ENVIRONMENTAL IMPACT WHITE PAPER

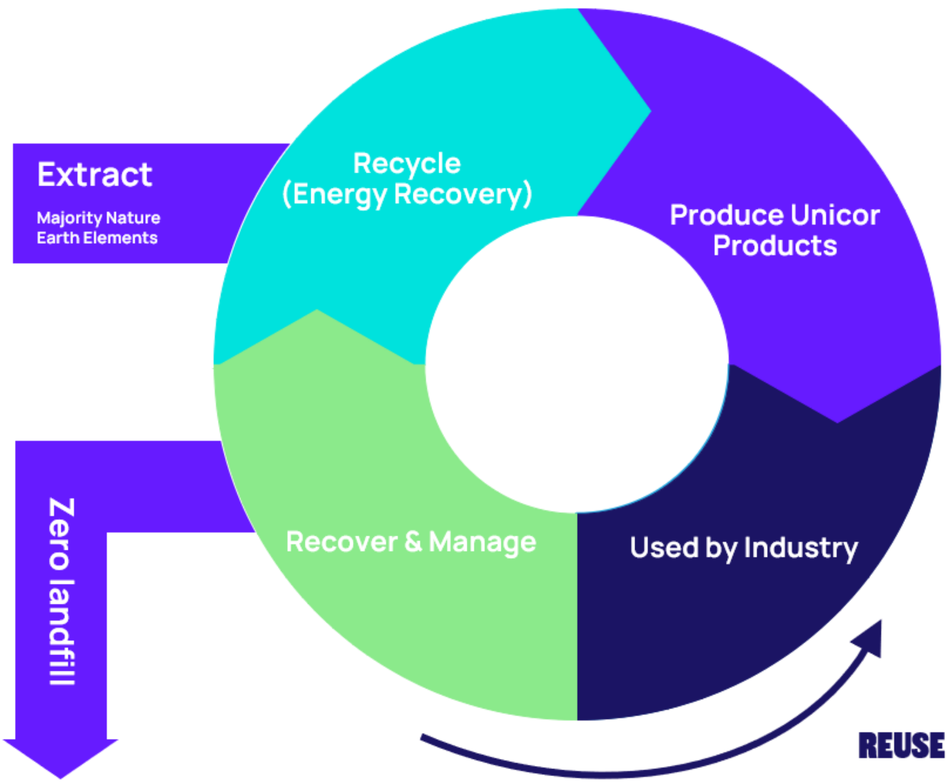
DISRUPTIVE PACKAGING

Better packaging. No compromises.

OVERVIEW

This paper outlines the benefits of a new packaging system for fresh produce and seafood that can achieve better business outcomes while reducing waste and emissions.

The packaging industry is under pressure to meet increasing demands for environmentally improved solutions. As the concept of a circular economy gains traction throughout the world, single use packaging is becoming much less acceptable. New innovative solutions are required. The new packaging system presented here, called Unicor®, is manufactured from at least 65% renewable materials and can be reused and recycled multiple times.



Disruptive Packaging

Disruptive Packaging Pty Ltd. ('DP'), headquartered in Sydney, Australia, is the inventor and manufacturer of Unicor®. The aim of the company is to provide the market with the world's first commercially viable, non-paper corrugated box and other packaging to tackle several logistics, cold chain and environmental issues.

For the last 25 years the packaging industry has tried to engineer a solution to waterproof conventional paper products whilst maintaining recyclability to solve these issues. The Unicor® material achieves this. In addition, the company's ethos is to embrace a circular economy by ensuring the material is 100% reusable and recyclable.

DRIVERS FOR CHANGE

Food producers and retailers are seeking more sustainable packaging solutions in response to several trends, including ambitious circular economy goals, recycling targets, increasing consumer interest in sustainable solutions and calls to phase out problematic packaging materials such as expanded polystyrene (EPS).

Striving for a Circular economy

There is increasing recognition that conventional linear models of production, use and disposal are no longer sustainable. We need to develop new business models that keep products and materials in use for longer and recover materials in high value, circular recovery loops.
This is the idea of a 'circular economy', which is championed by leading organizations such as the Ellen Macarthur Foundation (EMF).

The concept of a circular economy is based on three principles[1] :

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

EMF have identified three transitional strategies to achieve a circular economy for plastics[2] :

1. Without fundamental redesign and innovation, about 30% of plastic packaging will never be reused or recycled. One of the priority actions is to actively explore replacing 'uncommon' plastic packaging materials that make up a relatively low percentage of the packaging market, such as polyvinyl chloride (PVC), polystyrene (PS) and expanded polystyrene (EPS), with alternatives.

2. For at least 20% of plastic packaging, reuse provides an economically attractive opportunity. One of the priority actions is to scale-up reusable packaging in a business-to-business setting for large rigid packaging.

3. With concerted efforts on design and after-use systems, recycling would be economically attractive for the remaining 50% of plastic packaging.

Recycling targets

In 2018 Australian governments endorsed a target for 100% of packaging to be reusable, recyclable or compostable by 2025. This is supported by three other targets:

- An average 30% recycled content in packaging
- 70% of plastic packaging to be recycled or composted
- Phase out of problematic and unnecessary single use plastic packaging

These targets are included in the National Waste Policy Action Plan[3] that was endorsed by Australian Environment Ministers in November 2019. They are also aligned with targets proposed by the EMF globally and the Plastics Pact in the UK[4]

Consumer expectations

There is growing consumer interest in sustainable packaging, with a focus on issues such as reusability, recyclability, compostability and use of renewable materials[5] . Many brands are responding by implementing ambitious environmental or sustainability programs for packaging. This is demonstrated by the growing number of organizations that have signed up to the EMF's New Plastics Economy Global Commitment[6] .

Phasing out problematic materials

Many jurisdictions around the world, including in Australia, have identified single use plastic materials or products that should be banned or phased out because they are not recyclable or cause environmental harm. Some of these specifically target EPS, for example the UK Plastic Pact identifies 'all polystyrene' (including EPS) as one of the eight priority categories to be phased out[7] .

UNICOR®: A MORE CIRCULAR SOLUTION

Manufacturing

Unicor® is made from 65% calcium carbonate (limestone) and 35% high density polyethylene (HDPE). The limestone is extracted from existing limestone quarries and processed into a fine powder. The HDPE is currently manufactured from non-renewable oil and gas, but renewable alternatives including plastics made from sugar cane are being investigated. Unicor® is currently manufactured in China and delivered flat-packed to Australia for conversion into boxes. DP plans to manufacture the material in Australia and North America from 2023.

Functional benefits

Unicor® provides a packaging solution that is stronger, waterproof and more versatile than alternatives, at a competitive price. The corrugated boxes have unique advantages in environments where high compression resistance, impact resistance, resistance to large angle distortion or moisture resistance are critical.

Unicor® is suitable for manufacturing a wide range of products including boxes to transport vegetables, fruits, seafood, meat, poultry, electronics and electrical appliances, aviation instruments, heavy-duty mechanical and auto parts and pharmaceuticals. Other applications include signage, construction materials, pallets and industrial protective packaging. It can be customized according to customer requirements for colour, pattern, specifications, box shape, usage etc.

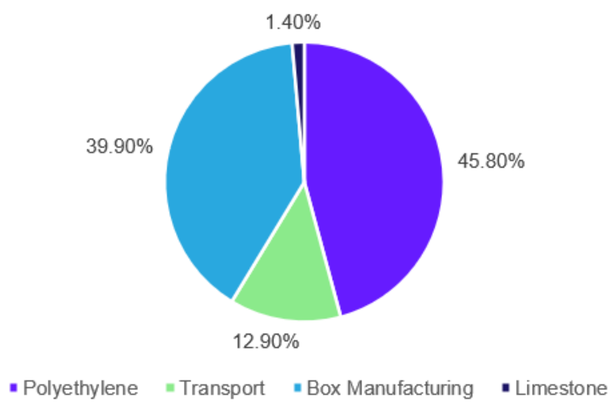
ENVIRONMENTAL IMPACT

The environmental impacts of Unicor® have been estimated using Life Cycle Assessment (LCA).

Box manufacturing

The manufacture of Unicor® boxes generates around 2.3 kg of carbon dioxide equivalent emissions (CO_2e) for each 100 litres of capacity[1] . Figure 1 shows that most of the impact is from manufacturing HDPE (45.8%) and box manufacturing (39.9%). Limestone has a very low impact despite making up a large proportion of the box's weight.

Figure 1: Climate change impact of a Unicor® box (CO_2e)



Life cycle impacts

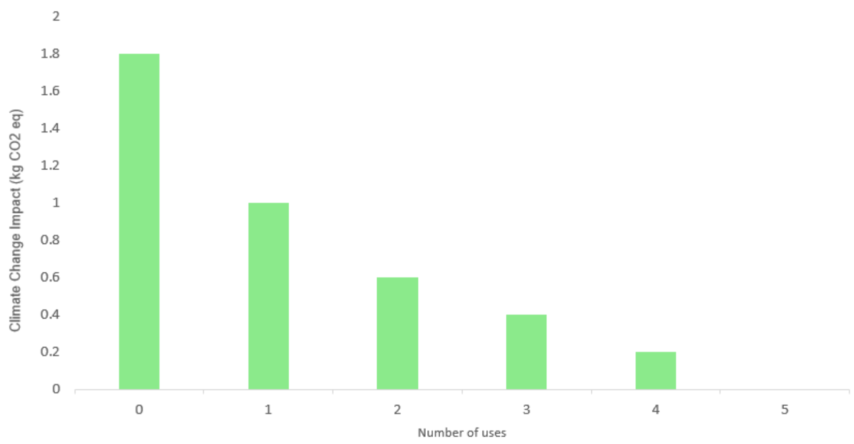
When the whole life cycle of the packaging is considered, from raw materials processing through to disposal (commonly referred to as 'cradle to grave'), the carbon footprint falls to 1.8 kg CO_2e if 50% of the boxes are recycled due to the carbon reductions that this achieves. Figure 2 shows the net carbon impact of the box. Most of the emissions are generated during materials manufacturing (mostly HDPE) and box conversion, with a relatively small contribution from transport. The carbon emission savings from recycling are based on a 50% recycling rate.

Figure 2: Climate change impacts of Unicor® over the full life cycle, per 100L capacity2

Reuse

Unicor® boxes are strong and scuff-resistant, so they can be reused up to five times. This reduces waste and avoids the impact from manufacturing material for new boxes. By reusing a box, the entire environmental cost of production for that box is offset for a small amount of transport. This means that one reuse essentially halves the environmental cost, two makes it one third of the cost, etc. This is shown in Figure 3.

Figure 3: Unicor®, global warming impact for number of reuses[3]



Recycling

Unicor® boxes can also be returned to DP for recycling, where they will be shredded, granulated and pelletized for manufacture into new boxes. Recycling reduces the carbon footprint significantly, from 2.3 kg CO_2e (assuming no boxes are recycled) to 1.8 kg if 50% of the boxes are recycled and 1.4 kg if 100% of the boxes are recycled, per 100L. A more conservative estimate of 50% recycling is assumed for the life cycle comparisons in the next section.

COMPARISON WITH ALTERNATIVE PACKAGING SYSTEMS

The main alternatives to Unicor® are EPS, waxed cardboard, uncoated cardboard and Corflute®.

Expanded polystyrene

EPS has excellent cushioning and thermal insulation properties and is therefore widely used to transport fresh produce, electronics and other goods. Waste management and recycling are problematic, however. EPS is bulky and therefore difficult and expensive to dispose of. While EPS is recyclable, it is generally uneconomic to collect and recycle because of the high volume-to-weight ratio, high costs of storage and transport and the low value of the recycled material.

Approximately 22,000 tonnes of EPS packaging were placed onto the Australian market in 2017-18 (including 12,000 tonnes of business-to-business (B2B) packaging) and 4,000 tonnes were recycled. This equates to a recycling rate of around 18%[8] . Most recovery is from large end users such as fish and produce markets. The remainder – around 18,000 tonnes or 360,000 m^3 – was sent to landfill. Around 240,000m^3 of this was B2B packaging including boxes.

Cardboard

Uncoated corrugated cardboard boxes are used extensively to transport dry goods at ambient temperatures. They are easy to recycle and have good secondary markets, but their poor water resistance means that they are generally unsuitable for cold chain distribution or other moist environments. Approximately 2.4 million tonnes of corrugated boxes were used in Australia in 2017-18 and 69% of this was recycled[9] . Most of the remainder – 745,000 tonnes – was sent to landfill.

Waxed cardboard

To achieve the necessary structural and water-resistant properties required for refrigerated products, corrugated cardboard boxes generally require a polymer or wax coating. This inhibits recycling because the coating is difficult to remove from fibre during the pulping process.
The recycling rate for waxed cardboard produce boxes is unknown, but is likely to be close to zero due to the material's incompatibility with the current paper recycling system. It has been estimated that around 400,000 tonnes of waxed or polymer coated cardboard are disposed to landfill each year[4].

Corflute

Corflute sheet is made from twin walled polypropylene. It is lightweight, durable and has good water resistance. While technically recyclable, the limited availability of collection and recycling services in the supply chain mean that recycling rates are likely to be very low. The recycling rate for all polypropylene packaging in 2017-18 was 8%[10].

LIFE CYCLE COMPARISON

The life cycle environmental impacts of Unicor® were compared to alternative packaging materials using LCA. This focused on three environmental indicators:

More information on the methodology is provided in the Appendix

Climate change impacts

Water consumption

Particulate emissions

Climate change impact

Greenhouse gas emissions generated by Unicor® boxes over their full life cycle are estimated to be 27% lower than cardboard, 40% lower than EPS, 55% lower than Corflute and 67% lower than waxed cardboard for an equivalent functional unit (100L capacity).

Figure 4 shows the relative contributions of each life cycle stage, from materials through to disposal, for each alternative. The bars above the line represent a negative impact and the bars below the line a positive impact (associated with recycling). The net impact is represented by the light purple bar. Unicor®'s impact is lower than EPS, even though EPS is much lighter in weight, because limestone has an extremely low carbon footprint. It is also expected to achieve a higher recycling rate. For these comparisons recycling rates of 10% were assumed for waxed cardboard, 20% for EPS, 50% for Unicor® and Corflute, and 80% for cardboard[5] . The net climate change impacts of the alternatives are highlighted in Figure 5.

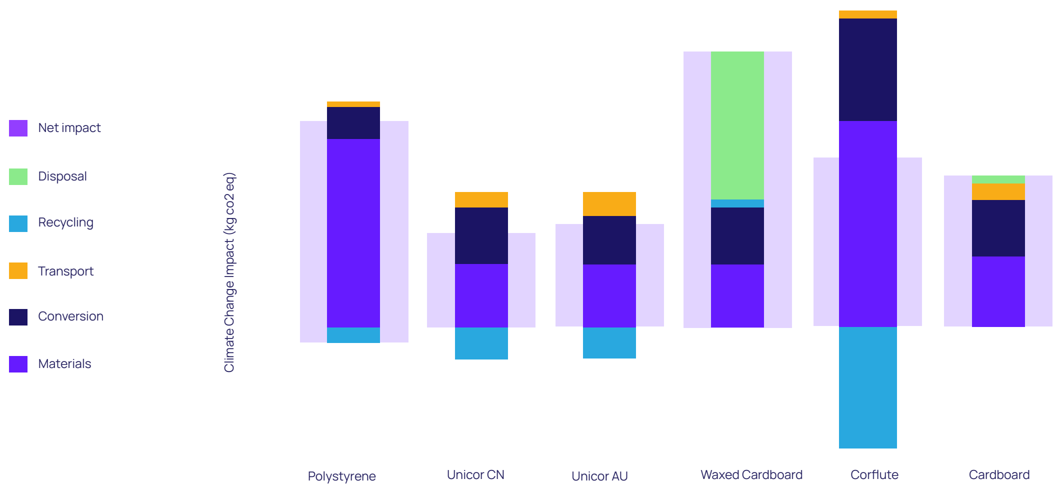
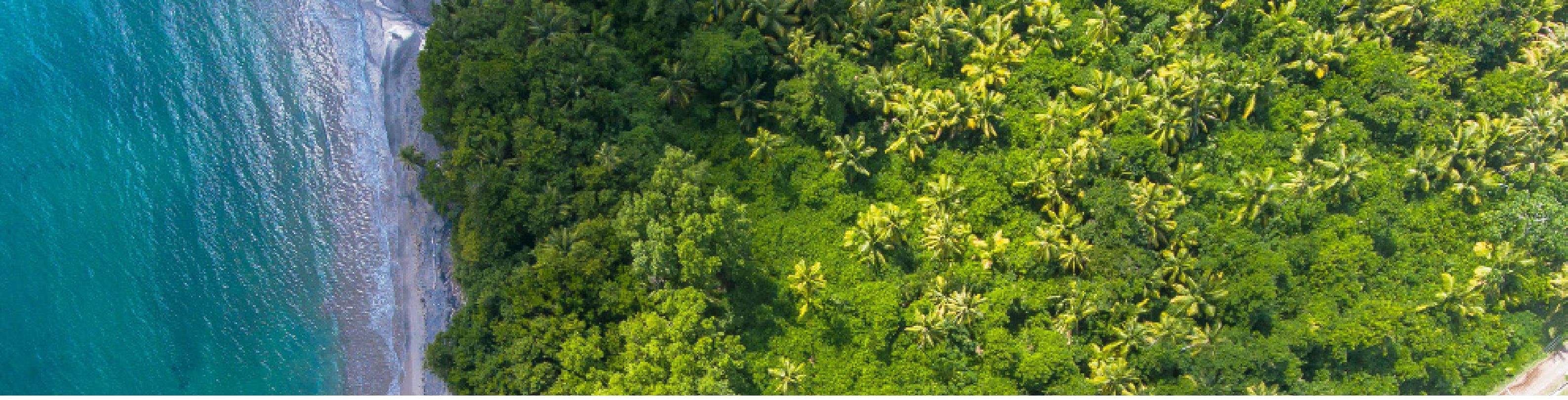


Figure 5: Net climate change impact of Unicor® (China and Australia), EPS, waxed cardboard, Corflute and cardboard; cradle to grave, per 100L



Water consumption

Water impacts of the different boxes are measured using a water scarcity metric. This considers both the amount of water used over the life cycle as well as the relative scarcity of water in the source locations. The LCA shows that the amount of water used to make Unicor® boxes over their full life cycle is estimated to be 50% lower than Corflute, 76% lower than cardboard, 88% lower than EPS and 85% lower than waxed cardboard for an equivalent functional unit (Figure 6).The main reasons for this are that limestone mining and milling uses very little water. The HDPE component of Unicor® requires 85% less water use than polystyrene on a kilogram for kilogram basis. Paper pulping is a relatively large water user, which increases the impact of cardboard. The net water impacts of the alternatives are highlighted in Figure 7.

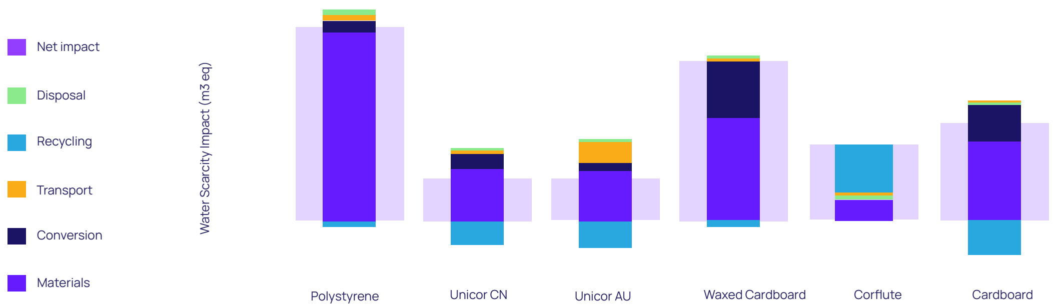


Figure 6: Water scarcity impact of Unicor® (China and Australia), EPS, waxed cardboard, Corflute and cardboard; cradle to grave per 100L7

Note: Results are shown for Unicor® manufactured in China (CN) and Australia (AU)

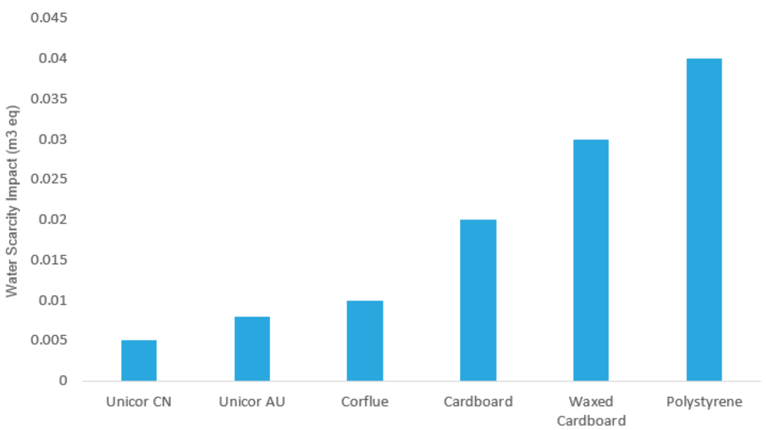


Figure 7: Net water scarcity impact of Unicor® (China and Australia), EPS, waxed cardboard, Corflute and cardboard; cradle to grave per 100L

Note: Results are shown for Unicor® manufactured in China (CN) and Australia (AU)

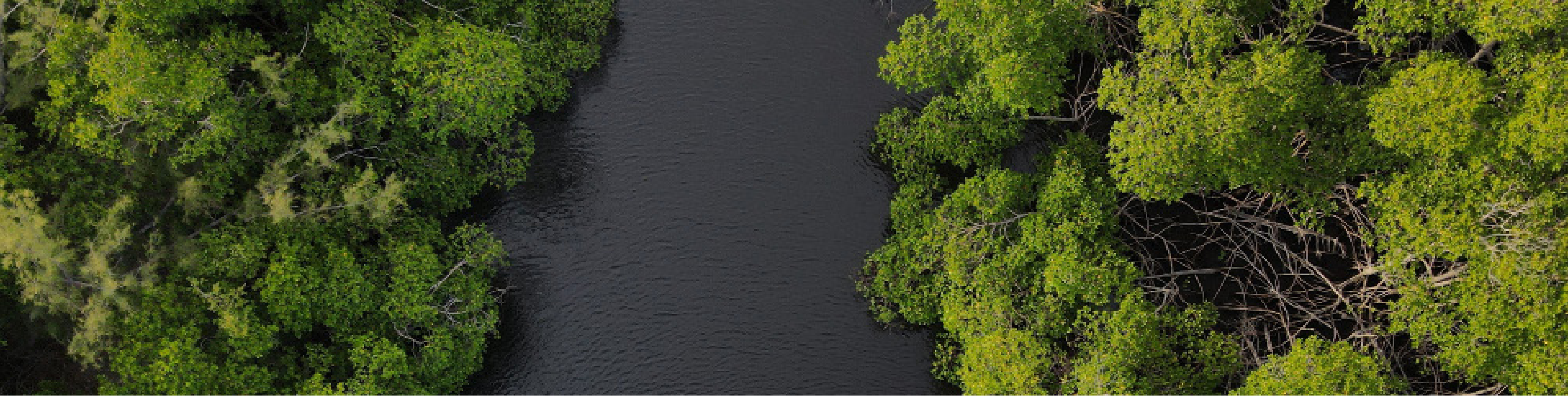
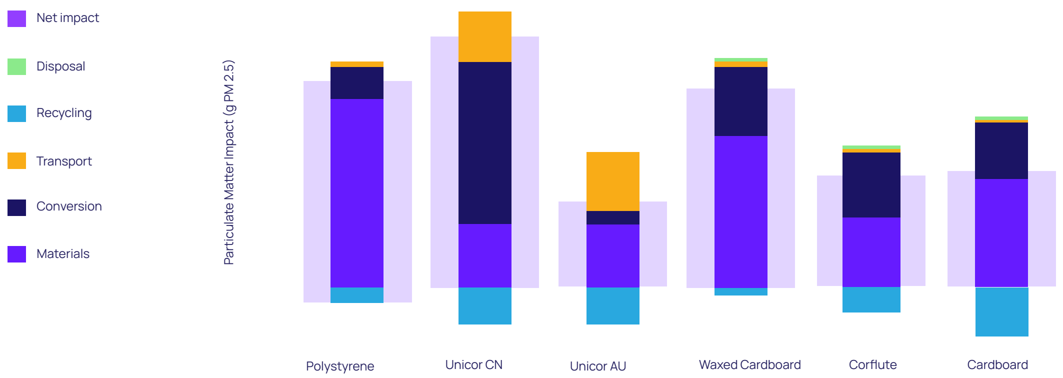


Figure 8: Particulate matter impact of Unicor® (China and Australia), EPS, waxed cardboard, Corflute and cardboard; cradle to grave per 100L8

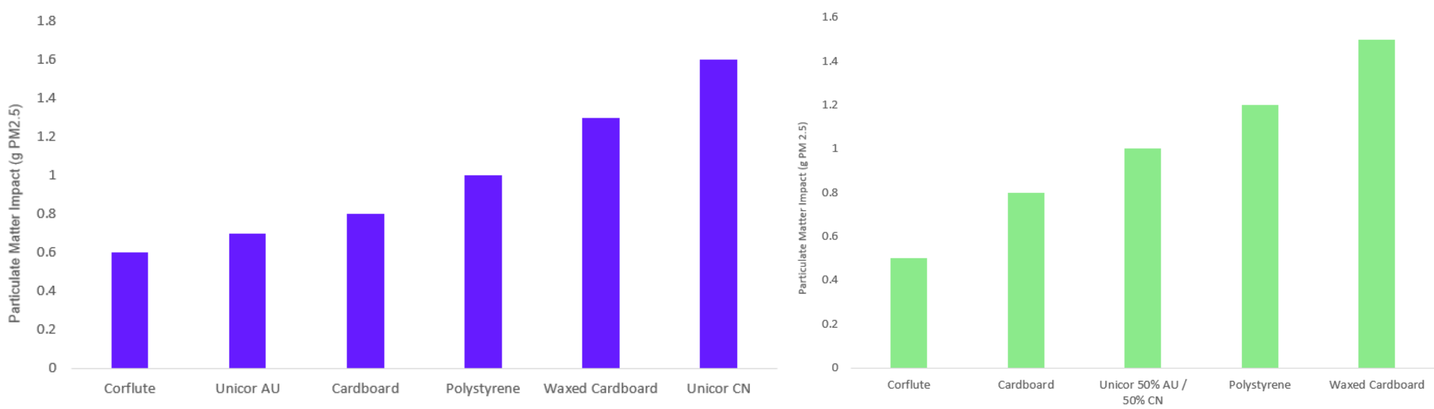


Particulate matter

Particulates in air emissions have a significant impact on human health. The impacts of Unicor® boxes on particulate matter over their full life cycle are higher than the alternatives when manufactured in China. This is because particulate emissions from Chinese power generation are a serious health concern. There is also an impact from transport to Australia. DP plans to move manufacturing to Australia and North America. Modelling of this option shows a significant reduction in emissions due to the cleaner electricity supply and reduced transport distances.

The LCA results show that under this scenario, particulate emissions for Unicor® are similar to Corflute but 20% lower than cardboard, 47% lower than EPS and 60% lower than waxed cardboard (Figure 9). Particulate emissions for EPS are primarily from oil and gas refining and the petrochemical supply chain. Impacts for cardboard are primarily from burning of biomass (pulpwood lignin) at pulp mills. The net particulate matter impacts of the alternatives are highlighted in Figure 8 & Figure 9.

Figure 9: Net particulate matter impact of Unicor® (China and Australia), EPS, waxed cardboard, Corflute and cardboard; cradle to grave per 100L



CONCLUSION

Unicor® is both reusable and recyclable. It has the potential to replace up to 12,000 tonnes of EPS packaging, which is difficult to recycle because of its high volume-to weight ratio and low commercial value at end of life.

Around 240,000m^3 of EPS from B2B packaging are currently disposed to landfill each year. Unicor® also has potential to replace some of the estimated 400,000 tonnes of non-recyclable waxed cardboard that is currently sent to landfill. Unicor® also has functional and environmental benefits compared the alternatives. Its main component is a renewable material (limestone); it can be reused up to five times and then recycled; and it has a lower carbon footprint and reduced water impacts over the full life cycle. Because the Unicor® material is currently manufactured in China and imported to Australia for conversion into boxes it has a higher impact on particulate emissions than alternatives.

In future DP plans to manufacture the material in Australia and North America, which will greatly reduce this impact.

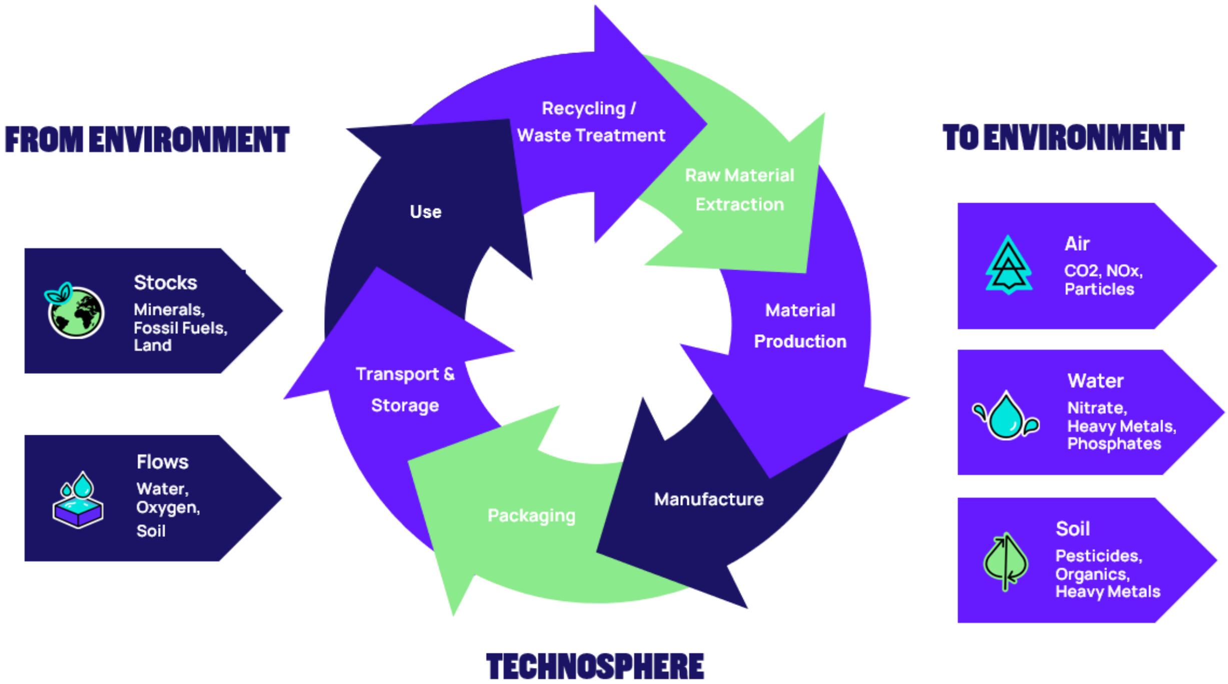
APPENDIX: LCA METHODOLOGY

This LCA was undertaken by Tim Grant from Life Cycle Strategies in September 2019.

What is life cycle assessment (LCA)?

LCA is a methodology for estimating environmental flows associated with a product. As shown in Figure 10 these include inputs from the environment (minerals, water etc.) and emissions and wastes into the environment (carbon dioxide, heavy metals etc.)

Figure 10: Material flows modelled in LCA



Functional unit

LCA is based on comparison of alternative ways to provide a defined function/utility/service. The functional unit for this LCA is based on delivery of 100 litres of produce to market.

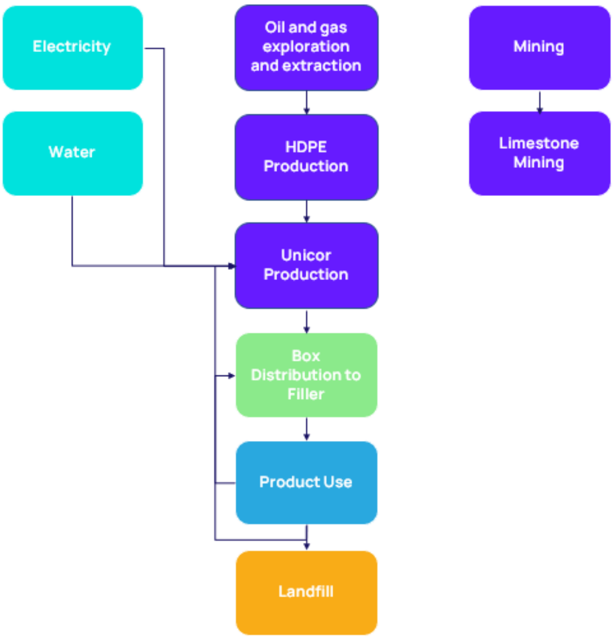
This equates to:

- 1.4 times the functional unit for a 71 litre Unicor® box weighing 1300g
- 1.4 times the functional unit for a 71 litre Corflute box weighing 1190g each
- 1.6 times the functional unit for a 64 litre waxed cardboard box weighing 1120g each
- 1.9 times the functional unit for a 53 litre cardboard box weighing 560g each
- 2.0 times the functional unit for a 50 litre EPS box weighing 378g each

System boundaries

The LCA modelled environmental flows from the extraction of raw materials through to landfill (Figure 11).

Figure 11: System boundaries for the comparative LCA



Indicators

The LCA used three indicators to measure environmental impact:

- Climate change measured as kg of carbon dioxide equivalents (kg CO_2 eq). This means that all greenhouse gas emissions including carbon dioxide and methane are converted into equivalent units of CO_2
- Particulate matter, which measures grams of particulate matter less than 2.5 microns in size (g PM2.5)
- Water scarcity measured in cubic metres equivalent (m3 eq). This combines water use over the life cycle of the product with a measure of relative water scarcity at the water source

Assumptions

Recycling rates

For these comparisons recycling rates of 10% were assumed for waxed cardboard, 20% for EPS, 50% for Unicor® and Corflute and 80% for cardboard.

Recycling process

Unicor® is assumed to be recycled using simple grinding process and reincorporated into new Unicor® material. By recycling boxes, the virgin HDPE and limestone materials are avoided. No washing or further processing is assumed in recycling model.

Box weight

Box	Box Weights (g/Box)	Box Weights (g/100L)
Unicor®	1,300g	1,831g
Waxed Cardboard	1,120g	1,750g
EPS	378g	756g
Cardboard	560g	1671g

Data

	Polystyrene	Unicor® CN	Unicor® AU	Waxed Cardboard	Corflute	Cardboard
Climate Change	3.10	1.83	1.86	6.48	4.11	1.61
Particulate Matter	1.18	1.73	0.62	1.54	0.56	0.79
Water Scarcity	0.0451	0.0051	0.0052	0.0415	0.0126	0.0149

Caveats

- The data used in the study are from small samples and exclude many minor components such as labelling, printing etc.
- Recycling process data are poor for all products.
- The source of resins and all other materials are assumed to be Australia, and impacts may change when more accurate supply markets are modelled.
- Results are indicative and should not be used for consumer claims as they are not compliant with ISO 14044 or Australian Consumer Law
- A more thorough analysis of both Unicor® and alternatives is required to confirm the benefits identified in this study.

1 The paper was prepared by Dr Helen Lewis from Helen Lewis Research. It incorporates the results of a Life Cycle Assessment (LCA) undertaken for Unicor® by Tim Grant from Life Cycle Strategies.

2 https://www.ellenmacarthurfoundation.org/assets/downloads/New-Plastics-Economy_Catalysing-Action_13-1-17.pdf

3 https://www.environment.gov.au/system/files/resources/5b86c9f8-074e-4d66-ab11-08bbc69da240/files/national waste-policy-action-plan-2019.pdf

4 http://www.wrap.org.uk/content/the-uk-plastics-pact

5 See for example the Globalwebindex survey results at https://blog.globalwebindex.com/chart-of-the-week/lifting-the lid-on-sustainable-packaging/

6 https://www.newplasticseconomy.org/projects/global-commitment

7 http://www.wrap.org.uk/content/eliminating-problem-plastics

8 Envisage Works (2019), Australian packaging consumption and resource recovery data, Draft 24 September, unpublished

9 Envisage Works (2019)

10 There is no available data on the national recycling rate for corflute. The national recycling rate for polypropylene is from Envisage Works (2019)

Whitepaper Author

Dr Helen Lewis has worked in the environmental management field for over 20 years. She currently works as an environmental consultant specialising in product stewardship and sustainable packaging.

In this role she been closely involved in the development and implementation of the Australian Packaging Covenant and has assisted industry clients to implement more sustainable packaging practices.

Helen was the part-time chief executive of the Australian Battery Recycling Initiative (ABRI) for six years until November 2016. ABRI was established in 2008 to promote the diversion of batteries from landfill through safe and environmentally responsible recycling programs. Its members include battery manufacturers and retailers, recyclers, government agencies and environmental organisations with a commitment to battery stewardship.

Until 2001 Helen was Director of the Centre for Design at RMIT University where she managed an innovative research, consulting and training program to promote more sustainable design of buildings, products and packaging. Prior to this she worked for federal and state government agencies in a range of industry policy and environmental program roles, and as environment manager for the Plastics and Chemicals Industries Association.

Helen has published widely on product stewardship and sustainable packaging. Her most recent book, Product stewardship in action: the business case for lifecycle thinking, was published in November 2016.

Helen is an Adjunct Professor with the Institute for Sustainable Futures (ISF). www.helenlewisresearch.com.au

Whitepaper Research

Tim Grant - Director and Founder Life Cycle Strategies Pty Ltd

Tim Grant is a specialist in life cycle assessment (LCA) with twenty years experience developing and applying LCA with a wide range of companies and organisations. Tim was a founding member and is the current Secretary of the Australian Life Cycle Assessment Society (ALCAS).

He is a co-author of the book Life Cycle Assessment: Practices Principles and Prospects (CSIRO, 2009).

Tim works across many different sectors in LCA including packaging, agriculture, energy, fuels, water products, buildings and waste management. In addition, he has worked on the development of LCA databases for Australia.

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