

Life Cycle Analysis (LCA)

Understanding Impacts Across a Product's Full Life Cycle

What is Life Cycle Analysis?

Life Cycle Analysis (LCA), also known as Life Cycle Assessment, is a standardized methodology used to evaluate the environmental and human health impacts of a product, process, or service across its entire life cycle from raw material extraction through manufacturing, transportation, use, and end-of-life management.

LCA serves as a decision-making tool that assesses impacts on air, water, land, energy use, and human health, providing a comprehensive understanding of trade-offs across a product's life cycle. Classically, it's a tool used by businesses voluntarily, but governments are increasingly requiring LCAs in their procurement practices.

Why LCA Matters

Traditional environmental assessments often focus on a single stage of a product's life cycle (e.g., waste or recycling). LCA takes a systems-based approach, helping policymakers and stakeholders:

- Avoid unintended consequences (e.g., shifting impacts upstream or downstream)
- Compare materials and technologies on a consistent basis
- Identify opportunities for emissions reduction and resource efficiency
- Support data-driven policy and investment decisions

Key Impact Indicators in Life Cycle Analysis (LCA)

LCAs take into account metrics that fall into the following categories.

1. **Climate & Air Impacts** – Looks at greenhouse gas emissions and air pollution that contribute to climate change, smog, and ozone damage.
2. **Ecosystems & Biodiversity** – Measures how production and resource use affect land, water, and wildlife, including habitat and ecosystem health.
3. **Water Use & Pollution** – Tracks how much water is used and how activities may pollute waterways or disrupt aquatic systems.
4. **Resource Use & Energy** – Examines the use of natural resources (like fossil fuels and minerals) and total energy consumption across a product's life cycle.
5. **Human Health** – Assesses how pollution and exposure to harmful substances can impact people's health.
6. **Waste & End-of-Life** – Evaluates what happens to materials after use, including landfill, recycling, and recovery, and their environmental trade-offs.
7. **Overall Impact (Big Picture)** – Brings all these factors together to show the total environmental footprint and help avoid shifting impacts from one area to another.



Environmental Implications

- **Reduce Climate & Air Impacts** – LCA helps identify ways to lower greenhouse gas emissions and air pollution across a product's full life cycle.
- **Protect Water & Ecosystems** – By tracking water use, pollution, and ecosystem impacts, LCA supports strategies that safeguard natural environments.
- **Conserve Resources & Improve Efficiency** – LCA highlights opportunities to reduce resource use and design more sustainable products.
- **Target the Biggest Impacts** – LCA identifies the most resource-intensive or polluting stages, allowing for focused and effective action.
- **Avoid Shifting Impacts** – A full life cycle approach ensures that solving one problem doesn't create another elsewhere.

Economic Implications

LCA also plays a key role in informing economic decision-making:

Cost Efficiency: Identifies opportunities to reduce material use, energy consumption, and operational costs

Innovation: Supports development of new materials, recycling technologies, and circular business models

Policy Design: Helps governments design effective regulations (e.g., EPR, recycling targets) based on full system impacts

Investment Decisions: Provides data to guide private and public sector investments toward lower-impact solutions

Implications for Policy in the Great Lakes Region

For policymakers and regional stakeholders, LCA offers a foundation for more effective circular economy strategies by:

- Supporting **evidence-based material and packaging policies**
- Enabling **better procurement decisions and policies**
- Informing **EPR program design and performance metrics**
- Guiding investments in **recycling infrastructure and innovation**
- Ensuring policies address **full life cycle impacts**, not just waste management



Key Takeaways

Use a Full Life Cycle Approach – Company policies should consider impacts across a product's entire life cycle from production to disposal to avoid shifting environmental burdens from one stage to another.

Support Evidence-Based Policy Design – LCA provides standardized and data-driven insights that can inform smarter material choices, packaging policies, and regulatory decisions.

Strengthen EPR and Performance Metrics – LCA can help design and evaluate Extended Producer Responsibility (EPR) programs by identifying the most impactful points in the system and measuring real outcomes.

Guide Strategic Investments – Insights from LCA can direct funding toward the most effective solutions, including recycling infrastructure, innovation, and circular economy initiatives.

Look Beyond Waste Management – Focusing only on recycling or disposal can miss larger environmental impacts. LCA ensures policies address emissions, resource use, and upstream production impacts as well.

Advance a More Resilient Circular Economy – By evaluating environmental and economic trade-offs, LCA supports decisions that improve resource efficiency, reduce emissions, and build long-term sustainability in the Great Lakes region.