



Sustaining our atmosphere

shecco Marketing Report

CO₂ Commercial Refrigeration

The European Market 2009

About shecco

shecco believes that investment decisions are better taken with a good understanding of the market. Our Marketing Research team can offer you tailor-made reports about CO₂ and other natural refrigerants in different world regions. Through our in-depth market analysis we will help you minimise investment risks, while our partner assessment studies will support you in finding the right business partner at the right time. When sounding out potential political and economic threats, and quickly expanding to new markets is crucial, shecco can help you optimise your business strategies to get your climate-friendly technologies faster to market.

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Cooling down the climate debate... with CO₂

“ The choice is not ‘green or grow’, you can do both, and you must do both “



Heading food retail chain Tesco, Terry Leahy summed up in late 2008 what leading supermarkets around the world would need to understand. In times of mounting pressure from consumers to lower their carbon footprint from daily shopping, and from legislators to comply with a wave of environmental laws, retailers cannot afford to maintain business-as-usual strategies for much longer.

This is even more true in a time when economic recession has cast its shadow over entire industries. As the sustainable development triangle of economic viability, social responsibility, and ecological protection is under threat to be abandoned to rescue short term market shares, the gap is widening between those investing in sustainable retailing today, and those still holding on to wait-and-see strategies.

The pressure to reduce or even ban high global warming substances from their stores altogether, however, is felt by an increasing number of retailers. Here, some have taken a leadership role to drive green business practices throughout their entire supply chains. Where other industries still spend vast amounts of money on tactics to fend off upcoming regulatory restrictions, the food retail industry in the EU has quietly started to sound out opportunities to move away from climate-changing refrigerants and anticipate an unavoidable disappearance of HCFCs and HFCs before long.

The rediscovery of CO₂ to keep foodstuff cool has come at the right moment to serve as an insurance against upcoming legislation, societal pressure, and high capital expenditures in the future. No matter if driven by inexorable F-gases restrictions, looming taxation, or governmental financial schemes, an early “natural move” might prove to be one of the best tools to save profits now and in the future.

But can CO₂ really serve as a game changer for the entire European food retail industry? How are the technological and economic prospects of a refrigerant that has made another strong entrance in the market after having been sidelined by several generations of chemical options? From which side is support to be expected at the EU and national level?

This summary report tries to answer some of these questions by looking at the policy frameworks affecting commercial refrigeration in selected EU countries today, and analysing the market situation and major trends for subcritical and transcritical CO₂ installations. It sums up findings from two separate market studies carried out by shecco in Winter 2008 and Spring 2009. The method followed combines scrutiny of publicly available data from governments, the academia, and industry sources, as well as first-hand research with relevant suppliers and manufacturers, including face-to-face meetings and surveys.

As the fastest growing market for CO₂ commercial refrigeration worldwide, this summary report exclusively focuses on the European Union, and here namely on Norway, Sweden, Denmark, the UK, Germany, Belgium, France, Switzerland, Spain, and Italy. As a result and due to the high dynamics in some EU countries currently pushing the number of CO₂ installations to higher levels on a monthly basis, some figures of total installations must be seen as a rather conservative estimate. However, one general trend can be observed in all countries described hereafter: While penetration rates for CO₂ commercial refrigeration might still vary largely for different countries, the natural refrigerant has set out to make inroads in Europe and beyond.

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The 4 Main Messages



The market for CO₂ is growing

In the EU, the total number of transcritical CO₂ installations to date is at least in the range of 250, and most likely even higher than that, following the rapid market development in Denmark, Germany, or the UK over the last few months. All through 2008 and early 2009 there has been a steep increase in the number of installed systems, suggesting that the financial turmoil has left the need to switch to low-impact cooling solutions largely unaffected. The subcritical market, seen by some as even more promising especially in hot Southern climates, is equally growing, although the choice between up to 9 different system layouts has made the positioning of CO₂ more complex. A general trend towards serial production within the next 2-3 years can be observed, depending on whether favourable incentives are in place.

Without policy no change...

Judging by the high success of CO₂ in Denmark and other Scandinavian countries, strong policy signals seem to be the only effective driver to “convince” an otherwise reluctant food retail industry to switch to HFC-free solutions. In Denmark, where a combination of high import taxes on HFCs and charge limits have made the use of fluorinated gases economically prohibitive, the industry expects CO₂ to have taken over all market shares from HFCs within the next five years. However, the recent example of Germany has shown that the “carrot” might lead to similar results as the Scandinavian “stick”. Here, food retailers’ first investments in energy-efficient refrigeration systems using natural refrigerants are largely covered by a federal incentive scheme. No matter which approach works best – the current random collection of HFC caps, cash carrots, and laissez-faire approaches found in the single EU states won’t help an early change, despite the long term ecological and economic benefits CO₂ holds.

...unless the competition changes

More than other industries, the food retail sector is under public scrutiny in the daily media. While green consumerism is no longer a side effect but a mass movement to cope with, supermarkets are either forced to react to pressure from environmental groups and the public at large, or proactively use environmental best practices to build their green credentials. Advertising CO₂ solutions as an integral part of a new way to store, preserve, distribute and sell food has become an effective marketing tool to outcompete retail chains lagging behind. Once a critical mass of installations is reached, CO₂ might soon turn into the next standard solution nurturing a supplying industry that has read the signs of the times. For this, however, frontrunners are needed to create a much-needed momentum. In highly competitive markets as the food retail industry, an early commitment to the best available technology by some has in the past proven to be the best door opener for not yet economically competitive solutions to be adopted by many. CO₂ technology is no exception.

Scandinavia is leading the crowd

The Scandinavian market is, in the short term, where the biggest potential for CO₂ technology is to be found. Given the temperature conditions, the potential to realise efficiencies and the existing legislation on HFCs, both the numbers of transcritical and subcritical CO₂ installations are expected to grow over the next few years. Already today, Denmark is the fastest expanding market, accounting for half of the total transcritical CO₂ systems installed worldwide. In the medium term, the biggest potential appears to exist in Germany, due to its size and the clear signals from the market to opt for CO₂ as a replacement in commercial refrigeration; and the UK where a surprisingly high number of system and showcase manufacturers have already developed or at least expressed a vivid interest in developing CO₂ solutions.

The European Food Retail Market

“Cut-throat competition and consolidation - a fragmented market moves towards R744”



The food retail market in the European Union is one of the most hard-fought ones with heavy cut-throat competition. However, despite all the attention given to competition levels, EU food retailing is still very fragmented, with different retail groups having a stronghold in certain geographical regions and countries. Recent attempts by market players to consolidate under depressed economic circumstances have received a close watch from EU regulators whether they might act against the interests of consumers and producers. On the other hand, consolidation trends could lead to greater efficiency and economies of scale with a favourable impact on common corporate environmental strategies and the implementation of more sustainable ways of cooling foodstuff. An adoption of CO₂ technology by the strongest market players as a company-wide practice to follow across all markets could create the momentum needed to cross the threshold for R744 to become a standard solution.

A significant number of market actors mentioned hereafter have already tested or moved towards a wider use of R744. Although most retailers are still in the process of evaluating pilot projects, some of them are more likely to replicate such projects and make CO₂ refrigeration a standard technology to be used in their new stores (e.g. Tesco) than others (e.g. METRO Group).

COMPANY	HEADQUARTERS	SALES IN \$ BILLIONS (YR 2007)	NUMBER OF STORES	COUNTRIES OF OPERATION
Wal-Mart Stores	U.S.	312.4	6,380	Argentina, Brazil, Canada, China, Costa Rica, El Salvador, Germany, Guatemala, Honduras, Japan, South Korea, Mexico, Nicaragua, Puerto Rico, United Kingdom, United States
Carrefour	France	92.6	12,179	Argentina, Bahrain, Belgium, Brazil, China, Colombia, Cyprus, Czech Republic, Dominican Republic, Egypt, France, French Polynesia, Greece, Guadeloupe, Indonesia, Italy, Malaysia, Martinique, New Caledonia, Oman, Poland, Portugal, Qatar, Reunion, Romania, Saudi Arabia, Singapore, Slovakia, Spain, South Korea, Switzerland, Taiwan, Thailand, Tunisia, Turkey, United Arab Emirates
Tesco	U.K.	\$69.6	2,365	China, Czech Republic, France, Hungary, Ireland, Japan, South Korea, Malaysia, Poland, Slovakia, Taiwan, Thailand, Turkey, United Kingdom
Metro Group	Germany	69.3	2,458	Austria, Belgium, Bulgaria, China, Croatia, Czech Republic, Denmark, France, Germany, Greece, Hungary, India, Italy, Japan, Moldova, Morocco, Netherlands, Poland, Portugal, Romania, Russia, Serbia and Montenegro, Slovakia, Spain, Turkey, United Kingdom, Vietnam
Costco	U.S.	52.9	460	Canada, Japan, South Korea, Mexico, Puerto Rico, Taiwan, United Kingdom, United States
Costco	U.S.	52.9	460	Canada, Japan, South Korea, Mexico, Puerto Rico, Taiwan, United Kingdom, United States
Rewe	Germany	51.8	11,242	Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Italy, Poland, Romania, Russia, Slovakia, Switzerland, Ukraine
Schwarz Group	Germany	45.8	7,299	Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, United Kingdom
Aldi	Germany	45	7,788	Australia, Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Slovenia, Spain, Switzerland, United Kingdom, United States
Auchan	France	41.8	2,686	Angola, China, France, Hungary, Italy, Luxembourg, Morocco, Poland, Portugal, Russia, Spain, Taiwan
Edeka	Germany	41.3	19,001	Austria, Czech Republic, Denmark, Germany, Russia
AEON	Japan	40.2	10,132	Canada, China, Hong Kong, Japan, South Korea, Malaysia, Philippines, Taiwan, Thailand, United Kingdom, United States
ITM (Intermarché)	France	37.7	3,932	Belgium, Bosnia and Herzegovina, France, Poland, Portugal, Romania, Spain, Serbia and Montenegro
Leclerc	France	35.4	581	France, Italy, Poland, Portugal, Slovenia, Spain

COMPANY	HEADQUARTERS	SALES IN \$ BILLIONS (YR 2007)	NUMBER OF STORES	COUNTRIES OF OPERATION
Seven & I	Japan	35.3	21,136	Australia, Canada, China, Denmark, Guam, Hong Kong, Indonesia, Japan, South Korea, Malaysia, Mexico, Norway, Puerto Rico, Singapore, Sweden, Taiwan, Thailand, Turkey, United States
Tengelmann	Germany	28.3	9,388	Argentina, Bahrain, Belgium, Benin, Brazil, Cameroon, Colombia, Comoros, France, Guadeloupe, Latvia, Lithuania, Lebanon, Madagascar, Martinique, Mauritius, Mexico, Morocco, Netherlands, New Caledonia, Poland, Reunion, Saudi Arabia, Switzerland, Taiwan, Thailand, Togo, Tunisia, United Arab Emirates, Uruguay, United States, Venezuela, Vietnam
Delhaize Group	Belgium	23.1	2,637	Belgium, Czech Republic, Germany, Greece, Indonesia, Luxembourg, Romania, United States

Table 1: Largest global food retailers in terms of sales in 2007

Source: Based on Planet Retail (2008)

The first transcritical CO₂ system in the UK was installed in 2006 at Tesco Swansea. Since then, CO₂ refrigeration systems have been installed in several Tesco flagship environmentally-friendly stores (Wick, Leicestershire, Manchester). The store in Manchester has been built using the company's new low carbon blueprint which will provide a foundation for stores built in the UK in the future. According to Tesco's carbon blueprint, "the majority of the stores Tesco built this year will have refrigeration systems that are cooled with carbon dioxide, which is thousands of times less damaging to the climate than traditional fridge gases."

The METRO Group is currently testing carbon dioxide refrigeration systems as a climate friendly alternative in its stores. For many years, several stores have operated CO₂ freezer systems. In 2007, pilot systems that also use carbon dioxide as a refrigerant to cool dairy products or meat were installed in two newly built Metro Cash & Carry stores in Denmark and Germany. Moreover, its environmental report states that the group will "replace the currently used refrigerants with environmentally friendly refrigerants step by step" [Metro 2007]

- Through its ICA brand, Ahold has several transcritical installations in Norway and Sweden.
- Europe's 3rd largest retail chain REWE has announced to use 1 000 R134a/R744 cascade systems for medium temperature application.
- The Schwarz Group has been active through installations at its Lidl stores. In addition to its R744 supermarket installations, Lidl has started construction works most recently on a new distribution centre to only use CO₂ and ammonia.
- Aldi has been especially active in transcritical installations at Aldi Süd in Germany. It was the first to install CO₂ transcritical systems in Germany in 2006, and according to the company with 13 CO₂ systems by early 2009 remains the retailer with the highest numbers of R744 installations and efforts to actively support the refrigerant in Germany. Aldi Süd has repeatedly stated that CO₂ will be used to phase out HFCs throughout all discount supermarkets. As a most recent innovation, Aldi Süd has announced a new electrically-driven transport refrigeration system using a closed CO₂ circuit powered by solar panels.

- Edeka has taken advantage of the generous German federal support scheme for natural refrigerants installations and has closed the gap to Aldi Süd and Lidl with several new test installations placed across different geographic regions of Germany.
- Finally the Delhaize Group in Belgium has been the first in the country to install a transcritical system.
- In a May 2009 Retail Forum¹ meeting Carrefour maintained that their experience with one CO₂ installation in France was not a good one. However, the representative was not in a position to discuss why this was the case, where the plant was located, its specifications etc.
- In the UK, Sainsbury's had converted 2 out of 765 stores to natural refrigerants as of summer 2008. The food retailer has recently stated its intention to move away from HFCs, but has, however, voiced concerns over the efficiency of CO₂ [EIA 2009a].

SWOT Analysis

“Technically viable, climate-friendly and the best insurance policy... but still not enough incentives”



Before going into details for policy and market drivers affecting the use of CO₂ technology in selected EU countries, a basic SWOT analysis might help visualise again the opportunities and challenges R744 is facing in the commercial refrigeration industry. This list can only be a non-exhaustive and sketchy one, as the economic and political conditions for its market uptake are differing widely across EU states and beyond.

Strengths

Technically viable : CO₂ has already been proven as an efficient and safe alternative in a variety of applications inside and outside the commercial refrigeration sector (see huge economic success of “Eco-Cute” R744 heat pumps in Japan).

Ready for serial production : Especially in the subcritical area and for cascade solutions involving other natural refrigerants or HFCs, suppliers confirm that there are hardly any technical challenges left. Transcritical solutions sold in Denmark have moved beyond the discussion of whether the technology is viable to questions of delivery times, quality, and price.

Compliance with environmental legislation : CO₂ is one of the best insurance policies against current and future restrictions regarding greenhouse gas emissions and energy efficiency, to name just two. Long term environmental policy objectives are easier to be set and achieved.

Investment security : An early investment in CO₂ technology avoids additional future capital expenditures for changing to yet another generation of F-gases. Stronger ties between food retailers and their supplying partners can be established.

Green image : Especially retailers are starting to use CO₂ as a tool to market their green credentials towards consumers. In other sectors (HPs in Japan) R744 is marketed as the greenest solution for heating.

Weaknesses

Pricing of CO₂ systems : Initially higher costs make CO₂ less attractive at first sight than a mere replacement with HFC-based systems. Not taking into account the financial payback through energy savings and legal compliance, this is perceived as the strongest argument against the use of R744.

Lack of components : Suppliers and end-users see the lack of suitable CO₂ components for a wider variety of applications as a major setback for a faster growth of transcritical applications. There is a lack of fitting equipment for some systems and layouts.

Lack of training : A lack of qualified installation and maintenance staff is acknowledged by the industry as a major barrier for expanding the use of CO₂ across domestic borders. Suppliers are hesitating to enter foreign markets not offering the same servicing infrastructure. In countries with sufficient training, maintenance staff confirms that CO₂ does not pose any challenge compared to conventional systems.

Public perception : The notion of CO₂ as a “bad” GHG contributing to climate change rather than offering a solution is firmly rooted in the collective psyche. Moreover, it is rejected as a non-safe gas due to its high pressure.

Opportunities

Early market : In most world regions the CO₂ market, especially transcritical, is only at a very early stage with high market growth potential for early adopters. Companies establishing themselves as leading suppliers today might gain benefits from this early market entry advantage later on.

Technical potential : As CO₂ is still in its development phase with its full potential not exploited and some applications not yet even considered, it holds unexplored potential in terms of a widening application range and additional energy savings.

Global policy climate : The current push towards a global deal to halt GHG emissions and never-ending national initiatives to reduce energy dependence offer the appropriate frame for proponents of natural refrigerants to position them as a viable alternative to ozone-depleting and high global warming substance.

Phase out of R22 and other ODS : In most world regions, especially developing countries, the transition from ozone-depleting substances either towards HFCs or a leap-frog to natural refrigerants will decide if the market entry of R744 is going to be postponed by yet another generation of chemical substitutes.

Prices of chemical refrigerants : Steadily rising costs for raw materials and a compliance with phase-out schemes have made synthetic gases less attractive and narrowed the price gap to CO₂.

Rising energy costs : In areas with favourable climate conditions for R744 systems, and where the right quality engineering and system layout exist, retailers confirm energy savings from the use of CO₂, compared to conventional refrigerants. Depending on the current level of energy prices, this can either serve as an incentive or threat to CO₂. However, when thinking long term, supplies of fossil fuels running out in some decades will spur the use of energy-efficient technology.

Threats

Economic crisis : Financial expectations have diminished and in some world regions the industry suggests a further delay of initially costly CO₂ Technology, especially in countries with no clear incentives to move towards a phase-out of HFCs.

Lack of standards : National and supranational energy efficiency standards for commercial refrigeration are largely missing in the EU. Some attempts have been made to work on minimum efficiency requirements for certain product groups (see section on policy drivers below).

Low GWP synthetic refrigerants : Active lobbying by global chemical companies, especially in the automotive sector, has pushed forward another generation of HFCs with low GWP but unknown long term consequences for the biosphere. Concrete alternatives for medium to small-sized systems have been put on the table that are in direct competition with CO₂.

Lack of policy incentives : Last but surely not least, policy has not been providing enough incentives for the use of CO₂, either in form of HFC limits and taxation or by direct financial support. The report's next part will sum up major initiatives at the EU and the national level.

Policy Drivers

“Without policy no change, but will policy change?”



A general consensus within the commercial refrigeration industry, namely system and component suppliers, exist that, without clear policy signals, no transition towards R744 is to be expected in the short to medium term. For the sake of this report, shecco has summarised the most relevant policy initiatives and pieces of legislation currently in place affecting the commercial refrigeration sector in the selected countries.

EU legislation

Several requirements in relation to refrigeration systems need to be respected at the European Union (EU) level. Among those, the F-Gases Regulation and the Eco-Design Directive are the most relevant for the uptake of CO₂-based commercial refrigeration systems, while more recently a self-regulatory environmental performance initiative was launched by the European Retail sector in conjunction with the European Commission:

- **The F-Gas Regulation²** addresses the containment, use, recovery and destruction of high-global warming fluorinated greenhouse gases (F-Gases), such as hydrofluorocarbons (HFCs). Its main impact is on systems containing 3 kg or more refrigerant, to which regular leakage checks and record keeping apply, in addition to end-of-life and repair requirements. The regulation is set for a review in 2011, which may provide a stronger signal to the industry to move away from HFCs. More recently, the European Commission presented a communication on the follow-up to the Kyoto Protocol, according to which the EU will push for the reduction of HFC emissions at the international climate change negotiations in Copenhagen to be held in December 2009. The EU position still needs to be crystallised, with a final statement expected later in 2009. Clear objectives as regards the reduction of HFC emissions at the international level may pave the way towards a revision of the F-gas regulation with stricter provisions on the use of F-gases in the EU.

² European Union regulations, as opposed to Directives, are self-executing and do not require any implementing measures.

- **Eco-Design Directive³:** It was adopted on 6 July 2005 to set maximum levels of energy consumption for a given performance/functionality of energy-using products (EuPs). Products which do not meet the requirements will not be allowed to be put on the EU market. Eco-design rules consider the environmental impact of energy-using products throughout their entire life cycle. “Commercial refrigerators and freezers, including chillers, display cabinets and vending machines” is one of the product groups for which performance/functionality requirements will be set under the Eco-Design Directive. A consultation process for setting requirements for this product group is undergoing, while adoption of a proposal by the European Parliament is expected by 2011. A successful market uptake and promotion of energy-efficient CO₂-based commercial refrigeration systems could serve as a benchmark when setting eco-design requirements, the respect of which would then encourage further market uptake of such systems in the EU. More recently, the European Commission unveiled its intention to establish efficiency standards for the product group “Refrigerating and freezing equipment” (Service cabinets; Walk-in cold rooms; Chillers; Ice-makers; Ice-cream and milkshake machines) in the period 2009-2011. In that respect, an Ecodesign preparatory study⁴, analysing whether and refrigerating equipment included in this product category was launched beginning of 2009.
- **Retailers Environmental Action Programme (REAP):** Responding to the European Commission’s Action Plan on Sustainable Consumption and Production, the European retail sector launched in March 2009 the “Retail Forum”, which is the first of two specific initiatives within (REAP). The Forum serves as a platform to share best practices and identify barriers and opportunities linked to sustainable practices. From a total of 24 retailers⁵ participating in REAP, only retailer Lidl refers to the use of natural refrigerants, failing, however, to commit to any target. Here, a more active representation of the interests of the natural refrigerants industry is needed to establish CO₂ as a market-ready technology. Already by May, two workshops concerning “Energy Efficiency of Stores” had taken place, where drivers, barrier and best practices regarding energy efficiency were discussed. Participants, including representatives from the HVAC industry, chemical industry and retailers, discussed the use of R744 in retail stores, but tended to discard such technology on the basis of lower energy efficiency compared to conventional technology. However, a lack of knowledge with regards to technical issues was observed among the participants as well as a lack of knowledge of the specifications of R744 case studies.

Legislation at the national level

Congruent to critics of CO₂ refrigeration technology repeatedly stating that the natural refrigerant will only hold efficiency gains in cold and medium ambient temperatures, the level of R744 market uptake today is indeed subject to a clear North-South divide within Europe. The following summary of national policy initiatives therefore explores policy frameworks from Scandinavia to the Mediterranean, starting with Norway.

3 A Directive is a legislative act of the European Union which requires member states to achieve a particular result without dictating the means of achieving that result. Directives normally leave member states with a certain amount of autonomy as to the exact rules to be adopted.

4 Complete information about the progress of the study can be found on the following website: <http://www.ecofreezercom.org>

5 There 24 retailers currently participating include: Asda/Wal-Mart, Auchan, C&A, Carrefour Group, CEC (Confederación Española de Comercio), Delhaize Group, El Corte Inglés, EuroCommerce, European Retail Round Table (ERRT), FCD (Fédération des Entreprises du Commerce et de la Distribution, IKEA, Inditex, Kauffland, Kingfisher plc, Leroy Merlin, Spain, Lidl, Marks & Spencer Group, Mercadona, Mercator, Metro Group, Quelle, REWE Group, Royal Ahold, Tesco.

Norway

Norway imports HFC and PFC gases for industrial use (refrigeration, air conditioning, fire extinguishers and foam blowing), as there is no domestic production of HFCs. Increasing imports of HFCs replace the decreasing import of HCFCs which are being phased out under Montreal Protocol arrangements. A tax (Regulations no. 1451 of 11 December 2001) and refund (Regulations no. 1060 of 30 June 2004) scheme for HFCs brings natural refrigerant alternatives within reach. The special tax (Regulations no. 1451 of 11 December 2001) is set at 190,50 Norwegian Kroner (approximately 24 €) per tonne of CO₂-equivalents and applies to both imports as well as national production (although there is currently none) of HFC gases, whether in bulk or in products. As a result, the tax for R404a is at approximately 82 €/kg and the one for R134a at 32 €/kg.

Moreover, even though it is not a member state of the European Union, it belongs to the European Economic Area (EEA), meaning that all environmental and internal market legislation of the EU applies in Norway, too. Therefore, the country has to comply with requirements under the F-Gas Regulation.

Sweden

Sweden has a long record of prohibiting HFC in large quantities and the refrigerant charge per system has been limited to some 30 or 40 kg for many years. As a result most Swedish supermarket refrigeration systems tend to be indirect systems [GTZ 2008]. Tax burdens on HFCs, following the example of Norway, are also in consideration and could lead to further barriers to the use of synthetic refrigerants in Sweden. The phase out time schedule for using CFCs and HCFCs in Sweden depends on the mode of application, i.e. whether it concerns new installations, refill of existing installations or a complete stop for use. More specifically: Stop for new installations: 1/01/1995 for CFC and 1/01/1998 for HCFC; Refill stop: 1/01/1998 for CFC and 1/01/2002 for HCFC; Stop for use: 1/01/2000 for CFC and not decided for HCFC.

Denmark

The worldwide leader in the market uptake of CO₂ solutions has opted for one of the most stringent combinations of HFC taxation and a partial ban to drive the agenda for natural refrigerants. Its policy approach currently serves as a role model for other countries striving to tackle growing greenhouse gas emissions from the retail sector. Besides the UK discussing a potential HFC phase out or tax scheme, Denmark's success in making the use of F-gases financially and technically prohibitive in food retailing within the shortest timeframe, is also lauded overseas in discussions to restrict the use of hydrofluorocarbons in California and at the federal US level.

The complete Danish refrigeration industry is subject to a gradual phase out of fluorinated greenhouse gases (HFCs, PFCs and SF₆), with the use of new refrigeration systems requiring more than 10 kg of refrigerant fluorinated having been banned since 1 January 2007 (Statutory Order no. 552 of 2 July 2002 governing fluorinated greenhouse gases). The ban is further complemented with a tax on the import of fluorinated greenhouse gases (Consolidated Act No. 208 of 22 March 2001 on tax on certain ozone layer depleting substances and certain greenhouse gases).

The stricter policy governing F-gases in Denmark, compared to the policy at the EU level, largely explains why the majority of transcritical CO₂ installations are found in the country. However, occasions have been observed where installers have found a way around the 10 kg limit, by combining several small HFC units. This, however, is considered a non-viable exceptional solution, as this year taxes on the import of HFCs have increased again to around €78 €/kg for R404a and 28 €/kg for R134a.

UK

The UK is one of the EU frontrunners in terms of climate change legislation. However, it has been lagging behind compared to countries in Scandinavia when it comes to national fluorinated gas regulation. Nonetheless, momentum is growing in the UK, where the HFC regulation debate is moving towards an HFC phase out or taxation [EIA 2009b]. As an example, SIRAC, the Industrial Academic Research Partnership Network on Sustainable Innovation in Refrigeration and Air Conditioning, recently set out to open a wider debate within the RAC industry on its proposal to introduce a tax on HFCs based on their Global Warming Potential (GWP), similar to the approaches taken in Norway and Denmark. Revenues would then be used to subsidise recovery, new technology and training. Regardless of the actual approach, it may be expected that the UK will introduce stricter F-gases regulations, which will provide an impetus for a faster uptake of natural refrigerants in the country. Two schemes might hold additional potential for CO₂ supermarket refrigeration:

The Enhanced Capital Allowance (ECA) provides businesses with enhanced tax relief for investments in equipment that meets published energy-saving criteria. There is a predetermined list of products (including refrigerated showcases and compressors) for which if installed, a business could qualify for receiving the allowance. Products that may be included in the ECA list have to meet certain criteria as prescribed by “The Energy Technology Criteria List” (ETCL). For showcases these include energy efficiency criteria, while for the case of compressors the scheme so far only covers products running on R407C and R404A. As the ETCL is subject to an annual review stakeholders can propose alternative technologies for inclusion in the. As a result, this could create opportunities for CO₂ Technology in the future, if active influence is taken.

The **Carbon Reduction Commitment (CRC)** will apply to large businesses (such as hotels, large shops, supermarkets, shopping centres) and public sector organisations whose annual half-hourly metered electricity use is above 6,000 MWh. In general, organisations spending more than £500,000 per year in the UK on electricity are likely to be included in the scheme. CRC targets both direct energy use emissions (from burning gas, oil, etc.) and electricity use emissions. Organisations covered by the scheme will be required to purchase ‘allowances’ corresponding to their CO₂ emissions from energy use. A three-year introductory phase will begin January 2010, while a capped phase will begin in January 2013, when ‘allowances’ will be auctioned.

Germany

Germany’s “Integrated Energy and Climate Protection Programme” formally recognises the environmental benefits from switching to natural refrigerants through four measures: 1. Climate protection regulation on chemicals; 2. Measures that would lead to an early switch from f-gas-operated Mobile Air Conditioning equipment to low-GWP alternatives in new passenger cars (here the German Environment Ministry, the Federal Environment Agency and several environmental groups openly support CO₂); 3. Renewal of EC regulations on f-gases; 4. Support of energy efficient and ecological refrigeration systems using natural refrigerants. The “Climate Protection Incentive Programme” launched end-2008 to advance the development and market launch of commercial refrigeration systems using natural refrigerants covers 25% of the net investment cost for a new or existing system using natural refrigerants. Funding for existing systems being afterwards more energy-efficient but still operating with conventional fluids will be supported by only 15% of net investment costs.

Only launched some months ago the incentive scheme seems to pay off for CO₂. Although this is an incentive given only to food retail chains (Aldi, Lidl, Edeka, Rewe etc.), system manufacturers have largely benefited from it (see market for CO₂ below).

Building on the experience accumulated during the programme's first year, the German Environment Ministry expects to prolong the scheme and make significantly more funding available as from end of 2009, also including suppliers of systems and components [shecco 2008].

Switzerland

Since 2007, there has been a trend within the retail industry towards obtaining the "Minergie" label in all stores. This voluntary guideline mandates a maximum energy consumption of 4 MWh per metre of open showcase. Leading retail chains Migros and Coop have announced to only build stores complying with the Minergie standard.

Most importantly, in Switzerland there are ongoing efforts to legally mandate the use of R744 in LT systems [Schmutz, 2007], while the risk of a future HFC tax already drives the market towards the use of natural refrigerants [Frigo-Consulting 2008].

In Switzerland, "substances stable in air", i.e. synthetic substances that share the common features of being highly persistent in the atmosphere, and exhibiting very high specific radiative forcing, such as HFCs, PFCs and SF₆, have been regulated since July 2003. The relevant provisions are contained in the Ordinance on Risk Reduction related to Chemical Products (ORRChem) and relate to licensing, reporting leak check, servicing and end of life requirements for equipment containing more than 3 kg of such refrigerants. The regulations are intended to reduce the contribution of synthetic greenhouse gas emissions to 2% by 2010.

France

F-Gas Regulation: In contrast to other EU Member States' national legislation enforcing the EU F-gases regulation (see above), the French decree targets all applications containing F-gases, with setting a minimum refrigerant charge of 2 kg instead of 3 kg as specified in the original EU framework document. As a result, even small applications will become subject to stringent provisions regarding refrigerant charging, commissioning and maintenance of equipment, tightness checks, or refrigerant recovery. From July 4, 2009, anyone having installed or intending to install refrigeration or air-conditioning systems including cooling fluids needs to have an attestation of capacity by obligation.

Spain

In Spain a new opportunity for manufacturers of energy-saving technologies could arise with a draft law voted on by the Spanish Parliament in February 2009. If enforced, it could double an existing 10% tax rebate for companies for environmental spending and extend the rebate beyond its current 2011 expiry date (Royal Decree 252/2003 modifying Article 40 of the Corporate Tax Regulation (Royal Decree 537/1997). The rebate would also be increased to 30% for small and medium sized companies. While the present tax rebate is only applicable to the use of renewable energy, the new bill accounts for more general investment in energy saving and efficiency measures. The parliament still has to pass the measure formally into law, which could provide opportunities to actively influence the legislative process to take into account other energy-saving measures outside the limited scope of renewable energies.

It is expected that the Bill is approved by the Council of Ministers this summer and then begin its parliamentary process.

Italy

No specific national legislation has been identified for Italy concerning the use of chemical refrigerants in the commercial refrigeration sector. As a member state of the European Union, however, all legislation adopted by the EU (i.e. F-Gas regulation) applies to Italy.

The EU Market for CO₂

“At the current pace of development, CO₂ could be a standard solution by 2011”



Transcritical

An estimated total of 60 transcritical centralised systems were built in Europe by the beginning of September 2007, of which 11 were located in Denmark. However, as of September 2008, more than 100 transcritical R744 systems have been installed in Denmark alone. A conservative estimate suggests that the number of transcritical systems in the EU today could be in the range of 200-250. However, as confirmed by several component suppliers, this figure is likely to be already well above the 300 mark, given the number of components sold for transcritical applications within the last few months.

Most of the installations to date can be found in Scandinavian countries where strong regulatory signals have been given. However, there are clear indications that the market in countries outside Denmark, Sweden, and Norway is starting to grow, due to other drivers such as a green image and insuring against potential future stringent regulations regarding the use of chemical refrigerants.

Suppliers and end-users see the lack of suitable CO₂ components for a wider variety of applications as a major setback for a faster growth of transcritical applications. Although international trade fairs confirm that the number of companies manufacturing parts for CO₂-only systems is steadily increasing, the products are mostly only available in small series or limited construction sizes. Manufacturers of compressors, tubing, heat exchangers or evaporators confirm that a serial production has not yet started or if it has, that it still lacks the necessary market demand to become a viable business. So far, European suppliers having recently entered the market are still manufacturing single pieces and sizes on request, with a timely production and delivery of transcritical components still posing a challenge. [Bock, 2008; Bitzer, 2008]

Other industry sources estimate that, at the current pace of development, transcritical CO₂ refrigeration could become established as a standard solution for the food retail market in about 2-3 years. While present investment costs would be about 50% higher than for conventional systems, in 3-5 years the difference might have dropped to 20-25% [GTZ, 2008].

The pace of technology uptake, heavily influenced by legislative drivers, is hardly predictable as the urgency to reduce direct and indirect greenhouse gas emissions from supermarkets is not the same for selected European countries.

By the end of 2007, there were several hundreds CO₂ cascade refrigeration systems operating in Europe - some industry sources estimate it to be even in the range of thousands. In most cases, CO₂ was used for the LT range and R404a for the MT range. Norway, Sweden, Denmark, Germany, Luxemburg, Switzerland and Italy are among the major markets. As of 2007, the demand for CO cascade systems was at 100-150 new supermarket installations per year; the growth rate at 20-30%.

Subcritical

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supermarket installations per year; the growth rate at 20-30%.

Currently, major European retailers are still in the process of evaluation. System manufacturers expect that within the next years, all retail chains will opt for one single solution to use throughout their European branch network. An island solution for certain countries within one retail chain is not considered to be viable as this would prevent economies of scale needed in globalised markets. However, with about 16 different system layouts alone in Europe - combining different refrigerants and/or technologies – the choice has made the positioning of CO₂ more complex. As a result, it is likely that single retailers will opt for different solutions. The market penetration of CO₂-x cascade systems is therefore expected to rise but its market share is still unknown. An overview of the European market for cascade R744 systems for supermarkets is provided below:

	HFC indirect brine / R744	HFC/R744 cascade	HFC indirect/ R744 cascade	HFC/R744 cascade – MT R744	R717/R744 cascade MT fluid refrigerant
Performance	40-1000 kW	40-1000 kW	All ranges	All ranges	All ranges
Type of cooling transfer	indirect	direct	MT: indirect; LT: direct	MT: indirect; LT: direct	MT: indirect; LT: direct
Refrigerants used	R404a, LT: R744	MT: R404 / R134a; LT: R744	MT: R134a/ R507a; LT: R744	MT: R134a/ R404a; LT: R744	R717, R744
Number of units installed	~ 100	100 from Linde; several hundreds in total	20-50	Few	Very few
Regional distribution	CH, D, F	CH, DK, D, I, L, N, S	CH, N	DK, N	N, S
System supplier	Various	BKT, Carrier/ Linde, Epta, Knudsen Køling, Norild, Superkøl	Carrier/Linde, Goetz	Carrier/Linde	Johnson Controls/Sabroe/ York (DK), Norild (N)
Retailer	Located in CH, DK, F, S	many	Coop (CH, N), ICA (N), Migros (CH)	Coop (N), Hurtigruteterminal (N)	Coop (N) + some in S

Table 2 : Overview European market - Cascade systems R744 for supermarkets

Source : Based on UBA, 2008

	R717/R744 cascade – MT R744	HC/R744 cascade – MT R744	R744 direct expansion (transcritical) *	R744 direct expansion in cascade to HFC / HC
Performance	All ranges	All ranges	All ranges; 40-140 kW supplied so far	All ranges, typically MT: 24 kW, LT: 10 kW
Type of cooling transfer	MT: indirect; LT: direct	MT: indirect; LT: direct	direct	direct
Refrigerants used	R717, R744 cascade – MT R744	R290, R744	R744	HFC/R744 or HC/ R744
Number of units installed	Less than 10	1	60	More than 100 in DK
Regional distribution	NL	DK	B, CH, D, DK, GB, I, L, N, S	DK
System supplier	Not known	Superkøl (DK), J&E (GB)	Epta, Goetz, Green & Cool, Knudsen Køling, Linde/Carrier, Trondheim Kulde	Tempcold
Retailer	Not known	Fakta (DK)	Different retailers	Rema 1000 and others

Table 3 : Overview European market - Cascade systems R744 for supermarkets, continued

Source : Based on UBA, 2008

Norway

Norway is constantly moving away from HFCs. A further increase in greenhouse gas taxes from 1 January 2007 on has helped to promote commercial refrigeration systems using natural refrigerants within the industry. Norwegian manufacturers and retail chains interpret the discussions within the EU F-gases legislation framework as a clear signal that life time of HFC-based systems will be limited. As a consequence, Norwegian retailers COOP, ICA and Rema og Norgesgruppen regard the use of natural refrigerants as highly positive. [Bakken, 2007]. A total of at least 14 such systems has been identified.

Sweden

Sweden is the second biggest market after Denmark in terms of transcritical R744 system installations in the food retail sector. A total of at least 43 such installations have been conducted in Swedish supermarkets, with the majority of systems manufactured by Green & Cool and Epta.

Denmark

Increased costs for the use of F-gases in combination with the new maximum charge limit have led to a surge of technologies based on natural refrigerants. Hence, as from 1 January 2007 on, practically every new-built system is using CO₂. As legislation was faster than the market development of CO₂ technology and corresponding knowledge, the Danish government decided to financially support training measures in the period 2007-2009 on how to install and service these applications. Free lessons available for engineers and servicing staff are meant to further accelerate the market uptake of CO₂. As a result, as of 1 September 2008 there were more than 100 installed transcritical R744-systems in Denmark [Kauffeld and Kaltenbrunner 2008].

UK

DEFRA estimates that around half million commercial units are replaced annually in the UK. However, only an estimated 0.46% of UK supermarkets has been converted to natural refrigerants [EIA 2009b). Nonetheless, CO₂ installations and momentum in the country are growing faster compared to those in the rest of the countries of interest to this report.

In 2007, M&S, Asda, Tesco, Somerfield, Waitrose and Sainsbury's jointly announced their intention to move away from HFCs. Subsequently, the environmental group "Environmental Investigation Agency" (EIA) sent out a detailed questionnaire to 11 UK supermarkets in summer 2008, asking them about specific actions taken to accelerate the use of natural refrigerants and efforts to reduce the climate change impacts from refrigeration [EIA 2009a]. Being one of the first surveys to raise public awareness with regards to the issue of direct emissions from refrigeration systems, its publication was covered by several media sources.

The EIA survey revealed that none of the large UK retail groups has more than four stores using HFC alternatives, and concluded that the supermarkets' response was inadequate given the announcements made and upcoming restrictions on the use of f-gases (F-gases Regulation).

Germany

In terms of CO₂ refrigeration technology, Epta and Carrier are the main manufacturers of R744 systems installed in the German retail sector. By September 2007, Carrier had provided systems for at least 12 refrigeration plants, while Epta accounted for another 2 systems. Linde further claims to have installed the world's largest transcritical CO₂ refrigeration system in a hypermarket in Northern Germany. Carrier equipment cools food, where three high temperature (HT) packs with total capacity of 670 kW and two low temperature (LT) packs with capacity of 130 kW have been installed.

The "Climate Protection Incentive Programme" launched by the German government end-2008, has accelerated the market uptake of R744 significantly (see section on policy drivers). Carrier confirms that many retailers have used this opportunity to test R744 systems in several regional branches and after initial doubts have quickly embraced CO₂ an efficient and safe solution. There are positive expectations that after the test phase retailers will decide for CO₂ and it will be established as a standard solution within the next 5 years. From 2 installations/year in the past, Carrier is now already planning 17 installations for 2009 alone. Germany's leading retailer Aldi Süd had 13 CO₂ installations in place by early 2009.

Switzerland

In Switzerland, a total of 30 transcritical installations can be found in the big commercial refrigeration area (supermarkets and wholesale-markets). Goetz, enEX, Green and Cool and Carrier are among the main manufacturers represented in current installations.

Belgium

12-13 CO₂ transcritical systems have been installed in Belgium.

France

In France an estimated 6 CO₂ cascade installations have been identified. However, recently the interest in CO₂ technology in the French market has started to grow.

Spain

Progress in the uptake of CO₂ technology seems slow in Spain, with many of the manufacturers admitting low interest in the near term for this market, mainly due to the warm climatic conditions. Manufacturers outside Spain confirm that a lack of servicing infrastructure in Southern Europe poses additional challenges to a wider spread of CO₂ technology.

Italy

In Italy there were 22 Low Temperature CO₂ systems installed by March 2008. Current installations amount to an estimated 30 [Carrier 2009]. Other industry sources confirm this range of figures for Italy: transcritical CO₂ supermarket systems in Italy amount to 2, while subcritical CO₂ cascade systems may be found to an estimated 20-30 supermarkets. [enEX 2009].

The warmer climatic conditions and the lack of consultants and installers with CO₂ know-how impede the uptake of CO₂ systems in the country [Frascold 2009].

Number of identified companies working or planning to work in CO₂ refrigeration by country and type of company as of spring 2009

Country	System Manufacturer	Installer/contractor	Showcase manufacturer	Retailer
Norway	4	4	4	3
Sweden	3	1	2	3
Denmark	6	6	5	10
UK	17	8	15	3
Germany	5		3	4
Switzerland	5	4	3	6
Belgium	2	2	2	1
France	5	8	3	n.a.
Spain	5	3	2	n.a.
Italy	6	1	3	n.a.

Conclusion



The above summary provided a brief overview of political, economic, and technical factors influencing a wider market uptake of CO₂ Technology in Commercial Refrigeration. The following messages could be extracted:

North-South & East-West divide: The EU market for the natural refrigerant CO₂ in supermarket refrigeration is still subject to a clear divide between the leading Scandinavian region and Southern Europe. Countries located in cold to medium ambient temperatures will likely opt for transcritical installations whereas Southern countries might favour cascade installations to optimise performance. Similarly, the emerging Eastern markets, not considered in this report, do not yet show the potential seen in Western countries. However, in the course of a company-wide policy to only use natural refrigerants throughout all stores of one retail chain, new EU Member States could increasingly move to the centre of attention.

Germany & the UK next markets: In Scandinavia, and here specifically Denmark, the market is rapidly moving towards a saturation within the next five years. Experiences and best practice gained with initial installation procedures and maintenance will be beneficial for followers, such as Germany and the UK. Both markets are considered to be the next two most promising ones for the R744 industry due to their market size and the rate of replacements of existing systems. While Germany's government is likely to increase its support for natural refrigerants, the UK retail industry might be moved to accelerate a switch by increasing public pressure and upcoming HFC reduction schemes currently under discussion.

Interest growing throughout the supply chain: With an identified 17 system and 15 showcase manufacturers alone, the UK is taking the lead among the surveyed EU countries as regards the current and future work with CO₂ commercial refrigeration. Also in other countries, the interest in the natural refrigerant is continuously growing throughout the supply and demand chain. Major system and showcase manufacturers active in several European countries are expected to export their expertise to non-domestic markets, once a basic stock of experience has been gathered and human resources capacities have been made available to build, install and service the R744 systems. Up until now, a lack of training and servicing infrastructure, as well as the early stage of the CO₂ commercial refrigeration market in most countries has been preventing this move for a majority of market players.

Glossary

CFCs Chlorofluorocarbons

CRC..... Carbon Reduction Commitment

DEFRA Department for Environment Food and Rural Affairs

ECA..... Enhanced Capital Allowance

Eco-Cute..... CO₂-based air to water heat pump water heater

EEA..... European Economic Area

ETCL Energy Technology Criteria List

EU..... European Union

F-gases..... Fluorinated gases

GWP..... Global Warming Potential

HCFCs Hydrofluorochlorocarbons

HFCs Hydrofluorocarbons

LT Low Temperature

MT..... Medium Temperature

ODS..... Ozone Depleting Substance

ORRChem..... Ordinance on Risk Reduction related to Chemical Products

PFCs..... Perfluorocarbons

REAP Retailers Environmental Action Programme

R-744 The chemical reference for carbon dioxide (CO₂) used as refrigerant

SF6 Sulfur hexafluoride

UK..... United Kingdom

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