Sustainability Victoria

Comparison of existing life cycle analysis of shopping bag alternatives

Final Report

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1 Introduction

1.1 Project background

In 2005, Australians used 3.92 billion lightweight single use high density polyethylene (HDPE) bags. 2.14 billion of these came from supermarkets, while the others were used by; fast food restaurants, service stations, convenience stores, liquor stores and other shops. Most of these go to landfill (rubbish tips) after they are used; some are recycled.

Plastic bags are commonly provided at the point of purchase, with no transparent charge. They are designed to be used once and then disposed.

The current rate of plastic shopping bag use and disposal is a significant concern amongst the Australian community. A study carried out by Roy Morgan in August 2004 found that 93% of Australians questioned were concerned about the impact that plastic bags had on the environment. The over consumption of plastic bags is an unnecessary use of resources, such as energy, water and materials. Plastic bags as litter create visual pollution problems and can have harmful effects on aquatic and terrestrial animals. Nearly half a million plastic bags are collected on Clean Up Australia Day each year.

In recent years, the consumption of plastic bags has trended downward and could best be described as a large scale change in consumer behaviour. This has been a result of a co-ordinated effort by governments, some major retailers, consumers and environmental organisations.

The switch away from lightweight single use HDPE carry bags has led to increased use in alternative forms of shopping bags manufactured from a wide range of materials. As a result, there are many different types of shopping bags being introduced into the Australian market at present, resulting in confusion for consumers and retailers about their environmental impacts and benefits.

In selecting a preferred alternative to single use HDPE plastic shopping bags there is a need to achieve an overall environmental gain.

1.2 Project scope

The objective of this study was to draw together existing life cycle assessment (LCA) data to compare the environmental impacts of shopping bags alternatives for carrying goods in Australia. It aims to help retail decision makers and consumers choose among alternatives by informing them about the life cycle impact of alternatives to single use HDPE shopping bags and the environmentally preferred alternatives.

No new modelling has been undertaken for this project. Data presented in this report has been drawn from a streamlined Life Cycle Assessment

(LCA) undertaken in 2002 / 2003 by the Centre for Design at RMIT University for the Department of Environment and Heritage (Department of Environment and Heritage 2002, Department of Environment and Heritage 2003), with a minor update correcting for changes in bag masses, relative capacity, and recycling rates. Also at this point, updated data on paper production was included which reduced the overall impacts of paper bags.

The streamlined LCA of shopping bags commissioned by the Department of Environment and Heritage focused on reusable and degradable bag options and was scoped without extensive industry consultation or primary inventory data collection. Data was derived from existing published inventory information.

An overview of the LCA methodology and assumptions used in modelling the shopping bag alternatives has been provided in Section 3 of this report to provide a context for the results.

Social impacts will be a mix of positive and negative impacts but were beyond the scope of this study.

2 Types of single use and reusable shopping bags

The major single use plastic bag types used in Australia are the:

- 'singlet' bag made of high density polyethylene (HDPE) – used mainly in supermarkets, fresh produce and take-away food outlets, and other non-branded applications
- 'boutique' bag made of low density polyethylene (LDPE) – generally branded and used by stores selling higher value goods such as department stores, clothing and shoe outlets.

Most major supermarket retailers also offer reusable non-woven plastic (polypropylene) 'Green Bags' and calico bags, for which they charge $1.00 – $2.00 per bag. The main types of shopping bags used in Australia and their key features are described below and summarised in Table 3-1. Whilst there are others on the market, they are not thought to be used in any great numbers.

2.1.1 Single use high density polyethylene (HDPE) bag

HDPE is manufactured from ethylene, a by-product of gas or oil refining. Around two-thirds of HDPE bags consumed in Australia are imported from south-east Asia, where the primary source of polyethylene is oil. The primary source for HDPE bags produced in Victoria is natural gas.

These plastic bags offer a thin, lightweight, high strength, waterproof and reliable means of transporting shopping goods.

The major HDPE plastic shopping bag used in Australia is the 'singlet' bag. These bags are typically a non-branded bag, used mainly in supermarkets, take-away food and fresh produce outlets, but also in smaller retail outlets such as service stations and newsagents. Some HDPE bags are also used in a 'wave top' shape with a reinforced handle.

Major supermarket chains in Australia have established a 'take-back' recycling system at stores for used HDPE shopping bags. Drop-off bins are provided at the entry of many major supermarkets for used HDPE shopping bags, which are collected for recycling into new products.

2.1.2 Single use low density polyethylene (LDPE) bag

Like their HDPE counterparts, LDPE is manufactured from ethylene, a by-product of gas or oil refining. They offer a thin, lightweight, high strength, waterproof and reliable means of transporting shopping goods.

The LDPE 'boutique' style bags are generally branded and are used by stores selling higher value goods, such as department stores, clothing and shoe outlets.

LDPE bags are less likely to enter the litter stream because their destination is normally the home.

No recycling program currently exists for LDPE bags.

2.1.3 Single use kraft paper bag

Kraft paper bags are mostly manufactured locally in Australia. Some Australian kraft paper bags contain up to 50% recycled content.

Pulping and bleaching processes involved in paper manufacture produce higher air emissions and waterborne wastes than plastics manufacture.

One of the major benefits of paper bags compared to plastics is that they are degradable and therefore have less impact in the litter stream. However, they also have a higher global warming potential if disposed to landfill.

Paper bags are highly recyclable, with collection and recycling systems for paper now widespread in Australia.

2.1.4 Single use degradable plastic bag

Plastic bags that can be broken down by chemical or biological processes are described as degradable. There are many different types of degradable plastics being introduced into the Australian market.

Degradable plastic bags can be classified in two ways:

- according to the way that they degrade (e.g. whether they require the actions of microorganisms, heat, ultraviolet light, mechanical stress or water in order to break down)
- according to the materials they are manufactured (e.g. whether they are made from natural starch polymers, synthetic polymers or from a blend of a conventional polymer with an additive to facilitate degradation).

There are five different types of degradable polymers:

- Biodegradable polymers: capable of undergoing decomposition into carbon dioxide, methane, water, inorganic compounds or biomass in which the predominant mechanism is the enzymatic action of micro-organisms that can be measured by standardised tests, in a specified time, reflecting available disposal conditions.
- Compostable polymers: degradable under composting conditions. To meet this definition they must break down under the action of micro-organisms (bacteria, fungi, algae), achieve total mineralisation (conversion into carbon dioxide, methane, water, inorganic compounds or biomass under aerobic conditions) and the mineralisation rate must be high and compatible with the composting process.

- Oxo-biodegradable polymers: undergo controlled degradation through the incorporation of 'prodegradant' additives (additives that can trigger and accelerate the degradation process). These polymers undergo accelerated oxidative defined degradation initiated by natural daylight, heat and/or mechanical stress, and embrittle in the environment and erode under the influence of weathering.
- Photodegradable polymers: break down through the action of ultraviolet (UV) light, which degrades the chemical bond or link in the polymer or chemical structure of the plastic. This process can be assisted by the presence of UV-sensitive additives in the polymer.
- Water-soluble polymers: dissolve in water within a designated temperature range and then biodegrade in contact with microorganisms.

The composition of degradable bags also varies, with the main categories being:

- thermoplastic starch-based polymers made with at least 90% starch from renewable resources such as corn, potato, tapioca or wheat
- polyesters manufactured from hydrocarbons (oil or gas).
- starch – polyester blends that mix thermoplastic starch with polyesters made from hydrocarbons.

Like the current ethylene shopping bags, degradable plastic bags are designed for a single use.

2.1.5 Reusable calico bag

Calico bags are made from woven cotton and can be reused many times. They are strong, durable and flexible.

The cotton growing industry is a major consumer of synthetic fertilisers and pesticides. The labour conditions for bag manufacture in the developing world would be an issue that would warrant careful examination if these bags were to be utilised on a broad scale in Australia.

No recycling program exists for damaged calico bags at the end of their useful life.

2.1.6 Reusable non-woven plastic (polypropylene) 'Green Bag'

Non-woven plastic (polypropylene) 'Green Bags' are manufactured from polypropylene gas, a by-product of oil refining. They are strong and durable, and can hold more than a conventional single use HDPE shopping bag.

These reusable bags usually have a sturdy removable base that is manufactured from a range of materials such as nylon, polyethylene or PVC.

These bags can be recycled through the plastic check-out bag recycling bins at many major supermarkets in Australia, although this option is not widely promoted or utilised by Australian consumers. As a result there is little recycling of these bags currently.

3 Life Cycle Assessment Methodology

3.1 Definition of life cycle assessment

A life cycle assessment (LCA) provides a framework and methods for identifying and evaluating environmental impacts associated with the complete life cycle of products and services, i.e. from the product cradle to the grave. The basis of an LCA study is an inventory of all the inputs and outputs of industrial processes that occur during the life cycle of a product.

The life cycle of a product or service includes extraction of natural resources; production of raw materials; processing, manufacturing, and fabrication of the product; transportation or distribution of the product; and the disposal or recovery of the product after its useful life.

3.2 Streamlined life cycle assessment of shopping bag alternatives

A streamlined Life Cycle Assessment (LCA) was undertaken by the Centre for Design at RMIT University using the LCA software package SimaPro 5.1. It compared the life cycle environmental impacts of shopping bags alternatives for carrying goods in Australia: single-use materials (i.e. plastic, paper and degradable materials) and reusable bags made from plastic and calico.

The LCA included production of the raw materials, manufacture of the bags, transport of the bags to the retailers, and disposal at the bags' end of life. Data used to model the materials was derived from existing published inventory information.

Australian data was used for energy production, some material production (e.g. PET and HDPE), transport, recycling and waste disposal (EcoRecycle 2001; EcoRecycle 2003). International public data was used to model the remaining materials.

Because consistent data sets are not available for production from all countries, most materials are modelled as being made with the same energy grid as Australia (unless specific data to the contrary was available). For imported materials, therefore, only the additional transport has been taken into account, rather than local production data from each country. The exception to this would be if the material was from Europe and high quality European data was available.

The LCA is based on specific bags in use to determine mass and material composition. Generic materials production and processing inventory data are then used as inputs to bag production. The bags pictured in this report are an illustrative example; however, the data is within a reasonable range of accuracy for the bag pictured.

As the data contained in this report is the result of a streamlined LCA study using existing data, rather than data from the actual processes used for each specific bag, the results should be used as indicative data rather than a full scientific study of relative impacts.

3.3 Shopping bag life cycle

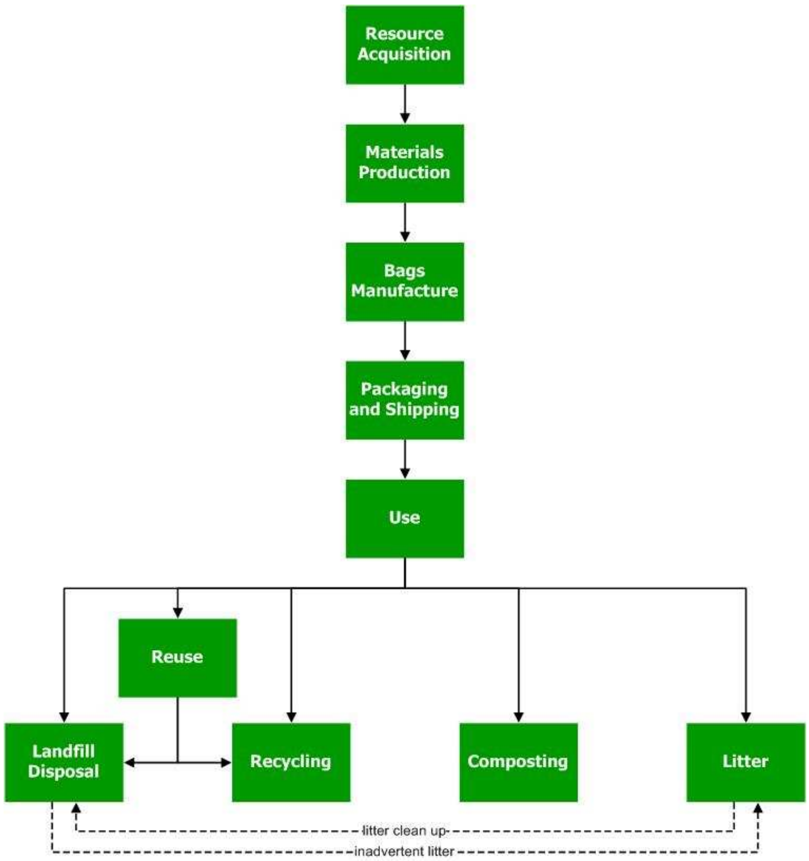

Figure 3-1 Generic life cycle of shopping bags[1]

3.4 Basis for the comparison

When comparisons of life cycle environmental impacts are performed, it is important that the products to be compared fulfil the same function. For the purpose of this study, the unit of comparison is defined as *the amount of*

[1] Inadvertent litter is usually associated with windblown litter from disposal routes such as litterbins and landfill sites. Intentional litter results from inappropriate disposal actions by consumers.

shopping bags consumed by a household to carry 70 grocery items home from the supermarket each week for 52 weeks.

3.5 Assumptions

Data on bag types relates to the most prominent example of each bag already in use in the Australian retail market.

To allow for size differences in bags, the assessment takes into account relative carrying capacity and expected life (see Table 3-1).

The assessment also takes into account any avoided impacts such as:

- avoided use of virgin polymer or paper fibre due to bag recycling programs
- avoided consumption of kitchen tidy bags as a result of bag reuse in the home.

Wherever possible, data is based on actual bag use acknowledging that there is variability of each bag type in the marketplace.

Although relevant to all retail applications, the assessment is based on an application for supermarket use.

Alternatives have been modelled assuming 52 shopping trips per year with 10 average plastic shopping bag loads each trip.

The manufacturing assessment of each shopping bag included the extraction of raw materials and the processing of them into the final product. For imported bags, overseas inventory data specific to the country of origin was used where possible.

The transportation of each shopping bag was factored into the LCA. This included the international shipping of imported bags to Australia (place of departure to the Port of Newcastle) as shown in Table 3-2. For internal transportation to retailers, a distance of 115km in a 28 tonne articulated truck was used for all bag alternatives.

No allowance has been made for maintenance of bags (washing and ironing) during the use stage.

Due to the variance in materials and expected life of many of the shopping bag alternatives, a number of end-of-life assumptions were factored into the LCA (Table 3-3). It should be noted that the analysis is highly dependant on assumptions made about reuse of bags; use patterns of reusable bags; purchase of alternative products (e.g. kitchen tidy bags); and the percentage of bags entering the litter stream.

Data on biodegradable plastic bags is the least reliable of all inventory data used in the analysis, as very little LCA work has been done on starch based plastics to date. It should therefore be treated with particular caution.

Table 3-1 Shopping bag types for assessment

Bag type	Features	Manufacturing process	Weight (g)	Relative capacity[(1)]	Expected life	Bags per year[(2)]
Single use plastic (HDPE) bag	Light, strong, durable, effective when wet, recyclable	Production of HDPE film from ethylene, a by-product of gas or oil refining	7	1	single trip	520
Single use plastic (HDPE) bag with 100% recycled content	Light, strong, durable, effective when wet, contains recycled content, recyclable	Production of HDPE film	7	1	single trip	520
Single use 'boutique' plastic (LDPE) bag	Light, strong, durable, effective when wet	Production of LDPE film from ethylene, a by-product of gas or oil refining	18.1	0.8	single trip	650
Single use kraft paper bag	Convenient, recyclable though the current kerbside system, manufactured from renewable resources	Production of paper bags	42.6	0.9	single trip	578
Single use kraft paper bag with 100% recycled content	Convenient, contains recycled content, recyclable though the current kerbside system, manufactured from renewable resources	Production of paper bags	42.6	0.9	single trip	578
Reusable kraft paper bag (2 trips)	Convenient, recyclable though the current kerbside system, manufactured from renewable resources	Production of paper bags	42.6	0.9	two trips	289
Reusable kraft paper bag with 100% recycled content (2 trips)	Convenient, contains recycled content, recyclable though the current kerbside system, manufactured from renewable resources	Production of paper bags	42.6	0.9	two trips	289
Reusable non-woven plastic (polypropylene) "Green Bag"	Strong, durable, effective when wet, reusable	Production of PP film from propylene gas, a by-product of oil refining	95 [(2)]	1.1	104 trips (2 years)	4.55
Reusable calico bag	Light, flexible, washable, reusable, reusable manufactured from renewable resources	Cotton processing	85	1.1	104 trips (2 years)	4.55

Single use degradable starch-polyester blend bag (e.g. Mater-Bi)	Light, strong, compostable, biodegradable, manufactured from renewable resources	Maize growing based upon data related to growing maize in the Netherlands. PCL is produced from cyclohexanone (95%) and acetic acid (5%) [7].	8.1	1	single trip	520
Single use oxo-biodegradable bag (e.g. TDPA-EPI)	Light, strong, degradable	Additive modelled as stearic acid and small amount of cobalt metal to represent the presence of cobalt stearate.	6	1	single trip	520

(1) A relative capacity of 1 = 6-8 items per bag. For the purposes of this study, 7 items to a bag for a relative capacity of one was used.

(2) Quantity of shopping bags used to carry 70 grocery items home from the supermarket each week for 52 weeks in relation to relative capacity and adjusted in relation to expected life

(3) Comprises a 65g bag and 30g base

Table 3-2 Transportation of imported shopping bag alternatives to retailer (in addition to the domestic distance travelled of 115km used for all bag alternatives)

Bag type	Percentage imported[1]	Origin and distance travelled (km)
Single use plastic (HDPE) bag	67	Hong Kong (7,000 km)
Single use plastic (HDPE) bag with 100% recycled content	67	Hong Kong (7,000 km)
Single use 'boutique' plastic (LDPE) bag	34	Hong Kong (7,000 km)
Single use kraft paper bag	0	n.a.
Single use kraft paper bag with 100% recycled content	0	n.a.
Reusable kraft paper bag (2 trips)	0	n.a.
Reusable kraft paper bag with 100% recycled content (2 trips)	0	n.a.
Reusable non-woven plastic (polypropylene) "Green Bag"	100	Hong Kong (7,000 km)
Reusable calico bag	100	Pakistan (11,000 km)
Single use degradable starch-polyester blend bag (e.g. Mater-Bi)	100[2]	Italy (16,000 km)
Single use oxo-biodegradable bag (e.g. TDPA-EPI)	100?	Concentrate from Canada (16,000km) and 50% of bags from Malaysia (6,000 km)

[1] The country of origin for different bags can be diverse and ever changing. For example, the ratio of HDPE bags from Australian sources has dropped from 50% in 2002 to 25% in 2006. At any time a supermarket may be sourcing a combination of local and imported bags. The country of origin identified in the table is therefore a best assessment of the likely sourcing profile.

[2] Material imported and bag manufactured in Australia

Table 3-3 End-of-life assumptions

Bag type	Landfill %	Recycled % (1)	Composted %	Litter % (2)	Reuse % (3)
Single use plastic (HDPE) bag	75.5	5	0	0.5	19
Single use plastic (HDPE) bag with 100% recycled content	80.5	0	0	0.5	19
Single use 'boutique' plastic (LDPE) bag	80.5	0	0	0.5	19
Single use kraft paper bag	39.5	60	0	0.5	0
Single use kraft paper bag with 100% recycled content	99.5	0	0	0.5	0
Reusable kraft paper bag (2 trips)	39.5	60	0	0.5	0
Reusable kraft paper bag with 100% recycled content (2 trips)	99.5	0	0	0.5	0
Reusable non-woven plastic (polypropylene) "Green Bag"	99.5	0	0	0.5	0
Reusable calico bag	99.5	0	0	0.5	0
Single use degradable starch-polyester blend bag (e.g. Mater-Bi)	70.5	0	10	0.5	19
Single use oxo-biodegradable bag (e.g. TDPA-EPI)	70.5	0	10	0.5	19

(1) Based on the current recycling industry it was assumed there would not be a recycling market for the reusable bags at end-of-life due to their relatively low volume.

LCA methodology does not allow for recycling credits to be counted twice. Therefore the benefits of recycling are either included at the manufacturing stage (recycled content) or at the end of life (recycling).

(2) All bags were assumed to have 0.5% of total bags entering the litter stream at end-of-life. This percentage was based on existing data relating to single use plastic (HDPE) bags entering the litter stream.

(3) Only single use plastic bag options were considered for reuse applications as it was assumed that the long life bags would be used for grocery shopping to the end of their functional life and would consequently be disposed of. It was assumed that 19% of single use plastic bags would replace the need for bin liners. This was calculated by using the average amount of household rubbish generated per week of 14kg. This equals 333g/L equalling 42 litres of rubbish per week. If one single use plastic (HDPE) bag holds approximately 10 litres, a maximum of five bags per household per week could be used as bin liners. As the average Australian household has 2.6 residents and the consumption of single use plastic (HDPE) bags is just under one per person per day, approximately 16 single use bags are collected per household per week. Based on the assumption that 60% of households reuse single use plastic bags as bin liners, the percentage of single use plastic supermarket shopping bags used for this purpose would be approximately 19%. This reuse as a bin liner for household waste results in avoided consumption of HDPE bin liner bags.

3.6 Indicators

The LCA considered environmental impacts under the following headings:

Material consumption	Material used in the manufacture of the bag (i.e. mass of the bag multiplied by the number consumed over one year).
Global warming	Climate change effects resulting from the emission of CO2, methane or other greenhouse gases into the atmosphere. Greenhouse impacts are dominated by carbon dioxide through electricity and fuels consumption, methane emissions through degradation of materials in anaerobic conditions (e.g. landfill), and nitrous oxide (N_2O) emissions in fertiliser applications on crops.
Energy consumption	Total energy use including fossil fuel, renewable, electrical and feedstock (i.e. the energy embodied in a bag's material).
Water use	Nett water use including potable, process, cooling water. Water quality, water depletion, biodiversity.
Litter marine biodiversity	This indicator estimates the time in which litter in marine environments has the potential for ingestion or entanglement by marine fauna. This indicator is mostly affected by the propensity of the material to float or sink.
Litter aesthetics	This indicator attempts to represent the visual impact of litter, which was taken to be related to the areas of the material and the time before it would degrade. To model this indicator an estimate of the average time a piece of litter may remain in the litter stream was needed. The data used for different materials was as follows: ▪ plastics (both single use and reusable, but not degradable polymers) – five years ▪ paper and degradable polymers – six months ▪ calico – two years.

4 Results

The following table summarises the findings of the streamlined environmental assessment of shopping bag alternatives. A rating of one to five was used to show the diversity of impacts for each criteria, with one being the lowest impact. In some cases at the high impact end, the impact value of the bag fell outside the rating scale. Impacts cannot be added together to produce an overall bag rating.

Table 4-4 Environmental impacts of single use HDPE shopping bags and their potential alternatives over the full life cycle of the bag

Bag type	Example	Material consumption (kg)	Global warming (kg CO_2 eq)	Energy consumption (MJ)	Water use (kL H_2O)	Litter marine biodiversity (kg.y)	Litter aesthetics (m^2.y)	Disposal options
Reusable non-woven plastic (polypropylene) "Green Bag"		♠	♠	♠	♠	♠	♠	Recycle at major supermarkets
Reusable calico bag		♠	♠	♠	♠♠♠♠♠	♠	♠	No recycling, dispose to landfill
Reusable kraft paper bag with 100% recycled content (2 trips)	Photo unavailable	♠♠♠♠♠	♠♠♠	♠♠	♠	♠	♠	Recycle in household recycling bin
Single use oxo-biodegradable bag (e.g. TDPA-EPI)		♠♠♠	♠♠	♠♠♠	♠	♠♠♠	♠♠	Reuse as a garbage bin liner (disintegrates over several years)
Single use plastic (HDPE) bag with 100% recycled content		♠♠♠	♠	♠	♠♠	♠♠♠♠♠	♠♠♠♠♠	Recycle at major supermarkets Reuse as a garbage bin liner

Bag type	Example	Material consumption (kg)	Global warming (kg CO_2 eq)	Energy consumption (MJ)	Water use (kL H_2O)	Litter marine biodiversity (kg.y)	Litter aesthetics (m^2.y)	Disposal options
Reusable kraft paper bag (2 trips)		♠♠♠♠♠	♠♠♠♠	♠♠♠	♠	♠	♠	Recycle in household recycling bin
Single use compostable starch-polyester blend bag (e.g. Mater-Bi)	Photo unavailable	♠♠♠♠	♠	♠	♠♠♠♠♠	♠	♠♠	Compost (degrades within six months) Reuse as a garbage bin liner
Single use plastic (HDPE) bag		♠♠♠	♠♠	♠♠♠♠	♠	♠♠♠♠♠	♠♠♠♠♠	Recycle at major supermarkets Reuse as a garbage bin liner
Single use kraft paper bag with 100% recycled content	Photo unavailable	♠♠♠♠♠	♠♠♠♠♠	♠♠♠♠	♠	♠	♠♠	Recycle in household recycling bin
Single use kraft paper bag		♠♠♠♠♠	♠♠♠♠♠	♠♠♠♠♠	♠♠	♠	♠♠	Recycle in household recycling bin
Single use 'boutique' plastic (LDPE) bag		♠♠♠♠♠	♠♠♠♠♠	♠♠♠♠♠	♠	♠♠♠♠♠	♠♠♠♠♠	No recycling, reuse as a garbage bin liner

5 Key findings

- Reusable bags have lower environmental impacts than **all** of the single use bags
- A substantial **shift to more durable bags** would deliver environmental gains through reductions in greenhouse gases, energy and water use, resource depletion and litter.
- The **reusable, non-woven plastic (polypropylene) 'Green Bag'** was found to achieve the greatest environmental benefits
- The **shift from one single use bag to another single use bag** may improve one environmental outcome, but be offset by another environmental impact. As a result, no single use bag produced an overall environmental benefit.
- **Recycled content** in bags generally led to lowering the overall environmental impact of bags
- The **end of life destination** is crucial, with greater environmental savings achieved from recycling all bags at the end of their useful life.

Average household savings from switching to reusable 'Green Bags'

There is significant potential to reduce life cycle environmental impacts of plastic bag usage in the form of resource consumption, greenhouse gas, energy, water and litter.

By taking reusable non-woven polypropylene 'Green Bags' when going shopping and refusing lightweight, single use HDPE shopping bags, the average Australia household would make a significant difference to the reducing the impact of climate change and conserving our energy and water resources.

Table 5-5 Annual environmental savings per household from switch to reusable 'Green Bags"

Greenhouse	6 kilograms of greenhouse gas emissions abated	Which is equivalent to not releasing over 100 black balloons of greenhouse pollution into the atmosphere[1]
Energy	Over 190 mega joules of energy saved	Which is equivalent to powering a television for six months[2]
Water	7 litres of water saved	Which is equivalent to the water used to flush the toilet[3]

[1] 1 black balloon = 50 grams of carbon dioxide (Sustainability Victoria, 2006)

[2] The average television in Australia could be expected to consume around 80 kWh per year in on-mode and around a further 30 kWh per year in passive-standby mode (Harrington *et al.*, 2006). 1 kWh = 3.6 MJ (Sustainability Victoria, 2007)

[3] New toilets use about six to eight litres of water with every full flush (ActewAGL, 2007)

Environmental savings from Australia switching to reusable 'Green Bags'

If every Australian household made the switch from the current annual consumption of lightweight, single use HDPE shopping bags to reusable non-woven polypropylene 'Green Bags', the following environmental savings would be achieved.

Table 5-6 Annual savings in Australia from switch to reusable 'Green Bags'

Materials	24,100 tonnes of waste avoided	Which is like avoiding 2,200 garbage trucks full of waste from being sent landfill[1]
Greenhouse	Over 42,000 tonnes of greenhouse gas emissions abated	Which is like taking over 9,800 Victorian cars off the road for a year[2] or equivalent to not releasing over 850 million black balloons of greenhouse pollution into the atmosphere[3]
Energy	1.4 million gigajoules of energy saved	Which is equivalent to powering 22,600 Victorian homes for one year[4]
Water	50,000 kilolitres of water saved	Which is equivalent to the water used by 210 Victorian homes for one year[5]

[1] 1 garbage truck = 11 tonnes of waste (Sustainability Victoria, 2006)

[2] 1 average car emits about 4.33 tonnes of carbon dioxide per annum (Sustainability Victoria, 2006)

[3] 1 black balloon = 50 grams of carbon dioxide (Sustainability Victoria, 2006)

[4] 1 average Victorian home consumes 65 gigajoules of energy (gas and electricity) per annum (Sustainability Victoria, 2006)

[5] 1 average Melbourne home uses about 240,000 litres of water each year (Museum Victoria, 2004)

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