Environmental Impacts of Refrigerant Gas in End of Life Vehicles in Australia



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Glossary

Bulk importers	Companies with a licence to import bulk refrigerant take delivery of ship borne ISO containers each carrying between 10 and 18 tonnes of gas (depending on the type). These refrigerants are typically pumped into large vertical or horizontal storage tanks at the importer's yards. The larger tanks will generally be capable of holding between 20 and 70 tonnes of gas, depending on the volumetric capacity and pressures of the refrigerant. Importers decant gas into tradeable quantities depending on purpose and market.
Chlorofluorocarbons (CFCs)	Molecules containing carbon, fluorine, and chlorine. CFCs are the major ozone depleting substance phased out by the Montreal Protocol on Substances that Deplete the Ozone Layer. Many CFCs are potent greenhouse gases.
Coefficient of performance (COP)	The ratio of the heat extraction rate divided by the power consumed by the refrigeration compressor(s) and necessary ancillaries. The COP is dimensionless and is used to express the system efficiency.
Compressor	A device in the air conditioning or refrigeration circuit which compresses refrigerant vapour, and circulates that refrigerant through to its phases of condensation and evaporation, in order to produce the refrigeration effect. The compressor is available in many forms such as piston, scroll, or screw.
CO ₂ refrigerant	A widely used industrial refrigerant with high thermodynamic properties is suitable for process refrigeration applications, and automotive air conditioning use. In the past its high operating pressures have limited its use in small to medium commercial refrigeration applications. Technical innovation such as micro cascade systems and commercial availability of components such as compressors and other in line accessories is assisting its transition into smaller scale applications.
CO ₂ e	Carbon dioxide equivalent is a measure that quantifies different greenhouse gases in terms of the amount of carbon dioxide that would deliver the same global warming.
Cumulative distribution function	Cumulative distribution function of the normal distribution with mean (μ) and standard deviation (σ) evaluated at a point in time (year x).
Direct emissions	Global warming effect arising from emissions of refrigerant, or any other 'greenhouse gas', from the equipment over its lifetime.
End-of-life equipment	Domestic, commercial or industrial device reaching the end of its useful lifespan.
End- of-life (EOL) emissions	End- of-life (EOL) emissions are direct emissions from ozone depleting substance (ODS) and synthetic greenhouse gases (SGG) refrigerants not recovered for destruction or reclamation.
End-of-life vehicles (Assignment definition)	Passenger and light commercial vehicles with a gross vehicle mass less than 3.5 tonnes that have been de-registered according to the State and Territory motor vehicle registration authorities (i.e. assumes a one month period of grace with renewals).
End-of-life vehicles (EC Directives definition)	The ELV-Directive (2000/53/EC) applies to vehicles and end-of-life vehicles, and the 'end-of life vehicle' means a vehicle as defined by nominated categories of vehicles types listed in the Directive. An End-of-life vehicle is considered waste and is defined in the Waste Framework Directive (2008/98/EC). The Waste Directive provides guidance on the distinction between waste vehicles and used vehicles. A used vehicles should be classed as waste if at least one of the following criteria applies:
	a. The vehicle is destined for dismantling and reuse of spare parts or for shredding/scrapping;
	b. The vehicle is cut into pieces (e.g. two halves), welded up or closed by an insulating foam (only by breaking open the waste vehicle can be made roadworthy) and/or used as "container" for spare parts or wastes;
	c. The vehicle stems from a waste collection or waste treatment system;
	d. The vehicle is a write-off /is not suitable for minor repair /has badly damaged essential parts (as a result of an accident, for example) or has no "Vehicle is repairable" certification where a competent authority has requested it;
	e. The existence of a certificate of destruction.
Equivalent Carbon Price (ECP)	Under the Australian Government's Clean Energy Future Plan, synthetic greenhouse gases listed under the Kyoto Protocol had an equivalent carbon price applied through the Ozone Protection and Synthetic Greenhouse Gas Management legislation from July 2012 through to June 2014. Gases covered included hydrofluorocarbons, perfluorocarbons (excluding gases produced from

aluminium smelting) and sulphur hexafluoride, whether in bulk form or contained in equipment.

Equivalent refrigerant The equivalent charge size relates to the amount of high GWP HFC that is used or will be displaced by an alternative refrigerant, not the actual charge of the lower GWP refrigerant which can be up to 30 per cent less. This also represents a worst case scenario in GWP terms. Refer refrigerant charge in glossary.

Gas A general term used throughout this report, referring to ozone depleting substances, synthetic greenhouse gases and natural refrigerants. The term can refer to refrigerants when the substance is used as a working fluid in equipment or used in other applications.

- Gas Species A gas species is defined as a refrigerant category based on its chemical family. For example CFCs, HCFCs and HFCs are all synthetic gases and are defined as different gas species. Similarly Hydrocarbon refrigerant is another gas species, and HC-600a, HC-290 and HC-436 (a blend of HC-600a and HC-290) refrigerants are all part of this family. Other gas species include anhydrous ammonia and Carbon Dioxide.
- Global Warming Potential A relative index that enables comparison of the climate effect of various greenhouse gases (and other climate changing agents). Carbon dioxide, the greenhouse gas that causes the greatest radiative forcing because of its abundance is used as the reference gas. GWP is also defined as an index based on the radiative forcing of a pulsed injection of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere, integrated over a chosen time horizon, relative to the radiative forcing of carbon dioxide over the same time horizon. The GWPs represent the combined effect of the differing atmospheric lifetimes (i.e. how long these gases remain in the atmosphere) and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.
- Greenhouse Gases (GHG) The Kyoto Protocol covers emissions of the six main greenhouse gases, namely Carbon dioxide (CO₂); Methane (CH₄); Nitrous oxide (N₂O); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulphur hexafluoride (SF₆). The scope of this study covers the equivalent in carbon dioxide due to indirect emissions from electricity generation, and direct emissions from HFCs.
- Hydrocarbons (HCs) The term hydrocarbon refers to the main types and blends in use in Australia including HC-600a, HC-290 and HC-436 (a blend of HC-600a and HC-290). HC-600a is the preferred hydrocarbon refrigerant in domestic refrigeration applications as it is suited to both refrigerator and freezer applications. HC-290 is the preferred hydrocarbon option for non-domestic stationary applications as its performance characteristics are more suited to medium temperature applications (i.e. greater than zero degrees Celsius). HC-436 is a hydrocarbon blend that is commonly used in mobile air conditioning retrofit applications.
- HydrochlorofluorocarbonsChemicals that contains hydrogen, fluorine, chlorine, and carbon. They deplete the ozone layer,
but have less potency compared to CFCs. Many HCFCs are potent greenhouse gases. HCFC-22 is the
most common refrigerant in the Australian refrigerant bank.
- Hydrofluorocarbons (HFCs) Chemicals that contain hydrogen, fluorine, and carbon. They do not deplete the ozone layer and have been used as substitutes for CFCs and HCFCs. Many HFCs are potent greenhouse gases.
- Hydrofluoro-olefins (HFOs), and HFO blends Chemicals known as hydrofluoro-olefins that contain hydrogen, fluorine, and carbon, and are described as unsaturated HFCs. They do not deplete the ozone layer and have very low GWP values. For example HFO-1234yf, with a GWP of 4 and HFO-1234ze with a GWP of 6. Refer Section 3.4 for further details.
- Kyoto ProtocolThe Kyoto Protocol sets binding emissions limits for the six greenhouse gases listed in the Protocol.
The Australian Government is committed to reducing emissions of the six main greenhouse gases,
which includes the synthetic greenhouse gases (SGGs) listed under the Kyoto Protocol, including
hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).
- Low GWP substances or refrigerants This term can and is used to refer to both the commonly referred 'natural' refrigerants, HFC substances with a GWP lower than those commonly used today and the near to commercial HFOs being scaled up by the major synthetic greenhouse gas manufacturers that are sometimes referred to as low GWP HFCs.
- Montreal Protocol The Montreal Protocol on Substances that Deplete the Ozone Layer sets binding progressive phase out obligations for developed and developing countries for all the major ozone depleting substances, including CFCs, halons and less damaging transitional chemicals such as HCFCs.
- Natural refrigerants Hydrocarbons (R600a, R290 and R436), ammonia (R717) and carbon dioxide (R744) are commonly referred to as natural refrigerants. The term 'natural' implies the origin of the fluids as they occur

	in nature as a result of geological and/or biological processes, unlike fluorinated substances that are synthesised chemicals. However it has to be noted that all 'natural' refrigerants are refined and compressed by bulk gas manufacturers via some process and transported like other commercial gases so also have an 'energy investment' in their creation, storage and transport.
Ozone depleting substances (ODS)	Chemicals that deplete the ozone layer (e.g. HCFCs) and controlled under the Montreal Protocol. The <u>Ozone Protection and Synthetic Greenhouse Gas Management Act 1989</u> controls the manufacture, import and export of ozone depleting substances in Australia.
Pre-charged equipment (PCE)	Pre-charged equipment is defined as air conditioning equipment or refrigeration equipment (including equipment fitted to a motor vehicle) that is imported containing a hydrofluorocarbon (HFC) or hydrochlorofluorocarbon (HCFC) refrigerant charge.
RAC	Refrigeration and air conditioning.
Recovery efficiency	Proportion of refrigerant charge that is recovered from a system when it is decommissioned at the end of its useful working life. The Recovery/recycling factor has a value from 0 to 1.
Refrigerant	Working fluid in the vapour compression refrigeration cycle.
Refrigerant bank	The 'bank' of refrigerant gases is the aggregate of all compounds and substances employed as working fluids in the estimated 44 million mechanical devices using the vapour compression cycle in Australia.
Refrigerant consumption	The Montreal Protocol definition of consumption is bulk imports plus manufacturing minus exports. Australian has not manufactured refrigerant since 1996. Bulk refrigerant is imported and consumed largely for servicing the existing refrigerant bank of equipment, as well as charging new equipment not imported as pre-charged equipment (PCE) and in other applications including foams, fire protection, aerosols, export and other.
Refrigerant decanting into tradable quantities	There are three significant import/decanting facilities in Australia. Gas is decanted at these sites into thousands of cylinders ranging in size through 10 kg, 18 kg, 60 kg and then larger transportable tanks. Transportable tanks with a volumetric capacity of approximately 900 litres are commonly referred to as 'one tonners', and 'half tonners' for tanks with a 450 litres capacity. These transportable tanks can contain between 400 kg and 700 kg of product depending on the gas involved.
Refrigerant charge	The original refrigerant charge of refrigerant used as the working fluid for heat transfer inside a piece of equipment. The actual refrigerant charge for passenger and light commercial vehicle air conditioners (in accordance with Australian vehicle imports for in the last 7 years) is typically: HFC-134a = 610 grams, CFC-12 = 700 grams and HC = 210 grams. Actual charge quantities by vehicle type can be found in technical guides (i.e. Adair Refrigerant Charge Quantities Guide), which shows a wide range and some newer models with HFC-134a charge sizes below 610 grams.
Refrigerant leak rate	The annual leak rate is defined as the sum of gradual leakage during normal operation, catastrophic losses amortised over the life of the equipment and losses during service and maintenance expressed as a percentage of the initial charge per annum.
Refrigerant recovery	Removal of refrigerant from a system and its storage into an external container. These containers can be cylinders that range in size through 10 kg, 18 kg, 60 kg and then larger transportable tanks. Transportable tanks with a volumetric capacity of approximately 900 litres are commonly referred to as 'one tonners', and 'half tonners' for tanks with a 450 litres capacity. These transportable tanks can contain between 400 kg and 700 kg of product depending on the gas involved.
Second Assessment Report (AR2)	Second Assessment Report of the United Nations Framework Convention on Climate Change, released in 1996. Australia's legally binding emission obligations under the Kyoto Protocol are calculated based on AR2 and therefore Australian legislation, including the <i>Ozone Protection and Synthetic Greenhouse Gas Management Act</i> , also cites GWPs from AR2.
Synthetic greenhouse gases (SGGs)	SGGs listed under the Kyoto Protocol and regulated under the <u>Ozone Protection and Synthetic</u> <u>Greenhouse Gas Management Act 1989</u> include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF ₆).
Synthetic substances or synthetic refrigerants	HCFCs, HFCs and HFOs are commonly referred to as synthetic substances or synthetic refrigerants.

Abbreviations

AC	Air conditioning
AR2	Second Assessment Report, similarly A4 is Forth Assessment Report
ABS	Australian Bureau of Statistics
ANZSCO	Australian and New Zealand Standard Classification of Occupations
CFCs	Chlorofluorocarbons
CO ₂ e	Carbon dioxide equivalent
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities, now Department of the Environment
DoE	Department of the Environment
ELV	End-of-life vehicle
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
kt	Kilo tonnes, or thousand tonnes
MAC	Mobile air conditioning
Mt	Mega tonne, or million tonnes
MVC	ABS Catalogue 9309.0, Motor Vehicle Census
The Act	Ozone Protection and Synthetic Greenhouse Gas Management Act 1989, including amendments.
ODS	Ozone depleting substances
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
P&LC	Passenger and light commercial
RAC	Refrigeration and air conditioning
RCFC	Refrigerated cold food chain
RRA	Refrigerant Reclaim Australia
RWO	Repairable write offs
SGG	Synthetic greenhouse gas
SNR	Stolen and never recovered
SWO	Statutory write-off'
Tonne	Metric tonne
UNFCCC	United Nations Framework Convention on Climate Change

1 Executive Summary

In 2013 approximately 658,000 passenger and light commercial vehicles were not re-registered in Australia. Approximately one third of these vehicles were damaged by a collision or event, or were part of the relatively small number of vehicles that were stolen. Approximately two thirds were not re-registered and retired from use as a result of old age, mechanical breakdown or due to economic circumstances decided by the vehicle owner.

It is estimated that as much as one third of all end-of-life vehicles (ELVs) had no residual refrigerant charge when dismantled or crushed. However, across the entire population of ELVs it is estimated that they contained on average 340 grams of refrigerant gas each. In aggregate, ELVs in 2013 were estimated to contain approximately 187 tonnes of high global warming potential (GWP) refrigerant, comprising 166 tonnes of HFC-134a and 21 tonnes of CFC-12.

Using a GWP of 1430 for HFC-134a, as published in the IPCC's Fourth Assessment Report, it is estimated that the residual HFC refrigerant in ELVs has an equivalent global warming impact of 237 kt of CO₂e. Using a GWP of 10900 (AR4 GWP-100 Year) for CFC-12 this component of the ELV gas pool was equivalent to 232 kt of CO₂ (noting that emissions of CFCs are not counted towards Australia's Kyoto Protocol commitments as they are managed under the Montreal Protocol). Thus the entire pool of 187 tonnes of residual high GWP refrigerant in ELVs in 2013 was estimated as equivalent to 468 kt of CO₂.

While we expect up to 10 per cent of that pool was recovered, that still means that the equivalent of more than 400 kt CO_2e was estimated to have been emitted. This is equivalent to 23 per cent of the estimated direct emissions from operating mobile air conditioning (MAC) systems in 2013 and is roughly equivalent to 5 per cent of total consumption (imports) in 2013 from all applications.

Overall the study was Refrigerant gas emissions from ELVs primarily occur at the point where the vehicles are dismantled for spare parts, and where the air conditioner is not first degassed.

A small number of ELVs may be crushed without first being stripped for parts. However because of the value of the non-ferrous metals and spare parts that can be recovered from ELVs, the majority of them will have been delivered to an auto-parts recycling business, and partly or completely dismantled to recover any saleable spare parts and non-ferrous metals before the chassis is crushed and sold for scrap steel.

It is estimated that there are more than 1,800 businesses and sole traders involved in dismantling ELVs. It is a commonly stated view by industry leaders who participated in this study that only a small proportion of the larger enterprises in this industry, and the industry associations¹, are working to achieve best practice outcomes and process ELVs with careful management of the many pollutants that the activity can produce, including recovery of remnant refrigerant gas.

Combined with hard data for recovery and destruction of the main species of gas found in ELVs, the anecdotal reports, from within the industry, of low levels of recoveries is reasonable grounds on which to determine that the majority of industry participants do not recover remnant refrigerant gas from the ELVs they process.

Overall compliance with a range of environmental and occupational health and safety (OHS) regulations in this industry was both reported to be, and observed as being, quite poor. The worst sites where ELVs are processed can clearly be seen, even in a cursory examination, to be highly polluted. While the oils, hydraulic fluids and solid waste that is commonly produced when processing ELVs are not in the scope of this study, the evident pollution at many car wreckers yards is indicative of the low level of concern for control of even highly visible pollutants by many industry participants.

Possibly half of the industry participants are essentially backyard operations or very small scale enterprises. Anecdotally, a number of the smallest operations will close up shop, and move and reopen at a new site frequently to avoid normal business reporting, or local government or environmental controls.

¹ Auto Parts Recyclers Association of Australia (AAPRA), Auto Recyclers Association of Australia (ARAA) and Australian Metal Recyclers Industry Association (AMRIA).

The willing and compliant enterprises operate at a commercial disadvantage (by incurring compliance costs), to the larger number of businesses who do not apply the same degree of commitment to meeting their regulatory obligations. The question of how to achieve a greater level of compliance across the industry, without disadvantaging those who willingly undertake refrigerant recovery, is a complex problem.

Given the economic disincentives to the recovery of remnant refrigerant in ELVs, as compared to the quick rewards available for rapid removal of compressors as saleable spare parts and condensers for their copper content, it is conceivable that effective management of the pool of remnant refrigerant in ELVs will not be achieved outside of the creation of an automobile stewardship scheme.

It must be noted that while data on the auto industry is generally very good and readily available, hard data about ELVs is not as easily available. The generally low level of compliance with environmental and business regulation across much of the industry, translates into a general lack of reliable data about the activities of business operators in the sector. At the same time, the few larger operators who work to be compliant with regulatory obligations did have good data that they made available, and from which, in combination with a range of other data available to the authors, some of the key findings of the report were able to be deduced.

The extent of the primary data was quite limited, although having access to any primary data from within the industry was invaluable. For instance one of the largest operators in the industry provided access to a full year's records of recovery of residual refrigerants from more than XX vehicles that were scrapped. A second source of primary data, on residual refrigerant charge sizes was a multi-site collection program run over a period of 15 months by Refrigerant Reclaim Australia. This program recovered, tested and weighed refrigerant from more than 28,000 vehicles held in the 'salvage yards' of auction houses.

These two sources of primary data are not entirely comparable for reasons discussed later in the report. Ultimately greater certainty in the findings of this report will only be achieved through the conduct of a larger, targeted program of refrigerant recovery and analysis, and data collection from a number of points on the reverse supply chain for ELVs.

2 Introduction

Synthetic greenhouse gases (SGGs) used in the majority of refrigeration and air conditioning (RAC) equipment are designed to be inert, non-toxic and long lived. These desirable attributes allow them to continue to do their job, as medium for transferring heat from one space to another, for a long time.

However, the most common SGGs in use for RAC also have a high GWP. As such, minimising the loss of these gases to atmosphere is an important priority for government.

Australia is a signatory to two international treaties, the Montreal Protocol and the Kyoto Protocol, under which it has made commitments to the international community to phase out and control emissions of a number of ozone depleting substances (ODS) and greenhouse gases. As part of fulfilling those obligations Australian governments, over the years, have developed a suite of regulatory controls on ODS and SGGs.

In Australia it is illegal to emit SGGs to air unless it is permitted under the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 (the Regulations). The management of SGGs in Australia is the responsibility of the Australian Government Department of the Environment under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and related regulations (the Act).

As part of these regulatory controls, the Australian Government empowers the Australian Refrigeration Council to administer a licensing and trading authorisation scheme for technicians and businesses involved in the handling and sale of synthetic refrigerant gases.

The refrigeration and air conditioning industry in Australia has a well established, industry funded, voluntary product stewardship scheme that manages a reverse supply chain for the recovery and disposal of refrigerant gas no longer fit or required for use. The scheme is operated by Refrigerant Reclaim Australia (RRA).

However, for a wide variety of reasons including, economic factors and practical issues of equipment ownership, and retirement and disposal decisions, the licensed technical workforce, with the tools required to recover waste gas, do not always get the opportunity to recover remnant refrigerant gas from the equipment that reaches the end of its life.

This is particularly the case with passenger and light commercial vehicles, which are the focus of this study. The scope of this study is limited to passenger vehicles and light commercial vehicles with a gross vehicle mass less than 3.5 tonnes (P&LCs). In 2013, 658,000 P&LCs reached the end of their useful life (ABS 9309.0 2014). The large majority of these vehicles are fitted with air conditioning (~6 per cent of ELVs have no MAC) and most contain a residual refrigerant gas charge when they are taken off the road. This residual gas is most commonly the auto industry standard HFC 134-a (~75% of ELVs), HC-290 (or hydrocarbon blend) and CFC-12, an ozone depleting substance from an earlier generation of refrigerants, are found in similar quantities (<10% of ELVs each).

It is an offence under the Act for ODS or SGG refrigerant to be emitted unless provided for under the regulations. It is also an offence under the Act to handle refrigerant without an appropriate licence. There is no obligation under the Act for owners of equipment to have refrigerant recovered from equipment they chose to retire or dispose of, however, as outlined above, it is an offence to emit refrigerant.

Despite this, the auto parts and metal recycling companies involved in this study perceived that no effective or widespread enforcement of the regulations on these enterprises is implemented.

To consider the environmental impacts of remnant refrigerant gas in ELVs, this study estimates the quantity of emissions from the fleet of ELVs in Australia and calculates the estimated global warming impact of these emissions in terms of carbon dioxide equivalent. This report studies the participants and pathways involved in the disposal of ELVs and explores how and when residual refrigerant gas is either recovered or released to air.

Data relating to ELVs was found to be quite limited. To understand the sources and causes of ELV emissions, and to estimate the environmental impact of them the study has combined what data was available from the Australian Bureau of Statistics (ABS) and some industry data, with a mix of quantitative, market and social research methods and tools.

The starting point of the quantitative methods is a proprietary stock model of all RAC equipment in the economy that has been built up over the course of research in this area over the last seven years. Specifically in relation to passenger and light commercial vehicles this stock model has been built up using data from the ABS of vehicle imports, sales, registrations and retirements, and manufacturer data on the size of the ODS or SGG gas charge in various models of cars.² The stock model also incorporates leak rates from MAC systems in operation, and compressor failure rates, collision rates, and maintenance recharge rates.

To understand the source of ELVs, the nature and management of the ELV population and the residual gas within ELVs, literature searches, site visits and interviews with expert informants and industry stakeholders was combined with the results of an online survey of technicians exploring industry practices and experience.

² ABS motor vehicle registration statistics are derived from data provided by the State and Territory motor vehicle registration authorities, and new vehicle sales from the Federated Chamber of Automotive Industry (VFACTS).

3 The Motor Vehicle Fleet

3.1 Passenger and Light Commercial Vehicle Fleet, MACs and SGGs

In January 2014 the ABS reported there were nearly 16.1 million P&LCs in Australia, and 730,000 larger trucks, buses and other road registered vehicles (ABS 9309.0 2014).

The total fleet of registered vehicles, including motorcycles, grew on average by 2.4 per cent per annum between 2008 and 2013 (ABS 9309.0 2014). With no data to suggest that there will be any significant change in this long-term trend, this value has been used to model the registered vehicle population for the five years into the future.

To help understand the make-up of the population of ELVs it is important to first understand the age of the registered vehicles in the fleet. In 2014 the ABS annual Motor Vehicle Census calculated the average age of all vehicles registered in Australia as being 10 years of age for the fifth consecutive year. For the age distribution of vehicles in the fleet, the census demonstrated that 50 per cent of vehicles were manufactured after 2003, with the very large majority of vehicles (>95 per cent) manufactured after 1993, with a long narrow tail of older vehicles spanning a couple of decades prior to that point in time. The vehicle age distribution from 1980 to 2013 is illustrated in *Figure 1*. There are another 235,600 vehicles not shown in this chart that would extend the distribution as far back as the early 1900s.



(Source: Motor Vehicle Census 2014, TableBuilder data)

The first MACs installed in the 1970s were largely retrofitted to vehicles where suppliers such as Air International would supply kits for dealer fitted air conditioning in cars like Jaguars, Volvos, HJ Holdens and others. The push for MAC in vehicles in Australia commenced around the mid-1980s when the Commercial Travellers Association and business managers started demanding air conditioning in their vehicles. It was at

³ There are a small number (i.e. 19,100) of vehicles with a 2014 year of manufacture that have been classified as 2013 in this assignment.

this time that the automotive manufacturers started factory fitting MACs. During this period it was often sold as an optional extra, however the penetration of MACs in vehicles was very high (>90 per cent) by the 1990s. By the turn of the century it was a standard feature in passenger vehicles with almost 100 per cent of passenger vehicles fitted with MAC, mostly during manufacture. A small portion of retrofits continued to around 2008, such as in the Toyota Hilux.

Originally, all MACs in Australia were charged with chlorofluorocarbons (CFCs), mainly CFC-12, a gas which is destructive to the ozone layer and has an extremely high GWP of 10900.⁴ As part of meeting its obligations under the Montreal Protocol, Australia ceased the import of and manufacture of all CFCs on 1 January 1996, with the exception of a very small number of internationally agreed essential uses. In the lead up to the 1996 deadline, the majority of local vehicle manufacturers ceased using CFCs at the end of 1993. Similarly imports of vehicles containing CFC-12 ceased at the end of 1993 and were part of the fleet by mid-1994.

Around the same time that CFCs were agreed to be phased out, an international push by global vehicle original equipment manufacturers (OEMs) greatly improved MAC design to reduce charge size and losses from leaks. This was the first time that most MAC systems had been re-engineered for decades, and reducing leak rates was a major objective. New types of hoses with triple crimp fittings were introduced; a reduction in average refrigerant charge size from around 700 grams to 610 grams was achieved, along with other design improvements.

Due to the timing of the roll out of MACs as a standard feature in passenger vehicles, they largely skipped the transition from CFCs to Hydrochlorofluorocarbon refrigerants (HCFCs) in the 1990s. The vast majority of operating mobile equipment either transitioned from CFCs directly to hydrofluorocarbons (HFCs - mainly HFC-134a) or were manufactured with HFC-134a as a result of the Montreal Protocol.

HFC-134a is a stable, inert, non-flammable and long-lived gas that has a GWP of 1430 (AR4 GWP-100 Year). The results of a RRA survey confirmed that more than 90 per cent of all MACs in the survey sample contained HFC-134a, which is consistent with estimates derived from the stock model developed for this study.⁵

MAC systems in P&LCs in the current fleet typically contain a charge of between 600 grams and 700 grams of refrigerant with new vehicles containing 610 grams on average and older vehicles retiring with a design based on a critical charge of 700 grams (for further information on refrigerant charge definitions refer to glossary). Across the entire fleet of vehicles this equates to a total of an estimated 9,500 tonnes of synthetic refrigerants in MACs. Thus MACs contain the second largest portion of the entire bank of refrigerant gases employed in the Australian economy, comprising approximately 21 per cent of the total in 2013 (DoE 2014a).

⁴ CFC-12 has a GWP of 8,100 (AR2 GWP-100 Year) and 10,900 (AR4 GWP-100 Year).

⁵ RRA conducted a survey of 350 vehicles (50 each in Brisbane, Adelaide, and Perth; and 100 each in Melbourne and Sydney) in early 2013 and a similar sample in 2014. Vehicles were selected randomly from workshops, the year of manufacture was recorded and the type of refrigerant was tested using Neutronics refrigerant gas analysers.



(Source: DoE 2014a)

Due to the relatively difficult environment in which MACs have to operate (high vibration, subject to jolts and the hot engine enclosure) compared to stationary equipment, MACs are a large source of emissions to air of refrigerant gas. This is a subject that auto makers and international regulators are well aware of and significant engineering effort and funds have been invested over the years in reducing leaks from MACs while improving equipment reliability.

Sector/applications	2013 total consumption (tonnes)	2013 bank (tonnes)
Domestic refrigeration	25	2,270
Refrigerated Cold Food Chain	1,000	5,070
Stationary air conditioning	1,535 (incl. 200 re-use)	28,680
Mobile air conditioning	1,250	9,515
Foams	200	-
Fire protection	50	-
Aerosols	40	-
Export and other	~90	-
Total	4,190	45,535

Table 1: Estimates of 2013 gas consumption and refrigerant bank by major sector in tonnes.

(Source: DoE 2014a)

Of the more than 1,200 tonnes of gas estimated to have been used servicing or manufacturing MACs in 2013, consumption of gas by OEMs in automotive and truck manufacturing was estimated to be 135 tonnes in 2013. P&LC manufacturing declined from 326,960 in 2006 to 211,429 in 2013, partially due to global competition and the closure of the Mitsubishi factory in 2008. This decline removed demand of between 50 to 60 tonnes per annum from HFC-134a consumption in Australia. The announced closures of the Ford Motor Company manufacturing operations in Geelong and Broadmeadows in Victoria by 2015, the GM Holden manufacturing facilities in Adelaide and Fisherman's Bend in Victoria by 2016, and the Toyota manufacturing operations in Victoria by 2017, are expected to further reduce bulk imports of HFC-134a by around 130 tonnes per annum by the end of 2017 (DoE 2014a).

Approximately 80 per cent of refrigerant gas consumed in MACs was consumed servicing air conditioning systems in existing vehicles, which have an estimated leak rate of around 10 per cent per annum. An additional allowance of 1.5 per cent per annum is included for P&LCs to replace gas lost from vehicles that had some form of collision or catastrophic failure (i.e. compressor failure). This demand to replace lost gas accounted for around 25 per cent of imports of all bulk gas (i.e. 994 out of 3,990 tonnes which excludes re-use) into Australia in that year.

If it is assumed that all gas consumed for servicing MACs, or for replacement of gas lost due to mechanical failure, is emitted to air, then the approximately 994 tonnes of gas consumed in servicing in 2013 was equivalent to carbon emissions of 1.4 Mt CO₂e (DoE 2014a). This is roughly equivalent to about 0.25 per cent of Australia's total greenhouse gas emissions in 2013.

The synthetic refrigerant gases used in MACs and in the servicing of MACs are subject to the same regulation and licensing controls under the Act as is refrigerant used in all other RAC equipment and applications. The details and requirements for practitioners are described in *The Australian automotive code* of practice for the control of refrigerant gases during manufacture, installation, servicing or decommissioning of motor vehicle air conditioners 2008 (DEWHA 2008) the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 and in licensing information issued by the ARC.

3.2 Number of ELVs in Australia

The starting point for calculating the number of ELVs in Australia is annual data produced by the ABS.

The ABS publishes an annual Motor Vehicle Census that accounts for the number of registered vehicles in Australia by type including passenger vehicles, light commercial vehicles, trucks, buses and other registered vehicles (ABS 9309.0 2014). The scope of this study is limited to P&LCs with a gross vehicle mass less than 3.5 tonnes. Therefore, trucks, buses and campervans were omitted from the ABS statistics used.⁶

The motor vehicle registration statistics in the Motor Vehicle Census are derived from data provided by state and territory motor vehicle registration authorities and assume a one-month period of grace with renewals to minimise anomalies due to late payments. There are some cars that are re-registered after this period however the number is statistically insignificant.

The registration data from the Motor Vehicle Census, combined with new sales data from the Federated Chamber of Automotive Industries known as VFACTS, is used to calculate an attrition rate for vehicles. The attrition rate (also known as the motor vehicle retirement rate) represents the estimated number of motor vehicles taken off the register since the previous census. *Figure 3* provides a trend of ELVs by state/territory over the last five years. The total number has grown from around 600,000 in 2008 to roughly 680,000 in 2012 and 2013. This is an average of almost 630,000 ELVs per annum and equates to approximately 4 per cent of the registered fleet of vehicles retiring per annum.

Not all of the vehicles that are retired and taken off the registration database automatically become ELVs. Some may be registered again at a later date when an owner might have repaired them, refurbished them or sold them on to a new owner after a period of not being used. To better understand the relationship between the vehicle fleet and the population of ELVs, the Expert Group developed a model of vehicle retirement rates

⁶ Passenger and light commercial vehicles made up 96 per cent of the registered fleet (excluding motor cycles) in 2008 and 2013.

known as the 'scrapping curve' that is described in detail in *Appendix A*. Using the data from the ABS Motor Vehicle Census and data on the age distribution of the fleet, the Expert Group ELV Model calculates that in 2013 658,000 vehicles entered the population of ELVs. For the purpose of this analysis we have focussed on this 2013 population of ELVs.

This estimate does not account for a relatively small number of vehicles that might simply be unregistered vehicles (i.e. law breakers). It also does not include the few thousands of vehicles that for various reasons are not included in the ABS data such as those registered by the defence forces, consular vehicles and vehicles not registered for road use (quad bikes, tractors, etc.), or vintage cars (different type of registration). The penetration of MAC in these latter classes of vehicles would be low.

Figure 4 shows the average dissection of ELVs by state/territory over the last six years with New South Wales (NSW), Victoria and Queensland accounting for more than 80 per cent of P&LC vehicles retiring.



3.3 ELV Feedstock

Vehicles are taken off the road for a number of reasons. Some are stolen, either by professional thieves seeking to make money out of resale of the vehicle, or opportunistically for joy rides, to commit another crime, or just by a petty criminal needing to get somewhere.

Many are not re-registered because they suffer damage in a collision, or an event such as a hail, flood or fire, that makes them uneconomic to repair. A large number simply get old and suffer mechanical problems that are uneconomic or beyond the means of the owner to repair.

Understanding the factors that cause a vehicle to become an ELV is important, as some of these factors directly influence the likely residual refrigerant charge, and impact on how the ELV is managed on its way to disposal. A model of ELV feedstock was developed using all available data and reasoned deductions to understand the likelihood of ELVs retaining a refrigerant charge. Because these estimates are based on limited data, deductions and reasoned assumptions, the process of defining the various elements and characteristics of the ELV feedstock is set out in some detail below.

Insurance statistics provide some insight into the source of ELVs and their disposal pathways. If a vehicle is comprehensively insured when it suffers significant damage, the insurer will generally have the vehicle assessed to determine if it can be repaired. If a vehicle is deemed uneconomic to repair by the insurer it is classified as a 'statutory write-off' (SWO), and its details are entered into the National Exchange of Vehicle and Driver Information System (NEVDIS) database⁷ ensuring that the vehicle can never be re-registered.

NEVDIS is the national database of Australian driver and vehicle information. State and territory road agencies are the source of NEVDIS data which includes detailed information such as the national Vehicle Identification Number (VIN) database and the national Written Off Vehicle Register (WOVR). The NEVDIS data on stolen vehicles and insurance write offs provides some insight into the origins of some of the ELV feedstock.

In 2013, 87,703 vehicles were classified as SWOs, contributing 13.3 per cent of the 2013 population of 658,000 ELVs (see *Table 2*).A further 43,640 vehicles were classified as repairable write offs (RWOs) in 2013 by insurance assessors. In other words, the vehicle could technically be repaired and there was no damage that was so severe to the structural integrity of the vehicle that it could not potentially be repaired and re-registered. However, from an economic point of view the insurance assessor judged that it would be cheaper for the insurance company to pay out the claim than to meet the cost of repairs.

In this case the vehicles are generally treated in the same manner as SWOs and sent to auction by the insurer where it is assumed, due to the high cost of repairing them, that the majority would have been purchased for dismantling and recycling of parts and scrap metal. Some however are purchased, repaired and re-registered.

For instance a 2009 report by the NSW Roads and Traffic Authority (NSW RTA 2009) indicates that about 40 per cent of RWOs get presented for re-registration. In recent years, many RWOs have been the result of hail damage, and the decision to write them off is partly made because the repair industry simply does not have the capacity to deal with them in a reasonable time frame. Many of these hail-damaged vehicles have been purchased and repaired in time, and many would have been able to be registered immediately.

Assuming that this rate of hail damaged vehicles being repaired and presented for registration is consistent across Australia and therefore that as much as 60 per cent of RWOs also become ELVs, these vehicles contributed another 26,184 ELVs to the 2013 population, or another 4 per cent of the total (see *Table 2*).

Some vehicles are stolen and never recovered. These are known as SNR vehicles. The National Motor Vehicle Theft Reduction Council (NMVTRC) reported 10,418 SNR vehicles in 2013. These can be considered as ELVs as they essentially disappear into criminal enterprises where the vast majority of them are stripped for valuable parts and the engine blocks and chassis sold for scrap metal. That is equivalent to another 1.6 per cent of the 2013 ELV population (see *Table 2*).

⁷ Reference to the National Exchange of Vehicle and Driver Information System (NEVDIS) – the process and role of assessment of vehicles as SWOs is further discussed in Appendix B.

Thus written off vehicles and SNR vehicles together may have contributed as many as 124,305 vehicles to the 2013 ELV population, or around 19 per cent (see *Table 2*).

A further 37,449 vehicles were reported stolen but recovered either intact or subject to malicious damage. The NMVTRC states that an unknown, but assumed to be small, number of this last category of stolen vehicle were recovered in a substantially stripped condition.

There is almost certainly some double counting of this category of stolen but recovered vehicles, and statutory write-offs (SWOs) reported by insurers. However, it might not be that large an overlap. The NMVTRC data shows that more than 60 per cent of vehicles that are stolen and recovered are more than 10 years old. Several reasons were identified for thieves' preferences for older vehicles including their being easier to break into, being easier to dispose of and being less likely to have anti-theft devices and tracking systems.

Older vehicles are also less likely to be financed and less likely to be insured, and therefore, less likely to be assessed and classified as a SWO by an insurance assessor following a theft and recovery. However, to avoid the possibility of double counting, an allowance has been made for some proportion of stolen and recovered vehicles to already have been captured in the insurance industry statistics as SWOs.

Firstly we have assumed that 30 per cent of all stolen and recovered vehicles were so damaged or stripped during the theft that they became ELVs (11,234). We further assume that one fifth of those vehicles were new enough, or valued enough by their owners, to have been insured and therefore classified as SWOs after recovery (2,246) and counted in the SWO figures above.

Thus deducting these SWOs from the stolen and recovered vehicles that have become ELVs, this source still only provides an additional 8,988 ELVs (~1.4 per cent of total ELVs). Combined with all SWOs, and with all SNR vehicles, this results in 133,293 ELVs which represents Twenty percent of the 2013 population of ELVs.

Many other vehicles become ELVs after being damaged in collisions or events that are not insured, and that also do not involve theft or other criminal activity. In these situations, the damaged vehicle is not reported to police or inspected by an insurance assessor.

However, other than in NSW, road accident statistics in all other states are only collated if a death or injury was involved. The NSW Department of Transport publishes data for *all* recorded road accidents. In 2012 they reported a total of 41,520 'crashes' involving a total of 68,984 P&LCs. A total of 18,446 of these crashes were severe enough to involve injury or deaths (18,110 injuries, 336 deaths) involving 26,850 P&LCs. If we assume that the rate of vehicle accidents is evenly distributed across the entire national fleet of vehicles, and noting that NSW has about 30 per cent of all registered vehicles, we could estimate that there were a total of some 230,000 vehicles involved in accidents on Australian roads in that year. For the sake of the argument we will assume that a similar number of vehicles were damaged in collisions on Australia roads in 2013.

Assuming that 90 per cent of the 87,703 SWOs in 2013 were written off as the result of collisions – that is 78,932 vehicles – which have to be deducted from our national estimate of a total of around 230,000 collision damaged vehicles, we arrive at an estimate of 151,067 uninsured vehicles involved in collisions during 2013. If half of those uninsured vehicles were damaged beyond repair and became ELVs, they contribute only another 75,533 vehicles to the 2013 ELV population (~11.5 per cent of total ELVs, see *Table 2*).

Thus accounting for all stolen vehicles, either not recovered or recovered but damaged, all vehicles written off and not repaired following insurance assessments and all other vehicles damaged beyond repair in collisions, brings us to an estimated total of 208,826 ELVs from all identified sources. To be safe, a further 10,000 to 11,000 might be added that are uninsured and damaged beyond economic repair as a result of some other event, such as fire, flooding, vandalism or hail, and we could say that total damaged or stolen vehicle contributions to 2013 ELVs is around 220,000 vehicles, or approximately 33.4 per cent of the total ELVs in that year.

We must therefore assume that the balance of ELVs, the other 66.6 per cent, or approximately 438,000 ELVs in 2013, suffered some combination of mechanical failures or cumulative wear and tear that rendered them

uneconomic for private owners to repair. They simply got too old and run down to bother with registering again.

This assumption is supported by feedback from the operators of large auto-parts recycling businesses who confirm that the majority of the vehicles they receive come direct from the public, from second hand dealers who accepted an old vehicle as a trade in, or via tow truck operators who collect them from the public.

What this means is that the majority of ELVs have not suffered any major collision damage when they become ELVs, an important factor when estimating the likely remnant refrigerant charge. A summary of the estimated sources of ELVs is provided in *Table 2* below.

Sources of ELVs: 2013	Percentage of vehicles from this source that become ELVs	Number of ELVs from this Source	Proportion of total ELVs from this Source
Statutory Write Offs (damaged in collision or event)	100%	87,703	13.30%
Repairable Write Offs processed as ELVs and are stripped and recycled	60%	26,184	4.00%
Stolen Not Recovered Vehicles (theft for profit)	100%	12,070	1.80%
Stolen Short Term and Recovered but Damaged beyond repair	24%	8,988	1.40%
Vehicles that are Uninsured and Damaged in Collision	33%	75,533	11.50%
Uninsured Vehicles Damaged beyond repair in non- collision Event	Estimate	~10,000 ⁸	1.50%
Retired vehicles (ELVs that were Uneconomic to Register and/or More Economic to dispose of/recycle)	Estimate	~438,000	66.60%
Total	-	658,000	100%

Table 2: Estimates of Sources of ELVs in 2013.

The ELV population then could be split up into two broad categories, one third having suffered some damage, and two thirds having retired without significant damage. This last category of vehicles, the 438,000 that were not re-registered in 2013 but without being damaged, has implications for the volume of residual refrigerant gases in ELVs because this large majority of ELVs that has suffered no damage is likely to have an intact compressor in any MAC installed, thus being likely to retain some of the refrigerant charge as compared to vehicles that have been damaged.

This population of effectively functional ELVs and their age also has implications for the mix of gases in the pool of residual refrigerant found in ELVs. An analysis of ABS data on the Australian motor vehicle fleet

⁸ This estimate was rounded to the nearest thousand ELVs.

revealed that, while the average age of all vehicles is 10 years, the average age at retirement is 19 years. Thus, the average age of vehicles that became ELVs in 2013 meant that many of them were manufactured in 1994, or earlier than that, at a time when any vehicle fitted with air conditioning had a compressor charged with CFCs. This issue is discussed further in *Section 3.5 Total Residual Refrigerant in ELVs*.

The process that results in a vehicle being retired and ultimately scrapped is illustrated in *Figure 5*, on the following page. This conceptual view of the decision-making process is useful for considering points at which intervention into the process might be most effective.



3.4 Average refrigerant charge of ELVs

For the purpose of estimating the average charge of refrigerant in ELVs, vehicles that have entered the ELV population as the result of some damaging event, and those that have simply been retired from service, are treated differently.

The average residual charge of refrigerant gas in MACs found in ELVs in Australia that have been sent to auction, after being written off by an insurance assessor, is estimated to be 230 grams. This value is based on

a large sample of 28,706 ELVs tested by RRA in auction yards during a fifteen-month campaign between November 2009 and March 2011. The RRA program recovered gas from vehicles in the salvage yard section of auction houses in Sydney and the NSW central coast.

It is logical to assume that very few uninsured or older vehicles would be assigned to auction after damage in a collision by a private owner. The value of a vehicle that was not worth insuring would generally not be high in the first place, and auction fees quickly outweigh the potential returns when the value of a damaged vehicle is low.

Thus the overwhelming majority of damaged vehicles sold at auction were almost certainly vehicles that had been consigned by insurance companies.

Under the RRA testing program, the average charge of cars that were found to have any refrigerant gas at all was 550 grams. Given the average range of 600 to 700 grams refrigerant charge size of vehicles in the current fleet, this indicates that many of the MACs in those vehicles were near to fully charged.

This result was somewhat surprising as there was an expectation that ELVs might generally be found to have a smaller proportion of the working charge remaining. Average charge of vehicles imported over the last seven years was 610 grams (calculated from DoE pre-charged import data from more than 5 million vehicles), however older vehicles in the fleet manufactured in the 1990s and before would typically have charges of ranging from 700 grams up to as much as a kilogram. Given that the data source was reliable and the method of collection was sound, it has to be accepted that ELVs with any charge left in them, will commonly have the majority of the working charge still in place.

However, 58 per cent of all the salvage cars tested (16,765) had no residual charge at all. This is almost certainly as a result of this population of ELVs suffering damage caused by a front-end collision, the event that has resulted in the vehicle being written off.

Number of vehicles tested with:			Sum of	Total	Average	Average
CFC- 12	HFC-134a	No charge	tested	recovered (kilograms)	vehicle with gas (grams)	vehicle across all vehicles (grams)
616	11,325	16,765	28,706	6 529	550	230
2%	40%	58%	100%	0,329	350	230

Table 3: Auction House Salvage Yard Refrigerant Recoveries from RRA Testing Program 2009 to 2011.

An important observation from the RRA testing program is the high average level of charge found in vehicles that had any charge at all (i.e. newer vehicles are less inclined to leak). With 550 grams, these systems are likely to have been operational. A second point of note is the very low proportion of CFC-12 (CFCs) discovered in this sample. This point is discussed later in the next *Section 3.5 Total Residual Refrigerants in ELVs*.

The second primary source of data on residual refrigerant charges in ELVs is a survey of businesses licensed by the ARC for the recovery of refrigerant gas. Respondents consistently reported that a larger proportion of ELVs arriving at car wreckers' yards were found to have a refrigerant charge than those tested at auction house salvage yards.

The average of all survey responses received was that 29 per cent were empty. One of the larger auto recyclers who keeps records of recoveries from around XX vehicles a year reported that on average they

found 33 per cent of vehicles had no charge. This may be explained as some of their ELV feedstock was also sourced from auction houses, including a number of vehicles that had suffered collision damage and were more likely to have lost the refrigerant charge. Given this data from a reasonably large sample, and the relatively close alignment of this finding with the average of responses to the survey, for the purposes of this study we will conservatively assume that 33 per cent of all ELVs received by wreckers have no residual refrigerant charge.

The higher number of ELVs containing a residual charge in wreckers' yards, as compared to those in auction house salvage yards, is considered to be a result of the higher proportion of ELVs that arrive at wreckers' yards that have simply been retired by a private owner, but without significant damage.

Twenty-six of the 38 respondents to the survey of licensed refrigerant gas recoverers answered a question about how much gas they recover on average from an ELV. The answers ranged from 100 grams to a full charge of 700 grams in older vehicles. The average of all responses to the survey was 413 grams.

Once again drawing on the experience of one of those respondents (an auto recycler who has kept detailed records of recoveries from around XX vehicles per annum) recoveries from vehicles with any gas in them at all was reported to be 600 grams on average, although in that large sample, 33 per cent of vehicles were found to be empty. This averages out to 396 grams per vehicle across the whole sample. While the recovery of an average of 600 grams from vehicles with gas in them was surprisingly high⁹, the average across the entire sample is a remarkably similar number to the 'crowd sourced wisdom' of the survey results.

If we accept this lower figure of 396 grams as a reliable value for recoveries from ELVs that retire without collision or damage, that effectively gives us two populations of vehicles:

- 1. Auctioned ELVs that is approximately one third of the total annual ELV population, has had collision damage and that averages around 230 grams per vehicle; and,
- 2. Old age ELVs that is approximately two thirds of the population and has retired effectively undamaged and contains around 396 grams per vehicle.

Applying these two values across the entire population of ELVs implies an average residual refrigerant charge of 340 grams per ELV.

Table 4 below sets out the estimated residual refrigerant charge in ELVs from the various ELV feedstocks.

⁹ The records examined at the business in question were assessed as being accurate and of high integrity. Thus what appears to be relatively high levels of average recoveries could suggest that car owners, even of older cars, tend to maintain their AC to the end of the vehicle life (noting the estimated 10 per cent leak rate per annum and that 80 per cent of refrigerant gas consumed in MACs was consumed servicing air conditioning systems in existing vehicles). It is also a fact that older vehicles did tend to have larger charge sizes in their AC (up to 1 kg) and as such recoveries from ELVs with working MAC at the lower end of the industry accepted average charge sizes simply indicates that these systems were regularly maintained. This data should be tested in the field with a wider and detailed audit of the age, models, recoveries and other characteristics of cars being processed by a number of well-run auto-recycling firms.

Sources of ELVs 2013	Number of ELVs	Proportion of Total ELVs (%)	Estimated Average Residual Refrigerant Charge (grams per ELV)			
	Fron	From nominated source				
Statutory Write Offs (damaged in collision or event)	87,703	13.30%	230 grams			
Repairable Write Offs processed as ELVs and are stripped and recycled	26,184	4.00%	230 grams			
Stolen Not Recovered Vehicles (theft for profit)	12,070	1.80%	230 grams			
Stolen Short Term and Recovered are damaged and become ELVs	8,988	1.40%	230 grams			
Vehicles that are Uninsured and Damaged in Collision become ELVs	75,533	11.50%	230 grams			
Uninsured Vehicles Damaged in non-collision Event that become ELVs	~10,000	1.50%	396 grams			
ELVs that were Uneconomic to Register and/or More Economic to Recycle	~438,000	66.60%	396 grams			
Total	658,000	100%	340 grams			

Table 4: Residual refrigerant and ELV feedstocks.

3.5 Total Residual Refrigerant in ELVs

Based on the 2013 population of ELVs of 658,000, and applying our broad average of 340 grams of residual refrigerant per vehicle, it is estimated that ELVs in Australia in 2013 contained an aggregate of approximately 224 tonnes of refrigerant (including HC) based on equivalent volume (refer glossary for definition of equivalent refrigerant charge).

To determine the total emissions from this pool of residual gas, there are several questions that must be answered. Firstly, what gas is it?

The RRA data, based on a large sample from auction houses, found only around 2 per cent to contain CFCs. However, the ELVs coming through auction houses can be expected to be from the youngest quartile of ELVs. They are insured, they are worth more, and they are newer than the majority of ELVs. It is thought that only a very few older cars, possibly collectible, rare and once expensive cars, that might have been insured when they suffered damage, would be valuable enough to assign to auction.

On the other hand, recoveries of gas from ELVs by one of the largest auto-parts recycling companies in Australia reported recovered volumes of CFC-12 of around 21 per cent of all recoveries by weight, which

equates to 11 per cent of vehicles when charge sizes are taken into account and that around one third will have no charge or MAC.¹⁰

This was a surprising result as across all RAC applications RRA find there is a diminishing pool of CFCs, with the volume being recovered and returned for safe disposal declining from 50 tonnes five years ago, to around 15 tonnes now, some 20 years since manufacture and import ceased.

The Expert Group ELV model¹¹ calculates the average age of ELVs as 18.6 years with a standard deviation of 6.2 years. The scrapping curve, coupled with sales data and the ABS Motor Vehicle Census, calculates 178,613 vehicles manufactured before 1994 retired in 2013, and thus 27 per cent of the 2013 ELV population were originally manufactured with CFCs.

There is no information available on the portion of ELVs manufactured containing CFC-12 that were converted to HFC-134a or to hydrocarbons. Anecdotal evidence from industry are that a higher portion of hydrocarbon retrofits are undertaken on older vehicles. Therefore, for the purposes of this analysis, the model assumes that 50 per cent of the 2013 ELVs that were originally charged with CFCs have since been charged with HFC-134a, and a further 15 per cent have had their charge replaced with HC.

Thus using the average gas charge calculated for all ELVs of 340 grams, the ELVs are estimated to contain 187 tonnes of synthetic refrigerants, comprising 166 tonnes of HFC-134a and 21 tonnes of CFC-12. A summary of the ELV Model outputs, auction house survey, auto wrecker survey and estimated remnant charges is outlined in the table below.

	Units	No-MAC	CFC-12	HFC-134a	HC	Total
ELV MAC Model	Vehicles	40,462	178,613	439,243	0	658,318
prior to conversions	%	6%	27%	67%	0%	100%
Auction house actual	58% no charge	-	2%	40%	-	42%
Auto wrecker actual	33% no charge	-	11%	41%	15%	67%
ELV MAC model after	Vehicles	40,462	62,515 ⁽¹⁾	486,627 (2)	68,714	658,318
conversions	%	6%	9%	75%	10%	100%
Residual charge	Grams	-	340	340	-	-
Synthetic refrigerant	Tonnes	-	21.3	165.5	-	186.7

Table 5: Refrigerant dissection of the 2013 ELV population by refrigerant type in vehicles and tonnes.

1. These estimates assume 50 per cent of ELVs that were manufactured containing CFC-12 have been converted to HFC-134a, 15 per cent to HC and the remainder contain CFC-12.

2. Similarly the ELV Model calculated there were 439,243 ELVs that were manufactured containing HFC-134a, a portion of these have been converted to HC making up 10 per cent in total and future projections assumes MACs originally manufactured containing CFCs or HFCs will be converted to a mix of low GWP refrigerants.

¹⁰ Assumes following average charge sizes (HFC-134a = 600 grams, CFC-12 = 700 grams and HC = 210 grams).

¹¹ The Expert Group ELV Model is explained in detail in Appendix A.

3.6 Total Emissions from ELVs

Using a GWP of 1430 for HFC-134a, as published in the IPCC's Fourth Assessment Report, it is estimated that the residual HFC refrigerant in ELVs has an equivalent global warming impact of 237 kt of CO_2 . This is not an insignificant amount, and for instance is many times the level of emissions that would qualify an Australian business to lodge reports under the *National Greenhouse and Energy Reporting Act 2007*.

Using a GWP of 10900 (AR4 GWP-100 Year) for CFC-12 this component of the ELV gas pool was equivalent to 232 kt of CO_2 (noting that emissions of CFCs are not counted towards Australia's Kyoto Protocol commitments as they are managed under the Montreal Protocol).

Thus the entire pool of 187 tonnes of residual synthetic refrigerant in ELVs in 2013 was equivalent to 468 kt of CO_2 . Leading members of the auto parts recycling industry estimate with some confidence that the larger industry participants – those that are most likely to make an effort to achieve compliance with environmental regulation and controls – process about 10 per cent of the annual supply of ELVs.

This suggests that as much as 10 per cent of the residual refrigerant gas pool was recovered during ELV stripping and decommissioning. Although given the disincentives to recovery discussed elsewhere in this report, this estimate is thought to be at the upper end of likely recoveries. Nonetheless, if 10% of residual refrigerant is recovered from ELVs, that still means that around 400 kt CO₂e was likely to have been emitted. This is equivalent to 23 per cent of the estimated direct emissions from operating MACs in 2013 and is roughly equivalent to 5 per cent of total consumption (imports) in 2013 for all RAC applications.

4 The Reverse Supply Chain

As the vehicle fleet in Australia has grown and changed in the course of the last 70 years, a complex and effective network of businesses has grown up that collect and manage the disposal or recycling of ELVs. The efficiency of this 'reverse supply chain' and the value of ELVs are evidenced by the near complete absence of broken down and abandoned cars in our cities, suburbs and country towns.

This reverse supply chain has become what is colloquially known as the 'car wrecking' industry, or more formally as the 'auto-parts recycling' industry. There are several participants in this supply chain including auction houses, tow truck drivers, wreckers yards and metal recyclers, although only the wreckers yards are 100 per cent devoted to the industry, with all the other players being participants in a wider field of economic activity.

This is an industry that has grown up, to a large extent, devoid of regulation, as a largely informal industry that initially worked in parallel with the auto repair and auto-parts wholesalers industries, and the waste management and land fill industries. For many decades landfills in Australia were the final resting place of most car chassis and tyres.

Since the 1980s, as ferrous and non-ferrous metal recycling became a substantial industry in its own right, and car chassis' became worth crushing, more material was diverted from landfill. This led to the economic value of ELVs improving to become one of the most completely recycled complex manufactured products in the modern economy.

Until recently the majority of the value of an ELV in Australia was in the value of the spare parts that could be recovered from it and resold in the domestic market for the repair of other vehicles. In the last decade and a half, a significant export industry has sprung up exporting the engine blocks and 'half cut' ELVs¹² from Australia to countries where re-registration of a vehicle is not as difficult as it is in Australia (i.e. Malaysia, Nigeria, and to the Middle East where they are traded into African countries) (VP 2014 and Expert Group site visits).

In the process of going from being a registered road vehicle to being stripped and sold for its component parts and materials, the majority of ELVs can pass through several sets of hands. However, due to the value of spare parts and non-ferrous metals that can be recovered from them, it is assumed that the vast majority of them will be processed by a 'car wrecker' prior to final crushing of the chassis and disposal of waste. These car-wrecking businesses range from back yard operators who strip down one car at a time, to national chains of auto-parts recyclers.

The diagram below in *Figure 6* illustrates the range of participants and common practices in various parts of the industry.

¹² A 'half-cut' is where a car is cut in half with an oxy torch and the front end of a vehicle, from the dash board forward, including all of the engine and driver controls, which is the most valuable part of the vehicle and is able to be easily stacked into a shipping container, is exported for re-integration into a complete vehicle in overseas markets.



4.1 Market Intermediaries for ELVs

Before ELVs reach a car wreckers' yard and the parts and commodities recovered are processed for recycling or waste, they are handled by, or become the property of, a range of market intermediaries including tow truck drivers, insurance companies and their preferred car repairers and car dealers.

Based on the analysis of ELV feedstocks it is likely that the largest sources of operational ELVs for the autoparts industry are private owners and the car dealership market itself.

It is widely known that car yards will offer to take almost anything on wheels as a trade in to secure a sale. Experienced new and second-hand car dealers would be able to quickly determine the economic prospects for a car accepted as a trade-in. Many car yards have long term relationships with car parts dealers to whom they sell low value trade-ins directly. For vehicles that for various reasons have a chance of achieving a better price in a wider market, a car dealer might choose to consign the vehicle to auction.

However, largely as a result of the strong Australian dollar since 2010 making new car imports relatively cheap, new car sales and second hand car volumes have climbed and second hand car prices have been very soft. Auto wreckers explain that more of the older vehicles previously accepted by motor dealers as trade-ins are now sent direct to wreckers for dismantling rather than to auction houses. The auction prices have fallen to the point where auction fees plus transport make that route for sale of ELVs less economic.

Some private owners, either unhappy with what they might get offered in a trade in or, as has happened increasingly in recent years as second hand car values have fallen, where a trade in was not offered when buying a new car, may consign cars to auction houses for sale. However, the majority of cars that become ELVs, based on the available data and industry information, appear to go directly from private owners to car wreckers.

Private owners, property owners left with abandoned vehicles, local governments and even insurance companies all have the option of also soliciting offers from the numerous 'cash for cars' types of businesses that operate around Australia. These businesses are the living proof of the economic value of ELVs. A quick internet search using the terms 'cash for cars' and any major city or regional centre in Australia generates hundreds of results of buyers offering to pay cash for cars in any condition. These 'cash for cars' businesses are generally the marketing front of a wrecking yard, or associated with a tow truck operator, or both.

Insurance companies who have taken possession of a car that they have declared a write-off would have the option of either sending higher value cars to auction, or sending them directly to salvage yards as a direct sale. Interestingly, as a result of the strong Australian dollar, cheap new car imports and relatively high Australian labour costs, damaged vehicles are becoming increasingly cheaper to replace than repair. It is possible that, for this reason, insurance assessors in recent years have been writing off more cars than prior to the existence of these conditions.

Auto repair companies, who have relationships with insurers as 'approved repairers', will often house a damaged vehicle while the insurance assessment process is undertaken. Once a vehicle is deemed a write-off the repairers may have some role in selecting the tow truck service to take the vehicle away, although it is more often the case that the insurer will contract removal to an approved tow truck operator, and direct the final destination of the vehicle.

Local governments, as operators of public housing, car parks, waste management sites and landfill, and public lands, also end up taking ownership of broken down, abandoned and unregistered cars as a result of their municipal responsibilities. Local governments would likely send most ELVs they take possession of direct to wreckers or in some cases direct to metal recyclers.

Finally, tow truck drivers are paid by private vehicle owners, property owners, local governments, police agencies, insurers, auto repairers, and finance companies to collect and dispose of SWOs and inoperable damaged ELVs. Tow truck drivers have relationships with auto wreckers, often just as a result of geographical proximity – tow trucks, as with all transport, tend to optimise returns by transporting goods the least possible distance to complete a transaction.

Ultimately, whether first passing through an auction house or going direct, the vast majority of ELVs pass through an auto-parts recycling business to be stripped down and the chassis and any engine blocks beyond repair are sold to a ferrous metal recycler.

4.2 *Economic Utilisation of ELVs*

To understand the value of remnant refrigerant gas in ELVs, and thus any economic incentive that the parties who process ELVs may or may not have to recover it, the value of other goods and materials recovered from ELVs must be understood. The value of the industry as a whole is also an important consideration.

The virtual absence of broken down and abandoned cars reflects the effective utilisation of ELVs and their economic value. At the very least an ELV is worth cash for its scrap metal value. An entire car, complete with engine and all components is worth at least \$480 per tonne according to industry informants. The chassis alone after having the engine, wheels, tyres, non-ferrous metals and any useful components, including the MAC compressor removed, is worth approximately \$200 at time of writing this report. The chassis only value to metal recyclers of all 2013 ELVs would involve purchases worth more than \$126 million by the large firms who can crush car bodies.

However, the larger part of the economic activity built on the processing of ELVs is in the auto-parts recycling industry. An auto-parts recycler may pay a private owner between \$200 and \$300 for a retired car and may pay for the cost of the tow to pick it up if it is broken down or un-roadworthy. Using an average cost of \$250 per unit this would value the stock of ELVs that retire into the hands of this industry at something in the vicinity of \$170 million dollars in 2013. This is a quite plausible sum when seen in the context of the IBISWorld estimate of the industry being worth \$2 billion in total per annum (IBIS 2014).

4.2.1 Auto-parts Recycling

ELVs are the primary supply of materials and product for the second hand car parts industry, or 'car wreckers' as they are commonly known. The second hand car parts industry is, in turn, a relatively small but important participant in the automotive repairs and maintenance industry, and serves important market functions including facilitating the affordable maintenance of many older vehicles, and providing competition that keeps the price of new car parts down.

The 'car wrecker', or auto-parts recycling industry is characterised by a large informal sector with many small and 'back yard' operators who may never engage in the formal economy, incorporate as a company, pay tax, or even use bank accounts (VP 2014 and interviews with Victoria Police).

A major investigation by the Victorian Police Department (Taskforce Discover, VP 2014) into the links between profit-motivated theft and the car wrecking and scrap steel industry conducted audits of 432 motor wreckers and scrap metal dealers in Victoria. It concluded that the motor wrecking and scrap metal industries primarily operated in the cash economy.

Business practices that are common in most industries, such as holding detailed computerised inventory of stock, and maintaining commercial accounts with terms of payment via electronic means and electronic funds transfers, are far from ubiquitous in this industry. Even in the more formal and visible segment of the industry, in which leading players have national chains of retail outlets, there are no clear market leaders.

ELVs when broken down produce many valuable product streams including rare metals from catalytic converters, lead from batteries, some copper, useable tyres and many types of car parts. A trip to any wreckers will testify to the array of parts and components that a wrecker will retrieve and keep in stock. This ranges from major items like entire engines, gear boxes and differentials to headlights, windscreens, every possible type of panel, door, boot and hood (being the most frequently damaged items of vehicles on the road), dashboards, car seats and wheel rims.

Anything that cannot be stripped and sold domestically or exported as useful parts is sent to the metal recyclers for crushing. While some recovered steel is re-smelted in Australia, key industry participants explain that the vast bulk of the recycled metal is exported.

An IBISWorld industry profile published in January 2014 reported that the 'Motor Vehicle Dismantling and Used Parts Wholesaling' industry in Australia had total revenue of \$2 billion in 2013-14, employing around 4,800 people in 940 enterprises (IBIS 2014b).

However, there is evidence to suggest that the IBISWorld figure could be a lower end estimate. The ABS identifies 1,018 businesses under the ANZSIC code 3505 for Motor Vehicle Dismantling and Used Parts Wholesaling (ABS 8165.0 2014). ABS collections cannot be expected to identify business operators who do not participate in surveys or take the time to identify and declare the appropriate ANZSIC code.

The Victorian Police audit of 432 auto-parts recyclers in Victoria stated that this represented about 90 per cent of the businesses in operation in that state. That suggests that there are as many as 480 businesses in Victoria alone.

The NMVTRC went on record for this study stating that there are about 600 businesses operating in NSW and the Australian Capital Territory (ACT), and another 300 in Queensland, which in combination with the Victorian operations suggests around 1,380 businesses in the three largest States in Australia. Given these three states contain around 76 per cent of the population of the country, that suggests, on a pro-rata basis, another 435 auto-parts recyclers could operate across Tasmania, South Australia, Western Australia and the Northern Territory.

This means that there could be 1,815 auto-parts recyclers across the country, or nearly twice the number that were visible in Yellow Pages counts and on public records that are used by researchers such as IBIS World.

This is consistent with information gleaned from interviews with David Nolan of the Auto Recyclers Association of Australia (ARAA), the Victorian Police and NMVTRC. Mr Nolan reported having more than 1,500 businesses on his database, although because of the grey area between parts recyclers and metals recyclers a minority of these businesses may be predominantly metal recyclers.

The Taskforce Discover report noted a number of 'phoenix' enterprises in the industry that acted effectively as 'pop-up' shops, setting up in a location for as short as a few months before closing down and then reappearing in a different area. These types of enterprises would not have registered in the IBISWorld study at all, and once again point to the extent of the 'informal' business activity in the industry.

However, even if the IBISWorld estimate of active business was only half of the actual number, it is logical to conclude that many of the enterprises that they did not count would be at the very smaller end of the scale, and some may be very short lived. Given this, it would not be prudent to suggest a total industry turnover of twice the IBISWorld estimate of \$2 billion.

Rather, for the purposes of this study, and in the absence of any better information, we assume that industry turnover is no less than \$2 billion in 2013 which, based on a total ELV population of 658,000 implies an average final ELV value of around \$3,040 each.

4.2.2 Metal recyclers – the final stop on the road

The final part of the reverse supply chain is scrap metal merchants and recycling companies. There are approximately 800 to 1,000 scrap metal merchants operating across Australia (KPMG 2014). These are mainly independent operators that receive scrap metal from kerbside scavengers (also referred to as small door traders), contractors (to LGAs and retailers), and service technicians. These companies mainly sell their scrap metal to the recycling companies after some rudimentary separation to recover any saleable items and more valuable metals, such as compressors and copper (KPMG 2014).

The main recycling companies are OneSteel, SIMS, Sell & Parker and Norstar. These companies operate 12 shredders in Australia. Most scrap metal is exported to China and South East Asia, but some recycled steel is used in the Victorian and NSW steel mills operated by Arrium and Bluescope.

An unknown number of the smaller scrap metal merchants also collect or receive ELVs. Some are actively involved in 'cash for cars' type advertising and will pay as little as \$50, and up to several hundred dollars, to someone to take away an unregistered or broken down car. Returns on sending a car to one of the major metal recyclers for crushing make this a quite profitable activity.

There is a grey area between some of the 'non-compliant' portion of the auto recycling business and scrap metal merchants, although those who are primarily metal merchants may only remove the obvious and easy to remove parts of an ELV that have higher value metals including batteries for lead, catalytic converters for platinum catalysts, and AC compressors for the copper content.

In cases where the smaller scrap metal merchants want nothing further, the chassis still containing the engine and all the running gear can be sold direct to a major recycler who has a mobile crusher and a shredding plant.

Shredding involves mechanical size reduction (literally tearing the vehicles apart into small pieces), followed by separation into metallic and non-metallic components by magnetic, eddy current, gravimetric, and other processes. At some shredders, the technology enables further separation into ferrous and non-ferrous components.

In NSW and Victoria most of the ferrous shredder output is sold to steel mills. It is not cost effective to transport the shredded metal interstate, so output from other states is exported to China and South East Asia for steelmaking (KPMG 2014).

Operators of mobile and stationary crushing plants and shredding machines routinely state that vehicles do not have refrigerant in them when they receive the vehicles, or the chassis. However, the majority of other participants interviewed in the reverse supply chain stated that any one of the major metal recyclers will accept a whole vehicle driven up to the gate, or dropped by a tow truck, and ask no questions about whether it contains refrigerant gas at the time of delivery. These contradictory statements by industry participants could possibly be resolved by conduct of random and unannounced auditing of vehicles arriving at crushing plants.

Figure 7 below illustrates the players in the reverse supply chain that manages this consumer waste stream, and the flows of goods and materials between the players.



5 Practices in the Auto Recycling Industry and Practical Obstacles to Refrigerant Recovery

5.1 Common Practice in the Auto-parts Recycling Industry

If an ELV reaches an auto wreckers yard with any remnant refrigerant on board the common practices employed in stripping cars effectively ensure that the gas will be lost to air at this point.

At the best managed sites, ELVs are disassembled to maximise return by recovering the maximum number of useful resalable car parts and the maximum materials, while at the same time managing pollutants and waste. If the ELV is a model where there is demand for the majority of parts, the disassembly process would normally involve:

- Identification of refrigerant type (i.e. HFC-134a, CFC-12 or HC) using a refrigerant gas analyser and marking the vehicle accordingly (i.e. no refrigerant, HFC-134a or waste);
- Draining and collection of waste oil and hydraulic fluids, and pumping down of refrigerant gas for resale or destruction;
- Removal of external panels and components still in good condition such as headlights, windscreens, windows, doors, bonnets, boots, fenders, grills, dashboards, seats;
- Removal of tyres and wheels;
- Removal of catalytic converters and MAC condensers for the platinum and copper values;
- Separation of the engine block from engine mounts and drive chain; and,
- Sale of chassis for crushing for scrap steel and, if the engine is not a sought after model, sale of the engine separately.

Better operations observed have undercover racking and storage for valuable parts and computerised inventories of parts available. They observe OHS laws and stack vehicles safely (i.e. when transporting or in yards), and may have hoists to raise the vehicle to facilitate the removal of oils and fluids before they are disposed of carefully. Tyres are sent to recyclers if they cannot be sold. Compressors are de-gassed before they are removed for metal recycling.

However, most auto-parts recycling firms in Victoria do not operate like this (evidenced by VP 2014, site visits, photos and interview records). In the most careless approach to the environmental outcomes, as described by industry participants, a forklift truck is driven into the front of the car and the engine block is essentially ripped from the chassis. The engine block might be loaded into a container for export, or just sold as scrap as it is worth more than the chassis. In the worst 'back yard' operations visited by the Expert Group for this study, the work sites look like trash heaps that were soaked in oils and where the ground was covered in glass, metal, rubber and vinyl sharps and glass shards. Extremely unsafe work practices were observed with unsecured vehicles precariously stacked on top of each other, unsecured racking, and burning drums of toxins meters away from pooling oil on a concrete floor at least several centimetres deep were just some of the easily identifiable unsafe practices. Industry participants claim they have seen vehicles stacked three high when transporting to site only secured with basic strapping. Operations with open disregard for observable breaches of the law are considered highly unlikely to have any regard for collecting and disposing of refrigerant unless there was some commercial benefit.

The series of pictures below were collected while Expert Group was accompanying the Victorian Police on visits to a number of auto-recycling businesses reviewed as part of the police *Taskforce Discover*.



During these visits Peter Brodribb from Expert Group interviewed business owners. The first impression was that they were all aware of the requirement to recover refrigerant gas, and most claimed that they did and were able to provide phone numbers of parties that had performed the work. These claims were later assessed to be fictitious.

Prior to the inspections accompanying police, Expert Group had conducted a series of 'blind' market surveys posing as individuals interested in buying a certain type of second hand compressor for a car. Twenty autorecycling businesses were contacted and engaged in a conversation about the availability of the part. During these conversations a typical response when asked if 'gas' needed to be removed before the part could be taken off a vehicle was, "there are a lot worse crimes being committed than letting out a bit of gas mate". In most of these conversations parts vendors soon became suspicious and were very guarded when questions were asked about handling refrigerant gas.

Interviews with industry members and representatives of the industry associations involved indicate that between 5 per cent and 10 per cent of industry participants are working to improve the image of the industry and change or eliminate common polluting industry practices.

A small number of these responsible industry participants, that together deal with at least 5 per cent of ELVs, were known to be active in recovering refrigerant gas. It must be noted however that even those industry members who strongly promote their environmental performance report that de-gassing costs them far more than they can recover from sale or re-use of the gas, and far more than they can recover via the RRA

destruction rebate paid for return of gas. One major participant explained the difficulty and obstacles in sourcing destruction cylinders for recovering refrigerant.

In a scenario where the recovery of refrigerant from MACs cannot be done profitably, and where the copper that can be recovered from condensers is worth much more than the refrigerant gas that can be recovered, it is likely that condensers will be ripped out of ELVs via the most expedient method available (which is generally to cut the connecting pipes with bolt cutters). Where this situation exists, refrigerant charge in ELVs will continue to be lost.

Even leading industry proponents interviewed for this study said that non-compliance with almost all controls and normal business practice was so wide spread in the industry, that the small number of exemplary enterprises were definitely the exception and not the rule. They also warn that while this is the case, those businesses that do work to comply with local, state or federal requirements are operating at a competitive disadvantage to those who pay no heed to the regulations.

Recoveries of refrigerant gas from ELVs, estimated at 19 to 20 tonnes per annum at most, are a fraction of recoveries of refrigerant gas that come from the stationary RAC industry, estimated to have been more than 400 tonnes in 2012 (KPMG 2014). Businesses operating on stationary RAC systems are wholly focussed on delivering an energy service dependent on the use of refrigerant. Maintenance of a refrigerant handling licence is essential to be able to participate in the RAC industry. As businesses are constantly dealing with refrigerant which has to be purchased and is a cost to the business, proper handling and management becomes part of day to day work practices.

On the other hand, despite being subject to the same licensing requirements as technicians and businesses in the broader RAC industry, refrigerant gas in the auto-parts recycling industry seems to be considered as a waste product with no meaningful value and is a very minor concern for auto-parts recycling businesses. The economic rewards in this industry result from the rapid processing and recovery of reusable auto parts and valuable metals, not from anything to do with the operation of MACs and safe handling of the refrigerants.

In the stationary RAC industry where the technical workforce deal with RAC applications and refrigerant gas all day, the focus on refrigerant management and recovery has to a great extent become standard practice. In the auto-parts recycling industry, it is a minor materials handling issue and a relatively expensive compliance issue for those who practice recovery, and effectively irrelevant for the majority that do not.

5.2 The Skilled Workforce

The ARC issues licences to qualified RAC technicians and authorisations to business operations that acquire, possess or dispose of synthetic refrigerant gases, including those that work with MACs.

As part of the RAC licensing scheme, licences are issued to technicians who satisfy competence standards for recovery of refrigerant from end-of-life equipment, but who may not be air conditioning or refrigeration mechanics as such. These are known as restricted refrigerant recovery licences.

There is also a class of licence for businesses who perform refrigerant recovery from 'end-of-life' equipment called a restricted refrigerant recovery trading authorisation (RTA). Several auto-parts recycling and metals recycling businesses hold these RTAs. Other auto-parts recyclers visited by Expert Group reported using restricted refrigerant recovery licence holders as contractors.

The ARC reported there are 285 restricted refrigerant recovery licence holders and 84 businesses that hold authorisations for refrigerant recovery. Some of the individual licensees are associated with some of the business licences so there is some double counting. The ARC could not confirm exactly how many of these licence holders were auto-parts recycling or metal recycling businesses.

Holders of these licences and authorisations were invited to participate in an online survey designed to understand more about the recovery rates of various refrigerant gases. After obvious repetitions were removed from the database provided by ARC, a total of 207 individuals and business were emailed with an invitation to complete the 25 questions of the survey. After 10 days, 38 responses had been received; a participation rate of more than 18 per cent.

Twenty-four of the respondents identified themselves as auto-parts recyclers or metal recyclers (>63 per cent) while seven (>18 per cent) identified as specialist refrigerant recovery businesses. Twenty respondents said that recovery of refrigerant comprised less than 10 per cent of their business, which one would expect if they were primarily auto-parts or metals recyclers. More than half of the respondents only recovered refrigerant from end-of-life vehicles.

Sixteen respondents (42 per cent) worked solely for auto-parts recycling businesses, two worked only for a smash repairer or panel beater while only one worked solely for a metal recycling business. Five respondents worked solely for a local government authority. None of the respondents did any work recovering gas from the salvage divisions at auction houses.

More than one third of respondents said that none of the gas recovered could be re-used. More than 20 per cent said that about half could be re-used, seven (18 per cent) said that between 70 per cent and 90 per cent of recovered gas was good enough to be re-used and four (11 per cent) respondents said that all of the gas could be used. Yet only five respondents (13 per cent) said that they tested the gas they recovered.

Four respondents said they sell between 10 per cent and 30 per cent of the refrigerant recovered to refrigeration mechanics, while one said that all recovered refrigerant was sold to refrigeration mechanics. Five respondents said they sold between 10 per cent and 70 per cent of refrigerant recovered to wholesalers for re-use while four said that they sold all recovered gas to wholesalers for re-use. Thus 14 respondents reported selling at least some of the recovered material to the trade for re-use. While undertaking site inspections, Expert Group observed smash repair workshop names on recovery cylinders destined for re-use. However, one major participant noted they had not sold any refrigerant since July 2014 since the removal of the Equivalent Carbon Price (ECP) and planned to lower prices by 50 per cent to clear some stock.

Twenty-four respondents (>63 per cent) said that they sent 100 per cent of recovered refrigerant to be destroyed as part of the RRA scheme and a further six said that they sent between 10 per cent and 90 per cent of recovered gas to RRA for destruction. Thus, it would appear that the majority of gas recovered by the respondents is being sent for destruction through the RRA stewardship program.

Of the 22 respondents that provided an estimate of the gas they recovered each month, the level of recoveries ranged from 300 kg per month to just 1kg per month. The average across the 22 respondents was 37 kg per month with about half collecting between 10 kg and 30 kg a month and eight collecting less than 10 kg per month. The average annual recovery of all respondents was around 440 kg a year, although one of the largest auto-parts recyclers active in this area reported recovering as much as 2.5 tonnes per annum.

While only 22 respondents volunteered a level of monthly recoveries, 25 provided an estimate of the time it takes to degas a vehicle, which ranged from just three to 45 minutes, the average being 16 minutes and the vast majority estimating between five and 20 minutes per vehicle.

The same 25 respondents offered estimates of time required to degas 10 vehicles on one site with the average of estimates being about 2 hours and 40 minutes – or once again an average of 16 minutes per vehicle.

All 38 participants responded to a question about what percentage of vehicles were found to have no gas at all and 18 (>47 per cent) said that they found that only 10 per cent were empty, while another five said 20 per cent were empty. Seven respondents said they found 30 per cent to be empty. Thus nearly 70 per cent of respondents reported that no more than 30 per cent of ELVs were empty. This is very different to the sample of more than 28,000 vehicles from the auction houses where almost 60 per cent of vehicles were empty.

Further detailed one-on-one interviews with some auto-parts recyclers indicated that the real number would be closer to 30 per cent than to 10 per cent and, to be conservative, the authors have assumed that one third of ELVs going to wreckers are empty.

Twenty-five of the respondents, essentially two thirds of them, said they recovered refrigerant gas because it was purely a legal requirement to do so. A further seven, or 18 per cent, said that it was a standard part of the service they offered. Eight respondents (24 per cent) said that they recovered gas to make money, selling it either to the trade or returning it for destruction, and five said they were paid by a third party to recover gas.

Fifty per cent of respondents said it was worth less than \$25 to them to recover gas from an ELV, and 36 per cent said they did not know what it was worth. Only five said it was worth more than \$25 to them to recover

gas from an ELV, almost certainly the same five who reported being paid by a third party. Interviews by Expert Group confirmed that typical prices paid were \$20 per kg for regular customers, and that the price had dropped to \$10 per kg following the removal of the ECP.

A question asking if there were any types of vehicles that were difficult to recover gas from attracted 15 responses and none of them reported any technical or design obstacle to recovering gas.

In response to a question about difficulties encountered when visiting wreckers' yards or auction houses, only one respondent said that stacks of cars were sometimes too dangerous to get access to and others noted that auction houses simply did not do any degassing. One respondent noted that in the Northern Territory there was no concern about gas recovery and pipes to compressors were just cut, and another noted that he did not think wreckers' yards actually employed recovery specialists, although they might claim they did as a "legal get around".

When asked at what point in the recovery chain was the best time to recover refrigerant from ELVs, several respondents said that it should be recovered at the auction houses before 'back yarders' and small time operators purchased the vehicle for stripping. Some respondents who run auto-parts recycling facilities said that it was best to do all the decommissioning at the same time, when oils and other materials were being removed.

Further comments offered at the end of the survey expressed some frustration with the lack of enforcement of existing regulations and the effect of the lack of enforcement on those who do the right thing. Some respondents perceived that the unscrupulous apparently run no risk of prosecution. This irritated some respondents who advised that they are investing time and effort, at their own cost, to comply with regulations that they felt were not enforced.

Respondents were asked for any suggestions that would make the recovery of refrigerant more valuable for them, or to ensure that more refrigerant is recovered. A few simply suggested that more be paid for returned refrigerant to make it worth recovering. Several said that enforcement of existing regulations on those autoparts recyclers who were not licensed would help. One suggestion was a rebate to cover the cost of replacing the recovery equipment regularly, as it was hard working equipment that often needed replacement. Another suggestion was to specify standardised recovery equipment (it is assumed to make it simpler for people to learn to use and make that skill transferable) and to enact a system of 'site licensees' while making it easier to get a licence to recover.

Finally, one respondent suggested that insurance companies be forced to have vehicles that were written off degassed before they were allowed to be auctioned. However it must also be noted that in the course of industry interviews it was stated on a couple of occasions that insurers did not want vehicles degassed because they were seen to be more valuable at auction if they had gas in and the MAC worked.

To put the value of recovered gas in context, even if the volume of gas recovered from the average vehicle found to contain gas was 600 grams (i.e. almost a full charge), the rebate earned returning that to the RRA scheme is less than \$3.

Based on the average sourced from the survey of 16 minutes to recover refrigerant from an ELV, and working on the lowest likely all up wages cost for a worker to do that task of \$24 an hour, it is going to cost at least \$6 in wages not including all of the equipment costs and other costs of operating a business. Autoparts recyclers who were interviewed were very clear that recovery of refrigerant cost them a lot more than it was worth.

5.3 Regulation and Compliance

From the 1940s when car ownership rates began to climb strongly, up to the late 1970s, the auto-parts recycling industry developed in a largely unregulated environment. The industry has been managing a consumer waste stream that, for at least the last three decades, has been sufficiently valuable to ensure that the market removed the majority of ELVs from Australian streets and has increasingly diverted material from landfills.

Over more recent decades, the auto parts recycling industry has been required to comply with a wider range of business and environmental regulations. This study identified three main areas of regulation that have developed that impinge on the management and use of ELVs. However, it is only rarely, and in limited jurisdictions, that auto-recyclers are subject to regulation specifically targeted at that industry.

Commercial licensing for the sale of motor vehicles and of second hand goods in all states and territories are generally consistent. The sale of second hand goods, a core activity for auto recyclers, is subject in each state and territory to licensing that requires a degree of record keeping sufficient to identify the seller and any buyer of second hand goods from the dealer. These licences also generally carry 'conditions of good character' that allow them to be withdrawn if fraudulent or criminal activity is engaged in. Motor vehicle traders' licences also require that the recording of the details of all purchases and sales of motor vehicles are sufficient to allow the identification of the source of, and the eventual buyer of any register-able road vehicle.

A second layer of regulation, generally the responsibility of local government agencies, relates to the planning permissions required for certain types of business facilities and activities. Local government planning requirements for businesses engaged in polluting or unsightly activities often cross with state planning and environmental rules relating to stormwater run-off into stormwater systems and natural water ways, and release of certain pollutants into soils.

There are also the nationally consistent rules, enforced by the equivalent of the roads and traffic authorities of each state and territory, regarding the reporting of damaged vehicles into the Written Off Vehicles Register (WOVR) maintained under the National Exchange of Vehicle and Driver Information System (NEVDIS). This database includes the national Vehicle Identification Number (VIN) database as well as the WOVR. How vehicles are entered into the WOVR and the operation of the register is explained in more detail in *Appendix B*.

Those industry participants looking to export ELVs or half-cut vehicles for recovery or final disposal will be subject to requirements of the *Hazardous Waste (Regulation of Exports and Import) Act 1989.* This legislation regulates the export and import of hazardous waste to ensure that it is disposed of safely both within and outside Australia, so that humans and the environment are protected from the harmful effects of that waste. This legislation requires that a permit be obtained before hazardous waste is exported from Australia or imported into Australia.

Nationally consistent OHS requirements of workplaces also apply to the operation of auto recycling facilities.

Finally regulation under the Act that dictates that it is illegal to emit ODS and SGGs to air are also applicable to auto recycling businesses, for which purpose some auto recyclers have take up licences to recover and handle refrigerant and others at have at least a commercial relationship with a licence holder.

Despite this range of regulatory controls, all the anecdotal evidence gathered in the course of this study suggests the majority of ELVs are being processed in an unregulated and, in many cases, highly polluting manner. Industry participants, regulators and law enforcement agencies involved in this study have all advised that many industry participants are operating with essentially no concern for workplace safety, environmental controls, or financial arrangements generally expected of compliant and legitimate businesses.

Further, all participants interviewed indicated that elements of the industry are also on the edge of facilitated criminal activities, such as car theft, vehicle insurance fraud, money laundering and receiving stolen goods.

A taskforce of the Victorian Police, "Taskforce Discover", which forms part of the vehicle crime squad, recently conducted an extensive investigation of the industry and its links to vehicle theft, criminal gangs and export markets.

Taskforce Discover assessed that 70 per cent of the 432 businesses inspected during its investigation were either not holding the required authorisations to trade in Victoria, or were non-compliant to some degree, and that 90 per cent were non-compliant with OHS and environmental regulations to some degree. The audits led to 41 businesses being reported for environmental breaches resulting in serious and ongoing pollution to soil and waterways.

The police noted that the level of non-compliance and the lack of record keeping in the motor wreckers and scrap metal industries in Victoria either deliberately or unwittingly facilitated profit-motivated theft. This characteristic of the industry created serious obstacles to tracking the chain of custody of vehicles and their disposal.

Enforcement of any regulation is also made more difficult by the industry structure. The IBISWorld industry report from January 2014 stated that the industry is, "characterised by hundreds of small players, none of which are public companies", and that "industry players are typically small, sole proprietor businesses... involved in a number of areas, including DIY (i.e. pick a part yourself), used part dealing (through large used car yards), vehicle dismantling, car wrecking, used parts retailing and recycling" (IBIS 2014b).

IBISWorld estimated that no single operator held a market share greater than 2 per cent of the industry and that the top four operators in aggregate had a market share of less than 5 per cent. Barriers to entry to the industry are very low, particularly for the 'backyard operator'.

There were some positive and interesting observations relevant to this study from the IBISWorld report including that, "The more astute operators in the industry are using environmental factors and general interest in recycling to promote and expand their businesses". And further that, "There has also been a concerted push among players to clean up the junkyard image of the industry. This can be seen in areas such as the provision of warehousing for car bodies and parts, rather than on lots in the open, guarantees on all parts and accessories sold and the increased use of new technology (e.g. hotlines), etc". These trends are being complemented by the computerisation of stock inventories and "the development of credit and account facilities for reliable customers, rather than a cash only basis".

The IBISWorld observations of an emerging environmental edge to some marketing, and an increased focus on customer service are potentially very important trends. The fact that it was noteworthy to mention the recent move away from a 'cash-only' basis, at least by some of the large players, speaks volumes about the widespread 'cash-only' business practices in the industry.

The improvements noted by IBISWorld were also echoed by industry observers interviewed for this study who could identify a few well established and reputable industry participants, some with many processing facilities and wholesale and retail outlets in several states, including some that operate under franchising models sharing marketing costs and expertise to open in new territories.

The large participants that invest in management of the many types of wastes that result from the dismantling and parts recycling process, and who work hard to comply with at least their local and state and territory governments' environmental and business trading conditions, are at a competitive disadvantage in purely mercantile terms as compared to the operators who pay no regard to environmental or other regulatory and business or legal requirements.

Further, the large unregulated and non-compliant portion of the industry (refer *Appendix C Australian Metal Recyclers Industry Association Media Statement* on non compliant businesses), the cash economy, and that vehicle theft and stripping for parts to sell is a 'bread and butter' and relatively low risk activity for habitual criminals, allows a criminal element to thrive on the fringes of this at least \$2 billion dollar a year industry.¹³

¹³A recent article in The Age newspaper explores some of the range of criminal activity that has been identified associated with *ELVs* and the disposal of stolen vehicles <u>http://www.theage.com.au/national/-10p9qi.html</u>

6 Future ELVs

The Expert Group ELV Model (described in detail in *Appendix A*) forecasts a steady rise in the numbers of ELVs per annum over the projection period, rising from approximately 600,000 in 2008 to more than 900,000 in 2025, an increase of more than 50 per cent



The result of this steady rise in ELVs per annum is projected to result in more than 10 million ELVs in total coming out of the fleet of vehicles in the 12 years from 2013 to 2025 inclusive.



Projections of the future environmental impact of the pool of residual refrigerant in the EVL population reveal several important trends.

The total GWP of the entire bank of refrigerant gas in the Australian economy is predicted to fall in the projection period as low and zero GWP gases become more widely employed in a number of major applications. The estimated change in the bank is notably led in the next few years by increases in refrigerants with a GWP less than 10 in MAC applications such as HFO-1234yf.

Projections of total tonnes from all applications across the economy are illustrated in *Figure 11* below. This projection shows the trends of different refrigerant types and the expected significant increase in low and zero GWP gases categorised as GWP <10 on the chart.



When viewed through the end-use applications in the stock of equipment and the common denominator of the CO_2 equivalent of all of the gases employed the decline in the total GWP of gases in MAC is clearly illustrated.



Projected increases in vehicles charged with a refrigerant with a GWP less than 10 can be seen in the wedge in the chart below equating to more than 35 per cent of the bank in 2025. The Expert Group ELV Model and refrigerant bank projection also suggest the long tail of older cars with charges of CFC-12 and no MAC will continue operating in the fleet and slowly retiring into the ELV population almost to the very end of the projection period.



This age distribution of the fleet with the long flat tail of older vehicles (shown in *Figure 1*) combined with the large existing bank of high GWP SGGs and CFC-12 contained in the fleet, means that as the overall GWP of the annual consumption of refrigerant in MACs falls in line with the expected growth in refrigerants with a GWP less than 10, relative contribution of ELVs to direct annual emissions from the sector increases.

By the end of the projection period, approximately 425 kt, more than 50 per cent of the potential total direct emissions from the sector, are projected to be from ELVs.



1. The above graph illustrates potential emissions from all ELVs and does not deduct 10 per cent to account for existing recovery levels as this could change with different measures into the future.

The high GWP bank working through the fleet is projected to remain in ELVs and is noticeable throughout the projection period even compared to total annual consumption for all RAC applications in Australia, which in GWP terms will fall overall.



1. The above graph illustrates the potential emissions from all ELVs and does not deduct 10 per cent to account for existing recovery levels as this could change with different measures into the future.

The total potential cumulative releases to air of residual refrigerant from ELVs in the projection period are estimated to be more than 3,050 tonnes of high GWP refrigerant.

In CO₂e terms, direct emissions of residual refrigerant from ELVs in the projection period is expected to total more than 4.88 Mt ($22\%^{ODS}$ and $78\%^{SGG}$) just over half of a full years consumption of refrigerant gas in all applications in 2013.



7 Conclusions

The approximately \$2 billion a year auto-parts recycling industry manages most of the consumer waste stream of ELVs in Australia and the recovery of valuable materials from the Australian ELV population. Most of the materials are recovered and some of the auto-parts and some of the vehicles themselves are exported from Australia.

This study estimates that a majority of residual refrigerants in ELVs (90 per cent) are emitted to air in Australia in the course of the dismantling and recovery of the valuable spare parts and recyclable materials contained in the population of ELVs.

As the value of the recovered gas is so small compared to the value of the other materials in an ELV, and the cost of properly extracting the gas and reusing it or returning it for destruction is relatively high for the majority of participants in the auto-parts recycling industry, there is no economic incentive to recover refrigerant gas.

Most participants are aware of the requirement to recover gas, however, they also consider that they face very little risk of any sanction or penalty for not complying with the requirement.

Alongside the many other non-compliant, 'informal', unregulated, and in some cases criminal aspects of the auto-parts recycling industry, the issue of refrigerant gas emissions is near to irrelevant for the majority of participants on a day-to-day basis.

A small portion of the industry, who process as much as 10 per cent of the ELV population per annum, are very good operators who work hard to both comply and record their efforts. These participants see themselves as doing an environmental good, although they also consider that they are doing so at their own cost, and that to do so puts them at a competitive disadvantage with regard to the rest of the industry.

Nearly all of the gas recovered from ELVs is sent for destruction. A small percentage of recovered gas is resold or reused. Given the specialised equipment required, the cost of recovery, and the value of the end product, it is unlikely that there is any material quantity being recovered from ELVs illegally and resold or reused. The value of the copper in the condensers is worth more than the gas in the condensers. The removal of the ECP may reduce resales marginally from a very small base, and if anything would further reduce any incentive for illegal degassing.

A small and still uncertain volume of direct emissions is the result of vehicles being crushed and shredded without having been degassed. Large metal recyclers are aware of the requirements, but claim that they simply never crush cars with refrigerant gas in them, and appear to have business structures in place that places any responsibility for handling refrigerants at arms-length and insulates them from the responsibility to investigate if they receive vehicles that contain refrigerant gas.

Similarly, insurance companies, that handled approximately 15 per cent of ELVs in 2013, appear to pay little heed to the presence, or not, of refrigerant gas in the cars they control during the process of assessing and writing insured vehicles off. Other industry participants pointed out that by leaving any refrigerant gas in place in an ELV, insurance companies both avoid the additional cost of removal, as well as potentially achieving a marginally higher return at auction or sale if the MAC is shown to be working. Whether insurance companies and their auction agents, are even aware of, or consider the issue of residual refrigerant as being in anyway their concern is uncertain.

A better understanding of any real opportunity to improve the management of residual refrigerants in ELVs by major metal recyclers, insurers and possibly auction houses, could be developed by developing professional and open relationships with the main players in these sectors and working with them to understand the obstacles and opportunities while ELVs are in their hands.

Many participants in the RAC industry and workforce appear to be aware of the fate of residual refrigerant gas in ELVs, specifically, that it is largely emitted. The effect this has on the RAC industry, and the impact it has on the credibility and value of the refrigerant handling licensing systems in Australia should not be underestimated.

However, ultimately, the fate of the hundreds of tonnes of remnant refrigerant in ELVs every year in Australia is tied to a much larger economic dynamic of the automotive industry and the management of the millions of tonnes of wastes and valuable commodities that result when ELVs are processed.

Encouraging initiatives by industry leaders in the auto-parts recycling industry are unlikely on their own to have a great effect on the volumes of gas recovered. Effective management of the majority of the remnant refrigerant pool in ELVs may need something as far-reaching and ambitious as an automobile product stewardship program to be introduced into Australia.

8 References

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ABS 9314.0 2014	Australian Bureau of Statistics, catalogue 9314.0, Sales of New Motor Vehicles, Australia, 2014.
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Appendix A

ELV model data sources and explanation

A model has been developed to predict volumes of ELVs per annum by refrigerant type (i.e. no-MAC, CFC-12, HFC-134a and low GWP refrigerants with a GWP <10) out to 2025.

The ELV model is a stock and retirement model based on the cumulative distribution function of a normal distribution with mean (μ) and standard deviation (σ) and a cumulative distribution function of a uniform distribution for the upper tail. The form of this model was chosen and the parameters of the distributions estimated using new vehicle sales from 1945 to 2025 and the age distribution of vehicles in the ABS Census of Motor Vehicles, 2014. This model is used to estimate and predict vehicle stocks in each year and ELVs per annum by refrigerant type based on year of manufacture. The survival curve is illustrated in *Figure 17*, which is a normal distribution with a mean retirement age of 18.6 years and a standard deviation of 6.2 years up to age 27, then uniform distribution out to age 64 years where it hits 100 per cent of retirements. *Figure 18* shows a comparison of the fit of the model age distribution in 2013 versus the ABS TableBuilder data.

The primary data sources used to develop the ELV model, annual stock levels and ELVs include:

- ABS Census of Motor Vehicles, 2014, TableBuilder. This provides the age distribution of (based on year of manufacture) vehicles at 31 January 2014 (i.e. assume equivalent to end of 2013) to develop a survival curve.
- ABS Catalogue 9309.0, Census of Motor Vehicles undertaken annually from 1955 to 2014 with some exceptions (i.e. 2000, 1994, 1992, etc.) based on motor vehicle registrations as well as ABS Catalogue 9311.0 Motor Vehicles in Australia. The Motor Vehicle Census (MVC) is a count of all in-scope vehicles registered with State or Territory motor vehicle registration authorities (MVR). *Figure 19* provides a comparison of the model stock versus ABS registrations plus a stock prediction out to 2025.
- Federal Chamber of Automotive Industries, VFACTS new vehicle sales from 2006 to 2013. New vehicles sales from ABS Catalogue 9314.0, other ABS vehicle registration publications with linear projections to estimate missing data points back to 1945. The new sales data used in the model is provided in *Figure 20*.









ELV model prediction versus ABS attrition

The ELV model calculates the number of units of a particular vintage that remain in service (the stock) in the middle of a given year and the number of units that are scrapped in the given year from each previous year.

Analysis of the age distribution and sales data supports the use of the chosen scrapping curve. The model assumes that on average, units are sold in the middle of a year. So for example, the number of units that were sold in the year 2000 that remain in service at the end of 2012 is given by, N_{2000} (1-p₁₂), where N_{2000} is the number of units sold in 2000, and p_{12} is the proportion that have been scrapped between 2000 and 2012 inclusive and is given by the following function:

Φ (2012 – 2000 + 0.5; μ, σ) = Φ (12.5; μ, σ)

Where Φ (x; μ , σ) is the cumulative distribution function (CDF) of the normal distribution with mean μ and standard deviation σ evaluated at x.

The number of units of a particular vintage that are retired in a given year equates to the number of units sold in the year of the vintage that remained in service at the beginning of the given year, minus the number that remain in service at the end of the given year.

The historical sales data is dissected by refrigerant species or type to predict the refrigerant mix of the bank and retiring equipment.

The ABS has published vehicle attrition rates and numbers of vehicles intermittently from the 1950s to 2014, also referred to as the motor vehicle retirements or scrappage, which are essentially the ELVs providing the vehicle definitions align.

The most recent publications of attrition rates can be found in ABS Catalogue 9309.0, Motor Vehicle Census (MVC) that calculates vehicle retirements based on the estimated proportion of motor vehicles taken off the register since the previous MVC. The number of registration lapses is calculated by adding the total registrations at the earlier MVC to the number of new motor vehicle sales between the MVCs, and subtracting the total registrations at the later MVC.

The attrition rate measures the number of registration lapses as a percentage of the total potential vehicle fleet, where the potential vehicle fleet is the number of registrations at the first MVC date plus the number of new motor vehicle sales between the two MVCs. The vehicle attrition rate has ranged from 3.5 per cent of the fleet to 5.5 per cent over this period, however has an average of 4.0 per cent over the last six years.

The ABS calculations include passenger vehicles, light commercial vehicles, campervans, light rigid trucks, heavy rigid trucks, articulated trucks, non-freight carrying vehicles and buses. An evaluation of the existing fleet from 2008 to 2013 shows that passenger and light commercial vehicles equated to 96 per cent. Therefore a multiplier of 0.96 was used to scale ABS attrition estimate for all vehicles to provide an estimate for passenger and light commercial vehicles.

Figure 21 provides a comparison of the model ELVs volumes to the ABS attrition estimates, and provides a projection of ELVs to 2025.



Appendix **B**

The National Exchange of Vehicle and Driver Information System and the Written off Vehicle Register

Summary

All state and territory jurisdictions have collectively developed and implemented changes to legislation and regulations to better manage written-off motor vehicles with the medium term aim of standardising management and record keeping relating to written off vehicles. The adopted changes were developed through consultation subsequent to a review of the management of written-off motor vehicles conducted in 2008 by the National Motor Vehicle Theft Reduction Council (NMVTRC).

The central repository of the information on written off vehicles is the National Exchange of Vehicle and Driver Information System (NEVDIS). This database includes the national Vehicle Identification Number (VIN) database and the national Written Off Vehicle Register (WOVR) database.

State and territory road agencies are the source of NEVDIS data although the decision to classify a vehicle as a write off is made by professional vehicles assessors, almost always in the employ of insurance companies.

If a vehicle has comprehensive insurance and it is seriously damaged as a result of a collision, or an event such as flooding or fire damage, the insurance assessment process may determine that the vehicle is a total write off and beyond repair.

Under Australia's national framework for the management of written off vehicles any vehicle must be classified to be either a Statutory Write-Off (SWO) or Repairable Write-Off (RWO) if it has been determined to be a total loss by an insurer or other notifier as a result of:

- Damage induced by a collision, fire, water inundation, other weather event, malicious action; or
- Dismantling or stripping.

The range of persons defined as 'notifiers' is specified in the related laws of each jurisdiction however it can include insurers, self-insurers, auction houses, motor car traders, automotive dismantlers or recyclers or even vehicle owners.

Types of Written-Off Vehicles

Total Loss

- Where the cost of repairs and salvage value exceed the market value of the damaged vehicle it is classified as a 'total loss'.
- Damaged vehicles that are a 'total loss' may be classified as either a 'repairable write-off' or a 'statutory write-off'.

Repairable Write-Offs

 Vehicles classified this way may be re-registered anywhere in Australia as long as they meet all repair and inspection requirements. A RWO may be repaired and re-registered subject to the vehicle passing specific safety and identification inspections.

Statutory Write-Offs

• Vehicles classified this way may not be re-registered in any jurisdiction. A SWO may only be sold subject to a statutory restriction that it may only be used for parts or scrap metal.

Ownership Of Written-Off Vehicles

Once classified as write-off ownership of the vehicle passes to the insurance company, or remains with the original vehicle owner if they are a self-insurer.

Written-Off Vehicle Register

When a vehicle is written-off, information about the incident, the vehicle damage, and the category of writeoff must be recorded against the Written-off Vehicle Register (WOVR). All jurisdictions maintain a WOVR and information is shared nationally.

Limited Exemptions

Limited exemptions are available for hail damaged vehicles, inherited vehicles, and where the applicant was the registered operator of the vehicle for more than 28 days prior to the damage occurring. But, statutory write-offs cannot be re-registered in any jurisdiction.

Written-Off Warning label

A Written-Off Warning Label must be attached securely in a conspicuous position to all vehicles that have been classified as write-offs.

The warning label must include the following statement: Statutory written-off vehicle – available for parts or scrap only – limited exemptions apply

An example of the regulatory definition of a written-off vehicle is included below, extracted from the NSW legislation.



State Legislation

As noted, legislation covering written-off vehicles is nationally consistent. The definitions and description below are extracts from the NSW Road Transport Act (2013), as an example of what appears in all state and territory jurisdictions.

Definition Of A Written-Off Vehicle

(Extract)

1.11 ROAD TRANSPORT ACT 2013 - SECT 83

NSW written-off vehicles register

1.111 83 NSW written-off vehicles register (cf VR Act, s 16B)

(3) In this section "written-off vehicle" includes any vehicle:

(a) that has been assessed to be a total loss by a person in accordance with Division 3, or

(b) that has been disposed of to an auto-dismantler by a self-insurer, or

(c) that has been demolished or dismantled by an auto-dismantler, or

(d) that is in the control of an auto-dismantler and is intended to be demolished or dismantled, or

(e) that was recorded on the register of written-off vehicles on the day on which Part 2AA of the Road Transport (Vehicle Registration) Act 1997 commenced, or

(f) that is prescribed by the statutory rules.

ROAD TRANSPORT (VEHICLE REGISTRATION) REGULATION 2007 - REG 83B

Meaning of "written-off vehicle"

83B Meaning of "written-off vehicle"

For the purposes of paragraph (f) of the definition of "written-off vehicle" in section 83 (3) of the Act a notifiable vehicle that has been assessed, in a vehicle damage assessment, as not being a total loss is prescribed if:

(a) the vehicle has non-repairable damage and the insurer has decided not to repair the vehicle, or

(b) the insurer has decided not to repair the vehicle and intends to sell, or has sold, the vehicle to a person other than the registered operator of the vehicle at the time the vehicle sustained the damage that resulted in it being presented for the vehicle damage assessment.

Assessment And Notification

A full explanation of the assessment criteria and notification requirements can be found here:

NSW RTA Written Off Vehicles - Assessment And Notification

http://www.rms.nsw.gov.au/registration/downloads/assessment_and_notification_of_writtenoff_vehicles_vfinal.pdf

Recent Reforms

All state and territory jurisdiction have agreed to maintain nationally consistent legislation. A description of recent reforms and regulatory updates can be found here:

NSW 2013 law changes

http://www.rms.nsw.gov.au/registration/written_off_vehicles/written-off_vehicles_reforms.html

Other Jurisdictions

These links are to the nationally consistent legislation in various states and territories. An effort has been made to highlight various sections of the legislation including: the written-off vehicle register; how to write off a vehicle; frequently asked questions; and the repairing of written off vehicles.

Victoria:

http://www.vicroads.vic.gov.au/Home/Registration/WhatHasToBeRegistered/Written-off+Vehicles/

Queensland:

http://www.tmr.qld.gov.au/Registration/Registering-vehicles/Written-off-vehicles/Written-off-vehicle-register.aspx

Tasmania:

http://www.transport.tas.gov.au/registration/information/written_off_vehicle_register_questions_and_answer

South Australia:

http://www.sa.gov.au/__data/assets/pdf_file/0013/11236/MR78.pdf

Western Australia:

http://www.transport.wa.gov.au/licensing/write-off-a-vehicle.asp

Northern Territory:

http://www.transport.nt.gov.au/__data/assets/pdf_file/0007/19609/V54-NT-Written-off-Vehicle-Register-WOVR-Dec-2012.pdf

Australian Capital Territory:

http://www.rego.act.gov.au/registrations/regowovregistration.htm - Repairing_a_written-off_vehicle

Car Safe – National Motor Vehicle Theft Reduction Council

Further information regarding the nationally consistent framework for assessing the damage and managing written-off vehicles can be found at the sites below:

Criteria for the Classification of Statutory Write-Offs:

http://www.carsafe.com.au/images/stories/pdfs/2011_reports/NMVTRC Technical Guide High Res Web.pdf

New Damage Assessment Criteria for the Classification of Statutory Write-Offs – Frequently Asked Questions:

http://www.carsafe.com.au/images/stories/pdfs/2013 Reports/New Damage Assessment Criteria FAQs - Sep 2013.pdf

Auto check – This is a site where prospective buyers may check the credentials of vehicles for sale:

https://www.autocheck.com.au/

Appendix C

Australian Metal Recyclers Industry Association Media Statement

AMRIA is an incorporated body representing independent scrap metal recycling businesses across Australia.

AMRIA and its members are aware scrap metal theft is a global and local problem that results in significant impacts on the community.

AMRIA and its members co-operate and communicate regularly with authorities in relation to matters involving metal theft and unregulated, unlicensed businesses that undermine legitimate business activities of members in the industry.

AMRIA has a theft reporting system to notify its members of metal thefts.

Authorities are invited to send information or theft reports to AMRIA that are on forward to members for assistance.

AMRIA is aware there are a large number of unregulated scrap metal recycling businesses "operating under the radar" across Australia, who do not run their businesses to the same standards and regulations as members.

Standards include holding the appropriate council planning permit to undertake material recycling, holding the appropriate state second-hand dealers licence, record keeping and identity recording for metal recycling retail transactions.

These unregulated unlicensed businesses provide an avenue to handle and export stolen metals out of Australia.

AMRIA has expressed concerns to government, councils and authorities that whilst these unregulated and unlicensed businesses are allowed to continue to operate, the problem of metal theft will continue to occur, even flourish and impact on the community.

<u>A starting point or solution</u> is for authorities to start closing down non permitted, unregulated, unlicensed businesses and drive scrap metal recycling transactions through regulated businesses where monitoring occurs.

(Prepared for ABC South West Mornings interview request September 2014)