

LIFE CYCLE ASSESSMENT

This lesson plan introduces students to life cycle assessments for a variety of common household products.

LESSON OBJECTIVES

Students will be able to:

- List the factors considered in LCA
- Assess the life cycle of common products, listing inputs and outputs
- Gain an understanding of the impacts of product design on the earth
- Use design-thinking strategies to develop new life cycles for products

SUMMARY OF TASKS

PART 1 – INTRODUCTION TO LIFE CYCLE ASSESSMENT

- Introduce students to key LCA vocabulary and ask them to draw out their own product consumption cycle. They should draw on arrows to show their understanding of each 'Cradle-to-X' phrase and discuss their answers.
- Students should then complete the 'Product Consumption Cycle' activity sheet

PART 2 – LIFE CYCLE ASSESSMENT OF COMMON PRODUCTS

- Discuss what happens in each of the four general phases of an LCA
- Split students into small groups and complete the 'Product Life Cycle Assessment' activity sheet
 - *Students may need access to the internet to look up product compositions*
- Students should then compare their product life cycle with another group with a different product, they should consider (1) The differences in the environmental impact based on the raw materials of the product. (2) The different disposal options. (3) Can they think of any improvements that could be made to the product to lower its environmental impact

RESOURCES/ EQUIPMENT

- 'Life Cycle Assessment' fact sheet
- 'Product Consumption Cycle' activity sheet
- 'Product Life Cycle Assessment' activity sheet
- Access to a computer

HOMEWORK/ EXTRA ACTIVITIES

- Complete an LCA on a product at home
- Students should explain how design-thinking strategies could be used to improve the LCA for the chosen product

FACT SHEET: LIFE CYCLE ASSESSMENT

FACT SHEETS HAVE BEEN DESIGNED FOR TEACHER USE TO AID CREATING OF TEACHING RESOURCES, OR THEY ARE FREE TO BE REPURPOSED FOR STUDENT USE.

PART 1 – INTRODUCTION TO LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) assesses the environmental impact of a product for its entire life cycle, from design to disposal. It considers the environmental effects associated with each stage of industrial processing looking at the water, energy or materials used as well as the waste products (solids/gases) produced. The aim of the process is to produce a detailed environmental profile of the product.¹ There are several different approaches to LCA:

- Cradle-to-Grave = a full LCA from the extraction of resources (cradle) to the disposal of the product (grave)
- Cradle-to-Gate = partial LCA from the extraction of resources (cradle) to the factory gate (before it is transported to shops)
- Cradle-to-Cradle = closed loop approach aiming towards a circular economy, full LCA from the extraction of resources (cradle) to the disposal of the product where this is a recycling process and production of new products (cradle)

The Cradle-to-Cradle approach lowers the associated environmental impact of a product because it can be recycled into a new product.

The product consumption cycle (Figure 1) shows the steps and process which are involved in producing products. Each of these stages needs to be considered when conducting an LCA.

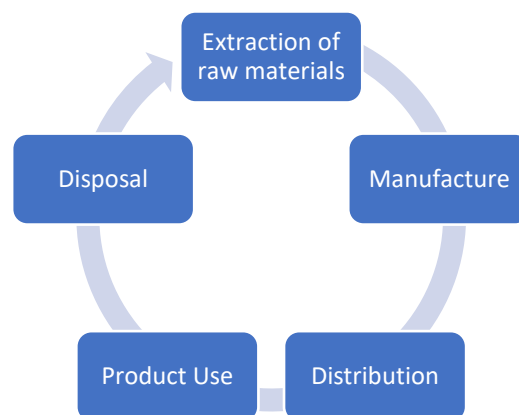


Figure 1: Product consumption cycle

¹ M. A. Ilgin and S. M. Gupta, J. Environ. Manage., 2010, 91, 563–591

PART 2 - LIFE CYCLE ASSESSMENT OF COMMON PRODUCTS

As reported by the National Risk Management Research Laboratory of the EPA, a full LCA considers the environmental impacts of a product by:

- Creating an inventory of energy and material *inputs* as well as the *outputs*, the waste generated
- Assessing the environmental impacts of the inputs and outputs (waste)
- Interpreting the results²

There are four main phases of undertaking an LCA. These stages are standard, as reported by the International Organization for Standardization, 14040 and 14044 standards.^{3,4}

1. Goal and scope
 - Define and describe the product
2. Inventory analysis
 - Identify the inputs and outputs
 - What materials are used?
 - How much energy/water is used at each stage?
 - Are there any waste products produced (gases/solids/wastewater)?
3. Impact assessment
 - What are the effects of the energy/water/materials and waste products on the environment?
4. Interpretation
 - Evaluate the results

² J. B. Guinée, R. Heijungs, G. Huppes, A. Zamagni, P. Masoni, R. Buonamici, T. Ekvall and T. Rydberg, Environ. Sci. Technol., 2011, 45, 90–96.

³ International Organization for Standardization (2006). Environmental management – Life cycle assessment – principles and framework (ISO 14040:2006)

⁴ International Organization for Standardization (2006). Environmental management – Life cycle assessment – requirement and guidelines (ISO 14044:2006)

ACTIVITY 1: PRODUCT CONSUMPTION CYCLE

Instructions

Please see the web page for more information about Life Cycle Assessments.

This activity is intended to prompt discussion around the factors that are considered for a Life Cycle assessment of products.

This activity is intended to be used alongside the 'Life Cycle Assessment' lesson plan.

Task

If you are based in a classroom

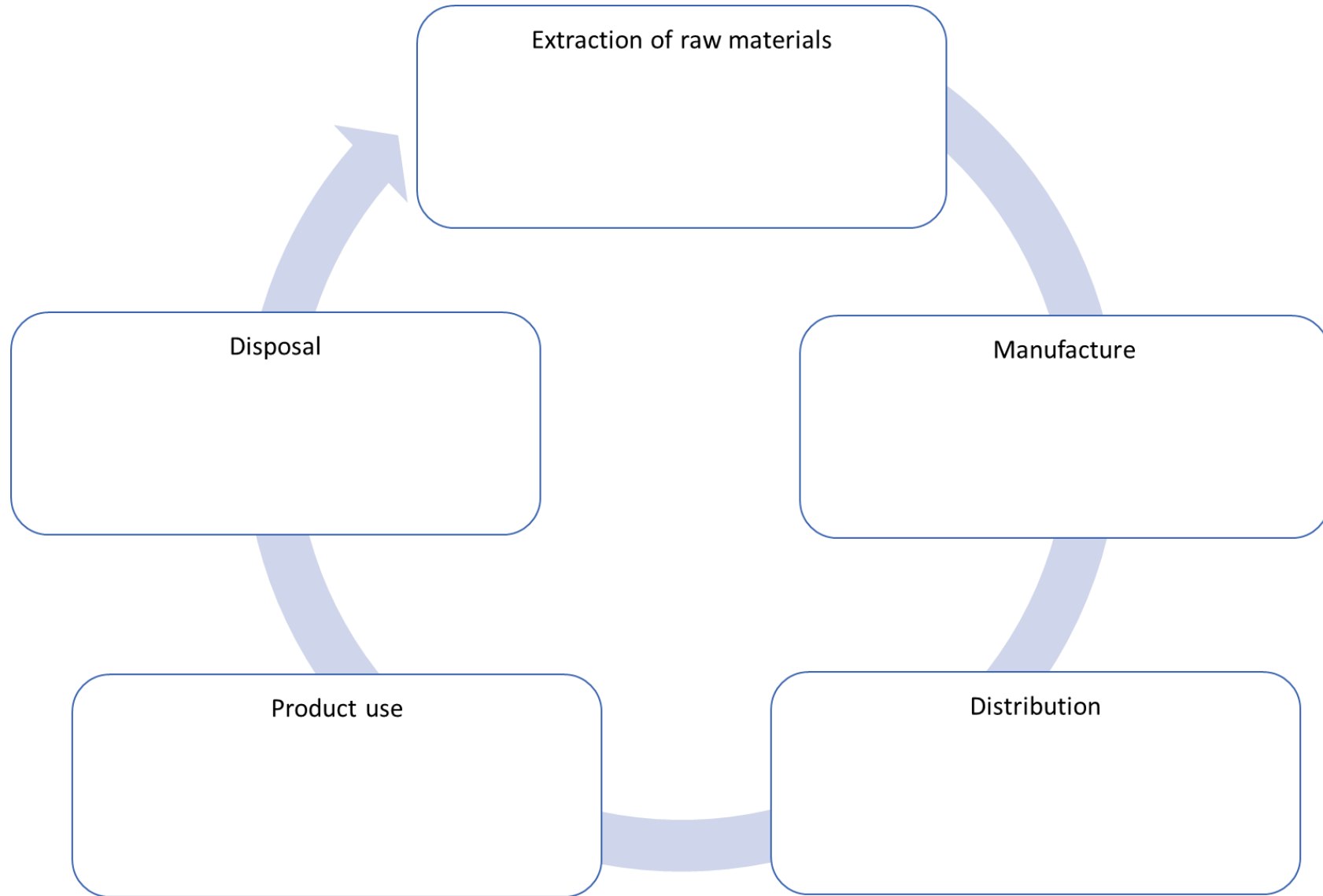
Cut out each statement in the table below, and scatter around the classroom.

Ask students to move around the classroom and sort each of the questions to the correct headings, to then write onto their own product consumption cycle. Students should consider what happens at each stage of a products life and the environmental impact this stage will have - for example, the use of water, the use of energy and the release of waste substances into the environment.

Can the student think of any more considerations for the sections?

Life Cycle Assessment
 Age Range: 13-16 years

Extraction of raw materials	Manufacture	Distribution	Product use	Disposal
Are the raw materials renewable?	What is the environmental impact of production?	What is the environmental impact of distribution?	How long does the product last?	Can the product be recycled?
Where are the raw materials found?	How are the materials processed?	How far does the product have to be transported?	Can the product be reused?	Is the product biodegradable?
How are the raw materials transported?	Is any waste generated during product production?		Does the product have an environmental impact?	How can the product be disposed of?
What is the environmental impact of ore extraction?			What are the implications of warehouses/storage?	What are the environmental impacts of disposal?
				Are there opportunities for energy recovery?



ACTIVITY 2: PRODUCT LIFE CYCLE ASSESSMENT

Instructions

Please see the web page for more information about Life Cycle Assessment.

This activity is intended to prompt thinking and discussion about the Life Cycle Assessment of common household products.

This activity is intended to be used alongside the 'Life Cycle Assessment' lesson plan.

Task

If you are based in a classroom

Split students into groups of 3-4.

Students should complete an LCA, filling in the four phases, for one of the following products:

- crisp packet
- mobile phone
- plastic toy
- wooden toy
- pair of jeans

(students can think of their own products if wanted).

For the inventory analysis and impact assessment, students should consider the factors from the 'Product Consumption Cycle' activity sheet, using the questions to prompt discussion.

Students should then discuss their work with another group who have selected a different product.

Further discussion should lead to a design-thinking strategy to make improvements to the product design to improve its environmental impact.

If you are doing this activity at home

You could compare the LCA for two similar products made from different materials, for example a wooden toy train vs. a plastic toy train.

Assess the environmental impact of both, which is the best design?

1. GOAL AND SCOPE

Define and describe the product

2. INVENTORY ANALYSIS

What are the inputs and outputs for the product?
What raw materials are used?
How much energy/water is used?
What waste products are produced (gases/solids/wastewater)?
Consider each stage of the product consumption cycle

3. IMPACT ASSESSMENT

What are the environmental impacts of using these inputs?
What are the environmental impacts of producing these waste products (outputs)?
Consider each stage of the product consumption cycle

4. INTERPRETATION

Evaluate the results
How can the design of this product be changed to improve the LCA?