

# Product and technology assessment



# Agenda

- Product and technology assessment
- Life Cycle Assessment

# Product and technology assessment (PATA)

It is a systematic assessment of primary, secondary, and tertiary impacts of products and technologies with respect to:

- Health
- Safety
- Environment &
- Society

That covers the life cycle from raw materials to final disposal.



# PATA is used for:

- Designing regulations and guidelines;
- Approving new products & technologies;
- Designing & improving products;
- Making purchasing decisions.

# Sources and perspectives of PATA

- Science, engineering, technology
- Economics and finance
- Political, cultural and social sources
- Ideological & political thought
- Religious organisations.

PATA is a process that relies on a set of different assessment approaches, in particular, Life Cycle Assessment (LCA). PATA differs from LCA by including health, safety, social and cultural factors and by not having an established methodology.

Other tools in the set include: Risk Management, Environmental Impact Assessment, Human Factors, and Environmental Communications.



# Life Cycle Assessment (LCA)

- An LCA is an assessment of the **environmental effects** a product or service has during its lifetime, from cradle to grave.
- In an LCA all the **important processes** during the products lifecycle is included.
- An LCA can for example be used for assessing how much greenhouse gas is emitted to the environment during the production of one litre milk.



# Understanding a life-cycle approach

## Exploring eco-efficiency



Did you know...



- Producing one ton of recycled steel saves the energy equivalent of 3.6 barrels of oil and 1.5 tons of iron ore, compared to the production of new steel?
- Producing paper using a chlorine-free process uses between 20 and 25 percent less water than conventional chlorine-based paper production processes?



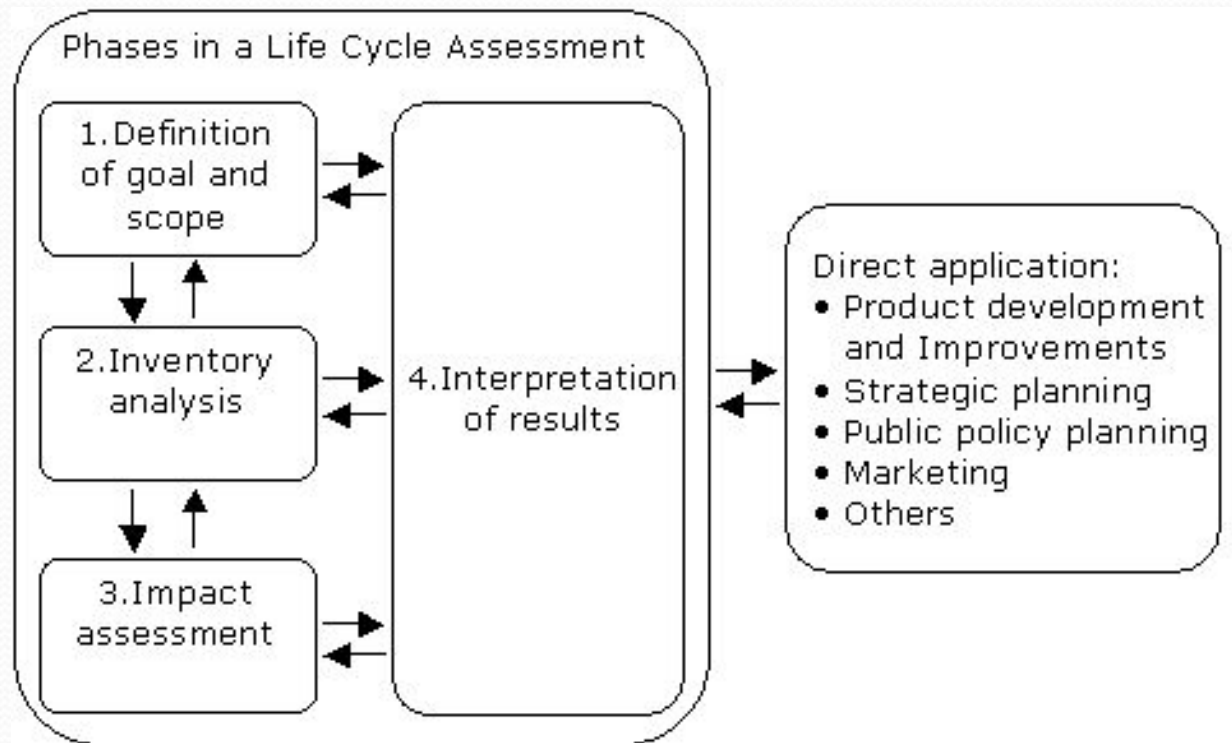
## Learning objectives

- Recognize where products come from and where they go after use = *life-cycle*
- Think about a product's impacts on the environment and economy throughout
  - Qualify impacts
  - Quantify impacts

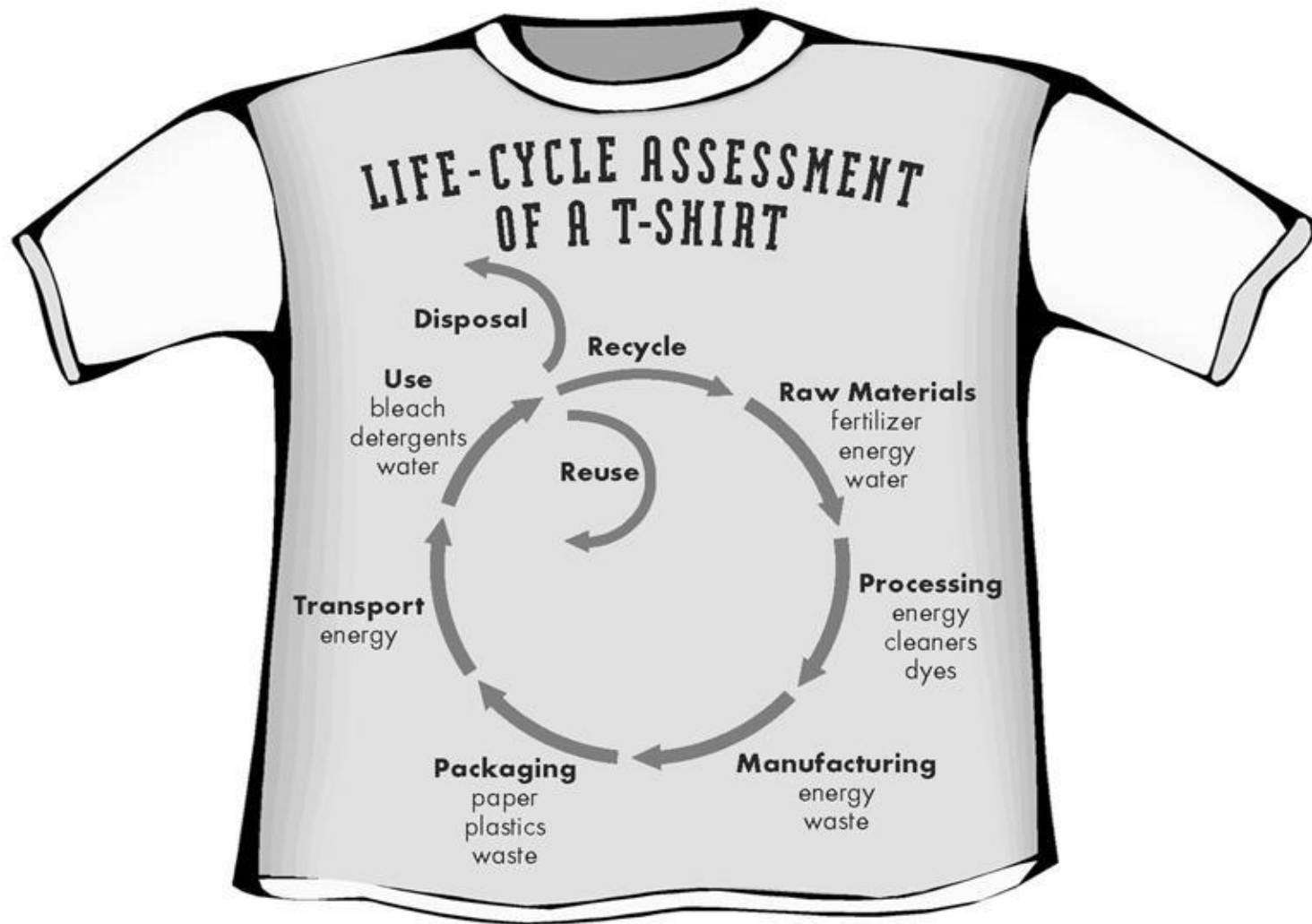
# Structure

- Life-cycle – what is it?
- Choosing boundaries and shifting issues
- A life-cycle approach
- Life-cycle assessment – one tool
- Segue to life-cycle exercise

# Phases in a Life Cycle Assessment







## Life cycle stages

- Products can be evaluated through each stage of their life-cycle:
  - Extraction or acquisition of raw materials
  - Manufacturing and processing
  - Distribution and transportation
  - Use and reuse
  - Recycling
  - Disposal
- For each stage, identify inputs of materials and energy received; outputs of useful product and waste emissions
- Find optimal points for improvement – eco-efficiency

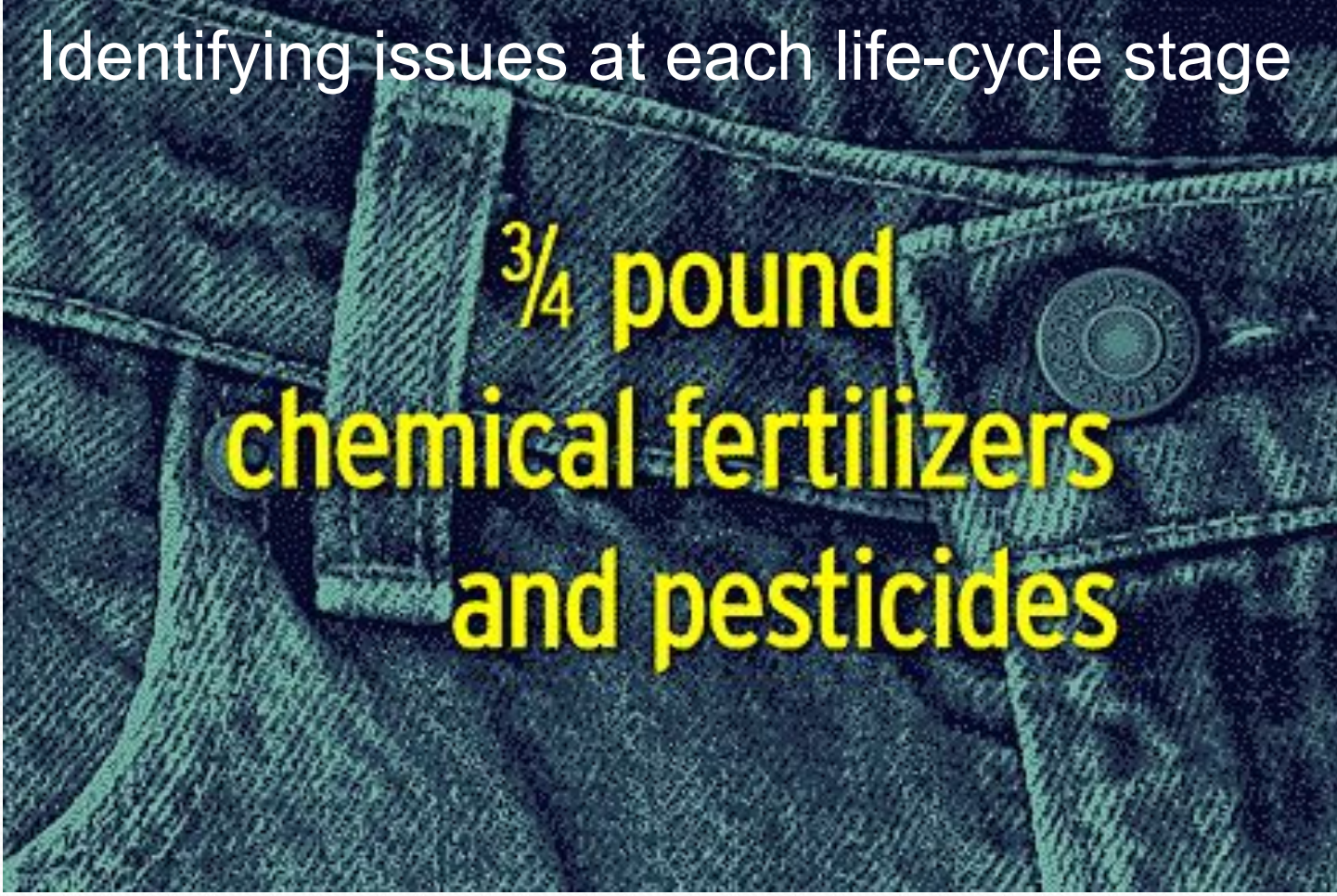


- Ensures companies identify the multiple environmental and resource issues across the entire life-cycle of the product
- Knowledge of these issues informs business activities:
  - planning, procurement, design, marketing & sales
- Rather than just looking at the amount of waste that ends up in a landfill or an incinerator, a life-cycle approach identifies energy use, material inputs and waste generated from the time raw materials are obtained to the final disposal of the product \*

\* *Product Life-Cycle Analysis: Environmental activities for the classroom*,  
Waste Management and Research Center, Champaign, IL, 1999



Identifying issues at each life-cycle stage



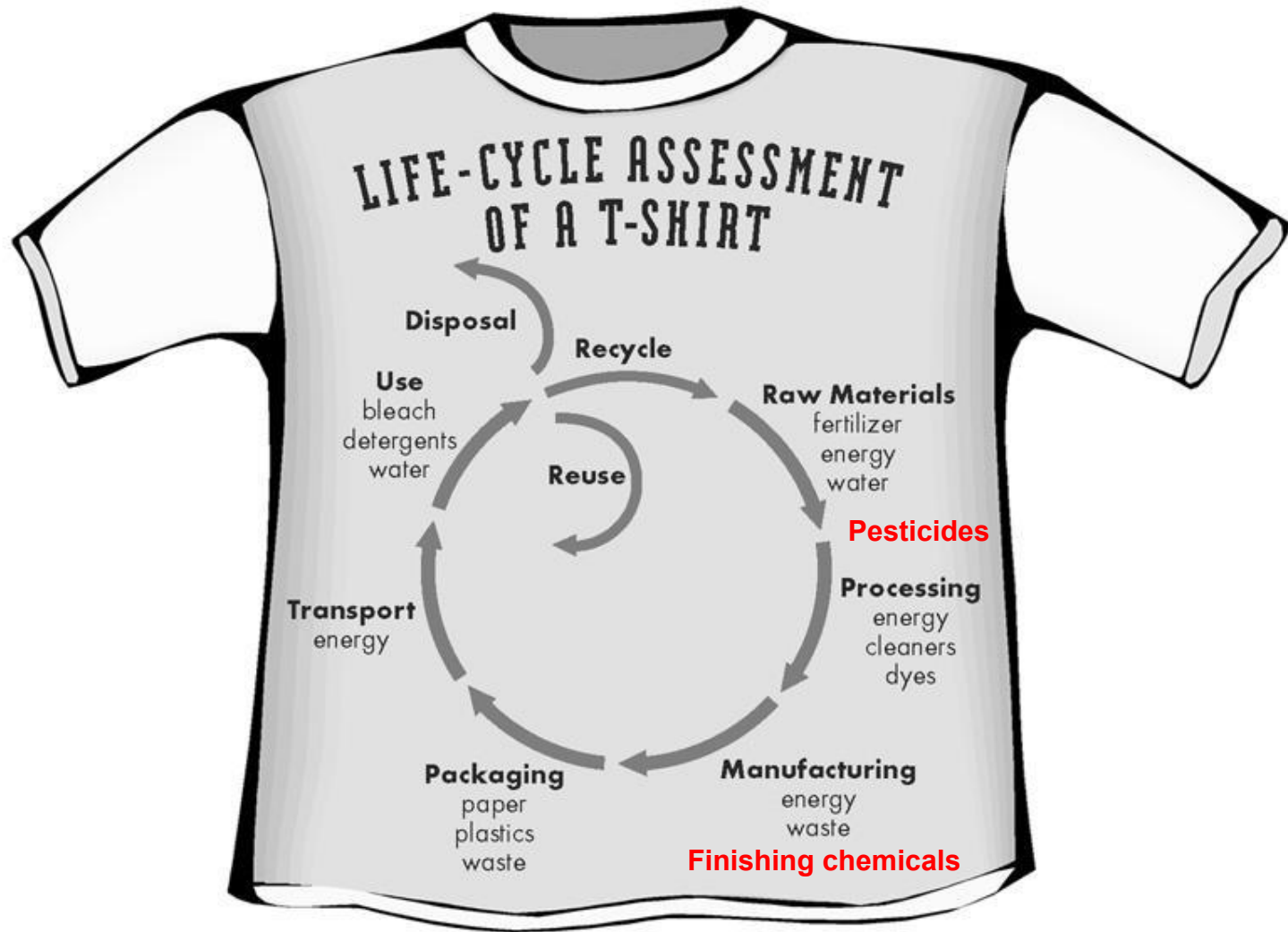
**$\frac{3}{4}$  pound  
chemical fertilizers  
and pesticides**

*Estimated amount of synthetic fertilizers and pesticides it takes to produce the cotton for a conventional pair of jeans.*

*Source: "The Organic Cotton Site: Ten good reasons"*

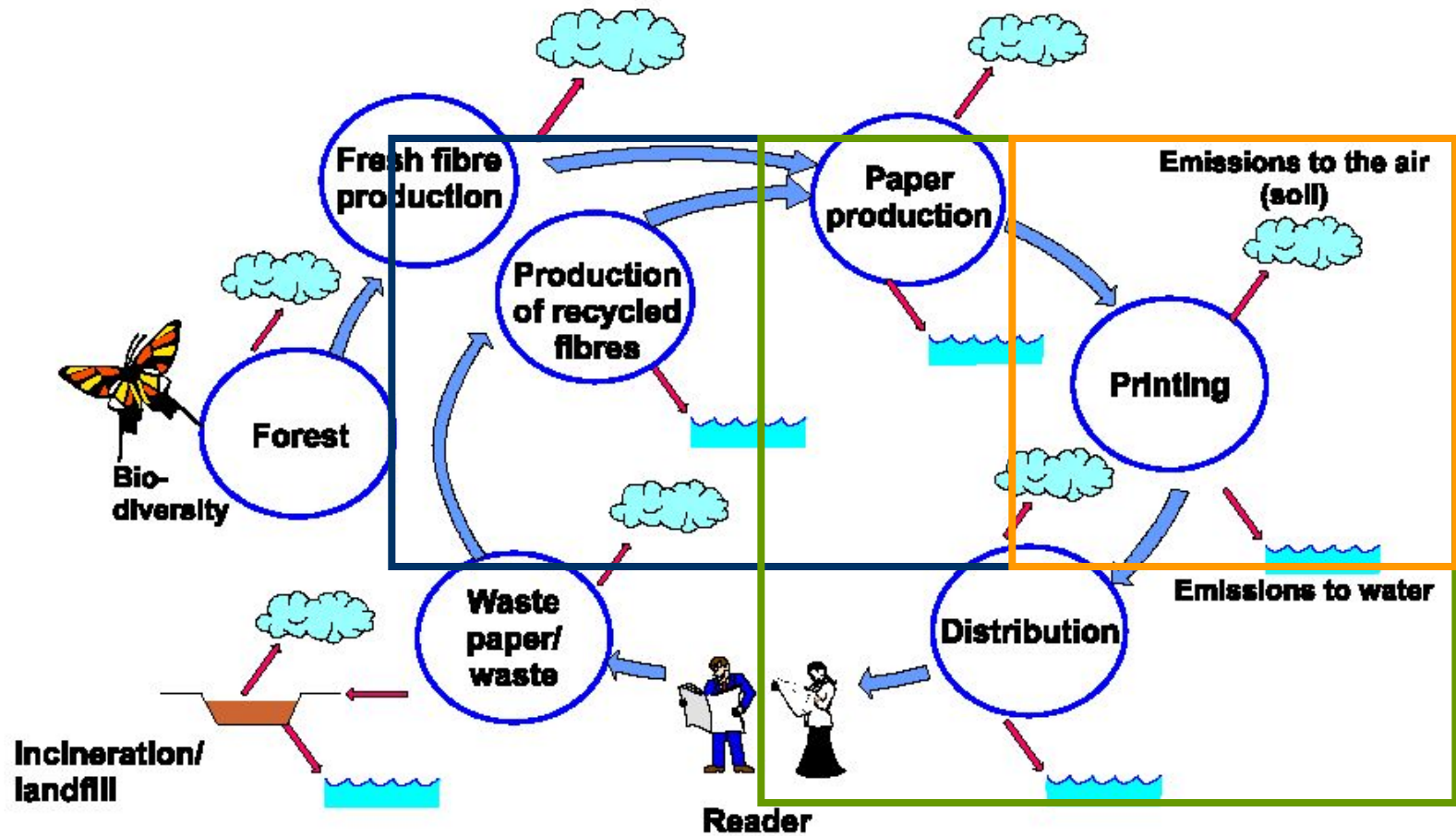




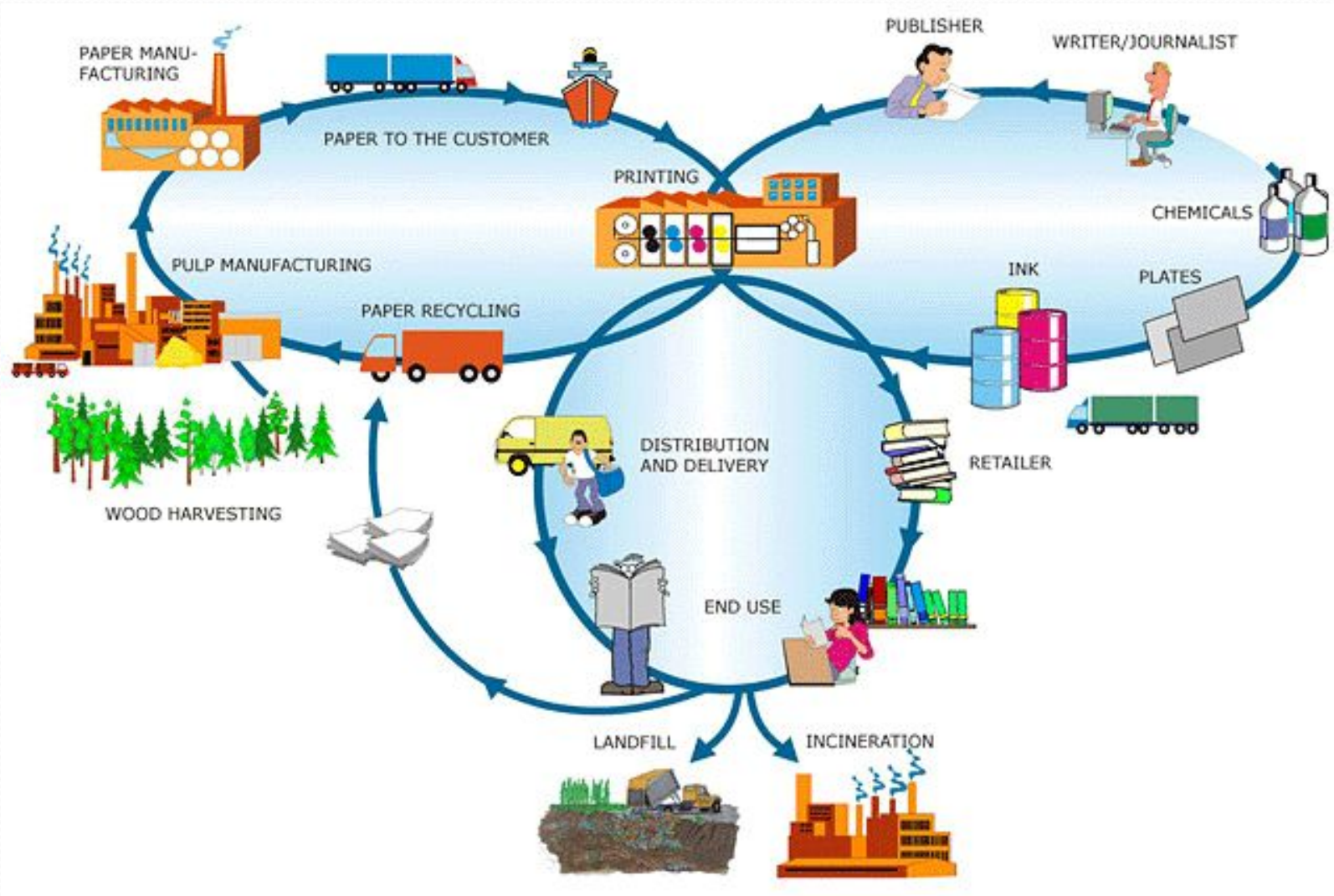





# Life-cycle – identify the boundaries



# Life cycle of print products





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- Looking at the entire life-cycle helps ensure reducing waste at one point does not simply create more waste at another point in the life-cycle
  - Issues may be shifted – intentionally or inadvertently – among:
    - Processes or manufacturing sites
    - Geographic location
    - Different budgets and planning cycles (first cost)
    - Environmental media – air, water, soil
    - Sustainability dimension: economic, social, environmental burdens
  - Depends on “boundaries”
  - Be conscious of what is shifted and to where!

# Methyl tertiary butyl ether - MTBE

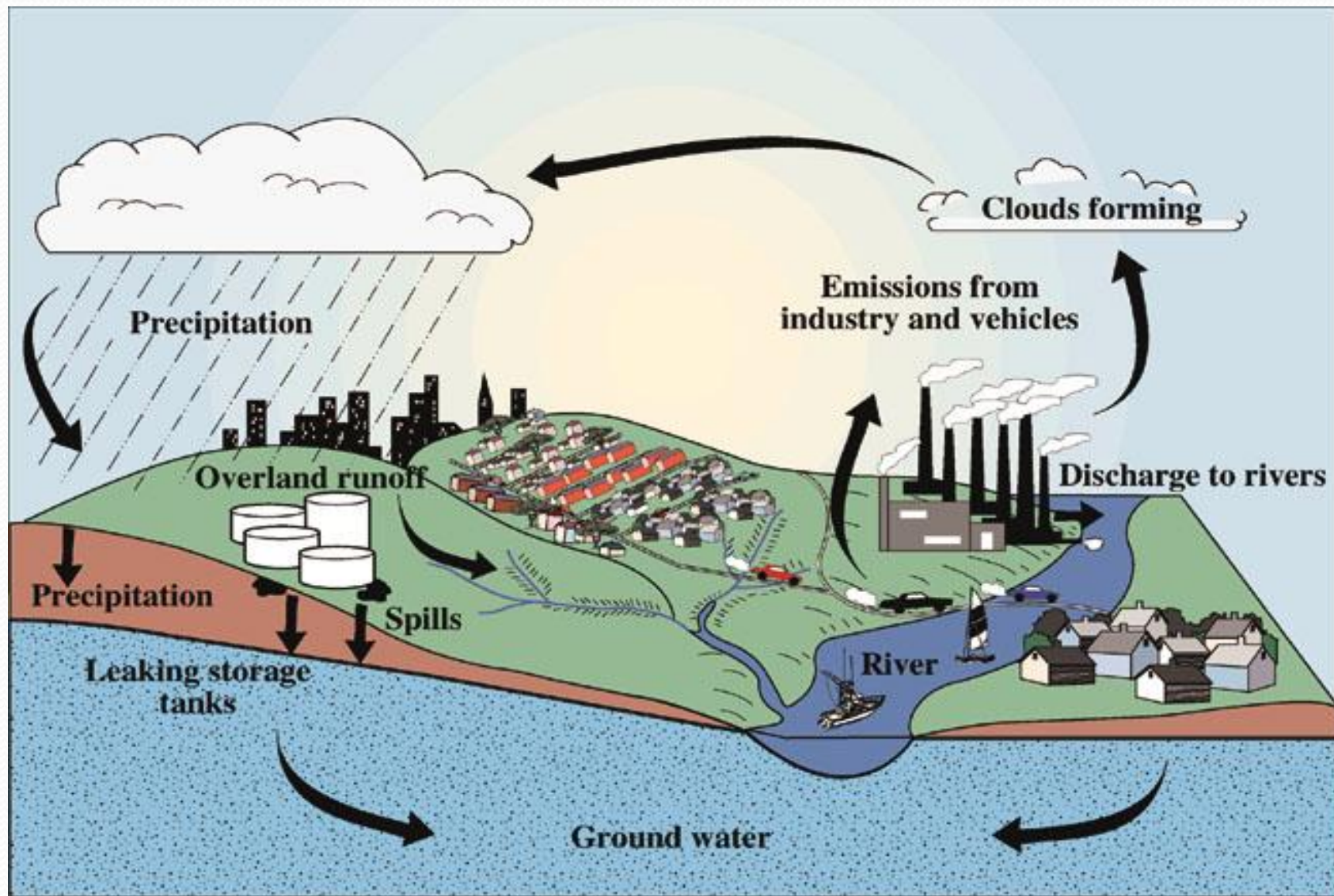




Methyl tertiary butyl ether - MTBE

CONTAINS  
**MTBE**

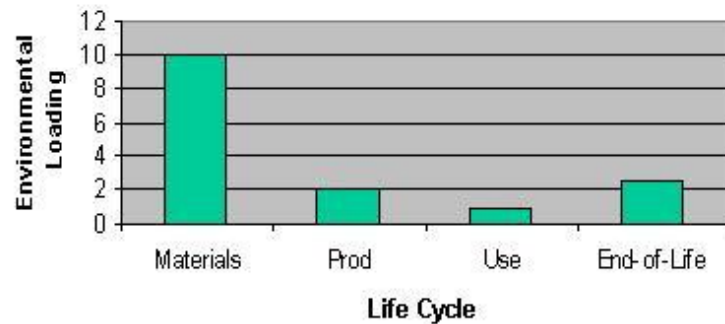
THE STATE OF CALIFORNIA HAS DETERMINED  
THAT THE USE OF THIS CHEMICAL PRESENTS  
A SIGNIFICANT RISK TO THE ENVIRONMENT



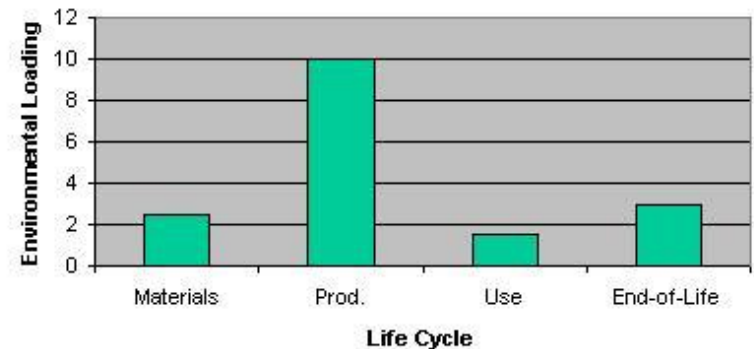


# Different products have impacts at different

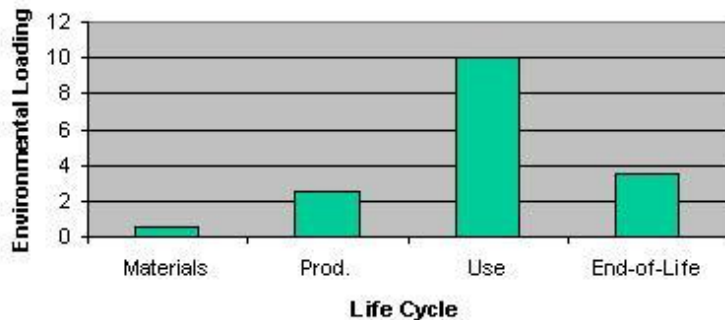
**Type a: short-lived material-intensive product  
(e.g. single use package)**



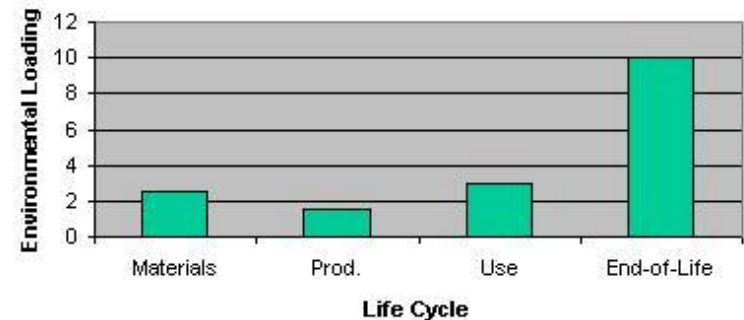
**Type b: manufacturing-intensive product  
(e.g. laptop computer, paper products)**



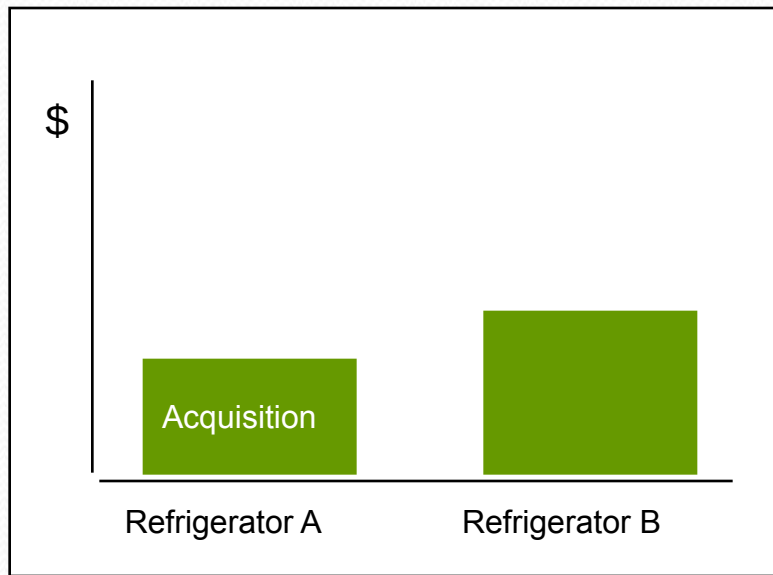
**Type c: long-lived, energy and resource  
consuming products  
(e.g. automobiles, appliances, buildings)**



**Type d: product with special end-of-life or  
disposal characteristics  
(e.g. single use diapers)**

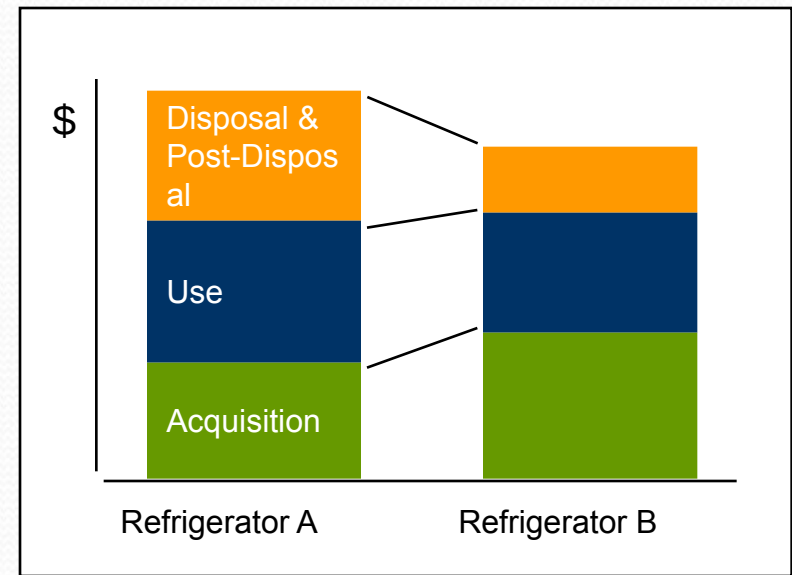


## Life-cycle – identify issues and costs



Purchase Price

Refrigerator A appears cheaper



Price + Life-Cycle Costs

Refrigerator B costs less overall



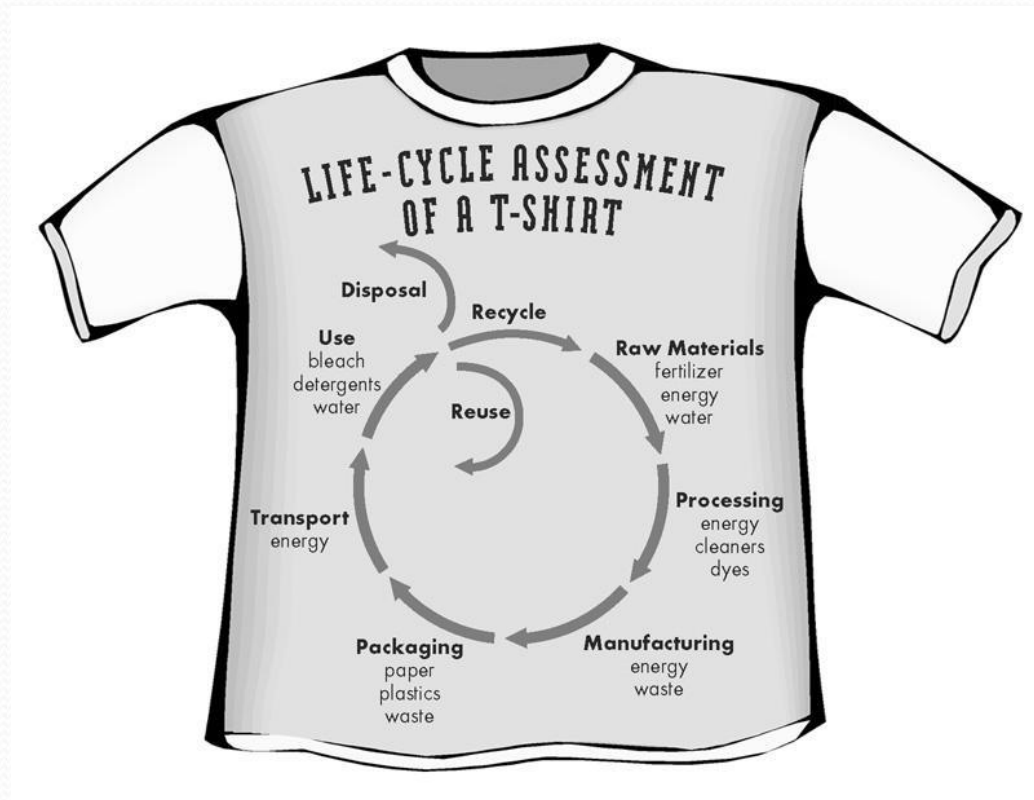


## A life-cycle approach

- With a life-cycle approach, companies employ the tools they need to:
  - Reduce impacts across the life-cycle
  - Capitalize on opportunities for their business
- Tools range from simple mapping of life-cycle stages to comprehensive quantitative assessments

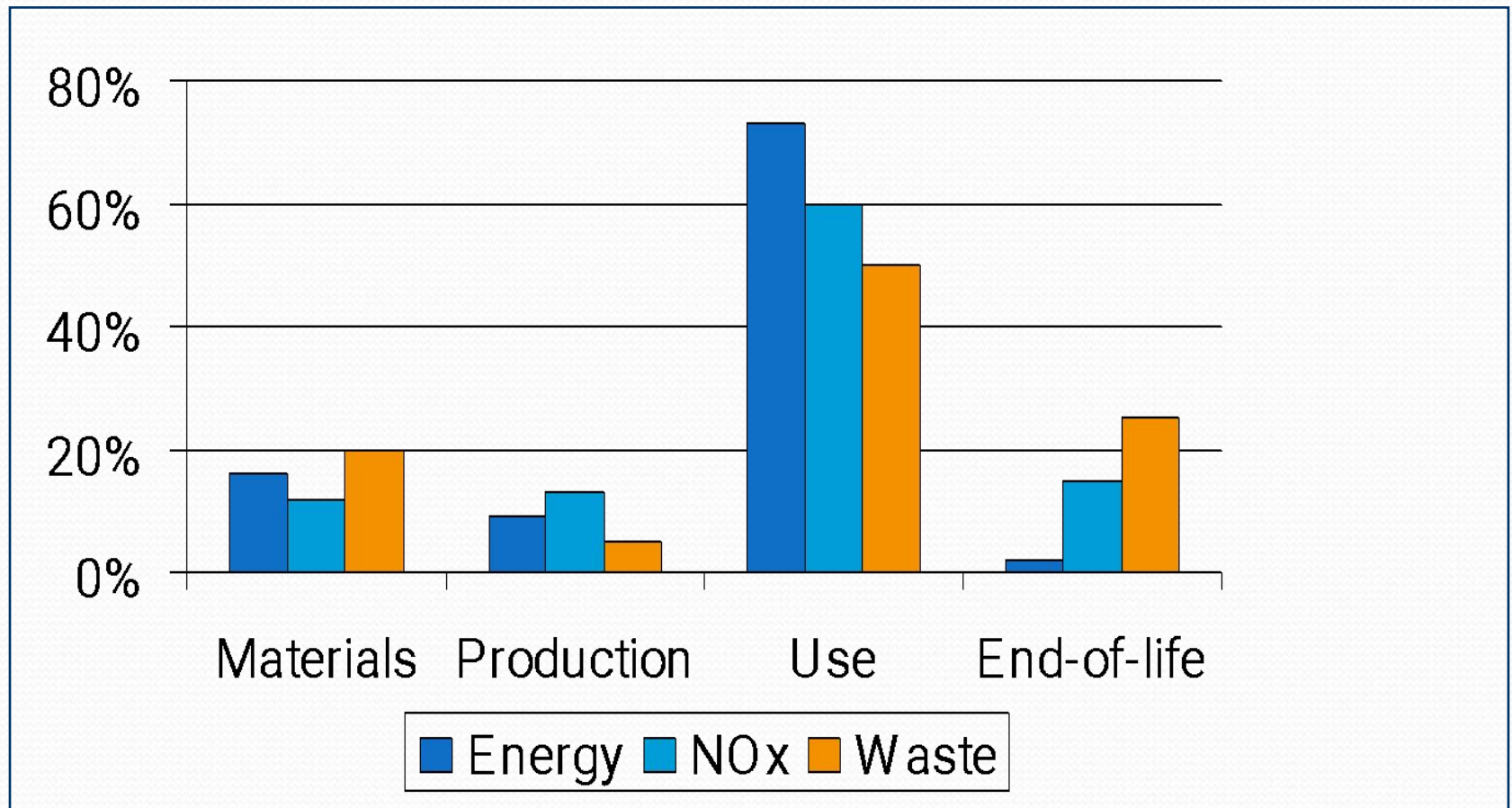
## Life-cycle assessment

- LCA is a tool to systematically measure the environmental impacts associated with each stage of a product's life-cycle






*Assessment of relative impacts across life-cycle –  
3 issues are included*



## Life cycle assessment

- Two attributes make LCA distinct and useful as an analytical tool:
  - whole system consideration of the total product life-cycle
  - presentation of tradeoffs among multiple environmental issues
- LCA is quantitative




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1. Determine scope and system boundaries
    - functional unit
    - life-cycle stages
    - define “unit processes”
  2. Data collection
  3. Analysis of inputs and outputs
  4. Assessment of numerous environmental issues
  5. Interpretation
    - LCA principles and framework are standardized by the Organization for International Standardization's 14040 series of standards (ISO14040)

## Conclusions – why take a life-cycle approach?

- Systems perspective
- Integrates environment into core business issues
- Efficiency
- Innovation
- Better return on investment – identify point of “biggest bang for the buck” \*
- Engage stakeholders – investors, customers, employees
- Environment is not a cost center for the company, but a business opportunity



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- Integrates environment into core business issues
  - Efficiency
  - Innovation
  - Better return on investment
  - Engage stakeholders
  - Environment is not a cost center for the company, but a business opportunity
    - Look beyond the company's gate
    - Expose trade-offs and and opportunities
    - Expand analysis of products, projects, policies and programs – what is the function, what are the boundaries, what are the impacts, where are the opportunities?

# Purpose of LCAs

A company can use LCAs for several purposes:

- To give the company an overview of the environmental impacts internally, which gives the company foundation for making environmental improvements and thereby decreasing their environmental impacts.
- To put pressure on the company's suppliers to make more environmentally friendly raw materials.
- In marketing, where the company can market one or more of their products on its environmental profile or they can market their products compared to other similar products on the market.
- In product development phase, eco-design. In eco-design an LCA can be used for assessing the possible environmental impacts from a product that is under development. The LCA results can this way be used to change parameters in the product or the production here of.



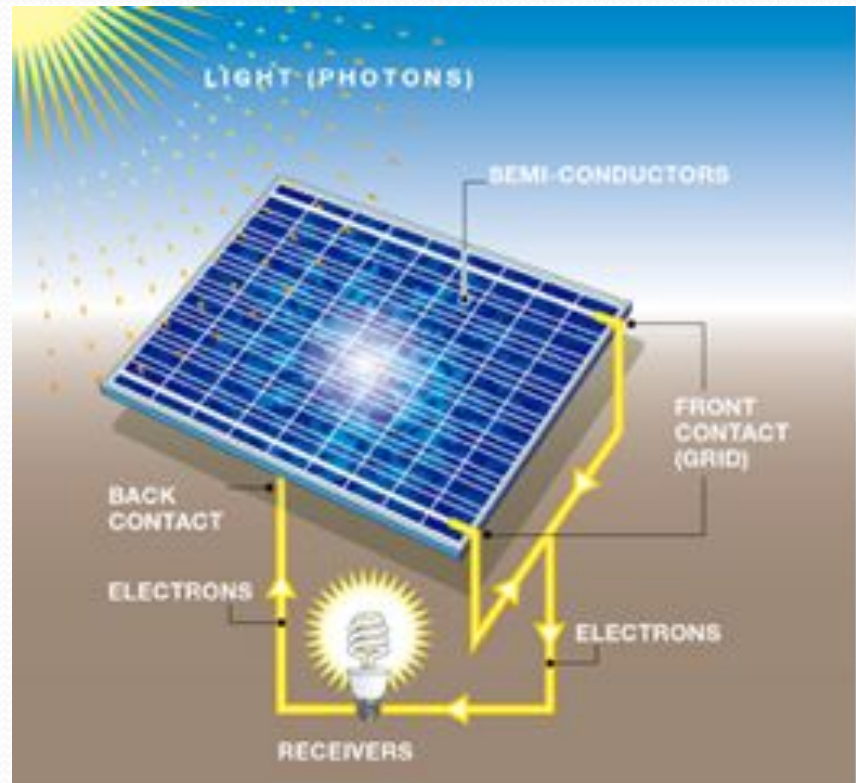
# Example: Solar Energy



*Source: Sandia National Laboratories*

# Background – Photovoltaics (PV)

- Converts light directly to electricity
- Created in 1950s for satellite use
  - Vanguard I, 1958
- Use on land began in 1970s
- Most widely known and adopted solar technology today



Source: Total.com



# Life Cycle Analysis (LCA)

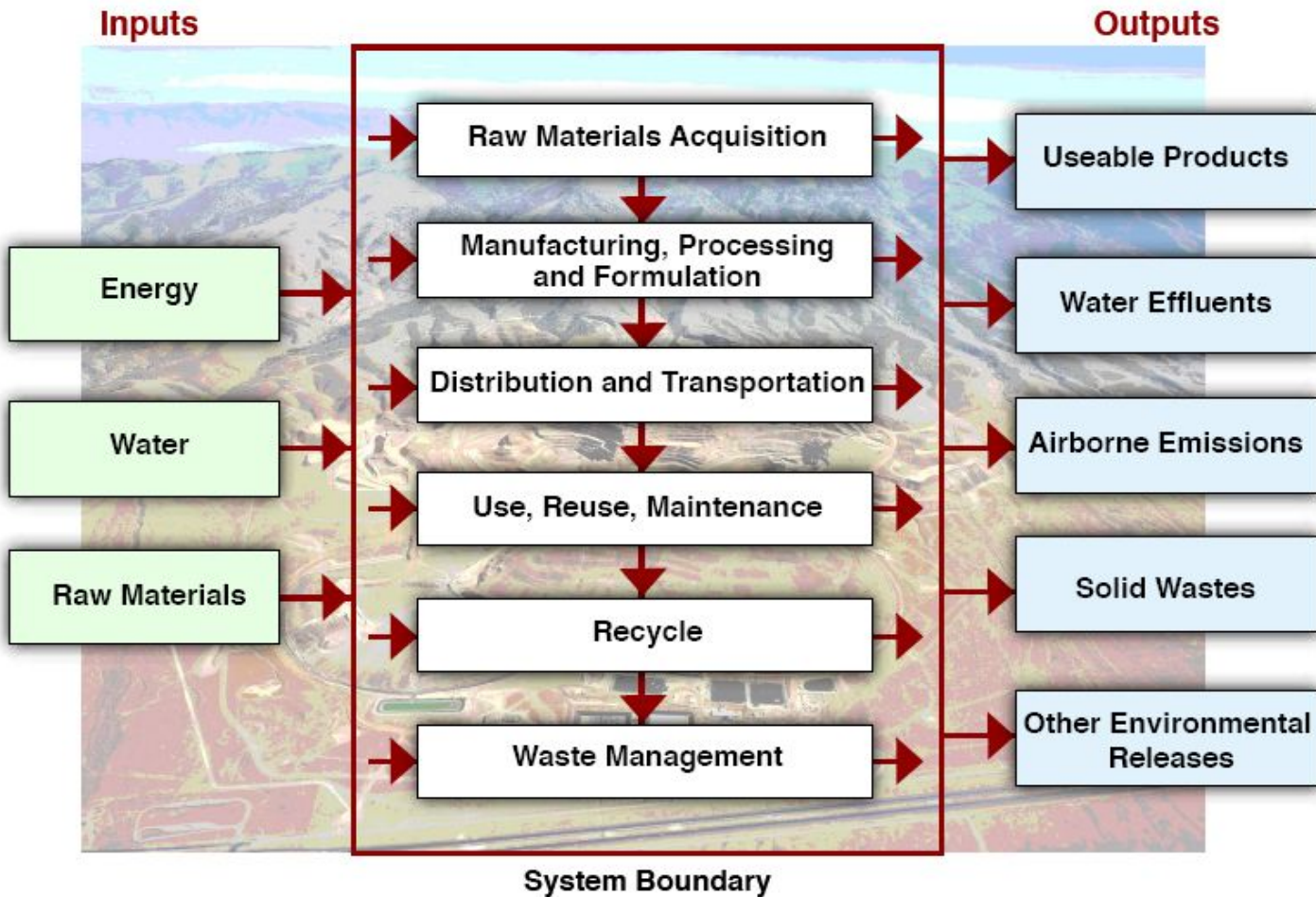
Traditional evaluations only consider the “use” phase of life

More accurate and comprehensive analyses consider a product "from cradle to grave"

Each phase of life factors into the LCA:

- Raw Material Acquisition
- Manufacturing
- Transport
- Use/Maintenance
- Recycle/Waste Management

# Life Cycle Analysis



Source: Lawrence Berkeley National Laboratory



# Life Cycle Analysis – Photovoltaics

$$R = f ( H \times E )$$

- Risk, R
- Hazard, H
- Exposure, E

Major hazards in PV manufacturing

Requires the use of rare-earth metals, of which China controls 95% of the market

Production undergoing rapid outsourcing to developing countries

No well-established PV recycling program

Module Type	Types of Potential Hazards
Crystalline-silicon (x-Si)	HF acid burns SiH <sub>4</sub> fires/explosions Pb solder/module disposal
Amorphous-silicon (α-Si)	SiH <sub>4</sub> fires/explosions
Cadmium Telluride (CdTe)	Cd toxicity, carcinogenicity Module disposal
Copper Indium Diselenide (CIS) Copper Indium Gallium Diselenide (CGS)	H <sub>2</sub> Se toxicity Module disposal
Gallium Arsenide (GaAs)	AsH <sub>3</sub> toxicity As carcinogenicity H <sub>2</sub> flammability Module disposal

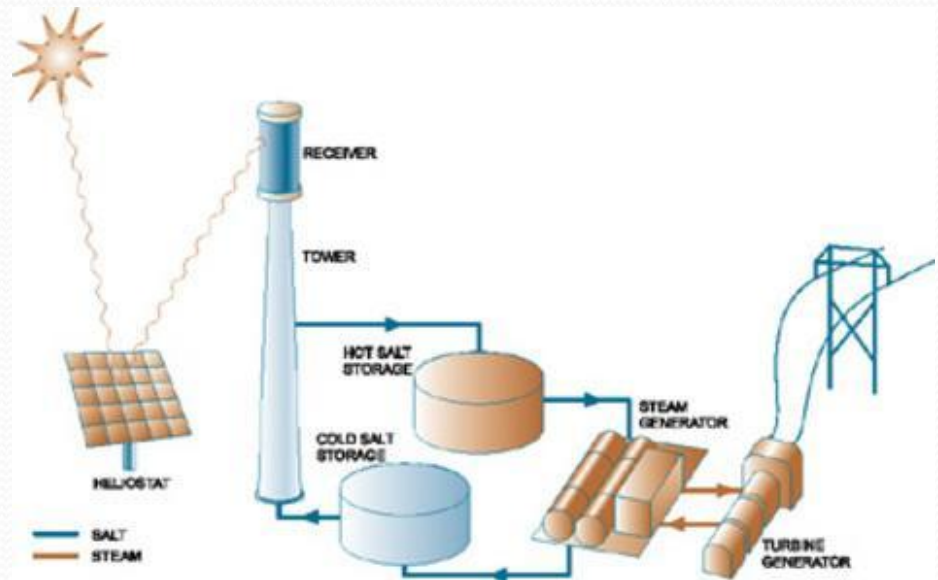
# Life Cycle Analysis – Concentrating Solar Power (CSP)

Composed mainly of  
common metals,  
glass, concrete, and  
HTF

Thermal hazard

Requires higher  
intensity solar  
radiation than PV

Allows for integrated  
energy storage



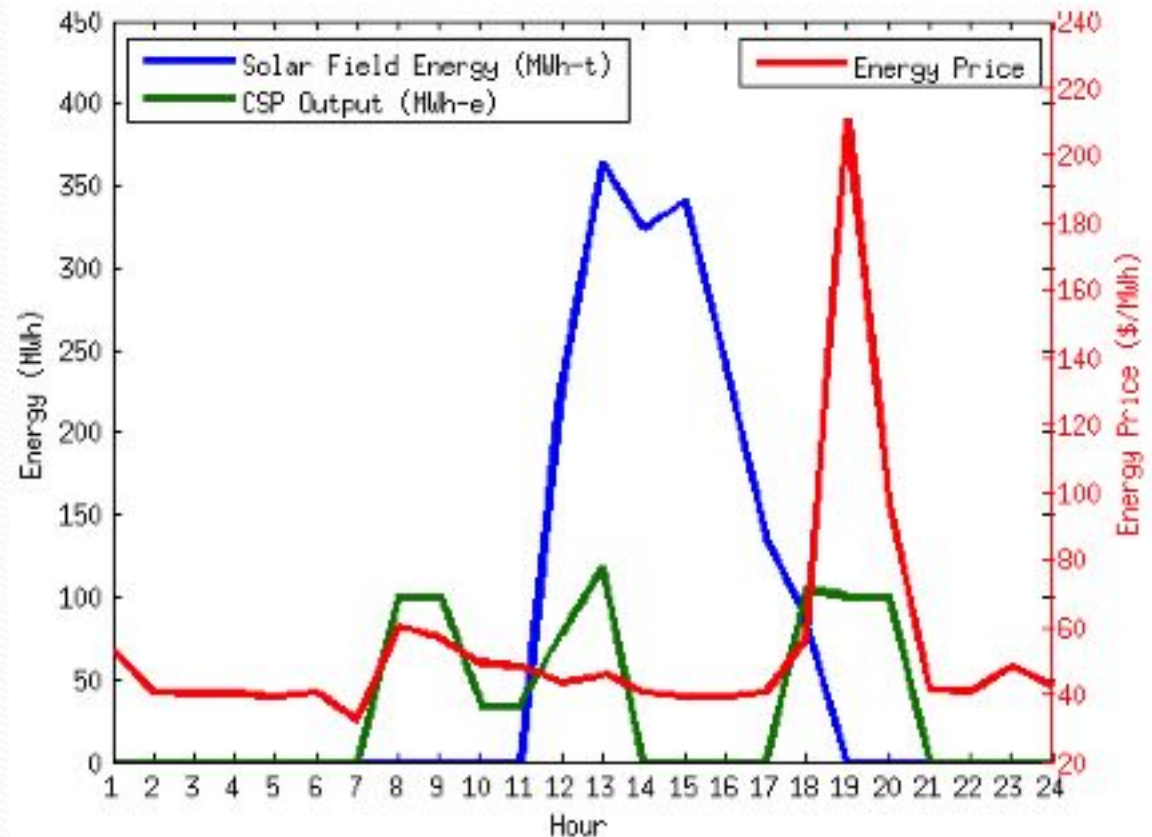
*Source: Sandia National Laboratory*





# Life Cycle Analysis - CSP

Thermal energy storage allows for decoupling of energy collection and electricity generation



Source: National Renewable Energy Laboratory

# Life Cycle Analysis - Comparison

## Photovoltaics

- 10-15% efficient (commercially)
- Advanced battery technology still in development
- Converts light directly to electricity
- Toxic feedstocks and waste
- More practical on a small scale

## Concentrating Solar Power

- 40-70% efficiency
- Integrated energy storage
- Converts light directly to heat
- Simpler and more benign materials
- Most practical on a large, utility scale



Hamburger exercise – life-cycle stages, inputs, outputs and issues ...

