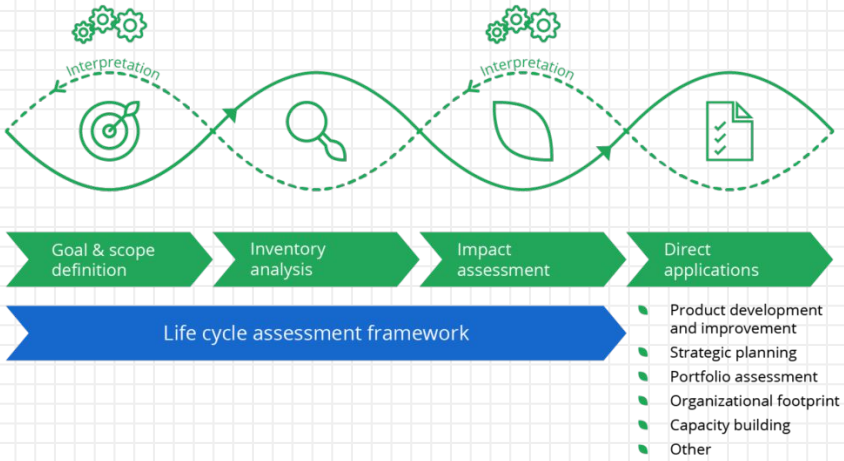
Life Cycle Assessment

Purpose of Life Cycle Assessment

- Identify where and how impacts occur
- Enable decisions and operations to counteract life cycle debt
- Translate the impacts to an understandable format that informs stakeholders



Creating a Life Cycle Assessment

Comprised of 4 steps:

1. Goal and Scope – Set the ground for which your assessment will cover. Generally 2–3 areas of what the total LCA encompasses. Define what you are evaluating.

2. Inventory Analysis – Gather material data, and energy usage. This include emission and waste through manufacturing, use, recycling, and disposal. Extensive data collection.

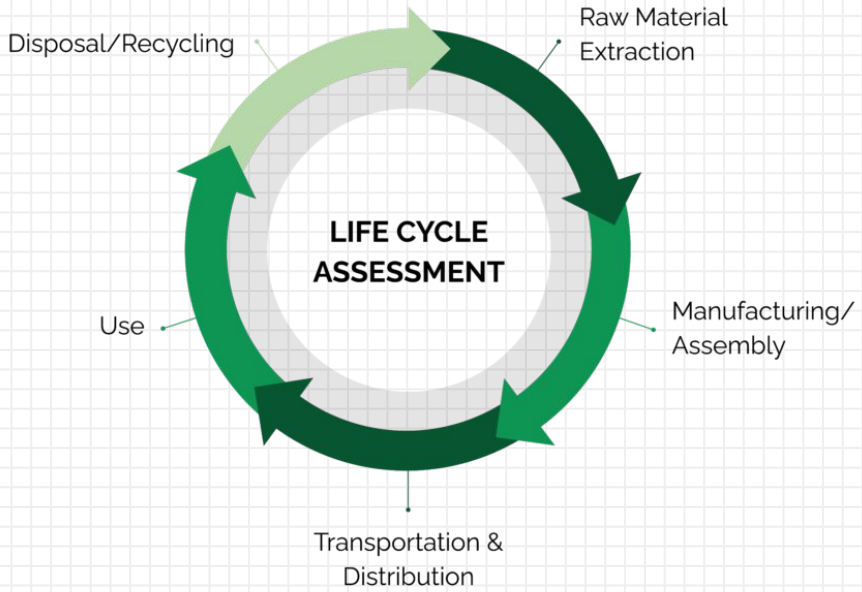
3. Impact Assessment – Evaluate the collected data to detail how much waste, the carbon footprint, and other impacts relevant to your goal and scope.

4. Interpretation – Use the results from Impact Assessment to create informed decisions that affect either the current design, or future designs/systems.

1. Goal and Scope

Example statement:

"The scope of the Life Cycle Assessment (LCA) of the Sample Subway evaluates the cradle-to-grave product life, examining the environmental and social impacts. This analysis will concentrate on the extraction and disposal of raw materials used for the development of the device. "

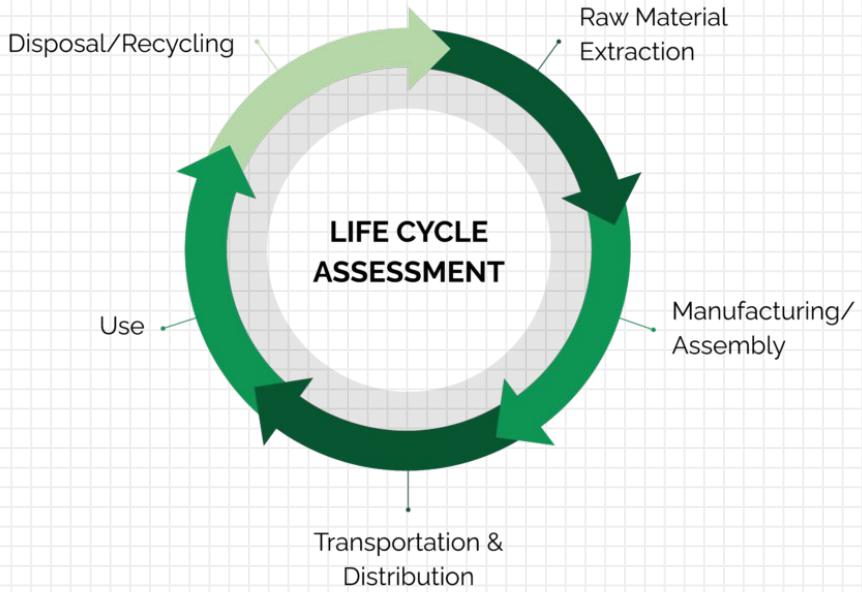


1. Goal and Scope

Define Functional Unit (Product / Task / Performance / Material / Service):

"One complete [product] used for [duration] under typical operating conditions."

"One hour of operation of [system] providing [service]."



2. Inventory Analysis

Break down the components of your device, and assess all the materials that it would be constructed of.

Like the nutrition label on food packaging.

1. Consider final product material
2. Apply material in CAD to get weight
3. Indicate metrics associated (weight %, cost %, etc.)

Product Composition

Components	Material	Weight (g)	Weight (%)
Chassis	Hydro 75R - Aluminum	2103.2	93.88
Wheels	Silicone	8.2	0.37
Circuit Board	FR4 Composite	25.0	1.12
Wires	Copper	25.0	1.12
Battery Cells	Lithium	3.78	0.17
Battery Cells	Lithium NMC Oxide	75.0	3.35

"For the extraction of raw material in our inventory analysis we focused on the material acquisition of aluminum and its impacts.

For the disposal of our device we followed the proposed disposal plan from Canadian Nuclear Laboratories (Chalk River)."

2. Inventory Analysis

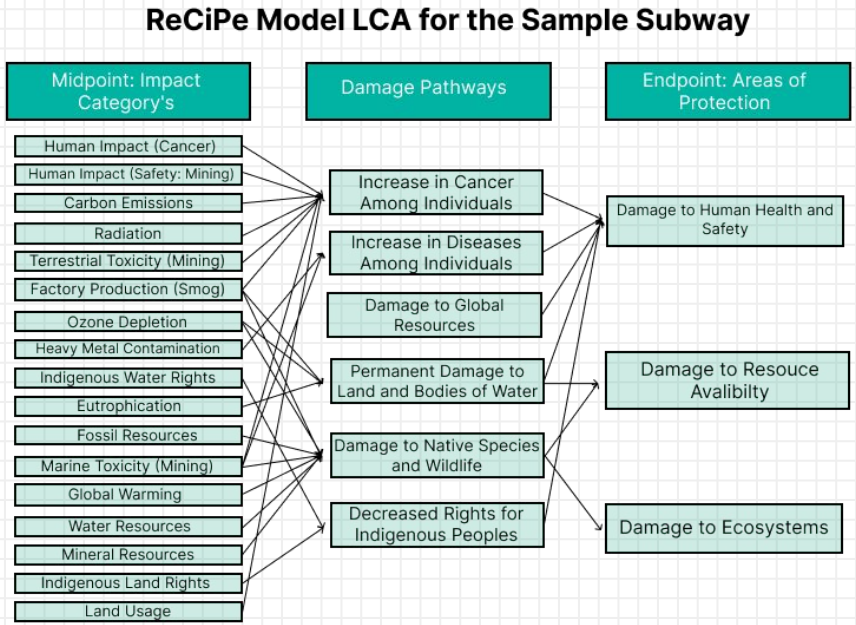
Further develop material data as it relates to your goal and scope.

Raw Material Acquisition	• Bauxite Mining • Alumina Refining (Bayer Process) • Primary Aluminum Production • Aluminum Fabrication • Recycling • Secondary Aluminum Fabrication (Post-Consumer Scrap) → Hydro CIRCAL 75R	• 4 tonnes bauxite = 2 tonnes alumina • <5kWh/t, <1.5 fuel/t (mining) • 15-25% of aluminum (in bauxite) • 2 tonnes alumina = 1 tonne aluminum • ≈150kWh/t (refinement) • 3 tonnes red mud = 1 tonne alumina • 5% of overall energy for primary production (recycling) • 75% recycled post-consumer scrap • 1.9kg CO2/kg Al (88% lower)
	Aluminum is the most metallic element and the third most common element found in the earths crust (8.23%). The production process of this raw material is classified as one of the most energy exhaustive processes, where primary production is approximately 10 times more than secondary. On a basis of one tonne, the whole process requires approximately 170,000 kWh of electricity.	
Disposal of Contaminated Material	• Disposal via CNL proposed Near Surface Disposal Facility at Chalk River • Alternative disposal via Port Hope, Greater Toronto Area and other existing Low Waste Disposal facilities • Intermediate Waste Disposal at Whiteshell Laboratories and Nuclear Power Demonstration	Scenarios for Waste Disposal: 1. Intermediate Waste Disposal for Lathe bit, silicone wheels, and containment system due to direct contact to pressure tube material. 2. Low Level Waste Disposal for Aluminum chassis and other components. It is likely that all components would fall into the low level waste category. This further exeplifies the necessity of CNLs Low Waste Disposal Facility at Chalk River.

3. Impact Assessment

Choose an Impact Assessment Method i.e. ReCiPe

This section should show your analysis, with supporting data, and clear connections to outcomes.



4. Interpretation

Major findings: "Disposal had negligible impact compared to material extraction."

Uncertainty: "Material choice significantly changes total impact. Manufacturing energy has less influence."

Improvement: "Reducing aluminum mass would produce the largest reduction in environmental impact."

Alignment "Given our scope focused on raw material extraction and disposal, most improvement opportunities relate to material selection and device recyclability."

Limitations: "Manufacturing and use-phase impacts were outside our scope, so total life-cycle impact may be underrepresented."

ISO: International Standards Organization

Aspect	ISO 14040	ISO 14044
Purpose	High-level framework	Detailed requirements & methodology
Scope	Defines phases and principles	Defines how to perform each phase
Level	Conceptual	Practical & technical
Audience	People learning/teaching LCA	People performing or reviewing LCAs
Content Type	Overview	Rules, methods, criteria