

WINTER 2017

ACCELERATE

ADVANCING HVAC&R NATURALLY

EUROPE

Menno
van der Hoff

p. 16

Person of the Year

Europe's market disruptor





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A time to celebrate

— Editor's note by Andrew Williams



The past twelve months have been full of innovation in the HVAC&R sector. Here at *Accelerate Europe*, as we begin to look ahead to next year, it's time to take stock of 2017 and naturally (pun intended!) to celebrate the people, companies and ideas that are disrupting the HVAC&R industry and making the business case for natural refrigerants even more compelling.

In an evening ceremony at our ATMOsphere Europe conference in September, five visionary movers and shakers were recognised with *Accelerate Europe* awards for their unique contributions to advancing natural refrigerants.

Our cover star, Menno van der Hoff, has devoted much of his career to furthering the cause of natural refrigerants in HVAC applications. I sat down with the Person of the Year award winner to find out what makes him tick ([p. 16](#)).

ATMOsphere Europe participants in Berlin were asked to choose the Innovation of the Year award winner in an exciting poll. End users, meanwhile, were recognised with Best in Sector awards in three different categories – food retail, light commercial, and industrial. I won't

spoil the surprise – turn to [page 20](#) for profiles of our lucky winners.

With Europe's industrial and commercial refrigeration sectors already adopting natural refrigerants at lightning speed, ATMOsphere Europe also focused on potential new growth areas – such as transport ([p. 38](#)). Buses are one area where natural refrigerants can make an impact here. We were at Busworld in Kortrijk, Belgium, to find out more ([p. 44](#)).

The HVAC theme continues with a journey to Denmark, where subsidies are supporting district heating networks that harness heat pumps to help reduce emissions and improve efficiency ([p. 26](#)).

Subsidies are helping to support the HVAC&R market in Spain too. At our ATMOsphere Ibérica conference in Madrid, the Spanish Environment Ministry announced a new subsidy that will help facilitate the transition to natural refrigerants ([p. 46](#)).

November's Meeting of the Parties to the Montreal Protocol in Montreal, Canada followed news from the preceding Conference of the Parties in Bonn, Germany that the Kigali Amendment will enter into force on the earliest possible date: 1 January 2019. We were

in both places to find out how these policy developments will affect the natural refrigerants market ([p. 50](#)).

The French government's ambitious environmental agenda, meanwhile, is helping natural refrigerants to take off in France. We were at Sifa, France's most important HVAC&R trade show, to find out about how regulation is influencing the market ([p. 60](#)).

With a majority of ATMOsphere Europe participants identifying heat pumps as the most promising future growth area for natural refrigerants, this issue's Technology Focus looks at what's needed to facilitate the transition away from HFCs ([p. 68](#)).

Coverage of the hydrocarbon standards process ([p. 54](#)), the HFC phase-down in Southeast Asia ([p. 56](#)), and compressor technology innovations ([p. 74](#)) are among other stories waiting for you in this winter edition.

Thank you for your loyal readership in 2017. On behalf of the *Accelerate Europe* team, I wish you and your loved ones a Merry Christmas, and a healthy and prosperous New Year. We look forward to bringing you more exciting natural refrigerant coverage in 2018! ■ AW



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ACCELERATE

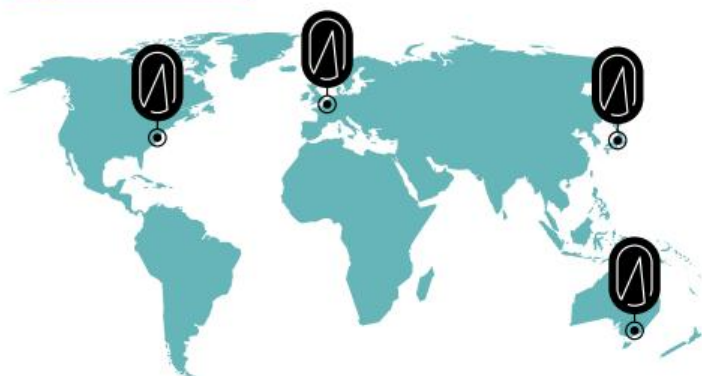
ADVANCING HVAC&R NATURALLY

EUROPE

About Accelerate Europe

Brought to you by shecco, the worldwide experts in natural refrigerant news, *Accelerate Europe* is the first quarterly news magazine written for and about the most progressive business leaders working with natural refrigerant solutions in all HVAC&R sectors.

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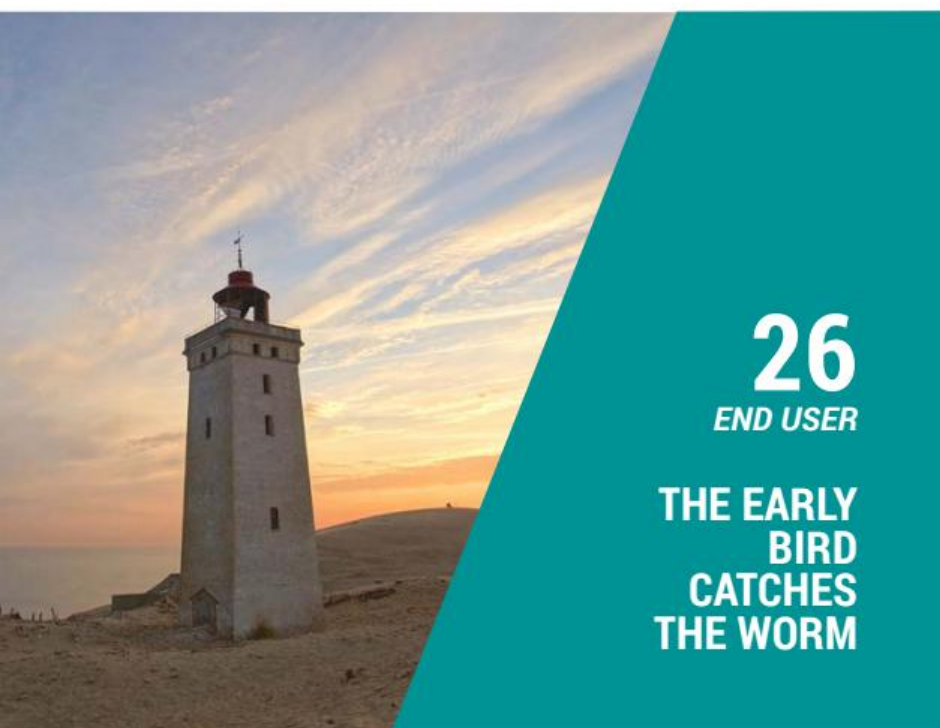
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We're on the right track

2018 is almost upon us and promises to be an exceptional year for the cooling sector. How so? The F-Gas Regulation's EU-wide quota system (the 'EU phase-down') is showing its impact through a stronger price signal.

The intention of the EU's F-Gas Regulation is to foster innovation using a market mechanism of increasing the scarcity of HFC supply. This approach was also favoured by many industry stakeholders wanting to avoid sectoral bans. It was never the intention that the accompanying prohibitions in the Regulation would be the principal driving force for change, as some stakeholders seemed to think until quite recently.

Just a year ago, conditions in the sector appeared fairly relaxed. Gas prices were low, and relevant actors had prepared for any shortages and built up their supplies. Things have now changed: the policy signal is there and it is time to respond. The steepest step in the EU phase-down is between 2017 and 2018, when the overall allocated quota goes down from 93% of the original baseline to only 63%. In addition, HFCs that are imported in pre-charged equipment have also been covered by the quota system since January 2017, reducing quota availability by another few percent.

The phase-down affects all sectors. According to conventional theory, change will happen in the sectors where it is easiest and cheapest to do. However, everyone is also in the same boat: if one sector is complacent about moving to more climate-friendly technology, then all others will have to do more. The softness of the landing will be determined by the sum of individual actions taken by all players on the market.

The phase-down will require a 79% reduction of HFC consumption and production by 2030. A back-of-the-envelope calculation tells us that the average GWP of HFCs used in 2030 should therefore be no more than 400. This is of course excellent news for all alternatives that are well below this threshold...

We are first movers in Europe, but with the Kigali Amendment to the Montreal Protocol, we have now also created a level playing field in a globally-agreed, worldwide technology conversion which should create significant new business opportunities for European companies.

Let us therefore accelerate our efforts and make the EU phase-down a success!

All the best for 2018!

Arno Kaschl

Arno Kaschl works in DG CLIMA at the European Commission. His principal objectives are implementing the EU's fluorinated gas policies and supporting the international negotiations under the Montreal Protocol to put into effect a global phase-down of HFCs.



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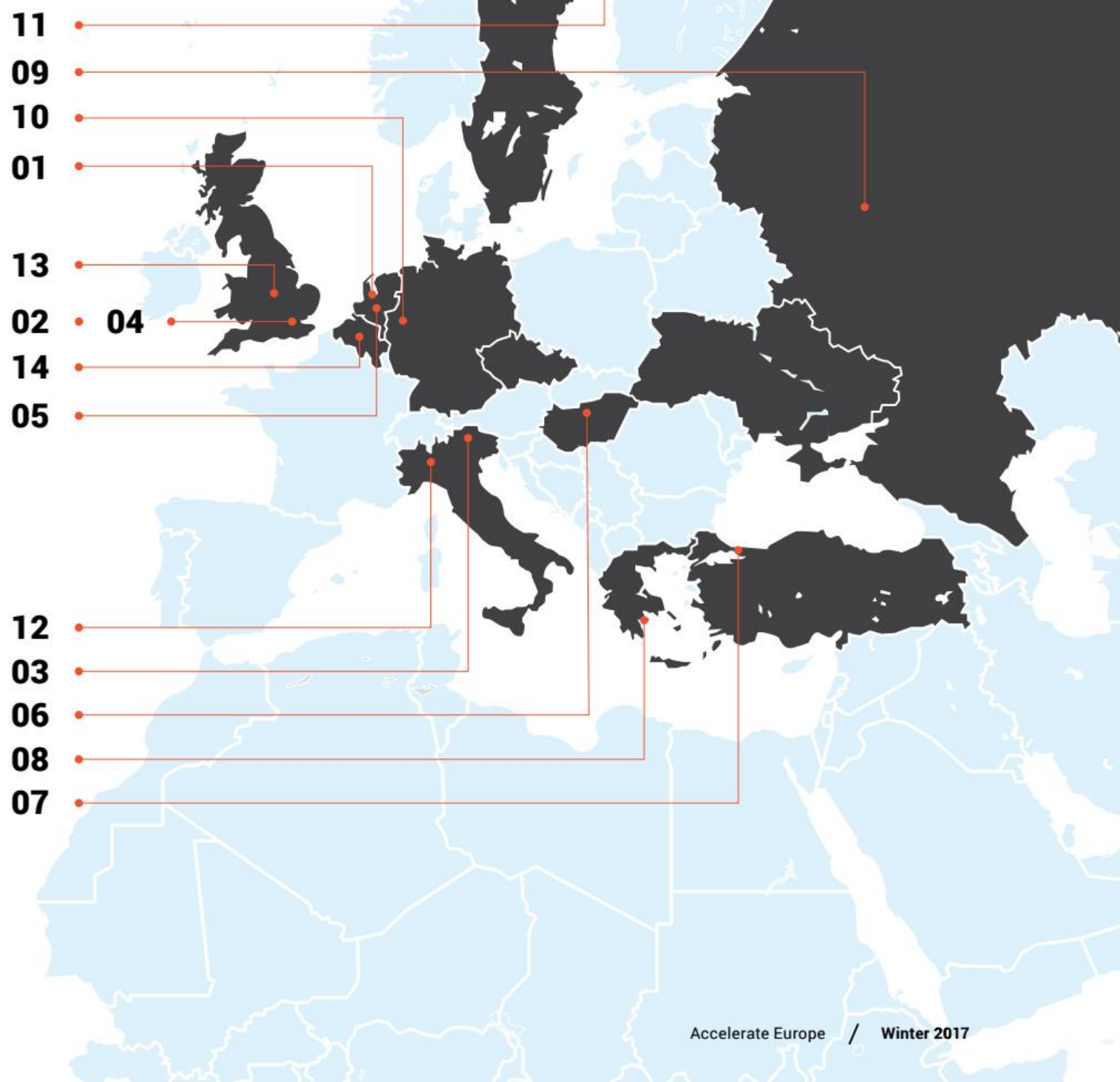
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EVENTS GUIDE

Jan / Feb 2018

Mar / Apr 2018



• **01** 8-11 January, Amsterdam, Netherlands
Horecava

www: <https://www.horecava.nl/>
twitter: @Horecava #Horecava

• **08** 9-12 February, Athens, Greece
Aqua Therm Athens 2018

www: <http://aquatherm.helexpo.gr/en>

• **02** 23-25 January, London, United Kingdom
The HVAC & Refrigeration Show

www: <http://www.hvacrshow.com>
twitter: @thehvacrshow #TheHVACRShow

• **09** 27 February-2 March, Moscow, Russia
Climate World

www: <https://climatexpo.ru/eng>

• **03** 24-27 January, Bolzano, Italy
Klimahouse

www: <http://www.fierabolzano.it/klimahouse/en>
twitter: @Klimahouse #Klimahouse

• **10** 6-9 March, Essen, Germany
SHK Essen

www: <https://www.shkessen.de/sectoral-meeting-place>
twitter: @SHK_Essen

• **04** 25 January, London, United Kingdom
IOR Annual Conference

www: <https://ior.org.uk/ior-annual-conference-2018>
twitter: @thecoolinghub

• **11** 12-15 March, Kiruna, Sweden
Cold Climate HVAC 2018

www: <http://www.cchvac2018.se>

• **05** 6-9 February, Utrecht, Netherlands
VSK International Trade Fair for Heating, Sanitary Engineering and Air-conditioning

www: <http://www.vsk.nl/en/Bezoeker.aspx>
twitter: @thecoolinghub

• **12** 13-16 March, Milan, Italy
Mostra Convegno Expocomfort

www: <https://www.mcexpocomfort.it/en>
twitter: @mcexpocomfort #MCE2018

• **06** 7-9 February, Budapest, Hungary
Sirha 2018

www: <http://sirha-budapest.com/en>

• **13** 16-18 April, Birmingham, United Kingdom
Foodex

www: <https://www.foodex.co.uk>
twitter: @Foodex #FDX2018

• **07** 7-10 February, Istanbul, Turkey
ISK-SODEX

www: <http://www.sodex.com.tr/en>
twitter: @ISK_Sodex

• **14** 24-26 April, Brussels, Belgium
Seafood Processing Global 2018

www: <https://www.seafoodexpo.com/global>
twitter: @euroseafood

EUROPE IN BRIEF

POLICY

CEN-CENELEC begins to remove barriers to hydrocarbons

European standardisation bodies CEN-CENELEC, in November, began to act on the European Commission's request to alleviate barriers posed by European standards that impede wider use of flammable refrigerants.

A European Commission report back in November 2016 had identified a number of standards that currently block the use of flammable HFC-free refrigerants. These standards could potentially jeopardise the European Union's ability to achieve the targets of its F-Gas Regulation.

Based on the report's findings, the European Commission had mandated European standardisation bodies to facilitate the update of relevant European standards, which CEN-CENELEC announced they would do. ■ [Klára Skačánová](#)

MARKET

HVAC has NatRef solutions

Air, water and ammonia have been successfully and efficiently used as refrigerants in chillers, heat pumps and air-cycle technology to provide heating and cooling in buildings. These different refrigerants were discussed as alternatives to high-GWP HFCs that are being phased down under the EU's F-Gas Regulation, during the ATMOSphere Europe 2017 conference in Berlin, Germany.

Germany-based GEA and Belarus-based Mavitech, with support from the UN Development Programme (UNDP), presented ammonia HVAC case studies. Japan-based Kawasaki Heavy Industries detailed its water as a refrigerant chiller and Ukraine-based UPEC explained how its Air-Cycle Turbo Technology (ATT) can be used. ■ [Charlotte McLaughlin](#)

RESEARCH

HFC reduction to play big part in keeping Earth below 2°C

Two teams of climate scientists working in conjunction announced, in September, that it is still possible to meet the goals of the Paris Agreement if action is taken now.

The groups of work, one published in the Proceedings of the National Academy of Science (PNAS) and another by the Institute for Governance & Sustainable Development (IGSD), outline three science-based strategies that could limit warming to well under 2°C and cite short-lived climate pollutants (SLCPs) as a key "climate lever" to keep the Earth well below catastrophic warming levels.

HFCs, along with other SLCPs, could avoid 0.6°C warming by 2050 and 1.2°C by 2100, the teams state in both papers. ■ [Charlotte McLaughlin](#)

MARKET

CAREL takes home sustainability award

CAREL won an award in the 'best environmental sustainability initiative' category at the World Beverage Innovation Awards 2017 in Munich, Germany for its Heez control solution for beverage coolers.

The Heez is designed to increase beverage cooler efficiency by managing the cooling systems, which typically use hydrocarbons.

"[This award] emphasises [...] our approach towards a more responsible and sustainable industry," said Alessandro Greggio, the CAREL Group's head of refrigeration and retail.

CAREL recommends adopting propane as the refrigerant, in combination with the Heez control solution, to help reduce environmental impact and energy consumption. ■ [Charlotte McLaughlin](#)

RESEARCH

New research finds propane performs better than alternatives

The University of Birmingham – supported by Emerson – released a report in October on 'Retail Refrigeration: Making the Transition to Clean Cold', finding that the benefits offered by propane systems in supermarkets could save millions through their energy efficiency and other operational costs compared to alternatives.

The report, authored by Professor Toby Peters of the University of Birmingham, cites a study conducted by independent refrigeration research institute ILK Dresden for Emerson that shows in a discount store with 10 display cases, integral propane systems (i.e. stand-alone or plug 'n' play systems as opposed to remote refrigeration systems) are €29,000 cheaper to install than CO₂ systems. ■ [Charlotte McLaughlin](#)

TECHNOLOGY

Enex upgrades commercial CO₂ system

An upgraded commercial HVAC&R CO₂ system from Italian designer and producer of refrigeration systems Enex allows for summer cooling and winter heating in a supermarket, using the energy from the compressors in a commercial refrigeration system.

The new concept can be used for any type of supermarket, whether small, medium or large.

The system also provides direct space heating and cooling, setting it apart from other systems, according to Enex President Sergio Giroto. "It is a heat recovery system in winter, but the advantage over existing systems is that there is direct heat transfer," Giroto explains. ■ [Charlotte McLaughlin](#)

HIGHLY EFFICIENT HYDROCARBON OPERATED COMPRESSOR TECHNOLOGY



EUROPE IN BRIEF

TECHNOLOGY

CO₂ TC vs CO₂-HFC cascades in warm ambients

Chiara Tognoli, Arneg, provided an analysis of two systems installed in similar supermarkets at ATMOSphere Europe in Berlin, Germany in September.

The first system is a CO₂ transcritical one with an ejector (in a 10,000 m² supermarket) and the other is a CO₂/HFC cascade (in a 9,500 m² supermarket). Both were installed in northern Italy.

The energy performance of the system was measured during the period August 2016 to August 2017, with conditions reaching 40°C in summer.

The CO₂ TC ejector system was found to save 9% over the twelve-month period with 60,300 kWh/year saved, which translates into a €10,800 annual saving for the end user compared to an HFC-CO₂ cascade. ■ [Charlotte McLaughlin](#)

POLICY

UK mulls fines for violating EU F-Gas Regulation

The UK Department for Environment, Food and Rural Affairs (DEFRA) conducted a consultation in October and November on introducing civil penalties for non-compliance with the EU's F-Gas Regulation.

The F-Gas Regulation governs the production and use of f-gases in the European Union, including by setting quotas for the import and use of HFCs. It also bans the use of certain HFCs in certain types of equipment.

If approved, the new fines would be introduced in April 2018, and would range in scale from £1,000 (£1,126) to £200,000 (€225,305). ■ [Marie Battesti](#)

MARKET

Maersk begins testing CO₂-cooled shipping containers

Maersk Line, the world's largest container shipping company, has begun testing 100 refrigerated shipping containers fitted with Carrier Transicold's NaturaLINE CO₂ refrigeration system at the port of Santa Marta in Colombia.

Back in March, Maersk Line ordered the first 100 of a total of 200 such containers. The shipping giant will initially deploy the units on closed-loop routes between Europe and the Americas.

The use of the NaturaLINE natural refrigerant systems is an important part of Maersk Line's larger corporate sustainability initiative to reduce its CO₂ emissions per container moved by 60% by 2020 (compared to 2007 levels). ■ [Andrew Williams](#)

RESEARCH

Southern European demand for air con to grow

Rising average temperatures due to climate change are increasing demand for comfort cooling in southern Europe, according to research published in the Proceedings of the National Academy of Sciences (PNAS).

The first six months of 2017 were the second warmest six-month period since modern records began, with 2016 being the warmest, according to NASA.

Wenz *et al.* contend that southern and northern Europe will experience dramatically different temperature changes. "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)," they write. ■ [Charlotte McLaughlin](#)

MARKET

Bitzer's Glass set for IoR presidency

Bitzer UK Managing Director Kevin Glass will be the next president of the UK's Institute of Refrigeration (IoR) after his nomination passed at the AGM on 2 November 2017.

The president-elect will support the existing president, Steve Gill, until his term of office ends in November 2018.

Glass had previously served on the IoR board of trustees and sat on the membership committee. ■ [Andrew Williams](#)

TECHNOLOGY

30-second installation for new 150 bar CO₂ pipe

Rapid Locking System (RLS) has developed the 'Stainless Press-To-Connect System' pipe (150 bar) for use with CO₂ and can be installed in 30 seconds.

"It is the world's first press-to-connect stainless system engineered for high-pressure systems," General Manager Michael Duggan said at ATMOSphere Europe 2017 in Berlin, Germany.

The system does not need welding, according to Duggan, therefore you have "savings in labour costs".

The piping has been in development for three years and has already been granted a patent, with other patents still pending. Duggan stated that the system would also have lower leak rates than the welded alternatives currently on the market. ■ [Charlotte McLaughlin](#)



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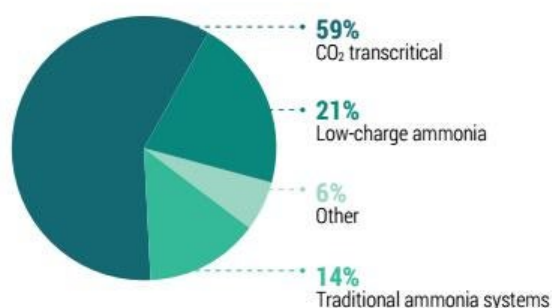
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- **GLOBAL:** one solution for all markets, sustainable in warm climate and super efficient everywhere, in all seasons
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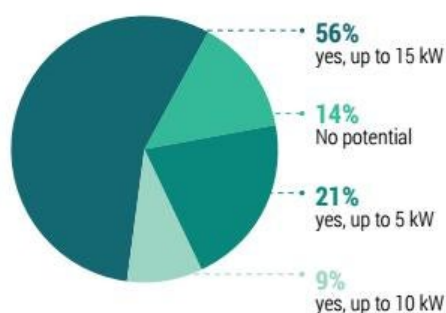
A window on Europe

ATMOsphere Europe participants opine on the direction – and regulatory drivers – of natural refrigerant uptake in Europe.

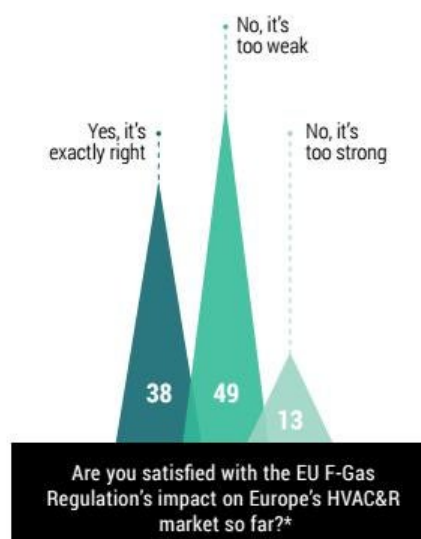
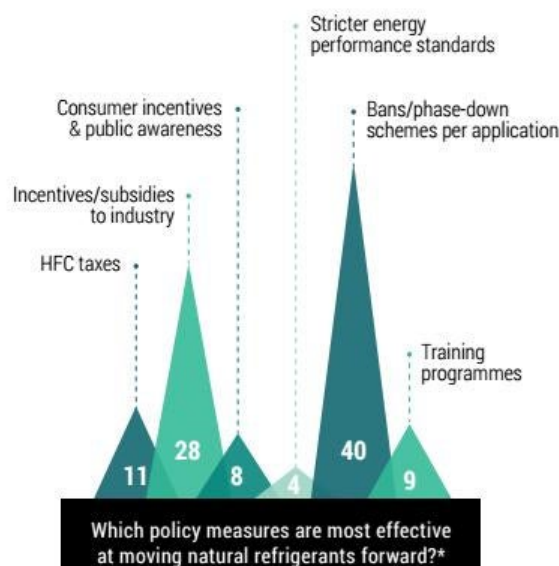
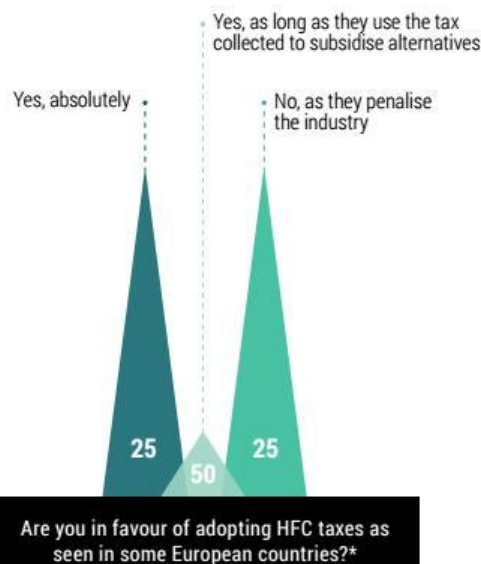
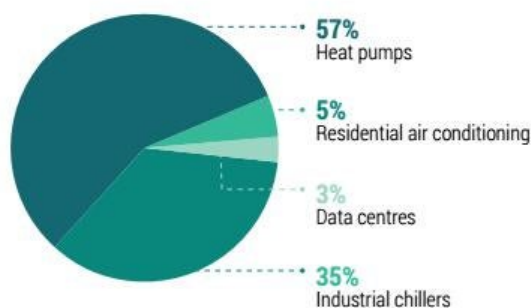
What will be the dominant technology for industrial refrigeration in Europe in 10 years' time?



Do you believe there is potential for hydrocarbons in large cooling capacities (above 1 kW) for commercial refrigeration applications?



Excluding commercial refrigeration, which industry sector do you expect to record the fastest growth in natural refrigerant adoption?



* All figures are percentages.



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Menno van der Hoff

Photo: Ben Beech

A labour of love

Menno van der Hoff has dedicated much of his career to furthering the cause of natural refrigerants in HVAC applications. *Accelerate Europe* sat down with the Person of the Year award winner to find out what makes the Dutchman tick.

— By Andrew Williams

As one of Europe's leading HVAC innovators, Menno van der Hoff is frequently on the move. Yet he rarely travels by air, preferring more environmentally friendly modes of transport such as the train or his bicycle. "When going on holiday, I stay at a campsite by the sea and ride by bike. A typical Dutch habit," Van der Hoff says with a smile.

Fresh from being crowned Person of the Year for his pioneering role in bringing to market the TripleAqua heat pump at the first ever *Accelerate Europe* awards at a 26 September ceremony held alongside the ATMOSphere Europe conference in Berlin (organised by *Accelerate* publisher shecco), he could certainly be forgiven for treating himself to a celebratory seaside break.

Van der Hoff was the driving force behind the development of the TripleAqua, an energy-efficient heat pump employing propæne (R433A), a mixture of the hydrocarbons propane (R290) and propene (R1270), with a global warming potential (GWP) of three and a charge of less than 11 lbs. (5 kg) (TripleAqua models up to 3CA65).

"TripleAqua is the world's first heat pump system in its market and size to operate on a natural refrigerant that is

able to heat, cool and store in one go," he enthuses. "It can easily redistribute heating and cooling around the building: the cooling energy of room A becomes the heating energy of room B."

Van der Hoff is head of R&D and HVAC manager at Uniechemie, a division of Swedish HVAC&R distributor Beijer Ref, which is marketing TripleAqua. According to Beijer Ref, TripleAqua can save up to 50% in heating and cooling costs in commercial buildings (including office buildings, hotels, supermarkets and hospitals) compared to traditional heat pumps, with a COP (coefficient of performance) between four and 10.

What's more, internal storage of both the heat and the cold allows the TripleAqua to meet demand in a passive manner. "This is totally new inside a heat pump. You double the efficiency, as you use the created thermal power twice," Van der Hoff says.

TripleAqua has the ability to store heat and cold in buffers for later use in the building, providing heating and cooling simultaneously or individually. It uses three rather than the customary four water-loop pipes to distribute heat and cold, and to return water at ambient temperature.

"The internal heat pump design and system concept is new: we have deleted the four-way valve, a common heat pump component," Van der Hoff explains.

Conventional heat pumps reverse the refrigerant flow, which reduces the efficiency of the heat exchangers. But with TripleAqua, the refrigerant cycle is no longer reversed between summer and winter mode. This means the heat exchangers are always and only used for the specific role for which they have been optimised.

"These are some of the novelties that have helped us to achieve top efficiencies," he says.

With many European governments pursuing green growth strategies, some are offering financial incentives to construct low-energy buildings. And much of Europe's ageing building stock is yet to be renovated. Looming HFC phase-down deadlines under the EU F-Gas Regulation are also raising interest in environmentally friendly HVAC solutions.

"All the success factors for the future are green," says Van der Hoff. "We're entering the market at exactly the right moment."

Van der Hoff studied telecommunications at university but had always enjoyed physics most at school. He wanted his first job to combine physics, electronics, mechanical engineering and climate control. "So I started in 1989 as a junior sales representative at Toshiba air conditioning."

Many would describe Van der Hoff as an inventor, yet the Dutch whizz is self-deprecating. "I do move at the forefront of applying new technologies, but I still see myself mostly as an HVAC engineer," he says. "My 'inventions' are all pretty straightforward."

The magic, Van der Hoff argues, lies in taking existing components and systems with proven track records and recombining them in a fresh manner to bring them to new areas of application. "To me, that's full HVAC engineering," he says.

New inventions are often more easily accepted if the applied technology or components have already been



The TripleAqua heat pump



TripleAqua provides heating and cooling

“Applying natural refrigerants in HVAC is or soon will be as logical as it is in your fridge at home, at your food manufacturer, or in your supermarket.”

– Menno van der Hoff

used in another field or sector. “I just happen to see new possibilities to do things slightly differently,” Van der Hoff says. “Architects never construct the same buildings again, but they’re not inventors either – they’re just innovative architects.”

For Van der Hoff, the beauty of HVAC lies in finding the optimal combination of physics, electrics, mechanical compression, energy, air, climate, and the gas laws of Boyle and Gay-Lussac. “HVAC really has it all in one. And you can make people very happy at work and at home by providing good climate control at the lowest energy costs throughout the year,” he says.

Asked when he became the natural refrigerants crusader that he is today, Van der Hoff replies modestly. “I don’t see myself as such a crusader,” he says. “Applying natural refrigerants in HVAC is or soon will be as logical as it is in your fridge at home, at your food manufacturer, or in your supermarket.”

“Some just need to start first and show others that it’s not that tricky,” Van der Hoff says. “The others will follow.”

He predicts a bright future for natural refrigerants in HVAC applications in

Europe. But with uptake currently rather small in scale, he calls for patience. “The move to natural refrigerants isn’t going as fast as I’d like it to,” he admits.

He puts this down to a fragmented market dominated by non-European manufacturers, and the fact that the rising prices of HFCs or HFOs are yet to significantly influence an HVAC market which tends to require only low charges of refrigerant.

Calling for more market accelerators to shake contractors and consultants out of their slumber, he urges governments in particular to put in place the policy ‘carrots and sticks’ that can help stimulate demand for natural refrigerant technologies.

Taxes, for example, help force financially driven end users to take account of the impact of refrigerants on the environment, he says, while government subsidies can help overcome the initial higher costs of ramping up production of new technologies.

“To accelerate the move towards natural refrigerants,” he argues, “we need more initiatives like TripleAqua, and to raise awareness among end users of the global warming impact of HFCs”.

He is dismissive of competition from new synthetic refrigerants. “HFOs do not need to play a role,” he says. “It is possible to move from HFCs to NatRefs without these ‘in between’ HFOs.”

Van der Hoff points to “significant disagreement” among scientists regarding the mid- to long-term impact of HFO emissions on the climate and on organic life. “It’s like history is repeating itself,” he sighs. “Don’t be surprised if HFOs are the next generation to be phased down.”

Personally, he sees no reason for heat pumps to work with high-GWP f-gases at all. “Buildings are responsible for 33-40% of the world’s total energy consumption. Two thirds of this usage goes on heating and cooling the buildings,” he says. “HVAC engineers should only apply technology which doesn’t leave a carbon footprint.”

So, what’s next for him? “I hope my vision, products and projects will be seen as proven examples to be broadly followed,” he says. “Also to convince the major suppliers and manufacturers in Asia and the USA to introduce environmental products too.”

■ AW



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REFRIGERATION



HVAC



LIGHTING



OTHER



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Honouring the trailblazers

Carrefour, Nestlé, the Staay Food Group, Viessmann and Menno van der Hoff received awards for advancing natural refrigerant adoption at an ATMOSphere Europe ceremony.

— By Andrew Williams

In an evening ceremony on 26 September at the ATMOSphere Europe conference – organised by shecco, publisher of the *Accelerate* magazine series – in Berlin, Germany, representatives of four companies and one individual were recognised with *Accelerate Europe* awards for their unique contributions to advancing natural refrigerants in Europe.

In selecting the Best in Sector Awards, the assessment criteria included metrics such as the number of installations of natural refrigerant systems, reductions in energy consumption and greenhouse gas emissions, commitment to future installations, and industry leadership.

The Innovation of the Year award looked at companies that had recently developed a particular natural refrigerant-based product with a significant impact on the market, with multiple installations in the field already. And for Person of the Year, we sought to recognise someone who has demonstrated clear leadership in forging new pathways for natural refrigerants in Europe – an individual who has changed the game.

Accelerate Europe profiles the winners on the following pages, while Person of the Year Menno van der Hoff is profiled in the previous article ([p. 16](#)).

All our winners reflect the mission of *Accelerate Europe*, which is to cover people, companies, technologies and ideas that disrupt the HVAC&R industry and advance the business case for natural refrigerants in Europe.





Left to right: Jaana Tiura (Viessmann), Jens Kallesøe (Advansor), Jean-Michel Fleury (Carrefour), Menno van der Hoff, Vincent Grass (Nestlé)

INNOVATION OF THE YEAR

CLICK4FOOD, VIESSMANN Tomorrow's shopping, today

At the EuroShop tradeshow in March 2017, Viessmann presented its 'Click4Food' solution using propane and isobutane for cooling. Fast forward to September, and ATMOsphere Europe participants – asked to vote in Berlin – chose the concept as the winner of the prestigious *Accelerate Europe* Innovation of the Year award.

Click4Food is Viessmann's answer to the European trend towards 'click & collect'-style shopping. It allows supermarket customers to order their shopping online and easily collect it from an external pick-up point – such as a train station, supermarket car park, petrol station, bus stop or airport.

"That was the big surprise for us, of course, that we were the winner of the Innovation award!" says Jaana Tiura, marketing director at Viessmann Refrigeration Systems. "I think it makes us humble, but of course very proud at the same time to have

been voted for from among the over 400 professionals here [at ATMOsphere Europe] working in the HVAC&R business."

Tiura sees the award as a clear sign that the HVAC&R industry is taking note of Europe's changing food retail environment. "Traditionally, we've been thinking that when people want to buy groceries, they'll go to a supermarket or discounter," she says. "In the future, people will have different needs and new channels in which they want to do their grocery shopping."

Viessmann's goal is to develop this 'click & collect' concept together with retail customers, expanding sales of refrigerated goods beyond the traditional grocery business.

"That's the innovation here – that we also need to think differently, and come up with new solutions for consumers," Tiura says.

The company has already installed Click4Food systems at locations in Sweden and Finland.

"Not everyone will buy online," Tiura admits. "But we believe that there is clearly a customer group who will start to use this kind of solution."



BEST IN SECTOR: FOOD RETAIL

CARREFOUR

Pushing the boundaries of CO₂

To reduce refrigerant emissions, the Carrefour Group is phasing out HFCs and replacing them with CO₂ for commercial refrigeration. Carrefour boasts over 400 stores with technologies using natural refrigerants worldwide, around 175 of which are fitted with CO₂ transcritical racks.

Overall the Carrefour Group is aiming to reduce carbon emissions by 40% by 2025 and by 70% by 2050 (compared to 2010 levels). There are around 12,300 stores under the Group banner in 35 countries and five continents.

This year, the retail giant has been testing CO₂ and hydrocarbon systems for its smaller Express store format. Factors ultimately influencing the decision to go for CO₂ or hydrocarbons include store size, equipment cost, and legislation in each country, according to Paolo Martini, refrigeration & HVAC manager for international support at the Carrefour Group.

Building on the results it is receiving from transcritical systems installed in two Brazilian stores in April 2016, Carrefour is also installing CO₂ systems in countries with warm ambient climates. The success of its installations in countries like Brazil, Italy and Spain proves that CO₂ refrigeration technology can now operate efficiently everywhere.

Assets Project Director Jean-Michel Fleury was in Berlin to receive the *Accelerate Europe* award on the Carrefour Group's behalf, in recognition of its uptake of natural refrigerants.

BEST IN SECTOR: LIGHT COMMERCIAL

NESTLÉ

Keeping cool with hydrocarbons

From industrial refrigeration systems with NH₃/CO₂ at key production sites in Switzerland to ammonia-cooled data centres and the worldwide deployment of hydrocarbons-based display cabinets, the commitment of Nestlé to natural refrigerants is consistent and firm.

By 2020, Nestlé is aiming to reduce greenhouse gas (GHG) emissions per tonne of product in every product category to achieve an overall reduction of 35% in its manufacturing operations (versus 2010). Also by 2020, the company is aiming to reduce GHG emissions in its distribution operations by 10% (versus 2014). Natural refrigerants have long played a central role in delivering this, in both the industrial and the commercial sectors.

Vincent Grass, Refrigeration Team Leader in the Corporate Operations – Engineering Services department at Nestlé, collected the Swiss multinational's award in Berlin, in recognition of its commitment to hydrocarbons for light commercial applications in particular.

With Click4Food, customers order their groceries online and pick them up at their own convenience. They receive a code via SMS to enter into the system. The code grants access to lockers containing the goods.

"Click4Food is a locker system for grocery e-commerce," Tiura explains. Lockers can be placed in most locations that are convenient. "Basically there are no limits as to where people could pick up their daily grocery shopping in the future."

"The benefit for the consumer is that you don't have to wait at home for home delivery," Tiura says. "You can easily [get your shopping] on your way back home from work, or on your way to work."

As with any retail format, food safety is paramount. "You have to keep the groceries at the right temperature, so therefore there are individual lockers for chilled food, for frozen food, and for ambient-temperature products," Tiura says.

Why did natural refrigerants come into the picture? "For us, it was clear from the beginning that we also want to make this a sustainable solution," says Tiura. "That's why we chose natural refrigerants for the locker system."



All Nestlé's new ice-cream freezers use hydrocarbons (either propane or isobutane). In 2011, Nestlé debuted its first hydrocarbon-based ice-cream chest freezer. Since 2014, all Nestlé's new ice-cream chest freezers in Europe are HFC-free (and since 2015, worldwide). Since 2016, all its new island and upright freezers worldwide use natural refrigerants.

By 2020, all new proprietary cold beverage dispensers of Nestlé Professional will use natural refrigerants.

BEST IN SECTOR: INDUSTRIAL

STAAY FOOD GROUP

The world's biggest CO₂ system

Dutch food company the Staay Food Group delivers fresh fruit and vegetables directly from growers to customers. As part of this service, it processes fresh fruit and vegetables into ready-made consumer products fit for supermarkets.

Jens Kallesøe, director (internal sales and projects) at Advansor, the Danish manufacturer of CO₂ refrigeration systems, collected the Best in Sector: Industrial award on behalf of the Staay Food Group. This year, Advansor completed the installation of a transcritical system at a Dutch lettuce processing plant managed by Staay.

The capacity of the system exceeds 3.36 MW, making it the largest CO₂ refrigeration project in the world.

Advansor has dedicated a team to the industrial sector that is separate from its traditional commercial refrigeration team, says Mark Kristensen, the company's industrial sales manager.

"We've realised that the demand for transcritical [in the industrial sector] has grown to the level where we can go in that direction," he says.

Most of Advansor's industrial transcritical systems operate in cold storage facilities. But blast freezing for food processing is a growing area "because we run down to -48°C," says Kristensen. "And you don't need a more complex cascade system; it's purely CO₂." ■ **AW**



THIS IS ENVIRONMENTALLY FRIENDLY

Parker HP3 is a control for reversible Heat Pump applications including the management of sanitary water and solar panel integration. HP3 has been developed to achieve the best efficiency using an advanced algorithm to optimize the performance of compressors, fans and hydronic pump. Parker offers also a complete product line suitable for natural refrigerants including an ATEX approved unipolar expansion valve CEV.



Parker control PSK3 for Rack CO₂ high pressure side is able to drive up to 5 valves including Gas Cooler and Flash Gas Bypass Valves and 3 modulating 3 way valves for heat recovery. The PSK3 stands as the perfect plug-and-play fit for any CO₂ rack controller when boosting energy efficiency and when optimizing the COP of CO₂ is the key.

Parker does its part in lowering CO₂ gas emissions by offering a full range of high efficiency products for commercial and residential application using CO₂ and Propane as refrigerants. This reflects Parker's commitment to solving the world's greatest engineering challenges.



ENGINEERING YOUR SUCCESS.

The early bird catches the worm

Denmark moved early to invest in district heating and natural refrigerant technology to reduce greenhouse gas emissions and increase efficiency, paving the way for the Scandinavian country to adopt large-scale, ammonia-based heat pumps.

— By Charlotte McLaughlin

For the Danes, the 1970s oil crisis hammered home the need to reduce energy consumption and invest in energy efficiency as oil prices skyrocketed. "This made it evident that it was necessary to save energy – including energy for space heating – to decrease dependency on imported fuels and to reduce consumers' heating expenses," states the Danish Energy Agency (under the auspices of the Danish Ministry of Energy, Utilities and Climate) in a report on district heating.

District heating networks centralise heating for entire residential and commercial areas, increasing the efficiency of heating compared to individual systems and thus saving costs.

Now two-thirds of Denmark's heat demand is covered by district heating networks, reports the Danish Energy Agency on its website, contributing to the Scandinavian country's "leading position in terms of renewable energy, energy efficiency and environmentally friendly heating systems".

It is difficult to assess the energy efficiency of district heating systems from country to country, but a 2009 report prepared for the UK government estimated that 'community heating' could save UK residents up to 60% on heating bills compared to utilities like gas or electricity.

The report also says that if a district heating network covering 250,000 houses were to be installed in the UK, it could prevent between

0.25 and 1.25 mega-tonnes of CO₂ emissions per year compared to residential self-heating.

Denmark already has the capacity to provide district heating to most people nationwide, putting the country in a great position to take full advantage of heat pumps' potential to boost energy efficiency and reduce direct emissions by availing of electricity rather than oil or gas.

A 2016 study investigating the potential for heat pumps in the Greater Copenhagen district heating system by *Bach et al.* concluded that heat pumps would significantly increase the supply of heating.

"Due to the higher COP, connecting heat pumps to distribution networks [like for district heating] results in significantly higher heat production," *Bach et al.* write.

The researchers found that a high-capacity heat pump could supply most of the heat energy required in an average year for a city like Copenhagen.

Harnessing natural refrigerants

To further increase the efficiency and sustainability of heating in Denmark, experts recommend using natural refrigerant-based heat pumps.

"Denmark is definitely among the world's elite within ammonia and other coolants for large heat pumps," Lars Reinholdt, an engineer at the



Early starter: Denmark has long been an enthusiastic adopter of district heating

Danish Technological Institute (DTI), told Danish public-private partnership the State of Green.

Reinholdt is running a testing laboratory for small- and large-scale heat pumps at DTI's refrigeration and heat pump technology centre in Aarhus.

Safe in the knowledge that district heating networks can boost heating efficiency, the Danish government is supporting large-scale heat pump installations using natural refrigerants. In 2015 the government awarded 10 large-scale heat pump installations in small district heating plants a total of DKK 26.6 million (€3.58 million).

"The goal of the subsidies is to demonstrate large-scale heat pumps in district heating systems," Thomas Capral Henriksen – chief consultant at Dansk Energi (the Danish Energy Association), which represents energy companies in Denmark (including producers and distributors of electricity and large producers of district heating) – told *Accelerate Europe*.

A 2016 report by the Danish Energy Agency confirmed that most of these projects would use ammonia as the refrigerant for large-scale heat pumps.

Henriksen, whose organisation follows the development of heat pumps, said that all the projects awarded subsidies in 2015 were likely to use natural refrigerants like ammonia.

"To our knowledge, all of the heat pumps are based on ammonia as the refrigerant due to HFC regulations in Denmark, which only allow the use of a maximum 10 kg HFC per unit," he said.

Denmark has stricter f-gas legislation than most other European countries, as it began to phase down HFCs in 2001, five years earlier than the EU as a whole (see *Accelerate Europe* #7 to learn more).

The Danish Energy Association has also supported the development of natural refrigerant technology through a research and development programme called ELFORSK.

"We are among the front-runners because funds have been allocated for development [under the ELFORSK programme] from the very start," says the Danish Technological Institute's Reinholdt.

Building heating takes time

Good progress has been made so far in Broager, a city in southern Denmark, which plans to install a heat pump at its district heating facility with funding from the Danish government.

The project was granted DKK 6 million (€806,306) from the Danish government in 2015 to install a groundwater ammonia heat pump, which is now almost complete.



"We can reduce our carbon footprint, so all the district heating customers in Broager contribute to the green change," Poul Bonde Christiansen, Broager's district heating manager, told the Project Zero website. "We're very much looking forward to the plant coming into operation. At the moment, we are testing the system and it looks really good."

The heat pump will reduce reliance on natural gas, according to the Broager project manager, Kresten Pedersen, who expects it to be completed soon. "We expect to cover 74% of the heat demand with the heat pump in the future [with the rest of the heat demand, namely] 17% [coming] from the solar heat and the remaining 9% from natural gas," Pedersen told Project Zero.

To ensure an adequate water supply from the ground to the heat pump, nine groundwater wells have been made nearby. Four of these are to source the water from the ground, while five are used to pump the (used) cooled water back into the wells, according to Pedersen.

The Rødkærø district heating plant in northwest Denmark has installed a heat pump that uses waste heat from industrial processes.

The ammonia heat pump, with the help of Danish system designer PlanEnergi, was inaugurated back in March 2016. It takes hot water at 25°C from Arla Rødkærø dairy treatment plant and heats it up to 73°C.

The project availed of DKK 2.4 million (€320,000) of funding from the Danish Energy Agency and received an additional grant from Midtjylland, the region in which Rødkærø is situated.

Some of the other recipients of heat pump subsidies are still carrying out environmental assessments. Johan Frey is manager of heating provider Dronninglund Fjernvarme, on Denmark's eastern coast, where the district heating network secured DKK 4.5 million

(€600,000) for a groundwater heat pump using ammonia as the refrigerant. He told *Accelerate Europe*: "We're still in the process of planning and examining the environmental impacts that the use of groundwater may cause."

The heat pump will supply 1,350 consumers with an annual 40,000 MWh/year of heating. This will be at an annual flow temperature of 75°C and a corresponding rendering return temperature of 40°C.

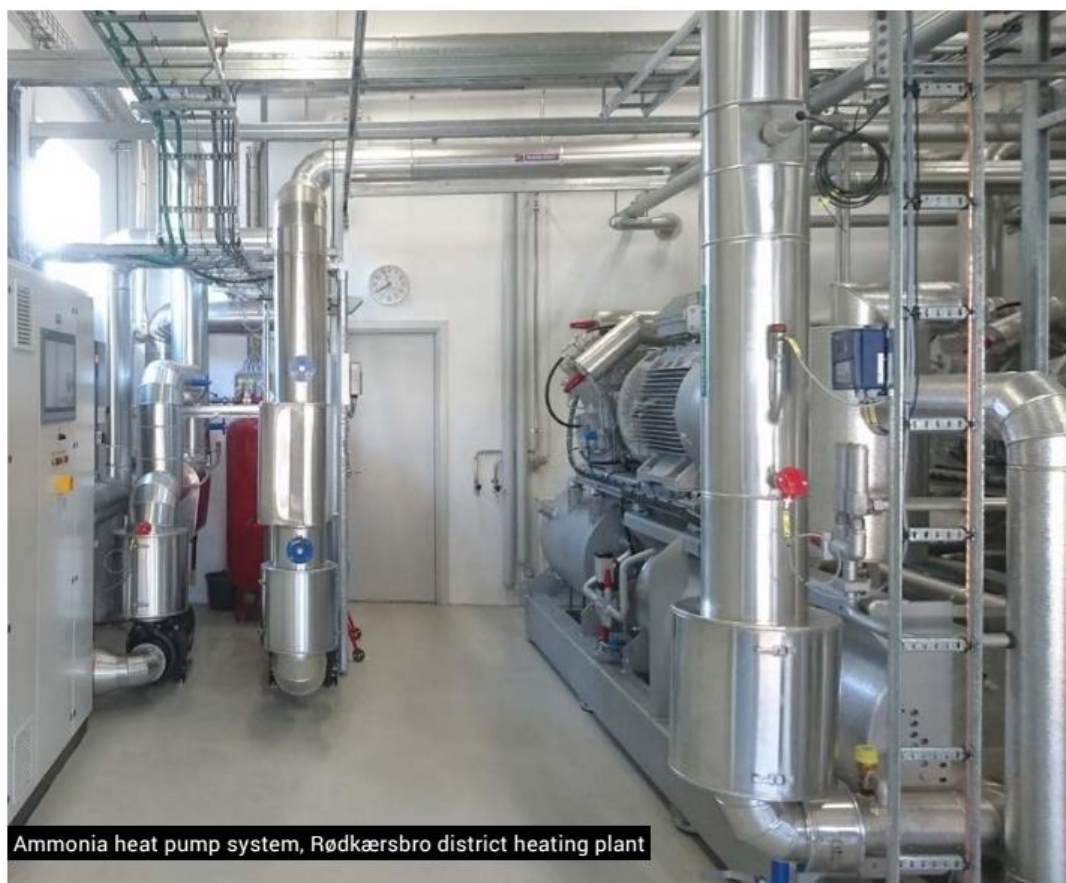
The 3.0 MW multistage heat pump will be installed and delivered with help from manufacturer Johnson Controls, PlanEnergi and Danish supplier AEA. "Maybe we will start building the plant in spring 2018," Frey said.

More subsidies, less tax

More heat pump projects will also be installed, the Danish Energy Association's Henriksen told *Accelerate Europe*, adding that subsidies would increase in the coming years.

The Danish Energy Agency announced it would put aside DKK 23.4 million (€3.14 million) in 2017 and DKK 27.9 million (€3.75 million) in 2018 to support electric heat pumps in small district heating networks.

Part of the motivation for all this investment is anticipation of new EU rules prohibiting the continuation of current subsidies for natural gas heating, according to Henriksen.



Ammonia heat pump system, Rødkærø district heating plant

Photo credit: Rødkærø Fjernvarme and PlanEnergi



Energy plant, Aarhus Bay

Photo credit: Aarhus Council

"Most of the support for decentralised natural gas-based [combined heat and power] CHP plants expires by the end of 2018. [Under] the EU's new state aid rules, this aid cannot be extended, so when the aid lapses, it can have significant consequences for the price of power and heat from CHP for district heating," he explains.

As state aid for natural gas throughout the European Union is dismantled, heating prices may increase in Denmark. "Relating to the expiry of the current subsidies, a coalition in parliament has decided to establish two new decentralised CHP subsidy schemes: a subsidy scheme for electrically-powered heat pumps for small CHP plants outside the EU carbon trading scheme, and a counselling scheme for the plants where the economic effect of the expiring subsidies would hit hardest," Henriksen says.

He reports that the Danish Energy Association is very satisfied with these initiatives that support the construction of heat pumps in district heating systems, adding that lowering taxes on electricity could further incentivise the market to adopt sustainable practices.

"The tax is currently higher on electricity for heating per energy content than on fossil fuels such as coal, oil and

gas," Henriksen says. "Heat pumps are more effective than boilers using fossil fuels, but the current taxation regime has not been favouring heat pumps in the Danish system."

"But recently a political agreement has been struck, which in the year from 2019 and onwards, step by step, will reduce the tax on electricity used in heat pumps significantly," Henriksen adds.

"This tax reduction gives more equal conditions for heat pumps, as electricity after the reduction will have approximately the same level as natural gas per energy unit used for district heating. Due to the high efficiency of heat pumps and this fair taxation, we could see a real breakthrough for heat pumps in Denmark," he argues.

The European Union also runs several investment schemes to support the transition away from fossil fuels towards sustainable heating.

A CHP plant in Aarhus, Denmark, has tapped into EU coffers to fund its use of seawater from the bay to provide inhabitants and companies in the east of the city with district heating. The ammonia heat pump will kick in when the price of electricity is low. It will be able to produce 4.0 MWh heat for each MWh of electricity used.

At times of high electricity prices when the heat pump does not operate, the extra heat will be provided by waste incineration.

The new plant has already replaced two oil-fired district heating stations that, during the coldest days of the year, provide east Aarhus with heat.

The EU gave €403,000 towards the development of the ocean heat pump. The project should be completed in 2018.

"The new power plant in Aarhus East will contribute with more than just district heating," Kristian Würtz, a member of Aarhus municipality's Department for Technology and Environmental Issues, told the State of Green. "The building will be an attraction for local citizens, but it will also be a display window for technical experts from the world's major cities who are looking for possibilities within the green transition."

Subsidies and know-how are helping to fuel the transition to natural refrigerant heat pumps in district heating networks in Denmark. Other European countries can surely learn lessons from the Danish market on how to implement sustainable heating plans.

■ CM

Keeping fit with CO₂

A Swiss university near Zürich installed a CO₂ heat pump for heating its saunas and showers in August.

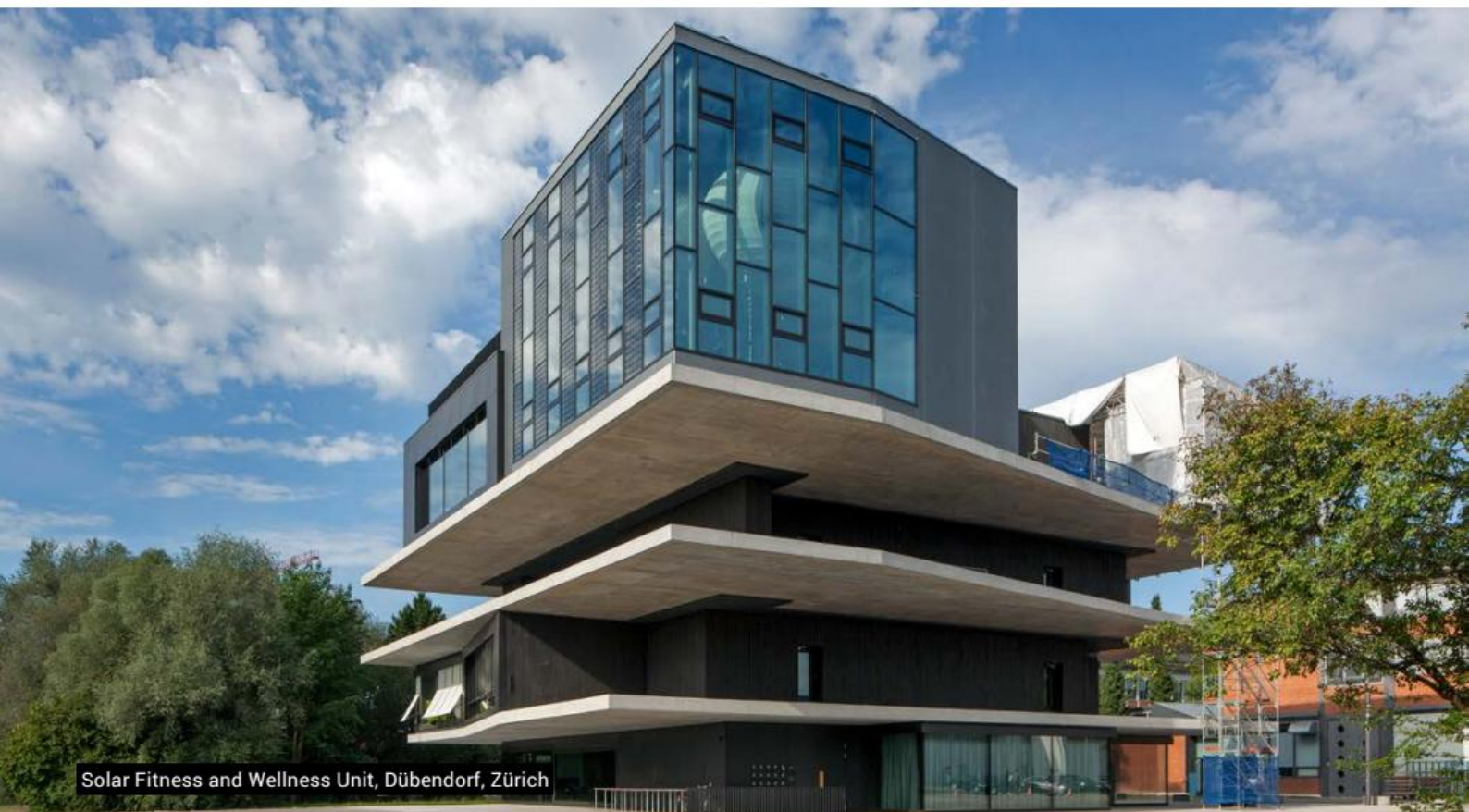
— By Charlotte McLaughlin

Working out should feel good for the mind and body. Yet somewhat ironically, gyms have a significant environmental footprint.

The Solar Fitness and Wellness Unit, which has been operating at the Swiss Federal Laboratories for Materials Science and Technology's (EMPA) campus in Dübendorf, near Zürich since 24 August, wants to be a gym with a difference.

All the gym's electricity demand – for the bikes and treadmills – is satisfied by energy from the sun, with its saunas and showers heated by a CO₂ heat pump.

The building contains three saunas, workout equipment and locker rooms that can be used by staff from EMPA and Eawag (the Swiss Federal Institute of Aquatic Science and Technology) and is part of a wider building project run by NEST (Next Evolution in Sustainable Building Technologies); an EMPA initiative.



Solar Fitness and Wellness Unit, Dübendorf, Zürich

Photos: EMPA / Mark Zimmermann



Finnish sauna, Dübendorf, Zürich

"Our objective is to be able to meet an energy-intensive need such as wellness entirely through renewable energy," says Peter Richner, deputy director of EMPA and strategic manager of NEST.

NEST is not just aiming to use renewables but also to reduce energy demand. "We want to operate the facility with one sixth of the energy that it would need with conventional operation," adds Mark Zimmermann, innovation manager for NEST.

The aim is to reduce the 120,000 kWh of electricity that the three saunas – the Finnish sauna, the bio sauna, and the steam bath – would normally swallow up per year to a figure of 20,000 kWh.

NEST was able to reduce electricity consumption by using a high-temperature CO₂ heat pump from Swiss refrigeration, heat pump and air-conditioning company Scheco AG, which delivers hot water at temperatures of up to 120°C (for the Finnish sauna) and down to 30°C (for the shower water).

The heat pump achieved a coefficient of performance (COP) of approximately three and reduced the Solar Fitness and Wellness Unit's energy consumption by some two-thirds.

"The capacity of our heat pump is 19 kW thermal, 5.7 kW electric," Zimmermann told *Accelerate Europe*.

Heat and moisture recovery from the sauna and steam bath also reduced ventilation loss by 50%.

"There is also a control system that responds to actual bookings of the wellness modules and only heats them up when necessary," explains Zimmermann. Improved heat insulation ensures that heat losses are only minimal.

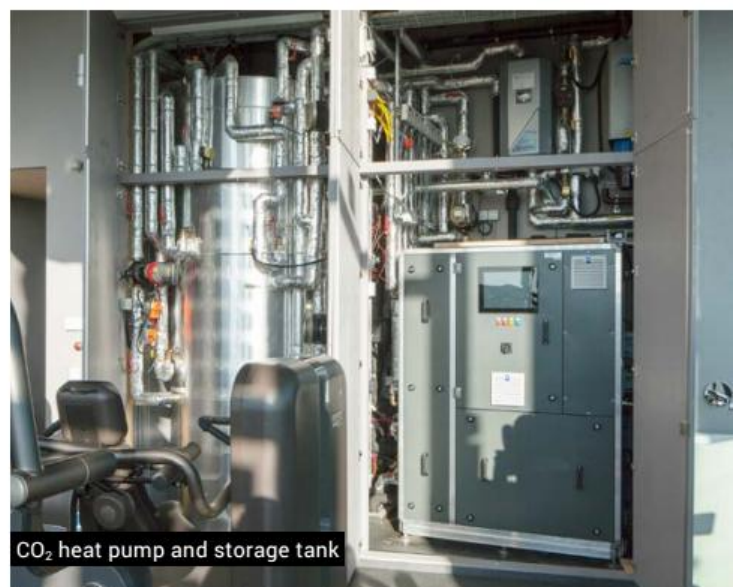
Eight-metre quadruple glazing, from Glas Troesch, on the building's north façade insulates the building effectively even in winter.

On the roof, solar generation from three photovoltaic systems provides 20,000 kWh of electricity per year. Gym users generate the rest of the electricity themselves, by using the fitness equipment. A solar thermal system produces additional warm water.

The underlying energy concept was developed jointly by EMPA researchers, the NTB International University of Applied Sciences and Technology at Buchs, and Lucerne University of Applied Sciences and Arts.

"In the Solar Fitness and Wellness Unit, representatives of every link in the value chain work together in partnership on a new sustainable solution – manufacturers of individual components, building technicians, planners, and potential customers," EMPA's Richner says.

■ CM

CO₂ heat pump and storage tank



Leader of the rack

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

– By Michael Garry

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

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

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

As of August 11, 2017, ALDI had deployed transcritical CO₂ systems – the majority of them the AdvansorFlex – in 69 stores, with more installations coming. Hillphoenix supplied 66 of these stores, with the other three using transcritical systems provided by a partnership between Hussmann and Canadian OEM Systèmes LMP. More than 10 projects so far have been in remodelled stores, and the rest of the systems were



ALDI US VP Aaron Sumida

installed in new locations. In stores without CO₂ refrigeration systems, ALDI currently uses R448A.

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

Known for its low prices (up to 50% lower than those of traditional stores, the company says), private brands and no-frills, efficient operation, ALDI US is a 41-year-old independently operated member of Mülheim, Germany-based ALDI South (Süd). Facing growing competition in the U.S. from traditional grocers and other European-based retailers, ALDI has announced store development plans that are nothing if not ambitious. By the end of 2022, it expects to have nearly 2,500 stores, funded by a \$3.4 billion (€2.87 bn) capital investment plan, putting it third in the U.S. in store count behind Walmart and Kroger.

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

Earlier this year, the company announced a \$1.6 billion (€1.35 bn) plan to remodel and

expand more than 1,300 existing U.S. stores by 2020. Remodelled stores will feature a modern design, open ceilings, natural lighting and environmentally friendly building features.

Immense impact of CO₂

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

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

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

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

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

ALDI US has not set a deadline to fully commit to CO₂ transcritical refrigeration systems, but "it's our long-term objective to standardise,"

Beyond CO₂

CO₂ is not the only natural refrigerant in which ALDI has invested.

All spot merchandiser freezers purchased since 2015 in about 200 stores use propane as the refrigerant. "They have a very low refrigerant charge and are environmentally friendly," said Aaron Sumida, an ALDI US vice-president based in upstate New York.

"We're constantly exploring new natural refrigerant solutions to evaluate the right direction for our stores," Sumida said.

ALDI also employs an ammonia refrigeration system at each of its 24 distribution centres.

Does ALDI plan to use natural refrigerants in HVAC systems or in refrigerated trucking? "We've considered the use in these applications and will continue to explore our options as the technology develops," Sumida said.

said Sumida. With about 800 new ALDI stores to open in the U.S. by 2022, each of the company's 24 divisions will begin to phase in CO₂ transcritical systems – including the 18 not currently committed to it – "to ensure preparedness by the refrigeration installers and technicians," he added.

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

"ALDI stores in other countries also use CO₂ systems as a standard and have set a strong precedent in the natural refrigerants category," Sumida noted. "ALDI in other countries serves as a resource for us. Some of the best examples for many of our environmental tests and initiatives begin with what other ALDI South group countries are doing. This collaboration across countries continues to drive results."

ALDI's primary refrigeration system

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

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

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

The AdvansorFlex's compact size enables it to be placed in a back room, on a mezzanine, on a rooftop or outside on the ground. Its sound-attenuating



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



Medium-temperature cases in Baldwinsville, N.Y., ALDI

panels allow it to be installed near the sales floor. Two units are being considered as a replacement for an HFC system in an existing grocery store.

The AdvansorFlex was developed to be a "lower-cost alternative" that smaller-format stores would be able to afford, noted Scott Martin, Hillphoenix's director of business development and industry relations. In addition to small-footprint grocery stores, it is suited for convenience and dollar stores.

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

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

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

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

- ALDI VP Aaron Sumida

An energy benefit

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

System specs

The AdvansorFlex is available in 36 models. The following is a summary of their specifications.

- ▶ Low-temperature (LT) load range: 50 kBTU/hr-125 kBTU/hr
- ▶ Medium-temperature (MT) load range: 100 kBTU/hr-425 kBTU/hr
- ▶ Standard low temperature: -25°F (-31.7°C) SST
- ▶ Standard medium temperature: 15°F (-9.5°C) SST (VFD in lead compressor)
- ▶ Gas cooler CO₂ outlet temperature: 85°F (29.5°C)
- ▶ Gas cooler powered separately from the rack
- ▶ Approximate CO₂ charge: 350 lbs. (159 kg)
- ▶ Chassis configuration for 100-230 kBTU/hr MT load models: two MT reciprocating compressors by two LT scroll compressors
- ▶ Chassis configuration for 425 kBTU/hr MT load model: three MT reciprocating compressors by two LT scroll compressors
- ▶ Height of 100-230 kBTU/hr MT-load models: 72 in. (183 cm)
- ▶ Height of 425 kBTU/hr MT-load model: 74 in. (118 cm)
- ▶ Weight of rack: 4,000-4,600 lbs. (1,814 kg-2,086.5 kg)



ALDI VP Aaron Sumida viewing inside of AdvansorFlex

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

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

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

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

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

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

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



— By Charlotte McLaughlin
& Andrew Williams

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

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

According to the United Nations Environment Programme (UN Environment), 65% of global HFC consumption (measured in global warming potential) in the refrigeration, air conditioning and heat pump (RACHP) sector comes from air conditioning and heat pumps, while only 35% comes from refrigeration. Overall, commercial and industrial refrigeration are the main sectors for HFC use, comprising over 90% of the total.

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

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

Andreas Meier, managing director of German manufacturer TEKO, says his company – which produces both commercial and industrial refrigeration solutions – is also heading down the natural refrigerants road. "This year we will have 60-70% natural refrigerants" as a proportion of total sales, Meier said.

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

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

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

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

Ammonia vs. CO₂

Industrial refrigeration has long been a success story for ammonia. Eric Delforge of Mayekawa, an industrial refrigeration and heat pump manufacturer, declared:

"For us, natural refrigerants are a no-brainer for industrial."

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

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

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

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

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



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

– Eric Delforge, Mayekawa

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

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

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

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

No ammonia circulates on site. Instead, it is restricted to the plant room, the evaporator and the evaporative condensers. “The liquid CO₂ is the

heart of the system. The pumped CO₂ provides the condensing medium for the subcritical DX frozen food system. We’ve got CO₂ for frozen, pumped CO₂ for the chilled, and ammonia to keep the CO₂ at the required temperature,” Arrowsmith said.

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

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

Technology training is crucial

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

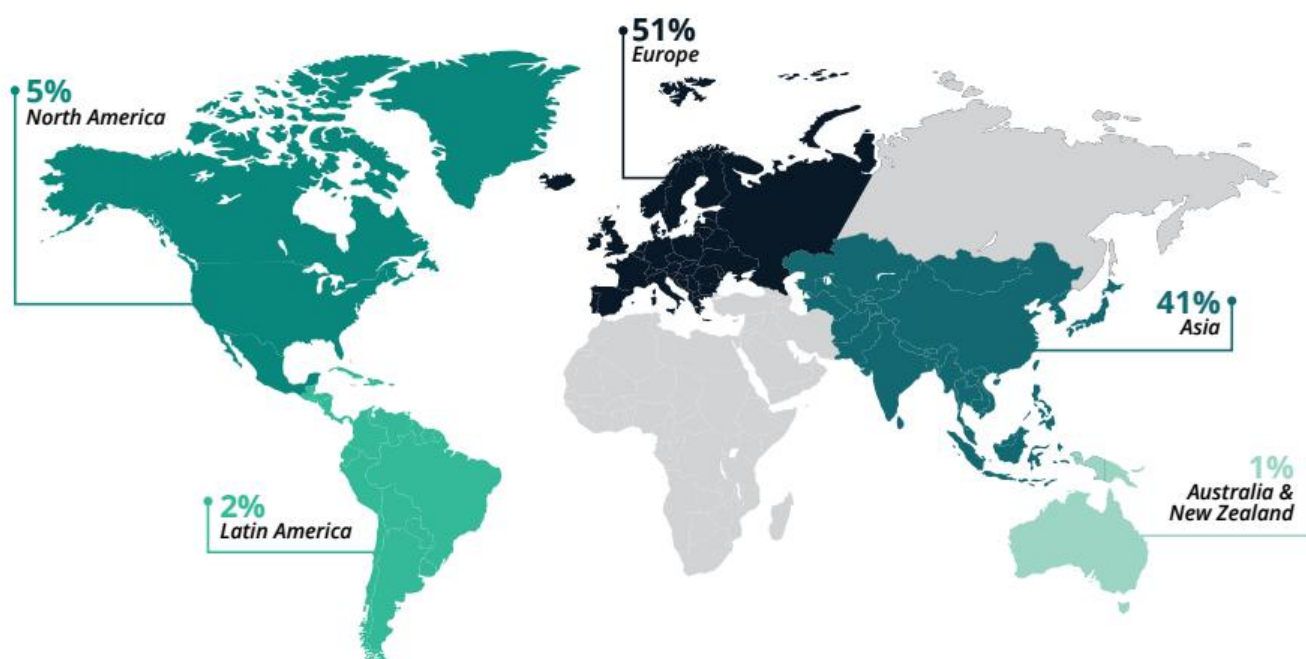
On 1 January 2018, the HFC quota under the F-Gas Regulation will fall to 63% of the 2015 baseline (which refers to the total quantity placed on the market in the period 2009-2012). The anticipated shortage has already led to price hikes for the most commonly used HFCs, such as R404A and R407.

Arno Kaschl from the European Commission’s climate action department told ATMOsphere Europe



Jonas Schönenberger, Frigo-Consulting

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



that, “the price signal is clearly there. Prices of HFCs are rising quite a lot”. These price hikes will mean that some manufacturers and end users could find themselves under even greater pressure to reduce their consumption of HFCs.

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

Buoni said: “Half a million are certified for f-gases; those people need to be trained and upskilled for alternative refrigerants.” AREA is a partner in ‘Real Alternatives for LIFE: Refrigerant Emissions Alternatives and Leakage’, an EU-funded project

to provide online and in-person training on low-GWP refrigerants.

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

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

Volker Stamer, director of BITZER’s SCHAUFLEER Academy, argued that online training was no substitute for live training sessions. The academy, which provides in-person training on compressor and system technology for CO₂, ammonia and

hydrocarbons, has “had 3,800 visitors in the first year – 80% of them are from outside Germany,” Stamer said.

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

Innovation in the transport arena

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

Martin Hasnik is a project manager for technology management and



From left to right: Marco Buoni (AREA), Volker Stamer (BITZER), Bafoday Sanyang (Gambia National Environment Agency) & Álvaro de Oña (shecco) talk training

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

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

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

In addition to the environmental and energy-saving benefits of CO₂

systems, Hasnik cited other important reasons to make the switch:

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

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

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

Despite this success, Sonnekalb noted that barriers remain to making CO₂ a reality. "We don't sell to the end user but the bus manufacturer, so he won't see the lifecycle cost but the

manufacturing cost," he said ([for more on CO₂ MAC in buses, see p. 44](#)).

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

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

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

There are clear signs, then, that the market for natural refrigerants is developing beyond the refrigeration arena. As the HFC phase-down moves into 2018, next year's ATMOSphere Europe will be an important opportunity to assess this progress. ■ CM & AW

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Busworld 2017: Accelerate Europe returns!

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

— By Charlotte McLaughlin

Two years ago, at Busworld Europe 2015 in Kortrijk, Belgium, *Accelerate Europe* interviewed Konvekta, a manufacturer of CO₂ mobile air-conditioning (MAC) systems for buses, and compressor manufacturer BITZER about using CO₂ in heating, ventilation and air-conditioning (HVAC) applications.

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

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

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

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

Emergence of CO₂ technology

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

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

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

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

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

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

“CO₂ is the big trend:
everyone wants it.”

– Manuel Grießer, Valeo

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

It also has an integrated heat pump, featuring an innovative airflow reversal function that makes the previously complex refrigerant circuit much simpler, according to Eberspaecher Suetrak.

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

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

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

Overcoming challenges

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

Christian Von Hochmeister, who works in sales at Denso Automotive Deutschland, explained that this might be a long process for his company.

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

UK HVAC manufacturer Grayson Thermal Systems is also looking into developing a CO₂ system, due

in part to the increasing price of R134a resulting from the HFC phase-down taking place under the EU F-Gas Regulation, said Pavel Ikrath, Grayson's R&D HVAC Principal Engineer E-Mobility.

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

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

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

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

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

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

■ CM





Networking break at ATMOSphere Ibérica

Spain to subsidise greener cooling

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

– By Álvaro de Oña & Pilar Aleu

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

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

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

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

The Ministry of Environment is submitting a draft decision to establish the subsidy to all relevant stakeholders, to receive their feedback with a view to making it effective as of 1 January 2018.

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

An underdeveloped market

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

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

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

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

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

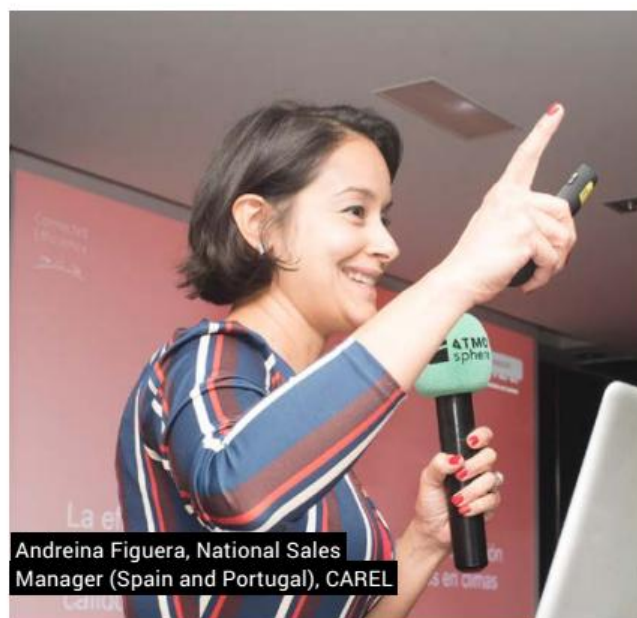
Julio Corrales of Arneg, whose 20 manufacturing plants around the globe supply technologies to countries with all kinds of climate conditions, argued that, "the use of additional technologies to boost energy savings, such as ejectors, makes CO₂ transcritical a more competitive solution compared to a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

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

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



Ignacio Gavilán, director (sustainability), Consumer Goods Forum



Andreina Figuera, National Sales Manager (Spain and Portugal), CAREL

Olalla sees the future of refrigeration as a competition between hydrocarbons, CO₂ and HFOs after 2022. "At Huayi we see hydrocarbons as the refrigerants of the future. Hydrocarbons improve efficiency and therefore they boost the overall efficiency of the system as well," he said.

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

Latin America captains NatRef projects

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

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

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

Argentina has many different climate conditions. "While there is only one CO₂ subcritical installation in the country, at a Walmart Caseros store, CO₂ transcritical installations are becoming more popular," said Agustín Maranca, director of Estudio Maranca.

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

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

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

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

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

Colombia also boasts a CO₂ transcritical system. Colombian grocery chain Éxito fitted its first such system in a new Bogotá store. The cabinets were provided by EXKAL and featured a rack from Advansor-Hillphoenix.

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

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

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

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



ATMOsphere Ibérica plenary



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Dispatch from Montreal

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

– By Marie Battesti

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

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

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



Energy efficiency

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

Countries requested the Technology and Economic Assessment Panel (TEAP), an advisory body to the Montreal Protocol Parties, to assess technology options, requirements and related costs to maintain or enhance energy efficiency while phasing down HFCs under the Kigali Amendment. TEAP will make its recommendations in a report to be presented to the next Meeting of the Parties, to be held in approximately one year's time in Ecuador (date TBC).

Replenishing the Multilateral Fund

One key decision was to determine how much money would be allocated to support developing countries in achieving the HCFC phase-out and the HFC phase-down required under the Montreal Protocol and the Kigali Amendment to the Montreal Protocol – i.e. the replenishment of the Multilateral Fund (MLF).

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

After long negotiations, the Parties adopted a budget for the MLF for the triennium 2018-2020 of US\$ 540,000,000 (€455,984,640).

Uncertain future for synthetic refrigerants

Norway and Switzerland reintroduced a draft decision to adopt a precautionary approach to the development and promotion of HFCs not listed as controlled substances by the Kigali HFC phase-down scheme, namely those with a GWP greater than 53.

In a final decision, the Parties requested the Protocol Assessment Panels to provide a report evaluating the consumption and production of these substances in time for the MOP in 2023. Renewed assessments will be required every four years thereafter, but will only serve for information purposes.

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

TFA's long-term toxicity is the subject of scientific study. One 2014 study in *Chemosphere* – 'A 17-fold increase of trifluoroacetic acid in landscape waters of Beijing, China during the last decade' – recommended that "measures are needed to control the increase of TFA in China".

"The Ozone Research Managers' conclusion that the formation of toxic TFA, as well as tropospheric ozone, results from the degradation of HFOs is a concern which requires further research and evaluation," said Philip Owen from the European Commission, the EU's executive arm.

Smarter standards to achieve Kigali HFC phase-down

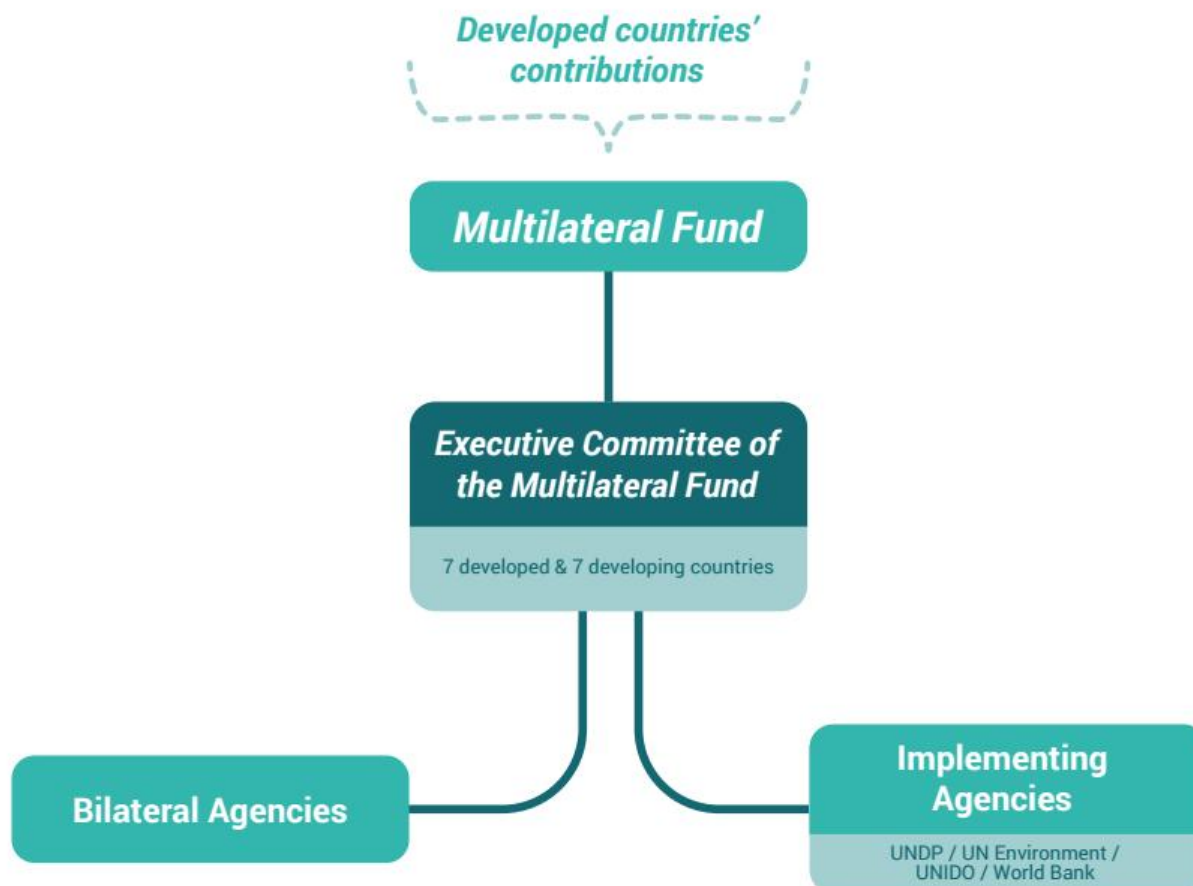
The need to update safety standards impeding the uptake of flammable refrigerants such as hydrocarbons was addressed by a number of countries throughout the week.

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

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

■ MB

Funding the Montreal Protocol



Funding the Montreal Protocol

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

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

- The **World Bank** focuses on large-scale phase-out and investment projects at plant and country levels.
- The **UNDP** organises demonstration and investment projects, technical assistance and feasibility studies.

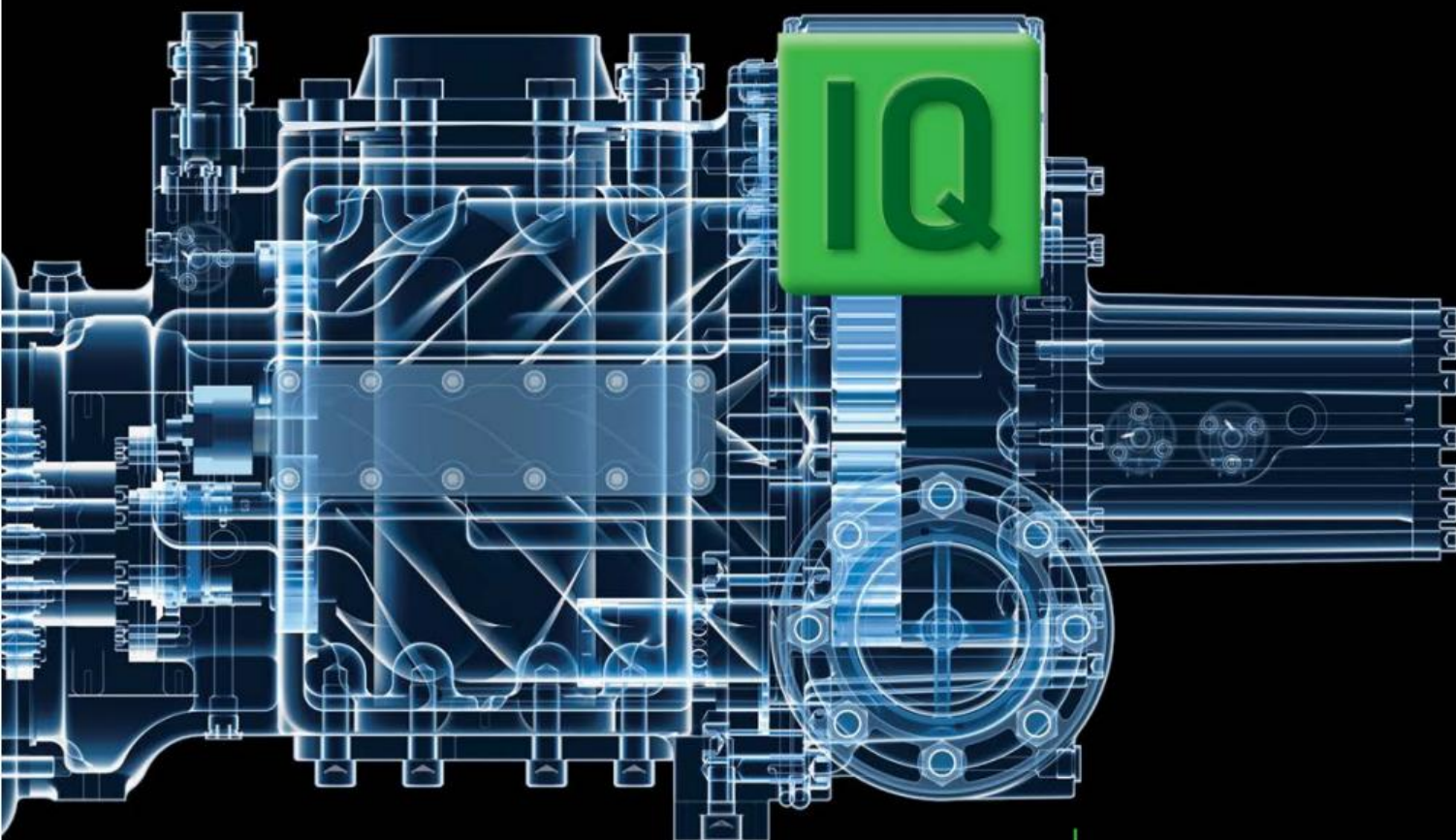
► **UNIDO** prepares and appraises investment project proposals and implements phase-out schedules at plant level.

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

Bilateral agencies

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

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



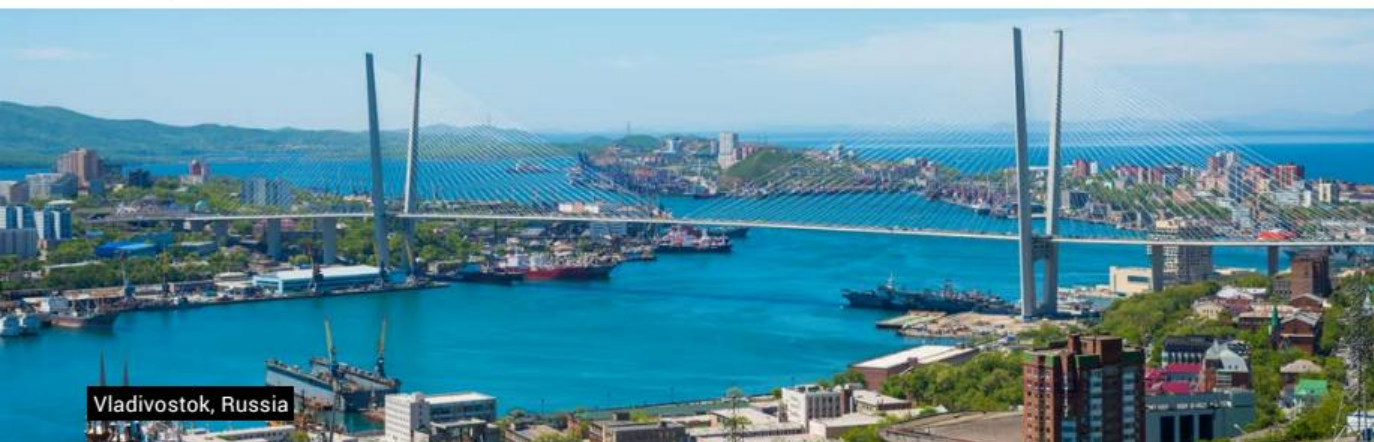
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Vladivostok, Russia

500g hydrocarbon charge limit moves closer

After a long road, the International Electrotechnical Commission's 150g charge limit for hydrocarbon commercial refrigeration equipment looks set to increase to 500g.

— By Klara Skačánová

The present international standard for hermetically sealed commercial refrigeration equipment (IEC 60335-2-89) – set by the International Electrotechnical Commission (IEC) – limits the use of flammable refrigerants to 150g. It is commonly accepted by experts that this limit does not allow manufacturers or end users to fully exploit the safe application of hydrocarbon refrigerants in the commercial refrigeration sector.

To address this, the Working Group SC61C/WG4 was created in 2014 with a view to raising the recommended charge limit for flammable refrigerants. After some three years of intense work, the working group has now approved the proposed text to amend the IEC standard, marking an important step in the process of standards development.

Standards from the IEC, a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence

the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

During a meeting on 7 October in Vladivostok, Russia, IEC subcommittee SC61C decided to advance the draft amendment of the IEC 60335-2-89 standard for commercial refrigeration, prepared by Working Group WG4, to the next stage in the process (the Committee Draft for Vote; CDV).

The final version of a draft amendment, which proposes to increase the propane charge limit to 500g, was prepared in October. The proposed charge limit is based on 13 times the low flammability limit (LFL) of propane. To ensure safety, the draft amendment will require a minimum amount of space in which the system can be placed. Systems will also have to pass a leakage test that shows the relative absence of flammable concentrations throughout the system, besides other construction requirements.

The charge limit increase will cover all safety classes of flammable refrigerant, but with different limits.

Nevertheless, the international standard amendment that could raise the charge limit for propane to 500g is still a long way from being finalised.

The CDV will be circulated for comment and voted upon by all national committees within the IEC in December 2017 at the earliest. A vote on the CDV is expected in the first half of 2018. Provided that more than two-thirds of the committee members vote in favour, the draft will go to final approval (FDIS; Final Draft International Standard) by the end of 2018 following the SC61C committee meeting in Busan, South Korea in October 2018.

A new version of the IEC standard is expected at the beginning of 2019.

■ KS

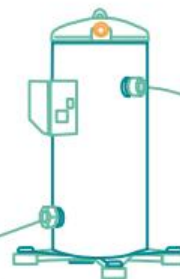
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Bangkok, Thailand hosted ATMosphere Asia 2017

Kigali implementation underway in Southeast Asia

Funding schemes and pilot projects are already underway in Southeast Asia as governments in the region begin planning to phase down HFCs. *Accelerate Australia & NZ* reports from ATMosphere Asia 2017.

— By Devin Yoshimoto

During the policy session at ATMosphere Asia 2017 – organised by *Accelerate* publisher shecco – attendees learned how governments in Southeast Asia are co-operating with UN agencies and overseas industry players to tackle the HFC phase-down requirements put in place by the Kigali Amendment to the Montreal Protocol.

ATMosphere Asia 2017 – which took place on 6 September and was held in Bangkok, Thailand for the first time – brought together Indonesian and Malaysian government representatives and speakers from UN agencies, equipment manufacturers and end users to discuss case studies, opportunities and challenges with natural refrigerant technology in the region.



HFC phase-down in Indonesia and Malaysia

Representing Indonesia's Ministry of Environment and Forestry was Bitul Zulhasni, head of the Sub-directorate for Ozone-Depleting Substances Control – Indonesia's national focal point for the implementation of the Montreal Protocol.

Asked why she was interested in attending ATMOSphere Asia, Zulhasni replied, "I'm looking for information on what direction natural refrigerant [technology] will go".

Zulhasni said that for Indonesia to come up with an effective HFC phase-down strategy, she would need more information on the technology roadmap and major market trends for natural refrigerants.

“Although there is still a long way to go, we have to think now because the baseline year begins in 2020. That's very fast.”

– Bitul Zulhasni

With respect to the major technology providers, Zulhasni asked: "What is their plan? Especially since they already know that our goal is to phase down HFCs soon – so how will they make [the technology] available for us? That is what we want to know."

During her presentation, Zulhasni outlined Indonesia's HFC phase-down targets. "Under the Kigali Amendment, Indonesia is classified as a Group 1 country," she said.

For Group 1 countries, the baseline years for measuring reduction targets are 2020-2022. Compared to developed countries, they have a grace period of about ten years.

Indonesia's phase-down will begin with a freeze in 2024 followed by a 10% HFC reduction target by 2029, explained Zulhasni.

"Although there is still a long way to go, we have to think now because the baseline year begins in 2020. That's very fast," she said.

Representing the Department of Environment of Malaysia was Yahya Bin Atan, who joined Zulhasni in speaking during the policy session.

Atan explained that Malaysia is also a Group 1 country whose baseline years are from 2020 to 2022.

Both countries are yet to ratify the Kigali Amendment to the Montreal Protocol.

However, both Zulhasni and Atan stated that they are focused on monitoring the ongoing natural refrigerant pilot projects in their countries, while forming their preliminary strategies for the HFC phase-down.

Pilot projects boast results

The first CO₂ condensing unit in Malaysia was installed and commissioned in May 2017 at one of Malaysian retailer Jaya Grocer's supermarkets.

Chai Chun Leong, a representative from project installation contractor and partner Coolcare, spoke during the end user session about this installation.

Two Panasonic 20 HP CO₂ outdoor condensing units were installed at the supermarket, providing cooling for a total of 23 medium temperature CO₂ display cases.

The project was carried out under the framework of Stage 1 of Malaysia's HCFC Phase-out Management Plan, which included assistance from the Multilateral Fund for the Implementation of the Montreal Protocol.

Though cost challenges remain, feedback from the end user has so far been positive, according to installation contractor Coolcare.

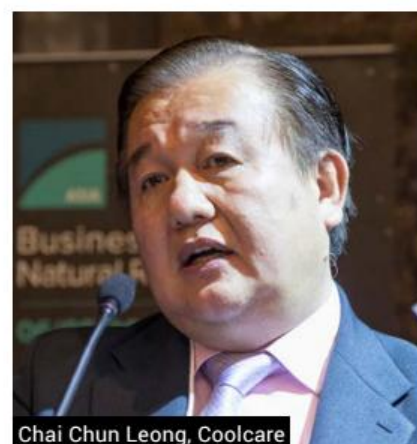
"For the energy savings, we have saved about 12.8% (in energy consumption costs compared to HFC-based systems)," said Leong.



Bitul Zulhasni, head of the Sub-directorate for Ozone-Depleting Substances Control, Indonesia



Yahya Bin Atan, Department of Environment, Malaysia



Chai Chun Leong, Coolcare



Panasonic has provided CO₂ condensing units at 12 Alfamidi grocery stores in Jakarta, Indonesia



Malaysia is receiving international funding to help phase down HCFCs

Masaaki Kanbe, senior manager for Japan-based retailer Lawson, Inc., took to the stage during the end user session to provide details of CO₂ pilot projects in Indonesia.

To date, Lawson has assisted with project management for the installation of a total of 26 Panasonic CO₂ condensing units at 12 Alfamidi grocery store locations in Jakarta, Indonesia.

The installations are part of a programme that began in 2013, called the 'Joint Crediting Mechanism Model Project'.

The programme is a joint collaboration between the Japanese and Indonesian governments, aiming to introduce energy-efficient technology to retailers while contributing to the emissions reduction targets of both countries.

Though challenges such as high installation costs and the need for training remain, the project so far boasts impressive results.

Combined with the installation of LED lighting and inverter-type air conditioning, the installation of Panasonic's CO₂ systems has allowed all 12 stores to achieve an average 40.3% reduction in total yearly power consumption.

Indonesia's Zulhasni said several other projects were underway in Indonesia, including the installation of propane (R290) chillers at the University of Indonesia and in a hotel in Bali.

These projects are all part of a larger push to raise awareness of natural refrigerants, especially among end users, in the rest of Southeast Asia.

Anshu Kumar, technical advisor for the United Nations Development Programme, underscored this point by saying: "The end user does not know about this change from synthetic to natural [refrigerants] and multilateral funding, so we need to work harder to increase this awareness among end users."

However, the direction of the industry is certainly set and the support infrastructure is there to begin the transition away from HFCs in Southeast Asia.

"We are working to remove all the barriers for adoption of the new generation of refrigerants," said Shaofeng Hu, regional network coordinator for the United Nations Environment Programme.

"With the Kigali Amendment, you will see more examples of natural refrigerant adoption in Southeast Asia." ■ DY

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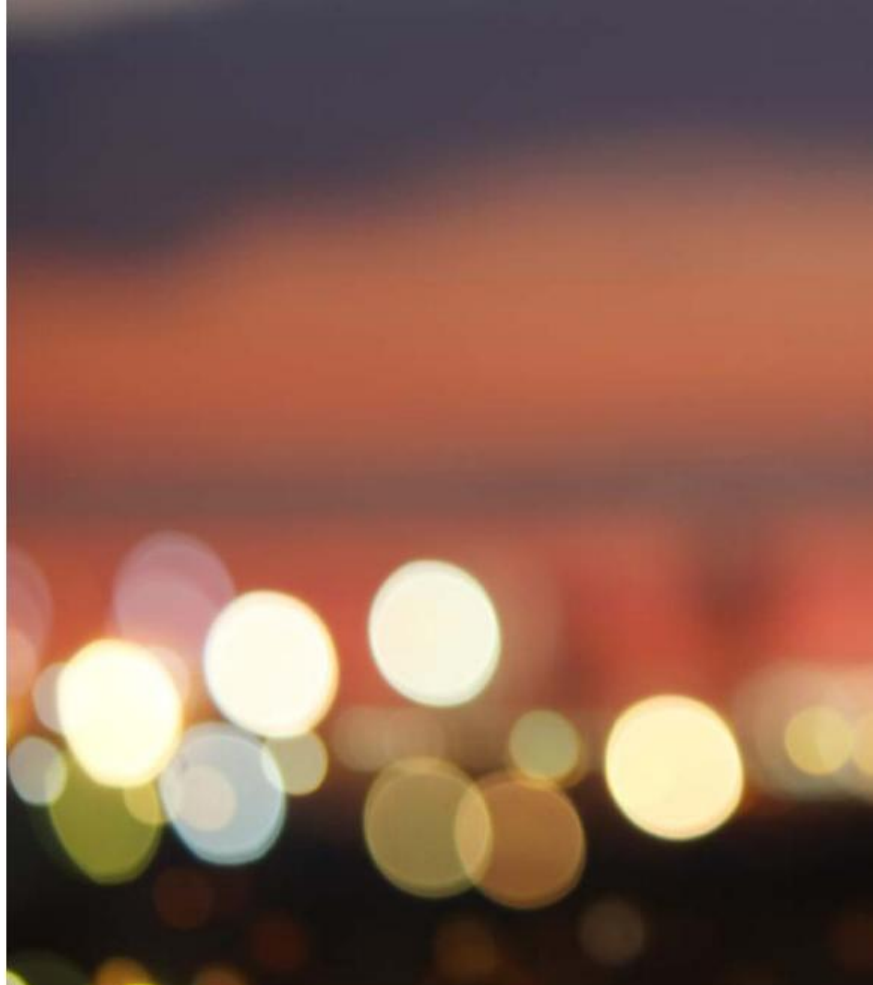


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Natural refrigerants in the City of Light

Understanding the HVAC&R sector in France is like getting to know the French: it's complex, sometimes contradictory, certainly unique – and most importantly, full of potential.

– By Marie Battesti



The market for natural refrigerants is beginning to take off in France, accelerated by the current government's ambitious environmental policies and an increasingly dynamic HVAC&R industry that may finally be ready to seize the opportunities presented by the f-gas phase-down. *Accelerate Europe* reports from Paris.

A complex market

The structure of the French refrigeration market adds a complex extra layer between manufacturers of systems and components, and end users.

French legislation requires end users to go through consultants (*bureaux d'études*) who recommend which type of HVAC&R system to choose before passing on their recommendations to the installer in charge of installing the system.

In this manner, the *bureaux d'études* are the gatekeepers of the French HVAC&R market and can therefore play an important role in encouraging – or hindering – the wider uptake of natural refrigerants.

Chemical refrigerant manufacturers lobby the *bureaux d'études*, which partly explains why the latter end up proposing chemical-based solutions to end users, industry professionals told *Accelerate Europe* at the *Salon Interprofessionnel du Froid et de ses Applications* (Sifa), France's

most important trade show in the HVAC&R sector, held in Paris on 3-5 October.

The regulatory framework, too, can also act as a barrier to the uptake of natural refrigerants in France.

For instance, French law largely forbids the use of flammable refrigerants, such as hydrocarbons, in public access buildings. Equipment containing flammable refrigerants can only be used up to a charge limit of 150g, and even then, only if it is stored in a room that the public cannot access.

Lack of trained workforce

Some French HVAC&R industry players reported problems recruiting qualified installers and maintenance personnel who are able to work with alternative refrigerants.

"Good installers and technicians are increasingly rare," Jean-Michel Fleury, assets project director at the Carrefour Group, told *Accelerate Europe* in an exclusive interview.

"This is a real problem that will increase in the coming years," Fleury said. "Manufacturers and the industry are yet to act on this problem enough. They must train more technicians, initiate more actions in schools, and launch partnerships."



A dynamic industry

Despite this, French companies look well placed to benefit from increased interest in natural refrigerants in France. A study conducted for the *'F-Gas Regulation Shaking Up the HVAC&R Industry'* report, by Accelerate publisher shecco, shows that at least 26 companies including equipment and component manufacturers, system suppliers and contractors headquartered in France work with natural refrigerants. Added to this figure are companies with offices and manufacturing plants in France, but which are not headquartered there.

Leading multinational retailers are also accelerating the uptake of natural refrigerants in France and beyond.

For instance, the Carrefour Group has already installed natural refrigerant-based systems in just over 400 stores in Europe.

"179 [of our] stores are 100% natural refrigerant-based systems using CO₂ transcritical," said Fleury. "The policy [of the group] is to go to 100% natural stores," he added.

France is also the European country with the largest number of organisations offering training on using natural refrigerant-based equipment. shecco identified 193 training organisations offering NatRef training in Europe, 40 of which are located in France. The United Kingdom has 34, Spain 15 and Italy 11.

French HFC tax draws nearer

Presented to the French parliament at the end of September 2017, the proposed tax on HFCs was not retained as part of France's finance law for 2018. Ahead of its introduction in parliament, the French HVAC&R sector had collectively opposed the tax with joint letters and initiatives addressed directly to the French environment minister.

However, the tax may yet reappear at a later stage. "At the United Nations General Assembly in New York last September, French Environment Minister Nicolas Hulot recalled his attachment to the tax, although the proposal is not in the legislative calendar for 2018," Florian Veyssilier, a representative of the Ministry of the Ecological and Inclusive Transition, told the industry at Sifa.

Philippe Roy, general secretary of SNEFFCA, one of France's main HVAC&R trade associations, told *Accelerate Europe* in an exclusive interview: "I will not be persuaded that the HFC tax project has been abandoned until I see the 2018 Finance Act in the Official Journal without this provision!"

With important f-gas phase-down milestones on the horizon, French industry and policymakers alike are increasingly looking to natural refrigerants as market-ready replacements for HFCs.

■ MB



Sifa venue, Paris



The Sifa conference

Photo: Louise Creuzeau



Keeping cool in the supermarket sector

The drive to achieve climate targets represents an opportunity for natural refrigerants in the supermarket sector. *Accelerate Europe* reports from a conference held at the Danish Technological Institute (DTI) in Taastrup, Denmark.

— By Álvaro de Oña & Charlotte McLaughlin

The natural refrigerant-based cooling systems that will help deliver the transition away from HFCs in the cooling sector are ready for market and already in place in many stores across Europe, heard participants in a two-day Danish conference on 'Refrigeration in the supermarket sector'.

Held on 8-9 November 2017 at the Danish Technological Institute (DTI) in Taastrup, Denmark (just outside Copenhagen), the conference highlighted different challenges and opportunities in the supermarket sector.

Participants discussed how updated climate policies represent an opportunity for the HVAC&R industry to help increase energy efficiency and reduce greenhouse gas emissions.

Esben Vendelbo Foged, team manager – refrigeration and heat pump technology (energy and climate) at

DTI, explained, "this conference is about gathering everyone from the industry from the installer to the end users [and] the authorities".

"What we have learned is that many of the technologies are ready," he said.

Kim Christensen of Advansor and Kenneth Bank Madsen of Danfoss gave concrete examples of how Danish technology has helped supermarkets shift from R404A – a high-GWP HFC blend – to the natural refrigerant CO₂ beyond Scandinavia to southern European climates.

"There can be no doubt about it: you can have CO₂ all over the world. It is just a matter of having the right technology," Foged told *Accelerate Europe*.

Innovative retailers are driving the adoption of CO₂ in some countries. Lidl Denmark's Orhan Ongun, who is

head of the supermarket giant's Danish construction department, said during the conference that in 2007 Lidl had selected a CO₂-based system for its stores.

Since then it has also integrated heat pump technology and LED lighting into its new builds. This early investment in green technology led the retailer to win an award for Europe's most sustainable grocery store in 2015.

The prize was awarded by LEED (Leadership in Energy and Environmental Design), a certification system developed by the U.S. Green Building Council (USGBC), for a supermarket in Sjælør station, Copenhagen.

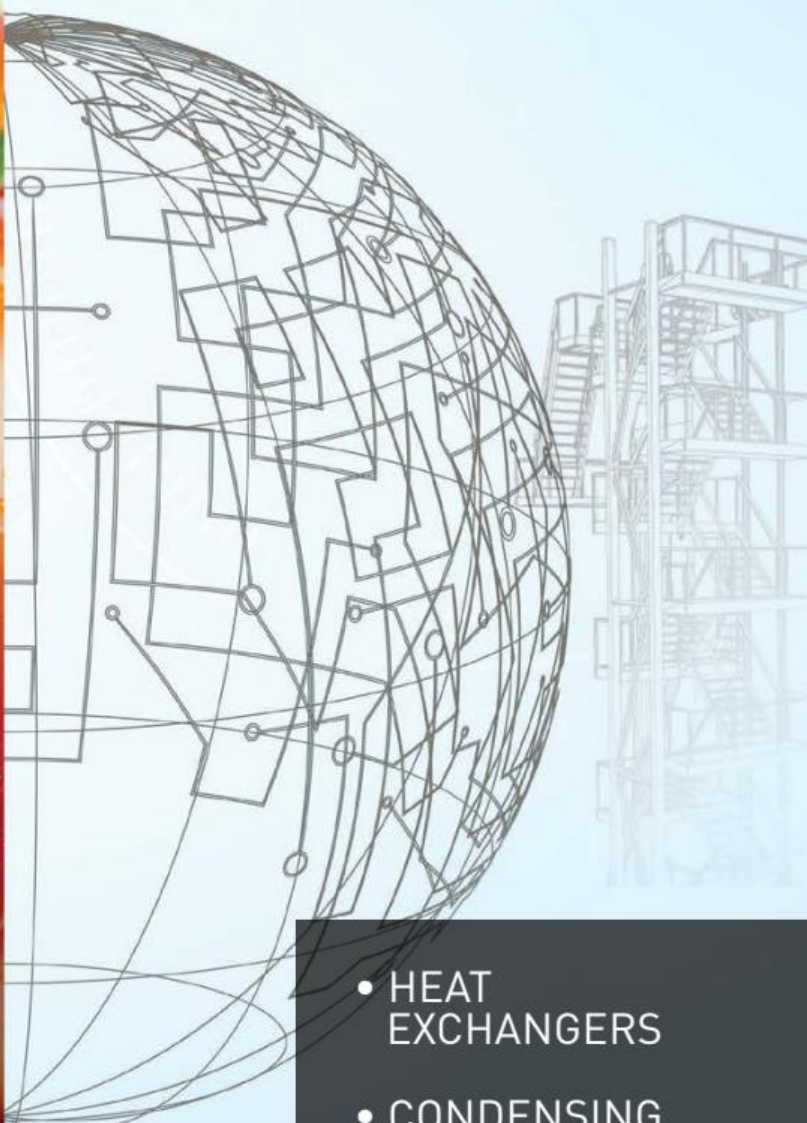
The supermarket reused heat from the CO₂ refrigeration system, generated electricity from solar panels, and used geothermal heating and rainwater, according to Ongun.

The substantial energy savings and environmental benefits led Lidl to incorporate the innovations into a new store that opened in 2016 in Aabenraa, southern Denmark.

The conference also introduced two new projects involving DTI; one on 'Super Supermarkets' that use excess heat from the refrigeration systems' compressors to provide district heating, and the other on IEA HPP Annex 44, which looks at creating energy-efficient supermarkets. ■ **AdO & CM**

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Lofty potential for CO₂ heat pumps in Australia

Mitsubishi Heavy Industries Air-Conditioners Australia (MHIAA) has completed its first Q-ton CO₂ air-to-water heat pump installation in Australia. Now WaterMark-certified, the Q-ton is demonstrating its cost effectiveness and potential to replace traditional hot water production systems around the country.

– By Devin Yoshimoto & Jan Dusek

Mitsubishi Heavy Industries Air-Conditioners Australia (MHIAA) has completed its first Q-ton CO₂ air-to-water heat pump installation at the Matterhorn Lodge Perisher Valley, New South Wales (NSW) – the first of its kind in the alpine region of Australia.

MHIAA received the WaterMark certification in June 2017, a mandatory certification issued by the Australian Building Codes Board that approves the Q-ton for use in Australia. Soon after this, the installation at Matterhorn Lodge was completed.

Accelerate Australia & NZ spoke to Trent Miller, air-to-water (A2W) manager for MHIAA in Australia, about the installation and the wider potential for CO₂ air-to-water heat pumps in Australia.



Mount Hotham in winter, Australian Alps

CO₂ in the mountains

"This Q-ton installation is a great example of an environment where natural refrigerants, such as CO₂, excel in performance over every other alternative," says Miller, detailing the installation at Matterhorn Lodge.

The lodge is located in the alpine region of Australia in Perisher Valley, where ambient temperatures can reach -20°C.

The owners of the lodge were looking for a safe and cost-effective solution to replace their existing diesel boiler and supply hot water to their hotel guests.

"Matterhorn Ski Lodge is looking to reduce reliance on liquefied petroleum gas (LPG) and potentially phase out the use of their boiler, which performed very poorly and inefficiently, accumulating considerable running costs," says Miller.

The lodge is located in the Kosciuszko National Park, so the owners were also looking to invest in reducing the facility's long-term environmental impact.

"They want to make sure the lodge is there for a long time to come and are quite forward-thinking and environmentally conscious in all the things that they do," says Miller.

MHIAA first approached Matterhorn Lodge about 12 months ago, Miller explains. The idea was to install the Q-ton and update the diesel boiler to an LPG boiler, as a hybrid system, with the goal of slowly phasing out the boiler.

Currently, the single Q-ton unit receives water at an inlet temperature of 2°C and can heat about 1,000 litres of water in two hours, in ambient conditions of -5°C.

Miller says that the Q-ton, however, has already exceeded Matterhorn Lodge's expectations and that the owners have been very happy with its performance.

"They've really seen that what we've been able to deliver so far has been exceptional. The 200 kW [LPG] boiler is only running for about three minutes and then shutting off every three or four hours, which is quite remarkable," says Miller.

"They are already looking at replacing their LPG boiler by next year," he adds.

The Q-ton is demonstrating how effectively CO₂ can outperform traditional boilers in that environment.

"If there is any environmental condition that natural refrigerants are made for, it's definitely in the alpine region," says Miller.

Cost savings: the bottom line

Though Matterhorn Lodge Perisher is a great example of an end-user company that is forward-thinking and environmentally responsible, the number one reason it chose to go with the Q-ton, Miller explains, was the cost savings that it delivers.

MHIAA predicts that by using the Q-ton, Matterhorn Lodge will cut 50% of its energy costs versus a traditional gas boiler. Though ambitious, Miller is confident in this figure and now he is seeing actual results.

"We were under a lot of pressure to deliver major savings," he says, "but [Matterhorn Lodge] has already been taking readings for gas usage and we've been able to deliver on those savings so far".

Miller says the impacts of these savings are even more apparent considering the limited period of time each year during which the system is actually in use.

"They only get three months where the lodge is fully booked and it's a four-month season," he says. "So for these guys to be saving enough money to invest in us to begin with is quite a big deal," he adds.



Trent Miller, MHIAA

“If there is any environmental condition that natural refrigerants are made for, it's definitely in the alpine region.”

– Trent Miller, MHIAA

► Burgeoning market for CO₂ heat pumps

Miller says demand for the Q-ton has already exceeded expectations, leading the company to revise its projections for the coming year.

Additionally, external factors such as rising natural gas costs in Australia and HFC phase-down regulations are likely to drive other end users to justify investing in CO₂ heat pumps for similar applications.

Miller discussed the likely possibility of natural refrigerant rebates for food manufacturing in Australia in the near future.

The rebates, Miller predicts, will be necessary as the government looks to encourage efficient energy use to handle Australia's electricity grid issues, and as demand for Australia's food products increases from China.

Though cost savings and energy efficiency have ultimately driven Matterhorn Lodge to use the Q-ton, Miller warns against underestimating the growing sustainability awareness of environmentally conscious business owners.

“These guys, they really saw the benefit to the environment, and that's what brought them home,” Miller says. ■ DY & JD



Mitsubishi Heavy Industries' Q-ton
Air-to-Water CO₂ heat pump

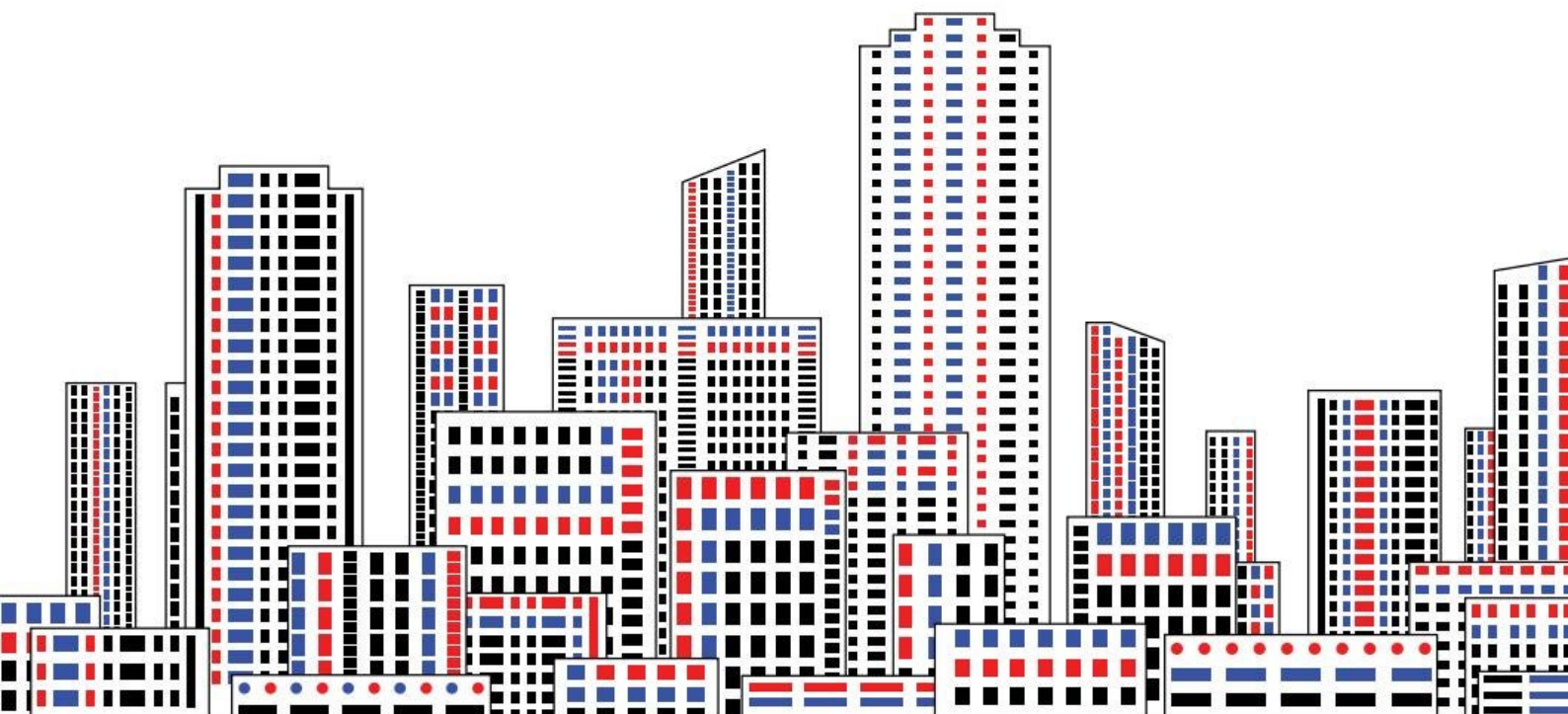
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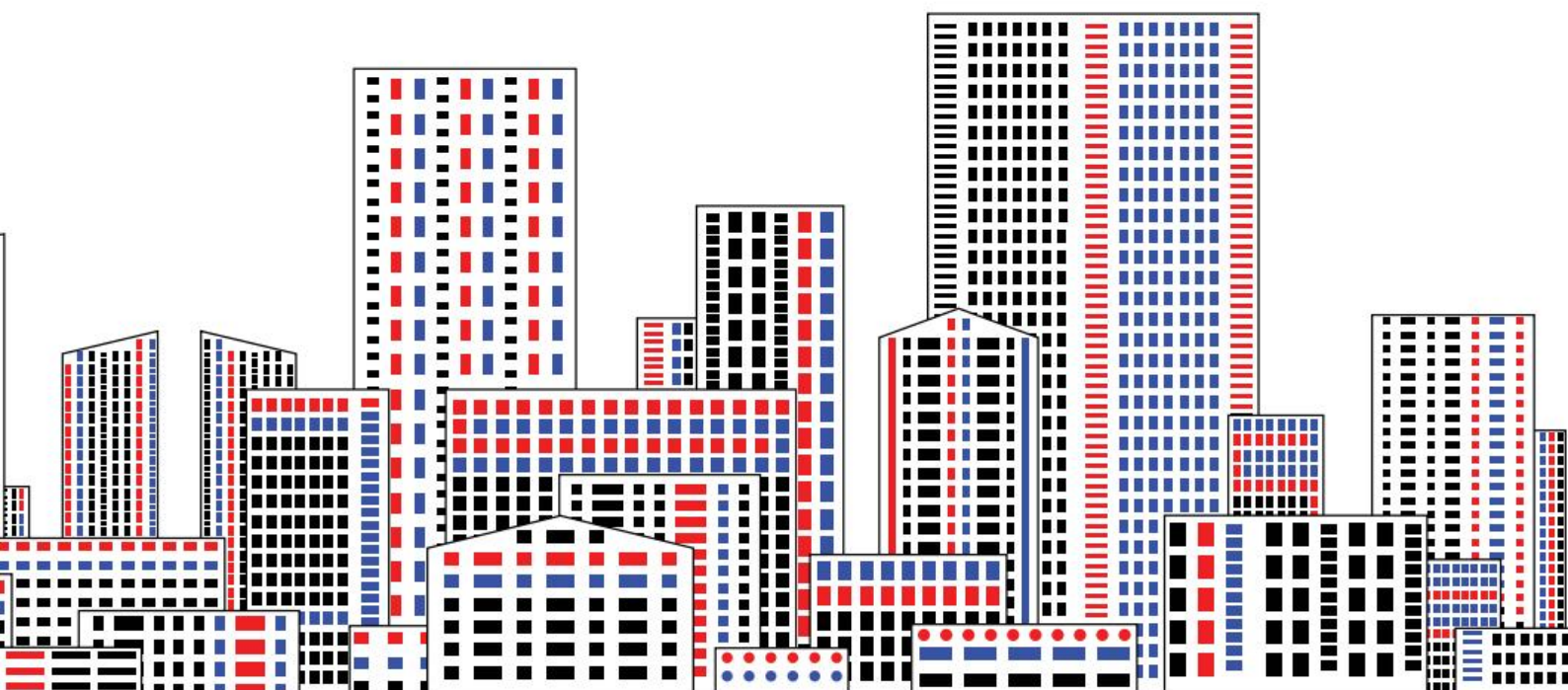
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The next big thing: NatRef heat pumps?

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

— By Charlotte McLaughlin, Marie Battesti & Eda Isaksson



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

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

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

He cited pressure from international agreements like the Paris Agreement, which will drive reductions in fossil-fuel use, the Kigali Amendment to the

Montreal Protocol, which will drive HFC reductions worldwide, and European directives pushing reductions in electricity consumption as key reasons why the use of gas, oil, electric heating and HFC heat pumps are all likely to fall.

In Europe, the transition towards HFC alternatives is already underway. On 1 January 2018, the HFC quota under the EU F-Gas Regulation will fall to 63% of the 2015 baseline (which refers to the total quantity placed on the market in the period 2009-2012). The anticipated shortage has already led to price hikes of the most commonly used HFCs, such as R404A and R407.

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

Fossil fuel-free heat pumps are "the low-hanging fruit" in tackling climate change, said Menno van der Hoff,

head of R&D and HVAC manager at Uniechemie and winner of the *Accelerate Europe* 'Person of the Year' award.

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

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

All these measures are putting further pressure on European



Pieter Boink, Nidec Global Appliance Germany, speaking at ATMOsphere Europe, Berlin, Germany

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

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

CO₂ or hydrocarbons?

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

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

CO₂ is also a viable refrigerant for residential heat pumps, according to Georges Khoury of SANDEN Europe. Khoury presented positive results from initial

installations and field tests of the company's soon-to-be-launched CO₂ heat pump – the ECONORDIC.

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

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

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

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

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

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

— Peter Jovic, NIBE

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

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

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

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

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

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

New opportunities, old concerns

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

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

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

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

To Pedersen, it's not so much training, knowledge or safety standards that are holding back uptake of natural refrigerants in residential heat pumps, but rather a question of money. "The main barrier to

me is the investment in product development that is required," he told *Accelerate Europe* at the heat pump event. "To me, training is not the main issue."

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



Emerson's Pascal Wilmot at the European Heat Pump Summit in Nuremberg, Germany

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

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

While the residential market for natural refrigerants in heat pumps is challenging, large-scale heating projects are proving fertile ground for ammonia. Industrial heat pump manufacturer Mayekawa's Eric Delforge, who chairs a European Heat Pump Association (EHPA) working group on industrial and commercial heat pumps, argued at ATMosphere Europe that ammonia is already a growing trend.

"Many others can learn from industrial systems," Delforge said.

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

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

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

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

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

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

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

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

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

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



Kenneth Hoffmann, GEA, at ATMOsphere Europe



Matteo Munari, Alfa Laval, at the European Heat Pump Summit

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Parallel compressors working together with ejectors can significantly improve the efficiency of transcritical CO₂ in warm climates, while other technology innovations can also boost CO₂ system performance. *Accelerate* reports from this year's ATMOsphere conferences in San Diego and Berlin.

– By Michael Garry & Andrew Williams

Trancritical CO₂ refrigeration systems have steadily gained traction in the food retail sector, with more than 12,000 installations in Europe and over 450 installations in North America, according to the latest data from sheccoBase, the market development arm of shecco, publisher of *Accelerate*.

Most of these systems operate in moderate climates, where their efficiency outdoes that of traditional HFC systems. But for CO₂ transcritical to achieve broader adoption – particularly in the United States, where it is playing catch-up with Europe – manufacturers are working hard to improve its efficiency in warm ambient climates.

CO₂'s high critical point – 31.10°C – means that at high ambient temperatures, CO₂ exists as a supercritical fluid (without distinct liquid and gas phases), and more energy is required in the vapour compression cycle.

Energy-enhancing technologies like adiabatic condensers, subcooling, parallel compression and ejectors are able to increase

the operating efficiency of transcritical systems, enabling them to break through the 'CO₂ equator' that has constrained adoption in southern climates. In Europe, for example, parallel compression in concert with ejectors has led to uptake of transcritical systems in warm countries like Spain and Italy.

At the ATMOsphere America 2017 conference in San Diego in June, representatives of US OEM Hillphoenix and Italy-based component maker Dorin spoke about the positive impact that ejectors and parallel compression can have on transcritical efficiency and how these technologies achieve this.

Flash gas problem

Hillphoenix's Danish subsidiary Advansor has placed 500 transcritical systems with parallel compression in Europe and more than 20 with ejectors as well. In the US, Hillphoenix is just getting started with these technologies, with a parallel compression system installed at a United States Navy commissary in Newport, Rhode Island, and an ejector-parallel compression system operating at a Sprouts Famers Market store in Woodstock, Georgia.

At ATMOsphere America, Jeff Newel, director of research & development at Hillphoenix, described a study that Hillphoenix did in its lab in Covington, Georgia, where the OEM compared the performance of a standard Advansor transcritical CO₂ booster system with that of the same system equipped with parallel compression and a gas ejector.

The main problem faced by transcritical systems in warm climates is that the 'flash gas' produced by the supercritical fluid as it enters the flash tank from the gas cooler does no useful work. The gas is essentially recycled through the system, initially at reduced pressure, as it moves from the flash gas control (bypass) valve through the medium-temperature compressors and back to the flash tank.

"That's where the energy issue arises," said Newel. "You've got this amount of flash gas, when you're in supercritical operation, that just goes around and around in a circle."

One way to address the flash gas problem is to eliminate, or at least minimise, the flash gas during supercritical operation. "That's where parallel compression comes in," Newel said.

Instead of going along its usual route to the medium-temperature compressors, the flash gas is redirected to an internal heat exchanger and then to the separate parallel compressor or compressors – a "satellite compressor group," said Newel. The sole purpose of the heat exchanger, he noted, is "to make sure there's enough superheat in the CO₂ as it goes back to the [parallel] compressor that you're not going to cause a problem".

The key, he noted, is that the flash gas is now at a higher suction pressure (matching the pressure of the flash tank) as it heads to the parallel compressor than it would be in a conventional scenario. "You're not paying to take a 36-bar flash gas and pass it through the bypass valve, where it drops down in pressure, and then re-compress it again," he explained. "That's what saves you money."

A gas ejector, inserted between the heat exchanger and the high-pressure control valve/flash tank, adds another layer of efficiency to the operation.

The ejector receives not only supercritical fluid from the gas cooler but low-pressure CO₂ gas from the medium-temperature suction line, and channels both to the flash tank. Then it proceeds back up to the parallel compressor, just as simple parallel compression does.

"It reduces energy further than even the parallel does and it gives that parallel compressor an opportunity to run for a longer time," said Newel. In effect, "the ejector really is just using energy that's been stored within the system. It's free energy."

Newel cited two types of ejector, an adjustable-nozzle type made by CAREL and Danfoss's multi-ejector with fixed ejector sizes applied in parallel. Hillphoenix is using the latter – "a little bit bigger than an iPad, maybe an inch and a half thick," said Newel – in its year-old test system.

On a theoretical basis, Hillphoenix expected that, in a hot climate, parallel compression would produce annual energy savings in the 6-8% range, and that parallel compression with a gas ejector system would deliver annual savings of 8-10%. The company's Advansor subsidiary in Denmark tested "optimised systems" with similar results.



Jeff Newel, Hillphoenix



Giacomo Pisano, Dorin

But in its lab, Hillphoenix tested a "non-optimised" system with a higher low-temperature load among other changes "because, believe it or not, systems out in the working world aren't always optimised," Newel said. The result was a 5.4% annual energy saving with parallel compression and a 6.5% saving with parallel compression and an ejector. "This is still good savings," he added.

Liquid ejector advantage

Giacomo Pisano, technical sales manager at Dorin, described at ATMosphere America how the company is enabling retailers like Carrefour to operate transcritical refrigeration efficiently in the warm climates of Italy. One way is with liquid ejectors.

In Europe, not only are manufacturers incorporating gas ejectors in transcritical systems, but liquid ejectors as well.

Liquid ejectors allow for a flooded evaporator design. Some liquid may come back from the evaporator, but would be collected into a low-pressure receiver and then pumped by a liquid ejector into an intermediate-pressure receiver. "By working in this way, you manage to raise the evaporating temperature by [as much as] six degrees Kelvin, which means a very high COP increase," said Pisano.

Pisano said a gas ejector works most efficiently in combination with a liquid ejector. "If you manage to raise your suction pressure with a liquid ejector, you will have a smaller differential pressure across the gas ejector – which will then be able to transfer more mass flow."

In Europe, there are about 100 transcritical systems running with gas and liquid ejectors, he said, especially in very warm areas like Italy or Greece. "This kind of system, using parallel compressors, liquid and gas ejectors, is managing to completely delete the so-called equator for CO₂ applications."

Pisano cited a Carrefour supermarket in Turin, Italy, as an example of where this enhanced transcritical system, with a rack from Italian OEM Enx and Dorin compressors, is running. The store has a medium-temperature capacity of 340 kilowatts and a low-temperature capacity of 66 kilowatts, performs heat recovery for ambient heating and sanitary hot water usage, serves 160 evaporators, and is designed to work in ambient temperatures up to 45°C.

According to Pisano, by using a system with parallel compression combined with gas and liquid ejectors, Carrefour gains 28% in efficiency over a basic transcritical system. "You can easily understand how, with this technology, you manage to boost the efficiency of a CO₂ system in very warm climates," he said.

At ATMosphere Europe, meanwhile, Pisano acknowledged that CO₂ is becoming increasingly competitive with ammonia in the industrial refrigeration market. He cited Dorin's six-cylinder transcritical compressors that can run up to 60 m³/h as a key technological development allowing CO₂ to operate at higher capacities. ■ MG & AW



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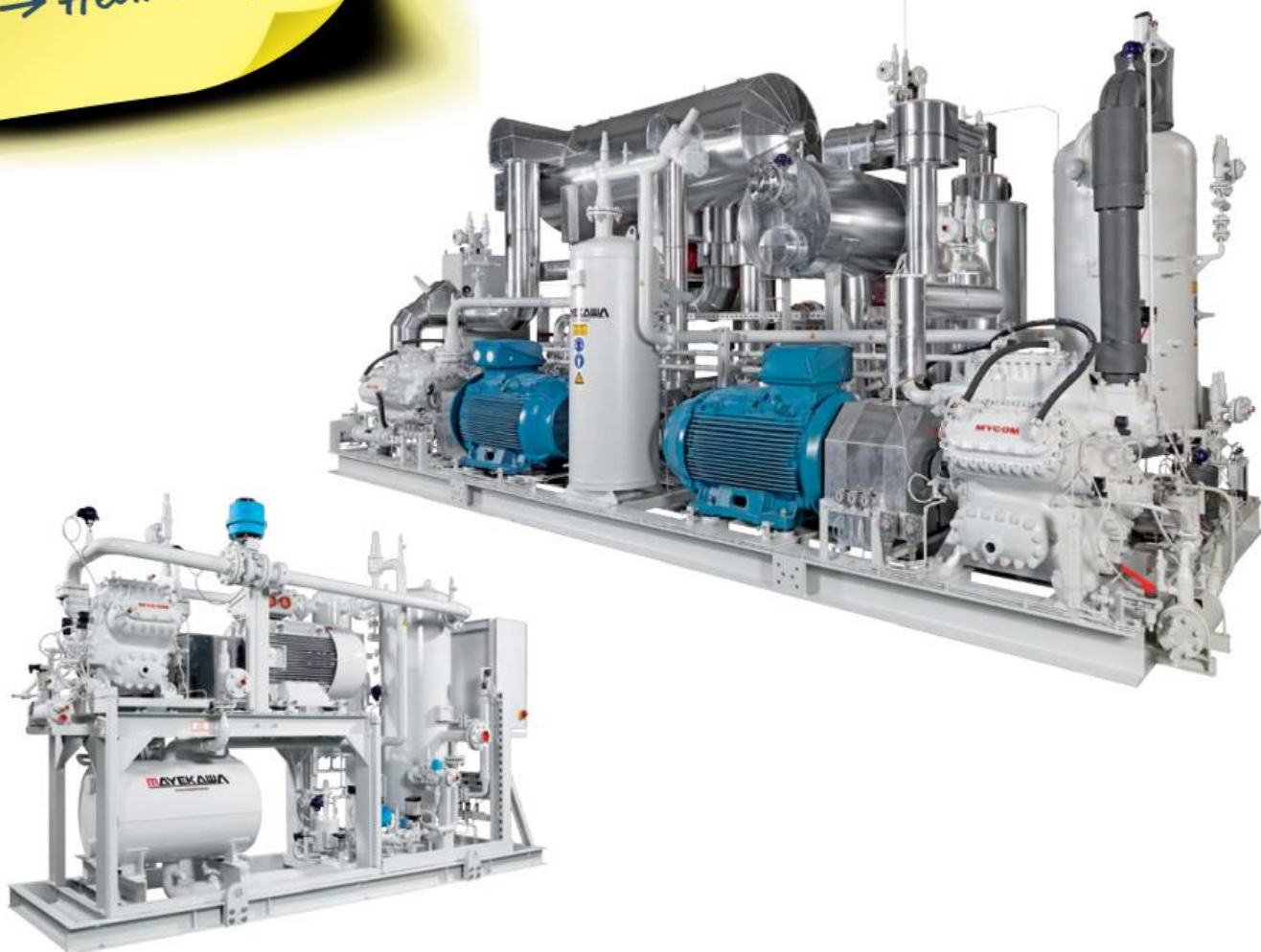
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