Final

Plastic Waste
Advanced Recycling Feasibility Study
Geelong-Altona Industrial Corridor

The opportunity for a local circular economy for plastic

Report on the findings from the joint feasibility study to determine the technical, economic, and environmental benefits of a local advanced recycling industry

amcor coles iQRenew Licella™ lyondellbasell Advancing Possible Nestlé

The time to act on plastic IS NOW

Disclaimer

This draft report was prepared by Licella Holdings Ltd (Licella), in conjunction with a number of consultants (including Envisage Works, Grant Thornton, Lifecycles and Capire) engaged with support from Amcor, Coles, iQ Renew, LyondellBasell and Nestlé in the course of a feasibility study led by Licella.

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This includes the information relating, but not limited to, Licella's technology and any projections included in this report.

National Plastics Summit signals changes for plastic recycling

At the National Plastics Summit in March 2020, Prime Minister Scott Morrison put the challenge to industry to take responsibility for its plastic waste. Alongside this, the Prime Minister foreshadowed budget announcements to encourage demand for recycled plastic products, and to expand our industry capability to produce them.

> We are working with state and territory governments to identify and unlock the critical upgrades that will lead to a step-change in their recycling capacity... Investing in the sector isn't just good for the environment, it's incredibly good for our economy as well.[1]
>
> **The Hon. Scott Morrison, Prime Minister**

The National Plastics Summit in 2020 was the catalyst for this industry collaboration and resulting report. We undertook this feasibility study to demonstrate that a circular economy for plastic is not only possible, but also essential for Australia to meet its National Waste Policy commitments.

Victoria's new circular economy policy

Recycling Victoria: a new economy is Victoria's circular economy policy and 10-year action plan to deliver a cleaner, greener Victoria with less waste and pollution, better recycling, more jobs and a stronger economy.[2] The policy sets out a 72% waste diversion from landfill target by 2025.[2]

Recycling Victoria commits to "stimulate innovation and the development of new technologies that will realise future recycling opportunities currently not available."[2]

In the policy, the Minister for Energy (Victoria), Lily D'Ambrosio, outlines the support her Government is committing to aid industry in achieving these targets.

> …We'll support industry and innovation, advancing research and development and supporting clean technologies that will create new markets and new business opportunities for recycled materials. Recycling Victoria will reduce waste, increase recycling and create more value from our resources. And with it, help transform our entire economy.[2]
>
> **The Hon. Lily D'Ambrosio, Minister for Energy**

1. Scott Morrison PM. Speech, National Plastics Summit - Australian Parliament House, ACT (2020).
2. The State of Victoria - Department of Environment, Land, Water and Planning. Recycling Victoria: A new economy (2020).

How advanced recycling complements mechanical recycling

Can recycle (plastic type):	Advanced recycling	Mechanical recycling
Mixed plastics	✓	✗
Multi-layer plastics	✓	✗
Flexible (soft) plastics	✓	Limited
Contaminated plastics	✓	✗
End-of-Life plastics	✓	✗
PET/HDPE containers	Mechanical recycling rejects	✓
PET/PP pots, tubs & trays	Mechanical recycling rejects	Limited
Food-grade output	**All output**	**Very limited**

Report at a glance

Licella, supported by Amcor, Coles, iQ Renew, LyondellBasell, and Nestlé, conducted this feasibility study, with the advice of a group of specialist consultants, to explore the potential of a local circular economy for plastic.

Our partnership is guided by our recognition that a successful transition to a circular economy for plastic can only be achieved through collaboration. We also believe that the system-wide transformation required for Australia to meet its plastic recycling targets needs governments to come on the journey with us – both to set appropriate policies, and to invest where it is needed.

This report outlines the exciting potential and considerable benefits of advanced recycling for Australia. It focuses on flexible plastic (also known as soft plastic), particularly post-consumer packaging, with most of this currently going to landfill.

Advanced recycling:

Can produce **food-grade** plastic packaging with **recycled content.**

High demand for recycled content by food manufacturers locally and internationally.

Complements mechanical recycling.

Is a **new advanced manufacturing industry**.

Can **increase the national plastics recycling rate** to help achieve the national 80% resource recovery target.

Supports the waste hierarchy, as it is a higher value, lower emissions use for packaging waste compared to waste-to-energy.

Much of the infrastructure needed is already in place in Altona. **An advanced recycling facility is the missing piece**.

Is an opportunity to **recycle some of the 500,000 tonnes of plastics currently going to landfill in Victoria** every year.

Would give Australia, and Victoria, **a chance to meet their plastics recycling targets.**

Is an **economically and environmentally sustainable** solution for End-of-Life plastic.

The proposed facility:

Would utilise Licella's Australian-developed ***Cat-HTR*™ technology, a form of hydrothermal liquefaction**.

The oil created from the waste plastic would be used in the local plastics supply chain, delivering a **64% CO_2 reduction vs crude oil**.

Has the potential to **create over 300 new jobs** in Victoria over the next 5 years.

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Dr Len Humphreys
CEO – Licella Holdings Limited

The technology

An innovative form of Advanced Recycling developed in Australia using hydrothermal liquefaction (HTL), water under high temperature and pressure, to chemically transform plastic back to oil. *Cat-HTR™* is able to process a mix of all different types of plastic and delivers higher yields and better-quality oil than pyrolysis, with a lower carbon footprint. Proven, using the mass balance approach, to integrate within the current plastic supply chain.

Cat-HTR™

Introduction
A plastic circular economy: the Australian opportunity

Collaboration makes it possible

We founded Licella in 2007 with a mission; creating a bridge to a lower carbon future. Our hydrothermal liquefaction (HTL) platform is central to this study and we hope, a key piece of the puzzle. Our study partners, Amcor, Coles, iQ Renew, LyondellBasell and Nestlé, all represent important pieces of the puzzle. I am grateful to them for coming on the journey with us.

Through the prototype *KitKat* wrapper, we demonstrated that it was possible to take post-consumer plastics - such as old *KitKat* wrappers - and convert them into new *KitKat* wrappers with our technology and the existing infrastructure of our partners.

We come together with a shared vision for a more sustainable future for plastic. We understand that together we can do more than we can individually.

The next-generation of advanced recycling

Hydrothermal liquefaction (HTL) uses water as the 'chemical' to convert plastic back to oil. Unlike pyrolysis, which heats plastic in the absence of oxygen, HTL mixes melted plastic with hot, pressurised water in a 'supercritical state'. This produces higher yields of 'Plasticrude' more efficiently (using less energy), from which new plastics can be made.

Our HTL process

I am proud of our Licella team for leading this study. We have spent over 13 years developing our *Cat-HTR™* advanced recycling platform. With commercial projects under development in the UK, Japan and North America, this feasibility study is the first step to building a circular economy for plastic in Australia.

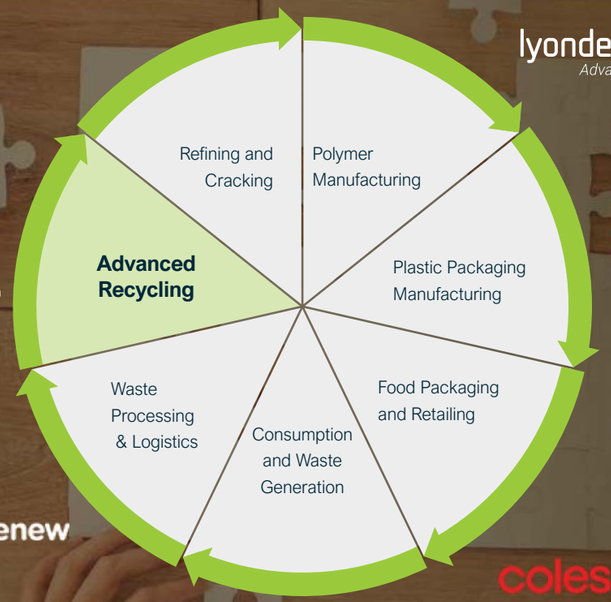
For every tonne of plastic recycled through the *Cat-HTR™*, we can produce 850kg of synthetic oil (85% plastics to oil conversion). This oil is used as a substitute for fossil oil in the existing plastic supply chain, creating a circular pathway for End-of-Life plastics that would otherwise go to landfill.

Every barrel of synthetic oil we produce, is one less barrel of fossil crude.

Every piece of plastic we recycle, is one less in landfill.

The time to act is now.

The collaboration behind this study



Licella™ HOLDINGS

lyondellbasell
Advancing Possible

amcor

Nestlé

iQRenew

coles

Industry collaboration pioneering a plastic circular economy

The world cannot get to net zero carbon emissions without a strong transition to a circular economy.[1] We need bold action to make this happen. This bold action comes in the form of a system-wide change.

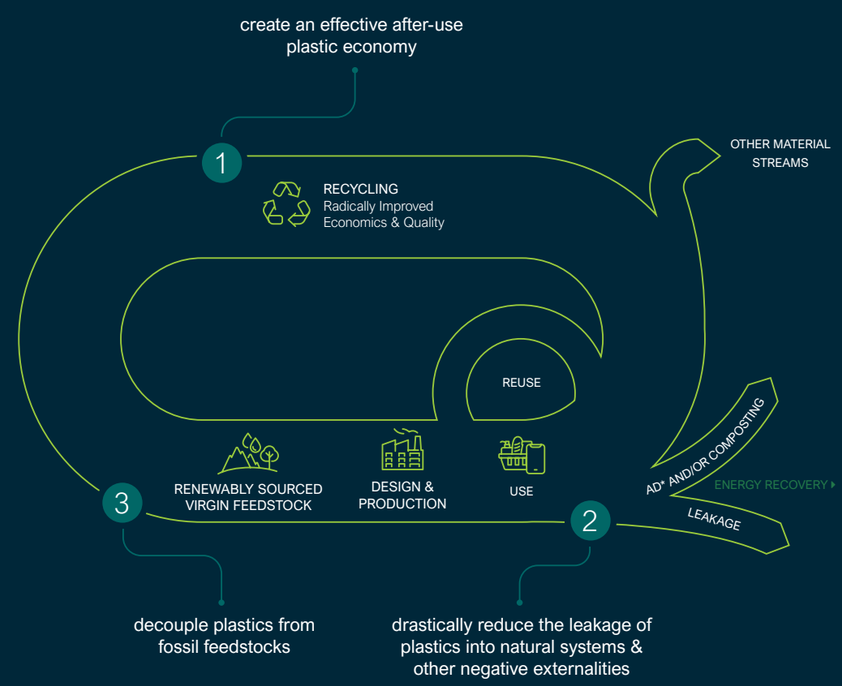
We all have a role to play – Governments, Industry, Consumers. A circular economy transformation is only possible when we all do our part. The solution is collaboration, and that is at the heart of this study.

Advanced recycling helps close the loop on the 87% of plastic that isn't recycled[2] in Australia each year

Plastic Waste - Advanced Recycling Feasibility Study - Geelong-Altona Industrial Corridor: The opportunity for a local circular economy for plastic investigates the exciting potential and considerable benefits of advanced recycling for Australia. It looks at the potential for Victoria to take a leadership role in creating a new advanced manufacturing industry. This report focuses on flexible (soft) plastic, particularly post-consumer packaging, with most of this currently going to landfill.

1. Ellen MacArthur Foundation. Completing the picture - How the circular economy tackles climate change (2019).
2. Australian Government Department of the Environment and Energy. National Waste Policy Action Plan (2019).

Rethinking the future of plastics: a circular economy approach[1]



*AD = anaerobic digestion

Circular Economy transition

We cannot get to net zero carbon emissions without a circular economy

The Ellen Macarthur Foundation estimates that around half of global emissions come from the products we consume in modern society.[1] While a transition to renewable energy is essential, it only solves half the emissions problem.

The Circular Economy is not only the new economic framework that will drive the jobs and industries of the future in Australia, it also has a critical role to play in reducing carbon emissions, tackling consumption and protecting biodiversity.[1] It is an opportunity to create value from what was previously lost to landfill or the environment, and shift society from linear (take, make, waste) to circular (use, reuse, recycle).[2]

Plastic recycling rates are still too low

Globally, organisations and governments have tried to rise to the challenge of improving the way we make and manage plastic. Despite this, recycling rates around the world are still low.

- *The National Waste Policy Action Plan 2019 (DEE, 2019),* sets out a clear target for Australia to reach by 2030 80% average resource recovery rate (Action 3.21).[3]
- In Victoria, the *Recycling Victoria: A new economy (2020)* policy sets out a 72% waste diversion from landfill target by 2025.[4]

Assuming export quantities do not change, this implies an increase in local reprocessing capacity (and end-markets for the products) of around 2.5 million tonnes per year (a 13-fold increase or so) is required in the next ten years, for plastics to make a proportional contribution to 80% recovery rate in the national targets.[5] It is hard to envisage how this target can be achieved for plastics without a system transformation, for which advanced recycling appears a strong potential contributor.[5]

1. Ellen MacArthur Foundation. Completing the picture - How the circular economy tackles climate change (2019).
2. World Economic Forum. It's time for the circular economy to go global and you can help (2019).
3. Australian Government Department of the Environment and Energy. National Waste Policy Action Plan (2019).
4. The State of Victoria Department of Environment, Land, Water and Planning. Recycling Victoria – A new economy (2020).
5. Based on the National Waste Report 2020 Data and Primary Research conducted by consultancy Envisage Works (2021).

The proposal: A new advanced manufacturing industry in Victoria

Impact

Our proposed advanced recycling plant would:

- Initially process 20,000 tonnes per annum of End-of-Life plastics with a plan to expand to **120,000 tonnes per annum**
- Producing 17,000 tonnes (increasing to over **100,000 tonnes**) per annum of oil that could be used back in the local plastic supply chain
- Over time would have the potential to produce nearly **100,000 tonnes** per annum of recycled plastics

Significant job creation and economic benefits from proposed plant:

- **Direct jobs: initially 31, increasing to 83** for plant operation and project development
- **Indirect jobs: initially 57, increasing to 152** in long term across the supply chain
- Over **80 construction jobs created** during the facility's expansion over the 5 year period investigated

Future opportunity

The proposed plant's modular design allows for easy expansion. Within 5 years, over 300 people could be employed, with the facility contributing over $100 million a year to the local economy.

Once established, similar plants can be replicated around the country, with the established Victorian infrastructure used as the hub to supply Australia and take advantage of significant export opportunities.

The business case for advanced recycling

As part of the study, Envisage Works was commissioned to investigate the long-term availability of suitable plastic feedstocks for the *Cat-HTR*™ advanced recycling process, and assess the local Australian demand for recycled packaging from major FMCG companies. This brand demand research was conducted in conjunction with AFGC (Australian Food and Grocery Council).

The findings of both the availability of suitable plastic feedstock and the brand demand for recycled content were extremely positive.

Availability of suitable plastics in Victoria

The study found it *highly likely* that a *Cat-HTR*™ facility would have *little trouble* sourcing End-of-Life plastic feedstock from Victoria for the initial plant (649,000 tonnes of plastics reaching End-of-Life in 2019-20).

Additionally, previously exported plastic will no longer be exportable following the implementation of the federal Waste Export Ban on unprocessed scrap plastics.[1] Without significant further local processing, this material will likely go to landfill.

The cost of disposal continues to increase with both the metro and non-metro landfill levies in Victoria continuing to increase (please refer to page 14), further discouraging the disposal of plastics to landfill. On top of this, there is a variable gate-fee added by waste providers.[2]

Demand for recycled plastic content

There is growing commitment from companies to partake in product stewardship schemes to ensure the material used for their products is recovered in a socially responsible way.

Local and international markets for 100% recycled content polypropylene (PP) and polyethylene (PE) resins are deep, with the local market for Post Consumer Recycled (PCR) resin into packaging conservatively estimated to reach 60,000–100,000 tonnes per year by 2025.[3]

Impact on packaging pricing

Both PP and PE virgin resin currently sell for between $1,500 - $2,200 AUD per tonne.[3] Post Consumer Recycled (PCR) resin, is reported as selling at 2-2.5 times the price of virgin polymers in European and North American markets[3], reflecting the additional costs associated with making PCR resin and establishing the new infrastructure required.

A 100% price premium on virgin resin (resulting in the PCR resin being double the price of virgin), would result in an increase in the finished film cost of around 30–50%. However, it is important to note that this assumes the film has 100% recycled content.[3]

1. Australian Government – Department of Agriculture, Water and the Environment. Exports of plastic waste (2020).
2. EPA Victoria. Waste Levy (2021).
3. Based on the National Waste Report 2020 Data and Primary Research conducted by consultancy Envisage Works (2021).

The study found that currently plastic packaging film (100% virgin resin based) is around 1% of the total input material costs incurred by brand-owners. Across the six products reviewed, the film sale price to brand-owners averaged $0.018 /pack.[3]

Based on the current prices for virgin and PCR content resins, the use of 100% recycled content film would result in a cost increase to brand-owners of less than a cent a pack for items such as confectionery and biscuits, and an average of 1.5c across the 6 items.[3]

Across the six products reviewed as part of the study, it was found that:

- Adopting 30% recycled content for the plastic packaging film would increase material input costs by 0.28% for brand-owners.[3]
- Adopting 100% recycled content plastic packaging film would increase material input costs by 0.92% for brand-owners. [3]

Envisage Works looked at six grocery products with flexible packaging as part of the pricing investigation within the Brand Demand report

> The reality of the Circular Economy is that if materials are to be recycled at the end of their life, appropriate systems and infrastructure need to be put in place and this costs money. To put this in perspective, to make a tonne of plastic from used *KitKat* wrappers you need to collect and reprocess 1.4 million used wrappers.
>
> That will cost more than making a tonne of plastic from virgin materials. It will also cost more than just landfilling those 1.4 million wrappers. So a Circular Economy requires a fundamental rethink about how we price virgin materials, landfill and resource recovery.
>
> **Mike Ritchie, Managing Director, MRA Consulting Group**

The opportunity for a local plastic Circular Economy in Victoria

The Geelong-Altona Industrial Corridor in Victoria is Australia's last petrochemical hub. There are a number of significant facilities in this area of relevance to the proposed *Cat-HTR*™ advanced recycling facility, which would form important linkages in establishing a local plastics circular economy. The Geelong-Altona area is also close to Metropolitan Melbourne, with a population of around 5 million people.

- The LyondellBasell (polypropylene) plant is integrated with the Viva Energy refinery in Geelong.
- The Qenos (polyethylene) plant and cracker is located in Altona, which is a designated Petro-Chem manufacturing area zone.

The area has a skilled manufacturing workforce looking for new jobs, particularly following the recent redundancies at the ExxonMobil refinery, NuFarm and Qenos facilities nearby. The area is geographically well placed to maximise on the export opportunity for PCR plastics, gained from this new advanced manufacturing industry.

There is a need for additional infrastructure to meet our targets.

In April 2020, Infrastructure Victoria released *Advice on Recycling and resource recovery infrastructure,* that aimed to direct the Victorian Government to areas in the waste sector that require significant increases in infrastructure capacity and capability.[1] Importantly, this advice provides estimates of the current and future plastics recovery capacity shortfalls in Victoria. The estimates are made by comparing current and projected plastics generation (and target recovery rates) with Victoria's current installed plastics processing capacity.

Infrastructure Victoria's *Advice on Recycling and Resource Recovery Infrastructure* (p50) includes a very useful summary of the projected gap in plastics processing capacity if the Victorian and Australian Government targets are to be met (see below).[1]

Plastics processing shortfall is expected by 2025 (tonnes)

Priority material	2025 (COAG ban & 70% recovery rate)	2030 (80% recovery rate)	2039 (90% recovery rate)
Generation	641,100	676,700	735,300
Current processing infrastructure capacity	160,050	160,050	160,050
Projected recovery required to meet policy settings	448,700	541,300	661,800
Excess or shortfall in capacity	**-288,650**	**-381,250**	**-501,750**

Source: Infrastructure Victoria (2020).

1. Infrastructure Victoria. Advice on Recycling and resource recovery infrastructure (2020) p50.

Plastic challenge, plastic opportunity

The plastic paradox

We understand that plastic is a necessary part of modern society – it protects our food, extends its life and keeps it safe to eat. It is used to securely package medicines, and it helps enable a global economy but, it has come at a cost. Plastic is so efficient, cheap, lightweight and versatile that a significant proportion of it has become a linear resource; one we use once and dispose of.

- **Globally, 91%** plastic has not been recycled.[1]
- **40% is packaging**, typically used for < 6 months.[1]

> The demand for recycled plastic continues to accelerate around the world. Enabling advanced recycling is critical to generate circularity for flexible packaging.
>
> End-consumers' needs are constantly changing. It is upon us to be part of the solution, supporting the development of new technologies, to help deliver local sustainable packaging solutions.
>
> **Simon Roy - Vice President & General Manager, Amcor Flexibles ANZ**

amcor

National Waste Management Target

To achieve the agreed **National Waste Management Target** of 80% average resource recovery rate[2], plastics will require proportionally an **additional 2.5 million tonnes of recycling capacity** already deployed.[3]

We need a rapid, system-wide transformation

Research by Planet Ark shows that 90% of Australians think recycling is the right thing to do.[4] Unfortunately, a lack of recycling infrastructure, the limitations of mechanical recycling for some types of plastic (such as packaging), together with a lack of consistent messaging, means that this strong community support for recycling is not reflected in our national plastic recycling rates.

We need a rapid, systems-wide change to the way we manage plastic.

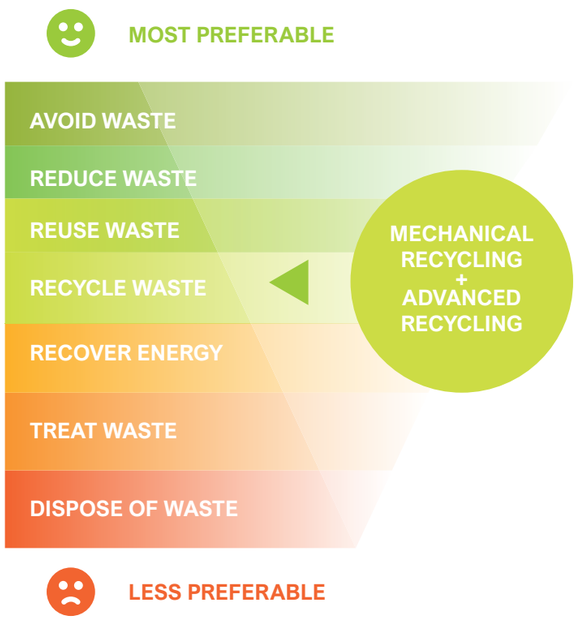
1. Geyer, R., et al. Production, use, and fate of all plastics ever made (2017).
2. Australian Government – Department of Agriculture, Water and the Environment. National Waste Policy Action Plan (2019).
3. Based on Primary Research conducted by consultancy Envisage Works (2021).
4. Planet Ark. So you think you can recycle? (2016).

Victoria needs higher recycling capacity

The importance of the waste hierarchy

The Victorian waste hierarchy expresses a preferential order to managing waste, and is embedded in state and territory policy frameworks.[1]

Advanced recycling complements mechanical recycling and supports the waste hierarchy.



Advanced recycling will help to close the loop on the vast majority of post-consumer plastics that go to landfill. It is a higher value, lower emission option compared to energy recovery (waste-to-energy).

New mechanical recycling facilities are unlikely to impact the demand for advanced recycling, given the shortfall in overall reprocessing capacity and the demand for PCR resin in packaging. By converting End-of-Life plastic back to oil, all new plastic produced through advanced recycling with the *Cat-HTR*™ advanced recycling technology can be food-grade.

Landfill levies in Victoria are set to increase, a further disincentive to sending plastic to landfill. This study has shown that a Circular Economy for plastic is possible but requires a fundamental shift in how we manage plastic. This will only be possible with investment into new infrastructure.

All future investment into recycling must consider the waste hierarchy to ensure the highest value, lowest emission option is selected to reach our resource recovery targets.

Victoria Metro area

Landfill levy (MSW)[2] 1 July 2021 ($/tonne)	**$105.90**
Landfill levy (MSW)[2] 1 July 2022 ($/tonne)	**$125.90**

1. Sustainability Victoria, Victoria State Government. Statewide waste and resource recovery infrastructure plan (2018).
2. EPA Victoria. Waste Levy (2021).

The size of the plastic problem

In Australia

3.4 million tonnes

of plastic consumed during 2019-20 with

2.5 million tonnes

reaching their End-of-Life with

326,000 tonnes: 13%

recovered.[1]

In Victoria

897,000 tonnes

of plastic consumed during 2019-20 with

649,000 tonnes

reaching their End-of-Life with

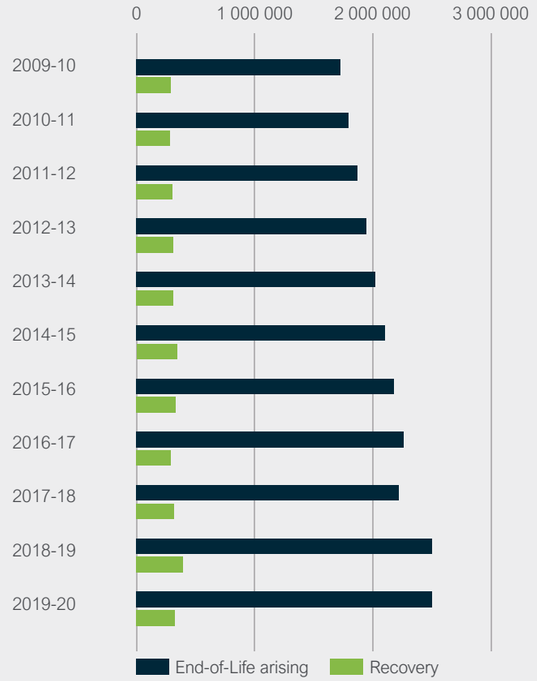
140,000 tonnes: 21%

recovered.[1]

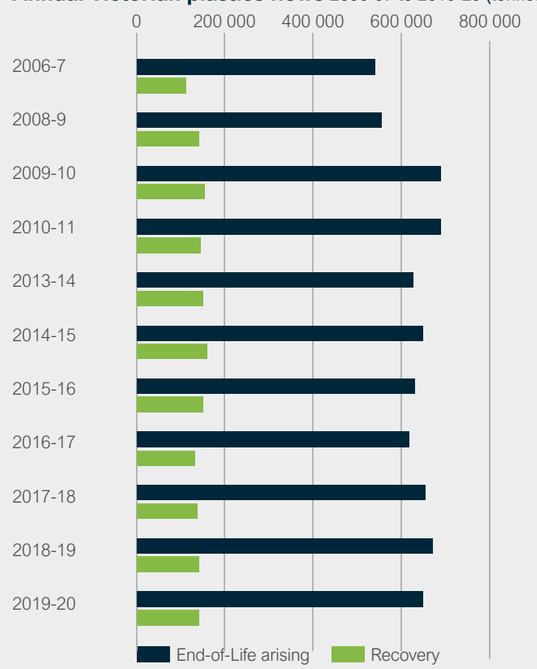
> It is hard to envisage how this target can be achieved for plastics without a system transformation, for which advanced recycling appears a strong potential contributor.
>
> **Kyle O'Farrell - Feedstock Consultant, Envisage Works**

1. Based on the National Waste Report 2020 Data and Primary Research conducted by consultancy Envisage Works (2021).

Annual Australian plastics flows



Annual Victorian plastics flows 2006-07 to 2019-20 (tonnes)

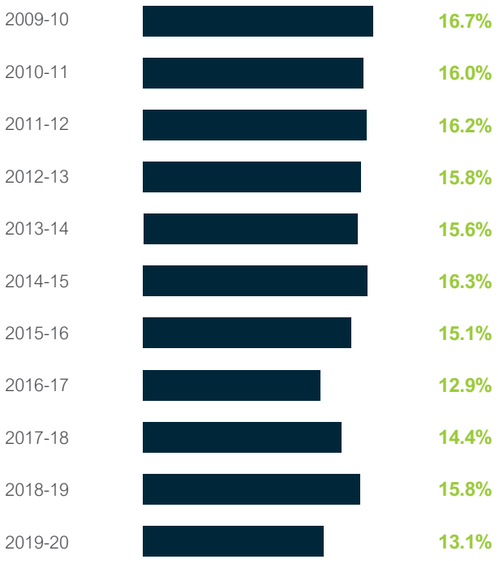


Source: National Waste Report (2020), Envisage Works (2021).

Australia's linear plastics economy

Recycling rates for plastic in Australia have continued to remain stubbornly low. The majority of End-of-Life plastics are discarded to landfill each year, with only 13% of total End-of-Life plastics directed to mechanical recycling during 2019–20[1]. This demonstrates a clear need for new reprocessing approaches to help close the loop for different streams of End-of-Life plastic products and packaging. Advanced recycling offers a profound opportunity to complement mechanical recycling in helping to increase the total capacity for plastics recycling in Australia.

Annual Australian plastics recovery rate 2009–10 to 2019–20



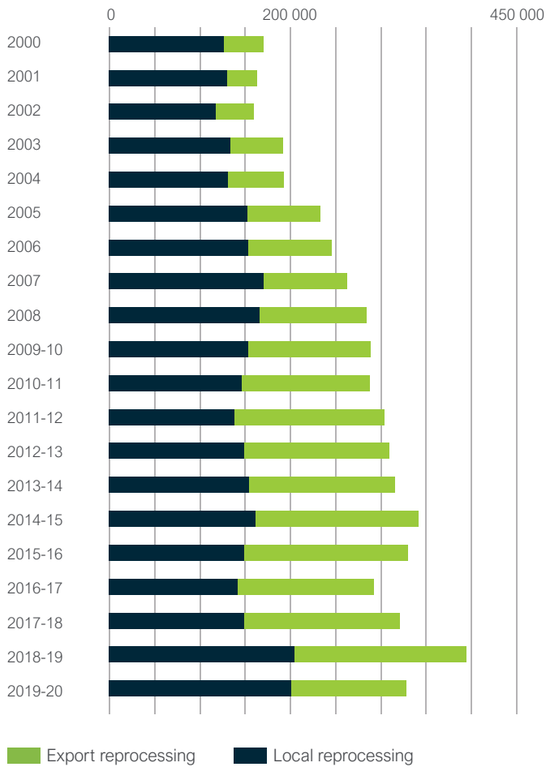
Source: National Waste Report (2020), Envisage Works (2021).

We need local solutions

The current recycling rate relies heavily on the export market

As can be seen from the chart below, of the plastics that are recovered there has been a strong reliance on exports for reprocessing. With changes in legislation, the ability to export these materials as we have been doing, will be significantly curtailed when the waste export bans come into effect.

Annual Australian plastics recycling 2000 to 2019-20, by location of reprocessing (tonnes)



Source: National Waste Report (2020), Envisage Works (2021).

Exporting mixed waste plastics for recycling is no longer an option

From July 1st 2021, mixed waste plastics that contain PET or HDPE can no longer be exported from Australia.[2] It is estimated that around 63% of the total 47,300 tonnes of scrap plastics exported from Victoria in 2019–20 are mixed and will thus be subject to the mixed polymer and export ban. Of this figure, around 16,600 tonnes is mixed polymer suitable for processing in the *Cat-HTR*™ facility.[3]

From July 1st 2022, the remaining 37% of scrap plastics are likely to become impacted by the export ban (i.e., sorted but not upgraded waste plastics).[3]

This would result in an additional ~9,500 tonnes of mixed polymer suitable for processing by the *Cat-HTR*™ facility becoming available.[3]

> The waste export ban states that from 1 July 2021 you cannot export mixed waste plastic, for example bales that include a combination of PET and HDPE. From 1 July 2022, you cannot export plastic that has been sorted only.[2]

1. Australian Government Department of Agriculture, Water and the Environment. National Waste Report (2020).
2. Australian Government – Department of Agriculture, Water and the Environment. Exports of plastic waste (2020).
3. Based on the National Waste Report 2020 Data and Primary Research conducted by consultancy Envisage Works (2021).

Why do we need advanced recycling?

Food packaging serves a very important function, keeping our food fresh and safe to eat. These benefits come with challenges, particularly when dealing with multi-layer plastic packaging with multiple polymer types.

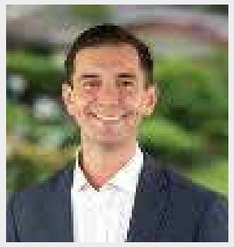
Packaging makes up 40% of all plastic applications globally[1]

We will not reach our ambitious 2025 Plastic Packaging Targets[2] without advanced recycling. Food-grade recycled plastic packaging is a key missing link in Australia's bid to improve waste management and build a Circular Economy. A lack of both collection and processing infrastructure is making it difficult to keep plastic out of landfill and virtually impossible to meet the demands for packaging with Post Consumer Recycled (PRC) content. Advanced recycling of plastics is the only way to recycle a significant portion of plastics back into new food-grade plastics.

The *Cat-HTR™* technology is an Australian innovation that is ready for commercial roll-out, enabling a Circular Economy for plastic packaging to become a reality in Australia.

1. Geyer, R., et al. Production, use, and fate of all plastics ever made (2017).
2. APCO. The Australasian Recycling Label Program (2018).

> This collaboration is an amazing and inspiring Australia taking over the world story… It is the result of innovative companies seeing an opportunity, taking the lead and creating a product that excites their customers... That spirit of innovation is easier to foster if Government is able to create the environment of policies, laws and settings that can help support entrepreneurs and innovators to succeed.
>
> **The Hon Trevor Evans MP - Assistant Minister for Waste Reduction & Environmental Management**



> For Nestlé to fulfill our vision for a waste-free future, we need to start thinking of used packaging as a resource, not as a waste. The answer is clear: we need circularity. We know it is technically possible to develop a better future for waste plastic here in Australia, but it will take collective will and collaboration to turn it into a reality.
>
> **Sandra Martinez - CEO, Nestlé Oceania**

Case Study

Case study: Australia's opportunity to close the loop on food-grade flexible plastics

The *KitKat* pilot represented Australia's first plastic food wrapper made with Post Consumer Recycled content.

The prototype *KitKat* wrapper was created by a coalition of companies including Nestlé, CurbCycle, iQ Renew, Licella, Viva Energy Australia, LyondellBasell, REDcycle, Taghleef Industries and Amcor. Each organisation brought their individual expertise together to collect and process waste soft plastic, turn it back into oil, and create the prototype wrapper.

The feedstock for the wrappers came from the Curby soft plastic collection trial on the NSW Central Coast, together with soft plastic collected via the REDcycle supermarket soft plastic collection.

To date, soft plastics collected in Australia have been made into products like outdoor furniture, added to road base or used in waste-to-energy.

To create the *KitKat* wrapper with 30% recycled content (demonstrating the ISCC PLUS and mass balanced methodology), the soft plastics were processed, then sent to Licella for conversion back into oil using the *Cat-HTR™* advanced recycling technology. This oil was then used within the existing plastic supply chain to produce new food-grade soft plastics.

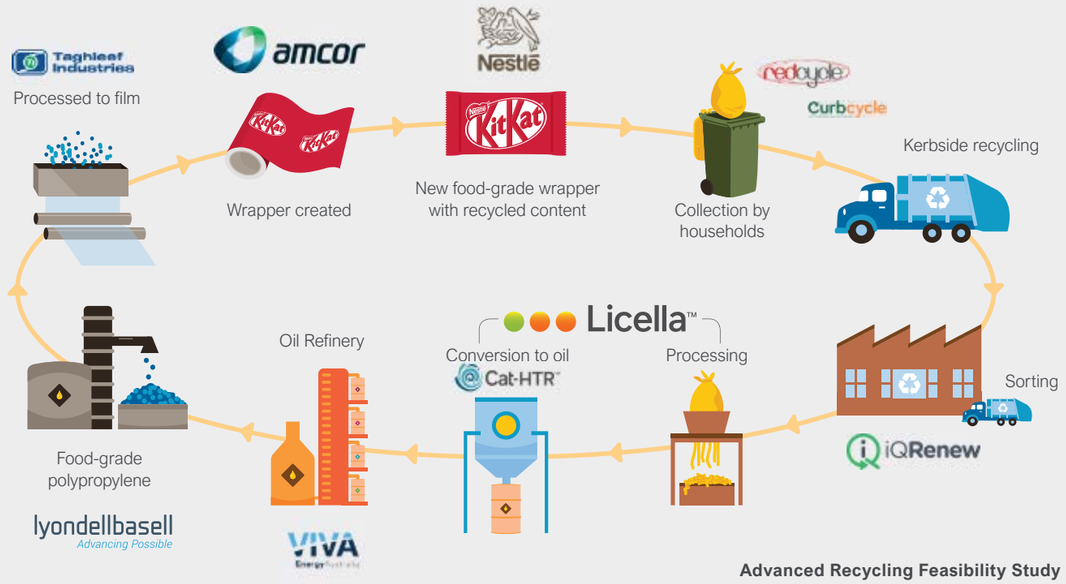
Sandra Martinez, CEO of Nestlé Oceania, said the project had been driven by a shared determination to resolve the soft plastics challenge – and an enormous amount of good will.

Prototype *KitKat* wrapper made with 30% recycled plastic content from advanced recycling

"Manufacturers like Nestlé will have a key role in driving demand for food grade recycled soft plastic packaging, and creating market conditions that will ensure all stakeholders throughout the value chain view soft plastics as a resource and not waste."

Sandra Martinez - CEO, Nestlé Oceania

The prototype *KitKat* wrapper was created by a coalition of companies with a shared vision



Product stewardship

What is product stewardship?

A concept of shared responsibility by all sectors involved in the manufacture, distribution, use and disposal of products, that seeks to ensure appropriate environmentally sensitive recovery of products or packaging at its End-of-Life.

> We need to move away from a linear economy and to a circular economy… We are going to need some support from government to help get this technology to scale.
>
> **Tanya Barden - CEO, Australian Food and Grocery Council**

Why it's important

There is an increasing shift from industry to recycle plastics, with major companies that use plastic in their products wanting the material to be recycled in a socially responsible way, such as reprocessing at a recycling facility.

It is impossible to implement plastic stewardship schemes without appropriate technology to process the waste material recovered.

Collection schemes for soft plastics

- The best-known product stewardship scheme for End-of-Life plastics in Australia is the *REDcycle* soft plastics collection bins in supermarkets (see Case Study on page 23). The scheme has collected over 2.95 billion pieces of plastic since it launched in 2011.
- Similar schemes exist for a variety of agricultural plastics.
- The AFGC is developing a National Plastics Recycling Scheme (NPRS), which aims to collect and recycle nearly 190,000 tonnes of plastic packaging per annum by 2025.[1]
- A pilot program *Curby* (see case study on page 23) is leveraging existing household recycling services, with residents using a bag to collect their waste soft plastics and place them in their usual recycling bin. This plastic has already been used in advanced recycling trials.

New potential supply of soft plastics from these schemes

The four high relevance schemes highlighted by Envisage Works (in the table on page 21) will generate around 600,000 tonnes of 'new' recovered plastics, which will primarily go to landfill, if they achieve their stated targets.[2]

Advanced recycling is a scalable solution for these difficult to recycle plastics

With new product stewardship schemes under development, and the opportunity to expand ones already in place, we must consider the recycling capacity in place.

The proposed *Cat-HTR*™ advanced recycling facility can process the vast majority of the plastics collected by the schemes listed in the table on the next page, including plastics that are difficult to recycle mechanically, such as soft plastic packaging.

Expanding these schemes in parallel to building the advanced recycling infrastructure necessary to recycle them is essential to ensure the additional plastics collected are not sent to landfill or energy recovery, in line with the preferences set out in the established waste hierarchy.

> Our industry is committed to working with stakeholders across the value chain to deliver solutions that reduce plastic waste and create an Australian Plastics Circular Economy. We are uniquely placed to offer our expertise in polymer technology, engineering and manufacturing at industrial scale to support the adoption of new, advanced recycling technologies that will enable Australians to maximise the potential of our valuable plastic resources.
>
> **Samantha Read - CEO, Chemistry Australia**

Australian product stewardship schemes offer a huge opportunity to recover plastics suitable for advanced recycling

Product Stewardship Scheme	Operator	Type of scheme	Target materials	Relevant targets	Potential new supply	Relevance rating
1. Australian Packaging Covenant	APCO	Co-regulatory	**Rigid and flexible (soft) plastic** packaging (and all other packaging).	70% of Australia's plastic packaging will be recycled or composted by 2025 (cf.18% in 2018–19)	520,000 tonnes	High
2. National Plastics Recycling Scheme	TBC	Under development	**Flexible (soft) plastic** packaging.	70% of Australia's plastic packaging will be recycled by 2025	300,000 tonnes (overlaps scheme 1)	High
3. REDcycle	RED Group	Collection program	**Flexible (soft) plastic** packaging.	None	10,000 tonnes (overlaps scheme 1 + 2)	High
4. Non-packaging agricultural plastics	RM Consulting Group	Under development	**Mixed plastics** - grain bunker bags, silage/net wrap, plastic dripper pipe, films, nets.	Under development	84,000 tonnes	High

Source: Envisage Works (2021).

It appears possible that all four of these schemes could be generating large quantities of recovered plastics across the next 2–5 year period.[2]

1. Australian Food & Grocery Council. Food and grocery manufacturers step up with national plan to tackle plastic (2020).
2. Based on Primary Research conducted by consultancy Envisage Works (2021).

Feedstock for advanced recycling

National Plastics Recycling Scheme (NPRS)

Australia's food and grocery manufacturers, represented by peak body the Australian Food and Grocery Council (AFGC), will develop Australia's largest industry-led plastic recycling scheme, which aims to collect and recycle nearly 190,000 tonnes of plastic packaging per annum by 2025.[1]

The scheme will initially focus on increasing the diversion of soft plastics such as bread, cereal and frozen vegetable bags, confectionery wrappers and toilet paper wrap from landfill and it will move on to support the increased recycling of other plastics that are currently difficult to collect and/or recycle. As an industry-led and funded scheme, the NPRS will coordinate and focus the efforts of well-known food and grocery brands to significantly increase the recycling and reuse of plastic packaging.

This will build on existing soft plastics recycling initiatives including the industry funded *REDcycle* program and the *Curby* soft plastic kerbside collection trial supported by Central Coast Council, Nestlé and iQ Renew.

Container Deposit Schemes

A Container Deposit Scheme (CDS) refers to the collection of drink containers in exchange for a refund. They involve the addition of a small, refundable deposit being added to the price of a beverage at the point of sale. This increase in cost is partially paid by the consumer and by the beverage company.

It is an existing example of product stewardship legislation in which the beverage industry is obliged to take greater responsibility for its packaging after it has been sold.

Currently, SA, Northern Territory, NSW, Queensland, the ACT and WA have Container Deposit Schemes. Tasmania and Victoria have announced their scheme models which are expected to launch in late 2022 and 2023 respectively.[2]

Return and Earn began in NSW on 1 December 2017. At the time, drink containers made up 44% of all litter in the state and cost more than $162 million to manage. In 2020 there was a 52% reduction in the volume of eligible container litter in NSW.[3]

These schemes give Material Recovery Facilities (MRFs) a relatively clean stream of plastics to recover. In NSW, it has allowed for an additional 300,000 tonnes of plastic material to be recycled.[3]

1. Australian Food & Grocery Council. Food and grocery manufacturers step up with national plan to tackle plastic (2020).
2. Australian Beverages Council. Container Deposit Schemes (2021).
3. NSW EPA. Return and Earn (2021).
4. REDcycle. About REDcycle (2021).
5. Curbcycle. Cleaning up Australia in a fun and rewarding way (2021).

Return and Earn

The Return and Earn Scheme came in that added 20c to a drinks bottle to pay for the recycling infrastructure. This shows its possible to add costs to enable circularity.

Case Study

REDcycle – Soft plastic collection via supermarkets

The *REDcycle* Program was developed and is run by Melbourne based RED Group. It is a recovery initiative for post-consumer soft plastic. The *REDcycle* Program has partnered with participating supermarkets all throughout Australia.

According to the *REDcycle* website, *"It forms a product stewardship model where manufacturers, retailers and consumers are sharing responsibility in creating a sustainable future."*[4]

The scheme has already collected over 2.95 billion pieces of plastic since it launched in 2011.[4] This study found that the scheme could deliver a potential 10,000 tonnes of additional plastic supply to advanced recycling (see table on page 21).

> We are delighted to have supported the study which has demonstrated the potential to close the loop on soft plastics, enabling them to be converted into food-grade soft plastics that could then be used in food packaging. Our ambition is to be Australia's most sustainable supermarket and we are committed to ensuring we are contributing to the circular economy and supporting a more sustainable future for plastic packaging.
>
> **Thinus Keevé - Chief Sustainability, Property & Export Officer, Coles**

Case Study

Curby – Soft plastic kerbside collection program

Nestlé and Australian recycler iQ Renew announced a collaboration to trial the *Curby* program at the National Plastic Summit in March 2020. The trial has so far collected 6,673kg of soft plastic from 2,280 households on the NSW Central Coast.[5] Following the success of the trial, the *Curby* program has been extended to all residents within Central Coast Council, the second largest LGA in Australia.

Participating households collected their clean soft plastics in a purpose-made bright yellow '*Curby*' bag, then when the bag is full, tie it up, tag it and place it in their yellow recycling bin for pick up with their regular recycling collection.

Tags identify the bags and help to improve the sorting process, ensuring they can be separated from other recyclables. The soft plastics were used by Licella at its *Cat-HTR™* advanced recycling pilot plant, including as feedstock for the recycled *KitKat* wrapper prototype.

> Currently there's no commercial solution in Australia that can efficiently deal with soft plastics. Unfortunately, most of them end up in landfill. Programs like *Curby* help us to collaborate with the community and give us the ability to harvest these soft plastics as a resource for advanced recycling, turning them back into new plastic.
>
> **Danial Gallagher - CEO, iQ Renew**

How will brands reach their sustainable packaging commitments without advanced recycling?

This report shows there just aren't enough recycled polymers to meet the current brand demand, let alone the future brand demand based on these commitments.

Some forms of plastic are essential and therefore can't be designed out of packaging.

Flexible (soft) plastic is still a major challenge for mechanical recycling, particularly when the packaging is multi-layered and needs to be sorted by type.

As part of this Feasibility Study, Envisage Works conducted a study that investigated the demand for recycled polymers from major producers and brands in Australia and globally. This demand is a direct result of the world's biggest FMCG brand's commitments to meet the targets set by governments and regulatory bodies (such as APCO in Australia), as well as, acting upon increased consumer demand for recycled packaging.

Demand for recycled polymers is well above supply, and the gap is forecast to grow

By 2025, the unmet global demand for recycled polymers will be over 2 million tonnes and this will climb to 10 million tonnes by 2030.[1] The supply of recycled oil from End-of-Life plastics is currently extremely constrained, with polymer suppliers struggling to meet demand across the world.[2]

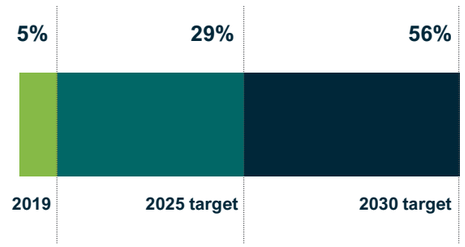
Even with relatively easy to collect and process plastic products, such as PET and HDPE bottles, the capacity for mechanical recycling to supply Australian demand for recycled polymers is already being approached. This is despite there being well under 20% Post Consumer Recycled content in these packaging formats.[3]

Commitments from brands and polymer resin manufacturers exceed recycled oil supply

At present, 15 of the largest global brands have committed to targets of 50% to 100% recycled content plastic resin in their products by 2030.[1] More companies are stepping up and starting to accept responsibility for the sustainability of their products and its End-of-Life, but they are limited by the small volumes of recycled content polymer available.

Recycled Content Targets for 15 Global Packaging Brands

average %, by weight, of Post Consumer Recycled content in plastic packaging



Global

15 of the top global FMCG brands[1]

Brands Commitments

2.15 million tonnes

15 of the largest global brands have committed to meet this target for recycled plastic content by 2025.[1]

4 million tonnes

This figure grows to 4 million tonnes to meet the targets set for 2030.[1]

0.35 million tonnes

Only a fraction of this target is being met by brands currently (2019).[1]

Polymer Manufacturer Commitments

2.4 million tonnes

8 of the world's leading polymer resin manufacturing companies have targets to reach a total of 2.4 million tonnes recycled and renewable-based polymers by 2025.[1]

9.5 million tonnes

This figure grows to 9.5 million tonnes by 2030.[1]

> LyondellBasell's ambition is to produce and market two million metric tons of recycled and renewable-based polymers annually, by 2030. Our participation in this important study for Australia is a demonstration of our global efforts to enable our customers and value chain partners to find solutions to transform their businesses. For advanced recycling to be viable in Australia and contribute to the circular economy of plastics, local refining and polymer production infrastructure needs to be retained."
>
> **Mitchell Killeen - Managing Director, LyondellBasell**

lyondellbasell
Advancing Possible

Brand demand for recycled content

1. See Appendix.
2. APCO. 2025 Recycled Content Targets (2020).
3. Ellen MacArthur Foundation. Completing the picture - How the circular economy tackles climate change (2019).

The gap between demand and supply

There is high demand from brands both locally and internationally for Post Consumer Recycled (PCR) plastic content, to help meet their sustainable packaging commitments.

Advanced recycling gives brands an opportunity to source this food-grade PCR plastic locally, creating local jobs, and increasing plastic recycling rates in the process. In addition, the scalable nature of the proposed *Cat-HTR™* facility means that there is an exciting export opportunity. Globally, brands are aiming to use a total of 2.15 million tonnes of recycled content plastic in their products by 2025 and a total of 4 million tonnes by 2030 (see appendix page 37).

The 2025 National Packaging Targets are supported by Australian industry and government to deliver a new and sustainable approach to packaging. They apply to all packaging that is made, used and sold in Australia. APCO is the organisation charged by government to facilitate the delivery of the 2025 Targets.[1]

APCO 2025 Recycled Content in Packaging Targets[2]

PACKAGING MATERIAL TYPE	CURRENT RECYCLED CONTENT RATE	2025 TARGETS
ALL PLASTICS	**2%**	**20%**
PET	12%	30%
HDPE	2%	20%
PP	3%	20%
FLEXIBLE PLASTICS	UNKNOWN	10%

Source: APCO (2021)

> This project is an important step towards addressing the challenge of building a circular economy for soft plastics and Australia's achievement of the 2025 National Packaging Target for recycled content. Industry is driving this collaborative approach by tackling this challenge head on and bringing advanced technologies into action to support Australia's market demand for getting recycled materials back into our packaging.
>
> **Brooke Donnelly - CEO, APCO**

To meet APCO's 2025 National Packaging Targets, a commitment to use an average of 50% recycled content in packaging by 2025 has been put in place.[1] As a result, the demand for food-grade recycled content is expected to grow significantly. However, without local supply, packaging manufacturers may be forced to source packaging or recycled polymer from overseas.

Current local supply vs demand

Post Consumer Recycled (PCR) plastic in packaging vs the 2025 National Packaging Target:[2]

2% Current

20% 2025 target

The gap in *local* supply

Additional PCR plastic required:

137,000 tonnes by 2025.[3]

Note: HDPE, LDPE and PP only. Accounts for APCO targets and projected demand growth.

Opportunity to supply *global* market

Total PCR plastic required globally needed:

4 million tonnes by 2030.[4]

The ANZPAC Plastic Pact is a collaborative solution that brings together key players behind a shared vision of a circular economy for plastic. Members of ANZPAC work together towards ambitious 2025 targets across the region, which include using an average of 25% recycled content in plastic packaging and increasing plastic packaging collected and effectively recycled by at least 25%. It is a voluntary scheme that demonstrates an industry-wide commitment to more sustainable plastic.

ANZPAC PLASTICS PACT

More information:
www.anzpacplasticspact.org.au/

1. APCO. Australia's 2025 National Packaging Targets (2021).
2. APCO. 2025 Recycled Content Targets (2020).
3. Based on Primary Research conducted by consultancy Envisage Works (2021).
4. See Appendix.

What kinds of plastic will the *Cat-HTR™* facility recycle?

The *Cat-HTR™* advanced recycling facility will be able to process a range of mixed End-of-Life Plastics that are difficult to recover mechanically. The vast majority of these plastics currently go to landfill.

Please refer to the Appendix (page 39) for a more detailed explanation of the polymer types suitable for this advanced recycling facility.

Plastics the facility will be able to process include:

Plastics that currently go in household waste (landfill) bins (e.g. soft plastics).

Plastics that go in household recycling bins that can't be mechanically recycled.

Plastics collected from product stewardship schemes.

Agricultural plastics from consumer & industrial applications.

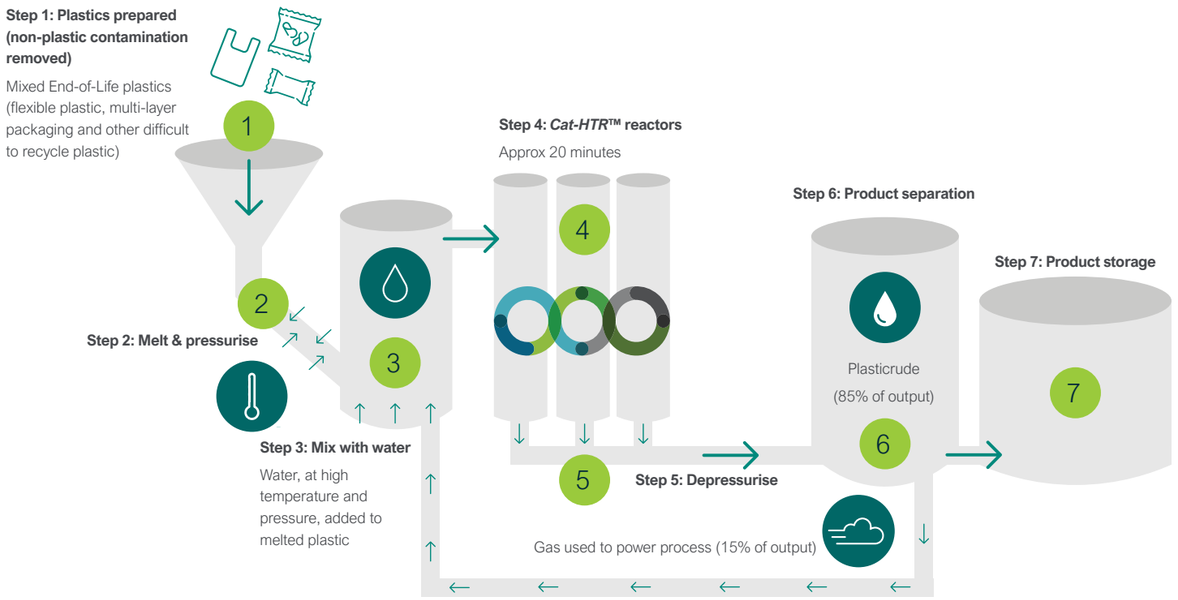
Plastics from consumer & industrial applications.

Plastics that contaminate paper recycling plants.

Other difficult to recycle plastics, such as oil containers and paint pails.

The technology

How hydrothermal liquefaction works



The Evolution of Advanced Recycling – HTL is The Next Generation

Gains maturity in early 19th century

PYROLYSIS

Converts feedstock to oil by heating it in the absence of oxygen.

WWII Onwards

GASIFICATION

Converts feedstock into gases at high temperatures (typically >700°C).

Licella begins continuous modern process early 2000s

HYDROTHERMAL LIQUEFACTION

Converts feedstock to synthetic oil using water under high temperature and pressure.

Commercial-scale *Cat-HTR*™ reactors at Licella's commercial demonstration plant in Somersby, on the NSW Central Coast

Australian developed advanced recycling technology

Licella is recognised as the global leader in hydrothermal liquefaction (HTL), the next-generation of advanced recycling. This *Cat-HTR*™ HTL technology is at the core of the advanced recycling plant proposed in this study.

By using water to control the thermo-chemical reactions, Licella reports that the *Cat-HTR*™ process operates at lower temperatures, using less energy, and retains more carbon in its products, compared to pyrolysis and gasification.

HTL is the most recent form of advanced recycling, using water at high temperature and pressure to take plastic back to its chemical building blocks.

Analysis completed on behalf of Licella, by an independent industry consultant, has shown that using the *Cat-HTR*™ platform to recycle plastic to oil creates double the value with half the emissions compared to incinerating the same plastic for energy (waste-to-energy).

The *Cat-HTR*™ technology has been extensively tested by Licella at their commercial demonstration plant in NSW on a wide range of End-of-Life plastics. The platform can chemically recycle mixed plastics, without needing to sort them by polymer type, a major advantage compared to pyrolysis. It also successfully recycles multi-layer plastic packaging.

High temperature and pressure water is used in the *Cat-HTR*™ HTL process (supercritical water is a state of water that occurs above 'critical' conditions of 374°C and 218 bar).

Water rapidly diffuses through the plastic and breaks the polymer bonds, which then re-arrange to form the 'Plasticrude' oil.

Using water helps control the process, meaning it uses less energy than other approaches and converts more plastic to oil.

Advanced recycling complements mechanical recycling

While some big-name brands have made the switch to using 100% recycled PET for their beverage bottles, the cap and label are usually still made from virgin materials. This is due to the need for the cap, in particular, to be made from food-grade content (which is difficult to achieve through mechanical recycling).

All new plastic created from advanced recycling is food-grade, so the whole bottle could be made with Post Consumer Recycled plastic.

The proposed *Cat-HTR™* plant can recycle most plastics that are difficult to recycle mechanically, without the need to sort them by polymer type. The process can comfortably recycle a mix of flexible plastics (including packaging and labels) and other mixed plastics that are today problematic for mechanical recycling.

The only plastics that need to be removed are chlorinated plastics such as PVC, which is on APCO's list of problematic plastics to be phased out in packaging.[2]

> Advanced recycling innovation could help Australia meet its national target of 70 per cent of plastic packaging recycled or composted by 2025, and 80 per cent average recovery rate from all waste streams by 2030.
>
> **Sarah King, Senior Research Consultant - CSIRO Manufacturing**

1. Based on the National Waste Report 2020 Data and Primary Research conducted by Consultancy Envisage Works (2021).
2. APCO. APCO Action Plan for Problematic and Unnecessary Single-Use Plastic Packaging (2020).

Product provenance provides confidence and assurance

In order to give both consumers and brands confidence that the plastics they are buying have come from Post Consumer Recycled (PCR) plastics, it is important that the provenance of the products can be demonstrated.

Fortunately, this requirement is not a new challenge. It has been necessary to provide similar assurances for consumers of renewable electricity or fair trade products, and accreditation organisations such as ISCC[1] and RSB have offerings and services to achieve this.

The various parties in the supply chain will need to understand their obligations and requirements, put appropriate procedures in place and be independently audited to ensure compliance. Once this is completed, appropriate on-pack certification can be made.

Our proposal is that a product provenance scheme for recycled plastic content in packaging would be established. In the area of PCR plastics, ISCC has an offering called ISCC Plus.[1]

1. ISCC. ISCC for the Circular Economy and Bioeconomy (2021).

Figure 1: The proposed Altona location for the *Cat-HTR*™ facility, showing proximity to closest residential area

The proposed site

The proposed site for this *Cat-HTR*™ facility is located at the under-utilised Dow Chemicals (Dow) manufacturing site in Altona (Victoria), which Dow previously used to manufacture over 100,000 tonnes of petrochemicals annually.

The area is in a designated Special Use Zone (SUZ) for petrochemical manufacture (SUZ3) with significant buffer zones of over 1.3km to the nearest residential areas (see Figure 1 above).

Dow have decided to retain ownership of the site and are looking for appropriate tenants. One of the tenants Dow has engaged on the site are EnviroPacific, a soil remediation company.

Commitment to community consultation

Licella is deeply committed to community consultation regarding the new *Cat-HTR*™ facility. Licella is in consultation with Hobsons Bay Council, as well as local community groups, about the proposed facility and the opportunities it can deliver to the community, with many new jobs and associated economic activity created as a result.

In addition, Licella has a strong workplace safety culture and will ensure similar best practices are used within this facility.

Image above: Entry to the existing site owned by Dow Chemicals, a designated SUZ3 area

Figure 3: The proposed site for the *Cat-HTR*™ facility, marked in yellow. The proposed solar facility is shown in green.

Commitment to sustainability

The electrical power for the site will be generated from 100% renewable electricity with a 2.4MWh solar array to deliver ~20% of the sites electrical demand, with the balance coming from other renewable sources.

Calorific gas produced in the *Cat-HTR*™ manufacturing process will be used for energy in a boiler to generate the supercritical water for the process. See the process diagram on page 28 for further details.

Opportunity to expand, creating further economic boost for the area

As seen from the above site map, there is room for expansion to process higher volumes of End-of-Life plastics, creating additional jobs and economic benefits to the area.

Environmental benefits

Alongside increasing recycling rates for plastics, advanced recycling also delivers significant environmental benefits.

Every barrel of oil we are able to manufacture in Australia is a barrel of oil that doesn't need to be extracted from somewhere in the world and transported here for our use. This results in reduced greenhouse gas (GHG) emissions.

For every tonne of residual plastic waste processed, the *Cat-HTR*™ technology provides a saving of 1.8 tonnes of CO_2-e emissions in comparison to waste-to-energy (WtE), presenting a better environmental outcome and demonstrating why advanced recycling should be given preference to residual plastic over WtE facilities.[1]

The *Cat-HTR*™ facility will produce a synthetic oil that can displace conventionally extracted crude oil, which would otherwise be imported to Australia. The GHG emissions associated with producing synthetic oil through the *Cat-HTR*™ platform would reduce GHG emissions by 64%.[1]

Cat-HTR™ oil delivers 64% CO_2 reduction vs conventional crude[1]

GHG emissions generated during the production of 1 tonne of *Cat-HTR™* oil vs fossil crude oil (kg CO_2-e)

Cat-HTR™ product (Plasticrude)	**203**
Conventional crude oil	**566**
Reduction	**363**
% Variation	**-64%**

Source: Lifecycles Life Cycle Assessment (LCA) 2021.

For example, once scaled to 120,000 tonne per annum advanced recycling facility will produce 102,000 tonnes recycled *Cat-HTR*™ oil. This results in a GHG saving of approximately 6,000 tonnes CO_2-e per annum, compared to the production of fossil-based crude oil.

These GHG savings are equivalent to:

11,000

less cars on the road, **or**;

84,000

barrels of oil consumed, **or**;

9,000

electricity for homes.

Source: Greenhouse Gas Equivalencies Calculator

Additional benefits are also delivered through reduced particulate emissions (air pollution) and reduced water usage

	Particulate Matter *G $PM_{2.5}$ EQ*	Consumptive Water Use *L*
Cat-HTR™	**-90.0**	**0.13**
Landfill	**2.74**	**0.29**
Waste-to-energy	**2.48**	**2.36**

Source: Lifecycles Life Cycle Assessment (LCA) 2021.

1. Based on Primary Research conducted by consultancy Lifecycles (2021).
2. Natural Resources Canada. Greenhouse Gas Equivalencies Calculator (2021).

Next steps – turning opportunity into reality

Licella, supported by Amcor, Coles, iQ Renew, LyondellBasell, and Nestlé, conducted this feasibility study, with the aim of demonstrating a pathway to a local circular economy for plastic by fast-tracking innovative Australian advanced recycling technology.

This report outlined the conclusive and compelling findings of the feasibility study, being:

In 2019-20, there were 649,000 tonnes of End-of-Life plastics in Victoria.

Despite years of investment, plastic recycling rates remain low, with:

- 140,000 tonnes of plastic recovered in Victoria (47,000 tonnes of this done overseas).
- Exporting mixed plastic waste no longer being an option.

The *Cat-HTR*™ advanced recycling technology can process a wide range of End-of-Life plastics, including soft plastic packaging, creating plastic-derived oil - from which new food-grade Post Consumer Recycled (PCR) plastic content can be made.

The plastic-derived oil (or Plasticrude) from the *Cat-HTR*™ advanced recycling process delivers a 64% CO_2 reduction vs importing conventional crude.

There is huge demand internationally for PCR plastic, as well as locally, with very little supply.

- 137,000 tonnes: estimated gap in Australian supply, required by 2025.
- 4 million tonnes: projected global demand by 2030.

The plastic recycling targets (Federal, State, ANZPAC or APCO) will NOT be met without a systems-wide change that includes advanced recycling.

Victoria is ideally placed to become Australia's advanced recycling hub with:

- Two operational polymer manufacturers committed to make PCR resins (LyondellBasell & Qenos);
- An operational refinery, seeking to explore alternative feedstocks (Viva Energy);
- Packaging companies with high market demand for PCR plastic packaging (Amcor, Taghleef Industries, Sealed Air);
- High brand demand for PCR plastic packaging, willing to pay a premium to meet their recycled content targets (Nestlé, Danone, George Weston Foods, Mars, Mondelez, Unilever);
- A suitable *Cat-HTR*™ facility site available close to Melbourne.

With a shared vision for a more sustainable future for plastic, this report represents our proposal to build a local advanced recycling industry that will help Victoria, and Australia, meet its sustainability commitments, significantly increase plastics recycling, and therefore significantly decreasing the amount of plastic being sent to landfill.

All this represents an amazing opportunity for Victoria to leverage its existing assets and capabilities and be at the forefront of a rapidly expanding new industry. It will create over 300 new jobs over the next 5 years, help protect existing businesses and create significant export opportunities for Australia.

The system-wide transformation required for Australia to meet its plastic recycling targets needs governments to come on the journey with us – both to set appropriate policies, and to invest where it is needed.

The first step is building a first-of-its-kind advanced recycling plant in Australia. These so-called 'Pioneer Plants' are more expensive than subsequent facilities and are therefore the ones the Capital Markets are prone to avoid. Getting this first Australian-developed advanced recycling plant built will require Government support. These sources include the Recycling Modernisation Fund and the Modern Manufacturing Initiative. Industry has already demonstrated that we can collaborate and work alongside State and Federal governments to make this happen.

Appendix

Top Global FMCG Brand Performance vs Commitments

Brands are aiming to use a total of **2.15 million tonnes of recycled content plastic in their products by 2025 and a total of 4 million tonnes by 2030**. With only **350,000 tonnes of recycled content** plastic used by brands in 2019, there is a deficit of at least 1.8 million tonnes for 2025 commitments and a shortfall of 3.7 million tonnes for 2030.

Brand Demand and Shortage in Supply of Recycled Polymers

Company	Total Plastic Packaging (tpa)	Recycled Content Plastic[1]						Additional Recycled Content Plastic required to meet 2025 demand (t)	Additional Recycled Content Plastic required to meet 2030 demand (t)
		2019 Progress (%)	2019 Amount (t)	2025 Target (%)	2025 Amount (t)	2030 Target (%)	2030 Amount		
Coca-Cola and Resort	2,981,421	9.7%	289,198	25%	745,355	50%	1,490,711	456,157	1,201,513
Colgate-Palmolive	275,440	7.0%	19,281	25%	68,860	50%[8]	137,720	49,579	118,439
Danone S.A.	800,000	10.6%	84,800	50%	400,000	100%	800,000	315,200	715,200
Diageo	31,900	2.5%	798	40%	12,760	100%	31,900	11,963	31,103
Essity	62,300	0.0%	0	25%	15,575	50%[8]	31,150	15,575	31,150
Henkel	361,000	8.5%	30,685	30%	108,300	50%[8]	180,500	77,615	149,815
Kellogg	62,927	0.5%	315	10%	6,293	30%[8]	18,878	5,978	18,563
L'Oreal	137,280	6.9%	9,472	50%	68,640	100%	137,280	59,168	127,808
Mars, Incorporated	191,217	0.0%	-	30%	57,365	50%[8]	95,609	57,365	95,609
Mondelez	187,000	0.3%	561	5%	9,350	25%[8]	46,750	8,789	46,189
Nestlé	1,524,000	2.0%	30,480	30%	457,200	50%[8]	762,000	426,720	731,520
PepsiCo	2,300,000	4.0%	92,000	25%	575,000	50%	1,150,000	483,000	1,058,000
Proctor and Gamble	600,000	5.7%	34,000	30%	180,000	50%[8]	300,000	146,000	266,000
SC Johnson	100,700	14.0%	14,098	15%	15,105	30%[8]	30,210	1,007	16,112
Unilever	700,000	5.0%	35,000	25%	175,000	50%	350,000	140,000	315,000
Total Plastic (t)	**7,333,764**		**351,489**		**2,149,448**		**4,071,997**	**1,797,959**	**3,720,507**

Source: Ellen MacArthur Foundation (2020).

1. Ellen MacArthur Foundation. The Global Commitment 2020 Progress Report (2020).
2. Reuters. Set, miss, repeat – big brands and plastic recycling targets (2020).
3. Plastics in Packaging. Danone sign up to Canada Plastics Pact (2021).
4. Diageo. Reinventing packaging (2020).
5. L'Oreal. We respect the beauty of our planet by reducing plastic packaging (2021).
6. PepsiCo. 2020 Sustainability Report – Goals and Progress (2020).
7. Talking Trash. A flurry of voluntary initiatives - Proctor & Gamble (2020).
8. Estimated 2030 targets based on projection of 2025 targets.

Top Global Polymer Producer Commitments

To accommodate for the rising brand demand for recycled content, eight of the world's leading polymer resin manufacturing companies have set commitments to reach **2.4 million tonnes** of recycled plastic and renewable-based polymers by **2025** and **9.5 million tonnes** by **2030**. However, their production volumes are limited by the amount of recycled oil available. With only small global capacity for producing recycled oil from recovered End-of-Life plastics, there is large opportunity for the *Cat-HTR™* technology, once established, to accelerate the conversion of waste plastics to recycled oil to help meet the significant demand for recycled polymer, both locally and for this large export market.

Announced Volume Commitments from Major Polymer Manufacturers

Manufacturer	2025 Target (t)	2030 Target (t)
Braskem	300,000	1,500,000
DOW		1,000,000
EASTMAN	250,000	500,000
ExxonMobil Chemical	300,000	3,000,000
INEOS	325,000	325,000[9]
LyondellBasell		2,000,000
SABIC	200,000	200,000[9]
Shell	1,000,000	1,000,000[9]
Total Recycled and Renewable Content	**2,375,000**	**9,525,000**

1. Braskem. Sustainable development macro goals – Goal 2020 (2020).
2. DOW. Dow sets targets to reduce GHG emissions, stop plastic waste, and drive toward a circular economy (2020).
3. Eastman. Policymakers can renew the recycling system through three actions (2021).
4. Packaging Gateway. Agilyx, ExxonMobil partner for recycling post-use plastics (2020).
5. Ineos. Circular Economy (2021).
6. LyondellBasell. LyondellBasell Sustainability Report Sets Ambitious Plastic Waste Targets (2020).
7. Sabic. Toward a circular future – Executive summary (2019).
8. Shell. Shell accelerates drive for net-zero emissions with a customer-first strategy (2021).
9. Estimated target based on 2025 goals.

There is local demand for recycled plastics

Local demand for Post Consumer Recycled (PCR) HDPE, LDPE and PP totaled 30,000 tonnes in 2019-20, which only makes up 4% of the total plastic packaging placed on the market.[1] To meet APCO's National Packaging Target for an average 20% recycled content across plastic packaging by 2025, there needs to be a significant increase in capacity to produce PCR resin.[2]

Based on the projected growth and APCO's target, this demand is estimated to rise to 167,000 tonnes of PCR resin by 2024-25.[1] The means 137,000 tonnes of PCR resin must be made available on the market, additional to the current demand.[1]

1. Based on the Primary Research conducted by consultancy Envisage Works (2021).
2. APCO. 2025 Recycled Content Targets (2020).

Advanced recycling will compliment mechanical recycling

Which plastics is advanced recycling suitable for?

1	2	3	4	5	6	7
PET	**HDPE**	**PVC**	**LDPE**	**PP**	**PS**	**OTHER**
Polyethylene terephthalate	High-density polyethylene	Polyvinyl chloride	Low-density polyethylene	Polypropylene	Polystyrene	Other
Mechanical + Advanced (Target rejects) ✓	**Mechanical + Advanced** (Target rejects) ✓	**Specialist Recycling** ✗	**Mechanical (limited) + Advanced** ✓	**Mechanical + Advanced** ✓	**Advanced** ✓	**Advanced** ✓
Common Products Water bottles, Soft drink bottles, Food bottles, Food jars	**Common Products** Milk cartons (mechanical), Detergent bottles, Shampoo bottles, Flower pots, Toys	**Common Products** Pipes, Garden hose, Pool liners, Auto product bottles, Twine	**Common Products** Food wrappers, Bread bags, Cling film, Grocery bags, Rubbish bags, Cereal box liners, Frozen food bags	**Common Products** Yoghurt pots, Butter tubs, Ice cream tubs, Bottle caps, Straws, Take-away containers	**Common Products** Insulated cups, Food cartons, Food trays, Packing foam, Plastic cutlery	**Common Products** Large water bottles, Medical containers, Nylon, ABS, Acrylic, PLA bottles, Eyewear, CDs & DVDs

Plastic Waste
Advanced Recycling Feasibility Study
Geelong-Altona Industrial Corridor

The opportunity for a local circular economy for plastic

Report on the findings from the joint feasibility study to determine the technical, economic, and environmental benefits of a local advanced recycling industry

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