INTRODUCTION TO LIFE CYCLE ASSESSMENT

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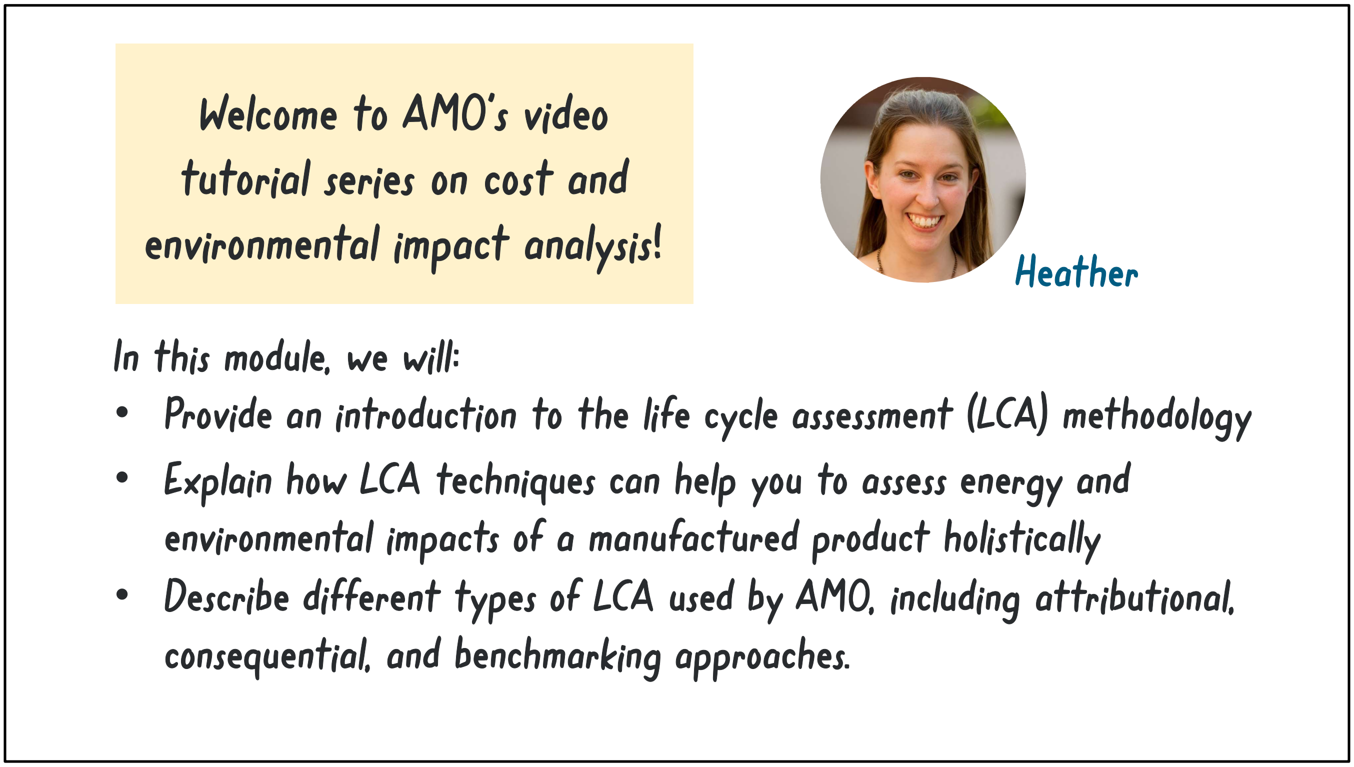
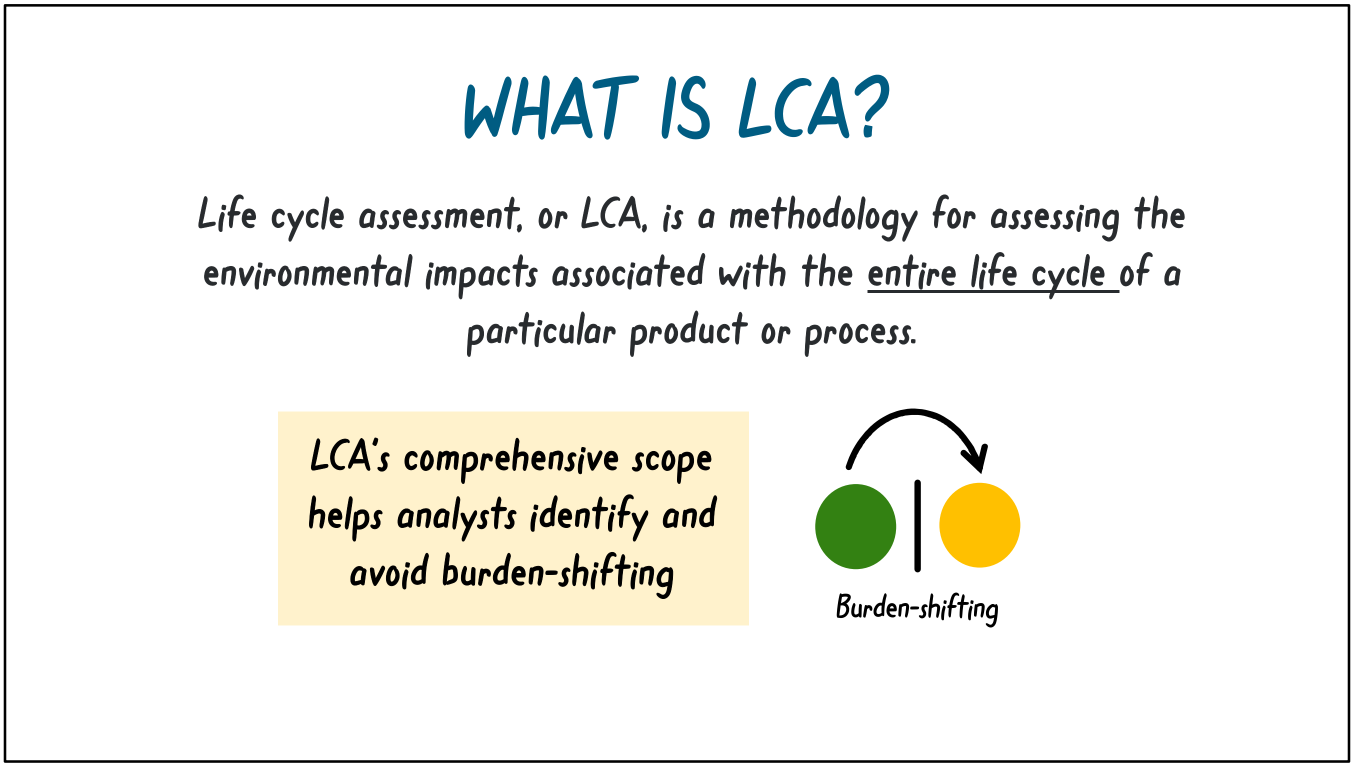


Welcome to AMO’s video tutorial series on cost and environmental impact analysis.

I’m Heather.

In this module, we will:

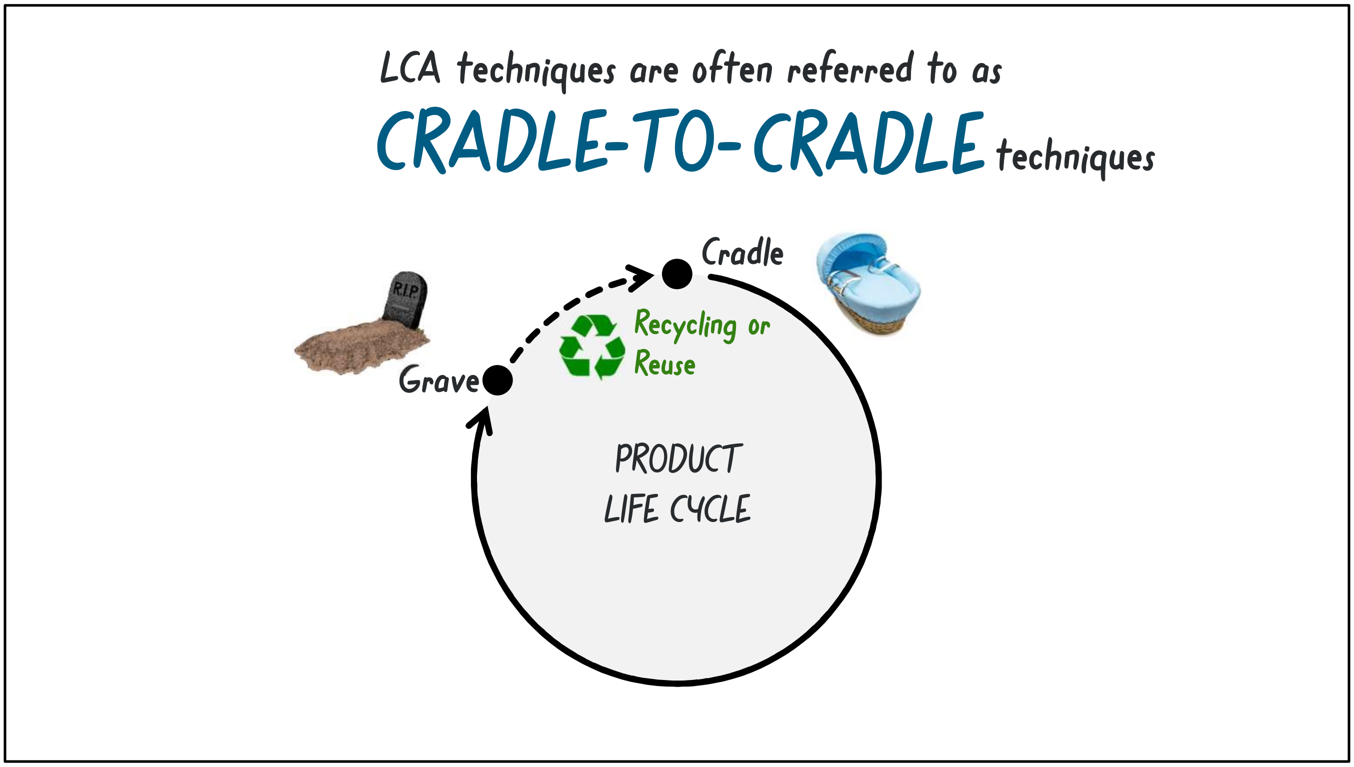
- Provide an introduction to the life cycle assessment (or “LCA”) methodology
- Explain how LCA techniques can help you to assess energy and environmental impacts of a manufactured product holistically; and
- Describe different types of LCA used by AMO, including attributional, consequential, and benchmarking approaches.



Life cycle assessment, or LCA, is a methodology for assessing the environmental impacts associated with the entire life cycle of a particular product or process.

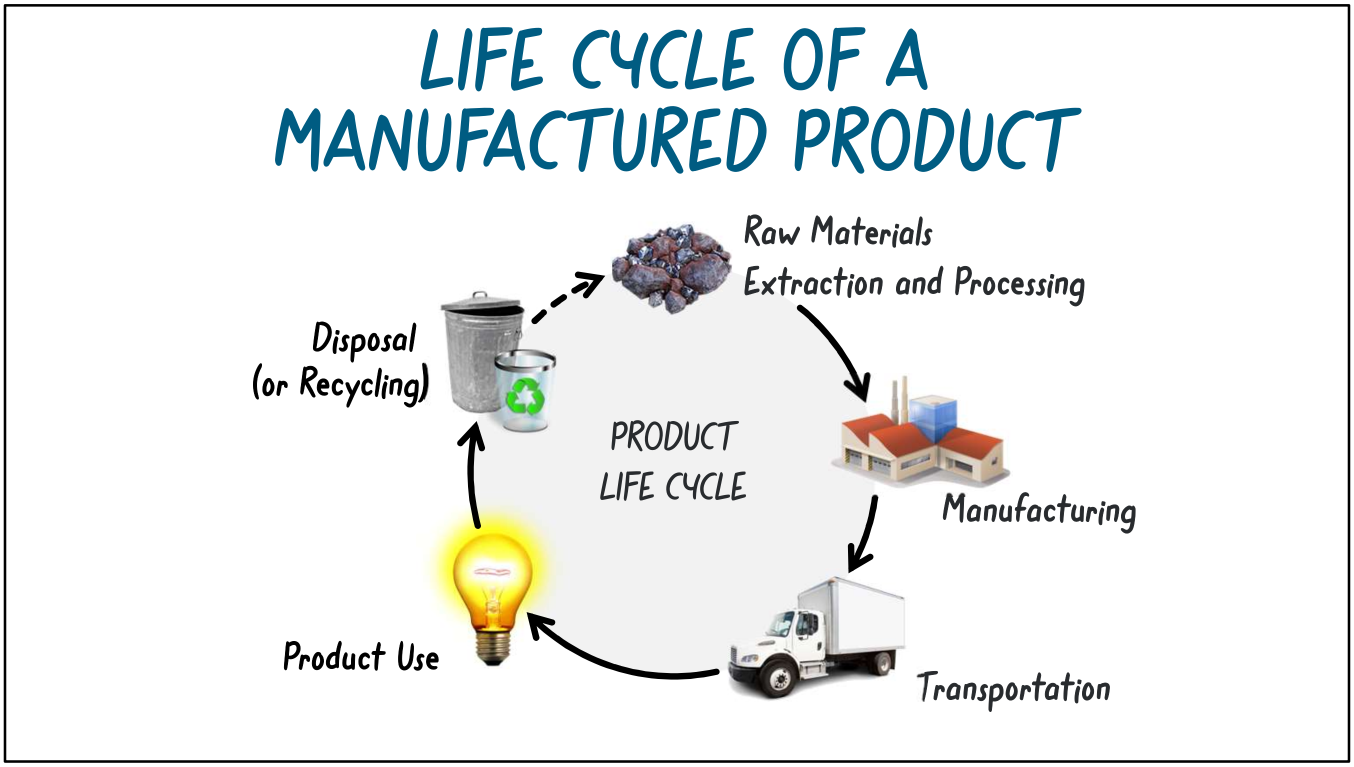
LCA's comprehensive scope helps analysts identify and avoid burden-shifting from one environmental impact to another.

An apparent energy reduction in one portion of the value-chain may result in an unintended consequence elsewhere. By examining the entire product life cycle, LCA helps capture these displaced impacts.



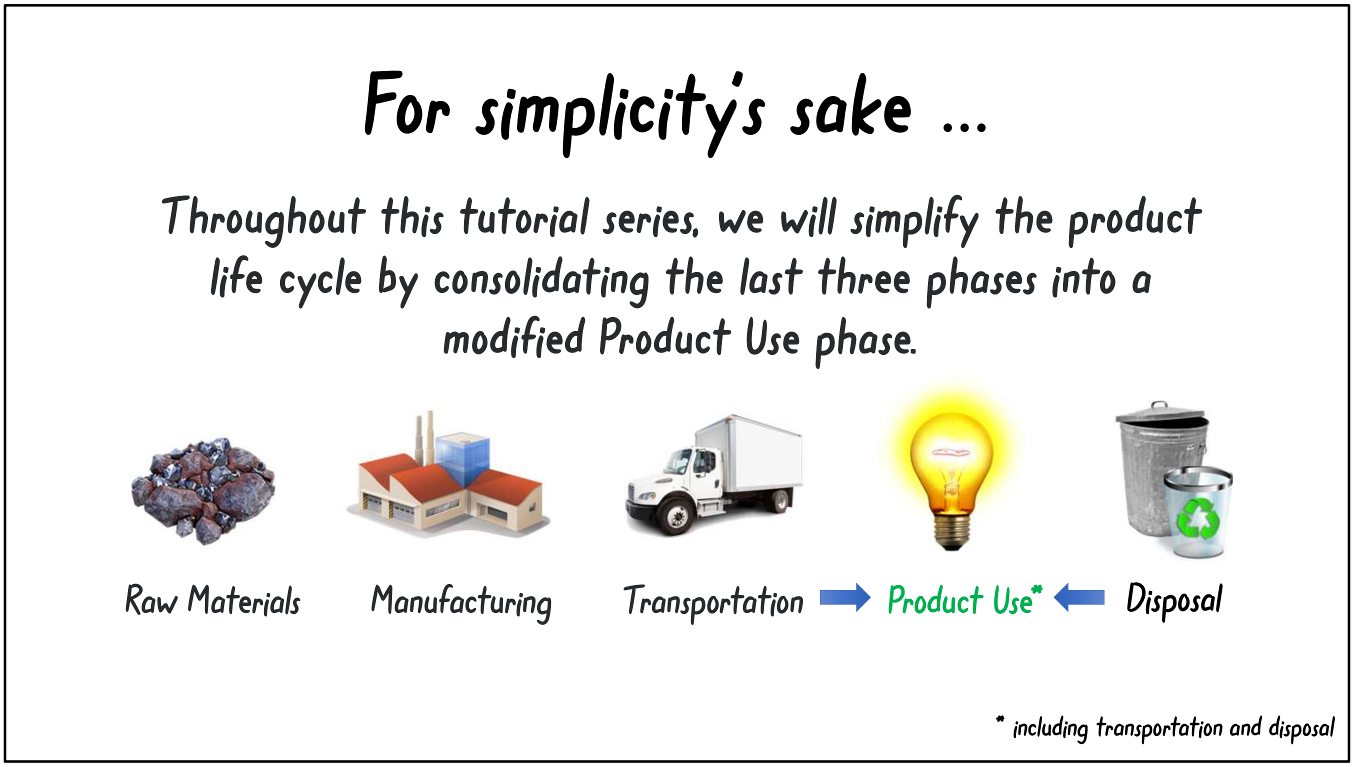
LCA techniques are often referred to as “cradle to grave” techniques, emphasizing the holistic focus on the overall life cycle rather than impacts on any one facility, user, or stakeholder.

If recycling and reuse of materials is included in an LCA analysis, the techniques may also be termed “cradle to cradle,” implying a continuous production loop or circular economy.

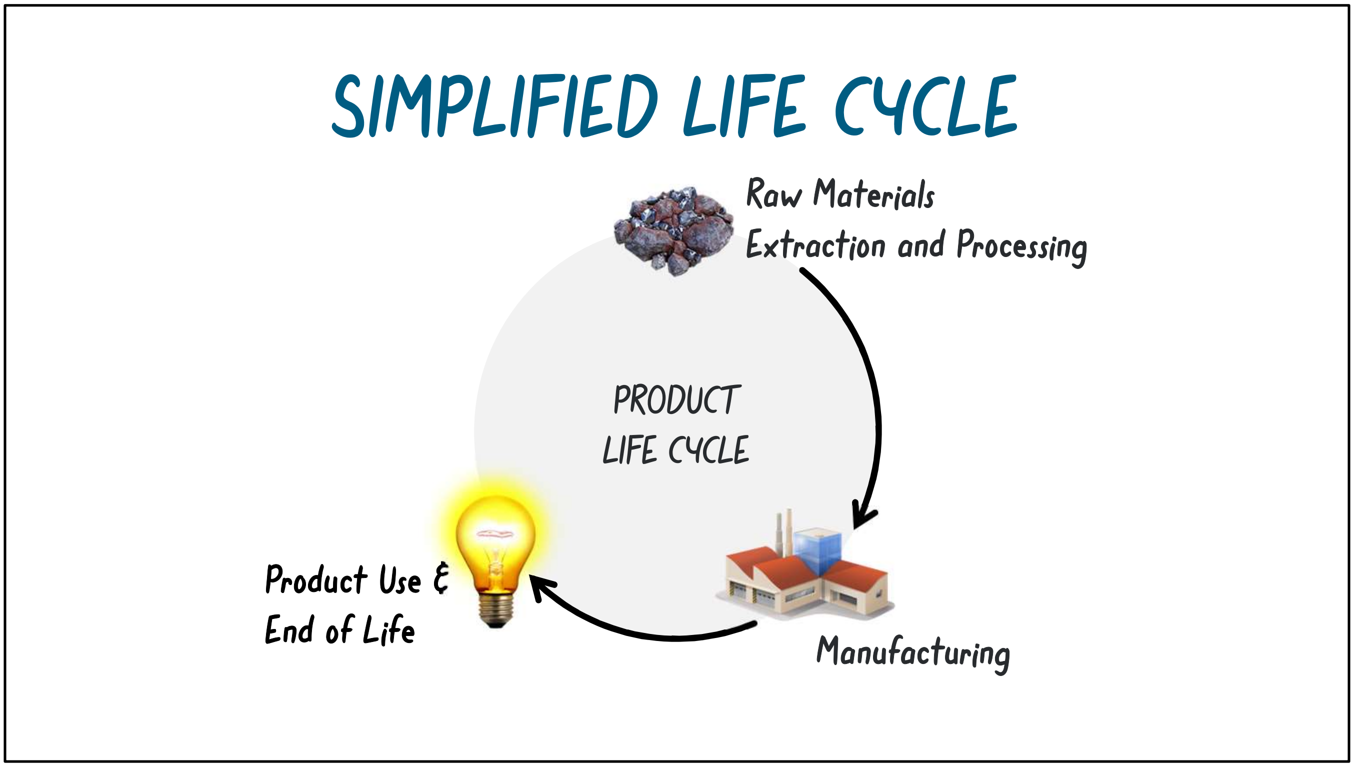


For example, the life cycle stages of a manufactured product include:

- Raw materials extraction and processing
- Product manufacturing
- Transportation of the product to its point-of-use
- Product use; and
- Final disposal (or end-of-life recycling)

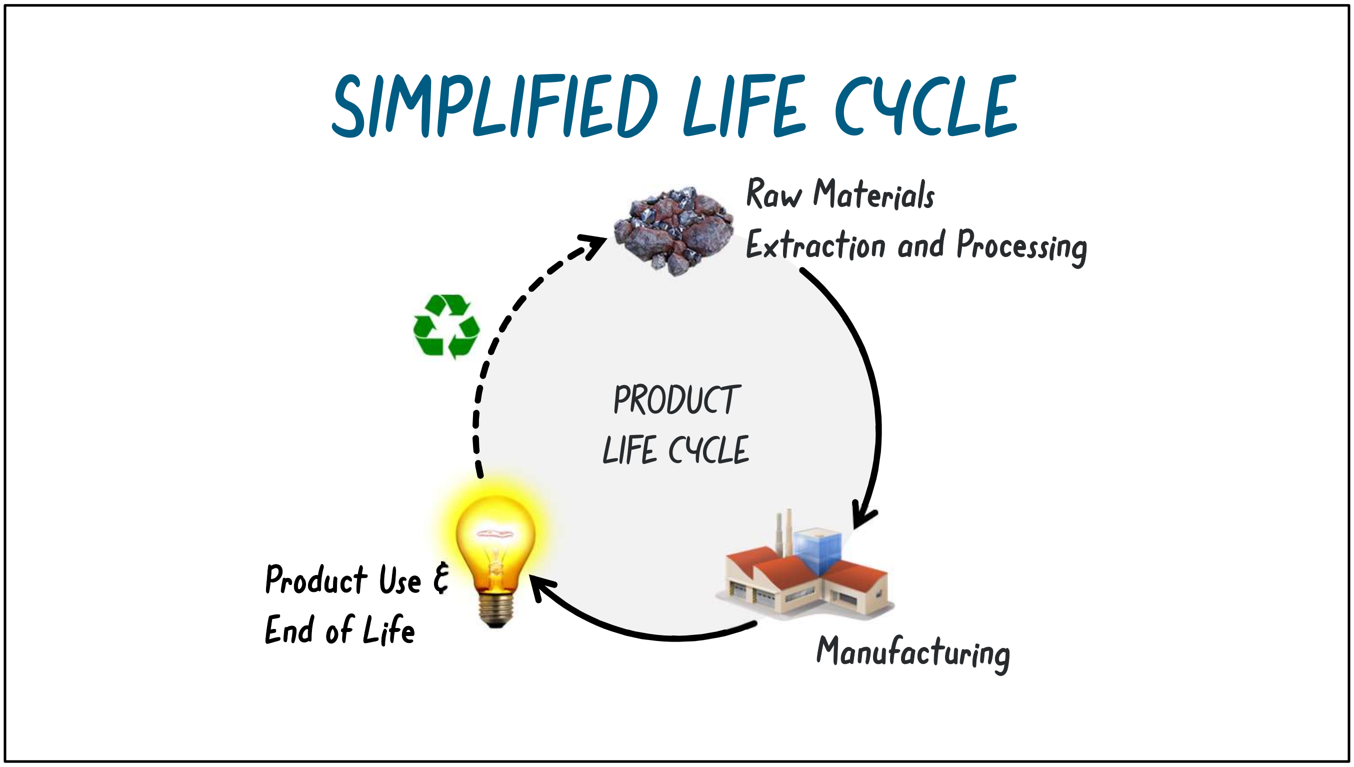


For simplicity's sake, throughout this tutorial series, we will simplify the product life cycle by consolidating the last three phases into a modified Product Use phase.

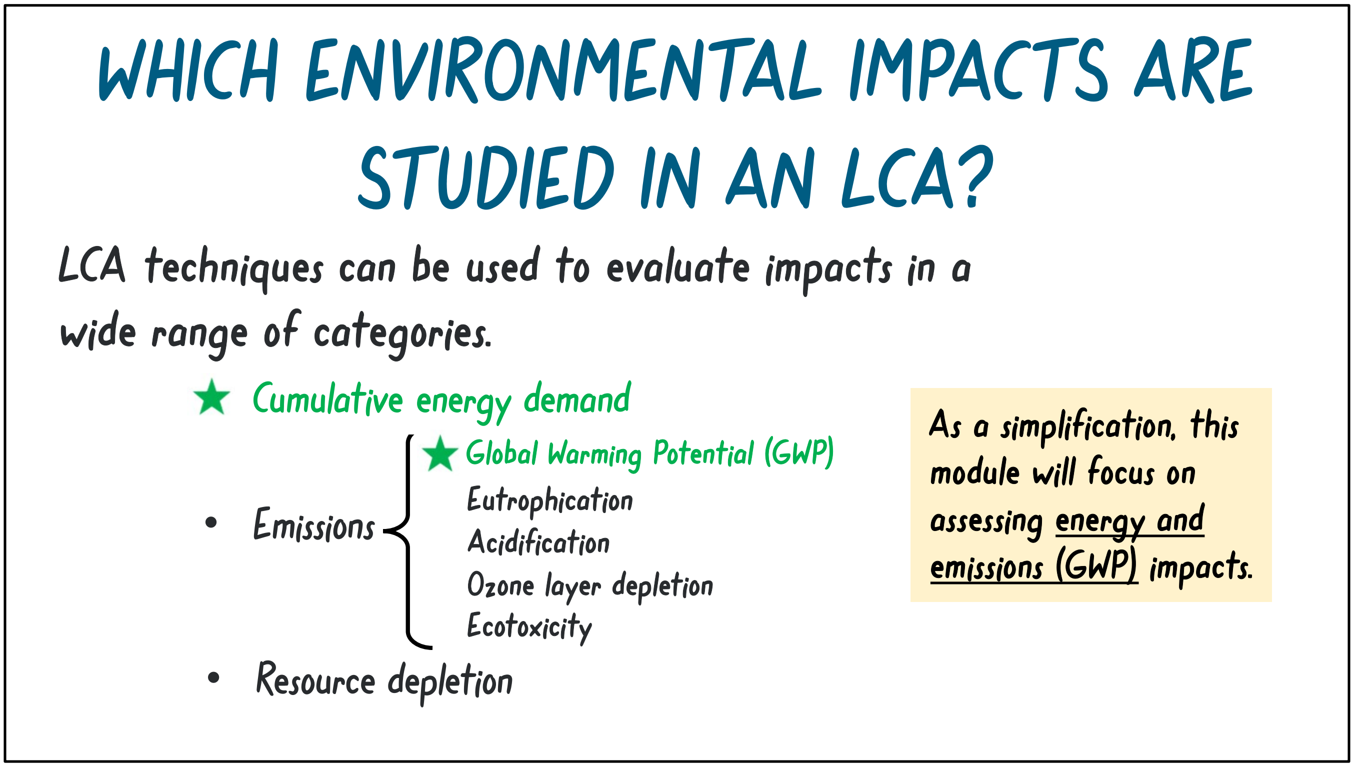


In our simplified life cycle, we will therefore consider the energy impacts from three discrete life cycle phases:

- energy embodied in raw materials;
- energy consumed during product manufacturing; and
- energy involved in the use of the product – including end of life.



We can also consider recycling or re-use, if applicable.



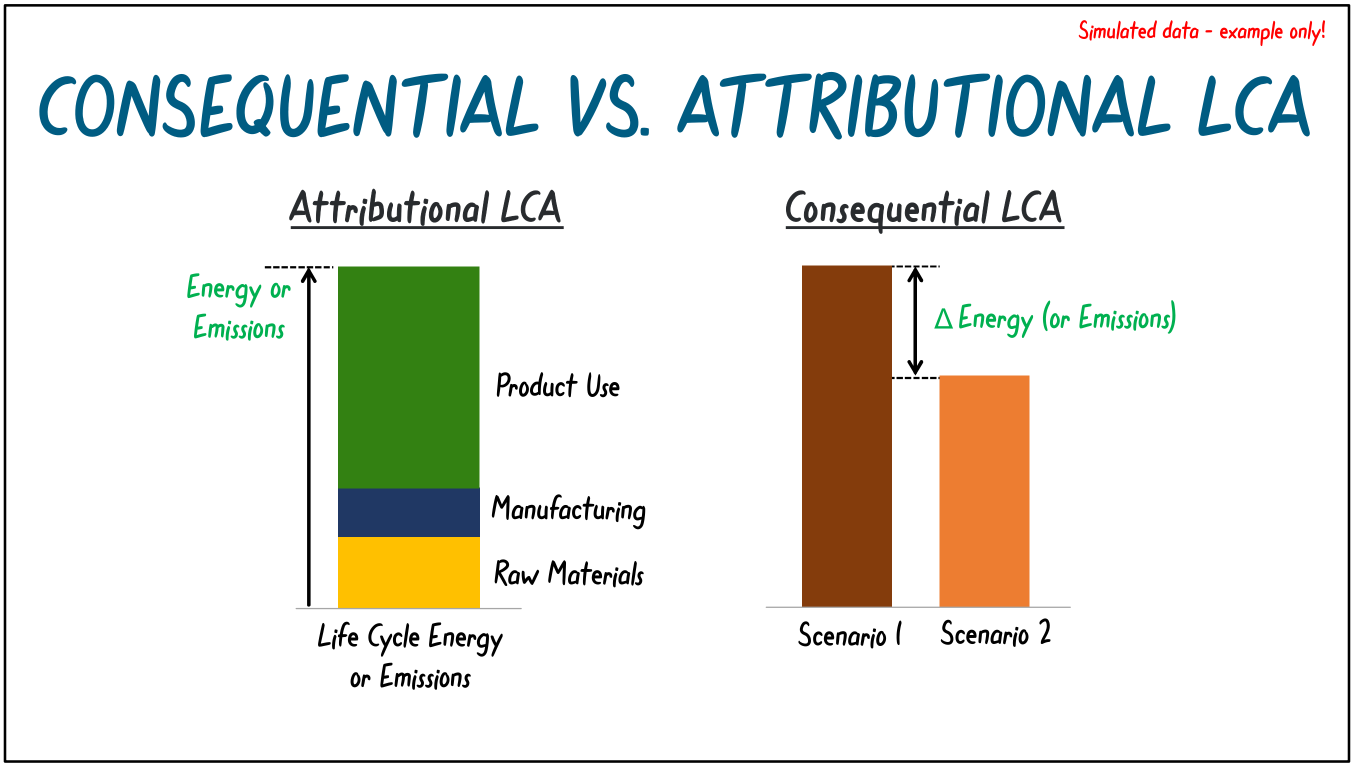
LCA techniques can be used to evaluate environmental impacts in a wide range of categories. One way to assess impacts is in terms of cumulative energy demand, or the total energy "embodied" into the product throughout its life cycle.

Another way to assess impacts is in terms of emissions. An accepted convention is to generalize emissions to standardized metrics based on the specific composition of pollutants being released.

For example, Global warming potential, or GWP, is driven by greenhouse gas emissions; while Eutrophication involves the over-enrichment of water with nutrients, such as from agricultural runoff. Other emission-related impact categories include:

- Acidification of waters and soils;
- Ozone layer depletion;
- and various forms of ecotoxicity.

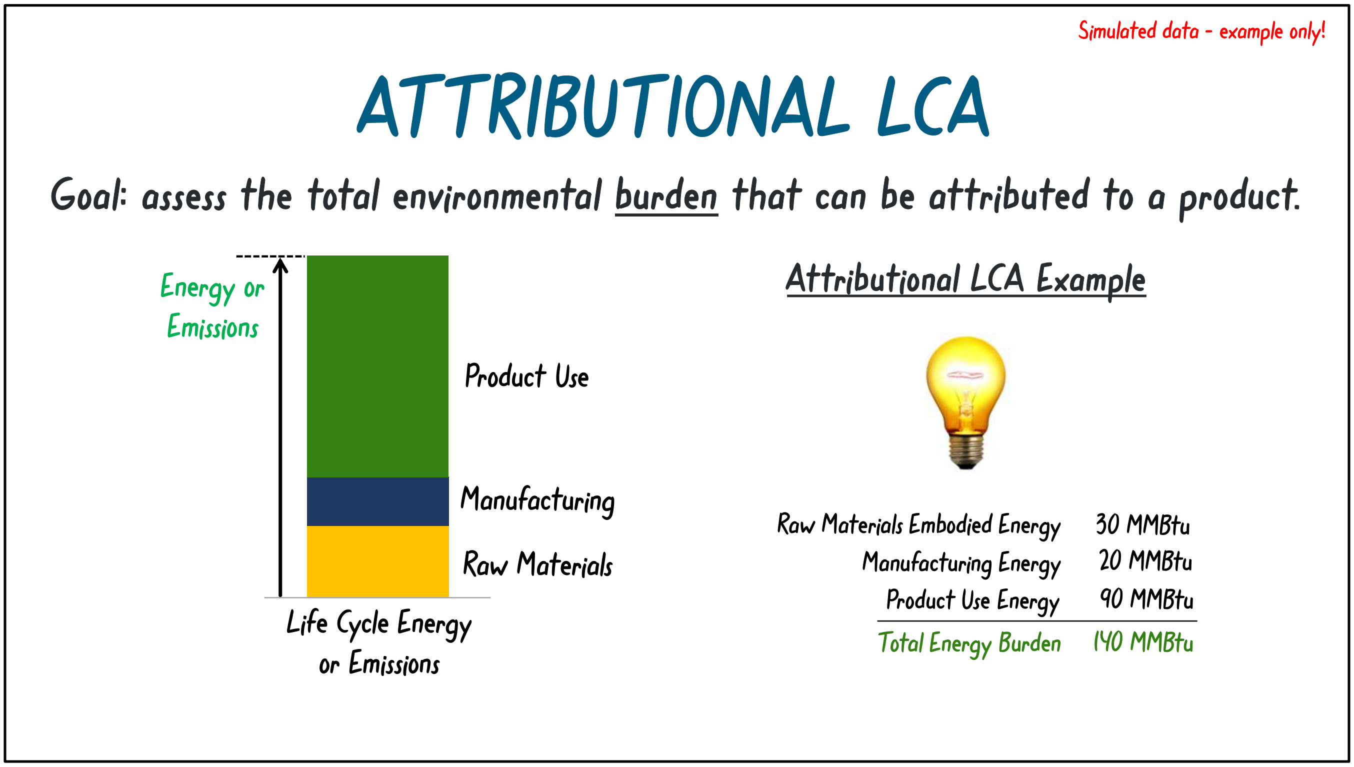
LCA techniques can also be used to examine the depletion of important resources, such as fossil fuels, water, and critical elements. As a simplification, this module will focus on assessing the energy and emissions GWP impacts of a given technology.



Two general LCA approaches that have been widely adopted in the LCA community include attributional LCA and consequential LCA.

Each of these approaches can be used to analyze impacts in any or all of the environmental impact categories we mentioned. The differences between the approaches are linked to analysis goals and boundaries.

Let's take a closer look at each approach.

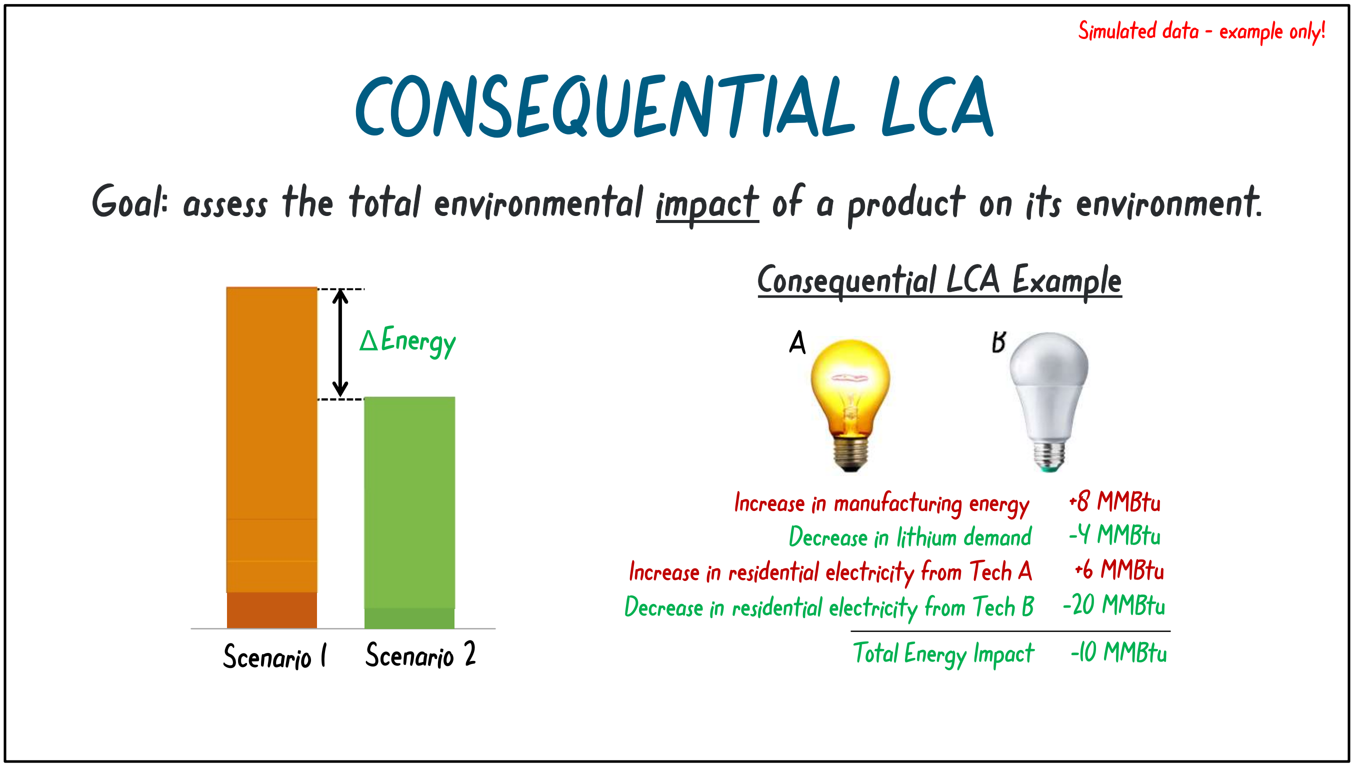


In the attributional LCA approach, our goal is to assess the total environmental burden that can be attributed to a particular product.

The total environmental burden will include contributions from all parts of the product life cycle:

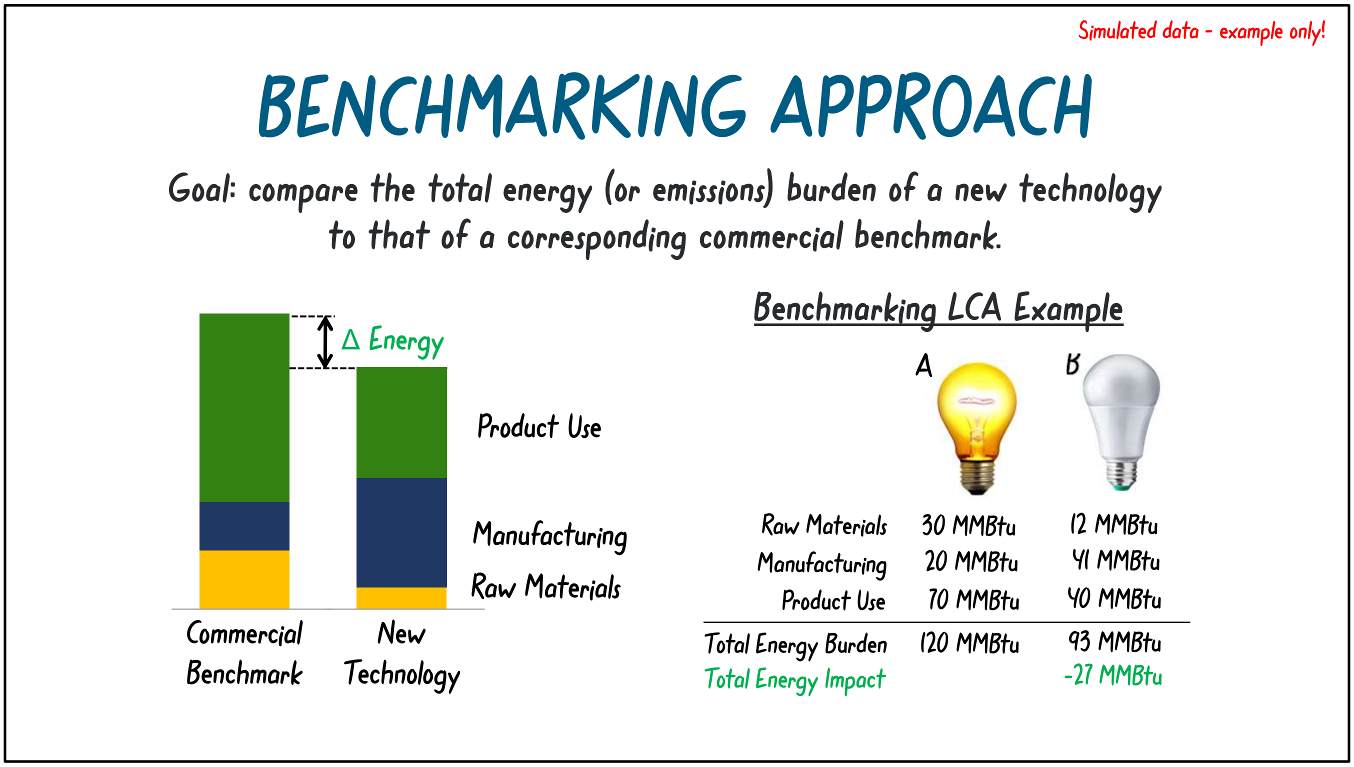
- Raw materials,
- Manufacturing, and
- Use Phase

In this example, we are considering the total environmental burden of a light bulb. After determining the burden attributed to each phase in the product's life cycle, we can express our results as a total energy burden – the amount of energy consumption associated with this product.



In a consequential LCA, our goal is to assess the total environmental impact of a product on its environment, typically in the context of a particular adoption scenario. In this case, we are considering not an energy or emissions total, but rather a total change in energy or emissions that may occur due to the product's existence. A consequential LCA assesses not only direct impacts of the product itself, but also indirect impacts that may occur in other products and other sectors – for example, impacts due to the displacement of other products or processes as a result of this product's use.

Consequential LCA is scenario-based. In this example, we examine the energy impacts from a potential change in lighting technology. The new technology introduces additional burdens in some categories and sectors, while introducing benefits in others. Summing all of these contributions gives us the net impact. In this scenario, the consequential change in energy relative to the baseline was an improvement.

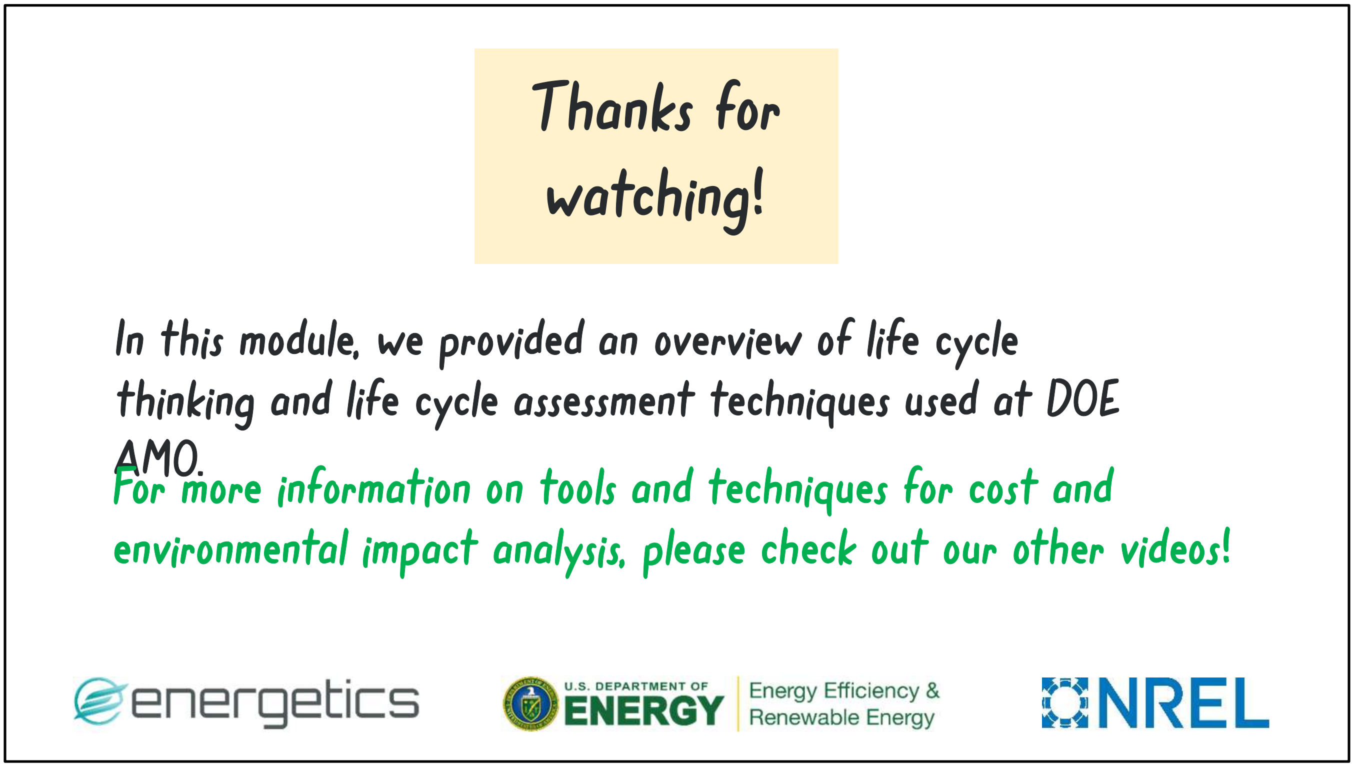


It is also possible to combine the features of attributional and consequential LCA using a benchmarking approach.

The goal here is to compare the total energy or emissions burden of a new technology to that of a corresponding commercial benchmark.

This hybrid approach is similar to an attributional approach in that we are assessing the total burden of a product. But, similar to the consequential approach, this method is also comparison-focused. We include a parallel assessment of a commercial benchmark technology alongside the new technology innovation.

The example shown illustrates how we can assess and compare life-cycle impacts across two technologies using a benchmarking approach. We can compare the total environmental burden associated with each life cycle phase and overall – and we can also assess the total impact as a result of the change in technologies.



In this module, we provided an overview of life cycle thinking and life cycle assessment techniques used at AMO.

For more information on tools and techniques for cost and environmental impact analysis, please check out our other short tutorial videos.