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

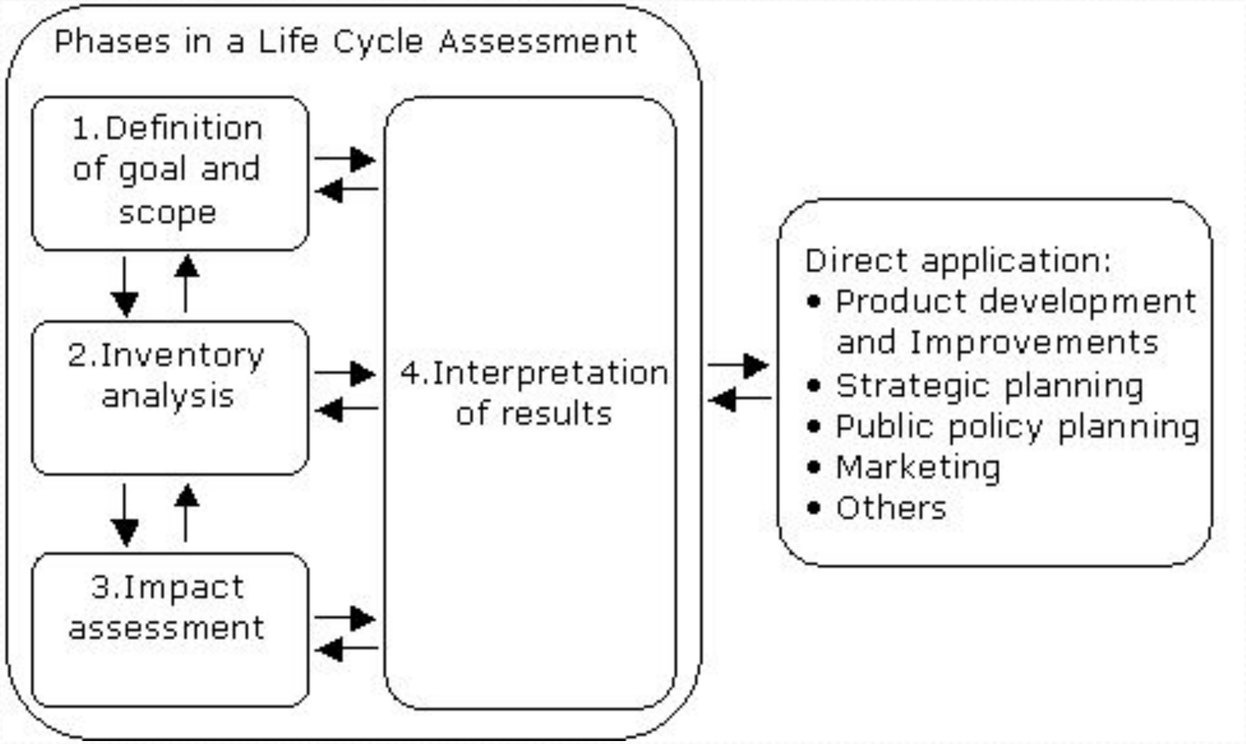
- Recognize where products come from and where they go after use = *life-cycle*

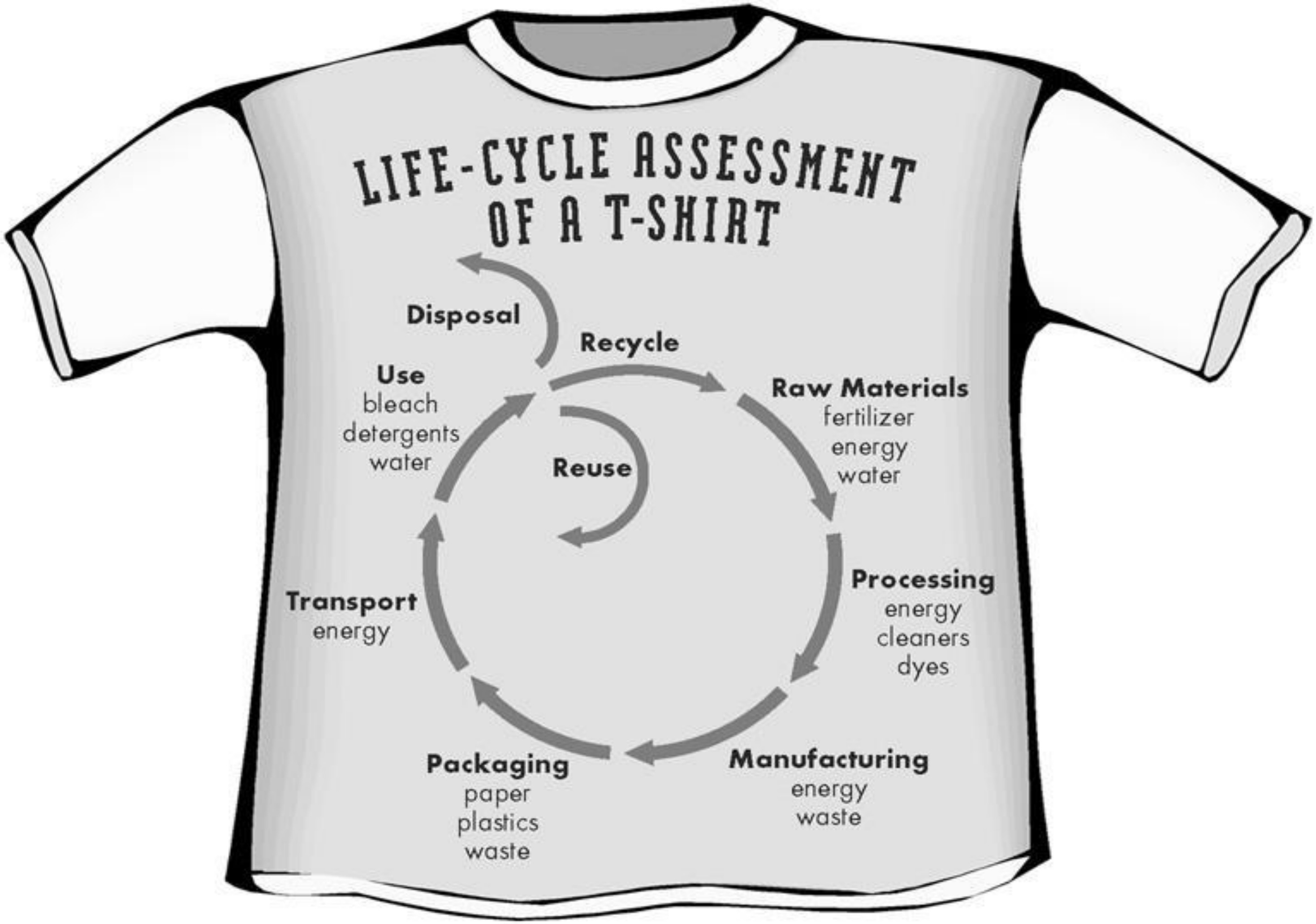
- Think about a product's impacts on the environment and economy throughout
  - Qualify impacts
  - Quantify impacts

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





Worldwatch Institute, Worldwatch Paper 166: Purchasing Power: Harnessing Institutional Procurement for People and the Planet, July 2003, www.worldwatch.org

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

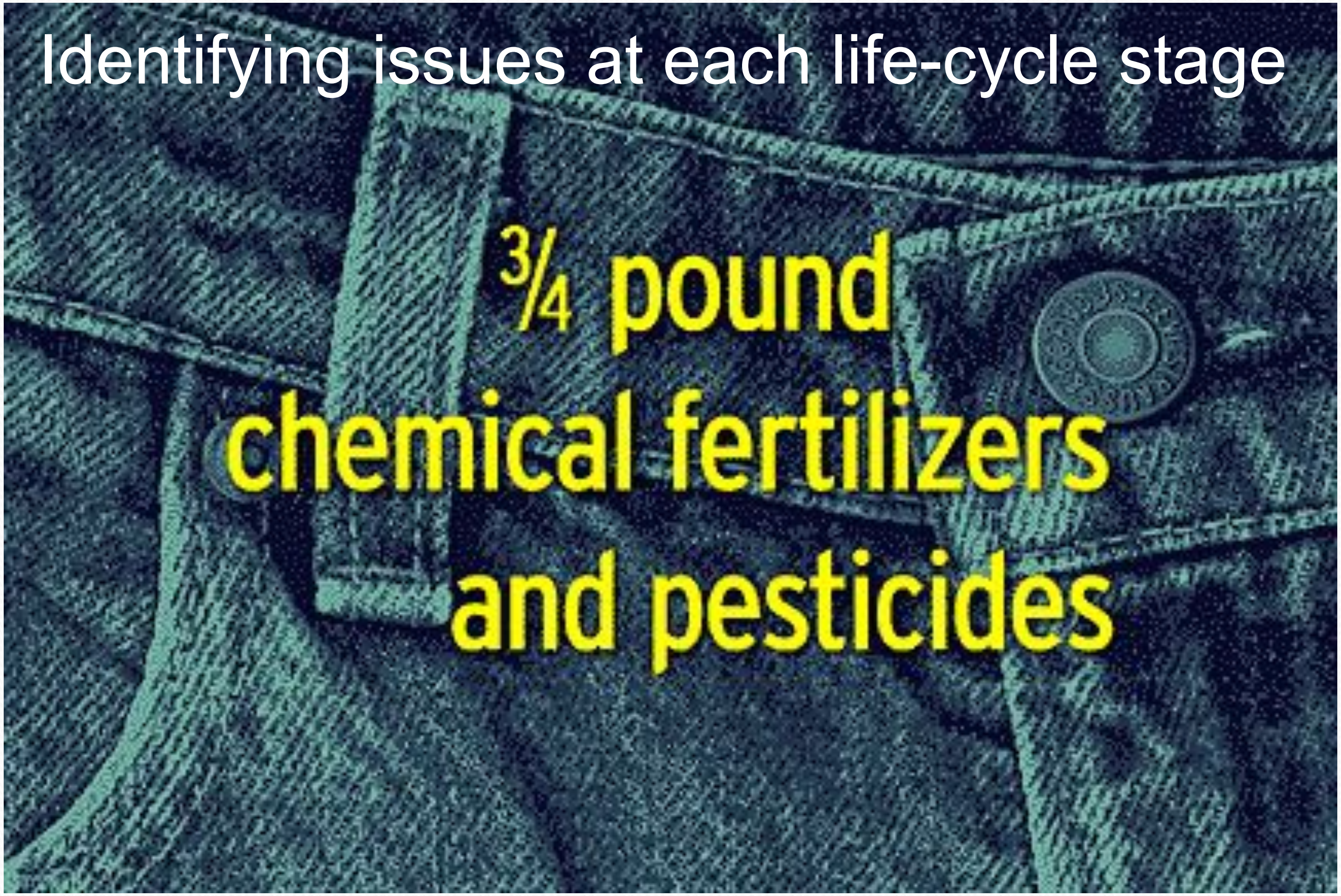
- Ensures companies identify the multiple environmental and resource issues across the entire life-cycle of the product

- 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

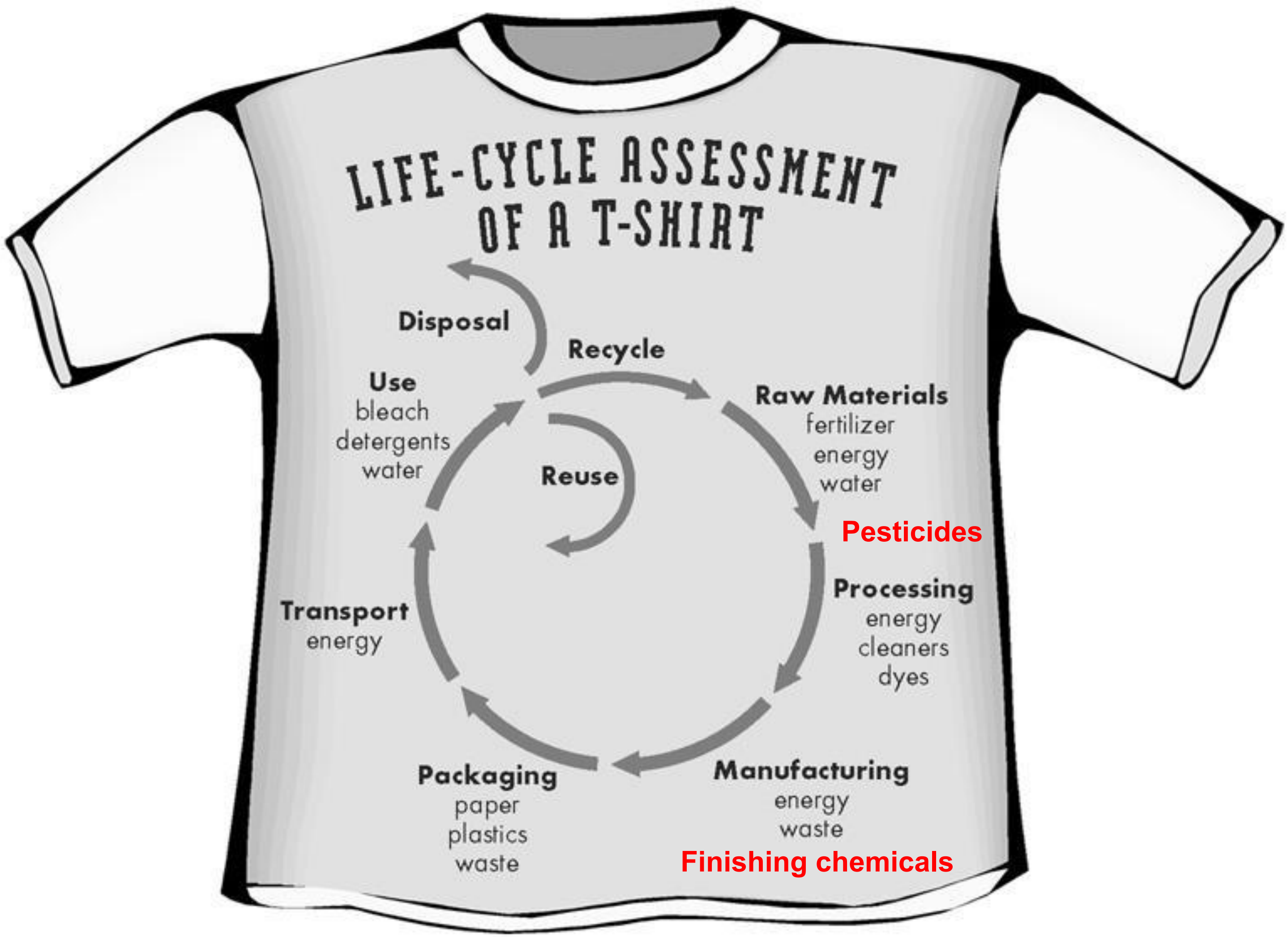
Identifying issues at each life-cycle stage



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

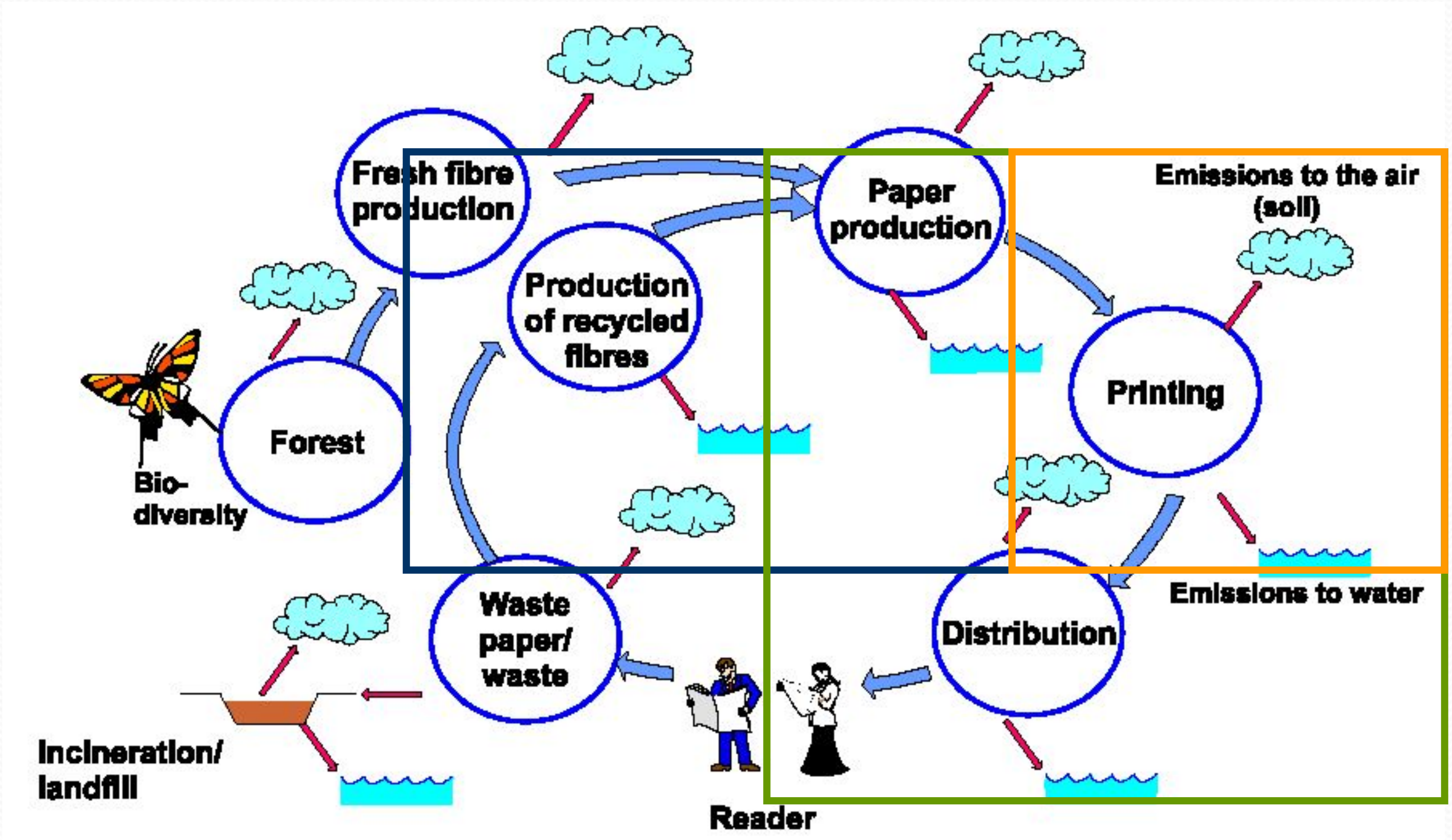
Source: "The Organic Cotton Site: Ten good reasons"


RECYCLING
COTTON PRODUCTION
END OF LIFE
FABRIC PRODUCTION
CONSUMER USE
GARMENT MANUFACTURING
TRANSPORTATION & DISTRIBUTION

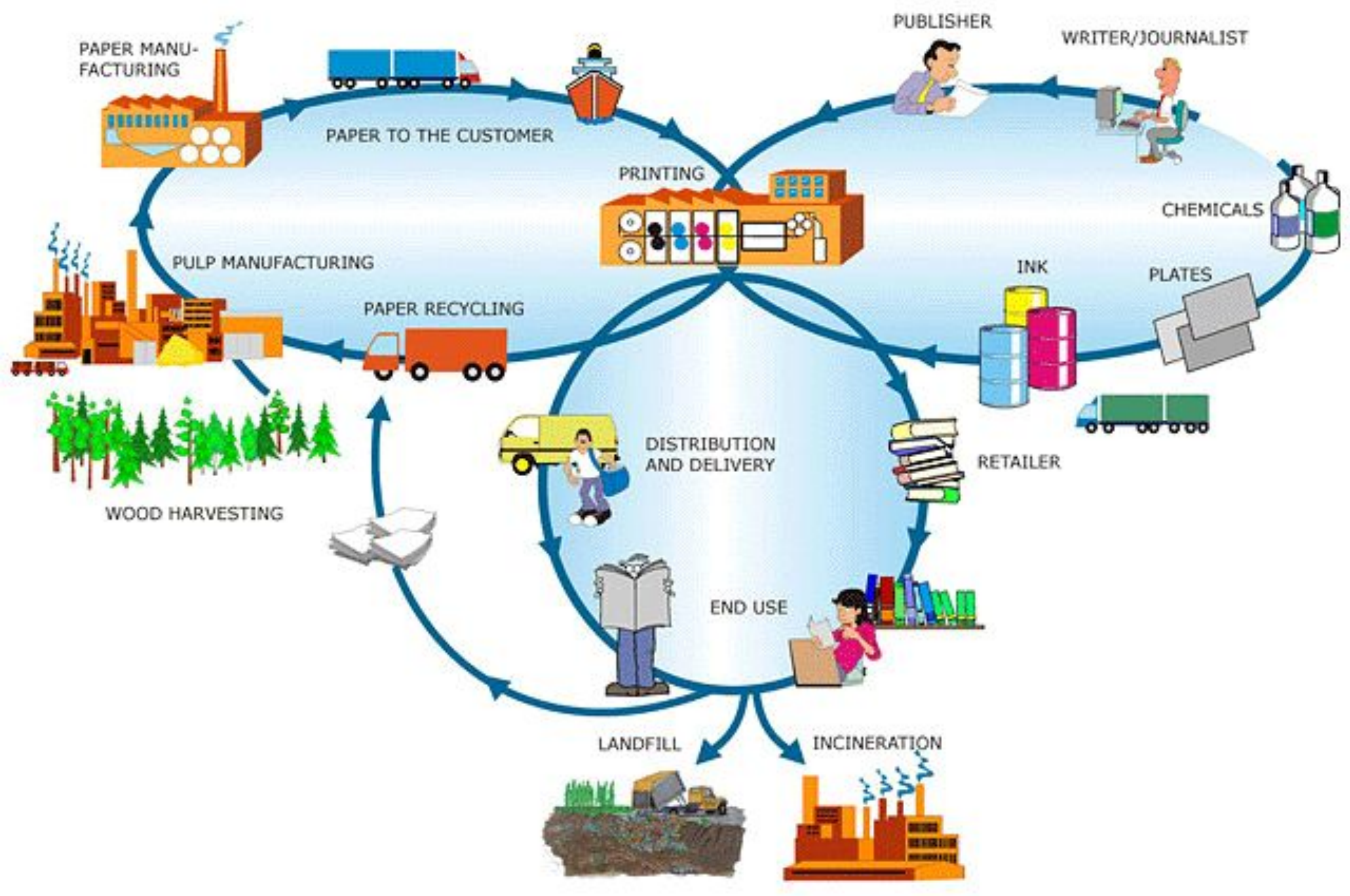


Worldwatch Institute, Worldwatch Paper 166: Purchasing Power: Harnessing Institutional Procurement for People and the Planet, July 2003, www.worldwatch.org

Life-cycle – identify the boundaries



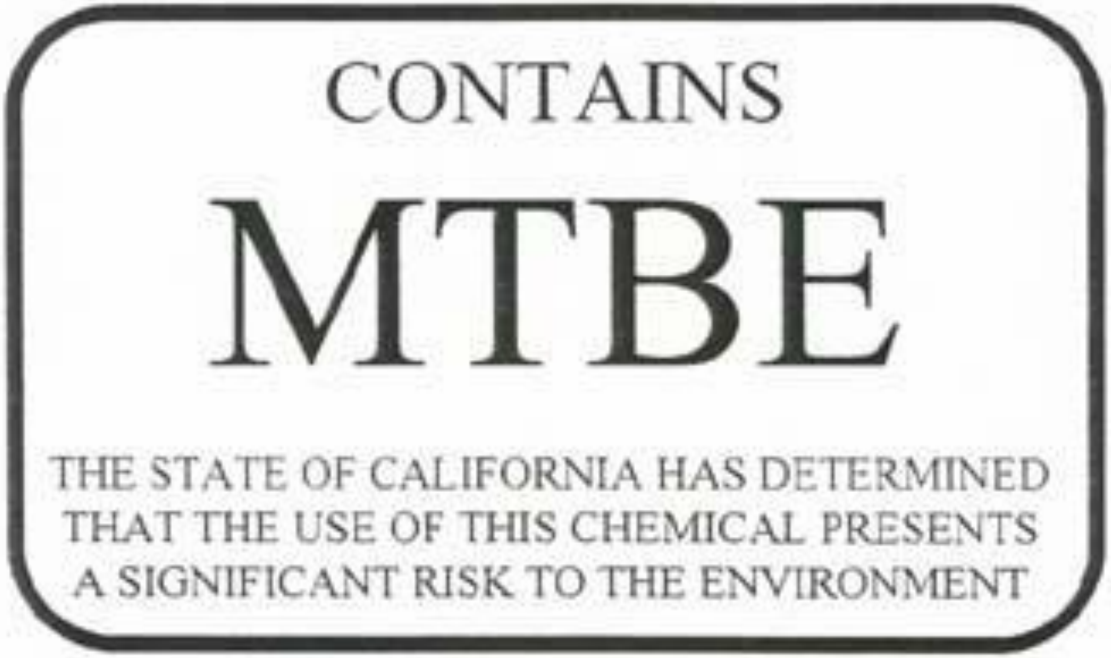
Life cycle of print products

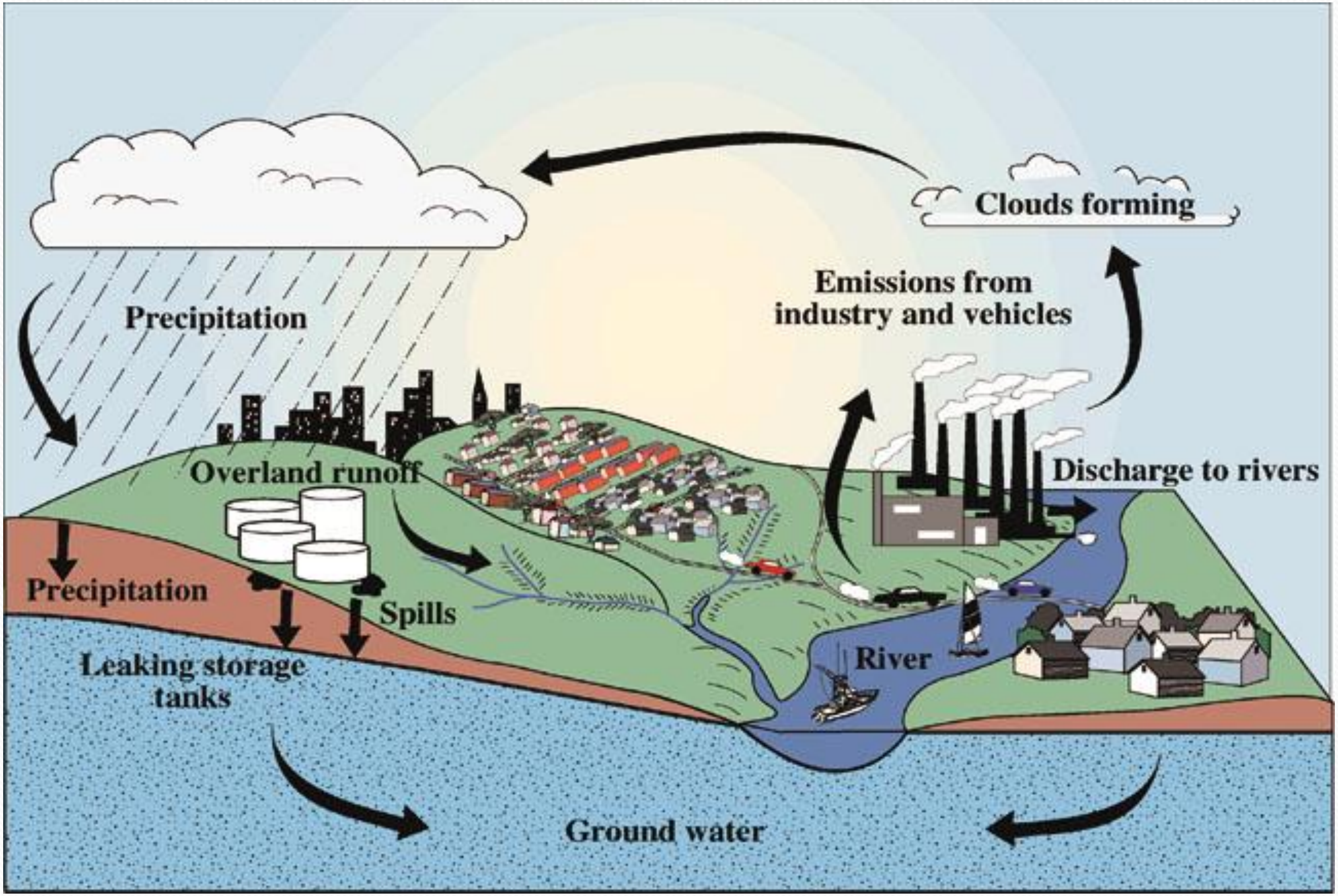


- Looking at the entire life-cycle helps ensure reducing waste at one point does not simply create more waste at another point in the life-cycle
- Issues may be shifted – intentionally or inadvertently – among:
  - Processes or manufacturing sites
  - Geographic location
  - Different budgets and planning 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

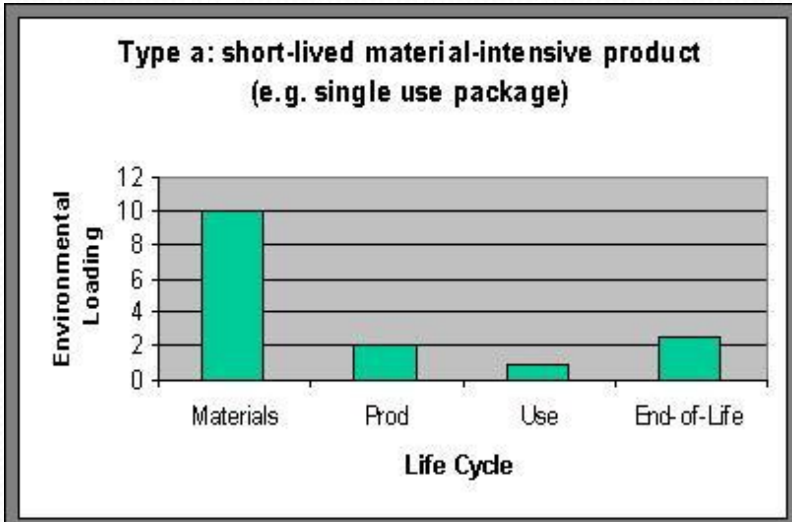
Methyl tertiary butyl ether - MTBE

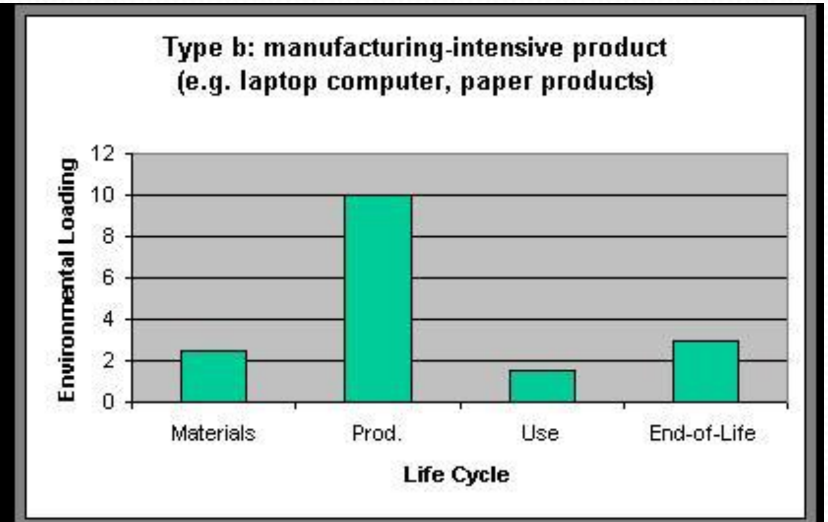


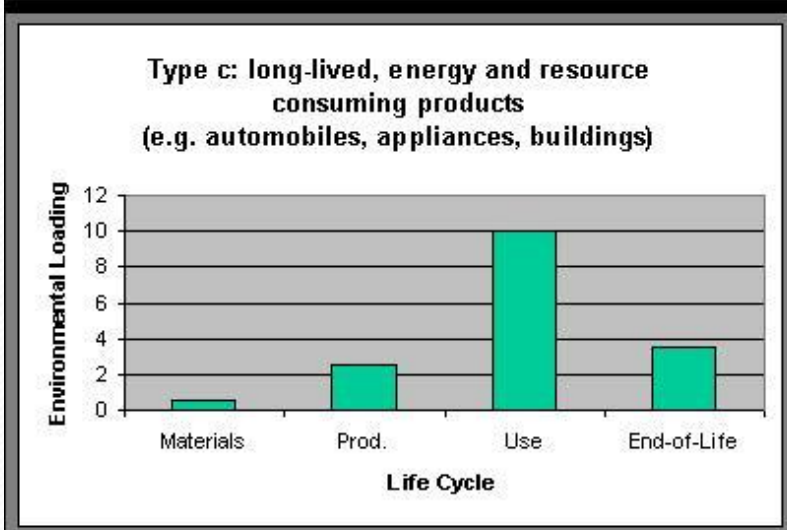


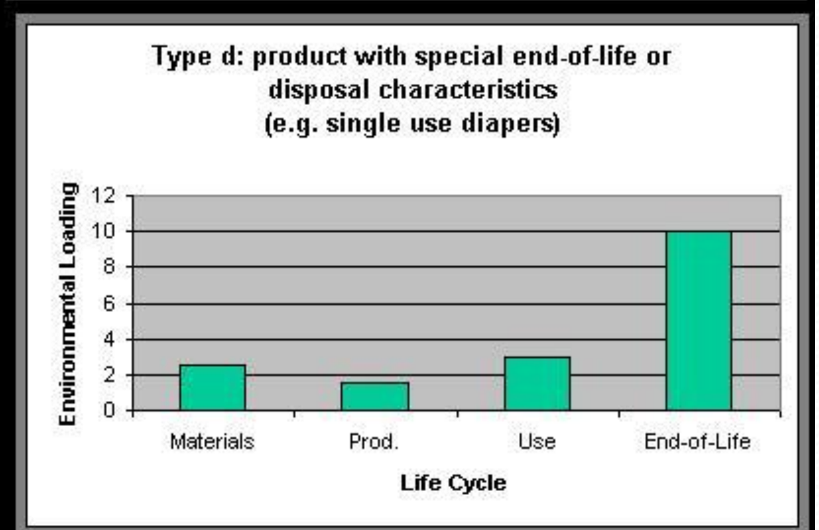
US Geological Survey, http://www.nwrc.usgs.gov/world/content/water1.html

Different products have impacts at different

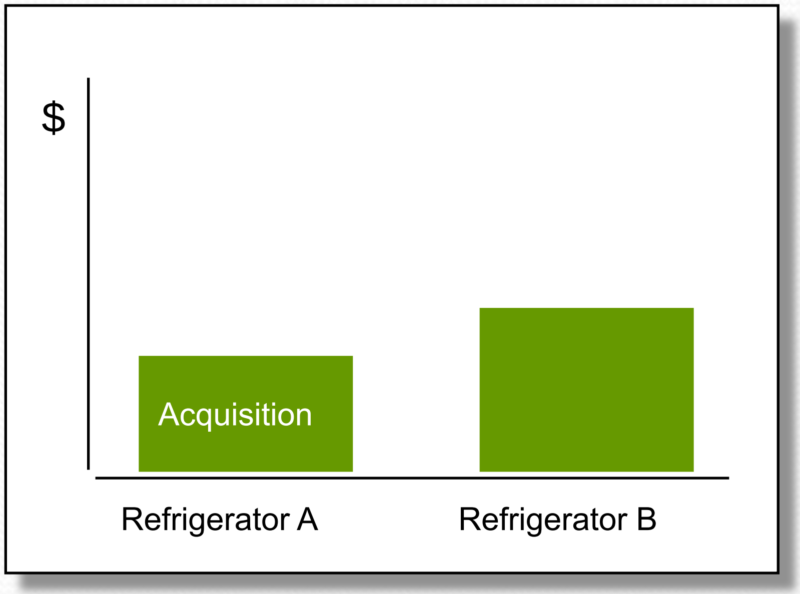


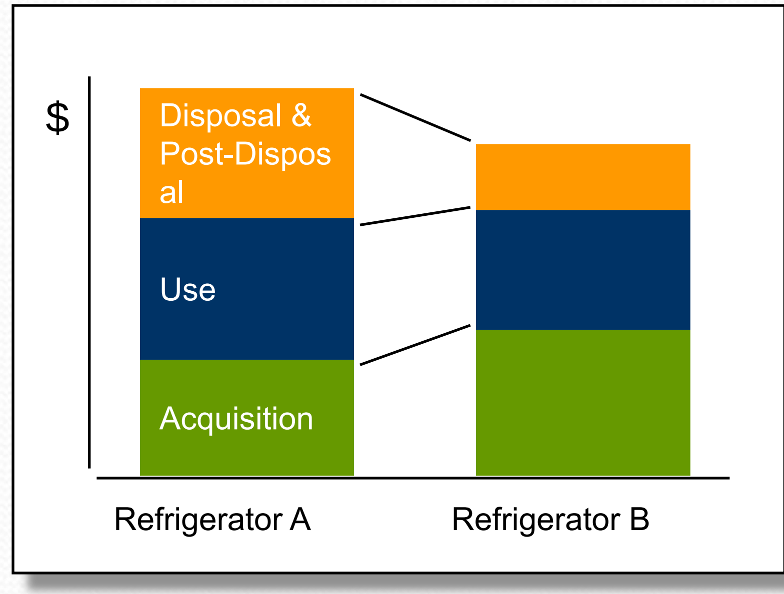






Life-cycle – identify issues and costs





Purchase Price

Refrigerator A appears cheaper

Price + Life-Cycle Costs

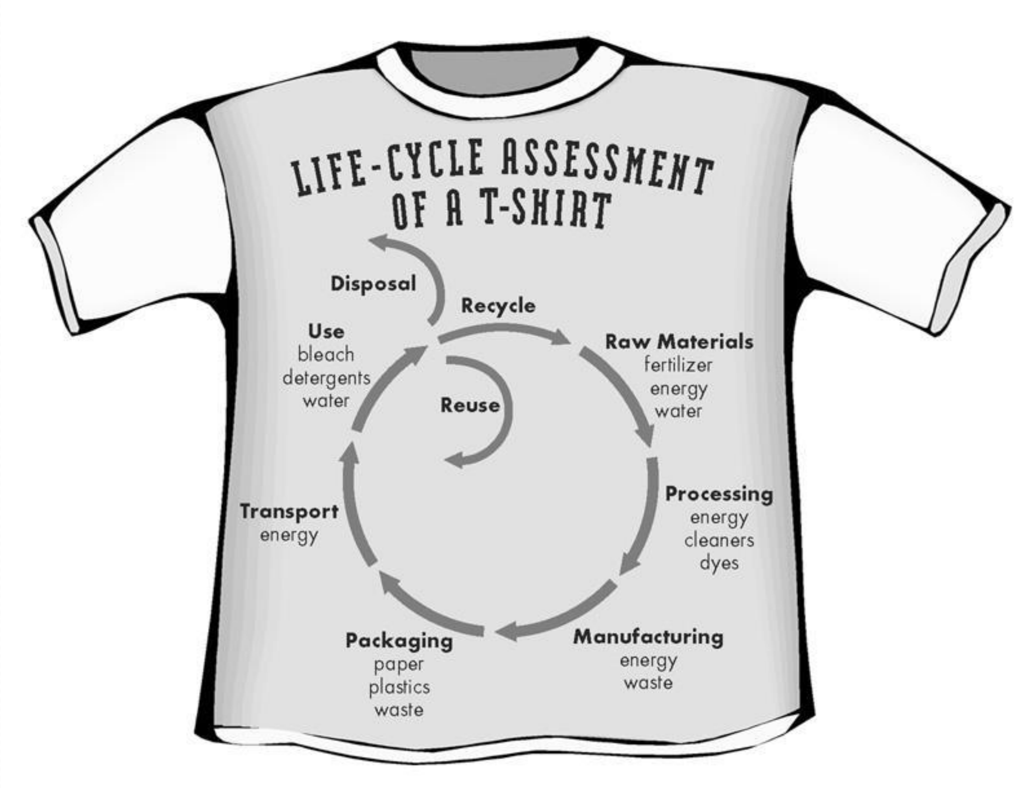
Refrigerator B costs less overall

A life-cycle approach

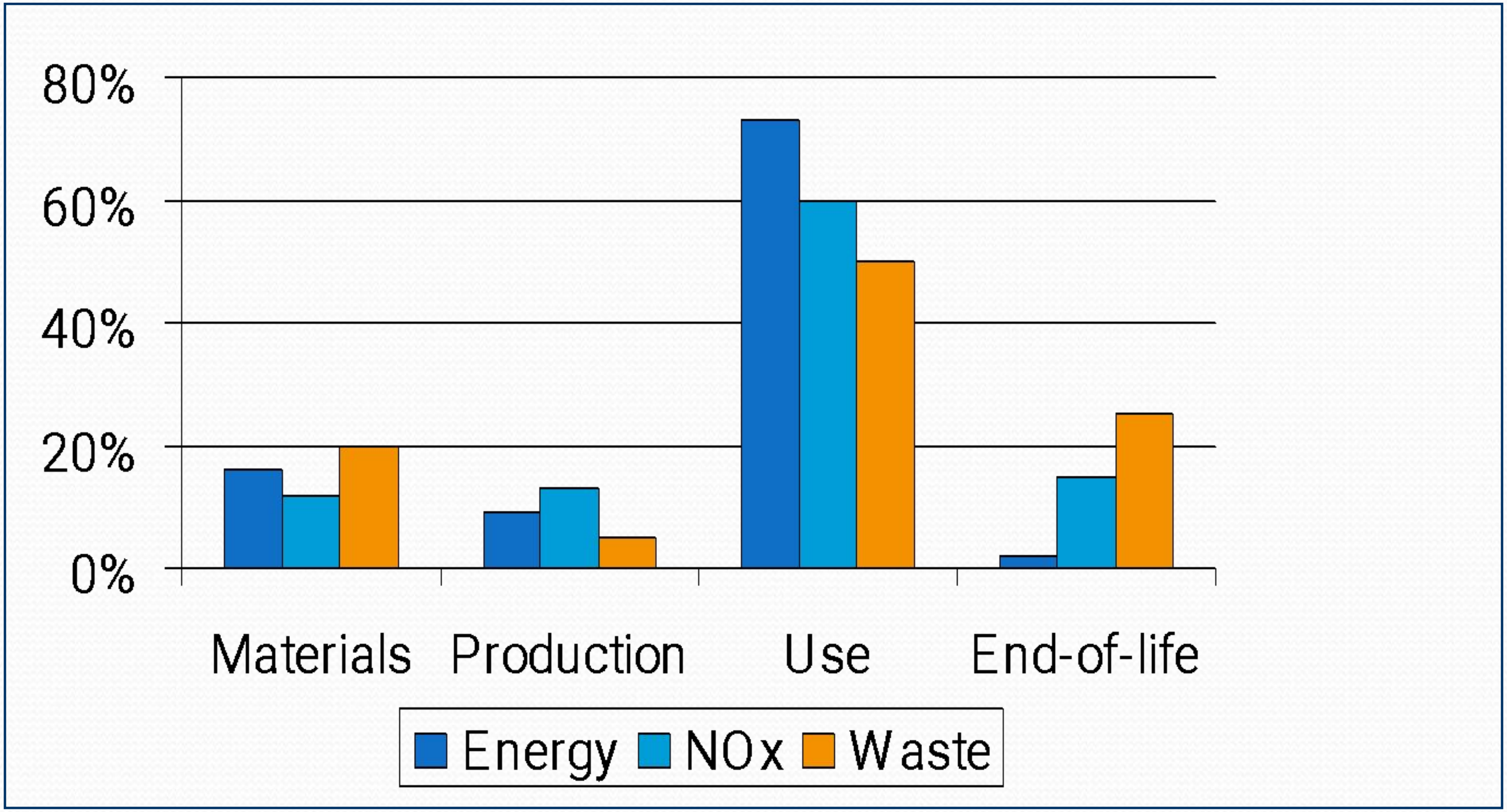
- With a life-cycle approach, companies employ the tools they need to:
  - Reduce impacts across the life-cycle
  - Capitalize on opportunities for their business
- Tools range from simple mapping of life-cycle stages to comprehensive quantitative assessments

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

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

* www.ciwmb.ca.gov/EPP/LifeCycle/default.htm

why take a life-cycle approach?

- Systems perspective
- 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:

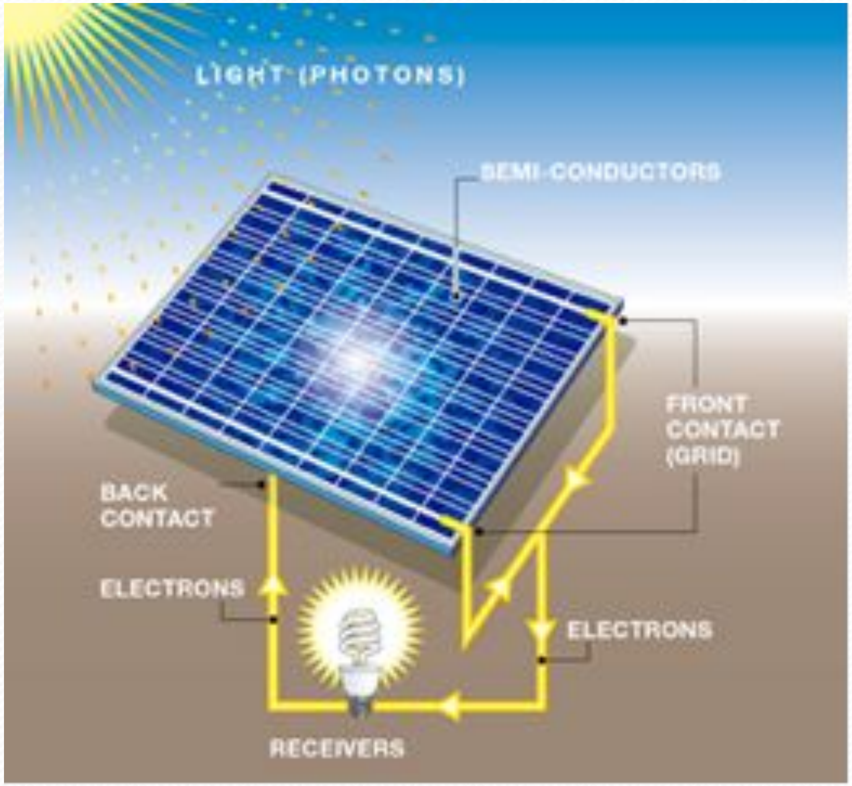
- To give the company an overview of the environmental impacts internally, which gives the company foundation for making environmental improvements and thereby decreasing their environmental impacts.
- To put pressure on the company's suppliers to make more environmentally friendly raw materials.
- In 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)

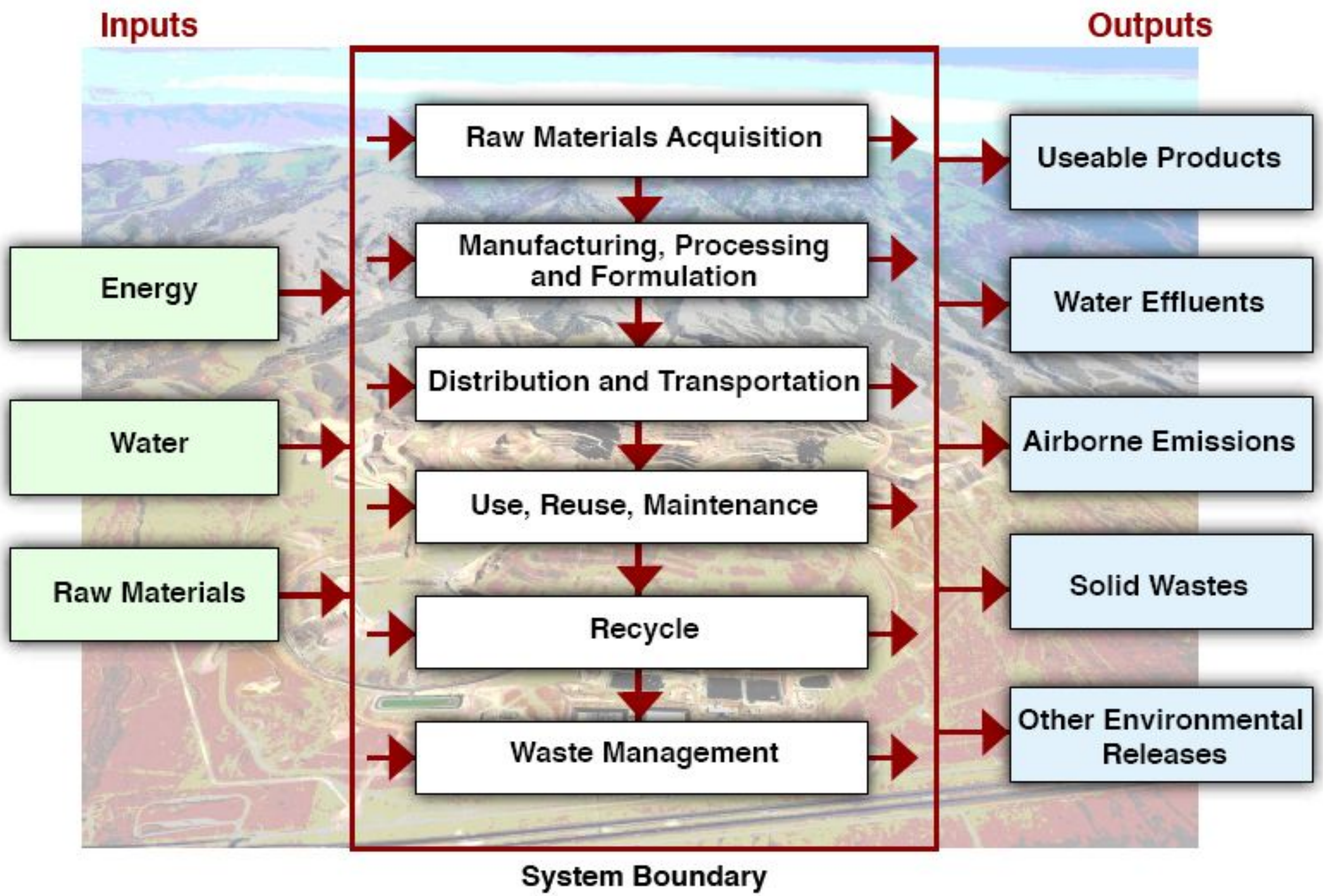
Traditional evaluations only consider the “use” phase of life

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

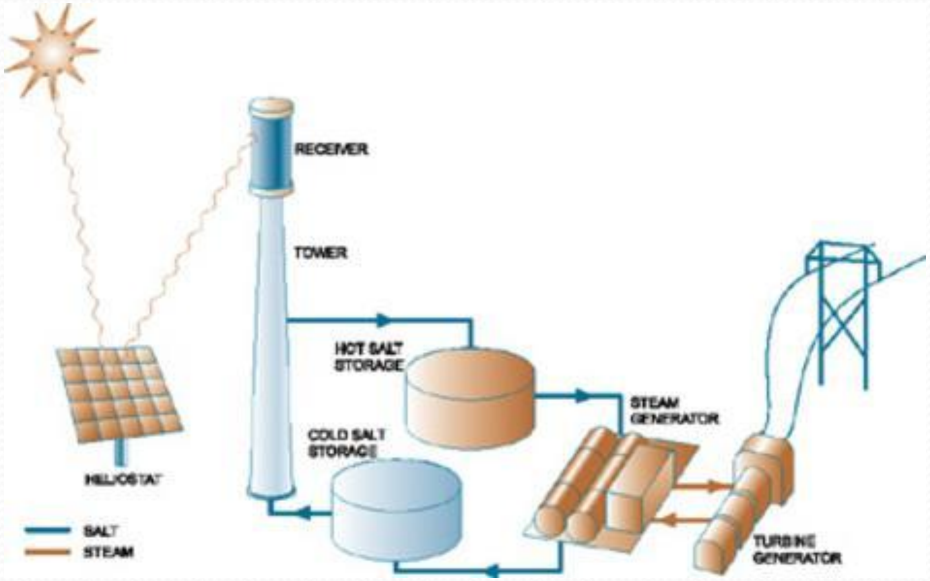
No well-established PV recycling program

Module Type	Types of Potential Hazards
Crystalline-silicon (x-Si)	HF acid burns SiH_4 fires/explosions Pb solder/module disposal
Amorphous-silicon (α-Si)	SiH_4 fires/explosions
Cadmium Telluride (CdTe)	Cd toxicity, carcinogenicity Module disposal
Copper Indium Diselenide (CIS) Copper Indium Gallium Diselenide (CGS)	H_2Se toxicity Module disposal
Gallium Arsenide (GaAs)	AsH_3 toxicity As carcinogenicity H_2 flammability Module disposal

Source: Brookhaven National Laboratory

Life Cycle Analysis – Concentrating Solar Power (CSP)

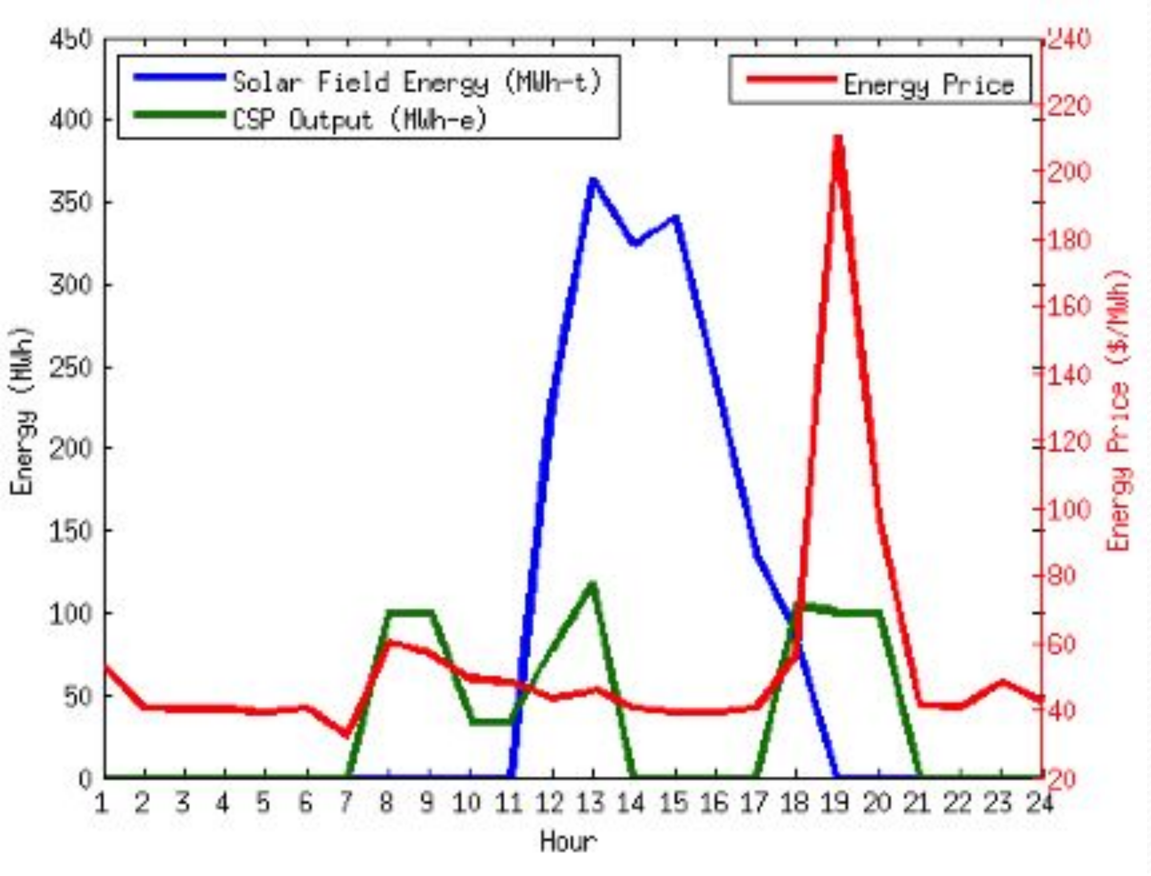
- Composed mainly of common metals, glass, concrete, and HTF
- Thermal hazard
- Requires higher intensity solar radiation than PV
- Allows for integrated energy storage



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 …