Packaging Materials Selector

Australian Fresh Produce Alliance
Growing a healthier Australia

Material	Material Characteristics	Applications	Raw Material	Barrier Characteristics	End Of Life	Carbon Footprint	Comments
Polyethylene terephthalate (PET) 1	Clear, tough, solvent resistant. Used for rigids, film, sheets and fibres. Softens: 55° C. SG = 1.38	Beverage, household products, bottles, food trays, laminated sheets, clear and printed packaging film.	Fossil Fuel (non-renewable). Limited availability of PET partially made from renewable resources, which is compatible with PET recycling.	Rigids: Barrier is gauge dependent. Good barrier to oxygen, medium barrier to moisture. Flexibles: Barrier can be enhanced by coatings or metallisation.	Rigid PET is widely accepted at kerbside and is technically recyclable. Additions of colours, seal coating or barrier layers might affect recyclability. PET flexible packaging film is not recyclable through REDcycle program*	2.99 kg CO2e per kg of basic material	Metallised PET films are excellent barriers to oxygen and often used to replace aluminium foil however note the recyclability concerns. Trays made of Crystalline PET (cPET) can be used in conventional ovens at up 220oC and are technically recyclable.
High density polyethylene (HDPE) 2	Hard to semi-flexible, waxy surface, opaque. Softens: 60° C SG = 0.96	Films, blow moulded containers and closures, crinkly shopping bags, freezer bags, milk bottles, buckets, rigid agricultural pipe and, milk crates.	Fossil Fuel (non-renewable). Sources of HDPE partially made from renewable resources (sugar cane/alcohol) are available and are compatible with HDPE for recycling.	Gauge dependent. A good moisture barrier and poor oxygen barrier.	Rigid HDPE is widely accepted at kerbside and is technically recyclable. Additions of colour may affect recyclability. Flexible HDPE can be recycled via the REDcycle program*.	2.17 kg CO2e per kg of basic material	Flexibles: HDPE can be used in multilayer co-extrusions to improve moisture barrier or rigidity, however this may affect the recyclability.
Polyvinyl chloride (PVC) Unplasticised (UPVC) 3	Hard rigid, can be clear, can be solvent welded. Softens: 70° C SG = 1.40	Clear food trays, clear cordial/ fruit juice handled bottles, blister packs, plumbing pipes and fittings.	PVC is largely derived from salt, an abundant, inexpensive resource, and ethylene, which is derived from natural gas (non-renewable).	Gauge dependent. A good oxygen barrier and a medium moisture barrier.	PVC is currently accepted at kerbside and can be recycled, however because of the negative impact this clear material has on the current plastic recycling stream, it's future at kerbside collection is in doubt.	2.20 kg CO2e per kg of basic material	Needs additives for processing and avoiding degradation. S ome additives are toxic.
Polyvinyl Chloride (V) Plasticised (PPVC) 3	Flexible, clear, elastic, can be solvent welded. Cling, good vapour barrier, excellent clarity and puncture resistant. Softens: 70° C. SG = 1.35	Meat and fresh produce wrap, Commercial stretch wrap, house-hold catering films and medical products.	PVC is largely derived from salt, an abundant, inexpensive resource, and ethylene, which is derived from natural gas. (non-renewable).	Gauge dependent. A good oxygen barrier and a medium moisture barrier.	Not Recyclable - Soft plastic is not recyclable at the MRF, and is not widely collected at kerbside. The soft plastic film is also a contaminant in REDcycle program*	2.20 kg CO2e per kg of basic material	PVC flexible properties make it suitable for food packaging to keep meat and other perishable produce fresh. Contains high level of plasticising compound. Incineration can generate hydrogen chloride gas and dioxins on burning.
Low density polyethylene (LDPE) 4	Soft, flexible, waxy surface trans-lucent, withstands solvents Softens: 40° C SG = 0.92	Plastic bags, packaging film (clear, coloured or printed), agricultural pipe, garbage bags, stretch and shrink films, silage and mulch films, garbage bin liners.	Fossil Fuel (non-renewable). Sources of LDPE made from renewable resources (sugarcane/alcohol) are available.	Gauge dependent. Good barrier to moisture, poor oxygen barrier.	Rigid LDPE is Recyclable at kerbside and will be recycled with the Mixed Plastics stream and some value will be lost. Soft LDPE film is only recyclable via REDcycle program*	2.35 kg CO2e per kg of basic material	Sub families include LLDPE, ULDPE, metallocene LDPE. These can provide superior properties enhancing clarity, sealability, strength, etc.. LDPE are often used as sealing layers in laminates and co-extrusion. Typical laminates (flexibles) include BOPP// LDPE, PET//LDPE, LDPE//LDPE. Recyclability may be affected.
Polypropylene (PP) 5	Semi-crystalline, wide property and application range. Translucent (injection moulded), exceptionally clear (cast film and BOPP films), hard, flexible, good chemical resistance, low SG. Softens: 80° C SG = 0.90	Films (confectionery & chip wrap), pails, clear punnets/trays, bottles, hinged caps and closures, micro-wave ware, packaging, plant pots.	Fossil Fuel (non-renewable).	Rigid containers: Good moisture barrier, poor oxygen barrier. BOPP film: Good moisture barrier, poor oxygen barrier. Metallised BOPP film: Excellent moisture barrier, good oxygen barrier.	Rigid PP containers are Recyclable at Kerbside and will be recycled with the Mixed Plastics stream, where some value will be lost. The addition of colour or seal coating or barrier layers also affect the recyclability. Thin films/ flexible packaging can also be recycled via the REDcycle program*	2.20 kg CO2e per kg of basic material	BOPP film is extensively used in flexible packaging (eg in lettuce bags) Permeability to moisture can be enhanced by laser micro perforation of by mechanically placed holes in the film.
Polystyrene (PS) 6	Clear, glassy, rigid, brittle, semi-tough, melts at 95°C. Softens: 85° C PS = 1.06	Meat & poultry trays, yoghurt and dairy containers, vending cups. Refrigerator bins and crispers, air conditioners, coat hangers. Ex-panded PS (EPS).	Fossil Fuel (non-renewable).	Medium barrier to oxygen and moisture in its unmodified form. Note that PS is vulnerable to stress cracking in the presence of fats and oils.	Polystyrene is currently recycled at kerbside and will be recycled with the Mixed Plastics stream and some value will be lost. Note: The future of Polystyrene as a recyclable material is currently under review.	3.96 kg CO2e per kg of basic material	Properties can be modified to meet requirements for both clarity, temperature performance and breakability. Expanded PS is extensively used in produce export boxes; however EPS is currently classified as not recyclable through Australian Kerbside collection.
Paper/Cardboard	Versatile material, light and strong, rigid or flexible, moisture sensitive, limited gas barrier, product invisibility.	Bags, sacks, sheets, cartons, boxes, trays, labels, inserts, cushions, laminates/coated paper.	Renewable Resource - Timber (assuming it is sourced from certified forest stewardship programs such as FSC or PEFC).	Very poor moisture and oxygen barrier in its uncoated form.	Recyclable. Addition of coatings to improve presentation (typically PET or PP laminates) or moisture resistance (PE extrusion coating) may affect recyclability.	1 - 1.5 kg CO2e per kg of basic material	Reduction in physical properties due to recycling; usually additives and/or more material needed to compensate loss of performance. To aid recycling, more rigid cardboard packaging needs to be flat (i.e. If the shortest dimension is <10% of the longest dimension, then the object to be two dimensional and will not be separated as plastic).
Compostable polymers 7 OTHER	A vast range of very different material families. Compostable certification required under the Australian Standards AS4736 for industrially compostable materi-als or AS5810 for home com-postable materials.	Bags, sacks, sheets, cartons, boxes, trays, labels, inserts, cushions, laminates.	Some are from renewable resources such as wood pulp, corn, bagasse, wheat straw, etc. Some are from non-renewable fossil fuels such as aliphatic polyesters. Some are hybrids of the above.	Material and structure dependent. Laminates can be formulated to improve moisture and oxygen barriers.	Currently consumers don't have ready access to facilities for the collection and composting of compostable packaging with organic waste. Home composting is an option, but these materials are not recyclable and may result in contaminating the recycling system. **Note that there is no composting or biodegradation in properly operated landfills.**	Broad range. Material dependent. Eg: 3.39 kg CO2e per kg of Polylactic Acid (PLA)	Verification of compostability according to Australian Standards AS4736 for industrial composting or AS5810 for home composting is available from the Australasian Bioplastics Association (ABA). Certified commercial composters can be identified via the Australian Organic Recycling Association (AORA).
Renewable polymers 7 OTHER	Made from renewable resources, obtained through chemical modification of natural polymers, such as starch, cellulose, or chitin. **Note that renewable materials are not necessarily compostable.**	Rigids containers, packaging films, trays.	Renewable resources include: **Sugarcane:** renewable PE, partially renewable PET. **Wood pulp:** paper, paperboard, cellulosic materials. **Sugarcane, cassava and corn:** renewable PBS **Corn starch:** Polylactides (eg PLA).	Material and gauge dependent. Generally poor moisture barriers unless metallised. Generally good oxygen barriers.	Certified compostable materials - refer above. Some renewable resources based materials will be compatible with the recycling system. Others are likely to end in landfill or be a contaminant to the recycling system. EOL option must be verified via APCO's PREP tool.	Broad range. Material dependent. Eg: 3.39 kg CO2e per kg of Polylactic Acid (PLA)	Suitability for the intended application needs to be assessed case by case, particularly to ensure approved/acceptable EoL options.

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Reference Information

Material Characteristics[1]

This provides a description of the characteristics of the primary packaging material, including chemical aspects and properties. Plastics information is available from Chemistry Australia's website, the pre-eminent national body representing Australia's chemicals and plastics industries.
Specific Gravity (SG) refers to material density, in gm/cm^3.

Application[1]

Information for plastics was sourced from Chemistry Australia[2], providing a list of the applications that primary packaging material can be used.

Raw Materials

Identifies the main raw materials used in the production of the material and if the material is a renewable or non-renewable.

Barrier Characteristics[2]

The Barrier characteristics of a material is dependent on the gauge of the materials. These indications provide comparison ratings on the various materials and do not provide specific barrier performance results. "Excellent" would reflect the oxygen and moisture barrier performance of materials such as steel, aluminium and glass. "Very Poor" would reflect the oxygen and moisture barrier performance of paper.

Barriers can also be enhanced by film orientation and applications of other polymers or metalising, these applications will impact the EoL treatment of the materials.

End of Life (EoL)[3]

This is a term used to describe the expected disposal option of packaging when the customer/consumer has removed the product, i.e. Reuse, Recycle, Compost or Landfill.

In 2018 the Australian Packaging Covenant Organisation (APCO) made available to its members the Packaging Recyclability Evaluation Portal (PREP). This online tool uses recyclability information gathered from across Australia and New Zealand to enable users to conduct a PREP assessment, generating reports. These reports are used to inform the application of the Australasian Recycling Label (ARL). The aim to increase recycling and recovery rates and contribute to cleaner recycling streams.

The Australasia Recycling Label (ARL) is an evidence-based, standardised labelling system that provides clear and consistent on-pack recycling information to inform consumers of the correct disposal method. The ARL is designed to be used in conjunction with PREP, which informs the user of the correct on-pack ARL artwork for each 'separable component' of packaging. It is a simple and effective method to improve consumer recycling behaviours.

*REDcycle Program

The REDcycle program was launched in 2011 and is a recovery initiative for post-consumer soft plastic. This product stewardship model is supported by leading brand owners, Supermarkets, Industry Groups and Governments. Over 90% of the Australian population have access to a REDcycle bin via the REDcycle supermarket drop off.

The recovered material is used as raw material for useful products such as benches, bollards, manufactured by REDcycle's partner, Replas. REDcycle also partners with Close the Loop and Downer Group for Australian municipal road infrastructure.

Carbon Footprint

Data Source: EcoInvent 3.3 database.

Conversion processes required to transform the material into its final packaging format will add to the carbon footprint.

Compostable and Renewable Polymers[4,5]

- Degradable polymers (including Oxo-biodegradable polymers and Photodegradable polymers) are those made with plastics, but with additives to help them disintegrate faster. It is still plastic which will end up in smaller pieces and be a bigger hazard to wildlife than plastic that take a long time to degrade. These materials are progressively being banned in advanced jurisdictions as they do not compost under home or industrial composting conditions.
- Water-soluble polymers are those that dissolve in water within a designated temperature range and then biodegrade in contact with micro-organisms. An example is PLANTIC, a high barrier biobased recyclable made from recycled PET, with a thin layer of Plantic R material. During the recycling process, the thin Plantic plant starch layer uniquely washes away, enabling the PET to be recycled.
- Biodegradable polymers. Biodegradable refers to a natural process during which micro-organisms that are available in the environment convert materials into natural substances such as water, carbon dioxide and biomass (artificial additives are not required). The process of biodegradation depends on the surrounding environmental conditions e.g. location or temperature, on the material itself, and on the application. Biodegradability is an inherent property of certain bioplastic materials that can benefit specific applications. e.g. food/organic waste bags, food service ware, agricultural films and wraps. However, the term biodegradable, by itself, does not imply any timeline to achieve full biodegradation, nor does it infer the usability or quality of the resulting by-products 4, 5. For EoL purposes, compostability is the target, not biodegradability.
- Compostable polymers are those biodegradable polymers (or goods made from them) that have been tested and verified to actually compost within the times and conditions specified. Additionally, the resultant compost meets specific quality and ecotoxicity criteria detailed in Australian Standards AS 4736-2006 (biodegradable materials suitable for commercial composting) or Australian Standard AS 5810-2010 (biodegradable plastics suitable for home composting). Verification of conformance to these Australian Standards is available via the Australasian Bioplastics Association.
- Starch – (aliphatic) polyester blends that mix thermoplastic starch with polyesters made from hydrocarbons. Examples: Bagasse & Wheat Straw

References

1. Chemistry Australia 'Plastics Identification Code'.
2. Moisture & Oxygen Barrier Chart: Best of plastics: Barrier packaging by Don Rosato.
3. Australian Packaging Covenant Organisation (APCO) APCO PREP.
4. Australasian Bioplastics Association Peak body for bioplastics and operating the verification program for compostable materials for AS4736 Industrially Compostable Materials and AS5810 Home Compostable Materials.
5. Environment Australia Biodegradable Plastics – Developments and Environmental Impacts. Prepared by Nolan-ITU Pty Ltd and ExcelPlas Australia.
6. Sustainable Packaging Design – Australian Institute of Packaging, K. Chessell, University of Melbourne, Food Packaging Materials Processes Graduate Program.

Sustainable Packaging Design

Packaging Design Guidelines[6]

Key functions of packaging.

1. Food packaging must ensure the safe delivery of food to the consumer, providing barrier from external element. Accordingly, the packaging must contain and protect the product from physical and temperature damage, including protection from chemical and microorganism deterioration.
2. The packaging must minimise the cost of materials and delivery.
3. The packaging needs provide safety features like tampering resistance and child proof closures.
4. The packaging provides the consumer with product information, allergens and nutritional data. For the manufacturer, it provides the key point of sale for the product to the consumer - product presentation, brand identification, information and convenience for the product from the moment of production through until it is ultimately consumed.
5. The packaging must be easy to carry, open, use and perhaps reseal. Consumers require convenience from the product they purchase and seek information of correct environmental recycling or repurposing.
6. Packaging plays an important role in protecting food from damage and contamination, it extends the useful life of food items on the retail shelf and at home, thus potentially reducing food waste and its significant environmental impacts. Today, there is a strong focus on the environmental aspects of food packaging to ensure that at the end of its life (after use of the product contained) that it can be reused, recycled or composted.

Key factors before commencing packaging design

1. As early as possible in the initiation stage of a packaging design project, it is suggested to have the Marketing & Product development groups document the following information:
   - Pack size (volume or weight),
   - Design or style of pack,
   - Shelf life of the product (barrier),
   - Process (temperature, pressure),
   - Sealing or lidding,
   - Usage of the product (dosage & handling),
   - Labelling and Branding,
   - Launch timing, and
   - Volumes.
2. Document with the Product Development groups assistance and agreement with the Manufacturing group the following production and process requirements:
   - Production line options,
   - Production line dimensional limitation – (packaging infeed, filler; sealer, packer, palletiser),
   - Capacity restraints, and
   - Change parts
3. The Retail or Wholesale customers requirements provide the final details and dimensional data required to allow the finalising of the package design. The Australian Food and Grocery Council (AFGC) has available on the ECR Australasia website and number of Toolkits to assist companies understand the Retailers requirements: www.tradingpartnerforum.com.au/toolkits/

Customer requirements (retailer/wholesaler) include:

- Case size (number per outer),
- Shelf Ready & Shelving dimensions,
- Case weight,
- Maximise Shelf & Palletisation,
- Barcoding, and
- Case branding & information.

10 key factors in designing sustainable packaging[6]

1. Start with commodity materials that are commonly recycled at major municipalities: #1 PET, #2 HDPE, aluminium, glass, paper, paperboard.
2. Design the package from a single material. Single-material packages are easier to identify and separate during recycling.
3. Undertake a PREP analysis to understand recyclability issues.
4. Review the product-to-package ratio. The package should be as small as possible while still protecting the product and providing adequate branding real estate.
5. Design for assembly at the point of manufacture. Think through the assembly steps, as well as the use of hand labour versus automation; the more efficient the better.
6. Avoid gluing and laminations. Laminations and glue make it difficult to separate materials for recycling and can negatively impact what would be an environmentally friendly package.
7. Design for distribution. Design the primary, secondary and tertiary package from the beginning, looking to optimise all package dimensions for pallet efficiency.
8. Eliminate secondary and tertiary packaging when possible. Look for opportunities to make the primary package more robust, as well as combining functions of shipper and point-of-purchase (POP) displays.
9. Design for disassembly. The end user will ultimately be responsible for cleaning and separating the packaging components for end of life disposal. Apply the Australasian Recycle label (ARL) so that the end user knows what needs to be done in disposing of the packaging.
10. Use Lifecycle Assessment. It is important to understand the entire supply chain in order to achieve sustainable savings and address environmental issues. Improvements in distribution could greatly offset a more premium material selection or increase in manufacturing complexity.

Australian 2025 National Waste Targets

The Australian Packaging Covenant Organisation (APCO) was endorsed to lead the government's response to the China Ban issue, setting targets to achieve 100% recyclable, reusable or compostable packaging in Australia by 2025, these are listed below: