REFRIGERANT RECLAIM AUSTRALIA

FUGITIVE EMISSIONS
THE CASE FOR IMPROVING REFRIGERANT RECOVERY FROM SPLIT SYSTEMS AT END-OF-LIFE

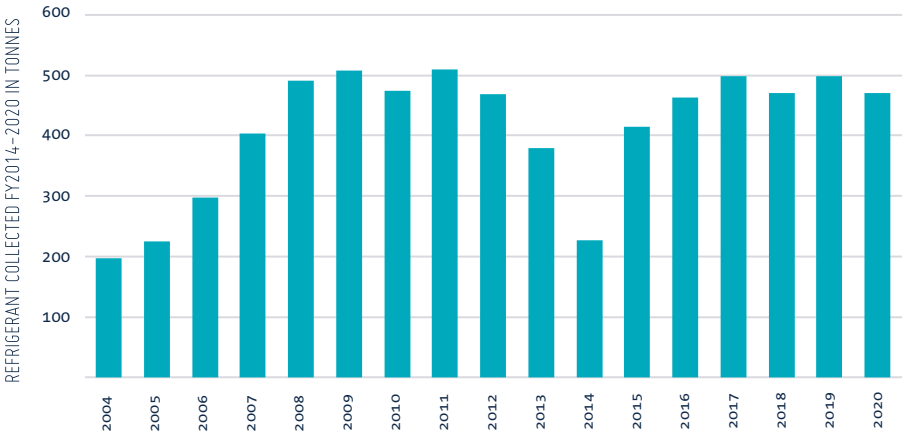
Initially created by industry in 1993, the Refrigerant Reclaim Australia (RRA) recovery program has grown from a humble voluntary initiative collecting 30-50 tonnes of contaminated and unwanted refrigerant each year to become a globally recognised leader[1,2,3] taking back and destroying in the order of 500 tonnes per annum. Having collected awards from the US EPA and the Montreal Protocol in earlier years the efficacy of the RRA program model has most recently been recommended by the Environmental Investigation Agency[4].

The environmental benefits of the program are clear. Over 8,000 tonnes of contaminated and unwanted refrigerant have been collected and destroyed preventing the destruction of more than 10 million tonnes of stratospheric ozone and preventing the emission of more than 14 million tonnes of carbon dioxide equivalent[5].

Yet, despite the success of the program RRA is cognisant that not all refrigerant potentially available for recovery and return is being presented for collection. Figure 1 displays refrigerant collected since the program become mandatory in 2004. The total annual volume collected has hovered around 500 tonnes on several occasions, to the extent that level may be an effective program limit.

1. US EPA Ozone Protection Award
2. Montreal Protocol Implementers Award
3. ICF International: Collection and Treatment of Unwanted Ozone Depleting Substances
4. Environmental Investigation Agency: Search Reuse and Destroy
5. Refrigerant Reclaim Australia Annual Report FY20

FIGURE 1: ANNUAL REFRIGERANT COLLECTIONS 2004–2020[5]



To enhance the program, boost returns, and provide greater environmental benefit more unwanted refrigerant needs to be collected. But where to look?

Not far, as it happens. The following two tables are extracted from Cold Hard Facts 2020[6], a report prepared by the Expert Group for the Department of Agriculture, Water and the Environment (DAWE).

FIGURE 2: MAIN REFRIGERATION AND AIR CONDITIONING METRICS 2019[6]

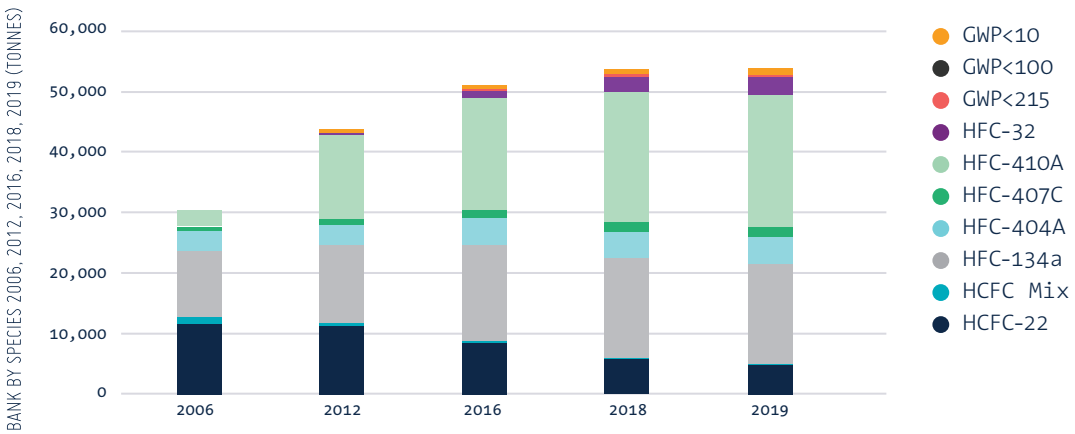
TABLE 1: MAIN REFRIGERATION AND AIR CONDITIONING METRICS FOR 2019.

METRIC	UNITS	AC	MAC	RCFC	DR
SHARE OF REFRIGERANT BANK	PERCENT	63%	21%	13%	3%
SIZE OF REFRIGERANT BANK	TONNES	33,200	11,000[4]	7,100	1,700[7]
ANNUAL USAGE OF HFCS TO REPLACE LEAKS (EXCL. OEM AND CHARGING NEW EQUIPMENT)	TONNES	715	735	906	4
REFRIGERNAT IN PRE-CHARGED EQUIPMENT IMPORTS [1]	TONNES	2,328	585	46	14
ESTIMATED STOCK OF EQUIPMENT	MILLION UNITS	>16.1	>19.3	1.8	20.0[7]

6 & 7. Cold Hard Facts 2020

It is immediately apparent that the Australian installed bank is dominated by refrigerant in stationary air conditioning equipment. Refrigerants contained in air conditioning units, R410A, R32, R407C, and R22 make up more than 60% of the installed bank. The past fifteen years has seen R410A replace R22 in the marketplace and now R32 is making rapid inroads. A deeper dive into the data revels that split systems account for more than 80% of total installed equipment.

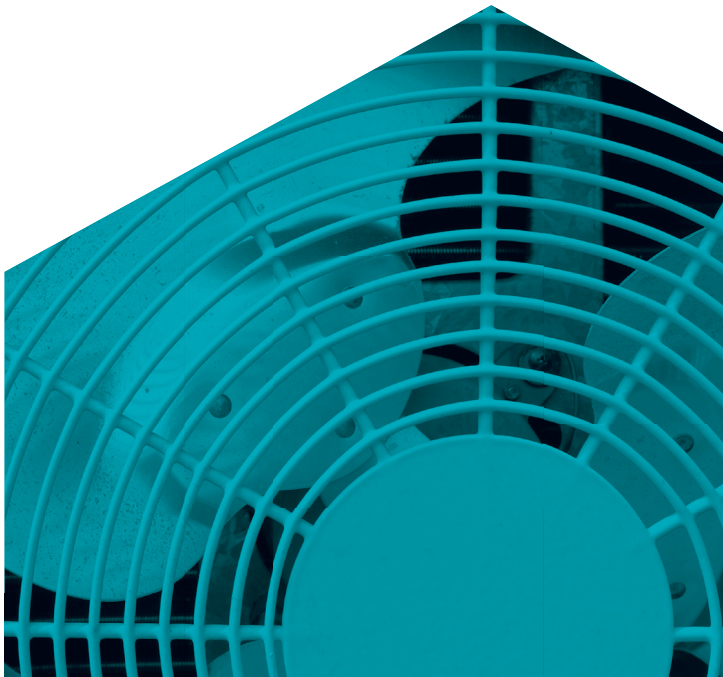
FIGURE 3: AUSTRALIAN REFRIGERANT BANK BY SPECIES[7]



RRA looked more closely at the domestic and light commercial air conditioning market yet, despite its size, factual data regarding charge sizes, leakage rates, and operational longevity were elusive, not just in Australia but globally. After considering options a local research project was initiated.

Following considerable debate on how best to collect data an easy-to-use App was created for Apple and Android devices. Contractors replacing existing systems were recruited to download the App and input data during the deinstallation process. The following information was sought:

- Year of manufacture/installation
- Type of refrigerant
- Initial refrigerant charge quantity
- Year of deinstallation
- Recovered refrigerant charge quantity

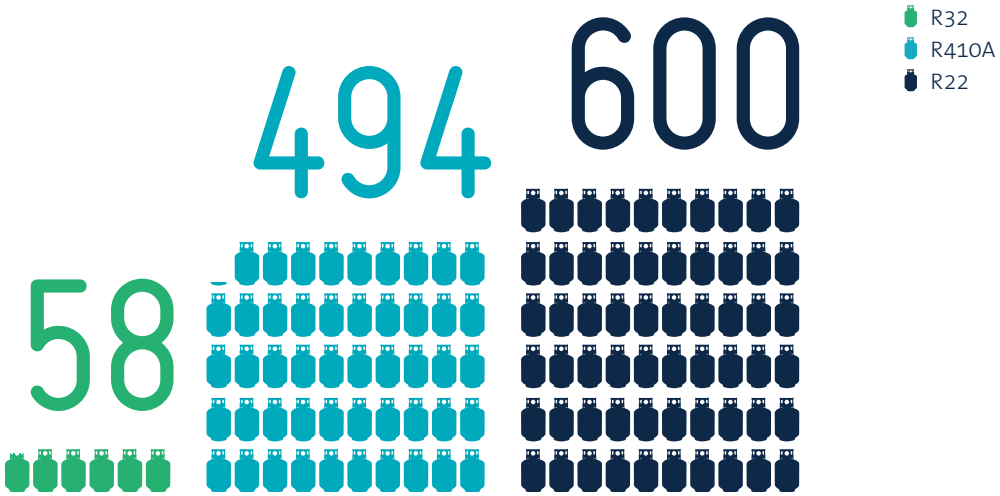


6 & 7. Cold Hard Facts 2020

More than 100 contractors contributed data via the App and, after filtering for missing data and misentries a total of 1,152 datasets were analysed.

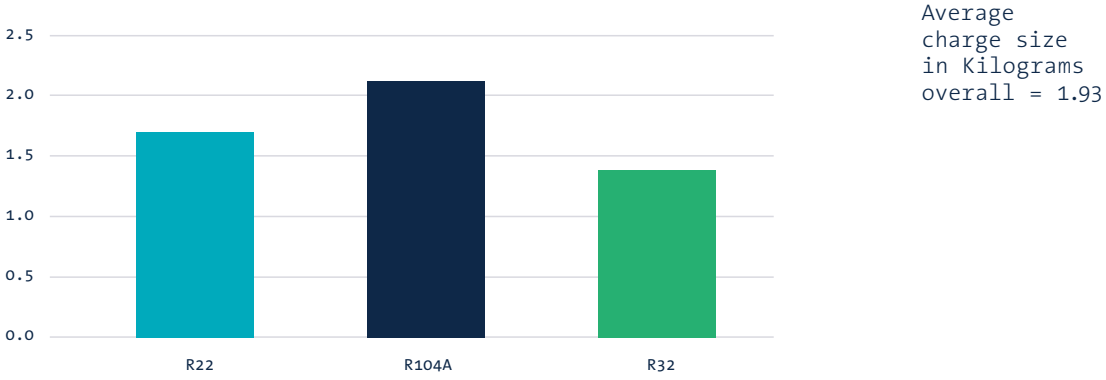
Of the 1,152 systems for which complete data was received 600 contained R22 (52%), 494 contained R410A (43%), and 58 contained R32 (5%). This result fits with the transition from R22 to R410A in the early to mid 2000's. The surprising number of R32 units replaced during the data collection period is the result of a catastrophic hailstorm that caused extensive damage to relatively newly installed systems at a particular location in Canberra.

FIGURE 4: REFRIGERANT IN REPORTED SYSTEMS



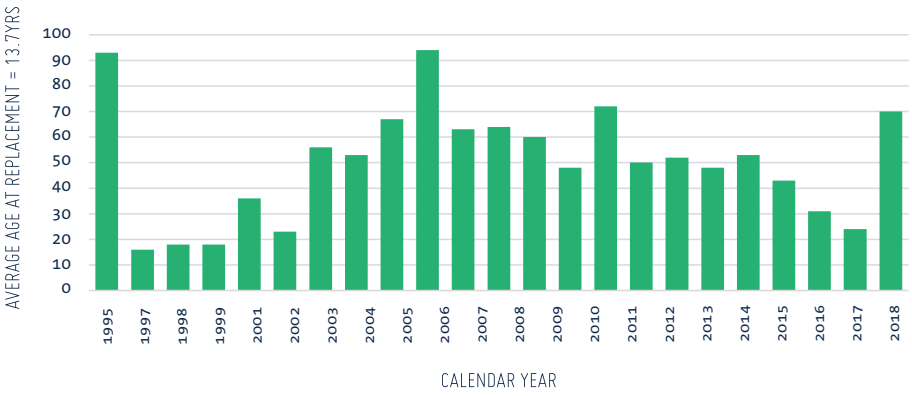
The average initial charge sizes are displayed in Figure 5. This is critical data for determining the potential quantity of refrigerant available for recovery at end-of-life.

FIGURE 5: AVERAGE CHARGE SIZES



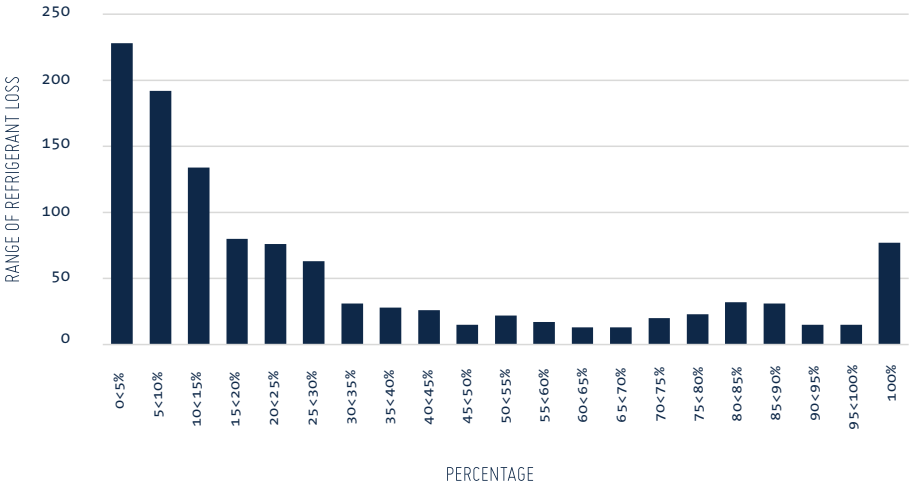
The data on year of manufacture/installation displays a reasonable disbursement except for the extremities. The earliest manufacture/installation year listed in the App was 1995 and there were a significant number of systems with install years prior to then. There is also a substantial number of relatively new systems replaced which were predominately the victims of the Canberra hailstorm. The overall average operating life is 13.7 years.

FIGURE 6: YEAR OF MANUFACTURE/INSTALLATION AND AVERAGE OPERATING LIFE



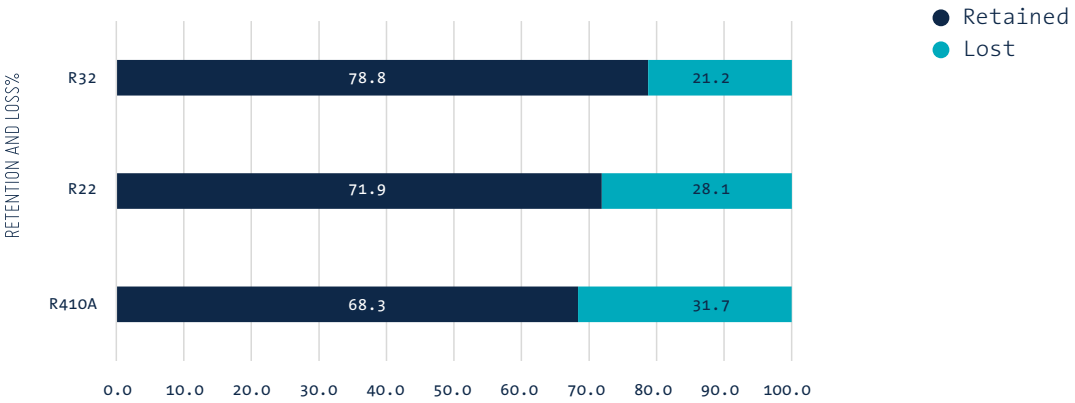
Refrigerant loss during the operating life of reported systems ranged from zero to 100%. Slightly more than 50% of systems exhibited refrigerant charge losses of 20% or less.

FIGURE 7: RANGE OF REFRIGERANT LOSS



Breaking down loss and retention to the refrigerant level provides an unexpected result: the loss rate for R22 systems appears to be less than that for R410A systems. The transition to R410A was not simply done by replacing the refrigerant in existing systems but involved a complete redesign of the equipment and components due the higher operating pressures of the new refrigerant. The redesign process resulted in more efficient systems, lesser charge sizes, and lower leakage rates.

FIGURE 8: RETENTION AND LOSS BY REFRIGERANT



Reviewers have suggested this seemingly contradictory result may be due to servicing of the R22 units. Some of the R22 systems will have been operating for more than twenty-five years and to have lasted so long will likely have been properly maintained with lost refrigerant replaced. However, information on maintenance is beyond the scope of this survey. The R32 sample size is small and influenced by climatic events but remains included as a reference for future analysis.

The overall average loss during the operating life of the air conditioning equipment is 30% leaving 70% of the average charge of 1.93 kilograms remaining in the system; 1.35 kilograms.

The key data points are:

- Average charge size: 1.93 kilograms
- Average retained charge at EOL:1.35 kilograms
- Average operating life: 13.7 years
- Average loss through operating life: 30%
- Average annual leakage rate: 2.2%

Having determined this information, it becomes possible to calculate the quantity of refrigerant available annually from end-of-life split air conditioning systems. Figure 9 displays imports of selected pre-charged equipment for the years 2005-2011.

Split systems imported in 2005 will, on average, retire in 2019, etc, leading to the following calculation:

- Number of systems: 700,233
- Installed charge 1.93kg: 700,233 x 1.93 = 1,351,450
- EOL charge 1.35kg: 700,233 x 1.35 = 945,314

FIGURE 9: IMPORTS OF PRE-CHARGED EQUIPMENT[8]

TABLE 17: STATIONARY AIR-CONDITIONING PRE-CHARGED EQUIPMENT IMPORTS IN AUSTRALIA 2005 TO 2011

PCE TYPE	2005	2006	2007	2008	2009	2010	2011
CHILLERS	1,291	504	804	1,169	722	1,476	1,096
PACKAGED	21,042	16,900	19,785	18,631	16,217	20,485	19,907
PACKAGED WINDOW/WALL	147,987	176,850	107,257	124,414	131,352	132,159	72,639
PORTABLE REFRIGERATED	25,188	77,940	87,009	117,344	137,611	129,781	48,810
SPLIT SYSTEM MULTI HEAD/VRF	30,625	37,312	43,093	49,900	35,128	30,955	29,655
SPLIT SYSTEM SINGLE HEAD	700,233	801,460	88,.572	77,184	741,118	968,107	797,043
TOTAL AC	926,366	1,110,966	1,144,520	1,090,642	1,062,148	1,282,963	969,150

The quantity available for recovery is 945.3 tonnes which is considerably more than is currently being collected. The available volume of only HFC refrigerant from end-of-life split air conditioning systems already exceeds annual recovered refrigerant collections. When potential recovery from the mobile air conditioning and refrigeration sectors is included, the current annual recovery of approximately 500 tonnes, while laudable, falls short of ideal.

However, the amount being reused is unknown. The question of reuse is both critical and problematic. There is no data on the level of reuse by contractors in the marketplace although it is understood that demand for R22 remains strong. It is known that substantial quantities of R22 entering the recovered refrigerant stream are reclaimed to new specification by wholesalers then sold back into the market. Given the demand it is reasonable to expect that a substantial amount of recovered R22 is being reused and is thereby not available for collection/return.

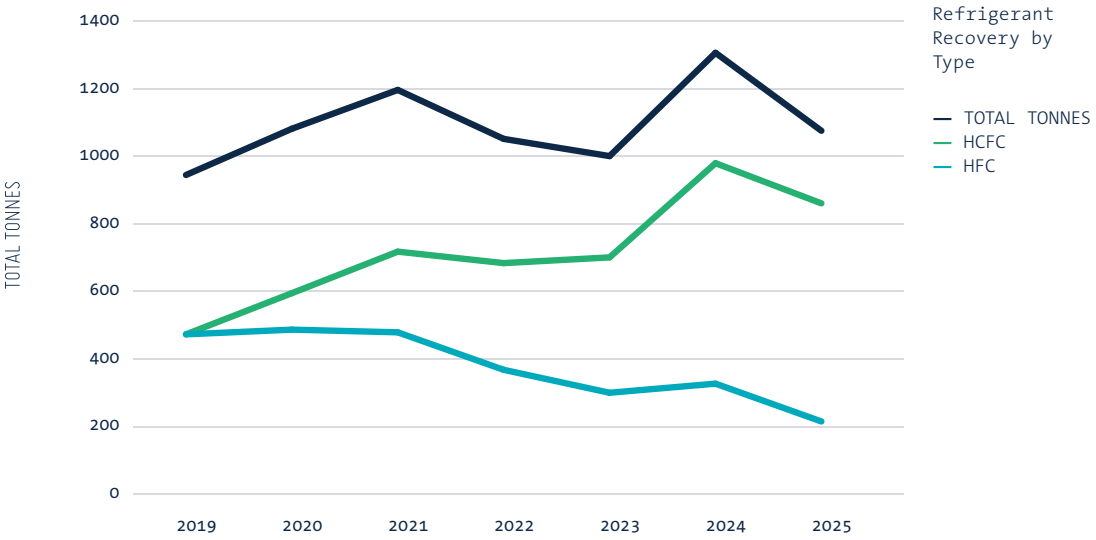
Over time, the percentage of retiring systems containing R22 will diminish with commensurate growth for the HFCs; R410A and R32. Just as R410A has overtaken R22, so will R32 take over from R410A with the potential to make redundant the large bank of that refrigerant.

Figure 3 displays the make-up of the bank that is almost half R410A. R410A based systems have been superseded by R32 systems and as installed units based on the formerly dominant technology reach end-of-life the recovered refrigerant is likely to be redundant. There will be some service requirements for remaining systems but R410A cannot be used in other equipment. Without improved rates of recovery, most of that refrigerant will be emitted; with a global warming potential of 2088 more than a million tonnes of CO_2e could be needlessly emitted annually.

8. Cold Hard Facts 2

Projecting forward potential recovery from in the near term is as follows, in tonnes:

FIGURE 10: PROJECTED RECOVERY BY SPECIES FROM SINGLE SPLIT AC SYSTEMS



The RRA recovery program appears to be a settled system with an upper limit in the order of 500 tonnes. The regulatory environment within which the program operates provides insufficient incentive for higher levels of compliance with required recovery operations in the split air conditioning sector, at least. To its credit, RRA is currently trialling increased financial incentives for the recovery and return of unwanted refrigerant, but early results are mixed and the solutions to substantially growing recovery are more complex and wide-ranging than simply increasing rebates.

RRA believes it is possible to increase collections to abate a further one million tonnes of CO_2e each year. In the coming months, RRA will consult directly with contractors and technicians to better understand the impediments to improving rates of recovery. RRA will then work with industry through associations such as the Refrigeration and Air Conditioning Contractors Association, the Vehicle Air-conditioning Specialists of Australasia, and the Air-conditioning and Refrigeration Manufacturers Association, along with licensing authority the Australian Refrigeration Council and the Department of Environment, to develop initiatives that will support and further assist the industry and lead to the collection of increased quantities of unwanted refrigerant from end-of-life equipment.