

SUMMER 2018

ACCELERATE

ADVANCING HVAC&R NATURAL

A U S T R A L I A & N Z

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is going to be
the new future”

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New beginnings

— Editor's Note by Andrew Williams

First up, let me take the opportunity to wish all our readers a Happy New Year! 2018 promises to be an eventful year for the HVAC&R sector as countries prepare for the entry into force of the Kigali Amendment to the Montreal Protocol in 2019.

We can expect new policy developments to boost the market prospects for natural refrigerants in the year to come. Australia is already one year ahead of the Kigali HFC phasedown schedule. It began reducing bulk imports of HFCs on 1 January, starting with a 25% cut. New Zealand, for its part, is expected to establish an import permitting system for controlling its phasedown of HFCs in the latter half of this year.

At global level, the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer gathered in Montreal, Canada in November to accelerate the transition to ozone- and climate-friendly refrigerants (p. 48).

Progressive industry leaders, meanwhile, are continuing to turn to natural refrigerants as a cost-effective and future-proof means of serving their HVAC&R needs.

Facing some of the highest energy costs in the world in its South Australia home, Drakes Supermarkets – Australia's largest independent grocery retailer – is more committed than ever to its natural refrigerant future. For this edition's cover story, we caught up with Bob Soang, Drakes' general manager, to hear about the firm's plans to open three new CO₂ transcritical-based supermarkets by the end of February (p. 22).

Retailers in search of inspiration from other parts of the world need look no further than ALDI and Sainsbury's. ALDI US is the no. 1 user of CO₂ transcritical refrigeration systems in the United States (p. 16). In the United Kingdom, see how natural refrigerants are helping Sainsbury's serve the shopping landscape of the future at the retailer's new online fulfilment centre in east London (p. 30).

Heat pumps are a promising future growth area for natural refrigerants. This issue's Technology Focus looks at what's needed to facilitate the transition away from HFCs (p. 68).

Coverage of ATMOSphere conferences on natural refrigerants in Madrid (p. 38) and Berlin (p. 40), new HFC reduction prospects in the America's Pledge report (p. 54), and the opening by Food Techno Engineering Co., Ltd. of a new testing facility for CO₂ transcritical systems in Japan (p. 64) are just three of the other stories waiting for you in this edition.

Here at *Accelerate Australia & NZ*, we see 2018 as an opportunity for new beginnings too. As we look ahead to an important year for natural refrigerants in the region, we are delighted to present our new-look magazine – I hope you enjoy reading it!

On behalf of the whole *Accelerate Australia & NZ* team, let me take the opportunity to wish you and your loved ones a healthy and prosperous 2018.

■ AW



Andrew Williams
Editor

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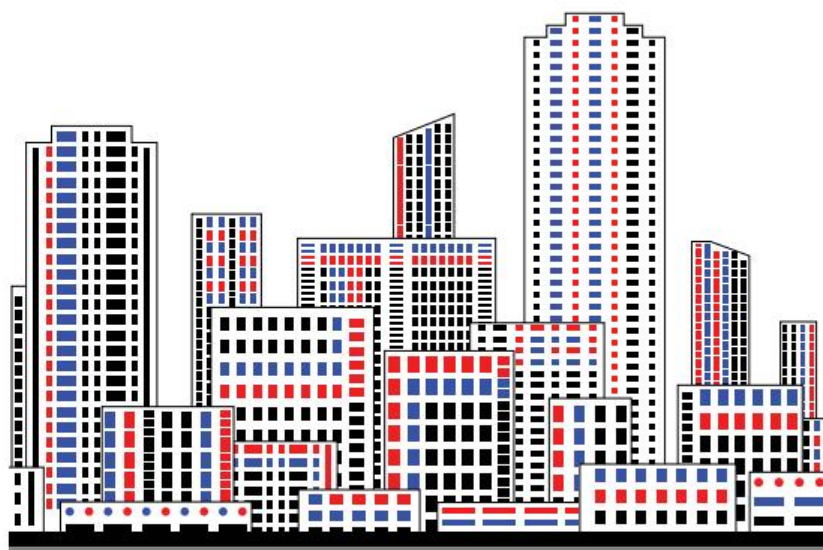
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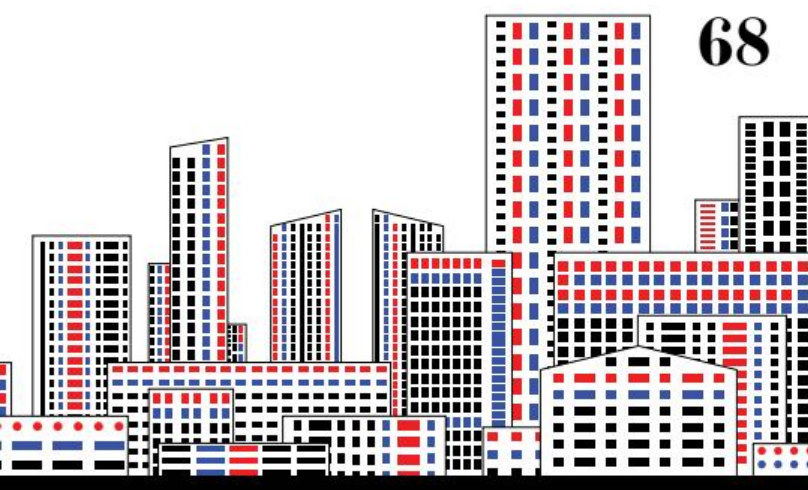




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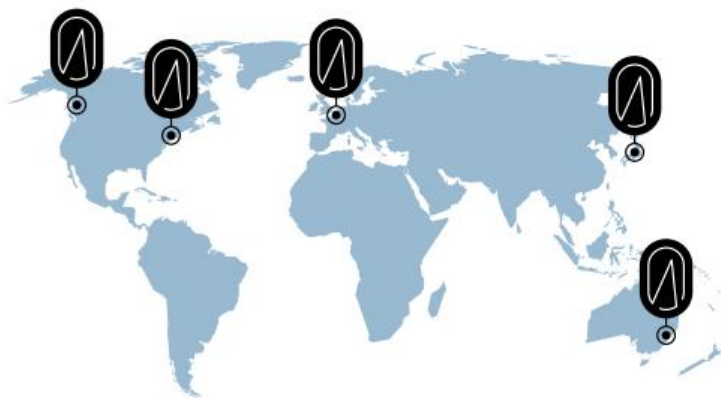
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Accelerate publisher shecco's network spans the globe with offices in Brussels, Tokyo, New York, Portland (Oregon) and Sydney.



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Accelerate Australia & NZ *Summer 2018*

Volume 2, Issue #8

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JAN — MAR

29.01

ASEAN Cooling Summit Bangkok, Thailand

The inaugural ASEAN Cooling Summit convenes regional leaders to examine the topic of cooling in the context of sustainable development and identify solutions. It takes place at the Sukhothai Hotel in Bangkok, Thailand.



<http://bit.ly/2rDPK7w>



13.02

ATMOsphere Japan 2018 Tokyo, Japan

A new venue, significant market developments: ATMOsphere Japan 2018 represents a unique opportunity to discuss natural refrigerants with key industry leaders.



www.atmo.org/Japan2018



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14-16.02

Supermarket Tradeshow 2018 Tokyo, Japan

Japan's largest retail exhibition.



www.smts.jp/en/

22-24.02

ACREX India 2018 Bangalore, India

ACREX India is South Asia's largest exhibition on air conditioning, ventilation, refrigeration and building services.



www.acrex.in



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04-06.03

China International Vending Machine & Self-service Facilities Fair 2018 Guangzhou, China

China VMF is an international trade fair for vending machines and self-service facilities. Within China, it is one of the leading international events in the industry with over 150 exhibitors on 10,000 m² of exhibition space.



www.chinavmf.com

08-11.03

Appliance & Electronics World Expo 2018 Shanghai, China

Organised by the China Household Electrical Appliances Association, this is among the world's three biggest exhibitions in the household appliance consumer market.



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MAR — APR

21-23.03**Sustainable Energy
Technology Asia
Bangkok, Thailand**

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www.iccc2018.medmeeting.org/en

09-11.04**China Refrigeration 2018
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sphere
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18-20.04**HVACR Vietnam 2018
Hanoi, Vietnam**

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AUSTRALIA & NZ IN BRIEF

Ozone healing linked to Montreal Protocol

Through direct satellite observations of the hole in the ozone layer, NASA scientists have shown for the first time that atmospheric levels of ozone-destroying chlorine are declining, resulting in less ozone depletion.

The decline is a direct result of the Montreal Protocol's phase-out of CFCs, which contain the ozone-depleting chemicals chlorine and bromine. Prior to the ban, initiated in 1987, CFCs were commonly used in refrigerators, air-conditioning units and even hairsprays.

The CFC phase-out, and the subsequent decline of chlorine in the atmosphere, has resulted in 20% less ozone depletion during the Antarctic winter than in 2005, the first year that measurements of chlorine and ozone were made by NASA's Aura satellite, according to a NASA study published in *Geophysical Research Letters* in January.

"We see very clearly that chlorine from CFCs is going down in the ozone hole, and that less ozone depletion is occurring because of it," said lead author Susan Strahan, an atmospheric scientist from NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Past studies have demonstrated that the ozone hole is getting smaller, while the new study, according to NASA, is the first to measure chemical composition inside the ozone hole.

The new NASA study used the Aura satellite's Microwave Limb Sounder (MLS), which measures microwave emissions in the stratosphere.

The ozone layer will still take decades to heal completely. "We're looking at 2060 or 2080. And even then, there might still be a small hole," said Anne Douglass, a fellow NASA atmospheric scientist and the study's co-author.

■ CM

CGF advocates HFC phase-out

The Consumer Goods Forum (CGF), a consortium of about 400 retailers, packaged-goods manufacturers and other stakeholders across 70 countries, reaffirmed its commitment to phasing out HFCs in a new report issued at the One Planet Summit on climate change in Paris.

"Our Board approved resolutions on achieving zero-net deforestation by 2020, phasing out HFCs and halving food waste by 2025," writes CGF Managing Director Peter Freedman in the report, entitled 'Low-Carbon Solutions in the Consumer Goods Sector'.

Large international CGF members include Unilever, Heineken, PepsiCo, and the Coca-Cola Company.

The report notes that natural refrigerants, unlike synthetic alternatives, offer a safeguard against future regulatory change. "They provide viable and future-proof alternatives to synthetic compounds, which are increasingly the focus of climate regulations."

"Switching to natural refrigerants is also becoming an economic choice, with the increased availability of efficient technologies and associated energy savings," the report says.

Adopting natural refrigerants can also significantly help to combat climate change, it argues.

The CGF report calls for wider adoption of natural refrigerants like ammonia and CO₂ for transport refrigeration. "By 2010, HFCs accounted for about 40% of refrigeration equipment for ships, 70% for road vehicles and 95% for intermodal carriers," it states.

■ CM

MHI to launch 20 HP CO₂ condensing unit

Mitsubishi Heavy Industries Thermal Systems Co. Ltd. (MHI) has announced the addition of a large-capacity 20 HP system to its lineup of CO₂ condensing units.

The announcement follows the recent debut of MHI's 10 HP CO₂ condensing unit at last year's International Food Machinery & Technology Exhibition, held in Tokyo in June 2017.

The large-capacity 20 HP condensing unit, dubbed 'C-puzzle HCCV2001M', will begin selling in April 2018.

According to MHI, the release of this new 20 HP unit is "in response to the refrigerated warehouse industry's demand for large-capacity CO₂ systems stemming from the introduction of Japan's Freon Emissions Control Law in 2015".

"The need for products with high efficiency and reduced environmental burden [is] increasing, and we are expecting high demand for this 20 HP unit from warehouses and supermarkets," states a press release from the company.

"CO₂ refrigerant has the strong advantage of not being affected by increasingly stringent refrigerant regulations."

MHI's 20 HP HCCV2001M C-puzzle CO₂ condensing unit uses MHI's patented two-stage scroll-rotary compressor technology, with scroll on the high side and rotary on the low side of compression.

The same compressor technology is used in the company's HCCV1001 10 HP unit as well as MHI's 'Q-Ton' CO₂ commercial heat pump water heater.

The system operates at temperatures of -45°C to -5°C and is rated for operation in ambient temperatures from -15°C up to 43°C. ■ DY



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AUSTRALIA & NZ IN BRIEF

2017 Chinese refrigerant prices rose 'dramatically'

The price of fluorite and hydrofluoric acid – vital ingredients in the production of HFCs – increased by 78.20% and 94.73% respectively in 2017.

"The supply of refrigerant raw materials, such as hydrofluoric acid and fluorite," has had an additional effect on the price of HFC refrigerants, according to Chinese financial website Sina.

Prices of refrigerants HFC R134a and HCFC R22 have increased by over 50% since September 2017, the website notes.

R32, meanwhile, rose from 14,000 yuan (2,731 AUD) per ton in September to 24,666 yuan (4,813 AUD) per ton at the close of 2017.

Similarly, Europe is experiencing significant refrigerant price increases as the EU's new F-Gas Regulation makes itself felt. On 1 January this year, the overall allocated quota of HFCs is set to fall from 93% of the original baseline to just 63%.

Sina cited numerous reasons for the Chinese price increase, including "the [Chinese] government's stepping up of environmental protection supervision and the increase in transportation costs".

Under the Montreal Protocol, developing countries like China must cut R22 consumption by 35% by 2020 and phase it out completely for most uses by 2030. New requirements under the Protocol's Kigali Amendment mean HFCs will eventually be phased down too. ■ CM

French government facilitates higher HC charge limit

In a long-awaited move that may pave the way for wider uptake of hydrocarbon refrigerants in the French retail sector, the French government has increased the maximum recommended charge limit for hydrocarbons used in shops and shopping centres to 1.5 kg per circuit.

The increased limit is enshrined in a new fire safety guide governing the use of flammable refrigerants in shops and shopping centres.

Published on 27 December, the 'Practical guide for fire safety in retail stores and shopping centres' accompanies the implementation of updated regulations and promotes the harmonisation of practices across the French retail sector.

It is targeted at designers, building owners, building operators, equipment installers, technicians, safety officials, and administrative authorities.

The guide gives indications that govern the use of flammable refrigerants – A2L, A2 and A3 (hydrocarbons) – in cooling cabinets in areas of shops and shopping centres accessible to the public.

Under the new guidance, for instance, the maximum recommended propane (R290) charge per circuit is 1.5 kg in circuits located on the ground floor of the retail facility and 1 kg in circuits located in underground areas accessible to the public (in line with updated European standard EN 378-1).

Previously, the French HVAC&R sector had tended to adhere to the non-mandatory 150g charge limit recommended by the first iteration of European standard EN 378. ■ AW

Chinese manufacturer recognised at MOP29

Leading Chinese industrial refrigeration system manufacturer Yantai Moon was recognised for its pioneering work with NH₃/CO₂ systems at the 29th Meeting of the Parties to the Montreal Protocol (MOP29).

The event, held in Montreal, Canada, marked the 30th anniversary of the Montreal Protocol.

Yantai Moon won the 'Exemplary Project Award'. China's Ministry of Environmental Protection-Foreign Economic Cooperation Office (MEP-FECO), meanwhile, won the 'Policy and Implementation Leadership Award'.

In 2011, Yantai Moon took on the United Nations Development Programme's initiative to replace R22, using NH₃/CO₂ cascade systems. To date, Yantai Moon has completed more than 200 NH₃/CO₂ system installations in China.

The NH₃/CO₂ cascade systems were installed across a number of sectors including food processing, ice-making, cold storage and logistics.

At MOP29, Yantai Moon was recognised for its contribution in the fields of environmental protection and alternative technologies and for achieving large-scale market penetration in a short time.

"Yantai Moon will continue its commitment to environmental protection and innovation by increasing our efforts in implementing HCFC elimination retrofit projects," said the company.

The awards ceremony, organised by the Ozone Secretariat, was held in Montreal on 23 November 2017. ■ DY

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Efficiency secrets for transcritical CO₂

Transcritical booster systems can run a lot more efficiently with direct heat reclaim, ECM fans for the gas cooler, and variable-capacity compressors, coupled with careful monitoring and analysis.

Over the last several years, my company has had the opportunity to do some detailed field analysis and study of a number of transcritical CO₂ booster systems from suppliers using equipment and components from several manufacturers.

The scope has mainly been to look at the operational efficiency of the systems, with a focus on heat reclaim, gas cooler performance and variable capacity compressors. As an energy consultant our role is obviously operational efficiency, but efficiency must never compromise effectiveness (performance).

Depending on geographical region, there are some variances that are needed in the system architecture or design. Initially, the use of transcritical CO₂ booster systems in North America was limited to more northern climates – where the amount of time that a system would run transcritical was relatively low because of the cooler annual ambient temperatures. With the development of some new technologies such as ejectors and improved knowledge of methods such as parallel compression and adiabatic gas coolers, we are starting to see CO₂ systems being installed in much warmer climate zones.

What have we learned? Generally speaking, my first comment is that many organisations are not practising the total cost of ownership model, even though they may claim to do so.

The reason for this is complex. In some instances it is a simple lack of knowledge or understanding. In others, it is simply that their purchasing process is focused on a lowest-bid-wins model. This means that suppliers are producing an effective system to win the work but these systems are far from energy efficient. And compromising on efficiency often results in increased service and maintenance costs and a shortened life expectancy.

So, what should you do? First, get as much knowledge and information as you can that relates to the system you need and the environment and geographical location that you are putting it in. You can get this information from an experienced consultant, but don't be afraid to engage with manufacturers and equipment suppliers. They have a lot of experience and knowledge that you can tap into.

Here are a few other considerations:

- ▶ Make sure that all the manufacturers you are considering are designing to the same conditions! This might sound obvious but sometimes the obvious gets missed, and we have seen different design criteria used by manufacturers bidding for the same work. If the design conditions are different, you are not comparing apples with apples!
- ▶ Make decisions in the design stage to help minimise costs. For example, if you plan to do heat reclaim for heating in your HVAC system using your transcritical refrigeration system, try to locate these as close together as possible to avoid extensive pipe runs; so try to locate the rooftop HVAC unit close to the refrigeration plant. This is particularly important if you are doing direct heat reclaim where you are running refrigeration lines rather than the plumbing lines needed for a secondary heat reclaim system using glycol.

► Consider what type of heat reclaim you are doing. Direct heat reclaim is more effective and therefore more efficient. It also requires less service and maintenance than secondary heat reclaim that has multiple heat exchangers and a circulation pump. In most jurisdictions, the use of a double wall heat exchanger means that direct CO₂ to domestic hot water is also possible.

► Consider your gas cooler operation and the fans and control strategy. Traditional staging of fans is simple and generally gets the job done, but doesn't afford any energy efficiency. Adding VFDs to the first couple of fans improves the operation, but you are likely to still be overusing the first part of the gas cooler and underutilising the last section.

Solve this issue by considering ECM fans, so that you can vary the speed of all the fans. This allows for full utilisation of the gas cooler. This also means that the fouling of the gas cooler coils happens across the entire unit. Traditional staging means that the first section of the gas cooler will be fouled faster, which reduces performance and over time increases degradation of the fins of the coils in this area.

► The use of variable capacity compressors allows for a much smoother operation of the rack and thus the entire efficiency of the refrigeration system. They also avoid short cycling of compressors, which typically leads to premature failure.

From the studies we have performed, the introduction of a variable speed drive or variable capacity compressor typically produces between 11% and 16% annual energy savings and simple payback of less than one year. The significant reduction in compressor short cycling that is facilitated by the variable capacity operation will help ensure that the maximum life expectancy of the rack is achieved without excessive repairs.

All of the analysis that we have performed has used the ClimaCheck Performance Analysis equipment and software. This

allows for monitoring of the system in real-time and also the creation of weather-normalised power profiles that can be used to compare system operations over different ambient conditions, system architectures or upgrades, and operational strategies.

In addition, the use of the System Efficiency Index (SEI) allows for easy comparison of systems, since it is a ratio of the theoretical coefficient of performance (COP), which assumes no energy losses, against the actual operating COP; this means that the SEI for a system that is operating well is unchanged across the entire range of ambient temperatures. This also means that systems in different geographical regions can be compared against each other.

The use of SEI is expanding as a method for undertaking performance-based maintenance and prediction of failures, since degradation in SEI typically precedes these occurrences. SEI calculations are done at the subsystem level (compressor, condenser, evaporation and refrigerant cycle), which helps identify where within a refrigeration system the degradation in performance is occurring.

So regardless of where you run a transcritical CO₂ system, there are straightforward upgrades you can make to ensure an efficient operation, and some great tools to measure that efficiency.



Darren Cooper
President
Renteknik Group

Darren Cooper is president of Renteknik Group, Burlington, Ontario, Canada, a consultancy focused on energy optimisation of HVAC&R systems.

Leader of the rack

With 69 installations, ALDI is the No. 1 user of transcritical CO₂ refrigeration systems in the U.S. supermarket industry, and its aggressive store expansion and remodelling plans call for even more.

— By Michael Garry



When Hillphoenix introduced the AdvansorFlex – a smaller capacity, less costly version of its Advansor transcritical CO₂ booster refrigeration system – in December 2015, the Conyers, Georgia-based OEM had in mind small-format stores as the primary end user.

Enter ALDI US, the fast-growing chain of nearly 1,700 value-oriented supermarkets in 35 U.S. states. The Batavia, Illinois-based company had already started installing Hillphoenix's Advansor system prior to the AdvansorFlex's release, but then switched to the smaller system.

"Hillphoenix engineered the AdvansorFlex specifically for ALDI stores, which have smaller footprints [about 20,000 sq. ft.; 6,100 m²]," said Aaron Sumida, an ALDI US vice-president based in upstate New York. "The Advansor CO₂ booster system is better suited to traditional supermarkets."

As of 11 August 2017, ALDI had deployed transcritical CO₂ systems – the majority of them the

AdvansorFlex – in 69 stores, with more installations coming. Hillphoenix supplied 66 of the stores, with the other three using transcritical systems provided by a partnership between Hussmann and Canadian OEM Systèmes LMP. More than 10 projects so far have been in remodelled stores. The rest of the systems were installed in new locations. In stores without CO₂ refrigeration systems, ALDI currently uses R448A.

With 69 installations, ALDI is the No. 1 user of transcritical CO₂ refrigeration in the U.S. supermarket industry. In North America, it's second only to Sobeys, which has approximately 100 stores with a transcritical system.

Known for its low prices (up to 50% lower than those of traditional stores, the company says), private brands and no-frills, efficient operation, ALDI US is a 41-year-old independently operated member of Mülheim, Germany-based ALDI South (Süd). Facing growing competition in the U.S. from traditional grocers and other Europe-based retailers, ALDI has announced store development plans that are nothing if not ambitious. By the end of 2022, it expects to have





nearly 2,500 stores, funded by a USD 3.4 billion (AUD 4.25 billion) capital investment plan, putting it third in the U.S. in store count behind Walmart and Kroger.

In July the chain opened a store in Baldwinsville, N.Y., overseen by Sumida, that runs an AdvansorFlex system.

Earlier this year, the company announced a USD 1.6 billion (AUD 2 billion) plan to remodel and expand more than 1,300 existing U.S. stores by 2020. Remodelled stores will feature a modern design, open ceilings, natural lighting and environmentally friendly building features.

IMMENSE IMPACT OF CO₂

As a parent company, ALDI South is dedicated to international carbon emissions reduction goals, setting the tone for its group countries. "We're committed to reducing, reusing and recycling waste, increasing energy efficiency, minimising our carbon footprint and improving our green building standards across all of our stores and operations," said Sumida.

In the U.S., ALDI has set a corporate goal of reducing greenhouse gas emissions by 30% per square metre of sales floor by 2020 compared to 2012. Rooftop solar panels on many of its stores and distribution centres represent one avenue to reduced emissions, and equipping new and remodelled stores with all-LED lighting and efficient HVAC systems is another. In addition, the potential emissions-reducing impact of installing transcritical CO₂ systems "is immense," said Sumida.

Replacing R404A, or even the lower GWP refrigerant R407A, with CO₂, he pointed out, means that the warming impact of a leak is reduced by 1/3,900th or 1/1,900th respectively. "Our stores are our primary source of emissions, so this can only help us meet our goal," he said.

ALDI US started installing transcritical CO₂ systems in earnest when it entered the southern California market in March 2016, and now uses them in new stores and major remodels in four of its 24 divisions – California, New England (Connecticut, Massachusetts, New Hampshire, Rhode Island and Vermont), New York and Virginia.

As of August 2017, 43 of ALDI's 69 transcritical stores had been awarded GreenChill Platinum certification by the Environmental Protection Agency's GreenChill Partnership, with more new and remodelled transcritical stores in the process of receiving this certification. Platinum is GreenChill's highest level of certification, achieved in this case by using a refrigerant with a GWP of under 150. In 2015, ALDI joined GreenChill, which calls on supermarket members to set emissions-reduction goals, report annual emissions, and work to improve existing and future store refrigeration and HVAC equipment.

ALDI US has not set a deadline to fully commit to CO₂ transcritical refrigeration systems, but "it's our long-term objective to standardise," said Sumida. With about 800 new ALDI stores to open in the U.S. by 2022, each of the company's 24 divisions will begin to phase in CO₂ transcritical systems – including the 18 not currently



Refrigerant-grade CO₂ stored at ALDI, Baldwinsville, N.Y.



ALDI US VP Aaron Sumida

“We genuinely believe that natural refrigerants are the best long-term solution.”

— ALDI US VP Aaron Sumida

committed to it – “to ensure preparedness by the refrigeration installers and technicians,” he added.

Why did ALDI US choose to install transcritical systems? “We genuinely believe that natural refrigerants are the best long-term solution,” said Sumida. And while ALDI US operates independently, it has also followed the example of ALDI South stores abroad, particularly in Europe. In February 2017, ALDI South made public that the company had installed its 1,000th store with a CO₂ system, representing 54% of its outlets; the UK division of ALDI South announced that it would convert all of its roughly 700 stores to CO₂, starting with 100 by the end of 2018.

“ALDI stores in other countries also use CO₂ systems as a standard and have set a strong precedent in the natural refrigerants category,” Sumida noted. “ALDI in

other countries serves as a resource for us. Some of the best examples for many of our environmental tests and initiatives begin with what other ALDI South group countries are doing. This collaboration across countries continues to drive results.”

ALDI'S PRIMARY REFRIGERATION SYSTEM

The AdvansorFlex – the primary refrigeration system for new and remodelled stores in four of ALDI's 24 divisions – represents the latest chapter of Hillphoenix's natural refrigerants journey.

A longtime provider of secondary and cascade CO₂ systems, Hillphoenix entered the all-CO₂ transcritical refrigeration category in 2011 with the acquisition of Danish OEM Advansor, a major supplier of transcritical systems to the European marketplace. By 2012, Hillphoenix had begun manufacturing its own Advansor-branded transcritical racks at its Georgia headquarters. By mid-2017, Hillphoenix had installed close to 300 transcritical racks in North America – out of a total of about 410 – the most of any OEM.

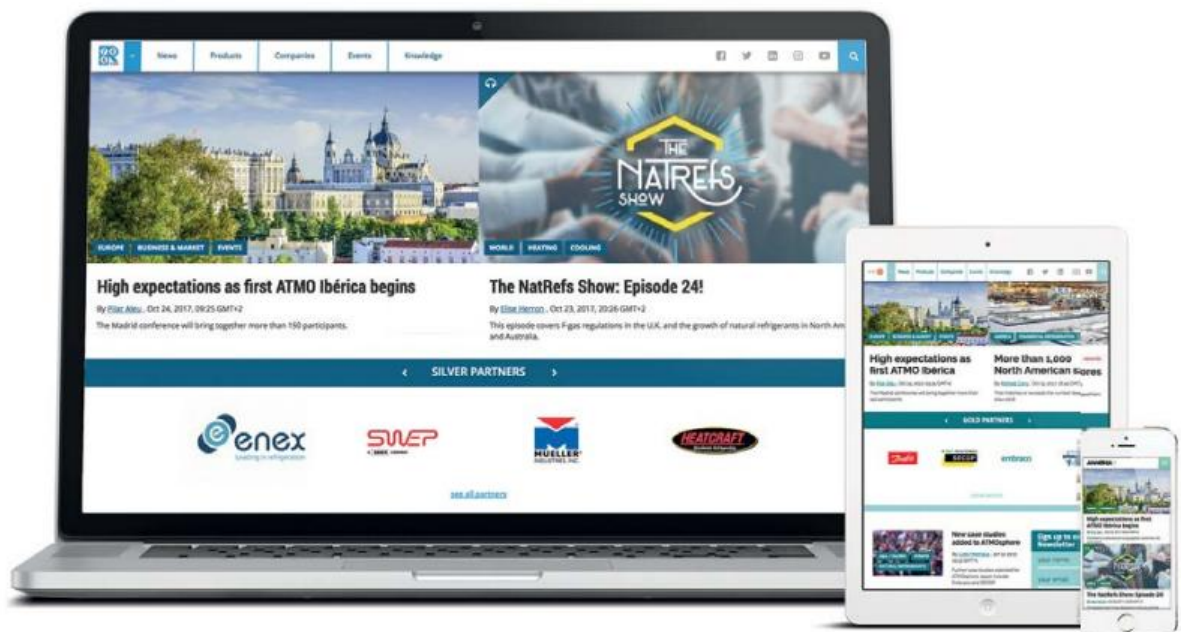
Contributing significantly to that growth is the AdvansorFlex, a smaller capacity, less costly (by 20%-30%) version of the original Advansor system, designed for small-format stores (though it can be used in larger formats as well as in multiples). Introduced in December 2015, the AdvansorFlex was specifically designed for the North American marketplace to meet stringent UL/cUL requirements and North American safety codes. Its rapid acceptance in the marketplace won Hillphoenix *Accelerate America's* Innovation of the Year award in 2017.

The AdvansorFlex's compact size enables it to be placed in a back room, on a mezzanine, on a rooftop or outside on the ground. Its sound-attenuating panels allow it to be installed near the sales floor. Two units are being considered as a replacement for an HFC system in an existing grocery store.

The AdvansorFlex was developed to be a “lower-cost alternative” that smaller-format stores would be able to afford, noted Scott Martin, Hillphoenix's director of business development and industry relations. ►

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ALDI VP Aaron Sumida viewing inside of AdvansorFlex

In addition to small-footprint grocery stores, it is suited for convenience and dollar stores.

Hillphoenix was able to reduce the cost of the AdvansorFlex by redesigning elements like the oil system. "It doesn't require a traditional oil system that includes a separator and reservoir," said Martin.

While its initial cost is still above that of an average HFC rack, the AdvansorFlex is designed to reduce installation and maintenance costs. For example, it uses smaller copper piping, less insulation and a less expensive refrigerant than an HFC system. Its electrical installation only requires a single point of connection from case controllers, which lowers costs. "All of this has to be rolled into an ROI calculation, and we help people with that," said Martin.

Like all transcritical systems, the AdvansorFlex's efficiency depends on its location; it is up to 18% more efficient than an HFC unit in cooler climates, says Hillphoenix, but its efficiency decreases in warmer climates. However, Hillphoenix has installed AdvansorFlex units with efficiency-improving adiabatic gas coolers in southern U.S. locations, said Martin.

AN ENERGY BENEFIT

Sumida acknowledged that there is a 20%-30% increase in upfront cost associated with the CO₂ transcritical systems compared to conventional HFC rack systems. However, ALDI anticipates a financial gain over the lifetime of the transcritical system, considering "avoided refrigerant phase-outs and reduced cost of refrigerant," he said. The company is still evaluating long-term maintenance costs and energy efficiency for transcritical, though "we've definitely seen an energy benefit in the cooler months". To improve the energy efficiency of transcritical systems located in warmer climates like southern California, ALDI employs an adiabatic condenser instead of a standard gas cooler.

In addition, as ALDI works to exceed national regulations related to refrigerant phase-outs, it expects to see additional savings from being able to avoid "increasing reporting regulations on non-natural refrigerants," said Sumida.

Utility incentives haven't covered any of ALDI's transcritical equipment or installation costs, though the company is exploring available incentives in the divisions committed to CO₂.

Like many end users of transcritical CO₂ equipment, ALDI has been challenged by the shortage of refrigeration technicians trained on this technology. One resource tapped by the company is Hillphoenix's Learning Center, which has trained at least 100 of the technicians providing service to ALDI.

Another challenge has been the availability of quality CO₂ refrigerant and system components, though with further adoption of CO₂ technology those items are now in greater supply.

ALDI shares its environmental accomplishments and progress in an environment section on its corporate responsibility website and on its social media channels. In Platinum-certified stores, said Sumida, "we also proudly display our EPA GreenChill Certification plaque" – representing the firm's industry-leading investment in transcritical CO₂ refrigeration.

■ MG



INNOVATION IN NATURAL REFRIGERANTS



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THE BIG COMEBACK

Facing the highest energy costs in the world, leading Australian independent retailer Drakes Supermarkets is more committed than ever to its CO₂ transcritical future.

— By Devin Yoshimoto & Caroline Rham

On

1 July 2017, South Australia made global headlines. On that day, the state overtook Denmark for the dubious honour of having the world's most expensive electricity, reported the Australian Broadcasting Corporation.

The ABC article detailed energy price hikes announced by Australia's three largest energy retailers in the middle of last year.

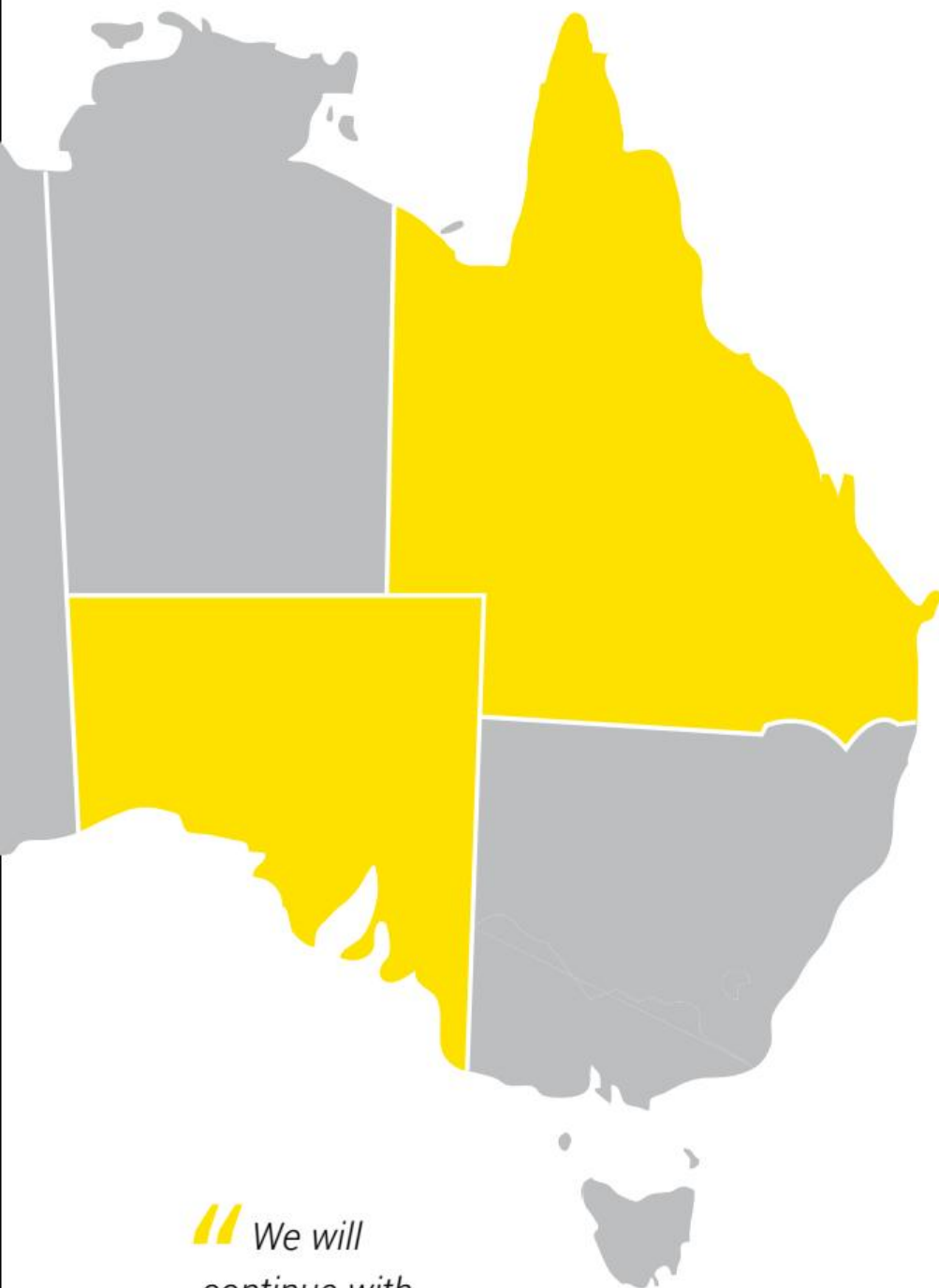
In a retail sector where profit margins are already razor-thin, fluctuating energy costs can have a dramatic effect on a supermarket's bottom line.

Few understand this better than Drakes Supermarkets, which currently operates around 60 stores in the states of South Australia (SA) and Queensland (QLD).

The company, founded by Roger Drake in 1974, began as a single three-lane supermarket on Henley Beach Road in Torrensville, SA. Today, Drakes Supermarkets is the largest independent grocery retailer in Australia, with an annual turnover of over \$1 billion.



Drakes' Foodland store, North Haven



“We will continue with CO₂ because I do think the [synthetic] gases’ lifespan is coming to an end.”

— Bob Soang,
Drakes Supermarkets

Faced with the challenge of reducing operating costs in today’s climate of rising Australian energy prices, the company is turning to natural refrigerants to carry it into the future.

Drakes is poised to open three new transcritical CO₂-based supermarkets. It expects CO₂ transcritical to save upwards of 20-25% on running costs compared to stores fitted with traditional HFC-based systems.

The stores, located at Goodwood Road, Wayville (SA), Stebonheath Road, Penfield (SA) and Ardrossen Road, Caboolture (QLD), are due to open by the end of February 2018.

Accelerate Australia & NZ travelled to the head office of Drakes Supermarkets in Torrensville to meet Bob Soang, the firm’s general manager.

Speaking eloquently about their journey so far, Soang – who boasts 38 years of experience at Drakes – outlined the most important lessons learned and set out why they see natural refrigerants as the future of Australian retail.

AHEAD OF THE TRANSCRITICAL CURVE

Drakes’ history with CO₂ dates back to 2007, when the retailer became the very first to install a transcritical CO₂ system in a southern-hemisphere supermarket.

Soang, who oversaw the installation of the system at the time, describes what motivated the decision.

“As we’re the largest independent, we’ve always felt that there is some onus on us to do some of the pioneering,” Soang says.

That first system was commissioned in December 2007 at a Drakes Foodmarkets store in Angle Vale, north Adelaide.

“We got a small government grant to help, because the CO₂ technology was quite a bit more expensive than the more traditional systems,” reflects Soang.

At the time, in an attempt to fight greenhouse gas emissions, the Australian government had made available a \$2 million subsidy fund to evaluate new technologies in the commercial refrigeration sector.

The subsidy was issued under the government’s Greenhouse Gas Abatement programme and administered by the Green Cooling Council.

“Additionally, the government had made a decision that it was going to keep taxing the carbon gases to the point where you really had to look for some other option,” Soang explains.

“And that’s exactly what we did.”

The combination of these factors led Drakes to move forward with the transcritical CO₂ installation. The result?

“It was a disaster,” laughs Soang. “We had all sorts of problems with it.”

DRAKES GOODWOOD FOODLAND

One of Drakes' three new CO₂ transcritical stores is located in Wayville, an inner-southern suburb of Adelaide.

The store will be fully serviced by a transcritical CO₂ plant and is scheduled to open in February 2018.

Store name:

Drakes – Goodwood Foodland

Location:

Goodwood Road, Wayville, SA

No. of transcritical racks: 2

LT rack capacity: 34.884 kW

LT operating temperatures:

-28°C to -33°C

No. of LT display cases: 12

MT rack capacity: 161.116 kW

MT operating temperatures:

-6°C to -10°C

No. of MT display cases: 37

Case supplier: Arneg

Contractor: AJ Baker

Soang believes the level of technological development of transcritical CO₂ systems simply made their adoption at that time too premature.

He is nonetheless keen to stress that the issues they experienced did not take away from the fact that the system was amazingly efficient.

Reflecting back, Soang says, "I've never forgotten how quick the pull-down was – and I'm talking about when we actually started the cases up. The power of that CO₂ transcritical system was able to reduce the temperature inside the cases so quickly".

"I had never seen anything like it before."

Problems stemming from poor design and technology eventually led Soang to swap the system out, but ever since he has been convinced that CO₂ is the way forward.

"In the end, I replaced the transcritical system and went back to the more traditional CO₂ cascade system," Soang says.

"The [transcritical CO₂ system] was pioneering – so with it came issues," he explains.

"From what I've seen now, we're starting to realise that maybe we were just ahead of the curve, that's all."

THE RETURN OF TRANSCRITICAL

Witnessing the potential of CO₂ at first hand convinced Soang to move forward with subcritical CO₂ cascade systems for the next ten years, building confidence and experience in using the technology along the way.

"Once we got the confidence that the systems work, we were quite happy to roll them out one after the other."

Since 2007, Drakes has installed subcritical CO₂ cascade systems at 14 store locations.

"When we first started with CO₂ and it was transcritical, it was a problem," Soang admits.

"But from that day onwards, we've had no problems with the





“The savings on the running costs and the operating efficiencies are such that [CO₂ transcritical is] where the future is going to take us over the next few years.”

— Bob Soang,
Drakes Supermarkets

ABOVE
Mark Turner, AJ Baker &
Sons (left) and Bob Soang,
Drakes Supermarkets (right),
Goodwood store

LEFT
Drakes supermarket in Owen
Terrace, Wallaroo.

Photography by:
Peter Barnes

technology. The [subcritical] CO₂ systems have worked brilliantly.”

Not only were the subcritical CO₂ systems running reliably, but they were also delivering 10-15% savings on running costs compared to Drakes’ standard HFC-based systems.

In the intervening years, Soang has been closely watching the level of transcritical CO₂ technology improve rapidly year on year.

The improvements in technology and design, combined with the promise of even further energy savings, have driven Drakes to take a second look at transcritical CO₂.

“Now, I’ve got to say, transcritical has raised its head again and there is a lot more modern technology that’s now making us reconsider our position on transcritical CO₂.”

Indeed, Drakes has already taken action, with the scheduled opening of the three new transcritical CO₂-based stores. Soang is expecting a further 10% energy savings.

“Now I know that the transcritical systems will be even more efficient than the current cascade systems that we’ve been using,” he says.

“They are still CO₂ but just more efficient CO₂, because the technology is more efficient.”

Indeed, it seems that the company’s original experiment with transcritical CO₂ did not discourage Soang, but instead gave him the confidence to return to the technology once it had matured.

“The efficiencies that I saw with transcritical at Angle Vale all those years ago – I was always impressed with how efficient the system was,” says Soang.

“The problem was that the design and the technology wasn’t right at that time.”



1/



2/

CO₂ CABINETS

In the new Drakes supermarkets, the cabinets in use on the shop floor play a crucial role in increasing the energy efficiency of the CO₂ transcritical system.

The cabinets – supplied by Italian firm Arneg – are fitted with glass doors.

"Obviously the cases have been modernised; you get cosmetic changes. But with cosmetic changes come technological advancements too," says Bob Soang, Drakes' general manager.

"A lot of our cases now have glass doors. We've obviously always had glass-door freezers but [now we use] glass-door dairy cases."

The relationship that Drakes enjoys with Arneg is one of trust, built up over many years. Both companies have been charting a pioneering course for natural refrigerants in Australia for a long time now.

"We've been a customer of Arneg's for nearly 20 years," says Soang.

"When Arneg was not in Australia, when we first started talking to them, they were operating out of Asia. That's got to be close to twenty years ago, when we first met. And then we started buying some cases and it grew to now, where Arneg are our preferred refrigeration case company."

Ever since, Arneg CO₂ cabinets have been successfully installed in all Drakes supermarkets.

1/ Arneg cabinets, Drakes
Goodwood Foodland

2/ Cabinets in Drakes Newton
Foodland, New Haven

THE TIME IS NOW

As Drakes moves forward with its plans for transcritical CO₂ in 2018, Soang hopes that the experience will serve as an example for other independent retailers in Australia.

He understands the challenges facing small companies in considering investing in transcritical CO₂ technology.

"To spend \$1 million, \$2 million, \$3 million on a fit-out or a refurbishment, if you're a single store operator or a small multi-store operator, that's a fairly serious risk that you put on your balance sheet," he says.

Nevertheless, Soang believes that now is the right time to be investing in good equipment that is future-proof and will save money in the long term.

"It's an opportunity to be a), investing money in refurbishments and b), to be doing them properly, because you benefit down the track," says Soang.

"Also, the technology is actually modern and likely to carry you through much longer than that cheap and nasty, low-cost budget quick fix."

This philosophy is in line with Drakes' overall culture, set by its founder, Roger Drake.

"We are long-term players in the industry so in every decision we make, we never consider the choice of 'Let's buy it cheap and let's do a cheap and nasty job'. We've never believed that works," says Soang.

"Roger has always been a guy that appreciated the value of technology and that we have to keep up with it."

Though Drakes considers itself to be a small player compared to the larger food retail chains in Australia, the investments made by the company in the past calendar year have been some of the most significant spends in its recent history.

"Last year, I think we spent \$27 million in refurbishments and fit-outs of stores," says Soang.

"Historically, we just know that it is worth the extra money to buy the right cases, to buy the right technology, and to run those cases and install them efficiently."

INVESTING IN KNOWLEDGE

What has driven Soang to take such a keen interest in refrigeration technology over the course of his almost four decades with Drakes?

"My dad used to say, if you look after the cents, the dollars follow," he says.

"But I still think that if you don't look after the real big dollar purchases, you are setting yourself up to fail."

Soang believes the real return on investment comes from looking after the big dollar spends of the business. And what does he consider one of the biggest spends for a supermarket? Refrigeration.

"When I talk to the guys coming through, when I look at my direct reports, we talk about return on investment," says Soang.

"I still believe you have to have a return on investment, so you have to understand what we do."

Soang emphasises the extra effort he puts into understanding the most important parts of his business, especially the technology, to help make the best decisions.

"The days of us just putting baked beans and products on the shelves are long gone. Leaders of this industry have to actually understand a lot more of the intricate parts of the important parts of the business – and refrigeration is without a doubt the most important part."

Soang is serious about his investment in understanding technology, not just by listening to the technology suppliers with whom he has built a close professional relationship, but also by travelling overseas himself.

He describes the visits he made last year to some of Europe's biggest names in retail and spoke enthusiastically about how generous they were with their knowledge and time.

"I've just come back from a European trip," says Soang.

"I met the guys at Gigante (Il Gigante, an Italian hypermarket) in Italy, Jumbo (a supermarket chain) in the Netherlands, and Migros in Switzerland (the country's largest retail company). These guys gave us a lot of time, like a day each, with their whole senior team."

Meeting these people, Soang explains, reinvigorated him and widened his perspective on today's retail industry.

Indeed, as reported by *Accelerate Australia & NZ* last winter, not only end users like Drakes but also several leading Australian HVAC&R companies were at EuroShop 2017 to learn from their European counterparts.

"It just makes you realise, it's not just the Australian world; it's the whole world that we all have to share. We all have to help," says Soang.



Bob Soang,
Drakes Supermarkets

THE FUTURE IS NATURAL

In terms of refrigeration technology, where does Soang see Australia's commercial retail industry heading in the next couple of years? "I have no doubt that the direction that we're in is the direction that we're going to continue to go," he says.

"That is, I think we will continue with CO₂ because I do think the carbon gases' lifespan is coming to an end."

Soang believes the future is transcritical because of the energy savings he has seen with these systems compared to cascades.

"Transcritical is going to be the new future because, yes, it is slightly more expensive," says Soang. "But the savings on running costs and operating efficiencies are such that that's where the future is going to take us over the next few years."

He expects the move to natural refrigerants to take place not just in commercial retail operations, but in industrial-sized systems too.

"We're looking at warehousing," says Soang.

"We run a couple of fresh food warehouses – one in South Australia and one in Queensland, and when you look at warehousing, you start talking about ammonia."

Soang admits that his knowledge of ammonia-based refrigeration systems remains limited. But the efficiency benefit of these systems is piquing his interest.

"I wonder if [ammonia] is that efficient, that perhaps that might be the future – the next step," says Soang. With retailers in Australia currently facing high energy prices – and after a long journey during which mistakes were made – Soang is confident that CO₂ technology is now at a critical juncture.

But this fact does not faze Soang, whose confidence comes from his experience.

"The advantage of being older is that I know the world is round, and everything goes around and around. So what was new today was old before and it becomes new again."

For Drakes, the natural refrigerants journey has now reached a turning point, where previous risks and experience gained is beginning to pay off.

As for Soang, his journey with Drakes has given him the confidence to lead the company – and Australian industry at large – towards a natural refrigerant future. ■ DY & CR

**HISTORICALLY,
WE JUST
KNOW THAT
IT IS WORTH
THE EXTRA
MONEY TO BUY
THE RIGHT
CASES, TO BUY
THE RIGHT
TECHNOLOGY,
AND TO
RUN THOSE
CASES AND
INSTALL THEM
EFFICIENTLY.**

INSIDE THE FUTURE OF SHOPPING



ABOVE
Sainsbury's state-of-the-art new online fulfilment centre in Bromley-by-Bow, London.

Photography by:
Anna Salhofer

Founded in 1869, Sainsbury's is proud of its long history of retail innovation. *Accelerate* visits the UK retailer's new online fulfilment centre in east London to see how natural refrigerants are serving the shopping landscape of the future.

— By Andrew Williams



ABOVE
Paul Arrowsmith,
refrigeration design
manager,
Sainsbury's
Supermarkets Ltd.

Ever since John James Sainsbury and his wife Mary Ann opened a shop at 173 Drury Lane, Holborn in 1869, Sainsbury's has maintained its place at the cutting edge of retail innovation. After opening a self-service branch in Croydon in 1950, the retailer became an enthusiastic early adopter of self-service supermarkets in the 1950s and 1960s.

The future of shopping

Fast-forward to today, and Sainsbury's is at the head of the pack once again. Its new online fulfilment centre (OFC) in east London is entirely dedicated to serving the UK's burgeoning online retail trade.

Brits are flocking to online shopping in their droves as already busy lifestyles become busier still. In Bromley-by-Bow,

Sainsbury's is looking to stay ahead of this curve. Without a single customer on the premises, Sainsbury's refer to the OFC as their 'dark store'. The site serves online shoppers across north and east London, from Camden to West Ham.

The facility is open around the clock. From roughly 02:00am until 09:00am, teams of 'pickers' are busy assembling customer orders. Loading of the delivery trucks begins around 04:00am, with the first deliveries going out at 07:00am.

Automation is the name of the game. An extensive lift and shuttle system is capable of taking up to 7,500 delivery boxes – known as 'totes' – from the shelves to the delivery trucks and back per hour.

According to sales forecasts, the site is currently operating at just 28-30% of capacity. "We're currently handling around 7,000 customer orders per week," says James Hunt, the OFC's commercial manager. "We're capable of fulfilling 20,000-25,000 a week."

The team of pickers fill totes and place the completed orders on a conveyer belt. Lifts drive the totes up above the picking floor, and shuttles take them on to their final destination in storage, from where they are loaded on to delivery trucks.

"We've got 36 shuttles going up and down, two per aisle. There are three levels of shuttle and 40 lifts between them. There are four lifts per lane – two for ambient produce, and two for chilled. Each shuttle can hold four customer totes at a time," Hunt says.

Upon arriving at work, pickers are each allocated a handset. Customer orders are communicated to the picking team via their handsets. Computers allow them to assemble orders in the most efficient manner according to delivery location.

"People come to work and log on to their handset, and it tells them what to do first. The system lets the person on the next task know when they can start their work too. This keeps everything out of the cold chain for as little time as possible. We've got a 20-minute 'load by' time," Hunt explains.

Customers can choose between delivery slots of one hour. For same-day delivery, they must order by midday. Next-day delivery orders can be amended until 11pm.

"Once that window has shut, we do the route planning. Then the picking team receives the orders for the 2:00am pick. So the online routing system does the route planning within a three-hour window. Every van must be filled according to its gross laden weight," Hunt says.

All this poses unique challenges for refrigeration. "During the picking period, the cabinets need to perform with the doors open," says Paul Arrowsmith, refrigeration design manager in the property department of Sainsbury's Supermarkets Ltd.

"It was a case of reverse engineering and testing the cabinets to be used as not originally built for."

At the facility's heart is an ammonia-CO₂ cascade refrigeration system from German manufacturer GEA. "It's pumped CO₂ for the chilled, cascaded from an ammonia system which keeps the pumped CO₂ at -6°C," Arrowsmith says.

No ammonia circulates on site. Instead, it is restricted to the plant room, the evaporator and the evaporative condensers.

"The liquid CO₂ is the heart of the system," Arrowsmith explains. "The pumped CO₂ provides the condensing medium for the subcritical DX frozen food system. We've got CO₂ for frozen, pumped CO₂ for the chilled, and ammonia to keep the CO₂ at the required temperature."

The ammonia that keeps the liquid CO₂ at -6°C is cooled by three compressors. "With one running, the system is at about 40% capacity," Arrowsmith explains. "The second would bring it up to 100%, and the third is a spare."

The CO₂ subcritical package serving all the frozen food areas, utilising the pumped CO₂ as a condensing medium, is an efficient means of meeting this refrigeration requirement. Like in the primary

ammonia system, two compressors provide the refrigeration duty, with a third compressor on standby.

On the medium temperature side, the system packs 825 kW of duty, with up to 104 kW on the low temperature side.

The consultant also looked into using an ammonia-only or a CO₂ transcritical system. It was the ammonia-CO₂ configuration that came out on top, based upon a 'balanced scorecard' approach of total equivalent warming impact (TEWI), energy efficiency, capital cost, and colleague safety perspectives.

"With a traditional distribution centre, whether for frozen or chilled, your starting point is ammonia," Arrowsmith says. "Here in Bromley-by-Bow, because this didn't slot into the category of a distribution centre or a supermarket, we looked at it as a blank canvas."

"We looked at ammonia only, we took HFCs as a benchmark, and we looked at pure commercial CO₂ refrigeration," he explains. "What we've installed here gave us the best balance between cost, energy and GWP – all the main measures you look at in an installation."

Natural refrigerants 'part of our DNA'

The use of natural refrigerants in Bromley-by-Bow is in keeping with Sainsbury's wider sustainability strategy. "Natural refrigerants are part of our DNA," says Arrowsmith.

The nationwide policy is to install CO₂ transcritical systems in all new Sainsbury's supermarkets, as well as in major retrofits. Early CO₂ trials began in 2008 and all new supermarkets have been delivered with CO₂ since 2010.

"If we deliver a new supermarket, it will be CO₂," Arrowsmith says. "In 2017 we also made a step-change in convenience stores – every new convenience store will be rolled out using a natural refrigerant – primarily CO₂."

RIGHT

Teams of pickers assemble customer orders in shifts.

"The first step is that we always use a natural refrigerant," he explains. "The commitment is to natural refrigerants wherever possible."

Sainsbury's is putting the HFC phase-down at the heart of its strategy for reducing operational carbon emissions by 30% absolute and by 65% relative (versus 2005) by 2020. The 2020 goal is part of a broader target of an absolute carbon reduction of 50% by 2050.

The supermarket giant operates 1,415 stores across the United Kingdom (May 2017 figure). When *Accelerate Europe* went to press last September, it boasted 216 CO₂ transcritical supermarkets in its portfolio. It also had eight convenience stores with natural refrigerants – seven with CO₂ booster systems, and one with a hydrocarbons-glycol configuration.

Arrowsmith sees scope for hydrocarbons to play a greater role in future. "Some of our more challenging





locations might be multiuser developments – if you've got domestic residents or share services with other trades, they might not necessarily want CO₂ at 80-90 bar in those areas, so we're also trialling hydrocarbons used in conjunction with a glycol system," he reveals.

"We envisage that CO₂ will be able to deliver 95% of what we need," he explains. "It's just the odd store that is more challenging, where you might need another tool in the toolbox to be able to implement a natural refrigerant solution."

LEFT

A lift and shuttle system takes up to 7,500 delivery boxes – known as totes – from the shelves to the delivery and back per hour.

Older stores installed between 10 and 20 years ago continue to operate on HFCs, so the company cannot yet say that it is HFC-free.

"When systems come to the end of their useful life, we'll replace them with a CO₂ system," Arrowsmith says. "If we're doing a substantial amount of work and changing nearly all the fixtures, then we'd change it out to CO₂."

A changing urban landscape

Hypermarkets still represent around 60% of Europe's food retail landscape. Yet urbanisation means space is at a premium in European cities. Other trends, such as smaller households and the growing popularity of convenience food for busy lifestyles, also favour smaller, more flexible store formats. Any future-proof refrigeration strategy must take account of these trends.

Convenience stores initially proved a tougher nut to crack for Sainsbury's. "In supermarkets you have larger systems, and it's easier to get efficient NatRef systems at cost-parity with HFC systems," Arrowsmith argues.

"The smaller format posed a few more challenges, but we're there now – it just took a little more of a rethink."

He is confident that the new generation of products for smaller capacities and smaller equipment can satisfy the demand. "It's becoming easier now, for smaller formats," he argues.

Arrowsmith would know. Prior to joining Sainsbury's in December 2013, he worked in the field of refrigeration contracting for 32 years.

"This experience helps when I'm talking to contractors, because I'm from their background," he says with a smile. "They're aware of my background, because I was probably a commercial retail competitor of theirs."

As refrigeration design manager for all Sainsbury's stores the length and breadth of the UK, Arrowsmith is well aware of the challenges facing the commercial refrigeration sector.

"It's no good having the latest thing on the market if it's not readily available or reliable – we can't have customers walking out without the frozen food that they're looking for," he quips.

One oft-cited barrier to wider market penetration of natural refrigerant-based HVAC&R systems is a reported shortage of components, particularly

Sainsbury's at a glance

Founded in 1869 by John James Sainsbury.

First store opens in Drury Lane, Holborn, London.

Headquartered in **Holborn, LONDON.**



UK's **second-largest** supermarket chain with a **16.9%** market share



162,700 employees
(2016)



1,415 stores
(May 2017)



for more complex CO₂ systems. Major end users like Sainsbury's therefore have the power to change the market by placing large orders. Procurement on this scale also helps to reduce the cost of natural refrigerant-based solutions by virtue of economies of scale.

"Initially we saw a cost premium for CO₂, but after working with our suppliers and as the technology has become more mainstream, the cost difference has eroded away," Arrowsmith argues.

"We're cost-neutral with HFC installations."

Some customers cite the perceived complexity of natural refrigerant-based HVAC&R systems vis-à-vis their HFC counterparts as another obstacle to overcome. But Arrowsmith argues that the situation is changing fast.

"Componentry now, for Sainsbury's and for our supplier base, is business-as-usual," he says. "There is no problem finding suppliers."

With natural refrigerants becoming increasingly mainstream HVAC&R options to help the European food

retail sector to comply with the HFC phase-down taking place under the EU's F-Gas Regulation, installers are becoming more comfortable with the technology and suppliers are more supportive.

"When we first started our CO₂ journey in 2008 and 2010, the componentry was more limited," Arrowsmith says. "We've seen a major step change in engineer competence."

In the early days, even the most highly qualified engineers were not necessarily familiar with working on CO₂ systems. "Sainsbury's recognised this, and working with our suppliers, we financed the training of 132 of our contractors and engineers so that they were competent to work with CO₂," Arrowsmith says.

The retailer also trains staff whenever it opens a new facility. "Awareness of the refrigeration is part of the training for whomever we're handing over the building to," he explains.

Driving force for NatRefs

Does Sainsbury's want to be recognised as a driving force for natural refrigerants? "We've made our commitment and we're delivering on it," Arrowsmith argues. "In

the UK, we're seen as one of the leaders in adopting natural refrigerants."

Asked what he enjoys most about working for Sainsbury's, the refrigeration boss highlights the job's variety.

"A commercial contractor probably only gets to see what his customers are doing, which may be relatively narrow," Arrowsmith says. "But here we're dealing with convenience stores, supermarkets, and industrial refrigeration."

"We have to approve any new piece of equipment that comes into the estate, assessing it for its efficiency, safety and performance. And then there's all the new innovation that people bring to the table, which we have to evaluate and decide whether is right for Sainsbury's as a business," Arrowsmith says.

After some 35 years in the business, what motivates him to come to work each day? "I genuinely enjoy engineering and refrigeration," Arrowsmith says.

"You can see that for the environment, this is naturally the right thing to do."

The future of Sainsbury's is in safe hands. ■ AW

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Busworld 2017: *Accelerate* returns!

Since attending Europe's leading bus tradeshow in 2015, *Accelerate* has seen the HVAC sector move to develop CO₂ heat pumps and air-conditioning systems.

— By Charlotte McLaughlin

Two years ago, at Busworld Europe 2015 in Kortrijk, Belgium,

Accelerate Europe interviewed Konvekta, a manufacturer of CO₂ mobile air-conditioning (MAC) systems for buses, and compressor manufacturer BITZER about using CO₂ in heating, ventilation and air-conditioning (HVAC) applications.

Reiner Boland, Konvekta's director of business for bus air conditioning, spoke of the company's commitment to CO₂ MAC in buses during the 2015 show but noted that a lack of components and industry support remained significant barriers to be overcome.

Back in 2015, BITZER Sales Manager Oliver Rathfelder noted that industry was indecisive when it came to choosing the refrigerant to replace HFC R134a.

R134a, still commonly used as a refrigerant for heating and cooling applications in buses, is becoming increasingly expensive as the HFC phase-down taking place under the EU's F-Gas Regulation picks up speed.

This is putting industry under considerable pressure to find a viable alternative.

EMERGENCE OF CO₂ TECHNOLOGY

The 24th edition of Busworld Europe, held in Kortrijk from 20-25 October 2017, brought together some 30,000 attendees and 376 exhibitors from 36 countries and provided a degree of certainty for system manufacturers and component suppliers for MAC systems and heat pumps.

Valeo, a company based in France that works primarily in the automotive sector, launched a CO₂ heat pump for cooling and heating buses at the event.





Valeo booth at Busworld

The system is a modular, reversible, environmentally friendly heat pump that heats, cools and demists electric vehicle cabins. "We developed [the system] with CO₂ as it works more efficiently [for] heating and cooling in extreme temperatures," Manuel Griebner, key account manager at Valeo Thermal Commercial Vehicles Germany, told *Accelerate Europe*.

The CO₂ model can operate in temperatures as low as -20°C.

The company has already seen a lot of interest in this heat pump system. "CO₂ is the big trend: everyone wants it," Griebner said.

German company Eberspaecher Suetrak also launched a system using CO₂ as the refrigerant for bus air-conditioning systems, which has a heat pump function too.

The air-conditioning manufacturer's CO₂ system is modular in design and is tailored to meet the key requirements of electric, hybrid and trolley buses.

It also has an integrated heat pump, featuring an innovative airflow reversal function that makes the previously complex refrigerant circuit

much simpler, according to Eberspaecher Suetrak.

The air vents are able to change the direction of the airflow to provide a seamless transition between cooling and heating mode.

The refrigerant circuit remains stable in all these operating states – there are none of the standstill times seen with more conventional systems.

An Eberspaecher Suetrak representative told *Accelerate Europe*: "We do not have it in any buses so far, but we have had lots and lots of people come to us at Busworld to check it out."

OVERCOMING CHALLENGES

Other HVAC manufacturers for the bus sector at the show were looking into developing similar solutions using CO₂ for bus air-conditioning and heat pump systems.

Christian Von Hochmeister, who works in sales at Denso

Automotive Deutschland, explained that this might be a long process for his company.

"We will start first in the automotive sector in Europe, as this is where we have the most experience, and then move to other applications such as buses," Von Hochmeister said.

UK HVAC manufacturer Grayson Thermal Systems is also looking into developing a CO₂ system, due in part to the increasing price of R134a resulting from the HFC phase-down taking place under the EU F-Gas Regulation, said Pavel Ikrath, Grayson's R&D HVAC Principal Engineer E-Mobility.

Ikrath believes components remain hard to come by. "We are looking into it but we are waiting for CO₂ compressors to become more widely available," he said.

Mobile Climate Control's (MCC) sales and engineering director in Europe, Björn Afzelius, said his company was working on a prototype CO₂ air conditioner to cool bus compartments and the driver's seat.

"[Our customers] want this, as they see CO₂ as more environmentally friendly," said Afzelius, before cautioning: "It would need a lot of development."

BITZER's CO₂ compressors for bus and train applications are available only on request. The company explained in a press release prior to the show that it has, "compressor technology for a wide variety of air conditioning and heat pumps for buses, including for natural refrigerants and with a high level of energy efficiency".

Konvekta was back at Busworld again presenting its CO₂ air-conditioning solutions. Two years on, it has also developed a heat pump system for electric buses.

Overall the development of CO₂ MAC systems and heat pumps for buses is clearly accelerating forwards. *Accelerate Europe* will be at Busworld 2019, at the Brussels Expo centre in Belgium, to bring you more news of exciting developments in the sector.

■ CM

SPAIN TO SUBSIDISE GREENER COOLING

A new subsidy from the Spanish Environment Ministry – announced at ATMOsphere Ibérica in Madrid – helps to lay the foundation for transitioning to natural refrigerants in the HVAC&R market.

– By Álvaro de Oña & Pilar Aleu



In a keynote speech at the inaugural ATMOsphere Ibérica conference, Guillermo Martínez, head of service at the Spanish Office for Climate Change – part of the Ministry of Agriculture and Fisheries, Food and Environment – announced the launch of a new subsidy for sustainable refrigeration.

Martínez told the event – organised by shecco, publisher of *Accelerate*, and held in the Spanish capital on 24 October – that the ministry is introducing a new subsidy programme to help the HVAC&R sector comply with upcoming HFC phase-down deadlines under the EU's F-Gas Regulation. Named 'plan PIMA frío', the total subsidy pot of €1.5 million will help to co-finance new installations of sustainable refrigeration systems.

"We understand that the sector is facing a challenge, and with this new subsidy we would like to provide additional support to facilitate the transition to sustainable refrigeration systems," said Martínez.

The subsidy will provide 15% of the total investment required. To be eligible, systems must use low-GWP refrigerants, have a capacity above 40 kW, and include measures to improve overall efficiency, such as the use of doors for cabinets under 6°C.

The one-day event, with 150 participants from more than 75 organisations, focused on the Spanish and Portuguese markets, as well as Latin America – often the destination of choice for Spanish companies looking for new markets.

An underdeveloped market

The Spanish market has been slower to adopt natural refrigerants than other European markets.

"Today Spain is perhaps not the easiest market for natural refrigerants, with the market characterised by misunderstandings and a lack of information on both the industry and end-user side alike," said Álvaro de Oña, COO and head of media at shecco, during the event.

"In this context, ATMOsphere Ibérica provided the perfect platform for discussion of natural refrigerants and facilitated exchanges of knowledge and experience between those that are already in the market and 'newbies'," de Oña said.

Many Spanish supermarkets are only just starting to consider natural refrigerant technologies. Only a few stores in Spain (primarily Carrefour and Consum) are currently using CO₂ transcritical technology.

Yet this is beginning to change as new technologies like ejectors, adiabatic coolers and parallel compression help to bring CO₂ transcritical to warmer climates, according to representatives of manufacturers EXKAL, Tewis, Pecomark, CAREL, Carrier and Frigo-Consulting, who also spoke at ATMO Ibérica.

Julio Corrales of Arneg, whose 20 manufacturing plants around the globe supply technologies to countries with all kinds of climate conditions, argued that, "the use of additional technologies to boost energy savings, such as ejectors, makes CO₂ transcritical a more competitive solution compared to a subcritical installation in warm climates".

Interest in these technologies is becoming more evident, as retailers in Spain like El Corte Inglés, Mercadona, Alcampo, DIA or Carrefour experiment with natural refrigerants.

Pedro Olalla, sales director at Huayi Compressor Barcelona, sees hydrocarbons as another option for the commercial refrigeration industry.

Olalla sees the future of refrigeration as a competition between hydrocarbons, CO₂ and HFOs after 2022. "At Huayi we see hydrocarbons as the refrigerants of the future.



ATMOsphere Ibérica plenary

Hydrocarbons improve efficiency and therefore they boost the overall efficiency of the system as well," he said.

In 2018, the compressor manufacturer expects hydrocarbon compressor sales to increase by 60% compared to the sales volume in 2008.

Latin America captains NatRef projects

The Ministry of the Environment of Colombia, Estudio Maranca (an Argentinian engineering consultancy) and the United Nations Industrial Development Organization (UNIDO) outlined pilot projects based on natural refrigerants in Latin America during a session dedicated to business opportunities in the region.

Andrés Celave, international projects manager at UNIDO, highlighted the role that his organisation is playing in supporting Latin America's journey towards inclusive and sustainable industrial development.

"We are looking forward to partners bringing efficient and sustainable solutions to Latin America," Celave told the audience.

Argentina has many different climate conditions. "While there is only one CO₂ subcritical installation in the country, at a Walmart Caseros

store, CO₂ transcritical installations are becoming more popular," said Agustín Maranca, director of Estudio Maranca.

"Today there are six transcritical CO₂ systems running and a few more projects in the pipeline, including the first system in a warm climate zone," Maranca added.

Supermarkets working with CO₂ include SAIEP, Walmart and Carrefour. Vital Pilar, a wholesaler, and Alvear Santa Fe Supermarkets are both planning to open CO₂ stores.

Colombia, meanwhile, is experimenting with pilot projects using hydrocarbons for air-conditioning systems.

The Ministry of the Environment in Colombia recently partnered with Thermotar, a local supplier, on a pilot project to manufacture propane-based air-conditioning units.

Under this project, Thermotar is making prototype condensing units, air handling units and rooftop units, all using propane.

Colombia also boasts a CO₂ transcritical system. Colombian grocery chain Éxito fitted its first such system in a new Bogotá

store. The cabinets were provided by EXKAL and featured a rack from Advansor-Hillphoenix.

The new store, which opened on 15 June, is located in the Colombian capital's Multiplaza La Felicidad mall.

Éxito is the main supermarket chain in Colombia, with a total of 266 stores. Looking at highly efficient and environmentally friendly alternatives to traditional refrigerants, EXKAL, based in Navarra, Spain, contributed to the CO₂ transcritical pilot project in the Multiplaza store with a full range of refrigerated cabinets.

"Interest in this technology is growing fast – there are already installations in Argentina, Chile, Brazil and now Colombia," EXKAL CEO Alfonso Antoñanzas told *Accelerate Europe*.

With growing demand in and outside the Spanish market, natural refrigerants look set to take off in the Spanish-speaking world. ■ AdO & PA



ATMOsphere Ibérica took place in Madrid.

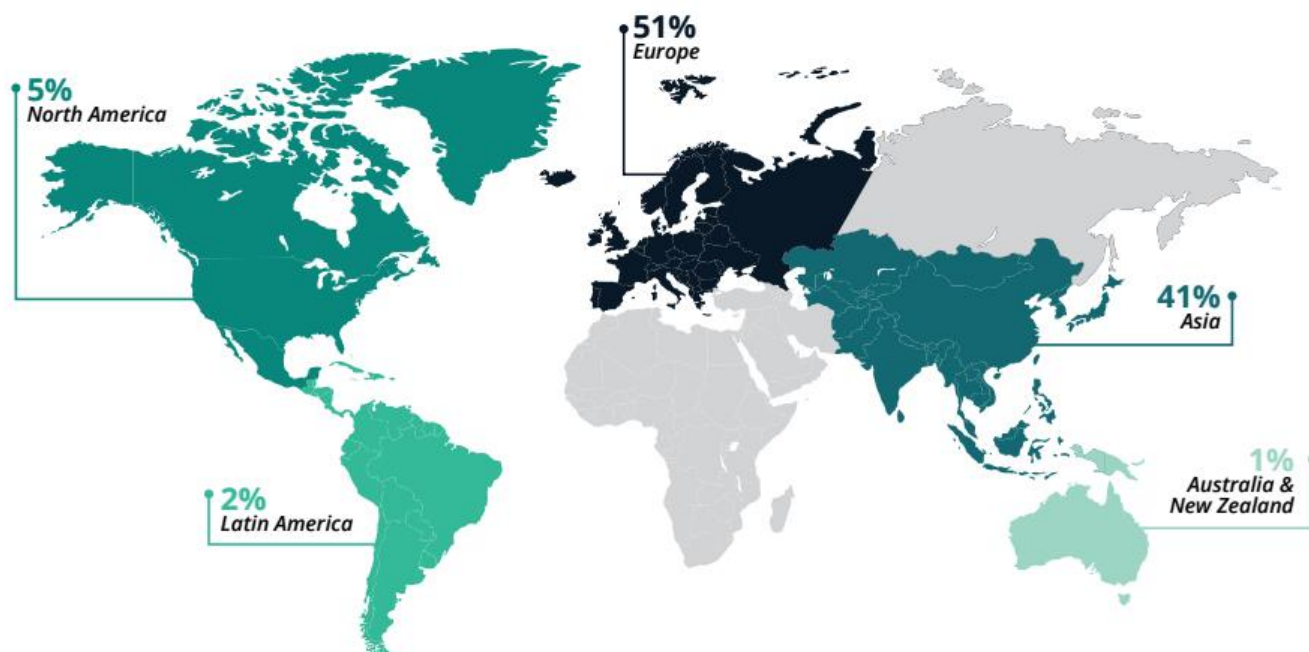
Which is the next big growth area for NatRefs in Europe?

With Europe's industrial and commercial refrigeration sectors moving at lightning pace towards natural refrigerants ammonia, CO₂ and hydrocarbons, the big question on everyone's lips at ATMOsphere Europe in Berlin, Germany was, what's next for natural refrigerants?

— By Charlotte McLaughlin & Andrew Williams



Which world region do you expect to experience the fastest growth in natural refrigerant adoption in the next 10 years?



At the ATMOSphere Europe conference – organised by *Accelerate* publisher shecco and held in Berlin, Germany from 25-27 September 2017 – the audience of over 400 HVAC&R professionals, end users and academics from around the world was asked on live polling platform *sli.do* to predict the market share of natural refrigerants as a proportion of Europe's total HVAC&R market in 2030. The current rate is commonly thought to be around 10%.

A majority of participants saw the total share as growing to 30-40% (29% of the vote), with 23% – the next largest section of the audience – voting for over 40% market share.

According to the United Nations Environment Programme (UN Environment), 65% of global HFC consumption (measured in global warming potential) in the refrigeration, air-conditioning and heat pump (RACHP) sector comes

from air conditioning and heat pumps, while only 35% comes from refrigeration. Overall, commercial and industrial refrigeration are the main sectors for HFC use, comprising over 90% of the total.

To realise the hopes of ATMOSphere attendees, the majority of Europe's commercial and industrial refrigeration sectors would have to use and make equipment using only natural refrigerants by 2030.

There is no doubt that the trend towards natural refrigerants is moving fast in these sectors. shecco COO Álvaro de Oña revealed data from sheccoBase – shecco's market development arm – putting the number of European supermarkets using transcritical CO₂ systems at 12,000, up from 9,000 in mid-2016.

Andreas Meier, managing director of German manufacturer TEKO, says his company – which produces both commercial and industrial

refrigeration solutions – is also heading down the natural refrigerants road. "This year we will have 60-70% natural refrigerants" as a proportion of total sales, Meier said.

Carrier's Guillaume Burvingt echoed this sentiment. "90% of our cabinets [for supermarkets] have been converted to R290 (a hydrocarbon refrigerant)," Burvingt said.

This may be due to the fact that commercial refrigeration is one area in which the EU F-Gas Regulation is already beginning to bite. In 2022, bans on using certain HFCs with GWPs above 150 in new centralised and plug-in commercial refrigeration equipment will come into effect.

However, as TEKO's Meier was keen to point out, greater uptake of natural refrigerants is not possible without the commitment of end users. "You need to have the right end users, like Nestlé, METRO, Carrefour and Roche," he said.

German retailer METRO AG's F-Gas Exit Program will phase out f-gases and replace them with natural refrigerants worldwide where technically and economically feasible. "CO₂ transcritical technology is our clear favourite but we support natural refrigerants, so that's CO₂, ammonia or hydrocarbons," said Olaf Schulze, director of energy management at the retail giant.

AMMONIA VS. CO₂

Industrial refrigeration has long been a success story for ammonia. Eric Delforge of Mayekawa, an industrial refrigeration and heat pump manufacturer, declared: "For us, natural refrigerants are a no-brainer for industrial."

Likewise, Vincent Grass, refrigeration team lead in the Corporate Operations – Engineering Services department at Nestlé, argued that the Swiss multinational is nearly there when it comes to industrial systems. "We still have HCFC and HFC systems to phase out, but 90% of our refrigerant charge is in industrial – and 90% of our industrial refrigeration is already natural refrigerants," Grass said.

Others see carbon dioxide becoming more competitive. "CO₂ is approaching ammonia" in the industrial refrigeration market, argued Giacomo Pisano, technical sales manager at Dorin, a compressor manufacturer. Pisano cited the company's six-cylinder transcritical compressors that can run at up to 60 m³/h – the largest transcritical CO₂ compressors on the market, according to Dorin – as a key technological development allowing CO₂ to operate at higher capacities.

Pisano believes the industrial market is moving towards CO₂ partly due to the safety and technical challenges of using ammonia – namely, that this commonly used industrial refrigerant is "toxic and flammable". In addition, ammonia systems "call for special and more expensive components," he claimed.

Jonas Schönenberger, head of R&D at Frigo-Consulting, a Swiss engineering company, also predicts a greater market share for CO₂ in industrial applications.

In August 2017, Frigo-Consulting installed a CO₂ transcritical system with ejectors in a fish factory in Valencia, Spain. "The main criterion from the customer was to get it into a very limited space, and to use only one refrigerant.

They did not want to handle many refrigerants [and] they wanted a future-proof, easy-to-handle refrigerant. CO₂ was the optimal option," said Schönenberger.

As technology develops, the ammonia charge can be reduced, thereby improving system safety, pointed out Wolfgang Dietrich, product manager (chillers) at GEA Refrigeration Germany.

The combination of CO₂ and ammonia in an NH₃-CO₂ cascade system appeals to Nicolas Pondicq-Cassou, director of engineering – mechanical systems at Profroid (a Carrier brand), and Paul Arrowsmith, refrigeration design manager at UK retailer Sainsbury's.

At its new online fulfilment centre in east London, Sainsbury's decided to go for an ammonia-CO₂ cascade refrigeration system from GEA. "It's pumped CO₂ for the chilled [products], cascaded from an ammonia system which keeps the pumped CO₂ at -6°C," Arrowsmith said.

No ammonia circulates on site. Instead, it is restricted to the plant room, the evaporator and the evaporative condensers. "The liquid CO₂ is the heart of the system. The pumped CO₂ provides the condensing medium for the subcritical DX frozen food system. We've got CO₂ for frozen, pumped CO₂ for the chilled, and ammonia to keep the CO₂ at the required temperature," Arrowsmith said.

A key reason for opting for this type of system was the high coefficient of performance (COP) of 4.0. "The increased cost of this system was recovered within half a year on paper," Arrowsmith said.

Similarly, in Profroid's experience CO₂ and ammonia together provide the best solution, according to Pondicq-Cassou. Comparing an ammonia system with an ammonia-CO₂ system, Profroid found the latter to offer the best combination of efficiency, safety and investment cost.

TECHNOLOGY TRAINING IS CRUCIAL

Though Europe's commercial and industrial sectors are both moving away from HFCs, low-GWP refrigerants will need to be utilised across the full HVAC&R spectrum to achieve the phase-down objectives under the EU's F-Gas Regulation.

On 1 January 2018, the HFC quota under the F-Gas Regulation fell to 63% of the 2015 baseline (which refers to the total quantity placed on the

market in the period 2009-2012). The anticipated shortage has already led to price hikes for the most commonly used HFCs, such as R404A and R407.

Arno Kaschl from the European Commission's climate action department told ATMOSphere Europe that, "the price signal is clearly there. Prices of HFCs are rising quite a lot". These price hikes will mean that some manufacturers and end users could find themselves under even greater pressure to reduce their consumption of HFCs.

Amid such pressure to reduce HFCs and embrace low-GWP alternatives, training will need to become a priority. Speaking in Berlin, Marco Buoni, vice-president of AREA (the European Association of Refrigeration, Air Conditioning and Heat Pump (RACHP) Contractors), highlighted the need to upskill the industry to use natural refrigerant-based equipment in order to meet the HFC phase-down objectives of the EU F-Gas Regulation.

Buoni said: "Half a million are certified for f-gases; those people need to be trained and upskilled for alternative refrigerants." AREA is a partner in 'Real Alternatives for LIFE: Refrigerant Emissions Alternatives and Leakage', an EU-funded project to provide online and in-person training on low-GWP refrigerants.

The programme, which began as an online project translated into 13 languages, will now run study visits (in five training centres in Belgium, Germany, the UK, Poland and Italy) and 'train the trainer' events (in five stakeholder locations, with 20 people at each).

Through online and in-person training, AREA and its other industry partners believe they have the potential to "reach 228,0000 employers, 26,000 RACHP installation businesses and 100 suppliers across Europe," Buoni says.

Volker Stamer, director of BITZER's SCHAUFLEER Academy, argued that online training was no substitute for live training sessions. The academy, which provides in-person training on compressor and system technology for



1 / Eric Delforge, Mayekawa

2 / Jonas Schönenberger,
Frigo-Consulting

*“For us, natural refrigerants
are a no-brainer
for industrial.”*

– Eric Delforge, Mayekawa

CO₂, ammonia and hydrocarbons, has "had 3,800 visitors in the first year – 80% of them are from outside Germany," Stamer said.

Stamer nonetheless noted that this training was no substitute for vocational refrigeration and air-conditioning schools. "On the path to natural refrigerants we need training," he said.

INNOVATION IN THE TRANSPORT ARENA

Another sli.do poll asked attendees, 'Which sector still needs more pressure or support from the policy side to quickly move towards NatRefs in Europe?'. Most (51%) opted for room air conditioning (see *Accelerate Europe* #8 for more on natural refrigerants in room air conditioning in Europe), along with mobile air conditioning (MAC) at 24%.

Martin Hasnik is a project manager for technology management and development at RegioNetz Verkehrs GmbH ('RNV'), a wholly owned subsidiary of DB Regio, the rail arm of Deutsche Bahn for regional transportation. Hasnik called on manufacturers at the conference to help Deutsche Bahn meet its goal of ensuring that all air conditioning in its new trains uses natural refrigerants by 2020.

Deutsche Bahn – the world's second-largest transport company and Europe's largest railway operator and infrastructure owner – described how it is already testing and using CO₂ mobile air conditioning in some trains. Despite its clear direction towards CO₂, the company still lacks enough suppliers of air-conditioning systems for trains.

The first DB Bahn train to be fitted with CO₂ air conditioning was a Siemens VT642 train, in Chemnitz (Saxony) in 2016. Since then the company has carried out a few more projects with a CO₂ air-cycle system (see *Accelerate Europe* #8). Energy savings are about 10% compared to the HFC R134a used previously, Hasnik said during the session.



Marco Buoni (AREA), Volker Stamer (BITZER), Bafoday Sanyang (Gambia National Environment Agency) & Álvaro de Oña (shecco) talk training.

In addition to the environmental and energy-saving benefits of CO₂ systems, Hasnik cited other important reasons to make the switch:

- ▶ The use of CO₂ eliminates 'dependence' on costly HFC refrigerants R134a, R407C and R404A;
- ▶ Integration of an innovative and patented air distribution system;
- ▶ Reduction of operating and maintenance costs, and;
- ▶ Possible technology transfer to other vehicles.

Two manufacturers that presented during the transport session, Faiveley and Konvekta, are currently working with Deutsche Bahn on CO₂ MAC projects.

Konvekta has had some success outside of DB with CO₂ MAC in buses in Germany and Austria. "The vehicles with CO₂ in operation number roughly 100," Michael Sonnekalb of Konvekta told the audience.

Despite this success, Sonnekalb noted that barriers remain to making CO₂ a reality. "We don't sell to the end user but the bus manufacturer, so he won't see the lifecycle cost but the manufacturing cost," he said ([for more on CO₂ MAC in buses, see p. 36](#)).

Lutz Boeck of Faiveley argued that MAC remains a cost-sensitive marketplace. "We would like to offer such solutions in 2020," Boeck said, noting that, "costs are significantly higher than for the R134a [air-con] system" that many train operators throughout Europe are currently using.

Faiveley is working on train air conditioning and heating systems in Scandinavia too.

If more large train operators were to opt for CO₂ and governments were to offer incentives for these systems, it could help bring this technology to market. "It would be nice to have incentives from the government, similar to the ones you have for stationary equipment" in Germany, said Konvekta's Sonnekalb.

There are clear signs, then, that the market for natural refrigerants is developing beyond the refrigeration arena. As the HFC phase-down picks up in 2018, next year's ATMOsphere Europe will be an important opportunity to assess progress.

■ CM & AW

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KIGALI AMENDMENT TO ENTER INTO FORCE

Last October, Australia became the 10th country to officially ratify the Kigali Amendment to the Montreal Protocol. Having since surpassed the required ratification threshold, the agreement is now poised to enter into force on 1 January 2019.

— By Andrew Williams & Devin Yoshimoto

The Kigali Amendment to the Montreal Protocol – a landmark international agreement to phase down the production and use of HFCs – is poised to enter into force with 24 countries having officially ratified to date.

That meets the threshold for the treaty to come into effect on the earliest possible date: 1 January 2019.

The Kigali deal stipulated that the treaty would enter into force on 1 January 2019 provided it had been ratified by at least 20 parties to the Montreal Protocol.

Countries to have ratified it recently include: Sweden, Trinidad & Tobago, Finland, the Lao People's Democratic Republic (Laos), Luxembourg, the Maldives, Slovakia, the United Kingdom, and Canada.

The Kigali Amendment – which applies to all 197 Parties to the Montreal Protocol – only becomes legally binding for individual signatories once they have formally ratified it. A complete list of ratifications is available on the United Nations Environment Programme Ozone Secretariat website.

HFCs are widely seen as the world's fastest-growing climate pollutant and are used in air conditioners and refrigerators.



LEFT
Parliament House,
Canberra, Australia



Rwandan capital Kigali

Kigali sees developed countries take the lead on phasing down these potent greenhouse gases, starting with a 10% reduction in 2019 and delivering an 85% cut in 2036 (compared to the 2011-2013 baseline).

Developing countries are split into two groups. The first one – which includes China and African nations – will freeze consumption of HFCs by 2024, with their first reduction steps starting in 2029.

A second group including India, Iran, Iraq, Pakistan and the Gulf countries will meet a later deadline, freezing their use of these gases in 2028 and reducing consumption from 2032.

Clear market signal

The imminent entry into force of the Kigali deal establishes a clear HFC phase-down schedule, giving a strong message to the HVAC&R sector to provide the technology solutions – including natural refrigerant-based equipment – that will deliver the Kigali targets.

The Australian government has demonstrated a clear commitment to phasing out HFCs since the beginning. In October 2016, Australia played a key role in co-chairing negotiations over the Kigali Amendment.

At the same time, Australia's government steadily moved forward with its own domestic HFC phase-down plan.

On 30 March 2017, the government introduced a bill to amend the country's existing Ozone Protection and Synthetic Greenhouse Gas Management (OPSGGM) Act.

The bill was passed on 19 June 2017 and Australia has now begun phasing down HFC imports since 1 January 2018.

The bill also brought the country's HFC phase-down schedule in line with the Kigali Amendment's phase-down steps and will allow Australia to achieve the Kigali target of an 85% reduction by 2036.

No HFCs are manufactured in Australia itself.

The government has suggested that the long phase-down period is intended to give sufficient time for the industry to transition towards alternative technologies.

"The long phase-down period means that consumers can continue to use equipment with HFCs until the end of its useful life," according to an official statement from Australia's Minister for Foreign Affairs Julie Bishop and Minister for the Environment and Energy Josh Frydenberg.

"There are already new technologies on the market which use fewer HFCs or different technologies altogether."

■ AW & DY

DISPATCH FROM

In November the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer gathered in Montreal, Canada to accelerate the transition to ozone- and climate-friendly refrigerants. *Accelerate* reports from their 29th Meeting.

– By Marie Battesti

Just a few days ahead of the 29th Meeting of the Parties to the Montreal Protocol (MOP29) in Montreal, Canada – held on 20-24 November – the Kigali Amendment on phasing down HFCs was ratified by Sweden and Trinidad & Tobago, bringing the deal over the required 20-party ratification threshold in order to enter into force on the earliest possible date: 1 January 2019.

The Kigali Amendment is a landmark international agreement to phase down the production and use of HFCs. It requires developed countries to take the lead on phasing down these potent greenhouse gases, starting with a 10% reduction in 2019 and delivering an 85% cut in 2036 (compared to the 2011-2013 baseline).

The primary goal of MOP29 was to make progress on adopting concrete implementing measures to ensure all signatories can achieve the Kigali Amendment objectives.

ENERGY EFFICIENCY

The topic of integrating energy efficiency into the requirements of the Kigali Amendment is relatively new to the MOP agenda. According to experts at the meeting, improving energy efficiency while phasing down HFCs could at least double the climate change mitigation benefits of the HFC phase-down.

Countries requested the Technology and Economic Assessment Panel (TEAP), an advisory body to the Montreal Protocol Parties, to assess technology options, requirements and related costs to maintain or enhance energy efficiency while phasing down HFCs under the Kigali Amendment. TEAP will make its recommendations in a report to be presented to the 30th Meeting of the Parties, to be held on 5-9 November 2018 in Quito, Ecuador.

REPLENISHING THE MULTILATERAL FUND

One key decision was to determine how much money would be allocated to support developing countries in achieving the HCFC phase-out and the HFC phase-down required under the Montreal Protocol and the Kigali



FROM MONTREAL

Amendment to the Montreal Protocol – i.e. the replenishment of the Multilateral Fund (MLF).

Delegates' most pressing task was to successfully conclude the MLF replenishment negotiations for the triennium 2018-2020. The MLF replenishment is crucial for developing (Article 5) countries, as the fund finances activities to help meet their compliance obligations to phase out ozone-depleting substances.

After long negotiations, the Parties adopted a budget for the MLF for the triennium 2018-2020 of US\$ 540,000,000 (A\$ 674,909,192).

UNCERTAIN FUTURE FOR SYNTHETIC REFRIGERANTS

HFOs came up as a topic of some concern in Montreal. Philip Owen from the European Commission, the EU's executive arm, cited the Ozone Research Managers' conclusion that the formation of toxic TFA (trifluoroacetic acid), as well as tropospheric ozone, results from the degradation of HFOs. This "is a concern which requires further research and evaluation," he said.

Questions have been raised about HFOs' impact on the environment, particularly their decomposition in the atmosphere into TFA, a long-lasting substance that descends to the earth as a form of 'acid rain' and accumulates in freshwater bodies.

TFA's long-term toxicity has been the subject of ongoing scientific study. One 2014 study in *Chemosphere* – 'A 17-fold increase of trifluoroacetic acid in landscape waters of Beijing, China during the last decade' – recommended

that "measures are needed to control the increase of TFA in China".

In other activity at MOP29, Norway and Switzerland reintroduced a draft decision to adopt a "precautionary approach" to the development and promotion of low-GWP one-component HFCs that are not listed as controlled substances by the Kigali HFC phase-down scheme and have a GWP greater than 53 (the lowest GWP of covered HFCs).

And in a final decision, the Parties at MOP29 requested the Protocol Assessment Panels to provide a report evaluating the consumption and production of these low-GWP HFCs in time for the MOP in 2023 and every four years thereafter.

SMARTER STANDARDS TO ACHIEVE KIGALI HFC PHASE-DOWN

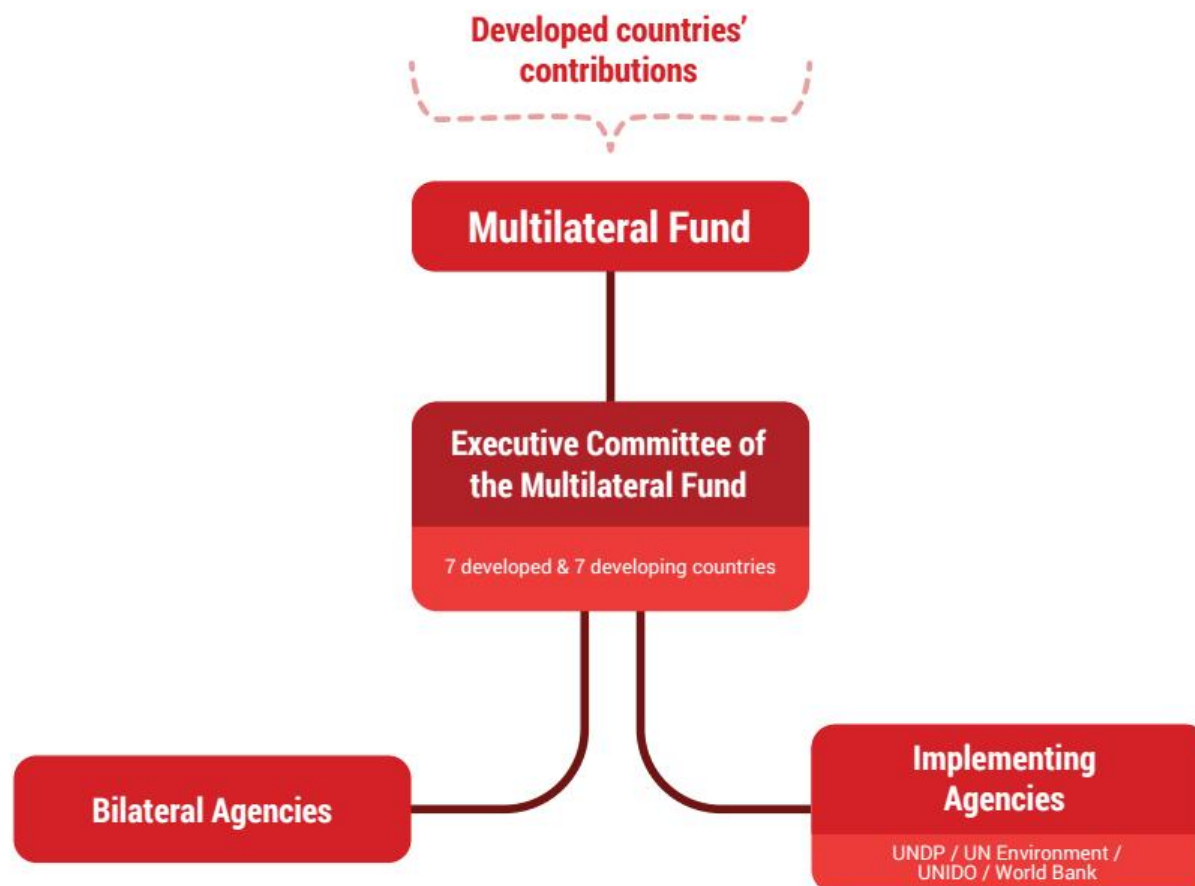
The need to update safety standards impeding the uptake of flammable refrigerants such as hydrocarbons was addressed by a number of countries throughout the week.

The Parties requested the Ozone Secretariat to hold regular consultations with relevant standardisation organisations, with a view to providing an overview of the relevant safety standards governing flammable low-GWP refrigerants.

The overview will include information on the scope of standards (i.e. activities, appliances or products covered), content (i.e. safety-relevant technical aspects addressed) and information on the review process.

■ MB

Funding the Montreal Protocol



FUNDING THE MONTREAL PROTOCOL

The Multilateral Fund of the Montreal Protocol helps developing countries to meet their Montreal Protocol obligations. The contributions to the Fund made by developed countries are established according to a UN scale. An Executive Committee manages the Multilateral Fund, with equal membership from developed and developing countries.

Projects and activities supported by the Fund, helping developing countries to achieve the HCFC phase-out and HFC phase-down required under the Montreal Protocol, are implemented by four international implementing agencies: the World Bank receives 45% of the Fund's budget, while UN agencies share the remainder. The United Nations Development Programme (UNDP) gets 30%, the United Nations Industrial Development Programme (UNIDO) gets 20% and the United Nations Environment Programme's (UN Environment) Division of Technology, Industry and Economics (UNEP/DTIE) gets 5%.

► The **World Bank** focuses on large-scale phase-out and investment projects at plant and country levels.

► The **UNDP** organises demonstration and investment projects, technical assistance and feasibility studies.

► **UNIDO** prepares and appraises investment project proposals and implements phase-out schedules at plant level.

► **UN Environment's** Division of Technology, Industry and Economics supports the establishment of infrastructure within which projects can proceed. This includes fostering regional networks, and helping to prepare country programmes. It also provides clearing-house functions, and produces a range of training materials.

BILATERAL AGENCIES

Contributing Parties can also use up to 20% of their annual contribution to carry out activities supporting developing countries in achieving the targets set by the Montreal Protocol on a bilateral basis.

Activities carried out include training, technical assistance, and the introduction of ozone-friendly technology such as natural refrigerant-based equipment.

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SLCP REDUCTION 'CAN CUT WARMING 0.9°C BY 2050'

UNEP's 2017 Emissions Gap report says reduction of short-lived climate pollutants, including HFCs, is an important part of mitigation efforts to meet Paris Agreement's 2°C target.

— By Michael Garry & Andrew Williams

The 8th Emissions Gap Report, published on 31 October 2017 by the United Nations Environment Programme (UN Environment), for the first time acknowledges the potential contribution that short-lived climate pollutants (SLCPs) such as HFCs, methane, and black carbon (soot) can play in the global effort to keep the planet from warming more than 2°C above pre-industrialised levels.

"Over the period 2018-2050, stringent SLCP reductions based on existing, demonstrated technical measures could reduce warming by between 0.3°C and 0.9°C relative to current emissions projections," the Emissions Gap report states.

"Roughly half of the mitigation potential is associated with methane, one third with black carbon, and the remainder (about 17%) with HFCs," it says.

Because they remain in the atmosphere for a shorter time than CO₂ emissions, "reductions in SLCPs have the potential to reduce the rate

and degree of warming in the next few decades," the report says. "In contrast, reducing CO₂ [...] tends to reduce warming more slowly."

One example of the potential of SLCP reduction is the Kigali Amendment to phase down hydrofluorocarbons (HFCs) under the Montreal Protocol. By the turn of the century, the Kigali Amendment could avoid up to 0.5°C of warming, notes UN Environment.

HFC alternative bring additional benefits too. "Technology alternatives to HFC cooling and refrigeration systems are [...] often much more energy efficient than the systems they replace, which provides additional CO₂ and air quality benefits by reducing energy consumption," according to the Climate & Clean Air Coalition (CCAC) Secretariat.

The Emissions Gap report added that transitioning to available low-GWP alternatives faster and more thoroughly than contemplated by the Kigali Amendment represents a "major opportunity" to achieve even greater cuts in HFC emissions. In countries

with high ambient air temperatures, almost 70% of sectors currently using HFCs “can leapfrog past [high-GWP HFCs] directly to low-[GWP] alternatives with equal or better energy efficiency”.

URGENT NEED FOR ACTION

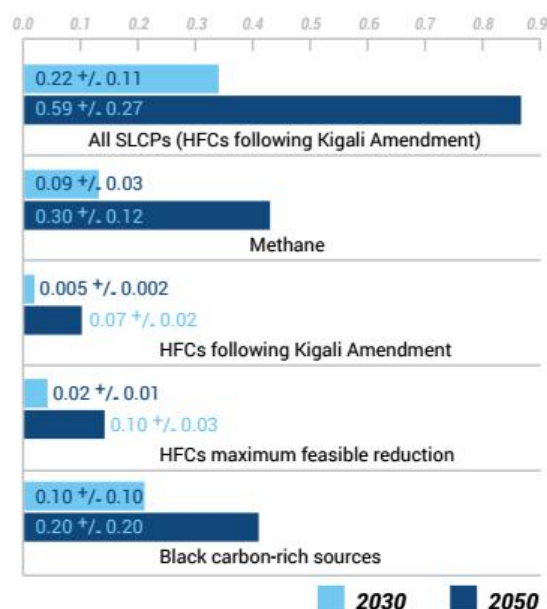
Overall, the report looks at the gap between emission reductions needed to hold global warming to well below 2°C (preferably no more than 1.5°C) and the likely emission reductions from full implementation of the Paris Agreement.

The report concludes that, “there is an urgent need for accelerated short-term action and enhanced longer-term national ambition if the goals of the Paris Agreement are to remain achievable – and that practical and cost-effective options are available to make this possible”.

Fast action to reduce SLCPs would also help “reduce climate change impacts caused by cumulative heat uptake (for example, sea-level rise, and glacier and ice-sheet melting) and reduce the likelihood of passing irreversible temperature thresholds and triggering large positive feedbacks,” said the CCAC Secretariat.

The lead authors of the SLCP section of the report, ‘*Bridging the gap – The role of short-lived climate pollutants*’) are Zbigniew Kilmont, research scholar at the International Institute for Applied Systems Analysis (IIASA) and Drew Shindell, professor of climate science at Duke University and chair of the Climate and Clean Air Coalition Scientific Advisory Panel. ■ MG & AW

Temperature Drop from SLCP Emission Cuts (C°)



sheccoBase

URGING ENERGY EFFICIENCY AT COP23

The United Nations' Climate Technology Centre & Network (CTCN), which facilitates transfer of climate-friendly technologies to developing countries, urged the adoption of energy-efficient systems at November 2017's COP23 climate talks in Bonn, Germany.

Energy-efficient, climate-friendly technologies include those that replace HFCs. This year, the CTCN developed a programme to support the replacement of f-gases in a refrigeration system used in fruit and vegetable processing and exports in Chile, in collaboration with United Nations Development Organization (UNIDO).

CTCN, a body hosted by the United Nations Environment Programme (UN Environment) and UNIDO, operates under the 'Technology Mechanism', created at COP16 in Cancún, Mexico, in 2010 to enhance the development and transfer of climate technologies to developing countries. The Technology Executive Committee (TEC) is the policy arm of the Technology Mechanism.

“Energy efficiency is critical to reach our target under the Paris Agreement,” Claudia Octaviano Villasana, a member of TEC, said at COP23, which stands for the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

Villasana outlined the CTCN's key policy recommendations on industrial energy and material efficiency in emission-intensive sectors: promote policies and programmes on industrial energy efficiency; and raise awareness about the potential costs and benefits of industrial energy efficiency. – Marie Battesti

America's Pledge includes HFC reduction

The report unveiled at COP23 by California Governor Brown and former New York Mayor Bloomberg reaffirms U.S. commitment to the Paris Agreement on climate change.

– By Michael Garry

Among the ways that a growing number of U.S. states, cities and businesses will work to reduce climate change and meet the U.S. commitment to the Paris Accord will be to seek deep cuts in greenhouse gases in addition to CO₂, including HFCs, according to phase one of a new report.

The report, which describes an initiative called America's Pledge, was presented on 11 November at the United Nations' COP23 Climate Change Conference in Bonn, Germany. It was unveiled by California Governor Edmund G. (Jerry) Brown Jr., who is COP23 Special Advisor for States and Regions, and former New York City Mayor Michael R. Bloomberg, who is the United Nations Secretary-General's Special Envoy for Cities and Climate Change.

The report is the first communication to the international community specifically addressing the scope and scale of non-federal climate action, in contrast to the Trump administration's decision to withdraw from

the Paris Agreement. Under the Obama administration, the U.S.'s Paris Agreement commitment was to reduce emissions by 26%-28% below 2005 levels by 2025.

The report points out that HFCs are a small but rapidly growing component of U.S. and global GHG emissions. Moreover, it notes that "successful transition from the HFCs specified by the Kigali Amendment [to the Montreal Protocol] will result in the avoidance of 80 billion metric tons of CO₂ equivalent by 2050 and some 0.5°C of warming by the end of the century".

The report also mentions that natural refrigerants like CO₂ and hydrocarbons represent alternatives to HFCs. "The shift away from HFCs is already underway, with many businesses transitioning to less HFC-reliant systems," the report says.

As an "opportunity to step up," the report suggests that "states, cities and businesses create public-private partnerships and/or incentive programs

to accelerate the phase-down of HFC use and emissions". Such collaboration "can include R&D support to businesses developing these technologies, internal commitments to low-GWP equipment procurement, and grant or rebate programs for low-GWP products for homes, businesses or plants".

In addition, states "can adopt new legislation to ban sales on high-GWP refrigerants in new equipment where lower-GWP alternatives are available".

The America's Pledge report cites instances of U.S.-based initiatives that are already reducing HFC emissions through the use of low-GWP alternatives. For example, as part of the U.S. Environmental Protection Agency's GreenChill Partnership, 43 supermarket companies have committed to reducing their HFC emissions, with 533 stores becoming certified under the program since 2008; many of those stores employ natural refrigerants.

In addition, the report notes, Coca-Cola, PepsiCo, Red Bull and Unilever



“Reducing these emissions will have a significant impact in the fight against climate change.”

— Senator Ricardo Lara

CALIFORNIA SENATOR PROPOSES LAW TO CUT HFCs

At the 23rd UN Climate Change Conference (COP23) in Bonn, Germany, California Sen. Ricardo Lara (D-Bell Gardens) proposed legislation – the California Cooling Act – to reduce HFCs, considered to be the fastest growing source of greenhouse emissions in California and around the world.

Notably, the California Cooling Act includes incentives for businesses and residents to switch to low-polluting air conditioning and refrigeration. The legislation will be introduced in 2018.

“The super pollutants inside air conditioners and refrigeration are like a silent assassin that threatens our global climate, and California is sounding the alarm about the threat they pose,” said Lara. “The California Cooling Act will help businesses and residents leave behind HFCs and support American manufacturers who are leading the way toward safer chemicals that do not contribute to global warming.”

HFCs “disproportionately contribute to global warming and the type of extreme weather events that California has been experiencing in recent months,” said an announcement issued by Lara.

The announcement follows a public workshop held by the California Air Resources Board (CARB) on October 24 as a first step towards adopting the Environmental Protection Agency’s (EPA) Significant New Alternatives Policy (SNAP) rules on HFC regulation, which are currently tied up in court proceedings. The workshop also addressed CARB’s plans to reduce short-lived climate pollutants (SLCPs), including HFCs.

have installed more than 5.5 million refrigeration units using HFC-free refrigerants, with nearly 400,000 of those installed in the U.S. The Target chain is also cited for installing propane display cases in more than 1,000 stores.

Finally, the report refers to the pioneering efforts by California to reduce “super pollutants” known as short-lived climate pollutants (SLCPs), which include HFCs. Under its SLCP plan, California intends to cut HFC emissions by 40% by 2030, compared to 2013 levels.

“California is planning to outpace the HFC emissions reductions expected under the Kigali Amendment to the Montreal Protocol by adopting additional regulations and incentivizing available [low-GWP] refrigerants where available,” says the report.

For its SLCP reduction program, the State of California was named the winner of the Climate & Clean Air Award in the Outstanding Policy category by the Climate & Clean Air Coalition (CCAC). CCAC announced the award

at COP23. “California represents what fast action on climate change looks like and the enabling environment its policies have created is driving innovation in clean energy and green technology,” said CCAC in a statement about the award.

The America’s Pledge report identified 20 U.S. states, 110 U.S. cities, and over 1,400 businesses that have adopted quantified emissions reduction targets.

“The group of American cities, states, and businesses who remain committed to the Paris Agreement represents a bigger economy than any nation outside the U.S. and China,” said Bloomberg. “Together they are helping deliver on the promise of the agreement and ensuring the U.S. remains a global leader in the fight against climate change. In Paris, the U.S. pledged to measure and report our progress reducing emissions alongside every other nation. Through America’s Pledge, we’re doing just that, and we’re going to continue to uphold our end of the deal, with or without Washington.” ■ MG

Large potential for NatRef heat pumps in Australian food industry

A recently published report has identified key market opportunities for high-temperature natural refrigerant-based heat pumps in Australia's food manufacturing sector.

— By Devin Yoshimoto

by declining costs of renewable electricity (and energy storage) and increasing costs of natural gas," the report states.

AUSTRALIA'S FOOD SECTOR: NATREF CASE STUDIES

The report details several NatRef heat pump case studies in Australia. Examples include:

► Mayekawa Plus+ Heat ammonia heat pump, installed in 2012 at Thomas Foods International's Lobethal Abattoir in Adelaide, resulted in a 40% reduction in liquefied petroleum gas costs.

► One 30 kW Mitsubishi Heavy Industries Q-ton CO₂ air-to-water heat pump was installed at Shene Estate Distillery in Tasmania in mid-2017. The Q-ton unit has achieved a COP of 4.2.

With Australia now phasing down HFCs and committed to reducing carbon emissions at national level, the report represents a clear opportunity for natural refrigerant heat pump technology to serve the market.

"The project team believes that there is sufficient potential for application of high temperature heat pumps to displace natural gas and deliver an attractive return for the Australian food industry [and] that further work is justified to develop the market," the report concludes.

"This may include part-funding the conduct of detailed feasibility studies and case implementation projects, to demonstrate the application in applications where there is substantial replication potential." ■ DY

The report is publicly available for download from the Australian Alliance for Energy Productivity website.

Amid rapidly rising natural gas prices, a fast-growing food processing industry, and Australia's HFC phase-down, there are significant market opportunities for high-temperature heat pumps in Australia – including natural refrigerant-based systems – a recent report has found.

The report, entitled '*High Temperature Heat Pumps for the Australian Food Industry: Opportunities Assessment*', was published by the Australian Alliance for Energy Productivity and is part of an initiative by the non-profit group to double the energy productivity of Australia's economy by 2030.

RISING GAS PRICES

The report identified several key market drivers that are creating opportunities for NatRef heat pumps in Australia's food manufacturing sector, the most significant being the rapidly increasing price of gas in Australia.

"This work is particularly important at a time when East Coast Australian companies have seen a rapid escalation of gas prices in the last two years, with many companies seeing contract prices double," the report states.

Citing key high temperature industrial heat pump technology developments over the past decade, the report highlights packaged CO₂ heat pumps like the 'Eco Cute' unit, popular in Japan, among the potential alternatives.

"While there is a significant capital cost for high temperature heat pumps," the report states, "the development of packaged 'Eco Cute' units in Japan provides relatively economical volume-manufactured units for heating water and air to 90°C".

"Improving technologies and economies of scale of production of packaged units are making heat pumps more competitive, supported



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Can low-charge systems ease technician crisis?

The safety and relative simplicity of low-charge ammonia packages could make them a better fit for an industry with a shrinking supply of qualified technicians in North America.

— By Elise Herron

It is widely acknowledged that the number of technicians trained to handle natural refrigerant systems is dwindling.

But the advent of small and standardized low-charge ammonia packaged systems, which can be used instead of traditional massive ammonia plants or synthetic refrigerant systems, will make it easier to train and maintain enough qualified technicians.

This was the contention of Mike Chapman, director of process safety management (PSM) compliance for Stellar, and Kurt Liebendorfer, vice-president of Evapco, in a presentation at the Refrigerating Engineers and Technicians Association (RETA) conference, held in Hershey, Pa., in September.

"There is a deficit of qualified technicians in our industry," Chapman said in his presentation, entitled '*Low-charge ammonia packages and safety*'. "It is a technician's market with regard to getting work."

Chapman and Liebendorfer pointed out that low-charge ammonia packaged units (coolers and chillers) are inherently safer than conventional ammonia-based refrigeration systems, which lessens the training requirement.

"Ammonia refrigeration is still, always has been, and always will be ammonia refrigeration — we're taking the heat out of something and the result is making it cold," said Chapman. "But the technology by which we're doing that is what's changing, improving and becoming more effective and safer."

THE RETIREMENT PROBLEM

The primary driver of the technician shortage is that seasoned technicians are retiring, and their replacements are not showing up in sufficient numbers.

A recent study cited by Chapman determined that there were around 745 qualified technicians for 4,500 jobs in the United States.

Not only are people retiring, Chapman said, younger generations are increasingly pursuing four-year degrees over community college, trade, or technology school programs. Quite simply, there aren't as many young people seeking trades careers as there once were.

"The four-year degree and advanced degree are great," said Chapman, "but if we lose out on that trades skill development piece, then we truly have a deficit and a void in our industry."

RIGHT
Low-charge ammonia
penthouse unit at Turner
Dairy, Memphis, Tennessee

BELOW
Training session on low-
charge systems at Turner
Dairy, Memphis, Tennessee





Another consequence of the retirement boom is that the remaining workforce has significantly less on-the-job qualifying experience.

"Nobody's invincible after a single training course," Chapman said. "Through the educational process in your career you become qualified to do the job."

Facilities directors at many of the big companies Chapman has polled say that their refrigeration technicians have less than five years of servicing experience.

"That's not a lot of time to get a lot of expertise under your belt in regards to trouble shooting advance technology and being able to figure out things and problem solve," he said.

However, Chapman was confident that the evolution of factory-tested systems like low-charge ammonia packages would ultimately make training easier, and more appealing, for new technicians in the field.

"We can get back to where we need to be," he said. "The old conventional-style systems are much larger, much more complex, have much more ammonia and inherently can be more dangerous and make things more difficult."

THE EVOLUTION OF PACKAGED UNITS

Low-charge ammonia packaged units continue to make inroads in industrial refrigeration, and even in some commercial applications.



“WE STILL HAVE TO TRAIN PEOPLE – REGARDLESS THE TYPE OF SYSTEM – BUT IT'S EASIER TO DO WHEN IT'S A SIMPLIFIED SYSTEM.”

– Mike Chapman, Stellar



Less ammonia, flexibility in installation location, less piping, ease of maintenance and installation, and safer start-up help make low-charge ammonia packaged units appealing to end users and technicians.

For technicians, the installation process is dramatically streamlined, and for end users there are energy-efficiency and refrigerant savings, as well as decreased regulatory burdens, which contribute to lower total cost of ownership.

“The central machine room goes away,” said Liebendorfer, “because you’ve got these packaged units distributed throughout the building locally serving the cooling loads”.

“They’re typically factory assembled and tested,” he added, “which can facilitate quick installation and start-up versus the field labor it takes to run all that piping.”

Following the presentation, Liebendorfer provided an example of a current low-charge installation – at a Turner Dairy plant in Memphis, Tennessee, owned by Prairie Farms. “Since the Evapcold units are completely packaged and enclosed, this work is much easier than if the new system were all traditional stick-built equipment,” he said. “The low-charge packaged solution has really helped them in this complicated building remodel and expansion/construction project.”

Another boon to low-charge technology is that ammonia systems operating with a charge under the threshold quantity of 10,000 pounds (4,536 kg) are not typically subject to the Occupational Safety and Health Administration’s Process Safety Management (PSM) rules and the Environmental Protection Agency’s Risk Management Program (RMP). They must still, however, adhere to the agency’s General Duty Clause.

Liebendorfer referred to a low-charge ammonia packaged chiller with a 3,800-lb (1,724 kg) charge. “It’s going to be self-evident, when facilities go from 18,000 pounds (8,165 kg) to 3,800 pounds (1,723 kg), that they will be less susceptible to fines – if properly executed.”

While low-charge ammonia packaged units are beginning to change industrial refrigeration, Chapman made sure to point that proper training remains crucial.

“We still have to train people – regardless of the type of system – but it’s easier to do when it’s a simplified system,” Chapman said. With the repeatable design of a small-charge system, even in a facility with multiple units “you could do one training session for all of those together”.

Training, backed by standardised documentation, has also been easier at the Turner Dairy plant, said Liebendorfer. “Having all the documentation like operating procedures, maintenance procedures and hazard reviews all completed and part of the operator training is very powerful stuff.”

Currently, Chapman said, the low-charge ammonia packaged unit industry is ready and waiting for technicians and end users to safely implement the new technology. Chapman and Liebendorfer both predict that the uptake of low-charge systems is on the brink of ballooning, and that while the technician field is currently meagre, it will continue to grow.

“The compliance and regulatory paperwork is available, and the ability to train operators on mechanical integrity – it’s all right there,” Chapman said.

“Bottom line, [low-charge ammonia package units] are a powerful and safe solution to ease the challenges of our day-to-day compliance and safety burdens.” ■ EH

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UP AND RUNNING

Advansor's first Australian CO₂ transcritical system

Advansor's first CO₂ transcritical system in Australia – in a United Food Express warehouse in Keysborough – was successfully commissioned in November.

– By Andrew Williams

Danish company Advansor's first CO₂ transcritical system in Australia began operating on 21 November 2017 at a new United Food Express warehouse in the Melbourne suburb of Keysborough.

Commissioning took two-and-a-half hours and went smoothly despite an ambient outside temperature of 32°C, says Jonathan Hare from the Natural Refrigerants Company Pty Ltd. – which represents Advansor in Australia.

United Food Express is a Victoria-based seafood importer and wholesaler that distributes to the Australian food service industry. The CO₂ transcritical system provides the chilling and freezing for the complex.

Lucas Refrigeration was responsible for installing the system. After talking with United Food Express, Lucas Refrigeration Managing Director Graeme Lucas opted for a CO₂ transcritical solution. The Natural Refrigerants Company is coordinating and providing back-up services for the installation.

Lucas describes the pathway United Food Express has taken. The wholesaler's previous premises in nearby Dandenong had run on R404A. "When the customer decided to move premises, he was still keen to go with the R404A," Lucas reveals.

But in presenting options for the project, he explains, "we offered him the CO₂ system – which he was keen to explore. So we got in touch with the Natural Refrigerants Company, who have an association with Advansor".

The rack boasts eight compressors including four medium-temperature compressors (60 kW), one parallel compressor and three low-temperature compressors (170 kW).

"The system is capable of achieving temperatures as low as -22°C," says Advansor's service manager, Kristian Sørensen, who was in Melbourne to assist with the commissioning process.

Sørensen is confident that United Food Express made the right choice in opting for this natural refrigerant.

"The rack is running very well," Sørensen says. ■ AW

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Japanese firm boasts 'world's first' CO₂ research laboratory

Food Techno Engineering Co., Ltd. has opened a research laboratory to test cutting-edge transcritical CO₂ refrigeration systems and educate the public on natural refrigerants.

– By Devin Yoshimoto, Rena Okabe & Jan Dusek

To push the development of CO₂-based HVAC&R technology forward – particularly in the food-manufacturing sector – Food Techno Engineering Co., Ltd. (FTE), an engineering and contracting company headquartered in Osaka, Japan – has opened a research laboratory to demonstrate and test cutting-edge transcritical CO₂ refrigeration systems.

The CO₂ research laboratory, named the 'FTE Academy', was launched as a division of Food Techno Engineering's main business, which is to provide engineering and planning services to food manufacturing and processing facilities.

Kenji Noda, FTE's representative director, sees significant opportunities for CO₂ systems in the future and hopes that the facility will help further boost the use of CO₂ technology, not only in Japan, but also globally.

"Though the handling of CO₂ refrigerant is now considered equivalent to HFCs, end users' safety concerns have not been immediately eliminated," says

Noda, referring to the Japanese government's decision last July to deregulate CO₂ as a high-pressure gas.

"Now more than ever, we need a steady effort from the end user's perspective in order to prove the safety of CO₂ use compared to other natural refrigerants. Based on the Academy, I hope that we can contribute, even just a little, to the market revitalisation and spread of CO₂ refrigeration systems," he adds.

CUTTING-EDGE CO₂ RESEARCH

The FTE Academy, designed to simulate an actual food manufacturing facility, is equipped with a CO₂ impingement tunnel freezer and a CO₂ booster unit.

The booster unit is designed to recover waste heat and is equipped with an air-cooled gas cooler and a water-cooled gas cooler.

LEFT

FTE President Kenji Noda (centre), and team members

(L to R) Satoshi Niwa, Norishige Sato, Takashi Tsujiuchi and Ginga Yamamoto

Photography:
Yingwei Tao

The FTE Academy research facility was designed with two primary considerations in mind. The first is that all CO₂ technologies are developed and tested with water-cooling technology, and the second is that there is an emphasis on heat recovery technology.

"Water-cooled systems improve coefficient of performance (COP), as the pressure becomes lower compared to air-cooled systems," says Noda.

"In addition, since food factories use hot water for washing and other things, there is a lot of potential to recover waste heat. To improve the COP in a food factory as a whole, we must develop energy-efficient CO₂ equipment that incorporates heat recovery technology."

In many countries, heat recovery is already used widely in large-scale supermarket systems and CO₂ direct expansion technology. However, in Japan it remains a relatively new concept due to the fact that CO₂ direct expansion systems are yet to become mainstream.

Additionally, at the laboratory it is possible to monitor, extract and analyse operational data while running under various environmental and temperature-controlled settings.

"You can run the system at winter temperatures during summer and at summer temperatures during winter, as well as switch between water-cooled or air-cooled, because it's a research facility," Noda says.

A number of projects are currently underway. "We are currently working with Panasonic Corporation Appliances Company and Shibata Welding Works Co., Ltd. (CAREL's distribution partner in Japan) on the development of a water-cooled refrigerator unit for food factories and low-temperature distribution centres," Noda says.

EMPHASIS ON EDUCATION AND AWARENESS

Noda strongly believes that CO₂-based cooling systems will play a key role in protecting the environment in the future.

"When considering the global environment, it is best to be able to use as refrigerants substances that are abundantly present on the Earth," says Noda.

That is why the FTE Academy has a strong focus on education, training and raising public awareness of CO₂-based technology.

On the second floor of the building, above the research laboratory area, there are large seminar rooms used for lectures, symposiums and discussion forums.

So far, Noda and his team have seen a large amount of interest from industry and the general public.

"Both the Japanese Ministry of the Environment and the Ministry of Economy, Trade and Industry visited the opening ceremony of this facility, and now there are about three companies visiting each week – many are food-related companies," says Noda.

"People who are visiting are very interested in what the next refrigerants will be after the Kigali Amendment and the Paris Agreement. Many facilities are still using R22 and are worried about the future."

Additionally, local students are given free laboratory tours.

"The other day, 22 students came to the internship training and did a study for five days in the lab," Noda says.

"We have invited local elementary school and junior high school students and are working hard to get them interested in environmental issues." ■ DY



FTE Academy research facility



NNS's CO₂ transcritical production facility in Shiga, Japan



Japan-based system manufacturer Nihon Netsugen Systems (NNS) has opened a new manufacturing facility dedicated to CO₂ transcritical rack systems for the Japanese market.

– By Devin Yoshimoto,
Rena Okabe & Jan Dusek

Japan's first manufacturing facility for industrial CO₂ TC systems opens

In a sign of growing competitiveness in Japan's CO₂ transcritical market, on 1 December system manufacturer Nihon Netsugen Systems (NNS) officially opened a new manufacturing facility.

The facility, located in Shiga prefecture in Japan, just east of Kyoto, is dedicated to making CO₂ transcritical rack systems for the Japanese market.

The systems are the first CO₂ transcritical racks designed for industrial refrigeration use in Japan. The opening of the facility signals increased demand for natural refrigerant-based systems in larger applications in the Asian nation.

“We want to develop a new CO₂ market in Japan.”

— Katsuhiko Harada, president, NNS

LEFT

NNS's new 'CO₂ Booster Super Green' transcritical CO₂ condensing unit debuted at the company's product launch event on 29 September.

100 CO₂ TC SYSTEMS MANUFACTURED PER YEAR

The system being produced at the factory is NNS' brand new line-up of transcritical CO₂ condensing units, dubbed CO₂ Booster Super Green, which debuted at the company's product launch event on 29 September.

Currently, the system is available in two temperature ranges: 0°C for cold stores and -25°C for freezers. Each is available in capacities of 30 kW and 60 kW.

The system is air-cooled and, according to NNS, saves more than 15% on energy costs compared to R404A.

“I think this really fits the [specific] size [required for] industrial refrigeration and cold storage. Therefore, we want to open the market and we want to develop a new CO₂ market in Japan,” says NNS President Katsuhiko Harada.

“This is, I think, quite a new challenge in the Japanese market,” Harada adds.

The company also highlighted the significant amount of design work that went into developing these systems, which boast a very compact design and small footprint.

Additionally, the pressure between the refrigeration system and the gas cooler is limited to 3.3 Mpa, increasing the overall safety of the unit.

To meet demand, the company is aiming to produce more than 100 units per year, remarked Harada. The company is currently already able to produce 12 units per month.

INTERNATIONAL PARTNERSHIPS

NNS has recognised the rapid spread of CO₂ systems in Europe, and is working with leading global suppliers of CO₂ technology.

NNS is partnering with compressor manufacturer GEA to supply the compressors for the CO₂ Booster Super Green unit.

“We are sure, based on our long-lasting and trustworthy co-operation, that we can start [...] this journey together by packaging CO₂ compressor systems for medium and larger applications, especially for cold stores and supermarkets,” says Klaus Stojentin, GEA's executive vice-president for product management & sales.

“It was a win-win situation from the beginning. For us, a supplier of CO₂ compressors, it is very important that we are cooperating with Nihon Netsugen Systems here in Japan, which has very broad application and system knowledge and builds state-of-the-art CO₂ units,” Stojentin adds.

“By building this new outstanding facility, and realising the CO₂ Booster Super Green, Nihon Netsugen sets an impressive mark on the future,” says Robert Gerle, managing director of gas cooler supplier Güntner, who is also co-operating with the company on this project.

Component manufacturers Danfoss, ESK Schultze, Emerson and Refrigeria Industriale are among the other suppliers.

At the time of going to press, some 50 units had already been installed around Japan. ■ DY, RO & JD

THE NEXT BIG THING: NATREF HEAT PUMPS?

With a majority of ATMOsphere Europe conference attendees identifying heat pumps as the most promising future growth area for natural refrigerants, *Accelerate* looks at what is needed to facilitate the transition away from HFCs.

— By Charlotte McLaughlin,
Marie Battesti & Eda Isaksson

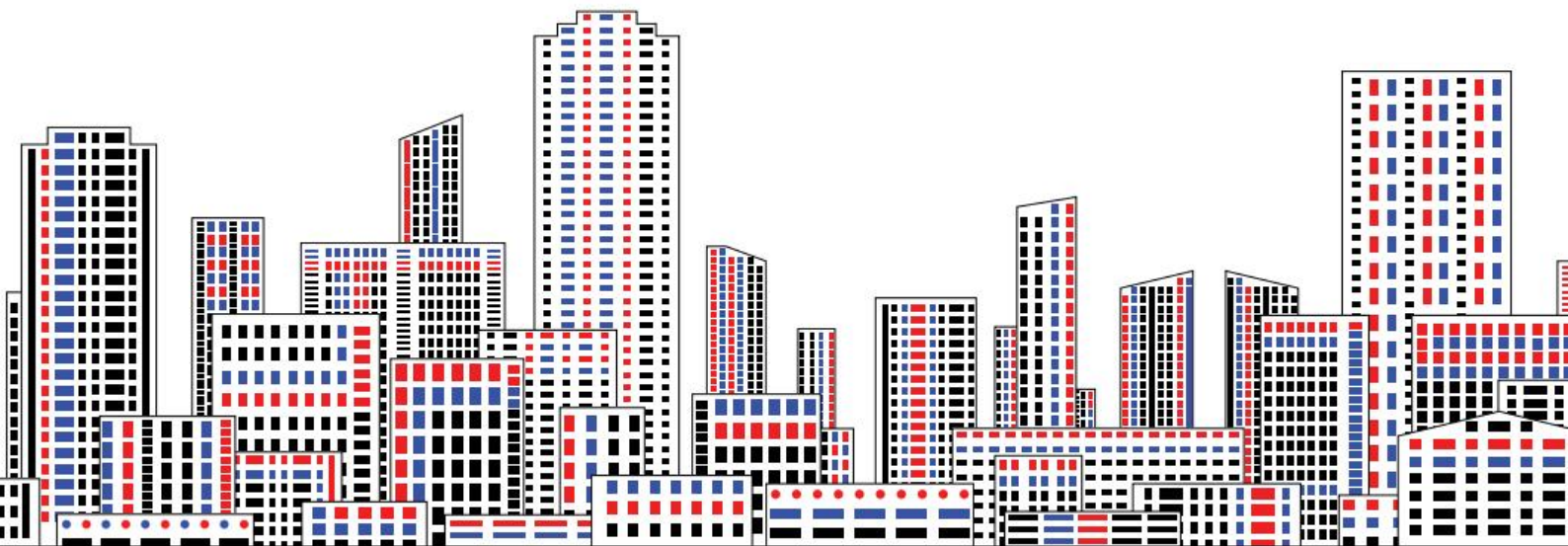
In a live poll at September's ATMOsphere Europe 2017 (organised by *Accelerate* publisher shecco) in Berlin, Germany, participants were asked, 'Next to commercial refrigeration, in what industry do you expect to see the fastest growth in natural-refrigerant adoption in Europe?' Most people (56%) plumped for heat pumps as the next big growth area for using natural refrigerants. The next highest, at 35%, was industrial chillers that are used in large scale air-conditioning and refrigeration projects. Just 6% opted for residential air conditioning, while 3% chose data centres.

Most of the heat pumps currently on the market use HFCs, according to Pieter Boink, head of business development and marketing at Nidec Global Appliance Germany, who spoke during the heat pump session at ATMOsphere Europe.

Boink expects this to change soon. "Heat pumps based on natural refrigerants are the ideal solution for future regulations and market demands," he argued.

He cited pressure from international accords such as the Paris Agreement, which will drive reductions in fossil-fuel use, the Kigali Amendment to the Montreal Protocol, which will drive HFC reductions worldwide, and European directives pushing reductions in electricity consumption as key reasons why the use of gas, oil, electric heating and HFC heat pumps are all likely to fall.

In Europe, the transition towards HFC alternatives is already underway. On 1 January 2018, the HFC quota under the EU F-Gas Regulation fell to 63% of the 2015 baseline (which refers to the total quantity placed on the market in the period 2009-2012). The



anticipated shortage has already led to price hikes of the most commonly used HFCs, such as R404A and R407.

Countries in the European Union are also required to reduce 40% of their greenhouse gas emissions by 2030 (from 1990 levels). Space heating and cooling and hot water are estimated to account for roughly half of energy consumption in buildings globally, according to the International Energy Agency's (IEA) Technology Roadmap on 'Energy-efficient Buildings: Heating and Cooling Equipment'.

Fossil fuel-free heat pumps are "the low-hanging fruit" in tackling climate change, said Menno van der Hoff, head of R&D and HVAC manager at Uniechemie and winner of the *Accelerate Europe* 'Person of the Year' award.

According to the European Union's heating and cooling strategy, published by the European Commission in February 2016, "84% of heating and cooling is still generated from fossil fuels while only 16% is generated from renewable energy". To fulfil the EU's climate and energy goals, "the heating and cooling sector must sharply reduce its energy consumption and cut its use of fossil fuels," the strategy states.

Other initiatives are also on the table. In November 2016, the Commission published the Clean Energy Package, which seeks to mobilise investment in decarbonising the EU economy. On September and November 2017 respectively, members of the European Parliament's environment (ENVI) and industry & energy (ITRE) committees agreed to increase the EU's proposed energy efficiency target from 30 to 40%. At the time of going to press, the full parliament was yet to pronounce on the matter.

All these measures are putting further pressure on European countries to reduce electricity consumption. The drive to increase energy efficiency has already had an impact on legislation in Germany where, on 1 January 2016, new rules on constructing new buildings entered into force. New buildings must now meet a maximum primary energy requirement that is 25% lower than the previous threshold.

The German law does not explicitly ban fossil-fuel heating systems, but in practice it would be nearly impossible to meet the new requirements with an oil or gas boiler. This means that people will have to find alternative ways of heating their homes, and heat pumps are one way to achieve this.

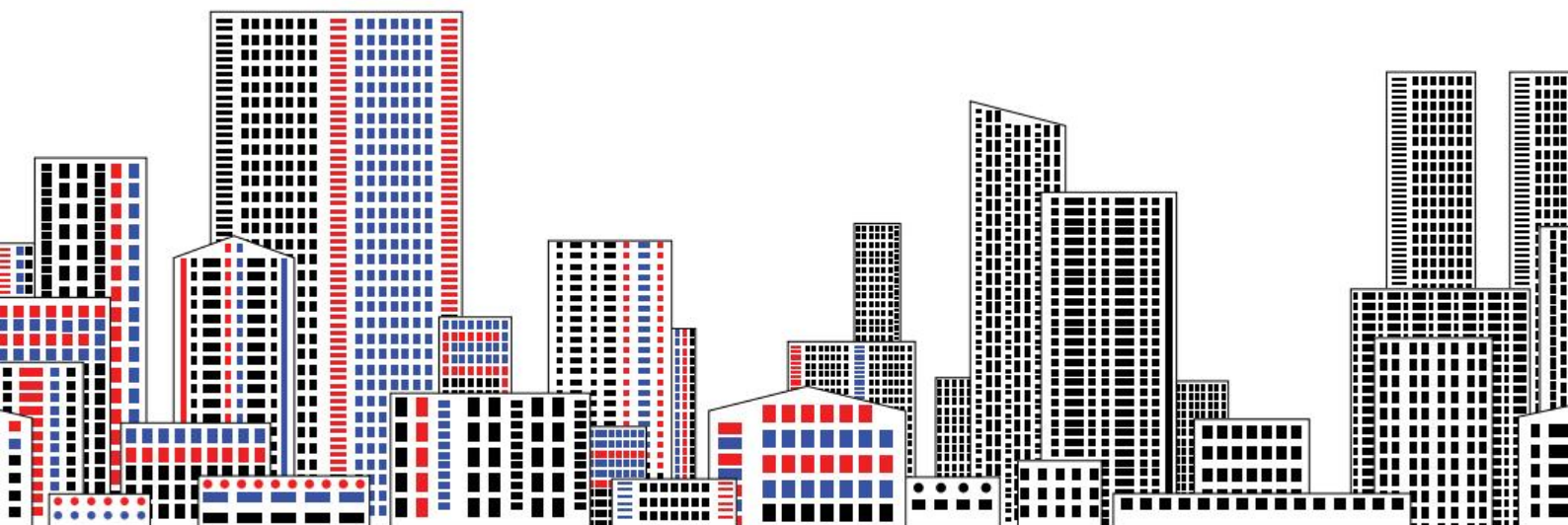
CO₂ OR HYDROCARBONS?

Energy efficiency, carbon reduction and the HFC phase-down, then, will all push the heat pump market towards natural refrigerants, according to Nidec's Boink. "Hydrocarbon technologies bring some challenges, but are totally feasible with the right approach," he says.

At ATMOSphere Europe, Boink shared some data from an R290-based domestic hot water heat pump serving a family of three adults, which replaced an R134a residential unit. Over 12 months, the propane heat pump reduced the heating-up time from 5-6 hours to 2-3 hours. It also delivered 15% less energy consumption and lower noise levels.

CO₂ is also a viable refrigerant for residential heat pumps, according to Georges Khoury of SANDEN Europe. Khoury presented positive results from initial installations and field tests of the company's soon-to-be-launched CO₂ heat pump – the ECONORDIC.

The ECONORDIC, designed for small residential applications, functions effectively in outside temperatures of up to 30°C, has a short payback period of between three to seven years even in refurbishment cases, and complies with all EU safety regulations, said Khoury during ATMOSphere Europe.





While CO₂ technology has long been used in Japan (a country with a 98% market share of CO₂ heat pumps, according to the 'GUIDE Japan 2016', published by shecco), hydrocarbons may have more of an edge in the European heat pump market, argued Pascal Wilmot from Emerson at the European Heat Pump Summit in Nuremberg, Germany.

At the summit, which took place on 24-25 October 2017 and was organised by the same team behind the larger HVAC&R show Chillventa, Wilmot said that in Japan, CO₂ heat pumps tend to be used for providing hot water, whereas in Europe they generally provide space heating.

Propane, according to Wilmot, is more efficient and requires relatively low charges in space heating applications. "Propane [...] has very good properties in terms of compression technology, [...] especially for an air-to-water application," he said.

"So there, you'll see a gain by using propane, just thanks to the refrigerant properties, which is quite interesting," Wilmot said. "You need also less charge in the system, with less charge meaning less cost."

Emerson presented its propane-based Copeland Scroll compressor for both fixed and variable speeds during the summit.

SANDEN Europe's ECONORDIC can also provide space heating and ventilation, and hot water production.

Compressor manufacturer Tecumseh's Anthony Ornatsky agreed that CO₂ is a better option. "To me, CO₂ is the best solution," Ornatsky said.

Besides Emerson, heat pump manufacturer NIBE is also working with R290. Since the early 1990s, NIBE has used propane in its exhaust heat pumps. "We are now developing into further applications with R290 together with [Alfa Laval]," NIBE's Peter Jovic told *Accelerate Europe* at the heat pump summit.

"We think it's the best choice for several reasons," Jovic said. "Thermally it's the best choice, and price-wise it's the best choice."

However, Emerson's Wilmot cites lack of knowledge among the HVAC&R workforce, including end users, installers and maintenance staff, as a current barrier to wider uptake of propane in heat pumps. "The technology is still new for most end users," he said.

LEFT
Kenneth Hoffmann, GEA,
at ATMOSPHERE Europe

RIGHT
Pieter Boink, Nidec
Global Appliance
Germany, speaking at
ATMOSPHERE Europe,
Berlin, Germany

“ We think [propane's] the best choice for several reasons. Thermally it's the best choice, price ways it's the best choice. ”

— Peter Jovic, NIBE

NEW OPPORTUNITIES, OLD CONCERNS

Fears over the flammability of hydrocarbons can also slow down the uptake of propane heat pumps. Wilmot believes such fears are largely unfounded. “The [propane bottle] I have at home for my grill has 13 kg of propane inside,” he said. “That’s huge compared to the 1.5 kg of propane you have in a heat pump.”

Various safety standards also limit the hydrocarbon charge that can be used in heat pumps across the European Union and in individual countries. These charge limits are currently being revised (for more on how hydrocarbon safety standards are being changed to accommodate higher charges of refrigerant, see *Accelerate Europe* #8).

Many others are also looking into hydrocarbons. Vinther Pedersen from the Danish Technological Institute says Danish companies increasingly see propane as an option.

“We have a company developing heat pumps and also manufacturing heat pumps – NILAN,” Pedersen says. “They are developing heat pumps with propane.”

To Pedersen, it’s not so much training, knowledge or safety standards that are holding back uptake of natural refrigerants in residential heat pumps, but rather a question of money. “The main barrier to me is the investment in product development that is required,” he told *Accelerate Europe* at the heat pump event. “To me, training is not the main issue.”

Changes in entrepreneurial behaviour and innovation are also set to favour natural refrigerant heat pumps, but more education and training are needed, argued Bert van Dorp of engineering consultants Witteveen & Bos at ATMosphere Europe.

Van Dorp also called for “a bigger focus on Total Cost of Ownership or Life Cycle Costing approaches”.

Uniechemie’s Van der Hoff called for fiscal measures to support wider uptake of natural refrigerants. “Taxes on energy consumption should be higher and tax breaks on energy savings should be increased,” he said. “With natural refrigerant heat pumps, you have a payback time: it’s not an investment, it’s not testing, it’s a reality.”

While the residential market for natural refrigerants in heat pumps is challenging, large-scale heating projects are proving fertile ground

for ammonia. Industrial heat pump manufacturer Mayekawa’s Eric Delforge, who chairs a European Heat Pump Association (EHPA) working group on industrial and commercial heat pumps, argued at ATMosphere Europe that ammonia is already a growing trend.

“Many others can learn from industrial systems,” Delforge said.

He pointed out that both heating and cooling should be integrated to make this more efficient. “We as manufacturers need to be clever whereby the same cycle can produce heat and cooling,” he said, lamenting that, “for commercial heating and cooling, it’s not the same people making the decisions”.

GEA was also represented at ATMosphere Europe. Kenneth Hoffmann, product manager (heat pumps) at the compressor manufacturer, gave an example of how waste heat from ventilation can be recycled.

In 2017 Islington Council in London, UK installed a 1,000 kW two-stage GEA heat pump in the London Underground. The heat pump turns the waste heat from a London Underground ventilation shaft into useable heat for a high-rise apartment block in the area.



By using two-stage piston compressors it was possible to achieve a heating COP of above 3.5, according to Hoffmann, thus saving the council money. As the project is next to a residential building, the installation includes an ammonia absorber, which filtrates the air from an emergency extract fan to ensure that the extracted air is ammonia-free. This was an essential part of the installation, as more high-rise buildings are planned in the area.

"London is not the only city in Europe with underground trains, so I think you will see a lot more of this type of application in the future," Hoffmann predicted.

Delforge, who outside of his work with the EHPA leads Mayekawa's public affairs team in Brussels, told the ATMosphere audience that low-charge ammonia systems would also increasingly be used.

Speaking at the European Heat Pump Summit, Matteo Munari, product and application development manager at Alfa Laval, previewed a prototype ammonia system for residential applications. The ammonia-water absorption heat pump for domestic heating uses the company's Alfa Nova plate heat exchangers to efficiently supply water at temperatures up to 65°C.

The units can be installed on a wall, taking up a surface area of 500x400 mm with a height of 800 mm, and on the floor with a total surface area of 600x600 mm and a height of 800 mm.

The first working prototype has already been built and results so far have been promising, according to Munari.

The prototype is just one of many heat pumps that will use natural refrigerants in the future. It remains to be seen how quickly the heat pump sector will transition away from HFCs, but innovating with natural refrigerants is clearly one way to get there. ■ CM, MB & EI



1 / Matteo Munari, Alfa Laval, at the European Heat Pump Summit in Nuremberg, Germany
2 / Emerson's Pascal Wilmot at the European Heat Pump Summit

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