

WINTER 2018

ACCELERATE

ADVANCING HVAC&R NATURAL

EUROPE

Introducing
the
2018

**PERSON
OF
THE
YEAR**

Sergio Girotto,
enEX

p.22

Also in this issue

Sun shines on
CO₂ in Jordan

p.18

AWARDS SPECIAL
Hail to the innovators

p.26

THE CO₂ MAGICIAN

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Hail to the trendsetters

— Editor's Note by Andrew Williams

As 2018 draws to a close, it's once again time to celebrate the innovators who have done the most to disrupt the HVAC&R industry and help make the business case for natural refrigerants even more compelling.

In an evening ceremony at this magazine publisher shecco's ATMOSphere Europe conference in November, five visionary movers and shakers were recognised with *Accelerate Europe* awards for their unique contributions to advancing natural refrigerants in Europe over the past year (p. 26).

Our cover star, Sergio Giroto, richly deserves his *Accelerate Europe* Person of the Year crown. During his long career in the HVAC&R industry, he has worked tirelessly to bring CO₂ to new areas of application. Of all his achievements, he is perhaps best known for installing the first-ever CO₂ transcritical system in a large supermarket, in 2001. I sat down with the enEX president to find out what's next for him and for the HVAC&R industry (p. 22).

2018 was a year of firsts for CO₂ transcritical around the world, and this magazine volume draws to a close with two more. The first CO₂ transcritical supermarket in the Middle East, in Jordan, has delivered energy savings since opening in February (p. 18), while Delhaize Serbia opened its first transcritical store in Serbia in November (p. 30).

If you're heading to the slopes this winter, why not use a CAPiTA snowboard? The Austrian company is using an ammonia heat pump at its new factory (p. 40).

With competition between CO₂, ammonia and hydrocarbons more fierce than ever, visitors to Chillventa 2018 discovered how natural

refrigerants have now become mainstream HVAC&R options as HFCs are phased down (p. 46).

At ATMO Europe, leading thinkers saw a bright future for CO₂ in industrial as well as commercial applications in Europe (p. 56), while French real estate giant Gecina wants to use natural refrigerants for HVAC (p. 42). At Sifa in Lyon (p. 54) and at ATMOSphere Ibérica in Madrid (p. 52), the French, Spanish and Portuguese natural refrigerant markets appeared ripe for growth too.

Policy could also help boost uptake of natural refrigerants. Parties to the Montreal Protocol are discussing support for energy-efficient technologies to complement the HFC phasedown (p. 60). A bigger charge limit for hydrocarbons is expected to boost the commercial refrigeration market next year (p. 64), while a new report looks at what more can be done to remove policy barriers to using these flammable natural refrigerants (p. 66).

This issue's Technology Focus, meanwhile, looks at the host of technologies now available to make CO₂ possible in warm ambient climate situations in Europe (p. 72).

Further afield, two progressive end users have turned to natural refrigerants for different reasons. Jewel Fine Foods chose ammonia for its new food production facility (p. 32), while Henningsen is testing CO₂ transcritical technology at two cold storage facilities in the United States (p. 36).

Thank you for your loyal readership in 2018. 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 cutting-edge natural refrigerant coverage in 2019.



Andrew Williams
Editor

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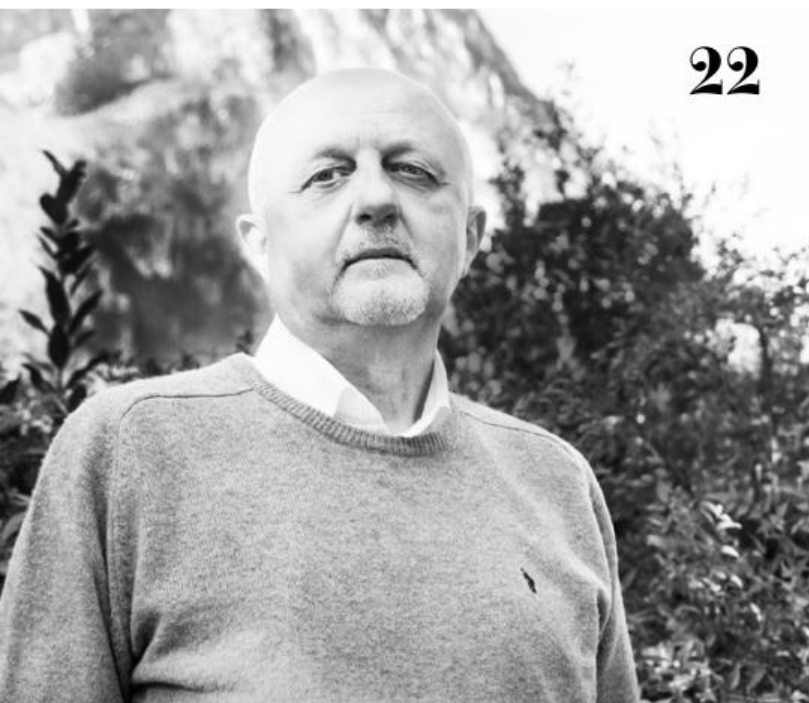
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About Accelerate Europe

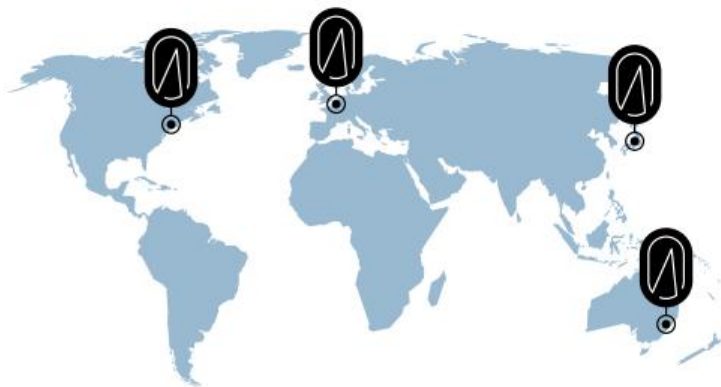
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Printed copies are available to pick up at leading HVAC&R tradeshow and are posted to key end users and industry professionals.

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Editorial Calendar

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FOCUS:
Industrial Refrigeration
PUBLICATION DATE:
5 March

// ISSUE #15 ***Summer 2019***

FOCUS:
The warm climate challenge
PUBLICATION DATE:
6 June

// ISSUE #16 ***Autumn 2019***

FOCUS:
*Rise of NatRefs in Central &
Eastern Europe*
PUBLICATION DATE:
12 September

// ISSUE #17 ***Winter 2019***

FOCUS:
*'Free heating' with NatRefs:
The benefits of integration*
PUBLICATION DATE:
5 December



#GoNatRefs



JAN - FEB

12-16.01

ASHRAE Winter Conference Atlanta, United States

The 2019 ASHRAE Winter Conference focuses on refrigeration, HVAC&R fundamentals and applications, systems and equipment, and common system misapplications, among others.



www.ashrae.org/conferences/winter-conference



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14-16.01

AHR Expo Atlanta, United States

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25.01

ASERCOM Annual Convention Brussels, Belgium

ASERCOM's next annual convention will take place in Brussels on 25 January 2019. ASERCOM members and guests alike will come together to exchange ideas, network and attend lectures by industry experts.



www.asercom.org/annual-convention-2019

5-8.02

Aquatherm Nitra Nitra, Slovakia

Aquatherm Nitra is an international trade fair for heating, ventilation, air-conditioning, measuring, regulation, sanitary and environmental technologies.



www.aquatherm-nitra.com/en



12.02

ATMOsphere Japan Tokyo, Japan

ATMOsphere Japan returns to Tokyo on 12 February 2019; one day before Japan's largest retail exhibition, the Supermarket Tradeshow.



www.atmo.org/events.details.php?eventid=74



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FEB—MAR



22.02

REFRIGERA Piacenza, Italy

REFRIGERA 2019 is an HVAC&R show dedicated to the whole production chain of industrial, commercial and logistics.



www.refrigera.show/2019/en

26.02-01.03

Climatización Y Refrigeración Madrid, Spain

C&R 2019 is an international HVAC&R exhibition put together by IFEMA, a Spanish events organiser.



www.ifema.es/climatizacion_06



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27.02-01.03

World Sustainable Energy Days Wels, Austria

This annual event focuses on energy efficiency and renewable energy as part of Europe's commitment to a clean energy transition.



<http://www.wsed.at/en/world-sustainable-energy-days.html>



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05-07.03

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11-15.03

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EUROPE IN BRIEF

NETTO opens its first Swedish 100% R290 store

Denmark-based NETTO has opened its first store in Sweden to use natural refrigerant propane (R290) for 100% of its refrigeration needs. The discount supermarket in the city of Perstorp, which opened at the end of September, operates on a propane-based waterloop refrigeration solution by Lithuanian firm FREOR.

In the Perstorp store, Coolfors – FREOR's partner in Sweden – installed FREOR's propane-based JUPITER multideck cabinets and high-capacity JUPITER ROLL-IN multidecks.

"All the refrigeration equipment is connected to our Hydroloop Glycol cooling system," said FREOR. Any excess heat is used to provide hot water. ■ AW

Danfoss inaugurates flammable testing lab

In September 2018, Danish multinational component manufacturer Danfoss opened its newly extended ATEX lab (a testing environment for explosive substances) in France. The facility tests the safety of flammable refrigerants in products.

"The refrigeration industry started around 200 years ago with natural refrigerants and they had two problems: toxicity and flammability," said Fabio Klein, vice-president (R&D Commercial Compressors), Danfoss at the inauguration.

"Afterwards other refrigerants appeared, and we had the ozone depletion and global warming issues. So natural refrigerants are coming back again," Klein said. ■ CM

UTC to spin off Carrier

In November 2018, United Technologies Corporation (UTC) announced its intention to separate its three brands – UTC, an aerospace systems supplier; Otis, a manufacturer of moving walkways; and Carrier, a manufacturer of HVAC&R equipment and a leading provider of CO₂ systems – into separate companies.

Carrier, with over 10,000 CO₂ subcritical and transcritical rack installations in European supermarkets, is expected to concentrate on developing its merger and acquisitions (M&A) portfolio.

"I think M&A is going to be part of the growth strategy of both Carrier and Otis," said Gregory Hayes, chairman and CEO of UTC. ■ CM

Denmark boasts 41 'large NatRef heat pump' installations

Speaking at the Chillventa Congress (on 15 October 2018), Lars Ove Reinholdt, product manager, refrigeration and heat pump technology at the Danish Technology Institute (DTI; based in Aarhus), said Denmark boasts 41 large natural refrigerant-based heat pumps, mostly with ammonia and mostly for district heating projects.

The heat pump capacities range from 0.2 to 10 MW. Subsidies granted by the Danish government to encourage district heating plants to install large heat pumps have played a crucial role in their proliferation, Reinholdt said.

■ CM

DSI, Erlinord merger creates DSI Freezing Solutions A/S

In November 2018, A/S Dybvad Stål Industri (known for its manually operated and automatic plate freezers for ammonia and CO₂-based applications) completed the acquisition of Erlinord A/S, a Danish company involved in the handling business, to create a single entity – DSI Freezing Solutions A/S.

The companies described the change as the result of a comprehensive strategic process to prepare for international growth and to support their positions as international market leaders in plate freezing and handling solutions.

The cost price of the equity investment was DKK 37,931,000 (~€5.85 million).

■ CM

French industry mulls overcoming NH₃ barriers

Barriers to ammonia in France remain, according to Yvan Le Picault and Eric Martin of Johnson Controls, who spoke at the annual conference of French HVAC&R trade association *Alliance Froid Climatisation Environnement* (AFCE), in September 2018 in Paris.

In France, ammonia-based systems with a charge greater than 50 kg per refrigeration unit are subject to mandatory reporting and periodic inspections by approved organisations. Authorisation from the prefecture is also required to use 1.5 tons or above of ammonia.

Le Picault and Martin argue this does not make sense given the attention to training and due diligence done by ammonia users. ■ CM



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EUROPE IN BRIEF

EU Commission probes Nidec's acquisition of Embraco

In November 2018, the European Commission launched an 'in-depth investigation' into the acquisition by Nidec of Embraco. The two companies are leading global suppliers of hydrocarbon-based household and commercial refrigeration compressors.

Nidec, which bought SECOP – another leading supplier of hydrocarbon compressors – in 2017, purchased Embraco from white goods manufacturer Whirlpool in April.

EU Competition Commissioner Margrethe Vestager said, "this industry is already highly concentrated, therefore the Commission will closely analyse the impact on competition of Nidec's proposed acquisition of Embraco, to ensure their customers and final consumers are not harmed due to higher prices or less choice".

■ CM

Brexit: If 'no deal', UK will set up f-gas system

In September 2018, the UK government confirmed that in the event of a 'no deal' exit from the European Union it would adopt the EU F-Gas Regulation – phasing down HFCs by 79% by 2030 (compared to 2009-12 levels) and adopting the bloc's quota method and schedule – but administer it through the UK Environment Agency.

The UK needs to agree a deal with the European Union (EU) by 29 March 2019 if it wants to prevent a 'no deal' Brexit, which would mean no formal agreement over the EU F-Gas Regulation.

■ CM

Semi-hermetic ammonia HVAC system installed in Eindhoven

In September 2018, a semi-hermetic ammonia heat pump for heating and cooling 40,000 m² of apartments and business premises was installed in the Netherlands.

The remodelled office complex, a former Philips factory in Eindhoven, will use the 800 kW ammonia heat pump system fitted with two twin screw compressors for space heating during the winter and air conditioning during the summer. It has an ammonia charge of 180 kg.

In addition to the heat pump, the building also uses biomass and solar energy to fulfil other heating needs and to produce electricity. ■ CM

Japan's Daikin acquires Austria's AHT

In the latest sign of its interest in the natural refrigerants sector, Japanese multinational air-conditioning giant Daikin has announced the acquisition of AHT Cooling Systems, an Austrian commercial refrigeration firm specialised in propane cabinets, for €881m (JPY 114.5 bn).

Daikin – the world's largest manufacturer of air-conditioning equipment – expects to complete the acquisition in January 2019. The Japanese firm said the deal would enable it to, "propose total systems that cover the entire cold chain," while also expanding its refrigeration business in the United States and Asia.

■ AW

CAREL debuts mobile interface to controllers

In a move to simplify interaction with HVAC&R units in the Internet of Things era, Italian component maker CAREL has introduced a new mobile service app, APPLICA, which allows end users to employ their smartphones as management tools.

APPLICA can be used to manage MPXone, the new CAREL controller for retail refrigeration units; µCHILLER, for control of chillers and heat pumps; and Heez, the control solution for refrigerated merchandisers.

When APPLICA connects to a controller, "it recognises the type of unit and downloads the applications it needs from the cloud," said CAREL.

■ MG

GEA bags award for heat pump at poultry farm

At Refrigeration & Air Conditioning (RAC) magazine's Cooling Industry Awards (hosted by the British magazine in London in September 2018), German manufacturer GEA was recognised for installing an ammonia-based heat pump at a Northern Irish poultry producer's Moy Park site.

The Cooling Industry award went to Moy Park in the category of 'Building Energy Project' for the plant's ability to reduce the company's energy use by reclaiming the heat from the ammonia refrigeration system (cited by RAC as a "prime example of innovation and significant energy savings," according to GEA). ■ CM

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Capitalising on Kigali

The latest Intergovernmental Panel on Climate Change (IPCC) report, published in October 2018, highlighted the stark reality of the impact of 2°C global warming. The need to make all possible reductions in greenhouse gases has never been greater.

Every industry needs to do its bit to help. The cooling sector is very well positioned to make a vital and significant contribution by rapidly transitioning away from climate-damaging refrigerant gases while improving energy efficiency, thus delivering a double benefit for the climate.

The Kigali Amendment can avoid almost 0.5°C of warming by phasing down hydrofluorocarbons (HFCs) and eliminating 70 billion tonnes of CO₂-equivalent emissions; combining energy efficiency with the phasedown could significantly increase this figure.

The Kigali Amendment comes into force in January 2019 with a 10% reduction from the 2011-2013 baseline for the first group of nations (developed, or so-called non-A5, countries). Developing countries have a later schedule, with most freezing HFC consumption in 2024 but, in the meantime, there are opportunities to skip HFCs entirely and go straight to natural refrigerant solutions. The path taken by the cooling sector in Europe will provide important signals to the rest of the world.

The transition from HFCs to natural refrigerants offers an opportunity to simultaneously improve energy efficiency. This will increase the climate benefits while also helping to offset initial costs

through energy savings over the lifetime of HVAC&R equipment. We are already seeing installations of equipment, controls and systems using natural refrigerants that offer significant energy-efficiency gains over the HFC systems they are replacing.

For countries to successfully implement the Kigali Amendment and swiftly transition to natural refrigerants, there are several barriers that need to be addressed:

- **Standards** – Outdated industry standards currently prevent the safe use of flammable refrigerants. We are working to update these standards. There is still time for natural refrigerant supporters to get involved in this ongoing process.

- **Training** – We need to increase the number of technicians trained to install and service natural refrigerant systems around the globe.

- **Finance** – We are engaging with the Multilateral Fund, the Montreal Protocol's dedicated financial instrument, to encourage guidelines that will create a sustainable financial framework that assists developing countries in transitioning to energy-efficient HFC-free technologies. Buyers' clubs and green public procurement for natural refrigerant technologies will lower initial costs while sending a clear message to manufacturers that market demand exists.

- **Awareness** – The Kigali Amendment will raise awareness of the need to rapidly transition away from HFCs. Widespread awareness-raising will help prevent inefficient HFC systems with high global warming potential from being locked in before the phasedown begins.

- **Enforcement** – Improved enforcement and monitoring of the Montreal Protocol and the Kigali Amendment is needed, especially in the face of unexpected emissions of CFC-11 traced back to the foam blowing industry in China as well as the illegal trade of HFCs currently taking place in the EU. A robust mechanism for monitoring and enforcement is essential for the continued success of the Montreal Protocol as the Kigali Amendment comes into force.



Sophie Geoghegan
Climate Campaigner
Environmental Investigation
Agency (EIA)

Sophie works on the NGO's campaign to eliminate powerful greenhouse gases used widely in the cooling sector, improve the energy efficiency of replacement technologies, and investigate the illicit trade in refrigerant greenhouse gases.



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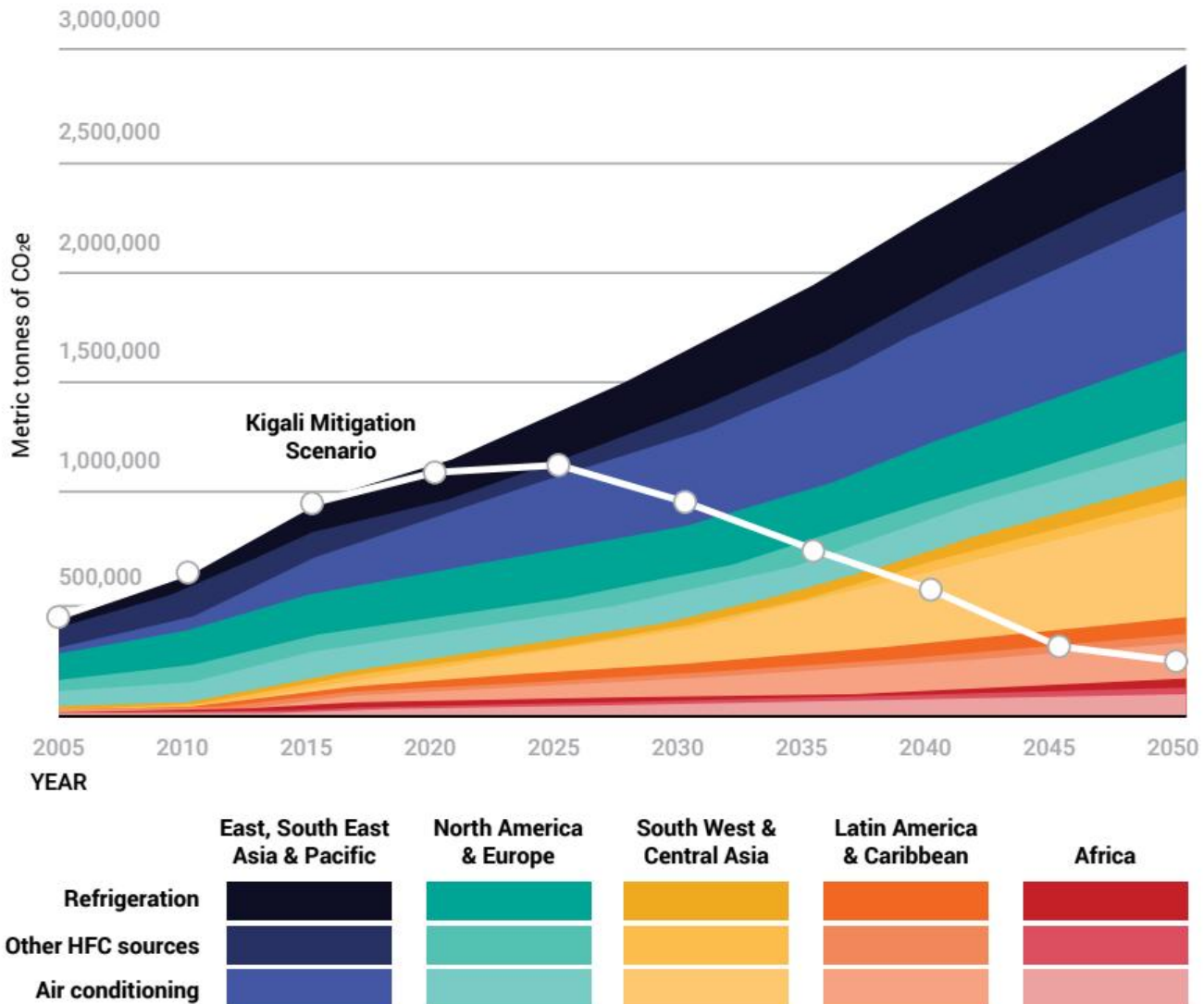
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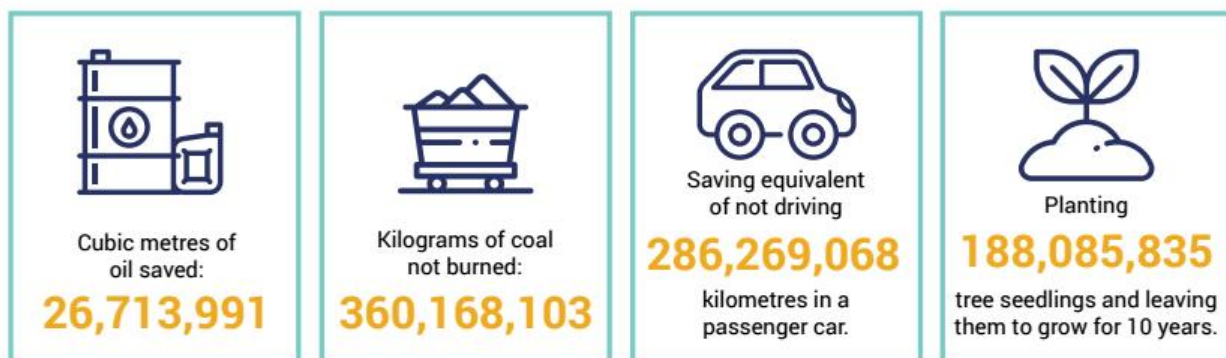


Worldwide impact of the Kigali Amendment

Evolution of HFC emissions from main sources and Kigali Amendment mitigation scenario*



Greenhouse gas mitigation impact**

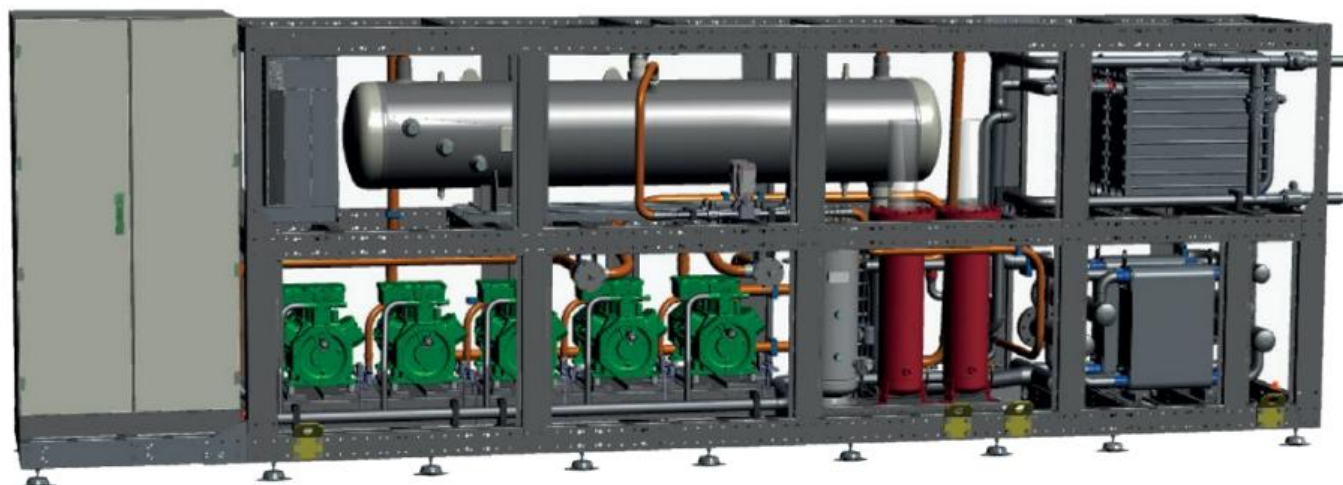


sheccoBase 

*International Institute for Applied Systems Analysis (IIASA) / Climate and Clean Air Coalition (2016-2017 Annual Report)
 **According to the European Commission, 80 billion metric tonnes of direct GHG and CO₂e emissions will be saved from Kigali between 2020 and 2050, which translates (using the U.S. Environmental Protection Agency's greenhouse gas equivalencies calculator) to the above.

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SUN SHINES ON CO₂ IN JORDAN

The first transcritical CO₂ supermarket in the Middle East, in Jordan, has been hailed as a success – delivering energy savings of 30% since opening this year.

– By Charlotte McLaughlin

The Hashemite Kingdom of Jordan is known for its high temperatures, as holidaymakers and anyone working on the Montreal Protocol know all too well.

The Montreal Protocol on phasing out substances that deplete the ozone layer (CFCs and HCFCs) and its subsequent Kigali Amendment, which phases down HFCs, lists Jordan as a so-called 'high ambient temperature' (HAT) country. The global agreements aim to get rid of high global-warming potential (GWP) and high ozone-depleting potential (ODP) substances.

Natural refrigerant CO₂ has not traditionally been noted for coping with sustained hot ambient temperatures. The so-called 'CO₂ equator' refers to the accepted geographical limit for cost-effective and efficient performance of transcritical CO₂ systems in all food retail store formats.

CO₂ has been able to overcome these issues with the use of innovative technologies like ejectors and parallel compression, which were used in this first installation in Jordan.

The CO₂ system at the Al-Salam military supermarket in Amman, Jordan in February 2018 was the first time the installer, Abdin Industrial, had worked with CO₂. Abdin is also responsible for future maintenance of the system.

The CO₂ transcritical system coped well with temperatures of up to 35-36°C between June and September, thanks to the use of the advanced technology.

enEX S.r.l., the Italian manufacturer of the CO₂ system, initially doubted that an HVAC&R company with limited knowledge of this natural refrigerant would succeed – and was pleasantly surprised when it did.

"In the beginning we were sceptical about the feasibility with a company that had never done CO₂, nothing,



Amman, home to the first CO₂ transcritical supermarket in the Middle East.

not even cascade, but then we had to rethink our ideas,” says Sergio Girotto, president of enEX and *Accelerate Europe* ‘Person of the Year’ (see ‘*The CO₂ magician*’, page 22). “They learned very quickly [about] CO₂ systems.”

“The fruitful cooperation of Abdin and enEX shows that local manufacturers and suppliers of commercial refrigeration equipment are able to leapfrog towards the latest CO₂ refrigeration technology,” says Dr. Armin Hafner of SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology in Trondheim, Norway).

Hafner served as technical adviser on the Amman project.

The system also features non-superheated evaporator technology, for both chilled and frozen food cabinets and storage rooms. The waste heat from the system is recovered for hot sanitary water supply, which increases the energy efficiency of this system still further.

“The refrigeration system in the supermarket in Amman, Jordan, is able to maintain chilled food at the set-point temperatures with an evaporation temperature of -2°C, while the frozen foodstuff is cooled by evaporating carbon dioxide at -25°C,” Hafner says.

The deployment of Dorin parallel compressors and Danfoss multi-ejector technology in the Middle East’s first CO₂ supermarket helped the system to function efficiently in hot climates and to realise energy savings. Alfa Laval, LU-VE and Temprite also supplied components.

After measuring the CO₂ system’s performance against an HFC-system in a similar supermarket in the same area, Abdin found that the CO₂ system performed more efficiently than the HFC one throughout the year.

Nasser Abdin of Abdin Industrial told *Accelerate Europe*, “we installed energy meters in both projects [and] we found that the CO₂ system had saved more energy than the other [HFC supermarket] by 20-30%”.

With a total surface area of 2,000 m², this supermarket represents a test for CO₂ in challenging weather conditions and could open the door to the expansion of CO₂ across the region.

“Recently I heard about the result – it seems [the military] is extremely satisfied [with] the energy saving,” says enEX’s Girotto.

Feedback from the military has also been good, according to Abdin. The customer has not experienced any maintenance or food wastage issues. The military is also exploring the potential to install CO₂ systems in other locations in Jordan in the future.

“After installing the first CO₂ project in Jordan, we as Abdin feel that we now have the responsibility and duty to inform [others in the industry] about the benefits of CO₂ systems,” Abdin explains. “I also think our government can do something to help [...], for example by [awarding] projects [to installers] that manage to reduce their energy bills.”

HOW IT ALL BEGAN

The Al-Salam supermarket previously used a chemical refrigerant that depletes the ozone layer and has a high GWP (HCFC-22), before the new system based on CO₂ (with a GWP of just one) was put in with support from Jordan's Ministry of Environment. The demonstration project was funded by the Climate and Clean Air Coalition (CCAC) and implemented by the United Nations Industrial Development Organization (UNIDO).

There are currently around 20,000 CO₂ transcritical supermarkets in the world, according to October 2018 estimates from sheccoBase (the market development arm of *Accelerate Europe* publisher shecco).

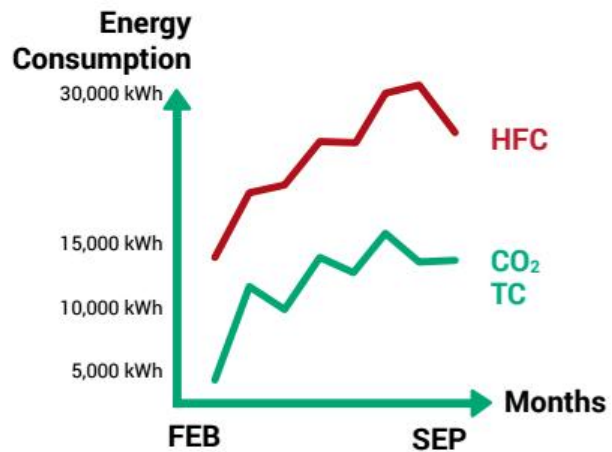
CO₂ has been successfully used in supermarkets in diverse and far-flung locations including Brazil, China, Russia, Indonesia, Peru and Australia, thanks to the commitment of local and multinational retailers, as well as similar international funding on occasion.

Sulafa Mdanat, UNIDO's country representative in Jordan, said: "CO₂ technology is spreading very fast in the world as it is considered one of the most energy-efficient and climate-friendly refrigeration technologies for the retail sector." ■ CM

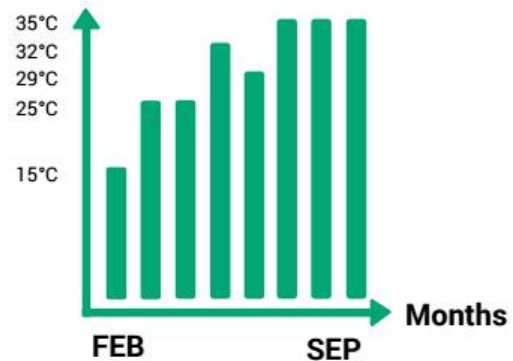
BELOW

CO₂ transcritical system, Al-Salam military supermarket, Amman.

COMPARISON BETWEEN AN HFC AND CO₂ TRANSCRITICAL SUPERMARKET IN JORDAN:



Average Ambient Temperature in Jordan in 2018



Source: Abdin Industrial

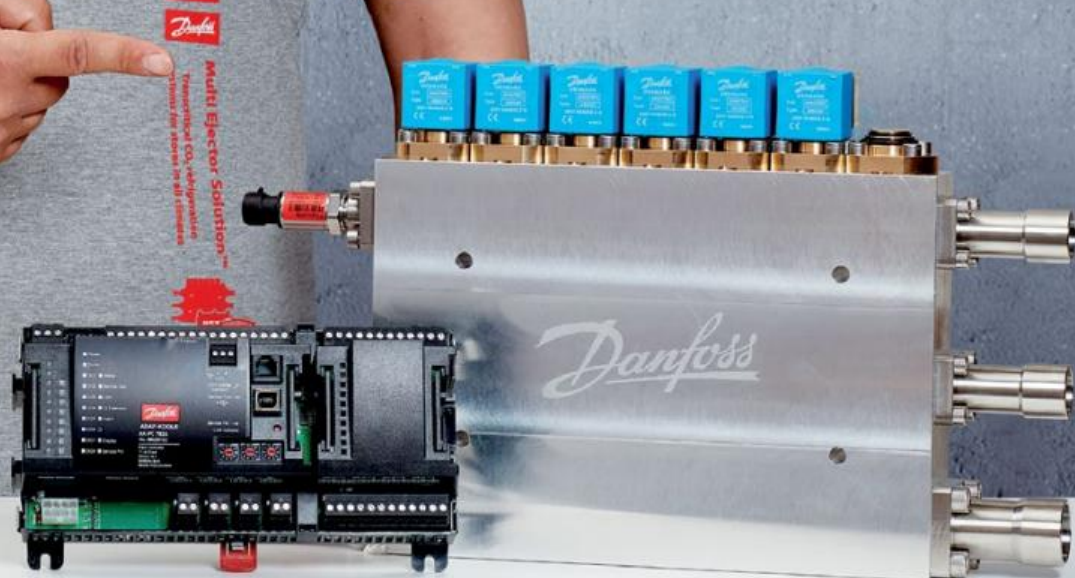


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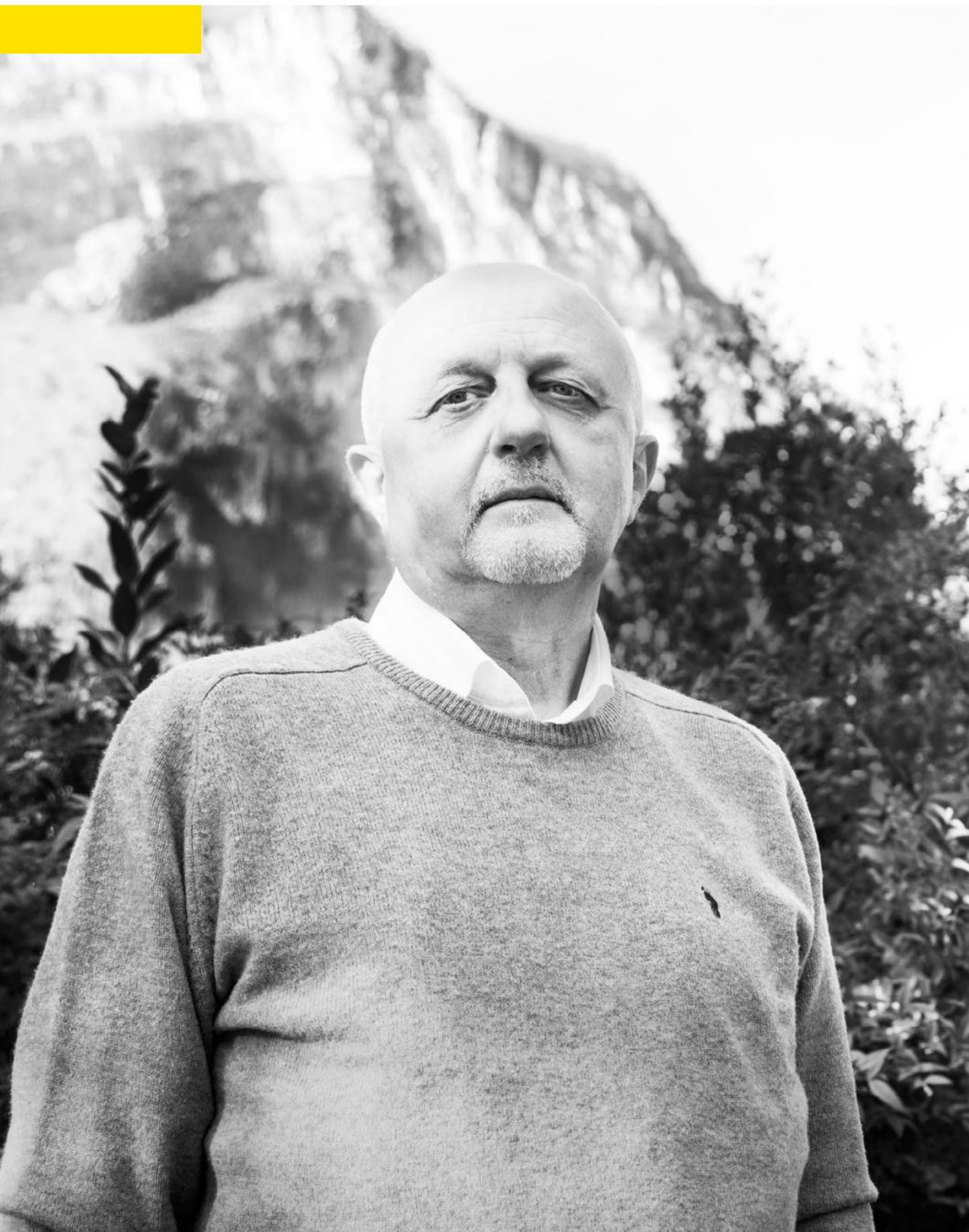
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THE CO₂ MAGICIAN

Sergio Girotto has worked tirelessly to bring CO₂ to new areas of application. *Accelerate Europe* sits down with the 2018 Person of the Year to find out what's next for the enEX president – and the HVAC&R industry.

– By Andrew Williams

Of all his achievements, Sergio Girotto is perhaps best known for installing the first-ever CO₂ transcritical system in a large supermarket, in 2001 – an adventure with natural refrigerants that began in 1996, when he asked Italian manufacturer Dorin to produce a CO₂ compressor.

In February 2018, Girotto added another string to his bow. His company, enEX, provided the system for the first CO₂ transcritical supermarket in the Middle East (see *'Sun shines on CO₂ in Jordan'*, page 18).

And on 20 November, this quiet and unassuming giant of the HVAC&R sector reached a new landmark when he was crowned *Accelerate Europe* Person of the Year 2018.

Girotto is characteristically modest in discussing his newfound status. "It's an honour to be Person of the Year," he says. "What I appreciate most is that I've been approached by several of my competitors who said, 'I'd choose you too'. I think this is the best recognition a professional can have."

A mechanical engineer by training, Girotto has enjoyed over two decades working for companies in the refrigeration sector, in roles including R&D, design, production and after-sales service.

In his long HVAC&R career, what's he most proud of? "Being a protagonist in the development of CO₂," replies Girotto with no hesitation.

Between 1988 and 1991, Norwegian researcher Gustav Lorentzen showed how the long-dormant refrigerant CO₂ could be used again as an active working fluid.

Girotto is quick to recognise Lorentzen's brilliance. "Professor Lorentzen had the intuition that CO₂ could become a major part of the answer to environmental issues in our sector," he says.

The crucial next step was to bring CO₂-based HVAC&R solutions to market, or as Girotto puts it, "moving from scientific papers into real systems". "I'm grateful for all the companies that have participated in the reinvention of this technology," he says.

Girotto himself has patented a number of refrigeration products and system designs. Among his personal favourites is a liquid ejector for overfeeding evaporators (see *'The restless innovator'*, *Accelerate Italy*, February 2018).

He founded his own company, enEX, in 2004. Ever since, the firm has focused solely on CO₂. Asked what he has enjoyed most about his time there, Girotto replies: "To have contributed to developing or bringing into practical use some of the main innovations in CO₂ technology."

At the forefront of an industry

At enEX, Girotto has been the driving force behind a host of innovations including the use of ejectors to recover energy in warm climates, auxiliary compressors for flash gas recompression, overfed evaporators, and water chillers – including an ejector version.

“

What I appreciate most about becoming Person of the Year is that I've been approached by several of my competitors who said, 'I'd choose you too'. I think this is the best recognition a professional can have.

– Sergio Girotto, enEX

”

His company has built over 1,000 CO₂ transcritical systems, the first of which came off the production line in 2006.

Asked why enEX chose to focus solely on CO₂, Girotto argues, “CO₂ is good for so many different applications and capacities that it doesn't make sense for us to expend our resources and energies in other directions”.

He is optimistic that his Person of the Year status will help to raise awareness of what his company, enEX, has to offer. “I hope and would like this visibility to help bring the name of the company and its products to a larger audience,” he says.

Targeting HVAC

Girotto is convinced that the future of the HVAC&R industry is natural. “10 years from now, natural refrigerants will be used in every HVAC&R application,” he says – with the exception of a few ultra-low temperature niche areas.

Air conditioning has proven a tough nut to crack. Girotto believes the most challenging area for natural refrigerants is domestic air conditioning, “where it is unrealistic to believe that flammable hydrocarbons will be the solution”.

Is it possible to use CO₂ in the HVAC sector? “Yes, absolutely!” Girotto says.

He points to his own company's achievements with CO₂ as examples. “enEX has already developed a product for direct heating and cooling – a kind of large VRF system,” he says. “And water and brine chillers are already available today.”

Girotto is convinced that the market share of CO₂-based products can increase at the same rate in HVAC as it has in commercial and industrial refrigeration. “There is no reason why not,” he says.

Asked why this is yet to happen, Girotto cites the “conservative approach” and “inertia” of many companies active in the HVAC sector who fear that change would make it harder to maintain their profitable status quo. “But they have no chance,” he says. “Solutions with natural refrigerants will take over the market.”

As Person of the Year, what advice would Girotto offer new engineers at the beginning of their HVAC&R journeys? “Keep an open mind, and be willing to work hard to be successful.”

How might their careers differ from his? The enEX president turns to the past to look to the future.

“Technology has evolved impressively since the 1980s. Not just the move from synthetic to natural refrigerants – but also the arrival of information technology into our sector,” Girotto says.

“Artificial intelligence is in its early stages. My guess is that AI will be the next revolution in the refrigeration and air-conditioning sector – the new engineers will have a completely new business area to develop,” he predicts.

Given his track record, only a fool would bet against him. ■ AW

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HAIL TO THE INNOVATORS

METRO AG, Unilever, E.ON Sweden, GEA and Sergio Giotto received *Accelerate Europe* awards for advancing natural refrigerant adoption at an ATMOsphere Europe ceremony.

— By Andrew Williams

In an evening ceremony on 20 November at the ATMOsphere Europe 2018 conference – organised by shecco, publisher of the *Accelerate* magazine series – at Lago di Garda, Italy, representatives of four companies and one individual were recognised with *Accelerate Europe* awards for their unique contributions to advancing natural refrigerants in Europe.

As with the first edition of the awards in 2017, the assessment criteria for the Best-in-Sector Awards 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.

For the second year running, the Innovation of the Year was chosen by the public. Conference participants could vote for it via the ATMOsphere Europe app, while this year people were also able to vote online in the week prior to the conference.

The Person of the Year award 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 Sergio Giotto is profiled in the previous article (p. 22).

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.



INNOVATION OF THE YEAR

BLUQ, GEA AIR CONDITIONING WITH AMMONIA

This year's winner of the Innovation of the Year award is German multinational GEA for the BluQ, a low-charge ammonia chiller for air conditioning large buildings.

Manuel Fröschle, GEA's application engineering manager responsible for natural refrigerants, said, "I collect this award on behalf of my colleagues in Berlin who were involved in the long process of developing this innovative product that can push the use of ammonia into air conditioning".

"Thank you very much to the voters who saw this innovation worthy of the award. We're very proud of it," Fröschle said.

The BluQ was launched at Mostra Convegno Expocomfort in Milan, Italy in March 2018.

BEST-IN-SECTOR: FOOD RETAIL

METRO AG BRINGING CO₂ TO NEW MARKETS

Germany-based METRO AG, the winner of this year's Best-in-Sector: Food Retail award, is a world-leading international wholesale and food retail company.

METRO has built a global reputation for environmental protection by committing to reducing CO₂ emissions across the group by 50% by 2030 (vs. 2011 levels).

The METRO Group's F-Gas Exit Program helps to deliver this target. In place since 2013, it aims to phase out f-gases in all METRO stores worldwide by 2030, replacing them with natural refrigerant systems where it is technically and economically feasible to do so.

The 2018 award recognises METRO's commitment to natural refrigerants in challenging new markets such as Russia and China in particular.

The installation of China's first transcritical CO₂ system in the retail sector, in a METRO wholesale store in the Lishuiqiao area of Beijing (which opened in January 2018), was the first step in a journey that will see the German multinational fit transcritical systems in all its new Chinese stores by 2025 (see '[Chinese retail's first transcritical CO₂ system](#)', *Accelerate China*, April 2018).

Olaf Schulze, METRO AG's director of facility, energy and resource management, collected the award on the group's behalf.



From left to right: Olaf Schulze, METRO; Manuel Fröschle, GEA; Fabio Roberti, Unilever; Sergio Giroto, enEX; Kenneth Hoffmann, GEA on behalf of E.ON Sweden.

"I'm very proud to receive this award. I take it on behalf of my colleagues, who are working with me in the 25-35 countries around the world in which we operate – in Germany, France, Bulgaria, Italy, Portugal, Russia, China and many more," Schulze said.

"We're all on the same team – fighting for natural refrigerants in METRO," he said.

BEST-IN-SECTOR: LIGHT COMMERCIAL

UNILEVER HYDROCARBON-COOLED ICE CREAM

Dutch-British transnational consumer goods giant Unilever picked up the Best-in-Sector – Light Commercial

award in recognition of its commitment to hydrocarbons, which it decided to adopt in 1999.

Unilever currently has some 2.6 million hydrocarbon-based ice-cream cabinets out in the field. It prefers to use propane (R290) and isobutane (R600a) for low-temperature applications.

Fabio Roberti, who is responsible for cabinets in Unilever's Italy office, collected the award at Lago di Garda.

"It's an honour for me to receive this award on behalf of Unilever," Roberti said. "I'm happy that the hard work of the past few years has been recognised."

"I'm proud that Unilever has purchased over 2.6 million ice-cream cabinets



running on natural refrigerants," Roberti said. "And that reducing the environmental impact of our cabinets is embedded in the Unilever Sustainable Living Plan."

Roberti explained that Unilever focuses on two areas. "The first is to cut greenhouse gases by switching to natural refrigerants, and the second is to dramatically reduce energy consumption, thereby decreasing indirect CO₂ emissions," he said.

"Our journey hasn't ended. Unilever will continue to work with and innovate alongside the key freezer manufacturers to further reduce energy consumption, and also to explore using renewable energies to run our cabinets," Roberti said.

BEST-IN-SECTOR: INDUSTRIAL

E.ON SWEDEN AMMONIA HEAT PUMPS IN MALMÖ HARBOUR

E.ON, one of the world's largest investor-owned electric utility service providers, won the Best-in-Sector: Industrial award for a 40 MW ammonia heat pump project for district heating in the harbour area of the city of Malmö, Sweden.

Four GEA ammonia heat pumps, each with a heating capacity of 10 MW, use the heat from Malmö's sewage treatment and waste incineration plants to deliver heating to approximately 100,000 homes in the Swedish city.

Mats Egard, E.ON Sweden's heating segment project manager, was responsible for delivering the Malmö installation, while Kenneth Hoffmann,

GEA's product manager for heat pumps, was also involved in the Malmö project.

Picking up the award on E.ON Sweden's behalf, Hoffmann said, "Mats is sorry he couldn't make it here today, and he's very happy that E.ON Sweden has won this award".

"Personally, I'm very pleased that this very big ammonia heat pump installation has won, because this is a territory into which natural refrigerants can still make a lot of progress," said Hoffmann, lamenting that the household heat pump market continued to be dominated by HFCs.

"This is an area where we must all work hard to grow natural refrigerants," Hoffmann said. "Hopefully this award is the first step in recognising that natural refrigerants are the way forward. I hope we'll see a lot more natural refrigerants in large heat pumps in the future," he said. ■ AW

Delhaize goes transcritical in Serbia

Delhaize Serbia – the country's biggest retailer and part of the natural refrigerant-committed Ahold Delhaize group – opened its first CO₂ transcritical store in Serbia in November 2018.

– By Margot Goles-Macesic



Last month Delhaize Serbia, part of multinational retail group Ahold Delhaize, opened its first CO₂ transcritical store – located in Serbian capital Belgrade.

The wider Ahold Delhaize group to which Delhaize Serbia belongs encompasses 21 local brands across some 6,500 stores around the world. By 2050, the group is aiming to reduce its greenhouse gas emissions by 40-70% compared to 2010 levels.

Today 13% of Ahold Delhaize sites already use natural refrigerant-based installations (end 2017), David Schalenbourg, director of department – building projects, format & maintenance at Delhaize Belgium, told the ATMOSphere France conference in July 2018. In Europe the figure is 33%.

STARTER FOR 10

Delhaize Serbia, the country's leading retailer, is also strongly committed to sustainability. It operates under the brand names Maxi, Shop&Go and Tempo in Serbia.

"From 2016 we banned R404A in our new installations and put in R449A as a temporary solution," Duško Pantović, expert associate for refrigerant installations, Delhaize Serbia, told *Accelerate Europe*.

Delhaize Serbia began improving energy efficiency in 2012, when the company implemented an electronic expansion valve instead of a classic thermo-expansion one, Pantović explains. "Since 2012, we've also been putting doors on all our cabinets, replaced classical thermo-expansion valves with electro-expansion valves (AKVs), and we've added ADAP-KOOL software," he says.

"Now we are capable of implementing CO₂ transcritical, and we will definitely go that way in the future," Pantović says.

On 7 November 2018, the retailer opened its first CO₂ transcritical store in Serbia, in Belgrade. "This was a very, very long journey," Pantović says.

Danish CO₂ transcritical rack manufacturer Advansor provided the system.

Danfoss, another Danish multinational, helped with the system design – working together with local installer Frigomax, according to Danfoss Serbia's website. LU-VE provided the gas coolers.

Frigomax, together with Danfoss, installed the CO₂ transcritical system and the Danfoss monitoring system. "Finally seven years after our first step [where we focused on increasing energy efficiency in our stores], we are opening our first CO₂ transcritical store," says Pantović.

Delhaize Serbia was supported with know-how, equipment and training by Danfoss. "We're very grateful to these guys," Pantović says. "We also owe a debt of gratitude to Professor Franc Kosi at the Faculty of Mechanical Engineering, at the University of Belgrade, for his support."

For Delhaize Serbia, this is only the beginning. The group plans to open a second CO₂ transcritical store by the end of 2018, and is targeting a minimum of 10 stores with natural refrigerants by the end of 2019.



1 /

"Next year we have a plan to have at least 10 shops with these systems, before we set a standard that in all new shops it has to be CO₂," Pantović told *Accelerate Europe*.

A SUPPORTIVE GOVERNMENT

Delhaize Serbia received a great deal of support for the CO₂ system.

Goran Trivan, Serbia's environment minister, attended the opening of this first eco-friendly store in the Balkans to learn more about natural refrigerant systems, reported news portal *Balkan Green Energy News*.

Minister Trivan encouraged Delhaize Serbia to continue with its natural refrigerant mission and invited other companies to jump on the HFC-free bandwagon, according to *Balkan Green Energy News*.

Delhaize Serbia is currently not required to limit its use of HFCs in the non-European Union country, which is not covered by the EU F-Gas Regulation.



2 /

Serbia is a party to the global HFC phasedown plan known as the Kigali Amendment to the Montreal Protocol, which puts it among 'developing' countries. It is therefore on a longer phasedown path than other European nations and will only start phasing down HFCs in 2024 (targeting a 10% reduction by 2029 compared to the 2020-2022 baseline period).

94% of the refrigerants Delhaize Serbia uses have zero ODP, according to 2016 figures on its website. ■ MCM

1 / Delhaize Serbia's first CO₂ transcritical supermarket, located in Belgrade.

2 / Duško Pantović, Delhaize Serbia (left) and Goran Trivan, minister of environment, Serbia, pictured during the supermarket's inauguration in November.

Photography by: Delhaize Serbia



Factory floor at Jewel Fine Foods Banksmeadow, Sydney.

Photography by: Simon Anders.

READY MADE, NATURALLY COOL

For more than twenty years, Jewel Fine Foods has strived to offer Australians fresh ready meals of the highest standard. This passion for excellence also extends to sustainability, with the leading Australian chilled food manufacturer keen to show leadership on reducing greenhouse gas emissions.

Jewel Fine Foods (JFF) currently produces a range of meals, soups and salads in the Thai, Indian, Malaysian, Vietnamese, Chinese, Mexican and European cuisines.

Jewel's new 16,200 m² production facility in Banksmeadow, Sydney – where production capacity is expected

to double – is demonstrating how using natural refrigerants helps growth and sustainability to go hand-in-hand.

JFF's customers include all of Australia's largest supermarket chains – including Coles, Woolworths, IGA, Costco, Metcash and Aldi. The firm also has partnerships with large global organisations and airlines.

"Years ago, we made it a priority to simplify the work of chefs in large kitchens," JFF Managing Director Kishore Matta told *Accelerate Australia & NZ*.

"Today, we continue to simplify the lives of families – providing high quality, affordable, freshly prepared,

Jewel Fine Foods strives to provide Australia with the freshest and highest quality ready meals. This commitment to excellence extends to production, where the food manufacturer is turning to ammonia to improve sustainability. *Accelerate Australia & NZ* reports.

– By Devin Yoshimoto

convenient and ready-to-eat meals," Matta says. "All you have to do is add heat."

The heat addition process is an easy one for many people to imagine, reminding them of preparing food at home. It is the heat removal process – which takes place in food manufacturing facilities worldwide – that is harder to understand.

Yet it is here that Jewel Fine Foods deserves recognition for taking its place among industry leaders whose use of natural refrigerants is contributing to advancing energy-efficient and environmentally sustainable refrigeration technology around the world.

Matta epitomises such leadership. He founded Jewel Fine Foods in 1997. JFF currently operates in Sydney, but its origins are in New Zealand, where Kishore and his wife Indrani opened a small restaurant called Jewel of India in 1991.

The restaurant's success led Kishore and Indrani to open up a one-room food production facility, where they began making samosas for customers to eat at home.

Naturally-powered growth

Fast-forward to today and the company has over 250 employees, producing 30 million meals per year and boasting annual revenue of A\$100 million (€64m).

Underscoring this growth is an ambitious target of increasing current production to 40 million meals by 2019. To achieve this, in January 2017 the company opened a new 16,200 m² ready meal production facility in Banksmeadow, Sydney, where an ammonia-based refrigeration system serves all the site's cooling, freezing, and air-conditioning needs.

The ammonia system plays a key role in achieving the company's operational growth and sustainability goals, which Matta sees as going hand-in-hand. "As a natural and highly-efficient refrigerant, ammonia is key to Jewel being environmentally sustainable," he says.

The new site is capable of producing over 50 million ready meals per year.

The ammonia pumped recirculation system is fitted with propylene glycol and water chillers, as well as evaporative condensers. The total operating ammonia charge is 5,000 kg.



GEA Duo Pack compressor package for propylene glycol chilling duty.

It was commissioned in two stages, firstly in January 2017, with the second stage beginning operations in July.

Efficiency through design

The decision to use ammonia stems directly from the company's philosophy of actively reducing its environmental impact wherever possible, says Peter Sayer, head of engineering at Jewel Fine Foods.

"We are working towards this by utilising ammonia as our refrigerant together with other initiatives," he explains.

JFF selected local industrial refrigeration contractor Tri Tech Refrigeration Australia (TTRA) to support the company during the installation. TTRA's previous work with natural refrigerants, as well as with JFF itself, made it the right fit.

Sayer describes the key factors that influenced the system's design. "The scope of the project was to convert the warehouse to a high-care, chilled, ready meals facility – including processes that required the use of chilled water, spiral freezers and chilled areas," he explains.

Kishore Matta, managing director,
Jewel Fine Foods





TTRA's previous work with Jewel Fine Foods included the installation and commissioning of an ammonia chiller system at the company's old facility in nearby Mascot.

At the new factory in Banksmeadow, ammonia serves as the primary refrigerant in a traditional centralised, pumped configuration that recirculates the refrigerant. Secondary heat transfer fluids – propylene glycol and water – are also used for other cooling processes.

The factory's soup spiral freezer and impingement freezer are cooled directly by the pumped recirculating liquid ammonia.

The propylene glycol, chilled by the primary ammonia system, is used to cool the storage rooms as well as several types of 'critical process equipment'.

The company employs a 'Cook, Quench, Chill' machine (used to cook and cool rice, pasta and vegetables) and a tumble chiller, which is used to quickly chill batches of food wrapped in flexible plastic wrapping.

Chilled water is used for air conditioning in the facility's cooking area, as well as in the 'rice cooker vacuum heat exchange system'.

The ammonia system was commissioned in late January 2017 and was expanded in July that year, to add production capacity.

"Start-up and commissioning went very well," says Sayer. "Tri Tech Refrigeration Australia supported us all the way through, and continues to do so. The system is reliable and performs as per specification."

Designing ammonia systems

Industrial refrigeration systems generally require a variety of cooling and freezing temperatures to satisfy different production processes, which is the case at Jewel Fine Foods.

"It is well known that ammonia is the most energy-efficient refrigerant due to its thermal properties, when the system is appropriately designed and installed," says Ananth Arkal, the senior project engineer at Tri Tech Refrigeration Australia who led on the JFF project.

That's why TTRA went the extra mile to install additional features at the Banksmeadow facility that maximise the already excellent energy efficiency of ammonia as a refrigerant itself.

At the Banksmeadow facility, all of the main compressors, condenser fans, chilled water and glycol pumps, and under-ceiling air-cooling units were fitted with variable speed drives (VSDs), for example, to control the output of each component according to the degree to which it is needed.

An automatic air purger was installed, "to ensure any non-condensable gases in the system are promptly removed, so as to have the system operating at its best possible efficiency by minimising head pressures to the furthest extent possible," Arkal explains.

Sayer is confident that Jewel Fine Foods will look into further use of increasingly advanced ammonia-based refrigeration systems as it looks to grow its food production business in future.

Asked what advice he would offer similar businesses that are interested in adopting ammonia-based systems rather than their HFC-based counterparts, Sayer says, "the environmental and efficiency benefits of ammonia massively outweigh the risks".

"Ammonia systems are flexible for different operations, processes and temperatures versus set systems, so you can also future-proof your factory," he adds. ■ DY



Pete Lepschat, Henningsen Cold Storage

Photography by: Thomas Patterson

TAKING ON TRANSCRITICAL IN COLD STORAGE

A longtime ammonia user, Henningsen Cold Storage is testing transcritical CO₂ refrigeration in two widely separated locations – among the first all-CO₂ industrial plants in the United States. *Accelerate America* reports.

— By Michael Garry

Pete Lepschat, engineering services manager for Hillsboro, Oregon-based Henningsen Cold Storage, has heard all of the “common folklore” about transcritical CO₂ refrigeration, such as that it uses a lot of energy.

So, he was expecting to see an energy penalty when he commissioned a comparison between a transcritical system’s projected energy consumption and that of a low-charge central ammonia system.

But the transcritical CO₂ system turned out to be slightly more efficient and is expected to save 46,000 kWh/yr. in electricity usage. “I was pleasantly surprised,” he told *Accelerate America*.

Supported by the promising energy data and other metrics, the transcritical

system has been running since 20 June at family-owned Henningsen’s new 111,000-sq-ft. (33,833 m²) cold-storage facility in Grandview, Washington, supplying 187 TR (658 kW) of refrigeration capacity for a freezer (157 TR; 552 kW) and a dock area (30 TR; 105.5 kW).

This is the 95-year-old cold-storage operator’s first transcritical system, one of a small number of such systems being used in industrial refrigeration facilities in the United States. Carnot Refrigeration supplied the system and PermaCold Engineering installed it.

Henningsen put the transcritical system (rack and condenser) on top of the dock roof, a small area that was relatively easy to support and offered more accessibility for forklifts.



Liquid and suction CO₂ pipes for freezer evaporators

The CO₂ system represents a bold departure for a cold-storage operator that has relied primarily on ammonia for decades. "It's our first one, but I'm guardedly optimistic," Lepschat said.

In September, Henningsen installed a second transcritical system, from Hillphoenix, at an existing plant in Scranton, Pennsylvania. Henningsen also runs 10 central ammonia refrigeration plants (three with a low-charge configuration) and one leased facility using a synthetic refrigerant.

For the Grandview project, Lepschat benefited from the advances transcritical refrigeration – more commonly employed in supermarkets – has made in the industrial sphere, particularly in Canada. "CO₂ is moving quickly in the market," he said. "So, there's more information on it."

Though hopeful, Lepschat understands that the jury is still out on the two new transcritical systems as he collects data on their energy performance, maintenance requirements and overall reliability in the demanding environment of a cold-storage plant. "It needs to be proven with real-life measures over the first year," he said.

The primary motivation Lepschat had for using CO₂ over ammonia is CO₂'s relative

safety. CO₂ has been used for decades in breweries, soft drinks plants and other industrial settings, yet "I would be hard-pressed to find cases in an industrial setting of fatalities from CO₂," he said. "It's not non-toxic, but it's not nearly as toxic as ammonia."

In an enclosed area, where there is the potential for asphyxiation from CO₂, "you start to feel crummy and get a headache before it reaches a toxic level," he said. "So, it is a little bit self-alarming." In any event, industrial areas tend to be too large to allow for that scenario, he explained.

Lepschat also cites the opportunity a transcritical system affords to eliminate the regulatory burdens imposed on users of ammonia systems: "If you can avoid the cost and exposure to great liability from fines, why not?"

But CO₂ still had to pass muster as a practical and economical refrigeration system before Lepschat could support investing in it. Most importantly, he had to answer the question, "Is there any one thing that's going to make us say no?" he noted at the ATMosphere America conference in June (organised by *Accelerate America* publisher shecco).

Lepschat first weighed transcritical CO₂ against other refrigeration options, such as the kind of low-charge central ammonia system he has installed over the past several years, low-charge packaged units, and even a packaged HFC unit.

He quickly eliminated the HFC unit because of the uncertainty surrounding its regulation due to HFCs' high GWP, its "brutal" energy performance and the high cost of HFCs.

He also dismissed packaged ammonia systems because of their cost, driven in part by the need for roof upgrades to support their weight.

That left low-charge central ammonia as the baseline for comparison to transcritical. In particular, Lepschat compared transcritical's actual and sometimes projected costs to the costs associated with his low-charge ammonia central system in a Salem, Oregon plant that opened in 2017, which is similar in size and scope to the Grandview facility.

Energy savings with CO₂

Among the key metrics that Lepschat analysed were reliability (no late-night calls that the system is down) and energy use, for which he could make projections. "These are the cornerstones of our business," he said.

Lepschat hired Energy350, Portland, Oregon, to compare the energy consumption per hour of every component of the transcritical system and the baseline system for a given TR. The company projected there would be

RIGHT

Pete Lepschat, Henningsen in the freezer area; Grandview, Washington facility.





electricity savings of 46,000 kWh/yr. Energy350 “has been amazingly accurate in the past with our ammonia plants,” he said. “So, I expect similar results.”

It is well known that the ambient climate affects a transcritical CO₂ system’s energy efficiency. Notably, warm climates in the 80°F-90°F (26°C-32°C) range complicate the condensation of CO₂, increasing the system’s energy usage. While Grandview has a moderate climate, its summers can be quite hot, as was the case this year.

But Lepschat gained confidence in transcritical’s efficiency in warmer ambient temperatures from a presentation about “using CO₂ with ammonia-type equipment,” given by Australian engineer Klaas Visser at an IIR conference. “He showed that the continental U.S. – save for South Florida – is a viable place for CO₂,” he said. Visser was among the “impartial” people “who helped me to justify this,” he added.

There are a number of changes in material and techniques that Lepschat had to make in transitioning from ammonia to CO₂. “You don’t do things because you did it that way with ammonia,” said Lepschat. “It might not be cost-effective, and it might be flat wrong.”

For example, with the CO₂ system Lepschat employed corrosion-resistant stainless-steel tubing in all suction and liquid lines connecting evaporators in the freezer and dock to the compressor rack and condenser/gas cooler, respectively. By contrast, he used arc-welded carbon-steel piping in the low-charge ammonia system.

The stainless-steel tubing is welded via machine-operated orbital welding, which is new for Henningsen and “a lot of people in the industry,” said Lepschat.

While Henningsen’s contractor, PermaCold Engineering, is familiar with orbital welding, this was the contractor’s first field experience with the technique. “They learned how to do it outside,” Lepschat said.

This is an example, he said, of PermaCold’s willingness to “step out of the box” and work with a new technology. “You’ve got to find a contractor willing to do that.” ■ MG

'WORLD'S BIGGEST SNOWBOARD FACTORY' PUTS FAITH IN AMMONIA



In Feistritz, Austria, snowboard maker CAPiTA is using a high-temperature ammonia heat pump at its new snowboard factory.

— By Charlotte McLaughlin

Austrian firm CAPiTA ranks among the biggest snowboard makers in the world – and is committed to energy efficiency.

Reducing energy costs was of paramount importance at its new factory, the Mothership, in Feistritz, Austria, which was built in 2016. “When planning the factory, we focused on energy efficiency right from the start,” says Michael Kollmann, CEO of CAPiTA MFG GmbH.

To achieve this, CAPiTA opted for an ammonia-based high temperature heat pump at the Mothership, which the snowboard maker believes is one of the largest snowboard production sites in the world.

The heat pump, manufactured by Austrian company Frigotherm Ferrari, is used for heating and cooling during the snowboard production process and for HVAC in the factory itself.

“[CAPiTA uses a] double-stage heat pump for the snowboard production plant,” Peter Rindler, owner, Frigotherm Ferrari, told last month’s ATMOsphere Europe 2018 conference (organised by *Accelerate Europe* publisher shecco) in Riva del Garda, Italy. “It has been running for two-and-a-half years.”

A double-stage heat pump is used to lift the temperature up to the requirements needed in two bursts, Rindler explains. The factory needs

medium-temperature heat (74-75°C) and low-temperature cooling (3°C).

The ammonia heat pump, which uses river water to heat the presses and print the boards, as well as to cool the presses and snowboard grinding machines, has helped CAPiTA to meet its energy reduction targets.

“Generating heating and cooling with a single system is the easiest and best way to achieve high efficiency goals,” says Franz Josef Schögl from Sattler Energie Consulting, the consultancy firm involved in the project.

Compared to its previous factory, with no heat pump, the company has saved 84% of its energy costs, which works out as €294,000, every year since installing the system. “Our new factory is, without doubt, the most energy efficient in the whole sector,” says CAPiTA’s Kollmann.

The German Energy Agency (dena) even awarded the snowboard manufacturer an Energy Efficiency Award in 2017 for its factory. “CAPiTA is a trailblazer for real-world innovation in the energy transition,” dena Managing Director Kristina Haverkamp said in November 2017.

Most of the materials used to produce the boards at the Mothership come from the surrounding Austrian forests. The Mothership also manufactures boards for Bataleon and Lobster Snowboards. ■ CM



NatRefs on the rise in challenging markets

German multinational METRO is opening CO₂ transcritical supermarkets in China and Russia, while Woolworths is adopting the technology in South Africa. French real estate giant Gecina, meanwhile, wants the HVAC industry to offer more natural refrigerant-based heating and air-conditioning solutions. *Accelerate Europe* reports from ATMOsphere Europe.

— By Andrew Williams & Charlotte McLaughlin

While acknowledging the challenges in adopting CO₂ transcritical technology in countries such as China, Russia and South Africa, leading food retailers told the ATMOsphere Europe conference in Italy that they remained more committed to natural refrigerants than ever.

"For us, natural refrigerants are the default option. There is nothing else," Alex Kuzma of Woolworths, a leading South African multinational retailer, told ATMOsphere Europe 2018, hosted by *Accelerate Europe* publisher shecco in Riva del Garda, Italy on 19-21 November.

"If you build any other type of store now, you're building a liability," Kuzma said.

CO₂ ripe for growth in South Africa

Woolworths operates 1,556 stores, serving 15 million customers in 14 countries across the southern hemisphere.

Woolworths first turned to natural refrigerants in October 2009, when it opened its first subcritical CO₂ store. It now has nine. It opened its first transcritical CO₂ store in November 2010, and currently boasts 69.

"Our CO₂ transcritical stores are working very well. We've kept our system design very simple, and it's incredibly reliable," said Kuzma.

The Woolworths representative spoke of South Africa's "unique opportunity" to leapfrog HFCs by adopting natural refrigerants as alternatives to HFCs instead.

Kuzma cited high initial cost premiums vs. f gas-based systems, fear of the unknown, relative system complexity, difficulties sourcing components, and the development of local skills among the initial obstacles of adopting CO₂ transcritical technology in South African food retail.

Among the CO₂ transcritical system innovations that have saved on energy consumption vs. traditional HFC-based systems, Kuzma cited the use of electronic expansion valves (7% energy saving), suction demand (13%), variable speed EC fans (26%), floating head pressures (32%) and variable-speed compressors (45%) alongside the elimination of defrost heating (48%).

“**For us, natural refrigerants are the default option. There is nothing else.**”



Alex Kuzma, Woolworths

Accelerate award winner bringing NatRefs to China, Russia

Germany-based METRO AG is a world-leading international wholesale and food retail company that has built a global reputation for environmental protection by committing to reducing CO₂ emissions across the group by 50% by 2030 (vs. 2011 levels).

The METRO Group's F-Gas Exit Program helps to deliver this target. In place since 2013, it aims to phase out f-gases in all METRO stores worldwide by 2030, replacing them with natural refrigerant systems where it is technically and economically feasible to do so.

"All our new store openings and refurbishments only use natural refrigerants," Olaf Schulze, director – energy, facility and resource management at METRO AG, told the conference.



Olaf Schulze, METRO AG

In recent months METRO has been focusing on new markets in China and Russia. The installation of China's first transcritical CO₂ system in the retail sector, in a METRO wholesale store in the Lishuiqiao area of Beijing (which opened in January 2018), was the first step in a journey that will see the German multinational fit transcritical systems in all its new Chinese stores by 2025 (see *'Blue-sky thinking', Accelerate China*, spring 2018).

This summer, METRO opened its first two CO₂ transcritical stores in Russia – in Odintsovo and Aparinki – along with its first in Bulgaria (see *'The Call of the East', Accelerate Europe*, summer 2018).

Migros committed to natural refrigerants

Migros, the largest retail company in Switzerland, currently includes around 700 supermarkets divided among 14 cooperatives.

Migros Ticino operates in an Italian-speaking part of Switzerland. The cooperative is seeking to reduce its electricity consumption by 10% by 2020 (compared to 2010 levels), improve energy efficiency by 19% by 2020 (compared to 2013 levels), and reduce its GWP by 50% by 2020, 70% by 2025, and 80% by 2030.

"Our transition to CO₂ transcritical systems, started in 2009, is bringing significant benefits in terms of environmental sustainability and energy saving," said Andrea Skory, Migros Ticino.

Since 2009, contractor Biaggini (in collaboration with Schneider Electric) has fitted transcritical CO₂ systems in all new or refurbished Migros Ticino stores.

The systems all offer heat recovery for heating and sanitary uses, and their rated performance is guaranteed in external temperatures of up to 37°C, said Luca Rossi, Biaggini.

Migros Ticino is seeking to convert all its remaining HFC-based stores to CO₂ by 2022. In 2019, the cooperative will install its first 'keys in hand' solution in Migros Riazino, where a single CO₂ transcritical system will serve the store's entire air conditioning, heating and refrigeration needs.

Fresco & Vario

Iceberg is a leading Italian distributor of fresh and frozen food products to the Ho.Re.Ca. sector. Today the company operates in a 9,000 m² plant with 35,000 m³ of cold storage rooms. In 2001, it opened its Fresco & Vario retail division, selling the same products to the general public in five stores across northeast Italy.

Iceberg, which had traditionally used R22, R404A and R507, turned to CO₂ as an alternative in 2015. It installed a transcritical system in a new Fresco & Vario store in Conegliano.

"The future is green. We will surely go CO₂ transcritical more in future," said Oscar Pesavento of Fresco & Vario.

The CO₂ transcritical store has delivered average energy savings of 10% compared to the firm's HFC-based shops.



Oscar Pesavento, Fresco & Vario



Laurent Bataille, Gecina

Call to arms on HVAC

Also at the conference, Laurent Bataille of French real estate giant Gecina called on the HVAC industry to develop heating and air-conditioning solutions based on natural refrigerants.

"What can we do about air conditioning with natural refrigerants?" Bataille asked technology providers assembled in Riva del Garda.

Gecina – which owns, manages and develops property holdings worth €19.8 billion, mainly offices and apartments in the Paris region – wants to move towards natural refrigerants like ammonia, CO₂, water, hydrocarbons and air for all its heating and cooling needs.

The real estate firm has a strong commitment to sustainability. It was ranked second in the Dow Jones Sustainability Index in 2016.

"We want to reduce our CO₂ footprint and increase our energy efficiency" in HVAC, said Bataille, identifying natural refrigerants as a key way to do this. "We have a lot of [global warming] impact coming [from our air conditioning]," he said.

Gecina is less worried about potentially higher upfront costs of natural refrigerant HVAC systems than other customers may be. It rather asks the HVAC industry to provide market-ready solutions that can be implemented in its office and apartment buildings by next year.

"We don't mind much in the beginning about costs," Bataille said. "We'd rather implement first."

The firm wants to have 50% of its building stock, which is over 100 buildings, running on natural refrigerants for heating and air conditioning. This includes catering facilities in office buildings.

The target is to implement this over the next 10 years, which would require converting ten buildings a year.

Air conditioning and heating units are generally installed on the roof, but in Gecina's Paris building stock, space is at a premium. "We need to find a smart solution," Bataille said.

Industry takes up the challenge

After Bataille's presentation, a host of manufacturers responded to Gecina's plea. Andreas Meier from TEKO (a German manufacturer of packaged systems) advocated adopting a range of natural refrigerant-based solutions: "You have propane, CO₂, and ammonia chillers available [to use for HVAC needs in commercial buildings]."

Meier argued that the price of this technology would fall as market demand for it from customers such as Gecina grows.

Rather than price, Meier believes the biggest hurdle facing such customers is, "the engineer situation in the HVAC industry," stressing the need to train more HVAC engineers on how to install natural refrigerant-based technologies.

Andy Pearson of Star Refrigeration told Gecina's Bataille that he knew of distributed CO₂-based HVAC systems that had been implemented in commercial buildings, including banks. "You can do incredible things with CO₂," he said.

Advansor's Kenneth Bank Madsen also advocated the CO₂ route. 10 years ago the Danish manufacturer of CO₂ transcritical systems installed a 1 MW CO₂ system in an office in Denmark for space heating and cooling.

Madsen did acknowledge that such a system would take up considerable space, but Gecina's Bataille replied that he would be willing to find an acceptable compromise.

"By the middle of next year, we hope to have five to seven projects [that we will carry out] with natural refrigerants," Bataille said.

At ATMOSphere Europe, then, participants were left in little doubt as to the commitment of leading European end users to pushing the boundaries of what natural refrigerants can achieve. ■ AW & CM

Natural refrigerants aim high at Chillventa





With competition between CO₂, ammonia and hydrocarbons more fierce than ever, visitors to Chillventa 2018 discovered how natural refrigerants have now become mainstream HVAC&R options as HFCs are phased down. *Accelerate Europe* reports from the Nuremberg home of one of the world's biggest HVAC&R tradeshow.

— By Andrew Williams, Charlotte McLaughlin & Michael Garry

LEFT

Chillventa is held at Nuremberg Messe.

In all the applications and markets in which Embraco is active, "natural refrigerants are the trend going forward," Luis Felipe Dau, president and CEO of the Brazilian multinational, told *Accelerate Europe* at Chillventa 2018.

Dau was talking about hydrocarbons, and about the focus of Embraco in particular. But his words captured the spirit of this year's Chillventa, which saw a record number of companies offer natural refrigerant-based HVAC&R solutions.

Chillventa 2018 broke a number of records. 35,490 visitors from 125 different countries streamed through the exhibition doors to visit 1,019 booths from 45 nations, spread across a trade area that was 2% bigger than the previous edition's in 2016. Visitor numbers were up 10%, with exhibitor numbers up 4%.

NatRefs spreading in HVAC market

Natural refrigerants have steadily been gaining market share in refrigeration and HVAC markets around the world. This is particularly true in Chillventa's home continent of Europe, where the new EU F-Gas Regulation – finalised in 2014 and in force since 2015 – aims to reduce the European Union's use of hydrofluorocarbons (HFCs) by 79% by 2030.

The EU phasedown, in fact, has already led to HFC price rises – creating more opportunities in Europe for natural refrigerant-based technologies to replace them as market-ready, environmentally friendly and inexpensive alternatives.

Commercial refrigeration end users are already adopting natural refrigerants at a promising rate. Some 16,000+ supermarkets in Europe already use CO₂ transcritical systems, for example, according to estimates by sheccoBase, the market development arm of *Accelerate Europe* publisher shecco.

The HVAC market, however, has been slower to pick up speed. But at Chillventa 2018, there were signs that this is beginning to change.

Euroklimat, for example, displayed its new propane-based (R290) heat pump at the show. With a propane charge of 5.5 kg, it has a heating capacity of 60 kW and is designed for outdoor installation.

"We did the first test and this is a prototype, it is not ready for the market," Giulia Fava, product developer at the Italian manufacturer of commercial and industrial heating and cooling solutions, told *Accelerate Europe*.

Euroklimat is currently testing the new unit in the laboratory and out in the field, with a view to putting it on the market in January-February 2019.

The unit on display targeted commercial buildings. Euroklimat is aiming "to have ready next year a range of propane heat pumps from 30 kW up to 150 kW," Fava said.

The unit uses Frascold compressors, an ATEX-certified pressure transducer and pressure transmitter, and CAREL's microprocessor. Asked how the prototype had performed in testing, Fava said, "it is working well, down to -20°C".

Fava said the firm decided to invest in this unit after receiving many requests from customers. "Most of our customers for propane are from northern countries. Two years ago they started asking us, 'Please, we need a heat pump down to -20°C!' and we didn't have it. So now we are trying to answer their requests," she said.

Low-charge NH₃ trend

Propane wasn't the only natural refrigerant to feature in HVAC equipment on display at Chillventa.

Growing interest in HVAC&R systems using ammonia at low charges is contributing to increased demand for plate and shell heat exchangers (PSHE), Jonathan Pascoe, president, Vahterus Americas, told *Accelerate Europe* at the show.

This "big market trend" towards natural refrigerants led Vahterus to develop the 'Vahterus Combined', said Pascoe.

The Vahterus PSHE Combined is a heat exchanger where the droplet separation system is integrated with a flooded evaporator, making it "particularly efficient and compact". "The product has been developed to reduce the dimensions of a traditional evaporator and separator system. Furthermore, it is designed to minimise the refrigerant charge," says the company on its website.

What makes the Vahterus compact, plate-type heat exchangers so fitting

for refrigeration applications is that they are fully welded – everything is contained and sealed, according to Pascoe.

"The high efficiency of a plate heat exchanger produces a very compact solution, and the great thing there is that it leads us into a low-charge solution," said Pascoe, adding: "It has become an enabling technology for contractors and end users."

End user demand drives growth

Vahterus Combined has played a critically important role in the proliferation of low-charge ammonia applications where the customer is seeking to drive down the plant's refrigerant charge, according to Pascoe.

"We see a lot of this in ice rinks in Canada, and end users like Pepsi, Kraft and General Mills in the USA – using this Combined product to move with the industry in terms of using natural refrigerants, but minimising the ammonia charge," Pascoe said.

Heat exchangers are used in almost every refrigeration application, from chillers and condensers to desuperheaters, sub-coolers, oil coolers and economisers.

CO₂ continues to impress

The Yukon CO₂ chiller range, displayed for the first time by Italian system manufacturer enEX, can now be used as a reversible heat pump and air conditioner in commercial buildings.

"We are now installing the first versions with reversible operations," said Sergio Giroto, president of enEX. "It means they work as a heat pump in winter and as a chiller in summer."

The Yukon, Enex's new family of CO₂-based 'plug and play', medium-sized water/brine chillers, comes in two offerings. One uses a pressure receiver for units up to 60 kW that permits a capacity increase and assures redundancy. The second unit, which uses gravity-fed evaporators, is a larger range of up to 450 kW and can be used with enEX's ejector technology.

"Nobody believed so far that CO₂ could be a good refrigerant for water chillers, but [with the Yukon chiller range] we proved that it is efficient," Giroto said. "[The ejector] makes the chiller efficient at 35°C ambient temperature."

The Yukon is particularly suited to space cooling in medium and large commercial buildings with a significant hot water demand, such as hotels, hospitals, gyms and wineries.

CO₂ transcritical for all climates

Market interest in CO₂ transcritical systems has grown dramatically in the past four years as technology developments such as ejectors help to overcome their operational limitations in warm climates, according to Kenneth Bank Madsen, business development manager at Danish multinational Advansor.

"Interest in our transcritical CO₂ racks has been huge," Madsen told *Accelerate Europe*. "We can clearly see a development since the last Chillventa, in 2016," he said.

Madsen was presenting Advansor's CO₂ transcritical systems for industrial and commercial applications. "We have a complete offering, from northern to southern Europe – we cover all climates," he said.

“

The high efficiency of a plate heat exchanger produces a very compact solution. It has become an enabling technology for contractors and end users.

”

– Jonathan Pascoe, president, Vahterus Americas

Ejector technology helps in this regard. “The ejector gives us that extra energy efficiency we need to operate in warm climates,” said Madsen, presenting a rack designed for Portugal that is capable of operating in temperatures of up to 43°C.

Italian multinational compressor manufacturer Dorin, meanwhile, believes CO₂ transcritical is poised to take off in industrial applications within the next 3-5 years as larger compressors hit the market, Giovanni Dorin, the firm’s marketing manager, told *Accelerate Europe*. “We’re ready to ride that wave,” he said.

Asked how the market for CO₂-based HVAC&R technologies had changed since the last Chillventa in 2016, Dorin said, “component availability and access to technology is more widespread”.

World premiere for CO₂ subcooling unit

In an effort to improve the efficiency of CO₂ in warm climates, German manufacturer BITZER presented the new EXPANDER subcooling unit for CO₂ transcritical refrigeration systems at Chillventa.

The EXPANDER is designed specifically for supermarket and logistics applications. At an ambient temperature of 32°C, BITZER claims that the new unit can increase a standard CO₂ booster system’s cooling capacity at the design point by up to 20%.

“The EXPANDER is a new way to improve the energy efficiency and cooling capacity of new and existing CO₂ transcritical refrigeration

systems,” Oliver Javerschek, project manager at BITZER, told *Accelerate Europe*.

Functioning much like traditional external subcoolers, the EXPANDER comprises a control valve and a heat exchanger in addition to the expander-compressor unit at its heart.

The unit relaxes the primary mass flow, while the energy it generates compresses the subcooler mass flow and feeds it back before the gas cooler.

“The principle relies on the fact that we have mechanical subcooling without requiring additional power input,” Javerschek said. “A single component retrofit can thus increase cooling capacity for transcritical CO₂ systems,” he added.

Castel – an Italian specialist in valves and other refrigeration and air-conditioning components – debuted new CO₂ transcritical valves for pressures of up to 140 bar at the show.

The valves are equipped with stainless steel connections, according to Antonio Sepe, product manager, Castel s.r.l., citing as an example the three-way ball valve for up to 140 bar.

“Three-way [motorised ball] valves [are] for [turning] heat recovery on and off. If you want [to control the] mass flow, there is an [electronic] modulating signal,” Sepe said.

“

For CO₂, component availability and access to technology is more widespread.”

— Giovanni Dorin, *Officine Mario Dorin*

Invertek unveils small VFD

UK-based Invertek Drives Ltd introduced its Coolvert variable frequency drive (VFD) at Chillventa, alongside a new CO₂ condensing unit controller from Danish company Reftronix ApS.

Invertek calls the Coolvert “one of the smallest [VFDs] in its class, providing OEMs with opportunities to reduce panel space and lower machine costs”. The VFD also has one of the widest ambient operating temperature ranges in its class, between -20°C to +60°C, said Invertek.

Invertek and Reftronix had announced their partnership in August.

Coolvert is compatible with all motor types, including induction motors, permanent magnet motors, brushless DC motors, synchronous reluctance motors and Line Start PM motors ranging between 1.5 kW to 11 kW, 2 HP to 15 HP, said Invertek. It has single and three-phase input of 200V to 480V.

“Coolvert’s wide voltage and power range and open RS485 Modbus serial port allows the OEM to seamlessly connect any manufacturer’s application controller to the drive,” said Mike Carmen, international business development manager at Invertek.

Connectivity the name of the game

To simplify interaction with HVAC&R units, Italian multinational CAREL presented at Chillventa a new mobile service app, APPLICA, which allows end users to employ their smartphone as a management tool.

APPLICA can be used to manage MPXone, the new CAREL controller for retail refrigeration units; µCHILLER, for control of chillers and heat pumps, and Heez, the control solution for refrigerated merchandisers.

When APPLICA connects to a controller, “it recognises the type of unit and downloads the applications it needs from the cloud,” said CAREL. “The user interface is therefore not fixed, but rather varies according to the specific unit, and is updated directly at the time of use.”

APPLICA was developed with the aim of facilitating both installation and maintenance, the company said. It allows users to interact with units via “a simple and intuitive graphic interface, replacing the typical search for unit parameters from a list of codes”.

New CO₂ condensing unit

Leading global compressor manufacturer Tecumseh announced at Chillventa the launch within 18 months of the show of its first CO₂ condensing unit.

Tecumseh is developing the CO₂ condensing unit “to extend its product range that is compliant with European regulations” such as the EU’s F-Gas Regulation and Eco-Design Directive, the Ann Arbor, Michigan-headquartered company announced.

Tecumseh was exhibiting a prototype of the new condensing unit at its Chillventa booth. The firm will face

competition from Panasonic, which was pushing its new VF Series of CO₂ condensing units for refrigerated and frozen goods at the show.

The Japanese multinational launched a 15 kW model on the European market this summer. A 4 kW unit has been available in Europe since last year.

The new product line-up offers customers a combination of 4 kW and 15 kW units for small to medium-capacity cooling and freezing applications, Shigeru Dohno, managing officer (food retail and commercial equipment business) at the Panasonic Corporation’s appliance company branch, said at Chillventa.

The VF Series targets the retail and food service sectors, such as small supermarkets, convenience stores and garage forecourts. It also serves the restaurant and hotel sectors.

Since its European launch in 2017, Panasonic has installed the 4 KW units in 250 stores in Europe, from Iceland in the north to Italy and Spain in the south.

With so many new products on show at Chillventa, the future looks bright for natural refrigerant-based HVAC&R solutions. ■ AW, CM & MG



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NATREFS ADVANCING IN SPAIN AND PORTUGAL

Uptake of natural refrigerants on the Iberian Peninsula is faster than ever and the growth prospects are strong, though doubts persist over training levels among technicians. *Accelerate Europe* reports from ATMOSphere Ibérica.

— By Dario Belluomini

The HVAC&R sector in Spain is increasingly turning to natural refrigerant-based technologies as market-ready, climate-friendly alternatives to their HFC-based counterparts, heard participants at the ATMOsphere Ibérica 2018 conference in Madrid, Spain, on 18 September.

"Reducing greenhouse gas emissions is a great idea, and natural refrigerants are a powerful tool in this direction," said Félix Sanz of AEFYT (the association of Spanish HVAC&R companies).

"Today more than 50% of AEFYT members are working with natural refrigerants," Sanz said.

He presented data revealing that installations of CO₂ transcritical systems had increased by 20%-30% in commercial refrigeration (150-300 kW) in Spain, and noted that ammonia use in industrial applications in Spain had been steadily growing since the 1990s.

This second edition of ATMOsphere Ibérica, organised by *Accelerate Europe* publisher shecco, attracted approximately 150 participants from 60 organisations. The packed programme included thematic sessions on market, policy and technology trends. "The industry is moving," said shecco COO Álvaro de Oña in his welcome speech. "We observe a significant evolution in the quantity and quality of the systems using natural refrigerants in Spain and Portugal."

NATURAL REFRIGERANTS ON THE RISE

Julio Minguillón of Carrier Ibérica told the conference that, "the use of CO₂ technology for refrigeration is unstoppable," since its "efficiency and safety are now well demonstrated". The group has already installed more than 90 CO₂ transcritical systems in Spain and Portugal.

Filipa Alves of Portuguese sustainability NGO ZERO credited innovative Portuguese retailers like Jerónimo Martins and SONAE with demonstrating to the market that CO₂ and hydrocarbons can be harnessed in Portugal too.

POLICYMAKER SUPPORT FOR NATURAL REFRIGERANTS

Public policy support plays a key role in the uptake of natural refrigerants. Guillermo Martínez from the Spanish Environment Ministry presented the government's 'Pima Frio' plan establishing a €1.5m subsidy in Spain for installing refrigeration systems with zero or low-GWP refrigerants.

"The Spanish government has also set a tax rate of €15 per tonne of CO₂ equivalent based on the global warming potential (GWP) of the refrigerant," Martínez said.

Monica Vidal of Spanish NGO ECODES argued that, "governments have to work to eliminate the barriers

and old standards that restrict the adoption of natural refrigerants". A positive example in this case is Portugal, where the government launched in early 2018 an environmental fund to support companies in the adoption of low-GWP solutions.

PROGRESS IN COMMERCIAL REFRIGERATION

INTARCON, a Spanish manufacturer of commercial and industrial refrigeration units, is piloting a double cascade R290-CO₂-CO₂ refrigeration system in an installation in Cordoba, southern Spain. Constituting a double cascade refrigeration system configured to use two CO₂ loops in conjunction with a propane loop to provide cooling to cabinets, freezers and cold rooms in a supermarket, "it performs better than other systems even in outside temperatures between 40°C and 50°C," INTARCON's Daniel Campaña told the conference.

Albert Albert, an independent consultant on CO₂ technology, argued that the smooth operation of CO₂ transcritical systems coupled with parallel compression, ejectors and heat recovery technology for air conditioning had already been demonstrated.

Albert called for future research efforts to focus on monitoring the yearly energy consumption of the circuit and the design of a multiejector in CO₂ transcritical systems.

TRAINING KEY TO BOOSTING NATREF ADOPTION

Wider training on natural refrigerants emerged as a key priority to boost uptake of these environmentally friendly HVAC&R options in Spain and Portugal, agreed participants in a workshop held during the course of the conference.

The workshop sought to draw up an action plan to gather industry support for wider uptake of natural refrigerants on the Iberian Peninsula, and included, amongst others, representatives of leading end users of HVAC&R technology in Spain (Mercadona, Masymas) and Portugal (Continente).

"Training, training and more training. I said it three times: it is extremely important for greater adoption of natural refrigerants and to raise awareness about their properties," said Félix Sanz (AEFYT). "We need more communication through like training courses, events, conferences and trade fairs."

"With this interactive workshop format, the idea was to encourage the active participation of all experts taking part at ATMOsphere Ibérica. Thanks to this, we now have valuable input in terms of recommendations on how to help the industry moving forward, addressing key priorities such as training or the competitiveness of natural refrigerant-based technology", said shecco's de Oña after the event. ■ DB



A turning point for natural refrigerants in France

The French HVAC&R market appears ripe for wider adoption of natural refrigerants, boosted by the recently adopted HFC tax and the sustainability commitments of forward-thinking end users. *Accelerate Europe* reports from Lyon, France.

— By Marie Battesti

The vast majority of companies present at this year's *Salon Interprofessionnel du Froid et de ses Applications* (SIFA), the national *rendez-vous* of the French HVAC&R industry, showcased CO₂, ammonia and hydrocarbon-based equipment.

Accelerate Europe was at the show, held this year on 28-29 November in the southeast city of Lyon, to take the pulse of the French natural refrigerants market from the perspective of local manufacturers and installers.

"There is a significant increase in demand for CO₂," said a representative from Fritec, a local installer. "The HFC tax will only amplify this trend. Coupled with the European Union's HFC quotas [under the EU F-Gas Regulation], we're advising our customers to move towards CO₂," he added.

"The future-proof investment argument is really key to convincing end users to adopt natural refrigerants," the Fritec representative said. "Training remains a big barrier – there is always a lack of training. We organise training on our

side, but there needs to be joint action from all players to fully tap into natural refrigerants' potential," he said.

Geneglance, a French icemaker, offers a CO₂-based model, arguing that the potential of this refrigerant is on everybody's lips now. "CO₂ shows its full potential in large-scale distribution, with distribution centres that run continuously," a Geneglance representative noted. "With CO₂, it is indeed preferable to run 24 hours a day," he said.

Gelkit, a French manufacturer for commercial and industrial applications, believes hydrocarbon propane (R290) is on the rise in small applications. "Regarding the HFC tax, I believe it will mostly penalise French manufacturers, which means a loss in terms of competitiveness compared to other countries," a Gelkit representative lamented. "We need subsidies for research and development to develop natural refrigerants-based solutions for all applications," he added.

The French Parliament recently adopted an HFC tax, but the adopted legislation doesn't include financial support for natural refrigerants as promised in the initial proposal. The tax will enter into force in 2021, but only if industry fails to meet voluntary commitments to further reduce its HFC consumption.

The tax is set at €15/ton of CO₂ equivalent (€/tCO₂e) in 2021, €22/tCO₂e in 2022, €30/t CO₂e in 2023 and €45/tCO₂e in 2024, a significant reduction compared to the figures that were initially proposed. Opponents fear that with no support mechanism, the tax won't be effective enough to accelerate the ecological transition towards HFC-free HVAC&R equipment, as there is no subsidy to mitigate the capital investment required to change equipment and re-design the French HVAC&R industry's business model.

Yet the business case for adopting natural refrigerants remains strong, with French end users leading the transition away from HFCs.

Jean-Michel Fleury – project director, international support at the Carrefour Group – set out the retail giant's vision for natural refrigerants at the ATMOSphere France conference organised by *Accelerate Europe* publisher shecco on 5 July 2018 (see '[Open for business in la Ville Lumière](#)', *Accelerate Europe*, summer 2018).

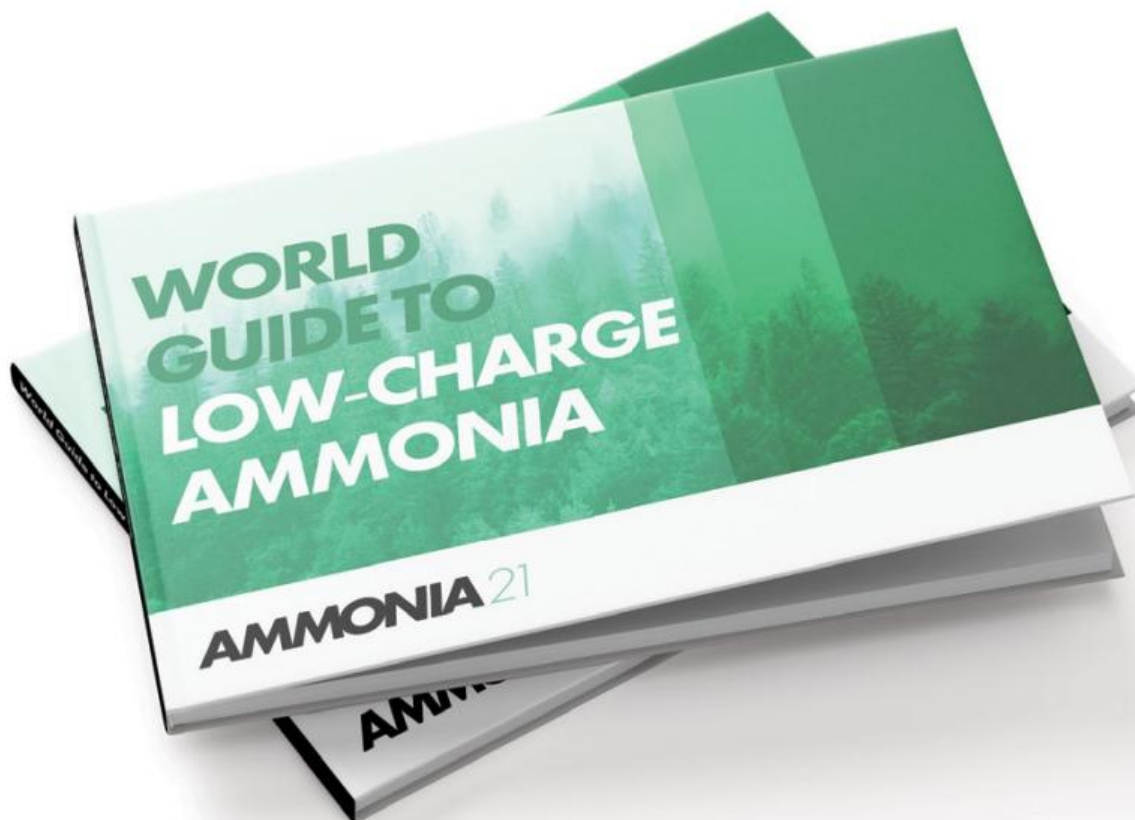
"We're targeting 100% natural refrigerants in all our installations, stores and logistics centres included, by 2030," Fleury said. "Group-wide, we're committed to bringing everyone on this journey."

■ MB

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A bright future

CO₂ has a bright future in both commercial and industrial applications, while hydrocarbons stand to benefit from a charge limit increase in 2019. *Accelerate Europe* reports from ATMOsphere Europe.

— By Andrew Williams

Natural refrigerant CO₂ will continue to grow in Europe's refrigeration market as new technology developments pave the way for it to make greater inroads into industrial as well as commercial applications, heard participants in ATMOsphere Europe 2018.

Victor Calvo, president, Carrier Commercial Refrigeration, told the conference – hosted by shecco, publisher of *Accelerate Europe*, at Lago di Garda, Italy from 19-21 November – that he sees both the commercial and industrial refrigeration sectors as promising growth areas for CO₂.

"We see more and more opportunities for CO₂ in the commercial segment," said Calvo. "Cold storage warehouses are also a significant growth area for CO₂, as well as industrial refrigeration more generally," he said.

Calvo said Carrier had made some 10,000 CO₂ rack installations in Europe so far, most of which are in large supermarkets. "Around three quarters of that number are CO₂ transcritical, and around a quarter are subcritical," he said.



Expanding production capacity

Andreas Meier, managing director of German system manufacturer TEKÖ, stressed the need to be ready to meet greater market demand. "For us, the need to add production capacity for natural refrigerant technologies is clear," he said.

To date, Meier said TEKÖ had installed some 2,900 CO₂ transcritical, 74 propane and 54 ammonia systems in Europe, mainly in Germany.

Meier stressed the importance of training HVAC&R technicians and installers in using natural refrigerants to ensure that they fulfil their potential in all world markets. "Practical training remains crucially important to growing the natural refrigerant sector," he said.

Kenneth Madsen from Advansor also expressed confidence in the growth prospects of CO₂. "Most of our sales are in Europe," said Madsen, estimating that Advansor had installed some 4,500 racks in Europe so far. "18 of Europe's top 20 retailers install CO₂ transcritical units from Advansor," he said.



ABOVE

From left to right: Victor Calvo, Carrier; Fabio Fogliani, Beijer Ref; Andreas Meier, TEKÖ; Kenneth Madsen, Advansor; Giacomo Pisano, Dorin; Jürgen Süß, efficient energy; Marco Buoni, AREA.

Madsen argued that this growth was all the more impressive, given that it was organic. "We don't have the luxury of our competitors in that we can't convert our existing HFC systems to CO₂."

Madsen identified Spain and Eastern Europe as promising regions for growth, but stressed the need to ensure that CO₂ transcritical technology is simple enough to be accessible to all.

"We need to turn the space shuttles that we have at the moment into Volkswagens that everyone can drive," he said. "Simplification is the key."

Larger capacity compressors

Giacomo Pisano from Italian multinational compressor manufacturer Dorin stressed the importance of offering CO₂ compressors for large capacities, "because otherwise you would need to install several racks" for big industrial applications.

Pisano sees little future in HFCs or HFOs. "We see many drawbacks of HFOs. New blends pop up every six months," he said.

Fabio Fogliani from Beijer Ref, meanwhile, expressed confidence that natural refrigerants would become ever more important to the HVAC&R giant's business. "We're confident that natural refrigerant technologies will continue to add to our turnover," he said.

"Asia is a growing market for us, following our acquisition of Heatcraft Australia," Fogliani said. "Africa is another important growth region."

"We think that we have a duty to develop natural refrigerant technologies and that they are the best solutions to apply," Fogliani said. "Every day, we're trying to convince our customers that natural refrigerants are the best solutions," he said.



Tackling industry ‘inertia’

Out-of-the-box thinking is needed in order to deliver the HFC phasedown enshrined in the EU F-Gas Regulation and in the Kigali Amendment to the Montreal Protocol.

“Too much activity has focused on dropping in similar refrigerants – for example, replacing HCFCs with CFCs,” said Clare Perry, senior campaigner at the Environmental Investigation Agency, an NGO.

Perry said the legacy of synthetic refrigerants “continues to haunt us” and described it as “too big to be ignored”.

“We need to go to natural refrigerants as quickly as possible. But there is mass inertia among industry,” Perry said.

Accelerating the transition towards natural refrigerants “ultimately comes down to political will among governments,” and in the case of the developing world, “on the amount of funding made available to developing countries by donor countries,” she said.



ABOVE

Clare Perry, Environmental Investigation Agency

Engage in the standards process

The maximum permitted charge of flammable refrigerants used in hermetically sealed commercial refrigeration units is poised for an increase in spring 2019.

An International Electrotechnical Commission (IEC) standard currently limits the use of flammable refrigerants in hermetically sealed commercial refrigeration equipment with an incorporated or remote refrigerant unit or compressor to 150g.

The 150g limit enshrined in IEC standard 60335-2-89 prevents refrigeration equipment manufacturers and users from fully exploiting the safe and

efficient application of hydrocarbon refrigerants in the commercial refrigeration sector. But it is set to increase to 500g in 2019 following a lengthy standards revision process (see *'The home straight'*, page 64).

The twists and turns of this process, which largely took place behind closed doors, serve as an example of why it is so important to get involved. "It's so important for companies to engage in the standards process," Perry said, urging companies to demand transparency from their industry associations.

"It's extremely hard to find out what's going on in those standards committees," Perry said. "The process is rather murky."

Boost certification

Marco Buoni from *Centro Studi Galileo*, an Italian HVAC&R training institute, stressed the importance of ensuring that people around the world are not just trained but also certified in using natural refrigerants.

"We want the end users to be safe, and therefore to certify as many people as possible in using natural refrigerants," Buoni said.

Indeed, participants in a *sli.do* poll during the conference identified lack of training alongside initial costs as the two biggest obstacles to wider uptake of natural refrigerants in Europe.

Andreas Meier from TEKÖ argued that improving the training offer could ultimately reduce the cost of natural refrigerant technologies, as more people develop the expertise to work with them.

With efforts underway to develop new technologies, revise standards and improve training, the future certainly looks bright for natural refrigerants. ■ **AW**

“
We want end users
to be safe, and
therefore to certify
as many people as
possible in using
natural refrigerants.
”

— Marco Buoni, *Centro Studi Galileo*



IMPLEMENTING THE KIGALI AMENDMENT

Parties to the Montreal Protocol are beginning to discuss supporting energy-efficient technologies while phasing down hydrofluorocarbons, improving compliance mechanisms, leapfrogging to natural refrigerants in emerging economies, and revising safety standards. *Accelerate Europe* reports from the 30th Meeting of the Parties to the Montreal Protocol in Quito, Ecuador.

— By Marie Battesti

With the Kigali Amendment to the Montreal Protocol on phasing down hydrofluorocarbons

(HFCs) poised to enter into force on 1 January 2019 after surpassing the required ratification threshold, the Parties met last month in Quito, Ecuador to negotiate practical arrangements for its swift implementation.

Although official decisions taken at the 30th Meeting of the Parties to the Montreal Protocol on 5-9 November focused on technical provisions such as approved technologies for the destruction of HFCs and new data-reporting requirements, it was the strength of political will to support the development of alternative technologies that took centre stage.

UNEXPECTED RISE OF CFC-11 EMISSIONS IN CHINA

The Environmental Investigation Agency (EIA) – an NGO active in the Montreal Protocol arena – in July revealed that several Chinese companies were still using refrigerant CFC-11 long after its phase-out in rigid polyurethane foam (used predominantly as insulation by the construction industry).

The Parties to the Montreal Protocol found themselves oscillating between old and new challenges: the old being having to address the unexpected rise in emissions in China of CFC-11, a substance that has been banned since 1996; and the new being the potential need to reassess the Protocol's institutions to address compliance and enforcement. The CFC-11 emissions problem "is a threat to the Protocol, as much as it is a threat to ozone-hole recovery," said the US in plenary,

urging Parties to "take a pause and reassess how we got here", reported [IISD Reporting Services](#).

It is critical to invest in systemic changes to aid continued compliance and also address the related issue of refrigerant banks, which could avoid up to 97 billion tonnes of carbon emissions equivalent globally between 2020 and 2050," said Avipsa Mahapatra, climate campaign lead in the EIA's US office.

In Quito, the Parties committed to providing all available data on the illegal use and production of ozone-depleting CFC-11, to enable the relevant Montreal Protocol bodies to act to ensure compliance with the United Nations environmental treaty.

Each Party will need to take measures to ensure that the phase-out of CFC-11 is sustained, and to share information on any illegal use or production of CFC-11 to the relevant Montreal Protocol bodies.

CALL FOR TECH NEUTRALITY ON SAFETY STANDARDS

European Commission representative Philip Owen stressed the need for the Montreal Protocol to be technologically neutral in analysing and identifying the relevant safety standards to achieve the HFC phasedown.

Owen highlighted the role of the Ozone Secretariat – part of the United Nations Environment Programme, and which organises the Montreal Protocol meetings – in providing the Parties with the relevant existing safety standards to help ensure that they fulfil their obligations under the Kigali Amendment.

ENERGY EFFICIENCY UNDER KIGALI TAKING SHAPE

Parties discussed the need to explore opportunities to create a financial architecture under the Montreal Protocol to support the development of energy-efficient refrigeration, air-conditioning and heat pump technologies while phasing down HFCs.

The Technical Economic Assessment Panel (TEAP) – a Montreal Protocol body – recommended that Parties update the Multilateral Fund, which finances projects in emerging economies and streamlines processes to enable timely access to funding through external financial institutions.

The Parties warned against making access to funding unnecessarily complex, which could jeopardise the Montreal Protocol's objectives. They stressed the need to keep the interests of consumers at the centre of the new funding architecture, by prioritising a mechanism that would mitigate the price of energy-efficient technology at the consumer stage.

RIGHT

Quito, Ecuador hosted MOP 30.





DEVELOPING COUNTRIES VOICE SUPPORT FOR NATREFS

Emerging economies are showing interest in leapfrogging hydrofluorocarbons (HFCs) by adopting natural refrigerants to replace the hydrochlorofluorocarbons (HCFCs) being phased out under the Montreal Protocol.

Chile and Cameroon told *Accelerate Europe* that they were interested in natural refrigerants as a means of leapfrogging from HCFCs to very low global warming potential (GWP) refrigerants. Most developing countries will freeze consumption of HFCs by 2024, with their first reduction steps starting in 2029.

"There is definitely very high interest in natural refrigerants in Africa," a delegate from Cameroon told *Accelerate Europe*. "I believe there is great potential for hydrocarbons," the delegate said.

Chile and Cameroon are eligible for financial assistance under the Multilateral Fund for the Implementation of the Montreal Protocol.

Claudia Paratori Cortés, from Chile's Office of Climate Change in the Ministry of Environment, highlighted progress made by South America in adopting CO₂ transcritical technology.

"Chile prioritises the adoption of natural refrigerants. We are trying to leapfrog from HCFCs to natural refrigerants, and we are trying to avoid HFOs as much as possible," Paratori Cortés explained.

"I see great potential to develop natural refrigerants in Chile. Many supermarkets are moving to CO₂ transcritical technology. Other industries, such as cold storage rooms, are also examining opportunities to adopt this technology," she said.

Growing awareness that the Parties will not be able to fulfill their objectives under the Kigali Amendment without natural refrigerants should help supporters of these environmentally friendly alternatives to HFCs to lift barriers to their uptake and allow them to fulfill their potential, according to Marie Battesti, a policy analyst for sheccoBase (the market development arm of shecco, publisher of this magazine).

Supporters of natural refrigerants must continue to monitor the negotiations and feed the debates with relevant market data and information regarding their potential to achieve the global HFC phasedown while saving energy compared to traditional equipment, urged Battesti in Quito. ■ MB

ABOVE

L-R: Gilbert Bankobeza, Ozone Secretariat; Tina Birmpilli, executive secretary, Ozone Secretariat; MOP 30 President Liana Ghahramanyan, Armenia; Megumi Seki, deputy executive secretary, Ozone Secretariat; Martha Leyva, Jacqueline Nyanjui, and Martha Mulumba, Ozone Secretariat.

Photo by IISD/ENB | Angeles Estrada.



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THE HOME STRAIGHT

The maximum permitted charge of flammable refrigerants used in hermetically sealed commercial refrigeration units is poised for an increase in spring 2019.

— By Marie Battesti & Michael Garry

A draft hydrocarbon charge limit increase is set to go to a final vote next year following its approval by an International Electrotechnical Commission (IEC) subcommittee.

International standard IEC 60335-2-89 currently limits the use of flammable refrigerants in hermetically sealed commercial refrigeration equipment with an incorporated or remote refrigerant unit or compressor to 150g.

The 150g limit prevents refrigeration equipment manufacturers and users from fully exploiting the safe and efficient application of hydrocarbon refrigerants in the commercial refrigeration sector.

To address these barriers, an IEC working group – later known as subcommittee 61C, or SC61C – was created in 2014 with a view to raising the recommended charge limit for flammable refrigerants.

The process of discussions, leak testing, and confirmation by the parties involved has resulted in numerous drafts since then.

In October 2018 in Busan, South Korea, SC61C analysed comments received from national committees during the CDV or Committee Draft for Vote stage into the new edition of IEC standard 60335-2-89 and voted 'yes'.

"Most of the CDV comments solutions proposed by WG4 [which began the revision process in 2014] were accepted, except the maximum charge of A2L, which will remain 1.2 kg," said Marek Zgliczynski, who chairs the IEC SC61C subcommittee on adopting the proposed update.

This means the IEC is likely to approve the propane charge limit increase from 150g to 500g, as the draft has been approved for the final vote phase (FDIS).

In the FDIS phase, the charge-limit document is circulated to national committees for a two-month voting period. An FDIS is approved if a two-thirds majority of P-members (participating members) vote to approve and if less than 25% of all the votes submitted are negative.

If the document is approved, it will progress to the final publication stage and could be published in the first half of 2019; if it is not approved, it will be referred back to a technical committee or subcommittee to be reconsidered.

The FDIS vote was expected to occur by the end of 2018, but "it's not ready yet," said Zgliczynski, who is director of commercial refrigeration product engineering for Embraco.

"It will go to IEC Central Office for translation and editorial revision by mid-December. So the vote will happen probably in mid-March, not earlier than that," he explained.

The vote is crucial for the hydrocarbons industry as national and regional standardisation bodies such as CEN/CENELEC in the European Union tend to harmonise their own standards with IEC and ISO benchmarks as much as possible.

■ MB & MG





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REPORT: CHARGE INCREASE TO FAVOUR HC UPTAKE IN EUROPE



A revision of international standards to increase the charge limit on hydrocarbons should expand the market for their use, according to new research.

— By Dario Belluomini

The revision of international standards to increase the charge limits on using hydrocarbons in HVAC&R systems should expand the market for these natural refrigerants, according to [new market research conducted for LIFE FRONT](#).

LIFE FRONT, coordinated by *Accelerate Europe* publisher shecco, is an EU-funded project aiming to remove barriers posed by standards to wider uptake of flammable refrigerants in refrigeration, air-conditioning and heat pump (RACHP) applications. It is funded under LIFE, the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the bloc.

Efforts are ongoing to review the current charge size limits for flammable refrigerants for RACHP systems at both EU and international level (within working group EN 378 and ISO 5149). International institutions like the European Commission are closely monitoring the situation.

Reviewing standards can take several years. The LIFE FRONT project aims to offer policymakers and standardisation bodies advanced technical input and expertise, with the purpose of revising standards to facilitate wider uptake of hydrocarbons in the EU.

The review of existing international and European safety standards shown in the report demonstrates that refrigerant charge limits are currently the main barrier to wider uptake of flammable refrigerants, limiting the ability of HVAC&R systems using such refrigerants to provide the desired cooling capacity. While discussions are underway on several issues concerning flammable refrigerants within group standards EN 378 and ISO 5149 (e.g. increased charge limit for hydrocarbons below ground), there is currently no clear timeline for publishing revised standards.

Based on an online survey of almost 500 HVAC&R experts, including interviews and quantitative data collection from leading European HVAC&R manufacturers, the report analyses the market availability of non-fluorinated flammable refrigerant products and the impact of standards on that market.

Over half of survey respondents indicated that they already work with hydrocarbons to some extent, while further uptake is expected by 2020.

The research shows that manufacturers are currently producing hydrocarbon-based equipment in relatively small quantities compared to HFC-based products, but that they expect this to rapidly change thanks to the EU F-Gas Regulation and the anticipated change in hydrocarbon standards, especially for commercial refrigeration applications.

For all the applications considered, survey respondents indicated that hydrocarbon-based products would become major elements of their portfolio should standards allow higher charges. The results are striking compared to the scenario of no standards revision: in the latter case the results of the survey would indicate a less bright future for RACHP applications using hydrocarbons.

According to the data collected, the uptake of hydrocarbon-based systems is strong in the commercial refrigeration sector, where 2.5 million installations use these natural refrigerants around the world. As for the other systems considered in the report, in Europe there are more than 200,000 heat pumps and a similar number of portable air conditioners using hydrocarbons. Positive growth expectations were recorded for both these categories, especially for portable air conditioners.

The report also includes interesting case studies describing how RACHP systems using higher charges of hydrocarbons are already being used in certain situations. French multinational Carrefour installed a combination of medium-temperature cabinets using more than 430g of propylene (R1270) and low-temperature cabinets using more than 550g of R1270 in a store in Brussels (Belgium), with a total refrigerant charge of 5.44 kg; this was possible thanks to the special design of the store (e.g. no electric sockets under or behind the cabinets) and continuous maintenance interventions.

Belgian retailer Colruyt Group is moving to hydrocarbons for all its in-supermarket cooling needs, using compact chillers with a maximum of 2.5 kg of propane (R290) or R1270.

This finding can be seen as industry anticipating the prohibitions on and growing prices of HFCs under the F-Gas Regulation, but also expecting standards revision to smoothen the transition to hydrocarbons within two years.

The report concludes that the right combination of mitigation measures such as good quality components, skilled certified technicians to handle systems, a thorough risk assessment and intuitive control systems could solve all safety issues and potential malfunctions of hydrocarbon-based RACHP applications.

To build a bridge between the market research and the standards revision, project partners presented the main findings of the report during a meeting of the European Committee for Standardization (CEN) working on the safety of refrigeration technology using flammable refrigerants (CEN/TC 182/WG12) in Milan, Italy in November.

In a sign that the situation is evolving not only in Europe but also internationally, a subcommittee of the International Electrotechnical Commission (IEC) in October crucially approved advancing to the decisive next stage in a standards process that could increase the charge limit on flammable refrigerants like R290 in commercial refrigeration equipment from 150g to 500g under the standard 60335-2-89 (see '[The home straight](#)', page 64).

The LIFE FRONT project partners exchange information and insights with the member of the IEC subcommittee to advance the use of natural refrigerants. Some of the companies contacted for both the market and qualitative research are involved in the workings of the IEC subcommittee. ■ DB

Natural refrigerants ripe for new markets

Air-conditioning and heat pump applications are promising growth markets for natural refrigerants, while risk reduction in the low-charge era heralds a 'renaissance' for ammonia. *Accelerate Europe* reports from ATMosphere Europe in Italy.

— By Andrew Williams



“Heat pumps are a perfect application for CO₂, especially to produce hot water.”

— Armin Hafner, NTNU

The properties of CO₂ make it an ideal refrigerant for heat pump applications, while the likely charge limit increase on hydrocarbons and the development of low-charge ammonia technologies will help natural refrigerants to grow into areas that previously had been dominated by HFCs, heard participants in the ATMOsphere Europe 2018 conference at Lago di Garda in Italy.

"Heat pumps are a perfect application for CO₂, especially to produce hot water, due to the large temperature glide and the increase in heat rejection loss," Professor Armin Hafner from the Norwegian University of Science and Technology (NTNU), told the conference plenary.

"These properties are unique to CO₂, making this refrigerant ideal for heat pumps," Hafner argued. "In a heat pump you can use CO₂ for space heating, cooling, and to produce hot water."

The ATMOsphere Europe conference, organised by shecco – publisher of *Accelerate Europe* – was held in Riva del Garda, on the shores of Lake Garda, Italy, from 19-21 November 2018.

CO₂ to grow in heat pump market

Hafner cited high refrigerant density; high compressor efficiency; and high heat transfer among the properties of CO₂ that make it a great refrigerant.

The professor outlined the 'multiPACK' project, funded by the European Union under the Horizon 2020 programme, which is looking into innovative new ways of applying CO₂ technology, such as in chillers for air conditioning.

He presented the ECO₂ chiller and heat pump, part of enEX's YUKON gravity family and developed by the Italian manufacturer for the project, as a "compact and energy-efficient solution" for domestic use. It produces chilled water for cooling in summer, works as a heat pump in winter, and provides hot water all year round.

The MultiPACK project has also developed a proposed commercial refrigeration system build integrating air conditioning and heating, using a



René van Gerwen, Entropycs

multi-ejector. "In this configuration, you only need one technician for your heating, cooling and air conditioning," Hafner said.

The professor also drew attention to the potential for CO₂ transcritical systems to be combined with cold storage. "Integrating cold thermal storage with CO₂ refrigeration technology can help to reduce food waste," Hafner said.

Risk reduction driving low-charge ammonia growth

The development of low-charge ammonia systems, meanwhile, potentially heralds a "renaissance" for this natural refrigerant, Andy Pearson, group managing director at Star Refrigeration, told conference participants.

"Ammonia has been in continuous use since 1830," Pearson said. "It's really safe and easy to use, and that's why we have used it for over 180 years."

Sustainability considerations are encouraging increased use of ammonia, while the desire to reduce risk is contributing to the development of lower charge systems, Pearson argued.

"Much of the fear of ammonia is based on fantasy, not fact," he said. "The way to minimise flammability and toxicity fears is to lower the charge."

"There is a point where the ammonia charge becomes low enough to reduce the safety risk without compromising on system performance," Pearson said. "That's the sweet spot that contractors are trying to hit for their customers."

So-called "distributed" or "packaged" systems, which don't require roof access, help to reduce the ammonia charge by eliminating the need for site piping and liquid receivers with high-side control, Pearson said.

“There is a point where the ammonia charge becomes low enough to reduce the safety risk without compromising on system performance.”

– Andy Pearson, Star Refrigeration



The ammonia, at 75%-90% less charge than in traditional systems, serves a secondary circuit of pumped CO₂, water or glycol.

Hydrocarbons 'major long-term refrigerants'

René van Gerwen of ENTROPY Cooling Solutions drew attention to the progress made in bringing to market hydrocarbon-based domestic refrigerators since the unveiling of a 'Greenfreeze' demonstration model by Greenpeace in March 1992.

In 1993, just 300,000 or so hydrocarbon-based domestic refrigerators were produced. Now there are around 100 million units per year.

"Hydrocarbons are among the major long-term refrigerants," Van Gerwen said. Yet given their flammability, ensuring that technicians are adequately trained in their use will continue to be a priority, he predicted.

Standards revision crucially important for market growth

Van Gerwen drew attention to the role that revising standards could play in broadening the market for hydrocarbons.

"Current charge limits are prohibitive and obstructive for hydrocarbons," he said.

Progress on this issue is already being made, with the maximum permitted charge of flammable refrigerants used in hermetically sealed commercial refrigeration units poised to increase in spring 2019.

The draft hydrocarbon charge limit increase is set to go to a final vote next year following its approval by an International Electrotechnical Commission (IEC) subcommittee at a crucial meeting in Busan, South Korea, in October 2018.

International standard IEC 60335-2-89 currently limits the use of flammable refrigerants in hermetically sealed commercial refrigeration equipment with an incorporated or remote refrigerant unit or compressor to 150g.

The 150g limit prevents refrigeration equipment manufacturers and users from fully exploiting the safe and efficient application of hydrocarbon refrigerants in the commercial refrigeration sector. The new limit

on the table is 500g (see *'The home straight'*, page 64).

Despite the evolving situation at the IEC level, Van Gerwen lamented that fragmented national standards and regulations continue to hold back hydrocarbons in Europe, despite "relatively clear" directives and regulations at EU level.

It is important to remove unnecessary barriers to hydrocarbons in product safety standards by focusing on design improvements, rather than fixating on charge limits, he argued.

"Charge limits aren't the only indicator of safety. We should be focusing on leakage rates," he said.

"Flammability is not unique to our business. We use flammable substances safely in many other aspects of our lives," Van Gerwen said.

At the conclusion of the conference, participants were left in little doubt as to the potential of new technology innovations to help grow the market for hydrocarbons, CO₂ and ammonia in HVAC&R applications. ■ AW

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CO₂: No longer sun-baked!

Upon its rediscovery as a refrigerant during the 1990s, CO₂ was not considered suited to warm climates – and this idea that it is a refrigerant only for cold countries has never really left the minds of many in the HVAC&R industry.

“For a long time, the greatest challenge for CO₂ [transcritical] refrigeration systems has been efficiency in warmer climates,” according to the *‘Technical report on energy efficiency in HFC-free supermarket refrigeration’*, published by the Environmental Investigation Agency (EIA) and shecco, publisher of this magazine, and funded by the Kigali Cooling Efficiency Program (KCEP).

This warm ambient climate issue is commonly defined as the ‘CO₂ equator’ – the previously accepted geographical limit for cost-effective and efficient performance of CO₂ systems in all food retail store formats.

Compared to other refrigerants, the thermodynamic properties of CO₂ are quite different, as acknowledged in a 2004 paper by Professor Petter Neskå of the Norwegian University of Science and Technology (NTNU), Trondheim.

“Experience from testing and modelling of CO₂ refrigeration and air-conditioning systems shows that cooling COP [coefficient of performance] is more sensitive to ambient temperature variation than with conventional refrigerants,” Neskå explains.

“This typically leads to the situation [...] where the CO₂ system is superior at moderate and low ambient temperature, and slightly inferior at very high temperature.”

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

Yet despite this efficiency challenge, CO₂ has been moving increasingly south to warm ambient temperature countries that were not though possible a few years ago, like Australia (see *‘One Man’s Vision’*, *Accelerate Australia & NZ*, winter 2018), China (see *‘Chinese retail’s first transcritical CO₂ system’*, *Accelerate China*, April 2018), Indonesia, India (see *‘Innovators take to Gustav Lorentzen stage’*, *Accelerate Europe*, autumn 2018), Jordan (see *‘Sun shines on CO₂ in Jordan’*, page 18) and Mexico (see *‘Casa Ley takes a swing at transcritical’*, *Accelerate America*, September 2018).

“To overcome such challenges, experts in the field developed and introduced certain types of processes and components, which managed to overcome the so-called CO₂ equator,” the EIA/shecco report says.

Various technologies are helping to make CO₂ possible in warm ambient climate situations in Europe.

— By Charlotte McLaughlin, Marie Battesti & Dario Belluomini

These technologies, familiar to CO₂ enthusiasts, include parallel compressors, liquid ejectors, adiabatic cooling and mechanical sub-cooling.

Saving with parallel compression

Parallel compressors enhance the performance of conventional CO₂ transcritical refrigeration systems by recovering the energy loss.

In simple terms, parallel compression recovers the flash gas (the refrigerant in gas form produced spontaneously when the condensed liquid is subjected to boiling) lost in a CO₂ transcritical cycle by using the compressors to compress some or all of the vapour generated by the liquid receiver from an intermediate pressure to a higher one, according to [Gullo et al.](#) in a 2016 paper: *'Energy and environmental performance assessment of R744 booster supermarket refrigeration systems operating in warm climates.'*

They recover the flash gas by re-directing it through an internal heat exchanger and then to the separate parallel compressor or compressors. "Adding parallel compression delivers 6-8% savings for the operation of the transcritical system," notes the *'Technical report on energy efficiency in HFC-free supermarket refrigeration'*.

Since the development of this parallel compression technology, many end users, such as Jordan's Al-Salam military supermarket, Makro in South Africa, Selgros Cash and Carry in Romania (see *'Scaling new heights in Romania'*, *Accelerate Europe*, autumn 2016), Migros in Switzerland (see *'In Migros's DNA'*, *Accelerate Europe*, summer 2018), Iper in Italy, and Carrefour in Spain (see *'Crossing the CO₂ equator: Carrefour leads the march south'*, *Accelerate Europe*, summer 2016) have used it in warm ambient climates to achieve energy efficiency with CO₂, according to the report.

Geeking out on ejectors

Added to this, the development of the ejector has been hailed as a key achievement that is bringing CO₂ to warm ambient climates.

The devices can improve the efficiency of refrigeration systems by up to 20, 30 or in some cases 40% (see *'Ejectors: To efficiency and beyond'*, *Accelerate Europe*, winter 2016).

How do they work? Figure 1 depicts the energy lost during the refrigeration cycle as heat is transferred between the condenser, expansion valve and evaporator. Introducing an ejector into this space can improve compressor efficiency by recovering energy that is normally lost during the vapour compression cycle.

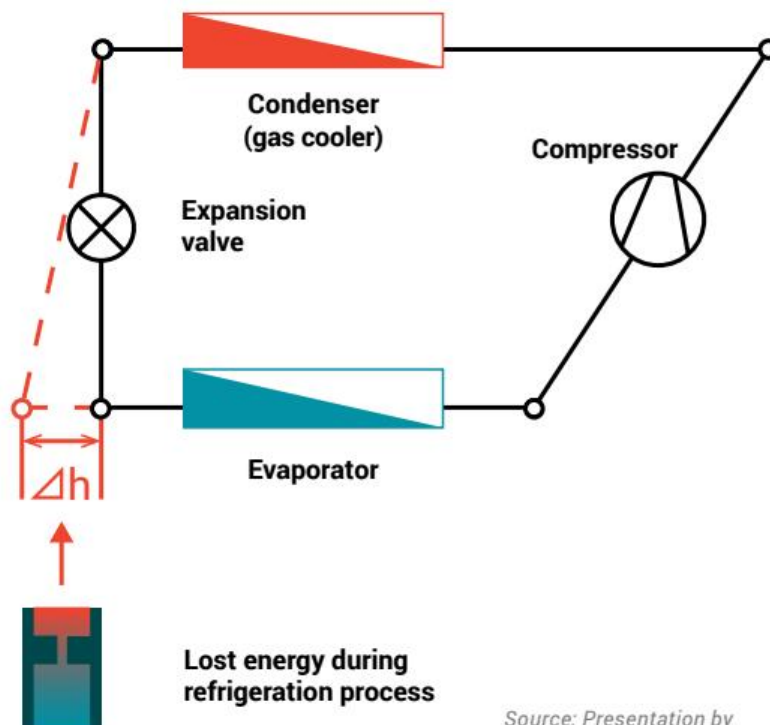
The ejector achieves this by increasing the compressor's intake pressure. Sounds complicated, right? The essential point is that ejectors yield significant long-term cost benefits to end users.

Many leading OEMs have had success with ejectors in the field – including enEX, Carrier/CAREL, Danfoss, Compact Kältetechnik and Würm – in a variety of different climates.

"We started trialling ejectors in 2014/2015 and released our first ejectors to the general market earlier this year, but we already have over 300 ejectors in the market," Danfoss' Hans Ole Matthiesen told *Accelerate Europe* at Chillventa 2018 in Nuremberg, Germany.

Danfoss primarily sells vapour multi-ejectors (which are made of blocs of around six ejectors stacked in rows), but they have also now launched a liquid ejector. "We were taking our time to bring the liquid ejector to market. I think it's very important to make sure the systems are simple [...]. We've been testing liquid ejectors for two years," Matthiesen adds.

Figure 1: Energy lost during refrigeration cycle



Source: Presentation by Masahiro Takatsu, DENSO, ATMosphere Asia 2016



CAREL/Carrier's EmJ modulating ejector. Ejectors help to improve efficiency in warm climates.

Liquid ejectors, comprising an expansion valve system, use the energy of the high-pressure gas to lift liquid from the suction accumulator.

Carrier/CAREL's electronic modulating ejector (EmJ), launched in a joint venture in 2016, has also been a success. "This is not [...] a novelty in the refrigeration industry," Diego Malimpensa, CAREL's business unit manager – retail solutions, argued at Chillventa, but did point out that more work needs to be done to make it a "standard" technology.

The EmJ's fundamental feature is the continuous modulation ensured by the ejectors, which via dedicated control algorithms allow the system to continuously adapt to a refrigeration system's typical variations in operating conditions. It now comes in various sizes suitable for small stores and large stores, as well as industrial refrigeration systems with CO₂.

Ejectors and parallel compression also can mean the systems end up paying for themselves, as demonstrated by the efficiency of the Jordan CO₂ supermarket. Industry experts quoted in another shecco report entitled '*F-Gas Regulation: Shaking up the HVAC&R industry*' from 2016 (see page 28 of the report) argued that the cost of ejectors is a non-issue – insisting that adding ejectors and parallel compression increases the price of a system by 10% at most.

Data from Danish CO₂ rack manufacturer Advansor reveals the strong relationship between increased efficiency of CO₂ systems and falling component prices (see table, [page 75, Accelerate Europe](#), winter 2016).

Ejectors are proving popular despite price challenges. A study, supported by the Swiss Federal Office of Energy (SFOE) and published in December 2017 by the German magazine *Kälte Klima Aktuell*, reports that, "according to estimates, several hundred [CO₂] ejector systems are currently in use, the majority of which are in Europe".

Migros, the largest retailer in Switzerland, last year counted 60 stores fitted with CO₂ refrigeration technology using ejectors and said it planned to add 30 more every year.

"Today, ejectors are integrated into the planning of cooling technology as standard for the renovation and new construction of Migros stores whenever they are economical," said Daniel Duss, head of construction and technology at Migros Cooperative in Lucerne.

Coop, Switzerland's second-largest retail chain, also has opted to use ejectors, according to the study. "Refrigeration needs in food markets accounts for about half of the electricity consumption, which is why the ejector makes a significant contribution to the reduction of energy

consumption," said Thomas Häring, head of energy and technology at Coop.

Opening up the bag of tricks

Apart from ejectors and parallel compression, there are other tools in the HVAC&R technician's box to increase the efficiency of CO₂ in warm climates.

At ATMosphere Europe 2018, organised by shecco – publisher of this magazine – at Lago di Garda, Italy on 19-21 November, the natural refrigerants conference dedicated a session to just this question.

EPTA's Refrigeration Systems Sales & Marketing Manager Francesco Mastrapasqua presented the Italian firm's FTE (full transcritical efficiency) concept, which works by flooding the evaporators to eliminate superheat. "The FTE system is leading to annual energy savings of around 10% in warm countries like Malta, Italy, and Portugal," said Mastrapasqua.

"FTE could use parallel compression, but we want to promote it as a simple system," he said, explaining that it was developed to take account of, "the situation in developing countries where the knowledge about CO₂ is not that advanced".

Mastrapasqua said that in one case study in Malta, the ROI on the system was just 1.5 years.

The FTE was also the subject of a site visit to the Italmark supermarket in Brescia. Alvise Case, energy manager at EPTA, said that the system had been running for two years. "It is leading to significant energy savings when compared with conventional installations in the same area," Case said.

LU-VE is also developing technologies that help to improve efficiency in warm climates. "We have been pioneers of CO₂ transcritical installations in Europe since the early 2000s, and in 2018 we were proud to install the first CO₂ transcritical systems in India and Jordan," said LU-VE Marketing Manager Livio Perrotta at ATMO Europe 2018.

The Emeritus, a solution developed with the Polytechnic University of Milan, involves adiabatic precooling with a spray function. In this way, the system exploits the synergy between two effects: adiabatic humidification and the evaporation of water on the coil. Thanks to a sophisticated control system, the Emeritus boasts efficient performance in different climatic conditions.

The group is now "pushing to install it in southern Italy," said Perrotta. "The results of a simulation for a store in Trapani (Sicily) show that the Emeritus would lead to 9% energy savings in a year, thanks to the increased efficiency of the system and the reduction in outlet temperature," he said.

Perrotta stressed the importance of training. "Not all installers are familiar with CO₂," he said.

Other manufacturers of heat exchangers such as Modine, Güntner, Evapco, Alfa Laval, and Baltimore Aircoil Company (BAC) also offer CO₂ adiabatic systems in Europe.

Giovanni Gonzato, sales and applications engineer at Frascold, showed the results of simulations done for a CO₂ transcritical system using the firm's CapaFlex capacity control system. "It was developed in a partnership with the University of Padua," said Gonzato.

"Thanks to the innovative stepless capacity control – without the use of variable frequency driver – the CapaFlex configuration is more efficient than conventional systems in high ambient temperatures," Gonzato said.

"Sometimes we do not need to look at the needs in terms of energy efficiency only, but also in economic terms," he said, showing how CapaFlex would lead to lower installation and maintenance costs. "We are running more simulations to support and validate this application to understand how to better use it," he said.

Other technology ideas were also being explored to increase the efficiency of CO₂ refrigeration systems like controls such as Eliwell's DOMINO solution, which has been used across Europe including in Italy, Belgium, Switzerland and Spain as well as in China; and BITZER, which recently launched a sub-cooling unit during Chillventa 2018 (see '[Natural refrigerants aim high at Chillventa](#)', page 46).

The DOMINO was used in China's second transcritical CO₂-based refrigeration system, at a CSF Market opened in Beijing in July 2018.

The control system from Eliwell and Dorin compressors in a Panasonic CO₂ transcritical rack is allowing the system to cope with the high temperatures of the Chinese city (July 2018 temperatures in Beijing hovered at 39°C).

Adiós to 'CO₂ equator'

CO₂ has seen impressive market success in warm ambient temperatures in Europe. 16,000+ CO₂ transcritical systems have been installed in supermarkets in Europe with the help of the various technologies cited above, according to data from sheccoBase, the market development arm of Accelerate Europe publisher shecco.

"CO₂ has demonstrated efficiency and security: Goodbye to the psychological barrier of the 'CO₂ equator'!" said Julio Minguillón of Carrier during ATMOsphere Ibérica, organised by shecco in Madrid on 18 September (see '[NatRefs advancing in Spain and Portugal](#)', p. 52).

"Carrier has installed more than 7,500 transcritical CO₂ systems in Europe, and 94 systems in the Iberian Peninsula, for 16 different clients," Minguillón added.

Boundary conditions like the warm climate of southern Europe had long been seen as a barrier to wider adoption of CO₂, limiting the efficiency of these systems.

Diego Ortega from EPTA showed during his presentation the field results of the Full Transcritical Efficiency solution to boost the efficiency of CO₂ transcritical systems. Ortega presented the results obtained in a CO₂-based commercial refrigeration installation of 139.5 kW (-10°C) on the medium-temperature side and 34 kW (-35°C) on the low-temperature side in Bologna, Italy.

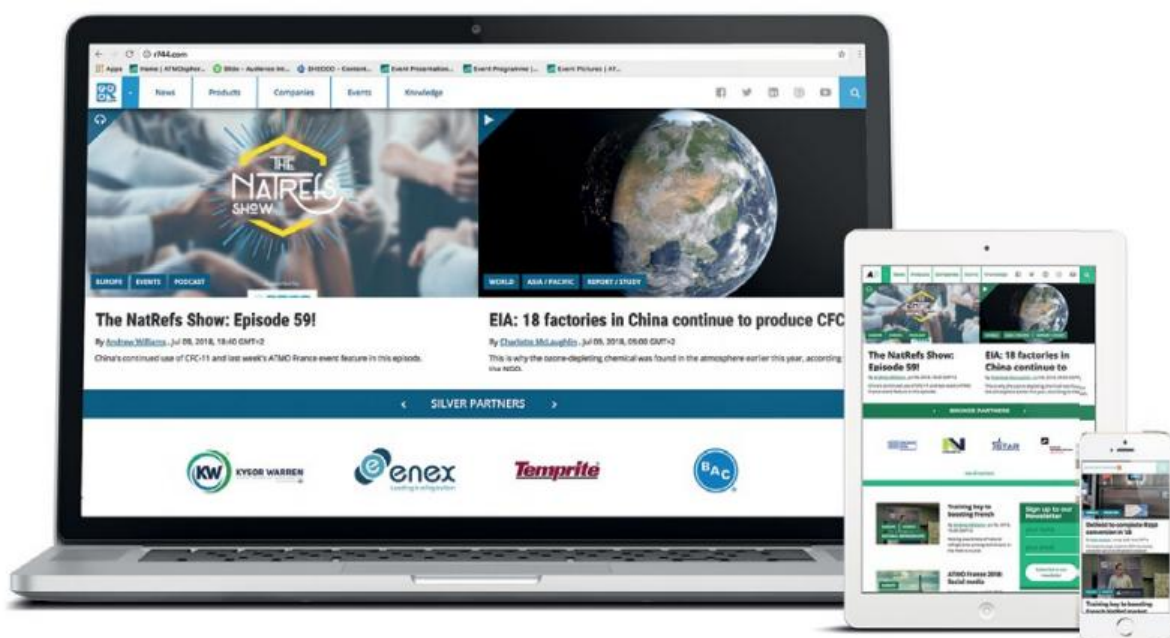
"The FTE solution has proven higher efficiency compared to a traditional system, even in warm ambient climates," said Ortega.

With all these technologies being employed in different configurations, it's 'adiós' to the CO₂ equator!

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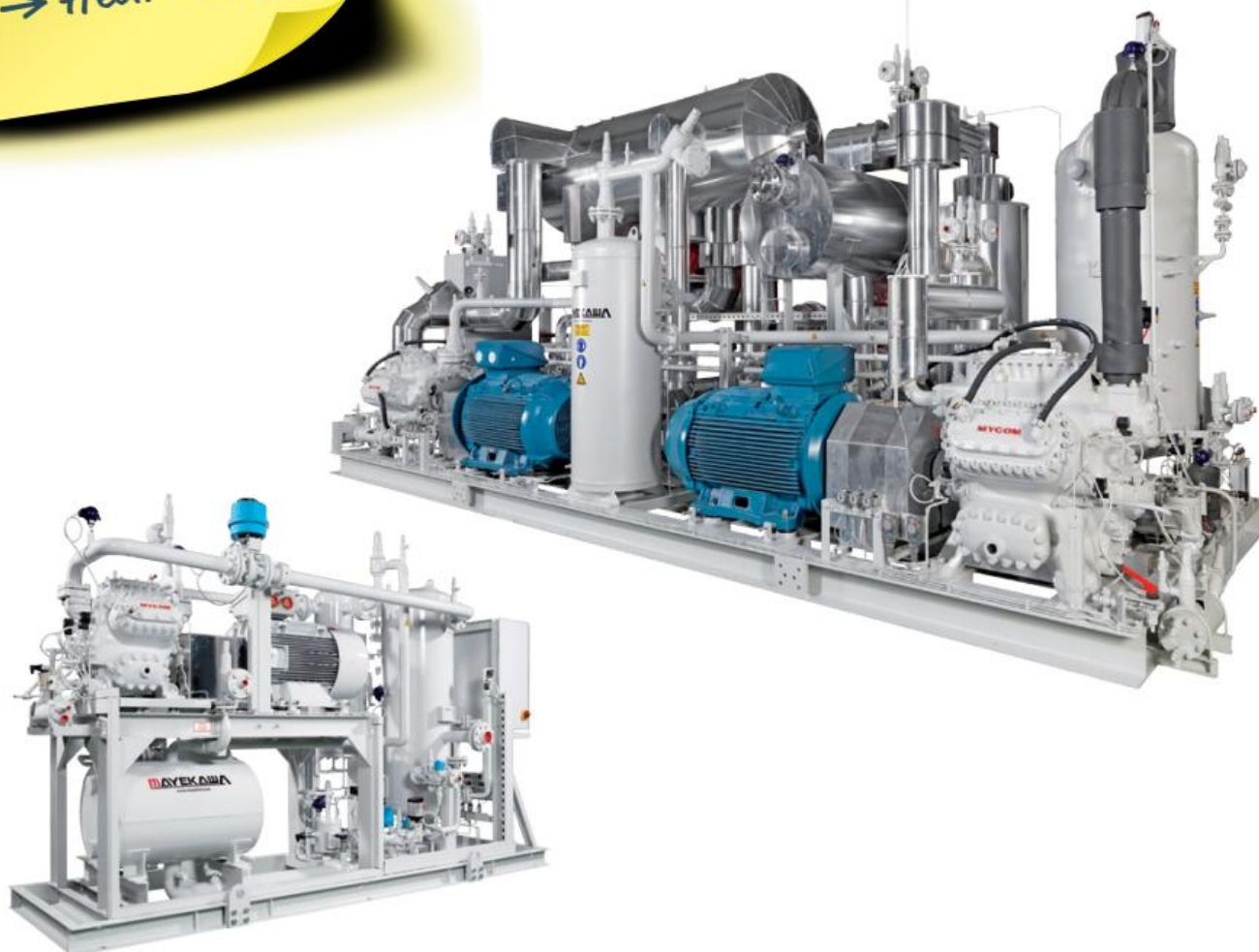
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