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LCT, LCA and transitioning to a Circular Economy

Life Cycle Thinking (LCT) and Circular Economy (CE) are complementary concepts that can help shape a more sustainable world. CE provides a strategic framework for closed-loop material flows and a gateway to LCT, whilst Life Cycle Assessment (LCA) complements CE by assessing environmental impacts, thus providing evidence critical for effective decision-making.

Interest from government and industry to transition Aotearoa New Zealand from a linear 'take-make-dispose economy' to a CE and improve our overall performance as a sustainable society has increased significantly in recent years.

The broad *accessibility* of CE is particularly positive as it is an easy concept for everyone to understand, however it is not well understood that life cycle thinking is key to understanding material flows (see definitions, pg 2).

Transitioning to a CE presents a significant shift in sustainable practice where collaborative systems design is needed to identify opportunities to 'close the loop' and change tack. This typically involves mapping material flows, supply chains and end-of-life pathways, which can drive change across multiple, connected organisations.

This mapping process instinctively uses a LCT approach. However, it is important to note that the CE scope is typically broader than a single product line.

In practice, this means aligning materials to either 'biological' or 'technical' cycles (see diagram, pg 2), such as developing and scaling reusable models or utilising a waste stream as an input into the manufacturing process. Design for effective re-use, recycling or composting at the end-of-life should be core to product or service development, including consideration taken to maintain material quality and avoid 'downcycling'. Mandatory product stewardship schemes proposed in New Zealand will benefit from both CE and LCA input at the design phase to help deliver successful outcomes.

CE is also influencing policy and strategic direction at the executive leadership and board level in New Zealand – impacting infrastructure investment, new business models, product redesign and sustainability reporting. New Zealand's first CE Summit, organised by Sustainable Business Network and WasteMINZ, was held in 2018 and was followed by the Ellen McArthur Foundation and Ministry for the Environment's Ōhanga Āmiomio Pacific Summit in 2019. In 2020, the economic response to the Covid-19 pandemic has the potential to accelerate major infrastructure investment. The concepts of CE and LCT will be essential in helping to provide a framework to reshape the economy into a low-carbon and low-waste sustainable economy. Quantifying impact change over time is critical.

The New Zealand life cycle community has a key role to play in this transformation, to ensure that the best decisions are made system-wide. It is crucial that environmental impacts and burdens are not simply shifted but rather any potential trade-offs are identified. We need to help promote the importance of using LCA and LCT in decision-making, system design, and transition work towards a Circular Economy to realise reduced impacts across the economy and society.

LCT, LCA and CE at a glance

Life Cycle Thinking (LCT): a *qualitative* approach that creates an understanding of the flow of materials over the life cycle of a product or service and encourages consideration of environmental impacts upstream and downstream of production and/or use.

Life Cycle Assessment (LCA): a *quantitative* evaluation to estimate potential environmental impacts across product or service life cycles, identifying any impact hotspots and providing a baseline to guide the reduction of impacts.

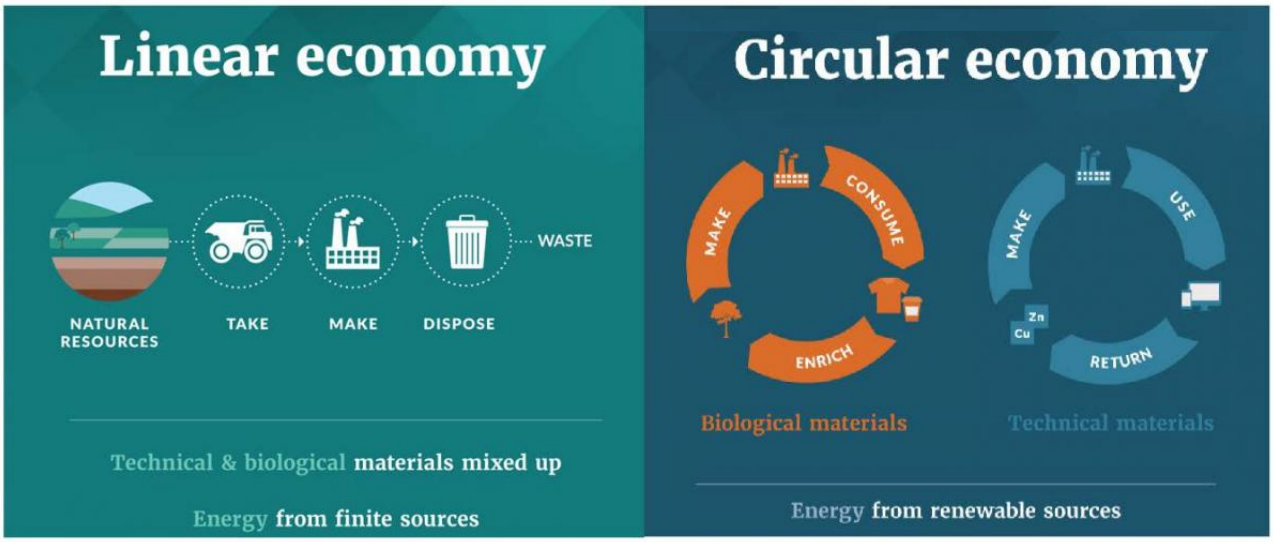
Circular Economy (CE): a holistic concept of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems; powered by renewable energy.

CE provides an accessible framework to address complex problems so stakeholders can engage and contribute to the development of strategic solutions. CE needs the fundamentals of LCT and LCA to ensure decisions are being made to benefit the whole system.

These relationships were recently explained in an article in *Sustainability Matters* by LCANZ's Australian counterpart ALCAS, outlining how LCA's evidence base facilitates strategic decision-making along the entire value chain.

Applying LCA towards CE

- LCA is an evidence-based tool with scientific rigour. The process can highlight hotspots across multiple impact categories and identify potential burden shifting or trade-offs.
- Accounts for changes along the product life cycle when progressing to a circular model.
- Can provide the information to assess the different decisions required to enable moving from a linear to a circular model.
- Integration of Material Circularity Indicator provides quantification of circularity (see 'Measuring Circularity' section).

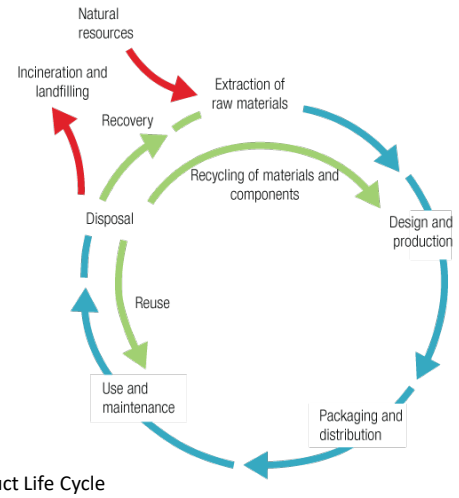


Linear economy vs Circular Economy

Image credit: Ellen MacArthur Foundation, n.d. Source

System visualisation:
LCA and CE both use a circular representation of the life cycle of a product but with a slightly different view. LCA clearly outlines the life cycle steps, while CE emphasises the processes and systems that keep materials in circulation.

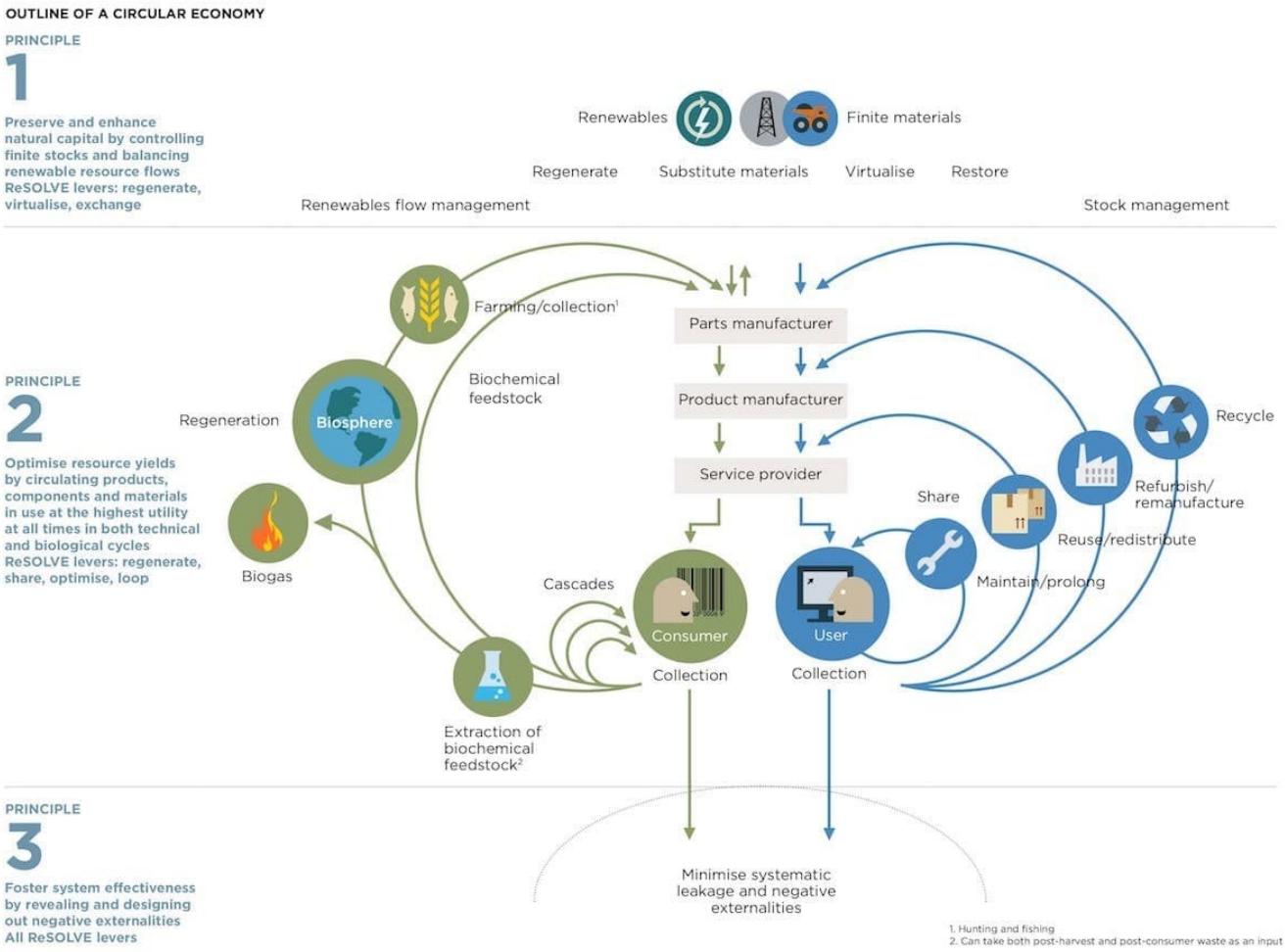
Life Cycle Assessment model



Product Life Cycle

Image Credit: UNEP/SETAC featured in Life Cycle Management: A Business Guide to Sustainability and Münster M., 2003, An introduction to Life-Cycle Thinking and Management. Environmental News, no. 68, Danish Environmental Protection Agency, Ministry of Environment. Source

Circular Economy model



Outline of a circular economy – biological and technological flows

Image Credit: Ellen MacArthur Foundation, SUN, and McKinsey Centre for Business and Environment, drawing from Braungart & McDonough, Cradle to Cradle (C2C), n.d. Source.

Measuring Circularity

Traditional environmental LCA indicators cover many important impacts, but do not provide an overall quantification of a circular approach. The Ellen MacArthur Foundation developed the Material Circularity Indicator (MCI) to fill this gap and measure the circularity of products (Ellen MacArthur Foundation, 2015).

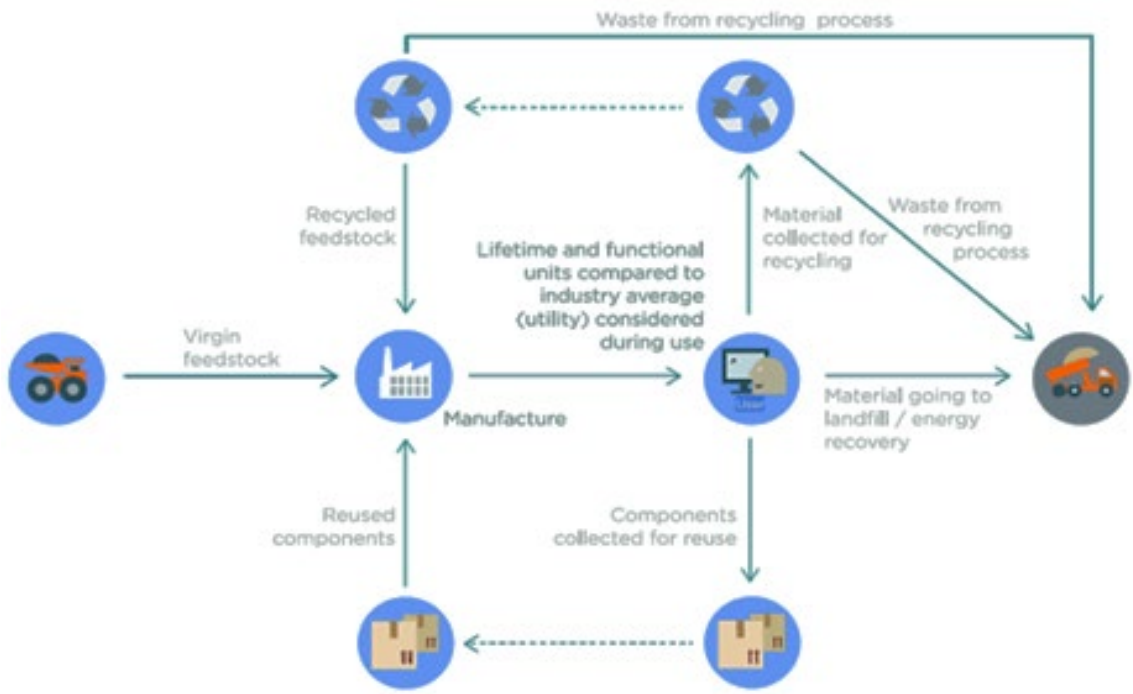
Originally focused exclusively on the technical flows of a product, an update in 2019 included biological materials and addressed some of the challenges associated with combinations of biological and technical materials. The MCI captures reuse and recycling rates throughout the life cycle, as well as tracking biological material feedstock from sustainable production and going to composting. The result is on a scale of 0 to 1, with 1 indicating a fully circular product.

The data required to calculate MCI overlaps almost entirely with that required for an LCA, making it a logical extension to LCA studies for companies working towards a CE.

Including MCI alongside traditional impact categories in an LCA allows for a more comprehensive analysis of changes to a product system. This allows a full picture of the environmental impacts of changes to a product design or system.

In addition to providing a robust quantification of a product's circularity, the MCI identifies hotspot areas throughout the supply chain, and sets a benchmark to track improvements.

For more information, check out the recent article in NZ Manufacturer by LCANZ member thinkstep-anz.



Material circularity indicator – representation of material flows

Image Credit: Ellen MacArthur Foundation, 2015, Source

LCA and CE in New Zealand

The LCANZ Best Practice Working Group (BPWG) has identified challenges and opportunities in this converging area for further discussion and development:

Challenges

NZ specific data gaps

- NZ's life cycle inventory (LCI) data needs improvement and should be linked to CE efforts.
- This includes up-to-date NZ specific data for upstream impacts from renewable energy, efficiency, and fuel mix for transport.
- There is also a need for up-to-date NZ industry LCI datasets.

Cost and time of carrying out an LCA

- Data access and collection is challenging and time consuming for individual businesses.
- This could be made more accessible and cost effective through the formation of industry groups to collect accurate and consistent data and calculating industrial averages.

Narrow focus of LCA goal and scope

- LCA is often carried out on the life cycle of an individual product or material, rather than assessment of a wider system. 'Systems design' and understanding mass material flows is critical to CE transition activities.
- Development of LCA model should include CE at the 'goal and scope' stage. Correct selection of functional unit/s and system boundaries are important levers for linear vs circular models. For example, the functional unit should consider the expected lifespan, quality and performance, while the boundary should address the scope of the assessment (cradle-to-gate, cradle-to-grave or cradle-to-cradle) and assumptions for consumer use and end-of-life pathways.

Missing impacts

- Environmental leakage risk is not well captured in Life Cycle Impact Assessment categories e.g. marine pollution and microplastics.
- Restorative and regenerative attributes, important to biological cycles, are difficult to measure e.g. biodiversity.

Opportunities

New audience for life cycle approach

- CE provides a new opportunity for LCA experts to engage with government and industry – helping guide decision-making and actions with robust data.
- LCA is a tool that can provide the scientific rigour behind CE decisions and system design to power CE towards a sustainable society.
- Life cycle thinking is a starting point for the transition to CE and should be supported by the life cycle community.

LCA is directly applicable to CE

- LCA can substantiate CE environmental claims, identify hotspots, and evaluate trade-offs.
- Specifically, LCA can account for any changes along the value chain when progressing to a circular model. LCA highlights burden shifting, where impacts can be reduced at one point and increased at another.
- Integration of the Material Circularity Indicator into LCA assessments provides a quantified measure of the circularity of a product or value chain.
- Although narrow in isolation, inventory data from product or material LCA can be utilised towards wider systems-level assessment

Greater involvement and support needed

- To provide information and guidance, a new website section 'LCA and Circular Economy' was added to the LCANZ website in 2019.
- The life cycle community needs to build on the accessibility of CE concepts and show the need for life cycle thinking and LCA to test and develop circular models.
- New Zealand has an opportunity to gain from worldwide CE and life cycle community experience and lead the global transition to a CE.

Relevant resources

- Material Circularity indicator
  - Ellen MacArthur Foundation Material Circularity indicator (MCI)
  - GaBi Material Circularity toolkit
  - SimaPro Material Circularity integration guidance
  - Material Circularity Indicator webinar and article by thinkstep-anz
- LCANZ LCA and Circular Economy section
- Ellen MacArthur Foundation Circular Economy introduction and definitions
- Ministry for the Environment and Circular Economy overview
- Cradle to Cradle and EPEA-Hamburg design principles
- Discussion of the relationship between Cradle to Cradle, LCA and Circular Economy by ALCAS
- Business Value of Life Cycle Assessment overview by ACLCA
- World Business Council for Sustainable Development Circular Economy case studies report
- Sustainable Business Network Circular Economy resources
- UN Sustainable Development Goals
- Stockholm Resilience Centre nine Planetary boundaries

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