Sustainability Victoria

End-of-life motor vehicles

Market snapshot 2007

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1 Introduction

End-of-life motor vehicles (ELV) are a significant contributor to waste volumes. Every year, over 500 000 vehicles in Australia reach the end of their life and enter the waste stream.

The number of ELVs arising in Australia each year is likely to increase at an escalating rate as the result of a continuing upward trend in the rate of vehicle ownership, the decreasing average age of vehicles at end-of-life, the declining cost effectiveness of owning older vehicles and the declining cost of new cars.

As the number of ELVs continues to increase, the proportion being recycled will need to be maximised to limit environmental impacts and resource loss.

At the moment, the most common method for ELV recycling involves dismantling of vehicles and removal of parts that can be sold for reuse, removal of potential environmentally damaging materials, shredding of metal content and the residual materials.

The main output from the shredding of car bodies is ferrous and non-ferrous materials.

The residual mixture, once the metal content has been removed, is classified as 'shredder floc' which is not recycled but disposed of to landfill as waste. This material is made up of plastics, rubber, glass, dirt, carpet fibres and seat foam.

With the increased use of plastics in new vehicles, the metal content will continue to decline leading to increased levels of shredder floc. Shredder floc is a key area of potential environmental concern in relation to ELVs.

1.1 Project purpose

The Victorian Government's *Sustainability in Action: Towards Zero Waste Strategy* sets priorities for waste and resource management in Victoria over the next 10 years. The Strategy identifies the need to increase the recycling rate from the Municipal and Commercial and Industrial sectors to 65% and 80% by 2014, respectively.

The Strategy assigns priority to a range of products offering significant capacity for improved resource recovery and/or reduced environmental harm when disposed of, as well as the additional emphasis on shared responsibility across the product life cycle. Motor vehicles have been identified in the Strategy as a key priority product.

In the lead up to the mid-term review of the Strategy, Sustainability Victoria has identified the need to develop supporting documentation on the status of motor vehicles to inform their strategic decision-making about the need to intervene to ensure that Victoria accomplishes the Strategy's objectives.

This study aims to inform Sustainability Victoria on how or whether to initiate programs to manage the end-of-life impacts from motor vehicles.

Proposed key outcomes of the study include:

- Enhanced understanding of consumption of motor vehicles in Victoria;
- Trends in use;
- Key materials used in the manufacture of motor vehicles – historically and currently;
- Quantification of motor vehicles and vehicle components entering the waste stream;
- A comprehensive understanding of the different disposal methods;
- Stakeholder identification;
- Literature review on local and international experiences;
- Identification of barriers to motor vehicle recovery;
- Economic value of ELVs; and
- Summary of possible future pathways.

2 Study Outline

The following is a summary of the project methodology undertaken for the study into end of life vehicles.

2.1 Desktop Review

A desktop review was undertaken to develop an understanding of the following issues at a local, national and international level:

- Trends in use of motor vehicles;
- Key materials used in the manufacture of motor vehicles;
- Implications of different disposal methods;
- Initiatives and approaches to improve ELV management;
- Barriers to improved recovery and recycling;
- Economic value of ELVs;
- Life cycle assessments and their relevance to the Victorian context; and
- Storage and dumping of motor vehicles.

Sources examined during the desktop review of these issues included websites and reports produced by:

- Vehicle manufacturers;
- Industry groups from the automotive, recycling/ disposal, and materials manufacturing industries;
- University research groups;
- Industry research groups; and
- Local, State and Federal Government departments.

The quantification of motor vehicles in Victoria, including sales, use and recycling/disposal using resources from the following sources:

- Australian Bureau of Statistics;
- Industry bodies;
- Retail sales data; and
- VicRoads.

2.2 Stakeholder Consultation

Relevant stakeholders were consulted by phone, email and where possible, face-to-face meetings to discuss the issues outlined in Section 2.1. Face-to-face meetings and follow-up phone conversations were held with metal recyclers and representatives from the dismantling/ parts reuse industry. Email and phone conversations were held with representatives from local government and land management authorities around Victoria to gain an understanding of the level of dumping of motor vehicles.

3 Market Snapshot of Motor Vehicles in Victoria

A flowchart depicting the full life cycle of motor vehicles in Victoria from sale of a new car through to disposal is provided in Figure 3-1.

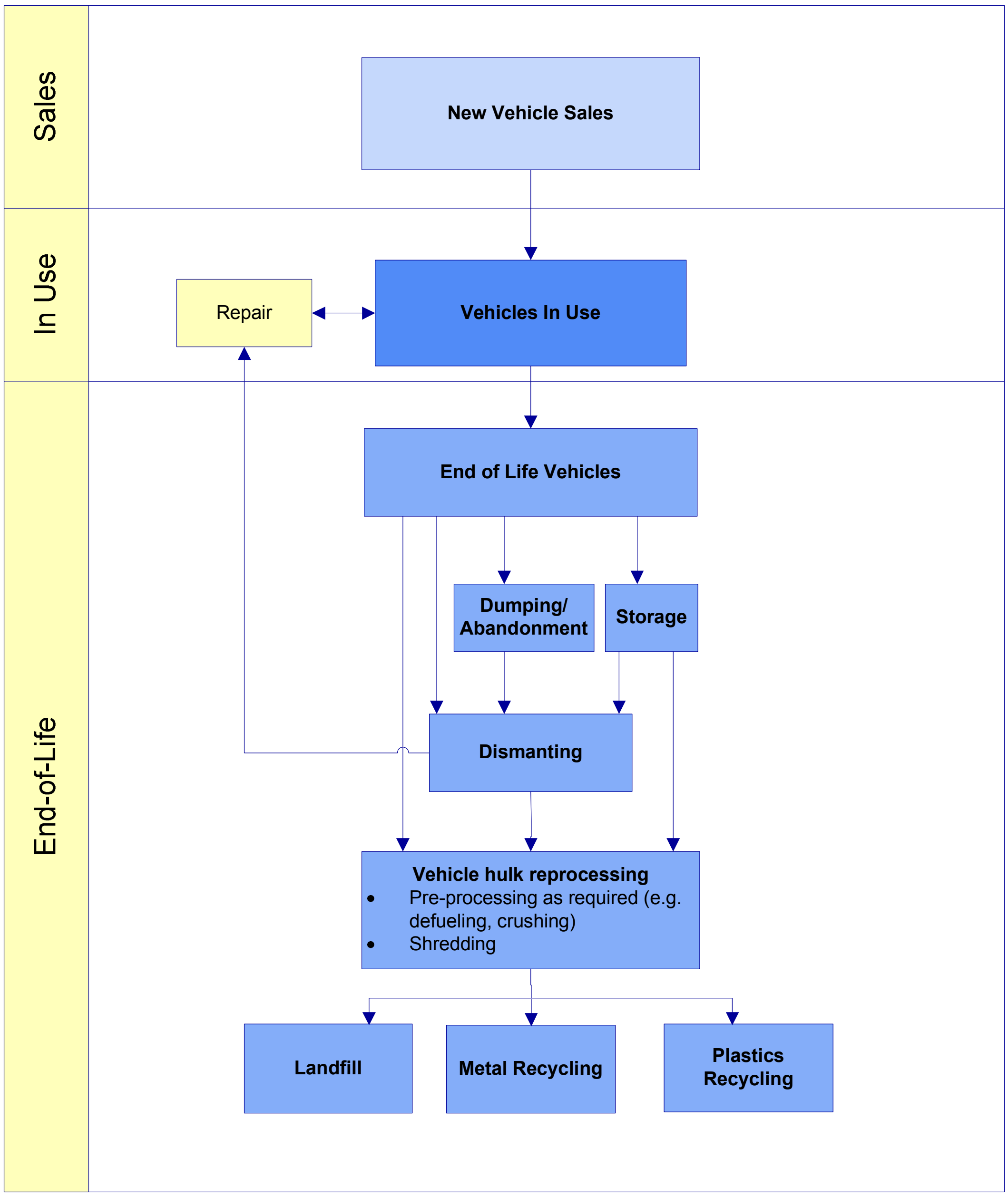

Figure 3-1 Motor Vehicle Lifecycle, Victoria

Each stage of the motor vehicle life-cycle is explored below.

3.1 New Vehicle Sales in Victoria

In 2006, 194,058 passenger motor vehicles, including Sports Utility Vehicles (SUV) were sold into the Victorian market. This represents an increase in annual sales of almost one third over the past ten years. Much of this growth has taken place in the SUV market sector, where sales have risen from 10 000 to 40 000 units. The trend in new vehicle sales for passenger vehicles, SUVs and other vehicles is illustrated in Figure 3-3. New car sales are currently growing at 6.5% of total vehicle numbers.

With de-registration at 4.7% annually, this represents a net increase in the vehicle fleet of 54 000 vehicles per annum.

The cumulative effect of several years of high increases in new vehicle sales has led to a major growth in the car population. As with many other consumer products, efforts to reduce consumption to more sustainable levels may need to be a part of a long term strategy for dealing with resource use in the motor vehicle sector. This also applies to the size of vehicles where there is a strong correlation between fuel efficiency and the size and weight of vehicles. There is more than a 3:1 ratio between the highest and lowest weight vehicles sold in Victoria. Any slowing of new car sales growth or down sizing of vehicle size and weight will flow through to reduce end of life resource levels. The average weight of new vehicles is likely to be around 1250-1300 kg. This is probably 20% lower than it was 15-25 years ago when large cars dominated vehicle sales and steel was a larger component of motor vehicles. To illustrate the range of typical weights, Figure 3-2 shows the kerb weight of different sized vehicles using Toyota models as an example.

Figure 3-2 Typical passenger motor vehicle size and weights, 2006

Model	Size category	Vehicle weight (kg)
Toyota Yaris	Light	1055
Toyota Corolla	Small	1225
Toyota Camry	Medium	1430
Toyota Aurion	Large	1540
Toyota Landcruiser	Large SUV	2550

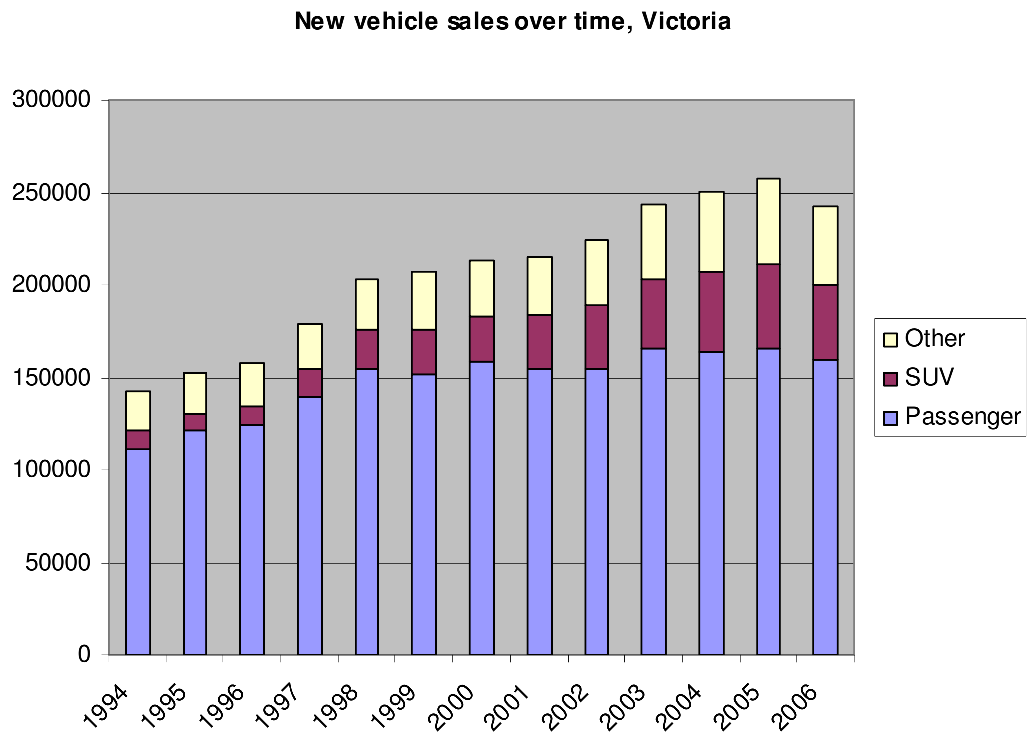

Figure 3-3 New vehicle sales, Victoria (all vehicle types) (ABS, 2007a)

Within the passenger vehicle market, the past five years has seen a sharp increase in smaller new car sales and a corresponding reduction in larger new car sales reflecting increasing petrol prices, increases in the safety standards of small cars and a growing awareness of environmental impacts. Figure 3-4 shows the new vehicle market by vehicle size and indicates the large and increasing proportion of small cars sold in Victoria in 2006.

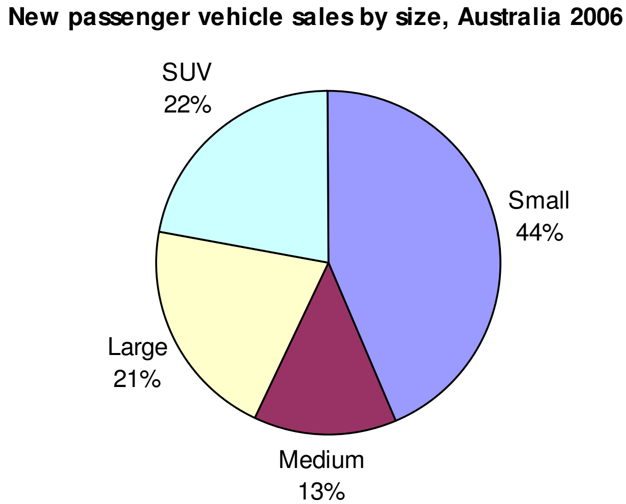

Figure 3-4 New passenger vehicle sales by size, Australia 2006 (FCAI 2007)

The distribution of new vehicle sales by manufacturer is illustrated in Figure 3-5. This graph shows that the three largest manufacturers are the locally based manufacturers and that these companies have a combined market share of 57%. The top ten manufacturers account for 83.5% of sales.

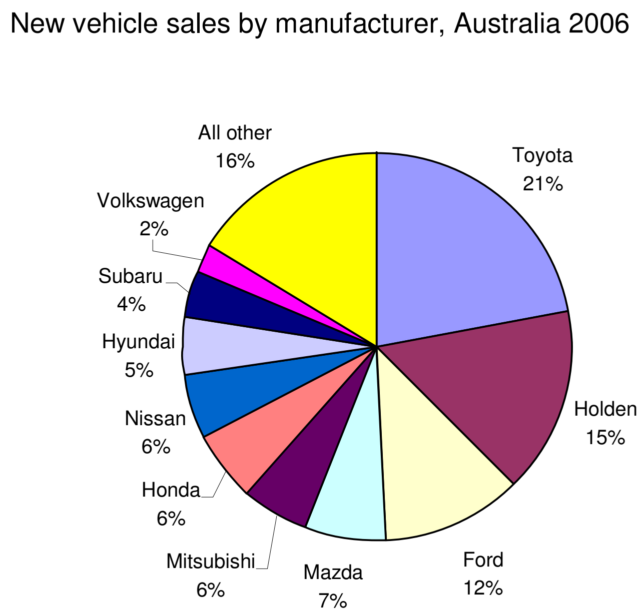

Figure 3-5 New vehicle sales by manufacturer, Australia 2006 (all vehicle types) (FCAI, 2007)

In 2006, imported vehicles accounted for 79% of all passenger vehicle sales in Australia. Six countries contributed 86.4% of the total number of imported passenger vehicles. These countries and the percentage of total imported passenger vehicles that they contributed is outlined in Figure 3-6.

Figure 3-6 Imported vehicles by country of origin, Australia 2006 (FCAI, 2007)

Country of origin	Percentage of imported passenger vehicles
Japan	48.3%
Thailand	13.6%
Korea	12.5%
South Africa	5.1%
Germany	4.3%
Belgium	2.6%
All other	13.6%
	100.0%

3.2 In Use

Through vehicle registration data the number of vehicles currently in use across Victoria is known accurately for passenger vehicles, including SUVs. There is no publicly available data that indicates the proportion of vehicles within size or weight categories.

In 2006, there was a total of 2 997 656 passenger vehicles registered in Victoria. Of these, a third of vehicles are less than five years old, reflecting the very strong growth in the sector in recent years. 60% are less than ten years old and only 4% are over 20 years old.

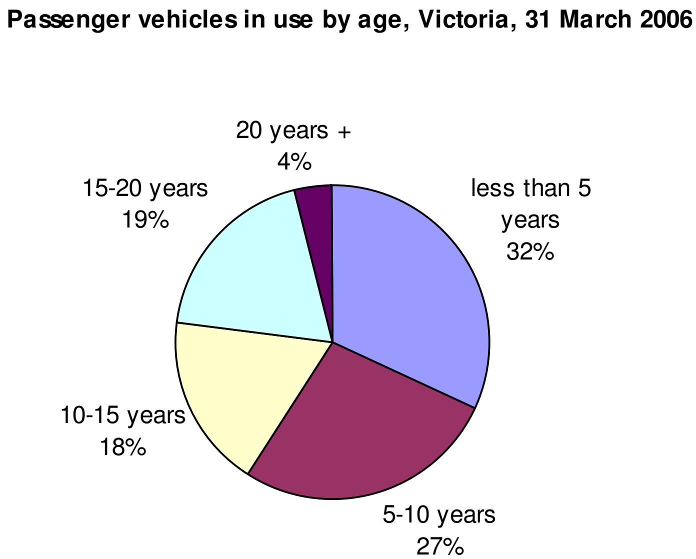

Figure 3-7 Passenger motor vehicles in use by age of vehicle, Victoria, 31 March 2006 (ABS, 2007b)

While our vehicle population is climbing by 1.8% net each year, the average age of vehicles is dropping. In 1996, the average age of a passenger vehicle in Victoria was 11.0 years (ABS, 1997). In 2002 the estimated average age was 10.5 years and in 2006 it was 10.1 years (ABS, 2007b).

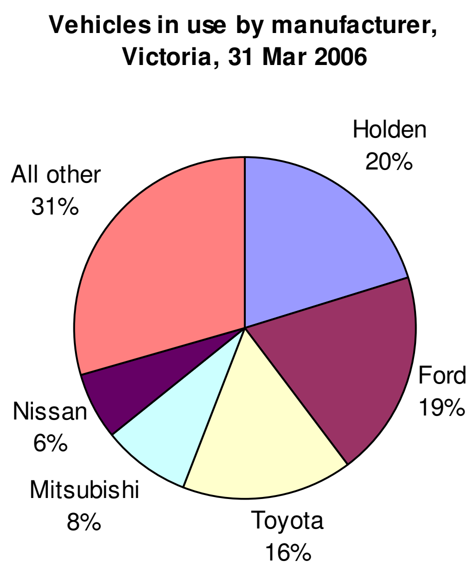

Figure 3-8 Vehicles in use by manufacturer (ABS, 2007b)

There is currently no data available to assess the level of used vehicle sales in Victoria (VACC, 2004). Data from NSW indicates that used vehicle transfers in 2003 were approximately two times that total number of new vehicle sales. In Victoria if this trend were applied to the 2006 data it would account for 400,000 vehicle transfers, or 13% of total passenger vehicles in use. The NSW data indicates that the proportion of private motor vehicle transfers is increasing, with fewer used car sales through licensed motor vehicle traders.

3.3 End of Life

The number of vehicles reaching end-of-life can be estimated through an analysis of registration data year on year. The attrition rate is the number of cars that were not reregistered from year to year, given as a proportion of the total number of cars in use during year two.

The estimated attrition rate from 2005 to 2006 was 4.7%. This equated to 135 348 reaching end-of-life during 2006.

De-registrations are occurring as a result of many factors including accidents resulting in write-off and mechanical or body fatigue. De-registration may also occur when a vehicle is disposed within their working life due to changing consumer preference. There is no direct quantification available, but the data on declining age of vehicles in use suggests a decline in life expectancy of many vehicle models alongside the impact of the recent growth in new vehicle sales. The age of end-of-life passenger vehicles in Victoria is illustrated in Figure 3-9, below.

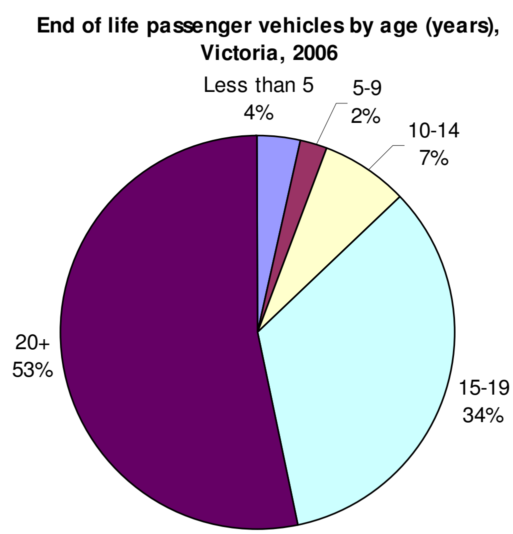

Figure 3-9 End of life passenger vehicles by age of vehicle, Victoria 2006 (ABS, 2007b; ABS, 2007c)

The average weight of end-of-life vehicles has been estimated at 1500 kg. This is higher than the average weight of new vehicles and represents that the vehicle population of 15-25 years ago was more dominated by large vehicles and these contained a higher proportion of steel and glass over other lighter materials such as plastics. The total weight of passenger vehicles reaching end-of-life in Victoria is therefore estimated at 203,022 tonnes. The material flows and final destination is illustrated in Figure 3-10. The total mass of material shredded in Victoria and proportion of material sent to landfill or recycled was estimated by industry representatives.

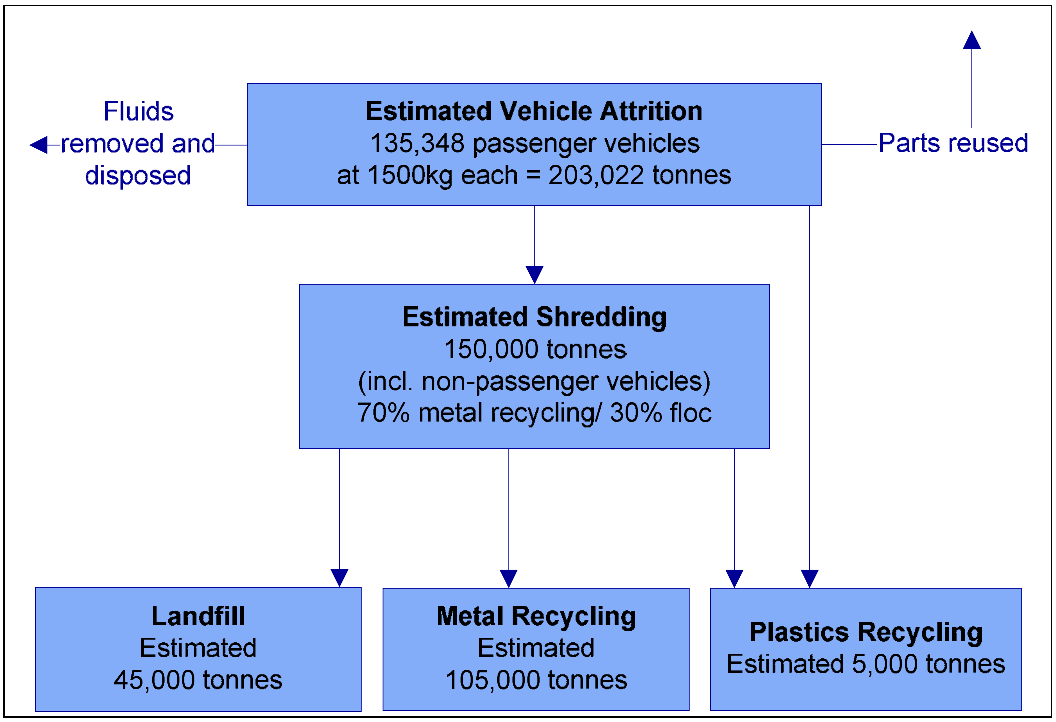

Figure 3-10 Estimated end of life vehicle material flows and destination

Information from auto recyclers and metal recyclers indicates that while there is often a delay between de-registration and eventual shredding or disposal, this is consistent annually and therefore the number of vehicles deregistered in any one year is an accurate estimate of the number of end-of-life vehicles.

There is no local data available on the composition of automotive shredder residue in Victoria. Figure 3-11 shows data drawn from studies conducted in Europe. Shredder operators in Victoria have reported that this is indicative of local shredder residue composition but that there is less metals in a component of dirt, largely due to vehicle hulk collection operations.

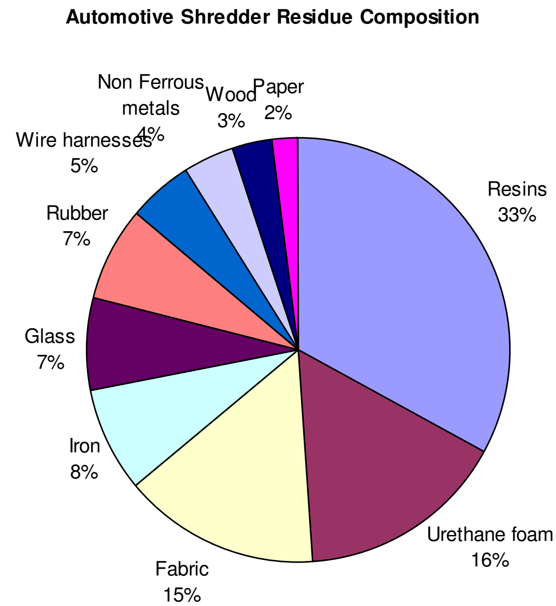

Figure 3-11 Automotive Shredder Residue Composition (Kanari et al. 2003)

4 Issues and Impacts

There are a wide range of perceived issues and impacts associated with the use and disposal of motor vehicles. These are summarised in Figure 4-1.

Figure 4-1: Issues and Impacts associated with motor vehicles

Issue/ Impact	Environmental	Social	Economic	**Evidence (reference)**
Increased volume of shredder floc to landfill due to increased proportion of non-metal components within ELVs • landfill space • resource loss • hazardous materials	☑	☑	☑	Environment Australia (2002), Field (1994), Discussions with metal recyclers
Increased landfill fees and levies for shredder floc			☑	Discussions with metal recyclers
Possible reclassification of shredder floc as hazardous waste.	☑		☑	Environment Australia (2002), Discussions with metal recyclers
Dumped vehicles • Leaking of hazardous materials such as vehicle fluids. • Cost to local authorities • Criminal activity through theft of number plates/ "re-birthing"	☑	☑	☑	Environment Australia (2002), Staudinger et al. (2001), Discussions with local council and land management authority representatives
Waste shredder floc produced during ELV processing	☑	☑	☑	Staudinger et al. (2001)
Leaching of hazardous materials from ELV reuse and reprocessing operations	☑			Staudinger et al. (2001), Discussions with metal recyclers
Leaching of hazardous materials from shredder floc in landfill	☑			Environment Australia (2002)
Resource loss through lack of recovery for reuse or recycling	☑	☑	☑	Environment Australia (2002)

5 Material composition of motor vehicles

The material composition of an average new motor vehicle is provided in Figure 5-1. The proportion of steel and other ferrous metals is generally reported as between 65% and 75% and the plastics content at between 7% and 10% by weight (Environment Australia, 2002).

Figure 5-1 Composition of an average new motor vehicle (Environment Australia, 2002)

Material	Proportion by weight
Steel and other ferrous metals	66%
Heavy non-ferrous metals (Zinc, copper, lead)	2%
Light non-ferrous metals (Aluminium)	6%
Plastics	9%
Rubber (tyres)	4%
Adhesive, paints	3%
Glass	3%
Textiles	1%
Fluids	1%
Other	3%

The material composition of new motor vehicles has changed over the past 20 years. The proportion of steel and other ferrous metals has declined, while the proportion of aluminium and plastics has increased. The change in proportion of six material categories is illustrated in Figure 5-2. This trend is expected to continue as motor vehicle manufacturers include higher proportions of plastic and light-weight metals, which improve vehicle performance.

Figure 5-2: Percentage by weight of six material categories for new motor vehicles

	2002*	1989**	1985**	1980**	1976**
Steel and other ferrous metals	66%	70%	71%	72%	74%
Heavy non-ferrous metals (Zinc, copper, lead)	2%	2%	2%	2%	3%
Light non-ferrous metals (Aluminium)	6%	5%	4%	4%	2%
Plastics	9%	7%	7%	6%	4%
Rubber (tyres)	4%	4%	4%	4%	4%
Glass	3%	3%	3%	2%	2%
* Environment Australia 2002					
** This data is from Ward's Automotive Yearbook, quoted in Field & Clarke 1994					

5.1 Composition of plastics of a typical new motor vehicle

The plastics composition of a motor vehicle can be further broken down into the types of polymers used. The most common polymer used within a typical Australian motor vehicle is polypropylene, accounting for nearly 40% of the plastics by weight. The proportion of different plastics, and their application within the vehicle, is outlined in Figure 5-3.

Figure 5-3 Polymer distribution within the plastic components of vehicles (PACIA 2005)

Type of plastic	% of plastic total	Typical car components made of this material
PP (Polypropylene)	39.2%	Bumper bar/bracket, grille, body side moulding, side skirt, mud flap, console, HVAC unit, seating trim, boot lining, battery casing, overflow bottle, engine shroud, wheel arch, miscellaneous
ABS (Acrylonitrile-Butadiene-Styrene)	18.8	Wheel trim, grille, tail lights, B/C pillar, badge, spoiler, instrument panel, fascia panel, interior door assemblies, overhead console, interior door handles, seating assemblies, steering wheel, hand brake assemblies, miscellaneous.
PU (Polyurethane)	12.6	Headliner, impact absorbers, adhesives, seat cushions, carpet backing
PVC (Polyvinyl chloride)	11.4	Window stripping, handbrake, console lid, interior surface skins
PA (Polyamides/ Nylon)	5.8	Bumper bracket, exterior door handles, fuel cap and lid, interior door handles, gearshift, engine shroud, intake manifold, fans, air ducting, carpeting, powertrain.
HDPE (High Density Polyethylene)	3.4	Fuel tank, seals and gaskets, tubing, coolant bottle
ASA (Acrylonitrile Styrene Acrylate)	1.6	Grills, mirror, frame
POM or Acetal (Polymoxymethylene or Polyformaldehyde)	1	Speaker grilles, fuse box
SAN (Styreneacrylonitrile)	1	Instrument panels, fans, housing
TPE (Thermoplastic elastomer)	0.9	Bumpers, fascia, air dams, weather stripping
PMMA (Polymethylmethacrylate or Acrylic)	0.6	Tail lights, rear décor panel
Other: includes PC (Polycarbonate), PBT, PET, PPE, PPO, GMT	3.7%	Tail lights and head lights, interior fascia panel, speaker grille, engine and fuel covers, exterior door handles, mirror brackets.

6 Existing systems and infrastructure for ELV waste management

The current system for recycling and recovery of ELVs is illustrated in Figure 6-1.

De-registrations are occurring as a result of many factors including accidents resulting in write-off and mechanical or body fatigue. De-registration may also occur when a vehicle is disposed within their working life due to changing consumer preference. There is no direct quantification available, but the data on declining age of vehicles in use suggests a decline in life expectancy of many vehicle models alongside the impact of the recent growth in new vehicle sales.

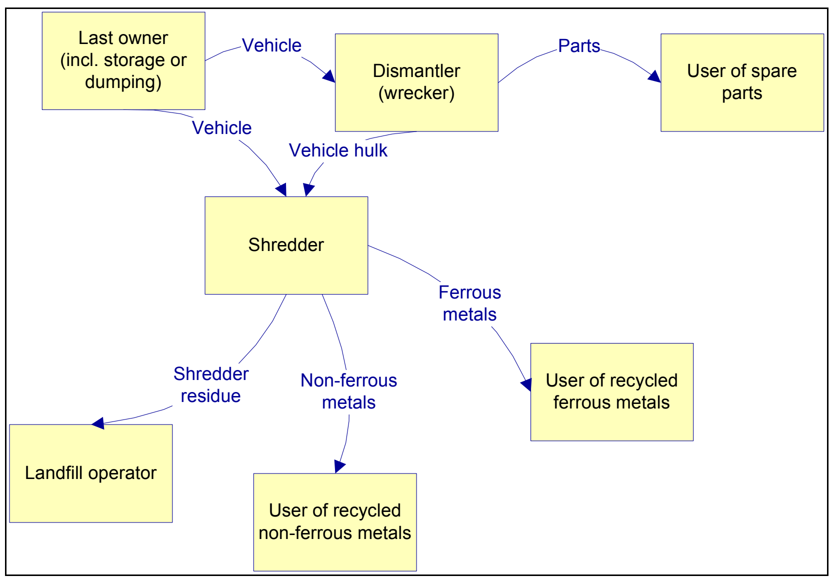

Figure 6-1: Pathways for ELVs

6.1 Last owner, storage and dumping

The last owner of a motor vehicle may store the vehicle for some time (Environment Australia 2002). Shredders reported that cars are stored for much shorter periods than previously due to more activity in vehicle recovery. The vehicle may then be taken to a scrap metal merchant, automotive recycler or metal recycler (shredder) or may be illegally dumped.

Vehicles that are dumped are generally recovered by the local council and then taken to the metal recycler or wrecker/ dismantler. Some dumped vehicles may be stolen and “re-birthed” as a second hand vehicle. Local councils report that dumped vehicles are recovered more quickly than previously (in large part to reduce the potential for illegal ‘rebirthing’).

6.2 Dismantling

The automotive dismantling industry includes two main types of operations: the self-serve or "pick-a-part" yard and the conventional dismantling operation.

The self-serve operators deal in older vehicles (10-15 years or older). Customers remove the parts themselves and as such they may remove any parts that are of use to them – a switch, a brake disc or whole engine. After a period of time or when all useful parts are removed, the remainder of the vehicle will be sold to a metal recycler (shredder).

The conventional dismantling operators generally focus on younger vehicles. These vehicles are drained of fluids and saleable parts are dismantled, catalogued and stored. These parts are then sold to the motor body or mechanical repair industries. Parts may include engines, transmissions, alternators, radiators, body panels or trim parts (Environment Australia, 2002).

The range of parts that are removed is influenced by the age of vehicle and the demand for parts. Younger vehicles may have panel parts removed but are less likely to have mechanical parts removed as these parts are generally covered by warranty up to 3-5 years. Panel parts are more highly sought after for use for collision repairs or other applications within recent model vehicles.

The demand for parts drives the operations of dismantlers as it is not economically viable to dismantle and store parts that ca be resold at a profit.

6.3 Shredding and recycling or disposal

Following the resale of parts through auto recyclers, the vehicle hulk is then transferred to the metal recycler where it is crushed and shredded. Ferrous and non-ferrous metals are recovered for recycling and the remaining materials are sent to landfill as automotive shredder floc. The composition of floc depends on the composition of the shredder feedstock, but is typically made up of plastics, rubber, textile and foam as well as dirt that has been picked up during collection of the vehicle hulks.

Some vehicles are directly transferred to shredders at end-of-life without any parts recovery for resale. These are from the following sources:

1 An end-of-life recovery service where cars are collected from the owner and a nominal value paid for the vehicles. Depending on location and vehicle type, this will be between $20 – $150 per vehicle. Many of these vehicles arrive at the shredder facility without having fluids drained.

There are no current requirements imposed on suppliers at the weighbridge other than the removal of gas cylinders. Despite this, most sites are required to inspect carefully for gas cylinders and even then these sometimes remain undetected and can explode in the shredder at large cost and damage.

2 Dumped vehicles recovered and delivered often without fluids removed.

3 Vehicles collected by the major shredders from regional areas. These are crushed at collection sites (often landfills/transfer stations) and generally have no residual fluids. They often have other appliances packed within the vehicles to increase tonnage.

7 Factors influencing current level of recycling and reuse

7.1 Economic value of an ELV

The level of reuse and recycling of ELVs is generally dictated by the cost of dismantling for reuse or recycling or separating materials for recycling relative to the economic value of the end product or material produced. The factors influencing operational costs of recycling or recovery are outlined in Figure 7-1.

Figure 7-1: Factors influencing the economic viability of recovery operations

Recycling or recovery option	Factors influencing cost of operations	Factors influencing value of end product
Dismantling of parts for reuse	Cost of transfer from the last owner to the dismantler Labour cost of dismantling Time taken to dismantle the parts Ease of dismantling	Cost of new parts Demand for replacement parts Acceptance of use of second hand parts Supply of second hand parts
Dismantling of parts for recycling	Cost of transfer from the last owner to the dismantler Labour cost of dismantling Time taken to dismantle the parts Ease of dismantling Ease of identifying which parts can or cannot be recycled	Availability of virgin materials Demand for the material
Separation of shredded material for recycling	Cost of transfer to the shredder, includes impact of geographic location of last owner or dismantler Availability and cost of technology to separate material	Availability of virgin materials Demand for the material

The current material flows of vehicles are illustrated in Figure 7-2.

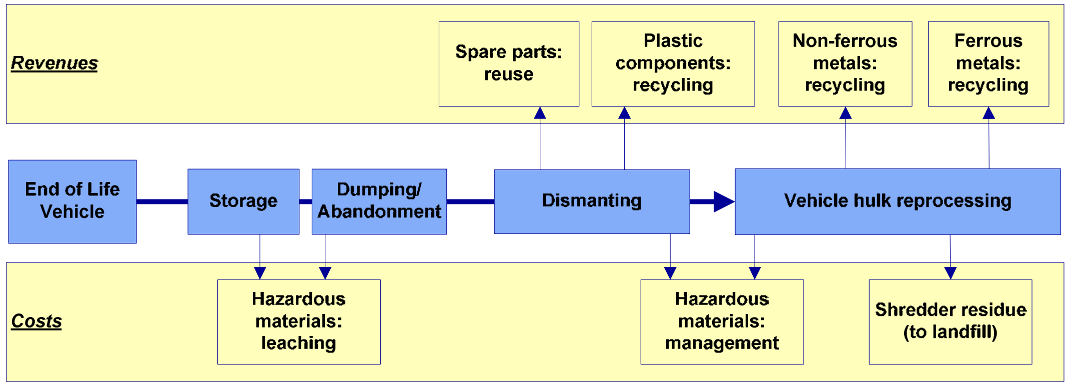

Figure 7-2 Material flows for vehicles (MIT, 2007)

7.2 Other factors

Other issues to address to increase recycling or recovery from ELVs include:

- Plastics recycling;
- Automotive glass management;
- Scrap tyre management;
- Hazardous materials;
- Aluminium scrap sorting; and
- Consumer awareness of ELV disposal options.

(Staudinger & Keoleian, 2001; Environment Australia, 2002)

7.2.1 Plastics recycling

A number of barriers exist to recycling of plastics from ELVs. There are technical difficulties of separating different resin types from each component. There are also difficulties due to variation in the quality, quantity and consistency of plastics, including contaminants. Plastics recycling also faces strong competition with virgin materials. As a result, the vast majority of the volumes of plastics from ELVs are disposed to landfill as a component of the shredder floc. The highly dispersed distribution of plastics throughout the vehicle and the variety of polymers in use cause difficulties in recycling.

At this point, the most likely increase in plastics recycling will come from dismantling of parts prior to shredding. There are no plans at this stage to sort plastics within the shredder floc residue.

7.2.2 Automotive glass management

Automotive glass is sometimes recovered by dismantlers as replacement parts where possible. Most glass is disposed to landfill, either with shredder floc or prior to transport to the shredder facility when ELVs are crushed for transport. There is an available market for automotive glass through Potters Industries, however the value is low and often exceeded by the cost of removal and transport.

7.2.3 Scrap tyre management

Auto recyclers may remove tyres which are in tact, however most vehicles arrive at the shredder with tyres intact. As a result, tyres still contribute a significant proportion of shredder floc (3-4%).

7.2.4 Hazardous materials

ELVs contain a range of hazardous materials. These include flammables such as petrol and oils and a range of brake transmission and air conditioning fluids.

7.2.5 Aluminium scrap sorting

As the proportion of aluminium in vehicles increases the high value of this material becomes more important in contributing to the financial viability of shredding operations. Most aluminium is shredded and recycled together into casting alloys for use in automotive applications such as transmission housings and engine blocks (Staudinger & Keoleian, 2001).

7.2.6 Consumer awareness of ELV disposal options

The final owner of an ELV has a number of options for disposal. The increased value of scrap metals has resulted in an increase in the number of backyard operators who will remove a car at no cost to the final owner. These operators may not correctly undertake the dismantling and removal of fluids and other hazardous materials. The promotion of operators who meet certain industry standards for ELV management would assist consumers in making an informed decision. This may include direct disposal by the vehicle owner. Any consumer awareness efforts should be structured to maximise reuse or recovery of all materials and environmental outcomes.

8 Lifecycle assessments and application to the Victorian context

A number of life cycle assessments undertaken are relevant to the Victorian context for end of life vehicle management. Life cycle assessments have focused on the whole vehicle life cycle while some focus more specifically the disposal/ recovery stage at end of life.

8.1 Assessments of vehicle lifecycle

Life cycle assessments of the whole vehicle lifecycle typically examine three stages: manufacture, use and disposal/recovery at end-of-life. An assessment may consider a range of environmental impacts across each stage or may focus on one impact, for example, greenhouse emissions. The use stage of the vehicle life cycle is generally reported as contributing around 80-90% of the total environmental impact (Environment Australia 2002, SMMT 2006, Castro et al. 2003). The impact of this stage varies greatly with the kilometres travelled. Some studies omit the disposal/ recycling stage from the life cycle analysis because the impacts of that stage is so far outweighed by the other stages of the life cycle (ILEA, 2007). The stages, environmental concerns and relative environmental burden are given in Figure 8-1.

Figure 8-1 Assessment of Vehicle Lifecycle

Stage	Activities	Impact (SMMT)	Impact (EA)	Issues
Production and distribution	Production of raw materials; Manufacturing into parts; Assembly into a vehicle	10	22%	Water and energy use Air quality, VOC emissions Waste generation
Use	Operation over entire in-use stage, including production and distribution and use of fuel, repairs	85	82%	Waste from tyres and servicing Air quality, traffic emissions Road safety Employment, including servicing, retailing and insurance Greenhouse emissons

Disposal/ Recycling		10	-10%*	Vehicle waste Health and safety of employees Disposal of hazardous materials

* Recycling of metals contributes positively to the vehicle lifecycle
References: Environment Australia (2002), SMMT (2006)

Other studies have focused on a single area of environmental impact, for example waste production or CO_2 emissions. Assessment of a generic US family sedan indicates that the manufacturing stage contributes 67% by weight of the total waste generation occurring during the vehicle life cycle, largely due to waste produced during materials production. The operational stage and end-of-life contribute 25% and 8% of waste, respectively (Staudinger & Keoleian, 2001).

Ford Motor Company compared the life cycle emissions for a representative mid-size car and an SUV in the United States (Ford, 2007). This demonstrated that fuel use during the operational stage accounted for 88.6% of total vehicle greenhouse emissions throughout the life cycle of the mid-size car and 90.4% of total vehicle greenhouse emissions of the SUV.

8.1.1 Implications for the Victorian context

From the results of the studies discussed above it would appear that:

- Initiatives to reduce the environmental impacts of the operational stage have the greatest ability to reduce the overall life cycle impacts of motor vehicles;
- Reduction in fuel consumption will significantly improve the impact due to greenhouse emissions;
- Reduction in waste generated during manufacture would significantly reduce the waste produced throughout the vehicle lifecycle.

Initiatives to improve the recovery for reuse or recycling at end-of-life should be carefully considered in the context of the overall life cycle impact. For example, an increase in plastic components of vehicles may improve the fuel efficiency during the use phase by reducing the weight of the car, but could result in a decrease in recycling under current operational conditions in Victoria.

In Europe it is estimated that the 180kg of plastic found on a typical vehicle provides a reduction in fuel consumption of around 10-12% (Autovinyl, 2007). The manufacture of plastics also consumes fewer resources and produces less emissions than metals, which allows a lower impact in the "production" life cycle phase as well (Environment Australia, 2002).

8.2 Life cycle assessments of ELV management options

Life cycle assessments have also been undertaken to compare alternative ELV management options. One such study assessed the environmental impacts of ELV management in Korea (Jeong et al. 2007). This demonstrated that metal recycling contributed significant benefits in avoiding resource depletion. It also demonstrated that improvements in the management of refrigerants during the dismantling stage would reduce the impact on global warming and that the improved management of batteries during the dismantling and recycling process would contribute to reducing acidification of land and water.

A study undertaken in 2003 compared the options for recovery or recycling of ELVs with consideration of their environmental and economic impacts. The study focused on seven different plastic vehicle components and considered six waste management options (mechanical recycling, blast furnace, cement kiln, syngas production, waste combustion and landfill). These were then combined with a lifecycle analysis taking into account the production and use phases. The study concluded that mechanical recycling is the best option for large, easily accessible parts made from a single plastic polymer. For other parts, feedstock recycling options and energy recovery gave the best environmental and economic outcomes (Jenseit et al., 2003).

8.2.1 Implications for Victoria

The results of these studies suggest the following:

- Current levels of metal recycling from ELVs should be continued
- Improved management of hazardous materials could reduce environmental impacts
- Large, easily accessible parts should be dismantled and recycled, smaller and less accessible parts should be used as a feedstock for energy recovery.

9 Local, State, National and International developments

A wide range of initiatives are in place in Australia and overseas for the management of ELVs. These are split into five categories:

- Initiatives to increase the reuse of parts
- Regulatory mechanisms for increased recovery
- Design for recycling
- Alternative processes for floc recycling/ recovery
- Industry programs, collaboration and targets

Relevant initiatives under each category are outlined below in Figure 9-1.

Figure 9-1: Initiatives to improve ELV management

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Reuse of parts					
Voluntary industry initiative to ensure correct procedures for dismantling	Accreditation with the APRAA (Automotive Parts Recyclers Association of Australia) requires compliance with a range of procedures. Accreditation is available at a number of levels with the higher levels indicating a higher level of service.	Australia	Industry	Vehicle dismantlers	APRAA (2007b)
Auto Parts Recycling Guide	A guide for automotive parts recyclers that gives basic information on materials, disposal, storage and safety for a range of automotive parts.	Australia	APRAA, Greenfleet, Holden	APRAA members	Available from: APRAA (2007b)
Car spare parts centres are encouraged to recover end-of-life parts	Toyota Australia aim to introduce return of old parts into parts distribution centres.	Australia	Toyota Australia	Distribution centres	Toyota (2006)
Online noticeboard for spare parts	http://ewreckers.com.au An online noticeboard for buying and selling spare parts from all types of vehicles and machinery.	Australia			Ewreckers (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Software to assist with vehicle dismantling	International Dismantling Information System (IDIS) IDIS software is designed to assist in dismantling and recycling of ELV parts. It allows the user to display the potentially recyclable parts from a vehicle, filter based on materials or parts of a vehicle, and consult specific manuals. There are 1206 vehicles (around 84000 parts) referenced in the database.	UK		Automotive manufacturers: 58 manufacturers have their vehicles listed.	IDIS (2007) Environmental Resource Management (2000)
Supply system for used parts	Toyota sells used parts through an electronic system across distributors of Toyota parts in Japan. In 2004, 77,000 items were sold.	Japan	Toyota	Toyota parts distributors (33 dealers across Japan)	Toyota Japan (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Regulatory mechanisms					
End-of-Life Vehicles (ELVs) Directive (Directive 2000/53/EC)	Adopted in 2000. The directive aims to prevent waste from ELVs and improve the recycling and reuse of ELVs. In the UK, the directive required: • that ELVs are handled by authorised dismantlers, • increased reuse and recovery of ELVs to 85% (average weight per vehicle) by 2006 and 95% by 2015 • vehicle design for recycling, • restriction on the use of heavy metals.	Europe	European Council		
Battery recycling EC Directive 91/157/EEC	Requires batteries with more than 0.4% lead by weight to be collected separately. This includes vehicle lead acid batteries.	EU	European Commission		Environmental Resource Management (2002)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
End-of-Life Vehicle Recycling Law	This law regulates for extended producer responsibility, requiring that manufacturers (including importers and handling agents) collect and recycle airbags, CFCs and shredder residues generated in the treatment and recycling of ELVs. The cost of recycling is paid through an advanced disposal fee by the owner when a new car is purchased. These fees are administered by fund management corporations and funds claimed back by manufacturers to cover their recycling costs. The fee paid by purchasers of motor vehicles is set by the manufacturers and approved by the government.	Japan		Manufacturers and importers; handling agents; CFC recoverers; dismantlers; shredders; owners.	PWMI (2007) Ministry of Environment (2007)
Alternative processes					
VW-SiCon Process	Mechanical treatment of shredder residue which allows the recovery of 95% of shredder residue being recycled into usable products: shredder granules, fibres and sand. Shredder granules include hard plastics and rubber; fibres include foams and textile fibres and sand includes glass, rust, iron particles and heavy metals.	Europe	Private company	SiCon GmbH in cooperation with Volkswagen AG	Sicon (2007)
Incineration of shredder residue	Shredder residue from end-of-life vehicles has been incinerated in a waste-to-energy plant in Wurzburg, Germany at concentrations of 4 to 10% of the total waste (mixed with household waste).	Germany	Private company		EUWID (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Cooperative Research and Development Agreement to develop sustainable ELV recycling techniques and reduce the amount of shredder residue going into landfills.	A pilot facility that separates shredder residue into four categories: • Fines (iron oxides, other oxides, glass and dirt); • Polyurethane foam; • Polymers (polypropylene, polyethylene, ABS, nylon, PVC, polyester, etc) • Ferrous and non-ferrous metals. The facility also has a plastics separation function that recovers the major plastics from shredder residue.	USA		US Department of Energy, Argonne National Laboratory, USCAR's Vehicle Recycling Parnership (includes DaimlerChrysler Corp., Ford Motor Corp., and General Motors Corp.), and the American Plastics Council	Automotive Learning Center (2007)
Design for Recycling					
Easy to Dismantle mark	Toyota has implemented a new "easy to dismantle mark" which is stamped on vehicle parts to indicate points to assist with dismantling – for example, the points where parts can be separated and locations for fuel removal holes.	Japan	Toyota Japan		Toyota Japan (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Design for recycling	Marking of materials to enable separation of parts for recycling. The Yaris hatchback, introduced in 2005, is an example of design for dismantling, as it includes: • Marks stamped to indicate where dismantling can best be commenced; • Dismantling marks stamped on front and rear door trim, deck side trim, back door trim and the front bumper • Clip fastenings rather than screw fastening points • A structure requiring no separating or sorting • An alignment mark for the fuel removal device on the bottom of the fuel tank. This ensures all fuel is safely removed during dismantling.	Australia	Toyota Australia		Toyota (2006)
Design for dismantling	An easy-to-dismantle vehicle structure has been implemented in Toyota Japan. The design features used have shortened the time for dismantling by 30% compared to the previous model. These features included: • Structures that allow areas to come apart when pulled hard • Clips used instead of screws where possible • Integration of parts • Avoidance of composite materials	Japan	Toyota Japan		Toyota Japan (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Industry programs, collaboration and targets					
Automotive Consortium on Recycling and Disposal (ACORD)	A voluntary agreement, signed in 1991, to improve the recovery and recycling of ELVs.	UK		Automotive and materials trade associations	Environmental Resource Management, 2000
Consortium for Automotive Recycling (CARE)	A collaborative project aiming to research and technically prove ELV materials re-use and recycling processes.	UK		Main UK motor manufacturers, importers and vehicle dismantlers.	Environmental Resource Management, 2000
Industry commitment to improve management at end of life	The SMMT included two commitments within their seventh Sustainability Report: • Provide facilities for consumer to return vehicles for disposal at end of life. • Design and make cars so that at least 95 per cent of the weight of materials used can be recovered at the end of life.	UK	SMMT (Society of Motor Manufacturers and Traders Ltd)	20 industry signatories to the report	SMMT (2006)
Bumper bar recycling	Recycling of bumper bars that are removed and replaced with bull bars.	Australia	Toyota Australia	Toyota Australia, Toyota Nunawading, Sims Plastics, Sustainability Victoria	Toyota (2006)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Targets for resource recovery of ELVs	Target: 95% resource recovery rate for cars at the end-of-life stage in Japan by 2010.	Japan	Nissan		Nissan (2007)
A corporation set up to manage programs to recycle mercury switches on a nationwide basis	End-of-Life Vehicle Solutions Corporation (ELVS) was set up to manage the collection and disposal/recycling of mercury-containing switches and to promote correct ELV disposal. (Note: there are no mercury switches on Australian vehicles)	USA	Automotive manufacturers	Participating automotive manufacturers and recyclers	Ford USA (2007) ELV Solutions (2007)
An initiative to ensure the correct disposal of end of life vehicles	This American company, 1877-EndOfLifeVehicles, arranges for ELVs to be picked up and handled appropriately, including the de-pollution at an accredited facility and recycling of the vehicle hulk at a shredder facility.	USA	1877-End-Of-Life-Vehicles	Automotive dismantlers can become affiliates of this organisation	1877-ELV (2007)

Policy	Description	Jurisdiction (local, state, national and international)	Lead organisation/s	Participants	Reference
Extended producer responsibility – a charge paid by the manufacturer or importer of a vehicle.	Manufacturers and importers of cars in the Netherlands have made a voluntary agreement to pay a fee for each car that is registered for the first time. The charge is collected by Auto Recycling Nederlands (ARN) which uses the fees to cover the cost of dismantling and recycling materials. Vehicle dismantlers can register with ARN and are then able to apply for a rebate for their costs. Dismantlers are required to meet certain standards to register.	Netherlands	Auto Recycling Nederlands (ARN)	Car manufacturers and importers; vehicle dismantling companies (262 currently registered)	Eur-Lex (2007)
An initiative to ensure the correct disposal of end of life vehicles	Autogreen is a group of automotive dismantlers who provide a network of Automotive Treatment Facilities to manage the ELV directive in the UK. Owners of certain vehicle makes are entitled to free vehicle take-back.	UK	Auto dismantlers	Auto dismantlers, vehicle manufacturers	AutoGreen (2007)

10 Factors which may impact ELV recovery in the future

A range of factors which may impact on the levels of ELV disposal and recovery in Victoria into the future are outlined in Figure 10-1.

Figure 10-1: Factors expected to impact recovery in the future

Factor expected to impact	How will it impact on ELV management	Evidence (reference)
Reduction in cost effectiveness of parts reuse due to: • Newer vehicles • Declining cost effectiveness of repair and maintenance of older vehicles	Less direct reuse of parts	Environment Australia (2002)
Demand for spare parts increased as insurance companies change their purchasing policy	More direct reuse of parts	Stakeholder consultation (auto dismantlers)
Declining cost effectiveness of repair and maintenance of older vehicles	Reduced life expectancy of vehicles, therefore more vehicles reaching end-of-life earlier	Environment Australia (2002) Stakeholder consultation (metal recyclers)
Increased cost of fuel leading to replacement of current vehicles with more fuel efficient models	Decreased life expectancy for less fuel efficient vehicles, more vehicles reaching end of life	Stakeholder consultation (metal recycler)
Implementation of design for reuse/ recycling	Increased reuse of parts through dealer networks; Greater use of recycled or rebuilt components in manufacture of new vehicles; Increased ability to recycle parts directly from dismantling stage of operation	Manufacturers websites Environment Australia (2002)
Greater number of single resin plastic components and coding of plastics using recognised markings	Increased ease and viability of recycling of plastic components at dismantling stage	Environment Australia (2002)
More plastic components	Decline in the recovery of	Environment Australia (2002)

Factor expected to impact	How will it impact on ELV management	Evidence (reference)
	ELVs (by weight)	
Decline in availability of landfill space	Increased costs of disposal to landfill	
Increased cost of landfilling shredder floc	May encourage alternative disposal including waste to energy, cement kiln fuel, pyrolysis	Environment Australia (2002) 8:42 Stakeholder consultation (metal recyclers)
Increased value of scrap metal	Less stockpiling/ storage of ELVs	Stakeholder consultation (metal recyclers)
Reclassification of shredder floc as hazardous material	Increased landfill costs could result in significant impact on the economic viability of recycling operations	Stakeholder consultation (metal recyclers)
Higher amounts of precious metals in ELVs, for example palladium from catalytic converters and NiMH from hybrids	Increased recovery due to economic viability	Stakeholder consultation (metal recyclers)
Improved technology for recovery of material from shredder floc	Increased recovery levels post-shredding	Stakeholder consultation (metal recyclers)
Improved technology for energy production from shredder floc	Incineration of shredder floc for energy production	Stakeholder consultation (metal recyclers)
Increased labour costs and requirements for OHS	Less dismantling for reuse	Stakeholder consultation (automotive dismantlers)
Uptake of accreditation schemes for auto dismantlers	Higher levels of environmental controls in place	Stakeholder consultation (automotive dismantlers)

11 Possible future pathways

The following is a summary of possible future recommendations for consideration and stakeholder discussion:

- Introduce a requirement for last owner to formally de-register the vehicle
- Enhance consumer awareness of options for ELV disposal
- Promote vehicle size reduction and vehicle longevity in community awareness programs for reduced environmental impacts during vehicle use and end-of-life
- Encourage collection points/ cooperation between local councils and metal recyclers – offsetting the cost of retrieving abandoned vehicles
- EPR initiatives – look at models for implementation of EPR initiatives
- Assess advanced disposal fee systems in Japan and Netherlands designed to cover the cost of correctly dismantling/ recycling vehicles
- Encourage promotion or possible requirement for automotive dismantler to actively implement industry Code of Practice-government verification of compliance
- Promote design for recyclability – using the following criteria as a set rather than individually:
  - Use recyclable materials
  - Use recycled content materials
  - Reduce the number of different materials and composites used within an assembly
  - Mark parts for simple material identification
  - Use compatible materials within an assembly
  - Make it easy to disassemble
- Discuss with metal recyclers the potential for requirements to remove fluids and recyclable components such as tyres, windscreens, radiators, bumper bars, batteries and gas cylinders before presentation at weighbridge
- Identify composition of shredder floc through site audits and sampling
- Channel landfill levy funds into shredder floc solutions
- Undertake further research into the viability of alternative disposal options for shredder floc, including exploring cement kiln feedstock as a shredder floc outlet

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