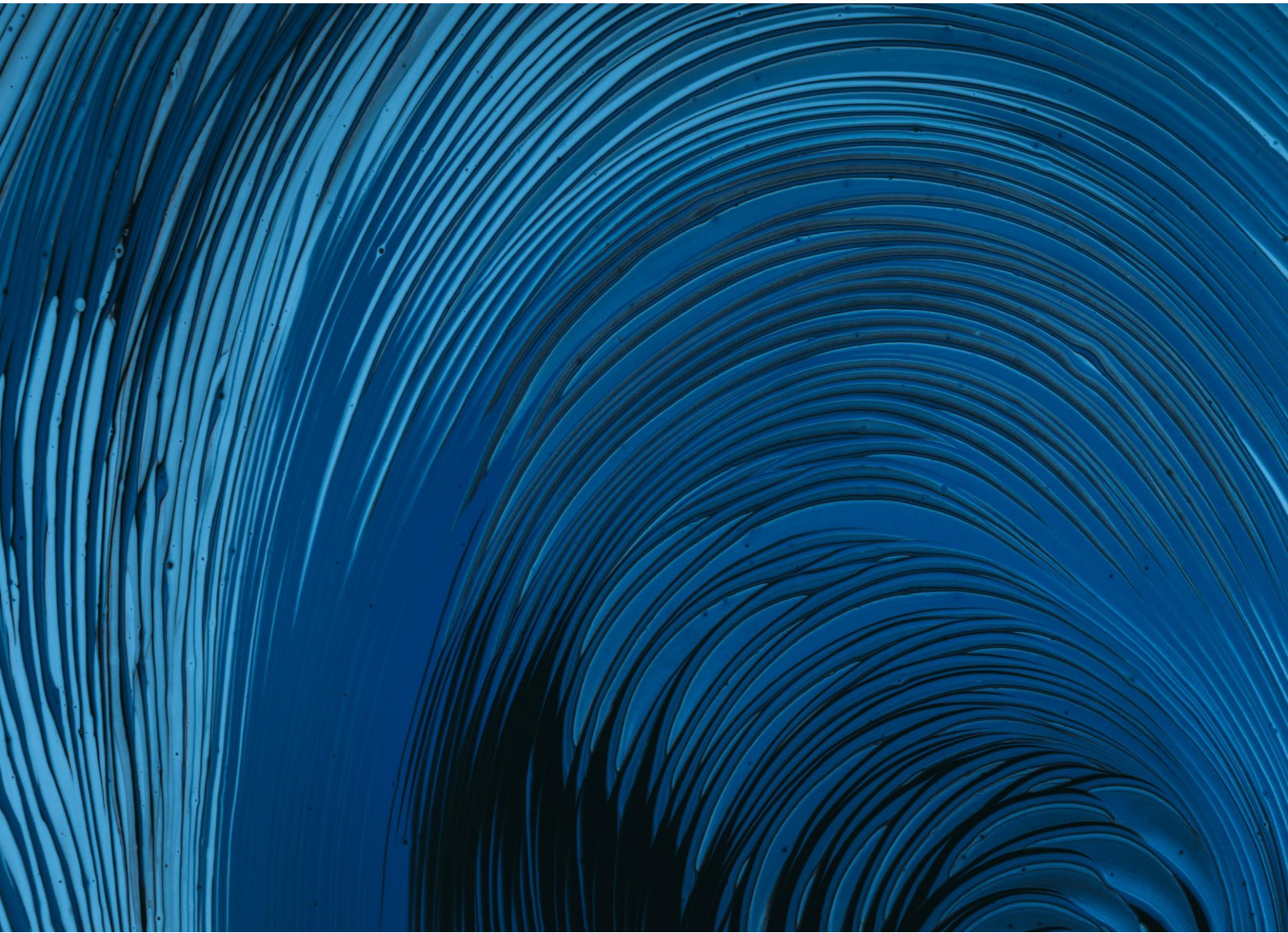
SCION NZ New Plastics Economy Roadmap

Making zero the hero

Moulding a plastics-circularity and narrative in New Zealand



Information sheet

Report title	***MAKING ZERO THE HERO - MOULDING A PLASTICS-CIRCULARITY AND NARRATIVE IN NEW ZEALAND***
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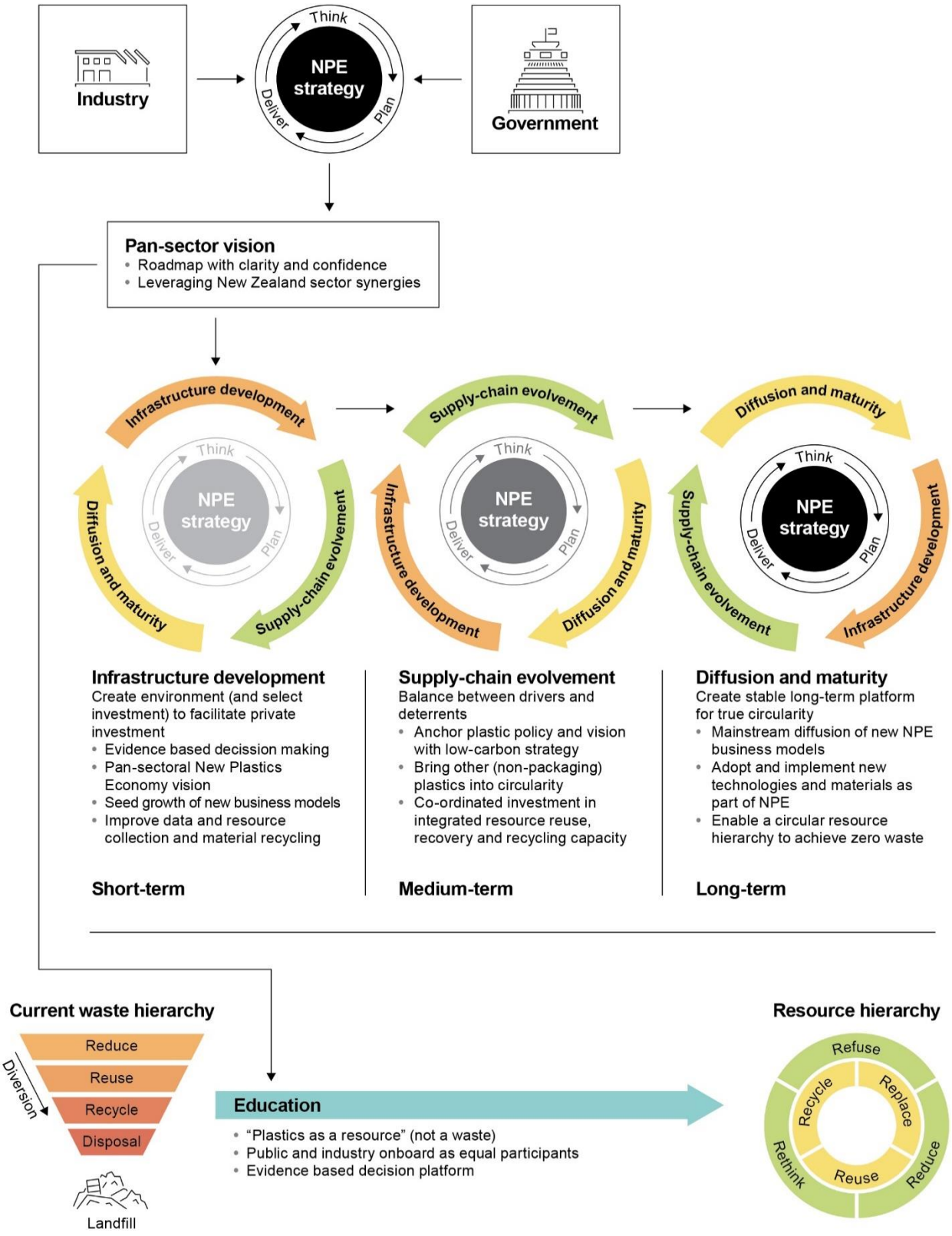
Moulding a plastics-circularity strategy and narrative in New Zealand



Moulding a plastics-circularity strategy and narrative in New Zealand

Together, New Zealand can reinvent its plastics industry

With a signposted direction and clearly signalled regulations and incentivisation, New Zealand can and must create a plastics circular economy.

However, creating the virtuous circle of a New Plastics Economy (NPE) will not be easy, nor can it happen overnight.

But, with INTENT, and following some core principles, NPE can be brought into being:

1. Government working WITH industry
2. Policy balance between forcing, enabling and supporting
3. Three-phased approach to an ever-increasing use of plastic as a resource, not discarded as a waste

This document is a call to arms that the New Zealand plastics industry is willing, ready and desirous of a shared way forward to an NPE.

It outlines strategies adopted by other countries and regions, and highlights some of the challenges which are unique to New Zealand.

These challenges are surmountable – but only if a shared vision, clear direction and certainty of strategy are put forward for how the country can achieve zero waste and a circular plastics economy.

An NPE can be brought into being – together.

A New Zealand New Plastics Economy won't happen, can't happen, by itself

As a trading nation, under the watchful gaze of a planet which expects our country to live the mantra of being clean and green, New Zealand can turn a plastics challenge into an economic and environmental opportunity.

Given the right intent, backed by sound actions, a country at the south-west corner of the Pacific can achieve zero waste and principled plastic production and use for a sustainable future.

However, there are many interdependencies, connections, infrastructure requirements and decisions which need to happen simultaneously and sequentially to achieve true circularity of plastics use and recycling.

The creation of a system that results in all plastic, at any stage of its lifecycle, being regarded as a resource, rather than waste, requires a coordinated effort to bring it about.

But if parts of the system are expected to spring into being fully formed, but in isolation from other crucial steps - nothing will happen.

While New Zealand could, in theory, simply adopt other countries' NPE strategies, its plastics profile is different to others. Strategy adoption will not necessarily lead to any success or create any benefit, but it can guide the way. At the same time there is immense danger in being a bit player in someone else's game while being seen as environmental laggards as it continues to promote the country as clean and green.

For this reason this document argues New Zealand needs to develop and enact its own plastics circularity answers - and indeed grow and transform the sector to become the integral part of the circular and low-carbon economy that it needs to be.

The coordination required will be difficult - but doable given the right will, and a collective effort.

This document outlines why we should head down a New Plastics Economy (NPE) path, a framework under which it needs to happen, and a strategy to achieve circularity within our plastics industry- while underpinned by a global plastics context, and other countries and regions' NPE strategies.

Specifically, it puts a New Zealand plastic industry lens on New Zealand's future in a New Plastics Economy.

Why New Zealand needs to create its own New Plastics Economy

Even though plastics' use is expected to strongly increase in the next 30 years, two powerful drivers will dictate its development:

- The expectation of the creation of a closed-loop plastics' recycling ecosystem
- The expectation that fossil fuels will increasingly not be used for the making of new plastics

Both these objectives are clearly desirable, but will take a considerable amount of coordination, and research and development.

Leveraging its existing plastics industry, New Zealand can develop its own closed-loop system, and potentially contribute to, or be benefactors of a non-fossil fuel plastics revolution.

Why New Zealand is different to other plastics economies

A key differentiating difference between New Zealand's and other countries is the quantity of raw plastic resin produced domestically – none – in 2020, all plastic raw material is imported to New Zealand.

New Zealand's plastic import reliance also creates a significant challenge to domestic plastic converters and processors when transitioning to a New Plastics Economy.

Enabling the existing and new technology and new material to become an everyday solution provides a major challenge since as a geographically remote and small market, the integration of New Zealand into the global New Plastics Economy is important.

This country also doesn't have recycling systems and plants for certain types of plastic - which until a couple of years ago was bundled and sent overseas for reprocessing.

While the domestic industry welcomes global initiatives it also highlights every country is different.

Put another way; New Zealand has its own unique challenges in creating a sustainable plastics circular economy - but with a willingness to commit to a course of action, sustainability can be achieved.

The industry's view on a New Zealand New Plastic Economy

Establishing the New Plastic Economy as a circular system in New Zealand will undoubtedly bring opportunities for domestic distributors, processors, and recyclers.

Most stakeholders consider their business engaged in the transition towards a New Plastics Economy.

However, economic, technological and perception challenges are associated with the continued transition towards a New Plastics Economy.

Fragmentation of waste collection and its sorting and re-processing, the lack of legislative guidance and support, and the lack of evidence-based industry, brand and consumer education on Circular Economy principles hamper any acceleration of the sector's transition.

While the current narrative around plastics ('plastics are the devil, plastic-free is good') is a challenge, shifting to a fact-based version provides an opportunity to leverage New Plastic Economy principles as progress towards New Zealand's zero-emission goals

A suggested strategy and way forward

Many international and domestic initiatives or plans which target the NPE, focus on single-use and packaging items.

Global brands or non-governmental organisations often drive such initiatives, for example, The Ellen MacArthur Foundation or New Zealand's Sustainable Business Network.

Under an NPE model, actions focus on:

- Plastic-use reduction through product redesign
- Improved reuse and recovery through better collection, sorting and recycling
- And use of improved materials or material combinations in general.

There appears to be an underlying assumption that the plastic industry (producing and converting), can easily implement plastic innovations required to drive the transition to the New Plastics Economy.

Some global plastic companies are actively pushing such a transition.

However, the New Zealand industry as a global minor-player in the plastics sector, is import-reliant and often produces products and goods destined for export.

If we are driving towards an NPE to reap its environmental, economic and social benefits the question is how the domestic plastics industry is involved and partners to enable this transition.

The study's purpose, summarised in this document, is to take a plastic industry view on the New Plastics Economy.

Data analysis and consultation aims to identify the challenges, barriers and opportunities for the country's plastics industry in the context of a New Zealand New Plastics Economy.

Combined with understanding how international plastic sectors are part of the transition, a roadmap for New Zealand's plastic sector has been developed.

This roadmap is based on in-depth interviews with suppliers, users and recyclers in the New Zealand plastics supply chain, and integrating their strong wishes to be both involved and profitable participants as part of the future circular economy, this paper recommends a multi-pronged and progressive implementation.

The strategy needs to be layered, certain and educative (of the general public and other industry), and is broken into short, medium and long term actions to bring about zero waste, and carbon neutrality to New Zealand's plastics economy.
This is laid out:

- Global NPE initiatives
- The New Zealand plastics flow: within a global context
- The New Zealand plastics industry response to a proposed and speculative NPE
- Opportunities and considerations for an NPE in New Zealand

The following diagram simplifies what is a complex and multifaceted challenge. This is seen in the complexity of fitting all its pieces together as explained in the rest of the document.

New Zealand could reshape a plastic waste-disposal mentality into a plastic resource- utilisation framework.

The challenge and opportunities can only be met through collective action.

This document seeks to aid the discussions, actions and infrastructure developments required to achieve a New Plastics Economy.

Suggested short term initiatives mainly target:

- Increased investment in infrastructure to enable and fast-track the private sector's transition to a circular system
- Evidence-based education of all value chain partners to ensure company and government-level long-term strategic decisions are fact-based, and
- Developing a pan-sector vision for early alignment of current and future value-chain partners.

The medium-term actions focus on the evolution from a plastic packaging focus to other plastic product groups. This needs to be in parallel with the development of a cohesive NZ New Plastics Economy framework and investment system.

We need to raise and improve public, brands, government and industry awareness on what is possible.

Broadening of the plastic focus needs to be combined with the development and implementation of new business models. For example, plastic products and services designed for reuse, refill and repair solution will change the way we use plastics in the future.

Suggested long-term action focuses on the diffusion of new technologies, services or materials required to implement a New Plastics Economy from niche to mainstream in New Zealand.

The transition towards a New Plastic Economy will also be a step towards "circularity beyond plastics".

Pathway to change – Putting the Steps in Place to Create a New Plastics Economy in New Zealand

Achieving a New Plastics Economy in New Zealand will require a complete value-chain (systems) approach.

Recommended short, medium and long-term actions are based on industry stakeholder feedback combined with relevant international recommendations to transition to a New Plastics Economy (page 88).

Suggested short term initiatives predominantly target:

- increased investment in infrastructure to enable and fast-track the private sector's transition,
- evidence-based education of all value chain partners to ensure company and government-level long-term strategic decisions are fact-based, and
- developing a pan-sector vision for early alignment of current and future value-chain partners.

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Suggested long-term action focuses on the diffusion of any niche technologies or materials required to implement a New Plastics Economy from niche to mainstream in New Zealand.

Short term	Medium term	Long term
Pan-sectoral NPE government infrastructure investment strategy and ncrease government infrastructure investment in collecting, sorting and mechanical recycling capabilities.	Establish incentives for additional investment into integrated recycling capabilities and the uptake of new systems.	Create stable long-term investment conditions to foster and enable the research, develop and implementation of new processing technology, products, materials, processes and systems and to advance them to mainstream.
Develop a pan-sectoral NZ New Plastics Economy Framework.	Anchor the NPE framework in government policy aligned with the NZ low-carbon strategy,	Establish plastic material (or intermediate) export sector to offset imported plastic goods by exported corresponding raw materials back into the global NPE supply chain.
Establish an evidence-based New Zealand long-term strategy on plastic beyond single-use & packaging.	Refine and extend MfE priority products based on a holistic lifetime assessment.	
Evidence-based stakeholder and public plastic resource education.	Extend NZ NPE framework to include reduction, capture and diversion targets for all plastic materials	Maintaining and maturing effective new business models targeting reuse, reduce and recycle.
Incentivise the NZ-specific development and implementation of new business models.		
Promote and enable the zero-waste hierarchy for plastics in agriculture and horticulture application.	Enable mainstream diffusion of new business models for plastic product reuse/refill/repair schemes	Establish a 6R resource hierarchy compliance framework for all plastic products.
Implement efficient and effective container deposit and product stewardship for all single-use / packaging products.	Standardised end of life labelling on all plastics products.	Establish collection and sorting systems adapted to NZ's integrated recycling capabilities.
Align collection and sorting criteria across municipalities and industry sectors.	Extend data capture approaches to all plastics materials	
Improved data capture strategies for food & beverage, hardware and construction and farm plastic in New Zealand.		

Contents

Introduction

About this document

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Combined with understanding how international plastic sectors are part of the transition, a roadmap for New Zealand's plastic sector has been developed.

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Setting the scene

Plastics materials are an integral and essential part of our lives, economies and the human world.

They touch all our lives as a vital enabler for many different sectors, including transportation, construction, telecommunication, agriculture, healthcare and food supplies.

Plastic's widespread use is based on its unique properties of low cost, durability, versatility and low weight. It makes up about 40% of computers and cell phones by weight, [1] and without lightweight and durable plastic parts, we would not have today's cars or planes [8].

Since plastic's advent in mainstream applications in 1950, its global production has quadrupled from 2 billion tonnes to about 9 billion tonnes (2017). Despite a general scepticism towards "plastics" due to associated environmental challenges, global cumulative plastics production is expected to increase to 34 billion tonnes by 2050 [2].

As a material class, "plastic" is as similarly diverse as metals: There is not one plastic but many different types which can be modified using additives and colourants to an indefinite number of formulations.

The flexibility plastics bring as a diverse group of materials explains their use in every sector of our society. But while it delivers many benefits, how we use it is critical for our future and environment.

As an example of a prominent plastic application, plastic packaging can increase the efficiency of food resource use. Modern plastic packaging extends shelf life and reduces food waste. It is a durable, lightweight option reducing product losses and fuel consumption for food products' transportation. In this way, plastic packaging delivers economic benefits and some environmental benefits through better resource utilisation.

However, our current "plastics economy" has significant environmental, social and economic shortcomings, becoming more evident by the day.

- The single-use of plastics, while sometimes unavoidable, is not a desirable scenario
- Plastic waste leakage into the environment, either as litter, waste or microplastics, can have severe environmental and human health consequences
- Lastly, the spread of plastic material to the environment, into landfill or waste incineration is also a material, resource and economic loss.

But efforts to overcome the plastics economy's challenges offer new opportunities: Plastic, material, economic and social innovation can help transition the industry into a circular economy – the **New Plastics Economy** (NPE) - with much-improved value captured and better environmental outcomes generated.

The New Plastics Economy – Circular Economy for Plastics

The concept of circular economies is gaining significant domestic and international attention.

Circular economic systems keep resources and material in flow in the form of the highest economic, environmental or social value.

There is no waste in a genuinely circular economy. All materials can be reused, repurposed or recycled mechanically, chemically or biologically.

Waste as we know it is eliminated and becomes a 'resource'.

Powered by renewable energy, a circular economy relies on the materials and resources available in a regenerative (economic and natural) system (Figure 1).

It does not require the addition of fossil fuel-derived resources that are not already in circulation.

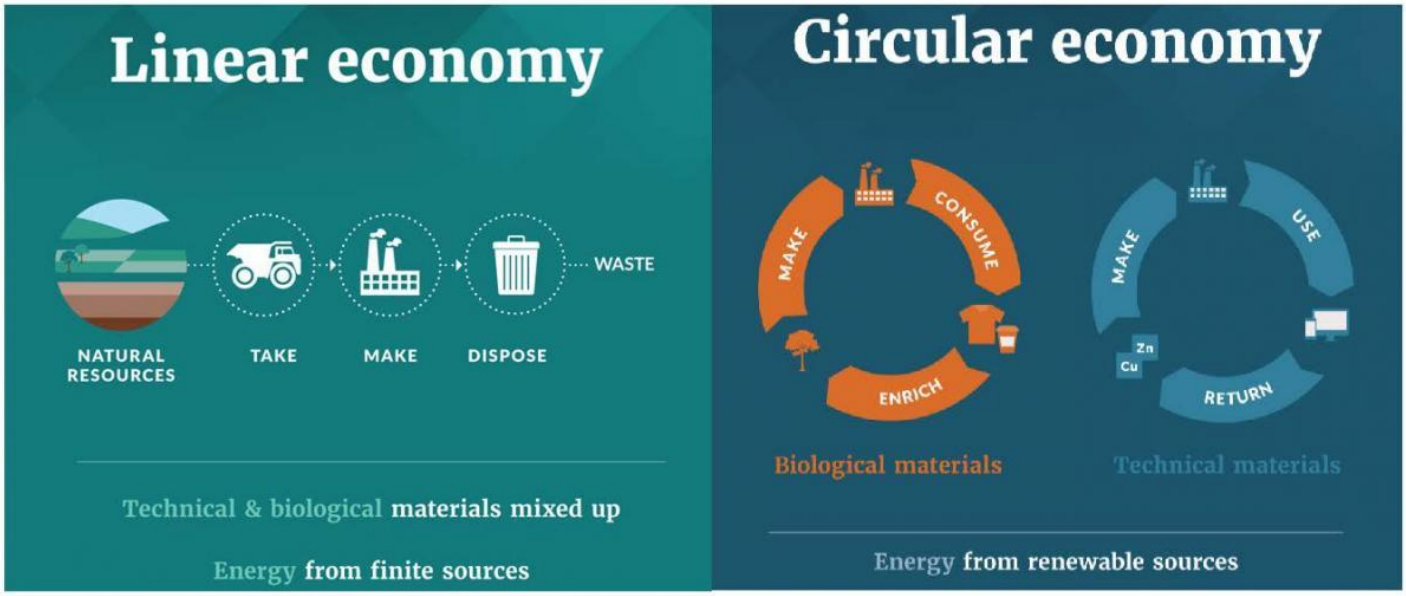

Figure 1: Current linear economy and future circular economy (© NZ Ministry for the Environment) [3].

"Today's economy is massively wasteful. Most of the materials we use, we lose, the things we make are consistently under-utilised, and our efforts to fix it treat the symptoms, not the cause." Andrew Morlet, an expert on the circular economy [3] https://www.mfe.govt.nz/waste/circular-economy

The pathway, opportunities, and barriers for the transition from our current linear economy to circularity is the subject of much international research and policy strategy.

These strategies align with at least one of three key concepts behind a circular economy:

- Designing out waste and pollution,
- Keeping products and materials in use,
- Regenerating natural systems [3, 5]

"Circular Economy" (CE) as a principle has sparked innovation and renewed systems thinking in many different sectors [9, 10]. Circularity requires open-minded, cooperative approaches and thinking.

A linear economy relies on trickle-down, flow-on, and market-pull effects.

A circular economy involves balance and coordination within and between sectors that have not traditionally been aligned [4].

The New Plastic Economy concept aims to create a circular economy for plastics materials and parts [5].

While The Ellen MacArthur Foundation (EMF) has taken a global leadership role to promote and facilitate steps towards a New Plastics Economy, and published various documents supporting NPE, other circular economy strategy documents follow similar concepts and approaches:

- Define and establish a plastics economy where after-use plastics is a raw material, not a waste
- A shift from fossil to bio-based feedstock
- Eliminate plastics resource leakage into the environment

Initiatives and strategies aligned with the New Plastics Economy predominantly target plastics in packaging applications [5].

This packaging focus is justified by the unique usage attributes and challenges that come with plastic packaging. Based on the Ellen MacArthur Foundation, packaging applications represent 26% of the global annual plastics consumption and 95% of plastic packaging (material value USD 80–120 billion annually), is lost to the economy after a short first use [5]".

However, the concept of a circular economy can only be realised when all materials are included. An effective New Plastics Economy must include all materials and applications.

Climate Change and Plastic

Plastics as a carbon-based material is part of New Zealand's and the global carbon cycle in the broader context. Its production, transport and end-of-use are associated with carbon emissions, and climate change discussions and considerations.

In the context of New Zealand's carbon emissions, plastics play a complex and multi-faceted role: their production is emission-intensive, but they improve resource efficiencies. They also enable the majority of renewable energy technologies.

Oil and gas are the raw materials and building blocks of fossil-fuel-based plastics.

While the sourcing and transportation of raw materials to centralised sites and subsequent conversion to plastic materials can be carbon and emissions-intensive activities, this is the current reality for many industrial materials, including glass, metals and paper [6, 7].

Waste management practices are pivotal for the carbon emissions and other environmental issues of plastics.

A 2019 report published by the Center for International Environmental Law (CIEL) has reviewed different plastics product lifecycle stages. The report highlights why plastics as a "*massive and grown source of greenhouse gas emissions has remained overlooked*" [11].

Especially in the "extraction and transport" and "production and manufacturing" stages of plastics, it is challenging to estimate greenhouse gas emissions due to a combination of different emissions' sources and processes.

For example, waste-to-energy end-of-life options also contribute to the plastics emissions profile [11].

However, transitioning to a New Plastics Economy that has effective recycling systems unlocks significant greenhouse gas emission reductions. "Recycling a metric ton of plastic packaging into new products conserves almost 1.4 Mt CO_2-e [11]

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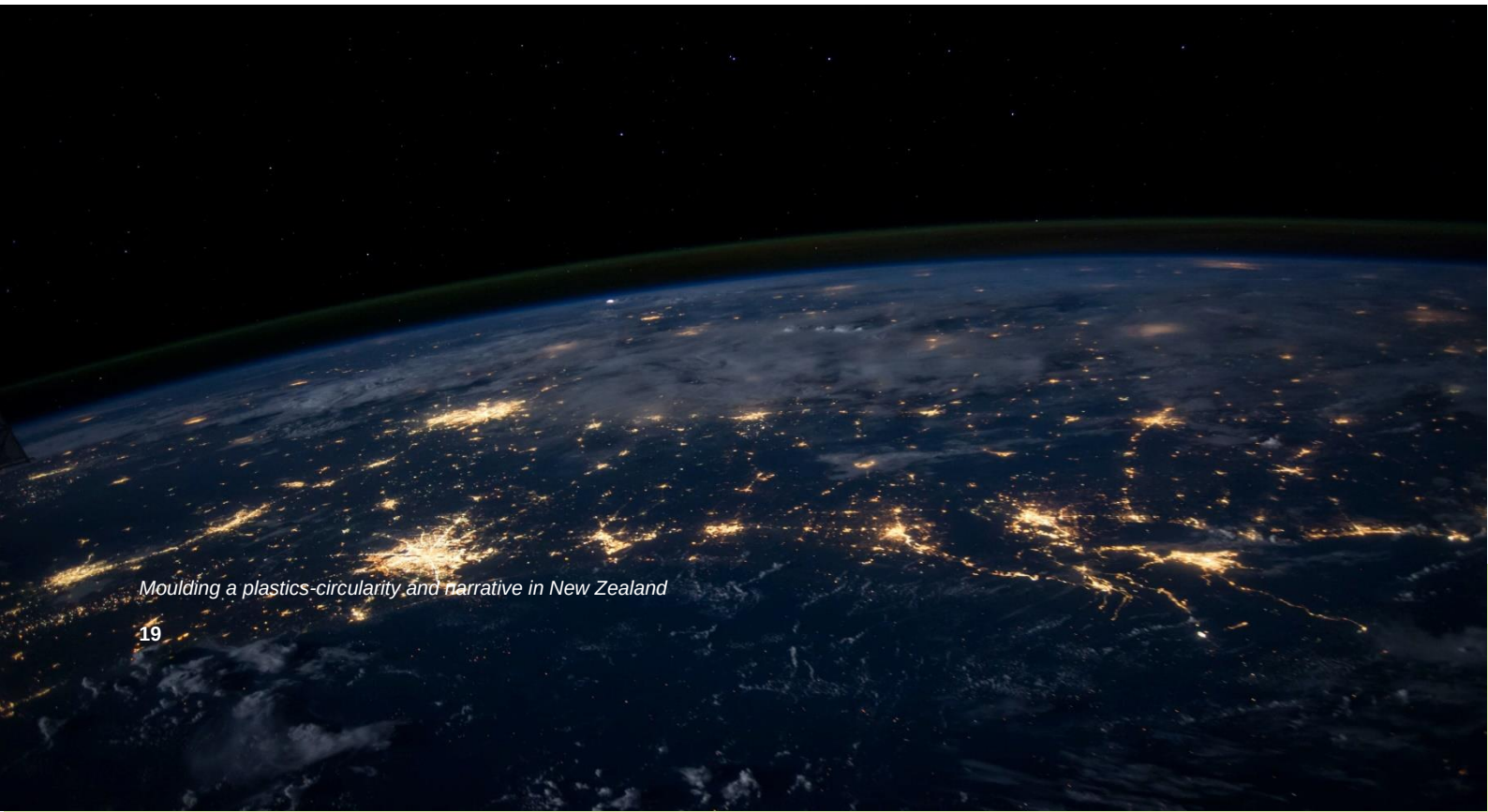
Chapter 1: Global New Plastics Economy Roadmap and Action Plan Review

Key points

- Global plastic recycling targets range from 55 % by 2025 to 75 % by 2030. Despite differences in definition and measures, these targets are well aligned between individual strategies.
- While not quantified, the economic benefits and potential a plastics sector shift to an NPE is mentioned in different documents, e.g. Netherlands, Finland, Ghana, Ireland. The potential synergies with other sectors, (e.g. Finland's pulp and paper) is highlighted and needs to be considered for New Zealand as well.
- The need for better communication and education for behaviour change, and improved recycling, materials and product design capabilities and capacity are featured in all strategies. Finland and the EU both identify the need for global partnerships.
- International plastics circular-economy (CE) initiatives range from only packaging-focused (UK), from single-use to all-plastics products (France), to broader circular economy strategies (Netherlands).
- International documents include approaches and aspects applicable to New Zealand:
- Specification and goal setting in the UK Plastic Pact, including targets for specific polymers.
- The French Pact's vision to extend from single-use plastics to the entire plastics sector.
- Ireland's plastic and recycling sectors face similar economy-of-scale challenges to New Zealand's.
- Finland aims to integrate the NPE-aligned plastics sector with its bioeconomy goals by leveraging existing biomaterial conversion, e.g. their pulp & paper industry.
- The Dutch approach is to separate plastic-consuming and plastics-producing companies in their actions and goal setting (with different standards for each).
- Ghana's approach is to focus on enforceable policy and actions rather than populistic but difficult to realise bans and restrictions.
- Malaysia's concise action plan builds on single-use plastics initiatives to transform its domestic plastics industry.



Overview of Global Documents

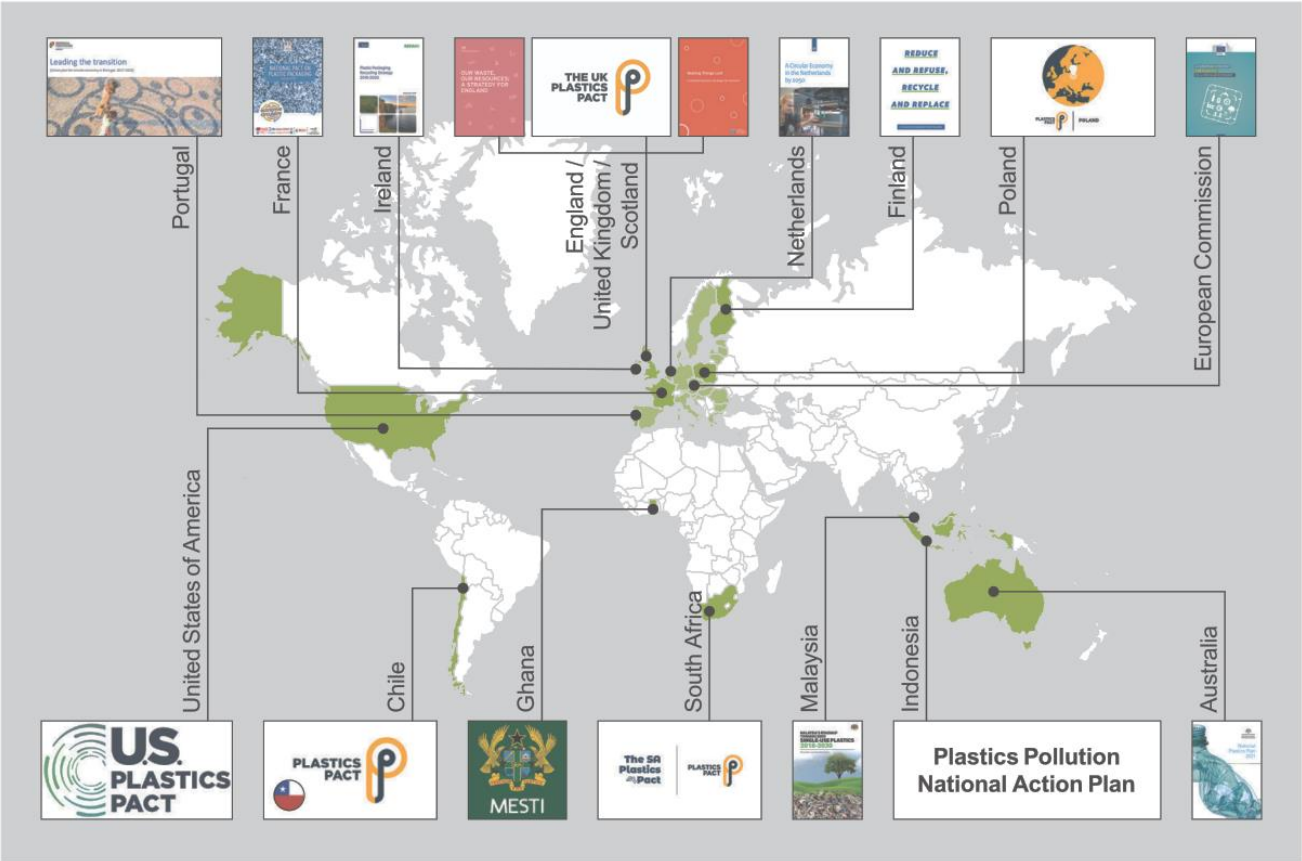


Figure 1: Overview of global NPE government strategy or policy documents.

England/United Kingdom

The UK government's 2018 waste strategy document outlines action steps to transition the UK towards a circular economy by 2050, with initial actions until 2032 particularly well described. Plastic-specific targets include standards for biodegradable plastics, recycling targets by 2030 and changes in government procurement. As the strategy includes the reduction of food waste, the importance of plastic packaging in this context is also highlighted. The UK Plastic Pact (2018) builds on the EMF New Plastics Economy and the waste strategy for England and outlines specific actions towards a circular plastics packaging economy by 2025, i.e. packaging redesign and recycling/composting targets.

The 2018 strategy document describes a vision of preserving "material resources by minimising waste,

promoting resource efficiency and moving towards a circular economy" [1]. It aligns with the UK governments 25-year Environment Plan. The waste strategy is meant to be a "blueprint for eliminating avoidable plastic waste over the lifetime of the 25 Year Plan, doubling resource productivity, and eliminating avoidable waste of all kinds by 2050." [1] It describes key milestone targets and actions to reach the 2050 goals. These targets are defined in more granularity for the years 2019 to 2023.

Based on the New Plastics Economy vision by the EMF, WRAP and its partner organisations developed a UK Plastic Pact. This was the first national Plastic Pact produced in the world, and the basis of the French and Chilean Plastic Pact documents. It focuses on plastics packaging, especially single-use packaging [2-4].

The Plastic Pact aims to transform "the way that the UK makes, uses and disposes of plastic" by bringing "together governments, businesses, local authorities, citizens and NGOs behind a common vision" and developing a roadmap/action plan to achieve it [4].

The UK Plastics Pact outlines four targets to be achieved by 2025:

- Elimination of problematic or unnecessary single-use plastics packaging
- "100 % of plastics packaging to be reusable, recyclable or compostable
- 70 % of plastics packaging effectively recycled or composted [and]
- 30 % average recycled content across all plastics packaging" [4].

Ireland

Repak's 2018 "Plastic Packaging Recycling Strategy" outlines actions for Ireland's plastics value-chain, and government bodies, to comply with the 2018 EU Strategy of Plastics in the Circular Economy, particularly in regards to plastics recycling. Actions are staged in two Phases: 2018-2020 and 2021-2030. The Irish plastics sector faces challenges that also apply to New Zealand: Economics of scale are challenging for the domestic recycling sector, and a lack of investment led to a slow increase in recycling capacities. The document recommends improved communication to drive change, increased infrastructure spend, financial incentives for recycling, and sector-wide collaborations as urgent actions to transition towards a circular economy model [5].

The "Plastic Packaging Recycling Strategy" was drafted by Repak after stakeholder consultation and includes the responses "of 65 different organisations and 81 individuals".

It suggests two phases to transition Ireland's plastics and recycling sector:

- Phase 1 (2018-2020) focuses on data and data gap analysis and stakeholder actions “within their current mandates” [5].
- Phase 2 (2021-2030) will be based on a revised and fully costed strategy to be published by Repak by 2021. This second strategy will recommend further industry and government actions based on the outcomes of Phase 1. The second Phase aims to deliver envisaged recycling targets.

The document recommends well-defined actions and priorities as well as including owners, to achieve the Repak’s Plastic Packaging Recycling Strategy vision. The quantification of plastic flow and plastic packaging waste is outlined as “one of the priorities for the National Waste Prevention Programme” and included in urgent actions (refer to Appendix 5 for details) [5].

While the document states a ‘whole systems’ approach is needed to achieve the strategy, it identifies the critical role government has in co-ordinating different elements. It also recommends that Repak facilitates future collaborations as a project central point.

France

The French National Pact on Plastic Packaging was finalised in 2019 and is the second national Pact that aligns with the EMF vision. It directly transfers the global EMF goals and global Plastic Commitments to a national level. In its approach, it focuses on packaging articles and outlines recycling content and material elimination targets by 2025. Industry system changes or opportunities for the French economy are not addressed. However, it mentions the ambition to extend the Pact from plastic packaging to other plastic products.

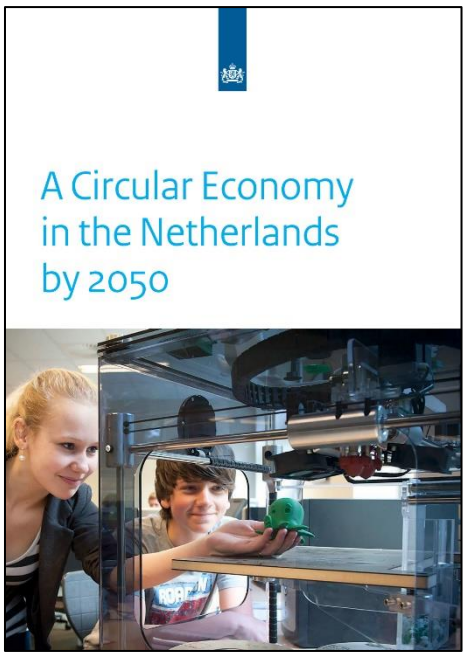
The French Nation Pact on Plastic Packaging was published in 2019 and draws from the EU Strategy on Plastics, the Circular Economy Roadmap and the EMF New Plastics Economy Global Commitment. The business signatories of this French national document committed to:

- define steps to eliminate “problematic or unnecessary plastic packaging by 2025, starting with EPS.” (Expanded Polystyrene) (e.g. eliminate PVC packaging by 2022) eco-designing packaging to make it reusable, recyclable or 100% compostable by 2025
- collectively reaching 60% of plastic packaging recycled by 2022
- incorporating an average of 30% recycled plastics into packaging by 2025 [3, 7].

Additionally to business commitments, the French government supports the Pact by committing to:

- ban the “use of EPS in food containers and single-use plastic cups” and enforce “the elimination of PVC” in packaging by 2022 explore the implementation of various financial mechanisms to incentivise redesign of products, particularly regarding recyclability, reuse and integration of recycled material
- evaluate concrete ways of improving collection, sorting, recycling and recovery schemes, and the related investments
- collectively achieve 60% of plastic packaging effectively recycled by 2022
- strengthen recycling infrastructures and innovate collection mechanisms that improve performance and target effective value sharing with all stakeholders by 2025
- encourage the co-creation of innovative solutions between public and private research” [7]

Netherlands



The Government of the Netherlands has published different circular economy strategy documents that also target plastics. Plastics, not limited to single-use or packaging, are a priority material in the Netherland’s Circular Economy Vision 2050. In 2019, the Plastic Pact NL was completed. While not explicitly based on or aligned with the EMF NPE vision, its targets align with the global Plastics Commitments. The Pact’s actions are to be enacted by 2025 and includes recycling or reuse, and plastic reduction targets. It focuses on single-use plastic items not limited to packaging, and includes thoughts on industry implementation and suggests feedstock changes.

The 2050 vision document does not differentiate between plastics of different applications (e.g. packaging vs. manufacturing). However, in its vision it allows for the consideration of technological feasibility: “In 2050, 100% renewable (recycled and biobased) plastics will be used without any harmful impact on the environment, wherever such is technically feasible” [9].

Furthermore, by 2050 plastic products have been designed for a circular economy, new markets for recycled and bio-based plastic have emerged and the global plastics value chain has been closed through international collaboration.

Three strategic goals to achieve the 2050 vision were defined: Plastic products are designed in such a manner as to enable reuse and high-grade recycling after being discarded

- Plastic materials in value chains are utilised as efficiently as possible, which would lead to a reduction in the need for raw materials and the prevention of “leakage” in the system

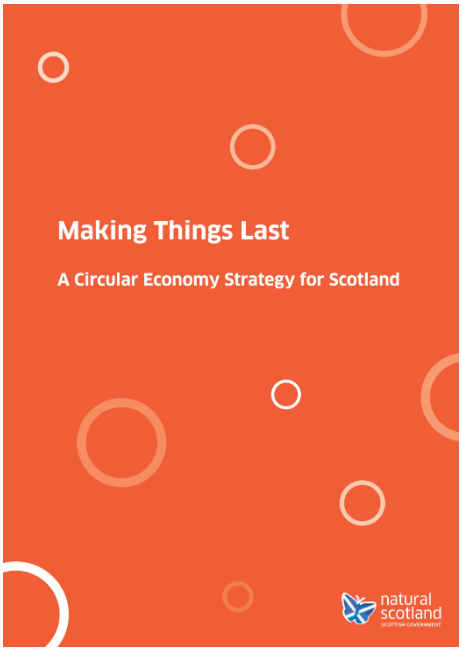
- Optimisation of the renewable use of plastic material flows, by large-scale usage of plastic recyclates and biobased plastics, and making use of biodegradable plastics in specific situations in which such plastics have added value for the circular economy (more effective joint processing with biotic residues; pollution risks for the marine environment)

The “upscaling of bioplastic production”, development of circular design guidelines for plastic producers (2013), a plastic bag ban, and plastic ocean-litter initiatives are described as ongoing national actions to achieve the 2050 vision.

The document also outlines the need for a plastic flow analysis which was started in 2016.

The Dutch Plastic Pact brings together “parties [that] want to do more, with less plastic in the circular economy”. It includes companies predominantly from the fast-moving consumer goods and recycling industry – 75 signatories in total. The parties agree to take actions, that by 2025 all single-use plastic products and packaging that the Plastics-Using Companies place on the Dutch market are reusable where possible and appropriate, and are in any case 100% recyclable. “Each of the Plastics-Using Companies avoids unnecessary use of plastic materials through reduced use, more reuse and/or use of alternative, more sustainable materials, resulting in a 20% reduction in the amount of plastics […]. The Plastics-Producing Companies will have created sufficient sorting and recycling capacity in the Netherlands so that at least 70% of all single-use plastic products and packaging […] are recycled […]” [12]

Scotland



One of the first published national implementation strategy or action plans was the Scottish circular economy strategy (2016). While not focused on plastics, it outlines waste diversion and reduction strategies and widely applicable strategies, e.g. priority products for product stewardship, consumer education and 2025 recycling targets. In 2019, an “Action on Plastics Programme” based on the Scottish Circular Economy strategy was announced.

The Scottish government has put a four-pillar framework in place to support the development of a circular economy:

- Requirements for separate waste material collection (2012) [15]
- A consistent approach to household recycling collection systems [16]
- A Scottish Materials Brokerage Service (initially established for glass, commingled materials and non-recyclable waste in 2014 [17])
- Procedure to improve the transparency of waste in the system [18]

The responsibility of producers for reuse and recycling schemes is identified as “opportunity to drive innovation and greater circularity”. In this context, the UK-wide producer responsibility schemes such as packaging is mentioned as “generally opaque to consumers”.

Between 2016 and 2018, Zero Waste Scotland obtained European Regional Development funding to help Scotland’s businesses transition to a more circular economy model. The funding was meant to contribute to Scotland’s Economic Strategy [19]. However, there is no readily available information on the funded project through Zero Waste Scotland or the Public Contracts Scotland Websites [19, 20].

Indonesia

In collaboration with the Global Plastic Action Partnership (GPAP), the Government of Indonesia has developed a plastics pollution national action plan and is currently developing an associated roadmap.
In March 2019, the Government of Indonesia announced a plan to reduce marine plastic debris and solids waste by 70% and 30%, respectively. The associated national action plan was designed in collaboration with the Global Plastic Action Partnership (GPAP), which is currently “working with stakeholders across the plastics ecosystem to co-develop a roadmap of actionable solutions” [22].

SYSTEMIQ, PEW Charitable Trusts and GPAP are working together to develop an analytical model for identify solutions to achieve the waste reduction targets, including:

- reducing overpackaging
- innovating recyclable plastic material
- substituting materials
- increasing recycling rates and
- improving waste collection rates.

The plan also includes the collaboration of the Indonesian Ministry of Maritime Affairs, Ministry of Environment and Forestry, local businesses and global partners to develop an investment and action pact including a roadmap for implementation [22, 23].

In 2017, Borealis and SYSTEMIQ launched Project STOP. It aims to “design, implement and scale circular economy solutions to marine plastics in Southeast Asia” [41].

Chile

After the UK and France, Chile has also developed a national Pact to catalyse the transition to a New Plastics Economy model. The Chilean Pact’s goals and targets are aligned with the global Plastics Pact by EMF, has led to Fundación Chile’s “New Plastics Economy” initiatives and is currently being translated into a Chilean Plastics Pact Roadmap, which was to be published in December 2019.

The Pact includes four specific commitments to be fulfilled by 2025:

- Actions to eliminate single-use plastic containers and utensils
- 100% of plastic containers and packaging must be designed to be recyclable, reusable or compostable
- 1/3 of the household and non-household plastic containers and packaging must be effectively recycled, reused or composted and
- Plastic containers and packages must have -among their different formats- on average, 25% of material recycling.

Chile’s president has outlined that a changed approach and business models in the plastics sector, “while keeping this material in use”, offers great economic benefit. The Chile Pact is aligned with the global Plastics Pact by EMF and aims at the generation of new circular development trajectories to decouple economic growth and the use of finite resources.

Malaysia

Malaysia's Roadmap Towards Zero Single-Use Plastics was published in 2018. While its immediate focus is single-use plastics, its outlined phases include the development of a Malaysian Circular Economy Roadmap for plastics (2018-2021). It also outlines timelines and associated action steps "towards a sustainable future" of Malaysia and the Malaysian plastics industry. Considered actions to drive change includes R&D, landfill levies and public awareness considerations.

While the roadmap focuses on single-use plastics, especially in its immediate/short-term goals, its overall aspiration applies to the plastics industry as a whole. The document identifies four key problem statements:

- Plastic pollution in Malaysia
- Low domestic plastic recycling rates
- The lack of cost-effective, eco-friendly alternatives
- "Absence of a uniform policy framework"

The roadmap action plan is separated in three phases:

- Phase 1 (2018-2021) includes the launch of the Malaysian Circular Economy Roadmap (CER) for plastics and CER workshops
- Phase 2 (2022 – 2025) focuses on the introduction of a legal single-use plastics framework, implementation of CER, a transition to biodegradable and compostable plastics for single-use items and the introduction of a pollution levy
- Phase 3 (2026 – 2030) aims at extending the use of biodegradable and compostable plastics to other single-use items and their production in Malaysia.

Ghana

The Ghanaian roadmap to "manage plastics sustainably" and shift towards a circular economy model also targets the plastics industry in Ghana by aiming to "reshaping the way plastics are produced". Similar to the Finnish plastics roadmap, it highlights the economic potential of the current plastic industry and the transition to a New Plastics Economy.

In 2021, the Global Plastic Action Partnership published "A deep dive into plastics action in Ghana". The report outlined domestic policy instruments and trade agreements as main mechanisms to drive the implementation of a circular plastics economy in Ghana [42].

Portugal

The Portuguese 2017 “Leading the transition” action plan outlines steps to initiate the transition of the Portuguese economy to a circular model. It outlines that the plastics industry is a key sector for this transition. The Portuguese government aims to facilitate products, processes or business model reinventions to ensure future economic sustainability [33]. This early action plan primarily identified EU funding opportunities to facilitate the transition.

The Portuguese Plastic Pact with its 23 members, including major food and beverage retailing brands, have committed to ambitious targets for 2025, including:

- Defining a list of single-use plastic items deemed problematic or unnecessary and the measures for their elimination, through redesign, innovation or alternative (reuse) delivery models by the end of 2020
- Ensuring that 100% of plastic packaging is reusable, recyclable or compostable
- Increasing collections so that at least 70% of plastic packaging is effectively recycled
- Incorporating, on average, 30% of recycled plastic in new plastic packaging

Finland

The Finnish “Reduce and Refuse, Recycle and Replace” plastics roadmap differs from most other roadmap and strategy documents by also outlining the potential economic value of the current plastics waste problem through new materials and processes. The roadmap outlines target areas to reduce - including tax, material identification, recycling technologies and knowledge creation. Measures and implementers for each target area are defined. However, timelines are rarely specified unless aligned with EU directives and strategies.

While the challenges that plastic and plastic waste pose are clearly outlined in the document, it also emphasises that “for Finland the solutions to the plastics problem are an opportunity”.

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The economic opportunity lies in the country’s biomaterials and technology competence. The authors see that “feasible, scalable solutions that also work in mass production” of biopolymers and bioplastics and

development in recycling technologies are still required and that “Finnish companies can be among the leaders in this” [34].

The Finnish roadmap outlines ten target areas with associated proposals for measures:

- “Reduce littering and avoid unnecessary consumption
- Study the possibility to introduce a tax on plastic
- Significantly increase the recovery of plastic waste
- Improve the identification of plastics in buildings and sorting of plastic waste at construction sites
- Promote the recycling and replacement of plastics in agriculture and horticulture
- Introduce diverse recycling solutions for recovered plastics
- Invest in new solutions and establish a New Plastics Economy knowledge network
- Export expertise and solutions
- Raise the plastics challenge high on the international agenda of Finland
- Enhance research knowledge on negative health and environmental impact of plastics and solutions to these” [34].

European Commission (EU)

The European Commission’s “Strategy for Plastics in a Circular Economy” summarises EU plastics actions. The EU focus is on improving reuse and recycling by 2025. The document outlines target areas, timelines and relevant measures. It not only highlights the plastic challenge but also the its potential for the EU economy. As an overarching European action plan, it focuses on legislative actions, and educational and framework development to promote the transition of the EU plastics industry towards a New Plastics Economy by 2025. Moreover, the strategy document also outlines the need for EU support for international actions.

The “Overview of Circular Economy in Europe” (2019) summarises the progress of countries to implement and fulfil the packaging focused EU Single-use Plastics Directive. An EU circular economy review also identified the need to map material flow on EU level.

The strategy suggests a number of measures to move towards a circular plastics economy in Europe. Firstly, it suggests, “improving the economics and quality of plastics recycling” which is to be achieved by:

- designing plastic articles and packaging for recyclability (“by 2030, all plastics packaging placed on the EU market is reusable or easily recycled”)
- boosting demand for recycled plastics (“develop a European market for recycled plastics”;
- “develop quality standards for sorted plastic waste and recycled plastics” and “ensure that by 2025, ten million tonnes of recycled plastics find their way into new products”) and

- better and more harmonised separate collection and sorting (“new guidance on separate collection and sorting of waste” and “better implementation of existing obligations on separate collection of plastics”) [6].

Secondly, eliminate “plastic waste and littering” by:

- “Preventing plastic waste in our environment” through “legislative initiative on single-use plastics at EU level”
- “establishing a clear regulatory framework for plastics with biodegradable properties” while restricting oxo-plastic
- “restrict the use of intentionally added microplastics” at an EU level [6].

Thirdly, “driving innovation and investment towards circular solutions” through:

- Horizon 2020 funded R&D
- “a Strategic Research and Innovation Agenda on plastics to provide guidance for future research and innovation funding after 2020”, and
- increased private and public investment in plastic strategy-related R&D [6].

Lastly, “harnessing global action” to enable “adequate plastic waste prevention, collection and recycling systems” in other parts of the world, which will require:

- ongoing EU support for international actions, and
- “development of international standards […] and EU certification schemes for recycling plants” [6].

Unlike many other documents discussed here, the European Commission’s strategy document “for plastics in a circular economy” includes a comprehensive list of actions to achieve the objectives summarised above

The 2019 EU Commission’s report on “the implementation of the Circular Economy Action Plan” summarises key milestones of the EU Plastics Strategy which were already delivered. “These include the new recycling target for plastic packaging, set at 55% in 2030, [and] obligations for separate collection and improvements in Extended Producer Responsibility (EPR) schemes.

The Circular Plastics Alliance (CPA) aims to increase the recycled plastics market in the EU to 10 million tonnes by 2025. The published commitments for actions include

- the identification of legal, economic and technical obstacles,
- summarising the investment needs to improve waste collection, sorting and recycling,
- setting up systems to monitor waste and recycling streams [43].

In 2020, CPA published a report on the state of plastic collection and sorting in the EU [44].

CPA estimated that 9.2 million tonnes of the 21 million tonnes of collected plastic waste are sent to recyclers. To increase the recycling tonnage, CPA is currently investigating additional collection

and sorting approaches. However, the CPA also highlighted the diversity of waste and data collection across EU member states, which limits the availability of detailed waste data.

The 2020 report includes a summary of the challenges, needs and R&D response for different sectors.

Agricultural plastic waste quality will depend on the on-farm technologies to reduce heavily solid products and requires increased collection, sorting and cleaning steps to improve the quality of recyclates.

The automotive industry identified the need for efficient plastic separation, while the construction industry requires “efficient tracking, automated analysis and sorting systems” [44].

The packaging sector identified challenges on the delamination of multi-material packaging products as a technology need to improve recycling efficiencies.

Poland

In September 2020, Poland joined the Plastics Pact. The Polish Plastics Pact is led by Kampania 17 Celów, a campaign which helps Polish businesses implement the 17 Sustainable Development Goals, and is supported by over 30 businesses and NGOs.

Poland hast set six goals as follows:

1. Eliminate unnecessary and problematic plastic packaging
2. A 30% reduction (by weight) in virgin plastic consumption across plastic packaging
3. Ensure that 100% of plastic packaging is reusable or recyclable
4. Ensure an average of 25% recycled content across all plastic packaging
5. Effective support of packaging collection and recycling systems that ensure at least 55% of plastic packaging is recycled on the Polish market
6. Conduct effective citizen engagement

USA

On 25th August 2020, the U.S. Plastics Pact was officially launched. Led by The Recycling Partnership and supported by the World Wildlife Fund, the US Plastics Pact currently has more than 60 companies, government agencies and NGOs that are committed to the four 2025 targets:

1. Define a list of problematic and unnecessary plastic packaging challenges by 2021, and take action to eliminate them by 2025
2. All plastic packaging to be 100% reusable, recyclable or compostable
3. Take actions to effectively recycle or compost 50% of plastic packaging. In particular this targets aims at:
    - "PET, PP and HDPE bottles have a minimum recycling rate of 70%,
    - PET non-bottle rigid packaging has a minimum recycling rate of 50%,
    - PP plastic non-bottle containers/rigid packaging have a minimum recycling rate of 50%,
    - HDPE plastic non-bottle containers/rigid packaging have a minimum recycling rate of 30%,
    - film and flexible packaging is collected for recycling via all recycling means, including drop-off,
    - collection and standard residential programs such as curbside collection,
        - PE film (including PE pouches) has a minimum recycling rate of 30%,
        - Other polyolefin film (i.e., PP or potential PE/PP mix) has a minimum recycling rate of 30%.".
4. 30% average recycled content or "responsibly sourced bio-based content" in plastic packaging [45].

The roadmap release in 2021, outlines key activities and the roles of government, NGOs, brands & retail, Pact steering committee and workstreams, industry and waste management towards achieving the four 2025 targets.

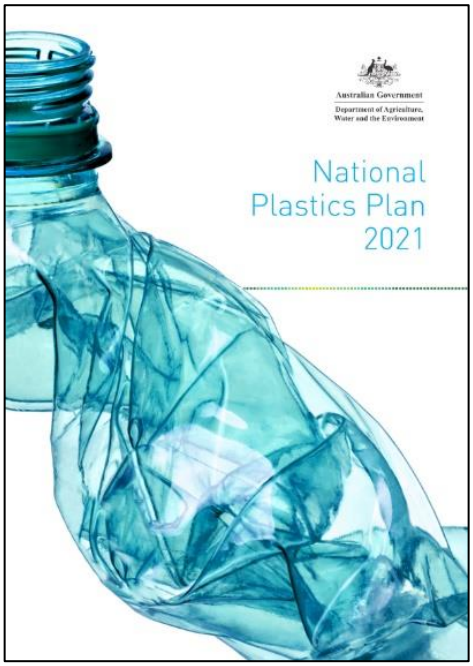
South Africa

A collaboration between businesses, government, NGOs and other organisations; all have signed up to a set of ambitious and time-bound targets to drive significant change by 2025.
The SA Plastics Pact builds on the positive work started by other initiatives and helps scale up and disseminate good practice more quickly.

By 2025, the SA Plastics Pact will transform the country's plastic packaging sector by meeting four ambitious targets:

- Taking action on problematic or unnecessary plastic packaging through redesign, innovation or alternative (re-use) delivery models
- 100% of plastic packaging to be reusable, recyclable or compostable
- 70% of plastic packaging effectively recycled
- 30% average recycled content across all plastic packaging

Australia



The Australian Nation Plastics Plan outlines waste reduction, plastics replacement and recycling targets that are in line with other international plans and ambitions (e.g. 70% of plastic packaging being recycled or composted). Two key differences are noteworthy to address issues that have become more topical recently: The plan includes a ban on biodegradable plastics that are based on “additive fragmentable technology” or that are not certified compostable. For 2030 a “phase-in of microfibre filters on new residential and commercial washing machines is planned”.

While there is a considerable packaging focus in the plan, some initiatives, for example, product stewardship, apply to “plastics products” in general.

In 2021 ANZPAC, a regional Plastics Pact for the Oceania region, was launched by the Australian Packaging Covenant Organisation. It “is a platform for committed and ambitious governments and organisations spearheading the transition towards a circular economy for plastic packaging”. The Pact sets out targets to eliminate unnecessary plastic packaging, increase the recycled packaging and recycled content and ensure that packaging is reusable, recyclable or compostable by 2025. As a regional Pact, it has set these targets for each of the three target areas: Australia, New Zealand and the Pacific Islands. With a goal of 25% plastic packaging being effectively recycled by 2025, the goals are less ambitious than those of other countries/regions, e.g. South Africa.

At the time of writing, there was not much evidence of active participation from key stakeholders in New Zealand in the ANZPAC regional Plastic Pact [46].

United Nations Treaty on Plastics

The United Nations (UN) treaty on plastic pollution is a global initiative that aims to establish an aligned governmental effort to transition towards a circular economy for plastics. The treaty is still in development but at the time of writing it included four main critical elements:

1. Monitoring and reporting including harmonising regulatory standards and common definitions across markets
2. Plastic pollution prevention including circular economy of plastics and clear national targets and action plans that aggregate to deliver on the treaty's overarching objective
3. Coordination with other international groups
4. Technical and financial support [47]

The business case for the UN treaty on plastic pollution published by WWF, the Ellen MacArthur Foundation and the Boston Consulting Group, has highlighted that voluntary Initiatives are increasing but need to e supported by regulatory measures. Such regulations are increasingly seen for plastic pollution and also start to emerge on tools to increase plastic return, reuse and recycling schemes.

However, many of the regulatory drivers are missing critical aspects or are misaligned, for example, a sole focus on single-use plastics. Additionally, legislation is fragmented and not aligned across regions or sometimes even within countries. This fragmentation makes it increasingly difficult for businesses to operate in a global environment.

The business case shows how the UN treaty aims to address these barriers through four main objectives:

- Harmonised definitions,
- common policy framework,
- global reporting methodologies, and
- international capacity building [48].

Summary

The documents summarised in this chapter also include aspects and considerations that can be relevant for the development of New Zealand strategies, roadmaps and action plans:

- The specificity in goal setting demonstrated by the UK WRAP
- The inclusion and consideration of action owners and implementors (those responsible for different parts of the strategy) (Ireland, Finland)
- Consideration of existing sectors and alternative material processing to accelerate the transition of the plastics sector and leverage synergies (Finland)
- Granularity in goal setting as demonstrated by the Dutch Plastics Pact
- The establishment of Pact workstreams and a Pact Committee (USA)

International examples of roadmaps, action plans and strategy documents to transition domestic economies and plastics manufacturing sectors from the current linear economic model towards a circular model already exist.

Most of these documents primarily focus on plastic packaging and single-use plastics. If targets and measures are quantified, they focus on recycling quotas.

The specified recycling targets range from 55% recycled plastic packaging by 2030 (EU [6]) to 70% recycling of single-use plastics by 2025 (Netherlands & UK [4, 11, 12]) and 75% packaging recycling rate by 2030 (England [1]).

However, the lack of a globally accepted definition for ‘recycling’ and ‘recyclable’ is also highlighted in different documents and may lead to differences in measurement and implementation success.

The fragmentation of regulatory drivers to transition towards a circular economy are an ongoing problem.

“The New Plastics Economy” is understood as a synonym for a society and economy – particularly a plastic manufacturing sector – that has adopted circular economy principles.

It is based on terminology and principles published and promoted by the Ellen MacArthur Foundation (EMF). Globally, three countries have translated the EMF vision into domestic strategies: United Kingdom, France and Chile.

Other countries have developed approaches based on individual domestic policies and strategies.

The Netherlands (NL) have published a Dutch Plastic Pact that is based on the Dutch 2050 Circular Economy vision. The overall Dutch vision and the Dutch Plastic Pact aligns well with the EMF-based vision of a New Plastics Economy.

However, it does consider unique aspects of the Dutch economy and its plastics sector into account and proposed specific activities for the different level of the plastic’s value chain. For example, the Dutch Pact specifies targets for so-called plastic-producing companies that are separate from those for plastic-using companies.

The example of the Malaysian Single-use Plastics Roadmap demonstrates how local environmental issues and global trends can be reflected in domestic goal setting. The roadmap includes waste reduction targets and

the promotion, development, standardisation and domestic production of biodegradable plastics to reduce pollution in Malaysia and gain economic benefit from global changes. It is based on federal legislation with state/regional governments responsible for implementation.

As a regional strategy, the European Commission's Plastic in a Circular Economy document summarises recommended steps to achieve the transition to a circular economy.

However, as a regional document, it focuses on legislative, educational and commitment actions.

Regional approaches, for example, the development of an Australia/New Zealand/Pacific Pact will have the similar challenges in capturing country-specific aspects in overarching strategies.

It is also important to note that the value of the plastics industry for individual economies and the potential that a closed-loop-plastics industry or a New Plastics Economy can bring to countries is highlighted in the Dutch, Portuguese, Finnish and Ghanaian visions and strategies (while not quantified). Finland envisages leveraging its existing pulp and paper and bioeconomic industry to drive the domestic transition to a circular economy and benefit from a global economic shift.

A similar strategy could be applied in New Zealand.

In Scotland's waste reduction strategy, the effectiveness of Producer Responsibility Schemes is challenged as consumers found them "generally opaque" (2016).

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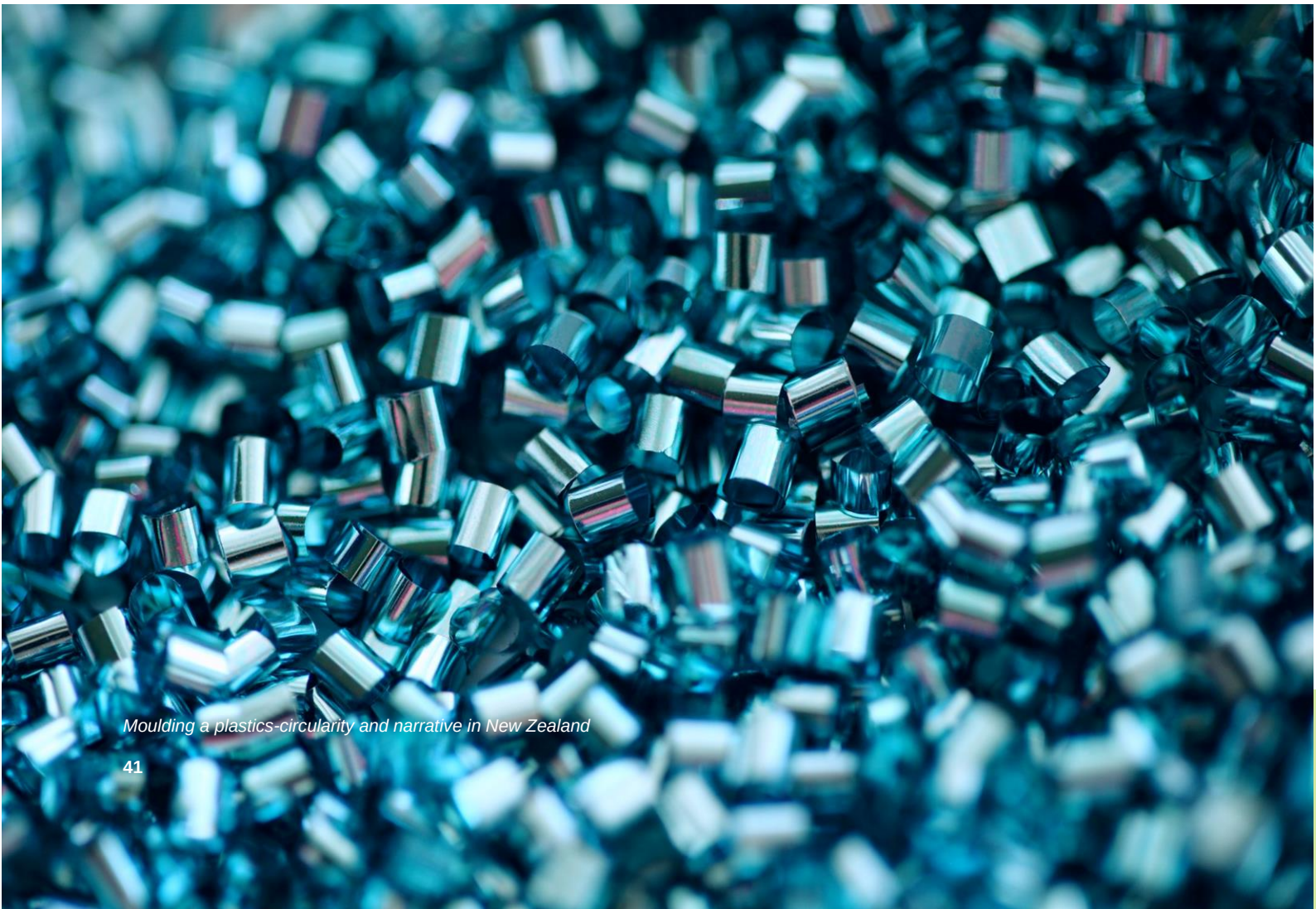
Chapter 2: Plastic in New Zealand

As plastic is produced in its raw form and processed into finished products, it is referred to in different ways. Here, the following terminology is used to describe plastic in its different forms through the value chain:

- Plastic raw material is plastic pellets, sheet, film, pipe, foam, filament and liquid forms, for example emulsions, that often undergo additional processing steps within the plastics industry
- Plastic products are the result of the conversion of plastic raw materials. Plastic products can be finished goods, for example rain gutter, or part of a finished good that is processed outside the plastics industry, for example plastic packaging that is used for packaging food
- Finished goods are products that can go into retail to customers

Here, the “Plastic industry” is defined as that part of the value-chain that processes (converts) plastics raw material to plastic products. This conversion can include change of shape, colour and physical properties, it can also be limited to cutting plastic to shape.



Summary

Global (virgin) plastic production in 2019 was 368 million tonnes [20], with further production and market growth expected to reach more than 1200 million tonnes by 2050 (Figure 1) [7, 21] Asia, in particular China, is the primary producer of plastic resins, i.e. plastic raw materials.

Globally, polyethylene-based materials resins, polypropylene and polyamide are the primary produced plastic.

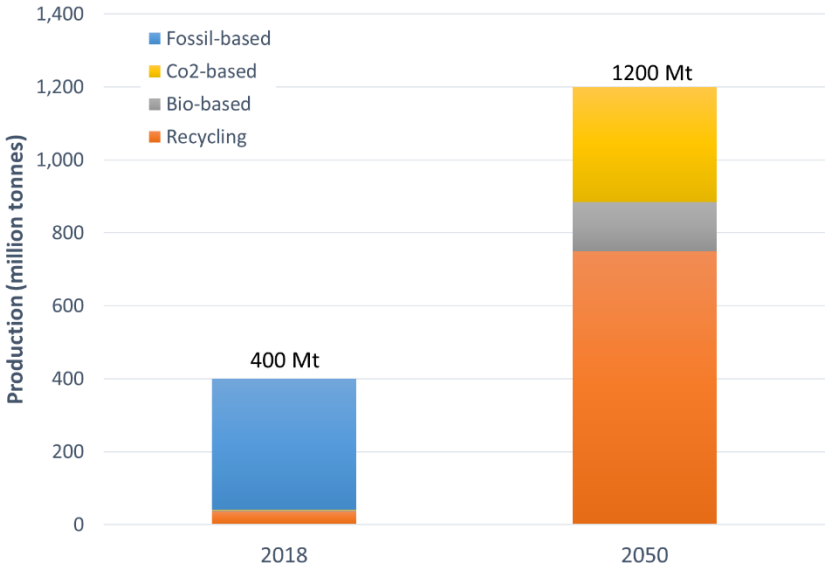


Figure 1: Expected growth in world plastic production [21]

Based on the import statistics and the industry survey conducted to prepare this document, about 398,100 tonnes ($1.2 billion) of plastic raw material were processed by New Zealand's plastic industry in 2020. Apart from domestic waste recycled plastic, all plastic raw material processed in New Zealand is imported, mainly as pellets, powder or flakes and sheet or film. With such import-dependence, global changes in the plastics industry will affect the New Zealand plastics industry. Similarly, with no domestic plastic production, the implementation of new material options depends on the global and domestic availability of new material solutions.

Recycling pre-consumer industrial plastic waste is an established process in the plastics industry. Pre-consumer industrial waste is recovered in manufacturing operations. Therefore it is easily collected, and any contaminations are usually well known. Some New Zealand converters stated that they include up to 15% of pre-consumer recycled plastic in products without marketing a 'recycled content'. Other NZ products are entirely made from pre-consumer recycled plastic [21].

Raw material (398,100 tonnes) and plastic product imports (110,800 tonnes in 2020) can be tracked and analysed with a high degree of accuracy and detail. However, the missing information on plastic imports as part of finished goods makes it impossible to estimate how much plastic enters New Zealand every year.

The packaging sector, followed by agricultural and construction and infrastructure materials, are the main users of products from New Zealand's plastic industry.

By volume, polyethylene-based materials, followed by polypropylene and polyvinylchloride, are the predominant plastic raw material entering the New Zealand plastics industry.

The overall material flow is complex, with up to 20% of materials classified as ‘others’ (plastic #7) under the resins identification code.

Plastic raw material and scrap exports have fallen in the past few years. In contrast, plastic product exports (for example, moulded containers, construction materials, bags and films) increased by an estimated $108 million between 2012 and 2020.

The European plastic market is well defined including a detailed breakdown of the different market sectors for plastics. This is not the case for New Zealand. However, assessing differences in material conversion and their respective markets allows conclusions on New Zealand’s plastics markets.

The main differences in the demand of New Zealand’s plastic industry and that of Europe are that New Zealand proportionally uses more polyethylene.

In contrast, the NZ plastic industry’s Plastic #5 and Plastic #7 demand is proportionally less than that of Europe and similar to that of Australia. On a per-capita demand, New Zealand’s plastics industry uses less plastic than Australia but more than the UK.

New Zealand’s plastics industry faces fundamentally different challenges to those experienced in other countries and regions:

- With no raw (virgin) plastics production in New Zealand, the industry is almost completely dependent on global material innovation trends and available supply.
- With the global plastics production centred in China, greater Asia, and NAFTA, the New Zealand plastics industry can be expected to feel market, regulatory, and social changes that affect production, material availability, and material price in these regions. There are only limited viable mitigation strategies in the absence of a local production or production infrastructure.

Plastics – a global view

The global plastic production in 2019 was 368 million tonnes [20], with further production and market growth expected to reach more than 1200 million tonnes by 2050 [7, 21].

Asia, particularly China, is the primary producer of plastic resins, i.e. plastic raw materials. Globally polyethylene-based materials resins, polypropylene and polyamide, are the most produced materials.

The global plastic resin production in 2019 was about 382 million tonnes (Mt) of raw plastic resin, with Asia, especially China, as the most significant production region (Figure 2). Combined with additives to achieve the required product performance and visuals for the different target applications, about 407 Mt of plastic was globally produced in 2019 [7]. Polyethylene (mainly high-density polyethylene and low-density polyethylene) were the most produced polymer type, followed by polypropylene, polyamide, polyvinyl chloride and polyethylene terephthalate (Figure 3).

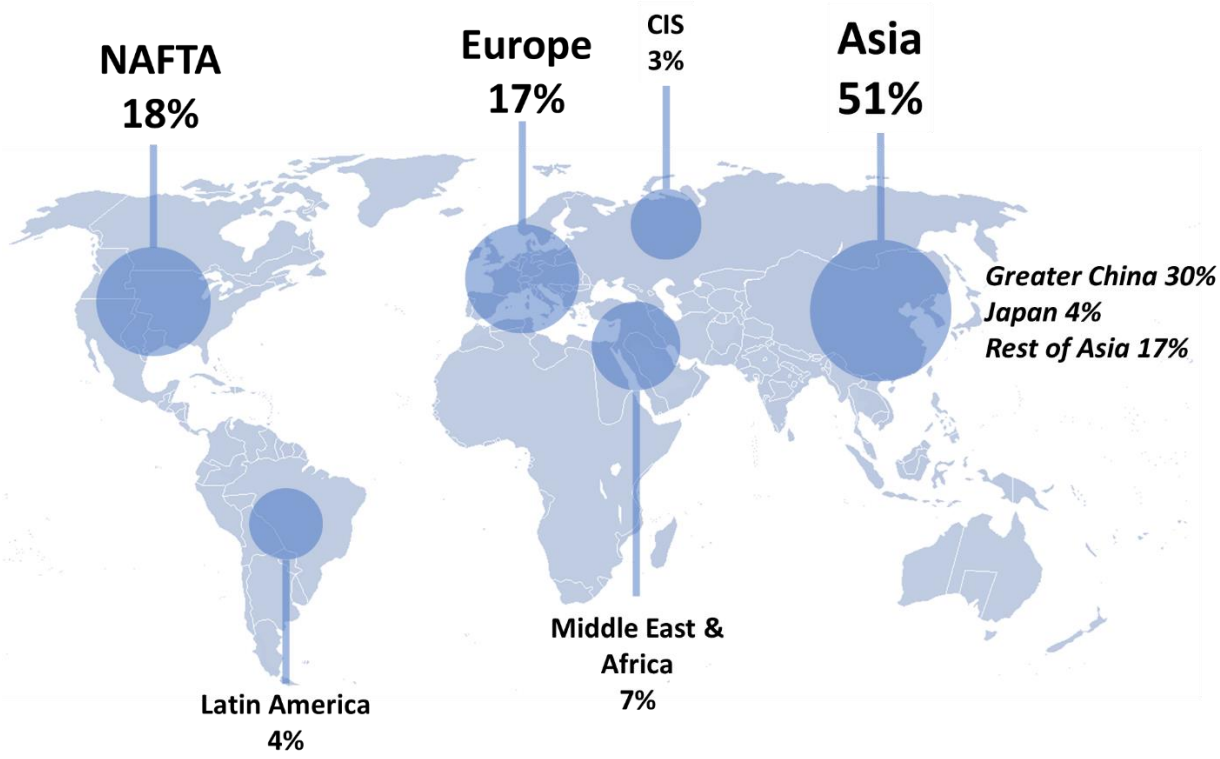


Figure 2: Global plastic production sites [6,7] (CIS: Commonwealth of Independent States)

Plastics are predominantly made from crude oil, coal or natural gas or, in the case of bio-based plastics, organic materials such as cellulose. While crude oil price also affects the global plastic market, only about 4% of the annual oil and gas production is used for plastics [10]. Crude oil as a feedstock is a complex (“crude”) mixture of thousands of different chemicals and needs to be refined before it can be used for plastic production.

Refining crude oil to individual fraction and chemical compounds is subsequently carried out at oil refineries. Specific purified chemicals are then combined into larger molecules using polymerisation to produce polymers. These polymers (‘many particles') are then combined with additives -for example, processing aids or stabilisers- which produces a plastic resin that can be used in subsequent processing to make plastic articles.

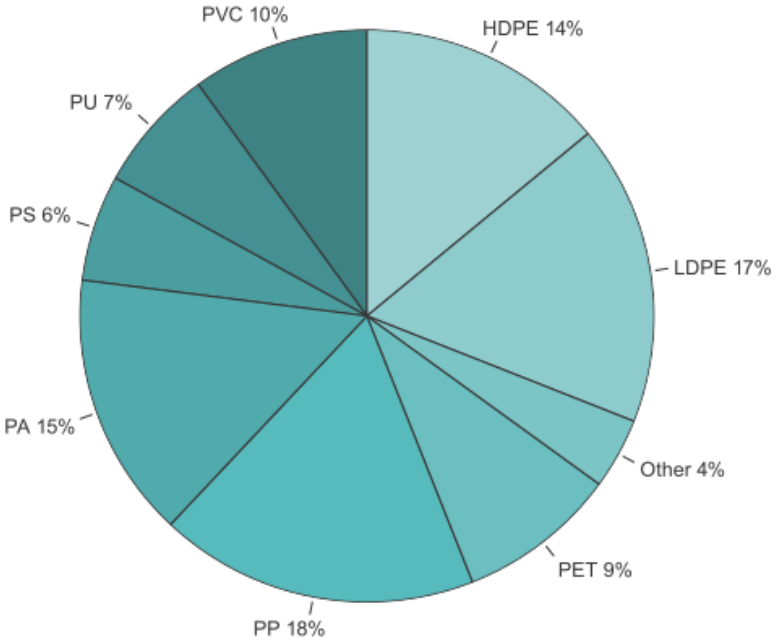


Figure 3: Global plastic production by plastic type [6]

The different types of plastic resins we use every day are based on different polymer chemistry, i.e. chemical structures. The chemical structure of the plastics dictates the properties of the material, which in turn enables specific applications.

There are two fundamentally different types of plastics:

1. Thermosets cannot be made malleable after they have set. They usually need to be heated or are combined with curing agents to set, for example, two-component epoxy resins.
2. Thermoplastics such as polyethylene, polypropylene or polyesters soften upon heating and solidify after cooling.

The processing technologies for thermosets and thermoplastics are fundamentally different, as thermosets cannot be softened and reshaped. This also leads to thermosets being not suited for mechanical recycling.

ASTM International Resin Identification Numbers

In the context of plastics recycling, plastic materials and products are often referred to by their ASTM International (formerly the American Society for Testing and Measuring) Resin Identification number (RIC) or recycling code, for example, polyethylene (PET) “Plastic #1” (Figure 4).
In the RIC system, seven identification codes were created by the equivalent of today’s US Society of Plastics Industry (SPI) in the 1980s.

Code	ASTM D7611 Code (Option A)	Material	Applications
1		Polyethylene Terephthalate	Soft drink and beverage bottles, electrical housings, food packaging
2		High-Density Polyethylene	Bottles (detergent and cosmetics, food products), industrial wrapping, sheets, water pipes and medical devices
3		Polyvinyl Chloride	Window frames, cladding, medical equipment, credit cards, water containers
4		Low-Density Polyethylene	Cling film, plastic bags, flexible containers and food wrap
5		Polypropylene	Yogurt and margarine containers, wrappers, medical packaging, crates, shampoo bottles
6		Polystyrene	Construction materials and insulation, geofoams, clamshells, disposable hot and cold drink cups and plates, yoghurt snap-pack
7		All other resins and multi-materials not otherwise defined	Toys, electronics, footwear, car parts, fire helmets and other composites and laminates

Figure 4: ASTM International Resin Identification Numbers [9]

The original RIC purpose was to “provide a consistent national system to facilitate recycling of post-consumer plastic.” [5]. Since the 1980s, the RIC codes have been adopted by many countries to assist in sorting plastics for subsequent recycling.

However, the code and especially the associated logo, have also been the source of considerable confusion. They are often associated with recyclability or recycled material.

In 2020 for example, Oceana published survey results showing 68 % of respondents thought products with the RIC symbol are recycled. RIC codes do not only apply to plastic packaging but are meant to be used on all plastic articles. As outlined (Figure 3), there are many different plastics. RIC code 7 captures all plastic materials that are not covered by codes #1 – #6, such as polycarbonate, new compostable plastics, or multi-material products.

To align with the terminology and classification often used in global discussion around plastic usage and the New Plastics Economy, plastic resins are described and categorised in this document in accordance with RIC codes, with further information added were required [17].

Plastics in New Zealand’s plastic industry

In 2020 398,100 t ($1.2 billion) of plastic raw material were processed by New Zealand’s plastic industry. Apart from plastic from domestic waste recycling, all plastic raw material processed in New Zealand is imported, mainly as pellets, powder or flakes and sheet or film. Therefore, global changes in the plastics industry will affect the New Zealand plastics industry. Similarly, with no domestic plastic production, the implementation of new material options is dependent on their global availability.

Recycling pre-consumer industrial plastic waste is an established process in the plastics industry and some converters include up to 15% of pre-consumer recycled plastic in products. Raw material (398,100 tonnes) and plastic product imports (110,800 tonnes in 2020) can be tracked and analysed with a high degree of accuracy and detail. However, missing information on plastic imports as part of finished goods makes it impossible to reliably estimate how much plastic enters New Zealand every year.

New Zealand currently does not have any polymer production facilities, and all polymers or raw plastic that is processed or sold in New Zealand is imported [3]. New Zealand’s total plastic consumption is through imported raw materials that are domestically processed into products (including domestically recycled material), through imported plastic products, and plastic as part of other imported finished goods.

To capture different materials, we differentiate plastic raw materials from plastic products:

- Plastic raw materials are materials in their primary form, i.e. powders, pellets, flakes, materials in the form of sheets and films, pipes and tubes, scrap (waste) and liquid form. For clarity “Liquid form” materials include emulsion used for coatings and paints. These are mostly thermoset components
- Plastic products are in many cases moulded articles

The most current and accurate source of plastic material imports, either as raw material or plastics product, is the NZ customs database that captures plastics as “plastics and articles thereof’ under commodity code 39 within the Harmonised Trade System.

By categorising commodity code 39 into a group of plastics or plastic identification code and combining it with elements of the industry stakeholder survey results summarised in Chapter 3, a detailed overview of the different imported and exported plastic materials was developed.

As outlined in the 2019 “Rethinking Plastics in Aotearoa New Zealand” report by the Prime Minister’s Chief Science Advisor, the amount of imported plastic materials has increased by about 43% between 2009 and 2018. This increase in demand is comparable with the observed global plastic demand increase, leading to a rise in global plastic production from 250 Mt in 2008 to 359 Mt in 2018 [4].

As part of this NPE Roadmap, a detailed analysis of the available import and export data was carried out. As the Covid-19 pandemic’s economic fall-out might have influenced the most recent full calendar year dataset (2020), we also analysed the plastic imports in 2019.

In 2019 about 532,100 tonnes of plastic was imported to New Zealand (Table 1). However, this included finished plastic products such as containers, lids, braces or plastic flooring panels, and plastic raw forms destined for further processing or conversion by plastic manufacturing companies.

In 2019, about 419,600 tonnes of raw plastic materials were imported to New Zealand at a combined value of $1.3 billion. In comparison, the combined value of the plastic products imported in 2019 (112,500 tonnes) was about $820 million.

As mentioned above, we differentiate between plastic products and finished goods containing plastic, such as packaging. Currently, it is impossible to quantify plastic imports through finished products, for example, electronics, toys, cars, medical goods or packaged food and goods. Therefore, this material is not included in any quantification.

Table 1: Overview of plastic import 2019 and 2020.

	Plastic Raw Material	Plastics Products	Total *
2019	419,600 t	112,500 t	532,100 t
2020	398,100 t	110,800 t	508,900 t

** not including currently not traceable plastics imported as part of finished goods.*

The domestic and global economic and supply chain challenges associated with the 2020 Covid-19 pandemic did not appear to have a significant effect on the volume of plastic imported between 2019 and 2020. In 2020, 509,000 tonnes of plastic was imported to New Zealand, with 78% (398,100 tonnes) raw material and 22% (110,800 tonnes) plastic products (Table 1).

In the overall context of plastic imports, it is essential to note the actual quantity of plastic imported to New Zealand is higher than the 509,000 tonnes figure.

Plastic is a crucial component of many of the products we use daily.

If plastic is only part of a finished-good component, there is currently no way to track this material into New Zealand [17]. This includes packaging imported as part of finished food products, for example.
Most other economies have similar challenges, and plastics-flow across countries and within trade-zones (e.g. EU), leakage and untracked disposal make a complete plastic flow analysis difficult [18, 19].

However, in New Zealand, brands and non-profit organisations have partnered to solve this material-flow-analysis challenge at a goods/product level.

Of the amount of plastic raw material imported in 2020, 70% were identified as “solid primary form”, i.e. as plastic pellets, flakes or powders (Figure 6).

However, while primary form solids are the most significant material quantity, they only account for 48% of raw material value.

It is not surprising. Material forms such as pipes and tubes or sheets and film have undergone more processing and have a slightly higher value (Figure 6).

The customs-declared combined value of all finished plastic goods was $838 million in 2020.

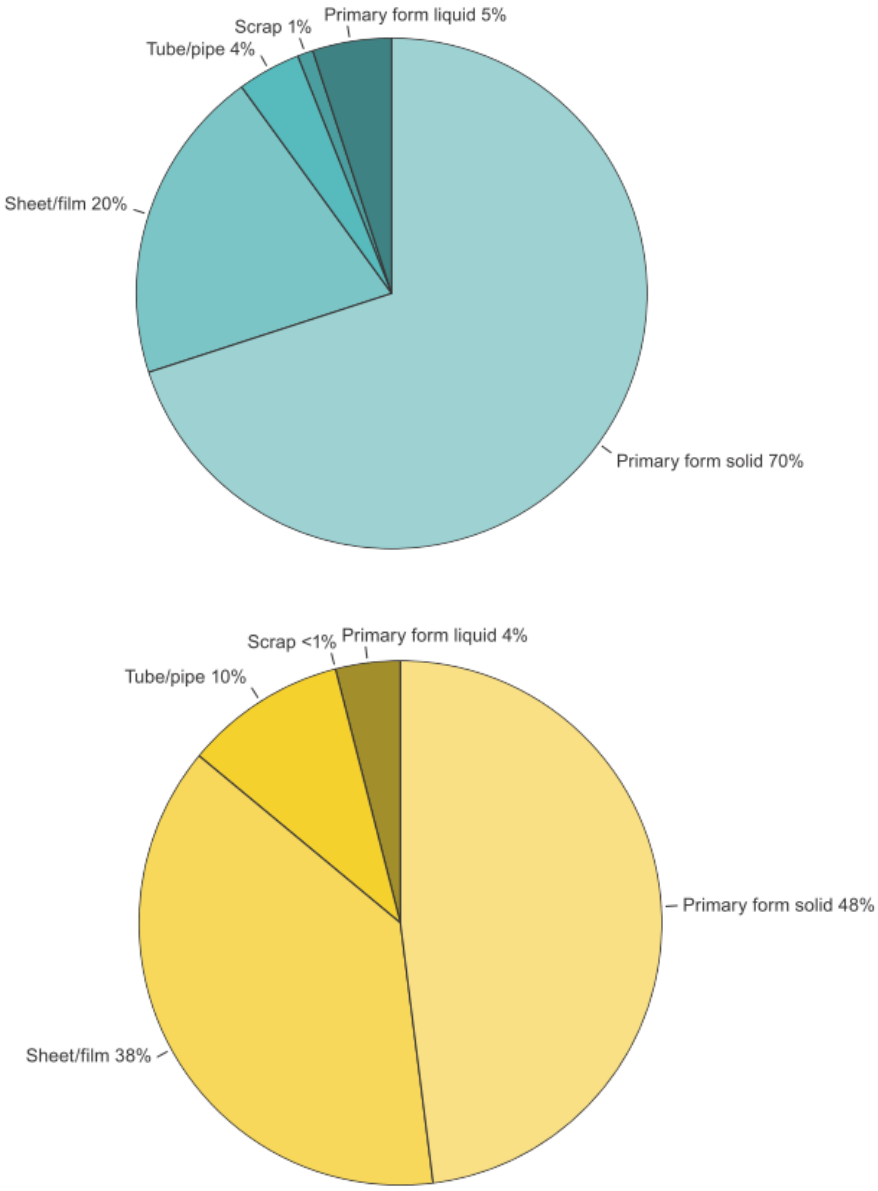


Figure 6: Amount material imported (top) and value of material imported (bottom)

Plastic demand distribution by resin types

By volume, polyethylene-based materials, followed by polypropylene and polyvinyl chloride, are the predominant plastic raw material entering the New Zealand plastics industry. The overall material flow is complex, with up to 20% of materials classified as ‘others’ (Plastic #7) under the resins identification code.

Domestic recycling can be sourced from pre-consumer industrial waste streams or post-consumer recycling operations. Plastic raw material and scrap export have dropped over the last years, while the export of plastic product, as defined above, increased by an estimated $108 million.

Breaking down the plastics flow into different plastic types has been the focus of international studies and many New Plastics Economy initiatives focus on packaging materials and products.

However, to enable a transition of the whole plastics industry, a full overview of different resin types is required.

Globally it is estimated that 60% of plastic is used in non-packaging applications. These non-packaging products need to be part of the discussion, thinking and transition initiatives to achieve a meaningful transition to a New Plastics Economy.

Additionally, the plastic types in circulation in current economies and systems must guide any steps towards changing and improving plastic end-of-life.

The raw material plastic types and their individual contribution to the plastic stream through New Zealand’s value chain are summarised in Figure 7.

There are two critical data gaps to describe plastic material flow in New Zealand fully:

- There is no comprehensive, up-to-date information on plastics end-of-life
- The number and quantity of imported goods and articles that include plastics or plastics packaging cannot be quantified (as mentioned above)

Because of the lack of data on imported multi-material products containing plastics, the quantity of plastic in New Zealand’s economy at any given point is unknown.

This ‘flow of hidden plastic’ is a global challenge - sometimes overcome by assuming easily measurable and trackable domestic products and imported materials are representative of domestic plastics flow [22].

However, due to the additional lack of data on exported finished goods that contain plastic, it not possible to estimate a proportion of raw plastics vs finished goods plastic stream in New Zealand.

The breakdown of imported materials can be used to derive a snapshot of materials used by New Zealand’s plastics industry (Figure 7).

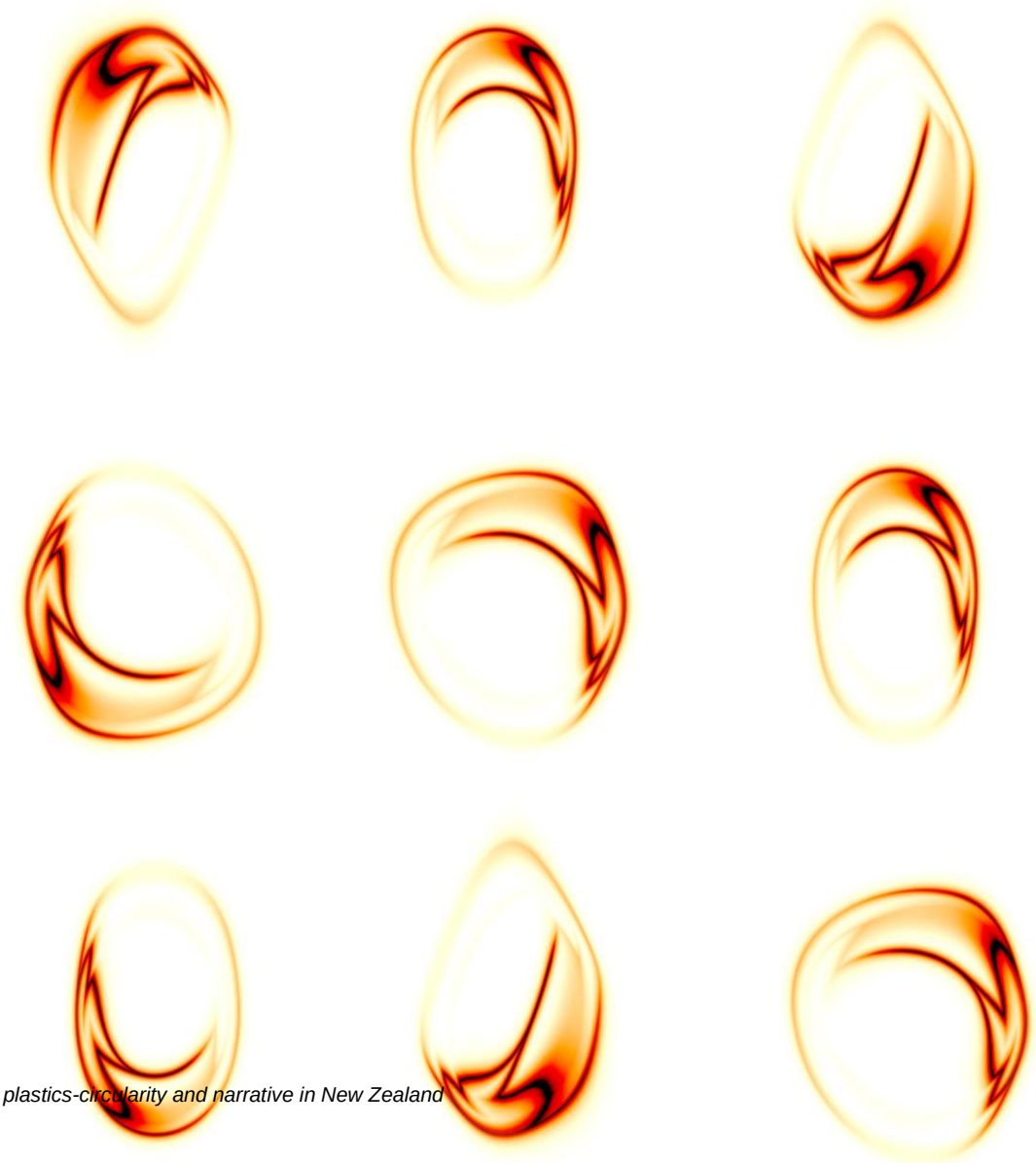
Polyethylene was NZ's most common polymer raw material type in 2020, accounting for 44% of the total raw materials.

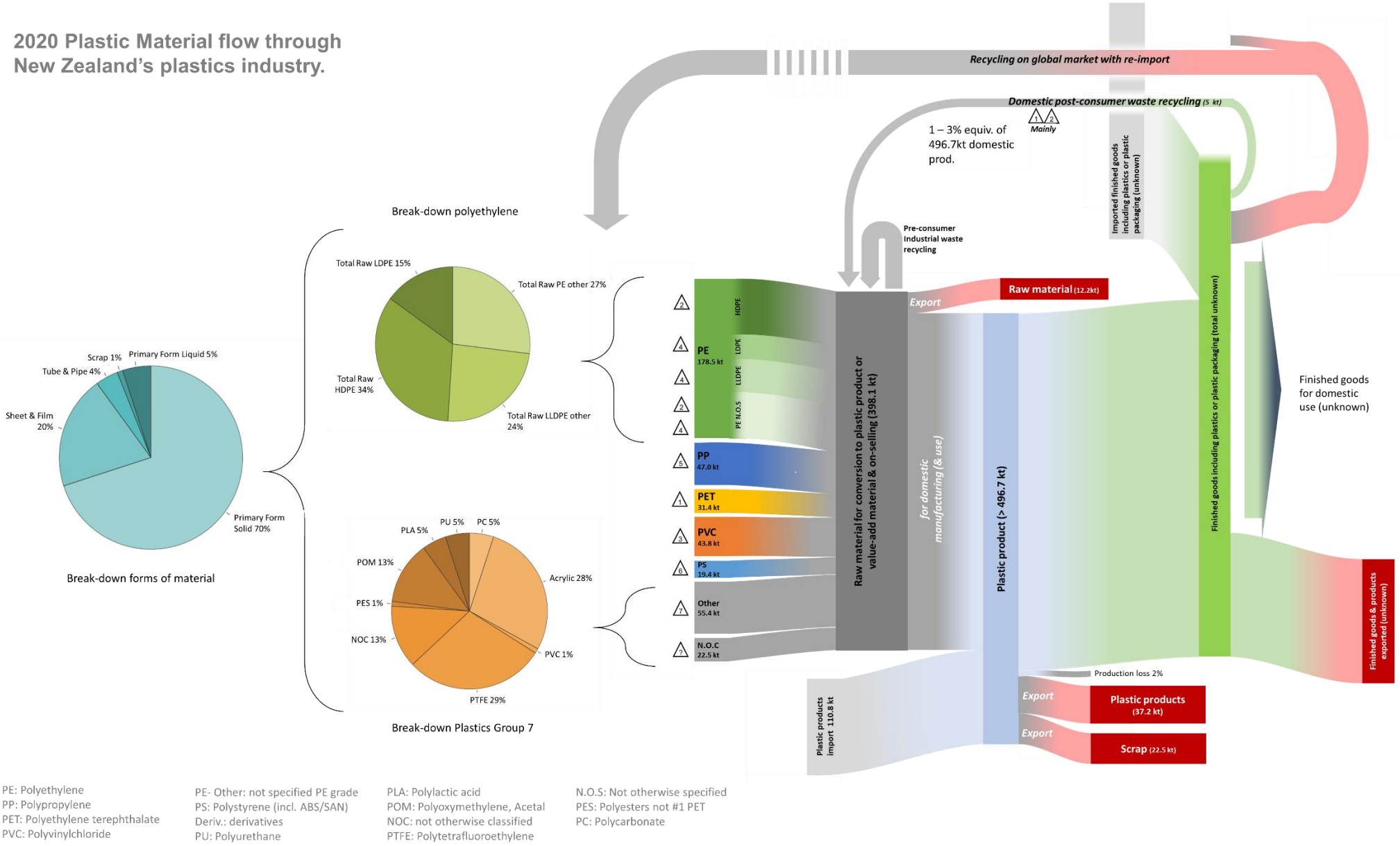
Using the global resin identification code system, polyethylene as a plastic resin is further distinguished into Plastic #2 and #4.

Plastic #4, low-density polyethylene (LDPE) and linear low-density polyethylene (LLDPE), is usually used in thin-film applications, stretch film, paper coating and moulded containers.

Plastic #2, high-density polyethylene (HDPE), is used in bottles (e.g. milk or shampoo), food containers, toys, wrapping and films, pipes, medical devices, water tanks, kayaks and other sporting equipment.

Annual polyethylene use by the domestic plastic industry is split between 34% Plastic #2, 39% Plastic #4 and 27% other polyethylene-based materials such as special grades or material blends.





PE: Polyethylene
PP: Polypropylene
PET: Polyethylene terephthalate
PVC: Polyvinylchloride

PE- Other: not specified PE grade
PS: Polystyrene (incl. ABS/SAN)
Deriv.: derivatives
PU: Polyurethane

PLA: Polylactic acid
POM: Polyoxymethylene, Acetal
NOC: not otherwise classified
PTFE: Polytetrafluoroethylene

N.O.S: Not otherwise specified
PES: Polyesters not #1 PET
PC: Polycarbonate

Figure 7: Plastics flow through the NZ plastics industry (2020)

With about 47,000 tonnes in 2020, polypropylene (Plastic #5) is the second most demanded plastic-type and accounted for around 12% of plastic raw material converted by the industry. Polypropylene has a broad range of application from food packaging, including yoghurt and margarine containers and wrappers, storage containers to carpet fibres, outdoor plastic furniture, medical and veterinary products, road stabilisation and water pipes.

About 49,000 tonnes of polyvinylchloride (PVC) as raw material was brought into New Zealand in 2020, making it the third most demanded resin. PVC is used to build products, including window frames and drainpipes, film applications, linings for swimming pools and water reservoirs, textile and metal coatings, electrical insulation, garden hoses, pools, and tents and medical products.

Internationally and in New Zealand, the use of polyvinyl chloride has been the focus of future material phase-outs. However, these phase-outs target PVC used in packaging applications. In New Zealand, PVC-film and moulded containers are used in some food packaging applications, albeit with few of these manufactured locally.

In 2020, 31,000 tonnes (7.8% of total) of raw polyethylene terephthalate (PET) (Plastic #1) was imported into New Zealand. Polyethylene terephthalate is used in soft drink bottles, food trays and containers and parts made by injection moulding as containers for pharmaceuticals and make-up and housing for electronics.

Depending on the classification of imported raw materials, the quantity of plastic materials classified as Plastic #7 (RIC #7) or “other” is between 14% and 20% (55,000 tonnes to 78,000 tonnes per year).

The 6% (or 23,000 tonnes) variance comes from a group of not otherwise classified (n.o.c) plastic materials that cannot be attributed to a specific plastic type, such as multi-material laminates.

If the current resin classification system is used, the group of Plastic #7 would be one of the biggest plastic types converted in New Zealand.

The relatively large fraction of “other” plastics brought into New Zealand highlights the complexities of the plastic industry. There are many different plastic types, and if the plastic industry beyond packaging manufacturing is considered, many applications rely on the unique properties individual plastics types offer. An example of “other” materials includes autoclavable polyurethanes used in medical devices.

Recycling

In recent years, considerable attention has focused on the shortcomings of New Zealand’s waste collection and recycling system [11, 17, 12].

However, this attention is almost exclusively focused on post-consumer waste.

During the conversion and processing of any material, some waste is produced. This waste source is often referred to as pre-consumer industrial waste. Its advantage over post-consumer plastic waste (‘kerbside recycling’) is that its composition, source and contaminants are known.

The plastics industry is very efficient in recycling its pre-consumer waste. Almost every respondent of our industry survey has in-house capabilities to reduce or eliminate waste-to-landfill and recycle their plastic waste in their products or through agreements with other plastic processors. These processes are highly integrated, and quantification is not possible. One industry respondent highlighted that their main packaging material is currently produced with up to 15% of their (pre-consumer industrial recyclate), others use up to 100 % pre-consumer recycled plastic in selected products [22].

International estimates on losses between plastics production and conversion are in the order of 1% to 2%.

The industry survey results discussed in Chapter 3 show the plastics industry in New Zealand is efficient. Industry estimates material loss, i.e. material-to-landfill, at about 1 %. Extrapolated to the entire industry, we estimate approximately 5,000 tonnes of pre-consumer industrial plastic waste was landfilled in New Zealand in 2020.

Domestic post-consumer plastic recycling is currently limited in plant number and accepted types of plastics. Based on plant capacity and industry data, the quantity of post-consumer plastic recycled and returned to the plastics industry as raw material is about 2-3% (8,000 tonnes to 12,000 tonnes) of the 398,100 tonnes raw material base.

This estimate does not include the estimated 45,000 tonnes of material exported for re-export after recycling in overseas facilities or a mass balance approach on imported recycled plastic resin [14].

Export

The total plastic raw material export in 2020 was 45,000 tonnes ($112 M), mainly from materials classified as scrap (22,700 tonnes) or as sheet and film (12,100 tonnes) (Figure 8).

Polyethylene-based materials were the main export (50%) with polypropylene (12%), not-otherwise-classified material sources (23%) and other plastics (2%) accounting for most of the other exports (Figure 9).

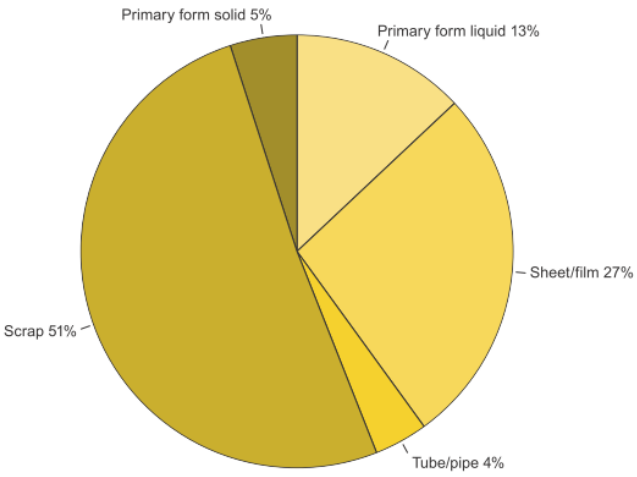


Figure 8: Types of plastic export (2020)

The material value analysis for the 2020 plastic raw materials exports highlights that some plastics are more sought after on the global recycling markets than others [17].
Polypropylene raw material exports were only 12% of the total exported amount but accounted for 23% of the exported material value.

The demand for recycled resins on the global markets is also reflected by a dramatic increase in polypropylene and polyethylene prices in 2021 [22].

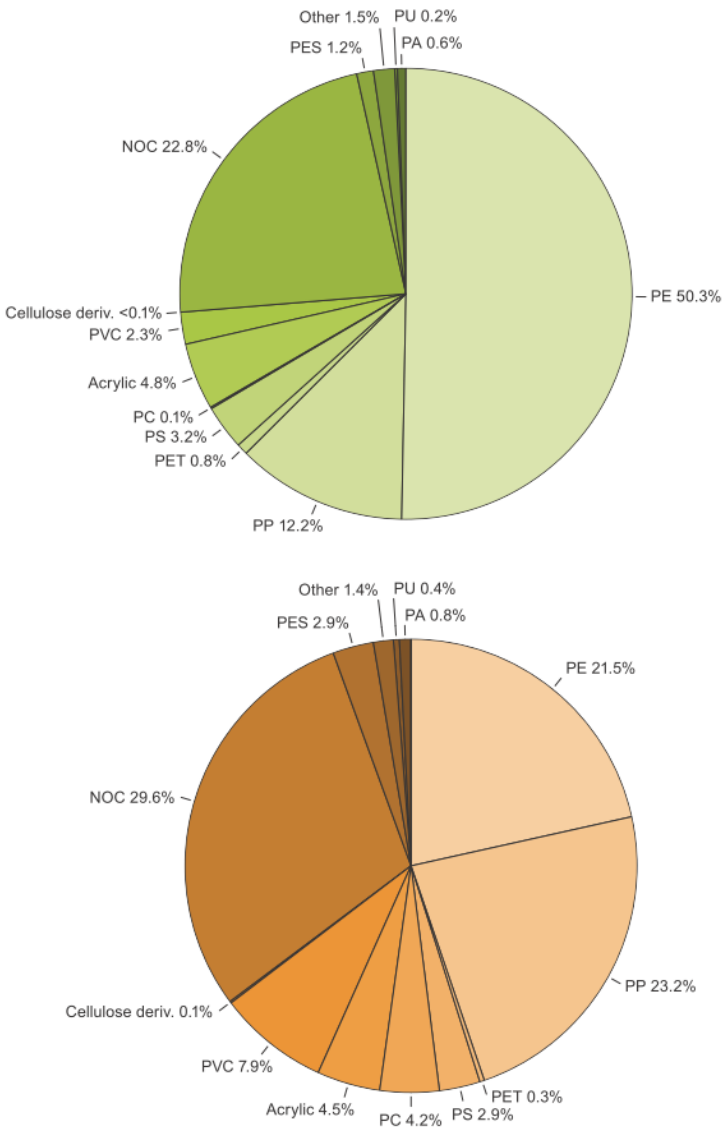


Figure 9: Breakdown of exported material by mass (top) and by value (bottom)

While the quantity of plastic products exported (37,000 tonnes) in 2020 was less than the plastic raw material export, at $322 million the product export had - not surprisingly - considerably higher value.

Based on feedback from plastic industry partners who contributed to this document's development, more than 90% of the NZ industry's plastic products are sold into the domestic market.

Over the past few years, the export of plastic for recycling and disposal has been more limited and regulated because of regional and international legislation [15, 16].

In 2018, the National Resource Recovery Taskforce estimated about 45 000 tonnes of plastic waste collected for recycling in New Zealand was exported [14].

Plastic scrap accounted for 62% of all plastic raw material exports (66,000 tonnes) in 2017. Since then, total plastic raw material and plastic scrap exports have dropped by 32% (21,000 tonnes) and 45% (19,000 tonnes), respectively.

How does the New Zealand plastics landscape compare with international markets?

The main differences in the demand of New Zealand's plastic industry and Europe's are that New Zealand proportionally uses more polyethylene.

In contrast, the NZ plastic industry's demand for Plastic #5 and Plastic #7 is proportionally less than that of Europe and similar to Australia. On a per-capita demand, New Zealand's plastics industry uses less plastic than Australia but more than the UK.

A challenge for the transition of any material-based economic activities or industry sector towards new ways of operation is the diversity of material types and uses.

Europe, including the UK, has the most New Plastics Economic-related policies and initiatives (Chapter 1).

PlasticEurope estimated the EU* converters' plastic demand in 2018 at about 51.2 Mt [6, 20].

Similar to New Zealand, polyethylene-based resins have the highest demand, followed by polypropylene and polyvinylchloride (Table 2).

Table 2: Polymer demand by type and region

Polymer type	Polymer type	EU* (2018)	EU* (2019)	NZ (2020)	AUS** (2018)
Polyethylene	HDPE	12.2 %	12.4 %	15.4 %	19.4 %
	LDPE	17.5 %	17.4 %	17.4 %	11.7 %
	Other PE	N/A	N/A	12.0 %	N/A
Polypropylene		19.3 %	19.4 %	11.7 %	13.8 %
Polyvinylchloride		10.0 %	10.0 %	11.0 %	12.0 %
Polyethylene terephthalate		7.7 %	7.9 %	7.9 %	10.4 %
Polystyrene		6.4 %	6.2 %	4.8 %	1.8 %
Other		26.9 %	26.7 %	19.8 %	17.1 % **

** EU28 + Norway and Switzerland*
*** 13% categorised as "unknown"*

In contrast to New Zealand, the EU plastics industry supplies into a domestic automotive industry (10%), which mainly requires polypropylene and products based on 'other' plastics [6, 1]. As polyethylene is mainly used in packaging and construction and in building applications, the small differences between the EU and NZ industry demand can easily be explained (Figure 10).

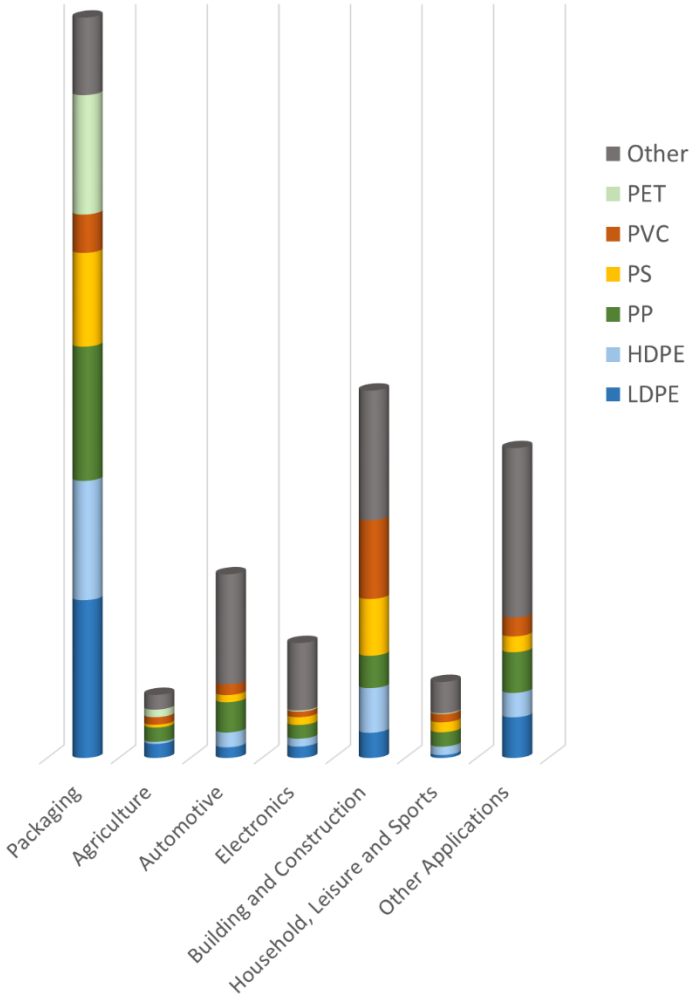


Figure 10: EU28 plastic use by sector 2018 [6]

Two recent plastics markets and plastics consumption studies were published by WRAP (UK, 2020) and CSIRO (Australia, 2020).

WRAP estimated that about 4.9 million tonnes (Mt) of plastic product, both for packaging (2.4 Mt) and non-packaging applications (2.5 Mt), were placed into the UK market in 2019 [1].

With a population of about 66.7 million, the per-capita demand of UK's plastic industry is 73 kg per year.

The 2021 Australian National Plastic plan outlines that about 3.5 Mt of plastic were used in Australia from 2018 to 2019, leading to a plastics per-capita use of 138 kg of plastic every year.

Based on the data summarised above, the per-capita import of plastic product to New Zealand was about 111 kg in 2020.

The 2020 plastic consumption and recovery published data from Australia shows HDPE, followed by PP and 'other' polymers, PVC, LDPE, and PET were the most used plastics in Australia in 2018 [22].

Where we use Plastic in New Zealand?

Packaging, followed by agricultural and construction products, are the main products of New Zealand's plastic industry.

Plastics NZ survey results from 2012 are the most current available data (Figure 11).

The plastic flow analysis for 2012 and 2020 allows comparing plastic types used now and then (Figure 12). The total amount of plastic raw material brought into the country increased from 2012 to 2020 by 71,500 tonnes.
However, the three most significant shifts in import quantity for different plastic types were: A 7.7 percent point increase of PET imports (from 3.8 kt to 31.4 kt). A 1.8 percent point reduction in styrene-based polymer imports, and a 3.0 percent point reduction in HDPE imports

Taking into account international statistics and assumptions on plastics use, shifts in plastic import flows between 2012 and 2020, global plastic consumption and industry survey feedback; we assume the packaging sector is still the main user of plastics converted by the New Zealand plastic industry followed by agriculture and construction.

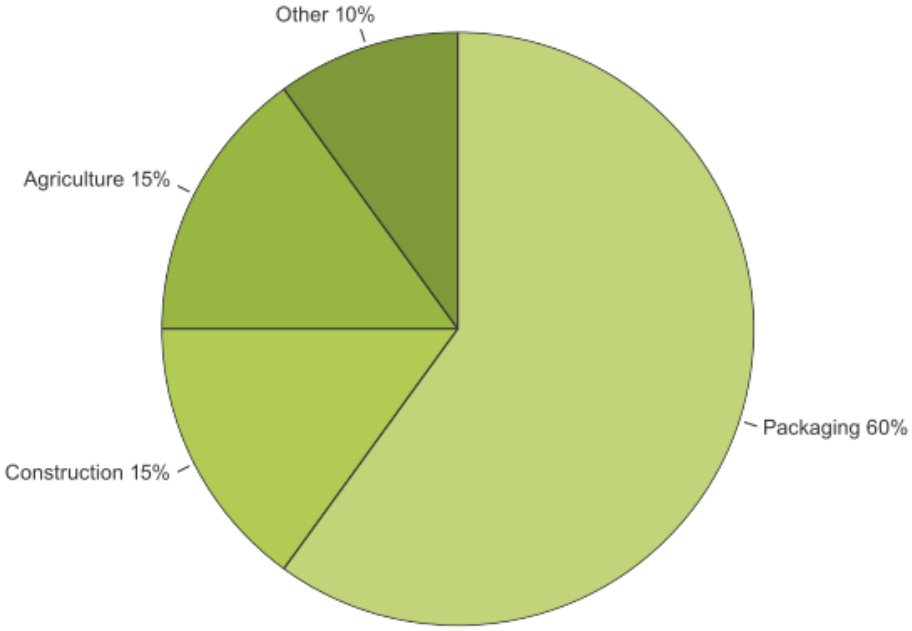
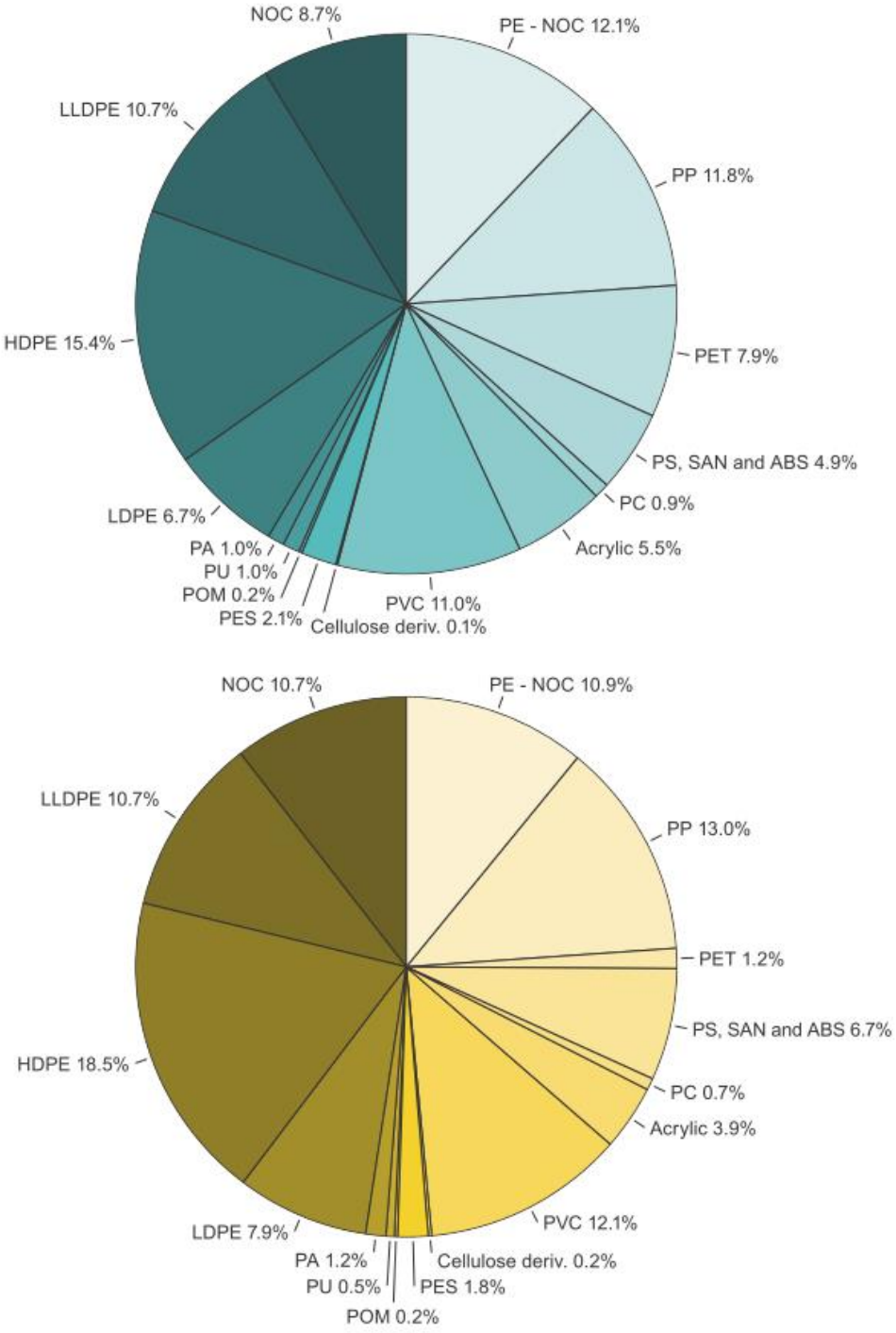


Figure 11: 2012 NZ plastics use by sector [17]



Note: PLA and PTFE have been exluded as they were both less than 0.1% for both 2012 and 2020.

Figure 12: Plastic raw material use in New Zealand in 2020 (top) and 2012 (bottom)

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Chapter 3: Industry response

New Zealand's plastic industry stakeholders and the New Plastics Economy

As outlined in previous sections, this roadmap takes a plastic industry-positioned view on transitioning New Zealand towards a New Plastics Economy.

Globally, successful implementation of this model of a circular plastics economy to reduce environmental effects from plastic "leaking" into the environment and reduce the economic losses from wasted resources will – amongst others - require significant involvement and leadership of the plastics processing sector.

Without the plastics processing sector creating and being part of an effective reduction, reuse and end-of-use system, or decoupling from fossil fuel feedstock – the twin pillars of the New Plastics Economy – a circular model is not possible [1, 2].

As an essential part of this roadmap development, New Zealand plastics industry stakeholders contributed to:

- An industry-oriented status-quo, and
- A future vision in the context of a New Plastic Economy

Industry stakeholders contributed essential quantitative and qualitative information and perspective on material flow, implementation challenges, drivers and opportunities for the development of this roadmap.

Their contribution informed the material flow and New Plastic Economy Future chapters and are summarised below.

In the New Zealand plastics industry, stakeholders have a good understanding of the New Plastics Economy, its global goals and relevance for New Zealand and the sector.

Enabling the diffusion of existing and new technology, material innovation from niche markets and comparatively small-scale to mainstream are the sector's primary concerns in the context of transitioning to a New Plastics Economy.

Fragmentation of plastic waste (secondary resource) collection and its sorting and re-processing, the lack of legislative guidance and support, and the lack of evidence-based industry, brand and consumer education on Circular Economy principles were the barriers identified as hampering any acceleration of the sector's transition.

In 2021, Plastics NZ launched a Waste Minimisation Fund supported initiative on plastic product design in the context of a New Plastics Economy which is a spearhead project. It demonstrates what is possible.

A perceived lack of understanding of circular economy principles by consumers and brands beyond populist "plastic elimination" and "plastic substitution concerns the sector, especially when New Zealand's Zero Carbon vision and targets are taken into consideration.

This lack of understanding of how plastics fit into a low-carbon economy can be detrimental to our progress.

Replacement of plastic with alternatives that increase weight, reduce shelf-life and increase food waste and fuel consumption lead to increased emissions.

The sector's understanding and awareness of the New Plastic Economy

Across respondents, there was a good understanding of the concepts underlying the New Plastics Economy and how these link to a broader circular economy discussion.

As expected for a material conversion-focused sector, increasing recycling rates featured strongly in industry feedback.

Almost all circularity enablers as defined by the Ellen MacArthur foundation featured in stakeholder responses (Figure 1):

- Recycling of plastics to keep existing resources in circulation
- Re-using materials and products (refurbish) to prolong its useful life
- Prolong useful product life by design and materials choice
- Avoid problematic materials
- Use of new compostable options where appropriate or required, and
- Transition to renewable feedstock

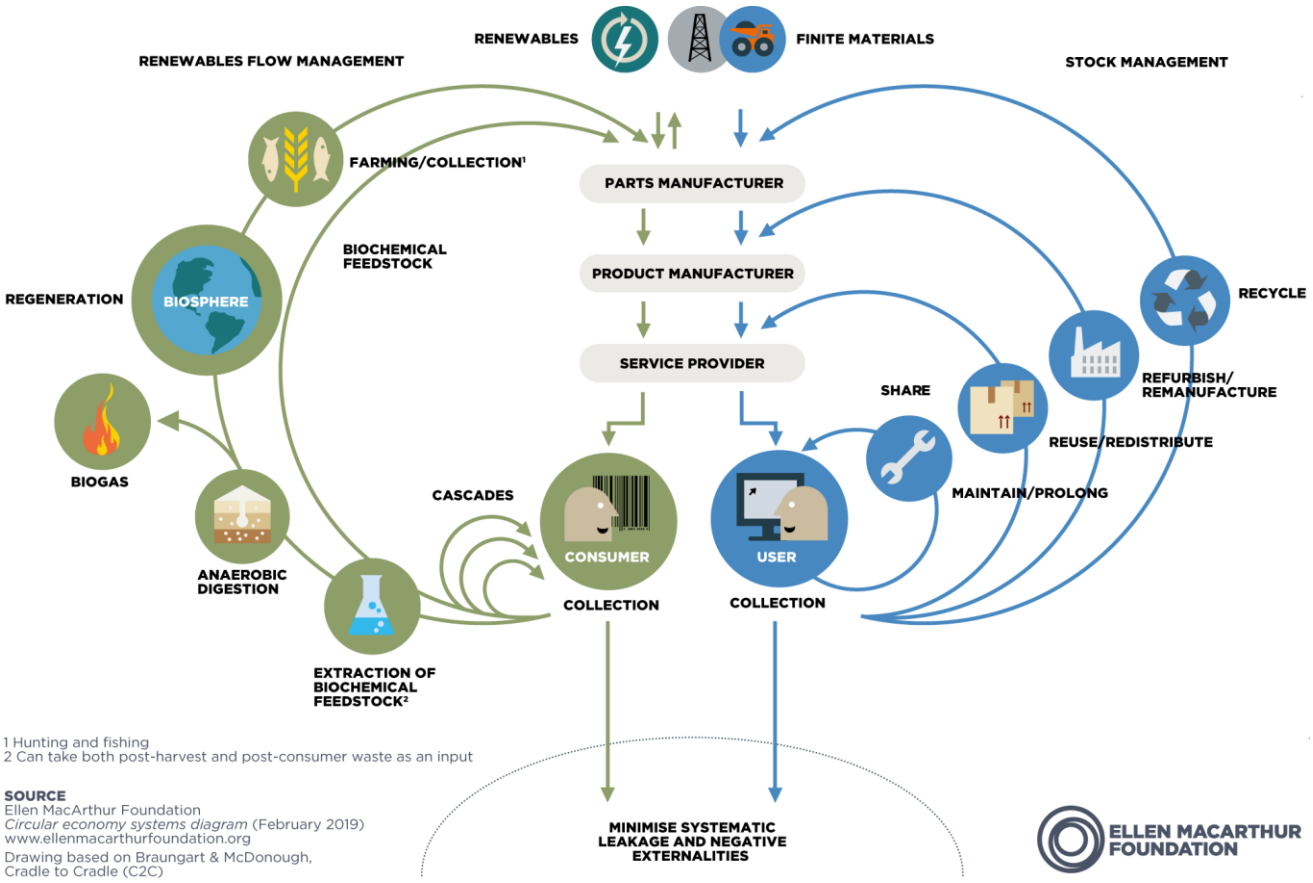


Figure 1: Circularity enablers for a circular economy; by the Ellen MacArthur Foundation

Some of the quotes from plastic industry participants were:

"The new plastics economy relates to the constant circulation and re-use of a plastic item."

"Reusing, recycling and repurposing of plastic waste, Sourcing sustainable products, Reducing our carbon footprint."

"A sustainable approach uses a cycle, where we take renewable resources, use intelligent design to make products fit for purpose, then after use return them to the environment from where they came. This is referred to as a 'Circular Economy', where we unmake what we make."

"This is part of our strategy 2030."

"Finding ways to reduce the amount of plastic that ends up in landfill and undesirable waste streams."

"Using plastic in appropriate ways to maximise its working life and minimise the waste produced."

"Circular/zero waste approach in mindset, behaviour and business. This is such an exciting initiative, and we are pleased to be already operating a zero-waste company."

"The new plastic economy involves a move in peoples thinking away from the linear process of plastic life, such as make, use, dispose into a circular economy."

"Plastic has its place in the market, and I don't believe it can be removed, but NZ is very well positioned to come up with some innovative ways to prevent it having to go back to landfill at the rates it has been."

"NPE should focus on maintaining resources at the highest level of economic value & minimising the volume of food waste that goes to landfill."

"Move away from a wild mix of plastics, recycle as much as possible."

"Circular Economy and New Plastics Economy are just new terms to sell the ideas that have been pushed for a while: Move away from a wild mix of plastics, recycle as much as possible."

"Developing circularity through the entire value chain."

The sector's thoughts on current New Plastic Economy aligned initiatives in New Zealand and globally

The respondents' understanding of global and domestic New Plastic Economy actions was that most actions appear to be in the hands of industry.

The industry is generally motivated and intentioned to reduce or eliminate waste and find ways to close the loop on plastic products. However, international initiatives and technologies are not always directly transferrable to New Zealand, as every market is different.

New Plastics Economic-related initiatives in the New Zealand plastics processing sector are primarily either pre-consumer waste -recycling related or client, consumer or brand-driven. Such initiatives are often focused on increasing recycling content as a circularity driver.

However, some plastic processing companies in New Zealand drive change through in-house initiatives and material substitution by "moving out of PVC and giving customers no choice but to use PET" as a recyclable alternative [8]

Of current initiatives in New Zealand which focus on the New Plastics Economy, recycling-related work is most prominent.

Recycled PET (Plastics #1) and materials changes to rPET seem to have gathered natural momentum. Respondents link this momentum to the established technology and infrastructure in New Zealand. An rPET-derived closed-loop momentum could enable broader New Plastic Economy initiatives, 'pulling' other plastics into recycling systems.

HDPE and PP are also considered material options suitable for closing the plastic loop in New Zealand as there are domestic markets and some re-processing infrastructure.

Some respondents assess material replacement (rethink) options to move away from fossil-based raw materials or more durable or compostable materials. Still, challenges with the public perception of all plastics are sometimes a deterrent to implementing these changes. An additional challenge is the costs of renewable feedstock based options are generally higher than their fossil-based counterparts.

While the link between plastic packaging and circular economy is accepted, well understood and, for example in rPET, already implemented, the extension to non-packaging, durable plastic products are not that prominent. This is most likely due to a lack of consumer pressure. Respondents consider closed-loop options for 'dirty' products as currently not feasible.

Most stakeholders consider their business engaged in the transition towards a New Plastics Economy (Figure 2). Material distributors or resin traders predominantly classify themselves as "other" or "not at all". They are reacting to market and customer needs.

Globally, the resin manufacturers are very involved in the transition and are actively progressing work into advanced recycling and trading of recycling and renewable resins.

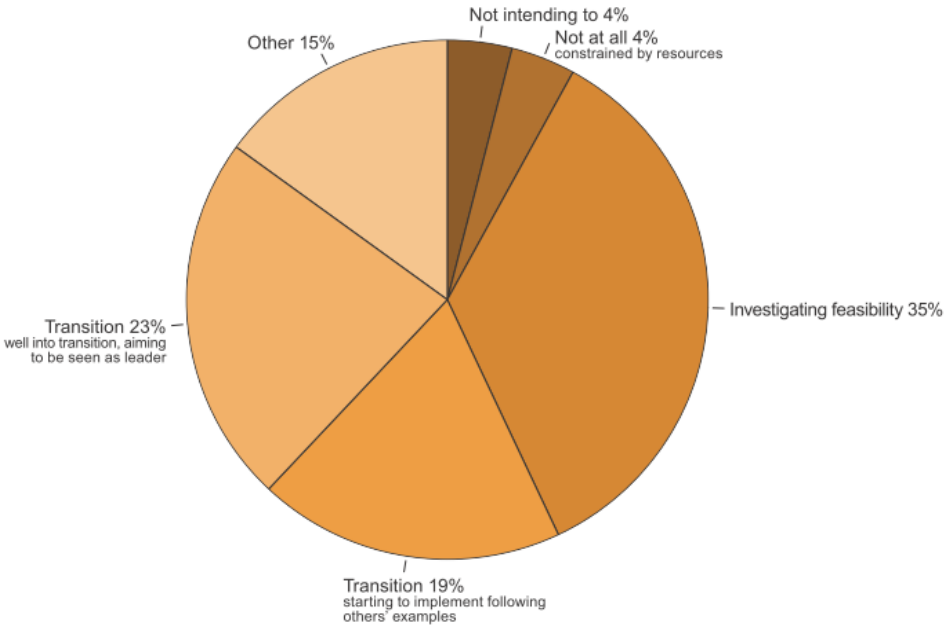


Figure 2: Status of respondents' businesses in terms of transitioning towards a New Plastic Economy.

They are prepared to offer new material options as they become available internationally. However, when the implementation and adoption of new materials are concerned, some respondents highlighted international supply and demand discrepancies, making adoption of new materials difficult even as niche products. This challenge can delay efforts to align operations with New Plastic Economy concepts.

Additionally, New Zealand's small market can make accessing and securing new materials difficult.

"In NZ, the implementation is happening in our recycling sector where valuable polymers like 1,2 and 5 are being identified for their ability to be in a circular model. A number of manufacturers are now onboard to use up the recyclate produced by plastics 1, 2 and 5. The investment of millions into better optical sorters will also help this."

"What is needed is a shift towards a Compostable Plastics Economy in NZ, with funding like recycling, has enjoyed for decades. Compostable plastics have relatively poor barrier properties making it unsuitable for most food packaging, but this will change over the next decade".

"Implementation needs to be led by legislation, e.g. EPS, single-use plastics etc."

"I understand more promotion, advertising and money are being poured into recycling in NZ."

"Not sure, plenty of talk about recycling, but not much action that I can see."

"There is immense pressure on manufacturers and FMCG to move to either 100% recyclable or some to compostable; however, the infrastructure controlled by the City Councils and Government is lagging well behind with very little clarity."

"Industry is ahead of the legislation. The industry producing soft plastics are already well down the road on recycling however nearly all soft plastics are directed to landfill."

"For us, it is impossible and impractical to develop circular usage of the plastic products. We produce products that are not single-use, they are long term plastic structures […]"

"Not much happening in NZ"

"The government are doing some good things, but I am concerned at the lack of knowledge and education on the matter that seems to be undermining the progression."

"What we need to watch is there are others that are attempting to green-wash the market with verbal claims that focus on the area that affects them and their pockets and don't join all the dots of a circular economy."

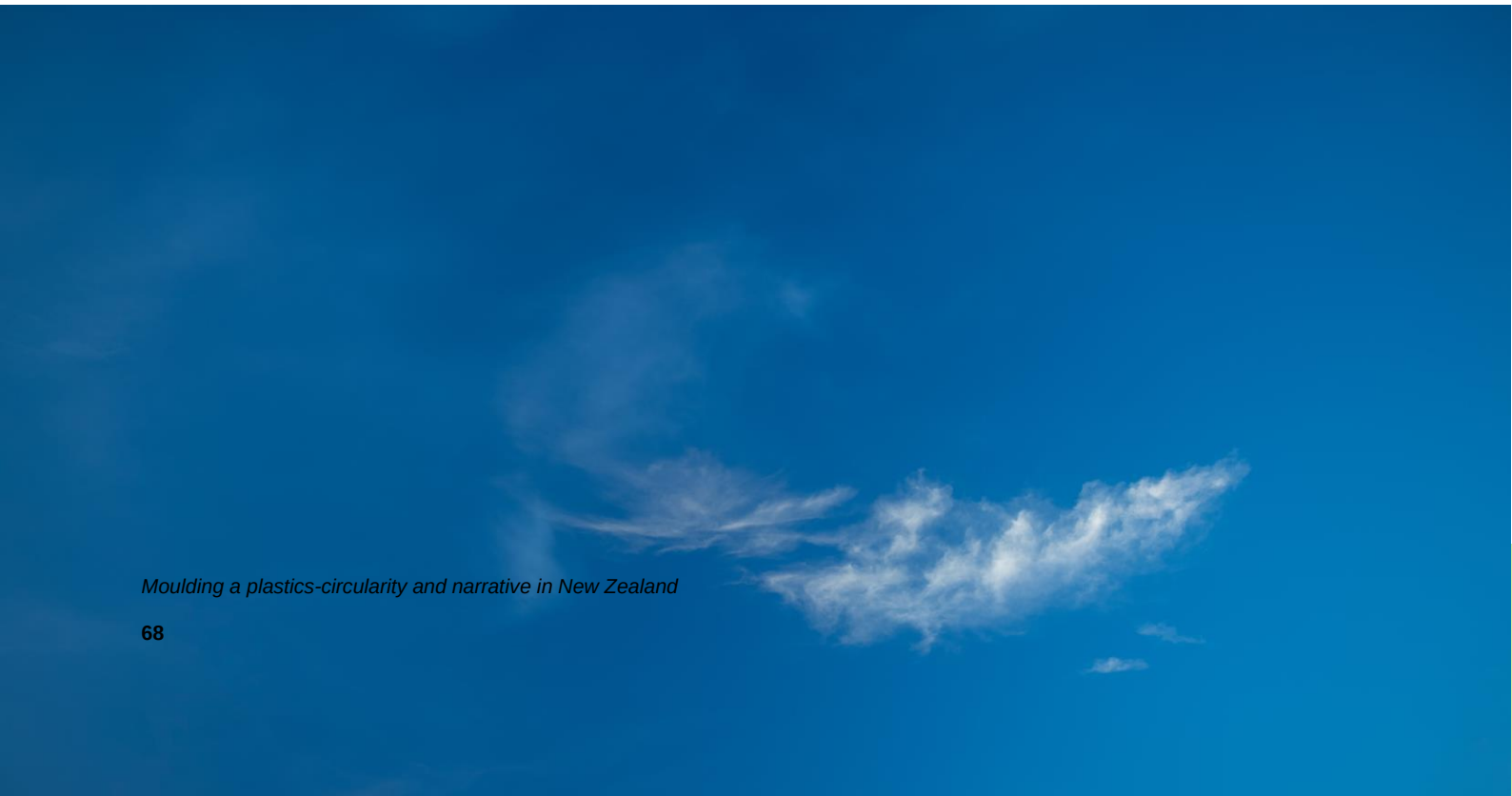
"Overseas bigger markets are enjoying flexible films collection sorting and re-use, rigid packaging re-use, tiny (i.e. pilot plant scale) prefractionation to component monomers, as well as the popular and efficient incineration via plasma gas or similar HT methods for embodied energy recovery."

"New Zealand could lead the way in the way we deal with our waste including plastic, but again unless the culture changes and mindsets change through education, then nothing will change."

"Lot's happening in this space in New Zealand, especially in the recycling of materials. Such initiatives have been pushed since the 1980 but struggled due to fragmented collection systems that is a business and needs to be viable as well. "

"While there are plastic recycling depots/companies that take the plastic away, this doesn't create a circular economy."

The level of progress and actionable steps towards meeting this target varies between participants but Australia has a clear plan for implementation through APCO



The New Plastic Economy in New Zealand - Opportunities, challenges and enablers

Establishing the New Plastic Economy as a circular system in New Zealand will undoubtedly bring opportunities for domestic distributors, processors, and recyclers.

Based on contributors' experience with past and current closed-loop initiatives, their understanding of the New Plastics Economy in a domestic and global context and their in-depth knowledge of their sector, the review highlighted challenges, opportunities, and enablers (or barriers) associated with a New Zealand New Plastic opportunity.

Challenges

The New Zealand plastics industry has already established closed-loop solutions within the sector through pre-consumer industrial waste recycling collaborations and agreements. This has, reduced plastic waste-to-landfill from the plastics industry to landfill to less than 2% (refer to Chapter 2).

However, economic, technological and (increasingly) perception challenges are associated with the continued transition towards a New Plastics Economy.

A lack of industry, government, brand, client and consumer understanding of the material and closed-loop options for plastic and non-plastic alternatives prevents fast and effective diffusion of circular economy initiatives in New Zealand.

Perception, rather than actuality, is driving current transitions and changes. This means the actual effects of changes on established recycling solutions or the environment are often not considered.

If effects are considered, they are often seen in isolation, for example, with end-of-life as the focus rather than low-carbon, whole-of-life or environmental impact.

One 'must' is that standardised and improved identification and labelling of plastics (and other materials) is a requirement for effective closed-loop systems.

The fragmented plastics collection and recycling system has been identified as a significant challenge preventing better closed-loop systems in NZ.

In two instances, respondents do use recycled material in current products but have to import recycled resins. At the same time, missing alignment between council collection and sorting systems leads to recyclable material being landfilled.

Infrastructure investment into the recycling sector is required to increase its capabilities (material diversity), ability to handle contamination, capacity and ability to supply recycled resin for domestic use.

This investment needs to be to be aligned with future rethink and reuse initiatives. *How does will the materials streams on the future look like*? *How will rethink and reuse change NZ plastic flow*?

Generally, the end-market environment limits pre-consumer waste utilisation. However, in some cases, the capital and operating cost of converting pre-consumer waste have been prohibitive to its implementation.

As a product export economy, New Zealand's plastics industry produces goods for many international markets - with different standards and regulations.

These regulations affect which material can be used in which market, for example, recycled plastic, and which end-of-use option is available in the target market.

Similar regulations apply to imported plastics products and goods or overseas initiatives applied in New Zealand, e.g. APCO's ANZPAC Plastic Pact.

While the domestic industry welcomes global initiatives it also highlights every country is different.

This provides a major challenge since as a geographically remote and small market, the integration of New Zealand into the global New Plastics Economy is important.

"A concern is the lack of understanding in all segments of society, of the comparative complexities of the plastics industry, compared with others such as glass, metals, cellulose fibre"

"The lack of understanding of natural end-of-life options for plastics is compounded with the huge volume of willful and ignorant misinformation over decades related to variations on the degradability theme".

"While I understand that we need to move to a "New Plastics Economy", we need to be mindful of all the components which make up the circle, from the design or redesign of a product to production, how we use it and how we re-use it."

"With all due respect to the expressed wishes of Government and authorities, the remoteness of NZ to other consuming markets reinforces that we must not rule out an incineration pathway"

"The main challenge, also a challenge of the past, are council collection systems. There is too much fragmentation. The councils individually go ahead with initiatives without doing the groundwork first, e.g. North Shores PP recycling effort that was done one a "build it and they will come" approach."

"Our products are exported, which means we also have to look at the requirements of the target markets and ensure products arrive safely."

"Different standards across the world are a challenge for companies exporting/importing; Access to these standards and requirements is sometimes difficult"

[…] "while changes are going to help, the new [waste] levy is not high enough to affect real change and to drive away from landfill."

Opportunities

The implementation of new materials, products and processes available on the global market is seen as a business and environmental opportunities for the industry.

New, high-value products for different markets, here and overseas, benefits local manufacturers, while new plastics with improved end-of-life profiles have environmental benefits if implemented appropriately. For example, the use of compostable options where recovery of clean materials is not feasible or the use of bio-based, recyclable resins that enable mono-material packaging applications.

New Zealand's plastic industry already seeks opportunities from recycled materials.

Improving the country's waste collection and sorting systems is an opportunity for short-term success in the long-term transition to a sustainable New Plastics Economy.

While the current narrative around plastics ('plastics are the devil, plastic-free is good') is a challenge, shifting to a fact-based version provides an opportunity to leverage New Plastic Economy principles as progress towards New Zealand's zero-emission goals.

One way is through product stewardship programs - an opportunity for pan-sectoral collaboration to share responsibility and ideas.

The implementation of a plastic circular economy will have spill-over effects into other sectors of the value chain and fast-track general circularity in New Zealand.

One way to achieve this for example, would be through technology and capability, or knowledge and systems sharing.

"Opportunity: Finding cheaper/environmentally friendly ways to produce and sell plastic materials to reduce carbon emissions while keeping viable with international competitors."

"Achieving a New Plastics Economy will require companies to become innovative with product design and polymer choices to fit with this vision."

"A New Plastics Economy is an opportunity for NZ: Better story – new markets to look at. However, the availability of raw material [to support a New Plastic Economy in NZ] is a key factor."

"Developing circularity through the entire value chain"

"The objective being to eliminate waste by recapturing all resources at the end of life for the given plastic product; encouragement of long term re-usability in place of single-use where possible and practical and a comprehensive range of recycling options involving broadening the base of mechanical recycling to cover as many polymers and products as possible, where there is no alternative with superior sustainability. Such alternatives would include a range of chemical recycling options, covering discrete polymer streams and mixed streams according to circumstances".

Enablers

Changing the narrative from “plastic is evil” to an evidence-based discussion will enable future change. Finding the correct term which satisfies all parties is a challenge.

Tying such an evidence-based discussion in with climate change considerations and other policy and framework such as Building Back Better will create awareness on best materials for a specific application.

As a result, an evidence-based discussion will enable future, long-lasting New Plastic Economy initiatives and approaches.

Pan-sectoral industry collaboration, supported by funding, is an essential enabler for a transition towards new systems. Central and regional governments have an indispensable role to play as a funding provider, for example, through the investment of a waste levy or as an enabler through regulations.

A global supply chain trend towards regionalisation, triggered by the 2020 interruptions due to the Covid-19 pandemic, is seen as a potential enabler to realise country-specific New Plastics Economy initiatives. Regionalisation and on-shoring ensure that local supply chains which are less reliant on globalised system transformations can fast track change.

Infrastructure investment in plastic collection, sorting and reprocessing technology is an initial requirement to enable private sector engagement. Economic enablers, for example, tax credits or accelerated capital depreciation, would further initiate change.

Equally, the implementation of internationally established new technology will improve domestic closed-loop systems.

Technical closed-loop systems need to sit alongside new business models for reuse and refill. While the implementation might sit outside the plastics industry as defined here, the sector is an enabler and benefactor.

However, new business models that align with the New Plastics Economy also need to be actively supported by the government.

“Economic enablers, such as accelerated depreciation or innovation-based tax credits would encourage private sector investment”

“To implement meaningful change, the media narrative needs to change from ‘plastic is evil’, to an educational approach-‘how to ensure a quality recyclable product’ ”

“In NZ as a nation, we will not achieve recycled content targets and a circular economy unless money is spent on sophisticated recycling plants and better collection system with clear instruction to the users.”

“The current proposal to finally begin by raising it [landfill levy] to $60 per MT is great, but it must continue to rise annually and by a significant amount. This is essential to drive the change needed to a sustainable circular economy and reduce litter and pollution.”

"The fragmented plastics collection and recycling system has been identified as the major challenge to enable better plastics recycling in NZ. In two instances, the need to import recycled plastic for local production was raised – alignment between council could make increased recycling in NZ viable. "

"We need regulatory measures or customer demand to shift our material base – currently none of the two in place."

"Education is key along with robust recycling options for plastic which of course is easy to say and hard to do."

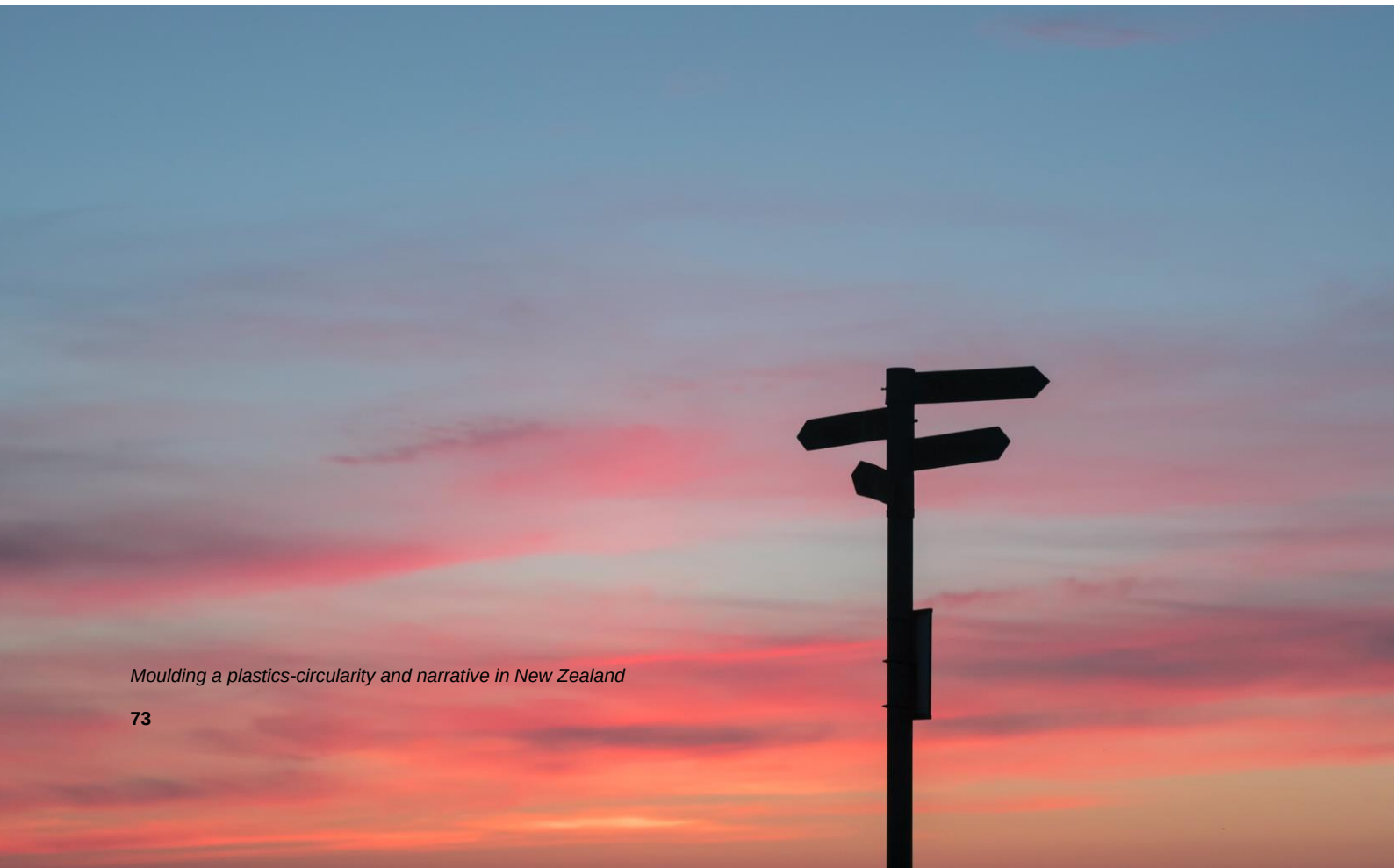
"Product stewardship programs are a great way to share responsibility and share ideas for the good of all rather than any selfish agendas."

"The cost to have a finished packaging product certified is expensive for smaller startup companies like us trying to do good and make change. It would be good if there was a fund available to help companies get their new packaging solutions AS5810 certified as a finished product. Rather than not making it here and importing from offshore."

"Infrastructure: if the government sets the right environment, the private sector makes it happen – the issue is so many different councils, different sorting, different contractors, different collection philosophies."

"We need government support for testing new business models and support for legislative changes to ensure safe reuse/refill for food, beverage and beauty products (maybe even pharmaceuticals)"

"There needs to be an investment into new business models that can be utilised for reuse, refill, circularity, etc."



Potential effects of the Covid-19 (and other "black swan event") related trade disruption

Globally, the Covid-19 pandemic has emphasised the big role plastics play in our daily lives, including health and wellbeing. Personal protective equipment, medical devices using plastics parts, even heavily criticised plastic packaging is essential in saving people's lives [4].

Plastics New Zealand estimates that about 80 % of New Zealand's plastic industry remained at least partially operational during the Covid-19 Level 4 lockdown to ensure essential service supply chains were maintained [8].

Increased demand for some plastics types, due to the increased demand for personal protective equipment (PPE) and medical devices during the pandemic, is expected to remain post-Covid-19 and influence the public's attitude to plastics [4,5].

The pandemic not only led to demand and price volatility but also severe and ongoing disruption in global supply chains [6].

However, despite the challenges that New Zealand's import-reliant plastics industry experienced, the contributors' responses show the Covid-19 related disruption should not deter from New Plastics Economy initiatives.

Indeed, the post-pandemic rebuilding phase is considered a barrier by some but an opportunity by most respondents.

In a post-Covid recovery, higher emphasis might be put on decentralised and regionalised manufacturing to ensure supply chain diversification and business resilience. This might lead to domestic opportunities for New Zealand's plastic industry.

The "Building Back Better" discussion targets resilience towards future "black swan" events and quick and robust recovery [7]. Industry participants have seen the opportunity to build back stronger by transitioning to New Plastics Economy concepts.

"R&D and innovation is essential for us to grow out of this Covid induced depression."

"Covid-19 is predominantly seen as an opportunity, not a distraction or hindrance."

"I see it as an opportunity as businesses have had to pause and reset their way of thinking to keep viable."

"Barrier post-Covid due to the unknown economic conditions, resistance for companies to spend money [but] there could be some opportunities as shipping delays on materials or overseas manufacturing holdups is affected."

"This has had a huge flow-on effect through household recycling practices in my region with council initiatives targeted at reduced landfill."

"Yes, it is a perfect opportunity for growth in new product development. NZ has some of the most creative minds on the planet - we can lead in this space."

"*We are not sure Covid-19 needs to be relevant to the speed at which we move. The speed is increasingly dependent on industry organisations, Council & Government efforts to educate consumers & support the establishment of networks & facilities to support the outcomes needs."*

"I think post-Covid the larger companies that have global supply chains will seriously consider where they can regionalise their supply chains by potentially manufacturing as an example closer to home. For plastics, this could mean more opportunity for manufacturing but along with that means more plastics waste so we would have to develop as an industry and a country a robust circular economy."

"Absolutely, the public is more motivated, and local manufacturing needs to be active in this, as imports are more difficult, so local manufacturing should grow."

"A temporary slowing down as businesses focus on survival first."

"Covid is irrelevant to developing a strategy for handling long term use structural plastic products."

Companies which are struggling financially are also less likely to invest in sustainable solutions. There are some opportunities though in increased awareness and reflection on environmental impacts throughout COVID and it could be leveraged as a trigger for change.

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Chapter 4: Opportunities for the New Plastics Economy in New Zealand

Globally it is estimated that in 2019, 95% of the plastic packaging material is lost to the economy after the first use - equivalent to US$80–120 billion annually [31].

The opportunity for durable plastic product applications is estimated to be at least equal to that of plastic packaging [2]. While (durable) non-packaging plastics usually have a longer lifespan than packaging products, about half of the global plastic articles and materials produced are thrown away every year [9]. This economic loss opens up new opportunities for dialogue within current supply chains, new markets, and potential future value chains and opens the possibility for technological and systems innovation.

The so-called “6R” waste hierarchy is an improved framework from the linear “3R” hierarchy [36]. It is often used to illustrate the transition towards a New Plastics Economy, which includes refuse, rethink and replace [36]. However, circularity within and between different stages of the waste hierarchy must also be considered to create an efficient circular system and closed-loop plastic (Figure 1).

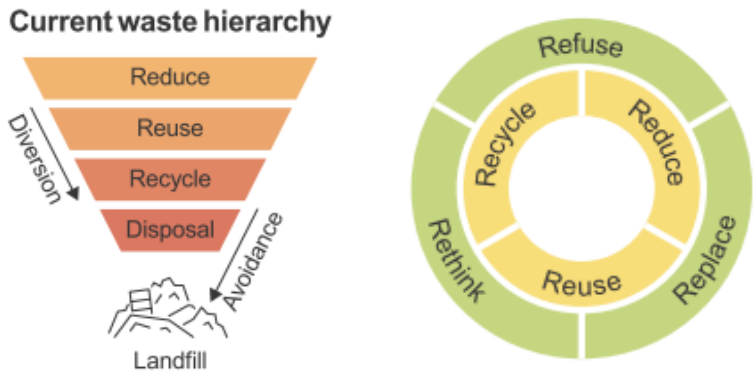


Figure 1: Linear waste hierarchy (left) and the improved 6R resource framework in the context of a circular economy (right)

New Plastics Economy and New Zealand’s plastic industry

The material flow through and within New Zealand’s plastics industry (described in Chapter 2), highlights specific opportunities and challenges in our transition to a New Plastics Economy.

The New Zealand plastics industry relies on the import of plastic raw material and is therefore exposed to supply chain changes and market interruptions.

This challenge offers two main opportunities:

- new materials can be accessed through existing international supply chains, and
- successful materials system innovations that become mainstream will be accessible in New Zealand using existing supply chains.

However, New Zealand's plastic import reliance also creates a significant challenge to domestic plastic converters and processors when transitioning to a New Plastics Economy.

The dependency on global material supply makes it difficult for New Zealand companies to take a leadership position in this area, for example, by offering a portfolio of new New Plastics Economy-aligned materials which facilitate NZ product redesign.

Trade policy is already used to address plastic pollution in a global context. The World Trade Organisation members are implementing procedures, including trade policies, to promote materials that align with the New Plastics Economy [11].

For example:

- "Import tariffs, bans and restrictions on certain types of plastic waste and plastic products" [11]
- "Environmental standards and labelling requirements for plastic products and production processes" [11]
- "Regulations to improve plastic supply chain transparency" [11]
- UNEA discussion on global plastic agreement [44]

Suppose a New Zealand New Plastics Economy is fully reliant on international material supply dynamics. In that case, its end-of-useful-life systems and approach need to reflect the global strategies these materials are designed for.

In such a scenario, New Zealand would take an innovation-follower position in a New Plastics Economy. Innovation in the supply chain is implemented (and de-risked) overseas before the material becomes mainstream here.

This may be appropriate given New Zealand's overall small total plastic import and consumption in comparison to markets where the development of new systems is occurring, for example, USA and EU.

As highlighted in Chapter 3, New Zealand plastic industry stakeholders generally see an opportunity for the country to transition to a New Plastics Economy.

However, investments in new business models, domestic infrastructure, a suitable legislative framework and a cohesive strategy, and better pan-sector industry and consumer education are required to achieve such a transition and system change.

The current gaps between the plastics industry, waste collection, consumers and municipalities in plastic product design, use, end-of-useful-life and recycling cannot be closed by voluntary or legislated system changes alone [31].

Technology, product changes and innovation, underpinned by industry and consumer education, need to sit alongside system changes [36].

For technical innovation, the general consensus in global action plans and frameworks is these must include:

- the designing and mainstream establishment of new materials and products
- sorting technology innovation to provide high-purity mono-material after their first use, and
- innovation in reuse, refurbish, recycle and re-processing technologies

The New Zealand plastics industry needs to be an integral partner in any waste management system changes in New Zealand's economy.

In the current plastic economy, innovation in the value chain is often uncoordinated and fragmented. Quick development, innovation and introduction of new types of plastic products into the supply chain often lead to inefficient after-use systems and infrastructures.

Material development strategies targeting the rethink, replace and refuse parts of the resource hierarchy need to include processing and resource management partners to ensure they do not adversely affect recycle-, reuse-, and reduce- related processes.

Even as more and more local initiatives such as improving collection schemes are launched, efforts remain small-scale and fragmented and often only target plastic packaging [32, 33, 34]. A cross value chain dialogue bringing the different actors together must happen to improve coordination. Only dialogue can enable meaningful change and utilise the environmental, economic and well-being benefits plastics can offer while minimising the trade-offs we have ignored too long.

In packaging applications, the development of new materials suitable for after-use infrastructure can create real economic and environmental benefits [37, 38].

For example, the development of mono-material packaging solutions that perform similarly to their multi-materials peers and that allow mechanical recycling in packaging or durable non-packaging applications or chemical recycling into virgin plastic. Such single-layer film packaging could be used instead of multi-layer packaging for certain applications when barrier properties are non-essential.

This roadmap aims to provide a plastic industry-focused view on the New Plastics Economy, including what current or future plastics processors require for transition.

Naturally, this leads to a more material and (re-)processing-centric view of activities, drivers, opportunities and barriers.

However, to implement a circular economy for plastics, all aspects along the value-chains, including the elimination of unnecessary usage (refuse), material replacement (replace), redesign and use-reduction (rethink), have an essential role.

The study's purpose, summarised in this document, is to take a plastic industry view on the New Plastics Economy. Plastic processors and distributor have an important part to play in the rethink, reuse, and refuse aspects of a resource hierarchy – which will also be required to transition to a New Plastics Economy.

These new business models have not been identified as the critical drivers in the industry consultation, though. Furthermore, these business models are considered to largely sit outside the current New Zealand plastics industry.

Brands, NGOs and communities currently drive many such individual initiatives, but under a NPE, all stakeholders would have to be much more integrated and involved.

An integrated plastic waste management portfolio in New Zealand

As highlighted in Chapter 2, there are many different plastics and even more forms of plastics materials used in products.

To establish efficient after-use systems and processes, the collection of these different materials is crucial.

Presently about 40 % of materials converted by the New Zealand plastic industry are non-packaging (durable) applications. While some of these products will be part of exported goods, durable plastic products currently going into landfill are presently lost.

Innovation in sorting technologies could increase the material value capture after the first use cycle. Improved sorting will make higher-purity materials streams available for reprocessing.

Overseas modern sorting facilities are relatively efficient for metals, glass, or paper using flotation, trammel screens, or magnets.

Plastics remain more challenging to sort due to the high diversity of polymers and grades, which need to be treated separately.

Three main opportunities arise from a sorting point of view:

- Optical sorting technology: Using Near Infrared (NIR) spectroscopy to recognise the polymer and grade scanned. This type of technology has already been testing in the UK to separate food-grade from non-food grade polymers [39].
- Image recognition and artificial intelligence (AI) systems: This could enable the recognition of specific packaging items and even the band in the long term. More research is required to get 100% accuracy and is therefore seen as an opportunity for R&D departments
- Marker technology: this technology is still being developed but could lead to the adoption of markers (e.g. barcode or chemical markers) that sorting machines can read

Improving sorting technologies and processes also needs to extend to non-packaging plastic products.

Globally, only about 39% of plastic is converted into packaging. In New Zealand, packaging products account for 60% of the processed raw plastic. It is likely that a reasonable portion of New Zealands' packaging products are exported as part of New Zealand's primary product exports.

Many of the non-packaging products are produced overseas and imported to New Zealand. If these cannot be directed into an effective and efficient collection, sorting and re-processing stream they will have to be exported as waste, landfilled or incinerated, and lost as resources.

However, the collection of durable plastic products might not be through kerbside waste streams in a New Plastics Economy. Alternative collection and sorting may still be required to complement the kerbside collection processing in so-called Material Recovery Facilities.

Recycled plastic material is not yet available in enough quantity and consistent quality.

New Zealand's after-use plastic re-processing capabilities and capacity (recycling) needs to further evolve to use materials in circulation.
Where recycled material is established and available on the global market, market prices rise significantly due to global demand increase - and availability actually declines.

New Zealand's recycling industry has already started to reconfigure to produce high-quality plastic resin for domestic conversion. Food-grade rPET is already available, with additional capacity expected in 2021. LDPE, HDPE and PP can all be recycled in sufficient quality for use in a variety of applications [45, 46, 47].

In essence, a New Plastics Economy must complement rethink, refuse, replace, reduce and reuse initiatives with materials sourced from either mechanical, chemical or (in the broad sense) biological recycling processes.

For New Zealand's plastic industry, which requires raw material to manufacture products, such an integrated recycling stream is one cornerstone of the transition towards a New Plastics Economy.

It has to be reflected in the vision for our re-processing sector.

While mechanical recycling, (i.e. shredding and melting of end-of-use plastics to mould other plastic items), is a well-established technology for thermoplastic available as a single-material source, there are limits to how much mechanically recycled plastic can be used in applications.

A switch to mechanically recycled material is currently still challenging in many applications. Legal safety regulations, quality considerations, and technical challenges currently prevent the use of mechanically recycled plastic packaging in food contact application – not just in New Zealand but globally [10].

However, mechanical recycling technologies are improving at a rapid pace globally. Most resin suppliers are investigating significant R&D into recycling technology [47]. The current industry view is that mechanical recycling may well be the best option for some materials to achieve a low carbon footprint.

Advanced recycling technologies, (for example, chemical monomer recycling or plastic pyrolysis to a crude (plastic) feedstock), need to sit alongside mechanical recycling to process problematic waste and form an integrated plastic waste management portfolio (Figure 2).

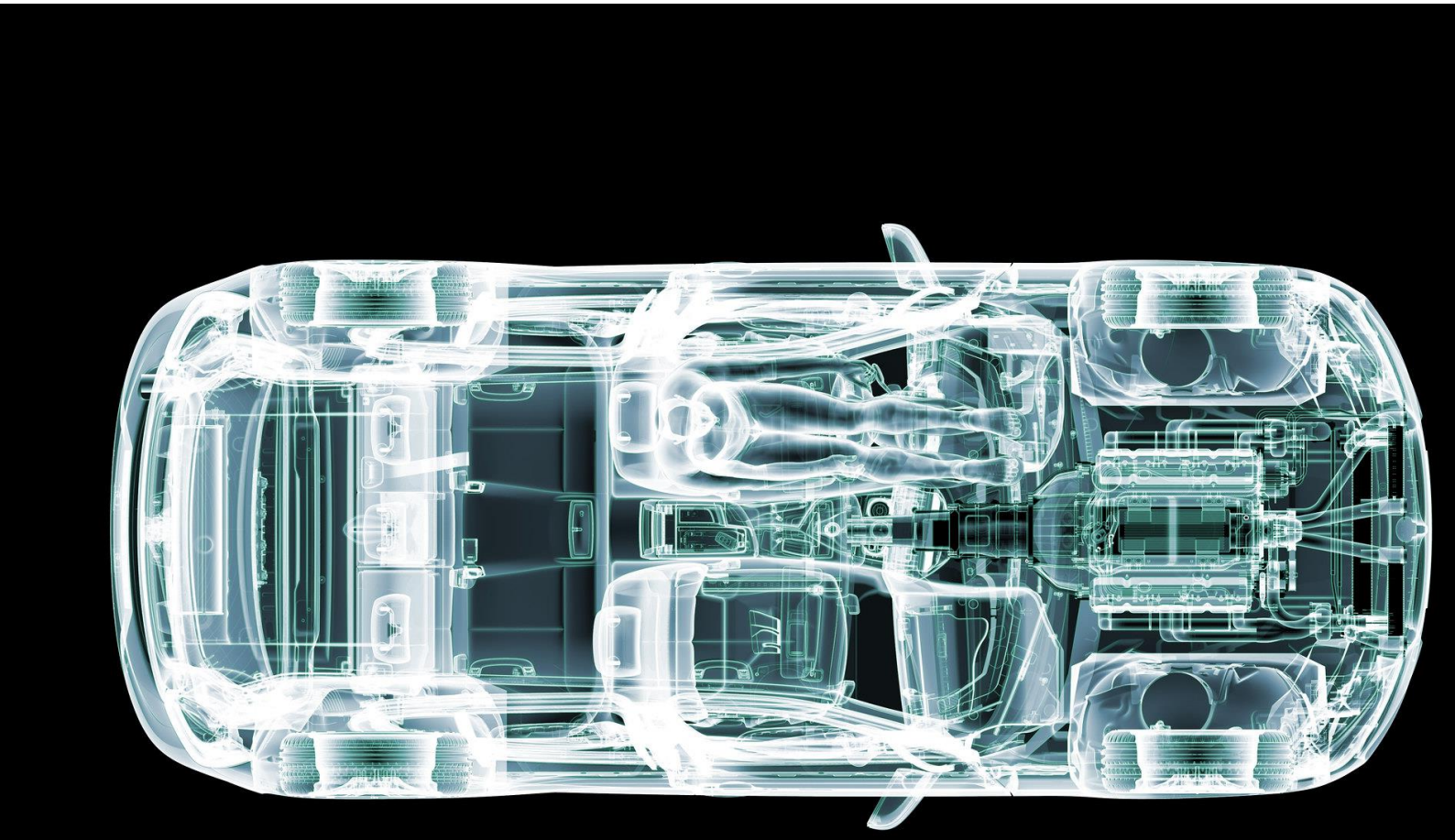
As the individual technology blocks of such an integrated system sit across different sectors, pan-sectoral collaboration is essential to establish and operate such a new value chain and implement a regenerative plastic system fit for a better world.

The challenge for New Zealand's current plastic industry is to enable, support and utilise such an integrated concept to allow a circularity of plastics, while also including the rethink, replace, reduce and reuse pillars for the resource hierarchy. This is especially so considering the relatively low total tonnage of plastic in New Zealand compared with international markets.

Additionally, essential parts of the portfolio do not exist domestically or require modification. An example of this is feedstock related activities (Figure 2).

However, an integrated reprocessing system does not have to be entirely onshore.

Internationally available reprocessing options can be integrated into the New Zealand value chain if it has suitable systems in place. For example, onshore reprocessing of waste in advanced recycling facilities could produce a pyrolysis liquid that is exported for re-conversion into materials.



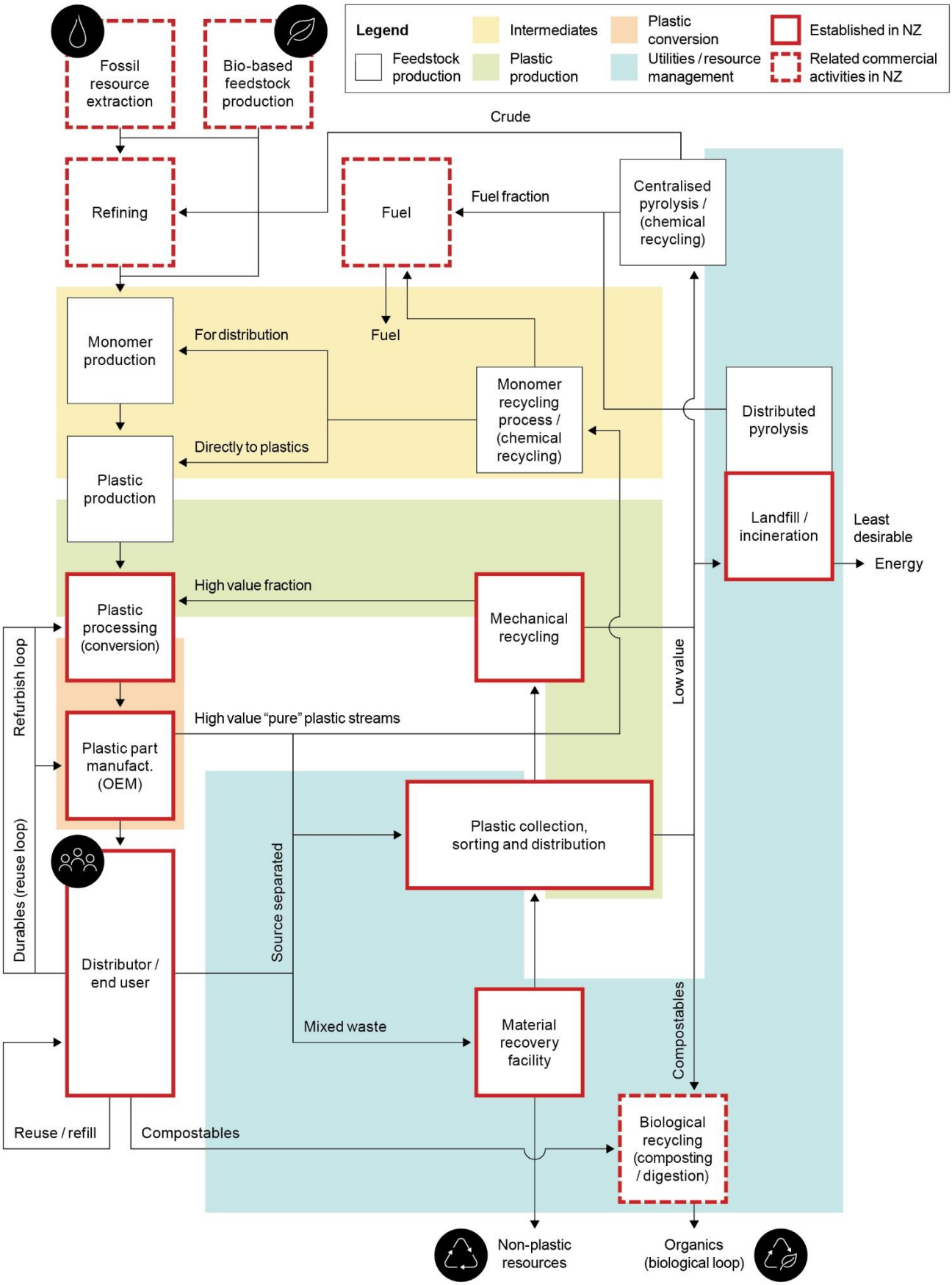


Figure 2: Integrated plastic waste management system combining different sectors and establishing now resource flow (based on adapted international models) [2]

The New Plastics Economy is an environmental, innovation and business opportunity for New Zealand.

Studies on the economic costs, benefits and opportunities from implementing circular, New Plastics Economy systems beyond only transitioning the plastic packaging sector are rare.

It is difficult to estimate the full impact of any transition as it also has to take into account connected economic activities such as new activities from improved reuse or refurbishing operations.

Plastics packaging products only have an average useful life of about half a year. In contrast, plastic containing consumer goods, machinery parts, and building and construction products have an estimated useful life of 3, 20 and 50+ years.

Globally and in New Zealand, 61% and 40% of plastics are used in non-packaging applications, respectively. An exclusive packaging focus neglects a large portion of plastic products.

Business Opportunities

International studies and analysis reports for individual countries and the European Union estimated GDP impact for the transition to a circular economy are between minus 0.8% to 7% GDP [7]. Therefore, the potential direct GDP contribution from a circular economy can be comparable to the GDP loss due to Covid-19 in the first year of the pandemic.

McKinsey & Company estimate the economic benefit from implementing a New Plastics Economy in Denmark at DKK 1.6 billion (NZ $392 million) per year. This is based on reduced plastic imports enabled by improved domestic recycling capabilities [2, 1].

The Danish plastic industry imports around 500,000 tonnes of virgin plastic per year and has a reported collection and recycling rate of less than 10%. Sixty per cent of the converted plastic is used for packaging [2].

Extending the underlying assumption from the Danish study on the economic loss from insufficient plastics recycling to New Zealand, companies and consumers lose about NZ $342 million every year [2,4,5, 6].

Internationally, sustainability and New Plastics Economy related policies are expected to increase in scope and size. Global supply chains need to prepare for future policy changes that some expect to be more radical [3].

“Black swan” events like the Chinese “National Sword” or the Covid-19 pandemic would further strain the global supply network. The OECD expects the increase in material use globally to “increase the pressure on the resource base […] and jeopardise future gains in well-being” [18].

By a transition to a New Plastics Economy, existing plastic resources will be used more efficiently through reduction, redesign, reuse, re-manufacture or recycling.

Implementing these new resource management systems in our economy will boost the resilience of New Zealand businesses to match global supply chain transitions and global sustainability trends and enable them to remain and become more competitive.

Proactive initiatives to transition the New Zealand plastics industry will allow the domestic manufacturing industry (which itself contributes 10% to NZ GDP [17]) to position itself as a leader in the New Plastics Economic materials, products, systems and services.

Globally, the GDP contribution from recycling operations is projected to grow faster than material use or mining [18] from 1.5% of GDP and 3.5% of GDP by 2030 and 2060, respectively.

The OECD estimates the output growth from manufacturing in 2060 will exceed that of the food and agriculture industry at a significantly lower material use intensity.

Transitioning New Zealand to a circular economy system will ensure that its economy, environment and people can benefit from these global changes.

"Manufacturing is a tough gig in New Zealand. You've got to be niche or specialist. Your service, your standards, the support of your customers and everything else has to be first class because there's just heaps and heaps of competition" (Managing director, 'plastics and rubber' firm [19])

Environmental and Climate Change Opportunities

Plastic products such as plastic packaging "can in many cases reduce the emission of greenhouse gases during the use phase" through, for example, reduced transport costs and improved fuel efficiency associated with lightweight parts and packaging, or reduced food loss due to increased shelf-life [29].

However globally, the feedstock extraction, plastic raw material production and linear economy end-of-use options led to 390 million tonnes of CO_2-e in 2012 alone [9].

The opportunities from increased recycling capabilities also extend to GHG emission savings. Plastic resin from mechanical recycling has lower embedded energy compared to virgin resin.

Recycling one tonne of plastic saves 130 million kJ of energy [9].

In 2020, the production-based carbon emissions associated with New Zealand's import of plastic with the RIC codes 1 – 7 alone was equivalent to about 771 kt CO_2-e. PET, PP and HDPE accounted for almost 330 kt CO_2-e [28].

Transitioning these material streams from virgin to recycled feedstock alone could reduce carbon emissions by 230 kt CO_2-e every year [28].

It is worth highlighting that currently, New Zealand greenhouse gas emission (GHG) accounting is done on production- not consumption-basis. Therefore, GHG emissions from resin production are not accounted for in New Zealand, despite the emissions being generated during the production of NZ-destined materials. In its 2021 advice, the Climate Change Commission has recommended to maintain a production-based carbon accounting.

An evidence-based transition to a New Plastics Economy strategically aligned to our GHG reduction targets would enable fact-based decisions within the rethinking, reusing, recycling, repairing and reduction framework.

This approach combines relevant policy metrics to achieve a balance between different economic, environmental and social goals.

The New Plastics Economy cannot sit alone.

Especially in the context of emission reduction, the full value chain and all available alternative materials and product should be considered. This ensures the best outcomes in regard to true environmental, economic and social impact are achieved.

In 2021, New Zealand Post and thinkstep-anz published a life cycle assessment study focused on material replacements for their courier bags. It showed courier bags made with NZ-recycled plastic had a lower carbon footprint than imported recycled plastic bags, virgin fossil or bio-based bags and fibre-based alternatives [21].

This example highlights how discussions and policy around plastic materials need to be aligned with other policies including carbon emissions.

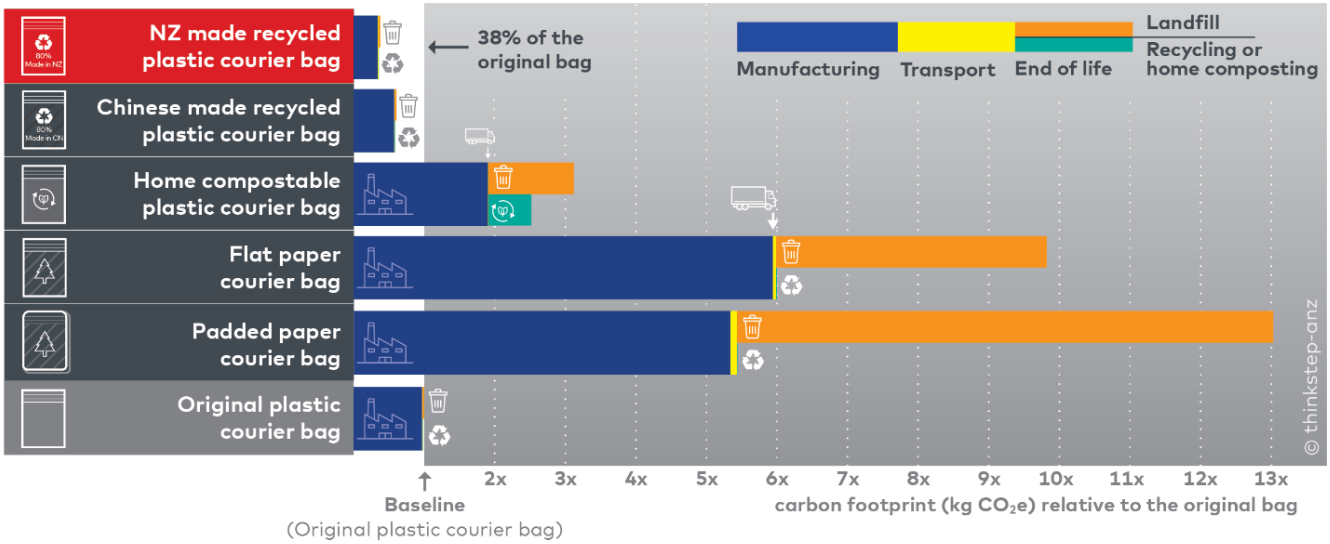


Figure 3: Carbon footprint of New Zealand Post courier bags made for different feedstock available already available in 2020 [21] (© thinkstep-anz).

Pathway to change – Putting the Steps in Place to Create a New Plastics Economy in New Zealand

Short term	Medium term	Long term
Increase government infrastructure investment to improve current collecting, sorting and mechanical recycling capabilities. (including compostables). Develop pan-sectoral NPE government infrastructure investment strategy to create stable investment conditions in the resource recovery and recycling sector and enable ongoing R&D support.	Establish industry-led (government-enable) or -coordinated incentives for additional investment into integrated recycling capabilities in NZ and the uptake of new materials and new operating systems.	Create stable long-term investment conditions to foster and enable the research, develop and implement of new processing technology, products, materials, processes and systems and to advance them to mainstream.
Develop a New Zealand New Plastics Economy Framework as a pan-sector vision that integrates all 6Rs of the resource hierarchy.	Anchor the New Plastics Economy Framework in government policy aligned with the NZ low-carbon strategy, NPE infrastructure and waste/resource management strategy. Refine and extend MfE priority products based on a holistic lifetime assessment.	Establish plastic material (or intermediate) export sector to offset imported plastic goods by exported corresponding raw materials back into the global NPE supply chain.
Development of an evidence-based New Zealand long-term, system-wide collective strategy on plastic beyond single-use & packaging plastics that is aligned with government priorities.	Extend NZ NPE framework or policy to include reduction, capture and diversion targets for all plastic materials in the economy and imported.	Divert any plastic from landfill by maintaining and maturing effective new business models targeting reuse, reduce and recycle.
Establish evidence-based education for industry, brands, governance and consumer education of current and future plastic use, production, end-of-use, innovation and global changes.	Enable mainstream diffusion of new business models for plastic product reuse/refill/repair schemes and embed these in NZ's plastic and broader manufacturing sector.	Establish a 6R resource hierarchy compliance framework for all plastic products.
Incentivise the NZ-specific development and implementation of new business models (e.g. reuse/refill/repair systems). Ensuring new business model opportunities align with government priorities and a pan-sectoral future vision, are evidence-based and suited for New Zealand.	Standardised end of life labelling on all plastics products (beyond packaging).	Establish collection and sorting systems adapted to NZ's integrated recycling capabilities to return materials into the circular resource hierarchy.
Promote and enable the zero-waste hierarchy for plastics in agriculture and horticulture application.	Extend data capture approaches to cross-sectional data capture strategies for all plastics materials in circulation in New Zealand.	
Complete the implementation of efficient and effective container deposit and product stewardship for all single-use / packaging products to divert plastics along with other materials from landfill and reduce plastic-type diversity in easy-to-recycle applications		
Align collection and sorting criteria across municipalities and industry sectors.		
Develop and implement data capture strategies for food & beverage, hardware and construction and farm plastic materials in New Zealand.		

Achieving a New Plastics Economy in New Zealand will require a complete value-chain (systems) approach. Government, plastic processors, manufacturers and retailers, brands, consumers, waste management, and academia need to be involved in the transition to effect meaningful impact.

The transition approach needs to consider several factor specific to New Zealand's plastics industry as highlighted in this document:

- Plastic raw material supply to New Zealand and plastic products imported to and exported from New Zealand is part of a global value chain and decisions made outside New Zealand.
- The existing reuse, collection and recycling structure and plastic value chains in New Zealand are different from most developed countries. Solutions and strategies adopted overseas may not be directly transferable to New Zealand or need adjustment
- As an exporter of packaged primary industry products, New Zealand companies who are clients of New Zealand's plastics industry need to operate within many overseas jurisdiction's regulations

The government will have a critical role in initiating, facilitating and enabling the transition of New Zealand and its plastics industry towards a New Plastics Economy.

Government policy instruments must target the industrialisation and diffusion stages of innovation and technology.

Industrialisation policy applies in the niche market phase and targets market formation. Its objective is to create conditions for companies to enter new niche markets, for example, through:

- Options to accelerate depreciation to release cashflow without liability
- Providing long-term funding loans for new operations not supported by the financial sector,
- Innovative tax credits, and regulations promoting market growth (e.g. feed-in tariffs in the overseas renewable energy sector)

Diffusion policy creates conditions that foster the diffusion of niche markets and technology into mainstream applications by lowering entry barriers for additional players.

New Plastics Economic-related policy instruments in New Zealand need to be developed while understanding that some areas are globally established but require improvement and growth in New Zealand.

Other aspects involve lengthy and higher-risk implementation pathways.

Guidance on policy approaches should be drawn from international energy examples.

In the renewable energy sector, quota mandates mainly stimulate competition that favours short-term success. In contrast, niche market development is favoured by price or procurement guarantees. They foster market development through de-risking early investment [12].

New Zealand plastic industry stakeholders intend to play their part in the transition but understand that systems shift is needed to continue adopting New Plastics Economic principles and be part of the country's transition to a circular economy system.

However, establishing New Plastics Economy objectives and actions requires all industry, consumer and brand owners, and government education, innovation and research and significant additional infrastructure investment to move forward at pace.

It is essential that all stakeholders are involved in the planning and delivery of such initiatives.

We suggest a 3-phased approach to transition New Zealand's plastic industry towards a New Plastics Economy.

Recommended short, medium and long-term actions are based on industry stakeholder feedback combined with relevant international recommendations to transition to a New Plastics Economy (Figure 3).

To support the transition of this sector of New Zealand's manufacturing industry, it is pivotal that government, academia, and private sectors jointly identify, develop and implement circular economy aligned approaches:

- eliminating unnecessary materials and products (reduce)
- replace problematic materials
- increasing durability and reuse, and
- ensure end-of-use options and considerations are included in any product design and available in New Zealand.

Collaboration of industry, government, academia and NGOs is required for meaningful action and progress in any future initiatives.

Short term initiatives

Suggested short term initiatives predominantly target:

- Increased investment in infrastructure to enable and fast-track the private sector's transition to a circular system
- Evidence-based education of all value chain partners to ensure company and government-level long-term strategic decisions are fact-based, and
- Developing a pan-sector vision for early alignment of current and future value-chain partners.

Increasing government infrastructure investment to improve current plastics resource collecting, sorting, and mechanical recycling capabilities is required to strengthen circularity. New Zealand's plastics industry is supportive of the transition towards a New Plastics Economy. However, the domestic recycling sector is only now transitioning from niche to mainstream. Implementing a long-term government investment strategy focused on re-processing infrastructure will create stable conditions to attract private sector investment in the resource recovery and recycling sector. Domestic and international estimates on investment costs indicate $0.2M/kt for material recovery facilities and in the range of $1.07 - $2.00M/kt for mechanical recycling plants, depending on technology and location [39].

Develop a New Zealand New Plastics Economy Framework as a pan-sector vision that integrates all 6Rs of the resource hierarchy. An aligned pan-sectoral approach is required to transform the plastic, recycling and waste management sector to adopt an aligned NPE framework. The example of the "Finnish road map to a circular economy" and the Finnish New Plastics Economy road map highlight how existing

processing and manufacturing sectors should be used to enable a transition in the economy, for example though establishing one pan-sectoral NPE implementation group that unites that sometime disjointed interest of sectors. New Zealand's primary industry and existing bioproduct processing sector needs to be integrated into a New Plastics Economy vision through embedding their thinking into future strategies and frameworks. Any framework needs to consider the resource hierarchy and all its elements: rethink, refuse, reduce, replace, reuse, recycle.

Development of a New Zealand evidence-based long-term, system-wide collective strategy on plastic beyond single-use and plastic packaging. The strategy should create additional consumer demand for New Plastics Economy-aligned products, processes and services (business models) and to eliminate "greenwashing" solutions. A long-term strategy will provide direction setting for industry and investment partners. Using an evidence-based approach aligned with broader government priorities, for example, GHG emission reduction and the Vision for the Agriculture, Food and Fibres Sector, will ensure continuity, longevity and meaningful outcomes. The current focus on the reduction of plastic packaging needs to be extended to other applications and balanced with global innovation progress ("what is possible now and in the future"), domestic implementation capabilities ("what can we adopt now and in the future") and how will initiatives affect and be balanced with other priorities.

Establish evidence-based industry, brands, governance and consumer education of current and future plastic use, production, end-of-use, innovation and global changes. For example, through targeted support for initiatives with pan-value-chain alignment that are underpinned by science, e.g. LCA; or requirements to substantiate NPE related marketing claims.
Plastics NZ's WMF-funded Circular Economy Programme initiative (2021) already targets industry and brand education and will "pull together key parties across the New Zealand system to find national recycling solutions for different plastic waste streams" [16]. Complementary initiatives are needed across the whole chain, including the consumers-level, to generate pan-sectoral support and ensure acceptance of a New Plastics Economy in New Zealand.

Incentivise the New Zealand-specific development and implementation of new business models, for example, reuse, refill and repair systems. Ensure these new business models align with government priorities and the pan-sectoral future vision, and are evidence-based and suited for New Zealand, for example through NZ-specific LCA as sustainability claim support. Rethink, reuse and replace are integral parts of the New Plastics Economy concept. As an important part of the plastics value chain, the NZ Plastics Industry can contribute invaluable input to these concepts and must not be seen as only processors or recycler.

Promote and enable the zero-waste (resource) hierarchy for plastics in agriculture and horticulture application. The circularity focus has to extend from plastic packaging and single-use plastic to other plastics' applications to achieve a New Plastics Economy. For example, fragmented initiatives targeting agricultural plastic already exist and need to be extended in scope and capacity in the short term [15]. Some of this thinking is the basis of declaring Farm Plastics as Priority Products. The pan-sectoral approach mentioned above is important; i.e. bringing primary industry and the plastics industry together to enable new and better ways of working and a New Plastics Economy with benefits for all.

Complete the implementation of efficient and effective container deposit and product stewardship schemes for all single-use plastic packaging products – extend to other packaging materials. Container deposit and product stewardship schemes effectively recover materials if implemented correctly [40, 41]. The currently planned schemes for plastic packaging needs to be extended to other packaging formats, for example, fibre-based packaging. This extension is important in order to not limit consumers' circularity thinking to specific sectors and avoid diversion of efforts towards environmentally less favourable options [29]. Effective stewardship schemes will enable end-of-use reuse or re-processing options. This requires that domestic re-processing facilities and systems are set up to allow future expansion into other plastics applications. Care must be taken when adopting international schemes that fit their specific infrastructure (e.g. incineration) but which might not suit New Zealand [42]. Stewardship scheme collection will also be a first step to fill some of the current plastics data gaps.

Align collection and sorting criteria across municipalities and industry sectors to increase material flow into existing recycling facilities. For example, through improved kerbside collection systems and new, additional durable collection schemes to build the supply basis for additional recycling capabilities in the short-term.

Develop and implement cross-sectional data capture strategies for all plastics materials in circulation in New Zealand. GS1 New Zealand, in collaboration with brands and industry, has already started testing the concept of the "GS1 ProductFlow" service across the food and grocery, and hardware and building sectors [13,14]. The concept and service need to be extended to capture the pan-sectoral plastic flow and enable data-based decision making on future economic viability, scale, scope and location of New Plastics Economy value chain elements, e.g. chemical recycling facilities, distributed pyrolysis units.

Medium-term actions

The medium-term actions focus on the evolution from a plastic packaging focus to other plastic product groups. This needs to be in parallel with the development of a cohesive NZ New Plastics Economy framework and investment system.

Broadening of the plastic focus needs to be combined with the development and implementation of new business models. For example, plastic products and services designed for reuse, refill and repair solution will change the way we use plastics in the future.

Establish government-led or coordinated incentives for additional investment into integrated recycling capabilities in NZ, and the uptake of new materials and new operating systems. Existing mechanical recycling systems need to be complemented by other solutions that keep plastics in the loop. Capital access in the material reuse and recycling sector is challenging even in overseas markets. Policy and incentives to encourage investment or provide risk-tolerant finance options are important for private sector in this area [30].

New processing and material options are unlikely to be fully private sector driven and funded, as even recent advances in mechanical recycling in New Zealand were, in many cases, government co-funded [22,23,24,25]. For example, international studies estimate that pyrolysis-based recycling technology requires about $2.25 M/kt [39].

Anchor the New Plastics Economy Framework in government policy aligned with any NZ low-carbon strategy, NPE infrastructure and waste/resource management strategy. Refine and extend the MfE Priority Products based on their holistic lifetime and usage-cycle assessment. Policy and implementation synergies and interdependencies need to be considered during implementation and associated investment planning and resource allocation. One example is the alignment of a low-carbon strategy with food packaging regulations to ensure new packaging formats have no adverse effects on carbon emissions from logistics or product loss. Support and incentives for industry-co-led research, development and implementation is important to ensure synergies of policies and initiatives are identified and explored. The MfE Priority Products declared in 2020 need to be refined and extended based on, for example, lifecycle assessment results for specific products and their relevance for all government priorities such as GHG emission reduction.

Extend the previous NZ NPE framework/policy to include and target plastic reuse, redesign, reduction and collection targets for all plastic materials in the economy (including imported). Only about 60% of New Zealand's plastic resins are converted to packaging. An effective circular economy needs to target as many product forms as possible. Synergies between product forms can be leveraged through a joint framework. This is directly dependant on the efficiency of New Zealand's plastics data collection, for example, detailed, comprehensive import and export data for different plastics and capture of material flow into products with long-lifetime (construction and infrastructure).

The 6R resource hierarchy applies to all materials in a circular economy. It needs to be considered for all plastic materials, not only packaging.

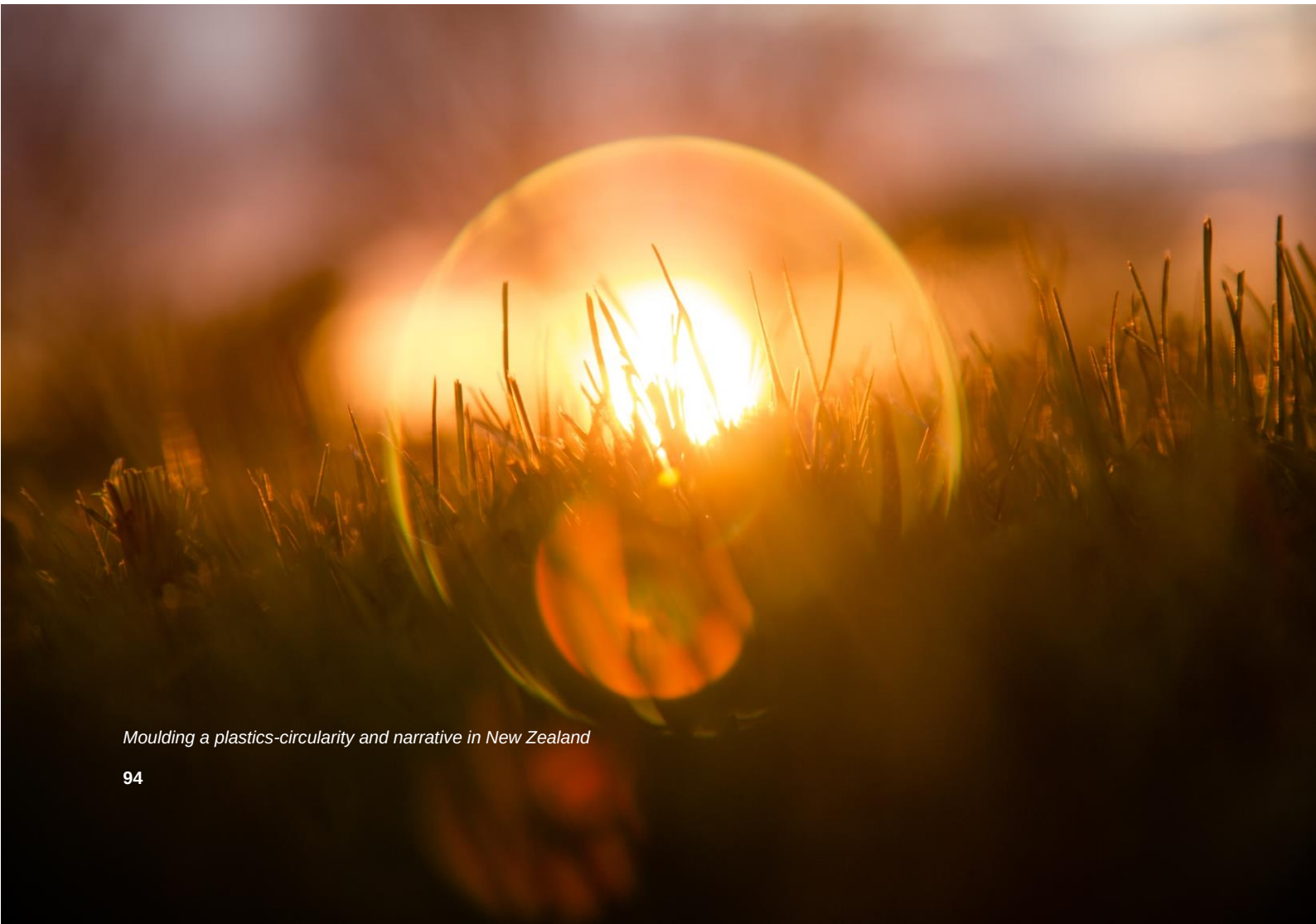
Enable mainstream diffusion of new business models for plastic product reuse, refill, repair schemes and embed these in the New Zealand plastics and broader manufacturing sector. All 6R of the resource hierarchy are core elements of the New Plastic Economy. The plastics supply-chain and plastics industry are key enablers for new plastic products and new business models that make better product and materials reuse, refill and repair a reality. For example, the aforementioned pan-sectoral NZ-NPE implementation group, with government support, would enable two-sided business markets and faster diffusion. Extend effective plastic resource collection systems (e.g. curbside recycling) to enable other schemes, e.g., collecting containers for refill.

Standardised end of life labelling on all plastics products (beyond packaging) is pivotal to ensure efficient collection and sorting of post-consumer materials and resources.

Extend and adapt plastic packaging regulations to relevant non-packaging plastic products, including materials outside plastic packaging in New Plastics Economic initiatives, and incentivise their inclusion in any closed-loop system.

Extend data capture approaches to cross-sectional data capture strategies for all plastics materials in circulation in New Zealand to ensure comprehensive materials data is available to support New Plastics Economy initiatives and policy that extends beyond plastic packaging.

Note: International trading of resources or intermediates (not unrecoverable waste) with other nations with effective circular economy systems should be considered.



Long term actions

Suggested long-term action focuses on the diffusion of any niche technologies or materials required to implement a New Plastics Economy from niche to mainstream in New Zealand.

Create stable long-term investment conditions to foster and enable the research, develop and implement of new processing technology, products, materials, processes and systems and to advance them to mainstream. Medium-term initiatives aim to ensure new products, processes, materials and systems can be developed and established in New Zealand, for example through government funding. However, different investment signals and conditions are required to evolve these to mainstream. Research and development of new products and materials, including traditional materials with new feedstock (bio-PP, bio-PE) and new resins (e.g polyethylene furanoate) need to compete with and, in part, replace incumbents. Support, such as long-term strategy and policy planning, tax incentives and financial risk-transfer or dispersion mechanisms specifically for NPE initiatives may be required to increase long-term investments. The evolution of New Zealand's waste management sectors towards an integrated system needs new products and materials as feedstock. It will be based on technology new to the sector. New systems and product and service offerings will come online that need require integration.

Establish raw plastic material (or intermediate) export sector back into the global New Plastics Economy supply chain to offset imported plastic goods by. A New Zealand integrated recycling (closed-loop) sector, requires balanced material flows to achieve resource circularity. Supply and demand of materials and products need to be balanced; otherwise, excess inputs, intermediates or outputs need to be stockpiled, which is not economically viable or environmentally feasible. Through international agreements, resources can be traded with markets which have implemented circular economy principles, e.g. the New Zealand circular economy trades with players in the global circular economy.

Establish collection and sorting systems adapted to NZ's integrated recycling capabilities to return materials into the circular resource hierarchy. The extension of New Zealand's recycling capabilities and capacity, driven by short and medium-term initiatives as well as product and materials innovation and replacement through the broader circular economy's actions, and their mainstream diffusion in the long term, need to be supported by limiting linear economy end-of-use options such as landfill.

Establish a 6R resource hierarchy compliance framework for all plastic products. Linking plastic products (and ideally all products) with one or more 6R resource hierarchy pillars will allow consumers, designer, brands and manufacturers to make informed choices. It will make end-of-use part of the circular life of a material and product.

Divert any plastic from landfill by maintaining and maturing effective new business models targeting reuse, reduce and recycle. Combined with the advances made due to implementing the short- and medium-terms steps, maturing new business models to mainstream applications, systems and services will enable an effective circular plastic economy.

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Glossary

ABS - Acrylonitrile butadiene styrene

AI - Artificial Intelligence

ANZPAC - Australia New Zealand Pacific

APCO - Australian Packaging Covenant

CE - Circular Economy

CER - Malaysian Circular Economy Roadmap

CIEL - Centre for International Environmental Law

CIS - Commonwealth of Independent States

CO_2-e - Carbon dioxide equivalents

CPA - Circular Plastics Alliance

Deriv. - Derivatives

DKK - Danish krone

EMF - Ellen MacArthur Foundation

EPR - Extended Producer Responsibility

EPS - Expanded Polystyrene

EU - European Union

GDP - Gross domestic product

GHG - Greenhouse gas emissions

GRAP - Global Plastic Action Partnership

HDPE - High-density polyethylene

kJ - kilo Joule

kt - kilo tonnes (1000 tonnes)

LDPE - Low-density Polyethylene

LLDPE - Linear Low-density Polyethylene

M - million

Mt - million tonnes

N.O.S - Not otherwise specified

NAFTA - North American Free Trade Agreement

NIR - Near infrared

NL - Netherlands

NOC - not otherwise classified

NPE - New Plastics Economy

NZ - New Zealand

OECD - Organisation for Economic Co-operation and Development

PA - Polyamide

PC - Polycarbonate

PE - Polyethylene

PES - Polyester

PET - Polyethylene Terephthalate

PLA - Polylactic acid

POM - Polyoxymethylene

PP - Polypropylene

PS - Polystyrene

PTFE - Polytetrafluoroethylene

PU - Polyurethane

PVC - Polyvinyl Chloride

R&D - Research and development

rPET - recycled Polyethylene Terephthalate

SAN - Styrene-acrylonitrile

UK - United Kingdom

UN - United Nations

UNEA - United Nations Environment Assembly

USD - United States Dollar

WMF- Waste Minimisation Fund

WWF - World Wildlife Fund

Appendix – Country and region specific NPE initiatives

England

"Our waste, our resources: A strategy for England" by HM Government (2018)

The 2018 strategy document describes a vision of preserving "material resources by minimising waste, promoting resource efficiency and moving towards a circular economy" [1]. It aligns with the UK governments 25-year Environment Plan. The waste strategy is meant to be a "blueprint for eliminating avoidable plastic waste over the lifetime of the 25 Year Plan, doubling resource productivity, and eliminating avoidable waste of all kinds by 2050." [1] It describes key milestone targets and actions to reach the 2050 goals. These targets are defined in more granularity for the years 2019 to 2023.

The report is structured into eight main chapters:

- Sustainable production (Chapter 1)
- Helping consumers take more considered action (Chapter 2)
- Recovering resources and managing waste (Chapter 3)
- Tackling waste crime (Chapter 4)
- Enough is enough: cutting down on food waste (Chapter 5)
- Global Britain: international leadership (Chapter 6)
- Research and innovation (Chapter 7)
- Measuring progress: data, monitoring and evaluation (Chapter 8)

While the "New Plastics Economy" is only mentioned in the context of international leadership in Chapter 6, Chapters 2, 3, 7 and 8 are also of relevance for the transition of the UK plastics economy.
Chapter 5 discusses the issue of food waste, its impact on the UK economy and GHG emissions. The UK is committed to reducing their food waste at consumer and retail levels by 50 % by 2030.
Waste reduction initiatives, e.g. WRAP Food Waste Reduction Roadmap, and targets, focus on redistribution - with the last resort being "recycling by anaerobic digestion", composting or incineration for energy recovery [135].

The role of food packaging in reducing food waste is mentioned in the context of supermarket layouts. The 25-year Environment Plan includes the introduction of plastic-free supermarket aisles. The authors "believe a balance can be struck which respects both the desire to cut [plastic] packaging and the desire to cut food waste". WRAP is also working with UK businesses on reducing food waste by redesigning current packaging, e.g. shift to re-sealable packaging, pack size adjustments and improved labelling.
In chapter 8, the need for measuring waste, including recycling and landfilling, is identified as a KPI to for the 25-year plan's goal of minimising waste.

The report also includes an evaluation/monitoring approach to ensure the performance of new policies, programmes and projects are tracked. Figure 2 summarises the "headline evaluation plan".

THE UK PLASTICS PACT

Based on the New Plastics Economy vision by the EMF, WRAP and its partner organisations developed a UK Plastic Pact. This was the first national Plastic Pact produced in the world, and the basis of the French and Chilean Plastic Pact documents. It focuses on plastics packaging, especially single-use packaging [2-4].

The Plastic Pact aims to transform “the way that the UK makes, uses and disposes of plastic” by bringing “together governments, businesses, local authorities, citizens and NGOs behind a common vision” and developing a roadmap/action plan to achieve it [4].

The UK Plastics Pact outlines four targets to be achieved by 2025:

- Elimination of problematic or unnecessary single-use plastics packaging
- “100 % of plastics packaging to be reusable, recyclable or compostable
- 70 % of plastics packaging effectively recycled or composted [and]
- 30 % average recycled content across all plastics packaging” [4].

WRAP also states the 2025 targets cannot be achieved “without citizens playing their part.” To increase public awareness and customer education, WRAP’s recycling campaign now focuses on plastics packaging [4].

The Pact identifies 2019, 2022 and 2025 key activities and envisaged key outcomes for each of the four targets outlined above.

For all four targets, the activities follow an identification/baseline (2019), progress-evaluation (2022) and review (2025) approach (Table 1, Appendix 1) [4].

Table 1: Summary of UK Plastic Pact activities

	2019 Activities	2022 Activates	2025 Activates
Elimination of problematic or unnecessary single-use plastics packaging	Initiate material review, develop material tracking systems	Target materials identified	“Criteria for ‘problematic’ and list of materials/items reviewed” [4].
Plastics packaging to be reusable, recyclable or compostable	Plans and guides developed and sector aligned	Trials completed, ready for scale-up; Continued education	Reusable and recycling/composting products commercialised
Plastics packaging effectively recycled or composted	Innovation project setup; new markets identified; Marketing campaigns established	Early success leads to additional funding for implementation; innovation scale-up ready	Funds from producer responsibility are sustaining investment.
30 % average recycled content across all plastics packaging	Flagship projects initiated and strategies outlined	Recycling capacity increased and content specified in products; New strategic partnerships established	“Recycled content in all products sold by members to meet The UK Plastics Pact guidelines” [4]; UK Recycling capacity increased to demand.

A document reporting on the steps taken over the first 18 months was released in December 2019.

Examples of progress made by members for every target is provided in Appendix 1.

Ireland

The 2018 “Plastic Packaging Recycling Strategy” for Ireland aims to solve recycling challenges in the context of the circular economy. It links to the 2018 European Strategy for Plastics in a Circular Economy by the European Commission (EC) in its target setting (50 % of all plastics packaging waste to be recycled by 2025) [5, 6].

The “Plastic Packaging Recycling Strategy” was drafted by Repak after stakeholder consultation and includes the responses “of 65 different organisations and 81 individuals”.

It suggests two phases to transition Ireland's plastics and recycling sector:

- Phase 1 (2018-2020) focuses on data and data gap analysis and stakeholder actions “within their current mandates” [5].
- Phase 2 (2021-2030) will be based on a revised and fully costed strategy to be published by Repak by 2021. This second strategy will recommend further industry and government actions based on the outcomes of Phase 1. The second Phase aims to deliver envisaged recycling targets.

The document recommends well-defined actions and priorities as well as including owners, to achieve the Repak’s Plastic Packaging Recycling Strategy vision. The quantification of plastic flow and plastic packaging waste is outlined as “one of the priorities for the National Waste Prevention Programme” and included in urgent actions (refer to Appendix 5 for details) [5].

While the document states a ‘whole systems’ approach is needed to achieve the strategy, it identifies the critical role government has in co-ordinating different elements. It also recommends that Repak facilitates future collaborations as a project central point.

Chapter 5 (“Design”) outlines challenges in current product design which also applies to New Zealand. For example that “packaging is designed and produced at international scale, and is not tailored to local recycling markets”, and that there is no agreed definition of recyclability [5]. Consequently, “the adoption of global guidelines/standards compatible with Ireland’s needs” is recommended [5].

Furthermore, in Chapter 6 it describes that “achieving economies of scale for Irish MRFs and reprocessing facilities” is challenging and that investment in improved recycling facilities in Ireland has been slow [5]. Suggested actions to address these challenges include:

- assess the feasibility of subsidies/penalties for materials depending on their complexity-to-recycle,
- “examine feasibility of a re-processor subsidy”, and
- “develop options to mitigate market vulnerability”.

The 2018 – 2030 strategy document’s appendix summarises the key issues of different stakeholder groups which were collated in the consultation phase. It separates between:

- manufacturers of plastic packaging
- waste collectors
- reprocessors and waste collectors
- sector representative bodies and
- education.

The challenges highlighted by the plastics packaging manufacturers were:

- Effective communication to support behaviour change and increased awareness
- “Behaviour change/awareness should be both incentivised and penalised” [5]
- Greater investment in infrastructure required to encourage recycling, e.g. better sorting
- “Financial incentives for companies that use recycled material” [5], e.g. through a tax incentive scheme or fee clawback models
- A collaborative approach to implanting voluntary incentives in recycled content and a supply-chain-wide approach to improving recycling rates.

France

The French Nation Pact on Plastic Packaging was published in 2019 and draws from the EU Strategy on Plastics, the Circular Economy Roadmap and the EMF New Plastics Economy Global Commitment. The business signatories of this French national document committed to:

- define steps to eliminate “problematic or unnecessary plastic packaging by 2025, starting with EPS.” (Expanded Polystyrene) (e.g. eliminate PVC packaging by 2022) eco-designing packaging to make it reusable, recyclable or 100% compostable by 2025
- collectively reaching 60% of plastic packaging recycled by 2022
- incorporating an average of 30% recycled plastics into packaging by 2025 [3, 7].

The signatories’ commitments draw directly from the EMF documents and vision but the French Plastic Pact also includes commitment timelines and signatories specific to France.
At the time of writing, the Pact signatories were Auchan Retail France, Bouvard Biscuits, Carrefour, Casino, Coca-Cola European Partners, Danone, Franprix, L'Oréal, LSDH, Monoprix, Nestlé France, Système-U, Unilever and the NGOs WWF France and the Tara Expeditions Foundation [3].

Additionally to business commitments, the French government supports the Pact by committing to:

- ban the “use of EPS in food containers and single-use plastic cups” and enforce “the elimination of PVC”in packaging by 2022explore the implementation of various financial mechanisms to incentivise redesign of products, particularly regarding recyclability, reuse and integration of recycled material
- evaluate concrete ways of improving collection, sorting, recycling and recovery schemes, and the related investments
- collectively achieve 60% of plastic packaging effectively recycled by 2022
- strengthen recycling infrastructures and innovate collection mechanisms that improve performance and target effective value sharing with all stakeholders by 2025
- encourage the co-creation of innovative solutions between public and private research” [7]

The public sector commitment outlined in the French Pact focuses on “leading awareness-raising and educational activities with the general public on the issues related to plastics pollution” [3].

Importantly, the vision of extending the Pact on Plastic Packaging to “all types of plastics products and packaging”, including textiles and micro-plastics and “all segments f the plastics value chain” is clearly spelt out as a vision for subsequent initiatives. However, no date for this second phase of transition is specified [7].

Within the “Circular Economy Update” by the European Sustainable Business Federation the French “proposal for VAT […] penalties on non-recycled plastic” is highlighted as an example of good circular economy practice [8].

Netherlands

“A Circular Economy in the Netherlands” is an overarching circular economy vision document, not explicitly focused on a plastics related roadmap. However, it forms the basis of the Dutch Pact, therefore summarised here.

The circular economy document published by the Dutch Ministry of Infrastructure and Environment and the Ministry of Economic Affairs in 2016 outlines “a vision of a future-proof, sustainable economy” for the Netherlands. This vision is to be realised by “developing a circular economy in the Netherlands by 2050” and a “50 % reduction in the use of primary raw materials by 2030.” The government document summarises current steps, initiatives and regulations and as well as an outlook to future steps to achieving the 2050 goal [9].

The document is structured in five chapters. Circular economy in a global/EU and Netherland context is discussed in Chapters 1 and 2, respectively. Chapters 3 and 4 explain the Dutch Cabinet’s ambitions and vision, and a transformation strategy. Government interventions are summarised in Chapter 4. Chapter 5 describes “efforts for the priorities that will be addressed first” with one section discussing plastics. The priority

criteria were based on the importance to the Dutch economy, environmental impact, existing social energy to drive economy transition and alignment with EU priorities.

The five priorities are:

- Biomass and food
- Plastics
- Manufacturing industry
- Construction sector
- Consumer goods

Priorities similar to NZ's products also exist in the Netherlands, with manufacturers and importer responsibilities for cars, tyres, electronic goods, packaging and batteries [10].

The 2050 vision document does not differentiate between plastics of different applications (e.g. packaging vs. manufacturing). However, in its vision it allows for the consideration of technological feasibility: "In 2050, 100% renewable (recycled and biobased) plastics will be used without any harmful impact on the environment, wherever such is technically feasible" [9].

Furthermore, by 2050 plastic products have been designed for a circular economy, new markets for recycled and bio-based plastic have emerged and the global plastics value chain has been closed through international collaboration.

Three strategic goals to achieve the 2050 vision were defined: Plastic products are designed in such a manner as to enable reuse and high-grade recycling after being discarded

- Plastic materials in value chains are utilised as efficiently as possible, which would lead to a reduction in the need for raw materials and the prevention of "leakage" in the system
- Optimisation of the renewable use of plastic material flows, by large-scale usage of plastic recyclates and biobased plastics, and making use of biodegradable plastics in specific situations in which such plastics have added value for the circular economy (more effective joint processing with biotic residues; pollution risks for the marine environment)

The "upscaling of bioplastic production", development of circular design guidelines for plastic producers (2013), a plastic bag ban, and plastic ocean-litter initiatives are described as ongoing national actions to achieve the 2050 vision.

The document also outlines the need for a plastic flow analysis. The Dutch plastics flow monitoring system was started in 2016.

Changing product "designs […] to increasing the use of plastic recyclates, upcycling, longer shelf lives, and improved repairability of plastic products", innovation, "usage of renewable (recycled and biobased)" and biodegradable materials as well as "international closure of the plastics value chain" are future planned actions.

The economic potential for Dutch businesses to benefit from knowledge and expertise "in the field of plastics clearance, but also regarding the prevention of marine litter" is explicitly mentioned [9].
The 2050 vision document does not specify targeted actions/date or detailed steps for future action or to realise the vision. However, the 2050 vision is the basis of a subsequent more detailed document by the Dutch government.

In 2019, the Dutch government published a Circular Implementation Programme, which, relating to plastics, includes that "government and industry will work together to reduce plastic waste. They will also make other waste more readily reusable and recyclable. These efforts will take place under the Plastics Pact" [11].

The Dutch Plastic Pact brings together "parties [that] want to do more, with less plastic in the circular economy". It includes companies predominantly from the fast-moving consumer goods and recycling industry – 75 signatories in total. The parties agree to take actions, that by 2025all single-use plastic products and packaging that the Plastics-Using Companies place on the Dutch market are reusable where possible and appropriate, and are in any case 100% recyclable. Each of the Plastics-Using Companies avoids unnecessary use of plastic materials through reduced use, more reuse and/or use of alternative, more sustainable materials, resulting in a 20% reduction in the amount of plastics […][…] The Plastics-Producing Companies will have created sufficient sorting and recycling capacity in the Netherlands so that at least 70% of all single-use plastic products and packaging […] are recycled […] [12]

- All single-use plastic products and packaging marketed by Plastic-Using Companies will contain the highest possible percentage of recycled plastics, with each company achieving an average of at least 35%
- Moreover, the plastics used will as much as possible be sustainably produced biobased plastics, in order to reduce the use of virgin fossil-based plastics" [12].

Unlike the UK, French or Chile Plastic Pact, the Dutch Pact does not use the EMF New Plastics Economy as the basis, but the Dutch 2050 Circular Economy vision described above.

Scotland

The Scottish Government has published a strategy document titled "Making Things Last: a circular economy strategy for Scotland" in 2016 [13]. It aims to identify priorities for transitioning the Scottish economy to a circular model where "products and materials are kept in high-value use for as long as possible" and builds on the EMF circular economy model [13, 14]. The document takes a material/product overarching approach in its strategy setting and does not focus on plastics products or the plastics industry.

The document summarises targets on waste reduction in 2025 that were set by the Scottish government and the EU, i.e. waste prevention to reduce food waste in Scotland by 33% by 2025.
One focus is design, including the design of products, the design of business models and the design of services and processes.

Priority areas to "improve awareness and capabilities around" circular economy models and implementation are

- calls for circular design projects through an EU-funded circular economy investment fund and
- company support to develop and implement circular economy business models.

"Reuse" focuses on second-hand goods.

The recycling vision is built on the “target to recycle 70% of all waste and to send no more than 5% of all waste to landfill” by 2025. The Scottish government has put a four-pillar framework in place to support the development of a circular economy:

- Requirements for separate waste material collection (2012) [15]
- A consistent approach to household recycling collection systems [16]
- A Scottish Materials Brokerage Service (initially established for glass, commingled materials and non-recyclable waste in 2014 [17])
- Procedure to improve the transparency of waste in the system [18]

The responsibility of producers for reuse and recycling schemes is identified as “opportunity to drive innovation and greater circularity”. In this context, the UK-wide producer responsibility schemes such as packaging is mentioned as “generally opaque to consumers”.

A more transparent reflection of the costs of packaging disposal is recommended as a future opportunity. The suggested priority areas to ensure producer responsibility include the exploration “of a single framework for producer responsibility” and also to “promote products that support a more circular economy”.

Waste tyres are used as a case study on producers' responsibility.

“Leakages” of materials and products from the circular economy system in Scotland could be utilised in waste to energy infrastructure. However, the document also outlines that any energy to waste infrastructure must not demand materials that could be kept in the circular economy stream as higher-value materials.

Between 2016 and 2018, Zero Waste Scotland obtained European Regional Development funding to help Scotland’s businesses transition to a more circular economy model. The funding was meant to contribute to Scotland’s Economic Strategy [19]. However, there is no readily available information on the funded project through Zero Waste Scotland or the Public Contracts Scotland Websites [19, 20].

Zero Waste Scotland also published a contract notice titled “Action on Plastics - community-based pilot project delivery and evaluation” on the Public Contracts Scotland Websites in 2019.

This “Action on Plastics programme seeks to appoint contractors who can pilot approaches to reduce the use of single-use items, which are predominantly made of plastic” [21]. The tender closed in August 2019, but at the time of writing no further information was available.

Chile

In April 2019, the Ministry of Environment and Fundación in Chile announced a Chilean Pact of Plastic including, Unilever, Amcor, Coca-Cola, Mall Plaza, Nestlé, Soprole and Resiter. After the UK and France, Chile is the third country to develop a domestic Plastic Pact that is aligned with the EMF New Plastics Economy vision.
The Pact includes four specific commitments to be fulfilled by 2025:

- Actions to eliminate single-use plastic containers and utensils
- 100% of plastic containers and packaging must be designed to be recyclable, reusable or compostable
- 1/3 of the household and non-household plastic containers and packaging must be effectively recycled, reused or composted and
- Plastic containers and packages must have -among their different formats- on average, 25% of material recycling.

Chile’s president has outlined that a changed approach and business models in the plastics sector, “while keeping this material in use”, offers great economic benefit. The Chile Pact is aligned with the global Plastics Pact by EMF and aims at the generation of new circular development trajectories to decouple economic growth and the use of finite resources. This will be achieved by the voluntary collaboration of public and private organisations which work towards the fulfilment of this ambitious common goal.

The Ministry of the Environment and the Fundación Chile, the Association of Municipalities for Environmental Sustainability (AMUSA), Agency for Sustainability and Climate Change, Packaging and Packaging Management System, Plastic Oceans Chile, Co-inventa, Corfo and Ministry of Economy are currently developing a 2025 Plastics Pact Road Map for Chile, which will be published in December 2025 within the framework of UN Climate Change Conference COP25 [2].

The Fundación Chile has initiated a “New Plastics Economy” initiative with its goals directly derived from the Chile Plastic Pact [24]. It summarised that Chile consumes about 990,000 tons of plastics per year of which about 8.5% is recycled. However, only 17% of recycled plastic is of domestic origin. Similar to New Zealand, the main plastic consumed in Chile is PET (Polyethylene Terephthalate) (55%) with the remainder being PP (Polypropylene) and PE (Polyethylene)[25].

Malaysia

In 2018, the Malaysian Ministry of Energy, Science, Technology, Environment and Climate Change published “Malaysia’s Roadmap towards zero single-use Plastics 2018 – 2030 – towards a sustainable future”. The “roadmap is to take a phased, evidence-based and holistic approach by involving all stakeholders in jointly addressing single-use plastics pollution in Malaysia” [26].

While the roadmap focuses on single-use plastics, especially in its immediate/short-term goals, its overall aspiration applies to the plastics industry as a whole. The document identifies four key problem statements:

- Plastic pollution in Malaysia
- Low domestic plastic recycling rates
- The lack of cost-effective, eco-friendly alternatives
- “Absence of a uniform policy framework”

The roadmap action plan is separated in three phases:

- Phase 1 (2018-2021) includes the launch of the Malaysian Circular Economy Roadmap (CER) for plastics and CER workshops
- Phase 2 (2022 – 2025) focuses on the introduction of a legal single-use plastics framework, implementation of CER, a transition to biodegradable and compostable plastics for single-use items and the introduction of a pollution levy
- Phase 3 (2026 – 2030) aims at extending the use of biodegradable and compostable plastics to other single-use items and their production in Malaysia.

The transition to biodegradable/compostable plastics for single-use items aligns with the country's 2017move to biodegradable shopping bags - which is linked to the development of biodegradable product certification by Malaysia’s Standard and Industrial Research Institute (ECO001) [27].

The economic benefits of a transition towards a Circular Economy, and the associated domestic knowledge development, are not mentioned beyond the need to balance economic advances with environmental protection.

Similar to New Zealand’s MfE waste levy, the Malaysian Government envisages introducing a pollution levy which will be used to mitigate plastic pollution effects and fund “research and development (R&D) on eco-friendly alternatives, incentives to manufacturers and” communication, education and public awareness activities.

Malaysia’s federal government leads the implementation of the action plan through the Ministry of Energy, Science, Technology, Environment & Climate Change. State governments are tasked with the harmonisation of state laws to implement the roadmap and to ensure that a coordinated approach is taken in regards to single-use plastic pollution. Manufacturers, suppliers and business operators are encouraged to proactively contribute to the implementation by providing business and technical input to government initiatives. “NGOs are encouraged to conduct and coordinate training, research, environmental education, awareness, capacity building and publications to assist in particular grassroots actions.” [26]

Ghana

In 2019 Ghana's president Nan Akufo-Addo announced the development of "a national roadmap for managing plastics sustainably and aim to shift towards a circular plastics economy". Similar to Indonesia, this initiative and the development of the roadmap is also aligned with GRPA. However, the Ghanaian Ministry of Environment, Science, Technology and Innovation which leads the development of the roadmap, also aims to "directly address the root cause of plastic pollution by fundamentally reshaping the way plastics are produced, used and re-used" [28, 29].

The roadmap aligns with Ghana's Plastic Management Policy launched in 2019. It aims to "unlock economic incentives for source separation, collection, processing and recycling of plastic wastes into valuable resources, generating revenue estimated at four hundred million US Dollars per year" according to Professor Kwabena Frimpong-Boateng, the Minister of Environment, Science, Technology and Innovation [29]. A social spill-over benefit from the economic potential is the creation of employment opportunities in a new national sustainable waste management sector and the associated social development [30].

The national roadmap has led to Ghana's National Plastic Action Partnership (NPAP), that aims to "translate policies to ground actions" [31]. Based on the project outline available at the time of writing, the NPAP is currently setting up working committees and projects. The expected NPAP outcomes are:

- Master framework in circular economy, regulations and enforcement
- New business models along the entire plastic value-chain including recycling, up-cycling, bio-plastic production and innovation
- Logistics architecture for collection and recycling
- Technology transfer, data and research, access to information
- Education, awareness creation and community engagement [31].

Unlike other African countries such as Rwanda and Kenya, Ghana aims to "improve their management" systems for plastics and transition towards a New Plastics Economy, rather than focusing on single-use plastic bans [28].

Professor Kwabena Frimpong-Boateng, Minister of Environment, Science, Technology and Innovation, stated that Ghana's reluctance to follow others' strategy of banning plastics, is due to concerns on how to "monitor and police" such a ban and the benefits that plastic have, e.g. "in hospitals, in homes, in industries and agriculture" [32].

"We may start by banning things that we may not need, for example, plastic bags, chewing gum, plastic cutlery, straws, and so on…we should learn how to manage plastics in its life cycle. When we do that it would be a very good thing. We would be able to create jobs, create employment and also clean our environment" [32].

Portugal

The action plan for Portugal to transition to a circular economy was adopted by the Council of Ministers in 2017. It aims to lead the EU transition to a circular economy model to derive economic value from the new model, early, and "encourage companies to adopt a preventive approach" [33]. The plan describes the potential benefit for the Portuguese economy that could be realised by transitioning to a circular model.

The document identifies plastics as one key sector to incentivise the transition to a "circular market". In particular, it suggests to "assess tax incentives associated with reducing consumption of plastic bags and consider their application to other disposable plastic-based products (of fossil-fuel origin)".

The need to map resource flow, "e.g. [the] use of plastics in the value chain – packaging, including bags" is highlighted and also reiterated in subsequent EU documents [6, 33].

As an early action list to implement the circular economy, the outlined actions focused on funding all application and consultation rounds.

The Portuguese Plastic Pact with its 23 members, including major food and beverage retailing brands, have committed to ambitious targets for 2025, including:

- Defining a list of single-use plastic items deemed problematic or unnecessary and the measures for their elimination, through redesign, innovation or alternative (reuse) delivery models by the end of 2020
- Ensuring that 100% of plastic packaging is reusable, recyclable or compostable
- Increasing collections so that at least 70% of plastic packaging is effectively recycled
- Incorporating, on average, 30% of recycled plastic in new plastic packaging

Finland

In 2018, the Finnish Ministry of the Environment published their “Reduce and Refuse, Recycle and Replace” plastics roadmap for Finland.

The roadmap was prepared by a stakeholder working group coordinated by the Finnish Ministry of the Environment but is, at least in parts, also based on “online idea generation”.

It “is the first proposal in Finland aimed to find diverse solutions to the plastics challenge.”

While the challenges that plastic and plastic waste pose are clearly outlined in the document, it also emphasises that “for Finland the solutions to the plastics problem are an opportunity”.

The economic opportunity lies in the country’s biomaterials and technology competence. The authors see that “feasible, scalable solutions that also work in mass production” of biopolymers and bioplastics and development in recycling technologies are still required and that “Finnish companies can be among the leaders in this” [34].

The Finnish roadmap outlines ten target areas with associated proposals for measures:

- “Reduce littering and avoid unnecessary consumption
- Study the possibility to introduce a tax on plastic
- Significantly increase the recovery of plastic waste
- Improve the identification of plastics in buildings and sorting of plastic waste at construction sites
- Promote the recycling and replacement of plastics in agriculture and horticulture
- Introduce diverse recycling solutions for recovered plastics
- Invest in new solutions and establish a New Plastics Economy knowledge network
- Export expertise and solutions
- Raise the plastics challenge high on the international agenda of Finland
- Enhance research knowledge on negative health and environmental impact of plastics and solutions to these” [34].

While measures for each of the ten target areas are described in the roadmap, quota, quantification relating to changes of material flow or delivery/completion timelines are rarely specified.

By 2019, Green Deal agreements on reducing single-use plastic packaging, not limited to food and other convenience packaging but also, for example, in the construction sector, will be in place.

Within the Finnish government vision of Green Deals, one associated with plastics has been concluded by the Finnish Ministry of the Environment so far: The Plastic Carrier Bag Agreement to reduce the number of plastic carrier bag used per person every year to less than 40 [35, 36].

Other key implementation measures include:

- Increasing public awareness of the plastics challenge, solutions and players
- Changes to public procurement and public events to reduce littering
- Effect of tax on consumer behaviour and single-use plastic consumption

- Expansion of waste collection and recycling facilities
- Plastic packaging design changes to reduce plastics usage and increase waste diversion ratio
- Replace fossil-fuel based plastics with bio-degradable options in agricultural applications
- Establish chemical recycling in Finland
- Establish The New Plastics Finland knowledge network
- Extend Finnish plastics solutions to EU strategies
- Develop and export technology solutions to address the global plastics challenge including ocean-plastics and microparticles.

Implementers for each target area are also specified in the roadmap.

These range from government departments, e.g. Ministry of the Environment, research providers (e.g. VTT) to industry associations (Finnish Plastics Industries Federation) and “companies”.

European Union

The European Commission’s strategy document “for plastics in a circular economy” summarises the key EU commitments for action. In the development of the strategy, the EU commission confirmed its focus not only on plastic use, but also production, and highlights the importance of the plastics industry to the European economy.

The strategy is based on a material-specific lifecycle approach and its overarching aim is to ensure “that all plastic packaging is recyclable by 2030” and to “identify key actions enabling multi-stakeholder engagement” [6, 37].

The strategy suggests a number of measures to move towards a circular plastics economy in Europe.
Firstly, it suggests, “improving the economics and quality of plastics recycling” which is to be achieved by:

- designing plastic articles and packaging for recyclability (“by 2030, all plastics packaging placed on the EU market is reusable or easily recycled”)
- boosting demand for recycled plastics (“develop a European market for
- recycled plastics”; “develop quality standards for sorted plastic waste and recycled plastics” and “ensure that by 2025, ten million tonnes of recycled plastics find their way into new products”) and
- better and more harmonised separate collection and sorting (“new guidance on separate collection and sorting of waste” and “better implementation of existing obligations on separate collection of plastics”) [6].

Secondly, eliminate “plastic waste and littering” by:

- “Preventing plastic waste in our environment” through “legislative initiative on single-use plastics at EU level”
- “establishing a clear regulatory framework for plastics with biodegradable properties” while restricting oxo-plastic
- “restrict the use of intentionally added microplastics” at an EU level [6].

Thirdly, “driving innovation and investment towards circular solutions” through:

- Horizon 2020 funded R&D
- “a Strategic Research and Innovation Agenda on plastics to provide guidance for future research and innovation funding after 2020”, and
- increased private and public investment in plastic strategy-related R&D [6].

Lastly, “harnessing global action” to enable “adequate plastic waste prevention, collection and recycling systems” in other parts of the world, which will require:

- ongoing EU support for international actions, and
- “development of international standards […] and EU certification schemes for recycling plants” [6].

Unlike many other documents discussed here, the European Commission's strategy document "for plastics in a circular economy" includes a comprehensive list of actions to achieve the objectives summarised above (Refer Appendix 1 for actions).

The EU Commission has also developed an EU plastics strategy related key document and factsheets to drive public awareness of the commission's actions and goals [38]

The 2019 EU Commission's report on "the implementation of the Circular Economy Action Plan" summarises key milestones of the EU Plastics Strategy which were already delivered. "These include the new recycling target for plastic packaging, set at 55% in 2030, [and] obligations for separate collection and improvements in Extended Producer Responsibility (EPR) schemes. EU leadership in bilateral and multilateral fora has been instrumental to keep up international momentum around the plastic agenda, as shown by initiatives such as the UN Environment's Global Plastics Platform and the upcoming International Partnership on Plastic Waste in the context of the Basel Convention. [37]"

The need to track plastic flow through the EU economy is also outlined in the 2019 study on "Circular economy strategies and roadmaps in Europe" to identify "synergies and the potential for cooperation and alliance building" by the European Economic and Social Committee [39]. The study's final report summarises the circular development approach and strategy of countries in the EU.

In 2019, the European Sustainable Business Federation published its "overview of circular economy in Europe" which is predominantly an its countries' progress on the transition from a linear to a circular economy. It also captures EU country specific single-use plastic article legislation, e.g. Bulgaria, Croatia, Cyrpus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Spain and the United Kingdom have outlined commitments to implement "the new EU regulations on waste management and plastics as soon as possible" – i.e. the EU Single-use Plastics Directive [8, 40]. The EMF "New Plastic Economy" is only mentioned in the update for the United Kingdom [8].

Poland

On September 10th, Poland joined the Plastics Pact. The Polish Plastics Pact is led by Kampania 17 Celów, a campaign which helps Polish businesses implement the 17 Sustainable Development Goals, and is supported by over 30 businesses and NGOs. Members include Alpla, Carrefour, Danone, Jeronimo Martins Kaufland, Korporacja KGL, Lidl, Lotte Wedel, LPP, Nestlé, Rekopol, Santander Bank and Unilever, who will work towards 2025 targets that are similar to other Plastics Pact goals.

While other Plastics Pact members have four targets, Poland hast set six goals as follows:

1. Eliminate unnecessary and problematic plastic packaging through redesign, innovation and alternative delivery methods
2. A 30% reduction (by weight) in virgin plastic consumption across plastic packaging put on the market (in absolute reduction, ie. based on the tonnages put on the market in 2018)

3. Ensure that 100% of plastic packaging is reusable or recyclable
4. Ensure an average of 25% recycled content across all plastic packaging
5. Effective support of packaging collection and recycling systems that ensure at least 55% of plastic packaging is recycled on the Polish market
6. Conduct effective citizen engagement in the field of reduction, reuse, sorting, and recycling of packaging.

South Africa

The South African Plastics Pact is in line with the Ellen MacArthur Foundation's New Plastics Economy vision.

It is a collaborative initiative that brings together key stakeholders from the local plastics value chain - including businesses, the South African government, NGOs and other organisations - to tackle plastics waste and pollution at its source. Currently, the SA Plastics Pact is composed of 23 members such as Clicks Group, Danone, Distell, HomeChoice, Massmart, Myplas, Nampak Rigids, Pick n Pay, Polyoak, Polyplank, Shoprite Group, SPAR, Spur Holdings, The Foschini Group, Tigerbrands, Tuffy, Unilever, ADDIS, Waste Plan, Woolworths, Coca-Cola Africa and RCL Foods.

The South African Plastics Pact provides a platform for collaboration and concerted action. All stakeholders have signed up to a joint set of ambitious and time-bound targets, ensuring this collaboration will drive significant change by 2025.

The SA Plastics Pact builds on the positive work started by other initiatives and helps scale up and disseminate good practice more quickly.

By 2025, the SA Plastics Pact will transform the country's plastic packaging sector by meeting four ambitious targets:

- Taking action on problematic or unnecessary plastic packaging through redesign, innovation or alternative (re-use) delivery models
- 100% of plastic packaging to be reusable, recyclable or compostable
- 70% of plastic packaging effectively recycled
- 30% average recycled content across all plastic packaging

Australia

Australia's National Plastics Plan 2021 is based on the Australian National Waste Policy Action Plan (NWPAP) from 2019. The NWPAP "aims to address impediments to a circular economy for waste in Australia" and sets out seven national waste reduction targets to achieve this:

1. Ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020
2. Reduce total waste generated in Australia by 10% per person by 2030
3. 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030
4. Significantly increase the use of recycled content by government and industry
5. Phase out problematic and unnecessary plastics by 2025
6. Halve the amount of organic waste sent to landfill by 2030
7. Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions.

The National Plastics Plan released in 2021 outlines five target plastics-specific areas and highlights associated actions.

In line with other global strategies, the phase out of problematic and unnecessary plastics (PVC, EPS) (Polyvinyl Chloride) is scheduled for 2022. The targeted phase-out includes all oxo-degradable and oxo-biodegradables by targeting "products with additive fragmentable technology that do not meet compostable standards".

A proposed industry shift to easier recyclable plastics options are included alongside national packaging targets of all “packaging being reusable, recyclable or compostable” by 2025.

The Plan’s second target area outlines plastics recycling targets. The 2025 target is to increase the recycling rate of all packaging from 39% to 50%.

To achieve these targets a Recycling Modernisation Fund ($1.5 billion), Product Stewardship Initiatives and an associated investment fund are being established, as well as national Material Performance Standards and government-initiated actions. Business commitments and regional solutions are also strongly suggested.

Target areas 3, 4 and5 respectively focus on kerbside collection and consumer education, avoiding plastics leakage into the environment and research and development towards recycling and waste management.

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