Unit 4: Life Cycle Assessment

Session 3:
Analysis Goal & Scope and
Inventory Methods

Professor Randolph Kirchain
Department of Materials Science & Engineering and
Engineering Systems Division

Goal & Scope Definition

- **Intent: Intended application of the study**
  - **For what purpose**
  - **Examples**
    - Identifying major problems
    - Selecting the preferred option
- **Context: For whom and compared to what**
- **Scope of Analysis**
  - **Functional Unit (Unit of analysis)**
  - **System boundaries:**
    - Conceptual
    - Geographic
    - Time period of study
  - **Types of impacts to consider**

Goal & Scope Definition: How far do we go?

- **Defining boundaries**
  - **No theoretical basis for exclusion**
  - **Often broken at environmental flows or economic flows of + value**
  - **Generally includes only processes in direct contact with product & raw materials entering that product**
- **Example: Oil Use**
  - **Combustion**
    - If electricity, consider: conversion efficiency & transmission eff.
  - **Extraction**
  - **Transport**
  - **Refining**

Inventory Analysis

- **Building a system model of the flows within your system**
  - **System boundaries and flow types defined in Goal & Scope**
  - **Typically includes only environmentally relevant flows**
- **Steps**
  - **Catalog what activities to include (draw a flowchart)**
  - **Data collection**
  - **Computation of flows per unit of analysis**
    - Serious challenges around allocation

Inventory Analysis: Data collection

- **Data collection**
  - **Inflows of materials**
  - **Inflows of energy**
  - **Releases to land, water and air**
- **Typically the most time consuming stage**
- **Data sources**
  - **Scientific literature, Published studies**
  - **Industry & government records**
  - **Industry associations**
  - **Private consultants**

Product Production Overview

- **Product *P* produced in plant *C***
  - ***C*: Metal sheets cut and pressed to make *P***
- **Plant *B* delivers metal sheets to plant *C***
  - ***B*: Ingots melted and rolled into sheets**
- **Ingots come from plant *A***
  - ***A*: Mineral is extracted, turned into metal, cast into ingots**

Product Production Details

- **Transport:**
  - *A* **to** *B*: **1000 km, by truck**
  - *B* **to** *C*: **0 km (adjacent)**
- **Scrap:**
  - **Process scrap from** *C* **returned to** *B* **for remelting**
- **Product** *P*:
  - **Weight = 40 g**
  - **6 m^2 metal sheet needed to make 1,000**
  - **Metal thickness = 1.0 mm**
  - **Metal Density = 8,000 kg/m^3**

Environmental Data – Plant A

Summary

Products	Metal ingots
Raw Material	Mineral

Inputs/Outputs

Description	Quantity	Units	Details
Total Annual Production	1200	tonnes/year	Product A
Use of raw material	4800	tonnes/year	Raw A
Use of energy in the process	1.20E+07	MJ/year	Oil Combustion
Emissions to air	600	kg/year	HCL
Emissions to water	600	kg/year	Cu
Non-hazardous solid waste	3800	tonnes/year	Solid Waste

Environmental Data – Plant B

Summary

Products	Metal Sheets
Raw Material	Metal ingots and process scrap

Inputs/Outputs

Description	Quantity	Units	Details
Total Annual Production	1600	tonnes/year	Sheets
Use of raw material - ingots	900	tonnes/year	Ingots
Use of raw material - scrap	700	tonnes/year	Scrap
Use of energy - smelting	3.04E+06	MJ/year	Electricity
Use of energy - rolling	1.76E+06	MJ/year	Electricity
Emissions to air	480	kg/year	HC

Environmental Data – Plant C

Summary

Products	Consumer Product *P*
Raw Material	Metal Sheets

Inputs/Outputs

Description	Quantity	Units	Details
Total Annual Production	400	tonnes/year	Product *P*
Use of raw material	480	tonnes/year	Sheets
Use of energy - oil	3.00E+05	MJ/year	Oil
Use of energy - electricity	1.20E+06	MJ/year	Electricity
Emissions to air	250	kg/year	HC
Process Scrap for Recycling	80	tonnes/year	Scrap

Environmental Data – Transportation and Energy Production

Transportation – Diesel Fuel

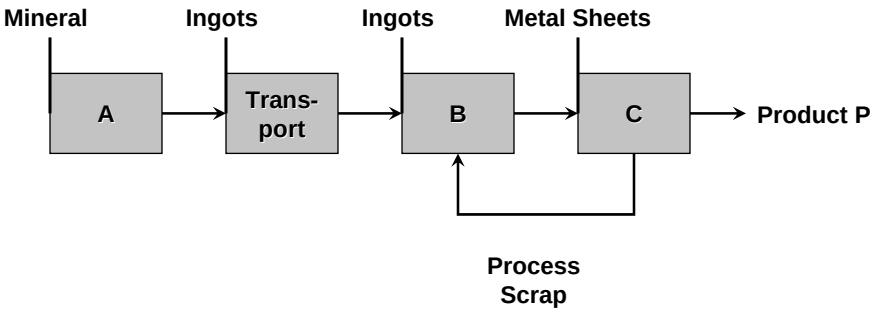
Energy

Driving Conditions	Energy Consumption	Units
Long Haul	1	MJ/tonne-km
City Traffic	2.7	MJ/tonne-km

Energy Production Emissions

Emissions (g/MJ fuel consumed)		
Substance	**Oil**	**Diesel**
HC	0.018	0.208
NOx	0.15	1.3
CO2	79.8	78.6

Flowchart



Process Emissions