

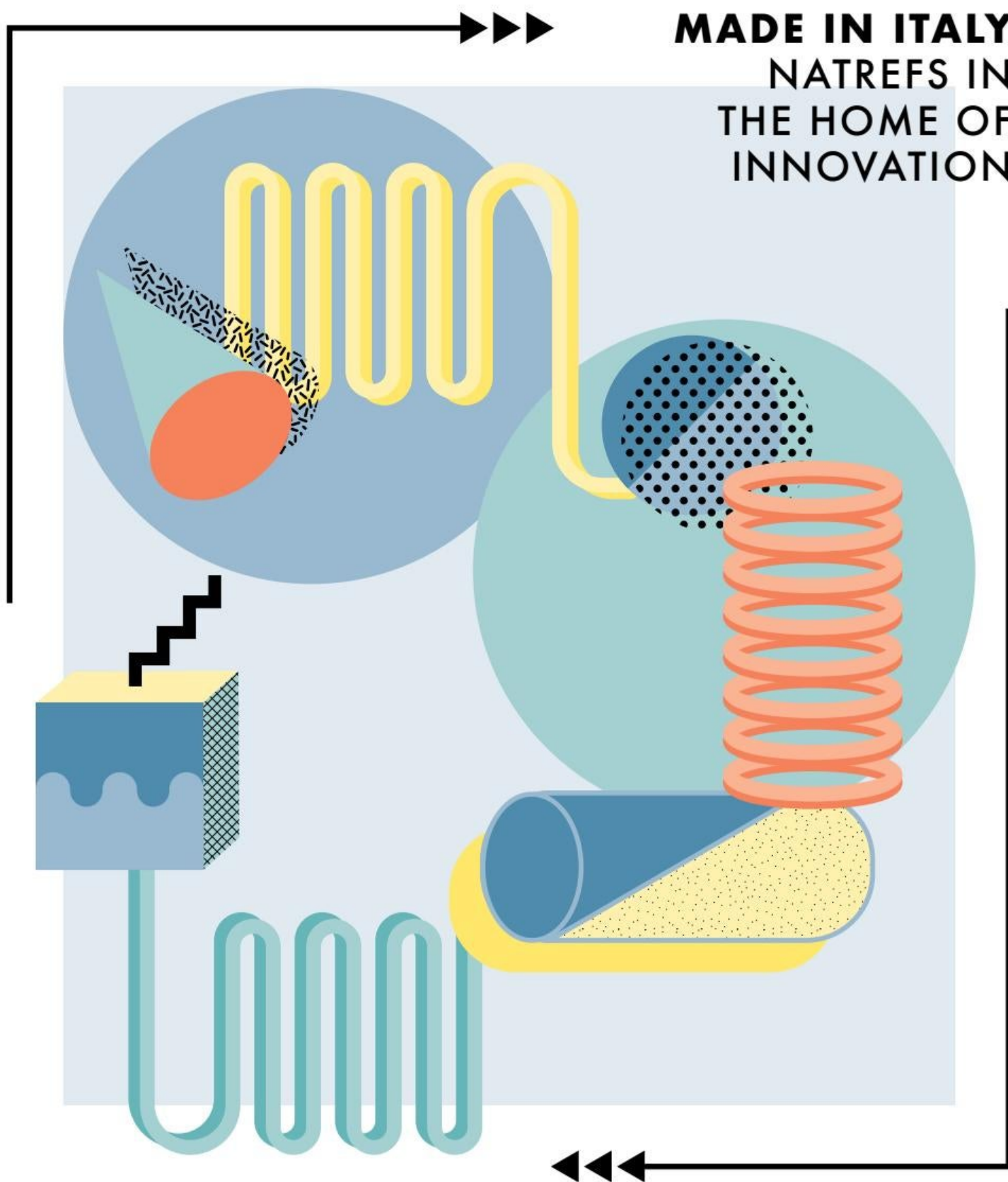
SPECIAL EDITION

ACCELERATE

ADVANCING HVAC&R NATURALLY

I T A L Y

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THE HOME OF
INNOVATION



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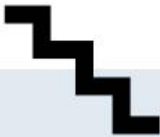
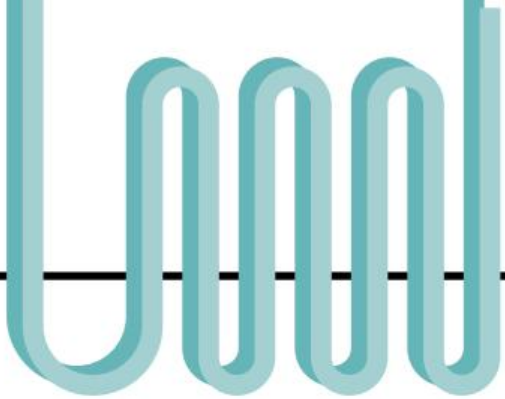
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INNOVATION BEGINS AT HOME

— Editor's Note by Andrew Williams

The designers and architects of the Memphis Group, founded by Ettore Sottsass and working out of Milan in the 1980s, produced post-modern furniture, fabrics, ceramics and other objects featuring colourful decoration and asymmetrical shapes. The group's highly acclaimed work made its debut at the 1981 *Salone del Mobile* in Milan, the world's most prestigious furniture fair.

Similarly, Italians based in the Milan-Turin-Venice corridor have played an influential role in bringing natural refrigerant-based technologies to market worldwide. And likewise, they will seize the opportunity to shine at crucial events in their native Italy: Mostra Convegno Expocomfort in Milan (13-16 March) – one of the world's biggest comfort technology tradeshow – and our ATMOsphere Europe conference on natural refrigerants, on the shores of Lake Garda (19-21 November).

Accelerate Italy, a special edition of our *Accelerate* magazine series, celebrates the passion of these visionaries in revolutionising their respective fields in this most exciting of years for natural refrigerants in Italy.

Italy looms large in the history of refrigeration. Our cover story focuses on some of the Italian movers and shakers whose innovations are helping to broaden the market for natural refrigerants around the world ([p. 14](#)).

Sergio Girotto is one of those movers and shakers. Since designing the first CO₂ transcritical supermarket in 1997, Girotto has continued to push the boundaries of what natural refrigerants can achieve. We spoke to the Enex founder and president about what's next ([p. 36](#)).

Officine Mario Dorin, an Italian compressor manufacturer, is celebrating its centenary this year. 71-year-old Mario Dorin, who has held just about every position in the company in his long career there, tells us why the future is bright for natural refrigerants ([p. 42](#)).

Policy-wise, the picture looks less rosy. The EU F-Gas Regulation heralds key HFC phase-down steps and upcoming refrigerant bans to which Italy must adhere. Yet a number of national decrees continue to represent barriers to wider adoption of natural refrigerants in the southern European country ([p. 48](#)).

Rewind to the 1970s, meanwhile, and training on natural refrigerant systems was difficult to come by. Nowadays, numerous Italian institutes and manufacturers are working hard to train the next generation to use these climate-friendly technologies ([p. 44](#)).

While refrigeration continues to make big strides towards natural refrigerants, air conditioning still lags behind. Our special Technology Focus looks at what Italian companies are doing to close this gap ([p. 54](#)).

I hope you enjoy reading about this cast of fascinating individuals and companies who are doing – and indeed have already done – so much to make the business case for natural refrigerants in Italy and beyond. Enjoy the issue!



Andrew Williams
Editor



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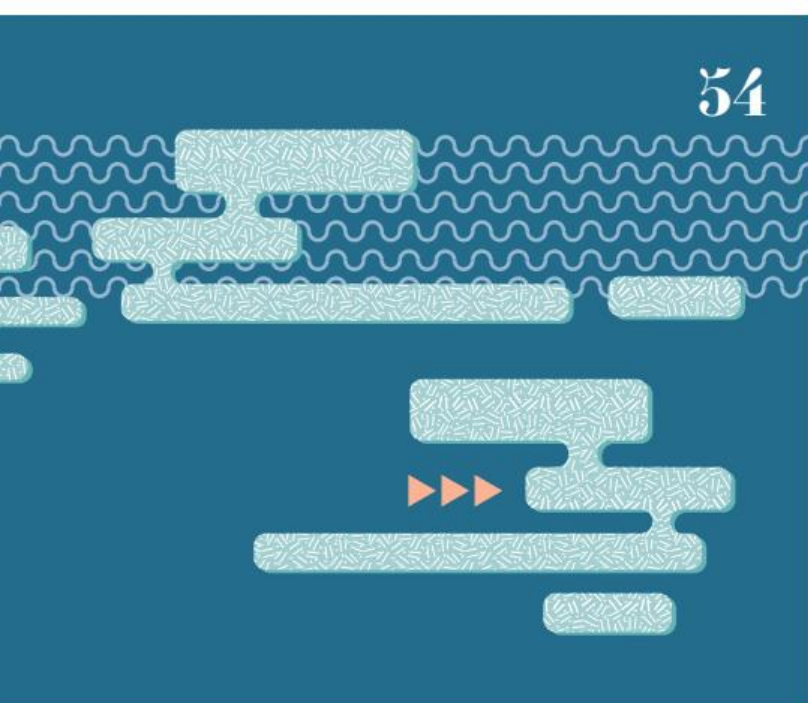
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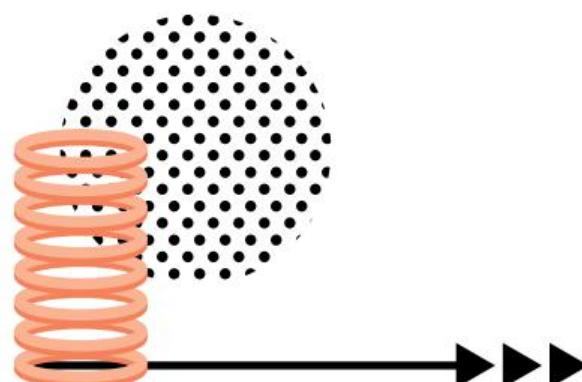
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SPECIAL EDITION

ACCELERATE

ADVANCING HVAC&R NATURALLY

ITALY

About *Accelerate Italy*

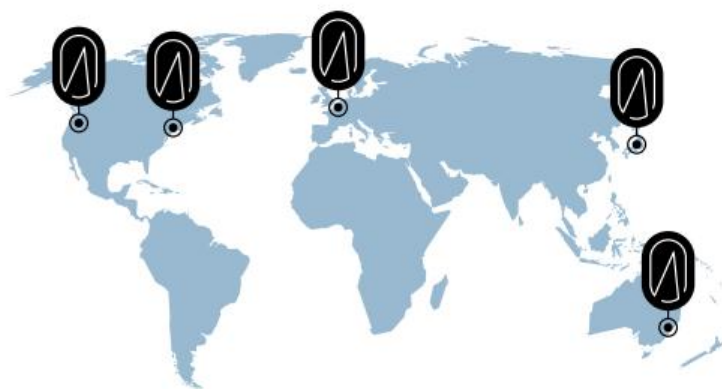
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Accelerate Europe:

WANT TO ADVERTISE?

/ Ad sales

Silvia Scaldaferri
silvia.scaldaferri@shecco.com
+39 331 961 395

GOT A STORY IDEA?

/ Editor

Andrew Williams
andrew.williams@shecco.com
+32 2 899 25 63

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Publisher

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

Editor

Andrew Williams
andrew.williams@shecco.com
@a_williams1982

Reporter

Charlotte McLaughlin
charlotte.mclaughlin@shecco.com

Contributing Writers

Marie Battesti
Michael Garry
Klára Skačánová
Devin Yoshimoto

Advertising Manager

Silvia Scaldaferri
silvia.scaldaferri@shecco.com

Events Coordinator

Silvia Scaldaferri

Art Director

Anna Salhofer

Graphic Designers

Charlotte Georis
Juliana Gómez

Illustrator

Juliana Gómez

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A roadmap for natural refrigerant training in Italy

What can be done to improve training in natural refrigerant-based HVAC&R technologies among installers, contractors and technicians? Governments could do more. Unfortunately, at the moment there are no European regulations to make training and certification on natural refrigerants mandatory by law.

The industry strongly supports our institute (*Centro Studi Galileo*), inviting our trainees to site visits on their premises, as well as providing equipment and expertise for participants to make the most of their training experience. We have currently trained more than 1,000 technicians in natural refrigerants.

Much equipment in the future will be equipped with flammable refrigerants. I would like to never again hear about accidents that could have been prevented through thorough training, quality maintenance and respect of safety measures. For this reason, I would like to see mandatory training and certification on these substances. Countries like the Netherlands and Spain already have such a system in place. The same should be available in Italy, where we install one million split air-conditioning systems each year, which could all be charged with R290 in the future.

Even in large supermarkets and hot water heat pumps, where CO₂ could be the best option, it is necessary to update technicians' skills in this new and unknown technology (for most). Thus, training and information is an essential component of competitiveness and competence in the market, and all technicians and industries must be up-to-date in terms of the best and safest methods of operation, which will also positively affect their business.

To be even more precise, I think it would be sufficient to have a mandatory certification, because through a third-party assessment we can check the competence and the ability of technicians to perform the activities needed for a refrigeration and air-conditioning system. The training will follow automatically, as it is the only way to build the competence of each technician.



Marco Buoni

is technical director at *Centro Studi Galileo*, an Italian HVAC&R institute. He is also secretary-general of Italian HVAC&R industry group *Associazione Tecnici del Freddo*. And he is vice-president of AREA, the European Association of Refrigeration, Air Conditioning and Heat Pump Contractors.

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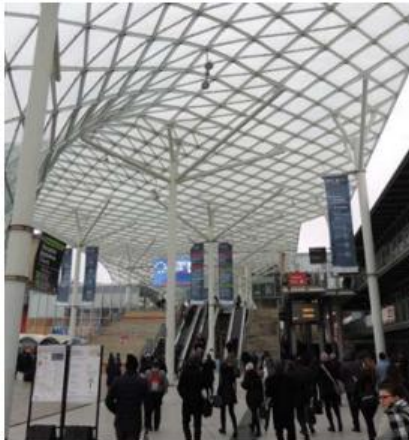
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ITALY IN BRIEF

Epta pushing FTE in Australia

Italy's Epta Group has 10 transcritical CO₂ installations up and running in Australia. To increase the efficiency of future installations, it has started field-testing its Full Transcritical Efficiency (FTE) concept there.

In 2016 Epta began field trials of the FTE in a transcritical CO₂ system with the help of Australian installer AJ Baker & Sons, according to Steve Laing, national commercial manager at Epta Australia.

18 months of results showed that the system had maintained its efficiency even in high-ambient temperature conditions. ■ DY

Blupura growing fast – with hydrocarbons

Having recorded growth of 30-40% every year for the past four years, Italian water vending machine and water cooler manufacturer Blupura was expecting to grow by an even more impressive 43% in 2017 – largely thanks to its commitment to future-proof natural refrigerants.

"We've moving our entire production to propane (R290). Our strategy is 100% R290," Massimiliano Santicchia, export manager at BLUPURA Srl, said at Vending Paris (15-17 March 2017).

The company is ceasing to manufacture water coolers based on isobutane (R600a) in favour of focusing 100% on propane. "R290 is better for water coolers," Santicchia argued.

■ AW

Frascold develops CO₂ selection software

Italian compressor manufacturer Frascold is providing customers with information on how to select compressors for CO₂ transcritical systems. "The problem with smaller OEMs is they don't know what they need," says Livio Calabrese, from the sales and development side of Frascold's business.

"Before, with other compressors, we asked them the capacity and application in a software tool, then told them which compressor they needed. With CO₂, it's more complicated," he adds.

Fracold's selection software for CO₂ does not just show compressor information but also allows the client to model the compressors in a CO₂ refrigeration system. ■ CM

Refrigera launches CO₂ valves at AHR

Italy's Refrigera Industriale S.r.l. launched new CO₂ valves that can withstand the high pressures of transcritical systems at the 2018 AHR Expo in the US city of Chicago.

Refrigera's new ball valve for CO₂ transcritical systems uses stainless steel with a K65 connection. "This product was developed for the US market to meet the requirements of the UL certification [a US safety body]," said Gabriele Bertossi from Refrigera.

The company has also launched a new strainer valve with stainless steel and K65, and a V-port valve. ■ CM

Ammonia in HVAC applications

"We can offer quite a wide range of evaporative ammonia condensers, for commercial HVAC, industrial refrigeration and process, as well power generation," says Massimo Volpini, manager of Italian firm W-Tech, which makes heat dissipation systems that use adiabatic technology.

The company has invested in targeting the industrial sector. "We see HVAC sector progressively requiring more evaporative condensation solutions – rather than systems utilising conventional air-cooled or water-cooled condensers – combined with more compact chiller solutions, for the benefit of performance, generally, as well to achieve lower power consumption," he says. ■ CM

CAREL to bring ejectors to North America

Italian controls manufacturer CAREL is introducing its EmJ modulating ejector line, which enables transcritical systems to run efficiently in warm climates, to the North American market this year.

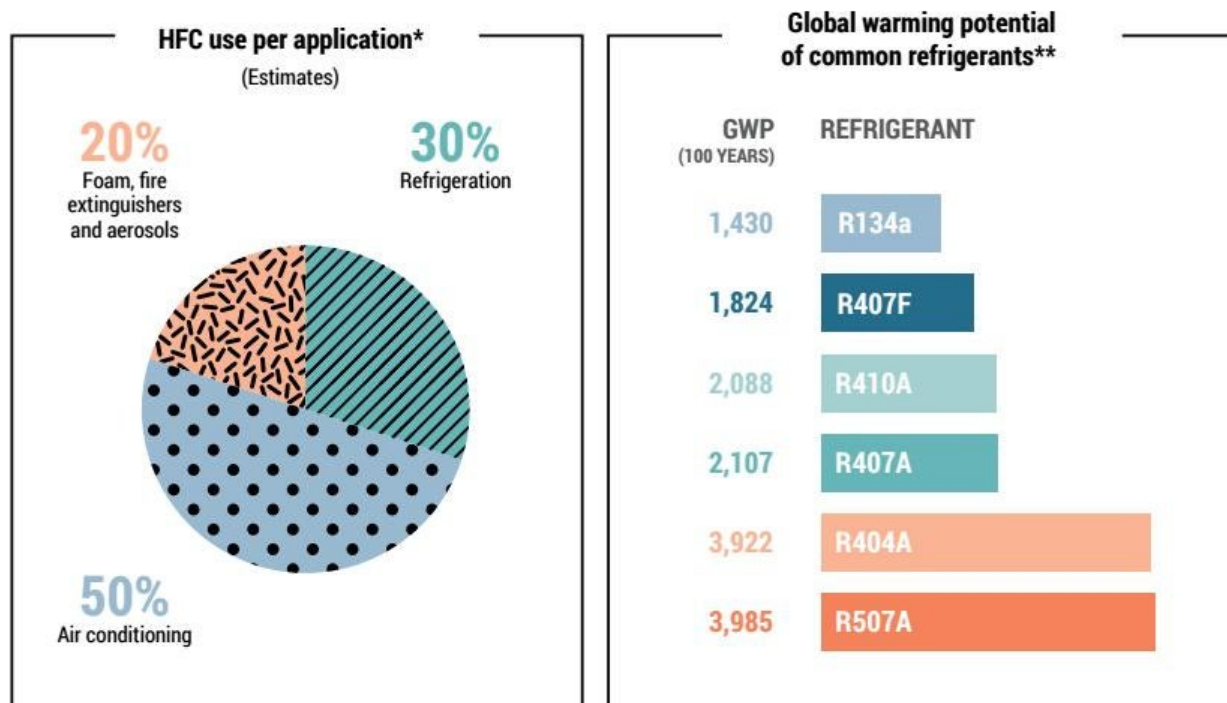
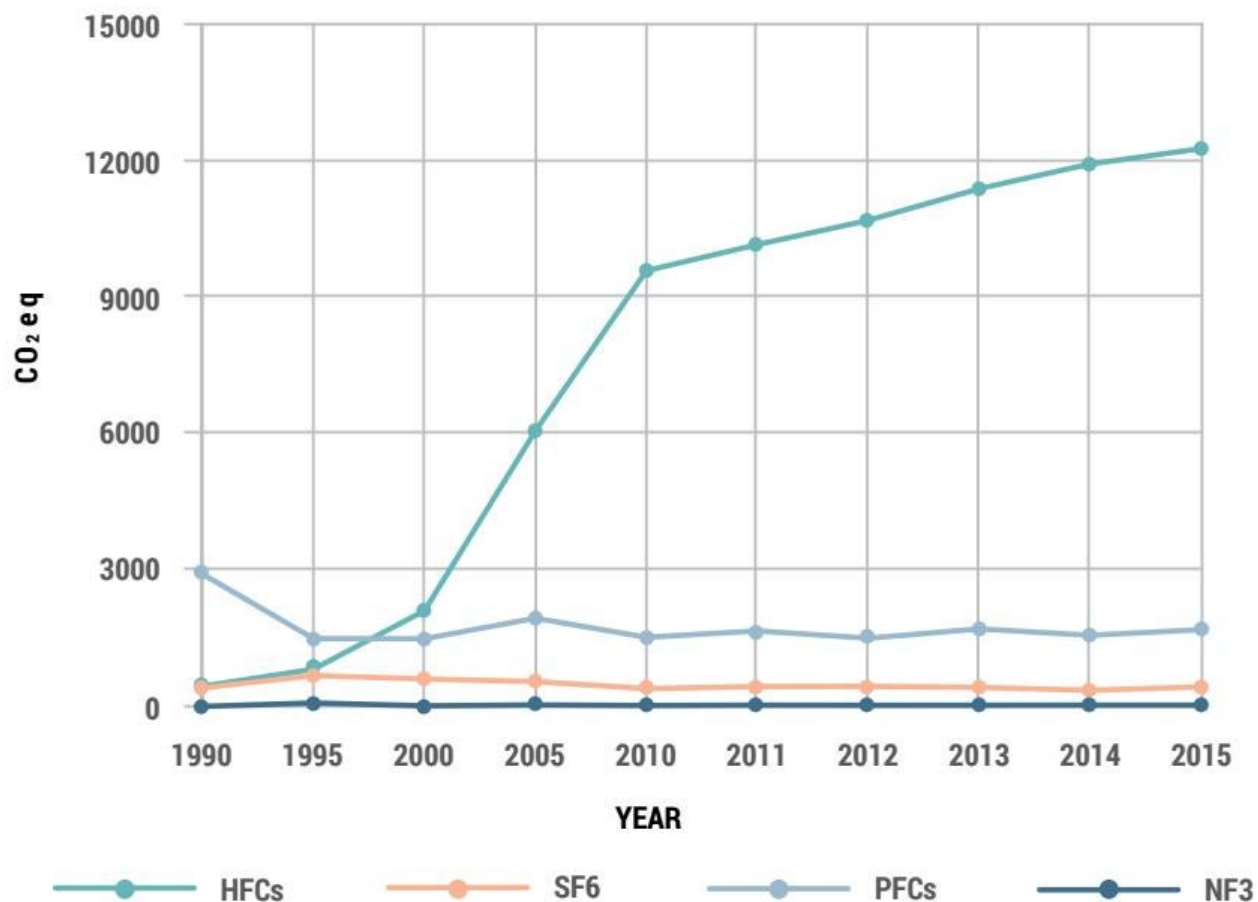
"After the interest we got in Europe, this is another important market for CO₂ transcritical," said Brandon Marshall, application manager refrigeration, CAREL USA, at the AHR Expo in Chicago.

The EmJ line is a partnership with Carrier. The ejector is being piloted in transcritical systems installed in Europe and will be sold commercially in North America and Europe in June.

■ MG

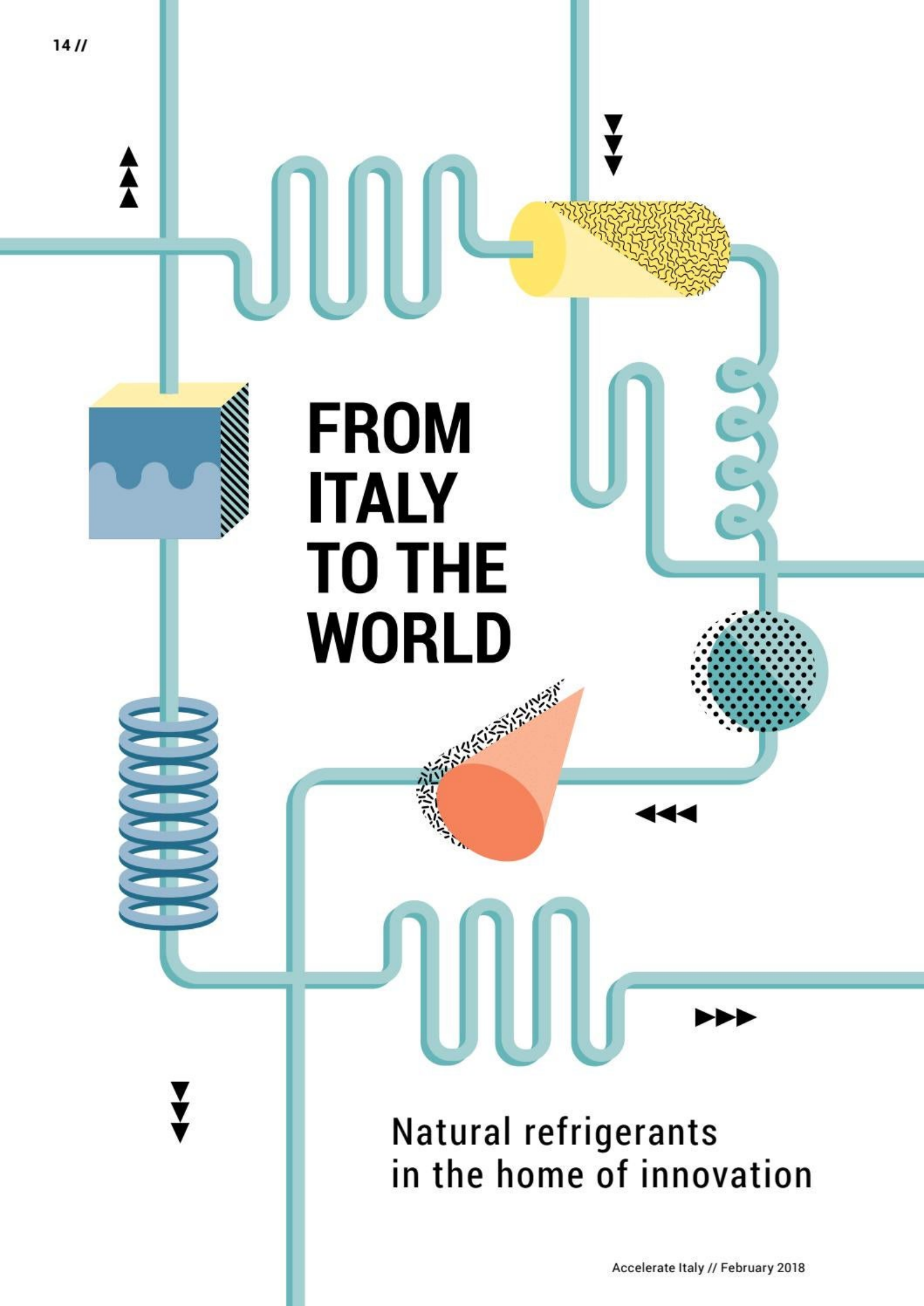
Italy's f-gas landscape

Growth of f-gases in Italy in CO₂ equivalent (CO₂ eq)*



* Source: Italian Greenhouse Gas Inventory 1990-2015: National Inventory Report 2017 by the Italian Institute for Environmental Protection and Research (ISPRA)

** Source: F-Gas Regulation Shaking up the HVAC&R Industry (shecco)



FROM ITALY TO THE WORLD

Natural refrigerants
in the home of innovation

Many Italian companies have played a central role in developing new innovations for natural refrigerants – from transcritical CO₂ racks or propane cabinets to low-charge ammonia systems. *Accelerate Italy* reports from the home of innovation.

— By Charlotte McLaughlin

Italy has enjoyed a reputation as a home of innovation for hundreds of years. In the 20th Century, Italy gave the world the fashion houses of Milan and the Memphis Group (the design and architecture group founded in Milan in 1982 by Ettore Sottsass, from which this magazine takes its inspiration), and in the 15th and 16th Centuries birthed the Renaissance – one of the most productive periods of architecture, art and science in history. Today it is also known for great food, even better wine, long summer days, and fast cars.

Yet in this celebration of all things Italian, it is easy to overlook that Italy is a world leader in the field of engineering. The Italian Trade Agency (ITA) estimates that 60% of the country's exports today come from industrial manufacturing including the HVAC&R sector.

Michele Scannavini, president of the Italian Trade Agency (ITA), said in 2017 that 4,600 companies in Italy make technology products, employing nearly 180,000 people.

Italy's significance to the HVAC&R industry cannot be ignored. It is hard to get exact data on the number of companies working in HVAC&R in each European Union member state, but it is reasonable to estimate that a large proportion of them are Italian.

"Italy is one of the leading countries in HVAC&R due to the great number of companies based here," Giovanni Dorin, marketing director of compressor manufacturer *Officine Mario Dorin*, told *Accelerate Italy*.

The new EU F-Gas Regulation obliges European companies to register their activities with f-gases. Of the 1,279 companies reporting their f-gas activity in 2016, the majority come from Italy, according to a 2017 report by the European Environment Agency.

The work Italian companies do to push innovative technology working with CO₂, hydrocarbons and ammonia is made possible by the country's strong HVAC&R tradition.

Go to any HVAC&R tradeshow in Europe, and you cannot miss the large number of Italian companies.

Italian firms accounted for 15 out of 69 (21%) of the companies working with natural refrigerants at EuroShop 2017 (source: *GUIDE EuroShop 2017*, produced by sheccoBase, the market development arm of *Accelerate* publisher shecco). Chillventa 2016 boasted similar numbers: 23% of the 190 companies working with natural refrigerants at that show were from Italy (a total of 44).

Northern Italy has hosted much of the country's manufacturing base, around cities like Turin and Milan, since the 19th Century. Today many HVAC&R companies are based in the so-called industrial triangle made up of the Lombardy, Veneto and Emilia-Romagna regions of the north.

Some consider the Italian capital of refrigeration to be a small northern town called Casale Monferrato, between Turin and Milan – according to Marco Buoni, technical director of Italian HVAC&R research and training institute *Centro Studi Galileo*, which is located there.



A LONG HISTORY

Most of the companies *Accelerate Italy* spoke to have been around for at least 30 years. *Officine Mario Dorin*, based in Compiobbi on the outskirts of Florence, is celebrating its centenary this year.

Founded in 1918, Dorin has been active in the field of refrigeration since 1932 ([see special feature on Dorin, page 42](#)). "We are one of the oldest companies manufacturing compressors globally," Giovanni Dorin told *Accelerate Italy*.

Arneg s.p.a., located in Campo San Martino, Padova in the region of Veneto, is steeped in Italian history "because Italian character is tradition and innovation, creative genius, craftsmanship and the instinct to survive and invent. In other words, the Italian character is the emblem of excellence," the company states on its website.

The global HVAC&R firm focuses on the commercial retail sector, a market in which it has been active for over 50 years and "is one of the leaders," according to Enrico Zambotto, customer & product support, Arneg.

CAREL s.p.a., founded in the province of Padova, has also been in the market for a long time. It started manufacturing steam humidifiers in the 1970s. In the 1980s, it branched out into controls for refrigeration and air conditioning.

Heat exchanger manufacturer LU-VE, listed on the Milan Stock Exchange, is headquartered in Uboldo, Varese in the Italian region of Lombardy. It has 10 production units around the world and has been in the sector for over 30 years.

"We have one of the biggest R&D laboratories in our sector in Europe and we have been collaborating closely for over 30 years with the Polytechnic University of Milan and 21 other universities all over the world," Livio Perrotta, marketing manager, cooling systems business unit, LU-VE GROUP, told *Accelerate Italy*.

This focus on R&D has allowed the company to become one of the world's leading manufacturers of heat exchangers.

Alessandro Vitri, vice-president of Rivacold – located in Vallefogli, a town in the Marche region located just below Emilia-Romagna – told *Accelerate Italy* that his company boasts a 50-year tradition in HVAC&R as part of the Vitri Alceste Group (VAG). "We are very proud," Vitri says.

"VAG has operated within commercial and industrial refrigeration with the Rivacold brand since 1966, in a competitive market that we lead thanks to investments in advanced technology, lean production and people's knowhow," he says.

SCM FRIGO S.p.A., a leading manufacturer of refrigeration systems established in 1979, has had almost 40 years' experience working in its Venice location in the Veneto region. "Our company will soon celebrate 40 years in refrigeration, the last 15 years with natural refrigerant CO₂," Nicola Pignatelli, managing director of SCM Frigo, told *Accelerate Italy*.

The manufacturer has been part of Beijer Ref – a leading Swedish HVAC&R multinational – since 2011.

There is a long tradition of collaboration between Italian and Swedish manufacturers. "Alfa Laval is a Swedish company with a long tradition in Italy," says Stefano Meloni, Alfa Laval's product manager (heat exchangers) in the Adriatic region. "The first Italian office was opened in 1911 and today we have several

production, commercial, engineering and research & development facilities with a total of about 1,000 employees."

The production facility is located in Monza, just northeast of Milan in the Lombardy region, where the firm manufactures heat exchangers used in refrigeration, air conditioning, and heat pumps working with CO₂, ammonia and hydrocarbons.

EXPORT-LED, HOME-GROWN

Most of these companies export the majority of their natural-refrigerant products to the rest of Europe, where demand for these technologies is higher.

"The overall situation of the Italian market is more conservative in terms of volumes compared to the other European countries, where there has been a lot of growth in natural refrigerants," argues Rivacold's Vitri.

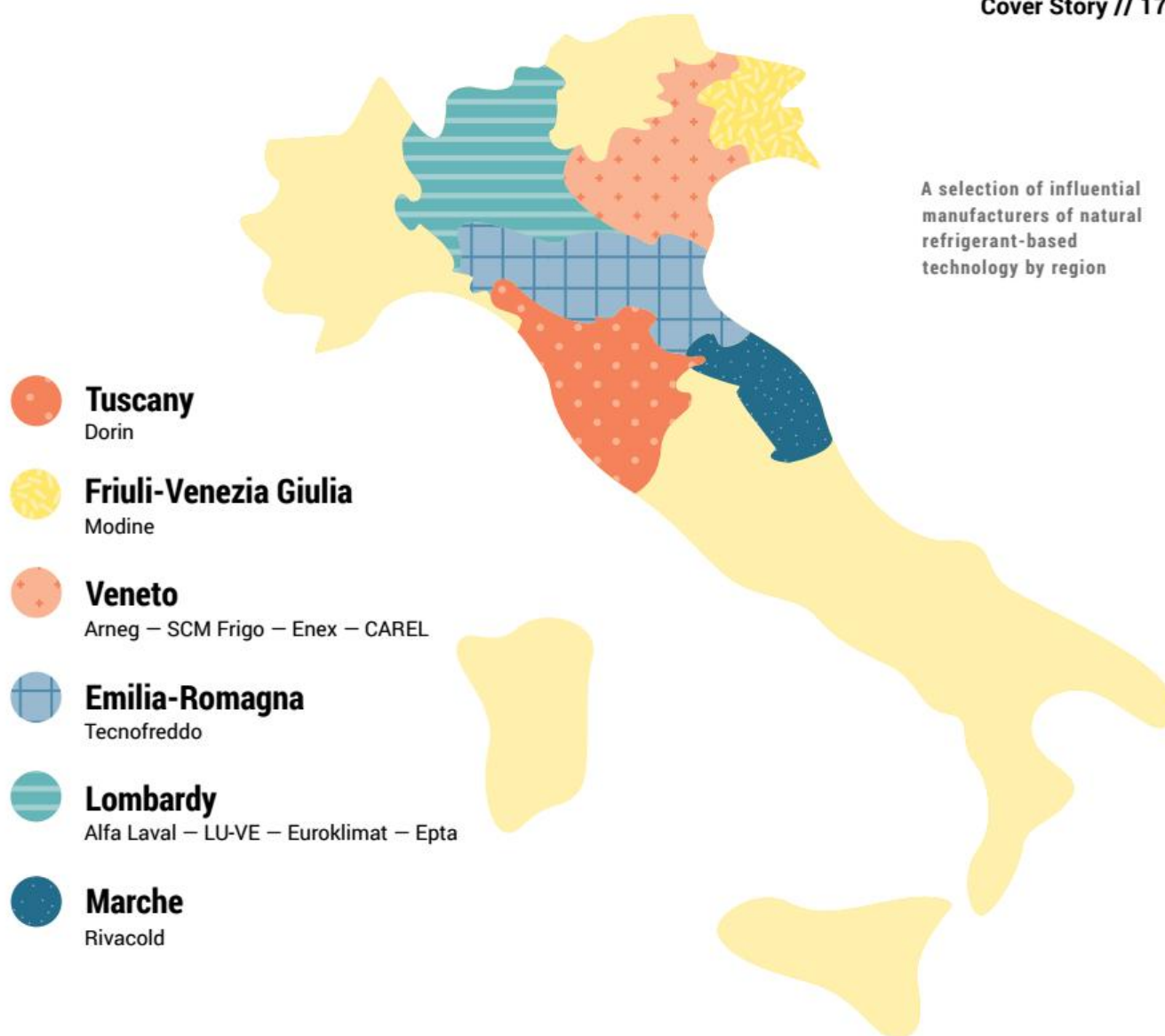
Italian HVAC&R controls manufacturer CAREL, based in Brugine, Padova in the Veneto region, would agree.

Last year, the group reported that 80% of its total sales in 2016 came from exports. Most export sales were to Europe, with an overall average increase of 19%. It also performed strongly in Asia (an increase of 8%).

"The focus of our innovation continues to be improved efficiency and sustainability in the air-conditioning and refrigeration sectors," says CAREL Group Managing Director Francesco Nalini. CAREL has recorded a significant spike in sales thanks to its low-GWP technology innovations.

"Our growth in 2016 is the result of the most innovative solutions in these areas, and shows how our R&D efforts are focused in the right direction," Nalini says.





CAREL reports a strong market for natural refrigerant technologies beyond Italy's shores. "It can be said that R744 got initial fast traction in low-temperature latitudes (e.g. northern Europe) due to the more suitable ambient temperatures," Alessandro Greggio, group head of marketing refrigeration and retail, CAREL, told *Accelerate Italy*.

"The Italian market has been typically very strong in small hydrocarbon applications, since the beginning, and several OEMs have been investing and become capable in CO₂ applications," Greggio says.

Similar to CAREL, much of LU-VE's focus is outside of Italy – it exported 80% of its production to 100 countries in 2016, meaning much of its consolidated sales revenues of €251.3 million came from outside Italy.

For some, the story is more complex.

"We have been more successful outside of the Italian market because CO₂ in refrigeration was more used in northern Europe," Pignatelli of SCM Frigo told *Accelerate Italy*.

Much of this growth, he estimates, has been down to governments in these northern countries accelerating the switch to natural refrigerants through taxes; such has been the case in Denmark ([see Accelerate Europe, issue #7](#)).

"But in the last 24 months we see increasing demand in terms of quotes and orders for CO₂ units also in Italy, and we expect a huge increase of sales in CO₂ in our domestic market," he adds.

Officine Mario Dorin also notes growth in natural refrigerant technology sales nationally and globally. Giovanni Dorin expects Italy's positive economic growth only to add to this: "Although the economy is timidly restarting with growth in the national GDP of some percentage points, the Italian HVAC&R sector will definitely take a very strong step in the next few years," he predicts.

He nonetheless sounds a cautious note. "Obviously on the international market, there are more players – large and middle-sized ones – giving more opportunities to our sales growth. Hence the success of our CO₂ products is global."



CO₂ TRANSCRITICAL: AN ITALIAN EXPORT

Norwegian scientist Gustav Lorentzen, a professor at the University of Trondheim, rediscovered how CO₂ could be used as a refrigerant in heating and cooling applications in the 1980s.

Lorentzen developed the modern thermodynamic transcritical CO₂ cycle in 1988-1991, heralding a crucial breakthrough that has led supermarkets to opt for transcritical CO₂ systems across Italy and the rest of Europe.

Today, over 12,000 European supermarkets use CO₂ transcritical systems, according to the latest data from sheccoBase, the market development arm of shecco, publisher of this magazine.

Much of this growth was driven by innovative Italian companies, including Enx (see interview with company founder Sergio Girotto, [page 36](#)). While working for Italian company Costan – part of the Epta Group – Girotto asked Dorin to produce a CO₂ compressor back in 1996.

Testing of these compressors, beginning in 1997, paved the way for Dorin to become one of the biggest advocates of CO₂ technology. "The process is reinforced by the determined adoption of CO₂ technology as a long-term solution," says Giovanni Dorin.

The compressor manufacturer has heavily invested in developing CO₂ compressors for industrial applications.

"Dorin is investing every year a lot in innovating its compressors, either with new products or by renovating previous models," Giovanni says. "For our CO₂ ranges alone – Series CD transcritical and CDS subcritical – we are already in the 4th generation of the models."

"Our feeling is this will be a reliable alternative to ammonia," said Giovanni Dorin at this year's AHR Expo in Chicago. "Ammonia has issues with safety."

Dorin's new semi-hermetic reciprocating compressors, marketed under the CD500 line and originally mentioned at Chillventa 2016, feature six cylinders, 50-80 HP and displacements of 40-60 m³/h. Like the two-year-old CD400 line, the CD500 compressors are designed such that the manifold is outside the crankcase, rather than inside, and the two are separated by a pocket of air. This allows the CO₂ gas to cool before being discharged by the compressor, lowering the temperature of the oil inside the crankcase and increasing efficiency and reliability, he said.

"This [design] is totally unique in the market," Dorin said. The high capacity of the CD500 line means fewer compressors are needed for an application, reducing costs, added Giacomo Pisano, Dorin's sales manager, CO₂ compressors.

Modine Manufacturing Company's Commercial & Industrial Solutions (CIS) division has its EMEA

1988

1996

1997



1988-1991
Gustav Lorentzen rediscovers how CO₂ can be used as refrigerant in heating and cooling applications. Lorentzen develops modern thermodynamic transcritical cycle.

Sergio Girotto, working for Costan, asks Italian manufacturer Dorin to produce a CO₂ compressor.

Dorin tests CO₂ compressor in factory conditions.

regional headquarters in Pordenone (Udine), in Friuli-Venezia Giulia region in north-eastern Italy. It is also investing in transcritical CO₂ for industrial applications.

"We're proud to have supplied seven large transcritical gas coolers with 'V' configuration heat exchangers to our Advansor customer for the realisation of the largest transcritical CO₂ installation in the world (3.4 MW), for Staay Food Group in the Netherlands," says Umberto Di Barbora, global product manager, commercial coolers, commercial and industrial solutions (CIS), Modine.

"It was certainly being part of this project that made us realise that the CO₂ boundaries are not limited to commercial refrigeration but can also be extended to the most challenging industrial refrigeration projects."

Modine CIS is one of the world's largest heat exchanger manufacturers. With a workforce of 3,500 in CIS and an additional 7,500 employees in other divisions, it has been working with CO₂ for some time. It provided the first heat exchangers, in the early- and mid-1990s, to European CO₂ test labs like the Danish Technology Institute (DTI) in Aarhus.

Similarly LU-VE, which closely collaborates with universities in Milan and around the world, was one of the first companies to work with CO₂. "Our first CO₂

plant dates back nearly 14 years to Switzerland (Zürich)," says LU-VE's Perrotta. "We provided the gas cooler with spray system."

In 2010 the company decided it would start Europe's first CO₂ test plant for CO₂-based finned heat exchangers, and also "to test CO₂ unit coolers and gas coolers in both subcritical and transcritical operation".

"The new testing plant enabled the launch of a specific project for a CO₂ fin-and-tube heat exchanger, with the primary aim of improving knowledge of heat exchange phenomena in evaporation, condensation and during transcritical gas cooling," Perrotta says.

"The influence of oil on the internal heat exchange coefficient also enters the scope of the research. We have the opportunity to calibrate our software that calculates product performance, and potential improvements to products. It is possible to calibrate a specific method able to consider the behaviour of the fluid during transcritical cooling, properly considering all the parameters affecting real performance."

LU-VE has adapted water injector systems developed in 1997 to modern CO₂ systems. "EMERITUS® is the latest innovation developed for the range of condensers, dry coolers and gas coolers manufactured by LU-VE Exchangers. This new technological advance (patent pending) is the result of collaboration with the Polytechnic University of Milan and brings together the benefits of spray systems and adiabatic pre-cooling," he says.

"When EMERITUS® is applied to CO₂ gas coolers, higher system [coefficient of performance] can be achieved even during the hottest hours of the year," he adds.

This investment in learning lessons from the past and applying them to new technology is part of the company's motto. "The future has an ancient heart," Perrotta says.

The Italian HVAC&R industry first manufactured CO₂ products for the commercial arena. "The first approach was with supermarkets, then a logistics plant, and now there are industrial applications," says SCM Frigo's Pignatelli.

SCM Frigo has put racks and condensing units in supermarkets, logistics centres, ice rinks and small stores throughout the world. The company boasts over 2,000 CO₂ installations globally, some of which are subcritical.

SCM Frigo began working with CO₂ in 2004, developing cascade systems for customers in its largest market of Scandinavia. At the time, the company was responding to growing customer demand for alternative refrigerants.

"There was a need for CO₂ units because of the huge taxes they had to pay for using HFCs in the European Nordic countries," says Anna Stella, key account manager, SCM Frigo.

In response, the company – just one year later in 2005 – began developing transcritical CO₂ systems. Asked why SCM Frigo had committed so strongly

1998



1997-1998: Girotto installs subcritical CO₂ cascade systems in supermarkets in Italy (Conegliano, Treviso) and the UK (Harlesden, London), while at Costan.

1999



Girotto designs the first-ever CO₂ transcritical system (Costan), fitted in a small supermarket without a compressor rack.

2001



Girotto installs the first-ever CO₂ transcritical system (Costan) in a large supermarket, presenting a paper on the installation at the International Institute of Refrigeration Congress in Washington, D.C. in 2003.

to CO₂, SCM Frigo Technical Director Mirko Bernabei explains that they believed it to be the best long-term solution at the time.

"We decided on CO₂ because we were convinced that CO₂ was easiest to manage," Bernabei says. Customers were looking for a solution that was easy, reliable, and would be future-proof and provide long-term certainty.

This commitment to CO₂ has paid off. SCM Frigo has seen a lot of success in Europe and beyond. It brought its new CUBO₂ Smart CO₂ condensing unit (CDU) to Australia last year.

The company was also heavily involved in the first transcritical CO₂ system in China's retail sector, for which it produced the rack, in a METRO wholesale store in Beijing.

The controls were provided by CAREL, which has also been at the forefront of developing the CO₂ market. "CAREL, being a solutions provider and an enabler of multiple ways of natural refrigerant adoption, values not only the final user and market demands but also the large OEM customer base," Greggio says.

Alfa Laval is also experienced in working with the high pressure of transcritical CO₂. "We have certainly been helped by customers who have believed in CO₂ since 15 years ago," says Meloni.

"By the time the [EU F-Gas Regulation came into force with] restrictions on the use of synthetic refrigerants, we were ready with full ranges," he adds.

Though these innovators were at the forefront, many more have since emerged on the scene to work with CO₂ in different applications. Arneg's Zambotto says the company had tried on many occasions to kick-start its CO₂ business, adding that the increasing cost of HFCs since the introduction of the EU's F-Gas Regulation gave the market the important push it needed to take off.

Rivacold, similarly, has found the journey difficult. Italian industry's "very first approach was a general caution on pressure levels and effective efficiency on high ambient temperature operations," according to Vitri.

The company started working with CO₂ 15 years ago, and admits to having difficulty getting components standardised and validated at first.

Rivacold now boasts a full CO₂ transcritical product range, from condensing units and evaporators to rack systems. "New condensing units and mini-packs for medium and low-temperature applications will cover small capacities for convenience stores with very high performance," Vitri notes.

2004

2006

2007



Giroto founds Enex.
Bitzer follows Dorin into
CO₂ compressor market.
Carrier installs its first CO₂
transcritical system, in
a Migros supermarket in
Switzerland.



Enex installs its first CO₂
transcritical system.



Advansor founded.

HYDRO CARBONS

A MAJOR PLAYER IN THE NATREF GAME

Hydrocarbons have also had a long tradition in Italy. "The Italian market was typically very strong in small hydrocarbon applications and, since the beginning, several OEMs have also been investing and become capable in CO₂ applications," says CAREL's Greggio.

Rivacold is one of the pioneers of propane condensing units and packaged units for cabinets and cold rooms. The company covers medium and low-temperature refrigeration applications.

"The volumes of Rivacold propane products are already at a top level within the market in Europe," Vitri says.

The company also sells heat exchangers, for propane and CO₂ (gas coolers up to pressures of 130 bar and evaporators up to 75 bar).

Originally, Rivacold's heat exchanger arm provided these products only internally. It is now part of two separate divisions that supply remote condensers and static and air-cooled evaporators to OEMs outside the company.

"Propane has become rather popular in commercial refrigeration, especially for refrigerated display case counters," says Modine's Di Barbora.

Arneg, meanwhile, is a leading manufacturer of propane-based (R290) plug 'n' play cabinets in supermarkets.

Getting propane into the HVAC sector may prove to be trickier. "As far as air conditioning is concerned, the issue is a little more delicate, since only recently have more manufacturers come up with R290 [and other low-GWP refrigerants] pushed by the EU F-Gas Regulation," according to Alfa Laval's Meloni.

Italian regulation remains highly restrictive for flammable refrigerants in public buildings ([see page 48](#)). Manufacturers like Modine think this will soon change. "We expect that the directives, especially the ones referring to hydrocarbons, will begin to take shape and be implemented at government level, in order to avoid dangerous interpretations," Di Barbora says.

Propane chillers are one option for air conditioning in which Italian companies Euroklimat, based near Milan in the Lombardy region, and Tecnofreddo, based in Modena in Emilia-Romagna, are investing ([see Technology Focus on page 54](#)).



AMMONIA

BUILDING ON TRADITION

Ammonia (NH₃) has long been used in industrial applications throughout Europe. Italian companies are pushing the boundaries of what this refrigerant can achieve, particularly at lower charges.

"We are continuing our development of very-low-refrigerant-charge solutions for NH₃," says LU-VE's Perrotta.

Since 2005 LU-VE has boasted a range of pumped ammonia LSA (large surface area) unit coolers that perform similarly to traditional ammonia products but with a lower charge. "Low refrigerant charge means a reduction of installation costs, a more compact separator, and lower operating costs," he adds. "In addition to savings in refrigerant, it means higher levels of safety."

Alfa Laval has used ammonia for a long time. "We are European pioneers and have always used this natural refrigerant," Meloni says. "Alfa Laval developed a plate application in

flooded systems, replacing the traditional and cumbersome shell and tube."

"In the industrial sector the competence of installers, contractors and manufacturers is very high with NH₃," Meloni says. He reports strong growth of this refrigerant in the Italian market.

Yet others lament comparatively low uptake of ammonia in Italy compared to other European countries. "In Italy the use of ammonia for industrial refrigeration installations is low," says Modine's Di Barбора. Giovanni Dorin agrees: "NH₃ is not very common in Italy."

COMING HOME

Natural refrigerant uptake, then, has perhaps been slower to take off in the country whose companies are manufacturing much of the technology to harness them. Yet there are signs of change.

Rivacold ran several workshops during 2017 focused on transcritical CO₂ in Italy. "We mainly dedicate them to installers. However, we also communicate from time to time our technology to other players such as contractors, system designers and end users," Vitri says.

Other market players are optimistic about the domestic market.

"The Italian market for natural refrigerants has seen a significant increase in recent years, albeit starting from a very low level – especially now that the technology has made solutions available for warm climate countries," notes Modine's Di Barбора.

A new Iper hypermarket in Milan – the largest hypermarket in Italy and one of the largest in Europe – opened its doors in April 2016. The CO₂ transcritical system uses ejector technology from Danish multinational Danfoss. Arneg provided the system itself.

Convinced by the results of numerous tests in recent years, Arneg decided to go for an ejector to enhance the hypermarket's energy efficiency.

Analysis from one year of operations in comparison to an HFC-CO₂ cascade

system was provided by Chiara Tognoli, customer technical support engineer at Arneg, at the ATMOSphere Europe conference in Berlin, Germany in September 2017.

The CO₂ transcritical system with an ejector (in the 10,000m² Iper supermarket) was compared to an HFC-CO₂ cascade (in a 9,500m² supermarket also located in northern Italy).

The energy performance of the systems was measured (with Arneg supervision system IRIS) during the period August 2016 to August 2017, when ambient conditions reached 40°C during the summer months, according to Tognoli.

The CO₂ transcritical system was found to save 9% energy over the twelve-month period (saving 60,300 kWh/year), which translates into a €10,800 annual saving for the end user compared to the HFC-CO₂ cascade system. "This makes CO₂ competitive in warmer climates," Tognoli declared.

"Ejectors have given us a great results in terms of energy consumption, installation and reliability. The results we had last summer have been fantastic," says Arneg's Zambotto.

"Last year the Italian market speeded up the introduction of CO₂ in the supermarkets in medium-temperature applications," he says.

Perrotta from LU-VE, which also worked on the Milan project, is conscious of the challenges of adapting CO₂ to warmer climates.

"One of the factors that influences efficiency in a transcritical installation is the ability of the gas cooler to cool the CO₂ temperature as much as possible, especially on the warmest days of the year," Perrotta notes. "To this purpose, CO₂ heat exchangers must be designed taking into consideration many important precautions compared to an HFC solution. Moreover, other complementary technologies help in overcoming this challenge: i.e. spray and adiabatic systems."

SCM Frigo, which has installed CO₂ transcritical systems with parallel compression and integrated air conditioning in Italy, is eyeing new such projects.

Work on a huge logistics centre in northern Italy (2.4 MW) using transcritical CO₂ will begin in summer 2018, according to Pignatelli.

"How did this come about? Thanks to a system designer who has known SCM Frigo for a long time," he says.

Italy, with its long history at the forefront of the HVAC&R industry, has long taken advantage of the European market for natural refrigerant-based technologies. Now there are signs that the domestic market is following suit. ■ CM

LU-VE TAKES CO₂ TO INDIA

LU-VE, located in the Italian region of Lombardy, has had great success working with universities to push the boundaries of what CO₂ technology can achieve.

The company is a partner of INDEE, an Indo-Norwegian project backed by the Norwegian Ministry of External Affairs and led by SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology) and the Norwegian Technical Institute (NTNU), both located in Trondheim.

"An INDEE industrial workshop at IIT Madras in March highlighted the possibilities of using CO₂ refrigeration technology in India," says LU-VE's Livio Perrotta. "The purpose of INDEE is to demonstrate the applicability of natural working fluid refrigeration technology in developing countries with high ambient temperatures."

INDEE has designed and built a test facility where interested parties can simulate supermarket operations.

"The gas cooler and the desuperheater both have CO₂ tube-and-fin heat exchangers from LU-VE," says Perrotta. "Performance evaluations will be carried out in high ambient conditions using CO₂ as the refrigerant."



CO₂ is the best refrigerant to guarantee both energy savings and to ensure a reduction in the impact the retail industry has on the environment.

Arneg Group as an international leader in the design, manufacture and installation of **complete equipment for the retail sector**, believing in high sustainability evolving hand in hand with intelligent technologies.

Interacting with the environment, society and its customers, Arneg aims to a continually improving quality of life and, as a fundamental part of this project, works on **CO₂ systems and applications**.



INNOVATION IN NATURAL REFRIGERANTS

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- CO₂ transcritical systems
- CO₂ subcritical systems
- CO₂ plug-in solutions



ITALIA



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Watch the video



Natural refrigerant CO₂ provides the cooling at the *Abbazia di Novacella* winery, high in the South Tyrol mountains of northern Italy.

— By Andrew Williams



Visitors to the *Abbazia di Novacella* (Kloster Neustift), high in the mountains of Italy's majority German-speaking South Tyrol (Trentino-Alto Adige/Südtirol) region close to the Austrian border, cannot help but be inspired by the beautiful surroundings of the Valle Isarco/Eisacktal valley.

Viticulture has been practised on the valley's sheltered slopes for over 2,500 years. Founded in 1142, the Augustinian Abbey of Novacella is one of the oldest monasteries in South Tyrol.

Beyond the gates of the monastic complex, green vineyards line the rolling foothills of the mountains that dominate the horizon. Wine has been produced at Kloster Neustift since it was founded, making the monastery one of the oldest active wineries in the world.

A member of the Grandi Cru d'Italia association of top Italian wine producers, the winery has been CO₂-neutral since 1992. It produces 70% white wine (in the Bressanone valley basin) and 30% red wine (in Cornaiano and Bolzano).

The cool climate and mineral richness of its vineyards, at an altitude of 260-900 metres, is ideal for cultivating white wines including Sylvaner, Müller Thurgau, Kerner, Gewürztraminer, Riesling and Veltliner. The reds include Lagrein, Pinot Noir, Moscato Rosa and Schiava (Vermatsch).

Novacella has proven to be self-sufficient and quick to adapt to changing circumstances ever since it was founded. The monastery was once a hospice and refuge for pilgrims.



NATURAL REFRIGERANTS: AT THE HEART OF WINEMAKING

At the heart of the medieval *Abbazia di Novacella* (Kloster Neustift) site, a state-of-the-art HVAC&R system – fitted by local installer Studio Fleischmann – adds a cutting-edge modern twist to the process of winemaking that has taken place here for centuries.

Two CO₂-based Yukon chillers – provided by Enex, headquartered in Padernello in the province of Treviso – serve a high-efficiency CO₂ transcritical system with gas coolers and heat recovery.

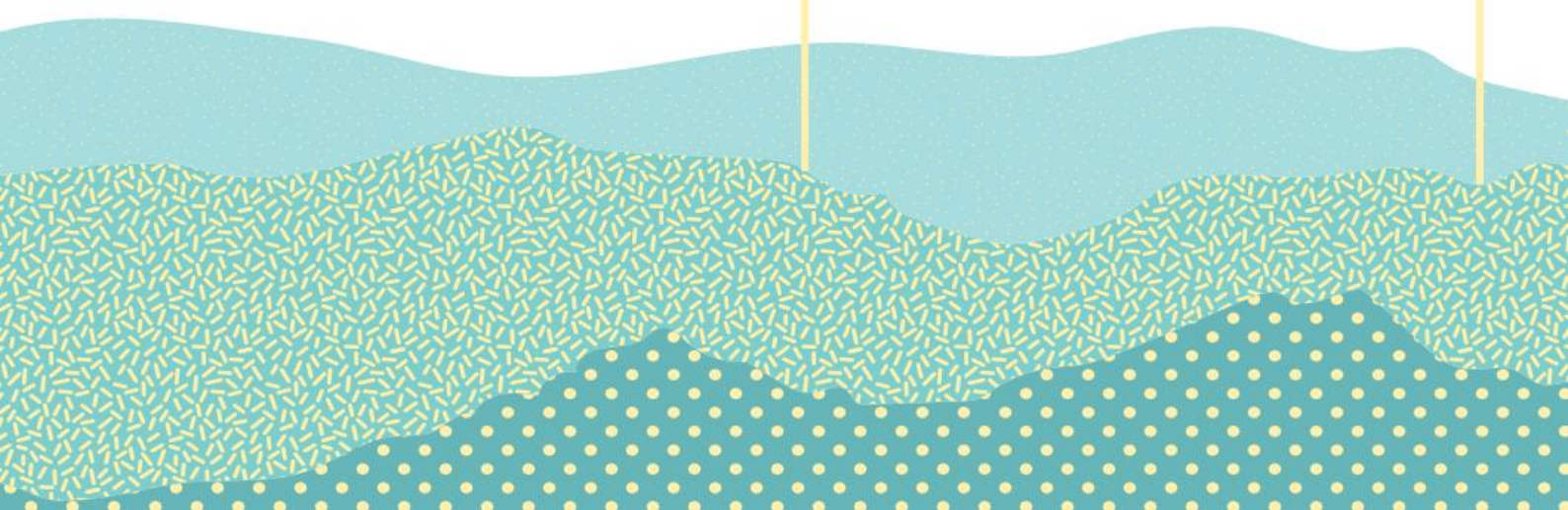
Water enters the system at 6°C and is cooled to 1°C. The system is capable of functioning in ambient outside temperatures of up to as much as 40°C.

Each of the chillers, installed in August 2017, has a cooling capacity of 60 kW. The two units are used to cool must when it increases in temperature during the fermentation phase; at the same time, heat recovery produces sanitary water at 90°C for cleaning the wine barrels.

Yukon is Enex's new family of CO₂-based 'plug and play', medium-sized water/brine chillers. The Yukon is particularly suited to space cooling in medium and large commercial buildings that have a significant hot water demand, such as hotels, hospitals, gyms – and wineries in the heart of South Tyrol.

The Yukon allows for overfeeding of the evaporators, which increases efficiency. It is available in two design concepts – the LPR (low pressure receiver) model for small systems and 'gravity overfeeding' for larger systems.

The optional addition of ENJECTOR technology improves the efficiency of the CO₂ transcritical cycle by recovering the energy contained in the high-pressure fluid entering the condenser/gas cooler.





Today, it runs a number of economically self-supporting enterprises, from herb garden to winery and from power plant to education centre.

It is the winery that gives the place its beating heart. Today Novacella Monastery owns 25 hectares, but controls and vinifies must (freshly pressed grape juice) from another 50 hectares owned by cooperative members, its exclusive suppliers. The abbey location is used to vinify and refine some of the wine.

Visitors to the monastery – an intoxicating mix of Romanesque, Gothic, Renaissance and Baroque styles – can enjoy a tour of the winery and taste its wines over a lunch of South Tyrol specialities such as speck, cheese, smoked sausage and rye bread in the Stiftskeller pub/restaurant, housed in a former mill.

The wider complex includes the two-story gate chapel of Castel Sant'Angelo (Engelsburg; Castle of the Holy Angel), a late Baroque basilica, a Gothic cloister, the Fountain of Wonders, a library and an art gallery.

The south side of the cloister provides the modern entrance to the monastery museum. Among its art treasures are numerous panel paintings and winged altars by well-known artists from the late Middle Ages. The abbey library, with its stucco ornaments dating from the transition period between the Rococo and Classicism, represents one of the most beautiful eighteenth century secular rooms in South Tyrol.

Ever since the abbey was founded, the key responsibilities of the Augustinian canons have included the cultivation of the solemn liturgy, the joint choir prayer, and pastoral care. Today, the Augustinian canons of Novacella work in pastoral care in twenty-five parishes in South Tyrol and East Tyrol.

In addition to vineyards, the monastery owns forests, meadows and orchards. The products made on site are sold in the monastery shop.

■ AW

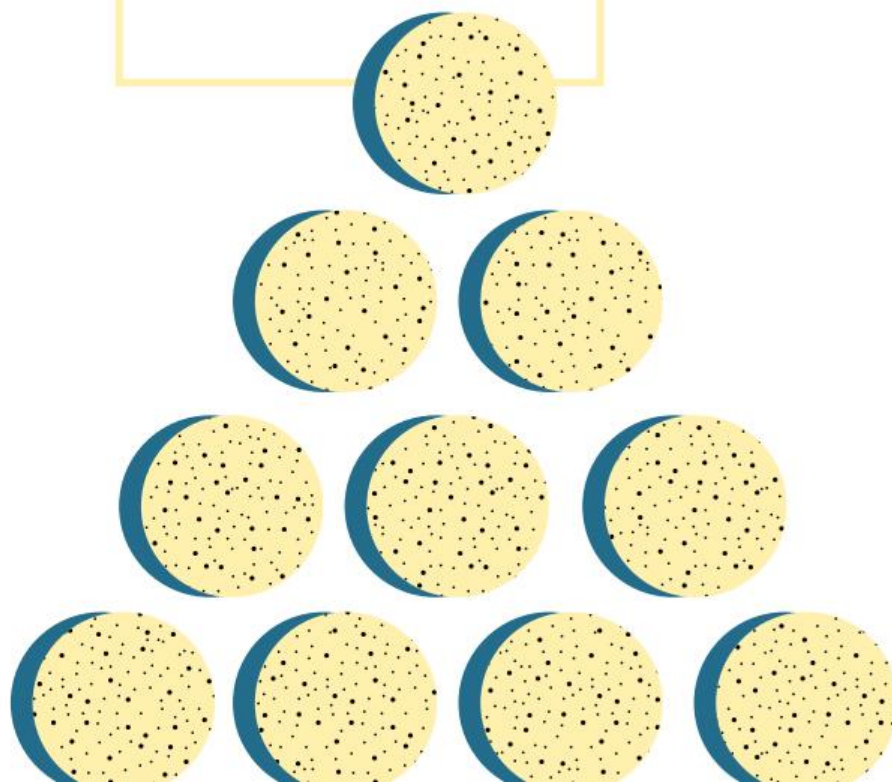
HOW DOES THE YUKON WORK?

The water chiller, depending on the cooling load request from the air-conditioning system, generates cold water.

It can operate in several ways. In the first operating mode, it rejects the heat into the ambient air.

A second operating mode is used when hot water is required. A three-way valve transfers the available heat to a water cylinder, and the mass flow of refrigerant bypasses the condenser/gas cooler.

A third option is to reheat the water in the cylinder. Here the CO₂ passes through both the heat recovery heat exchanger and the condenser/gas cooler. In this manner, it is possible to produce sanitary hot water almost for free.





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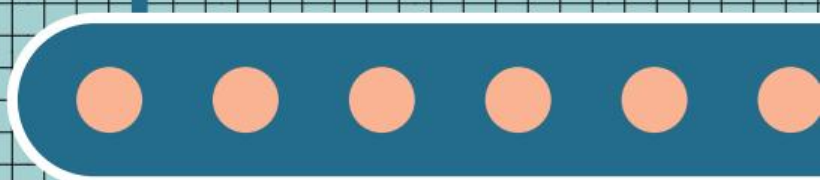
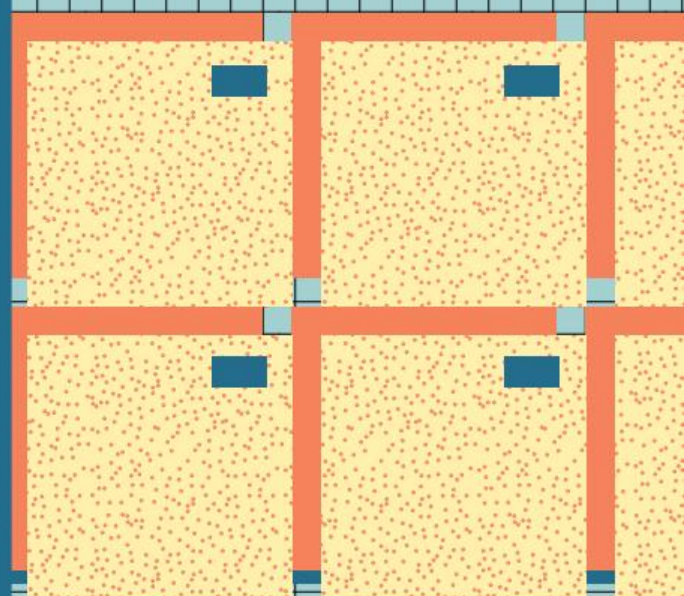
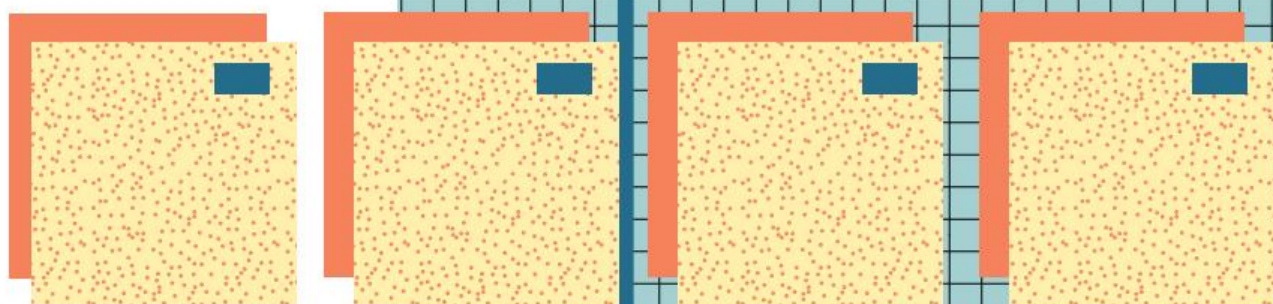
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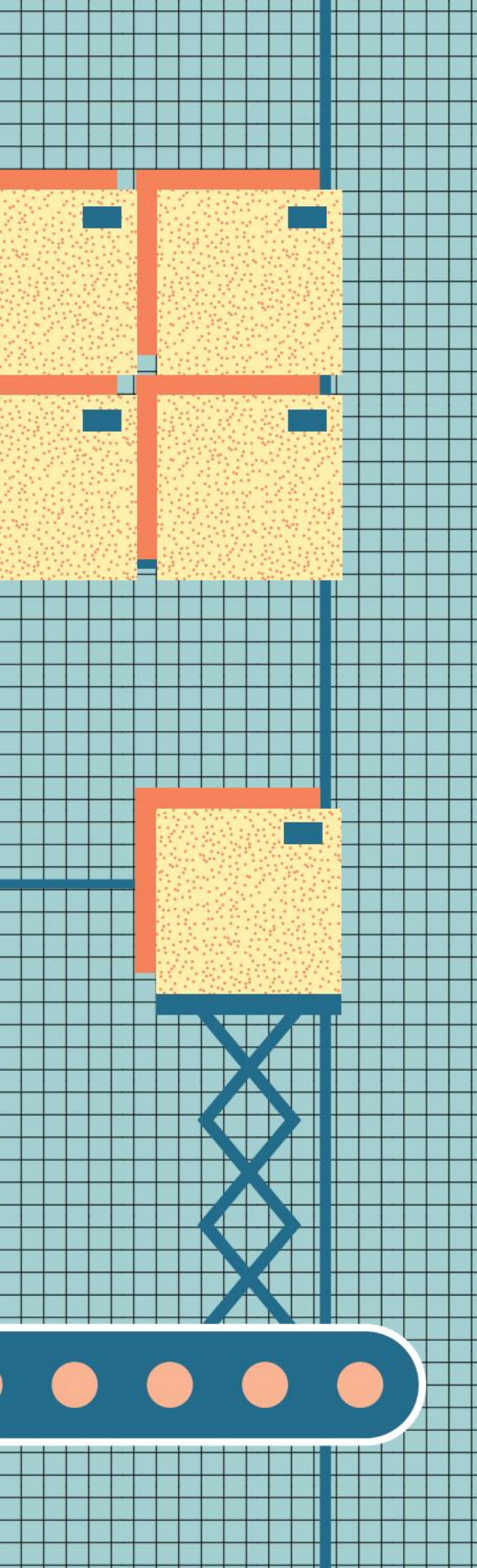


PROPANE AIR CONDITIONS METRO STORE

A METRO Cash and Carry store in Padova, Italy boasts a transcritical CO₂ system to cool the produce and propane chillers cooling the customers.

— By Charlotte McLaughlin





METRO AG – also known as the METRO Group – operates over 2,000 stores in 29 countries – including more than 700 METRO stores and 284 Real hypermarkets (2016 figures). In addition to METRO/MAKRO Cash and Carry stores and Real hypermarkets, its sales divisions include Media Markt and Saturn, its commercial electronics stores.

Germany's METRO AG, an international wholesaler with operations in Italy and across Europe, Asia and northern Africa, has long been committed to natural refrigerants through its F-Gas Exit Program.

A cornerstone of the firm's emissions reduction strategy, it will see METRO AG phase out f-gases by 2030, replacing them with natural refrigerants in all store locations worldwide – where it is technically feasible and economically reasonable to do so.

"We're on track in our programme. Every year we're executing it a little bit more," Olaf Schulze, director, energy management, METRO AG, told *Accelerate Italy*. "METRO's F-Gas Exit Program will phase out f-gases and replace them with natural refrigerants worldwide where technically and economically feasible."

The policy in Europe is to fit every new and remodelled METRO Cash and Carry store with a CO₂ transcritical system. "Country-by-country, we're changing stores – usually from R404A to CO₂ transcritical systems," says Schulze.

Some 140 METRO Cash and Carry stores already use CO₂. 60 of these are CO₂ transcritical (2017 figures). METRO AG has also opened a Cash and Carry store with a CO₂ transcritical system in China.

Though CO₂ transcritical systems are the retailer's primary means of meeting its f-gas commitments, METRO is also using other natural refrigerants like ammonia and hydrocarbons to meet its climate goals.

Natural refrigerants are doing just that in Italy, in a METRO Cash and Carry store in Padova. Opened in 1997, it was retrofitted in 2016 with natural refrigerant systems.

"The project developed in Padova is an important part of METRO's [F-Gas Exit] Program from HFCs to natural refrigerants," METRO Italia Cash and Carry's energy manager, Roberto Scarano, told *Accelerate Italy*.

The store uses a transcritical CO₂ system to cool all the store's display cabinets and other cooling units.

The Padova METRO Cash and Carry store opened in 1997. At the end of the existing equipment's life-cycle, METRO switched to a new transcritical CO₂ system in 2016. The store's net sales area is around 5,800m².

The transcritical CO₂ system cools all the store's display cabinets and cold storage facilities. "The cooling system is composed [of] two CO₂ racks: one [...] low and medium temperature with parallel compression and booster system. The other cooling [rack] [is set for] neutral temperature [also using] parallel compression," Scarano explains.

Air conditioning with propane

What makes this store so unique? Two propane chillers, from Italian manufacturer Euroklimat, serve two different purposes: first, providing "cooling power to [the] subcooling system after the [CO₂ transcritical] gas cooler," and second, air conditioning the store during the hot Italian summer, he says.

The propane chillers are part of an indirect system that provides the air conditioning and the subcooling. No refrigerant is circulated in the store.

"This solution increases the efficiency of the cooling system. We also optimise the equipment installed and the spaces used, because these chillers have a double function," he says.

Together the chillers provide a cooling capacity of 510 kW, according to Euroklimat's product developer, Giulia Fava, who spoke at ATMOSphere Europe in Berlin, Germany about the project in September 2017.

Steps must be taken to ensure that the chillers comply with local safety standards. "You need a provision from the fire department and you need to conduct an in-depth analysis" to install this type of equipment, Fava said.

The analysis recommended that METRO install a safety grid around the propane chillers in the Padova store, within which only authorised people can venture.

The chillers also have compressors and pressure switches that comply with the EU directive on controlling explosive equipment (known as ATEX), and a gas detector for leakage purposes.

The propane chillers translate into lower emissions and greater energy efficiency compared to an R410A chiller (see graphic below), according to Euroklimat.

Natural refrigerants like CO₂ and propane, with a global warming potential (GWP) of one and three respectively, offer significantly less CO₂-equivalent (CO₂e) emissions than other refrigerants, and the equipment has higher energy efficiency ratios (EER) compared to HFC equipment.

Taking as a benchmark the UK Institute of Refrigeration's (IOR) EU-wide estimated average leak rate of 3%, HFC-based equipment in the Padova store would release 4.2595 tons of CO₂e emissions. Propane chillers by contrast would only emit 0.0036 tons of CO₂e.

This translates into a direct saving, in terms of CO₂e emissions, of 99.9% per ton in the propane system.

"In the whole store in Padova, there are only natural refrigerants," says Scarano.

METRO Italia Cash and Carry will replace HFCs with CO₂ transcritical in one further store in 2018, bringing the total to seven at the end of the current fiscal year. ■ CM

	R290	VS	R410A
Cooling Capacity	255 kW		253 kW
Charge	10 kg x circuit		17 kg x circuit
EER	2.98		2.86
GWP	3		2088
Leakage rate: 3% 			
Direct CO₂ eq.	0.0036 ton.		4.2595 ton.
Direct Savings: 99.9% ton. CO₂ eq.			

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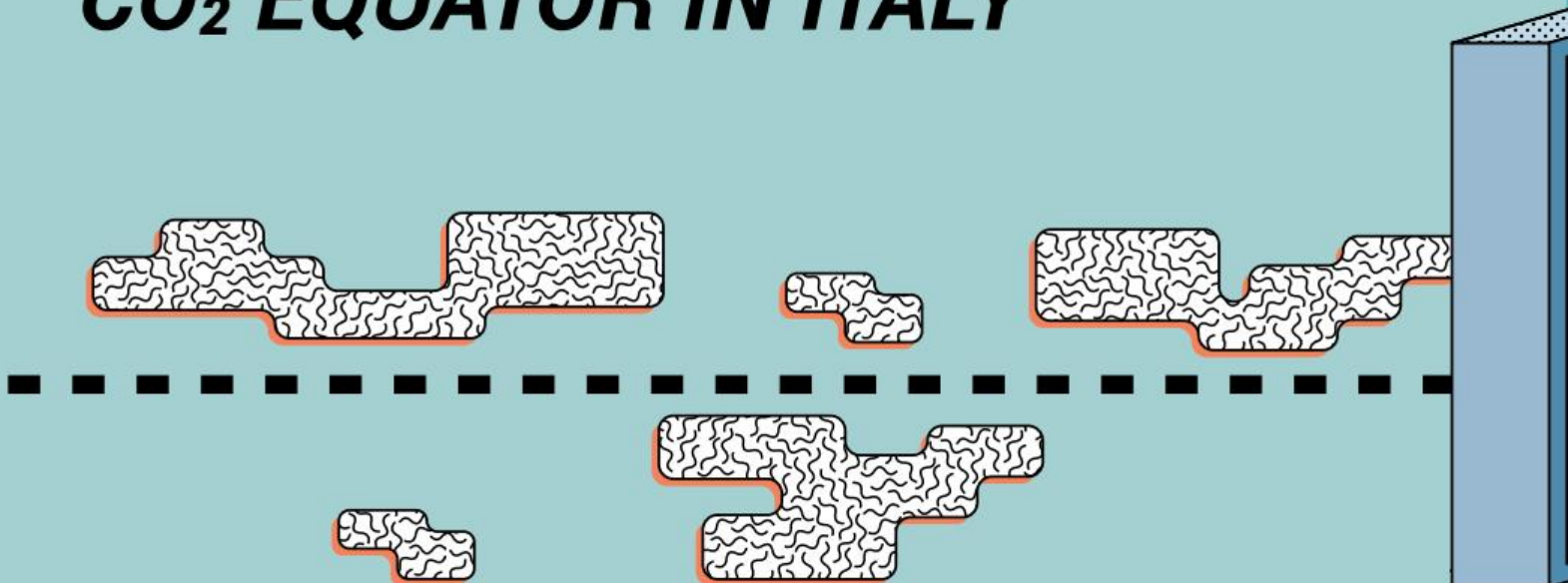
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CARREFOUR CROSSING CO₂ EQUATOR IN ITALY



In a demonstration of its continued commitment to natural refrigerants, supermarket giant Carrefour has joined over 90 other French companies in signing the 2018 French Business Climate Pledge, which sees signatories reaffirm their climate-change mitigation efforts for the next three years.

In total, signatories of the pledge represent six million jobs and some €1,500 billion of turnover or net banking income. The signatories have committed over €320 billion for the period 2016-2020.

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

Carrefour is taking action at two levels: the primary direct sources of CO₂ emissions (energy consumption and use of refrigerants), and indirect

sources – the carbon footprints of the goods that it sells and their transportation in particular.

Jean-Michel Fleury is director of international support at Carrefour, where he oversees innovation in energy efficiencies for all the group's entities around the world.

Carrefour has invested around €150 million in phasing down HFCs and replacing them with CO₂ systems since 2015. It has primarily been focusing on installing CO₂ systems in supermarkets and hypermarkets, but is also employing them in convenience stores, says Fleury.

BRINGING CO₂ TRANSCRITICAL TO TURIN

As part of this strategy, the retailer fitted its new hypermarket in the Italian town of Nichelino, near Turin, with a state-of-the-art CO₂ transcritical system with parallel compression, heat recovery for tap water and facility heating (400 kW), and liquid and gas ejectors.

Designed by Swiss refrigeration consulting and engineering company Frigo-Consulting, at the system's heart are two booster racks conceived to provide 360 kW of medium-temperature (MT) refrigeration at -2°C and 72 kW of low-temperature (LT) refrigeration at -26°C.

"With CO₂ technology there will be no impact by the F-Gas Regulation," says Dario Agostini, the project manager in charge of the Nichelino system at Frigo-Consulting. "The installation will probably have a longer life."

The racks supply a sales area of 7,500m² featuring 380m of cabinets and 570m² of refrigerated rooms.

"The gas and liquid ejectors, combined with the parallel compression, facilitate savings in energy consumption, because they are reducing the compressors' work and the throttling losses on the high-pressure valve," Agostini says.



To reduce refrigerant emissions, multinational supermarket giant Carrefour is phasing out HFCs and replacing them with CO₂ for commercial refrigeration. *Accelerate Italy* reports on a new hypermarket in Nichelino, near Turin.

– By Andrew Williams

The pressure difference between the high-pressure side and the liquid receiver allows the ejectors to convey liquid and vapour CO₂ to the receiver, without requiring any additional energy.

"Through liquid ejectors, it is possible to overflow the evaporators: the CO₂ in the liquid phase has a notably higher heat transfer capacity than it does during the gas phase," Agostini says.

Consequently, based on the evaporator's potential, the evaporation temperature could increase from -7°C to -2°C on the MT side and from -30°C to -26°C on the LT side. "This leads to further reductions in the compressors' work, and, ultimately, to an electrical energy consumption reduction," Agostini says.

In Nichelino, the average year-round ambient temperature is 12.8°C. Similar installations in place in nearby Switzerland have delivered electricity consumption savings of 25% compared to a traditional booster system with parallel compression.

"Don't forget the huge environmental benefits," says Agostini. The system reduces the store's carbon footprint by reducing both direct and indirect emissions – achieving the former by switching from R404A (whose GWP is 3,922) and R134a (GWP: 1,430) to CO₂ (GWP: 1), and the latter thanks to "the advanced refrigeration and the reduced energy heating request".

CARREFOUR COMMITTED TO NATREFS

In the context of the HFC phase-down taking place under the EU's F-Gas Regulation, some end users are opting for HFOs, another synthetic option. But Fleury affirms Carrefour's commitment to natural refrigerants.

"Carrefour has a very cautious policy regarding the use of HFOs," he says, citing uncertainty surrounding their impact on public health and noting that the ingredients used in HFOs "take centuries to degrade".

Fleury acknowledges that HFOs have a low GWP, but says Carrefour's position is that natural refrigerants provide a better solution, even if converting to the technology requires a refrigeration system retrofit.

To increase the efficiency of transcritical CO₂ installations in warmer climates such as Spain and Italy, Carrefour has deployed auxiliary technologies including adiabatic gas coolers, parallel compressors and ejectors. By using transcritical CO₂ systems instead of conventional HFC options, Carrefour achieves energy savings of 8-12% in warmer regions such as southern Spain, and savings of 18-20% in areas with more temperate climates such as Brussels or Paris.

In October 2017, the Nichelino hypermarket received an award for the 'most sustainable shopping centre', within the framework of the international SBChallenge, organised by CommonEnergy, an EU-funded research project. ■ AW



The restless innovator

Since designing the first CO₂ transcritical supermarket in 1997, Sergio Girotto has continued to push the boundaries of what CO₂ as a natural refrigerant can achieve. *Accelerate Italy* spoke to the Enex founder and president about what's next.

— By Andrew Williams

Sergio Girotto is a man who gets things done. He installed the world's first CO₂ transcritical system to be used in a supermarket, back in 1999.

"For a long time, I've been asking myself why I like thermodynamics so much. I settled on an answer only recently," Girotto says. "Thermodynamic is elegant."

LEARNING FROM THE MASTER

A pioneer of CO₂, Girotto has enjoyed a long career in the HVAC&R business. He has produced with his company, Enex, over 1,000 CO₂ transcritical systems.

Girotto traces his interest in CO₂ technology back to 1996, when he asked Italian manufacturer Dorin to produce a CO₂ compressor.

"In 1997, I saw the first transcritical CO₂ compressor running. It was the most exciting moment," he says.

Girotto is justifiably proud to have played a pioneering role in bringing to market CO₂ transcritical refrigeration systems. What inspired him to devote so much of his career to this technology?

"The most influential person I have met — even in largely indirect terms — was Professor Gustav Lorentzen," Girotto says. "I only met him once, but I've read all his late papers. He was a man with a vision."

After obtaining his degree in mechanical engineering, Girotto has worked for some 20 years for companies in the refrigeration sector, in roles including R&D, design, production, and after-sales service.

In 1997 and 1998, Girotto installed subcritical CO₂ cascade systems in supermarkets in Italy (Conegliano, Treviso) and the UK (Harlesden, London). By 1999, his focus had turned to 100% CO₂, when he designed the first-ever CO₂ transcritical system (fitted in a small supermarket without a compressor rack).

In 2001, Girotto installed the first-ever CO₂ transcritical system in a large supermarket. He was invited to Washington, D.C. to present a paper on the installation at the International Institute of Refrigeration Congress in 2003.

It took dedication to put together all the pieces of the puzzle and bring the technology to market. Not everyone was convinced that the market potential justified the investment.

"It wasn't easy to bring all the companies into the loop," Girotto admits. Yet he was willing to persevere. "The fact is we were creating the future. Decisions could not be based on the past. It's as simple as that."

He founded Enex in 2004. "I decided to follow my own way with my company, to be able to develop and build what I believe is the future without depending on other people's decisions."

The company installed its first CO₂ transcritical system in 2006.

Girotto has patented a number of products and system designs. Among his personal favourites is a liquid ejector for overfeeding evaporators, the potential of which he believes is yet to be fully exploited. "It could be the Columbus' Egg for further simplifying refrigeration systems," he argues.

A new method for efficiently chilling water with CO₂ also ranks highly among his favourite inventions.

What drives him to push back the boundaries of what natural refrigerants can achieve?

"I'm simply following my ideas," Girotto says. He sees two ways to rid the world of harmful refrigerants. The first is to identify and design HVAC&R systems around natural refrigerants instead, and the second is to harness chemistry to create new refrigerants.

“For a long time, I’ve been asking myself why I like thermodynamics so much. I settled on an answer only recently. Thermodynamic is elegant.”

“The problem with the second approach is that there are no new refrigerants to be developed, as all the combinations of the few elements which form a synthetic refrigerant have been exploited. Moreover it has been proven that sooner or later every synthetic substance used as a refrigerant turned out to have some kind of drawback,” says Girotto. “So why take the second path?”

MADE IN ITALY

In his native Italy, Girotto assesses the market prospects for natural refrigerants as “extremely favourable”.

If anything, Girotto argues, the move away from HFCs to natural refrigerants may be happening too quickly for manufacturers, technicians and installers to satisfy the demand.

“The risk is mistakes – that people who aren’t properly trained will start using the technology, and also bad efficiency, poor performance, low reliability,” he warns.

Girotto believes pressure from end users and the rush to enter the market can be bad in terms of efficiency and product quality.

“The big risk I see is people starting immediately to compete on price, removing what appears redundant but actually is not,” he says.

Training a new generation of technicians and installers is vital. Girotto is confident that industry will step up to the plate. Enx trains its own customers on using CO₂, offering theoretical training at its office in Paese (near the north-eastern city of Treviso), and practical training on site.

Why does Girotto think so many Italian HVAC&R companies are concentrated in the north of the country along the Turin-Milan-Venice corridor?

“There are certainly historical reasons. New companies were born when employees of ‘old’ companies started their own businesses, in the 1980s and 1990s,” he says.

Girotto believes many of these firms are simply responding to increased market demand for natural refrigerant-based solutions. “All the companies are moving into natural refrigerants – especially CO₂ and propane,” he says.

“These companies in northern Italy are following the trend, because there is the demand. It’s not about the environmental aspect, because they’re still producing equipment for HFCs, HFOs and HCFCs,” he argues.

“It’s about the market opportunities,” he says.

Enx is different. Since Girotto founded the company in 2004, it has focused solely on CO₂. Is he confident that the decision to invest in CO₂ at the beginning was the right one?

“Yes. I’m more and more convinced that the choice was correct.”

THE FUTURE OF NATURAL REFRIGERANTS

As natural refrigerant technologies continue to develop, Girotto sees CO₂, hydrocarbons and ammonia becoming increasingly competitive with one another in a wider range of applications.

“There is an overlap, in the sense that in the past, the idea was: ammonia for large systems, propane for small and medium chillers, and CO₂ for commercial refrigeration. Now, it has been demonstrated that CO₂ can be used up to 1 MW, and that it can be used efficiently in water and brine chillers,” he says.

“It is clearly taking over part of the market from ammonia and hydrocarbons.”

Tapping into the heat pump sector, he believes, may take more time. “The heat pump market is dominated at the moment by conventional heat pumps. It is difficult for CO₂ heat pumps to compete, because the key argument is price,” Girotto says.



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"There is only one heat pump application for which CO₂ is at an advantage – hot water," he argues.

EU countries have, since 2015, actively been phasing-down HFCs under the European Union's new F-Gas Regulation. 2018 will mark the sharpest drop yet in the EU's overall allocated HFC quota.

Arno Kaschl from the European Commission told *Accelerate Italy* that the intention of the F-Gas Regulation is to foster innovation using a market mechanism of increasing the scarcity of HFC supply.

"The steepest step in the EU phasedown is between 2017 and 2018, when the overall allocated quota goes down from 93% of the original baseline to only 63%," Kaschl said.

"Just a year ago, conditions in the sector appeared fairly relaxed. Gas prices were low, and relevant actors had prepared for any shortages and built up their supplies," said Kaschl. "Things have now changed: the policy signal is there and it is time to respond."

Giroto, for his part, argues that the EU's HFC phase-down policy is already having an impact on the ground. "Until 2017, the general attitude was, 'we'll see, we have time'. Now, end users are becoming aware of the huge risk of using fluids for which there is no future certainty," he argues.

"They're experiencing what 'lack of availability' and 'huge price rises' really means," he says.

As the price of HFC refrigerants increases, "everyone's jumping into the CO₂ business and looking at the lowest price, without having the experience of hundreds of installations," he says.

With the EU F-Gas Regulation in place, what market share does he estimate that natural refrigerants will have in Europe by 2022? "More than 50%," he says. "Probably much more."

As HCFCs and now HFCs are phased down around the world, chemical companies are pushing a new generation of synthetic refrigerants known as hydrofluoroolefins (HFOs).

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

"In 1997, I saw the first transcritical CO₂ compressor running. It was the most exciting moment."

Speaking at the 29th Meeting to the Parties to the Montreal Protocol (MOP29) in Montreal, Canada in November 2017, Philip Owen from the European Commission – the EU's executive arm – said, "the Ozone Research Managers' conclusion that the formation of toxic TFA, as well as tropospheric ozone, results from the degradation of HFOs is a concern which requires further research and evaluation".

"Nobody should invest in systems based on uncertain solutions," Giroto says.

For Enex, the uncertainty surrounding HFOs only serves to confirm that the decision to focus on natural refrigerant CO₂ was the right one.

"There are some studies about HFOs dissolving into TFAs," he says. "But legislation does not consider this. I see the risk that in three, four, five years' time, we'll face another problem – starting with another story about the limitations of HFOs."

How optimistic is Giroto about the future for CO₂?

"In some places like Denmark and the UK, the market has grown very quickly," he says. "But I can't say that the overall development has been as quick as I expected – in many countries the market has developed very slowly."

"As for the Italian market, that's special," Giroto says. He characterises the HVAC&R market in his home country as being dominated by big incumbent players that have held back uptake of CO₂ technology because they themselves were not ready to develop it.

"Now the market is open. The market in Italy is growing," he says. ■ AW



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Rolling out the red carpet for CO₂

To mark Italian compressor manufacturer Dorin's centenary year, Mario Dorin, who has held just about every position in the company in his long career there, tells *Accelerate Italy* why the future is bright for natural refrigerants.

– By Andrew Williams



With the global HFC phase-down mandated by the Kigali Amendment to the Montreal Protocol giving end users and manufacturers of HVAC&R technologies alike an extra incentive to chart a more environmentally friendly course, *Officine Mario Dorin* – a leading global manufacturer of compressors – is confident that the stage is set for natural refrigerants to grow exponentially.

“The modern HVAC&R sector is very much influenced by new regulation on acceptable gases. Nowadays, the EU F-Gas Regulation and similar regulations around the world are giving a great push towards the total transformation of the sector,” Mario Dorin, grandson of the first Mario Dorin – who founded the company in 1918 – told *Accelerate Italy*.

Founded as a manufacturer of machine tools and air compressors and repairer of motor vehicle engines, *Officine Mario Dorin* began producing open-type compressors for refrigeration systems in 1932. They soon became the company's core business.

In 1952, thanks to the mechanical intuition of founder Mario and his son Giovanni, Dorin began making semi-hermetic reciprocating compressors for air conditioning and refrigeration.

“The opportunity is just outside the window. Dorin is seizing it with both hands!,,

Since those early days, the founder's children and grandchildren have worked hard to continue their forefather's legacy, positioning Dorin as a provider of future-proof technology solutions. Today, the company produces over 50,000 piston compressors every year.

“The real challenge triggered by the HFC phasedown relates to the type of gas that will replace them,” Dorin says. “This is causing turbulence in the HVAC&R sector, for manufacturers and end users alike.”

A natural future

“The real alternatives are natural refrigerants, in all their forms (CO₂, ammonia/NH₃, hydrocarbons and maybe one day H₂O too),” Dorin argues. “The innovative technology present today and the trend in new technological solutions are clearly rolling out the red carpet for developing these refrigerants in the next ten years,” he says.

“The opportunity is just outside the window. Dorin is seizing it with both hands!”

With natural refrigerants becoming increasingly mainstream options to help European industry to comply with the HFC phase-down taking place under the EU's F-Gas Regulation, it is imperative for installers to be comfortable with the technology and for suppliers to be supportive.

Dorin already boasts over 35,000 CO₂ compressors in operation worldwide (2016 figures). As these numbers grow, the company recognises the crucial importance of familiarising HVAC&R professionals with this refrigerant.

“Sustainable refrigeration – meaning environmentally sound refrigeration – is an excellent challenge as well as an exciting opportunity,” Mario says.

“The real challenge is definitely the professional training of the technicians that have to manufacture and service the CO₂ systems,” Dorin says.

With this in mind, Dorin offers its partners and customers free training. “Our professional engineers also participate globally at tradeshow and conventions to clear the correct use of CO₂ compressors,” Mario says.

To accommodate ever-increasing production, *Officine Mario Dorin* moved to its present 20,000m² facility in Compiobbi, on the outskirts of Florence, in 1970.

Amid competition from other natural refrigerants, Dorin is confident that CO₂ is well placed to seize the initiative. “Current technology trends are giving a great push to the use of CO₂ as a refrigerant,” Mario says.

He argues that CO₂ performs better than ammonia in many applications and conditions. “It's interesting for all large systems – where hydrocarbons are not useable and where NH₃ sometimes can't be used for safety reasons.”

An industrial surge

“Commercial refrigeration is well-known to be on the road to CO₂,” Mario says. He is confident that CO₂ can dominate the industrial sector too. “Industrial refrigeration, which used to solely focus on ammonia, is now diverting its interest to CO₂,” he argues.

It is this trend that motivated Dorin to design its wide range of CD500 and CD600 CO₂ compressors for industrial applications. “For years, distribution and warehousing have been looking at CO₂ refrigerant as the sole and most viable alternative to HFC refrigerants in large systems,” Mario argues.

Heat pumps offer another avenue for pushing wider uptake of natural refrigerants. “For a few months, we've been studying dedicated CO₂ compressors specifically designed for use in heat pump systems,” Mario says.

As fossil-fuel prices continue to rise, the company expects more customers to consider heat pumps as competitive HVAC&R solutions. “Dorin is here, ready to support them with the CO₂ compressors they need,” Mario says.

Is Dorin proud of its Italian heritage? And are its Italian origins an important part of the brand? “Absolutely, yes – on both counts! Italy has a long and very important tradition in HVAC&R,” Mario says.

“Italy is also very sensitive to environmental issues.” ■ AW

A DIFFICULT PAST,



A BRIGHT FUTURE

Rewind to the 1970s, and training on natural refrigerant-based HVAC&R systems was difficult to come by. Today, several Italian institutes and manufacturers are working hard to train a new generation of installers, contractors and technicians in using these climate-friendly technologies.

— By Charlotte McLaughlin

In the 1970s, HVAC&R training in Italy was primarily provided by manufacturers and vendors of the equipment themselves.

"These training courses were [tailored] to [companies'] products, for example specific tools for vacuum, charge and recovery of the system, or for installing and repairing a particular refrigeration unit," Marco Buoni, technical director of Italian HVAC&R research and training institute *Centro Studi Galileo*, told *Accelerate Italy*.

The situation began to change in the late 1970s, when key Italian stakeholders began to turn their attention to training. "A small number of secondary schools then started vocational training for marine applications in refrigeration, due to the importance of this sector for the coastal and fisheries economy," says Buoni, secretary-general of Italian HVAC&R industry group *Associazione Tecnici del Freddo* (ATF), and vice-president of AREA, the European Association of Refrigeration, Air Conditioning and Heat Pump Contractors.

"A few years later, this was extended to agricultural and meat applications, which in those years were also increasing exponentially in Italy due to demographic growth," Buoni adds.

In 1975, Italy's first independent training school – *Centro Studi Galileo* (CSG) – launched in Casale Monferrato, "a small town which was already considered the Italian capital of refrigeration," according to Buoni.

Today, CSG now offers theoretical and practical training to turn Italian HVAC&R technicians into what Buoni describes as "super-technicians".

"We offer many different types of training: for beginners (starting from physics, legislation and basic refrigeration topics), for industrial/commercial refrigeration, for maintenance/installation, for natural refrigerants, and so on," he says.

The institute is also active beyond its Italian home. "We conduct many sessions all over Europe and now also in Africa and South America. In March, we will start our first group of sessions and seminars in China, too!" Buoni says.

The training courses are structured as a blend of practical and theoretical experiences. "We believe that discussion, Q&A sessions, practical demonstrations, visits to plants and site visits are just some of the ingredients of a perfect training course to raise competence," he explains.

CSG stresses the essential importance of interaction between trainer and student, but also offers e-learning courses to help maximise its reach.

"CSG now boasts 300 training sessions and upskills 3,000 technicians per year in Italy. It also provides 50 sessions worldwide and is considered a 'global training provider'," Buoni says.

F-gas training certification is mandatory across Europe and has played a key role in changing Italy's HVAC&R landscape. Arriving there in 2011, it pushed hundreds of training schools to open across the country but with "uncertain results," according to Buoni.

CSG itself organises f-gas training and certification across Italy once a month, "both for beginners and for renewals, which are also very important for technicians to maintain the correct level of competence due to fast technological changes," he says.

Buoni adds: "The majority of training sessions organised and carried out in Italy are still about HFCs: mostly because technicians are legally obliged to obtain the f-gas certification if they want to purchase or handle these gases, and because most existing equipment is still operating using them."

Natural refrigerant training is becoming more popular as the number of installations mounts. In Italy, much of this training is provided by CSG and ATF.

"We support the use of a robust qualification for technicians who handle these refrigerants because to best support and develop the sector, all components must combine correctly in order to achieve our ultimate goal of providing refrigeration safely," Buoni explains.

The '*GUIDE Training 2017*' report, produced by *Accelerate* publisher shecco, revealed that Europe boasts nearly 200 companies providing some form of natural refrigerant training, 11 of which are based in Italy.

Beyond CSG and ATF, most of the other training in Italy is provided by system manufacturers such as Epta, which is "providing CO₂ training in commercial and domestic refrigeration areas to qualify internal staff," according to *GUIDE Training*.

De Longhi, a manufacturer of propane-based air conditioners, is providing practical training on installations to customers, while system manufacturer SCM Frigo runs CO₂ courses. Euroklimat offers hydrocarbons training for its customers.

Italian consultancy Mbassi #224 works with *Centro Studi Galileo* and provides both practical and theoretical training on hydrocarbons and CO₂, and the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) offers in-person and web-based ammonia and CO₂ training.

As for *Centro Studi Galileo*, it reports an exponential rise in demand for courses on natural refrigerants CO₂ and hydrocarbons. Of the two, most requests currently concern propane (R290) and isobutane (R600a). As CO₂ becomes increasingly popular, Buoni expects demand for training on this natural refrigerant to grow quickly too.

CSG also plays a risk assessment role when technicians install equipment or work with flammable refrigerants like hydrocarbons. Familiarity with the design of new products is very important for training within Italy, according to Buoni.

"[CSG has] test rigs specifically designed for all refrigerants where technicians can experience running and installing a



ABOVE
Chinese delegation of
university professors
attends *Centro Studi
Galileo* training course.

refrigeration system, using the new natural refrigerants in a safe environment," he says.

"Currently I would say there is a major need for training on design within the industry, and following that I would probably say installation and maintenance training, due to the adaptation and transitional phase from equipment and machinery that worked with HFCs and now must be redesigned to suit alternative refrigerants," he explains.

"Air conditioning is still an uncertain ground where ammonia will have an important role to play, but the distribution throughout the building will be done with a secondary loop system such as water," he argues.

Buoni sees a bright future for natural refrigerants. "Now in 2018, the sector has returned to its origins, where only high quality and qualified schools are delivering valuable training on all types of refrigerant, including CO₂, hydrocarbons and ammonia: matching future technicians' requirements for handling flammable and new refrigerants," he says. ■ CM

New horizons

The European Association of Refrigeration, Air Conditioning and Heat Pump Contractors (AREA), where Buoni is vice-president (international affairs), offers technicians guidance and online training under the EU-funded project 'REAL Alternatives for LIFE'.

"We are promoting the broader usage of natural refrigerants, a mission which is also shared by each of the individual training partners of the project. Just to mention the latest developments, we are about to launch Real Alternatives in Tunisia and Ivory Coast, and have already done so in China, Argentina and the Caribbean islands in the last few months," Buoni says.

REAL Alternatives, in which *Centro Studi Galileo* is a partner, will also carry out in-person 'train the trainer' events across Europe.

In 2017, CSG trained a delegation of 18 university professors and two senior government officials from the People's Republic of China on using eco-friendly refrigerants (24-29 July).

The main focus of the course was safety issues related to using hydrocarbons and ammonia. Delegates also looked at cascade systems working with carbon dioxide.

Companies working in the HVAC&R sector in Italy provided much of the training at CSG. SandenVendo – the vending arm of Sanden, the European HQ of which is in Italy – provided training on working with CO₂. CAREL contributed too, with a fully equipped laboratory on CO₂ near Padova.

Italian compressor manufacturer Dorin, meanwhile, covered compressors, cascade systems and innovative software utilising CO₂ technology, while fellow Italian firm Castel explored the workings of hydrocarbons in HVAC&R systems.

The training was part-funded by the EU's 'REAL Alternatives for LIFE' project that provides online training on low-GWP refrigerants throughout the European Union. Recently it decided to move into live training.

The Chinese delegation also visited Italian firm Epta-IARP. Participants received a certificate for the training received.

Centro Studi Galileo was asked by the UN to provide the training. CSG has provided refrigeration and air-conditioning training to more than 70 nations throughout the world.

Recently, training has taken place in Sri Lanka, Thailand, Ethiopia, Eritrea, Rwanda, Benin, Tunisia, The Gambia, Montenegro, Bosnia Herzegovina, Turkey, Belarus, Ukraine, Uzbekistan, Tajikistan, Ghana, Colombia, the United States of America, Nigeria, Saudi Arabia, Jordan, Bahrain, the United Arab Emirates, India and the Caribbean.

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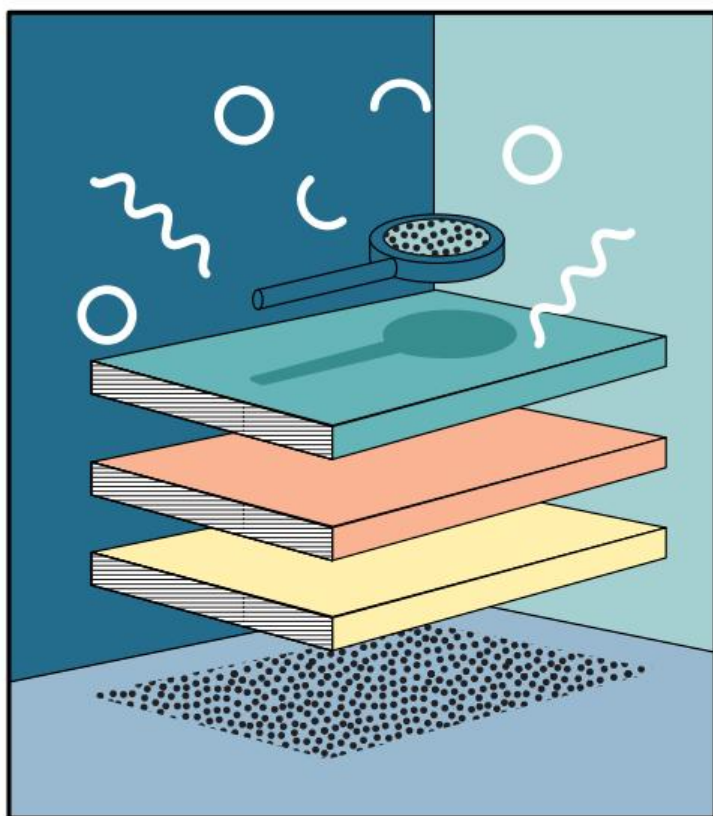
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UNDER THE MAGNIFYING GLASS

ITALY'S REGULATORY LANDSCAPE



Having entered into force on 1 January 2015, the European Union's new F-Gas Regulation – which Italy is yet to transpose into national law – aims to reduce Europe's HFC use by 79% by 2030 (compared to average levels in the period 2009-2012). To help deliver this target, it is progressively banning the use of certain HFCs in different types of new equipment.

Producers and importers of f-gases are allocated annual quotas that allow them to place a certain amount of HFCs on the market.

Companies supplying f-gases and f gas-based equipment, "are distributed across all EU member states but concentrated in Italy, Germany, France, the United Kingdom, Poland and Spain," according to a 2017 European Environment Agency (EEA) report. The largest number of equipment manufacturers hails from Italy.

The EU F-Gas Regulation heralds key HFC phase-down steps and upcoming refrigerant bans to which Italy must adhere. Yet a number of national decrees continue to act as a barrier to wider adoption of natural refrigerants in the southern European country.

– By Charlotte McLaughlin,
Klára Skačánová & Marie Battesti

PHASING DOWN HFCs

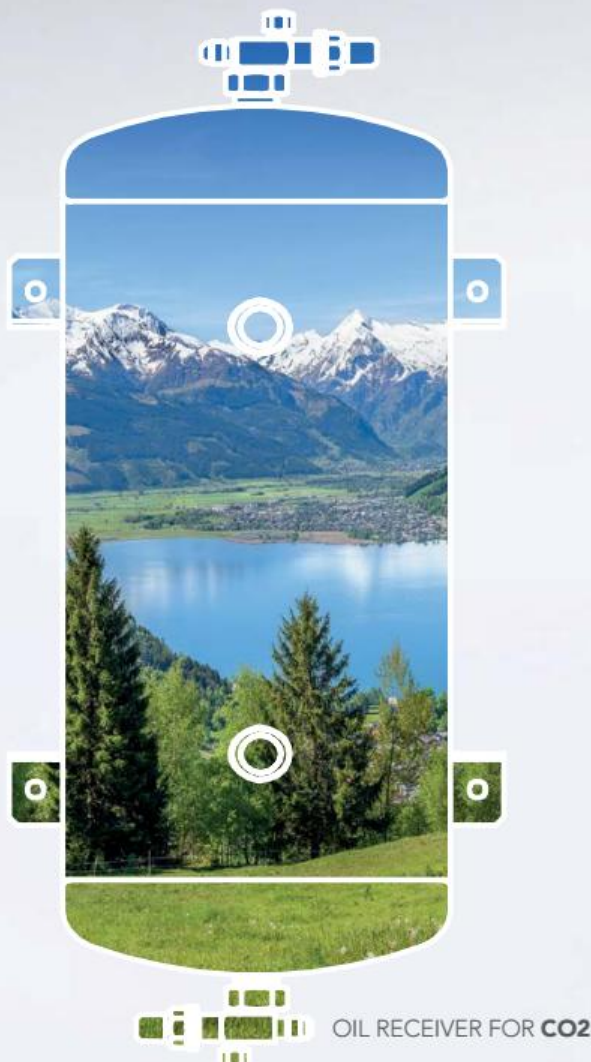
Italy does not supply any refrigerant gases but is a key exporter of equipment containing HFCs. Italian companies will therefore need to change many of the refrigerant gases inside their equipment.

The Italian government has yet to introduce national implementing regulations determining precisely how it will implement the new EU F-Gas Regulation. Italy had previously been threatened with legal action over its failure to implement the 2006 F-Gas Regulation.

The new European Union HFC quotas – applicable as of 1 January 2018 – and the inclusion of HFCs in pre-charged equipment in the quota system as of 2017 together represent an estimated 44% reduction of permitted HFC use in the past two years.

The European HVAC&R industry has faced record HFC price rises since summer 2017, in anticipation of the 2018 HFC quotas. These price hikes are expected to further accelerate the uptake of natural refrigerant-based equipment.

Bans on using certain HFCs above a specific global warming potential (GWP) can also play a central role in delivering the objectives of the EU F-Gas Regulation.



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The Regulation will abolish the use of very high-GWP gases (GWP above 2,500) not just in new equipment but also in existing installations. From 2020, it will be forbidden to service existing refrigeration equipment with HFCs that have a GWP of 2,500 or above, unless these refrigerants are recycled or reclaimed. Such HFCs could still be used until January 2030 in existing equipment.

Bans on HFCs in air conditioning will not come into force until 2020 for moveable/portable air conditioners and 2025 for split air conditioners. There are no bans for larger air-conditioning equipment, such as chillers and larger split systems, or for heat pumps.

MAJOR BARRIERS TO HYDROCARBONS UPTAKE

To meet the HFC phase-down targets enshrined in the EU F-Gas Regulation, manufacturers of HVAC&R equipment – including those based in Italy – will need to invest in technologies based on alternative refrigerants. Yet the technology is not all that needs updating. In Italy, a number of Ministerial Decrees affecting various public access buildings restrict the use of flammable refrigerants (A2L and A3), such as hydrocarbons in air-conditioning equipment.

A European Commission report on barriers posed by codes, standards and legislation to using climate-friendly technologies in the refrigeration, air conditioning, heat pump and foam sectors – published in December 2016 – identified Italy among the EU countries that still had restrictive national standards for flammable refrigerants in place.

The report showed that local building codes and fire regulations, as well as transport and storage-related codes in Italy (alongside France and Spain), “severely restrict” the use of flammable refrigerants.

In view of the EU F-Gas Regulation, the Italian Ministry of the Environment, Land and Sea is currently working in partnership with the Italian Institute for Environmental Protection and Research (ISPRA) on a study to find feasible alternatives to HFCs.

Two years on from the publication of the European Commission’s report, Italy still has these Ministerial Decrees on the books. Each type of building (hotels, malls, buildings for public shows, schools, hospitals, offices, kindergartens, airports and freight) where restrictions apply is covered in separate Decrees. The rules specifically affect air conditioning. They do not apply to refrigeration or heating-only heat pumps.

The Decrees are all similar in nature, and contain similar clauses that affect air-conditioning systems used in the types of building defined in each decree. The requirements specify that refrigerants used for air conditioning must be non-flammable and non-toxic. The use of hydrocarbons or other flammable refrigerants (unsaturated HFCs or HFC-32) is therefore not permitted under current legislation.

The Italian Ministry of the Interior, which is responsible for these decrees, will have to consider making a formal review soon to change these rules. Allowing the use of low-GWP flammable alternatives is essential if industry is to meet the objectives of the F-Gas Regulation. Increasing HFC prices will gradually impose a bigger economic burden on manufacturers and end users, giving them an incentive to invest in alternative technologies.

At EU level, the EN 378 and EN 60335-2-40 standards allow the use of hydrocarbons in chillers and air conditioners but restrict the maximum permitted charges.

The international standard IEC 60335-2-40 for heat pumps and air conditioners is currently under review to increase the allowable charge size for A2 and A3 refrigerants by using mitigation measures such as improved system tightness, minimum airflow and the determination of the maximum releasable charge. The IEC proposal for A3 refrigerants is currently in committee draft stage and the timeline for progressing remains unclear. Experts involved in the revision process estimate that a revised standard could be published in the 2019-2022 timeframe.

Any revision of international standards can be expected to influence Italy’s own regulatory landscape. ■ CM, KS & MB

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

Domestic refrigeration



Movable room AC



Stationary refrigeration (except < -50°C)



Hermetically sealed commercial refrigeration



Centralised commercial refrigeration (≥40kW), except in the primary refrigerant circuit of cascade systems where f-gases with a GWP<1,500 may be used



Single split AC (< 3kg of f-gases)



shecco 

Source: 'F-Gas Regulation Shaking Up the HVAC&R Industry', shecco

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ITALY LENDS A HELPING HAND

A new report sees the government of Italy team up with UNIDO to help African countries identify priority areas for the successful implementation of the HFC phasedown.

– By Charlotte McLaughlin

African policymakers will need help constructing the regulatory framework necessary for implementing the Kigali Amendment to the Montreal Protocol, support in adopting low-GWP substances and technologies, and help from the Multilateral Fund (a Montreal Protocol fund for installations that harness sustainable refrigeration and air-conditioning technologies), argues a report on *'Africa and the Kigali Amendment'*, published late last year.

The report was produced by the United Nations Industrial Development Organization (UNIDO) with the support of the government of Italy, as a way to help African countries phase down HFCs under Kigali.

"The scope of the present work is to hear the voices of African countries, and to identify their specific needs, concerns and challenges in effectively implementing the Kigali Amendment," wrote Francesco La Camera, director-general for sustainable development, energy and climate at the Italian Ministry of Environment, Land & Sea, in the report.

African countries are in the developing-country (Article 5) pathway of the Kigali Amendment, which aims to phase down HFCs, and will only start phasing down HFCs by 10% in 2029, while developed (non-Article 5) countries like Australia, the USA and EU member states will start in 2019.

"As a consequence, product strategies adopted by major RAC exporters – in China, Japan, Europe or the USA – have a decisive impact on the adoption of low-GWP technologies," the report notes.

Natural-refrigerant expert Nina Masson, the report's lead author, said there is an infrastructure of RAC associations and training institutes in most African countries, describing it as a "stable basis for raising the skills level of the RAC sector and policymakers".

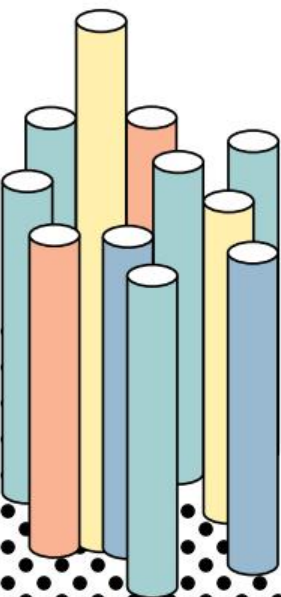
The Italian Ministry of the Environment has transferred additional money to the Multilateral Fund to help aid projects, according to La Camera.

"It's very obvious we have a lot of alternatives," notes Juliet Kabera of the Rwanda Environment Management Authority in the report. "The use of carbon dioxide should be really common compared to what it is right now. In my country, we have it as a byproduct from one big project of extracting methane gas and I was wondering why we have to always import instead of using what we already have."

Countries should therefore not only start exploring existing sources of propane, CO₂ or ammonia as byproducts from industrial processes to refine them as high-purity natural refrigerants, but should also build a regional supply chain for sustainable refrigerants. A plant in Nigeria is about to start producing propane refrigerant, to reduce dependency on hydrocarbon imports from Europe or China.

It is easier to switch to some technologies than others. "Converting domestic refrigeration to low-GWP (mostly hydrocarbon R600a) will be rather easy," says Masson.

"Trends indicate that by 2020 around 75% of the domestic refrigerators on the global market will be equipped with R600a," the report notes. ■ CM



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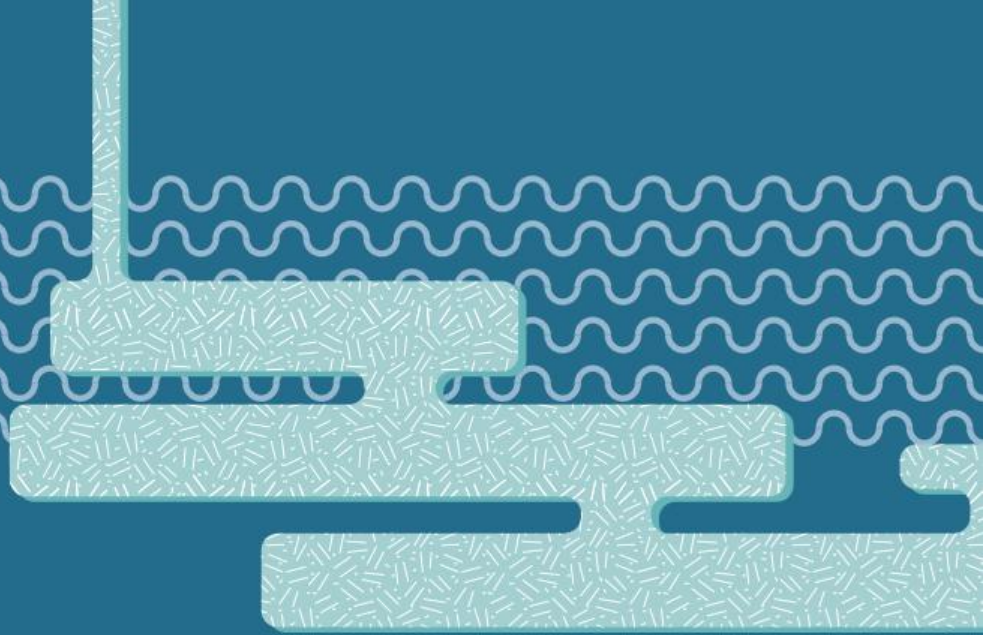
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FROM COOLING YOUR FOOD TO COOLING YOUR OFFICE

While refrigeration continues to make big strides towards natural refrigerants, air conditioning is still lagging behind. *Accelerate Italy* reports.

– By Charlotte McLaughlin

Around the world, every segment of the HVAC&R market – from commercial and residential to industrial – is taking the natural refrigerant plunge. Yet progress is faster in some sectors – and in some geographies – than in others.

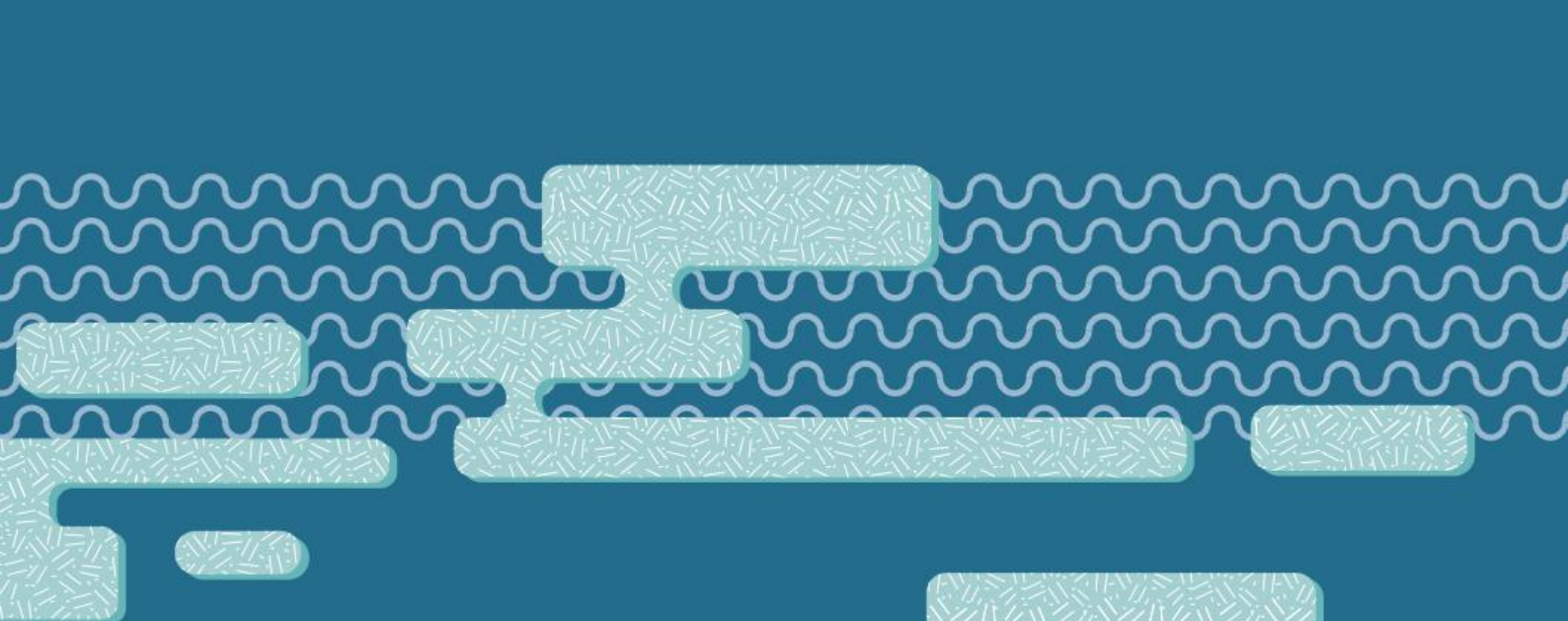
A report produced by the Replenishment Task Force of the Technology and Economic Assessment Panel (TEAP) – an advisory body to the Parties to the Montreal Protocol (the treaty which is phasing out ozone-depleting refrigerants and has been amended to also phase down HFCs) – argues that, “by 2020 around 75% of new refrigerators will likely contain [hydrocarbon, HC] R600a (a small proportion using HC-HFO blends), with the remainder containing HFC-134a or HFO-1234yf”.

The light commercial sector is also increasingly moving towards hydrocarbon refrigerants such as propane (R290), isobutane (R600a) and propylene (R1270). Austrian company AHT Cooling Systems GmbH estimates

that it currently has some 1.5 million plug ‘n’ play hydrocarbon cabinets operating worldwide; it is producing new units at a rate of over 300,000 per year.

The number of CO₂ transcritical supermarkets in the EU, Norway and Switzerland, meanwhile, has tripled in the last three years. It is now estimated to represent 12% of the overall food retail market, according to research conducted by sheccoBase, the market development arm of shecco, publisher of this magazine. Ammonia, meanwhile, has long had a strong foothold in industrial refrigeration.

“Europe has led the way in the adoption of natural refrigerants since the introduction of the new F-Gas Regulation,” Manuela Rallo of Italian HVAC&R equipment manufacturer Tecnofreddo told *Accelerate Italy*. “It is still playing a pivotal role in stimulating innovation and green technology in the HVAC&R sector, to move away from high-GWP HFCs,” says Rallo, sales area manager at the firm, which includes propane chillers in its portfolio.

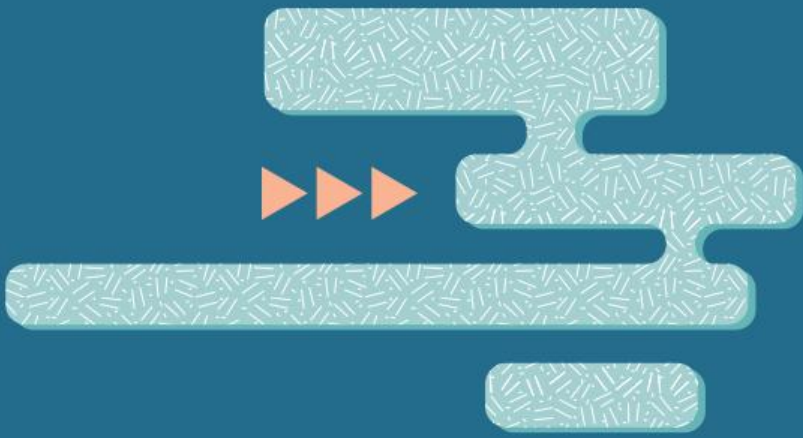


Air conditioning (AC), by sharp contrast, does not boast the same number of natural refrigerant-based systems. Yet with demand for comfort cooling expected to soar – UN Environment estimates that global stock will reach \$1.5 billion by 2030 – electricity consumption and greenhouse gas emissions will increase too unless significant market changes take place to meet climate commitments.

The air-conditioning sector, which is often the largest source of electricity demand in warm climates, is booming thanks to increasing urbanisation, rising incomes and falling air-conditioner prices in many developing economies. This means by 2030 an additional 700 million units will be added to the global air-conditioner stock, according to the Environmental Investigation Agency (EIA), an NGO. It should also be noted that 65% of HFC usage comes from air conditioning (UN Environment).

Global temperature increases, accelerated in part by emissions of greenhouse gases, are expected to increase demand still further. 2017 was the third consecutive year in which average global temperatures were more than 1°C above late 19th Century levels, according to NASA scientists.

Meeting the demand for air conditioning in a sustainable manner is therefore essential. A good way to start is by using propane chillers, which are traditionally used in refrigeration and process cooling, for air conditioning too.



“Propane will be one of the main refrigerants from 5-500 kW, which will be a cheap alternative to CO₂ and ammonia,” Jonas S. Nielsen, from Danish company Bundgaard (which focuses on chillers and heat pumps), told *Accelerate Italy*.

Nielsen argues that propane is a particularly successful refrigerant in water-loop systems in “small convenience stores and supermarkets where the refrigeration system has to supply the condenser side in the integral cabinets in the shop, the air conditioning in the shops, the cold water for the ventilation system, and at the same time produce hot water for taps or the heating system”.

Equipment for propane chillers is also widely available. “Most of the principal components – including condensers and evaporators; filter driers; sight glasses; check valves; safety valves; shut-off valves; solenoid valves; pressure switches; and thermistors – are no different from those fitted in an HFC or HCFC refrigerant chiller,” notes a 2016 report by the UK-based Chartered Institution of Building Services Engineers (CIBSE). “Expansion valves specifically designed for use with the operating conditions of the propane refrigerant should be fitted to chillers.”

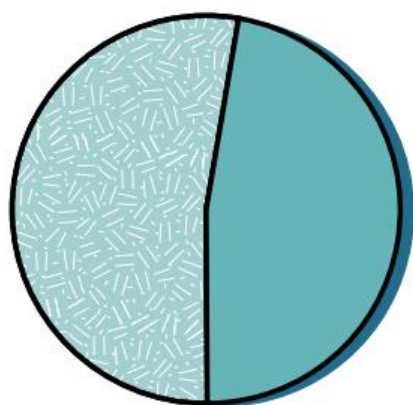
Training & safety: Two sides of the same coin

Though similar in design to chemical refrigerant-based systems, propane chillers do require manufacturers to pay extra attention to safety. "Propane's high flammability raises concerns from a safety point of view, both in use and maintenance. It is concerning that there is still a lack of R290 general safety standards and adequate training," argues Tecnofreddo's Rallo.

"More trained and certified technicians will accelerate the safe growth of this technology," Rallo predicts.

Italian chiller manufacturer Euroklimat is working hard to change this. "After the results of [a survey of 30 of our customers], we really believe that bigger efforts in training on hydrocarbon refrigerants are necessary," Giulia Fava, product developer at Euroklimat, told *Accelerate Italy*. The company organises customer training sessions focused on the safety devices it uses in propane chillers.

Is training on hydrocarbon refrigerants available in your country?
(30 respondents)



53.3%
Yes

46.7%
No

Source: Euroklimat market research



A Euroklimat propane chiller.

"Today, there are a lot of companies and training centres in Europe that are specialised in hydrocarbons," says Fava, noting that perception remains a problem.

All Euroklimat's propane chillers are ATEX-certified and comply with safety codes and legislation.

Beyond Italy's shores, UK-based Cool-Therm is also providing training to improve awareness of the specificities of flammable refrigerants in the context of the HFC phasedown.

"We are working hard with clients and consultants through our 'Continuous Professional Development' programmes to ensure the need to move away from HFC refrigerants is clearly understood," says Emma Pender, marketing consultant at Cool-Therm.

Keeping the hydrocarbon charge as low as possible is as important as training the people working with the technology.

"From Tecnofreddo's point of view, as a manufacturer, the key is to limit the charge of propane. Less charge in the system will involve less security actions to take," Rallo says. "Appropriate components that limit refrigerant charges, control possible leaks and allow the extraction of any flammable substances, as well as electrical safety precautions, are some characteristics that Tecnofreddo has chosen specifically for this technology."



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Tecnofreddo propane chiller.

Marketing natural refrigerants

Rallo expects the market for propane chillers to grow substantially in the future. At the moment hydrocarbon systems account for just 5% of the Tecnofreddo products already operating worldwide.

The chiller manufacturer has installed its largest R290 air-cooled water chillers in a dairy and meat processing plant with a reversible heat pump.

"R290 chillers supplied for such applications were up to 400 kW, with one or more circuits, heat recovery (partial or total), hydronic modules, and using semi-hermetic compressors and equipped with EC fans, inverter and dedicated PLC," Rallo says.

Euroklimat, which primarily focuses on R290 chillers and heat pumps, is already seeing the market shift as a result of the EU F-Gas Regulation. "When we started, more than 10 years ago, the customers were predominantly based in northern European countries. Today, we have R290 chillers installed in many European countries and customers/consultants in England, Ireland, Norway, Sweden, Denmark, the Netherlands, Belgium, Switzerland, Germany, Austria, Poland, Romania, France and Italy," says Euroklimat's Fava.

She says large commercial refrigeration end users are driving the market.

In early 2018 the Italian company reports growing demand for its propane chillers. "Comparing January 2018 vs. January 2017, we can see a +50% in incoming R290 orders," Fava says.

Cool-Therm also expects sales to increase in 2018. "The European market is buoyant at the moment, driven by the need to move away from HFC refrigerants due to the f-gas legislation and the reduced quotas of HFC refrigerants now available," Pender says.

Cool'n Tool, a Polish company founded in 2014, is expecting sales of its modular small propane chillers to increase.

In 2016 7% of Cool'n Tool's product portfolio was for natural refrigerants CO₂ and propane, which Jessica Kuhle, the company's sales manager, predicts will rise to 37% within two years.

The company has so far installed natural refrigerant technologies in over 400 installations.

Manufacturers argue that the energy efficiency of propane chillers versus their HFC counterparts makes them a good solution.

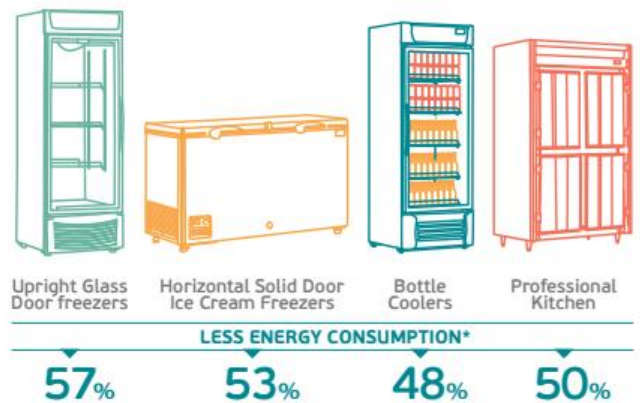
Customers in warm climates stand to benefit from this technology. Tecnofreddo's Rallo gives a comprehensive account of why this is the case: "R290's behaviour shows a lower increase of energy consumption with increasing ambient temperature. More precisely, it has favourable thermodynamic properties and low energy requirements during compression."

R290 discharge pressures are also 20% lower with propane than with HFCs. "Lower operating discharge pressures reduce the work that the compressor has to do, thus improving the life of the compressor by improving stability of the refrigerant and lubricant," Rallo says.



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"The lower density of R290 also reflects the lower requirement of refrigerant mass, which results in better heat transfer coefficients in the evaporator and condenser. All these advantages equate to a big energy saving and efficiency compared to HFCs."

Fava agrees that the "maximum condensing temperature is very high, up to 65°C (Frascold semi-hermetic) / 70°C (Copeland Scroll)" which helps increase the efficiency of these systems.

Tecnofreddo's Rallo says: "Thanks to the peculiar thermodynamic properties, the energy consumption in hydrocarbon systems is between 12 to 15% lower than a similar application with R404A."

Euroklimat has measured the performance of propane compared to different HFCs like R410A, R407C and R134a, finding that the coefficient of performance is comparatively high.

Cool'n Tool agrees: "We estimate an energy consumption saving of round about 30% compared to 'traditional' technology by using propane chillers," says Kuhle.

The Polish company believes the secret to high efficiency comes down to an innovative heat exchanger that increases overheating and undercooling and provides a stable evaporating process.

The company's end users agree. "The energy consumption was reduced. Thanks to that, the number of defrosts could be changed from seven to four per 24 hours after the installation, an energy saving calculated to about 25%. I have also noticed a remarkable difference of the shelf life of the vegetables stored in the walk-in fridge," says Magnus Engebom of the Radisson SAS Royal Viking Hotel, in Stockholm.

Magnus Pojen of McDonalds, which installed a Cool'n Tool unit in its Orebro restaurant, reports "savings in energy consumption between 25-40%".

Moving the air-conditioning market

The efficiency of propane could help make it a viable alternative to HFC-based chillers used in AC applications.

Cool Therm supplies some R290-based, air-cooled water chillers (mainly for comfort cooling applications in large commercial buildings) but has only supplied a limited number so far.

Tecnofreddo, meanwhile, hopes to enjoy similar success in the AC market to that which it is reporting for process cooling.

"Propane systems can be used in building air-conditioning systems, although their application in such sectors is a more recent practice. Although Tecnofreddo has provided propane chillers mostly for process cooling, the company believes that as long as charge limits and safety standards [are] regulated [well], there will be increasing demands for this type of technology in the building industry, since R290 presents a very good environmentally friendly alternative," says Rallo.

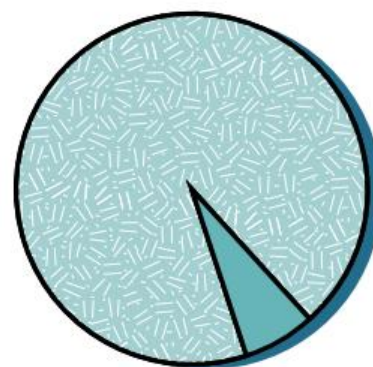
Euroklimat sees larger buildings as a promising future growth area for propane chillers. "We have different experiences of R290 chillers for air conditioning, especially for large buildings and high cooling demands," Euroklimat's Fava explains.

"We think that this is perfect business in which we need to invest, as we got the following information from a survey to our customers: 93% of them (from a sample of 30) believe that comfort applications are interesting for R290," she says.

Propane chillers, then, look set to move beyond refrigeration into air conditioning. Stay tuned for more on this story! ■ CM



In your experience, is R290 interesting for comfort applications?



93.3%
Yes

6.7%
No

Source: Euroklimat market research.

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