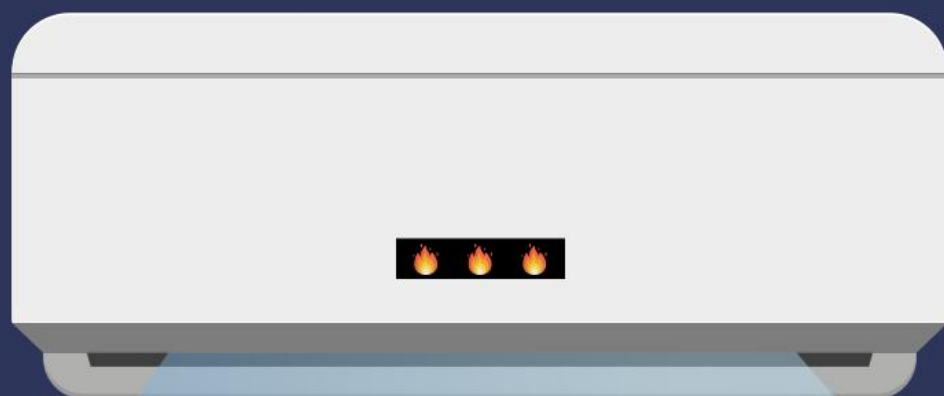


OCTOBER 2019

ACCELERATE

ADVANCING HVAC&R SUSTAINABLY

MAGAZINE



HOW DO WE COOL A WARMING WORLD (Without Making It Warmer)?

p.28

North America
Weis Markets'
CO₂ Success

p.36

Europe
Delhaize Store
Saves Energy with
NH₃/CO₂/glycol

p.46

China
Spar Store
Opts for R290

p.78



The future of CO₂ refrigeration is now!

Carrier Commercial Refrigeration celebrated the delivery of its 10.000th CO₂ mechanical system in Europe.

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A Quick Look

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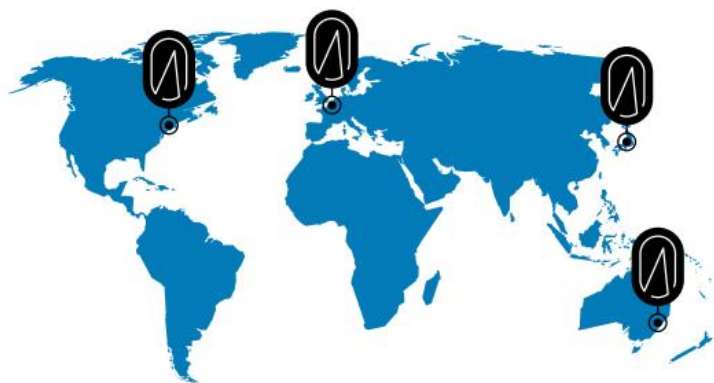
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ACCELERATE

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.

Sign up [here](#) to receive a regional Accelerate24.news newsletter highlighting the top stories, delivered every Tuesday.

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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: Where do we stand?

Publication Date: November 19

Ad Deadline: November 5

// ISSUE #106

January 2020

Cover Story:

Women in Natural Refrigerants

Publication Date: January 8

Ad Deadline: December 20

Print Distribution:

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

// ISSUE #107

February 2020

Cover Story:

How are NatRefs transforming heating and cooling of buildings?

Publication Date: February 6

Ad Deadline: January 27

// ISSUE #108

March 2020

Cover Story:

Which NatRef is Best: CO₂, Ammonia or Hydrocarbons?

Publication Date: March 5

Ad Deadline: February 21

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

// ISSUE #109

April 2020

Cover Story:

How CO₂ heat pumps make electric cars go further

Publication Date: April 8

Ad Deadline: March 27

// ISSUE #110

May 2020

Cover Story:

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

Publication Date: May 6

Ad Deadline: April 24

The editorial calendar is subject to change by the publisher.

The Climate Blind Spot

— by Michael Garry

While not as dramatic as power plants, oil and gas boilers and automobiles, HVAC&R technology is a major contributor to the climate crisis — one that many people overlook. In fact, it's been described as a "blind spot" in the climate agenda.

If the average person knows anything about the impact of refrigerants on the environment, it's usually the ozone-layer-depleting effect of "Freon," the popular name for CFCs and HCFCs. It's easy to understand that the ozone layer protect us from cancer-causing ultraviolet radiation, and that we needed to get rid of refrigerants that interfere with that protection.

Those refrigerants, as well as their replacements (HFCs) are also super-powerful greenhouse gases that contribute to the warming of the earth thousands of times more than CO₂ emissions from fossil fuels. That's something that most people don't realize unless they carefully follow environmental news.

The global-warming impact of fluorinated gases is significant enough that 197 nations approved the creation of the Kigali Amendment in 2016 to substantially phase down their production and use by 2047 (2036 for developed nations). So far 83 nations have ratified the amendment. (See [page 20](#)) Full implementation will reduce global warming by up to 0.4°C (0.7°F) by 2100, a significant number as the world struggles to keep temperatures from rising more than 1.5°C (2.7°F).

But it's not just refrigerant emissions that matter. In fact, they account for about a third of the overall CO₂e emissions created by cooling equipment, with the rest generated by electricity use, if supplied by fossil fuel plants.

Natural refrigerants can help reduce the amount of electricity usage by boosting the efficiency of the equipment, but other factors play into efficiency as well, like variable-speed fans and compressors and better maintenance. All told, efficiency improvements combined with natural refrigerants can cut warming by as much as 1°C (1.8°F) by 2100.

And that's still not all. As described in this month's cover story ([page 28](#)), rising global temperatures are driving much greater use of air conditioning among the middle class in developing countries, and that is adding to the climate emergency. Moreover, there are millions who lack access to life-saving cooling, and filling that void will contribute further to global warming.

According to the International Energy Agency (IEA), energy needs for space cooling will triple by 2050. The adoption of efficient ACs equipped with natural refrigerants, among many other measures described in the cover story, will be urgently needed over the next decade.

Of course, the decarbonization of energy and the transition to renewables must take place at an expedited pace, and even here the refrigeration cycle plays a key role in the form of energy-efficient electric heat pumps that use natural refrigerants. These devices have been identified as a vital part of the effort to transition away from natural gas and other fossil fuels (oil and propane) used in homes and buildings. (See "[NatRef Heat Pumps: A Key Piece in a Decarbonized Future](#)," *Accelerate America*, April-May 2019.)

If we solve the climate crisis, as we must, a major contribution will be made by the HVAC&R sector.



Michael Garry
Editor in Chief

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For further information on our **V-SHAPE**, please visit our website.



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Letters to the Editor

DENY, DELAY, DOMINATE AND DUMP

It is commendable that *Accelerate Magazine* is staying on top of the potential dangers of large-scale HFO emissions ("HFOs: How much is too much?" September 2019). The concern about TFA accumulation in drinking water is especially poignant. The fact is that the potentially critical impacts of HFOs may not be knowable until it is too late. Governments are being negligent in not regulating these substances.

The 2018 Scientific Assessment of Ozone Depletion report's conclusion that "there is 'increased confidence' the TFA produced from the degradation of [HFO] 1234yf and other refrigerants 'will not harm the environment over the next few decades,'" is hardly reassuring. What about the following few decades? It will all depend on the volume of total global emissions. With governments giving a green light to limitless HFO consumption, industry will never voluntarily curtail emission levels.

It's no surprise that Chemours (formerly part of DuPont) dismisses the potential ecological danger of TFA accumulation resulting from HFO emissions. Of course. This is in keeping with DuPont's playbook. The company has a pathetic track record, from the 1970s, 1980s and beyond, of vigorously marketing their fluorocarbon refrigerants (CFCs, HCFCs and HFCs), even after there was conclusive scientific evidence that their products were endangering the ozone layer and the global climate.

From the onset of the ozone-layer crisis, the chemical industry's strategy to protect their global monopoly of the refrigerants market, can be summarized by the four D's: deny, delay, dominate and dump: Deny that there is an urgent problem, and that they and their products have any responsibility; delay effective national and international regulatory action that might negatively impact upon their profits; dominate the public

debate, governments' responses, and most importantly, the marketplace; and, whenever possible, dump your obsolete technologies in the vulnerable markets of developing countries to extract further profits.

For example, on June 30, 1975, a DuPont advertisement in the *New York Times* read: "Should reputable evidence show that some fluorocarbons cause a health hazard through depletion of the ozone layer, we are prepared to stop production of the offending compounds." Around the same time the trade magazine *Chemical Weekly* quoted the Chair of the Board of DuPont as saying that ozone-depletion theory is "a science fiction tale...a load of rubbish... utter nonsense."

A DuPont newsletter, written in 1990 but circulated as late as 1992, ridiculed those, like Greenpeace, who were calling for an immediate ban on ozone-depleting substances (ODSs) such as CFCs and HCFCs: "We certainly have the option of no longer refrigerating our food supply, 75% of which is refrigerated as it is harvested, processed, stored, distributed or served. Are we prepared to be totally dependent on food that is consumed as soon as it is harvested? Or food that is dry, canned, smoked, salted or pickled to prevent spoilage?" The newsletter then asserted that for "...40% of the CFC market, largely refrigeration, no completely environmentally neutral alternative has yet been developed, nor is any likely in the near future."

On December 1, 1992, the London *Financial Times* reported that "DuPont had invested US\$450 million in HCFC and HFC production, and expects to hit the US\$1 billion mark in 1995, with an expected recovery period for the investment of no less than 10 years. The company claimed to require another 10 to 20 years of HCFC and HFC production to profit above and beyond recouping their investment."

But DuPont was not alone. Other chemical corporations joined in the concerted effort to delay regulatory actions on fluorocarbon refrigerants and the uptake of sustainable alternatives, such as natural refrigerants.

In 1991, Hoechst distributed millions of leaflets in Germany stating that "Greenpeace is endangering the lives of children all over the world by opposing refrigerant substances necessary for refrigeration and for the food chain."

The same year ICI wrote to U.K. Greenpeace supporters: "Can we all go back to the laboratory and spend the next 10 years working on Greenpeace ideas to see if they can be made to work in practice? Greenpeace have refused to join in any discussions of what might actually be done about the problem in a practical way. After all, it is so much easier to stand on the sidelines and criticize."

And in 1992, a high-level ICI representative was quoted as saying: "Greenpeace lacks a sense of urgency. Most alternatives it talks about are not available. They're either pie-in-the-sky or will only be feasible next century. Our alternatives are available now."

In 1992 Greenpeace Germany initiated the commercial development of a hydrocarbon domestic refrigerator, Greenfreeze, which is safe for the ozone layer and the climate. Greenpeace made the new technology freely available to the world in 1993. Today there are over 1 billion Greenfreeze refrigerators in the world, and the technology is set to dominate the domestic refrigerator market.

Had the chemical industry's long-term strategy prevailed, there would not be any alternatives to fluorocarbons in domestic refrigerators today.

It looks like the chemical industry is headed for an encore performance with its HFO generation of fluorocarbon refrigerants.

Janos Maté
Senior Consultant
Greenpeace International
Vancouver, B.C., Canada

USING AMMONIA FOR AC

In regards to using ammonia as a refrigerant in air conditioning systems ("[What About Ammonia for Air Conditioning?](#)" *Accelerate Magazine*, July-August 2019), Azane and its parent company Star Refrigeration have installed our air-cooled ammonia packages for air-conditioning on a number of occasions. It might be surprising to know that we've even installed ammonia for air conditioning for a department clothing store. In every instance, the end user was specifically looking for a natural refrigerant solution, but they were also looking for something that, of course, made business sense.

The payback can vary, primarily depending on climate. If it's done right, there's no doubt ammonia will be more efficient, more reliable, and give double the lifespan of a commercial system; but if the system only runs two months out of the year, the payback component related to energy performance can be diminished.

On the flip side, the business case in warmer climates can be really compelling – just as it is for process applications that work their systems hard and require high levels of resilience and reliability. In some of these applications, a commercial chiller may only last five years!

Total cost of ownership (TCO) is another thing all businesses like to talk about, though customers who are myopic in nature will look for the lowest capital cost at the expense of lifecycle cost. I've not looked at any job and found the TCO of an ammonia system to be more than an HFC system; even if the payback is pushed out in some air-conditioning applications, the TCO savings over the life of the system are still dramatic.

Caleb Nelson
Vice President, Business Development
Azane
Missoula, Mont.

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.

Natural Refrigerants in South Africa

Ammonia, CO₂ and hydrocarbons have contributed to the economic growth of South Africa, and their impact continues to increase.

— By John Ackermann

Since the 1930s, large ammonia refrigeration plants in South Africa have cooled fruit and provided cold storage for meat exported from neighboring countries via the port of Cape Town.

South Africa has also accumulated a wealth of expertise and experience in ammonia refrigeration with other large public cold storage facilities, abattoirs, supermarket distribution centers, and scores of Controlled Atmosphere (CA) apple storage facilities, as well as wineries, fish processing, and breweries.

In the gold and platinum mining sectors, ammonia refrigeration plants have made it possible to mine at depths beyond 3km. Large poultry and dairy industries have high tonnages of installed ammonia refrigeration plants, many that have been operational for well over 40 years.

The application continues to expand as systems become smaller in response to the availability of small-capacity compressors designed for smaller charges of ammonia. These low-charge ammonia systems – in particular packaged and containerized units – are gaining wider use as a result of promoting greater safety compliance.

To support the many ammonia systems within its borders, South Africa has a pool of well-established contractors who specialize in design, installation, repair and maintenance. With their experience, South African contractors have gained

contracts across Africa, including the island of Mauritius, and have even sent equipment to South America. Ammonia refrigeration systems for fruit cooling, in particular pome fruits, and beer brewing have stimulated international technology transfer and contracts for projects to be undertaken in foreign countries.

CO₂ FOR COMMERCIAL REFRIGERATION

In South Africa, the large-scale use of natural refrigerants in commercial refrigeration, in particular the retail sector, has only taken off in the past 10 years. Since the signing of the Montreal Protocol in 1987, the commercial refrigeration sector has been bombarded continually with new generation synthetic refrigerants claiming to be immune against international environmental embargos, only to discover years later that these would also be phased out or down. Commercial refrigeration was in need of a natural refrigerant that has the same reliance and performance that ammonia has had for decades.

In 2008, Woolworths, together with Commercial Refrigeration Services (CRS) and Mainstream Refrigeration, started to develop cascade R134a/CO₂ systems for its supermarkets. A year later, GIZ funded two cascade CO₂ systems in Pick 'n Pay stores, one in Cape Town and another in Johannesburg.

The lack of skilled technicians, limited availability of components, and caution

around the excessive pressures gave a slow start to the application of CO₂ refrigeration systems in South Africa. Initially, many in the industry thought it to be merely academic and not a viable long-term solution.

But by the start of 2018, that situation had changed completely, with many CO₂ systems operational in Woolworths, Makro, and Pick 'n Pay stores. In recent times, most new CO₂ systems have been transcritical.

The pool of skills required for CO₂ has grown and the so-called "fear" of high pressures has faded. The Kigali Amendment and its inclusion in the Montreal Protocol, and a looming carbon tax – no matter how distant or uncertain it may be in South Africa – are changing attitudes towards the perceived hurdles and misconceptions around natural refrigerants in AC and refrigeration applications.

Natural refrigerants are beginning to cross sectors. Ammonia, which has for many years been the norm in industrial applications, is moving towards commercial applications. CO₂, well established in the commercial sector, is moving towards industrial applications. Meanwhile, a large percentage of domestic refrigerators manufactured in South Africa are charged with isobutane (R600a). Propane (R290)-charged bottle coolers, self-contained vending cabinets and island freezers are being installed in supermarkets and convenience stores.

ADDRESS SAFETY HEAD ON

The resistance to natural refrigerants stems mainly from a lack of handling skills, misconceptions, and lack of knowledge. The most effective option to overcome the resistance is to address the safety challenges around each natural refrigerant head on, and to find a way to make it feasible for the desired application without any compromise on safety. This requires training and employing skilled persons only.

The lack of regular inspections by government departments is often given as an excuse for noncompliance to safety standards. However, the high cost of accidents and the risk to insurers should never be overlooked.

The South African National Standard (SANS) for the design and operation of refrigeration and air-conditioning systems, SANS 10147, is being updated to incorporate changes in international standards and some new refrigerants used in air conditioning and refrigeration. In addition, the national training curriculum for refrigeration technicians is being reviewed to incorporate specific skills required for all the commercially used natural refrigerants. These developments bode well for the future use of natural refrigerants in South Africa. ■ JA



John Ackermann has been involved in the refrigeration industry for nearly 50 years. He runs his own refrigeration components business and founded *The Cold Link* newspaper in 1987, travelling the world to report on topical issues and present at conferences. He maintains a vigorous involvement with industry associations around the world and plays an active role in the implementation of the Montreal Protocol in South Africa, working closely with the GIZ, UNIDO, and other industry role players.

AMERICAS

October 8

EPA GreenChill Webinar: Benefits of Partnering with GreenChill for Small and Independent Grocers, Online

The U.S. Environmental Protection Agency's GreenChill program hosts this webinar, which features Rene Tanner of the Port Townsend Food Co-op and Patrick Cribb and Brett Frazer of City Market.



<https://bit.ly/2m6XoFc>

October 8-11

RETA National Conference, Las Vegas, Nev.

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



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



@RETA_HQ

October 12-15

The National Frozen & Refrigerated Foods Convention, Orlando, Fla.

The event focuses on one-on-one business meeting among retailers, manufacturers, sales agents, logistics providers and suppliers.



<https://bit.ly/2meq7bm>

November 5

International Conference on Solar Air Conditioning, Santiago, Chile

SAC 2019 features solar cooling systems based on the coupling between PV and air-conditioning systems. It covers usage of solar heat beyond simply cooling, such as domestic hot water, space heating, process heat, and heating for networks.



<https://bit.ly/2ke2AXr>

November 27-29

ExpoFrioCalor Bolivia 2019, Santa Cruz de la Sierra, Bolivia

International Exhibition of Air Conditioning, Heating, Refrigerating and Sanitary Hot Water. The exhibition, talks and activities are all taking place in parallel, allowing contact with companies and speakers, who will inform visitors about new energies, sustainability, energy efficiency, alternative energies and environmental impact reduction.



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



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



Santa Cruz de la Sierra, Bolivia

EUROPE, MIDDLE EAST & AFRICA

October 16-17

ATMOsphere Europe 2019, Warsaw, Poland

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



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



@ATMOEvents #ATMOEurope

October 22-23

European Heat Pump Summit, Nuremberg, Germany

This event covers the European heat pump market, including technology and application trends.



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

October 24-25

Sustainable Retail Summit, Berlin, Germany

This Consumer Goods Forum event showcase examples of retail industry challenges and how to overcome them. The SRS covers the entire sustainability eco-system.



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



@CGF_The_Forum

October 28

RHC: 100% Renewable Heating & Cooling for a Sustainable Future, Helsinki, Finland

The European Technology and Innovation Platform on Renewable Heating and Cooling brings together stakeholders from the biomass, geothermal, solar thermal and heat pump sectors to define a common strategy for increasing the use of renewable energy technologies for heating and cooling.



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



#100RHC



Helsinki, Finland

November 12-14

Aclima, Tel Aviv, Israel

Aclima is a trade event in Israel for Air-Conditioning, Refrigeration, Heating & Ventilation Systems.



<https://bit.ly/2qUYrr1>

ASIA PACIFIC & AUSTRALIA

October 9-11

Refrigeration & HVAC Indonesia, Jakarta, Indonesia

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



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



@Messeninfo

November 7-9

ChinaShop 2019, Qingdao, China

ChinaShop 2019 is a retail exhibition featuring technologies and solutions for commercial design and point-of-purchase displays, cold-chain logistics and equipment, as well as local and overseas merchandising.



<http://en.chinashop.cc/>

November 7-10

HVAC/R Philippines, Pasay, Philippines

HVAC/R Philippines event is designed for manufacturers, suppliers, and buyers in the heating, ventilating, air-conditioning, and refrigeration industry. It gathers architects, developers, builders, contractors, engineers, and end-users for a showcase of the best and latest in HVAC&R technologies.



<https://bit.ly/2ompiC8sdfs>



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

November 15-15

Asia Cold Chain Show, Bangkok, Thailand

This trade show is dedicated to the cold chain industry. It attracts technology providers exhibiting cold storage infrastructure, temperature controlling, IT solutions, material handling equipment, and cold chain companies.



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



@AsiaColdChain

November 21-25

REFCOLD India, Hyderabad, India

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



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



@refcoldindia



Hyderabad, India



Cooling with natural refrigerants

GEA reciprocating and screw compressors

As a technology partner for refrigeration, air-conditioning and heating applications GEA offers comprehensive knowledge and equipment for the natural refrigerants ammonia (NH_3), carbon dioxide (CO_2 subcritical and transcritical), and hydrocarbons (HC/R290). For commercial requirements our CO_2 and HC compressors provide economically efficient solutions. For industrial applications our successful range of compressors includes long-proven ammonia systems.

Whether GEA Bock HG CO_2 , GEA Bock HC, GEA Grasso M, or GEA Grasso V – our extensive portfolio of commercial and industrial compressors is available for any task.



The Amount of Preventable F-Gas Refrigerant Emissions¹

Global Emissions Avoidance Potential

96.5

gigatons of CO₂e
between 2020 and 2050
by minimizing leaks and
increasing end-of-life recovery²



U.S. Emissions Avoidance Potential

39,000

metric tons³
of recoverable HFCs and
HCFCs in retired refrigeration
and AC equipment in 2020



U.S. Supermarket Emissions Avoidance Potential

8,600

metric tons⁴
of reclaimed HFCs
and HCFCs in 2017

22%

Rate of reclamation⁵

30,400

metric tons
of unrecovered refrigerant⁶
(58.5 million metric tons of CO₂e,
which is the same as that
produced by 12.5 million cars)

13.9%

Average annual emissions
(leak) rate of supermarkets
in U.S. EPA GreenChill
program (29% of all stores)

25%

Average annual emissions
rate of other U.S.
supermarkets⁷

30 million

metric tons of CO₂e
Annual emissions reduction
if all U.S. supermarkets'
leak rate was 13.9%

**\$156
million**

Annual refrigerant-
replacement cost reduction
if all U.S. supermarkets' leak
rate was 13.9%⁸



1. F-gas refrigerants include HFCs, HCFCs and CFCs. / 2. Project Drawdown, Refrigerant Management: <https://www.drawdown.org/solutions> / 3. <https://bit.ly/2kLaA2j> / 4 & 5. <https://www.epa.gov/section608/summary-refrigerant-reclamation-trends> / 6. U.S. EPA GHG Equivalency Calculator / 7. https://www.epa.gov/sites/production/files/documents/GChill_Retrofit.pdf / 8. U.S. EPA GreenChill Program

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

ECOTM heat transfer coolers



CO₂ SOLUTIONS

EXPERIENCE

Many years of proven experience with thousands of Modine ECO branded CO₂ gas coolers, unit coolers and heat exchangers introduced in all possible applications

INNOVATION

Modine uses state-of-the-art technologies allowing the installation of its gas coolers in regions with higher temperatures

ENERGY SAVING

CO₂ systems recover an important part of the heat they produce, which can be used for heating buildings

RELIABILITY

Thanks to the type of tubes used in Modine units, the maximum operating pressures that they can withstand are 80 bar for CO₂ unit coolers and 130 bar for CO₂ gas coolers



Get to know the most comprehensive product range in the market

www.modine.com

Kigali Update

Eighty-three countries (including the European Union) have accepted, ratified or approved the Kigali Amendment to the Montreal Protocol as of October 2, 2019.*

The countries that have done so since June 5 include: Cuba, Ethiopia, Cyprus, South Africa, Ghana, Peru, Seychelles, Cook Islands, Bhutan and Vietnam, the last two on September 27.

The Kigali Amendment was enacted on October 15, 2016, by 197 countries (parties) in Kigali, Rwanda; it took effect on January 1, 2019. The Amendment calls for the phase down of the production and use of HFCs by developed and developing countries following the acceptance, ratification or approval of the amendment by each country.

The 50 developed (Non-Article 5) countries start with a 10% HFC phase down in 2019 (compared to a baseline of average HFC production/use in 2011-2013), except for Belarus, the Russian Federation, Kazakhstan, Tajikistan and Uzbekistan, which start with a 5% phase down in 2020. All developed countries end with an 85% HFC phase down by 2036. Thirty-one have so far accepted, ratified or approved the Amendment.

The 147 developing (Article 5) countries fall into two groups. The majority starts a freeze in 2024 at a baseline of average HFC production/use in 2020-2022; those countries end with an 80% HFC phase down by 2045. The other Article 5 countries (Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates) start a freeze in 2028 at a baseline of average HFC production/use in 2024-2026; those countries end with an 85% HFC phase down by 2047. So far, 52 Article 5 countries (both groups) have accepted, ratified or approved the Amendment.

Here is a list of the 83 countries that have accepted, ratified or approved the Kigali Amendment as of October 2.

* 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
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

Participant	Acceptance(A), Ratification, Approval(AA)
Albania	Jan 18, 2019
Armenia	May 2, 2019 A
Barbados	Apr 19, 2018
Benin	Mar 19, 2018
Bhutan	September 27, 2019
Burkina Faso	Jul 26, 2018
Chad	Mar 26, 2019
Chile	Sep 19, 2017
Comoros	Nov 16, 2017
Cook Islands	Aug 22, 2019 A
Costa Rica	May 23, 2018
Côte d'Ivoire	Nov 29, 2017 A
Cuba	June 20, 2019
Democratic People's Republic of Korea	Sep 21, 2017
Ecuador	Jan 22, 2018
Ethiopia	July 5, 2019
Gabon	Feb 28, 2018 A
Ghana	Aug 2, 2019
Grenada	May 29, 2018
Guinea-Bissau	Oct 22, 2018
Honduras	Jan 28, 2019
Kiribati	Oct 26, 2018
Lao People's Democratic Republic	Nov 16, 2017 A
Malawi	Nov 21, 2017
Maldives	Nov 13, 2017
Mali	Mar 31, 2017 A
Marshall Islands	May 15, 2017
Mexico	Sep 25, 2018 A
Micronesia (Federated States of)	May 12, 2017
Montenegro	Apr 23, 2019

Participant	Acceptance(A), Ratification, Approval(AA)
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
Seychelles	Aug 20, 2019 A
Senegal	Aug 31, 2018
South Africa	Aug 1, 2019
Sri Lanka	Sep 28, 2018
Togo	Mar 8, 2018 A
Tonga	Sep 17, 2018
Trinidad and Tobago	Nov 17, 2017
Tuvalu	Sep 21, 2017
Uganda	Jun 21, 2018
Uruguay	Sep 12, 2018
Vanuatu	Apr 20, 2018
Vietnam	September 27, 2019 AA





World Ozone Day: '32 Years and Healing'

— By Tine Stausholm

Every year on September 16th, World Ozone Day is celebrated around the world, marking the 1987 signature of the Montreal Protocol on Substances that Deplete the Ozone Layer.

In 1974, scientists discovered that the CFCs ubiquitous in HVAC&R were damaging to the stratospheric ozone layer – a major threat to life on earth.

This realization led to the adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987, including CFCs, HCFCs and other ozone-depleting substances (ODSs). The treaty was signed on September 16 of that year and has since been ratified by all 197 United Nations (UN) member states.

Recognizing the impact of the treaty, in 1994, the UN General Assembly proclaimed September 16 the International Day for the Preservation of the Ozone Layer (World Ozone Day).

This year, World Ozone Day has been given a theme, “32 Years and Healing,” signaling more than three decades of successful international cooperation to protect the ozone layer and the wider climate, but also that there’s still work to be done.

World Ozone Day is recognized around the world. In Africa, the nation of Zimbabwe scheduled a symposium in Chinhoyi “to enlighten stakeholders on activities underway to protect the ozone layer and combat climate change,” said Perrance Shiri, the country’s Lands, Agriculture, Water, Climate and Rural Resettlement Minister, according to an article on the website Zimbabwe Situation (<https://bit.ly/2mc5Y5z>).

“The theme for this year’s commemorations is ‘32 years and healing’ and it celebrates over three decades of remarkable international cooperation to protect the ozone layer and the global climate system under the Montreal Protocol,” Shiri said. “It reminds us that we must keep up the momentum to ensure healthy people and a healthy planet.”

Photo by eberhard grossgasteiger
on Unsplash

Phase outs of ODSs

Under the Montreal Protocol, developed countries, in a stepwise fashion, phased out CFCs by 1996 and are set to eliminate HCFCs as of January 2020, while developing countries phased out CFCs by 2010 and are slated to remove HCFCs by 2030.

In 2016, HFCs, which don’t degrade the ozone layer but contribute significantly to global warming, were added to the treaty under the Kigali Amendment. A phase-down schedule will cut HFCs by 85% for developed countries by 2036 and by 80-85% for developing countries by 2047. The Kigali Amendment, which has so far been ratified by 83 countries, took effect on January 1, 2019. ([See page 20](#))

The Montreal Protocol has resulted in the elimination of “99% of ozone-depleting chemicals in refrigerators, air conditioners and many other products,” according to the UN’s website. Given the treaty’s far-reaching scope, in 2004 former UN Secretary-General Kofi Annan called the Montreal Protocol “perhaps the single most successful international agreement to date,” a view that is shared widely in the international community.

But has the treaty’s efforts had the desired effect on the ozone layer and human health?

In 2018, the World Meteorological Organization, with assistance from the United Nations Environmental Program (UNEP) among others, published a scientific assessment of ozone depletion. The assessment concluded that outside the polar regions, the ozone layer has increased by 1-3% per decade since 2000 and the so-called ozone hole in the Antarctic is “is recovering, while continuing to occur every year.”

At the current projected rates, the Northern Hemisphere ozone layer will be completely healed by 2030. The Southern Hemisphere and the polar regions will follow in 2050 and 2060, respectively.

The Montreal Protocol has also recently been proven to be successful in reducing the amount of UV radiation reaching Earth. A new study published in *Nature Scientific Reports* concluded that without the measures included in the Protocol, and its subsequent amendments, the amount of UV radiation reaching Earth would now have increased by 20% since 1990, and would quadruple by 2100.

The greater amount of UV radiation would have resulted in millions of additional cases of melanoma, other cancers and eye cataracts, according to the UN Environment Program.

On a wider scale, the efforts to protect the ozone layer have contributed to the general fight against the climate crisis by averting an estimated 135 billion metric tons of CO₂e between 1990 and 2010, according to the UN’s ozone website ozone.unep.org

However, the complete recovery of the ozone layer by the expected time frames is by no means assured. Recent examples of Montreal Protocol noncompliance could put this in jeopardy, delaying the return to historical levels by decades, and reducing the positive effects the Protocol has had on the wider climate issues.

In other words, healing – not healed. “Let us keep on working and healing the ozone layer together,” said Shiri. ■ TS

“

[World Ozone Day] reminds us that we must keep up the momentum to ensure healthy people and a healthy planet.

”

– Perrance Shiri, Zimbabwe’s Lands, Agriculture, Water, Climate and Rural Resettlement Minister

Global Poll Shows Differences in Attitudes Toward Climate Change

Views on the topic vary based on geographic location, according to a YouGov study.

— By Ilana Koegelenberg

A new YouGov study of 30,000 people in 28 countries (see <https://bit.ly/2kjVjVV>) has uncovered noticeable differences in attitudes around the world towards whether or not climate change is a real problem and the extent to which human activity is responsible for it.

YouGov, a U.K.-based online research organization, found that the people of India (71%) are the most likely to think that the climate is changing and human activity is the main reason for it, while the least likely are Norwegians and Saudi Arabians at 35%.

The poll concluded that U.S. residents are the most likely to believe that climate change isn't happening (6%) or if it is, it has nothing to do with human activity (9%). But these numbers are in the minority and in most countries, only 0-3% of people are in denial about climate change.

Across the world, people tend to expect that climate change will have a large or moderate impact on their own lives, the study found. There is, however, a notable East/West divide.

"People in Eastern and Middle Eastern countries tend to be much more likely to think that climate change will have a

great impact than those in the West," it said. For instance, while 75% of Filipinos and 65% of Qataris expect to have their lives disrupted in a large way, in Europe the most worried nation is Spain, at only 32%. The Nordic nations come in at the very bottom, with only between 10% and 14% thinking climate change will significantly disrupt their lives.

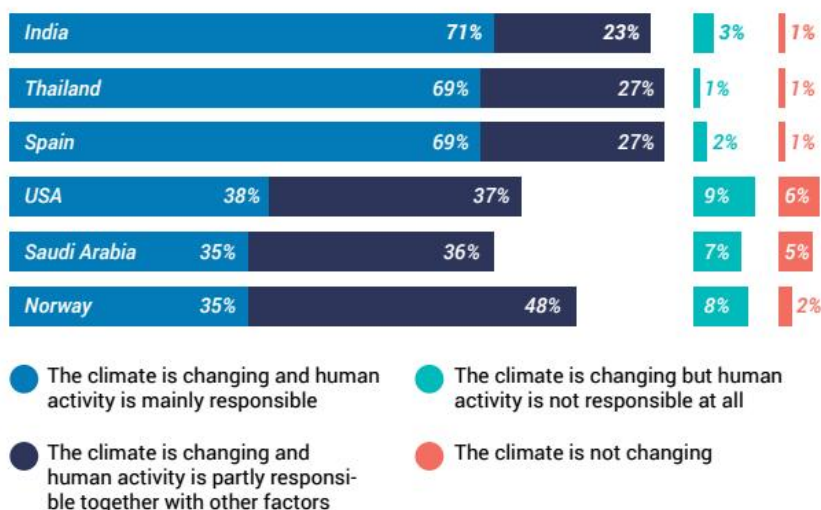
When asked which countries in particular they blame, the finger is pointed primarily at China and the U.S. — the largest greenhouse gas emitters — with India further away in third place.

DRASTIC ACTION NEEDED

The good news is that the public has faith that the worst effects of climate change can still be averted, but that dramatic action will be needed. The "drastic change" most people have in mind is reducing consumption. In 24 of the 28 countries surveyed, slowing the rate at which we consume resources is the preferred means by which we should combat climate change, as opposed to relying on technological innovation.

There is a strong tendency to believe that individuals can contribute more. European countries, however, believe that individuals lack the power to contribute. ■ IK

A LOOK AT SOME COUNTRIES AND THEIR VIEWS ON CLIMATE CHANGE



Source: YouGov



FOOD FOR THOUGHT.



Your fruits, vegetables, meats, dairy are all too precious to risk with any other but Hillphoenix®, the global leader in transcritical CO₂ refrigeration systems. Our installations number nearly 6,000 around the world, over 35 countries in climate zones from the Arctic Circle to below the equator — including over 800 installations in North America. Our extensive portfolio of CO₂ systems insures a perfect fit to every client's exact requirements. And our breadth and depth of experience in sustainable systems far exceeds any other supplier in the industry. Are we exaggerating to make a point? Not even a little bit.

Hillphoenix
a DOVER company

World in Brief

Stellar Appoints New CEO And President

Stellar, a Jacksonville, Fla.-based firm that designs, engineers and installs ammonia systems, has named Mike Santarone as its new CEO, while Brian Kappele has been promoted to Chief Operating Officer (COO) and President.

Mike Santarone joined Stellar as a Field Engineer in 1986 while Brian Kappele began his career at the company as an intern in its Food and Beverage division in 1997.

Stellar is an integrated engineering company that provides design, construction, installation and services to food processing plants, refrigerated warehouses, distribution centers and commercial buildings. The company has around 750 employees. ■ TS

Epta Announces Acquisition of Sofrico, Boosting CO₂ In Pacific

Effective August 30th, Epta SpA acquired Sofrico, a New Caledonia-based company specializing in systems, cabinets and cold rooms for commercial and industrial refrigeration.

With this acquisition, Epta, an Italian refrigeration OEM focusing on CO₂ systems, strengthens its operations in the Asia-Pacific region where it already has a presence in Australia, China, Thailand, Singapore, Malaysia and the Philippines.

"We are proud to welcome Sofrico to our Group," said Gennaro Gentile, General Manager of Epta Asia Pacific. "It confirms our desire to continue to strengthen our

TEKO Brings CO₂ Training to Bangkok

With increasing pressure on Thailand to phase down its f-gas usage, efforts by both local and international organizations to train the Thai industry on alternatives such as CO₂ are ramping up.

To that end, German OEM TEKÖ held its first CO₂ training session for Thai industry stakeholders in Bangkok, Thailand, on September 23.

The training session was an official side event of the ATMOSphere Asia 2019 conference (organized by shecco), which was held in Bangkok on September 25.

The goal, according to TEKÖ, was to provide participants with a basic introduction to the using CO₂. ■ DY

market share in strategic areas with high growth potential. This acquisition will make it possible to deliver to the Pacific Region the latest technology in refrigeration and know-how in the use of natural refrigerants such as CO₂."

"We are excited to join the Epta family," said Jérôme Lajouanie, Engineering Director of Sofrico – a company that offers design, sales and contracting services. "The combined strength of Epta's portfolio and Sofrico's engineering expertise will boost CO₂ technology expansion in Polynesia, Vanuatu, Fiji Islands, Samoa and the wider Pacific Region." ■ TS

Voting Closes October 16 for Innovation of the Year Award

Voting will close October 16 at 3 pm CET for *Accelerate Magazine*/Europe's Innovation of the Year award.

The award, voted on by the public leading up to the ATMOSphere Europe conference in Warsaw, Poland, October 16-17, recognizes companies that have developed an innovative natural refrigerant-based product expected to have a significant impact on the market.

This year's nominees are:

► Area Cooling Solutions' iCool Max CO₂ refrigeration unit

► Dorin's CD600 range of transcritical CO₂ compressors

► Mirai's Cold 15 O/A air-cycle refrigeration machine

For detailed descriptions of each nominee, go to <https://bit.ly/2mhsABO>.

To submit your vote, go to: <https://bit.ly/2mHwBQy>.

The winner will be announced during a special ceremony at the ATMOSphere Europe conference beginning at 7 pm CET on October 16.

Other *Accelerate Magazine*/Europe awards will be announced at the conference, including: Best in Sector/Food Retail, Best in Sector/Industrial, Best in Sector/Foodservice and Person of the Year.

These awards recognize people and organizations excelling in advancing natural-refrigerant technologies. ■ MG

Nidec's Secop Makes Comeback As Stand-Alone Company

German compressor manufacturer Secop was put up for sale earlier this year following parent Nidec's commitment to the European Commission to sell certain of its compressor business lines. This was a condition of approval for Nidec's acquisition of Embraco from the Whirlpool Corporation. The ESSVP IV fund has since successfully completed the acquisition of Nidec's Secop business.

Secop is a global provider of specialized compressors for refrigeration and freezer appliances, including an extensive line of R290 and R600a hydrocarbon compressors. The company has three manufacturing facilities in Slovakia, Austria, and China, as well as R&D hubs in Germany, Austria, Slovakia, China, and the U.S. and employs over 1,800 experienced employees.

As of September 9, Secop operated as a stand-alone company and will continue to operate globally under the Secop brand. "As a stand-alone company, Secop will be even more customer-centric, agile, and flexible and will strive to deliver superior value to customers and business partners," Secop stated in a press release.

Secop has set aside more than €33 million (about US\$36 million) in Austria and €24 million (about US\$26 million) in Slovakia to fund the development and further improvement of the design and manufacturing of the compressors produced in the two countries. Significant investments are also planned for Secop's plant in China to strengthen its position in the light-commercial and battery-driven business units. ■ IK

Evapco Expands Line of Low-Charge Ammonia Chillers

U.S. OEM Evapco has announced the expansion of its LCR-C line of low-charge packaged ammonia chillers, adding capacity and larger compressors for production and process cooling as well as air conditioning in a range of industrial applications.

Evapco, based in Taneytown, Md. Introduced the line in 2017 with the SS (small-single family) unit, 10 of which have been installed in the field, including at several dairies, a food ingredient manufacturer, a chemical manufacturer and a produce warehouse, according to Kurt Liebendorfer, Vice President at Evapco.

He described the "sweet spot" for the LCR-C chiller product line to be 0-35°F (-17 to 2°C) chilled-fluid temperatures. ■ MG

Australian Ammonia Training Program Wins Award

The Refrigerated Warehouse and Transport Association of Australia (RWTAA) launched in 2018, and has since been hard at work educating the country's cold-chain industry, even winning a 2019 Commissioner's Award for its accredited ammonia training on August 9.

It offers the only accredited ammonia training program in the country – the RWTAA Ammonia Emergency Management Training Program. It was created in conjunction with Australia's temperature-controlled industry and the Queensland Fire and Emergency Services (QFES) to provide a nationally accredited and recognized two-day training package.

The association has since held four training sessions with a fifth planned for October 5. ■ IK

'Chill Challenge' Seeks Solutions for Affordable Fridges

Non-profit organization Engineers Without Borders USA (EWB-USA) has launched the Chill Challenge: Affordable Off-Grid Refrigeration for Developing Countries. This offers natural refrigerant engineers, and others, the chance to help solve a growing problem by developing energy-efficient off-grid refrigeration solutions. The deadline for proposals is December 16, 2019.

The goal of the challenge is to help fill the refrigeration "gap" for the 60-150 million homes in developing nations that, over the next 20 years, are projected to acquire electricity via "mini-grids" or solar home systems. The task is to develop refrigerators and community icemakers that are significantly more affordable than units currently available.

"As many as 2 billion people live without refrigeration," said Andrew Dowdy, one of the EWB-USA engineers behind the challenge. "It's more than just a convenience; refrigeration can be an essential service, improving the quality of life for millions of people in a number of important ways. But it has largely been an unaffordable option, especially for those that live without access to grid power."

The challenge will offer up to 10 grants of US\$25,000-\$50,000 to support the development of proof-of-concept prototypes. More information can be found at <https://bit.ly/2p98co5> ■ TS



With temperatures and air-conditioning usage climbing, several new global initiatives are pursuing ways to improve the efficiency of ACs, paving the way for greater use of natural refrigerants like propane.

— By Michael Garry



HOW DO WE COOL A WARMING WORLD (Without Making it Warmer)?

The climate crisis has generally been regarded as a fossil-fuel problem, but it turns out there's another, often overlooked, contributor: artificial cooling.

Humans react to higher temperatures by flipping on their air conditioners, usually around the same time. Those air conditioners add to global warming by consuming energy and using high-GWP refrigerants.

More global warming means higher temperatures, which means more ACs, particularly in developing countries with a growing middle class like China and India. But more ACs mean more global warming. And so on.

Other refrigerant-related equipment at the residential, commercial and industrial levels also contribute to global warming. But the fastest-growing cooling segment, with the biggest impact, is expected to be room air conditioners, which have taken on elevated significance.

This is a departure for cooling, which has traditionally taken a back seat to heating as a focus of climate-change action. "Historically most of the emissions have been from the industrial north where the problem was heating, not cooling; so cooling was a blind spot," said Dan Hamza-Goodacre, Executive Director for the Kigali Cooling Efficiency Program (K-CEP), a philanthropic, efficiency-focused program supporting the Kigali Amendment to the Montreal Protocol. "But with the heat waves in places like Europe, Japan and Canada, that is changing."

The change was particularly evident in the lead up to, and during, Climate Week, held in New York City September 23-29, as numerous cooling-related

initiatives focused on efficiency were launched. Natural refrigerants, notably propane (R290) are beginning to play an important role in this effort to boost the efficiency of room air conditioners, particularly in India and China. (See sidebar, page 33.)

How much does cooling contribute to global warming? A seminal 2018 report by the Paris-based International Energy Agency (IEA), "The Future of Energy: Opportunities for energy-efficient air conditioning," offers some eye-opening data on the historical and projected growth of cooling.

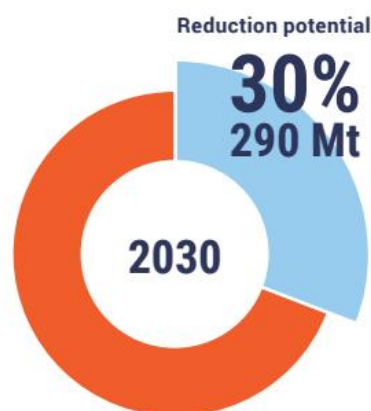
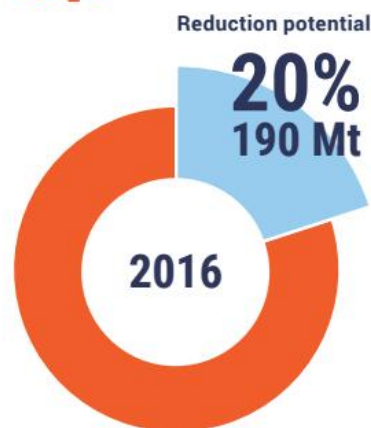
The current picture:

- ▶ The use of energy for space cooling is growing faster than for any other end use in buildings, more than tripling between 1990 and 2016.
- ▶ Since 1990, annual sales of ACs worldwide nearly quadrupled to 135 million units.
- ▶ There are about 1.6 billion ACs in use, with over half in China and the U.S.
- ▶ Keeping ACs running consumes over 2,000 terawatt hours (TWh) of electricity every year, which is 2.5 times the total electricity use of Africa.
- ▶ Space cooling accounted for around 14% of peak demand in 2016.
- ▶ Of the 2.8 billion people living in the hottest parts of the world, only 8% currently possess ACs, compared to 90% ownership in the U.S. and Japan.
- ▶ In all major markets today, people are typically buying air conditioners whose average efficiencies are less than half of what is available.

Global Emissions Reductions Via Optimization, Monitoring, and Maintenance of Unitary ACs¹

Emissions from electricity use (2016)

950 Mt
CO₂e²



1. Source: K-CEP, "Optimization, monitoring, and maintenance of cooling technology"

2. Green Cooling Initiative

2050 projections:

► In a baseline scenario, energy needs for space cooling will triple by 2050, reaching 6,200TWh, with nearly 70% of the increase coming from the residential sector.

► The lion's share of the projected growth in energy use for space cooling by 2050 comes from emerging economies, with just three countries – India, China and Indonesia – contributing half of global cooling energy-demand growth.

► The share of space cooling in peak electricity loads is projected to rise sharply in hot countries such as India, where the share would jump from 10% today to 45% in 2050.

► The share of space cooling in total electricity use in buildings will grow to 30%.

► Cooling growth would require adding the equivalent of all electricity demand today in the United States and Germany.

► Solar would contribute one-third of the cooling-related generating capacity in a baseline scenario.

In the face of this baseline scenario, the IEA report propose an alternative "efficient cooling scenario," based on much stronger policy action to limit the energy needed for space cooling, and compatible with the Paris climate agreement.

In particular, the report supports policies such as more stringent minimum energy performance standards (MEPS) and other measures such as labeling that could more than double the efficiency of AC equipment between now and 2050.

Under the efficient cooling scenario cooling-related energy demand climbs to 3,400TWh in 2050 – 45% lower than the level in the baseline scenario, a savings equivalent to all the electricity consumed by the European Union in 2016.

1. Source: Green Cooling Initiative, "Green Cooling Technologies," GIZ Proklima

2. SEAD, 2013

3. Park et al., 2007

4. Wang et al., 2004

Energy Efficiency Measures for Unitary AC¹

Cycle Improvements²

Improvement in COP	
Inverter/variable speed	20-24.8%
Compressor	6.5-18.7%
Heat exchanger	9.1-28.6%

Parasitic Loss Prevention²

Standby mode	0.8-9% (lower capacity, higher savings)
Crankcase heating and control	9.8-10.7%

Refrigerant

Hydrocarbons	4 ³ -30 ⁴ %
--------------	-----------------------------------

Change in use

Occupancy sensor

New programs abound

In recent months, the cooling challenge has captured the attention of the world and spawned several new global initiatives.

For example, The Climate Group, an international non-profit, in September launched the EP100 Cooling Challenge calling on companies to take steps to cool their operations more efficiently. Early joiners of the program include auto and farm-equipment manufacturer Mahindra & Mahindra, Dubai-based retailer Majid Al Futtaim and conglomerate Godrej Industries Limited and Associate Companies (GILAC).

In May, the Climate and Clean Air Coalition (CCAC) launched a multi-stakeholder efficient cooling initiative co-led by France, Japan, the UN Environmental Programme and the Institute for Governance and Sustainable Development (IGSD). In August, at the G7 roundtable in Biarritz, France, several countries followed up by pledging to take immediate steps to support energy efficiency in the cooling sector while phasing down HFCs.

The aim of the efficient cooling initiative is to “raise ambition and awareness at the highest levels of government about the opportunity and potential to find synergies between the HFC phase down and programs enabling efficiency,” said Nathan Borgford-Parnell, CCAC’s Scientific Advisory Panel and Science Affairs Coordinator. CCAC will organize meetings, he added, to “identify financial opportunities and technical and non-technical ways to improve efficiency or limit the need for cooling.”

In April, the Cool Coalition was formed. Led by UN Environment, the Climate and Clean Air Coalition (CCAC), K-CEP, and



Godrej's R290 inverter AC is an example of a highly efficient unit needed to reduce global AC usage.

Sustainable Energy for All (SEforALL), the Cool Coalition aims to facilitate a rapid global transition to efficient and climate-friendly cooling. It promotes a “reduce-shift-improve-protect-leverage” approach ([see page 34](#)) to meet the cooling needs of both industrialized and developing countries through better building design, energy efficiency, renewables, and thermal storage, as well as phasing down HFCs under the Kigali Amendment to the Montreal Protocol.

Hamza-Goodacre describes the Cool Coalition as an attempt to help many of the disparate groups working on cooling to “all work more closely together so we can speak with a louder voice and get the profile of cooling higher on the political agenda.”

The Cool Coalition comprises over 80 partners, including about 15 countries. Some examples of partners are the ministers of environment from Chile and Rwanda, the minister of foreign affairs from Denmark, as well as the heads of

Danish component maker Danfoss and French utility Engie. Partners fall under five stakeholder clusters: national governments and intergovernmental initiatives, cities, businesses, finance, and civil society.

During Climate Week, the Cool Coalition released a four-page brochure, “We Will: Efficient, Climate Friendly Cooling for All,” which, among other things, includes a map highlighting 26 developing countries that are developing national cooling plans or developing minimum energy performance standards, or both ([see page 32](#)).

This is part of an 18-month effort, including finance initiatives, cooling audits, cool-roof deployments, cooling technology pilots, cooling-as-a-service agreements and district cooling projects, that together represent “the biggest coordinated surge of activity in history to make efficient, climate-friendly cooling accessible to all,” says the Cool Coalition in its brochure.



Focus on developing countries

K-CEP, with US\$51 million in funding from 17 foundations and individuals, aims to help increase the energy efficiency of cooling for both fridges and ACs in developing countries in parallel with the phase down of f-gases as required by the Kigali Amendment. "We focus on the energy-efficiency of components like compressors and heat exchangers rather than the efficiency gains of refrigerants," which is left to the Kigali Amendment, said Hamza-Goodacre.

K-CEP helps developing countries identify, develop and adopt "the right policies," said Hamza-Goodacre. "We set out plans of action, including getting cooling to people most at risk from heat." The program also facilitates funding from institutions like the World Bank and private equity by covering the costs of analysis and due diligence.

Though K-CEP's focus is not on refrigerants, Hamza-Goodacre strongly supports the adoption of natural refrigerants. "In my view, to get to net-zero energy, we need natural refrigerants," he said. He agrees that R290, for example, offers efficiency benefits for ACs, though he sees greater gains from variable-speed compressors ([see chart, page 30](#)).

An often-overlooked way to improve efficiency is proper servicing and maintenance of equipment, which "doesn't carry on functioning in the same way forever after you install it," said Hamza-Goodacre. To that end, K-CEP is working with the government of Lebanon to incorporate energy-enhancing servicing measures into training for preventing f-gas leaks. "This is something the Montreal Protocol and the Multilateral Fund should pay for right off the bat," he said. "It's so obvious."



Continue on p. 34

Global Efforts to Develop Efficient Cooling

- 1 Mexico
- 2 Bahamas
- 3 Cuba
- 4 Jamaica
- 5 Dominica Republic
- 6 Saint Lucia
- 7 Barbados
- 8 Trinidad & Tobago
- 9 Colombia

- 10 Brazil
- 11 Chile
- 12 Argentina
- 13 Uruguay
- 14 Ghana
- 15 Nigeria
- 16 South Africa
- 17 Kenya
- 18 Egypt

- 19 Lebanon
- 20 Sri Lanka
- 21 Bangladesh
- 22 Thailand
- 23 Vietnam
- 24 China
- 25 Philippines
- 26 Palau



Source: Cool Coalition, "We Will: Efficient Climate-Friendly Cooling For All"

- Developing national cooling plans
- Developing minimum energy performance standards
- Developing national cooling plans + Developing minimum energy performance standards

Growing Use of R290 ACs in China and India

In the last few years, ACs that use R290 refrigerant have emerged as one of the most efficient comfort cooling units in the marketplace. India and China have so far led the development of these ACs.

Chinese manufacturers such as Midea, Gree and Haier recently confirmed production of 157,920 R290 split-type RACs, as of August 2019, according to a recent joint statement from Li Xiaoyan, Program Officer at China's Ministry of Ecology and Environment/Foreign Economic Cooperation Office (MEE/FECO) and Dou Yanwei, in the Department of Integrated Affairs at the China Household Electrical Appliances Association (CHEAA). (See ["Chinese Companies Report Production of Nearly 160,000 Propane Room ACs," Accelerate Magazine](#), September 2019.)

Orders were mostly bulk procurement from organizations such as schools or public buildings. There have been no reports of any private purchases.

The R290 ACs are fixed-frequency, 1.5HP units with energy-efficiency (EE) grade II, which signifies better energy conservation. (OEM Haier has produced 50,000 units of grade I EE, which represents the lowest energy consumption.) The R290 charge size is around 300g, following the requirements of China's national safety standard GB4706.32. (The International Electrotechnical Commission has begun looking at updating the charge-limit standard for hydrocarbons in AC; see sidebar, [page 35](#).)

One of the leading manufacturers of R290 room AC is the Indian OEM Godrej Appliances, which has sold 650,000 units since 2012, over 95% in India, according to Santosh Salian, Product Group Head – Air Conditioners.

Godrej can manufacture up to 180,000 R290 AC units per year. To support those units, the company has more than 4,500 "Smart Buddy" technicians in the Indian market, "who are skilled adequately to handle hydrocarbon refrigerants," said Salian.

In line with European EN378 standard, the ACs' refrigerant charge run from 300-380g for capacities ranging from 12,000-24,000BTUs.

Godrej started with a fixed-speed R290 room AC unit but has phased out that model and is focusing on R290 inverter (variable-speed) split air conditioners

based on a high-efficiency platform, which have an India Bureau of Energy Efficiency (BEE) rating of 5 and 3 stars (on a scale of 1 to 5, the latter being most efficient). Its latest such unit is the NXW AC with Green Inverter Technology, which also employs a variable-speed electronic expansion valve. "India is moving aggressively towards inverter split air conditioners," said Salian.

In a comparison of 12,000BTU, 5-star ACs, the Godrej inverter unit uses 158kWh per year less energy than an HFC-based inverter AC, said Salian.

India also measures the efficiency of appliances with ISEER (Indian Seasonal Energy Efficiency Ratio). The ISEER of R290 models with inverter technology ranges from 4.55 to 6.15, "one of the highest ISEER rating categories in the Indian market," said Salian.

The R290 models are priced close to \$50 more than HFC-based ACs, said Salian, who acknowledged his main challenge selling R290 units is the higher cost. But the efficiency of the R290 units "offsets the primary cost difference through increased savings in energy consumption in the long run," and the R290 models have "a better lifecycle."

Currently, there are no rebates or subsidies for R290 ACs in India. However, said Salian, a strong case can be made in requesting a cut in the goods-and-services tax (GST) on R290 AC units "with the relevant authorities in India."

Over the next five years, Godrej is looking at expanding its sales of R290 ACs to markets like South Asia, Europe and the Middle East, said Salian, who doesn't foresee much difficulty in marketing R290 ACs around the world. "There is already a very good customer base built up since 2012 for these R290 AC SKUs," he said. "We are able to deliver the proposition of R290 refrigerant [having] high energy efficiency, powerful cooling and increased electricity savings over the years."

Salian is bullish on R290 air conditioning. "With its GWP as low as three, zero ODP, non-toxicity and excellent thermodynamic properties, R290 is the future of the residential room AC industry."

The Cool Coalition's Approach to Efficient, Climate-Friendly Cooling for All

REDUCING the need for mechanical cooling through better urban planning and building, including nature-based solutions such as green spaces, roofs, and walls.

SHIFTING cooling to renewables, thermal storage, and district cooling approaches.

IMPROVING conventional cooling by increasing the efficiency, reducing the GWP of air conditioning and refrigeration equipment, and taking demand-response measures.

PROTECTING vulnerable people from the effects of extreme heat and the consequences of unreliable medical and agricultural cold chains.

LEVERAGING cooperation between different actors to achieve a greater collective impact.

Source: Cool Coalition, "We Will: Efficient Climate-Friendly Cooling For All"

▶ Continued from p. 32

Last year K-CEP issued a knowledge brief, "Optimization, monitoring, and maintenance of cooling technology," which reported that for unitary ACs, optimized maintenance has the potential to reduce energy-driven CO₂e emissions by 290 megatons (Mt) by 2030, a 31% reduction.

"If you go to restaurants and look at the fridges, the vents are full of dust and grease," which drives higher energy use, said Hamza-Goodacre. "There's a case for government intervention to require regular auditing of energy use and equipment functioning." Middle Eastern countries like Kuwait – where equipment is susceptible to clogging by sand – have such laws for equipment that use a certain amount of energy, he said.

Even a simple tool like a dust-containment bag for condensing units called Coilpod, used to facilitate vacuuming of debris from a self-contained cooling

cabinets, can produce a marked improvement in efficiency, said New York-based Richard Fennelly, who markets the bags and is a passionate advocate for improving efficiency via proper maintenance. He estimates that monthly use of the product can save about US\$500 in energy costs for a single-door merchandiser otherwise serviced every six months.

Another approach to efficient cooling being supported by K-CEP is "cooling as a service," whereby end users pay for the cooling they need rather than purchase the physical product that provides the cooling. (See [page 60](#).) Cooling as a service can "increase the likelihood that cooling equipment is effectively serviced and maintained, lowering the risk of unplanned breakdowns and creeping inefficiency," says a K-CEP knowledge brief called "Cooling as a Service" (CaaS).

K-CEP is working with the Basel Agency for Sustainable Energy in Switzerland on a cooling-as-a-service initiative, said Hamza-Goodacre. "I think this can help move us toward better servicing and also swapping out refrigerants and using natural refrigerants that we know are best for the planet."

Like the IEA, K-CEP is a strong proponent of minimum energy performance standards, and provides technical assistance to help identify minimum standards for cooling appliances, mostly ACs. "They are absolutely critical in cutting the worst appliances out of the market," said Hamza-Goodacre. "And we need incentives to drive customers toward the most efficient appliances."

In Rwanda, K-CEP has supported a government incentive program by helping to design the program and contributing economic analysis. K-CEP also works with the private sector on financing efficiency incentives in developing countries.

Hamza-Goodacre noted that efficient ACs are already available in the marketplace, though they are not always the first choice of consumers. Certainly there is a great range of efficiencies; according to IEA, the best available air-conditioning equipment is up to five times more energy efficient than the least efficient units.

Meanwhile, the Global Cooling Prize, a program to spur the development of a room AC that is at least five times lower in climate impact than standard units, is scheduled to reveal up to 10 finalists at a ceremony in New Delhi, India, on November 15. (See [Global Cooling Prize Announces Ceremony for Finalists](#), *Accelerate Magazine*, September 2019.) "The prize will flesh out what is commercially and technically possible," said Hamza-Goodacre.



Dan Hamza-Goodacre, K-CEP.

Hamza-Goodacre acknowledged that in the short term high-efficiency AC units may be priced higher in some markets, but pointed out that over time the prices decline. "Since minimum energy standards have been introduced in the U.S. and the U.K., prices have come down," he said. Still, he would like to see more payment options like cooling as a service or favorable loans available "to help customers not be put off by the cost of capital."

Reducing peak loads

One of the key hazards of air conditioning is the stress they put on the grid during peak heating hours, which can result in the construction of additional power plants. K-CEP is focused on figuring out ways to reduce that pressure. "One way is through efficiency," said Hamza-Goodacre. "Another is demand-response programs where utilities will engage with consumers to control energy." However, he added, those programs are not very common at the residential level in many parts of the world. Even in developed countries, they are used primarily with large industrial users.

K-CEP is also supporting district cooling and urban planning projects, including nature-based solutions. During Climate Week, the president of Colombia, Iván Duque Márquez, spoke about a K-CEP-backed project in Medellín that created "green corridors" along roads and waterways that reduced temperatures by more than 2°C. The project won the 2019 Ashden Award for Cooling by Nature.

K-CEP also wants to reduce the demand for cooling by, for example, retrofitting buildings. "We think about the thermal envelope of buildings and shifting where we can to renewable resources or thermal cooling," said Hamza-Goodacre.

K-CEP recently announced the 10 finalists in its "million cool roofs challenge" – patterned after the Global

Cooling Prize – which is "the largest ever attempt to scale of deployment of cool roofs around the world," said Hamza-Goodacre. Each finalist received US\$100,000 and has until the beginning of 2021 to install as many cool roofs as possible, with the first team to deploy 1 million m² (1.8 million ft²) of cool roofs receiving US\$1 million. "Hopefully this will give us more evidence of how and where cool roofs can be effective," he said. "It's one of the more simple retrofits that can be done on a building."

Every little bit helps. ■ MG

Vote on R290 Charge Limit Delayed

The International Electrotechnical Commission (IEC) is looking at updating the charge-limit standard for hydrocarbons in stationary air conditioning and heat pumps under IEC 60335-2-40.

The IEC had been hoping to issue a CDV (committee draft for vote) towards the end of this year, but it now looks more likely to happen in April or May of 2020, said Daniel Colbourne, U.K.-based consultant for GIZ Proklima, referring to an interim vote by national committees. He expects considerable opposition from companies "with A2L interests."

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

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

Weis Markets' CO₂ System Avoids Transcritical Mode in First Year

U.S. chain's initial CO₂ installation operates efficiently during peak summer temperatures.

— By Michael Garry

U.S. chain Weis Markets reported that a transcritical CO₂ refrigeration system installed at a 54,000ft² (5,017m²) store in Randolph, N.J., has “not once” entered less-efficient transcritical mode over the first year of operation, including during summer months when ambient temperatures exceeded 100°F (38°C).

The report was provided by Paul Burd, Manager of Refrigeration Engineering for the Mid-Atlantic chain of 204 grocery stores, at the Food Marketing Institute's Energy & Store Development Conference, held in Dallas, Texas, U.S., September 8-11.

Weis has been monitoring the energy performance of the Randolph store since it opened in July 2018. Burd offered data covering one year of operation, from August 1, 2018 through July 31, 2019, as well as from August 25 to September 5, 2019.

Because of its low critical-point temperature (88°F/31°C), CO₂ at high ambient temperatures becomes a supercritical fluid that can't be condensed by an air-cooled condenser (the transcritical mode). To avoid that scenario, Weis installed two adiabatic gas coolers from Baltimore Aircoil Company (BAC) on the roof of the store, which employ water at higher ambient temperatures to keep the CO₂ below its critical-point temperature.

Burd attributed the system's ability to avoid transcritical operation to the adiabatic gas coolers. “Our concern was going into transcritical mode,” Burd said. “I wanted to be sure as much as I could that we didn't go into transcritical mode, so we chose the adiabatic gas coolers.”

Weis's transcritical CO₂ rack, an Advansor unit from Hillphoenix, employs three low-temperature and five medium-temperature compressors, with a CO₂ charge of 1,100lbs (499kg). It supplies a low-temperature capacity of 343.2kBTU/hr at -24°F (-31°C), and a medium-temperature capacity of 1,137.3kBTU/hr at 19°F (-7°C).

Store energy comparison

Burd also presented 12 months of data comparing the transcritical system to three other refrigeration systems used by Weis in similar stores with comparable loads and ambient conditions.

He previously presented data on these stores covering August 2018-May 2019 at the ATMOsphere America conference in June in Atlanta, Ga., U.S. (See, “[Weis Markets Reports Dramatic Energy Savings with Transcritical CO₂](#),” *Accelerate Magazine*, July-August 2019.)

During that period, the transcritical system's energy usage was 250,790kWh, substantially below the energy consumed by the other systems, all based on HFC or HFO refrigerants.

Over the 12-month period, the transcritical system continued to show superior energy numbers, consuming 494,541kWh, 43% less than a 1.5-year-old secondary glycol/DX system, 62% less than a seven-year-old distributed rack system, and 80% below a 23-year-old centralized DX system.

Burd acknowledged that the closest “apples-to-apples” comparison was between the transcritical system and the secondary glycol/DX system.

Regarding costs, Burd said at the ATMOsphere Conference that while installation costs were comparable to its DX/secondary glycol system, there was still a “little upcharge” for the transcritical system, though Weis is working with Hillphoenix on design changes that could reduce the cost.

At the FMI Energy conference, he added that while working with the system manufacturers, “we found that the cost was where it needed to be for the ROI, but we can improve those numbers.”

Over the next month, added Burd, “we will probably be presenting to senior management that we may be – and probably will be – going to CO₂ as our standard.” ■ MG

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EPA GreenChill Recognizes ALDI US for Most Certified Stores



Amber Hardy of ALDI US (left), received GreenChill's store certification excellence award from Tom Land, retiring manager of the GreenChill program.

The chain received platinum-level certification for 81 transcritical CO₂ stores in the past year; it has more than 200 CO₂ stores overall.

— By Michael Garry

The U.S. Environmental Protection Agency (EPA)'s GreenChill Partnership awarded ALDI US its store certification excellence award for achieving more GreenChill store certifications, all at platinum-level, than its peers over the past year.

Hillphoenix received an award for supplying more GreenChill-certified stores with refrigeration equipment than any other manufacturer over the past year. The OEM was given the award for the eighth consecutive year.

GreenChill certifies individual stores at silver, gold and platinum levels for limiting refrigerant leaks and charges to designated levels or for employing advanced refrigeration systems.

The GreenChill program handed out these and several other awards at its annual awards breakfast during the Food Marketing Institute (FMI) Energy & Store Development Conference on September 10. Tom Land, manager of the program, announced his retirement after hosting the ceremony. ([See Page 39.](#))

According to Land, ALDI US, based in Batavia, Ill., had 81 certified stores in 2018, while Conyers, Ga.-based Hillphoenix supplied equipment to 204 certified stores. All of ALDI US's certified stores employ transcritical CO₂ refrigeration systems; Hillphoenix is a major supplier of transcritical CO₂ equipment to ALDI US.

Amber Hardy, Director of Energy Management for ALDI US, noted that the chain had installed transcritical CO₂ systems in more than 200 stores, the most

of any retailer in the U.S. Many of its stores have 8-10 self-contained R290 cases, she added.

Launched in 2007, the GreenChill program helps U.S. food retailers reduce refrigerant leaks and charges while enabling the adoption of natural refrigeration systems. GreenChill Partners had an average leak rate of 13.9% in 2018, said Land; they emit at least 65% less refrigerant than the average supermarket, according to the EPA.

Over the past decade, participation in the GreenChill Program has grown from 4,500 stores to over 11,000 stores, representing about 29% of the U.S. supermarket industry.

Other award categories and winners included:

Best Emissions Rate:

Harris Teeter, Matthews, N.C., achieved the lowest refrigerant emissions rate among retail supermarket chains last year. Cook County Whole Foods Co-op, Grand Marais, Minn., received this recognition for the category of small-independent grocers. In 2018, 12 GreenChill retailers achieved emissions rates under 10%, said Land.

Most Improved Emissions Rate:

Hanover Co-op Food Store, Hanover, N.H., has documented the largest refrigerant leak-rate reduction as compared to the year it joined GreenChill. McQuade's Marketplace, Westerly, R.I., lowered its emissions rate more than any other GreenChill partner as compared to the previous year.

Goal Achievement

GreenChill's five "Superior Goal Achievement" award recipients voluntarily set and achieved their corporate goal for reducing refrigerant emissions. Recipients include: Hy-Vee, West Des Moines, Iowa; King Kullen, Bethpage, N.Y.; Price Chopper, Schenectady,

N.Y.; Raley's, West Sacramento, Calif.; and Sprouts Farmers Market, Phoenix, Ariz. Hy-Vee, King Kullen, and Sprouts Farmers Market also earned "Exceptional Goal Achievement" for meeting an even more stringent "stretch" goal to reduce refrigerant emissions.

Distinguished Partner

Hy-Vee received this recognition for leadership through active participation and initiative in achieving GreenChill goals.

Best of the Best

Target, Minneapolis, Minn., was honored as the "Best of the Best" within GreenChill's store certification program for installing micro-distributed stand-alone refrigerated cases in multiple small-format stores. The retail chain has installed these cases, typically using R449A and a water-loop heat removal system, in 21 stores, "with a number in the works," said Erich Schwab, Lead Mechanical Engineer, Refrigeration Engineering and Store Design for Target.

"We would like to move to R290 [propane]" in these stores when the U.S. adopts higher charge limits for R290 cases, added Schwab. The U.S. and other countries are considering adopting a new global charge-limit standard, which was increased this year by the International Electrotechnical Commission (IEC) to 500g (18oz) from 150g (5.3oz). "Five hundred [grams] would be better; we could probably work with 300," he said. Target uses up to 150g of R290 in spot merchandisers throughout its 1,800-store chain.

Store Re-Certification

Weis Markets, Sunbury, Pa., operates a store in Hanover, Pa. that was recognized as the first supermarket in the U.S. to be GreenChill-certified for 10 consecutive years. Eight stores were recognized for achieving GreenChill certification for five consecutive years. Sprouts Farmers Market achieved this honor for stores in Birmingham, Ala.; Lakeland, Tenn.; Madison, Ala.; Mansfield, Texas; Peoria,

Ariz.; Scottsdale, Ariz.; and two stores in Kansas City, Mo.

"We applaud the supermarket chains for their environmental leadership in minimizing refrigerant emissions and their adoption of advanced refrigeration technologies," said Anne Idsal, Acting Assistant Administrator for EPA's Office of Air and Radiation. "They're not just protecting the environment; they're keeping costs down for themselves and their customers." ■ MG

GreenChill Manager Tom Land Retires

Tom Land, manager of the U.S. Environmental Protection Agency (EPA)'s GreenChill Partnership and a 27-year employee at the agency, announced at the Food Marketing Institute (FMI) Energy and Store Development Conference on September 10 that he was stepping down from his post and retiring from the EPA at the end of the month.

Land, 60, made the surprise announcement after handing out GreenChill awards to supermarket companies at a breakfast ceremony. A full room of attendees gave him a standing ovation.

Kirsten Cappel will replace Land as program manager. Gerald Wozniak will serve as technical advisor.

Launched in 2007, the GreenChill program has helped U.S. food retailers reduce refrigerant leaks and charge while enabling many to adopt natural refrigeration systems. Land replaced founding GreenChill manager Keilly Witman in 2013.

"I have loved working with this industry and watching you guys do great things for the environment and great things for your companies," Land said. "I will miss it."

AHRI Asks California for More Time on GWP Changes

Trade group also wants to change CARB's definition of new equipment so that it doesn't impact retrofits, and seeks stakeholder input.

— by Michael Garry

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI), based in Arlington, Va., on September 20 submitted an updated proposal to the California Air Resources Board (CARB) asking for a deadline extension and other changes in CARB's proposed refrigeration regulations on GWP limits for refrigerants in commercial refrigeration.

AHRI believes the regulations would be burdensome to HVAC&R end users.

These regulations — expected to influence the regulatory direction of other states — include a 150GWP cap on refrigerants used in new systems containing more than 50lbs (23kg) of refrigerants by January 1, 2022. It also includes a ban on the sale of virgin refrigerants with a GWP above 1,500 by that date; and a proposed 750GWP cap for new stationary air-conditioning systems by January 1, 2023. CARB plans to submit a final ruling to its board in May 2020.

AHRI is asking for a “two-step approach, which gives us a bit more time to comply with current regulations,” said Lauren MacGowens, Sector Lead — Refrigeration Technology for AHRI, in a presentation at the Food

Marketing Institute's (FMI) Energy & Store Development Conference in Dallas, Texas, U.S. on September 10. AHRI also wants more time to “get safety standards in place so A2L and A3 refrigerants can safely be used in these applications,” she said.

Under its two-step approach, AHRI is asking, according to MacGowens' FMI presentation, that medium-size commercial refrigeration units with 50-300lbs (23-136kg) of refrigerant be capped at 1,500GWP in 2021 but not capped at 150GWP until 2024, contingent on the adoption of safety standards in the California State Code.

In its new proposal, AHRI is also recommending that new remote condensing units and those used in new construction, with 50-300lbs of refrigerant, have a GWP cap of 1,500 in 2021, and a 300 (as opposed to 150) GWP for 2024. AHRI argues that a 150 GWP cap for condensing units would preclude all synthetic refrigerants and allow only CO₂ refrigerant; the trade group said CO₂ condensing units are not a practical option in the U.S. due to higher costs for energy-efficient models and an inadequate supply chain for components. CO₂ condensing units are widely used in Japan and are entering the European market; in the U.S. Efficiency

“

[AHRI's goal is to] increase allowable flammable refrigerants and update mitigation requirements so that we can safely transition to flammable refrigerants.

”

— Lauren MacGowens, AHRI

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Vermont, a utility, is planning to test CO₂ condensing units. (See [“Vermont Utility Gives Incentives For NatRef Systems,” Accelerate Magazine](#), September 2019.)

A 300-GWP cap would allow R454, an A2L HFO blend, among others to be used in condensing units, AHRI said.

MacGowens asked the FMI conference audience for input on CARB’s proposals and their potential impact on the commercial refrigeration market. “CARB continues to think that ammonia and CO₂ options will be viable for all new stores and retrofit and replacement applications as well. We do not agree,” she said. “The industry voice must be heard and we need your help.”

AHRI, she added, wants to see “an industry-driven change with viable options that meet the needs of all of our customers without straining equipment or putting stores out of business.” CARB’s position is that it needs aggressive GWP caps and timelines to meet its statutory requirement to cut HFC emissions by 40% below 2013 levels by 2030.

AHRI is also focused on CARB’s definition of the new equipment to which the new GWP limits would apply. The definition encompasses not only new stores, but also existing stores where equipment is modified to handle an expanded cooling load, or where the cost of components of equipment being replaced in whole or in part exceeds 50% of the cost of replacing an entire system.

AHRI is concerned that, under this definition, equipment replacement “could mean changing entire stores long before they are due for a retrofit,” as well as looking at under-150GWP options “much sooner than equipment life span,” MacGowens said.

In its new proposal to CARB, AHRI said that retrofit, maintenance and replacement of equipment components “cannot be done for all applications given the current equipment limitations and restrictions of safety codes and standards.”



Lauren MacGowens, AHRI

UPGRADING A3 REFRIGERANT STANDARDS

AHRI believes that flammable refrigerants will play a key role in the transition to under-150GWP systems, but that safety standards for higher charge limits for these refrigerants must first be implemented in North America. This year, the charge limit standard for A3 (flammable) refrigerants (under IEC 60335-2-89) was raised from 150g (5.3oz) to 500g (17.6oz) by the International Electrotechnical Commission (IEC), while the limit for A2L refrigerants was raised from 150g (5.3oz) to 1.2kg (2.7lb); however, this global standard only takes effect when adopted at the regional level.

“We need to look at upgrades to [flammable refrigerant] safety standards,” said MacGowens.

To that end, AHRI has been helping to update the UL 60335-2-89, the North American standard, with plans to serve on the CANENA working group that will work on this standard. AHRI has also launched a Safe Refrigerant Transition Task Force to move along standards

adoption “in a timely manner,” she said; interested stakeholders are invited to participate.

AHRI’s goal is to “increase allowable flammable refrigerants and update mitigation requirements so that we can safely transition to flammable refrigerants,” said MacGowens, who noted that the North American charge limit may be different from the new IEC standard.

She referred to the model building codes that also need to incorporate any standards adopted at the regional level. AHRI would like to see standard updates completed by 2021 so that they can be considered for inclusion in the 2024 model codes, she said. The updated model codes could then be followed on a state-by-state basis.

MacGowens also pointed out the Department of Energy efficiency standards going into effect next year for walk-in coolers and freezers and the new standards that will take effect in 2023. ■ MG

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Battle of the Shelf Blades

Two U.K. companies enter the U.S. with energy-saving shelf-edge blade systems designed to keep cold air inside open display cases.

— By Michael Garry

Last month, at the Food Marketing Institute (FMI) Energy & Store Development Conference in Dallas, Texas, two U.K. companies made their first appearance at the conference at tables in the exhibition hall.

The companies, Aerofoil-Energy and Wirth Research, are bringing to the North American market similar blade-like systems that attach to the front of open multi-deck refrigerated display cases. Both systems employ aerodynamic principles to manage the airflow in front of open display cases to prevent them from losing cold air, thereby saving energy and boosting the quality of the cold food on display. Wirth uses two blades running parallel to the front of display shelves, to which they are attached, while Aerofoil employs one blade.

The systems offer an alternative, albeit a less efficient one, to enclosing the cases with glass doors, which some retailers believe hurts product sales.



Wirth Research's double-blade Ecoblade shelf-edge system is being marketed in North America in partnership with Dover Food Retail.

Wirth Research is partnering with Dover Food Retail (which comprises Hillphoenix and Anthony) to market the Ecoblade shelf-edge system with Hillphoenix open refrigerated display cases. While Wirth's product could be seen at the Dover table, Aerofoil-Energy was marketing its product at its own table at the FMI conference, held September 8-11.

The Ecoblade has been installed in about 349 Waitrose stores in the U.K., where Wirth partners with NRMS Global, Carter Retail Equipment, Koxka and others cabinet makers, said Nick Wirth,

President and Technical Director at Wirth Research, at the FMI event. More than half of those Waitrose stores use water-cooled hydrocarbon self-contained display cabinets – with propylene (R1270) in most of them and propane (R290) in the remainder, explained Geoff Amos, co-founder of NRMS Global.

The technology behind Ecoblade incorporates “the same techniques that streamline airflow more efficiently around race cars to enable them to corner at high speeds,” said Dover Retail, adding that Ecoblades reduce energy consumption of display cases up to 33%.



Aerofoil-Energy's single-blade shelf-edge system is widely adopted in the U.K.

"Ecoblade offers industry-best energy and food temperature performance to retailers for open multi-deck refrigerated cases, especially for merchandising perishable meat products," said Anshuman Bhargava, director of product management with Dover Food Retail, based on Conyers, Ga., U.S.

The system is being tested by several large U.S. retailers "with one already making the commitment to specify for use in all new stores," said Bhargava. It can be used with Hillphoenix cases and also retrofitted on any manufacturer's existing cases. In North America, Hillphoenix is known for having sold

more than 500 transcritical CO₂ racks including full-size systems (called Advansor) and downsized units (called AdvansorFlex).

"We are delighted to be working with Hillphoenix," said Wirth. "It is a fantastic endorsement of our technology and services to be partnering with one of the largest refrigeration OEMs in the world. We look forward to accelerated adoption of our technology and helping U.S. grocers and shoppers make their contribution to the planet by saving energy and cutting carbon dioxide emissions."

"We look forward to accelerated adoption of our technology and helping U.S. grocers and shoppers make their contribution to the planet by saving energy and cutting carbon dioxide emissions."

— Nick Wirth, Wirth Research

Starting with Sainsbury's

Aerofoil is the brainchild of Paul McAndrew, who invented the system in 2013 and later designed it for commercial use in collaboration with Williams Advanced Engineering.

After testing the technology, Aerofoil-Energy received a "big order" in 2017 from U.K. retailer Sainsbury's, said McAndrew. This was followed by a string of orders from Asda, Tesco and Marks & Spencer over the past 18 months accounting for about 4,000 stores, or 70% of the U.K. grocery market, said McAndrew.

Aerofoil-Energy's shelf-edge blade is designed "like an airplane wing" to bend cold air toward the shelves, keeping warm air out without creating "turbulence," explained McAndrew. The blades reduce energy consumption on average by 15%, according to a 2018 Sainsbury's sustainability update published by Aerofoil-Energy. Sainsbury's is also a major user of CO₂ refrigeration systems.

In the U.S. Aerofoil-Energy has started a two-store trial with Walmart, which will expand to additional stores, said McAndrew, who added that other large U.S. retail chains are slated to follow suit.

Aerofoil-Energy mainly retrofits retailers' existing cabinets, though it also supplies case manufacturers with its product, Andrews said. Retrofitting a cabinet with the shelf blades costs about £250 (US\$307). ■ MG

Ammonia/CO₂/Glycol System Saves Belgian Store Up To 42% on Energy Bill

A family-owned Delhaize supermarket chooses unusual natural refrigeration system instead of CO₂.

— By Zita Laumen

“*Firstly, we wanted a refrigerant that was neutral in terms of CO₂ emissions. Then came the safety aspect and the energy savings.*”

— Luc Bormans, Delhaize store owner

Delhaize store owner Luc Bormans joined a select group of food retailers by installing an ammonia/CO₂/glycol system at a new store in Rhisnes, Wallonia (Belgium) last year, rather than a far more commonly used transcritical CO₂ system or f-gas system.

The ammonia/CO₂/glycol system has been saving Bormans a considerable amount of money in energy consumption. At his 800m² (8,611ft²) store in Rhisnes, Bormans was able to reduce his overall annual electrical energy consumption from 500-600kWh/m² (46-56kWh/ft²), which is typical for similar stores using f-gases, to a maximum of 350kWh/m² (32kWh/ft²), a savings of up to 42%. This was largely thanks to the natural refrigeration system, insulating the building and pipes, and installing LED lighting, as well as rotating doors and efficient isothermal rooms.

The significant energy savings means that he will be able to recoup the premium paid for the complete ammonia system compared to a transcritical CO₂ system (including refurbishment work) in four years – and just 2.5 years for the central refrigeration equipment.

Because they use ammonia (though not inside the store), ammonia/CO₂/glycol or ammonia/CO₂ systems are rarely used around the world, despite

their considerable energy savings and excellent safety and performance record. (See sidebar, page 47.)

The Bormans family has an “affiliated” status with Delhaize (part of the Ahold Delhaize Group) but is otherwise entirely independent. As such, they could select an ammonia/CO₂/glycol system for their new store. Bormans’ two other Delhaize stores rely on f-gas refrigerants.

According to Bormans, his motivation for opting for this specific system was based on three key factors: “Firstly, we wanted a refrigerant that was neutral in terms of CO₂ emissions,” he explained. “Then came the safety aspect and the energy savings.”

Multiple suppliers

Each segment of the ammonia/CO₂/glycol system had a different supplier. French manufacturer Engie Axima built the ammonia circuit (and installed the entire refrigeration system). Profroid (a part of Carrier) manufactured the CO₂ circuit, while George Fisher supplied the glycol equipment.

Ammonia is the high-side refrigerant, confined to the plant room. Glycol is used to cool medium-temperature cases, while CO₂ serves low-temperature cases. Heat is recovered from the condensers.



A total of 40kg (88.2lbs) of ammonia is used to achieve a total cooling capacity of 110kW (31.3TR), yielding a specific ammonia charge of 364g/kW (2.9lbs/TR).

The pressure in the plant room is limited to 8-10 bar and the store itself to 1-1.5 bar. The CO₂ system works in subcritical mode with a maximum pressure of 30 bar.

Bormans considers the system to be safe because the ammonia is confined to the machine room and any leakage would result in an odor, making it easy to detect. Additionally, the installer Engie Axima gave him a 10-year guarantee that the system will remain leak-free.

Engie Axima is responsible for the project's overall maintenance, with a focus on ammonia safety. The company offers both internal and external training on the safe handling of ammonia. (It has supplied three other stores with ammonia systems.) It regularly does safety trainings with the Antwerp, Belgium fire brigade.

Nonetheless, "there are no additional labor costs for the maintenance of ammonia compared to other HFC installations," said Dominique Köttgen, Manager Division Smart Solutions at Engie Axima. ■ ZL

Ammonia rack used in ammonia/CO₂/glycol system at Delhaize store in Belgium.

Ammonia/CO₂ in Retail

Ammonia/CO₂ refrigeration systems (with or without glycol) are rare in the food retail industry, with only a handful installed in stores around the world.

In Europe, the Bormans Delhaize ammonia/CO₂/glycol installation marks the third one of its kind for Engie Axima (all are medium-sized Delhaize stores). In Australia there is only one known installation – a supermarket in Western Sydney that was later retrofitted with a transcritical CO₂ system. In South Africa, there are three stores known to use this technology.

In the U.S., four supermarkets employ an ammonia/CO₂ system: an Albertsons in Carpinteria, Calif.; a Piggly Wiggly (owned by JTM Corp.) in Columbus, Georgia; a Whole Foods Market in Dublin, Calif.; and Defense Commissary Agency (DeCA) unit in San Antonio, Texas at the Lackland Air Force Base. Raley's plans to open a store next March in Sacramento, Calif., with an ammonia/CO₂ system, its first.

At the International Institute of Ammonia Refrigeration (IIR) Natural Refrigeration Conference and Expo, held March 4-6 in Phoenix, executives who have worked on four of the five U.S. installations of ammonia/CO₂ said that the relatively small amount of ammonia used in these systems should not pose a safety concern. However, the initial cost of the system remains high. (See "[Should Grocers Fear Ammonia?](#)" *Accelerate America*, April-May 2019.)

USING AIR AS A REFRIGERANT

German cryogenic operator Coolinn is launching a sauna that uses Mirai's COLD air-cycle technology to achieve -110°C (-166°F) temperatures.

— by Tine Stausholm



Mirai COLD 10 air-cycle refrigeration unit

On October 12, German cryotherapy operator Coolinn will introduce its first cryogenic sauna with an air-cycle refrigeration unit, which boasts lower power consumption and reduced maintenance costs as compared to similar cascade vapor compression systems.

A cryogenic sauna is essentially a reverse sauna – a very cold room without the humidity of a conventional sauna. Cryogenic saunas are used by athletes for “cryotherapy,” which can improve physical performance and aid recovery from injury. It can also be helpful in treating certain diseases like rheumatism, fibromyalgia and inflammatory ailments, according to Coolinn’s website (<https://coolinn.de>).

The refrigeration technology driving the new cryogenic sauna, called Mirai COLD, is provided by European engineering and manufacturing company Mirai Intex. Founded in 2015, Mirai presented its first Mirai COLD unit at the Chillventa exhibition in Nuremberg, Germany, in 2016.

Mirai COLD units use only air as a refrigerant to achieve very low temperatures, from -40°C (-40°F) to -110°C (-166°F), in a one-stage system. Traditional low-temperature equipment typically use three-stage cascade systems charged with R404A, R23 and R14 – all of which have extremely high GWPs of 3,922, 14,800 and 5,700, respectively.

Mirai COLD currently comes in three versions, with power capacities of 10kW, 15kW, and 22kW and cooling capacities of up to 5kW/1.4TR, up to 8kW/2.3TR and up to 12kW/3.4TR, respectively; each unit can be tailored to serve a particular temperature. A new model, called the Mirai Cryo, uses nitrogen instead of air and can achieve temperatures from -130°C (-202°F) to -160°C (-256°F), with a cooling capacity of up to 3kW (0.9TR). Mirai Cryo is not commercially available yet, though pre-orders can already be placed.

Mirai is not the only company developing air-cycle low-temperature technology. Japanese manufacturers Mayekawa and

Mitsubishi have also developed air-cycle machines, mainly for rapid freezing of tuna.

The turbo module

The core of Mirai’s low-temperature products is the “turbo module.” It consists of a centrifugal compressor and an expander mounted on opposite ends of the same drive shaft, which is driven by a speed-controlled electric motor. The mounting of the compressor and the expander on the same shaft makes the system up to 30% more energy efficient than similar systems, according to Mirai.

In the Mirai COLD system, air is heated in the compressor. The high-pressure warm air is sent through a series of heat exchangers where it is cooled, before finally being expanded in the turbo expander to reach very low temperatures and low pressure. This type of air-cycle technology is also known as the Bell-Coleman cycle and has been known for over 100 years.

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MIRAI COLD 10



MIRAI COLD 15



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1 /



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The Mirai turbo module creates a completely frictionless operation and eliminates the need for an oil-management system, the company said. It does this by using air-foil bearings to support the central shaft. When the shaft is stationary, it is supported by the bearings. When the machine is turned on and the shaft starts spinning, centrifugal forces generate an outward pressure, forcing the bearings away from the shaft, thereby creating an air cushion between the bearings and the spinning shaft. The result is a "reduction of operation costs and increase of the longevity of our machines," said Vladyslav Tsyplakov, Development Director at MIRAI Intex.

The heat generated by the turbo module is rejected to ambient air or cooling water via a heat exchanger on the high-pressure side of the system. However, Mirai COLD is capable of operating in conjunction with heat recovery systems to increase energy savings, if these systems are able to "ensure constant heat rejection, in order to keep the cooling air at a stable operational temperature," Tsyplakov said.

The Mirai units also feature a humidity-extraction device, which prevents accumulation of ice and removes the need for defrosting.

Other applications and ROI

Other potential applications of the Mirai COLD technology include cryogenic storage of biological samples used in research, freeze-drying of foodstuffs and other products, industrial cooling, and product climate testing.

Mirai acknowledged that its technology is around 36% more expensive than comparable low-temperature vapor compression systems. However, power consumption is 30% lower than for comparable systems, and the maintenance cost is only 10% of that of similar cascade vapor compression system, the company said.

At temperatures below -50°C (-58°F), the Mirai machines have a coefficient of performance (COP) that is almost 30% better than cascade systems, said Mirai.

1 / Mirai COLD 15 air-cycle refrigeration unit

2 / Mirai Turbo module

"Very quickly this price difference will be rewarded if we count other more important aspects like running and maintenance cost during machine lifetime," Tsyplakov said, adding that "return of investment for such an application, based on all of these aspects, can be less than five years."

Mirai's figures for energy saving and running costs have been confirmed by Professor Michael Kauffeld, an independent expert from the Karlsruhe University of Applied Sciences in Germany, who tested two versions of the Mirai COLD.

"The development by Mirai Intex makes sense from an energetic point of view as well as from a refrigerant point of view," Kauffeld said. ■ TS

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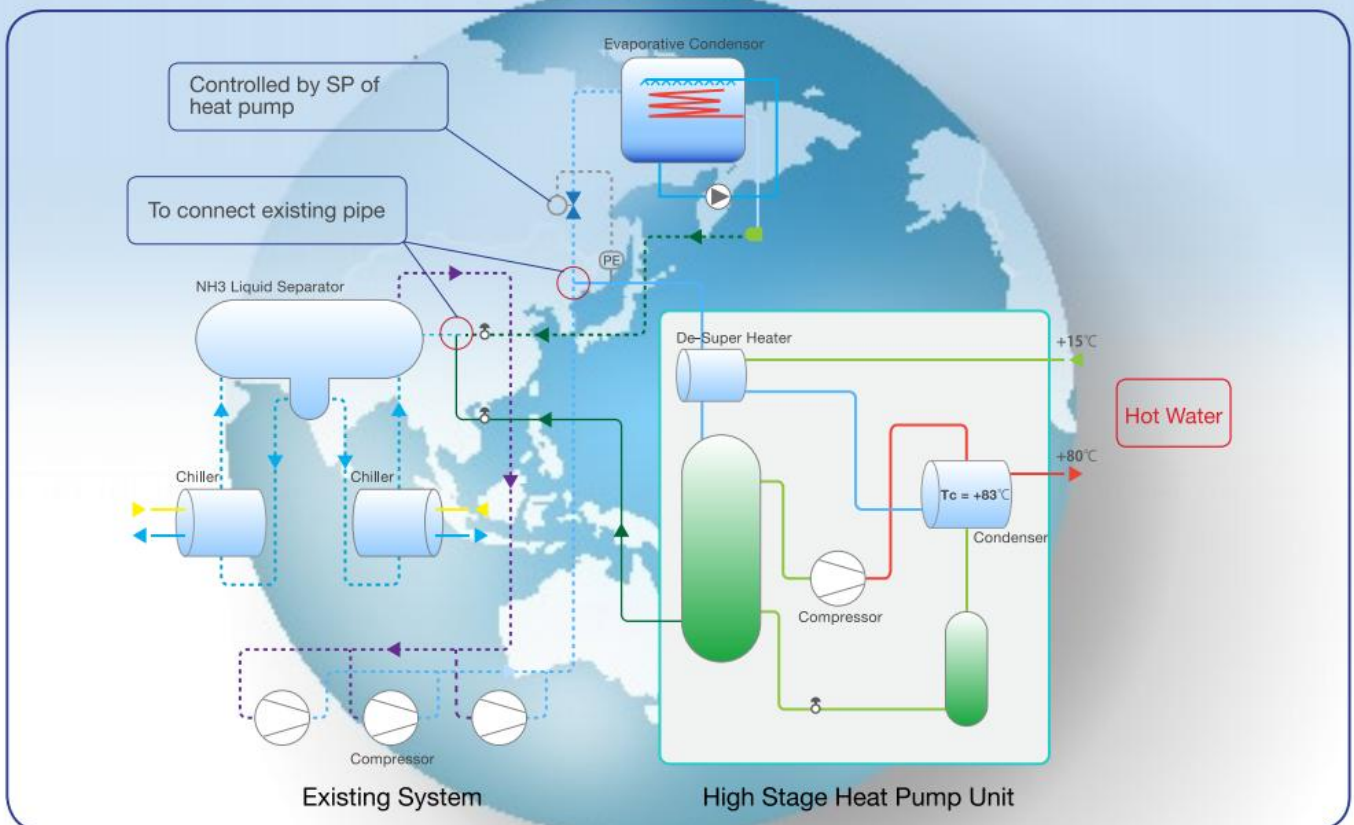
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How to Install on Existing Refrigeration System



'The Future is Smart Systems'

Enrico Mirandola of RDM talks about the important relationship between controls and energy efficiency, particularly for natural refrigerant systems. Can you afford to be left behind in the age of IoT?

— By Ilana Koegelenberg



Enrico Mirandola, RDM

At ATMosphere Europe in October, Enrico Mirandola, Group Sales and Marketing Officer of Resource Data Management (RDM), a U.K.-based controls company, will take part in the "Industry 4.0" panel to discuss the application of smart systems and the Internet of Things (IoT) to HVAC&R.

In the following interview, we talk to him about the natural refrigerant controls industry, and particularly the integration of smart systems using the IoT.

// **Accelerate Magazine (AM):** How important is natural refrigerants to RDM's business?

Enrico Mirandola (EM): From conception, RDM focused its direction of product development by asking prospective customers what would help them deliver their corporate objectives. The insight gathered, coupled with founder Andrew Chandler's vision, took RDM in the direction of remote monitoring and refrigeration controls. Over the succeeding years, we have continued with this philosophy of working with end users, OEMs, Value Added Resellers (VARs), and consultants to provide custom, flexible, and sustainable control solutions to help implement new natural refrigerant systems.

“

In my opinion, the most significant risk of any individual responsible for the management of HVAC&R assets is to not protect those assets with a monitoring solution that allows them to analyze operating data effectively.

”

— Enrico Mirandola, RDM

It is part of RDM's philosophy to be environmentally aware. We are passionate about protecting the environment. Implementing, whenever possible, processes and structures that minimize energy consumption and carbon footprint is important to Andrew Chandler, both on a personal and a business level. This consciousness, coupled with a drive to continually evolve and expand our solution offering, meant a natural progression towards ammonia and secondary control systems, which were introduced into our product offering in 2004, followed by CO₂ controls in 2007. Since then, the product range has developed and evolved to accommodate the different processes used to control natural refrigerants.

// AM: Are you planning on penetrating the U.S. market following your installation at the Lunds & Byerlys supermarket chain? What are your plans for global expansion?

EM: Since our formation, we have grown to over 200 employees, across five locations worldwide, who are all

supported by a strategically positioned affiliate and distributor network. Our subsidiary locations in Asia and the U.S. mirror the sales, support and training facilities offered in the U.K. head office. We are committed to supporting our customers globally.

When we launched the U.S. office back in 2012, we faced much resistance. Mostly it was the fear of change, both in terms of changing brands but also very much in terms of changing technologies. The U.K. approach to control strategies is quite different from the standard U.S. approach. We couldn't pick up our successful model in the U.K. and replicate it directly in the U.S., so we had to adapt and re-educate.

The new technologies we introduced meant that early adopters had to commit to a steep learning curve. For them, the steep learning curve and our investment have paid off. We are now at a tipping point, with U.S. customers better understanding the benefits that modern control solutions can offer. Training and specialized support have been, and will continue to be, essential

to support our growth. I feel confident with the team that we have in place and am very excited for the years ahead.

// AM: How much can controls help improve the energy efficiency of CO₂ and other systems?

EM: Massively. Energy efficiency and control go hand in hand — a well-maintained system will perform close to its design efficiency envelope. Our products and software applications are designed with energy efficiency in mind. A major U.K. retailer that is committed to combating climate change has implemented many of our energy-efficiency options to successfully improve efficiency. Their challenge is to find new ways to reduce energy. An opportunity they identified was suction-pressure optimization, using our rack controllers to offset the target suction pressure in response to fluctuations in the cooling load. The project focused on HFC refrigerant-based systems, as CO₂-based cascade systems inherently allow suction pressure to float in response to cooling demand.

The savings reported by our customers demonstrate what is possible. U.S. grocer Lund & Byerlys, using an integrated control-and-monitoring solution from RDM, saved US\$8 million over six years, across just 18 stores — a considerable saving that they were able to reinvest to grow their business.

// AM: What trends are you noticing in the refrigeration industry, particular in natural refrigeration controls?

EM: We have noted a definite step towards technologies such as waterloop and solar systems. The European F-Gas legislation has also been a disrupter.

Two years ago, we worked with an OEM partner to develop a controller to support a new variable-speed driven, multi-refrigerant condensing unit range. The condensing unit can be installed either on top of or underneath the display case.

The heat generated by the compressor and the display case is not directly released into the immediate vicinity but is transferred outside by a waterloop system to a dry air cooler. The technology was installed by RDM New Zealand for food retailer Foodstuffs, reducing refrigerant charge by 90%, compared to a centralized pack system.

A more recent project, with our Dutch distributor, was a solar-powered cold storage facility. In regions without a steady power grid, remote locations and disaster-stricken areas, the lack of reliable cooling systems makes it challenging to prevent food waste or store medicines securely. To work around the problem of electricity availability, the Dutch company Vink Koeltechniek developed a cold-storage facility powered exclusively by solar energy. Relying on solar power for 100% of energy use, cold storage facilities have no running costs and are eco-friendly; they also require little maintenance and, with remote monitoring in place, technician visits are limited to the absolutely necessary ones.

In Europe, the requirement to reduce f-gas consumption by 2030 is forcing companies to stand up and take note of the changes that they need to make. We see this as an opportunity, not just for RDM, but for our customers. Yes, they will need to invest in their infrastructure to make a move from traditional refrigerants to alternates such as ammonia or CO₂. But by investing sooner rather than later they can achieve cost savings, higher ROI and quick payback on the investment, through improved energy efficiency. At the same time, they can demonstrate environmental awareness and responsibility – making the change because they can, rather than because they are forced to.

//AM: What role can IoT play in refrigeration controls and smart systems?

EM: The principles of IoT are fundamental to the creation of a successful control and smart-system strategy.

It is not possible to predict every failure, but if we can identify the systems that are failing slowly and not operating efficiently, we can save a considerable amount of energy and reduce environmental impact. This can happen with IoT.

For example, we help customers to make informed decisions on the balance between the environmental impact of ripping out and potentially scrapping their old system with the benefits that can be achieved from installing a new control solution. We can also provide options to retain elements of their legacy system but enhance the efficiency and performance by updating specific elements.

//AM: What are the biggest challenges you face with IoT?

EM: Not all communication protocols are what they at first appear. There are currently some protocols that are billed as “open protocol.” But they are not because they still need an expensive gateway at the device level, or typically users will be required to pay an annual subscription to be a member of the protocol organization. This is not a true open free-to-use protocol.

Another challenge is a lack of knowledge. Some people are simply not aware of the options that are available. RDM installed the first refrigeration controller with IP connectivity and the ability to capture data remotely in 2004. Yet, we still meet companies for whom

temperature compliance is critical that manually capture and store temperature data. These companies may be losing thousands of man hours, and potentially millions in revenue, by manually checking and recording data that could be done automatically or more accurately.

//AM: Overall, what are the benefits of integrating IoT-enabled smart systems?

EM: The benefits are endless. Insight and automated processes lead to improved efficiencies, reducing operating costs, energy consumption and carbon footprint. It is a domino effect that comes 360 and allows a business to thrive, reinvest and grow. It can give companies the tools to manage vast estates that can even span multiple countries. It's all done remotely by filtering and channelling the information that is important to the right people, all in real-time.

//AM: Where are we going with the integration of smart systems?

EM: As companies look to become more efficient and drive better results, many will turn to predictive analytics to help determine strategy moving forward. The future is the adoption of smart systems. They will be an essential requisite, if a business wants to be the best in their marketplace. In my opinion, the most significant risk of any individual responsible for the management of HVAC&R assets is to not protect those assets with a monitoring solution that allows them to analyze operating data effectively. ■ IK

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ECO STORE INSTALLS NORTHERN IRELAND'S FIRST FREOR PROPANE SYSTEM

The system includes self-contained R290 cabinets with heat removed to the outside by a glycol loop.

— by Ilana Koegelenberg

Lithuanian commercial refrigeration equipment manufacturer Freor has installed its first propane (R290) self-contained waterloop system in Northern Ireland, fulfilling a new ECO store's refrigeration needs for compact, yet large-capacity display showcases for the meat, dairy, bakery, and frozen food sectors.

The ECO store was opened in Castlewellan in May as an environmentally friendly outlet by owner Fresh Food Centre (which has two other stores in Northern Ireland). The owner is "very happy" with the system's performance so far, according to a Freor representative. The retailer was interested in a propane-based refrigeration system due to its energy efficiency and upcoming regulations on HFC usage in commercial refrigeration, the representative added.

"It makes us glad that the store has chosen a green refrigeration solution with a thought of the future of the environment," said the representative.

Freor has equipped around 400 stores with waterloop R290 systems around the world. Most of them are in Europe, with one in South Africa, and one upcoming store in the Philippines ([See page 72](#)).

There are 12 refrigeration points at the ECO store, for which Freor's energy-efficient Green Wave plug-in R290 products were selected and connected to Freor's



hydroloop-glycol system. To reach even higher results in reducing energy consumption, every refrigerator has a hot gas defrost system, which optimizes and accelerates the defrosting process.

The hydroloop system allows condensation heat to be removed through liquid pipes to the exterior of a building, avoiding overheating in the store. R290 waterloop solutions such as the hydroloop system are gaining ground in different parts of the world, with an estimated 2,000 stores globally using this technology, according to shecco (publisher of *Accelerate Magazine*).

The R290 waterloop technology offers both an environmentally friendly and a cost-friendly solution, said Freor. Other benefits include easier installation and close-to-zero leakage.

Installed Freor cabinets include: Erida upright glass-door freezer, Pluton Space chilled display cabinet, Jupiter glass doors multideck display fridges and Elisa QB stand-alone refrigerated bakery case.

The project was carried out by Northern Ireland refrigeration engineers DS Refrigeration, which ECO complimented for its reliability and thorough service. ■ IK

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Giant Produce Market Installs 1.9MW CO₂ System

Evergreens, the largest independent fresh produce retail/warehouse store in the Southern Hemisphere, chooses industrial-scale transcritical CO₂ to feed its 167 refrigeration points.

— By Ilana Koegelenberg

When it comes to its food offerings, South African retail/wholesale outlet Evergreens is very hands-on, visiting every farm and factory before taking in their products. Similarly, company executives visited refrigeration manufacturer CRS's workshop to make sure they were happy with the operation before agreeing to let the OEM build their new transcritical CO₂ refrigeration system.

South Africa-Based CRS (a subsidiary of holding company Sphere), then custom-designed, built, and manufactured the system, and installed it at Evergreens' brand new 22,000m² (236, 806ft²) store in Johannesburg, South Africa, which opened in August. Evergreens' other store, in Pretoria, employs an HFC-based refrigeration system.

The new store boasts the largest transcritical CO₂ installation in the South African commercial sector — and one of the largest commercial systems in the world — with a refrigeration capacity of 1.9MW (540TR) serving 167 loads, said CRS.

CRS, the primary supplier of CO₂ systems in South Africa, has installed more than 100 transcritical CO₂ systems in the country (and beyond). Evergreens, however, is their largest commercial installation to date with a capacity more akin to an industrial system. Transcritical CO₂ is, in fact, being adopted by a growing number of cold-storage plants around the world.



2 /

1 / The 22,000m² Evergreens fresh produce retail/wholesale store in Johannesburg opened in August.

2 / There are 167 refrigeration points in the store, all fed by the two CO₂ racks.

Established 35 years ago, Evergreens is a one-stop shop that supplies fresh produce, groceries and frozen goods for both retail and bulk shoppers, including everything from restaurants and schools to hotels and nursing homes. It includes a butchery, a bakery and a hot-foods section that the company is looking to expand. There is even an onsite packaging and processing facility to deal with produce as it comes into the receiving side.

The business commands high food-safety standards in all practices, with multi-temperature refrigerated trucks to ensure the products last as long as possible. It employs its own buyers who source produce directly from farms daily via nearly 500 suppliers.

KIGALI'S IMPACT

Although CO₂ seems like an unconventional choice for this type of installation, there has been a big push for South African retailers to go green and opt for natural refrigerants to bring local stores in line with global policy. The Kigali Amendment to the Montreal Protocol – ratified by South Africa on August 1 – continues to have a great impact on the future of refrigerants around the world,

adding pressure to phase down towards more environmentally friendly refrigeration systems.

CRS pitched the CO₂ option to Evergreens as the size of the project meant that it fell into a gap where it is large enough for it to be cheaper than a synthetic-refrigerant solution and small enough to be cheaper than ammonia. Not only was the capital expenditure less than the alternatives, but CO₂ provided the benefit of being more energy efficient.

"The client was looking for a future-proof solution and after considering the environmental impact of different refrigerants and the phase out and phase down of greenhouse gases, they decided that CO₂ was the better option," said Maurice Robinson, Director of Sales and Marketing at Sphere.

In addition to two transcritical racks, CRS supplied the evaporators, as well as a monitoring system. The refrigeration racks were all custom-built and locally manufactured at the CRS premises in Johannesburg.

The main distribution board manages the racks as well as the evaporator coils. The racks, each with medium-temperature and low-temperature circuits, cool about 167 points, including various cold and freezer rooms, freezer and cold cabinets, and chillers.

Loads range in temperature depending on the product, with the freezer rooms being kept at -20°C (-4°F), the citrus at 2°C to 5°C (35.6°F to 41°F), and the avocados and bananas at 14°C (57.2°F). This is because if it is too hot, it will ripen fruit too fast, and if too cold, will make the fruit go black.

There are night blinds on all cabinets and freezers on the shop floor to ensure no energy is wasted because of unnecessary refrigeration. (No doors are used.)

The large vegetable rooms can fit 1,500 pallets and employ 12m (39.4ft) insulated panels from Dalucon – the largest single-mold injected panels available locally. The rooms are also equipped with Storax mobile racking from Barpro Storage that can move within just 2mm (0.8in) from one another before a sensor automatically stops them.

The estimated heat rejection is around 384kW (109TR), and this is used to heat water from 20°C to 55°C (68°F to 131°F). Hot-gas defrost has been included instead of the normal element heater that uses a lot of electricity.

"Using heat reclaim and hot-gas defrost minimizes the need for electrical elements within the store set up, reducing the overall energy consumption of the fresh market," said Robinson.

HAPPY SO FAR

So far, Evergreens is very happy with the refrigeration installation and how it is running, confirmed David Lopes, its Senior Buyer and Project Manager for New Business.

"The site is relatively new and therefore the plant has run for only a few months and while the initial indicators currently show good performance levels, we will continue to monitor the consumption," said Robinson.

The system was sized for future expansion, with an extra 24 refrigeration points available for new cabinets.

Future plans include adding a coffee shop above the shop floor and a 1,200m² (12,916ft²) liquor store (which should be open by the end of the year). ■ IK

Outsourcing Model Offers Alternative to NatRefs Capital Cost

Energy Partners is installing commercial and industrial refrigeration systems for which the end user pays only cooling and fixed maintenance costs.

— by Ilana Koegelenberg

One of the obstacles to purchasing a commercial or industrial natural refrigerant system has been its high capital cost. While costs have declined in Europe and other parts of the world with economies of scale, they may be higher than those of traditional systems, and in any case represent a major investment that may take years to recoup with energy savings.

But what if an end user could avoid capital costs altogether and just pay for the cooling provided by an installed system as if it were a utility?

This is not a new model as it is similar to that of large-scale district cooling installations. However, for commercial or industrial installations for single end users, it is a relatively new concept.

South Africa-based Energy Partners, one of a handful of companies that have entered this arena, is currently installing three ammonia systems that will be based on its outsourcing model. (It also has installed multiple outsourced f-gas refrigeration systems.) Other providers include Sphere Solutions in South Africa,

the Caribbean Basin Sustainable Energy Fund, Daikin in Belgium, Smart Joules in India for hospital installations, and the Swiss foundation BASE.

Energy Partners' outsourced model "is a utility approach where clients purchase the 'cooling energy' and do not have to be concerned with the cost or hassle of owning the equipment," said Dawie Kriel, Director at Energy Partners, which also provides solar, steam, water and fuel solutions. "This allows for a consistent and reliable supply of cooling energy for customers." Customers also pay a fixed cost for maintenance, which is managed by Energy Partners. The company builds its outsourced equipment.

Energy Partners pays for the electricity that the refrigeration system uses to produce the cooling that the customer buys from them. "We, in effect, guarantee the conversion of electricity to cooling over the life of the plant (usually 15 years)," explained Kriel. Although there are seasonal differences, the company does advanced modelling of the plant beforehand to arrive at the best performance a specific system can achieve and then guarantees a minimum of 80-90% of this, depending on the circumstances.

Energy Partners boasts a team of more than 400 people including more than 80 engineers, offering the integrated skills of engineering, project implementation, and investment. It has been using this outsourced model for three years and offers it for CO₂ systems as well (which they can also manufacture and maintain in-house). "It came about because our customers wanted to achieve energy savings but had problems finding/motivating the necessary capital required to get it done," said Kriel. "We also determined that a large percentage of the savings were operationally driven (such as plant control and maintenance) and this made outsourcing logical."

CONSIDER LIFECYCLE COSTS

Kriel estimates that energy consumption makes up 60% to 75% of the lifecycle cost of most commercial and industrial refrigeration systems. Capital expenditure is around 15% to 20% and maintenance close to 10% to 17%. "This makes energy efficiency by far the most critical factor in the lifecycle cost," he said.

He contends that the traditional ownership model has no way to measure and control lifecycle cost. "This puts natural refrigerant systems on the back foot as they



An ammonia refrigeration rack built by Energy Partners for the GIZ's thermal test chamber in South Africa.

look expensive using only the capital cost criteria," he said. "Owners have no real understanding of the energy part of the lifecycle cost and often it isn't even measured. Therefore, system decisions are based on the things the owners can control, which is mostly capital cost, risk and to some degree maintenance cost." By contrast, Kriel said, the outsourced refrigeration model uses the total lifecycle cost as the main criteria for system selection.

Kriel said end users are attracted to the outsourcing arrangement for "peace of mind and the ability to focus on their core business while we look after their cooling needs. It also gives them the opportunity to invest their capital in other parts of their business that will help them grow and increase profitability."

When asked why he uses this outsourced refrigeration model, Energy Partners end-user Nick Jewkes, co-owner of South African supermarket Pick n Pay's Darras store, said: "It is easy, the energy saving pays for the plant, and there are no more surprise expenses."

Another end user, South African poultry producer Sovereign Foods, is considering the outsourcing model. Pieter van der Smit, Engineering Manager at Sovereign Foods, said this model would help the company focus on its core business. "The outsourcing module is designed to incentivize the highest coefficient of performance, over the life of the contract period," he said. "With the correct pricing structure, both the client and service provider will profit from a well-maintained plant." ■ IK

OUTSOURCED AMMONIA SYSTEMS

Energy Partners is busy with three outsourced ammonia projects in South Africa:

- ▶ One is a 450kW medium-temperature system upgrade for the fruit-export sector in South Africa. This will be the first phase of a three-phase expansion over the next few years and will eventually have a capacity of 1,000kW and include rapid pull-down rooms, holding rooms, and logistics areas. "This is an example of investment into an existing plant, where we take over the old plant at nominal value, upgrade it to the latest technology and expand it for future growth all under a cooling sales model," explained Dawie Kriel, Head of Refrigeration at Energy Partners. It will be operational by December 2019.
- ▶ The second system is for a food processing facility operated by an international food company. It consists of about 1,000kW of low- and high-stage cooling driving both spiral freezers, holding freezers and raw material medium-temperature cold storage. This is a greenfield project and will be operational by February 2020. It is fully outsourced, including all the piping and coolers in the factory.
- ▶ The third system is the largest, around 3,500kW, and operates in the abattoir sector. It will be fully operational by July 2020 and uses a combination of direct ammonia and secondary cooling for different areas. About a third of the load is low stage at -40°C (-40°F).

PRIORITIZING SUSTAINABILITY, IGA STORE CHOOSES CO₂



1 /

The IGA Creswick supermarket's transcritical CO₂ installation is one of the latest examples of an independent Australian retailer moving towards natural refrigerants.

— By Ilana Koegelenberg

Thanks to its natural refrigeration system, a significant reduction in carbon footprint is projected for the new IGA Supa retail and liquor store, which opened in Creswick, Australia on August 8.

Owner Steve Sellars put extensive thought into this project and after listening to input from the community, decided to implement a number of sustainability initiatives. Other than the natural refrigeration system, which incorporates air conditioning, he installed LED lighting and solar panels. The store also uses Supercart trolleys made from recycled plastics.

"We will have a 47% reduction in our carbon footprint because we chose natural refrigerants over high-GWP refrigerants, and our emissions will be 6,209 CO₂e tons less per year," said Sellars. "We will also heat our store and produce hot water from the excess heat generated by the CO₂ system, further reducing costs and emissions."



2 /

1 / IGA Creswick opened on August 8 with a transcritical CO₂ system.

2 / Steve Sellars, owner of IGA Creswick, and his wife, Jacqui.

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Other considerations that motivated the business case for a CO₂ system were cost savings, energy efficiency and future-proofing the store, noted Sellars.

Sellars has 15 years of experience in chain stores and 25 years with independents. He has owned a supermarket in Creswick for 16 years and had his heart set on creating a "green" store with this new project, seeing the long-term value in moving to naturals.

Sellars stressed the importance of good partnerships when tackling a new project and as such, has hand-picked his team of experienced manufacturers and installers for this CO₂ installation.

The project was a greenfields site and construction started in December 2018. According to Shaun Davis, MB Group General Manager, the project ran extremely well thanks to a great team.

The refrigeration system is a CO₂ booster system with parallel compression and Danfoss gas ejectors as built by Sphere in South Africa and installed by MB Group. There is also a brazed plate heat exchanger on the rack that uses the CO₂ to cool down water for the AC requirements of the store.

First Koxka CO₂ cabinets

IGA Cheswick is Spanish cabinet manufacturer Koxka's first transcritical CO₂ project in the Australian market. It has, however, done some subcritical stores before with another transcritical project in the pipeline for next year.

"Koxka is heavily investing in natural refrigerants, both transcritical CO₂ and R290," said Jesus Beraza, Chief Strategy and Innovation Officer at Koxka.

Koxka sold cases directly to the end user and then worked closely with the MB Group to ensure its cases would communicate with the refrigeration rack. The case specification was standard for the most part, said Matthew Bennett, National Sales Director of Koxka; however, Koxka did need to change the control interface to facilitate

communication with the system's back end. It also required thicker gauge copper tube to comply with the much higher CO₂ pressure and an AKV valve.

When it comes to the Australian market, Bennett believes there are a lot of opportunities to go natural, especially in the plug-in market. "For smaller cases with smaller refrigerant charges, it is an easy fix to replace synthetic refrigerants with hydrocarbons at a manufacturing level," he said. However, he believes the challenge is greater for larger stores such as Creswick where the initial cost of an f-gas system is still cheaper than CO₂. "That's where the education comes in."

Slow uptake by independents

Although more independent retailers in Australia are going the natural refrigerant route, there is still a long way to go...

Dave Redden, now-retired principal at Refrigeration Innovations, the consultant on the Creswick project, presented a paper at Refrigeration 2019 called "Independent Retailers Moving to Natural Refrigerants". During his presentation at this Australian event, he noted: "The uptake of natural refrigerants in the smaller and independent grocery retailer market in Australia has been slow." This is mainly due to factors such as costs, lack of skill, and poor information and skills sharing, he said.

"Whilst the refrigeration industry has made great progress in the transitioning to natural refrigerants through forward-thinking companies, there are still sectors of our industry that are neither willing to invest in training or are living in the hope that it is business as usual," said Redden. "These companies present an obstacle to giving clients the advice they need to make an informed decision. We must overcome this for the good of the clients and the industry as a whole."

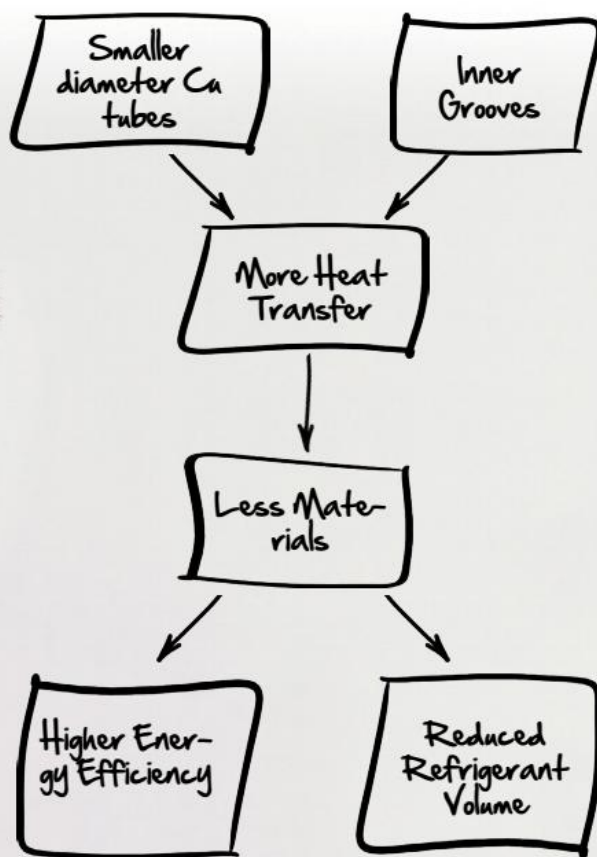
"Retailers are more and more willing to accept and adopt the move to natural refrigerant solutions and we must not allow our own industry to impede this progress," Redden concluded. ■ IK

System Specs

IGA Creswick's Transcritical CO₂ System

- **OEM:** Sphere
- **Installer:** MB Group
- **Compressors:** Copeland
- **Drives:** ABB
- **Controls:** Danfoss
- **Gas Ejectors:** Danfoss
- **Rack:**
 - Three low-temperature compressors
 - Three medium-temperature compressors
 - Three parallel compressors
 - 60bar intermediate-pressure rating
 - Two gas ejectors
- **Capacity:**
 - 29kW (8TR) at -27°C (-16.6°F)
 - 134kW (38TR) at -8°C (17.6°F)
 - 88kW (25TR) AC load
- **Case supplier:** Koxka
- **Number of cases:** 33
- **Case types:**
 - Full-height multidecks with doors
 - Full-height open multidecks
 - Low-height multidecks
 - Freezers
 - Refrigerated and hot deli cases.

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Making Buildings More Efficient in Australia

Along with data analysis and electrification, natural refrigerant-based air conditioning can play a key role in reducing emissions in the building sector.

— by Devin Yoshimoto and Caroline Rham

“*I call on all of you to make digitalization ethical and sustainable.*”
- Simon Carter, Morphosis



Future of HVAC 2019 conference. Photo: AIRAH

This year's Future of HVAC conference focused on ways in which the HVAC industry can increase the energy efficiency of buildings and lower building emissions, including the use of natural refrigerants.

The conference, organized by the Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH), took place in Brisbane, Australia from September 11-12.

Almost a quarter of emissions in Australia are due to the "construction, operation and maintenance of buildings", according to an article published earlier this year by Australian news outlet *The Conversation*. It said that with the Australian population expected to grow to an estimated 31 million in 2030, there will be even more buildings and thus even higher emissions.

With this projected growth, there is growing pressure on building owners to increase the energy efficiency in their buildings, especially heating and cooling technologies which often take up the bulk of annual energy consumption.

Ammonia-based air conditioning

One example raised at the conference involved Scantec Refrigeration Technologies, an industrial refrigeration system manufacturer and contractor in Australia. In 2011, Scantec installed a water-cooled ammonia chiller system which provided air conditioning for the Council Administration Center in Logan City, Australia.

Stefan Jensen, Managing Director of Scantec, presented a case study about this installation titled "Operating experiences with an Australian air conditioning system employing ammonia refrigerant".

According to Jensen, the ammonia system replaced an R22-based system and resulted in significant reductions in maintenance and energy costs in the following eight years of operation.



Phil Wilkinson at the podium at Future of HVAC 2019. Photo: AIRAH

The Logan City Council website stated that "the system is saving [an estimated] US \$200,000 a year in costs relative to the system it replaced, resulting in an approximate five-year payback period". The payback period was initially estimated at 8.5 years.

"What is probably most important to the Council staff, who on a daily basis work in the air-conditioned environment provided by the new air conditioning system, is that there has been no change to their comfort levels over the last eight years," said the technical paper that covered the Scantec case study.

Building digitalization and electrification

In addition to the ammonia-based air conditioning system, several other issues were discussed at the event, including the increasing importance of data collection and analysis in the building sector.

"Digitalization is happening at an accelerating rate," said Simon Carter, Founding Director of the Sydney, Australia-based sustainability strategy consultancy

Morphosis, who gave the keynote address on the morning of the first day. "I call on all of you to make digitalization ethical and sustainable," he said.

Chris Stamatis, Director of building energy analytics firm CopperTree Analytics, also addressed the topic of data and analytics for building efficiency. "The future is integration, AI and machine learning, automated optimization, and predictive optimization," he said. "The future challenges, however, are security, reliability, stability, resistance to change, and costs."

Heat pumps were also discussed as playing an important role in the reduction of building emissions through electrification. In a presentation titled "Our all electric future," Paul Stoller, Director of engineering consulting firm Atelier Ten, talked about the use of heat pump technology.

"If renewables uptake by the grid continues, all electric heat pump systems will result in lower emissions by 2030-2035," said Stoller. "Expect heat pumps to play an increasing role in heating large buildings." ■ DY & CR

Phil Wilkinson Leaves AIRAH

During the Future of HVAC 2019 conference, AIRAH's Phil Wilkinson announced his resignation, according to Australian news site *HVAC&RNews*.

Wilkinson served AIRAH in various positions over his 18-year tenure, including Technical Manager, Business Development Manager, CEO, and most recently as the Executive General Manager – Technical Services and Government Relations.

"Throughout his time with the Institute, Phil has been a credit to AIRAH, its members and to our industry," said Tony Gleeson, CEO of AIRAH to *HVAC&RNews*. "He has worked energetically to promote an industry and issues he's passionate about, making many friends along the way."

"He has at all times put AIRAH and our members first, helping to position us as a leader and innovator in the HVAC&R industry," said Gleeson. "Phil has a considerable skill set and admirable qualities that will be welcomed by many organizations."

Hydrocarbon Training Building Momentum in Australia

Vocational training provider TAFE believes that R290 training is crucial to prepare the Australian HVAC&R industry for the future.

— by Ilana Koegelenberg

The propane (R290) training program offered by Technical And Further Education (TAFE) New South Wales (NSW) is growing in Australia and Fiji in preparation for what is expected to a much greater role for the refrigerant, according to Glenn Marsh, its Head Teacher for Air Conditioning and Refrigeration.

Marsh took part in the “Fridgies of the Future” panel discussion at ATMOSphere Australia 2019, sharing information on how TAFE is faring with its natural refrigerant training, particularly hydrocarbons like R290.

TAFE NSW is a government-run training provider that offers more than 1,000 courses, including a multitude of HVAC&R programs. It has trained nearly 3,000 apprentices in refrigeration and has offered hydrocarbon system training since 2010.

Marsh has been in the industry for 26 years and has a big passion for hydrocarbons, he explained at ATMOSphere Australia, held in May. He believes that the training sector needs to be ahead of the curve when it comes to changing over to natural refrigerants. “We need to be in readiness for the tides of change that are coming,” he said.

He echoed the words of his colleague Steve Smith, Head of Skills Point Team – Refrigeration, who is of the firm opinion that “natural refrigerants will be the sole remaining option in 15 to 20 years. Evidence points that synthetics will be non-existent or at best extremely expensive.”

ADDRESSING PERCEIVED DANGERS

Marsh shared teaching perspectives for the region, giving insight into how the courses currently work and what students are learning. He also spoke about future plans. TAFE has a vision for a two-day short course for R290 where the theory part can be done online, backed up by short, sharp practical events. The intent is to minimize disruption to normal business routines.

He then spoke about the challenges and opportunities for hydrocarbon training in Australia and Fiji. Marsh cited the industry’s concerns about the perceived dangers of hydrocarbons as the main reason for the slow uptake of these systems in the region. He blamed the public’s poor understanding of hydrocarbons and skewed social media representation of accidents. “I worry that people are going to blame the substance, rather than the person working on it,” he said. “That’s where we need to do the training and get the social understanding.”

Opportunities include upskilling the work force and improving understanding, particularly regarding the benefit to the environment and energy efficiency. Marsh suggested encouraging students to be the voice of the industry online, aiding healthy social perceptions where hydrocarbons themselves are not blamed for incidents.

Marsh called on manufacturers to make hydrocarbon technologies more accessible and more integrated with training providers. He also suggested that natural refrigerants should be made a core, compulsory module for all refrigeration students.

He ended with a call to action, sharing a quote from the TAFE NSW 2017 valedictorian, Mohammed Shuaib, who said: “Some say that ‘Knowledge is Power’. I would like to add one thing to that – Action. Knowledge with Action is Power!”

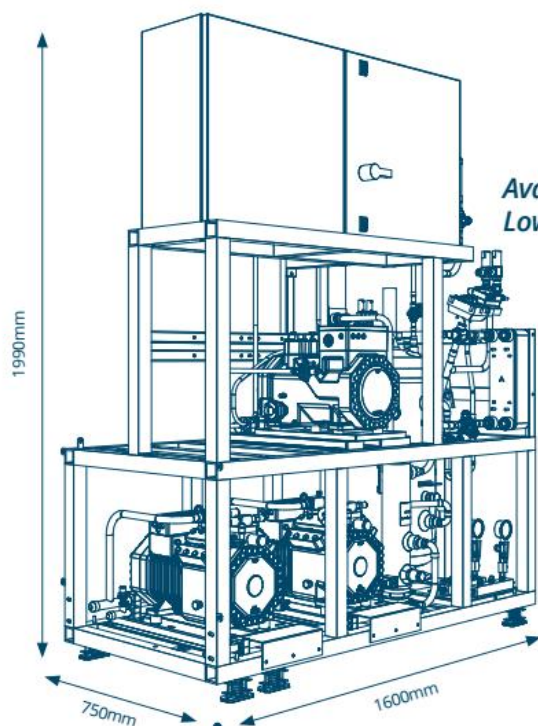
■ IK



Glenn Marsh of TAFE NSW, presenting at ATMOSphere Australia 2019 in May.

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Japan's Largest Refrigerated Warehouse Satisfied with NH₃/CO₂ Systems

In a major overhaul, Tokyo Danchireizo replaced its R22 systems with NH₃/CO₂ technology.

— by Devin Yoshimoto, Rena Okabe, Tomoro Sato



Tokyo Danchireizo's Heiwajima Distribution Center in Ota Ward, Tokyo.

Demonstrating Japan's continued progress in keeping up with natural refrigerant technology, Tokyo Danchireizo's Heiwajima Distribution Center in Ota Ward, Tokyo — Japan's largest refrigerated warehousing facility — installed NH₃/CO₂ refrigeration systems to replace R22 systems as part of a major renovation last year.

Feedback from the management staff has been positive since the facility reopened in March last year.

"Operation has been smooth so far," said Takayuki Togou, Facility Management Department Manager, during an interview conducted at Tokyo Danchireizo in August.

The installation of the NH₃/CO₂ cooling systems during the renovation was mainly motivated by Tokyo Danchireizo's desire to reduce CO₂ emissions and eliminate its use of f-gases.

The need for renovation was identified because of the natural aging of the facility and its increasing susceptibility to seismic activity, Togou said.

In addition to this, Tokyo Danchireizo wanted to expand the capacity of the facility — going from 147,840 Japanese

tons (369,600m³ or 5,220,920ft³) to 177,873 Japanese tons (444,682m³ or 15,703,796ft³).

The company also considered environmental impact and energy efficiency as a high priority when selecting its replacement refrigeration equipment.

"From the point of view of environmental sustainability, including CO₂ emission reduction and the use of f-gas alternatives beginning in 2020, the need for the revamping of the in-house refrigeration equipment arose, and the refrigeration equipment for the warehouse was completely rebuilt," stated a press release from last year when the new facility was opened.

Tokyo Danchireizo's use of NH₃/CO₂ is just the latest example of the adoption of the next generation of industrial refrigeration systems based on natural refrigerants to replace systems running on R22.

The Japan Association of Refrigerated Warehouses (JARW), the central association representing the refrigerated warehouse industry in Japan, estimates that 68% of its members still use R22.

Two NH₃/CO₂ suppliers

The Tokyo Danchireizo facility is located in a major logistics and cargo area near Tokyo Port and serves as a major low-temperature and chilled food logistics base for the Tokyo metropolitan area.

The facility is split into two wings — north and south. The north wing has a total volume of 130,023 Japanese tons (325,057m³ or 11,479,297ft³) while the south wing has 47,850 Japanese tons (119,625m³ or 4,224,517ft³).

In the north wing, there are 11 NewTon R-8000 NH₃/CO₂ secondary systems supplied by Japanese OEM Mayekawa, which provide the cooling for the low-temperature freezing areas. Nine NewTon C NH₃/CO₂ secondary systems are used for the chilled temperature areas.

In the facility's south wing, four CLTS NH₃/CO₂ secondary systems, supplied by Japanese OEM Mitsubishi Heavy Industries Thermal Systems, provide the cooling for low-temperature freezing areas. An additional two CLTS NH₃/CO₂ secondary systems provide the cooling for the chilled temperature areas. ■ DY, RO & TS



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Roy Alvin Tañedo, Royal Duty Free Shops

Philippines' First All-R290 Store Influenced by Millennial Customer Base

Sustainability, flexibility, and reduced maintenance costs were also factors highlighted by Royal Duty Free Shops at ATMOsphere Asia 2019.

— By Devin Yoshimoto

Sustainability goals and a largely "millennial" customer base ultimately drove Royal Duty Free's decision to install exclusively R290-based display cases and cabinets at its flagship store in the Philippines, said Roy Alvin Tañedo, Assistant Vice President Support Services for Royal Duty Free Shops Inc. at the ATMOsphere Asia 2019 conference held in Bangkok, Thailand, on September 25.

Royal Duty Free is the first store in the Philippines to be outfitted with all R290-based showcases and cabinets with a combined water-loop system. The store is located in Subic Bay — a special economic zone a few hours' drive northwest of the Philippines' capital city of Manila. (See "[Royal Duty Free Is First in the Philippines with All-R290 Store](#)," *Accelerate Magazine*, June 2019.)

One of the company's core values relates to the Filipino word "malasakit", which Tañedo explained roughly translates to a genuine concern for others. "We would like to be known as a company that cares and we have engaged in several green projects in the past — from tree planting to using eco-friendly paper bags," he said. "We are more than willing to help in any way we can to propagate the use of R290."

According to Tañedo, these sustainability goals are a key part of differentiating itself to its increasingly "millennial" customer base. "We believe that our new primary customers, the millennials, advocate for sustainability as well," Tañedo said.



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► In addition to wanting to be more sustainable, eliminating heat emissions inside the store also drove Royal Duty Free to install the water-loop system, explained Tañedo. Royal Duty Free has been interested in the water-loop system to help address the indoor heat emission issue since the team first saw it exhibited at the Euroshop exhibition in 2014.

High maintenance costs were also a big problem and a driver for change, Tañedo said. "It was almost every week that we would get reports of breakdowns on our refrigeration and our costs were really high," he said.

Another key priority was layout flexibility. The company has two stores in the area and Tañedo explained that if there arose a requirement to close one store and relocate to the other, Tandedo wants to have the flexibility to change the layout.

Finally zero downtime was a top consideration for Royal Duty Free Shops, Tañedo said, especially as the fourth quarter of the year is approaching — traditionally the busiest sales season of the year for retailers.

"So it shows that the benefits outweigh the risks that everyone is scared of," Tañedo said.

The project's first phase was completed in August, with several of the R290 plug-in units already installed and operating, according to Emilio Gonzalez La'O, President of Philippines-based installation contractor Cold Front Technologies Asia. Those cases were provided by Austrian multinational refrigeration system manufacturer AHT,

The water-loop system is currently being installed in the store, and the rest of the R290 showcases are en route to the Philippines. (The water-loop system and remaining R290 cases are provided by Lithuanian-based manufacturer Freor.) Installation is scheduled to be completed by December.

Water-loop systems growing in Asia

Installation contractor Cold Front has experience installing water-loop systems in the country, having installed the first one (but not for all cases) in the Philippines at a Citimart supermarket located in the province of Batangas in November 2016.

Cold Front, an exclusive distributor of Freor's products in the Philippines, has since installed Freor's water-loop systems at three Rustan's supermarkets in Manila as well.



Emilio Gonzalez La'O, Cold Front Technologies Asia

One of the factors driving interest in R290 systems for both new and remodeled stores is the very high cost of electricity in the Philippines coupled with the energy-saving capability of R290. "Part of why we are seeing a lot more interest, and why we are pushing for R290 and water-loop systems together, is the feedback we are receiving on energy savings," said Jennifer V. Gonzalez La'O, Cold Front's Vice President of Finance and Administration.

Freor has started promoting this technology in Asia. Its R290 water-loop system was exhibited for the first time at the Supermarket Tradeshow 2019 exhibition, held at in Tokyo in February, where it generated significant buzz.

Freor, which supplies supermarket chains throughout Western Europe and the Nordic regions, has seen strong sales growth for its R290 systems and believes there is big potential for them to thrive in the Japanese market. "Freor's sales of propane-based equipment almost doubled in 2018 compared to 2016," said Jūratė Mizarė, Freor's Marketing Manager, during the Tokyo exhibition. ■ DY



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REGULATORY ACTION ON F-GASES SOUGHT IN THAILAND

Thai government is not doing enough to control emissions in industrial sector, say stakeholders at ATMosphere Asia and R&HVAC 2019.

— by Devin Yoshimoto



Although the Thai government has expressed its intentions to reduce f-gas emissions in the HVAC&R sector, some industrial refrigeration stakeholders say there is little regulatory control over f-gases in cold storage and food processing facilities.

Stakeholders pointed to a lack of government direction for end users to move away from HCFCs and HFCs, and a lack of control over the use and disposal of f-gases, which is resulting in a large amounts being released into the atmosphere.

"We still see heavy use of R22 in Thailand and several users are purging R22 into the air," said Kosuke Yamamoto, Managing Director of Mayekawa Thailand during the ATMosphere Asia 2019 conference, held on September 25 in Bangkok, Thailand. Mayekawa Thailand is one of the largest suppliers of industrial refrigeration system suppliers in the country, specializing in the food processing sector.

"There is no law concerning the recovery and destruction of f-gases as well," said Yamamoto. "We need the government to provide a clear direction to the industry in terms of control and disposal of f-gases."



Yamamoto explained that not only are f-gases being intentionally released into the air, but end users are also choosing to continue installing f-gas systems in this sector.

In the past, 90% of the systems in Thailand were ammonia or ammonia/CO₂, but recently Mayekawa is seeing demands from clients for R404A, such as in expansion projects in the fishing industry, said Yamamoto.

The lack of direction in the control and regulation of f-gases in this sector is a major issue that is often overlooked and needs immediate attention, said Yamamoto. "In order to reduce f-gases in Thailand, first we need the government to make a clear indication to the industry," he said. "Especially in the refrigeration industry, we feel we are left behind."

Feedback from government

A Thai government official provided some feedback on its regulatory efforts at the ATMosphere Asia 2019 conference.

According to its Nationally Determined Contribution (NDC) Roadmap (2021-2030) plan, established by the government in 2017, Thailand aims to reduce total GHG emissions by 20-25% from Business as Usual (BAU) by 2030. However, within the HVAC&R sector, the government only recently began focusing on reducing emissions, acknowledged Dr. Kittisak Prukkanone, Director of the Measure and Mechanism Development Section for Thailand's Ministry of Natural Resources and Environment.

"It's quite new for us to work in the RAC sector on the climate-change aspect," said Prukkanone.

The Thai government has a number of initiatives currently underway to tackle emissions in the HVAC&R sector in Thailand. One of the main efforts is the Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action (RAC NAMA) project, which aims to support the transition to natural refrigerants in domestic refrigerators, commercial refrigerators, air conditioners, and chillers in the country.

1 / Kosuke Yamamoto, Mayekawa Thailand, at ATMosphere Asia 2019

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

More commentary at R&HVAC 2019

At the R&HVAC 2019 exhibition, also held in Bangkok the day after the ATMosphere Asia conference, a number of suppliers echoed the need for government direction in the industrial refrigeration sector, where smaller-sized facilities are continuing to use f-gas systems.

"I think that the people who used to use R22 and are now using R404A, will keep doing it," said Mathieu Balay, Engineering Director, of industrial refrigeration system supplier Sirayooth.

Balay acknowledged the lack of urgency or awareness in the Thai cold-storage and food-processing industries. "Everybody is thinking that we still have time and that what we are doing now still works and will still work for quite some time," he said. "The only thing that could make them change their minds is if there are strong policies or laws that pass."

Another major industrial refrigeration system supplier, Patkol, confirmed that a number of R22 and R404A systems are still being installed in the smaller-sized cold storage and food processing facilities.

"There is very little awareness of environmental impact and energy efficiency with end users in that sector," said Naradom Padoongtam, Design Engineer for Patkol. "They are just looking for the cheapest system."

When asked for a solution, other than government involvement, Padoongtam said "contractors like Patkol and others can do more to communicate the issues with installing freon systems with their customers."

"Internally even, companies can do more to communicate with their own sales engineers and educate them about the risks and impacts of installing f-gas systems at their facilities," said Padoongtam. ■ DY

SPAR STORE CHOOSES R290 OVER R404A

Several Spar stores are installing R290 units in China.

Chengdu, China, outlet installs propane plug-in freezer cabinets because of their greater energy efficiency.

— By Devin Yoshimoto

Marking the continued uptake of R290 light-commercial plug-in systems in China, retailer Spar China recently installed 32 plug-in freezer cabinets charged with R290 at a store opened in July.

Spar China is a part of Spar, a Dutch multinational group that oversees independently owned and operated retail stores worldwide. The new store is located in the city of Chengdu and is owned by Spar Sichuan Dehui, a division of Spar China that operates more than 400 stores in nine Chinese provinces.

The R290 plug-in freezer cabinets were supplied by AHT Cooling Systems (Changshu), a division of Austrian multinational refrigeration system manufacturer AHT.

The decision by the store owner to install the R290 units was driven mainly by the energy savings when compared to a traditional R404A system, according to AHT. "The owner was planning to use a remote R404A system," explained Felix Liu, China Sales Director for AHT. Liu estimates the energy savings to be "up to 40%" compared to a remote R404A system, which would result in a payback period of two years for the premium paid.

In addition, Liu said that the advantages for the end user included "no piping or water-drain work" due to the plug-in nature for the premium paid of the systems.

Energy efficiency is also driving Spar Beijing Huaguan, another division of Spar China,

to install R290 plug-in systems at its stores. Presenting during ATMosphere China 2018 in Beijing, a representative from Spar Beijing Huaguan said that the retailer would adopt R290 plug-in freezers for all new stores and would gradually replace 300 of the R404A units in old stores.

Spar Beijing Huaguan found that the energy consumption for a R290 unit was 6.8kWh per day, 24% lower than a similar cabinet using R404A.

High energy rating

Given the interest in energy efficiency in China, AHT has been emphasizing that feature as it makes inroads into the Chinese marketplace. This was evident at the company's first AHT-branded booth at ChinaShop 2018 last November in Kunming, China.

All of the AHT cabinets on display at the exhibition boasted a "Level 1" rating on the China Energy Label (CEL) — an energy consumption label for products in China

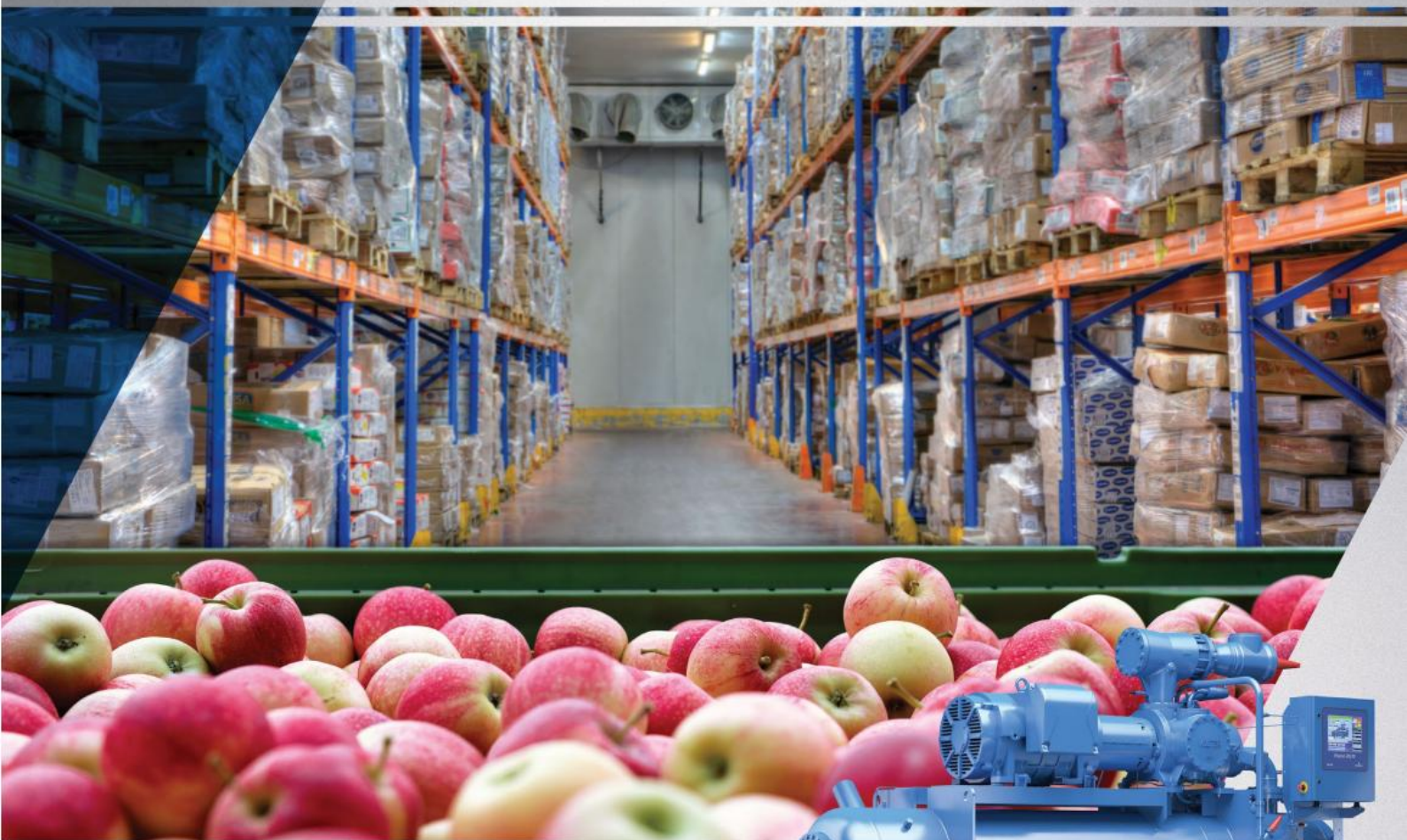
similar to the European Union energy label.

It is very rare for a product to achieve the highest energy-efficiency rating, according to Jonas Chen, General Manager, AHT Cooling Systems (Changshu).

He attributed AHT's score to using propane refrigerant together with variable speed drives.

"We are very happy because not many equipment providers can provide 'Level 1' plug-in units," Chen said during the event. "But we already have a whole series of these models here."

With a charge limit increase from 150g (5.3oz) to 500g (17.6oz) for hydrocarbons in commercial refrigeration set this year by the International Electrotechnical Commission (IEC), Chen predicts a positive effect on the uptake of AHT's larger R290 cabinets in China once this global standard is adopted at the regional level as well. ■ DY



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German Researchers Developing a New Type of Magnetocaloric Heat Pump

Team at Fraunhofer IPM aims to produce a highly efficient, affordable system that can compete with vapor compression.

— by Ilana Koegelenberg

“Efficient, refrigerant-free heat pumps based on the magnetocaloric cycle have the potential to revolutionize cooling technology.”

— Dr. Kilian Bartholomé, Fraunhofer IPM

By the end of this year, Dr. Kilian Bartholomé and his team at the Fraunhofer Institute for Physical Measurement Techniques (IPM) in Freiburg, Germany, expect to finish developing a prototype of a very efficient heat-pump system based on magnetocaloric technology that eliminates the need for vapor compression systems and environmentally damaging refrigerants.

The prototype, using a patented heat transfer concept, would be the world's first refrigerant-free heat-pump system with a capacity of 300W (putting it in the range of a household refrigerator, typically between 50 and 100W), a material temperature change of 35°K, and a coefficient of performance (COP) of greater than five, said Bartholomé.

“Efficient, refrigerant-free heat pumps based on the magnetocaloric cycle have the potential to revolutionize cooling technology,” he said.

The researchers in Freiburg have been working on this project for four years and hope to break a world record for magnetocaloric heat-pump systems with regards to the frequency at which the magnet vibrates (greater than 10hz). They also aim to achieve 50% of the theoretical maximum efficiency level possible for magnetocaloric systems. (Comparable existing systems reach approximately 30%.)

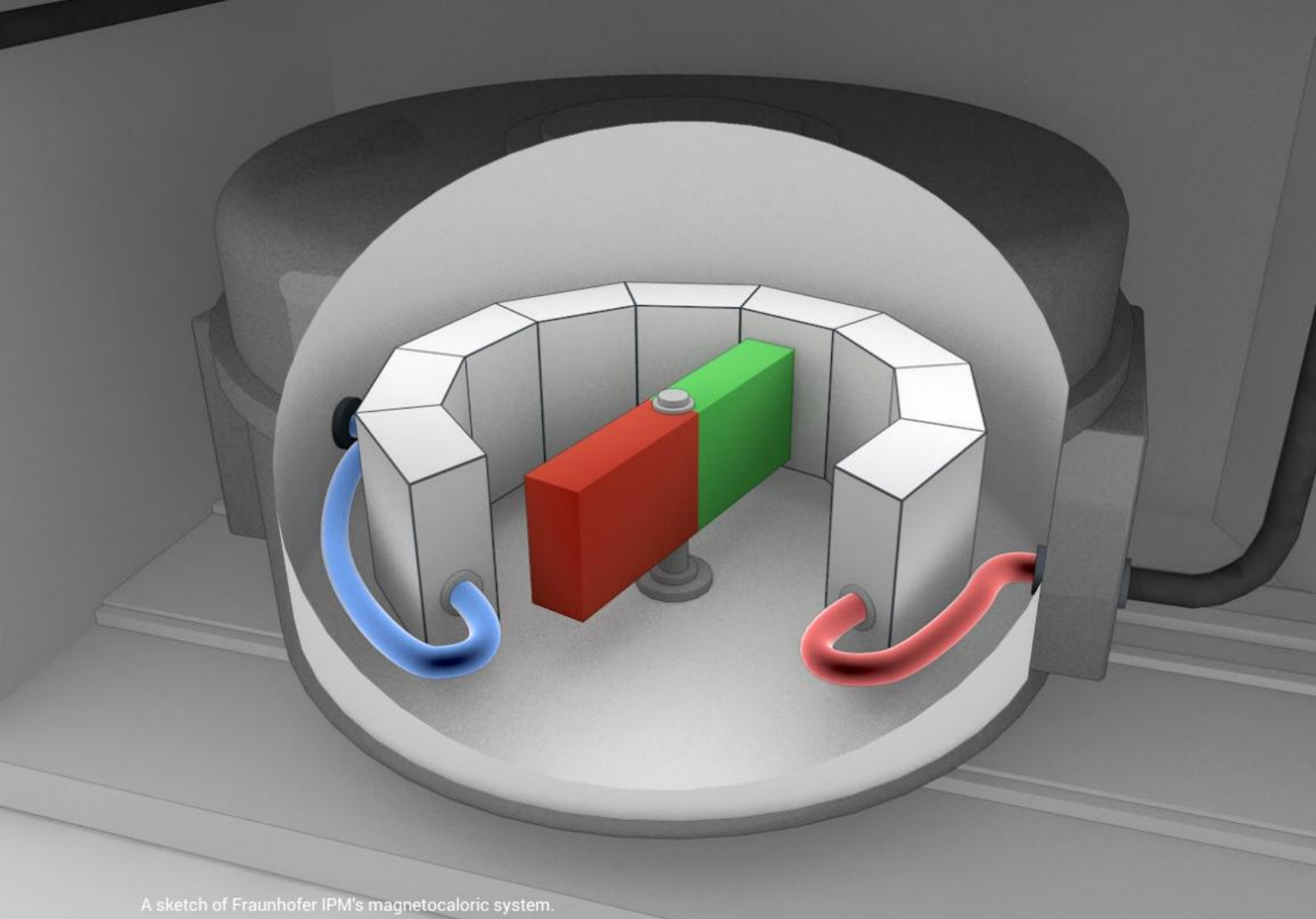
According to Bartholomé, the larger the system's frequency, the cheaper it can be. “The goal is to eventually be able to build magnetocaloric systems that are cost-competitive with vapor-compression systems,” he said.

PATENTED HEAT TRANSFER

Although magnetocaloric technology has been around since the early 1900s, it wasn't until the late 1990s that alloys were developed that are magnetocaloric at room temperature and can be produced cost-effectively on an industrial scale. One of these is the lanthanum-iron-silicon alloy being used by the working group at Fraunhofer IPM.

The magnetocaloric material heats up when exposed to a magnetic field and cools down again once the field is removed, reaching a lower temperature than at the start of the cycle. In a cooling cycle, the heated material is connected to a heat exchanger to transfer the heat produced, while the cooled material is connected to the system to be cooled, absorbing heat until it returns to its starting temperature.

Bartholomé and his team have developed and patented a special “heat pipe” procedure for transferring the heat produced. The efficient transfer of heat between the magnetocaloric material and the heat exchanger is a decisive factor in the overall efficiency of the magnetic cooling cycle. Previous prototypes are based on active magnetic regeneration



A sketch of Fraunhofer IPM's magnetocaloric system.

(AMR) where a fluid is pumped through the magnetocaloric material to transfer heat. A low heat-transfer coefficient and resulting low-cycle frequency, as well as the large amount of pumping energy required, make AMR concepts inefficient overall.

The heat pipe concept for heat transfer developed by Fraunhofer IPM facilitates passive heat transfer through the evaporation and condensation of a fluid (water or ethanol) in a hermetically sealed volume. Such heat exchangers, also known as thermosiphons, are used as solar collectors and in computer cooling. In magnetocaloric cooling, the heat pipe technique "makes the heat transfer way more efficient and thereby a lot faster, which in the end will lead to more cost-effective and efficient cooling systems," explained Bartholomé.

By evaporating a fluid such as water at the heat source and subsequently condensing it, it is possible to achieve

heat-transfer coefficients that are several orders of magnitude higher than those achieved in traditional heat transfer using thermal conduction or convection.

THE ROAD TO COMMERCIALIZATION

Although there are a number of magnetocaloric cooling prototypes on the market, many are still walking the long road to commercialization. French company Cooltech Applications had a number of systems running but it declared bankruptcy in 2018 and was taken over by Ubiblue. In 2016, the Ames Laboratory at Iowa State piloted an effort called CaloriCool to develop a commercial application for magnetocaloric cooling. Other companies that have worked on the commercialization of magnetocaloric cooling include Boston-based General Electric, two German companies (BASF and Vacuumschmelze), the Chinese firm Haier and Astronautics Corp. of America.

For Fraunhofer, there is still a long way to go until commercialization, which Bartholomé estimates at about five years. "First applications will be niche like medical applications, where it is easier to enter the market with a new technology, since the cost pressure is not as high as, for example, in household applications," he said.

Industry players are already expressing great interest in this research. Philipp Kirsch GmbH, which manufactures special refrigerators for medical laboratories, pharmacies and hospitals, is working with Fraunhofer IPM on a project sponsored by the German Federal Ministry of Economics and Technology (BMWi). "Magnetocaloric has a very large disruptive potential and could be capable of replacing compressor-based cooling in the medium-term time frame, said Dr. Jochen Kopitzke, CEO of Philipp Kirsch. "We see here a clearly developing market which we can penetrate." ■ IK

HARNESSING THE SUN TO CUT COOLING COSTS

SolXenergy's ThermX system improves the efficiency of refrigeration, air-conditioning and heat pump systems, using only sunlight to achieve up to 60% energy savings, the company said.

— by Tine Stausholm

“We are currently developing a new version of our ThermX panel which will be able to be installed on CO₂ systems.”

— Russell Eaton, SolXenergy

British company SolXenergy has developed a solar thermal collection system called ThermX that uses free thermal energy from the sun to power refrigeration, air-conditioning and heat pump systems, thereby reducing the compressor workload, the company said.

The patented ThermX thermal collector – a “three-party heat exchanger” – is installed between the compressor and the condenser. It is designed to channel heat from the sun to the compressor’s refrigerant discharge, which is contained within the copper piping of the system. This, the company said, improves heat transfer (delta T) at the condensation point. Better heat transfer improves subcooling, increasing the quality of liquid flow through the expansion valve, reducing or eradicating flash gas, and enhancing the cooling capacity in the evaporator.

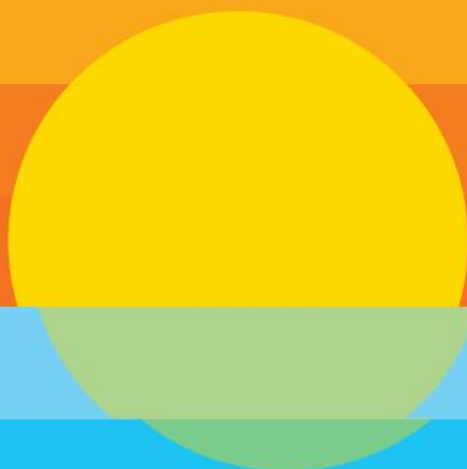
Recognizing this improvement, the system controller allows a variable-flow compressor to slow down (or a staged

system to shut down), achieving energy reduction, the company said. The more sun, the more energy saved.

The improved efficiency of the system, and the resulting reduced compressor workload, can result in up to 60% reduction of the energy consumption in commercial refrigeration systems, according to SolXenergy. The system works best with air-cooled variable refrigerant flow (VRF) systems. However, the system does not work in cooling systems with a single, fixed-speed compressor.

ThermX is used by companies like Texaco, Pizza Hut, Cummins, SPAR, Applebee’s and Sodexo, according to SolXenergy’s website. It has also been installed in leisure centers, schools and casinos, according to Russell Eaton, Sales Manager at SolXenergy.

The system has been available globally in the retrofit market since mid-2015 and, as of August 2019, SolXenergy has installed the ThermX in 47 different countries, Eaton said.



Natural refrigerant options

The original ThermX model was developed for systems using traditional synthetic refrigerants. "We are currently developing a new version of our ThermX panel which will be able to be installed on CO₂ systems," said Eaton. "We are still in the stage of evaluating the savings on such systems and as such it is a little early for us to commit to a release date."

Eaton further explained that the ThermX would deliver savings on R290 systems, but due to the risks involved with flammable refrigerants, the company has not pursued development in this area.

ThermX will also deliver savings on ammonia-based systems using air condensers, but due to the typical size of such systems the company has yet to identify a client who is prepared to be an early adopter, Eaton added.

The company has not disclosed system costs, but said that typically, one solar collector is required for between 12.3kW

(3.5TR) and 24.5kW (7TR) of cooling. "A typical baseline ROI is almost always below four years, the majority below three years, and in some case below two years," the company said on its website.

In addition to being supplied as a complete packaged solution for all applications, the solar thermal collection system can be retrofitted onto most types of existing screw type, digital scroll, inverter and staged scroll refrigeration, HVAC and chiller systems. Capacities include 2.6-12kW (0.74-3.4TR) for split residential AC systems and 7-900kW (2-256TR) for commercial chillers.

ThermX can also be used to enhance heating in a heat pump, where it works almost the same way, reversing the flow from the cooling mode.

The largest ThermX installation in the U.K. is at a company called Chingford Fruit, a fruit packaging company based in Kent, southeast England. Chingford Fruit's

site encompasses 5,575m² (60,000ft²) with a 1MW refrigeration system. After installing 54 ThermX thermal collectors on the roof of its facility in February 2016, Chingford fruit experienced a 92,500kWh reduction in energy consumption over a two-and-a-half month evaluation period. The reduction came despite production being much higher than the previous year, according to Colin Ormerod, central services manager at Chingford Fruit.

Chingford Fruit has also experienced another benefit from installing the ThermX. Prior to the installation, the company replaced on average three compressors a year, at a cost of £7,000 (US \$8,400) each. In the three years since installing the ThermX, the company has only replaced two compressors in total, according to Eaton. ■ TS

Study Recommends Integrated CO₂ Heat Pumps for Modern, Low-Energy Buildings

But the space heating demand needs to be less than that for hot water.

— By Tine Stausholm

A new study from the Arctic University in Norway, published in the *International Journal of Refrigeration* (<https://bit.ly/2IZ-PWeU>), looked at the efficiency of integrated CO₂ heat pumps that combine space and water heating and found them to be good performers under certain conditions.

"A CO₂-based integrated heat pump system with an ejector is a recommended heating system for modern, well-insulated, low-energy buildings," the study said.

Performance of these systems depends on several factors including inlet and outlet water temperatures; the size of gas coolers, evaporators and heat exchangers; compressor efficiency; and the profile of the heating demand.

The researchers found that integrated CO₂ heat pumps can outperform traditional R410A systems when the following conditions are met:

- ▶ The ratio of space-to-water heating is less than 0.6 – 1.0; meaning that the space heating demand is less than the hot water requirements.
- ▶ The inlet water temperature is below 20°C (68°F).
- ▶ The heat exchangers are designed with tight temperature pinches below 10°K (10°C/18°F).

Buildings where the space-to-water heating ratio is less than 1.0 include modern low-energy buildings and buildings with large hot water requirements, such as hotels and sports complexes. The required inlet water temperature of less than 20°C (68°F) makes it suitable for moderate climates such as in Northern Europe.

In Norway, where the study was done, low-energy housing has annual space-to-water ratios of 0.40 – 0.85. In 2014, only 3% of Norway's housing was low-energy, but this percentage is expected to increase to 40% in 2050.

The CO₂-based integrated heat pump systems can be optimized by introducing an ejector, the researchers found. Ejectors improved the Coefficient of Performance (COP) of a CO₂ system up to 11%, whereas an ejector in a R410A system only increased the COP by less than 3%. ■ TS





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A LIFETIME IN NATURAL REFRIGERANTS

Andy Pearson started working with ammonia-related systems when he was 10 in 1973 and hasn't stopped, adding CO₂ along the way to become one of the world's leading experts on natural refrigerants.

— By Michael Garry



Andy Pearson, group managing director at Glasgow, Scotland-based OEM Star Refrigeration, has had a long and distinguished career pioneering the development of natural refrigeration in industrial applications, and he's showing no signs of slowing down.

In August, he delivered two papers on the energy performance of industrial systems at the ICR 2019 conference in Montreal, Canada, taking time away from his demanding role at Star. As Star's Group Managing Director, he oversees its many divisions, which include industrial refrigeration engineering and low-charge ammonia chiller manufacturing at U.S. affiliate Azane.

Among Pearson's achievements, he was named an ASHRAE Fellow in 2016 for his work in natural refrigeration, served as President of the Institute of Refrigeration (IoR) from 2010 to 2013 and for six years as a Director of the International Institute of Ammonia Refrigeration (IIAR), and edited guide books on ammonia and CO₂ as refrigerants for the International Institute of Refrigeration (IIR).

Accelerate Magazine recently asked for his perspective on the natural refrigerants industry, including his recent papers on energy efficiency.

// Accelerate Magazine: When and how did you get started working with natural refrigerants?

Andy Pearson: I first worked for Star Refrigeration in 1973 when I spent a day (aged 10) with my older brother poking holes in plastic pipe ends to make water distributors for a tube ice plant that was being built for a pigment factory. Fourteen years later I was back at the pigment plant as a young graduate installing and commissioning a much larger flake ice system. Both plants used ammonia as the refrigerant. The flake ice system was extended several times and eventually produced 300 tons of ice per day.

// Accelerate Magazine: How would you describe the progress made by ammonia and CO₂ refrigeration in industrial and commercial applications since you started?

Andy Pearson: When I joined Star full-time in 1986, most of our business was with R502 and R22 but over the next five years we switched rapidly to ammonia, so by the mid 1990s it was about 90% of our business. The switch to CO₂ was much slower — our first installation was an R&D job for a customer in 1991 (the first CO₂ supermarket in the U.K., and one of the first in the world). It took 16 years for the supermarket to install



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their second system. So I am really pleased to see that it has now become so widespread and successful.

// Accelerate Magazine: Which natural refrigerant projects are you proudest of?

Andy Pearson: I have worked on a lot of groundbreaking projects with ammonia/carbon dioxide cascade systems, including the first large freeze-dry project in the world, the first distribution warehouse in the world, the first IT cooling project in the world and the first plate freezer plant in the UK. Each of these is special to me in its own way. However, the use of transcritical CO₂ in low-pressure receivers, which formed part of my PhD thesis, is particularly important to me so I am really pleased to see projects of that type being installed now.

// Accelerate Magazine: In recent years, low-charge packaged systems have emerged as solutions for a variety of industrial applications, both chillers and freezers. How would you describe their progress and prospects?

Andy Pearson: There is far more to the successful use of low-charge ammonia systems than simply reducing the amount of ammonia in the system. We have found that it is very difficult to do it right, but the rewards in terms of increased efficiency, reduced maintenance and improved reliability are massive, so it is well worth persevering.

// Accelerate Magazine: What about low-charge centralized systems?

Andy Pearson: It's great to see the creativity that's now being applied to so many types of systems. As with packaged systems, there are tricks to doing a low-charge central plant successfully. One of the keys is to understand what you can and can't get away with; it's not the same as it was with traditional systems.

// Accelerate Magazine: How would you describe the progress and prospects of CO₂ refrigeration in industrial applications, including transcritical and ammonia/CO₂ cascade?

Andy Pearson: I'd say that ammonia is still by far the best refrigerant for large-scale industrial systems

down to about -40°C (-40°F). If ammonia is not feasible for any reason, then CO₂ is probably going to be the best alternative, perhaps in a cascade system, or perhaps transcritical depending on the application.

// Accelerate Magazine: You recently delivered two papers on energy performance in industrial performance at the ICR 2019 conference in Montreal. What are the most important takeaways from those papers?

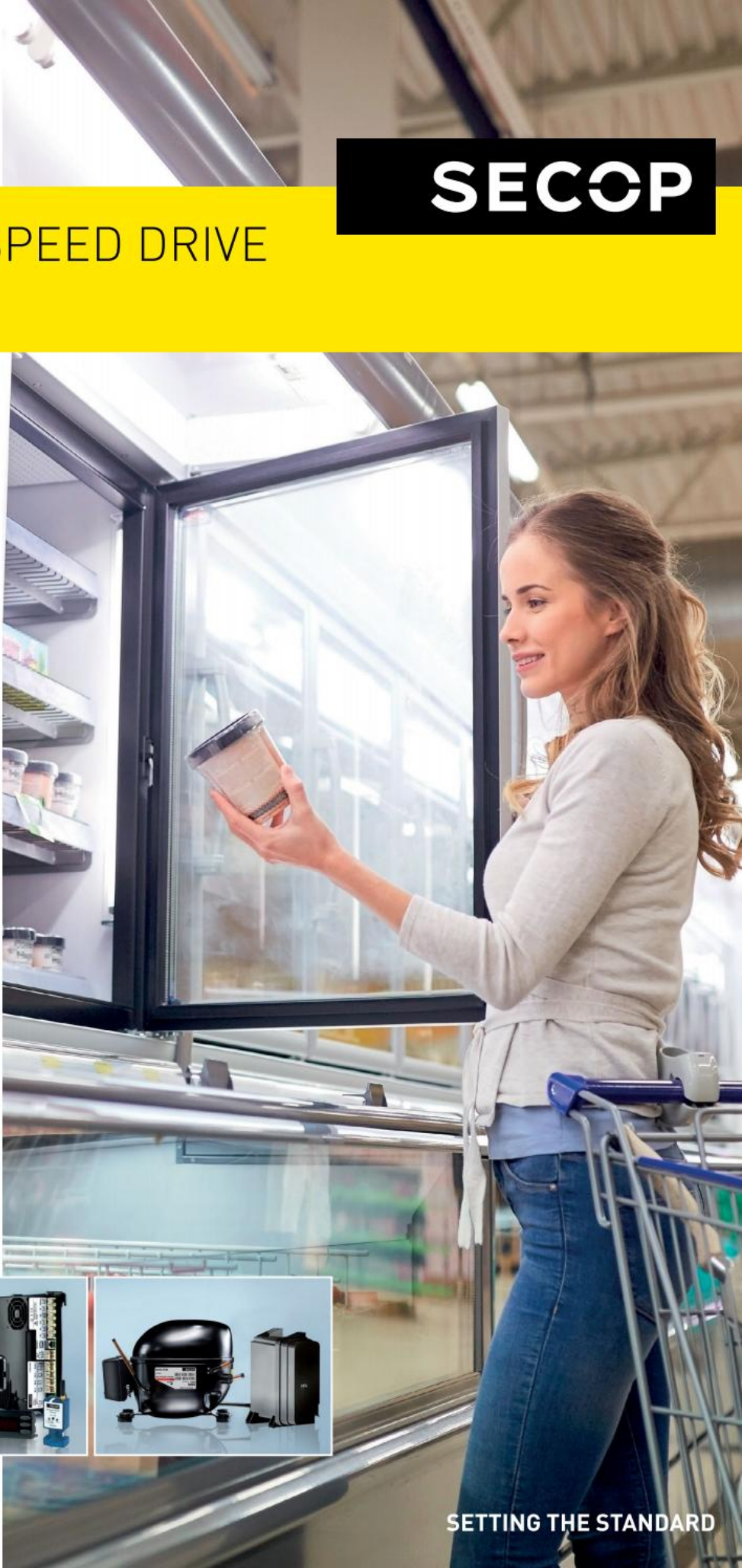
Andy Pearson: I'm really impressed to see the attention that is now being paid to energy efficiency. My main message was that it is possible to do exceptionally low-energy systems but it needs attention to detail in all aspects; the things that we are used to doing because they are convenient or cheap can sometimes cause huge losses of efficiency. Once a system has been built like that it is difficult to make it better without significant investment, so it pays to get it right the first time.

// Accelerate Magazine: How would you generally compare the energy efficiency of natural refrigerant systems to those using f-gases?

Andy Pearson: It's partly a question of scale. In large systems there are many ways it can go wrong and in some ways this is less likely with ammonia than in large f-gas systems. On paper I would expect ammonia to use at least 20% less energy than R404A but there are so many factors in play it is hard to generalize.

// Accelerate Magazine: Is specific energy consumption (SEC) the best measure of energy efficiency in a refrigeration system?

Andy Pearson: I really think so, because it relates directly to the energy bill that is paid at the end of each month and it encapsulates all of the factors that affect performance. There is no point in having the most efficient compressor in the world if the cold store doors are left open all the time or the condenser is left full of air. The really compelling thing about SEC is that it shows such a huge variation across different sites – it is really hard to understand how some of them can be so bad. It seems to be the result of generations of low expectations ingrained into our acceptance of badly performing systems to the extent that plants are massively oversized and then run flat out, but still fail to achieve the required duty. ■ MG



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