ANALYSIS OF BATTERY CONSUMPTION, RECYCLING AND DISPOSAL IN AUSTRALIA

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Analysis of Battery Consumption, Recycling and Disposal in Australia

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for

Australian Battery Recycling Initiative
(ABRI)

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Front cover photos (top to bottom):

Photo 1 – Used Lead Acid Batteries (ULABs) separated at waste transfer station.

Photo 2 – mixed Handheld batteries for processing overseas - www.stewardship.gatech.edu/batteries.php

Photo 3 – many batteries are embedded in products like mobile phones, cordless power tools and other digital devices - http://www.resourcesmart.vic.gov.au/for_households/dropoff_points_3797.html

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EXECUTIVE SUMMARY

Batteries are integral to the functioning of our economy and support many aspects of modern lifestyles. They provide the portable power solution for mobile telecommunications, computers, construction tools, emerging electric vehicles and standby back up power in addition to many other solutions. However, we do not understand the magnitude of battery use from a mass flow perspective. For example, how many tonnes of batteries are there in active service within the economy? How quickly do they reach their end-of-life? What happens at their point of discard? What challenges do different chemistry types present? These questions need to be answered in ordered to understand the potential impacts of battery consumption and to develop solutions for resource recovery.

The Australian Battery Recycling Initiative (ABRI) is a not-for profit incorporated association of members who seek to maximise resource recovery from batteries. ABRI members also seek to achieve the highest resource order or value stemming from recovered materials. ABRI aims to stop batteries going to landfill, and is motivated by the economic value arising from the recovery and recycling of valuable and finite materials. As part of delivering ABRI's vision and mission, ABRI has commissioned this comprehensive and detailed assessment of the Australian battery market as an important step in developing a robust plan for battery stewardship implementation.

Battery Classification

Developing a classification system for batteries is important from a stewardship perspective. Systems are needed to channel certain types of batteries to their appropriate recycling option. The following hierarchy is suggested for a battery classification system in Australia:

- household and commercial, or large and industrial. There is a difference in battery chemistry and size between batteries that are used in household and office applications, and those used in heavy industrial applications for standby power and motive power. Collection systems will also need to be tailored to domestic and commercial sources, and industrial sources, with the former favouring drop off or small container delivery systems and the latter favouring individual site pick up
- technology/chemistry type. Materials of manufacture are critical determinants of recycling opportunities and also requirements. For example, Nickel Cadmium (NiCd) batteries are processed differently to Zinc Carbon battery types
- typical uses, for example embedded or stand alone. If a battery is embedded in another product, such as a television or video or mobile phone, then the recovery channel will need to deal with the bulk of the product mass before the battery is 'liberated' for recovery
- handheld (<1kg) or heavy (>1kg). This will be the primary determinant of the resource recovery channel in that heavy batteries are most likely to be found in industrial or automotive applications and are likely to require pick up
- single use or rechargeable. This factor is a primary determinant of the length of time a battery remains operational within the economy. Rechargeable batteries will go through many charge cycles and as such will outlast single use batteries in a given application. Thus the replacement rate (and hence the waste arising rate) is likely to be higher for single use batteries
- Customs and ABS codes. It is important to calibrate with existing systems of battery classification in Australia. For example Australian Customs Tariff Nomenclature and Statistical

Classification, and the Australian Bureau of Statistics (ABS) system for battery classification under the Australian and New Zealand Standard Commodity Classification (ANZSCC)

– hazardous. The hazardous nature of batteries needs to be clearly defined and articulated. For example, a NiCd mobile phone battery at its end-of-life is likely to be classified as hazardous, however this does not make the mobile phone or even the battery hazardous in its working life.

National Material Stocks and Flows of Batteries

Estimating the materials stocks and flows for all batteries in Australia is a complex task, given the differences in battery types, applications and channels to market. The methodology used in this study draws on information from a number of sources including Australian Bureau of Statistics, scientific literature, public reports, government (state, federal and international), battery manufacturers, ABRI Working Group, industry participants, and resource recovery companies.

Battery **inputs** are the consumption of batteries; **stocks** are those batteries in service within the economy; and **arisings** are batteries that have reached the end of their service life (or are unwanted for any other purpose) and require a resource recovery or waste management solution. In each table data is presented for a single year based on the most recently available data (the methodology is explained in detail in Chapter 2 and the Appendices). A breakdown of the estimated inputs, stocks and arisings of batteries in Australia by count is presented in the table below.

Table – Estimated Australian battery materials stocks and arisings by count*

Type	*Inputs*	*Stocks*	*Arisings*
Handheld	345,270,000	465,300,000	264,297,000
Automotive Starting Lighting and Ignition (SLI)	5,840,800	15,440,000	5,410,000
Large and Industrial	1,748,000	6,641,000	1,473,000
Total Units	**352,858,800**	**487,381,000**	**271,180,000**

* Information in the tables may not total due to rounding

A similar breakdown of the estimated inputs, stocks and flows (waste arisings) of batteries for Australia by weight is presented in the table below.

Table – Estimated Australian battery materials stocks and arisings by weight (kilograms)

Type	*Inputs*	*Stocks*	*Arisings*
Handheld	16,140,000	26,240,000	11,904,000
Automotive SLI	85,670,000	224,170,000	80,260,000
Large and Industrial	51,680,000	198,500,000	42,785,000
Total Weight (kilograms)	**153,490,000**	**448,910,000**	**134,949,000**

From this analysis it is estimated that approximately 350 million batteries are consumed annually in Australia, either as stand alone batteries or embedded in products such as mobile phones and automobiles. The majority of these batteries on a count basis (98 per cent) were 'Handheld' batteries, in other words, batteries less than 1 kg in weight. However, the weight of all battery inputs into Australia was more than 150 million kilograms (150,000 tonnes) and Handheld batteries were only approximately 10 per cent of this total.

The bulk by weight (nearly 90 per cent) is composed of Automotive Starting, Lighting and Ignition (SLI) batteries and Large and Industrial batteries, even though on a count basis they are only 2 per cent of inputs. This difference in proportion between weight and count is the primary reason that data is presented on both count and weight. Without information on both aspects of battery inputs, stocks and arisings, important challenges facing battery stewardship can be overlooked.

Handheld Battery Inputs

The nearly 350 million Handheld battery inputs comprise approximately 300 million batteries in 'stand alone' sales and 45 million batteries in embedded products. All Handheld batteries are imported as there is no local production of the original battery. Six main channels to the Handheld market for 'stand alone' sales were identified as part of this study. These include:

- grocery, for example Woolworths, Coles and independent supermarkets. This is the largest channel with an estimated 60 per cent of market share
- mass merchant, for example K-Mart, Big W, and Target with an estimated 10 per cent of the market
- hardware, for example Bunnings, Mitre 10, and Home Timber and Hardware with an estimated 10 per cent of the market
- electrical retail, for example, Harvey Norman, Dick Smith Power House and Tandy with an estimated 7.5 per cent of the market
- office supplies, for example Office Works, with an estimated 7.5 per cent of the market
- speciality stores and online sources with an estimated 5 per cent of the market.

Batteries embedded in products such as mobile phones account for a further 45 million batteries. A breakdown of Handheld battery inputs by size, count and weight is presented in the table below.

Table – Estimated Australian Handheld battery inputs by size, count and weight

Size	*Number of Batteries*	*Proportion Count*	*Average Weight (grams)*	*Total Weight (kg)*	*Proportion Weight*
AAA	98,505,000	29%	12.0	1,180,000	7%
AA	147,730,000	43%	24.0	3,545,000	22%
9v	24,629,000	7%	42.1	1,037,000	6%
C	16,423,000	5%	65.0	1,068,000	7%
D	16,423,000	5%	135.1	2,218,000	14%
Other Size	19,701,000	6%	6.1	120,000	1%
Lantern	4,939,000	1.4%	742.5	3,667,000	23%
Mobile	7,860,000	2.3%	21.2	167,000	1%
Digital Device	4,030,000	1.2%	21.3	86,000	0.5%
Laptop	1,460,000	0.4%	563.7	823,000	5%
Cordless Power Tools	1,750,000	0.5%	546.3	955,000	6%
Sealed Lead Acid	1,820,000	0.5%	700.0	1,274,000	8%
Totals	**345,270,000**	**100%**		**16,140,000**	**100%**

The battery sizes AA and AAA account for the greatest number of Handheld inputs with an estimated 147.7 million and 98.5 million batteries respectively sold for a combined share of 72 per cent of Handheld battery inputs by count.

However, on a weight basis it is the batteries that weigh on average over 500 grams per battery that make the disproportionate contribution. Lantern, laptop, cordless power tools and Sealed Lead Acid Batteries (SLAB) account for only 3 per cent of Handheld battery inputs on a count basis, yet make up approximately 42 per cent of inputs on a weight basis. This compares to AA and AAA batteries, which together make up for approximately 29 per cent of Handheld inputs on a weight basis.

Handheld Battery Inputs by Chemistry Type

Alkaline chemistry is the dominant form of Handheld battery inputs both on a count basis and on a weight basis. Alkaline accounted for 57 per cent of Handheld battery inputs (198 million) on a count basis and 57 per cent (9,248 tonnes) on a weight basis. The break down of Handheld battery chemistry types is shown in the table below.

Table – Estimated Australian Handheld battery inputs by chemistry type, count and weight (kilograms)

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (kg)*	*Proportion Weight*
Alkaline	198,000,000	57%	9,248,000	57%
Carbon Zinc	65,992,000	19%	1,973,000	12%
Lithium	33,796,000	10%	1,963,000	12%
Nickel Metal Hydride	20,664,000	6%	899,000	6%
Nickel Cadmium	10,150,000	3%	656,000	4%
Lead Acid (SLAB)	1,820,000	0.5%	1,275,000	8%
Other (ZA, SO, ZC)	14,850,000	4%	126,000	1%
Total	**345,270,000**	**100%**	**16,140,000**	**100%**

Automotive Starting, Lighting and Ignition (SLI) Batteries

Automotive Starting, Lighting and Ignition (SLI) batteries are such a dominant sub-category within the total stocks and flows of batteries in Australia that they warrant specific discussion. It is estimated that nearly six million Automotive SLI batteries entered into the Australian economy. Approximately one third of these batteries are locally manufactured. There are four main channels for Automotive SLIs to enter the market:

- ‘do-it-yourself ‘where the battery is bought direct from a retailer such as SuperCheap, Autobarn or Repco. This is the largest channel with approximately one third (35 per cent) of Automotive SLI batteries being sold through DIY stores
- ‘do-it-for-me’ change over at a service centre, for example vehicle repairs or tyre outlets. It is estimated that this channel accounts for a similar proportion to the direct battery replacement channel at 25 per cent of Automotive SLI battery inputs
- embedded in a new car sale, either locally produced or imported. Based on estimates of new vehicle sales in Australia, approximately 20 per cent of Automotive SLI battery inputs are in new vehicles, with the majority of these (approximately 85 per cent) imported

– direct battery replacement, for example through roadside replacement programs, with approximately 20 per cent of the inputs through the direct replacement channel.

The largest inputs of Automotive SLI batteries by count were passenger vehicles with approximately 75 per cent of the total by count and also by weight. Next largest was Light Commercial with approximately 15 per cent by count and also by weight. A further breakdown of Automotive SLI battery inputs by vehicle type is presented below.

Table – Estimated Australian Automotive SLI battery inputs by vehicle type, count and weight (tonnes)

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	260,000	4%	3.0	780	1%
Passenger Vehicle	4,413,000	76%	14.3	63,110	74%
Light Commercial	863,000	15%	15.7	13,550	16%
Rigid Trucks	172,000	3%	23.0	3,960	5%
Articulated Trucks	61,000	1%	31.5	1,920	2%
Non-Freight Carrying Trucks	9,000	0%	31.8	290	0%
Buses	65,000	1%	31.6	2,070	2%
Total Automotive SLI	**5,840,000**	**100%**		**85,670**	**100%**

All of the Automotive SLI battery inputs are lead acid batteries. The weight of the Passenger Vehicle and Light Commercial batteries accounts for 90 per cent of Automotive SLI battery inputs (85,670 tonnes) and over 55 per cent of all battery inputs (153,490 tonnes).

Large and Industrial Batteries

Large and Industrial batteries is the category of batteries that picks up non-automotive lead acid batteries such as those used in marine and mining applications, for traction and motive power and large stationary standby power storage applications. It also includes other chemistry types that provide motive power for electric vehicles and hybrid electric vehicles in addition to standby power for photovoltaic systems and emergency back up. The categories within Large and Industrial batteries include:

– marine engine applications

– forestry, farming, construction and mining applications where engines are used on items such as excavators, front-end loaders, dozers, graders, tractors, harvesters, trucks, feller-bunchers, compressors and gensets

– traction and motive power applications, for example golf carts, mobility scooters, small fork lifts, large materials handling units, hybrid vehicles and electric vehicles

– large stationary standby applications, including emergency power and renewable energy storage systems.

This category of battery use is the least well known with little data available. As such it relies on calculations built within the model. It is estimated that approximately 1.75 million Large and Industrial batteries enter into the Australian economy each year. These inputs are fairly evenly split across the four categories of use on both a count and weight basis.

The total weight of 51,680 tonnes for Large and Industrial battery inputs represents one third of the weight of total Australian battery inputs, even though on a count basis these batteries are less than one per cent of the number of battery inputs. A breakdown of Large and Industrial battery inputs by application is presented below.

Table – Estimated Australian Large and Industrial battery inputs by application, count and weight (tonnes)

Application	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Marine	289,000	17%	21.8	6,310	12%
Forestry/Farm/Constr/Mine	600,000	34%	34.4	20,660	40%
Traction and Motive	430,000	25%	22.6	9,710	19%
Large Stationary Standby	429,000	25%	35.0	15,000	29%
Total Large and Industrial	**1,748,000**	**100%**		**51,680**	**100%**

Large and Industrial Battery Inputs by Chemistry Type

Lead based chemistry dominates Large and Industrial battery inputs into Australia with approximately 90 per cent by count and also by weight. (Note that this includes lead acid batteries, sealed lead acid batteries, and lead based gels). The remaining battery chemistry types have been allocated on the same proportion as arisings between nickel metal hydride, nickel cadmium and lithium based (including lithium ion and lithium polymer). This breakdown is presented in the table below.

Table – Estimated Australian Large and Industrial battery inputs by chemistry type, count and weight (kilograms)

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Lead based	1,574,000	90%	46,670	90%
Nickel Cadmium	105,000	6%	3,020	6%
Nickel Metal Hydride	17,000	1%	490	1%
Lithium based	52,000	3%	1,500	3%
Total	**1,748,000**	**100%**	**51,680**	**100%**

Battery Arisings

Battery arisings from the Australian economy are defined as batteries that have finished their active service life and now require an end-of-life management solution, such as resource recovery. These estimates of arisings were built on a predictive model based on the amount of battery inputs and replacement rates as a function of battery stocks.

The chemistry, total tonnages and also unit count is important to understand with regard to battery arisings in Australia. Batteries with a high weight and low number of units present an ideal opportunity for resource recovery as they are readily identified and can be aggregated into large numbers for reprocessing.

However, in terms of sheer number and ubiquity throughout the economy, a stewardship solution is also required for low weight Handheld batteries. A breakdown of battery arisings by chemistry, count and weight is presented in the table below.

Table – Estimated Australian battery arisings by chemistry type, count and weight (tonnes)

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Alkaline	157,636,000	58%	7,180	5%
Carbon Zinc	52,513,000	19%	1,530	1%
Lithium	17,423,600	6%	1,440	1%
Nickel Metal Hydride	11,089,100	4%	623	0%
Nickel Cadmium	13,374,500	5%	1,772	1%
Lead Acid	7,829,800	3%	122,218	91%
Other (ZA, SO, ZC)	11,314,000	4%	186	0%
Total	**271,180,000**	**100%**	**134,949**	**100%**

This analysis shows that lead acid batteries account for over 90 per cent of all battery arisings in Australia on a weight basis, which is approximately 122,000 tonnes out of 135,000 tonnes of total battery arisings. However, given the large average weight of a lead acid battery, they account for only 3 per cent on a count basis, which is 7.8 million batteries out of a total arisings of 271.2 million batteries.

Fate of Battery Arisings

The fate of battery arisings was calculated according to the following end-of-life outcomes:

- reprocessed in Australia
- legal export for reprocessing overseas
- landfill
- stockpiled formal, in warehouses and at industrial facilities according to relevant legislation for battery storage in bulk
- stockpiled informal, for example left embedded in products such as mobile phones or left to accumulate in the house, garage, office, barn or mine site
- rebirthing, which is the inappropriate re-branding of an end-of-life battery for resale
- illegal export, which although is likely to be for reprocessing, nevertheless carries all of the risks of potentially hazardous materials being processed at unlicensed facilities.

A breakdown of the fate of battery arisings is presented in the table below. This shows that for total battery arisings in Australia, three quarters of batteries by weight are estimated to be reprocessed in Australia.

Table – Estimated fate of Australian battery arisings by category and tonnes					
Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total*	*Total Proportion*
Reprocessed in Australia	350	66,050	34,350	100,750	75%
Legal Export	150	-	150	300	0%
Landfill	8,024	2,000	1,350	11,374	8%
Stockpiled Formal	250	3,960	2,290	6,500	5%
Stockpiled Informal	3,070	1,650	1,100	5,820	4%
Rebirth	10	1,320	725	2,055	2%
Illegal Export	50	5,280	2,820	8,150	6%
Totals	**11,904**	**80,260**	**42,785**	**134,949**	**100%**

The resource recovery of battery arisings is dominated by lead acid batteries which make up virtually the entirety of Australian battery reprocessing. The estimated 100,250 tonnes of lead battery reprocessing is approximately 75 per cent of all battery arisings and 82 per cent of all lead acid battery arisings. (Note that the legal export of lead acid batteries ceased after October 2009 when an application for an export permit was not granted. No reason for refusing the application was given on the official notice of decision, however the excess in processing capacity for lead acid batteries (143,000 tonnes of capacity and an estimated 122,218 tonnes of lead based battery arisings) would have been a significant factor.)

The fate of arisings on a count basis is also presented in the table below (estimated using average weights). This shows that reprocessing of batteries, legal export and formal stockpiling only accounts for 6 per cent of all battery arisings on a count basis.

Table – Estimated fate of Australian battery arisings by category and count (average weight basis)					
Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total*	*Total Proportion*
Reprocessed in Australia	2,109,000	4,452,000	1,183,000	7,744,000	3%
Legal Export	3,330,000	-	5,000	3,335,000	1%
Landfill	183,389,000	135,000	46,000	183,570,000	68%
Stockpiled Formal	5,551,000	267,000	79,000	5,897,000	2%
Stockpiled Informal	68,546,000	111,000	38,000	68,695,000	25%
Rebirth	229,000	89,000	25,000	343,000	0%
Illegal Export	1,143,000	356,000	97,000	1,596,000	1%
Totals	**264,297,000**	**5,410,000**	**1,473,000**	**271,180,000**	**100%**

'Leakage' in battery arisings comes from informal stockpiling, within households and offices for handheld batteries and in remote and rural locations for Automotive SLI and Large and Industrial batteries. Informal stockpiling accounts for 4 per cent of battery arisings on a weight basis, which is 5,820 tonnes, including approximately 2,560 tonnes of lead acid batteries and over 3,000 tonnes of Handheld batteries. On a count basis the Handheld batteries increase the proportion of batteries informally stockpiled to 25 per cent of all battery arisings.

Similarly, the landfill of batteries is estimated to be approximately 8 per cent of battery arisings including 8,000 tonnes of Handheld batteries and also 3,000 tonnes of lead acid batteries when assessed on a weight basis. However, on a count basis landfill of batteries accounts for nearly 70 per cent of all batteries.

If landfill is considered an undesirable management option for batteries, and is grouped with illegal export, rebirthing and informal stockpiling (all arguably undesirable from a stewardship perspective), then approximately 20 per cent of all batteries in Australia by weight are not being managed in an optimal way. This is 27,400 tonnes of batteries, comprising 15,940 tonnes of lead acid batteries and over 11,000 tonnes of Handheld batteries. On a count basis, the proportion increases to 94 per cent of all batteries ending up in sub-optimal management options, which is 254.2 million batteries per annum.

The table below presents a breakdown of the fate of Australian battery arisings by category and tonnes, but excludes lead acid based chemistry. This suggests that nearly two-thirds of non-lead acid battery arisings are ending up in landfill, and nearly one quarter of arisings being stockpiled informally (in other words, temporarily 'landfilled' in household and office cupboards and drawers). On a count basis, this equates to approximately 250 million batteries.

Table – Estimated fate of Australian battery arisings by category and tonnes – excluding lead acid batteries

Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total*	*Total Proportion*
Reprocessed in Australia	100	-	400	500	4%
Legal Export	150	-	150	300	2%
Landfill	7,820	-	310	8,130	64%
Stockpiled Formal	240	-	250	490	4%
Stockpiled Informal	2,860	-	250	3,110	24%
Rebirth	10	-	50	60	0%
Illegal Export	50	-	100	150	1%
Totals	**11,230**	**-**	**1,510**	**12,740**	**100%**

Challenges for Battery Resource Recovery

There is a high resource recovery rate when all batteries in Australia are considered as a whole (75 per cent as measured by weight as a percentage of arisings). However, there are very few Handheld batteries recovered for recycling, with only 750 tonnes across all chemistry types collected for local processing and legal export. This represents a recovery rate of 6 per cent of Handheld batteries by weight or 4 per cent by count. The main barriers for increased recovery of Handheld batteries are the establishment of collection systems and reprocessing capacity.

Automotive SLI batteries have a recovery rate of 87 per cent (when including formal stockpiling and reprocessing as a percentage of arisings), owing to their size and also to the value of lead as a commodity. Large and Industrial batteries are also dominated by lead acid battery chemistry and have a high recovery rate.

However, even with the established industry of lead acid battery reprocessing in Australia, the emerging picture is that a significant tonnage of material is being managed through ‘undesirable’ options such as landfill, informal stockpiling and illegal export. Thus there is room for improved stewardship of lead acid batteries including taking action on the eradication of illegal export, improved recovery from remote and regional sites and prevention of batteries entering the urban waste stream and being landfilled.

Recommendations

This analysis of the Australian battery market has demonstrated that there are significant numbers of batteries being consumed each year, and as a result, there will be increasing numbers of batteries arising in the foreseeable future. Handheld batteries of all chemistry types are most likely to end up in landfill, unless systems for collection and reprocessing can be established. While there are existing resource recovery solutions for lead acid batteries, there is also room to improve their performance.

It is recommended that ABRI take a lead role in delivering the following outcomes:

- improved collections of Handheld batteries to capture a critical mass for reprocessing of these batteries within Australia
- a sustainable funding model to support the collection of Handheld batteries
- eradication of illegal export of batteries by working with relevant authorities
- improved recovery of Automotive SLI and Large and Industrial batteries from remote and regional sites
- prevention of batteries entering the mixed urban waste stream
- design of a product stewardship model with the capacity to deliver the above desired outcomes.

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TABLES

GLOSSARY AND ABBREVIATIONS

ABRI	Australian Battery Recycling Initiative
ABS	Australian Bureau of Statistics
ANZSCC	Australian and New Zealand Standard Commodity Classification
Arisings	Batteries that have reached the end of their service life (or are unwanted for any other purpose) within the Australian economy and require a resource recovery or waste management solution
Formal stockpiles	Batteries that are stored in accordance with relevant regulations prior to transport or processing
Informal stockpiles	Storage of batteries on an ad-hoc basis, for example, in a disused piece of equipment within a household, or separately in rural and regional settings
Inputs	The consumption of batteries within Australia
LAB	Lead Acid Battery
Li-ion	Lithium Ion
MSFA	Materials Stocks and Flows Analysis
NiCd	Nickel Cadmium
NiMH	Nickel Metal Hydride
OEM	Original Equipment Manufacturer
Outputs	Batteries that reach the end of their service life – see also arisings
PDA	Personal Data Assistant
SLAB	Sealed Lead Acid Battery
SLI	Starting Lighting and Ignition
SO	Silver Oxide
Stocks	Batteries that are in service life within the Australian economy
ULAB	Used Lead Acid Battery
UNLAB	Used Non-Lead Acid Battery
ZA	Zinc Air
ZC	Zinc Chloride

1 BACKGROUND AND INTRODUCTION

Batteries are essential to the functioning and performance of many products. They range in size and application from large arrays of lead acid batteries for motive power, to small button cells for digital devices. There is also a wide variety of recycling activities and resource recovery performance. By far the most successful recycling initiatives in Australia have been for lead acid batteries (car batteries) due to the commercial value of scrap lead. Initiatives for the smaller Handheld battery types, however, are in their infancy.

Currently, only a small number of local activities to recycle Handheld batteries operate in Australia. Due to the wide variety of Handheld battery types, recycling is a labour intensive and expensive process because of the sorting required. For example, Handheld battery types include single use alkaline, carbon zinc, lithium, zinc air, silver oxide and zinc chloride batteries, in addition to rechargeable lithium ion, nickel cadmium, nickel metal-hydride and lead acid batteries.

The Australian Battery Recycling Initiative (ABRI) is a not-for profit incorporated association of members who seek to maximise resource recovery from batteries. It seeks to divert batteries from landfill and to generate economic benefits from increased recovery and recycling of valuable and finite materials. As part of delivering ABRI's vision and mission, ABRI has commissioned this comprehensive and detailed assessment of the Australian battery market as an important step in developing a robust plan for battery stewardship implementation.

This analysis of the Australian battery market will allow ABRI and other relevant stakeholders to better assess the current breakdown of batteries in waste arisings and prioritise product stewardship activities for batteries in Australia.

Product stewardship involves 'shared responsibility for reducing the environmental, health and safety footprint of manufactured goods and materials across the manufacture-supply-consumption chain and at end of life'.[1] For batteries, this responsibility is shared between organisations at every stage of the product supply chain, including battery producers, equipment manufacturers, retailers, collectors and recyclers, in addition to consumers and all levels of government.

1.1 Overview of Report

The structure of this report is presented in Figure 1 below. Following this introduction and background to the study, Section 2 presents a description of the methodology used in this study. This includes discussion on the materials stocks and flows model and also the limitations to this approach. Section 3 examines some options for the classification of batteries and develops a classification system for use in Australia. This provides the framework for a practical approach taken in the study to collect data according to Handheld, Automotive SLI and Large and Industrial batteries.

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[1] *Department of Environment, Water, Heritage and the Arts, 2009, 'National Waste Policy: Less Waste, More Resources', Environment Protection and Heritage Council, Adelaide, accessed at http://www.ephc.gov.au/sites/default/files/WasteMgt_Rpt__National_Waste_Policy_Framework_Less_waste_more_resources_PRINT_ver_200911.pdf, September 2010.*

Sections 4, 5 and 6 present the results of the study in terms of battery inputs (consumption), stocks, and arisings respectively. A summary of the national material stocks and flows of batteries in Australia is presented in Section 7.

Section 8 provides an overview of battery recycling programs, while Section 9 examines the emerging trends in battery use and the impact these trends may have on battery arisings and chemistry types. The report concludes with Section 10, which provides a summary of main findings and recommendations. A detailed set of appendices is also included, which covers further information on the project, the methodology that was used, battery chemistry types and recycling programs in Australia.

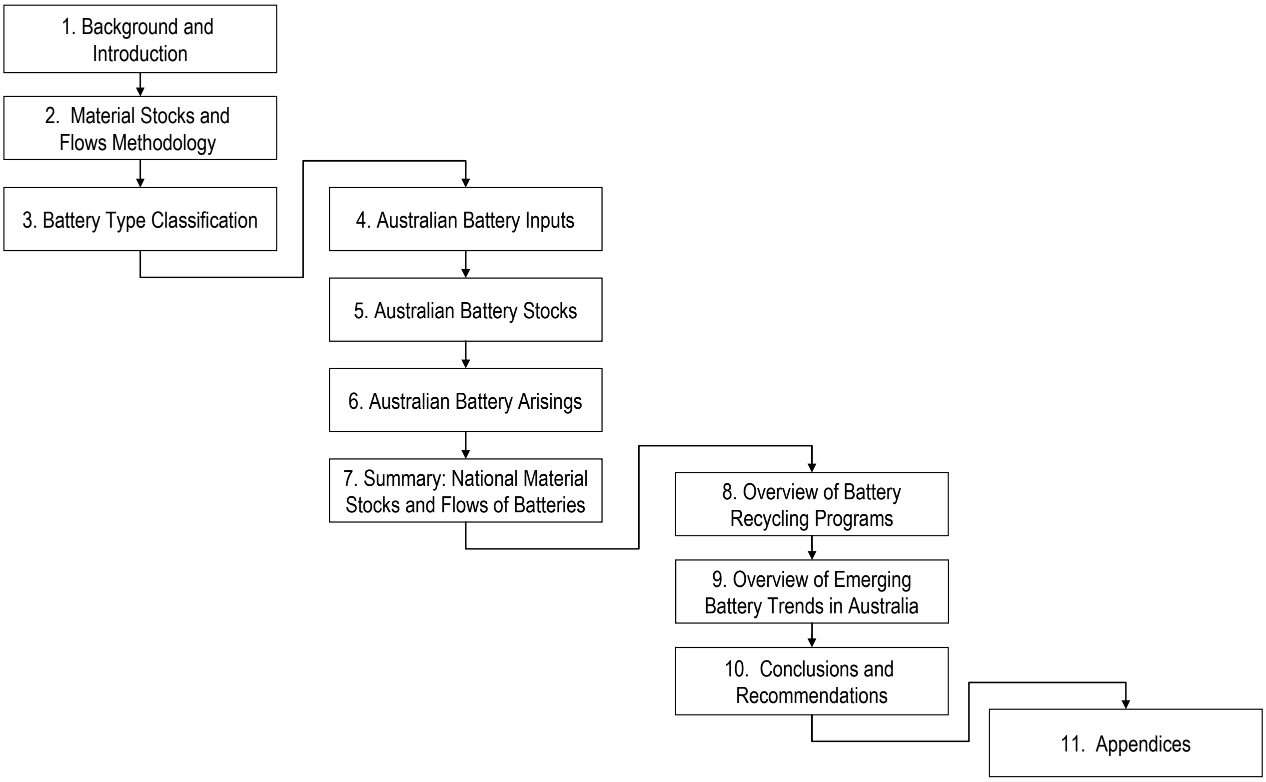

Figure 1 – Structure of Report

2 MATERIAL STOCKS AND FLOWS METHODOLOGY

The project methodology was based on a combination of research, consultation, and client liaison to acquire relevant information needed to build a material stocks and flows model. This model was used to estimate battery consumption, stocks and arisings in Australia. The data were then synthesised into the final report to provide a clear analysis of battery consumption, recycling and disposal in Australia. The methodology, assumptions and overall approach taken are presented in the following sections.

2.1 Materials Stocks and Flows Model

A material stocks and flows model of battery inputs, stocks and arisings within Australia was prepared for this study as shown in Figure 2 below. Battery **inputs** are the consumption of batteries; **stocks** are those batteries in active service within the economy; and **arisings** are batteries that have reached the end of their service life (or are unwanted for any other purpose) and require a resource recovery or waste management solution. The intention of the model is to reflect the current state of battery consumption and recycling within Australia in order to provide an evidence base for the expansion of product stewardship programs and ABRI's advocacy efforts.

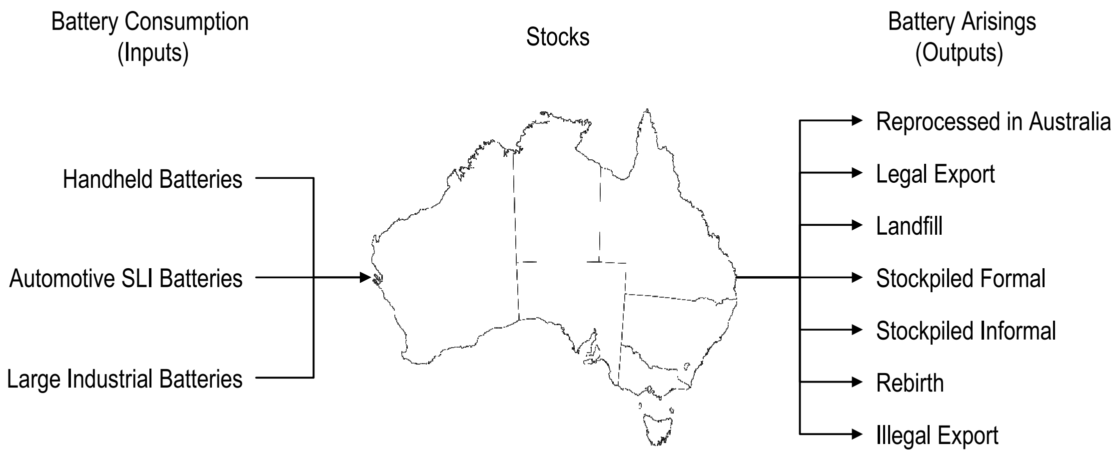

Figure 2 – Overview of stocks and flows model

The model is an estimated mass balance of current battery usage in Australia. By definition all of the data generated by the model with regard to the inputs, stocks and arisings of batteries are estimates. This has been highlighted in table headings in the Executive Summary, but has been discontinued in the body text to avoid repetition. Also note that the numbers in the tables may not add up due to rounding.

Data are reported on both a count and weight basis. This was done to ensure that the potential impacts of high count/low weight categories of batteries were not overlooked. For example, battery arisings measured in the hundreds of millions on a count basis create a significant impact and challenge for product stewardship purely on the basis of their number, even though they may have a comparatively small cumulative mass. Similarly, opportunities to recover significant tonnage of batteries could be overlooked if data were reported only on a count basis.

Information used in the material stocks and flows model was obtained from several sources and from differing years, including:

- Australian Bureau of Statistics
- battery based studies
- battery manufacturers and importers
- resource recovery companies
- industry reports
- government (state, federal and international)
- industry participants
- battery recycling programs
- other reports on waste generation, resource recovery and stewardship in Australia.

A literature review provided the foundation for the classification of battery types, the material stocks and flows analysis, and the overview of battery recycling programs.

A project fact sheet was prepared to explain the context of the study and used in making contact with battery stakeholder organisations. A copy of this fact sheet is presented in Appendix 1. Organisations contacted as part of this study are listed in Appendix 2. (Note that contact with a stakeholder should not imply their input into the study or any implied agreement with findings from this study).

Commercial information was treated as confidential and only aggregated data is presented in this report. The calculation of arisings provides an estimate of flows into domestic recycling, export, stockpiling and recovery activities as well as landfill. The intention was to construct an accurate model of the flows of batteries in Australia, as opposed to preparing a precise market breakdown of commercial interests. The benefit of such a model is that it enables the establishment of priorities for battery stewardship policy and programs.

For practical and data collection purposes, the battery inputs were broken into three categories:

- Handheld batteries of less than 1 kg in weight from all chemistry types
- Automotive Starting Lighting and Ignition (SLI) batteries that are used in registered on-road vehicles and that use lead acid chemistry
- Large and Industrial batteries (essentially greater than 1 kg) that are used in non-registered or off-road engine applications, for example, mine sites and agriculture, in addition to batteries used for traction and motive, and standby power.

Note that a further classification of batteries was developed according to additional criteria and is detailed in Section 3.

A summary of the modelling process for the three main battery types is presented in the following sections, with more detailed supporting information presented in the Appendices.

2.2 Handheld Batteries

The consumption (inputs) of single use and rechargeable Handheld batteries in the Australian economy was estimated from ABS customised reports on imports for the financial year 2009/2010, together with information from industry sources. Original Equipment Manufacturer (OEM) data were sourced to gain the following average weights and sizes:

- AAA – 12 grams
- AA – 24 grams
- 9v – 42 grams
- C – 65 grams
- D – 135 grams
- other size (primarily button cells) – 6 grams
- lantern – 742.5 grams.

Six main channels to the Handheld market for 'stand alone' sales were identified in discussion with industry as part of this study. These include:

- grocery, for example Woolworths, Coles and independent supermarkets. This is the largest channel with an estimated 60 per cent of market share
- mass merchant, for example K-Mart, Big W, and Target with an estimated 10 per cent of market
- hardware, for example Bunnings, Mitre 10, and Home Timber and Hardware with an estimated 10 per cent of the market
- electrical retail, for example, Harvey Norman, Dick Smith Power House and Tandy with an estimated 7.5 per cent of the market
- office supplies, for example Office Works, with an estimated 7.5 per cent of the market
- speciality stores and online sources with an estimated 5 per cent of the market.

Other battery sizes in the Handheld category related to the main associated product of use, for example, mobile phones. Online sources of OEM data were used to estimate an average weight for each battery type. The following types of batteries and weights were used:

- mobile phone batteries – 21 grams
- batteries embedded in digital devices such as iPods, MP3 players, and personal data assistants – 21 grams
- laptop power packs – 564 grams
- cordless power tools – 546 grams
- Sealed Lead Acid Batteries (SLAB) used in emergency lighting and standby power applications – 700 grams.

An estimate of the number of batteries embedded in products sold into the Australian economy was also made to arrive at a total estimate on battery consumption (inputs equals battery stand alone sales plus embedded products).

In addition to the product categories immediately above, the following products were considered when estimating embedded inputs:

- smoke detectors
- portable electronic items (cd/ cassette player, walkman, radio)
- cordless appliances with their own recharger such as phones, torches, tooth brushes, shavers vacuums, other kitchen appliances, toys and remote control cars
- non portable radios, clock radios,
- lanterns and torches
- battery operated toys using single use batteries.

The chemistry of Handheld batteries was estimated on the basis of the following chemistry types:

- alkaline
- carbon zinc
- lithium based (ion and polymer)
- nickel metal hydride (NiMH)
- nickel cadmium (NiCd)
- lead acid
- other, for example, zinc air (ZA), silver oxide (SO), and zinc chloride (ZC).

Further information on these chemistry types is provided in Appendix 3 – Battery Chemistry.

Stocks of Handheld batteries, defined as batteries in active service life, were estimated by compiling an average household bundle of appliances using batteries and an average commercial office bundle of appliances using of batteries.

Arisings of Handheld batteries were estimated on the basis of estimated battery life and the level of replacement sales. Further information on the methodology related to Handheld batteries is provided in Appendix 4.

2.3 Automotive SLI Batteries

Automotive Starting, Lighting and Ignition (SLI) batteries are such a dominant sub-category within the total stocks and flows of batteries in Australia that they warrant specific discussion. (Note that Automotive SLI Batteries specifically excludes Handheld (<1kg) SLAB and Industrial (>1kg) SLAB).

There are four main channels for Automotive SLIs to enter the market:

- 'do-it-yourself' where the battery is bought direct from a retailer such as SuperCheap, Autobarn or Repco. This is the largest channel with approximately one third (35 per cent) of Automotive SLI batteries being sold through DIY stores
- 'do-it-for-me' change over at a service centre, for example vehicle repairs or tyre outlets. It is estimated that this channel accounts for a similar proportion to the direct battery replacement channel at 25 per cent of Automotive SLI battery inputs
- embedded in a new car sale, either locally produced or imported. Based on estimates of new vehicle sales in Australia, approximately 20 per cent of Automotive SLI battery inputs are in new vehicles, with the majority of these (approximately 85 per cent) imported
- direct battery replacement, for example through roadside replacement programs, with approximately 20 per cent of the inputs through the direct replacement channel.

Automotive SLI batteries were differentiated according to vehicle type in line with the Australian Bureau of Statistics reporting on national fleet size. Average weights were estimated by sourcing a range of battery sizes within a category of vehicles and calculating an average.

These vehicle types, battery weights and expected life spans, in addition to the national fleet size are presented in Table 1 below. ABS motor vehicle census data for 2008 and 2009 was used to estimate the fleet size for the 2008/09 financial year (fleet at 2008 plus fleet for 2009 divided by two equals fleet for 08/09).[2] Note that campervans and trailers were excluded from the analysis as they are unlikely to use an SLI battery.

Table 1 – Summary of Automotive SLI battery data

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Size*	*Replacement Rate*	*New Vehicle Sales*	*Vehicles Retired*
Motorcycle	3.5	3	1	595,800	24%	116,000	59,900
Passenger Vehicle	3.5	14.3	1	11,913,300	31%	755,800	475,400
Light Commercial	3.5	15.7	1	2,329,600	29%	187,200	96,500
Rigid Trucks	3	23	1	416,300	36%	22,000	8,400
Articulated Trucks	3	31.6	2	80,200	35%	4,200	900
Non-Freight Trucks	3	31.6	1	22,100	36%	1,200	600
Buses	3	31.6	2	82,500	37%	4,400	900
Total				**15,440,000**		**1,090,800**	**642,600**

Further information on the methodology related to Automotive SLI batteries is provided in Appendix 5.

[2] *ABS, 2009, '9309.0 - Motor Vehicle Census, Australia, 31 Mar 2009', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/9309.0?OpenDocument, July 2010.*

Some of the key points for Automotive SLI data include:

- replacement sales were calculated as the replacement rate multiplied by the fleet size
- replacement rate was calculated based on average life with a normal distribution
- other inputs are from sales of new vehicles
- all Automotive SLI batteries are lead acid batteries
- stocks are taken to be the fleet size
- arisings were calculated as battery replacements plus retirement of vehicles from the fleet
- vehicles retired equal the size of the previous financial year's fleet size, plus new sales, minus the size of the fleet at the end of the current financial year.

2.4 Large and Industrial Batteries

Large and Industrial batteries is the category of batteries that picks up non-automotive lead acid batteries such as those used in marine and mining applications, traction and motive power, and large stationary standby power storage applications. It also includes other chemistry types that provide traction and motive power for electric vehicles and hybrid electric vehicles, and standby power for photovoltaic systems and emergency back up. The category covers:

- marine engine applications
- forestry, farming, construction and mining applications where engines are used on items such as excavators, front-end loaders, dozers, graders, tractors, harvesters, trucks, feller-bunchers, compressors and gensets
- traction and motive power applications, for example golf carts, mobility scooters, small fork lifts, large materials handling units, hybrid vehicles and electric vehicles
- large stationary standby power applications.

A similar approach to Automotive SLI batteries was taken in that a national fleet size was estimated for each battery application, in addition to replacement rates and average weights of each battery. A summary of these estimates is presented in Table 2 below. Further information on the methodology related to Large and Industrial batteries is provided in Appendix 6.

Table 2 – Summary of Large and Industrial battery data

Category	*Average Life (Years)*	*Average Weight (kg)*	*Batteries per Application*	*Fleet Size*	*Replacement Rate*
Marine	3	21.8	1	716,100	35%
Forestry/Farm/Constr/Mine	2	34.4	1-4	1,202,300	60%
Traction and Motive	5	22.6	various	336,200	20%
Large Stationary Standby	10	35.0	various	2,857,100	15%
Total Large and Industrial				**5,112,000**	

Lead based chemistry is the largest form of Large and Industrial battery input into Australia with approximately 90 per cent by count and also by weight of the Large and Industrial sub-category. (Note that this includes lead acid batteries, sealed lead acid batteries, and lead based gels). For the sub-categories of Marine and Forestry, Farming, Construction and Mining, all battery types were counted as lead based. The remaining battery chemistry types have been allocated between nickel metal hydride, nickel cadmium and lithium based (including lithium ion and lithium polymer) on the basis of discussions with industry and reference to ABS customised battery import data.

2.5 Limitations of the Model

This is the first time that a comprehensive analysis of Australian battery consumption, recycling and disposal has been undertaken. Although batteries are an everyday part of life, there are several knowledge gaps with respect to consumption of batteries by battery chemistry and size, in addition to gaps around the stock of batteries within the economy.

Any model that attempts to estimate material flows at a national level is limited by the quality of source data and by assumptions that are necessary to overcome data gaps. The following hierarchical approach was taken to managing data quality:

- use of customised ABS reports
- use of current battery manufacturer and/or importer information
- use of publicly available ABS information
- industry reports available for purchase
- industry personal communications
- projections based on industry personal communications
- use of per capita or per household estimates
- informed estimates
- calculations using the above and other referenced assumptions
- assumed similarities of battery consumption between user groups.

Adjustments for economic growth were made where data was more than two years old. Outputs from the model were also rounded. As such the information presented in tables may not total.

The strength of the model is that it provides a clear articulation of the probable scenario for battery consumption, recycling and disposal in Australia. Its major limitation is the quality of data used to estimate inputs, stocks and arisings. This quality of data will improve over time as part of ABRI and other battery industry stewardship initiatives. A summary of data status is presented in Table 3 below. (Additional information on data sources is presented in the Appendices).

Table 3 – Summary of battery data sources and confidence levels

Inputs	*Stocks*	*Arisings*	*Overall Confidence*
	Handheld Batteries		
ABS customised report, industry data and industry personal communications	Per household rates from published studies with ABS data on population, extrapolations to business on a per business basis	Calculated from stocks using an estimated life span in active service	Medium – relies on modelling and also assumptions on stocks and arisings
	Automotive SLI Batteries		
ABS customised report, ABS published data, industry personal communications and calculations	ABS published data, industry data	Calculated on inputs and stocks in combination with life span	High - good data on fleet size and reasonable data on LAB requirements
	Large and Industrial Batteries		
ABS published data, industry data, similar international studies, calculations and extrapolations	Estimated on basis of per business use rates with ABS published data on industry size and count	Calculated on stocks in combination with estimated life span	Low to Medium – relies on modelling and assumptions for inputs, stocks and arisings

3 BATTERY TYPE CLASSIFICATION

Batteries are highly engineered electrochemical devices that are able to convert chemical energy into direct current for release on demand. They operate as the power source for many products in the economy, ranging from providing starting, lighting and ignition functions for cars, to keeping people in contact through powering mobile phones, and from industrial to domestic users.

The chemistry of batteries is similarly varied, ranging from 'wet cell' lead acid batteries used in cars to 'dry cell' zinc carbon and alkaline batteries used in AA, C, and D size batteries. The chemistry of a battery also determines whether or not the battery is rechargeable or is for single use. Furthermore, some of the materials used to manufacture batteries cause end-of-life management issues owing to the hazardous nature of these materials.

Developing a classification system for batteries is important from a resource recovery perspective in that reverse logistic systems need to channel the right types of batteries to their appropriate recycling option. A battery classification system needs to give consideration to the following issues:

- application
- rechargeable or single use
- chemistry and materials of manufacture
- physical form, for example, weight, volume, separate or embedded
- hazardous waste regulations
- collection systems
- options for resource recovery
- import and export reporting.

A review of existing classification systems for batteries is provided in the sections below. A critique of each system is provided against issues related to resource recovery and recycling and a suggested classification system is developed for the purposes of this study.

3.1 Existing ABRI Classification

The existing ABRI classification system for batteries is shown in Figure 3 overleaf. The primary distinction is at the macro level of battery operation, namely wet cells versus dry cells. Wet cells are then differentiated according to application, with three categories of standby power, motive power and SLI (starting lighting and ignition). Dry Cells, on the other hand, differentiate between single use and rechargeable batteries, in addition to emerging technologies which could be either single use or rechargeable. The next level of classification is according to chemistry type and then finally the application or use of the battery.

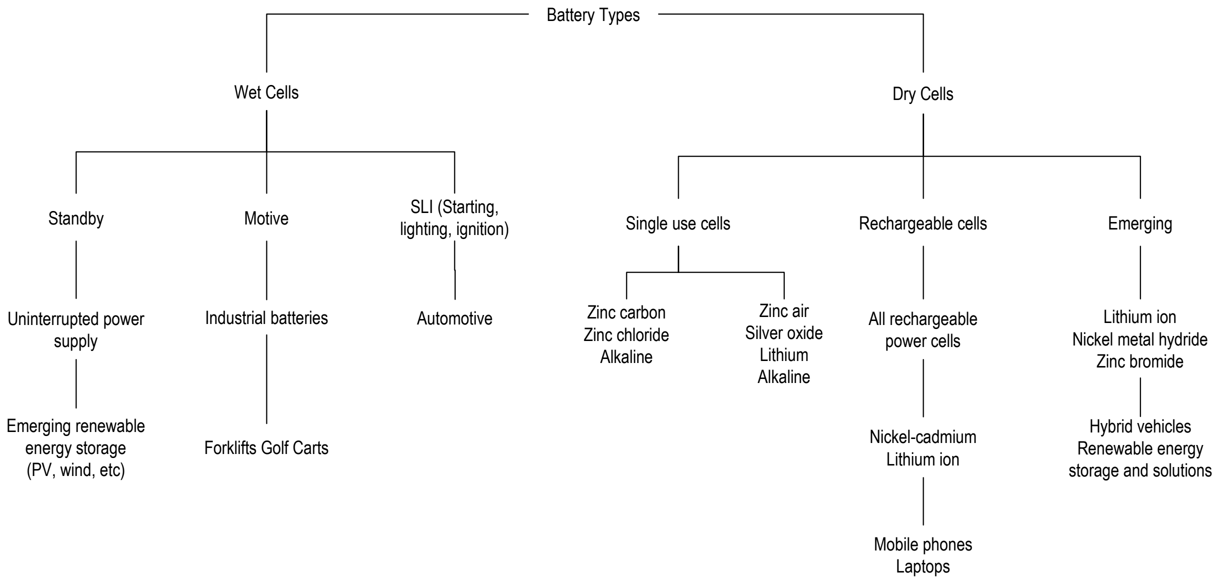

Figure 3 – Current ABRI classification system for batteries

The main advantage of this classification system is that it distinguishes between lead acid batteries and non-lead based chemistry. Given that the bulk of batteries consumed and available for recycling by weight are going to be used lead acid batteries (ULABs), this distinction has a practical logic. However, from an end-of-life perspective there could be times when smaller Sealed Lead Acid Batteries (SLAB) are confused with dry cell technology.

3.2 European Union

A review of policy options for the EU Battery Directive[3] identified a system of classification that differentiated between batteries on the basis of battery users, battery technology, typical uses of battery types, the portability of the battery, and rechargeability. This approach is shown in Table 4 overleaf.

The United Kingdom takes a similar approach by grouping batteries in terms of portable, industrial and automotive.[4] The strength of this approach is the differentiation based on portability and battery user. For example, an industrial user of a non-portable battery is unlikely to dispose of the battery into a domestic mixed waste stream as the battery will be too large to fit into a wheelie bin. Also some form of recycling is likely to be pursued owing to the resource value of large and heavy batteries. Portable batteries present the biggest challenge as they will outnumber non-portable batteries and are most likely to be disposed into a mixed waste stream.

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[3] *Bio Intelligence Service, 2003, 'Impact Assessment on Selected Policy Options for Revision of the Battery Directive', Environment Directorate-General of the European Commission, Brussels, accessed at http://ec.europa.eu/environment/waste/batteries/pdf/eia_batteries_final.pdf, July 2010. Also referenced in European Commission, 2003, 'Staff Working Paper Directive of the European Parliament and of the Council on Batteries and Accumulators and Spent Batteries and Accumulators', Commission of the European Communities, Brussels, accessed at http://ec.europa.eu/environment/waste/batteries/pdf/exten_impact_assessment.pdf, July 2010.*

[4] *Premier Farnell, 2009, 'New Batteries Directive', Premier Farnell, Leeds, accessed at http://hk.farnell.com/images/en_UK/rohs/pdf/battery_directive_june09_v3.pdf, July 2010.*

<table>
<tr><th colspan="6">Table 4 – European approach to battery segmentation</th></tr>
<tr><th>Users</th><th>Technology/Chemistry</th><th>Typical Uses</th><th colspan="3">Type of Batteries</th></tr>
<tr><td rowspan="8">Households and Professional Users</td><td>General Purpose (Alkaline Manganese and Zinc Carbon)</td><td>Clocks, portable audio and devices, torches, toys and cameras</td><td rowspan="7">Portable (<1 kg)</td><td rowspan="7"></td><td rowspan="3">Non-rechargeable (primary)</td></tr>
<tr><td>Lithium (Li)</td><td>Photographic equipment, remote controls and electronics</td></tr>
<tr><td>Button Cells (zinc air, silver oxide, manganese dioxide and lithium)</td><td>Watches, hearing aids, calculators</td></tr>
<tr><td>Nickel Cadmium (NiCd)</td><td>Cordless phones, power tools and emergency lighting</td><td rowspan="11">Rechargeable (secondary)</td></tr>
<tr><td>Nickel Metal Hydride (NiMH)</td><td>Cellular and cordless phones</td></tr>
<tr><td>Lithium Ion (Li-ion)</td><td>Cellular phones, laptops and palms</td></tr>
<tr><td>Lead Acid</td><td>Hobby applications</td></tr>
<tr><td>Lead Acid</td><td>Automotive/motorcycle Starter Lighting and Ignition (SLI)</td><td rowspan="7">Large (>1 kg)</td><td>Starter Batteries</td></tr>
<tr><td rowspan="6">Industrial</td><td>Lead Acid Standby</td><td>Alarm systems, emergency back-up systems, eg. rail and telecommunications applications</td><td rowspan="6">Industrial Batteries</td></tr>
<tr><td>Lead Acid Traction</td><td>Motive power sources eg. forklift trucks, milk floats</td></tr>
<tr><td>Nickel Cadmium (NiCd) Standby</td><td>Motive and standby applications eg. satellite and rail applications</td></tr>
<tr><td>Nickel Cadmium (NiCd) Motive Power</td><td>Electric vehicles</td></tr>
<tr><td>Nickel Metal Hydride (NiMH)</td><td>Hybrid vehicles</td></tr>
</table>

3.3 Australian Customs Tariff Statistical Code

When batteries are imported they are reported by Australian Customs according to the relevant statistical code. For example, the Working Tariff page gives access to an online version of the Australian Customs Service document titled 'Combined Australian Customs Tariff Nomenclature and Statistical Classification' and commonly known as the Working Tariff Pages.[5]

The Customs Tariff Act 1995, Schedule 3 - Listing of Goods, gives products their classification and duty rates. Batteries appear under 'Chapter 85 - Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles.' Battery specific classifications listed in Chapter 85 are shown in Table 5 below.

[5] *Accessed online at http://www.customs.gov.au/site/page5663.asp, and current as at 14 July 2010.*

Table 5 – Australian Customs Tariff Nomenclature and Statistical Classification

Statistical Code	*Description*
8506	Primary Cells And Primary Batteries:
8506.10.00	Manganese dioxide with anode of lithium or a lithium compound, or Manganese dioxide other
8506.30.00	Mercuric Oxide
8506.40.00	Silver Oxide
8506.50.00	Lithium
8506.60.00	Air-zinc
8506.80.00	Other primary cells and primary batteries
8506.90.00	Parts
8507	Electric accumulators, including separators therefore, whether or not rectangular (including square):
8507.10	Lead-acid, of a kind used for starting piston engines
8507.10.10	---Of a kind used as components in passenger motor vehicles
8507.10.90	--- other for motor vehicles or other
8507.20.00	Other lead acid accumulators
	--- for traction purposes
	--- Regulated sealed valve type with a capacity greater than 65 Amperes/hour at C 20 (for 20 hour rate) at 25 ºC
	---other
8507.30.00	Nickel-cadmium
8507.40.00	Nickel-iron
8507.80.00	Other accumulators alkaline or other
8507.90	Parts
8507.90.10	---Of a kind used as components in passenger motor vehicles
8507.90.90	other
8548	Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators; electrical parts of machinery or apparatus, not specified or included elsewhere in this chapter
8548.10	Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators

The Customs Tariff classification system reinforces the ABRI classification system in the macro distinction between dry cell batteries and lead acid batteries. However it includes the potential for rechargeable dry cell batteries to be included in the same grouping as lead acid batteries. For example, at a high level (8506 vs 8507) the system would not be able to differentiate between lead acid batteries and rechargeable dry cell batteries.

3.4 Australian Bureau of Statistics

The Australian Bureau of Statistics (ABS) also has a system for battery classification under the Australian and New Zealand Standard Commodity Classification (ANZSCC).[6] Batteries are grouped under '464: Accumulators, primary cells and primary batteries, and parts thereof'. Further detail is supplied in Table 6 below.

Table 6 – Australian and New Zealand Standard Commodity Classification (ANZSCC)

ANZSCC	*Description*
464.11	Primary cells and primary batteries (non-rechargeable batteries) Note: For quantity report the number of cells
464.12	Electric accumulators
464.12.01	Lead-acid batteries - dry charged and wet cell (ie secondary rechargeable)
464.12.01.11	S.L.I. automotive 6 V, new
464.12.01.12	S.L.I. automotive 12 V, new
464.12.01.13	Traction (fork lifts, mining etc) 2 V cells, new
464.12.01.14	Semi-traction and commercial 2 V cells, new (including home lighting, solar power)
464.12.01.15	Stationary or stand-by 2 V cells, new (telecommunications, U.P.S., etc)
464.12.01.90	Other (including all rebuilt batteries and motor cycle batteries)
464.12.02	Alkaline batteries, rechargeable (ie secondary type)
464.13	Parts of primary cells, primary batteries and electric accumulators (battery components) (including separators)
464.90	Accumulators, primary cells and primary batteries, and parts thereof, not elsewhere classified

Again the ABS system reinforces the ABRI classification in that distinction is made at the macro level between wet cell batteries, single use dry cell and rechargeable dry cell batteries.

3.5 Hazardous Waste Classification

Certain types of batteries are classified as a hazardous waste that require special handling, treatment, disposal and recycling under the Hazardous Waste (Regulation of Exports and Imports) Act 1989. The object of this Act is to regulate the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner so that human beings and the environment, both within and outside Australia, are protected from the harmful effects of the waste.[7]

Hazardous waste is classified in the Act as wastes that belong to any category of wastes to be contained as listed in Annex I to the Basel Convention. For example Y23 Zinc Compounds,

[6] *ABS, 1996, 'Australian and New Zealand Standard Commodity Classification (ANZSCC'),Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/ausstats/abs@.nsf/0/9CA00D0AF41993B2CA25697E00184B82?opendocument, July 2010.*

[7] *Australian Commonwealth Government, 2009, Hazardous Waste (Regulation of Exports and Imports) Act 1989, accessed at http://www.environment.gov.au/settlements/chemicals/hazardous-waste/guide.html, June 2010*

Y26 Cadmium; cadmium compounds, and Y31 Lead; lead compounds. Wastes can also be classified as hazardous if they exhibit Annex III hazardous characteristics such as flammable, explosive, poisonous, infectious, corrosive, toxic, and ecotoxic. Waste material types that are listed in Annex VIII List A and that are relevant to battery consumption and recycling include:

- A1160 - waste lead acid batteries, whole or crushed
- A1170 - unsorted waste batteries excluding mixtures of only list B batteries.
- A1180 - waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A,

Note that list B batteries are identified as waste batteries conforming to a specification, other than those made with lead, cadmium or mercury.

A summary of relevant state and territory regulations relating to battery classification is presented in Table 7 below. A more detailed discussion of regulatory settings as they relate to batteries is presented in Appendix 7.

Table 7 – Summary of National, State and Territory battery regulations and guidelines

Jurisdiction	*Specific mention of batteries*	*Act or regulation batteries classified in*	*Existing waste strategy and status of batteries*	*Battery collection and/or recycling program(s)*
National	Lead acid batteries, and unsorted waste batteries if containing lead, cadmium or mercury are hazardous	Hazardous Waste (Regulation of Exports and Imports) Act 1989	National Waste Policy: Less Waste More Resources	None identified
NSW	Lead acid and nickel cadmium classified as hazardous, all other batteries 'wastes of concern'	Waste Classification Guidelines, Part 1: Classifying Waste	NSW Waste Avoidance and Resource Recovery Strategy 2007, NSW Extended Producer Responsibility (EPR) Priority Statement	Household Chemical CleanOut
Queensland	Batteries as 'regulated waste'	Environmental Protection Regulation 2008	Waste Strategy 2010-2020 (consultation draft)	None identified
Victoria	Unclear as no specific mention of battery classification	Environmental Protection (Prescribed Waste) Regulations 1998	Towards Zero Waste Strategy	Detox Your Home BatteryBack
SA	Lead acid batteries are hazardous, other batteries should be separated from normal waste, and need for action on nickel cadmium batteries	Hazardous Waste Strategy, 2006-10	Zero Waste South Australia 2010-2015 Consultation Draft	Chemical drop-off site in Ceduna that Government assists to operate Lead acid battery ban from landfill starting 1 September 2010

Table 7 – Summary of National, State and Territory battery regulations and guidelines

Jurisdiction	*Specific mention of batteries*	*Act or regulation batteries classified in*	*Existing waste strategy and status of batteries*	*Battery collection and/or recycling program(s)*
Tasmania	Batteries from industry, vehicle servicing, domestic sources, electrical equipment and telecommunications as controlled waste.	Environmental Management and Pollution Control Act (1994)	Tasmanian Waste and Resource Recovery Strategy	Developing Household Hazardous Waste (HHW) collection scheme
ACT	Unclear as no specific mention of battery classification	Environment Protection Act 1997	No Waste Strategy by 2010	None identified
NT	Lead acid batteries are Listed Wastes	Waste Management and Pollution Control (Administration) Regulations	None identified	None identified
WA	Unclear as no specific mention of battery classification	Environmental Protection (Controlled Waste) Regulations 2004	Waste Strategy for Western Australia	All Regional Councils in Perth Dry Cell Battery Collection Program (operated by local government)

Batteries containing lead are usually categorised as hazardous. Wastes containing cadmium and cadmium compounds, mercury and mercury compounds, nickel compounds and zinc compounds are also usually flagged as hazardous materials, however with the exception of nickel cadmium batteries, other batteries are not classified as hazardous, even though there are many instances where it is implied that 'batteries' are toxic. For example, batteries are collected through Victoria's 'Detox Your Home' programs.

3.6 Suggested Battery Classification

The following hierarchy is suggested for a battery classification system in Australia:

- household and commercial, or large and industrial. There is a big difference in battery chemistry and size between those batteries that are used in household and office applications, and those that are used in heavy industrial applications for standby power and motive power. Collection systems will also need to be tailored to domestic and commercial sources, and industrial sources, with the former favouring drop off or small container delivery systems and the latter favouring individual site pick up
- technology/chemistry type. Materials of manufacture are critical determinants of recycling opportunities and also requirements. For example, NiCd batteries are processed differently to Zinc Carbon battery types

- typical uses, for example embedded or stand alone. If a battery is embedded in another product, such as a television or video or mobile phone, then the recovery channel will need to deal with the bulk of the product mass before the battery is 'liberated' for recovery
- handheld (<1kg) or heavy (>1kg). This will be the primary determinant of the resource recovery channel in that heavy batteries are most likely to be found in industrial or automotive applications and are likely to require pick up
- single use or rechargeable. This factor is a primary determinant of the length of time a battery remains operational within the economy. Rechargeable batteries will go through many charge cycles and as such will outlast single use batteries in a given application. Thus the replacement rate (and hence the waste arising rate) is likely to be higher for single use batteries
- Customs and ABS codes. It is important to calibrate with existing systems of battery classification in Australia. For example Australian Customs Tariff Nomenclature and Statistical Classification, and the Australian Bureau of Statistics (ABS) system for battery classification under the Australian and New Zealand Standard Commodity Classification (ANZSCC)
- hazardous. The hazardous nature of batteries needs to be clearly defined and articulated. For example, a Nickel Cadmium (NiCd) mobile phone battery at its end-of-life is likely to be classified as hazardous, however this does not make the mobile phone or even the battery hazardous in its working life.

The suggested matrix of battery classification for Australia is presented in Table 8 overleaf. From a practical perspective, this classification suggests that batteries could be classified as either household and commercial, or large and industrial from a user perspective, or either handheld or heavy from a weight perspective. The one type of battery that does not fit neatly into these distinctions is Automotive Starting Lighting and Ignition (SLI). Furthermore, as will be shown in following sections, the Automotive SLI category is the major category in terms of battery flows by weight, and as such has been given its own category. Data is thus reported according to:

- Handheld batteries less than 1 kg in weight for household and commercial users
- Automotive SLI batteries
- Large and Industrial batteries greater than 1 kg in weight for industrial users.

Table 8 – Suggested matrix of battery classification

Users	*Technology/Chemistry*	*Typical Uses*	*Handheld/ Heavy*	*Single Use/ Rechargeable*	*Customs*	*ABS*	*Hazardous (National)*
Household and Commercial	Alkaline Manganese AlMn	Clocks, portable audio and devices, torches, toys, cameras, remote controls and electronics	Handheld (less than 1 kg For example, AAA, AA, C,D, 9V, Lantern, Mobile Phone, PDA and Laptop)	Single Use	8506.80.00	464.11	Low Potential
	Zinc carbon				8506.50.00		
	Zinc Air	Watches, hearing aids, calculators			8506.60.00		
	Silver Oxide				8506.40.00		
	Manganese Dioxide				8506.10.00		
	Nickel Cadmium (NiCd)	Cordless phones, and power tools		Rechargeable	8507.30.00	464.12.02	Potential in Volume
	Nickel Metal Hydride (NiMH)	Mobile and cordless phones			8507.80.00		
	Lithium	Mobiles, laptops and digital devices including cameras and PDAs			8506.50.00		
	Lead Acid	Hobby, small UPS for office use, alarms and emergency lighting (SLAB)			8507.20.00	464.12.01.90	Hazardous
		Starting Lighting and Ignition (SLI) for cars, trucks and motorcycles	Heavy (more than 1 kg)		8507.10.10	464.12.01.11 464.12.01.12	
Large and Industrial		Motive Power for industrial fork lifts			8507.20.00	464.12.01.13 464.12.01.14	
		Standby Power for photovoltaic systems and emergency back up			8507.20.00	464.12.01.14 464.12.01.15	
	Nickel Cadmium (NiCd)	Standby Power for photovoltaic systems and emergency back up			8507.30.00	464.12.02	Potential in Volume
		Motive Power for electric vehicles				464.12.02	
	Nickel Metal Hydride (NiMH)	Motive Power for hybrid cars			8507.80.00	464.12.02	
	Lithium ion	Motive Power for electric vehicles			8506.50.00	464.12.02	
	Lithium polymer	Motive Power for emerging electric vehicles, hybrid electric vehicles			8506.50.00	464.12.02	

4 AUSTRALIAN BATTERY INPUTS

Battery inputs into the Australian economy are defined as batteries sold as a 'stand alone' purchase and those that are sold 'embedded' in products. These inputs essentially represent the consumption of batteries in Australia. Battery inputs are presented in the sections below for Handheld, Automotive SLI and Large and Industrial batteries.

4.1 Handheld Battery Inputs

It is estimated that nearly 350 million Handheld batteries enter the Australian economy each year. This total comprises approximately 300 million 'stand alone' sales and 45.3 million sales in embedded products. This total also represents the number of Handheld batteries imported as there is no local production of Handheld batteries.[8] A breakdown of Handheld battery sales, by size, channel to market and count is presented in Table 9 below. (Note that Sealed Lead Acid Batteries (SLAB) were allocated 100 per cent to speciality stores because of a lack of any other data on channel.)

Table 9 – Breakdown of Handheld battery 'stand alone' sales market by size, channel and count

Size	*Office Supplies*	*Hardware*	*Mass Merchant*	*Electrical Retail*	*Grocery*	*Speciality*	*Totals*
AAA	6,720,000	8,960,000	8,960,000	6,700,000	53,730,000	4,480,000	89,550,000
AA	10,070,000	13,430,000	13,430,000	10,070,000	80,600,000	6,700,000	134,300,000
9v	1,680,000	2,240,000	2,240,000	1,680,000	13,430,000	1,120,000	22,390,000
C	1,120,000	1,490,000	1,490,000	1,120,000	8,960,000	750,000	14,930,000
D	1,120,000	1,490,000	1,490,000	1,120,000	8,960,000	750,000	14,930,000
Other Size	1,340,000	1,790,000	1,790,000	1,340,000	10,750,000	900,000	17,910,000
Lantern	340,000	450,000	450,000	340,000	2,690,000	220,000	4,490,000
SLAB	-	-	-	-	-	1,500,000	1,500,000
Totals	**22,390,000**	**29,850,000**	**29,850,000**	**22,370,000**	**179,120,000**	**16,420,000**	**300,000,000**
Proportion	7.5%	10.0%	10.0%	7.5%	60%	5%	100.0%

The bulk of Handheld battery stand alone inputs on a count basis are through the Grocery channel. There was not sufficient data available to break down the channels to market for batteries embedded in products. This was partly because of the addition of mobile phone, digital device, laptop cordless power tools, and sealed lead acid batteries. However, a breakdown of embedded Handheld battery inputs, by size and count is presented in Table 10 below.

[8] *No local production at scale was identified during the course of this study. It is noted that some businesses are assembling rechargeable battery packs in Australia – however this was not counted as original manufacture.*

Table 10 – Australian embedded Handheld battery inputs by size, and count		
Size	*Number of Batteries*	*Proportion Count*
AAA	8,955,000	20%
AA	13,430,000	30%
9v	2,239,000	5%
C	1,493,000	3%
D	1,493,000	3%
Other Size	1,791,000	4%
Lantern	449,000	1%
Mobile	7,860,000	17%
Digital Device	4,030,000	9%
Laptop	1,460,000	3%
Cordless Power Tools	1,750,000	4%
SLAB	320,000	1%
Totals	**45,270,000**	**100%**

Combining sales and embedded products gives a breakdown of Australian Handheld battery inputs by size, count and weight which is presented in Table 11 below.

Table 11 – Australian Handheld battery inputs by size, count and weight					
Size	*Number of Batteries*	*Proportion Count*	*Average Weight (grams)*	*Total Weight (kg)*	*Proportion Weight*
AAA	98,505,000	29%	12.0	1,180,000	7%
AA	147,730,000	43%	24.0	3,545,000	22%
9v	24,629,000	7%	42.1	1,037,000	6%
C	16,423,000	5%	65.0	1,068,000	7%
D	16,423,000	5%	135.1	2,218,000	14%
Other Size	19,701,000	6%	6.1	120,000	1%
Lantern	4,939,000	1.4%	742.5	3,667,000	23%
Mobile	7,860,000	2.3%	21.2	167,000	1%
Digital Device	4,030,000	1.2%	21.3	86,000	0.5%
Laptop	1,460,000	0.4%	563.7	823,000	5%
Cordless Power Tools	1,750,000	0.5%	546.3	955,000	6%
SLAB	1,820,000	0.5%	700.0	1,274,000	8%
Totals	**345,270,000**	**100%**		**16,140,000**	**100%**

The battery sizes AA and AAA account for the greatest number of Handheld inputs with an estimated 147.7 million and 98.5 million batteries respectively sold for a combined share of 72 per cent of Handheld battery inputs by count.

However, on a weight basis it is the batteries that weigh on average over 500 grams per battery that make the disproportionate contribution. Lantern, laptop, cordless power tools and Sealed Lead Acid Batteries (SLAB) account for only 3 per cent of Handheld battery inputs by count, yet make up approximately 42 per cent of inputs by weight. This compares to AA and AAA batteries, which together make up for approximately 29 per cent of Handheld inputs by weight.

4.1.1 Handheld Battery Inputs by Chemistry Type

Alkaline chemistry is the dominant form of Handheld battery inputs both on a count basis and on a weight basis. They accounted for 57 per cent of Handheld battery inputs (198 million) on a count basis and 57 per cent (9,248 tonnes) on a weight basis as shown in Table 12 below.

Table 12 – Australian Handheld battery inputs by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (kg)*	*Proportion Weight*
Alkaline	198,000,000	57%	9,248,000	57%
Carbon Zinc	65,992,000	19%	1,973,000	12%
Lithium	33,796,000	10%	1,963,000	12%
Nickel Metal Hydride	20,664,000	6%	899,000	6%
Nickel Cadmium	10,150,000	3%	656,000	4%
Lead Acid (SLAB)	1,820,000	0.5%	1,275,000	8%
Other (ZA, SO, ZC)	14,850,000	4%	126,000	1%
Total	**345,270,000**	**100%**	**16,140,000**	**100%**

The table above includes standard sizes (AA, AAA, C, D etc) and non standard sizes (mobile phone, digital device, laptop and cordless batteries). A breakdown according to 'standard and non-standard' and 'rechargeable versus single use' is presented in Table 13 below.

There has been an emerging trend in the use of lithium in single use batteries. Although this is a different chemistry type to a rechargeable lithium battery, and with different value to a potential battery reprocessor, no breakdown of the split between single use and rechargeable lithium batteries was made owing to data limitations. Thus the 'Rechargeable' category includes all of the lithium, nickel metal hydride, nickel cadmium and lead acid battery chemistries.

The overall breakdown between single use and rechargeable shows rechargeable batteries are 19 per cent of the count of Handheld battery inputs and 30 per cent of the weight. Also it shows that non-standard batteries are only 5 per cent of the count of inputs, but are 21 per cent of the weight. The main feature is that non-standard sized batteries are all primarily rechargeable and even though they are only one quarter of the count of rechargeable Handheld batteries, they make up nearly 69 per cent of the weight of rechargeable Handheld inputs.

Table 13 – Australian Handheld battery inputs by standard sizing and rechargability

Category	*Number of Batteries*	*Proportion Count*	*Total Weight (kg)*	*Proportion Weight*
Single Use	278,850,000	81%	11,350,000	70%
Rechargeable	66,420,000	19%	4,790,000	30%
Totals	**345,270,000**	**100%**	**16,050,000**	**100%**
Standard size	328,350,000	95%	12,840,000	80%
Non Standard	16,920,000	5%	3,300,000	20%
Totals	**345,270,000**	**100%**	**16,050,000**	**100%**

4.2 Automotive Starting, Lighting and Ignition (SLI) Battery Inputs

Automotive Starting, Lighting and Ignition (SLI) batteries are a such dominant sub-category within the total stocks and flows of batteries in Australia that they warrant specific discussion. It is estimated that nearly six million Automotive SLI batteries enter into the Australian economy. Approximately one third of these batteries are locally manufactured. All of the Automotive SLI battery inputs are lead acid batteries. A breakdown of Automotive SLI inputs by channel to market, count and weight is presented in Table 14 below.

Table 14 – Australian Automotive SLI inputs by channel to market, count and weight

Channel	*Number of Batteries*	*Proportion Count*	*Weight (tonnes)*
Direct Replacement	1,200,000	21%	17,600
Do-it-for-me (service centres)	1,450,000	25%	21,270
Do-it-yourself	2,100,000	36%	30,810
New vehicle sales	1,090,000	19%	15,990
Totals	5,840,000	100%	85,670

The largest channel to market for Automotive SLI batteries is the do-it-yourself segment, which accounts for more than one third of inputs by weight. Service centres accounted for one quarter of battery inputs. Direct replacement and new vehicle sales are approximately equal and together account for approximately 40 per cent of battery inputs. No differentiation on the basis of battery type and channel was made and so the proportion on a count basis was used to calculate total tonnes of Automotive SLI battery inputs to each channel.

Inputs of Automotive SLI batteries comprise the total number of replacement batteries sold in Australia, in addition to the number of batteries that are embedded in new vehicle sales.
A breakdown of replacement Automotive SLI batteries by vehicle type, count and weight are presented in Table 15 below.

Table 15 – Australian replacement Automotive SLI battery inputs by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	144,000	3%	3.0	430	1%
Passenger Vehicle	3,657,000	77%	14.3	52,300	74%
Light Commercial	676,000	14%	15.7	10,600	15%
Rigid Trucks	150,000	3%	23.1	3,460	5%
Articulated Trucks	56,000	1%	31.8	1,780	3%
Non-Freight Carrying Trucks	8,000	0%	31.3	250	0%
Buses	61,000	1%	31.6	1,930	3%
Total Replacement Automotive SLI	**4,750,000**	**100%**		**70,750**	**100%**

It is estimated that 4.75 million batteries are sold as replacement automotive batteries. The largest number of Automotive SLI inputs are passenger vehicle batteries with an estimated 77 per cent by count and 74 per cent by weight. A breakdown of new vehicle Automotive SLI batteries by vehicle type, count and weight are presented in Table 16 below. It is estimated that nearly 1.1 million batteries enter the Australian economy embedded in new vehicles. Of these, 84 per cent are embedded within imported vehicles. (Note that batteries exported in vehicles have been subtracted from the figures in Table 16. These accounted for approximately 117,500 batteries in 2008/2009).

Table 16 – Australian new vehicle Automotive SLI battery inputs by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	116,000	11%	3.0	350	2%
Passenger Vehicle	755,800	69%	14.3	10,850	73%
Light Commercial	187,200	17%	15.7	2,900	19%
Rigid Trucks	22,000	2%	23.1	510	3%
Articulated Trucks	4,200	0%	31.8	130	1%
Non-Freight Carrying Trucks	1,200	0%	31.3	40	0%
Buses	4,400	0%	31.6	140	1%
Total New Vehicle Automotive SLI	**1,090,000**	**100%**		**14,920**	**100%**

Replacement Automotive SLI batteries are added with new vehicle Automotive SLI batteries to provide the total Automotive SLI inputs. A breakdown of total Automotive SLI battery inputs by vehicle type, count and weight is presented in Table 17 below. The largest number of inputs are passenger vehicle batteries with an estimated 75 per cent by count and also by weight. Next come light commercial batteries with an estimated 15 per cent by count and also by weight.

Table 17 – Australian total Automotive SLI battery inputs by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	260,000	4%	3.0	780	1%
Passenger Vehicle	4,413,000	76%	14.3	63,110	74%
Light Commercial	863,000	15%	15.7	13,550	16%
Rigid Trucks	172,000	3%	23.1	3,960	5%
Articulated Trucks	60,000	1%	31.8	1,920	2%
Non-Freight Carrying Trucks	9,000	0%	31.3	290	0%
Buses	65,000	1%	31.6	2,070	2%
Total Automotive SLI inputs	**5,840,000**	**100%**		**85,670**	**100%**

4.3 Large and Industrial Battery Inputs

Large and Industrial batteries is the category of batteries that picks up non-automotive lead acid batteries such as those used in marine and mining applications and also for traction and motive power in addition to large stationary standby power storage applications. It also includes other chemistry types that provide motive power for electric vehicles and hybrid electric vehicles in addition to standby power for renewable energy systems and emergency back up.

This category of battery use is the least well known with little data available. As such it relies on assumptions and calculations built within the model. It is estimated that approximately 1.75 million Large and Industrial batteries enter into the Australian economy each year. These inputs are fairly evenly split across the four categories of use on both a count and weight basis.

The total weight of 51,680 tonnes represents one third of the weight of Australian battery inputs, even though on a count basis it is less than one per cent of the number of battery inputs. A breakdown of Large and Industrial battery inputs by application is presented in Table 18 below.

Table 18 - Australian Large and Industrial battery inputs by application, count and weight

Application	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Marine	289,000	17%	21.8	6,310	12%
Forestry/Farm/Constr/Mine	600,000	34%	34.4	20,660	40%
Traction and Motive	430,000	25%	22.6	9,710	19%
Large Stationary Standby	429,000	25%	35.0	15,000	29%
Total Large and Industrial	**1,748,000**	**100%**		**51,680**	**100%**

4.3.1 Large and Industrial Battery Inputs by Chemistry Type

Lead based chemistry is the largest form of Large and Industrial battery input into Australia with approximately 90 per cent by count and also by weight of the Large and Industrial sub-category. (Note that this includes lead acid batteries, sealed lead acid batteries, and lead based gels). The remaining battery chemistry types have been allocated on the same proportion as Large and Industrial battery arisings between nickel metal hydride, nickel cadmium and lithium based (including lithium ion and lithium polymer). This breakdown is presented in Table 19 below.

Table 19 – Australian Large and Industrial battery inputs by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Lead based	1,574,000	90%	46,670	90%
Nickel Cadmium	105,000	6%	3,020	6%
Nickel Metal Hydride	17,000	1%	490	1%
Lithium based	52,000	3%	1,500	3%
Total	**1,748,000**	**100%**	**51,680**	**100%**

4.4 Summary of Battery Inputs

A summary of all battery inputs into the Australian economy is presented in Table 20 below. This shows that by count, Handheld batteries made up the vast majority of battery inputs at nearly 98 per cent of total battery inputs (approximately 350 million). However, on a weight basis, Handheld batteries only account for 10 per cent of the total. The dominant category by weight is Automotive SLI batteries, which make up 56 per cent of the total weight of batteries.

This breakdown shows the dominance by weight of lead acid battery chemistry. Of the total 153,400 tonnes of battery inputs, 133,615 tonnes or approximately 87 per cent are lead acid or lead based chemistry.

Table 20 – Summary of Australian battery inputs

Type	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Handheld batteries	345,270,000	97.8%	16,050	10%
Automotive SLI batteries	5,840,800	1.7%	85,670	56%
Large and Industrial batteries	1,748,000	0.5%	51,680	34%
Total Batteries	**352,858,800**	**100%**	**153,400**	**100%**

5 AUSTRALIAN BATTERY STOCKS

Stocks of Australian batteries are defined as batteries in active service life. Estimates of battery stocks thus rely on estimates of the national 'fleet' of products that use batteries. For example, electronic and electrical items, computers, cars and so forth. Estimates of stocks are useful in that they give insight to the likely trends of future battery inputs and arisings. Battery stocks are presented in the sections below for Handheld, Automotive SLI and Large and Industrial batteries.

5.1 Handheld Battery Stocks

Handheld battery stocks are presented in Table 21 below. More information is provided in Appendix 3 on how appliances were selected and modelled for the household and commercial bundles.

Table 21 – Australian Handheld battery stocks by size, count and weight

Bundle/Item	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion by Weight*
Domestic Bundle	170,000,000	36%	7,000	27%
Misc Commercial	164,000,000	35%	6,800	26%
Mobile Phones	25,000,000	5%	500	2%
Digital Devices	12,000,000	3%	300	1%
Remote control units	84,000,000	18%	2,000	8%
Laptops	6,800,000	1%	3,800	14%
Power Tools	7,000,000	1%	3,800	14%
Sealed Lead Acid	3,200,000	1%	2,200	8%
Totals	**472,000,000**	**100%**	**26,400**	**100%**

On the basis of this breakdown it is estimated that the average household has approximately 30 Handheld batteries in active service life. Note that this excludes 'hoarded' stocks of old batteries or batteries that are no longer working but are in discarded appliances such as might be found in the garage. These batteries are accounted for under arisings stored informally.

5.1.1 Handheld Battery Stocks by Chemistry Type

An estimate of predicted battery chemistry amongst Handheld stocks is presented in Table 22 below. This shows that chemistry is affected by 'large' batteries within the Handheld category, for example, laptops and cordless power tools that weigh over 500 grams. These battery types make a significant contribution to determining the proportions of Handheld batteries according to chemistry.

Table 22 – Australian Handheld battery stocks by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Alkaline	239,000,000	51%	9,060	34%
Carbon Zinc	80,500,000	17%	3,010	11%
Lithium	67,000,000	14%	5,790	22%
Nickel Metal Hydride	37,000,000	8%	1,940	7%
Nickel Cadmium	27,400,000	6%	3,720	14%
Lead Acid (SLAB)	3,200,000	1%	2,200	8%
Other (ZA, SO, ZC)	17,900,000	4%	680	3%
Total	**472,000,000**	**100%**	**26,400**	**100%**

Using the same methodology used to calculate the split between single use and rechargeable batteries in Handheld battery inputs, it is estimated that on a count basis one quarter of Handheld battery stocks are rechargeable. Because rechargeable batteries tend to be heavier than single use batteries, especially in embedded products such as cordless power tools, the split on a weight basis between single use and rechargeable is approximately 50:50.

5.2 Automotive Starting, Lighting and Ignition (SLI) Battery Stocks

The stocks of Automotive SLI batteries directly relate to the size of the national fleet of registered vehicles. This means that estimates for Automotive SLI stocks are very accurate as they are based on regularly updated ABS data. A breakdown of Australian Automotive SLI battery stocks by vehicle type, count and weight (tonnes) is presented in Table 23 below.

Table 23 – Australian Automotive SLI battery stocks by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	595,800	4%	3	1,780	1%
Passenger Vehicle	11,913,300	77%	14	170,380	76%
Light Commercial	2,329,600	15%	16	36,560	16%
Rigid Trucks	416,300	3%	23	9,600	4%
Articulated Trucks	80,200	1%	32	2,550	1%
Non-Freight Carrying Trucks	22,100	0%	31	690	0%
Buses	82,500	1%	32	2,610	1%
Total Automotive SLI	**15,440,000**	**100%**		**224,200**	**100%**

All of the 224,200 tonnes of Automotive SLI battery stock are lead acid batteries. As with inputs and arisings, passenger vehicle batteries are the dominant category by count and by weight.

5.3 Large and Industrial Battery Stocks

An estimate of the Large and Industrial battery stocks in Australia is presented in Table 24 below. Large stationary standby power applications are estimated to make up the bulk of stocks by count and by weight. However it should be noted that this category relies the most on calculations within the model.

Table 24 – Australian Large and Industrial battery stocks by application, count and weight (tonnes)

Application	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Marine	716,000	11%	22	15,600	8%
Forestry/Farm/Constr/Mine	1,202,000	18%	34	41,400	21%
Traction and Motive	1,923,000	29%	23	43,500	22%
Large Stationary Standby	2,800,000	42%	35	98,000	49%
Total Large and Industrial	**6,641,000**	**100%**		**198,500**	**100%**

5.3.1 Large and Industrial Battery Stocks by Chemistry Type

The same chemistry break down for Large and Industrial battery inputs was used to estimate stocks. This means that lead based chemistry again dominates Large and Industrial battery stocks accounting for approximately 90 per cent on both a count and weight basis. Approximately one-third of these batteries is estimated to be in spark ignition engine use in marine, forestry, farming, construction and mining applications. Estimates of other chemistry types are primarily in traction and motive, and large standby power applications. A breakdown by chemistry is presented in Table 25 below.

Table 25 – Australian Large and Industrial battery stocks by chemistry type, count and weight (kilograms)

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Lead based	5,979,900	90%	179,200	90%
Nickel Cadmium	398,900	6%	11,600	6%
Nickel Metal Hydride	64,600	1%	1,900	1%
Lithium based	197,600	3%	5,800	3%
Total	**6,641,000**	**100%**	**198,500**	**100%**

5.4 Summary of Battery Stocks

A summary of all battery stocks within the Australian economy is presented in Table 26 below. This shows that by count, Handheld batteries made up the vast majority of battery stocks at 95 per cent. However, on a weight basis, Handheld batteries only account for 6 per cent of the total. The dominant category by weight is Automotive SLI batteries, which make up half of the total weight of battery stocks.

This breakdown again shows the dominance by weight of lead acid battery chemistry. Of the total 448,910 tonnes of battery stocks, 405,570 tonnes or approximately 90 per cent are estimated to be lead based chemistry.

Table 26 – Summary of Australian battery stocks

Type	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Handheld batteries	465,300,000	95%	26,240	6%
Automotive SLI batteries	15,440,000	3%	224,170	50%
Large and Industrial batteries	6,641,000	1%	198,500	44%
Total Batteries	**487,381,000**	**100%**	**448,910**	**100%**

6 AUSTRALIAN BATTERY ARISINGS

Battery arisings from the Australian economy are defined as batteries that have finished their active service life and require an end-of-life management solution such as resource recovery. The estimates of arisings were built on a predictive model based on battery inputs and replacement rates as a function of battery stocks. The fate of battery arisings has also been assessed. Battery arisings and the fate of these arisings are presented in the sections below for Handheld, Automotive SLI and Large and Industrial batteries.

6.1 Handheld Battery Arisings

It is estimated that over 265 million Handheld batteries reach the end of their service life each year. This includes direct 'stand alone' replacement of batteries where a spent battery has been generated, in addition to arisings from batteries that are still embedded within a product and where the product (as opposed to the battery *per se*) has reached the end of its service life. A breakdown of Handheld battery arisings, by size and count is presented in Table 27 below.

Table 27 – Australian Handheld battery Arisings by size, count and weight

Size	*Number of Batteries*	*Proportion Count*	*Average Weight (grams)*	*Total Weight (kg)*	*Proportion Weight*
AAA	75,655,000	29%	12.0	906,000	8%
AA	112,343,000	43%	24.0	2,696,000	23%
9v	18,724,000	7%	42.1	788,000	7%
C	12,479,000	5%	65.0	812,000	7%
D	12,479,000	5%	135.1	1,685,000	14%
Other Size	14,979,000	6%	6.1	91,000	1%
Lantern	3,745,000	1%	742.5	2,781,000	23%
Mobile	7,430,000	3%	21.2	158,000	1%
Digital Device	3,180,000	1%	21.3	68,000	1%
Laptop	1,160,000	0%	563.7	654,000	5%
Cordless Power Tools	1,435,000	1%	545.7	783,000	7%
SLAB	688,000	0%	700.0	482,000	4%
Totals	**264,297,000**	**100%**		**11,904,000**	**100%**

As with Handheld battery inputs, the 'large' Handheld battery categories of lantern, laptop, cordless power tools and sealed lead acid battery dominate on a weight basis. This grouping makes up approximately 40 per cent or 4,700 tonnes of battery arisings, even though on a count basis they comprise only 3 per cent or 7 million batteries.

However, the more common batteries in terms of number of batteries arising, are the AA and AAA batteries, comprising 71 per cent on a count basis. Even though each battery is relatively light on a per battery basis, the sheer number of these batteries means that they account for 30 per cent of the weight of Handheld battery arisings, which is 3,600 tonnes.

Batteries embedded in products, such as mobile phones, digital devices, laptops, cordless power tools and other appliances account for over 16 million batteries, which is 6 per cent of total Handheld battery arisings. On a weight basis, embedded Handheld batteries are estimated to be 15 per cent of the total arisings, which is 1,800 tonnes.

6.1.1 Handheld Battery Arisings by Chemistry Type

Alkaline chemistry is the dominant form of Handheld battery inputs and also arisings on a count basis and on a weight basis. The break down of Handheld battery arisings by chemistry types is shown in Table 28 below. As with Handheld battery inputs, the dominant chemistry type by count and weight is Alkaline. (The proportion of Alkaline and Carbon Zinc changes from count to weight because a larger proportion of Handheld lantern batteries are estimated to be Alkaline chemistry).

However the notable differences between Handheld inputs and arisings on a chemistry comparison is the increase of NiCd chemistry in arisings compared to Lithium and NiMh. This is consistent with a reduction in use of NiCd batteries, as they will still be present in battery arisings for some time given their extensive use in applications such as cordless power tools.

Table 28 – Australian Handheld battery arisings by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (kg)*	*Proportion Weight*
Alkaline	157,636,000	60%	7,180,000	60%
Carbon Zinc	52,513,000	20%	1,530,000	13%
Lithium	17,408,000	7%	989,000	8%
Nickel Metal Hydride	11,084,000	4%	474,000	4%
Nickel Cadmium	13,343,000	5%	862,000	7%
Lead Acid (SLAB)	999,000	0%	683,000	6%
Other (ZA, SO, ZC)	11,314,000	4%	186,000	2%
Total	**264,297,000**	**100%**	**11,904,000**	**100%**

Using the same methodology as was used to calculate the split between single use and rechargeable batteries in Handheld battery inputs and stocks, it is estimated that on a count basis 16 per cent of Handheld battery arisings are rechargeable batteries. This reflects the longer service life of rechargeable batteries, meaning that single use batteries have a higher 'churn' rate. The split for Handheld Arisings on a weight basis between single use and rechargeable is approximately 75:25 respectively.

6.2 Automotive Starting, Lighting and Ignition (SLI) Battery Arisings

The amount of Automotive Starting, Lighting and Ignition (SLI) battery arisings in Australia is the sum of replacement batteries sold and the estimated number of vehicles retired from the national fleet. A breakdown of the 5.4 million Automotive SLI batteries arising is presented in Table 29 below according to vehicle type.

Table 29 – Australian Automotive SLI battery arisings by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	203,900	4%	3	610	1%
Passenger Vehicle	4,132,400	76%	14	59,100	74%
Light Commercial	772,500	14%	16	12,110	15%
Rigid Trucks	166,800	3%	23	3,850	5%
Articulated Trucks	57,700	1%	32	2,310	3%
Non-Freight Carrying Trucks	9,300	0%	31	290	0%
Buses	62,800	1%	32	1,990	2%
Total Automotive SLI	**5,410,000**	**100%**		**80,260**	**100%**

All of the Automotive SLI batteries are lead acid chemistry, meaning that 80,260 tonnes of Automotive ULAB arisings are generated in Australia. It is estimated that retiring vehicles from the national fleet contributed 653,400 batteries weighing 9,510 tonnes to this total, as is shown in Table 30 below.

Table 30 – Australian Automotive SLI battery arisings from retired vehicle by vehicle type, count and weight

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	59,900	9%	3	180	2%
Passenger Vehicle	475,400	73%	14	6,800	72%
Light Commercial	96,500	15%	16	1,510	16%
Rigid Trucks	16,800	3%	23	390	4%
Articulated Trucks	1,700	0%	32	530	6%
Non-Freight Carrying Trucks	1,300	0%	31	40	0%
Buses	1,800	0%	32	60	1%
Total Automotive SLI	**653,400**	**100%**		**9,510**	**100%**

6.3 Large and Industrial Battery Arisings

Estimates of Large and Industrial battery arisings have been previously identified as having 'low to medium confidence' due to the lack of available data. In spite of these limitations, estimated Large and Industrial battery arisings by application, count and weight are presented in Table 31 below.

Table 31 – Australian Large and Industrial battery arisings by application, count and weight

Application	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Marine	253,000	17%	22	5,520	13%
Forestry/Farm/Constr/Mine	540,000	37%	34	18,580	43%
Traction and Motive	413,000	28%	23	9,340	22%
Large Stationary Standby	267,000	18%	35	9,345	22%
Total Large and Industrial	**1,473,000**	**100%**		**42,785**	**100%**

6.3.1 Large and Industrial Battery Arisings by Chemistry Type

Lead based chemistry dominates the Large and Industrial battery category accounting for over 95 per cent of Large and Industrial batteries on both a count and weight basis. More than half of these batteries (56 per cent) are used in engine applications, either in off-road vehicles or in stationary engines. The remainder are used for traction and motive power and large stationary power applications. Other chemistry types were allocated according to industry input. The break down of Large and Industrial battery arisings by chemistry types is shown in Table 32 below.

Table 32 – Australian Large and Industrial battery arisings by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Lead based	1,420,800	96%	41,275	96%
Nickel Cadmium	31,500	2%	910	2%
Nickel Metal Hydride	5,100	0%	150	0%
Lithium based	15,600	1%	450	1%
Total	**1,473,000**	**100%**	**42,785**	**100%**

6.4 Summary of Battery Arisings

A summary of estimated annual battery arisings from the Australian economy is presented in Table 33 below, comprising over 270 million batteries with a total weight of approximately 135,000 tonnes. The breakdown shows that by count, Handheld batteries make up the vast majority of battery arisings at 97.5 per cent of total battery arisings (nearly 265 million).

However, on a weight basis, Handheld batteries only account for 9 per cent of the total at approximately 11,900 tonnes. The dominant category by weight is Automotive SLI batteries, which make up 59 per cent of the total weight of battery arisings (80,260 tonnes), even though Automotive SLI batteries are only 2 per cent of arisings on a count basis.

Table 33 – Summary of annual Australian battery arisings

Type	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Handheld batteries	264,297,000	97.5%	11,904	9%
Automotive SLI batteries	5,410,000	2.0%	80,260	59%
Large and Industrial batteries	1,473,000	0.5%	42,785	32%
Total Batteries	**271,180,000**	**100%**	**134,949**	**100%**

This analysis again shows the dominance by weight of lead acid battery chemistry. Of the total 134,949 tonnes of battery arisings, 122,218 tonnes or approximately 90 per cent were lead acid or lead based chemistry.

A summary of all battery consumption, stocks and arisings and the gate of battery arisings in Australia is presented in the following section.

7 SUMMARY OF NATIONAL MATERIAL STOCKS AND FLOWS OF BATTERIES IN AUSTRALIA

A breakdown of the estimated inputs, stocks and flows (waste arisings) of batteries for Australia by count is presented in Table 34 below.

Table 34 – Australian battery materials stocks and arisings by count

Type	*Inputs*	*Stocks*	*Arisings*
Handheld	345,270,000	465,300,000	264,297,000
Automotive SLI	5,840,800	15,440,000	5,410,000
Large and Industrial	1,748,000	6,641,000	1,473,000
Total Units	**352,858,800**	**487,381,000**	**271,180,000**

A similar breakdown of the estimated inputs, stocks and flows (waste arisings) of batteries for Australia by weight is presented in the Table 35.

Table 35 – Australian battery materials stocks and arisings by weight (kilograms)

Type	*Inputs*	*Stocks*	*Arisings*
Handheld	16,140,000	26,240,000	11,904,000
Automotive SLI	85,670,000	224,170,000	80,260,000
Large and Industrial	51,680,000	198,500,000	42,785,000
Total Weight (kilograms)	**153,490,000**	**448,910,000**	**134,949,000**

As a result of this analysis it is estimated that approximately 350 million batteries are sold in Australia, either as stand alone batteries or embedded in products such as mobile phones and automobiles. The majority of these batteries on a count basis (97.5 per cent) are 'Handheld' batteries, in other words, batteries less than 1 kg in weight. However, the weight of all battery inputs into Australia is approximately 154 million kilograms (154,000 tonnes) and Handheld batteries only make up approximately 11 per cent of this total.

The bulk by weight (nearly 90 per cent) of battery inputs is composed of the Automotive SLI batteries and Large and Industrial batteries, even though on a count basis they are only 2 per cent of inputs. This highlights the dominance of lead based chemistry on a weight basis.

Stocks of batteries are greater than inputs because of the life span of batteries such as Automotive SLI, which will last approximately 3.5 years. Even with Handheld batteries, stocks are accumulating owing to the use of stand alone rechargeable batteries and also rechargeable batteries embedded in products like cordless power tools and digital devices. Furthermore, there are many products with single use Handheld batteries that are not used continuously, which 'extends' the service life of the battery. The likely fate of battery arisings is discussed in the following section.

7.1 Fate of Battery Arisings

Battery arisings from the Australian economy are defined as batteries that have finished their active service life and now require an end-of-life management solution, such as resource recovery. These estimates of arisings were built on a predictive model based on the amount of battery inputs and replacement rates as a function of battery stocks.

The chemistry, weight and unit count are all important to understand with regard to battery arisings in Australia. Batteries with a high weight and low number of units present an ideal opportunity for resource recovery as they are readily identified and can be aggregated into significant numbers for reprocessing.

However, in terms of sheer number and ubiquity throughout the economy, a stewardship solution is also required for low weight Handheld batteries. A breakdown of battery arisings by chemistry, count and weight is presented below in Table 36.

Table 36 – Australian battery arisings by chemistry type, count and weight

Chemistry	*Number of Batteries*	*Proportion Count*	*Total Weight (tonnes)*	*Proportion Weight*
Alkaline	157,636,000	58%	7,180	5%
Carbon Zinc	52,513,000	19%	1,530	1%
Lithium	17,423,600	6%	1,440	1%
Nickel Metal Hydride	11,089,100	4%	623	0%
Nickel Cadmium	13,374,500	5%	1,772	1%
Lead Acid	7,829,800	3%	122,218	91%
Other (ZA, SO, ZC)	11,314,000	4%	186	0%
Total	**271,180,000**	**100%**	**134,949**	**100%**

The fate of battery arisings was calculated according to the following end-of-life outcomes:

- reprocessed in Australia
- legal export for reprocessing overseas
- landfill
- stockpiled formal, in warehouses and at industrial facilities according to relevant legislation for battery storage in bulk
- stockpiled informal, for example left embedded in products such as mobile phones or left to accumulate in the house, garage, office, barn or mine site
- rebirthing, which is the inappropriate re-branding of an end-of-life battery for resale
- illegal export, which although is likely to be for reprocessing, nevertheless carries all of the risks of potentially hazardous materials being processed at unlicensed facilities.

A breakdown of the fate of all battery arisings by weight is presented in Table 37 below.

Table 37 – Fate of Australian battery arisings by category and weight (tonnes)

Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total Weight*	*Total Proportion*
Reprocessed in Australia	350	66,050	34,350	100,750	75%
Legal Export	150	-	150	300	0%
Landfill	8,024	2,000	1,350	11,374	8%
Stockpiled Formal	250	3,960	2,290	6,500	5%
Stockpiled Informal	3,070	1,650	1,100	5,820	4%
Rebirth	10	1,320	725	2,055	2%
Illegal Export	50	5,280	2,820	8,150	6%
Totals	**11,904**	**80,260**	**42,785**	**134,949**	**100%**

This shows that for total battery arisings in Australia, three quarters of batteries by weight are estimated to be reprocessed in Australia. However, the resource recovery of battery arisings is dominated by lead acid batteries which make up virtually the entirety of Australian battery reprocessing. The estimated 100,250 tonnes of lead battery reprocessing is approximately 75 per cent of all battery arisings and 82 per cent of all lead acid battery arisings.

The fate of arisings on a count basis is also presented in Table 38 below (estimated using average weights). This shows that desirable management outcomes including reprocessing of batteries, legal export and formal stockpiling for reprocessing only accounts for 6 per cent of all battery arisings on a count basis.

Table 38 – Fate of Australian battery arisings by category and count (average weight basis)

Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total*	*Total Proportion*
Reprocessed in Australia	2,109,000	4,452,000	1,183,000	7,744,000	3%
Legal Export	3,330,000	-	5,000	3,335,000	1%
Landfill	183,389,000	135,000	46,000	183,570,000	68%
Stockpiled Formal	5,551,000	267,000	79,000	5,897,000	2%
Stockpiled Informal	68,546,000	111,000	38,000	68,695,000	25%
Rebirth	229,000	89,000	25,000	343,000	0%
Illegal Export	1,143,000	356,000	97,000	1,596,000	1%
Totals	**264,297,000**	**5,410,000**	**1,473,000**	**271,180,000**	**100%**

Note that the legal export of lead acid batteries ceased after October 2009 when an application for an export permit was not granted. No reason was given on the official notice of decision, however the excess processing capacity for lead acid batteries (143,000 tonnes of capacity compared to 122,218 tonnes of lead based battery arisings) would have been an important factor.[9]

'Leakage' in battery arisings comes from informal stockpiling within households and offices for handheld batteries and in remote and rural locations such as mine sites for Automotive SLI and Large and Industrial batteries. Informal stockpiling accounts for 4 per cent of battery arisings on a weight basis, which is 5,820 tonnes, including approximately 2,560 tonnes of lead acid batteries and over 3,000 tonnes of Handheld batteries. On a count basis the Handheld batteries increase the proportion of batteries informally stockpiled to 25 per cent of all battery arisings.

Similarly, the landfill of batteries is estimated to be approximately 8 per cent of battery arisings including 8,000 tonnes of Handheld batteries and over 3,000 tonnes of lead acid batteries when assessed on a weight basis. On a count basis, landfill of batteries accounts for nearly 70 per cent of all batteries.

If landfill is considered an undesirable management option for batteries, and is grouped with illegal export, rebirth and informal stockpiling (all arguably undesirable from a stewardship perspective), then approximately 20 per cent of all batteries in Australia are not meeting their desired management option on a weight basis. This is 27,400 tonnes of batteries, comprising 15,940 tonnes of lead acid batteries and over 11,000 tonnes of Handheld batteries. On a count basis, the proportion increases to 94 per cent of arisings or 254.2 million batteries per annum.

Table 39 below presents a breakdown of the fate of Australian battery arisings by category and tonnes, but excludes lead acid based chemistry. This suggests that nearly two-thirds of non-lead acid battery arisings are ending up in landfill, and nearly one quarter of arisings being stockpiled informally (in other words, temporarily 'landfilled' in household and office cupboards and drawers). On a count basis, this equates to approximately 250 million batteries.

Table 39 – Fate of Australian battery arisings by category and weight (tonnes) – excluding lead acid batteries

Fate of Arisings	*Handheld*	*Automotive SLI*	*Large and Industrial*	*Total*	*Total Proportion*
Reprocessed in Australia	100	-	400	500	4%
Legal Export	150	-	150	300	2%
Landfill	7,820	-	310	8,130	64%
Stockpiled Formal	240	-	250	490	4%
Stockpiled Informal	2,860	-	250	3,110	24%
Rebirth	10	-	50	60	0%
Illegal Export	50	-	100	150	1%
Totals	**11,230**	**-**	**1,510**	**12,740**	**100%**

[9] *Commonwealth of Australia Gazette, No. S162, Wednesday 7 October 2009, 'Notice of Decision to Refuse a Permit Under the Hazardous Waste (Regulation of Exports and Imports)Act 1989, accessed at http://www.ag.gov.au/portal/govgazonline.nsf/113C9B628895535FCA25764800073170/$file/S162.pdf, August 2010.*

Estimates for the above table were generated in consultation with the collection and re-processing industry. The collection and reprocessing of non-LAB batteries in Australia, especially for alkaline chemistry types, is still an emerging practice, with potential for increased volumes.

Even with the established industry of lead acid battery recycling in Australia, the emerging picture for lead acid batteries is that a significant tonnage of material is being managed through 'undesirable' options such as landfill, informal stockpiling and illegal export.

8 OVERVIEW OF BATTERY RECYCLING PROGRAMS

Resource recovery of batteries needs effective systems in place for the collection of batteries, either as direct collection services or as drop-off points where consumers can return end-of-life batteries. Reprocessing of batteries is also required. Australia now has sufficient reprocessing capacity to handle all of the lead acid battery arisings, and is developing capacity for non-lead acid battery types. Further to the 'nuts and bolts' of recycling infrastructure is the advocacy and awareness raising to ensure that available battery services are fully used. An overview of these battery programs in Australia is presented in the following sections, with more detail on individual programs presented in Appendix 10.

8.1 Battery Collection

The type of battery collection service available in Australia relates primarily to the size of the battery being collected. Small Handheld batteries have the most potential to use a 'courier' style of collection where specialised containers can be used by an office or a household to aggregate 5 kilograms of batteries (approximately 230 AA batteries). Larger batteries like Automotive SLI and Industrial batteries, need palletised systems and as such rely on direct pick-up of batteries from service centres or large users of batteries.

8.1.1 Handheld Batteries

A number of the major waste and specialist recycling companies offer a Handheld battery collection service. For example:

- CMA Ecocycle
- Orbitas
- SITA Environmental Solutions
- Transpacific Cleanaway
- Veolia Environmental Services.

These services provide a specific battery collection container, with size ranging from 10 to 20 litres (around 15 kilograms of Handheld batteries). A fee is paid to cover transport and costs of reprocessing. Once the container is full, it is sent locally for battery sorting and reprocessing or for export. Some companies offer the ability to include small items of electrical and electronic waste, for example, mobile phones.

Collection of Handheld batteries is a relatively new service, however because mail/courier systems can be used, there is effectively national coverage for Handheld battery collection. Services are voluntary opt-in and on a fee-for-service basis. Thus costs are passed directly to the consumer and the success of the service relies on a willingness to pay, as there are no prohibitions on disposal of batteries in mixed waste to landfill.

8.1.2 Automotive SLI Batteries

There are many collection options for Automotive SLI batteries (Used Lead Acid Batteries – ULAB). For example, companies like C.D. Dodd Scrap Metal Recyclers in Western Australia and Orbitas on a national basis will arrange collection of ULAB if there are sufficient numbers. There are also a number of 'informal' ULAB collection agencies. For example when the lead price is high and scrap metal merchants and reprocessors are paying more for batteries, there will be ad-hoc operators collecting batteries from service centres.

Payment for ULAB is usually made with the amount paid determined by commodity prices for lead. However, bulk volume is required, or at least a pallet full of batteries. There were no collection pickup services identified for a single battery.

Furthermore the transport of ULAB triggers many regulatory requirements as ULAB materials are hazardous waste. This places constraints on ULAB handling, transport and delivery. Properly licensed service providers and facilities are important in meeting regulatory requirements. Additional information on regulatory settings is provided in Appendix 7.

8.1.3 Large and Industrial Batteries

The size of Large and Industrial batteries makes their collection an imperative with limited options for drop-off services. Companies like Toyota have systems in place for collection of batteries used in their hybrid cars, ensuring that their end-of-life management is environmentally responsible. Electric vehicle manufacturers are also setting up similar systems.

Standby power and traction power batteries are generated in sufficient bulk for dedicated collection. Similar to the collection of automotive ULAB, a payment is made for lead acid batteries. It is not known whether other chemistry types such as Nickel Metal Hydride and Lithium polymer require a fee for service, or whether a payment is made based on the value of the metals.

8.2 Battery Drop-Off

Battery drop-off programs are in place for Handheld batteries on a trial or ongoing basis. Automotive SLI batteries have drop off points through large chain outlets that target the DIY market. Industrial batteries are not suited to drop-off programs because of their size.

8.2.1 Handheld Batteries

Collection programs for Handheld batteries can be grouped together on the basis of how they are funded. For example, existing programs are funded by governments, industry associations or individual retailers.

A number of government funded programs exist such as BatteryBack in Victoria and the Perth Regional Councils program, in addition to other programs run by local governments on a campaign basis. The general model is that drop-off bins are placed in high traffic areas such as hardware stores, shopping malls and electrical and electronic retailers, in addition to special locations such as schools and local government buildings. Batteries are dropped off and then a container load is sent for sorting and then local processing or export. (Note too that in some cases there is local stockpiling as a means of gathering the critical mass needed for reprocessing).

The Australian Mobile Telecommunications Association (AMTA) runs the Mobile Muster program which, while not directly targeted at batteries, illustrates the funding model through a peak national body. A range of handset manufacturers, network carriers, service providers and distributors voluntarily fund the program, which provides a free recycling service for mobile phone handsets, batteries and accessories, through a range of drop-off and collection points.

Funding by individual retailers involves the retailer internalising the costs of operating a battery drop-off and collection point. For example, Battery World offers individual consumers a free recycling service through their stores. Other examples include IKEA, which provides recycling services for products such as light globes and batteries at selected stores.

The cost of these programs is not borne directly by the consumer, but rather by the program sponsor, which has been industry, local or state government to date. These drop-off programs rely on voluntary participation, but at lower cost for the consumer than a direct fee-for-service collection. There are also potential models that involve sponsorship and promotional opportunities for the return of batteries, for example, discounts on additional battery purchases.

Other battery drop off programs for Handheld batteries are linked to drop off services for other products. For example, many local governments provide a household chemical drop off service for residents, and these often attract batteries as well as chemicals. However, in many of these cases, the batteries are collected for disposal, as opposed to reprocessing.

8.2.2 Automotive SLI Batteries

The focus for Automotive SLI drop-off points is on the swap-over of a car battery in the DIY market. For example, when the battery is replaced it is dropped off at a retail store. The 'recycle my battery here' program, run by Century Yuasa in conjunction with battery retailers such as Super Cheap Auto, Repco Auto Parts and Battery World, provides a network of drop-off points for car ULAB. There is no charge for the drop-off of a single car ULAB through the 'recycle my battery here' network. However, there is also no payment.

Exide Batteries also operate a collection service aimed at their battery customers (whether service centres, stores or individuals) as part of their 'total battery management' program. Delivery vans that drop off new batteries also collect the spent batteries as a change over service. There is no charge, and again no payment for single batteries. In some circumstances payment will be made to high volume customers of batteries.

Some scrap metal merchants will also accept car ULAB and in some cases may make a small payment for each battery, or for batteries that are delivered in bulk.

8.3 Battery Reprocessing

Australia has lead acid battery reprocessing capacity and emerging non-lead acid battery capacity in NSW and Victoria across five organisations. The ULAB reprocessing industry is well established and has recently seen a new entrant into the market. Non-ULAB reprocessing capacity is developing, and still faces some challenges in becoming established.

8.3.1 Lead Acid

Australian Refined Alloys (ARA), Hydromet and Renewed Metal Technologies (RMT) operate lead acid battery reprocessing facilities.

- ARA operates two lead recycling plants at Laverton North, Victoria and Alexandria, New South Wales. ULABs are processed into their component parts and the lead content smelted and refined into alloy grade lead ingots which are sold to Australian and overseas battery producers. Plastic is also recovered from battery casings and sold to the plastics industry for recycling. The two ARA facilities have a combined processing capacity of 65,000 tonnes of ULAB
- Hydromet operates a lead recycling plant at Unanderra (near Wollongong) New South Wales that processes ULAB into lead metal, lead paste, plastic and weak acid streams in order to recover lead products as feed material for secondary lead smelters. The Hydromet facility has a capacity of 36,000 tonnes of ULAB
- RMT in Wagga Wagga New South Wales new lead recovery and reprocessing facility for the reprocessing of ULAB into their component parts and then smelting and refining the lead content into alloy grade ingots for sale into domestic and international markets. The process was commissioned in the first half of 2010 and also recovers plastic and sodium sulphate as byproducts. RMT has 42,000 tonnes of ULAB reprocessing capacity.

Australia thus has a total ULAB reprocessing capacity of 143,000 tonnes, which is over 20,000 tonnes above the estimated amount of lead acid battery arisings (122,218 tonnes). This means that Australia is able to process all lead based battery arisings and there is no need for exporting ULAB to other countries for processing (see also discussion on the Basel Convention in Appendix 7).

8.3.2 Alkaline and Other Handheld Batteries

AusBatt (AusZinc Metals and Alloys) and MRI operate facilities that have current reprocessing capacity for alkaline or other Handheld batteries, in addition to having plans for further expansion:

- AusZinc Metals and Alloys accept bulk loads of rechargeable and single use Handheld batteries at their facility in Port Kembla, near Wollongong in New South Wales. Alkaline batteries are processed on-site for zinc recovery and the recovery of other metal components on a campaign basis, with a continuous operation to develop in line with numbers collected. Other battery chemistry types (for example, NiCd, NiMH and Li-ion) are exported overseas for processing and resource recovery
- MRI operates facilities in Brisbane, Sydney and Melbourne and accept all types of batteries including: lead acid, nickel cadmium (sealed and vented), lithium, alkaline, and nickel metal hydride batteries. Vented NiCd batteries are processed on site, with other battery types that cannot be recycled locally exported under permit to a partner in Korea. MRI also has plans to introduce lithium ion battery processing capacity in 2012.

No other battery processing capacity or plans were identified as part of this study. This lack of existing capacity presents one of the main challenges facing the industry for processing of Handheld batteries. Rechargeable batteries have greater value in terms of their materials content, but also account for a lower number of arisings. Thus any solution for Handheld batteries will probably have to accept all chemistry types.

8.4 Advocacy and Awareness

A number of organisations are actively promoting the recycling of batteries. The main level of work is around Handheld batteries, as collection services and reprocessing capacity are relatively new. For example:

- Planet Ark operate a comprehensive website called 'Recycling Near You' with their joint venture partner Sensis. This website allows the user to search for recycling solutions for batteries based on their location
- Clean Up Australia has specific battery based resources on their website aimed at promoting the recovery of batteries
- other Environment NGOs such as Total Environment Centre are involved with promoting battery recovery
- many local governments provide information resources on battery recycling and some also provide a drop-off site for used batteries.

8.5 Capacity, Gaps and Areas for Growth

The recovery rate for batteries in Australia is over 75 per cent, making the category of 'batteries' one of the most recycled products in Australia. However this recovery is dominated by lead acid batteries, and even within the lead acid battery category there are gaps and areas for improvement.

8.5.1 Handheld Batteries

Handheld batteries present the main gap and potential for growth for battery recovery in Australia. The current estimate is that 6 per cent of Handheld battery arisings are recovered for reprocessing. (This includes all chemistry types, local reprocessing, legal export and formal stockpiling). The two main issues for Handheld battery recovery are collection systems and reprocessing capacity. Collection of Handheld batteries needs to progress to the point where Australian reprocessing facilities are viable. Work is needed on a sustainable funding model for the collection of Handheld batteries.

8.5.2 Automotive SLI Batteries

Automotive SLI batteries have the highest recovery rate of 87 per cent (including lead reprocessing and formal stockpiling), owing to their size and also to the value of lead as a commodity. However, there are still opportunities for improvement in what could be a '100 per cent' recovery stewardship scenario.

These opportunities include:

- eradication of illegal export
- improved recovery from remote and regional sites where the bulk of informal stockpiling is likely to occur
- prevention of batteries entering the mixed urban waste stream and ending up in alternative waste technology plants or landfill.

It is estimated that nearly 10,250 tonnes of Automotive SLI batteries are lost through these undesirable management options.

8.5.3 Large and Industrial Batteries

Large and Industrial batteries are dominated by lead acid battery chemistry. This means that there is capacity for reprocessing within Australia. The main challenges for Large and Industrial batteries are improved recovery from remote and regional sites and gaining a better understanding of the standby power sector.

It is estimated that nearly 6,000 tonnes of Large and Industrial batteries are lost through undesirable management options. This gives a current estimated recovery rate of 86 per cent for Large and Industrial, with the recovery dominated by lead acid battery reprocessing of Marine; Forestry, Farming, Construction and Mining; and Traction and Motive batteries.

There is a gap in reprocessing capacity for large traction batteries and large standby power batteries from non-lead based chemistry types owing to the relatively small weight of arisings and the ability to export these battery types overseas. The issue of reprocessing capacity, and other emerging battery trends in Australia is discussed in the following section.

9 OVERVIEW OF EMERGING BATTERY TRENDS IN AUSTRALIA

Batteries serve many important functions within the Australian economy, and these are likely to increase over the foreseeable future especially given the anticipated roll out of electric vehicles and the use of batteries as load levelling devices for renewable energy. The focus of battery technology development has been on improving the efficacy of existing battery types, for example improving the life of a battery and the amount of power delivered. Other work has also focussed on new battery chemistry formulations that will deliver longer life and greater power. An overview of these trends is presented below.

9.1 Large and Industrial – Electric Vehicles and Standby

9.1.1 Electric Vehicles

The US has identified batteries for electric vehicles as a key 21st century technology and has made a commitment of up to US$4.5 billion in funding to 2015. The focus of activities will be on enabling US based battery manufacturing development of advanced batteries with the following aims:[10]

- reduce US dependence on foreign oil
- reduce automotive greenhouse gas emissions
- create jobs in advanced manufacturing
- enable further penetration of renewable energy sources such as wind and solar.

Electrification of the national vehicle fleet in Australia is also a key medium term opportunity identified as part of Australia's automobile technology roadmap. Plug in Hybrid, Plug in Electric and Fuel Cell technologies all play a part. Priorities for electrification that will influence the consumption, stocks and arisings of batteries in Australia include:[11]

- supercapacitors for electric vehicles as a primary energy storage solution
- high energy density batteries to improve electric vehicle range and performance
- modular, standardised battery packs for electric vehicles 'swap and go'
- development of seamless integrated charging infrastructure to provide customer convenience
- a utility-level energy grid management system to leverage electric vehicles and plug-in hybrid vehicles as a distributed electricity storage system
- develop end-of-life market applications for used electric vehicle batteries
- innovative finance models for electric vehicles (to fast track fleet change over from liquid fossil fuels to electricity).

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[10] *US Department of Energy, Energy Efficiency and Renewable Energy, 2008, 'National Battery Collaborative (NBC), Roadmap (Draft),' accessed at https://files.me.com/john.petersen/kcj7tv, September 2010.*

[11] *AutoCRC, undated, 'Automotive Australia 2020 Technology Roadmap', Port Melbourne, accessed at http://www.autocrc.com/files/Image/2009/AA2020TechnologyRoadmap.pdf, September 2010.*

Hydrogen fuel cells may be one way of powering the electric vehicle, in addition to providing portable energy solutions (laptop computers, video cameras, mobile phones) and other commercial transport energy applications such as forklifts and buses. Fuel cells could be a disruptive technology that reduce demand for batteries. However, in Australia, these opportunities will be 'emerging' around 2020, so are unlikely to immediately compete with battery power storage.[12]

As part of the drive towards electric vehicles, lithium ion battery production (25kWh) is anticipated to increase tenfold from 2010 to 2015.[13] This will eventually drive an increase in Large and Industrial battery arisings because of the weight of electric vehicle batteries. However, this may take some time given life expectancies of greater than eight years and also the potential to reuse the battery for renewable energy applications at the end of its (motive) life.

9.1.2 Standby Power

Load levelling devices are used to store power generated during off-peak hours, allowing large generators of electricity to be more efficient by generating at stable levels for longer periods of time. It also avoids the need for additional power generation during peak demand, as peak supply can be delivered from a load levelling device, such as pumped storage of water, compressed air storage, and storage batteries.[14] As more renewable power comes online with inherent variability of generating capacity (for example wind power only is available when the wind blows), there will be an additional increase in demand for load levelling devices.

An example of a load levelling storage battery is the zinc bromine battery. An American company received funding from the US Department of Energy to develop a zinc bromine battery with reduced manufacturing costs and increased energy with reduced weight. One advantage of the zinc bromine battery is that cycle life is not degraded by deep discharging, and the lack of degradation of cathode active components contributes to long cycle life.[15]

Other chemistries for standby power are also being investigated. For example, an Australian vanadium redox battery was developed with a higher potential energy density than other vanadium batteries and has the potential to achieve 80 per cent efficiency in storing and releasing the electricity produced.[16]

9.1.3 Other Large and Industrial

Other factors governing the use of Large and Industrial batteries include:

- the mining boom driving demand for mining equipment which relies on large lead acid based industrial batteries
- removal of gas engines for use with indoor forklifts because of OH&S concerns will drive demand for lead acid traction batteries and possibly other battery types.

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[12] *Wyld Group, 2008, ''Hydrogen Technology Roadmap', Australian Government, Department of Resources, Energy and Tourism, Canberra, accessed at http://www.ret.gov.au/energy/clean_energy_technologies/energy_technology_framework_and_roadmaps/hydrogen_technology_roadmap/documents/hydrogen%20roadmap.pdf, September 2010.*

[13] *Miller, J. and Duong, T., 2010, 'Advanced Battery Manufacturing', US Department of Energy, Energy Efficiency and Renewable Energy, accessed at http://www.itif.org/files/Miller.Battery.Manufacturing.pdf, September 2010.*

[14] *US DOE, 2001, 'Deep-Discharge Zinc-Bromine Battery Module Offers Megawatts Capacity', United States Department of Energy, Washington DC, accessed at http://www.nrel.gov/docs/fy01osti/29466.pdf, September 2010.*

[15] *ibid 2001.*

[16] *CEGT, 2005, 'New battery technology breathes life into renewable energy sources', Centre for Energy and Greenhouse Technologies, Melbourne, accessed at http://www.vfuel.com.au/CEGT_Vanadium_Bromide_Redox_Battery_Media_Release_12_J.pdf, September 2010.*

The lead acid battery platform for traction power within industrial applications is very well established. Other battery types would have to work hard to overcome this competitive position, which seems unlikely in the short to medium term. However, lead acid batteries do not feature as a motive power solution hybrid or electric vehicles, which is driving a focus on the development of lithium chemistry solutions. (Note that there is still demand for Starting, Lighting and Ignition batteries even in electric vehicles, as discussed in Section 9.4).

9.2 Focus on Lithium

Lithium is recognised as a commercially available battery chemistry technology with potential for improvement. Supplies of Lithium are abundant, with known reserves sufficient for 100 billion electric vehicles. Increased capacity for electric vehicles is driving lithium based battery development with a focus on the following tasks:[17]

- increasing the stability of cathode materials
- increasing capacity of electrode materials
- more stable electrolytes, especially with regard to heat tolerance.

Lithium ion batteries have doubled in energy density between 1995 and 2005, and are approximately triple the energy density of NiCd batteries and nearly double that of NiMh.[18] The cost per kWh of storage capacity of lithium ion batteries has also declined dramatically as shown in Figure 4 below.

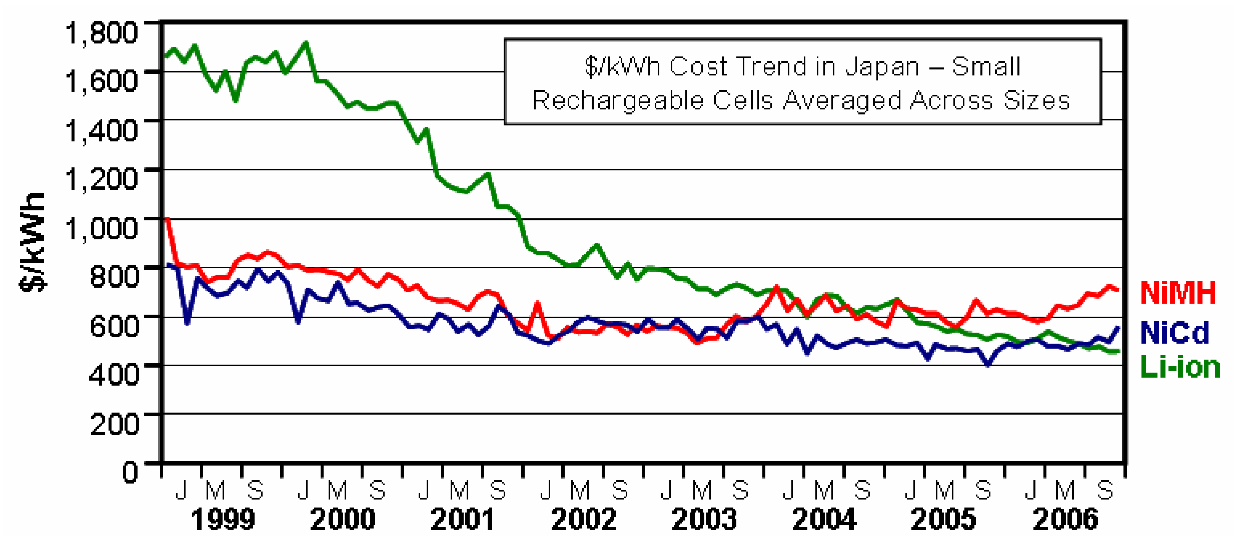

Figure 4 – Cost of lithium-ion batteries for consumer electronics continues to decline[19]

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[17] *Hollenkamp, T., 2010, 'Lithium-ion Batteries: A 'Lightweight' Taking on a Heavyweight Task', AutoCRC, Melbourne, accessed at http://www.autocrc.com/files/File/2010/EV%20Melbourne%20May%202010/Battery%20Technology.pdf, September 2010.*

[18] *Simpson, A., 2009, 'Smart Grids enabling Plug-in Vehicles with Renewable Energy', Curtin University, Perth, accessed at http://ece.curtin.edu.au/local/information/Anrew%20Simpson%20-%20091130_Curtin_SGForum_EVs_Renewables.pdf, September 2010.*

[19] *Duong, T., 2007, 'Research Needs: A Transportation Perspective', US Department of Energy, Energy Efficiency and Renewable Energy, accessed at http://www.ornl.gov/sci/sp/Pres/Duong.ppt, September 2010.*

Organisations like CSIRO in Australia and NREL in the United States have lithium battery development programs.[20] The focus of these programs is on improving energy density, reducing cost per kWh of storage and lengthening the number of charge cycles (in the case of rechargeable batteries). The Australian Media and Communications Authority believes that nanotechnology will also have an application in lithium battery technology to improve energy density and reduce charging time.[21] CSIRO is also researching room temperature ionic liquids to develop a safe rechargeable lithium metal battery that works over a wide temperature range while delivering more energy.[22] These factors, combined with toxicity concerns around NiCd batteries, point to Lithium based chemistry dominating rechargeable battery types in the future.

9.3 Single Use and Rechargeable Handheld Batteries

The overall use of Handheld batteries is increasing. This is a function of a number of factors including the transition of communications to a wireless platform that necessitates portable power supply, and also the growth in popularity of products with embedded batteries such as mobile phones, personal data assistants (PDAs), music players, and laptops.

New technology has already had an impact on communication devices such as mobile phones, flat screen TVs and digital cameras resulting in rapid development of new products. Computing processing power is also anticipated to continue to increase, doubling in capacity every eighteen months. This in turn gives rise to faster computing, new software, enhanced social networking and increased bandwidth, which in turn drives increased redundancy of equipment. New display technologies are also evolving, especially around portable devices.[23]

These factors point to an ongoing evolution in hardware for devices such as mobile phones, PDAs, tablet and laptop computers. This in turn points to an increased per capita concentration of these devices, with an associated increase in embedded battery consumption. So although the energy requirement of the device is decreasing, sales of these units are increasing, resulting in increased levels of battery consumption.

The proliferation of Handheld devices will also drive consumption of single use and rechargeable batteries. Convenience is a major driver for consumer goods, which makes increased sales of single use alkaline batteries a likely feature of the Handheld battery market for the foreseeable future. This balance could shift as more cordless telecommunication and computing products rely on lithium batteries and as wireless charging pads (conductive charging) start to become popular.

If the wireless charging of batteries embedded in products were to be applied to household applications such as remote controls, then the convenience factor could move in favour of rechargeable Handheld batteries, and shift the current split in battery consumption between single use and rechargeable.

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[20] *NREL, 2009,' Energy Storage R&D Thermal Management Studies and Modeling', National Renewable Energy Laboratory, Colorado, accessed at http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/45531.pdf, September 2010.*

[21] *ACMA, 2008, ' Top Six Trends in Communications and Media Technologies, Applications and Services-Possible Implications', Australian Media and Communications Authority, Canberra, accessed at http://www.acma.gov.au/webwr/_assets/main/lib310658/top_six_trends.pdf, September 2010.*

[22] *CSIRO, undated, ''Innovation for the Automotive Industry', CSIRO Publishing, Melbourne, accessed at http://www.csiro.au/files/files/plkn.pdf, September 2010.*

[23] *ACMA, 2008, ' Top Six Trends in Communications and Media Technologies, Applications and Services-Possible Implications', Australian Media and Communications Authority, Canberra, accessed at http://www.acma.gov.au/webwr/_assets/main/lib310658/top_six_trends.pdf, September 2010.*

However it is unclear whether single use batteries will disappear owing to their high convenience factor and also decreasing costs of production in Asia. What is likely is the growth in both stand alone sales and embedded products where a rechargeable battery is built in.

9.4 Automotive SLI

The national automotive fleet is increasing at a rate of approximately 3 per cent per annum.[24] This points to an ever increasing demand for Automotive SLI batteries. Balanced against this is the search for fuel solutions that do not rely on liquid fossil fuels (see the electric vehicle discussion above), which could imply a decrease in demand for Automotive SLI batteries. However, the following factors are of significance:

- any renewable biofuel vehicle with an internal combustion engine will require an SLI battery
- hybrid vehicles will require an SLI battery, primarily for lighting and auxiliary electricity needs
- electric vehicles will require a lead acid battery to handle peripheral systems (lighting, audio and the like) as they have different requirements to traction and motive power
- fuel cell technology powering cars will also need a SLI battery for the same reasons as hybrid and electric vehicles.

It is estimated that demand for Automotive SLI batteries will continue to grow in line with the national fleet growth of approximately 3 per cent per annum over the foreseeable future. No disruptive technologies have been identified, meaning that these batteries will use lead acid chemistry or a combination thereof. For example CSIRO is developing the UltraBattery, a novel approach of integrating a supercapacitor with the ability to store a large charge for quick release, with a lead acid battery. This approach is anticipated to provide commercial benefits of longer life, more power, and reduced costs.[25]

9.5 Summary

The use of batteries as portable power supply devices will increase within the economy as more products are 'disconnected' from mains power supply. This trend and the constant updating of technology platforms will drive increased consumption of Handheld batteries, with a direct increase in arisings of these battery types.

Fuel cell technology may reduce the new take up of stationary power and motive battery systems, however it is unlikely to affect lead acid batteries as the chemistry of choice in Automotive SLI applications over the short to medium term.

Furthermore, it is likely that the focus on electric vehicles will drive the concentration of lithium based batteries in the economy, and will slowly start to increase the weight of lithium batteries in national battery arisings.

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[24] Derived from ABS, 2009, '9309.0 - Motor Vehicle Census, Australia, 31 Mar 2009', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/9309.0?OpenDocument, July 2010.

[25] CSIRO, undated, ''Innovation for the Automotive Industry', CSIRO Publishing, Melbourne, accessed at http://www.csiro.au/files/files/plkn.pdf, September 2010.

10 CONCLUSIONS AND RECOMMENDATIONS

Batteries play an essential role in everyday life, especially given the level of car ownership, the trend towards wireless communications and other products that rely on a portable source of power. However, despite their importance little is understood about battery material stocks and flows and any associated impacts of these flows. This report represents a significant step forward in understanding the consumption of all battery types in Australia and the fate of their arisings.

Battery inputs are the consumption of batteries; stocks are those batteries in service within the economy; and arisings are batteries that have reached the end of their active service life (or are unwanted for any other purpose) and require a resource recovery or waste management solution. The materials stocks and flows model built for this study presents a breakdown of information on batteries according to:

– Handheld batteries of less than 1 kg in weight from all chemistry types
– Automotive Starting Lighting and Ignition (SLI) batteries that are used in registered on-road vehicles and that use lead acid chemistry
– Large and Industrial batteries (essentially greater than 1 kg) that are used in non-registered or off-road engine applications, for example, mine sites and agriculture, in addition to batteries used for motive and standby power.

A detailed classification system for batteries was also developed on the basis of sectoral use (household and commercial versus industrial); battery chemistry; typical uses of the batteries; size (Handheld <1kg, or heavy >1kg), rechargeable or single use; customs and ABS codes; and hazardous properties. However, for practical purposes, the above three categories were used for data collection and modelling.

A top down and bottom up approach was also used for modelling purposes. This involved the use of detailed ABS customised reports on the import of all battery types into Australia as a 'top down' starting point. Information from industry, combined with a 'bottom up' classification of battery uses, was then employed to identify battery type and chemistry, in addition to estimating the likely arisings based on estimated stocks and replacement rates. The number and weight of batteries were estimated for the following chemistry types:

– alkaline
– carbon zinc
– lithium based (ion and polymer)
– nickel metal hydride (NiMH)
– nickel cadmium (NiCd)
– lead acid
– other, for example, zinc air (ZA), silver oxide (SO), zinc chloride (ZC).

Battery Consumption (Inputs)

One of the key findings of this study was that Australians consume over 350 million batteries each year, weighing over 150,000 tonnes.

These battery inputs comprise approximately (with rounding):

- 345 million Handheld batteries weighing 16,000 tonnes and representing 98 per cent on a count basis, but only 10 per cent on a weight basis
- 5.8 million Automotive SLI batteries weighing 85,700 tonnes. Although this was less than 2 per cent of the count, it represented the largest category (56 per cent) of battery inputs on a weight basis
- 1.7 million Large and Industrial batteries weighing 51,700 tonnes. This was even less that Automotive SLI batteries on a count basis (0.5 per cent), but a large category (34 per cent) of battery inputs on a weight basis.

Battery Stocks

Stocks of Australian batteries are defined as batteries in active service life. Estimates of battery stocks thus rely on estimates of the national 'fleet' of products that use batteries. On this basis it was estimated that nearly 500 million batteries are in service in Australia weighing nearly 450,000 tonnes. These totals comprise (with rounding):

- 465.3 million Handheld batteries weighing 26,240 tonnes (95 per cent on a count basis and 6 per cent on a weight basis)
- 15.4 million Automotive SLI batteries weighing 224,200 tonnes (3 per cent on a count basis and 50 per cent on a weight basis)
- 6.6 million Large and Industrial batteries weighing 198,500 tonnes (1 per cent on a count basis and 44 per cent on a weight basis).

Battery Arisings

Battery arisings are the batteries that reach the end of their service life each year in Australia. It is estimated that approximately 271.2 million batteries present as an end-of-life management issue weighing 134,950 tonnes. Battery arisings comprise (with rounding):

- 264.3 million Handheld batteries weighing 11,900 tonnes and representing 97.5 per cent on a count basis, but only 9 per cent on a weight basis
- 5.4 million Automotive SLI batteries weighing 80,300 tonnes. This was 2 per cent of the total battery count, but the largest category (59 per cent) of battery inputs by weight
- 1.5 million Large and Industrial batteries weighing 42,800 tonnes, with 0.5 per cent of the total battery arisings, but 39 per cent of arisings on a weight basis.

The majority of battery arisings on a weight basis are lead acid batteries. They account for over 90 per cent of all battery arisings in Australia on a weight basis, which is 122,218 tonnes of the total weight of battery arisings (134,950 tonnes).

If lead acid batteries are excluded from the analysis, the next dominant chemistry type in arisings is alkaline and carbon zinc Handheld batteries with 8,570 tonnes or over two-thirds of the 12,740 tonnes of non-lead acid battery arisings.

Fate of Battery Arisings

The fate of battery arisings is also dominated by lead acid batteries which make up virtually the entirety of Australian battery reprocessing and export for reprocessing. The estimated 100,000 tonnes of lead acid battery reprocessing is approximately 75 per cent of all battery arisings and 82 per cent of all lead acid battery arisings.

(Note that the legal export of lead acid batteries ceased after October 2009 when an application for an export permit was not granted. No reason was given on the official notice of decision, however the excess in processing capacity for lead acid batteries (143,000 tonnes of capacity and 122,218 tonnes of lead based battery arisings) would have been an important factor).

If landfill is considered an undesirable management option for batteries, and is grouped with illegal export, rebirth and informal stockpiling (all arguably undesirable from a stewardship perspective), then approximately 20 per cent of all batteries in Australia are not being managed in an optimal way. This is 27,400 tonnes of batteries, comprising 15,940 tonnes of lead acid batteries and over 11,000 tonnes of Handheld batteries, including:

- 11,400 tonnes of batteries disposed of to landfill (8 per cent of total arisings)
- 5,800 tonnes of batteries stockpiled informally, for example left embedded in products such as mobile phones or left to accumulate in the house, garage, office, barn or mine site (4 per cent)
- 2,100 tonnes of batteries being 'rebirthed', which means they are inappropriately re-branded for resale with no quality control or assurance (2 per cent)
- 8,150 tonnes of illegal export, which although is likely to be for reprocessing, nevertheless carries all of the risks of hazardous materials being processed at unlicensed facilities (6 per cent).

Challenges for Battery Resource Recovery

Even though there is a relatively high recovery rate for all batteries in Australia (75 per cent), there are very few Handheld batteries recovered for recycling, with only 750 tonnes across all chemistry types collected for local processing and legal export.

Handheld batteries thus present the main gap and potential for growth for battery recovery in Australia. The current estimate is that 6 per cent of Handheld battery arisings are recovered for reprocessing. The two main issues for improving Handheld battery recovery are the need for more extensive collection systems and reprocessing capacity.

Automotive SLI batteries have the highest resource recovery rate, owing to their size and also to the value of lead as a commodity. The recovery rate is 87 per cent when including formal stockpiling for reprocessing is included.

However, there is still room for improved stewardship amongst lead acid batteries including taking action on the eradication of illegal export, improved recovery from remote and regional sites and prevention of batteries entering the urban waste stream and being landfilled.

Large and Industrial batteries are also dominated by lead acid battery chemistry. This means that there is capacity for reprocessing within Australia. The main challenges for Large and Industrial batteries are improved recovery from remote and regional sites and gaining a better understanding of the standby power sector.

Recommendations

It is recommended that ABRI take a lead role in delivering the following outcomes:

- improved collections of Handheld batteries to capture a critical mass for reprocessing of these batteries within Australia
- a sustainable funding model to support the collection of Handheld batteries
- eradication of illegal export of batteries by working with relevant authorities
- improved recovery of Automotive SLI and Large and Industrial batteries from remote and regional sites
- prevention of batteries entering the mixed urban waste stream
- design of a product stewardship model with the capacity to deliver the above desired outcomes.

11 APPENDICES

11.1 Appendix 1 – Project Fact Sheet

ABRI

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Project Fact Sheet
Analysis of Battery Consumption, Recycling and Disposal in Australia

Background

Batteries are an essential component of many products. They range in size and function from large arrays of lead acid batteries for motive power, to small button cells for digital devices. There is also a wide variety of recycling activities and resource recovery performance. By far the most successful recycling initiatives in Australia have been for lead acid batteries (car batteries) due to the commercial value of scrap lead. Initiatives for the smaller portable battery types, however, are in their infancy.

Currently, only a small number of local activities to recycle portable batteries operate in Australia. Due to the wide variety of battery types, recycling is a labour intensive and expensive process. For example, battery types include single use alkaline, carbon zinc, lithium, silver zinc, and lithium batteries, in addition to rechargeable lithium ion, nickel cadmium, lead acid and nickel metal-hydride batteries.

One of the key barriers to potentially improved recycling is the lack of a thorough market analysis. To this end ABRI has comissioned a comprehensive and detailed assessment of the Australian battery products market. In particular it will identify current recycling and recovery rates to serve as a base-line measure for future initiatives and provide input to the development of product stewardship programs.

Aims of the Project

In order to develop a comprehensive analysis of the Australian battery market, the study will be focusing on the following activities:

- a battery materials stocks and flows model including quantitative data on consumption, recycling and disposal of batteries
- recycling rates for different types of batteries
- analysis of trends in battery consumption by type and chemistry
- an overview of battery recycling programs in Australia.

How to Participate

During the months of July and August 2010, Matthew Warnken will be contacting ABRI members, other battery value chain participants, representatives from the waste management and recycling industry and environment and community groups in order to gather data, identify issues and report on battery recycling activities. Please note that all data gathered directly from participating organisations will be treated as commercial-in-confidence and only aggregated data will be used in the final report.

Additional Information

If you would like to participate in the study or find out more about it please contact:

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11.2 Appendix 2 – Organisations Contacted

The following organisations were contacted during the course of this study. Note that this list in no way implies that these organisations endorse the findings of the report, or made any direct contribution to any data contained within the report.

- Australian Refined Alloys
- AusZinc
- Battery World
- Century Yuasa
- Close the Loop
- Club Assist
- CMA EcoCycle
- Department of Environment, Climate Change and Water (NSW)
- Department of Sustainability, Environment, Water, Population and Communities (Federal)
- Duracell
- Eastern Metropolitan Regional Council (EMRC)
- Energizer
- Exide
- Hydromet
- MRI
- Orbitas
- Panasonic
- Renewed Metal Technologies
- Planet Ark
- Sanyo
- SITA Environmental Solutions
- Sustainability Victoria
- Toshiba
- Transpacific Cleanaway
- Varta
- Veolia Environmental Services

11.3 Appendix 3 – Battery Chemistry

The operation of a battery is designed to deliver a direct current flow on demand. An anode and cathode are electrodes through which electric current flows. The anode is the negative terminal in a discharging battery, and negative ions (anions) move towards the anode. In a recharging battery, the anode is positive. A cathode is positive in a discharging battery, and negative in a recharging battery. When discharging, the cathode is the source of electrons. It attracts the positive ions (cation) in a circuit or chemical reaction. The form of the anode and cathode depends on the type and purpose of the battery.

11.3.1 Wet Cell Batteries

Wet cell batteries are an electrochemical cell with a liquid electrolyte that can be either disposable or rechargeable in nature. These types of batteries were initially developed in the early 1800s and were the predecessors to dry cell batteries. The most common form of wet cell battery is the lead acid battery.

Wet cell batteries contain an electrolyte, anode and cathode. An electrolyte conducts electricity between battery plates, and can store energy on plates themselves. Electrical current is carried through the electrolyte by electrons. This is shown in Figure 5 below which is a basic wet cell battery comprising an anode, cathode and acid solution electrolyte. An electrolyte may be in liquid or gel form, depending on the type and purpose of the battery.

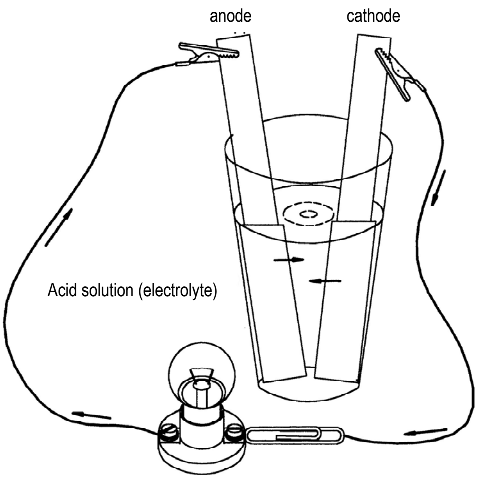

Figure 5 – Basic wet cell battery operation[26]

Wet cell batteries are common in automotive, industrial and standby power applications. For example, traction and motive batteries are commonly used to power motors and specific tasks in electric vehicles such as forklifts and scissor lifts. Starting, lighting and ignition (SLI) batteries start vehicles containing an internal combustion engines. Standby batteries supply electrical power to critical systems in the event of a power outage.

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[26] *Accessed at http://cnx.org/content/m22636/latest/Picture%2011.png. September 2010.*

Wet cell batteries will eventually cease working after extended use. For example, in a lead acid battery, a build up of sulphur on positive plates will flake off and settle on the bottom of the battery. This will eventually short out the battery.

11.3.1.1 Lead Acid Battery

The most common wet cell battery is a Lead Acid Battery (LAB). LABs are used in a variety of applications, most common perhaps being for automotive use in cars, trucks and motorcycles. They are also used for industrial Uninterrupted Power Supply (UPS) units, for example in hospitals, and to provide power in electric vehicles such as forklifts and golf buggies (traction and motive).

A lead acid battery is made up of a series of plates that contain lead paste pressed into lead alloy mesh. These plates are covered with a sulphuric acid and distilled water solution. Lead is highly toxic to humans, plants and other animals when ingested or inhaled. Recycling and recovering of used materials is essential to avoid human and environmental health risks.

Figure 6 – Automotive SLI lead acid battery[27]

11.3.2 Dry Cell Batteries

Dry cell batteries are the most common type of battery available and are used for a variety of functions, including personal application devices. Dry cell batteries are single use (disposable) or rechargeable.

Dry cell batteries convert chemical energy to electrical energy. The addition of electrons to the cathode (negative) and reduction of electrons at anode (positive) generates power. This is called the redox reaction. Electrodes are electrically connected by the electrolyte (solid or liquid) inside the dry cell battery.

Single use batteries can be used immediately following assembly and are intended to be used once before disposal. These are used in low drain power devices. Rechargeable batteries use electrical charging to reverse the chemical reactions that take place during discharge.

[27] *Sourced at http://www.ace4parts.com/images/products/UB12350_medium.jpg, September 2010.*

Figure 7 – Common Dry Cell Batteries[28]

Numerous forms of dry cell batteries exist. The most commonly used disposable batteries are alkaline batteries, which are suitable for use in a range of products and applications. Alkaline batteries come in AA, AAA, C and D sizes. D cell batteries are the largest of these and have a higher energy capacity. Other disposable dry cell batteries include zinc carbon, zinc chloride, zinc air, and lithium chemistries.

Nickel metal hydride and lithium ion are the most common rechargeable dry cell batteries. Nickel cadmium batteries were the first competitive rechargeable dry cell on the market, but have since been overtaken in sales by other rechargeables.

11.3.2.1 Alkaline Batteries

Alkaline batteries are currently the most sold Handheld battery on the Australian market. Developed in the 1960s, alkaline batteries have a high energy capacity, good high and low temperature storage, and long service life.

The alkaline battery has a zinc anode, and a cathode composed of manganese dioxide paste and carbon powder. The electrolyte of potassium hydroxide is responsible for the improved performance of alkaline batteries in comparison to other dry cell batteries.

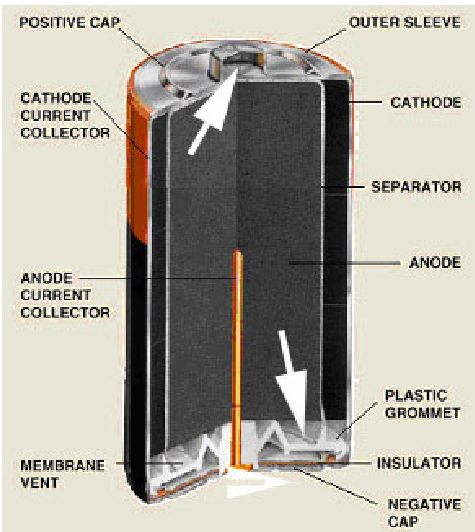

Figure 8 – Alkaline battery structure[29]

[28] *Sourced at http://www.hollyhockbatteries.com.au/AAA_Batteries.html, September 2010.*

11.3.2.2 Zinc Carbon Batteries

The zinc carbon battery is the oldest form of disposable dry cell battery. They are the cheapest battery to produce and often used by manufacturers in products that are sold with batteries included. Zinc carbon batteries can be used in any low charge device such as remote controls, toys and flashlights.

A zinc casing can act as the container and anode, while the cathode is a mixture of manganese dioxide and carbon powder. The electrolyte is paste of zinc chloride and ammonium chloride dissolved in water. Zinc carbon batteries generally provide 1.4 – 1.7 volt of DC electric power that gradually declines to 0.9V during use.

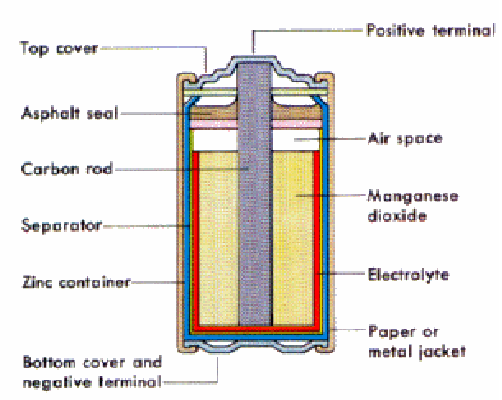

Figure 9 – Zinc carbon battery structure[30]

11.3.2.3 Zinc Chloride Batteries

A zinc chloride battery is a more effective and powerful form of zinc carbon battery. The use of more pure chemicals are the major reason for increased service life and steadier voltage output.

A zinc casing can act as the container and anode, and cathode is composed of carbon and refined manganese dioxide. A highly conductive and slightly acidic electrolyte of mainly zinc chloride in water is the reason for the increase in operating capacity. Over 1.6 V of DC electric power is generally provided.

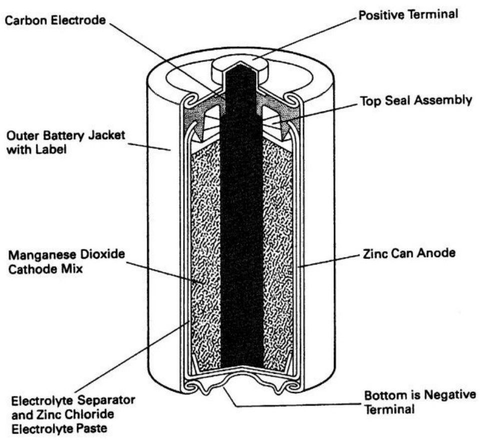

Figure 10 – Zinc chloride battery structure [31]

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[29] Sourced at http://rogercortesi.com/portf/highpresbat/batterycutaway.jpg, September 2010.

[30] Sourced at http://www.kwarc.org/bulletin/2000-09/battery1.gif, September 2010.

11.3.2.4 Zinc Air Batteries

Zinc air batteries are a specialised form of disposable battery that use an electrochemical reaction involving oxygen to generate power. Zinc air batteries are packed in an inactive state with a removable plastic seal. This seal must be removed to expose the battery to air and activate the cell.

The anode is primarily composed of granulated zinc, while oxygen from air is employed by the cathode. The electrolyte is alkaline. The small space required by the cathode increases the zinc anode size and output potential.

Zinc air batteries are used in hearing aids, pagers and medical devices.

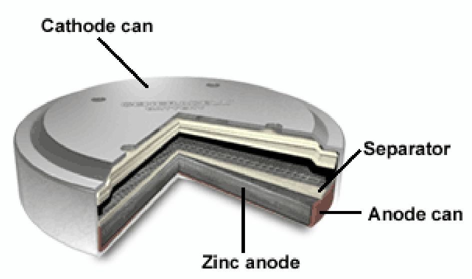

Figure 11 – Zinc air battery structure[32]

A zinc air battery generates a flat discharge voltage of around 1.4 V, has increased safety and environmental benefits by avoiding a potentially toxic cathode, have a good shelf life and low cost. However, their reliability in extremely wet or dry environments, limited output and short active life can be disadvantageous.

11.3.2.5 Silver Oxide Batteries

Silver oxide batteries are a miniature form of disposable battery that were developed primarily for aircraft use. Silver oxide batteries were the power source of all Apollo spacecraft, lunar module and lunar rover eqipment during the 1960s and 70s.

The anode of a silver oxide battery is made of zinc, while the cathode is silver oxide. Two types of silver oxide batteries exist and the difference is the type of alkaline electrolyte used. These batteries last 2-3 years and are ideal for analog or digital watches without a backlight. Batteries with a potassium hydroxide electrolyte generate shorter bursts of higher current and are used in LCD watches with backlights, hearing aids and electronic measuring devices.

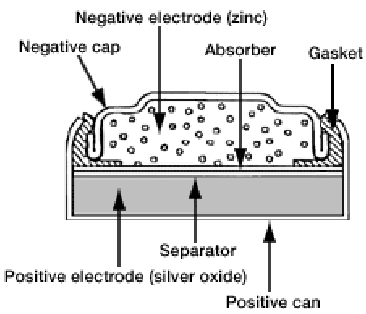

Figure 12 –

[31] Sourced at http://support.radioshack.com/support_tutorials/batteries/images/zincchloride.jpg, September 2010.

[32] Sourced at http://micro.magnet.fsu.edu/electromag/electricity/images/batteries/zincair.gif, September 2010.

[33] Sourced at http://www.maxell.com.sg/industrial/batteries/sr_button/images/diagram.gif, September 2010.

11.3.2.6 Nickel Cadmium Batteries

Nickel cadmium (NiCd) batteries were the first commercially priced rechargeable battery on the market. The principle behind rechargeability in batteries requires both electrode reactions to be reversible – external input forces the discharge reaction in reverse. In NiCd batteries, oxidation which occurs at the negative electrode is equal to the oxidation reduction at the positive electrode.

NiCd batteries use nickel metal hydroxide and metallic cadmium as electrodes. The two types of NiCd battery are vented cells and sealed cells. Vented cells must be properly positioned so that they vent properly and require water for maintenance. Sealed cells require no maintenance, are used in any position and can be discharged-charged many times. A typical NiCd can be discharged-charged between 500 – 700 times and used in scanners, portable radios, electric model airplanes, electric vehicles and standby power.

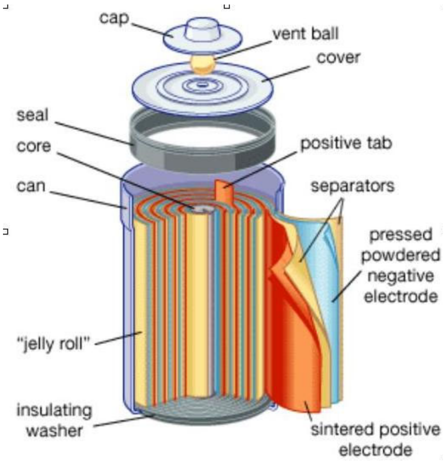

Figure 13 – Nickel cadmium battery structure[34]

11.3.2.7 Lithium Ion Batteries

Lithium ion (Li-ion) batteries are a form of rechargeable battery that are increasingly used in a range of applications. Li-ion batteries use a variety of cathodes and electrolytes to generate power. Commonly they use an anode combination of lithium ions dissolved in carbon or graphite with a cathode of lithium cobalt oxide or lithium manganese oxide in liquid electrolyte of lithium salt.

Lithium ion polymer batteries are the next stage in lithium battery development. These use a plastic electrolyte rather than liquid, and allow Li-ion batteries to be made in various sizes and shapes.

Lithium can also be used in single use batteries. Benefits of lithium batteries include high voltage (up to 4 V), high energy density, good operating capability over a wide range of temperatures and good shelf life. Lithium batteries are used in long life, critical devices such as pacemakers and other implantable medical devices, as well as clocks and cameras.

A lithium metal or compound is used as the anode. These are lightweight, capable of high voltage and a good conductor of energy. A porous carbon cathode is employed. Variations in lithium batteries occur through the use of different electrolytes.

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[34] *Sourced at http://media-2.web.britannica.com/eb-media/17/54317-004-45BBCD9E.gif, September 2010.*

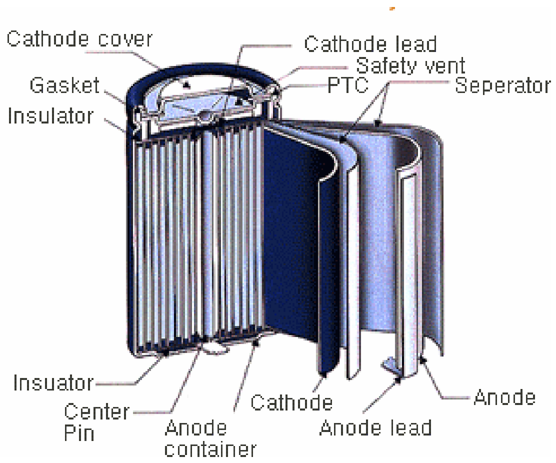

Figure 14 – Lithium ion battery structure[35]

11.3.2.8 Nickel Metal Hydride Batteries

The nickel metal hydride (NiMH) battery is a rechargeable electrochemical battery similar to a nickel hydrogen cell that was introduced to market in 1989.

The positive electrode contains nickel hydroxide, while the negative electrode is mainly composed of hydrogen absorbing alloys. The association of a high energy electrode with high energy alloys for the negative electrode led to the development of the high energy NiMH cell.

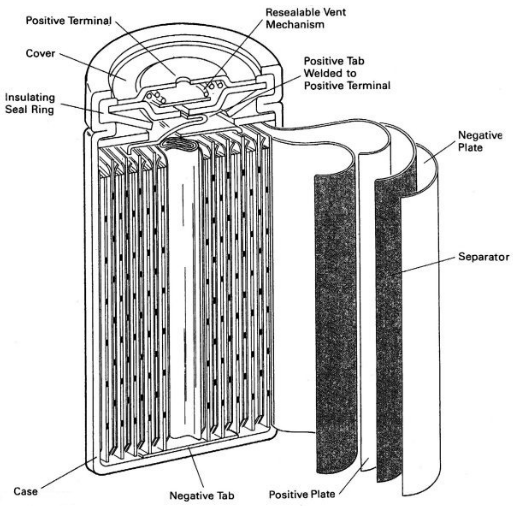

Figure 15 – Nickel metal hydride battery structure[36]

One advantage of NiMH batteries is that they contain no cadmium. They also have good energy density and shelf life. A NiMH battery has around 300 – 400 recharge life cycles.

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[35] *Accessed at http://www.gm-volt.com/wp-content/uploads/2008/02/lithium_ion_separator.gif, September 2010.*

[36] *Accessed at http://support.radioshack.com/support_tutorials/batteries/Images/rchg-cyl.jpg. September 2010.*

11.4 Appendix 4 – Handheld Battery Methodology

Handheld batteries were assessed according to 'stand alone' sales of single use and rechargeable batteries, in addition to batteries that are embedded within products. Stand alone import data were derived from an Australian Bureau of Statistics Customised Report on battery imports into Australia for 2009/2010.[37] Information on the following Harmonised Tariff Item Statistical Classification – Codes was used:

- 8506100070 Primary cells and primary batteries of manganese dioxide with anodes of lithium or a lithium compound
- 8506100071 Primary cells and primary batteries of manganese dioxide (excl those with anodes of lithium or a lithium compound)
- 8506300072 Primary cells and primary batteries of mercuric oxide
- 8506400073 Silver oxide primary cells and primary batteries
- 8506500074 Lithium primary cells and primary batteries
- 8506600075 Air-zinc primary cells and primary batteries
- 8506800076 Primary cells and primary batteries (excl. those of manganese oxide, mercuric oxide, silver oxide, lithium and air-zinc)
- 8507300082 Nickel-cadmium type electric accumulators, including separators therefor
- 8507400083 Nickel-iron type electric accumulators, including separators therefor
- 8507800084 Alkaline electric accumulators
- 8507800085 Electric accumulators (excl lead-acid, nickel-cadmium, nickel-iron and alkaline accumulators)
- 8507200081 Lead-acid type electric accumulators (excl those of a kind used for starting piston engines, those used for traction purposes, and regulated seal valve types with capacity > 65 amps/hr at C20)

The above import data means that the model is using robust estimates of 'stand alone' or replacement Handheld battery inputs. Batteries embedded in products were estimated to 10 per cent of Handheld battery inputs. The process for allocating these inputs by channel, chemistry and size are discussed in the following sections.

11.4.1 Channels to Market (replacement Handheld battery inputs)

Table 40 below contains a breakdown of the channels to market of Handheld battery sales that were derived from personal communications with industry.

[37] *ABS, 2010, 'Customised Report – Imports of Batteries 2009/2010', Australian Bureau of Statistics, Canberra.*

Table 40 – Breakdown of market by channel[38]

Channel	*Office Supplies*	*Hardware*	*Mass Merchant*	*Electrical Retail*	*Grocery*	*Speciality*
Proportion	7.5%	10%	10%	7.5%	60%	5%

11.4.2 Weights and Chemistry Proportions

Table 41 below presents the proportions of battery chemistry used for stand alone Handheld batteries. ABS customised reports were used for macro estimates of battery chemistry. Industry estimates were used to provide a break down according to battery size and then a process of allocation on likely usage and chemistry type was used to create the full table spread. Weights were identified through online websites and averaged.[39] 'Other size' represents an average of cells smaller than D size weighted by the number of cells in one tonne.

Table 41 – Chemistry proportions and battery weights used in stand alone Handheld batteries

Chemistry	Total AAA	Total AA	Total 9v	Total C	Total D	Other Size	Total Lantern	Averages
Alkaline	65%	60%	65%	65%	65%	18%	97%	60%
Carbon Zinc	20%	22%	20%	20%	20%	8%	2%	20%
Lithium	8%	8%	8%	8%	8%	3%	1%	8%
Nickel Metal Hydride	5%	6%	5%	5%	5%	2%	1%	5%
Nickel Cadmium	3%	3%	3%	3%	3%	1%	0%	3%
Other (ZA, SO, ZC)	1%	1%	1%	1%	1%	68%	0%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Weight (g)	12	24	42	65	135	6	742.5	

The chemistry proportions above were used in both stand alone sales and battery inputs in embedded products, with the exception of sealed lead acid batteries which were calculated as a stand alone category with ABS customised report data as the reference point. Also calculated separately were the chemistry types for mobile phones, cordless power tools, laptops and digital devices. (These are discussed further in following sections).

BatteryBack data supplied by Sustainability Victoria was used to provide an alternative estimate of chemistry for Handheld arisings, and the mid-point between the original model outputs based on input chemistry and BatteryBack data was used (see Appendix 11.10.14 for BatteryBack data).

[38] *Source: Battery industry personal communications as an informed estimate.*

[39] *For example, http://www.hollyhockbatteries.com.au/AAA_Batteries.html, http://www.powerstream.com/Size.htm, http://data.energizer.com/SearchResult.aspx.*

11.4.3 Mobile Phones and Digital Devices

Australian Communications and Media Authority[40] and Mobile Muster[41] data on phone services were used to estimate the 'fleet' of mobile phone handsets. mobile phone sales and hoarded handsets. 40 mobile phone batteries were selected from www.ebattery.com.au and averaged to estimate the mobile phone average battery weight of 21 grams.

Inputs were calculated as the batteries in new mobile phone services. Stocks were estimated according to the number of active mobile phone services. Arisings were calculated by estimating that 90 per cent of sales were replacements for existing services.

Chemistry types were estimated on the basis of reported battery usage as:

- Lithium: 60 per cent
- Nickel Metal Hydride: 30 per cent
- Nickel Cadmium: 10 per cent.

The same chemistry proportions were used for inputs, stocks and arisings.

Digital devices were estimated to have the same chemistry as mobile phones and to be a function of mobile devices in terms of count: 2 mobile services per single digital device. Digital devices include items such as iPods, MP3 players, and personal data assistants.

11.4.4 Laptop Power Packs

The stock of laptops was calculated on the basis of estimated domestic and commercial usage. Laptop inputs were estimated as 20 per cent of stocks. Laptop arisings were estimated based on a replacement rate that uses an average battery life of 6 years and a normal distribution to calculate that 17 per cent of batteries in the national laptop stock reach the end of their service life each year.

A report for the NSW Department of Environment, Climate Change and Water on household electrical and electronic waste (the Ipsos Report) was used to derive a per household laptop ownership factor.[42] This was reduced from 0.3 to 0.2 to avoid the potential for double counting as part of commercial laptop use. This factor was applied to family households and was halved for group and lone person households to calculate household laptop stocks. Further information on household counts is presented in Section 11.4.7 below.

A commercial bundle of laptop ownership was estimated as 100 for large companies (100 plus employees), 10 for small to medium companies (5-100 employees) and 0.5 for micro businesses (less than 5 employees). Further information on business counts is presented in Section 11.4.8 below.

15 batteries were selected from www.batterymall.com.au and averaged to estimate the average laptop weight of 564 grams. Laptop chemistry identified was lithium based. It was estimated that lithium accounts for 95 per cent of laptop batteries with a 5 per cent allowance for nickel metal

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[40] *ACMA, 2010, 'Communications Report 2008-2009', Australian Communciations and Media Authority, Canberra, accessed at http://www.acma.gov.au/webwr/_assets/main/lib311252/08-09_comms_report.pdf, August 2010.*

[41] *Mobile Muster, 2010, 'Australia: A Nation of Mobile Phone Hoarders', Austrailan Mobile Telecommunciations Assocation, Sydney, accessed at http://www.mobilemuster.com.au/files/Australia.A.nation.of.mobile.phone.hoarders.pdf, August 2010.*

[42] *Ipsos, 2005, Household Electrical & Electronic Waste Survey 2005: Report of Findings', NSW Department of Environment, Climate Change and Water, Sydney, accessed at http://www2.epa.nsw.gov.au/resources/spd060220_ewaste_ipsosreport.pdf, August 2010.*

hydride battery types, which were identified as in use for laptop applications as part of the online review of battery information.

11.4.5 Cordless Power Tools

The stock of cordless power tools was calculated on the basis of estimated domestic usage. Power tool inputs were estimated as 25 per cent of stocks. Power tool arisings were estimated based on a replacement rate that uses an average battery life of 5 years and a normal distribution to calculate that 20.5 per cent of batteries in the national cordless power tool stock reach the end of their service life each year.

The Ipsos Report was used to derive a cordless power tool ownership factor of 1 for family households and 0.5 respectively for group households and lone person households. 6 batteries were selected from www.power-battery.com.au and averaged to estimate the average cordless power tool battery weight of 546 grams. Chemistry types were estimated the basis of reported battery usage as:

- Lithium: 30 per cent
- Nickel Metal Hydride: 30 per cent
- Nickel Cadmium: 40 per cent.

11.4.6 Sealed Lead Acid Batteries (SLAB)

The stock of Sealed Lead Acid Batteries (SLAB) was calculated on the basis of estimated domestic and commercial usage. SLAB inputs were estimated as 10 per cent of stocks. SLAB arisings were estimated based on a replacement rate that uses an average battery life of 5 years and a normal distribution to calculate that 20.5 per cent of batteries in the national SLAB stock reach the end of their service life each year.

Sealed Lead Acid Batteries (SLAB) are used in emergency lighting and standby power applications.

A commercial bundle of SLAB ownership was estimated as 50 for large companies (100 plus employees), 5 for small to medium companies (5-100 employees) and 0.1 for micro businesses (less than 5 employees). Additionally an estimate of 1 SLAB for 10 per cent of households was also made to account for domestic usage. 5 Sealed Lead Acid Batteries were selected from www.batteriesplus.com.au and averaged to give an indicative weight of 700 grams.

11.4.7 Household Information

The number of households in Australia and definition of household type were taken from the Australian Bureau of Statistics. Table 42 below presents the breakdown by household type and by state in Australia for end of calendar year 2008.

Table 42 – Number of households by type and state for Australia end 2008[43]

Household Type	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aus
Family households	1,905,992	1,447,116	1,179,044	448,865	598,182	141,071	51,061	94,312	5,866,231
Group households	93,878	77,636	68,981	20,120	27,243	6,053	3,291	6,701	303,915
Lone person hshlds	637,326	488,763	358,238	176,961	200,150	54,115	14,141	31,108	1,960,995
Total	2,637,196	2,013,515	1,606,263	645,946	825,575	201,239	68,493	132,121	8,131,141
Total Proportion	32.4%	24.8%	19.8%	7.9%	10.2%	2.5%	0.8%	1.6%	100.0%

The stock of batteries used in households was calculated on the basis of an estimated household bundle of battery usage. The stock of household batteries was used to estimate arisings (but not inputs as this data was supplied through ABS customised reports on imports as outlined in Section 11.4.1). Arisings were estimated based on a replacement rate that uses an average battery life of 1.75 years and a normal distribution to calculate that 75 per cent of batteries in the household bundle of battery stock reach the end of their service life each year.

The household bundle of battery stock was constructed using data from the 2005 Ipsos study entitled 'Household Electrical & Electronic Waste Survey 2005: Report of Findings'. Household estimates were applied nationwide for family households and were halved for group and lone person households. Information from other reports was used to estimate smoke detectors[44] and clock radios.[45] Table 43 below shows the household bundle of equipment and the number of batteries per item of equipment.

Table 43 – Number of batteries per item of household equipment

Appliance Item	*Family households*	*Group households*	*Lone person households*	*Battery Type*
Smoke Detectors	2.0	2.0	2.0	9V
Clock radio	1.4	1.4	1.4	9V
Radios	1.5	0.8	0.8	2*AA
Portable electronic items (CD/cassette player, walkman, radio)	1.4	0.7	0.7	2*AA
Cordless phone	1.0	0.5	0.5	2*AA
Lantern	0.2	0.1	0.1	Lantern
Torch - not cordless	1.0	0.5	0.5	2*AA
Cordless torch	0.1	0.1	0.1	Package
Electrical tooth brushes	0.6	0.3	0.3	1*AA

[43] ABS, 2010, 'Household and Family Projections, Australia, 2006 to 2031', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3236.0Explanatory%20Notes12006%20to%202031?OpenDocument, August 2010.

[44] National Appliance and Equipment Energy Efficiency Committee, 2004, 'Product Profile Smoke Alarms', Australian Greenhouse Office, Canberra, accessed at http://www.energyrating.gov.au/library/pubs/sb200405-smokealarms.pdf, August 2010.

[45] Harrington, L. and Kleverlaan, P., 2001, 'Residential Standby Power Consumption in Australia', Australian Greenhouse Office, Canberra, accessed at http://www.energyrating.gov.au/library/pubs/standby-2001.pdf, August 2010.

Appliance Item	Family households	Group households	Lone person households	Battery Type
Digital cameras	0.5	0.3	0.3	Various
Cordless shavers	0.3	0.2	0.2	Various
Video Cameras	0.3	0.2	0.2	Various
Cordless vacuums	0.2	0.1	0.1	Various
Cordless kitchen appliances	0.1	0.1	0.1	Various
Other cordless with recharger including toys and remote control cars	0.1	0.1	0.1	Various
Battery operated toys using single use batteries	4	1	1	2*AA
Remote Controls (TV, DVD, Stereo)	6	3	3	2*AA

An average life of 1.75 years was used for all batteries in the domestic bundle. This was calculated as the half way point between 0.5 years and 3 years. This range of service life was taken to cover applications where batteries were in high use, and applications where batteries were in effective storage owing to low usage rates. When applied to a normal distribution (see Appendix 5 for more discussion) the replacement rates accounted for short life single use batteries, batteries which had occasional use in products and also rechargeable batteries.

Applying the above household bundle of batteries to the number of households in Australia and rounding up to the nearest 10 million gives an estimate of 170 million batteries, weighing 7,000 tonnes.

11.4.8 Commercial Business

A similar approach to households was taken to develop a commercial business bundle of equipment that used batteries. Information from the Australian Bureau of Statistics on the number of businesses by employee number was used as a starting point to estimate a commercial bundle of battery usage. Business sizes are defined as:[46]

- micro business: non employing plus 1-4 employees
- small to medium business: 5-100 employees
- large business: more than 100 employees.

Table 44 below has a breakdown of business count according to the above definition. State breakdowns were scaled according to the proportion of businesses operational in June 2007. Australian total business counts were estimated by applying the 2003-2006 industry growth rate of 1.3 per cent to June 2006 operational businesses.

[46] *Derived from ABS, 2007, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2007', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202007?OpenDocument, August 2010. (A growth rate of 1.3 per cent was used to extrapolate to the end of 2008.*

Table 44 – Estimated number of businesses by type and state for Australia June 2009

Type of Business	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aus
Large business	4,715	3,496	2,808	997	1,422	262	96	169	13,966
Small to medium business	105,266	78,056	62,691	22,270	31,742	5,859	2,141	3,775	311,800
Micro	579,243	429,519	344,967	122,543	174,666	32,243	11,782	20,771	1,715,733
Total	689,224	511,071	410,466	145,810	207,830	38,364	14,019	24,715	2,041,499
Total Proportion	33.8%	25.0%	20.1%	7.1%	10.2%	1.9%	0.7%	1.2%	100.0%

An assumption was made that commercial usage of batteries would be similar to household usage. This assumes that the commercial bundle has the same number of batteries as in the 'household' pack (even though uses although not specified will be different). Rounding to the nearest one million batteries gives an estimate of 164 million batteries, weighing 6,800 tonnes.

11.5 Appendix 5 – Automotive SLI Battery Methodology

The approach taken with Automotive SLI Batteries was to estimate stocks of batteries as the national fleet of registered vehicles. Inputs were calculated as the number of replacement batteries plus the number of new vehicle sales. Replacement rate was calculated using average battery life and a normal distribution. Arisings were calculated as replacement batteries plus the number of end-of-life vehicles.

The model was then compared against information from an Australian Bureau of Statistics Customised Report on battery imports into Australia for 2009/2010. Information on the following Harmonised Tariff Item Statistical Classification – Codes was used:

- 8507101077 Lead-acid type electric accumulators of a kind used as replacement components in passenger motor vehicles
- 8507109078 Lead-acid electric accumulators, of a kind used for starting piston engines for motor vehicles (excluding those used as replacement components in passenger motor vehicles).

This information, in combination with discussions with industry on the local manufacture of lead acid batteries was used to confirm the accuracy of the model in estimating the number of replacement battery sales in Australia for Automotive SLI batteries.

11.5.1 National Fleet Data

The national automotive fleet was calculated according to the following steps:

- ABS motor vehicle census data for 2008 and 2009 were used to estimate fleet size for 2008/09 financial year (fleet at 2008 + fleet for 2009 divided by two equals fleet for 08/09)
- campervans have been excluded from the analysis on the basis that they are unlikely to contain an Automotive SLI battery
- motorcycles include two and three wheeled mopeds, scooters, motor tricycles and motorcycles with sidecars. The main battery used weighs three kilograms, will last an average of 3.5 years and one battery is used per motor cycle. Annual growth rate over 2003/09 is 9.5 per cent and the estimated replacement rate (based on fleet size) is 24.1 per cent
- passenger vehicles include cars, station wagons, and four-wheel drives. These vehicles have a range of battery weights from 9.1 kg to 21.1 kg, with 14.3 kg used as the average. One battery is used per car with an average life of 3.5 years
- light commercial vehicles are registered for commercial use and used for carriage of goods under 3.5 tonnes (gross vehicle mass). These vehicles include utilities, panel vans, cab-chassis and some four wheel drives. Because of the range of vehicles in this fleet, battery weights range from 10.5 kg to 21.1 kg, with 15.7 kg used as the average. One battery is used per vehicle with an average life of 3.5 years
- rigid trucks - trucks of gross vehicle mass (GVM) greater than 3.5 tonnes and constructed with a load carrying area. The range of battery weights is from 17.3 kg to 28.1 kg, with

23.0 kg used as the average. One battery per vehicle is used with an average life of 3 years

- articulated trucks - primarily for load carrying, consisting of a prime mover having no significant load carrying area, but with a turntable device which can be linked to one or more trailers. Battery weights range from 25.6 kg to 53.9 kg, with 31.6 kg used as the average. Two batteries per vehicle are used with an average life of 3 years
- non-freight carrying trucks - specialist vehicles having little or no goods carrying capacity (for example, ambulances, cherry pickers, fire trucks and tow trucks). The range of battery weights is from 25.6 kg to 53.9 kg with 31.6 kg used as the average. Two batteries per vehicle are used with an average life of 3 years
- buses - constructed for the carriage of passengers. Included are all motor vehicles with 10 or more seats, including the driver's seat. The range of battery weights is from 25.6 kg to 53.9 kg with 31.6 kg used as the average. Two batteries per vehicle are used with an average life of 3 years.

A summary of this data was presented earlier in the report in Table 1 in Section 2.2. Information on the national fleet was presented in Table 23 in Section 5.2. A further state by state breakdown of the national fleet is presented in Table 45 below.

Table 45 – Automotive fleet size by vehicle and state for Australia 2008/2009[47]

Type of Vehicle	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Aus
Motorcycle	155,573	141,810	145,531	42,043	82,027	12,861	5,213	10,774	595,832
Passenger Vehicle	3,591,986	3,149,413	2,332,456	949,848	1,320,315	283,330	79,123	206,848	11,913,317
Light Commercial	626,396	518,659	601,516	156,358	291,479	80,143	32,519	22,581	2,329,649
Rigid Trucks	118,224	97,992	96,888	28,054	57,826	10,658	4,263	2,404	416,306
Articulated Trucks	16,814	23,880	18,180	6,981	11,528	1,635	938	220	80,175
Non-Freight Trucks	3,587	6,099	4,926	1,791	4,271	1,006	293	82	22,054
Buses	22,029	17,730	18,638	4,805	12,553	2,413	3,328	1,003	82,497
Total all vehicles	**4,534,609**	**3,955,583**	**3,218,135**	**1,189,880**	**1,779,999**	**392,046**	**125,677**	**243,912**	**15,439,830**

11.5.2 New Vehicle Sales

Information on automotive sales for 2008/2009 was sourced from the Department of Innovation, Industry, Science and Research and their report 'Key Automotive Statistics 2009'. Note that the 2008/2009 FY information was taken as the average between 2008 and 2009 sales. This information is shown in Table 46 below.

[47] *Derived from ABS, 2010, '9309.0 - Motor Vehicle Census, Australia', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/9309.0?OpenDocument, August 2010.*

Table 46 – Automotive sales for 2008/2009[48]

	2007	*2008*	*2009*	*2008/2009*
Total passenger local production	157,262	132,499	112,230	122,365
Total imports	479,757	464,046	428,332	446,189
Total retail sales	*637,019*	*596,545*	*540,562*	*568,554*
Local Assembly SUV and Light Trucks	43,143	38,933	35,171	37,052
Import SUV and Light Trucks	332,589	340,761	334,040	337,401
Total SUV and Light trucks	*375,732*	*379,694*	*369,211*	*374,453*
Local Assembly Heavy Trucks	16,424	16,100	12,191	14,146
Import Heavy Trucks	20,807	19,825	15,364	17,595
Total Heavy Trucks	*37,231*	*35,925*	*27,555*	*31,740*
Local Total Trucks	59,567	55,033	47,362	51,198
Import Total Trucks	353,396	360,586	349,404	354,995
Total Trucks	*412,963*	*415,619*	*396,766*	*406,193*
Total Vehicle Sales (ex Motor Bike)	**1,049,982**	**1,012,164**	**937,328**	**974,746**

Motor Bike sales were estimated from the Motor Council of NSW which reported on official figures released by the Federal Chamber of Automotive Industries (FCAI) which showed that 115,981 motorcycles, scooters and all-terrain vehicles were sold in 2009. This represented a decrease of 13.6 per cent (18,298 units) over 2008.[49]

11.5.3 Replacement Rate

Estimates of average life for different uses of Automotive SLI batteries were averaged from OEM data found online. It is assumed that the expected life span will follow a normal distribution. Standard deviations have been arbitrarily set at one third of the mean. The implications for Automotive SLI battery life are presented in Figure 16 below using a passenger vehicle battery with an average life expectancy of 3.5 years as an example. (This is the indicative life span of motorcycle, passenger and light commercial vehicles based on personal communications with industry).

[48] *DISR, 2009, 'Key Automotive Statistics 2009' Department of Innovation, Industry, Science and Research, Canberra, accessed at http://www.innovation.gov.au/Industry/Automotive/Documents/Key_Automotive_Statistics_2009.pdf, August 2010.*

[49] *MCC of NSW, 2010, 'Solid Result for Motorcycle Sales in 2009', Motor Cycle Council of New South Wales, Sydney, accessed at http://mccofnsw.org.au/a/207.html, August 2010.*

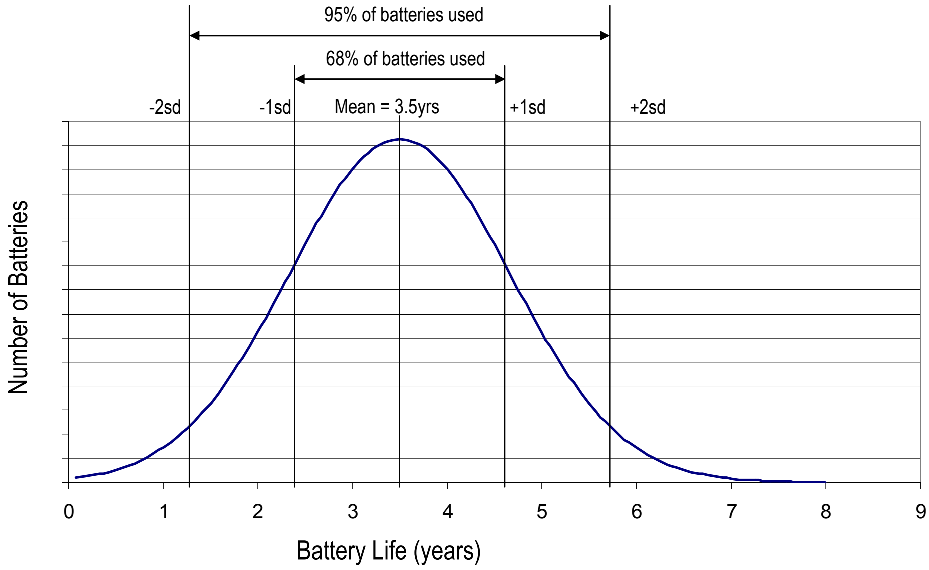

Figure 16 –Normal distribution of battery life (automotive batteries)

This model predicts that for Automotive SLI batteries used in passenger vehicles:

- 98.4 per cent of batteries will last longer than one year (1.6 per cent of 0-1 year old batteries will end up in arisings)
- 89.6 per cent of batteries will last longer than two years (10.4 per cent of 1-2 year old batteries will end up in arisings)
- 65.4 per cent of batteries will last longer than three years (34.6 per cent of 2-3 year old batteries will end up in arisings)
- 32.2 per cent of batteries will last longer than four years (10.4 per cent of 3-4 year old batteries will end up in arisings)
- 9.3 per cent of batteries will last longer than five years (90.7 per cent of 4-5 year old batteries will end up in arisings)
- 1.5 per cent of batteries will last longer than six years (98.5 per cent of 5-6 year old batteries will end up in arisings)
- 0.1 per cent of batteries will last longer than seven years (99.9 per cent of 6-7 year old batteries will end up in arisings)

The model used for Automotive SLI batteries took into account the changing size of the fleet over time and the predicted life span of the battery type in order to estimate the replacement rate of batteries in the national fleet. (Note that this approach has also been used for Handheld and Large and Industrial batteries).

11.5.4 Retirement of End-of-Life Vehicles

Vehicles retired were calculated as the previous financial year's fleet size, plus new sales, minus the size of the fleet at the end of the current financial year. A breakdown of this information is presented in Table 47 below.

Table 47 – Australian automotive vehicle retirement

Vehicle Type	*Number of Batteries*	*Proportion Count*	*Average Weight (kg)*	*Total Weight (tonnes)*	*Proportion Weight*
Motorcycle	59,900	9%	3	180	2%
Passenger Vehicle	475,400	73%	14	6,800	72%
Light Commercial	96,500	15%	16	1,510	16%
Rigid Trucks	16,800	3%	23	390	4%
Articulated Trucks	1,700	0%	32	530	6%
Non-Freight Carrying Trucks	1,300	0%	31	40	0%
Buses	1,800	0%	32	60	1%
Total Automotive SLI	**653,400**	100%		**9,510**	100%

11.6 Appendix 6 –Large and Industrial Battery Methodology

The Large and Industrial battery methodology followed the Automotive SLI methodology. Estimates of stocks were calculated on the basis of a national 'fleet' of equipment that used the specific Large and Industrial battery type. Inputs were calculated as the number of replacement batteries plus the number of new equipment sales. Replacement rate was calculated using average battery life and a normal distribution. Arisings were calculated as replacement batteries only as there was no reliable data on end-of-life equipment rates. The groupings within the Large and Industrial category were Marine, Forestry/Farm/Construction/Mine, Traction and Motive, and Large Stationary Standby.

11.6.1 Marine

Key data points and assumptions include:

- state vessel registrations for June 2007 from Boating Industry Association of NSW[50] and for September 2009 from Marine Queensland[51] used to estimate the national fleet by using combined population of NSW and Queensland to scale to a national basis.
- national growth rate in registrations of 3.6 per cent
- NSW breakdown on vessel registrations by length and craft type has been used to estimate the national vessel fleet. All canoes, catamarans (sail), punts, row boats, sailing ships, sailing vessels, tri-sails and 'unknown' have been excluded, in addition to all craft under three metres, on the basis that they are unlikely to use a lead acid battery. This exclusion has reduced the total fleet size by 15 per cent
- the range of battery weights is from 15.1 kg to 30 kg, with an average of 21.8 kg used. One battery per vessel is used with an average life of 3 years
- new sales of boats are estimated as 5 per cent of the national fleet.

A summary of this data is presented in Table 48 below.

Table 48 – Summary of data on marine applications

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Marine (sail)	n/a	n/a	0	3.6%	126,372	n/a
Marine (ex sail)	3	21.8	1	3.6%	716,100	37.0%
Total					**842,742**	

11.6.2 Traction and Motive

The traction and motive category includes golf carts, mobility assisted travel and electric fork lift equipment. Key data points and assumptions for golf carts and mobility assisted travel vehicles are outlined overleaf:

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[50] *Boating Industry Association of NSW, 2007, 'Vessel Registration Statistics for NSW year ending 30 June 07' accessed at http://www.bia.org.au/data-pdf/BIANSW-DATA41.pdf, July 2010.*

[51] *Marine Queensland, 2009, 'Total Qld Registered Vessels', accessed at http://www.marineqld.com.au/sites/default/files/l%20September.pdf, July 2010.*

- there are approximately 1,530 golf courses in Australia[52]
- an average of 25 golf carts is estimated to be associated with each club. This formula estimates a fleet of 38,250 golf carts in Australia. The range of battery weights is from 10.5 kg to 33 kg with an average of 22.6 kg used. Six batteries are used per cart with an average life of five years due to a lower frequency of use compared to SLI batteries
- in the absence of any other data, it is assumed that there is the same number of mobility equipment in Australia as golf carts. The range of battery weights is from 10.5 kg to 33 kg. An average of 22.6 kg has been used, and two batteries per vehicle with an average life of five years.

Another component of Traction and Motive is electric fork lift equipment. There is a wide variety of this type of equipment. For example consider Crown's product range:

- powered pallet trucks
- walkie stackers
- rider pallet trucks
- mid/high-level order pickers
- counter balanced trucks
- work assist vehicle
- narrow aisle reach and turret trucks.

Figure 17 –Types of electric traction applications[53]

For simplicity this wide range of forklift equipment has been divided into large and small classes:

- Materials Handling – Small – 2005/06 ABS data on business size and subdivision was used to identify all manufacturing businesses that also were employers,[54] and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009 (58,065). This was used as a baseline to identify the number of small equipment handling items that exist in Australia, scaled according to the number of employees. For example, a manufacturing

[52] *See for example, http://www.golfaustralia.org.au/default.aspx?s=statisticsandquickfacts*

[53] *Source accessed at http://www.crown.com/asia/products/index4.html, September 2010.*

[54] *ABS, 2008, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2006', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202006?OpenDocument, July 2010/. This data on business size and subdivision was used to identify all manufacturing businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.*

business employing 50-99 people was estimated to have 8 items of small materials handling equipment. This led to an estimated fleet size of 150,000 small material handling items. The range of battery weights is from 10.5 kg to 33 kg. An average of 22.6 kg has been used here, and two batteries per equipment item with an average life of five years

– Materials Handling – Large – the same methodology was used as above to estimate a fleet of 110,000 large material handling pieces of equipment. For example, a manufacturing business employing 50-99 people was estimated to have 4 items of large materials handling equipment. These forklifts use a battery that comprises an array of 2-volt cells that are either 158 mm wide (British Standard), or 198 mm wide (German standard). The height and thickness of each cell will vary, giving a variety of weights ranging from 20 kg to 50kg. An average 24 volt array weighing 300 kg has been used with an average life of 5 years (each battery is assumed to have a 5 hour run time with 1,500 cycles of charge and recharge, which gives an average of 30 hours run time per week). It is also noted that some 36 volt batteries that weigh one tonne are quite common and also that some special application batteries for mine sites can contain 56 cells and weigh nearly 3 tonnes.

Information on the fleet size for electric fork lift equipment is presented in Table 49 below.

Table 49 – Estimated national fleet electric fork lift equipment

Employee Range	1-4	5-19	20-49	50-99	100-199	200+
Number of businesses within range	28,223	20,676	6,964	2,426	1,163	907
Number of small materials handling items per business	1	2	4	8	16	16
Estimated number of small materials handling items	28,223	41,352	27,855	19,410	18,611	14,520
Number of large materials handling items per business	1	2	2	4	8	8
Estimated number of small materials handling items	28,223	41,352	13,927	9,705	9,306	7,260

A summary of the Traction and Motive category data is presented in Table 50 below.

Table 50 – Summary of data on golf carts, mobility assisted travel and electric fork lift equipment

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Golf Carts	5	22.6	6	3.4%	38,250	20%
Mobility	5	22.6	2	3.4%	38,250	20%
Materials Handling - Small	5	22.6	2	3.4%	149,971	20%
Materials Handling - Large	5	25	12	3.4%	109,773	20%
Total					**336,244**	

11.6.3 Forestry, Farming, Construction and Mining

This category of Large and Industrial battery use in non-registered vehicles and other plant on industrial premises, earth-moving, demolition and construction (including landfill), farming and agriculture, mining and forestry applications. While direct industry information was unavailable a reasonable package of equipment was constructed and multiplied by the relevant business count (scaled according to employee size) in order to estimate the national fleet size.

11.6.3.1 Industrial Premises

Key data points and assumptions for the 'industrial' fleet of plant that uses lead acid batteries:

- internal combustion – small. The fleet of small gas operated forklifts and materials handling equipment is estimated as 60,359 (one piece of equipment per manufacturing businesses that also was an employer),[55] with an average battery weight of 9.1 kg, one battery per vehicle and an average life of 3 years
- internal combustion forklifts - port/container. The fleet of large diesel operated forklifts/materials handling equipment is estimated as 60,359, (one piece per manufacturing businesses that also was an employer), with an average battery weight of 31.6 kg, one battery per vehicle and an average life of three years.

A summary of this data is presented in Table 51 below.

Table 51 – Summary of data on Industrial plant

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Internal Combustion Forklifts/Materials Handling - Small	3	9.1	1	3.4%	60,359	36%
Internal Combustion Forklifts/Materials Handling - Large	3	31.6	1	3.4%	60,359	36%
Total					**116,130**	

11.6.3.2 Earth-moving, Demolition and Construction (including landfill)

The fleet of equipment for the 'earth-moving, demolition and construction (including landfill)' category includes:

- excavators and front-end loaders
- dozers and graders
- compressors and gensets
- bobcats – small plant items also including mini ditch diggers etc.

[55] ABS, 2008, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2006', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202006?OpenDocument, July 2010/. This data on business size and subdivision was used to identify all manufacturing businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.

There are 28,704 businesses that are nominated as 'employers' in ABS industry data on 'general construction' as at June 2006.[56] Grouping these businesses according to employment size and adjusting for growth to June 2009, it is estimated that that there will be a fleet factor of 47,604 for each piece of the above equipment items. These calculations are shown in Table 52 below.

Table 52 – Summary of business count data for Earth-moving, Demolition and Construction (including landfill)

Industry Sector		*Employee Numbers*					
41	*General Construction*	*1-4*	*5-19*	*20-49*	*50-99*	*100-199*	*200+*
Number of operational businesses		20,607	6,204	1,221	357	180	135
Plant items per business		1	2	4	8	16	16
Estimated fleet of equipment		21,421	12,898	5,077	2,969	2,994	2,245
Total estimated fleet factor		**47,604**					

Other key data points and assumptions for the 'earth-moving, demolition and construction (including landfill)' fleet of plant includes:

- excavators, front-end loaders, dozers and graders with a range of battery weights from 25.6 kg to 32.1kg. An average of 27.9 kg has been used here, and 1 battery per plant item with an average life of 2 years
- compressors and gensets with a an average weight of 19.4 kg, 1 battery per plant item and an average life of 2 years
- bobcats with an average weight of 9.1 kg, 1 battery per plant item and an average life of 2 years (increased number of start-ups)

A summary of this data is presented in Table 53 below.

Table 53 – Summary of data on earth-moving, demolition and construction (including landfill) equipment

Category	*Average Life (yrs)*	*Average Weigh (kg)t*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Excavators	2	27.9	1	3.4%	47,604	60.6%
Front-end loaders	2	27.9	1	3.4%	47,604	60.6%
Dozers	2	27.9	1	3.4%	47,604	60.6%
Graders	2	27.9	1	3.4%	47,604	60.6%
Compressors and Gensets	2	19.4	1	3.4%	47,604	60.6%
Bobcats (small items)	2	9.1	1	3.4%	47,604	60.6%
Total					**285,624**	

[56] *ABS, 2008, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2006', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202006?OpenDocument, July 2010/. This data on business size and subdivision was used to identify all general construction businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.*

11.6.3.3 Farming and Agriculture

The fleet of equipment for the 'farming and agriculture' category includes:

- tractors
- harvesters
- trench diggers.

There are 63,597 'farming and agriculture' businesses that are nominated as 'employers' in ABS industry data.[57] Grouping these businesses according to employment size and adjusting for growth to June 2009, it is estimated that that there will be a fleet factor of 233,821 pieces of each of of the above equipment items. These calculations are shown in Table 54 below.

Table 54 – Summary of business count data for Farming and Agriculture

Industry Sector	*Employee Numbers*					
01 Agriculture	*1-4*	*5-19*	*20-49*	*50-99*	*100-199*	*200+*
Number of operational businesses	39,210	19,995	3,141	768	312	171
Plant items per business	1	4	16	32	64	64
Estimated fleet of equipment	40,759	83,140	52,242	25,547	20,757	11,376
Total estimated fleet factor	**233,821**					

Key data points and assumptions for the 'farming and agriculture' fleet of plant that uses lead acid batteries includes:

- tractors, harvesters, and trench diggers with an average weight the same as for the earth moving sector (27.9 kg), 1 battery per piece of equipment and an average life of 2 years.

A summary of this data is presented in Table 55 below.

Table 55 – Summary of data on farming and agriculture equipment

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Tractors	2	27.9	1	3.4%	233,821	60.6%
Harvesters	2	27.9	1	3.4%	233,821	60.6%
Trench Diggers	2	27.9	1	3.4%	233,821	60.6%
Total					**701,463**	

[57] *Ibid 2008. This data on business size and subdivision was used to identify all agriculture businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.*

11.6.3.4 Mining

The fleet of equipment for the 'farming and agriculture' category includes:

- dump trucks
- dozers and scrapers
- wheel loaders
- shovels
- ancillary equipment such as gensets, lighting etc.

There are 3,762 businesses listed as 'employers' across Coal Mining, Oil & Gas Extraction, Metal Ore Mining and Other Mining sectors in ABS industry data.[58] Grouping these businesses according to employment size and adjusting for growth to June 2009, it is estimated that that there will be a fleet factor of 9,674 for each piece of the above equipment items. The one exception is ancillary equipment, including lighting, generation sets and other small pieces of plant and equipment. It is estimated that four times as much of this equipment is used when compared to other larger plant. These calculations are shown in Table 56 below.

Table 56 – Summary of business count data for Mining

Industry Sector	*Employee Numbers*					
Mining	*1-4*	*5-19*	*20-49*	*50-99*	*100-199*	*200+*
11 Coal Mining	114	87	33	18	12	9
12 Oil & Gas Extraction	252	75	36	15	6	6
13 Metal Ore Mining	510	177	105	42	15	24
14 Other Mining	1446	387	273	87	24	9
Number of operational businesses	2322	726	447	162	57	48
Plant items per business	1	2	4	8	16	32
Estimated fleet of equipment	2,414	1,509	1,859	1,347	948	1,597
Total estimated fleet factor	**9,674**					

Other key data points and assumptions for the mining fleet of plant that uses lead acid batteries includes:

- dump trucks, dozers, wheel loaders, and shovels using the largest sized battery of 53.9 kg, an average of 4 per vehicle and a life of 2 years
- ancillary equipment with an average weight of 19.4 kg, a life span of 3 years and 1 battery used per piece of equipment

[58] *ABS, 2008, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2006', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202006?OpenDocument, July 2010/. This data on business size and subdivision was used to identify all mining businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.*

A summary of this data is presented in Table 57 below.

Table 57 – Summary of data on mining equipment

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Dump Trucks	2	53.9	4	3.4%	9,674	60.6%
Dozers and scrapers	2	53.9	4	3.4%	9,674	60.6%
Wheel Loaders	2	53.9	4	3.4%	9,674	60.6%
Shovels	2	53.9	4	3.4%	9,674	60.6%
Ancillary equipment (eg gensets, lighting etc.)	3	19.4	1	3.4%	38,696	36.0%
Total					**77,392**	

11.6.3.5 Forestry

The fleet of equipment for the 'forestry' category includes:

- feller bunchers
- chippers

There are 3,762 businesses listed as 'employers' in the Forestry and Logging sector in ABS industry data.[59] Grouping these businesses according to employment size and adjusting for growth to June 2009, it is estimated that that there will be a fleet factor of 8,550 of each of the above equipment items. These calculations are shown in Table 58 below.

Table 58 – Summary of business count data for Forestry

Industry Sector			*Employee Numbers*			
01 Agriculture	*1-4*	*5-19*	*20-49*	*50-99*	*100-199*	*200+*
Number of operational businesses	738	480	138	39	21	12
Plant items per business	1	4	16	32	64	64
Estimated fleet of equipment	767	1,996	2,295	1,297	1,397	798
Total estimated fleet factor	**8,550**					

[59] *ABS, 2008, '8165.0 - Counts of Australian Businesses, including Entries and Exits, Jun 2003 to Jun 2006', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun%202003%20to%20Jun%202006?OpenDocument, July 2010/. This data on business size and subdivision was used to identify all forestry businesses that also were employers, and then a growth rate of 1.3 per cent was used to bring the estimate up to June 2009.*

Key data points and assumptions for the forestry fleet of plant that uses lead acid batteries includes:

– feller-bunchers and chippers with an average weight the same as for the earth moving sector (27.9 kg), 1 battery per piece of equipment and an average life of 2 years.

A summary of this data is presented in Table 59 below.

Table 59 – Summary of data on forestry plant

Category	*Average Life (yrs)*	*Average Weight (kg)*	*Batteries per Vehicle*	*Fleet Growth Rate*	*Fleet Size*	*Replacement Rate*
Feller-bunchers	2	27.9	1	3.4%	8,550	60.6%
Chippers	2	27.9	1	3.4%	8,550	60.6%
Total					**17,100**	

11.6.4 Large Stationary Standby

The type of batteries in the large stationary standby sector include:

– stand-by power

– photovoltaics

– wind power

– uninterruptible power supplies (large scale, that is, not commercial use sized).

This sector of ULAB battery arisings has the least information regarding potential fleet size and composition, and also has a large number and variety of importers and resellers. Note that it also includes battery packs that are made up of individual cells (for example, D size) in stand alone 'large' power supply units.

A report for the Department of Trade and Industry in the UK estimated that there would be approximately 26,700 tonnes of heavyweight and lightweight lead acid batteries arising from stationary standby power applications in 2005.[60] This amount was converted to a per capita amount and translated using the Australian population. This provides an estimated amount of 9,345 tonnes of arisings.[61] (Note that it was assumed to include all chemistry types and not just lead acid – although lead acid is the dominant chemistry type).

The estimate of arisings was rounded up to 10,000 tonnes to provide an estimate of replacement sales, with a long life and conservative replacement rate of 10 per cent. The replacement rate was then used to calculate the national 'fleet' size. This allowed the estimation of large stationary standby stocks in Australia. New sales were estimated at 5 per cent of the national fleet, which allowed the calculation of Large and Industrial battery inputs.

[60] *Environmental Resources Management, 2000, 'Analysis of the Environmental Impact and Financial Costs of a Possible New European Directive on Batteries', UK Department of Trade and Industry, accessed at http://www.berr.gov.uk/files/file30640.pdf, August 2010.*

[61] *UK population of 61.8 million sourced from ONS, 2010, 'UK population grows to 61.8 million', UK Office of National Statistics, accessed at http://www.statistics.gov.uk/cci/nugget.asp?id=6, September 2010. Australian population of 21.7 million sourced from ABS, 2009, 'Australian Demographic Statistics', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Dec%202009?OpenDocument, August 2010.*

11.6.5 Large and Industrial Chemistry

The chemistry for Large and Industrial batteries in marine and forestry, farming, construction and mining categories was estimated to be all lead based, given the SLI application in a spark ignition engine. After a review of ABS customised information and industry input,[62] the remaining applications of traction and motive power, and large stationary standby power were broken down accordingly:

- lead based: 90%
- nickel cadmium: 6%
- lithium based: 3%
- nickel metal hydride: 1%.

[62] *Specifically Information on the following Harmonised Tariff Item Statistical Classification – Code 8507200081: Lead-acid type electric accumulators (excl those of a kind used for starting piston engines, those used for traction purposes, and regulated seal valve types with capacity > 65 amps/hr at C20)*

11.7 Appendix 7 - Battery Regulations and Guidelines

11.7.1 National battery regulations and guidelines

Certain types of batteries are classified as a hazardous waste that require special handling, treatment, disposal and recycling under the Hazardous Waste (Regulation of Exports and Imports) Act 1989. The object of this Act is to regulate the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner so that human beings and the environment, both within and outside Australia, are protected from the harmful effects of the waste.[63]

A hazardous waste is classified in the Act as wastes that belong to any category of wastes containing materials listed in Annex I to the Basel Convention. For example Y23 Zinc Compounds: Y26 Cadmium compounds, and Y31 Lead compounds. Wastes can also be classified as hazardous if they exhibit Annex III hazardous characteristics such as flammable, explosive, poisonous, infectious, corrosive, toxic, and ecotoxic. Waste material types that are listed in Annex VIII List A and that are relevant to battery consumption and recycling include:

- A1160 - waste lead acid batteries, whole or crushed
- A1170 - unsorted waste batteries excluding mixtures of only list B batteries. Waste batteries not specified on list B containing Annex I constituents to an extent to render them hazardous
- A1180 - waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (for example, cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B1110).

The Annex VIII List B exclusions include:

- waste electrical and electronic assemblies or scrap containing components such as batteries
- B1090 waste batteries conforming to a specification, excluding those made with lead, cadmium or mercury
- B1110 electrical and electronic assemblies:
  - electronic assemblies consisting only of metals or alloys
  - waste electrical and electronic assemblies or scrap (including printed circuit boards) not containing components such as accumulators and other batteries included on list A,

[63] *Australian Commonwealth Government, 2009, Hazardous Waste (Regulation of Exports and Imports) Act 1989, accessed at http://www.environment.gov.au/settlements/chemicals/hazardous-waste/guide.html, June 2010*

- mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or not contaminated with Annex I constituents (for example, cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the characteristics contained in Annex III (note the related entry on list A A1180)
- electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct re-use, and not for recycling or final disposal.

The Act encourages environmental sound management of hazardous waste. This is described as taking all practicable steps to ensure that the waste is managed in a manner that will protect human health, and the environment, against the adverse effects that may result from the waste. Any breaches or offences against the Act are punishable in accordance with the Criminal Code.

Exporting used lead acid batteries (ULABs) for treatment and recycling is permitted by the Federal Government to avoid unsafe disposal such as landfilling or incineration. This is only permissible after the application and approval of an export licence from the Federal Department of Sustainability, Environment, Water, Population and Communities. (Note that it is doubtful whether a permit would be granted while there is more reprocessing capacity in Australia than there is ULAB arisings).

No federally operated or assisted programs with implications for battery resource recovery were identified and no direct funding provided to State Governments or organisations to operate battery recycling programs. However, there is a national waste policy. The 'National Waste Policy: Less Waste, More Resources' refers to the establishment of a shared responsibility to reducing the environmental footprint of products and materials.[64] While there are no plans in the public domain to include batteries in a NEPM or the development of specific battery recycling programs or strategies, the National Waste Policy could facilitate the development of a 'shared responsibility' approach to battery stewardship.

11.7.2 New South Wales battery regulations and guidelines

The NSW Department of Environment and Climate Change and Water (DECCW) classify lead acid and nickel cadmium batteries as hazardous waste.[65] The NSW Waste Avoidance and Resource Recovery Strategy 2007 reports that batteries have been identified by the NSW Extended Producer Responsibility (EPR) Priority Statement for 2005/06 as a 'waste of concern'.[66] The commencement of dialogue around EPR was due to NSW community expectations that industry increase efforts to improve design, cut down on manufacturing waste and actively drive initiatives to increase recycling end-of-life products. These actions must be economically viable, simple for the community to use,

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[64] *Department of Environment, Water, Heritage and the Arts, 2009, 'National Waste Policy: Less Waste, More Resources', Environment Protection and Heritage Council, Adelaide, accessed at http://www.ephc.gov.au/sites/default/files/WasteMgt_Rpt__National_Waste_Policy_Framework_Less_waste_more_resources_PRINT_ver_200911.pdf, September 2010.*

[65] *DECCW, 2008, 'Waste Classification Guidelines, Part 1: Classifying Waste', Department of Environment, Climate Change and Water, Sydney, accessed at http://www.environment.nsw.gov.au/resources/waste/08202classifyingwaste.pdf, June 2010*

[66] *DECCW, 2007, 'NSW Waste Avoidance and Resource Recovery Strategy 2007', Department of Environment, Climate Change and Water, Sydney, accessed at http://www.environment.nsw.gov.au/resources/warr/07226_WARRreport07.pdf, June 2010*

and deliver positive environmental results. No EPR legislation or regulation that includes batteries has been implemented in NSW.

The DECCW introduced the statewide 'Household Chemical CleanOut' strategy in 2003.[67] This is a free service run in partnership with local governments that gives residents the opportunity to dispose of chemicals that are not safe to landfill and are commonly found in the house. Household hazardous wastes that are collected include batteries, paint and paint related products, pesticides, herbicides, poisons, motor oils, fuels and fluids, gas bottles and fire extinguishers. This service aims to remove chemicals from households that could threaten human or environmental health if disposed incorrectly. 418,354 kg of batteries have been collected under the scheme since 2003, with 76,925 kg collected in 2006/07. Of this, 75,057 kg were lead acid batteries, 258 kg nickel cadmium, 156 kg nickel hydride, and 1,455 kg other types of batteries. The NSW Environmental Trust funds this scheme. It is not known whether any of these materials are recycled.

11.7.3 Queensland battery regulations and guidelines

Lead acid batteries are classified as 'regulated waste' in Queensland. Waste is classified as either general waste or regulated waste. The Environmental Protection Regulation 2008 defines regulated waste as:

- commercial or industrial waste, whether or not it has been immobilised or treated, and
- is of a type, or contains a constituent of a type, mentioned in Schedule 7.[68]

Schedule 7 contains 72 wastes that are deemed regulated and in need of special treatment, storage, transport and recycling (if applicable). For example, tyres, vegetable oils, fly ash and asbestos are included in Schedule 7. Regulated waste requires special treatment, storage, transport and recycling (where facilities can do this safely). In the case of batteries, the Environmental Protection Regulation 2008 states that battery recycling is a form of waste management and requires an operating licence for recycling and reprocessing of any batteries.

No regulations or legislation exist that stipulates treatment and/or recycling for batteries. Operating a facility for receiving and commercially recycling or reprocessing any kind of battery would require an Environmental Impact Assessment in order to be licensed by the Queensland Department of Environment.[69]

The 'State of Waste and Recycling in Queensland 2007' states that batteries were not counted at landfills and hence not included in the report.[70] The Greens Party has led calls to introduce a battery recycling scheme similar to that operating in the European Union.[71]

The Queensland Department of Environment and Resource Management (DERM) has also recently released its 'Waste Strategy 2010–2020 Waste Avoidance and Recycling Consultation

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[67] Department of Environment and Climate Change, 'Household Chemical Cleanout', 2009, accessed at http://www.environment.nsw.gov.au/households/cleanoutguide.htm/, June 2010

[68] *Queensland Department of Environment, 2009, 'Environmental Protection Regulation 2008', DE, Brisbane, accessed at http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/EnvProtR08.pdf. June 2010*

[69] *Queensland Department of Environment, 2009, 'Environmental Protection Regulation 2008', DE, Brisbane, accessed at http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/EnvProtR08.pdf. June 2010*

[70] *Queensland EPA, 2008, 'The State of Waste and Recycling in Queensland 2007; Technical Report', Queensland EPA, Brisbane, accessed at http://www.epa.qld.gov.au/publications/p02638aa.pdf/The_state_of_waste_and_recycling_in_Queensland_2007.pdf, June 2010*

[71] *Andrew Wight, 2008, Greens take lead on battery recycling campaign', Brisbane Times, Brisbane, accessed at http://www.brisbanetimes.com.au/news/queensland/greens-take-lead-on-battery-recycling-campaign/2008/12/28/1230399035705.html, June 2010*

Draft'.[72] The aims are to introduce a new strategy, new legislation and an industry waste levy. Batteries are identified as potential priority products.

11.7.4 Victoria battery regulations and guidelines

Sustainability Victoria has developed a 'Towards Zero Waste' (TZW) strategy that works in cooperation with other State government strategies, including 'Melbourne 2030' and the 'Victorian Greenhouse Strategy', to help achieve environmental sustainability goals. TZW identifies batteries as a priority material and product (in both commercial and industrial, and municipal waste streams).[73] Other products included as a priority waste in Victoria includes tyres, treated timber and E-waste (waste derived from electronic equipment and peripheral devices).

Sustainability Victoria advocates a range of initiatives to encourage battery recycling and more appropriate end-of-life solutions. The first of these is to facilitate the establishment of product stewardship arrangements supported by appropriate tools such as regulatory underpinning legislation or sustainability covenants for batteries. The second is to provide appropriate infrastructure at landfills and resource recovery facilities to enable safe car battery recycling. Providing facilities to population centres with more than 5,000 persons has been identified as a priority infrastructure project. These facilities will also enable other recyclable products such as metals, timbers, oils and paints to be delivered on site for transport and treatment. Sustainability Victoria will also encourage takeback programs for products such as batteries. The strengthening and development of markets for recycled products is critical to achieving target recovery rates.

'BatteryBack' was established as a pilot battery takeback program in Victoria. It was initially trialled in a small geographic area for an extended period of approximately 18 months and was extended for a further 12 months from July 2010. The program encourages consumers to deliver used batteries of any form to nominated retail stores including supermarkets, major electrical retailers and specialty camera stores. The batteries are then collected and transported to specialist battery recycling facilities for sorting and reprocessing.

Sustainability Victoria also operates a scheme called 'Detox-Your-Home' in partnership with local governments of Victoria. This is a free service that allows residents to deliver used, unwanted and potentially hazardous substances such as batteries, oils and paints to either permanent facilities in their area or to a mobile service location during specified times. These substances and products are transported to specialist waste treatment facilities for disposal. (It is not known if any resource recovery occurs).

11.7.5 South Australia battery regulations and guidelines

Batteries are classified as hazardous waste under the Environment Protection Agency's 'Hazardous Waste Strategy, 2006-10'. Hazardous wastes include waste streams or wastes having as constituents including lead, mercury, cadmium, zinc. Batteries contain one or more of these

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[72] *DERM, 2010, 'Waste Strategy 2010–2020 Waste Avoidance and Recycling Consultation Draft', Department of Environment and Resource Management, Brisbane, accessed at http://www.derm.qld.gov.au/environmental_management/waste/strategy/pdf/waste-consultation-draft.pdf, September 2010.*

[73] *Sustainability Victoria, 2005, 'Towards Zero Waste Strategy', State Government of Victoria, Melbourne, accessed at http://www.dse.vic.gov.au/CA256F310024B628/0/BE725B844A060DA6CA2574D30082EBD9/$File/TowardsZeroWasteStrategy.pdf, June 2010*

chemicals. Also, wastes that are explosive, flammable, toxic, ecotoxic, or have potential to have a significant adverse impact on ambient water quality are classified as hazardous.[74]

The 'Hazardous Waste Strategy 2006-10' recommends action in reducing battery waste and improving treatment and recycling options in South Australia. The Strategy states that the South Australian government should encourage local governments to separate oils, paints and batteries from regular waste. The Strategy also declares that the establishment of a nickel cadmium treatment and recycling facility is unlikely to eventuate in Australia due to the large number of batteries needed to ensure commercial viability. Australia does not produce enough end-of-life nickel cadmium batteries to warrant such commercial facilities. The Strategy acknowledges the risk of landfilling these forms of batteries. However, it recommends that through Commonwealth, State and Local government partnership a collection and disposal program to export used nickel cadmium batteries to an OECD country for safe recycling be developed. Also recommended is the development of product stewardship and extended producer responsibility (EPR) initiatives with industry, underpinned, if necessary, by a legislative safety net.

South Australia's 'Waste Strategy 2010-2015 (consultation draft)' sets priorities for action including the establishment of extended producer responsibilities schemes by 2015 for 'e-waste, TVs, tyres and the like. This is a continuation of the 'Zero Waste South Australia, 2005-10' waste strategy developed and implemented by State and Local government agencies, waste management industry, business and the community to ensure a healthy environment for South Australia.

In South Australia a recent decision was made to ban lead acid batteries from landfill starting 1 September 2010. This action was taken as part of landfill reforms under the Environment Protection (Waste to Resources) Policy 2010.[75]

The EPA and Zero Waste South Australia provide a collection service for hazardous household wastes and chemicals in Ceduna, northwest of Adelaide.[76] The collection depot accepts around 50 tonnes of used products and hazardous materials annually, comprising oils, paints and used lead-acid batteries (ULABs). These are treated locally or sent interstate to appropriate treatment and disposal facilities.

11.7.6 Tasmania battery regulations and guidelines

Tasmania has no specific regulation or legislation relating to battery treatment, transport, recycling or reprocessing. Batteries are classified as a controlled waste in the category of inorganic waste. Controlled wastes in Tasmania are those wastes that are hazardous or potentially hazardous. The 'Environmental Management and Pollution Control Act (1994)' lists the types of waste that are deemed as controlled.[77] This list is derived from the 'National Environmental Protection Measure (Movement of Controlled Waste between States and Territories)'.[78] Controlled wastes include

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[74] SA EPA, 2008, 'Hazardous Waste Strategy 2006-10', SA EPA, Adelaide, accessed at http://www.epa.sa.gov.au/pdfs/hws.pdf, June 2010

[75] SA EPA, 2010, 'Environment Protection (Waste to Resources) Policy 2010., Government of South Australia, Adelaide, accessed at http://www.legislation.sa.gov.au/LZ/C/POL/ENVIRONMENT%20PROTECTION%20(WASTE%20TO%20RESOURCES)%20POLICY%202010/CURRENT/2010.-.UN.PDF, September 2010.

[76] Ceduna – South Australia, 2007, 'Hazardous Waste Collection', accessed at http://www.ceduna.net/site/page.cfm?u=394, June 2010

[77] State Government of Tasmania, 1994, 'Environmental Management and Pollution Control Waste Management) Regulations 2000, State Government of Tasmania, Hobart, accessed at http://www.thelaw.tas.gov.au/index.w3p, June 2010

[78] Australian Government, 2007, 'National Environment Protection (Movement of Controlled Waste between States and Territories) Measure' Canberra, accessed at http://www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrument1.nsf/0/A0BCCC6C6CC24E54CA2572FE0001A082/$file/FinalCWNEPM26June1998.pd, June 2010.f

waste streams or wastes having as constituents including lead, mercury, cadmium, zinc. Many batteries contain one or more of these chemicals. Also, wastes that are explosive, flammable, toxic, ecotoxic, or have potential to have a significant adverse impact on ambient water quality are considered controlled waste.

The Department of Environment, Parks, Heritage and the Arts has released a 'Draft Controlled Waste Strategy Report' that briefly discusses the current use, disposal and recycling patterns for batteries Tasmania.[79] The Report states the importance of waste transfer stations (WTSs) in sorting waste and recovering controlled wastes such as vehicle batteries. At present, only a small number of WTSs are capable of achieving this objective. It is recommended that an increased number of WTSs be established.

A household hazardous waste scheme is currently being developed. Like those operating elsewhere in Australia, this will aim to divert potentially toxic products such as paint, motor oil and vehicle batteries away from landfill.

The 'Draft Controlled Waste Strategy Report' states that zinc batteries are primarily sent to landfill, while a small number of nickel cadmium batteries are collected and sent interstate for treatment and recycling. A larger number of ULABs are also collected and sent to Victoria for recycling and reprocessing. For nickel cadmium and ULABs, the Report suggests a continuation of the current system of collection and interstate processing as a result of the small number of batteries collected and the difficulty in establishing a suitable commercially viable facility in Tasmania.

The 'Tasmanian Waste and Resource Management Strategy' does not specifically mention batteries. However, the Tasmanian Government does commit to 'participate in and support the development of Extended Producer Responsibility and Product Stewardship programs.'[80] This presents a possible framework for batteries.

11.7.7 Australian Capital Territory battery regulations and guidelines

Waste management is administered under the 'Environment Protection Act 1997.'[81] Non-liquid hazardous waste in the Australian Capital Territory are any waste that meets the criteria for assessment as dangerous good under the 'Australian Code for the Transport of Dangerous Goods by Road and Rail'. ACT's 'Environmental Standards: Assessment & Classification of Liquid and Non-liquid Wastes' categorise these materials as one of the following substances:

- explosive
- flammable
- toxic substances.[82]

The Australian Capital Territory Department of Environment, Climate Change, Energy and Water in partnership with Territory and Municipal Services (TAMS) have developed the 'No Waste by 2010'

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[79] *Sustainable Infrastructure Australia, 2008, 'Draft Report; Current and Future Controlled Waste Practices in Australia', Tasmania State Government, Hobart, accessed at http://www.environment.tas.gov.au/index.aspx?base=2545, June 2010*

[80] *DPIWE, 2009, 'Tasmanian Waste and Resource Management Strategy', Department of Primary Industries, Parks, Water and Environment, Hobart, accessed at http://www.environment.tas.gov.au/file.aspx?id=5857, September 2010.*

[81] *Australian Government , 2010, 'Environment Projection Act 1997, Canberra, accessed at http://www.legislation.act.gov.au/a/1997-92/current/pdf/1997-92.pdf, June 2010.*

[82] *ACT Environment, 1999, 'ACT's Environmental Standards: Assessment & Classification of Liquid and Non-liquid Wastes', ACT Environment, Canberra, accessed at http://www.environment.act.gov.au/environment/environment_for_business_and_industry/wastemanagementandhazardousmaterials, June 2010*

strategy. This strategy aims to help the Australian Capital Territory to 'become a waste free society'.[83] This document includes no specific references to batteries, but a ban on the disposal of computers to landfill has been in place since 2005.

11.7.8 Northern Territory battery regulations and guidelines

Batteries are classified as a listed (hazardous) waste in the Northern Territory under the Waste Management and Pollution Control (Administration) Regulations.[84] Similarly to other States and Territories in Australia, Northern Territory has used the schedule of waste from the National Environmental Protection Measure (Movement of Controlled Waste between State and Territories) as that for its own Regulations. Batteries are hazardous wastes in Northern Territory as they contain mercury, lead and acid compounds.

The Northern Territory Government has produced a fact sheet on ULAB disposal procedures.[85] It states that landfilling or incinerating ULABs is prohibited due to their status as a listed waste. Alternatively, ULABs should be delivered to a LAB retailer or wholesaler, battery manufacturer, or a recognised Environmental Heritage and the Arts Division or Department of Natural Resources, Environment and the Arts collection or recycling facility. Solid waste disposal facilities are obligated to provide provisions for ULAB separation as a precursor to recycling.

11.7.9 Western Australia battery regulations and guidelines

Batteries are classified as controlled (hazardous) waste in Western Australia.[86] Similar to other states and territories in Australia, Western Australia has used the schedule of waste from the National Environmental Protection Measure (Movement of Controlled Waste between State and Territories). Batteries are hazardous wastes in Western Australia as they contain mercury, lead and acid compounds.

Hazardous waste in Western Australia is defined as a 'component of the waste stream which by its characteristics poses a threat or risk to public health, safety or the environment (includes substances which are toxic, infectious, mutagenic, carcinogenic, teratogenic, explosive, flammable, corrosive, oxidising and radioactive).'[87] Household hazardous waste covers all unwanted hazardous substances and dangerous goods generated by households.[88] Other hazardous household wastes include bleach, flares, paint and gas cylinders.

Batteries are identified under Western Australia's 'Draft II Waste Strategy for Western Australia' as a household hazardous waste. No comprehensive management strategy for the disposal or recovery of household hazardous waste currently operates in Western Australia.[89] However,

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[83] *ACT Government, 1996, 'N Waste by 2010', ACT Government, Canberra, accessed at http://www.tams.act.gov.au/__data/assets/pdf_file/0013/12460/nowasteby2010strategy.pdf, June 2010*

[84] *NT Government, 2004, 'Waste Management and Pollution Control (Administration) Regulations', NT Government, Darwin, accessed at http://notes.nt.gov.au/dcm/legislat/legislat.nsf/d989974724db65b1482561cf0017cbd2/83bb2203b8e2e53269256f40001ceb87/$FILE/Repw015R3.pdf, June 2010*

[85] *NT Department of Natural Resources, Environment and the Arts, '2008, 'Fact Sheet; Disposal of lead-acid batteries', NT DNREA, Darwin, accessed at http://www.nt.gov.au/nreta/environment/waste/factsheets/pdf/disposalbatteriesoct08.pdf, June 2010*

[86] *WA Government, 2004, 'Environmental Protection (Controlled Waste) Regulations 2004', WA Government, Perth, accessed at http://www.austlii.edu.au/au/legis/wa/consol_reg/epwr2004575.txt/cgi-bin/download.cgi/download/au/legis/wa/consol_reg/epwr2004575.txt, June 2010*

[87] *Wastenet, 2005, 'State Definitions', accessed at http://www.wastenet.net.au/information/streams/legal, June 2010*

[88] *Western Australia Waste Management Board, 2006, 'Collection and Storage Facilities for Household Chemical Waste at Landfills and Solid Waste Depots, accessed at http://www.zerowastewa.com.au/documents/hcw_storage_design_draft.pdf, June 2010*

[89] *WAWA, 2010, 'Draft II Waste Strategy for Western Australia', West Australian Waste Authority, Perth, accessed at http://www.zerowastewa.com.au/documents/waste_strategy_draft2_mar2010.pdf, September 2010.*

environmental and human threats from battery being disposed of in landfill or incinerated have been recognised and individual collection schemes have been introduced. For example, the Regional Councils operate a Dry Cell Battery Collection Program which involves collection points for dry cell batteries at primary schools, council libraries, council administration offices, transfer stations, landfill facilities and shopping centres within the Region.

Rechargeable batteries have been described as a 'problematic product' in the waste stream of Western Australia.[90] To effectively manage rechargeable batteries in the waste stream, appropriate investment in resource recovery infrastructure has been recommended, as well as the introduction of a product price surcharge to support end-of-life recovery and recycling options.

11.7.10 Summary of National, State and Territory battery regulations and guidelines

Table 7 in Section 3.5 provides a summary of the status of batteries as a hazardous waste, the Act or regulation related to batteries, the name of existing waste strategy in each state or territory and whether batteries are included, and the name of any state or territory operated or assisted battery recycling programs.

[90] *WA DE, WA Waste Management Board, 2003, 'Strategic Direction for Waste management in Western Australia', WA Government, Perth, accessed at http://portal.environment.wa.gov.au/pls/portal/docs/PAGE/DOE_ADMIN/POLICY_REPOSITORY/TAB1144266/1862_STRATEGIC_WASTE_0308.PDF, June 2010*

11.8 Appendix 8 – Imports of Batteries by Country of Origin

According to the Australian Bureau of Statistics, Australia imported over 300 million batteries during the financial year 2009/2010. There were nearly 50 countries that exported batteries to Australia. However the top twelve countries account for 98 per cent of all imports. These top twelve countries of origin are presented in Figure 18 below.

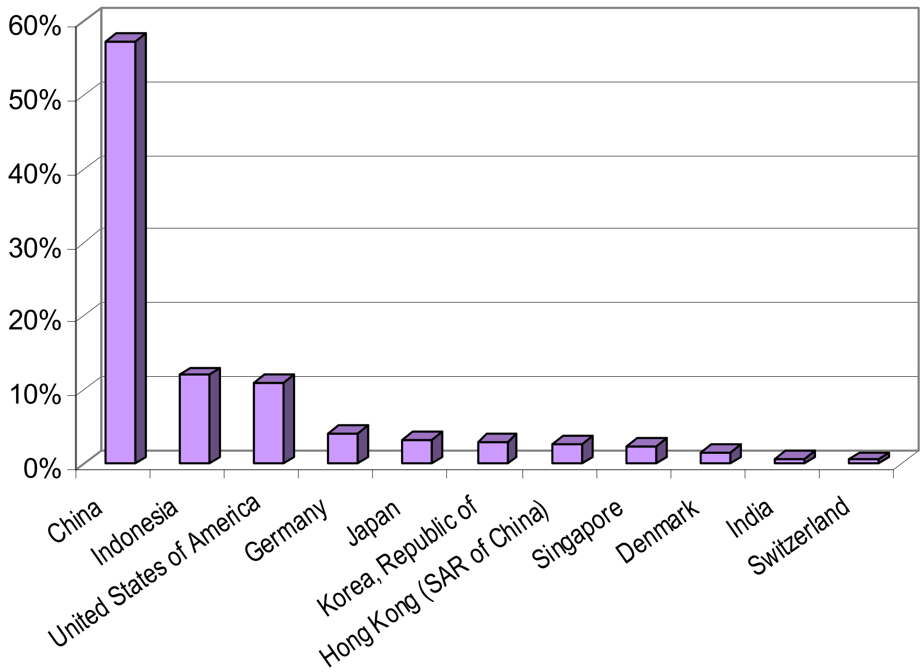

Figure 18 – Battery imports by country of origin [91]

China dominates as the major source of battery imports into Australia accounting for 57 per cent of all imports. Indonesia and the US account for 12 and 11 per cent of the total imports respectively. Nine other countries share 18 per cent between them, with an additional 36 countries accounting for the remaining 2 per cent of imports.

[91] *Derived from ABS 2010, 'Customised Report: Imports of Batteries Financial Year 2009-10', Australian Bureau of Statistics, Canberra.*

11.9 Appendix 9 – Analysis on a State-by-State Breakdown

A break down of battery inputs, stocks and arisings for Handheld, Automotive SLI and Large and Industrial batteries is presented in the tables below on a state by state basis. The breakdown has been undertaken on the basis that there is no differentiation between proportional allocation across inputs, stocks and arisings. For example if Handheld stocks in a given state were estimated to be 35 per cent of the national total, then the same proportion would also apply to inputs and arisings for that state. Note also that totals may not add because of rounding of proportions.

Table 60 below presents the population data used in this analysis.

Table 60 – Australian population on a state by state breakdown[92]

State or Territory	*Population*
New South Wales	7,075,707
Victoria	5,381,828
Queensland	4,366,397
South Australia	1,612,625
Western Australia	2,211,608
Tasmania	500,935
Northern Territory	222,784
Australian Capital Territory	348,506
Australia	**21,722,820**

11.9.1 State by state analysis of Handheld batteries

The following assumptions have been made with regard to Handheld batteries:

– use of household counts on a state basis for the domestic 'bundle', laptops and cordless power tools and SLAB

– use of business count on a state basis for the commercial 'bundle', laptops and SLAB

– population count on a state basis for mobile phones and digital devices.

Table 61 below presents a state by state breakdown for Handheld battery inputs, stocks and arisings. Note that columns may not total due to rounding.

[92] *ABS, 2009, 'Australian Demographic Statistics', Australian Bureau of Statistics, Canberra, accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Dec%202009?OpenDocument, August 2010.*

Table 61 – Handheld battery inputs, stocks and arisings by State, count and weight (kilograms)

State or Territory	*Count*			*Weight*		
	Inputs	*Stocks*	*Arisings*	*Inputs*	*Stocks*	*Arisings*
New South Wales	113,690,000	153,220,000	87,030,000	5,315,000	8,640,000	3,920,000
Victoria	85,850,000	115,690,000	65,710,000	4,013,000	6,520,000	2,960,000
Queensland	68,740,000	92,640,000	52,620,000	3,214,000	5,220,000	2,370,000
South Australia	26,280,000	35,420,000	20,120,000	1,229,000	2,000,000	910,000
Western Australia	35,100,000	47,300,000	26,870,000	1,641,000	2,670,000	1,210,000
Tasmania	7,750,000	10,450,000	5,930,000	362,000	590,000	270,000
Northern Territory	2,760,000	3,720,000	2,110,000	129,000	210,000	100,000
Australian Capital Territory	5,080,000	6,850,000	3,890,000	238,000	390,000	180,000
Australia	**345,270,000**	**465,300,000**	**264,297,000**	**16,140,000**	**26,240,000**	**11,904,000**

11.9.2 State by state analysis of Automotive SLI batteries

The following assumptions have been made with regard to Automotive SLI batteries:

- use of national fleet data breakdown on a state by state basis
- imports allocated according to the national fleet breakdown on a state by state basis
- vehicles retired allocated according to the national fleet breakdown on a state by state basis

Table 62 below presents a state by state breakdown for Automotive SLI battery inputs, stocks and arisings.

Table 62 – Automotive SLI battery inputs, stocks and arisings by State, count and weight (kilograms))

State or Territory	*Count*			*Weight*		
	Inputs	*Stocks*	*Arisings*	*Inputs*	*Stocks*	*Arisings*
New South Wales	1,715,000	4,535,000	1,589,000	25,160,000	65,840,000	23,570,000
Victoria	1,496,000	3,956,000	1,386,000	21,950,000	57,430,000	20,560,000
Queensland	1,217,000	3,218,000	1,128,000	17,860,000	46,720,000	16,730,000
South Australia	450,000	1,190,000	417,000	6,600,000	17,280,000	6,190,000
Western Australia	673,000	1,780,000	624,000	9,880,000	25,840,000	9,250,000
Tasmania	148,000	392,000	137,000	2,180,000	5,690,000	2,040,000
Northern Territory	48,000	126,000	44,000	700,000	1,820,000	650,000
Australian Capital Territory	92,000	244,000	85,000	1,350,000	3,540,000	1,270,000
Australia	**5,840,800**	**15,440,000**	**5,410,000**	**85,670,000**	**224,170,000**	**80,260,000**

11.9.3 State by state analysis of Large and Industrial batteries

ABS business count data was used to provide a state by state breakdown for Large and Industrial battery inputs, stocks and arisings. This breakdown is provided in Table 63 below.

Table 63 – Large and Industrial battery inputs, stocks and arisings by State, count and weight (kilograms))

State or Territory	*Count*			*Weight*		
	Inputs	*Stocks*	*Arisings*	*Inputs*	*Stocks*	*Arisings*
New South Wales	590,000	2,242,000	497,000	17,450,000	67,010,000	14,440,000
Victoria	438,000	1,663,000	369,000	12,940,000	49,690,000	10,710,000
Queensland	351,000	1,335,000	296,000	10,390,000	39,910,000	8,600,000
South Australia	125,000	474,000	105,000	3,690,000	14,180,000	3,060,000
Western Australia	178,000	676,000	150,000	5,260,000	20,210,000	4,360,000
Tasmania	33,000	125,000	28,000	970,000	3,730,000	800,000
Northern Territory	12,000	46,000	10,000	350,000	1,360,000	290,000
Australian Capital Territory	21,000	80,000	18,000	630,000	2,400,000	520,000
Australia	**1,748,000**	**6,641,000**	**1,473,000**	**51,680,000**	**198,500,000**	**42,785,000**

11.10 Appendix 10 – Recycling Activities in Australia

A summary of the battery recycling activities in Australia is presented in the following sections.

11.10.1 Century Yuasa Recycle My Battery

Century Yuasa is an affiliate of the GS Yuasa Corporation, and is Australia's oldest battery manufacturer with a history spanning over 80 years. Battery applications include automotive, speciality and industrial uses. Century Yuasa is both a manufacturer and distributor of lead acid batteries and is committed to a philosophy of cradle to grave manufacturing.

Century Yuasa has established the 'recycle my battery' program on a 'shared approach' across the supply chain with trading partners. It features a website dedicated to the recycling of used lead acid batteries (ULAB), and is supported through the establishment of designated recycling centres. More information on the program is presented in Table 64 below.

Table 64 – Century Yuasa 'Recycle My Battery'

Organisation	Century Yuasa in combination with participating Century Yuasa retailers
Coverage	Australia wide
Program Description	Dedicated website www.recyclemybattery.com.au allows customers to search for a site to return their car battery by entering their address. Website directs user to www.batteryworld.com.au for information on how to recycle other battery types.
Stage	Operational
Types of Batteries	Used lead acid batteries (ULAB) (starting lighting and ignition)
Specific Exclusions	Non-ULAB
Reported quantity recovered and recycled each year	No volumes have been reported as yet, but 800 sites have been established as battery recycling centres across Australia
Destination of Batteries	Not stated
How Funded	Not stated, although the value of lead means that a 'free' drop off service would pay for itself through the commodity value of lead.
When it started	In March 2009 CenturyYuasa launched its 1300 recycling number (1300 650 702) in conjunction with the recyclemybattery.com.au website
End date (if applicable)	Ongoing
Contacts	www.recyclemybattery.com.au; 1300 650 702

11.10.2 Battery World

Battery World is a Queensland based national franchise business focused on the battery category. The retail stores deliver a product range of over 8,000 batteries for cars, 4WDs, trucks, boats, motorcycles, tractors, jet skis, and mobility scooters, in addition to batteries for digital equipment such as mp3 players, game consoles, mobile phones, digital and video cameras, and other application including power tools, hearing aids, and smoke alarms.

Battery World operates a recycling program with a free battery recycling service offered directly to consumers. More information on this program is provided in Table 65 below.

Table 65 – Battery World's Recycling Program

Organisation	Battery World
Coverage	Across all Battery World stores nationally
Program Description	Drop off service for customers
Stage	Operational
Types of Batteries	Dry Cell batteries
Specific Exclusions	Not stated
Reported quantity recovered and recycled each year	Not stated
Destination of Batteries	Not stated
How Funded	Promotional initiative of Battery Worlds for consumers
When it started	Not stated
End date (if applicable)	ongoing
Contacts	http://www.batteryworld.com.au/asp/index.asp?pgid=11219, 13 17 60

11.10.3 Exide Total Battery Management

Exide Technologies is a global supplier of lead-acid batteries for network power, motive power and automotive applications. In Australia, Exide manufactures products from their facility in Elizabeth (near Adelaide) South Australia.

With regard to environmental issues and recycling, Exide Technologies applies a business approach called Total Battery Management™ (TBM). The goal of TBM is to manage the life cycle of a battery, from manufacturing and distribution to the responsible collection and storage of spent batteries, and then the safe transportation and reprocessing of battery materials and use of those materials in the production of new batteries. More information on the program is presented in Table 66 below.

Table 66 – Exide Total Battery Management

Organisation	Exide Technologies Australia Pacific
Coverage	Australia wide
Program Description	A battery swap is offered to 'single-battery' customers where the spent battery is recovered through the van delivery network and is aggregated before transport to a ULAB reprocessor. For large volume customers a separate service is offered including the payment of a fee for sufficiently high volumes of ULAB
Stage	Operational
Types of Batteries	Lead acid batteries
Specific Exclusions	Non-lead acid batteries
Reported quantity recovered and recycled each year	Approximately 1.5 million batteries in Australia and New Zealand recovering approximately 7,500 tonnes of lead and 750 tonnes of plastic
Destination of Batteries	ULAB reprocessing facilities in Australia (and New Zealand for New Zealand arisings only)
How Funded	Service is free and is funded through the inherent value of the lead materials
When it started	Pre-1995
End date (if applicable)	Ongoing
Contacts	www.exide.com.au; 1800 800 811

11.10.4 CMA Ecocycle

CMA Ecocycle is a company that specialises in the recycling of mercury containing wastes such as fluorescent tubes, HID lamps and globes, amalgam fines, spent catalysts from power plants or refineries, mercury containing ores from mining industry and various wastes contaminated with mercury. Also processed are mercury bearing electrical devices and mercury button cell batteries. CMA Ecocycle also operates a silver recovery facility, looking at x-ray materials.

As part of their service provision, CMA Ecocycle operate collection service for ULABs and also a 'bucket' container collection service for handheld batteries that sorts and aggregates the batteries before delivering them to a reprocessor for recycling. More information on the program is presented in Table 67 below.

Table 67 – CMA EcoCycle Battery Recycling Program

Organisation	CMA Ecocycle
Coverage	Victoria and NSW (with plans to expand nationally)
Program Description	ULAB picked up on request. Handheld batteries collected in either a 5 litre or 11 litre bucket for sorting and aggregating prior to delivery to a reprocessor.
Stage	Operational
Types of Batteries	All handheld battery types are collected in the special purpose battery buckets. ULAB by arrangement
Specific Exclusions	None
Reported quantity recovered and recycled each year	2010 is the start-up year for the battery buckets, so no firm data as yet
Destination of Batteries	Local reprocessors
How Funded	For a fee – price given on request
When it started	2010
End date (if applicable)	Ongoing
Contacts	www.cmaecocycle.net, 03 9308 9415

11.10.5 SITA Battery Recycling

SITA Environmental Solutions (SITA) is a resource recovery, recycling and waste management company. SITA believes the future of waste management in a carbon constrained world will be based on much greater levels of resource recovery, recycling these materials, and in particular, reusing the valuable organic material for compost and energy production.

SITA operates advanced resource recovery facilities (also referred to as alternative waste technologies or AWTs) for the processing of municipal solid waste. Other services include liquid/grease trap waste and also medical waste collection and treatment. SITA has also established a collection service for handheld batteries. Summary details of the battery collection service are provided in Table 68 below.

Table 68 – SITA Battery Recycling - Recycle Batteries for the Environment

Organisation	SITA Environmental Solutions
Coverage	Australia wide
Program Description	Battery collection service through a dedicated box.
Stage	Operational
Types of Batteries	Single use batteries as found in torches, radios, watches, calculators, remote controls and smoke alarms, in addition to rechargeable batteries found in mobile and cordless phones, laptop computers, digital and video cameras, remote controlled toys, cordless power tools and electric shavers
Specific Exclusions	Not stated
Reported quantity recovered and recycled each year	Not reported
Destination of Batteries	The full battery recycling box is couriered to specialist e-waste battery recycling facilities where batteries are sorted. Batteries are recycled within Australia and/or shipped (pursuant to Environment Australia permits) to approved overseas recycling centres.
How Funded	A service fee is charged to cover collection and recycling costs
When it started	Not stated
End date (if applicable)	Ongoing
Contacts	http://www.sita.com.au/our-services/collection-services/battery-recycling-.aspx; 13 13 35

11.10.6 Veolia RecyclePak

Veolia Environmental Services (Veloia), formerly known as Collex is a waste management and resource recovery company that also provides Industrial services such as Industrial Cleaning and Facilities Management. Key services include liquid and solid waste management; recycling and resource recovery; industrial services including facilities management; and municipal and council waste collections.

One of Veolia's specialty collection services is for fluorescent tubes, through a RecyclePak system designed for small quantity recycling arising in multiple locations. Recently Veolia has added a RecyclePak system designed for handheld batteries and mobile phones, with each 'bucket' able to hold up to 15kg of batteries and phones. More information is presented in Table 69 below.

Table 69 – Veolia RecyclePak

Organisation	Veolia Environmental Services
Coverage	Australia wide
Program Description	Battery collection service through a dedicated container.
Stage	Operational
Types of Batteries	Veolia accepts common dry cell batteries including: NiMH Batteries, NiCd Batteries, Alkaline Batteries, and Mobile Phones
Specific Exclusions	Lithium, wet cell and lead acid batteries
Reported quantity recovered and recycled each year	Not reported
Destination of Batteries	Not stated
How Funded	A service fee is charged to cover collection and recycling costs
When it started	Not stated
End date (if applicable)	Ongoing
Contacts	http://www.veoliaes.com.au/commercial-services/recyclepak/battery.asp; 1800 VEOLIA (836 542)

11.10.7 Transpacific Cleanaway's Battery Recycling Program

Transpacific Industries Group is an integrated environmental waste services and industrial solutions provider. Services range from waste management, recycling, waste-to-energy, industrial, manufacturing and heavy vehicle distribution services. Transpacific Cleanaway is a solid waste management operator providing waste collection and transportation solutions.

One of the services on offer is a battery recycling service for dry cell batteries. More details on this program are presented in Table 70 below. Transpacific Cleanaway also offers a range of other services related to battery recycling such as industrial battery recycling and bulk battery collections.

Table 70 – Transpacific Cleanaway's Battery Recycling Program

Organisation	Transpacific Cleanaway
Coverage	Australia wide
Program Description	Battery collection service through a dedicated container.
Stage	Operational
Types of Batteries	Primary batteries: described as rechargeable and commonly alkaline batteries with Zinc and Manganese chemistry; in addition to secondary batteries: described as rechargeable and are usually Nickel Cadmium, Nickel Metal Hydride or Lithium Ion chemistry.
Specific Exclusions	Not stated
Reported quantity recovered and recycled each year	Not stated
Destination of Batteries	Batteries are sorted by type and shipped to licensed recycling facilities where the metals are recovered.
How Funded	A service fee is charged. Pricing includes delivery, return postage of the full box and recycling of the batteries.
When it started	Not stated
End date (if applicable)	Ongoing
Contacts	http://www.transpacific.com.au/tpi/battery_recycling_program.php; haztechnswenquiries@transpac.com.au; 13 13 39

11.10.8 MRI

MRI is an Australian company with 20 years experience in computer recycling and ewaste solutions. As part of its service offering, MRI accepts all battery types at facilities located in Melbourne, Sydney and Brisbane.

All batteries received are sorted according to chemistry type. Nickel Cadmium (NiCd) batteries are processed on site, while other batteries are exported to Korea for reprocessing. MRI plans to commence the first stage of Li-ion battery recycling in 2012 and ramp up in line with collected numbers. A summary of the MRI battery recycling program is presented in Table 71 below.

Table 71 – MRI Battery Recycling

Organisation	MRI
Coverage	Australia wide
Program Description	Battery receival, sorting, aggregation, processing, storage and export
Stage	Operational
Types of Batteries	MRI accepts all types of batteries including: Lead Acid (Pb), Nickel Cadmium (NiCd), sealed and vented, Lithium Ion – Lithium Ion Polymer, Lithium Batteries, Alkaline Batteries, and Nickel Metal Hydride (Ni-MH)
Specific Exclusions	None – however customers need to keep separate lead acid batteries from other batteries and consider safe transport requirements
Reported quantity recovered and recycled each year	Handle between 800 and 1,000 tonnes of batteries per annum.
Destination of Batteries	Commenced in-house processing of vented NiCd batteries, other battery types that cannot be recycled locally are exported under permit to partner in Korea. Looking to install processing capacity for Lithium ion batteries, plan to commence first stage pre-processing in 2012.
How Funded	Fee for service, ranging from $3.85 per kg for alkaline batteries to $8.80 per kg for lithium batteries (volume discounts are available)
When it started	Commenced 1999
Contacts	http://www.mri.com.au/batteryrecycling.htm; 1300 4 EWASTE (39278)
Comments	Recycles Honda and Toyota hybrid batteries, listed receival partner for Battery World recycling program, partner for Mobile Muster program

11.10.9 AusBatt

Auszinc Metals & Alloys, operates from Port Kembla New South Wales and produces a range of primary and secondary zinc alloys used in the galvanizing industry, diecasting industry and for other special purposes, including zinc chemicals and fertilizers.

AusBatt, as AusZinc's battery recycling initiative, is committed to the recovery of zinc from alkaline batteries in an environmentally sustainable manner. Alkaline batteries contain approximately 20 per cent zinc by weight and AusZinc has developed a proven process (patent pending) that will allow recycling of alkaline batteries with recovery of all metals and other components of the used cells. Batteries that cannot be recycled by AusBatt will be aggregated and exported to existing overseas recycling facilities. A summary of the AusBatt recycling program is presented in Table 72 below.

Table 72 – AusBatt Battery Recycling

Organisation	AusZinc Metals and Alloys
Coverage	Australia wide (in combination with collection partners) – on a wholesale basis
Program Description	Battery receival, sorting, aggregation, processing, storage and export
Stage	Operational at a trial/campaign level, will ramp up processing in line with collection volumes
Types of Batteries	All dry cell batteries (single use and rechargeable), other handheld chemistry types, however do not accept direct from public, but from collection partners
Specific Exclusions	No specific exclusions, however focus is on dry cell batteries and handhelds (licensed to accept all battery chemistry types).
Reported quantity recovered and recycled each year	Currently less than 100 tonnes per year, but anticipating to ramp up to over 600 tonnes per year.
Destination of Batteries	Alkaline batteries are processed internally for zinc recovery and the recovery of other metal components. Other battery chemistry types (for example, NiCd, NiMH and Li-ion) are exported overseas for processing and resource recovery.
How Funded	A fee is charged to accept batteries, starting from $2.40/kg plus GST
When it started	Commenced operational trials 2007
End date (if applicable)	ongoing
Contacts	http://www.ausbatt.com.au/contact.html, +61 2 4275 8888

11.10.10 Orbitas

Orbitas is a provider of resource recovery solutions and management programs that meet the needs of business and the environment. Orbitas operates an Australia wide network of agents and service providers to deliver solutions for recycling and reprocessing of Used Lead Acid Batteries, Used Non-Lead Acid Batteries, Metal, and Oil and by-products. The focus is on collection, identification, packaging, documentation, material disposal certificates and transportation, all according to best practice and legislative guidelines.

With regard to batteries in particular, Orbitas offers collection services for ULAB (used lead acid batteries) and UNLAB (used non-lead acid batteries). A summary of these programs is presented in Table 73 below.

Table 73 – Orbitas Resource Recovery

Organisation	Orbitas
Coverage	Australia wide
Program Description	Collection service for bulk ULAB and non-ULAB batteries
Stage	Operational
Types of Batteries	Used Lead Acid Batteries and non-used lead acid batteries (single use and rechargeable)
Specific Exclusions	None
Reported quantity recovered and recycled each year	Over 20,000 tonnes of batteries are collected through the Orbitas network, with plans in place to increase this amount
Destination of Batteries	Collected ULAB are sent to reprocessing facilities in Australia. UNLAB are also sent to reprocessing facilities in Australia, or if unavailable, are stockpiled for export to an international reprocessor
How Funded	The lead value in bulk ULAB collections means that payment is made for suitable volumes. A fee is charged for UNLAB collections
When it started	2007
End date (if applicable)	Ongoing
Contacts	www.orbitas.com.au; support@orbitas.com.au; 1300 783 879

11.10.11 Australian Refined Alloys

Australian Refined Alloys Pty Ltd (ARA) is a used lead acid battery recycling joint venture owned 50 per cent by Nyrstar and 50 per cent by the Sims Group with Nyrstar as the operating partner. ARA operates two lead acid battery recycling facilities in Australia, located at Alexandria in Sydney and Laverton in Melbourne.

ULABs are smelted into alloy grade lead ingots which are sold to Australian and overseas battery producers. Plastic is also recovered from battery casings and sold to the plastics industry for recycling. The two ARA facilities have a combined processing capacity of 65,000 tonnes of ULAB. Further information on the ARA facility is presented in Table 74 below.

Table 74 – Australian Refined Alloys

Organisation	Australian Refined Alloys
Coverage	Operating in Sydney and Melbourne, and accepting ULAB from all over Australia
Program Description	Receives ULAB and processes into alloy grade lead ingots for battery producers
Stage	Operational
Types of Batteries	ULAB
Specific Exclusions	Non-ULAB
Reported quantity recovered and recycled each year	Capacity to process 65,000 tonnes of ULAB
Destination of Batteries	Lead ingot products and then for sale into lead acid battery manufacturing
How Funded	Value of the lead that is recovered
When it started	Not Stated
End date (if applicable)	Ongoing
Contacts	03 9314 2111 (Melbourne) and 02 9516 5099 (Sydney)

11.10.12 Hydromet

Hydromet is an Australian owned industrial residue treatment and recycling company. It operates a lead recycling plant at Unanderra (near Wollongong) New South Wales that processes ULAB into lead metal, lead paste, polypropylene and weak acid streams in order to recover lead metal and oxide as feed material for secondary lead smelters.

The Hydromet facility has a capacity of 36,000 tonnes of ULAB and Hydromet has submitted a development application to relevant authorities to build a secondary lead smelter at its established Newcastle operations. The new facility will convert lead recovered from ULABs at Unanderra to high grade lead metal and lead alloys. Further information on the Hydromet facility is presented in Table 71 below.

Table 75 – Hydromet	
Organisation	Hydromet
Coverage	Receives ULAB from all around Australia
Program Description	Processing of ULAB into metal (grids and posts) and lead paste, in addition to plastic and weak acid by-products
Stage	Current processing is operational – note plans to upgrade the operation to smelt on-site and produce refined lead products
Types of Batteries	ULAB
Specific Exclusions	non-ULAB
Reported quantity recovered and recycled each year	Approved to process 36,000 tonnes each year, with capacity to expand to 44,000 tonnes each year.
Destination of Batteries	Lead products are sold onto secondary lead smelters for refining into refined lead
How Funded	Value of the lead in ULAB
When it started	October 2006
End date (if applicable)	Ongoing
Contacts	www.hydromet.com.au, office@hydromet.com.au, phone 02 4271 1822

11.10.13 Renewed Metal Technologies

Renewed Metal Technologies (RMT) operate a new lead recovery and reprocessing facility that was commissioned in March 2010, and is located in Wagga Wagga, New South Wales – about half way between Sydney and Melbourne. The Wagga plant deconstructs ULAB into their component streams and then processes them to produce refined soft lead and lead alloy products, in addition to recovered plastic and sodium sulphate for sale into domestic and international markets.

The RMT facility has the capacity to process 42,000 tonnes of ULAB each year. Lead products are sold to battery manufacturers for the production of new lead acid batteries, lead sheeting, cabling and many other uses. Further information on the RMT facility is presented in Table 72 below.

Table 76 – Renewed Metal Technologies

Organisation	Renewed Metal Technologies
Coverage	Operating in Wagga Wagga NSW and receives ULAB from across Australia
Program Description	Receives ULAB and processes into soft lead and alloy grade lead ingots for the lead market
Stage	Operating at full scale
Types of Batteries	ULAB
Specific Exclusions	NON-ULAB
Reported quantity recovered and recycled each year	Capacity to process 42,000 tonnes of ULAB
Destination of Batteries	Lead ingot products (soft lead and alloys) for sale into lead market for new battery manufacture and other permissible uses
How Funded	Value of recovered materials
When it started	Commissioned March 2010
End date (if applicable)	Ongoing
Contacts	www.rmt.com.au, info@rmt.com.au, 02 6937 1900

11.10.14 Battery Back

Batteryback™ is an initiative of Sustainability Victoria, Australian Battery Recycling Initiative, Bunnings, Coles, Michaels Camera, Atomik Green and Officeworks. It is a free service for consumers to drop off used single-use and rechargeable batteries for recycling at participating retail stores in and around Melbourne.

The service is being trialled to gain data and to judge community response. The current second-stage trial operates until 30 June 2011. The trial and the knowledge gained is aimed at contributing to the design of a potential future industry-wide battery collection model.

Close the Loop, was engaged by Sustainability Victoria to collect the batteries from participating retail stores. (Close the Loop operates an expansive logistics network of active collection points for the recycling of toner and inkjet cartridges, toner bottles as well as other print consumables across Australia and is expanding it's collection and processing facilities in the US).

Batteryback™ accepts all domestic alkaline (single use) and rechargeable batteries including Nickel Cadmium (NiCd), Nickel Metal Hydride (NiMH) and Lithium Ion (Li-Ion). Collected batteries are sorted by chemistry type and then sent on to the respective recyclers in Australia and overseas. More details of the programme are presented in Table 73 below.

Table 77 – Batteryback by Sustainability Victoria

Organisation	Sustainability Victoria
Coverage	Metropolitan Melbourne
Program Description	Drop off collection program for household batteries run in conjunction with participating retail stores
Stage	Second pilot
Types of Batteries	Domestic alkaline (single use) and rechargeable batteries including Nickel Cadmium (NiCd), Nickel Metal Hydride (NiMH) and Lithium Ion (Li-Ion
Specific Exclusions	Industrial and automotive batteries
Repored quantity recovered and recycled each year	Over 1,000 kilograms of batteries have been collected since the start of the program
Destination of Batteries	Recyclers in Australia and overseas
How Funded	Supported by project partners: Sustainability Victoria and, Australian Battery Recycling Initiative with in-kind support from Bunnings, Coles, Michaels Camera, Atomik Green and Officeworks
When it started	July 2007
End date (if applicable)	June 2011
Contacts	http://www.resourcesmart.vic.gov.au/for_households_3797.html

Information collected over the trial period for October 2009 to February 2010 is presented in Table 74 below. This shows the dominance of alkaline batteries at 84 per cent of the total collection.

Table 78 – Batteries collected through Battery Back for October 2009 to February 2010

Type	*Chemistry*	*Weight (kg)*	*Percentage/Total*
Non-Rechargeable	Alkaline	373	84%
	Lithium Primary	6	1%
	Buttons	1	0%
Rechargeable	NiCd	18	4%
	NiMH	22	5%
	Li-ion	13	3%
	Lead-Acid	9	2%
Unknowns	Unknowns	0	0%
	Waste	0	0%
Total Weight		*443*	

11.10.15 Battery recycling program – Perth Metropolitan Regional Councils

The Eastern Metropolitan Regional Council (EMRC) established Western Australia's first school dry-cell battery collection program for household batteries. This program was subsequently expanded to public places such as libraries, Council administration offices and shopping centres.

The public place battery recycling program was then also adopted by all metropolitan regional councils including Mindarrie, Southern Metropolitan, Western Metropolitan and Rivers Regional Councils. The program now provides residents across Perth with the opportunity to recycle their household batteries. Further information on the program is provided in Table 79 below.

Table 79 – Battery recycling program – Perth Metropolitan Regional Councils

Organisation	Eastern Metropolitan, Mindarrie, Southern Metropolitan, Western Metropolitan and Rivers Regional Councils
Coverage	Perth Metro
Program Description	public place collection of dry cell household batteries
Stage	operational
Types of Batteries	AA and AAA cells (single use & rechargeable batteries) C and D sized batteries Button batteries (e.g. from watches) 9V batteries 6V batteries (e.g. lantern/torch batteries)
Specific Exclusions	Automotive lead acid batteries, sealed lead acid batteries and mobile phone batteries (these can be recycling through Mobile Muster).
Reported quantity recovered and recycled each year	More than 10 tonnes per annum
Destination of Batteries	Australian reprocessing facility, and then any batteries which cannot be recycled in Australia, exported to European and Asian battery recycling facilities
How Funded	Partly through local government waste education levy and partly through the state run Household Hazardous Waste program and also through the support of a Strategic Waste Initiative Scheme (SWIS) grant
When it started	2003 with East Metropolitan Regional Council and 2009 all other Perth metropolitan regional councils
End date (if applicable)	Ongoing
Contacts	http://www.emrc.org.au/battery-recycling-programs.html, http://www.wmrc.wa.gov.au/your-waste/battery-recycling-locations/, www.smrc.com.au,
Comments	Program summary sourced from Wells, T., 2010, 'Creating a Generation of Battery Recyclers', Waste & Recycle 2010 Conference: Our Generation: How does it measure up? 14–17 September 2010, The Esplanade Hotel Fremantle, Western Australia.

11.10.16 Planet Ark – RecyclingNearYou

Planet Ark's RecyclingNearYou website is a joint venture between Planet Ark and Sensis. Planet Ark is not-for-profit Environmental organisation that was founded in 1992 to educate people and business about the simple ways in which they can reduce their impact on the planet.

Planet Ark operates a number of popular campaigns, including Walk to Work Day; Aluminium Cans; Business Recycling; Carbon Reduction Label; 'Cartridges 4 Planet Ark'; Festive Recycling; National Recycling Week; National Tree Day; 'PaperCutz 4 Planet Ark'; and Plastic Bag Reduction, in addition to RecyclingNearYou. More information on RecyclingNearYou is presented in Table 76 below.

Table 80 – Planet Ark – RecyclingNearYou

Organisation	Planet Ark in combination with joint venture partner Sensis
Coverage	Australia wide
Program Description	A web based one stop shop for local recycling information. The website allows the user to search for recycling solutions for batteries based on their location.
Stage	Operational
Types of Batteries	Users can search for solutions for 'Batteries' and 'Car Batteries'
Specific Exclusions	n/a
Reported quantity recovered and recycled each year	Batteries (all types grouped together) is the second most searched for product on the website (note period was May 2008 to April 2009).
Destination of Batteries	n/a
How Funded	The service is free and is made available to the public through the support of program sponsors including Sensis; Aluminium Can Group; Cartridges 4 Planet Ark; CenturyYuasa; Kmart; Tetra Pak; Varta; Bingo Skip Bins; Pitney Bowes; and MobileMuster
When it started	November 2006
End date (if applicable)	Ongoing
Contacts	http://recyclingnearyou.com.au/, 1300 733 712