One Planet Consulting

# THE RECOVERY OF EXPANDED POLYSTYRENE IN AUSTRALIA: CURRENT SITUATION AND FUTURE OPPORTUNITIES

## EXTRACT FROM REPORT TO ACT GOVERNMENT - FOR PUBLIC USE

One Planet Consulting

Original Report: 14 August 2017

Revised document: 9 November 2018

**Disclaimer**

This document presents a summary of publicly available information on expanded polystyrene in Australia and internationally.

These parts were originally included in a commissioned report for the Australian Capital Territory (ACT) Government in August 2017. The ACT Government had appointed One Planet Consulting to undertake a Preliminary Regulatory Impact Statement, comprising research, stakeholder engagement and evaluation of options.

With the permission of the ACT Government, One Planet Consulting has redacted sections of that report, done a light edit, and updated some of the data and quantities so it is now relevant and available for others in Australia. For the purpose of consistency, the Australia-wide data and quantities are from 2015-16 reports which were used in the original report.

One Planet Consulting has revised the original report to make these sections publicly accessible so that others in governments, industry groups, business and communities can make decisions on improving the management and recovery of expanded polystyrene in Australia.

While every care has been taken to ensure that the information contained in this report is accurate, One Planet Consulting accepts no liability or responsibility whatsoever for any use of or reliance upon this report by any third party.

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November 2018

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*The ACT Government engaged One Planet Consulting (OPC) and expert colleagues to research options for recovering expanded polystyrene (EPS) used in packaging and durable applications.*

*The project involved a review of local and international research, industry experience, detailed interviews and a workshop with priority relevant stakeholders. Management and recovery options were evaluated through the workshop, with ACT Triple Bottom Line criteria, costs and opportunity costs and recommendations made for consideration of the ACT Government. The research and recommendations were presented to the Government in the form of a Preliminary Regulatory Impact Statement (RIS) in August 2017.*

*This document is a summary of the RIS, developed to permit wider dissemination and assist stakeholders outside of the ACT to make informed decisions about EPS recovery. References to the ACT and all sensitive information have been removed, to make this report suitable for release into the public domain.*

# 1 EXECUTIVE SUMMARY

Through this policy research project, OPC identified the following key points:

EPS consumption has been increasing. Its annual rate of growth is estimated as: packaging ~5% (especially fish and broccoli) and durable building product ~10% (especially wall and flooring insulation).

1. It is estimated that 74,800 tonnes of EPS was consumed in Australia in 2015-16, of which around 20-30% or nearly 3 million cubic metres went to landfill (mostly from packaging and building applications). Considerable quantities are in long term use as insulation, and the current recycling rate for EPS across all applications is around 12.1%.
2. EPS is a recyclable polymer, particularly from retail (e.g. dry bulky goods packaging) and building (insulation). There is capacity and demand for up to 3,000 tonnes of EPS recyclate in Australia, principally in Sydney and Melbourne manufacturing plants. There is strong demand from export markets for compacted, clean EPS (not considered a waste in China's criteria).
3. Comprehensive EPS collection schemes in Europe have reached highs of 50% recycling, with 27% the average (excluding incineration), and up to 40% into local reprocessing and 60% to export.
4. Virgin EPS resin in Australia sells at around $2,000 / tonne, whereas compacted EPS sells between $350-$750 / tonne depending upon the quality and density.
5. EPS is problematic as it is not accepted in kerbside collections, is persistent in the natural environment, fills landfills, and with standard landfill pricing for weight, its collections are barely viable. Localised EPS recycling schemes in Australia do have the potential for expansion.
6. There are some EPS formats that are being voluntarily phased out by industry and retail without negative impacts, namely packaging peanuts and takeaway food containers.

# 2 CONTEXT, EPS FACTS AND RATIONALE

## 2.1 Project purpose and method

In terms of environmental impact, Expanded Polystyrene (EPS) is a particularly problematic plastic as minimal quantities are recycled in Australia, some formats contain possible carcinogens which can be leached in landfill or the environment, and it occupies a large space in landfill without commanding a fair price per tonne due to its extremely low density (weight). It also inhibits the compaction of waste in landfills.

This document is an extract from the final report on a project which investigated the problems with EPS and identified potential solutions. In undertaking the project work, the Project Team prepared an Options Paper, conducted targeted interviews and convened a workshop of relevant stakeholders across the EPS supply chain to elicit stakeholder views and to refine a range of proposed options for consideration of the ACT Government.

The project method was designed to gather factual information and industry expert views on the material, identify potential solutions and then assess these solutions using the ACT Government's Triple Bottom Line Framework.

This project was carried out via these five steps:

1. Market analysis of industry production, imports, existing recycling programs and destinations both in Australia and overseas, including impacts upon landfill
2. Detailed structured interviews with specialists in EPS (manufacturing, collection and reprocessing) and retailers on uses, alternative packaging, destinations, trends and demand
3. Workshop with relevant organisations identifying the 'problem statement', and testing five optional product stewardship schemes
4. Analysis of all findings, further research and triple bottom line assessment of recommended schemes
5. Presentation of draft findings and integrating into a final report.

This document is a summary of the Preliminary Regulatory Impact Statement presented to the ACT Government, with sensitive and identifying information removed to make it suitable for public use whilst retaining information of value to decision makers in Australia.

## 2.2 What is EPS and how is it manufactured and used in Australia

EPS is a form of styrene, a polymer resin created from fossil fuels. A special high temperature process causes it to expand, and EPS can be extruded into moulds or cut. It has excellent thermal insulating and shock absorbing qualities. It is water resistant, inert, rigid and non-conductive, and can have fire-retardant chemicals added into the resin if required.

For these reasons, it is used in two basic applications:

1. Packaging– boxes especially for temperature control of food or as shaped shock-absorbing packaging for electronic or bulky goods
2. Durable product – as large 'waffle pod' slabs for building insulation (floors and walls) and for composite panels with metal or other plastics for such products as refrigerators, eskys, walls and ceilings.

### 2.2.1 Packaging

Importantly for recycling, EPS is reasonably visually distinctive in these applications from other types of polymer. However, it can be confused with plant-based polymers like PLA or corn starch when it appears as packaging 'peanuts' which are used as loose packaging for books or toys, or for takeaway food containers. Neither the EPS packaging peanuts nor takeaway containers are accepted in recycling collections.

In terms of dry goods packaging, EPS use is either declining or stable depending upon the product. According to book and toy store representatives, there is a downward trend in the use of EPS peanut format packaging, as it is being replaced by moulded plastic or cardboard, with remaining EPS mainly used in speciality hobby products. One bookstore noted they no longer use EPS, and another that their EPS peanuts are used repeatedly in shipments between suppliers, warehouse and stores in a loop, with a small quantity disposed to landfill.

According to retail representatives in furniture, white and brown goods, EPS use is stable or growing. It is used as protective packaging for a range of products such as shelves and desks, large and small kitchen appliances and electronic goods such as TVs and heaters. Some EPS remains in the store, and a considerable quantity (30% to 100%) ends up with the consumer.

There have been campaigns in Australia and overseas to phase out all EPS packaging as it is not welcomed by large scale sorting facilities, and therefore excluded from residential kerbside recycling collections. As industry experts and retailers noted, this has prompted some electronic goods and brand owners, such as Apple and Dell, to switch to more expensive moulded cardboard packaging, and supermarkets to use flat pack reusable plastic boxes.

In the case of packaging for products such as broccoli, beans and fish, food growers and food processors continue to prefer EPS, and domestic EPS food packaging production is growing at around 5% per year in line with food production and exports. Some interviewed representatives report it is growing with home deliveries. Supermarkets and food premises (restaurants and catering businesses) are seeing a growing quantity of EPS packaging, with interviewees estimating it comprises up to 5-10% of their volume of general waste to landfill.

In terms of specific EPS use in packaging subsectors, Figure 1 illustrates the applications in Europe. Australia lacks a similarly precise set of data on EPS (packaging and durables) as there is neither a comprehensive recycling or measurement system.

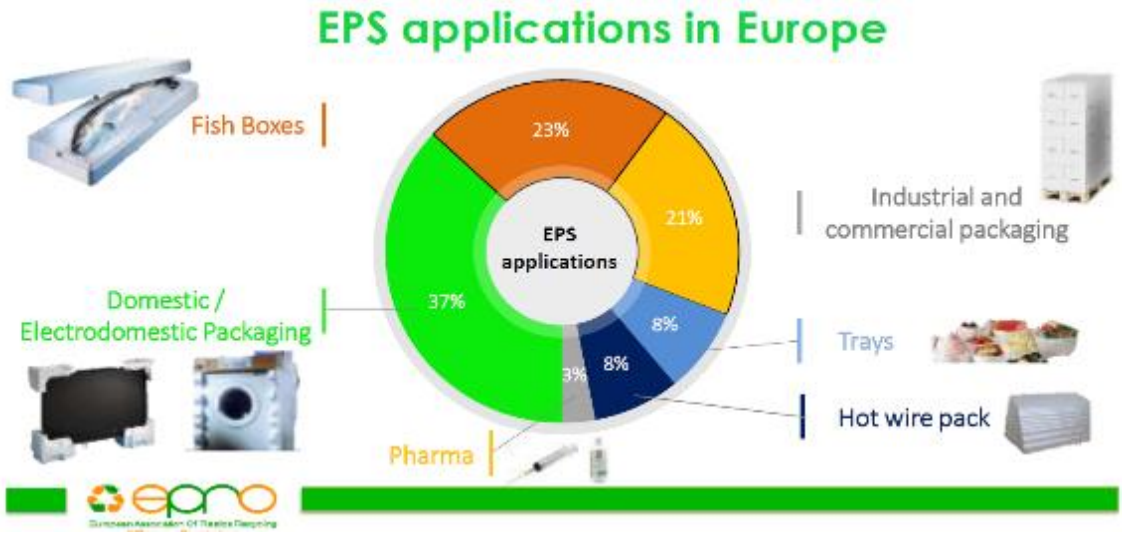


*Figure 1. EPS packaging applications in Europe, 2015-16 (source EPRO, 2016 Seminar)*

### 2.2.2 Durable product

Australian EPS production is also growing to meet market demand for building insulation for floors, walls and ceilings, historically for insulated cool room wall and ceiling panels, but now increasingly into residential construction. Available national EPS industry estimates are that around 30,000 tonnes of EPS went into the built environment during 2015-2016, and is growing around 10% per year.

Expanded Polystyrene Australia (EPSA) estimates that more than 90% of the EPS going into the built environment is used in waffle pods. Waffle pods are EPS blocks incorporated into building foundation slabs to significantly reduce the amount of concrete (along with other benefits) required. Some, but not all manufacturers, use a special EPS resin for the built environment that contains fire retardant. This additive is currently under review, with alternatives under consideration (with possibly lower bio-accumulative impact) (see Appendix 6.2 for a more detailed discussion on HBCD) and the Stockholm Convention listing).

In Australia, the average free-standing single-story house slab is around 200–240 $m^2$ (ABS, 2013). If a waffle pod based slab construction technique is adopted, the quantity of EPS contained in the slab is around 220–260 kg (see Appendix 6.2).

In addition, during construction a degree of over-ordering of waffle pod material is required to ensure that sufficient waffle pod is on hand, and off-cuts are also generated on site during installation. This excess waffle pod is typically a few percent of that purchased, or around 2$m^3$ per average residential construction (see Appendix 6.2). This excess material is commonly collected by the waffle pod supplier and returned to manufacturing facilities for recycling back into new waffle pods.

There are a few manufacturers in most Australian capital cities close to their customers, and some in major food growing areas, such as Mildura for grape growers. They all manufacture EPS on site using virgin styrene resin imported from overseas. EPS manufacturers of building product can and do receive recovered EPS for in-house reprocessing, and can mix up to one third recycled material into new product. Manufacturers of EPS for food packaging, such as Andpak in Red Cliffs near Mildura do not reprocess EPS due to food packaging standards, but surplus or damaged boxes from farmer customers go to companies such as Integrated Recycling in Mildura for mixing with other polymers to make fence pickets, garden edging, planks and railway sleepers.

## 2.3 How much EPS in Australia, sources and destinations now and in future

To carry out this project the first step was to quantify the tonnes, volume and value of EPS into the economy, and its impact through losses to landfill.

Based on Australian Plastics Recycling Survey data it is estimated that in 2015–16, around 23,500 tonnes of EPS packaging was consumed nationally, out of a total of around 74,500 tonnes of EPS consumed across all applications, and including imported EPS packaging. It's worth noting that around a third of EPS consumed in Australia goes into packaging applications, another third goes into the built environment, with the rest spread across a range of other application areas (Envisage Works, 2016c).

The weight of EPS consumed, and the proportion recycled varies considerably across states, as shown in Figure 2. Across Australia, 12.1% of EPS is recycled with the highest proportion in NSW (18.4%) and the lowest in NT at 0.1%.

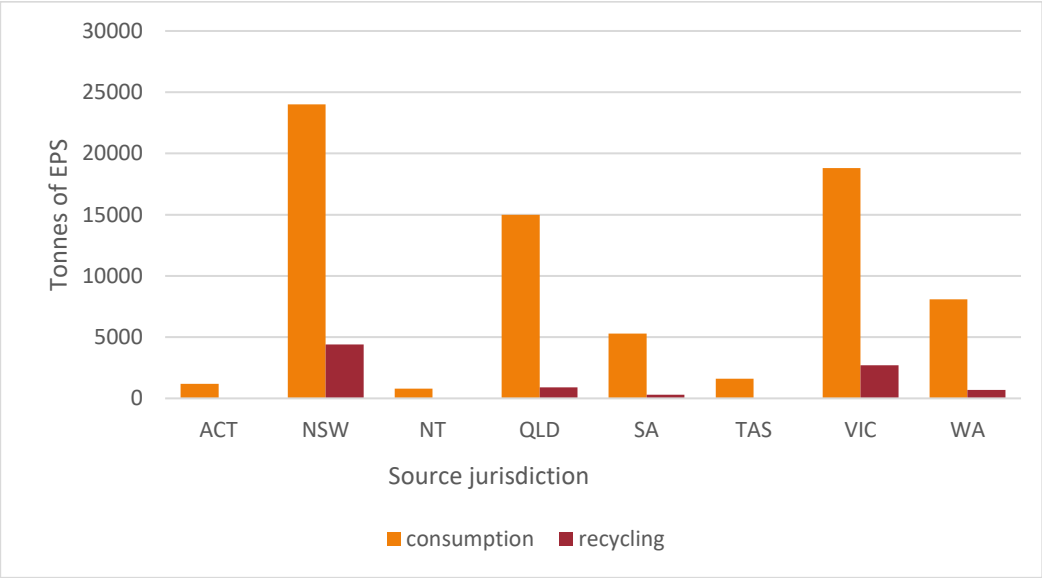


*Figure 2: Quantity of EPS consumed and recycled (tonnes) by source jurisdiction in 2015-2016 (Envisage Works, 2016c)*

## 2.4 Current EPS recovery and pricing systems in Australia and overseas

### 2.4.1 Australian EPS recovery programs

There are currently no product, packaging or landfill bans on EPS in Australia, and currently no formally coordinated suite of measures as part of a scheme by sector or by region. In most parts of Australia, EPS goes to landfill as part of general waste.

From early 1990s for over 10 years the industry association, EPSA, managed a scheme funded by members for loose un-compacted EPS to be both deposited at collector sites in major capital cities, and to be collected and sold. The Melbourne Metropolitan Waste and Resource Recovery Group also undertook a project to establish several public drop-off sites at local council depots in late 2000s, a few of which remain in operation today. The challenges were principally around costs of logistics and labour, namely unsupervised drop off leading to high contamination and small cages requiring frequent collection initially by manufacturers and later by a specialist collection company.

There are a few different EPS collection systems currently in place in Australia. These various voluntary systems have been put in place by different businesses and local governments with varying degrees of success (for more detail see Appendix 6.3).

A different approach was taken by the NSW who provided a grant to IS Recycling to commence EPS collections from commercial premises. IS Recycling has grown its geographic reach and services such as access to compactors, and now also collects flexible film, e.g. pallet wrap from client sites.

| Recovery model | Where operating | Fee system | Storage |
|---|---|---|---|
| Manufacturer product stewardship take back scheme for reprocessing into both packaging and durable building EPS product | Melbourne, Sydney, Mildura | Free collection (backhaul) from customer as value-add service | Clear Bags & loose storage on-site for collection |
| Logistics operator backhaul service for EPS packaging from retailer customers such as Harvey Norman | Canberra, Melbourne, Sydney, Brisbane | Nominal fee ~$17.00/2.5m$^3$ bag to retailer customers (backhaul) | Velcro tie bulka bags provided to retail outlet |
| Retailers and warehouses such as Good Guys compact EPS and commercial collector/ equipment supplier collects | Sydney & Melbourne region | Rebate paid for compacted EPS to suppliers for collected compacted EPS | On pallets |
| Public drop off at Council recycling depots | Melbourne region, Sydney | Varies from free to nominal fee for commercial volume EPS loads | Various, incl cages |

***Table 1 Current EPS recovery systems in Australia***

Through the interviews and workshop, industry figures revealed 2017 price for virgin EPS resin is around AUS$2,000 per tonne (2018 ~$2,500), recovered compacted EPS sells for ~$350–$750 per tonne (2017 & 2018) depending on the quality. Cold compacted EPS is lower in value due to lower density (weight), and un-compacted loose EPS is currently backhauled by EPS manufacturers in Australia.

### 2.4.2 Overseas EPS programs

EPS food service packaging has faced a great deal of pressure and product bans, the most notable being New York City's ban. New York banned EPS food service packaging with effect from 1 July 2015 due to environmental concerns and a lack of recyclability. While the scheme was subject to legal challenge in 2016 it is now operational (NYC Department of Sanitation, 2017).

> '(a)s a result of this determination, on and after November 13, 2017, no food service establishment, mobile food commissary, or store shall possess, sell, or offer for use single-service articles that consist of expanded polystyrene ("Food-Service Foam"), unless otherwise exempt under Local Law 142. In addition, no manufacturer or store shall sell or offer for sale polystyrene loose fill packaging ("Foam Packing Peanuts").'

The principal model of a regulatory approach to promote recycling of EPS is Korea's incorporation of EPS into its extended producer responsibility (EPR) framework. The original EPR framework was introduced in 2003 and has been expanded over time to address a broader range of products. Among other responsibilities, producers and importers are responsible (either individually or through funding industry collectives) for collecting target volumes of materials as determined by Korea. The recycling target for EPS has progressively increased from 61.3% in 2005 to 79.0% in 2014, with a stated long-term target of 80.5%. If the recycling targets are not met, producers and importers are liable for the costs of recycling the unmet amount of material plus a 30% premium (Republic of Korea, 2015).

EPS recovered through the Korean EPR system is used in synthetic wood such as skirting boards, art frames and building products (Choi, 2014).

In terms of recycling EPS packaging in Europe, Figure 3 shows the average is 27%, with 40% for energy recovery and only 33% to landfill. In two sample countries, the rates are as follows:

| | Recycling % | Energy recovery % | Incineration % | Landfill % | Total % |
|---|---|---|---|---|---|
| Italy | 37 | 20 | 3 | 40 | 100 |
| Belgium | 48 | 47 | 0 | 5 | 100 |


*Figure 3. Averages for consumption and recycling of EPS packaging in Europe (source EPRO, 2016 seminar)*

The reference presentation for European data delves into detail on EPS packaging for Belgium to show that there is more packaging going into households than into industry, and that there is a slightly higher recovery rate from industry (50%) than from households (46%).

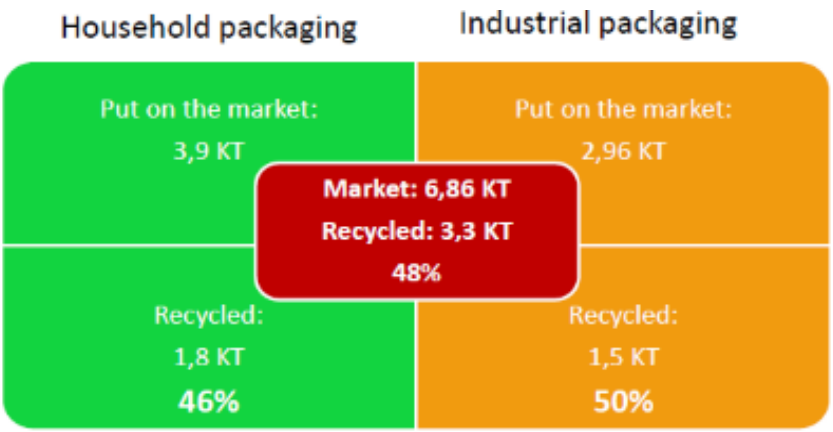


*Figure 4. EPS packaging consumption and recycling in Belgium (source EPRO, 2016 seminar)*

In terms of industry sectors receiving EPS packaging, Australian industry experts are not able to break down figures to a comparable level of detail, and it is difficult to anticipate the number of businesses that may be caught up in EPS recycling, so Figure 5 and Figure 6 possibly provide the best guide. These illustrate the sectors that may be affected by a scheme should one be introduced, and the number of

businesses in those sectors that may be affected by a scheme (bearing in mind these figures only address packaging, and do not include durable EPS for building insulation).

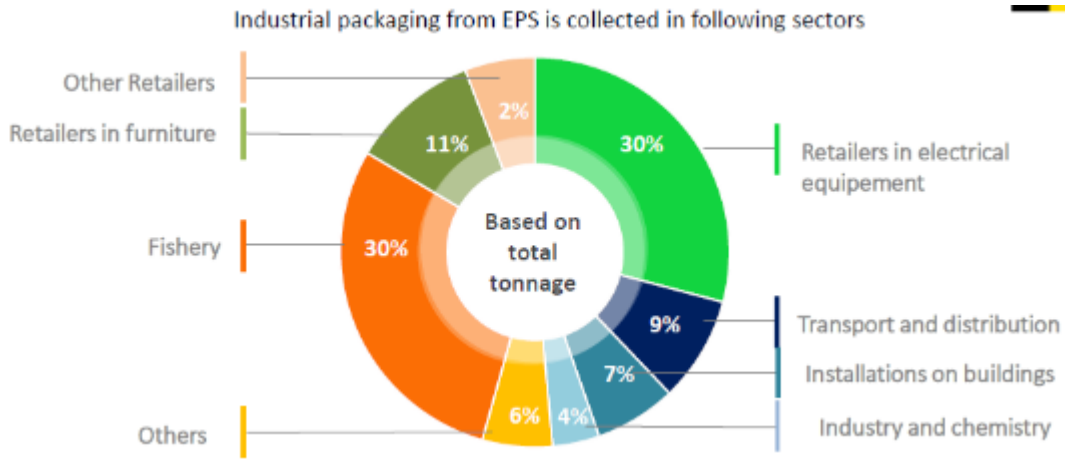


*Figure 5. Industry sector contribution to EPS packaging recycling in Belgium (source EPRO, 2016 seminar)*

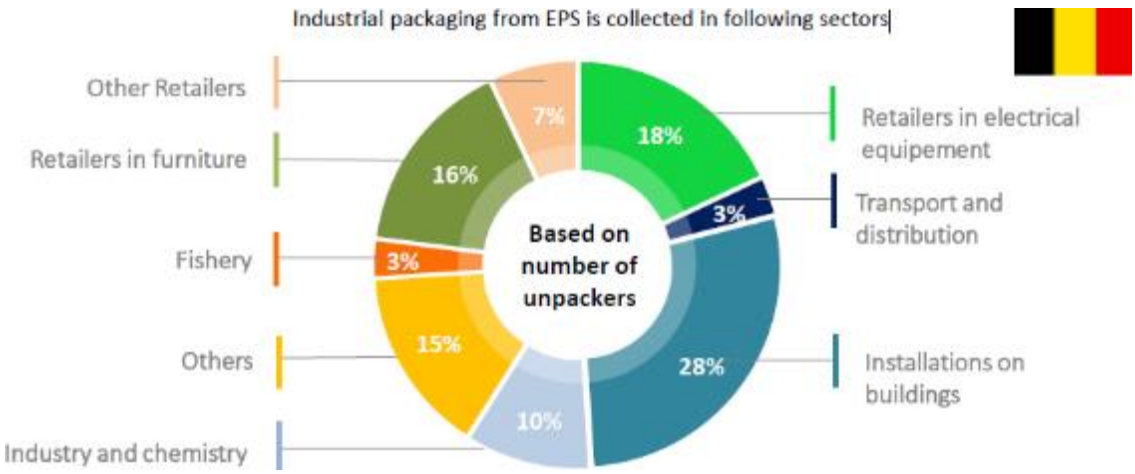


*Figure 6. Number of companies contributing to recycling EPS packaging by sector, Belgium (source EPRO, 2016 seminar)*

Approximately 74% of EPS (in tonnes) collected in Belgium is collected by companies specialising in EPS, and only 4% of all waste collectors specialise in EPS. In other words, multi-material collectors are less interested in EPS collection and it tends to be a specialised service, which is the case for current collections in Australia. Furthermore, in 2013 nearly 50% of EPS was collected in bulk, not compacted, and 40% was used in local building insulation material while 60% was compressed and exported. This illustrates a scheme with two markets to meet demand and reduce risk in exports.

The Norwegian experience with EPS recycling is instructive for potential schemes in Australia. Managed as an industry product stewardship scheme, in 1995 Green Dot Norway established standard contracts with 120 collectors, 50% of whom specialise in EPS, and all obtain EPS for free (no charge for pick up) for sale onto the open market.

Green Dot Norway can regulate the remuneration price paid to collectors, relevant to fluctuations in the sale price, such as China's Green Fence periods, which means that the collections and processing continue irrespective of international commodity fluctuations. After five years in operation, the scheme expanded in 2000 to include household kerbside collections (using special bags with identification tags). Remuneration by Green Dot Norway to collectors undertaking mechanical recycling can be as high as €272 per tonne, on top of market selling price.

# 3 OPTIONS WITH EPS

In practice, there are many combinations of approaches to collection, cost recovery and responsibility for recycling systems. In undertaking this project we grouped these options into three categories and presented them to the ACT Government. We assessed each option using the ACT Government's Triple Bottom Line Assessment Framework, SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis, in-depth interviews and a workshop.

The three options considered and assessed were:

1. Extended Producer Responsibility (EPR)
2. Product Stewardship; and
3. Container Deposit Scheme (CDS)

### 3.1.1 Extended Producer Responsibility (EPR)

The Organisation for Economic Co-operation and Development (OECD) defines EPR as (OECD 2014):

> *"...an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle."*

Since the late 1980s, EPR has aimed to make producers responsible for the environmental impacts of their products throughout the product value chain. In so doing, it was hoped that EPR would relieve the burden on municipalities and taxpayers for managing end-of-life products, reduce waste generation and increase recycling rates. EPR schemes aim to shift the costs (and associated price signals) associated with managing the waste from local councils, who have no power to change the amount or form of waste they must manage, to the designers and manufacturers of the product. This incentivises them to design for the environment. Discussions over the past several years have also sought to use EPR to enhance resource productivity and the Circular Economy (OECD, 2016).

Although numerous approaches are available and may be implemented in combination, the OECD groups EPR or stewardship approaches into four principal categories (OECD, 2014):

- product take-back requirements that require the producer or retailer to collect the product at the post-consumer stage. In practice, these requirements are usually discharged through a collective group known as a producer responsibility organisation (PRO) (sometimes referred to in Australia as a product stewardship organisation, or PSO) funded by producers;
- economic and market-based instruments including deposit-refund schemes/CDS, advance disposal fees (ADFs), material taxes, and upstream combination tax/subsidies that incentivise the producer to comply with EPR;
- regulations and performance standards such as minimum recycled content standards that can be either mandatory or voluntary; and
- accompanying information-based instruments including reporting requirements, labeling of products and components, educating consumers about product stewardship/EPR, and informing recyclers about the materials used in products.

While there are only a few basic approaches with EPR, there are many variants and no one particular 'best practice' model. Approaches must be tailored to local needs, the needs of various stakeholders and the stated objectives.

While many EPR schemes allow producers to demonstrate responsibility for their own products, producers most frequently contribute financially to a collective PRO to discharge obligations on their behalf. Producers have varying degrees of flexibility in delivering program objectives. A common model is

to deliver program objectives through a not-for-profit PRO accountable to a board comprised primarily or exclusively of funding industry representatives and other stakeholders such as retail businesses. (OECD 2014, OECD 2016, PSI 2016)

While EPR has delivered a variety of benefits across product types, EPR's direct impact on a primary objective, design for environment, has been quite limited overall and focused mainly on packaging design considerations. This limited impact is due primarily to the collective approaches producers often use to discharge their obligations, but also to the fact that EPR is but one of many design considerations. Design for environment is also more viable in consumer products with more rapid design turnover, such as packaging and e-waste. (OECD 2016, PSI 2016)

### 3.1.2 Product Stewardship

Product stewardship is a form of EPR. In Australia, a number of product stewardship frameworks have been reflected in the *Product Stewardship Act 2011.* These can be:

- accredited voluntary arrangements created under the Act's process (MobileMuster and FluoroCycle are the two current examples);
- co-regulatory arrangements (e.g., the Australian Packaging Covenant created prior to the Act and National Television and Computer Recycling Scheme, or NTCRS, enabled by the Act); or
- mandatory (the Product Stewardship for Oil Program was made mandatory in 2001 to enable levy collection).

Program costs are generally incorporated in purchase prices so that consumers are not charged when they return items at end-of-life. Responsibility is invariably shared across a range of stakeholders, including consumers.

Product stewardship models may be voluntary or have a regulatory underpinning that helps address 'free riders' that benefit from having a scheme in place without contributing significantly. Most international models are EPR, which almost always have a regulatory underpinning designating affected products and requiring certain actions of producers or first importers placing designated products on the market.

### 3.1.3 Container Deposit Scheme (CDS)

A CDS is a form of EPR. Simple in principle, CDS involves placing a deposit or offering a refund value on certain beverage containers motivating consumers to return the containers for recycling in order to have the deposit refunded. Alternatively, for consumers that forego the deposit, councils can redeem the deposit through kerbside collections and individuals can pick up littered beverage containers to return them for the deposit.

In Australia, the following jurisdictions have CDS in place (as of November 2018): South Australia, Northern Territory, NSW, Queensland and ACT.

# 4 PROBLEM STATEMENT

This 'Problem Statement' for EPS was developed during the project.

**Summary: EPS is inert in landfill and lasts for hundreds of years. However, it occupies a large volume (space) in landfill for a long time. Positively, it is recyclable and there is market demand for it in Australia and offshore; however, collection costs are often greater than landfill costs.**

- **Most EPS is sent to landfill and is not recycled**

Almost all EPS in Australia currently goes in general waste to landfill. EPS is not accepted at Material Recycling Facilities (MRF) and is therefore excluded as an acceptable packaging form within residential kerbside collections. EPS is also problematic for commercial collections. There is currently no consistent EPS recycling collection or drop off service for the public, food premises, the building construction industry or most retail outlets. There are isolated drop-off points for EPS around the country, run by bulky goods retailers or some local councils. Despite these problems, polystyrene (EPS and XPS combined) has the sixth highest recycling rate of all plastics in Australia at 12.1% (Envisage Works, 2016c).

With regard to recycling, EPS, with or without fire retardant, can be recycled multiple times before a degradation occurs in the mixed polymer and in product. Recovered EPS is only used in durable product such as building waffle pods in Australia and overseas in products such as picture frames. It is not used in food packaging due to food standards for use of virgin materials. Demand for recovered EPS in both Australia (for building underfloor insulation estimated ~3,000 tonnes) and offshore (for moulded frames) depends upon consistent supply, quality and virgin resin price.

- **EPS is being used in increasing quantities**

While some products have shifted to cardboard or air pocket packaging, overall there are growing quantities of EPS as a result of both increased manufacturing in Australia (for both packaging and durable products) and increased quantities of imported products. Despite campaigns, EPS remains the preferred packaging for foods (broccoli and fish in particular) requiring maximum insulation.

- **EPS recovery is problematic**

Most EPS is rigid and can break into tiny fragments, becoming scattered into streets and stormwater and thence into waterways and the marine environment. A sizeable proportion of EPS for buildings (industry estimates 70% of waffle pod and 95% wall sheet) contains a flame retardant additive to minimise fire risks on building sites prior to installation.

In 2013, the Stockholm Convention on Persistent Organic Pollutants (POPs) listed hexabromocyclododecane (HBCD) for a complete phase-out by ratifying parties within five years, with alternatives preferred. While HBCD is used in an array of products, including textiles, EPSA members have agreed to this phase out and the Australian Government is considering ratifying for phase-out to occur. This would result in the use of additives with possibly lower bio-accumulating impacts (see Appendix 6.2 for a more detail).

- **Recycling EPS is not always profitable**

There are volatilities in the selling price of recycled EPS, which means collection and reprocessing can be unprofitable unless underpinned by other mechanisms. Volatilities are also affected by the fluctuating prices of comparative products (namely virgin styrene resin and oil) and the Australian dollar.

- **EPS is bulky and lightweight**

Landfill fees are based on weight not volume, nor future cost, so therefore do not reflect the real externalities of landfilling EPS. Landfill is increasingly financially, environmentally and socially expensive, so filling landfill space with recyclable EPS represents high opportunity cost.

The economics of compaction equipment is undermined by the low cost of disposal to landfill and low quantities arising in any one location or by any one business. Nevertheless, estimates are that a $15,000 compaction machine can achieve a payback in less than four years for medium-high volume generators or collectors, and this varies according to landfill price. Compacted EPS is currently only sought by export markets whereas uncompacted EPS is suitable for Australian reprocessing into building product.

Storage and transportation can be difficult and expensive because of the bulky, lightweight nature of the material. When collecting EPS for recycling, the extent of contamination can be difficult to monitor, and decontamination via washing increases the costs and inefficiency of recycling. Contamination of EPS typically arises from the originating site, such as food organics being left in produce boxes (broccoli or fish) and dirty handling on building sites.

**Concluding observations**

The patchwork of voluntary existing EPS recycling programs in Australia show it is feasible to establish EPS schemes, and the successful structured schemes overseas show the potential for high diversion rates averaging 27%, and as high as 50%.

These schemes appear to stimulate improved business productivity, economic activity and minimise negative impact upon the community and environment.

# 5 EPS APPLICATIONS AND RELEVANT SECTORS FOR A POTENTIAL SCHEME

The introduction of a scheme focused on EPS could assist improved recycling from both construction and retail sectors in particular.

Table 2 provides a breakdown of the applications and sectors using EPS in packaging and durable product formats. Columns recommending various actions for consideration of the ACT Government have been redacted.

This table nevertheless presents some information that may be useful in designing the scope and approaches for EPS recovery schemes, and the stakeholders to be engaged.

| Application | Sector |
|---|---|
| EPS food takeaway containers (incl. drink cups and clam shells)? | Food outlets |
| Food produce boxes (incl. broccoli, beans, seafood) | Food outlets (incl. restaurants, grocers, supermarkets) |
| Loose EPS 'peanut' form packaging (incl. books, toys, hobby craft) | Specific retailers |
| Dry bulky goods packaging | Electrical Retailers & Shopping Centres |
| Building insulation panels (floor and walls) | Builders, largely residential |
| Building ceiling and sandwich panel insulation | Builders of cold stores, commercial and industrial buildings |

*Table 2. Different EPS applications by industry sector*

# 6 APPENDICES

## 6.1 EPS flows

### 6.1.1 EPS consumption

Data drawn from the Australian Plastics Recycling Survey (APRS) provide estimates of national EPS consumption, into all applications, of around 74,000 tonnes, of which an estimated 24,000 tonnes or 32% went into packaging applications (Envisage Works, 2016c; Envisage Works, 2016b), with another third into the built environment, and the rest spread across a range of other application areas such as transport (e.g. locally manufactured and imported cars) and electrical appliances (e.g. refrigerators and freezers).

No EPS resin is currently manufactured in Australia, with all EPS entering the country from overseas either as resin for processing by local manufacturers (47,000 tonnes), or as components of finished or semi-finished goods (20,300 tonnes).

Our best current estimates of national imports of EPS packaging on finished goods is conservatively estimated at around 6,000–8,000 tonnes in 2015–16, mostly coming as packaging on consumer goods.

### 6.1.2 EPS disposal

Australian Plastics Recycling Survey (APRS) data for 2015–16 indicate that around 12%, or 9.1 tonnes, of EPS in Australia is recycled, and the recorded quantities are for packaging. The recycling rate of EPS reaching end-of-life from non-packaging applications is unknown, but will be lower than the packaging recycling rate.

Around two-thirds of the recycled EPS packaging from Australia is reprocessed overseas, with the remaining one-third reprocessed in one of 11 plants in Australia. These reprocessing plants were in Queensland (four reprocessors), Victoria (three reprocessors), New South Wales (two reprocessors) and Western Australia (one reprocessor).

### 6.1.3 EPS fates in 2015–16

The major uses of recovered EPS include:

- waffle pods for under slab construction of buildings
- synthetic timber applications, including fence posts, bollards, photo frames and decorative architraves
- extruded polystyrene (XPS) insulation sheeting
- lightweight concrete.

| Polymer type | Agricul-ture | Automotive | Built environ-ment | Electrical & electronic | Packaging | Other applic. area | Unidentified applications | Total |
|---|---|---|---|---|---|---|---|---|
| PET (1) | >500 | 0 | 16 400 | >500 | 116 800 | 55 100 | 42 400 | **230 900** |
| PE-HD (2) | 9 800 | 0 | 130 400 | 9 000 | 301 400 | 70 200 | 28 800 | **549 600** |
| PVC (3) | >500 | 17 400 | 259 000 | 35 300 | 23 600 | 41 800 | 7 400 | **384 900** |
| PE-LD/LLD (4) | 70 000 | 0 | 26 800 | 3 300 | 218 100 | 24 900 | 21 500 | **364 600** |
| PP (5) | 2 800 | 55 200 | 15 700 | 12 400 | 88 500 | 70 800 | 42 700 | **288 100** |
| PS (6) | >500 | 3 900 | 8 900 | 21 400 | 11 700 | 8 100 | 1 100 | **55 200** |
| PS-E (6) | 0 | 900 | 27 500 | 19 700 | 23 500 | 1 700 | 1 500 | **74 800** |
| ABS/SAN (7) | 0 | 39 800 | 1 000 | 13 500 | 2 900 | >500 | 1 500 | **58 900** |
| PU (7) | 0 | 22 000 | 21 100 | 900 | 0 | 28 300 | 3 600 | **75 900** |
| Nylon (7) | 0 | 800 | 2 400 | 0 | >500 | 37 700 | 13 900 | **54 900** |
| Other (7) | >500 | 26 200 | 25 800 | 5 300 | 5 700 | 34 400 | 142 500 | **240 300** |
| Bioplastic (7) | 0 | 0 | 0 | 0 | >500 | 0 | 0 | **0** |
| Synthetic rubbers (7) | 0 | 6 500 | 12 000 | 900 | 0 | 67 900 | 107 500 | **194 800** |
| Unknown polymer | 500 | 2 600 | 16 600 | 27 300 | 52 000 | 157 600 | 82 200 | **338 800** |
| **Total** | **84 100** | **175 200** | **563 800** | **149 200** | **844 300** | **598 700** | **496 700** | **2 912 000** |

***Table 3. Polymer quantities (tonnes) consumed in Australia by sector, 2015–16, Source: Envisage Works (2016c, p. 26).***

## 6.2 Flame retardants in EPS for the built environment

Flame retardant is a chemical additive in many products including EPS resin, and is only used in EPS for buildings, not packaging. Flame retardant is also used in a wide array of products such as textiles (carpet and curtains).

Around 95% of built environment EPS consumption goes into as 'waffle pods' (the primary function of which is to minimise the use of concrete), with most of the remainder into composite structure insulated wall panels. Currently flame retardant is not mandatory in building EPS in Australia, but there are views that it should be. Industry experts estimate that flame retardant is used in 70% of waffle pod product and 95% of EPS wall sheet product.

As to potential impact upon reprocessing and end-products, there is no reprocessing of EPS into packaging in Australia, largely due to food grade packaging standards which exclude use of recycled materials. Most EPS reprocessed for end product in Australia goes into built environment EPS, largely waffle pods, with minor quantities into light-weight concrete and synthetic timber substitutes. Most collected EPS is compacted and exported.

### 6.2.1 Current situation – Use of flame retardants in EPS

The chemical currently used in Australia as a flame retardant in built environment EPS and XPS insulation panels and EPS waffle pods, is hexabromocyclododecane (HBCD). HBCD, like its substitutes, is added into the resin during manufacture, prior to importation. HBCD is added at ~ 1% concentration to achieve the required flame retarding performance, and so the 30,000 tonnes of EPS/XPS going into the Australian market each year may contain around 300 tonnes of HBCD.

From another perspective, assuming an average free-standing house slab (based on a single-story waffle pod design) of around 200–240 $m^2$ (ABS, 2013), and waffle pod thickness of 0.3 m and void of ~80%, and slab coverage of 90% (Attwood, 2017), the quantity of HBCD contained in the waffle pods for this dwelling would be ~2 kg, with around 220–260 kg of EPS typically incorporated into the slab.

During construction, a degree of over-ordering of waffle pod material is required to ensure that sufficient waffle pod is on hand, as well as waffle pod off-cuts that are generated on site. This excess waffle pod is

(very approximately) a few percent of that purchased, or around 2m$^3$ per average residential construction (Attwood, 2017; Envisage Works, 2016c, p. 26). This excess material is commonly collected by the waffle pod supplier and returned to manufacturing facilities for recycling back into new waffle pods.

The HBCD is added to waffle pod resin to reduce the building site fire risk relating to the *uninstalled* waffle pods sitting at a building site, prior to installation, and not fire risk to the finished building. There is no material fire risk relating to waffle pods that are fully encapsulated in the finished concrete slab.

As noted elsewhere, there is currently minimal recovery of EPS in Australia and minimal local reprocessing back into product. According to industry sources, it is only the EPS manufacturers who are doing backhaul collections from construction sites of off-cut EPS during the installation phase.

In terms of building demolition, there is currently negligible recovery of EPS/XPS, primarily due to the relatively recent introduction into residential and commercial buildings. A common use that has occurred for many years is EPS/XPS in cool room panels. However, this foam is prohibitively expensive to recover due to the cost of transport, the handling costs of separating the outer layers from the panel core, and issues with contamination with the adhesives used to bond the panel together.

### 6.2.2 Stockholm Convention and Australian ratification of the listing of HBCD

In 2013, the Stockholm Convention (Convention) on Persistent Organic Pollutants (POPs) listed HBCD in Annex A to the Convention. An Annex A listing requires a complete phase-out of a chemical by ratifying parties (i.e., countries that agree to the listing) within five years. Each party must ratify the listing before responsibilities under the Stockholm Convention apply in relation to that chemical.

The use of HBCD as a flame retardant in EPS and XPS in buildings is allowable as a “Specific exemption” under the Stockholm Convention, meaning that once Australia ratifies the listing of HBCD in Annex A of the Convention, Australia can apply to continue using HBCD in building EPS/XPS (Stockholm Convention, 2010).

It is worth noting that it is a requirement under the Stockholm Convention that once a specific exemption for HBCD is registered the party (e.g. Australia) “shall take necessary measures to ensure that expanded polystyrene and extruded polystyrene containing hexabromocyclododecane can be easily identified by labelling or other means throughout its life cycle (Stockholm Convention, 2013)”. So, should Australia ratify the listing of HBCD in Annex A, local manufacturers and importers of built environment foams containing HBCD will be require to effectively permanently label their products that contain HBCD.

Australia is currently at an early- to mid-stage of assessing the industry and regulatory impacts of phasing out HBCD, and this process can probably be expected to run for another few years or so before a decision is made whether to ratify the listing of HBCD in Annex A. Following this, Australia may decide to register for a specific exemption of the use of HBCD in built environment EPS/XPS, allowing its use for another five years. Under this scenario HBCD would continue to be sold into the Australian building materials market for most of the next decade.

Although arguably, once local manufacturers and importers of EPS/XPS foams containing HBCD are required to extensively and permanently label EPS/XPS products as containing a chemical that is persistent, bioaccumulative and toxic (PBT), this will hasten the adoption of alternative flame retardants.

### 6.2.3 Local industry position on the use of flame retardants

Consultation with the local EPS industry indicates that manufacturers will probably discontinue the use of HBCD as soon as substitutes are commercially available in Australia. EPS resin destined for waffle pods and insulation panels is currently (usually) imported with HBCD already incorporated into the resin, ready for blowing, and the lowest cost overseas suppliers (predominately China based) are not driving a shift to

the alternative flame retardants, and are not currently supplying substitute flame retardant impregnated EPS resin at a similar cost to the HBCD impregnated EPS resin.

Part of the reason for this slow transition is reported to be the currently limited global manufacturing capacity for the main HBCD substitute (brominated styrene-butadiene (BSB) copolymer), and its assumed higher cost, due to restricted production and possible patent protections.

The local industry perceives HBCD and BSB copolymer to be functionally equivalent, with possibly slightly higher concentrations of the substitute required for functional equivalence.

In summary, the local industry will probably discontinue using HBCD once the substitute flame retardants reach a commercially equivalent price, or due to regulation, potentially driven by Australia's ratification of the listing of HCBD to the Stockholm Convention.

### 6.2.4 Implications of HBCD to any future scheme

An evaluation of the human and environmental health implications of HBCD cross-contamination with EPS used for packaging are beyond the scope of this work, and EPS impregnated with HBCD is not currently categorized as a hazardous waste in any jurisdiction in Australia. However, while international, national and state/territory level regulatory matters develop, it may be important to investigate in further detail the collection and reprocessing systems to ensure and consider:

a) recycled EPS is only reprocessed into EPS for the built environment, and not food packaging,
b) separately labelling collections to avoid the cross contamination of EPS/XPS recovered from the built environment with EPS sourced from packaging applications.

This would address potential issues for EPS recyclate saleability and safety.

### 6.2.5 Implications of HBCD substitutes to any future scheme

As introduced previously, the main current substitute for HBCD is BSB copolymer. In 2014, the US EPA reported that this chemical is anticipated to be safer than HBCD, but the "alternative (BSB copolymer) is inherently persistent and its long-term behavior in the environment is not currently known" (US EPA, 2014, p. ii). Furthermore, and while the literature review was brief, no information on the degradation products of the long polymer chain BSB copolymer was discovered, nor the human and environmental health implications of these inevitable degradation products.

## 6.3 Existing EPS Recycling Programs in Australia

The below table presents a summary of facts and contacts for known existing EPS recycling programs in Australia, as of July 2017.

| Models | Company | Collecting EPS From | Start | Collection Method | Processing Method | End Destination |
|---|---|---|---|---|---|---|
| EPS Manufacturer-Collection & Drop (Not Retail) | Foamex | Collect EPS from clients using waffle pods & off cuts | 2005 | Foamex truck collects EPS off cuts from jobs it supplies | Reprocess EPS into new waffle pods & panels | Waffle Pods & Panels for domestic market |
| EPS Manufacturer-Collection & Drop (Not Retail) | Unipod | Drop off loose EPS for recycling | 2007 | Drop off at their Derrimut site | Reprocess EPS into new waffle pods | Waffle Pods domestic market |
| EPS manufacturer – collection and drop off from customers | Andpak | Collect unwanted fruit box packaging from farmer customers | N/A | Backhaul from farmer customers or drop off | Deliver ~900m$^3$ to Integrated Recycling for plastics recycling mix for product | Composite plastic product i.e., fence pilings |
| Reverse Logistics | QLS Logistics | Retail chain stores including: Harvey Norman, Good Guys & Bing Lee in Vic, NSW, ACT, QLD, SA & WA | 2013 | Purpose design EPS collection bags (see image overleaf) | Hot compaction | China |
| Equipment Provider – Buy Option | IS Recycling | Sydney Fish Market (SFM) & City of Monash | 2012 | Loose in bags & hot compacted | Hot compaction | China |
| Transfer Station Drop Off | City of Monash | ESP drop off at Notting Hill transfer station including local retail outlets including furniture & electrical retail | 2012 | Loose EPS drop off at transfer station | Hot compaction | China |
| Transfer Station Drop Off | City of Wyndham | ESP drop off at Werribee transfer station including local retail outlets including furniture & electrical retail | 2012 | Loose 20m$^3$ mesh cage | Collected by GT Recycling, Cold Compaction | China |
| Transfer Station Drop Off | Randwick City Council | Loose EPS Drop Off | 2012 | | Hot Compaction | China |
| Recycling Collection Company | Cleanaway | EPSA EPS Recycling Drop Off in ACT | 2016 | Cleanaway Transfer Station ACT | Drop Off Transfer Station | TBC |


**SOURCE: QLS WEBSITE** http://www.qlslogistics.com.au/recycle.html

## 6.4 Sample case study

DJR ENVIRONMENTAL

# Metropolitan Waste Management Group Polystyrene resource recovery project

### Background

The Metropolitan Waste Management Group (MWMG) in 2011 received funding from Sustainability Victoria's *Driving Investment for New Recycling* program, to undertake a 12 month pilot program to improve the efficiency of existing resource recovery centres through the establishment of collection points for the recovery of aggregated volumes of expanded polystyrene (EPS).

The project involved a partnership between the MWMG, nine metropolitan local governments, and EPS reprocessors - Foamex and Unipod.

### DJR Environmental's role

In partnership with the MWMG, DJR Environmental participated in the initial scoping of the project and subsequent funding application to Sustainability Victoria. The MWMG was awarded the project by Sustainability Victoria, and at that point DJR Environmental was appointed to support the MWMG with project management. During the pilot this included:

- Supporting the establishment of the trial with local government members and the reprocessors
- Organising for the fabrication and placement of EPS recovery infrastructure at participating sites
- Monitoring the recovery of EPS from the trial sites
- Monitoring the reprocessing and market outlets for the recycled EPS
- Reporting on the site specific and overall outcomes of the project

### Outcomes

The establishment and trialling of EPS drop off opportunities at select resource recovery centres during the 12 month pilot.

The MWMG, participating local governments and other interested Councils considering models to extend the program more broadly across the network of metropolitan Melbourne resource recovery centres, based on the viability of recovery, reprocessing and end markets identified in the initial pilot.

### SUMMARY

**Client**

Metropolitan Waste Management Group (MWMG)

**Completion date**

December 2012

**Services**

Project management

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RESOURCE MANAGEMENT / ENVIRONMENTAL SUSTAINABILITY / CONSULTATION

## 6.5 Abbreviations

ACT ..... Australian Capital Territory
ADF ..... Advance Disposal Fees
APRS ..... Australian Plastics Recycling Survey
BSB ..... Brominated Styrene Butadiene
CDS ..... Container Deposit Scheme
EPA ..... Environment Protection Authority
EPR ..... Extended Producer Responsibility
EPS ..... Expanded Polystyrene
EPSA ..... Expanded Polystyrene Australia
HBCD ..... Hexabromocyclododecane
MRF ..... Material Recycling Facility
NSW ..... New South Wales
NTCRS ..... National Television and Computer Recycling Scheme
OECD ..... Organisation for Economic Co-operation and Development
OPC ..... One Planet Consulting
PBT ..... Persistent, Bioaccumulative and Toxic
PLA ..... Polylactic Acid
POP ..... Persistent Organic Pollutants
PRO ..... Producer Responsibility Organisation
PSO ..... Product Stewardship Organisation
RIS ..... Regulatory Impact Statement
SWOT ..... Strengths, Weakenesses, Opportunities and Threats
XPS ..... Extruded Polystyrene

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