FaBA Food and Beverage Accelerator

Sustainable Packaging Trends Report

Opportunities to support the transition to a circular packaging economy in the Australian food and beverage ecosystem

Report No. 2

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The Food and Beverage Accelerator (FaBA) acknowledges the Traditional Owners and their custodianship of the lands where we live and work.

We pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country.

We recognise their valuable contributions to Australian and global society.

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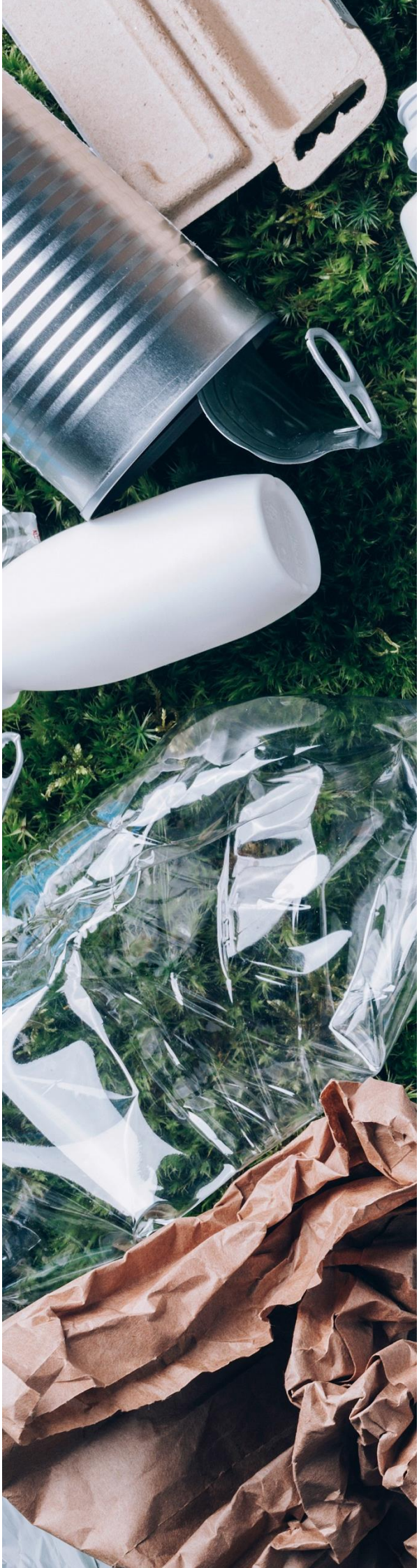

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Foreword

Australia's food and beverage sector is on a critical journey towards greater use of sustainable packaging. With global projections indicating that 29 million metric tonnes of plastic could enter our oceans annually by 2040 if current practices persist, the urgency for change has never been greater. This report delves into 12 key trends across four priority areas that are shaping the future of sustainable packaging. From innovative waste management strategies to cutting edge design principles for circularity, it explores the multi-faceted approach required to address complex challenges of packaging sustainability. This report brings together insights from a comprehensive range of industry, research and government experts, to provide a roadmap for stakeholders. As we navigate the challenges and opportunities presented by these trends, this report aims to facilitate crucial conversations and decision-making processes.

Dr Chris Downs

Together, we can drive innovation, reduce environmental impact, and create a more sustainable future for our industry and our nation.

On behalf of Australia's Food and Beverage Accelerator (FaBA), I commend this report to you.

Dr Chris Downs
FaBA Director

We are delighted to bring you the Sustainable Packaging Trends Report – an initiative of FaBA's Innovation Pathways Program. Innovation Pathways adopts an industry-led, multi-disciplinary approach that holistically addresses important real-world problems, co-creating value with industry benefitting end users and policy makers, taking business on a path of rapid product and service development to market, based on data-driven consumer and market insights. We apply an approach that is personalised to each industry partner's needs.

Professor Janet McColl-Kennedy

Professor Janet McColl-Kennedy
Lead, Innovation Pathways Program, FaBA

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Executive Summary

Adopting sustainable packaging is one of the most immediate and impactful ways Australia's food and beverage (F&B) sector can transition to a circular economy. However, stakeholders in the food packaging value chain report difficulties in ensuring sustainable packaging, waste management, and circular economy practices. This report outlines the latest sustainable packaging trends to inform stakeholder discussion and decisions towards the sustainable development of the Australian food and beverage sector. Drawing on an analysis of market, industry, and government publications, this report identifies 12 key trends mapped to four priority areas shaping future directions for sustainable packaging development.

Priority Area 1: Governing Waste for Sustainable Packaging Development

Trend 1. Regulating packaging waste (regulatory action, bans on problematic plastics, and extended producer responsibility schemes).

Trend 2. Committing to end packaging pollution (global partnerships, commitments and agreements).

Trend 3. Facilitating systemwide packaging transformation (leadership, coordinated action, and a shared vision).

Trend 4. Capturing economic value from a circular packaging economy (closing the loop on waste and capturing economic value from recovery).

Priority Area 2: Designing Packaging for Circularity

Trend 5. Designing for recycling (recyclable packaging, recycling programs and services).

Trend 6. Designing for composting (compostable packaging and composting standards).

Trend 7. Designing for reusing (refillable packaging and systemic reuse).

Priority Area 3: Leveraging Packaging Design for Sustainable Food Life Cycles

Trend 8. Packaging design to reduce food waste (balancing sustainable packaging and food waste reduction).

Trend 9. Packaging design to reduce emissions (net-zero emissions and reducing emissions).

Trend 10. Packaging to support conscious consumption (leveraging consumers' environmental consciousness and enabling sustainable choices).

Priority Area 4: Innovating Technologies for Sustainable Packaging Development

Trend 11. Advancing next-gen recovery (advanced plastics recycling technologies and biorecycling)

Trend 12. Advancing the bio packaging solutions (bio-based materials and biodegradable bioplastics).

The report highlights the main challenges and opportunities of each trend and their relevance to different stakeholders in the food packaging value chain. It also provides actionable recommendations for leveraging sustainable packaging to build and transition to a circular economy in the Australian food and beverage ecosystem.

Introduction

Adopting sustainable packaging is one of the most immediate, impactful, and universally appealing ways the food and beverage sector can transition to a more sustainable future (1-3). Given projections of 29 million metric tonnes of plastic entering the ocean annually by 2040 should we continue business-as-usual (4, 5), and the food and beverage sector being the leading generator of fast-moving consumer goods (FMCG) packaging worldwide (6), a wide range of stakeholders – including governments, consumers, and businesses – consider embracing sustainable food packaging a critical move. In Australia, there is increasing acceptance of the need to transition from a "linear" to a "circular" economy and a harmonised "whole-of-system" approach, with sustainable packaging highlighted as a key recommendation area to expand innovation and add value to Australia's food and beverage manufacturing sector (7). Accordingly, this report addresses recommendation number 21 of the 2025 *Food for Thought* Australian parliamentary inquiry (7). While there are several challenges stakeholders will need to navigate to achieve greater packaging sustainability, there are also many opportunities to leverage sustainable packaging to enhance business profitability, unlock innovation, and help build a circular economy.

Australia's Food and Beverage Accelerator is committed to driving growth and innovation in Australia's food and beverage sector, co-creating solutions to address complex industry challenges and enabling commercial success. Against this backdrop, this report investigates what and how sustainable packaging trends can provide opportunities for stakeholders in the Australian food and beverage ecosystem to support a transition to a circular packaging economy. Key challenges and opportunities associated with the identified trends are described, and recommendations provided for stakeholders to leverage these trends to meet global circularity targets and drive sustainable change.

Drawing on a systematic review of the latest market, industry, and government publications (2019-2024) – including those released by food and beverage and packaging peak bodies, leading management consultancy firms, market research agencies, government and non-governmental agencies, and food and beverage and packaging industry news – this report synthesises the supply and demand side trends, as well as perspectives on sustainable packaging from different stakeholders in the food and beverage ecosystem. Machine learning and natural language processing (NLP) techniques were used to uncover the key sustainable packaging trends and associated challenges and opportunities.

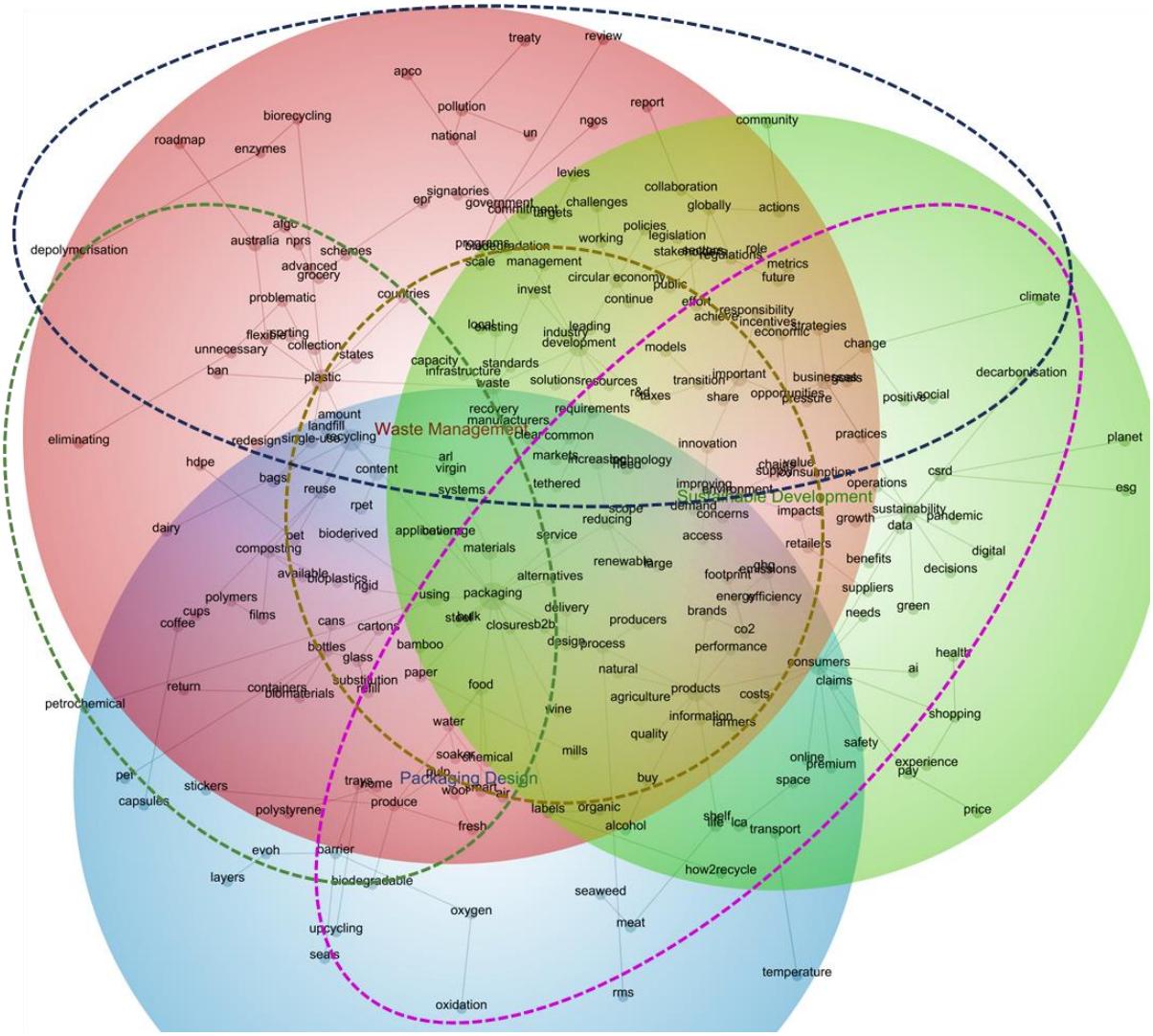
Our analyses identified 38 topics pertaining to sustainable packaging, which we reviewed and categorised into 12 key trends. After multiple validation cycles, we mapped these 12 trends to four key priority areas – (i) governing packaging waste for sustainable development, (ii) designing packaging for circularity, (iii) leveraging packaging for sustainable food life cycles, and (iv) innovating technologies for sustainable packaging development – which lie at the intersection of three key themes: waste management, packaging design, and sustainable development.

The report begins with an overview of the 12 trends and their relevance to different stakeholders in the food and beverage packaging ecosystem. Then, we describe each of the trends, highlighting their key associated challenges and opportunities. Next, we provide recommendations to facilitate collaborative dialogue among stakeholders regarding pathways to support the transition to a circular packaging economy in the Australian food and beverage ecosystem. We conclude with a set of case examples to illustrate the trends. Supplementary material – including a description of the method, a list of examples in the report, a glossary of terms, and references for further reading – is provided at the end of the report.

The Four Priority Areas

Our text-based analyses indicate that sustainable packaging transitions encompass the design of packaging and waste management systems to achieve sustainable development. Transitioning to a circular economy is key to achieving sustainable development goals (8, 9), where a circular economy is based on three principles, driven by design: (i) eliminate waste and pollution, (ii) circulate products and materials (at their highest value), and (iii) regenerate nature (10). We identify four sustainable packaging priority areas aligned with these principles: (i) *governing* packaging waste for sustainable development, (ii) *designing* packaging for circularity, (iii) *leveraging* packaging for sustainable food life cycles, and (iv) *innovating* technologies for sustainable packaging development.

Figure 1 illustrates how these four priority areas (dotted circles) lie at the intersection of packaging design, waste management, and sustainable development (bubbles).



--- **Priority area 1.** Governing waste for sustainable packaging development
--- **Priority area 2.** Designing packaging for circularity
--- **Priority area 3.** Leveraging packaging for sustainable food life cycles
--- **Priority area 4.** Innovating technologies for sustainable packaging development

Figure 1. Sustainable packaging concept map in Leximancer and the four priority areas.

The Twelve Trends

Twelve interrelated trends were mapped to the four priority areas. Figure 2 illustrates the relevance of these trends to stakeholders in the food and beverage packaging ecosystem.

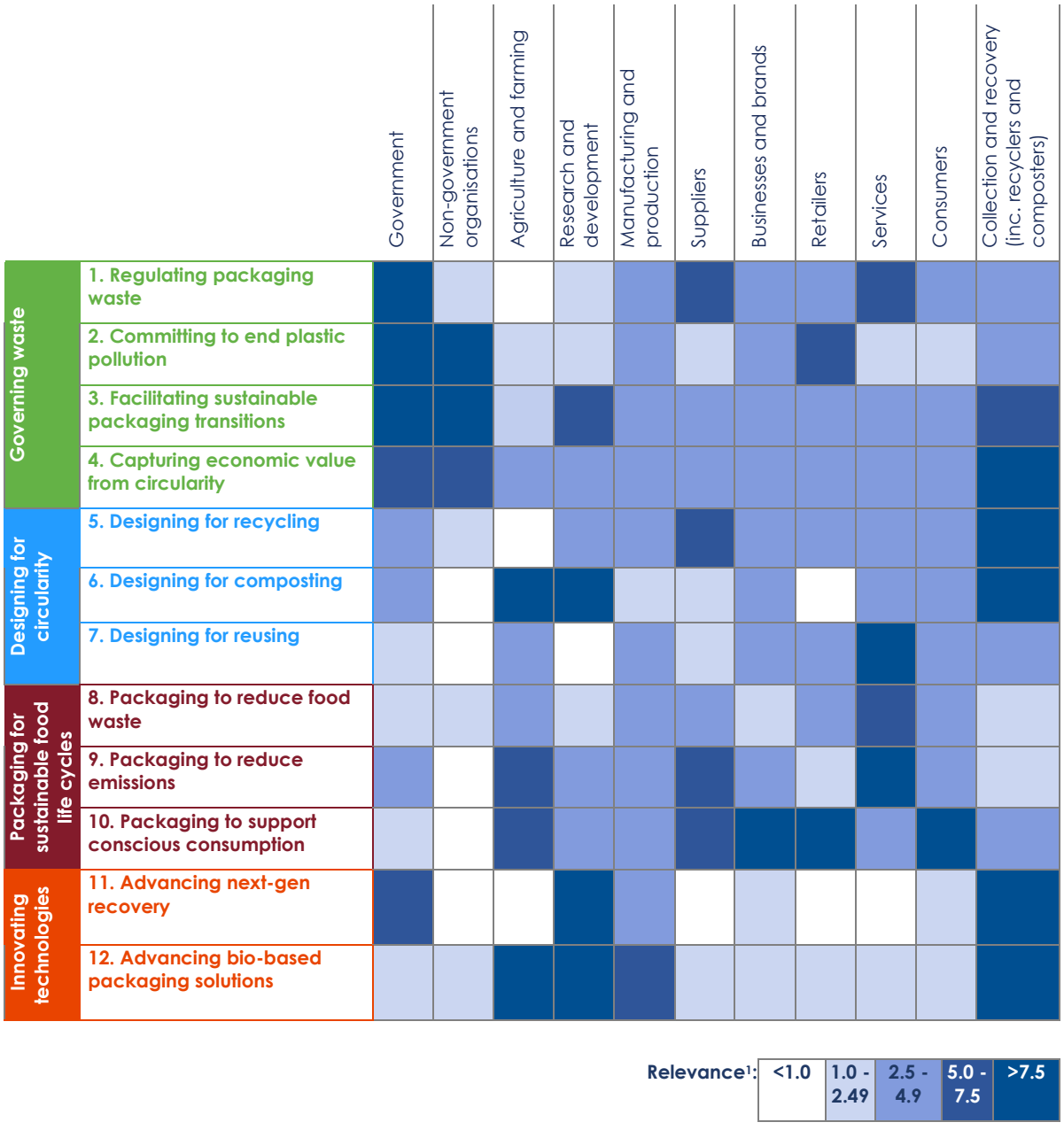
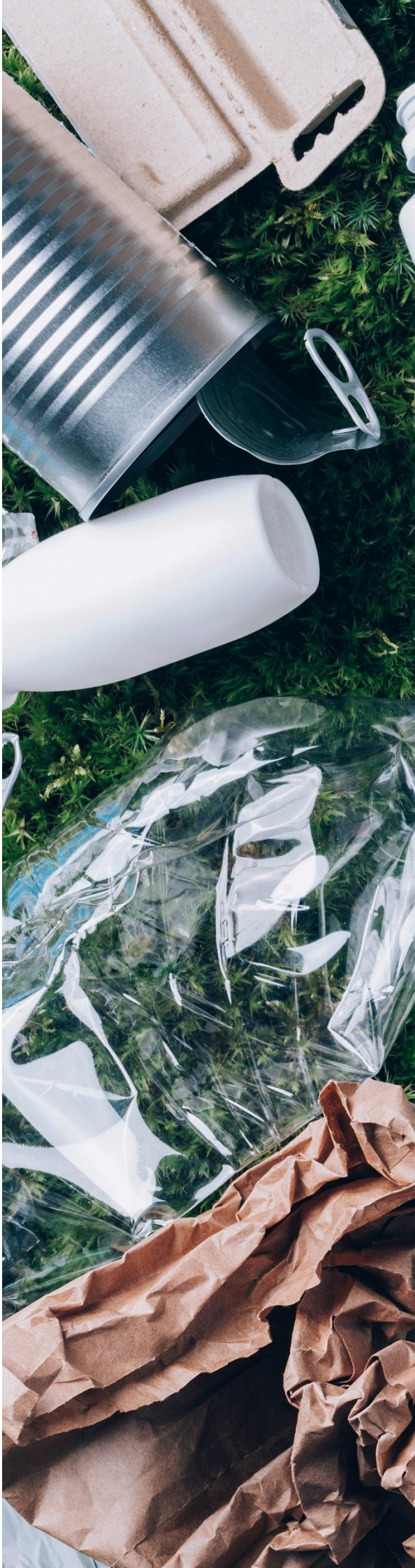


Figure 2. The 12 trends mapped to priority areas and their relevance to food ecosystem stakeholders

[1] See the Method for details of how the relevance was calculated using Leximancer prominence scores.

Priority Area 1: Governing Waste for Sustainable Packaging Development

Navigating trends towards regulating packaging waste, ending plastic pollution, facilitating systemwide transformation, and capturing economic value from a circular packaging economy



Trend 1: Regulating packaging waste

As countries develop and implement different approaches to regulate packaging waste, stakeholders in the food packaging value chain face increasing complexity in navigating the regulatory landscape.

Packaging waste: A target of global regulatory pressure

Regulatory action is proving essential to steer packaging development in a sustainable direction, and with external environmental pressures increasing, so too is the scale of legislation targeted at reducing packaging waste (11, 12). Global sustainable packaging regulations – such as single-use plastic bans, environmental taxes (13), deposit systems, Extended Producer Responsibility (EPR) schemes, and chemical regulations – are accelerating and becoming increasingly ambitious. Many of these regulatory approaches are still in the early stages of development and vary considerably by region, country and even state, leading to a regulatory landscape that is complex to navigate (14, 15). Despite this heterogeneity, several common patterns of development can be seen, including a focus on plastic packaging, primary packaging, and beverage packaging, restricting certain materials, and packaging waste management via EPR schemes (14).

Bans on problematic plastics

With rising efforts to address the environmental and economic impacts of marine litter, plastics and single-use plastics in particular have become the targets of the majority of packaging waste regulation (16). Several food industries, such as seafood, meat, and produce (17) are impacted by plastic contamination and welcome strategies to address problematic plastics and marine plastic pollution (18). At the same time, increasing consumer sentiment toward banning single-use plastics is placing further pressure on governments, producers, and retailers to phase out problematic plastics (19). However, the gap between consumers' intended and actual shopping choices of products with less packaging emphasises the importance of regulation as a way forward (11). Australia's *National Plastics Plan 2021*(20) highlights the phase-out of problematic and unnecessary single-use plastic packaging as a critical prevention measure to address plastic waste at the source and includes working with industry to deliver on this National Packaging Target (21).

Extended producer responsibility

Extended product responsibility (EPR), as defined by the Organisation for Economic Co-operation and Development (OECD), is 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" (22, p. 3). Recognised as a crucial mechanism to fund packaging collection, sorting, and recycling, EPR schemes are gaining traction and increasing global support (23).

Currently, the implementation of EPR schemes is evolving and varies considerably from country to country, with many countries having emerging, limited, or voluntary EPR legislation likely to evolve as momentum grows (12). Countries with advanced EPR in place – such as the United Kingdom, European Union (EU) member states, Chile, and Colombia – serve as examples of EPR implementation and the benefits that can be realised (24, 12). In Australia, the Australian Packaging Covenant Organisation (APCO) *2030 Strategic Plan* leverages EPR schemes to ensure reuse and recovery systems are in place for all packaging (25). Funded through the eco-modulation of member fees, these EPR schemes aim to provide adequate financial resourcing to tackle problematic packaging materials that cannot be collected through current collection and recycling systems (25).

Most relevant stakeholders

- Government
- Suppliers
- Collection and recovery
- Recycling
- F&B businesses and brands
- Manufacturing and production

Key challenges

- Globally, progress in legislating EPR mechanisms has been limited due to voluntary participation, lack of specific policies, and the complexity of setting up governance mechanisms and price points, leading to inconsistent implementation and limited overall impact (26, 27).
- Regulation will place increasing pressure on food and beverage businesses and packaging suppliers to consider packaging disposal and end-of-life in the production stage and as part of their design process. At the same time, many chemicals classified as hazardous are found in plastic packaging; suppliers and businesses must consider these toxicity regulations in planning for circularity (12).
- Measuring the effectiveness of co-regulatory arrangements can be challenging because there are no clear KPIs, and data is either not available, not consistently collected or reported (21). For instance, in the National Environment Protection (Used Packaging Materials) Measure 2011, there are nine different administrators (including each of the participating jurisdictions and APCO), which raises challenges for achieving consistency and for the different stakeholders navigating the co-regulatory arrangements (21).
- Plastic taxes around the world are not coordinated, which presents global businesses with the challenge of managing diverse tax exposures across jurisdictions (13). At the same time, country-specific regulations increase the complexity of reporting requirements (12).
- Policies supporting recyclability can hinder the development of refillable options, and vice versa. Industries need to decide which model to prioritise and lobby for, which can differ by product category (11).

Key opportunities

- Implementation of national-level plans can prevent inefficiencies of uncoordinated local schemes. This should streamline regulatory compliance and create a more predictable business environment (11).
- Embracing and aligning packaging waste regulation at a global level enables progress toward a concerted effort by all nations to curb packaging pollution (26). Chile is an example of a country that has set ambitious regulations on single-use plastics (11). Other examples of best practices include the EU and Japan (26), which set examples for other regions to follow.
- It will be important for companies to monitor and keep up to date with evolving regulations and develop a corresponding sustainable packaging strategy. Engaging with relevant industry partners and associations and developing dedicated in-house teams to meet this requirement will be vital (13).
- With regulatory requirements for sustainability reporting, businesses can harness data analytics and digital technologies (12), such as smart sensors, the Internet of Things, and blockchain technology, to measure, track, and authenticate the impact of different solutions (28).
- Financial costs often limit the development and effectiveness of packaging collection and recycling. As more regions adopt EPR schemes for packaging waste, there is an opportunity to evaluate the effectiveness of fees paid by producers to EPR schemes and eco-modulated fees to cover these costs (25).
- Diversity in plastic taxes worldwide offers an opportunity for tax teams to protect the company from risks, leverage economic incentives, and align with sustainability trends (13).
- Regulations and taxes are often implemented to encourage upstream packaging design changes. By anticipating such regulations, packaging suppliers and F&B businesses can pre-emptively transition their packaging design towards new requirements. See trends 5-7.

Trend 2: Committing to end plastic pollution

To address the global plastic pollution crisis, stakeholders across the food packaging value chain increasingly recognise the importance of international partnerships and commitments to end plastic pollution in the ecosystem.

Partnerships and cooperation

Plastic pollution is one of today's most critical global challenges (29, 30), and in line with Goal 17 of the United Nations (UN) Sustainable Development Goals (31), many stakeholders in the food packaging value chain are recognising and committing to partnerships and cooperation to address the plastics problem (29, 30).

Partnerships are increasingly recognised for facilitating global commitment and action, raising awareness about plastic pollution, and influencing consumption habits (e.g., 32, 33), as well as enabling systemwide change through inclusive, multi-stakeholder decision-making incorporating innovation through knowledge sharing (34). For example, collaboration between international non-government organisations (NGOs) – the *World Economic Forum's Global Plastic Action Partnership (GPAP)*, the *Ellen Macarthur Foundation's Plastics Initiative*, and *The Waste and Resources Action Programme (WRAP)* – is creating a *knowledge exchange network*, which aims to bring together stakeholders across the plastics value chain – including businesses, governments, NGOs, and citizens – to build a shared plastics vision (34). The network aims to convene individual Plastic Pacts –National Plastic Action Partnerships (NPAP) from around the world to share information on best practices and combine global resources to facilitate the development and delivery of national action plans, catalysing system-wide transitions (34).

Commitment and agreements

Global commitment to changing how plastic is produced and consumed is rising. For instance, the *Global Commitment*, launched in October 2018 by the UN Environment Programme (UNEP) and the Ellen MacArthur Foundation, is the biggest global voluntary effort to tackle plastic pollution and has seen more than 1,000 signatories since its inception (35), uniting businesses, governments and other organisations worldwide behind a common vision to tackle plastic pollution at its source, setting a target of "100% reusable, recyclable, or compostable plastic packaging"(35, p. 6).

Despite strong progress, it is predicted that 2025 targets will be missed, reinforcing the urgency for government and businesses to accelerate action (36). Currently in negotiation is the *UN Plastic Treaty*, with 175 nations agreeing to develop a legally binding agreement on plastic pollution by 2025 (37, 38). Like other multilateral agreements, such as the *Montreal Protocol*, that have historically worked well to create change, the *UN Plastic Treaty* can drive change by establishing standards and environmental stewardship, introducing targets and restrictions, and driving technological progress (39). Australia is contributing to these global efforts to end plastic pollution, not only by supporting the new global treaty on plastic pollution (40), but also through their contributions to the *High Ambition Coalition* and *Global Commitment* (41).

Most relevant stakeholders

- NGOs
- Government
- Retailers
- F&B businesses and brands
- Collection and recovery
- Research and development

Key challenges

- Solutions to plastic pollution often involve behavioural components embedded in social, cultural and political dimensions. Consequently, the causes of and ways to tackle plastic pollution are frequently debated, with various stakeholders (e.g., government, NGOs, and the public) holding different beliefs about its cause and effect (42).
- Business signatories to The Global Commitment are significantly outperforming their peers in tackling plastic pollution; however, these signatories only represent 20% of plastic packaging globally, and a majority of the global plastic packaging market (80%) is yet to take action. Increasing voluntary business action is needed to accelerate progress (43).
- Some developing countries lack the resources to effectively manage their waste, and those importing waste from other countries may be overwhelmed as their local infrastructure cannot cope with the amount of plastic waste to process. International partnerships and cooperation must be genuinely equitable, with developed countries (e.g., those exporting their plastic waste) investing in and supporting infrastructure development in low- and middle-income countries (42, 44).

Key opportunities

- Governments can continue to endorse and invest in coordinated global action to address marine litter and work with industry to establish a national monitoring protocol and database for plastic pollution, phase out problematic plastics entering the ocean, and promote stewardship, such as through Australia's *Recycling and Waste Reduction Act* 2020 (20).
- As internationally legally binding treaties progress, businesses may seek opportunities for representation through entities such as the *Business Coalition for Global Plastics Treaty* (45) and leverage such treaties as a catalyst for change (12).
- Coordinating efforts across jurisdictions provides an opportunity to address infrastructure limitations and capture greater economic value from waste. For instance, trade agreements among nations could ensure that the inflow and outflow of packaging waste can be regulated by import and export requirements and that domestic infrastructure is not burdened by unwanted packaging waste. At the same time, there is an opportunity to create "hubs" for different recycling processes based on capacity (26).
- Awareness and education play vital roles in fostering a lasting culture of sustainability, which can support and encourage stakeholder participation and cooperation now and into the future (30).
- A life cycle approach to plastic pollution, which considers the environmental impact from the extraction of raw materials to end-of-life management, enables stakeholders to understand their impact as part of a wider and interconnected system. Initiatives – such as UNEP's *Life Cycle Initiative* (46) – offer opportunities to encourage stakeholder participation and collaboration to effect global systemic change (47).

Trend 3: Facilitating systemwide packaging transformation

The proliferation of sustainable packaging innovations increases the complexity of deciding which options to pursue to achieve a circular packaging economy. Thus, leadership, coordinated action, and a shared vision are key.

Sustainable packaging leadership

The influx of sustainable packaging innovations has increased the complexity decision-makers face in transitioning to sustainable packaging (48, 49). As such, industry leadership, education, and best practice approaches are increasingly relevant to supporting decisions towards sustainable packaging (50). Around the world, not-for-profit organisations – such as the *World Packaging Organisation* (51), World Business Council for Sustainable Development (52), and the *Ellen MacArthur Foundation* (53) – connect and collaborate with the global packaging ecosystem, providing examples of best practices and sharing knowledge through learning. In Australia, the *Australian Packaging Covenant Organisation (APCO)* is leading the development of a circular packaging economy and working with the government to deliver on the *2025 National Packaging Targets* (54). Through initiatives such as the *Sustainable Packaging Guidelines (SPGs)*, APCO assists businesses to design and manufacture packaging that balances the demands of people and the environment (55).

At the same time, their *National Consumer Education Campaign*, and flagship education program, the *Australasian Recycling Label (ARL)*, are working to improve stakeholder awareness, understanding, and behaviour by providing a consistent approach to sustainable packaging messaging and education (56). Sustainable packaging design awards – including the World Packaging Organisation's (WPO) Worldstar Packaging Awards (57, 58), Australian Institute of Packaging's (AIP) Packaging Innovation and Design Awards (PIDA) (59), and APCO awards (60)– further illustrate how businesses can lead the way, creating a standard of sustainable packaging excellence and best practices from which others may learn, such as closed-loop collection (e.g., KitKat; 61), recyclable materials (e.g., Coca Cola; 62), refillable packaging (e.g., Oasis & qDesign Enterprises; 63), bio-based and compostable materials (e.g., Punchbowl Packaging; 64), and optimising transport packaging (e.g., Woolpak; 65).

Coordinated action and a shared vision

It is widely agreed that coordinated action is essential to achieving sustainable packaging goals. This requires a shared understanding of each stakeholder's obligations and responsibilities and a common vision for change (66, 21). A review of Australia's co-regulatory arrangement under the *National Environment Protection (Used Packaging Materials) Measure 2011* indicated that there is currently no single agreement reflecting a shared view of the role and obligations of stakeholders who influence the packaging lifecycle (21, 67).

Australia's key actor facilitating transitions to a circular packaging economy, *APCO*, works to facilitate coordinated action through the *Collective Impact Framework* comprising five core building blocks: (i) a common agenda, (ii) continuous communication, (iii) a backbone function consisting of skills to co-ordinate participating organisations, (iv) mutually reinforcing activities, and (v) a shared measurement system (68, 69). APCO further works with specific industries to offer roadmaps, such as the *Australian Dairy Sustainable Packaging Roadmap to* 2025 (70) and *Food Services Packaging Sustainability Guidelines* (71), tailored to specific industry requirements.

Most relevant stakeholders

- NGOs
- Government
- Research and development
- Collection and recovery
- Services
- F&B businesses and brands

Key challenges

- Sharing new solutions and developing collective approaches to sustainable packaging problem-solving requires businesses to balance a collaborative versus competitive mindset, where their level of differentiation and protection of commercial sensitivities must be considered (72, 68).
- Best practice approaches may vary across regions based on the availability of local material inputs, services and infrastructure. For instance, the availability of food grade rPET (70) and the recycling capabilities of different LGAs (68).
- Implementing and supporting best practice approaches often comes at a higher cost, a key barrier for many stakeholders in the food packaging ecosystem (73).

Key opportunities

- Industry leaders and network facilitators can enable the transparent exchange of circular packaging insights and learnings by developing community platforms on sustainable packaging best practices (12).
- Transparency about the challenges facing the business and its stage in the sustainable packaging journey provides opportunities for knowledge-sharing and to identify other stakeholders who can facilitate in filling gaps in capabilities (74).
- Establishing mandatory packaging reporting frameworks and clear definitions and standards for reporting can help to increase accountability, traceability and provide comparable data and insights across sustainable packaging target areas. For example, the *EU Directive 94/62/EC on packaging and packaging waste* requires countries to report on recycling targets to be achieved by 2025 and 2030, with an implementing act *Decision 2005/270/EC* setting out the "formats, as well as the rules for calculation, verification and reporting of data that must be provided by EU countries to the Commission each year" to monitor the implementation of the directive (75).
- Setting shared goals can stimulate friendly rivalry, helping to push companies in the same direction (72). Businesses and brands can leverage benchmarking to identify areas where brands outperform competitors (76).
- Industry-led programs – such as Paintback and Big Bag recovery – provide brand owners with opportunities to manage the systemic recovery of certain types of packaging (21).
- Companies can set their own sustainability targets in line with non-binding international goals, which can serve as a basis for future legislation and corporate strategies (11).

Trend 4: Capturing economic value from circularity

The substantial material value lost in today's linear economy is increasingly becoming realised. Material recovery can capture greater economic value from the food packaging supply chain and is key to a circular economy transition.

A circular economy: Closing the loop on waste

Transitioning to a circular economy has risen to the fore globally in recent years. To date, close to 70 circular economy roadmaps and strategies worldwide offer long-term visions and time-dependent actions, while approximately 40 more are in scoping or development or are national 'calls to action' (77). One example is Australia's CSIRO *National Circular Economy Roadmap for plastics, glass, paper, and tyres,* which provides guiding pathways to circularity for packaging made with these materials (78). Unlike the traditional linear "take-make-dispose" economy, a circular economy keeps materials in circulation, ensures they never become waste, and decouples economic activity from the consumption of finite resources (10).

Fast-moving consumer goods – such as food and beverages and their packaging – have received attention in circular economy discussions (79), with their low unit cost, high throughput volumes and frequency of consumption, and short service life, resulting in a significant contribution to municipal waste generation (79). While strategies to unlock circular economy transitions in packaging are plentiful, they often share a common focus on consistent standards, regulations and messaging paired with authentic and transparent reporting; innovating and improving packaging design, collection and sorting; building reprocessing and recycling infrastructure capacity; growing circular business models and end markets; and implementing system-level changes to support commitment, participation, and collaboration in the circular economy and sustainable practices (78, 76, 12).

Capturing economic value from recovery

The potential to capture significant economic value from the recovery of packaging is increasingly realised and is a key driver of circular economy transitions (80). Today, a substantial portion of the material value of packaging is lost after one use. This is particularly prevalent for plastic packaging, with the 14% collected for recycling, well below global recycling rates for paper (58%) and iron and steel (79-90%) (81). The Ellen MacArthur Foundation estimates that 95% of plastic packaging material value, or USD$80-120 billion annually, is lost to the economy after just one use (81).

In Australia, an estimated 44% of packaging placed on the market was disposed to landfill in 2021- 22, representing a loss of resources with an estimated value of $900 million (82). Food Innovation Australia Limited (FIAL) highlights that the large portion of food packaging ending up in landfills highlights a major opportunity for the agrifood sector to extract more value from the supply chain, with sustainable packaging including its recycling and recovery. presenting an AUD$3 billion value-add potential to Australia's $200 billion opportunity in 2030 (83). In recent years, considerable emphasis has been placed on converting waste into resources and maximising their value (84). Investment in recovery and recycling – such as Australia's *Recycling Modernisation Fund* (85) – and encouraging the use of recycled content (86) are key initiatives underway to accelerate value capture opportunities.

Most relevant stakeholders

- Collection and recovery
- NGOs
- Government
- Recycling
- Manufacturing and production
- Research and development

Key challenges

- Collection and recovery of resources are key to a circular economy, with consumers' recycling efforts playing a vital role. However, at present, the importance of consumers closing the loop on waste and their role as key suppliers of secondary materials is largely undervalued (12).
- At the same time, global operational inefficiencies in packaging recycling, such as the effective collection, sorting, and processing of soft plastics, is resulting in significant loss of materials and limiting the (re)use of secondary materials (12).
- To demonstrate circularity, consumer packaged goods companies must track and report what and how secondary materials are (re)used (87). However, they are currently limited by the availability of end-to-end visibility of the packaging supply chain, including data and technologies to track upstream material sourcing and downstream end-of-use treatment (27, 12).
- Financing is key to scaling circular economy solutions; however, securing investments in and accentuating the attractiveness of circular solutions has its challenges, in part due to potentially longer return on investments and perceived risks associated with innovative "first-of-their-kind solutions" (27).

Key opportunities

- Governments play a crucial role in encouraging transitions to a circular packaging economy, from setting targets and developing policy frameworks to create a shared vision in the circular packaging ecosystem to providing financial incentives and education (27).
- R&D activity and investments can significantly increase the value and uptake of secondary materials. For instance, CSIRO highlights how the value of recycled plastics can be increased by developing technologies to improve: (i) cost effectiveness of waste collection, (ii) efficiency of sorting, (iii) use of underutilised feedstocks, and (iv) delivery of higher quality resins that compete with virgin materials on price and quality (88).
- Technologies – such as digital watermarks - can improve transparency and traceability of packaging materials flowing through the circular value chain roadmap (70).
- Consumer packaged goods companies can contribute to a circular economy transition by embracing "circular design," packaging based on a mindset that embraces three key circular economy principles: (i) eliminate waste and pollution, (ii) keep materials in use, and (iii) regenerate natural systems (89).
- Systemwide transitions to a circular economy require scaling solutions across the entire value chain. Collaboration among stakeholders in the ecosystem is key, such as advancing coordination mechanisms to facilitate transitions across sectors, regions, and stakeholders and developing partnerships to support R&D and secure investment to strengthen commercial viability (90).

Priority Area 2: Designing Packaging for Circularity

Embracing trends towards designing packaging for recycling, composting, and reusing

Trend 5: Designing for recycling

Recycling is recognised as the baseline level of commitment for sustainable packaging. Recyclable packaging aligned with current kerbside collection and recycling capabilities is key to increasing recycling rates.

Packaging to support current recycling technologies

Packaging recyclability has dominated sustainable packaging discourse and sustained its relevance over the past five years. As the baseline and minimum level of commitment for sustainable packaging (49), recycling is the focus of many national packaging targets (e.g., 91-93), and part of every big player's corporate social responsibility (CSR) strategy (49). In Australia, demand for materials recovery and sorting is rising alongside growing recycling rates, with greater household environmental consciousness and businesses supporting this trend (94).

A central consideration for recyclable packaging is whether it supports current recycling systems (48), where, at present, mechanical recycling is well-established and the dominant technology (95, 96). Packaging aligned with mechanical recycling capabilities is ubiquitous in beverages, where rigid packaging formats (e.g., plastic/glass bottles and metal cans) are common (97), highlighting how other food products can shift to formats with stronger recyclability and renewability profiles aligned with current recycling technologies (98-100). For instance, in beverages, there is a shift towards metal cans, a packaging format that, compared to plastic, has infinite recyclability and provides an opportunity to close the loop (97). Despite this advantage, the adoption of metal cans in food is projected to decline. This is largely due to category exposure, where cans are primarily used for processed foods, and consumer wellness trends are increasing a preference for less processed options (97).

Additional packaging design considerations to support recycling include shifting away from composite packaging materials (101, 15) and multi-layered films, tethered caps (102), phasing out colours contaminating the natural PET recycling stream (86), and reducing contaminants (e.g., labels, adhesives, and inks; 86).

Packaging recycling programs and services

Globally, recycling infrastructure and rates vary by material and country (95). A lack of programs and services and understanding of how to participate are cited as the top two barriers to recycling (103). Yet, a global survey indicates substantial variation in consumer assessments of local recycling services and guidelines for household recycling, with Australians more approving of recycling services and the clarity of recycling instructions than the global average (19). This can be attributed in part to the inclusion of the *Australasian Recycling Label (ARL)* on packaging and associated tools such as the *Packaging Recyclability Evaluation Portal (PREP)* and digital apps such as *Recycle Mate* (21, 104). In particular, the ARL has demonstrated impact across three areas pertaining to (i) increasing awareness and recognition of the ARL, (ii) maximisation of resource recovery from the waste stream, and (iii) continual improvement of packaging design to increase recyclability (105).

Currently, not all plastics in Australia can be recycled through kerbside collection programs (106), with Australians possessing a higher awareness of these limitations than the global average (19). The limitations of mechanical recycling programs to deal with soft (i.e., flexible) single-use plastics are acknowledged, and several initiatives – including the *Australian Food and Grocery Council's* collaborative development of the *National Plastics Recycling* Scheme (21) and *Soft Plastic Stewardship Australia (SPSA)* (107) – are underway.

Most relevant stakeholders

- Collection and recovery
- Recycling
- Suppliers
- Consumers (inc. households)
- Manufacturing and production
- Retailers

Key challenges

- Recycling alone may not be sufficient to sustainably manage the amount of waste we produce, with recovery rates yet to pick up momentum (49, 7). For instance, Queensland's Container Refund Scheme, with an annual recovery rate of 67.4% (108), is currently the subject of a Queensland parliamentary inquiry to boost recycling rates and meet legislated recovery targets of 85% (109, 110).
- Many local government areas (LGAs) lack the infrastructure to effectively collect and process certain types of materials, such as soft plastics (111, 101), which are unsuited to current mechanical recycling capabilities (112). Without improvements to infrastructure, efforts to achieve a circular packaging economy cannot be realised (43).
- Current mechanical recycling capabilities face limitations in the number of times materials can be recycled before quality (e.g., consistency, colour, and material properties) is diminished (113).
- Suppliers of packaged food and beverages face a unique challenge compared to other FMCG categories in that the recycled materials used must be at a food-grade level (11).
- Consumer confusion around what can be recycled continues to be a major challenge to increasing packaging recovery and recycling rates (49). While recycling labels help to reduce confusion, they remain voluntary and are often located on the back of the pack, which reduces their visibility (49).
- Demand for recycled plastics is expected to significantly outpace its available supply by 2030, increasing costs of using recyclable materials and making it more difficult to comply with consumer and regulatory pressures (114). At the same time, many businesses are yet to demonstrate a willingness to pay a premium for recycled content (112) despite consumer expectations (112).
- While mono-materials can improve recyclability, they risk increasing or shifting the environmental impact, given that many of these formats increase the weight and size of the packaging compared to flexible, lightweight alternatives (115).

Key opportunities

- Improving collection and sorting is key to greater recovery of packaging waste. This can include initiatives from increasing access to recycling collection points outside the home, to address increasing consumption of on-the-go trends (49), to investing and leveraging technologies, such as AI and higher-quality washing systems to improve sorting and the quality of recycled materials (116).
- Successful packaging recycling requires consumers to separate their packaging waste into the correct stream (116). Desirable recycling behaviour can be facilitated through access to recycling infrastructure (e.g., kerbside recycling; (113), education, incentives (e.g., container deposit schemes; 117), enforcement and labelling (113). Mandating and prescribing the use, placement, and size of recycling labels can maximise correct recycling behaviours (49).
- Developing a strong and reliable secondary raw materials (SRM) market enables recyclables to re-enter the production value chain and reduces dependency on primary resources (7). Mechanical recycling is, in many cases, cash-positive and generates margins to provide an acceptable return on capital (113). In Australia, high revenue growth is projected for waste remediation and material recovery services from 2025-2030 (94).
- Incorporating recycled content into packaging increases demand for recycled substrates; however, to close the loop, F&B businesses should ensure recycled content is also recyclable (86).

Trend 6: Designing for composting

Compostable packaging is a key pathway to achieving a circular packaging economy and transitioning away from single-use plastics, particularly in applications where packaging is disposed of alongside food waste.

Packaging to meet composting standards

Shifting towards compostable packaging materials is increasingly recognised as a sustainable pathway for managing food packaging (118) and is a key part of Australia's 2025 National Packaging Targets (119). By 2032, the global compostable packaging market is projected to increase at a CAGR of between 6.2-8.4%, reaching an estimated total value of up to US$197.85 billion (120-122), with the Asia-Pacific region encompassing the fastest growth area (121, 123).

Compostable packaging is particularly relevant to food products and services given that in theory it can be disposed of together with food waste in organics collections (124-126). Compostable packaging can be "broken down into carbon dioxide, water, and biomass by the natural action of microorganisms" (127) and "converted into compost… which could be used to improve soils for more efficient production of crops (118). To be labelled as compostable in Australia, packaging must be designed in accordance with the *Australian Standard Industrial Composting Label (AS 4736* or *Australian Standard Composting Label (AS 5810)* provided by the *Australasian Bioplastics Association* (ABA; (124). It is important to recognise, however, that packaging materials that meet the industrial composting standard do not necessarily break down under home composting conditions (118, 124), which raises questions about the actual sustainability of packaging that is compostable only in industrial facilities (123), particularly should *Food Organics Garden Organics (FOGO)* collection be unavailable or not accept compostable packaging (128, 124, 129).
In addition to verifying the packaging according to ABA standards (124, 126), key design considerations for compostable packaging include labelling to direct consumers to the correct disposal (124, 130), avoiding use of the term "biodegradable" and misleading claims (126), and phasing out materials with chemicals of concern and ensuring safer chemistry composition (e.g., 131).

Substituting plastic flexibles with compostable packaging

There has been considerable attention to the role of compostable packaging in facilitating transitions away from single-use, fossil-based flexible plastics (132). Substitution strategies – such as switching to a different material like paper or compostable plastics (133, 6) – are particularly relevant when single-use flexible packaging cannot be eliminated without unintended consequences (134). Specific applications where substitution to compostable packaging is relevant include food packaging that is likely to remain contaminated with food (e.g., sauce sachets) and packaging-related items frequently found in organic waste streams (e.g., fruit stickers, tea bags, and bags to collect organic material) (125). For example, BioPak, a provider of certified compostable packaging, focuses on eliminating the use of single-use fossil-based plastics in the food and food service industry by designing and providing certified compostable packaging made from rapidly renewable plant-based materials, such as bioplastics and bagasse pulp (135-137).

Most relevant stakeholders

- Agriculture and farming
- Research and development
- Recycling
- Collection and recovery
- Government
- Food service

Key challenges

- For many producers and manufacturers, the costs and infrastructure requirements of shifting to compostable alternatives are often a key barrier to adoption. For example, compostable produce stickers are noted as more expensive than standard labels and can require costly changes to equipment, such as new applicators (125). At the same time, the cost-savings associated with compostable alternatives are often seen by composters rather than producers and retailers implementing these alternatives (125).
- Compostable packaging has some performance challenges, particularly regarding shrink capability, puncture resistance, and handling moisture (138).
- Terminology surrounding compostable packaging is complex and often confused with biodegradable and bio-based packaging, leading to incorrect disposal and handling, and miscommunication of the environmental impacts (118, 124, 127).
- Disposal of compostable packaging in landfill (where there is low to no oxygen) results in the production of the greenhouse gas, methane (118).
- Contamination is a key challenge facing composters, which occurs as non-compostable products enter the compost stream.

Key opportunities

- Education and motivation are key to assisting consumers in understanding the correct disposal of compostable packaging and increasing caring to initiate positive behaviour change (139).
- On its own, shifting to compostable packaging materials is not a circular solution. To close the loop, collection and composting services also need to be provided. For instance, BioPak, has created a circular system to ensure that packaging and its food are composted and create value through soil improvement (140). Organics recycling infrastructure must be included in local and state government planning (141).
- Scaling innovative designs for compostable packaging remains key to achieving widespread circularity. Government investment, providing tax incentives and subsidies for the use of compostable materials, could help to address costs to producers associated with shifting to compostable alternatives (73).
- Further the development of markets for compost (e.g., agriculture, mine site rehabilitation and urban development) to increase demand for compost products (141), and explore how compostable packaging has beneficial end uses (119).
- Investigate policy frameworks to ensure the equitable distribution of costs in switching to compostable packaging alternatives. For instance, EPR schemes featuring eco-modulated fees provide an opportunity to facilitate the equitable distribution of composting costs (25).

Trend 7: Designing for reusing

Transforming packaging to fit within reuse systems is a key way to close the loop on waste. The ability to refill and return are two important aspects of reusable packaging design.

Designing reusable and refillable packaging

The movement towards reusable and refillable packaging is gaining attention (6, 142), particularly for sustainability-minded brands and customers (6), despite a brief downturn in public discourse during COVID-19. According to the Ellen MacArthur Foundation, four types of business-to-consumer (B2C) packaging models are driving the reuse revolution (143). These vary depending on packaging ownership (i.e., customer-owned and refilled vs. business-owned and returned) and where refill/return occurs (i.e., at home vs. on-the-go). First, "refill at home" enables customers to refill reusable containers at home with product refills (143), which are delivered to their door or bought at the store. Refills are designed to generate less waste by offering refills that are returnable (e.g., SodaStream; 144), enable consumers to buy in bulk (e.g., koor; 145, 146) or in solid or concentrated forms (e.g., waterdrop; 147). Second, "refill on-the-go" allows customers to refill their reusable containers at a dispensing point away from home (143). For example, Nestlé in partnership with MIWA, a leader in reuse and refill dispenser technology (148), piloted refillable packaging for instant coffee (149), which demonstrated success in terms of acquiring new customers, customer satisfaction and higher-than-expected sales (143). Third, "return from home" is associated with a delivery service in which products are delivered to customers' homes and empty packaging is either collected by the service provider (e.g., Loop; 143, 150) or mailed to them (e.g., Raw Bulk Foods Online; 151), where it is subsequently cleaned and refilled. Fourth, "return on the go" enables customers to purchase a product in a reusable container in-store and return it to a drop-off point, where it is subsequently cleaned and refilled (143). For example, Coca-Cola introduced the "Universal Bottle", where multiple sparkling and still brands are offered in the same reusable bottle with a single colour, shape and size (152). In addition to B2C reuse models, the Ellen MacArthur Foundation (2020) (143) highlights that a wide range of business-to-business (B2B) packaging models exist, ranging from individual companies offering their own packaging and reuse systems (e.g., CHEP; 143, 153)) to industry-wide solutions (e.g., Swedish Return System's reusable food pallets and crates; 154).

Systemic reuse: Learnings from coffee cups

A systemic perspective, one that considers the needs and interactions among various stakeholders and the social rules and norms guiding behaviour, is vital to successfully implementing different reuse models (143). One leading example of packaging creating a systemic shift in norms and behaviours towards a closed-loop, reuse revolution is the reusable coffee cup market (155). Australian-owned business KeepCup is widely recognised as a pioneer and category name for reusable coffee cups (156). From gaining acceptance from the café community – including getting baristas on board with the world's first barista-standard reusable cup and empowering individuals to use the KeepCup – to challenging convenience-based social norms and creating a culture normalising reusability, KeepCup demonstrates a successful example of supporting systemwide shifts towards reusability (156). Since then, several coffee reuse systems have evolved, including Cercle's reusable cup system for workplaces (157) and Huskee's reusable coffee cups made from coffee husk waste (158).

Most relevant stakeholders

- Food service
- Collection and recovery
- F&B businesses and brands
- Consumers
- Recycling
- Retailers

Key challenges

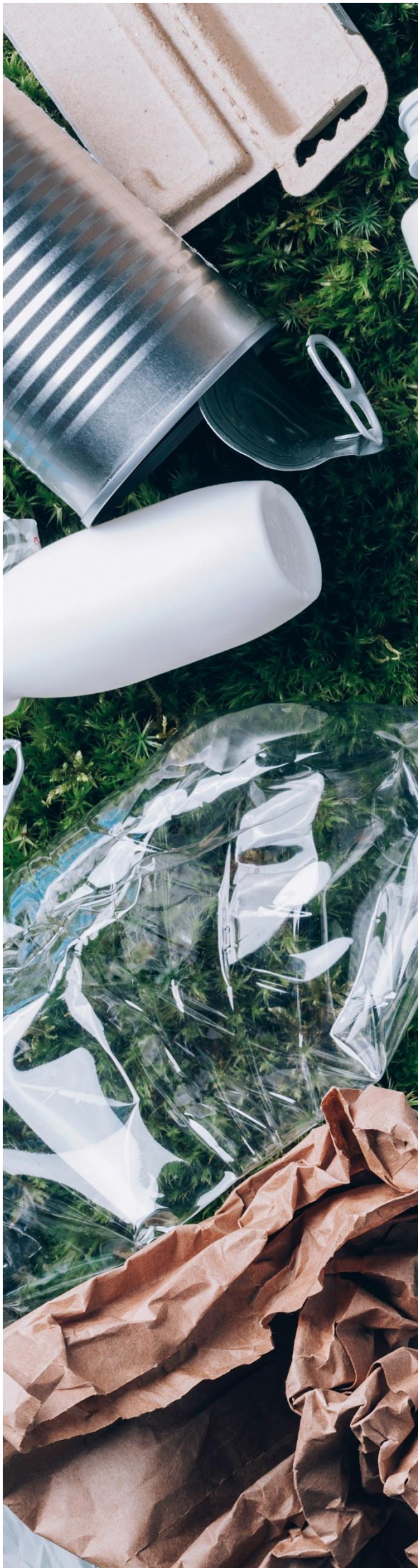
- At present, the current market penetration of refill systems, beyond a few established systems for beverages in select countries, remains small (142).
- Retailers and consumers often express their concerns regarding hygiene, practicality and environmental impact of food/product waste associated with spillages (142).
- Changing consumers' behavioural patterns and habits regarding the purchase, use and disposal of products with single-use packaging presents a key challenge to the adoption of refillable solutions (159).
- Refillable solutions require additional services (e.g., washing and sanitation) and infrastructure (e.g., collection points) for effective reuse systems. However, this can shift the environmental impact, such as to energy and water use. Thus, it is important to ensure reuse does not create other unintended trade-offs (160).

Key opportunities

- Several key markets that offer promise for reusable packaging solutions include beverages, food service, food requiring low- to no-barrier properties (e.g., dry bulk foods), and retail secondary/transport packaging (161).
- Developing a standardised approach for measuring and reporting progress on reuse models across industries and jurisdictions can provide relevant data to aid the decision-making and target-setting goals of corporate stakeholders, policymakers and standard-setters (162).
- Establishing standards for the reuse of packaging for food and beverage product applications across jurisdictions. For example, packaging for products with swine origins is prohibited for use in foods of non-swine origin, and bottles used for alcoholic beverages are prohibited for reuse in any other non-alcoholic categories (26).
- Digitalisation is a promising way for many businesses to overcome the challenges of implementing and scaling up reuse systems, which requires the involvement and coordination of multiple diverse stakeholders from engaging consumers and suppliers to working with retailers and logistics service providers (74).
- Refill systems can enhance the customer experience by adapting to their needs (e.g., enabling customers to only buy and pay for the quantity they need), providing customisation (e.g., adding or mixing different flavour combinations), and offering additional benefits (e.g., smart dispensers and smart packaging to enable smart payments) (143, 163). Some pilots have shown that reusable containers can offer greater convenience and simplicity via refill models facilitated by digital technology (164), such as smart-powered dispensing machines, Radio-Frequency Identification (RFID) tags and readers for trackability and traceability (143).
- Brand-directed refill systems, such as Soda stream (143), inherently require customers to "keep coming back", which can significantly benefit brand loyalty (143).
- Beverage brands and manufacturers may consider switching to concentrated or solid product forms, which can be provided as refills in "refill at home" models.
- By leveraging smart powered dispensing machines associated with refillable packaging solutions, there is an opportunity to collect and analyse data to inform business intelligence and decision-making, such as demand forecasting and optimisation (163).

Priority Area 3: Leveraging Packaging Design for Sustainable Food Life Cycles

Addressing trends towards leveraging packaging to reduce food waste, reduce carbon emissions, and facilitate conscious consumption



Trend 8: Packaging to reduce food waste

Packaging is widely emphasised as key to reducing food waste, recognised for its protecting and preserving capabilities. However, there is a need to balance the reduction of food waste and packaging waste.

Balancing sustainable packaging and food waste reduction

Solutions to reduce food waste are a global priority for ensuring food security and environmental sustainability (165, 166). Food packaging is widely recognised as a leading solution to reduce food loss and waste (48, 66) and as a key area for technology innovation in Australia's *National Food Waste Strategy* (167). *Save Food Packaging (SFP)* recognises the need to strike a balance between food waste reduction and sustainable packaging targets (168, 169) and outlines five key design criteria to achieve this (170) that are discussed as follows. First, product protection is key to preventing damage and spoilage impacting food quality and safety. Packaging features to facilitate protection include product barrier technologies (e.g., tear, puncture, and abrasion resistant materials; 171), quality sealing and anti-tamper protections (e.g., 172, 173), and temperature control (e.g., Woolpak Thermal Insulation; 65).

Second, extending shelf life is key to reducing food waste (170, 66, 48). Packaging technologies such as vacuum packaging (174-176), modified atmosphere packaging (177) and active barriers (e.g., Cryovac® Freshness Plus® Active Barrier Packaging; 178) can prevent undesirable ripening and spoilage, while ventilated and breathable packaging supports temperature and humidity control (177, 179). Design features enabling authentication and traceability (e.g., 2D barcodes with GS1 standards; 180), and intelligent packaging – such as real-time dashboard air temperature monitoring systems and indicators of days left to safely consume (174) – are key to optimising inventory management and enabling users to monitor food quality throughout the supply chain.

Third, packaging can facilitate food waste reduction by facilitating consumer convenience, particularly regarding ease of engaging in food waste reduction behaviours. For instance, ease of opening, dispensing and stability can help prevent spillage resulting in food waste (170), while portion control (e.g., available in various sizes) and ease of storing leftovers (e.g., easy to freeze) can help to reduce food leftovers that are wasted (170).

Fourth, messages and labels on food packaging play an important role in communicating information to reduce food waste, including best-before and use-by dates to help users prioritise which product must be consumed first (170), storage instructions, and on-pack recipe ideas (170). Finally, a truly *Save Food Waste* design cannot be achieved until it is tested for its effectiveness in reducing food and packaging waste (170).

Leveraging life cycle assessments

There is growing awareness of the need to consider the entire product life cycle when assessing the environmental impact of different packaging solutions reducing food waste (181, 182). Life cycle assessments (LCAs) provide an objective way to quantify the environmental impacts associated with all stages of a product's life, including raw material extraction, transport, manufacturing, distribution, use, disposal and/or recycling and recovery (183). Life cycle impact assessment tools – such as Sphera's GaBi packaging calculator (177, 184) and the Life Cycle Decision Packaging for SMEs by AIP and Empauer (185, 183) – are useful for evaluating the environmental impact of different packaging solutions designed to address food waste.

Most relevant stakeholders

- Services, including food service
- Manufacturing and production
- Agriculture and farming
- Suppliers
- Consumers
- Collection and recovery

Key challenges

- Finding a balance between food and packaging waste continues to be a challenge (169).
- Recent findings from a Save Food Packaging survey (169) highlight that executives and managers are yet to claim responsibility for food waste reduction, and 30% of stakeholders are unwilling to redesign a product's packaging to reduce food waste, with the industry only willing to act if this does not increase the cost.
- Consumer acceptance of chemical packaging technologies – such as modified atmosphere and active packaging – may be a hurdle to adoption (48).
- While LCA is helpful in supporting companies to evaluate the environmental impacts of their product and packaging, there are several limitations that must be considered, including favouring short-term benefits over systemic change, ignoring hard-to-measure impacts (e.g., reuse), and arriving at different conclusions due to different assumptions and data (186).

Key opportunities

- Nurture a sense of accountability and consciousness within the industry to explore alternative packaging that is both sustainable and contributes to reducing food waste (187).
- To support *Save Food Packaging* design, stakeholder awareness and education are needed. For instance, campaigns to "increase consumer knowledge around the purpose and correct interpretation of packaging and labelling information (such as portions and expiry dates)" can support consumers in reducing food waste (66, p. 19).
- CSIRO Futures highlights research into sustainable packaging to extend food shelf life as a key R&D priority area. This includes improving smart, intelligent packaging design, which can help to administer the right physical environment for storage and manage food to surpass shelf-life (66). Research programs, such as those by *End Food Waste Australia*, will be crucial to developing sustainable packaging solutions to reduce food waste alongside food industries (188, 189).
- Predictive modelling can be used to optimise SFP design. For example, researchers at Massey University are using predictive models to refine packaging for Kiwi, a climacteric fruit that is extremely sensitive to ethylene, causing softening and reducing shelf life, by modelling cooling rates and packaging strength as a function of case dimensions, venting, and pack density (177). Similarly, predictive analytics drawing on advanced packaging air temperature monitoring for perishable foods, like fresh meat, can help forecast potential issues compromising cold chain integrity and improve predictions to streamline logistics to minimise spoilage (174).
- Robotics and sensing technology can improve produce quality assessment, assurance, and traceability to track supply chain information, such as time in storage, while optimising the sorting and packing of different grades of produce to appropriate end user streams (190).
- Businesses can develop innovative packaging models specifically designed to help consumers avoid food waste. For instance, MIWA in the Czech Republic provides an online service enabling customers to purchase precise amounts of food in reusable packaging (191).

Trend 9: Packaging to reduce emissions

Food and beverage packaging is increasingly recognised for its role in reducing emissions. With the growth of zero-emissions markets, packaging to facilitate net-zero transitions presents a key innovation opportunity.

Committing to net-zero emissions

Globally, our food systems are responsible for a third of greenhouse gas (GHG) emissions (192). In response, stakeholders across the food and packaging value chain – including governments, CPG companies, investors, and consumers – are increasingly realising the urgency of accelerating reducing GHG emissions across the food value chain (66, 193-195). For instance, the Australian Government's *Net Zero Plan* aims to guide transitions towards a net zero economy and meet the legislated target of net zero GHG emissions by 2050 (196), crucial to upholding Australia's commitments under the *Paris Agreement* (197).

At the same time, emissions targets are becoming incorporated into environmental sustainability roadmaps across the Australian food and beverage industry, such as those by the *Australian Beverages Council* (ABCL; 198), *Australian Eggs* (199), *Meat & Livestock Australia* (200), and *Wine Australia* (201). The packaging of food and beverage products is increasingly recognised for its ability to contribute to net-zero transitions (95, 202, 194), and as transitions towards net-zero advance, markets for zero-emissions offerings, including sustainable packaging, are expected to expand (203).

Designing packaging to reduce scope 3 emissions

For food and beverage companies, emissions are predominantly generated along the value chain (i.e., Scope 3 emissions) – both up and downstream (204, 193, 194). Most upstream emissions are linked to the purchase of inputs to production processes (e.g., chemicals and ingredients), while downstream emissions are largely generated during the transportation and distribution of the final product (204). Regarding food packaging, this involves consideration of not only the emissions associated with the material inputs (e.g., selection of paper, glass, plastic materials; 192) but also those associated with transportation and distribution (e.g., design of package weight, size and shape; 205) of the packaged product. For example, a LCA of the Australian wine industry found that the largest share of their carbon emissions comes from glass packaging and downstream transport, with 1L of wine packaged in a cask (or Bag-in-box) reducing emissions by up to 45% compared to heavier, 500g standard glass bottles (206).

Key design considerations to account for Scope 3 emissions include light-weighting (e.g., 207, 206), reducing material used in packaging (e.g., Holle Baby Food; 194), switching to alternative, less heavy formats (e.g., glass to PET bottles; 207), distributing to export markets in bulk (206), increasing proportion of recycled content (e.g., Evian bottled water; 194), carbon labelling (e.g. 194), and designing packaging to reduce food waste (66).

Most relevant stakeholders

- Food services
- Suppliers
- Agriculture and farming
- Manufacturing and production
- F&B businesses and brands
- Consumers

Key challenges

- Low carbon products – such as recycled plastic and aluminium – could see supply shortages as demand for greener materials increases (208).
- Tackling Scope 3 emissions requires companies to engage up and downstream with suppliers, distributors, and customers, and deal with the complexity and fragmentation of consumer sector value chains (204).
- To account for and track packaging related Scope 3 emissions, companies must navigate the complexities of carbon accounting practices (e.g., methods for calculating emissions) and obtaining reliable emissions data from suppliers and other value chain partners, where, if unavailable, may lead to a reliance on imprecise, secondary data (209).

Key opportunities

- Actions to reduce Scope 3 emissions while maintaining value can include introducing product transparency requirements, adjusting product assortments (e.g., lower-emissions alternatives) and specifications (e.g., product size and shape), and improving supply chain financing based on suppliers' GHG footprint (210). For example, Wine Australia has identified packaging-related initiatives to reduce emissions, including transitioning to lighter-weight glass bottles and lower energy glass production, as well as improving packaging shape for greater space efficiency during transportation (201).
- Circular packaging solutions – including recovery and recycling – can decrease virgin material reliance, in turn, reducing emissions (211).
- There is an opportunity to collaborate with upstream and downstream suppliers to develop carbon scenarios and set shared emissions targets (212).
- While retailers contribute to only 4% of food-related GHG emissions, they are uniquely positioned to support the decarbonisation of upstream and downstream (213, 192).
- Supplier training, education, and knowledge-sharing on practices to reduce emissions can build supplier capacity and overcome barriers to decarbonisation efforts (204).

Trend 10: Packaging to support conscious consumption

Rising environmental consciousness is driving consumers' preferences for sustainable products. Yet, several trade-offs continue to influence their acceptance of and preferences for sustainable packaging and labelling.

Leveraging environmental consciousness and behaviours

Globally, consumers' environmental consciousness is growing (214-216), with more consumers reporting their engagement in eco-friendly and sustainable behaviours (217, 218). This rising environmental sentiment is beginning to influence consumers' everyday purchases, particularly in grocery, food and beverage, and restaurants (214, 215). Importantly, consumers place considerable emphasis on sustainable packaging in their efforts to shop more sustainably (216, 214, 215), with a range of factors underlying their concerns, including climate change, marine and air pollution, deforestation, waste production, and resource depletion (219, 220). Consequently, sustainable packaging has become the focus of many consumers' eco-conscious behaviours, for instance, "intentionally buy[ing] items with eco-friendly packaging or less packaging" and "check[ing] the labelling/packaging for sustainability certification(s)" (218), p. 11), and recycling or composting household trash (214).

Navigating complex customer requirements

Understanding and responding to consumers' acceptance of and preferences for sustainable packaging solutions is fundamental to encouraging the behavioural change necessary to achieve systemwide transitions towards packaging circularity (216). While consumers increasingly highlight sustainable packaging as an important factor in their food product choices (220, 221), several trade-offs continue to influence their sentiments and preferences for sustainable packaging. These include consumers' preferences for healthy eating (222); food safety and hygiene (222, 220, 223), particularly during health crises such as COVID-19 (217); convenience (216, 224); affordability and value for money (223, 215, 225), particularly with cost-of-living and inflationary pressures (6, 142); e-commerce (6, 225, 226), such as food delivery kits, which are often criticised for their excessive packaging (227); and an enhanced shopping experience, such as feeling indulged, rewarded, and "wowed", is a key driver of packaging trends (e.g., unboxing)(48, 142).

Enabling sustainable choices: ESG claims and labelling

As consumers shift towards more environmentally friendly and ethical products, on-pack ESG-related claims and labels are crucial to informing consumers' purchase decisions. Notably, a joint study from McKinsey and NielsenIQ analysing five years of sales data (2017-2022) found a clear link between ESG claims and consumer spending, with products making ESG-related claims averaging 28% cumulative growth versus 20% for products that did not make such claims (228). They found six types of ESG claims influencing consumer spending: (i) animal welfare, (ii) environmental sustainability, (iii) organic certification, (iv) plant-based, (v) social responsibility, and (vi) sustainable packaging claims. Such information is essential to communicating a brand's actions and contributions to sustainable business practices to consumers. Thus, it is paramount for brands to back ESG-related claims with legitimate actions, while ensuring traceability and transparency of those actions (218) - to avoid "greenwashing", which poses reputational risks and erodes consumer trust (229).

Most relevant stakeholders

- Consumers
- F&B businesses and brands
- Retailers
- Agriculture and farming
- Producers and manufacturers
- Suppliers

Key challenges

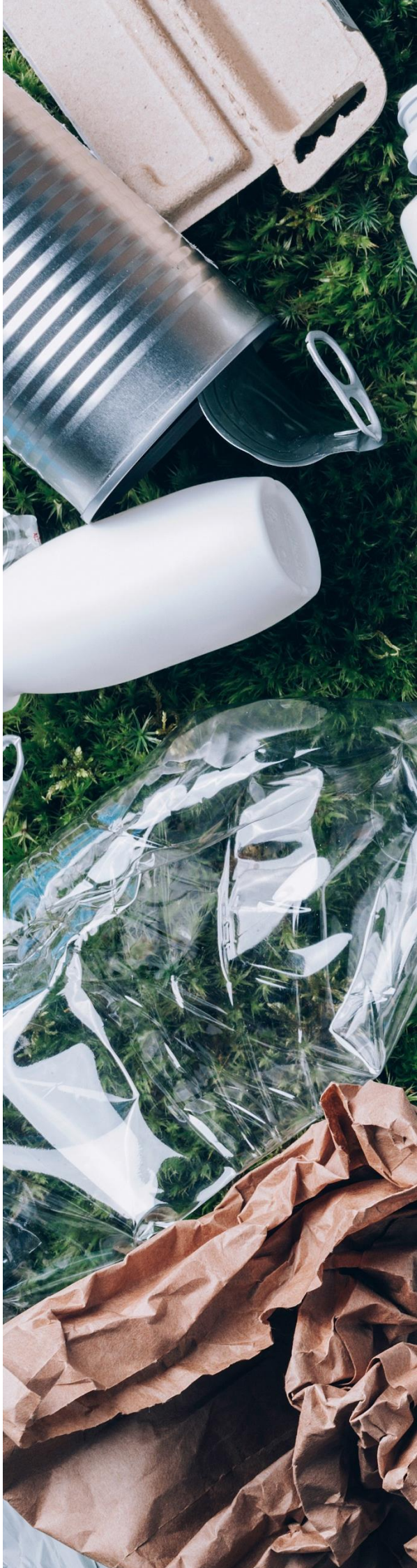
- Many consumers remain confused about what makes a product sustainable and the types of packaging which are most sustainable, impacting their ability to make informed sustainable purchase decisions (220, 230).
- Consumer confusion is exacerbated by the lack of global standardisation in labelling, which creates differences in what is considered "sustainable" (e.g., recyclable, compostable, sustainably sourced, organic, etc) and can lead to consumer scepticism (231).
- F&B businesses and brands must understand consumers' complex preferences for sustainable packaging and the trade-offs that they make with other influential packaging features, such as balancing a desire for an enhanced shopping experience facilitated by packaging (e.g., unboxing) while maintaining packaging sustainability.

Key opportunities

- McKinsey and Company's latest pulse survey indicates that 74% of consumers are changing their shopping behaviour to get more for their money, including buying food in bulk and adjusting the quantities purchased (222). F&B brands and retailers could consider how consumers' price sensitivity could be leveraged to transition to more sustainable packaging alternatives, such as offering products in bulk and eliminating the need for packaging.
- While consumers often report a willingness to pay more for sustainable packaging (220), many perceive sustainable products and brands as too expensive (216, 218). Packaging design strategies such as pack sizing and pricing strategies (6, 142) and using economical packaging alternatives (flexible/refill pouches instead of rigid plastic; (232) can be implemented to offset elevated costs.
- With global e-commerce sales projected for a 9% CAGR over 2022-2017 (6), food manufacturers and retailers must address key consumer pain points – such as reducing product damage or leakage and improving shipping/delivery times (6) - alongside their sustainable packaging strategy.
- Embracing omnichannel shopping to meet environmentally-conscious shopping experience, e.g., using buy online pick up in store (BOPIS) to reduce carbon emissions and packaging (233).
- Digitalisation – including AI and automation – is recognised for its value to "fast-tracking new pack development, adding efficiency and flexibility to analysis, and to pack design/prototype innovation" (6).

Priority Area 4: Innovating Technologies for Sustainable Packaging Development

Harnessing trends towards next-gen recovery and bio-based packaging solutions



Trend 11: Advancing next-gen recovery

Advanced recycling is touted as a promising solution to the recycling crisis. By breaking polymer chains down into their original building blocks, these technologies can improve recycling rates, particularly for hard-to-recycle formats, and provide feedstocks for "new" recycled materials.

Advanced plastics recycling technologies

Despite worldwide recycling targets, plastic recycling rates remain low (234-236). Increasing demand for recycled plastics as a result of recycled content targets is yet to be met (237). In recent years, there has been a surge of global interest in advanced recycling technologies to improve recycling rates, complement mechanical recycling capabilities, and process harder-to-recycle plastics and packaging formats (238, 113, 116, 239). These technologies are generally grouped into three types of processes which break down plastics into feedstocks for "new" plastics: (i) decomposition (i.e., breaking down plastic polymers or molecular bonds back down to their basic building blocks, known as monomers), (ii) conversion (i.e., similar to decomposition and involves converting polymers into liquid or gaseous hydrocarbons), and (iii) purification (i.e., polymers are dissolved in solvents to separate and extract a "purified" plastic out from a mixture of other components, such as additives and dyes)(238, 113, 237).

The advanced technology landscape highlights the potential to meet the demand for recycled content, with recent government investment in advanced and innovative recycling technology (85) and a growing number of advanced technology providers with the potential to grow and scale (237, 96). For example, Naula Pty Ltd received more than $5 million for the advanced sorting and processing of soft and mixed plastics to refine them into new plastics such as food-grade packaging (240). At the same time, recent advances in sorting technology – such as near-infrared technology and smart-AI enabled sorting - offer the ability to optimise waste sorting through automation (101, 241). As the adoption and scaling of advanced recycling technologies accelerate, these solutions are expected to play a crucial role in achieving circular food packaging targets, particularly given their ability to accept a range of polymers, including mixed plastics with potential contamination, which can help to expand the amounts, types, and qualities of plastics that can be recycled (238).

Biorecycling

Biological recycling, also known as biorecycling, has emerged as a promising solution to the recycling crisis (239). Using enzymatic reactions to break plastic polymer chains back down into the original monomers, without the need for high temperatures or chemical catalysts, biorecycling is noted for its ability to provide "sustainable, commercially viable and near-infinite recycling of synthetic polymers" (242), p. 52). It offers several advantages over mechanical and chemical recycling, such as its potential to produce higher-quality substrate recycled materials and allow for mixed and low-quality plastics to be recycled (243, 244).

Innovation and investment in enzymatic recycling technologies have significantly increased in recent years (242, 244). For example, in Australia, the Government has invested in the Australian company, Samsara, to scale up patented bio-polymer technology, which allows plastics to be continuously recycled using an enzyme that speeds up the breakdown of plastic into its original building blocks for reuse, including its reuse to manufacture new food-grade plastics (245, 246).

Most relevant stakeholders

- Recycling
- Research and development
- Collection and recovery
- Manufacturing and production
- Government
- Non-government organisations

Key challenges

- Scaling advanced recycling is limited due to high technology and infrastructure costs (112, 113).
- Increasing demand for petrochemical-based packaging – including polyethene (PE), polypropylene (PP), polyethene terephthalate (PET), polystyrene (PS), and polyvinyl chloride (PVC) (247) - highlights the importance of recycling capacity development, particularly in advanced recycling technologies to address contamination and degradation of the material properties during recycling (238).
- While advanced recycling offers a complementary way to expand the recycling landscape (238), resistance from mechanical recyclers should be considered. For instance, in a recent McKinsey and company report (116) one-quarter of mechanical recyclers consider chemical recycling as potential competition for raw materials, while 35 per cent view chemical recycling technologies as adjacent players or potential partners that can complement the recycling landscape.
- New materials developed with recycled content from advanced recycling processes will need to be verified for quality and safety in food and beverage packaging (112).

Key opportunities

- Harnessing advanced recycling technologies into the mix of production methods to generate recycled material is necessary to meet domestic brand-driven demand for recycled content (238). There is the potential to scale such technologies through global partnerships and consortiums (248).
- With a projected supply-demand imbalance for high-quality recycled plastics, there is potential for high premiums, which are already being observed in several plastics categories (249).
- Biorecycling offers an excellent opportunity to capture greater value from the food packaging value chain, enabling the near endless recycling of plastic waste while upholding material quality (250). Consequently, there are opportunities to accelerate the development of these technologies by promoting the adoption of biorecycling as a viable solution and increasing investment and R&D activity to scale biorecycling technologies.

Trend 12: Advancing bio-based packaging solutions

Digital transformation combined with breakthroughs in biological science has sparked a new wave of bio-based packaging derived from renewable resources, offering a promising path towards a circular packaging economy.

Transitioning to bio-based materials

Despite prolonged growth in the global petrochemicals industry underpinned by robust demand from food packaging and consumer-goods companies (251), a focus on bio-based packaging solutions is emerging (252, 76, 49). While bio-based substrates, such as paper (76, 253), have long been available, recent years have seen "advances in biological science [...] bolstered by accelerating innovations in computing, automation, and artificial intelligence (AI), resulting in a new wave of innovation known as the Bio Revolution" ((252), para. 2). As highlighted in a recent McKinsey Global Institute report (254), over the next 10 to 20 years, new biological ways of producing materials, chemicals, and energy could amount to $200 billion to $300 billion in global market growth. This has the potential to transform the global food packaging value chain as bio innovations in materials, chemicals and energy spill over into the packaging sector that uses these products as inputs (254).

The term "bio" in bio-based packaging can assume several meanings. Yet typically refers to materials that are (a) derived from renewable resources and polymerised through chemical mechanisms, (b) polymers extracted from biomass, (c) produced through biological processes, or (d) produced using a combination of these processes (255, p. 118). Bio-based polymers can be further classified into three broad categories based on their origin, chemical nature, and means of production (256), including (i) polymers directly extracted from biomass (256), such as plants (e.g., bagasse; 257, 136, 135) and proteins (e.g., collagen and gelatine; 258), (ii) polymers synthesised from bioderived monomers (256), such as polylactic acid PLA; (259), and (iii) polymers produced by microorganisms or genetically modified bacteria, such as Polyhydroxyalkanoates (PHAs; (256). Given their renewability, bio-based alternatives have the potential to address environmental challenges, through an ability to reduce the use of fossil-based feedstock, CO2 emissions and environmental leakage of non-biodegradable materials (252, 260).

Biodegradable bioplastics

While bio-based materials are renewable, they are not always biodegradable (255, 126). Of particular interest to stakeholders investigating bio-based sustainable packaging solutions are the opportunities afforded by biodegradable bio-based plastics (49, 258, 261). At present, PHA, PLA, PBS, and PBAT bio-based plastics are acknowledged for their biodegradable properties (126, 262) and have many flexible packaging applications (e.g., coatings, films, and bags; 261). However, "biodegradable" is a loosely coined term referring to a range of processes spanning compostable in high-heat industrial composting facilities to an ability to break down in the natural environment (263, 127), with only PHAs able to break down in the latter (256). Thus, many industry associations advise against using the term "biodegradable"(126). Examples of biodegradable bioplastics include Greenhope's biodegradable packaging made from cassava starch (264, 265), Mycelium-based compostable packaging by Evocative Design (266, 267) and Fungi Solutions (268, 269). Biodegradable bioplastics can provide value in situations where current packaging formats are not easily recyclable (e.g., plastic films with high degrees of food contamination; 261), and where packaging is disposed with food waste (e.g., produce stickers; 125).

Most relevant stakeholders

- Research and development
- Agriculture and farming
- Manufacturing and production
- Recycling
- Collection and recovery (inc. composting facilities)
- Suppliers

Key challenges

- Feedstock sustainability is one of the biggest challenges in the bioderived polymers market (270), including the high cost, competing sources of demand, and ethical concerns about using natural resources or protein (e.g., animal products) (261).
- Bio-based materials require considerable research and investment (270) and often involve costly production processes and infrastructure (261). While bioderived polymers from food sources are easily developed at a lab and pilot scale, they often face limited implementation due to performance limitations (e.g., inferior permeability and mechanical properties to protect food products; 270).
- Bio-based plastics face multiple challenges to become a scalable and sustainable alternative to virgin plastics. For example, managing biodegradable and non-biodegradable bio-based plastics involves difficulties such as specific degradation conditions, contamination of recycling streams, CO2 emissions, competition for biomass, and difficulty in collecting smaller plastic pieces (271).
- Limited consumer knowledge of what comprises bio-based packaging (e.g., from regenerative sources; 270) and how to dispose of it impacts the sustainability of such solutions (261).

Key opportunities

- Bio packaging solutions have the potential to perform the same, if not better, than traditional packaging materials (261). It is important, however, to demonstrate how these new alternative materials offer superior environmental performance compared to the conventional plastics they are replacing, such as through LCA(160).
- The sustainability of bio-based polymers, including recyclable and biodegradable bioderived polymers, can be significantly improved by using agricultural waste as feedstock (270). For example, Dr Nasim Amiralian, Leader of the Bio-Inspired Materials Group at The University of Queensland, has developed a world-leading packaging technology developed from sugarcane waste that is 100% bio-based and biodegradable that can replace plastic packaging and be used to extend the shelf life of produce (272).
- Investment support from industry, corporations, and government is crucial to advancing and scaling up the commercial viability of bio-based packaging solutions.
- Assuring the chemical safety of new packaging materials is crucial to the health of people and the planet; however, protecting confidential business information is critical to promote financial investment for innovative solutions. As such, disclosure to neutral third-party assessors – such as ChemFORWARD (131) – under a non-disclosure agreement enables transparency of chemical hazard assessments while protecting business IP (273).

Recommendations

This section highlights five cross-cutting and interrelated recommendations that can be leveraged to address the challenges and capitalise on the opportunities identified across the 12 trends. Recommendation 1 emphasises the importance of collaborative partnerships to exchange knowledge and build capacity to achieve systemwide change towards circularity. Recommendation 2 advocates for an ecosystem mindset recognising the importance of governance and facilitation to achieve collective action. Recommendation 3 highlights the importance of data analytics and digital technologies for developing and improving sustainable packaging solutions. Recommendation 4 accentuates the need for R&D to develop and improve innovative, sustainable packaging solutions. Recommendation 5 focuses on accelerating efforts to scale up emerging sustainable packaging solutions. The following table highlights each recommendation's relevance to the 12 trends.

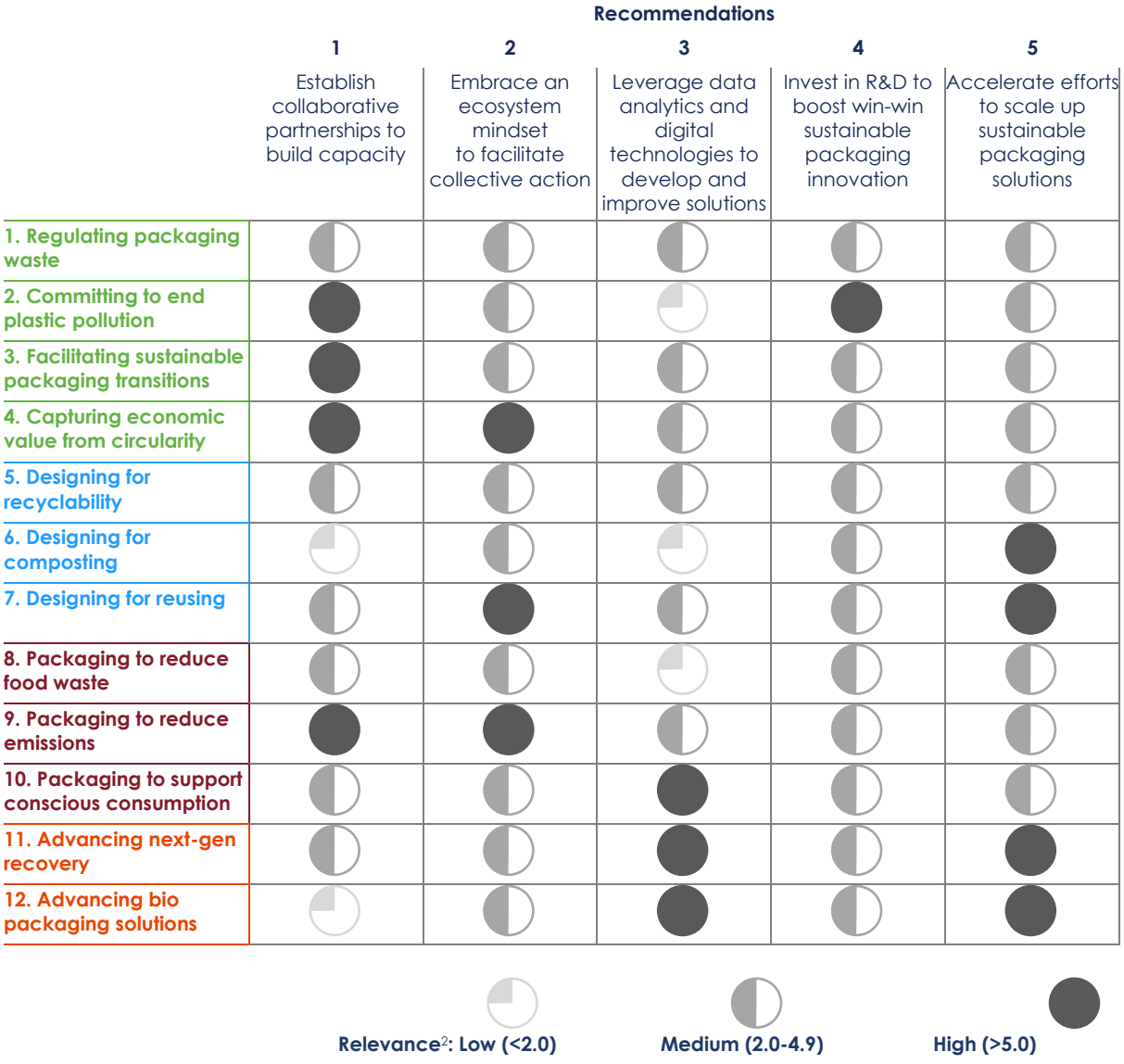


Figure 3. The 12 trends and their relevance to each recommendation

[2] See the Method for details of how the relevance was calculated using Leximancer prominence scores.

Recommendation 1: Establish collaborative partnerships to build capacity

Transitioning to a circular packaging economy requires diffusing solutions across the food and beverage packaging ecosystem. However, across the 12 trends, it was evident that the skills, knowledge, and resources required to adopt and engage in sustainable packaging solutions vary considerably within and across stakeholder groups. For instance, many businesses face challenges in designing for recyclability due to the availability of local material inputs, services, and infrastructure (114), such as the availability of food-grade rPET (70) and the recycling capabilities of different LGAs (68). At the same time, higher costs associated with many circular packaging solutions are often a key barrier for smaller businesses (73). Diverse multi-stakeholder partnerships – such as from academia, businesses, and government – are key to identifying potential challenges, enhancing innovation, and identifying joint solutions, as they bring a diverse pool of knowledge, resources, and capabilities (274-276).

Capacity building offers a promising pathway to address disparities in stakeholder knowledge and resources by "developing and strengthening the skills, instincts, abilities, processes, and resources that organisations and communities need to survive, adapt, and thrive in a fast-changing world" (277). Collaborative partnerships can facilitate capacity building by enabling the pooling of resources (e.g., co-investing to develop recycling capability; 278), sharing of knowledge (e.g., participating in networks and knowledge-sharing sessions that bring together key stakeholders, such as government and industry, to support stakeholders to take practical action; 279, 280), and development of innovative solutions that align with the capabilities of other stakeholders in the value chain (e.g., ensuring solutions meet customers' needs and leverage their competencies; 281).

Bringing together dominant players from each stage of the food packaging life cycle – including agriculture and food manufacturers, plastics manufacturers (e.g., Amcor, Visy, and Sealed Air Australia; 282, 283), supermarket giants (e.g., Woolworths and Coles; 284), and waste remediation and materials recovery services (e.g., Sims, Veolia Environmental Services, and Cleanaway Waste Management; 94) – will be key to establishing the direction for a circular packaging economy in Australia. Establishing multi-stakeholder partnerships among such players, for example, through a circular packaging economy business advisory network (e.g., 285), will not only provide an opportunity to leverage collective knowledge, resources and influence but will also ensure that the development of circular solutions, including government regulation, is both practical and implementable at scale.

Recommendation 2: Embrace an ecosystem mindset to facilitate collective action

A collective approach is crucial for transitioning to a circular packaging economy, as circularity inherently requires coordinated effort across the entire value chain. An ecosystem mindset realises that it is not the responsibility of any one stakeholder to support this transition; rather, each stakeholder has an important role in the interconnected and dependent system (286). Regardless of the sustainable packaging solution – whether it be building a sustainable recycling system (286), transitioning to reusable packaging systems (161), or sharing transparent end-to-end supply chain information in real-time (287) to facilitate conscious consumption or tracking GHG emissions (209) – leveraging the capabilities of all ecosystem stakeholders is key to achieving shared goals (287). For example, an ecosystem mindset can help to identify and develop solutions to key barriers to scaling reusable packaging solutions, such as the costs to different ecosystem stakeholders, including consumers, brands, converters, refilling and cleaning operations, logistics, and retailers (e.g., the requirement for consumers to return containers to a store, businesses' increased capital expenditure associated with upgrading to refill and return technology, cleaning and quality control). This can facilitate the development of a "cost-efficient ecosystem with infrastructure across the

entire value chain, from brands to converters, filling operations, and retailers" (161, Key enablers section, para. 8).

Building and leveraging ecosystems is increasingly recognised as key to successful sustainable packaging solutions (288). Many stakeholders have the potential to serve as ecosystem orchestrators, including governments, network facilitators, and companies. For instance, governments can help to establish robust regulatory frameworks that recognise the need for collective efforts and equitable distribution of costs across different stakeholders (e.g., EPR schemes and eco-modulated fees; 25), while network facilitators can encourage participation from a diverse range of stakeholders across the packaging value chain (e.g., leveraging tools such as the *Collective Impact Framework*; 289) and third-party entities can support business collectives to fulfil their obligations related to sustainable packaging waste management (e.g., producer responsibility organisations (PROs) ensuring producers and manufacturers meet legal requirements for waste management; 22).

Companies can also work together to influence and shape the strategies of others, not only facilitating transitions to sustainability in the broader system but also creating a favourable business environment enabling their own companies to flourish (288) (290). For example, the *Sustainable Food Policy Alliance* (SFPA; (291) was established by four leading food companies - Mars Incorporated, Danone, Nestlé, and Unilever – to shape food-related regulation, including regulations focused on packaging design, material use, and emissions to shift the industry towards a circular economy (290). Such efforts help to capture greater economic value from circularity by identifying ways in which value can be co-created for different stakeholders in the value chain, aligning roles and goals to stimulate long-term value co-creation, supporting business models that use financial incentives, and enabling companies to distribute market risk by uniting their efforts to shift the policy environment around sustainable food (290, 292).

Recommendation 3: Leverage data analytics and digital technologies to develop and improve solutions

Across the 12 trends, leveraging data analytics and digital technologies was widely acknowledged as key to developing and improving solutions that facilitate transitions to a circular packaging economy. The opportunities afforded by such technologies are far-reaching. For instance, smart sensors, the Internet-of-Things, and blockchain technology can be leveraged to measure, track, and authenticate the impact of different packaging solutions, supporting transparent reporting (28), while tracking up and downstream material sourcing (12, 27) and emissions (209), supports end-to-end visibility of the packaging supply chain. At the same time, many technologies associated with the optimisation of sustainable packaging solutions – such as sensors and AI-technology to monitor food quality and safety (e.g., food temperature and packaging damage) and the data collected by smart dispensing machines for refillable packaging to improve demand forecasting (163) – also help to reduce food waste.

Integrating AI into sustainable packaging solutions offers many valuable opportunities to transform the food packaging ecosystem (293). For example, ideating and designing packaging prototypes that meet stakeholder preferences can be improved by integrating the capabilities of artificial intelligence, 3D printing, and computer-aided design (CAD) (294). AI algorithms can facilitate the development of new bio-based packaging materials (252). For example, Toronto-based start-up *erthos* (295) leverages predictive modelling, material science, and biobased ingredients to rapidly design industry scalable biomaterials and iterate formulations optimised for performance and composting requirements (296). At the same time, AI is facilitating efficient recovery and recycling processes – such as AI-led waste recognition apps to facilitate correct disposal by consumers (101). In addition, intelligent robotics and autonomous systems are being employed to effectively sort complex recycling streams encompassing co-mingled materials (297) and camera sensing technologies

applied to waste traps are helping detect and classify plastic pollution in waterways (298) – all of which help to close the loop on waste.

Recommendation 4: Invest in R&D to boost "win-win" sustainable packaging innovation

Many challenges across the 12 trends highlight sustainability trade-offs as a key barrier to the adoption of sustainable packaging solutions. For instance, one barrier to eliminating packaging is the potential for compromised shelf-life performance leading to food waste (see Trend 8), while reusable packaging is often associated with greater energy and water use for sanitation (see Trend 7). At the same time, stakeholders across the value chain cite a range of trade-offs, such as affordability, food safety and hygiene, and the need for enhanced shopping experiences as key barriers to accepting sustainable packaging solutions (see Trend 10). Rather than viewing these trade-offs as a barrier to circular packaging transitions, stakeholders can embrace them as unique R&D opportunities to develop innovative, "win-win" sustainable packaging solutions.

R&D is key to stimulating the emergence of novel solutions that can simultaneously address multiple sustainability goals and trade-offs, and to accelerate their application in the real world. For example, product concentrates in compact powder and tablet forms help to reduce packaging waste while reducing emissions and food waste (e.g., *Overherd's* Oat milk powder; 299). While tablet concentrates are largely available in personal care and cleaning products (144), there is a significant opportunity to explore the potential for such options in the food and beverage industry. Another example is dedicating R&D to developing new packaging materials that leverage food by-products and waste (300, 301), such as *AB InBev's* alternative to cardboard beer holders made from barley straw, a by-product of barley used in beer brewing (100) and *Fungi Solutions'* Myco-Material bio-regenerative, home-compostable packaging generated through *Myco-Cycling*, transforming organic waste into using mycelium (268, 269).

Initiatives to boost innovation in win-win solutions, such as the *Save Food Packaging* project, focused on developing solutions that reduce food waste while achieving sustainable packaging targets (170) and the *Bioplastics Innovation* Hub, focused on turning food waste into compostable packaging (302), are crucial for promoting investment in win-win packaging solutions. Importantly, beyond supporting the development of novel win-win sustainable packaging solutions, is the need for R&D investment to commercialise new solutions and identify scalable pathways (242, 90), which is discussed as follows.

Recommendation 5: Accelerate efforts to scale up sustainable packaging solutions

Accelerating the adoption of sustainable packaging solutions at scale – including reusable packaging systems (162, 303), compostable packaging (235, 140), next-generation recycling technologies (242, 113), and biodegradable bioplastics – are recognised across the 12 trends as a priority to achieve a circular packaging economy. Scalable solutions are those that are implemented across the entire value chain, feasible beyond lab tests and pilots (162, 304), and adopted across a wide range of products, sectors, and geographies (303). Given their potential for widespread adoption and impact, prioritising and investing in scalable, sustainable packaging technologies is vital to achieving a circular packaging economy. For example, the Ellen MacArthur Foundation highlights that converting just 20% of single-use plastic packaging into reuse models presents a business opportunity worth at least USD$10 billion (144). Reuse models present an opportunity to tap into shifting user preferences for personalisation, physical and digital retail, and quality user experiences through their smart system potential (i.e., incorporating digital technologies into the reuse system and gathering intelligence on user preferences) and offering superior packaging design qualities (144). While scaling such models is a key challenge (161, 142), several beverage examples – including Soda Stream, Coca-Cola Freestyle, and Pepsi Spire – demonstrate the potential to achieve global scale adoption and impact (144).

Scaling up sustainable food packaging technologies across the Australian food and beverage ecosystem and beyond will require concerted efforts across several key areas. A willingness to learn from initial R&D investments, including pilots and trials, are needed to shape and guide the progress of scalable models (113, 278). Current business models must also be reimagined to accelerate efforts to scale new technologies, with the need for businesses to consider new ways of using technologies and approaching the value chain (305). Efforts dedicated to the adoption of new sustainable packaging technologies and business models across sectors, regions, and stakeholders will be key (113, 305). This includes addressing key barriers to adoption across different products, sectors, and geographies. For example, reducing the costs of implementing new technologies (e.g., through economies of scale; 306), improving access to infrastructure (e.g., providing business-owned services where council infrastructure is not offered; 140) and enhancing the versatility of solutions (e.g., enhancing barrier properties of compostable packaging to expand its application areas; 235).

Illustrative Case Studies

This section presents examples of organisations collaborating with FaBA, illustrating how stakeholders across the food packaging value chain can leverage opportunities arising from the 12 trends. These organisations include Edible Cutlery, koor, Lilly's Little Lunchbox, and Meat and Livestock Australia (MLA). The table below highlights the trends that have been identified and seized as market opportunities by each of the four organisations. Below, we discuss how these organisations capitalise on opportunities and address challenges presented by the trends[3].

	Edible Cutlery ediblecutlery.au/	**koor** koor.life/	**Lilly's Little Lunchbox** lillyslittlelunchbox.com/	**Meat & Livestock Australia** www.mla.com.au/
1. Regulating packaging waste				✓
2. Committing to end plastic pollution	✓			✓
3. Facilitating sustainable packaging transitions	✓		✓	✓
4. Capturing economic value from circularity	✓			✓
5. Designing for recyclability	✓		✓	✓
6. Designing for compostability	✓			
7. Designing for reusability		✓	✓	
8. Packaging to reduce food waste	✓	✓	✓	✓
9. Packaging to reduce emissions			✓	
10. Packaging to support conscious consumption	✓	✓	✓	
11. Advancing next-gen recovery				✓
12. Advancing bio packaging solutions	✓			

[3] The information provided by the industry participants is verified by them and not by the authors of the report.

Edible Cutlery
https://ediblecutlery.au/

Edible Cutlery is an Australian company on a mission to "revolutionise the way we eat on the go" (307) with innovative solutions that not only change the way people eat but address the global plastic waste crisis (308). Edible Cutlery produces a range of edible alternatives to plastic utensils and food service packaging, from Edible Spoons (309) to Edible Cups (310), which are made from "100% naturally produced multi-grain flour and extracts from wheat, rice, cane sugar, millet, corn, tapioca, and mung beans" (308). By leveraging bio-based and compostable materials as alternatives to single-use plastics, Edible Cutlery's products are seizing several market opportunities afforded by sustainable food packaging trends. While Edible Cutlery is designed to be consumed with or after meals to minimise disposable waste, uneaten Edible Cutlery can be disposed of within kerbside food organics bins or backyard composting, where it naturally biodegrades within 1-2 weeks (311). The packaging of Edible Cutlery products has also been designed with sustainability in mind, with recyclable paperboard boxes and plastic comprising less than 5% of plastic used, with offsets in place for plastic usage, energy, and carbon footprint through their partners (311). Edible Cutlery is not individually wrapped, which further reduces their use of packaging.

A key challenge to facilitating conscious consumption is navigating complex consumer requirements, including trade-offs influencing their preferences for eco-friendly alternatives. To address this, Edible Cutlery has not only refined functional product features, such as the texture and time it takes to go soggy, but they also aim to provide consumers with a culinary experience through their range of sweet and savoury flavours to suit the accompanying food (308). Edible Cutlery further facilitates conscious consumption through their plant-based and vegan claims and displays nutritional information on the packaging to support healthy eating. By leveraging social media and influencer collaborations, Edible Cutlery aims to spread awareness of sustainability, showcase their products' benefits, and inspire consumers and the food service industry, including, for example, restaurants, cafes, and catering services, with the goal of making more conscious choices (312).

koor
https://koor.life/

koor is an Australian packaging start-up with a focus on designing for reusability, with their award-winning refillable packaging solution providing an alternative to single-use packaging for food and household products (313-315). koor aims to address the plastic waste crisis by replacing single-use plastic packaging with a durable, continuously reusable alternative made from food-grade polypropylene that is FDA 21 CFR 177.1520 and EU Directive 2006/122/EC compliant. In line with refill-at-home business-to-consumer packaging models (144), koor encourages consumers to buy foods in bulk, targeting "on-the-go" viscous liquid food categories such as yoghurt, which are typically sold in single-use pouches (316). In addition to supporting reusability, koor's packaging promotes sustainable and responsible product life cycle management, minimising waste sent to landfill by providing replaceable parts to extend the packaging's lifespan (317, 318). Their pricing strategy further reflects their mission to encourage packaging repair, with spare parts sold at discounted prices. koor also strives for "win-win" innovation, aiming to address not only key environmental challenges like packaging and food waste reduction (e.g., portion size control and enabling the storage and freezing of leftovers) but also key social challenges through their packaging design. koor is exploring opportunities for its unique packaging design to provide greater accessibility to consumers, such as those who experience eating challenges (319). Jean-Francois Roiron, founder and inventor of koor, highlights that "the main drivers for me to invent koor were to help families to save money by buying in bulk or making homemade food and to encourage our kids to -"do the right thing"- by making eco-friendly choices and reducing plastic waste".

One of the key challenges associated with designing for reusability is changing consumers' behavioural patterns and habits towards adopting refillable solutions. koor's packaging design seeks to address this challenge by prioritising user functionality and convenience through features including a compact design to fit inside lunch boxes or bags, a quick-release cap for easy opening, a plunger inspired by the design of a syringe enabling easy refill and minimising spillage, and ease of cleaning (e.g., dishwasher safe materials). At the same time, koor provides a range of educational videos to facilitate consumer use and repair of their packaging (320) and engages with the community, such as collaborating with local schools, to encourage a community-wide shift towards sustainability. Encouraging the adoption of koor's refillable food packaging is only the first step in their vision towards a circular economy. At present, koor is exploring pathways for a refill-on-the-go zero-waste distribution system. Acknowledging that refillable packaging must fit within broader reuse systems to close the loop on waste, koor has a vision to facilitate refill-on-the-go by developing refill stations and exploring different schemes for refill in-store.

Lilly's Little Lunchbox
lillyslittlelunchbox.com/

Lilly's Little Lunchbox is a family-owned business based in Brisbane, Queensland, dedicated to delivering healthy, convenient, fresh, tasty, and nutritious meals and smoothies. Inspired to remove the daily hassle and stress of preparing healthy and nutritious school lunches and driven by a mission to "be the world's largest and healthiest canteen – delivered, instilling healthy eating habits in younger generations", Lilly's Little Lunchbox delivers dietitian-designed, fresh and healthy lunches made for kids, using the highest quality, all-natural ingredients, free from additives, preservatives, or fillers (321). Now scaling into the NDIS and aged care sectors, their premium pre-made meal delivery service aims to provide a convenient solution for busy parents, individuals with disabilities, and seniors by delivering these meals directly to homes, schools, daycare facilities, and other venues across Queensland, Victoria, the Australian Capital Territory, and New South Wales (322).

Sustainability has been a core principle of Lilly's Little Lunchbox since its inception. The company initially launched with compostable meal trays, but due to practical limitations impacting food freshness and requiring multiple deliveries per week—thus increasing environmental impact—they transitioned to recyclable and reusable materials to strike a balance between sustainability and product longevity. This shift allowed Lilly's Little Lunchbox to move to one day delivery per week per household, down from two to three times per week per household, significantly reducing the number of trucks on the road and subsequently lowering their carbon emissions. Today, Lilly's Little Lunchbox's product offerings address several sustainable packaging opportunities, from reducing food waste to carefully selecting packaging materials that encourage recycling and reuse (323).

Lilly's Little Lunchbox's prepared meals are packaged and delivered with food waste minimisation in mind, using a three-compartment tray wrapped in insulation with a cold gel pack, designed to maintain food freshness, quality, and shelf life. Their real-time delivery tracking system further helps to minimise food waste by providing customers with an expected time of arrival (ETA) for their delivery and encouraging prompt refrigeration at five degrees or less (322). The company also reduces food waste through efficient kitchen operations and strategic relationships with food growers and suppliers. At the same time, Lilly's Little Lunchbox's meal trays are designed to be both reusable and recyclable, encouraging customers to recycle responsibly while offering creative ideas for repurposing trays through their LLL Recycle Project—such as using them as seedling planters for gardens or art projects for children (323). Customers can also return gel packs for reuse and recycling, contributing to a more sustainable future.

In summary, Lilly's Little Lunchbox's approach to packaging balances the need for food safety and freshness with recyclability and reusability, while maintaining a commitment to

adopting biodegradable materials as technology advances. This approach aligns with their long-term vision of reducing waste and contributing to a healthier, more sustainable future.

Meat & Livestock Australia
https://www.mla.com.au/

Meat & Livestock Australia (MLA) is a service provider working in partnership with the red meat industry and the Australian government to provide marketing, research and development products and services to the Australian red meat and livestock industry (324). Sustainability is a core aspect of MLA's purpose (325), with several of their R&D projects dedicated to guiding the development of an environmentally sustainable packaging value chain for the Australian red meat industry (326). The Australian red meat industry relies heavily on plastic packaging to deliver its products to domestic and international consumers (327, 328). Plastic packaging is leveraged to minimise food waste by extending product shelf life and ensuring product integrity and food safety are maintained by providing barrier protection (327). However, plastic packaging poses environmental challenges, particularly in end-of-life management, where most red meat packaging ends up in landfill due to limited circular options, such as the absence of a nationwide soft plastics recycling scheme (327, 328).

MLA has engaged in several sustainable packaging R&D projects to address these challenges and identify innovative packaging solutions that balance sustainability with functionality. For instance, MLA's 2021 A *Horizon Scan of Sustainable Red Meat Packaging: What's New, Innovative, and Ready to Market* highlights that while complete elimination of plastic is not yet feasible, due to the need for robust shelf-life performance, alternatives such as reduced and non-petrochemical-based plastics are available (329). The report highlights the importance of designing materials with recyclability and reusability in mind, including recyclable plastic trays containing mono materials and recycled plastic, as well as continued development of advanced recycling technologies, biopolymers, and effective labelling, collection, and sorting schemes (329). Other innovative packaging formats emphasised include a corrugated tray, which combines paperboard and plastic film that can be easily separated (up to 80% reduction in plastic), and flow-wrap formats for mince suitable for MAP, recyclable and tear open (up to 70% reduction in plastic) (329, 175). Other past MLA investments have included evaluating edible packaging materials for red meat derived from seaweed and plants, other materials derived from repurposed food waste for prototype compostable materials (330), and bloodmeal as a feedstock for biodegradable plastics (331).

MLA's 2023 *Meat Packaging – The State of Play in An Evolving Market* report identifies red meat packaging materials at risk in the Australian market (i.e., deemed non-compliant based on current and expected legislation) and opportunities for sustainable packaging innovation in line with APCO requirements (328). In addition to providing an APCO-compliant *Packaging component sustainability guidance* tool for different types of meat packaging, the report highlights the need for a complete system approach to support a circular economy, with a particular focus on the collection and reprocessing of materials, such as soft plastics, that can be used again for food packaging (328). Recently, the 2024 *MLA Red Meat Packaging Stewardship Framework* highlights the benefits of a product stewardship approach, including extended producer responsibility, which encourages "all stakeholders in the supply chain – from producers and manufacturers to brands and retailers – taking responsibility for minimising the environmental and health impacts of their products and packaging throughout their lifecycle" (p. 2,(327). By embracing such an approach, MLA fosters collaboration and engagement with industry, and promotes shared responsibility among producers, manufacturers, brands, and retailers to support sustainable packaging innovation and sector-wide circularity (327). MLA continues to welcome R&D proposals for possible co-funding support from innovators and end-users in this field.

Method

Data collection

We conducted a systematic review of recent market, industry, and government publications (2019- 2024) related to sustainable packaging in the global food and beverage sector. This involved manually searching the websites and databases across sources – including leading analytics and management consultancy firms, market and consumer research agencies, research and development corporations, industry associations in the packaging and food and beverage sectors, and government and non-governmental agencies – using a combination of the terms "sustainable" AND "packaging". Where a search function was unavailable on the website, we browsed all publications to identify those related to sustainable packaging. These sources returned a wide range of publications – including articles, reports, press releases, news, webinars, podcasts, interviews, case studies, and media coverage – reporting on supply and demand side trends, as well as perspectives across multiple stakeholders in the food and beverage packaging ecosystem. Our search process further involved reading the full text of each publication to assess its relevance in providing insights into sustainable packaging trends, opportunities, and challenges in the global food and beverage sector. Through this process, 1061 publications were identified and included in our analysis. In addition, 114 publications were identified following further manual searches tailored to the identified trends.

Data analysis

To identify relevant themes and topics representing sustainable packaging trends, we used a two-phase approach integrating Leximancer's qualitative analytical capabilities with BERTopic's quantitative topic modelling strengths. In the initial phase, Leximancer, a machine-learning-based text analysis software (332), was used to explore the dataset. Specifically, we used Leximancer to zoom in (i.e., obtain a granular, concept-level view) and zoom out (i.e., obtain a higher, theme-level view) of the data, which was enabled by its ability to identify and visualise relevant concepts and their interrelationships through concept mapping (333, 334). A total of 246 concepts were identified through Leximancer's automatic content analysis of the dataset, which draws on the identification of relevant lexical terms based on word frequency and co-occurrence (334). The three overarching themes – including packaging design, waste management, and sustainable development - were identified based on the co-occurrence of word terms in the text, allowing for the emergence of themes as clusters of related concepts. We draw on these three themes to develop our definition of sustainable packaging transitions as the design of packaging and associated waste management systems to achieve sustainable development. These themes are collections of word terms that are contextually linked, providing a rich, qualitative insight into the dataset's thematic structure. As shown in Figure 1, we identified four key priority areas at the intersection of the identified themes: (1) governing waste for sustainable packaging development, (2) designing packaging for circularity, (3) designing packaging for sustainable food life cycles, and (4) innovating technologies for sustainable packaging development.

Complementing our Leximancer analysis, the second phase applied topic modelling, an advanced natural language processing technique, to the same dataset. This technique was applied to discover latent topics in a large collection of documents (335). The implementation of topic modelling involved the Bidirectional Encoder Representations from Transformers (BERT) technique applied to the task of topic modelling (an algorithm known as BERTopic) (336). Topics are defined by collections of semantically related terms, where

BERTopic accounts for the context of these terms by leveraging transformers and text embedding techniques (337). We implemented the BERTopic algorithm using the library of "BERTopic" in Python (336). The topic modelling analysis revealed 38 topics, which we manually reviewed and mapped to the relevant priority areas identified through our Leximancer analysis. This exercise also served as a validity check of the sustainable packaging concepts and terms comprising themes and topics identified through Leximancer and BERTopic. We identified 12 key trends based on this review of the topics, their relevance over time, and mapping to the Leximancer analysis. To calculate the relevance of trends to stakeholders and recommendations in Figures 2 and 3 respectively, we selected relevant concepts identified in the Leximancer analysis that represented each trend, stakeholder group, and recommendation, and used the co-occurrence prominence scores for relevant pairs of concepts (e.g., regulation AND government) calculated by Leximancer. Prominence scores combine the strength and frequency of co-occurrence using Bayesian statistics and are the joint probability divided by the (product of marginal probabilities). Given each trend comprised multiple concepts (e.g., Trend 1 encompassed concepts such as "regulation", "policies", and "legislation"), a mean prominence score for each stakeholder concept was calculated across each theme's relevant concepts. A prominence score of >1.0 indicates that co-occurrence happens more often than by chance.

Across the two phases, our analyses were validated by two members of the research team and an external reviewer to ensure consensus was reached regarding (1) interpretation and relevance of concepts identified in the Leximancer analysis, (2) interpretation and mapping of topics into relevant trends and priority areas, and (3) selection of Leximancer concepts to represent the trends, recommendations, and stakeholders included in Figures 2 and 3. Across our two-phase approach, we conducted a robust exploration of concepts, topics, and themes within the corpus, where Leximancer's detailed concept insights and thematic overview complement BERTopic's identification of topics and their relevance over time, providing a richer, multi-layered understanding of the data.

List of Examples

Relevant Trend	Name	Description	Reference
1	UK's grocery industry agreement	A voluntary agreement between stakeholders in the grocery sector in UK to reduce food and packaging waste	(72)
1	Chile's circular economy roadmap	An example of a national circular economy action plan	(338)
2	Woolworths – Meat Pack	Recyclable meat pack redesign reduces plastic by 75%	(339)
2	Woolpack Thermal Insulation	Packaging solution for thermal insulation made from 100% sheep's waste wool	(65)
2	Tesco	Large UK supermarket chain committed to reduce plastic packaging	(340)
3	Coca-Cola rPET bottle	Coca-Cola converts all single-serve PET bottles to 100% recycled plastic (rPET)	(62)
4, 6	Compost Connect	A national (Australia) composting network connecting individuals and composting hubs	(129)
4	Opal	A company offering circular solutions for cardboard and paper recycling in Australia and New Zealand	(341)
4	Edge Environment	A sustainability consultancy firm with a data-approach to facilitate circular economy adoption	(342)
5	Plantic Technologies	A company has developed a recyclable high skin barrier pack to use in meat trays	(176)
5	UPM Raflatac and Kiwi Labels	A new solution for washable labels for fruit containers	(343)
5	Replated	A reusable food packaging system made from recycled plastics and glass	(74)
6, 12	BioPak	Compostable foodservice packaging made from renewable plant-based materials for single-use packaging	(140, 135, 137)
7	KeepCup	A pioneer company on reusable cups	(156)
7	Huskee	Reusable coffee cups from coffee husk waste	(158)
7	Cercle	A reusable cup system for workplaces	(157)
8	Fresh Technologies & Sealed Air	Packaging solution aimed at increasing avocado spreads shelf-life and reduce food waste	(178)
8	Woolworths	A major retailer and selected suppliers are using 2D barcodes to enhance food safety and reduce food waste	(180)
8	Edgell	A packaging design for chips aimed at reducing food waste	(344)
8	Mushrooms and microorganisms	Bio packaging solutions	(345)
9	Kua Coffee	A closed-loop coffee service	(346)
9	Evian Bottled Water	Increasing the recycled content in packaging	(194)
12	Greenhope	Biodegradable packaging made from cassava starch	(264, 265)
12	Evocative Design	Mycelium-based compostable packaging	(266, 267)
12	Fungi Solutions	A company producing custom bio-regenerative packaging solutions from organic waste	(268)
Recommendations	Erthos	A start-up leveraging AI and digital technologies to create bespoke packaging solutions	(296, 295)
Recommendations	Overherd	An oat milk in a powder format to reduce emissions, packaging and food waste	(299)
Recommendations	AB Inbev	A beer company committed to zero-waste targets by adopting a circular approach to packaging	(100)

Glossary of Terms

ARL: Australasian recycling label

B2B: Business to business

B2C: Business to consumer

BOPIS: Buy online, pick up in store

CAD: Computer-aided design

CAGR: Compound annual growth rate

CPG: Consumer packaged goods

CSR: Corporate social responsibility

CRC's: Cooperative research centres (Australia)

EPR: Extended producer responsibility

ESG: Environment, social and governance

FMCG: Fast-moving consumer goods

FOGO: Food organics garden organics

F&B: Food and beverage

GHG emissions: Greenhouse gas emissions

LCA: Life-cycle assessment

LGAs: Local government areas

NGOs: Non-governmental organization

PBAT: Polybutylene adipate terephthalate

PBS: Polybutylene succinate

PE: Polyethylene

PET: Polyethylene terephthalate

PIDA: Packaging Innovation & Design Awards

PHAs: Polyhydroxyalkanoates

PLA: Polylactic Acid

PP: Polypropylene

PREP: Packaging recyclability evaluation portal

PS: Polystyrene

R&D: Research and development

RFID: Radio-Frequency Identification

SME's: Small and medium enterprises

SPGs: Sustainable Packaging Guidelines

Organisations:

ABA: The Australasian Bioplastics Association

ACE Hub: Australian Circular Economy Hub

AFGC: Australian Food & Grocery Council

AIP: Australian Institute of Packaging

AMPC: Australian Meat Processor Corporation

APCO: Australian Packaging Covenant Organisation

CHEP: Commonwealth Handling Equipment Pool

CSIRO: Commonwealth Scientific and Industrial Research Organisation

FIAL: Food Innovation Australia Limited

MLA: Meat & Livestock Australia

NWRIC: National Waste and Recycling Industry Council

OECD: Organisation for Economic Co-operation and Development

SPC: Sustainable Packaging Coalition

UN: United Nations

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

EPA: United States Environmental Protections Agency

WBCSD: The World Business Council for Sustainable Development

WEF: World Economic Forum

WPO: World Packaging Organisation

WRAP: The Waste and Resources Action Programme

WWF: World Wildlife Fund Australia

References

1. NielsenIQ. (2023). The changing climate of sustainability. https://nielseniq.com/global/en/insights/analysis/2022/the-changing-climate-of-sustainability-has-reached-a-critical-moment/
2. NielsenIQ. (2023). The green divide: how to influence and change conscious consumer behavior. https://nielseniq.com/global/en/insights/report/2023/how-to-turn-green-consumer-intentions-into-sustainable-actions/#report
3. Brea, E., et al. (2023). Global food and beverage trends report: opportunities to unlock innovation in the Australian food and beverage sector Innovation Pathways, Australia's Food and Beverage Accelerator (FaBA). The University of Queensland.
4. Lau, W.W.Y., et al. (2020). Evaluating scenarios toward zero plastic pollution. Science, 369(6510), 1455-1461. https://doi.org/doi:10.1126/science.aba9475
5. The Pew Charitable Trusts. (2020). Breaking the plastic wave: a comprehensive assessment of pathways towards stopping ocean plastic pollution. https://www.pewtrusts.org/-/media/assets/2020/10/breakingtheplasticwave_mainreport
6. Downey, R. (2023). Top four trends shaping global consumer packaging. Euromonitor International.
7. Parliament of Australia. (2025). Food for thought: the opportunities and challenges for Australia's food and beverage manufacturing industry. https://www.aph.gov.au/About_Parliament/House_of_Representatives/About_the_House_News/Media_Releases/Food_for_Thought
8. United Nations. (n.d.). New economics for sustainable development: circular economy. United Nations Economist Network. https://www.un.org/en/desa/unen/policy-briefs
9. Schröder, P. and Barrie, J. (2024). How the circular economy can revive the Sustainable Development Goals: priorities for immediate global action, and a policy blueprint for the transition to 2050 Environment and Society Centre. Chatham House.
10. Ellen MacArthur Foundation. (n.d.). Circular economy introduction: what is a circular economy? https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview
11. Barry, M. (2023). Upcoming trends in FMCG packaging legislation. Euromonitor International.
12. Spindler, W. and Jamieson, S. (2023). The future of packaging in the circular economy, 5 actions for long-term success. Accenture. https://www.accenture.com/content/dam/accenture/final/accenture-com/document/Future-of-Packaging-Accenture.pdf#zoom=40
13. Turnsek, A. (2021). Why tax and finance functions must pay heed to plastic taxes. Ernst & Young (EY). https://www.ey.com/en_gl/insights/tax/why-tax-and-finance-functions-must-pay-heed-to-plastic-taxes
14. Cherel-Bonnemaison, C., et al. (2022). Sustainability in packaging: global regulatory development across 30 countries. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-global-regulatory-development-across-30-countries
15. Berg, P., et al. (2020). The drive toward sustainability in packaging—beyond the quick wins. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/the-drive-toward-sustainability-in-packaging-beyond-the-quick-wins#/
16. United Nations Environment Programme (UNEP). (2019). Tackling the environmental scourge of single-use plastics through legal and voluntary approaches. https://www.unep.org/news-and-stories/story/tackling-environmental-scourge-single-use-plastics-through-legal-and
17. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. (2023). Plastic pervasive in food supply: new study. https://www.csiro.au/en/news/all/news/2023/may/plastic-pervasive-in-food-supply-new-study
18. Daw, M. (2022). Fishing for data on plastics. Fisheries Research and Development Corporation (FRDC). https://www.frdc.com.au/plastic-free-july-turn-tide-one-choice-time
19. Ipsos. (2019). A throwaway world: the challenge of plastic packaging and waste.
20. Australian Government, Department of Agriculture, Water and the Environment (DAWE). (2021). National plastics plan 2021. https://www.dcceew.gov.au/environment/protection/waste/plastics-and-packaging/national-plastics-plan
21. Matthews Pegg, Consulting Pty Ltd. (2021). Review of the co-regulatory arrangement under the national environment protection (used packaging materials) measure 2011. Prepared for the Department of Agriculture, Water and the Environment, Canberra.
22. Organisation for Economic Co-operation and Development (OECD). (2016). Extended producer responsibility: guidance for efficient waste management. http://dx.doi.org/10.1787/9789264256385-en
23. Ellen MacArthur Foundation. (2021). Extended producer responsibility statement and position paper. https://emf.thirdlight.com/file/24/Nh4L9FbNpqPTjtNhOJMNAzR91O/Extended%20Producer%20Responsibility%20-%20Statement%20and%20Position%20Paper.pdf
24. Cano, A. I. and Osman, N. (2023). Extended producer responsibility era. PricewaterhouseCoopers (PwC). https://www.pwc.com/gx/en/services/legal-business-solutions/entity-governance-compliance/extended-producer-responsibility-era.html

25. Australian Packaging Covenant Organisation (APCO). (2024). 2030 strategic plan. https://documents.packagingcovenant.org.au/public-documents/2030%20Strategic%20Plan
26. United Nations Environment Programme (UNEP) & GA Circular. (2019). The role of packaging regulations and standards in driving the circular economy.
27. PricewaterhouseCoopers (PwC). (2023). The role of the public sector in driving a circular economy in Southeast Asia.
28. KPMG. (2023). Advanced industrial manufacturing supporting a circular economy. https://kpmg.com/au/en/home/insights/2023/10/industry-4-0-industrial-manufacturing-circular-economy.html?tileListID=1&nocache=true
29. Organisation for Economic Co-operation and Development (OECD). (2022). Environment Ministers' commitments on plastics.
30. United Nations Development Programme (UNDP). (2023). Environment week 2023: joining forces to beat plastic pollution. United Nations Development Programme, Suriname. https://www.undp.org/suriname/press-releases/environment-week-2023-joining-forces-beat-plastic-pollution
31. United Nations (UN), Department of Economic and Social Affairs. (2023). The sustainable development goals report 2023. https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf
32. United Nations Environment Programme (UNEP). (2019). UN environment partners with Schurmann family for ambitious new "voice of the oceans" expedition. https://www.unep.org/news-and-stories/press-release/un-environment-partners-schurmann-family-ambitious-new-voice-oceans
33. United Nations Environment Programme (UNEP). (2019). Latin american, caribbean scouts join the global fight against plastic pollution. https://www.unep.org/news-and-stories/press-release/latin-american-caribbean-scouts-join-global-fight-against-plastic
34. Ellen MacArthur Foundation. (2023). Collaboration between international NGOs coordinates efforts to tackle plastic pollution ahead of global treaty to end plastic pollution. https://www.ellenmacarthurfoundation.org/press-release-collaboration-between-international-ngos
35. Ellen MacArthur Foundation. (2023). The global commitment 2023: progress report.
36. United Nations Environment Programme (UNEP). (2023). Global efforts show progress on plastic pollution is possible – but world remains off track. https://www.unep.org/news-and-stories/press-release/global-efforts-show-progress-plastic-pollution-possible-world
37. United Nations Environment Programme (UNEP). (2022). Historic day in the campaign to beat plastic pollution: nations commit to develop a legally binding agreement. https://www.unep.org/news-and-stories/press-release/historic-day-campaign-beat-plastic-pollution-nations-commit-develop
38. United Nations Environment Programme (UNEP). (2024). Plastic pollution negotiations adjourn with new text and a follow-up session planned. https://www.unep.org/inc-plastic-pollution/media#PressRelease2Dec
39. Lau, D. (2023). We need a global treaty to solve plastic pollution – acid rain and ozone depletion show us why. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. https://www.csiro.au/en/news/All/Articles/2023/November/global-treaty-solve-plastic-waste
40. Australian Government, Department of Foreign Affairs and Trade (DFAT). (2024). International cooperation on climate change: action on plastics. https://www.dfat.gov.au/international-relations/themes/climate-change/international-cooperation-on-climate-change#action-plastics
41. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2022). Australia joins global efforts to end plastic pollution. https://minister.dcceew.gov.au/plibersek/media-releases/australia-joins-global-efforts-end-plastic-pollution
42. Anie, A.J. (2023). Upstream approaches to reducing the generation of plastic waste in Ghana: an experiment by UNDP accelerator lab in Ghana. United Nations Development Programme, Ghana.
43. Ellen MacArthur Foundation. (2023). The global commitment five years in: learnings to accelerate towards a future without plastic waste or pollution.
44. Organisation for Economic Co-operation and Development (OECD). (2024). Plastics. https://www.oecd.org/en/topics/plastics.html
45. Ellen MacArthur Foundation. (n.d.). Business coalition for a global plastics treaty. https://www.businessforplasticstreaty.org/
46. Life Cycle Initiative. (2023). Life cycle initiative. https://www.lifecycleinitiative.org/
47. United Nations Environment Programme (UNEP). (2022). How can a life-cycle approach curb the plastic pollution crisis? https://www.unep.org/news-and-stories/story/how-can-life-cycle-approach-curb-plastic-pollution-crisis
48. Dussimon, K. (2020). New frontiers in packaging technology. Euromonitor International. https://www.euromonitor.com/new-frontiers-in-packaging-technology/report
49. Shah, T. (2019). Sustainable packaging: moving beyond recycling labels. Euromonitor International.
50. Australian Packaging Covenant Organisation (APCO). (2022). APCO celebrates 2022 annual award winners. https://apco.org.au/news/20Y9e00000001IwEAA
51. World Packaging Organisation (WPO). (2024). WPO in brief. https://worldpackaging.org/wpo/1/

52. The World Business Council for Sustainable Development (WBCSD). (2024). Sustainable plastics & packaging value chains. https://www.wbcsd.org/actions/sustainable-plastics-packaging-value-chains/
53. Ellen MacArthur Foundation. (n.d.). About us: what we do. https://www.ellenmacarthurfoundation.org/about-us/what-we-do
54. Australian Packaging Covenant Organisation (APCO). (2024). About APCO. https://apco.org.au/about-apco
55. Australian Packaging Covenant Organisation (APCO). (2020). Sustainable packaging guidelines (SPGs).
56. Australian Packaging Covenant Organisation (APCO). (2024). National consumer education campaign. https://apco.org.au/national-consumer-education-campaign
57. World Packaging Organisation (WPO). (2024). WorldStar: about. https://worldstar.org/about/
58. Australian Institute of Packaging (AIP). (2023). Australia & New Zealand continues its reign in the WorldStar packaging awards for 2023. http://aipack.com.au/australia-new-zealand-continues-its-reign-in-the-worldstar-packaging-awards-for-2023/
59. Australian Institute of Packaging (AIP). (2022). Winners announced for 2022 Australasian packaging innovation & design awards (PIDA). http://aipack.com.au/winners-announced-for-2022-australasian-packaging-innovation-design-pida-awards/
60. McCleery, A. (2024). APCO Awards put focus on circular economy. Food & Beverage Magazine. https://www.foodmag.com.au/apco-awards-put-focus-on-circular-economy/
61. Australian Institute of Packaging (AIP). (2022). Case study: Nestlé KitKat prototype recycled content wrapper. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Nestle_KitKat_2022.pdf
62. Australian Institute of Packaging (AIP). (2020). Case study: Coca Cola Europacific Partners Australia Pacific Indonesia (CCEP API). http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Coca_Cola_recyclable_post-consumer_recyclate_rPET_bottles_2020.pdf
63. Australian Institute of Packaging (AIP). (2021). Case study: Oasis & qDesign Enterprises - Oasis spice shaker. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Oasis__qDesigns_Spice_Shaker_2021.pdf
64. Australian Institute of Packaging (AIP). (2019). Case study: Punchbowl packaging Kaituna blueberries fibre punnet. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Punchbowl_Packaging_Kaituna_Blueberries_fibre_punnet_2019.pdf
65. Australian Institute of Packaging (AIP). (2017). Case study: Woolpack thermal insulation. http://aipack.com.au/wp-content/uploads/2017_AIP_SFP_Case_Study_Woolpack_Thermal_Insulation.pdf
66. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. (2023). Reshaping Australian food systems.
67. National Waste and Recycling Industry Council (NWRIC), Australia. (2022). Review finds packaging regulation fails to drive change. https://www.nwric.com.au/2022/04/26/review-finds-packaging-regulation-fails-to-drive-change/
68. Australian Packaging Covenant Organisation (APCO). (2020). Our packaging future: a collective impact framework to achieve the 2025 national packaging targets.
69. Australian Packaging Covenant Organisation (APCO). (2020). Our packaging future report launches to outline critical steps required to deliver Australia's 2025 national packaging targets. https://apco.org.au/news/20Y4a00000000FVEAY
70. Australian Packaging Covenant Organisation (APCO). (2021). Australian dairy sustainable packaging roadmap to 2025.
71. Australian Packaging Covenant Organisation (APCO). (2019). APCO launches new guidelines to improve sustainable food service packaging. https://apco.org.au/news/20Y4a00000000DeEAI
72. Ellen MacArthur Foundation. (2021). United Kingdom: bringing industry together to tackle food packaging waste. https://www.ellenmacarthurfoundation.org/circular-examples/united-kingdom-bringing-industry-together-to-tackle-food-packaging-waste
73. Accenture & Australian Packaging Covenant Organisation (APCO). (2021). Costs and incentives for a more circular packaging system. Accenture. https://documents.packagingcovenant.org.au/public-documents/Costs%20and%20Incentives%20For%20a%20More%20Circular%20Packaging%20System
74. Australian Circular Economy (ACE) Hub. (2022). RePlated: a food packaging solution with reuse and recycling at its core. https://acehub.org.au/knowledge-hub/case-studies/replated
75. European Union. (1994). European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31994L0062
76. Bain & Company. (2023). Paper & packaging report 2023: unpack the power of sustainable packaging.
77. Chatham House, The Royal Institute of International Affairs. (2020). Circular Economy. Earth. https://circulareconomy.earth/?policy=ce-rs-rd&year=2024

78. Schandl, H., et al. (2020). Circular economy roadmap for plastics, glass, paper and tyres: pathways for unlocking future growth opportunities for Australia. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia.
79. Ellen MacArthur Foundation. (2013). Towards the circular economy: opportunities for the consumer goods sector. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-2-opportunities-for-the-consumer-goods
80. Gatzer, S, et al. (2022). Playing offense on circularity can net European consumer goods companies €500 billion. McKinsey & Company. https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/playing-offense-on-circularity-can-net-european-consumer-goods-companies-500-billion-euros#/
81. Ellen MacArthur Foundation. (2016). The new plastics economy: rethinking the future of plastics.
82. Australian Packaging Covenant Organisation (APCO). (2024). Australian packaging consumption & recovery data 2021–22. https://documents.packagingcovenant.org.au/public-documents/APCO%20Australian%20Packaging%20Consumption%20And%20Recovery%20Data%202021-22
83. Food Innovation Australia Limited (FIAL). (2020). Capturing the prize: the A$200 billion opportunity in 2030 for the Australian food and agribusiness sector. Food & Agribusiness Growth Centre, Food Innovation Australia.
84. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). Waste and recycling. https://www.dcceew.gov.au/environment/protection/waste
85. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). Investing in Australia's waste and recycling infrastructure. https://www.dcceew.gov.au/environment/protection/waste/how-we-manage-waste/recycling-modernisation-fund
86. Australian Packaging Covenant Organisation (APCO). (2021). Recycled content guide. https://documents.packagingcovenant.org.au/public-documents/Recycled%20Content%20Guide
87. Fraser, M., et al. (2024). The circularity gap report 2024. Circle Economy Foundation & Deloitte. https://www.circularity-gap.world/2024
88. Jones, C. (2019). The second life of plastics (*). Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. https://www.csiro.au/en/news/All/Articles/2019/May/the-second-life-of-plastics
89. Bodreau, A. (2021). How circular design guidelines unlock organisations' potential for change. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/articles/how-circular-design-guidelines-unlock-organisations-potential-for-change
90. Poh, J. (2022). 3 ways we can collaborate better for a stronger circular economy. World Economic Forum (WEF). https://www.weforum.org/agenda/2022/05/3-ways-we-can-collaborate-better-for-a-circular-economy/
91. European Commission. (n.d.). Packaging waste: EU rules on packaging and packaging waste, including design and waste management. https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en
92. United States, Environmental Protections Agency (EPA). (2024). U.S. national recycling goal. https://www.epa.gov/circulareconomy/us-national-recycling-goal#:~:text=The%20National%20Recycling%20Goal%20is,is%20managing%20materials%20more%20sustainably
93. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). 2025 National packaging targets. https://www.dcceew.gov.au/environment/protection/waste/packaging/2025-national-packaging-targets
94. Reeves, M. (2024). Waste remediation and materials recovery services in Australia - market research report (2014-2029). IBISWorld. https://www.ibisworld.com/australia/industry/waste-remediation-and-materials-recovery-services/5025/
95. Carbinato, D., et al. (2022). A roadmap for sustainable packaging in consumer goods. Bain & Company. https://www.bain.com/insights/a-roadmap-for-sustainable-packaging-in-consumer-goods/
96. King, S., et al. (2021). Advanced recycling technologies to address Australia's plastic waste. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. https://research.csiro.au/ending-plastic-waste/advanced-recycling/
97. Barry, M. (2023). Beyond beer and soda: cans and the future of beverages packaging in the Americas. Euromonitor International.
98. Doucette, J., et al. (2022). How can packaging keep things fresh without lasting a lifetime? Ernst & Young (EY). https://www.ey.com/en_au/consumer-products-retail/sustainable-flexible-plastic-packaging-strategy
99. Kirste, A. and Droll, M. (2021). Riding into the future on a new wave of beverages. Kearney.
100. Ward, A. (2023). The advance of sustainability in alcoholic drinks. Euromonitor International.
101. Shah, T., et al. (2020). Global flexible packaging: state of play and sustainability. Euromonitor International.

102. Downey, R. (2021). Tethered closures: EU plastic packaging regulation and what it means for the beverage industry. Euromonitor International.
103. World Economic Forum (WEF), SAP & Qualtrics. (2021). The climate progress survey: business & consumer worries and hopes, a global study of public opinion. World Economic Forum.
104. Recycle Mate. (n.d.). Recycle mate. https://recyclemate.com.au/
105. Australian Packaging Covenant Organisation (APCO). (2023). Australasian recycling label impact framework report 2023.
106. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2021). Recovering food packaging.
107. Soft Plastic Stewardship Australia. (2024). Progress for a lasting solution for soft plastic recycling in Australia. https://spsa.au/
108. Container Exchange. (2024). COEX Annual report 2023-2024. https://containerexchange.com.au/wp-content/uploads/2024/10/3690_COEX_Annual-Report-2024_FA-Spreads.pdf
109. Queensland Government. (2025). Parliamentary inquiry launched into Queensland's container refund scheme. The Queensland Cabinet and Ministerial Directory. https://statements.qld.gov.au/statements/102057
110. Queensland Government. (2018). Queensland legislation: waste reduction and recycling (container refund scheme): amendment regulation 2018. https://www.legislation.qld.gov.au/view/html/published.exp/sl-2018-0167
111. Trute, P. (2024). Statement on REDcycle. Australian Food & Grocery Council. https://www.afgc.org.au/news-and-media/2022/11/statement-on-redcycle
112. Ernst & Young (EY). (2021). Can repurposing drive your purpose? How chemical companies can leverage circular economy to create long-term value. Ernst & Young (EY).
113. Hundertmark, T., et al. (2019). Accelerating plastic recovery in the United States. McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/accelerating-plastic-recovery-in-the-united-states
114. Hoffman, S. and Rexhausen, D. (2023). Reimagine, reuse, recycle: how to reach sustainable packaging targets in retail. McKinsey & Company. https://www.mckinsey.com/industries/retail/our-insights/reimagine-reuse-recycle-how-to-reach-sustainable-packaging-targets-in-retail#/
115. Pauer, E. (2023). Top 9 sustainable packaging trends. Sphera. https://sphera.com/resources/blog/top-9-sustainable-packaging-trends/
116. Kirilyuk, M, et al. (2020). The european recycling landscape—the quiet before the storm? McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/the-european-recycling-landscape-the-quiet-before-the-storm
117. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). Find out about plastics. https://www.dcceew.gov.au/environment/protection/waste/plastics-and-packaging/find-out-about-plastics
118. Sonkkila, C. (2019). Biodegradable versus compostable - knowing your eco-plastics. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. https://www.csiro.au/en/news/All/Articles/2019/May/biodegradable-versus-compostable-knowing-your-eco-plastics
119. Australian Packaging Covenant Organisation (APCO). (2021). APCO launches new strategy to provide clear and consistent national approach to compostable packaging. https://apco.org.au/news/20Y9e000000001JEAQ
120. Future Market Insights Inc. (2022). Biodegradable packaging material market: market summary. https://www.factmr.com/report/2063/biodegradable-packaging-material-market#:~:text=Global%20Biodegradable%20Packaging%20Materials%20Market,6.8%25%20from%202022%20to%202032
121. Data Bridge Market Research. (2024). Global compostable packaging market –industry trends and forecast to 2031. https://www.databridgemarketresearch.com/reports/global-compostable-packaging-market
122. Singh, A. (2024). Compostable packaging market size, share, trends and growth. Towards Packaging. https://www.towardspackaging.com/table-of-content/compostable-packaging-market-sizing
123. Ellen MacArthur Foundation. (2022). Where compostable packaging fits in a circular economy. https://www.ellenmacarthurfoundation.org/articles/we-need-compostable-packaging-but-its-still-single-use
124. Australian Packaging Covenant Organisation (APCO). (2020). Considerations for compostable plastic packaging.
125. Kachook, O. (2021). Produce stickers: the benefits of going compostable. Sustainable Packaging Coalition. https://sustainablepackaging.org/2021/05/19/produce-stickers-the-benefits-of-going-compostable/
126. Australian Packaging Covenant Organisation (APCO). (2021). National compostable packaging strategy.

127. Ellen MacArthur Foundation. (n.d.). Compostable, biodegradable, and bio-based plastic – what's the difference? https://www.ellenmacarthurfoundation.org/compostable-biodegradable-and-bio-based-plastic-whats-the-difference
128. Compost Connect. (2024). Australian councils composting. https://www.compostconnect.org/councils/
129. Australian Circular Economy (ACE) Hub. (2022). Compost connect: disrupting the food service industry with circular solutions. https://acehub.org.au/knowledge-hub/case-studies/compost-connect
130. Kachook, O. (2022). Getting clear on compostable packaging with a practitioner's roadmap. Sustainable Packaging Coalition. https://sustainablepackaging.org/2022/11/10/getting-clear-on-compostable-packaging-with-a-practitioners-roadmap/
131. Ritch, E. (2023). CleanPackage: supporting safe + circular materials for packaging. https://sustainablepackaging.org/2023/08/01/cleanpackage-supporting-safe-circular-materials-for-packaging/
132. Ellen MacArthur Foundation. (2022). Flexible packaging: strategy summary.
133. Ellen MacArthur Foundation. (2022). Flexible Packaging: Substitution to compostable flexibles, design and circulation. Deep Dive.
134. Ellen MacArthur Foundation. (2022). Flexible packaging: move away from single-use flexibles, direct elimination. Deep Dive.
135. Australian Institute of Packaging (AIP). (2021). Case study: Biopak & Kapiris Bros tomato punnet. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_biopak_and_Kapiris_Bros_Tomato_Punnet_2021.pdf
136. Australian Institute of Packaging (AIP). (2021). Case study: Blue Harvest oyster tray. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Blue_Harvest_Oyster_Tray_2021.pdf
137. Australian Institute of Packaging (AIP). (2018). Case study: Biopak sugarcane pulp foodservice packaging. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_Biopak_Sugarcane_pulp_food_service_packaging_2018.pdf
138. Australian Meat Processor Corporation (AMPC). (2020). Packaging targets 2025: road to sustainable packaging. https://www.ampc.com.au/news-events/events/packaging-targets-2025-road-to-sustainable-packaging
139. Guinyard, S. (2023). In search of the cleanest compost: highlights from BPI's inaugural summit. Sustainable Packaging Coalition. https://sustainablepackaging.org/2023/11/07/in-search-of-the-cleanest-compost-highlights-from-bpis-inaugural-summit/
140. Ellen MacArthur Foundation. (2021). Closing the loop on single-use food packaging: BioPak. https://www.ellenmacarthurfoundation.org/circular-examples/closing-the-loop-on-single-use-food-packaging
141. Australia National Waste and Recycling Industry Council (NWRIC). (2019). Composting remains our biggest recycling opportunity. https://www.nwric.com.au/2019/08/01/composting-remains-our-biggest-recycling-opportunity/
142. Downey, R. (2022). The future of plastic packaging amid sustainability pressures. Euromonitor International. https://www.euromonitor.com/the-future-of-plastic-packaging-amid-sustainability-pressures/report
143. Ellen MacArthur Foundation. (2020). Upstream innovation: a guide to packaging solutions.
144. Ellen MacArthur Foundation. (2019). Reuse: rethinking packaging. https://emf.thirdlight.com/file/24/_A-BkCs_aXeX02_Am1z_J7vzLt/Reuse%20–%20rethinking%20packaging.pdf
145. Lloyd, J. (2024). Food and beverage packaging manufacturers shine at 2024 PIDA awards. Food & Beverage Magazine. https://www.foodmag.com.au/food-and-beverage-packaging-manufacturers-shine-at-2024-pida-awards/
146. koor. (2024). How can Koor solve the problem of single-use plastics? https://koor.life/#:~:text=Durability%20and%20Reusability%3A%20Koor%20is,koor%20can%20save%20you%20money
147. Waterdrop. (n.d.). No sugar, less plastic. https://waterdrop.com.au/pages/sustainability
148. MIWA Technologies. (2025). Homepage | MIWA. https://www.miwa.eu/
149. Nestle. (2020). Nestlé pilots reusable and refillable dispensers to reduce single-use packaging. Nestle - Latest News. https://www.nestle.com/media/news/nestle-pilots-reusable-refillable-dispensers-reduce-single-use-packaging
150. Loop. (2024). A global reuse ecosystem - partnerships. https://exploreloop.com/partners/
151. Rawbulkfoods. (n.d.). How does it work? https://rawbulkfoodsonline.com/pages/how-it-works
152. The Coca-Cola Company. (2022). The Coca-Cola Company announces industry-leading target for reusable packaging. https://www.coca-colacompany.com/media-center/coca-cola-announces-industry-leading-target-for-reusable-packaging
153. Commonwealth Handling Equipment Pool (CHEP), Australia. (2022). CHEP Australia recognised for outstanding achievements in sustainable packaging solutions. https://www.chep.com/au/en/chep-australia-recognised-for-outstanding-achievements-in-sustainable-packaging-solutions
154. Svenska retursystem. (n.d.). Our SRS pooling system. https://www.retursystem.se/en/our-system
155. Elobeid, E. (2023). Deconstructing 'the perfect cup of coffee'. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/articles/deconstructing-the-perfect-cup-of-coffee

156. Australian Circular Economy (ACE) Hub. (2022). KeepCup: how KeepCup built a worldwide reuse revolution. https://acehub.org.au/knowledge-hub/case-studies/keepcup
157. Australian Circular Economy (ACE) Hub. (2023). Cercle: a hassle-free reusable cup for a circular future. https://acehub.org.au/knowledge-hub/case-studies/cercle
158. Australian Circular Economy (ACE) Hub. (2023). Huskee: creating reusable coffee cups from coffee husk waste. https://acehub.org.au/knowledge-hub/case-studies/huskee
159. Koelsch Sand, C. (2022). Gordon Robertson: rational thoughts on sustainable packaging. Food Technology Magazine, Institute of Food Technologists (IFT). https://www.ift.org/news-and-publications/food-technology-magazine/issues/2022/may/columns/packaging-gordon-robertson-sustainable-packaging
160. United Nations Environment Programme (UNEP). (2023). Turning off the tap: how the world can end plastic pollution and create a circular economy.
161. Feber, D., et al. (2022). Reusable packaging: key enablers for scaling. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/reusable-packaging-key-enablers-for-scaling
162. Almeida, T, et al. (2024). Scaling reuse models: a guide to standardized measurement. World Economic Forum & Kearney.
163. Ellen MacArthur Foundation. (2022). Pay for the product, not the packaging: Algramo. https://www.ellenmacarthurfoundation.org/circular-examples/pay-for-the-product-not-the-packaging-algramo
164. Murphy, C. (2022). The rise of single-use plastic packaging avoiders. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/articles/the-rise-of-single-use-plastic-packaging-avoiders
165. United Nations Environment Programme (UNEP). (2020). Food loss and waste must be reduced for greater food security and environmental sustainability. https://www.unep.org/news-and-stories/press-release/food-loss-and-waste-must-be-reduced-greater-food-security-and
166. Food and Agriculture Organization (FAO). (2023). FAO in Europe and Central Asia 2022. Food and Agriculture Organization of the United Nations, Budapest.
167. Australian Government, Commonwealth of Australia. (2017). National food waste strategy: halving Australia's food waste by 2030.
168. End Food Waste Australia. (2023). Save food packaging criteria and framework. https://endfoodwaste.com.au/projects/save-food-packaging-criteria-and-framework/
169. Kelton, N. (2021). Industry report: lack of responsibility on food waste. https://www.packagingnews.com.au/latest/industry-report-lack-of-responsibility-on-food-waste
170. Francis, C., et al. (2023). Save food packaging design criteria and guidelines. End Food Waste Cooperative Research Centre.
171. Australian Institute of Packaging (AIP). (2021). Case study: Junee prime lamb & Sealed Air. http://aipack.com.au/wp-content/uploads/2021_AIP_SFP_Case_Study_Junee_Lamb_and_Sealed_Air.pdf
172. Australian Institute of Packaging (AIP). (2021). Case study: True Foods & Result Group http://aipack.com.au/wp-content/uploads/2021_AIP_SFP_Case_Study_True_Foods_and_Result_Group.pdf
173. Koelsch Sand, C. (2019). Testing the integrity of package seals (*). Food Technology Magazine, 73(7). https://www.ift.org/news-and-publications/food-technology-magazine/issues/2019/july/columns/packaging-seals-tests-standards
174. Koelsch Sand, C. (2023). Toward smart(er) fresh meat packaging. Food Technology Magazine. https://www.ift.org/news-and-publications/food-technology-magazine/issues/2023/july/columns/packaging-toward-smarter-fresh-meat-packaging
175. Youil, P. and Tabbakh, F. (2020). Evaluation of red meat in vacuum skin packed on board retail ready format. Meat and Livestock Australia Limited.
176. Food Innovation Australia Limited (FIAL). (2021). Sustainable vacuum skin packaging: Plantic Technologies | celebrating Australian food and agribusiness innovations 2020. Food & Agribusiness Growth Centre, Food Innovation Australia. https://www.fial.com.au/blogs/post/sustainable-vacuum-skin-packaging
177. Koelsch Sand, C. (2023). Progressive produce packaging. Food Technology Magazine, 77(4). https://www.ift.org/news-and-publications/food-technology-magazine/issues/2023/may/columns/packaging-progressive-produce-packaging
178. Australian Institute of Packaging (AIP). (2017). Case study: Sealed Air & Fresh Technologies. http://aipack.com.au/wp-content/uploads/2017_AIP_SFP_Case_Study_Sealed_Air_and_Fresh_Technologies.pdf
179. Hort Innovation. (2023). Review and evaluation of mushroom packaging options.
180. GS1. (2022). 2D Barcodes case study: Woolworths Australia seeing multiple benefits from 2D barcodes. https://www.gs1.org/sites/gs1/files/case_study_library_item/case-study-woolworths-gs1australia.pdf
181. Koelsch Sand, C. (2020). Life cycle assessments guide sustainability. Food Technology Magazine 74(5). https://www.ift.org/news-and-publications/food-technology-magazine/issues/2020/may/columns/life-cycle-assessments-guide-sustainability

182. Sphera. (2023). How to achieve true packaging sustainability. https://sphera.com/resources/blog/how-to-achieve-true-packaging-sustainability/
183. Australian Institute of Packaging (AIP). (2024). AIP & Empauer webinar: measure packaging circularity through LCAs. https://vimeo.com/showcase/11019142
184. Sphera. (2023). Sphera sase study: sustainable packaging for Naturata's products: simplifying complexity through fact-based decision-making.
185. Australian Institute of Packaging (AIP). (2024). AIP and Empauer partner to deliver an innovative life cycle assessment decision package for SMEs. http://aipack.com.au/aip-and-empauer-partner-to-deliver-an-innovative-life-cycle-assessment-decision-package-for-smes/
186. Ellen MacArthur Foundation. (n.d.). Life cycle assessment for the circular economy. https://www.ellenmacarthurfoundation.org/life-cycle-assessment-for-the-circular-economy
187. Australian Institute of Packaging (AIP). (2023). AIP to recognise international day of awareness of food loss and waste on 29 September. http://aipack.com.au/aip-to-recognise-international-day-of-awareness-of-food-loss-and-waste-on-29-september/
188. End Food Waste Australia. (2023). Reducing waste throughout the food supply chain. https://endfoodwaste.com.au/reduce/
189. End Food Waste Australia. (2023). Consumer perceptions of packaging's role in reducing food waste. https://endfoodwaste.com.au/consumer-perceptions-of-packagings-role-in-reducing-food-waste/
190. Australian Tree Crop. (2020). Trials underway for new packing and sorting technology at avocado packhouse. https://www.treecrop.com.au/news/trials-underway-new-packing-and-sorting-technology-avocado-packhouse/
191. Ellen MacArthur Foundation. (2021). Completing the picture: how the circular economy tackles climate change.
192. Crippa, M., et al. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. Nature Food, 2(3), 198-209. https://doi.org/10.1038/s43016-021-00225-9
193. Jesse, B., et al. (2022). Decarbonizing grocery. McKinsey & Company. https://www.mckinsey.com/industries/retail/our-insights/decarbonizing-grocery
194. Santos, N., et al. (2022). Investing in carbon neutrality: utopia or the new green wave? Challenges and opportunities for agrifood systems. Food and Agriculture Organization (FAO) of the United Nations. https://openknowledge.fao.org/server/api/core/bitstreams/d6318c17-8ea9-4cc9-bdac-0c3f31387084/content
195. Gómez, MI, et al. (2020). Agricultural value chains and social and environmental impacts: trends, challenges, and policy options. Food and Agriculture Organization (FAO) of the United Nations. https://openknowledge.fao.org/server/api/core/bitstreams/d68206d0-c1e2-4b77-a113-1c4283dc8dda/content
196. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). Net zero. https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero
197. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). International climate action. https://www.dcceew.gov.au/climate-change/international-climate-action#toc_0
198. Australian Beverages Council Limited (ABCL). (2022). Environmental sustainability roadmap to 2030. https://abclsite.wpenginepowered.com/wp-content/uploads/2024/02/ABCL-ESR30-Membership-Brochure-2024.pdf
199. Australian Eggs Limited. (2020). Egg and chicken meat industries create roadmap to carbon neutral. https://www.australianeggs.org.au/news/egg-and-chicken-meat-industries-create-roadmap-to-carbon-neutral
200. Meat & Livestock Australia (MLA). (2020). The Australian red meat industry's carbon neutral by 2030 roadmap. https://www.mla.com.au/globalassets/mla-corporate/research-and-development/program-areas/environment-and-sustainability/2689-mla-cn30-roadmap_d3.pdf
201. Wine Australia. (2023). Safeguarding the future for Australian wine: an emissions reduction roadmap. https://www.wineaustralia.com/getmedia/409219da-5883-41db-a492-8534eb7cdc1f/WineAustralia_EmissionsReductionRoadmap.pdf
202. Biswas, S., et al. (2023). Shaving carbon across the supply chain: from the design studio to store floor. Kearney. https://www.kearney.com/service/operations-performance/article/shaving-carbon-across-the-supply-chain-from-the-design-studio-to-store-floor
203. Birshan, M., et al. (2022). Playing offense to create value in the net-zero transition. McKinsey & Company. https://www.mckinsey.com/capabilities/sustainability/our-insights/playing-offense-to-create-value-in-the-net-zero-transition
204. Bricheux, C., et al. (2024). Tackling scope 3 emissions through supplier collaboration. McKinsey Sustainability. https://www.mckinsey.com/capabilities/sustainability/our-insights/sustainability-blog/tackling-scope-3-emissions-through-supplier-collaboration
205. Wine Australia. (2020). Global packaging trends. Market Bulletin (226). https://www.wineaustralia.com/news/market-bulletin/issue-226

206. Hirlam, K. (2023). Life cycle assessment (LCA) of Australian wine industry. The Australian Wine Research Institute (AWRI). https://www.wineaustralia.com/getmedia/5996a3e5-3cbd-40d8-bbb9-8d632f443652/AWR-2201-LCA-Final-Report.pdf
207. Wine Australia. (2024). Cheers to sustainable thinking. https://www.wineaustralia.com/news/articles/cheers-to-sustainable-thinking
208. Krishnan, M., et al. (2022). The net-zero transition: what it would cost, what it could bring. McKinsey & Company.
209. Spiller, P. (2021). Making supply-chain decarbonization happen. McKinsey & Company. https://www.mckinsey.com/capabilities/operations/our-insights/making-supply-chain-decarbonization-happen
210. Francois, M., et al. (2022). How grocers could use sustainability to transform Asian food systems. McKinsey & Company Insights. https://www.mckinsey.com/industries/retail/our-insights/how-grocers-could-use-sustainability-to-transform-asian-food-systems
211. Coronado Robles, M., et al. (2021). From sustainability to purpose: refocus on the planet. Euromonitor International.
212. Hoffmann, Y., et al. (2023). Toward net-zero emissions: achieving Luxembourg's sustainability ambitions. McKinsey & Company Insights. https://www.mckinsey.com/capabilities/sustainability/our-insights/toward-net-zero-emissions-achieving-luxembourgs-sustainability-ambitions
213. Gatzer, S., et al. (2023). Using sustainability to transform food systems in South Korea. McKinsey & Company Insights. https://www.mckinsey.com/industries/retail/our-insights/using-sustainability-to-transform-food-systems-in-south-korea
214. Weir, N. and Mukherjee, S. (2023). Emerging eco-consciousness in Asia-Pacific summons a future of sustainable growth. Deloitte. https://www2.deloitte.com/us/en/insights/environmental-social-governance/eco-consciousness-sustainable-products.html
215. Cascone, J., et al. (2023). Green products come of age. Deloitte. https://www2.deloitte.com/us/en/insights/industry/retail-distribution/consumer-behavior-trends-state-of-the-consumer-tracker/sustainable-products-customer-expectations.html
216. Carbinato, D., et al. (2023). Sustainable packaging: what consumers want next from the paper and packaging industry. Bain & Company. https://www.bain.com/insights/sustainable-packaging-paper-and-packaging-report-2023/
217. Downey, R. (2020). The impact of coronavirus on packaging. Euromonitor International.
218. PricewaterhouseCoopers (PwC). (2021). The global consumer: changed for good. https://www.pwc.com/gx/en/consumer-markets/consumer-insights-survey/2021/gcis-june-2021.pdf
219. Feber, D., et al. (2020). Sustainability in packaging: inside the minds of US consumers. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-inside-the-minds-of-us-consumers#/
220. Eriksson, D., et al. (2020). Sustainability in packaging: inside the minds of global consumers. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-inside-the-minds-of-global-consumers
221. Babbage, N. (2020). #Who cares? who does? 2020: attitudes and actions towards living sustainably and reducing waste. Kantar Group and Affiliates. https://www.kantar.com/inspiration/fmcg/sustainability-could-bring-382-billion-to-fmcg-brands
222. Grimmelt, A., et al. (2022). Hungry and confused: the winding road to conscious eating. McKinsey & Company. https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/hungry-and-confused-the-winding-road-to-conscious-eating
223. Gruenewald, F., et al. (2023). The potential impact of reusable packaging. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/the-potential-impact-of-reusable-packaging
224. Läubli, D. (2023). Convenience will always matter. McKinsey & Company. https://www.mckinsey.com/industries/retail/our-insights/convenience-will-always-matter
225. Wine Australia. (2020). Global consumer trends in the short term. Market Bulletin (207). https://www.wineaustralia.com/news/market-bulletin/issue-207
226. Feber, D. (2022). Creating good packaging for packaged goods. McKinsey & Company. https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/creating-good-packaging-for-packaged-goods
227. United Nations Environment Programme (UNEP). (2020). Most subscription services are not delivering on sustainability. https://www.unep.org/news-and-stories/story/most-subscription-services-are-not-delivering-sustainability
228. Frey, S., et al. (2023). Consumers care about sustainability—and back it up with their wallets. Nielsen IQ & McKinsey & Company.
229. Weghmann, K. and Locke, R. (2023). How good governance can keep corporates clean from greenwashing. Ernst & Young (EY). https://www.ey.com/en_au/insights/assurance/how-good-governance-can-keep-corporates-clean-from-greenwashing
230. Feber, D. and Nordigarden, D. (2023). Sustainability in packaging: US survey insights. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-us-survey-insights#/

231. Gatzer, S. and Magnin, C. (2021). Prioritizing sustainability in the consumer sector. McKinsey & Company. https://www.mckinsey.com/industries/retail/our-insights/prioritizing-sustainability-in-the-consumer-sector
232. Downey, R. (2023). Consumer packaging strategies: adapting to cost pressures. Euromonitor International.
233. Hippold, S. (2019). Retailers: master the art of buy online, pick up in store. Gartner. https://www.gartner.com/smarterwithgartner/retailers-master-art-buy-online-pick-store
234. United Nations Environment Programme (UNEP). (2019). Plastic recycling: an underperforming sector ripe for a remake. https://www.unep.org/news-and-stories/story/plastic-recycling-underperforming-sector-ripe-remake
235. Feber, D., et al. (2021). Sustainability in packaging: investable themes. McKinsey & Company. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/sustainability-in-packaging-investable-themes
236. Australian Packaging Covenant Organisation (APCO). (2024, 29 April 2024). Australian packaging consumption and recovery data 2021-22. https://apco.org.au/news/20YOI000007XWzbMAG
237. Closed Loop Partners. (2021). Accelerating circular supply chains for plastics: a landscape of transformational technologies that stop plastic waste, keep materials in play and grow markets. https://www.closedlooppartners.com/wp-content/uploads/2021/01/CLP_Circular_Supply_Chains_for_Plastics_Updated.pdf
238. Peng, Z., et al. (2022). Advanced recycling: opportunities for growth. McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/advanced-recycling-opportunities-for-growth
239. Maust, R. (2023). "Biorecycling" is chemical recycling, and biorecyclable packaging already exists. Sustainable Packaging Coalition. https://sustainablepackaging.org/2023/03/01/biorecycling-is-chemical-recycling-and-biorecyclable-packaging-already-exists/
240. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). Joint media release: soft plastic recycling gets $15.6 million boost in Victoria. https://minister.dcceew.gov.au/plibersek/media-releases/joint-media-release-soft-plastic-recycling-gets-156-million-boost-victoria
241. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2021). Research, innovation and data. https://www.dcceew.gov.au/environment/protection/waste/plastics-and-packaging/national-plastics-plan/research-innovation-data#smart-aienabled-automation-and-upcycling-solution-for-plastic-recycling
242. Peng, Y., et al. (2023). Facing our plastic waste crisis: biorecycling as a promising solution. Microbiology Australia, 44(1), 52-56. https://doi.org/https://doi.org/10.1071/MA23013
243. Uekert, T., et al. (2023). Technical, economic, and environmental comparison of closed-loop recycling technologies for common plastics. ACS Sustainable Chemistry & Engineering, 11(3), 965-978. https://doi.org/10.1021/acssuschemeng.2c05497
244. Gilani, Z. (2022). Enzymatic depolymerization and recycling: using enzymes to convert linear waste streams into circular supply chains. Cleantech Group. https://www.cleantech.com/enzymatic-depolymerization-and-recycling-using-enzymes-to-convert-linear-waste-streams-into-circular-supply-chains/
245. Australian Government, Department of Industry, Science and Resources. (2022). Government invests in infinite plastic recycling technology. https://www.minister.industry.gov.au/ministers/wilson/media-releases/government-invests-infinite-plastic-recycling-technology
246. Australian Government. (n.d.). CRC Projects selection round outcomes. https://business.gov.au/grants-and-programs/cooperative-research-centres-projects-crcp-grants/crc-projects-selection-round-outcomes
247. Peng, Z., et al. (2022). Petrochemicals 2021: regional fortunes and growing sustainability. McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/petrochemicals-2021-regional-fortunes-and-growing-sustainability
248. Ordorica Lenero, P., et al. (2022). Reimagining Mexico's chemical industry. McKinsey & Company.
249. Azevedo, M., et al. (2022). Capturing the green-premium value from sustainable materials. McKinsey & Company. https://www.mckinsey.com/industries/metals-and-mining/our-insights/capturing-the-green-premium-value-from-sustainable-materials
250. Ladent, E. (2022). Our waste is valuable: how one company is creating a circular economy for plastics. World Economic Forum. https://www.weforum.org/agenda/2022/06/plastics-biorecycling-circular-economy/
251. Çetinkaya, E., et al. (2022). Excellence in petrochemicals: what it will take to win. McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/excellence-in-petrochemicals-what-it-will-take-to-win
252. Brennan, T., et al. (2021). The third wave of biomaterials: when innovation meets demand. McKinsey & Company. https://www.mckinsey.com/industries/chemicals/our-insights/the-third-wave-of-biomaterials-when-innovation-meets-demand

253. United Nations Development Programme (UNDP). (2024). Production of sustainable packaging, including using biodegradable materials. https://sdginvestorplatform.undp.org/market-intelligence/production-sustainable-packaging-including-using-biodegradable-materials?_gl=1*1k5wgue*_ga*MTkyNzY3MDYyNy4xNzEwMTA5MzEz*_ga_3W7LPK0WP1*MTcxMDEwOTMxMy4xLjEuMTcxMDEwOTM0OC4yNS4wLjA.
254. Chui, M., et al. (2020). The bio revolution: innovations transforming economies, societies, and our lives. McKinsey & Company.
255. Rosenboom, J-G., et al. (2022). Bioplastics for a circular economy. Nature Reviews Materials, 7(2), 117-137. https://doi.org/10.1038/s41578-021-00407-8
256. Donkor, L., et al. (2023). Bio-based and sustainable food packaging systems: relevance, challenges, and prospects. Applied Food Research, 3(2), 100356. https://doi.org/10.1016/j.afres.2023.100356
257. Food Innovation Australia Limited (FIAL). (2022). Blue Harvest: certified compostable pulp-based trays improving industry sustainability. Food & Agribusiness Growth Centre, Food Innovation Australia. https://www.fial.com.au/blue-harvest
258. Kieselbach, S., et al. (2021). Plastic-free packaging: stretching the limits of sustainable possibility. Sphera.
259. Caggiano, M. (2023). NatureWorks announces next phase of construction on new fully integrated Ingeo™ PLA biopolymer manufacturing facility in Thailand. The Australasian Bioplastics Association. https://bioplastics.org.au/natureworks-announces-next-phase-of-construction-on-new-fully-integrated-ingeo%EF%B8%8F-pla-biopolymer-manufacturing-facility-in-thailand/
260. The Australasian Bioplastics Association (ABA). (2019). Bioplastics is a global market that is on the move. https://bioplastics.org.au/bioplastics/market/
261. Walberer, A., et al. (2023). Bioplastics have shown promise, but are they truly a sustainable packaging solution? https://www.kearney.com/service/sustainability/article/bioplastics-have-shown-promise-but-are-they-truly-a-sustainable-packaging-solution
262. The Australasian Bioplastics Association (ABA). (2019). Bioplastics: materials. https://bioplastics.org.au/bioplastics/materials/
263. The Australasian Bioplastics Association (ABA). (2019). Bioplastics explained: what differentiates bioplastics from conventional plastics? https://bioplastics.org.au/bioplastics/bioplastics-explained/
264. Claridge-Chang, A. (2023). Entrepreneurs hone innovations to tackle plastic waste in Indo-Pacific. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. https://www.csiro.au/en/news/All/Articles/2023/July/Entrepreneurs-tackle-plastic-waste-Indo-Pacific
265. Greenhope. (2024). Greenhope. https://www.greenhope.co/
266. Ellen MacArthur Foundation. (2021). Packaging from 'mushroom plastic': Ecovative. https://www.ellenmacarthurfoundation.org/circular-examples/packaging-from-mushroom-plastic-ecovative
267. Ecovative. (2024). Ecovative. https://www.ecovative.com/
268. Australian Circular Economy (ACE) Hub. (2022). Fungi Solutions: reimagining and transforming organic waste using mycelium. https://acehub.org.au/knowledge-hub/case-studies/fungi-solutions
269. Fungi Solutions. (2024). Fungi Solutions. https://www.fungisolutions.com.au/
270. Koelsch Sand, C. (2023). A bright future for bioderived plastic. Food Technology Magazine 77(9). https://www.ift.org/news-and-publications/food-technology-magazine/issues/2023/october/columns/packaging-a-bright-future-for-bioderived-plastic
271. McKinsey & Company. (2019). The new plastics economy: a danish research innovation and business opportunity.
272. AgriFutures. (2024). Revolutionary bio-packaging from agricultural waste tackles plastic pollution. https://www.growag.com/highlights/article/revolutionary-bio-packaging-from-agricultural-waste-tackles-plastic-pollution
273. Sustainable Packaging Coalition (SPC). (2024). ICYMI: "Beyond PFAS-free packaging" webinar recap. Sustainable Packaging Coalition & ChemForward. https://www.chemforward.org/news/icymi-beyond-pfas-free-packaging-webinar-recap
274. United Nations (UN). (n.d.). Multi-stakeholder partnerships. https://sdgs.un.org/topics/multi-stakeholder-partnerships
275. United Nations Development Programme (UNDP). (2023). National plastic action partnership discusses how to reduce plastic waste in Vietnam. https://www.undp.org/vietnam/press-releases/national-plastic-action-partnership-discusses-how-reduce-plastic-waste-viet-nam
276. World Economic Forum (WEF). (2023). Partnerships can help scale and accelerate circularity: here's how. https://www.weforum.org/stories/2023/09/partnerships-help-scale-accelerate-circularity-sdim23/
277. United Nations (UN). (n.d.). Capacity-building. https://www.un.org/en/academic-impact/capacity-building#:~:text=Capacity%2Dbuilding%20is%20defined%20as,in%20a%20fast%2Dchanging%20world
278. Australian Food & Grocery Council (AFGC). (2024). AFGC welcomes progress in soft plastics recycling in Queensland. https://afgc.org.au/News/afgc-welcomes-progress-in-soft-plastics-recycling-in-queensland/
279. Ellen MacArthur Foundation. (2021). The Plastics Pact network. https://www.ellenmacarthurfoundation.org/the-plastics-pact-network

280. Australian Government, Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2021). National plastics plan: pathway to more sustainable use of expanded polystyrene (EPS). https://www.dcceew.gov.au/environment/protection/waste/publications/npp-pathway-to-more-sustainable-use-eps
281. Accenture. (2021). Tetra Pak: adapting to protect our future. https://www.accenture.com/content/dam/accenture/final/a-com-migration/r3-3/pdf/pdf-168/accenture-the-industrialist-nov-2021-elena-moruzzi-interview-v2.pdf
282. Gonzales, K. (2024). Plastic bag and film manufacturing in Australia - market research report (2014-2029) - ANZSIC C1911. IBISWorld. https://www.ibisworld.com/australia/industry/plastic-bag-and-film-manufacturing/200/
283. Gonzales, K. (2024). Plastic bottle manufacturing in Australia - market research report (2014-2029) - ANZSIC C1912a. IBISWorld. https://www.ibisworld.com/australia/industry/plastic-bottle-manufacturing/198/
284. Martin, D. (2025). Supermarkets and grocery stores in Australia - market research report (2015-2030) - ANZSIC G4111. IBISWorld. https://www.ibisworld.com/australia/industry/supermarkets-and-grocery-stores/1834/
285. Australian Institute of Packaging (AIP). (n.d.). AIP helps SME's with sustainable packaging design and meeting the 2025 national packaging targets. https://aipack.com.au/aip-helps-smes-with-sustainable-packaging-design-and-meeting-the-2025-national-packaging-targets/
286. Sustainable Packaging Coalition (SPC). (2023). It will take a village to recycle all plastics. https://sustainablepackaging.org/2023/01/18/it-will-take-a-village-to-recycle-all-plastics/
287. Hippold, S. (2022). The rise of the ecosystem — and 4 more supply chain predictions. Gartner. https://www.gartner.com/en/articles/the-rise-of-the-ecosystem-and-4-more-supply-chain-predictions
288. Young, D. and Beck, S. (2022). The strategic race to sustainability. Boston Consulting Group (BCG). https://www.bcg.com/publications/2022/winning-strategic-race-to-sustainability
289. Australian Packaging Covenant Organisation (APCO). (2024). Driving change with the collective impact model. https://apco.org.au/what-is-collective-impact
290. Kerrigan, S. and Kulasoorlya, D. (2020). The sustainability transformation: look ahead, look inside, and look around. Deloitte Insights. https://www2.deloitte.com/us/en/insights/topics/strategy/sustainable-transformation-in-business.html
291. Sustainable Food Policy Alliance. (2024). Sustainable food policy alliance. https://foodpolicyalliance.org/
292. Sustainable Food Policy Alliance. (2024). Environment. https://foodpolicyalliance.org/issue/environment/
293. McColl-Kennedy, J.R. and Hine D.C. (2024). Food AI: a game changer for Australia's food and beverage sector. Innovation Pathways Program - Australia's Food and Beverage Accelerator (FaBA). The University of Queensland.
294. Kelly, A. (2024). Industrial design services in Australia: market research report (2014-2029) - OD5443. IBISWorld. https://www.ibisworld.com/australia/industry/industrial-design-services/5443/
295. erthos. (2024). Welcome to erthos® studio. https://www.planeterthos.com/studio
296. Buckley, S. (2024). erthos: giving the plastics industry an AI-driven, biobased upgrade. Sustainable Brands. https://sustainablebrands.com/read/materials-packaging/erthos-plastics-ai-biobased-upgrade
297. Sustainable Packaging Coalition (SPC). (2022). 2022 SPC Innovator Award winners announced. https://sustainablepackaging.org/2022/10/26/2022-spc-innovator-award-winners-announced/
298. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. (2020). CSIRO and partners take aim at ending plastic waste. https://www.csiro.au/en/news/All/News/2020/November/CSIRO-and-partners-take-aim-at-ending-plastic-waste
299. Overherd. (2024). Overherd: oat milk powder. https://overherd.uk/?srsltid=AfmBOorHRJwAbD_rGWZ58xKJOLvKhEsvh2qP9UNi9g7sbt-9UjrD0L1n
300. Ellen MacArthur Foundation. (2019). Food and the circular economy – deep dive. https://www.ellenmacarthurfoundation.org/food-and-the-circular-economy-deep-dive
301. New Plastics Economy Initiative. (2017). Discover the winners: innovation prize summary. Ellen MacArthur Foundation. https://emf.thirdlight.com/file/24/XoGiOySXo.BHLAqXoPdYXnF6.csX/Innovation%20Prize%3A%20Discover%20the%20winners.pdf
302. Australian Government, Minister for Industry and Science. (2024). Fantastic new bioplastic hub to keep the lid on waste. https://www.minister.industry.gov.au/ministers/husic/media-releases/fantastic-new-bioplastic-hub-keep-lid-waste#:~:text=A%20co%2Dinvestment%20collaboration%20between,commercial%20pathways%20for%20compostable%20plastics
303. Ellen MacArthur Foundation. (2023). Unlocking a reuse revolution: scaling returnable packaging. https://www.ellenmacarthurfoundation.org/press-release-unlocking-a-reuse-revolution-scaling-returnable-packaging

304. Maust, R. (2023). How can the chemical recycling industry optimize its role in the circular economy for plastics? Sustainable Packaging Coalition. https://sustainablepackaging.org/2023/04/06/how-can-the-chemical-recycling-industry-optimize-its-role-in-the-circular-economy-for-plastics/
305. Unnikrishnan, S., et al. (2023). New business models—not new technologies—will unleash sustainability in CPG. Boston Consulting Group (BCG). https://www.bcg.com/publications/2023/why-cpg-leaders-must-reimagine-business-models
306. Feber, D., et al. (2019). No ordinary disruption: winning with new models in packaging 2030. McKinsey & Company.
307. Edible Cutlery. (n.d.). About us: embrace the change with Edible Cutlery, where great taste meets sustainability. https://ediblecutlery.au/about-us/
308. Edible Cutlery. (n.d.). Edible Cutlery: a global plastic waste solution. https://ediblecutlery.au/crunching-the-plastic-problem-edible-cutlerys-role-in-tackling-global-waste/
309. Edible Cutlery. (n.d.). Edible Spoon. https://ediblespoon.com.au/
310. Edible Cutlery. (n.d.). Edible Cups. https://ediblecups.au/
311. Edible Cutlery. (n.d.). Frequently asked questions. https://ediblecutlery.au/faqs/
312. Edible Cutlery. (n.d.). Food for thought: how edible cutlery is sparking conversations about sustainability. https://ediblecutlery.au/food-for-thought-how-edible-cutlery-is-sparking-conversations-about-sustainability/
313. Hughson, L. (2024). PIDA 2024: food packaging design. PKN Packaging News. https://shorturl.at/2mnD0
314. Australian Institute of Packaging (AIP). (2024). 2024 Australasian Packaging Innovation & Design (PIDA) awards. https://aipack.com.au/wp-content/uploads/2024_PIDA_winners_media_release.pdf
315. Hughson, L. (2024). PIDA 2024: domestic & household. https://www.packagingnews.com.au/design/pida-2024-domestic-and-household
316. Kaur, N. (2024). New koor pack for on-the-go market. https://www.packagingnews.com.au/food/new-koor-pack-for-on-the-go-market
317. koor. (2025). Spare parts. https://koor.life/collections/spare-parts
318. koor. (2025). The new refillable bottle. https://koor.life/
319. koor. (2025). Accessibility. https://koor.life/pages/accessibility
320. koor. (2025). Instructions. https://koor.life/pages/instructions
321. Lilly's Little Lunchbox. (2021). Lilly's Little Lunchbox: about us. https://www.lillyslittlelunchbox.com/about-us
322. Lilly's Little Lunchbox. (2021). How it works. https://www.lillyslittlelunchbox.com/how-it-works
323. Lilly's Little Lunchbox. (2021). LLL's recycle project. https://www.lillyslittlelunchbox.com/recycleproject
324. Meat & Livestock Australia (MLA). (2024). About MLA. https://www.mla.com.au/about-mla/
325. Meat & Livestock Australia (MLA). (2020). MLA strategic plan 2025. https://www.mla.com.au/globalassets/mla-corporate/about-mla/documents/planning--reporting/Strategic-Plan-2025.pdf
326. Meat & Livestock Australia, MLA (2024). Sustainable packaging. https://www.mla.com.au/research-and-development/product-and-packaging-innovation/sustainable-packaging/
327. Waddington, A. (2024). MLA red meat packaging stewardship framework. Meat & Livestock Australia (MLA). https://www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/mla-red-meat-packaging-framework---final.pdf
328. Blanchard, S., et al. (2023). Meat packaging – the state of play in an evolving market. Meat & Livestock Australia (MLA). https://www.mla.com.au/contentassets/2ed210eb71184b008a19edf1d3d2a598/mfs.0005-meat-packaging_final-report_v03-2.pdf
329. Blanchard, S., et al. (2021). A horizon scan of sustainable red meat packaging: what's new, innovative, and ready to market. Meat & Livestock Australia (MLA). https://www.mla.com.au/globalassets/mla-corporate/research-and-development/final-reports/v.rmh0127.redmeatpackaging-006.pdf
330. Meat & Livestock Australia (MLA). (2020). Red meat joins the war on waste. https://www.mla.com.au/news-and-events/industry-news/red-meat-joins-the-war-on-waste/#:~:text=A%20new%20way%20of%20packaging,by%20reinventing%20red%20meat%20packaging.&text=MLA%20worked%20with%20American%20start,%2Dfree%2C%20compostable%20meat%20tray
331. Harpur, D. (2015). Novatein bio-polymer. Aduro Biopolymers Limited Partnership. Meat & Livestock Australia (MLA). https://www.mla.com.au/news-and-events/industry-news/red-meat-joins-the-war-on-waste/#:~:text=A%20new%20way%20of%20packaging,by%20reinventing%20red%20meat%20packaging.&text=MLA%20worked%20with%20American%20start,%2Dfree%2C%20compostable%20meat%20tray
332. Leximancer Pty Ltd. (2021). Leximancer: Leximancer user guide.
333. Angus, D., et al. (2013). Making sense of big text: a visual-first approach for analysing text data using Leximancer and Discursis. International Journal of Social Research Methodology, 16(3), 261-267. https://doi.org/10.1080/13645579.2013.774186
334. Smith, A.E. and Humphreys, M.S. (2006). Evaluation of unsupervised semantic mapping of natural language with Leximancer concept mapping. Behavior Research Methods, 38(2), 262-279. https://doi.org/10.3758/BF03192778

335. Antons, D. and Breidbach, C.F. (2018). Big data, big insights? advancing service innovation and design with machine learning. Journal of service research, 21(1), 17-39. https://doi.org/10.1177/1094670517738373
336. Grootendorst, M. (2022). BERTopic: neural topic modeling with a class-based TF-IDF procedure. Ithaca: Cornell University Library, arXiv.org.
337. Devlin, J., et al. (2019). BERT: pre-training of deep bidirectional transformers for language understanding. Ithaca. Cornell University Library, arXiv.org.
338. Ellen MacArthur Foundation. (2022). Chile's circular economy roadmap: collaboration for a shared action plan. https://www.ellenmacarthurfoundation.org/circular-examples/chiles-circular-economy-roadmap
339. Food Innovation Australia Limited (FIAL). (2022). Woolworths: recyclable redesign reduces plastic by 75%. Food & Agribusiness Growth Centre, Food Innovation Australia https://www.fial.com.au/woolworths
340. Ellen MacArthur Foundation. (2021). Eliminating unnecessary plastic packaging: Tesco. https://www.ellenmacarthurfoundation.org/circular-examples/tesco
341. Australian Circular Economy (ACE) Hub. (2021). Opal: creating circular solutions for packaging and beyond. https://acehub.org.au/knowledge-hub/case-studies/opal
342. Australian Circular Economy (ACE) Hub. (2020). Edge environment: providing the evidence for good circular economy decision-making. https://acehub.org.au/knowledge-hub/case-studies/edge-environment
343. Australian Institute of Packaging (AIP). (2020). Case study: UPM Raflatac & kiwi labels - washable adhesive on rPET punnet. http://aipack.com.au/wp-content/uploads/AIP_Case_Study_UPM_Raflatac_Kiwi_Labels_2020.pdf
344. Food Innovation Australia Limited (FIAL). (2022). Edgell: no more soggy chips, less waste and improved consumer experience. Food & Agribusiness Growth Centre, Food Innovation Australia. https://www.fial.com.au/blue-harvest
345. Cecchini, C. (2021). Climate Action: How mushrooms and microorganisms could transform food packaging. World Economic Forum. https://www.weforum.org/agenda/2021/10/how-mushrooms-and-microorganisms-could-transform-food-packaging/
346. Australian Circular Economy (ACE) Hub. (2021). Kua coffee: the company creating closed-loop cuppas for some of Australia's most progressive workplaces. https://acehub.org.au/knowledge-hub/case-studies/kua-coffee

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Macarena developed her knowledge of integration in innovative entrepreneurial firms through her PhD in Strategy, Innovation & Entrepreneurship at the University of Sydney. Throughout her career, Macarena has transitioned from the practice of architectural design to entrepreneurship and innovation research, by leveraging interdisciplinary experience leading innovation and product development projects. She has worked as an Innovation Manager and completed a Master's of Integrated Innovation from Carnegie Mellon University in the United States. More recently, Macarena has worked as an academic and researcher in several universities in Australia, including The University of Queensland where she currently works.

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