

# SECTION 4

## Life Cycle Assessment

*Consumer choices can play a role in reducing carbon emissions.*



### MANY PEOPLE HAVE A HUGE DIVERSITY OF GOODS AND SERVICES

conveniently available to them. This makes it challenging for them to choose products that have less impact on the environment. Most of us think that the life of a product begins when we open the box and ends when we throw it away. However, when scientists, engineers, and marketing professionals refer to the “life cycle” of a product, they include everything from the acquisition of the raw materials through use and finally disposal of those materials. *Life cycle assessments* provide key information that help people understand how human activities affect environmental and social *systems*. By understanding the life cycles of products, consumers can compare the environmental impacts of various products and choose those that support their values and beliefs. In particular, consumers can choose products that *mitigate climate change* because they

- are produced using fewer *greenhouse gases* in production, shipping, and use;
- *sequester carbon* (wood products for example);
- can be reused or *recycled* instead of thrown away.

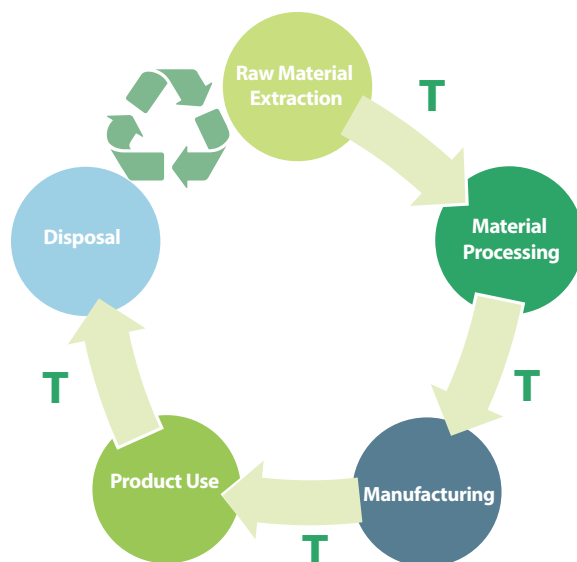
### Life Cycle Assessment

Life cycle assessment involves taking a detailed look at the entire life cycle of a good or service. To do this, scientists define a product system and look at the material and energy flows into and out of that system during each step in the life cycle. Consider something as common as a cell phone. The circuits within your cell phone require an assortment of metals, including copper, gold, and lead, as well as lesser known metals such as tantalum and beryllium. The battery contains still more metals—usually nickel or lithium. These metals are mined and collected from all around the world. Then there’s the casing and the screen for the phone, both usually made of synthetic plastics or resins. These materials must be transformed from their natural state so they can be used to manufacture the various parts of the phone. Then those parts must be assembled. Energy and additional materials are used at each step of the manufacturing process. In short, a world of activity has taken place before our new phone ever reaches us. Likewise, the phone’s impact does not end when we throw it away. The materials within the phone continue to have both

A cell phone is a commonly used product with a very complex life cycle. Metals, plastics, resins, and other materials are all transformed to complete the manufacturing step of the life cycle!



**Figure 1.** Stages of the life cycle of a service or product are shown in this figure, with transportation from one stage to another designated by the letter T. The recycling arrows between Disposal and Raw Material Extraction indicate that some products may be recycled to make other products.



ecological and economic impacts. Some of those materials are toxic, and many are quite valuable if they can be recycled and used in other electronic products. Those materials that are not recycled typically end up in landfills.

Figure 1 illustrates the generalized steps of a product's life cycle. The arrows represent energy and resources used to transport materials from one step to another. Energy and materials that flow into the product system at each stage are called resources. Materials flowing out of the system are called *emissions*. Life cycle assessment looks at the environmental effects of the resource use and of the emissions created.

The three activities in this section allow students to learn about the environmental impact of products and to consider how the decisions and actions of consumers can affect local and global systems.

**ACTIVITY 9: The Real Cost** introduces the hidden impacts of everyday products that students might buy, such as t-shirts, fruit, and a bottle of water. Through a simulated shopping experience, students become consumers and choose which of two similar products to buy. This exercise is done twice—before and after reading information about the environmental *externalities*

of those products. This activity enables students to explore the social and ethical implications of product cost and quality.

**ACTIVITY 10: Adventures in Life Cycle Assessment** is an opportunity for students to investigate actual life cycle data from the National Renewable Energy Laboratory (NREL) U.S. Life-Cycle Inventory Database. This activity asks students to imagine that their school has asked them to decide which type of outdoor dining furniture should be purchased for a new cafeteria patio—a product that will contribute the least to climate change. Using a three-act play or group presentations, students uncover life cycle data for the *greenhouse gas emissions* of pine, aluminum, and plastic resin furniture. An optional enrichment exercise includes a tutorial that walks advanced students through the process of using the NREL database to create a life cycle assessment for products of their choice.

**ACTIVITY 11: Life Cycle Assessment Debate** uses a classroom debate to help students consider advantages and disadvantages of similar products. The experience helps them consider the key questions that can be asked about any product when considering whether or not to buy it. Recognizing that life cycle data are not readily available and that answers are not always easy to find, the outcome of this activity is a blueprint that students can use to help guide their consumer decisions.

### Potential Areas of Confusion

There are several topics in this section that may be sources of confusion for students, based on their assumptions, prior experiences, or existing knowledge. You may be able to use questions to uncover this confusion and steer students toward the clarifications provided in the table.

| Assumption or Confusion   | More Adequate Conception   |
|---|--|
| <p>Recycled is another word for renewable resources.</p>                                      | <p><b>Recycled</b> means that the product was returned to a pre-production state and used to make new products. <b>Renewable</b> means the original ingredients of the product are capable of reproducing or reforming, such as deer, trees, and soil. Resources that are not renewable are in limited supply, such as some minerals. Plastic bottles made from petroleum are recyclable but are not from a renewable resource. Many people consider <b>nonrenewable resources</b> to be the highest priority for recycling, so that we can continue to use these resources in the future.</p> |
| <p>Life cycle assessment is easy to do on any product.</p>                                    | <p>The more ingredients a product has, the more difficult it is to determine the impact of every ingredient. Everyday products, such as cell phones, are composed of dozens of different materials and parts, each of which can have a separate path of production. Further complicating matters is the fact that some production processes are proprietary information and not available to curious consumers. While everything has some level of environmental impact, it is often difficult to know what it is.</p>   |
| <p>The way a product is produced represents the largest impact of a product's life cycle.</p> | <p>The materials and energy needed to make a product may represent larger impacts than other stages of the life cycle, but this is not always the case. For example, with cotton clothing, the amount of energy used for washing (in hot water) and drying the clothing over the course of its lifetime can be more than the energy used during production.</p>  |
| <p>Life cycle assessment can tell us which product is better.</p>                             | <p>Determining "better" is often difficult because products have different types of impacts. Which is worse: Water pollution or climate change? Using a nonrenewable feedstock for a product that lasts 50 years or using disposable and renewable material? Such questions are the essence of interesting debate and are often decided with values, not science. In addition, the "best" answer may vary in different parts of the country or in different contexts.</p>  |
| <p>Similar products are made the same way.</p>  | <p>People can tell the difference between different brands of ice cream because they have different ingredients and may be made through different processes. The same may be true for various brands of anything. This makes life cycle analysis difficult, since brands may be produced differently.</p>  |

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By analyzing life cycles of comparable products, one can determine if there are critical environmental impacts that should be considered prior to making a purchase.

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### Key Concepts in This Section

- Negative externalities often impact the environment and society; their costs may be borne by everyone or they may be ignored.
- Negative externalities can occur at any point in a product's life cycle—not just when the product is made or used.
- Life cycle impacts include more than the ingredients and distance traveled. How the product is used and maintained (dry clean or wash; hang dry or use an electric drier; dispose or repair) and whether the product can be recycled or composted can vary.
- By analyzing life cycles of comparable products, one can determine if there are critical environmental impacts that should be considered prior to making a purchase.
- Consumers can influence economic markets by creating a demand for products that have low greenhouse gas emissions throughout their life cycle.
- **Product life cycles** intersect with climate change in a variety of ways, including greenhouse gas emissions through production and transportation, emissions resulting from the use and disposal of the product, and opportunities to sequester and store carbon.