

FACT SHEET 2

Overview of HFC Market Sectors

1. Introduction

This Fact Sheet provides a brief overview of the market sectors that use HFCs. Each market sector is discussed in more detail in Fact Sheets 3 to 14.

To assess the potential to reduce demand for HFCs it is important to understand their main applications and to consider the possibilities and the constraints to using alternatives with lower GWPs. Prior to 1990 there was almost no use of HFCs. At that time, the current HFC markets were consuming ozone depleting substances (ODS), mainly CFCs and HCFCs. As ODS were phased out under the Montreal Protocol, HFCs were amongst the most important chemicals selected as replacements.

In some of the former ODS markets it was possible to move to non-fluorocarbon alternatives. For example, a significant part of the largest ODS market, aerosols, was able to move to propellants such as hydrocarbons or not-in-kind technologies such as pump sprays or roll-ons. However, in some significant markets such as refrigeration and air-conditioning, HFCs were attractive alternatives, being non-flammable and having low toxicity. HFCs were developed as ODS replacements. The production of HFCs grew rapidly to serve the key markets discussed in Section 4 below.

In this Fact Sheet the following topics are briefly introduced:

- a) The main HFC chemicals being consumed
- b) The key HFC market sectors and, where relevant, market sub-sectors
- c) The opportunities available to reduce current use and emissions of HFCs

The use of HFCs in different market sectors and different regions of the world is changing rapidly. In Article 5 countries HFC use is growing due to the phase out of ODS and economic growth. In some non-Article 5 countries HFC use is falling due to climate change policies. There is relatively little consistent data at global level about HFC production and consumption. Consequently some of the data in this Fact Sheet has been estimated from a number of published sources, including comprehensive data from specific regions together with consumption modelling studies. The data should not be treated as precise global figures, but as useful indicators that describe the key HFC markets.

2. The HFC Chemicals

HFCs form a large family of fluorocarbon chemicals. Each one consists of different combinations of hydrogen, fluorine and carbon. There are 19 different HFCs, with GWPs¹ ranging from under 100 to nearly 15 000. Only a few HFCs dominate the market:

- Figure 1 shows that in terms of metric tonnes of global consumption, five HFCs represent over 90% of the total. These are HFC-134a, HFC-125, HFC-143a, HFC-32 and HFC-152a.
- Three of these HFCs the most dominant part of total consumption when the data is expressed in terms of tonnes CO₂ equivalent². Figure 2 shows that HFC-134a, HFC-125 and HFC-143a represent around 90% of GWP weighted total. HFC-32 and HFC-152a become a smaller proportion of total GWP-weighted consumption as they both have much lower GWPs than the three more dominant HFCs.
- Most of "other HFCs" in Figures 1 and 2 is the consumption of three further HFCs. These are HFC-245fa, HFC-365mfc and HFC-227ea.

¹ All global warming potential (GWP) values are based on the IPCC 4th Assessment Report

² Tonnes CO₂ equivalent are calculated by multiplying the metric tonnes of each HFC by its GWP

Figure 1 Split of global HFC consumption, metric tonnes 2012

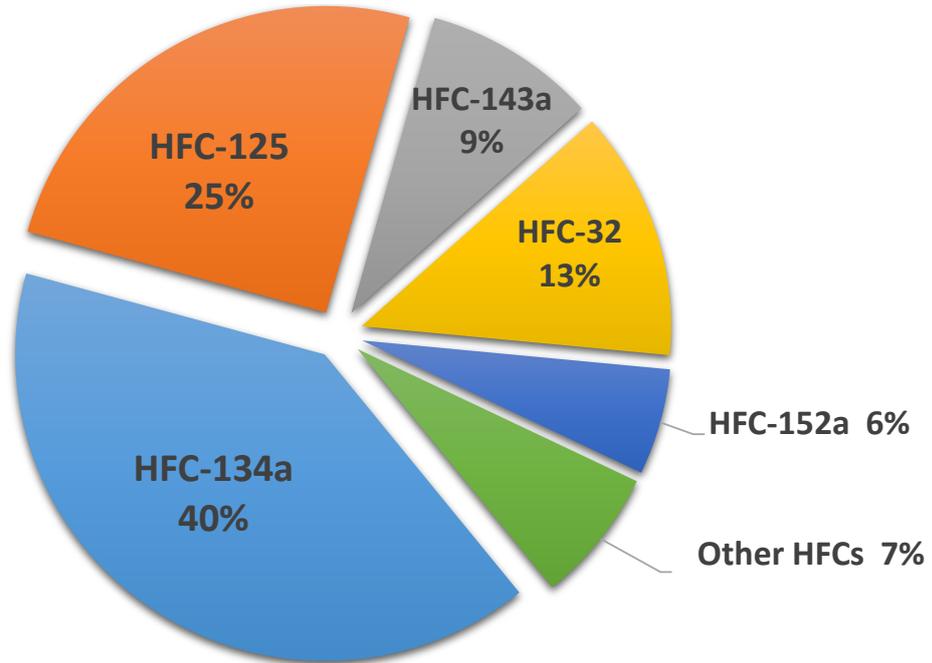
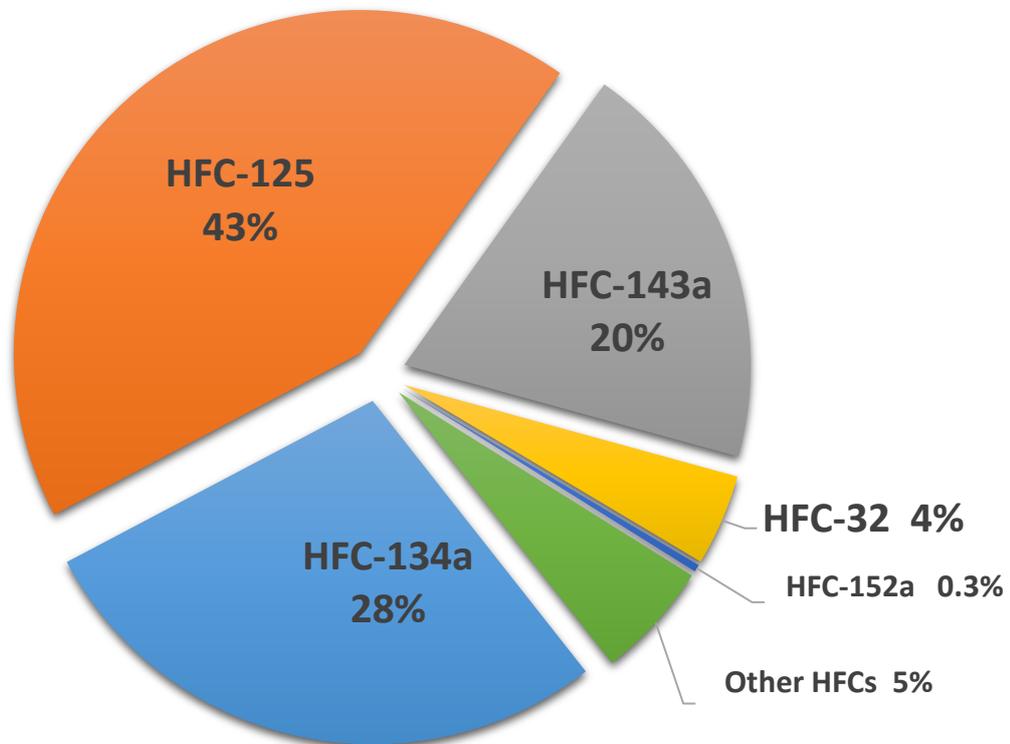


Figure 2 Split of global HFC consumption, tonnes CO₂ 2012



3. HFC Blends

Of the dominant HFCs shown in Figures 1 and 2, only HFC-134a is used in significant quantities as a pure fluid. HFC-125, HFC-143a and HFC-32 are used as components of blends used mainly in the refrigeration and air-conditioning sector. HFC-152a is used in blends for aerosols and for foams. There are numerous refrigerant blends available – and the number is growing rapidly as new blends are rapidly being introduced in response to regional controls on the use of high GWP HFCs.

There are already over 60 different blends listed in the ASHRAE refrigerant numbering system. As with the pure HFCs, the use of HFC blends is dominated by a small number of blends. The three dominant HFC blends (over 90% of the GWP-weighted consumption of all blends) used in 2012 were:

- R-404A
- R-410A
- R-407C

4. HFC Markets

There are 5 main market sectors that use HFCs:

- a) RACHP (refrigeration, air-conditioning and heat pumps)
- b) Foam insulation
- c) Aerosols
- d) Fire protection systems
- e) Solvents

The split of usage in these markets is shown in terms of metric tonnes in Figure 3 and in terms of GWP-weighted tonnes CO₂ equivalent in Figure 4.

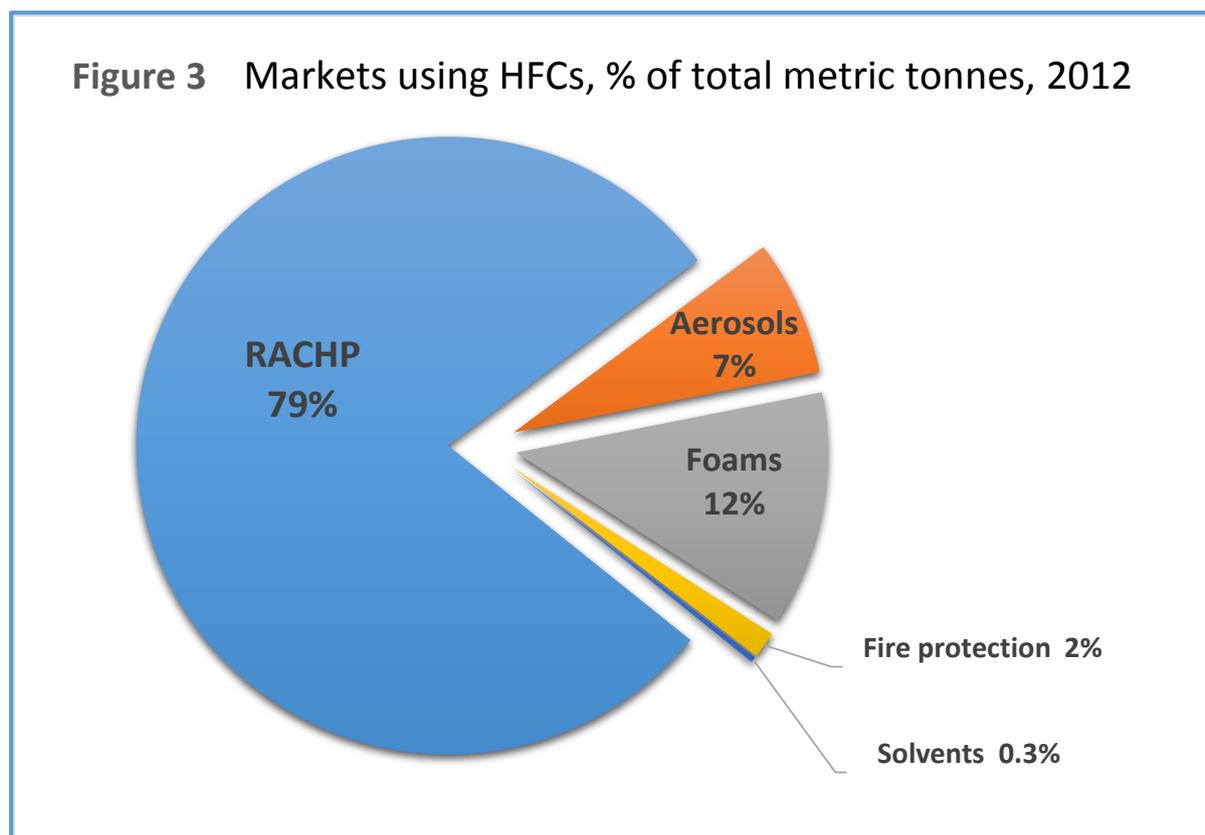
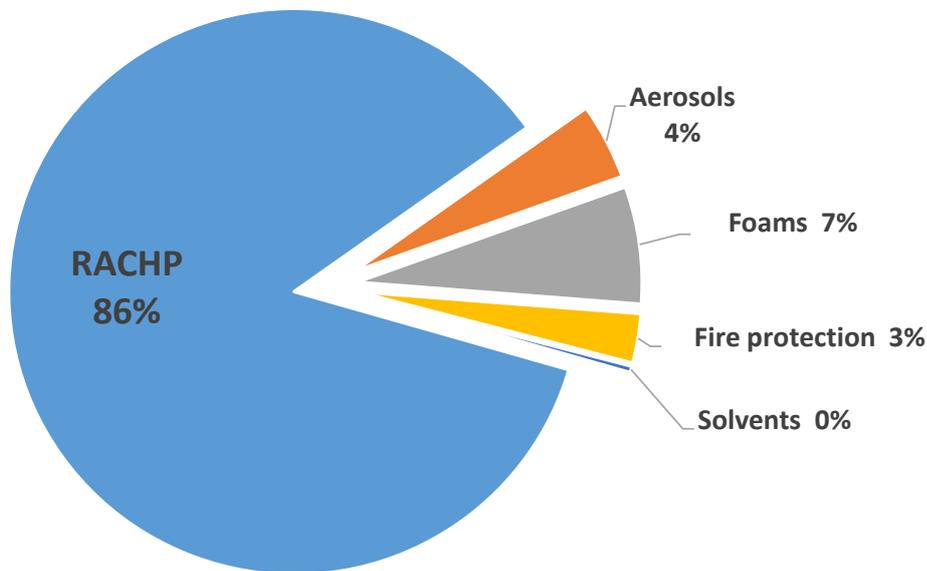


Figure 4 Markets using HFCs, % of tonnes CO₂ 2012



Comments on HFC Markets

Refrigeration, air-conditioning and heat pumps (RACHP) is the dominant market. RACHP represents 79% of the metric tonnes consumption of HFCs. This rises to 86% of HFC use in terms of GWP-weighted tonnes CO₂ equivalent. This increase is because RACHP applications require HFCs with a higher average GWP than the other major markets. The average GWP of HFC refrigerants currently used is estimated to be around 2200.

Aerosols and foams together use nearly 20% of the metric tonnes of HFCs, but the HFCs used have on average a lower GWP than those used in RACHP, so they only use 11% of the GWP-weighted tonnes CO₂ equivalent. The average GWP of HFCs currently used as foam blowing agents and aerosol propellants is around 1000.

The markets for HFCs in fire protection and solvent cleaning are both very small compared to RACHP, aerosol and foams. Fire protection systems use high GWP HFCs, but the volumes used are very small.

HFC-134a is used in all three of the dominant markets (RACHP, aerosols and foams).

Most of the other HFC refrigerants used in the RACHP sector in 2012 were blends.

HFC-227ea is used in small quantities in aerosols, foams and fire protection

Table 1:
Key HFCs used in main market sectors

Market	Key HFCs	GWP
RACHP	R-404A	3922
	R-410A	2088
	R-407C	1774
	HFC-134a	1430
Aerosols	HFC-134a	1430
	HFC-152a	124
	HFC-227ea	3220
Foams	HFC-134a	1430
	HFC-245fa	1030
	HFC-365mfc / HFC-227ea	960 - 1100
	HFC-227ea	3220
Fire protection	HFC-125	3500
	HFC-23	14800
	HFC-4310mee	1640
Solvents	HFC-4310mee	1640

5. RACHP in more detail

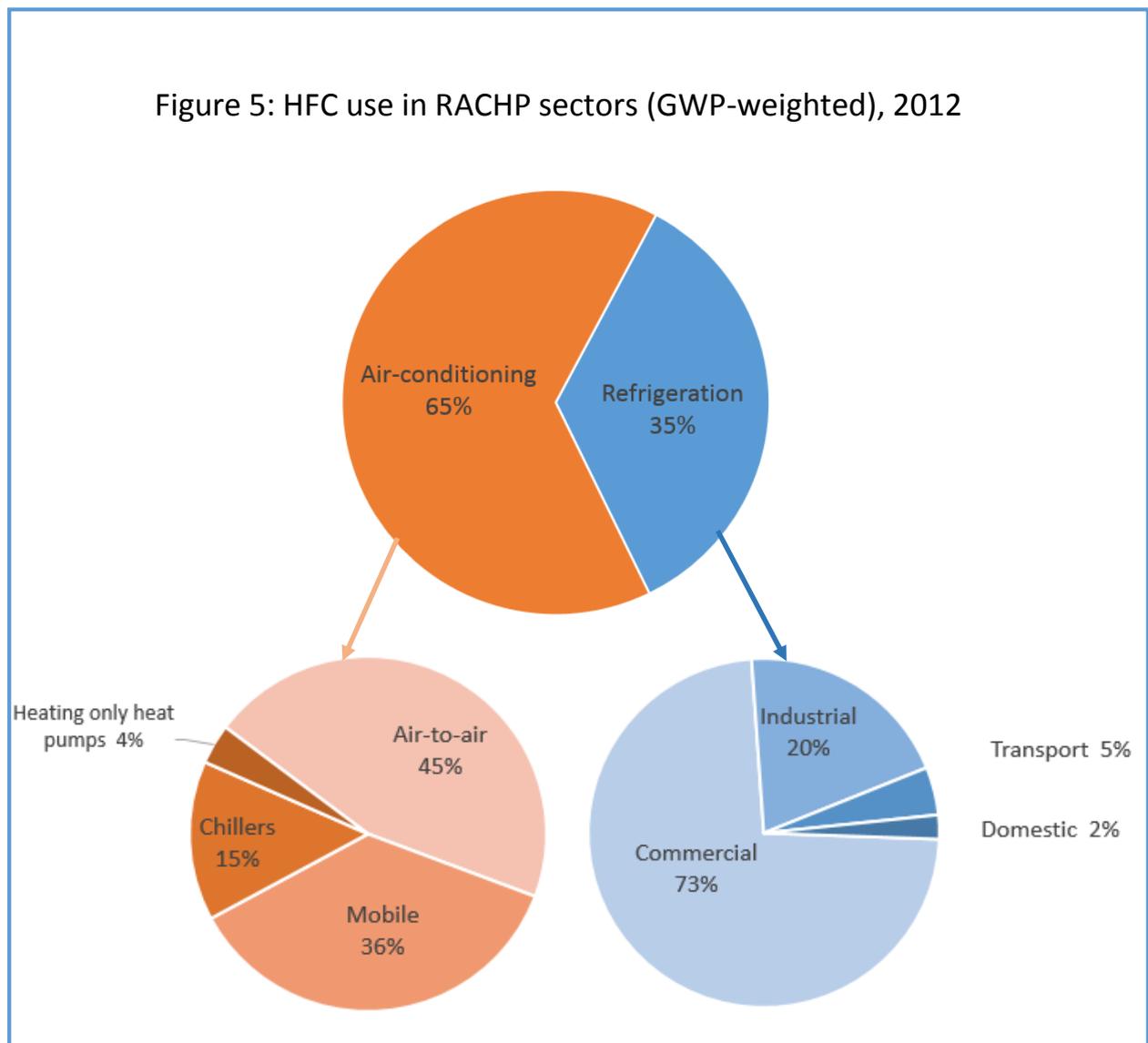
As the RACHP sector represents such a large percentage of HFC use, it is important to understand the way HFC consumption is split between different sub-sectors. It is estimated that 65% of the global GWP-weighted HFC consumption in the whole RACHP market is for air-conditioning and that 35% is for refrigeration.

The RACHP market can be sub-divided into four refrigeration sub-sectors and four air-conditioning / heat pump sub-sectors, as illustrated in Figure 5.

Air-to-air air-conditioning systems and mobile air-conditioning systems dominate the use of HFCs in air-conditioning, representing around 80% of the total. The air-to-air sector includes a significant proportion of reversible units that operate as air-conditioners and air-source heat pumps.

Commercial and industrial refrigeration systems dominate the use of HFCs in refrigeration, representing over 90% of the total.

Figure 5: HFC use in RACHP sectors (GWP-weighted), 2012

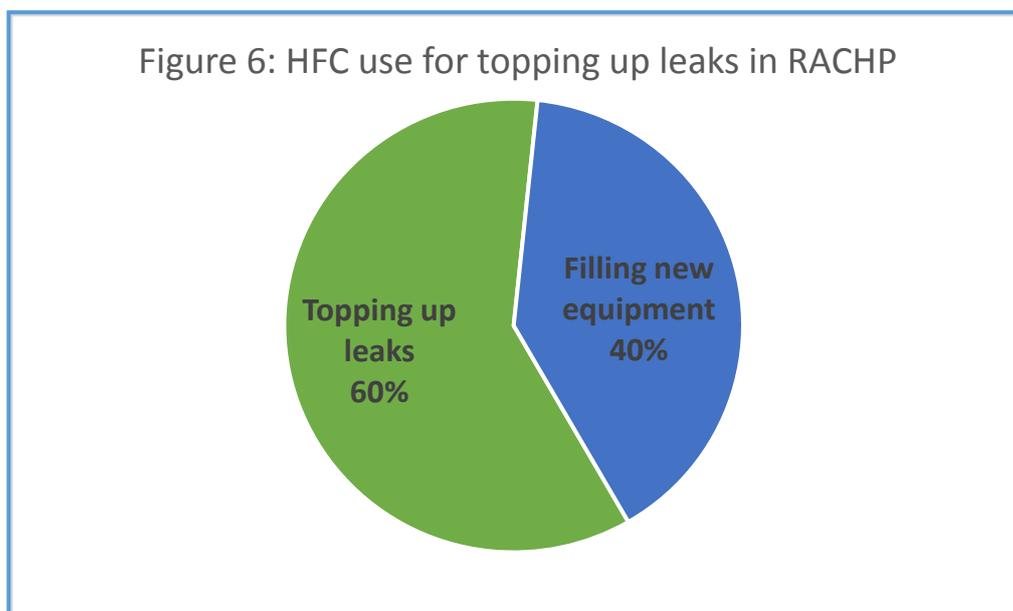


HFC use in new RACHP equipment and for maintenance

Figure 6 illustrates an estimated split between the use of HFCs for filling new equipment and for maintenance. Many RACHP systems have relatively high rates of leakage; more than half of total HFC consumption is for topping up refrigerant lost through gradual leakage or more major total loss incidents (e.g. a car air-conditioning system involved in an accident).

The level of leakage varies considerably between different parts of the RACHP market. Three sectors with historically high levels of leakage are large commercial refrigeration, industrial refrigeration and mobile air-conditioning. Small hermetically sealed equipment (such as domestic refrigerators) have very low leakage levels. Properly installed split air-conditioning systems have much lower levels of leakage than commercial refrigeration systems.

These high leakage figures illustrate the importance of trying to reduce leakage as part of an HFC consumption reduction initiative.



6. Other markets in more detail

Aerosols

The use of HFCs as aerosol propellants can be sub-divided into 2 main sectors:

- **Medical aerosols** (metered dose inhalers, MDIs) used for administering respiratory drugs represent about 65% to 75% of total aerosol consumption of HFCs. Most MDIs use HFC-134a. Around 5% use HFC-227ea.
- **Technical aerosols and novelty aerosols** represent about 25% to 35% of total aerosol consumption of HFCs, mostly using HFC-134a plus some HFC-152a.

Foam Insulation

The use of HFCs foam blowing agents can be sub-divided into 2 main sectors:

- **Extruded polystyrene foam** represent about 40% to 50% of total foam consumption of HFCs.
- **PU-type foams** (including polyurethane, polyisocyanurate and phenolic foams) represent about 50% to 60% of total foam consumption of HFCs. The largest users of HFCs for PU-type foam are appliances, discontinuous boards / panels and spray foam, representing around 75% of the total.

7. Opportunities to reduce HFC consumption

The opportunities to reduce current levels of HFC consumption fall into 4 main groups:

- 1) **Use of lower GWP alternatives in new equipment.** As existing equipment reaches end-of-life and is replaced, there is an opportunity to use a suitable alternative with a lower GWP. In some cases, there are good technical options to use a very low GWP alternative (e.g. with a GWP below 10, such as R-744, HC-290 or HFO-1234ze). This will reduce the GWP-weighted consumption by nearly 100%. In some market sub-sectors it may be necessary to use an HFC-based alternative with a moderate GWP on the grounds of cost or safety. There are a number of lower GWP alternatives in the GWP range of 200 to 700, which will provide a reduction in GWP-weighted consumption of 60% to 90%.
- 2) **Use of lower GWP alternatives in existing equipment where appropriate.** While it is not appropriate to retrofit many types of HFC-containing equipment including hermetically sealed systems, many types of equipment with large charge sizes, such as centralised rack commercial refrigeration systems, can be safely retrofitted. Many of these HFC refrigeration systems use R-404A, a refrigerant with a GWP of 3922. It has been demonstrated that it is cost effective to replace R-404A in many systems. Existing equipment can be retrofitted with a refrigerant with properties similar to R-404A but with a GWP in the range 1400 to 2100 – a reduction of GWP-weighted consumption of 50% to 70%. In many cases the converted refrigeration system has a better efficiency than the old R-404A system, thus saving money on electricity and also reducing energy related CO₂ emissions. This is an important option to deliver quick reductions in HFC consumption.
- 3) **Leak prevention.** In the RACHP sector, use of HFCs to top-up leaks is estimated to represent 55% to 65% of total HFC consumption. There are excellent opportunities to reduce leakage. This is another strategy that can deliver quick HFC consumption reductions.
- 4) **Use of reclaimed HFCs.** As old equipment containing HFCs reach end-of-life it is important to recover the old HFCs. This reduces end-of-life emissions and creates an opportunity to reclaim the recovered refrigerant for re-use. Allowing use of reclaimed refrigerant outside of a “phase-down quota system” can be an important strategy to encourage end-of-life recovery.

8. Technical development of low GWP alternatives

There has been rapid development of low GWP alternatives to the currently used HFCs. This has been driven mainly by the introduction of regulations to reduce HFC usage in some regions. In Fact Sheets 3 to 14 numerous low GWP alternatives are described and discussed. As recently as five years ago many of these alternatives were not available.

The alternatives fall into two groups:

- Existing alternatives (hydrocarbons, R-744 (CO₂), R-717 (ammonia) and HFC-32) for which new technologies have been developed to improve efficiency, address safety issues or reduce costs. It should be noted that these new developments may not necessarily be applicable to all applications or to all climatic conditions. There has been much innovation in recent years and the number of installed applications using these alternatives has risen exponentially. A good example is the use of R-744 for supermarket refrigeration – the systems currently available are more efficient and more cost-effective than those available 5 years ago.
- Introduction of new chemicals that were previously not commercially available. This applies to new HFO fluids (also known as unsaturated HFCs) and to blends of HFOs with HFCs. The first of these fluids was introduced around 5 years ago. There are now several pure fluids and numerous blends on the market or under development.

It is expected that the technical development of these and other low GWP alternatives will continue during the next 5 to 10 years.