The future of making

Progressing net-zero circular advanced manufacturing in Aotearoa New Zealand

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Bringing ideas to life

The future of making

Insights from recent work in NZ and Australia…

1. NZ manufacturing resource flows
2. Digital enablers, including digital twins
3. Circular precincts

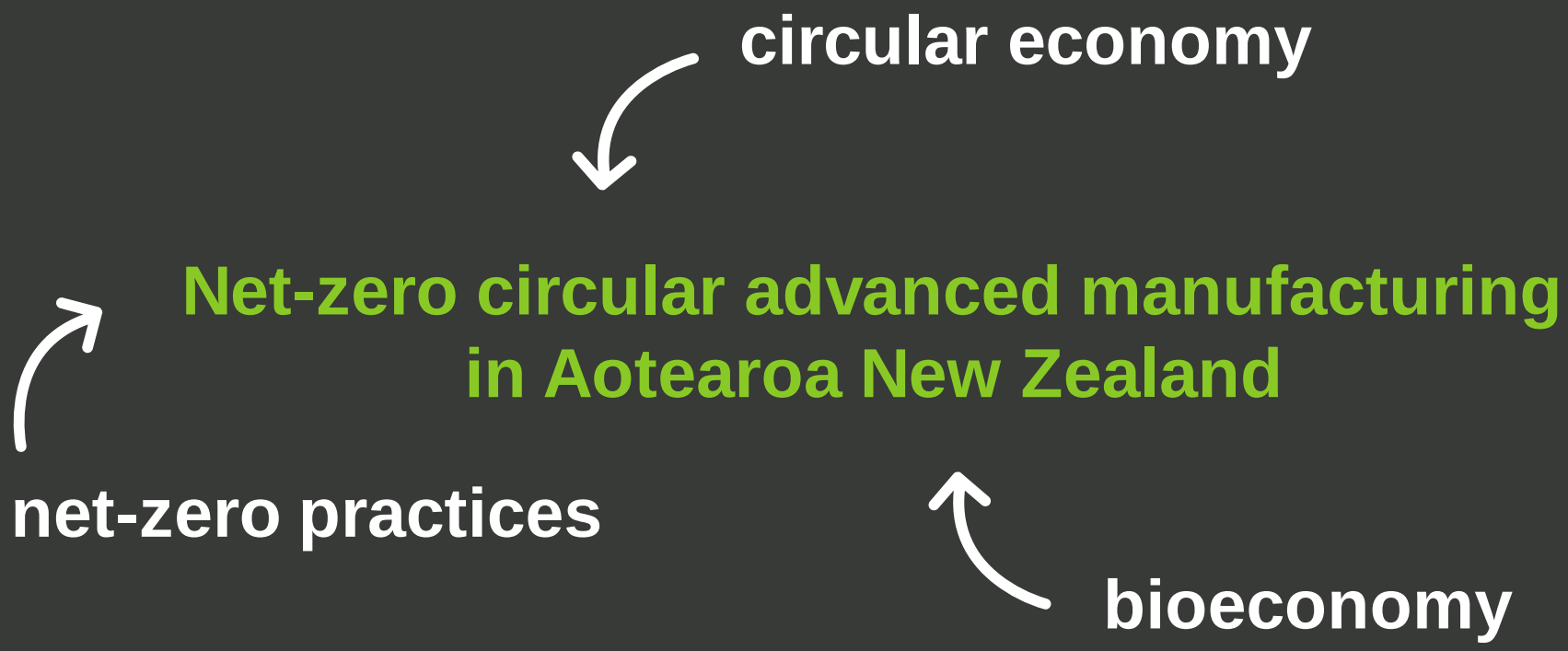
How does the waste and resource recovery sector fit in?

What information is missing?

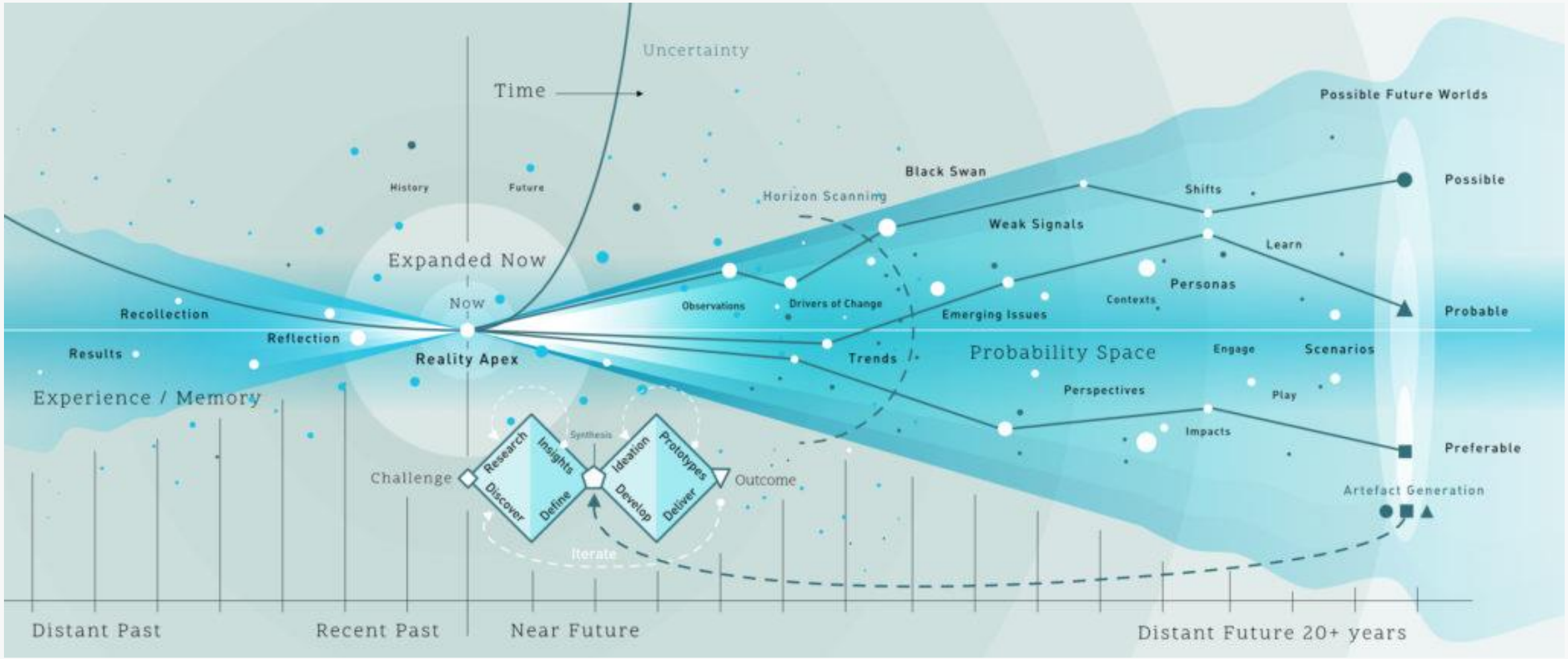
How can digital tools accelerate change?

What about industrial symbiosis through co-location?

What do we mean?



What about the future?



Futures cone by Steven Santer, 2016 - Comparison of time-scales and activities between Futures Thinking and Design Thinking processes

Hierarchies of ‘R’s

Circular

Use less

Use longer

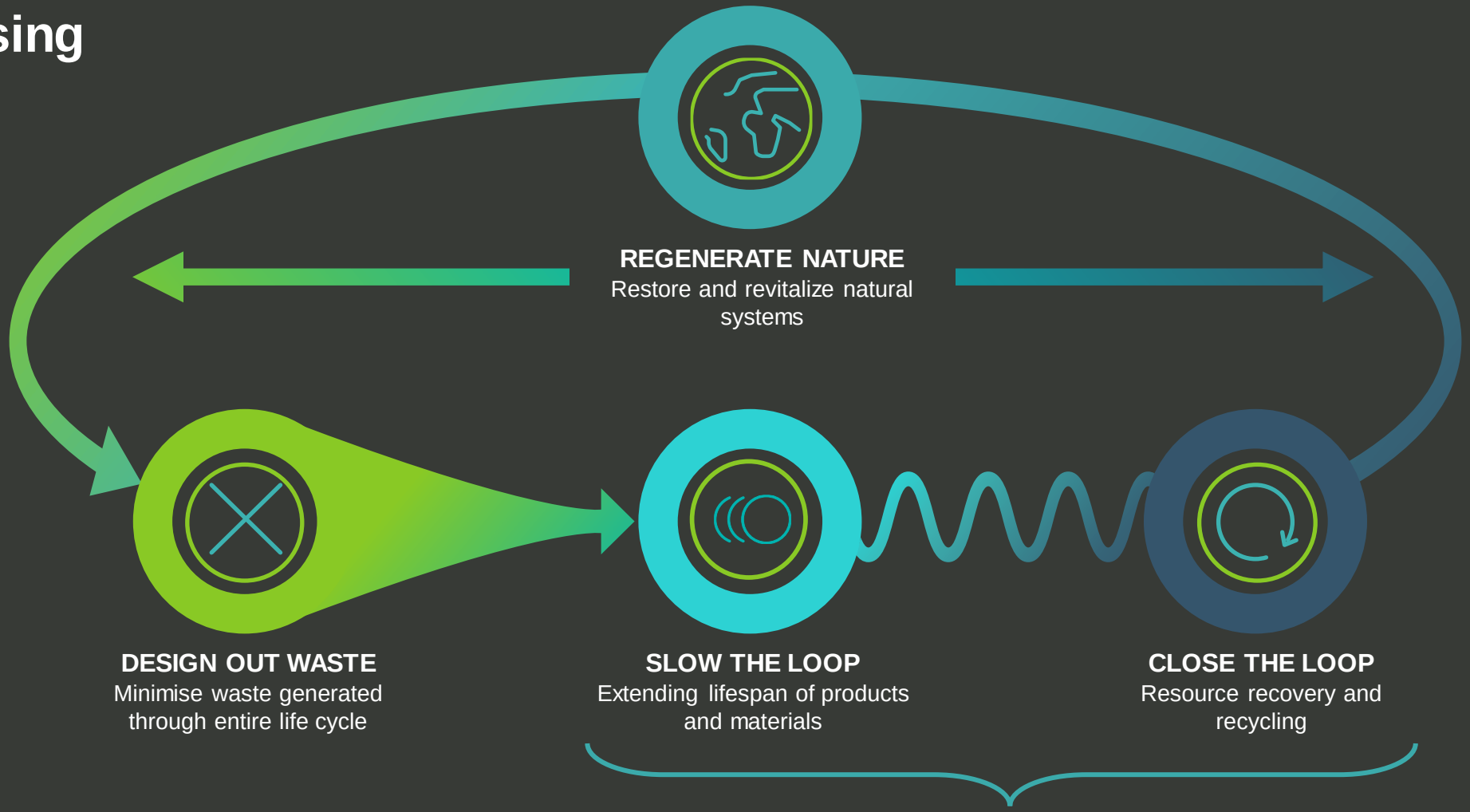
Use again

Linear

Strategy	Description
Refuse	Making a product redundant by cancelling its function, or by substituting it with a radically different product. Choosing to build, buy or use less.
Reduce	Intensifying asset use by sharing multifunctionality. Using assets with more care, and for longer. Using fewer natural resources and materials to manufacture products and assets.
Reuse	Reusing a second hand or discarded asset or product for the same purpose, by a different user (with or without exchanging money).
Repair	Repairing broken or malfunctioning equipment to enable continuation of its original function.
Refurbish	Replacing or repairing components of an older product to upgrade quality, retaining the overall structure of the product for use in its original function.
Remanufacture	Returning used or non-functional equipment or parts to ‘as-new’ or ‘better-than-new’ condition through a controlled industrial process.
Repurpose	Using discarded products or their parts in new products with a different function. For example, side streams or by-products from agricultural processes in new products.
Recycle	Converting waste materials into secondary raw materials for use in manufacturing or construction.
Recover	Recovering energy from materials.

https://www.aurecongroup.com/insights/decarbonisation-circular-economy

Slowing and closing the loop



Why is it valuable to map systems?

Holistic View

System maps help us to view the system as a whole

Analysis of Structure

Mapping linkages reveal the underlying structure

Shared Perspective

Creating a shared visual diagram can help us to build a shared understanding

Course of Action

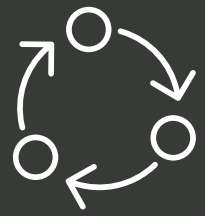
Share understanding reveals points of intervention and consensus on action

Why is it valuable to map systems?

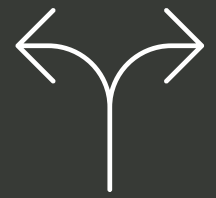
The **patterns** **paradigms** that enforce the system

The **mindset** that formed the system

The **goals** and/or **rules** of system



The **feedback** loops



The **structure** flows, stocks and parts

The **constants** **parameters** **incentives** that operate within the system

Highest leverage
Hardest to influence

Lowest leverage
Easiest to influence

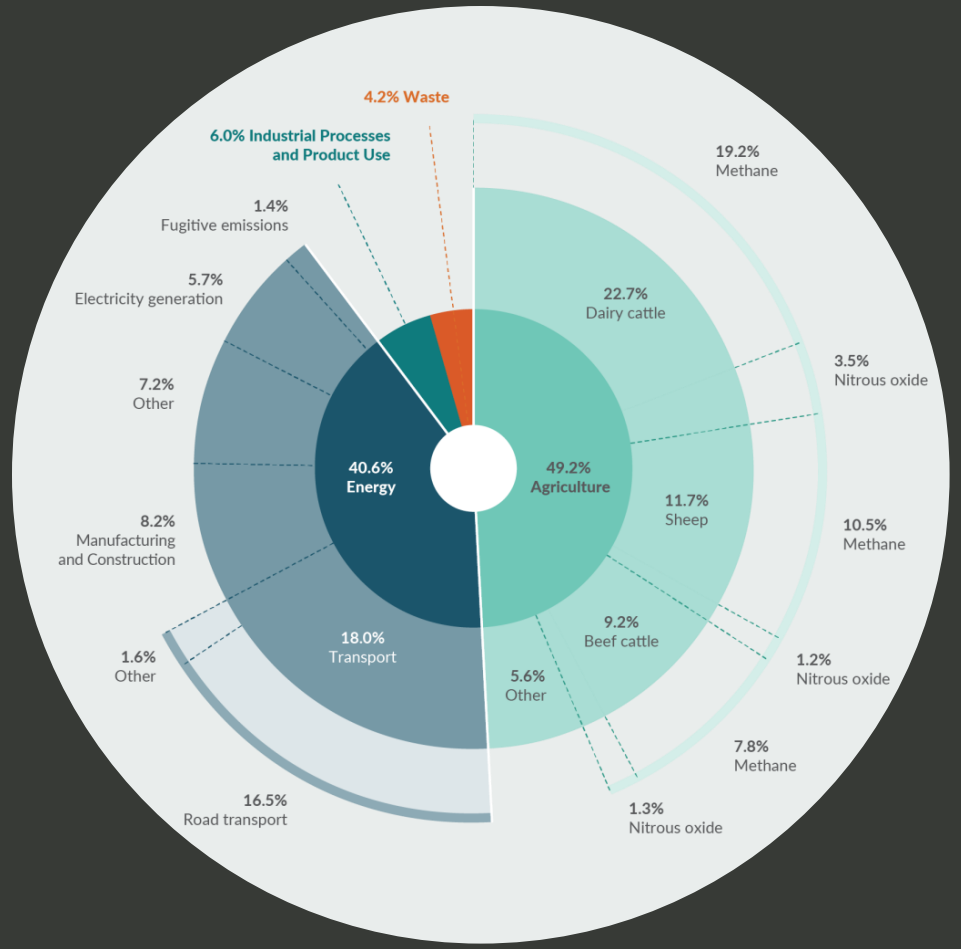
New Zealand's manufacturing landscape presents unique challenges and opportunities for decarbonisation and the circular economy

Agri-sector driven
Localised supply chains, seasonal production, unique asset base

Asia dominated export market
Top exports are dairy, food products, followed by wood and industrial machinery

Few large resources processing
International companies with local footprint (e.g. steel, aluminium), driven by global parent policy

Many small and medium businesses
Innovation mindset, scale challenging for accessing international markets and applying advanced manufacturing



A unique emissions profile
Gross greenhouse gas emissions in 2021 (MfE, 2023)

Businesses across Aotearoa are already making progress

Many large energy users have:

- completed **energy transition plans**
- implemented **energy recovery and energy efficiency** projects
- are now targeting harder to abate projects (e.g. investigating **fuel switching options)**

Circular practices are also being seen across industry, including but not limited to:

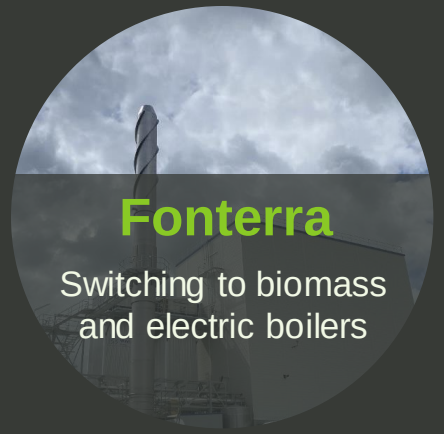
- diversion of food/material waste from one process to another
- CO_2 capture and repurposing
- repurposing end of life materials (e.g. food, textiles, plastics, packaging)

Mataura Valley Milk

Project Recharge: full site electrification goal

Mint Innovation

Green metals recovery



Fonterra

Switching to biomass and electric boilers

Young Henrys

Algae CO_2 capture from brewing producing methane buster agri feed

Ecogas

Food waste-to-bioenergy facility at Reporoa

Recent research

Highlighting progress and how we can drive aspirations forward

1. Resource flows

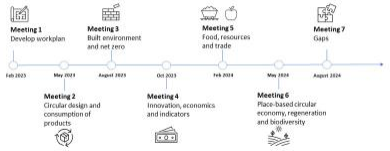
Ministry for Business Innovation & Employment 2024

Mapping emissions and waste stream profiles, and opportunities for achieving net-zero circular advanced manufacturing

2. Digital enablers

Ministry for Business Innovation & Employment 2024

Enabling digital technologies for New Zealand's circular and bioeconomy, including the role of digital twins



3. Circular precincts

Australian Government & Circular Australia 2024

Circular precincts, insights on the potential for place-based circular economy in Australia

CASE STUDY 1 | Resource flows

Our approach to the data

Includes industry collaboration and input, and wider govt initiatives (Emissions Reduction Plan, Waste Strategy, EECA).

Project aim

To baseline NZ manufacturing emissions and waste flows at a granular level to inform MBIE's manufacturing work programme.

How

Very iterative!

- Subsector mapping
- Top-down and bottom-up dataset development
- Consideration of existing decarbonisation and circular manufacturing practices and trends
- Testing with industry

Outcomes

- Identify key data gaps + provide recommendations to address
- Demonstrate the potential value of insights from this dataset over time to help inform and support the sector towards net-zero circular advanced manufacturing

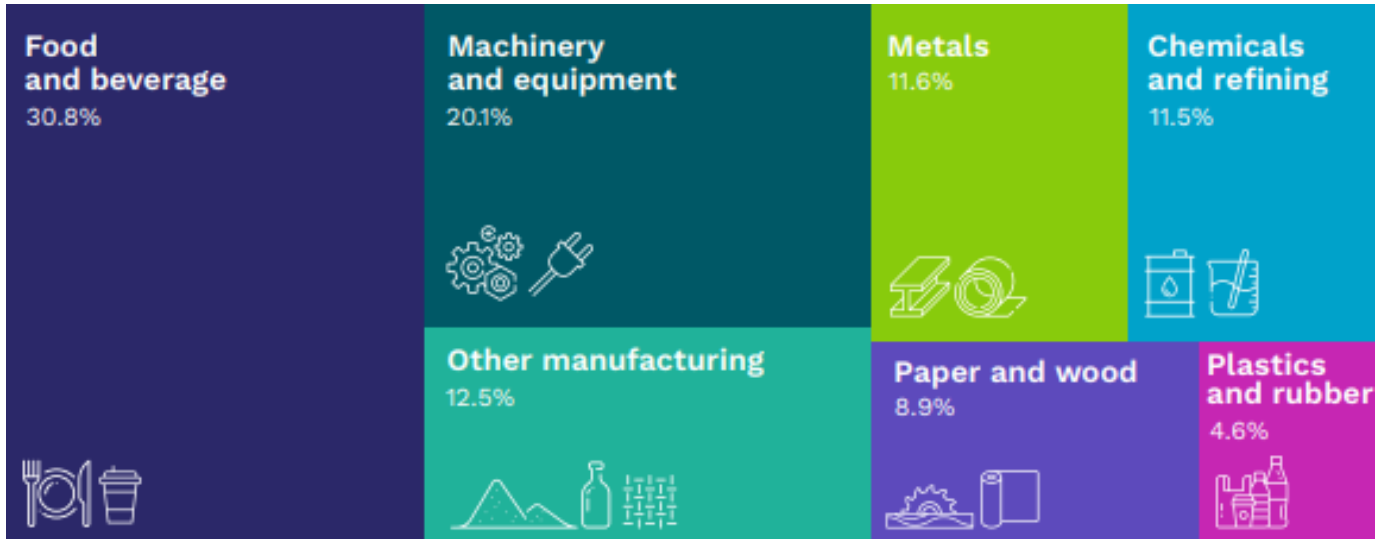
Circular economy reminder:

Manufacturing subsectors are very different

The study looked at seven advanced manufacturing sectors:

- Food & beverage
- Machinery & equipment
- Metals & metal products
- Chemicals and refining
- Wood & paper
- Plastics & rubber
- Other manufacturing – including textiles, furniture, cement, glass, ceramics

Advanced manufacturing makes up 10% of the economy (24.1billion GDP)



Advanced manufacturing GDP by subsector (2020) (millions)

Our approach to mapping

- **Mapping systems is messy!**
  Quantitative and qualitative approaches help us build a more accurate picture of the current state situation and interdependencies.
  Considerations also include manufacturing processes and activity location.

- **Data is valuable as it informs decisions at different scales.**
  Advanced manufacturing sub-sectors profiles and supporting data will be used to prioritise transition activities and measure progress over time.

- '**So what?**'
  High-level identification of barriers, enablers and opportunities for net-zero circular advanced manufacturing

- **Industry input**
  Data workshop Feb 2024 with 60+ attendees
  18 follow up 1:1 interviews

You have to start somewhere

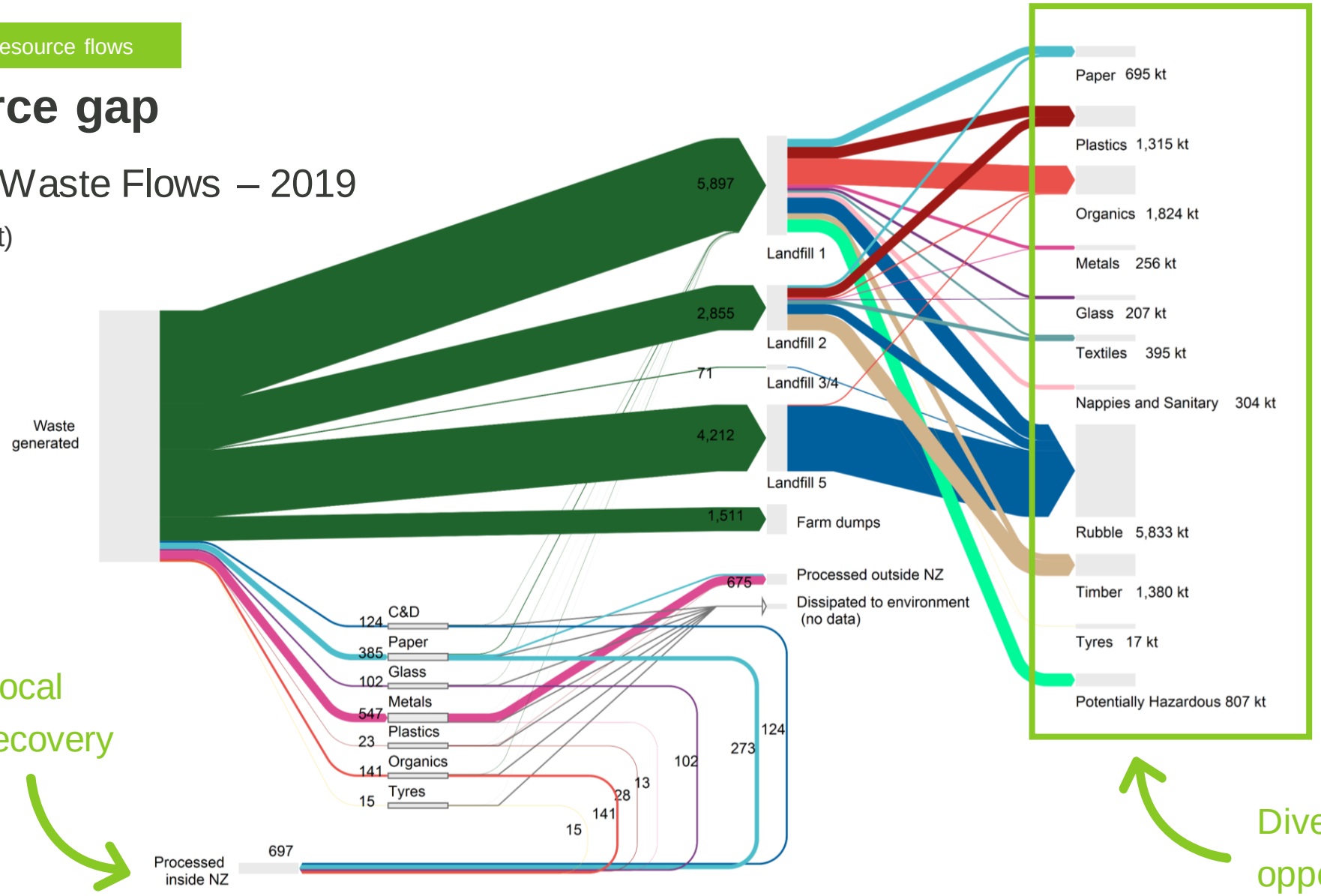
It only gets easier (/better)

Known unknowns are precious

Waste source gap

New Zealand Waste Flows – 2019

Thousand tonnes (kt)



Data gap

Local recovery

Diversion opportunities

Class 1 Landfill - Municipal Solid Waste Landfill or Industrial Waste Landfill
Class 2 Landfill - C&D Landfill or Industrial Waste Landfill
Class 3/4 Landfill - Managed / Controlled fill
Class 5 Landfill - Cleanfill

Data sources: National Waste Generation and Recycling Snapshot (2023), Waste Management Sustainability report (2020), MPI (2019), Plastic Packaging Stewardship Forum (2022), Plastics and Agrecovery (2020), Eunomia (2015)

Existing resource flows

Co-products, by-products and waste streams at a product-level were identified through qualitative mapping.

Waste trends identified:

- Common waste streams associated with manufacturing included personal protective equipment (PPE), packaging and potentially hazardous outputs.
- Organic waste was associated with Food and beverage, Wood and Paper and Other manufacturing.

Further work is required to confirm manufacturing waste flows at a facility level and to encourage sharing of this information, including monofill related data.

Flows within and between manufacturing sectors, and into others (such as agriculture or waste and resource recovery) sit outside current reporting and can be commercially sensitive

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What are digital twins and the technology that supports them?

AI integration identified as key emerging technology and leadership opportunity for NZ

Digital twins

"A dynamic and interconnected digital representation of a physical asset or system, enabling comprehensive insights and informed decision making"

DT components include:

- A physical entity
- A digital entity
- An information flow between the physical and digital entities

Supporting Technology

- Artificial Intelligence (AI)
- Robotics and automation
- The Internet of Things (IoT)
- Software as a Service (SaaS) including mobile apps
- Online trading platforms
- Digital Passports
- 3D Printing/additive manufacture
- Digital Engineering

Current development of digital twins in New Zealand driven by costs, resource management and efficiency – not circular economy

…however there is opportunity for these drivers to support circular practices

Circular economy attributes

- Design out waste
- Use renewable materials
- Reuse/Repurpose
- Refurbish/Remanufacture
- Repair
- Product Leasing
- Recycling of materials
- Use of recycled material

Digital twin circular enablers

- Optimisation and monitoring of resources
- Addressing barriers, including:
  1. Incomplete information about product composition and conditions preventing reuse or recycling.
  2. Transaction costs around identifying sources of secondary or excess materials.
  3. Tracking significant components as they move in the value chain.

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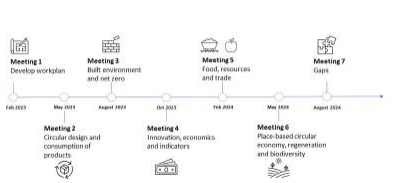

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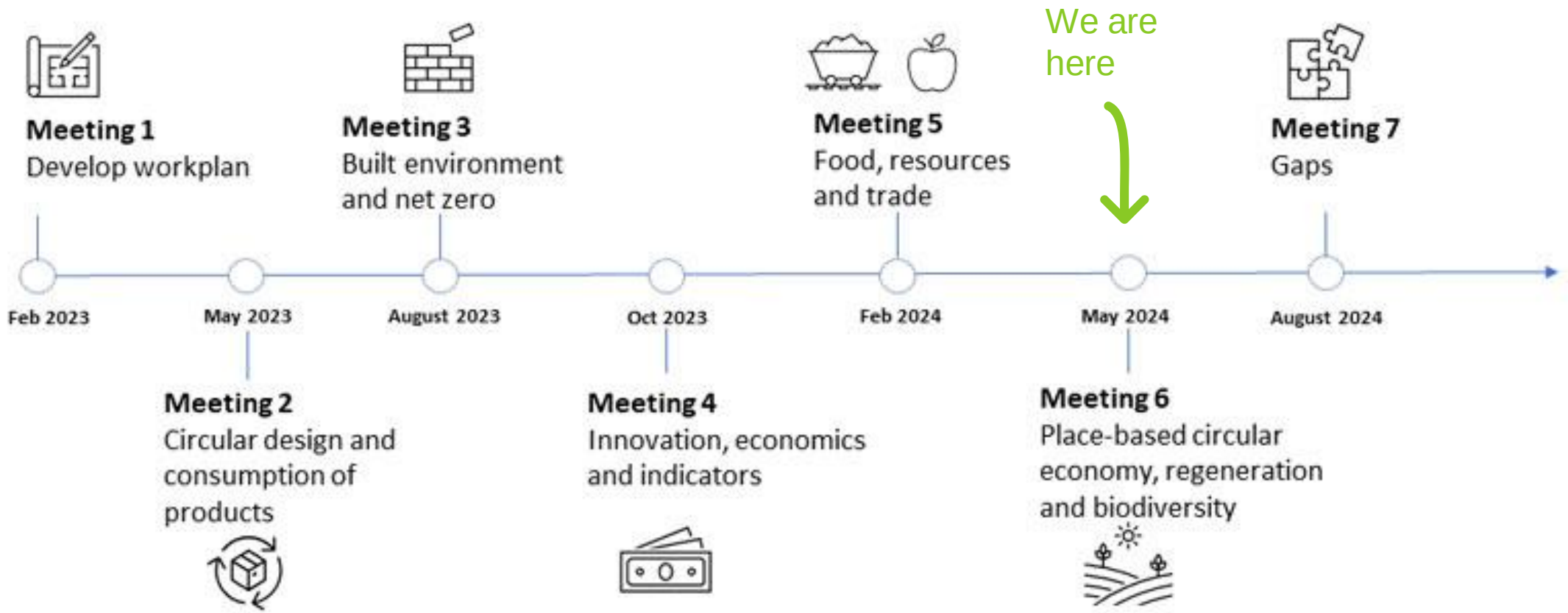
CASE STUDY 3 | Circular Precincts

Circular economy ministerial advisory group plan – place-based circular economy, regeneration and biodiversity happening now



CASE STUDY 3 | Circular Precincts

Circular precincts - insights on the potential for place-based circular economy in Australia

- Taskforce led by Circular Australia, supported by Aurecon
- 30+ interviews and counting with govt officials, experts, developers, businesses and innovators, across Australia
- Three emerging precinct typographies:
  1. Industrial ecology –local/regional
  2. Urban regeneration – local/hyper local
  3. Resource and innovation – hyper local

Sneak peek on insights

- Fuzzy boundaries between activities, scale and user groups
- Interconnected objectives, incl natural systems
- Isolation can drive ecosystem innovation
- Investment needed for on-shore manufacturing capacity to repurpose assets, products and materials
- Long term commitment – policy and procurement for certainty
- Strong governance to activate place-based ecosystem

Circular adoption by control, influence and interest – role of local government to support industrial ecology precinct development

Area	Role example	Opportunity examples
Clean tech (including resource recovery)	*Influence*	*Establish a clean tech cluster that connects innovation with investment.*
Manufacturing	*Interest*	*Support collaboration between research institutions and local businesses.*
Food Systems	*Influence*	*Encourage local food production by supporting small-scale farmer and urban farming initiatives*
Built Environment	*Control*	*Prioritise implementation of circular strategies during the design phase, as it enables the integration of circular economy principles.*
Water and Energy Infrastructure	*Influence*	*Take advantage of greenfield nature to co-locate energy and utilities infrastructure.*

Key takeaways

There is some way to go confirming manufacturing-related waste generation and internal loops that are not captured in reporting. Overcoming commercial challenges to data sharing critical.

Digital twins incredible opportunity to progress circular practices, but must align with other drivers. Data access and interoperability a barrier for progress

Co-location through circular precincts foster industrial symbiosis at a local and regional level, including clean tech innovation.

Macro-level insights shape policy, research and investment

Final thoughts

How can our on-shore manufacturing and resource recovery sectors work more closely together?

What ecosystems and tools are needed for this to flourish?

What is your area of control, interest and influence?

Thank you

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