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Raising a glass to hydrocarbons

As technology develops, natural refrigerants are cementing their place not just as market-ready alternatives to HFCs today, but also as the future-proof HVAC&R solutions of tomorrow. Hydrocarbons, in particular, are making greater inroads into a variety of applications. Part of this progress can be put down to the commitment of major multinational end users to include greener cooling in their climate strategies.

Heineken is one such company. This edition's cover story looks at how the Dutch multinational brewing giant is adopting hydrocarbons for all its new beer fridges worldwide – and is also harnessing them in draught beer equipment. At the firm's Amsterdam headquarters, we met the duo in charge of this transformation – Graeme Houghton and Hans Donker (p. 24).

Hydrocarbons are also making a difference in the hotel business. The Corbie Ring Hotel in the Belgian town of Lommel has opted for the TripleAqua – a complete heating and cooling system that also stores energy – thanks to its efficiency and environmental credentials (p. 18).

European cash & carry giant the Transgourmet Group, for its part, has opted for a CO₂ transcritical system to provide cold storage at its massive new distribution centre in Hamburg (p. 34).

Natural refrigerants are also taking a growing share of the comfort cooling market. Read our report of the recent Mostra Convegno Expoconfort tradeshow in Milan to discover some of the new technologies on offer in this sector (p. 42).

Our *Accelerate Europe* awards – to be presented at ATMOSphere Europe in Italy on 19-21 November – will recognise the movers and shakers doing the most to drive natural refrigerant uptake in Europe. Turn to [page 58](#) to find out how to submit your nominations.

China also features strongly in this issue. Having already penetrated the domestic refrigeration market, hydrocarbons look ripe for growth in China's light commercial sector (p. 60). The Chinese government, meanwhile, continues to promote NatRefs as alternatives to HCFCs and HFCs. Read more about these trends in our coverage of China Refrigeration 2018 (p. 48) and the ATMOSphere China conference (p. 52) in Beijing.

In Europe's food retail sector, competition between CO₂ and hydrocarbons is becoming more intense as retailers decide which natural refrigerants to adopt as replacements for the HFCs being phased down under the EU's F-Gas Regulation. This issue's Technology Focus looks at the new technologies on offer and hears from the end users that are adopting them (p. 68).

Other innovative companies, meanwhile, are pushing the boundaries of what water can achieve as a refrigerant (p. 74).

Features on Liberty Cold Storage in the United States (p. 38), Italy's progress in implementing the EU F-Gas Regulation (p. 56), and the penetration of hydrocarbons into the U.S. domestic refrigeration market (p. 64) round off our summer line-up.

Enjoy the issue!



ABOVE

Accelerate Europe at Heineken headquarters in Amsterdam.



Andrew Williams
Editor

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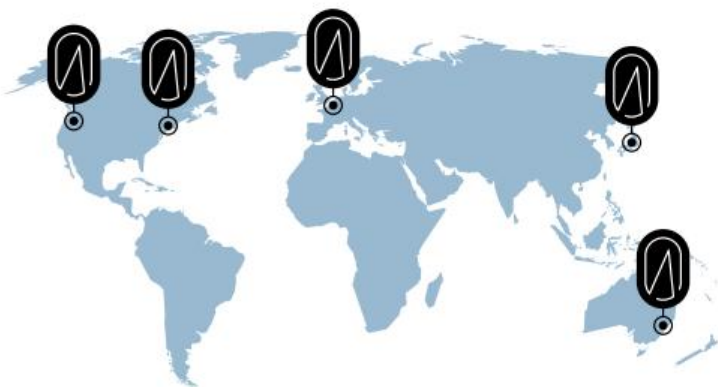
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The *Accelerate* family of magazines includes editions in Europe, America, Japan, and Australia & New Zealand.

Printed copies are available to pick up at leading HVAC&R tradeshows and are posted to key end users and industry professionals.

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// ISSUE #12 *Autumn 2018*

FOCUS:

TBC

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September

// ISSUE #13 *Winter 2018*

FOCUS:

TBC

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December

// ISSUE #14 *Spring 2019*

FOCUS:

TBC

PUBLICATION DATE:

March

// ISSUE #15 *Summer 2019*

FOCUS:

TBC

PUBLICATION DATE:

May



#GoNatRefs



JUN -

27-28/06**interCOGEN & WTT-Expo
Karlsruhe, Germany**

interCOGEN is a central marketplace for cogeneration technology, virtual power plants, and smart energy distribution and control systems. WTT-Expo focuses on industrial heat exchangers and heat transfer technology.



<http://www.ceb-expo.de>



@interCOGEN @WttExpo

05/07**ATMOsphere France 2018
Paris, France**

The day will focus on the opportunities offered for natural refrigerants in France, and will be held in French. Around 100 participants are expected to join.



www.ATMO.org/France2018



@ATMOEvents #ATMOFrance

06-07/07**ECSEE: European Conference
on Sustainability, Energy and
the Environment
Brighton, UK**

Held concurrently with the European Conference on the Social Sciences 2018 (ECSS2018). Keynote, featured and spotlight speakers will provide a variety of perspectives from different academic and professional backgrounds.



<https://ecsee.iafor.org>



@iafor #ECSEE2018

21-24/08**Nor-Fishing 2018
Trondheim, Norway**

Since 1960, Nor-Fishing has been an important national and international meeting place for the fisheries industry. Today it is one of the largest fisheries technology exhibitions in the world, attracting around 15,000 visitors from about 50 countries.



<http://www.nor-fishing.no/pamelding/?lang=en>



@NorFishing #NorFishing

25-30/08**INPAK
Gornja Radgona, Slovenia**

INPAK (the 21st International Fair of Packaging, Packing Techniques and Logistics) is organised simultaneously with the 56th International Agriculture and Food Fair AGRA, attended by 120,000 international visitors.



<http://www.pomurski-sejem.si/index.php/en/agra/about-agra-fair>



SEP -

04-06/09**Sustainable Development & Planning 2018
Siena, Italy**

10th International Conference on Sustainable Development and Planning. The conference will discuss new academic findings and their application in planning and development strategies, assessment tools and decision-making processes.



<http://www.wessex.ac.uk/conferences/2018/sustainable-development-and-planning-2018>



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06-07/09**ColdChain Eurasia
Istanbul, Turkey**

The region's first dedicated cold chain trade exhibition, bringing together professionals who own, lease or manage temperature controlled transport, storage and lifting products and services across a variety of industry sectors.



<https://coldchain-eurasia.com/Home>



@coldchain_expo

05-08/09**Food Istanbul
Istanbul, Turkey**

This trade fair will focus on the Food and Beverage, Food Processing, Storage, Cooling Technologies, Logistics and Store Equipment industries.



<http://cnrfoodistanbul.com/index.aspx?ln=2>



@cnrfoodistanbul #cnrfoodistanbul

10-12/09**Energy Quest 2018
New Forest, UK**

The 3rd International Conference on Energy Production and Management: The Quest for Sustainable Energy aims to discuss the future of energy production and management in a changing world.



<http://www.wessex.ac.uk/conferences/2018/energy-quest-2018>



@wessexinstitute #SustainableEnergy

18/09**ATMOsphere Ibérica 2018
Madrid, Spain**

A forum to discuss the opportunities and challenges of efficient and sustainable solutions with natural refrigerants in commercial and industrial applications, and the latest advances in regulation, standards and market trends.



www.ATMO.org/Iberica2018



@ATMOEvents #ATMOiberica

**18-19/09****39th AIVC conference:
Smart ventilation for buildings
Juan-les-Pins, France**

The context defining the core theme of this conference is the correct functioning of ventilation systems, whether natural, mechanical or hybrid. While experience shows that these hurdles are difficult to pass, they also represent fantastic opportunities for design, method, and product development.



<http://aivc2018conference.org>

EUROPE IN BRIEF

UK government 'failing to enforce' F-Gas Regulation

A report published in April by the UK Parliament's Environmental Audit Committee claims the government needs to do more to implement the new EU F-Gas Regulation, which requires the UK to phase down HFCs by 79% by 2030.

"The government is failing to enforce the regulations surrounding f-gas emissions, particularly on car air conditioning units, while the NHS [the UK's National Health Service] remains reliant on f gas-fuelled [asthma] inhalers despite less damaging alternatives being available," said Mary Creagh, chair of the Environmental Audit Committee and a Labour MP, in a statement.

■ CM

Lidl distribution centre opts for ammonia/CO₂

On 26 March, Lidl opened a new ammonia/CO₂ logistics centre for fruit in Moerdijk, in the West Brabant province of the Netherlands. The cold storage facility will supply 78 national and regional Lidl distribution centres with fruit from the southern Dutch port town, according to logistiek.nl.

The ammonia/CO₂ booster installation has a capacity of 2.5 MW. The facility also functions as a European hub for frozen products.

"[The] new pearl in the field of logistics," said Harm van Oorschot, real estate manager at Lidl Nederland, during the opening.

■ CM

ALDI Süd receives 100,000th Bitzer CO₂ compressor

German retail giant ALDI Süd has taken delivery of the 100,000th Bitzer CO₂ compressor, cementing its position as a pioneering adopter of transcritical CO₂ systems.

ALDI Süd has been investing exclusively in CO₂ transcritical systems for its stores since the beginning of 2006. Thus far 1,350 stores have been equipped with reciprocating compressors for transcritical CO₂ applications.

Erik Bucher, director of refrigeration sales at Bitzer, was on hand to present ALDI Süd with the 100,000th CO₂ compressor to be produced by the company, headquartered in Sindelfingen, Germany.

■ CM

Panasonic CDU hits European shores

Panasonic has developed a new 7.3 kW (10 HP equivalent) CO₂ outdoor condensing unit designed for use in Europe.

The unit, targeted at small-format food retailers, has been available since April.

Already in widespread use in Japan, the system has been tailored for Europe and is available in two specifications: standard and heavy duty.

"While taking full advantage of the abundant know-how cultivated in Japan, we are complying with various regulations and safety standards required in Europe," said the company in a press release.

■ DY & RO

New CO₂ training centre opens in Italy

Offering training on CO₂ since 2013, Italian manufacturer SCM Frigo, part of the Beijer Ref Group, is now stepping up its offer with a brand new centre that shows off the latest technology available in the market.

Starting this spring, the new Beijer Ref Academy will offer technicians and installers the opportunity to learn how to operate CO₂ refrigeration systems in different configurations, from condensing units to complete racks with parallel compression, and the latest generation of ejectors, among other options.

The new centre was officially inaugurated on 21 March at SCM Frigo's headquarters in Veneto, near Padova.

■ AdO

SANDEN to reorganise in Europe

As of 1 April 2018, SANDEN International Europe Ltd., SandenVendo and SANDEN Environmental Solutions are merged into SandenVendo. The Japanese company also announced that heat pump activities will be gradually phased out, in order to make room for this revised strategy.

The move aims to strengthen the firm's Europe, Middle East and Africa (EMEA) assets to focus more on the cold chain and foodservice business.

With a plan to make CO₂ condensing units one of the key growth drivers of the new combined offer, SANDEN expects to service a wider range of sectors.

■ AG



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EUROPE IN BRIEF

Germany in the dock in mobile AC case

In April, the European Court of Justice's (ECJ) Advocate General Paolo Mengozzi released an opinion stating "the Federal Republic of Germany has failed to fulfil its obligations under Articles 12 and 30 of [the MAC] Directive" that requires European Union countries to regulate the use of HFCs in vehicles.

Though the Advocate General's opinion is not binding, the ECJ (based in Luxembourg), agrees with it 67% of the time (from current statistics).

On 10 December 2015, Germany was referred to the ECJ for the government allowing Daimler to use R134a in newly-built car air-conditioning systems.

■ CM

Dairy company reduces NH₃ charge

In 2017, SSP Kälteplaner finished the decommissioning of Swiss dairy company Emmi's old direct evaporation ammonia system and installed a new reduced-charge ammonia cooling system.

The retrofit allowed the company to reduce the NH₃ charge from 3,600 kg to just 750 kg. The firm is best known for brands including Swiss yoghurt drink Benecol, as well as its ice cream, cheese and milk products.

Despite the significant charge reduction, Emmi's logistics facility in Emmen, Switzerland is still able to provide 2,700 kW of cooling power, according to SSP Kälteplaner.

■ CM

Whirlpool sells Embraco to Nidec

In a move that could have widespread implications on the market for light-commercial hydrocarbon-based compressors, the Whirlpool Corporation announced on 24 April it had agreed to sell Embraco – the Brazilian multinational manufacturer of hydrocarbon-based compressors – to Japanese company Nidec for \$1.08 billion (€890 million).

The move follows last year's acquisition by the Nidec Corporation of German firm SECOP, another manufacturer of hydrocarbon-based compressors.

Marc Bitzer, chief executive officer of Whirlpool Corporation, said, "since Embraco operates in the business-to-business space, this transaction enhances our strategic focus on investing in and growing our consumer-facing business".

■ CM

Unilever and M&S go nitrogen

UK retailer Marks & Spencer and Dutch food conglomerate Unilever have both opted to trial Dearman's liquid nitrogen-powered engine and cooling system, both firms have announced.

British firm Dearman's Transport Refrigeration Unit (TRU) is the world's first 'clean-cold' engine driven by the expansion of liquid nitrogen to produce clean power and cold air with zero emissions, according to a press release by Unilever.

Unilever has been trialling it since 2017 and found it reduced carbon dioxide emissions by 600 kg per month compared to a conventional diesel system.

■ CM

Mars' strong NatRef commitment

The Consumer Goods Forum's (CGF) updated 'Refrigeration Booklet', published in April, cites the example of global food manufacturer Mars' commitment to phasing out its use of HFCs.

The CGF, which counts Mars among its members, groups CEOs and senior management of some 400 retailers, manufacturers, service providers and other stakeholders across 70 countries.

100% of Mars' ice cream factories use natural refrigerants like ammonia and CO₂. In 2010 converting to natural refrigerants helped a French plant to reduce its electricity consumption by 26%.

The factory "also delivered a 'sweet result' for consumers in the form of creamier ice cream benefitting from smaller ice crystals," according to Mars.

■ CM

Carrefour's first CO₂ TC convenience store

European retailer Carrefour announced in March that it had installed a full-CO₂ transcritical remote unit at a Carrefour City store in Vannes, Brittany.

This is the first such unit installed in a convenience store by Carrefour. "The opening of the store is a very positive signal for all retailers who are waiting for natural refrigerant-based refrigeration solutions for small shops," said Jean-Michel Fleury, project director at Carrefour.

The mini-booster transcritical CO₂ refrigeration system is a two-stage central unit with 22 kW of medium-temperature (MT) cooling and 2.2 kW of low-temperature (LT) cooling.

■ MB

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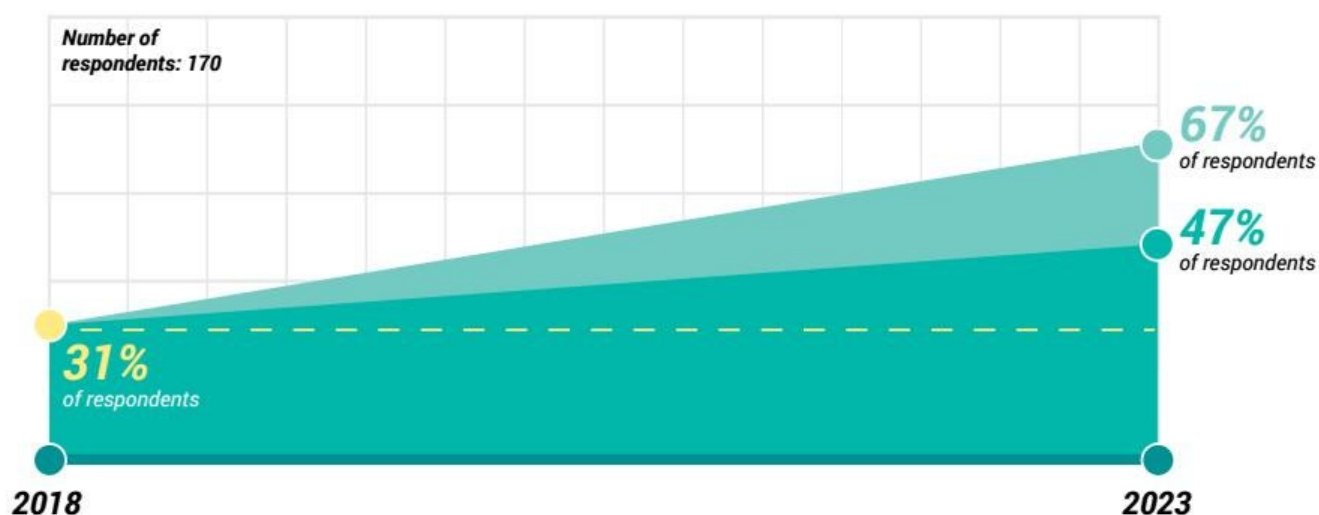
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Impact of standards on hydrocarbon uptake in HVAC&R market

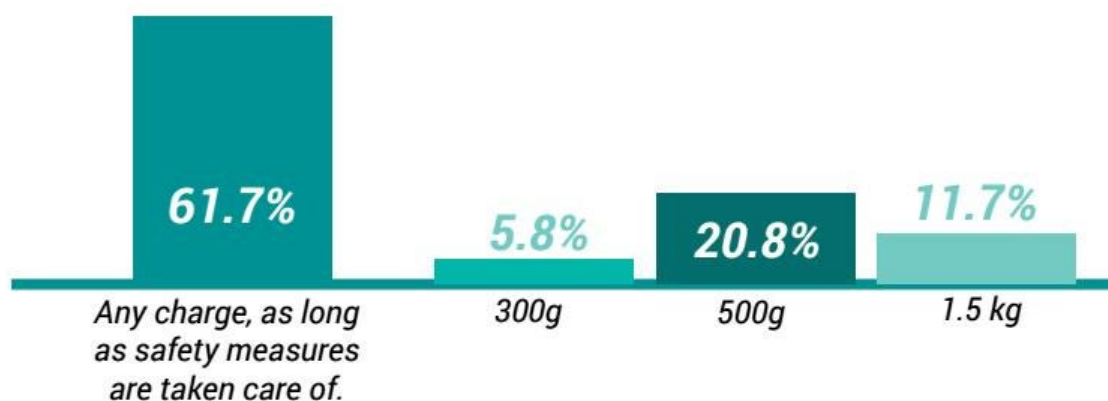
Do you expect the share of your organisation's product portfolio related to hydrocarbons to exceed 25% by 2023?



- Yes, if standards allow higher charges
- Yes, if standards don't allow higher charges
- 31% of respondents said their hydrocarbon share already exceeds 25%

What's the maximum charge limit your organisation would be comfortable working with?

Number of respondents: 154



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Facilitating wider HC uptake...with standards

“As with any standardisation process, progress is not always at breakneck speed on account of detailed investigations and prolonged discussions. But nevertheless, it is expected that over the next few years there will be some major developments enabling wider and safer application of hydrocarbons.”

Throughout the European market, a gradual increase can be seen in the uptake of hydrocarbons (HCs) – primarily R290 – in commercial refrigeration.

This is both in so-called ‘light commercial’ (such as small plug-ins) and larger commercial (such as supermarkets). Broadly, hydrocarbon plug-ins currently represent about one third of the installed population of cabinets, although there is considerable variation across regions and countries. Supermarket installations typically involve water-cooled integrals and sometimes a centralised hydrocarbon (HC) chiller to provide a chilled heat transfer medium, such as water, glycol or brine.

To date there are no known centralised direct expansion pack/rack systems using HCs (and neither are they anticipated).

Although remote/condensing unit systems have been toyed with, their population is negligible. Such systems raise concerns due to uncertainty over leakage indoors and similarly their much larger charge size due to long pipe runs.

Regulation, end users driving uptake

The EU F-Gas Regulation has augmented current interest in HCs, although that is not to neglect the steady rise in use previously driven by end users’ desire to reflect their intention to be environmentally friendly; a good example of this is the activities of the Refrigerants, Naturally! members.

In parallel, there is increasing availability of system components, especially compressors, which is a major key to greater acceptability.

Previously cost – or at least perceived costs – was considered to be a major barrier, but as the technology has become more mature and clever ways of resolving the economic implications have been found, the incremental cost compared to conventional HFCs has lessened. The increasing price of higher GWP refrigerants has assisted this, thus going beyond parity and turning the now reduced cost into a driver in many cases.

Whilst carbon dioxide (R744) presents the most significant ‘competition’ to HCs in commercial applications, there is also increasing awareness of the potential use of ‘medium’ and ‘lower’ GWP HFC mixtures, such as those comprising unsaturated HFCs (R1234yf, R1234ze(E)) as well as R152a and R32, plus a dash of R744 and some HCs. All of those with a medium-to-low GWP remain flammable (A2 or A2L), and initial testing and simulations indicate that the efficiency falls short of the state-of-the-art baselines: HCs and R744. The main challenge, however, is that there are so many options on the table (at least 20 and rapidly growing) that the R&D challenge for system and compressor manufacturers is considerable; not to mention the possible obsolescence of most of the options.

It seems to be a clear trend amongst most manufacturers that the natural options are the only serious contenders.

Barriers to wider use

The main barriers to wider uptake of HCs at present may be grouped into stakeholder safety concerns, applicable to both product and servicing safety. Note that 'concern' may be deemed to be the barrier, rather than the flammability hazard itself. Within this category, flexibility of safety standards is arguably the primary barrier, where restrictive standards not only inhibit uptake through limits to charge amounts and associated costs but also impose doubt on manufacturers' consciousness. Of course it is healthy to adopt a precautionary approach, but this must be balanced against the 'real' flammability risk as well as thorough training and good manufacturing processes.

There are no European-level legal restrictions concerning the amount of HC charged into systems, either in the Machinery or ATEX Directives. Whilst certain safety standards do impose charge limits, such as 150g, 1,500g and 8g/m³ of room volume, they do not represent legal constraints. Whilst EN 60335-2-89 is a harmonised standard (inferring it provides a presumption of conformity to EU directives), it is not a legal requirement. Anyone placing a product on the EU market has the option of demonstrating the safety of their product according to the applicable directives, thus only requiring good safe design and demonstrating that no adverse risk is presented.

Justifying exceeding these standardised charge limits is of course potentially daunting for companies that are either not specialists in such tasks or fear the potential consequences of taking a wrong step; it is easier to keep the comforting duvet wrapped around them.

Whilst charge size limits pose certain problems, the EU directives nevertheless pose potential complications in other respects in terms of the need to demonstrate conformity to the requirements of, particularly, ATEX. Trying to follow and interpret the essential health and safety requirements (EHSRs) can be challenging for those outside industries that are used to handling flammable gases. Added to this is the fact that the (refrigeration) safety

standards do not reflect many of the requirements and in some cases in fact conflict with ATEX. Thus a thorough effort to adhere to and document compliance with ATEX is the most sensible action to take.

Having said that, there are activities underway to revise and improve safety standards. At international level, IEC SC61C WG4 has developed a new draft for IEC 60335-2-89 which should permit up to about 500g of propane (R290) in commercial appliances. This proposal is currently at committee draft for vote (CDV) stage and if there is enough support it should be adopted; eventually it will (should) become EN 60335-2-89.

At the same time, in Europe, CEN TC182 WG6 is substantially revising EN 378, which will include major improvements for HCs. In addition, there are additional activities at European level under CEN TC 182 WG12, which is specifically investigating improved safety requirements for flammable refrigerants, with particular attention to HCs, in response to a mandate from the European Commission.

As with any standardisation process, progress is not always at breakneck speed on account of the detailed investigations and prolonged discussions. But nevertheless, it is expected that over the next few years there will be some major developments enabling wider and safer application of HCs.



Dr. Daniel Colbourne

is a member of various European, IEC and ISO safety standard working groups and the UNEP RAC&HP Technical Options Committee under the Montreal Protocol.



The Corbie Ring Hotel, Lommel, Belgium.

Photography by: Charlotte Georis

A SUSTAINABLE BELGIAN HOTEL, THANKS TO HYDROCARBONS

The Corbie Ring Hotel in Lommel, which officially opened its doors in February 2018, opted for the TripleAqua – a complete heating and cooling system that also stores energy – thanks to its efficiency and environmental credentials.

– By Charlotte McLaughlin

The Belgian town of Lommel – a jewel of the Flanders region – is rich in the quartz sand that forms the basis of the high-quality glass for which the area is famous. It is also home to the largest solar park in Belgium, which produces energy for over 24,000 households in the region.

The town now has another claim to fame – the Corbie Ring Hotel, arguably the most sustainable hotel in Belgium. During construction of the hotel, which is now partially open, the owner opted to install the TripleAqua: an energy-efficient heat pump employing natural refrigerant propane (R290), a hydrocarbon, with a global warming potential (GWP) of three.

“This is the most sustainable hotel in Belgium thanks to the TripleAqua,” Bart Beerten, owner of HVAC contractor Willems-Diels – which installed the unit at the Lommel hotel – told *Accelerate Europe*.

1 / Bart Beerten, Willems-Diels (l) and Filip Van Hulle, ECR Belgium (r).

2 / The hotel's breakfast area.

3 / Ventilating the hotel.

Jan-Baptist Koch, the hotel's owner, nods in agreement. He has a passion for sustainability, and has even installed solar panels in his home. "We asked [Beerten] to look for a good technique to put savings in our pockets, of course, [and one which] is environmentally sound."

Koch is also owner and manager of two other Corbie hotels – one in Lommel and one in Mol, where his parents first started the business. A further Corbie hotel is run by his sister Pauline Koch, who is also an artist and is responsible for the design and decoration of the Lommel Corbie Ring hotel, which incorporates the local area's high-quality glass in its aesthetic.

The hotel has 27 hotel rooms and 20 business flats, with a small reception area and a breakfast area. It generally caters for business guests.

The TripleAqua, an invention of *Accelerate Europe's* 'Person of the Year' for 2017 Menno Van der Hoff (head of R&D and HVAC manager at Uniechemie, a division of Swedish HVAC&R distributor Beijer Ref), is an outdoor 113 kW unit. It has been placed on the roof of the hotel.

The unit provides the hotel's entire space heating and cooling throughout the year. It is connected to 54 internal HVAC units and a floor heating circuit, allowing guests and staff to adjust the temperature in individual rooms and common spaces according to their needs.

Van der Hoff explains, "this the perfect place to install it, as hotels have different customers with very different needs. One may wish to heat, another may want to cool".

"This is the first TripleAqua in Europe in a hotel," he says. "I am convinced that this application will take hold."

Many ideas, one solution

In choosing the right heating and cooling system in the hotel, HVAC engineer Beerten – who has run the Willems-Diels business with his wife since taking it over from his father-in-law over 20 years ago – went through several options.

Knowing he needed an environmentally sound, cost-effective and long-lasting solution, "the market is getting to more environ-

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3/





1/

mentally friendly [solutions]. People expect long-lasting and ecological" products and places to stay, Koch told *Accelerate Europe*.

Most hotels install a boiler and a separate VRF split air-conditioning (AC) system that traditionally uses high-GWP HFCs. The heat in the other Corbie hotel in Lommel, with solar panels on the roof, is produced by solar energy. Beerten installed that hotel's HFC-based VRF AC system only later, as air conditioning was not as popular in 2005 when the hotel first opened.

"With VRF you need multiple copper piping and leak detectors in every room," Beerten explains. "[With the TripleAqua] water just goes through, also in the underfloor heating" – a simpler design for the installer, he argues.

"I also explained [to the owner of the hotel] that f-gases will be more expensive in the future," he adds. "Prices of R410A are increasing."

He first met Van der Hoff at an HVAC&R show where the latter was exhibiting the TripleAqua. He approached Filip Van Hulle, sales manager at ECR Belgium (part of the Beijer Ref Group) – who is responsible for TripleAqua sales in Belgium – to discuss various sustainable HVAC&R options.

Van Hulle proposed the TripleAqua, to produce all the building's space heating and cooling in combination with a condensing water heater to produce

hot water as an extremely energy-efficient solution. The other option was to install a separate heat pump to provide hot water to serve the hotel's entire demand, including the showers.

Beerten also looked at integrating solar energy into the hotel's energy picture. In the end he decided on the TripleAqua together with a separate condensing water heater for hot water production, with no solar panels because the heat pump takes up too much space on the roof. The solar park and wind turbines close to the town serve the hotel's energy needs.



2/

1/ Hotel owner Jan-Baptist Koch and ECR Belgium's Filip Van Hulle converse alongside the TripleAqua.

2/ Guests can regulate the temperature in their rooms.

3/ The TripleAqua was installed on the hotel roof.

3/





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Hotel owner Jan-Baptist Koch

▶ According to Beerten's calculations, the current setup was the best option, as space heating and cooling is generally responsible for the majority of a building's energy consumption. It also had the highest payback for the end user and was the most environmentally friendly solution, Beerten argues.

For Koch, trust played a key role in following Beerten's recommendations. "I looked over it and said [to Beerten], if you say this is the best option, I will go for it," he said.

The return on investing in the TripleAqua will be four years, according to Van Hulle. Beerten has made a theoretical calculation comparing it to his work in the other Corbie hotel, where he installed a different heating and cooling system. "It's [around] 50% more efficient," he told *Accelerate Europe*.

Beerten also praises the uniqueness of the system. "We can take heat from the south [which has glass windows that warm up the reception area] and [redistribute] it to the north side," which does not get as much sun during the colder winter months.

"We [also supplied] the hotel [with a balanced] ventilation system," Beerten says. In a balanced ventilation system, a network of ducts throughout the building supplies air to vents in each room without the different airflows crossing each other and recovers air through a heat exchanger.

"This allows us to recover warm air during the winter and cool air during the summer," Beerten says. Also, "during the winter the water is stored for later heating [in the system] and can also be used later as heat," he notes.

An important aspect of the system is its low-temperature lift. Most heating systems use radiator pipes at temperatures of up to 70°C, according to Beerten, but rooms can be heated efficiently with under-floor water pipes at lower temperatures.

The TripleAqua generally heats and cools the three water pipes to return ambient temperatures ranging from 28-36°C and 12-16°C.

"We told [Koch] to keep the rooms at 18°C" as standard, and then let the customer change the temperature through a small panel in their room to what they want," Beerten says.

This system is not the only environmental technology employed in the hotel. Beerten recommended collecting rainwater to use in the toilets and elsewhere.

Another installation?

Koch is also expanding the family business: "We [may start building] a new hotel in the summer." The TripleAqua could also be installed there. Koch has been pleased with it so far and plans to add a page on the system's environmentally friendly credentials to the hotel guide that he is writing.

"We will convince them to install the TripleAqua [again]," Beerten says. "We think it's the best solution for a hotel."

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Hans Donker (l) and Graeme Houghton (r),
HEINEKEN Global Procurement

Cheers to a greener world!

Convinced of the role that natural refrigerants can play in reducing its carbon footprint, Dutch multinational brewing giant Heineken is adopting hydrocarbons for all its new beer fridges worldwide. *Accelerate Europe* reports from the company's global headquarters in Amsterdam.

— By Andrew Williams

An important stop for many visitors to the bike-mad city of Amsterdam is the canal-side brick structure that housed the original Heineken brewery, which closed in 1988 and is preserved as the Heineken Experience. Founded by Gerard Adriaan Heineken in 1864, today Heineken is the second-largest brewer in the world by revenue. It operates more than 170 breweries, malteries, cider plants and other production facilities in over 70 countries and its beers are available in 192 nations.

The firm – whose brands include Heineken, Amstel, Strongbow, Red Stripe and Bulmers – is proud of its long history at the forefront of innovation.

In 1886, for example, Dr. H. Elion – a pupil of French chemist Louis Pasteur – developed the 'Heineken A yeast' in the firm's laboratory. The yeast remains the most important ingredient in Heineken beer to this day. During his tenure from 1917-1940, meanwhile, the founder's son Henry Pierre Heineken developed transformative techniques to maintain consistent beer quality during large-scale production.

Today, a team of modern-day pioneers are proud to be following in the footsteps of their innovative predecessors. In 2010, Heineken CEO Jean-François van Boxmeer gave his team the target of reducing the energy consumption of beer fridges. Thus began Heineken's hydrocarbon journey.

Accelerate Europe was at Heineken's Amsterdam headquarters next to the former brewery to meet

“We've got to the point where the green way – with hydrocarbons – is an accepted part of the Heineken way of life. And it's reflected in our logo!”

— Graeme Houghton, Heineken

two of the people responsible for making this vision a reality – Graeme Houghton, Global Category Leader – Commercial Equipment & Servicing, HEINEKEN Global Procurement and his colleague Hans Donker, Global Category Buyer – Fridges & Draught Beer Equipment.

“I got the briefing, ‘you need to buy green fridges’. That's what we said, so I asked, ‘what's a green fridge?’ It took them a few months to say, ‘best in class’. That wasn't very specific,” recalls Donker.

“So we thought about it ourselves, and we said, ‘a green fridge is a fridge that has a hydrocarbon refrigerant, LED illumination, and a smart thermostat (energy management system)’,” he says.

Once the decision had been taken to opt for hydrocarbons, things moved quickly.

“A letter was sent out by our corporate affairs director to the regional presidents of Heineken saying, ‘we need to buy green fridges’,” Donker says. “It said, ‘if you don't understand, call Hans!’ I've still got the letter somewhere.”

“In that first year, we saved 30% on energy consumption,” he adds.

A resident of Eindhoven, Donker has enjoyed a long and varied career in several different sectors, ranging from plant heating to X-ray design. He first entered the brewing industry as a technical manager working on innovation. “Then I moved to Heineken – I've been here eight years,” he says.

'Drop the C'

Heineken's overall climate strategy is driven by the 'Drop the C' programme, which aims to “significantly reduce” carbon

“We adopted hydrocarbons for two reasons – one, because they help to deliver the energy efficiency that we want; and two, because of their significantly lower GWP.”

– Graeme Houghton, Heineken

emissions across the business. By 2020 the company is targeting 40% lower emissions from production, 50% lower emissions from fridges, and 20% lower emissions from distribution in Europe and the Americas.

Conscious of the private sector's responsibility to cut emissions and help lead the transition to a low-carbon and climate-resilient economy, in 2018 Jean-François van Boxmeer joined the Alliance of CEO Climate Leaders, an informal network of CEOs committed to climate action facilitated by the World Economic Forum.

In early 2018, 'Drop the C' was extended to renewable energy, with the target of growing renewable energy usage to 70% by 2030.

Surpassing the 2020 commitment, Heineken achieved a 41% reduction in relative CO₂ emissions in 2017 (2016: 37%). Emissions have also decreased in absolute terms; even though production volumes were 57% higher than in 2008, emissions were down 7%.

This was primarily achieved by improving breweries' energy efficiency, using more renewable energy, and replacing high CO₂ fuels with lower-emission alternatives.

Putting sustainability at the heart of its business model, Heineken sets itself various targets under its 'Brewing a Better World' strategy.

The brewing giant is continuously introducing more renewable energy sources into the production energy mix; 29% of Heineken's electrical energy and 7% of its thermal energy came from renewable sources in 2017 (2016: 25% and 5%).

For production Heineken has set new targets for 2030: growing the share of renewable energy from 14% in 2017 to 70% by 2030, implying an 80% reduction in emissions per hl compared to 2008.

Proud to be green

Targeting 50% lower emissions from fridges by 2020, Heineken provides 'green' fridges whenever a fridge needs replacing and tests fridges against the Heineken Energy Efficiency Index (HEEI).

The brewer defines green fridges according to the following four principles: the use of hydrocarbon refrigerant, LED illumination, an energy management system, and energy efficient fans.

"We discovered hydrocarbons as part of our 'Brewing a Better World' programme. We adopted them for two reasons – one, because they help to deliver the energy efficiency that we want; and two, because of their significantly lower GWP compared to the existing refrigerants we used in our fridges," Houghton says.

"So that was the pairing of it. We work with a number of cooling partners. We use an independent cooling advisory group, which helps us with the technology side of things, plus our cooling partners – the fridge manufacturers," Houghton says.

To facilitate the optimal serving of Heineken and the other brands, whether in cans, bottles or draught, the company itself provides the infrastructure. "In the majority of cases, we own the fridges and draught beer equipment. We place it with our customers to help them serve the perfect Heineken," Houghton says.

Currently a resident of Amsterdam, Houghton's Heineken career began in his native UK, where he was responsible for procuring draught beer equipment. "Six years ago now, I moved to the centre to cover that globally," he says.

He became leader of the team that manages both draught beer and fridges a year ago.

In 2017, almost 100% of the 137,818 new fridges Heineken bought had one or more (and in many cases all four) green features. CO₂ emissions per fridge were 48% less than in 2010 (2016: 46%). Since the beginning of 2018, 100% of the fridges Heineken is purchasing are 'green'.

"Because of the lifecycle of fridges, which we expect to be around about eight years, we anticipated that in order to reach our target in 2020, we needed to start immediately," Houghton says.

The company started to use fridges based on hydrocarbons in 2010. "We expect that by 2020, the majority if not all of our fridge population will be green, with natural refrigerants," Houghton says.

"It's a lifecycle thing. The policy is 'all new fridges'," he explains.

Adopting natural refrigerants is helping Heineken to improve the energy efficiency of its fridge portfolio. "When we started, we made enquiries with our fridge suppliers, asking them how many energy savings introducing hydrocarbon refrigerant, LED illumination, and a smart thermostat (energy management system) would deliver," Donker says.

"They said, 'if you do hydrocarbons, you'll get 7% more efficient fridges; if you do LED, you'll save 15%; and the energy management system gives another 15%'. That's how it was described to us," he explains.

"It's about the overall tuning of the system, all of the components coming together to produce energy savings," adds Houghton.

From Amsterdam to the world

With operations in so many countries, Heineken is mindful of the large contribution that adopting greener cooling practices can make to reducing its overall climate impact.

"Cooling is a significant part of our CO₂ footprint. We've got over a million fridges out there in the field. We're reducing their energy consumption by half," says Donker.

The two are responsible for procuring Heineken's fridge fleet worldwide. "We have the power to change things. It takes time, model-by-model and area-by-area, until it becomes standard," Donker says.

"We buy roughly 140,000 fridges a year," says Houghton. "All the fridges we buy are hydrocarbons. We're on a journey. It's about changing our entire fleet."

"The average lifetime of our fridges is about eight years, and we're currently about eight years in. So if you do the maths – allowing for a bit of a dropout rate, it's probably fair to say that we have about a million fridges in the market with natural refrigerants," he estimates.



ABOVE
The Blade

BELOW
The David XL Green
Heineken's propane-based
draught beer dispensers
(see p. 28).



Asked whether it is more challenging to adopt hydrocarbons in some parts of the world than others, Donker replies: "Europe was easy."

Mexico, for example, took a little more time. "We are a big player in Mexico. We told the supplier that we wanted to change to hydrocarbons. One of the questions that surrounded hydrocarbons was their servicing," Donker says.

"It took our supplier two years to completely switch over Heineken Mexico to hydrocarbons, including servicing," he says.

Houghton is pleased with the positive impact that his work is having on the environment. "We can be very proud that we're almost at 50% [less CO₂ emissions from fridges today compared to 2010] in such a short period of time," he says.

The firm's use of natural refrigerants is not restricted to fridges. Since 2012, all Heineken's new draught beer dispensers in Europe have used hydrocarbons (and in Mexico since 2014).

The European Union's new F-Gas Regulation, which entered into force in 2015, aims to reduce HFCs by 79% by 2030, as compared to average levels in 2011-2013. To help deliver this target, it is progressively banning the use of certain HFCs in different types of new equipment. In 2022, for example, bans on using certain HFCs with GWPs above 150 in new centralised and plug-in commercial refrigeration equipment will come into effect.

In October 2016 in Rwandan capital Kigali, meanwhile, the world adopted a Montreal Protocol amendment limiting the production and use of HFCs.

For Heineken, these developments serve to confirm that the firm is going in the right direction. Yet Donker is keen to stress that the firm first embarked on its natural refrigerants journey long before Kigali entered the HVAC&R lexicon.

At Heineken, the primary motivation for the firm's hydrocarbons policy came from within. "The driver for us was not regulation. It was our CEO, who made the statement that we want green cooling," Donker says.

"That gave us the licence to operate. So that's when I asked, 'what's green cooling?' They didn't know precisely, so we specified. And that's when it all began," he says.

Economics were also a driver. "If you switch in good time to the refrigerant that's here to stay, then you can still repair those fridges," says Donker, whereas "if you buy a R134a fridge now, then you'll have an issue in the years to come".

"It's about making the smart choice," he says.

Some users of HVAC&R technologies are adopting HFOs, the new generation of synthetic refrigerants, as a means of complying with the HFC phasedown. Did Heineken also consider going down that road?

"I looked at HFOs, but they're mixed gases," says Donker. "In my experience, mixed gases make life difficult."

"Frankly speaking, I don't think HFOs are here to stay," he says.

Heineken's decision to use proprietary technology is an integral part of its wider strategy for reducing its carbon footprint. The company works with different fridge suppliers around the world.

The Blade – Heineken's latest draught beer dispense innovation – has a keg volume of eight litres and is capable of chilling beer to 2°C, delivering beer at 3°C in the glass. It uses isobutane (R600a) as the refrigerant. "It's already live in selected markets and will go further," Houghton says.

The propane-based David XL Green draught system, meanwhile, stores and chills 20-litre kegs in a fridge directly below the counter so the beer does not have to travel far to the tapping point. Over 12,000 of the systems have

been installed in 25 markets across Europe, Africa & the Middle East, Asia and the Americas.

David XL Green (double tap of beer) is the line extension of David Green (single tap of beer), the world's first 'green' draught beer system. Last year Heineken celebrated placing its one hundred thousandth David Green on the market.

"It's about deploying the right equipment in the right outlet, and applying the right technologies to make sure you're as efficient as possible," Houghton explains. "It's a holistic approach."

What challenges has Heineken faced in adopting hydrocarbon-based fridges and draught beer equipment?

"It was quite a smooth process. The apprehension, and the pushback from some of our markets, was that this is different technology," Houghton says. "We sometimes see this resistance when we introduce new technologies."

Hydrocarbons vs. CO₂

The Coca-Cola Company, another beverage giant, initially opted for CO₂ – another natural refrigerant – over hydrocarbons for its beverage coolers and vending machines before later deciding to use hydrocarbons as well.

"Coca-Cola knocked on our door and said, 'do you want to join us?' Whereas we add around 140,000 fridges a year, Coca-Cola buy around one million per year," Donker says. "So this was a difficult consideration to make."

So what motivated Heineken to choose hydrocarbons from the start?

"What we've heard is that CO₂ has higher working pressures and is less efficient," Donker says, adding: "The only benefit it has over hydrocarbons is that it's not flammable."

"We stuck to our hydrocarbons programme, and now, five years since they started with CO₂, Coca-Cola is also going to hydrocarbons," Donker observes. "We made the right choice."

HEINEKEN AT A GLANCE

Selected brands

★ Beers:



★ Craft & variety



★ Ciders:



Sustainability highlights



29%

Decrease in water consumption (hl/hl) in breweries since 2008



41%

Decrease in carbon emissions (kg-CO₂e hl/hl) in breweries since 2008



42%

of Heineken's agricultural raw materials used in Africa and the Middle East sourced locally.



300

Beer & cider brands

Established in



1864

by the Heineken Family



80,000

Employees



70

Countries

Highlights from 2017 Annual Report:



218.0 mhl

Consolidated beer volume



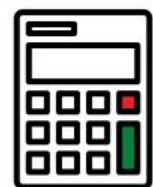
36.0 mhl

Heineken volume



€21.908m

Revenue



€3.759m

Operating profit

Today, Heineken uses hydrocarbon equipment all over the world. "At first we didn't do it in Central Africa," Donker says. "We assessed the risk and we didn't want to introduce hydrocarbons there. But we have done so now."

Initially, the maturity of the service organisations posed challenges in some parts of the world.

"It was a gradual thing. Europe was phase one, in terms of the maturity and pushing this through, followed by the Americas," Houghton says.

"Asia and Africa followed afterwards. We were familiar with the suppliers present in those markets from working with them in Europe and the Americas, but they took time to develop the service agents who could look after the equipment," he explains.

The equipment suppliers themselves provide Heineken's customers with training on how to work with hydrocarbons.

"We went through a change process, to get our clients and our sub-contractors on board," Houghton says. "We were pleasantly surprised by the robustness of the technology.

We've had no misery. It proves that we've done the right thing."

"It's been a great story for everyone," he says.

For light commercial refrigeration equipment, the International Electrotechnical Commission (IEC) is expected to formally increase the hydrocarbon charge limit to 500g in standalone equipment in the framework of IEC SC61C WG4.

"What's stopping us from going further is the charge limitation of 150g. Above a certain cooling power, 150g is not enough," says Donker.

"The first double-door fridge we bought had two 150g systems inside. Of course that's not very economical, but it is green. That's how we started," he recalls. "In the meantime, cooling systems have become more efficient and you can produce more cooling power from the same 150g charge."

"We would have moved sooner in some countries if the hydrocarbon regulation were up to European standards," Houghton concedes. "Now, we're not really asking anything of anyone. We've still got some way to go, so we need to get bigger cooling power. We're looking at new innovations to deliver the cooling we need without compromising too much on performance or cost."

For any business, cost effectiveness plays an important role in deciding which technologies to adopt. "We've absorbed the cost of getting to this point so far. We need to come to good solutions, but we're almost there. Technology is catching up," Houghton says.

"I don't think I have anything to ask of legislation," he adds.

Does Heineken want to be recognised as a global driver for natural refrigerants? Houghton replies with an emphatic, "yes".

In some countries, Heineken puts stickers on its fridges hailing the progress it has made in improving energy efficiency – '70% less energy, 100% fresh beer'.

The company shares the progress it is making on its natural refrigerant journey in its annual reports, but not to customers. "Our customers just want cold beer, and in many parts of the world, cold bottles of beer. They don't necessarily think about the process that goes into doing that," Houghton says.

As a global company, Heineken is aware of the responsibility it shares to reduce the environmental impact of making cold beer available the world over. "We know our carbon footprint, and we're actively trying to reduce it," Houghton says.



All Heineken's new beer fridges use hydrocarbons.





The original Heineken brewery in Amsterdam, now home to the Heineken Experience Museum.

Looking to the future

With so much progress already made, what motivates Houghton and his team to push ahead with each new day?

"I like to visit the mountains, and I want to make sure that there's some snow left for me to enjoy!" says Houghton with a smile.

His efforts to reduce environmental damage extend to his personal life too. "Here in the Netherlands I have a bike. I haven't had a car for six years," he says.

Houghton's colleague Donker, meanwhile, has a hydrocarbon fridge at home. In building his house back home in Eindhoven, he worked hard to install an efficient heating system and the best possible insulation. "I've got two kids. One day the world will run out of oil. We need to find alternative energy solutions," Donker says.

What's next for Heineken?

"We're up to date regarding the latest technologies and the latest thinking for how we can achieve our targets and push ahead," Houghton says.

Yet the company continues to push boundaries in order to maximise energy efficiency. In Mexico this year, for example, "we launched fridges with variable-speed compressors, which we'd never done before at Heineken, in order to achieve that next step," Houghton says.

"We need to know where the next energy efficiency boost will come from, and we look to the market for the latest innovations that will do that," he explains.

Houghton does not see major differences between doing business in Europe and elsewhere in the Heineken universe.

"Other than the speed of change and the speed of adoption, it's pretty much the same. We're one of the few global departments in a very decentralised company," he says.

"It's about persuasion and about commitment from the top. This came from CEO, which helps, because then it's on everyone's radar," Houghton says.

"We've got to the point where the green way – with hydrocarbons – is an accepted part of the Heineken way of life. And it's reflected in our logo!" he grins. ■ AW



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Hamburg home to Transgourmet's largest CO₂ transcritical system

The 2 MW CO₂ transcritical system was installed to provide cold storage at a 120,000 m³ distribution centre.

– By Charlotte McLaughlin

ABOVE
Hamburg logistics centre.

RIGHT
CO₂ rack by Advansor.

European cash & carry giant the Transgourmet Group sees natural refrigerant technology playing a central role in delivering its goal of becoming CO₂-neutral by 2023.

"We have been set a target by our shareholders. We have to be CO₂-neutral by 2023, across the whole Transgourmet Group," Hans-Dieter Bruss, a vice-president in the group's Central and Eastern European arm, which operates cash & carry and wholesale stores in Germany, Poland, Romania and Russia, told *Accelerate Europe* in 2017 ([see cover story, autumn 2016 edition](#)).

Transgourmet Central and Eastern Europe is part of the wider Transgourmet Holding AG, which also includes business divisions in France and Switzerland. Together, Transgourmet Holding AG is the second largest cash & carry and food service company in Europe.

The group is adopting CO₂ for all refrigeration, air conditioning and heating applications, not just in new and updated stores but also in distribution centres. These projects include the large distribution centre in Hamburg – which began operations in May 2018 – and local distribution centres in Polish capital Warsaw and the city of Bistrita, Romania.

"CO₂ is an excellent alternative to ammonia, particularly in small and medium-sized distribution centres," Bruss argues. He is confident that the decision to opt for CO₂ over ammonia for warehouses will deliver energy savings to the tune of at least 20%.

In the facility

The Hamburg distribution centre represents another step on that journey. The installation, which was commissioned in March 2018, employs four CO₂ transcritical racks from Advansor to deliver 2 MW of cooling power.

"Transgourmet's refrigeration facility in Hamburg is one of the biggest, or even the biggest, transcritical CO₂ installation used in a logistics application in Germany," Kristian Nakladal, project manager at Swiss refrigeration and engineering company Frigo-Consulting International Ltd., told *Accelerate Europe*. Frigo-Consulting has been helping the Transgourmet Group to make the transition to natural refrigerants for four years now.



The 20,000 m² logistics centre and administration building located in the port of Hamburg has roughly 5,265 m² of refrigeration and 5,527 m² of deep-freezing warehouse space. It also contains 9,000 m² of non-refrigerated space.

The facility operates as a hub for Transgourmet's north German stores and receives goods from Europe and Germany. Many of these stores are likely also to be cooled with CO₂.

"Whatever the project or application, we first check the feasibility with CO₂. We try to apply CO₂ in every store and country, but we must always consider local circumstances like availability of spare parts, infrastructure, and existing know-how about CO₂," says Transgourmet's Bruss.

Though Bruss has acknowledged there is not yet a precise timetable in place for delivering the transition away from HFCs, he has stated that the Transgourmet Group's goal is to become HFC-free "in the near future".

"We're trying to change four, five or six installations to CO₂ every year," he says. At this pace, will the Group achieve its goal of becoming CO₂-neutral by 2023? He answers with an emphatic "yes!"

Currently the group has 30 stores using CO₂ transcritical systems.

Ejectors – a major boost

At the logistics centre, the wholesale giant has not been afraid to work with new technology like ejectors. "The challenge of this project was the system's newness with regard to the ejector technology. It is actually the first one of its kind, and works with a new type of [medium-temperature, six-cylinder] compressor," says Frigo-Consulting's Nakladal.

Ejectors are known to dramatically extend the scope to use CO₂ as a natural refrigerant across the spectrum – from smaller convenience stores to large supermarkets – by helping to overcome the so-called 'CO₂ equator'.

The CO₂ equator refers to the previously accepted geographical limit for cost-effective and efficient performance of CO₂ systems in all food retail store formats. The devices can also improve the efficiency of refrigeration systems by up to 40% ([see *Accelerate Europe*, winter 2016 edition for more](#)).

Two vapour and one liquid Danfoss ejector blocks were installed in each

CO₂ rack by Advansor.

of the four CO₂ booster rack systems at the Hamburg logistics facility.

Ejector technology has been thriving in Europe thanks to the energy savings it promises. A study, supported by the Swiss Federal Office of Energy (SFOE) and published in 2017 by the German magazine *Kälte Klima Aktuell*, reports that, "according to estimates, several hundred [CO₂] ejector systems are currently in use, the majority of which are in Europe".

Coop, Switzerland's second-largest retail chain and the parent company of Transgourmet, has also opted to use ejectors, according to the study. "Refrigeration needs in food markets account for about half of the electricity consumption, which is why the ejector makes a significant contribution to the reduction of energy consumption," said Thomas Häring, head of energy and technology at Coop, in the report.

Transgourmet itself also has previous experience of using ejectors. "We have already put several transcritical CO₂ refrigeration systems with ejectors into operation," Michael Zammert, who is responsible for purchasing capital goods like refrigeration systems, LED lighting and shelves at Transgourmet, told *Accelerate Europe*.

The estimated payback time for an ejector is between one and six years depending on the size of the supermarket, according to the report.

Inside the Hamburg facility

The low-temperature side of the installation has been running since the beginning of March and the medium-temperature side since the beginning of April.

One of the CO₂ booster systems utilises parallel compressors and the gas and liquid ejectors to provide a further 400 kW for the air conditioning system.

Heat recovered from the refrigeration system is used to provide tap water (120 kW at 65-55°C) and space heating (320 kW at 38-25°C), and to defrost the deep-freezer units.

A heat pump is also integrated for peak load periods. It uses the ambient air as a heat source via evaporator coils in the gas coolers.

The total yearly energy consumption of the system is 2,600,000 kWh.

Transgourmet is happy about the running of the installation so far. "This system has been working for a short time now,"

Zammert told *Accelerate Europe*. "We can say that all the running has been smooth."

After the initial startup phase, Transgourmet will carry out training. "The personnel responsible will get new training from the manufacturer and will be introduced to all the important parts of the system," Zammert says. "Additionally, documents containing CO₂ refrigeration instructions and information will be created. These will be integrated in the regular work-protection trainings."

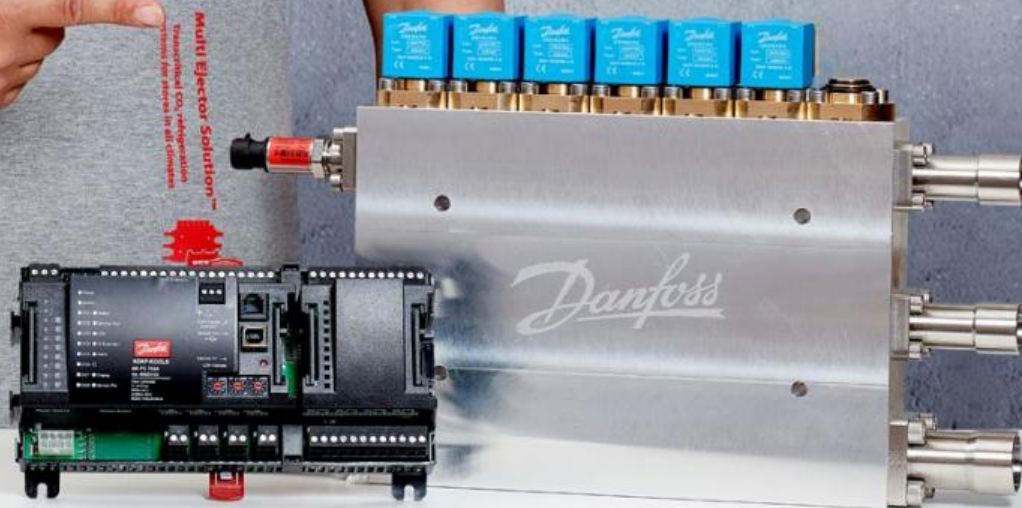
With the use of CO₂ in distribution centres currently being fulfilled as an important part of Transgourmet's strategy, *Accelerate Europe* has learned that this will not be the last installation to harness ejectors.

"We are currently planning with Frigo-Consulting another transcritical CO₂ system with ejectors," Zammert says. "This will have even more cooling power than the current system in Hamburg. We assume that the handover will be in the summer and will be a new milestone in our plan." ■ CM

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When Western Liberty Foods, an Iowa-based meat processor, opened a cold-storage facility in Illinois in 2015, it decided to use a lot less ammonia for refrigeration than it employed at its four processing plants.

Those plants have vast quantities of NH_3 in a liquid-overfeed process, including one facility in Illinois that holds 80,000 lbs. (36,287.39 kg) of the hazardous refrigerant. By contrast, the cold-storage plant it opened, Liberty Cold Storage, located in Bolingbrook, Illinois, near Chicago, uses 7,500 lbs. (3,401.94 kg) to refrigerate West Liberty's meats and an array of produce, desserts and other third-party foods.

The Liberty Cold Storage plant, which underwent a 123,000-sq.-ft. (11,427-sq.-m) expansion completed in early 2018, now encompasses 253,360 sq. ft. (23,537.91-sq.-m), and its ammonia charge supports a capacity of 928 TR (3,264 kW), with a ratio of 8.1 lbs/TR (1.05 kg/kW).

This is a much-reduced amount of ammonia. It keeps the charge under the 10,000-lb. (4,535.92 kg) threshold above which cold storage plants need to abide by strict regulations mandated by several U.S. regulations including the Environmental Protection Agency (risk management plan), the Occupational Health and Safety Administration (process safety management), and the Department of Homeland Security (chemical facility anti-terrorism standards).

1 /

1 / Tim Cox, Liberty Cold storage.

2 / Frick screw compressors in engine room.

3 / Dock area.

HOW LIBERTY COLD STORAGE GOT ITS AMMONIA CHARGE DOWN

The Chicago-area operator invested in a low-charge ammonia DX system configured to use less than 10,000 lbs. (4,535.92 kg) of NH_3 for both low and medium temperatures. *Accelerate America* reports.

– By Michael Garry

“It just seemed like the right fit. We went with their recommendation and it's worked out well.”

— Tim Cox, Liberty Cold Storage

How did Liberty Cold Storage get its refrigerant charge down?

One of the ways that cold storage operators are reducing their ammonia charge is to install one or more low-charge packaged systems, either on a rooftop or on the ground outside.

But another approach — the one implemented by Liberty Cold Storage — is to keep the stick-built, central-engine-room format traditionally used by industrial operators, but employ a DX (direct expansion) evaporator from Colmac Coil Manufacturing for both medium-temperature and low-temperature applications.

DX evaporators, which require much less ammonia than an overfeed system, have been used for medium-temperature but not for low-temperature applications. However, Colmac Coil, based in Colville, Washington, came up with a design (called ADX or Advanced DX) to make them work with low temperatures.

Tim Cox, vice-president at Liberty Cold Storage, who previously spent nine years at parent West Liberty Foods, made the decision to invest in the Colmac Coil ADX evaporators, with direction from his refrigeration contractor, AMS Mechanical Systems, Woodridge, Illinois — and in particular, industry veteran Rick Watters, AMS' VP (refrigeration/food process piping) who has been with the company almost 35 years.

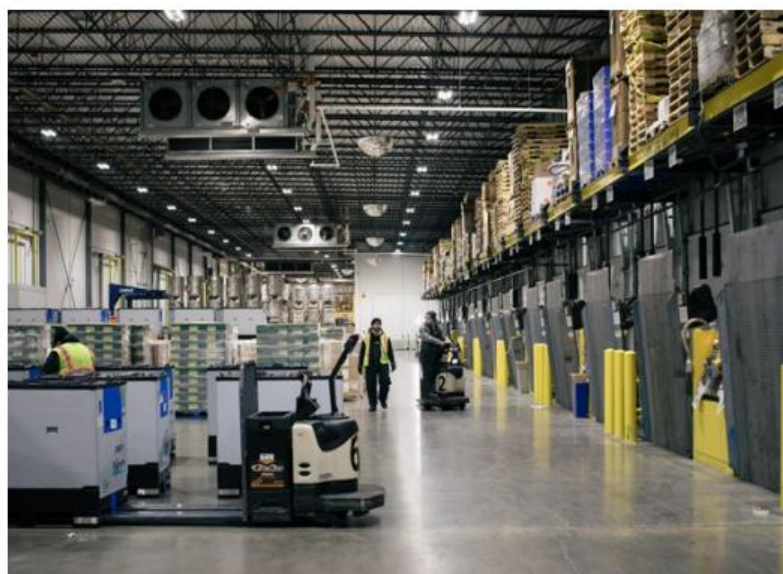
The number one priority was “less ammonia in the facility,” acknowledged Cox. “Being under the 10,000 pound mark was important to us.”

Watters designed and installed one of the first ADX installations, at another Chicago-area warehouse (Joliet Cold Storage, Joliet, Illinois) in 2014, and since then has followed suit at other plants, including Liberty Cold Storage.

The ADX system primarily reduces the ammonia charge by dint of the patented design of the evaporator. According to Bruce Nelson, president, Colmac Coil, the internal surface of the evaporator tubes has a “wicking structure,” which produces “sufficient capillary pressure to cause liquid ammonia to completely coat the inside of the tubes.” “Otherwise, the liquid falls to the bottom of the pipe, with incomplete wetting,” he said.



2 /



3 /

Watters likened the grooves inside the tubes to that of a rifle barrel, which enables the ammonia to rotate 360 degrees through the length of a tube like a spinning bullet, enhancing the heat transfer.

The other part of the evaporator system that lowers the charge is a distributor that optimises the flow of ammonia throughout the tubes (circuits). “What the distributor does is it allows each tube to get the same amount of liquid as the others,” Watters notes.

Cox thinks the ADX system “makes more sense in how it delivers ammonia to the evaporator and gets on coils versus a traditional system”.

The technology behind this evaporator is actually not new, but Colmac Coil found a way to harness it differently in the ADX unit to reduce the amount of ammonia needed, noted AMS Mechanical Systems' Watters.



Penthouse DX evaporators



Hanging DX evaporators in dock area.

By reducing the ammonia charge, the ADX system becomes simpler to manage than a traditional system, said Cox. "The engine room seems simpler when you compare the two for me. It sends out the liquid ammonia that the system needs instead of over-pushing it and bringing it back wet. With ADX it all comes back as a gas."

The ADX system also uses smaller vessels that reduce the amount of ammonia held and eliminate the liquid ammonia pumps used in recirculated systems along with "valving, regulators, reliefs and electrical," said Watters.

"To me, [the ADX system] is simpler to operate," said Watters, pointing to the ease of restarting the system after a power failure. "It's as easy as flipping on a light switch."

Preventive maintenance is handled by AMS, which monitors the system remotely and visits the plant every other week. "For this system I don't need someone on site — AMS supports it," said Cox.

Safety first

To enhance the safety of the system, most of the 32 evaporators used at Liberty Cold Storage are housed in penthouse enclosures on the roof of the building, blowing cold air through ducts into the cooling area. (The exception is the dock area and a small cooler, which use hanging evaporators). In this way they resemble low-charge packaged units, except that the latter contain all of the refrigeration equipment, not just the evaporators.

With penthouse evaporators on the roof, "no ammonia is in the room itself," noted Cox. That means they are out of reach of forklifts that may bump into a hanging evaporator.

In addition to safeguarding employees, the lower ammonia charge helps keep stored products out of harm's way, which aligned with the overall design of the building. "When we built Liberty Cold Storage, we tried to build with the idea of food safety and food security inside and outside the building," said Cox. "And give people peace of mind that we have control of the product."

While Cox wants to reduce the amount of ammonia he uses, and recognises its potential toxicity, he still appreciates its value as an environmentally friendly natural refrigerant with a GWP of zero. "We did not want a Freon system," he said.

Cost advantage

In terms of cost, Cox saw "an advantage on price" with the ADX system being a little less expensive (in equipment plus installation) than a liquid-overfeed system. According to Nelson of Colmac Coil, what is helping to drive adoption of the ADX system is its lower cost — 2% to 5% less than that of a traditional overfeed system.

Watters calculated that the Joliet facility's ADX system cost 2.4% less than a liquid-overfeed system, a saving of \$100,000 (£81,444). "We priced it both ways," he said.

Saving energy was another consideration for Cox. In a presentation at the Global Cold Chain Expo in Chicago last year, Watters, in a presentation with Nelson, provided an energy-usage comparison of the Liberty Cold Storage and Joliet plants with a Chicago-area facility that uses a liquid-overfeed system.

In 2015, the Joliet plant used 38% less power (annual average power/sq. ft.) than the liquid-overfeed facility, while Liberty Cold Storage (which does blast freezing in its main freezer) consumed 18% less. (The ADX plants did use VFDs for evaporator fan motors while the overfeed facility did not.)

Watters sees the low-charge movement as a good direction for the industrial refrigeration industry. "The less ammonia, the better, period," he said. "There's always risk, so why not minimise the risk?"

■ MG

HIGHLY EFFICIENT HYDROCARBON OPERATED COMPRESSOR TECHNOLOGY



NatRef innovation hot off the Milan catwalk



Natural refrigerant-based air-conditioning, heat pump and chiller products were among the stars of the show at this year's Mostra Convegno Expoconfort (MCE), one of world's biggest comfort technology tradeshow with 2,400 exhibitors and 162,000 attendees.

ABOVE
Milan cathedral.

ABOVE RIGHT
GEA's new ammonia chiller at Mostra.

— By Charlotte McLaughlin



Shaking up the chiller market

German compressor and systems manufacturer GEA was among those innovating in the chiller market, exhibiting a new ammonia chiller and screw compressor designed for air-conditioning applications.

"We managed after seven years to produce a semi-hermetic [compact] screw compressor [including an oil separator] for ammonia," Dirk Oschetzke, product manager – screw compressors, GEA, told *Accelerate Europe*. "Everyone thinks from the same look and feel that it's like a [HFC] chiller, but it's different."

The compressor has a suction-cooled motor and copper winding, helping to increase system efficiency.

GEA also introduced a chiller using the firm's semi-hermetic compact screw compressor. As the price of HFCs increases thanks to the reduced HFC quota under the new EU F-Gas Regulation, the product grants end users the ability to install a future-proof solution.

"Everyone is unsure. We have new refrigerants, but the price [of refrigerants] is going up," said Oschetzke. "For this kind of chiller at 1.2 MW, we have [...] 60 kg of ammonia charge. Others [HFC chillers] have 400 kg of [HFCs] that [can cost] 10,000 euros."

GEA is not yet selling the chiller commercially. It is currently field testing the product and will start selling it to the market in the near future.

Many of the companies at Mostra Convegno – a bi-annual tradeshow held on 13-16 March at Fiera Milano Rho in Milan, Italy – continue to rely on HFCs that are being phased down in Europe and globally in their air-conditioning, heat pump and chiller portfolios.

HFC usage is particularly high in the HVAC sector, with 65% coming from air conditioning, according to UNEP. Rising average global temperatures caused by climate change are likely to increase demand for comfort cooling in southern Europe, according to 2017 research published in the journal *Proceedings of the National Academy of Sciences* (PNAS).

2017 was the third consecutive year in which average global temperatures were more than 1°C above late 19th Century levels, according to NASA scientists.

The extent to which countries face temperature increases varies dramatically between southern and northern Europe. "We find significant increases in average daily peak load and overall electricity consumption in southern and western Europe (3 to 7% for Portugal and Spain) and significant decreases in northern Europe (-6 to -2% for Sweden and Norway)," say Wenz *et al.* in the PNAS article.

The new EU F-Gas Regulation is putting European companies under significant pressure to develop solutions that lower the GWP of the refrigerants they use. On 1 January 2018 the overall allocated quota of HFCs under the F-Gas Regulation fell from 93% of the original 2015 baseline to just 63%, causing HFC prices in Europe to rise.

Some manufacturers at Mostra, from the heating and cooling industry in the commercial, industrial and residential sectors, showcased solutions to address Europe's need for environmentally friendly HVAC technologies.

Propane is also making greater inroads into the chiller market. To keep up with this demand Frascold, an Italian manufacturer, launched two new propane compressors at MCE.

The company is not just conscious of the ramifications of the EU F-Gas Regulation but is also trying to keep up with EU-wide energy efficiency regulations governing chillers, said Livio Calabrese, from the sales and development side of Frascold's business.

Chinese manufacturer Fuijian Snowman (Snowkey) also introduced new propane-based products for chillers.

"There is big demand for these products [in Europe]," said Yury Chelnintsev of Fuijian Snowman. "That's why we have new [propane] products here for Mostra."

For more on how the market for propane chillers is developing, check out the [Technology Focus](#) in the previous edition of *Accelerate Europe*.



ABOVE RIGHT
Roccheggiani's new
propane heat pump system.

Heating the office

Italian HVAC company Roccheggiani also launched a new propane heat pump capable of heating and cooling offices.

The firm is targeting space heating and cooling for offices, hospitals and standard commercial applications with this technology.

"We have been developing this series [for] three years," Stefano Biondini, HVAC project and sales manager at Roccheggiani, told *Accelerate Europe*. "Now we're ready to manufacture and sell in the market."

The 100 kW unit, containing 2.5 kg of propane in each of its two refrigerant circuits, is the first in a series of similar units the HVAC equipment manufacturer is hoping to introduce to the market.

The company plans to market the 100 kW model this year before rolling out similar units in higher capacities.

"The complete series will use propane as a refrigerant in the future [...] up to 300 kW," Biondini said.

The company is confident it will have strong success with this product. "For this year we forecast 30 [100 kW] units. Next year I hope to see 100," Biondini said.

Italian firm Blauwer, which debuted its high-temperature CO₂ heat pump for heating and cooling at the previous edition of the show, has seen confidence grow in the market since 2016.

"The heat pump is mainly used in process cooling applications like cooling plastics and the car industry, where you need to increase or decrease the temperature quickly," said Vittorio Pozza, managing director, Blauwer. "CO₂ is perfect to do this."

For the heat pump, the return of investment (ROI) is also quite high at less than a year-and-a-half, according to Pozza.

Bringing NatRefs home

Meanwhile, a ban on using HFCs with a GWP above 150 in portable air-conditioning systems from 2020 is beginning to have an effect.

At Mostra, *Accelerate Europe* noted seven companies, including Midea Group, TCL Corporation, Gree Electric, Kaysun, Olimpia Splendid, Blaupunkt and Innova, that exhibited propane-based portable air-conditioning systems.

This marks a big change over previous years when as little as two companies were using propane in portable air conditioners, according to research by sheccoBase, the market development arm of *Accelerate* publisher shecco.

German firm Blaupunkt is confident its new portable air conditioner will prove a market success. "This is what the market is demanding now," said Jet Chen Chuang of Blaupunkt.

Despite the promising success of natural refrigerants on the portable front, they are finding it harder to penetrate the split system market.

Split systems (ductless and ducted) have the largest share of the global air-conditioning market (>85m units sold per year in 2014), according to German Federal Environment Agency (UBA) research.

For split units, an EU F-Gas Regulation ban on using refrigerants with a GWP below 700 will come into effect in 2025. This leaves the door open for the flammable HFC R32 with its high GWP of 675.

Many split-system manufacturers at Mostra were showcasing products using R32. From an environmental point of view this is a concern. Dichloromethane (a feedstock in the production of R32) – also known as methylene chloride – could delay the healing of the ozone layer for 30 years

as its use is increasing, particularly in the solvent industry. This is according to 2017 research by Dr. Ryan Hossaini, a geoscientist at Lancaster University in the UK.

Hossaini cites research by Dr. Emma Leedham Elvidge, senior research associate at the School of Environmental Science at the University of East Anglia, UK and colleagues suggesting that the recent growth in dichloromethane emissions may also stem from production leaks or deliberate venting when manufacturing R32 or difluoromethane from dichloromethane.

A key manufacturer making inroads into split R290 market is Midea ([see page 46](#)).

Adding to the good news for residential applications, Emerson launched heat pump components designed for R290 residential space heating at Mostra. "Emerson is presenting [...] a complete range of propane products and solutions designed for residential heat pumps," Pascal Wilmot, product manager at Emerson Commercial and Residential Solutions, told *Accelerate Europe*.

The company started developing propane products in 2015 for residential heating, launching its first fixed speed compressor that year.

It is currently marketing a 46cc variable-speed compressor with an optimised inverter drive, along with a controller, electronic expansion valve and sensor, all of which are optimised for R290-based residential heat pumps.

"This compressor will give more or less 16 kW heating capacity at full-speed operating conditions," Wilmot said.

The company is targeting heat pump manufacturers who are looking for a better thermodynamic option for this particular application. "The second reason is that the transition to low-GWP refrigerants, which is driven by the [EU] F-Gas Regulation, is making propane a really attractive candidate for system manufacturers," Wilmot added.

The manufacturers mentioned above will play crucial roles in developing the market for natural refrigerants in HVAC applications, by producing technology that is environmentally sound and energy efficient. ■





Midea advertises on billboards at Times Square (Photo: Business Wire)

Midea pushes split R290 AC at Mostra

One of the leading manufacturers of air-conditioning systems – Midea Group – was presented with the German Ecolabel ‘Blue Angel’ by the Federal Environment Agency (UBA) for its split air-conditioning (AC) system using propane (R290) at Mostra on 14 March.

The ‘Blue Angel’ initiative is an Ecolabel for certifying some 120 different product types, including split ACs with non-halogenated – meaning natural – refrigerants. “We try to support the market for R290 split air con,” Dr. Daniel de Graaf, from the substance-related product issues section of the UBA, told *Accelerate Europe* in September.

The ‘Blue Angel’ Ecolabel, launched in 1978, is voluntary. Split AC manufacturers have been able to apply for it since August 2016. “The criteria of the German Ecolabel are very strict and those applying need an SEER rating of seven at least,” de Graaf said.

Midea Group has been working on this product for some time. For the last nine years, the Midea team has been developing the core components of the split AC system including the R290 compressor, the heat exchanger, and the electronic expansion valve. The team also produced unique R290 circuits, variable frequency electrical controls, and safety protection schemes.

De Graaf believes this will encourage manufacturers to be more active in bringing their propane units to market. “Our real hope is that Chinese manufacturers will supply their R290

units in the European and Asian markets on a greater scale than has been seen so far,” he said.

The Midea split AC product is not currently available in the European market, according to the Blue Angel website, but it is expected to reach the European market this year, according to Midea.

The Chinese company is taking this seriously as evidenced by its advertisement in Times Square in New York, where a billboard can set you back approximately \$30,000 (€24,380) per week for a 15-second slot once per hour.

Four German bodies administer the Blue Angel certification:

- The Environmental Label Jury: the independent decision-making body of the Blue Angel with representatives from across the industry including consumers.
- The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: the owner of the label and the communication point for the Label Jury.
- The Federal Environment Agency: develops the technical criteria for awarding the Blue Angel.
- ‘RAL gGmbH’: the sign registry that helps with the process of criteria development and organises the independent expert hearings for getting interested parties involved. ■ CM

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China Refrigeration 2019 took place at the New China International Exhibition Center in Beijing.

China Refrigeration: NatRef market set for growth

The Chinese market for natural refrigerant-based technologies is picking up as competition between different HVAC&R solutions increases. *Accelerate Europe* reports from China Refrigeration 2018 in Beijing.

– By Andrew Williams

Compressors and ejectors were among the natural-refrigerant technologies to receive innovation awards at China Refrigeration 2018, the country's leading HVAC&R tradeshow, which was held at the New China International Exhibition Center in Beijing from 9-11 April.

Hydrocarbon, CO₂ and ammonia-based technologies received 'Innovation Product Awards', with Bitzer, Nidec, York (Wuxi), Jinan Dasen Refrigeration Equipment Co., Ltd. and CAREL all winning for the following products and categories:

► Bitzer Refrigeration Technology China won an award in the 'Refrigeration Component' category for its 'ECOLINE+' range of CO₂ trans-critical compressors.

► CAREL Electronic (Suzhou) won for its Electronic Modulating Ejector (EMJ) in the 'Refrigeration Component' category.

► Nidec Compressors (Tianjin) Co., Ltd. was recognised for its variable-speed propane compressors in the 'Refrigeration Component' category.

► York (Wuxi) Air Conditioning and Refrigeration Co., Ltd. received an award for its CO₂/ammonia freezing package in the 'cold chain and cold storage equipment' category.

► Jinan Dasen Refrigeration Equipment Co., Ltd. won for its CO₂ flow ice-hot water combined supply unit in the 'energy utilisation and other heat pump equipment' category.

PANASONIC UNVEILS CO₂ TRANSCRITICAL RACK

Panasonic chose China Refrigeration 2018 as the stage on which to unveil its first CO₂ transcritical rack, broadening its offer in an increasingly competitive global market for larger capacity CO₂-based HVAC&R systems.

The rack, on display at the show, was assembled in Europe and designed by Panasonic Appliances Refrigeration System (Dalian) Co., Ltd. (PAPRSDL).

It has already been sold to a domestic Chinese retailer and will be installed in a Beijing supermarket shortly, Li Li Du – PAPRSDL's overseas sales director – told *Accelerate Europe* at the Bingshan Group's China Refrigeration booth (where the rack was being exhibited).

PAPRSDL, a joint venture between Japan's Panasonic Corporation and China's Bingshan Group – one of the country's largest manufacturers of refrigeration and air-conditioning equipment – was established in July 2016.

Du expects PAPRSDL to install more such systems in China in the coming years. "We plan to sell more CO₂ transcritical racks, to more customers," Du said, citing cold storage operators as potential clients alongside retailers. The company is targeting customers elsewhere in Asia too, she added.

Eliwell provided the system controls for the rack on display in Beijing, and Dorin supplied the compressors.

TACKLING THE TRAINING CHALLENGE

Du identified availability of system components, training and maintenance among the biggest challenges facing the Chinese market as it moves towards wider adoption of natural refrigerant technology.

"We'll provide complete training and maintenance for the customer," she said.

Giacomo Pisano, technical sales manager at the system's compressor provider Dorin, said improving training on natural refrigerants among local contractors and maintenance staff

would be crucially important in triggering their wider uptake in China.

"Without proper training for contractors, the future may still prove challenging," Pisano said. "But Panasonic definitely have the expertise to grow into this field here in China," he added.

EFFICIENCY REGULATIONS TRIGGERING NATREF INTEREST

Compressor manufacturer Nidec won a prestigious 'Innovation Product' award for a newly launched variable-speed compressor operating with natural refrigerant propane (R290).

The NLV12.6CN dual frequency (50/60 Hz) variable-speed compressor was on display at Nidec Compressors (Tianjin) Co., Ltd.'s China Refrigeration booth.

"The advantage for the customer is that they don't need to buy more products. They can use the same product to cover different cooling capacities," Lily Li, senior director of global business development and marketing at Nidec, told *Accelerate Europe*.

Li cited low noise and vibration levels, better temperature control, and reduced inventory costs among the

benefits of the new compressor model. Its dual frequency allows it to be used in different regions and different applications.

A crucial feature of the Innovation Award-winning solution is the controller, which serves the system as well as the compressor itself. "The controller gives you a choice," said Li. Compatible with different world regions, it can programme the compression cycle and provide operating data.

In China, new government regulations on energy efficiency are triggering increased interest in Nidec's natural refrigerant portfolio, said Li. She cited full compliance with these regulations among the benefits of the new model.

To help inform the HVAC&R market of the benefits of adopting natural refrigerant-based solutions, Nidec Compressors (Tianjin) Co., Ltd. has been organising a roadshow in China for the last three years, with another to come this year.

"This is really helping us to open up the market and raise awareness of propane, particularly variable speed," said Li. "The roadshows help us inform the customer that propane is not dangerous, and offers many benefits."



Nidec's variable-speed propane compressor won an Innovation Product award.

HYDROCARBON MARKET RIPE FOR GROWTH

AHT Cooling Systems GmbH presented the 'VENTO Green' complete plug-in cooling solution for supermarkets based on propane (R290).

"Our propane solution with fully hermetic multi-deck 'VENTO Green' cabinets only requires two connections – brine and electricity," Reinhold Resch, vice-president (R&D) at AHT, told the Ozone2Climate conference, held at China Refrigeration and organised by UN Environment, the United Nations Development Programme (UNDP) and the Chinese government's Foreign Economic Cooperation Office (FECO).

The cooling system centres on the VENTO Green multi-decks, based on R290, which require two connections: electricity, and a pre-installed tubing system for brine. The plug-in, low-temperature display cases are also based on one connection (electricity).

Outside the supermarket, there is a dry cooler and pump station with a connection for heat recovery.

The new multi-circuit version keeps the refrigerant charge per circuit below 150g and has already been installed in over 100 markets. "This solution can be fitted very quickly and very easily," said Resch.

AHT is a leading manufacturer of self-contained units in the supermarket and ice-cream sectors. "800,000 of our propane-based units have been installed in supermarkets worldwide," said Resch. "700,000 of these are in Europe."

Hydrocarbons certainly appear to be on a positive growth path in China. "We estimate that there are over 4,000 hydrocarbon-based plug-in cabinets in Chinese supermarkets," Jan Dusek, APAC business development manager for *Accelerate* publisher shecco, told the Ozone2Climate conference.

"We see increasing competition between different natural refrigerant-based HVAC&R solutions," Dusek said, adding: "The cost of equipment is becoming comparable to systems using HFCs."



Panasonic's first CO₂ transcritical rack attracted attention in Beijing.

EMJ MODULATING EJECTOR BAGS AWARD

The EmJ modulating ejector, developed by CAREL, won China Refrigeration 2018's Innovation Product Award in the Refrigeration Component category. Ejectors can help transcritical systems to run efficiently in warm climates.

The EmJ made its debut in 2016 in partnership with Carrier at the ATMOSphere Europe conference hosted by *Accelerate* publisher shecco.

"From the United States to China, CAREL is recognised as an innovator," said Diego Malimpensa, the firm's business unit manager – retail. One feature of the ejector is continuous modulation that, through control algorithms, helps the refrigeration system to adapt to the variations in operating conditions that are typical of refrigeration systems, he said.

Compressor manufacturer Dorin, another Italian firm, is also eyeing opportunities in the Chinese market.

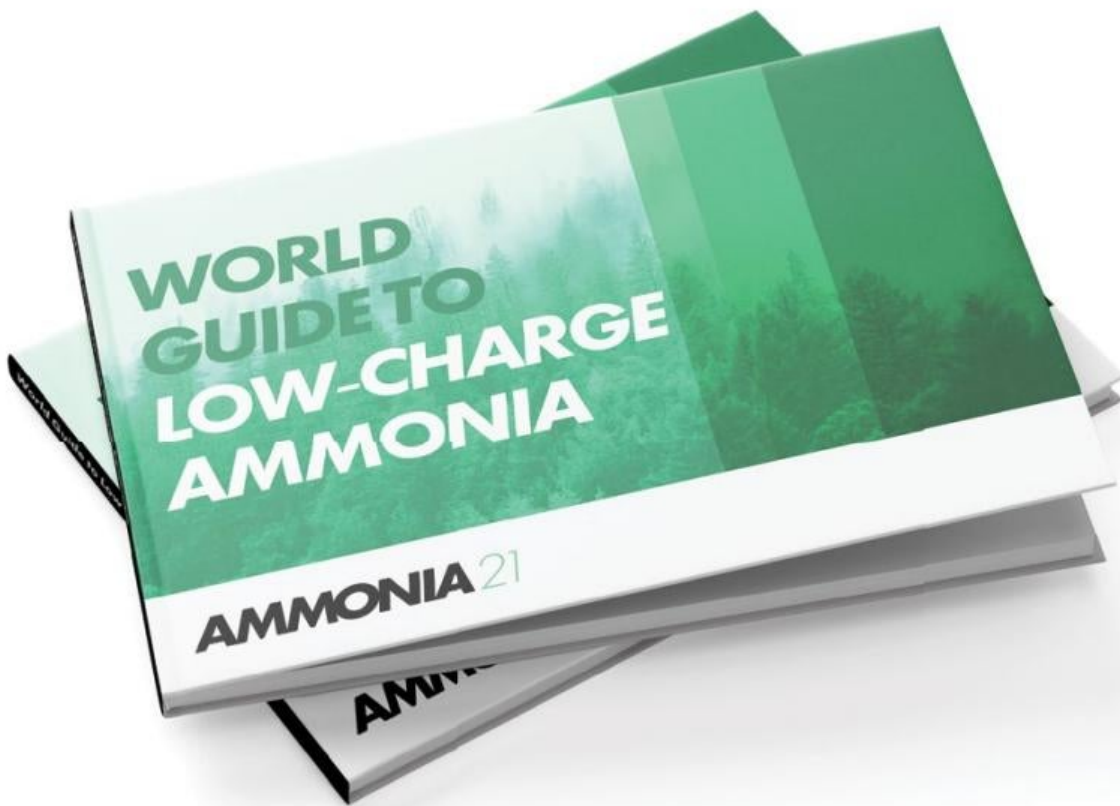
"I've been speaking with some customers and they are really interested in applying CO₂ in industrial systems," said Giovanni Dorin, marketing manager at *Officine Mario Dorin S.p.A.* "We're currently ready with our engineers to present our innovative solutions."

"I think the time is ripe for China to get going with this technology," Dorin said. "Other natural refrigerants are already used – China is used to using ammonia and hydrocarbons. But CO₂ is really something newer here. And the market is requiring that kind of technology." ■ **AW**

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CHINA TARGETS NATREFS FOR 'BRIGHTER FUTURE'

The Chinese government will continue to promote natural refrigerants as alternatives to HCFCs and HFCs. But technology suppliers warn that training and local availability of components must be improved if their market potential is to be fulfilled. *Accelerate* reports from ATMOSphere China in Beijing.

– By Andrew Williams & Devin Yoshimoto





Natural refrigerants are well placed to gain momentum in the Chinese HVAC&R market as the country prepares to leapfrog from HCFCs to solutions based on ammonia, CO₂ and hydrocarbons in the context of the global HFC phasedown, heard participants in April's ATMOSphere China conference in Beijing.

"China has an opportunity to jump straight from HCFCs to natural refrigerants," said Mauro De Barba, senior product marketing manager at Eliwell by Schneider Electric.

The conference – the first ATMOSphere event to be held in China; organised by *Accelerate* publisher shecco – took place on 9-11 April 2018 at the Sheraton Grand Beijing Dongcheng Hotel in the Chinese capital.

"China is rapidly adopting natural refrigerant solutions," said De Barba.

Yet as technology suppliers sell more natural refrigerant-based systems to the Chinese market, panellists stressed the need to improve training and local availability of components to allow these solutions to fulfil their market potential.

"Natural refrigerant technologies are complex, so support and training will be key to increasing their uptake," De Barba said.

Torben Funder-Kristensen, head of public and industry affairs at Danfoss, also expects natural refrigerants to play a greater role in China in the future.

"Technology development of applications using natural refrigerants is gaining momentum here," he said.

Government promoting NatRef uptake

The Chinese government is accelerating its efforts to implement the Kigali Amendment to the Montreal Protocol on phasing down HFCs and is promoting natural refrigerant alternatives by developing new standards.

"All the controlled substances under the Kigali Amendment will be phased out by 2045," Zhong Zhifeng, vice-chief of Division III in the Chinese

Ministry of Environmental Protection – Foreign Economic Cooperation Office (MEP-FECO), told the Sheraton audience. "These HFC applications will be 100% eliminated."

"In normal industries, we will never use HFCs," said Zhifeng.

"We have a very clear direction forward: we're developing alternatives," he said, before citing "special industries" working with flammable refrigerants as exceptions where the evolution may take longer.

Going forward, Zhifeng expects to see quick progress in the room air-conditioning segment in particular, with a 45% reduction in HCFC consumption by 2020.

China to revise domestic standards

China is building up production capacity for natural refrigerant technologies, and in the room air-conditioning sector, "we're improving the standards system for alternative refrigerants," Zhifeng said.

"Our current domestic standards are not helpful for promoting alternatives," he admitted. "We're revising standards to improve safety levels and promote natural refrigerants, which are the future market trend."

André Paz Rosa, senior R&D manager (Asia Pacific) at Embraco, identified safety concerns, lack of knowledge among light commercial refrigeration equipment manufacturers, and the fact that the Chinese government is yet to put in place an HFC phase-out plan as the biggest obstacles to wider uptake of hydrocarbons in China.

Nidec's Ricardo Maciel (president of the light commercial division at the compressor manufacturer) cited the high level of investment required to convert compressor production lines from HCFCs and HFCs to hydrocarbons as another obstacle to their wider uptake in China.

Yet a likely global increase in the hydrocarbon charge limit to 500g, the putting in place of HFC phase-out regulations worldwide, and tighter new energy efficiency standards in China will all boost the market for hydrocarbons in the Chinese market, according to Pedro Olalla, sales director, Huayi Compressor Barcelona.

Fresh food trend driving China retail

Representatives of top Chinese HVAC&R industry associations took to the ATMosphere stage, showing a united front in pushing China's industrial, commercial and consumer sectors towards a sustainable future with natural refrigerants.

Representing the China Chain Store & Franchise Association, Wenhua (Wendy) Wang said the organisation was actively encouraging its members to be more energy efficient through the use of new technology, including natural refrigerants.

However, Wang cited several significant barriers that lie ahead before more natural refrigerant uptake can be realised.

"In China, supermarkets are located in areas with dense populations; that's why safety regulations are strict," she said. "We need the government to form these safety standards and help boost confidence in the market."

Representing the China Household Electrical Appliances Association, Vice-President Lei Wang discussed the widespread use of R600a in China's household refrigerators and the industry's commitment to the use of R290 in room air-conditioning units as long-term solutions for their members to achieve energy efficiency.

"In the air-conditioning sector, we have come to realise that R290 will be the ultimate and final solution for us because it will meet our environmental sustainability requirements, and the efficiency is very high," said Wang.

State-of-the-art NH₃ making inroads into China market

State-of-the-art ammonia systems, meanwhile, are making inroads into the Chinese industrial refrigeration market. Ammonia has attracted a degree of attention among the Chinese public and government since two fatal accidents occurred in 2013. This, in turn, has resulted in strict regulation of the refrigerant in the Chinese market, said Jin Ma, representing the Chinese Association of Refrigeration (CAR).

CAR is creating and enforcing design and operational standards that guarantee safety when working with ammonia systems. "Based on my observation in the past few years, we can obviously see that cascade NH₃/CO₂ large-scale refrigeration systems will become the mainstream," said Ma.

"We now have 100-200 sets of these systems that have come up in the last few years. This will be the future trend."

End users such as Nestlé and Shandong Meijia are adopting state-of-the-art ammonia systems for industrial refrigeration, helping to broaden understanding and acceptance of the technology in China.



Zhong Zhifeng, MEP-FECO, Government of China

Swiss multinational Nestlé began replacing its CFC and HCFC systems with natural refrigerants in 1986. Today, its commitment to adopting natural refrigerants for HVAC&R applications wherever possible is helping to bring the technology to new parts of the world.

In China specifically – Nestlé's second-largest market – the firm uses packaged ammonia chillers in many of its refrigeration plants, Daiqian Zhang, from Nestlé China Ltd., told the event.

Ammonia chillers provide chilled water for process cooling and for humidity and temperature control in hygienic zones, for example, while larger ammonia systems are used for freezing ice cream.

Nestlé has installed ammonia refrigeration systems in its Hong Kong, Shuangcheng, Tianjin and Guangzhou factories, and packaged ammonia chillers at sites in Qingdao, Shanghai, Tianjin and Taizhou.

The success of these installations is helping Nestlé to convince local governments unfamiliar with ammonia that this natural refrigerant can be used safely, Zhang said.

The Shandong Meijia Group Co. Ltd., a leading Chinese seafood and frozen food processing company, opted for an ammonia-CO₂ cascade system in its Keyuan factory.

Xiaohua Guo, the group's executive vice-president, outlined four "tangible benefits" of the new system: increased safety, increased energy efficiency, environmentally friendly operation, and the use of automatic or remote controls reducing the need for manual labour.

The Chinese market, then, looks poised to continue to adopt natural refrigerants across their full range of application.

■ AW & DY



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NEW ITALIAN REGULATION SET TO BOOST NATREF UPTAKE

This spring the Italian government took an important step towards implementing the EU F-Gas Regulation, despite political turmoil following the recent elections. Yet a lack of qualified personnel and dedicated training may slow down uptake of natural refrigerants in the country.

– By Dario Belluomini

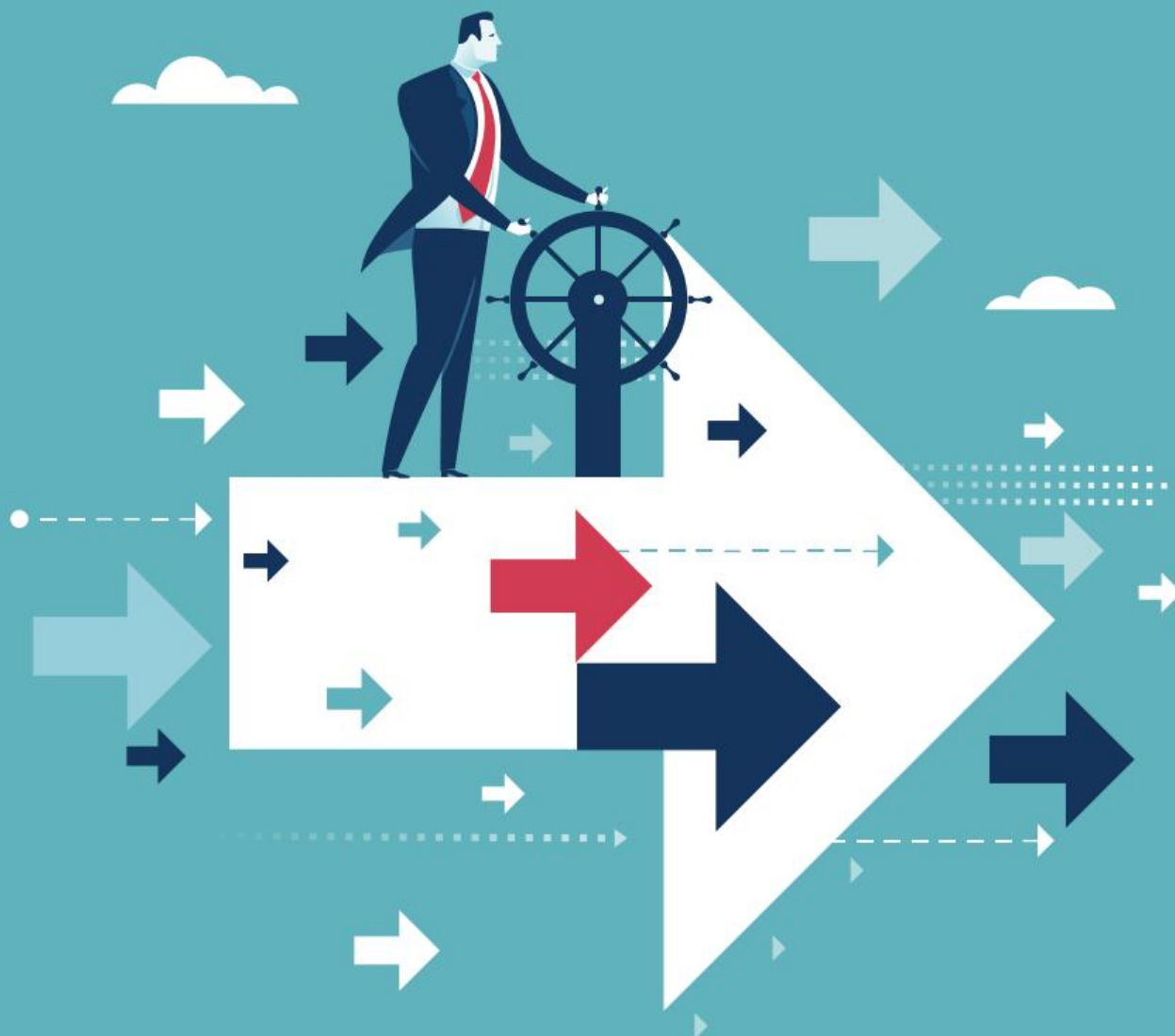
On 16 March, the Council of Ministers of the Italian government, on the initiative of Prime Minister Paolo Gentiloni and Environment Minister Gian Luca Galletti, approved a much-awaited preliminary measure to implement the EU F-Gas Regulation in Italy (No. 517/2014).

The decision was taken before Italy was able to form a new government in the wake of elections on 4 March. Coalition negotiations hit a stumbling block over the nomination of a new prime minister, and at the time of going to press, a new snap election looked likely to held in September. The intention to implement the F-Gas Regulation was nonetheless published in the Official Gazette of the Republic.

The Council of State analysed the legislative text and on 24 May

required the Ministry of Environment to put in place concrete monitoring and sanctioning mechanisms as well, to ensure the full effectiveness of the Regulation. The text will then return to the Council of Ministers for definitive approval and the consequent publication in the Official Gazette of the Republic.

Although the EU's F-Gas Regulation entered into force in 2015, member states need to adopt their own legislation to implement it. The EU regulation obliges member states to reduce their HFC use by more than two thirds by 2030, opening the door to alternative refrigerants with a lower GWP, such as natural refrigerants ammonia, carbon dioxide and hydrocarbons. Italy is at the forefront of innovation with natural-refrigerant technologies, yet its environmental policies have been less ambitious than most of its EU neighbours.



In defining measures to adopt the EU regulation on the greenhouse gases used as refrigerant, extinguishing, blowing, propellant and insulating agents (and their applications in electric devices), the Italian regulation:

- ▶ Identifies the Ministry of the Environment as the public authority appointed to relate with companies and market operators;
- ▶ Intervenes on the certification system of the bodies responsible for training technical personnel;
- ▶ Intervenes on the registration system and the implementation of the national online register of individuals and companies operating in relevant sectors;
- ▶ Identifies the independent control organisms monitoring the data on the commercialisation of equipment using f-gases;

▶ Establishes a database to collect and store data on such gases, and;

▶ Establishes the obligation to train technical personnel and certify enterprises.

The European Commission had previously reprimanded Italy for failing to implement the previous iteration of the F-Gas Regulation.

Federico Riboldi, head of communications at the *Associazione dei Tecnici Italiani del Freddo* (the Italian Association of Refrigeration Technicians), insisted that the HVAC&R sector is working hard to meet the HFC phasedown requirements of the EU F-Gas Regulation and the Kigali Amendment to the Montreal Protocol, a global agreement to phase down HFCs. "The transition towards new refrigerants is a very delicate phase for the RAC sector, as it entails a return to the use of natural refrigerants, used at the outset of refrigeration," he argued. Riboldi stressed the importance of training technicians to ensure the swift and wider adoption of new technologies. ■ DB

A photograph of several light-colored wooden blocks arranged to form a pyramid shape. The blocks are of various sizes and are stacked on a dark grey surface. The background is a solid light blue-grey color.

NOMINATIONS OPEN FOR
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The awards will recognise end users of commercial and industrial refrigeration that are doing the most with natural refrigerant solutions in Europe. A Person of the Year will also be named.

– By Andrew Williams

Since its launch in December 2015, *Accelerate Europe* has been highlighting the most progressive individuals and organisations working with natural refrigerants in HVAC&R applications in Europe. A highlight of last year's ATMOsphere Europe conference in Berlin – hosted by *Accelerate* publisher shecco – was the first edition of the *Accelerate Europe* awards, which recognise three end-user companies, a manufacturer and one individual for doing the most to drive the adoption of natural refrigerants.

This year's awards, which will be presented at the next ATMOsphere Europe conference on the shores of Italy's Lake Garda (19-21 November 2018), comprise three categories: Best in Sector, Person of the Year and Innovation of the Year.

A Best-in-Sector Award will go to one end-user company in each of three sectors – food retail, light commercial and industrial – that has gone far in advancing the adoption of natural refrigerant technologies in HVAC&R applications in the previous 15 months.

Companies will be recognised for natural refrigerant technologies or systems that are part of new builds or remodels completed between July 2017 and September 2018. Nominations must include system performance studies completed during this time period; the studies can refer to systems installed prior to July 2017, provided that system performance data covers part of the period July 2017 to September 2018.

Criteria for assessing systems and companies for the Best-in-Sector Awards include:

- ▶ A reduction in energy consumption.
- ▶ A reduction in greenhouse gas emissions.
- ▶ Ease of reproduction.
- ▶ A business case including installation, operation, maintenance and training, and return on investment.
- ▶ Commitment to future natural-refrigerant installations.
- ▶ Industry leadership.
- ▶ Innovation and perseverance.

Complementing the Best-in-Sector Awards, the Person of the Year Award will honour the single individual who has done the most to advance the adoption of natural refrigerant technologies in HVAC&R applications in Europe between July 2017 and September 2018. The award is open to individuals from end users, manufacturers, policymaking, academia and research.

Criteria for assessing individuals include:

- ▶ Impact on development and/or implementation of natural refrigerant solutions.
- ▶ Leadership within their organisation and/or their industry.
- ▶ Innovation and perseverance.

The Innovation of the Year award recognises companies that have recently developed a particular natural refrigerant-based product with a significant impact on the market, with multiple installations in the field already.

The nominating process for the awards is now open and will run until the end of September 2018. Nominations may be submitted by anyone involved with HVAC&R; companies and individuals may nominate themselves. In October 2018, a panel of experts assembled by shecco will review the nominations, and select winners.

During ATMOsphere Europe 2018, shecco will host a special ceremony honouring the *Accelerate Europe* Award winners. A future issue of *Accelerate* will profile the winning companies and individual. ■ AW

Submit your nominations here:

<http://www.shecco.com/accelerateawards>.

A new dawn for hydrocarbons in China

China has already come to grips with hydrocarbons in domestic refrigeration. The light commercial market is next.

– By Charlotte McLaughlin & Devin Yoshimoto



The success of hydrocarbons in domestic refrigeration partly boils down to an unlikely tale of an NGO, an old German factory and a campaigner named Wolfgang Lohbeck.

The entry into force of the Montreal Protocol in 1989 marked the beginning of the end for chloroflourocarbons (CFCs) – which first created the hole in the ozone layer – and HFCs were looked on as the major alternatives.

Greenpeace and energy expert Wolfgang Lohbeck – also known as Wolo – decided to start the ‘GreenFreeze’ refrigeration project in 1992.

“[Wolo] was the right person at the right time. The world is a better place because of his work,” Janos Maté, a senior consultant in Greenpeace International’s political business unit who worked with him on the project, told *Accelerate Europe*.

Wolo met scientists in Dortmund, Germany who showed him that switching to hydrocarbon refrigerants such as isobutane and propane was a viable option for the household sector. He found a fridge manufacturer called DKK Scharfenstein, which was about to go bankrupt, and convinced it to start working on hydrocarbon fridges. The rest is history.

Within a year, his initiative had resulted in the highly successful commercialisation of so-called ‘GreenFreeze’ hydrocarbon refrigeration in Germany. The technology spread rapidly. “Greenpeace now estimates that currently there are between 900 million and one billion domestic hydrocarbon (‘GreenFreeze’) refrigerators in the world,” Maté says.

Household refrigerators in China are already largely based on hydrocarbons. “Most [household] appliances use R600a [isobutane], which is a natural refrigerant,” Jason Qian, Greater China sales and marketing director for Brazilian compressor manufacturer Embraco, told *Accelerate Europe*.



Chinese compressor manufacturer Huayi Compressor Co., Ltd. already sells 18 million hydrocarbon-based compressors for household applications per year in China. In 2018, the firm expects that figure to grow to 20 million, according to David Zhu, marketing manager for Huayi Compressor Co., Ltd.

"R600a will soon be used in 100% of household fridges," Zhu predicts.

Commercial refrigeration is expected to be a harder nut to crack than the household market, which has converted almost fully to hydrocarbons.

Light commercial products like freezers, display cases and bottle coolers mainly still use R134a in China.

Some manufacturers of compressor and display case technology believe much remains to be done to help OEMs and end users in China to switch from f-gases to propane for light commercial refrigeration.

Embraco's Qian sees two major challenges: a lack of knowledge and education among small Chinese OEMs, and difficulties in actually providing the professional service and know-how required by these companies.

The majority of the Chinese market for hydrocarbon-based compressors consists of small OEMs.

compressor, but also the entire system design, system integration tests in our lab, etc.; sort of a combined service package. As we have limited resources, this is also a challenge."

Huayi's experiences are similar. "At this moment, small OEMs in particular don't want to invest too much in changing their production lines and technology," says Zhu.

"They want to monitor and watch the market. If they see that their customers say, 'no, I don't want R134a, I want R290', then they will have no choice. They must change," Zhu explains.

"We want to put some effort into guiding them towards R290."

Nidec Global Appliance Germany, formerly Secop, identifies the government as a key player in triggering greater hydrocarbon uptake in China.

"The Chinese government encourages natural refrigerant usage in China, and has increased the energy efficiency standards of the light commercial market," says Pieter Boink, head of business development and marketing at Nidec Global Appliance Germany. "This will be carried out from June 2018. It will push natural refrigerant usage in China."

GETTING THERE

European OEMs are also hoping to change the market.

AHT Cooling Systems GmbH, an Austrian manufacturer of cabinets operating in China under AHT Cooling Systems Changshu Co. Ltd., is marketing natural refrigerants strongly. "AHT is working on some major projects in China," says Ulrich Bartoleit, head of corporate communications and marketing at AHT. "We see a big interest in replacing old units in the market with AHT's new R290 cabinets."

The cabinet manufacturer has received positive feedback from other customers about this technology.

"Very low energy consumption and stronger cooling performance," Bartoleit says. "And, especially with AHT's plug-in technology, hydrocarbons and plugins are the perfect match. The customers benefit from having a sustainable system with longer reliability and less lifecycle costs, straight from the initial investment."

Going forward, Embraco's first priority is to educate the market and end users on the importance of considering total cost of ownership, through partnerships with big OEMs

"The application of propane as a refrigerant is becoming mature with the big OEMs, but the majority of the market is not yet aware of this importance. They don't know how to start," Qian explains.

"They have to upgrade their facilities, upgrade their production lines, all without the full range of knowledge about natural refrigerants. So how we can help them manage that transition and increase awareness and education is the key."

Qian adds that these small companies also need professional service to help them integrate the new technology into their products. This is the second big challenge.

"As a leading and experienced supplier, we are expected to provide the total solution," says Qian.

"This means not just the physical hardware components, like the



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1 / Embraco's Plug n' Cool unit

2 / AHT's new Vento Green refrigerated shelf at EuroShop 2017

and promotion of new hydrocarbon-based light commercial solutions.

The company last year partnered with Chinese multinational Haier, one of the largest white goods suppliers in the world. "We are proud to launch [a bottle cooler] with R290 with Haier. It's really important for the Chinese market," said Herlon Eckermann da Silva, sales account manager for the Asia-Pacific region at Embraco, at China Refrigeration in 2017.

"In China, for most of the market, everything is based on cost," his colleague Qian explains.

"The big advantage offered by natural refrigerants is the energy savings. That's why we are introducing this Plug n' Cool concept to help raise the awareness of total cost of ownership with end users."

Nidec is also seeking to make greater inroads into the Chinese market. Last September, it organised a roadshow on natural refrigerant technology.

The fourth annual Nidec/Secop Technology Roadshow saw the company share its experiences with cabinets, vending machines and bottle coolers that use R290 in three different Chinese cities: Qingdao (18 Sept.), Shanghai (20 Sept.) and Shunde (22 Sept.).

"Almost 150 audience members attended these roadshows [and] we shared the content about R290 compressor alternative solutions, NLE, DLE, SCE compressor technical data, a low-temperature cabinet solution, R290 safety, etc.," says Boink.

The company is also helping big end users move HFC fridges to hydrocarbons in China. "We are involved in many of the projects driven by the big end user groups," he says.

"A clear example of this is the initiative *Refrigerants Naturally!* which is driven by the Coca-Cola Company, PepsiCo, Red Bull and Unilever, and supported by Greenpeace and UN Environment," he adds.

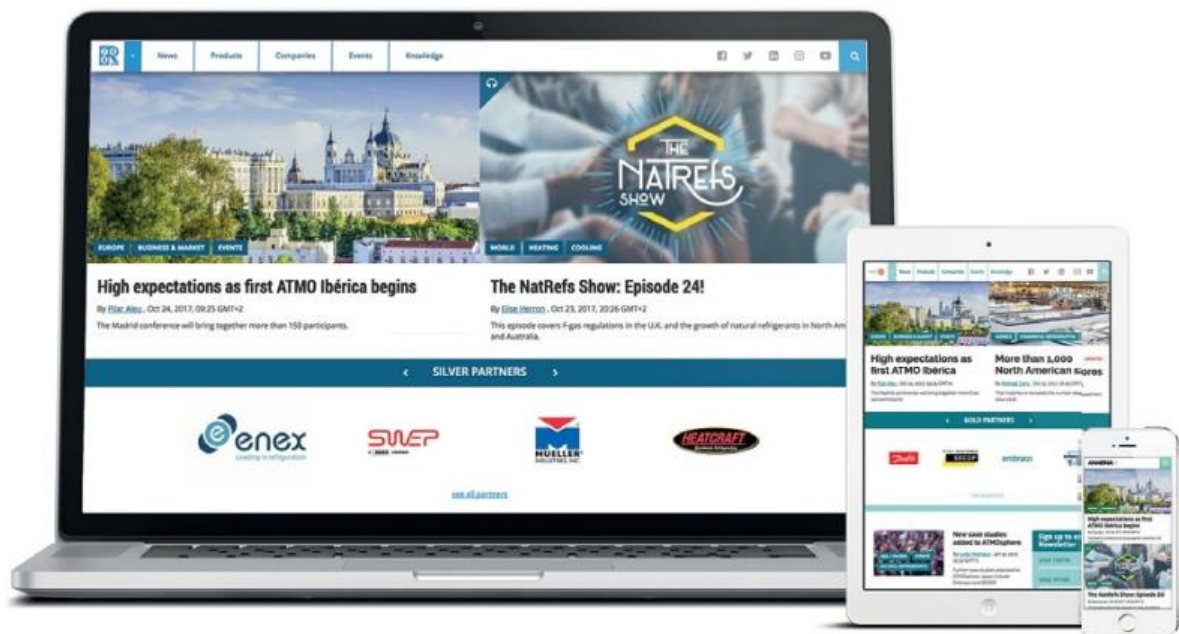
With these manufacturers' help, the journey towards hydrocarbon-based HVAC&R technology – which began with a man called Wolo back in the 1990s – is set to further transform the commercial refrigeration sector in China into an energy-efficient, lucrative and climate-friendly business. ■ CM & DY



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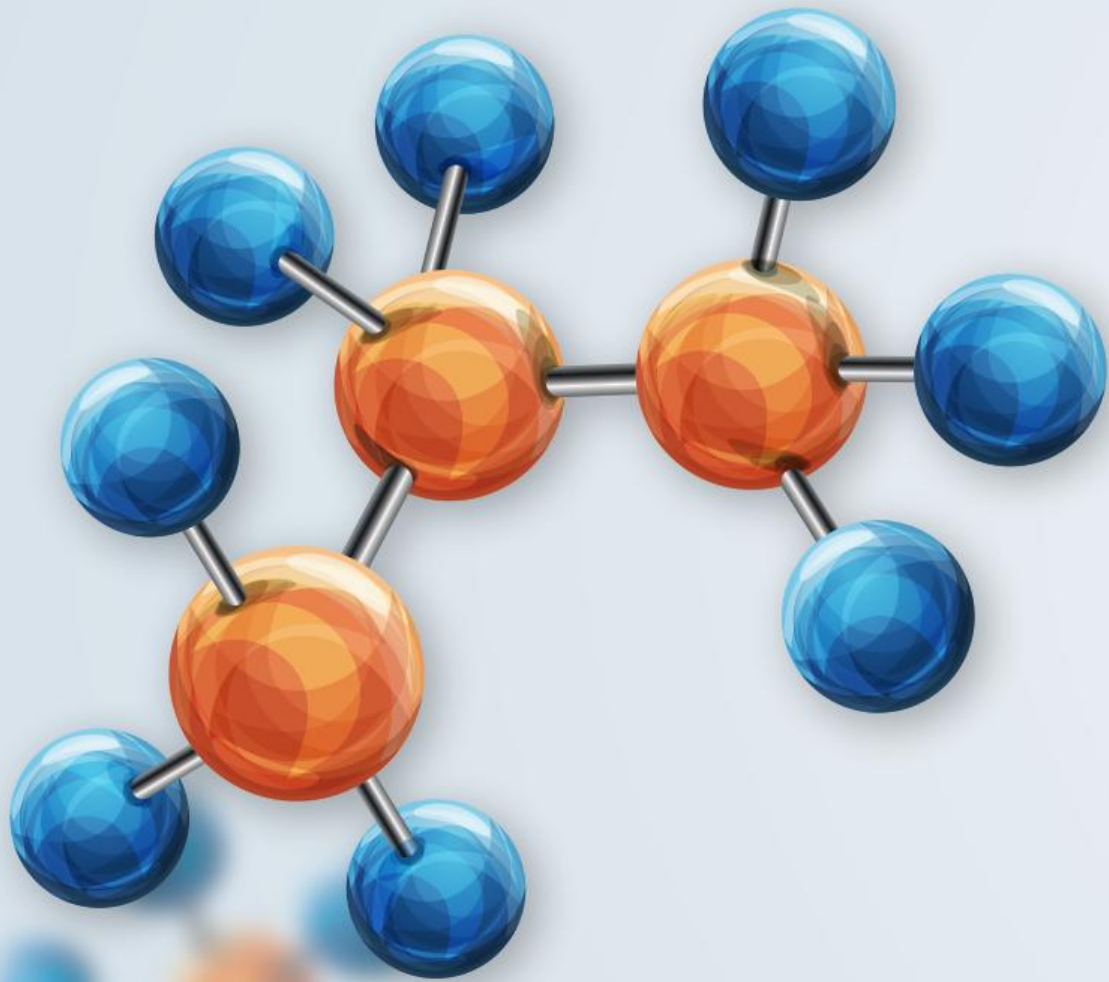


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U.S. HOME FRIDGE MAKERS PUSH FOR HIGHER HYDROCARBON CHARGES

In the United States, the Association of Home Appliance Manufacturers (AHAM) is pushing the Environmental Protection Agency (EPA) to raise the hydrocarbon charge limit to 150g. Yet the EPA has thus far moved back and forth on this issue. *Accelerate America* reports.

— By Michael Garry

For the past decade, the Washington, D.C.-based Association of Home Appliance Manufacturers (AHAM) has been playing “whack-a-mole” when it comes to transitioning to isobutane (R600a) refrigerants for home refrigerators, said Kevin Messner, its senior vice-president (policy and government relations).

That is, as soon as one issue is addressed, another one pops up. “We’re an industry that is willing and committed to transition to isobutane,” he said. “We make these products for the rest of the world and it would be great from a manufacturing perspective to get them as harmonised as possible.”

Domestic refrigerator manufacturers have already invested close to \$100 million (€84.5 million) in gearing up to make conventional home refrigerators with isobutane, he said.

To enable the complete transition to happen, AHAM has been pushing for the charge limit for isobutane in home fridges set by the U.S. Environmental Protection Agency to increase from 57g to 150g.

That is the standard outside of North America and the amount of isobutane needed to cost-effectively produce large home refrigerators.

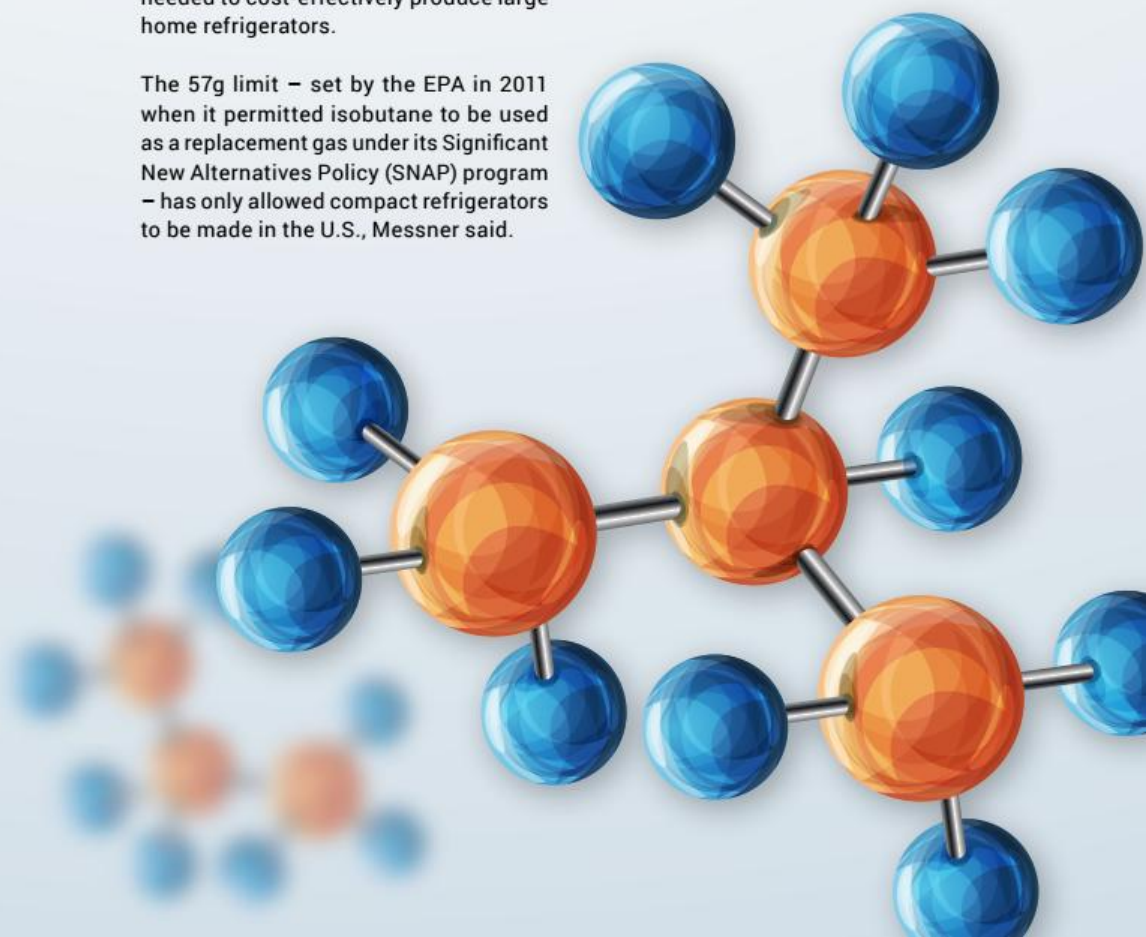
The 57g limit – set by the EPA in 2011 when it permitted isobutane to be used as a replacement gas under its Significant New Alternatives Policy (SNAP) program – has only allowed compact refrigerators to be made in the U.S., Messner said.

Last December, it looked as if AHAM would get its wish as the EPA issued a “direct final rule” raising the hydrocarbon charge limit to 150g for domestic fridges, based on a UL (a U.S. safety body) standard set last year that raised the charge limit to that amount.

However, that was pending a comment period, and in February the EPA reversed course after receiving a small number of “adverse comments” on the change. But the agency said it would address those comments as it continued to consider the charge increase. (See [‘EPA Pulls Charge Boost for Domestic Fridges’, *Accelerate America*, March 2018.](#))

AHAM was also eager to see the charge limit rise to 150g because the EPA SNAP program announced in 2016 that R134a, the primary HFC used in U.S. domestic refrigerators, would no longer be allowed beginning in 2021.

Given its difficulties getting the charge limit raised for R134a’s replacement, AHAM considered the 2021 deadline too soon, and requested that it be moved up to 2024. “Rushing it would not be good for anybody,” said Messner. “Another few years would have a negligible impact on the environment.”



COURT RULING'S IMPACT

However, that scenario has changed as a result of a D.C. Court of Appeals ruling last August invalidating the EPA's ability to strike HFCs from use as replacements for ozone-depleting gases.

Though the rule only applied to EPA SNAP Rule 20, which didn't contain the impending prohibition against R134a in home fridges, the ruling is expected to apply equally to Rule 21, which does contain that prohibition.

That would remove the 2021 deadline for replacing R134a, and it doesn't preclude manufacturers from using R600a once its charge limit is raised – results favourable to AHAM.

On the other hand, in April, the EPA said it "plans to begin a notice-and-comment rulemaking process to address the remand of the 2015 rule".

The agency added that it "intends to consider the appropriate way to address HFC listings under the SNAP program in light of the court's opinion" and also consider "the larger implications of the court's opinion remanding the rule to the agency".

In addition, a bill was introduced in February in the U.S. Senate that would provide the EPA with the power to regulate HFCs; the Senate may also take up for ratification the Kigali Amendment to the Montreal Protocol, which calls for a global phasedown of HFCs.

Further complicating matters, the California Air Resources Board announced in March that it was preserving the SNAP rules on HFCs in the Golden State.

The upshot for AHAM, explained Messner, is that AHAM still wants to see the EPA raise the charge limit for isobutane to 150g as soon as possible; that would give manufacturers certainty about

moving forward with their plans for using the refrigerant in larger U.S. home fridges, even as the U.S. government figures out how it wants to regulate HFCs, which Messner thinks could take a while.

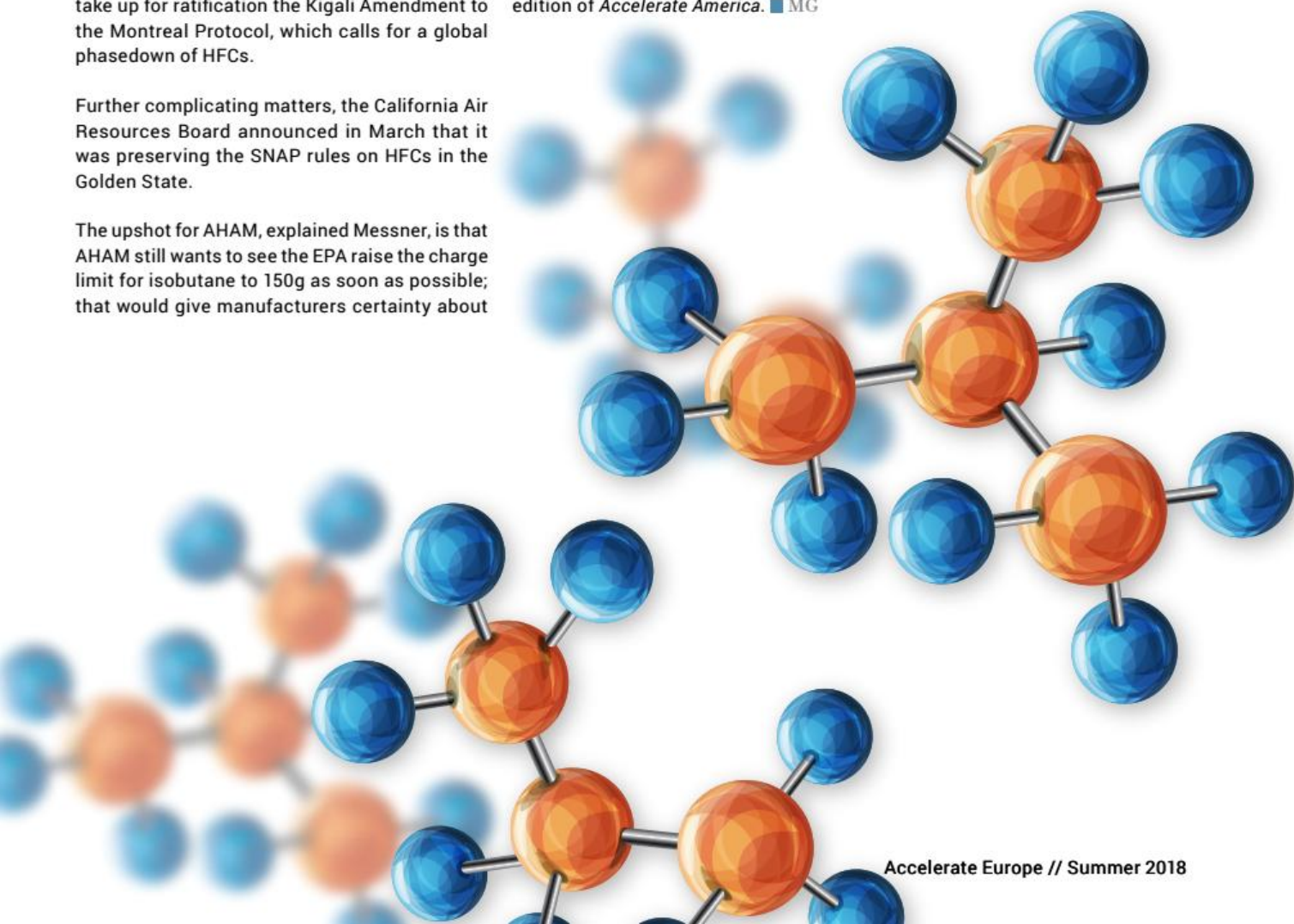
Even without the EPA increasing the charge limits, the court ruling allows manufacturers to use 150g of isobutane under standards set by UL.

But AHAM is still seeking the EPA's endorsement of the charge limit change. "There's the final investment that can't happen till we know what the charge size is," said Messner.

In preparation for the transition to isobutane, AHAM last year released guidelines for the safe servicing of residential appliances with flammable refrigerants. (See '[Are Home Fridges in U.S. Turning Toward Hydrocarbons?](#)', *Accelerate America*, November-December 2017.)

Messner noted that domestic fridge manufacturers are not able to use HFO refrigerants and are not interested in using HFO blends that have a GWP up to 700. "They'd rather just go for the natural refrigerant," he said.

Read the [full version](#) of this article in the May 2018 edition of *Accelerate America*. ■ MG





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Banking on NatRefs in European food retail

As Europe's food retail sector strives to improve its energy efficiency, *Accelerate Europe* compares how CO₂ and hydrocarbons are helping to reduce energy consumption in supermarkets.

— By Charlotte McLaughlin and Michael Garry



Supermarkets are estimated to be responsible for around 3-4% of the total energy consumed in an EU country, according to a 2016 report by the EU-funded SuperSmart project.

The report of the project, which was funded under the EU's Horizon 2020 programme with the collaboration of partners including shecco (publisher of this magazine), noted that a large proportion of the average European supermarket's total energy costs come from lighting, heating, ventilation and air conditioning, with the biggest share coming from refrigeration. Analysis collated by SuperSmart revealed that refrigeration typically takes up 35-50% of total energy use.

Reducing the energy consumption of supermarket refrigeration systems, therefore, can deliver significant cash savings. With European supermarket chains increasingly turning to natural refrigerants as market-ready alternatives to the HFCs being phased down under the EU F-Gas Regulation ([see our feature in the spring 2017 edition of *Accelerate Europe*](#)), this Technology Focus looks at the current state-of-play regarding CO₂ and hydrocarbon technologies in Europe's food retail sector.

The efficiency debate

A study conducted by HVAC&R component manufacturer and solutions provider Emerson, in conjunction with German research institute ILK Dresden, sought to compare the efficiency of CO₂ and hydrocarbon systems. The research, published in January 2018 and conducted from 2015 to 2016, purports that hydrocarbon integral (or self-contained) display cases with a condensing water loop are more efficient than remote CO₂ transcritical rack systems.

To compare the CO₂ and R290 setups, the study focused on a typical European discount store with 10 display cases and a vending area of approximately 1,000 m² (which is within the most common size category for a European supermarket as identified by the SuperSmart report).

The analysis compared integral propane (R290) and remote CO₂ systems and found that by opting for the propane setup, retailers could achieve savings on maintenance, energy consumption and refurbishment of €50,000 per store over a 10-year period.

"Any operator with 10,000 stores could therefore achieve potential savings of more than €500,000,000 over a ten-year lifespan of their refrigeration systems," said Emerson in a press release.



CO₂ transcritical on the march

Many of Europe's leading retailers – including Sainsbury's, Carrefour S.A., METRO AG, Coop, Transgourmet, Aldi Süd, Recheio and Ahold Delhaize (see previous editions of *Accelerate Europe*) – have already opted for CO₂ transcritical to service most of the refrigeration needs in their stores, sometimes in conjunction with free-standing hydrocarbon cabinets.

Europe is estimated to have 14,000+ supermarkets with CO₂ transcritical technology, according to research by shecco's market development arm sheccoBase.

First-mover advantage

In view of the Emerson report's conclusion that hydrocarbon solutions can be more efficient, what may have motivated these retailers' decision to go for CO₂? In economics, 'first mover advantage' refers to when a company gets an advantageous and perhaps unbeatable market position by being the first to market. In some ways CO₂ is a commercial refrigeration success story in this regard. Retailers looking for a sustainable, energy-efficient solution settled on CO₂ remote racks as they were suited to the size of their supermarkets and were available commercially at the time they started to make the transition away from HFCs.

Some retailers say that the hydrocarbon-based commercial refrigeration equipment available at the time was not capable of servicing entire stores when they made the decision to adopt natural refrigerants.

"Around 2008, we decided to go for natural refrigerants in light of recent developments at that time," David Guthörl, head of the 'Energy/CO₂ Sustainability Unit' at Swiss retailer Coop, told *Accelerate Europe*. "Plug-in units [or so-called] water-loop systems as they are known today were no option because they did not exist in this form," he says. Nearly half of Coop Switzerland's supermarket portfolio (400 of 850) uses CO₂ as the sole refrigerant, the company stated in 2017.

"These days, hydrocarbon plugin units are still used to complement CO₂ technology, for example, in conjunction with remote cabinets, due to the flexibility which those systems provide," Guthörl explains.

Collin Bootsvelde, a project engineer at Belgium's Colruyt Group, says: "Water-loop systems with a very small, water-cooled cooling system on top of the cabinet were not available for our needs in 2015."

The retailer has opted for propane chillers in its stores in Belgium and CO₂ remote systems in its Colruyt prix-qualité stores (one of the brand names under which the Colruyt Group operates in France).

"We are looking for solutions for our small [Belgian] store format (OKay Compact). Integral cabinets with a water loop are an option," Bootsvelde notes.

'First mover' commercialisation plays an important role here. "By early 2017, it is thought there were almost [...] 700,000 hydrocarbon integral units. The number of stores wholly converted to hydrocarbon integrals with water-cooled loops is much smaller, estimated at around 500 today, but is growing," states the Emerson report.

AHT Cooling Systems GmbH, for its part, is a leading manufacturer of self-contained units in the supermarket and ice-cream sectors. "800,000 of our propane-based units have been installed in supermarkets worldwide," says Reinhold Resch, vice-president (R&D) at AHT. "700,000 of these are in Europe."

What about heat reclaim?

The Emerson/ILK Dresden study does not include heating or air-conditioning costs in its energy, installation or running costs breakdown, a factor readily acknowledged by Eric Winandy, director (integrated solutions) at Emerson Commercial & Residential Solutions and his colleague Thomas Tomski, vice-president (marketing).

Yet system integration can lead to cost savings. Instead of having separate HVAC and refrigeration systems, retailers are increasingly looking at combining them into one HVAC&R solution.

Delhaize Belgium, part of the Ahold-Delhaize group, is using heat reclaimed from a CO₂ rack installed in a Brussels supermarket to warm the greenhouse of a rooftop 'Urban Farm', as well as to provide heat and hot water for the store below ([see Accelerate Europe, spring 2018 edition](#)).

Research conducted by SuperSmart, citing several studies, contends that heat recovery can increase the total COP of a CO₂ transcritical system by 20%.

Colruyt's Bootsvelde is in a good position to compare the performance of CO₂ and hydrocarbons. "In France, our Codifrance colleagues have opted for CO₂ cooling," he told *Accelerate Europe*. "The main reason was that we did not have the engineering capacity in Belgium to support the introduction of hydrocarbon chillers in France and CO₂ was commercially available."

They used heat reclaim in these stores. "The first impression is a disappointment. The COP has gone down significantly and the energy savings are not as large as expected. We found that the integration on the hydraulic side needs improvement. In the end both CO₂ and hydrocarbon systems need to transfer their heat to a water-based distribution system, so this part is essentially the same for both," he says.

On the other hand, Bootsvelde says, "a CO₂ system can provide hot tap water, whereas our hydrocarbon chillers cannot. Theoretically it would be possible to use the superheat from the hydrocarbon chillers to provide 10% of the waste heat at high temperature levels".

The Colruyt Group is currently testing CO₂ heat pumps for tap water. "The nominal 3.5 kW heating power satisfies perfectly the needs of our butcheries in Colruyt supermarkets," he explains. "The results are satisfying, but we are disappointed to see so few Japanese manufacturers bringing these heat pumps to the European market."

"Also we have noticed that the CO₂ heat pump is very effective in heating cold tap water to 65°C but that the efficiency drops when we introduce a recycle of hot water, which is necessary in larger systems. In that case hydrocarbons would become an interesting possibility," he says.

“The comparison between CO₂ rack systems and hydrocarbon-based cabinets needs further studies before any conclusions can be made. Both systems have their advantages.”

— Jaana Tiura, Viessmann



Commercial refrigeration display case at Emerson's Europe Solution Center in Aachen, Germany.



Dealing with warm ambient climates

Efficient heating and cooling depends not just on the choice of refrigerant but also the location of the system. CO₂ used to be seen as inefficient in warm climates as the refrigeration system gets closer to the transcritical point. But developments like ejectors, parallel compression and adiabatic cooling are helping to mitigate this.

"Thanks to the parallel compressor and the ejector, the summer COP is now very good and comparable with the HFC gases," Enrico Zambotto, refrigeration director at Arneg (a leading provider of commercial refrigeration equipment using both hydrocarbons and CO₂), told *Accelerate Europe*.

Coop's Guthörl agrees: "The difference in climate can be mitigated by the ejector which provides the necessary efficiency boost of the CO₂ technology (in cold as well as in warm climates). In the cold climate more heat is needed for heating [through heat reclaim], which is comparable with cooling at high ambient temperatures."

In hydrocarbon cabinets, he asserts, "the energy usage still is far from efficient as the waste heat emitted has to be dealt with separately".

Integral water-cooled systems cited in the Emerson/ILK study can solve this problem. "The study was based on self-contained hydrocarbon cabinets with a condensing water loop," says Emerson's Tomski. "Therefore, heat is transferred outside of the store."

Emerson's Winandy told *Accelerate Europe* that both of the tests done by ILK took place in Germany, in relatively low ambient temperatures. They conducted a sensitivity analysis showing that using hydrocarbon cabinets in Barcelona gains a 10% efficiency edge over CO₂, as propane works better in warmer conditions. In the colder climate of Gothenburg, CO₂ gained 4% over hydrocarbon technology.

AHT hails the energy savings from using the heat that is rejected by hydrocarbon cabinets. "During spring, autumn and winter, you can save energy, because the 'rejected heat'

will be re-used to heat the store," argues AHT's Werner Schwaiger. "For us it is clear – hydrocarbons are the best technology in terms of energy saving (reduction of CO₂)."

Maintenance is important too

The Emerson report also contends that retailers can save on installation and maintenance costs by opting for hydrocarbons over CO₂. Tomski admits that the study "questions the architecture [of the] remote system" that represents a large part of the CO₂ market.

Yet Benjamin Tissot, sales engineer at the European arm of Japanese firm SANDEN, argues that maintenance costs are also low for CO₂, because the equipment is durable and has a long lifetime.

"With hydrocarbon cabinets, if you have a problem you might simply decide to throw them away," he suggests, while remote CO₂ systems have "more durability" and maintenance can be done away from the shop floor.

With hydrocarbons, "the difference is that you don't have rack and machine rooms, so you don't need certain check times and certain steps," says Emerson's Tomski.

AHT, meanwhile, argue that their self-contained propane cases – including multi-decks and deep freezers – are designed to offer a simpler alternative to remote systems, one that provides retailers in urban environments "with more flexible spaces," said Drew Tombs, president of AHT Cooling Systems USA, during a recent Emerson E360 webinar.

“Remote CO₂ systems have more durability.”

– Benjamin Tissot, SANDEN

Changing times

As technology improves, so does system efficiency. Manufacturers of hydrocarbon and CO₂ system components all boast of the efficiency gains that their technologies can deliver. “Understanding the impact [of new hydrocarbon and CO₂ technology] would require a detailed study,” admits Emerson’s Winandy.

An increase in hydrocarbon charge limits would also change the game. AHT’s larger units, such as some of its multi-decks, are designed with multiple propane circuits (each still under 150g) to accommodate bigger loads, says AHT’s Tombs. With a higher charge limit, one circuit would be sufficient, reducing the cost of the cases.

In the meantime, “we have invested in how to do micro-distributed systems with multiple circuits that can still meet current regulations and bring propane into the market while legislation continues to look at [charge] increases,” says Tombs.

Even if higher hydrocarbon charge limits come into being, Sanden’s Tissot argues that some retailers would still need to get over the “psychological barrier” of using hydrocarbons.

“There have been reservations about hydrocarbons [being] flammable,” acknowledges AHT’s Schwaiger.

Indeed, this is one of the reasons why Coop opted for CO₂. “It’s non-flammable and therefore, the safety requirements to deal with the gas are relatively low,” Guthörl says.

Colruyt, which opted for hydrocarbon chillers in its Belgian stores, offers up a different opinion. “Hydrocarbons are much easier to handle, requiring lower

pressures,” says Bootsvelde, “but they also require trained personnel to handle the refrigerant circuit”.

For Viessmann’s marketing director, Jaana Tiura, “the comparison between CO₂ rack systems and hydrocarbon-based cabinets needs further studies before any conclusions can be made”.

“Both systems have their advantages,” Tiura told *Accelerate Europe*. She cited multiple variables such as store location and size, geographical and climate conditions, the presence of other HVAC technology, and the in-store share of chilled and frozen food categories as influencing the optimal system to choose. Viessmann supplies hydrocarbon cabinets and has come up with a propane heating, cooling and storage solution for commercial refrigeration.

While comparisons between CO₂ and hydrocarbon systems are difficult to make given the many variables in play, it is clear that many European retailers are opting for natural refrigerants.

The SuperSmart project is seeking to create a benchmark by drafting criteria for a proposed “new EU Ecolabel for food retail stores”.

■ CM & MG

“For us it is clear – hydrocarbons are the best technology in terms of energy saving (reduction of CO₂).”

– Werner Schwaiger, AHT

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HARNESSING WATER FOR COOLING

Accelerate Europe takes a look at three innovative companies employing water as a refrigerant in centrifugal, evaporative and absorption cooling for air-conditioning and refrigeration purposes.

– By Charlotte McLaughlin

Water (referred to as R718 as a refrigerant) is one of the earliest providers of cooling. Harnessed in the form of snow and ice since 1,000 B.C., it was first used to preserve food by the Persians in around 400 B.C. when they started putting ice in a pit called a Yakhchal (a primitive type of evaporative cooler).

Since these early beginnings water – which is readily available, odourless, colourless, non-toxic and non-flammable, and has zero ozone-depleting potential (ODP) and zero global warming potential (GWP) – has been little thought about as a cooling technology.

This is changing as three innovative companies, solely focused on water as a refrigerant, are employing very different technologies to use water for air-conditioning and refrigeration purposes – heralding a return to this most natural of natural refrigerants.

THE CENTRIFUGAL WATER-CHILLER

German company Efficient Energy has been winning awards for its eChiller, which employs a centrifugal system.

In 2016 it won a German Refrigeration Award and in 2017 it won two awards – one from the Future Thinking Data Center conference and the other from the company Partslife.

The eChiller uses a turbo motor to evaporate and condense water in a vacuum to provide cooling and reject waste efficiently, according to Jürgen Süß, CEO of Efficient Energy.

Its COP is four times higher than an R410A system, offering electricity savings of 50,000 kWh, electricity cost reductions of €7,000 and emissions reductions of 31 tonnes CO₂e, as demonstrated over the course of 2015 in a data centre application: namely the server cooling racks, says Süß.

Field tests have also shown that it provides 35 kW refrigeration capacity even in warm ambient conditions – and is therefore capable of providing year-round cooling.

Production costs are also low. Most of the components can be made of plastic due to the low pressures that are used by the machine, according to Süß. Low pressures of 10 to 100 mbar mean they “don’t have to comply with pressure regulations,” Süß says, making the units safe and economical to produce.

The eChiller has been commercially available since the last quarter of 2017, following a test phase. It has primarily

been installed in data centres, but also in plastic modelling, the chemical industry and the car industry.

"One project was to cool a building," Süß told *Accelerate Europe*. Efficient Energy is seeing more market success as word gets out about the chiller. "They tell their colleagues what we have been able to achieve, and they contact us," he says.

"We are now doing three to five projects a month," he adds. This year Efficient Energy is hoping to install between 75 and 100 of the chillers. "It will be a three-digit number by the end of the year," he believes.

SOLAR COOLING YOUR HOME, YOUR NEIGHBOURHOOD

Purix, established in 2011 in Denmark and with an Italian subsidiary in Bari, offers a conventional absorption cooling system with a difference. The big difference is that it is hooked up to a solar heating system to provide renewable energy.

The units are a plug 'n' play modular system design, meaning they can be stacked together in a system for higher capacities. They can deliver cooling capacities from 2.5 kW right up to 160 kW, using water as the refrigerant.

The company is mainly targeting the residential and district cooling sector with this technology, seeing potential in its ability to replace traditional air-conditioning technology. "The largest market segment for air conditioning is systems with low cooling capacities below 10kW. Global cooling demand is growing fast, and we can see great market potential," Lars Munkøe, co-founder and director at Purix Aps, told *Accelerate Europe*.

Compared to a traditional HFC-based direct expansion split air-conditioning system with an A class EU energy rating, the Purix system was found to deliver an 85% reduction in CO₂ emissions and electricity consumption, according to Munkøe.

For Munkøe, in countries that have experienced power outages from high air-conditioning use like Australia, "it's a matter of whether you have cooling or not".

The attachment of a solar generation system negates the need for electricity. "I don't think you can go anywhere and buy a solar absorption system," he says. Absorption cooling and solar generation can be integrated but are usually sold separately, he says, meaning consumers are responsible for choosing the most environmentally friendly and stable option.

The system can also be hooked up to an existing solar heating system, a gas boiler or a district heating network. "There is high potential with district heating networks," says Munkøe, "where the heat is not used during the summer months".

This type of system would be well suited to Italy's warm summer climate, he believes. According to trade body Euroheat & Power, the southern European country has 303 district heating systems, which could use the heat that does not need to be produced in the summer months for cooling instead.

The product also is able to cope with warm ambient temperatures. "Italy is very far south and we have a factory there," Munkøe says. The company also believes this technology could be employed in data centres.

Munkøe predicts strong growth for the company. "Annual growth will be 50% in 2018," he says.

EVAPORATING THE HEAT AWAY

HVAC firm Oxycom can evaporate one cubic metre of water to deliver almost 700 kWh of cooling. In a power plant, for example, the same amount of water is used to generate just 50 kWh of electricity, according to Oxycom – which conventional split air-conditioning systems can convert to no more than 150 kWh of cooling.

The Dutch company uses evaporative technology to recirculate water to pre-cool the ambient air. As no humidity is added, the air leaving the heat exchanger has a lower dry bulb and wet bulb temperature than the outside air.

BELOW
Efficient Energy's
water chiller.

"Over the past 10 years we have developed indirect evaporative cooling with the main goal of being as good as traditional air conditioning but saving 90% energy, and we managed," Hans Reinders, CEO of Oxycom, told *Accelerate Europe* at Mostra Convegno Expocomfort in Milan, Italy in March 2018.

The company typically installs the system in building environments and in pre-condensing cooling chillers to increase the efficiency of chiller systems. "We make chillers just 30-40% more efficient," Reinders says.

The inter-cool system works like traditional air conditioning, he says, explaining: "The unit filters the air, the

unit heats the air, the unit cools the air, and all that with 80-90% savings."

The company has made installations in the United Arab Emirates (UAE) and Saudi Arabia as well as in its home market of the Netherlands.

"Mostly we have installed them in industrial spaces, in warehouses and in production places, where there are lots of people. We all know that indoor air quality is very important," Reinders says. "We know that if we can create quality indoor air in a production environment, then you can get 5-10% more performance of your people, you get 30% less sickness, and all that due to the simple fact that you have clean air."

Reinders argues that heating and cooling with evaporative technology can help homeowners to save on their air-conditioning and heating bills.

"A typical Dutch home uses 150 euros per month in gas and electricity," he argues. "If we can bring that down to 75 euros, we would save a lot on CO₂ and energy costs for a home."

All these different companies using water as a refrigerant are showing that R718-based technology is a viable energy-efficient solution for cooling that does not have to contend with some of the problems facing other refrigerants. ■ CM



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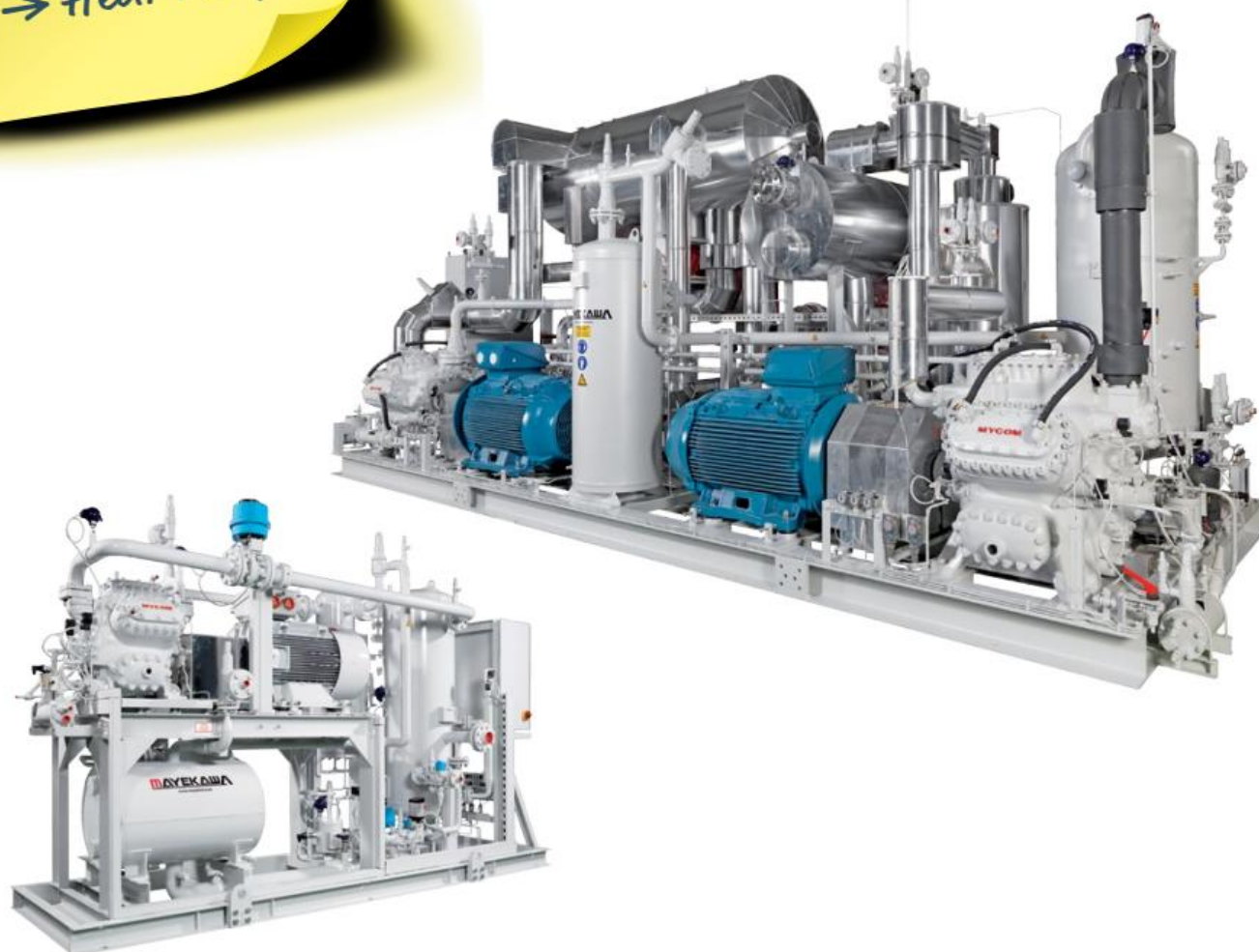
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