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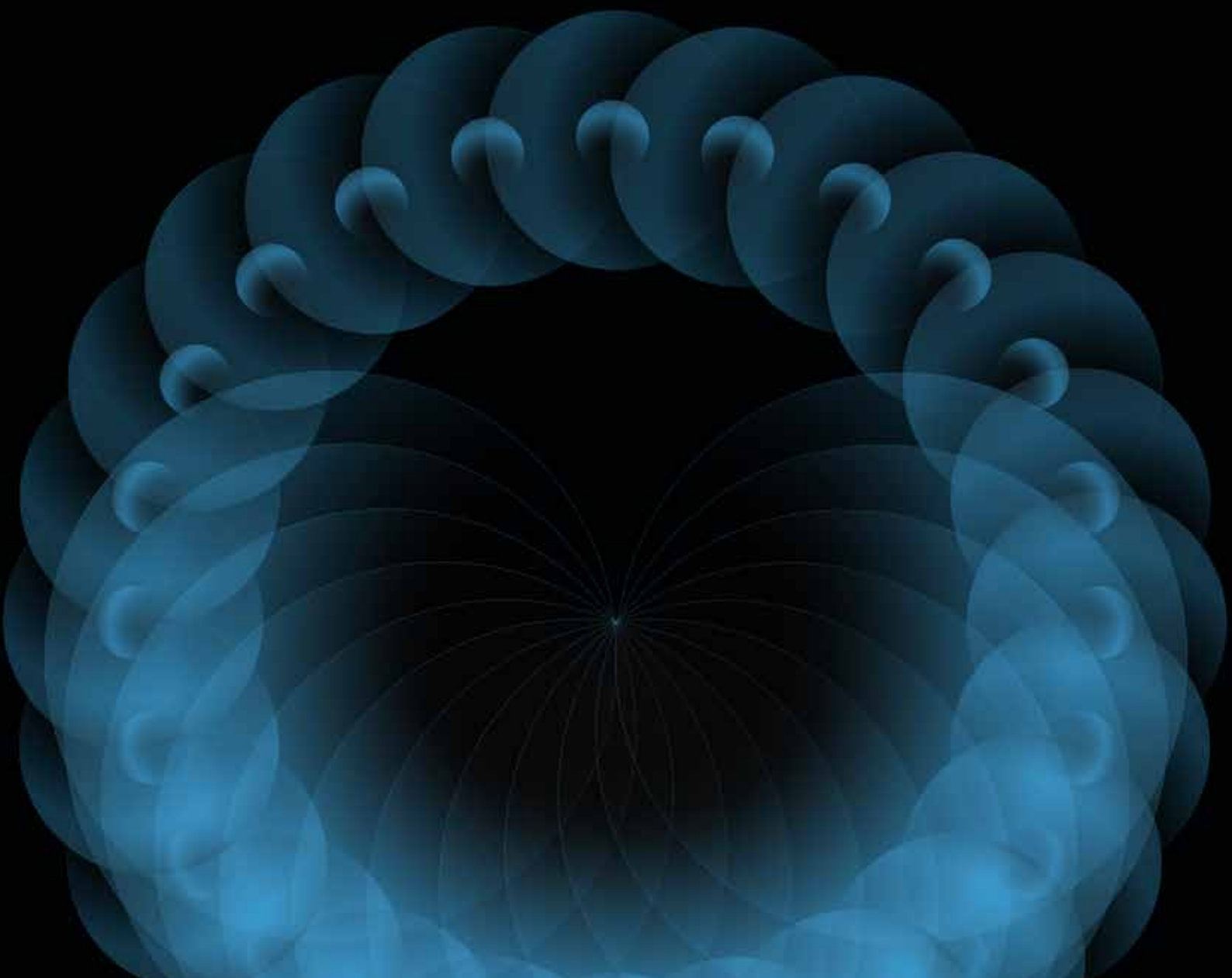

Phased

The HFC phase-down definitively explained.

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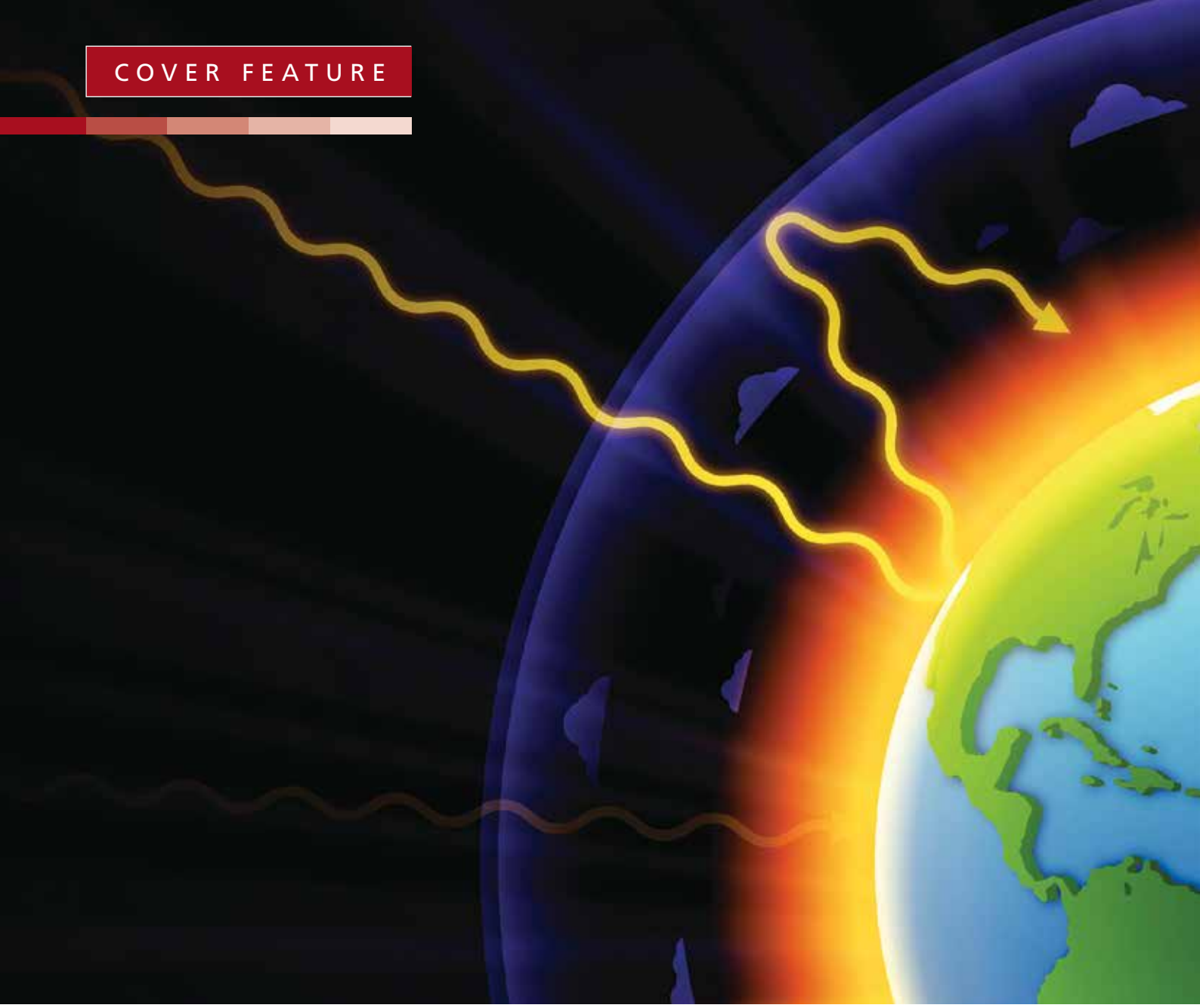

Low-down on the phase-down

The Australian HFC phase-down commenced on January 1. Six months later, apart from some high-level industry discussions and government communications, there does not appear to be a great deal of awareness or change happening on the ground in the refrigeration and air conditioning industry at the grass-roots level. In this article **Vince Aherne, M.AIRAH**, looks at the phase-down, and considers how this technology transition might impact the industry, in the short and longer term.

WHAT IS THE HFC PHASE-DOWN?

The HFC phase-down has been introduced by the Australian government to help Australia meet its international commitments to the Montreal Protocol, and in particular the Kigali Amendment.

Montreal Protocol /Kigali Amendment

The Montreal Protocol was agreed in 1987 and has phased-out over 99 per cent of the production and import of nearly 100 ozone-depleting substances. All 197 UN member countries agreed to use the Montreal Protocol to phase down production and import of hydrofluorocarbon (HFC) refrigerants, through the Kigali Amendment. Australia ratified the Kigali Amendment in October 2017 and Australia's HFC phase-down started on January 1 2018.

The Montreal Protocol reduced greenhouse gas emissions globally by 135 billion tonnes CO_2-e between 1990–2010. The Kigali HFC phase-down will avoid 72 billion tonnes of global CO_2-e emissions up to 2050.

This is an HFC phase-down, not an HFC phase-out. The importation quota controlling the HFC phase-down is CO_2-e based. This means that the lower the global warming potential (GWP) of a refrigerant is, the more kilograms can be imported before the import quota is exhausted.

HOW DOES THE HFC PHASE-DOWN WORK?

Refrigerants have a measured property, their GWP. This represents an "equivalent carbon dioxide effect" (CO_2-e).

High GWP is bad, low GWP is good. Many of the synthetic refrigerants currently used in refrigeration and air conditioning have a high GWP.

What is Global Warming Potential and CO_2-e?

Global Warming Potential (GWP) is a measure of the ability of a substance to trap heat in the atmosphere. Carbon dioxide (or CO_2) is used as the baseline with a GWP of 1. Carbon dioxide equivalent (CO_2-e) is the measurement of the GWP of a refrigerant. The higher the GWP, or the more CO_2-e a refrigerant has, the more potential it has to increase climate change. There is no globally accepted definition for high GWP or low GWP for a refrigerant; the closer GWP is to zero the better.

The Table below shows the GWP of some common refrigerants and the amount of grams of refrigerant that would be equivalent to one tonne (1,000,000 g) of CO_2. Astonishingly, a little more than a quarter kilogram of R404A or R507A can produce the same climate effect as a tonne of CO_2.

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The HFC phase-down sets an import quota on specified high-GWP refrigerants, based on their cumulative GWP or CO_2-e. This quota limit will be reduced, in gradual measured steps, from 100 per cent (or 8.0 million tonnes CO_2-e) in 2018 to 15 per cent or (1.6 million tonnes CO_2-e) at the end of 2036, an 85 per cent reduction. The residual 15 per cent will be an ongoing import limit.

Refrigerant	GWP (AR5/4)	Grams equivalent to 1 Tonne (1000 kg) CO_2
R134a	1300	769g
R404A	3922	255g
R407A	2107	475g
R407C	1600	625g
R407F	1825	548g
R410A	2088	479g
R417A	2346	426g
R422A	3143	318g
R422D	2729	367g
R434A	3245	308g
R448A	1387	712g
R449A	1397	716g
R452A	2140	467g
R507A	3985	251g
R32	677	1477g
R1234ze	≤ 1	≥ 1,000,000g
R290	3	333,333g
R744 (CO_2)	1	1,000,000g
R717 (NH_3)	0	—

Table 1: GWP of some common refrigerants.

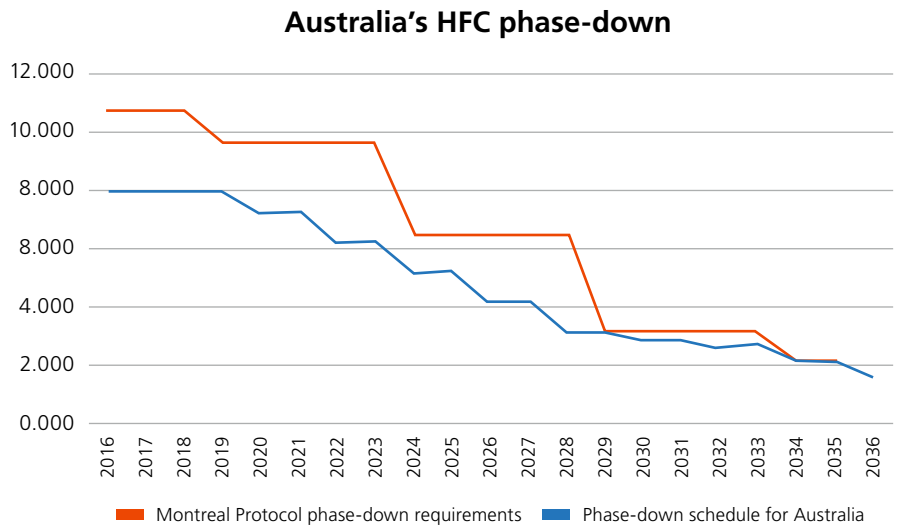

Figure 1: Australia's HFC phase-down.

HFCs covered in the phase-down				
HFC-23	HFC-32	HFC-41	HFC-125	HFC-134
HFC-134a	HFC-143	HFC-143a	HFC-152	HFC-152a
HFC-227ea	HFC-236cb	HFC-236ea	HFC-236fa	HFC-245ca
HFC-245fa	HFC-365mfc	HFC-43-10mee		

Table 2: HFCs covered in the phase-down.

The overall pace of the phase-down is designed to match projected demand and equipment replacement at end of life.

In Figure 1, the legislated phase-down for Australia is shown by the blue line and Australia's Montreal Protocol requirement by the orange line.

The phase-down will apply to all HFCs covered by the Montreal Protocol, which comprise the 18 HFCs shown in Table 2.

The phase-down also applies where refrigerant blends contain these HFCs. The HFC portion of any blend counts towards the HFC quota.

Common refrigerant blends that will be affected include R404A, R407 blends, and R410A.

Hydrofluoroolefins (HFOs) are low-GWP synthetic refrigerants and are not included in the phase-down. However, if an HFC is part of an HFO blend, the HFC component will be counted in the quota.

An example is the R134a drop-in R513A, which contains 44 per cent R134a and 56 per cent HFO1234yf.

Because all high-GWP refrigerants are currently imported into Australia, this effectively creates an upper limit for the size of the high-GWP HFC refrigerant bank available to the industry. As the quota reduces over time, the available bank of high-GWP refrigerant will reduce. Under the arrangement more R32 refrigerant could be imported into Australia than R410A, because R32 has a lower GWP and CO_2-e than R410A.

Low-GWP refrigerants (natural refrigerants and HFOs) are not affected by the phase-down and their use is expected to increase exponentially.

CURRENT SITUATION

In many sectors of the industry, the use of high-GWP HFC refrigerants is high and growing. The following figure (from Cold Hard Facts 3 or CHF3) outlines the current bank of HFC and HCFC refrigerants, representing more than 50,000 tonnes. The graph shows 17 per cent growth since 2012 and an

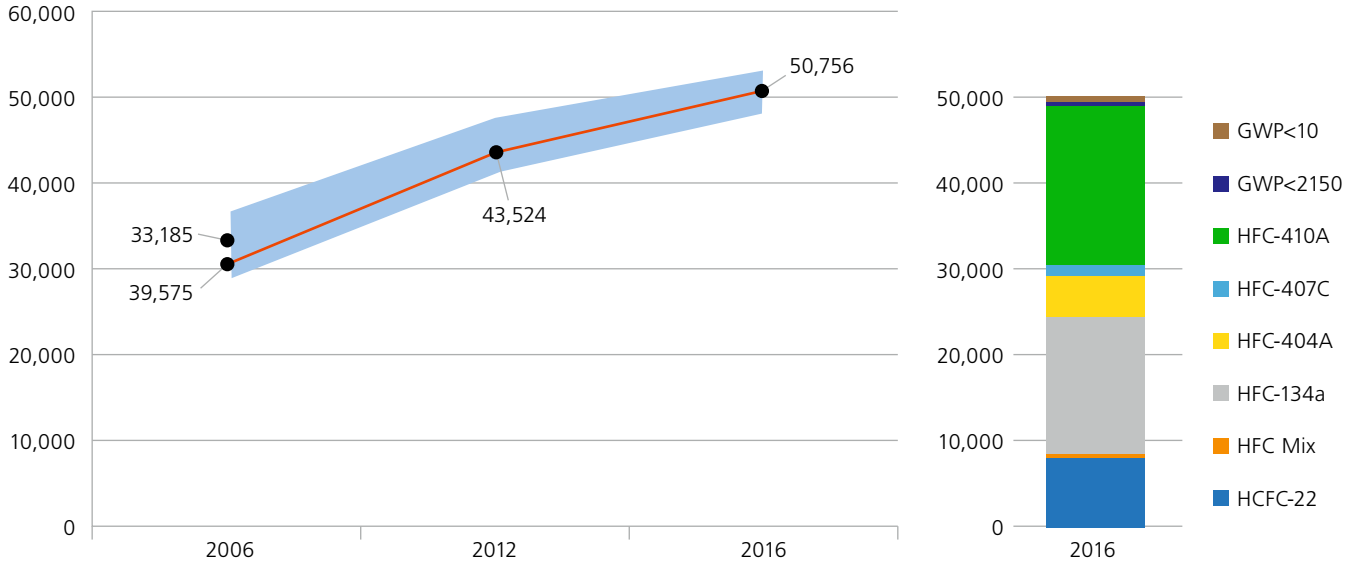

Figure 2: Size and breakdown of the refrigerant bank (CHF3).

increase of more than 50 per cent in the decade. This 50,000 tonnes represents a huge and growing CO_2-e burden that has to be controlled.

Most of the refrigerant bank is comprised of R22, R134a, R404A, R407C, R410A, and all of these refrigerants (except the already phased-out R22) are targeted in the phase-down.

As the availability of these refrigerants becomes limited, demand will increase and prices could rise unsustainably. Certainly, there is evidence of this in Europe, although the EU has the F-Gas regulations and a different HFC phase-down schedule than Australia, so it is difficult to draw exact comparisons.

WHAT IS INTENDED TO HAPPEN?

The gradual reduction in the availability of high-GWP refrigerants, engineered by the HFC phase-down, is designed to send the refrigeration and air conditioning (and related) markets a strong price signal to transition towards low-GWP technical solutions. This could include transition to low-GWP-refrigerant-based systems or even towards non-refrigerant-based technologies (although these potential disruptors still seem some way off).

There should be ample capacity within the current refrigerant quota to service existing high-GWP systems, as long as the "existing" service base does not continue to increase but instead begins to decrease – i.e., as long as industry stops designing and installing high-GWP systems. This is an important point, a critical point, because it means that all (or most) new and replacement RAC systems will have to be low-GWP – starting from now.

The "industry" is expected to transition to low-GWP solutions for new and replacement systems and to service and maintain existing high-GWP systems, with a strong focus on refrigerant management. Minimising refrigerant leakage and emissions and maximising system operating performance means regular inspections, monitoring and leak detection.

Refrigerant Leakage – inspections, monitoring and detection

To comply with AS/NZS 5149.4, maintenance procedures must include the application of a leak inspection regime, using direct and indirect leak-detection methods every three, six or 12 months, depending on the mass of refrigerant contained in the system (the refrigerant charge):

- *Inspections every month for systems containing 300kg or more refrigerant, every six months for systems containing between 300kg and 30kg, and every 12 months for systems containing between 30kg and 3kg of refrigerant.*
- *Systems with over 3kg of refrigerant should have a refrigerant logbook to record the quantity of refrigerant installed, added, or recovered.*
- *When a system contains more than 300kg a refrigerant detection and alarm system is also required, and these must also be maintained annually.*

Action must be taken to eliminate every leak that is detected. Leak sites should be re-inspected a month after repair.

Any high-GWP refrigerant that is surplus to needs must be disposed of appropriately, in accordance with existing environmental regulations. However, with a decreasing supply it is likely that refrigerant recovery and reclamation rates will increase, and destruction rates will decrease. Refrigerants become more valued as their prices rise.

WHAT COULD ACTUALLY HAPPEN

As with any market, particularly one that is being manipulated artificially by external forces, it is difficult to accurately predict what will actually happen. There is one certainty, however: change will happen. Significant change.

Government advice is that the phase-down has been designed to facilitate an orderly technology transition towards low-GWP refrigerants. The phase-down provides small reduction steps over a long period, providing ample time for change, as long as the change (i.e., the technology transition) begins in January 2018.

Industry associations and interest groups all acknowledge the considerable challenges for industry in making this technology transition, although perspective, focus and details vary. Estimates of the financial investment required to achieve this technology transition by 2035 are staggering. Yet the cumulative Australian direct spending in refrigeration and air conditioning services and technology between now and 2035 is a big number anyway, no matter which way you look at it – probably more than half a trillion dollars.

The market will likely respond with a range of strategies, including a steady move towards low-GWP refrigerants, more emphasis on refrigerant handling best practices, and increasing research and development into low-emission high-efficiency RAC alternatives. However, the timing and strength of the industry response is not certain and has been relatively lacklustre and restrained so far.

Metric	2012	2016
	Size and proportion	
Employment	173,000 (1.5%) of 11.53 million	213,966 (1.7%) of 12.47 million
Direct spending	$26.2 Bn (1.8%) of $1,493 Bn	$28.04 Bn (1.7%) of $1,650 bn
Electricity use	59,100 GWh (23.5%) of 251,000 GWh	61,000GWh (23.6%) of 258,000GWh
Greenhouse emissions (direct and indirect)	64.5 Mt CO2e (11.9%) of 547Mt	68.95 Mt CO2e (12.5%) of 554Mt
Stock of equipment	45 million pieces	50 million pieces

Table 3: The extent and growth of the RAC industry – snapshot 2012 and 2016 (CHF3).

Species	Bank 2012 (Tonnes)	Bank 2016 (Tonnes)	Change (%)
CO_2	80	127	+ 37%
Ammonia (R717)	4,400	4,800	+ 8%
Hydrocarbons (HC)	320	566	+ 44%
Total	4,800	5,493	+ 11%

Table 4: Natural refrigerant bank in Australia (CHF3).

WORST-CASE SCENARIO?

What is the worst that can happen you ask? The industry continues to specify and install RAC systems based on high-GWP refrigerants at current levels. The demand for high-GWP refrigerants continues to increase while supply stocks fall. Refrigerant prices rise rapidly, and industry end users begin to demand alternatives.

Due to previous low demand for low-GWP technology there are too few suppliers with too little capacity, which also drives prices up and creates significant skills gaps. Higher prices attract commercial interests that may not have the correct skill set or motivation to create high-efficiency low-GWP HVAC&R. Prices rise, standards fall, skills and services are unavailable.

REFRIGERANT TRENDS

Natural refrigerants tend to be low-GWP, and they will become increasingly in demand. There is already evidence of strong growth in the bank of natural refrigerants in Australia.

The transition to natural refrigerant technology is not plug-and-play, and a range of new skills and competencies will be required. New format air conditioning, refrigeration and heat pumps in CO_2 or NH_3 are already available, ongoing research into expanding the safe application of hydrocarbon and other flammable refrigerants continues.

To make the most effective use of the CO_2-e import quota, high-GWP HFC refrigerants will most likely be phased out in favour of lower GWP HFCs.

The synthetic refrigerants industry will facilitate a transition to reduced-GWP refrigerant replacements (reduced-GWP HFCs or HFC/HFO blends) for existing systems or low-GWP refrigerant alternatives (low GWP HFOs) for new plant and equipment. There will be choices available, but different choices in different sectors, refrigeration or air conditioning, commercial or residential.

Many low-GWP refrigerants are flammable, and that brings a range of new challenges, competencies and opportunities to the industry and its stakeholders. The technical skills gaps associated with the transition to flammable low-GWP refrigerants may act as a barrier to an orderly transition.

One thing that will likely drive change is the price of refrigerant. If the demand for high-GWP refrigerants continues to increase and the supply decreases, prices are highly likely to rise. However, market complexities such as improved handling practices, stockpiling, private storage, reclamation and reuse, and the speed and direction of the technology transition will all have an effect on refrigerant wholesale and retail pricing, which is not overly transparent at the best of times.

How will the phase-down impact owners/operators?

For existing systems using high-GWP refrigerants, owners and operators need to take a renewed focus on leak minimisation. There should be a medium to long-term view towards system replacement with a low-GWP alternative.

If high-GWP HFC refrigerant prices do rise significantly the refrigerant charge in an existing system could represent a considerable financial risk to an owner in the event of a catastrophic loss. These costs may be limited or may not be covered under existing insurance arrangements.

In the interim period the refrigerant manufacturing industry will offer "reduced" GWP replacement refrigerants that may be retrofitted (at a range of different complexity levels) to existing systems that currently use high-GWP refrigerants.

Reduced-GWP refrigerants will put less upward price pressure on the market because under the HFC phase-down CO_2-e quota, if the GWP is halved the equivalent refrigerant quantity is doubled. You can import more reduced-GWP refrigerant than high-GWP refrigerant.

For new and replacement systems a more immediate change is required. Owners need to make sure that their current and future investments in refrigeration and air conditioning are not investments in high-GWP refrigerant-based technologies that are heading for obsolesence.

- Instruct designers and specifiers in what is wanted in terms of life-cycle analysis or TEWI comparisons.
- Refuse to procure high-GWP systems unless all other alternatives have been explored.

Operators need to make sure that refrigerant leakage and system energy efficiency is a key focus of the maintenance strategy for the refrigeration and air conditioning assets under their control. As new low-GWP-based systems come online, operators will need to develop new competencies and practices dependent on the technology being applied.

How will the phase-down impact designers/specifiers?

Designers will need to stop specifying systems that operate using high-GWP refrigerants, ideally moving to specifying low-GWP-based systems. This is not as straightforward as it may seem because there are a range of options available, all with differing technical requirements to be met. Often low GWP designs have to incorporate significantly different technical approaches from today's business-as-usual plug-and-play approach found in many RAC applications. Different solutions will be available for different sectors, and most designers will be on a learning curve.

Many low-GWP refrigerants are flammable, necessitating a change in design and installation practices. Other low-GWP alternatives include higher pressure, higher specification, different materials and practices, new assessment procedures. WHS requirements and implications for safety in design practices will need to be accommodated.

How will the phase-down impact technical service providers?

Perhaps the greatest impact will be on the tens of thousands of refrigeration and air conditioning technicians who are tasked with installing and maintaining these systems. While retaining all of the knowledge and skills required to service the existing legacy systems there will be a range of new skills and knowledge that will need to be acquired.

In a world of evolving technology and controls complexity, hazards assessments, risk management, energy-targeted maintenance, and best-practice leak minimisation are all areas that will come to the fore in low-GWP RAC. There will be a high demand for new skills and a potential limited availability of high-quality training.

It is possible that there will be greater specialisation within the RAC trade as the skills sets required for different sectors and different technologies diverge.

The good news is that there will be plenty of ongoing work to do as the industry transition continues. Markets for maintenance and retrofits should be robust, and significant opportunities will exist for the delivery of new future-proof low-GWP low-emission HVAC&R.

How big is the challenge?

The HFC phase-down is one step (albeit an important step) in the journey to low-emission HVAC&R and a net-zero carbon future.

Drawdown – Refrigerant management

Project Drawdown has identified refrigerant management as the number one most critical step towards reducing global CO_2-e emissions. The Australian HFC phase-down and the Montreal Protocol are significant mechanisms in reducing the impact refrigerants have on the environment. Low-emission HVAC&R requires the highest efficiency low-GWP plant available to be optimised for the facility and powered in total or in part by renewable or low-carbon energy.

Over the short term the challenge is certainly manageable but management of it has to start now, not when it is too late.

Over the longer term the changes are significant, it can't be denied. But perhaps the refrigeration and air condition industry, which is used to big shocks and change, is better placed than most to take on the challenge. Although it is a highly time-poor and cost-driven industry that is fragmented across numerous sectors and applications, it is also clever and innovative. It is an industry used to rising to the challenge of technical and regulatory change.

Due to this huge technology transition and renewal of existing RAC infrastructure over the next 15 years, the individual and commercial opportunities within the industry are almost unlimited. It will be a great time to be in the industry. It's a great industry that is cleaning up its act, and it is a pivotal industry that will drive how far and how fast the global community can move towards net zero emmisions.

The biggest threat is to do nothing. The phase-down is a reality, the transition to low-GWP technology must happen, the industry must rise to the challenge. Rise, humans of HVAC&R.

What can I do to prepare for the HFC phase-down?

The first best thing anyone in the industry can do is to learn about the low-GWP refrigerant-based solutions and alternatives that are currently available in your sector and the new technologies and methodologies that are under development. Inform yourself of what you are using now and its potential replacement.

Stop designing and installing with high GWP refrigerants, now!

The worst thing anyone can do is to do nothing. Do something.

Start the conversation with your colleagues and clients:

Are we ready for the HFC phase-down?