

# OENG1118 Sustainable engineering practice and design

---

Week 5: Life cycle assessment  
Goal and scope



## LCA: goal and scope

## Skills – LCA: goal and scope

Formulate a **goal statement**

Formulate a **functional unit**

Draw a **system boundary diagram** that includes (1) unit processes, and (2) elementary flows and intermediate flows of materials, energy, emissions, and other releases

## Goal and scope: take-home message

As we learn more about our product and the available data, we adjust the goal to make the LCA study consistent and congruent.

## Goal statement

## Goal and scope

We use the goal to decide which of the following to include:

- Life cycle stages
- Processes
- Flows
- Environmental impacts
- Language
- etc.

## Goal statement

Our goal statement includes the following:

### *Intended application*

- Are we looking for information to support: marketing claims, product design, process improvement, policy decisions, certification, strategic planning, priority setting, etc.?

### *Reason*

- Ask ourselves *why?* a few times to get to the root reason. Is it related to high costs, high environmental impact, shrinking market share, high risk, etc.? We specify the questions that we'll address.

### *Intended audience*

- For whom will we write our report? Who will make a decision based on the results? Is it manufacturers, users, government, investors, etc.?

## Functional unit

## Functional unit

What are the functions of a pair of shoes?

- Protect the feet from impact forces Primary function
- Protect the feet from dirt
- Protect the feet from water
- Provide comfort to the feet
- Be fashionable
- Contribute to a collection
- Etc.



## Functional unit

Consider the *functional unit* of protecting the feet from 700N of ground impact during 1000 km of walking.

	<b>High-quality shoe</b>	<b>Low-quality shoe</b>
Service/pair:	1000km @ 700N	200km @ 700N
Materials/pair:	600g leather 500g rubber 10g thread 5g adhesive	200g leather 300g rubber 200g canvas 5g adhesive
Materials total:	600g leather 500g rubber 10g thread 5g adhesive	1000g leather 1500g rubber 1000g canvas 25g adhesive

Reference flow

## Functional unit

To define the functional unit, we:

1. distinguish between the *primary* and *secondary* functions according to the goal. What is the main service?
2. consider the *size* and *duration* of the main service:
  - Size: How much does one service provide?
  - Duration: How long does one service take?
  - Duration: How long will each reference flow last before needing replacement?
3. write *one sentence* that quantifies the primary function of the product (or service).

## System boundary diagram

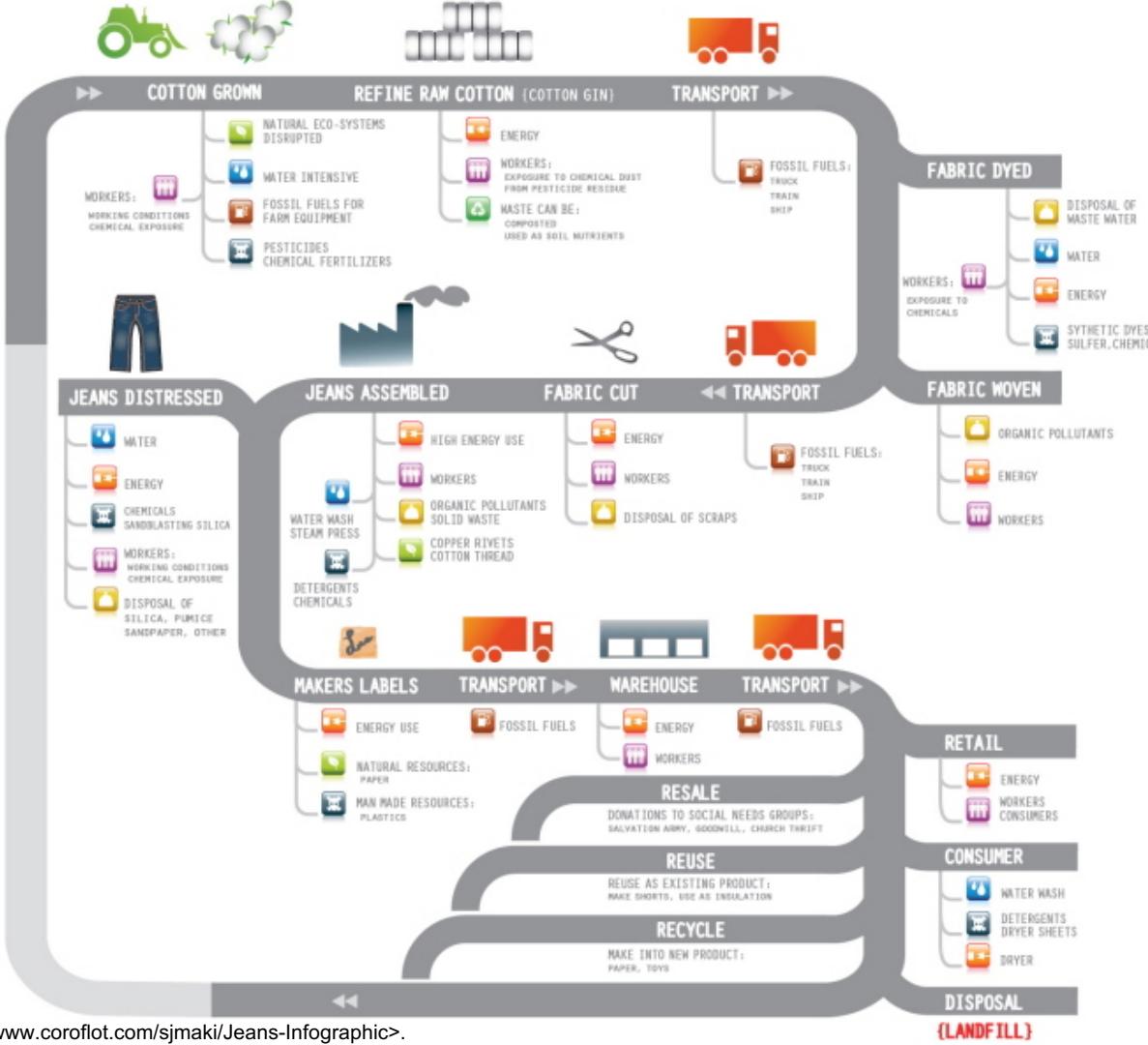
# System boundary diagram

Map of the:

- processes
- product flows
- major environmental input flows
- major environmental output flows

Each node is a process

Reference flow is at the *use* stage

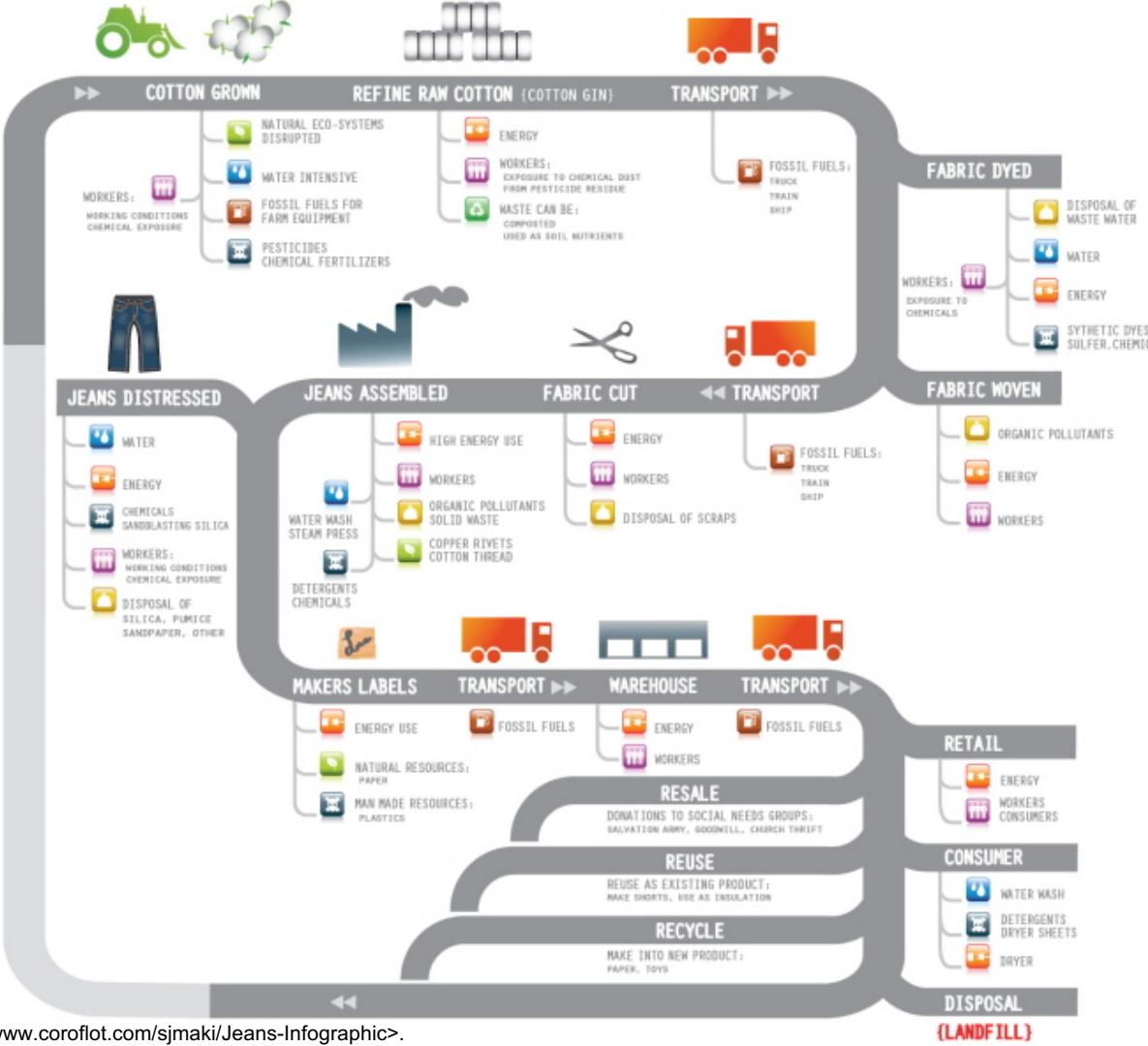


# System boundary diagram

What might the goal say about:

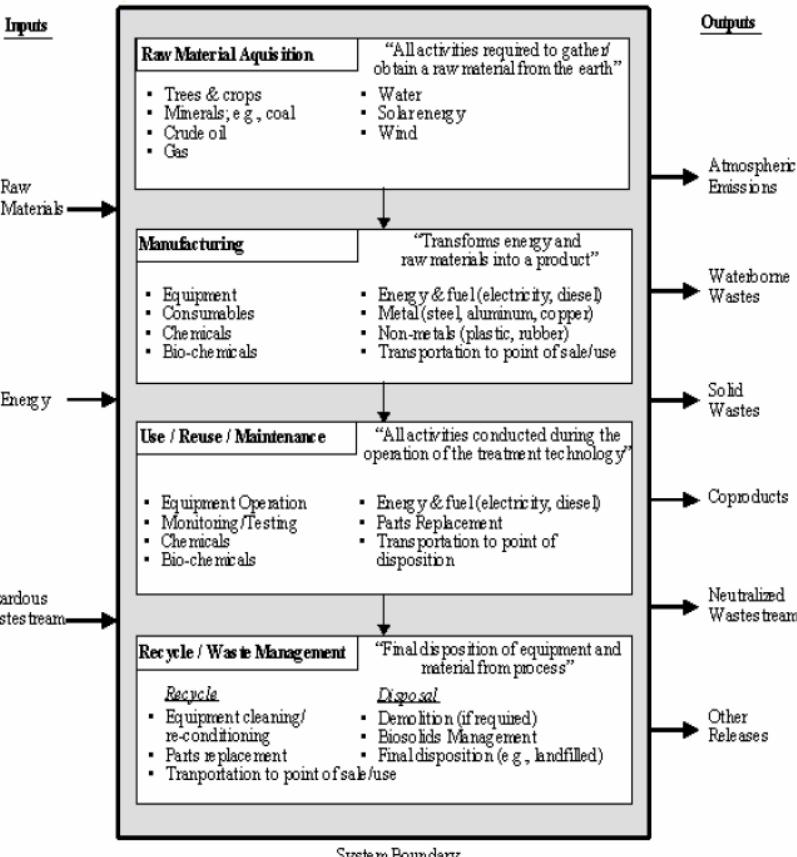
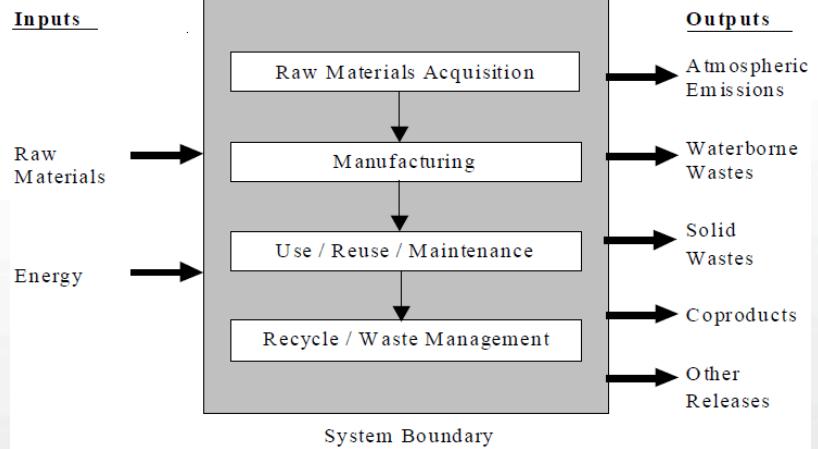
- life cycle stages
- process
- flows
- environmental impacts
- language

?



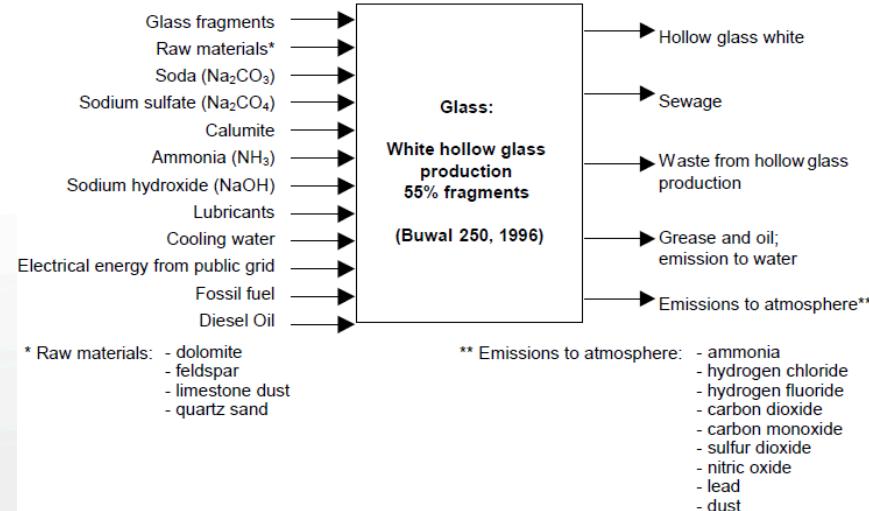
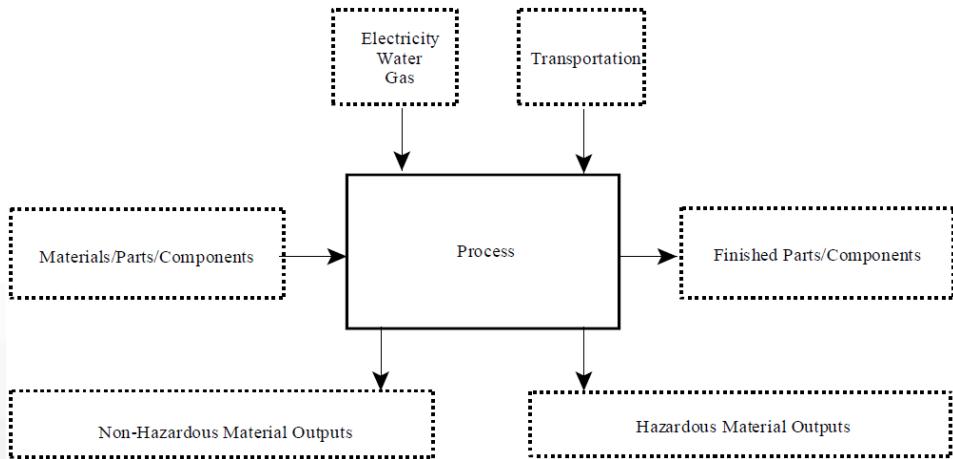
# System boundary diagram

## Life cycle



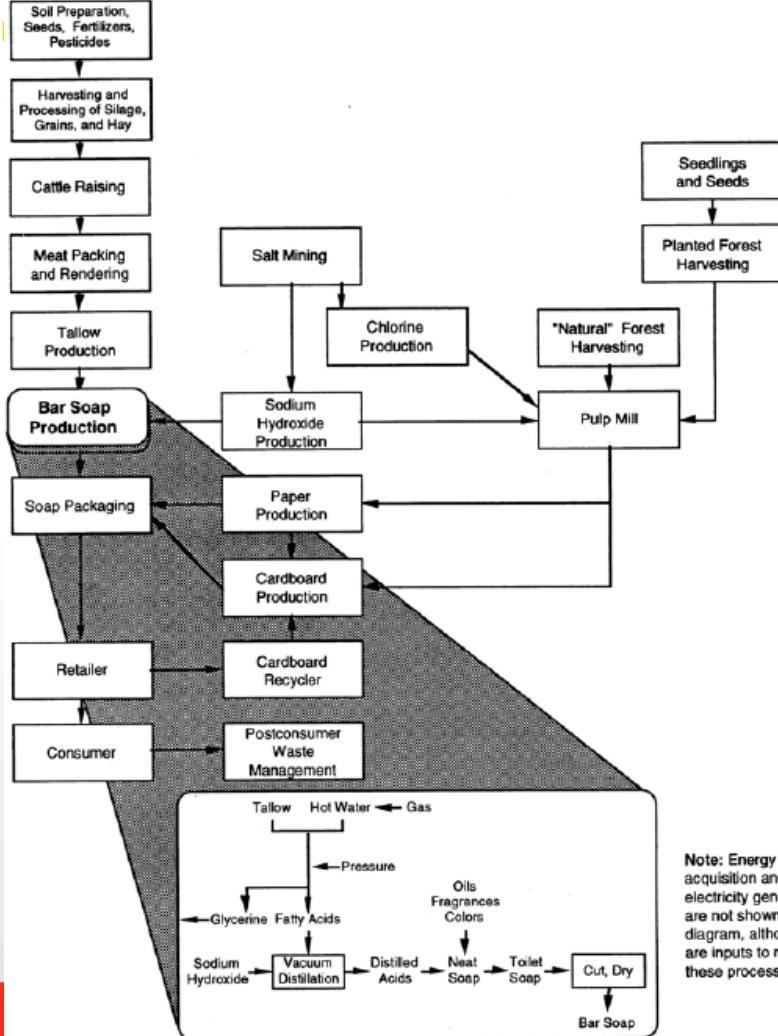
# System boundary diagram

## Unit process



# System boundary diagram

Draw a circle around a unit process.



## System boundary diagram

We often exclude:

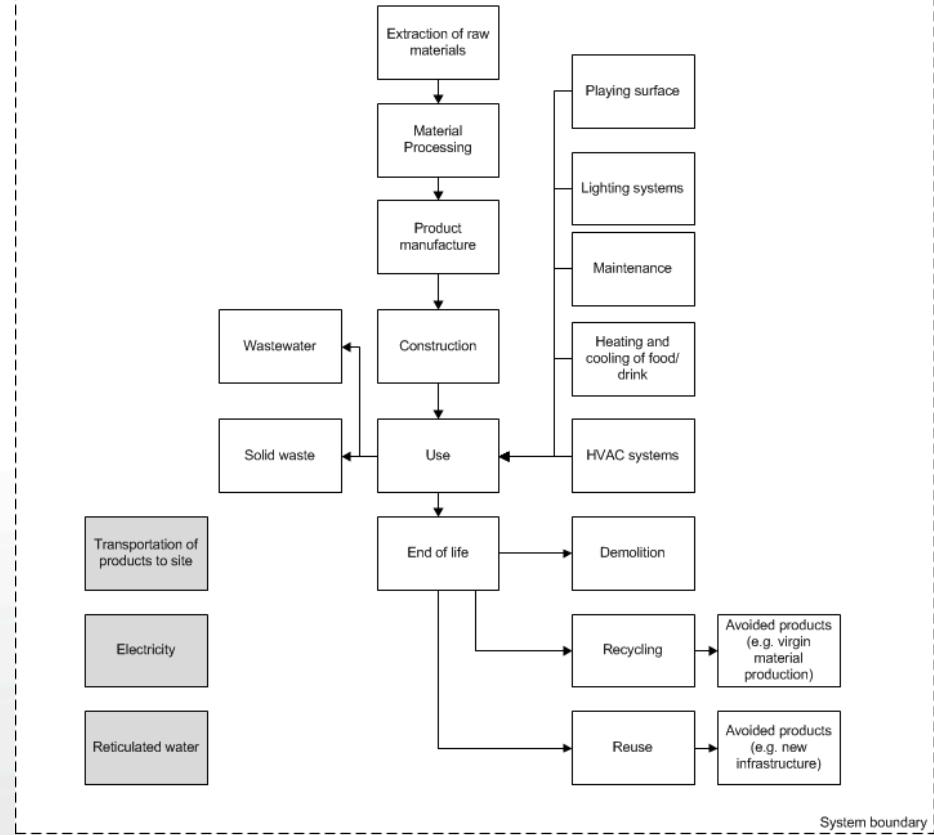
- capital equipment and maintenance (but some are still in our models)
- human labor
- accidents
- internal transportation of materials

# System boundary diagram

Our style convention:

- *Single diagram* for all competing products
- *Dashed box* for the system boundary
- *Solid boxes* for unit processes
- *Direction of arrows* should be correct
  - Raw materials go in
  - Waste goes out
- *Shared processes* may be disconnected and shaded a different colour
- *Excluded processes* may be disconnected and identified by a caption
- *Functional unit* should be shown
- *Elementary flows* excluded in full LCA; major *elementary flows* included in streamlined LCA
- Use Microsoft Visio

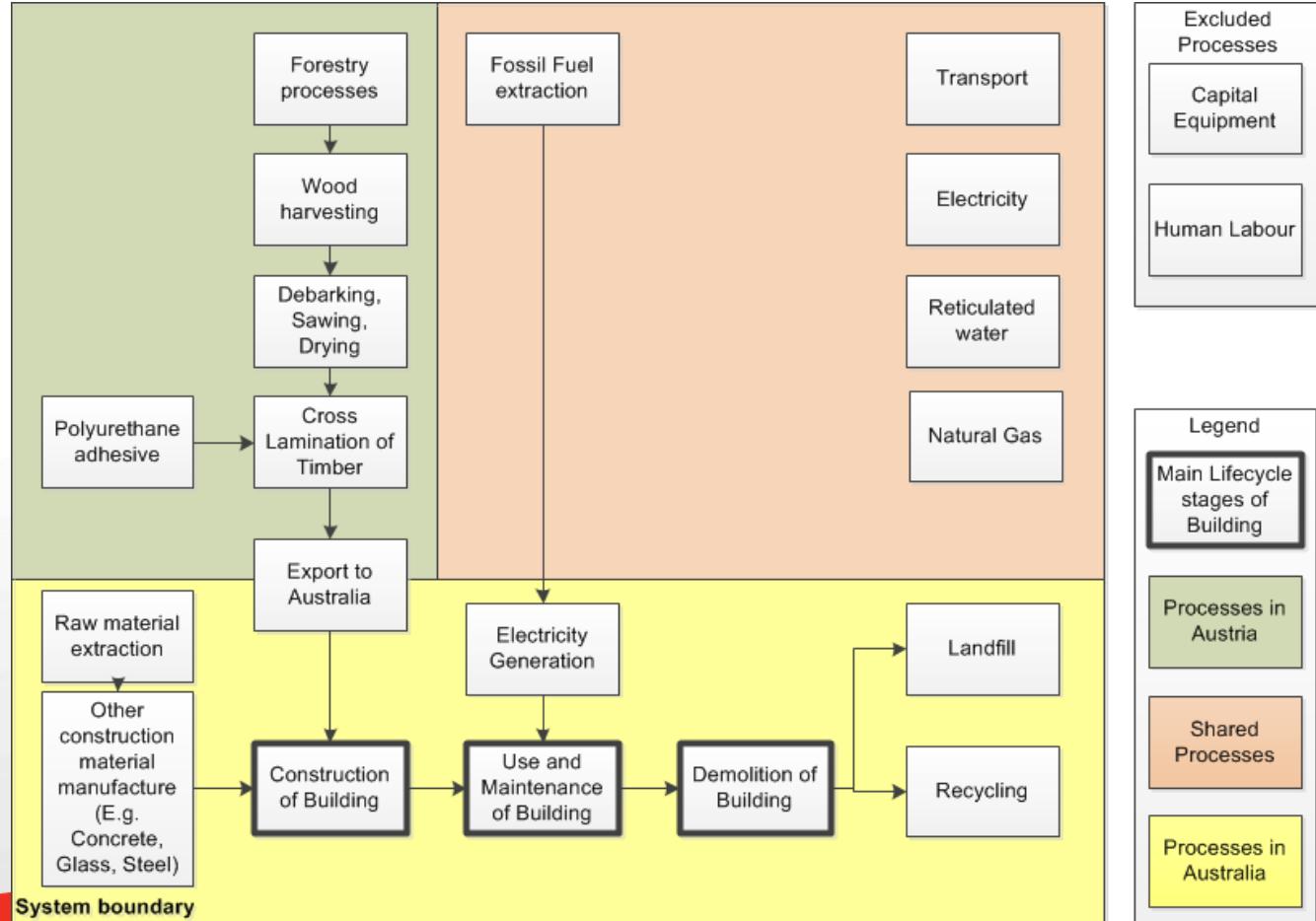
# System boundary diagram



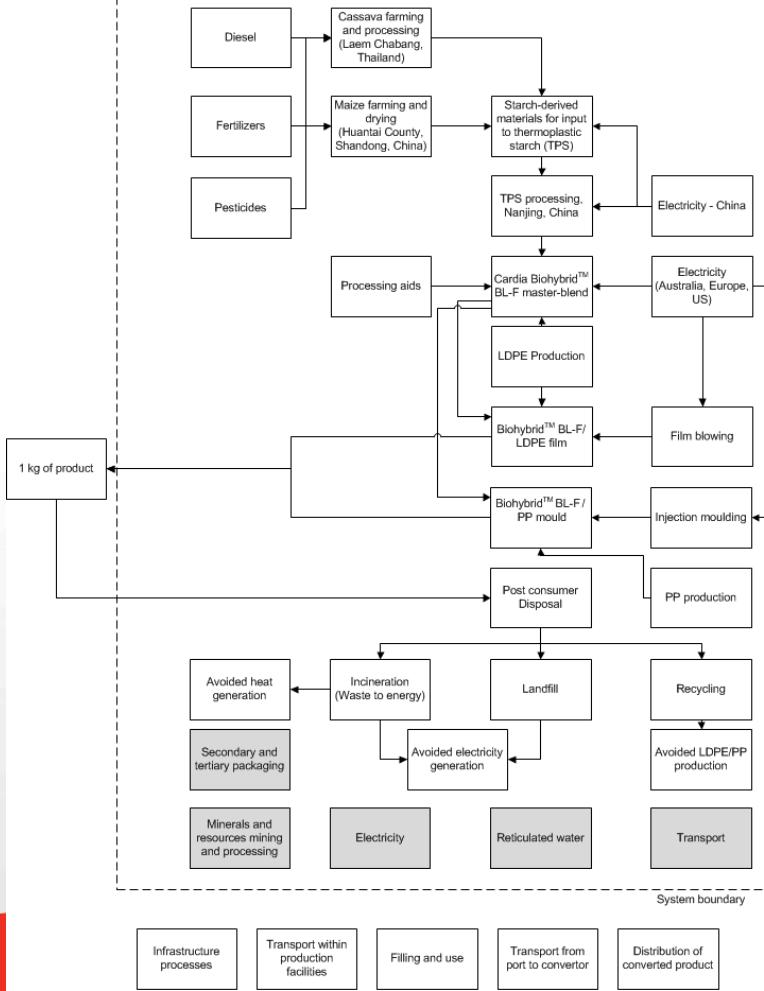
Excluded processes

- Production of food and drink
- Transport of patrons to events

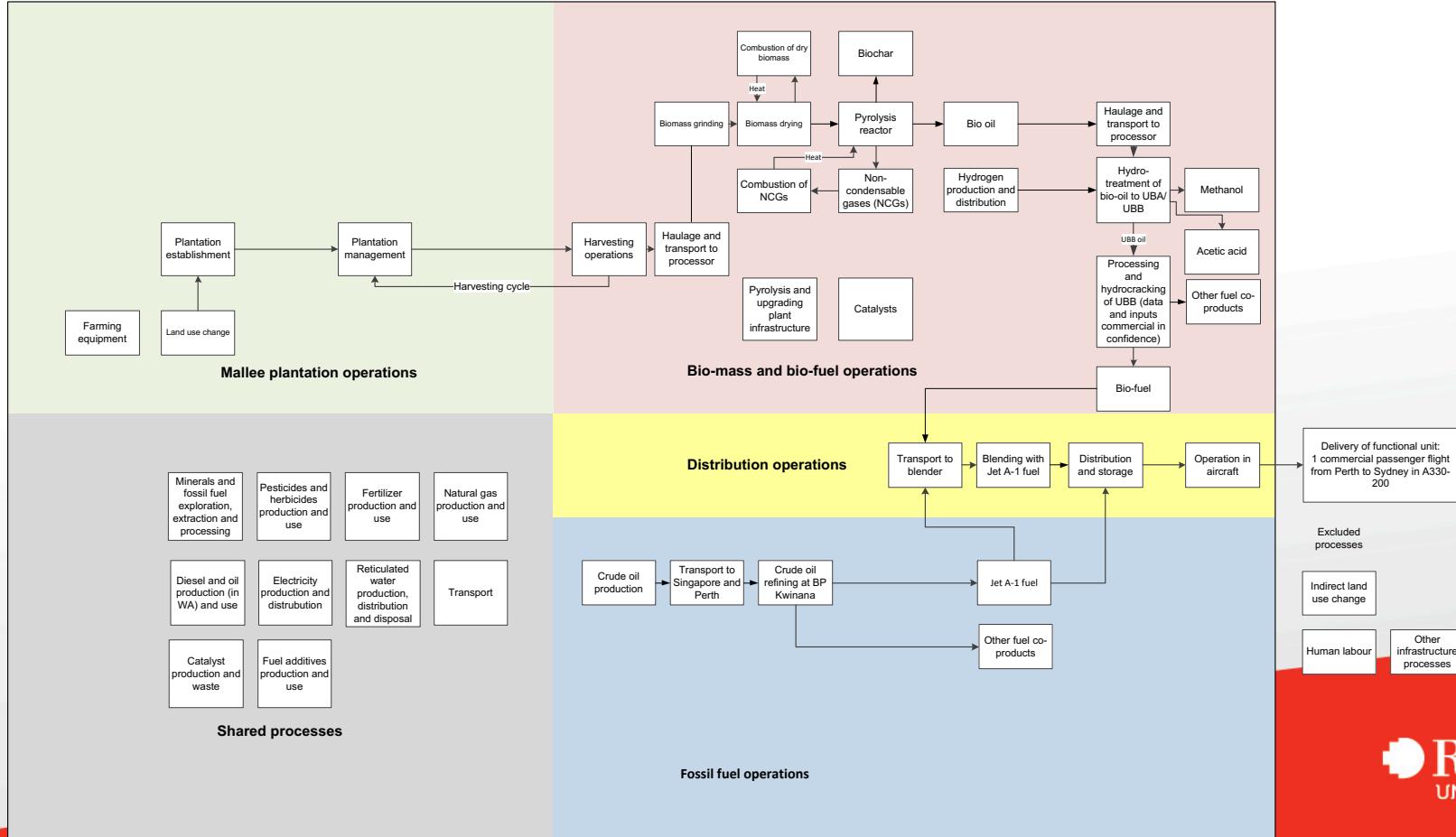
# System boundary diagram



# System boundary diagram



# System boundary diagram



# Quiz

## Goal statement: intended applications

Intended application:

- A. is similar to the reason; we usually omit it
- B. might be something related to policy development, marketing strategy, process improvement, or certification
- C. is something related to the functional unit and product.

## Goal statement: reason

In a statement of the reasons to conduct an LCA study, we:

- A. must specify questions that the study will address
- B. must specify only a topic area (and then explore that topic during the study)
- C. may define environmental indicators
- D. may do all of the above.

## Goal statement: intended audience

What are the benefits of producing a report that is catered to an particular audience?

## Functional unit

Determine the **primary function** of:

- a pet
  - Companionship
- a smartphone
  - Communication
- indoor paint
  - Coverage
- a light bulb
  - Emit artificial light
- a soft drink bottle
  - Deliver beverage to a consumer

## Functional unit

We want to conduct an LCA study to compare various outdoor wall coverings. Which of the following is the most correct functional unit?

- A. Wall covering with: an area of 20m<sup>2</sup>, a heat resistance of 2 mK/W, a Rockwell hardness of 80, a coloured surface of 98% opacity, and life of 5 years between re-colourings
- B. Wall coverings resist heat, don't scratch, cover the wall, and don't fade for at least 5 years
- C. The wall's functional unit depends on its size; larger walls do more
- D. All of the above

How might the functional unit change if the wall coverings were for indoor walls?

## Functional unit

Formulate a **functional unit** for:

- a pet
  - Live domestic companion for 10 years
- a smartphone
  - Verbal conversation at 60 dBA for 1000 hours
- indoor paint
  - Cover 20m<sup>2</sup> of surface with 98% opacity and an 80 Rockwell hardness for 5 years
- a light bulb
  - 500 lumens of artificial light for 10 years
- a soft drink bottle
  - Deliver to a consumer 1 L of beverage at 700 kPa within 1 year

## Functional unit

Which of the following don't we need to know to define a functional unit?

- A. The product
- B. The reference flow
- C. The primary functions
- D. The secondary functions

## Functional unit

Product	Light bulb	Bottle	Hand drying
Functions	<ul style="list-style-type: none"> <li>- Providing illumination</li> <li>- Generating heat</li> <li>- etc.</li> </ul>	<ul style="list-style-type: none"> <li>- Protection of beverage</li> <li>- Facilitating handling</li> <li>- Part of product image</li> <li>- etc.</li> </ul>	<ul style="list-style-type: none"> <li>- Drying hands</li> <li>- Removing bacteria</li> <li>- etc.</li> </ul>
Selected function for a particular LCA	Providing illumination (outdoor lamp only)	Protection of beverage	Drying hands (hygienic function judged irrelevant)
Functional unit	300 lx in 50 000 h matching the daylight spectrum at 5 600 K.	50 000 l of beverage protected between tapping and consumption	1 000 pairs of hands dried
Performance of the product	100 lx with a lifetime of 10 000 h	0,5 l one-way bottle	One paper towel for drying one hand
Reference flow			

## Skills – LCA: goal and scope

### Formulate a **goal statement**

- intended application, reasons for carrying out the study, intended audience

### Formulate a **functional unit**

- product/system, primary and secondary functions, size and time or service, functional unit, reference flow

Draw a **system boundary diagram** that includes (1) unit processes, and (2) elementary flows and intermediate flows of materials, energy, emissions, and other releases

- processing, production, distribution, use/commissioning/maintenance, end-of-life/decommissioning, recovery, disposal

## Goal and scope: take-home message

As we learn more about our product and the available data, we adjust the goal to make the LCA study consistent and congruent.

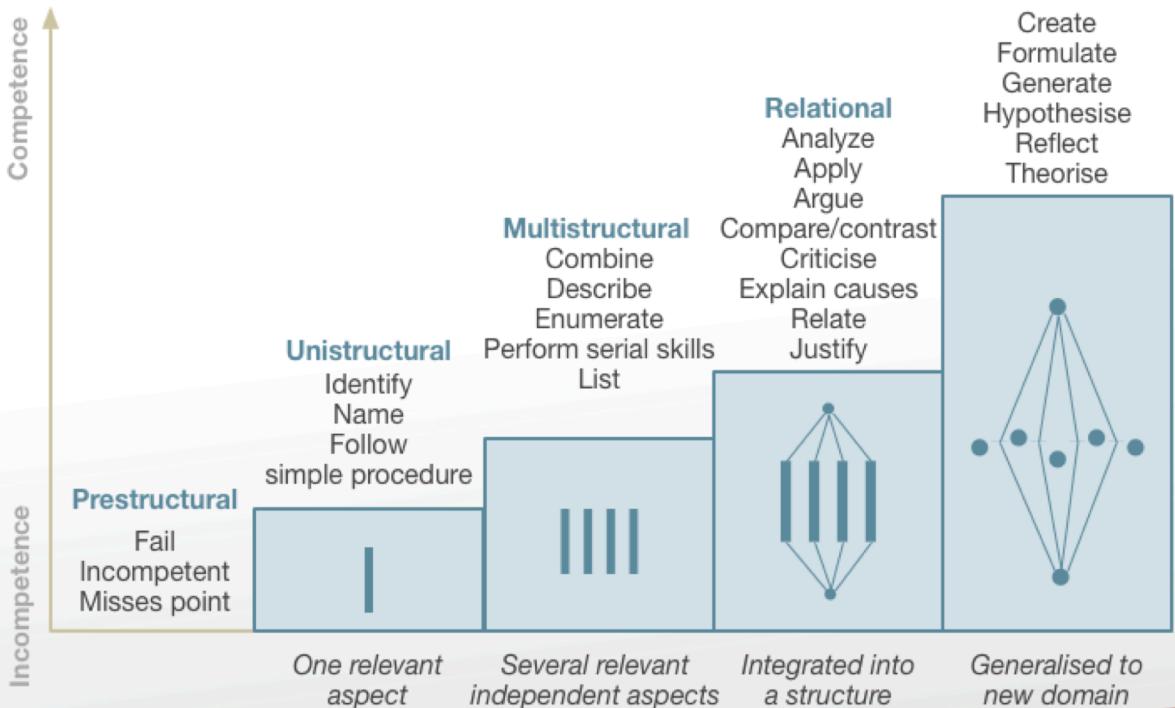
Thanks!

# Assessment standards

## SOLO taxonomy

Video (4 min)

Text (100 words)



Source: The Australian National University 2014, *Unravelling Complexity*, The Australian National University, Canberra. <http://vc-courses.anu.edu.au/uc/home>, viewed 4 March 2014.