WINTER 2016

ACCELERATE

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EUROPE

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Member of the
European Parliament

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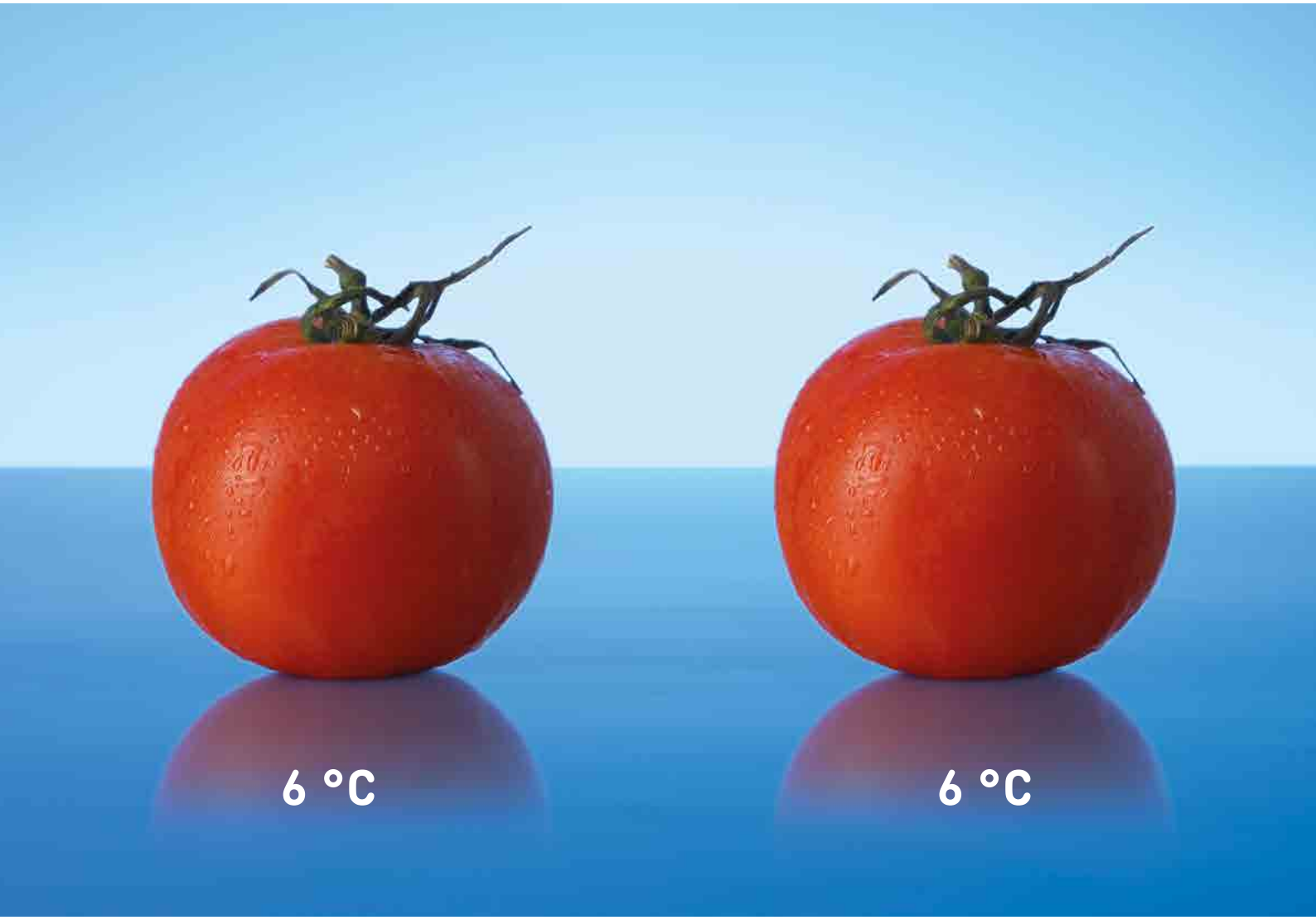
NATREFS POST-KIGALI: A new world order?

There's a difference .... obviously



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Towards a new world order?

— By Andrew Williams

With many in the HVAC&R industry still mulling over the implications of the Kigali Amendment to the Montreal Protocol, the winter edition of *Accelerate Europe* assesses whether the deal struck in the Rwandan capital heralds a new dawn for proponents of natural refrigerant solutions.

As governments around the world prepare to translate the ambitions of Kigali into deliverable regulation at home, 2017 is set to be a once-in-a-generation opportunity for natural refrigerants as market-ready replacements for climate-damaging HFC systems.

The new post-Kigali world order is beginning to take shape. Dutch Green MEP Bas Eickhout sheds light on the key achievements and shortcomings of the Kigali deal, while the European Commission's Philip Owen argues that the EU's flagship F-Gas Regulation can inspire other world regions as they embark on a more sustainable course for the HVAC&R sector (p. 18).

Many of the solutions that will deliver the transition are already out there – with more on the way. At this year's Chillventa in the German city of Nuremberg, over 180 companies were showcasing natural refrigerant technologies – a 50% increase since the previous Chillventa in 2014. Hear from the tradeshow floor about the exciting innovations that are cementing the place of natural refrigerants in the future HVAC&R landscape (p. 46).

As the HFC phase-down begins to transform markets worldwide, Møgens Soholm, CEO of German compressor manufacturer SECOP, sees opportunities for the hydrocarbons-based company. Fully convinced of the role to be played by natural refrigerants, he outlines his personal commitment to a wider rollout of hydrocarbons in light commercial applications (p. 68). For this issue *Accelerate Europe* also visited Huayi Compressors Barcelona, part of the world's biggest compressor manufacturing group Huayi, which is gearing up for an expected steep increase in hydrocarbon solutions globally (p. 72).

The customer base is growing too. Ice rinks are an exciting growth area for manufacturers of natural refrigerant systems and components. Ammonia has long been the refrigerant of choice for ice rink installers, but it is facing growing competition from another natural refrigerant – CO_2 (p. 32).

A report from German brewing tradeshow BrauBeviale (p. 56), features on the growing importance of heat pumps in the energy market (p. 62 and p. 64), and a technology focus on ejectors (p. 74) add to this winter edition of *Accelerate Europe*.

To all our readers: thank you for your loyalty in 2016. On behalf of the whole *Accelerate* team, I wish you and your families a Merry Christmas, and a prosperous and healthy New Year – it promises to be an exciting one for the sector. We look forward to bringing you more cutting-edge natural refrigerant news in 2017! ■ AW

VOLUME 2, ISSUE #5, DECEMBER 2016

ACCELERATE

ADVANCING HVAC&R NATURALLY EUROPE

ABOUT *ACCELERATE EUROPE*

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

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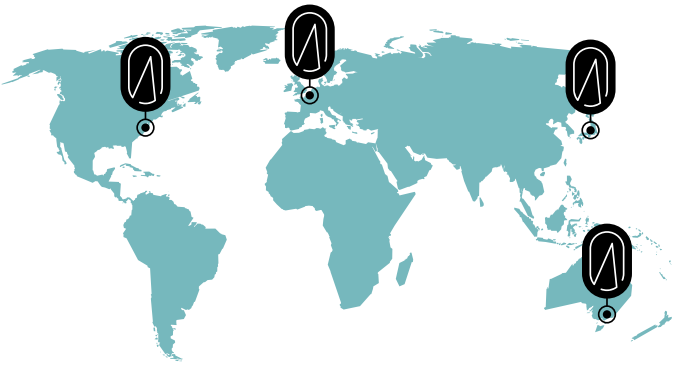

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KIGALI: What's in it for ***natural refrigerants?***

The Kigali amendment is a step in the right direction, but the details don't pack a hard enough punch.

The Kigali amendment agreed in October is the first change to the Montreal Protocol on ozone-depleting substances in the past decade. Though a great leap forward in the fight against climate change, the amendment nonetheless falls short of the high level of ambition boasted about in the run-up to the meeting.

An ambitious HFC phase-down – the low-hanging fruit of climate change mitigation – could prevent up to 0.5°C of global warming by 2100, bringing the world closer to its ambition of reducing overall warming by 1.5°C.

Many hail the Kigali deal as a step in the right direction. Initial reactions from governments, industry and NGOs were supportive. The EU's commissioner for climate action and energy, Miguel Arias Cañete, declared the deal "a huge win for the climate," arguing that it will help the world to stick to the promise made in last year's Paris Agreement to slash half a degree off the median global temperature rise by the end of the century.

These ambitions, however, will only only be realised with a far more stringent agreement.

The pace of the Kigali HFC phase-down is slow – almost too slow. The deal does not place enough emphasis on the opportunity to leapfrog HFCs in favour of new natural refrigerant-based technologies that are cost effective, energy efficient and readily available.

Given the technology solutions available today, developed countries could achieve their phase-down of 15% of their baseline far more quickly than by 2036, the date agreed in Kigali.

For developing countries, the deadlines are even looser. The baseline years taken as reference for the phase-down are far into the future, allowing for increased use of HFCs before the eventual freeze and reduction. Split into two groups, they will only start freezing HFC use in 2024 or 2028, achieving the phase-down in 2045 or 2047 respectively.

The Kigali text recognises the need "to avoid transitions from hydrochlorofluorocarbons to high-GWP hydrofluorocarbons" but still offers flexibility if alternatives cannot be found. Necessity is the best stimulant for innovation, but the amendment is weak on necessity.

A lawyer by training, Ermenegilda Boccabella is the public affairs campaigner at shecco and represented the company at the Kigali negotiations. shecco is the publisher of Accelerate Europe.

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WE'RE STUCK WITH THIS FOR A WHILE

The amendment is inflexible yet will be operational for a long time. It will be difficult to change, with future alterations likely to require new decision texts rather than becoming part of the Montreal Protocol itself.

The most inflexibility can be found in the list of substances, which currently includes 19 known one-compound saturated HFCs. HFCs used in heating, air conditioning and refrigeration tend to be blends of these. Adding new substances to the list may take years. This is a problem – this list is not exhaustive, leaving substances such as unsaturated HFCs (so-called HFOs) on the market.

The HFC phase-down is measured in CO_2 equivalents (GWP x kg of refrigerant), leaving the door open for the chemical industry to push new HFO-HFC blends onto the market whose GWP is still rather high. This will reduce industry's incentive to shift away from HFCs. Adopting intermediate solutions would come at a high price for end users.

'LOW' GWP MIGHT LEAD US TO ACID RAIN

The decision text fails to define high and low GWP, allowing substances that are comparatively noxious greenhouse gases to fall through the cracks and be classified as low GWP.

More worrying still is the risk of industry making another historic mistake. The decade since the Protocol was last amended has been the hottest on record. Temperatures are expected to keep rising. After damaging the ozone layer and warming the planet with CFCs and HCFCs, a new generation of fluorinated refrigerants are not just still on the table: their use is likely to grow.

The Kigali deal allows unsaturated synthetic substances to be considered 'low GWP' and therefore widely used as alternatives. Despite their lower GWP than HFCs, they break down in the atmosphere into trifluoroacetic acid, creating acid rain. Will we wake up in 10 years lamenting the damage done again? Or finally learn from past mistakes and avoid creating new problems when trying to fix existing ones?

EXEMPTIONS

The decision text fails to tackle the 'high ambient exemptions' issue. It allows countries where ambient temperatures are high to apply for exemptions from the HFC phase-down. What's more, as the world gets warmer, more countries will become eligible for high ambient exemptions. The Kigali amendment fails to address this.

There is no reason for countries not to act. Innovation is quickly eroding arguments that high ambient temperatures compromise technological efficiency. Come 2032 the parameters will be entirely different.

NO SILVER BULLET

The Kigali amendment will deliver a global phase-down of HFCs. It also put the HVAC&R sector back in the global and mass media spotlight. Yet it is no silver bullet for the harmful effects of synthetic refrigerants.

The amendment was expected to be far more aggressive, saving us from the dangers of a two-degree rise in average global temperature. Phasing in refrigerants that will need to be phased out again is irresponsible when viable alternatives are already available on the market.

The decision text mentions 'zero GWP' alternatives but does not specifically name natural refrigerants. Natural refrigerants are the only genuinely sustainable solution. It is up to innovators to improve technological efficiency, legislators to create better standards, and educators to provide comprehensive training. These are the priorities that international negotiations must focus on. ■ EB

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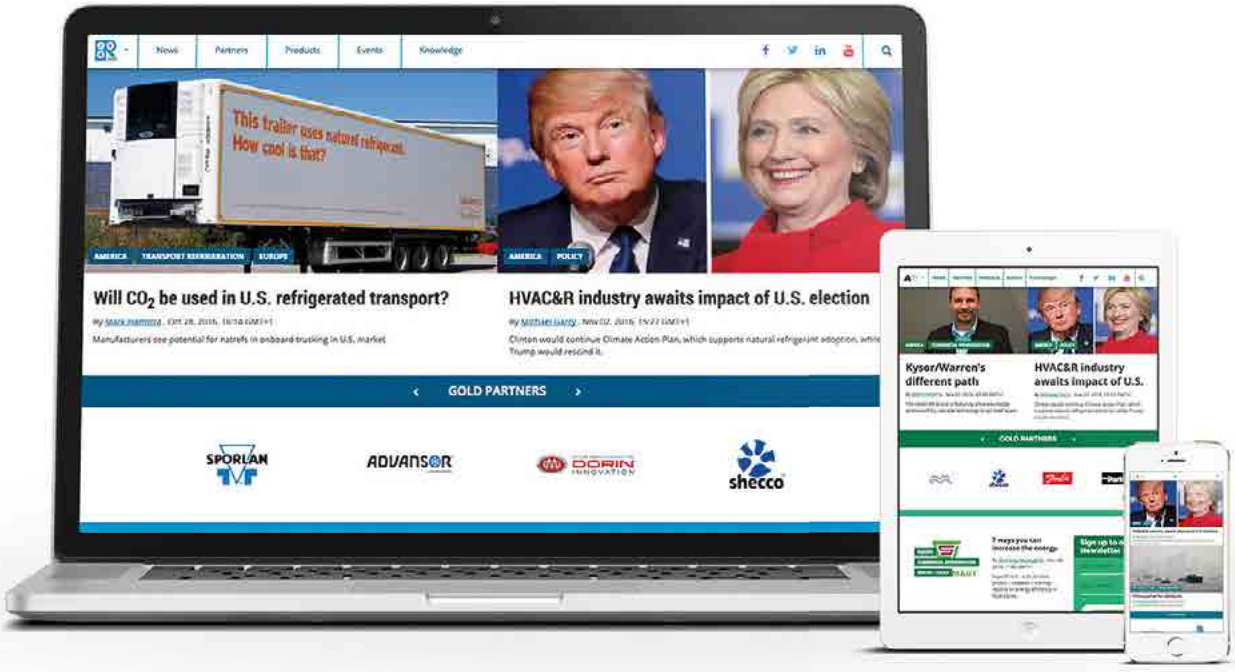

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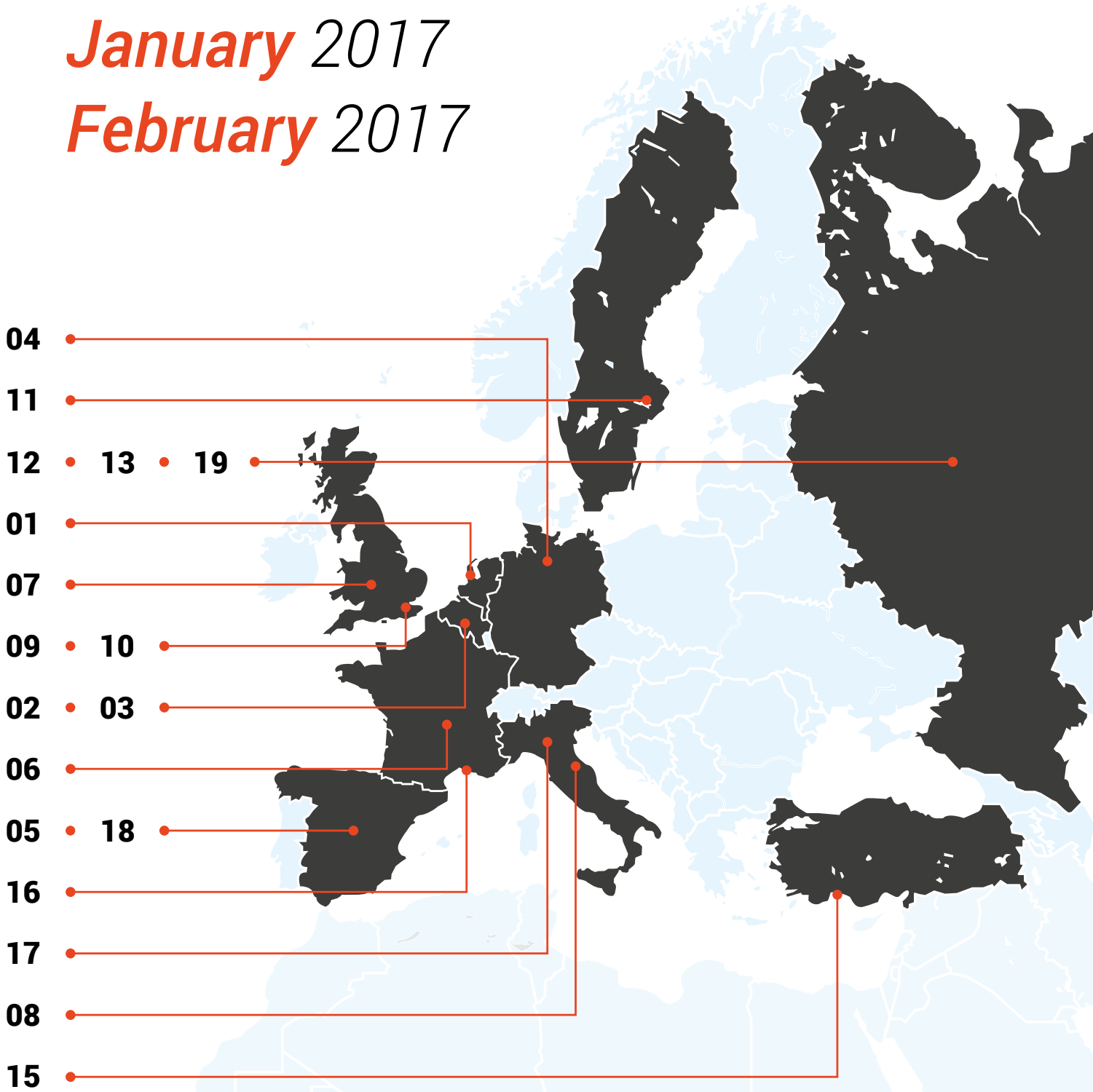

01 9-12 January, Amsterdam, Netherlands
HORECAVA 2017
www: http://www.horecava.nl/
twitter: @Horecava

02 12-13 January, Brussels, Belgium
ASERCOM 2017 Annual Convention
www: http://asercom.org/news

03 12-24 January, Brussels, Belgium
95th European Motor Show
www: http://autosalon.be/en

04 13-15 January, Hamburg, Germany
Hamburger Energietage
www: 13-15 January, Hamburg, Germany
twitter: @HambEnergietage

05 18-20 January, Madrid, Spain
HOREQ 2017
www: http://www.ifema.es/horeq_06/

06 21-25 January, Lyon, France
Sirha 2017
www: http://www.sirha.com/en
twitter: #Sirha @Sirha_Lyon

07 23-25 January, Birmingham, UK
Great Hospitality Show
www: http://en.sigep.it/
twitter: #Sigep2017 @SigepRimini

08 23-27 January, Rimini, Italy
Sigep
www: http://en.sigep.it/
twitter: #Sigep2017 @SigepRimini

09 30-31 January, London, UK
Facilities Management Forum
www: http://facilitiesmanagementforum.co.uk/
twitter: #FMForum @FMForum

10 30 January-2 February, London, UK
16th Annual Temperature Controlled Logistics Meeting
www: http://www.temperaturecontrolledlogistics.com/

11 1-2 February, Stockholm, Sweden
Restaurang 2017
www: http://www.easyfairs.com/fastfood-cafe-restaurangexpo-2017/restaurangexpo-stockholm-2017/

12 6-10 February, Moscow, Russia
Prodexpo Moscow
www: www.prod-expo.ru

13 7-10 February, Moscow, Russia
Aqua-Therm Moscow
www: http://www.aquatherm-moscow.it/

14 14-17 February, Novosibirisk, Russia
Aqua-Therm Novosibirisk
www: http://www.aquatherm-novosibirsk.it/

15 15-18 February, Antalya, Turkey
Anfas Food Product Antalya
www: www.anfasfoodproduct.com

16 20-22 February, La Grande-Motte, France
SIPRHO
www: www.salondesplages.com

17 25-28 February, Brescia, Italy
Golositalia Montichiari
www: www.golositalia.it

18 28 February-3 March, Madrid, Spain
Climatización & Refrigeración 2017
www: http://www.ifema.es/climatizacion_06/

19 28 February-3 March, Moscow, Russia
Climate World 2017
www: http://climatexpo.ru/eng/

EVENTS GUIDE

March 2017

01 2-5 March, Athens, Greece
Infacoma
www: http://infacoma.helexpo.gr/

02 3-6 March, Thessaloniki, Greece
Aqua-Therm Athens
www: http://aquatherm.helexpo.gr/en

03 3-6 March, Thessaloniki, Greece
Detrop Oenos
www: http://detrop.helexpo.gr/

04 5-9 March, Düsseldorf, Germany
EuroShop 2017
www: http://www.euroshop-tradefair.com/
twitter: #euroshop @EuroShop

05 7-9 March, Sofia, Bulgaria
Smart Cities
www: http://viaexpo.com/en/pages/smart-cities

06 8-10 March, Amsterdam, Netherlands
20th European Cold Chain Conference
www: http://www.gcca.org/20th-european-cold-chain-conference/

07 15-16 March, London, UK
Data Centre World 2017
www: http://www.datacentreworld.com/
twitter: #datacenter #DCWHK16 @DataCentreWorld

08 15-17 March, Paris, France
Vending Paris
www: https://www.vendingparis.com/
twitter: @VendingParis

09 16 March, Kremsmünster, Austria
TÜV AUSTRIA Kälte Klima Fachtage 2017
www: https://www.tuv-akademie.at/kursprogramm/detail/p/119.016/event/tuev-austria-kaelte-klima-fach.html

10 19-22 March, London, UK
IFE London
www: http://www.ife.co.uk/
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11 23-26 March, Bucharest, Romania
Romtherm Bucharest
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EUROPE IN BRIEF

TRENDS

Propane chillers trending in Europe

Propane (R290) chillers, working with a secondary fluid like glycol or CO_2, are growing in popularity in Europe for such applications as medium-temperature supermarket display cases and commercial air conditioning, according to an Emerson Climate Technologies executive.

"I'm seeing a whole bunch of propane products for commercial and residential use in Europe," said Dr. Frank Rinne, director, application engineering for Emerson Climate Technologies' Aachen, Germany office, at Emerson's booth at Chillventa 2016.

On the residential side, he said, propane is being used in heat pumps located outside a building and circulating warm water inside.

On the commercial side, supermarkets like Waitrose in the U.K. and Colruyt in Belgium are employing propane chillers with glycol or CO_2 for medium-temperature display cases, and self-contained propane freezer cases. Emerson supplies Copeland scroll compressors for these systems.

The medium-temperature and low-temperature systems can be linked, he noted, by cascading the condenser heat from the low-temperature system via a heat exchanger into the compressor of the medium-temperature unit. Rinne called this a "propane-propane cascade system".
■ Michael Garry

POLICY

France mulling faster adoption of natrefs

In November, the French Ministry of Ecology, Sustainable Development and Energy held its latest meeting with industry representatives to identify barriers to the wider uptake of natural refrigerant-based technology in France, the removal of which would facilitate implementation of the EU F-Gas Regulation.

The Ministry is also looking at possible ways to accelerate the introduction of natural refrigerants through incentives and awareness-raising initiatives. To this end, the Ministry collaborated with the French Environment and Energy Management Agency (ADEME) to publish a call for projects earlier this year supporting the commercialisation of low-GWP technologies.

Following the Kigali Amendment agreed in October, the French government is eager to help companies get on the right path as soon as possible to avoid the adoption of intermediary solutions and boost their competitiveness in future-proof natural refrigerant-based technology globally.
■ Klára Skačanová

POLICY

Italian government wants to know more about natrefs

The Italian Environment Ministry (Ministero dell'Ambiente) has been consulting with the natural refrigerant sector about legislation, regulations and the direction that the HVAC&R sector is taking. A recent meeting with the Ministry was well attended and included presentations by industry and NGOs. Chief among the issues discussed were technology and regulatory support. Similar such meetings have been taking place elsewhere in Europe, particularly in countries with traditionally restrictive standards on training or handling of natural refrigerants.

The meetings were organised in the lead up to the F-Gas Regulation Consultation Forum, which took place on 1 December 2016 in Brussels. The European Commission is charged with evaluating codes and standards, training on f-gas alternatives, the quota allocation method and the feasibility of the 2022 ban on HFCs in centralised refrigeration systems. It is due to report on this during the first half of 2017. With most implementation work occurring at national level, member-state input is important here.
■ Ermenegilda Boccabella

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EUROPE IN BRIEF

TRAINING

Danfoss launches mobile training unit for CO_2

The new container classroom, equipped with CO_2 technology and interactive learning modules, comes in response to industry demand for training on CO_2 refrigeration systems.

"Our mobile training unit will go a long way in promoting the benefits of CO_2," says Hans Ole Matthiesen, Segment Marketing Director, Food Retail at Danfoss.

The training unit features equipment and components for CO_2 solutions, accompanied by hands-on training panels, with on-site instruction by Danfoss experts. The unit can accommodate up to 12 people at a time. Its first stop will be Danfoss' US headquarters in Baltimore, Maryland on 10 January 2017.

The company's goal is to launch several training containers that can serve its primary markets in North America, Europe, and Asia.
■ Eda Isaksson

RESEARCH

R290 outperforms HFOs, new research finds

Propane (R290) boasts superior heat transfer potential than R32, R1234ze and a combination of R32 and R1234ze, according to a recent paper from the University of Padova, Italy.

Performing vaporisation tests on four different refrigerants, researchers from the University of Padova found that R290 offers the biggest potential to replace the widely used R32 in several heating and cooling applications, by virtue of its heat transfer properties.

Azzolin et al, in their paper *Developments on heat transfer with low-GWP refrigerants*, tested heat transfer performance during condensation and vaporisation of new fluorine-based refrigerants – including the hydrofluoroolefin (HFO) R1234ze and an HFC blend – compared to the hydrocarbon R290.

The researchers compared these alternatives to the commonly used HFC R32, which some HVAC&R industry players are touting as an answer to the phase-down requirements of the EU's F-Gas Regulation.

Propane was the most similar to R32 and required the same amount of refrigerant charge – making it an efficient refrigerant, they concluded.
■ Charlotte McLaughlin

TECHNOLOGY

Mobile ammonia refrigeration without battery, compressor

Coldway, a French company, has developed an ammonia mobile refrigeration unit for deliveries for the food, health and pharmaceutical sectors. "The technology works with a sort of 'thermal energy battery' that can be regenerated indefinitely, always available for powerful cooling or finely regulated refrigeration," said Magali Ferrer, health market sales manager at Coldway.

Ammonia and salts interact to create the heating and cooling effect. The units are proving popular in the catering and healthcare service sectors. Ferrer sees the unit as, "the answer to the environmental and physical concerns facing the cold chain currently".
■ Charlotte McLaughlin

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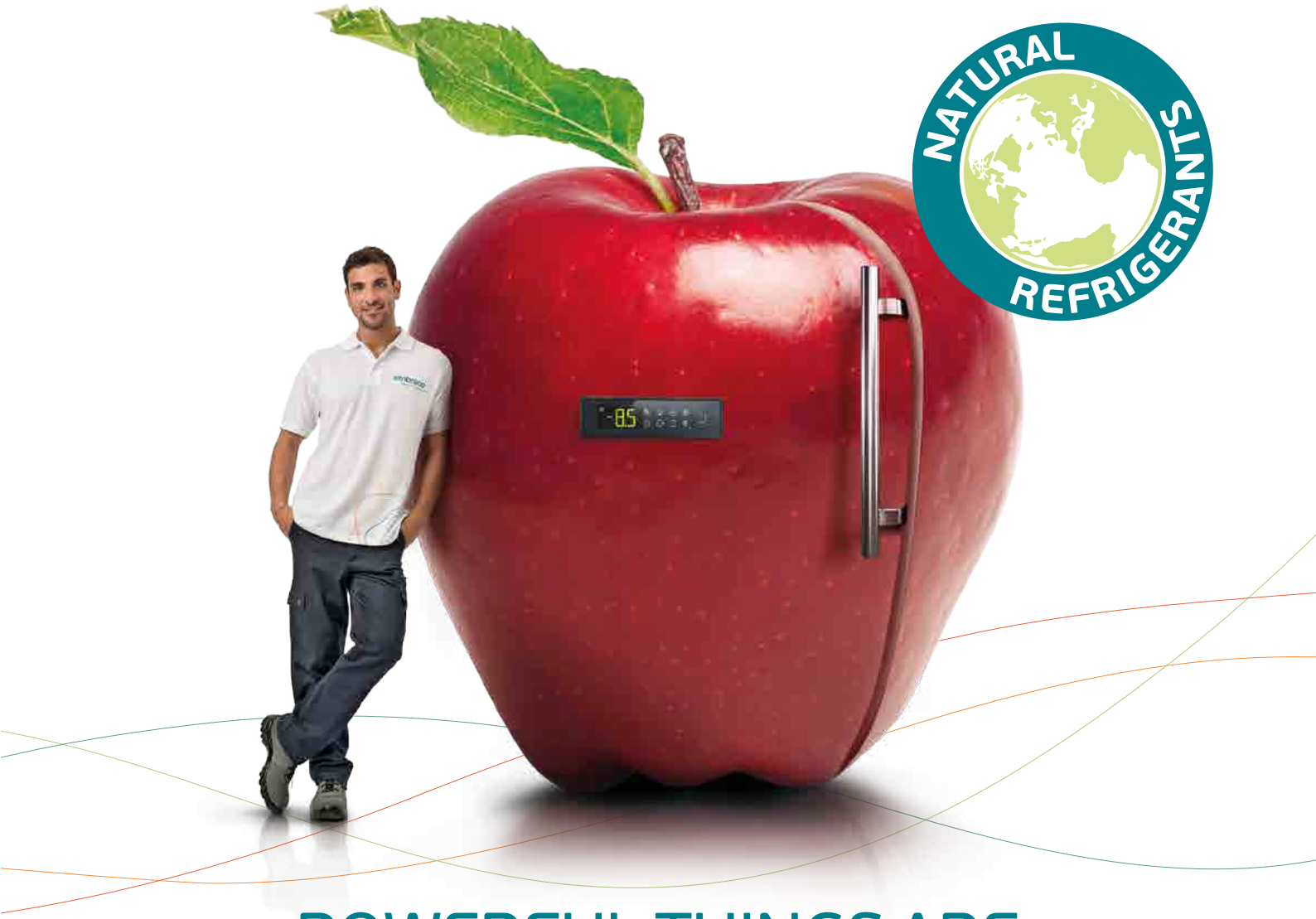

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NATREFS POST-KIGALI: A new world order?

In October, over 190 countries struck a landmark deal to phase down HFCs globally under the Montreal Protocol. *Accelerate Europe* asks key European decision-makers about the implications of the coming transition for natural refrigerants and the future of Europe's HVAC&R sector.

— By Andrew Williams

In Rwandan capital Kigali in the early hours of 15 October, the world clinched an historic deal to limit the production and use of HFCs.

Following years of difficult negotiations, developed and developing nations adopted an amendment to the Montreal Protocol that could prevent 0.5 degrees Celsius of global warming by 2100.

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

The Kigali amendment – which is legally binding for all 197 Parties to the Montreal Protocol – sees developed countries take the lead on phasing down these potent greenhouse gases, starting with a 10% reduction in 2019 and delivering an 85% cut in 2036 (compared to the 2011-2013 baseline).

Shortly after the agreement was sealed, *Accelerate Europe* met a prominent member of the European Parliament, Bas Eickhout, at the EU assembly's seat in Brussels. In an era abundant with international agreements that are often hailed as game-changers, Eickhout is wary of rushing to early conclusions. Yet he senses that Kigali may indeed be the real deal.

"It's probably the most far-reaching global deal on climate change policy. There's the Paris Agreement, of course – that's setting the agenda, but it remains to be seen what that will really look like," he stated.

As a Green member of the European Parliament (MEP) from the Netherlands, Eickhout knows the HVAC&R sector well. Having been responsible for steering the EU's flagship legislation for reducing HFC consumption – the new F-Gas Regulation – through the European Parliament in 2014, he witnessed first-hand the challenges that limiting production and consumption of HFCs can bring.

A green at heart as well as by political stripe, Eickhout is committed to stronger measures in the fight against global warming, and is

28th Meeting of the Parties to the Montreal Protocol, Kigali, Rwanda

also active in environmental legislation in fields such as renewable energies and competitiveness.

"Kigali is legally binding, it addresses an entire group of gases – f-gases – and it sets a long-term phase-out trajectory. I truly think that this one is an historic deal," the Green MEP says.

The Kigali deal splits developing countries into two groups. The first one – which includes China and African nations – will freeze consumption of HFCs by 2024, with their first reduction steps starting in 2029. A second group including India, Iran, Iraq, Pakistan and the Gulf countries will meet a later deadline, freezing their use of these gases in 2028 and reducing consumption from 2032.

The HFCs specifically targeted by the Kigali amendment include the following:

R134, R134a, R143, R245fa, R365mfc, R227ea, R236cb, R236ea, R236fa, R245ca, R43-10mee, R32, R125, R143a, R41, R152, R152a, R161 and R23. Some of these are components of commonly used HFC blends like R404A and R410A, which the amendment also covers.

EU INSPIRATIONAL IN KIGALI

In the European Union, natural refrigerants like CO_2, hydrocarbons and ammonia will have a key role to play in the context of the HFC phase-down taking place under the bloc's new F-Gas Regulation, which entered into force in 2015 and aims to reduce Europe's HFC use by 79% by 2030. 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.

"Kigali wouldn't have delivered this result without the EU F-Gas Regulation being in play," Eickhout argues, adding: "The entire discussion was made possible by the EU showing that a law can be passed, and that markets will respond to and act on it. That ensured a positive mood."

On the ground in Kigali, however, Eickhout sensed the agreement could have been more ambitious. He noted, for example, that the United States and China tended to be in the driving seat during the negotiations. "The EU is not so good at reacting to other positions on the spot," he argues, adding: "It's a pity that Europe didn't really push for a bigger achievement."

Chief among his disappointments is that the Kigali agreement provides for phasing down HFCs rather than banning them outright. "The big discussion that we had in designing the EU regulation was, 'shouldn't we have some sectoral bans?' In sectors [where the phase-down is progressing quickly], why don't we say, 'after such and such a year, it stops for you'," Eickhout asks.

"That just wasn't in the debate in Kigali – so that's what I prefer about the European legislation," he says.

To complete the EU institutional picture, *Accelerate Europe* spoke to the European Commission too. As the EU's executive arm, the Commission was responsible for drawing up the F-Gas Regulation in cooperation with the Parliament as co-legislator – and it was on the ground negotiating in Kigali.

"We think the EU proved that a phase-down works, because we're showing that alternatives are available," Philip Owen – who heads the unit responsible for Montreal Protocol issues in the Commission's directorate-general for climate action – told *Accelerate Europe.*


European Parliament, Brussels

For the Commission's Owen, the Gulf countries and India were always likely to fight hard for an agreement under the Montreal Protocol reflecting their position as fast-growing economies that are at an earlier point in their phase-down pathway than Western nations.

"The Gulf countries got a pretty good deal. But it was very important to understand the Indian position – this is a country that expects significant growth, and has far lower penetration of air conditioning equipment than China, for example. There are good reasons for allowing India the flexibility to grow its economy in a satisfactory way," Owen says.

Ultimately, however, he believes China holds the key to what the future will bring. As the world's biggest producer and consumer of refrigerants, China's efforts to reduce HCFC and subsequently HFC consumption will have a major global impact. "If we've already moved developed and other developing countries to lower GWP alternatives sooner, then the supply side will cut back. That's why I don't think India will grow into high-GWP HFCs – because of China more than anywhere else. China is the crucial player," Owen argues.

In international climate diplomacy, "the expectation of negotiators is that these countries will jump from [HCFCs] straight to lower GWP alternatives," the Commission official says.

HFC BANS: A CLEAR MARKET SIGNAL

With a clear global phase-down schedule now in place, hopes are high that the market will step up to deliver the targets enshrined in the Kigali deal.

"The progressive industries always say, 'give us legislation, give us a target – we can move there, but the market needs a signal of where to go to'. They need a push," says Eickhout.

Investors, too, "need to get the idea, 'OK, so we'll put our money there'," he says, lamenting the attitude of politicians who warn against overregulation here.

"The market is asking for it – it's there in our study," the MEP says, referring to a report on the EU F-Gas Regulation commissioned by the Greens/European Free Alliance Group in the European Parliament.

"The study shows that sectors where the ban is in place are already moving. You can really see the signal that the legislation is giving. The sectors that are only part of the phase-down are hardly doing anything at the moment, so you really see the quick reactions in the sectors that have to stop," Eickhout says.

As for Kigali, the Montreal Protocol amendment will take effect on 1 January 2019 – if at least 20 countries have ratified it by that point – or on the 90th day after ratification.

Will the Kigali Agreement be ratified smoothly? "It has to happen, because that's the first step!" quips the Commission's Owen.

"It would be a huge mistake to let this opportunity go by. Putting the US aside for now [in the wake of Donald Trump's election as president in November], I think you'll see other key players like the EU, Norway, Switzerland, Australia, Japan and Canada all going forward in this respect," Owen argues.

He expects developing countries to ratify Kigali quickly too – not least in order to secure swift access to climate finance allocated to them under the terms of the deal.

As countries around the world begin to implement the Kigali Agreement, chemical companies that manufacture a new generation of fluorinated refrigerants (so-called HFOs) are expected to push for these to be adopted as alternatives to HFCs. What will happen if these require phasing down further down the line as environmental protection measures intensify?

EU F-GAS REGULATION: SELECTED KEY DEADLINES

- 1 January 2015: Entered into force
- 2016: HFC phase-down of 7% (excluding pre-charged equipment)
- 1 January 2017: HFC phase-down to include pre-charged equipment
- 2018: 37% cut in HFC quotas (estimated 44% including pre-charged equipment ban)
- 2021: 55% cut in HFC quotas
- 2022: Ban on using certain HFCs (GWP ≥ 150) in new plug-in commercial refrigeration equipment
- 2022: Ban on using certain HFCs (GWP ≥ 150) in new centralised commercial refrigeration equipment (with minor exemptions)
- 2030: Phase-down of bulk HFCs by 79%

"A tougher phase-down or more sectoral bans would give a clearer signal to the market to skip this intermediate phase and go to the natural [refrigerant] alternatives right away. Kigali could have been better there," Eickhout argues.

The European Commission must remain technologically neutral and cannot back one option over another as long as they all comply with existing legislation. "We wouldn't want to pick winners," says Owen. Nonetheless, he predicts that natural refrigerants will continue to grow. "They have to increase to make the phase-down work," he says.

TOWARDS A REFRIGERANT LABEL?

In the European Union, household appliances are fitted with 'eco-labels' evaluating their performance in terms of energy efficiency. Does Eickhout think a similar label for refrigerant emissions – or to show that a piece of equipment runs on natural refrigerants – is feasible?

"I'm a bit sceptical, to be honest," he confesses. "Unfortunately we're going through a phase where EU regulation is not the most popular level of policymaking! So the Commission is a bit more reluctant to propose laws that are perceived as being more invasive. The escape is always labelling – let's label, and leave it to the consumer," Eickhout says.

Instead, the MEP places the ball firmly in politicians' court in terms of introducing stricter legislation. "As politicians, why not simply push the market in a certain direction?" he says.

In the European Union, for example, "we could expand eco-design [rules] into other areas, including greenhouse gas emissions," he reasons.

At the European Commission, there is little desire to table new labelling schemes either. "Positive labelling I don't see happening. I don't think there's much appetite for another eco-labelling scheme at European level," Owen says.

MARKET RESISTANCE AND OPPORTUNITIES

Drawing from his experience steering the F-Gas Regulation through the European Parliament, the MEP stresses the need to emphasise the economic as well as environmental benefits of phasing down HFCs in order to move the market.

"I'm a 'green lunatic' so I'm very much driven by climate and why it's important to do things due to their impact on the climate. But what's nice about this topic is that there's an alternative industry that can gain from it," Eickhout says.

Chemical companies that produce fluorinated refrigerants know this. "There was a big lobby against [the F-Gas Regulation] by the big chemical players who thought it was going too fast. We managed to overcome this because the innovative part of industry was supportive and outspoken," he states.

The MEP believes Europe is in a good position to benefit from the HFC phase-down. "We import the majority of our f-gases. But the alternative [technology] is often from European industry. You have alternatives that are better for the environment and better for these companies – we'd be stupid not to go for it!" he argues.

The reach of chemical companies that manufacture patented refrigerants is not to be underestimated. Often they have permanent advocacy staff based in Brussels, the home of the EU institutions. Politicians can help to ensure that a greater diversity of voices is heard.


Dutch Green MEP Bas Eickhout


European Parliament


Philip Owen, European Commission, at the Kigali meeting

Eickhout cites CO_2 refrigeration as an example. "As rapporteur [during the F-Gas Regulation negotiations], I organised working sessions with other political groups and I invited the progressive, smaller [company] players to Brussels," Eickhout explains. Politicians of all stripes heard "totally different stories to what the big players were telling them – because they were saying, 'It's not possible in the South, it's too expensive, it's dangerous,' you know, all that stuff," he says.

"Suddenly they heard, 'it's already there, it's already being implemented, people are already doing it'. That helps to get regulation agreed – and it's regulation that pushes this up-and-coming market," Eickhout argues.

He believes politicians won't hesitate to act if the market does not move this way of its own accord. "Why should it be an ideological decision? Everyone should be concerned about the climate. But OK, if [companies] don't want to be, then policy comes into play," Eickhout says.

"You'll always have good players leading the market in the right direction, which is great. Politics is just pushing the rest of the market. That's what we're doing in Europe with the F-Gas Regulation," Eickhout says.

Many European companies are market leaders in developing state-of-the-art natural refrigerant-based systems and components capable of outperforming their HFC-centred counterparts across the economy. Why is it so difficult to accelerate the transition?

"It's because you're moving the market to other players. The chemical industry plays less of a role in this natural refrigerant world. But the chemical industry is a very well organised, well-established world with big players. Big voices get heard," Eickhout warns.

The MEP is speaking from experience. "After we managed to get Parliament to adopt a progressive position [on the EU F-Gas Regulation], we had a huge fight with the EU member states," he says, recalling the obstructive role played on occasion by certain countries that host large chemical producers.

"It's classic – you see the vested interests getting into their trenches saying, 'don't move too fast, we're in the middle of the transition'," Eickhout says.

The voices of the new industry players supporting natural refrigerant solutions are more diverse. "They're smaller, they're up-and-coming, they may not have time to follow what's going on in Brussels because they're building their industry back home. They don't have full-time lobbyists walking around here – that also makes it difficult," the MEP says.

He expects this to change as HFCs are phased down and alternatives – including natural refrigerants – take their place on a wider scale. "Once your business takes off, you become an important player yourself. The political level can help give you a push. Business does the rest," he says.

VIEW FROM PARIS

Accelerate Europe chats to Florian Veyssilier, a policy advisor at the French Ministry of Ecology, Sustainable Development and Energy.

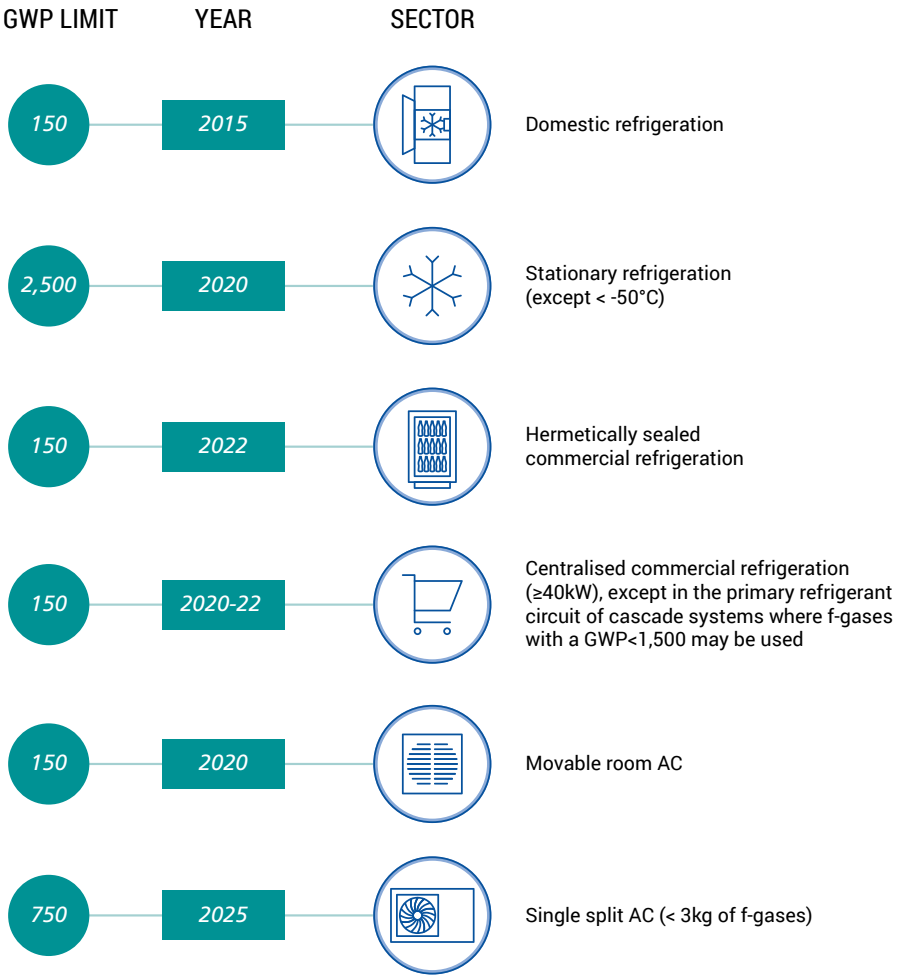
Could the EU F-Gas Regulation be more ambitious? Are there ways to change its course?

When drafting the F-Gas Regulation, some stakeholders, including France, supported an auction-like mechanism to deliver quotas. The regulation, as it is published, doesn't include such a mechanism. But the quota decrease is quite strong and quite simple to implement. The Commission must soon produce a report on how successfully the regulation is working on this particular issue, and if implementing a different mechanism would bring more benefits. This will help to make good decisions on this in the future.

How would you assess Kigali?

The amendment gives a clear signal to companies and governments that HFCs will no longer be a promising market but rather substances to give up. Investment in innovations will be more focused on alternative gases. This will reduce their cost. Natural refrigerants will play a key role in delivering Europe's HFC phase-down targets.

SECTOR-BY-SECTOR: HFC BANS UNDER EU F-GAS REGULATION



Source: F-Gas Regulation Shaking Up the HVAC&R Industry, produced by shecco and commissioned by The Greens/ European Free Alliance group in the European Parliament, October 2016

TOWARDS A PAID HFC QUOTA SCHEME?

The introduction of a paid cap-and-trade system governing production and consumption of HFCs, in the spirit of the EU's Emissions Trading Scheme, would be one way for politics to steer the European market towards alternatives.

"I'm interested in it. It creates revenue that helps industry and supports it in making the shift," says Eickhout. But like any potential EU initiative involving new taxes or fees, a cap-and-trade system for HFCs would be difficult to introduce. Not least because "this was heavily opposed in the [F-Gas Regulation] negotiations," he warns.

The MEP intends to use a review of the F-Gas Regulation's quota allocation mechanism – due by July 2017 – to argue his case once again. "Of course we'll push for that. The Commission is obliged to look at it," Eickhout says.

The EU executive is more cautious. The cap-and-trade system is "something that the Parliament was very keen for the EU member states to do something about," Owen says. "I think the political reality is that the Council [of EU countries] wouldn't want it. It's not something that found favour a couple of years ago," he explains. "At present I don't think there's the appetite for [cap-and-trade], for many reasons – such as the complexity and the administrative burden, let alone the politics of it," the Commission official says.

Nonetheless, he expects it to be discussed. "I'm sure it'll be one of the questions on the table in the next review," he says.

Should such a scheme materialise, it would send a powerful signal to the rest of the world that Europe is serious about phasing down HFC emissions. "We have to take it step-by-step. We're dependent on the Commission, and the Commission is dependent on the member states," says Eickhout, warning that the EU can be "a slow-moving beast".

"The review is a new moment, where we're going to push this topic again and make sure that the Commission considers it," he says.

The EU executive warns against drawing early conclusions on the need for major reform of the F-Gas Regulation, which only came into force on 1 January 2015. "We're certainly meeting our targets for 2015, the first year," says Owen. He characterises instances of non-compliance so far as misunderstandings rather than deliberate attempts by industry to outsmart the system.

As is often the case with EU legislation, implementation of the F-Gas Regulation currently varies from country to country. "This is the challenge of having one regulation applied in 28 EU member states and in so many languages. There are bound to be differences in understanding," Owen says.

The F-Gas Regulation stipulates that the Commission must publish two reports on f-gas alternatives by 1 January 2017. The first concerns existing training on using such equipment. The second concerns current standards and codes governing the use of f-gas alternatives, with a view to identifying barriers to wider rollout of the technology.

The European Commission is also looking at standards and codes currently in place in EU countries and at EU level that act as barriers to the adoption of HFC alternatives.

"Standard-setting is a real challenge for the introduction of alternatives in many sectors," Owen admits. "The challenge with standards is the multi-layered approach: global, European, national and local level. You get down to local building regulations in certain member states, and find that you're blocked there. It's an issue, and we're working hard at EU level to do something about it," he explains.

Owen stresses the importance of convincing industry to move in the same direction. "There is global recognition as part of the Kigali package that this is an area that deserves work – specifically to allow the introduction of hydrocarbons in domestic applications," he says.

Clearly, then, the new post-Kigali world order is only just beginning to take shape. The Kigali Amendment was strongly inspired by the EU's own F-Gas Regulation, which is already helping Europe to navigate the future HVAC&R landscape.

As attention turns to the longer term, it is clear that European industry has a unique opportunity to capitalise on its impressive technological knowhow to bring natural refrigerant solutions to a global audience. ■ AW

WHAT OTHERS ARE SAYING:

CALIFORNIA AIR RESOURCES BOARD:
"The Kigali Amendment saw positive compromise resulting in a stronger phase-down for developed countries than was detailed in the initial North American proposal submitted by the United States, Canada, and Mexico."

"A revised Short-Lived Climate Pollutant (SLCP) Plan from ARB is expected in the coming months. It will reflect California's proposed actions to further reduce HFC emissions, pending evaluation of projected HFC emissions and reductions from the global phasedown amendment."

PAULA TEJÓN CARBAJAL, GREENPEACE INTERNATIONAL:
"The chemical industry […] is betting on HFOs to maintain the multibillion dollar global monopoly over the refrigeration market it has enjoyed with CFCs, HCFCs and HFCs […].

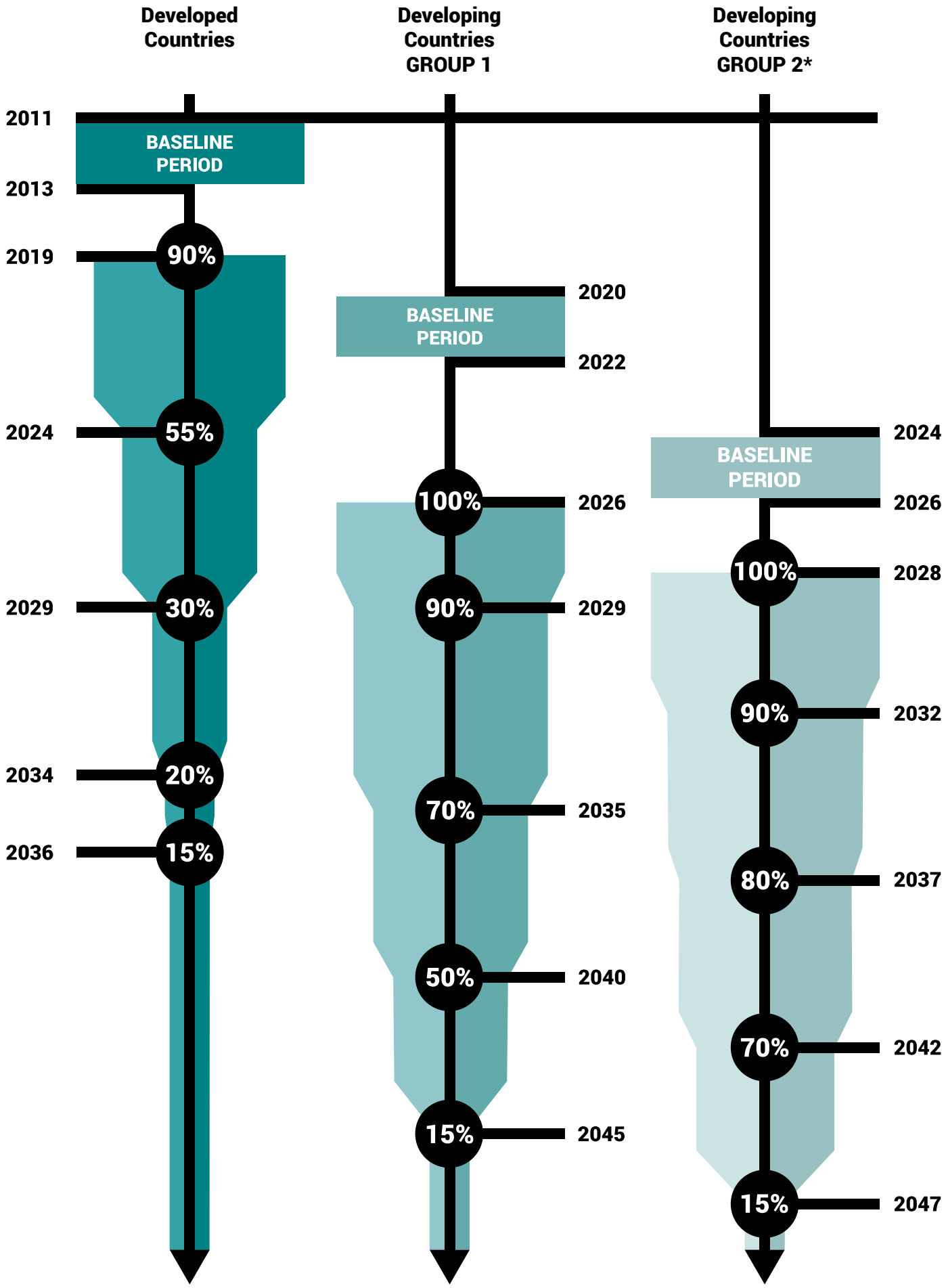
[It] has a sorry track record with its CFC, HCFC and HFC products. They have caused extensive environmental damage and endangered life on the planet […].

The costs of cleaning up have been left to the public purse […]. There is no credible reason for governments to accept at face value industry's claims regarding the safety and technological benefits of HFOs. Who will pay the mitigation costs should the large-scale production of HFOs result in yet another global crisis? Greenpeace calls for governments to hold the chemical industry accountable."

OLAF SCHULZE, DIRECTOR (FACILITY, ENERGY AND RESOURCE MANAGEMENT), METRO AG:
"Kigali underlines for us that we are on the right path with our F-gas exit programme.

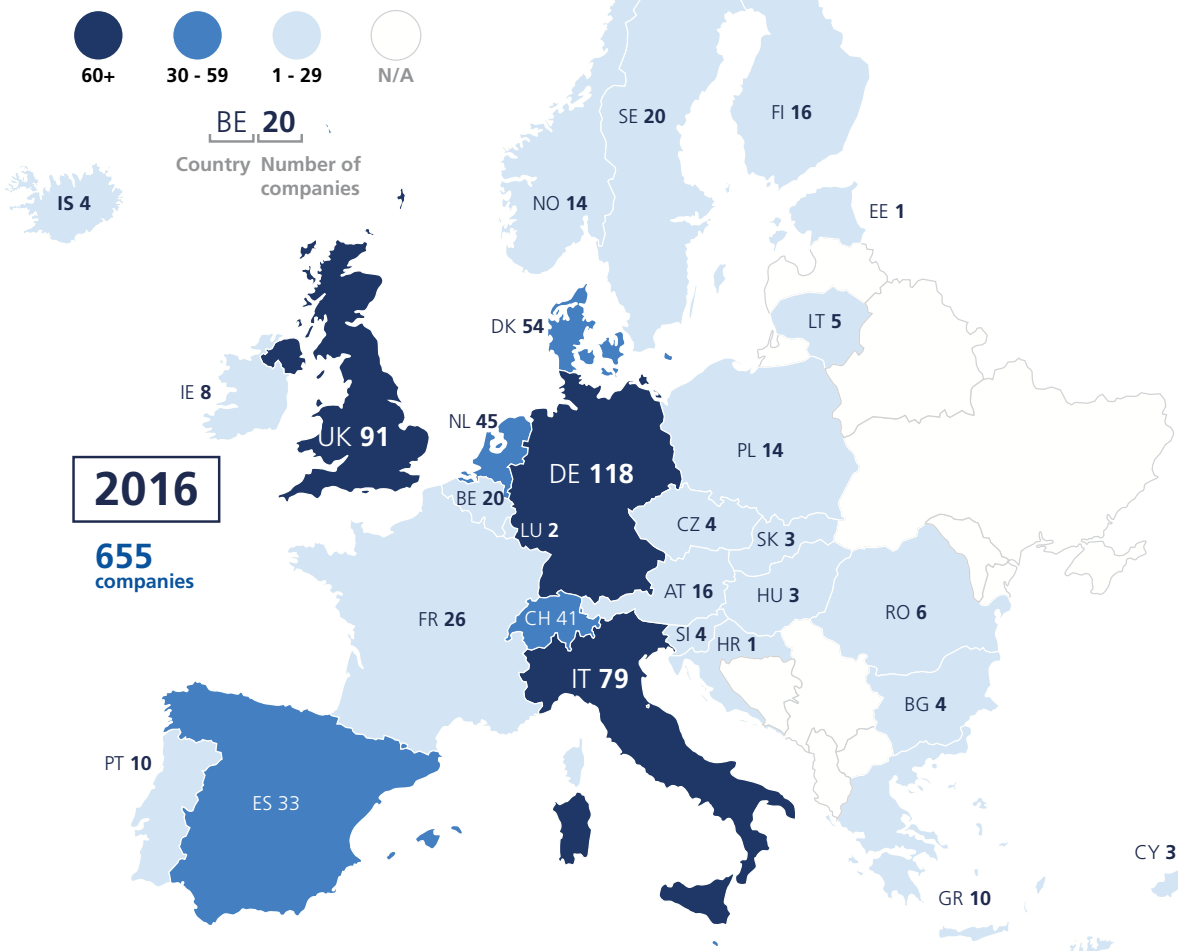
Kigali itself has no influence on our F-gas exit programme, but we can underline that METRO is on a very good trajectory worldwide. We want to have already implemented a large part of our exit plan by 2025."

THE KIGALI HFC PHASE-DOWN SCHEDULE



* India, Iraq, Iran and the Gulf States

Impact of EU's F-Gas Regulation on Natural Refrigerant Market

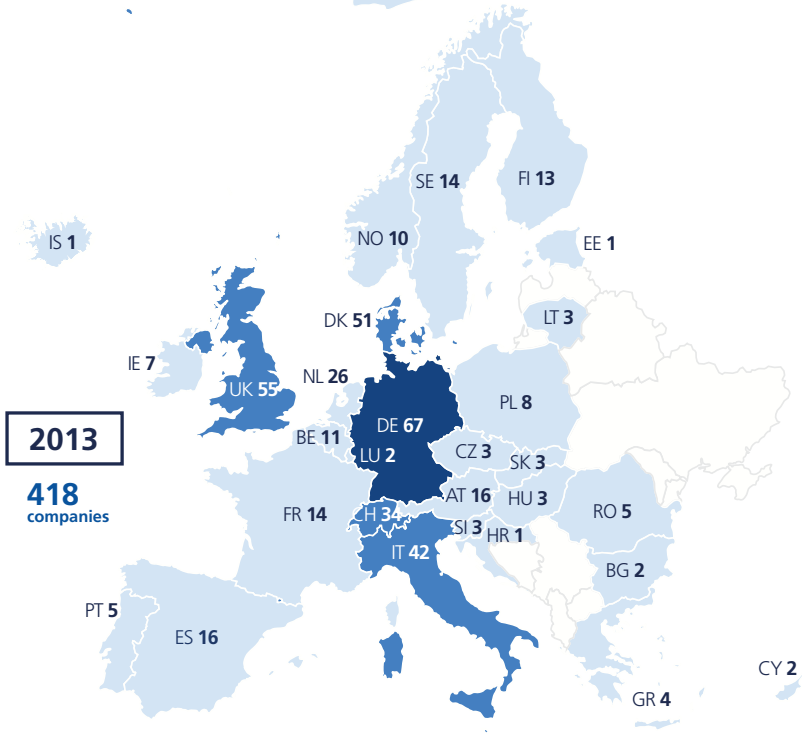


The impact of the EU's new F-Gas Regulation, which took effect on 1 January 2015, is already being felt in the natural refrigerant marketplace. This chart shows its effect on the number of natural refrigerant component and system suppliers, contractors and service providers, country-by-country. The total number has risen by 237, or 57%, between 2013 (when the new F-Gas Regulation was still on its way) and 2016.

While reasonable efforts were made to account for the number of natural refrigerant companies as accurately as possible, these figures are not necessarily exhaustive and will serve as an estimate of the market.

For a list of countries and their abbreviations, see http://sustainablesources.com/resources/country-abbreviations

Source: F-Gas Regulation Shaking Up the HVAC&R Industry, produced by shecco and commissioned by The Greens/ European Free Alliance group in the European Parliament, October 2016.



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SETTING THE STANDARD

Europe: ***Triple growth in CO_2 stores in three years***

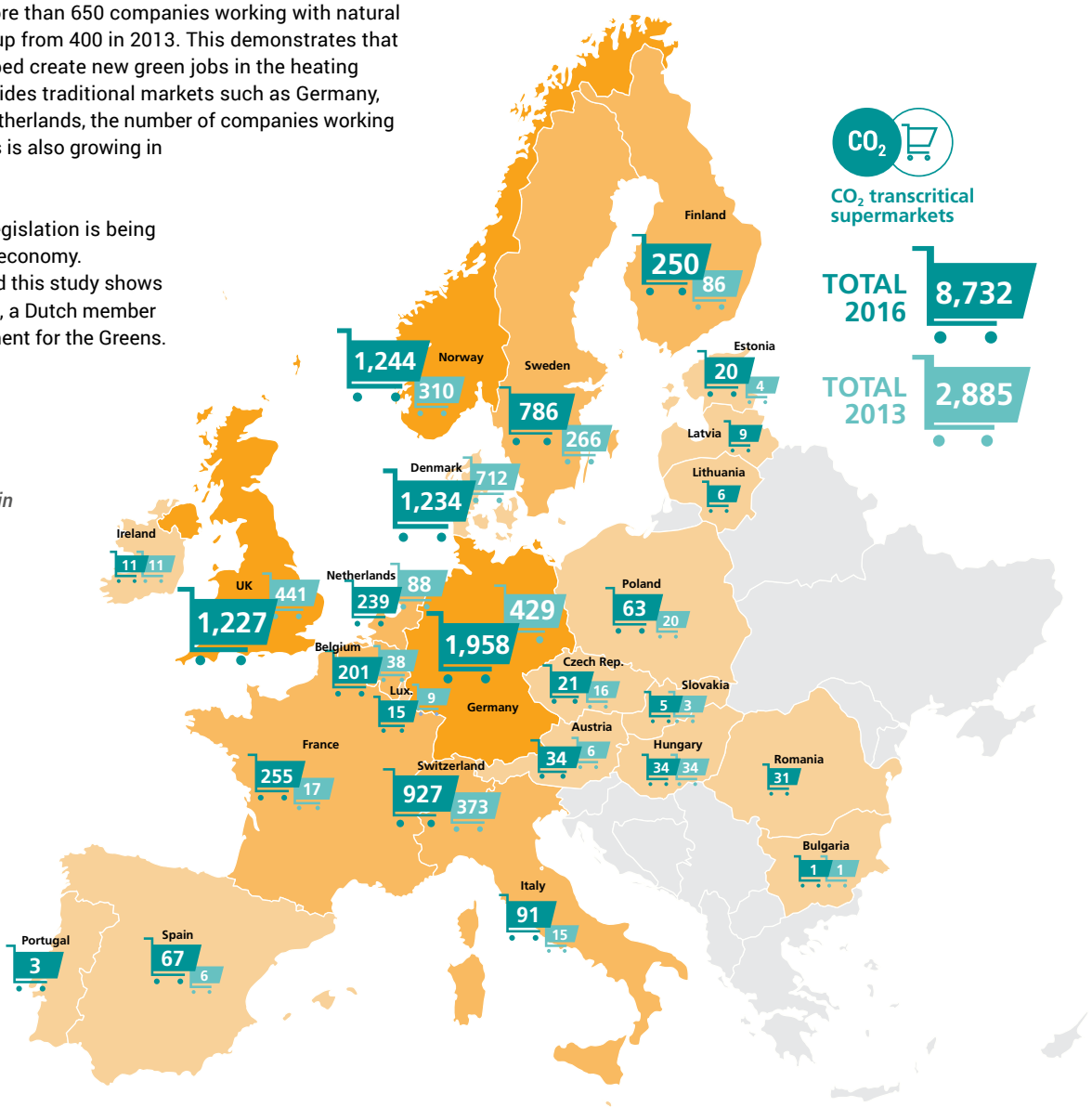
New data reveals a marked increase in the number of CO_2 transcritical stores as well as companies working with natural refrigerants in Europe over the last three years. The report, published by shecco in October 2016 in collaboration with Bas Eickhout, a member of the European Parliament, looks at the impact of EU legislation on HFCs in Europe and beyond.

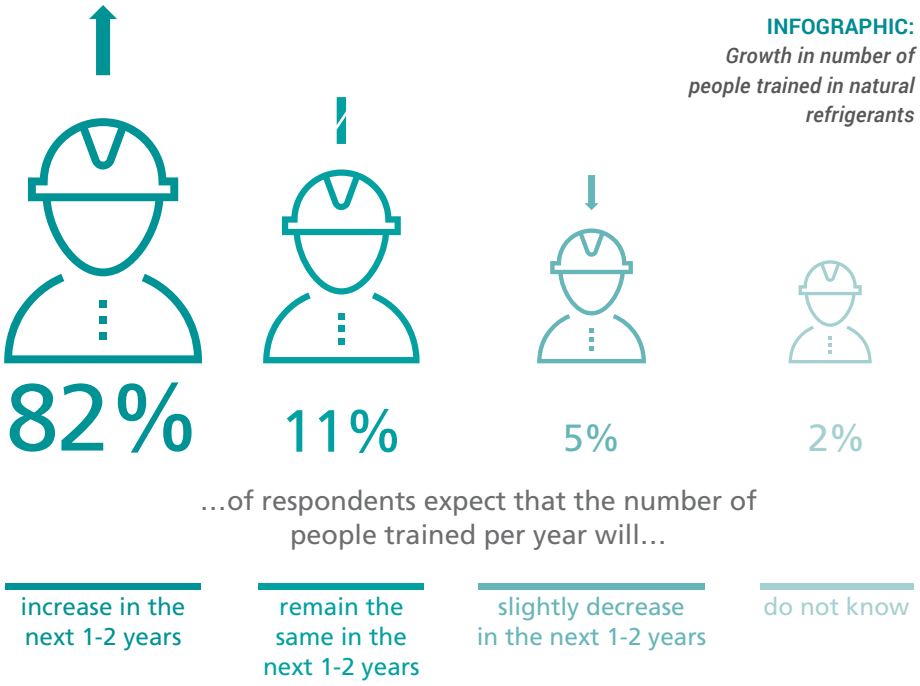
— By Klára Skačanová

The study, entitled 'F-Gas Regulation shaking up the HVAC&R industry', found that there are more than 650 companies working with natural refrigerants in Europe, up from 400 in 2013. This demonstrates that the Regulation has helped create new green jobs in the heating and cooling sector. Besides traditional markets such as Germany, Switzerland, and the Netherlands, the number of companies working with natural refrigerants is also growing in Southern Europe.

"Often environmental legislation is being seen as harmful to the economy. The opposite is true, and this study shows that," says Bas Eickhout, a Dutch member of the European Parliament for the Greens.

INFOGRAPHIC:
Stores using CO_2 transcritical technology in Europe 2013-2016





INFOGRAPHIC: *Growth in number of people trained in natural refrigerants*

"Good environmental legislation highlights the path of sustainable growth that industry inevitably needs to take. The EU F-Gas Regulation led to a boost in the uptake and improvement of natural alternatives," Eickhout says.

First-movers who had invested in future-proof HFC-free solutions ahead of the EU-wide regulatory changes were already reaping the benefits of their competitive advantage before the Regulation came into effect, the report finds. Over 230 industry representatives were asked how the F-Gas Regulation had impacted the availability, efficiency and cost of natural refrigerant-based technologies.

HFC BANS DRIVE INDUSTRY TO FUTURE-PROOF TECHNOLOGIES

50% of survey respondents stated that the most significant impact of the global HFC phase-down would be the shift away from high-GWP refrigerants across all sectors. Sector-specific bans on HFCs would be the most effective measure in driving industry towards long-term technologies and avoiding intermediate steps, the research found.

Supermarkets are a good example of how bans on certain HFCs (to be put in place in 2022) are already significantly increasing the commercial availability of natural refrigerant-based refrigeration equipment. The number of stores using CO_2 transcritical systems in Europe has tripled in the past three years. CO_2 transcritical systems can now be found in approximately 8,730 stores, representing 8% of the European food retail sector.

The F-Gas Regulation has boosted investment in innovative technologies for warmer climates, with a number of companies introducing CO_2 solutions that have proven to work efficiently in temperatures of up to 45°C. A growing number of CO_2 stores have been emerging in Spain, Italy, Romania and the south of France. Eastern European countries Latvia and Lithuania began adopting the technology in 2013.

GROWING NUMBER OF TRAINED TECHNICIANS

The HVAC&R industry is responding to the growing need for trained personnel, with the number of training programmes and dedicated centres on the rise. Of a total of 160,000 technicians, the report estimates that around eight to ten thousand received training in natural refrigerants in 2015. Four in five HVAC&R industry experts expect to see the number of people trained on natural refrigerants increase within the next two years. Almost 50% of those that do not currently provide or receive training on natural refrigerants plan to do so between 2016 and 2020.

EU REGULATION WITH GLOBAL IMPACT

The EU F-Gas Regulation has set a precedent for phasing down climate-damaging refrigerants and replacing them with readily available climate-friendly alternatives, such as natural refrigerants. It is proving to be an inspiration for legislators around the world who are designing their own rules to limit production and consumption of HFCs (see 'Natrefs post-Kigali: A new world order?, p. 22).

Glenn Gallagher, air pollution specialist for the California Air Resources Board (ARB) and the key person in charge of developing California's strategy for reducing HFC emissions, considers the EU Regulation to be the "best existing programme in the world to reduce f-gas emissions". The ARB, which is currently working on measures to curb HFCs, believes bans can reduce HFC emissions quickly and plans to outstrip the EU F-Gas Regulation in terms of their introduction.

At global level, the work that the EU has done in Europe serves as a great example of what can be done on a global scale to reduce HFC emissions and thereby avoid 0.5°C of global warming by 2100.
■ KS

The report is available to download for free at http://publication.shecco.com.

Will **ice rinks** go CO_2 in future?

Ammonia has long been the refrigerant of choice for ice rink installers. But it is facing growing competition from another natural refrigerant – CO_2.

— By Charlotte McLaughlin, James Ranson, Yukari Sahashi and Alvaro De Oña

CO_2 ice rink in Bahcohallen sports complex, Enköping, Sweden

CO_2 ice rink, Mechelen, Belgium

Jörgen Rogstam, managing director of Swedish refrigeration engineering consultants Energi & Kylanalys (EKA) is in confident mood. "Ice rinks will go CO_2 in the future," he declares.

Thanks to their impressive energy efficiency, ammonia systems dominate Sweden's ice rinks. 85% of them use the natural refrigerant, with the remainder using R404A and R134a or other hydrofluorocarbon (HFC) refrigerants.

With HFCs currently being phased down under the EU's F-Gas Regulation, manufacturers of CO_2 technology are targeting the ice rink sector too.

Yet for CO_2, "commercialisation has been a problem," according to Rogstam. While ammonia has a long history of use in ice rinks, CO_2 was first used in an ice rink in 1999 – in an ammonia cascade system in Austria. The first ammonia ice rink was installed in New York back in the 1870s.

In 2002, the International Hockey Federation called for the adoption of CO_2 as the primary refrigerant for ice rinks. Yet it was not until 2010 that the first transcritical CO_2 ice rink was installed, in Saint Gédéon, Canada to retrofit an R22 system.

WHY HAS UPTAKE BEEN SLOW?

In the early 2000s, components for transcritical CO_2 systems tended to be expensive and lacked cooling power. During this time, "the CO_2 ice rink refrigeration system would have required about 15 [compressors], whereas a typical ammonia system would only use two compressors, which made the CO_2 system seem expensive and impractical," Rogstam says.

"Today the number of CO_2 ice rinks is growing rapidly. There are now 25-30 CO_2 ice rinks in the world," he says. 20-25 of these CO_2 ice rinks are in North America, 20 of which are in Canada (mostly in Quebec) and three are in Alaska, according to EKA.

Carnot Refrigeration has been leading the way in North America. Marc-André Lesmerises, CEO and co-founder of Carnot – which has installed 65 CO_2 transcritical systems in supermarkets across Canada and the US – sees potential for CO_2 applications "everywhere". Carnot has already put CO_2 systems in "eleven rinks in eight different facilities," according to Lesmerises.

In Europe the ice rink market has been slower to pick up. Although there are over 8,500 transcritical CO_2 racks in supermarkets, there are fewer than than 10 CO_2 ice rinks in Europe. This may in part be due to Europe's long tradition of using ammonia in ice rinks. In the US, strict public safety regulation in some states has prevented ammonia installations.

SCM Frigo transcritical CO_2 rack at the ice rink in Mechelen, Belgium

CO_2 ice rink, Mechelen, Belgium

THE TIMES THEY ARE A' CHANGING

The more the cost of the system components has decreased, the more people have invested in CO_2 transcritical technology, Rogstam observes. EKA installed the continent's first CO_2 transcritical ice rink in the small town of Gimo, Sweden in 2014.

During the first six months of operation the system's total energy usage was 296 MWh, saving the operator 60% in energy costs. "Our electric energy consumption is way below what I thought was possible. It is less than half the cost compared to our second ice rink," says the ice centre's Technical Operations Manager Lasse Karlsson.

"We are very proud to have this facility. If I were to build a new ice rink facility today, I would only consider CO_2, because the benefits are so great," Karlsson adds.

"There are five CO_2 ice rinks in operation right now and there will be a sixth just before Christmas. We, EKA, have designed five out of these six. We will probably add another five to seven CO_2 rinks by the start of next season [...]. There is a huge interest in CO_2 technology in the ice rink business right now," says EKA's Rogstam.

CO_2 is also making inroads elsewhere in Europe. The new home of the Belgian national ice hockey team opened in Mechelen, Belgium in September 2016. The SCM Frigo facility is the country's first ice rink to use CO_2 as the sole refrigerant and the first capable of operating all year round.

"We noticed a much better ice quality in this installation. The feedback from the skaters and users is clear: they feel the difference [with CO_2]," says Mirko Bernabei, technical director at SCM Frigo.

CO_2 SERVES BOTH HEATING AND COOLING NEEDS

Ice rinks consume an enormous amount of energy, with the average usage of a Swedish rink weighing in at around 1,000 MWh per year. Typically the refrigeration system – whose cooling capacity is usually 300-350 kW – is the main contributor, consuming about 43% of total energy. Heat reclaim can help to mitigate these costs.

"CO_2 has favourable properties for heat reclaim," argues Rogstam, pointing out that CO_2 systems installed for ice rinks can be used to heat adjacent sports facilities as well.

EKA argue that CO_2 is the ideal choice for integrated systems. "CO_2 can provide more heat at higher temperatures compared with other refrigerants," Rogstam says. Compared with ammonia, which can only provide 15% of heat above 35°C, CO_2 can deliver 60% above 35°C – according to EKA research.

The system in Gimo, Sweden was not just able to cool the ice rink but also heat a swimming pool in an adjacent facility via a secondary loop. EKA is now seeking to improve the heat reclaim technology further to make it more commercially viable and to build more CO_2 ice rinks in Europe.

SCM Frigo also used heat reclaim. Excess heat from the Mechelen system's operation is recovered to provide sanitary hot water, and underground heating for the arena seating and the bar annexed to the ice rink – reducing energy consumption.

The ice rink is the latest fruit of cooperation between Italian firm SCM Frigo and Belgian partner Sabcobel that has been going on for 10 years now, helping to increase knowledge of natural refrigerants in the Benelux region.

Sabcobel has come a long way since its first installation with natural refrigerants in 2005. "90% of the installations we do currently, both for commercial and industrial systems, are with CO_2," says Herwig Coppens, Sabcobel's general manager. That said, the company has previously worked with and continues to work with ammonia in ice rinks.

US NHL TEAMS: SKATING ON AMMONIA

Ammonia seems to be going strong. Leading North American firm CIMCO has had a strong relationship with the National Hockey League for some time. "I'm the point guy with the NHL," says Jose Mergulhao, CIMCO's US operations manager, who has worked at CIMCO for 21 years and is a big hockey fan.

Working closely with the NHL to design and install most of their ice rinks is a dream come true for Mergulhao. "I played hockey up to university as well, so it's fun," he says.

CIMCO has been a force in the North American industrial refrigeration market since the early 1900s. Originally a Canadian company, it is now one of the largest refrigeration companies in Canada, USA and Mexico.

Back in April 2016, CIMCO completed an ammonia ice-rink at the T-Mobile NHL arena in south Las Vegas, Nevada. The 650,000 square-foot (198,000 square-metre) ice arena features a 17,000 square-foot (5,200 square-metre) ice rink.

The arena, which will host 100-150 events per year, is designed to be a multipurpose entertainment venue capable of hosting NBA and NHL teams, concerts, boxing, mixed martial arts, awards shows and other major events. Coldplay, the Los Angeles Lakers and Billy Joel have all recently played there.

At the Las Vegas ice rink, Mergulhao worked to NHL specifications to project-manage and put in place a CIMCO ice rink with impressive energy efficiency and safety credentials. "The two packages [ammonia refrigerant and glycol solution] are designed for the most possible charge that we can put in there," he says.

The ammonia charge is kept as low as possible by "optimising the condenser design, optimising the chiller, and reducing the charge," says Mergulhao, helping to make it even safer for NHL players to skate on.

CIMCO's attention to detail and willingness to adapt technology has allowed it to develop a long-standing relationship with the NHL, he explains. They plan to build an ice rink for the Detroit Red Wings, and another rink in Las Vegas will be completed soon.

Diversification holds the key to success in any business, according to Mergulhao. With CO_2 now part of CIMCO's ice rink portfolio, he is enthusiastic about the growth possibilities in this market. "We hold patents for CO_2 ice rinks in Canada" and patent approval is pending in the USA, he says.

Natural refrigerants will play a crucial role in CIMCO's future success. "You can either roll the dice and take another blend of refrigerant or take a natural refrigerant," Mergulhao says.

JAPAN LOOKS TO COMBINE AMMONIA WITH CO_2

In Japan, meanwhile, the number of ice-skating rinks has fallen in recent years. From a peak of 550, the number of rinks had dwindled to between 150-170 in 2016. The decline is largely due to higher energy costs. Nonetheless the tide is starting to turn, thanks to the work of companies like Patine Leisure, which are adopting efficient, natural refrigerant-based cooling technology.

Patine Leisure is a Japanese specialist in the ice-skating business, designing and installing rinks while operating and managing around 50. It covers 90% of the ice-rink market in Japan, and plans to expand its business to other Asian countries.

In 2014, Patine Leisure turned a corner by partnering with Mayekawa, a leading distributor of industrial natural refrigerant cooling technology, to open a next-generation ice skating rink in Saitama that uses Mayekawa's NewTon NH_3/CO_2 packaged unit.

Today there are eight ice rinks – from Patine Leisure and others – that use natural refrigerants in Japan. Around 150 rinks still employ R22 as the primary refrigerant, but as Patine Leisure has a stake in the majority of them, it hopes to convert as many as it can to natural refrigerant technology by 2020.


Akinori Ogiwara, president, Patine Leisure

The policy is a culmination of a four-year journey that began in Canada with Akinori Ogiwara, Patine Leisure's president and a former speed skater. Since then, "becoming environmentally friendly and energy efficient by using natural refrigerants" has become one of the company's core ambitions, Ogiwara says.

In Canada, Ogiwara learned about an ammonia/CO_2 cooling technology from Mayekawa that had been used in Sweden. He expected to hear about energy savings in the realm of 10%. What he discovered came as a shock: the energy savings were in fact closer to 30%.

Excited by the prospect, Ogiwara and his team took the opportunity to see the system in action in Sweden alongside representatives of Mayekawa. Following the expedition Mayekawa worked with Patine Leisure for two years on a joint R&D project to develop a NH_3/CO_2 trial system for an ice rink in Japan.

After returning to Japan, Ogiwara started trials at the company's factory in Karuizawa. The testing took two years, using ammonia freezers and CO_2 refrigerant, and comparing cooling pipes made of copper, aluminum, and other materials. The results revealed even higher energy savings of 50%.

Patine Leisure is also working on a new speed-skating ice rink project in Japan. If all goes according to plan, construction will start in 2017 and be completed in 2018.

CO_2 is unlikely to replace ammonia but it looks like NH_3 will no longer dominate the market so dramatically. The duo are set to get the world skating on 100% natrefs! ■ EB

Mayekawa's NewTon system at Saitama ice arena

Coca-Cola targets **100% natural refrigerants** for vending equipment

Global beverage giant the Coca-Cola Company is aiming to be 100% HFC-free for all new cold drinks equipment by the end of 2020. It plans to achieve this target by primarily adopting natural refrigerants CO_2 and hydrocarbons – with its Japanese branch leading by example. *Accelerate* magazine reports.

— By Andrew Williams & Jan Dusek

Globally, the Coca-Cola Company is already adopting natural refrigerants propane and CO_2 in bottle coolers and vending machines on a grand scale. By the end of 2015, the Coca-Cola Company had deployed more than 1.8 million HFC-free units worldwide.

Antoine Azar, the firm's global programme manager, set the scene at the ATMOsphere America conference in Chicago in June. "We have natural refrigerant equipment everywhere in the world where we operate today. Our equipment is distributed among developed and developing countries and in hot, humid or cold climates. Wherever you find a Coca-Cola can, there is possibly HFC-free equipment working in that country," he said.

The Coca-Company overall is striving to be 100% HFC-free in all new equipment purchases – primarily bottle coolers and vending machines – within two years (except for certain speciality equipment).

By HFC-free, the Coca-Coca Company means 100% natural refrigerants. It currently has 280 CO_2 cooler, vending machine or fountain machine models certified and ready for use. Overall, its percentage of HFC-free new equipment is already high – in some markets more than 75% of cooling system purchases are HFC-free.

COCA-COLA JAPAN LEADS THE WAY

In Japan, the objective is slightly different: the beverage giant has adopted an official target of moving to 100% natural refrigerants – meaning CO_2 or hydrocarbons – in all vending equipment on the Japanese market by 2020.

Accelerate met with Stan Mah, representative director and president of Coca-Cola Tokyo Research & Development Inc. – a subsidiary of the Coca-Cola Company – at his renovated R&D facility in Odaiba, Tokyo to find out more.

"Our plan is to move out of HFCs. We continue to be on track for that. Specifically for Japan, we are definitely on our way," says Mah.

Local Coca-Cola bottling companies operate 980,000 vending machines in Japan. Estimating that the lifecycle of this equipment is eight years, Mah says, "we should be able to replace our entire fleet by 2020".

Mah's team is currently using natural refrigerants in over 500,000 Japanese vending machines. At present, the majority of these are CO_2 (roughly 80%; shecco estimate) rather than hydrocarbons (roughly 20%; shecco estimate).

His team started to go down the natural refrigerants route in 2002. "When we look at HFC-free, we look at CO_2 and also hydrocarbons. Our HFC-free commitment is definitely on the way. We will deliver it through a combination of CO_2 and hydrocarbons," he says.

Asked to outline the main drivers of Coca-Cola Japan's decision to start using natural refrigerants in 2005, Mah declared: "Before 2005, as a big corporation we were still serious about social responsibility. The 2005 announcement was about showing our commitment to energy savings and environmental sustainability."

"I don't think the attitude had changed – it was just another step further. We're just making it public," he explains.

Mah remains committed to adopting natural refrigerants despite the extra cost of CO_2 or hydrocarbon vending machines compared to conventional HFC technology. "I don't think we made a mistake – social responsibility isn't a mistake. It's a commitment we take very seriously," he says.

"We know these machines are more expensive but we continue to stand by our commitment," he insists.

Stan Mah, representative director and president, Coca-Cola Tokyo Research & Development Inc.

Stan and his team

New Coca-Cola can and plastic bottle vending machines in Japan have been using natural refrigerants since 2011. "We're actually trying to consolidate more. Wherever possible, we're using HFC-free machines. A lot of these are CO_2. But for certain small sizes, CO_2 cannot be an option currently – so we use something else," Mah explains.

Coca-Cola Japan works with other Coca-Cola Company branches worldwide to help ensure that each country adopts the technology that is most suited to its domestic market. Having originally established that CO_2 would be the standard refrigerant for new beverage coolers, vending machines and fountain equipment, in the United States the Coca-Cola Company "will open the door" to hydrocarbon refrigerants for smaller cooler equipment, Azar told the ATMOsphere America conference in June.

Azar defined smaller equipment as units with a volume at or below 300 litres, which accounts for 10% of its equipment. "Everything above 300 litres must still be CO_2. Below 300 you can go with either CO_2 or hydrocarbons [either propane or isobutane]," he said.

Ultimately, bottlers will make the decision locally. But the Coca-Cola Company will no longer allow R134a to be used in smaller units. Company HQ has therefore strengthened safety requirements for hydrocarbon equipment. The charge limit is 50g; all electronic components must be spark-free; and condenser fans must remain on in case of leaks.

Azar left open the possibility that the Coca-Cola Company would one day allow hydrocarbons to be used in larger units too. "Our only concern with hydrocarbons has been safety. We know it's a great refrigerant," he said.

Commenting on these developments, Mah says: "Currently our position in Japan is that we're open to hydrocarbons in vending

machines. We're open to hydrocarbon models, but we prefer CO_2. For bottle coolers too, we can use hydrocarbons but we prefer CO_2 as well."

Pragmatism is king. "We want to make sure we don't limit ourselves too much. We have a preference for CO_2," he says.

'PEAK SHIFT' TECHNOLOGY DELIVERING ENERGY SAVINGS

The average energy consumption of Coca-Cola Japan's latest vending machines is just one sixth of what it was 15 years ago. After the Great East Japan Earthquake of 2011, companies were encouraged to reduce their electricity consumption to help put an end to the blackouts that had been plaguing the country in the wake of the nuclear disaster at Fukushima.

Coca-Cola Japan responded by launching the 'Peak Shift' vending machine – containing a CO_2 compressor – in 2013. Designed to reduce daytime electricity consumption, the Peak Shift has become the firm's flagship vending machine. "At present we have about 145,000 of these machines in the field," says Mah.

"It works really well in daytime. It's not big usage, but we still want that energy consumption to go down. We always look the way to make it even more efficient," Mah says.

In 2015 Coca-Cola Japan announced plans to add ejector technology to the mix. Field tests in different parts of Japan are continuing, and Mah sees that CO_2 vending machines with ejectors reduce power consumption compared to conventional HFC models.

Until costs come down, Mah is not ready to commit to scaling up adoption of CO_2 vending machines with ejectors. "We're still evaluating. They save energy, but they cost a lot. We want to balance cost and energy savings," he explains.

With all this investment in CO_2 technology, what future does Mah see for hydrocarbons in Coca-Cola Japan's refrigeration strategy? "CO_2 is our preferred choice, but we're covering hydrocarbons too. We don't see it as 'either or'."

He believes Coca-Cola Japan is already reaping the benefits of its 11 years using natural refrigerants. "Our commitment hasn't changed. Consumers do know we're using them. We're on a journey with CO_2 and hydrocarbons, and the choices have been correct," he says.

According to shecco's GUIDE Japan 2016 – published on 28 June – with over 1.35 million Japanese beverage vending machines already using CO_2 or hydrocarbons from a potential total of 2.5 million, natural refrigerants make up over 50% of the market. CO_2-based vending machines reached over 850,000 units. Use of hydrocarbon vending machines in Japan nevertheless remains strong, with over 500,000 R600a units installed by several leading operators. New data identifies natrefs in vending machines as a future growth area in Japan.

The report also reveals that Japan's light commercial refrigeration market is dominated by beverage vending machines. With Japan boasting more vending machines per capita than any other country, the use of natural refrigerants in these systems has a huge impact on the overall uptake of natrefs in Japan.

Yet some potential users of natural refrigerant technologies still complain that manufacturers are unable to provide solutions for their needs. Has Mah experienced similar frustrations? "The technology is moving along. But with smaller-sized equipment, the technology is taking longer than we thought," he admits.

Economies of scale always influence the rollout of new technologies. Natural refrigerant-based HVAC&R equipment "is no different from other technology – getting more companies to adopt it would bring the costs down," Mah says.

Compressor size is one area where he would like to see more progress. "For smaller coolers, it's a challenge right now for us to use CO_2," he says. More generally, "we'll continue to work with our suppliers to drive efficiency improvements and energy savings.Those are things we expect every year," he adds.

As the man in charge of Coca-Cola Japan's R&D centre in Tokyo, Mah knows a thing or two about pushing technological boundaries to deliver results. Coffee machines are a case in point. "Last year, we ran a specific programme for wintertime called 'Plus 2 Degrees', because we know our customers desire warmer coffee during the winter. This year, we tested an ice-cold machine – Ice-Cold Coca-Cola," he says.

"We kept the product at -4 degrees. We slow-cooled it, so it's not frozen. But the moment it comes out, it freezes. It comes out like a Slurpee," Mah explains.

The new ice-cold drinks machine looks like a vending machine but is actually a cooler. Coca-Cola Japan recently rolled it out across some 1,000 7-Eleven stores.

HFOS 'NOT IN OUR SCOPE'

Many companies are responding to f-gas regulations by adopting synthetic refrigerants – so-called HFOs – which have a lower GWP than traditional HFCs. Did Coca-Cola Japan also consider going down this road?

Mah is resolute in his response. "Right now, HFOs are not in our scope. I know other industry players are looking into it, but currently our position is CO_2 or hydrocarbons. HFOs are not an option currently."

Natural refrigerants are not limited to light commercial applications. They are widely used for cold storage in warehouses and distribution centres, and can also be used in transport refrigeration. Does Coca-Cola Japan plan to adopt natural refrigerant technologies in other areas of the business?

"HFC-free is one of our key initiatives. But we're also looking at total energy savings and sustainability. That might not be about HFC-free – we have hybrid trucks, for example," Mah says.

Coca-Cola Japan's sustainability strategy addresses many different areas – the cold chain is just one aspect. "We look at it as an entire environmental sustainability platform. HFC-free is part of that," Mah says.

Asked whether he has considered using ammonia for cooling applications in manufacturing or distribution facilities, Mah admits there is room for improvement here. "We need to follow through – that's the part we haven't thought about. With the supply chain, it's mostly about energy saving and recycling," he says.

Lack of training among maintenance technicians and installers – particularly on handling flammable refrigerants like hydrocarbons – is often cited by potential users of natural refrigerants as a barrier to their wider uptake. Mah, however, says Coca-Cola Japan is yet to experience such frustrations.

"A lot of the maintenance is done by our supplier. They are really good, so there are no problems. We don't see any issues, whether CO_2 or hydrocarbons," he says.

"The supplier provides maintenance for the compressor. Our people handle the machine itself, and disposal of our machines is handled separately. No issues with maintenance – the supplier has been really good, and does the training for natural refrigerants."

The Coca-Cola Company does not appear to have encountered the so-called 'training gap' elsewhere either. At ATMOsphere Chicago in June, Azar confidently declared: "So far we haven't faced any major issue in servicing CO_2 equipment. Frankly speaking, CO_2 today can be serviced either in the field or in some cases in the service centre."

Mah is keen to stress that manufacturers and even governments have crucial roles to play in raising awareness of natural refrigerant technologies. "Our role is not to teach. Our role is to use equipment that's environmentally friendly. It may not be just a manufacturer effort either – it could be a government effort. That's a very hard question, the issue of who is responsible for education."

Safety is another issue that sometimes slows down uptake of hydrocarbon-based HVAC&R technologies. Is safety an issue in Japan? "No. Based on our testing, the potential for a fire is extremely low. We don't see it as an issue in Japan," Mah says.

POLICY HELPING TO DRIVE INCREASED NATREF UPTAKE

Many countries around the globe have put in place incentive schemes to encourage wider uptake of natural refrigerant-based alternatives to climate-damaging HFC technologies. Japan is a leader in this regard. Its Top Runner Programme seeks to encourage companies to target the highest energy efficiency possible in beverage vending machines. Companies that meet specified targets are given the Top Runner label.

From 2000-2005, the Top Runner Programme delivered energy efficiency improvements of 37.3% for vending machines for canned and bottled beverages. From 2005-2012, efficiency was improved by 48.8% compared to 2005.

To help companies switch to eco-friendly goods and services, the Japanese Ministry of Environment actively facilitates supply and demand for eco-friendly technologies via its own purchasing. This has had a direct impact on the installation of beverage vending machines, with public institutions purchasing energy-efficient, natural refrigerant-based units.

Yet despite the significance of this regulatory activity, Mah insists that corporate sustainability targets were the biggest driver of Coca-Cola Japan's decision to embark on its natural refrigerants journey.

"For us, this has always been a corporate commitment, rather than something that the Japanese government is pushing. We decided to do this due to the corporate commitments that we've made," he explains.

At global level, the Coca-Cola Company is a member of Refrigerants, Naturally! – an initiative of international companies taking action against global warming and ozone layer depletion by replacing harmful greenhouse gases in point-of-sales cooling and freezing units with climate-friendly natural refrigerants.

The goal of the group – which sees the Coca-Cola Company, SABMiller, Red Bull, PepsiCo and Unilever join forces with supporting partners Greenpeace and UNEP – is to make natural refrigerants the preferred cooling technology in a safe, reliable and cost-effective manner.

Mah appreciates that role that such groups play in communicating the actions that Coca-Cola Japan is taking to a wider audience. "It's pretty clear that we're making an effort to take charge in the public domain. I think that as a system, whatever the corporate headquarters does, places like Asia will follow," he argues.

"Our corporate commitments are the right thing for the environment and consumers. This is a pretty loud message. It's clear," he says.

The Coca-Cola Company also plays an active role in pushing for stronger government policies on phasing down HFCs. This is where its membership of the Consumer Goods Forum (CGF) comes to the fore.

In 2010, the CGF – which brings together over 400 manufacturers and retailers of consumer goods seeking to pursue more sustainable, safer and consumer-friendly business practices – adopted a resolution recognising that the HFCs used in the majority of refrigeration systems are powerful greenhouse gases and pledging to start the process to replace them with natrefs.

The 2010 resolution saw some of the world's biggest companies pledge "to begin phasing out HFC refrigerants as of 2015 and replace them with non-HFC refrigerants (natural refrigerant alternatives) where these are legally allowed and available for new purchases of point-of-sale units and large refrigeration installations".

NATURAL REFRIGERANTS GAINING GROUND

Fast-forward to this year, and CGF members have installed low-carbon refrigeration systems in over 4,000 supermarkets and four million ice cream and drinks chiller units worldwide. The majority of these systems use natural refrigerants. In January, they agreed to consider increasing their use of natrefs as an alternative to climate-damaging HFCs still further.

Subsidies and other financial incentives, more aggressive regulations, taxes or tax benefits, and recognition schemes are just some of the tools at the disposal of national governments to accelerate the use of more sustainable HVAC&R technology in the beverage sector.

Asked what he would like to see from Japanese legislators to push forward uptake of natural refrigerants, Mah replies: "Any support would be helpful – all the things you mentioned would be great! I don't think this is something that industry can do by itself, so it's something that government can expedite."

A true global citizen, Mah holds U.S. citizenship, has a Japanese wife and has lived in Japan on and off for 21 years – interspersed with spells in Singapore and Shanghai. How have these experiences shaped his view of his adopted country? "Japanese culture is very respectful of people and the environment," he says. He takes his cue from that. "I drive a hybrid car, and I recycle," he says.

Having graduated from university with a degree in environmental engineering, Mah has long been interested in environmentally friendly technology. "As an engineer, how can I not be curious about it," he jokes.

Yet he is quick to adopt a more serious tone. "I wouldn't be supportive of anything that isn't environmentally friendly – as an individual or as part of a management team."

Is that what motivates him to go to work each morning? Mah replies: "I have kids. I'll be gone in a few years, but I want to make sure things will be the same or even better for them." ■ AW & JD

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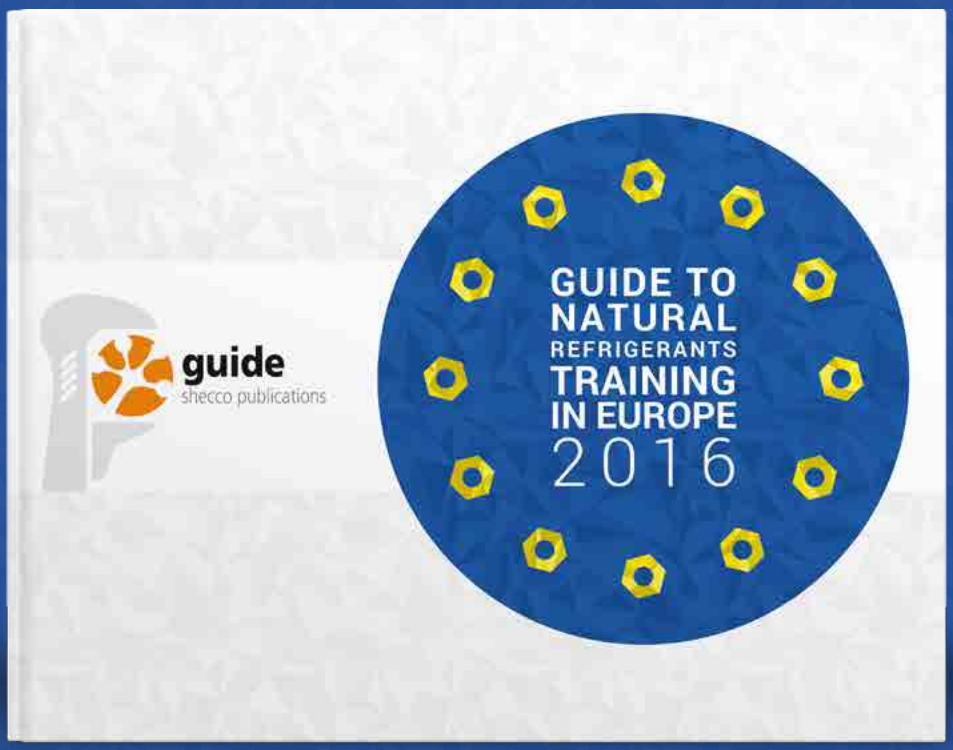

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GUIDE TO NATURAL REFRIGERANTS TRAINING IN EUROPE

— STATE OF THE INDUSTRY

THE reference tool for those looking for guidance on how to select the right training providers, knowledge sources and partners to build their business case around the use of CO_2, NH_3 and hydrocarbons.

Natural refrigerants steal the show ***at Chillventa 2016***

Over 180 companies among close to 1,000 exhibitors at Chillventa – taking place from 11-13 October in Nuremberg, Germany – were showcasing natural refrigerant technologies. This marks a 50% increase since the previous Chillventa in 2014, where only 120 companies were showcasing hydrocarbons, CO_2 and ammonia solutions.

— By Andrew Williams, Charlotte McLaughlin, Michael Garry & Christine Noël

"For natural refrigerants, we're well beyond the point of no return," Eric Delforge, corporate business and policy officer at Mayekawa Europe, told *Accelerate Europe* at the biannual Chillventa – one of the world's largest shows for refrigeration, air-conditioning and heat pumps – at the Exhibition Centre in Nuremberg.

The concept at the heart of Mayekawa's product portfolio is the 'Natural Five': a range of HVAC&R solutions based on the five natural refrigerants – ammonia, CO_2, hydrocarbons, water and air – that will help drive the phase-out of harmful HFCs.

"We have a lot of experience in different applications and in different industries. This carries us forward to proclaim that propane, ammonia and other natural refrigerants are the solution – especially for industrial refrigeration," Delforge said.

Natural refrigerants were certainly on the radar of many of the 32,206 visitors and 982 companies participating in this year's Chillventa.

The global deal to phase down HFCs stuck the same week at the Montreal Protocol meeting in Rwandan capital Kigali – alongside strong regulation already in place in Europe and the United States – are creating opportunities for natural refrigerant technologies worldwide.

The US Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) programme and the European Union's F-Gas Regulation, which seek to phase down f-gas emissions, are forcing the HVAC&R industry to adopt environmentally friendly alternatives to HFCs – including natural refrigerants.

"2018 will be a key first step in the EU's F-Gas Regulation implementation, in conjunction with the development of high-efficiency products to comply with EU Eco-Design legislation," said Régis Leportier of ASERCOM, the Association of European Component Manufacturers.

In 2020, an EU ban on using certain HFCs in new stationary refrigeration equipment comes into effect, accompanied by bans on servicing and maintaining existing equipment. "The EU phase-down mechanism is key for our industry in order to allow adaptation to sustainable alternatives," Leportier said.

US policy is having a similar effect on the other side of the pond. In early October, the EPA announced changes of listing status for certain high-GWP fluorinated gases, such as R404A, R410A, R134a and R407C. These f-gases will no longer be acceptable for the following uses:

- For new centrifugal chillers and new positive displacement chillers, as of 1 January 2024.
- For new cold storage warehouses, as of 1 January 2023.
- For new retail food refrigeration (refrigerated food processing and dispensing equipment) and new household refrigerators and freezers, as of 1 January 2021.

"We're seeing restrictions and bans on HFCs in commercial refrigeration in the United States," said Steve Yurek, president of the Air Conditioning, Heating and Refrigeration Institute (AHRI), which represents HVAC&R manufacturers in the US and worldwide.

"Big changes are coming. High-GWP refrigerants will be phased down on a global scale. The good news is that our industry will be prepared," said Yurek.

EUROPE AT THE FOREFRONT OF HYDROCARBONS DEVELOPMENT

With the global HFC phase-down and the drive for energy efficiency improvements picking up speed, the market for hydrocarbon technology is ripe for growth – particularly in the United States, according to SECOP CEO Mogens Søholm.

"There are three key topics for us at Chillventa: natural refrigerants, energy efficiency, and the variable speed aspect – going electronic with these products," said Søholm.

SECOP was at Chillventa to showcase its new variable speed drive 'DLV' and 'NLV' series compressors for use in commercial cooling systems.

"We believe the whole market is changing focus, especially in light commercial. Where we're putting our development money these days for light commercial is a full range of hydrocarbon compressors – mainly R290 (propane)," said Søholm.

"If you convert a traditional R134a system to hydrocarbons, you gain a lot of efficiency by changing the refrigerant alone. If you add variable speed technology on top of that, then you see improvements – in terms of energy efficiency and noise, for example – that are tremendously large," the SECOP boss said.

The variable speed drive enables needs-based adjustment of cooling capacity and delivers high efficiency even in partial load operations. Compared to fixed speed refrigeration compressors, variable speed drives can achieve energy savings of up to 40%.

Huayi Compressors Barcelona S.L also launched variable speed compressor models for propane and isobutane – more will be launched in the coming year, when they will expand into their whole capacity range. Their factory in China exclusively makes R600a (isobutane) models.

"In the US with the new regulation [DOE energy conservation standards], a lot of customers are worried about energy efficiency. They believe the only way to meet these energy standards is with variable speed," said Pedro Olalla, sales director at Huayi.

Embraco, the Brazilian compressor maker, is also banking on a combination of hydrocarbon refrigerants and variable-speed compressors to maximise energy efficiency.

According to Peter Bukšár, technical support senior specialist for Embraco, isobutane or propane (at a maximum charge of 150g) will alone boost the energy efficiency of a commercial self-contained refrigeration unit by 5 to 15% over traditional refrigerants, but adding a variable-speed compressor further increases the overall efficiency.

Bukšár gave several examples of this combination at work, including an ice cream freezer (more than 25% energy reduction vs. HFCs/ on-off compressor unit), and a bottle cooler (an almost 50% energy drop).

Variable-speed compressors are costlier than traditional compressors, but with energy savings, "it's easy to calculate how much you are able to save on the lifetime of the application to justify the additional investment," he said.

REGULATORY CHANGE BOOSTING HYDROCARBONS

In some parts of the world, use of hydrocarbons is restricted by regulation imposing charge limits for certain applications. But as knowledge of the technology grows, this is beginning to change.

"The best example of these recent big changes is the United States. A couple of years ago, you'd have never believed the US would change this quickly. But today they are very focused both on improving energy efficiency and phasing out HFCs," said SECOP boss Søholm.

In 2011, the US Environmental Protection Agency approved R290 for commercial food refrigeration, and R600a (isobutane) and R441A (a hydrocarbon blend) for domestic refrigeration.

Last year, the agency expanded the regulations, allowing R290 in domestic refrigeration and R600a and R441A in commercial refrigeration. But the charge limits for commercial and domestic applications, in line with UL standards, were set at 150g and 56g respectively.

"I strongly believe that with more insight into and knowledge of the technology, regulators will figure out that today's charge limit of 150g should probably increase," Søholm said.

He believes the advantages of moving to hydrocarbons are so significant in terms of energy efficiency and environmental impact that the only conceivable obstacle to their wider uptake is flammability. "But […] today's technology knowhow limits those risks," he said, pointing out that hydrocarbons have already been used safely in household domestic appliances in Europe and Asia for many years.

Huayi's Olalla is in no doubt as to the boost that a charge limit increase would bring. "If it moves from 150g to 500g or 350g, this challenge of refrigerant charge for some types of application would be solved. There would be no challenge in light commercial applications for hydrocarbons then."

Other companies echoed this view. "We see more interest in propane compared to [the last Chillventa] two years ago. It's taking off in Europe in particular, but also in the US," said Stefan Lammert, a key account manager at Danfoss. "We'd like to see the charge limit increased to help grow the market further."

Indeed, manufacturers worldwide are calling for an easing of regulatory restrictions to help broaden the range of applications and boost uptake of natural refrigerant technologies.

"The industry is moving forward. OEMs are starting to select alternatives [to HFCs], and to develop components and equipment for them. Now, the regulatory and safety barriers must be adopted to allow safe use of equipment using […] A3 refrigerants," said AHRI President Yurek, whose organisation represents technology manufacturers worldwide.

Yurek argued that hydrocarbons (A3 refrigerants) are viable environmentally friendly alternatives to HFCs, but that safety standards currently in place in the United States are too restrictive. "In general, US codes are very restrictive for […] A3 refrigerants. Safety standards must be modified to ease restrictions on use of […] A3 refrigerants," he said.

HYDROCARBON HEAT PUMPS ON THE RISE

Accelerate Europe also heard about the development of the hydrocarbon heat pump market in Europe. Swedish manufacturer Beijer Ref has developed a highly efficient hydrocarbons-based heat pump, the TripleAqua, which is already running in two offices and a supermarket in the Netherlands.

The company plans to build a factory, which will be used in part to construct TripleAqua units. "We are building a unit for bigger buildings for end users with a policy of using natural refrigerants, and for government buildings like town halls," said Menno van der Hoff, manager of R&D HVAC for Dutch supplier Uniechemie (Union Chemicals), a division of Beijer Ref.

Beijer Ref argue that the TripleAqua can save up to 50% in heating and cooling costs in commercial buildings compared to traditional heat pumps, with a COP of between four and ten.

The system employs propaene (R443A), a mixture of the hydrocarbons propane (R290) and propene (R1270), with a global warming potential (GWP) of three and a charge of less than 11 lbs.

Beijer Ref's TripleAqua

(5 kg). "Propane is known for its efficiency and propene outperforms propane at negative temperatures," said van der Hoff. "And propene has a strong smell, which people like for safety."

The TripleAqua has the ability to store heat and cold in buffers for later use in the building, providing heating and cooling simultaneously or individually. It uses three water-loop pipes to distribute heat (28°C-36°C), cold (12°C-18°C) and return water at ambient temperature.

AMMONIA: 'A MARKET THAT WILL NEVER DIE'

Stephan Leideck, project engineer at compact Kältetechnik GmbH, told *Accelerate Europe* that, "ammonia is never new but the market [in Europe] is showing big demand for large ammonia plants, and lately for smaller machines up to 200 kW. We never really have a supermarket request. But storage, supermarket distribution centres, ice rinks and so on – this is a market that will never die".

Ulrich Klauck, manager for Europe and the Middle East at Hansen Technologies – a global manufacturer of controls and valves for ammonia – echoed this sentiment. "Ammonia is a solid market and a long-term business. Now we are growing even more."

Signs that the ammonia market is growing were everywhere. German manufacturer compact was exhibiting, "one [of the biggest ammonia machines on the market] with the biggest Bitzer screw [compressor] on the market, that delivers 600 kW of refrigeration capacity. It's big, so it's for storage cooling".

Compact were also exhibiting, "one of the smallest ammonia machines on the market – with a piston compressor from GEA Bock. Complete with control panel and a capacity of about 25 kW [for the system]. Both machines go to -10°C," Leideck said.

GEA and Bitzer – who are major competitors in the global compressor market – were showcasing huge ammonia compressors at their Chillventa booths to keep up with demand for a wider spectrum of ammonia solutions. "We have the biggest and smallest ammonia compressor on the market currently [part of their HG line], and we are constantly pushing ammonia as an answer to our customers for most uses," said Dirk Oschetzke, project engineer at GEA.

At Chillventa, much interest was shown in GEA's new Red Astrum ammonia heat pump, which will be used to heat Islington station on the London Underground by reclaiming hot air from a ventilation shaft at a constant temperature of 24-30°C.

"Ammonia is the safest refrigerant," said Isolde Dobelin, director of the Open Trade Training Centre (OTTC) – which trains technicians on using ammonia in HVAC&R applications in South Africa – at a Chillventa event organised by EU trade association Eurammon (which promotes natural refrigerants).

Dobelin believes a combination of regulation and technological innovation has successfully addressed safety fears regarding the toxicity of ammonia. The OTTC offers training courses leading to diplomas in Springs, near South African capital Johannesburg, on safely using ammonia for refrigeration and air conditioning in commercial and industrial applications.

"If you have training and maintenance plans in place, no accidents will happen. Once you're trained in its use, ammonia is much safer than other refrigerants," said Dobelin.

Some observers see China as the next big market for natural refrigerant technologies. "We should never underestimate the efforts that China is making to support the uptake of natural refrigerants," said Mayekawa's Delforge.

Advansor's new cassette for CO_2 air conditioning

Advansor: CO_2 pioneer

"I think we may be surprised by bold and pragmatic decisions in China, where some industries may decide to go full-steam ahead for natural refrigerants. These will be the game-changers in niches. This will then spread all over," he said.

BRINGING JAPANESE KNOW-HOW TO EUROPE

CO_2 condensing units for convenience stores (CVS) are already well established in Japan, while in Europe many small stores use hydrocarbons. During Chillventa many innovative companies launched their CO_2 condensing units and air-conditioning for smaller applications, pushing CO_2 in a new market direction.

"We dream only CO_2," Advansor Managing Director Kim G. Christensen told *Accelerate Europe* at Chillventa 2016. The Danish manufacturer is ready to capitalise on the European food retail sector's move towards smaller stores by providing integrated heating and cooling systems.

Advansor were particularly excited to be showcasing their new CO_2 cassette for air conditioning. Driven from the refrigeration rack, the unit is capable of providing cooling or heating as required.

"In Europe, all the retailers are investing in small supermarkets. You have to go where the money is. So that's why we're offering our cassette system, together with the ValuePack" refrigeration system, Christensen explained.

The Danish company has also identified a gap in its portfolio between the larger ValuePack and its small condensing unit. It will launch a new 'mini-booster' product for medium capacities of up to 25 kW at EuroShop – Europe's biggest tradeshow for the retail sector – in March 2017.

Christensen remains convinced that Advansor's decision to focus 100% on CO_2 technology was the right one. "We want to be the best in the [CO_2] market. If you want to be a professional tennis player, you wouldn't try to play football too," he said.

CO_2 was on the radar of other companies at Chillventa too. Green & Cool – part of the Carrier Transicold Group – formally launched its compact CO_2Y condensing unit designed for convenience stores, petrol stations and other small businesses. The small stand-alone unit is suited to less demanding refrigeration applications such as small cold rooms, display cases and petrol stations.

The CO_2Y is "basic and cheap, but still bears state-of-the-art eco-performance," Johan Hellman, sales engineer at Green & Cool, told *Accelerate Europe*. With a maximum capacity of 5.5 kW at ambient temperatures of up to 30°C, the unit features a DC rotary compressor that can be regulated at various speeds of up to 100 rotations per minute.

"The 2-9 kW segment, which CO_2Y falls into, has enormous future potential since there has not been an economical environmentally friendly alternative until now," said Joakim Westerberg, responsible for refrigeration appliances at Kylkvalitet, a Swedish supplier of Green & Cool systems.

Green & Cool's Johan Hellman

GROWING COMPETITION FOR SMALL-SCALE CO_2

With other companies like Sanden, Panasonic and Advansor also rolling out CO_2 condensing units in Europe, are Green & Cool ready to rise up to the challenge?

"We're not the only ones, but we think that we're the first ones who are ready to sell the product [...]. It is ready for the market," Hellman said.

Another European stalwart of the refrigeration scene, the Epta Group, is also seeking to tap into growing demand for smaller scale CO_2 systems as competition with hydrocarbons in the convenience store market intensifies.

Epta was at Chillventa to show off its ECO_2 small-scale transcritical CO_2 booster package. "The system allows full heat reclaim, thus exploiting the advantages of CO_2. It represents a big step ahead in the transition towards Nearly Zero Energy Buildings," Francesco Mastrapasqua, the group's sales and marketing manager for refrigeration systems, told *Accelerate Europe*.

The Epta Group is optimistic that CO_2 technology will continue to flourish, particularly in Europe.

"In Europe, demand for CO_2 and other natural [refrigerant] systems is already much consolidated. CO_2 is considered the baseline and the choice of all major retail chains," Mastrapasqua argued.

With the drive to deliver energy savings fast becoming the primary focus of innovation in the HVAC&R sector everywhere, he believes that manufacturers of CO_2 systems and components are well placed to capitalise – worldwide.

"CO_2 can ensure significant benefits, in particular where HVAC&R are integrated. We consider the gap between eco-sustainability and cost to be finally closed, as CO_2 systems are becoming more affordable even in emerging market economies with hot climates," Mastrapasqua said.

Describing the ECO_2 as "ideal for convenience stores and hard discounters," Mastrapasqua said, "this all-in-one, complete system has an integrated electrical board, liquid receiver and seasonal optimised circuit".

As Chillventa 2016 drew to a close, participants were left in no doubt as to the natural refrigerant industry's position at the forefront of developing innovative HVAC&R solutions, pushing the boundaries of what CO_2, ammonia and hydrocarbons can achieve.
■ AW, CM, MG & CN

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Hydrocarbon limit likely to move to 500 grams by 2018

A potential hydrocarbon charge increase being considered by an international standards body should create new business opportunities for manufacturers of plug 'n' play refrigeration systems.

— By Charlotte McLaughlin

Driven by increasing pressure on HFC-based equipment, the review of standards with a higher limit for flammable refrigerants can trigger a massive uptake of hydrocarbons-based plug 'n' play refrigeration systems around the globe.

Standards by the International Electrotechnical Commission (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 a meeting in Dublin, Ireland on 1-2 December, an IEC working group on household and similar electrical appliances began to prepare a draft to change the charge limit on hydrocarbons. The new limit was expected to change from 150g to 500g; this could shift the market towards bigger, more efficient hydrocarbon cabinets once it is adopted by the full IEC.

The working group was established to suggest changes to the current IEC 60335-2-89 standard that has maintained charge limits for hydrocarbons at 150g, limiting their use.

Countries are, however, free to go beyond what the IEC suggests. The UK has been using charges above 150g in commercial refrigeration units for a while, and is ready to go higher still. "In the UK they want to go to 1kg," says Werner Schwaiger, head of laboratory at AHT Cooling Systems GmbH and chair of the IEC

working group. The group will be recommending a new maximum flammable refrigerant amount for appliances that will change the IEC standard 60335-2-89.

The EU F-Gas Regulation, which foresees a ban on the use of HFCs with GWP over 150 in plug-in commercial refrigeration as of 2022, is triggering wider uptake of hydrocarbons in this sector.

In the US, the Environmental Protection Agency (EPA) only allowed the charge limit to move to 150g in 2011. This is due in part to the fact that the national ASHRAE 15 standard bans the use of hydrocarbon refrigerants, except in systems with charge sizes below 150g.

TESTS CONFIRMS HYDROCARBON SAFETY

Resistance to hydrocarbons has come from detractors claiming that their use is unsafe. The IEC working group asked independent stakeholders to carry out safety tests to determine whether these flammability concerns were warranted.

"The charge limit of 150g is completely outdated and unrealistic. It needs to be changed," says Florian Koch of German environmental group *Deutsche Umwelthilfe*.

"In the past 20 years there has been no change. However I think the F-Gas Regulation has pushed this to the fore, as R134a and R404A are being phased out in the next five years," Koch says.

He designed a test together with standards expert Dr. Daniel Colbourne and the IEC working group. German plant and product safety assessor DMT GmbH & Co. KG carried out the test, leaking propane from a commercial refrigeration cabinet to determine whether it would cause a flammable reaction.

"We tried to design a test with the worst-case scenario […]. The leakage holes [in the equipment] are catastrophic, like if somebody hit with them an axe," Koch says. Unlike in a real supermarket, the test took place in two small rooms of 20m^2 and 40m^2, making the concentration of propane substantially higher when it started to leak. "A store is around 1,100m^2 or greater," he says.

Two of the tests - one with 1kg of charge and a condenser on the top in a 40m^2 room, and a second with 500g and a condenser on the bottom in a 20m^2 room – revealed significant insights. The leak rate was set at 10g, 30g and 60g per minute.

"This would never be the case in reality. Even with the lower leak rate of 10g per minute, this would never happen in a supermarket, as they are hermetically sealed," Koch told *Accelerate Europe*.

The risk was assessed via sensors all over the small room, which revealed even in these extreme conditions, the amount of propane in the room had no chance of becoming flammable, except if the fans were off and the condenser was on the bottom.

"You need to meet safety conditions, like making a top condensing unit, keeping likely leak points up (high), and the fan on," he urged.

IEC: FROM IMPLEMENTATION TO ACCEPTANCE

The 26 working group members – comprising 13 countries, including Germany, New Zealand, Japan, and the United States – are expected to increase the limit to 500g by 2018.

Koch believes that in fact the limit need to go as high as 1,000g, arguing that "then you will have a more efficient system than 500g because you have one refrigerant loop and therefore need fewer components, using less energy".

"The resistance is because some [in the working group] do not build the machines for the upper limit of 1,000g," according to Koch. The EPA has also been reluctant to move from 150g in the US and for some applications like water coolers it is still at 80g. If US companies want to sell commercial units globally, however, a new IEC standard would put the EPA under pressure to act.

After Dublin, the working group will create a document for comments and the document will then go through other IEC committees prior to its adoption as a new industry standard.

Even changing to a 500g charge limit can potentially transform the market. "Production of the equipment will increase with a charge limit above 150g," AHT's Schwaiger predicts.

The charge limit increase could go a long way to help countries in other parts of the world meet their HFC phase-down requirements under the Montreal Protocol amendment agreed in Kigali in October. "Those who are in the global south believe hydrocarbons are better for the environment already. So, they really want to increase the charge limit of commercial applications and go this way when the standard comes into force," Schwaiger says.

AHT and other suppliers already provide hydrocarbon training when they sell their products in Asian countries and indeed all over the world, helping to mitigate safety concerns in the region.
■ CM

BrauBeviale 2016, Nuremberg, Germany

Cheers to natrefs! ***Brewing goes green***

Natural refrigerants are playing an increasingly dominant role in the brewing industry's efforts to address climate change, with hydrocarbons and ammonia refrigeration becoming standard. *Accelerate Europe* reports from BrauBeviale.

— By Charlotte McLaughlin

HVAC&R professionals were among some 38,000 visitors and 1,118 exhibitors gathering at international beverage tradeshow BrauBeviale – held at Nuremberg Messe on 8-10 November – to discuss raw materials, technologies, logistics and marketing in the brewing industry, with a special emphasis on green solutions.

AMMONIA & BEER: A MATCH MADE IN HEAVEN

Natural refrigerant ammonia has an ODP (ozone depleting potential) and GWP (global warming potential) of zero – meaning that it does not contribute to climate change.

Its long history of use in industrial refrigeration gives HVAC&R professionals and their customers plenty of experience to draw on. "The use of natural refrigerants [like ammonia] is probably more prevalent in breweries than in most industrial or commercial refrigeration plants," Mark Bulmer, global segment manager (cooling) at GF Piping Systems, told *Accelerate Europe*.

Wolfgang Dietrich, product manager for chillers at GEA, agrees. "Ammonia has been the dominant refrigerant in industrial refrigeration or more than 100 years, and thus also in breweries," he says.

Brewing has always been the business of ammonia. The story begins with Carl von Linde, who is credited with creating the first refrigeration machine. After presenting his machine at a brewing conference in Austrian capital Vienna in 1870, Linde went on to invent the first ammonia compressor in 1876.

Refrigeration is an essential part of the brewing process, especially in the summer months. Yeast, used in the brewing process, is a sensitive ingredient. If exposed to warm temperatures, it can make the beer taste unpleasant. The beverage industry depends on cooling throughout the production process – from brewing to transportation right the way to the pub or shop floor.

Robert Kain of Haas Anlagenbau, an installer of ammonia refrigeration systems, points to how widespread ammonia is in the


GF Piping Solutions' glycol pipes at their BrauBeviale stand

beer industry, "We have installed ammonia refrigeration for most of the breweries in Bavaria [including Paulaner, Lowenbrau and Augustiner]," he says.

Haas also installs ammonia systems in ice-skating rinks, mainly in Bavaria. "For us it is environmentally beneficial and more efficient for industrial purposes," Kain says.

NEW AMMONIA TRENDS

Due to its toxicity, traditionally ammonia has primarily been used in industrial settings away from public exposure. Yet Bulmer believes growing interest in low-charge ammonia will create opportunities in supermarkets, district heat pumps and other more public applications.

"There is just so much experience in ammonia, and with low-charge ammonia it can enter new areas of industry," he says.

Bulmer highlights the US trend towards using ammonia/CO_2 cascade systems to deliver efficiency gains in supermarkets. A recent installation by US retailer Piggly Wiggly saved the store $200,000 a year (see 'US retailer Piggly Wiggly's ammonia/CO_2 experiment', autumn edition, *Accelerate Europe*).

This is yet to translate to the European market. Bulmer believes this is about to change. "You will start seeing more low-charge ammonia smaller installations for small distribution centres and supermarkets. Ammonia, unlike CO_2, has a lot of knowledge to draw on," Bulmer says.

Refrigeration systems are also getting larger. "We are seeing a trend towards bigger capacity systems with a smaller charge," Matthias Wiegand, a sales manager at GEA Germany, told *Accelerate Europe*.

GEA's Blu-Chillers can work with charges of between 50 and 100g per kW of cooling capacity. "Using the lowest possible ammonia charge in systems is increasingly important. Ultimately it is a question of eliminating risks," says his colleague Dietrich.

"They are compact (about 5m^2 installation area for 1,000 kW cooling capacity) [and] have low operation and maintenance costs with an excellent ESEER (European seasonal energy efficiency ratio) of up to 9.4. These low-charge ammonia chillers can mitigate the risks to safety and increase efficiency," Wiegand says.

They have already been used in a lot of different areas. Dietrich says, "you can find these chillers across food industry, storage, central refrigeration systems, chemistry) as well as in high-quality air-conditioning like data centres".

KEEPING YOUR BEER COLD WITH HYDROCARBONS

Hydrocarbons, another natural refrigerant, have also leaped in to new areas and become the market standard. Many businesses in the light commercial beverage sector – using small fridges, ice cream freezers, beer tap refrigeration equipment and water coolers – cite the European F-gas Regulation, the cost of hydrofluorocarbon-based (HFC) systems and the efficiency savings as key drivers.


GEA compressor

This has pushed the beverage sector to fully commit to a climate-friendly hydrocarbon future. "R134a and R404A (high-GWP hydrofluorocarbons) will be gone everywhere [for light commercial applications] in a few years," says Burak Türk, area sales manager at Ugur – a Turkish manufacturing group who make hydrocarbon fridges.

Cost is a key factor. "Propane compressors are a little cheaper than the alternative," says Türk, citing this as a key driver of the adoption of propane in fridges used for cooling beer and soft drinks in supermarkets, bars and concert venues.

Alex Panas, marketing director at Turkish commercial refrigeration company Klimasan (exhibiting under the Metalfrio Solutions banner), echoed Türk's sentiments. "We only see a few markets using R134a and R404A, in sub-Saharan Africa and the Middle East. Hydrocarbons are a done deal for the rest."

Europe is driving uptake of hydrocarbons but other regions are getting in on the act. "Currently Europe is at 100%, the US is catching up, and Asia is not far behind," Türk says.

Globally, the Coca-Cola Company is already adopting hydrocarbons in bottle coolers and vending machines on a grand scale. By the end of 2015, the beverage giant had deployed more than 1.8 million HFC-free units worldwide.

Both Ugur and Metalfrio Solutions have begun to supply the Coca-Cola Company with fridges. "Jupiler, Heineken, Coca-Cola, Pepsi…there is huge demand for this equipment. Everyone has gone this way," Panas says.

Metalfrio has been supplying drinks companies with fridges for some time now. Ugur also supplies the Coca-Cola Company, Pepsi, Tuborg (a popular Danish beer), Carlsberg and Heineken with hydrocarbon systems – mainly using R600A.

'GREEN' BEER ON THE COLD TAP

Getting that cold draught beer from your local used to be the job of R404A or R134a – now hydrocarbons have cornered the market.

Lindv, a Czech company, welcomes the phase-out of high-GWP refrigerants currently taking place under the EU F-Gas Regulation. Tomáš Sopek, Lindv's foreign trade manager, believes this is moving the market towards natural refrigerants. "We anticipated the change, so we are definitely ready to completely turn towards propane as soon as possible," Sopek says.


Lindv's draught tap refrigeration machines at their booth

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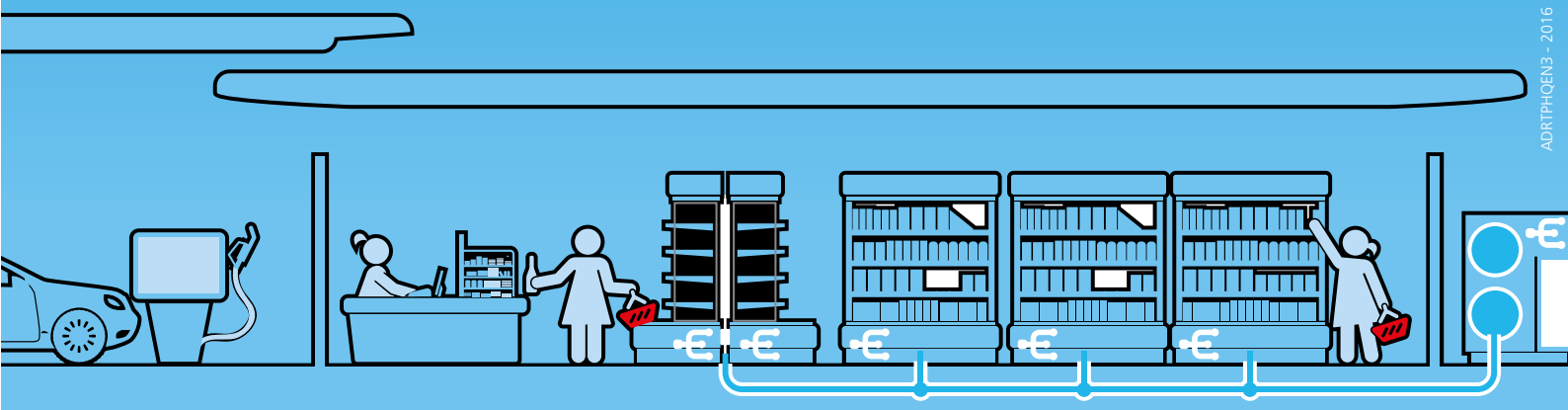

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Regulation aside, propane is simply a good working refrigerant for many suppliers. "Our strongest coolers [for beer on tap] are with propane. It's so much more efficient than R134a," he says.

Gordana Grgetič Štabi of Oprema – a Croatian manufacturer of refrigeration equipment for pub beer taps – agrees with Sopek. "We prefer R290. It not just has excellent thermodynamic properties but it's ecological. We always use the green angle to promote it to our customers like bars and music festivals."

"First, before the industry was aware of it [R290] we had to communicate about its flammability and train the customer. Yes, there are still those who are not comfortable [fixing hydrocarbon equipment] but in this case we do offer service," Štabi says.

Others are getting in on the R290 action. Italian company Vinservice has started manufacturing R290 beer dispensers with 50% more cooling power than R404A, according to Area Manager Alberto Monzani.

"We are trying to get customers green solutions – so propane was perfect for us," Monzani says.

At first this took a lot of engineering. "We studied the cooling capacity and make up of hydrocarbons to make sure we got it right the first time. Then we bought propane compressors from Embraco, which increased the energy efficiency [compared to R404A] by 33%. But we wanted to increase it further," Monzani explains.

Vinservice introduced a variable speed piston pump into the upgraded version of the machine – pushing savings up to 50%. "This is all so we can make a product that is at its most climate friendly during its lifecycle," he says.

PACKAGING TURNING GREEN TOO

BrauBeviale participants also discussed ecological developments in packaging. Günther Guder from the Federal Association of the German Beverage Industry says Germany is leading the way by pushing breweries to commit to 'reduce, reuse and recycle'.

Accelerate Europe observed that most packaging companies are seeking to reduce plastic consumption by reducing the amount of packaging they use or by using biodegradable substances. KeyKeg, a Netherlands-based keg manufacturer, displayed reusable beer and wine kegs that can also be recycled.

Watching the participants sample the wares on offer at BrauBeviale, it became clear to *Accelerate Europe* that the beverage industry is heading for a sustainable and energy-efficient future.
■ CM

Blupura's booth at BrauBeviale 2016

FIRST-MOVER ADVANTAGE PAYS OFF

Italy's Blupura, established in 2008, was the first company to start using hydrocarbons in water coolers – giving them an edge in the crowded marketplace. "We were the first in our industry [water coolers] to do propane," Blupura CEO Luca Costantini told *Accelerate Europe* at BrauBeviale.

"Me and my business partner [Gianni Grottini] wanted to come up with a product that had zero impact on the environment. We chose to use metal instead of plastics and R290 instead of R134a [an HFC usually used in water coolers]," Costantini says.

Blupura set about making R290 central to their brand, labelling their products and informing customers that propane is environmentally friendly and cost-effective. "We find R290 saves 15-20% more energy than R134a because you can use a smaller compressor," he explains.

"At the start it was hard going, the market was obsessed with the flammability [of propane], but we have had no issues in eight years," he says.

Their status as an early mover has paid off. The US Environmental Protection Agency now allows water coolers to use 80 kilograms of R290. Blupura is taking full advantage of the rule change.

"We are doing more and more business in the US now – mainly in our small units. We have opened up Blupura US in Miami, Florida to deal with this growing demand," Costantini says.

"We have also been selling a lot in South Africa and Australia. Now we are looking into South America," he adds.


#GoNatRefs

Heat pumps on the rise *in Germany*

With the German heat pump market on an upward trajectory, the opportunity is ripe for natural refrigerants to further penetrate the sector. *Accelerate Europe* reports from Berlin.

— By Christine Noël

Politicians and industry representatives alike see heat pumps as a crucial means of achieving Germany's climate and energy efficiency targets. Gathering for the 14th Heat Pump Forum organised by the *Bundesverband Wärmepumpe* (BWP), held in Berlin on 10-11 November, politicians and industry representatives discussed the key role that heat pumps can play in reducing greenhouse gas emissions across the economy.

Paul Waning opens 14th Heat Pump Forum

AN ADAPTABLE TECHNOLOGY

Heat pumps work by compressing the refrigerant to a high pressure. To drive the compressor, additional energy is needed: from electricity, gas or thermal energy. On the discharge side of the compressor, the hot high-pressure vapour passes through a condenser – releasing the heat into the heating system.

The condensed refrigerant passes through a pressure-lowering device, the expansion valve. The now low-pressure liquid refrigerant then enters the evaporator, in which the fluid absorbs heat and boils. From there, the cycle starts again.

By retrieving heat from outside and transferring it inside, heat pumps are recognised as an energy-efficient solution for certain HVAC&R applications. The cycle can be reversed, meaning heat pumps can be used for cooling as well as heating.

Heat pumps therefore act as a bridge between electricity and heat. Combined with renewable energy sources, they can be an efficient cross-sector and climate-friendly technology. An efficient and correctly installed heat pump can transform one kWh of energy into about three to four kWh of heat. "70% of the energy which a heat pump generates is free, renewable and comes directly from the environment. Today, no heating technology exists that can compare with the efficiency of heat pumps," says Sean O'Driscoll, chief executive of the Glen Dimplex Group, a Northern Irish electrical goods firm.

DELIVERING ON CLIMATE PROTECTION TARGETS

Germany's targets for delivering the energy transition – its *Energiewende* – require reducing emissions by 80% to 95% in CO_2e by 2050 compared to 1990. Every industry sector must play its part in delivering this goal by achieving individual targets. According to recent data from the *Bundesministerium für Wirtschaft und Energie* (BMWi), buildings are responsible for 35-40% of energy consumption in Germany, a large part of which is water and space heating. The heating sector is responsible for one third of overall greenhouse gas emissions in Germany, shows a study from the *Umweltbundesamt* (UBA). Heating can therefore make a significant contribution to delivering the *Energiewende*.

In this context, heat pumps are increasingly seen as an option for space heating – a trend reflected in their rapid increase in Germany and elsewhere. For heating of new buildings, the share of heat pumps has increased from 1% to over 22% in the last 20 years, according to O'Driscoll. However, their share in existing buildings is still below 2%. Matthias Kunath, managing director at envia THERM, believes the future of heating will be decided in the existing building sector.

Some industry representatives are calling on governments to actively support heat pumps by financial and non-financial means. O'Driscoll compares the necessity for public policy to support heat pumps to current support for electric mobility, another cross-sectoral technology that can reduce carbon emissions. "If support is justified for e-mobility – which it is – it is also justified for e-heat – which it is," he argues.

INNOVATIVE TECHNOLOGIES NEEDED TO OPTIMISE HEAT PUMP PERFORMANCE

As the stock of renewable energy-based heat pumps increases, so does the need for flexibility and energy storage. Development of new batteries and storage will play a decisive role in the success of heat pumps and other innovative technology for Germany's *Energiewende*. With more intermittent energy from renewable sources coming online, storage availability is crucial to the long-term viability of the energy transformation.

To fully exploit their environmental potential, Prof. Dr. Volker Quaschning from HTW Berlin – the University of Applied Sciences – called for heat pumps to exclusively use climate-friendly refrigerants. In a statement reacting to the Kigali amendment to the Montreal Protocol in pursuit of a global HFC phase-down, BWP Managing Director Karl-Heinz Stawiarski hailed the potential for natural refrigerants in the heat pump sector.

Representatives and attendees agreed that, politically, the heat pump industry today is where its proponents always wanted it to be. With more promotion and support, the market is poised to increase dramatically in the near future. Manufacturers and suppliers need to prepare themselves for growing demand for heat pumps across Germany.

■ CN

Heat pumps, system integration herald bright future for natrefs

The refrigeration devices of the future will provide heating alongside cooling, harnessing natural refrigerants to help reduce electricity consumption and wean the world off fossil fuels, argues Eric Delforge of the European Heat Pump Association (EHPA).

— By Andrew Williams

Eric Delforge, EHPA

Driven by innovation and a passion for sustainable solutions, EHPA board member Eric Delforge is keen to discuss ways of integrating heat pumps into smart energy systems on a massive scale. Comparing synthetic fluids to tobacco, he sees natural refrigerants as the only sustainable solution for the industry.

"In every refrigeration device, to a certain extent the refrigeration is a by-product of a cycle which in fact offers more heating than cooling," says Delforge, who chairs an EHPA working group on industrial and commercial heat pumps.

The trend towards more integrated systems is sweeping through the HVAC&R world just like in other sectors. "Especially in industry – sectors that use or need refrigeration also need heat, upstream or downstream. It's should be self-evident to combine the use of heating and cooling," the expert argues.

HEATING AND COOLING… WITH NATURAL REFRIGERANTS

Let us take the example of conventional fridges. Like other refrigeration technology, they use the traditional Carnot thermodynamic cycle of expansion and compression to reject energy. The rejected heat is pushed into the room via a heat exchanger at the back of the fridge or into the atmosphere via rooftop ventilation. "If on top of that you're burning fossil fuels for your heating, then in fact you're investing in a heating device twice," Delforge argues.

Rather than evacuating waste heat solely into the building, the EHPA expert believes refrigeration equipment should be connected to space heating systems. "In a house, you always need hot water – even in summer. The heat exchanger in your fridge should feed into your water boiler," he argues.

The logical next step would be for manufacturers of cooling devices and their boiler-making counterparts to offer heating and cooling in a single product – saving energy by requiring just one electrical input. "Why not? Heating and cooling with the Carnot cycle is simple, energy-efficient and doesn't need fossil fuels," says Delforge. "Ideally it should use natural refrigerants," he adds.

He argues that the effort required to deliver this vision pales in comparison to the trials of finding and extracting the Earth's remaining fossil fuels.

The dairy industry epitomises his vision. "At the end of the chain dairy products need to be cool. But before you can process the milk, it needs to be pasteurised. So the cooling plant offers waste thermal energy to provide water at 90 degrees Celsius for the pasteurisation process. You only need one electrical motor to do that, and the hot air from the cooling machine is reused," the EHPA expert explains.

MAYEKAWA PUTTING FAITH IN NATURAL REFRIGERANTS

Delforge is also corporate business and policy officer at Mayekawa Europe, where he sees his vision is shared. "The transition of this century is to stop burning fossil fuels," he declares.

With HFC phase-down deadlines under the EU's F-Gas Regulation on the horizon, he believes that "for natural refrigerants, we're well beyond the point of no return".

In Europe, he observes that many companies that have been actively using HFCs in their technologies are slowly but surely making the transition to natural alternatives.

Delforge sees opportunities for natural refrigerants here. "It will be a huge challenge for the chemical industry to justify the penetration of HFOs into the industrial market. I'm confident that end users will leapfrog them and decide to go for natural refrigerants," he says.

"If as a company you opt for a chemical as the refrigerant, you're bound by the technical boundaries of that refrigerant. Your customers will also be at the mercy of availability and pricing" – thus you find yourself restricted in terms of the type of technology you can build, Delforge argues.

At Mayekawa, "we have a lot of experience in different applications and in different industries. This carries us forward to proclaim that ammonia, CO_2, propane and other natural refrigerants are the solution – especially for industrial thermal applications," Delforge says.

HEAT PUMPS ON THE RISE

At the domestic and light commercial scale, he expects heat pumps to eclipse refrigerators in terms of their importance to the HVAC&R sector. What place for natural refrigerants here? According to Delforge, heating will play a crucial role in their growth.

"Most domestic energy goes into heating. Take Sweden: 90% of households use heat pumps, not condensing boilers. Imagine how much refrigerants they account for! The revolution is going to take place in households – switching from fossil fuels [in condensing boilers], which will one day be extinguished, over to heat pumps or hybrid systems. This accounts for dramatically more refrigerants than refrigeration only," he says, arguing that natural refrigerants will increasingly be applied in domestic heating applications.

Delforge is dismissive of those who believe that 2050 – the deadline by which the EU is seeking to cut carbon emissions to 80% below 1990 levels – is a long way off.

"Investments in thermal energy-generating devices are meant to last 20-30 years. A decision today to use synthetic refrigerants means being held hostage to consume them for 30 years," he warns.

Delforge compares today's battles over energy sources and the refrigerant mix to the past tussles of health advocates over tobacco. "It took fifty years for it to be accepted that tobacco is bad for your health. Production and use of synthetic refrigerants and fossil fuels are simply bad for our children and for the planet," he says.

"There is no other pathway than to step away from carbon-emitting activities and massively apply heat pump technology for heating, from domestic and commercial to industrial applications," argues Delforge, stressing the importance of ensuring that heat pump manufacturers opt for natural refrigerants. "Tomorrow is too late," he warns.

HEAT PUMPS IN THE HOME

Refrigeration on an industrial scale deals in megawatts, but a household heat pump accounts for just 5-11 kW. Putting his EHPA hat back on, Delforge nonetheless insists that the battle will be decided by the future choices of consumers.

"Domestic is going to be a game-changer. We're talking about a lot of devices. To influence the domestic market, you need to reach many more individuals – it's another public entirely," he says.

Delforge highlights the potential for governments to help change the game, drawing parallels with European legislation introduced to phase out incandescent light bulbs.

"I don't think there's any sensible citizen who'd like to turn back the clock on light bulbs. For refrigerants in certain applications, we need bold decisions from legislators," he says, citing the example of Denmark, where a political decision to ban most uses of HFCs is already delivering innovation benefits as demand for alternatives soars.

"Just imagine if French politicians – whose country is Europe's most electrified – were to decide, 'from 2020 onwards, every new building must have a heat pump'. It's doable and would be a game changer." AW

VOLUME 3

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HFC phase-down triggering ***hydrocarbons growth***

As the HFC phase-down and the drive for energy efficiency improvements begin to change markets worldwide, Mogens Søholm, CEO of German compressor maker SECOP, argues that hydrocarbon technology is ripe for growth – particularly in the United States.

— By Andrew Williams

Fully convinced of the role to be played by natural refrigerants, SECOP CEO Mogens Søholm is personally committed to seeing hydrocarbons assume a significant portion of the light commercial refrigeration market over the next few years. He shared his vision of SECOP's position in a changing HVAC&R market with *Accelerate Europe*.

"The best example of these recent big changes is the United States. A couple of years ago, you'd have never believed the US would change this quickly. But today they are very focused both on improving energy efficiency and phasing out HFCs," says Søholm.

In 2011, the US Environmental Protection Agency approved R290 for commercial food refrigeration, and R600a (isobutane) and R441A (a hydrocarbon blend) for domestic refrigeration. Last year, the agency expanded the regulations, allowing R290 in domestic refrigeration and R600a and R441A in commercial refrigeration. But the charge limits for commercial and domestic applications, in line with UL standards, were set at 150g and 56g, respectively.

"I strongly believe that with more insight into and knowledge of the technology, regulators will figure out that today's charge limit of 150g should increase," Søholm says.

SECOP CEO Mogens Søholm

HYDROCARBONS HAVE THE EDGE

He believes the advantages of moving to hydrocarbons are so significant in terms of energy efficiency and environmental impact that the only conceivable obstacle to their wider uptake is flammability. "But today's technology know-how limits those risks," he says, pointing out that hydrocarbons have been used safely in household domestic appliances in Europe and Asia for decades.

Given the efficiency advantages of hydrocarbons, Søholm sees little reason to opt for new synthetic refrigerants instead. "I don't understand why from a technical point of view, it's not possible to make the jump and choose the technology that has the obvious advantage," he argues.

As for flammability, "some HFOs are also flammable – and they're chemical blends. Hydrocarbons are purely natural. That makes a difference," Søholm says.

"We're seizing every opportunity we can to demonstrate what our products can achieve. You don't have to be very technical to go in and evaluate the advantages of making the shift to hydrocarbons, because the advantages are so big – for the environment, for energy efficiency, for everything," he insists.

SUPERMARKETS: A KEY GROWTH DRIVER

The efficiency improvements are helping SECOP to increase its market penetration.

Supermarkets are crucial customers for hydrocarbon systems. Søholm splits the supermarket sector into two philosophies: hypermarkets with big remote systems, where the refrigerant is piped into the store and the refrigeration equipment is housed away from the shop floor; and self-contained, hermetic systems with smaller compressors.

"The advantage of self-contained systems is that they allow you to change the layout of your supermarket," he says.

Smaller convenience stores are becoming increasingly popular. "People don't want to sit in a car and drive 20km" to shop in a hypermarket, says Søholm, arguing that the trend towards smaller, local stores supports wider uptake of hydrocarbon technology.

Søholm cites bottle coolers as another growth area. "For years, this segment has been extremely cost-driven," he says.

Asked about competition with CO_2 – another popular natural refrigerant, particularly in the supermarket sector – Søholm replies: "I'm a big fan of hydrocarbons. Otherwise you wouldn't have seen me invest so much in this!"

He concedes that CO_2 has a role to play in larger supermarkets but is convinced that impressive energy efficiency, quieter compressor operation, and relative lack of construction materials give hydrocarbon systems the edge in smaller store formats. "The only disadvantage of hydrocarbons compared to CO_2 is that hydrocarbons are flammable and CO_2 isn't," he argues.

Does SECOP fear increased competition in smaller store formats from CO_2 condensing units being marketed in Europe by the likes of Panasonic, Green & Cool and Advansor?

"Of course we're following what's happening. But from a technical point of view, hydrocarbon is still the better solution. Condensing units don't make CO_2 more energy efficient or make the compressors any quieter. They're just a different way of providing the refrigeration system," Søholm argues.

GROWING INTEREST STATESIDE

Do SECOP market compressors on the basis that hydrocarbons are environmentally friendly? "We do what we can to communicate the value of that," he says.

"Some clients in the market are extremely visionary in trying to push the market in the direction of hydrocarbons," he says. Large end users have also understood this, integrating HFC phase-out or natural refrigerant uptake targets into their sustainability strategies, he argues, citing the example of a large US retailer that uses only hydrocarbon bottle coolers.

"Smaller companies then follow the example of what the trendsetters are doing," Søholm says.

To capitalise on growing interest in hydrocarbon refrigeration units in the Americas, SECOP is helping OEMs to convert from HFCs to hydrocarbons at its US testing facility near Atlanta.

"We're taking cabinets from [OEM] customers in North America and Latin America and doing optimisation and conversion to R290 [propane] or R600a [isobutane]," says Sam Huffman, a key account manager at the German firm.

Huffman is based at SECOP's US headquarters in Roswell, Georgia, which opened in 2013 and is "100% focused on hydrocarbons on our product development," he says.

The optimisation and conversion process involves changing the condenser, fan and controller, Huffman explains. "This allows customers without internal testing capabilities who are still interested in pursuing natural refrigerants to convert their cabinets."

The applications undergoing conversion cover everything from glass-door merchandisers and food service equipment to freezers and water dispensers.

OEMs of water dispensers, for which the US EPA in September approved propane as a refrigerant, have been working "proactively" with SECOP to prepare for the rule change, Huffman says. "They knew it was coming, so they wanted to be prepared. They approached us to do baseline testing and see what other components they may need to look at."

While technological innovation has had a major impact on the development of the market in Europe, the more litigious nature of the US business environment has seen lawyers play a larger role on the other side of the pond. "The US has tended to focus on the risks," CEO Søholm says.

"If something were to happen, what would happen to the companies providing the hydrocarbon systems? That's perhaps the fear there. But it is taken totally out of proportion," he argues.

SPOTLIGHT ON A CHANGING MARKET

At the heart of SECOP's product offering for hydrocarbons at October's Chillventa tradeshow in Nuremberg was the new SLVE compressor, which is more powerful than previous models thanks to its use of energy-optimised components.

"There are three key topics for us: natural refrigerants, energy efficiency, and the variable speed aspect – going electronic with these products," Søholm says.

SECOP was also showcasing new variable speed drive 'DLV' and 'NLV' series compressors for use in commercial cooling systems.

"If you convert a traditional R134a system to hydrocarbons, you gain a lot of efficiency by changing the refrigerant alone. If you add variable speed technology on top of that, then you see improvements – in terms of energy efficiency and noise, for example – that are tremendously large," Søholm says.

Switching from R134a to HFOs, meanwhile, does not result in any efficiency gains, he adds.

The variable speed drive enables needs-based adjustment of cooling capacity and ensures high efficiency even in partial load operations. Compared to fixed speed refrigeration compressors, variable speed drives can achieve energy savings of up to 40%.

"We believe the whole market is changing focus, especially in light commercial. Where we're putting our development money these days for light commercial is a full range of hydrocarbon compressors – mainly R290," he concludes.

■ AW

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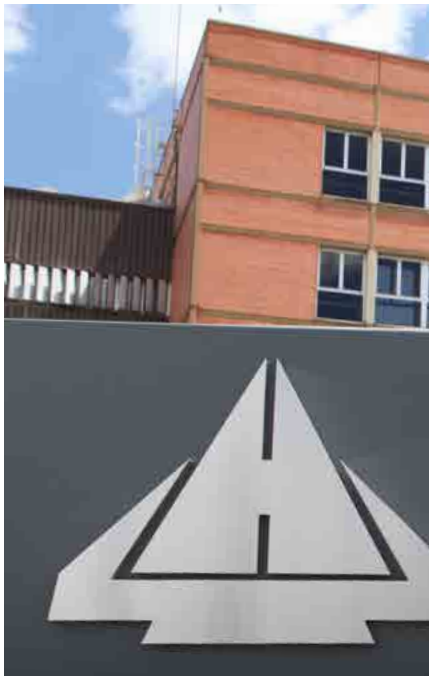
HUAYI gearing up for the hydrocarbons age



Leading manufacturer Huayi Compressor Co. Ltd. is betting on propane for domestic and light-commercial refrigeration applications.

— By Alvaro de Oña

Anticipating growth in global demand for hydrocarbons, Huayi Compressor Barcelona with its brand Cubigel Compressors (the European arm of Huayi Group) is already investing 80% of its R&D effort in natural refrigerants. Amid strong focus on innovation and fluid cooperation with headquarters in China, *Accelerate Europe* visited Huayi's European office on the outskirts of Barcelona to find out more.

PIONEER IN R290

Beaming with pride, Sales Executive Pedro Olalla says, "we were the first ones to develop a whole range of propane (R290) compressors back in 2000".

Olalla, an engineer by training, has spent almost his entire career helping to transform Huayi into the successful firm it is today. But it has not always been plain sailing. "We expected the whole market for commercial refrigeration to follow the same path as for domestic refrigeration, which switched very quickly to hydrocarbons. Unfortunately the evolution is slower in reality," Olalla laments.

Existing standards limiting the refrigerant charge to 150 grams and a lack of qualified after-sales technicians are both slowing propane's transition to becoming the standard solution for light commercial refrigeration. But with standards currently being revised, change may be on the horizon.

As for propane's ultimate potential, Olalla's assessment is clear: it can deliver the best performance.

"Variable speed compressors are the only option to reach higher efficiency levels," argues Olalla, pointing out that Huayi's latest compressor range can deliver up to 50% more efficiency than comparable HFC models.

"When somebody asks for variable speed compressors, in fact they are practically asking for propane," confirms Vicente Guilabert, director of R&D at the group's European HQ. "For 2-3 years, propane has represented 80% of our R&D efforts, but only 25% of our total sales. It feels like preaching in the desert," Guilabert admits.

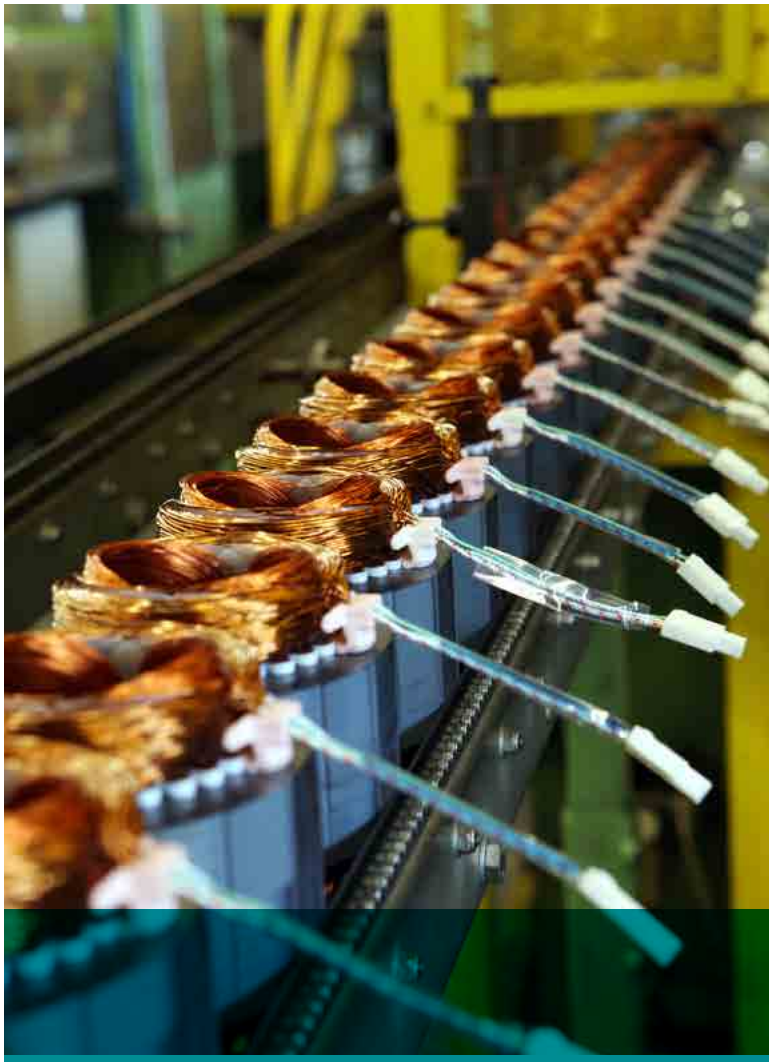
Although the evolution has been slow to get off the ground, the company is firmly committed to its strategy of focusing on natural refrigerants and developing more efficient models. "For next year we expect to launch a new range of R290 variable speed compressors with small cooling capacity for chest freezers and ice cream freezers. We will also be looking to extend variable speed to high displacement compressors in order to have a complete offer," Olalla announces.

INNOVATION HOLDS KEY TO SUCCESS

Since 2013, the Huayi Group has been the biggest compressor manufacturer in the world, boasting estimated sales of 39 million compressors in 2015. Chinese branch Jiaxipera accounts for the lion's share of manufacturing. It has the capacity to produce 25 million compressors annually, thanks in particular to its dominant position in isobutane (R600a) compressors for domestic fridges.

Huayi's European arm focuses on commercial refrigeration, but synergies exists between the group: "Each plant has a dedicated R&D team, and we plan to open a new technology centre on 28 December this year in China," Guilabert explains.

"We have a regular exchange of staff, and collaborate frequently on issues of common interest. From China we get technical expertise and support to develop new innovations. In exchange, we bring our market knowledge, share our commercial strategy, and help with lab testing for different applications," says Guilabert.



At the production site near Barcelona, Huayi develops extensive testing on both existing and future models, following strict guidelines to maintain quality standards (such as ISO). Each compressor model is tested under extreme conditions for length of use, wear and tear, leakage rates, and noise. "Noise reduction is a key aspect of compressor development. And not only in isolation, but also as part of a whole system, where a single variation from the positioning of one component could result in higher noise levels of a whole unit," Guilabert explains.

LEGISLATION CREATING OPPORTUNITIES – WORLDWIDE

Regulatory change is fast becoming a primary driver of renewed interest in hydrocarbons. "The F-Gas Regulation in Europe and the SNAP approval (Significant New Alternatives Policy) in the US are reinforcing the use of hydrocarbons. It started in Europe many years ago, and now we see growing interest in the US, and also in China and in developing countries," Olalla says.

Should the market turn more decisively towards hydrocarbons, Huayi is set to benefit from a strong position and network.

Interest is also growing in Latin America, as "many customers are asking for alternative models, and comparing their performance to guide their choice," says Olalla.

"Big OEMs (Original Equipment Manufacturers) are not even asking for chemical refrigerants anymore. They are only waiting to see hydrocarbon charges over 150g allowed in the market," Olalla insists.

The Huayi Group sees a bright future for these natural refrigerants. "In the coming years it is very likely that hydrocarbons will be the only refrigerant used for light commercial applications," he concludes.
■ AO

BORN TO BE INTERNATIONAL

Currently part of Chinese giant Sichuan Changhong, a consumer electronics conglomerate with over 90,000 employees worldwide, the Huayi Group comprises three subsidiaries: Huayi, Jiaxipera and Huayi Compressor Barcelona (operating under the brand name Cubigel Compressors). The latter is the smallest of the group, with approximately 400 employees, but serves as a gateway to the European market from its privileged location in northeast Spain.

Cubigel (literally 'ice cube' in Catalan) started off as a family business back in 1962, driven by the vision of a local entrepreneur. The company had an international vocation from the outset, and saw periods of cooperation with Electrolux in the 1980s, and the extinct ACC Compressors later on. Since 2012, Huayi Compressor Barcelona has been the light commercial refrigeration branch of the Huayi Group, manufacturing compressors and condensing units.

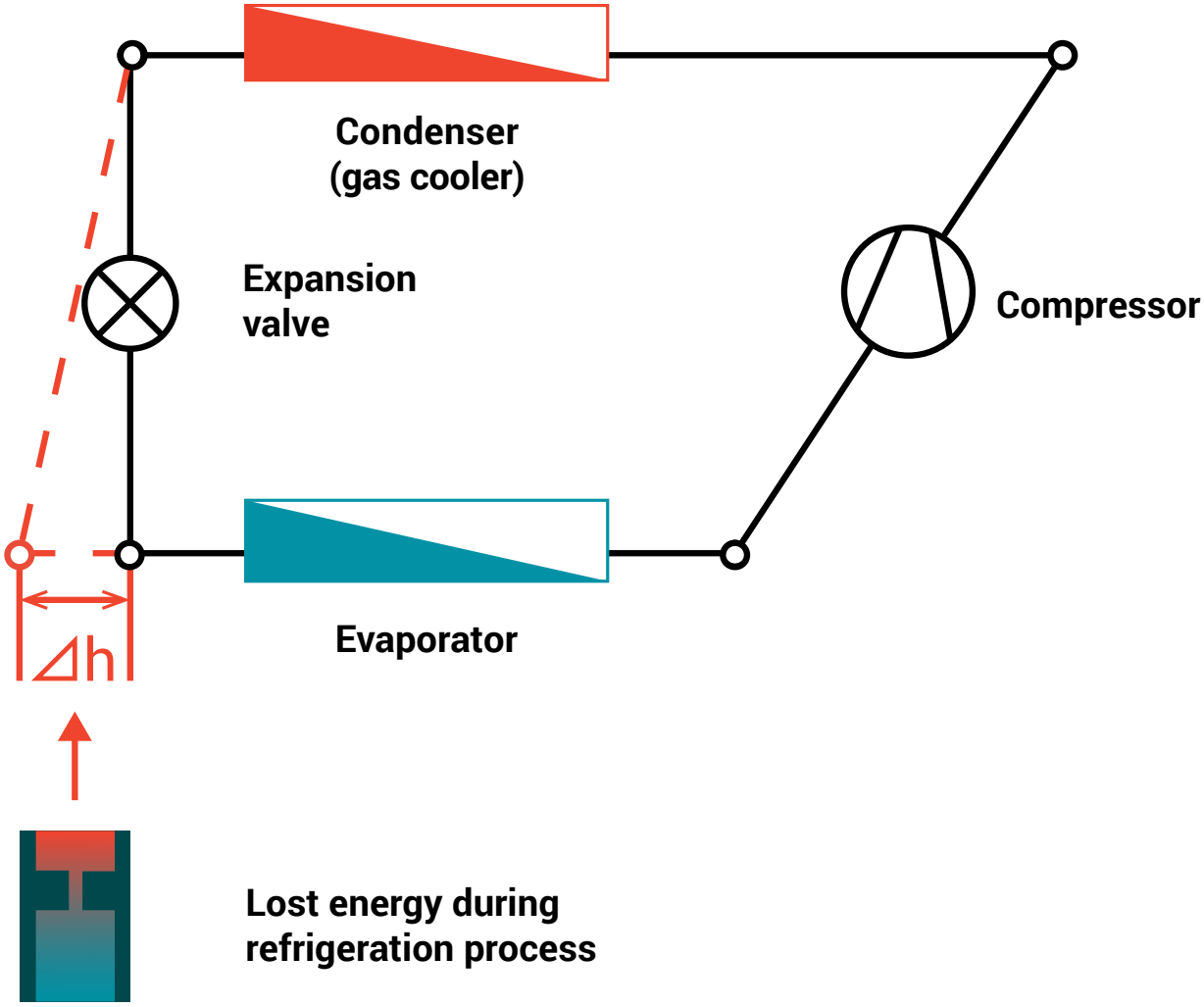
Ejectors can boost supermarket refrigeration efficiency

Ejectors: *to efficiency and beyond!*

In today's dynamic refrigeration world in which CO_2 systems are becoming ever more innovative, ejectors are bringing the natural refrigerant to new locations and applications.

— By Charlotte McLaughlin

Figure 1:



Source: Presentation by Masahiro Takatsu, DENSO at ATMOsphere Asia 2016

Overcoming the so-called 'CO_2 equator' – the previously accepted geographical limit for cost-effective and efficient performance of CO_2 systems in all food retail store formats – would dramatically extend the scope to use CO_2 as a natural refrigerant across the spectrum, from smaller convenience stores to large hypermarkets.

The power of ejectors to help deliver this vision has never been clearer to the commercial refrigeration sector. With more companies entering the market and new ejector models being developed, *Accelerate Europe* asked industry experts how the technology works and why it is important.

Reducing energy demand can help industry to meet economic and sustainability targets alike. In the commercial refrigeration sector, ejectors are one way to get there. The devices can improve the efficiency of refrigeration systems by up to 20, 30 or in some cases 40%.

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

Sounds complicated, right? The essential point is that ejectors yield significant long-term cost benefits to end users.

An example of a Danfoss ejector

DELVING INTO THE SCIENCE

In Europe, ejector manufacturers have tended to focus on commercial refrigeration. Two common ejector types – the fixed and the modulating ejector – both have strengths and weaknesses.

"I think that the best one is the 'fixed nozzle' ejector in combination with parallel [compression]" configured in such a way to maximise system efficiency, says Sergio Girotto, president of Italian refrigeration firm Enex.

Carrier and CAREL have joined forces to develop and industrialise a high-efficiency modulating CO_2 ejector, potentially putting an end to the concept of the CO_2 equator. Launched at the ATMOsphere Europe conference in April 2016, the new ejector "is capable of increasing system efficiency by up to 25% - with annual averages of 10% in the typical climates of southern Europe," CAREL's Alessandro Greggio told *Accelerate Europe*.

Danfoss has begun looking into stacking ejectors on top of each other to improve the efficiency gains even further. "The multi-ejector is not commercially available but we have several prototypes that are just built for purpose and can be ordered [by customers]", says Torben Funder-Kristensen, vice-president of public and industry affairs at Danfoss.

Ekaterini Kriezi, another Danfoss technology expert, told *Accelerate Europe* how the concept works. "The multi-ejector is capable of recovering energy while controlling the high pressure of the transcritical application. [This] eliminates the need for redundant, cascade refrigeration systems, providing improvements in energy efficiency of 10% or more," she says.

Ejectors have long occupied the minds of academics. At the last Gustav Lorentzen conference on natural refrigerants, many research papers looked into what ejectors are truly capable of. *Haida et al* demonstrated that the multi-ejector concept can increase a system's cooling power by 33% in their paper, 'Experimental analysis of the R744 [CO_2 as a refrigerant] vapour compression rack equipped with the multi-ejector expansion work recovery module'.

A comparison of various supermarkets carried out by *Fredslund et al*, in the paper 'CO_2 installations with a multi-ejector for supermarkets, case studies from various locations', concluded that "operation efficiencies [can be] above 25%" provided that certain design conditions like pressure, oil and compressor size are met.

Smolka et al compared both fixed and modulating ejectors, determining that it is difficult to do so as energy savings often depend on how the ejector is integrated into the system's design.

"I do not believe that some companies claiming to produce them have really understood the challenge," says Enex's Girotto. Despite the complexity of the science behind ejectors, the body of research clearly reveals that ejectors are capable of delivering huge energy savings.

TRAINING PLAYS KEY ROLE IN WIDER ROLLOUT

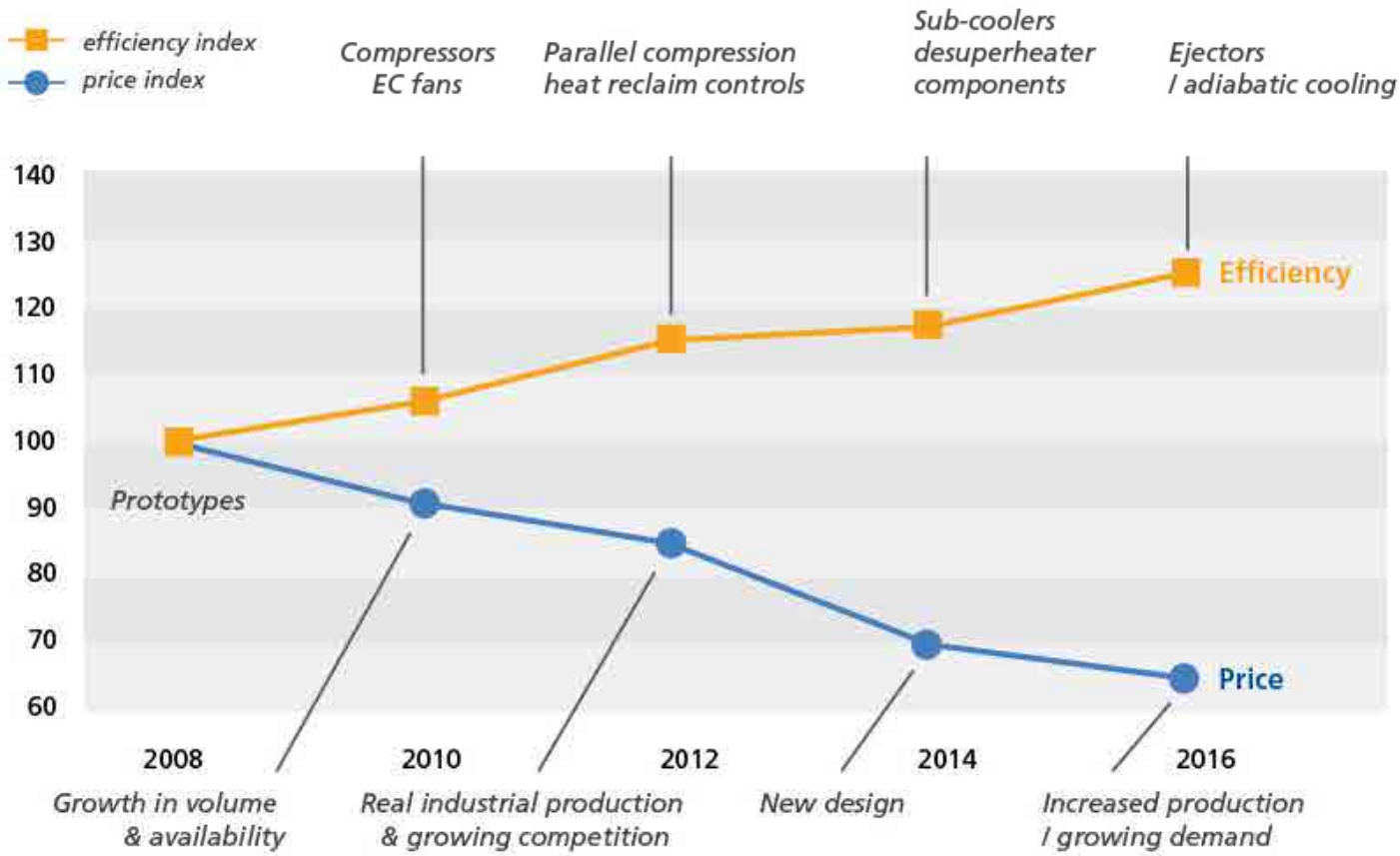
Ejector manufacturers often provide training themselves, so lack of training is not much of a barrier to increased ejector use. "Using ejectors is not complicated. It just means some things need to be different," says Enex's Girotto. "You just need to provide training, especially for installation," he says.

Carrier also helps contractors and end users get to grips with ejectors. As reported in the spring edition of *Accelerate Europe*, Carrier's CO_2OL academy training facility in Mainz, Germany offers bespoke training programmes within a 400m² recreated store environment.

The firm also provides wider training on CO_2 systems at the Mainz facility.

Industry experts quoted in the report '*F-Gas Regulation: Shaking up the HVAC&R industry*' (see page 28) argued that the cost of ejectors is a non-issue – insisting that adding ejectors and parallel compression increases the price of a system by 10% at most.

Data from Danish CO_2 rack manufacturer Advansor reveals the strong relationship between increased efficiency of CO_2 systems and falling component prices (see table below).



Source: Advansor, ATMOsphere Europe 2016

TRAVERSING THE 'CO_2 EQUATOR'

Danfoss point out that the multi-ejector solution has been engineered specifically to overcome warm climate conditions. "We have reduced energy penalties associated with operating transcritical CO_2 systems in high ambient temperatures, making transcritical CO_2 systems more efficient than HFC systems in any climate zone," says Danfoss' Kriezi.

Over 100 manufacturers, retailers, contractors and consultants gathered in the Italian city of Padova on 29 September 2016 to address the issue of how developments in ejector technology can improve the performance of CO_2 refrigeration systems in warm climates.

Enex's Girotto, who helped to organise the Padova event, demonstrated how using ejectors improves upon system design. "This is critical in a southern European climate, because several component breakdowns were recorded using the conventional system in warm climates," he says.

"With ejectors, units in Italy are working during the warmest summer days in air temperatures of higher than 40°C for a significant number of hours. It means that even if they have not yet been installed in the extreme south of Europe, like Greece, they will work there," Girotto explains.

OPPORTUNITIES ELSEWHERE

Ejectors can improve system efficiency wherever they are deployed. "In the warm climates of southern Europe, Carrier's high-efficiency vapour ejector system has achieved total store energy savings of more than 13% versus our standard transcritical CO_2OLtec system. Similar energy savings may be achieved in northern climates, although this depends on a number of factors such as ambient temperature profile and heat recovery configuration" says James Nutting, director of marketing, key accounts and sales development at Carrier Commercial Refrigeration Europe.

"In addition, the ejector can be combined with other high efficiency components including the economiser cycle and liquid pump to further maximise energy savings across all climates," Nutting says.

Danfoss has installed over 50 ejectors in Europe. Once it has refined the technology here, the company plans to roll it out elsewhere. "We now have to get a good foot in the market. We will then push in North America in the second instance and then we will go to other markets," says Funder-Kristensen.

Enex has sold about the same number of ejectors as Danfoss in Europe, including in Italy, Poland, Romania, Switzerland and Germany. Most European countries, with the exception of Scandinavian nations and northern Germany, would benefit from ejectors and parallel compression, according to Girotto. "Those countries all have at least two to three days of warm temperatures from an operational point-of-view," he says.

Girotto says Enex is open to partnering with a US company to bring its systems to the United States.

Other companies sense an opportunity to develop their own ejector. Compact Kältetechnik's Stephan Leideck told *Accelerate Europe* that the company's ejector for transcritical CO_2 systems would hit the market by 2017.

The German manufacturer assembles custom-built CO_2, ammonia and propane solutions according to market demand. "The examples at [Chillventa] are made for our customers and they will go to them after the show. Due to the market situation we decided to manufacture our own ejector," says Leideck.

The company is currently testing a prototype at its test site. It plans to bring to market by 2017 a gas and liquid ejector system with a built-in controller – developed together with German controls manufacturer Eckelmann.

Accelerate Europe has heard whispers of other commercial refrigeration players in the CO_2 arena taking the plunge. Stay tuned for more on this story.
■ CM

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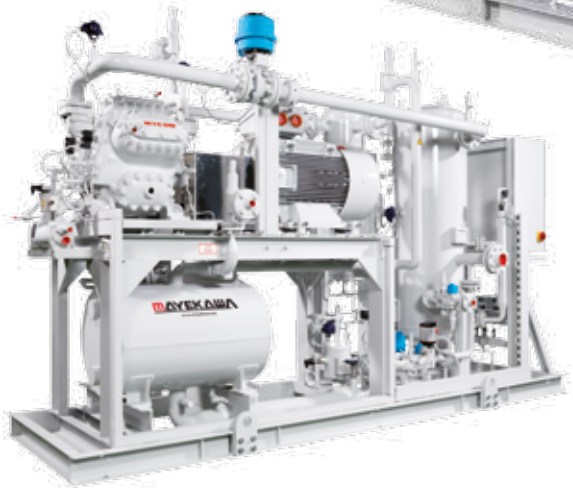

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