

Using Life Cycle Assessment to achieve a circular economy

Contributed by: Claudia Peña^{}, Bárbara Civit²; Alejandro Gallego-Schmid³, Angela Druckman⁴, Armando Caldeira- Pires⁵, Bo Weidema⁶, Eric Mieras⁷, Feng Wang⁸, Jim Fava⁹, Llorenç Milà i Canals⁸, Mauro Cordella¹⁰, Peter Arbuckle¹¹, Sonia Valdivia¹², Sophie Fallaha¹³, Wladimir Motta¹⁴.*

¹ADDERE, Chile; ²National Technological University, Argentina; ³University of Manchester, UK; ⁴University of Surrey, UK; ⁵University of Brasilia, Brazil; ⁶Aalborg University, Denmark; ⁷PRé, The Netherlands; ⁸UNEP, France; ⁹Anthesis Group, Costa Rica; ¹⁰European Commission (JRC), Spain; ¹¹USDA; ¹²World Resource Forum, Switzerland; ¹³CIRAIG Polytechnique Montreal, Canada; ¹⁴CEFET-RJ, Brazil.

Background and purpose of this position paper

Circular Economy (CE) is a concept originally coined by Pearce & Turner¹ as an economy where wastes are recycled into resources, either through a technological feedback mechanism or through a natural ecosystem feedback mechanism, so that the stock of resources is constant or increasing over time. More recent usage stresses that this aim might also be achieved by keeping products, components, and materials at their highest level of utility and value for as long as possible, designing out waste and pollution and regenerating natural systems². CE is gaining increasingly more attention worldwide as a way to advance efficiently towards sustainable consumption and production patterns³. The current global interest in CE opens an opportunity to make society's consumption and production patterns more resource efficient and sustainable. However, such growing interest calls for precaution as well, as there is yet no harmonised method to assess whether a specific CE strategy contributes towards sustainable consumption and production. Life Cycle Assessment (LCA) is very well suited to assess the sustainability impacts of CE strategies.

This position paper provides an LCA perspective on the development, adoption, and implementation of CE, while pointing out strengths and challenges in LCA as an assessment technique for CE strategies.

Circular Economy and its challenges

The objective of the CE may be achieved through the application of CE strategies, or value retention loops, for instance as illustrated in UNEP's Building Circularity platform. The transition to CE implies direct linkages to international trade, and may lead to structural changes in the economy, which in turn may impact on trade flows of primary and secondary resources⁴. If emerging economies are left out of the analysis of the consequences of CE design and strategies, it could lead to adverse ecological, social and economic consequences, because they are part of the global supply chain of many production systems. This calls for a holistic assessment of the economic, social, and ecological transition pathways along the value chain.

Recycling is not always the best option...

Levi Strauss conducted and published a life cycle assessment on their iconic 501 denim jeans. The study identified two life cycle areas that are major contributors to environmental impacts: cotton production and washing the jeans. It stands to reason that recycling creates opportunities for eliminating the dependence on virgin cotton. However, a closer look at the recycling systems in place shows that cotton textile recycling results in shorter fibre lengths, which reduces their ability to be used in new products. Recycled fibers must be blended with either virgin cotton or with other materials, such as recycled plastics, to create different types of textiles. Of course, recycled fibers can also be used to create new materials for other applications, such as insulation. Facing uncertainty about the best options for recycling, other solutions such as reuse and other recovery options may have more environmental gains. To assess and compare different strategies for CE, LCA is a very useful technique to consistently and effectively quantify systemic impacts, by answering questions such as: What is the best pathway for improving the circularity of the textile sectors?

[PRé 2016]

¹ Pearce D W, Turner P K. (1990). The economics of natural resources and the environment. Hemel Hempstead: Harvester Wheatsheaf

² EMF. 2012: [Ellen MacArthur Foundation Towards the Circular Economy](#)

³ UNEA4/Res.1 [Innovative pathways to achieve sustainable consumption and production](#)

⁴ OECD. (2018). [International Trade and the Transition to a Circular Economy](#)



Life Cycle Initiative

At the same time, decision-making processes in CE strategies could be biased by a naïve understanding of what “closing the loop” implies (see box). CE approaches that focus on specific physical resources may assume that these resources are the most valuable area of protection, ignoring other resources / impacts. Consequently, there is a need to develop assessment techniques that can prevent CE strategies from overlooking potential upstream and downstream impacts as well as shifting the burden of those impacts from one resource or impact area to another, which could lead to inappropriate or less efficient solutions.

Strengths of Life Cycle Assessment to assess Circular Economy strategies

Life Cycle Assessment is a science-based technique for assessing the impacts associated with entire product life cycles, standardised in the ISO 14040-series. LCA can provide technical support to CE decision-makers, to assess trade-offs of impacts on a variety of environmental impact indicators, such as water use, energy, climate change, and raw materials. LCA may also be applied to identify the most promising CE strategies and options for improving the environmental performance of society's consumption and production patterns. For example, LCA provides a correction to economic analyses based on current taxation regimes, where labour is taxed more than material resources.

LCA can also bring a holistic perspective into decision-making, by assessing beyond the biophysical environment into the social and economic effects of a decision (also called a Life Cycle Sustainability Assessment, LCSA). LCA can highlight situations where CE projects may be too narrowly focussed on the “circularity” of a specific resource, and where the specific circular strategy is not the best choice from a broader sustainability perspective.

Challenges of applying LCA to assess Circular Economy strategies

For a better application of LCA to support CE strategies, a number of shortcomings of the current LCA need to be resolved, notably:

- Consistent accounting for changes in stocks of resources respecting mass balance principles.
- Consistent modelling of open recycling loops.
- The inclusion of all relevant resources and impacts, i.e. a full economy-wide LCSA perspective.
- Transparency of assumptions, reliability of data, and critical interpretation of results and trade-offs between a globally agreed numbers of impact categories, e.g. through valuation, as suggested in ISO 14008.

Position and recommendations of the Life Cycle Initiative

The Life Cycle Initiative promotes using LCA as a methodology to build more robust CE strategies that consider potential upstream and downstream impacts and encompass all relevant resources and impact categories, leading to better decisions for sustainability. The inclusion of the life cycle perspective when assessing CE strategies requires LCA professionals to address the technical and scientific challenges involved in this assessment, as well as the implications for the sustainability of both emerging and developed economies. Specifically, the Life Cycle Initiative aims to contribute to:

- Consensus building within the LCA community on terminology related to CE;
- Resolve the technical and scientific challenges to advance in the implementation of LCA in the assessment of CE strategies;
- Assessment methodology and metrics for CE, starting from the recognition of historical limitations in the way LCA models raw materials and resource considerations (which often take the linear economy as the frame of reference);
- Global and regional CE forums, particularly within the technical working groups of the ISO of CE (TC / 323);
- Promote the application of LCA in assessing and planning CE strategies, i.e. involving the LCA community globally in designing the approach, monitoring and evaluation, as well as in data collection and assessment of CE strategies.