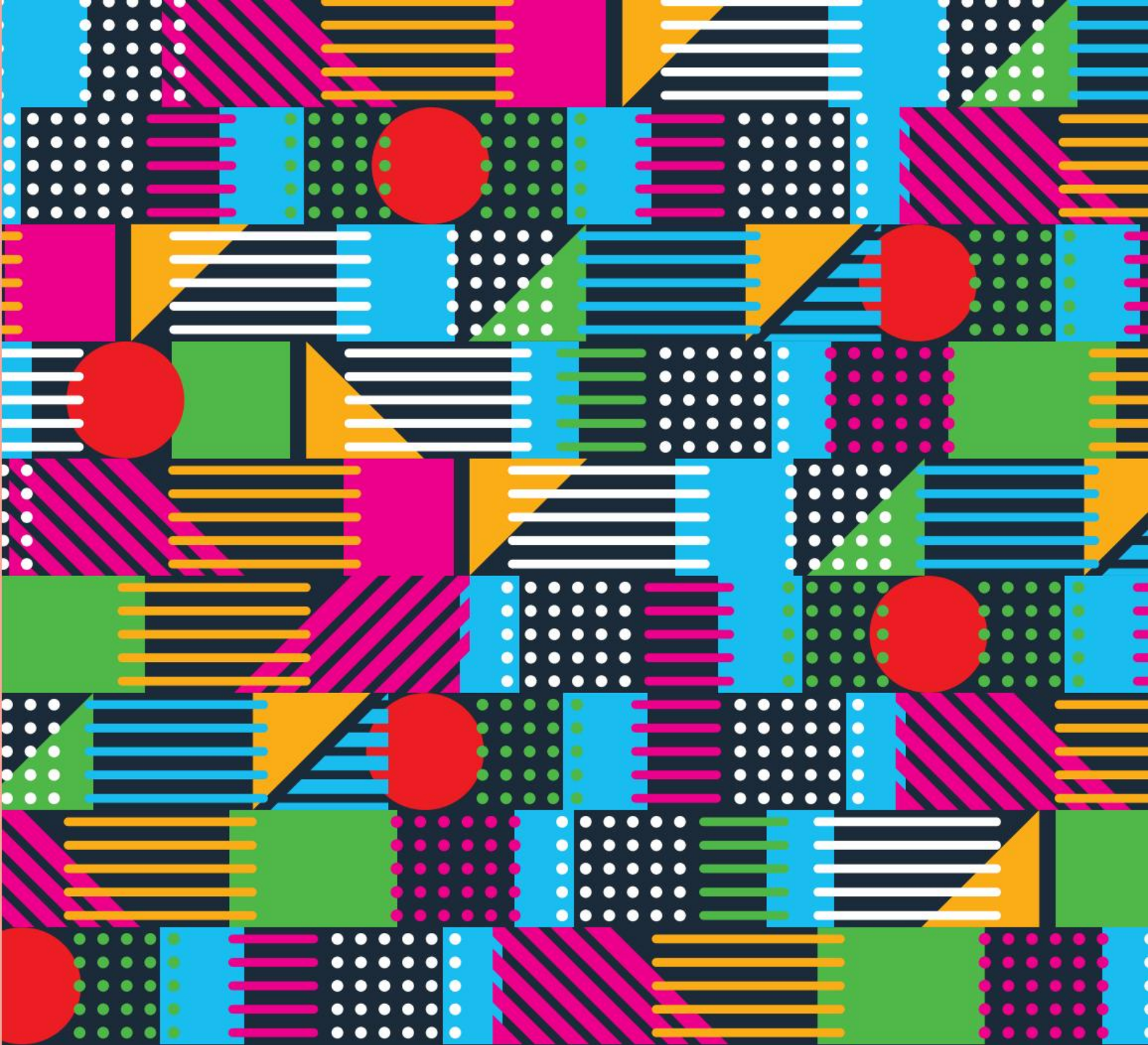
In terms of maintenance, Baisley expects about the same for the transcritical as for the R22 system. "It looks relatively the same whether it's washing coils or daily checks in the system. We haven't changed too much equipment." The transcritical system uses fewer condenser fans and fewer evaporators (35), he noted.

DeLong acknowledged that the transcritical system was "slightly more expensive" than alternatives, but "within an acceptable range." But energy and other savings – such as having a future-proof system immune to regulations – will deliver a favorable total cost of ownership (TCO), he said. ■ MG

SYSTEM SPECS

The transcritical CO₂ system at Hannaford's Shodack Landing, New York (U.S), warehouse has the following specifications:

- ▶ Temperature range: -5°F (-21°C) to 55°F (13°C)
- ▶ Total capacity: 227 TR (798kW) low-temperature; 783TR (2,754kW) medium temperature; 1,010 TR (3,553kW) total
- ▶ One 680HP low-temperature rack serving a 172TR (605kW) freezer room (-4°F/-20°C) and a 55TR (193kW) freezer dock, with reheat.
- ▶ Three medium-temperature racks (400HP, 350HP and 350HP) serving
 - A boxed meat cooler: 164TR (577kW) at 28°F (-2°C)
 - A wet cooler: 50TR (176kW) at 35°F (2°C)
 - A cooler dock: 25TR (88kW) at 30°F (-1°C)
 - Dry storage: 40TR (141kW) at 55°F (13°C)
 - Dairy/deli: 284TR (999kW) at 36°F (2°C)
 - Produce: 50TR (176kW) at 55°F (13°C)
 - Truck dock: 22TR (77kW) at 55°F (13°C)
 - A banana room: 60TR (211kW) at 45°F (7°C), using glycol plate chiller



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U.S. Cold-Chain Industry Welcomes Reversal of Obama Safety-Rule Amendments

GCCA calls elimination of RMP's third-party audit requirement "a major accomplishment," but Texas environmental group objects.

– By Michael Garry



U.S. Environmental Protection Agency

The Global Cold Chain Association (GCCA), a U.S.-based trade group representing an array of industrial operators using ammonia refrigeration, said it supports a final rule issued by the U.S. Environmental Protection Agency (EPA) on November 21 that rescinds most of the changes made to the EPA's Risk Management Program (RMP) by the Obama Administration.

At least one environmental group has pushed back against the new rule, and the GCCA expects opponents to consider legal challenges to the rulemaking.

The RMP, launched by the EPA in 1999, cover a set of safety requirements that facilities using what are considered dangerous chemicals, including ammonia, must follow. In 2017, the Obama Administration, in one of its final regulations, amended the RMP with a series of new requirements related to third-party audits, safer technology analysis, information sharing and engaging with emergency responders.

After the Trump Administration took office in January 2017, the EPA issued a series of delays to the effective date of the RMP amendments and began a rulemaking process to reconsider the changes made by the Obama Administration. "GCCA has been an active participant throughout the rulemaking process," the group said on its website.

The new "Reconsideration Rule," which took effect December 19 upon publication in the Federal Register, rescinds almost all the requirements added in 2017 to the accident prevention program provisions of the RMP regulation, said the GCCA.

"Industry welcomes the finalization of the RMP Reconsideration Rule and appreciates EPA's recognition that several provisions included in the RMP Amendments Rule at the end of the Obama Administration were unnecessarily burdensome," said Lowell Randel, Vice President of Government and Legal Affairs for GCCA. "In particular, industry is pleased that EPA has rescinded the provisions related to independent third-party audits."



The GCCA called the elimination of the third-party audit provisions “a major accomplishment” and “one of GCCA’s top priorities for the rulemaking.”

The EPA, in its “RMP Reconsideration Final Rule Fact Sheet,” said its new rule will “better address potential security risks, reduce unnecessary and ineffective regulatory burdens on facilities and emergency responders, harmonize rather than conflict with the Occupational Safety and Health Administration’s (OSHA) Process Safety Management (PSM) standard, address the concerns of stakeholders, and save Americans roughly \$88 million a year.”

However, in an op-ed article published in the *New York Times* on December 6, Ana Parras, co-executive director of Texas Environmental Justice Advocacy Services, wrote, “This regulatory rollback gives chemical plants across the country a free pass, in pursuit of greater profits, to operate in a way that endangers families and workers.”

Provisions eliminated

In rescinding the 2017 amendment’s requirement to hire a third-party to conduct a compliance audit after an RMP-reportable accident, the EPA said in its fact sheet that it was “unnecessary.”

The EPA also rescinded a 2017 requirement to assess “theoretically safer technology and alternative risk management measures applicable to eliminating or reducing risk from process hazards.” The agency said this was “not practical to implement or necessary given that the evidence does not demonstrate reduction in accidents,” adding that it was “the costliest provision of the RMP Amendments.”

Another 2017 requirement eliminated under the new rule was one to conduct and document a “root-cause analysis” after an RMP-reportable accident or a “near miss.” The EPA said this was rescinded “to maintain consistency” with OSHA’s PSM standard. “Many facilities may already use root-cause analysis for incident investigations,” the agency said.

The EPA also rescinded a provision of the 2017 rule requiring information about chemicals used by a facility to be made public by request. This will remove “the significant risk” that released information “could pose a security/terrorism threat.” However, the final rule allows local emergency responders to obtain “other information necessary for developing and implementing the local emergency response plan.”

The new rule retained the requirement – which took effect September 21, 2018 – that facilities must coordinate annually with local response organizations and document coordination activities.

The EPA also retained the requirement for “annual notification drills,” but changed the compliance date from March 15, 2021, to five years after the date of publication of the new rule in the Federal Register. Similarly, the requirement to perform field and “tabletop” exercises was delayed from March 15, 2021, to four years after publication in the Federal Register (December 19). The frequency of field exercises was changed from at least once a decade to a schedule established by an owner/operator and local emergency response officials.

The EPA also modified the 2017 requirement to hold a public meeting after an incident to only those incidents that have offsite impacts, vs. those with onsite impacts only.

The EPA said it is prioritizing inspections and enforcement “on high-risk facilities, and recently entered into the largest-ever settlement in the history of enforcing the RMP rule, valued at approximately \$150 million, in 2018.” ■ MG

Nestlé Uses Natural Refrigerants to Reach Sustainability Goals



The food and beverage giant has announced a net-zero energy plan, aiming to use 100% renewable energy by 2050.

— By Tine Stausholm

Vincent Grass,
Nestlé

Nestlé has announced a net-zero energy plan in which the multi-national conglomerate, headquartered in Switzerland, aims to use natural refrigerants to help reach its goals, which include a target of 100% renewable energy, by 2050.

Vincent Grass, Global Refrigeration Leader for Nestlé, told the attendees at the 2019 ATMOsphere Europe Conference in Poland that becoming “fully transferred to natural refrigerants” ties into the company’s plans to become net-zero.

The net-zero plan was unveiled before ATMOsphere Europe in October ([see page 54](#)) and the details will still evolve over

the next two years, according to Grass. One short-term commitment is reducing the company’s greenhouse gas (GHG) emissions by 25% by the end of 2020, and Nestlé is already well underway in its efforts to reach this goal. At the end of 2018, the emissions were down by 22%.

Apart from the adoption of natural refrigerants, Nestlé also uses other means to improve its sustainability. This includes leveraging a number of biomass points, such as spent grounds from its coffee production for steam generation.

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Nestlé uses a variety of natural refrigerant solutions to help it become more sustainable, and the company looks mainly at total cost of ownership when choosing a specific solution; this can include “water usage at the expense of energy, and vice versa,” according to Grass.

“We sometimes operate in very scarce areas where there is a lot of water stress,” Grass added. “So sometimes we actually go for air-cooled options, which are less efficient, and sometimes we will go for water-cooled options; basically it depends on the total cost of ownership and footprint.”

Since 2016, the company has only used hydrocarbons in its ice cream freezers, and it started employing transcritical CO₂ for refrigeration in its supermarkets six to seven years ago, according to Grass.

Since most people know Nestlé for its food and beverage products, it may come as a surprise that the company also runs 21 supermarkets in Switzerland. These stores feature both Nestlé products and other brands to provide a complete shopping experience.

For warehouses and production facilities, Nestlé utilizes ammonia and ammonia/CO₂ for refrigeration. For large and medium-sized systems, and for processing, the go-to solution is; the latest example of this is being built for a large factory in Mexico. The company is also expanding its capacity in Russia with another ammonia/CO₂ system.

Nestlé also has systems using only ammonia. In the U.S., the company has

some large plants with refrigeration systems that use substantial amounts of ammonia.

However, Nestlé also has smaller warehouses that use only CO₂. The first such system was installed in Spain four to five years ago, and another CO₂ cold-storage facility is underway in Tunisia, where Nestlé is considering the use of Panasonic condensing units.

An early adopter

Nestlé was an early adopter of natural refrigerants, replacing its first CFC and HCFC systems in 1986 before the Montreal Protocol was adopted. Most of the Nestlé factories have now transitioned from HFCs to natural refrigerants.

“Not many” are left to convert, Grass said, attributing the early adoption to a “loss of trust” in synthetic refrigerants because every time a new product generation came out, a few years later, problems would be discovered.

To communicate its sustainability efforts, Nestlé publishes an annual Rating Share Value report that includes a summary of the company’s environmental efforts.

Nestlé also helps its retail customers to spread the word by, for example, attaching stickers to its ice cream freezers explaining that the unit is using a hydrocarbon refrigerant.

For more about Nestlé’s use of natural refrigerants, see “Nestlé’s Pioneering Vision,” Accelerate Europe, Summer 2017.

Nestlé’s Net-Zero Emissions Plan

Ahead of the 2019 U.N. Secretary-General’s Climate Action Summit last year, Nestlé signed “Business Ambition for 1.5°C – Our Only Future” pledge (See <https://bit.ly/2SYhq3i>.) As part of its commitments, the company announced a net-zero greenhouse gas (GHG) emissions plan, aiming for 100% renewable energy by 2050.

“Climate change is one of the biggest threats we face as a society. It is also one of the greatest risks to the future of our business,” said Mark Schneider, CEO of Nestlé. “We are running out of time to avoid the worst effects of global warming. That is why we are setting a bolder ambition to reach a net-zero future.”

Some of Nestlé’s actions include:

- ▶ Speeding up the transformation of its products in line with consumer trends and choices.

Nestlé will launch more products that have a better environmental footprint. It will also look to reformulate its products using more climate-friendly ingredients, and it’s moving to alternative packaging materials.

- ▶ Scaling up initiatives in agriculture to absorb more carbon. Nestlé will strengthen its programs with farmers to restore land and limit GHG emissions.

- ▶ Using 100% renewable electricity in Nestlé factories, warehouses, logistics and offices. A third of Nestlé factories (143) are already using 100% renewable electricity.

Nestlé will review its progress annually to ensure it is on track. ■ TS

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'BEST CRAFTSMAN IN FRANCE' HONORED FOR CO₂ REFRIGERATION DESIGN

Refrigeration technician Simon Lor-saw has won the prestigious competition in the refrigeration category for his cheese-ripening project.

— By Ilana Koegelenberg and Pauline Bruge

Simon Lor-saw, a technician for French contractor Mondial Frigo, won the coveted 2019 Meilleur Ouvrier de France (Best Craftsman in France) award in the refrigeration category for his innovative CO₂ refrigeration system design for a dairy processing facility.

His system allows cheese to ripen in only three weeks instead of the usual six to eight months. His former employer, Perrier, owns the prototype, which was built by a subcontractor.

The Meilleur Ouvrier de France (MOF) competition, held every four years by the French Ministry of Labor, was created in 1924 to recognize workers in over 200 professions, such as florists, carpenters and butchers. This was the first time that the refrigeration category was included.

The competition evaluates the dexterity, knowledge of modern and traditional techniques, know-how and creativity of candidates.

Along with the title, winners receive a medal and state diploma.

A TOUGH COMPETITION

The MOF is known to be a very challenging competition. Winning took a lot of hard work and dedication, said Lor-saw, 29. He worked long nights, holidays and weekends, even ending up in a hospital from sheer overexertion. "I worked day and night for four years, only sleeping three or four hours a night," said Lor-saw, who was also employed during the day. But in the end, it all paid off, he said. "It took a few days to sink in after they phoned me to announce the results – I am now the number-one refrigeration technician in France."

The MOF competition's qualifying rounds, which started in September 2017, comprised a written and oral presentation of an innovative and environmentally friendly installation. Lor-saw's project was based on a CO₂ refrigeration system design for an organic cheese-processing facility with a dryer and cheese cold room. The aim was to find a way to ripen the cheese in three weeks instead of the usual six to eight months without losing any of the taste or compromising the visual quality of the product.

The next round involved putting theory into practice. Lor-saw implemented his new system at Fromagerie de Valmont, located in Côte-d'Or (Bourgogne region), France.

The final round took place on-site in October 2018, and the judges made their decision based on the following:

- Design and study of the cheese facility's refrigeration system.
- Preparation of a quotation and marketing.
- Material order, site monitoring and subcontractor management.
- Design of refrigeration equipment.
- Calculation of power, function control, energy costs.
- Comparison of performance against the study.

For the final round, contestants were judged on their written report, oral test and the final implementation of their project. Additionally, Lor-saw submitted reports on CO₂ as a new refrigerant.

Lor-saw has a great deal of experience dealing with CO₂ in supermarket installations. He's worked with it since it first came on the market – first in subcritical installations and later in transcritical. "CO₂ is the future, but it requires know-how and should be handled with great care," he said. "This refrigerant should be adopted by small traders as well as by the industry at large."

STARTING YOUNG

Lor-saw comes from the Lyon region in France, where he was exposed to the refrigeration industry at a very young age. His father's family owns a contracting business, Azerg Froid et Clim, and he's been visiting the copper workshop since age four.

He completed a four-year apprenticeship at the Edmond Labbé high school in Oullins and then studied at the AFPM college in Lyon, specializing in refrigeration and air-conditioning technology. Afterwards, he joined his father's company, where he continued learning about refrigeration equipment, air handling units, water chillers, and more.

He later joined the Perrier company in Marcigny. There he worked on a variety of applications, including large kitchens, central kitchens, hospitals, medium- and large-sized stores, and other smaller installations.

Now at Mondial Frigo he focuses on large, industrial-scale refrigeration installations, controls, automation and customized cooling solutions.

Winning the MPF competition has been a springboard for Lor-saw's career. "It has allowed me to meet people I would never have met otherwise and to receive endless job offers and an evolution in my career," he said. "This title will allow me to promote the refrigeration sector to young people and try and address the lack of skills in the industry," he said.

Skills are very important, explained Lor-saw, and he believes that there will always be work for refrigeration engineers – both male and female. "The world needs more and more refrigeration," he said. "Cooling is the future."

■ IK & PB

Simon Lor-saw, wearing the medal he received as Best Craftsman in France in the refrigeration category.



Lessons from Decade-Old NH₃/CO₂ Supermarket Installations

The system, estimated to save 30% in energy, experienced one leak, but the contractor believes it's safe.

— By Ilana Koegelenberg

Over 10 years ago, Pick 'n Pay (PnP), a South African food retailer, installed ammonia/CO₂ (NH₃/CO₂) cascade systems in three stores, discovering various benefits and challenges to this refrigerant combination, which has never taken off globally.

Only a handful of supermarkets are known to use NH₃/CO₂ cascade refrigeration. The PnP installations are among the first.

Hout Bay, Cape Town,
South Africa

Photo by Carolin
Cavalli on Unsplash

"With all the buzz around transcritical CO₂ systems, industry newcomers often overlook other efficient natural refrigeration options for retail applications," said Marius La Grange, Manufacturing Manager at Energy Partners Refrigeration Solutions, the contracting company that manufactured and installed the refrigeration system at one of these pilot projects.

"Like many good things, cascade systems need to be applied correctly and in suitable applications to have the best potential results," he said. "But a potential saving of 30% or more really justifies this option and makes it worth considering."

La Grange considers an ammonia system safe to use, with only one leak experienced in a decade.

In 2009, German development agency, GTZ (now GIZ), funded the three ammonia/CO₂ cascade installations in South Africa for PnP at stores based in Strand, Rand Park Ridge and Hurlingham, which came online in that order.

The PnP Strand, located in the Western Cape province, near Cape Town, installed a NH₃/CO₂ cascade system with a secondary circuit (water/glycol) for medium-temperature loads. The ammonia part of the system uses open-drive reciprocating compressors and an evaporative condenser.

A similar system is used at PnP Rand Park Ridge in Johannesburg. The only difference was that the medium-temperature and low-temperature loads varied slightly between the two stores. Both were retrofits of F-gas systems.

At the Strand location, one of the biggest challenges was that the store could not be closed down for the revamp, explained La Grange. The new equipment, with all its reticulation, had to be installed and connected to the new cabinets and evaporators in under a few days, he said.

In addition, the store had to identify a new machine-room area, one that would comply with all health and safety regulations. An open area on the first floor was selected. "The area was rather limiting, so ample planning had to go into what specific [equipment] options would satisfy the requirements and also fit into the space," said La Grange. The available space had to be narrow and long, instead of square, to accommodate the evaporative condenser, for example.

ENERGY SAVINGS

"Applying a TEWI [total equivalent warming impact] view and looking at the refrigerant's direct GWP figures, this type of installation is cleaner than a similarly sized transcritical installation," explained La Grange. "When considering indirect emissions from the energy consumed to operate the plant, this type of installation is also highly likely to come out on top."

Ammonia is the most energy-efficient solution for medium-temperature applications "by some margin," he said. The CO₂ low-temperature system is also operating within a set of operating conditions where it is very energy efficient, he added. Then, of course, there is the added bonus of zero ODP and a GWP of only 1. In both cases, the charge of the refrigerant was very limited.

With no recorded energy consumption from the F-gas system before the revamp, the reduced energy consumption could not be verified. "But we believe that the new installation saved significantly on the electricity bill the store had," said La Grange.

He estimated that the installation would offer a 30% or higher rate of saving in energy consumption over an HFC-charged DX installation. "Maintaining an ammonia system is more costly than an HFC system, but the saving in operational costs offset that additional cost by some margin."

The medium-temperature air coolers (heat exchangers) that were made to fit into the cabinets and rooms have a very low delta T (temperature difference between the coolant and the air temperature). This offers a few advantages. "One of the biggest is the fact that very little ice buildup on the outside of the air coolers takes place," explained La Grange.

USING AMMONIA

Ammonia's pungent odor and potential toxicity are what keep most supermarkets from using it. Needless to say, a suitable sensor is required in any NH₃/CO₂ system.

In the 10 years since the installation of the PnP systems, only once, when a heat exchanger failed internally, did ammonia leak into the secondary cooling circuit. Since ammonia has a corrosive effect on any copper components, it is potentially very damaging unless it is detected and rectified immediately.



The PnP Strand CO₂ refrigeration rack arriving on-site.

The store did experience an ammonia smell with some of the secondary coolants leaking at a connection, so it was evacuated for a few hours until it was well vented. Fortunately, there were no injuries.

But fixing the issue was easier said than done. "We had a very challenging task to replace the heat exchanger," La Grange recalled. "In the end, we replaced it with a unit that Vatherus made in a few days, and we air-freighted it to get the store in operation again."

Despite this incident, La Grange is not worried about the perceived safety risks of working with ammonia in a retail installation. "I don't believe it is a risk, provided that all the required precautions are taken during the design, construction and, maintenance of such a plant," he said. "The ammonia has a limited charge and is confined to the machine room only, so there is no ammonia where the customers and staff are."

Another challenge with a secondary cooling system is removing air from the system, said La Grange. A centrifugal pump is constantly circulating the secondary coolant around the pipe network. "The pipe design and installation should therefore be done in a way to remove air from any part of the pipe networks as easily as possible." A small make-up tank at the highest point of the pipe network, used to return liquid into, and draw liquid from, the pump station, solves many of these problems, he noted.

The pump station is also something that needs careful consideration, according to La Grange. What should the supply pressure from the pump station be? As low as possible. "We simply need to circulate constantly at below 3.3ft/s (1m/s) at full load where possible." The lower the energy consumption to circulate, the better the overall plant COP (coefficient of performance). A variable-speed drive could be made to fit the pump to alter speed. ■ IK



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New Australian Store Employs Fully Integrated CO₂ System



The transcritical system supplies 90 refrigeration points at Michael's SUPA IGA store in Keysborough, Victoria.

— By Ilana Koegelenberg

Transcritical CO₂ system at Michael's SUPA IGA store

A new Michael's SUPA IGA store in Keysborough, Victoria, Australia, boasts two state-of-the-art CO₂ transcritical racks that feed 90 refrigeration points as well as a two-metric-ton ice flaker.

In addition to refrigeration, the fully integrated system includes space heating, domestic hot water and cooling.

Work on the 3,500m² (37,673.7ft²) store started in July of 2018 and was completed on November 22, 2019, according to Quintan Naude, Project Manager at MB Refrigeration (part of the MB Group), which handled the design and installation of the refrigeration system.

The store includes sections for meat, fish, sushi, dairy, liquor and frozen retail stock – among others. It also has a custom-designed aging room for the butchery area

and a decorative glass wall entering into the liquor cold room.

The retailer specified natural refrigerants, according to Naude. "They invested in the future of the planet by promoting a lower carbon footprint."

According to Naude, the size of the store made it difficult to coordinate all the elements. "The most difficult obstacle was our piping route that clashed with mechanical ducting and underground services," he explained. "This was resolved by good communication skills with relevant parties on site by means of detailed drawings and landscape surveyors."

The system includes two refrigeration racks, manufactured by South African OEM Sphere. The capacities of the two systems are as follows:

► Low temperature: 19.86kW (95.65TR) at -33°C (-27°F) and 20.68kW (5.89TR) at -26°C (-14.8°F)

► Medium temperature capacity: 85.39kW (24.28TR) at -8°C (18°F) and 78.48kW (22.32TR) at -6°C (21°F)

According to Naude, the retailer is very satisfied with the final product and commented that it is looking forward to doing future business with MB Group (which has worked on a number of IGA installations). "Our decision to use MB for this project was certainly the right one! Been a great journey with the team on this project with more to come," said Domenic D'Agostino, Operations Manager at Michaels/Fairleys SUPA IGA Stores in a comment to a post by Naude on LinkedIn. ■ IK



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NEW MELBOURNE SUPERMARKET TARGETS ENERGY SAVINGS WITH TRANSCRITICAL CO₂



Local Australian contractor AJ Baker & Sons installed Epta's ECO₂Small system at a FreshPlus store.

— By Devin Yoshimoto

Melbourne skyline
Photo by Road Trip
with Raj on Unsplash

FreshPlus, a community-based supermarket chain, has installed an ECO₂Small transcritical CO₂ system supplied by Italian OEM Epta in its recently opened fourth store in Craigieburn, a northern suburb of Melbourne, Australia, according to Australia-based refrigeration contractor AJ Baker & Sons' website.

AJ Baker & Sons did the installation for the store, which opened last October.

The decision to use transcritical CO₂ was based on the energy efficiency and environmental friendliness of the system, according to AJ Baker's website. "For this store, we selected the ECO₂Small transcritical compressor rack, which runs both medium and low temperature in one combined frame," the website said. The compressor rack has a weather-proof enclosure and is located on the roof.

"AJ Baker was involved in guiding the customer to select the transcritical CO₂ system to future-proof the new installation," said Claus Mecklinger, Director, AJ Baker. "The focus of the new design was low energy consumption and environmental friendliness of the system to remove the reliance on HFC refrigerants."

Other energy-saving features in the system include Carel electronic E2V expansion valves, variable-speed drives on the compressors and gas-cooler fans, and an adiabatic Carel chill-boost to assist in hot weather.

The store manager can supervise the case temperatures and plant operation via a centralized Carel Boss supervisory system.

A variety of Epta store freezers, vertical chillers, and island display cases were used to optimize efficiency. These include the new Skylight glass-door vertical freezer, which offers enhanced energy efficiency due to a low heat-extraction rate, and low-consumption LED door lighting. One of its main features is the reduction of the defrost cycle to once per week, which reduces energy consumption and results in a more stable product temperature.

AJ Baker & Sons said it had installed transcritical CO₂ systems at 26 stores across Australia by the end of 2019. Its first transcritical CO₂ store installation was in April 2014. The company has also recently partnered with the Technical and Further Education (TAFE) South Australia (SA) training academy to develop virtual reality (VR) content for a hydrocarbon refrigerant training module. ■ DY

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Sydney Harbour Bridge and Olympic Swimming Pool. © Mletsch/ 123RF.com

AMMONIA HEAT PUMPS SEEN AS OPTION FOR AUSTRALIAN OLYMPIC POOL

The payback for a low-charge ammonia heat pump would be under five years, says Scantec's Stefan Jensen.

— By Devin Yoshimoto

An Olympic pool in North Sydney, Australia, that is undergoing redevelopment is providing an opportunity for ammonia-based water-to-water heat pumps to significantly reduce its energy usage.

This was according to Derek Harbison, a Renewable Energy Consultant at Queensland-based energy consultancy firm SmartConsult, which recently held a seminar in Sydney about integrated energy systems for aquatic centers.

Around 30 people attended the seminar on November 15, including the North Sydney Council and representatives from system suppliers Johnson Controls and Scantec Refrigeration Technologies.

A development application (DA) for the redevelopment of the North Sydney Olympic Pool was open for comment until December 13, according to the North Sydney Council website. "The proposed redevelopment upgrades the 50m [164ft] pool and provides a range of facilities to meet a wide range of community needs," the website stated.

Scantec Managing Director Stefan Jensen spoke about how low-charge ammonia water-to-water heat pumps could work and perform in the Australian

climate. "The payback of a low-charge ammonia heat pump would be under five years," Jensen said.

Harbison compared the use of heat pumps to more traditional solutions used today, such as gas boilers and resistance heating. "What is being done in Europe with heat pumps is the future," he said.

Harbison also spoke at ATMosphere Australia 2019, which took place on May 8-9 in Melbourne, Australia, about how water-to-water heat pumps can significantly reduce energy use in aquatic centers.

Alexander Cohr Pachai, Technology Manager at Johnson Controls Denmark, spoke about heat-pump installation case studies in Europe, and emphasized the lack of discussion about storing heat and the high maintenance costs of gas boilers.

Trent Hawkins from Northmore Gordon Energy Consulting, which previously worked on the North Sydney Olympic Pool, talked about the disadvantages of using cogeneration to heat swimming pool water. "Cogeneration is not efficient and has high maintenance costs and cannot be used as the sole source of heat," he said.

The seminar was followed by a site visit to the North Sydney Olympic Pool. ■ DY

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Japanese Retail Giant Aeon Group Continues Commitment to NatRefs

Its new retail complex in Okayama has installed CO₂ equipment from new vendors, bringing total natural refrigerant installations to more than 600 stores.

— By Tomoro Sato, Rena Okabe and Devin Yoshimoto



Aeon Style Okayama Aoe, a retail complex in Okayama, Japan

Aeon Group, the Chiba, Japan-based retail conglomerate with 21,996 stores in Japan, China and Southeast Asia, has made a commitment to natural refrigerants since launching its Aeon Natural Refrigerant declaration in 2011.

The policy states that Aeon Group will "introduce facilities with natural refrigerants at all new stores while converting to natural refrigerants at existing stores over time."

As of September 2019, the company has installed natural refrigerant (mostly CO₂) equipment at 635 stores, including 31 general merchandise stores, 298 supermarkets, 285 drug stores and 21 convenience stores.

One of its biggest recent efforts took place in July 2019, when its division Aeon Retail opened a renovated large-scale commercial retail complex in Okayama City in southern Japan.

The retail facility, Aeon Style Okayama Aoe, which has a sales floor area of approximately 82,623ft² (7,676m²), has 10 directly managed stores and 10 tenants — mainly supermarkets offering everyday goods ranging from groceries and pharmaceuticals to health and beauty products. The community-based complex targets the community's single and dual-income residents in their 30s and 40s.

It is here where Aeon Retail installed CO₂ refrigerated display cases, supplied by Fukushima Galilei (formerly Fukushima Industries Group). Out of 141 refrigerated display-cases, about 100 employ CO₂, mainly for frozen foods, ice, meat, fish, and produce.

Aeon Retail mainly uses open-type display cases, and for frozen food and ice cream employs reach-in display cases or floor-mounted flat-type display cases with sliding doors, said Akihito Narita, Store Planning Group Manager for the Development Division of the Construction Department for Aeon Retail.

Chainwide, Aeon Retail has now installed natural refrigerant equipment (CO₂ or hydrocarbons) in 31 of its stores. By the end of its 2019 fiscal year, the company is scheduled to open, in Japan's Iwate Prefecture, Aeon Style Esashi (the tentative name), where approximately 40% of the refrigerated display cases will run on CO₂.

Firsts for Fukushima, Aeon Group

Fukushima Galilei, an Osaka, Japan-based manufacturer of industrial and commercial freezers and refrigerators, has recently emerged as a new player in the CO₂ refrigerated display-case market; this is the first time Fukushima's CO₂ display cases have been installed in supermarkets. It is also the first time Aeon Group has installed CO₂ display cases from Fukushima and CO₂ outdoor condensing units (20HP) from Mitsubishi Heavy Industries.

Until this project, Aeon Group had mostly employed CO₂ equipment from Japanese OEM Panasonic Appliances Company, one of a very limited number of Japanese manufacturers supplying CO₂ refrigerated display cases.

Asked if Aeon Retail has any concerns in taking this new step, Kiyoshi Kataoka, Purchasing Manager for the Store Planning Group in the Construction Department of Aeon Retail, noted that there was almost no difference in cost between Panasonic and Fukushima Industries. "We also have done a lot of business with Fukushima with conventional R410a display cases," he said. "With those conventional display cases that we often use, considering the fact that we have had a lot of success with them, it followed naturally that we would also introduce its CO₂ refrigerated display cases."

At its other stores, Aeon Retail has also installed CO₂ refrigerated display cases from Okamura, another Japanese OEM. Aeon Group, has also installed self-contained CO₂ refrigerated display cases from Japanese OEM Mitsubishi Electric Corporation.



Akihiko Narita (left) and Kiyoshi Kataoka, Aeon Retail Co. Ltd.

NatRef Lessons Learned

Aeon Group's interest in natural refrigerants began in August 2009, when Panasonic Appliances Company conducted an R&D demonstration test of Japan's first CO₂ refrigeration system at one of Aeon Group's "Max Value Express" supermarkets in Tokyo.

Two years later, after additional tests and support provided by Japan's New Energy and Industrial Technology Development Organization (NEDO), Aeon Group launched its Aeon Natural Refrigerant declaration.

"In 2009, together with Panasonic, we took on the challenge of making the first attempt [at CO₂ refrigeration] in Japan,"

said Haruko Kanamaru, Corporate Social Responsibility Division Manager for Aeon Group. "In actuality, with this attempt, despite concerns about costs, we found that the high energy efficiency and the accuracy of the temperature control not only contributes to environmental protection, but also to stable operations and energy-use savings."

As the number of CO₂ installations increases steadily year after year, the company continues to find zero operational issues, excellent power consumption compared to conventional R410a and R404A equipment, and the ability to fully utilize CO₂ as a refrigerant in frozen display cases.

While Aeon Group is steadily increasing the number of stores with natural refrigerant installations, including large-scale installations such as Aeon Style Okayama Aoe, the company explained that two challenges continue to exist.

The first is installation cost. Kataoka said that although the product line-up of manufacturers for natural refrigerant refrigeration systems and display cases is growing, there is still a cost premium of about one and a half times the cost of conventional freon-based systems at the time of installation.

With the help of subsidies from Japan's Ministry of Environment, this cost premium can be reduced to around 1.1 to 1.2 times the cost of conventional systems. For Aeon Style Esashi, subsidies have been used; however, subsidies were not granted for Aeon Style Okayama Aoe due to difficulties with the subsidy application process and timing. Despite this, Aeon Group moved forward with CO₂. In order to continue promoting natural refrigerant equipment, there is still plenty of opportunity for review of the subsidy program, Kataoka said.

The second issue is the need for a greater variety of natural refrigerant products. At Aeon Style Okayama Aoe, 70% of the display cases use CO₂, while at Aeon Style Esashi, 40% of the display cases will do, while the rest will be HFC-based equipment.

One area where it is difficult to use CO₂ display cases is the "Delica" sushi area. Here, the display cases are set to temperatures of between 13°C (55°F) and 18°C (64°F). "For CO₂ as a refrigerant, I wonder whether this temperature range is difficult, or if the products for this range have not yet been developed," said Kataoka. In addition, for "super-low-deck" display cases, which are at a height of 7.1in (18cm) above the floor, CO₂ compatible coolers for this application have not been developed. "Is this a technical barrier?" he asked.



1 / Mitsubishi Heavy Industries Air-Conditioning and Refrigeration outdoor CO₂ condensing units

2 / Freon-free sticker affixed to Fukushima CO₂ display case

As a result of these limitations, CO₂ display cases are able to cover around 70% of the sales area at the Aeon Style Okayama Aoe facility. Nevertheless, said Kataoka, "there are still several instances where you can feel the evolution in the product line-up and performance compared to the past."

There are still several issues Aeon Group needs to solve, including getting to 100%

use of natural refrigerants at new stores, as well as switching to natural refrigerants at existing stores; the latter is a major issue in Japan, due to the risks associated with major plumbing work in closed stores.

Nevertheless, operating under its Natural Refrigerant Declaration, the Aeon Group is expected to continue adopting natural refrigerants. ■ TS, RO & DY

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Japanese C-Store Chain Lawson Opens First 100% NatRefs Store

The freon-free store is the first to use hydrocarbon plug-in equipment, along with CO₂ cases.

– By Devin Yoshimoto and Rena Okabe

Lawson's first freon-free store, which employs hydrocarbon plug-in equipment and CO₂ cases, in Kanagawa, Japan.



Japanese convenience store chain Lawson has opened its first freon-free store, which employs only natural refrigerant-based equipment.

Lawson, which operates more than 14,000 outlets, is one of Japan's top three convenience store chains, together with 7-Eleven and Family Mart.

The store, which opened on September 23, is billed as an "environmentally friendly model store" that employs CO₂ and hydrocarbon refrigeration equipment. It is located on the Shonan Fujisawa Campus of Keio University, in Kanagawa Prefecture — about one and a half hours southwest of Tokyo by train.

The Keio University store is also Lawson's first to use hydrocarbons for its smaller plug-in upright and under-counter refrigerators as well as its ice makers.

Lawson has long been one of the world's leading end users of CO₂ systems, opening its first CO₂ store in 2010 and expecting to reach 3,700 stores by February 2020. However, CO₂ is limited to Lawson's large applications, which include in-store refrigerated and frozen display cases and outdoor condensing units.

Japanese OEM Hoshizaki supplied the hydrocarbon plug-in equipment while Panasonic provided the CO₂ equipment.

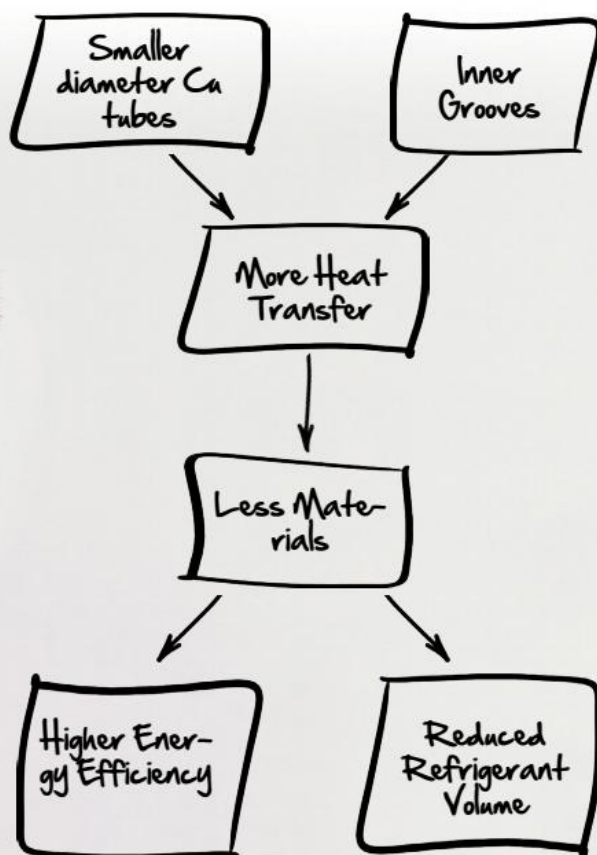
Hydrocarbons progressing in Japan

While Japan has long taken a very strict stance towards the use of hydrocarbon-based commercial refrigeration equipment, the opening of this Lawson store is one of several important hydrocarbon developments happening in the country.

The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) is expected to issue its official guideline on the safe use of hydrocarbons in March 2020, while continuing to proceed with its risk assessment for A2L and A3 refrigerants. (See, "[Japan Stresses Safety As It Explores Hydrocarbons](#)," *Accelerate Magazine*, November-December 2019.)

Lawson is scheduled to present its latest updates and future vision of natural refrigerant use on February 10 at the ATMOSphere Japan 2020 conference (organized by shecco, publisher of *Accelerate Magazine*). See the latest program at <https://bit.ly/34Q5qTl>. Registration for the event is open at <https://bit.ly/2Qc5MyP>. ■ DY & RO

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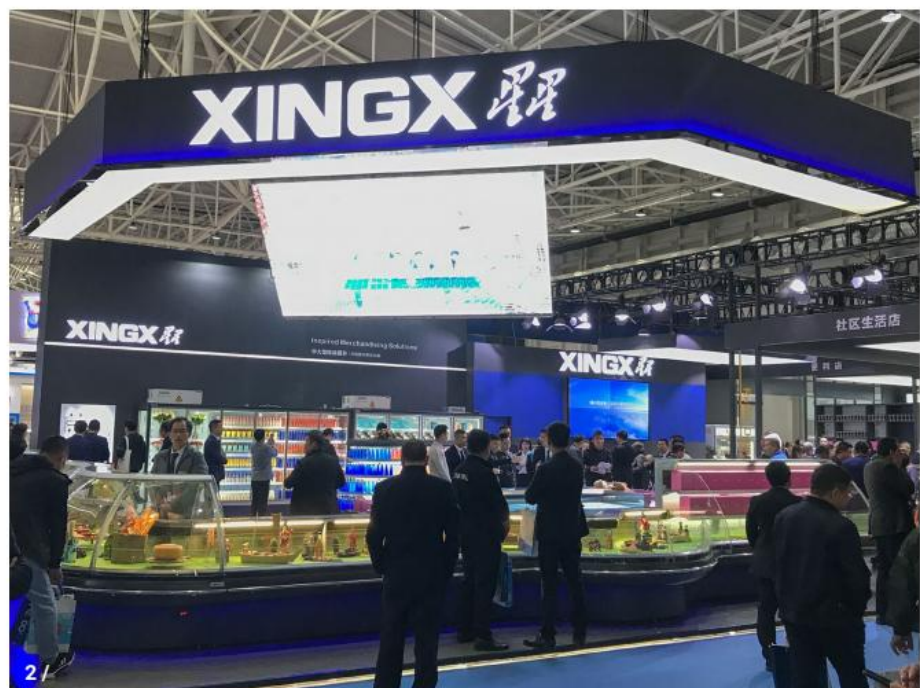
1 /

Community food stores are seen as target for R290 plug-ins, say attendees at ChinaShop 2019.

— By Devin Yoshimoto

1 / ChinaShop 2019, Qingdao, China

2 / Zhejiang XingXing Refrigeration's booth



2 /

As e-commerce players like Alibaba and JD.com put pressure on China's brick-and-mortar food retail sector, traditional retailers are introducing a wide variety of store sizes, formats, and layouts to stay competitive.

This, in turn, is heavily influencing the stores' refrigeration equipment needs, opening up opportunities for natural refrigerant systems like propane (R290) cases, according to attendees at ChinaShop 2019. The trade show, held November 7-9 in Qingdao, China, is China's biggest exhibition for the food retail industry.

One of the largest opportunities for natural refrigerant systems is in the "community food store" market segment. Ranging from 6,458-10,763ft² (600-1,000m²), these stores are usually smaller than traditional supermarkets, and are located near residential areas. The stores focus on carrying fresh and frozen foods as young people become more accustomed to ordering non-food items online.

"This is one of the fastest growing market segments, and it is where we see the biggest opportunity in the future for our propane cabinet sales," said TingXun Zhang, Director of Cold Chain Research Institute for Chinese OEM Zhejiang XingXing Refrigeration. The company had several pieces of R290 plug-in equipment on display at its ChinaShop booth.

One Chinese retailer that has successfully implemented R290 equipment is SPAR China (a division of Dutch retail giant SPAR), which was also present at the exhibition. "R290-based equipment is quite commonly used among our members, and has already produced very good results," said Junbo Chen, Marketing and Communications Director for SPAR China.

Several SPAR China group members like SPAR Beijing Huaguang have installed R290 equipment supplied by AHT Cooling Systems (Changshu), a division of Austrian multinational refrigeration system manufacturer AHT. In addition, SPAR Sichuan Dehui recently installed several AHT R290 island freezer chests at its new store in Chengdu this past summer.

Chen added that SPAR China is "seeing a growing need for R290-based equipment, as it has a more stable market price compared to hydrofluorocarbon (HFC) and hydrochlorofluorocarbons (HCFC) systems," although ensuring appropriate and thorough maintenance remains a concern.

“

This is one of the fastest growing market segments, and it is where we see the biggest opportunity in the future for our propane cabinet sales.

– TingXun Zhang, Zhejiang XingXing Refrigeration

Transcritical CO₂ performing well

”

Meanwhile, a handful of standard-size stores in China are testing transcritical CO₂ systems.

After more than a year of operation, China's second transcritical CO₂ system – installed in a remodeled CSF Market store – has been "operating successfully," according to Li Li Du, Overseas Sales Director for Panasonic Appliances Refrigeration System (PAPRSDL), based in Dalian, China. ([See page 42 for profile of Du.](#))

"The system has been running very reliably, there have been no leakages and the customer is very satisfied with the energy savings," said Du during a seminar called "Green Operations in China's Retailing Industry: Climate Change & Store Operation," at ChinaShop 2019.

CSF Market is one of China's fastest growing retail chains. PAPRSDL, which supplied the system, is a joint venture between Japan's Panasonic Corporation and Bingshan Group, one of China's largest manufacturers of refrigeration and air-conditioning equipment.

Panasonic's booth at ChinaShop 2019 exhibited its new 80HP transcritical CO₂ rack, which was also built by PAPRSDL.

Another retailer, METRO China (previously owned by German retailer METRO AG, now owned by Chinese retailer Wumart, which has a majority stake), has installed transcritical CO₂ systems at three of its stores: a transcritical CO₂ ejector system supplied by Carrier in Chongqing; a transcritical CO₂ booster system in Beijing; and, a transcritical CO₂ multi-parallel unit system in Beijing.

Overall, the systems' energy performances have been positive, according to Alan Lin, Head of Facility Management for METRO China, who also spoke during the ChinaShop seminar. However, Lin did note that a significant number of adjustments were needed to achieve an optimal level of good energy performance in the early stages of operation.

ChinaShop 2020 will be held from November 19-21 in Shanghai, China. ■ DY



From left: Khumnuan Phenraksa, Pornkamon Kietmongkonkun, Takashi Obata, Weerachai Songthongkum and Yoshitaka Naito, all with Panasonic Appliances Cold Chain Thailand.

Japanese CO₂ Leader Panasonic Embraces Hydrocarbons in Thailand

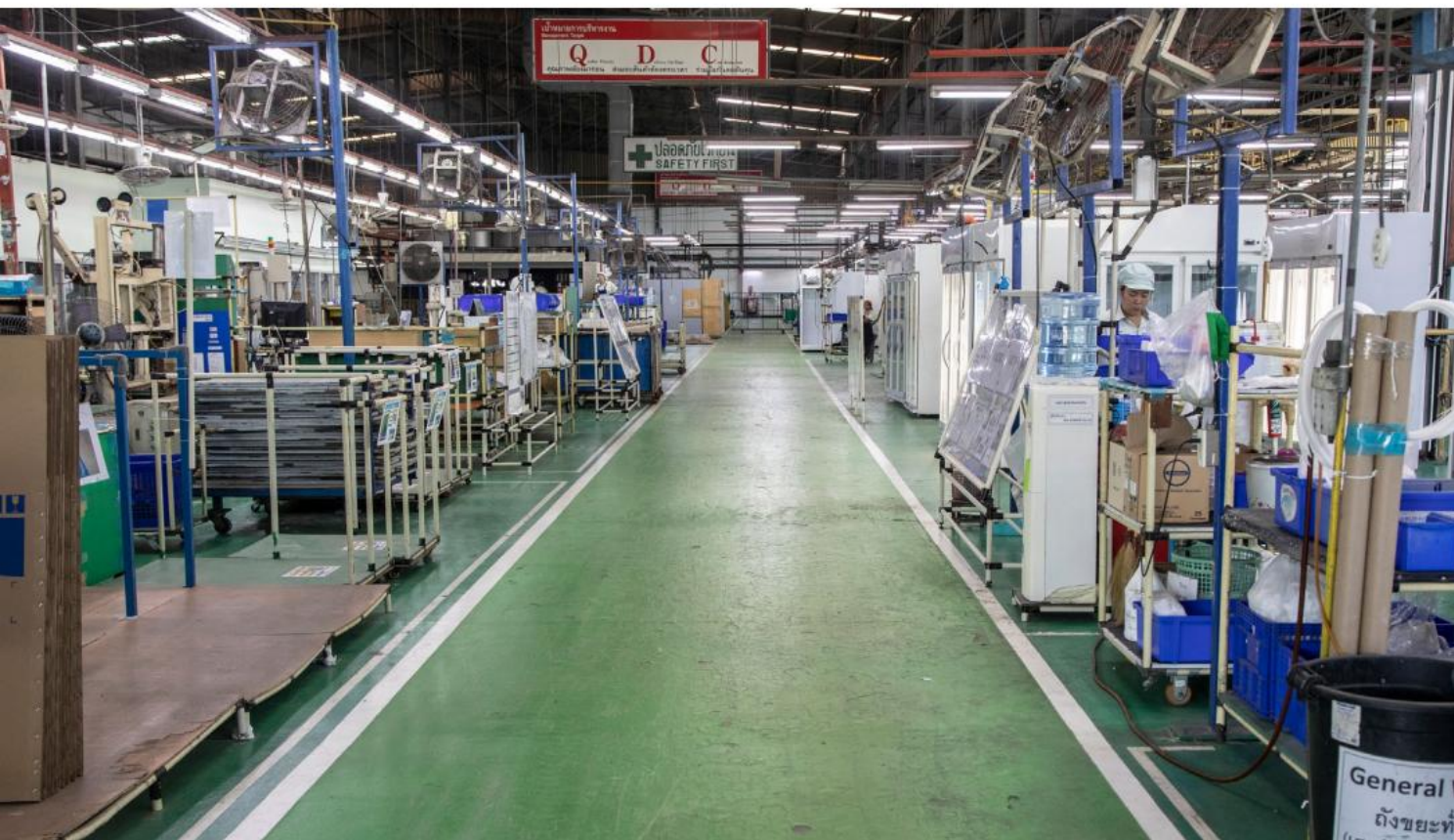
In an exclusive interview, Takashi Obata of Panasonic Appliances Cold Chain Thailand sheds light on the company's plans to transition towards 100% hydrocarbons, with the support of the RAC NAMA initiative.

— By Devin Yoshimoto, Jan Dusek, Tomoro Sato and Rena Okabe

Japanese manufacturer Panasonic has already established itself as a global pioneer of CO₂ refrigeration. Can the company also be a pioneer in hydrocarbons?

It's starting to become one in Thailand, through Panasonic Appliances Cold Chain Thailand, based in the town of Chachoengsao, just east of Bangkok.

"As a global company, we believe that being able to respond flexibly to customer requirements is our most important proposition," said Takashi Obata, Managing Director of Panasonic Appliances Cold Chain Thailand. "That is why we should have, not only CO₂, but also refrigerant options like propane [R290] or isobutane [R600a]."



Panasonic Appliances Cold Chain Thailand's manufacturing facility in Chachoengsao.

Until recently, Panasonic Appliances Cold Chain Thailand mainly used R134a and R404a refrigerants for its refrigerated showcases, beverage coolers and ice cream freezers, targeted at the convenience store markets in Southeast Asia and Japan. However, in 2019, the company began transitioning towards full-scale production of equipment using R600a and R290.

"Freon alternatives still exist in Asia's cold-chain market, including Japan," said Obata. "However, amidst the need to reduce and transition away from freon use, we now think it is a situation where we must proceed with next-generation refrigerant product development in the next one to two years."

Panasonic Appliances Cold Chain Thailand is currently developing products that employ R600a. However, the company is considering the development of propane equipment in collaboration with the Oceania division of U.S.

commercial refrigeration manufacturer Hussmann, which Panasonic acquired in 2015. These products are targeted at the Oceania market, which is fairly advanced in its adoption of environmentally friendly equipment, Obata said.

Help from RAC NAMA

In 2017, Panasonic Appliances Cold Chain Thailand's manufacturing facility in Chachoengsao became the company's main factory, significantly increasing its production capacity for its commercial equipment. The expansion of its product line-up will continue to be a focus, along with an emphasis on safety, energy efficiency, and ease of maintenance, said Obata.

The company's Chachoengsao factory has been equipped with flammable-refrigerant charging equipment, with support from Thailand's RAC NAMA (Thailand Refrigeration and Air-Conditioning Nationally Appropriate Mitigation

Action) project, an international initiative to execute a transformation to green cooling in Thailand. (See sidebar, page 78.) In addition, the facility has set up a production line that can produce both propane and isobutane equipment in parallel.

In its efforts to transition towards hydrocarbon technology, Panasonic Appliances Cold Chain Thailand joins a number of other Thai manufacturers of refrigeration and air conditioning equipment making this transition with the support of the RAC NAMA project. (See ["Pushing Natural Refrigerants in Southeast Asia"](#) in the September 2019 issue and ["The Cool Sees R290 as the Future"](#) in the November/December 2019 issue of *Accelerate Magazine*).

So far, the company's development of R600a products "is progressing," said Obata. Regarding R290, "the key will be how well the running costs for propane-based equipment can be managed and

About RAC NAMA

The Refrigeration and Air-Conditioning Nationally Appropriate Mitigation Action (RAC NAMA) project is a Thai initiative aimed at initiating a sector-wide transformation towards the use of climate-friendly and energy efficient cooling technologies.

The NAMA Facility, a joint initiative of Germany and the U.K., commissioned the project to GIZ, Germany's international cooperation agency, in April 2016; it runs until March 2021.

The project is being implemented in partnership with the Thai Government, represented by the Office of Natural Resources and Environmental Policy and Planning (ONEP) and the Department of Alternative Energy Development and Efficiency (DEDE). The Electricity Generating Authority of Thailand (EGAT) is host of the RAC NAMA Fund, the financial facility of the RAC NAMA project.

By promoting climate-friendly and energy-efficient cooling technologies based on natural refrigerants (green cooling technologies), the RAC NAMA project supports Thailand in reaching its energy savings and greenhouse-gas mitigation targets.

For more about the RAC NAMA project see "[Transforming Thailand's Cooling Sector with NatRefs](#)" in the November/December 2019 issue of *Accelerate Magazine*.



In 2019, Panasonic Appliances Cold Chain Thailand began transitioning towards full-scale production of equipment using R600a and R290.

► controlled," he added. "However, in the mid- to near-term future, I don't imagine we'll be dealing with R134a products. I believe we'll have switched almost 100% to hydrocarbons."

To that end, Obata believes it is essential for the business to thrive in the domestic Thai market, which has a big manufacturing base, as well as the commercial market. He also sees the need for a natural refrigerant subsidy scheme similar to Japan's or stricter freon regulations similar to Europe's. In addition, Obata stressed that it is important to avoid creating friction with other local manufacturers, so "our idea is to protect and nurture the market while co-existing with the other local manufacturers," Obata said.

During the ATMOSphere Japan 2019 conference (organized by shecco, publisher of *Accelerate Magazine*), held in Tokyo in February, Panasonic announced that it would widen its focus on not only CO₂ but hydrocarbons as well. "For us, from the standpoint of a manufacturer, the need to push ourselves towards new things is our mission," said Obata. "That push is represented by our capital investment in product development for isobutane and propane equipment. Now that everything is in place, it is time to take on that challenge."

Following Panasonic's development and success with CO₂ systems globally, the company is now set to see its hydrocarbon-based equipment be adopted, not only in Southeast Asia and Japan, but potentially globally as well. ■ DY

Filipino Cold Storage Operator Cuts Risks and Energy With Ammonia/CO₂

Jentec Storage has installed the NewTon at three small facilities in the past two years rather than ammonia alone.

— By Devin Yoshimoto

Since opening its first cold-storage facility in 1997, Jentec Storage has used ammonia (NH₃) refrigeration at the majority of its roughly 30 facilities in the Philippines.

However, beginning in early 2018, the company began adopting ammonia/CO₂ systems at some of its small-sized facilities in an effort to reduce risks to its employees as well as save on energy use.

It's a significant move for Jentec, one of the biggest food-logistics companies in the Philippines, with over 100,000 cold-room pallet spaces and 60,000 dry-pallet spaces. The company serves well-known food manufacturing brands and fast-food chains such as Jollibee, Nestlé, Selecta/Unilever, KFC and many others.

Jentec now has three cold-storage facilities using the NewTon 3000 ammonia/CO₂ secondary packaged system, manufactured by Japanese OEM Mayekawa, said a Jentec representative.

The first was installed in March 2018 at Jentec's Sucat facility near Manila, and the second in July 2019 at its Palawan facility in the city of Puerto Princesa on Palawan Island in the western part of the Philippines. Jentec installed the third in August 2019 at its Kalibo facility in the city of Aklan in the country's Visayas region.

Preventing harmful leaks

One of Jentec's main challenges is preventing ammonia leaks that can harm employees. The reduced ammonia charge in the NewTon ammonia/CO₂ secondary systems has helped achieve this goal, while avoiding the use of freon and supporting sustainability goals, said the representative.

Additionally, while operating the first ammonia/CO₂ system at its Sucat facility over the past year, the company has seen energy-efficiency gains compared to freon-based systems, (such as those using R404A scroll compressors) operating at similarly sized facilities, said the representative. (Specific data for this NewTon system such as specific energy consumption could not be obtained for this article.)

The packaged NewTon systems also have a "much smaller" physical footprint, taking up less space than reciprocating ammonia-compressor systems, the representative said.

However, high initial costs for the ammonia/CO₂ systems remain a challenge. These systems are often five-to-six times the initial investment of comparable freon systems, Jentec said.

Despite this, Jentec believes that the benefits will justify the costs over time. The rest of the cold-storage industry, though, is still a very "price driven market," said Jentec, adding that end users alone should not be expected to bear the burden of these upfront costs, which should be balanced among all stakeholders in the industry.

Going forward, the company is considering retrofitting refrigeration systems at three more facilities with ammonia/CO₂ systems.

For the Philippines' rapidly expanding cold-chain industry, Jentec's use of ammonia/CO₂ systems signals one of a number of steps the industry is taking to adopt some of the latest energy-efficient technologies. ■ DY

Industrial Contractor GNQ Sees Opportunity in the Philippines

In an exclusive interview, *Accelerate Magazine* speaks with Alejandro Quitilig, President of GNQ — one of the top refrigeration contractors in the Philippines — about its use of natural refrigerants in the country's fast-growing cold-chain market.

— By Jan Dusek and Devin Yoshimoto



The cold-chain market is expanding in the Philippines, fueled by a growing population — projected to reach 142 million in 2045, up from 104 million today — and government investments in rural infrastructure.

For GNQ Industrial & Contracting Corporation (GNQ), one of the top industrial refrigeration contractors in the country, this represents a considerable opportunity to grow its business, but also significant challenges, including rapidly changing refrigeration technology, increasing competition and environmental regulations.

To shed light on GNQ's opportunities and challenges, including its use of natural refrigerants, *Accelerate Magazine* interviewed Alejandro Quitilig, President of GNQ, at his office in Parañaque City, Metro Manila.

// Accelerate Magazine: When did GNQ start working with natural refrigerants?

Alejandro Quitilig: We started using natural refrigerants, meaning ammonia, in 1988. This was when we were appointed exclusive distributors of Frick screw compressors by York, which owns

Frick. The challenge at the time was how to gain market acceptance of the screw compressors because most end users were using reciprocating compressors.

The first customer we approached was brewery San Miguel Corporation, because they were the largest end user of refrigeration. Once we were able to convince them to use screw compressors, it became easier for us to approach the other beverage and cold chain companies. Today, our focus is in the beverage sector, meaning soft drinks and beer, as well as the cold-storage industry. About 90% of our business is with ammonia and 10% is with freon.

// Accelerate Magazine: What is your view on the current state of the cold-chain industry in the Philippines?

Alejandro Quitilig: It is expanding. There are new companies entering the cold-chain market. There only used to be a few cold-storage operators, but now even certain companies that were originally only contractors have entered the cold-storage business. We see our customers increasingly building new cold-storage facilities in the regions of Cebu and Davao, which are further away from the more developed area of Manila.

// Accelerate Magazine: What do you think is driving this expansion of the cold-storage industry?

Alejandro Quitilig: It's the population. The population of the Philippines is increasing, so the government is constructing infrastructure in Visayas and Mindanao. They want to spread the population outside of Manila, which is already congested. We also have to take into consideration that the Philippine economy continues to grow.

// Accelerate Magazine: Going forward, what does this mean for GNQ as a business?

Alejandro Quitilig: Our competition is increasing. There used to only be a handful of companies competing for projects. But lately, there is an increasing number of foreign contractors coming into the market. Our strategy to compete is to continue to be cost competitive with our ammonia systems. For example, formerly, we were using components imported from certain overseas companies that were very expensive. But now we are able to look for components from other manufacturers in other regions with very competitive prices. So this lowers the overall costs for our customers.



Mount Apo, overlooking Davao City, a commercial center located on the southern Philippine island of Mindanao.

GNQ at a Glance:

- Designer, supplier, and installer of industrial refrigeration systems
- Established in 1975
- Appointed exclusive distributor of York refrigeration products in 1988
- Major sectors: Food and Beverage Processing, Breweries, Cold Storage and Distribution
- Major customers: Nestle, San Miguel, Zenith Foods, Royale Cold Storage, ISOC Holdings.
- Main office: Parañaque City, Metro Manila, Philippines

// Accelerate Magazine: In terms of technology, how have the refrigeration systems that you design, supply and install for your customers evolved?

Alejandro Quitilig: Overall, there had not been much change until two years ago when we heard about these new low-charge ammonia systems. We were about to use them but we found out that the air coolers were very expensive. They are twice the normal cost so we were not able to use them. To clarify, these were ammonia direct expansion systems as opposed to our usual pumped recirculated systems.

// Accelerate Magazine: What is the current level of awareness of low-charge ammonia technologies among end users in the Philippines. Do you see any interest?

Alejandro Quitilig: Yes, there is interest in these new technologies, of course, because everybody wants to be competitive and they want more efficient refrigeration systems. The cost of electricity is high as well, so they are also trying to find means to lower power consumption. In our projects, we always select the system that will give the highest Coefficient of Performance (COP).

In addition, especially in the beverage industry, companies are trying to minimize [ammonia] refrigerant charge. They are doing this by using a plate heat exchanger. The plate heat exchanger is an independent unit — one condenser, one evaporator — whereas before, it was centralized so we would have a large volume of refrigerant. We want to avoid that in case of a leak. If the company were located in a residential area, the government would go after them.

// Accelerate Magazine: Do you see any potential for CO₂ transcritical systems in the Philippines?

Alejandro Quitilig: Here in the Philippines, I believe CO₂ transcritical is not applicable because of the ambient temperature, which is usually around 35°C (95°F) to 40°C (104°F) in summer. We don't know much about this application yet, but if there is new technology that will overcome this condition, we will go for it. We are open to new technology.

// Accelerate Magazine: How is GNQ preparing for these future low charge ammonia and CO₂ technologies?

Alejandro Quitilig: We are closely cooperating with our partner Johnson Controls to actively seek out and learn about these new kinds of systems. We would like to



Alejandro Quitilig,
President, GNQ Industrial &
Contracting Corporation

use NH₃/CO₂ systems here in the Philippines, for example. In addition, we continually send our technicians for training conducted by Johnson Controls in Thailand. In the coming years, if there are any new developments, we will participate in that training.

// Accelerate Magazine: Finally, what is driving you personally?

Alejandro Quitilig: Our mission has always been to make GNQ lead the industry. So, we are teaching our people — teaching them how to run the business and also about the technology. We want this to continue. That is our mission. ■ JD & DY

TAPPING INTO THE COLD OF OUTER SPACE

SkyCool Systems has developed a system that leverages radiative cooling to improve the efficiency of refrigeration and air conditioning – and even to generate electricity.

– By Michael Garry

SkyCool panels serving as a subcooler for a store in Northern California (U.S.)



Humankind relies on the sun as a source of heat energy, but Aaswath Raman points out that there is another renewable resource above us: the sky, and beyond it, the cold of space.

Raman, an electrical engineer at the University of California, Los Angeles, is co-founder of SkyCool Systems, a Davis, California (U.S.)-based start-up. His work focuses on leveraging a natural phenomenon— radiative cooling – whereby materials exposed to the night sky emit more thermal (infrared) radiation than they take in, thereby becoming colder than the ambient air. The ancient Persians used this technique to create ice.

Funded by the U.S. Department of Energy, SkyCool has developed a prototype system whereby mirror-like reflective panels, made of special materials, leverage radiative cooling not only at night but also during the day to passively cool water.

During the day, these panels both reflect sunlight and radiate heat at particular wavelengths that break through the atmosphere and pass into space. The panels'

temperature can drop to up to 15°F (8.3°C) below ambient, according to Eli Goldstein, CEO of SkyCool and its other co-founder. (See, "[New Kids on the Block](#)," *Accelerate America*, January 2018.)

As a passive cooling system, SkyCool's technology can be employed as a condenser or subcooler in commercial refrigeration, providing a 10%-15% efficiency boost, said Goldstein. The system could be particularly useful as a gas cooler in a transcritical CO₂ system, he noted.

SkyCool recently completed the installation of its first supermarket pilot in Northern California (U.S.), using the panels as a subcooler, Goldstein said. "Happy to report that we are seeing a good amount of subcooling, and are hitting the 10% to 15% efficiency improvement target." Subcooling can be as much as 20°F (11°C) below the outlet of the condenser, he added.

Raman recently co-authored an article in the November 20 issue of the journal *Joule* (<https://bit.ly/2ScPyl6>) in which another application of the technology was described: using radiative cooling at night as a means to generate enough

electricity to power a light bulb. This device creates a cooling effect on one side, while the opposite side remains warmer; the difference in heat is converted into electricity (25 mW/m²) via a thermoelectric generator.

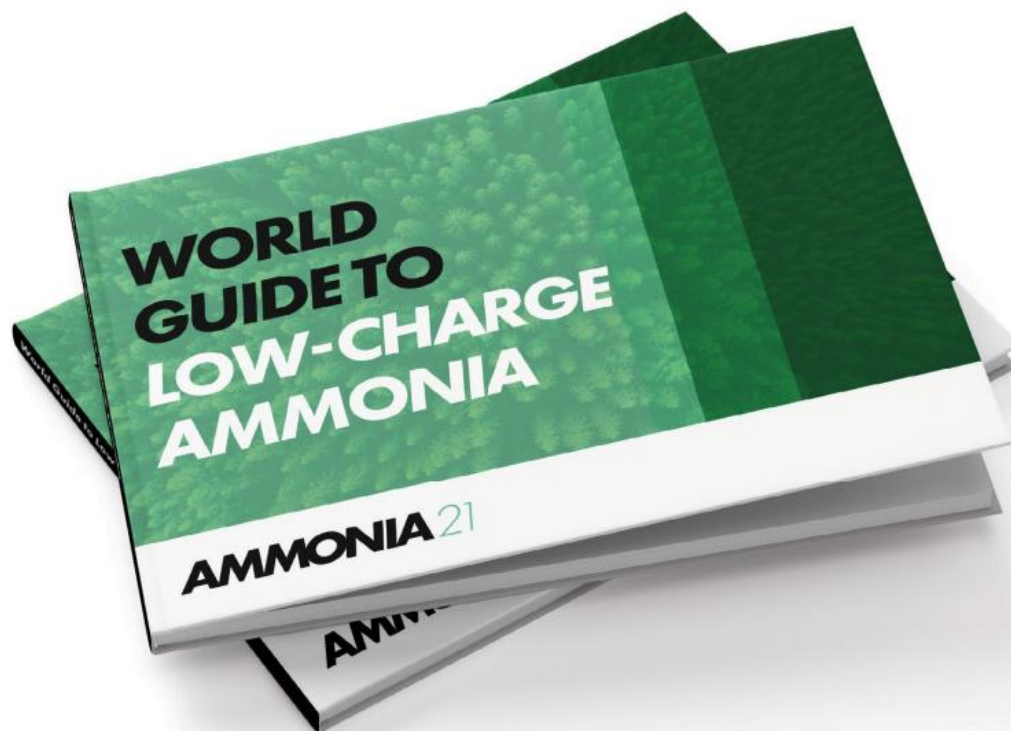
The window to space

In explaining radiative cooling at a TED Talk presentation in 2018, Raman said that the greenhouse effect, in which the atmosphere absorbs and reflects thermal radiation back to earth, doesn't capture all of the heat; some of it – at wavelengths between eight and 13 microns – trickles through into space.

Radiative cooling, he noted, is negated during the day by the radiation from the sun. To overcome that, Raman used insights from nanophotonics and metamaterials research to design a multi-layer optical material more than 40 times thinner than a typical human hair. This material releases its thermal radiation to "precisely where our atmosphere lets that heat out the best," he said. "We targeted the window to space." The material also reflects sunlight to avoid being heated up. ■ MG

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CLOSING THE GAP BETWEEN IDEAL AND ACTUAL



Ethos dashboard for MacBook

The Ethos optimization system identifies problems in refrigeration systems and suggests corrective actions, thereby improving efficiency, says Star Technical Solutions.

— By Tine Stausholm

In this age of the Internet of Things and the primacy of data, Star Technical Solutions (STS), the technical advisory service of U.K.-based Star Refrigeration Group, has created a data-driven performance optimization system called Ethos to help commercial and industrial end users find ways to save energy.

For example, a U.K. supermarket chain that installed the system at one of its distribution centers was able to reduce energy usage by 680,000kW, or 23%, thereby saving £68,000 (US\$88,500), said STS. This equaled a reduction of 190 metric tons of CO₂ emissions in a year.

Another end user, the Ice Co Storage & Logistics, located in West Yorkshire in Northern England, has installed the device at its cold-storage facility.

"We knew there were savings to be had, but Ethos has allowed us to identify where those savings could be made and how," said Malcolm Dufton, The Ice Co's Group Property and Energy Director, in a statement provided by STS. "The result is over £100,000 (US\$130,000) saving per annum on electricity, so now we are going to incorporate more plants into the network and roll out the program to our other plants and cold stores."

Current and historical data

Ethos is a standalone device, which can be fitted on both new and old HVAC&R equipment. It can be installed without

disturbing existing operations, according to STS, and it comes with its own 4G internet router that can send the information gathered to a web portal showing both current and historical data. Email and text message alarms can be set up for irregular operating conditions.

The device measures the gap between ideal and actual operating conditions, identifies problems and suggests corrective actions to reduce the gap. Measuring energy consumption throughout the day, the device calculates the estimated annual savings that can be achieved if the suggested actions are acted upon.

Typical savings achievable are 10% to 30%, according to STS, and large corrective investments are not always necessary, meaning that these savings can often be achieved at little additional cost.

For the U.K. supermarket, some of the maintenance actions suggested by Ethos were thorough cleaning of all condensers, replacement of condenser float switches, repair of passing control valves, purging of air from the condenser, and optimization of adjustable Vi slides on the compressor.

Ethos also suggested equipment upgrades and replacement, which would require capital investment. According to STS, if carried out, these would have the potential to reduce the energy cost by a further 27%. These include the replacement of the condenser, which could give a 15% saving, and replacement of the evaporator, which could give a further 12% saving. ■ TS

A study by the National Technical University of Athens shows a mean 23% COP improvement via subcooling with an ammonia absorption chiller.

— by Michael Garry

ENHANCING A CO₂ SYSTEM'S EFFICIENCY WITH AN ABSORPTION CHILLER

A number of technologies have been developed to help increase the efficiency of transcritical CO₂ refrigeration systems, especially in high ambient conditions.

When the ambient temperature is higher than the critical point of CO₂ (88°F/31°C), CO₂ enters the supercritical phase and can't be fully condensed. It can be cooled, and the cooled gas-liquid mixture is further treated to create liquid CO₂ for the evaporator.

Adiabatic gas coolers, ejectors, parallel compression and subcooling are some of the key technologies that are used to reduce the workload in a transcritical CO₂ system in high ambients, thereby improving its efficiency.

A new research paper proposes another method: the use of an absorption chiller for subcooling. The paper, "Enhancing the performance of a CO₂ refrigeration

system with the use of an absorption chiller," was published in the December issue of the *International Journal of Refrigeration* and can be accessed at <https://bit.ly/34F5i9k>.

In this scenario, an absorption chiller, which does not use a compressor, is fed by waste heat generated by the transcritical compressors. The authors of the study – Evangelos Bellos and Christos Tzivanidis of the Thermal Department, School of Mechanical Engineering, National Technical University of Athens – found that in all cases, the examined system is more efficient than the reference, with a mean COP (coefficient of performance) enhancement of about 23% and a maximum improvement of 75%. The enhancements are greater in the cases with a higher compressor pressure ratio.

No external energy

According to the paper's abstract, the objective of the study was to "examine a transcritical CO₂ refrigeration system coupled to a single-effect absorption chiller." The role of the absorption machine is to create subcooling after the gas-cooler in order to increase the COP. The analysis is conducted with a validated numerical model, which is developed in Engineering Equation Solver.

Because the absorption system is fed by waste heat from the CO₂ compressors, "there is not any need for any external energy source," the abstract noted.

The system was studied and optimized for different heat rejection temperatures from 35°C (95°F) up to 50°C (122°F), and for different refrigeration temperatures from -35°C (-31°F) up to 5°C (41°F). The study found that "there is COP enhancement in all the operating scenarios and especially in the cases with higher heat-rejection temperature and lower refrigeration temperature," said the abstract. "The mean COP enhancement is about 23.4%, which is an important enhancement for designing more efficient systems." ■ TS



Dutch NatRef Pioneer Looks into His Crystal Ball

René van Gerwen, who has worked with natural refrigerants for more than a quarter of a century, talks about what's next.

— By Michael Garry



René van Gerwen

Twenty-five years ago, at the dawn of the modern natural refrigerants era, Dutch engineer René van Gerwen received a patent for a system that uses the most natural of all substances – air – in an industrial blast-freezer system.

Since then van Gerwen has dedicated his professional life to removing barriers to the wider application of sustainable refrigeration and heat pump technologies, focusing on energy efficiency, natural refrigerants like ammonia, hydrocarbons, CO₂ and air, as well as alternative technologies like Stirling, magnetocaloric and thermoacoustic refrigeration.

He is currently owner of Entropycs (Entropy Cooling Solutions), a refrigeration consultancy that he founded in 2016. Prior to that, he was Global Lead Engineer for many years at Unilever, one of the largest end users of refrigeration in the world.

In 2004, van Gerwen co-founded Refrigerants, Naturally, an association alliance of multinationals and NGOs promoting use of natural refrigerants in point-of-sale equipment; he represented Unilever in the group until 2016.

Last year, as board member of the Dutch Refrigeration Association KNVvK, he founded the Dutch Platform for Natural Refrigerants, of which he is now coordinator. He is also actively working on safety standards for hydrocarbons, CO₂ and ammonia.

This year, he was a co-initiator of RefrigerantsNaturally4Life, a European Union project focusing on small retailers.

To get his views on where he sees natural refrigeration going, *Accelerate Magazine* conducted the following interview.

// *Accelerate Magazine*: How would you assess the progress made by low-charge ammonia systems in industrial refrigeration?

René van Gerwen: The progress depends on the specific low-charge technologies. DX is already successful for smaller systems, with reduced costs. Indirect and cascade systems (combined with CO₂, water, brines) are almost state of the art in cold-storage facilities in several European countries. Very low-charge condensers, air coolers and separators are still not so common and often too expensive or not sufficiently reliable; there may be a longer way to go for those.

There is still a certain conservatism with contractors in Europe preferring to go for the conventional pumped-recirculation technology with lots of ammonia, but that may be a matter of time to change, when there will be more experience, particularly with controls.



“ I fear the hypothetical sad moment in the future, when we may identify that [HFOs] have serious negative environmental effects. ”

// Accelerate Magazine: How widely used will transcritical CO₂ systems become in industrial refrigeration?

René van Gerwen: I expect its use may be limited in industrial, as high-stage ammonia or propane, with low-stage CO₂, may be more attractive and feasible alternatives, particularly in warmer climates.

// Accelerate Magazine: Which refrigerant has the best prospects for commercial and industrial heat pumps, propane, ammonia or CO₂?

René van Gerwen: For industrial, I expect that ammonia may have the best prospects, and propane for the smaller ones. In commercial it depends on the applicability of ammonia and propane at a specific site, and the local safety regulations. Highly efficient CO₂ heat pumps may become pretty complicated and costly, so not all contractors and

end users are able or willing to choose that alternative.

// Accelerate Magazine: Which refrigerant has the best prospects for commercial and industrial chillers: propane, ammonia or CO₂?

René van Gerwen: For chillers, the situation may be quite similar to the heat pump situation, explained above.

// Accelerate Magazine: What impact will the rise in the IEC charge limit for hydrocarbons in commercial cases from 150g to 500g have on adoption of hydrocarbon cases?

René van Gerwen: The voting process for this IEC 60335-2-89 standard change was a fantastic achievement, where the natural supporters did a great job after the first, negative-voting, result. This change definitely opens a larger window

of opportunities for hydrocarbons, as in various applications it is not practical or feasible to keep charge below 150g.

For example, when I worked on some specific types of ice-cream cabinets with propane, we decided to have two separate refrigerant circuits to keep charge per circuit below 150g, making the business case quite problematic. Being able to do this with one circuit helps for further market penetration.

Also, this is a precedent for IEC standards for air conditioners and heat pumps, where a similar change is in preparation now. We intend to adopt these standards as EN (European) standards as well, which may further increase the impact of this change.

// Accelerate Magazine: Will propane be widely used in room air conditioners?

René van Gerwen: That will be a matter of time for very small charges, with a bit of additional safety features included. In international standardization bodies like CEN, ISO and IEC, we are working on this. And do not forget the future market for small domestic heat pumps, particularly in those countries where natural gas heating becomes problematic. Propane is the ideal refrigerant for those applications.

// Accelerate Magazine: Which refrigerants will ultimately be more widely used in commercial, industrial and residential HVAC&R: natural refrigerants or HFOs/HFO blends?

René van Gerwen: This is the ultimate key question. We will know the answer in 10 years. My personal opinion is that we all should have a clear preference for naturals, which are proven as environmentally benign. Only where and when natural is not (yet) feasible, we may (temporarily) use HFOs, blends or R32.

I fear the hypothetical sad moment in the future, when we may identify that those substances have serious negative environmental effects. Once spread over the world as refrigerants in a wide variety of appliances, it is very difficult to remove those substances from the planet again. We know this from the past, where we already have experienced such "aha moments" twice, with the ozone hole and global warming, and I do not want to have such an experience a third time. But, HFOs, blends or R32 are commercially much more attractive than the cheap naturals. So, where is my crystal ball?

// Accelerate Magazine: Do end users promote their use of natural refrigerants enough?

René van Gerwen: The big (multinational) end users have to make the difference; they have the power to make the change to naturals and to lead by example, as some big supermarket and food companies have shown already. For example, during the years I worked at Unilever, we pioneered since 2003 using propane in small plug-in commercial appliances, which is today fully state-of-the art. In this process, NGOs have successfully pushed this, and may continue to challenge other big companies.

For smaller end users this is much more difficult as they do not have the resources, time and expertise to be pioneers. Therefore, recently the EU project RefrigerantsNaturally4Life started, focusing

on small retailers, in particular in the organic food business. In addition, the association called Refrigerants Naturally! is now open for all end users, contractors and suppliers to join forces.

// Accelerate Magazine: What alternative refrigeration system, such as magneto-caloric or thermoacoustic, has the greatest chance to seriously compete with traditional vapor-compression systems?

René van Gerwen: Alternative technologies like Stirling, magnetocaloric, thermoacoustic and others may have attractive niche market opportunities, but may remain too expensive to compete in mainstream applications. And we often forget the disadvantage of most of these alternatives, which require secondary circuits to distribute heat from and to the primary system, while vapor compression includes an efficient distribution function in itself.

Other alternatives based on sorption technologies (classical absorption or adsorption) have a good chance in several application areas, where this secondary-circuit disadvantage does not exist; in addition, attractive opportunities for heat recovery, heat pump and combined heat and power (CHP) functions may make sorption even more competitive. And last but not least, my open air-cycle baby (patented in 1994) has not grown into a great adult yet, but I still see it as a serious future competitor, because of its extreme simplicity resulting from the fact that air is directly cooled or heated without the need of any additional refrigerant.

// Accelerate Magazine: What's the biggest change in refrigeration that you've seen in your career?

René van Gerwen: Until 1989, we all thought that refrigeration was a fully developed and mature, stable technology, with a simple choice among four refrigerants.

Then the big change came, triggered by the hole in the ozone layer. Since then, we have had to learn to cope with very dynamic businesses with continuous changes, difficult strategic choices among numerous refrigerant options, emerging new technologies and innovations. Because of these continuous dynamics, it is a fantastic business to work in, with never a dull moment. ■ MG



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