

A policymakers' guide to Life Cycle Assessment

Policy Brief¹

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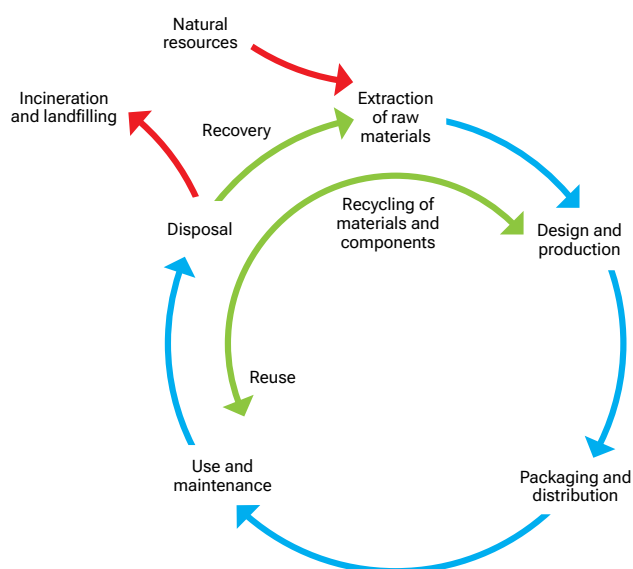


Figure 1: A representation of the life cycle of a product or service (Source: [Life Cycle Initiative](#))

This policy brief focuses on the application of generic Life Cycle Assessment (LCA) studies to inform problem and policy framing². The International Organization for Standardization (ISO) defines a life cycle as “consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal” (ISO 2006) (Figure 1). Life Cycle Assessment (LCA) is then defined as the “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle” (ISO 2006).

Policy recommendations

The use of LCA information in the early stages of policymaking can ensure a robust, faster and more efficient achievement of internationally agreed goals. LCA and other life-cycle approaches guide focus of action on the relevant impact hotspots and help identify potential trade-offs early on. The systemic nature of LCA can ensure consistency and coherence among different policies and sectors. This is because life-cycle models can reflect the complex nature of value chains³ and technology options to make them understandable and to support decision making.

Some policy questions that LCA can inform include:

1. What are the environmental hotspots of (unsustainable) consumption and production patterns, where policy attention should focus?
2. What are the priority areas and achievable targets for reducing environmental impacts in products or industries?
3. What are the potential effects and trade-offs of specific improvement measures on life-cycle performance?
4. How do different solutions compare in terms of environmental impacts, and under what conditions is one better than another?
5. What are most effective strategies for implementing eco-design, sustainable procurement and circular economy practices?
6. What are the potential environmental impacts of different policy options?

¹ The aim of this policy brief is to pinpoint where LCA can offer value and to furnish policymakers with clear criteria to distinguish between robust and inadequate LCA practices. Specific terminology used in this brief can be found in <https://www.lifecycleinitiative.org/life-cycle-terminology/>

² Application of LCA in later stages of the policy cycle, such as policy implementation (e.g. to define eligibility of a specific material as “sustainable”; or to inform product sustainability information), requires strict adherence to product-specific LCA rules and to agree upon background data to ensure strict reliability and comparability of results. The Product / Organisation Environment Footprint (EF) method are good examples of such stricter LCA rules in the European Union.

³ E.g. according to McKinsey, an auto manufacturer has around 250 tier-one suppliers, but the number raises to 18,000 across the full value chain. This level of complexity is found in other value chains. [Reimagining industrial supply chains | McKinsey: https://www.mckinsey.com/industries/advanced-electronics/our-insights/reimagining-industrial-supply-chains](https://www.mckinsey.com/industries/advanced-electronics/our-insights/reimagining-industrial-supply-chains) by Baumgartner, Malik, Padhi

Beyond their traditional application at product level, **LCA studies applied at the economy-wide level also help identify high-impact sectors / human activities that cause a significant share of impacts** (e.g. food, housing, transportation). Hence, by focusing more policy attention on these sectors driving the impacts, LCA helps addressing the triple planetary crisis of climate change, nature loss and pollution more effectively, and its framework is conducive to consider broader impacts on the social and economic pillars of sustainable development, even if these are not assessed within environmental LCA. Social Life Cycle Assessment (S-LCA) can complement this by incorporating gender-disaggregated data, helping to understand how different genders are affected by the environmental impacts of policies. The Sustainable Consumption and Production Hotspot Analysis Tool (SCP-HAT) is a United Nations Environment Programme (UNEP)-hosted life cycle based tool available for quick analyses of national footprints and high-impact sectors. Furthermore, the European Commission has developed the Consumption Footprint, an assessment framework to monitor the overall environmental footprint of European Union (EU) production and consumption systems.

Policymakers need to ensure that their teams possess adequate capacity to advise and interpret the results of LCA studies and to distinguish robust studies that can support policy design, implementation and monitoring. While robust LCA studies will help by focusing action on impact hotspots and identifying potential trade-offs of policy actions, poor (or even misleading) LCA practice could result in disinformed decisions and the perpetuation of unsustainable practices. The UNEP-hosted Life Cycle Initiative compiled a succinct checklist for technical advisors to policymakers to distinguish good LCA practice from potential misuse of LCA in [this page](#).

By following this Four-Point Guidance, policymakers should be able to distinguish between robust science-based LCA and ill-defined studies that could mislead the early stages of policymaking. Good LCA practice places a lot of attention on proper documentation, so the following information should always be available; any study that fails to clearly provide information on any of the topics below should be ignored.

1. Adherence to recognized standards and methods:

- Check if the study adheres to recognized standards and methods (such as ISO standards 14040-14044 and Environmental Footprint methods), that lend credibility to the study and ensure methodological rigour and transparency.
- Note that adherence to standards alone does not guarantee the suitability of the LCA study to support a specific policy question; assessment against the following points is needed.

2. Goal and scope alignment:

- Evaluate if the stated goal, scope and functional unit⁴ of the study align with the policy you need to inform with a clear indication of applicability and limitations of results. Ensure that the specific technical, regional and temporal context of the LCA study is relevant for the policy context. E.g. a study made in Europe may not be applicable in the context of Latin America, but it can still be informative with adequate caveats.
- Also the origin of the underlying data is important to ensure relevance of results; locally sourced / generated data are



Photo: Cottonbro Studio/Pexels

generally preferred, although international datasets adapted to local conditions may also be adequate and necessary, depending on the policy question at hand.

3. Comprehensiveness of LCA:

- Verify that the LCA includes all relevant life-cycle stages (from resource extraction, through processing and manufacturing, use and end-of-life) and impact categories (e.g. climate change, human health, resource depletion and ecosystem health).
- Ensure the study does not overlook important stages (e.g. end-of-life phases) or focus solely on single scores (e.g. greenhouse gas (GHG) footprint), which could lead to oversimplified or misleading conclusions.

4. Critical review and transparency:

- Ensure that the interpretation of results provides an understanding of the underlying methods, assumptions and uncertainty e.g. through sensitivity and scenario analyses.
- The software, data sources (with clearly and transparently documented quality requirements), methods employed in the study and assumptions to facilitate reproducibility and peer review are available and consistent with the goal and scope.
- Check that the study has undergone a critical review process. Pay special attention to studies commissioned by parties with vested interests in specific outcomes, as their independence and objectivity may be compromised.
- Disregard studies not critically reviewed or not showing the reviewers' statement. The critical review statement should give enough assurance that the LCA study is methodologically robust and adheres to established standards.
- The critical review panel should include relevant stakeholders, LCA experts, policymakers and sector-product experts with knowledge of conducting such a review. Observing gender balance is encouraged in the panel. This may be complemented with public consultations of the study involving a balanced pool of experts.

⁴ Functional unit: quantified performance of a product system for use as a reference unit (ISO 2006)

Why is LCA so useful?

A life-cycle approach, and specifically the LCA methodology, recognizes that our choices influence every stage of a product's life cycle, from raw material extraction to disposal. It is particularly strong in identifying both hotspots (i.e. the materials or processes in the life cycle that contribute the most to the environmental impacts), and effective improvement strategies while identifying burden shifting

(i.e. solutions that solve one issue—such as carbon emissions—but create another—such as water use). The identification of hotspots and improvement opportunities makes LCA incredibly useful to inform all stages of the policy cycle, from problem and policy framing to policy implementation and monitoring and evaluation. Also, LCA focuses on the function requested from products or systems, and hence allows a fair comparison of alternatives to deliver such function (see Box 1).



Figure 2: Comparison of single-use and reusable beverage cups in Thailand. Y-axis shows the relative impacts of different cup options, taking the option with highest contribution in that impact category as the 100%. Functional unit: 650 mL container for one drink each workday for a year (260 drinks a year). **Source:** Redrawn from Changwichan and Gheewala (2020).

Box 1: In the context of comparing packaging materials from an environmental perspective, LCA is a crucial tool. The comparison must be based on the function delivered by the packaging design (same functional unit), as different materials may require different quantities of material, production processes and use (as well as user behavior), and end-of-life scenarios. Rather than evaluating the impacts on a single environmental impact (e.g. climate change), LCA examines multiple impact categories, such as acidification, eutrophication, human- and eco-toxicity. A specific packaging format could have lower impacts on climate change, but it would be incorrect to claim that it is “environmentally preferable”. In fact, the LCA study might indicate that this format has higher impacts for all other impact categories. In addition, comparing the environmental impacts of different packaging materials at the level of one life-cycle stage (e.g. manufacturing or end-of-life) is likely to yield misleading conclusions. Instead, packaging formats must be compared considering all life-cycle stages (from cradle-to-grave) to deliver a specific function. For instance, UNEP (2021) provides a meta-analysis of LCA studies comparing single-use plastic cups and their alternatives, and concludes that reusable cups have lower environmental impacts than any single-use alternatives, regardless of the materials. Such LCA studies also point at the key parameters that determine the impacts, such as the number of cycles the reusable cups are used; the efficiency in the reverse logistics (including washing) for the reuse system; the end-of-life management etc. Figure 2 shows selected results from one of these studies in Thailand, showing Climate Change impact (Global Warming Potential) and two impact indicators representative of potential damages to ecosystems and human health (Acidification and Human Toxicity).



Photo: UNEP

Box 2: European Union Packaging and Packaging Waste Regulation (PPWR): A group of over 50 experts (Cottafava *et al.* 2024) submitted a letter to the European policymakers negotiating the PPWR, which advocated for robust LCA studies based on ISO standards, emphasizing comprehensive environmental indicators and rigorous scrutiny of underlying assumptions. The concerns were raised about LCA reports published by private sector companies on the benefits of single-use packaging, containing methodological flaws and ignoring the complexity of the studied system and related environmental impacts.

Application of LCA in global policy frameworks

The significance of life-cycle thinking—including LCA—has garnered recognition on the international stage for several years. This acknowledgment is evidenced by the inclusion of life-cycle texts in various policy frameworks, including the Sustainable Development Goals (SDGs), the Global Framework on Chemicals, the Malmö Ministerial Declaration (UNEP 2000), the Strategic framework for the implementation of the Basel Convention and resolutions from the United Nations Environment Assembly (UNEA), (e.g. UNEP/EA.2/Res.8; UNEP/EA.4/Res.1; UNEP/EA.4/Res.9; UNEP/EA.5/Res.11; UNEP/EA.5/Res.14 among others). Notably, UNEA-4 (2019) underscored the importance of life-cycle approaches in addressing resource efficiency, energy management and waste and chemical management.

Regional and national policies have increasingly integrated life-cycle considerations. Recent initiatives such as the European Green Deal, along with its accompanying programs like the Farm to Fork Strategy, the Chemicals Strategy for Sustainability and legal acts like Ecodesign for Sustainable Products Regulation and the proposal for a Green Claims Directive, exemplify the integration of life-cycle thinking and tools such as LCA (Sala *et al.* 2021) and environmental footprint assessments. The U.S. Inflation Reduction Act (IRA, The White House

Resources to ensure good practice

Conducting a robust LCA study demands substantial expertise and access to LCA data, along with agreed-upon life-cycle impact assessment methods. There is a pressing need for global investment in capacity development to ensure a sufficient pool of experts capable of conducting LCA studies and conducting thorough reviews. Since its inception in 2002, the [Life Cycle Initiative](#), hosted by UNEP, has been dedicated to enhancing the enabling conditions for robust LCA studies, such as capacity development, access to and interoperability of life-cycle inventory data, and consensus on life-cycle impact assessment methods. Continued support for such initiatives is vital to enhance LCA practice globally.

2022) tax credit provisions for clean energy (hydrogen, sustainable aviation fuel and electricity) include LCA requirements. Other noteworthy developments further underscore the global adoption of LCA in policymaking, including the Circular Economy Law of Mexico City (SEDEMA 2023), which uses LCA to evaluate circularity; Chile's Law 20920 (Chile 2016) on Extended Producer Responsibility and Circular Economy; Brazil's National Solid Waste policy (Brazil 2010); Public Tenders (2021) or on Green Mobility (2024); South Africa's requirement for producers to conduct LCA as part of their Extended Producer Responsibility (EPR) scheme; and Thailand's integration of life-cycle approaches in green public procurement, using life-cycle measurements of GHG emissions as an Eco Efficiency key performance indicator of state enterprises.

However, despite the growing interest and established standards surrounding LCA, the approach remains vulnerable to specific interests and potential misuse (see Box 2). Hence, it is imperative to provide decision-makers with the necessary context and tools to discern between sound and flawed LCA practices. The Four-Point Guidance in section 1 provides a first-level checklist to do this; for further detail, the Life Cycle Initiative has compiled key recommendations for technical advisors to policymakers in a dedicated webpage: <https://www.lifecycleinitiative.org/criteria-good-LCA-practice>.

References

- Brazil (2010). Brazilian Law on Solid Waste Management. [Online] Available at: <https://braziliannr.com/brazilian-environmental-legislation/law-no-12305-brazilian-national-policy-solid-waste/> (Accessed: 18 October 2024).
- Brazil, Ministry of the Environment (2021). Public Tenders. [Online] Available at: https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/114133.htm (Accessed: 18 October 2024).
- Brazil, Ministry of the Environment (2024). Green Mobility. [Online] Available at: https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/L14902.htm (Accessed: 18 October 2024)
- Changwichean, K., Gheewala, S.H. (2020). Choice of materials for takeaway beverage cups towards a circular economy. *Sustainable Production and Consumption*, 22(4). DOI:10.1016/j.spc.2020.02.004
- Chile (2016). Law 20920. Extended Producer Responsibility and Circular Economy. Available in: <https://economiacircular.mma.gob.cl/ley-rep/> (Accessed: 18 October 2024).
- Cottafava, D., Brussa, G., Cavenago, G., Cespi, D., Rigamonti, L., Bala, A. *et al.* (2024). Requirements for comparative life cycle assessment studies for single-use and reusable packaging and products: recommendation for decision and policy-makers. *The International Journal of Life Cycle Assessment* 29(5), 909-911.
- European Commission (n.d.). Consumption Footprint. [Online] Available at: <https://eplca.jrc.ec.europa.eu/sustainableConsumption.html> (Accessed: 18 October 2024).
- Global Framework on Chemicals. Available at: <https://www.chemicalsframework.org/>
- International Standards Organization (2006). ISO 14040: Environmental Management - Life Cycle Assessment - Principles and Framework. Geneva: International Organization for Standardization.
- Sala, S., Amadei, A., Beylot, A. and Ardente F. (2021). The evolution of life cycle assessment in European policies over three decades. *The International Journal of Life Cycle Assessment*, 26, 2295-2314
- SEDEMA (2023). Ley De Economía Circular De La Ciudad De México. Available in: <https://www.sedema.cdmx.gob.mx/storage/app/uploads/public/640/775/796/640775796545e564034573.pdf> (Accessed: 18 October 2024)
- South Africa (2021). Draft Amendments to the Regulations And Notices Regarding Extended Producer Responsibility, 2020. Available online: https://www.dffe.gov.za/sites/default/files/gazetted_notices/nemwa_extendedproducerresponsibility2020regulationsnotices_g44295gon239.pdf (Accessed: 18 October 2024).
- Strategic framework for the implementation of the Basel Convention. Available at: <https://www.basel.int/Implementation/StrategicFramework/Overview/tabid/9298/Default.aspx>
- Sustainable Consumption and Production Hotspot Analysis Tool. Available at: <https://scp-hat.org/>.
- The White House (2022). Inflation Reduction Act. Available at: <https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/>
- United Nations Environment Assembly (2019). Fourth session of the United Nations Environment Assembly (UNEA-4). Available at: <https://www.unep.org/environmentassembly/unea4>
- United Nations Environment Assembly (2016). UNEP/EA.2/Res.8: *Sustainable consumption and production* (23–27 May 2016). Available at: <https://documents.un.org/doc/undoc/gen/k16/071/79/pdf/k1607179.pdf>.
- United Nations Environment Assembly (2019). UNEP/EA.4/Res.1: *Innovative pathways to achieve sustainable consumption and production* (11–15 March 2019). Available at: <https://documents.un.org/doc/undoc/gen/k19/010/42/pdf/k1901042.pdf>.
- United Nations Environment Assembly (2019). UNEP/EA.4/Res.9: *Addressing single-use plastic products pollution* (11–15 March 2019). Available at: <https://documents.un.org/doc/undoc/gen/k19/011/21/pdf/k1901121.pdf>.
- United Nations Environment Assembly (2021 and 2022). UNEP/EA.5/Res.11: *Enhancing circular economy as a contribution to achieving sustainable consumption and production* (22–23 February 2021 and 28 February–2 March 2022). Available at: <https://documents.un.org/doc/undoc/gen/k22/007/01/pdf/k2200701.pdf>
- United Nations Environment Assembly (2021 and 2022) UNEP/EA.5/Res.14: *End plastic pollution: towards an international legally binding instrument* (22–23 February 2021 and 28 February–2 March 2022). Available at: <https://documents.un.org/doc/undoc/gen/k22/007/33/pdf/k2200733.pdf>
- United Nations Environment Programme (2000). Malmö Ministerial Declaration. Governing Council (6th special sess. : 2000 : Malmö, Sweden). Available at: <https://digitallibrary.un.org/record/666264?ln=en> (Accessed: 18 October 2024).
- United Nations Environment Programme (2021). *Addressing Single-Use Plastic Products Pollution using a Life Cycle Approach*. Available at: <https://www.unep.org/resources/publication/addressing-single-use-plastic-products-pollution-using-life-cycle-approach> (Accessed: 18 October 2024).

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