TECHNO-ECONOMIC ASSESSMENT

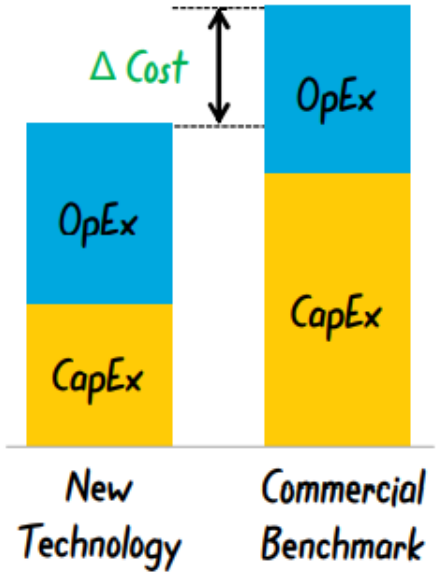
Techno-economic assessment is a method for evaluating the economic performance of a technology

Source: https://www.energy.gov/sites/default/files/2022-01/2022-01-19%20-%20Intro%20to%20TEA%20-%20Slides%20and%20Transcript_compliant_1_0.pdf

MANUFACTURING COST COMPARISON

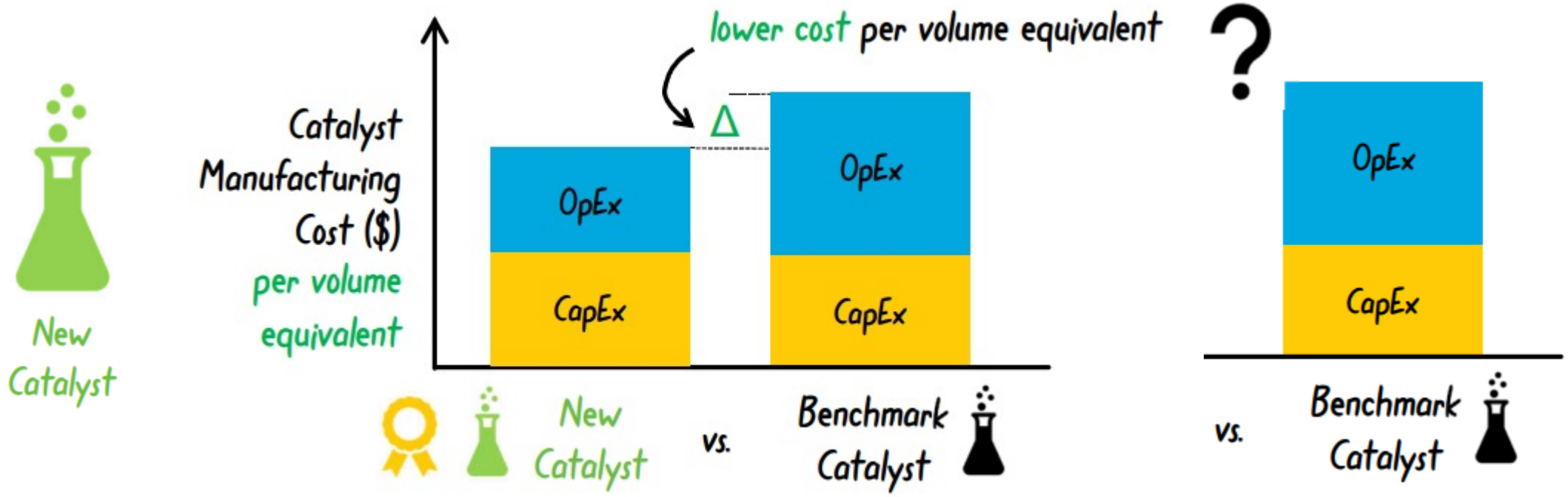
Manufacturing Cost

Cost Benchmarking



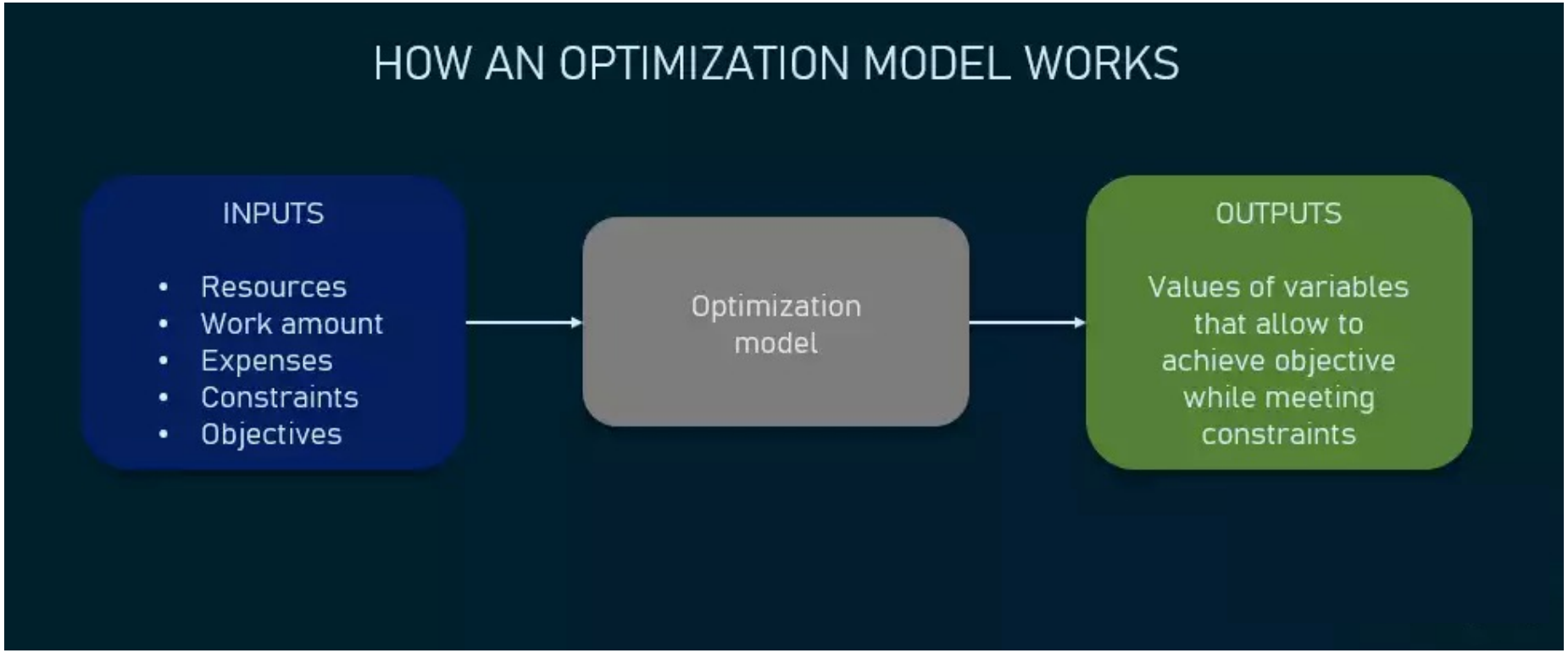
Source: https://www.energy.gov/sites/default/files/2022-01/2022-01-19%20-%20Intro%20to%20TEA%20-%20Slides%20and%20Transcript_compliant_1_0.pdf

EXAMPLE
COST COMPARISON: CATALYSTS FOR ETHYLENE MANUFACTURING



Source: https://www.energy.gov/sites/default/files/2022-01/2022-01-19%20-%20Intro%20to%20TEA%20-%20Slides%20and%20Transcript_compliant_1_0.pdf

OPTIMIZATION MODEL (BOTTOM-UP ENERGY MODEL)

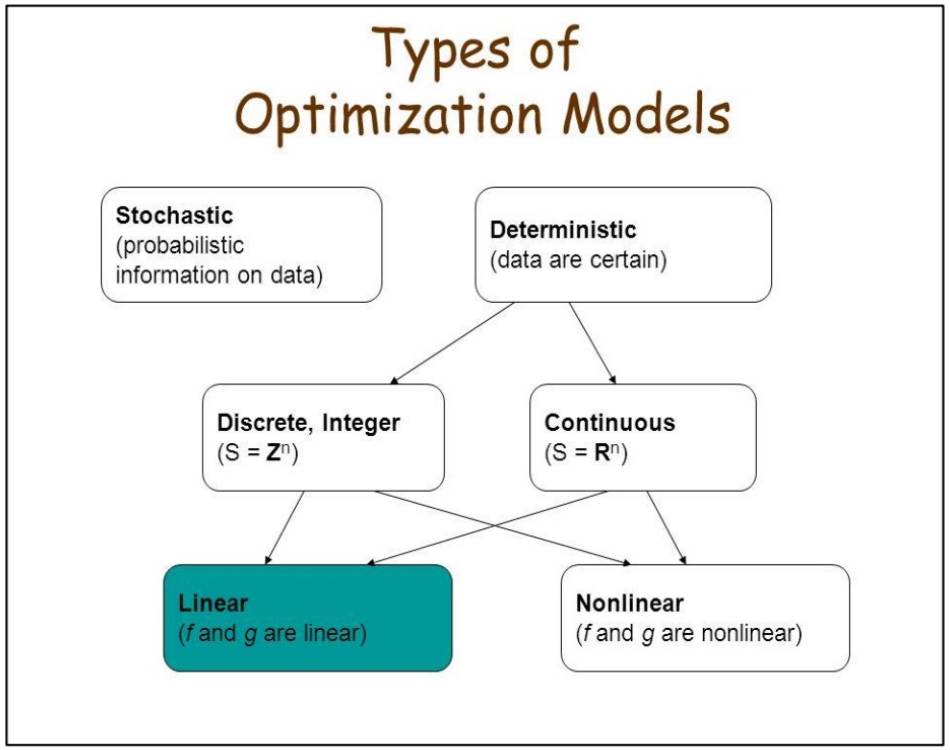


Source: https://www.altexsoft.com/blog/schedule-optimization/

FEATURE OF OPTIMIZATION MODEL

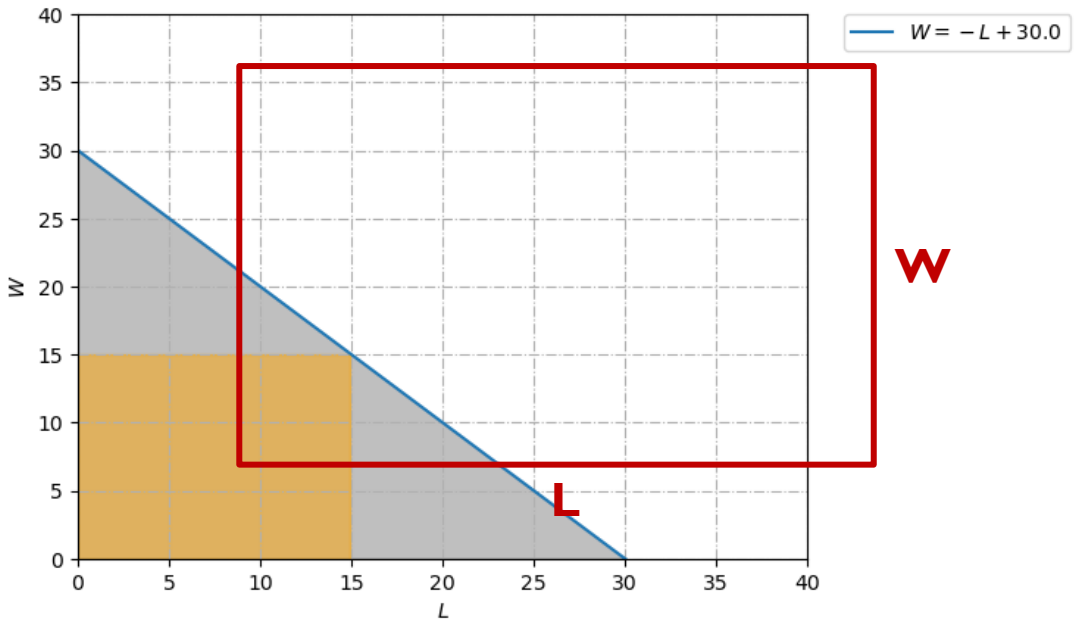
An optimization model has three main components:

- An objective function. This is the function that needs to be optimized.
- A collection of decision variables. The solution to the optimization problem is the set of values of the decision variables for which the objective function reaches its optimal value.
- A collection of constraints that restrict the values of the decision variables.



Source: https://old.mu.ac.in/wp-content/uploads/2017/10/Optimization-Models.pdf

SIMPLE EXAMPLE OF OPTIMIZATION



- Example: You have 60 feet of fence available, and wish to enclose the largest rectangular area possible. What dimensions should you choose for the fenced-off area?
- Variables: Length – L, Width – W;
- Objectives: max L*W;
- Constraints:

$$2L + 2W \leq 60$$

$$L > 0$$

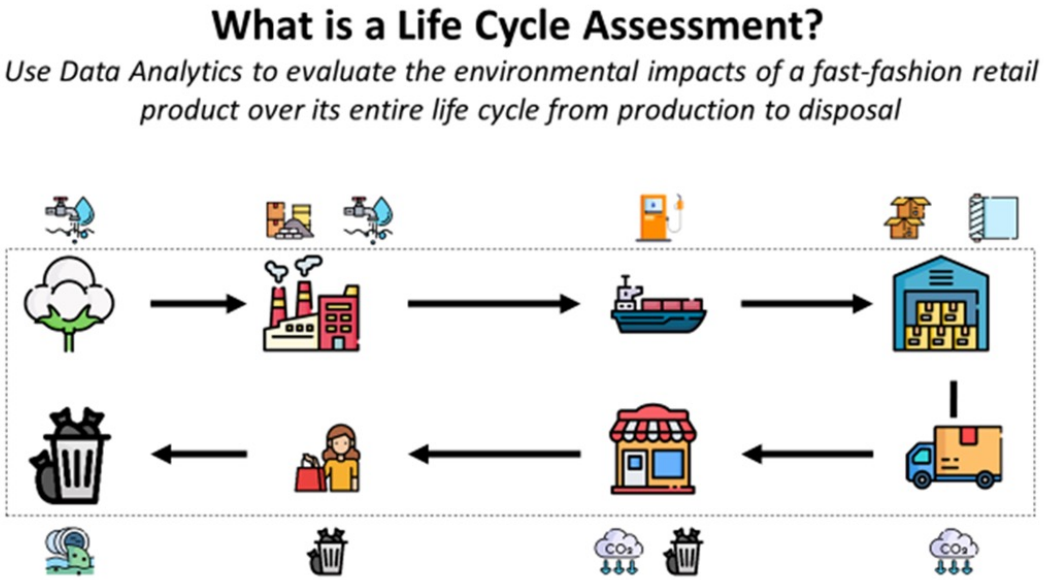
$$W > 0$$

- Result: when L=W=15, max area = 225

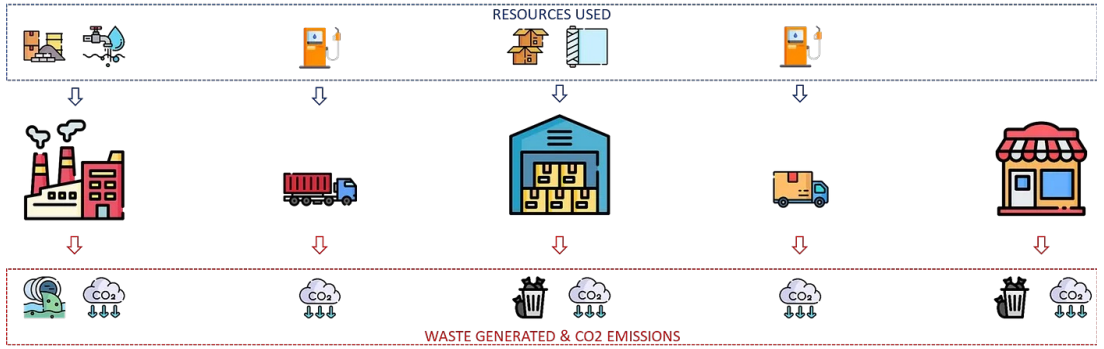
Source: Basic Optimization Concepts. CE 377K. Stephen D. Boyles. Spring 2015.

LIFE CYCLE ASSESSMENT (LCA)

What is a Life Cycle Assessment?



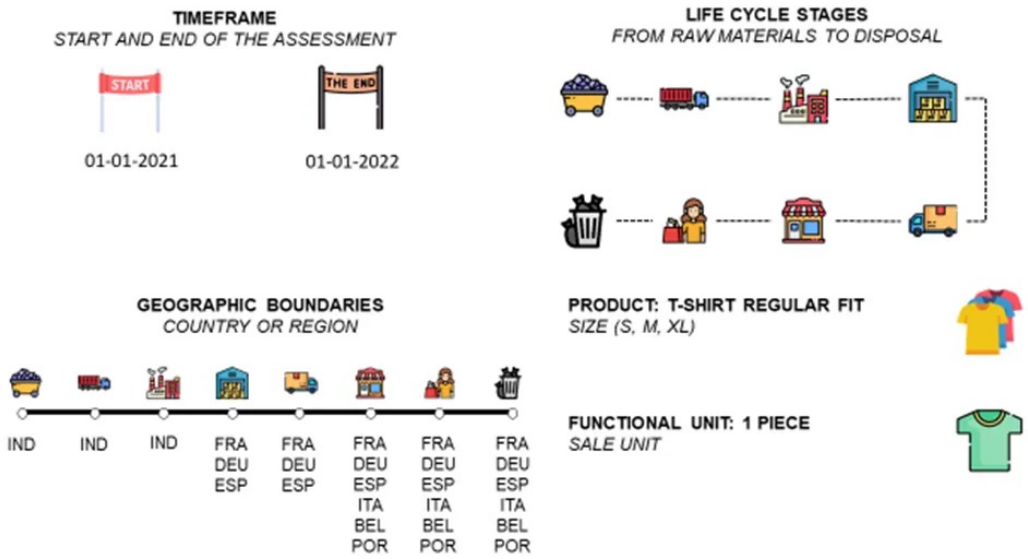
What is the environmental impact of the cheap t-shirt?



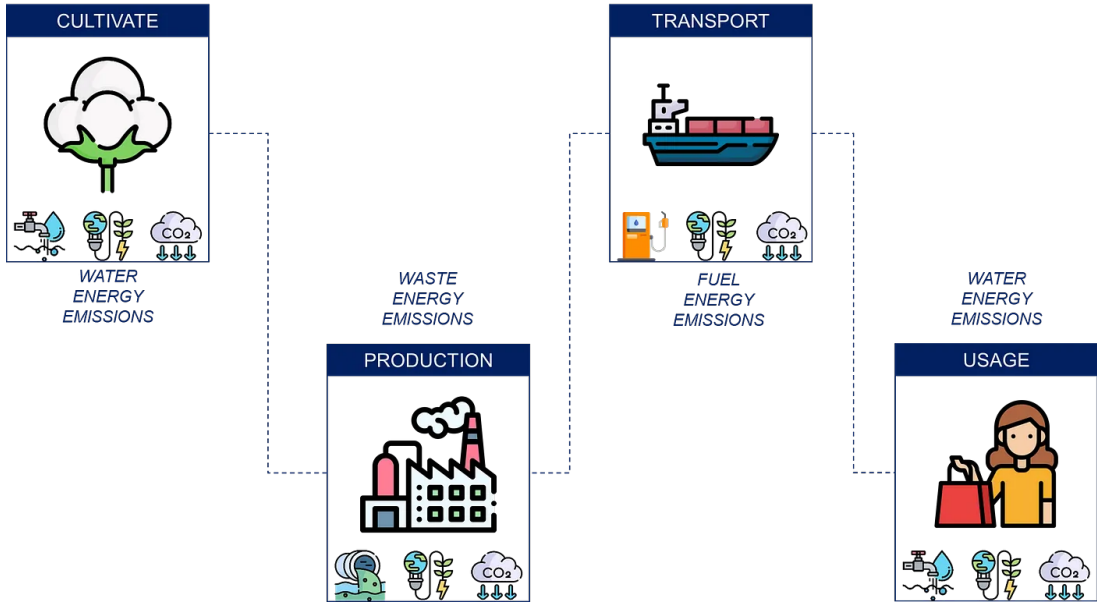
Source: https://www.bpf.co.uk/sustainable_manufacturing/life-cycle-analysis-lca.aspx

FOUR STEPS OF LCA

1. Goal and scope definition



2. Inventory Analysis



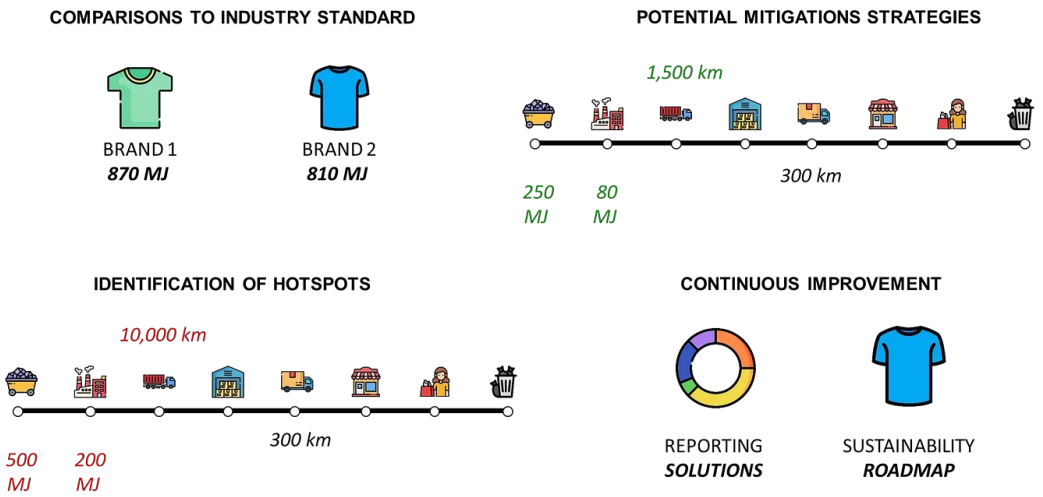
Source: https://www.bpf.co.uk/sustainable_manufacturing/life-cycle-analysis-lca.aspx

FOUR STEPS OF LCA

3. Impact assessment

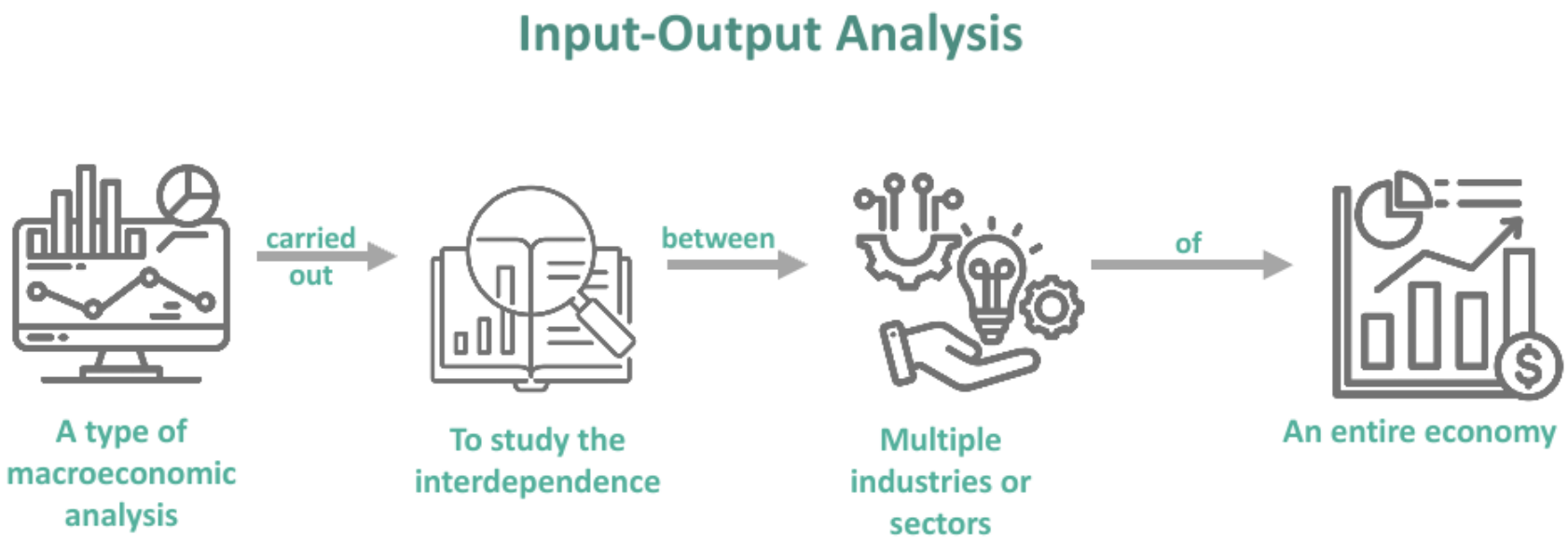
- Energy consumption: 870 MJ -- *58% consumed during the production*
- Greenhouse gas emissions: 46 kg CO2e -- *With a majority of emissions during production*
- Water consumption: 3,500 L -- *57% consumed during production*
- Solid waste: 0.5 kg -- *generated during production*
- Air pollution: 0.8 g of SOx and 0.5 g of NOx emissions -- *emitted during transportation*

4. Interpretation and evaluation



Source: https://www.bpf.co.uk/sustainable_manufacturing/life-cycle-analysis-lca.aspx

INPUT-OUTPUT ANALYSIS (TOP-DOWN ENERGY MODEL)



Source: https://www.wallstreetmojo.com/input-output-analysis/

INPUT-OUTPUT TABLE EXAMPLE

Input flow from other industries to Industry 1

Output flow from Industry 1 to other industries

From	To	Industry 1	Industry 2	Industry 3	Industry 4	Final demand: Households	Final demand: Government	Final demand: Investments	Final demand: Export	Total (X)
	1	z_{11}	z_{12}	z_{13}	z_{14}	c_1	g_1	i_1	e_1	X_1
Industry	2	z_{21}	z_{22}	z_{23}	z_{24}	c_2	g_2	i_2	e_2	X_2
	3	z_{31}	z_{32}	z_{33}	z_{34}	c_3	g_3	i_3	e_3	X_3
	4	z_{41}	z_{42}	z_{43}	z_{44}	c_4	g_4	i_4	e_4	X_4
Primary input factors	Labor	l_1	l_2	l_3	l_4					L
	Capital	k_1	k_2	k_3	k_4					K
	Government	o_1	o_2	o_3	o_4					O
	Import	m_1	m_2	m_3	m_4					M
Total (Z)		Z_1	Z_2	Z_3	Z_4	C	G	I	E	

INPUT-OUTPUT TABLE EXAMPLE

External economic shock

From	To	Industry 1	Industry 2	Industry 3	Industry 4	Households	Government	Investments	Export	Total (X)
Industry	1	z_{11}	z_{12}	z_{13}	z_{14}	c_1	g_1	i_1	e_1	X_1
	2	z_{21}	z_{22}	z_{23}	z_{24}	c_2	g_2	i_2	e_2	X_2
	3	z_{31}	z_{32}	z_{33}	z_{34}	c_3	g_3	i_3	e_3	X_3
	4	z_{41}	z_{42}	z_{43}	z_{44}	c_4	g_4	i_4	e_4	X_4
Primary input factors	Labor	l_1	l_2	l_3	l_4					L
	Capital	k_1	k_2	k_3	k_4					K
	Government	o_1	o_2	o_3	o_4					O
	Import	m_1	m_2	m_3	m_4					M
Total (Z)		Z_1	Z_2	Z_3	Z_4	C	G	I	E	

- External economic shocks result in the unbalance of the I-O table;
- I-O table has to be rebalanced to reveal the influence on the whole economic system.
- I-O table can also be extended to analyze environmental impacts, such as carbon emission and air pollution and energy consumption.

EXAMPLE

External Shock

- Energy prices surged 20%
- The price of each barrel of crude oil increased and averaged $106.96, up by 15.3% (used to be $92.77).

Direct Impact

- Consumers primarily purchase less durable goods, such as new houses and cars;
- Firms minimize their investment spending owing to uncertainty.

Spillover Effect

- Impact on real GDP;
- Lead to a fall in social surplus, decelerating economic growth;
- Result in higher global costs.

Source: https://www.wallstreetmojo.com/input-output-analysis/