Consumption of plastic lids in Australia:
A Case Study

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1. Introduction

Over the last 50 years, plastic has changed the way we package. It is cheap, easy to mould, lightweight and incredibly durable, which makes it of critical functional importance for almost everything in our lives, especially in the medicine and food industries. However, plastic production is now being overly used and misused, such as in the case of single-use plastic (SUP), which has had a great impact on natural resources and the environment (Milà I Canals, 2021).

One of the problems involved in SUP use is the inappropriate disposal of the plastic at the end of its use cycle. Large amounts of it are ending up in the environment, contributing to the pollution of land and water. This is evidenced by low recycling rates – in Australia, only 13% of total plastic used is being recycled (DAWE, 2021). Furthermore, from one million tonnes used for packaging, only 6.1% was recovered between 2018-19 (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a).

In other words, a valuable resource is being discarded, and with it the embodied energy and resources that were used in the manufacturing process. Many factors contribute to this problem. Australia's fragmented recycling industry depends on what is stipulated in each state's legislation, leaving some city councils to manage the kerbside collection themselves and others to rely on contractors. This can be costly and go unchecked. Additionally, there is a lack of technology and infrastructure to process large amounts of "waste" plastic into new products. Finally, the fact that it is cheaper to use imported virgin plastic rather than recycled, provides very few incentives for ensuring correct disposal and recycling (WWF 2021).

Some non-profit organisations are implementing new recycling practices, such as recycling items that are not commonly taken by the kerbside system (e.g. plastic lids, rings and bread tags). In addition, some organisations are working towards connecting consumers and recyclers around Australia, with the aim of ensuring that plastic is correctly managed. For example, Rethink Recycling Co-op not only connects consumers and community with business for a more sustainable environment, but also educates communities about the importance of being responsible for what people consume and its final disposal.

2. Overlooked Issues

Plastics are not limited to plastic bottles or soft plastic used in supermarkets and packaging, but can also be found in many overlooked everyday items such as plastic rings, pumps, clips and lids. These products are typically ignored due to their size and are hard to collect and process with the current available technology. Current available plastic reports only measure the items that are processed in Materials Recovery Facilities (MRFs), which means that the smaller plastics that were not collected have no reported data. Unfortunately, this means that it is not possible to calculate exactly how many lids are being recovered by MRFs and its subsequent impact on the environment.

2.1. Available Information

The National Plastics Plan 2021 and the Australian Packaging Consumption Recycling Data 2018-19 and 2019-2020 are some of the reliable sources that can be consulted to know the quantities of plastic used in Australia for packaging that was placed on the market (POM). Table 1 shows that 1 million tonnes and 1,124 million tonnes of plastic were used for packaging purposes in 24 months. Some of this plastic was produced in Australia and some was manufactured overseas & imported (Table 2 and 3).

Table 1 Packaging POM from 2017–18 to 2019–20, by material group (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021b).

Material group	2017–18	2018–19	2019–20	Change 2018–19 to 2019–20
	(tonnes)	(tonnes)	(tonnes)	(%)
Paper & paperboard	2 901 000	3 262 000	3 277 000	0%
Glass	1 273 000	1 283 000	1 156 000	-10%
Plastic	1 067 000	1 000 000	1 124 000	12%
Metal	213 000	246 000	248 000	1%
Wood	NR[a]	124 000	462 000	272%
Total (tonnes)	**5 453 000**	**5 916 000**	**6 266 000**	**6%**
Total (kg/person)[b]	**218**	**233**	**244**	**5%**

Table 2 Packing POM in 2018-19, by material group, location of material source and manufacturing (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a).

Material group	Locally manufactured packaging		Overseas manuf. packaging	Total
	Local source	Overseas source	Overseas source	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper & paperboard	1 598 000	119 000	1 546 000	3 262 000
Glass	900 000	1 000	382 000	1 283 000
Plastic	188 000	320 000	492 000	1 000 000
Metal	13 000	187 000	46 000	246 000
Wood	63 000	1 000	61 000	124 000
Total (tonnes)	**2 762 000**	**628 000**	**2 527 000**	**5 916 000**
Total (%)	**46.7%**	**10.6%**	**42.7%**	**100.0%**

Table 3 Packaging POM in 2019–20, by material group, location of manufacturing, and material source location (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021b).

Material group	Locally manufactured packaging		Overseas manufactured packaging		Total
	Local source	Overseas source	Filled packaging	Empty packaging	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper & paperboard	1 540 000	437 000	1 183 000	117 000	3 277 000
Glass	840 000	0	152 000	164 000	1 156 000
Plastic	195 000	488 000	82 000	359 000	1 124 000
Metal	13 000	171 000	53 000	10 000	248 000
Wood	252 000	0	200 000	9 000	462 000
Total (tonnes)	**2 841 000**	**1 096 000**	**1 671 000**	**659 000**	**6 266 000**
Total (%)	**45.3%**	**17.5%**	**26.7%**	**10.5%**	**100.0%**

In 2018-2019, 81% of Australian Plastic packaging was from an overseas source, 61% of this was also manufactured overseas; just 18% was manufactured locally from a local source (Table 2). This compares with 2019-2020, where 83% of packaging was from an overseas source, while the rest was locally manufactured with local materials (Table 3). It is possible to assume that the same percentage of plastic lids were produced overseas and then imported with the bottles.

The demand for plastic, in general, has dramatically grown since the 1970s and is expected to double in the next 20 years (DAWE 2021). This means that Australia will have even more post-consumer plastic products to manage and will require better processing of the materials previously being exported. Since the Recycling and Waste Reduction Act 2020, (active December 2020), bans the export of unsorted mixed plastic materials from 1st July 2021 and unprocessed single polymer or resin plastics from 1st July 2022 (DAWE 2021).

The Table 4 and 5 below show the amount of plastic that was used for packaging, for 2018-2019 and 2019-2020, for "Bottles or Jars". It can be assumed, for the purpose of this case study, that all the plastic bottles or jars had plastic lids.

Table 4. Packaging POM in 2018-19, by material group and component group (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a*)*.

Material type	Paper & paperboard	Glass	Plastic	Metal	Wood	Total	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)
Bag or pouch	90 000	0	181 000	0	0	271 000	4.6%
Barrel or drum	0	0	11 000	22 000	0	33 000	0.6%
Bottle or jar	0	1 283 000	425 000	0	0	1 708 000	28.9%
Can	0	0	0	221 000	0	221 000	3.7%
Carton or box	2 899 000	0	16 000	0	25 000	2 940 000	49.7%
Closure or label	0	0	13 000	0	0	13 000	0.2%
Pallet or bin	0	0	5 000	0	97 000	102 000	1.7%
Shopping bag	0	0	33 000	0	0	33 000	0.6%
Tableware	22 000	0	7 000	0	1 000	29 000	0.5%
Tub, tray or punnet	52 000	0	87 000	3 000	0	142 000	2.4%
Tube or cartridge	0	0	8 000	0	0	8 000	0.1%
Wrap	88 000	0	109 000	0	0	196 000	3.3%
Other	84 000	0	20 000	0	2 000	106 000	1.8%
Unknown	27 000	0	87 000	0	0	114 000	1.9%
Total	**3 262 000**	**1 283 000**	**1 000 000**	**246 000**	**124 000**	**5 916 000**	**100.0%**

Table 5. Packaging POM in 2019–20, by material group and component group (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021b).

Component group	Paper & paperboard	Glass	Plastic	Metal	Wood	Total	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)
Bag or pouch	95 000	0	351 000	0	0	446 000	7.1%
Barrel or drum	0	0	22 000	23 000	7 000	51 000	0.8%
Bottle or jar	0	1 156 000	298 000	0	0	1 454 000	23.2%
Can	0	0	0	218 000	0	218 000	3.5%
Carton or box	2 885 000	0	0	0	45 000	2 930 000	46.8%
Closure or label	0	0	38 000	4 000	0	42 000	0.7%
Pallet or bin	0	0	12 000	0	408 000	420 000	6.7%
Shopping bag	0	0	20 000	0	0	20 000	0.3%
Tableware	60 000	0	25 000	0	2 000	88 000	1.4%
Tub, tray or punnet	57 000	0	109 000	3 000	0	169 000	2.7%
Tube or cartridge	0	0	13 000	0	0	14 000	0.2%
Wrap	81 000	0	106 000	0	0	186 000	3.0%
Other	99 000	0	35 000	0	0	134 000	2.1%
Unknown	0	0	96 000	0	0	96 000	1.5%
Total	**3 277 000**	**1 156 000**	**1 124 000**	**248 000**	**462 000**	**6 266 000**	**100.0%**

In the same reports, we can find the tables indicating number of units produced during those two periods respectively, as shown below, Table 6 and 7.

Table 6. Packaging counts POM in 2018-19, by material group and component group – B2C and B2B (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a).

Material type	Paper & paperboard	Glass	Plastic	Metal	Wood	Total	
	(million units)	(million units)	(million units)	(million units)	(million units)	(million units)	(%)
Bag or pouch	4 240	0	26 790	0	0	31 020	21.4%
Barrel or drum	0	0	2	2	0	4	0.0%
Bottle or jar	0	5 090	11 930	0	0	17 030	11.7%
Can	0	0	0	8 150	0	8 150	5.6%
Carton or box	17 400	0	0	0	2	17 400	12.0%
Closure or label	0	0	5 750	40	0	5 790	4.0%
Pallet or bin	0	0	0	0	3	3	0.0%
Shopping bag	0	0	3 010	0	0	3 010	2.1%
Tableware	1 820	0	1 720	0	0	3 550	2.4%
Tub, tray or punnet	1 760	0	4 950	570	0	7 270	5.0%
Tube or cartridge	0	0	440	0	0	440	0.3%
Wrap	31 250	0	11 960	0	0	43 210	29.7%
Other	8 020	0	400	0	0	8 420	5.8%
Total (million units)	**64 480**	**5 090**	**66 960**	**8 750**	**5**	**145 290**	**-**
Total (%)	**44.4%**	**3.5%**	**46.1%**	**6.0%**	**0.0%**	**100.0%**	**100.0%**

Table 7. Packaging counts POM in 2019–20, by material group and component group – B2C and B2B (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021b).

Component group	Paper & paperboard	Glass	Plastic	Metal	Wood	Total	
	(million units)	(million units)	(million units)	(million units)	(million units)	(million units)	(%)
Bag or pouch	5 770	0	50 400	0	0	56 170	33.7%
Barrel or drum	0	0	7	3	0	11	0.0%
Bottle or jar	0	4 590	7 280	0	0	11 880	7.1%
Can	0	0	0	7 680	0	7 680	4.6%
Carton or box	17 700	0	0	0	4	17 700	10.6%
Closure or label	0	0	4 090	450	0	4 540	2.7%
Pallet or bin	0	0	0	0	12	13	0.0%
Shopping bag	0	0	1 330	0	0	1 330	0.8%
Tableware	6 080	0	4 920	0	0	11 000	6.6%
Tub, tray or punnet	1 880	0	4 770	610	0	7 260	4.4%
Tube or cartridge	0	0	440	10	0	450	0.3%
Wrap	29 320	0	6 170	0	0	35 490	21.3%
Other	12 750	0	340	0	0	13 090	7.9%
Total (million units)	**73 500**	**4 590**	**79 750**	**8 760**	**17**	**166 620**	**-**
Total (%)	**44.1%**	**2.8%**	**47.9%**	**5.3%**	**0.0%**	**100.0%**	**100.0%**

Information about plastic lid production or plastic use for this purpose was not found in consulted reports (Australian Packaging Covenant Organisation or National Plastic Plan), hence it can only be assumed that plastic lids production may not be public information or easily accessible for public viewing. For the purpose of this case study, it was assumed that between 2018-2019 and 2019-2020, a total of 19.2 million plastic lids were placed on the market - the same as their plastic bottle counterparts.

A small survey was carried out among several organisations around Australia regarding historical data in post-consumer plastic lid collection or recycling. Table 8 outlines the estimated number of plastic lids collected by eight different organisations that were consulted via email and social networks. Extrapolating this information, these organisations recovered approximately 42,483,540 lids per year.

Table 8. Estimated number of plastic lids collected by eight different organisations (2022).

Origin of Lids	Monthly Collections
Lids4Kids	277,778
Bottlehill Top	103,017
Claw Environmental	2,666,667
Endeavor Industries (Lids4Kids)	120,000
WatchyourWaste	350,000
Holy Cross School, Wooloowin	5,583
Capricornia Correctional Centre (CCC)	7,250
Rethink Recycling Co-op	10,000
Total lids a month	**3,540,295**
Total lids a year	**42,483,540**

Table 9. Percentage of lids consumed in Australia compared to collected for recycling.

Assumed lids imported and produced in Australia in 2018-2019 (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use, 2021a)	11,930,000,000
Assumed lids imported and produced in Australia in 2019-2020 (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use, 2021b)	7,280,000,000
Average between the two periods	9,605,000,000
Total lids collected from collection sources a year based on survey (Table 8)	42,483,540
Percentage of collection/reported	0.44%

From these estimates, it is assumed that only 0.44% (Table 9) of the lids on the market are being collected or recycled every year. Although data is assumed, it still highlights the issue surrounding the impact of plastic lids and highlights the many unknowns regarding their end-of-life cycles.

2.2. Actions Taken in Australia

Several non-profit organisations in Australia have been voluntarily tackling the plastic lid issue by collecting, segregating, recycling, manufacturing, or sourcing recycled resin to other manufacturers.

With the information collected, it is assumed that 0.44% of plastic lids have been diverted from the landfill and environment through these organisations. Additionally, these organisations have the potential of offering meaningful volunteer opportunities, impacting communities in a positive way.

Product stewardship in Australia is an initiative where everyone in the supply chain shares responsibility to reduce the different impacts of the products (DCCEEW 2021). The Australian Packaging Covenant Organisation (APCO), intermediates between the government and the industry to ensure the reduction of the environmental impacts of consumer packaging. The APCO encourages businesses to design their packaging in a way that is more sustainable, including plastic bottle lids, with the goal of increasing plastic packaging recycling rates and phasing out SUPs by 2025 (DCCEEW 2022).

2.3. Environmental Impact

The environmental impact of the plastic lids can be difficult to measure due to the lack of information, consistency, and reporting framework to keep track of the lid manufacturing processes and imports. However, it is possible to make educated assumptions to assist in determining their impact.

2.3.1. Recycling and Landfill Diversion

According to the National Plastics Plan 2021, the plastic packaging landfill rate is 84% and only 13% of it is recycled (DAWE 2021). There are several explanations as to why lids' end destination is landfill rather than being recycled. Unfortunately, plastic lids are not being recycled by MRFs in most Australian states. Due to their small size, they fall through the machinery onto the floor or jam, breaking the machines (Tayao n.d.). When lids are left on their plastic bottle counterparts, the plastic recycling load can be contaminated as they are typically made from two separate polymer types, and because the monetary value of the plastics that are used for plastic lids is low in the market, they are not prioritised or even considered worth the process (Earth911 n.d.). Lastly, the plastic lids can be quite a workplace hazard when lids are left on the bottles. When the bottles are going through the machinery, the pressure build-up from the process causes the lids to shoot off at high velocities (Laclette 2018). The recycling industry recommends community members to separate the lids from their bottles and ensure liquid has been emptied to prevent interruptions in the air sorting processes (Hoh 2017).

2.3.2. Energy Consumption

According to Beyond Zero Emissions (2019), to produce one tonne of polyethylene terephthalate (PET), which is most commonly used in food and drink containers, the energy consumed is 22,972 kWh, emitting 3.0 T CO2e, one tonne of polypropylene (PP) consumes 23,056 kWh and emits 2.0 T CO2e, and one tonne of high-density polyethylene (HDPE)

consumes 21,111 kWh and emits 1.9 T CO2e. These are the most common plastic polymers used in the manufacturing of bottle lids because of their different characteristics (Caprite Australia n.d.).

Research carried out by the North American Association of Plastic Recyclers reports that using recycled plastic using the cut-off method, which is a method referred in the document, where "all virgin material production burdens are assigned to the first use of the material, and the burdens assigned to the recycled resin system begin with recovery of the postconsumer material. All the burdens for material recovery, transport, separation and sorting, and reprocessing are assigned to the recycled material", reduced total energy consumption by 79% for PET, by 88% for HDPE and by 88% percent for PP (Franklin Associates, A Division of Eastern Research Group (ERG) 2018).

2.3.3. Packaging Loss of Value

The APCO presents estimates of the loss of value of the packaging sent to the landfill between 2018-19. For plastics, it is estimated that the value loss of 818,000 tonnes of plastic packaging sent to the landfill was $190 million (AUD). No data currently exists regarding the loss of value from plastic bottle lids, however, given they associated with most drink containers, this value provides an idea on the amount of money being wasted and the potential value of our plastic 'waste' (Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a).

2.3.4. Ocean Pollution

Mismanagement of plastic has led to worldwide pollution problems, with issues ranging from littering to microplastic contamination. According to Oceana (Petsko 2021), up to 23 million metric tonnes of plastics end up in rivers, lakes, and oceans, lingering for extended periods of time once entered into these systems. Plastic can be deadly to marine animals who may ingest them or become entangled. The accumulation of microplastics has become a global threat to marine habitats and ecosystems (Petsko 2021).

Researchers suggest that the presence of these plastics are impacting the oceanic environment and the consequences are becoming irreversible, for instance, bacteria present in the oceans, who oversee capturing carbon from the atmosphere, are being negatively impacted (changing the carbon cycles) and hence contributing to global warming (Petsko 2021).

There are no records showing the volume of plastic lids ending up in the oceans, however it is estimated that 21-34 billion SUP bottles end up in the ocean each year. It is reasonable to consider the possibility of a similar number of lids lingering in the ocean (Petsko 2021).

A report conducted by the Marine Debris Program of the U.S National Ocean Service after a marine debris removal in Midway Atoll, a pacific island with less than 60 people, found 4,781 bottle lids in the shoreline, most of them made from polypropylene (PP) (Marine Debris Program 2021).

Organisations like Clean Up Australia, who carry out litter clean-up projects in locations around Australia, have found that plastic lids are in the top 10 rubbish items as a percentage of the total rubbish collected, representing 4.3% of the total 379,606 items collected from 944 surveyed locations in 2021. Thanks to these actions, approximately 17,462 lids were saved and recovered from the environment (Clean Up Australia 2021).

2.3.5. Energy Consumption

According to Beyond Zero Emissions, to produce one tonne of polyethylene terephthalate (PET), which is most used in food and drink containers, the energy consumed is 22,972 kWh, emitting 3.0 T CO2e, one tonne of polypropylene (PP) consumes 23,056 kWh and emits 2.0 T CO2e, and one tonne of high-density polyethylene (HDPE) consumes 21,111 kWh and emits 1.9 T CO2e. These are the most common plastic polymers used in the manufacturing of bottle lids because of their different characteristics (Beyond Zero Emissions 2019).

Research carried out by the North American Association of Plastic Recyclers reports that using recycled plastic using the cut-off method, which is a method referred in the document, where "all virgin material production burdens are assigned to the first use of the material, and the burdens assigned to the recycled resin system begin with recovery of the postconsumer material. All the burdens for material recovery, transport, separation and sorting, and reprocessing are assigned to the recycled material", reduced total energy consumption by 79% for PET, by 88% for HDPE and by 88% percent for PP (Franklin Associates, A Division of Eastern Research Group (ERG) 2018).

2.3.6. Carbon Emissions and Water Consumption

As mentioned previously, producing one tonne of PET, mostly used in food and drink containers, emits 3.0 T CO2e, one tonne of PP emits 2.0 T CO2e, and one tonne of HDPE emits 1.9T CO2e. However, research carried out by North American Association of Plastic Recyclers demonstrates a reduction in CO_2 emissions by 67% to 71% for PET, HPDE and PP polymers when resins are recycled (Franklin Associates, A Division of Eastern Research Group (ERG) 2018).

This same research also showed the amount of water used to produce one kilogram of virgin resin for PET (9.89L), HDPE (8.33L), and PP (8.58L). Although recycling PET used 4% more water than producing virgin PET, recycled HDPE used 59% less and PP used 46% less water. This outlines both the carbon emissions and water consumption savings possible with using recycled plastic as a resource (Franklin Associates, A Division of Eastern Research Group (ERG) 2018).

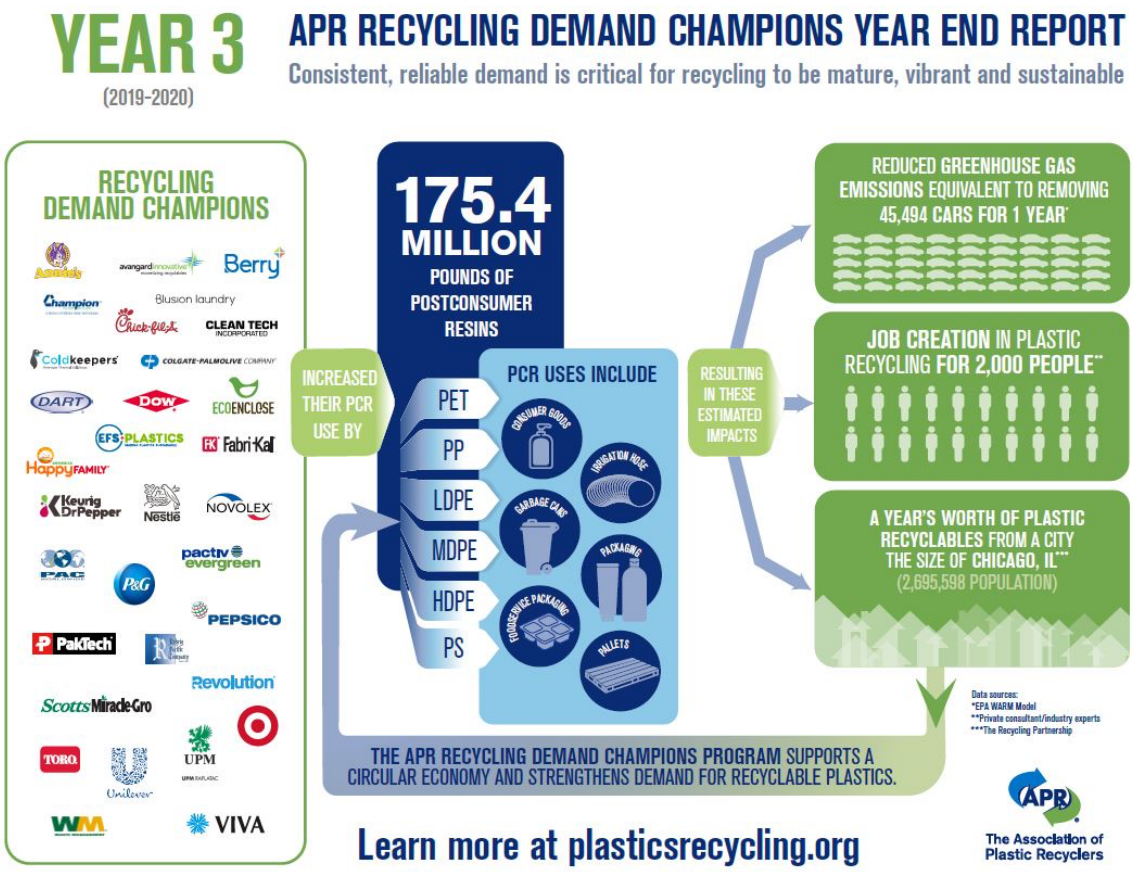
2.4. International Actions

Similar recycling situations to Australia exist elsewhere in the world. In the United States of America, according to the Earth911 (n.d.) website, several states have passed laws requiring

plastic bottles to be recycled, however, nothing can be found on the recycling or disposal of plastic lids. The Association of Plastic Recyclers (APR), an international trade association representing the plastics recycling industry located in Washington DC, supports the “Caps on” message along its members, an initiative that encourages to leave the cap on the bottle, due to the growing markets for HDPE and PP. In fact, the APR (2015) recommend different positive recycling practices available for the public in their website. Although the APR supports MRFs in the process, this initiative is also dependant on their willingness to take the lids.

For instance, one of the many members of the APR is Waste Management, Inc., also known as WM, a company that offers waste management services in the USA wide except for Alaska and Montana, for both residential and industrial customers. The company encourages their customers to put the caps back on the bottle before putting it in the bin (WM n.d.).

Figure 1 APR Recycling Demand Champions Year 3 Report (Alexander 2021)



The American Chemistry Council, Inc. (ACC) has launched ‘Plastics Make Possible’, an online site where consumers can browse compelling innovations of plastic usage worldwide. The website recommends consumers to leave their lids on their plastic bottles as some ACC members (plastic recycling industry companies) are starting to possess the ability to process both lids and bottles together, however, this remains to be thoroughly detailed. Ultimately, residents must adhere to the instructions of their local council, which are based on their servicing MRF (Alexander 2017).

Further south in Colombia, a company located in the region of Valle del Cauca, Recuperadores de Materiales Industriales SAS, works with the local city council by offering residential collection services in exchange for recyclable materials and encourages the inhabitants of the city to keep plastic lids on their bottles (RMI n.d.). They not only offer collection services, but they also process the plastic and sell it on the market, further driving the local economy.

3. Proposals

3.1. Lid Reporting framework

This report highlights the difficulty in finding accurate or available data regarding the current manufacture, importation, and consumption of plastic lids in Australia. There exists an opportunity to establish a reporting framework where organisations dealing with lids (manufacturing, importing, recycling, or disposing) can record their data. This will enable a more accurate database to measure the environmental and economic impacts of plastic lids in Australia.

One organisation positioned to champion such a database is Rethink Recycling Co-op, who are establishing themselves as a plastic lid recycler in Melbourne. Partner organisations, such as Clean Up Australia, lid manufacturers, and lid importers, may also participate in updating the framework with their lid metrics, which will capture a more holistic picture.

This database will be free to access, measure environmental impacts and recycling/collection rates, and support other environmental systems and sustainability projects. It will even provide information regarding material flow for circular economy plans at local government area (LGA), state, and Australia-wide levels.

3.2. Rethink Recycling Co-op Centres

Rethink Recycling Co-op has the potential to process 5000kg of lids every month per centre, equating to approximately 1.2 million lids rescued from landfill, and reintroduced into the market as recycled resin, plastic sheets, and other products. This performance can be upscaled in the following years as the organisation grows.

This organisation is tackling the plastic lids problem by collecting and processing lids, whilst creating local jobs and contributing to the growing circular economy in Victoria and rest of Australia.

Table 10. Average lids production and Rethink Recycling Co-op Centre performance

Assumed lids imported and produced in Australia in 2018-2019 (Australian Packaging Consumption and Recycling Data)	11,930,000,000
Assumed lids imported and produced in Australia in 2019-2020 (Australian Packaging Consumption and Recycling Data)	7,280,000,000
Average between the two periods	9,605,000,000
One RRC Centre Lids Processing Capacity (yearly)	6,000,000
One RRC Centre processing capacity of overall lids	0.062%
Number of RRC Centres required to process lids	1,601

Rethink Recycling Co-op has the capacity to process approximately six million lids per year and has the potential of diverting 0.062% of plastic lids from landfill. In order to reach 100% recovery, RRC would need to establish 1,601 centres in LGAs across Australia. Establishment of centres in particular locations will be dependent on the LGA's waste and recycling generation per capita, population, and community support. The RRC Centre is currently being trialled in an Eastern Melbourne suburb to determine its feasibility and effectiveness. There is great potential of creating local jobs, meaningful volunteering positions, reducing the impact of the plastic in the environment, reducing the dependence of imported materials both virgin and recycled, and improving the Australian manufacturing industry as the lids diverted from landfill would increase plastic recycling rates in Australia.

4. Conclusion

Australian plastic recycling rates are very low and have potential to be increased with the help of frontline environmental and educational organisations to recycle plastic not processed by local councils. It has been demonstrated that recycling plastic uses less resources, emits less CO_2, and generates less waste than the manufacture of plastic from virgin materials and to also be a sustainable practice with more benefits than drawbacks.

The lack of recycling reporting framework is one obstacle when assessing the environmental impacts of plastic. Its inconsistency and lack of unification across states in Australia makes it a fractured system. There is great potential for creating a reporting framework for the plastic lids collection. This case study had some limitations in data collection for plastic lids. Firstly, there was difficulty in reaching out with various recycling industry stakeholders. The lack of a public reporting framework resulted in several assumptions being made. There is a need for a reporting framework to facilitate analysing the impact from plastic lids.

The estimations made in this document regarding the number of lids manufactured, imported and lost to landfill per year gives helps to visualise the importance of the issue. There is great potential for plastic lid recovery, job creation, and reduction in the impact of plastic in the environment.

Something to consider is the environmental impact and loss of value of plastic lids is not being measured due to a lack of studies and assessments to support it. It can be assumed due to their plastic properties; plastic lids have similar environmental impacts as other plastic items that are measured. How many lids being recycled, diverted to the landfill, or lingering in the environment remains unclear. If left unmeasured, plastic lids have the potential of continuing to be a large contributor to the plastic problem.

Rethink Recycling Co-op's micro-centres provides a good example of a sustainable business that is not only reducing environmental impacts while recovering materials but also affecting social change, through jobs creation and community integration, and supporting a transition to a circular economy in Australia.

Bibliography

Alexander, S 2017, *Can You Recycle Plastic Bottle Caps and Lids?*, Plastics Make it Possible American Chemistry Council, Inc, viewed April 2022, <https://www.plasticsmakeitpossible.com/plastics-recycling/how-to-recycle/at-home/keep-your-top-on/>.

Alexander, S 2021, *2020: Year in Review*, The Association of Plastic Recyclers, viewed March 2022, <https://plasticsrecycling.org/blog/2020-year-in-review>.

Beyond Zero Emissions 2019, *How to Electrify Plastic*, Beyond Zero Emissions. (https://bze.org.au/wp-content/uploads/2020/12/BZE-Electrifying-Plastic-Brief-2019-Beyond-Zero-Emissions-Australia.pdf)

Caprite Australia n.d., *How are Plastic Bottle Caps Made?* Caprite Australia, viewed April 2022, <https://caprite.com.au/2020/08/28/how-are-plastic-bottle-caps-made/>.

Clean Up Australia 2021, *2021 Rubbish Report National*, Clean Up Australia. (https://irp.cdn-website.com/ed061800/files/uploaded/2021_National%20Fact%20Sheet.pdf)

DAWE 2021, *National Plastics Plan 2021*, Department of Agriculture, Water and the Environment, Canberra. CC BY 4.0. (https://www.agriculture.gov.au/sites/default/files/documents/national-plastics-plan-2021.pdf)

DCCEEW 2021, *Product stewardship in Australia*, Department of Climate Change, Energy, the Environment and Water, Canberra, viewed March 2022, <https://www.dcceew.gov.au/environment/protection/waste/product-stewardship>.

DCCEEW 2022, *Australian Packaging Covenant*, Department of Climate Change, Energy, the Envirnoment and Water, Canberra, viewed March 2022, <https://www.dcceew.gov.au/environment/protection/waste/plastics-and-packaging/packaging-covenant>.

Earth911 n.d., *How to Recycle Plastic Caps & Lids*, Earth911, viewed March 2022, <https://earth911.com/recycling-guide/how-to-recycle-plastic-caps-lids/>.

Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021a, *Australian Packaging Consumption Recycling Data 2018-19*, Australian Packaging Covenant Organisation.

(https://documents.packagingcovenant.org.au/public-documents/Australian%20Packaging%20Consumption%20And%20Recycling%20Data%202018-19)

Envisage Works, IndustryEdge, Randell Environmental Consulting and Sustainable Resource Use 2021b, *Australian Packaging Consumption Recycling Data 2019-21*, Australian Packaging Covenant Organisation.
(https://documents.packagingcovenant.org.au/public-documents/Australian%20Packaging%20Consumption%20And%20Recycling%20Data%202019-20)

Franklin Associates, A Division of Eastern Research Group (ERG) 2018, *Life Cycle Impacts for Postconsumer Recycled Resins: PET, HDPE, AND PP*, The Association of Plastic Recyclers.
(https://plasticsrecycling.org/images/library/2018-APR-LCI-report.pdf)

Hoh, A. 2017, *War on Waste: What plastics can be recycled?* ABC Radio Sydney, viewed March 2022,
<https://www.abc.net.au/news/2017-05-24/what-plastics-can-i-recycle-war-on-waste/8548658>.

Laclette, A. 2018, *A new packaging label making recycling easier to understand*, Planet Ark, viewed March 2022, <https://planetark.org/newsroom/archive/2543>.

Marine Debris Program 2021, *Plastic Bottle Caps*, U.S. Department of Commerce, viewed March 2022, <https://marinedebris.noaa.gov/plastic-bottle-caps>.

Milà i Canals, L. 2021, *How to reduce the impacts of single-use plastic products*, UN Environment Programme, viewed April 2022,
<https://www.unep.org/news-and-stories/story/how-reduce-impacts-single-use-plastic-products>.

Petsko, E. 2021, *The global plastic pollution crisis is approaching an irreversible 'tipping point'*, Oceana, viewed March 2022
<https://oceana.org/blog/global-plastic-pollution-crisis-approaching-irreversible-tipping-point/>.

RMI n.d., *RUTA DE RECOLECCIÓN PGIRS*, RMI, viewed March 2022,
<https://reciclaje-rmi.com/web/portafolio.html>

Tayao, I. G. n.d., *How To Recycle Bottle Caps: Are Bottle Tops Recyclable?*, Waster, viewed April 2022, <https://waster.com.au/recycle-bottle-caps/>.

The Association of Plastic Recyclers 2015, The Association of Plastic Recyclers Washington DC, viewed March 2022, <https://plasticsrecycling.org/apr-events-webinars/keep-your-caps-on-a-2015-update-presented-october-27-2015?highlight=WyJjYXBzIiwib24iLCJjYXBzIG9uIl0=>.

WM n.d., *Recycling 101*, WM, viewed April 2022, <https://www.wm.com/us/en/recycle-right/recycling-101>.

WWF 2021, *The state of Australia's recycling - how did we get into this mess?*, viewed April 2022, <https://www.wwf.org.au/news/blogs/the-state-of-australias-recycling-how-did-we-get-into-this-mess>.