

# Streamlined Life Cycle Assessments and Input- Output Analyses

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## Lesson 4

The previous presentations have noted some of the uncertainties and difficulties associated with life cycle assessments. Conducting an LCA can be time consuming and expensive, and the resulting data may be ambiguous or highly uncertain. Yet, thinking comprehensively about the entire life cycle of a product and all the emissions, material use and energy use associated with the product can be very informative.

How can we preserve the advantages of life cycle assessments, yet avoid some of the disadvantages? In this presentation, we will examine two simplified methods for Life Cycle Assessment that are widely used. These methods are streamlined life cycle assessments and input-output analyses.

## Streamlined life cycle assessments

Inventory Category/Life Stage	Premanufacture	Product manufacture	Product delivery	Product use	Refurbishment, recycling, disposal
Materials choice					
Energy use					
Solid residues					
Liquid residues					
Gaseous residues					

- Group life cycle stages into broad categories
- Group impacts into broad categories
- Establish a matrix of life cycle impacts and life cycle stages

In “streamlining” a life cycle assessment the goal is to preserve a comprehensive examination of the product life and environmental impacts, while simplifying data collection.

There are a variety of methods for streamlining the Life Cycle Assessment process. One method for streamlined life cycle assessment, described in the background reading and by Graedel and Allenby (“Design for Environment”, Prentice Hall, 1996), consolidates life cycle stages into 5 simple categories and environmental impacts into 5 simple categories.

This creates a matrix of life cycle impacts and life cycle stages. The goal of the streamlined assessment is to fill in this matrix with information about the magnitude of environmental impacts.

One method of summarizing information in the matrix is to assign scores to each of the parts of the matrix.

## Streamlined life cycle assessments

Score	Condition
0	<p>For the case where supplier components/subsystems are used: No/little information is known about the chemical content in supplied products and components</p> <p>For the case where materials are acquired from suppliers: A scarce material is used where a reasonable alternative is available. (Scarce materials are defined as antimony, beryllium, boron, cobalt, chromium, gold, mercury, platinum, iridium, osmium, palladium, rhodium, rubidium, silver, thorium, and uranium.)</p>
4	No virgin material is used in incoming components or materials.
1, 2, or 3	<p>Is the product designed to minimize the use of scarce materials (as defined above)?</p> <p>Is the product designed to utilize recycled materials or components wherever possible?</p>

- Assign scores, ranging from 0-4 (0=poor performance, 4=excellent performance), to each part of the matrix – the example above is for premanufacture stage of the life cycle in the material choice impact category
- Document the rationalization for the scores

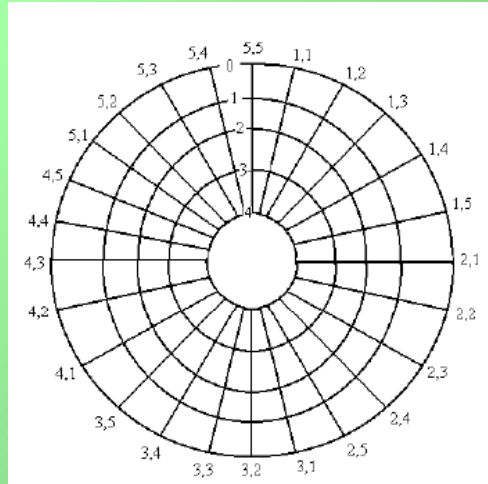
The streamlined LCA method described by Graedel and Allenby (1996) suggests assigning scores of 0-4 to each part of the matrix. A score of 0 indicates to poor performance while a score of 4 indicates excellent performance.

Graedel and Allenby suggest a variety of criteria for assigning scores. For example, for the premanufacture stage of the life cycle in the material choice impact category, criteria include the extent to which recycled materials are used and whether the materials used are relatively plentiful or relatively scarce.

Filling in the entire matrix results in a total of 25 scores, ranging from 0-4. Clearly, assigning scores is a somewhat subjective process the rationalization for assigning the scores should be well documented.

## Streamlined life cycle assessments

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- Identify areas of concern, for example, by using a target diagram

Because the scores are somewhat subjective, often the scores are only used to identify life cycle stages and impact categories that deserve attention. One way of calling attention to areas that require attention is to report the scores using a target diagram. In this diagram, high scores are plotted near the target, while low scores are shown as off-target.

## Streamlined life cycle assessments: advantages and disadvantages

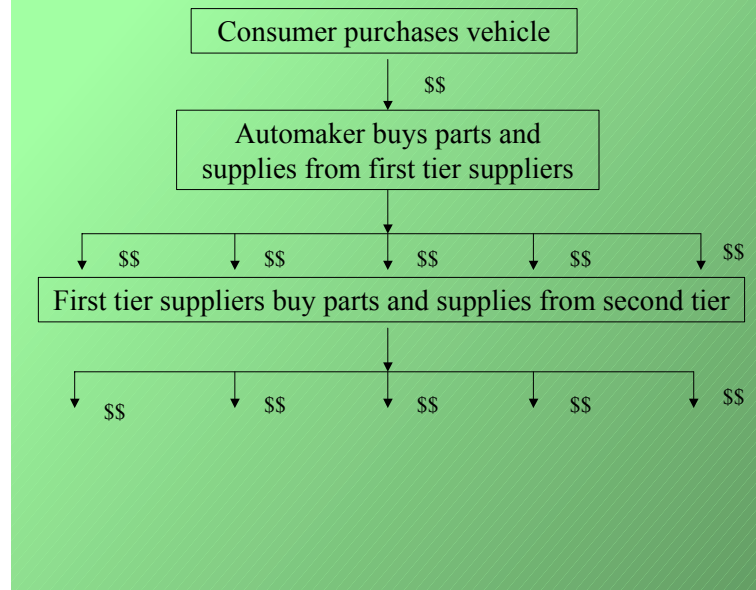
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- Simple and cost effective
- Preserves focus on entire life cycle and all impact categories
- Possible to identify areas of concern
- Scores can be viewed as arbitrary

The primary advantage of a streamlined life cycle assessment is its simplicity. The procedure considers the entire life cycle and considers multiple impact categories; the output of the analysis is the identification of critical areas of concern.

The major disadvantage of the method is that the assignment of scores can be highly subjective, even arbitrary.

# Economic input-output analyses



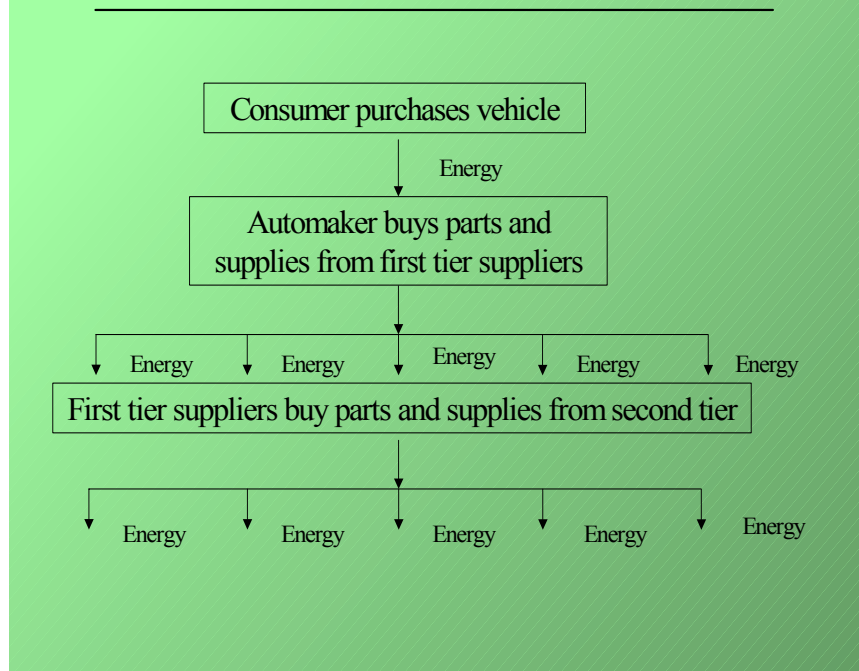
Another simplified approach to Life Cycle Assessment relies on Input-Output Analysis.

This type of analysis originated in the field of macroeconomics and is best explained through an example.

Consider the flow of dollars in the economy that occurs as the result of a customer purchasing an automobile from an automaker. The consumer pays the automaker for the vehicle, as illustrated by the top-most arrow labeled \$\$ in the slide. The automaker uses a large portion of those sales dollars to purchase parts and supplies from another group of companies (battery manufacturers, steel manufacturers, paint manufacturers and others; these flows of dollars are represented by the next level of arrows labeled \$\$ in the slide). That first tier of suppliers, in turn, purchases parts and supplies from a second tier of suppliers (coal producers, iron ore producers, battery component manufacturers and others). This continues through many tiers of suppliers. Every dollar expended in the purchase of the automobile, drives \$2-3 in economic flows through the economy as a whole.

Economists have mapped these flows of dollars among economic sectors in Input-Output models. The models track dollars flowing into and out of sectors of the economy. The models that have been adapted for life cycle assessment purposes divide the economy into approximately 500 different sectors. For each sector, the flows of dollars into that sector from all other sectors are mapped, and the flows of dollars out of the sector into all other sectors are mapped.

# Environmental input-output analyses



An environmental input output analysis tracks material flows, energy flows and emissions in a similar way.

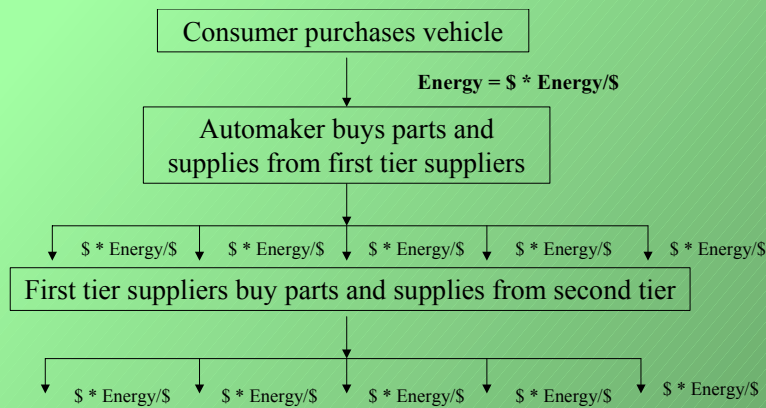
Consider the use of energy in the economy that occurs as the result of a customer purchasing an automobile from an automaker. The consumer pays the automaker for the vehicle, as illustrated by the top-most arrow labeled (Energy) in the slide. This purchase causes the automaker to use a certain amount of energy at their facility. The automaker purchases parts and supplies from another group of companies (battery manufacturers, steel manufacturers, paint manufacturers and others). These purchases cause these first tier suppliers to use energy. The first tier of suppliers, in turn, purchases parts and supplies from a second tier of suppliers (coal producers, iron ore producers, battery component manufacturers and others), who also consume energy. This continues through many tiers of suppliers.

Numerous databases exist documenting energy use, material use, and emissions within sectors of the economy.

The challenge in developing an environmental input-output analysis is to understand how the use of energy (or the use of materials, or the generation of emissions) in one sector of the economy (for example, automobile manufacturing) drives energy use (or material use or emissions) in another sector (for example, battery manufacturing).

# Mapping economic I/O analyses into environmental I/O analyses

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The key assumption in environmental input-output analyses is to assume that dollar flows will drive energy flows, material flows and emissions. If dollar flows in a sector double, then energy consumption doubles. Material use doubles. Emissions double.

If we make this assumption, we can use economic input-output models, together with data on energy use, material use and emissions in industrial sectors to create an environmental input-output model.

# EIOLCA

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- Interactive tool at [www.eiolca.net](http://www.eiolca.net)
- Can be used to answer questions such as:
  - What is the most energy intensive sector of the economy (using a life cycle perspective)?
  - What suppliers to the automotive sector have the greatest emissions of SO<sub>2</sub> (or carbon dioxide or nitrogen oxides or toxics)?
  - How does the energy used in the wood products sector compare to the energy used in the plastics sector?

The current generation of environmental input-output models were developed at Carnegie-Mellon University and can be operated on-line at the web site listed on the slide.

Visit the site – which contains all the information you need to run the model.

Use the model to address the types of questions listed in the slide:

What is the most energy intensive sector of the economy (using a life cycle perspective)?

What suppliers to the automotive sector have the greatest emissions of SO<sub>2</sub> (or carbon dioxide or nitrogen oxides or toxics)?

How does the energy used in the wood products sector compare to the energy used in the plastics sector?

## Input/Output assessments: advantages and disadvantages

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- Simple and cost effective
- Preserves focus on the life cycle up through and including the manufacturing stage, but does not include use or disposal
- Preserves focus on multiple inventory categories and provides quantitative data
- Possible to identify areas of concern
- Characterizes the entire economy in approximately 500 sectors

The input-output approach is simple and cost effective; it retains a life cycle perspective, although it only considers the life cycle up through manufacturing. So, in our automotive example, the input-output model results would only give us information about manufacturing the vehicle. We would not get information about its use or disposal.

The approach is also quantitative.

It's main disadvantage is that the input-output model breaks the economy into relatively coarse sectors. So, while there is a sector for automakers, the model does not distinguish between the manufacture of conventional, electric or hybrid vehicles.

Nevertheless, it is another tool that we can use to begin to assemble information about energy use, material use and emissions over the life cycle of products.