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GUIDE TO NATURAL REFRIGERANTS TRAINING IN EUROPE 2017

GUIDE to Natural Refrigerants Training in Europe 2017

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WELCOME MESSAGE BY LEAD AUTHOR

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There is currently a significant level of uncertainty regarding the availability of natural refrigerant training in Europe. This is due to a number of factors. Firstly, there is not a single body coordinating the training activities on natural refrigerants, but a wide variety of industry players are involved in such training, including system and component manufacturers, training institutes, vocational schools and universities as well as associations and end users. They all have different roles in the industry and target different groups of HVAC&R industry representatives.

Secondly, EU legislation does not mandate the training providers to report about their activities on natural refrigerant training and numbers of people trained, unlike for training on f-gases. This means that national authorities do not get a good picture about the availability of natural refrigerant training in their countries. This is becoming a concern for some of the member states that are commencing initiatives to cover natural refrigerants in national training and certification schemes.

With a view to bring more clarity to the industry and policymakers about the current and future status of the market for natural refrigerant training, shecco has initiated a project the result of which is this GUIDE to Natural Refrigerant Training in Europe. For the first time, we have created a list of organisations that offer training for CO_2, hydrocarbons and ammonia. We were pleasantly surprised that there are already close to 200 such organisations around Europe. The findings of the report are to a large extent based on an online survey that was conducted among more than 340 industry experts.The large number of participants is an indication that the industry is interested in this topic and is eager to get more clarity about different aspects and future expectations with regard to natural refrigerant training.

This report finds that the uptake of training on natural refrigerants in Europe is progressing rapidly, mainly as a consequence of the F-Gas Regulation that drives the industry away from high-GWP HFCs, nevertheless there are still barriers to overcome. Among them, lack of awareness and investment costs related to both setting up training facilities and taking part in courses appear as the biggest ones. It is now up to all industry players as well as governments to work together to facilitate the wider uptake of natural refrigerant training as a prerequisite for the safe use of natural refrigerants on a broader scale.

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1 About this GUIDE

A SHORT OVERVIEW

Chapter 1:
About this GUIDE

This chapter provides an introduction to the GUIDE Training on natural refrigerants and a simple overview of the topics that are in focus on the publication. It starts by presenting the structure and a brief overview of the chapters.

The chapter also provides an overview of the profiles of respondents to the survey, which was conducted among European industry experts to enhance the understanding of the current and future market for natural refrigerant training.

Chapter 2:
Natural refrigerants and their application

To better understand the basic characteristics of natural refrigerants this chapter details their key features. In addition, a short overview of the typical applications is mentioned.

The current state of the European market for natural refrigerants is explored in three 'ecosystems': City & buildings; Industry, special applications and sports; and Food chain. The purpose of the 'ecosystems' is to highlight the variety of natural refrigerant products and technologies currently in use in Europe and the huge scope for their further adoption.

Chapter 3:
Training in Europe - an overview

This chapter looks at the key aspects of HVAC&R training in general and the training on natural refrigerants in particular. The first section outlines the key factors that determine the importance of HVAC&R training as well as main carrier option and specialities in this sector.

The following section addresses natural refrigerant training in particular and starts by detailing the training requirements that are specific to natural refrigerants. Furthermore, to better understand drivers and barriers for the uptake of natural refrigerant training, the chapter analyses the results of the survey conducted among industry experts.

Chapter 4: Market for natural refrigerant training today & tomorrow

Through independent market research, surveys and interviews, this chapter offers a comprehensive evaluation of current and future status of natural refrigerant training in Europe. A map of natural refrigerant training providers gives a better perspective on the current situation, while the analysis of the survey findings unveils more details in regard to availability, topics covered, cost.

This chapter also examines the industry viewpoint on the future developments with regard to natural refrigerant training.

Chapter 5: Policy for natural refrigerant training

As one of the most significant drivers for the uptake of natural refrigerants training, legislative measures at international, EU and national level play an important role. This chapter zooms in on the key pieces of EU legislation, while providing examples of best practice in some of the member states, which could be an inspiration for others looking to streamline the training on natural refrigerants.

Directory of natural refrigerant training providers

The final section of the GUIDE lists organisations that offer theoretical or practical training on natural refrigerants in Europe.

SURVEY ABOUT NATURAL REFRIGERANTS TRAINING

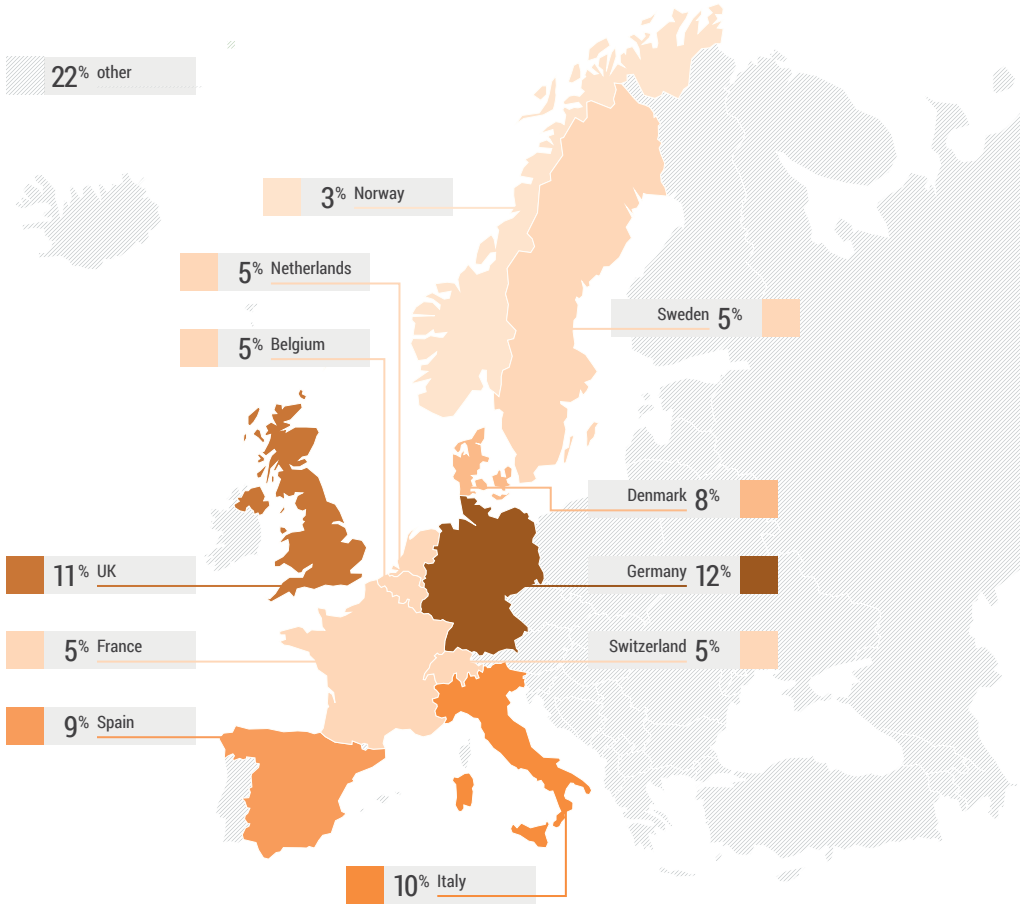
TO PROVIDE AN OVERVIEW OF THE CURRENT MARKET SITUATION OF TRAINING FOR NATURAL REFRIGERANTS IN EUROPE AS WELL AS ITS FUTURE OUTLOOK, SHECCO CONDUCTED AN ONLINE SURVEY AMONG 340 EXPERTS IN THE EUROPEAN HVAC&R SECTOR. THE DATA AND FINDINGS REFLECTED IN GUIDE TRAINING EUROPE 2017 ARE BASED ON THIS SURVEY.

The survey asked the opinions of key stakeholders from Europe on subjects such as the state of the market, the potential drivers and barriers for the uptake of natural refrigerant training and the effectiveness of current relevant policy as well as the perceived effect of potential upcoming policy changes.

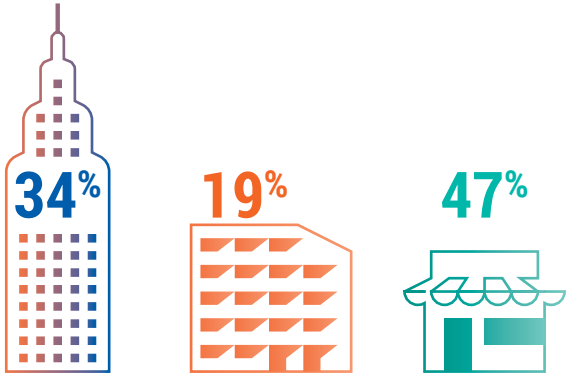
The results show that there is a great degree of diversity in the survey respondents' profiles.

Representation dominated by Western Europe

The location of the organisations that responded to the survey was predominantly in Western Europe, with a fair share of representatives from Southern Europe as well. Most of the respondents were located in Germany (12.6%), the United Kingdom (11.3%), Italy (11%) and Spain (9.2%).

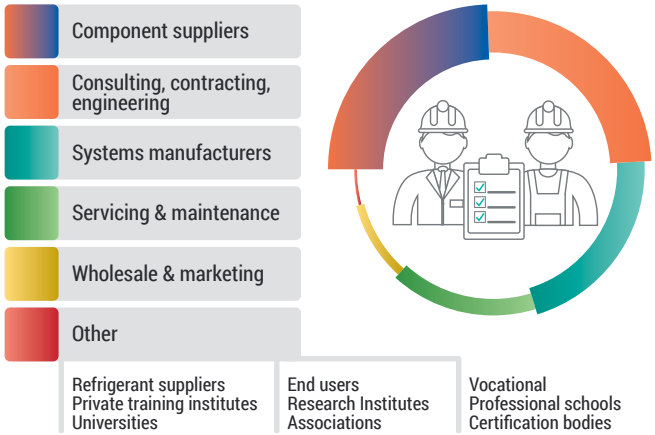


Small companies show highest interest



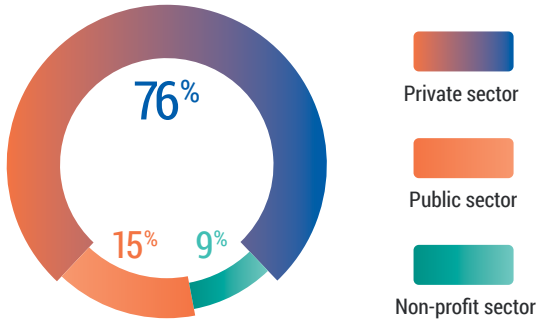
Close to half of the respondents were representatives of small companies (less than 99 employees). A bit more than one-third of those that participated in the survey were representatives of large companies (over 500 employees), with the remaining share representing medium-sized organisations (100-499 employees).

Component suppliers and contractors prevail



Component suppliers and consulting, contracting and engineering firms were the most represented in the survey (30% representation each). System manufacturers were the third most represented group (26%). A relatively high percentage of servicing & maintenance companies as well as wholesale & marketing organisations answered the survey, with 20% and 11% representation, respectively. Other organisation types with representation between 2.5 - 7% included private training institutes, universities, research institutes, end users, associations, refrigerant suppliers and certification bodies.

Strong representation of private sector



Given that most of the organisations were manufacturers of systems and components it is no surprise that the representation of private sector organisations was dominant in the survey with over three-quarters of representatives that identified this option. 15% of organisations were from the public sector, with the rest representing non-profit sector.


AMMONIA
SABROE

2 Natural refrigerants and their application

ABOUT NATURAL REFRIGERANTS

AS A GENERAL DIFFERENTIATION, "NATURAL REFRIGERANTS" ARE SUBSTANCES THAT EXIST NATURALLY IN THE ENVIRONMENT, WHILE "NON-NATURAL REFRIGERANTS" OR "SYNTHETIC REFRIGERANTS" ARE MAN-MADE CHEMICALS. THE MOST COMMONLY USED NATURAL REFRIGERANTS TODAY ARE AMMONIA (NH_3, R717) CARBON DIOXIDE (CO_2, R744), AND HYDROCARBONS (HCS), SUCH AS PROPANE (R290), ISOBUTANE (R600A) AND PROPYLENE, ALSO KNOWN AS PROPENE (R1270).

The precision of the term "natural refrigerants" is sometimes debated, given that, to be used as refrigerants, ammonia, carbon dioxide, and hydrocarbons also undergo an industrial purification and manufacturing process. However, today there is a well established distinction between substances whose chemical properties and safety aspects have been studied in their entirety and fluorinated gases, which, given their chemical complexity and comparatively short period of usage, have confirmed and/or unknown negative effects on ozone depletion, global warming and ecological safety, and therefore, are subject to continued debate. Moreover, natural refrigerants are naturally ocurring substances, whereas fluorinated gases are not.

Mixtures of ammonia and dimethyl ether (R723) have been developed, as well as various hydrocarbon blends with optimized performance and safety properties (isobutane, propane, R441 etc.). Water as a refrigerant has been used especially in absorption and adsorption chillers. The use of air is less common, but has been developed for deep-freezing applications.

ODP :
Ozone Depletion Potential

GWP :
Global warming Potential

Carbon dioxide (ODP= 0; GWP= 1)

Carbon dioxide is colorless, odorless and heavier than air. With a Global Warming Potential (GWP) = 1, CO_2 is the reference value for comparing a refrigerant's direct impact on global warming.

Carbon dioxide carries an A1 safety classification (the safest possible), indicating that it has low toxicity and is non-flammable. CO_2 as a refrigerant is sourced as a by-product from a number of production methods. With a long atmospheric lifetime, CO_2 does not lead to any by-product formation or decay products with serious environmental impact.

When used as a refrigerant, carbon dioxide typically operates at a higher pressure than fluorocarbons and other refrigerants. While this presents some design challenges, they can be overcome in systems designed specifically to use carbon dioxide. It is generally regarded as a cheap and easily available refrigerant.

Key applications

In Europe, the use of CO_2 in commercial refrigeration (centralised systems in supermarkets) has become particularly popular, while the refrigerant is also becoming common in industrial refrigeration plants, either as a sole refrigerant or in combination with ammonia. Besides these large equipment applications, CO_2 is a common refrigerant in plug-in commercial refrigeration equipment, such as vending machines, bottle coolers and display cabinets. Moreover, CO_2 heat pumps for residential, commercial and industrial use have been increasingly utilised and are poised to gain more popularity in the years to come. In transport applications, CO_2 has been used for refrigeration of goods in transit, while air-conditioning systems using the refrigerant have been developed for cars, buses and trains.

Ammonia (ODP= 0; GWP= 0)

Ammonia is a colorless gas at atmospheric pressure. With zero ozone depletion and global warming potential, as well as a short atmospheric lifetime, it does not form any by-products or decomposition products with negative environmental impact.

Despite its undisputed energy efficiency benefits, the use of ammonia is restricted in certain applications and geographic regions due to its toxicity. As a result, R717 is effectively prohibited from use inside occupied spaces but can be used in unoccupied areas or outside.

However, many advances have been made in recent years to minimise risks for human health, particularly for ammonia installations in populated areas. These advances include using ammonia in conjunction with other refrigerants, such as in secondary systems, in order to reduce and isolate an ammonia charge, using advanced safety equipment, deploying containment casings, or using ammonia absorption systems.

It is important to note that ammonia has a strong odor, making leaks easy to detect.

Key applications

Today, more than 90% of large industrial refrigeration facilities in Europe use ammonia as a refrigerant. Besides food processing, cold storage and distribution, ammonia has found its place in breweries, wineries, ice rinks, chemical plants, cargo ships and fishing vessels as well as district heating and cooling and large-scale air-conditioning for office buildings, universities and airports.

Hydrocarbons (ODP= 0; GWP< 4)

With zero ozone depleting-characteristics and an ultra-low global warming impact, hydrocarbons (HCs) do not form any by-products or decomposition products in the atmosphere.

Hydrocarbon (HC) refrigerants can be applied either in systems designed specifically for their use, or as replacements in a system designed for a fluorocarbon refrigerant. This makes them a cost-competitive solution, and optimal for developing countries.

Hydrocarbon refrigerants are flammable and, as a result, carry an A3 safety classification, which means they have a low toxicity but are in the higher range of flammability. HCs are often subject to stricter safety requirements concerning the quantities permitted in occupied spaces.

Key applications

Typical applications for hydrocarbons include self-contained residential and light commercial equipment, such as domestic refrigerators and freezers, air-conditioners and dehumidifiers, as well as stand-alone light commercial refrigerators, bottle coolers, ice cream freezers, beverage dispensers and beer coolers. In addition, hydrocarbons are used in supermarket refrigeration in combination with secondary cooling or as a high temperature stage in a cascade CO_2 system. Today more than 700 million domestic fridges utilise isobutane as a refrigerant worldwide, with Europe being 100% converted to this refrigerant in new equipment. Over two million HFC-free units are used in light commercial refrigeration in Europe, most of which use hydrocarbons.

Water (ODP= 0; GWP= 0)

Water (R718) is one of the oldest refrigerants used for refrigeration applications. It is an environmentally safe refrigerant with zero ozone depletion potential and zero global warming potential. It is odourless, colourless, nontoxic, nonflammable, non-explosive, easily available, and it is one of the cheapest refrigerants.

Key applications

In refrigeration applications, the use of water as a refrigerant has been mostly limited to absorption and adsorption systems that can be driven by heat sources such as solar thermal, biomass or industrial waste heat, which provides additional environmental and economic benefits as compared to electric driven machines. Water as a refrigerant can provide cooling for buildings, such as universities, offices and data centres.

Air (ODP= 0; GWP= 0)

Air is one of the oldest refrigerants used for refrigeration applications. It is an environmentally safe refrigerant with zero ozone depletion potential and zero global warming potential. It is odourless, colourless, nontoxic, nonflammable, non-explosive, easily available, and it is one of the cheapest refrigerants.

Key applications

Air as a refrigerant was used on refrigerated cargo ships around the turn of the 20th Century. Today, at least 54 units using air as a refrigerant have been installed in Japan and other Asian countries in a number of applications, including chemical process cooling, ultra-low temperature warehouses, and rapid freezing. Systems using air as a refrigerant have not yet been commercialised in Europe.

Refrigerants number	R717	R744	R290	R600a	R1270	R718	R729
Chemical formula	NH_3	CO_2	C_3H_8	C_4H_{10}	C_3H_6	H_2O	-
GWP (100 years)	0	1	3.3	4	1.8	0	0
ODP	0	0	0	0	0	0	0
Normal boiling points (°C)	-33.3	-78	-42.1	-11.8	-48	100	-192.97
Critical temperature (°C)	132.4	31.4	96.7	134.7	91	373.9	-
Critical pressure (bar)	114.2	73.8	42.5	36.48	46.1	217.7	-
Safety group	B2	A1	A3	A3	A3	A1	-
Molecular weight (g/mol)	17.03	44.0	44.1	58.12	42.08	18	28.97


#GoNatRefs

AN ECOSYSTEM APPROACH

THE PURPOSE OF THE "ECOSYSTEMS" IS TO OUTLINE THE SECTORS AND APPLICATIONS WHERE NATURAL REFRIGERANTS ARE DEPLOYED IN EUROPE TODAY. HERE ARE EXAMPLES OF INSTALLATIONS USING A VARIETY OF NATURAL REFRIGERANTS IN DIFFERENT EUROPEAN COUNTRIES.

The ecosystems are categorised into the following sections:

CITY, BUILDINGS & TRANSPORT:

Natural refrigerants can be used in a variety of applications in public and commercial buildings, data centres, district heating and cooling and private residential housing. In the transport sector, natural refrigerants are used in buses, trucks, trains, electric vehicles & fuel stations.

INDUSTRY, SPECIAL APPLICATIONS & SPORTS

Natural refrigerants are applied in larger scale applications like industry processing in laboratories, pharmaceutical, petrochemical industry, agriculture and power plants. Today, natural refrigerants are also used in ice rinks, snow making, and aquatic centres in many European countries.

FOOD CHAIN:

Natural refrigerants are widely adopted in food and beverage storage, distribution, production and processing, and supermarkets, basically covering the entire food chain.

CITY & BUILDINGS

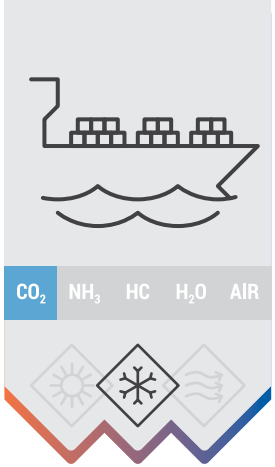
REFRIGERANTS

- CO_2 Carbon dioxide
- NH_3 Ammonia
- HC Hydrocarbons
- H_2O Water
- AIR Air

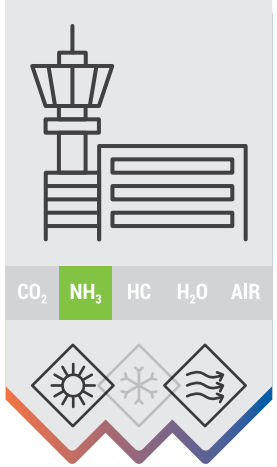
USE

- heating
- refrigeration
- air-conditioning

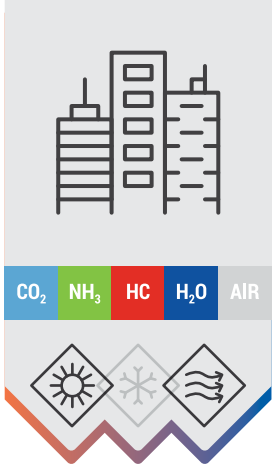
Ship terminals



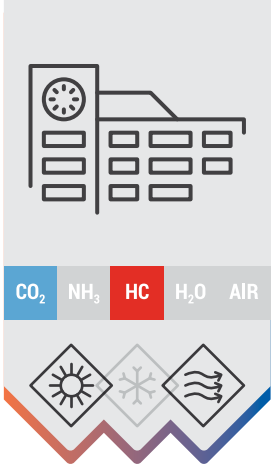
Airports



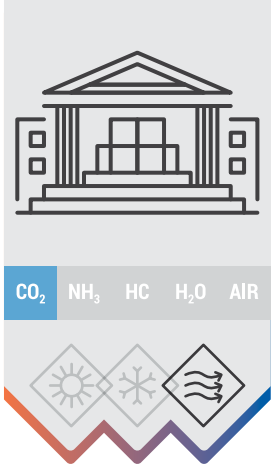
Office buildings



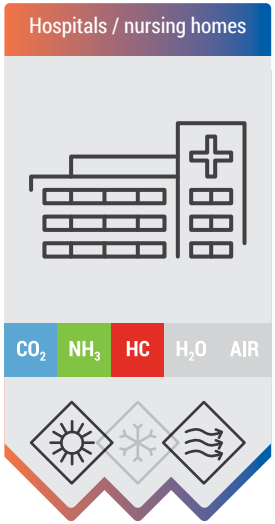
Universities



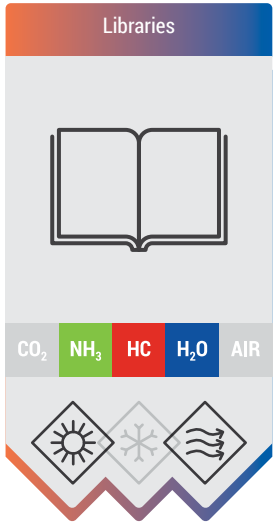
Museums



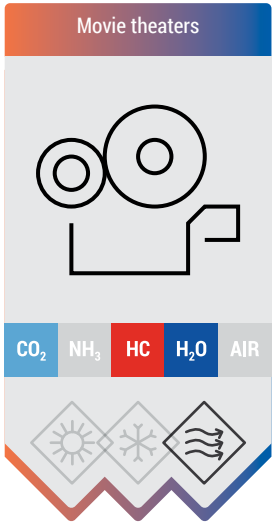
Hospitals / nursing homes



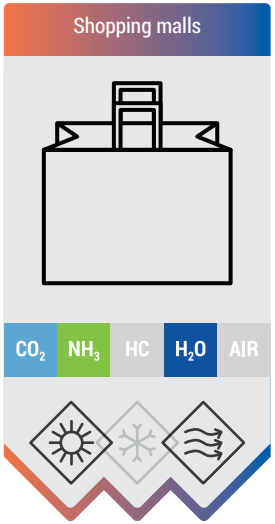
Libraries



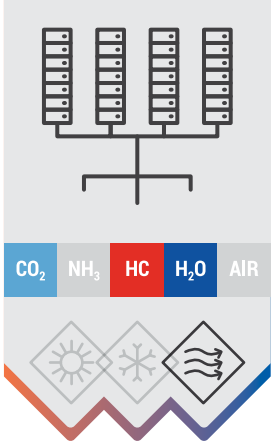
Movie theaters



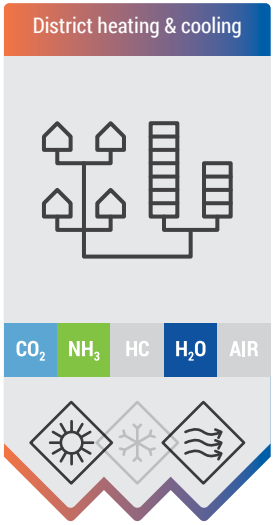
Shopping malls



Data centers



District heating & cooling



RESIDENTIAL

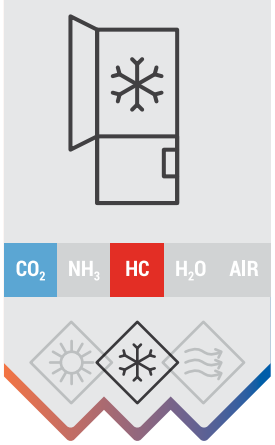
REFRIGERANTS

- CO_2 Carbon dioxide
- NH_3 Ammonia
- HC Hydrocarbons
- H_2O Water
- AIR Air

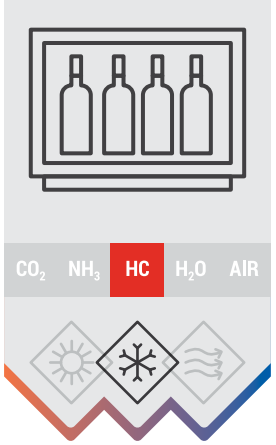
USE

- heating
- refrigeration
- air-conditioning

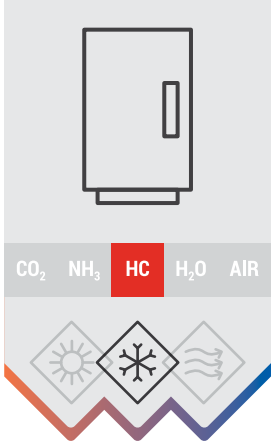
Domestic refrigerators / freezers



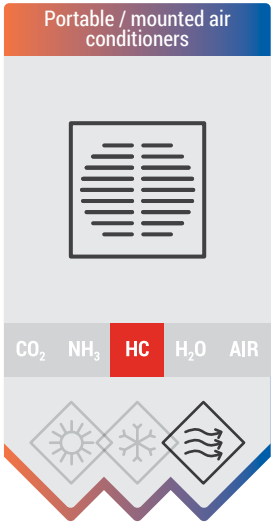
Wine cabinets



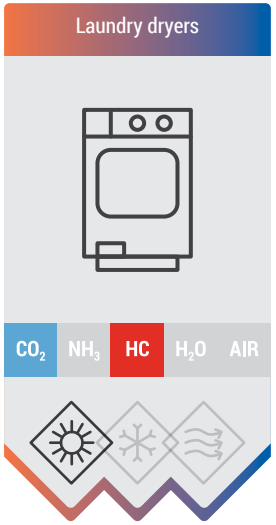
Mini bars



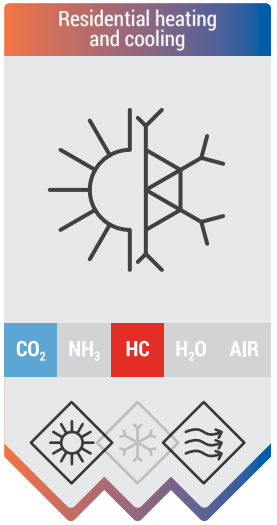
Portable / mounted air conditioners



Laundry dryers



Residential heating and cooling



TRANSPORT APPLICATIONS

REFRIGERANTS

- CO_2 Carbon dioxide
- NH_3 Ammonia
- HC Hydrocarbons
- H_2O Water
- AIR Air

USE

- heating
- refrigeration
- air-conditioning

Buses

CO_2 NH_3 HC H_2O AIR

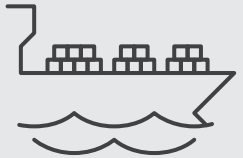
Trains

CO_2 NH_3 HC H_2O AIR

Refrigerated transport (trucks)

CO_2 NH_3 HC H_2O AIR

Cargo ships / reefers / fishing vessels

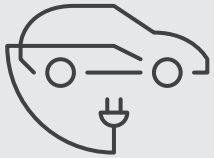


CO_2 NH_3 HC H_2O AIR

Passenger cars

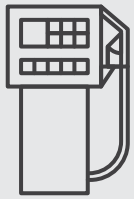
CO_2 NH_3 HC H_2O AIR

Electric vehicles



CO_2 NH_3 HC H_2O AIR

Petrol stations



CO_2 NH_3 HC H_2O AIR

CITY, BUILDINGS & TRANSPORT

Public and commercial buildings

CO_2

Shipping company Hurtigruten's terminal in Bergen, Norway uses the natural refrigerant CO_2 for cargo storage. The refrigeration system is 100% CO_2, and was chosen as an alternative to the environmentally harmful R22 (chlorodifluoromethane, a type of HCFC). The cooling and freezing area covers an area of 4,100m^2 and is located on the mezzanine above the loading bays on the landsides for cargo from the ships. The excess heat from the cooling and freezing areas is used to heat the terminal and offices.

NH_3

A commercial office building in Slough, United Kingdom was one of the first in the country to install an NH_3 heat pump for heating and cooling. The installation of an energy-efficient ammonia heat pump, which took place in 2015, has reduced operating costs by 96% compared to a conventional chiller/boiler combination.

London's Heathrow Airport has a central chilling plant with four energy-efficient chillers, each with a cooling capacity of 6.6MW, or 1,875 tonnes. The units, powered by high-voltage electricity, use twin compressors, which ensures efficient part load performance, while the 11 kilowatts (kW) motors reduce transformer losses. Since the large-scale R717 chillers deliver higher efficiencies than smaller local chillers, they are expected to reduce energy consumption by at least 30% and possibly benefit more from the chilled water store.

HC

As the Aarhus University Hospital Skejby in Denmark has gradually expanded over the years, the facility's heating and cooling capacity has become insufficient. New hydrocarbon chillers been installed to replace out-of-date R22 chillers, and hydrocarbon heat pumps have also been put in place. The larger chiller system uses nine air-cooled propane (R290)- based chillers, each with a cooling capacity of 250kW and a coefficient of performance (COP) of 4.5, and using a total of about 210kg of refrigerant.

Eight 650kW water-cooled water chillers using hydrocarbon refrigerant R290 were installed at the Co-operative Group's new headquarters in Manchester, the largest ever propane chiller project in a commercial building in the UK. The building has achieved the highest BREEAM rating, receiving the 'outstanding' accreditation for a large, commercial building in the UK.

H_2O

The Reichstag building in Berlin, Germany has a total floor area of approximately 240,000m^2 and uses three absorption chillers with capacity of 850kW for cooling purposes during the summer. The surplus heat resulting from operation of the motor-driven cogeneration plants is stored as hot water in an aquifer deep below ground. Thanks to the chillers and other green technologies, the building's energy requirements are so small that it produces more energy than it consumes, allowing it to act as a mini power station supplying nearby government buildings.

Data centers

HC

A cooling unit using propane was installed in Lübbecke's public utilities building in Germany. The R290 system satisfies cooling demand for the building's air-conditioning and for cooling the server room, while at the same time helping to reduce operating costs.

CO_2

A new STABILO Cube office building in Heroldsberg, Bavaria, includes a 400m^2 data centre, a combination of geothermal plant, a CO_2 heat pump and free cooling is designed to maximise sustainability. Waste heat from the data centre is also used to fuel the energy cycle.

Scientific research by Y. Solemdal, T.M. Eikevik; I. Tolstorebrov and O.J. Veiby concluded that CO_2 is more energy efficient than HFCs in data centre cooling. The research team conducted the study on an existing indirect refrigeration plant using R410A in Trondheim, Norway and compared it with a direct CO_2 system as well as with a filled indirect CO_2 system. The tests revealed that the direct CO_2 system only used 52% of the energy consumed in the existing system while the indirect system performed even better by consuming only 29% of the energy.

H_2O

In the iDataCool project, jointly developed by the University of Regensburg and the IBM Research and Development Lab Böblingen, an innovative adsorption chiller driven by waste heat was installed in the computing centre of Regensburg University, Germany.

District heating and cooling

NH_3

Several hundred ammonia heat pumps have been installed in Norway since the early 1990s. Most installations are in larger buildings (200 kW to 2 MW) and in district heating and cooling systems (700 kW to 8 MW). In a large district-wide natural heat pump system in Drammen Fjord near Oslo, Norway, an ammonia heat pump is used to provide over 13MW of heat for a community of 60,000 people. The system supplies hot water through underground pipes to heat several thousand homes and businesses.

At Glasgow University in the UK, ammonia heat pumps are used to meet the University's heating needs. The ammonia heat pump delivers 14 megawatt (MW) of heat at over 90°C and saves 15% in terms of energy consumption. In recent years, high temperature heat pumps for various applications that can extract heat from a wide variety of sources and produce hot water up to 90°C are more and more widely used in Europe.

The London Underground has a large ammonia heat pump installed in autumn 2016 that reclaims hot air from the underground's ventilation shaft which is constantly at around 24 to 30°C. The system is an extension of the Islington Council district-heating network that started in 2013. Heat recovered from the ammonia heat pump in London's underground will be used to supply both cooling capacity for the underground trains as well as hot water for the nearby buildings within the network.

CO_2

A large-scale 100% renewable energy project that provides the Danish city of Marstal with district heating system incorporates a 1.5MW thermally CO_2-driven heat pump. The project, developed with a grant from the EU's Seventh Framework Programme, includes a solar plant, a combined heat and power (CHP) system, an Organic Rankine Cycle (ORC) Unit and a 75,000 m³ pit for heat storage, with the CO_2 heat pump moving energy to the energy storage pit.

H_2O

In the Mediterranean city of Montpellier, France, a district solar cooling project with an absorption chiller was built for the Arche Jacques Coeur building, which includes 11,000m² of office space, 170 residences and 3,000m² of commercial space. The solar cooling and absorption chiller installation is estimated to reduce CO_2 emissions by 40 tonnes per year, the equivalent of 25 cars driving 10,000km per year.

Passenger cars, buses

CO_2

Régie des transports de Marseille (RTM) is moving to phase out the refrigerant R134a in its mobile air conditioning, running tests using CO_2 on two of its new buses in 2015. As well as trialling 100% electric buses in 2015, the transport authority RTM, which governs the bus, train and tram networks in Marseille, has turned to the environmentally friendly refrigerant CO_2 to increase energy efficiency and reduce its carbon emissions.

CO_2 mobile air conditioning systems have also been installed in trains. Deutsche Bahn, a German railway company, began field trials of this equipment in 2011.

Refrigerated transport

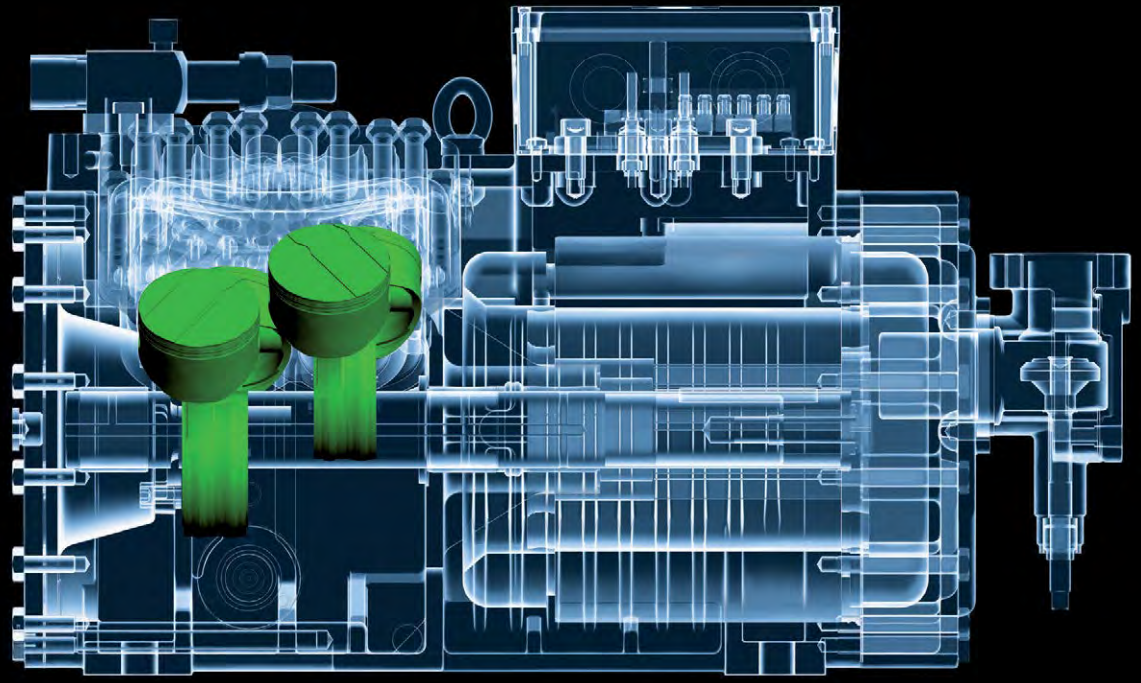
CO_2

Since 2012, a CO_2-based shipping refrigeration container has proven practicality and efficiency for marine transport applications. The system's total CO_2 equivalent emissions (CO_2e) are up to 35% less than previous equipment. As the CO_2 refrigerant is recycled from the atmosphere, the unit eliminates concerns about direct emissions in the event of a refrigerant leak. Over its lifetime, the system's CO_2e (CO2 equivalent) emissions are 10% less than the closest competitive unit.

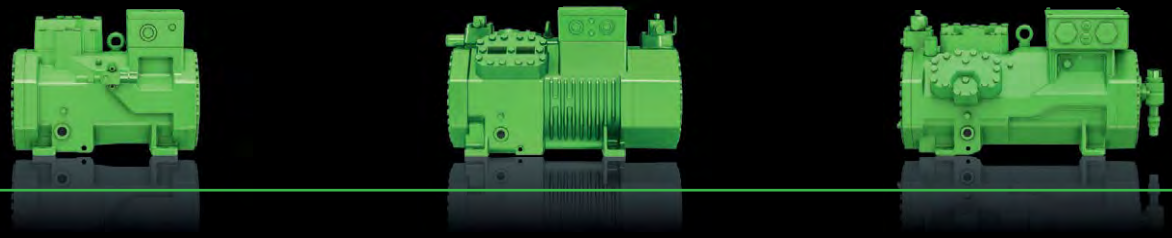
A CO_2-refrigerated shipping container has been modified for use in road transport refrigeration. The container was mounted to a box trailer and transported on land. Sainsbury's, a leading UK food and beverage retailer, has been testing the unit for over a year across Greater London, with the system receiving a RAC cooling Industry Award in 2014 for refrigeration innovation. These units reduce CO_2-equivalent emissions by up to 35% compared to the previous equipment. Sainsbury's hopes they will save over 70,000 tonnes of CO_2 emissions compared to its current refrigerated trailer fleet.

At the International Motor Show in Frankfurt, Germany in September 2016, a new transport cooling system with CO_2 was introduced to the market. The supermarket chain Netto is the first one to use this cooling unit in a pilot phase starting October 2016. The transporter is amongst the first ones worldwide to be solely based on natural refrigerants and is a big step towards environmentally friendly transport cooling.

CO_2 transcritical refrigeration systems have been installed in fishing vessels in Europe. The cooling and freezing compressors are mounted on one frame that includes oil systems, tanks, pumps and everything else needed, allowing for instant freezing on the vessel through its plate freezers. The plate freezers, which use CO_2, provide a high freezing rate in addition to shorter freezing times, saving energy. They also bring the added benefit of preserving the natural quality and freshness of the fish.



SEVEN AT A STROKE. **PURE INNOVATION.**



Sustainable, efficient and reliable: such are the trans-critical CO_2 reciprocating compressors from BITZER. The series, that has been enjoying success for a decade, has been enhanced by BITZER. Seven compressors will systematically broaden the range of applications of the entire series. The 2-cylinder compressors are small, light and complement the lower end of the series with displacements starting at 3.3 m^3/h. In the higher capacity ranges, the 6-cylinder models open up new application options with displacements of up to 37.9 m^3/h. BITZER stands for systematic innovation. Learn more about our products at www.bitzer.de

Bitzer

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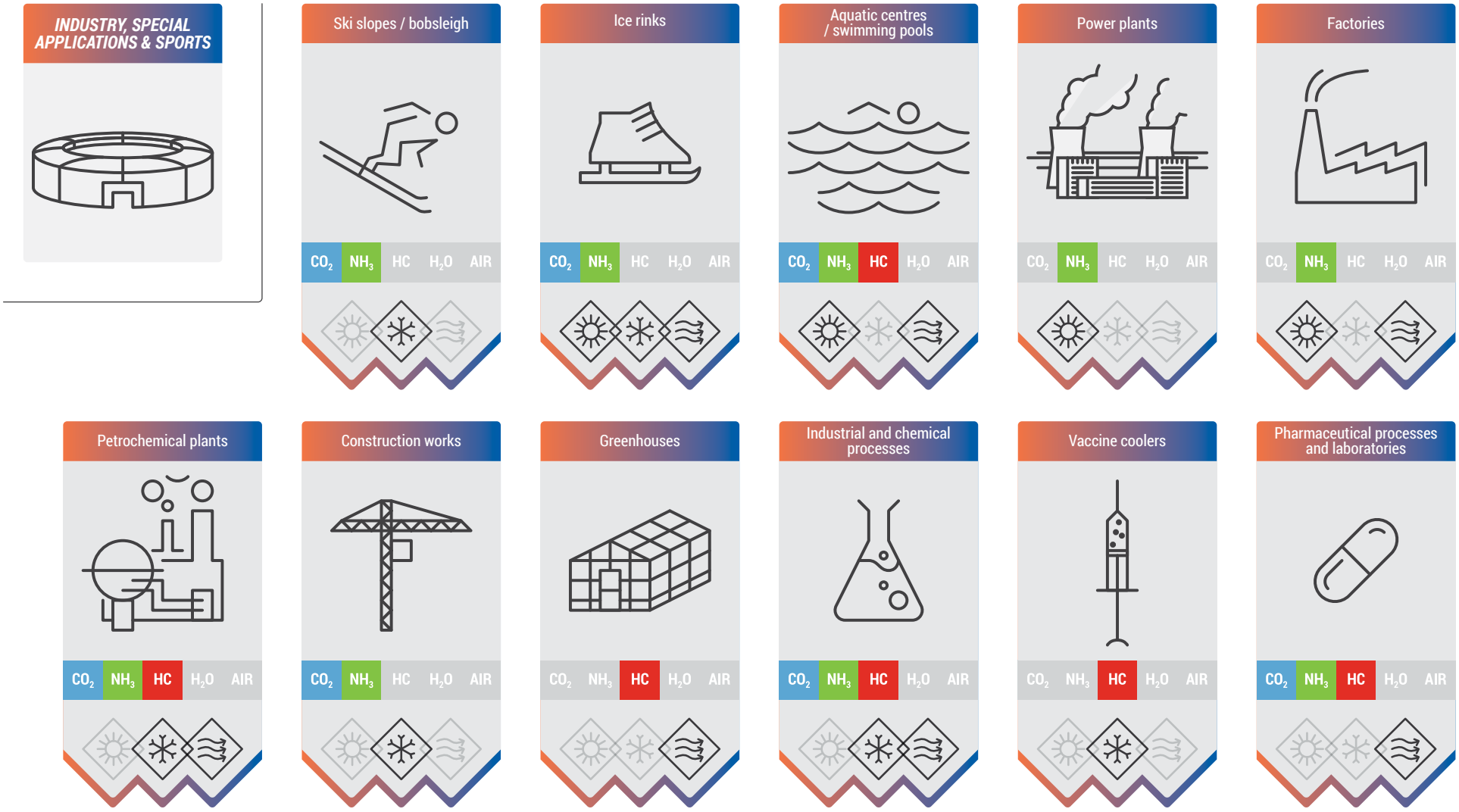

INDUSTRY, SPECIAL APPLICATIONS & SPORTS
Ski slopes / bobsleigh
Ice rinks
Aquatic centres / swimming pools
Power plants
Factories
Petrochemical plants
Construction works
Greenhouses
Industrial and chemical processes
Vaccine coolers
Pharmaceutical processes and laboratories
CO2 NH3 HC H2O AIR
REFRIGERANTS
CO2 Carbon dioxide
NH3 Ammonia
HC Hydrocarbons
H2O Water
AIR Air
USE
heating
refrigeration
air-conditioning

INDUSTRY, SPECIAL APPLICATIONS & SPORTS

NH_3

For cooling industrial processes, such as in the chemical, petrochemical, and pharmaceutical sectors, ammonia refrigeration systems are used to provide effective and stable cooling performance. Neste Oil in Finland replaced its R22 refrigeration system with an ammonia system. In Belgium, a 500 kW ammonia heat pump was installed in Emerson's factory in Welkenraedt, where waste heat from the factory is reused.

Following a recommendation by the Commission for a Sustainable London 2012, the cooling system of the Aquatic Centre was converted to an ammonia-based system, reducing its climate change impact. The large-scale Olympic Energy Centre also features ammonia chillers and provides efficient and low-carbon power by using new technology, including biomass boilers and a trigeneration plant (delivering power, heating and cooling), which captures heat generated as a by-product of electricity production.

Oxford's popular ice rink was refurbished with an ammonia refrigerant cooling system. A 360kW ammonia chiller, which reduces running costs by up to 20%, was installed.

HC / CO_2

A propylene/CO_2 cascade refrigeration system was installed in a German chemical plant. The evaporator (propylene) in the high cascade stage is simultaneously the condenser of the lower cascade stage (CO_2). The liquid CO_2 evaporator cools the chemical process down to -50°C.

HC

In a plastic production plant of Borealis, a Belgian manufacturer of polyethylene and polypropylene, the original R22 refrigeration unit was replaced by an R1270-based refrigeration system. Thanks to the conversion, Borealis now saves approximately 33% on its energy bill.

The gas processing plant of NAM in Den Helder, the largest natural gas producer in the Netherlands, adopted a refrigeration unit with R290 as a refrigerant and a cooling capacity of 2 x 2110kW to replace its old R22 units.

NH_3 / CO_2

NH_3/CO_2 cascade refrigeration systems are widely used where low temperatures must be attained economically and within compressor application ranges. A NH_3/CO_2 soil-freezing containerised refrigeration unit was used in the underground construction works of a building in Germany. The NH_3/CO_2 cascade refrigeration system was selected to enable lower cooling temperatures down to -50°C.

CO_2

In the ice rink industry today, mainly in Europe, there are more than 20 rinks that have adopted CO_2 in the second-cycle of the refrigeration system. The first ice rink in Europe that was purely cooled with CO_2 is in Gimo, Sweden. It has been in operation for nearly two years and has already shown significant reductions in energy consumption by now. In fact, during the first 6 months of operation, the energy cost reductions were more than 60% compared to the previously used system. The project thus proves the huge potential for CO_2 cooling in the ice rink industry.

NH_3 / H_2O

A final-year student at Loughborough University in the UK designed a backpack to keep vaccines cool for up to 6 days, using ammonia-water absorption refrigeration technology. Currently, it is often problematic to deliver vaccines to developing countries while meeting the World Health Organisation's safe vaccine transportation practices. The innovative prototype of the ammonia-water backpack unit cooler can be recharged on the go in just over one hour and could solve those issues.

FOOD CHAIN

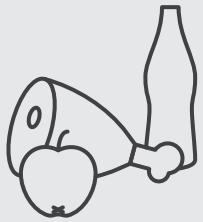
REFRIGERANTS

- CO_2 Carbon dioxide
- NH_3 Ammonia
- HC Hydrocarbons
- H_2O Water
- AIR Air

USE

- heating
- refrigeration
- air-conditioning

Food and drinks processing



CO_2 NH_3 HC H_2O AIR

Wineries & breweries

CO_2 NH_3 HC H_2O AIR

Food storage / distribution

CO_2 NH_3 HC H_2O AIR

Supermarkets

CO_2 NH_3 HC H_2O AIR

Transport refrigeration

CO_2 NH_3 HC H_2O AIR

Fast-food restaurants

CO_2 NH_3 HC H_2O AIR

Ice makers

CO_2 NH_3 HC H_2O AIR

Ice cream freezers

CO_2 NH_3 HC H_2O AIR

Water dispensers

CO_2 NH_3 HC H_2O AIR

Water dispensers

CO_2 NH_3 HC H_2O AIR

FOOD CHAIN

Food processing

NH_3

An ammonia-based refrigeration unit was installed in Vlevico, Colruyt's renewed meat plant in Halle, Belgium. The heat released from the refrigeration unit is recuperated for the production of hot water. The plant also reduced its CO_2 emissions by 1,602 tonnes per year. The BESS study (Benchmarking and Energy management Schemes in SMEs) has declared Vlevico one of the most efficient and ecological meat processing companies in Europe.

One of the largest Swiss food retailers, Coop, installed a new integrated ammonia chiller heat pump system in their chocolate factory in Basel. The system provides both process heat and cooling for the chocolate production process. The system can work with two types of condensation, namely by means of water or with an air-cooled condenser. The system integrates six chillers with screw compressors that offer a combined refrigeration capacity of 6,000 kW. Moreover, the heat pump system with the chiller is integrated with a water circuit. Reciprocating compressors condensate the ammonia at high temperatures and provide 2,000kW of heating capacity. The ammonia then condensates at 65°C and delivers water at 60°C.

CO_2

In a Norwegian ice cream plant, a transcritical CO_2 cooling and freezing system was installed. The 220kW (at -38°C) CO_2 system with 150kW of heat recovery and hot gas defrost achieves reductions of 1,000 tonnes of CO_2 equivalent per year (direct and indirect emissions) in comparison with a similar R404a system.

Schlachtbetrieb Zürich AG installed the largest CO_2 heat pump system with 800kW in Switzerland. The three CO_2 heat pumps are used to produce high temperature hot water (90°C) for the slaughterhouse based on waste heat from refrigeration systems. As a result, about 260,000 m^3 of natural gas has been saved per year and the annual CO_2 emissions have been reduced by around 30%, or 510 tonnes per year.

HC

Eight 650kW water-cooled water chillers using hydrocarbon refrigerant R290 were installed at the Co-operative Group's new headquarters in Manchester, the largest ever propane chiller project in a commercial building in the UK. The building has achieved the highest BREEAM rating, receiving the 'outstanding' accreditation for a large, commercial building in the UK.

HC / CO_2

A meat processing plant in Osnabrück (Germany) has installed a propane-CO_2 cascade system for refrigeration and deep-freezing in processing and cold storage applications. The technical and constructional innovation of this system is the combination of propane (R290) and CO_2 in a single loop. The new, integrated solution reduces the amount of space required as well as installation costs.

NH_3 / CO_2

An NH_3/CO_2 cascade system was installed in a German bakery plant, where the CO_2 cycle was used for direct cooling in the freezers applied in the system, with limited NH_3 quantity. When calculated over one year of operation, 870,000 kWh of energy could be saved per year. At 70 cents per kW, this would result in savings of more than €600,000 per year.

In Russia, Nestlé invested in an NH_3/CO_2 cascade refrigeration system at its coffee processing plant in Timashvesk. The system greatly reduces the ammonia charge, increasing system safety and facilitating system supervision. The use of screw compressors in the CO_2 stage reduces the number of compressors required by half and third the time needed between maintenance operations.

Wineries & breweries

NH_3

The Daniel Thwaites brewery in Northern England installed a reciprocating compressor using ammonia as the working fluid. The ammonia system has resulted in an increased output of 400 kW compared to the 310 kW supplied by the previous installation. In addition, the energy efficiency has improved, saving the owners approximately £2,000 (around €2,500) per week in electricity costs, which means that the investment will be paid back in less than 18 months.

CO_2

The Norwegian brewery Mack installed two CO_2 transcritical chillers with a total cooling capacity of 500kW. The system satisfies Mack's requirements for performance, safety and reduced environmental impact.

In an Anheuser Busch InBev Brewry in Leuven, Belgium, a 670kW CO_2- based refrigeration unit is used for process cooling. The system uses heat released during the refrigeration process to evaporate CO_2, which is essential to carbonate beer. Thanks to this heat recovery, InBev Belgium consumes no extra energy, limiting the impact on the environment and lowering the energy bill substantially.

H_2O

A solar cooling system in the cellar of the GICB winery (Groupement Interproducteurs du Cru de Banyuls) in the south of France installed an absorption chiller. The project was the first in France in the private food sector and one of the first in Europe. Energy consumption is 2,800 kWh which corresponds to a cost of only €280/year. The energy savings are estimated at €950/year (on the basis of an average increase of energy price of 5% per year).

Food storage & distribution

CO_2

A lettuce processing plant by the Staay Group in the Netherlands has installed a CO2-based cooling system with a total capacity of 3,36 Megawatts. The installation is considered to be the world's biggest CO2 plant to date. The system will use 45 compressors in total and will be able to reach a range of temperatures with different charges between 0°C and -28°C.

The food retailer SPAR opened the first ever distribution centre in Austria fitted with a transcritical CO_2 refrigeration system in autumn 2016. It is a large installation in a distribution centre in Ebergassing, Austria, where 19,000m^2 of floor space are used for product refrigeration. SPAR expects that the natural refrigerant-based solution meets its needs for long-term and cost-effective refrigeration solutions.

NH_3 / CO_2

At the site of the German discounter Lidl in Hüfingen, Baden-Württemberg, 6,000 m^3 of deep freezing and refrigerated space are cooled with a NH_3/CO_2 system. The waste heat from the refrigeration is recovered to heat other parts of the building.

One of the leading French food retailers installed a NH_3/CO_2 cascade system in October 2016 to serve one of its distribution centres. Compared to the previous system with glycol, the NH_3 evaporating temperature is higher, boosting the COP by 5% at full load. There are thus significant energy savings compared to the old setup with DX Freon coolers and commercial compressor racks. Moreover, the CO_2 distribution pumps need much less power to operate and indirect energy savings are thus also made.

NH_3

One of McDonald's suppliers in the UK, Keystone Distribution, has installed a 2,000kW two-stage ammonia refrigeration plant for its state-of-the-art Hemel distribution facility. The ammonia refrigeration system incorporates several energy saving features that contribute to 15Mw of yearly energy savings.

Bonduelle Group, supplier of canned or deep-frozen vegetables, and processed salads upgraded its cold storage with an ammonia refrigeration system in its site in Estrées, France. The facility lowers energy consumption by 25% compared to a conventional cold room and saves a total of 500 tons CO_2e per year.

HC

R1270 (propylene) chillers have a proven economic track record in terms of lower capital costs and reduced energy consumption, making them one of the preferred technologies for food cold storage. Mansfield's Fruit Farms, Grimsby Fish Market, Peake Fruits - Suffolk UK, Liverpool Fruit Terminal, as well as Nestlé in the UK installed R1270 chillers in their facilities.

Supermarkets

CO_2

Europe is the world leader in terms of CO_2 adoption in commercial refrigeration. For the food retail industry, CO_2 transcritical systems have become the mainstream technology amongst innovative and sustainable refrigeration solutions. Overall, as of March 2017 there are well over 9,000 stores in Europe (European Union, Norway and Switzerland) using CO_2 transcritical technology. This means about 8% of all European food retail stores are now equipped with this technology.

The efficiency of CO_2 refrigeration systems in warmer European climates has long been a matter of intense debate and source of concern among experts. However, recent findings indicate that technical challenges that often result from a lack of awareness are slowly being overcome. The number of supermarkets using CO_2 transcritical technologies has increased drastically in countries such as Spain, Italy, Romania and the south of France. In Italy, for instance, as of September 2016 there were 91 stores with CO_2 transcritical systems as opposed to 15 stores in 2013. This drastic increase in numbers further demonstrates that CO_2 refrigeration is advancing across Southern Europe as an efficient and viable solution.

HC

The Colruyt Group, a Belgian supermarket group, plans to reduce its overall emissions by replacing their current cooling systems (which primarily use R507 with GWP 3,900) with an unprecedented shift to R290 chillers in all of its 516 stores in Belgium. From 2017 onwards, all new cooling installations will use natural refrigerants. There are already 50-60 installations in the pipeline right now and at the planned pace, all replacements will be finished by 2027. The new R290 chillers use less than 2.5 kg of propane, compared to 100-150 kg of R507 before. The leakage rate is also reduced considerably from about 5% in the old systems to almost negligible in the new ones.

Aldi Nord announced in 2017 its plan to install brand new propane heat pumps at 10 of its sotres, that started in 2015.

Over a 12-month test period, the health and safety and energy efficiency of the entire installation was measured. After recording significant energy savings in testing, the retailer confirmed it will be further using an integral system with natural refrigerants. The systems are based on propane heat pumps in combination with optimised refrigerated cabinets and cold rooms, as well as an integrated ice energy storage unit and photovoltaic system.

HC / CO_2

Since 2009, German retailer Lidl has relied on compact refrigeration units using propane for normal refrigeration, a heat pump for heating and CO_2 for deep-freezing. More than 200 units are in operation today, showing that propane is already suitable for series production. The compact refrigeration unit is designed to be cost efficient and environmentally friendly, producing the refrigeration needed to cool shelves, refrigerate counters, cold rooms, cold storage cells and for air-conditioning. It also generates floor heating and integrates the electro technical equipment for the whole store.

Light commercial refrigeration (water coolers, drink dispensers and ice machines)

HC

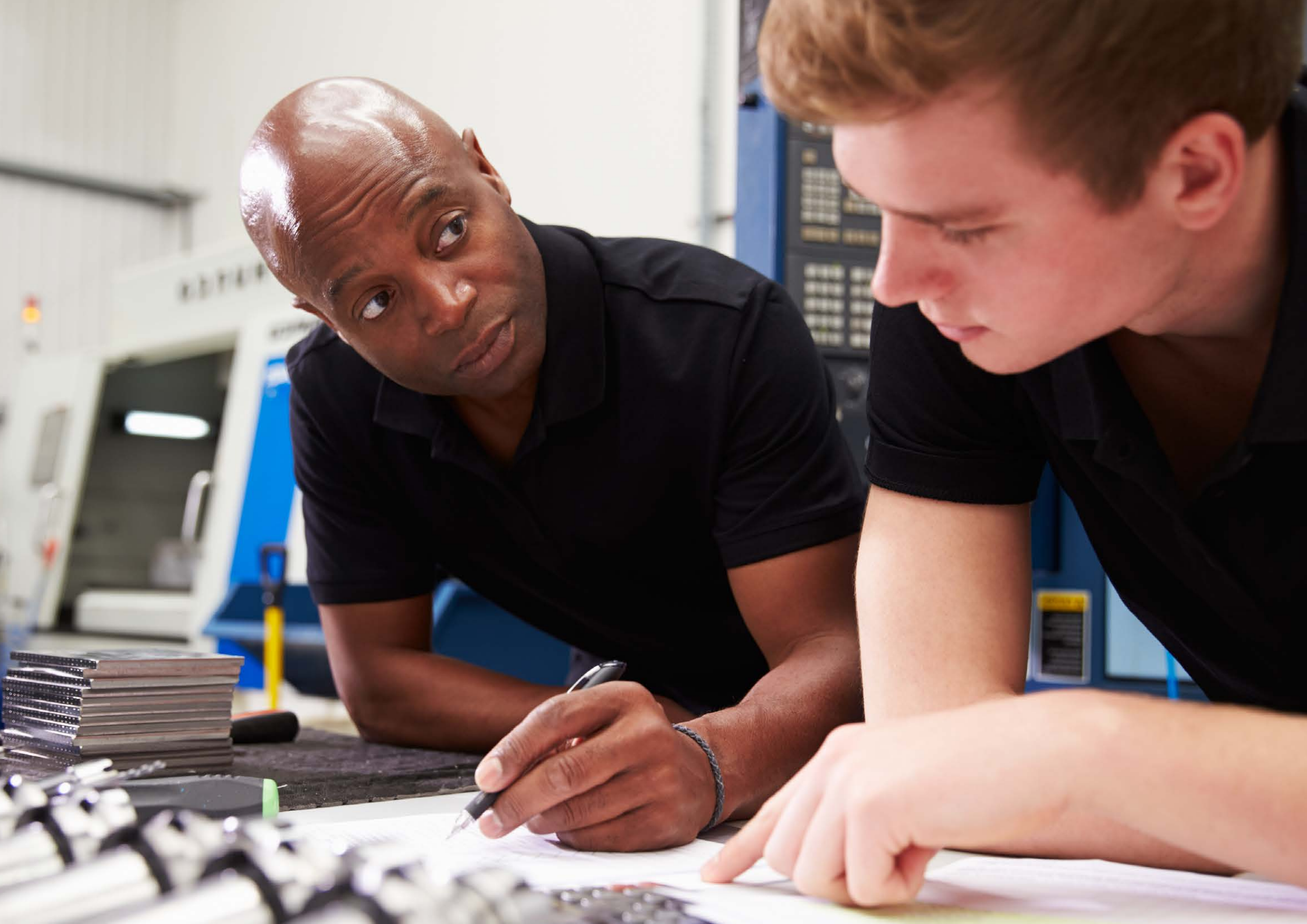
The use of HFC-free technology in light commercial applications is now becoming a standard across Europe. As of 2013, there were already more than 480,000 hydrocarbon plug-in cabinets in usage across the continent. Expectations and market trends suggest that this number has increased exponentially over the past 3 years and will continue on this trajectory thereafter.

In Europe, R290- and R600a-cooled water coolers, vending machines, ice cream freezers and fountains are widely used. Moreover, the use of hydrocarbons in domestic and commercial ice machines is steadily growing in Europe.

In domestic refrigeration, all new equipment in Europe uses hydrocarbons as a standard. Globally, there are more than 700 million domestic fridges using hydrocarbons.

CO_2

CO_2 is another alternative for light commercial refrigeration (mainly bottle coolers, vending machines, refrigerated cabinets), which is used by a number of end-users. In 2009, the Coca-Cola Company had decided to shift to CO_2 vending machines, which helped in pushing this market forward on a global scale.



3

Training in Europe – an overview

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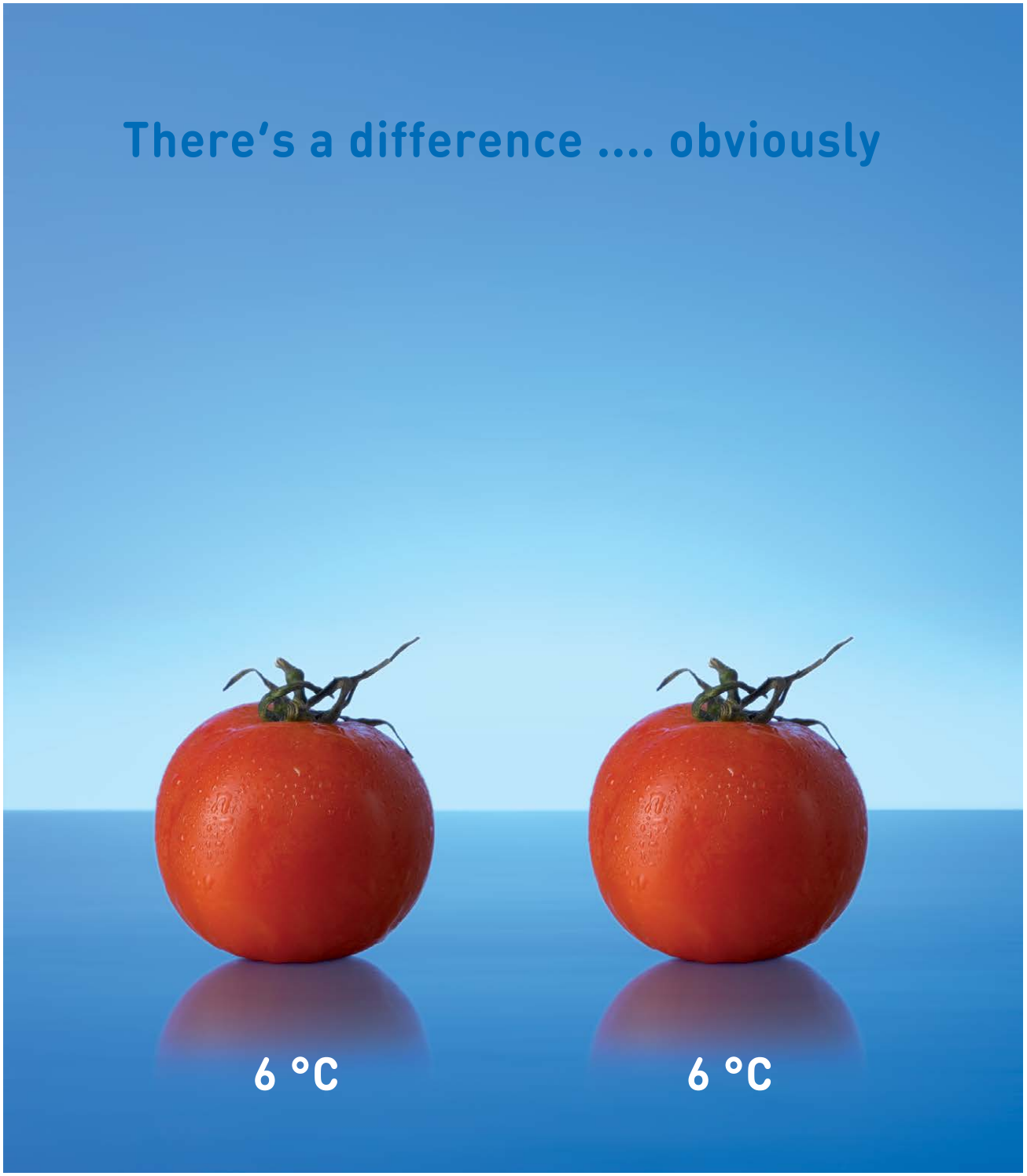
THE IMPORTANCE OF HVAC&R TRAINING

THE HVAC&R INDUSTRY IS A RAPIDLY CHANGING FIELD AND TODAY'S HEATING AND COOLING SYSTEMS ARE FAR MORE ADVANCED THAN THOSE MANUFACTURED JUST A FEW YEARS AGO. ADVANCES IN COMFORT AND ENERGY EFFICIENCY MEAN NEW OPPORTUNITIES FOR END USERS LOOKING TO UPGRADE THEIR OLD SYSTEMS.

Besides the fact that it is legally required that persons handling refrigeration, heating and cooling equipment are properly trained and hold appropriate certification, training is a prerequisite to ensure a safe and correct handling of refrigerant-containing equipment. To keep pace with the rapid technology advancements in the HVAC&R sector, technicians need to have access to continuous training to ensure they are up to speed with the latest developments.

With growing trends such as the greening of HVAC&R technology, the adoption of smarter and energy efficient heating and cooling systems, and the changing environmental regulations set forth by local and national governments, HVAC&R is expected to be a thriving field in the future promising a boost of jobs in the sector.

The key factors that determine the importance of HVAC&R training can be identified as follows:



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OFFICES IN SPAIN / ITALY / ROMANIA / POLAND

Safety

Any technician or engineer handling heating and cooling technology that uses refrigerants has a duty of care. The health and safety duties require technicians to consider all risks, not only those for which regulations, codes of practice, and industry guides exist.

Safety is of concern when applying any refrigerant, with respect to hazards arising from toxicity, asphyxiation, pressure explosions, mechanical injury, and others. It is therefore important to be familiar with the potential safety hazards that each refrigerant can represent. In principle, all refrigerants can be dangerous if misused or applied in a system inappropriately.

Safety features of refrigerants vary and so does the design of systems using different refrigerants, which should mitigate potential risks. It is therefore important that technicians have thorough understanding of the specific characteristics of refrigerants (whether fluorinated or natural) and practical training before they install, maintain or service the equipment. Education and lifelong training, as well as enforcement of safety rules are the key measures to ensure the safety of refrigeration systems.

Performance & energy efficiency

The growing emphasis on reducing emissions of greenhouse gases (direct and indirect) encourages organisations and individuals to pay special attention to preservation of energy. Energy efficiency has become an integral part of HVAC&R systems design, maintenance and modernisation.

To ensure energy efficient operation of HVAC&R systems, it is essential that professional technicians carry out proper and regular maintenance. Adequate training should also ensure that the personnel handling the equipment are skilled at identifying opportunities for energy saving during their routine day-to-day activities.

Durability

HVAC&R systems are here to perform a function, whether it is to provide refrigeration, heating or air conditioning. Unless they are properly maintained, they will not be able to perform as desired or as long as they are intended to last. Without proper maintenance, the service life of HVAC&R systems and components might fall.

The average life expectancy of various HVAC&R equipment tends to stay around the same range. However, each system has unique characteristics that may lead to variations in life expectancy. Regardless of age, regular precautionary and seasonal maintenance as well as the quality of installation play an important role in determining products lifecycle. Proper training and keeping skills up to date will guarantee that the lifespan of systems is enhanced as much as possible.

CAREER OPTIONS AND SPECIALTIES IN HVAC&R SECTOR

THE HVAC&R SECTOR OFFERS A WIDE VARIETY OF CAREER OPTIONS TO BOTH TRAINED AND UNTRAINED WORKERS, INCLUDING ARCHITECTURE AND ENGINEERING, INSTALLATION AND MAINTENANCE, PRODUCTION, SALES AND A NUMBER OF HORIZONTAL FUNCTIONS. THESE ROLES SUPPORT KEY FUNCTIONS AT HVAC&R MANUFACTURERS, WHOLESALE DISTRIBUTORS, CONTRACTORS, ENGINEERING COMPANIES AND OTHER INDUSTRY ACTORS ACROSS THE ENTIRE HVAC&R SUPPLY CHAIN.

Each of the occupation families requires different level of practical and / or theoretical training concerning HVAC&R technologies. The largest occupation family in terms of job openings is installation, maintenance and repair. Jobs in this field also require the highest level of practical and theoretical HVAC&R training, including relevant licences or certificates.

Level of skill or experience of a worker in the HVAC&R sector in the installation, maintenance and repair depend on the position. The basic positions can be identified as follows:

Assistant is someone who normally supports technicians in all aspects of the trade while learning on-the-job. The assistant is normally required to have some experience in HVAC&R sector.

Technician installs, maintains and repairs HVAC&R systems. Technician may also specialise in installation or in maintenance and repair, and in either refrigeration, heating or air conditioning systems.

Apprentice learns the HVAC&R trade by combining on the job training with formal technical education. Some businesses employ HVAC&R apprentices without any former training.

Supervisor assumes complete responsibility for installation and repair of all HVAC&R equipment-related operations and maintenance. A supervisor is responsible for assigning tasks, scheduling personnel, inspecting and auditing work in process and completed work. Several years of experience in the HVAC&R field are normally required at this position.

Contractor is self-employed, has a strong operational experience in HVAC&R and normally works independently. Contractor might be also responsible for recruiting and training sub-contractors, controlling the communications with the customer, ensuring that proper permits and licenses for all the jobs and installations have been obtained.

Occupational families, like architecture and engineering, construction, production also require theoretical and practical knowledge concerning HVAC&R equipment, in order to be able to perform the jobs properly. Other occupations, including sales, IT, office and administrative support, transportation, business and financial operations, do not require formal training. Nevertheless, theoretical knowledge regarding the functioning of HVAC&R systems might be necessary, depending on the position.

TOP HVAC&R OCCUPATION FAMILIES INCLUDE

theoretical and practical training	formal practical and theoretical training with certification and / or licences (vocational training in most cases)	theoretical training might be required (at secondary or higher education level)

ARCHITECTURE, ENGINEERING, CONSTRUCTION, PRODUCTION

- SYSTEM & APPLICATION ENGINEER
- ARCHITECT
- CONSULTANT/ DESIGN ENGINEERS
- PRODUCTION/ PROJECT/ SERVICE MANAGEMENT
- QUALITY ASSURANCE
- R&D ENGINEER
- TECHNICAL TRAINER
- PROFESSOR/ ACADEMIC STAFF

INSTALLATION, MAINTENANCE AND REPAIR

- CONTRACTOR
- SUPERVISOR
- TECHNICIAN refrigeration, heating, gas, geothermal
- MECHANIC Refrigeration, AC
- TECHNICAL ASSISTANT
- PLUMBER
- APPRENTICE

HORIZONTAL FUNCTIONS

- SALES
- BUSINESS & FINANCE
- HR
- IT
- TRANSPORT & LOGISTICS
- OFFICE & ADMINISTRATION

KEY HVAC&R SPECIALTIES

ALL HVAC&R JOBS CAN BE GROUPED INTO TWO MAIN STREAMS DEPENDING ON WHETHER THE TRAINING OBTAINED IS MORE PRACTICAL OR ACADEMIC. THE PRACTICAL STREAM REPRESENTS QUALIFICATIONS THAT ARE ACQUIRED AT TECHNICAL COLLEGES, SCHOOLS OR RECEIVED VIA THE ON-THE-JOB TRAINING, WHILE ACADEMIC QUALIFICATIONS ARE NORMALLY ACQUIRED AT UNIVERSITIES.

Careers in the practical stream

Refrigeration and air conditioning mechanics / technicians install, alter, repair and maintain refrigeration and air conditioning systems in residential, commercial and industrial applications.

Gas technicians install, service, maintain, troubleshoot, and repair gas systems and appliances. The systems and appliances that gas technicians typically work on include boilers, ovens, central heating systems, gas fires, and water heaters, among others.

Domestic / commercial gasfitters install, test, maintain, manufacture, assemble, construct, operate, alter and repair propane/natural gas regulated products, such as: supply lines, appliances, equipment and accessories for use in residential and commercial premises.

Plumbers install and repair piping, fixtures, appliances, and appurtenances in connection with the water supply, drainage systems, etc., both in and out of buildings.

Oil burner mechanics install and service heating systems, components, piping equipment and controls to residential, commercial, institutional, industrial or public buildings. They work in cooperation with other trades to ensure that all specifications, including legislative requirements are met to guarantee safe and efficient operation.

Sheet metal workers fabricate, assemble, install, and repair sheet metal products and equipment, such as ducts, control boxes, drainpipes, and furnace casings.

Heating technicians perform construction-related tasks in the residential market dealing with the design, installation and servicing of heating, ventilation and cooling systems through forced air or hydronic means, often including either sheet-metal / duct work and / or piping installation.

Geothermal technicians operate, maintain or repair geothermal power plants and commercial and residential geothermal heating installations. Their tasks include monitoring the processes that lead to electricity and heat production and intervene when adjustments of parameters or equipment repair is necessary.

Pipefitters / steamfitters install, assemble, fabricate, maintain and repair mechanical piping systems. They deal with industrial / commercial / marine piping and heating / cooling systems.

Careers obtained via academic stream

Sales engineers / managers work as technical sales consultants to engineers, architects, utility companies, contractors, and owners/ developers in the design, application and sale of heating and ventilation systems, controls and related material across a distributor network.

System & application engineers' daily tasks include engineering and equipment selections, HVAC&R system design, specification review, unit pricing, and project quoting. Application engineers are responsible for coordination with vendors, basic accounting and invoicing, submittal creation & review, review of terms and conditions, preparation of subcontract agreements, release of equipment.

Installation managers ensure installers are completing the installation properly including technical competency, paperwork, post installation checklist, etc., approve completed installations.

Production, project, service managers make strategic and tactical decisions on the overall operation of the organisation to meet quality, delivery, revenue and cost objectives, including: manufacturing / production, production control and planning, quality engineering, equipment and facilities engineering, inventory and materials control, and customer support.

Professors / lecturers teach various HVA&R courses at the universities, and vocational training organizations. They are responsible for providing quality instruction to students through classes, relevant assignments, etc.

R&D engineers take an active role in modelling, prototyping, evaluating, testing, and collaborating with others. They are also involved in hands-on testing of custom equipment designed to meet the stringent requirements of clients.

Consulting / design engineers work directly with clients to design new or replacement heating, cooling and refrigeration systems, specific to customer needs and building specifications. Their tasks include completing HVAC&R-related drawings, preparing project estimates, and overseeing the installation of projects to completion.

Quality assurance managers plan, coordinate, and direct quality assurance programmes designed to ensure quality production of products consistent with established standards.

Technical trainers are responsible for facilitating the skill advancement and education of HVAC&R and plumbing application and service solutions by continuously enhancing the knowledge level of the industry through designing, coordinating and executing training (live, eLearning, webinars, and recorded).

TRAINING ON NATURAL REFRIGERANTS

REFRIGERATION AND AIR CONDITIONING EQUIPMENT USING NATURAL REFRIGERANTS IS INCREASINGLY BECOMING POPULAR ACROSS DIFFERENT APPLICATIONS IN EUROPE. TO A LARGE EXTENT, THIS IS THE RESULT OF NATIONAL, REGIONAL AND GLOBAL POLICIES PHASING DOWN HIGHLY POLLUTING HFCS. AS END USERS HAVE GAINED EXPERIENCE AND CONFIDENCE USING NATURAL REFRIGERANTS, A GROWING NUMBER OF THEM ARE COMMITTING TO USING HFC-FREE EQUIPMENT IN NEW SYSTEMS.

The growing demand for natural refrigerant-based systems puts pressure on the existing workforce, to update their knowledge, practical and theoretical skills to enable them to safely handle equipment using natural refrigerants.

This chapter explores the specificities of training requirements for natural refrigerants. In addition, based on the results of an industry survey, the GUIDE outlines key drivers and barriers for the uptake of natural refrigerants training.

General requirements for natural refrigerant training

This GUIDE covers training related to carbon dioxide, ammonia and hydrocarbon (R290, R1270, R600a) used as refrigerants in heating, refrigeration and cooling equipment. Natural refrigerants have specific properties that are different to fluorinated gases, which require particular attention and specialised theoretical and practical training in order to ensure safety, energy efficiency, durability and proper functioning of equipment.

Compared to fluorinated gases, natural refrigerants have zero or near to zero GWP. Due to the difference in properties as compared to traditional f-gas refrigerants a number of aspects need to be considered:

- Operating pressures;
- Performance – capacity and efficiency;
- Material compatibility, including compressor lubricant;
- Safety, including flammability and toxicity;
- Temperature glide;
- Ease of use and skill level of design engineers and technicians who install, service and maintain equipment.

While each natural refrigerant has its specific characteristics, which need to be addressed in the training, certain general minimum requirements for training could be applied for all natural refrigerants. The European association of refrigeration, air conditioning and heat pump contractors (AREA) has made recommendations for minimum requirements for training and certification concerning HFC replacements, including both theoretical and practical training.

The minimum requirements outlined here are not exhaustive, but serve as a basic overview of theoretical and practical knowledge and skills that technicians should acquire in order to be able to safely and properly handle equipment using natural refrigerants.

Theoretical training should include classes on refrigerant basic thermodynamics and physics, health & safety requirements, and regulations & standards, including:

- Thermodynamic properties of natural refrigerants: temperature, pressure, density, thermal capacity, p/h diagram
- Differences between natural refrigerants and HFCs
- Toxicity characteristics, grades and limits for the human body
- Flammability characteristics, lower and upper flammability limits, occupancy
- Specific components needed for specific refrigerant in the refrigeration cycle
- Material compatibility
- Oil compatibility, requirements and oil return
- European and national regulations and standards
- Storage & transport of refrigerants
- Health & safety rules, incl. location of emergency exists, fire alarms, leak detectors, and others
- Calculation of lower flammability limits (LFL) in confined space
- Calculation of confined space risk for asphyxiation

During practical training technicians should acquire relevant skills to be able to perform the following tasks:

- Select appropriate tools, equipment and personal protective equipment for work on natural refrigerant RAC systems
- Recover the refrigerant
- Vent the refrigerant in a safe way (in accordance with national legislation)
- Calculate safe fill weight for the recovery cylinder (density difference between HFCs and natural refrigerants)
- Check leaks with the correct equipment
- Make refrigerant vacuum preventing moisture in the system and refrigerant emissions
- Refill refrigerant without emission relief
- Make connections without brazing with alternative connections
- Check the correct functioning of the safety ventilation system
- Check the correct functioning of the safety system controls
- Perform safe system shutdown and isolation
- Extinguish a fire
- Perform first aid for frostbite, fire burn, suffocation due to breathing problems

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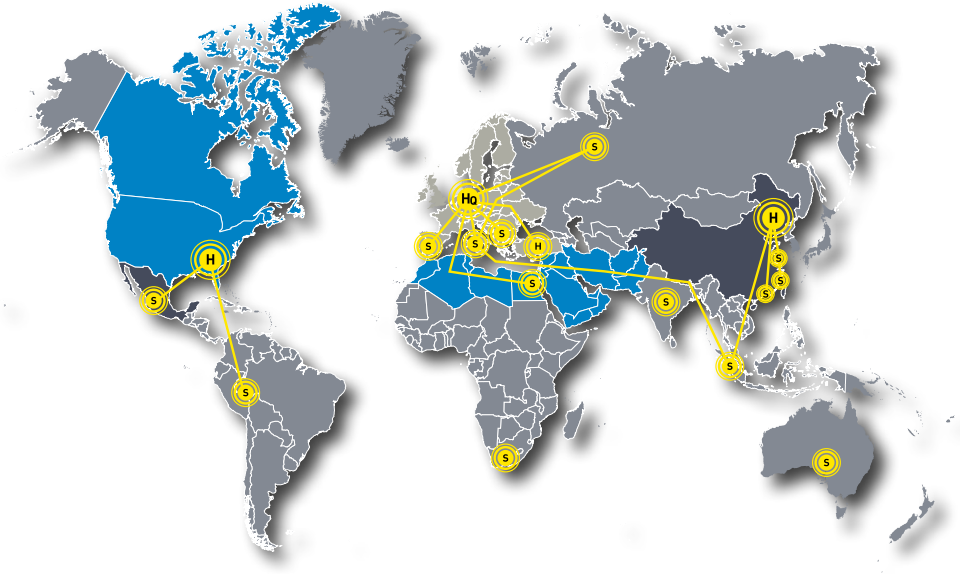
SECOP

SECOP COMPRESSORS – CUSTOMER SUPPORT



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Secop has headquarters in Flensburg, Germany and further production facilities in Austria, China and Slovakia. Moreover, Secop has sales offices in USA, Russia, China, Italy and Turkey as well as strategically located support centres.

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SPECIFIC REQUIREMENTS FOR TRAINING ON CO_2, AMMONIA AND HYDROCARBONS

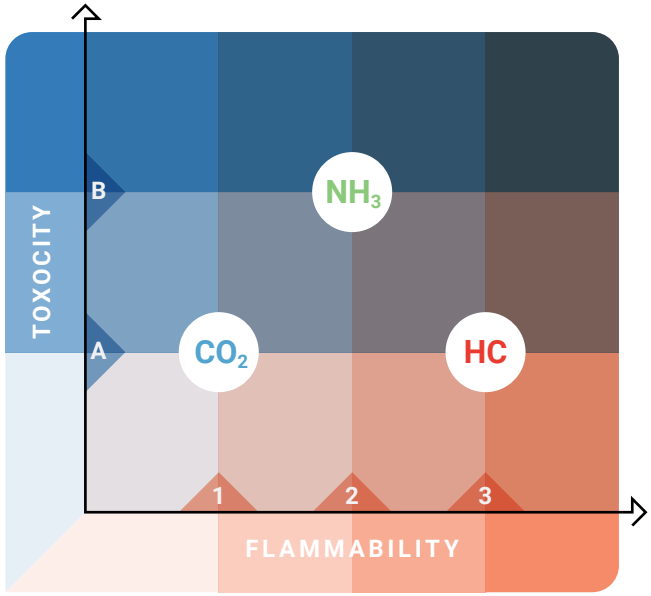
IT IS IMPORTANT TO HIGHLIGHT THE SPECIFIC CHARACTERISTICS OF EACH NATURAL REFRIGERANT, WHICH NEED CAREFUL CONSIDERATION.

Within the HVAC&R industry refrigerants are assigned safety classification, which is a function of toxicity and flammability. The classification scheme is adopted by standards such as EN 378 and ISO 817. The toxicity classification is divided into two toxicity classes:

- **Class A** refrigerants are those where no toxicity has been observed below 400 ppm
- **Class B** refrigerants are those where toxicity has been observed below 400 ppm

The flammability classification depends upon whether or not the substances can be ignited in standardised tests, and if so, what the lower flammability limit (LFL) and the heat of combustion are. There are three flammability classes:

- **Class 1** refrigerants are those that do not show flame propagation when tested in air at 60°C and standard atmospheric pressure
- **Class 2** refrigerants are those that exhibit flame propagation when tested at 60°C and atmospheric pressure, but have a LFL higher than 3.5% by volume, and have a heat of combustion of less than 19,000 kJ/kg
- **Class 3** refrigerants are also those that exhibit flame propagation when tested at 60°C and atmospheric pressure, but have an LFL at or less than 3.5% by volume, or have a heat of combustion that is equal to or greater than 19,000 kJ/kg



Training on carbon dioxide

R744 is not flammable, but its higher operating pressures, toxicity at high concentration and potential for dry ice formation must be taken into account when applying and handling.

Technicians need to follow strict safety procedures when handling, servicing and installing CO_2-based equipment. Prior to working or training on a system or handling refrigerant, technicians should be equipped with necessary safety equipment, as well as check the material safety data sheet regarding the refrigerant. Technicians should wear safety glasses and goggles at all times when handling the refrigerant and system. They should wear a proper respiratory protection for any work on CO_2 equipment in a closed area where leak is suspected.

Compared to fluorinated and other natural refrigerants, CO_2 operates at a higher pressure, especially when ambient temperatures cause the system to work above the critical point. However, only in a few parts of a CO_2 system will the pressure be higher than in a conventional system, and special components are available and used for that purpose. Systems are typically designed to withstand the maximum working pressures of CO_2 of up to 52 bar in subcritical cycles and 140 bar in transcritical cycles (although such pressures are rarely reached). When working with a CO_2 system, personnel should always check the operating pressures of the refrigerant by using gauges to monitor the pressure. CO_2 system components, pipe work, tools and equipment must be rated to safely operate at a higher pressure. To make sure that the pressure does not reach the relief pressure in case of power failure or an unexpected shutdown, the systems can also be fitted with a small supporting cooling system.

R744 is an asphyxiant with a threshold limit value (TLV) of 5,000ppm (0.5%), beyond which CO_2 concentration might affect health. One must ensure that the facilities with CO_2 equipment are equipped with ventilators, as well as with gas sensors that will prompt an alarm when the CO_2 concentration reaches a specific limit.

Formation of dry ice (solid R744) can occur if a system is not handled properly. This happens when CO_2 pressure and temperature drop below the triple point if the refrigerant is vented during servicing or when a system below 4.2bar is charged. Dry ice absorbs heat from the surroundings as it transforms into gas. With significant increase in pressure dry ice can block vent lines and care must be taken by servicing personnel to ensure this does not happen.

Technicians must also learn how to charge CO_2 systems safely. Some systems, such as cascade systems and parts of transcritical systems, have a lower maximum operating pressure than the CO_2 cylinder pressure. Therefore, to prevent pressure relief valves discharging, the systems must be charged slowly and carefully.

Training on hydrocarbons

Hydrocarbons carry an A3 safety classification, which means they have a low toxicity but are in the higher range of flammability. Hydrocarbons are subject to strict safety requirements concerning the quantities permitted in occupied spaces. Therefore, an increased training offer must remain a priority for the industry in order to safely handle hydrocarbon refrigerant-based systems. Training techniques and tools are in place to manage safety challenges.

Before starting to train or work on systems containing hydrocarbon refrigerants, safety checks are needed to ensure that the risk of ignition is minimal. The area should also be checked with an appropriate refrigerant detector to ensure that technician is aware of potentially flammable atmospheres.

All the equipment and tools must be checked for suitability to work on hydrocarbon systems, with particular attention to refrigerant recovery and leak testing units, electrical test meter, refrigerant recovery cylinders, portable lightning.

All work with the flammable refrigerants must be covered under the controlled procedures to make sure that the risk of the flammable gas and vapour is eliminated while the work is done.

Technicians must also train how to properly and safely charge the system with hydrocarbon refrigerant. The charging of the refrigeration system is similar to the fluorinated refrigerants. The system must be charged with hydrocarbon refrigerant in the liquid phase and technicians must ensure that contamination of different refrigerants does not occur while using charging equipment. After the system is charged, the system must be labelled, showing that hydrocarbon refrigerants have been charged in the system and that it is flammable. After the charging, the system must be leak tested.

Training on ammonia

Ammonia is categorised as a B2 refrigerant, which equals higher toxicity and mild flammability. The acute toxicity of ammonia is a major consideration in the safe design and operation of refrigeration systems. Ammonia is a gas with a distinctive pungent odor, which can normally be detected by smell at concentrations of 5-10 parts per million (ppm). Higher concentrations are easily detected. It should be noted that the effect of ammonia is a function of concentration level and length of exposure time. Higher concentrations can be tolerated for short periods but the effect of ammonia breathed into the lungs or in the eyes can persist for long periods.

Depending on the duration and quantity of the exposure, ammonia can cause slight irritation, suffocation or death, so adequate training is required wherever the product is stored or handled.

Technicians must always wear suitable personal protective equipment including gloves and goggles. Technicians must also ensure that breathing apparatus or respirator masks are available and close to hand to be used in case of emergency. In addition, fire-fighting equipment must be accessible in the machinery room.

If special work must be carried other than a routine check of the ammonia system, technicians should work in pairs.

NATURAL REFRIGERANT TRAINING – DRIVERS & BARRIERS

LACK OF TRAINED TECHNICIANS ABLE TO HANDLE NATURAL REFRIGERANT-BASED EQUIPMENT IS OFTEN CITED AS ONE OF THE MOST IMPORTANT BARRIERS TO INTRODUCTION OR WIDER UPTAKE OF THESE TECHNOLOGIES. THIS SECTION LOOKS AT THE KEY FACTORS THAT INCENTIVISE THE INDUSTRY TO TAKE UP A NATURAL REFRIGERANT COURSE OR INVEST IN SETTING UP A TRAINING FACILITY FOCUSING ON SUCH TECHNOLOGY.

The industry survey carried out by shecco also investigated the key barriers to uptake of natural refrigerants training both from the view of training providers and receivers.

Drivers

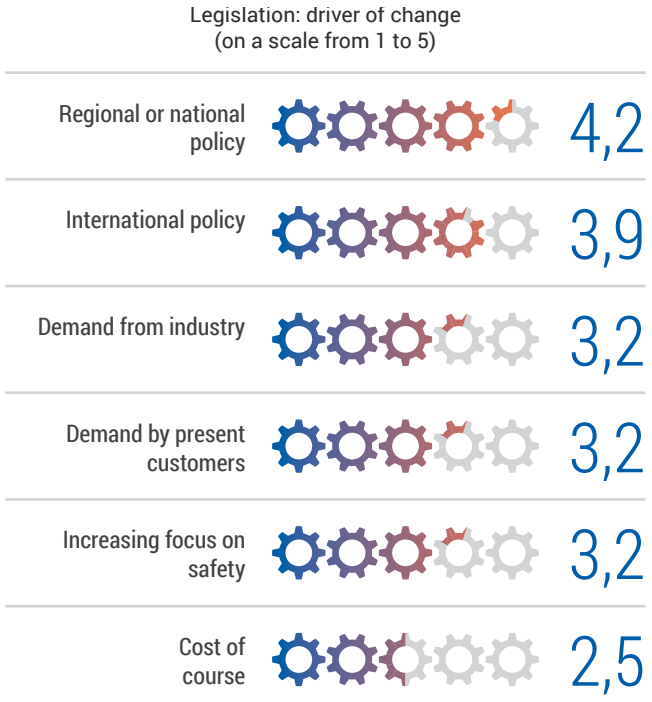
The future HFC phase down under the Montreal Protocol and the EU-F Gas Regulation are the key instruments incentivising the industry move towards environmentally friendly alternative technology. The uptake of new technology creates demand for training relevant to these technologies.

Demand by the industry and present customers, as well as increasing focus on safety are among relevant drivers. The survey respondents did not consider cost of a training course to play a key role in the uptake of natural refrigerant training, although in was mentioned as one of the barriers.

Policy as the main driving factor for natural refrigerants training

Legislative requirements that limit the use of HFCs and incentivise the adoption of natural refrigerants have clearly been identified as the most important factor in the uptake of natural refrigerants training. Policy developments are driving the uptake of natural refrigerants all around the world. The 2016 amendment to the Montreal Protocol will see a global phase down of HFCs - this major development is expected to change the face of today's HVAC&R industry.

The survey respondents ranked national and regional legislation as the most important driver for the European market. The EU F-gas Regulation is the main instrument that will require the industry to phase down HFCs by two-thirds (compared with 2014 levels) by 2030.



The current mandatory training and certification requirements under the F-Gas Regulation address only fluorinated refrigerants. Nevertheless, the changing legislative landscape will require the European HVAC&R industry to transition to alternative refrigerant technology that does not rely on HFCs. This will in turn propel the uptake of necessary training on natural refrigerants that technicians will have to acquire in order to be able to handle the equipment. Moreover, there are certain standards and directives that require technicians working with natural refrigerants to have appropriate training
(N.B. this is explored in more detail in the following chapter).

Increasing focus on safety

Safety should always be in the centre of consideration when handling any refrigerant. Manufacturers of natural refrigerant-based equipment and components have a strong interest in ensuring safety of the technology, which has different characteristics than the traditional HFC-based. Safe installation and maintenance is a prerequisite for the success and wider uptake of the technology in the future. Any mishandling that could lead to potential accidents would be a major risk for the acceptance of the technology by end users.

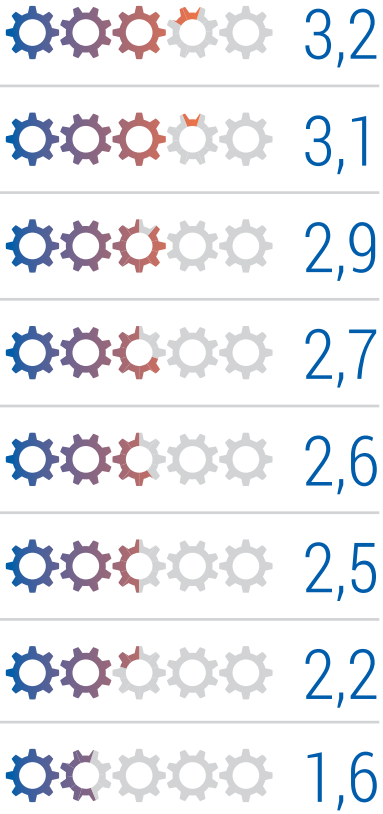
To this end, adequate theoretical and practical training to ensure safe design, installation, servicing and operation of natural refrigerant-based systems becomes even more important as the technology becomes more widespread.

Demand determines the offer

Whilst, policy might give a push to the industry to shift towards natural refrigerants, the real demand for the training derives from the industry and end users of the technology.

Barriers

Key reasons for not providing training on natural refrigerants (on a scale from 1 to 5)



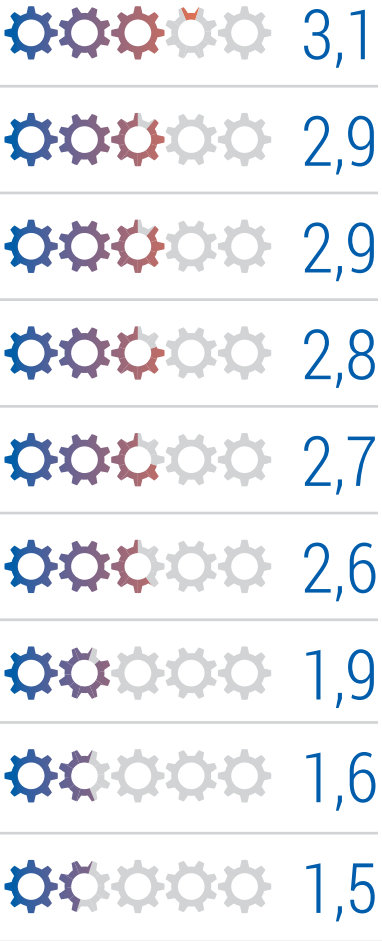
Training providers

The survey asked industry representatives about the key reasons for not providing training on natural refrigerants. Training providers identified costs associated with investments in trainers with the adequate skills and setting up the training centres as the key constraint. Unavailability of adequate premises to offer the training as well as lack of relevant training material were also among important barriers for a number of training providers.

Training receivers

According to survey respondents the main reason for not taking up a formal training on natural refrigerants is the high cost of such training. For a number of representatives, on-the-job training is sufficient to perform their duties and no formal training is required. Several respondents noted that there is still a gap between the demand and offer as they see that there is either lack of available training courses or they find it difficult to access the training that is being offered.

Main reasons for not taking up training on natural refrigerants (on a scale from 1 to 5)



Investment costs rank high for both training providers and receivers

Training providers highlighted that it requires substantial investment costs to employ HVAC&R instructors, establish training centres and purchase the necessary equipment, including tools, systems and other material for training purposes. Nevertheless, with the growing demand for natural refrigerants training such investment becomes increasingly worthwhile.

From the point of view of training receivers (including contractors, end users and others), the investment cost to formally train technicians on natural refrigerants is seen as too high. A large share of European HVAC&R companies are small-sized businesses that do not have the necessary financial resources. To solve this issue, it is often the equipment and component manufacturers who offer their trained technicians to guarantee safe installation and maintenance of the natural refrigerant-based systems, rather than relying on external support. Alternatively, the manufacturers provide training for their customers free of charge.

Formal training & certification is not required

In Europe, it is not allowed to work in the HVAC&R sector without adequate training. Handling technology, which contains f-gases, requires technicians to undergo training and obtain special certifications. However, there are no mandatory certification requirements for natural refrigerant training at the EU level. Therefore, there is no requirement to report to national authorities whether someone handling natural refrigerant-based systems underwent appropriate training. It is therefore often the current practice, especially within smaller companies, to employ trainees who will learn the trade on the job working together with qualified professionals.

According to the training receivers, the absence of a requirement for a formal certificate is one of the main reasons for not following a training on natural refrigerants. This is not necessarily a barrier but it rather shows that formal training on natural refrigerants, compared to f-gas training, is not yet a common way of learning in Europe.

Lack of available training courses

Training receivers identified the lack of training courses on natural refrigerants as a third reason for not taking up such training. The training gap between available and required training varies from country to country and depends on the specific needs of individual companies. Overall, shecco has identified close to 200 companies in Europe that offer training related to natural refrigerants and this number is constantly growing. Theoretical, practical, online and on-site training is offered by training institutes, system and component manufacturers, universities, research institutes, associations and other organisations.

One of the ways to close the training gap would be to increase the awareness of the training that is already available in different countries. The following chapters look more closely at the current market situation, while the directory, which is an integral part of this report lists the current training providers.

A range of training material is available, many of which can be accessed free of charge. This is a good basis for the rollout of new training courses. These materials are, however, not available in all European languages - translations into all relevant languages could support a wider use across the EU.

INDUSTRY VIEWPOINT – ON CO_2 TRAINING...

Antoine Azar,
refrigeration consultant, former
global programme Director at
the Coca-Cola Company

"We have been hearing about the difficulties in servicing CO_2 in the field, but I can ensure you that [...] having proper training and proper people to do the job [is] all you need to service CO_2. It's a matter of being well trained."

Giovanni Dorin,
marketing manager
at Dorin Innovation

"Many local associations are setting up training courses in CO_2 applications and alternative systems, and this has to be implemented more and more. Actually the government should support these trends in order to put professionals in the position to handle the new refrigerants safely. At Dorin, we also conduct yearly training for our customers."

Kevin Glass,
UK managing director
at BITZER

"Carbon dioxide, in particular, is clearly a major area of development for the future. BITZER is supporting this with its focussed carbon dioxide training course, based at the company's headquarters in Germany."

Bart Driessens,
director, service operations
at Carrier Commercial Refrigeration Europe

"Participating in internal training activities under best-in-class conditions enables our field technicians to gain and apply the latest knowledge on how to install and service CO_2OLtec® turnkey projects with the highest level of quality and reliability."

Kim G. Christensen,
managing director
at Advansor

"The story that there isn't enough CO_2 training capacity is a lie."

José María De Santos,
head of refrigeration installations
at Makro

"The main handicap is training for installers and maintenance personnel. Most of them are not prepared or don't have a chance to work with this kind of installation. It will take a bit of time, three or four years."

Christian Heerup,
technology manager, refrigeration,
at DTI

"There are lots of people that want a better understanding of what's go and no-go with CO_2. The market has matured in Denmark and now we're seeing people with different kinds of occupations attend the courses.

The course is a combination of theory and hands-on, people can see it work with high pressures and train for set points.

A lot of people are a little bit afraid of CO_2 as a refrigerant because they are not used to working with high pressures and suddenly they can see a system working right in front of them with 100 bar reading on the gauge so they are much more confident after doing the hands-on training."

INDUSTRY VIEWPOINT – ON HYDROCARBON TRAINING...

Berty Jakob,
senior research and development manager
at Unilever

"Regarding the implications for servicing it is important to ensure that service engineers are skilled and properly trained for working with hydrocarbons. Training of service personnel is key. Do it right first time and it will serve you for years to come."

Marek Zgliczynski,
manager of commercial refrigeration
product engineering at Embraco

"EU refrigeration technicians' mandatory certification does not include flammable refrigerant topics. This gap has to be quickly corrected to allow fast and safe growth of natural refrigerant technologies."

INDUSTRY VIEWPOINT – ON AMMONIA TRAINING...

Carsten Dahlgaard,
industrial refrigeration global
marketing director at Danfoss

"The biggest challenge today is the lack of skilled people able to operate these systems [NH_3/CO_2 systems], from both the engineering and contractor side. The knowledge today on how to handle and build such systems is still very limited, although we have seen some improvements. Danfoss' strategy is therefore to also help our customers by providing support with training."

Peter White,
director
of Polar Pumps

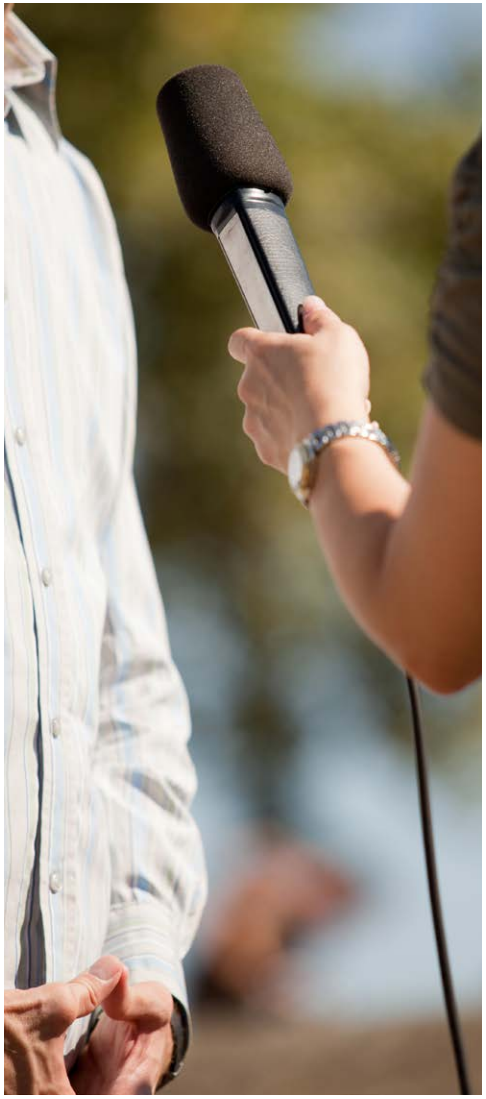
"50% of those we train are for ammonia and this seems to be growing. The industry is changing as refrigerants have gone from CFCs, HCFCs, HFCs and now on to HFOs. People want a bit of security; ammonia has been here since forever and it will stay here forever."

Jason Clark,
senior training consultant
at the Grimsby Institute of Refrigeration

"The industry leads and we follow along. There's no point us putting out training if there's no industry out there wanting it... And as the industry introduces all of these natural refrigerants, the training sector will catch up and it will mingle in. I do think it is just a matter of time".

INTERVIEWS

Vittorio Iormetti
D&AM Technical Support - Embraco



What has been your balance so far regarding training on natural refrigerants?

Embraco is committed to educating the market on the safety and handling of hydrocarbons, providing trainings to OEMs, distributors and end-users, supporting training providers, being stakeholders of EU Alternative Refrigerants e-learning and organizing webinars.

The scope is to improve technical skills and the attention to regulations, standards and guidelines, with a particular focus on safety, duty of care, risk assessment and responsible approach.

The spread of hydrocarbons is increasing once more, both for having negligible impacts on the environment and for the important role on the reduction of the equipment's energy consumption, which means that it solves both direct and indirect CO2 emissions at once.

What has been the feedback from people participating in the natural refrigerants training sessions organized by your organization?

The interest in Natural refrigerants training is very high, and is intended to grow, due to a low knowledge on the use and management of hydrocarbons inside the system.

There are still some concerns and misconceptions regarding the flammability and safety of hydrocarbons, and a low confidence on its use, that's why trainings in this directions are needed.

Prepared and responsible technicians will facilitate the diffusion of Natural Refrigerants, optimizing performance, energy saving, environmental protection, reducing TCO of the applications, all fields where Embraco is considered as a reference.

One of the main requests coming from OEMs attending trainings on Natural Refrigerants, is the increase of the charge limit of propane (now is <150g) and there is a common effort to make it up to 300-500 grams to cover all plug-in range with single circuit solution recommended, in order to best exploit the potential of propane in bigger systems.

What do you see as the main challenges and barriers to offer natural refrigerants training in Europe?

Right now a certification for hydrocarbons training doesn't exist but the EU Directive 517/2014 requires that those who get the existing certification for HFC gases will be informed also about the use of hydrocarbons.

Since Embraco believes on the R290 as the refrigerants of the future worldwide, having an official certification would be very important, in order to dissolve risks of hydrocarbons linked to flammability and safety. It could moreover help installers to adopt solutions with these refrigerants earlier, by offering them security and trust on hydrocarbons.

A big challenge to support the spread of hydrocarbons is the need of high financial investment in order to install the charge station for propane.

How many people has your organization trained last year, and what is your estimate for the coming years on this number?

Since years Embraco is committed to educating the market on the safety and handling of hydrocarbons, providing hundreds of trainings to OEMs, distributors and end-users, supporting training providers, being stakeholders of EU Alternative Refrigerants e-learning and organizing webinars.

In the last years are growing in numbers training providers and Embraco is willing to focus even more to support them with material and resources; they attract producers and installers in all Europe and in the world and they release a certification of attendance at the end.

Volker Stamer, SCHAUFLER Academy Director - BITZER

BITZER's SCHAUFLER Academy opened last year to provide training specifically designed for technicians/engineers in the HVAC&R sector. What has been your assessment so far regarding training on natural refrigerants?

The interest in our training at the SCHAUFLER Academy in Rottenburg (Germany) has been immense. Our CO_2 and ammonia seminars in particular are much in demand, but propane is constantly growing in importance too. One reason for this is that the complexity of the systems and thus the need for training is increasing. CO_2 (R744) for example has a global warming potential (GWP) of 1, making it virtually climate-neutral. However the thermal loads and the high operating pressures require well-trained specialists for efficient operation.

What has been the feedback from people participating in the natural refrigerants training sessions organised by your organisation?

The feedback from our seminars has been unanimously positive. The participants are enthusiastic about the amount of information and the concrete example applications. Our courses are led by employees with plenty of practical experience from the application engineering department, from sales and from product management. In specially equipped rooms we can also simulate real system conditions. On request, visitors on a guided academy tour can learn more about the SCHAUFLER Academy's energy concept which has won several awards, and how modern systems can be used efficiently so as to protect the environment.

What do you see as the main challenges and barriers to offer natural refrigerants training in Europe?

The sector is strongly characterised by small businesses employing craftsmen, who simply don't have the time to send employees on training courses. It is also comparatively expensive for them. Everyone has to try hard to take suitable measures and create the right motivation. Apart from that, there are currently not enough training options. For about 2,850 specialist companies in this country for example, there are just a handful of training facilities, so with the international SCHAUFLER Academy, BITZER has created a modern facility which is open to everyone.

How many people did your organization train last year, and what is your estimate for the coming years on this number?

In 2016 we trained 2,300 specialists at the SCHAUFLER Academy. A number that we are proud of. Nevertheless, now and in the future we have a clear goal. At BITZER we count on the quality of the training and not on the quantity. After a seminar at the SCHAUFLER Academy you are at the latest state of the art.

Giovanni Dorin Marketing Manager - Dorin

What has been your balance so far regarding training on natural refrigerants?

We have handled in 2016 several training courses for our partners in handling and reparation of CO_2 compressors on different applications. We strongly consider that the training of operators is deeply important in order to make transcritical applications easier and more appreciated. Technicians confidence in this relatively new and very interesting technology is absolutely the basis for a further development of Natural Refrigeration

What has been the feedback from people participating in the natural refrigerants training sessions organized by your organization?

All the participants were profoundly interested and grateful for the very much interesting information given. They also appreciated very much the chance to have a hands on experience with the machines while attending the course.

What do you see as the main challenges and barriers to offer natural refrigerants training in Europe?

We do not foresee any significant barriers to offering natural refrigerant training neither within Dorin nor within Europe.

How many people has your organization trained last year, and what is your estimate for the coming years on this number?

We trained about 25 people in 2016 and we expect more or less the same number in 2017. As I said, it is not an open training but it's reserved for our partners and their technicians on demand.

4 Market for natural refrigerant training today & tomorrow

GIVEN AN INCREASING MARKET SHARE OF NATURAL REFRIGERANT-BASED TECHNOLOGY IN EUROPE AND GROWING COMPLEXITY OF COMPONENTS AND NEW SYSTEM SOLUTIONS, INCLUDING ELECTRONIC MODULATING EJECTORS, INTEGRATED FREQUENCY INVERTERS, ELECTRONIC COMPONENTS OR COMPRESSORS, DEMAND AND SUPPLY OF PROPER TRAINING ON NATURAL REFRIGERANTS IS STEADILY RISING.

This chapter looks closely at the current status and future situation when it comes to availability of natural refrigerant training from the side of training providers as well as interest in such training from the side of training receivers. A map of natural refrigerant training providers shows there are already close to 200 organisations offering training on CO_2, ammonia and hydrocarbons, while the survey analysis demonstrates this number will likely grow over the next few years.

A survey conducted among more than 340 industry experts provides insights into types of training, most popular ways of training delivery, applications, topics covered and others. The findings indicate that most industry representatives that provide or receive natural refrigerant training are involved in training on CO_2. Training related to this refrigerant is also expected to register the strongest growth in the next 5 years - this is a clear correlation with the market developments as CO_2 is becoming a refrigerant of choice for a number of applications, especially commercial refrigeration, but increasingly also industrial refrigeration as well as smaller equipment.

NATURAL REFRIGERANT TRAINING TODAY

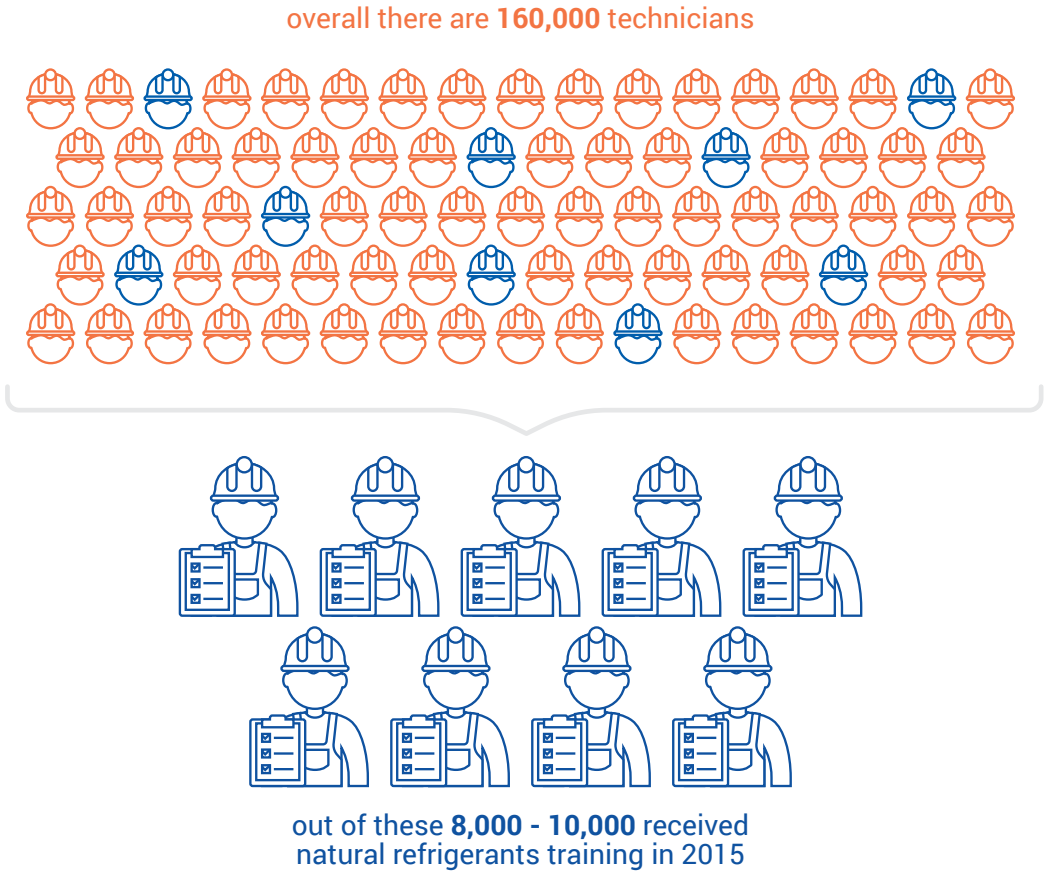
TODAY THERE ARE AROUND 160,000 TECHNICIANS WORKING FOR 40,000 CERTIFIED COMPANIES IN 21 EU MEMBER STATES, ACCORDING TO A REPORT PUBLISHED BY THE EUROPEAN COMMISSION IN DECEMBER 2016, WHICH EVALUATED THE AVAILABILITY OF TRAINING REGARDING SAFE HANDLING OF F-GAS ALTERNATIVES.

The research conducted by Gluckman Consulting and Ricardo-AEA on behalf of the European Commission indicated that there was a significant level of uncertainty about the number of technicians trained to handle natural refrigerants. This is due to the fact that currently there is no requirement to report on natural refrigerant training to central authorities (unlike for f-gas training). The data was collected from national authorities while it did not investigate about the situation amongst the industry representatives.

The findings indicate that there is a higher level of training available for ammonia, while there seem to be a significant gap in availability of training for CO_2 and hydrocarbons. Based on the records of national authorities, more than 4,700 technicians were trained to handle ammonia in the EU, which represents only 2.3% of the total number of f-gas trained technicians. The training on hydrocarbons seems to be the least available. Nevertheless, the data should be treated as underestimate as it does not fully reflect the actual market situation.

Ammonia	71%	2.3%
CO_2	52%	2.2%
HC smaller equipment (plug-in)	48%	0.7%
HC larger equipment (chillers, split systems)	35%	0.05%

Source: European Commission (2016), Report from the Commission on availability of training for service personnel regarding safe handling of climate-friendly technologies replacing or reducing the use of fluorinated greenhouse gases



To get a more comprehensive picture of the number of technicians trained in natural refrigerants, shecco conducted a survey among HVAC&R industry experts. The findings indicate that the number of technicians who received training on natural refrigerants in 2015 was at least 8,000-10,000.

This estimate is based exclusively on the results of the survey and the actual number was likely higher given that several respondents (10% of training providers) could not estimate how many technicians they have trained. In addition, there are other training providers who have not taken part in the survey.

Close to 200 companies provide natural refrigerants training in Europe

For this first edition of GUIDE Training, shecco compiled a directory of companies in Europe that provide training on natural refrigerants in any form. The list is not comprehensive but rather serves to get an idea of what trainings and formations are available in which country. Furthermore it helps interested parties to get to know the institutions and companies active in the sector and find useful contacts for own training requirements.

Several companies in Europe are already taking steps to provide training on natural refrigerants. shecco has identified close to 200 companies in Europe, including training institutes, system and component manufacturers, universities, research institutes, associations and other organisations, who offer training related to natural refrigerants.

The majority of the training providers (approximately half of the total) are universities, vocational schools or training institutes. These play a key role in providing entry-level education as well as continuous learning to more experience engineers and technicians. About a third of the training providers are from the supplier side of the HVAC&R industry, such as system or component manufacturers, refrigerant suppliers or engineering and installation firms. This shows that there is active involvement of the industry itself to promote natural refrigerants and train their staff or people from outside accordingly to adopt these new technologies. Besides these, there are a number of associations that provide courses on natural refrigerants or are in some way involved in coordinating the activities on such training for its members.

The wide spectrum of training providers is a reflection of the whole market realising the potential of natural refrigerants and the importance an appropriate training will have on the future industry. Engineers and technicians need to have access to the relevant training on natural refrigerants during their initial stages of education and throughout their careers to be able to keep up with the market development.

Most training providers identified in this research offer on-site training and more than half of the organisations offer some sort of practical training besides the theoretical one, which is provided in all cases.

In this directory, about 80% of the organisations provide training on CO_2 as a refrigerant, while 50% provide training on ammonia and hydrocarbons each.

The United Kingdom and France appear to be hotspots for training on natural refrigerants, followed by Germany, Spain, Italy and Sweden. It is important to note though that the number of training providers does not necessarily correspond with the number of trained technicians by country - one training facility could train more people than others.

The available natural refrigerants training outlined in this map also depend on each organisations' communication about these. It can be noted that while the market for natural refrigerants training is highly varied with different actors, universities, associations, suppliers and others are increasingly becoming more outspoken, which goes hand in hand with growing interest in these kind of courses.

The directory, which is an integral part of this report, lists the European natural refrigerant training providers by country. It provides additional information that helps guide those looking for suitable courses to enhance their practical and theoretical training on CO_2, ammonia and hydrocarbons.

leading organisations that provide training active in the European market in 2016

40	France	4	Greece
34	UK	4	Ireland
18	Germany	4	Norway
15	Spain	3	Bulgaria
11	Italy	3	Poland
11	Sweden	3	Portaugal
9	Netherlands	2	Austria
9	Switzerland	2	Hungary
8	Denmark	2	Russia
5	Belgium	1	Czeck Rep.
4	Finland	1	Georgia
193	Total		

Disclaimer: These figures are based on analyses of leading organisations active in the European market in 2016. While reasonable efforts have been made to identify the number training providers as close to reality as possible, these figures are not exhaustive and shall serve as an indication of the market for natural refrigerants training.

Please contact research@shecco.com if you would like to be included in this map and the directory of natural refrigerant training providers.

Natural refrigerant training providers

In Europe, practical and theoretical training on natural refrigerants is offered by universities, training institutes, system manufacturers, component manufacturers, associations, end users, private training providers, consulting, contracting, engineering firms, vocational/professional schools, certification bodies, research institutes.

The choice of a training provider depends on a number of factors, including the level of prior knowledge, accessibility of training offered, cost of a training course, relationship with the training provider and others. According to the survey results, the most preferred training providers are system manufacturers, followed by component suppliers and consulting, contracting and engineering firms. Servicing, repair, maintenance firms and end users were the least two favourite choices among training receivers that took the survey.

System manufacturers

Carrier's CO_2OLacademy, a training facility opened in 2015 in Mainz, Germany, provides the company's technicians from across Europe with knowledge of CO_2 refrigerant technologies.

Carrier organises five-day courses for 7-10 key trainers who come from different countries. A few weeks after the training, these key trainers return to Mainz with technicians from their respective countries, and the key trainers teach these technicians in their mother tongue. These two-day sesions are organised in small groups of not more than ten participants. Before the course, technicians receive e-learning material, ensuring they already have a certain level of knowledge before arriving in Mainz. The training is 40% theoretical knowledge and 60% practical exercises.

Since the opening of the training facility, Carrier has targeted to train approximately 600 people by the end of 2016 by organising training courses for 25 countries – first concentrating on the regions with the highest density of CO_2 installations, but also planning to expand the programme to other countries later on.

EPTA SPA , system manufacturer based in Italy, is providing CO_2 training in commercial and domestic refrigeration areas to qualify internal staff. The training is available in English, Italian, French and German and covers topics, such as basic thermodynamics and physics, material compatibility, lubricants, application area, case studies, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation and maintenance.

Danish system manufacturer **Advansor** provides practical and theoretical training on site, as well as theoretical courses online for CO_2 refrigerant. Applications covered by training are commercial and industrial refrigeration, air conditioning and heating. The purpose of the programme, which is free of charge, is to train the company's own staff as well as its customers. Following a two-day course, a certificate is provided at the end of the training.

Component manufacturers

BITZER's training centre, the **SCHAUFLER Academy**, had its official inauguration in February 2016. The Academy seeks to develop a close and constructive relationship with schools and universities, while spreading knowledge about new HVAC&R technologies and refrigerants beyond Germany's borders.

All the academy's refrigerant training sessions cover issues like thermodynamics, safety, material compatibility and system design. Courses on transcritical and subcritical CO_2 systems also offer hands-on training: participants are equipped with the necessary skills to deal with day-to-day operating demands, as well as learning how to fill systems up properly or start them up from scratch.

The academy welcomes consultants, system manufacturers, service staff and operators from all over the world to its courses. The Schaufler Academy has five rooms for theoretical work and three rooms for practical training. It also contains an office space for instructors and a canteen with seating for 110 training participants as well as employees of the production facility and competence centre.

In November 2016, **Danfoss** has launched a mobile CO_2 training unit, equipped with CO_2 technology and interactive learning modules. The CO_2 solutions presented in the mobile training unit range from simple gas-bypass systems to more complex parallel compression solutions with or without heat reclaim. The training unit introduces Danfoss' brand new ejector technology. The training unit can accommodate up to 12 people at a time. As it travels to new locations, it will be updated with new components, know-how, and learning modules to reflect these changes. The company's goal is to launch several training containers that can serve its primary markets in North America, Europe, and Asia.

Universities

IES Llombai and **Jaume I University of Castellón** are pioneers in CO_2 training in Spain. Thanks to collaboration with secondary schools and private companies, the training courses have been successfully run since 2011.

In 2014, the universities successfully ran a training course that was specifically provided for refrigeration technicians, food retailer sector in particular, and focused on subcritical CO_2 systems. In 2015, they offered two courses: one focused on subcritical CO_2 systems, including new features such as plate heat exchangers and micro-channel condenser technology sessions, the other one focused on CO_2 transcritical applications and secondary systems for commercial refrigeration applications.

In the frame of the IESCO_2 project, the universities have developed and commissioned four cascade systems at four secondary schools and the Jaume I University of Castellón. These installations, which are monitored and running, provide valuable information and are open to all students.

Associations

The **AFPA**, the French Association for Vocational Training, together with the distributor Eberhardt Frères is providing training to installers on hydrocarbons R600a (isobutane) and R290 (propane). Taking theory, safety measures and support for the general use of these refrigerants into account, the association sees it necessary to keep up to date with their increased use in the professional refrigeration sector, especially given the implementation of the EU F-Gas Regulation promoting the use of low-GWP refrigerants.

Georgian Association of Refrigerating, Cryogenic and Air Conditioning Engineers provides theoretical and practical training on ammonia industrial refrigeration systems in Tibilisi, Georgia. The course covers basic thermodynamics and physics, material compatibility and lubricants, regulations and standards, safety aspects and practical handling of ammonia refrigerant. The course costs €200 per person and a certificate recognised in Georgia can be achieved after successful completion of the training.

A Spanish association, **Confederación Nacional de Instaladores, C N I**, provides on-site practical courses and online theoretical training for CO_2 and ammonia systems. The training covers different kinds of applications where these refrigerants are commonly used, including commercial and industrial refrigeration. The topics covered during the course include: basic thermodynamics & physics, material compatibility, lubricants, application areas, case studies, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation and maintenance. The courses are free of charge and available in Spanish, English, German and French.

End users

UK retailer **Sainsbury's** launched a Carbon Academy in 2011 to raise awareness and improve skills among its contractors, retailers and employees. The training ranges from explanations of how small changes in everyday working practices can reduce carbon impact, to highly-specialist skill acquisition such as CO_2 refrigeration. The declared objective is to train 20,000 people by 2020.

Private training providers

CO_2Academy by **Frigo Natural** provides transcritical CO_2 technology training for technicians. Both practical and theoretical aspects are covered during the course. The two-day professional training includes topics such as introduction, practical operation with CO_2 as a refrigerant, commissioning

and adjustment of CO_2 systems, the Pressure Equipment Directive and general rules for using CO_2 as a refrigerant, CO_2 systems, knowledge of materials and brazing technology. The courses are available in Swedish, English and Dutch. All courses are taking place in the PTC+ (Practical Training Center) in Ede, the Netherlands.

Consulting, contracting engineering

Tewis Smart Systems , a consulting, contracting, engineering firm based in Spain, provides theoretical and practical training for CO_2 and ammonia refrigerants for commercial and industrial systems. Trainees need to have semi-professional level of knowledge to be able to follow the course. No certification is provided at the end of the courses. The topics covered by the natural refrigerant training are basic thermodynamics & physics, material compatibility, lubricants, application areas, case studies, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation, maintenance. The classes are available in Spanish and French.

Certification body

Bavarian Environment Agency is providing theoretical training on hydrocarbon, CO_2, and ammonia in order to raise awareness in the region due to the phase down of HFCs. The training course in German is free of charge and covers topics such as application areas, case studies, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation and maintenance. The agency does not provide any practical training on natural refrigerants.

Research institute

Re/genT BV, a research institute, as well as consulting, contracting and engineering company based in the Netherlands, has recently started to provide theoretical and practical training classes on hydrocarbons and CO_2 in domestic and light commercial refrigeration areas. The company also provides general refrigeration courses related generally to all kind of refrigerants. The courses on CO_2 and HC cover basic thermodynamics & physics, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation, maintenance. The price per person is flexible, depending on what client needs.

Vocational / Professional school

Norddeutsche Kälte-Fachschule (NKF) provides training for CO_2, ammonia and water refrigerant-based technology. The training combines both theoretical and practical lessons on site and covers basic thermodynamics & physics, material compatibility, lubricants, application areas, case studies, regulations and standards, safety aspects, efficiency, COP evaluation, practical handling of refrigerant, system design, installation, operation, maintenance. The average cost per course per person is €700 and courses are available both in German and English. NKF is also a certification body. Therefore, the Master of Crafts certificate recognised in Germany can be achieved after successfully completing the course.

EU Funded Projects

SuperSmart, an EU-funded project that aims to speed up the uptake of more energy-efficient refrigeration, heating and cooling solutions for Europe's food retail sector, has published seven free reports to help food retailers and their partners select best-available HVAC&R technologies and practices. The reports provide concrete recommendations on how to map and reduce non-technological barriers, how to build new stores and refurbish existing ones, and how to select the right tools and methods to maintain high levels of energy-efficient operation.

The team has also developed a series of training modules for offering free-of-charge tailor-made or public training events across Europe. Interested food retailers, HVAC&R partners and other organisations are welcome to register their interest in a tailored training session via the project website: http://www.supersmart-supermarket.info/get-involved/

Types of natural refrigerant training

Theoretical and practical training are both important phases of learning - a balanced combination of both is necessary to ensure the desired level of knowledge.

Theoretical training forms the basis of knowledge and is indispensable to gain the necessary information that can then be further developed through practical experience. In the HVAC&R industry, theoretical training can be delivered on-site as well as through online (e-learning) and offline (long-distance learning) channels. According to the industry survey results, 98% of natural refrigerant training providers offer theoretical classes.

While theoretical training is essential, for certain types of HVAC&R professions it is not sufficient to ensure that the necessary skills & competencies are acquired. In case of engineers and technicians who need to handle natural refrigerant-based equipment in any way it is indispensable to go through a **practical training**. Such training enables technicians to get hands-on experience with the natural refrigerant-based technology in order to ensure maximum safety. Moreover, it develops a better understanding and helps retain the theoretical knowledge in mind. In practical training, students and technicians are usually confronted with situations that can possibly happen in real life, thereby preparing them for their jobs.

The results of the industry survey showed that 80% of natural refrigerant training providers offer practical training, either on-site or long-distance in form of participative webinars or similar.

THEORETICAL TRAINING...

98% of natural refrigerant providers offer theoretical training

90% on-site

33% online / e-learning

16% offline / distance learning

PRACTICAL TRAINING...

80% of natural refrigerant providers offer practical training

75% on-site

09% online / e-learning

06% offline / distance learning

On-site trainitng remains the most common type of training delivery

Trained teachers normally deliver on-site training in a classroom in a systemic intentional way within a school, college, institute, university, etc. Such training is suitable for both theoretical and practical types of training.

As compared to other types of training (online and distance offline), on-site training requires availability of a facility that can accommodate the desired number of trainees. In addition, training providers need to make significant investments in equipment and tools. In a number of cases, the investment burden can be overcome through collaboration between manufacturers, training providers and others as well as through financial support from governments.

On-site training has traditionally been the most popular in the HVAC&R sector due to the nature of the work. The survey demonstrated that this continues to be the case for training on natural refrigerants. According to the survey results, 90% of all natural refrigerants training providers offer theoretical training, while 75% provide practical training on site.

E-learning gaining popularity

E-learning is a learning environment which uses information and communication technologies as a platform for teaching and learning activities. E-learning is a practical way of learning theory especially for the adult learners having limitations in time, distance or finances. However, e-learning cannot replace practical training, especially in the HVAC&R field where technicians and engineers need to have an on-site practice in order to be able to handle heating and cooling equipment.

E-learning is becoming very popular in Europe, with 33% of HVAC&R training providers saying that they offer theoretical courses online. In addition, 9% of survey respondents indicated that they offer practical training online. A good example of an EU-wide free e-learning training platform is the Real Alternatives project that aims to increase the skills of people working in the refrigeration and air conditioning sector with CO_2, ammonia and hydrocarbon refrigerants. The project developed a free training material (e-learning, face-to-face training, practical exercise, assessments and e-library). It offers free e-learning modules and booklets - resources that can be studied individually or adapted by training providers to produce courses and in-house training sessions. The material integrates the existing industry guidance and on line tools, which have been reviewed by the project and collected into an evolving central electronic library. Those who successfully complete the end of course assessment are issued with a REAL Alternatives Certificate of CPD.

Besides the Real Alternatives e-learning platform, online natural refrigerant courses are also offered by a number of technology providers, for example Star Refrigeration and Danfoss.

Long-distance learning used to a limited extent

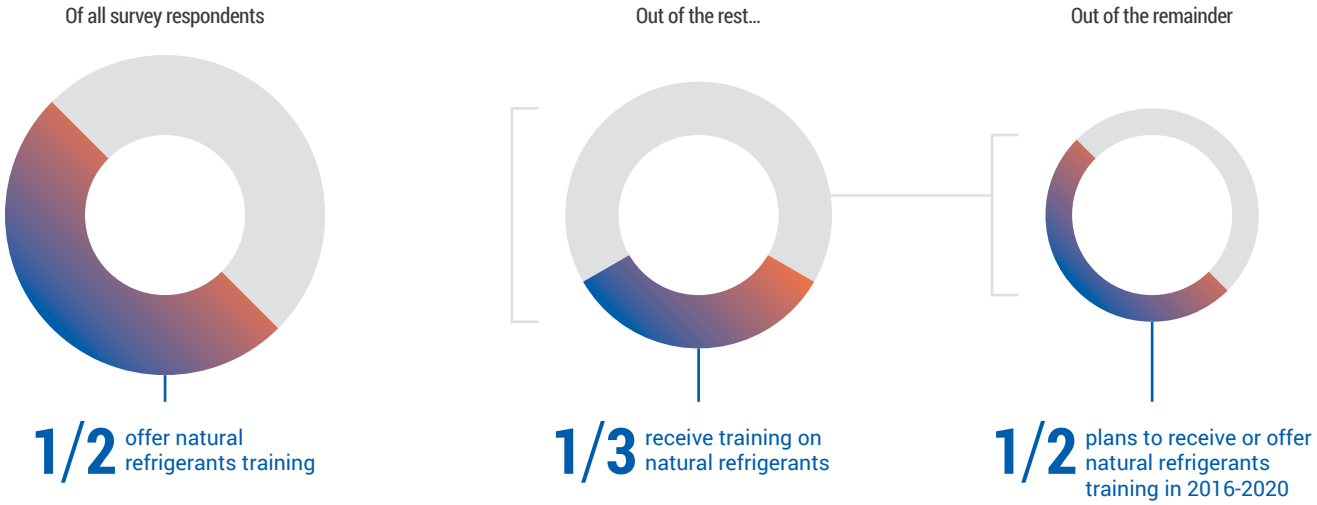
Offline / Long-distance learning is a type of education that offers the possibility to follow courses while not being physically present at a training facility. Offline/long distance learning is more suitable for learning theory rather than for practical learning, especially in the field of HVAC&R.

Survey results showed that offline/long-distance learning is not a very popular way of teaching and learning among HVAC&R training providers. This simply can be explained by the HVAC&R job nature itself – technicians and engineers need to be trained on how to practically use different tools, how to safely and efficiently handle refrigeration, heating and air conditioning systems, etc. Long-distance learning is more typical for theoretical training and it is often coupled with on-site training.

Survey on natural refrigerant training

To better understand the current market for natural refrigerant training, shecco's industry survey investigated among training providers different aspects of their training offerings, including which refrigerants, topics, applications, languages they cover as well as what is the average cost for a course. Receivers of natural refrigerants training were asked similar questions, which helps evaluate whether there is a match in demand and supply or if there are any gaps.

Majority of survey respondents are already involved in natural refrigerant training today

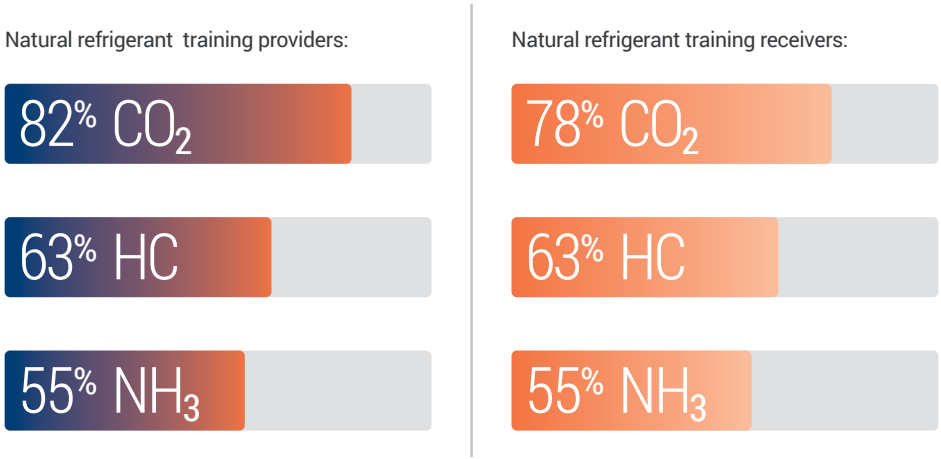


Close to half of all survey respondents (over 150 individuals) indicated they provide training on natural refrigerants. Of those that do not provide natural refrigerant training, over one-third responded they have received such training. The rest of survey participants were not yet involved in natural refrigerants training, but almost half of them indicated they were considering to get involved in the near future (between 2016-2020 horizon). Future plans are examined in more detail in the following section of this chapter 'Natural refrigerant training TOMORROW'.

The survey findings indicate there is a good correlation between training natural refrigerant providers and receivers when it comes to the type of natural refrigerant for which they either receive or provide training. Both groups of respondents indicated strong involvement in CO_2 training, with over 80% of providers offering this training and a similar proportion of training receivers who indicated they have participated in such training. Second most popular is training for hydrocarbons and ammonia comes in the third place for both groups of survey respondents.

Overall, a bit more than a third of all natural refrigerant training providers said they offer exclusively training on natural refrigerants, while the rest provides also training on f-gases, including HFCs (half of all natural refrigerant training providers) and unsaturated HFCs, so-called 'HFOs' (two-fifths of all natural refrigerant training providers).

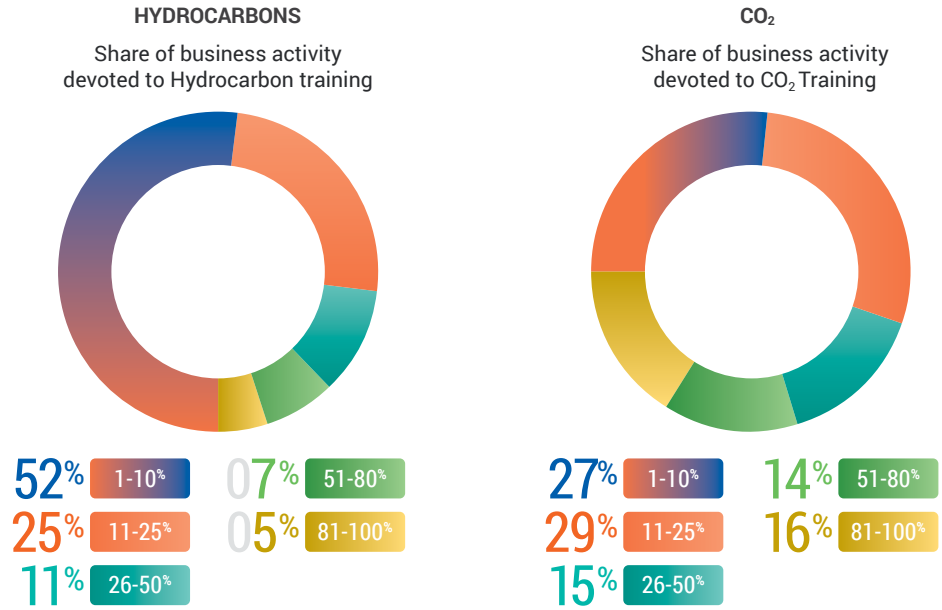
CO_2 training is a clear leader



Natural refrigerant training represents so far a small share of business

It is clear from the survey that for most training providers the share of business from individual natural refrigerants represents so far a small portion of their overall training offer. Over half of those offering hydrocarbon training indicated it represents around 1-10% on their overall business, while for another quarter it is between 11-25%. Only for a smaller proportion of hydrocarbon training providers it represents a larger share in business.

Providers of CO_2 training portrayed a slightly different picture, reporting a stronger interest in such training. For almost a third of the organisations operating in this field, CO_2 training represents 11-25% share on their total training activities. In addition, there are around 16% of CO_2 training providers for which such training is the main activity and represents 81-100% of their total business.



AMMONIA

Share of business activity devoted to ammonia training

32% 1-10%
26% 11-25%
14% 26-50%
16% 51-80%
12% 81-100%

In case of providers of ammonia training, for majority of respondents (a third) this training represents 1-10% in overall training activities, while for another quarter it is between 11-25%.

Natural refrigerant training for refrigeration applications prevail

The survey by shecco investigated whether the existing training offer on natural refrigerants matches the demand. To a large extent, training providers and receivers showed a similar assessment of the applications for which training is needed. Commercial, industrial and light commercial refrigeration rank the highest for both groups of respondents - this is in clear correlation with the market uptake of natural refrigerants in these sectors. A slight discrepancy can be observed for the sector of industrial refrigeration, where the natural refrigerant providers have indicated significantly higher supply compared to demand from the training receivers side.

Besides the refrigeration sector, both supply and demand side of the natural refrigerant training ranked commercial & industrial air conditioning as well as commercial & industrial heating relatively high. Transport refrigeration and mobile air conditioning sectors recorded the lowest interest from natural refrigerant training receivers. These were also the sectors for which there seems to be the lowest coverage in natural refrigerant training courses. This comes as no surprise given the current low level of natural refrigerant use in these applications.

Surprisingly, 20% of training receivers indicated they would be interested in general training on natural refrigerants that would cover a wider spectrum of applications. However, such training is currently offered by only around 10% of training providers, according to the survey findings, which seems to indicate a gap in the training market.

Applications most covered by natural refrigerant training providers:

1. Industrial refrigeration
2. Commercial & light commercial refrigeration
3. Commercial & industrial air conditioning
4. Commercial & industrial heating
5. Domestic refrigeration

Applications most desired in natural refrigerant training by receivers:

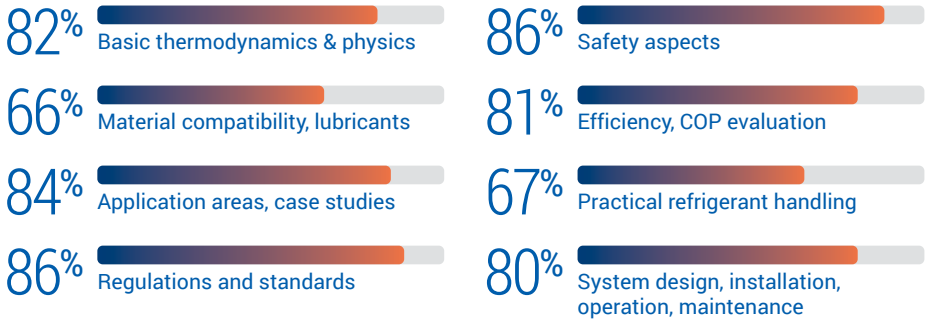
1. Commercial refrigeration
2. Industrial & light commercial refrigeration
3. Commercial & industrial air conditioning
4. General - all applications
5. Commercial & industrial heating

Training providers cover a wide range of topics, receivers are mostly interested in safety

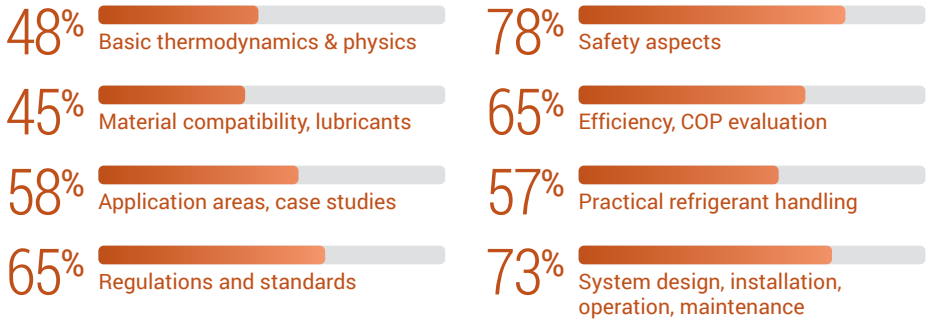
The survey findings indicate that training providers cover a wide range of topics in their natural refrigerant courses. Most of respondents who provide training on natural refrigerants said that their courses include safety aspects, regulations and standards, application areas and case studies, basic thermodynamics & physics, system design, installation, operation and maintenance. Topics that are covered less widely include practical refrigerant handling and material compatibility.

With regards to the topics that training receivers are most interested in, most ranked safety aspects the highest, followed by system design, installation, operation and maintenance. Respondents also indicated interest in efficiency and COP evaluation as well as regulations & standards. The least popular topics were basic thermodynamics & physics and material compatibility.

Toptics covered by natural refrigerant training providers:



Topics that natural refrigerant training receivers are most interested in:



Over a third of natural refrigerant training providers offer free courses

Investment costs were identified as a major barrier for a wider uptake of training on natural refrigerants. This is especially the case for small businesses that do not have the necessary resources to keep the employees up to date on the latest technologies. To get a better understanding of the real cost of training courses, the survey asked training providers how much they normally charge for a course on natural refrigerants per person. Surprisingly, over a third of the respondents said they offer their courses free of charge. It could be therefore concluded that there is currently a lack of awareness in the HVAC&R industry about the free courses and better communication could immediately improve the knowledge on natural refrigerants.

Training providers noted that payed courses range quite widely between €100 - €5,000 per course per person, depending on group size, location, contents, duration of the training, clients requirements, and others. The most common cost of a course on natural refrigerants quoted by training providers was €500.

The survey also asked training receivers how much they would be willing to invest in a course per person. Close to half of the respondents said that they do not know how much they would pay for a course, while 17% said that the course should be free of charge. This reinforces the argument that there is a low level of awareness of training courses that are available for free.

Over a third of training receivers indicated an average price per course they would be willing to invest. The price varied from €100 to €2,500, with €500 being the most popular answer among training receivers, which matches the most common cost charged by training providers.

Average cost for natural refrigerant course

Cost charged by **training providers**

38% offer free courses

34% indicated cost between €100 - €5,000 (€500 most common)

28% do not know

Cost that **training receivers** are willing to invest

17% think courses should be free

38% indicated cost between €100 - €2,500 (€500 most common)

45% do not know

Natural refrigerant courses geared mostly towards professionals

When asked what level of prior knowledge participants need to have to take a course, a large majority of training providers indicated that the courses are tailored for professionals who already possess substantial prior knowledge about HVAC&R technology. This seems to be the appropriate level from the point of view of a majority of respondents on the training demand side too.

Both training providers and receivers indicated courses targeting amateurs who have a basic level of prior knowledge as the second most common. The least common are the courses either for experts with a substantial level of prior knowledge or for beginners with no prior understanding.

Most of the training courses are without certification

Survey results show that training providers don't normally do not offer any certification for natural refrigerant courses. This trend was confirmed by three-quarters of providers of training on natural refrigerants. Around one fifth of the respondents said that national certification can be achieved after following their courses. Only a very small share of training providers noted that a certification recognised in their region or worldwide can be achieved.

In addition, some of the respondents named some of the certifications recognized in their respective countries, such as UK's City and Guilds certifications: C&G 2079 and C&G 6187-21.

NATURAL REFRIGERANTS TRAINING TOMORROW

BESIDES INVESTIGATING ABOUT THE CURRENT SITUATION OF NATURAL REFRIGERANTS TRAINING IN EUROPE, THE SURVEY ASKED THE INDUSTRY EXPERTS ABOUT THEIR EXPECTATIONS FOR FUTURE DEVELOPMENTS.

Industry highly optimistic about the uptake of natural refrigerant training in the next 1-2 years

To evaluate the number of people that received training on natural refrigerants the previous year, the survey asked training providers how many people they trained in 2015. A majority of the respondents said they trained 11-50 people, followed by another group that trained 51-100 people. There was also a small proportion of those that trained more than 500 people.

As for the organisations at the training demand side, over two-thirds specified that between 1-10 people received training on natural refrigerants in 2015 in their organisation. A smaller portion of respondents said that it was between 11-50 people that received such training and the rest did not have this information.

People trained on natural refrigerants in 2015 - training receivers

Training receivers' expectations for number of people trained

The receivers of training showed great optimism for future developments, with over 70% saying they expect more people from their organisations to take up training on natural refrigerants in the next 1-2 years. Slightly less than one fourth of respondents noted that the number of trained people would remain the same.

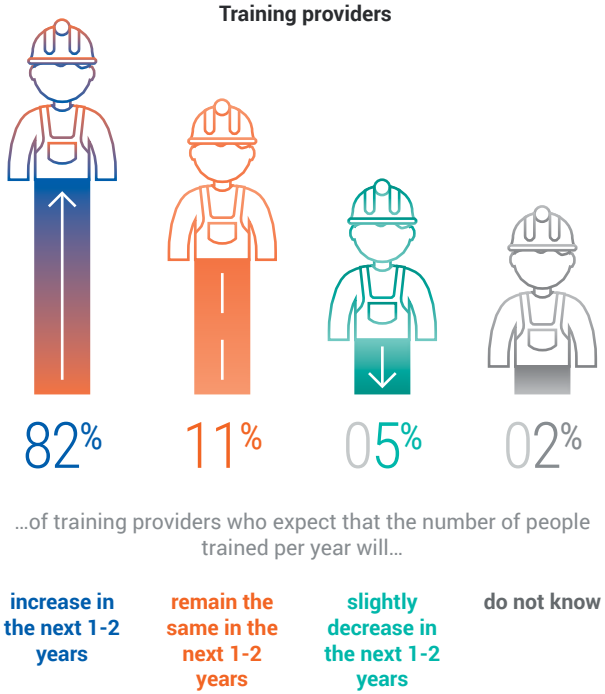
Training receivers

...of training receivers who expect that the number of people trained per year will...

increase in the next 1-2 years	remain the same in the next 1-2 years	slightly decrease in the next 1-2 years	do not know

Number of people trained on natural refrigerants expected to grow strongly

Natural refrigerants training providers expressed great optimism when it comes to the expected growth in the number of people trained on natural refrigerants per year. Four in five of HVAC&R industry experts expect to see this number increase in the next one to two years. In addition, just over one tenth of natural refrigerant training providers said that the numbers would remain the same. 5% of respondents were not so optimistic saying that it will decrease slightly, while 2% said they do not know how this will change.

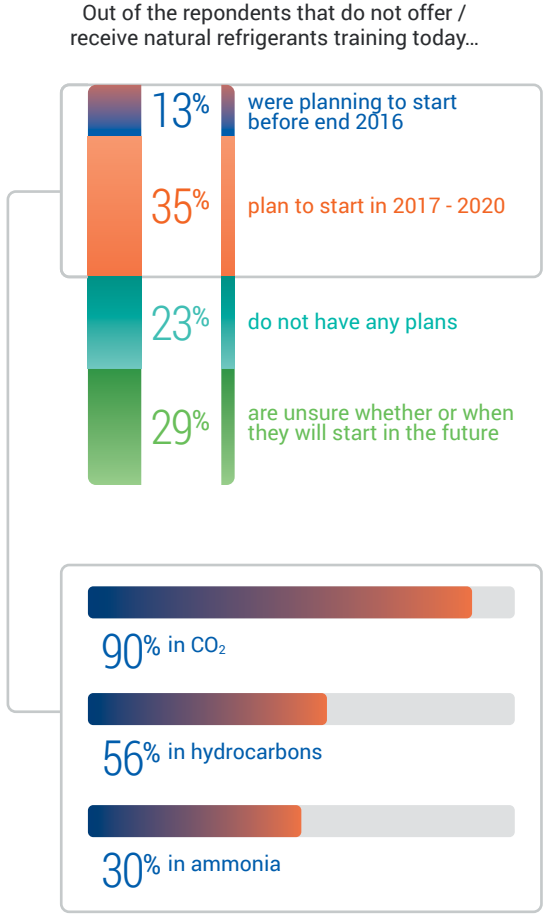


Future plans to offer / receive natural refrigerants training

Regarding the future plans to either provide or receive training on natural refrigerants, almost half of survey respondents who currently do not provide or receive training on natural refrigerants said that they plan to do so in 2016-2020. Considering that those that already provide / receive natural refrigerants training will also grow their offer and demand as the technology using natural refrigerants becomes more and more common, this trend shows that natural refrigerants training will see a steady growth in Europe.

The future is bright for the training on CO_2 refrigerant, with more than 90% of industry respondents saying that they plan to provide or receive training related to this refrigerant. The expectations are mostly linked to the strong growth in CO_2-based installations in commercial and industrial refrigeration. More than 50% of respondents plan to offer or receive training on hydrocarbons in the future and slightly less on ammonia.

Close to one third of those that do not offer / receive training on natural refrigerants today were not sure yet whether this will change in the future. Their decisions will likely depend on the market adoption of natural refrigerants in the coming years, as the effects of the F-Gas Regulation will become more pronounced.



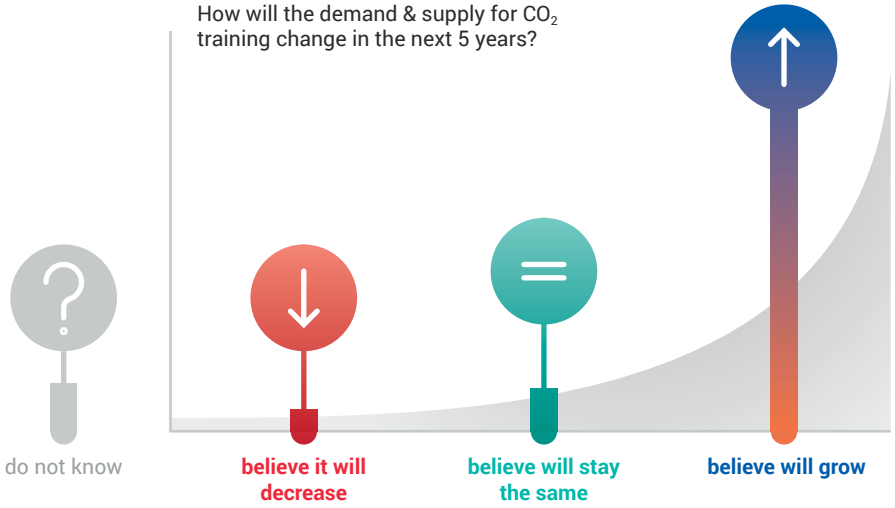
Future demand & supply of natural refrigerant training

The online survey asked industry representatives how they expect the demand and supply for natural refrigerants training to change in their region in the next five years. The findings indicate that the industry expectations for demand generally correlate with the expectations for supply, although it can be noted that the future demand is estimated to be slightly higher than supply.

The supply in natural refrigerants training is driven by demand. The key driver for demand is the legislation as well as other market factors. The EU F-Gas Regulation will introduce stricter measures over the next five years - such as 37% cut in HFC quotas by 2018 and 55% by 2021, a ban on certain HFCs in commercial refrigeration (plug-in and centralised) by 2022, which will inevitably create greater interest in technologies that do not rely on HFCs.

CO_2 training

The industry believes that CO_2 training will see the highest increase in demand and supply, with 79% and 74% of respondents, respectively, stating it will grow either strongly or slightly. This is an indication that CO_2 is already on a strong growth trajectory and the industry has already fully embraced this fact. In the next five years, CO_2 is expected to be a standard refrigerant in commercial refrigeration across Europe, where it has already gained significant market share - with well over 9,000 CO_2 transcritical stores, it has reached 8% of the overall market share in the food retail sector. Moreover, CO_2 is becoming more popular in both larger (e.g. industrial refrigeration) and smaller applications (e.g. heat pumps, vending machines), which will further fuel the demand and supply of relevant training to ensure safe and effective handling of the technology.

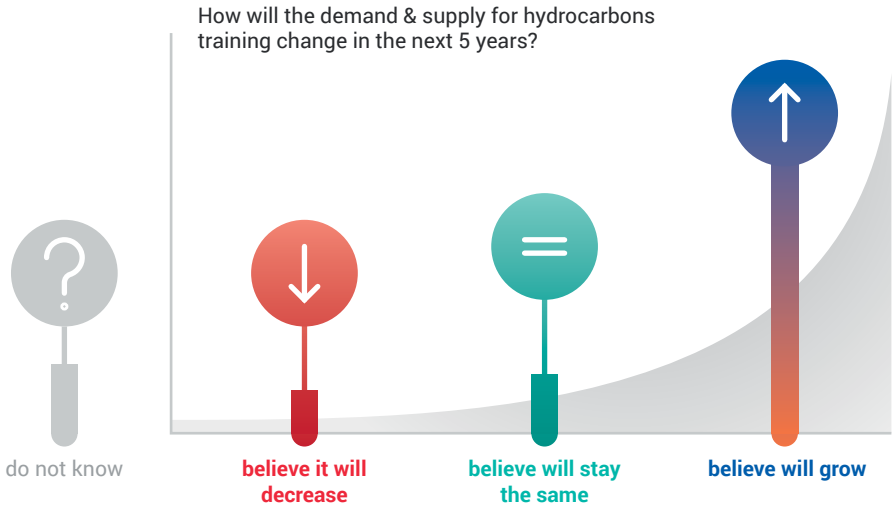


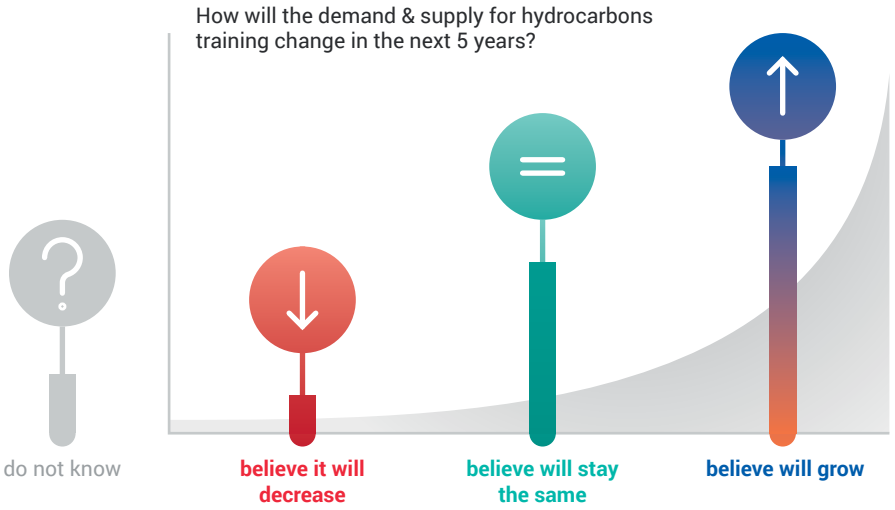
Hydrocarbon training

A large majority of respondents (over two thirds) expect that there will be a growth in supply and demand for hydrocarbons training in the next five years. Some respondents were unsure how the situation will evolve, which could be to some extent explained as uncertainty regarding the development of standards that currently limit the charge size for hydrocarbon-based equipment and thereby the growth potential of the technology. Another uncertainty factor is the acceptance of equipment using hydrocarbons among end users. Nevertheless, with the growing use even in larger equipment and awareness-building about the safety and energy efficiency, end users are expected to become more and more open to adopt this technology.

Ammonia training

Out of the three natural refrigerants, the industry representatives expect the demand and supply for ammonia training to grow the least. Nonetheless, still a significant number of experts (around 50%) predict it will increase in the next five years. A higher number of respondents (around 30%) compared to training on CO_2 and hydrocarbons believe that the supply and demand for ammonia training will remain stable. This comes as no surprise given that ammonia training is currently the most established out of these given the long tradition in use of ammonia-based technology. In the next five years, the market for ammonia is expected to grow in the its traditional sector of industrial refrigeration, but it will also become a solution for other medium and small refrigeration and AC applications.





INDUSTRY VIEWPOINT

Volker Stamer,
SCHAUFLER Academy director,
BITZER

"Education and knowledge are key elements to provide good solutions for the market. Training has always been important for BITZER, but now we finally have a facility that serves as a central hub."

Diego Malimpensa,
Business unit manager for retail solutions,
CAREL

"Worldwide, the situation is different, depending on the specific country, and the use of natural refrigerants is facing some of the same barriers that slowed down their deployment in Europe several years ago: there are gaps in the industry in terms of knowledge and training, the presence of local legislation that may help accelerate the introduction, and the presence and market acceptance of real alternatives that are now available."

Christian Heerup,
Technology manager, refrigeration,
Danish Technological Institute

"There will be great opportunities for Danish companies manufacturing components and systems compatible with natural refrigerants to address the European market because this market will grow dramatically. Until now, there have been a limited number of experts who are skilled enough to handle CO_2 systems. This number must increase. And of course, there will be a need for training all over Europe."

Giovanni Dorin,
Marketing manager,
Dorin

"Many local associations are setting up training courses in CO_2 applications and alternative systems, and this has to be implemented more and more. Actually the government should support these trends in order to put professionals in the position to handle the new refrigerants safely."

Nacho Fandos,
Professor,
IES Llombai

"An increased interest in CO_2, new technologies and areas of application have resulted in a wider and more comprehensive offering of training. However, this topic is not included as a regular subject in schools. At the institutional level, there have not been significant developments."

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An annual report is usually read for around three minutes. In our opinion, that was far too short for
organisations in Germany for people with disabilities. The solution was a tear-off calendar, 365
through the year and ensure that the activities of ACTION MENSCH remain in people's conscience. This
designing the thickest report in the history of our agency, which absolutely paid off in a
when we carefully pointed out all the extra work it involved, it was charmingly
for the agency would mean less money for the pony stables at a home

5 Policy for natural refrigerant training

THE SURVEY AMONG EUROPEAN INDUSTRY EXPERTS INDICATED THAT POLICY IS THE MAIN DRIVER FOR NATURAL REFRIGERANT TRAINING. NATIONAL, REGIONAL AND INTERNATIONAL LEGISLATIVE MEASURES INCREASINGLY IMPOSE RESTRICTIONS ON HFCS, A GROWING MARKET FOR NATURAL REFRIGERANTS. INTERNATIONALLY, THE AMENDMENT TO THE MONTREAL PROTOCOL AGREED IN OCTOBER 2016 WILL SEE A GLOBAL PHASE DOWN OF HFCS, WHICH WILL INCREASE THE INTEREST OF INDUSTRY IN NATURAL REFRIGERANTS. GAINING NECESSARY KNOWLEDGE AND COMPETENCES TO HANDLE THESE SUBSTANCES WILL BE AN ESSENTIAL PREREQUISITE FOR A SUCCESSFUL TRANSITION.

At the EU level, the F-Gas Regulation acts as the main driver for the shift away from high GWP refrigerants. While it imposes gradual restrictions on HFCs it does not mandate training and certification requirements related to HFC alternatives, such as natural refrigerants, except for the need to cover information on f-gas alternatives during training on HFCs. Besides the EU F-Gas Regulation, other EU legislation exists that regulates safe handling of refrigerants and risks associated with the use of certain substances. Of particular importance are the Framework Directive on Safety and Health at Work and the ATEX Directives for hydrocarbons and the Pressure Equipment Directive for CO_2. It is through these directives and complementary safety standards that the safe handling of natural refrigerants is regulated. Unlike Regulations, EU Directives give member states a certain degree of flexibility in transposing the legislation in their national laws, which is why differences across the EU may occur.

In the absence of harmonised minimum training requirements and certification on natural refrigerants at the EU level, national initiatives play an important role. Denmark, Belgium or the Netherlands, for instance, have introduced a variety of measures to support uptake of natural refrigerants training, while others might be currently considering legislation to ensure safe handling of HFC-free refrigerants.

EU F-GAS REGULATION

THE EU F-GAS REGULATION, WHICH ENTERED INTO FORCE IN 2015, IS THE KEY LEGISLATIVE DRIVER FOR THE EUROPEAN HVAC&R INDUSTRY TO MOVE AWAY FROM HIGH GWP HFCS. THE REGULATION HAS INTRODUCED A COMBINATION OF MEASURES, TO CUT DOWN THE EMISSIONS OF F-GASES BY TWO THIRDS BY 2030. THIS WILL IN TURN GREATLY INCREASE THE ADOPTION OF HFC-FREE TECHNOLOGIES. ENSURING THAT THESE SYSTEMS ARE PROPERLY AND SAFELY HANDLED IS KEY TO MAKING THE TRANSITION A SUCCESS.

The HFC phase-down that will reduce HFCs placed on the EU market by 79% by 2030 is considered to be the backbone of the Regulation. Moreover, bans on certain HFCs in specific sectors will have a direct impact on the growth of the market for natural refrigerants. These include commercial refrigeration (both smaller plug-in units and centralised systems) that use HFCs with GWP > 150 as of 2022 as well as small AC units (portable and single split).

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

Other regulatory measures on HFCs include strengthened containment, labelling and end-of-life requirements.

The F-Gas Regulation requires mandatory training and certification for HVAC&R equipment using fluorinated refrigerants. However, it does not address safe handling of HFC replacements, such as CO_2, ammonia and hydrocarbons. The EU-level legislation does not set minimum training requirements for natural refrigerants, nor does it require that persons handling such equipment have certification that would be recognised across the EU. The Regulation only requires certification programmes and training to include "information on relevant technologies to replace or to reduce the use of fluorinated greenhouse gases and their safe handling".

The Regulation mandates the European Commission to examine the EU legislation with regard to the training related to refrigerants to replace F-gases by 1 January 2017. In its evaluation in December 2016, the Commission came to a conclusion that the current legislative framework complemented by existing standards is appropriate to ensure safe handling of f-gas alternatives. It does not therefore consider it necessary to legislate the training on natural refrigerants at the EU-level.

Key elements of the F-Gas Regulation

FRAMEWORK DIRECTIVE ON SAFETY AND HEALTH AT WORK

THE AIM OF THE FRAMEWORK DIRECTIVE IS TO INTRODUCE MEASURES TO ENCOURAGE IMPROVEMENTS IN THE SAFETY AND HEALTH OF WORKERS AT WORK. IT APPLIES TO ALL SECTORS OF ACTIVITY, BOTH PUBLIC AND PRIVATE, EXCEPT FOR SPECIFIC PUBLIC SERVICE ACTIVITIES, SUCH AS THE ARMED FORCES, THE POLICE OR CERTAIN CIVIL PROTECTION SERVICES

The Framework Directive lays down general principles of the protection of workers at work, as well as provides general requirements for the training of employees. The employer is required to ensure that workers receive adequate safety and health training. This means that for equipment using any refrigerant, including hydrocarbons, ammonia and CO_2, employers have to consider measures that will mitigate risks, including providing adequate training to its employees.

According to the Framework Directive, the employer shall ensure that each worker received health and safety training, in particular in the form of information and instructions specific to his workstation or job:

- On recruitment (before starting work);
- In the event of a transfer or a change of job;
- When work equipment is introduced for the first time or changed;
- When new technology is introduced.

Training of workers must be repeated at suitable intervals. The duty to provide training also applies to the outside contractors. Training must be given by a competent person. Records should be kept in writing of the date and content of training activities and the participants.

ATEX DIRECTIVES RELEVANT TO HYDROCARBON TRAINING

THE EXPLOSIVE ATMOSPHERE DIRECTIVE 2014/34/EC AND THE SAFETY AND HEALTH PROTECTION OF WORKERS DIRECTIVE 1999/92/EC ADDRESS SAFETY REQUIREMENTS IN RELATION TO EXPLOSIVE ATMOSPHERES AND FOR IMPROVING THE SAFETY AND HEALTH PROTECTION OF WORKERS POTENTIALLY AT RISK FROM EXPLOSIVE ATMOSPHERES.

According to this Directive, employers are responsible for providing appropriate training to workers in relation to risks from explosive atmospheres. It does not specifically mention refrigerants but is relevant to all systems using flammable refrigerants. It applies, for example, to service engineers working with hydrocarbon systems. According to this Directive, employers must make sure that employees are properly informed about and trained to control or deal with the risks from the potentially explosive substances.

The non-binding guide to good practice for implementing the Directive prepared by the European Commission prescribes that employers must provide workers with training, which informs them of the explosion hazards at the workplace and the protective measures taken. This training must explain how the explosion hazard arises and in what parts of the workplace it is present. The measures taken should be listed and their operation explained. The correct way of working with the equipment available must also be explained to workers. Employees must be instructed in safe work in or near hazardous places. This also involves explaining the meaning of any marking of hazardous places and specifying what mobile work equipment may be used there. Employees must also be instructed in what personal protective equipment they must wear at work. The available operating instructions should be covered during the training.

PRESSURE EQUIPMENT DIRECTIVE RELEVANT TO CO_2 TRAINING

The Pressure Equipment Directive (PED) (2014/68/EU) provides a legislative framework for equipment and assemblies with a maximum allowable pressure greater than 0,5 bar. It concerns items such as vessels, heat exchangers, pressurised storage containers, piping, safety accessories and pressure accessories. It is especially relevant to equipment using CO_2. The Directive refers to the training required by notified bodies, third party organisations and user inspectorates conformity assessment and specifies that the personnel has sound technical and vocational training.

EU STANDARD ON COMPETENCE OF PERSONNEL

European standard EN 13313, “Refrigerating systems and heat pumps - Competence of personnel” sets training requirements for all refrigerants, including natural working fluids.

This standard establishes procedures for achieving and assessing the competence of persons who design, construct, install, inspect, test and commission, maintain, repair, decommission and dispose of refrigerating systems and heat pumps with respect to health, safety, environmental protection and energy conservation requirements. It sets requirements for training, assessment, and maintenance of competence.

The standard does not apply to those persons who carry out work on the basis of instructions if they are supervised by a competent person or operate the system according to the operation manuals or who carry out work that does not affect the refrigerant circuit.

It also does not apply to persons carrying out work in a manufacturing process (from the initial design of the product to the complete manufacture of the product) provided the process is controlled and the methods used are checked by a competent person.

BEST PRACTICE INITIATIVES AT NATIONAL LEVEL

WHILE CERTIFICATION AND MINIMUM TRAINING REQUIREMENTS FOR NATURAL REFRIGERANTS ARE NOT DIRECTLY MANDATED AT THE EU-LEVEL, SOME GOVERNMENTS HAVE INTRODUCED INITIATIVES TO RAISE AWARENESS AND ENSURE SAFE HANDLING OF HFC-FREE EQUIPMENT AT THE NATIONAL LEVEL. THESE RANGE FROM INFORMATION CENTRES, FINANCIAL INCENTIVES TO TRAINING PROVIDERS TO MANDATORY MINIMUM TRAINING REQUIREMENTS, FORMAL GUIDELINES, CURRICULA AND OTHERS. TO ESTABLISH AND RUN THESE INITIATIVES, GOVERNMENTS USUALLY COLLABORATE WITH UNIVERSITIES, TRAINING CENTRES, ASSOCIATIONS AS WELL AS COMPANIES.

The section below outlines some examples of best practice initiatives that are either already underway or currently under consideration in different EU member states. Besides the examples outlined other countries are also looking at ways to support natural refrigerants training - Spain and the United Kingdom plan to include the aspects of natural refrigerants in their national training qualifications while national training organisations in Finland intend to improve the training on alternative refrigerants.

Denmark

In 2005, the Danish Environmental Protection Agency has set up an “HFC-free Centre” (http://www.hfc-fri.dk/), which is financed by the government. The Centre offers consultancy services that are free of charge (up to 5 hours of engineering consultancy) for the refrigeration industry and installers to help them implement alternative technologies, such as using CO_2, ammonia and hydrocarbons. Enquiries and questions may be directed to the knowledge centre via telephone or e-mail or by visiting the centre during its opening hours.

Germany

As part of Germany’s Climate Action Programme 2020, the government is considering measures that would reinforce and facilitate the implementation of the F-Gas Regulation at national level. To this end, the government is preparing measures that would improve the uptake of natural refrigerants training. These could include financial support for training facilities and on-the-job practical training on natural refrigerants, which would help familiarise trainees and professionals with the technology. In addition, the government intends to set up an information portal and helpdesk on natural refrigerants.

In order to overcome the lack of trained engineers and technicians that are able to handle natural refrigerants, Germany is considering introducing mandatory practical training on natural refrigerants as part of initial vocational training, which would be prepared by the German Federal Association of Guilds.

Estonia

Estonia has launched a project to promote f-gas alternatives and help companies to make informed decisions about new technology purchases. During the first stage of the project, the website covering information about natural refrigerants was created (http://www.klab.ee/f-gaasid/alternatiivid/) and physical education material about the natural refrigerants was also developed. In addition, the project mapped the best practices on natural refrigerant technologies in the EU member states. In the second stage of the project the training facility for natural refrigerants-based technology will be established in one of the universities in Estonia. The training facility will aim to attract not just Estonian technicians but also Latvians and Lithuanians.

Belgium

The initiatives concerning the training on natural refrigerants in the Flemish region of Belgium are incorporated in the Flemish reduction plan of HFC emissions 2015-2020. In particular, the Flemish government is adapting the existing professional qualification curricula, which form the basis of the education of refrigeration technicians in every school, to incorporate information in HFC-free technologies. As a result of this every school in the future will be obliged to adapt their trainings and pay the necessary attention to natural refrigerant-based technologies.

Besides the theoretical training on natural refrigerants, the Flemish government has started a dialogue with schools/training centers and industry to identify the necessary steps that should be taken to increase the availability of practical training on HFC-free technology in schools and beyond. The government with the industry is looking into how to eliminate the existing bottlenecks (financial aspect and expertise) and achieve that schools do the necessary investments. At the moment there are two universities that provide practical training on CO_2 - UCLL high school in Houthalen-Helchteren and AP high school in Antwerpen.

The Netherlands

In the Netherlands, the government has worked closely with the Dutch association for refrigeration and air handling (NVKL) to establish a safe working environment for natural refrigerants in the industry. Three practice guidelines, for each CO_2, hydrocarbons and ammonia, were formulated and are formalised within the legislation. These guidelines prescribe to Dutch companies the training requirements for handling natural refrigerants in a formal way.

Using the guidelines as a basis, the NVKL developed goals and study requirements for books and exams on natural refrigerants, which are used by educational institutes and examination bodies.

Furthermore, the NVKL established a central training center "GO°", which has so far provided 500 training certificates for ammonia to technicians since 2011. Training for hydrocarbons and CO_2 started in 2016 and so far 100 technicians have been certified. In order to obtain the certificate, technicians must undergo 2 - 4 day training courses, followed by a final exam, which is based on the Dutch guidelines for natural refrigerants.

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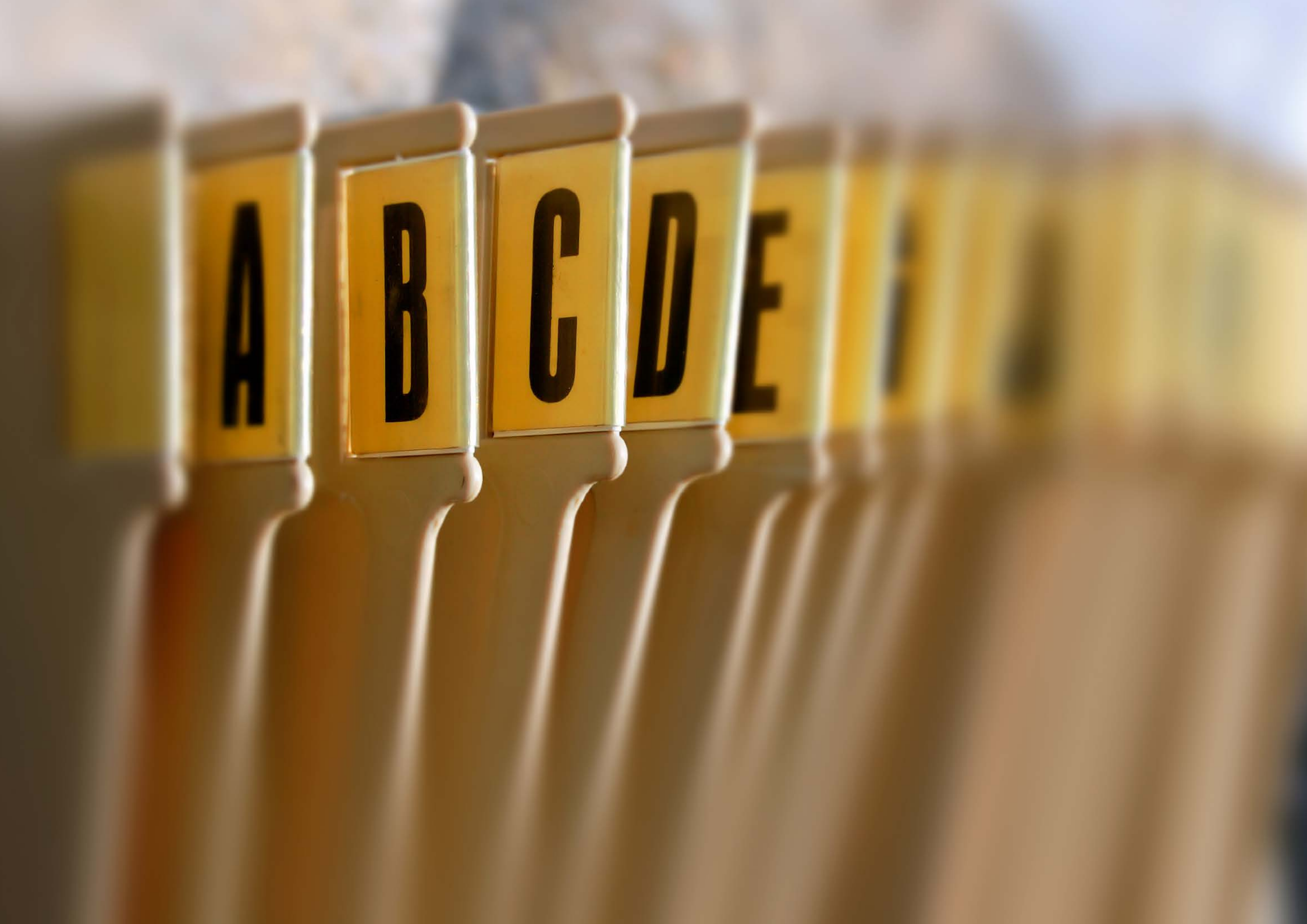
A B C D E

6 Directory

PREMIUM DIRECTORY

	**BITZER**	http://www.bitzer.de	Components manufacturer, Servicing, repair, maintenance	CO_2 NH_3 HC
	Germany	academy@bitzer.de	Theoretical training, Practical training, Presence / Course on site	
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	Germany	-	Theoretical training	
	**Officine Mario Dorin Spa**	http://www.dorin.com	Components manufacturer	CO_2 NH_3 HC
	Germany	dorin@dorin.com	Theoretical training, Practical training	
	**Embraco Europe Srl**	http://www.embraco.com	Components manufacturer	HC
	Germany	-	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	

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CO_2 NH_3 HC H_2O

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Germany

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info@co2academy.com

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Theoretical training | Practical training

CO_2

Huayi Compressor Barcelona

Spain

http://www.huayicompressor.es

info@huayicompressor.es

Components manufacturer

Practical training

HC

DIRECTORY

#

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
[CF] Training - Fischer Kälteklima	Germany	http://www.kaeltefischer.de/cf-training.html	Consulting, contracting, engineering	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
3T Services Limited	United Kingdom	http://www.3tservices.co.uk	Consulting, contracting, engineering, Certification body, Training institute	Theoretical training, Practical training, Presence / Course on site	HC

A

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
A-comfort #505	Denmark	http://www.a-comfort.dk	System manufacturer, Components manufacturer, Consulting, contracting, engineering, Servicing, repair, maintenance	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Advansor	Denmark	http://www.advansor.dk	System manufacturer	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2
AEFYT	Spain	http://www.aefytonline.com	Association	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
AF Consulting	Sweden	http://www.afconsult.com	Consulting, contracting, engineering	Theoretical training, Presence / Course on site	CO_2
AFP	France	http://ofpc.fr	Training institute	Theoretical training, Presence / Course on site	CO_2
AFPA	France	https://www.afpa.fr	University, Training institute	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
AFPI formation	France	http://www.afpi-acmformation.com/	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2
A-Gas (with Cool Concerns)	United Kingdom	http://www.agas.com	Refrigerant supplier	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 HC
AJI Training (by I-I-ICE)	United Kingdom	http://www.ajitraining.co.uk	Consulting, contracting, engineering; Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3
Alfa Laval	Sweden	http://www.alfalaval.com	Components manufacturer; Wholesale, sales, marketing	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
AMF (Matal Training Association)	France	http://www.matal-formation.fr	Training institute	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning	CO_2 NH_3 HC
Ammonia Partnership AB	Sweden	-	Association	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
APIEF	Portugal	http://www.apief.pt	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Arctic Circle Ltd	United Kingdom	http://www.acl-online.com	System manufacturer; Components manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2 HC
AREA	Belgium	http://area-eur.be	Association	Theoretical training; Online course / e-learning	CO_2 NH_3 HC
Artesis Plantijn Hogeschool Antwerpen	Belgium	https://www.ap.be	University	Theoretical training; Practical training; Presence / Course on site	CO_2
Association Française du Froid	France	http://www.association-francaise-du-froid.fr	Association	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Association Suisse du Froid	Switzerland	http://www.asf-froid.ch/formation-continue-fr201.html	Association	Theoretical training, Practical training, Presence / Course on site	CO_2
Atecyr	Spain	http://www.atecyr.org/eATECYR/formacion/cursos/index.php	Association	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2, NH_3
ATF ASSOCIAZIONE TECNICI DEL FREDDO	Italy	http://www.associazioneatf.org	Association	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Ausbildungszentrum Innung der Feinwerktechnik Mittelfranken	Germany	http://www.innung-feinwerktechnik-mfr.de	Vocational / professional school	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC

B

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Bavarian Environment Agency	Germany	http://www.lfu.bayern.de/analytik_stoffe/f_gase/cooperation_israel/index.htm	Certification body	Theoretical training, Presence / Course on site	CO_2, NH_3, HC, H_2O
BORRESEN COOLTECH AS	Norway	http://www.borresen.no	Wholesale, sales, marketing	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning, Online course / e-learning	CO_2, NH_3, HC, H_2O, AIR
Budapest Technical University	Hungary	http://www.bme.hu	University	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Bundesfachschule Kälte	Germany	http://bfs.trialserver.xyz	Vocational / professional school	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Business Edge	United Kingdom	http://www.businessedgeltd.co.uk/index.html#.Vt2oTxCrRLw	Components manufacturer, Servicing, repair, maintenance, Vocational / professional school	Theoretical training, Practical training, Presence / Course on site	CO_2, HC, H_2O, AIR

C

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Carrier	Germany	http://www.carrier.com	Components manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2
Celcia	Sweden	http://celcia.se	Training institute	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
CEMAFROID	France	http://www.cemafroid.fr	Association	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Center of knowledge and technologies transfer for HVAC&R	Russia	http://hvaccenter.ru	Research institute	Theoretical training; Online course / e-learning	CO_2 NH_3 HC
Centre des formations Industrielles (CFI)	France	http://www.cfi-formations.fr	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
CENTRO SERVIZI per IMPIANTISTI e MANUTENTORI srl (with Assogrigoristi)	Italy	http://www.centroserviziimpiantisti.it	Association; Training institute	Theoretical training; Presence / Course on site	CO_2 NH_3 HC
Centro Studi Galileo	Italy	http://www.centrogalileo.it	Training institute	Theoretical training; Presence / Course on site	CO_2 NH_3 HC
CFTRN-Johnson Control	France	http://www.johnsoncontrols.com/fr_fr/buildings/our-solutions/training	System manufacturer; Components manufacturer; Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3
ChillAir (UK) Training Academy	United Kingdom	http://www.refrigerationtraining.org	Training institute	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning	CO_2
Chlodmex	Poland	-	System manufacturer; Components manufacturer; Refrigerant supplier; Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC H_2O

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
CIAT	France	http://www.ciat.fr	System manufacturer; Consulting, contracting, engineering; Consulting, contracting, engineering; Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2
CIBSE	United Kingdom	http://www.cibse.org	Certification body; Course materials and guide books	Theoretical training; Online course / e-learning	CO_2 NH_3
CIPFP Catarroja	Spain	http://www.fpcatarroja.com	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2
CIT Cork (Cork Institute of Technology)	Ireland	http://www.cit.ie	University	Theoretical training; Practical training; Presence / Course on site	NH_3
CITB - skills Awards	United Kingdom	http://www.citb.co.uk/awards/qualifications-and-courses/utilities-engineering/refrigeration/	Vocational / professional school; Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3
CLAUGER #105	France	http://www.clauger.com	Components manufacturer; Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	NH_3
Clima Mobil Service EOOD	Bulgaria	http://www.clima-mobil.com	Components manufacturer; Refrigerant supplier; Consulting, contracting, engineering; Servicing, repair, maintenance; Wholesale, sales, marketing	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
CNAM	France	http://www.cnam.fr	University	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Cofrico (training for their staff only)	Spain	http://www.cofrico.com	System manufacturer	Practical training; Presence / Course on site	CO_2 NH_3
Confederación Nacional de Instaladores, C N I	Spain	http://www.cni-instaladores.com	Association	Practical training; Presence / Course on site; Online course / e-learning	CO_2 NH_3
Cool Concerns Ltd	United Kingdom	http://www.coolconcerns.co.uk/training-services.php	Consulting, contracting, engineering; Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Coolmark #516	Netherlands	http://www.coolmark.nl	Components manufacturer; Wholesale, sales, marketing	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
COPROTEC – Colmar	France	http://www.coprotec-elearning.com	Training institute	Theoretical training; Online course / e-learning	CO_2 NH_3
COSTIC	France	http://www.costic.com	Research institute	Theoretical training; Presence / Course on site	CO_2 NH_3
Crownship	United Kingdom	http://www.crownship.com	Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3
CRYOlogic	Greece	http://www.cryologic.gr	Consulting, contracting, engineering	Theoretical training; Presence / Course on site	CO_2
CSKK #350	Switzerland	-	System manufacturer; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	CO_2
CTA #228	Switzerland	http://www.cta.ch	System manufacturer	Theoretical training; Presence / Course on site	CO_2 NH_3 HC

D/E/F

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Danfoss	Denmark	http://danfoss.com	System manufacturer; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC
Danish Technological Institute	Denmark	http://www.dti.dk	Consulting, contracting, engineering; Research institute; Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
DCI Refrigeration	United Kingdom	http://www.dcirefrigeration.co.uk	Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	CO_2
De' Longhi Appliances S.r.l. #397	Italy	http://www.delonghi.com	System manufacturer	Practical training; Presence / Course on site	HC
DEF - university of Florence	France	http://www.unifi.it	University	Theoretical training; Presence / Course on site	CO_2
DIT Dublin (Dublin Institute of Technology)	Ireland	http://www.dit.ie	University	Theoretical training; Practical training; Presence / Course on site	HC
Eastleigh College	United Kingdom	http://www.eastleigh.ac.uk/careers/refrigeration-and-air-conditioning/	University	Theoretical training; Practical training; Presence / Course on site	CO_2 HC
Ecole des Mines	France	http://www.mines-paristech.fr	University	Theoretical training; Presence / Course on site	CO_2
Education centre GO°	Netherlands	http://www.opleidingscentrum-go.nl	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Edupoli	Finland	http://www.edupoli.fi	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
EINDHOVEN CENTER FOR SUSTAINABLE ECFS	Netherlands	https://educationguide.tue.nl	University	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Ellis Training and Consultancy	United Kingdom	http://www.ellistraining.co.uk	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
ENEA	Italy	http://www.enea.it/it	Association	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3
Energi & Kylanalys	Sweden	http://www.ekanalys.se	System manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Energy Training Hub	United Kingdom	http://energytrainginghub.co.uk/courses/refrigeration-training-courses/	Training institute	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
ENGIE Axima (former GDF SUEZ)	France	http://www.aximaref.com	Training institute	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2, NH_3, HC
ENTROPYCS (ENTROPY Cooling Solutions)	Netherlands	http://www.Entropycs.net	Consulting, contracting, engineering, Training institute	Theoretical training, Practical training, Presence / Course on site, Offline / Long distance	NH_3
EPTA Spa	Italy	http://www.eptarefrigeration.com	System manufacturer, Consulting, contracting, engineering, Servicing, repair, maintenance, Wholesale, sales, marketing	Theoretical training, Practical training, Presence / Course on site	CO_2
ESS Ltd.	Ireland	http://www.essltd.ie	Consulting, contracting, engineering	Theoretical training, Practical training, Presence / Course on site	NH_3
Fachschule für Kälte- und Klimatechnik München	Germany	http://www.hamec.de	Vocational / professional school, Training institute	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
FEMEVAL	Spain	http://www.femeval.es	Association	Theoretical training, Presence / Course on site, Online course / e-learning	CO_2, NH_3
FIMED, S.L.	Spain	http://www.fimed.es	Association, Vocational / professional school, Training institute	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2, NH_3, HC
Friginor	Sweden	http://www.friginor.se/index.html	System manufacturer	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning, Offline / Long distance	CO_2
Frigo Polska #232	Poland	http://www.frigopolska.pl/index.php?&lang=e	Consulting, contracting, engineering, Servicing, repair, maintenance	Theoretical training, Practical training, Presence / Course on site	CO_2

G/H

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
GCM - Kaeltesysteme GmbH	Germany	http://www.gcm-kaelte.de	System manufacturer	Theoretical training, Offline / Long distance	NH_3, HC
GEA Bock	Germany	http://www.gea.com	Components manufacturer	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3
GEFEN - Alfortville	France	http://www.gefen.org	Training institute	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Georgian Association of Refrigerating, Cryogenic and Air	Georgia	http://www.garcae.org.ge	Association	Theoretical training, Practical training, Presence / Course on site	NH_3
GIZ	Germany	http://www.giz.de/proklima	Development agency	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Green & Cool #133	Sweden	http://www.greenandcool.com/en/	System manufacturer, Consulting, contracting, engineering, Servicing, repair, maintenance	Theoretical training, Practical training, Presence / Course on site	CO_2
Grimsby Istitute	United Kingdom	http://www.grimsby.ac.uk	University	Theoretical training, Presence / Course on site	NH_3, HC
GTC Fluides et Energies	France	http://www.lasalle-troyes.fr	Vocational / professional school, Training institute	Theoretical training, Practical training, Presence / Course on site	NH_3
GTS	Netherlands	http://www.gastreatmentservices.com/en/	Consulting, contracting, engineering, Servicing, repair, maintenance, Engineering firm	Theoretical training, Practical training, Presence / Course on site, Offline / Long distance	CO_2
H.A.L. Training	United Kingdom	http://hal-training.co.uk	Training institute	Theoretical training, Practical training, Presence / Course on site	NH_3, HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
H.Seabra #95	Portugal	http://hseabra.seabraglobal.com/en/	Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3
Hall Training Centre (part of North West Kent College)	United Kingdom	http://www.northkent.ac.uk/commercial-courses/the-hall-training-centre.aspx	Vocational / professional school; Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3
Hansen Technologies	Denmark	http://www.hantech.com	Consulting, contracting, engineering	Theoretical training; Practical training; Presence / Course on site	NH_3
Hawco Ltd	United Kingdom	http://www.hawco.co.uk	Components manufacturer	Theoretical training; Practical training	CO_2
HRP Ltd	United Kingdom	http://www.hrponline.co.uk	Wholesale, sales, marketing	Theoretical training; Presence / Course on site	CO_2 HC
HRP Technical training	United Kingdom	https://www.hrponline.co.uk	Wholesale, sales, marketing; Training institute	Theoretical training; Online course / e-learning	HC
HSR Fachhochschule rapperswil	Switzerland	http://www.hsr.ch	University	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Hungarian Climate Protection Authority #489	Hungary	-	Certification body	Theoretical training; Online course / e-learning	CO_2 NH_3 HC
HUURE GROUP OY	Finland	http://www.huurre.com	System manufacturer; Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
HYSAVE	United Kingdom	http://www.hysave.com	Components manufacturer	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR

I/J/K

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
IES Llombai	Spain	http://iesllombai.edu.gva.es	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2
IES Salvador Victoria	Spain	http://iesmonre.educa.aragon.es	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2
IES Xebic	Spain	http://iesxebic.edu.gva.es	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2
IFFEN (Institute Francais de Formation en Energique)	France	http://iffen.fr	Training institute	Theoretical training; Presence / Course on site	CO_2 HC
IIR	France	http://www.iifiir.org	Association	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
IKKE gGmbH Informationszentrum für Kälte-, Klima und Energietechnik	Germany	http://www.i-k-k-e.com	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
INSA (Institut national des sciences appliquees)	France	https://www.insa-lyon.fr	University	Theoretical training; Presence / Course on site	CO_2 NH_3 HC
Institut Français du Froid Industriel (IFFI)	France	http://iffi.cnam.fr	Research institute; Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Invensor GmbH	Germany	http://www.invensor.com	System manufacturer	Theoretical training; Practical training; Presence / Course on site	H_2O
IOR (The Institute of Refrigeration)	United Kingdom	http://www.ior.org.uk/ior_filter_technical.php?r=34EM3M4NAE	Association	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
ITE N.V. #349	Belgium	http://www.ite-tools.com/en	Components manufacturer	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
Jaume I University of Castellón	Spain	https://ujiapps.uji.es	Research institute, University	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
Kältetechniklehrgänge Bremerhaven	Germany	http://www.kaeltelehrgaenge-brhv.de	Vocational / professional school, Training institute	Theoretical training, Practical training, Presence / Course on site	NH_3
KEK IVEPE	Greece	http://www.ivepe.gr/el/	Training institute	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3
Kelvin srl	Italy	http://www.kelvinitaly.it	System manufacturer	Theoretical training, Presence / Course on site	CO_2
KHLIM	Belgium	http://www.khlim.be	University	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Klima-Therm Academy	Poland	http://www.klima-therm.pl/en/182/academy	Servicing, repair, maintenance, Wholesale, sales, marketing, Research institute	Theoretical training, Practical training, Presence / Course on site	HC
Koulutuskeskus Salpaus	Finland	http://www.salpaus.fi/Sivut/default.aspx	Vocational / professional school	Theoretical training, Practical training, Presence / Course on site	CO_2
KTH	Sweden	http://www.kth.se	University	Theoretical training, Presence / Course on site, Online course / e-learning, Offline / Long distance	CO_2, NH_3, HC
KWA Business consultants	Netherlands	http://www.kwa.nl	Consulting, contracting, engineering	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC, H_2O, AIR

L

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
LA RPF Formation	France	http://larpfformation.fr/category/co2/	Training institute	Theoretical training, Practical training, Presence / Course on site	CO_2
LEZIN-FORMATION - Montauban	France	http://www.lezin-formation.com/	Training institute	Theoretical training, Presence / Course on site	CO_2
Lycée Branly - Boulogne	France	http://lycee-branly.org	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée d'Alzon - Nîmes	France	http://www.dalzon.com	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée la Fontaine des eaux - Dinan	France	http://www.lycees-dinan.fr	University	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
Lycée La Martinière	France	http://www.lamartinieremonplaisir.org	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée La Providence - Amiens	France	http://www.la-providence.net	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée Maximilien Perret	France	http://www.maxp.fr	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée Mermoz	France	http://www.lycee-mermoz.net/joomla/index.php	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Lycée Raspail - Paris	France	http://www.ldmraspail.fr	University	Theoretical training, Practical training, Presence / Course on site	CO_2
Lycée Saint Joseph - Troyes	France	http://lasalle-troyes.fr	University	Theoretical training, Practical training, Presence / Course on site	CO_2

M/N

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Maskinmesterskolen København	Denmark	http://www.msk.dk	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
Matal Formation	France	http://www.matal-formation.fr	Association; Training institute	Theoretical training; Presence / Course on site	CO_2 NH_3
Mbassi #224	Italy	-	Consulting, contracting, engineering	Theoretical training; Presence / Course on site	CO_2 HC
Multiconsult	Norway	http://www.multiconsult.no	Consulting, contracting, engineering	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3
National Technical University of Athens (Metsovio Polytechneio)	Greece	-	University	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC H_2O AIR
NCOI #153	Netherlands	http://www.ncoi.nl/	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC H_2O
Nestlé	Switzerland	http://www.nestle.com	End-user	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC
NORD	Russia	http://www.nord-sm.ru	System manufacturer; Components manufacturer; Refrigerant supplier; Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	CO_2
Norddeutsche Kälte-Fachschule	Germany	http://www.nkf-springe.de	Certification body; Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 H_2O
NTB - Interstaatliche Hochschule für Technik Buchs	Switzerland	http://www.ntb.ch/studium	University	Theoretical training; Practical training; Presence / Course on site	CO_2 NH_3 HC H_2O AIR

O/P

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
NTNU #79	Norway	https://www.ntnu.edu	University	Theoretical training; Presence / Course on site	CO_2 NH_3 HC
Oy Combi Cool #355	Finland	http://www.combicool.fi/en	Components manufacturer; Refrigerant supplier; Wholesale, sales, marketing	Theoretical training; Practical training; Presence / Course on site	CO_2 HC
Parker Hannifin	Switzerland	http://www.parker.com	Components manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2
Polar Pumps Ltd	United Kingdom	http://www.polarpumps.co.uk	Servicing, repair, maintenance; Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3 HC
Pole Cristal	France	http://www.pole-cristal.fr/nos-prestations/formation/	University; Training institute	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 NH_3 HC H_2O AIR
Polytechnic University of Valencia	Spain	www.iie.upv.es_	University	Theoretical training; Practical training; Presence / Course on site	CO_2 HC
Polytechnical University of Catalonia	Spain	http://www.upc.edu/?set_language=en	University	Theoretical training; Practical training	CO_2
Practical Refrigeration Training Centre	United Kingdom	http://www.prtc.co.uk	Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3 HC
PROFROID	France	http://www.profroid.com/profroid/cms/7128/accueil.dhtml	System manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2
PTC+	Netherlands	http://www.ptcplus.com/_	Training institute; Business development	Theoretical training; Presence / Course on site	CO_2 NH_3 HC

R/S

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
RD&T	United Kingdom	http://www.rdandt.co.uk	Research institute	Theoretical training, Practical training, Presence / Course on site	NH_3, HC
Re/genT BV	Netherlands	http://www.re-gent.nl	Consulting, contracting, engineering, Research institute	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
Red Dragon Air Conditioning	United Kingdom	http://www.red-dragon-airconditioning.com	Training institute	Theoretical training, Practical training, Presence / Course on site	HC
Refcom - can't find info on training	United Kingdom	http://www.refcom.org.uk	Training institute	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning, Offline / Long distance	CO_2, NH_3, HC, H_2O, AIR
REFTEC	Switzerland	http://www.reftec.ch/Berufsbildung.htm	Consulting, contracting, engineering	Theoretical training, Practical training, Presence / Course on site	CO_2, HC
Sächsische Kältefachschule	Germany	http://www.kaelteschule-sachsen.de	Vocational / professional school	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Sainsbury's	United Kingdom	http://www.j-sainsbury.co.uk	End-user	Theoretical training, Practical training, Presence / Course on site	CO_2
Scantec #462	Austria	-	Consulting, contracting, engineering	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3
SCHKT	Czech Republic	http://www.chlazeni.cz/o-schkt/info-in-english	Association	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
SCM Frigo	Italy	http://www.scmfrigo.com	System manufacturer	Theoretical training; Practical training; Presence / Course on site	CO_2
SERC Lisburn	Ireland	http://www.serc.ac.uk/Pages/default.aspx	Training institute	Theoretical training; Presence / Course on site	NH_3
Sneffcca / Cristal Formation	France	http://www.snefcca.com	Association	Theoretical training; Practical training; Presence / Course on site	CO_2
Sole Trader	United Kingdom	-	Consulting, contracting, engineering	Theoretical training; Practical training; Presence / Course on site	HC
South Eastern Regional College	United Kingdom	http://www.serc.ac.uk	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2 HC
SP technical research institite of Sweden	Sweden	http://www.sp.se/en/Sidor/default.aspx	Research institute	Theoretical training; Presence / Course on site	CO_2 NH_3 HC
Star Learning solutions (Star refrigeration)	United Kingdom	http://www.i-know.com	Training institute	Theoretical training; Online course / e-learning	CO_2
SuperSmart	Europe wide	http://www.supersmart-super-market.info/training-interest	University	Theoretical training; Presence / Course on site; Offline / Long distance	CO_2 NH_3 HC
SWEP #199	Sweden	http://www.swep.net/	Components manufacturer	Theoretical training; Presence / Course on site; Online course / e-learning	CO_2 NH_3 HC

T/U/V/W/X

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Taiga Training	United Kingdom	http://www.taigatraining.co.uk	Consulting, contracting, engineering; Servicing, repair, maintenance	Theoretical training; Practical training; Presence / Course on site	HC
Technical College of Jutland	Denmark	http://www.djhhadsten.dk	Vocational / professional school	Theoretical training; Practical training; Presence / Course on site	CO_2; NH_3; HC
TECSISEL, LDA	Portugal	http://www.tecsisel.pt	System manufacturer; Consulting, contracting, engineering	Theoretical training; Practical training; Presence / Course on site; Online course / e-learning; Offline / Long distance	CO_2; NH_3; HC; H_2O; AIR
TEPSE	Greece	http://www.tepse.gr/55687285.el.aspx	Training institute	Theoretical training; Presence / Course on site	CO_2; NH_3
Test- und Weiterbildungszentrum Wärmepumpen und Kältetechnik (TWK)	Germany	https://www.twk-karlsruhe.de/Kurse/R744	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2
tlk-thermo gmbh	Germany	http://www.tlk-thermo.de	Consulting, contracting, engineering	Theoretical training; Presence / Course on site	CO_2; NH_3; HC
Training World	United Kingdom	http://www.trainingworld.co.uk	Training institute	Theoretical training; Practical training; Presence / Course on site	NH_3
TÜV Austria Akademie	Austria	https://www.tuv-akademie.at	Training institute	Theoretical training; Practical training; Presence / Course on site	CO_2; NH_3; HC
UCLL highschool	Belgium	https://www.ucll.be/studeren/navorming/koeltechnieken-co2-als-koelmiddel	University	Theoretical training; Practical training; Presence / Course on site	CO_2
UNEP		http://web.unep.org	International Organisation	Theoretical training; Online course / e-learning; Offline / Long distance	CO_2; NH_3; HC

COMPANY	COUNTRY	WEBSITE	TYPE	TRAINING	REFRIGERANTS
Université Grenoble	France	http://www.univ-grenoble-alpes.fr	University	Theoretical training, Presence / Course on site	CO_2, NH_3, HC
Université Marne la vallée	France	http://www.u-pem.fr	University	Theoretical training, Practical training, Presence / Course on site	CO_2, NH_3, HC
Université Rouen	France	http://www.univ-rouen.fr	University	Theoretical training, Presence / Course on site	CO_2, HC
University of Agder #445	Norway	http://www.uia.no/en	University	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2, NH_3, HC
University of Food Technologies	Bulgaria	http://uft-plovdiv.bg	University	Theoretical training, Practical training, Online course / e-learning	CO_2, NH_3, HC
Vestfrost Solutions	Denmark	http://www.vestfrostsolutions.com	System manufacturer	Theoretical training, Practical training, Presence / Course on site	HC
Walter Wettstein AG	Switzerland	http://www.wwag.ch	System manufacturer	Theoretical training, Presence / Course on site	CO_2, NH_3
Xabec	Spain	http://www.xabec.es	Vocational / professional school	Theoretical training, Practical training, Presence / Course on site, Online course / e-learning	CO_2, HC

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Marc Chasserot is the CEO of shecco, with over 10 years' experience in the HVAC&R sector. In 2006, he founded the industry leading website for CO2 cooling and heating experts worldwide: www.R744.com. This was followed by three platforms for hydrocarbons, water and ammonia. He has chaired and organised numerous international workshops for policy and industry experts to discuss how to bring natural refrigerants faster to market, known as 'ATMOsphere'.

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- District heating at high altitude – City of Saas-Fee (CH), 1x 650 kW, NH3
- Biopharma – BioArk, Visp (CH), 1x150 kW + 1x 220 kW, NH3
- Industrial plant – BASF Suisse SA, Monthey (CH), 1 x 650 kW, NH3
- Dairy – Cremo SA, 4 production center (CH), 7x650 kW + 4x 350 kW, NH3
- IQF Tunnel Freezer – Pitteloud Fruits SA, Sion (CH), 1 x 320 kW, CO_2 transcritical
- Sport Arena – Armasuisse, Payerne (CH), 2x 40 kW, CO_2
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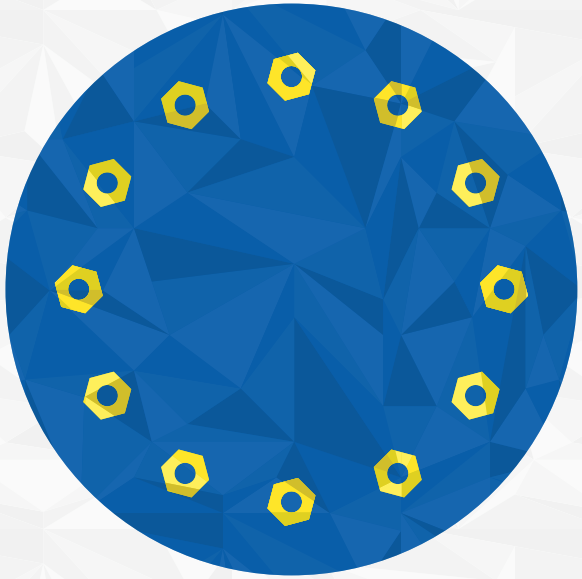

Get in touch with shecco's Market Development team to learn more about the market for natural refrigerants in Japan or find out how we can help you in gathering market intelligence and proactively building your business with our tailored market development services, to get your technology faster to market.

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