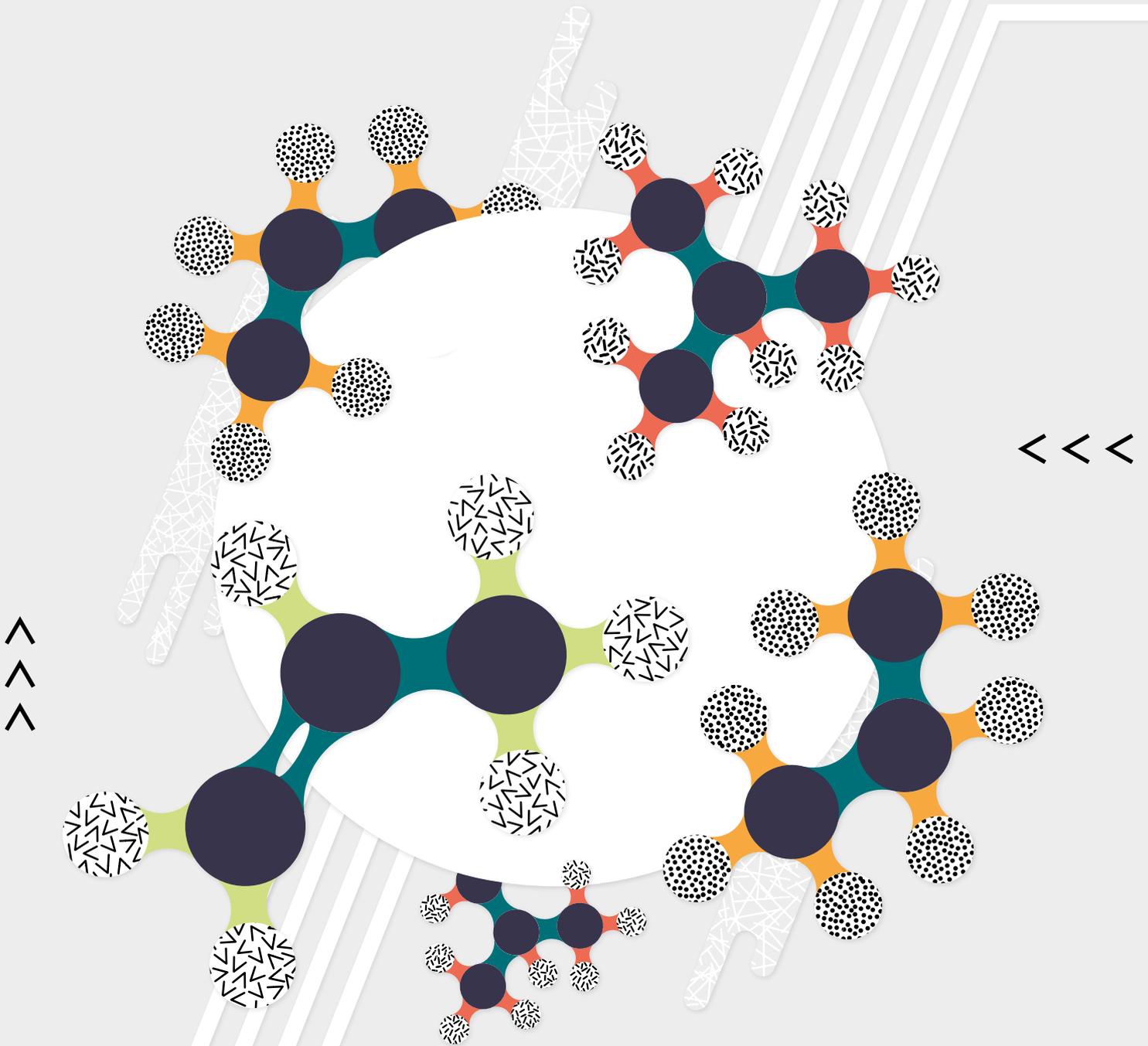


SPECIAL EDITION: SEPTEMBER 2017

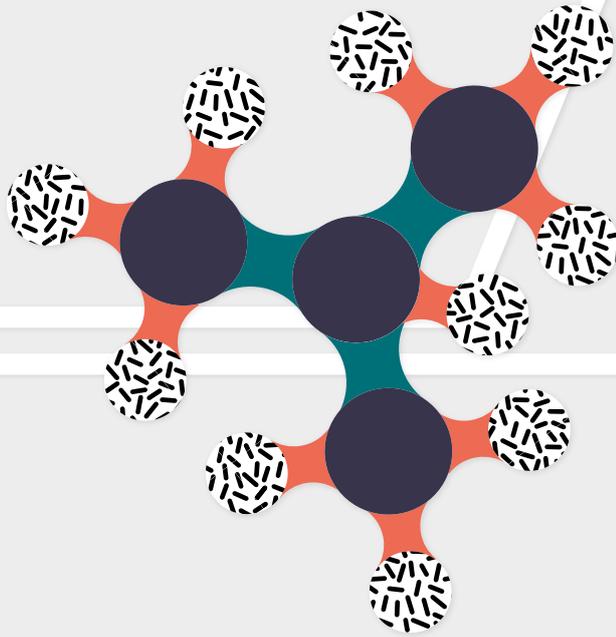
# ACCELERATE

ADVANCING HVAC&R NATURALLY

C O R P O R A T E



▶ HYDROCARBONS – A NEW WORLD ORDER >>>



## About

### **ACCELERATE CORPORATE**

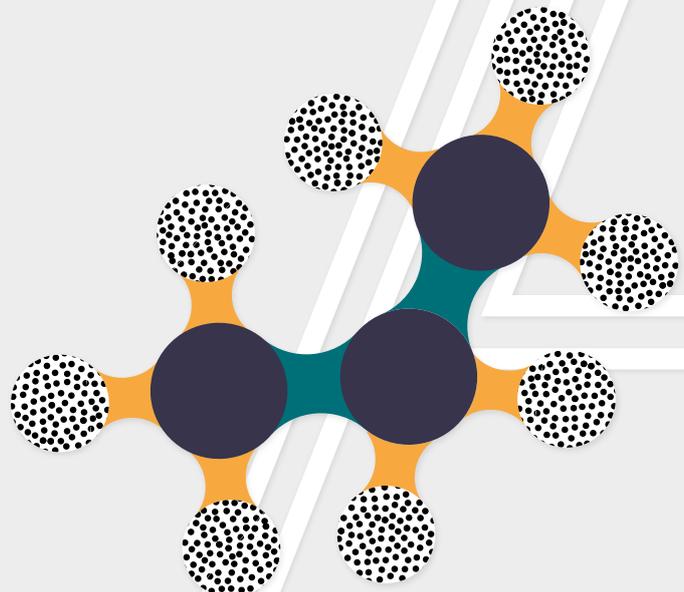
*Accelerate Corporate* captures the efforts of market leaders in advancing the use of natural refrigerants across different applications, industry sectors and continents.

Each issue of the magazine is prepared in partnership with an influential corporation, organisation or group of entities striving to accelerate the uptake of climate-friendly, natural refrigerant-based technologies.

*Accelerate Corporate* seeks to showcase end users' experiences working with natural refrigerants and to highlight the underlying market, policy and technology trends driving their uptake.

This issue of *Accelerate Corporate* was made possible by the support of:

**embraco**



# The Age of Hydrocarbons



– Editor's note by Andrew Williams

As technology develops and the global HFC phase-down picks up pace, natural refrigerants are cementing their place not just as market-ready alternatives today but also as the future-proof HVAC&R solutions of tomorrow.

This special edition of *Accelerate* looks at how hydrocarbons, in particular, are expanding into a wider range of business sectors and applications. Thanks to their impressive efficiency performance – particularly in warmer climates – they are fast becoming the natural refrigerant solution of choice in small-scale applications such as bottle coolers and vending machines.

Hydrocarbons – already dominant in the domestic refrigeration market in many parts of the world – are solidifying their place in the commercial and light commercial sectors. Globally, they are making their presence felt. The only household refrigeration markets that remain largely untouched by hydrocarbons, for example, are North America and Africa. We take an in-depth look at these and other market trends in our special feature (p. 26).



For hydrocarbons to make inroads into new areas of application, however, charge limits will need to be revised. This year, standards bodies in the United States and worldwide will consider increasing these limits amid mounting pressure from industry (p. 30).

Embraco, a multinational company focused on refrigeration solutions, is banking on disruptive technologies to stay ahead of the pack. We sat down with CEO Luis Felipe Dau to find out how the company sees the position of hydrocarbons in the global HVAC&R market unfolding in the future (p. 8).

Our series of case studies from around the world provides a snapshot of how innovative solutions are helping end users in different sectors of the economy to make the switch to hydrocarbons.

From professional kitchens to medical laboratories, a growing number of markets are taking advantage of the efficiency and versatility of hydrocarbons. In domestic and light commercial refrigeration in particular, their use is projected to grow significantly. Criotec and Thermo Fisher Scientific are among the companies banking on hydrocarbons to improve cooling system performance (p. 16).

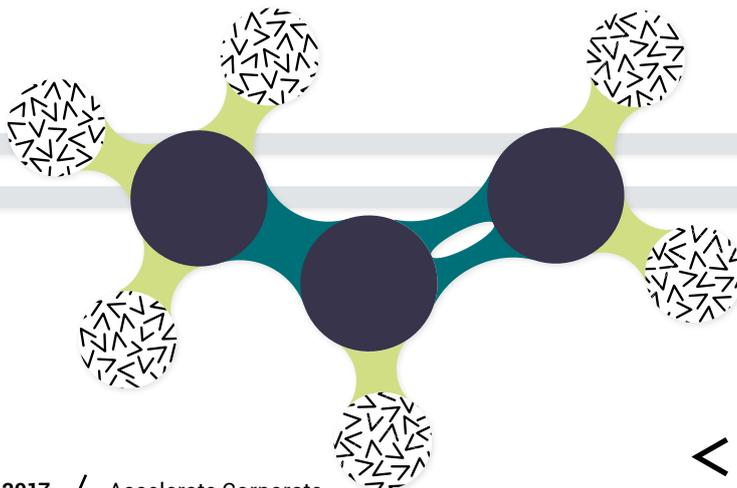
In Brazil, two innovative companies with close ties to that country – Embraco and Eletrofrío – are helping Mig supermarkets to adopt propane-based plug 'n' play cabinets (p. 12).

In Europe, natural refrigerants are helping the Colruyt Group to save money and deliver on environmental targets. The Belgian retailer is moving to hydrocarbons for 100% of its in-store cooling needs (p. 20).

Brewing giant Heineken also recognises the business case for natural refrigerants. CEO Jean-François Van Boxmeer argues that sustainable refrigeration is one of the best investments that companies can make to secure our planet's future (p. 23).

All the end users featured in this issue recognise the role that hydrocarbons can play in putting the world on a more sustainable footing for future generations. I would like to take this opportunity to thank Embraco, whose support made this special edition of *Accelerate* possible.

With a clear global HFC phase-down pathway now in place and innovative companies working together to develop market-ready replacement technologies, the world stands on the cusp of a new Age of Hydrocarbons. ■ AW



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# Let's reform the obstructive AC&R safety standards

– By Dr. Daniel Colbourne

**A**part from historical and industrial use, the possibility to use hydrocarbons (HCs) as alternative refrigerants to ozone-depleting substances (ODSs) began to gain momentum about 25 years ago. Following the success of the Greenpeace 'Greenfreeze' revolution, stakeholders began to consider the viability of HCs in applications beyond domestic refrigeration, such as room air conditioners, chillers, vehicle air conditioning and commercial refrigeration.

Interest and enthusiasm in HCs was generated from various directions. From the early 1990s HC refrigerant producers such as Calor Gas, Ecozone, Esantyl (now HyChill) and OZ Technology promoted the technology. Under the Montreal Protocol it was implemented by national agencies – particularly GTZ (now GIZ) and INFRAS – leading to an uptake in both Article 5 and non-Article 5 countries almost in tandem (at least for domestic refrigeration). Progress was eventually facilitated in the mid-1990s by the advent of safety standards covering HC refrigerants, such as EN 60335-2-24, and British and German safety standards – BS 4434 and DIN 7003 respectively – for non-domestic applications. Similarly, deeper technological insight was accelerated by international events such as the International Institute of Refrigeration's (IIR) 'New Applications for Natural Working Fluids' conference; initially at Hannover in 1994, now the biennial Gustav Lorentzen (GL) conference.

Over the past 20 years, that interest and enthusiasm has fluctuated widely, with periods when numerous manufacturers and end users of heat pumps or air conditioners or chillers or refrigerated display cabinets would adopt the technology, followed by episodes where there has been a lull in tangible fervour. This of course broadly follows the

ebbs and flows of national, regional and international legislation relating to ozone and climate issues. HCs – along with other natural refrigerants – potentially offer a panacea for climate-damaging refrigerants, but only if the industry safety standards are remedied to overcome the frustrating and often nonsensical restrictions buried within.

With the introduction of the new EU F-Gas Regulation in 2014, the onerous phase-down schedule has created a significant shift in the way decision-makers in Europe approach this trade-off between environment and efficiency versus the headache of handling flammability. Coupled with the advent of the new Kigali Amendment, again there seems to be a re-energised surge of enthusiasm in HCs for certain applications. This is perhaps reflected by the number of articles on HCs published in scientific journals and conferences, the rate of which is about double that of five years ago (compared to an increase of about 1.25 times for scientific articles in general). Along with other natural refrigerants such as R717 and R744, HCs are largely seen as 'the end game' by many stakeholders (within the context of available technologies).

Currently there are a limited number of manufacturers producing systems with HCs: a fair number for commercial refrigeration products, some making chillers and heat pumps, yet very few indeed involved with stationary air-conditioning units – and none whatsoever when it comes to mobile/ car air conditioning (MAC). Indeed, this is particularly disappointing from an environmental perspective, since small air conditioning (single splits and MACs) is responsible for more than half of the global refrigerant-related global warming impact, despite posing the lowest flammability risk amongst all these sub-sectors.

To some extent, this lacklustre situation is broadly affected by stakeholders' anxieties over flammability safety issues: "it just doesn't feel safe", "more than 150g cannot be safe", "yes, an ideal refrigerant, but..." – emanating not only from non-specialists but even from engineers and scientists in the field. Arguably, this typifies the disappointingly trivial number of research articles published on HC safety compared to those, for example, on thermal engineering of HC systems; it is all very nice presenting a study on how efficient R290 is in this compressor or that system, but if this fundamental barrier is not comprehensively addressed, the far-reaching substitution of HFCs with naturals will remain unreachable. Despite this, the landscape is beginning to look greener, with a three-fold increase, for instance, in the number of articles addressing this topic at the last IIR GL conference.

The reason for this is the (im)balance between the 'push' and 'pull' of key stakeholders. With commercial

refrigeration, a small number of major end users provide enough 'pull' to encourage manufacturers to commit to environmentally-friendly technology. Conversely, for split ACs and MAC, the choice of technology is dictated by system manufacturers, since no single group of end users (predominantly, individual members of the public) has the critical mass to impose that demand upon the manufacturers.

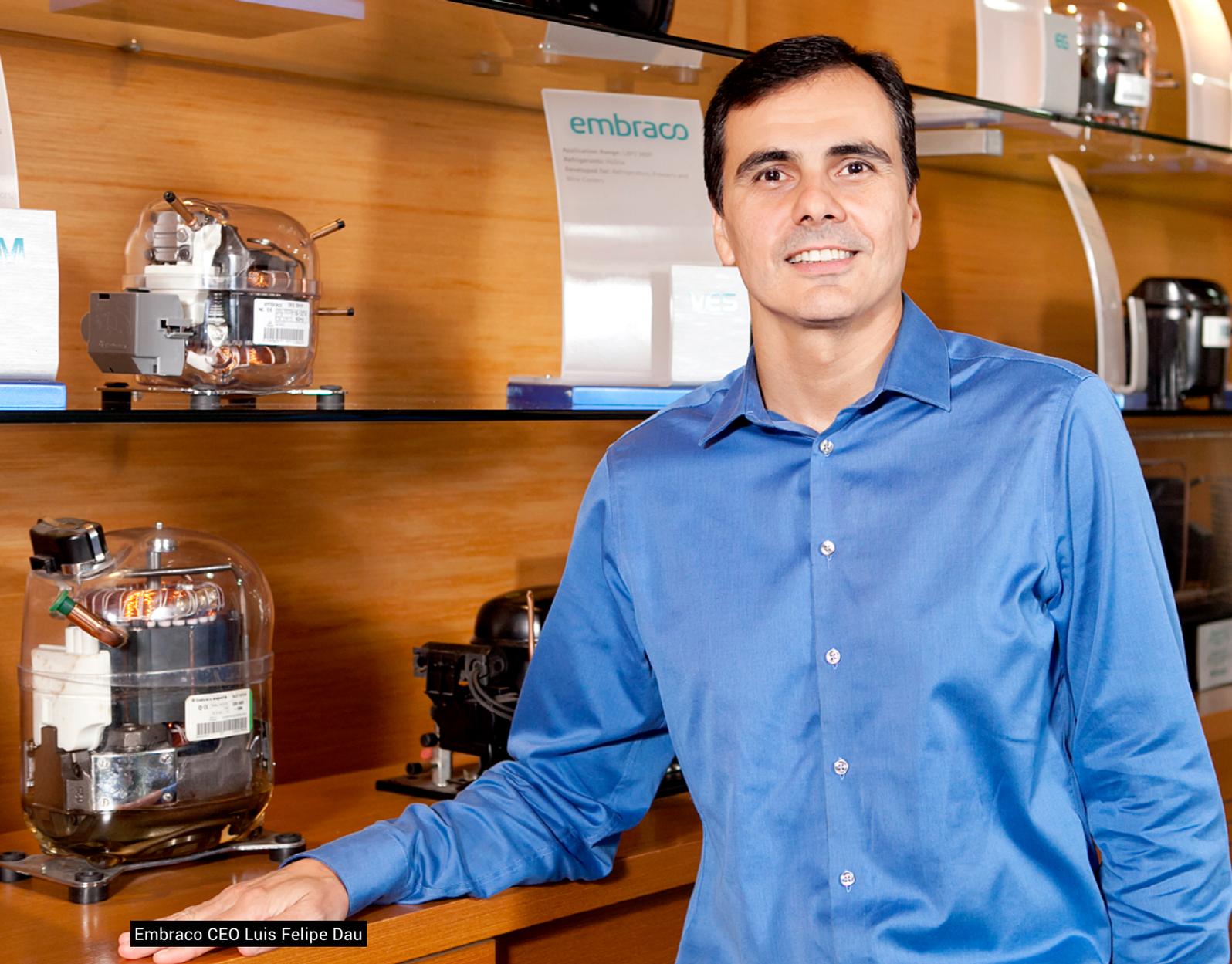
These two issues are manifest in the gloomy state of the currently obstructive AC&R safety standards. Whilst the new EN 378: 2016 contains some welcome improvements for HCs, many unhelpful and irrational rules, limits and omissions remain. Recently convened working groups for EN 378 and the product standards for commercial refrigeration (IEC 60335-2-89) and air conditioners (IEC 60335-2-40) are in progress to (in part) deal with overcoming these issues. Despite substantial and novel research on HC safety and improved safety measures, there remains resistance exerted by

established stakeholders forcefully dominating the process and persistently opposing improved rules for HCs.

In absence of any new 'miracle' technology, there is a broad consensus within the industry that HCs – along with R744 and R717 – should become the technology of choice. But with the current rate of uptake seemingly dependent upon the environmentally driven demands of disparate end users, it will be necessary for industry stakeholders to put aside their emotional prejudices, and the enthusiasm of engineers to go beyond their comfort zone, to address ways and means of applying HCs to adequately minimise risk of flammability.



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



Embraco CEO Luis Felipe Dau

# ***Constructive disruption***

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

– By Andrew Williams

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

- Luis Felipe Dau

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

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

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

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

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

Connectivity is another relevant trend, closely related to the Internet of Things. In the case of refrigerators,

new features will be developed to increasingly connect the user to equipment, bringing advantages in food preservation and equipment maintenance.

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

**Dau:** For more than 20 years, Embraco has used natural refrigerants in its compressor portfolio for commercial and household use to reduce the negative effects on the ozone layer, greenhouse effects and to improve the equipment’s energy efficiency.

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

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

Regardless of the current legislation in the various countries where Embraco operates and the imminent ban on the use of HFCs, the company is prepared to meet future legislation and best practices demanded by the global market.

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

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

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

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

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

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

**Dau:** Our global team is highly experienced in natural refrigerants. We can tailor our portfolio to our customers' specific needs.

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

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

**Dau:** Rules and regulations will continue to evolve, which is why we place a great deal of focus on our research and development to ensure that we develop

the most energy efficient, dependable and innovative compressors and cooling solutions. We believe that natural refrigerants will be the reality after HFCs.

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

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

**Accelerate: How important is R&D to your strategy?**

**Dau:** We invest annually 3% to 4% of net revenue in R&D. About 600 professionals are dedicated exclusively to this department – with approximately 120 university partners. Additionally, Embraco has 47 research laboratories on four continents.

The world is changing fast. The refrigeration market has quickly evolved. Innovation is part of our company's DNA and, more than just keeping up with this evolution with agility, we seek to be true protagonists of what's to come. We invest annually in our technology DNA to keep our position as a technology leader.

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

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

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

The market, especially the end user, is each time more demanding, so we see as trends for commercial solutions all the features of Fullmotion (variable speed) technology, such as food preservation,

energy efficiency and lower noise. We're also betting on compressors with R290, due to the trends on energy efficiency and new refrigerant regulations.

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

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

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

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

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

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**Accelerate: How would you currently describe the natural refrigerants market in Embraco's native Brazil, and how do you see it developing in future? What about the natural refrigerants market in Latin America more generally?**

**Dau:** In Brazil, there is no regulation that prohibits the use of HFCs or even legislation for minimum energy efficiency in the commercial segment. In Latin America, few countries have a direction on that, but the cost of electricity is high, so the market is already looking for more efficient options, such as R290 or Fullmotion inverter compressors.

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**Accelerate: What's next for Embraco more generally?**

**Dau:** Our Vision 'To be leader everywhere by 2020 and recognised by customers as the preferred partner' is what drives our way of doing business. In the last two years, we've intensified the cultural

transformation within the company aiming to become even simpler, more innovative and customer-centric. The challenge of doing things differently has brought new opportunities in all our units, whether in revenue generation, cost optimisation or working capital improvements.

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

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**Accelerate: What can you tell us about your biography?**

**Dau:** I graduated as a B.S. in Electronic Engineering from the Federal University of Rio de Janeiro (UFRJ - Brazil) and pursued an MBA in General Management at Tuck School of Business at Dartmouth.

After working as an industrial engineer for a Brazilian branch of AB-InBev and as a consultant for McKinsey & Company, I joined Embraco in 2006.

My biggest motivation to join the industry was its challenges, the opportunity of continuous learning in a global scenario, and to match technology to improve people's lives.

I have worked as director for our Program Management Office (PMO), as the director of Embraco's Brazil Plant, general manager for our Embraco SnowFlake JV in China, Vice-President for Asia and Global Vice-President for Business & Marketing. In March 2016, I was fortunate enough to be appointed as Embraco CEO.

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

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





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# ***Brazil riding the propane wave***

Two innovative companies with close ties to Brazil – Embraco and Eletrofrio – helped Mig Supermarkets go towards R290 plug 'n' play cabinets.

– By Charlotte McLaughlin



Embraco's Plug n' Cool unit

**B**razil's average annual temperatures of 22-26°C (72-79°F) in the Amazon region and 38°C (100°F) in the northeast can pose a challenge to potential users of natural refrigerant-based HVAC&R equipment.

Mig Supermarkets, a Brazilian company founded in 1976 by Arlindo Miguel in the city of Mafra in the southern state of Santa Catarina, accepted the challenge.

In a long-standing store in Mafra, the retailer decided to retrofit its old refrigerated cabinets with environmentally friendly technology.

"When you install a green solution, it is less impactful on the environment," Josué Cesar Miguel, co-owner of the Mig group, told *Accelerate*. "When a company has this consciousness, it reflects on to their direct customers, and as a B2C business, it impacts on consumer perception, which impacts on business."

A "respect for people" drives all Mig's activities, Miguel says. "This means respect for customers, employees, suppliers and competitors. It also means respecting the environment around these people. When you respect people, you make sustainable choices – and adopt green solutions."

In the Mafra store, Embraco and Eletrofrío were only too happy to lend a helping hand to retrofit the previous R22-based system – centred on a remote rack system – with freestanding hydrocarbon-based cabinets.

The new cabinets use Embraco's self-contained R290 Plug n' Cool solution. The complete cooling system targets reach-in cabinets for supermarkets, convenience stores and professional kitchens.

Eletrofrío started using the Plug n' Cool solution in its 'Green Line' brand of cabinets and this year it installed the system in the Mafra store during the same period.

The work involved changing the cabinets to Eletrofrío's Green Line. Miguel says the advantages of the system were evident immediately.

"Since we changed some other things on the store, it's hard to measure exactly how much the cabinets impacted on the electricity bill, but the expectation is that the ratio of energy consumption per exhibition area inside the store will significantly decrease," he says.



Embraco's Plug n' Cool solution on top of Eletrofrío cabinets, Mig supermarket, Mafra, Brazil

## Summer is coming

Mig had feared that self-contained refrigeration solutions would be hot and noisy. "We feared that migrating to a self-contained refrigeration solution would increase the heat inside the store and increase the noise as well," Miguel says. He needn't have worried. Thanks to the air flow and the position of the Plug n' Cool system on top of the equipment, this didn't happen, Miguel explains.

The system, installed in the Brazilian winter, has been able to cope with Brazil's high ambient temperatures so far. "This year our winter has been crazy. There were some really hot days. So, the expectation is that there will be no problem in summer either," he argues.

He is also impressed with the improved cooling quality compared to the previous remote [HCFC-based] system that was installed in the store. "We are now using this self-contained refrigeration system, and also doors. So, we perceived a significant increase in the 'quality of the cold' inside the cabinet."

More stable temperatures inside the cabinets result in lower average temperatures, because there is less fluctuation. This helps to maintain the meat at the highest quality until the customer is ready to consume it. "It's about food security and respect for people," Miguel says.

Another knock-on effect of using a remote refrigeration system is the space it saves in the supermarket,

freeing up space for other products because the store does not need to house a refrigeration rack.

Above all, Miguel cites the "maintenance and peace" of the Plug n' Cool as the most impressive benefits. "When the store had the machine room, me and the store managers had to be always alert because something could happen to the refrigeration system at any time – and so we had the risk of losing all the food we had on the supermarket floor," he explains.

Three employees were dedicated to the maintenance of the rack. "Now with the Plug n' Cool solution applied in Eletrofrío's Green Line cabinets, if one of the refrigeration systems fails, there will be no damage to the products inside the cabinet, since the other Plug n' Cool units can keep the inside temperature cold enough for a long time even with a broken unit," Miguel argues.

The three employees now can dedicate their time to other supermarket activities.

The success of this project has now convinced Miguel to use this green technology. "We are very proud to be 'greener'," he says.

Mig will be rolling out the new solution in other stores. "We plan to change the cabinets of old stores to this solution too," Miguel says. ■ CM



# Hydrocarbons bridging the gap

From professional kitchens in Europe to medical laboratories in the United States and Brazil, a growing number of markets are taking advantage of the efficiency and versatility of hydrocarbons.

– By Devin Yoshimoto & Andrew Williams



**A**s an alternative to HFCs, hydrocarbons are considered to be one of the most efficient options in terms of energy consumption.

Their impressive thermodynamic properties lend themselves especially well to applications in the domestic and light commercial refrigeration markets.

In fact, hydrocarbons are already being used extensively in domestic refrigeration. To date, an estimated 1.5 billion domestic refrigerators worldwide use hydrocarbons. By 2020, 75% of all new domestic refrigerators are expected to use R600a or R290.

In light commercial refrigeration, hydrocarbon use is also projected to grow significantly over the next few years.

With respect to larger plug-in units used in supermarkets, Austria-based manufacturer AHT Cooling Systems GmbH estimates that over 1.5 million of its own such units are currently in operation worldwide.

The adoption of hydrocarbons is expected to accelerate even more quickly as governments around the world impose stricter energy-efficiency standards on manufacturers.

Many manufacturers have responded by doubling down on their investments in hydrocarbon-based systems.

On 27 March 2017, the U.S. Department of Energy began enforcing new energy-efficiency standards for commercial refrigeration equipment, and manufacturers are turning to hydrocarbons to meet these new standards.

Earlier this year, U.S.-based commercial refrigeration supplier True Manufacturing announced a commitment to moving its entire production portfolio to 100% hydrocarbons by 2019.

“At the moment we are two-thirds through the transition from R134a and R404A to R290,” said Kurt Bahnmaier, European marketing coordinator for True Manufacturing, at the EuroShop 2017 tradeshow in Düsseldorf in March.

## Multinationals moving the market

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<sub>2</sub> and hydrocarbons – with its Japanese branch leading by example.

Globally the Coca-Cola Company is already adopting natural refrigerants propane and CO<sub>2</sub> on a grand scale. By the end of 2015, the Coca-Cola Company had deployed more than 1.8 million HFC-free units worldwide. By HFC-free, the Coca-Cola Company means 100% natural refrigerants.



Research by shecco, publisher of *Accelerate*, reveals that there are now 1.35 million beverage vending machines in Japan that use either hydrocarbons or CO<sub>2</sub>. This includes more than 550,000 R600a vending machines currently in the market.

In Japan, Coca-Cola's objective is slightly different: the beverage giant has adopted an official target of moving to 100% natural refrigerants – meaning hydrocarbons or CO<sub>2</sub> – in all vending equipment on the Japanese market by 2020.

Also in Japan, in February 2015, convenience store chain Save On became the first company to open a store equipped with exclusively R290 plug-in refrigeration showcases.

Hydrocarbons, then, are already being put to use in a wide range of economic sectors on a global scale.

The next two pages of case studies take a closer look at how these efficiency improvements are continuing to drive adoption of hydrocarbons in a variety of markets – and indeed increasing their competitiveness vis-à-vis CO<sub>2</sub> and other refrigerants – in a wide range of applications.



Thermo Fisher Scientific manufactures hydrocarbon-based medical and laboratory equipment



Fanem conservation chambers for blood and vaccines



**Brazilian, U.S. medical lab equipment makers banking on hydrocarbons**

For manufacturers in the medical and laboratory equipment field, hydrocarbons are proving to be efficient refrigerants that give their products a competitive advantage.

Thermo Fisher Scientific, a U.S. manufacturer specialising in the development of ultra low-temperature refrigeration systems, was looking for ways to improve the efficiency of its products.

The challenge, however, was how to improve the energy efficiency of the systems without compromising on their performance.

Thermo Fisher Scientific's line of TSX ultra-low temperature cascade refrigeration systems typically operate from -90°C to -70°C (-130°F to -94°F).

Because these products are used mainly in the chemical and medical industry, performance and reliability is an extremely important consideration.

When Thermo Fisher Scientific decided to go with the use of hydrocarbon compressors – R290 and R170 – initial tests found that due to the

switch to natural refrigerants alone, its line of TSX ultra-low temperature systems gained 17% efficiency.

The power used in the cascade system's first and second stage compressors was reduced and the entire system's coefficient of performance increased from 2.39 to 2.80.

Compared to their old single speed systems which ran on HFCs R404A and R508B, the TSX systems now deliver up to 50% energy savings, especially with the use of Embraco's Fullmotion Inverter technology, which helps increase efficiency even further.

The use of R290 is also helping a Brazil-based medical and laboratory equipment manufacturer reach its energy efficiency goals.

Fanem, a Brazilian manufacturer of haemato-immuno conservation chambers used to preserve and store blood and vaccines, requires its cooling systems to be reliable and energy efficient, and variable at low temperatures. They must also have the capacity to deal with voltage fluctuations.

When Fanem decided to switch to using R290, initial tests showed that the system was also now able to achieve a 30% improvement in the 'pull-down' rate

– the time it takes for the product being stored to reach the same temperature as the interior of the chamber.

Compared to Fanem's old prototype HFC R134a system, which took 10 hours to cool the contents from 32°C to 4°C (90°F to 39°F), the new system only took three hours.

Most significantly the system was also able to achieve a 50% reduction in energy consumption.

Hydrocarbons are proving themselves to be extremely efficient refrigerants, with great potential to impact the medical laboratory equipment industry.



Thermo Fisher Scientific's TSX Series



## Mexico-based Criotec slashes freezer energy consumption

For Mexico-based commercial refrigeration manufacturer Criotec, social responsibility tops its list of core values as an organisation.

The company sought to improve the TEWI figures of its refrigerators and opted for R290 as a means of doing that.

In cooperation with Embraco, a test was conducted to see how the use of R290 would impact not only the energy efficiency of the refrigerators but the overall TEWI figures as well.

The company took its CTCC-25 model horizontal freezer (internal volume 643 litres) and swapped out the R134a compressor, replacing it with an R290-based compressor.

The compressor was the only part of the system that changed. The results were significant: the freezer using the R290 compressor recorded a 24% decrease in energy consumption.

The figures showed that the R134a compressor consumed about 3.337 kWh per day, whereas the R290 compressor consumed 2.663 kWh per day.

The system using the R134a compressor had a measured TEWI of 5,316, whereas the system using the R290 compressor had a TEWI of 3,951 – a 26% reduction mainly due to R290's low global warming potential (GWP) value of just three (versus R134a at 1,430 GWP).

For Criotec, reducing the energy consumption of its products while also reducing environmental impact was a win-win, helping the company to truly live up to its core values.



## Professional kitchens meet new EU regulations with hydrocarbons

The European Union and its member states continue to move energy-efficiency standards forward, putting increased pressure on manufacturers.

Since 1 July 2016, under the EU Eco-Design Directive, all newly manufactured commercial refrigeration equipment must meet new minimum energy-efficiency requirements.

In addition, a new mandatory energy-labelling scheme was created to help end users and consumers to determine more easily the energy-efficiency ratings of different products.

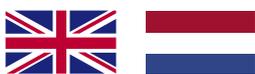
A key target of the new regulation was refrigeration equipment used in professional kitchens.

Embraco conducted energy consumption tests with stainless steel single-door coolers (internal volume 500-700 litres) – a popular type of refrigerator in busy kitchens and restaurants around the world.

Over a period of 24 hours, Embraco measured the energy consumption of a refrigerator using an HFC-based compressor and compared it with two refrigerators using two models of its own R290-based compressors.

The results showed that, compared to the benchmark HFC-based standard commercial refrigerator, the first R290 refrigerator achieved an energy use reduction of 37.3%. The second R290 refrigerator achieved an energy use reduction of 41.12%.

The tests show that hydrocarbons are perfectly suited to helping equipment manufacturers to meet increasingly stringent energy-efficiency standards and end users to save money on their energy bills.



## Unilever harnessing natural refrigerants

Dutch-British transnational consumer goods giant Unilever is committed to natural refrigerants. It made the decision to adopt hydrocarbons in 1999, after having also considered CO<sub>2</sub>.

Berty Jakob, senior research and development manager at Unilever, shared the company's experience of using hydrocarbon refrigeration equipment. "In the area of

refrigerants, we made a commitment in the year 2000. And by 2014 we already had over 12,000 hydrocarbon cabinets in place. We were very consistent and persistent in the way we moved ahead," said Jakob.

Fast forward to 2016, and Unilever had 2.2 million hydrocarbon cabinets. It prefers to use hydrocarbon refrigerants R290 and R600a for low-temperature applications.

"Regarding the implications for servicing it is important to ensure

that service engineers are skilled and properly trained for working with hydrocarbons. Training of service personnel is key. Do it right first time and it will serve you for years to come," Jakob said.

Unilever found hydrocarbon cabinets to be equally as reliable as their HFC-based counterparts. "We have more than 10 years' experience of working with hydrocarbon cabinets, and we have never had any safety issue," Jakob said.



## ***Colruyt charts course for 100% hydrocarbons in stores***

Natural refrigerants are helping the Colruyt Group to save money and deliver its environmental targets, with the leading Belgian retailer moving to hydrocarbons for 100% of its in-store cooling needs. *Accelerate* reports.

—By Andrew Williams

**F**ounded in 1925, the Colruyt Group – headquartered in the town of Halle near Brussels – is one of Belgium’s biggest retailers, with annual revenue of over €9.1 billion (\$10.85 bn). Employing over 29,000 staff, it boasts 516 shops. Three shop formats in Belgium have product cooling: Colruyt supermarkets (237), OKay convenience stores (120) and Bio-Planet (19) organic stores (autumn 2016 figures).

The Colruyt Group’s official target is to reduce relative CO<sub>2</sub> emissions by 20% by 2020 compared to 2008 levels. It runs its own energy company, Eoly, to help deliver this target. Electricity from solar panels, wind turbines and CHP (combined

heat and power) plants powers Colruyt Group stores and distribution centres.

With the Belgian retailer having already switched to electricity from 100% renewable sources, refrigeration now makes a proportionally larger contribution to its carbon footprint. Choosing the right refrigerant, therefore, is crucial for meeting its sustainability targets.

The Colruyt Group's ultimate goal is to become HFC-free. In 2012, it launched a feasibility study. This led to the adoption in December 2014 of the official target of using 100% natural refrigerants for all its cooling needs.

Since the end of 2016, Colruyt is no longer building HFC-based cooling systems in its stores.

## Regulation: An 'extra stimulus' for NatRefs

Natural refrigerants like CO<sub>2</sub>, hydrocarbons and ammonia will have a key role to play in the HFC phase-down taking place under the EU's F-Gas Regulation, which since 2015 has been reducing the total amount of HFCs that can be sold in Europe. In 2020, a ban on using certain HFCs in new equipment comes into effect,

accompanied by bans on servicing and maintaining existing equipment.

"We were already adopting natural refrigerants before the EU F-Gas Regulation came into force. The F-Gas Regulation was not the primary driver, but it does give us an extra stimulus," Collin Bootsveld, a project engineer at the Colruyt Group, told *Accelerate*.

After considering which natural refrigerant would best match their needs, Bootsveld and his team opted for propane (R290) for in-store cooling. "It's not that we think CO<sub>2</sub> is bad. After an honest evaluation, we think propane is the best solution for us," Bootsveld says.

His team installed their first propane system in an OKay store in Roeselare in 2013. It took a year to secure the necessary paperwork – even though the 14kg of propane was housed outside. "We couldn't go through that 40 times a year to comply with the regulations," Bootsveld says.

At the system's heart are compact chillers containing less than 2.5kg of propane or propene. With a refrigeration capacity of 30-50 kW, one chiller can cool the Group's smaller OKay (convenience) and Bio-Planet stores. Colruyt supermarkets need to run two compact chillers. An extra chiller

is always added redundantly, ready to step in should one chiller fail.

Colruyt supermarkets also feature special cold rooms in which customers choose fruit, vegetables and other products from shelves. There are no refrigerated cabinets.

Air handling units above the cold room remove the air inside, cool it down with glycol, and put it back in through perforated walls, creating a temperature of 3-4°C (37.4-39.2°F) on the shelves and 7°C (39.2°F) in the room. Constantly circulating cold air negates the heat given off by from customers and the surrounding shop.

At the entrance of the cold room, an air curtain stops the cold air from escaping by blowing air at room temperature from a vent above the cold room's open doorway. Rather than mixing together, the warm and cold air roll against and away from one another – creating an 'air door' that pushes the cold air back into the cold room. This principle is used in all new OKay and Colruyt stores.

Bootsveld's team calculates that this is not just cheaper but also five times more efficient than using display cabinets. "Cabinets lose a lot of cold when customers open the doors," Bootsveld says.



Cold room in Bio-Planet, Braine l'Alleud



Collin Bootsvelde in Bio-Planet, Mons



Propane system in Bio-Planet, Mons

▶ Colruyt's chest freezers have been using the natural refrigerant R600a (isobutane) for over 10 years. They are stand-alone, giving store managers flexibility regarding layout. Pictures on the lid depict what's inside, so customers do not need to open them to discover their contents. "They are plug 'n' play. If one freezer breaks down, just swap it with another. They also use five times less energy than display cabinets," says Julien Meert, a project engineer in Bootsvelde's team.

High outside ambient temperatures are of little concern. "Propane installations can easily handle it. Our system was designed to operate in temperatures of up to 35°C (95°F), but we've recorded 42°C (107.6°F) in Braine l'Alleud and it's still running fine," Bootsvelde says.

### Overcoming safety concerns

Safety is often cited as an obstacle to wider use of hydrocarbon systems. But the Colruyt Group is working hard to overcome flammability concerns.

"Our systems are fitted with propane and propylene detectors, and there is a fan which will extract any flammable substances. The amount of

propane is also so low that it is very difficult for anything bad to happen," Bootsvelde argues.

Leakages from HFC refrigerants currently represent 12% of the Colruyt Group's greenhouse gas emissions in Belgium. "This 12% will be completely eliminated by the propane cooling project within 10 years," Bootsvelde says.

In the event of a leak, the new systems shut themselves down automatically. Risk is kept to minimum by limiting the number of connections.

### 'No regrets' over hydrocarbons switch

All new Colruyt Group cooling installations have used natural refrigerants from 2017 onwards. Currently there are around 50 new refrigeration systems in the pipeline, a mix of new shops and refits of existing stores. So when will the Group achieve the target of using hydrocarbons for 100% of its in-store cooling needs? "At the current pace we will be ready in 2027," says Bootsvelde.

The Colruyt Group has "no regrets" about the switch to hydrocarbons. Indeed, Bootsvelde and his team are now innovating with other natural refrigerants too. The Group's distribution centres, for example, are cooled with ammonia. It opened its first ammonia plant in 1999.

In the wake of the Kigali Amendment to the Montreal Protocol – which put in place a global HFC phase-down trajectory – Bootsvelde is even more convinced that adopting natural refrigerants is the right way to go. "There is always a learning curve, and we've started that curve early. We've moved to a new technology, and we've done it in a reliable manner," he says.

Bootsvelde argues that early adoption of natural refrigerants is already putting Colruyt at a competitive advantage compared to retailers that are yet to begin their transition away from HFCs.

By 2018, Colruyt hopes to be building shops without any fossil-fuel connections at all. "In September, our CEO decided that every time we remodel a shop, we'll insulate it to the same level as our new shops. Within the next 10-12 years, all our shops will be well insulated," Bootsvelde says.

Such insulation reduces heat demand to the extent that the store's heating needs can be entirely served by waste heat from the cooling system. "The shops will be 100% electric. Fossil-fuel free!" Bootsvelde says.

With innovations such as these, the Belgian retailer looks well placed to meet its sustainability targets. ■ [AW](#)



# *Heineken ready to act on HFC use*

Dutch brewing giant Heineken recognises the business case for natural refrigerants. CEO Jean-François Van Boxmeer argues that sustainable refrigeration is one of the best investments that companies can make in the future of the planet.

– By Charlotte McLaughlin

The Heineken Group, the second-largest brewer in the world by revenue, is setting ambitious climate goals to reduce its emissions of greenhouse gases. The global giant is targeting 40% lower emissions from production, 50% lower emissions from its fridges and 20% lower emissions from distribution in Europe and the Americas compared to 2008 levels – all by 2020.

The company – which recorded profits of \$1.7 billion in 2014 – has already achieved much so far. It is well on course to meet its 2020 target of reducing its CO<sub>2</sub> emissions from production. In 2016, the Dutch brewer achieved a 37% cut in emissions compared to 2008. Its emissions are also falling in absolute as well as relative terms. Despite production volumes being 52% higher in 2015 than in 2008, emissions fell by 5%.

This success can partly be attributed to its commitment to environmentally friendly fridges. Heineken Group CEO Jean-François Van Boxmeer recognises hydrofluorocarbons (HFCs) as one of the world's fastest-growing climate pollutants and a major source of greenhouse gas emissions today. The group is seeking to cut down on its use of HFCs by switching to natural refrigerants instead.

“By 2020, we will have cut the CO<sub>2</sub> emissions from our fridges in half compared to 2010,” says Van Boxmeer.

The Belgian CEO of the Dutch brewing giant argues that the role of refrigerants in the fight against climate change is often misunderstood. HFCs are widely expected to add up to 0.5°C (32.9°F) to the average global temperature by the end of the century if their use is not curbed.

As the world's second-largest brewer by revenue, the Heineken Group's action on this issue could significantly reduce global emissions. According to 2017 figures, Heineken owns over 165 breweries in more than 70 countries. It produces 250 international, regional, local and specialty beers and ciders and employs approximately 73,000 people. 21% of its CO<sub>2</sub>-equivalent emissions come from cooling.

To reduce its own impact on the climate, Heineken is adopting natural refrigerants like hydrocarbons and increasing the energy efficiency of its HVAC&R equipment.

Van Boxmeer has been very active in pushing members of the Consumer Goods Forum (CGF) – which brings together over 400 consumer goods

manufacturers seeking to pursue more sustainable business practices – to limit their use of HFCs as well.

“At Heineken, we try hard to make a contribution to the essential goal of limiting global warming by making thoughtful choices about resource usage,” Van Boxmeer told a CGF summit in Berlin, Germany in June.

In October 2016, the CGF Board passed a resolution committing its members to deploying natural refrigerants wherever possible, effective immediately.

Van Boxmeer recommends other companies do the same, replacing HFCs with hydrocarbon refrigerants to mitigate harmful emissions and increase the energy efficiency of cooling equipment.

In addition to installing hydrocarbon-based technology, the beverage giant recommends taking the following steps to further increase the efficiency of fridges:

- ▶ Replacing standard lighting with LED illumination;
- ▶ Introducing an energy management system, and;
- ▶ Installing energy-efficient fans.



## ▶ Innovating at home

Heineken plans to install 'green' fridges, both when replacing old fridges with new ones and when installing a fridge in a new location. In 2014 alone, the brewer purchased 152,000 fridges, 99.8% of which had one or more of the above 'green' characteristics. Two-thirds of the fridges were compliant with all four.

To reach this point, Heineken worked with its partners to develop the iCool fridge, an innovative fridge that is 70% more energy efficient than related beverage coolers from 2010.

The innovation does not stop at fridges. Heineken's 'David XL Green' solution, which it proclaims is the world's greenest draught system, has won sustainability awards around the world.

David XL Green was named winner in the 'End User of the Year – Non-Supermarket' category of RAC Magazine's industry awards in 2014.

In addition to improving the overall serve quality of Heineken beer, results show that the David XL Green reduces energy consumption by 50% versus conventional draught systems.

Heineken believes the technology could easily be applied to a vast number of retail outlets across the world.

In 2014, Heineken created the SmartDispense system for the UK market. SmartDispense reduces the need for cellar cooling by cooling beer as it leaves the keg, rather than cooling the surrounding environment. It reduces a pub's average energy use for cooling installations by 90%.

The dispenser also saves the average pub around 12,000 pints (6,819 litres) of water, 90 pints (51 litres) of cleaning chemicals, and £2,300 (€2,488) of product waste every year.

The three new innovations have already helped the company achieve energy savings of 45% compared to 2010. "We work together with our suppliers of fridges to foster related innovations and drive energy reduction," Van Boxmeer says.

Heineken is certainly putting natural refrigerants – and cooling in general – at the heart of its strategy for reducing its climate footprint. ■ CM



“By 2020, we will have cut the CO<sub>2</sub> emissions from our fridges in half compared to 2010.”

- Heineken Group CEO Jean-François Van Boxmeer



Heineken is headquartered in Amsterdam, Netherlands





# *Hydrocarbons: A NatRef success story*

Hydrocarbons dominate the domestic market and are solidifying their place in commercial and light commercial applications.

– By Charlotte McLaughlin, Michael Garry, Andrew Williams & Eda Isaksson

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

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

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

“[Wolo] was the right person at the right time. The world is a better place because

of his work,” Janos Maté, a senior consultant in Greenpeace International’s political business unit who worked with him on the project, told *Accelerate*.

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

Within a year, his initiative had resulted in the highly successful commercialisation of so-called ‘Greenfreeze’ hydrocarbon refrigeration in Germany. The technology spread



rapidly. “Greenpeace now estimates that currently there are between 900 million and one billion domestic hydrocarbon (‘Greenfreeze’) refrigerators in the world,” Maté says.

The Replenishment Task Force of the Technology and Economic Assessment Panel (TEAP) – an advisory body to the Montreal Protocol Parties – argues that, “by 2020 around 75% of new refrigerators will likely contain [hydrocarbon, HC] R600a (a small proportion using HC-HFO blends), with the remainder containing HFC134a or HFO-1234yf”.

The biggest global fridge manufacturers are European, Chinese, Japanese and Indian. The only household refrigeration markets that remain largely untouched in terms of hydrocarbons are North America and some parts of Africa, according to research conducted by shecco, publisher of *Accelerate*.

In a report called ‘Bringing the U.S. Fridge Market into the 21st Century’, the Environmental Investigation Agency (EIA) – an environmental group – pointed out that multinational companies like AB Electrolux, Samsung Electronics and Haier are forced by restrictive standards to sell domestic refrigerators with R134a in the United States, despite already successfully producing and selling models using hydrocarbons in other markets.

Before 2011, hydrocarbons were not really allowed in fridges in the USA. In 2011, hydrocarbons R600a and R441A – an HC blend – were approved for use in domestic refrigeration in the United States, when the Environmental Protection Agency (EPA) listed these refrigerants as suitable substitutes for HCFCs under the Significant New Alternatives Policy (SNAP) programme. In 2015 propane was also added as a suitable alternative.

Nevertheless, faced with a charge limit of 57g for A3 (flammable) refrigerants in domestic refrigeration (compared to 150g in Europe), manufacturers operating in the United States have faced significant challenges in introducing such products.

“With nearly one billion hydrocarbon fridges in the world operating perfectly safely, why are North American consumers denied the right to purchase climate-friendly refrigerators?” Maté wonders.

## Change is coming

There are signs that things are changing. The Underwriters Laboratories (UL), a U.S. safety body, has adopted a new safety standard, UL 60335-2-24, Edition 2, which will boost the hydrocarbon charge allowed in U.S. domestic refrigerators to 150g from 57g, the amount allowed under UL 250.

The EPA would also need to incorporate the UL standard, if these appliances are to be sold in the United States as an alternative to R134a models.

The current 57g charge limit for hydrocarbons “is too small to allow cost-effective and energy-efficient manufacturing,” Christina Starr, climate policy analyst at the EIA, wrote on her employer’s website.

Substituting R134a with a climate-friendly refrigerant in new fridges would avoid emissions of up to 3.7 million metric tons of direct CO<sub>2</sub> equivalent, according to the EIA.





NAFEM Show, Orlando, Florida

## A European journey

Outside the United States, OEMs have long taken advantage of the efficiency of hydrocarbons in refrigeration. Commercial refrigerators using hydrocarbons have been used for more than 20 years, with more than four million units installed today, according to U.S.-based OEM True Manufacturing.

Many exhibitors and visitors to the world's biggest retail fair EuroShop – held at the Messe in Düsseldorf, Germany from 5-9 March 2017 – commented on the widespread use of CO<sub>2</sub> and propane for food retail, with many believing these natural refrigerants will become the global 'standard' for commercial refrigeration.

Austrian company AHT Cooling Systems GmbH already has over one million propane-based food and beverage retail cabinets in operation worldwide.

"We think propane is the best solution on the market for supermarket units," says Reinhold Resch, vice-president (research and development) at the Austrian firm.

He is convinced that independent plug-in cabinets are the way to go. AHT's plug-ins boast leakage rates of less than 0.1%. Opting for a plug-in solution dispenses with the need for both external production of the cold and the secondary circuit to transport it.

Turkish manufacturer Ugür, meanwhile, produces around 6,000 propane fridges per day; largely thanks to demand from "big suppliers like Pepsi, Unilever and Coca-Cola," Özgür Erkek, the company's export director, told *Accelerate*.

This success with global beverage companies – who often provide distributors such as supermarkets and convenience stores with the fridges that display their wares – has allowed Ugür, established in 1954, to become operational in 142 countries.

"Most of Europe and the United States has gone down the hydrocarbons route but in some parts of South America and Asia, this is taking a while," Erkek says.

In a bid to enter the lucrative supermarket sector, Liebherr showcased its new line of energy-efficient chest freezers using R290 for larger sizes and R600a for smaller offerings.

The firm is confident its new products will prove popular. "We are 20% better than the competition in terms of energy savings," insists Heiko Schulz, international sales manager for food retail at Liebherr.

Schulz cites the company's investment in research and development at its energy department as a key driver of cost savings for customers.

## United States, Europe closer together in commercial sector

In commercial refrigeration, the move towards hydrocarbons has been somewhat smoother. In the United States, it has been facilitated by new Department of Energy (DOE) efficiency standards and a more open charge limit of 150g for commercial refrigeration equipment.

The DOE standards went into effect on 27 March 2017. The standards cover a wide array of equipment and require the average commercial refrigeration unit to be about 30% more efficient compared to the previous standards.

OEMs interviewed in February at the NAFEM Show in Orlando, Florida, said switching from HFCs to hydrocarbons – and using the compressors and other equipment that support hydrocarbons – would provide a critical boost to the efficiency of a commercial refrigeration system.

"Major light commercial equipment suppliers, if not all, have developed or are developing hydrocarbon solutions for the majority of their models," says Antoine Azar, former global programme director at the Coca-Cola Company and head of his own sustainability consulting practice, Sustainable Solutions.

Indeed, in some cases, only by using hydrocarbons can equipment meet the DOE's demanding 2017 standards. That was true for Guatemalan OEM Fogel, says Federico Barquero Tefel, the company's vice-president of commercialisation.

Fogel's small countertop cooler was able to meet the DOE's 2012 efficiency standard using R134a. "But if we want to use that now, the unit would not pass [the 2017 standard]," Tefel says. "So we went with [propane] and lowered its energy consumption. And that's just one example."

When Liebherr began to target the supermarket sector, it knew there would be a trade-off between energy efficiency of the product on the one hand and visual appeal on the other. "I think we have really found the maximum possibility between the display [through the glass freezer door] and energy efficiency," Schulz says.

Schulz believes hydrocarbons are the clear answer for plug-ins. "There is some activity with CO<sub>2</sub> [as a refrigerant for plug-in units] but I think the technology is not really ready for the market yet," he says.

"Hydrocarbon refrigeration will be the leading technology," he believes. The firm is currently growing in Southeast Asia and plans to increase sales there.

Similarly, manufacturer Embraco has recently seen success in bringing energy-efficient compressors to the Asian market – notably selling India's first R290-based vertical freezer units last year, according to CEO Luis Filipe Dau.

## Pressure will increase in USA

Back in the United States, more regulatory action is on the horizon; the EPA's SNAP programme plans to delist HFCs in stand-alone commercial equipment in 2019 and 2020, forcing manufacturers to switch to lower-GWP refrigerants.

Over the past two years, U.S.-based True Manufacturing has converted about 80% of its foodservice and food retail coolers and freezers from HFCs to propane refrigerant, says Todd Washburn, the company's director of sales & marketing, retail division. "The fact that we started with hydrocarbons much earlier than others puts us in a good position to meet the 2017 requirements."

Another major OEM, Welbilt (formerly Manitowoc Foodservice) has completed conversion of its reach-in and under-counter refrigerator and freezer units for chain restaurants to propane refrigerant from R404A.

The full conversion of those units to propane, completed late last year, followed a rollout of R290 units by a large chain customer, says Sara Sunderman-Kirby, product manager for Welbilt's Delfield brand, who declined to name the retailer without its permission.

Minus Forty Technologies Corp., a Georgetown, Ontario-based manufacturer of freezer and refrigerated cabinets, has converted all but one of the 36 products in its portfolio to propane.

"We've been working towards converting our entire product line to R290 for two years now," says Chris Strong, the company's vice-president of sales and marketing. "What we discovered

in our research and speaking to our component suppliers is that we had a better chance of achieving the DOE initiatives by converting to R290, because it operates as a more efficient refrigerant."

OEM Beverage Air also plans to convert all of its myriad foodservice refrigeration equipment to propane refrigerant from HFCs by the end of the year, according to Bill Siskar, vice-president of manufacturing and engineering.

So far, all under-counter, worktop and sandwich prep units have been converted to propane. "Only hydrocarbons let us meet the DOE 2017 requirements for under-counter and worktop units," he says. The conversion to propane will also help the company deal with the EPA's delisting of HFCs in a few years. "It kills two birds with one stone."

The journey towards hydrocarbon-based HVAC&R technology – which began with a man called Wolo back in the 1990s – is transforming the commercial sector into an energy-efficient, lucrative and climate-friendly business. ■ CM, MG, AW & EI



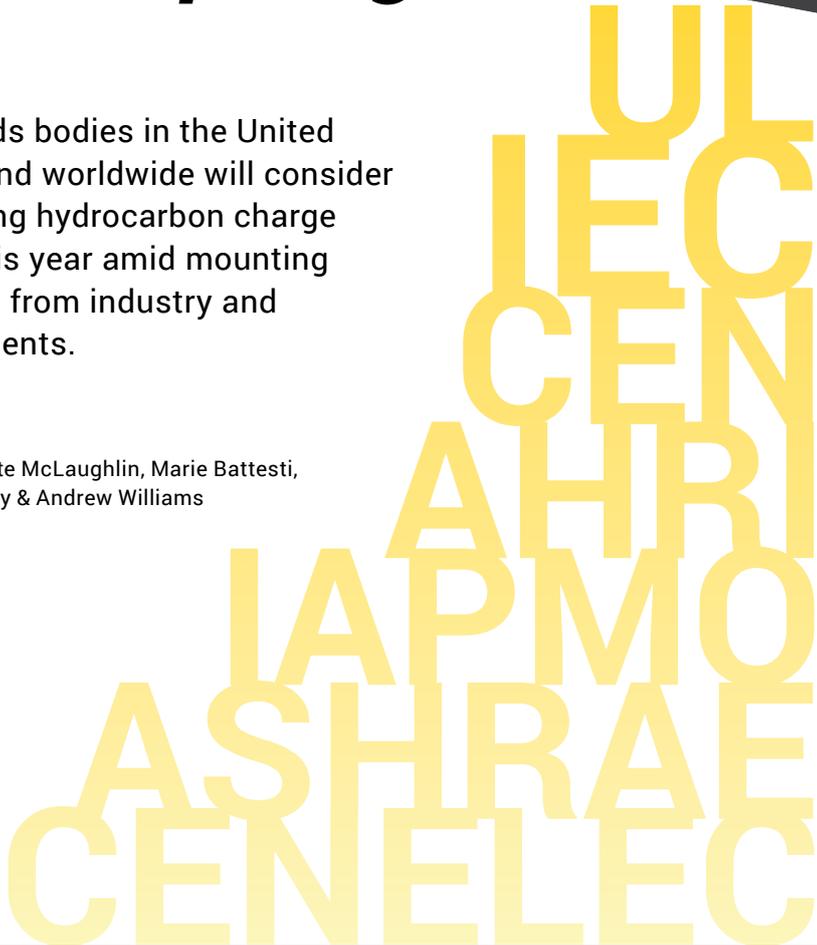
AHT's new Vento Green refrigerated shelf at EuroShop 2017

# Hydrocarbon charge limits under spotlight



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

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



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

Glenn Gallagher, air pollution specialist at the California Air Resources Board (CARB) – speaking at the ATMOsphere America 2017 conference in San Diego, California (5-7 June 2017) – expressed hope that A3 refrigerant

safety standards would be revised in time to use flammable alternatives like hydrocarbons.

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

Europe is seeing similar pressure to move. Standards governing hydrocarbons must be adapted to encourage their wider rollout, according

to a European Commission report on the barriers posed by codes, standards and legislation to using climate-friendly technologies in the refrigeration, air-conditioning, heat-pump and foam sectors. The report was published at the end of 2016 under the EU's F-Gas Regulation on phasing down HFC use.

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

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

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

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

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

Prior to the Kigali Amendment to the Montreal Protocol, the U.S. EPA had already listed hydrocarbons as suitable alternatives to HFCs in a number of applications under the Significant New Alternatives Policy (SNAP) programme, playing a key role in their adoption in the United States.

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

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

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

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

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

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

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

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

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

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

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

Photo by IISD/Sean Wu (enb.iisd.org/ozzone/oewg39/11jul.html)



Delegates from China in Bangkok

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

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

### A major international push

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

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

"A new Draft for Comments (DC) document that considers the 500g limit for propane charges and which will also allow the use of slightly

flammable A2L safety class refrigerant alternatives [was] circulated in May," explains Embraco's Marek Zgliczynski, chair of IEC SC61C.

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

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

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

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

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

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

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

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

According to Bourillet, there will be a place for hydrocarbons. The French Ministry of the Interior is currently drafting a risk assessment study, the results of which will be published this year. The study will focus on the feasibility of raising charge limits for flammable refrigerants in public buildings, in terms of safety and level of training for the French workforce (see '[Hydrocarbons: A NatRef success story](#)', p.26).

## United States must act quickly

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

For the United States this means, "many of these revisions in standards [for flammable refrigerants] must be published by the end of 2017, so the ICC [the International Code Council] and the IAPMO [the International Association of Plumbing and Mechanical Officials] codes can be revised in the next code cycle," UL's Haseman says.

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

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

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

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

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

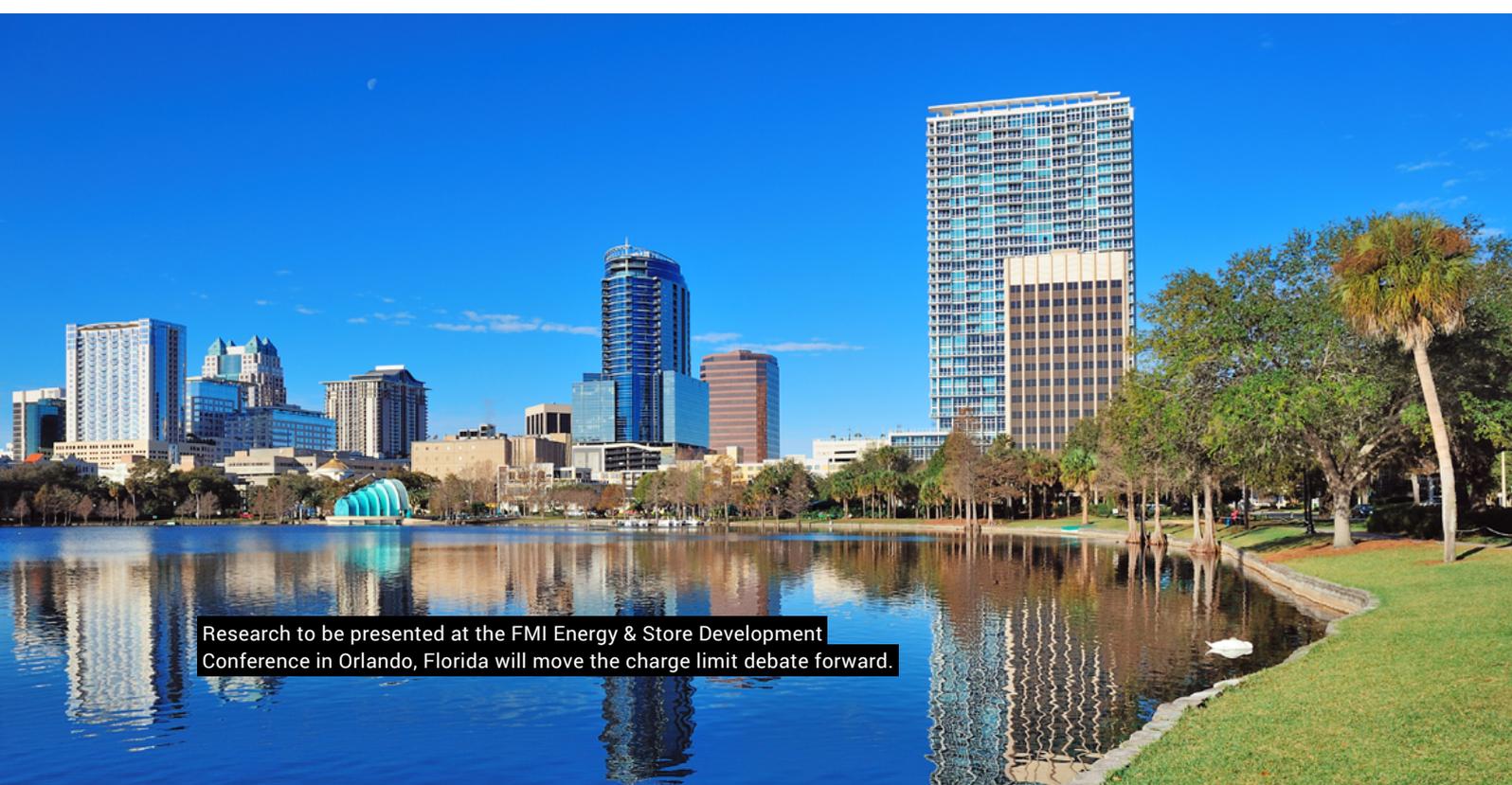
The research focuses on benchmarking risks from leak and emissions testing, assessing flammable refrigerants' post-ignition risk, determining charge limits, and producing a guide to handling and servicing A2L refrigerant-based HVAC&R equipment.

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

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

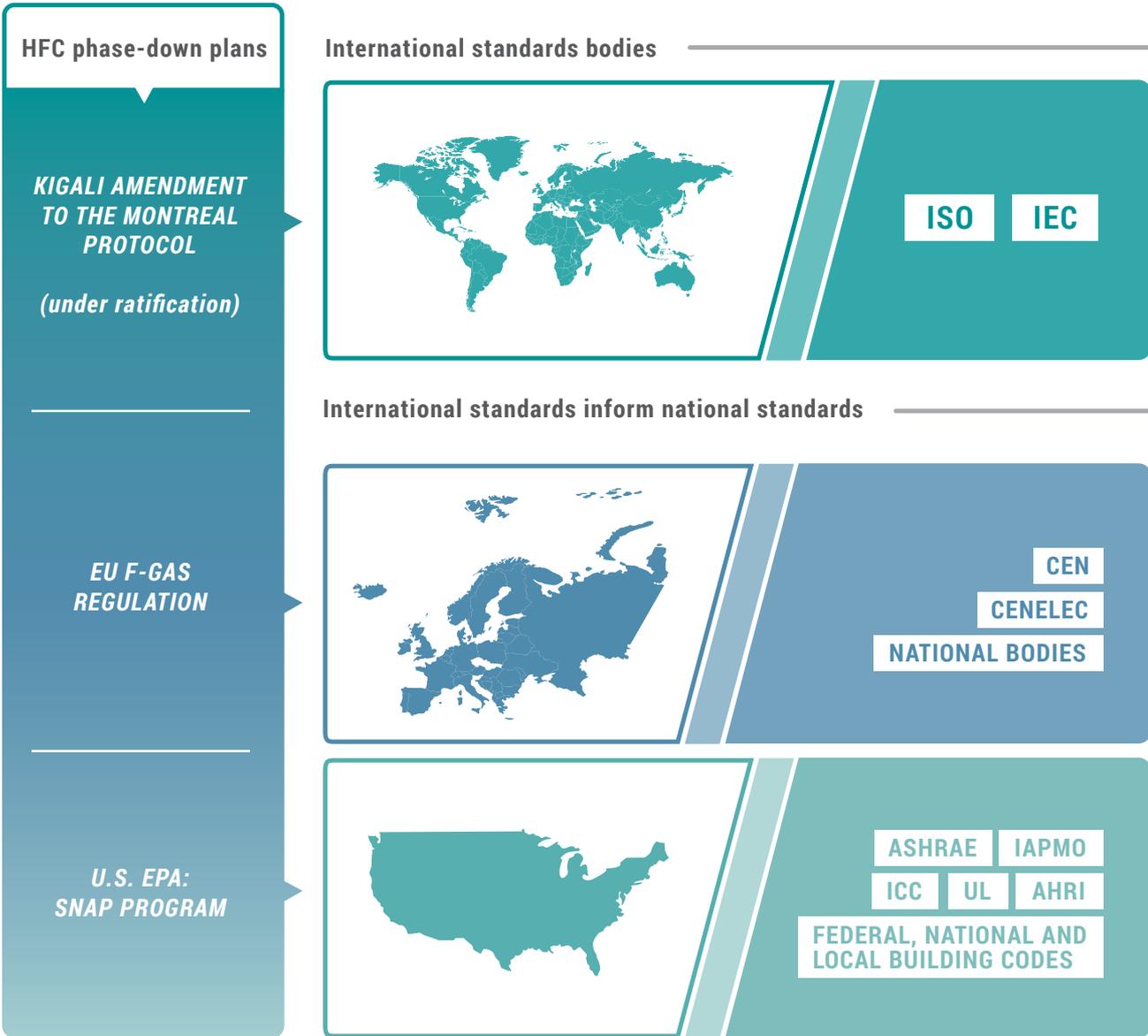
The results will be used to update ANSI/ASHRAE Standard 15-2013 (Safety Standard for Refrigeration Systems) and ANSI/ASHRAE Standard 34-2013 (Designation and Safety Classification of Refrigerants).

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



Research to be presented at the FMI Energy & Store Development Conference in Orlando, Florida will move the charge limit debate forward.

# Driven by the HFC phase-down: Hydrocarbon standards revision



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



**COMMERCIAL REFRIGERATION**

**IEC 60335-2-89**

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



**AIR CONDITIONING**

**IEC 60335-2-40**

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

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



SPECIAL EDITION: SEPTEMBER 2017

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