

**EIO/LCA METHOD TUTORIAL  
&  
STAKEHOLDER & POLICY ANALYSIS**

**Recitation 9**

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**ESD.00**

# LIFE CYCLE ASSESSMENT OF TRANSPORTATION SYSTEMS: GOAL & SCOPE

- Components considered in this analysis

	Rail	LCA Type	Aviation	LCA Type
<i>Vehicle</i>	Manufacturing Operation Maintenance Insurance	Process Process Process & EIO LCA EIO LCA	Manufacturing Operation Maintenance Insurance	EIO LCA Process EIO LCA EIO LCA
<i>Infrastructure</i>	Construction & Maintenance Operation Insurance	Process & Hybrid  Process EIO LCA	Construction & Maintenance Operation Insurance	EIO LCA & Hybrid  Process & EIO LCA EIO LCA
<i>Fuel</i>	Production	Process	Production	Process

Adapted from

Chester, "Life-cycle Environmental Inventory of Passenger Transportation Modes in the United States"

# APPROACHES TO LCA: ECONOMIC I/O

## ■ Economic Input-Output method.

- Uses information about monetary transactions between sectors.
- Most nations create economic input-output tables every so many years (e.g. U.S. models created every 5 years).
- To combine LCA with EIO, traditional economic I/O models are appended with information on emissions.

Sample Input-Output Table

Industry Producing	Agriculture	Food & Beverages	Textiles	Apparel	Lumber & Wood	Furniture & Fixtures	Paper & Allied Products	Total Output
Agriculture	10.86	15.70	2.16	0.02	0.19		0.01	44.26
Food & beverages	2.38	5.75	0.06	0.01			0.03	40.30
Textiles	0.06		1.30	3.88		0.29	0.04	9.84
Apparel	0.04	0.20		1.96		0.01	0.02	13.32
Lumber & wood	0.15	0.10	0.02		1.00	0.39	0.27	6.00
Furniture & fixtures			0.01			0.01	0.01	2.89
Paper & allied products		0.52	0.08	0.02		0.02	2.60	7.90
<b>Total Outlays</b>	<b>44.26</b>	<b>40.30</b>	<b>9.84</b>	<b>13.32</b>	<b>6.00</b>	<b>2.89</b>	<b>7.90</b>	

Figures in billions of U.S. dollars

Image by MIT OpenCourseWare.

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

## ■ Step 1:

### Choose a Model

- Models available for 1992, 1997, 2002.
- 2002 is a Producer Price model (“cradle to gate”) – does not include distribution costs to consumer.
- Important to use the same model to compare HSR and aviation.
- Suggested model: 2002.

The screenshot displays the EIOLCA web interface with three tabs: 'Use Standard Models', 'Create Custom Model', and 'Documentation'. The 'Use Standard Models' tab is active. The interface is divided into five numbered steps:

- 1 Choose a model:** The current model is the 'US 2002 Benchmark', which is a 'Producer Price Model'. A dropdown menu shows 'US 2002 (428)'. A link for '(Show more details)' is present.
- 2 Select industry and sector:** A search box for a sector by keyword is available, along with a 'Search' button. Below it, there are two dropdown menus: 'Select a Broad Sector Group' and 'Select a Detailed Sector'.
- 3 Select the amount of economic activity for this sector:** A text input field contains the number '1', followed by the text 'Million Dollars' and a link for '(Show more details)'.
- 4 Select the category of results to display:** A dropdown menu is set to 'Economic Activity', with a link for '(Show more details)'.
- 5 Run the model:** A message states 'You must select a sector in order to run the model.' and a 'Run Model' button is visible.

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

- **Step 2: Select Industry & Sector**
  - The model divides the economy into 428 divisions grouping businesses that produce similar goods or services, or that use similar processes.
  - Can either search for a sector by keyword.
  - In this case, select “Aircraft manufacturing” (note that this only includes the aircraft frame – we’ll look at engines separately).

The screenshot shows the EIOLCA web interface with five numbered steps. Step 2, 'Select industry and sector:', is highlighted with a red rounded rectangle. The interface includes tabs for 'Use Standard Models', 'Create Custom Model', and 'Documentation'. Step 1 shows the current model as 'US 2002 Benchmark'. Step 2 includes a search box and a dropdown menu for 'Select a Broad Sector Group'. Step 3 shows a value of '1' for 'Million Dollars'. Step 4 shows 'Economic Activity' as the category. Step 5 has a 'Run Model' button.

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

## ■ Intermediate Step: Determine Costs

- For Step 3, you must have an estimate of costs for the components or processes of interest.
- The *commercial* price of an average Boeing 737-700 is \$67.9 million.<sup>1</sup> (see link below for data on the full 737 family).
- We will deduct the engine price, and assume a 10% markup.

Description	Amount
Boeing 737-700 (commercial price)	\$67.9 M
CFMI CFM56-7 Engine (per engine) <sup>2</sup>	\$6 M
Boeing 737-700 minus Twin Engines	\$55.9 M
Boeing 737-700 minus 10% markup = (\$55.9 M/1.1)	\$50.8 M

Adapted from eiolca.net, Green Design Institute

1: <http://www.boeing.com/commercial/prices/>

2: [http://www.cfm56.com/press/news/cfm+logs+\\$600+million+cfm56-7b+engine+orders/129](http://www.cfm56.com/press/news/cfm+logs+$600+million+cfm56-7b+engine+orders/129)

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

- **Step 3: Enter the Amount of Economic Activity**
  - We computed the level of economic activity associated with the production of one (1) aircraft frame on the previous slide.
  - Enter \$50.8 M for this example.

The screenshot displays the EIOLCA web interface with three tabs: "Use Standard Models" (selected), "Create Custom Model", and "Documentation". The interface is divided into five numbered steps:

- 1 Choose a model:** The current model is the "US 2002 Benchmark", which is a "Producer Price Model". A dropdown menu shows "US 2002 (428)".
- 2 Select industry and sector:** A search box for a sector by keyword is present, along with a "Search" button. Below it, there are two dropdown menus: "Select a Broad Sector Group" and "Select a Detailed Sector".
- 3 Select the amount of economic activity for this sector:** A text input field contains the value "1", followed by the text "Million Dollars".
- 4 Select the category of results to display:** A dropdown menu is set to "Economic Activity".
- 5 Run the model:** A "Run Model" button is visible at the bottom.

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

- **Step 4: Select Category of Results**
  - Select the type of result to display (e.g. Greenhouse gas emissions, Energy).
  - Select “Energy” for this example.

The screenshot shows the 'Use Standard Models' tab of the EIOLCA interface. It contains five numbered steps:

- 1 Choose a model:** Your current model is the **US 2002 Benchmark**, which is a **Producer Price Model**. [\(Show more details\)](#)  
US 2002 (428)
- 2 Select industry and sector:** Search for a sector by keyword:    
Or browse for a sector below:  
Select a Broad Sector Group  Select a Detailed Sector
- 3 Select the amount of economic activity for this sector:**  
1 Million Dollars [\(Show more details\)](#)
- 4 Select the category of results to display:** **Economic Activity**  [\(Show more details\)](#)
- 5 Run the model:** You must select a sector in order to run the model.

# EIOLCA: AIRCRAFT MANUFACTURING EXAMPLE

## ■ Step 5:

### Run the Model

- Click “Run Model”.
- Results should provide you with amount of energy (in terajoules) to manufacture one (1) aircraft.
- You’ll then use this figure to determine the amount of energy required over the aircraft’s lifetime.

The screenshot displays the EIOLCA web interface with three tabs: 'Use Standard Models', 'Create Custom Model', and 'Documentation'. The 'Use Standard Models' tab is active and contains five numbered steps:

- 1 Choose a model:** Your current model is the **US 2002 Benchmark**, which is a **Producer Price** Model. [\(Show more details\)](#)  
US 2002 (428)
- 2 Select industry and sector:** Search for a sector by keyword:    
Or browse for a sector below:  
Select a Broad Sector Group  Select a Detailed Sector
- 3 Select the amount of economic activity for this sector:**  
1  Million Dollars [\(Show more details\)](#)
- 4 Select the category of results to display:**  
Economic Activity  [\(Show more details\)](#)
- 5 Run the model:** You must select a sector in order to run the model.

The 'Run Model' button in step 5 is highlighted with a thick black border.

# STAKEHOLDERS

- In the case of high-speed rail and aviation infrastructure investment, who are the stakeholders?

# STAKEHOLDERS

- In the case of high-speed rail and aviation infrastructure investment, who are the stakeholders?
  - Citizens where high-speed rail and aviation services are being considered.
  - Citizens whose home/land may be affected by transportation expansion.
  - Environmental groups.
  - The airline and high-speed rail industries.

# POLICY IMPLICATIONS

- Historical and current status of high-speed rail in the U.S.
  - Historically, limited support for passenger rail investment in the U.S.
  - A new president who strongly support HSR investment.
  - An issue that has become highly politicized.
- Potential policy implications of this analysis:
  - Help to make the environmental impacts of aviation and high-speed rail more *transparent* – to support decision-making.
  - If we find that high-speed rail is *not* as environmentally-friendly as compared with aviation, what are the implications?

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