Battery Waste and Recycling

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Increased battery recycling in Australia will help to conserve non-renewable resources and reduce pollution from landfills.

Batteries provide a portable power source for many of the products that have become important to our way of life, from cars and boats through to laptop computers, mobile phones and hearing aids. Like all manufactured products, however, batteries have impacts on the environment at every stage of their life cycle. The metals used to manufacture batteries are non-renewable finite resources, and mining and processing of metal ores is energy-intensive.

Batteries also have environmental impacts at the end of their life. While most automotive batteries are recycled, the majority of smaller "dry cell" batteries consumed in Australia still go to landfill. In poorly managed landfills, batteries have the potential to leach toxic heavy metals such as lead, mercury and cadmium into the surrounding soil, surface and groundwater. The Australian Battery Recycling Initiative (ABRI) was established in 2008 to promote effective product stewardship for batteries to reduce these impacts.

The environmental impacts and recyclability of batteries are linked to their chemistry. The lead–acid battery, which is used for starting, lighting and ignition in cars and boats, recently turned 150 years old. Invented by French physician Gaston Planté in 1859, it was originally used to keep the lights on in railway cars stopped at stations and standby power for utilities. A lead–acid battery contains two plates of lead "mesh", each of which is encased in lead oxide paste. Both plates are submerged in a sulfuric acid solution and the battery is encased in plastic. New batteries are being developed to meet the needs of electric and hybrid electric vehicles.

The smaller portable batteries used in electrical and electronic products come in a wider range of shapes, sizes and chemistries. This makes them more complex and expensive to sort and reprocess (Table 1).

More than 90% of lead–acid batteries are recycled in Australia, although there is some uncertainty about the exact recycling rate. ABRI recently commissioned a comprehensive study of battery consumption, disposal and recycling in Australia, which will provide more accurate data than has previously been available. This study will be completed in late 2010.

Lead–acid batteries are collected from service stations, battery retailers and some council transfer stations. A national system of battery recycling centres has also been established by Century Yuasa Batteries (www.recyclemybattery.com.au). The companies that reprocess batteries in Australia – Hydromet, Australian Refined Alloys and Renewed Metal Technologies – recover the lead, sulfuric acid and plastic (polypropylene) casing, and sell these materials for use in a wide range of applications.

Collection facilities for the recovery and recycling of smaller consumer batteries are more limited, but a number of exciting new initiatives are under way. In Melbourne, for example, a pilot program called BatteryBack has been introduced by Sustainability Victoria with the support of ABRI and several retailers. Perth's five regional councils have worked

Table 1. Types of batteries

Users	Technology	Typical uses	Type	
Household and professional users	General purpose (alkaline manganese [AlMn] and zinc carbon [ZnC])	Clocks, portable audio and devices, torches, toys and cameras	Portable (<1 kg)	Non-rechargeable (primary)
	Lithium (Li)	Photographic equipment, remote controls and electronics		
	Button cells (zinc air, silver oxide, manganese oxide and lithium)	Watches, hearing aids, calculators		
	Nickel cadmium (NiCd)	Cordless phones, power tools and emergency lighting		Rechargeable (secondary)
	Nickel metal hydride (NiMH)	Cellular and cordless phones		
	Lithium ion (Li ion)	Cellular phones, laptops and palms		
	Lead acid	Hobby applications		
	Lead acid	Automotive/motorcycle starter lighting and ignition (SLI)	Large (>1 kg)	
Industrial	Lead acid standby	Alarm systems, emergency back-up systems (e.g. rail and telecommunications)		
	Lead acid traction	Motive power sources (e.g. forklift trucks)		
	Nickel cadmium (NiCd) standby	Motive and standby applications (e.g. satellite and rail)		
	Nickel cadmium (NiCd) motive power	Electric vehicles		
	Lithium ion (Li ion)	Electric vehicles, hybrid electric vehicles		
	Lithium polymer (Li–poly)	Hybrid electric vehicles		
	Nickel metal hydride (NiMH)	Hybrid electric vehicles		

Adapted from a report for the European Commission (2003): ***Impact Assessment on Selected Policy Options for Revision of the Battery Directive*****, p. 33.**

together to establish over 150 collection points for household batteries in libraries, community centres, council offices and schools. The initiative was based on the Eastern Metropolitan Regional Council's household battery collection and recycling model (see box, p.26). Battery World stores provide a free recycling service for their customers, and a number of other companies, including AusBatt, MRI, SITA Environmental Solutions and Veolia, can provide a collection and recycling service for a small fee (for contact details see www.batteryrecycling.org.au).

Rechargeable batteries collected in Australia through these programs are exported to companies overseas with the capacity to reprocess them, such as SNAM in France. Valuable metals such as cadmium, ferro-nickel alloys and ferro-cobalt alloys are recovered for use in a range of products, including new

batteries.

The alkaline battery is the most commonly used portable dry cell used in Australia, representing approximately 80% of the batteries consumed and about 6000 tonnes per annum disposed to landfill. These batteries contain steel, zinc and manganese. However, no recycling option has been available in Australia and the batteries have been considered a throw-away item.

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A new facility is now being commissioned to recycle general purpose (alkaline) batteries at AusZinc in Port Kembla, NSW. AusZinc has developed a proven process that will allow recycling of alkaline batteries and recovery of all metals and other components of the used cells. The steel will go to Bluescope Steel to make new products such as rainwater tanks, zinc for galvanized steel products such as light posts, and the manganese for making new batteries and steel alloys.

ABRI is a relatively new organisation, established to promote effective stewardship of all end-of-life batteries. It has a broad membership, encompassing battery manufacturers and retailers, recyclers, government agencies and environmental organisations. ABRI's goals of effective stewardship and diversion of batteries from landfill are consistent with the National Waste Policy (2009), which promotes "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".

For ABRI, the priority is to encourage the expansion of collection and reprocessing facilities for all batteries. This will have a number of important environmental benefits:

- recovery of non-renewable resources for other beneficial uses;
- reduction of the environmental impacts of mining and manufacturing virgin materials;
- reduction of the environmental impacts of landfill; and
- less contamination of recycling programs for organic materials.

The metals used to make batteries are a finite resource. A 2010 report by CSIRO entitled *Peak Minerals in Australia* noted that ore grades are in terminal decline for a range of metals including nickel and lead–zinc–silver ores. As the most accessible and higher grade ores are depleted, mining operations target deeper or lower-grade deposits. These tend to have higher social and environmental costs. For example, their extraction and processing requires more energy and generates more greenhouse gas emissions per tonne of metal.

Recycling has the ability to generate a substantial and growing resource, and will become more economically viable as virgin resources are depleted and become more expensive. It also has other environmental

Battery Recycling in Schools

Fifty-five primary schools participate in the battery recycling program run by the Eastern Metropolitan Regional Council (EMRC) in Perth. Students bring in spent batteries from home and place them in the battery recycle bin at school, and the EMRC collects them once the bins are full. When a sufficient quantity has been accumulated, the batteries are transported to AusZinc in NSW for sorting and processing.

The program is offered free of charge to schools located in the EMRC council areas of Bassendean, Bayswater, Belmont, Kalamunda, Mundaring and Swan. Schools are encouraged to run a recycling competition, with prizes awarded to the school that recycles the most by weight. In-house competition between classes is also often initiated in varying forms by the individual schools, making recycling fun for students.

Students, teachers and parents are keen to participate, particularly if their school is already involved in the Waste Wise program. Last year's first-place prize went to Greenmount Primary, which collected nearly 800 kg, and the runner-up was Woodlupine Primary with just over 300 kg. In 2009, over 8 tonnes of batteries were collected from schools and residents in the Eastern Metropolitan Region.

For more information visit www.rgang.org.au/rgang-page-School_Drycell_Battery_Collection_Program_799.asp or contact EMRC's Waste Education Officer, Lisa Griffin, on (08) 9424 2271.

benefits. Using recycled rather than virgin materials avoids the environmental impacts associated with mining, such as land degradation, waste and energy use. The manufacture of recycled materials requires less energy and generates less pollution than the manufacture of virgin materials. For example, a journal article by Carl Rydh and Magnus Karlstrom (*Conservation and Recycling*, 2002) concluded that 46% and 75% less energy is required to recycle cadmium and nickel, respectively, compared with the extraction and refining of virgin metal.

One of the most important advantages of recycling batteries is the reduction in their environmental impact at end-of-life. Most dry cell batteries and a small percentage of lead–acid batteries are currently disposed of in landfill. While there is still considerable uncertainty about the environmental impacts of batteries in landfill, there is some evidence that heavy metals from electronic products, including batteries, mobilise to some extent in landfill. This process may take decades or much longer, depending on environmental conditions (temperature, rainfall, landfill design etc.).

A journal article by Rebecca Slack, Jan Gronow and Nikolaos Voulvoulis in 2004 concerning landfill leachate in the Northern Hemisphere (*Science of the Total Environment*, 2004) notes that batteries and appliances are a potential source of cadmium, nickel, zinc, lead and mercury in landfill leachate. While the authors did not consider heavy metals to be a groundwater pollution threat, they noted that concentrations in leachate sampled in the US and eastern Europe exceeded legislative permits and drinking water limits.

From a risk management perspective it makes sense to remove products containing heavy metals from the waste stream before they enter a landfill. This is particularly important given the continuing growth in demand for electronic devices and the batteries that power them.

The presence of batteries in household waste also causes problems if that waste is processed to recover the organic component, primarily food and garden waste. Alternative waste facilities are becoming increasingly common in Australia. These vary in their source of waste, processing methods and end products, but most remove recyclable and non-degradable

A battery collection bin in Bunnings' Hawthorn store, which is one of the participants in the BatteryBack pilot program. Photo: Sustainability Victoria

materials and then generate energy and compost from the remaining organic fraction. For example, Global Renewables Limited (GRL) processes municipal solid waste using a combination of mechanical biological treatment, anaerobic digestion and composting at its Eastern Creek (Sydney) facility. According to a report in *New Scientist* (7 July 2007), GRL remove around 60–80 batteries per day in a "pre-sort" facility at the front end of the process. Unless they are removed, batteries can contaminate the organic product and make it unusable.

ABRI is committed to the diversion of batteries from the waste stream into recycling programs that recover valuable metals and other materials. Programs are well established for lead–acid batteries but only in the very early stages for portable dry cell batteries. Barriers to be overcome include the high costs of collection and sorting and the lack of product stewardship regulations for these products. ABRI intends to work closely with battery manufacturers and retailers, recyclers, governments and environmental organisations to achieve its vision of responsible stewardship.