

AUTUMN 2017

ACCELERATE

ADVANCING HVAC&R NATU

EUROPE

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Deutsche Bahn**

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**Hydrocarbon
charge limits
under spotlight**

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**Technology focus:
Air conditioners**

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***Inside the
future of
shopping***

PAUL ARROWSMITH
Refrigeration Design Manager
Sainsbury's Supermarkets Ltd.

p. 22



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All aboard the NatRef train!

– Editor's note by Andrew Williams



With its HFC phase-down pathway enshrined in the EU's F-Gas Regulation and a plethora of innovative manufacturers and progressive end users, Europe ranks among the world's most developed markets for natural refrigerant-based HVAC&R solutions.

Amid uncertainty in the United States over the long-term impact of a federal court ruling that may restrict the Environmental Protection Agency's (EPA) ability to pursue an HFC phase-down under the SNAP (Significant New Alternatives Policy) programme, it is particularly pleasing to see Europe on the fast track to a brighter future.

France is poised to join other European countries like Denmark, Slovenia, Spain and Norway in introducing a tax on HFCs. The European Commission, meanwhile, has reaffirmed a ban on HFCs in multipack centralised commercial refrigeration as originally adopted in the 2014 EU F-Gas Regulation.

Europe's retail sector has long been a driving force for innovation. In the UK, Brits are flocking to online shopping in their droves as already busy lifestyles become busier still. Sainsbury's has been quick to respond to this trend.

We visit the retail giant's new online fulfilment centre in east London to see how natural refrigerants are serving the shopping landscape of the future (p. 22).

Retailers aren't the only ones looking to stay ahead of the curve. As the world's second-largest transport company and Europe's largest railway operator and infrastructure owner, Deutsche Bahn is acutely aware of its power to contribute to improving the sustainability of our environment. From 2020 onwards, it plans for its air conditioning in new trains to use natural refrigerants (p. 16).

Manufacturers, too, are getting on the NatRef train. As natural refrigerants become increasingly popular HVAC&R solutions for complying with the EU's F-Gas Regulation, the need to train technicians to operate these systems is becoming more acute. In Altenstadt, we saw at first hand how the German manufacturer TEKO is investing in training to stay one step ahead of the competition (p. 64).

Indeed, Germany is home to more of Europe's most important users of natural refrigerant-based technologies – not to mention much of the manufacturing base. Later this month, the key movers and shakers driving uptake of

natural refrigerants in Europe will be in Berlin for the eighth edition of our ATMOsphere Europe conference.

The packed three-day programme features exclusive presentations from major end users including Deutsche Bahn, UK pharmacy chain Boots, Metro and Carrefour. One highlight is the first-ever *Accelerate Europe* awards ceremony, recognising the end users that are doing the most with NatRef solutions in Europe. We'll also hail a Person of the Year and an Innovation of the Year. Check out our preview – and the full conference programme – [on page 34](#).

Our popular 'Technology Focus' series continues with a look at how the market for propane-based air conditioners is developing worldwide (p. 68).

Chief among the other highlights of this autumn edition are a wide-ranging interview with Luis Felipe Dau, CEO of Embraco – a multinational focused on refrigeration solutions (p. 74), and extensive coverage of our ATMOsphere America conference in San Diego (p. 44).

Thanks for your loyal readership. I look forward to seeing many of you in Berlin!

■ AW



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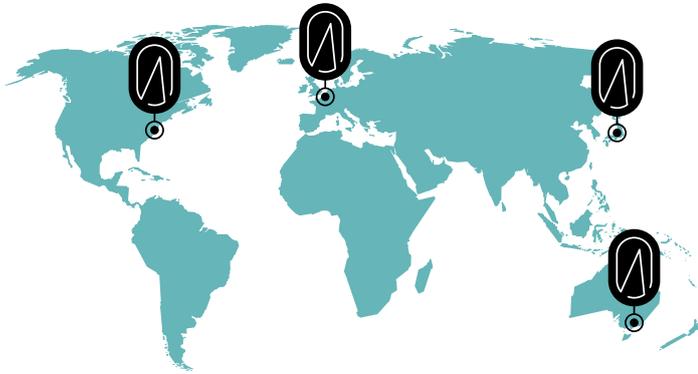
ADVANCING HVAC&R NATURALLY

EUROPE

About Accelerate Europe

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

<http://accelerateEU.com>



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END USER

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TRANSCRITICAL CO₂ STORE:
BUILDING NATREF MOMENTUM
IN AUSTRALIA



Trends in the European energy market

One would have to be living in a cave not to have heard a lot of noise about global warming and climate change and how fossil fuels are bad and renewable energy is good. More recently, transport emissions have come under scrutiny due to high levels of NOx emissions. What is usually missed, however, in both these cases is that firstly it isn't just about electricity generation and transport in respect of energy, and secondly, it isn't just about tailpipe or exhaust emissions with regard to air pollution.

Energy used for heating and cooling in industry represents some 50% of EU energy use (European Commission figures). Meanwhile, NOx emissions from commercial gas use are expected to grow significantly as a proportion of London's emissions. In central London, NOx emissions will increase from 30% in 2013 to 38% in 2020 (figures from London Environment Strategy, Mayor of London).

We need to find new ways of heating our buildings and domestic water that are lower carbon and lower emissions.

Fortunately, in 1852 Lord Kelvin picked up on the work of many others and spoke about heat engines for useful heating and cooling. Mechanical refrigeration took off and is commonplace. Heat pumps, as they became known, have always struggled in a competitive market vs. gas. Firstly, they are more expensive to buy, even if cheaper to run, and oftentimes that isn't true either. With no appreciable value placed on carbon savings and a very well developed gas distribution network, not much has happened. There is also the reality that heat pumps have typically not been very good for buildings that needed warmer water, circa. 80°C and certainly over 60°C. While there is no hard and fast reason for such high temperatures not to be achievable, it has been a barrier.

The 2050 goal is total decarbonisation of the heating sector. There isn't enough biomass and not likely enough low-carbon H2 or biomethane. With a market for interruptible electricity for heat pumps, we won't be taking combustibles and using them for easy jobs, so heat pumps have to step up to the challenge and offer any building, new or old, big or small, heating from high efficiency devices; at least 300% if not more. There is also a growing trend for cooling, sometimes coincident with heating, certainly diurnally across the year.

So here's where I see heat pumps.

Firstly the market can be seen in quadrants,

- ▶ Smaller Old Buildings (approx. 70°C), e.g. older houses;
- ▶ Smaller New Buildings (approx. 55°C), e.g. new houses;
- ▶ Bigger Old Buildings/Districts (approx. 75°C) e.g. cities and universities, and;
- ▶ Bigger New Buildings (approx. 65°C). e.g. new office buildings and airports/shopping malls.



Working fluids also come in various forms. Synthetic working fluids like HFCs or the newer HFOs are the mainstay of the smaller equipment manufacturer and very large turbo-machinery. HFCs, like HCFCs and CFCs before them, are now seen as environmentally challenging and are being phased down. HFOs bring a new opportunity with lower GWPs around four times that of CO₂. But they also have modest flammability and efficiency similar to HFCs, which were generally seen as not as good as HCFCs e.g. R22. There are some rumblings in the marketplace about the toxicity of HFOs, and in particular, the toxicity of combustion components. They are also the first family of working fluids to break down easily in the atmosphere but hopefully not inside the system.

I remain sceptical for two reasons. Firstly, CFCs were brilliant for 70 years till we discovered they weren't. Secondly, all systems leak in both directions, so we should expect HFOs to leak out and air to leak in. Will this air lead to a breakdown or the creation of unwanted substances inside the system? Probably not. But not definitely not. The cost per kilogram is also high.

Natural working fluids are harder to work with but have two rewards. The efficiency tends to be higher. Given that running costs make up 70% of the life cost of a heat pump, efficiency is king in my opinion, especially if we see new business models emerging where ownership is with the utility company. In outdoor units, hydrocarbons are quite easy to use and in large systems ammonia is now available for delivery temperatures of up to 90°C; plenty warm enough.

The big questions with heat pumps are where to get the heat from, and will there be enough electricity? Traditionally the heat source has been viewed in smaller systems as air source or closed loop ground source, but the market has moved to allow larger systems with open loop ground source and indeed surface water such as seas and rivers. Domestically, perhaps one of the most exciting developments is

for thermal panels to be mounted on a building with the working fluid inside, but I'd implore the players in this market to establish an outdoor heat pump using hydrocarbons. The last thing we need is millions of HFO/HFC heat pumps leaking in a few years.

The higher than 90°C category is also interesting and it would be great to find viable solutions and applications here. Steam has been the main delivery fluid of industrial heating for centuries, but we must assess if we really do need steam. One example we were involved in used coal-fired steam boilers to keep chocolate above 50°C. A pinch analysis or exergy analysis would be sensible in every case.

Better efficiency is critical to avoid lots of poor efficiency heat pumps. This is a factor in 'is there enough electricity?' questions. Upwards of 300% is still a lot of extra electricity but it doesn't have to be during peak hours. Thermal storage is far cheaper than batteries, so we should be building storage into our networks and solutions. Water storage is often suitable and very cheap. Inter-seasonal allows far higher COPs so maybe the goal is 600%, in which case the challenge is only 18% of what the doom-mongers say it is.

So what does the heat pump market need to blossom? The technology gets better every year, and the business models more adaptive to human eccentricities. But given that the goal is to decarbonise and reduce fossil fuel use, when are we going to bring downward pressure on this end of the equation? All the incentives in the world won't overcome a ready supply of cheap gas. Just as NOx pollution is now recognised as a major challenge and some are even pointing out that a significant percentage of the NOx in cities is from gas boilers and gas CHP engines, we need to move forward with the right heat pumps.

2050 is one generation away. We can't afford to fit interim solutions.

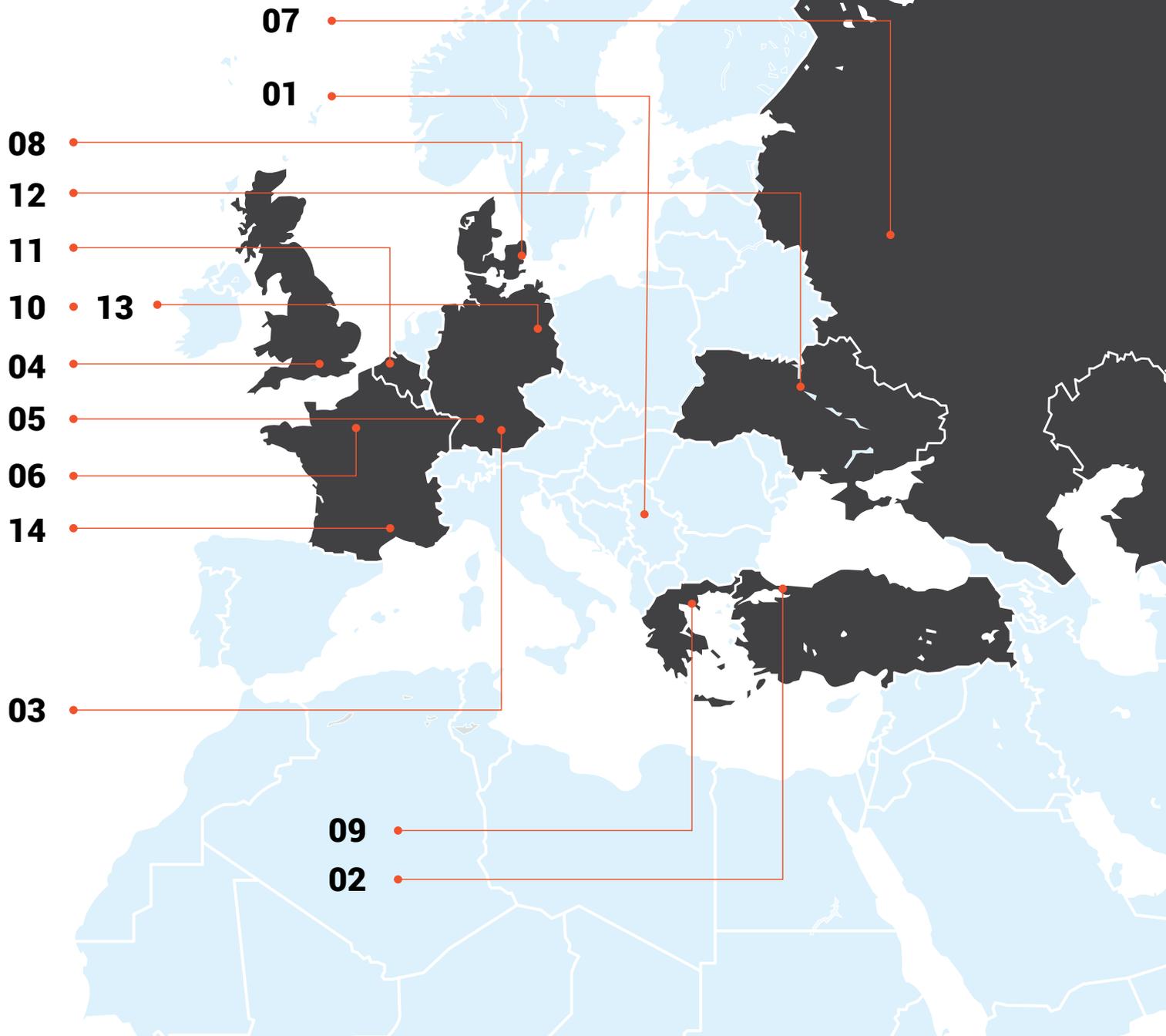
We've got one last chance to get it right.

Dave Pearson is director of Star Renewable Energy, a business unit of Glasgow-based Star Refrigeration.

EVENTS GUIDE

September / October 2017

November / December 2017



- **01** 13-15 September, Belgrade, Serbia
Cool Expo Balkan
www: <http://www.alexpo.co.rs/cool-expo2017.html>
- **02** 20-23 September, Istanbul, Turkey
FOOD ISTANBUL
www: <http://cnrfoodistanbul.com>
twitter: @cnrexpoistanbul
- **03** 21-22 September, Augsburg, Germany
RENEXPO
www: <http://www.renexpo.de/en.html>
twitter: #RENEXPO
- **04** 18-19 October, London, UK
Future Food-Tech
www: <http://www.foodtechlondon.com>
twitter: @foodtechinvest #FutureFoodTech
- **05** 21-23 October, Stuttgart, Germany
SÜFFA
www: <http://www.messe-stuttgart.de/en/sueffa>
twitter: @SUEFFA #SUEFFA17
- **06** 23-25 October, Paris, France
Food Processing & Technology
www: <http://foodtechnology.conferenceseries.com>
twitter: @foodtech_conf #FoodTechnology2017
- **07** 24-26 October, Moscow, Russia
PCVEXPO
www: <http://www.pcvexpo.ru/en-GB>
twitter: #PCVEXPO
- **08** 1-2 November, Copenhagen, Denmark
Building Green 2017
www: <http://buildinggreen.eu/cph/en>
twitter: @BuildingGreenDK #RetailWorld
- **09** 10-12 November, Thessaloniki, Greece
Hotelia
www: <http://hotelia.helexpo.gr/en>
twitter: @TIFHelexpo #Hotelia
- **10** 15-16 November, Berlin, Germany
Retail World 2017
www: <http://www.handelskongress.de/EN>
twitter: @handelskongress #BG18
- **11** 19-23 November, Gent, Belgium
Horeca Expo 2017
www: <http://www.horecaexpo.be/nl>
twitter: @HorecaExpo #horecaexpo
- **12** 5-7 December, Kiev, Ukraine
Fresh Business Expo
www: <http://www.freshbusinessexpo.com/en>
twitter: @FreshBusinessUA #freshbusinessexpo
- **13** 11-12 December, Berlin, Germany
EUREKA 2017
www: <https://www.eureka-hvacr.eu>
- **14** 13-14 December, Montpellier, France
EnerGaia
www: <http://energaia.fr/?lang=en>
twitter: @Energaia_ #Energaia17

EUROPE IN BRIEF

MARKET

EU maintains HFC ban in supermarket refrigeration

The European Commission on 4 August decided to maintain a ban on HFCs in multipack centralised commercial refrigeration as originally adopted in the 2014 EU F-Gas Regulation.

A regulation review clause requires the Commission to evaluate the feasibility of a ban on HFCs with a GWP of over 150 in multipack centralised refrigeration systems, foreseen to enter into force in 2022 (except in the primary refrigerant circuit of cascade systems, where HFCs with a GWP of up to 1,500 may be used).

To this end, the EU executive assessed the availability of cost-effective, technically feasible, energy-efficient and reliable alternatives to HFCs in this sector.

The Commission found no need to amend the original provision, finding sufficient evidence that today, alternative technologies are already on the market that comply with the future HFC ban.

These alternatives are cost-competitive today or will be by 2022, when the requirement enters into force, the EU executive found.

The Commission also found that concerns over efficiency in warm climates no longer apply to the most advanced CO₂ systems available today.

The report notes that the price gap between CO₂ transcritical and HFC-based systems is expected to close by 2022, based on feedback from equipment manufacturers and the superior efficiency performance of CO₂. ■ [Klara Skačanová](#)

RESEARCH

New EU project to remove barriers to NatRefs

The EU's new project 'Flammable Refrigerant Options for Natural Technologies – Improved standards & product design for their safe use (FRONT)' aims to remove "barriers posed by standards" for 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.

The project also seeks to increase the "availability of suitable alternatives" in those areas, by improving system design to address flammability risk and encourage the use of climate-friendly alternatives to f-gases.

LIFE FRONT seeks to combine existing and new evidence for a safe and proportionate use of flammable refrigerants, to transfer theoretical analysis into applied research, to apply risk mitigation mechanisms to real-life RACHP equipment, to influence on-going standardisation processes at the EU and international levels, and to remove knowledge barriers among major stakeholder groups.

It will result in Europe's largest leakage size and simulation database for equipment using flammable refrigerants. It will also seek to determine the extent to which it is safe to operate with higher charges of flammable refrigerant.

The project began in mid-June 2017 and work will continue until end-July 2020. ■ [Anti Gkizelis](#)

MARKET

Aldi to roll out CO₂ technology in all UK stores

On 15 August, German retail giant Aldi announced plans to convert all its UK stores to natural refrigerant CO₂. By the end of 2018, up to 100 outlets will be equipped with natural refrigerant-based systems at an investment of some €22 million (£20m).

Thanks to this strategy, Aldi will see a reduction in its potential refrigerant gas carbon emissions by 99%.

Mary Dunn, communications director at Aldi UK, said: "By choosing natural refrigerants, we are reducing our impact on the environment while also assuring our stores are future-proofed for years to come."

Up to 100 of Aldi's circa-700 UK stores are set to incorporate CO₂ refrigerant by the end of next year. All its existing UK stores will eventually be converted to CO₂.

"We are continually looking for ways to improve our environmentally friendly credentials, and upgrading our entire stores to energy-efficient refrigeration is a key part of our commitment to being a responsible retailer," said Dunn. ■ [Pilar Aleu](#)

Advansor Product Portfolio 2017 - Call or mail for further information

compSUPER XXS

Condensing unit
1350 x 1000 x 800 mm

- Small single weatherproof compressor unit
- Retail/Pharmaceutical 5 evaporators



compSUPER XXS

Mini-Booster
800 x 1000 x 2100 mm

- Small compact multi-compressor unit
- Discount/Convenience



compSUPER XS

ValuePack
2800 x 1900 x 800 mm

- Medium multi-compressor unit
- Supermarket/Convenience



compSUPER S/L

Dimensions upon request

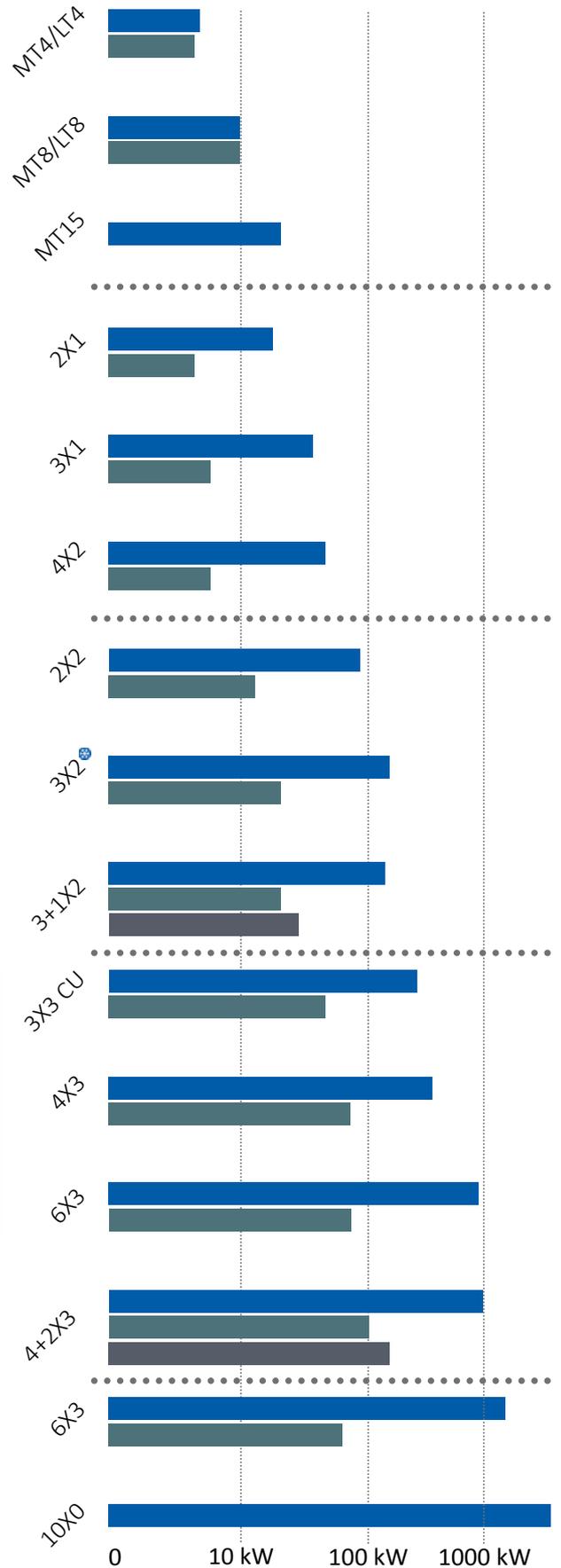
- Medium + Large multi-compressor unit
- Supermarket/Hypermarket



compINDUSTRI XL

Dimensions upon request

- Large + X Large compressor unit
- Industrial



⊗ 3x2 = 3 MT compressor and 2 LT compressor

■ MT / cooling capacity

■ LT / freezing capacity

■ AC / air condition capacity



EUROPE IN BRIEF

WORLD

Japan eases CO₂ regulation

On 25 July 2017, the Japanese government eased restrictions on CO₂ use. Stakeholders believe this signals a major shift in the perception of CO₂ refrigeration systems and may lead to widespread new adoption in Japan.

Under Japan's High Pressure Gas Safety Act, CO₂ has been reclassified from the most restrictive level of Group 3 to the least restrictive level of Group 1, removing significant administrative costs for users and manufacturers of CO₂ systems.

Businesses that handle refrigeration systems with a refrigeration capacity between 20 and 50 tons are now only required to submit a notification to their local government, rather than both submitting a notification and requesting permission.

Businesses that handle refrigeration systems with a refrigeration capacity of less than 20 tons are no longer required to submit any notification.

Japan's Ministry of Economy, Trade and Industry says the goal is "to contribute to the further dissemination of carbon dioxide refrigerants".

Hidekazu Tachibana, general manager in the refrigeration systems division of Panasonic, a pioneer in the domestic CO₂ market, said, "because CO₂ will now be regulated in the same group of high pressure gases as non-flammable HFCs, there are now significantly less barriers for end users when considering CO₂". ■ [Devin Yoshimoto](#)

RESEARCH

R32 production 'may be affecting ozone layer'

After last year's announcement that the ozone layer was healing, it has now been discovered that dichloromethane could delay that healing for 30 years as its use is increasing, according to Dr. Ryan Hossaini of Lancaster University in the UK.

Hossaini cites research by Dr. Emma Leedham Elvidge's team at the University of East Anglia and colleagues suggesting that recent growth in dichloromethane emissions may also stem from production leaks or deliberate venting when manufacturing R32 or difluoromethane from dichloromethane.

"This is a possible contributor to the observed increases in dichloromethane seen since the early 2000s. However, the overall cause of recent growth is still unknown," Hossaini says.

When in the atmosphere dichloromethane, according to Hossaini, has an average lifetime of only a few months until it breaks down and releases chlorine, which can destroy ozone if it reaches the stratospheric ozone layer.

Hossaini believes that by 2050, dichloromethane could account for "a quarter of all the chlorine in the lower stratosphere," thereby preventing it from healing.

Current forecasts in the New Scientist predict that the hole over the Antarctic should fill by about 2065, but ignore dichloromethane.

If emissions of this substance are included and its consumption increases at the same rate as it is currently, Hossaini thinks the healing of the ozone layer will not occur until 30 years later than expected. ■ [Charlotte McLaughlin](#)

WORLD

Industry waits for EPA's next move after US court ruling

Industry reaction to a federal court ruling on the US Environmental Protection Agency's (EPA) authority to regulate HFCs has so far been reserved as the EPA and intervening defendants contemplate their next step.

The US Court of Appeals for the District of Columbia Circuit ruled on 8 August in *Mexichem Fluor, Inc. v. EPA* that the EPA cannot require companies to replace HFCs designated for HVAC&R equipment or other applications with low-GWP substances under the SNAP (Significant New Alternatives Policy) programme.

While the ruling would appear to be a setback for low-GWP HFC replacements like natural refrigerants, several industry players said it was too soon to know its ultimate effect given the different directions the case or the EPA can still take.

"This decision is a temporary speed bump on the path to phasing down HFCs," said Avipsa Mahapatra, climate campaign lead at the Environmental Investigation Agency. "It is not going to stop the increasing global demand for future-proof solutions."

The Obama administration in 2015 extended the original SNAP programme – which only dealt with ozone-depleting substances (ODS) – to HFCs, which are non-ODS but have a high global warming impact. ■ [Michael Garry](#)

Nidec

All for dreams

ENERGY-OPTIMIZED PROPANE COMPRESSORS

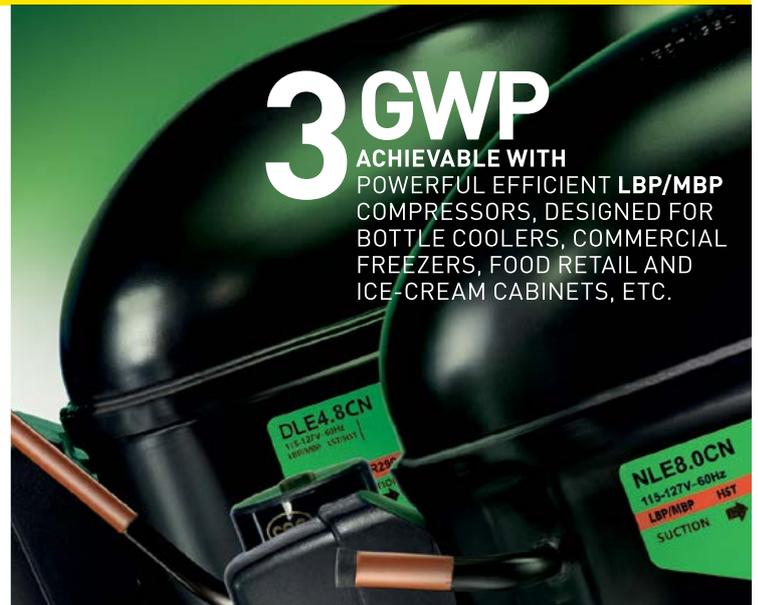
SECO

R290

DLE-CN COMPRESSORS
NLE-CN/CNL/MN, NLY-CN COMPRESSORS
SCE-CNL/MNX COMPRESSORS

3 GWP

ACHIEVABLE WITH
POWERFUL EFFICIENT LBP/MBP
COMPRESSORS, DESIGNED FOR
BOTTLE COOLERS, COMMERCIAL
FREEZERS, FOOD RETAIL AND
ICE-CREAM CABINETS, ETC.

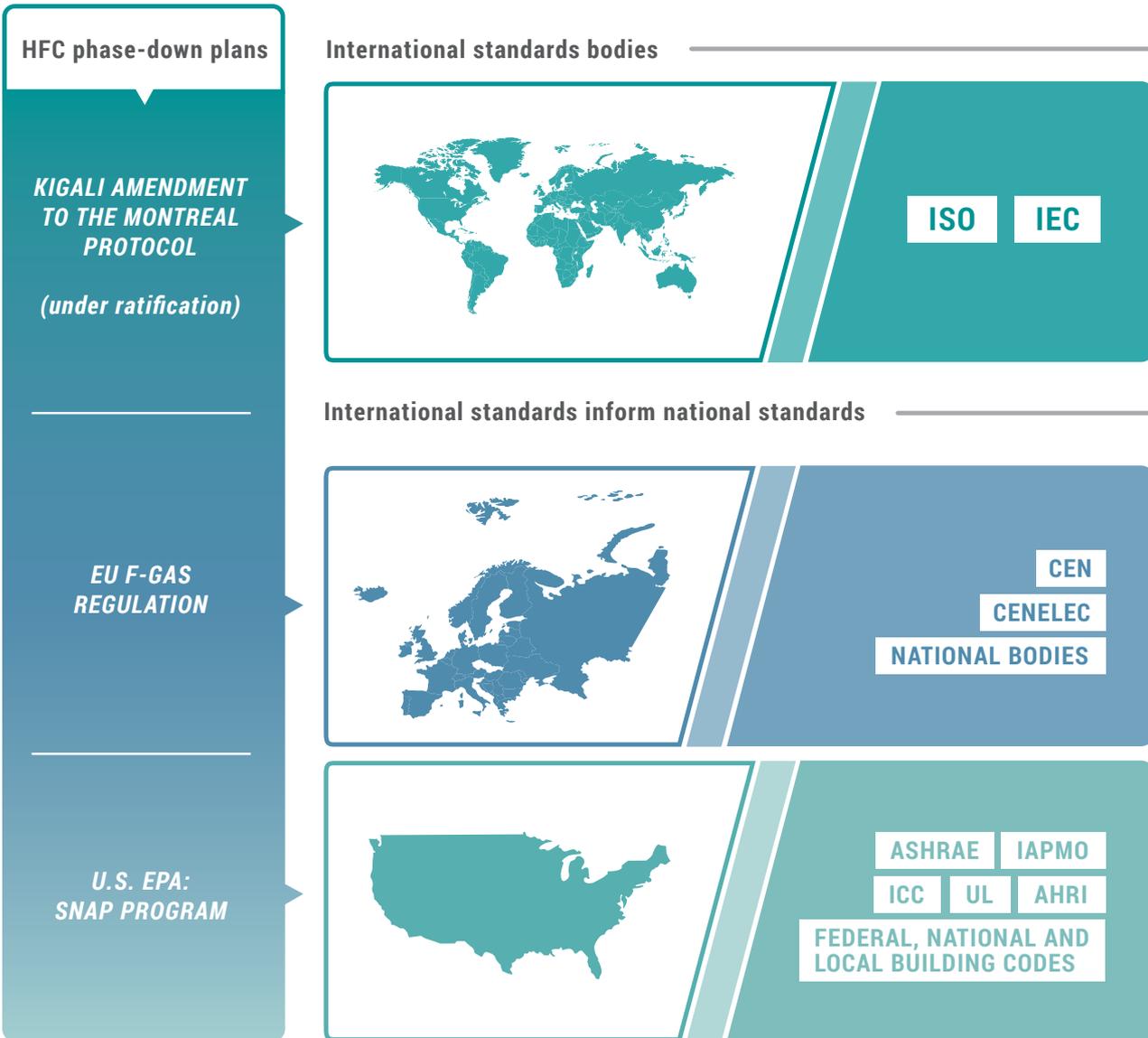


For more than 25 years, Secop has been developing highly efficient compressors working with hydrocarbons (R290 and R600a).

The new **DLE**, **NLE/NLY** and **SCE** compressors for R290 are tailored for commercial use and capable of replacing products made for high global warming potential (GWP) refrigerants such as R404A and R134a. With these compressors, Secop perfectly meets the increasing market demand for the highest efficiency while utilizing natural refrigerants with very low GWPs.

On August 1, 2017, Nidec successfully acquired the German compressor manufacturer Secop.

Driven by the HFC phase-down: Hydrocarbon standards revision



Hydrocarbon standards are being revised at the global level by the International Electrotechnical Commission (IEC) in two working groups

Alongside the IEC, many national and local standards bodies are also looking at revising their own standards.

COMMERCIAL REFRIGERATION

IEC 60335-2-89

May decide to move A3 (hydrocarbon) charge limit from 150g to 500g in 2018

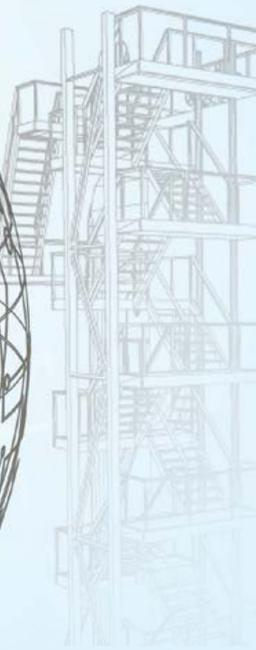
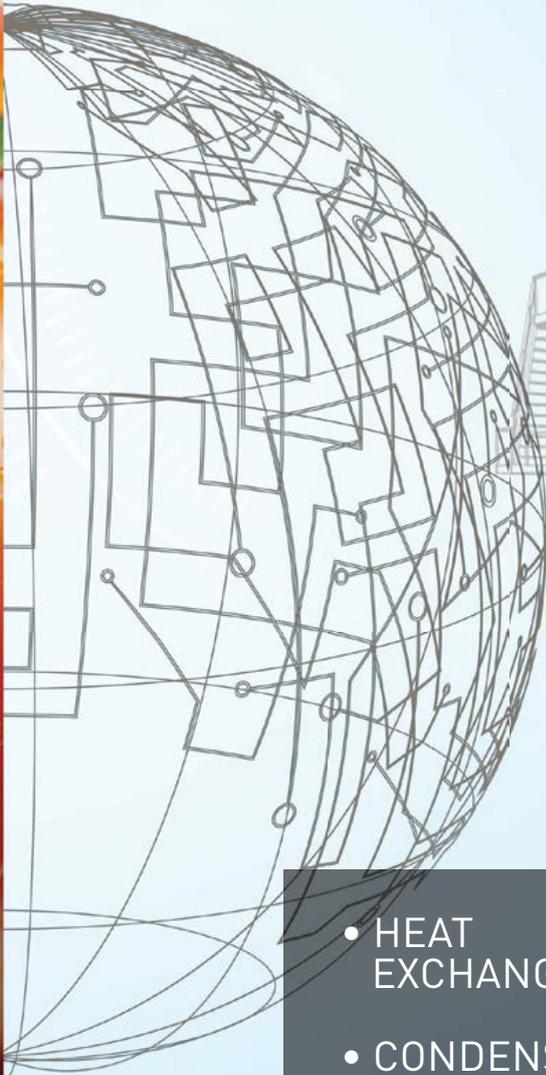
AIR CONDITIONING

IEC 60335-2-40

Possible increase of charge limits for A3s (hydrocarbons) and A2Ls (HFOs)

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- PACK SYSTEMS
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RIVACOLD
MASTERING COLD



Full steam ahead

To help it to reduce its greenhouse gas emissions and become a leader in climate technology, German rail giant Deutsche Bahn plans for its air conditioning in new trains to use natural refrigerants by 2020.

– By Charlotte McLaughlin



S-Bahn train on its way to Munich, Germany

As the world's second-largest transport company and Europe's largest railway operator and infrastructure owner – running two billion passenger journeys per year – Deutsche Bahn (DB) AG is acutely aware of its power to contribute to improving environmental sustainability. It boldly proclaims on its websites that it is an 'eco-pioneer', harnessing the latest technologies to reduce emissions – and natural refrigerants are one step along this journey.

The publicly-owned German company's rail network is 34,000 km long. DB operates 5,681 train stations and runs more than 40,000 train journeys every day.

Deutsche Bahn AG is aiming to reduce its group-wide specific CO₂ emissions from rail, road, air and ocean transport by 30% (compared to 2006 levels) by 2020 – under the framework of its so-called 'DB2020+' goal. "Every

day we're developing new technologies with the help of external companies, so that we can become leaders in the future," says Martin Hasnik, a project manager for technology management and development at RegioNetz Verkehrs GmbH ('RNV'), a small wholly-owned subsidiary of DB Regio, the rail arm of DB for regional transportation.

DB Bahn manages the Deutsche Bahn group's passenger travel activities within Germany. DB Bahn is divided into two business areas: DB Fernverkehr AG covering long-distance passenger journeys, and DB Regio AG for short and medium-distance passenger journeys, both of which are share-based companies and 100% subsidiaries of the group holding Deutsche Bahn AG.

Deutsche Bahn AG does not just include DB Bahn in its portfolio. It also oversees four other operations groups: Arriva (European regional transport), DB Dienstleistungen (services such

as heavy maintenance and cleaning), DB Netze (German national rail track), and DB Schenker (road logistics), to which its overall corporate sustainability goals also apply.

The group has been quite active so far. It has managed to reduce its CO₂ eq. emissions by 24.5% by 2015, exceeding its stated target of reducing them by 20% by 2020.

To run its trains, DB Bahn uses a staggering amount of electricity every year: the 12 terawatt hours represent a massive 2% of all the electricity consumed in Germany.

The Deutsche Bahn group is also aiming to increase its use of renewable energy. By 2020, it wants to raise the share of renewable energy to 45% – based on its own transporters. Currently, renewables make up 42% of the entire current traction mix (i.e. the energy that powers trains on the tracks).

The group is now aiming to buy and invest in more renewables to power even more DB Bahn trains. By 2050, DB Bahn wants to achieve rail transport that is completely CO₂ emission-free.

NatRefs on board

For DB Bahn, one way of achieving the sustainability goals in the DB2020+ corporate strategy is to use natural refrigerants in its air conditioning in all new trains.

“We developed the air con to make a contribution to climate goals. These are set from the government but also in our company under DB2020+,” says DB’s Hasnik.

The German government owns Deutsche Bahn AG, along with the subsidiary DB Bahn, but the group has operated as a joint stock company since it was founded in January 1994 following the reunification of East and West Germany.

This does not mean the German government grants DB Bahn subsidies to install natural refrigerant-based air conditioning (AC), says Hasnik. “We have an internal budget for technology to test and install natural refrigerant-based air conditioning,” he says.

The global warming potential (GWP) of the refrigerant used by DB Bahn at the moment, R134a, is approximately 1,300 times that of one unit of CO₂. Replacing R134a with natural refrigerant CO₂ will significantly reduce the company’s emissions. “Because we use CO₂ as the only refrigerant gas, our emission savings are 100% compared to R134a,” Hasnik says.

Currently, there are an estimated 230 DB Bahn trains in Germany fitted with R134a air conditioning. Many of the group’s trains are yet to be fitted with air conditioning.

From 2020 onwards, it plans for the air conditioning in all its new trains to use natural refrigerants. The desire to improve sustainability is not DB Bahn’s only motivation for choosing natural refrigerants. The company is well aware of the HFC phase-down

implications of the EU’s F-Gas Regulation. “It’s a mixture for us. The company wants to reach the goals of DB 2020+ and limit our emissions [...]. F-Gas is coming and we need to adjust to that as well,” Hasnik says.

The EU F-Gas Regulation does not directly apply to trains, but in phasing down HFCs it will most certainly limit the availability of R134a. DB Bahn’s use of natural refrigerants will also aid Germany’s commitment under the EU F-Gas Regulation to reduce the production and use of f-gases by 80% by the year 2030, according to Germany’s State Secretary for the Environment Jochen Flasbarth.

Sweeping away the leaves on the track

Natural refrigerants, then, are an important step towards the final destination. But it has been a long journey for Deutsche Bahn to develop a modular CO₂ AC system specifically designed for trains.



Deutsche Bahn headquarters in Potsdamer Platz, Berlin, Germany



The CO₂ heat pump runs on DB Bahn's short and medium-distance Regio line in the Erzgebirge Mountains of Saxony, Germany.



"[Since 2015] we've been developing air con with CO₂ as the refrigerant together with an industrial partner, which is the first time it has been engineered in trains," Sören Claus, who is head of technical development at RNV and has worked on the project since the beginning, told *Accelerate Europe*. "Sadly, one important partner dropped out [at the beginning of the project], so we were forced to find a new partner for development [...]. This taught us an important lesson."

One of the difficulties that DB Bahn has faced since the beginning is that not enough companies in Europe have been manufacturing CO₂-based air conditioning for trains and buses. "We have to wait and see how this develops," Claus says. "We have already invested heavily into this ourselves and we hope it will get more competitive."

Now DB Bahn is working with several innovative German companies in

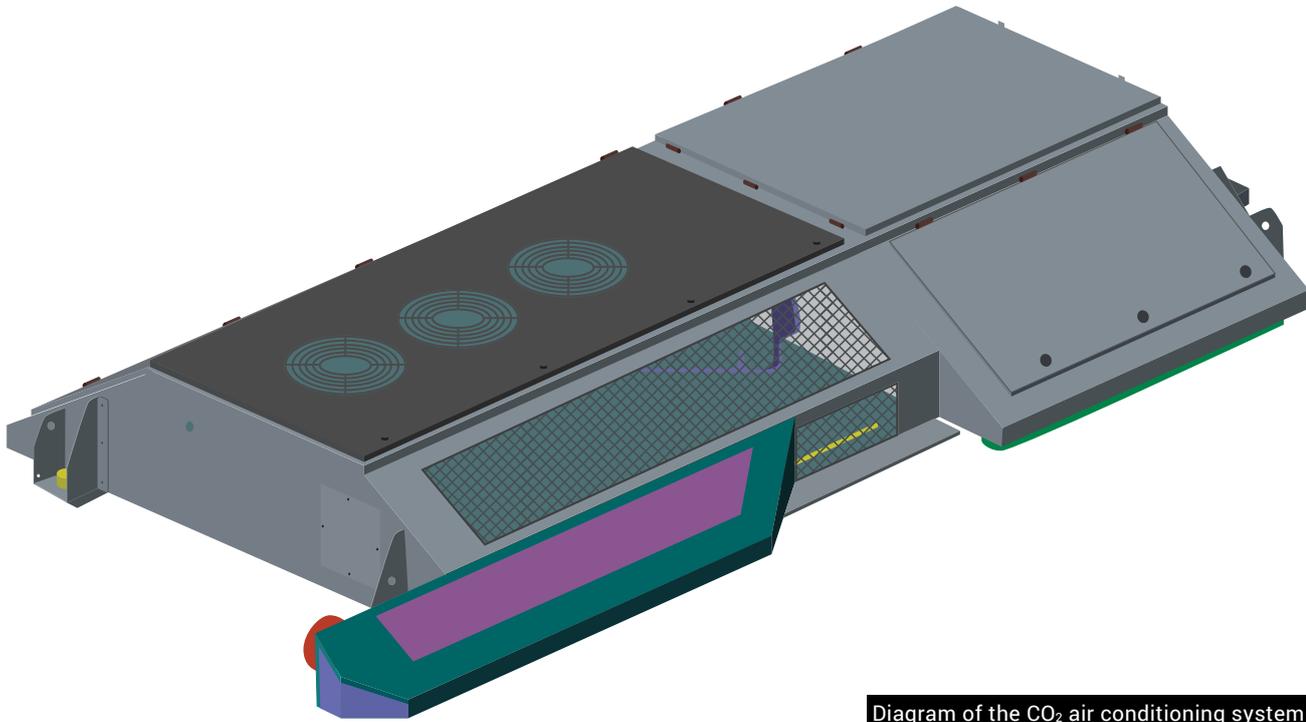
the transport refrigeration and air-conditioning business, including Konvekta, Wabtec (previously Faiveley Transport Leipzig GmbH), UPEC Industrial Group, Liebherr and Vossloh.

"The old AC was mechanical. [Now with CO₂] it is completely electrified, making it very easy to implement. It's better for the business," Hasnik says.

The project has taken time to come to fruition. A number of tests and phases are necessary to ensure that the technology is truly future-proof.

"We are now in our third and final phase," Claus says. This final phase is to measure the CO₂ system's performance in a climate test chamber. "We have had no major failure so far," he says.

If DB Bahn is to adopt the CO₂ technology, then not only must it function properly in trains – it must also be better than

Diagram of the CO₂ air conditioning system

the previous system installed. "One common complaint from customers is that the air con isn't working, or that it makes them too cold. It's an intense topic in Germany," Hasnik explains.

"Additionally, we added a complete new air distribution to the train so that the passengers do not get cold feet and a warm head," Claus says. "A balanced air conditioner for the whole train was as important as the carbon footprint being reduced by using natural refrigerants."

The first DB Bahn train to be fitted with CO₂ air conditioning was a Siemens VT642 train, in Chemnitz (Saxony) in 2016. "This is an inter-regional train with a max speed of 120 km/h," he explains.

The CO₂ AC system is designed to withstand speeds of up to 160 km/h.

The innovative HVAC project has produced good results so far. "Our energy savings are about 10% compared to R134a in our old trains. Much more is possible, if we install our product in a new train," he argues. DB Bahn also expects to see lower lifecycle costs compared to the older systems that use R134a.

The new 'Eco-train' concept

DB Bahn has installed another similar system, manufactured by Vossloh, on its so-called 'EcoTrain'. It uses a modular technology platform with a hybrid electric drive system, and

an environmentally friendly CO₂ air conditioning system with a heat pump.

The project, funded by the federal government, operates on electricity. It is more energy-efficient, quieter and generates up to 35% less CO₂ than most trains. "This is an environmentally friendly, intelligent hybrid train which also uses this new air con," Hasnik says.

The CO₂ heat pump runs on DB Bahn's short and medium-distance Regio line in the Erzgebirge Mountains of Saxony, Germany.

It also uses a frequency-controlled compressor and an electronic expansion valve, which add to the energy efficiency of the CO₂ AC system.

The train boasts four CO₂ air-conditioning units that also can be used as heat pumps, each with a heating capacity of 24 kW and a cooling capacity of 20 kW.

Endless innovation

DB Bahn has also invested in a new system that uses air circulation to provide cooling.

Since 2015, the BMUB (Federal Ministry for the Environment) and Deutsche Bahn have been testing the system – installed by Liebherr Transportation – on the ICE 3 train 'Freiburg im Breisgau', named after the famous town in the Black Forest in southern Germany.

The cold-air systems take process air from the surroundings and expand it with a cooling turbine. The pressure reduction results in lower temperatures, which cool the passenger compartment via an air-air heat exchanger. Finally, the process air is re-compressed to ambient pressure and released again.

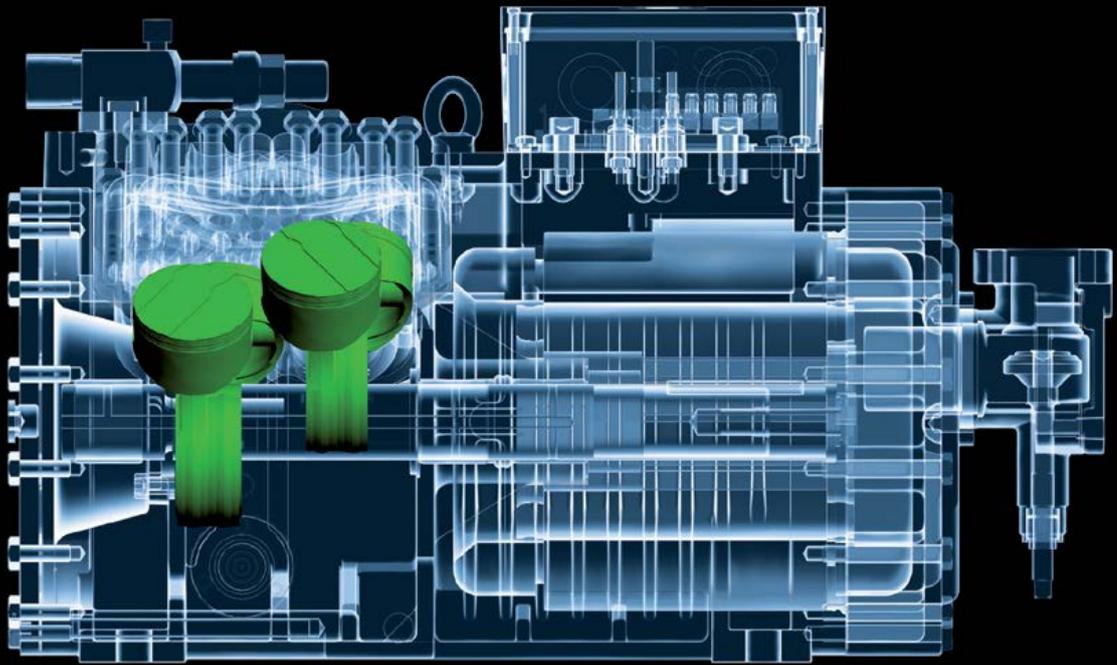
Deutsche Bahn and the BMUB's data from the test project revealed that the new air-based technology is a probable alternative solution, as it runs without polluting refrigerants and is easy to maintain. Further testing is needed to confirm whether it is more cost-effective over its life cycle than f-gas alternatives.

Claus predicts that, "both systems will be found [on our trains] in the future," but notes that the air-based system is a little more complicated to fit in trains.

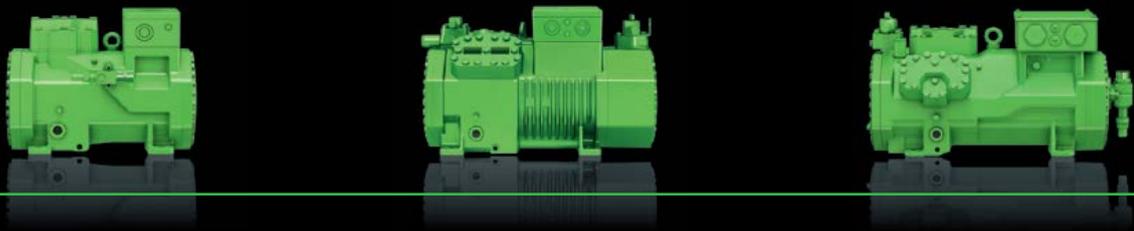
"An air system is actually heavier because of higher operating pressures, so you won't find it in city trains or buses," he says.

DB Bahn wants to expand the technology further and hopes other train companies in Europe will get on board the NatRef train. "We want to share our knowledge [..], so the technology is less expensive," Hasnik says.

If more train companies buy a ticket, then CO₂ MAC may soon pull into a station near you. ■ CM



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THE HEART OF FRESHNESS



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

Conquering new frontiers

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

— By Andrew Williams



Delivery trucks at the ready

Photography: Anna Salhofer

Away to the south, the gleaming towers of Canary Wharf shimmer in the summer heat. To the north, the graceful lines of Sir Anish Kapoor's Orbit reach for the stars in the Queen Elizabeth Olympic Park. Amid these gleaming temples of modernity, small wonder that Sainsbury's chose this inspirational site on the banks of the River Lea to house its brand new online fulfilment centre.

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

The future of shopping

Fast-forward to 2017, and Sainsbury's is at the head of the pack once again. Its new online fulfilment centre (OFC) in east London is entirely dedicated to serving the UK's burgeoning online retail trade.

Brits are flocking to online shopping in their droves as already busy lifestyles become busier still. Online grocery sales in the UK are forecast to reach £11.1 billion (€12.3 bn.) in 2017, up from an estimated £9.9

billion (€10.97 bn.) in 2016, according to research from Mintel, a leading market intelligence agency.

The online grocery market is forecast to grow by 12% this year, meaning that the value of virtual shopping trolleys is growing at a faster rate than their physical counterparts. Online grocery sales rose by an estimated 15% in 2016, when total food retail sales grew by just 1.5%.

In Bromley-by-Bow, Sainsbury's is looking to stay ahead of this curve. The OFC is a unique environment. Without a single customer on the premises, Sainsbury's refers to it as a 'dark store'. The site serves online shoppers across north and east London, from Camden to West Ham.

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

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



Teams of pickers assemble customer orders in shifts

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

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

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

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

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

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

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

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

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

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

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

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

"GEA was our existing installation and service provider," he says. "They worked in conjunction with one of our commercial refrigeration contractors, who commissioned

Sainsbury's at a glance



162,700 employees
(2016)

Founded in 1869 by John James Sainsbury.

First store opens in Drury Lane, Holborn, London.

Headquartered in **Holborn, LONDON.**



1,415 stores
(May 2017)

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



the frozen and produce cabinets, while GEA did all the commissioning of the refrigeration system."

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

The CO₂ subcritical DX package serving all the frozen food areas, utilising the pumped CO₂ as a condensing medium, is an efficient means of meeting this refrigeration requirement. Like the primary ammonia system, the refrigeration duty is provided by two compressors with a third compressor on standby.

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

The consultant also looked into using an ammonia-only or a CO₂ transcritical system. It was the ammonia-CO₂ configuration that came out on top, based upon a 'balanced scorecard' approach of total equivalent warming

impact (TEWI), energy efficiency, capital cost, and colleague safety perspectives.

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

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

The site remains Sainsbury's most recent and this is the model that future such sites will follow.

Natural refrigerants 'part of our DNA'

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

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

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

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

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

The supermarket giant operates 1,415 stores across the United Kingdom (May 2017 figure). It currently boasts 216

CO₂ transcritical supermarkets among its portfolio. It also has eight convenience stores with natural refrigerants – seven with CO₂ booster systems, and one with a hydrocarbons-glycol configuration.

Arrowsmith sees scope for hydrocarbons to play a greater role in future. “Some of our more challenging locations might be multiuser developments – if you’ve got domestic residents or share services with other trades, they might not necessarily want CO₂ at 80-90 bar in those areas, so we’re also trialling hydrocarbons used in conjunction with a glycol system,” he reveals.

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

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



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





The refrigeration system was commissioned by GEA

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

A changing urban landscape

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

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

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

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

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

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

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

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

For Arrowsmith, one highlight of his job is the number of interesting people and places he gets to see. “It’s a good balance between my desk, and travelling up and down the country,” he says. “We also do a lot of work with academics.”

One often-cited barrier to wider market penetration of natural refrigerant-based HVAC&R systems is a reported shortage of components, particularly for more complex CO₂ systems. Major end users like Sainsbury’s therefore have the power to change the market by placing large orders. Procurement on this scale also helps to reduce the cost of natural refrigerant-based solutions by virtue of economies of scale.

“Initially we saw a cost premium for CO₂, but after working with our suppliers and



Above and below: The system uses natural refrigerants ammonia and CO₂



▶ as the technology has become more mainstream, the cost difference has eroded away," Arrowsmith argues.

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

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

"Componentry now, for Sainsbury's and for our supplier base, is business-as-usual," he says. "There is no problem finding suppliers. Yes, there are new components and emerging technologies like ejectors and parallel compressors, which we evaluate. But availability of system components is not an issue."

With natural refrigerants becoming increasingly mainstream HVAC&R options to help the European food retail sector to comply with the HFC phase-down taking place under the EU's F-Gas Regulation, installers are becoming more comfortable with the technology and suppliers are more supportive.

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

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

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

The shadow of Brexit

Like in many other policy areas in the UK, the shadow of Brexit looms large over any discussion of environmental policy. Does Arrowsmith expect the UK's upcoming departure from the European Union to affect Sainsbury's f-gas strategy?

"As far as participation in the EU's F-Gas Regulation is concerned, I think the uncertainty might be in the allocation of production quotas," he says.

Asked whether Brexit would weaken Sainsbury's commitment to natural refrigerants, Arrowsmith was firm: "No! We've signed up to the Consumer Goods Forum and their Resolution on Refrigeration, and we're aligned to that."

In 2010, the Consumer Goods Forum – which brings together over 400 consumer goods manufacturers seeking to pursue more sustainable business practices – adopted its first resolution to replace HFCs with natural refrigerants. It reaffirmed this commitment with a second resolution in 2016.

Does the new generation of synthetic refrigerants or HFOs also have a role to play? "We only use HFOs as part of our f-gas exit strategy," Arrowsmith explains.

"The cost of R404A is rising, so we have the option of replacing it with a lower GWP refrigerant and recycling the R404A for use in other existing systems. When the plant reaches the end of its useful life or when we do a major refit on the premises, we take it out and replace it with a natural refrigerant system."

More exciting projects in the pipeline

Fresh from the experience at Bromley-by-Bow, Sainsbury's is planning to implement similarly innovative sustainability projects in other locations.

Next summer, the retailer hopes to open a new frozen food distribution depot in Northampton. The new facility, which is replacing an existing depot, will feature an ammonia-based refrigeration system, a combined heat and power plant, and an absorption chiller.

Sainsbury's is also trialling natural refrigerant trailer units for its delivery trucks. In April 2016, it became the first customer in the world to receive Carrier Transicold's prototype transport refrigeration system based on CO₂ refrigerant.



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

► The April delivery was the first of three units to join Sainsbury's fleet in 2016 as part of a three-year technology field trial.

"The beauty of Carrier Transicold's prototype trailer unit is it delivers a massive reduction in f-gases by using a natural refrigerant," says Gary King, Sainsbury's operations support manager. "This will directly help us to achieve our ambitious environmental and sustainability goals, whilst delivering a seismic leap forward in terms of sustainability within the cold chain."

The current trial builds on the success of a 2013 pilot, which saw the supermarket operate a modified road-ready version of Carrier Transicold's NaturalLINE refrigeration system for ocean containers.

The 2013 pilot was the first natural refrigerant-based truck operating anywhere in the world.

Sainsbury's sees its adoption of natural refrigerants as part of a wider sustainability strategy encompassing a number of different areas.

To complement the efficiency gains delivered by natural refrigerants, the retailer is working with a company called Aerofoil Engineering – which is involved with the Williams F1 team – to help reduce energy consumption still further.

"It's simply about putting an aerofoil on the front edge of the display cabinet shelving, so that it stabilises the air curtain," Arrowsmith says. "We're seeing a reduction in the energy consumption of our refrigeration plants, and we're reducing the cold spill into our supermarket aisles – so the temperature for the customers is 2-3°C warmer."

To date, Sainsbury's has installed 173,000 photovoltaic panels across 239 sites. It has also fitted LED lighting in 308 supermarkets and 342 convenience stores. Thirteen stores boast combined heat and power (CHP) plants operating on biomethane certified by the Green Gas Certification Scheme, which is run by a subsidiary of the Renewable Energy Association. 97 biomass boilers have been installed across its store portfolio.

The retailer uses ground-source heat pumps in conjunction with CO₂ and HFCs, ranging from 300-500 kW, across 32 sites.

"It's a broader picture – we're not just focusing on refrigeration," Arrowsmith confirms.

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

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

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

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

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

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

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

Photography: Ben Beech



Dario Ferlin, Woolworths' sustainable innovations engineer

Woolworths' first transcritical CO₂ store: Building NatRef momentum in Australia

On 16 May retail giant Woolworths opened its first transcritical CO₂ store, in Colebee, New South Wales. Designed for ambient temperatures of up to 45°C, fitting the robust system has helped to train local HVAC&R talent along the way, laying the foundations for future growth of natural refrigerant-based HVAC&R systems in Australia. *Accelerate Australia & NZ* reports.

– By Devin Yoshimoto & Andrew Williams

A single bottle of champagne sat on a bottle cooler shelf in an empty walk-in cool room. The rest of the 3,200m² supermarket was virtually empty of stock.

Two weeks before the grand opening of Woolworths' new store at Greenway Village mall in Colebee, New South Wales, *Accelerate Australia & NZ* toured the facility with Dario Ferlin, Woolworths' sustainable innovations engineer, alongside other key team members Shaun Merry, national installations manager for the Woolworths design and installation team, Jim Dowling, Woolworths senior refrigeration field engineer, and Gary Howle, system commissioner.

"You'll notice that somebody's already put out a bottle of champagne," remarks Ferlin with a smile.

No doubt Ferlin and the rest of his team later cracked open the bubbly in celebration of Woolworths' first transcritical CO₂ store, which is now open to trade.

The pilot transcritical CO₂ system is certainly a great technological achievement: it is designed to operate in ambient temperatures of up to 45°C reliably and efficiently, incorporating the latest in commercial refrigeration technology innovation.

"This journey has taken quite a number of years to get to where we are today," Ferlin explains. "But along the way, there have been quite a few learnings, all with the view to developing, what we believe, is the best the world can offer for the Australian environment."

It is not just the technical achievements that make the system so remarkable.

As Ferlin led the *Accelerate Australia & NZ* team around the facility, he revealed the true significance of Woolworths' pilot transcritical CO₂ system.

"This isn't about simply opening up a store successfully and then walking away. This is about building up the skill sets in the industry. It's about sparking creativity and imagination – with other contractors and other retailers – so we can start the ball rolling," says Ferlin.

From the outset, Ferlin and his team recognised the opportunity to use the development of this store to help move Australia's wider HVAC&R industry forward.

"We used, almost exclusively, local technology providers," says Ferlin, "which meant the R&D, the development and the support was all done locally. It also means the day we open to trade, that skill set is still around. It's available for the next store – or our competitor's next store."

Woolworths' first transcritical CO₂ store, Ferlin explains, was just an early but important step towards the wider HVAC&R industry's evolution to an HFC-free future.

"This is what I mean about the momentum after the store opening," says Ferlin. "We're opening up a new horizon to the industry and it goes beyond the conversation limited to this store alone. That's exciting."

Towards an HFC-free reality

Woolworths' industry-leading sustainability initiatives began more than ten years ago.

In 2006, Woolworths released its 2007 to 2015 sustainability strategy, which targeted a reduction of carbon emissions by 40% – an ambitious target and a remarkable achievement, which the company hit in 2015.

The conversation about Woolworths' pilot transcritical CO₂ system began in 2010, when it became a signatory to the Consumer Goods Forum agreement to phase out the use of high-GWP refrigerant gases, announced on the first day of the UN climate talks in Cancún, Mexico. It was at this time that Woolworths committed to begin phasing in HFC-free supermarkets.



From left to right: Jim Dowling, Woolworths senior refrigeration field engineer / John Nemet, senior installation technician / Dario Ferlin, Woolworths sustainable innovations engineer / Gary Howle, system commissioner / Shaun Merry, national installations manager for Woolworths D&I team

In 2017, Woolworths doubled-down on that pledge by announcing its '2020 Corporate Responsibility Strategy' – which aims to reduce carbon emissions by an additional 10% below their 2015 levels by the year 2020.

Natural refrigerant systems are key to delivering this strategy. "By 2020, we will install ten natural systems employing technologies such as transcritical CO₂ or water-loop," reads the statement.

The path leading towards Woolworths' first transcritical CO₂ system became an opportunity to push not just Woolworths itself, but the whole commercial refrigeration industry ecosystem, towards an HFC-free future.

In light of Australia's impending HFC phase-down – beginning January 2018 – the wider need to upskill the entire industry has also become immediate and apparent.

Investing in local

Investment in upskilling the local industry began with stakeholder engagement – "one of the key pieces for me and my team coming in to this project," says Merry, national installation manager at Retail FM, a wholly Woolworths-owned subsidiary that served as the installation contractor for the project.

"On this job, everyone was coming along for the same trip," says Merry. "The case manufacturers, the rack manufacturers, the electricians, the people who do the architecture for the controls, have all worked together to get here."

The collaborative approach helped establish local transcritical CO₂ know-how. "This exchange – this ongoing dialogue between stakeholders – meant that the knowledge base, collectively, was increasing," Ferlin says.

"It's not only about the technology. It's about creating a momentum within the industry and bringing it with us, not just going on a journey on our own," adds Merry.

Australian tailor-made solution

Woolworths' pilot transcritical CO₂ system is unique in that it is designed for ambient temperatures of up to 45°C, with a view to replicating it almost anywhere in Australia.

"This is a template, which we aim to replicate. One that is robust, energy-efficient, and simple to service in the years to come," Ferlin says.

The system consists of two independent racks, each one serving 50% of the freezer load and 50% of the medium temperature load.

The main challenge lies in managing flash gas – a side effect resulting from the operation of the system in transcritical mode on hot days. Managing this is key to maintaining the system's efficiency and reliability in Australia's blistering summer temperatures.

"This plant room, in the middle of summer," explains Ferlin, "could very easily get to 40 or 45 degrees."

The solution chosen to manage the high proportion of flash gas was the use of parallel compression – a well-known flash gas management method tested in several transcritical CO₂ systems around the world.

That method comes with its own challenges. "We took that step in full knowledge that it would add complexity and cost, but create a very good template which we could then replicate almost anywhere in Australia," Ferlin says.

Just the beginning

Greenway Village is just a pilot store, laying the groundwork for Woolworths to roll out ten CO₂ transcritical stores in Australia by 2020.

"We were really driven by the objective of getting momentum happening within the industry," Ferlin says.

His conviction is firm, and no doubt necessary, in order to continue driving Woolworths – and the rest of the industry – forward towards an HFC-free future.

"We are facing a reality now where HFCs are going to be phased out. So we, as an industry, have to start taking measures towards that HFC-free environment. We need to start investing in upskilling the industry now," Ferlin says. "I believe this is what we're doing here." ■ **DY & AW**



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Natural refrigerants set for Berlin stage

The key movers and shakers driving uptake of natural refrigerants in Europe will be in Berlin on 25-27 September for the eighth edition of ATMOsphere Europe and the first-ever *Accelerate Europe* awards. Conference participants in the German capital will hear about cutting-edge technology case studies, new applications, end user perspectives, and policy and market developments.

– By Pilar Aleu & Eda Isaksson

Europe ranks among the world's most developed markets for natural refrigerant-based HVAC&R solutions. Germany itself is home to many of the continent's most important manufacturers and end users. They will showcase the German-speaking world's major influence in the world of natural refrigerants during a special session at this year's ATMOsphere Europe on 'NatRefs: Lessons Learned from the German-Speaking Market'.

A growing number of European end users are seeking HVAC&R solutions that will make their businesses more efficient and environmentally friendly, pushing manufacturers to develop more innovative technologies – all within the regulatory framework of the EU's F-Gas Regulation and the global HFC phase-down.

The central role that natural refrigerants will play here is already reflected in the impressive number of CO₂ installations in Europe: according to research by shecco, publisher of *Accelerate Europe*, there are over 9,000 transcritical CO₂ stores in Europe today – an increase of almost 50% compared to the 5,500 stores in 2015.

While ammonia has long been the go-to solution for industrial applications, today it is facing competition from other natural refrigerants, with CO₂ making inroads into large industrial applications such as Staa Food Group's new lettuce processing plant in the Netherlands or a new ice rink in Mechelen, Belgium.

Hydrocarbons are definitely a rising star of the natural refrigerants stage. They stand ready to take on a wider range of applications if charge limits – currently under review in many European countries and worldwide – are increased. Hydrocarbons' rise to fame will be reflected in the first-ever ATMO Europe session dedicated solely to these natural refrigerants, during which manufacturers will showcase their latest projects and technologies.

First-ever *Accelerate Europe* awards

The first-ever *Accelerate Europe* awards ceremony, recognising the end users that are doing the most with NatRef solutions in Europe, is a major highlight of this year's conference. A Person of the Year and an Innovation of the Year will also be named.

The full spectrum of applications of different natural refrigerants will be presented in case study sessions, including commercial refrigeration for small and medium-sized stores, industrial installations, heat pumps, HVAC, and more.

End users in the spotlight

End users will also share their expertise with different natural refrigerants. As always, an essential aspect of this year's ATMO conference is retailers' perspectives: key European players Ahold Delhaize, Metro AG, Colruyt, Sainsbury's, ICA Sweden and Walgreens Boots Alliance will be on stage to share their experiences, the challenges they have encountered in implementing natural refrigerant-based solutions and how they overcame them, and current and future projects.

Boots, the leading UK pharmacy chain, will present its natural refrigerants journey, from feasibility work on systems based on natural refrigerants such as propane/propylene and CO₂, to various pilot projects that are being developed, says Adeleke Ige, Boots' technical engineering manager.

The conference will convey the message that NatRefs are an option no matter what the application, and that competition is growing between different natural refrigerants in different applications. The current trajectory suggests that NatRefs are here to stay – and yet the market is developing at different speeds. While they are already standard solutions in western and northern Europe, there are still untapped opportunities in southern and eastern European countries, usually due to misconceptions related to system performance, efficiency and lack of suppliers or training. ATMOsphere Europe in Berlin acts as a bridge between these markets and a meeting point to share experiences and knowledge.

The regulation and standards session is a must-attend panel with speakers from the European Commission, national governments, and other significant organisations. A notable speaker in this session is Florian Veyssilier of the French Ministry of the Ecological and Inclusive Transition, given that France is poised to join other European countries like Denmark, Slovenia, Spain and Norway in introducing a tax on HFCs.

Transport, another hot discussion topic in the natural refrigerants sector, is integrated into the conference programme with exciting presentations from Deutsche Bahn, Wabtec, Cemafruid, Konvekta and Dearman, highlighting the opportunities and challenges for NatRefs in trains and road transport.

As always, an essential aspect of this year's ATMO conference is retailers' perspectives: key European players Ahold Delhaize, Metro AG, Colruyt, ICA Sweden and Carrefour will be on stage to share their experiences, the challenges they have encountered in implementing natural refrigerant-based solutions and how they overcame them, and current and future projects.

The conference will end with the EDEKA Group, one of the largest German supermarket chains, opening the doors of its CO₂-cooled EDEKA Specht store in Ludwigsfelde, Berlin for a visit organised by system provider Epta. ■ PA & EI



ATMO sphere

Business Case for Natural Refrigerants

25-27/09/17 - Berlin

PROGRAMME

DAY 1 - Monday 25 September

10:00 / Pre-Event Workshop

SuperSmart + shecco

12:30 / Registration and Welcome Lunch

13:30 / Welcome and Introduction

14:00 / Thought Leaders Panel

Nestlé, Metro AG, AHT, Panasonic, Energi & Kylanalys and ISECO

15:30 / Networking Break

16:00 / Market Trends & Opportunities Panel

*Norwegian University of Science and
Technology (NTNU), Carrier, TEKO, Mayekawa,
Madine, Johnson Controls and shecco*

18:00 / Networking Reception

Sponsored by SCM Frigo

DAY 2 - Tuesday 26 September

08:00 / Networking Breakfast

08:30 / NatRefs - Lessons Learned from
the German-Speaking Market

*German Federal Ministry for the Environment,
Nature Conservation, Building and Nuclear Safety,
German Environment Agency (UBA), Metro AG, AHT,
Öko-Recherche, Frigo-Consulting and efficient energy*

10:30 / Networking Break

11:00 / Parallel Sessions

CASE STUDIES: SMALL AND MEDIUM-FORMAT COMMERCIAL REFRIGERATION

*SCM Frigo, Frigo-Consulting, Advansor,
Panasonic, Viessmann and Emerson*

CASE STUDIES: INNOVATION

*Carrier, Epta, Arneg, CAREL,
HB Products and RLS*

HEAT PUMPS

*European Heat Pump Association (EHPA) (chair), TripleAqua
by Unichemie, SANDEN, Secop and Witteveen & Bos Deventer*

12:30 / Networking Lunch

14:00 / Parallel Sessions

INDUSTRIAL REFRIGERATION PANEL

*Colruyt, LU-VE, Frigo Consulting,
GEA and efficient energy*

TRANSPORT WORKSHOP

*Deutsche Bahn, Faiveley,
Cemafroid, Konvekta and Dearman*

CASE STUDIES: COMMERCIAL REFRIGERATION

*Carrier, SANDEN, TEKO, WURM, Danfoss and
University Braunschweig - Institute of Technology, Eliwell*

16:00 / Networking Break

16:30 / Parallel Sessions

CASE STUDIES: HYDROCARBON COMMERCIAL REFRIGERATION

*Embraco, CAREL, Eliwell, Huayi
Compressor Barcelona and Tecumseh*

CASE STUDIES: INDUSTRIAL REFRIGERATION

*Sainsbury's, Profroid, SCM Frigo,
Dorin, Advansor and Euroklimat*

CASE STUDIES: HVAC

*Norwegian University of Science and Technology (NTNU) (chair), GEA,
Kawasaki Heavy Industries, United Nations Development Programme (UNDP)
& MyasoMoMontazh OJSC, GIZ and UPEC Industrial Group*

19:30 / Networking Dinner and Accelerate Europe Awards Ceremony

Sponsored by Carrier

DAY 3 - Wednesday 27 September

08:00 / Networking Breakfast

09:00 / Parallel Sessions

FOOD RETAIL PANEL

*Ahold Delhaize, Walgreens Boots Alliance, Metro AG,
Colruyt and ICA Supermarket Sweden*

TRAINING

*Air Conditioning Refrigeration European Association (AREA), Bitzer,
National Environment Agency of Gambia, Aeres Tech and shecco*

11:00 / Networking Break

11:30 / Policy & Standards Panel

*French Ministry of Ecological and Inclusive Transition,
Environment Agency Austria, European Environmental Citizens'
Organisation for Standardisation (ECOS), European Environment
Agency (EEA), Environmental Investigation Agency (EIA) and shecco*

13:00 / Conclusions and Farewell Lunch

14:00 / Post-Event Site Visit to EDEKA Store, Ludwigsfelde

Organised by Epta

Programme subject to change.



ATMOsphere

Business Case for Natural Refrigerants

25-27/09/17 - Berlin

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Piazza del Duomo, Milan

HVAC&R innovation in trendy Milan

The 'XVII European Conference' on the latest refrigeration and air-conditioning technologies demonstrated how technological and regulatory developments are helping to boost uptake of natural refrigerants in the HVAC&R sector worldwide.

– By Charlotte McLaughlin & Anti Gkizelis

The XVII European Conference on the latest refrigeration and air-conditioning technologies took place in the Italian city of Milan on 9-10 June 2017.

The conference was organised by the United Nations Environment Programme (UNEP), the International Institute of Refrigeration (IIR), Italian refrigeration association *Associazione Tecnici Del Freddo*, Italian refrigeration study centre *Centro Studi Galileo*, the European Energy Centre, and the European Centre of Technology.



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“We welcomed the participation of 250 experts and delegates from 30 countries and four continents at the 17th European Conference, united by the will to ensure there is momentum in the coming years that allows the HVAC&R sector to create and develop new working environments, while respecting the environment at the same time,” said Marco Buoni, technical director of *Centro Studi Galileo* and vice-president of AREA, the European Association of Refrigeration, Air-Conditioning and Heat Pump Contractors.

The sessions gave participants an insight into how innovative new technological developments could be harnessed in the future.

Could CO₂ be used to heat and cool buildings?

Armin Hafner from SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology in Trondheim, Norway) presented a prototype HVAC unit called the ‘Multipack’ on the first day of the conference.

The pack is designed to heat and cool buildings even in warm ambient climates with CO₂ as the working refrigerant.

Hafner believes heating is something “you can do easily with CO₂ systems”.

The prototype is a reversible HVAC system with a multi-ejector. It can be used in cooling, in hot water production, and in cooling with hot water production modes.

He told the audience, “we are looking for partners interested in a demonstration site, such as a hotel or spa”.

Torben Funder-Kristensen, vice-president of public and industry affairs at Danfoss, believes CO₂ has a role to play by harnessing excess refrigeration capacity in a heat pump.

Supermarkets can recover excess heat from the refrigeration system and sell it to a district heating network. In this way they can substantially reduce costs and emissions, according to Funder-Kristensen.

Supermarket refrigeration systems are generally made for the hottest day in a ten-year period, explains Funder-Kristensen, pointing out that a normal refrigeration system has substantial surplus capacity. He believes around 70% of this capacity can be utilised to supplement external energy systems.

Using CO₂ as a refrigerant reduces system emissions even further thanks to its low GWP and high efficiency. “Assuming we use a CO₂ system, and integrate it with other systems, then you get a good performance and it’s environmentally friendly,” he said.

CO₂ entering new areas

Adrian Muresan, application engineer at Italian compressor manufacturer Dorin, argued that CO₂ would be able to deliver ever-larger cooling capacities.

With six compressors (from Dorin’s CD500 range), a single rack can provide cooling of 1.1 MW for a cold storage room. Indeed, Italian rack manufacturer Enex is already operating such a configuration.

Japan’s SandenVendo is another firm innovating with CO₂ in new and exciting ways. It presented its CO₂-CO₂ cascade system for convenience stores. The system works much like a cascade system and has CO₂ on both a high-temperature and low-temperature loop.

Compared to an R404A system, the CO₂ cascade system was 10-20% more efficient in high temperatures, according to Yukio Yamaguchi of SandenVendo.

On top of this, size matters. “Our system is not so big,” Yamaguchi says. “In Europe the booster system is popular, but it is big. Our system is smaller,” he says.

In addition to these innovative concepts, some see CO₂ as a means of phasing down the use of HFCs in transport refrigeration.

Gérald Cavalier – president of French logistics company Cemafroid and president of the International Institute of Refrigeration’s (IIR) transport and storage section – presented a research

paper entitled ‘F-gas 2017: Revolution in refrigerated transport’ at the conference.

In it, Cavalier weighed up the pros and cons of different refrigerants in transport refrigeration.

“Refrigerated transport is the kingdom of R404A,” says Cavalier. He points out that R404A is currently used in 95% of the French refrigerated transport fleet and alternative options must therefore be found in order to comply with the EU F-Gas Regulation.

He rules out flammable refrigerants as a long-term alternative to R404A, citing safety issues. “The natural fluids family and especially CO₂ will certainly also take part in the revolution and ask for the power [to dominate the transport industry],” he says.

Touching on hydrocarbons

The conference featured presentations on other natural refrigerant-based technologies. Embraco’s new variable speed compressors aim to increase the efficiency of light commercial hydrocarbons-based refrigeration.

“In the light commercial sector, end users push system manufacturers to offer systems with better efficiency and environmental performance,” says Enrico Albera of Embraco.

This is why propane is becoming the main refrigerant for light-commercial plug ‘n’ play systems, Albera argues.

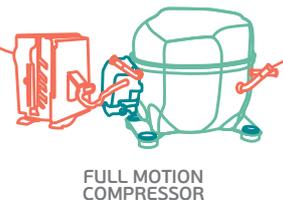
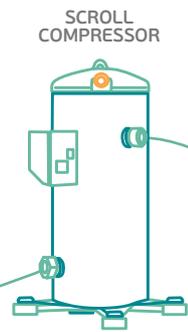
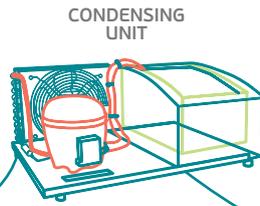
Along with variable speed technology, Embraco has embraced inverters in its isobutane (R600a) units. Embraco’s isobutane compressors “had 25% energy savings [compared to standard compressors. A lot of this] optimisation [is] thanks to the inverter,” he argues.

Natural refrigerants, then, look well placed to prosper in the refrigeration and air-conditioning landscape of the future. ■ [CM & AG](#)

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Thought Leaders Panel, ATMOsphere America 2017

US NatRef industry determined to grow

Thanks to their superior efficiency over HFC-based systems, uptake of natural refrigerant-based HVAC&R solutions is poised to increase in the United States despite a climate of regulatory uncertainty. *Accelerate America* reports from ATMOsphere America 2017.

– By Andrew Williams & Michael Garry

On 1 June, President Donald Trump announced that the United States would pull out of the landmark, globally accepted Paris Agreement on mitigating climate change.

While there has been much speculation about the impact of this decision, 78% of attendees polled at ATMOsphere America 2017 – held in San Diego on 5-7 June – said they did not expect the market prospects for natural refrigerant solutions in North America to be affected.

Speakers taking part in the seven-person ‘Thought Leaders’ panel discussion – which kicked off the conference – echoed that view. “There’s too much



momentum [behind natural refrigerants]," said Bryan Beitler, vice-president and chief engineer at Source Refrigeration, an Anaheim, California-based contractor with 1,400 technicians. "Folks have already invested significantly."

Scott Martin, director of business development and industry relations at Hillphoenix, said it would be "shortsighted" for businesses to react adversely to US withdrawal from the Paris accord. "Ultimately, I don't think it'll have much of an impact on the adoption of natural refrigerants," he said, pointing out that natural refrigerants' strong track record should lead to future growth.

The Thought Leader panellists saw many positive signs for natural refrigerant growth in North America. "I believe the train is leaving the station," said Antoine Azar, who after 16 years at the Coca-Cola Company now runs a consulting business called Sustainable Solutions.

Fernando Campos, deputy director for sustainability infrastructure at Walmart Mexico, said that, "to improve the sustainability of our operations, we need to take a deep look at natural refrigerants. Over the coming years it will make more and more sense to invest in these technologies. We think there is a business model in place".

Walmart, which operates stores in 28 countries, is weighing options for complying with the global HFC phase-down put in place by the Kigali Amendment to the Montreal Protocol last October. The retail giant currently has 34 outlets in Mexico with self-contained propane (R290) cases, "which will become a bigger number by the end of the year," said Campos. Walmart has also installed CO₂ systems in the US, Canada and Africa.

Whole Foods Market is another retailer that is investigating the adoption of natural refrigerant-based systems. Of its 465 stores in total, Whole Foods now runs 22 using CO₂ in some form in a remote system, with 12 that employ only natural refrigerants, including 10 transcritical operations. More than 50 Whole Foods stores have propane display cases.

Tristram Coffin, director of sustainability and facilities in Whole Foods Market's Northern California Region, extolled the virtues of natural refrigerants. "These are good refrigerants," he said. "They're efficient, and they work well. That's why we're all sitting in this room today – not because we're worried about regulation, but because we know that natural refrigerants have a positive effect on the environment and on companies' bottom lines."

“ The war is over. R290 has won in the small commercial marketplace. ”

– Jim Rutz, Tecumseh Products Company

Gerard von Dohlen, president of Newark Refrigerated Warehouse, is convinced that ammonia, hydrocarbons and CO₂ are the refrigerants of the future. "They are easy to handle and easy to use," he said. "They can take all kinds of abuse, they're tolerant of oil, they run really well, and they're very resilient."

Coffin pointed out that there's a "huge opportunity" to "merge expertise" about natural refrigerant applications in the commercial and industrial sectors "so we can move forward as one rather than in separate sectors".

Praise for propane

Propane got a lot of support at the panel discussion. Coffin argued that R290 in self-contained display cases is already becoming a mainstream refrigerant in food retail today. "[OEMs] True and AHT have dedicated their cases to propane almost exclusively, so [retailers] will be buying natural refrigerant-based systems whether they know it or not," said Coffin.

Self-contained propane cases are particularly suitable, Coffin added, in smaller urban stores and mixed-use buildings "where you can't fit in centralised racks".

"In retail applications, R290 is hard to beat," said von Dohlen.

Chiming in from the audience, Jim Rutz, global platform director, light commercial, for compressor maker Tecumseh Products Company, declared: "The war is over. R290 has won in the small commercial marketplace. There are a few manufacturers who don't realise it yet, but they're going to get steamrolled." His remarks elicited applause in the room.

However, one challenge facing the use of self-contained propane cases is meeting the requirements of store merchandisers "who care about case depth and width and want to know that they can merchandise their products," noted Coffin.

An oft-cited limitation of hydrocarbons is the small charge that is allowed – 150g for commercial applications (60g for water coolers) and 57g for domestic uses – by the US Environmental Protection Agency (EPA).

▶ At a global level, the International Electrotechnical Commission (IEC), through its SC61C Sub-Committee Working Group (WG4), is focused on raising the charge limit for flammable (A3) refrigerants by next year. The new maximum charge under consideration for propane is 500g.

“From a technical perspective, the challenge is always going to be charge limits,” said Coffin. “Assuming we can get beyond the charge limit regulations, we’ll be in really good shape – R290 self-contained cases will be a winner across the board.”

With regard to the flammability of hydrocarbons, Walmart’s Campos said that could be dealt with via proper design, operation and maintenance. “When the gasoline car came out, you could have said, ‘it’s dangerous so let’s keep riding horses,’” he said.

Beitler of Source Refrigeration emphasised the importance of training technicians on propane as well as other natural refrigerant-based technology. Some manufacturers, such as True Manufacturing with its propane cases, “have a great contractor supply network to take care of their systems,” but others “don’t have a strategy for repairs”.

Source Refrigeration has its own training facilities at three locations where it keeps its technicians up to speed on the latest natural refrigerant-based technologies. Beitler also works on training with groups like RSES, NASRC and RETA, with whom he is working on a CO₂ certification manual.



Fernando Campos, Walmart Mexico

What about HVAC?

Coffin expressed the view that “we don’t talk enough about naturals in the HVAC space”.

Taking up that challenge, Campos noted that because commercial HVAC systems are mostly situated on rooftops, flammable hydrocarbon refrigerants could be employed with minimal risk using a secondary refrigerant inside the occupied space.

While some of these systems exist in Europe, they are not available in North America. “It’s important to get that here,” he said. “We need a rooftop unit to operate with a natural refrigerant, whether R290, CO₂ or ammonia.”

Hillphoenix’s Martin observed that with the advent of low-charge ammonia systems, “ammonia would be great for [commercial] air conditioning”.

Von Dohlen believes ammonia could be used in hotels in large central air-conditioning systems using centrifugal compressors, though others noted the obstacles posed to such applications by local codes and high costs.

Dealing with uncertainty

The panellists did not shy away from delving into other challenges facing natural refrigerant adoption. For example, along with its withdrawal from the Paris accord, the Trump administration has created some uncertainty with its aggressive anti-regulatory posture, they noted.

“How do you build a refrigeration system that copes with the lack of certainty about regulation in the United States in the coming months and years?” asked von Dohlen. “I’m trying to build systems that avoid uncertainty, because I don’t know what’s going to happen.” ▶

“ To improve the sustainability of our operations, we need to take a deep look at natural refrigerants. ”

– Fernando Campos, Walmart Mexico

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▶ Von Dohlen quipped: “There’s nobody in this room who has a better guess than my cocker spaniel what Trump is going to do next!”

OEMs, end users and engineering groups, Coffin pointed out, need to manage to “the most stringent regulations in the marketplace,” which could end up being the HFC-reduction rules under consideration in California.

Perhaps the biggest challenge facing the natural refrigerants marketplace is finding a good retrofit solution for existing facilities, since retrofits through drop-ins are not yet possible with naturals, and end-of-life system retrofits can be cost-prohibitive.

Coffin agreed that finding a cost-effective retrofit solution for natural refrigerants is “the Holy Grail”. “We’ll still be talking about this in 10 years until we come up with a better retrofit solution,” he said.

Hillphoenix’s Martin warned that HFO refrigerants also represent a retrofit option for end users. “Make no mistake – there will be a play in our lifetimes for HFOs and HFO blends,” he said. “For every one of us innovators here, there may be a hundred who would love to have a refrigerant they could drop in to their systems today. The world wants a drop-in, simple solution. It’s up to us as contractors, installers, engineers and equipment designers to build low-cost, highly efficient systems.”

Azar of Sustainable Solutions urged putting a greater emphasis on total cost of ownership (TCO) in the evaluation of natural refrigerant-based HVAC&R solutions. That includes considering the efficiency and other attributes of these systems.

“We know that natural refrigerants are efficient,” said Azar. “We know they work. It’s not like 15 years ago. Now, it’s about mass production – and going to market.”

Ricardo Garcia, director of engineering and projects at Mexican cold storage operator Frialsa, is another firm believer in the TCO argument. Five of the company’s 24 cold storage facilities use NH₃/CO₂ systems.

“At first, NH₃/CO₂ systems may be more expensive,” he said. “But your return on investment down the line will be better with natural refrigerants. We look at natural refrigerants because they’re good for the environment – but they’re also good for business.”

Coffin thinks more education of retailers and consumers about natural refrigerants could put pressure on retailers to make a change, but he put a lot of the onus for future progress on manufacturers. “If OEMs continue to invest more in natural refrigerant solutions and bring costs down, then end users are going to adopt them.” ■ **AW & MG**

ATMOsphere America 2017 took place in San Diego





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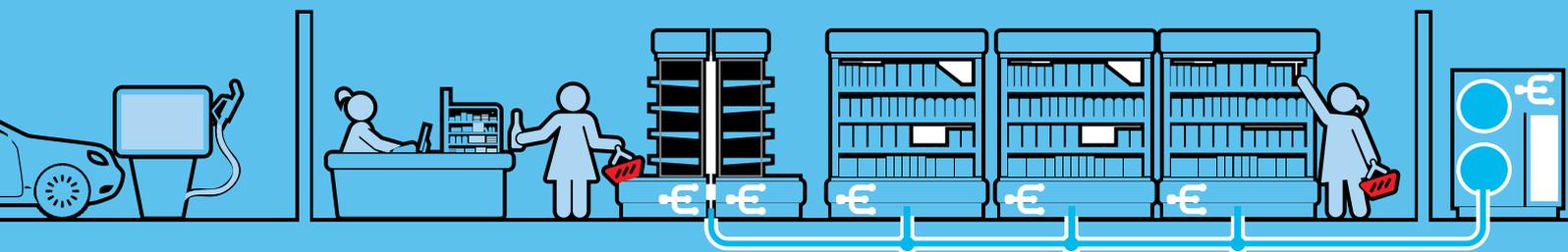
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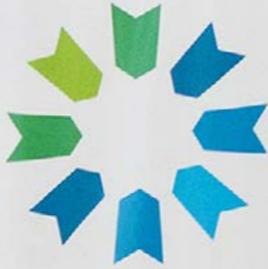
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Centralised low-charge ammonia stands out at GCC Expo

US manufacturers Colmac Coil, Evapco and M&M Refrigeration make the case for reduced-charge ammonia in industrial plants with centralised refrigeration systems. *Accelerate America* reports.

– By Michael Garry & Andrew Williams

Low-charge ammonia packaged systems have become an emerging force in the North American industrial refrigeration industry, with rooftop or outside ground-level units being tested by a slew of cold-storage and food-processing operators.

Accelerate America takes a look at the centralised low-charge scenarios on offer at the second annual Global Cold Chain Expo – held at McCormick Place in Chicago, Illinois (13-15 June 2017) – including Colmac Coil's ammonia DX systems, Evapco's low-recirculation-rate evaporators, and M&M Refrigeration's ammonia/CO₂ cascade systems.

Ammonia DX saves energy and charge

In a comparison of two low-charge-ammonia DX (direct expansion) systems (ADX) to a traditional pumped liquid overfeed system in cold-storage facilities, the DX systems used 18% to 38% less electricity as well as far less ammonia, according to a presentation given at the GCC Expo.

The ammonia DX systems – both ADX systems made by Colmac Coil Manufacturing, Colville, Washington state – were installed at Joliet Cold Storage, Joliet, Illinois, in 2014 and Liberty Cold Storage, Bolingbrook, Illinois, in 2015.

Rick Watters, vice-president of refrigeration group AMS Mechanical Systems, Woodridge, Illinois, attributed the difference in energy consumption between the two ADX facilities to variances in blast freezing production, along with other energy-saving techniques.

The construction cost of the ADX system at the Joliet facility was USD 100,000 less than that of a liquid overfeed system, which uses a 3-1 ammonia ratio. "That was also the opposite of what was predicted," said Watters.

In ammonia charge, the Joliet facility uses 8 lbs./TR (4 kg); Liberty, 11.6 lbs./TR (5.2 kg) and liquid overfeed, 72 lbs./TR (36 kg). The Joliet and Liberty plants both deliver temperatures of -15°F (-26°C) and 20°F (-15°C), and utilise thermosiphon oil cooling, low-charge condensers and stainless-steel piping.

Ammonia DX technology is one of the low-charge scenarios that has emerged in the last few years in response to growing regulatory oversight of industrial facilities with more than 10,000 lbs. (4,536 kg) of ammonia in the US. "Regulations and risk have driven interest in using ammonia and getting the benefits of it but using less of it," said Bruce Nelson, president of Colmac Coil, also speaking at the GCC Expo session.

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Several technological advancements were required to enable the ADX system to reduce ammonia charge, such as “enhancements” inside the evaporator tubes. “We also use better distribution to get the ammonia to the right parts of the heat exchanger,” he said. “That’s the secret sauce.”

Colmac also figured out the management and removal of water in pipes and vessels, he added. Both Joliet and Liberty plants use anhydrators to remove water.

US-based manufacturer Evapco continues to promote its low-charge-ammonia Evapcold packaged units and its low-charge evaporators designed for stick-built central systems.

“Whether in a packaged unit or a stick-built system, we’re using the same low-charge techniques – low recirculation rates and smaller evaporator tubes, line sizes, pumps and vessels – everything is smaller,” John Kollasch, Evapco’s vice-president for industrial refrigeration product application & marketing, told *Accelerate America*.

The reduction in equipment size as well as costs – while maintaining the same capacity – is making the low-charge approach more popular in central systems, with low-recirculation-rate evaporators being adopted by “a lot of customers,” said Kollasch. “I see people gravitating to lower charge sometimes not for the sake of the low charge but for the smaller systems and lower costs,” especially for plants that would already be under the regulatory threshold of 10,000 lbs.

CO₂ for plant expansions

He is also seeing more interest in low-charge secondary systems, with ammonia restricted to the equipment room and glycol or CO₂ used in the refrigerated space.

The CO₂ in these scenarios is used as the cooling agent, with ammonia serving to condense the CO₂ in what is known as an ammonia/CO₂ cascade system.

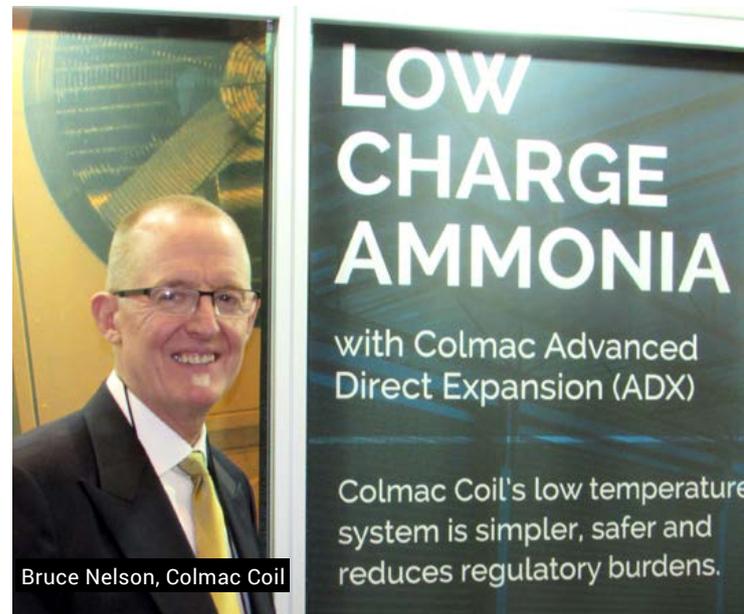
Since 2004, M&M Refrigeration – a leading supplier of ammonia/CO₂ cascade systems based in Federalsburg, Maryland – has installed more than 55 ammonia/CO₂ systems in North and Central America and southeast Asia, said Todd Donohoe, an account executive at M&M.

Asked about the growth of the market for ammonia/CO₂ systems, he said M&M cold-storage operators planning to add a frozen room to an existing facility may initially inquire about a standard single-stage or two-stage ammonia system. “We say, ‘Have you thought about CO₂ because it can save you money in the long run,’” Donohoe told *Accelerate America*. “That’s where the conversation usually starts.”

CO₂/NH₃ cascade technology is a compelling option for industrial operators employing blast or spiral freezers because it uses smaller line sizes than ammonia, is easier to install and reduces the ammonia charge – “all the buzzwords,” said Donohoe. Moreover, the cascade systems are up to 35% more efficient than a two-stage ammonia system at -58°F (-50°C) saturated suction temperature, he noted. ■ **MG & AW**

“Regulations and risk have driven interest in using ammonia and getting the benefits of it but using less of it.”

- Bruce Nelson, president, Colmac Coil



Bruce Nelson, Colmac Coil



Todd Donohoe, M&M Refrigeration

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Hydrocarbon charge limits under spotlight

Standards bodies in the United States and worldwide will consider increasing hydrocarbon charge limits this year amid mounting pressure from industry and governments.

– By Charlotte McLaughlin, Marie Battesti, Michael Garry & Andrew Williams

Many experts believe that in order to meet the objectives of global HFC phase-down agreement struck in Kigali, Rwanda last October, refrigerant standards need revising.

Glenn Gallagher, air pollution specialist at the California Air Resources Board (CARB) – speaking at the ATMosphere America 2017 conference in San Diego, California (5-7 June 2017) – expressed hope that A3 refrigerant safety standards would be revised in time to use flammable alternatives like hydrocarbons.

“Eventually, the codes and standards will be updated. We don’t know if it’s going to be in three or five years. We’re trying to extrajudicially that where we can, by being active on the [standards] committees,” Gallagher said.

Europe is seeing similar pressure to move. Standards governing hydrocarbons must be adapted to encourage their wider rollout, according to a European Commission report on the barriers posed by codes, standards and

legislation to using climate-friendly technologies in the refrigeration, air-conditioning, heat-pump and foam sectors. The report was published at the end of 2016 under the EU’s F-Gas Regulation on phasing down HFC use.

Local building codes and fire regulations, as well as transport and storage-related codes, can “severely restrict” the use of flammable refrigerants in many EU countries, the report declares.

Italy, Spain and France have the most severe restrictions on using flammable refrigerants in air-conditioning applications in certain types of public access buildings, the EU report alleges. In Italy a number of Ministerial Decrees ban the use of flammable refrigerants in split air-conditioning applications, the report says.

Similarly in France, a single Decree creates a nationwide barrier to using hydrocarbons in split air-conditioning units and chillers in public access buildings.



Such sentiments were echoed by UL – a US safety body – in its Flammable Refrigerants Webinar Series on Codes and Standards Activities on 29 March 2017.

“The Montreal Protocol has driven the [US] Environmental Protection Agency (EPA) to adopt regulations, which in turn drive UL and ASHRAE standards, which in turn are referenced in the building codes,” said Randall J. Haseman, UL’s principal engineer for refrigeration and room air-conditioning equipment.

Prior to the Kigali Amendment to the Montreal Protocol, the US EPA had already listed hydrocarbons as suitable alternatives to HFCs in a number of applications under the Significant New Alternatives Policy

(SNAP) programme, playing a key role in their adoption in the United States.

SNAP lists “acceptable substitutes” to high-GWP refrigerants, either with or without restrictions on their use. Ethane (R170), isobutane (R600a), propane (R290) and hydrocarbon blend R441A were listed as acceptable substitutes in certain refrigeration and air-conditioning applications in February 2015. These refrigerants have been exempted from venting prohibitions, meaning that they are easier to dispose of than HFCs.

The most recent SNAP application to be approved for hydrocarbons was a 3 January 2017 decision to allow the use of propane for ice machines, water coolers and very low-temperature equipment (from -40°C (-40°F) to

-85°C (-121°F). The charge limit remains 150g, except for new water coolers, for which the limit is 60g.

Other countries are also already implementing HFC phase-down plans including Australia, New Zealand and Canada.

Changes to standards are required to facilitate the switch to low-GWP refrigerants, according to experts who attended the 39th Meeting of the Open-Ended Working Group (OEWG39) of the Parties to the Montreal Protocol (11-14 July 2017) in Bangkok, Thailand.

A Workshop on Safety Standards Relevant to the Safe Use of Low Global Warming Potential (GWP)

Alternatives to Hydrofluorocarbons (HFCs) was held on 10 July prior to OEWG39. It addressed safety standards for flammable refrigerants used in the HVAC&R sector.

It was organised at the request of China, backed by other developing countries. China has already submitted documents to the International Electrotechnical Commission (IEC) working group on air conditioning to revise standards on flammable refrigerants.

Standards from the IEC, a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

At present, China's HVAC&R sector mainly uses HCFCs and high-GWP HFCs. Yet the government is already setting about leapfrogging HFCs to low-GWP refrigerants. In August 2016, the Chinese Ministry of Environmental Protection's Foreign Economic Cooperation Office (FECO) – responsible for climate and environmental policy – released the First Catalogue of Recommended Substitutes for R22. Natural refrigerants play a key role as substitutes for R22 in the majority of the sectors listed. Hydrocarbons R290 and R600a are particularly recommended for room air conditioners, heat pump water heaters and stand-alone refrigeration systems.

Six sessions were organised during the 10 July meeting to discuss safety issues, with some speakers suggesting it may be another four or five years before any new international standards are adopted.

Representatives from India and China informed participants of the significant progress they had made in using hydrocarbon refrigerants at higher charges and with more stringent safety measures in their countries.

However, they pointed out that to facilitate large-scale production, international standards would have to allow them to export around the world.

The workshop conclusions were also presented to the Parties to the Montreal Protocol in OEWG39 for further consideration. Another Meeting of the Parties (MOP) to the Montreal Protocol in November will discuss these recommendations further.

A major international push

Amid pressure from industry and policymakers to raise hydrocarbon charge limits, various bodies including the IEC, and the Fire Protection Research Foundation and the EPA in the United States, are committed to reconsidering current safety standards in 2017.

The IEC working group on household and similar electrical appliances has begun to prepare a draft to change the charge limit on hydrocarbons. The new limit is expected to change from 150g to 500g; this could shift the market towards bigger, more efficient hydrocarbon cabinets once it is adopted under the IEC standard IEC 60335-2-89.

"A new Draft for Comments (DC) document that considers the 500g limit for propane charges and which will also allow the use of slightly flammable A2L safety class refrigerant alternatives [was] circulated in May," explains Embraco's Marek Zgliczynski, chair of IEC SC61C.

"If positively commented upon and if a consensus is reached, the document will be submitted to the SC61C committee to go to the first official vote as a Committee Draft (CDV) during the Plenary Meeting of the SC61C in October in Vladivostok," he says.

Assuming a majority backs the new limit in October's plenary, then the final standard amendment will be published.

At the same time a different IEC working group – the SC61D – is considering "flexible charge size limits [in a given room size] for A2 and A3 refrigerants" in air-conditioning applications, says consultant Dr. Daniel Colbourne, who sits on the UNEP RAC&HP Technical Options Committee under the Montreal Protocol.

The IEC 60335-2-40 standard applies to air conditioning. It currently sets a maximum charge limit of 990g of propane per circuit, with the maximum limit varying according to the room area and installation height, according to Colbourne.

The working group includes a Chinese delegation. China has already submitted two proposals regarding this standard. There is no formal date for revising the standard, but any revision would most likely take place in late 2017 or early 2018.

Both these IEC standards will inform any revision of Chinese, European and US standards too.



Marek Zgliczynski, chair of IEC SC61C

Photo by IISD/Sean Wu (enb.iisd.org/ozone/oweg39/11jul.html)

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France recognises that national standards will also need to be revised further.

Cédric Bourillet of France's Ministry for the Ecological and Inclusive Transition says, "all this regulation has been published in a world that was 100% HFC and that has since become incompatible with the [EU] F-Gas [Regulation]".

According to Bourillet, there will be a place for hydrocarbons. The French Ministry of the Interior is currently drafting a risk assessment study, the results of which will be published this year. The study will focus on the feasibility of raising charge limits for flammable refrigerants in public buildings, in terms of safety and level of training for the French workforce.

United States must act quickly

Brian Rodgers, UL's principal engineer for heating, ventilation and large-scale cooling, argued at a recent UL seminar that international and UL standards must complement one another more effectively in future.

For the United States this means, "many of these revisions in standards [for flammable refrigerants] must be published by the end of 2017, so the ICC [the International Code Council] and the IAPMO [the International Association of Plumbing and Mechanical

Officials] codes can be revised in the next code cycle," UL's Haseman says.

Both the ICC and IAPMO cover the whole of the US, bar the states of Maine and Hawaii, and publish updated editions of building codes and standards every three years. The next revision is in 2018.

This date is very important as UL and ASHRAE standards inform the ICC and IAPMO standards and building codes. UL wants to update the requirements before the 2018 date, so IAPMO and the ICC can revise their standards too.

For air conditioning, UL is proposing safety standards that would require flammable refrigerant-based air conditioners to be fitted with leak detection systems, and to either keep their fans switched on all the time, or only once a refrigerant leak has been detected. The proposed standards also cover refrigerant piping requirements.

ASHRAE, another body that sets US standards, is speeding up its normal process of revising standards to meet the 2018 deadline by publishing its next Addendum in 2017 rather than 2018.

The Addendum will be informed by the Fire Protection Research Foundation's research on A3s.

The research focuses on benchmarking risks from leak and emissions testing, assessing flammable refrigerants'

post-ignition risk, determining charge limits, and producing a guide to handling and servicing A2L refrigerant-based HVAC&R equipment.

At the upcoming FMI Energy & Store Development conference on 24-27 September in Orlando, Florida, Paul Anderson, senior director of engineering at retailer Target, will present the US Fire Protection Research Foundation's evaluation of the fire hazard posed by flammable refrigerants as a pathway to raising charge limits. Anderson worked alongside the North American Sustainable Refrigeration Council (NASRC) on the project.

This would lay the groundwork for raising the 150g federal charge limits on hydrocarbon refrigerants in the United States.

The results will be used to update ANSI/ASHRAE Standard 15-2013 (Safety Standard for Refrigeration Systems) and ANSI/ASHRAE Standard 34-2013 (Designation and Safety Classification of Refrigerants).

Many governments, standards bodies and international forums, then, recognise that standards governing hydrocarbons need revising and are actively working to do so. ■ [CM](#), [MB](#), [MG](#) & [AW](#)

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Article 5 parties confer in Bangkok, Thailand

All photos by IISD/Sean Wu (enb.iisd.org/ozone/oewg39/11jul.html)

Going the Kigali distance

Delivering the Kigali Amendment to the Montreal Protocol's objectives will require government and industry to come together to make available the funding and technology required to phase down HFCs.

– By Marie Battesti, Charlotte McLaughlin & Michael Garry

Policymakers worldwide are busy putting in place their strategies for phasing down hydrofluorocarbons (HFCs) under the Kigali Amendment to the Montreal Protocol agreed in the Rwandan capital last October.

Under the auspices of the Montreal Protocol, which is designed to reduce the world's use of ozone-depleting substances (ODSs), the Kigali Amendment will help to facilitate the replacement of HFCs with low global-warming potential (GWP) alternatives such as natural refrigerants.

To agree on the steps forward to make this transition happen, the 39th Meeting of the Open-Ended Working Group (OEWG39) of the Parties to the Montreal Protocol took place in Bangkok, Thailand this summer (11-14 July 2017).

"We'll show the world that a global issue like ozone-layer depletion, which is usually considered as distant, complex, huge, overwhelming and overall too big to handle, can actually be addressed effectively when we humans work in partnership," Tina Birmpili, executive secretary of the Ozone Secretariat at UNEP (UN Environment Programme), told participants in the Bangkok gathering.

Standards on global radar

While some of the meeting was technical in scope, focusing on progress reports from the Montreal Protocol parties, the issues of financing HFC alternatives for less-developed countries and putting in place adequate safety standards remained hot topics.

A 'Workshop on Safety Standards Relevant to the Safe Use of Low Global Warming Potential (GWP) Alternatives to Hydrofluorocarbons (HFCs)', held in Bangkok on 10 July ahead of OEWG39, addressed safety standards for flammable refrigerants used in the HVAC&R sector.

The workshop was organised at China's request, supported by a group of other developing countries. China has already submitted documents to the International Electrotechnical Commission (IEC) working group on air conditioning to revise standards on flammable refrigerants.

Standards from the IEC, a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

Any revision of an IEC standard informs changes to Chinese, European and US standards as well.

Six sessions of the workshop were organised to discuss all aspects related to safety. Many speakers suggested that it would take another four to five years before any new international standards are adopted.

Representatives from India and China informed participants of the significant progress they had made in using flammable refrigerants with higher charges and more stringent safety features in their local economies.

"To have a flammable refrigerant you need to take certain precautions," Abhijit Acharekar of Indian company Godrej told the Bangkok audience. "The risk can be fairly addressed in terms of the design and manufacturing" of the product.

Godrej has been making R290 air conditioners in India for some time now and has worked with the Indian government to reform the standards to allow their use in public buildings.

Similarly, Tingxun Li of Chinese RAC manufacturer Midea pointed out that all Chinese companies had developed some form of R290 air conditioning and had experienced "no leakages and no accidents" so far.

To facilitate large-scale production, international standards would have to allow Chinese companies to export around the world.

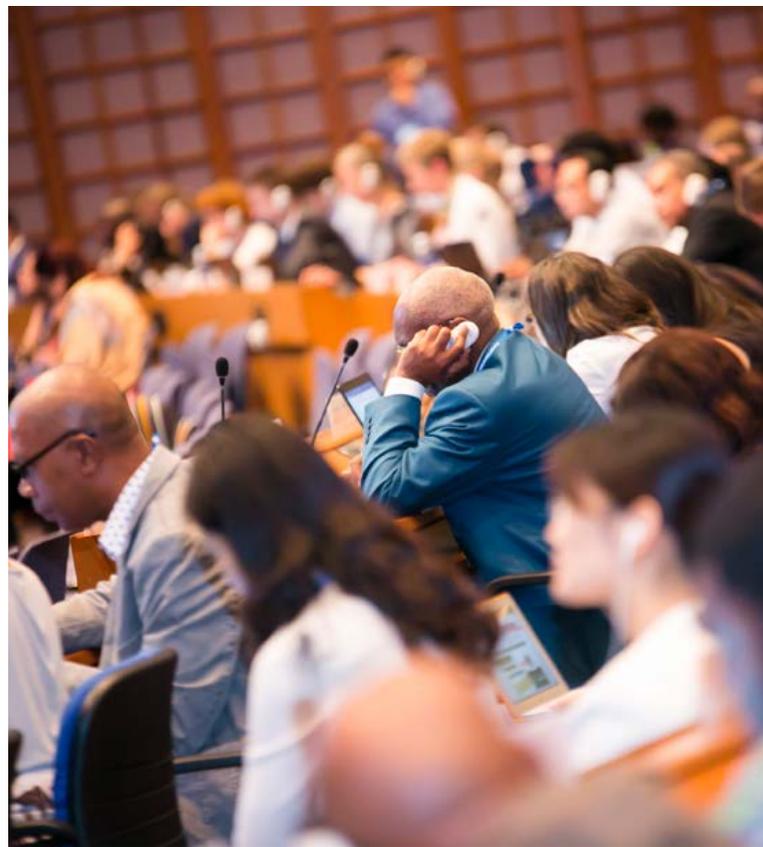
Current international standards limit the amount of hydrocarbon charge permitted in refrigeration, air-conditioning and heat pump technology (see '[Hydrocarbon charge limits under spotlight](#)', p. 54).

The Parties to the Montreal Protocol considered the workshop's conclusions during OEWG39.

Some participants expressed concern at the manner of the standards reform. According to the draft report on the OEWG39 meeting, many were worried that Kigali may trigger the revision of the standards without allowing the IEC and other standards committees enough time to weigh up the associated risks.

One person, according to the report, "expressed the view that any new safety standards should be at least as good, and preferably better than, the standards they replaced in ensuring safety".

Others disagreed, calling for "rapid action" on standards and "regular consultations with the relevant international standards bodies".





Delegates from China in Bangkok

► Funding the transition

Many developing countries will have problems funding this transition. Parties debated the possible allocation of additional funding to the Multilateral Fund for the Implementation of the Montreal Protocol for demonstration and viability projects with HFC-free technology.

Such support could help to maximise the climate benefits of accelerating the phase-down of HFCs in developing countries.

The funding will apply to developing countries or so-called Article 5 Group One and Group Two countries, which will start freezing their HFC consumption by 2024 (Group One) and 2028 (Group Two).

The Replenishment Task Force of the Technology and Economic Assessment Panel (TEAP) also presented its preliminary findings on the next replenishment, and a breakdown of estimated costs (expressed in ranges).

TEAP is a technology and economics advisory body to the Montreal Protocol Parties. It is composed of experts from various fields worldwide, including policy and research bodies. TEAP presented funding proposals for HFC phase down-enabling activities for the period 2018-2020 of up to USD 21.5-44.2 million. USD 13.5-20.2 million would be dedicated to non-investment projects (including project preparation and demonstration projects), and USD 8-24 million to investment projects.

Categories for enabling activities are defined as capacity-building and training, licensing, reporting, demonstration projects, and development of national strategies.

Investment projects under consideration include conversion projects to low-GWP alternatives.

Parties will debate the full allocation of funding for HFC-free technology at the next Meeting of the Parties (MOP39) to the Montreal Protocol on Substances that Deplete the Ozone Layer, which takes place in Montreal, Canada (20-24 November 2017).

More funding on its way

The United Nations and the World Bank, separately to the Montreal Protocol meetings, launched a new 'Cooling for All' initiative under the Sustainable Energy for All (SEforAll) programme to identify the challenges and opportunities associated with providing access to affordable, sustainable cooling solutions.

The new initiative will focus on "how we embed growing cooling demands that can reach everyone within a clean energy transition, and in turn, support faster progress to achieve the goals of the Montreal Protocol's Kigali Amendment agreed to last year in Rwanda," the announcement said.

With populations rising, growing demand for cooling risks creating a significant increase in energy demand, which if not managed through super-efficient technologies or clean sources may cause further climate change impacts and a rise in emissions, the group said.

The initiative will aim to create "a direct intersect" between three internationally agreed-upon goals: the Paris Climate Agreement; the Sustainable Development Goals; and the Montreal Protocol's Kigali Amendment, which will limit consumption and production of high-GWP HFC refrigerants.

An important part of the initiative will be its Cooling for All Global Panel, which will bring together a group of high-level leaders from government, academia, civil society, business and finance leaders.

The panel will be co-chaired by two governments that are dealing with issues of cooling access in their countries. The co-chairs will lead the group's work in developing a comprehensive report that offers solutions for accelerating the uptake of cooling solutions to create sustainable cooling access for all, including the poorest countries.

"As the world grows dangerously warm, access to cooling will become the difference between life and death in some parts of the world that suffer from extreme heat," says Rachel Kyte, chief executive officer of Sustainable Energy for All, and special representative of the UN Secretary-General for Sustainable Energy for All, who will act as secretariat for the Global Panel.

The initiative will convene its first panel meeting this September in New York on the sidelines of the UN General Assembly and Climate Week NYC, where co-chairs and panel members will be announced. The panel's report will be launched in 2018. ■ MB, CM & MG

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Staying ahead of the pack

As natural refrigerants become increasingly popular HVAC&R solutions for complying with the EU's F-Gas Regulation, the need to train technicians to operate these systems is becoming more acute. German manufacturer TEKO is investing in training to stay one step ahead of the competition. *Accelerate Europe* reports from Altenstadt.

– By Andrew Williams

The bees in the hedgerows are not the only ones buzzing with expectation as the sun beats down on the headquarters of TEKO Kältetechnik in the German town of Altenstadt, some 30 kilometres northeast of Frankfurt-am-Main.

For today is a special day. HVAC&R technicians from across Germany are on site to learn more about working with natural refrigerants, which currently represent 60% of the German manufacturer's product portfolio.

"We want to share our knowledge with our customers, because they do all the installation and servicing. They have to know what to do to get their plant running correctly and efficiently," says Jürgen Schmidt, the training manager.

TEKO has been offering training courses since 2012. Currently it offers two types of training. The first centres on planning complete projects, and is custom-designed for technicians, planners and engineers. The second course type is customised for contactor's needs and focuses on the installation of CO₂ units.

"Most of our customers are contractors, who build the plants for food retailers. Nevertheless, we also have some from the industrial sector," Schmidt says.

In 2016, the company trained 600 people, 300 of whom received training on CO₂. Schmidt expects this number to increase. "Every course is requested very well. We're trying to have smaller groups, because then the learning effect for participants is much higher," he says.

Change is coming fast

The EU F-Gas Regulation aims to reduce the bloc's HFC use by 79% by 2030, compared to the baseline of average levels in 2009-2012. To help deliver this target, it is progressively banning the use of certain HFCs in different types of new equipment. In 2022, for example, bans on using certain HFCs (GWP ≥ 150) in new centralised and plug-in commercial refrigeration equipment will come into effect.

"For everyone in the industry, the changes are very fast. We're facing a shortage of trained technicians. We train

internally a lot. But the refrigeration schools have to do more education on natural refrigerants," says TEKO Managing Director Andreas Meier.

Meier argues that it would too simple to characterise this so-called 'training gap' as industry-wide. "If you go to Switzerland or Germany, people are already trained," he argues. The next phase will be to train individuals from countries that are less familiar with natural refrigerants, he believes, citing Poland or other Central and Eastern European nations as examples.

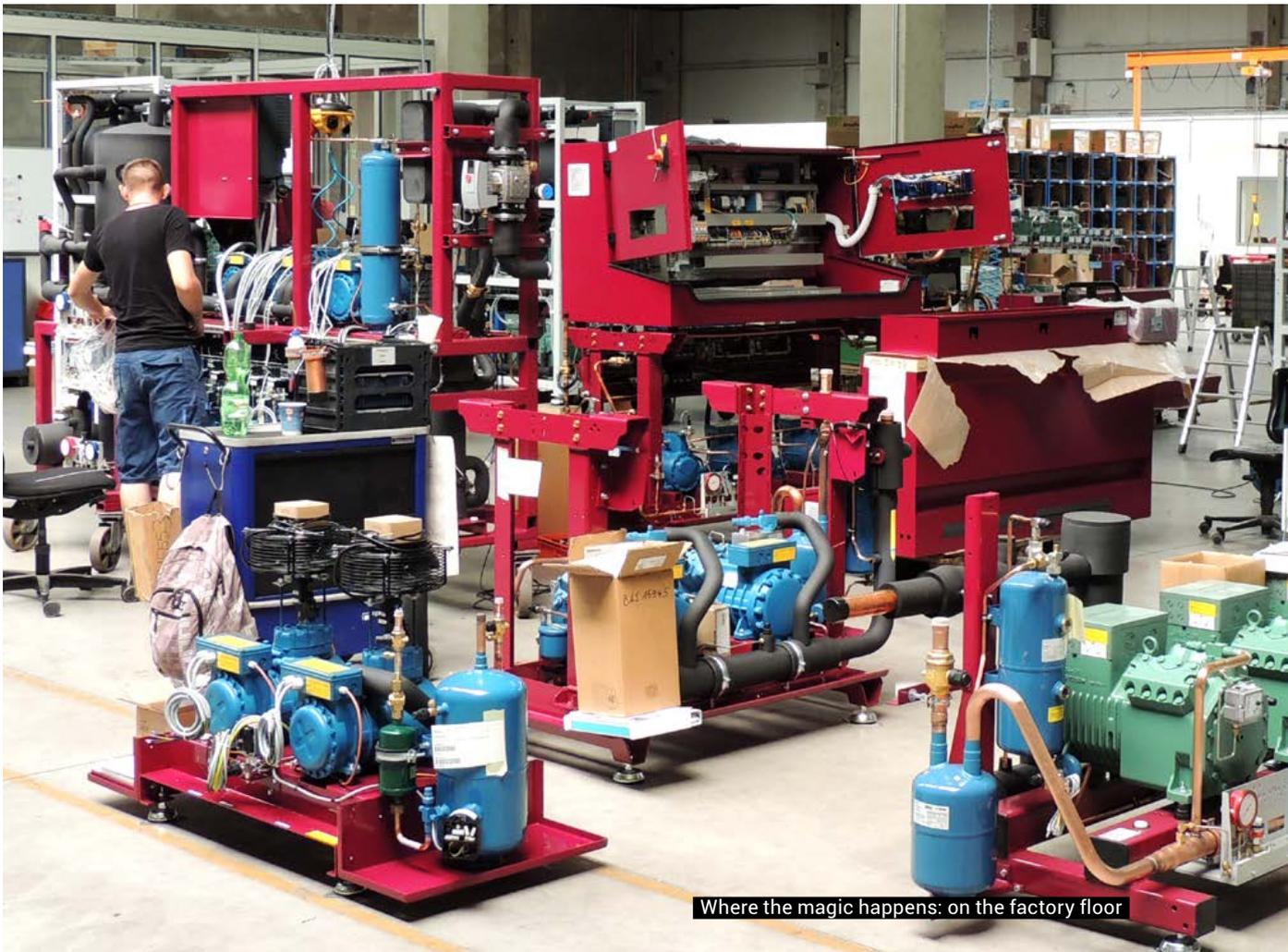
TEKO has been offering CO₂ training since 2012. "You can only get people to overcome their fears by training them," Meier says.

The CO₂ courses are designed to teach participants what to consider when planning and installing a system. They are complemented by practical exercises, for example in TEKO's test supermarket installation or on the working CO₂ rack housed opposite the training centre.

"We also give an impression of control strategies, which is about Wurm control systems," Schmidt says.

Most courses are held in German but TEKO has already hosted groups from Poland and the Netherlands, for whom the training takes place in English. "I also travel a lot, mostly for specialised training on customers' needs," says Schmidt.

TEKO is considering adding training courses on hydrocarbon chillers for air conditioning. For now it is not



Where the magic happens: on the factory floor



Participants can train on a working CO₂ transcritical rack



Andreas Meier, managing director, TEKO



TEKO's test supermarket



Jürgen Schmidt holds court inside the training centre

▶ planning to offer ammonia training, because that is already readily available elsewhere.

A number of TEKO's competitors offer similar training courses. Does the company see these as competition? "The more people are trained, the better it is for the industry," Schmidt argues.

Growing the NatRef market

How competitive are natural refrigerant-based systems compared to their HFC-based counterparts? "I think they are already competitive. The lobby for NatRefs has to grow and fight more against the chemical lobby. Raising awareness among end users is still crucially important for NatRefs to become more competitive," says Meier.

He is particularly impressed by the interest in natural refrigerants in his native Germany. "There is strong movement towards natural refrigerants. The retail chains are increasingly adopting CO₂ or even hydrocarbons," he says.

"In Germany, the natural refrigerant market in the retail industry really took off two years ago. In the industrial sector above 500 kW, they've been there for years already – it's always been natural refrigerants," he observes.

Meier believes future growth of natural refrigerants will ultimately depend on which applications they are used for. "It depends on the size of refrigeration system. In small capacities of up to 20 kW, HFCs are still hard to beat in terms of system price. Between 20 kW and 500 kW, NatRefs are quite competitive. Over 500 kW, NatRefs have been and will be the choice," he argues.

Indeed, Meier sees the beginnings of competition between different natural refrigerants themselves. "Depending on the capacity of refrigeration system, I see CO₂ taking part of ammonia's share in industrial installations, such as cold storage facilities, due to new technologies and high competitiveness," he predicts.

In Europe, the uptake of natural refrigerant-based HVAC&R systems is often driven by decisions by large end-user companies to adopt them as part of their sustainability strategies. Procurement on this scale has the power to transform the market.

"Very large, powerful end users like Nestlé, Roche, and big retailers are deciding to go for natural refrigerants. This has a strong push and pull effect on smaller ones. Knowledge is getting better, and components are getting cheaper. We're also pushing with our marketing to get natural refrigerants in," Meier says.



An original ammonia machine from 1922 takes pride of place on the forecourt

▶ Economies of scale will play a role in making natural refrigerant-based systems more accessible. “Even if you want to be environmentally friendly, you also have to take care of your efficiency and your installation costs. If you see mass production of natural-refrigerant systems for small capacity applications too, I think we’ll see them become more competitive,” he argues.

Opponents of natural refrigerants often cite safety concerns and tough regulatory requirements as obstacles to their wider uptake. But Meier suggests such fears are exaggerated. “If you respect European rules, then there’s not much difference between what you have to do whether you’re using HFCs, HFOs or natural refrigerants. For us, the key point is reliability,” he argues.

The rise of CO₂

TEKO reports impressive growth in its CO₂ business. The company has already installed around 2,500 systems, with requests for CO₂ transcritical systems doubling every six months for the past two years.

What does Meier think is driving this growth? “First of all, the EU F-Gas Regulation. Secondly, the decisions of end users like retail chains to go for NatRefs. And last but certainly not least, the products are becoming more and more competitive with HFCs,” he says.

What about competition from the new generation of synthetic refrigerants? “It still isn’t clear where HFOs will go. In air conditioning I see demand for them growing vis-à-vis HFCs. But in retail and industrial applications, HFCs are being replaced by NatRefs,” Meier says.

TEKO works hard to communicate the benefits of natural refrigerants to a wider audience. “If customers visit our website, they see lots of arguments in their favour,” he says.

The company’s commitment to investing in training, meanwhile, looks set to grow. “Once someone has been trained by us, then he knows us – he knows the company and he knows who to talk to. Once he’s been here and you’ve gone out for drinks in the evening, it’s a completely different thing,” Meier says.

“At the end of the day, it’s business,” he adds.

Meier has been in the HVAC&R industry for 13 years, working in air conditioning, commercial refrigeration and industrial refrigeration. He has been at TEKO for two years. “What do I like about my job? The challenge of changing an industry, and working with my team to satisfy our customers’ needs.”

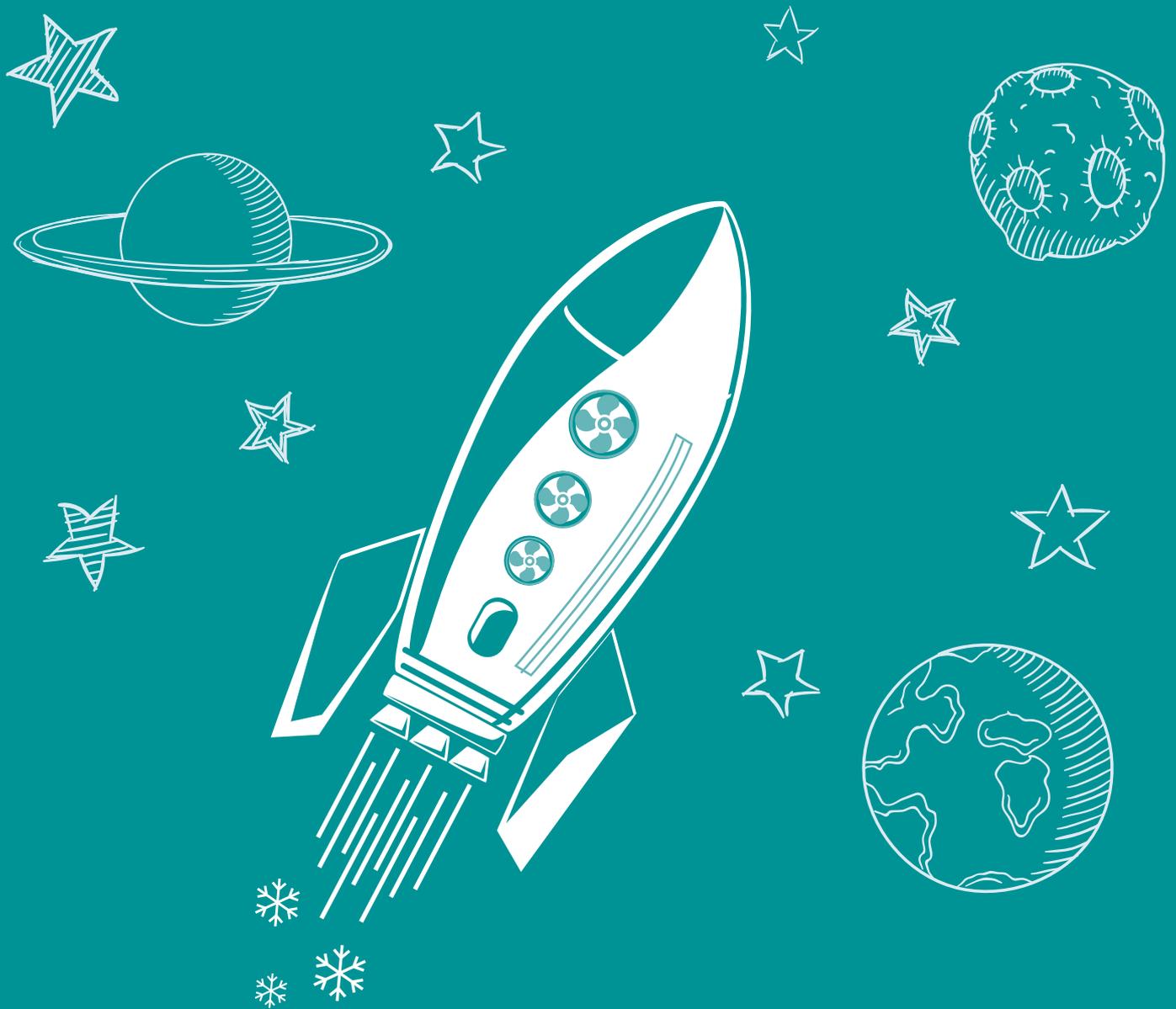
“If you’ve been in the business as long as I have, then you have friends all over the world. I like this industry very much, because it’s a familiar industry,” he says.

What motivates Meier to work with natural refrigerants? “Sustainability, efficiency, and the fact that they’re future-proof. And of course a growing market. It’s also about having fun!” he says with a smile.

“These are the oldest refrigerants in the world. In front of our building you’ll see an old ammonia plant from 1922,” Meier enthuses.

Schmidt agrees with his boss. “Environmental friendliness, and the fact that it’s such an interesting field. They’re also future-proof for my employer,” he says.

As the sun sets in the cloudless Hessen sky, it is clearer than ever that TEKO can look forward to a bright new dawn. ■ AW



Split AC: The final frontier

While Europe is increasing its uptake of portable propane-based air conditioners, the market is moving more slowly on the split system front. Asia, meanwhile, is making good progress with split propane systems. With experts identifying the transition from high-GWP, HFC-based options to lower GWP air conditioning as vital to addressing climate change, the shift to R290 cannot come sooner.

— By Charlotte McLaughlin & Jan Dusek

Globally, the need for air conditioning (AC) is only set to increase. The first six months of 2016 were the warmest six-month period since modern records began (NASA), and the International Energy Agency (IEA) expects to see demand for air conditioners grow by US \$200 billion by 2050.

Rising average temperatures are increasing demand for comfort cooling worldwide. This – coupled with growing middle classes in developing economies – is increasing demand for air conditioning. The United Nations Environmental Programme (UNEP) estimates that global stock will reach over \$1.5 billion by 2030, with air conditioning already representing 20% of household energy consumption in warm climates.

From an environmental perspective, it is crucially important to reduce this growing energy demand. A United4Efficiency report (a joint partnership between UNEP and other NGOs) found that consumers could achieve \$56 billion in energy savings (\$17 billion in India alone) by 2030 “by improving air conditioner energy efficiency policies” now.

The only other high-efficiency, low-cost options cited by the report are R32 (an HFC with a global warming potential of 650) and R290 (propane).

At the same time, it is worth noting that 65% of HFC usage comes from air conditioning (UNEP). “From an environmental and performance perspective, there is little disagreement that R290 (and R1270) represent the best options” as they have a negligible GWP, says consultant Dr. Daniel Colbourne, who sits on the UNEP RAC&HP Technical Options Committee under the Montreal Protocol.

“R290 provides improved performance in high ambient temperatures due to its high critical temperature” of 96.7°C (compared to R32’s 78.1°C and R410A’s 71.4°C),” Philipp Denzinger – a project manager of various ambitious projects related to green cooling for the *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH* – told *Accelerate Europe*.

This means that R290 could be a lot more effective in higher ambient temperatures than HFCs.

China is moving

Some countries have recognised that R290 represents a good long-term bet for addressing energy efficiency and climate concerns in the HVAC&R sector.

Efficiency, performance in high ambient temperatures, low GWP and manageable safety considerations are some of the key reasons why China decided to select R290 as a replacement for R22 – the most dominant refrigerant for air conditioning in the Asian market – in its split and portable air conditioners.

At the ‘International Workshop on Designing, Production and Installation with R290 in Air-Conditioning Industry’ in Ningbo, China on 9-10 April, a Chinese Household Electrical Appliances Association (CHEAA) representative told the audience how propane (R290) was selected.

In China, all air-conditioner manufacturers have designed an R290 RAC product.

Peng Min of CHEAA told the audience at the event – organised by the Chinese government, UNIDO, UNEP and GIZ (a German public-benefit federal enterprise) – that the primary aim was “ensuring the long-term sustainability of the alternative technology adopted”.

Min believes propane will solve the problem. In some production lines that have already been converted to R290, one knock-on benefit is that “the capacity and [Energy Efficiency Ratio] EER of R290 is better than other refrigerants [in] the high ambient region”.

As a flammable refrigerant, propane does bring with it a certain degree of safety risk. A “risk assessment on using R290 was developed by the [Chinese Tianjin] fire-fighting research institute,” says Min.

CHEAA conducted an extensive risk assessment and concluded that the risk levels in case of an electrical shock, lightning or a traffic accident were acceptable.

China, as the world’s biggest manufacturing country in RAC appliances with a market share of 85%, produces 100 million air-conditioning units per year, according to Denzinger, who works for Proklima, a programme implemented by GIZ.

“China has been very active and has put in place a production capacity with the potential to make 1.8 million domestic units using R290 per year,” Denzinger says.

Zhong Zhifeng, vice-chief of Division III in FECO – an agency attached to China’s Ministry of Environmental Protection – told *Accelerate Europe* that FECO expects local manufacturers to deliver 100,000 R290-based



Photo by IISD/Sean Wu (enb.iisd.org/ozone/oweg39/11jul.html)

Abhijit Acharekar, Godrej

split units this year. This represents just 0.1% of China's current output but is nonetheless a step in the right direction.

Germany's *Umweltbundesamt* (UBA; German Environment Agency) says that so-called split AC already constitutes over 95% of the Chinese market at capacities of 5 kW or under. The appliances are split into an inside and outside unit, connected by refrigerant piping. R290 is taking longer to gain a foothold in the split AC market in China than it is in India, for example.

Indeed in India, much of the action has been in split AC – which represents 80% of the total number of air conditioners sold in India, according to the UBA. Few portable ACs are sold there.

Indian manufacturer Godrej & Boyce – in a project involving GIZ and German company HEAT GmbH – started producing R290 split systems in 2012. Since then Godrej has sold 350,000 split-type R290 RAC units in the Indian market, mainly in institutionalised projects with no individual sales.

At a recent meeting in Bangkok on 10 July 2017, Godrej's Abhijit Acharekar estimated that R290-based ACs would increase to 35-45% of its current portfolio once it has delivered "a contract from the Indian government of close to 40,000 ACs". Currently 25-35% of Godrej's air-conditioning line uses R290.

Colbourne puts the success down "to the fact they had an existing sales, training and service infrastructure that extends the length and width of India and thus enables them to keep tight control on safe handling".

Europe: Portable is making headway

In Europe, the situation could not be more different. Unlike in India and China, the shift of production lines to R290-based split systems has not happened on the same scale.

"So far there has not been a concerted effort to shift in Europe regarding R290 split ACs," Denzinger told *Accelerate Europe*.

He argues that this will hopefully change once Chinese manufacturers – who have the biggest share of the global RAC appliances market – begin to mass-produce R290-based air conditioners. "In Europe, propane is already being used in portable air conditioners. However, introducing R290 split ACs in Europe requires demand from Europe, which needs to be accelerated," he says.

Midea Germany has already imported portable hydrocarbon-based portable AC units from its Chinese branch. DeLonghi – an Italian company – has been selling portable R290 units in Europe for some time now, Denzinger says.

In the portable AC market, the market is changing more quickly. The EU F-Gas Regulation bans the use of HFCs with a GWP above 150 in portable air-conditioning systems from 2020.

For split units, a ban on using refrigerants with a GWP below 700 will come into effect in 2025 – essentially keeping the door open for R32.

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

Colbourne says this is a big issue. “The reduction in emissions of HFCs by switching from high-GWP technologies such as R410A, R407C and R32 to R290, R1270 or other negligible GWP alternatives in split air conditioning is potentially vast,” he argues, as they represent such a large share of current HFC production (around 45% of HFC use in air-conditioning applications comes from single splits).

Time is running out

In the European market, several issues have slowed down uptake of hydrocarbon-based split systems. “Myriad explanations and pretexts are offered and it is difficult to decipher these to identify what the core reasons really are,” he says.

He believes there are three clear paths forward: stronger legislation, increased customer demand and reductions in product costs.

Colbourne argues that legislation is unlikely to change, pointing out that current European legislation is unlikely to be drastically revised in the immediate future. The new EU F-Gas Regulation only entered into force in 2015.

Reducing product costs depends on relaxing the currently restrictive standards governing hydrocarbons in air conditioners, according to Colbourne, who sits on several International Electrotechnical Committee (IEC) working groups related to flammable refrigerants.

Standards from the IEC, a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

Colbourne confirmed that the working groups under the IEC are working on more flexible charge limits for air conditioners.

“However, the process is long and convoluted and there are several dominant global stakeholders who could easily delay or block the progression of the desired requirements if they chose to do so,” he says.

In a recent report on the EU’s F-Gas Regulation, the European Commission strongly called for restrictive standards in Europe to be revised.

The Commission report calls on European standardisation bodies CEN and CENELEC to update standards at EU level and invites companies to contribute by collecting evidence enabling better risk minimisation approaches for all flammable refrigerants.

It also encourages EU countries with restrictive national codes, standards or legislation, “to consider a review in light of technical developments that would allow the safe use of alternative refrigerants”.

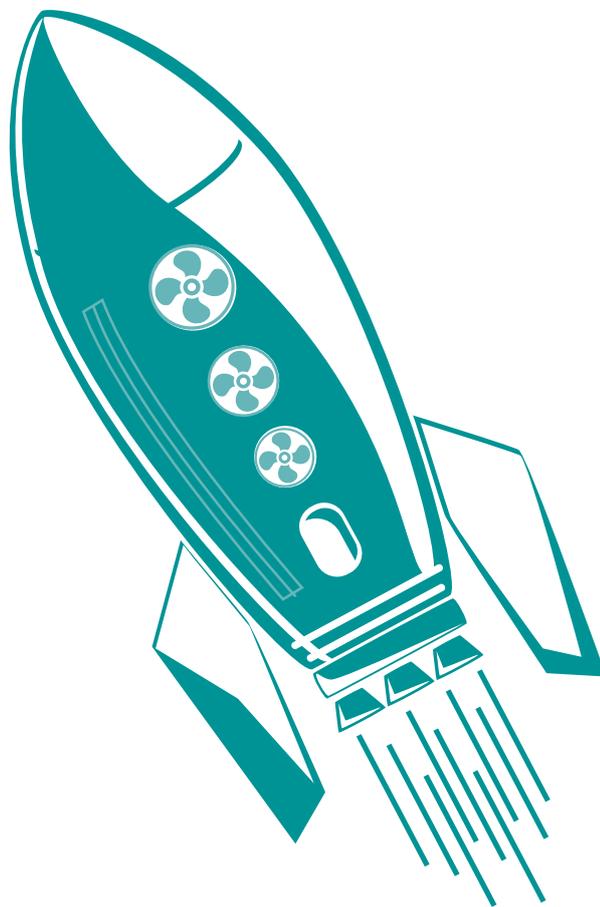
Colbourne believes his third suggested path – customer demand – is the “most viable driver for increased uptake of the technology”.

He cites the uptake of natural refrigerants first in domestic refrigeration and now in commercial refrigeration as examples, highlighting for the latter the role of large end users in driving this market forward. The split AC market will need a collective push by all users if the technology is to be driven forward.

“The movement most likely to truly shift the market towards environmentally friendly refrigerants in split ACs is large-scale collective



A Midea R290-based split AC unit



► demand from individual consumers and corporate end users, and at least one large equipment producer that is prepared to satisfy that new demand,” Colbourne says.

Some large equipment producers are already moving in this direction.

Haier – one of the world’s biggest white goods suppliers – was certified by German inspection and product certification company TÜV Rheinland for its propane split air-conditioner production line in a factory in Jiaozhou Shandong province, China, in June.

The factory meets all safety requirements specified in the EU’s ATEX directives on equipment for potentially explosive atmospheres: Risk Assessment for Hazardous Environments and Ignition Sources, Establishment of Safety Measures and Equipment Selection, and Installation Inspection.

The Jiaozhou factory is fully capable of mass-producing R290 intelligent inverter air conditioners, a press release stated.

Maurizio Boldrini, director marketing commercial comfort at Emerson, believes R290 air conditioning can be provided for light commercial applications, especially when heating is also requested.

“Emerson has already successfully expanded its line-up of R290 Copeland Scroll™ fixed speed compressors and launched a line-up of R290 Copeland Scroll variable speed compressors with inverter drives designed for mini reversible chillers and heat pump applications,” Boldrini says.

Germany has also come up with an innovative way to further encourage consumers to buy natural refrigerant-based ACs and to urge producers to make them.

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

The ‘Blue Angel’ Ecolabel, launched in 1978, is voluntary. Split AC manufacturers have been able to apply for it since August 2016.

“The criteria of the German Ecolabel are very strict and those applying need an SEER rating of seven at least,” de Graaf explains.

Of the manufacturers that have applied so far, the UBA has identified one application that it expects to be successful. Although it does not think many more manufacturers will meet the stringent conditions, the agency does see the label as a signal to the market. “This Ecolabel is a sign to the German market and globally to show that there is a big difference between using R410A [or R32] and R290,” he says.

De Graaf believes this will encourage manufacturers to be more active in bringing their propane units to the market. “Our real hope is that Chinese manufacturers will supply their R290 units in the European and Asian markets on a greater scale than has been seen so far,” he says.

A report published by Danish HVAC&R component manufacturer Danfoss in 2017 warned that barriers still remain regarding the use of natural refrigerants in air conditioning, but it also highlighted that there is hope.

The report on ‘Refrigerant options now and in the future’ for air conditioning predicts that hydrocarbons will be used as either “the main refrigerant” or in “regular use” for residential applications in most countries in the world by 2025.

Denzinger argues that in Asia, R290 split systems have been introduced successfully. “If India manages to introduce [hundreds of thousands] of R290 split ACs, it should work anywhere. Godrej has had no accidents so far,” he says.

R290 air conditioning will happen if manufacturers, industry and consumers all work together for a sustainable future. Let’s make it across the final frontier! ■ CM

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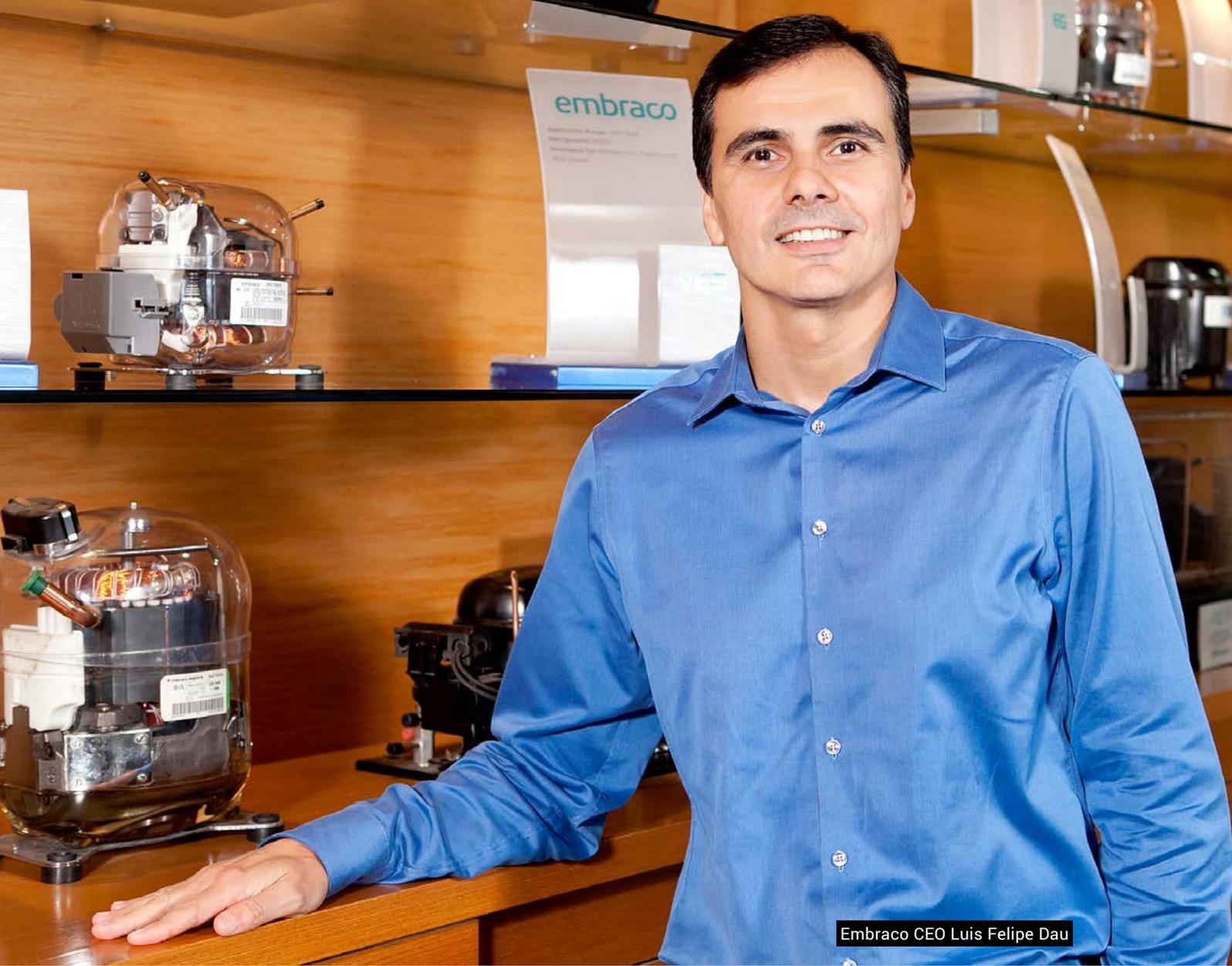
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Embraco CEO Luis Felipe Dau

Constructive disruption

Embraco, a multinational focused on refrigeration solutions, is banking on disruptive technologies to stay ahead of the pack. *Accelerate* sat down with CEO Luis Felipe Dau to find out more.

— By Andrew Williams

“ We believe that using natural refrigerants – especially hydrocarbons – is the ideal solution for the future of refrigeration by sustainably aligning economic and environmental needs. ”

- Luis Felipe Dau

Accelerate: How would you currently characterise the global HVAC&R market? What do you see as the top drivers of change?

Dau: The refrigeration value chain must continue to reinvent itself and innovate much more. Whoever does this best and as a first mover will bear significant value creation in our industry. There are several opportunities to be explored.

The market – particularly manufacturers – is passing through a moment that is challenging yet full of opportunities. The biggest challenge I see in the industry is differentiation in the eyes of end users. Researching in detail consumer behaviours and translating them into a few attributes that consumers truly value, segment-by-segment, country-by-country, is one key factor for success.

Increasing consciousness of environmental sustainability has driven more energy-efficient systems and regulations. Additionally, an increasing appeal for health, translated into food preservation and consumer choices for a healthier lifestyle, is also emerging strongly.

Variable speed compressors are a current reality that will accelerate in the near future. We already see movement in the Latin American, Asian and European markets. The motivation brought by growing demand for refrigeration systems with higher energy efficiency, lower noise and longer food preservation is an opportunity to differentiate by matching system and compressor in a unique way.

Connectivity is another relevant trend, closely related to the Internet of Things. In the case of refrigerators, new features will be developed to increasingly connect the user to equipment, bringing advantages in food preservation and equipment maintenance.

Accelerate: Does Embraco see an opportunity in the HFC phase-down plans being put in place locally and globally? Does this sustainability drive pose challenges for your business too?

Dau: For more than 20 years, Embraco has used natural refrigerants in its compressor portfolio for

commercial and household use to reduce the negative effects on the ozone layer, greenhouse effects and to improve the equipment's energy efficiency.

We believe that using natural refrigerants – especially hydrocarbons – is the ideal solution for the future of refrigeration by sustainably aligning economic and environmental needs.

The use of natural refrigerants with low GWP is on the agenda worldwide, both for use in household refrigeration, as well as for commercial. The US and many other countries are making strides in the refrigeration industry, specifically in commercial food service and retail, to limit energy consumption and harmful environmental impacts. We believe that HFCs will become unfeasible for large-scale production in the medium term.

Sustainability drives our company strategy. We have the constant challenge of being at the forefront of developing new technologies and solutions that meet customer demand, promoting energy efficiency, reducing consumption of natural resources and lessening impact on the environment.

Accelerate: How would you currently describe the commercial refrigeration market in particular, in terms of opportunities and challenges?

Dau: This market is changing faster than ever, due to several regulations all over the world, driving increased efficiency as well as GWP reduction. Production, products and systems using fewer materials are also increasingly driving segments of the refrigeration industry.

Our main driver is to keep developing solutions to support our customers in the short term and researching others for the long term. The main challenges are related to the next wave of regulations, which will push our customers to increase energy efficiency even more.

A combination of drivers – sustainability, health and connectivity – has brought new opportunities to innovate.

Accelerate: Do you think Embraco is well placed to take advantage of the shift towards hydrocarbons in household and commercial refrigeration?

Dau: We are pioneers in using natural refrigerants that, compared to other fluids, make a negligible contribution to global warming and are harmless to the ozone layer. Natural refrigerants also contribute significantly to reducing energy consumption. By adopting propane (R290), in addition to the environmental benefits, we helped our customers manage future regulatory risk.

Accelerate: How do you see the market developing in the next 10 years? Are we looking at a post-HFC world in the realm of commercial refrigeration?

Dau: Rules and regulations will continue to evolve, which is why we place a great deal of focus on our research and development to ensure that we develop the most energy efficient, dependable and innovative compressors and cooling solutions. We believe that natural refrigerants will be the reality after HFCs.

Accelerate: Do you expect uptake of hydrocarbon solutions to proceed more quickly in certain regions than others?

Dau: Yes. All countries have to act, in view of the Kigali Amendment to phase down high-GWP refrigerants. Some regions with more evolved regulations about refrigerants and energy savings, such as Europe and the USA, tend to migrate more quickly to hydrocarbons. Other regions where similar regulations are not yet in place will move more slowly, but because hydrocarbons are more efficient refrigerants, we believe they will also migrate in that direction.

Accelerate: What is the top compressor trend in commercial refrigeration?

Dau: Through anticipating trends, Embraco has been able to develop energy-saving products that reduce the total cost of ownership in the value chain of the light commercial refrigeration segment.

Embraco's pioneering research has led to the development of new technologies and solutions, such as variable speed solutions and products that use natural refrigerants. I would like to highlight Fullmotion, the EMC Compressor, Plug N' Cool and Condensing Units.

Accelerate: Do you think sustainable refrigeration is an opportunity or challenge for your company?

Dau: It's an opportunity certainly. Our focus on transforming technology into innovation challenges us to go further and keeps us as a global benchmark in the refrigeration market. In 2015 we began a scientific study to help us identify critical points to further reduce our ecological footprint.

Looking at global challenges such as climate change, waste generation and natural resource exhaustion, we took inspiration from nature to create Nat.Genius, a business unit that uses decades of reverse logistics expertise of our compressors. With this operation, we recycle several discarded electro-electronic products at the end of their useful life and we make sure that no refrigerant leaks into the atmosphere.

Accelerate: Do you see compressors using HFO blends as representing a serious alternative to hydrocarbon compressors?

Dau: We consider HFO blends to have intrinsically lower efficiency, and to be less competitive and less sustainable than hydrocarbons.

Accelerate: What's next for Embraco more generally?

Dau: Our Vision 'To be leader everywhere by 2020 and recognised by customers as the preferred partner' is what drives our way of doing business. In the last two years, we've intensified the cultural transformation within the company aiming to become even simpler, more innovative and customer-centric. The challenge of doing things differently has brought new opportunities in all our units, whether in revenue generation, cost optimisation or working capital improvements.

Focusing on disruptive technology projects, Embraco seeks opportunities aimed at expanding the portfolio. New initiatives are part of the company's strategies and this is why the company partners with institutions and start-ups.

Accelerate: Do you consider sustainability and environmental issues to play an important role in your personal life too? Do you do anything in particular to reduce your environmental footprint at home?

Dau: Being an outdoor-sport enthusiast, a father of three kids and wishing for a better world for them (and my future grandkids) made me reflect a lot and adapt several of our habits at home over the years. Little things make a big difference not only for a more sustainable world but also for educating the kids. ■ AW

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Publisher

Alvaro de Oña
alvaro.de.ona@shecco.com

Editor

Andrew Williams
andrew.williams@shecco.com
[@a_williams1982](https://twitter.com/a_williams1982)

International Editors

Michael Garry
michael.garry@shecco.com
[@mgarrywriter](https://twitter.com/mgarrywriter)

Reporter

Charlotte McLaughlin

Contributing Writers

Pilar Aleu
Marie Battesti
Jan Dusek
Anti Gzikelis
Eda Isaksson
Klara Skačánová
Devin Yoshimoto

Advertising Manager

Silvia Scaldaferrri

Events Coordinator

Silvia Scaldaferrri

Art Director

Anna Salhofer

Graphic Designers

Charlotte Georis
Juliana Gomez

Photographers

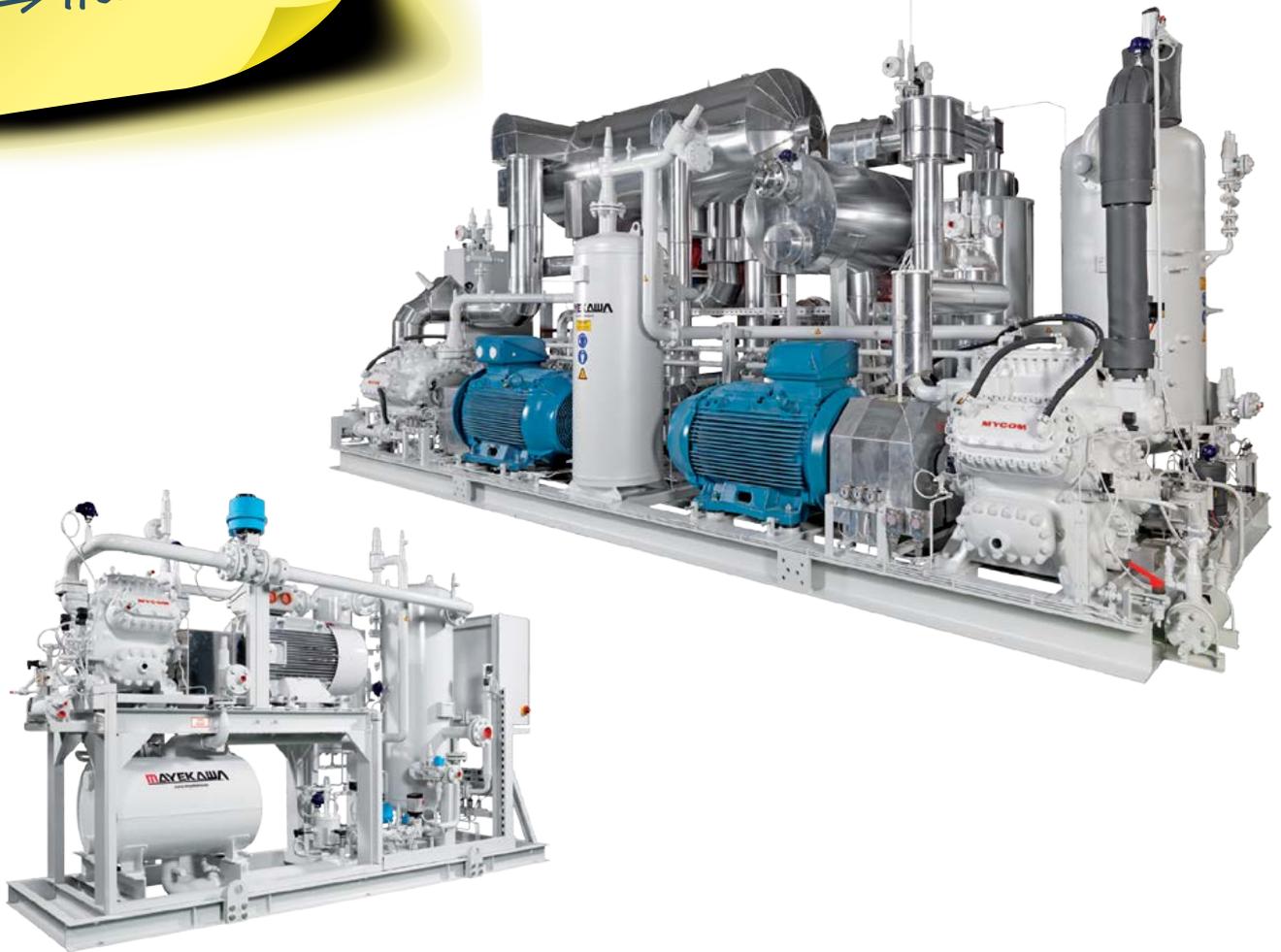
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