



Chilling Facts VII:

Are Europe's supermarkets ready to quit HFCs?

ABOUT EIA

EIA is an independent campaigning organisation committed to bringing about change that protects the natural world from environmental crime and abuse. We have developed innovative and effective investigative methods for defending the environment and seek lasting solutions to the problems we uncover.

As part of our work, we have undertaken ground-breaking investigations into the illegal trade of ozone-depleting substances (ODS) and have been closely involved in international ozone and climate negotiations for well over a decade.



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BACKGROUND

Hydrofluorocarbons (HFCs) are potent climate pollutants widely used as cooling agents in refrigeration and air-conditioning. In Europe, the supermarket sector represents about one-third of total HFC consumption in carbon dioxide-equivalent (CO₂e).¹

Since 2008, EIA has carried out a series of supermarket surveys to document the use of HFCs and climate-friendly alternatives in Europe.

Primarily introduced as replacement refrigerants for ozone-depleting substances (ODS) such as hydrochlorofluorocarbons (HCFCs), HFCs are some of the most powerful greenhouse gases in existence, with global warming potentials (GWP) hundreds to thousands of times more powerful than CO₂. Phasing out these gases in favour of climate-friendly alternatives represents one of the most viable and cost-effective near-term solutions to tackling climate change.



THE 2017 REPORT

Since 2008, EIA's *Chilling Facts* reports have documented the growing uptake of natural refrigerants among some of the world's leading retailers, reflecting a market shift towards climate-friendly refrigeration in the supermarket sector.

Since the last report, *Chilling Facts VI: Closing the door on HFCs*, was published in 2014, the HFC regulatory landscape has changed dramatically. In 2015, the European Union (EU) F-gas Regulation came into force, putting in place a fast-acting HFC phase-down that will slash HFC supply by approximately 48 per cent in 2018.²

Then, in October 2016, the 28th Meeting of Parties to the Montreal Protocol adopted the Kigali Amendment on HFCs, an historic accord committing the world's nations to significantly reduce consumption and production of HFCs. It is estimated the Kigali Amendment will prevent 70 billion tonnes CO₂e by 2050 under a business as usual scenario, avoiding more than 0.4°C warming by the end of the century.³

In keeping with the positive political developments that have been made on HFCs, 2016 also saw the Consumer Goods Forum (CGF) agree a new Refrigeration Resolution, committing its members, wherever viable, to immediately adopt low-GWP refrigerants across their estates and to work with their supply chains, governments, civil society and other stakeholders to remove any remaining barriers.⁴

For the seventh *Chilling Facts* report, 22 retailers participated by submitting data covering the 2015 calendar year from supermarkets across 37 countries. Our findings show that the uptake of HFC-free technology is well under way across the EU, with CO₂ transcritical systems spreading eastward and southward throughout Europe.

This year's participants have once again shown that taking advantage of newly optimised refrigeration equipment and installing CO₂ transcritical systems with parallel compression and ejector technology will reap energy efficiency rewards, even in locations in Brazil, Italy and southern Spain. For retailers still struggling to introduce natural refrigerant technology in warmer climates, these latest developments should finally put to bed the myth that carbon dioxide systems cannot keep their cool in warm temperatures.

Our survey represents just a snapshot of the number of natural refrigerant systems on the market. Industry expert Shecco estimates there are almost 9,000 CO₂ transcritical systems in operation in Europe and predicts an additional 6,000 new systems each year as the EU F-Gas phase-down gets well under way.⁵

BELOW:

Vincent Biruta, President and Minister of Natural Resources for Rwanda, gavels the adoption of the Kigali Amendment to the Montreal Protocol.



EIA's supermarket survey was designed, in part, to help gauge readiness of the European supermarket sector for implementation of the F-Gas Regulation. The findings show that while retailers are well aware of upcoming bans, there is a lack of understanding or consideration of the impact of the phase-down, which is based upon a much faster transition away from HFCs than that predicated on the bans. Although many retailers are adopting HFC-free technology, few are currently matching the level of uptake required to meet the phase-down.

In particular, we are concerned at the lack of awareness relating to the large HFC supply cut in 2018, which in real terms is as much as 48 per cent below the baseline. This deep cut combined with ongoing HFC usage in a sector that was expected to be a front runner in the shift away from HFCs risks leaving many retailers with eye-wateringly high annual refrigerant bills. Smaller retailers, vulnerable to

price hikes and supply shortages, are clearly trailing behind in adopting HFC-free technology. We have already seen HFC suppliers increase the price of HFC-404A by 62 per cent in the first quarter of 2017.⁶

Many retailers have recognised the need to stop using HFCs with a very high GWP, such as HFC-404A and HFC-507A, and their use is declining. However, the use of other high-GWP HFCs such as HFC-134a and HFC-407A (with GWPs of 1,430 and 2,107 respectively) is rapidly increasing. These HFCs will not be exempt from the price hikes caused by ongoing demand, with prices already increasing by 32 per cent in the first quarter of 2017.⁷

EIA urges retailers to act quickly to comply with the EU F-Gas Regulation and avoid spiralling HFC costs by installing HFC-free systems in all new supermarkets and refits.

“Since the last report, *Chilling Facts VI: Closing the door on HFCs*, was published in 2014, the HFC regulatory landscape has changed dramatically”

GREEN COOLING LEADERS



The Green Cooling Leader title is awarded to those retailers who demonstrate real commitment to rolling out HFC-free refrigeration across their global estate.

This year, our Green Cooling Leaders are Albert Heijn, Aldi Süd, Carrefour, Kaufland, Metro Cash & Carry, Migros, Tesco and Waitrose.

In keeping with the ambition required to meet the goals of the EU F-Gas Regulation, retailers are assessed on their general readiness for the phase-down, including their efforts to transition away from HFCs beyond what is required by upcoming bans.

Other criteria for determining Green Cooling Leader status include willingness to address high leakage rates of refrigeration equipment, use of HFC-free technology in warmer climates and a demonstrated drive to communicate the benefits of using natural refrigerants to wider industry and the general public.

This year, three new retailers have been nominated as Green Cooling Leaders. Having criticised parent company Metro for its lack of natural refrigerant use outside of its domestic stores in our 2014 report, EIA is pleased to announce that Metro Cash & Carry has been awarded Green Cooling Leader status, having since

introduced natural refrigerants to stores across its estate, including in China, Russia and Turkey.

Kaufland has also been awarded Green Cooling Leader status as a result of its commitment to use natural refrigerants across its estate with over 130 HFC/CO₂ hybrid cascade systems in eastern European stores and a new commitment to HFC-free systems in all new stores and major retrofits.

Albert Heijn, which was reported under the name Royal Ahold in *Chilling Facts VI*, has earned its Green Cooling Leader status due to committed investment in HFC-free technology and impressively low leakage rates.

Retaining the title from our 2014 report are: Aldi Süd - which impressed us with its large roll-out of HFC-free refrigeration, including now in the UK; Carrefour - with its pioneering work with transcritical CO₂ in warmer climates; and Tesco, Migros and Waitrose - with their continued drive to move away from HFCs across their estates.

KEY FINDINGS

ALBERT HEIJN

998 stores, HQ in Netherlands, reported under Royal Ahold in *Chilling Facts VI*

GOOD:

- Since 2013, the number of stores operating on HFC/CO₂ hybrid cascade systems has increased from 262 to 367
- Appears to have taken on criticism of over-reliance on HFC/CO₂ hybrid cascade systems by extending rollout of HFC-free refrigeration from three to 63 stores during this time
- Has committed to using transcritical CO₂ systems in all new Dutch installations
- Low leakage rates of 5.4 per cent

BAD:

- High direct emissions vs indirect emissions
- Still using CFC-12 in US estate

EIA GREEN COOLING LEADER



ALDI NORD

4,876 stores, HQ in Germany

GOOD:

- Operating five CO₂ cascade systems
- Says that use of natural refrigerants is now standard for all new stores
- All new stores have closed fridge doors for meat and fish

BAD:

- Incomplete survey
- Behind on its rollout of natural refrigerant systems both in point-of-sale equipment and distribution centres compared to other retailers of its size

ALDI SÜD

3,429 stores, HQ in Germany

GOOD:

- Has new natural refrigerant systems across Europe, including 111 CO₂ cascade systems in Austria, five in Hungary and four in Slovakia, plus eight stores using CO₂ transcritical in Switzerland
- Appears to have taken on criticism that CO₂ rollout was limited to domestic stores, from 2017 CO₂ systems will be installed in all new stores in the UK and Republic of Ireland
- Communicating the benefits of using CO₂ with consumers by marking chillers with specially designed green cooling stickers

BAD:

- Incomplete survey
- Yet to install any doors on its fridges

EIA GREEN COOLING LEADER



ALNATURA

113 stores, Germany

GOOD:

- Plans to run all new stores with natural refrigerants by 2017, exploring the use of both hydrocarbon and CO₂ technologies
- Using doors on fridges in 100 per cent of its 113 stores

BAD:

- Incomplete survey
- Current over-reliance on HFC-based systems lacks the ambition required to meet the goals of the F-gas phase-down
- Yet to use any HFC-free systems other than 'plug and play' units

AUCHAN PORTUGAL

33 stores, HQ in France

GOOD:

- Using CO₂ cascade technology in one store
- Is starting to implement doors on fridges across its estate

BAD:

- Incomplete survey
- Heavy HFC-404A consumption with no clearly communicated plans to transition out of it

BIO COMPANY

50 stores, Germany

GOOD:

- Using doors on fridges in 100 per cent of its stores.
- Using a salt water cooling system in one store

BAD:

- Incomplete survey
- Heavy HFC-404A consumption with no clearly communicated plans to transition out of it

CARREFOUR

3,835 stores, HQ in France

GOOD:

- Since 2013, the number of HFC-free systems has increased from 36 to 147, including in locations in France, Belgium, Italy, Spain, Romania, Poland, Argentina and Brazil
- Has installed 202 HFC/CO₂ hybrid cascade systems as an interim measure to becoming HFC-free
- Engaging in information-sharing of the benefits of using natural refrigerants with other retailers
- Has increased its rollout of doors on fridges to 355 stores in France
- Has reduced leakage rates by almost half since 2013

BAD:

- Direct refrigerant emissions in 2015 were almost as high as indirect emissions associated with energy usage from refrigeration

EIA GREEN COOLING LEADER



DELHAIZE BELGIUM

181 stores, HQ in The Netherlands

GOOD:

- Using HFC/CO₂ hybrid cascade systems or CO₂ transcritical as standard for all new stores and retrofits
- 80 per cent of stores in Belgium and Luxembourg have doors on fridges
- Roll out of HFC-free systems in Belgium has increased from three to 17 stores since 2013
- Number of stores using HFC-CO₂ cascades has increased from 37 to 48

BAD:

- Although in process of addressing this, leakage rates for Delhaize Serbia stores is high at 58 per cent
- Parent company Ahold Delhaize has not stated F-gas compliance plans for other subsidiary stores in Czech Republic, Greece and Romania

DIA

7,824 stores, HQ in Spain

GOOD:

- Over 1,000 stores using doors on fridges, with signage in store in place to notify customers of the environmental benefits of closed refrigeration
- A small number of stores using HFC/CO₂ hybrid cascade systems

BAD:

- Incomplete survey
- Yet to trial any HFC-free systems
- Plans to transition existing equipment to HFC-134a, which lacks the ambition required to meet the EU F-Gas phase-down goals

EBL BIO-SUPERMARKET

25 stores, Germany

GOOD:

- Uses propene and salt water cooling for its general and butcher storage rooms
- All 25 stores are using CO₂ systems, but not exclusively

BAD:

- Incomplete survey

JERÓNIMO MARTINS

436 stores, HQ in Portugal

GOOD:

- Appears to be leapfrogging HFC/CO₂ hybrid cascade systems. Since 2013 it has increased the number of stores using CO₂ transcritical systems from three to 12
- HFC-free systems are now standard for all new and retrofitted stores
- Using doors on fridges in more than 1,000 stores, about 33 per cent of its total estate

BAD:

- Roll-out of natural systems is still slower than that of other retailers its size

KEY FINDINGS

KAUFLAND

More than 1,230 stores, HQ in Germany

GOOD:

- Since 2013, roll-out of HFC/CO₂ hybrid cascade systems has increased from 99 stores to 300, including in Bulgaria, Czech Republic, Poland, Romania, Slovakia and Hungary
- Having been criticised of its failure to trial HFC-free systems in the past, it has now installed CO₂ transcritical systems in 20 stores, with this being adopted as standard for all new installations and retrofitted systems
- Communicating the benefits of using natural refrigerants to consumers in customer magazine
- Using doors on fridges in 35 stores, doors are now standard for new stores and in refits.

BAD:

- High ongoing use of HFC-404A

EIA GREEN COOLING LEADER 

MARKS & SPENCER

914 stores, HQ in UK

GOOD:

- CO₂ transcritical systems being adopted as standard for all new stores since 2016
- Has 37 stores running on CO₂ transcritical
- Low HFC-404A usage

BAD:

- Less than one per cent of stores using doors on fridges

METRO CASH & CARRY

757 stores, HQ in Germany, part of Metro Group

GOOD:

- CO₂ transcritical technology has been rolled out to 51 stores, including one in Romania, five in Italy and one in Spain
- CO₂ cascade systems have been rolled out to 66 stores, including 28 in China, one in Ukraine, 18 in Russia and three in Turkey
- Actively communicating the benefits of using natural refrigerants in media and through production of reports and briefings
- Half of all fridges have doors fitted

BAD:

- Still uses HCFCs in 137 of 757 stores worldwide

EIA GREEN COOLING LEADER 

MIGROS

632 stores, HQ in Switzerland

GOOD:

- Rollout of CO₂ transcritical technology has increased from 362 systems to 403 since 2013
- Low HFC-404A usage
- Leakage rates for non-natural refrigerants are down to six per cent
- Good communication with industry stakeholders and media about the benefits of using natural refrigerants

BAD:

- Has reported some small ongoing HCFC use

EIA GREEN COOLING LEADER 

MUSGRAVE

670 stores, HQ in Republic of Ireland

GOOD:

- Has rolled out doors on fridges to almost 15 per cent of stores in Republic of Ireland
- One pilot HFC-free system using glycol

BAD:

- Huge reliance on HFC technology, 70 per cent of stores use HFC-404A and remaining 30 per cent still use HFCs with a high GWP (e.g. HFC-134a)
- No awareness of what stores are doing to reduce leakage, due to franchised nature of business
- Incomplete survey

REAL

293 stores, Germany, part of Metro Group

GOOD:

- Uses HFC/CO₂ hybrid cascade systems in 23 stores
- Six stores use CO₂ transcritical systems
- Has been tracking leakage electronically since 2014
- 147 stores have doors on fridges, with 26 planned this year which will bring the total to 60 per cent of stores


BAD:


- Incomplete survey and lack of detail in data provided
- Still mainly using HFCs

| REWE |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3,500 stores, HQ in Germany |
| GOOD: |
| <ul style="list-style-type: none"> • Uses CO₂ refrigeration technology in 79 stores, with a further 115 planned, however it is unclear if these are mostly HFC/CO₂ hybrid systems |
| BAD: |
| <ul style="list-style-type: none"> • Incomplete survey • Heavy reliance on HFC-404A |

| SONAE |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 249 stores, HQ in Portugal |
| GOOD: |
| <ul style="list-style-type: none"> • Rolling out HFC/CO₂ hybrid cascade systems to replace HFC-404A in all new stores and large refurbishments of existing stores, with 52 of these now in operation • Has four ammonia/CO₂/glycol cascade systems |
| BAD: |
| <ul style="list-style-type: none"> • Incomplete survey |

| SUPERBIOMARKT |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26 stores, Germany |
| GOOD: |
| <ul style="list-style-type: none"> • Use of doors on fridges in 88 per cent of its stores |
| BAD: |
| <ul style="list-style-type: none"> • Incomplete survey • Yet to pilot natural refrigerant systems, other than 'plug and play' devices • Over-reliance on HFC-based systems lacks the ambition required to meet the goals of the F-Gas phase-down |

| TESCO |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5,801 stores, HQ in UK |
| GOOD: |
| <ul style="list-style-type: none"> • Roll-out of CO₂ systems has increased by almost 25 per cent from 190 to 250 stores since 2013 • Leakage rates are low at less than six per cent • Use of doors in fridges across much of its estate, including in about 55 per cent of stores outside the UK |
| BAD: |
| <ul style="list-style-type: none"> • Slow rollout of natural refrigerants in wider European estate and in Thailand since our 2014 report |
| EIA GREEN COOLING LEADER  |

| WAITROSE |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 343 stores, UK |
| GOOD: |
| <ul style="list-style-type: none"> • Rollout of HFC-free stores using hydrocarbon/water-cooled solution has increased from 111 to 168 stores; 48 per cent of all stores are HFC-free • Leakage rates are down to just below seven per cent • Good communications on the benefits of using natural refrigerants within industry and provision of technical support for other retailers |
| BAD: |
| <ul style="list-style-type: none"> • No use of doors on fridges in stores |
| EIA GREEN COOLING LEADER  |



UPTAKE OF HFC-FREE COOLING

This year's *Chilling Facts* focuses on the uptake of in-store HFC-free cooling as this is the largest source of HFC demand in retailers. We have not reported progress on HFC-free cooling in transport refrigeration because there appears to be very little progress, despite a significant timeframe since the last *Chilling Facts* report. Some retailers have moved away from HFC cooling in distribution centres; however, we did not receive enough data to report on this fully. We have also omitted updates on the use of HFC-free 'plug and play' integral systems, since these are now well-established.

Leaders of the pack

Since *Chilling Facts VI* in late 2014, some retailers have forged ahead in their adoption of HFC-free technology.

Top of the list on the roll-out of HFC-free cooling is Aldi Süd. It has increased the number of stores using natural refrigerant technology from 345 in 2014 to 891 in 2016; 602 of these are using CO₂ transcritical systems. This progress is not just limited to Germany – it has natural refrigerant systems across

Europe, including 111 CO₂ cascade systems in Austria, five in Hungary and four in Slovakia and eight stores using CO₂ transcritical in Switzerland. Aldi Süd has been criticised over the years for its lack of investment in HFC-free cooling in its British and Irish stores but it seems that it is now moving in the right direction and has committed to HFC-free refrigeration in all new stores.

Carrefour has impressed with its ongoing commitment to HFC-free cooling across its entire estate. It is the only retailer to be embracing HFC-free cooling in stores located in warmer climates. Since 2013, the number of these CO₂ transcritical systems has increased from 36 to 147 in locations in Italy, Spain, Romania, Poland, Argentina and Brazil. It has a further 202 HFC/CO₂ hybrid cascade systems, up from 97 in 2014. It is currently exploring the market and technical options for using natural refrigerants in its Chinese and Taiwanese stores.

Tesco now has 250 CO₂ transcritical stores, including 40 in Hungary, 14 in

“The uptake of HFC-free technology is well underway across the EU, with CO₂ transcritical systems spreading eastward and southward throughout Europe”

Poland, 11 in Ireland, five in Czech Republic, three in Slovakia and two in Thailand.

Kaufland has picked up the pace on its adoption of HFC/CO₂ cascade hybrid systems and now has them in 300 stores, including sites in Germany, Bulgaria, Czech Republic, Poland, Romania, Slovakia and Hungary. Kaufland also seems to have taken on board EIA's concern that it was focusing on hybrid technology at the expense of investing in HFC-free systems and now has CO₂ transcritical in 20 stores and has further committed to going HFC-free in all new stores and major retrofits.

Albert Heijn has increased the number of stores operating on HFC/CO₂ cascade hybrid systems from 262 in 2013 to 367. It has also extended its roll-out of HFC-free refrigeration during this time from three to 63 stores.

British retailer Waitrose has now rolled out its hydrocarbon/water-cooled solution to 168 stores, meaning 48 per cent of all stores are now HFC-free. It has been refining this technology over the years and now has a Mark III system which utilises individual hydrocarbon-refrigerated cabinets with a cooled water loop as a condenser medium; the water loop circuit is cooled using a dry air cooler only.

Metro Cash and Carry has made tremendous progress since our last report, when it had just 20 systems using natural refrigerants. Now it is reporting that CO₂ transcritical technology has been rolled out to 51 stores, including in locations in Romania, Italy and Spain. CO₂ cascade systems have been rolled out to 66 stores, including stores in China, Ukraine, Russia and Turkey.

Swiss retailer Migros continues to show its commitment to HFC-free refrigeration in all new stores and now has 403 CO₂ transcritical systems.

BELOW:

Aldi Süd is swiftly converting to HFC-free cooling.

BOTTOM:

Transcritical CO₂ booster system at Tesco's latest concept refresh store in Swansea, built by Advansor and installed by Space Engineering.



© Bernd Wittelsbach



© Tesco UK

Middle of the road

British retailer Marks and Spencer's store closures has meant its number of systems using naturals has dropped since our previous survey, but it has moved away from using HFC/CO₂ hybrid cascades and now has 37 CO₂ transcritical stores.

Jerónimo Martins has increased its number of HFC-free systems from three to 12 since 2013.

Portuguese retailer Sonae now has 52 HFC/CO₂ hybrid cascade systems and four ammonia/CO₂/glycol cascade systems.

Rewe has rolled out CO₂ technology in its Green Building projects, completing 79 out of 194 planned; however, it is not clear if these are mostly HFC/CO₂ hybrid cascade systems. Now is the time for Rewe to commit to HFC-free in all new stores.

Real is following in the footsteps of parent company Metro, with a focus on retrofitting stores with CO₂ technologies. It has taken the first steps towards meeting this goal but needs to accelerate the transition and focus more on CO₂ transcritical technology.

Delhaize Belgium has increased its roll-out of HFC-free systems from three to 17 stores since 2013. Additionally, the number of stores using HFC/CO₂ cascades in Belgium and Luxembourg has increased from 37 to 48.

Trailing behind

Worryingly, a significant number of retailers across the EU are failing to recognise the need to invest in

HFC-free cooling. While some of the larger retailers in Germany are global leaders in the uptake of natural refrigerants, there is still a lack of planning and investment in HFC-free cooling among others.

We were surprised at Aldi Nord's lack of investment in HFC-free technology, given the size of this retailer and the excellent work Aldi Süd has done. Despite having almost 5,000 stores across Europe, it has just five stores using CO₂ cascade systems in Germany and 20 using CO₂ chilled freezers in Spain. This is particularly surprising in Germany, where Government subsidies lower the investment costs for CO₂ systems, making them lower than their HFC equivalent. Aldi Nord says the use of natural refrigerants is now standard for all new stores; it is to be hoped it manages to implement this commitment.

Spanish retailer Dia has reported it has a small number of systems using HFC/CO₂ hybrid cascades. However, it is investing in systems which use HFC-134a and HFC-407F and does not seem aware of sharp price implications due to the EU F-gas phase-down. Dia reports that natural refrigerants are not economically or functionally viable in its stores, which are mostly small, in residential areas and in warmer climates. Although this may have been true a few years ago, manufacturers are seriously turning their attention from a traditional focus on large CO₂ systems to smaller systems, particularly in Japan but increasingly in Europe. This is discussed further on page 19.

Auchan Portugal is reportedly using CO₂ cascade technology in one store and is in the process of drafting a transition plan to move away from HFCs.

BELOW:
CO₂ transcritical refrigeration.





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Irish retailer Musgrave appears to be unprepared for future HFC price hikes. It has trialled one glycol system and is looking into this as a future option. While we recognise the challenges associated with running a franchise business, we urge Musgrave to speed up adoption of HFC-free technology.

Smaller retailers

This year's *Chilling Facts* survey had high levels of participation from small organic German supermarkets. Our findings revealed that despite a high awareness of sustainability, many smaller retailers have little technical capacity and are only taking first steps.

We applaud German retailer Alnatura for its pledge to run all new stores with natural refrigerants from 2017; however, it is unclear how this commitment will be met, given that in 2015 the retailer had yet to trial HFC-free systems other than 'plug and play' systems.

Small German retailer Superbiomarket is in a similar position – it is yet to put in place any HFC-free pilots to replace its centralised systems but does have some hydrocarbon 'plug and play' systems.



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Despite its small size, EBL Biosupermarket seems to be investing in HFC-free cooling; 25 stores are using CO₂ systems and it uses propene and salt water cooling for meat storage.

Biocompany, another small German retailer, is using an HFC-free salt water-based cooling system in one store but has not articulated plans to start piloting natural refrigerants.

ABOVE:
Rewe is rolling out CO₂ technology in its Green Building projects.

THE HIDDEN PHASE-DOWN

Supermarkets have rightly been looking at upcoming bans under the EU F-gas Regulation but there appears to be a lack of awareness regarding the impact of the HFC phase-down, which is the fundamental legislative measure seeking to reduce HFC use.⁸

The HFC phase-down is a progressive reduction of HFCs placed on the EU market each year, starting in 2015 and running through 2030 and beyond. It is measured in carbon dioxide equivalence (CO₂e). The maximum quantity of HFC quotas available in 2015 corresponded

to 100 per cent of the annual average demand during 2009-12, approximately 182.5 million tonnes (Mt) CO₂e, which is also referred to as the “baseline”. The maximum quantity or baseline is then reduced in steps shown in Table 1.

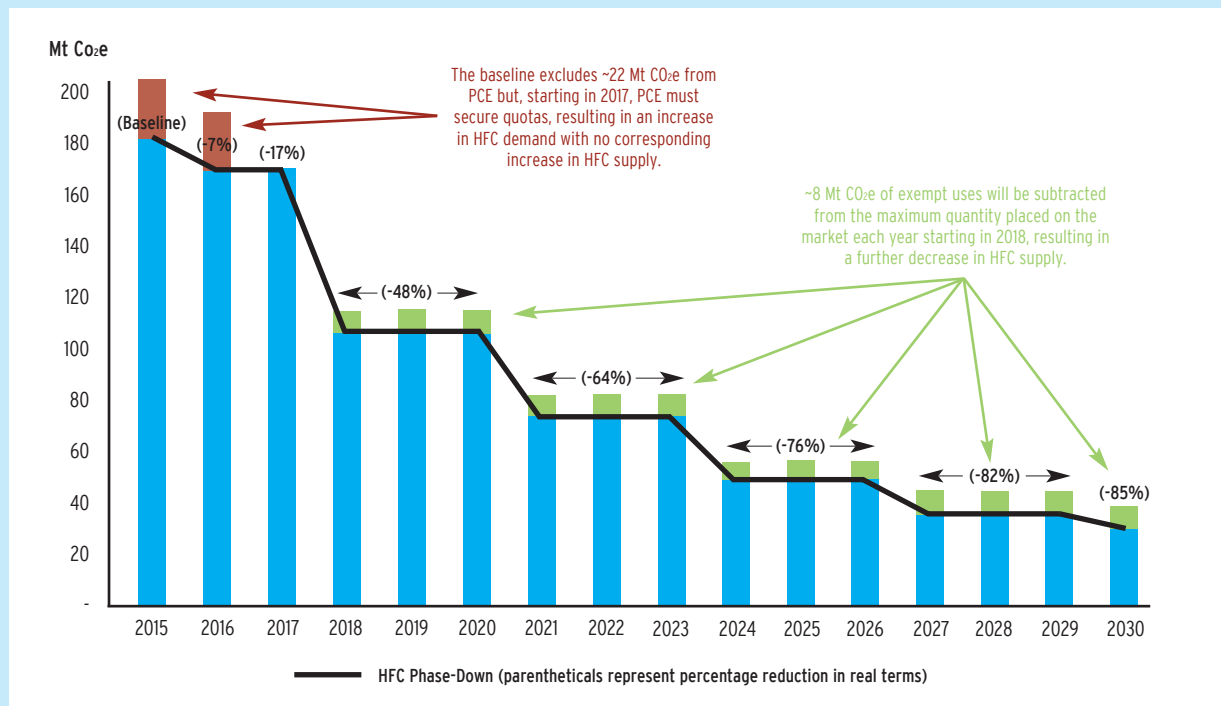
However, the HFC phase-down is actually more stringent than it initially appears. In 2018, the maximum quantity of HFC quotas available on the market will be adjusted downward to remove HFC allowances for exempt uses. At the same time, as of 2017 any pre-charged equipment (shown as PCE on Figure 1) containing HFCs placed on the market in the EU will have to obtain an HFC quota. This has the effect of further reducing the quotas available for other uses, such as supermarket refrigeration. By 2018, the cut in HFC supply in real terms will be closer to 48 per cent below the baseline (see black line in Figure 1). This is a much bigger reduction than the official 37 per cent figure.

The HFC phase-down was based on a study carried out for the European Commission’s *Preparatory Study* for the EU F-Gas Regulation which mapped out

TABLE 1:
HFC phase-down schedule under the EU F-Gas Regulation, based on 2009-12 baseline

| Years | HFC reduction steps (in CO ₂ e) |
|---------|--------------------------------------------|
| 2015 | 100% |
| 2016-17 | 93% |
| 2018-20 | 63% |
| 2021-23 | 45% |
| 2024-26 | 31% |
| 2027-29 | 24% |
| 2030 | 21% |

FIGURE 1:
HFC phase-down reduction steps in real terms



annual HFC demand in the European Union for each year from 2015-30.⁹ With respect to new centralised supermarket systems, the study assumed that 46 per cent of all new multipack centralised refrigeration systems installed in 2015 should be relying on low-GWP technologies, increasing to 100 per cent in 2019.¹⁰ The phase-down therefore assumes that HFC quotas are not required for these systems, neither for first fill nor refill during their lifetime. This means that any new HFC-based centralised refrigeration system installed in, for example, 2019 will be consuming HFC quotas not anticipated under the phase-down schedule.¹¹

In order to meet the HFC phase-down schedule in 2015 we should have seen approximately 9,500 medium-temperature and 9,000 low-temperature low-GWP systems installed. Industry estimates that in 2016 there were more than 8,700 transcritical CO₂ refrigeration systems in Europe.¹²

Trends in HFC usage

Using data from this year's report and *Chilling Facts VI* we were able to analyse trends in HFC usage among participating retailers.

The table shows the rate of change in annual HFC usage for four retailers over a range of years. The column named "Average" shows combined percentage change in annual HFC usage for retailers Carrefour, Delhaize Belgium, Migros and Waitrose between 2013-16. Overall, there is a sharp drop in HFC-507A use. The average drop in HFC-404A is just 23 per cent, while use of HFC-407A, HFC-407C and HFC-407F is up by

12 per cent, as supermarkets use these to refill HFC-404A systems.

While these trends represent positive steps that will help shield the companies from the worst impacts of HFC phase-down, the pace at which retailers divest themselves of HFCs needs to be increased to avoid the disruption associated with imminent supply cuts and price hikes.

It is worth noting that three of the four retailers who have shared their data with us in this format are Green Cooling Leaders and as such are likely to be more proactive in reducing their HFC use than others.

"The HFC phase-down is actually more stringent than it initially appears"

BELOW:

The use of HFC-407C, with a GWP of 1,774, is growing as it is used to replace HFC-404A.



TABLE 2:

Change in annual HFC usage by retailers

| | RATE OF CHANGE BETWEEN 2013-2016 | | | | |
|----------------------------------------------------------------|------------------------------------------------------------------|---------------------|--------|----------|---------|
| | Carrefour Group (excluding Argentine and Brazilian stores) | Delhaize Belgium | Migros | Waitrose | Average |
| HFC-404A (GWP 3,922) | -20% | -62% | -17% | -55% | -23% |
| HFC-507/507A (GWP 3,985) | -91% | -12% | -21% | not used | -72% |
| HFC-407A + HFC-407C + HFC-407F (GWPs between 1,774 - 2,107) | 101% | 180% | 11% | -28% | 12% |
| HFC-134a (GWP 1,430) | 13% | 29% | -3% | 71% | 3% |

HFC-404A still dominates retailers' demand for refrigerants

Figure 2 offers a snapshot showing the contribution very high-GWP HFCs made to retailers' annual HFC use in 2015 and 2016. The data was calculated based on annual refrigerant refill data in kilogrammes (kg), not CO₂e tonnes. While the data is useful to highlight retailers which may experience problems during the phase-down, it should be noted that it does not fully capture retailers which are investing in hydrocarbon-based HFC-free systems which require very little annual refills, such as Waitrose. Despite the limited data, it is clear to see that many retailers remain heavily invested in HFCs with GWPs over 2,500. Unless they act quickly to reduce their high-GWP HFC consumption they will face supply disruption and heavy financial burdens.

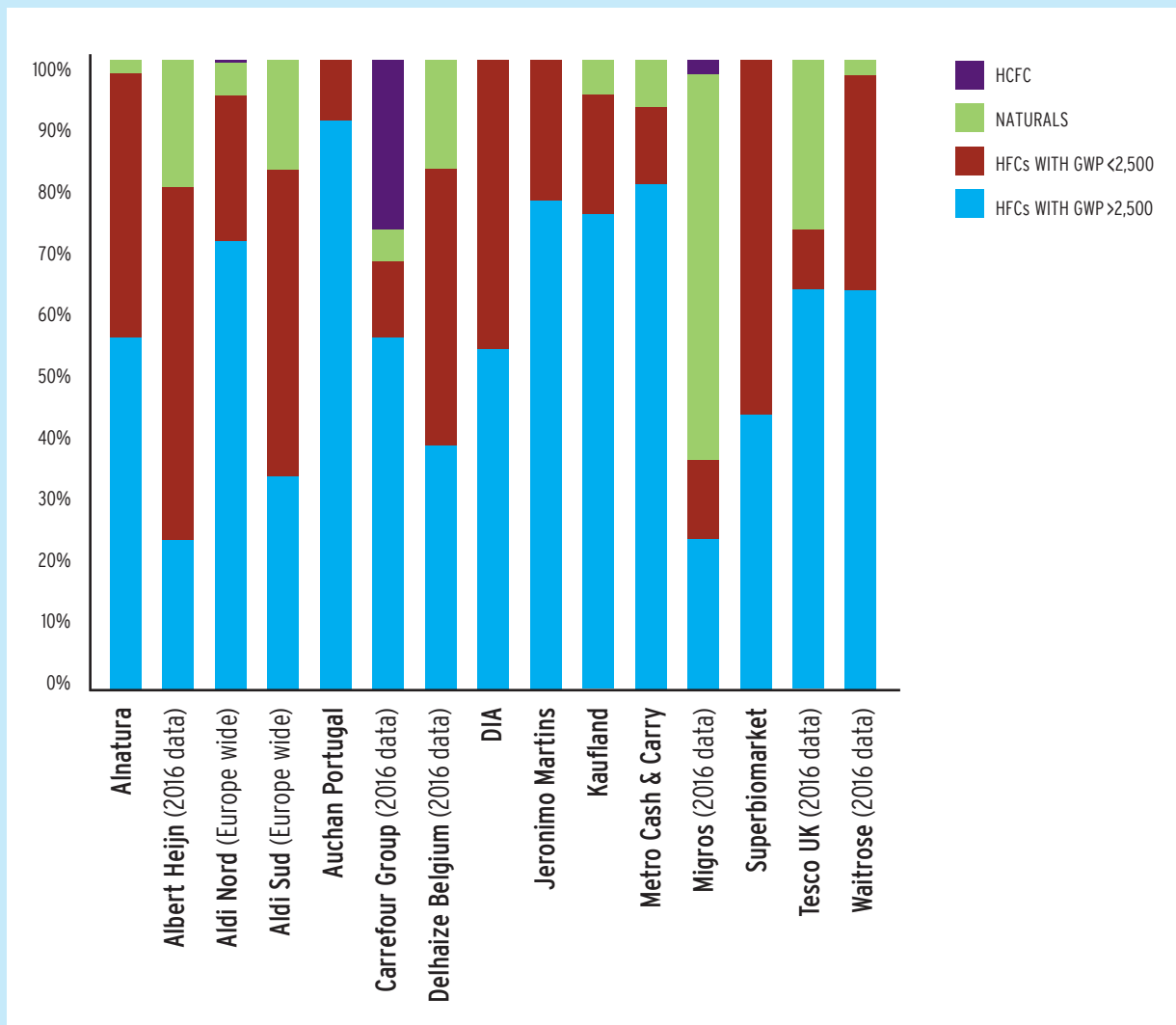
Avoiding the HFC price premium

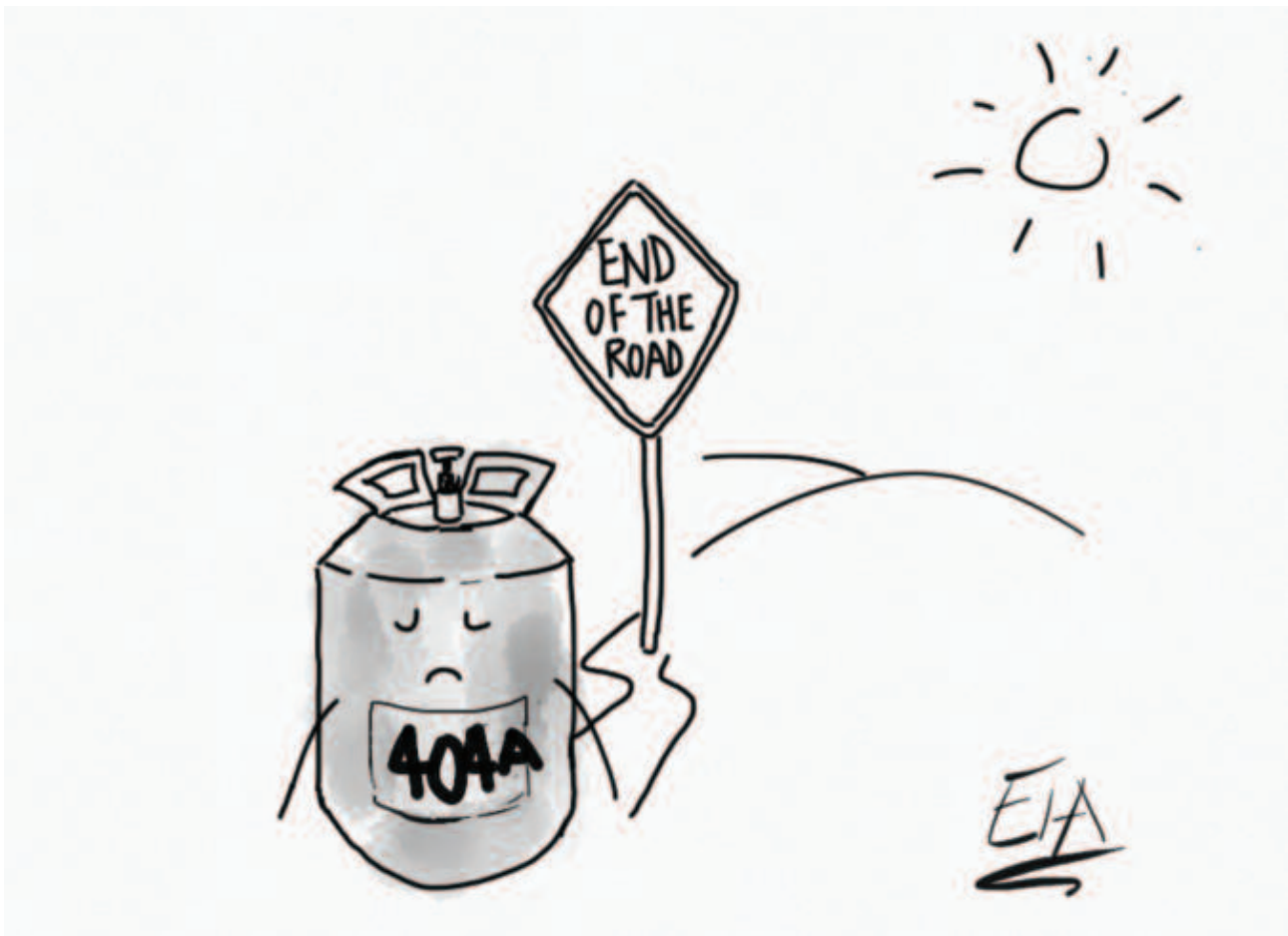
The HFC phase-down is intended to induce HFC quota shortages which will in turn increase HFC prices, making HFC technologies less attractive from a cost perspective. This does not only apply to very high-GWP F-gases such as HFC-404A (GWP 3,922) but also to other high-GWP HFCs currently being promoted as alternatives, such as HFC-407A and HFC-407C, which have GWPs of 2,107 and 1,174 respectively. The use of these HFCs may be necessary to retro-fill existing systems to meet the 2020 service ban but their use in new equipment is extremely short-sighted, given the significant cuts in HFC quotas happening now.

HFC prices have already begun to rise in anticipation of supply cuts, with all major producers announcing price

FIGURE 2:

The percentage of very high-GWP HFCs (HFC-404A, HFC-507 and HFC-422D) in retailers' annual refrigerant refill in 2015 or 2016 (data depending), based on consumption data in kg.





increases since 2015. In March 2017, refrigerant suppliers in the UK announced price increases of up to 30 per cent for HFC-404A and 20 per cent for HFC-407A, HFC-407C and HFC-134a.¹³ This was soon followed by further price increases. For example, Chemours has increased the price of HFC-404A by 62 per cent over the first quarter of 2017.¹⁴ Wholesale retailers have also warned of another 40 per cent price increase for HFC-404A this summer.¹⁵ This matches with industry observations which predict annual price increases of HFC-404A of approximately 100 per cent for the next few years.¹⁶ Honeywell has stated its intention to stop supplying HFC-404A and HFC-507 from 2018, and other suppliers are warning that 2018 will see supply problems as well as further price rises.¹⁷

Other HFCs will not be exempt from price increases. Chemours has already announced rises of 32 per cent for HFC-134a, HFC-410A, HFC-407A and HFC-407C for the first quarter of 2017.¹⁸ The soaring price of fluorospar has also contributed to HFC-134a increases in China, resulting in a 160 per cent rise in the cost of HFC-32 since February 2017.¹⁹

The price of each HFC varies immensely depending upon who is buying it. Online

retailers are currently offering HFC-404A at over €100/kg.²⁰ However, bulk prices are subject to heavy discounts. Discussions with retailers indicate that very large end-users can currently purchase HFC-404A for about €13.50/kg.²¹ Smaller retailers, however, may not be able to get such large discounts; we hypothesise that a rate of up to €35/kg is currently a realistic price. A 40 per cent increase this summer followed by a 100 per cent increase in 2018 would take costs up to a range of €37.8/kg to €98/kg. Taking the average of about €60/kg and assuming an initial HFC-404A charge in a direct expansion system of 750kg with 15 per cent annual leakage, the initial charge would cost approximately €45,000 while refill each year would be an extra €6,750.

Many retailers have reported HFC-free systems are continually reducing in price; for example, Carrefour's return on investment for its CO₂ transcritical systems is typically 18-24 months. However, several retailers have stated that disproportionately high costs are hampering their adoption of low-GWP refrigeration. Retailers need to ensure they are building in the full costs of an HFC system.

ABOVE:

High-GWP HFCs like HFC-404A will be subject to severe price hikes and supply shortages in 2018.

“Ongoing HFC usage in a sector that was expected to be a front runner in the shift away from HFCs risks leaving many retailers with eye-wateringly high annual refrigerant bills.”

LEAKAGE

Leakage continues to be a problem for some retailers. Progress has been made but more needs to be done to address leakage which impacts on the efficiency of the systems in place as well as the cost and climate impact through unnecessary HFC emissions.

Table 3 shows the evolution of leakage rates where comparable data was received. Leakage rates are expressed as a percentage of system charge lost over a year.

What can we hope to achieve?

Industry leaders Albert Heijn, Mega Image, Migros and Waitrose are now achieving leakage rates of about 5-7 per cent. Worryingly, many retailers were unable to provide data on leakage rates, despite the fact it is mandatory for servicing log books to be kept under the F-gas Regulation. In EIA's view, it is likely that the data in Table 3 paints an

overly optimistic picture as the more environmentally proactive retailers tend to be better at data monitoring.

Ahold Delhaize (which owns subsidiaries across Europe, Asia and the US) also shared useful regional data on leakage rates, demonstrating enormous variation in leakage rates between its subsidiaries. Delhaize Serbia and Lion Super in Indonesia have extremely high leakage rates of 58.54 per cent and 46.16 per cent. At the other end of the scale, Albert Heijn and Mega Image have 5.4 and 6.66 per cent leakage annually. There is no single solution to tackling leakage, but it is essential to share information regarding which approaches work.

The benefits of digital data monitoring

Although Aldi Nord was unable to share its annual leakage rate data with us, it did give information on its internet-based leakage monitoring system, Mobilec, which it claims has reduced leakage to just one per cent in its test location. The Mobilec system records services, maintenance, leakage checks and filling amounts in order to identify any potential risks at an early stage. Data can be entered directly via a mobile phone and transferred to the central server by SMS. All refrigerant leakages can be reported by the technicians directly from the store and entered into the system. It now has this system running in 2,164 stores in Germany and will implement it in Dutch stores from 2017.

Tips on reducing leakage

Walmart subsidiary Asda has been proactive on tackling leakage in its UK stores. It has published detailed information on how it successfully reduced leakage rates to 7.5 per cent in existing stores and 3.6 per cent in new stores.²² The procedures it has adopted go above and beyond what is required under the F-gas regulations. In Asda's view: "if you adopt the minimum F-gas regulations leak-testing periods, you will struggle to control leakage."²³

Some of the key aspects of its approach include:²⁴

- all data collected under the F-gas regulations is used to produce a leak coding database. The data is used to

TABLE 3:

Evolution of leakage rates where comparable data was received. Leakage rates are expressed as a percentage of system charge lost over a year.

| RETAILER | LEAKAGE RATES (PER CENT) | |
|------------------------------|--------------------------|-------|
| | 2014 | 2015 |
| Alnatura | 8.9 | - |
| Dia | 24.17 | 20.01 |
| Kaufland | 10 | 10 |
| Marks & Spencer | - | 15 |
| Metro | 11.1 | 9.8 |
| Migros | 6.6 | 6 |
| Waitrose | 6.35 | 6.98 |
| Delhaize America* | - | 12.72 |
| Ahold USA* | - | 11.64 |
| Delhaize Belgium | - | 17.25 |
| Albert Heijn (Netherlands) | - | 5.40 |
| Alfa Beta* (Greece) | - | 9.24 |
| Delhaize Serbia* | - | 58.54 |
| Lion Super Indo* (Indonesia) | - | 46.16 |
| Mega Image* (Romania) | - | 6.66 |
| Albert* (Czech Republic) | - | 8.74 |

* these retailers are subsidiaries of Ahold Delhaize; although they did not participate fully in the report, Ahold Delhaize shared their leakage data.

identify areas with greatest risk of leakage and deploy engineers accordingly;

- all stores have annual preventative maintenance and a monthly health check, both involving the leak-testing of all refrigeration equipment;
- each piece of refrigeration equipment has scheduled maintenance visits appropriate to the risk of leakage experienced using historical data;
- all engineers are assigned to specific stores and take ownership of all refrigeration equipment and issues within each of their assigned stores.

Impacts of leakage on HFC phase-down

The HFC phase-down assumes full implementation of containment and recovery provisions.²⁵ This means operators and contractors are assumed to take all precautionary measures to reduce leakage during use of the equipment and ensure recovery at its end of life. For this to happen, there must be the widespread adoption of best practices by operators and contractors, something that seems unlikely to occur in the near-term without further intervention, given the historical “low degree of overall compliance” with these provisions.²⁶ Ongoing high leakage will

continue to create demand for HFCs that was unforeseen within the phase-down schedule, adding further pressure to predicted shortages and price hikes.

Direct emissions are nearly as high as indirect emissions

Among those retailers with consistent reporting from our previous *Chilling Facts* survey, direct emissions have dropped on average by 11 per cent between 2013 and 2015. Retailers whose direct emissions dropped by more than 20 per cent were Jerónimo Martins, Metro Cash & Carry and Waitrose.

When *Chilling Facts* was first released in 2009, the assumption was that direct emissions from leaking refrigerants were much lower than indirect emissions (those associated with the energy used by refrigeration systems). However, the data shared with us by retailers showed that direct emissions were often higher than indirect emissions. Worryingly, seven years on we find average direct emissions remain almost equal to indirect emissions.

This information puts energy-saving discussions into context. The data tells us that still almost half of the total climate impact of HFC-based refrigeration systems comes from leaking emissions.

BELOW:

Direct emissions from the release of HFCs are still nearly as high as indirect emissions associated with energy use in many supermarkets.



ENERGY EFFICIENCY OF HFC-FREE COOLING IN WARM CLIMATES

Breaking the 'CO₂ efficiency equator' has been the target of refrigeration innovation for several years, resulting in significant technological breakthroughs that now enable HFC-free systems to compete with and actually beat their HFC-based counterparts, even on a hot day.

The integration of heating systems into a CO₂ transcritical system is well known. However, the relatively recent integration of air-conditioning systems into the CO₂ refrigeration system, by adding a heat exchanger before the receiver, offers extra energy savings for systems in hot countries.²⁷

We first reported on the benefits of using parallel compression in 2014. Parallel compressors work by accepting the CO₂ 'flash gas' and a higher pressure. This technology is proving to be as good as it promised, offering energy savings

on traditional CO₂ booster systems in the region of 10-15 per cent.²⁸

Ejectors have also proven to be useful components to recover expansion losses which occur when operating in warm temperatures, thereby avoiding high throttling losses in high pressure expansion valves.²⁹ Various analyses have shown that a multi-ejector device can improve the system efficiency up to 20 per cent.³⁰

There are further energy-saving options available, including mechanical sub cooling and evaporative cooling, although the costs and benefits of these need to be evaluated by the end user.

Retail giant Carrefour has been investing in innovative CO₂ transcritical refrigeration technologies for several years and is steadily rolling them out through its estate. It now has 147 stores



running on CO₂ transcritical, with 18 in Spain, 19 in Italy and one in Argentina. In its Alzira store in Valencia, southern Spain, it is reporting energy savings of 12 per cent over HFC systems, once other improvement devices have been accounted for.

Despite the proven efficiency of CO₂ transcritical systems in warm climates, most retailers operating in southern Europe said they remained concerned about the energy efficiency or costs of HFC-free systems. Better communication of new innovations is clearly needed, alongside government incentives to make the switch to HFC-free.

Progress for smaller systems

More and more manufacturers are turning their attention to smaller CO₂ systems, starting in Japan but increasingly in Europe, where small format stores are on the increase.

Japan's three largest convenience store chains all have outlets that use CO₂ condensing unit technology.³¹ Panasonic has released four different models in Japan designed for smaller installations and has supplied about 6,000 units to Japanese retailers. They are said to be 20 per cent more energy efficient than products using HFC-404A, and in addition are smaller and lighter.³² European companies are also beginning to launch their own CO₂ condensing units – Advansor since 2013, with SCM Frigo, Carrier Transicold UTC (Green & Cool) and SANDEN Europe following suit. The cost of the units is coming down and the manufacturers report good performance in warm climates.

Shut that door!

Retailers who are serious about cutting the energy consumption of their refrigeration should recognise the need to close their cabinets with doors. On average, retailers reported energy savings of approximately 32 per cent from the use of doors on fridges.³³ In addition to reducing energy bills, closed cabinets also create a more comfortable environment for shoppers and improve food safety by maintaining lower temperatures inside the cabinet.

Retailers progressing in rolling out doors on fridges include Alnatura, Bio Company, Delhaize Belgium, Dia, Jeronimó Martins, Metro Cash & Carry, Real, Superbiomarkt and Tesco.



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What the retailers said when asked "What can your government do for you?":

- * Economic incentives, especially for equipment replacement and for small- and medium-sized enterprises
- * Increase the maximum charge of hydrocarbons from 150g to 600g
- * Revise the regulations banning the use of A2L refrigerants
- * Exemption for HFC/ CO₂ hybrids beyond 2022
[NB - EIA believes that CO₂ technologies are fully ready for market now and that the current exemption will not be needed beyond 2022]
- * Incentivise innovation and financially support efficient low-GWP solutions
- * Encourage adoption of doors on fridges in smaller formats
- * Give clearer signals regarding the evolution of the regulations on refrigerants
- * Better training on natural refrigerants for contractors.

CONCLUSIONS

Looking back over the nine-year period since *Chilling Facts* started to document progress and challenges in the adoption of HFC-free commercial refrigeration, European retailers stand out as global leaders. The commitment and investment of a group of leading retailers has significantly reduced costs, driven innovation and energy efficiency and increased the skills base of engineers able to work with natural refrigerants.

The rationale for the rapid shift to natural refrigerants goes beyond sustainability and increasing brand equity. It allows supermarkets to realise long-term savings for the benefit of shareholders and shoppers.

Despite the fact that HFC-free refrigeration is now well established, its uptake across the majority of European retailers is behind the pace needed to meet the EU's fast-acting HFC phase-down. From 2018, the supply of HFCs to the market will be cut by 48 per cent in real terms, yet many retailers still use HFCs such as HFC-404A across the majority of their estate. HFC producers and suppliers are responding to anticipated shortages by dramatically increasing the cost of the HFCs with highest GWPs. Retailers who want to avoid the risk of disrupted supplies

should act quickly to remove HFC-404A from their estate.

HFC shortages will not only result in bigger refrigerant bills, but ongoing heavy demand from retailers may drive illegal trade in HFCs. Leading HFC manufacturers are already voicing concerns about potential illegal HFC imports representing more than five per cent of the quota in 2015.³⁴

While Europe is clearly the leader, many other countries are taking steps to phase out HFCs and nowhere is this more apparent than in the commercial refrigeration sector. This is backed by the 2016 Consumer Goods Forum Resolution, which commits members to "install new equipment that utilise only natural refrigerants or alternative ultra-low GWP refrigerants, effective immediately" in all commercial and industrial refrigeration equipment along the food and beverage supply chain.

There is no excuse for inaction by Europe's retailers. The commercial refrigeration sector must swiftly adopt HFC-free refrigeration, a move that makes perfect business sense given the inevitable supply shortages and high prices of HFCs in the years to come.

"The rationale for the rapid shift to natural refrigerants goes beyond sustainability and increasing brand equity. It allows supermarkets to realise long-term savings for the benefit of shareholders and shoppers."



RECOMMENDATIONS

RETAILERS:

- Commit to HFC-free refrigeration in all new stores and refits
- Immediately remove HFCs with a GWP of 2,500 or more in existing equipment
- Fit doors on all chiller and freezer units.

MANUFACTURERS:

- Invest in CO₂ and other natural refrigerant technologies for large- and small-format supermarkets
- Participate in international standards bodies to support the update of safety standards to safely allow higher hydrocarbon charges.

GOVERNMENTS:

- Financially support smaller retailers to transition away from HFCs, particularly with respect to costs for new equipment
- Support work to address overly restrictive refrigerant charge safety standards
- Provide incentives for doors on fridges.

GLOSSARY

CO₂

Carbon dioxide is the reference used to compare the impact of other greenhouse gases on the climate system in terms of their global warming potential (GWP). It is also used as a refrigerant.

GWP

Global Warming Potential. This defines the warming effect of a gas compared to the same mass of CO₂ released into the atmosphere. GWPs used in this report are based on a 100-year time frame.

Hybrid

Any system using two refrigerants for different parts of the cooling cycle; often these combine a natural refrigerant with an HFC, although sometimes both refrigerants are HFC-free.

Indirect emissions

Emissions from a refrigeration system resulting from the energy used to operate the system.

Plug and play systems

These refer to integral refrigeration systems which are completely self-contained. Can also be referred to as standalone cabinets.

CO₂ Cascade

Refers to a system using CO₂ in the low temperature cycle and another refrigerant in the medium temperature cycle.

Transcritical CO₂

Refers to a system using CO₂ in both the low and medium temperature cycles.

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