Welcome to the Life Cycle Assessment (LCA) Learning Module Series

Liv Haselbach    Quinn Langfitt

For current modules email haselbach@wsu.edu or visit cem.uaf.edu/CESTiCC

ACKNOWLEDGEMENTS:

CESTiCC    WASHINGTON STATE UNIVERSITY    FULBRIGHT
LCA Module Series Groups

Group A: ISO Compliant LCA Overview Modules
Group α: ISO Compliant LCA Detailed Modules

Group B: Environmental Impact Categories Overview Modules
Group β: Environmental Impact Categories Detailed Modules

Group G: General LCA Tools Overview Modules
Group γ: General LCA Tools Detailed Modules

Group T: Transportation-Related LCA Overview Modules
Group τ: Transportation-Related LCA Detailed Modules
Goal, Function, and Functional Unit

MODULE $\alpha_1$

It is suggested to review Modules A1 and A2 prior to this module
Goal

First component of an LCA following the requirements of ISO 14044

Goal must state:
- Intended use
- Reasons for study
- Audience
- Whether comparative and disclosed to public

Helps form the basis for:
- Scope definition
- Methodologies used
- Presentation of results

Not reviewable in the critical review
## Goal Statement Example

**Introduction**

The goal was to generate a quantitative environmental profile of the management system for all of the used oil generated in California. The results of the LCA, when combined with a closely integrated economic assessment performed by the economic contractor, will provide sufficiently broad information to be used by CalRecycle to fulfill its duties pursuant to Section 48651.5 (b) (1) (D), namely to provide suggestions to the Legislature regarding possible policy changes to promote increased collection and responsible management of used oil. The intended audience of the study is CalRecycle, all industries involved in and affected by the management of used oil generated in California, and the public at large. The results of this study are intended to be used in comparative assertions intended to be disclosed to the public.

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**Reason for carrying out**

**Intended use**

**Intended audience**

Public, comparative

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Goal Statement Guides Analysis

Include definitions for technical terminology?
Public among intended audience
YES!

Include multiple scenarios covering different combinations of disposal techniques?
Intended use to provide info to legislature for policy development
YES!

Analyze general US impacts for other states to be able to use the data?
Carried out specifically to serve decision making in California
NO!
Function

What the product(s) or process(es) is designed to do

Often intuitive
- However, function must be stated to make it unambiguous

Important to help define the system and functional unit

Generate Light
Transport People
House Students
Functional Unit Definition

Functional Unit

“Quantified performance of a product system for use as a reference unit.”

*ISO 14044
Functional Unit

Functional unit defines what quantity of the product’s function is achieved to cause the environmental impacts identified

- Light bulb functional unit might be 1,000,000 lumen-hours of light
- Bus functional unit might be 10,000 passenger-kilometer
- Dormitory building functional unit might be house 200 students for one year

For 20 Million lumen-hours

Functional Unit

Some consider correct determination of functional unit the highest priority in LCA*

Must be “clearly defined and measurable”**

Especially important in comparative studies to ensure fair comparison

Value not particularly important
  ◦ Unit is very important

Best to set functional unit before collecting data (though not required)
  ◦ Can always change it later

Product life time should be considered later when applying functional unit

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Functional Unit Example Statement

Situation: Comparing an LED, CFL, and incandescent bulb

Example statement: The function of the compared product systems is to provide lighting in residential applications. The functional unit is defined to be twenty million lumen-hours of light, with a wavelength between 450-600 nm, provided. This functional unit was chosen because lumen-hours is a common unit of cumulative illumination measurement, twenty million lumen-hours represents approximately one LED lamp’s illumination over its full life time, and the wavelength range represents visible light appropriate for home illumination.
Functional Unit Choice not Trivial

Shopping bag comparing paper, plastic, and cloth

- Functional unit could be to carry a certain volume or a certain weight of groceries a certain number of times (i.e. 5 kg of groceries on 10 trips)


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Relating to the functional unit basis

Collect input/output data based on how much of the function is accomplished

Express inputs/outputs in terms of one unit of function

Multiply by value of functional unit

Functional unit = 50,000 passenger-miles traveled
Relating to the functional unit basis

Manufacture
1,000 lb steel per car which lasts for 100,000 miles at average occupancy of 1.5 persons

Use
Gaseous emissions:
20 lb CO₂ per gallon of gas, which powers car for 28 miles w/ 1.5 pass

Brake/tire wear:
• 0.2 lb PM₁₀ per 60000 miles w/ 1.5 passengers

Disposal
1,000 lb steel to be recycled per car

Collect input/output data based on how much of the function is accomplished

Express inputs/outputs in terms of one unit of function

Multiply by value of functional unit
Relating to the functional unit basis

Manufacture

\[
\frac{1000 \text{ lb steel}}{100,000 \text{ mi} \times 1.5 \text{ pass}} = 0.0067 \frac{\text{lb steel}}{\text{pass} \times \text{mi}}
\]

Use

**Gaseous emissions:**

\[
\frac{20 \text{ lb CO}_2}{1 \text{ gal gas}} \times \frac{1 \text{ gal}}{28 \text{ mi} \times 1.5 \text{ pass}} = 0.48 \frac{\text{lb CO}_2}{\text{pass} \times \text{mi}}
\]

\[
\frac{1000 \text{ lb steel}}{100,000 \text{ mi} \times 1.5 \text{ pass}} = 0.0067 \frac{\text{lb steel}}{\text{pass} \times \text{mi}}
\]

**Brake/tire wear:**

\[
\frac{0.2 \text{ lb PM}_{10}}{60000 \text{ mi} \times 1.5 \text{ pass}} = 2.2 \times 10^{-6} \frac{\text{lb PM}_{10}}{\text{pass} \times \text{mi}}
\]

Disposal

\[
\frac{1000 \text{ lb steel}}{100,000 \text{ mi} \times 1.5 \text{ pass}} = 0.0067 \frac{\text{lb steel}}{\text{pass} \times \text{mi}}
\]

Collect input/output data based on how much of the function is accomplished

Express inputs/outputs in terms of one unit of function

Multiply by value of functional unit
Relating to the functional unit basis

**Collect input/output data based on how much of the function is accomplished**

**Manufacture**

\[
\frac{0.0067 \ lb\ steel}{pass\cdot mi} \times 50,000 \ p \times m = 335 \ lb\ steel
\]

**Use**

**Gaseous emissions:**

\[
\frac{0.48 \ lb\ CO_2}{pass\cdot mi} \times 50,000 \ p \times m = 24,000 \ lb\ CO_2
\]

**Brake/tire wear:**

\[
2.2 \times 10^{-6} \frac{lb\ PM_{10}}{pass\cdot mi} \times 50,000 \ p \times m = 0.11 \ lb\ PM_{10}
\]

**Disposal**

\[
\frac{0.0067 \ lb\ steel}{pass\cdot mi} \times 50,000 \ p \times m = 335 \ lb\ steel
\]

**Express inputs/outputs in terms of one unit of function**

**Multiply by value of functional unit**
Thank you for completing Module α1!

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Homework

1. Write a goal statement for a fictitious LCA of your choosing.

2. Find an LCA in a journal or online and examine its goal statement. Does it cover all necessary information as outlined in ISO 14044? Summarize the statements on the four points, or if any are not included state that.

3. Determine what functional unit should be used for an LCA comparing gasoline and ethanol production (hint: think energy). Explain your choice.

4. Consider the use stage of a life cycle assessment on an incandescent light bulb. Assume that the only flow within the system during that stage is the electricity needed to operate the bulb. The bulb consumes 1 kWh of electricity to produce 16,000 lumen-hours of light. Each kWh of electricity has the following simplified inputs and outputs to and from nature:
   - Inputs: 0.356 kg coal
   - Outputs: 1.01 kg CO₂, 1.60×10⁻³ kg NOₓ, 1.22×10⁻² kg SO₂, and 9.26×10⁻⁶ kg PM₁₀

   Considering the functional unit is 20,000,000 lumen hours, convert the LCI data into the quantities of inputs and outputs based on the functional unit.