Fundamentals of Sustainable Waste Management Part 1

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Business As Usual Is Not An Option

Business As Usual Is Not An Option

For 20 years or more we have recognized that the way we do business has serious impacts on **the world around us**.
Now it is increasingly clear that the state of the world around us **affects the way we do business.**

Business As Usual Is Not An Option

We present a system of ten sustainability megaforces that will impact each and every business over the next 20 years.

Our report shows that global megaforces are likely to bring significant threats and opportunities.

Global Sustainability Megaforces

- Climate Change
- Energy & Fuel
- Material Resource Scarcity
- Water Scarcity
- Population Growth
- Wealth
- Urbanization
- Food Security
- Ecosystem Decline
- Deforestation

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Global Sustainability Megaforces

Climate Change

Energy & Fuel

Material Resource Scarcity

Water Scarcity

Population Growth

Wealth

Urbanization

Food Security

Ecosystem Decline

Deforestation

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Fundamentals of Sustainable Waste Management

What If…?

- …landfill airspace & tipping fees became unimportant?
- …disposers became managers of…?
  - valuable materials
  - energy sources
  - beautiful lands
- …your facilities were welcomed by the community?

Fundamentals of Sustainable Waste Management

Course Objective:

To equip you with understanding, strategies and decision making tools for advancing toward sustainable waste management.

Fundamentals of Sustainable Waste Management

Outline:

Part 1

I. Sustainability Principles

II. Waste Management Hierarchy

Application: Framework for Change

Part 2

III. Evaluation Tools

IV. Case Studies

Application: Elements of Successful Projects

I. Sustainability Principles

I. Sustainability Principles
Section Objective

To provide a conceptual level overview of sustainability as it relates to waste management with emphasis on flow of energy and materials.

This will include touching on economics, which is defined as the study of how societies manage resources to satisfy people's wants and needs.

"When I am working on a problem, I never think about beauty..... but when I have finished, if the solution is not beautiful, I know it is wrong." Richard Buckminster Fuller

I. Sustainability Principles
"Sustainable" and "Waste" Defined

Sustainable:

- An activity is sustainable if it can be continued indefinitely.
- If an activity consumes resources faster than they can be replenished or produces wastes faster than they can be assimilated then it's not sustainable. Eventually the resources are depleted or the wastes accumulate to such a degree that the activity must stop.

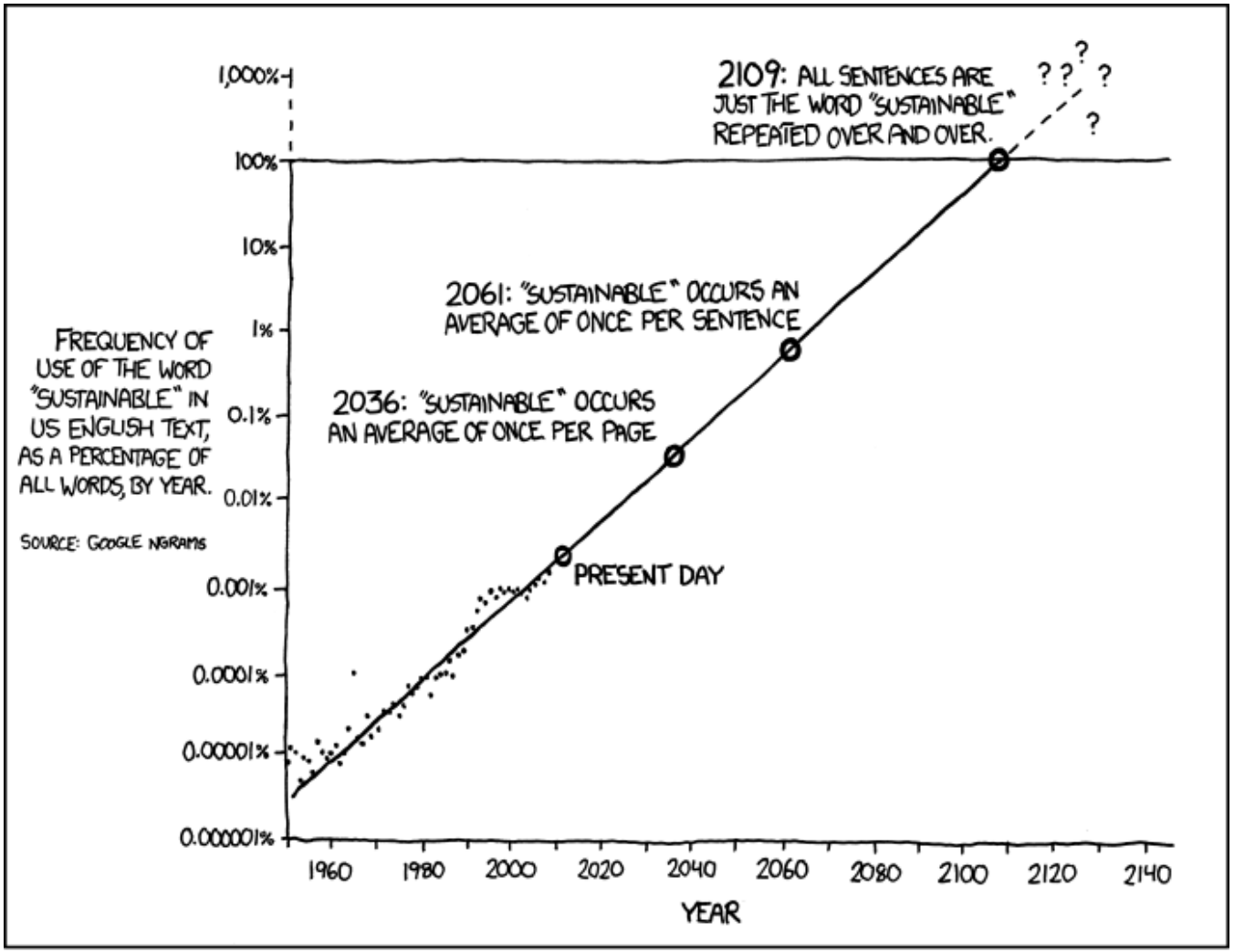
I. Sustainability Principles
"Sustainable" and "Waste" Defined

Sustainable Development:

- The result of sustainability is the continued prosperity of all living things. (AIA)
- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Brundtland Commission Report, UN, 1987)

I. Sustainability Principles

"Sustainable" and "Waste" Defined



I. Sustainability Principles
"Sustainable" and "Waste" Defined

Pitfalls on the Road to Sustainability:

- "Being nicer to the planet" without grasping the consequences of continued unsustainable activity.
- Attempting to apply solutions without understanding the scope and extent of the problems.
- Stacking up "green" features without understanding relationships between them.

A systems approach is needed.

I. Sustainability Principles
"Sustainable" and "Waste" Defined

Waste (n.):

- Material that is not wanted; the unusable remains or byproducts of something.

- **Waste is what's left when you run out of imagination.**

Zero Waste

- The ideal solution to the waste problem is of course to produce no waste.
- A laudable goal that we can and should make great progress toward, but…
- Absolute zero waste is not achievable
  - Losses occur

I. Sustainability Principles
Sustainable Waste Management

Goals of Waste Management (in general)

- Protect human health and the environment
- Conserve resources (materials, energy, land, water, air)

An Additional Goal for Sustainable Waste Management

- Manage waste materials in a way that does not leave any burden for neighbors and future generations.

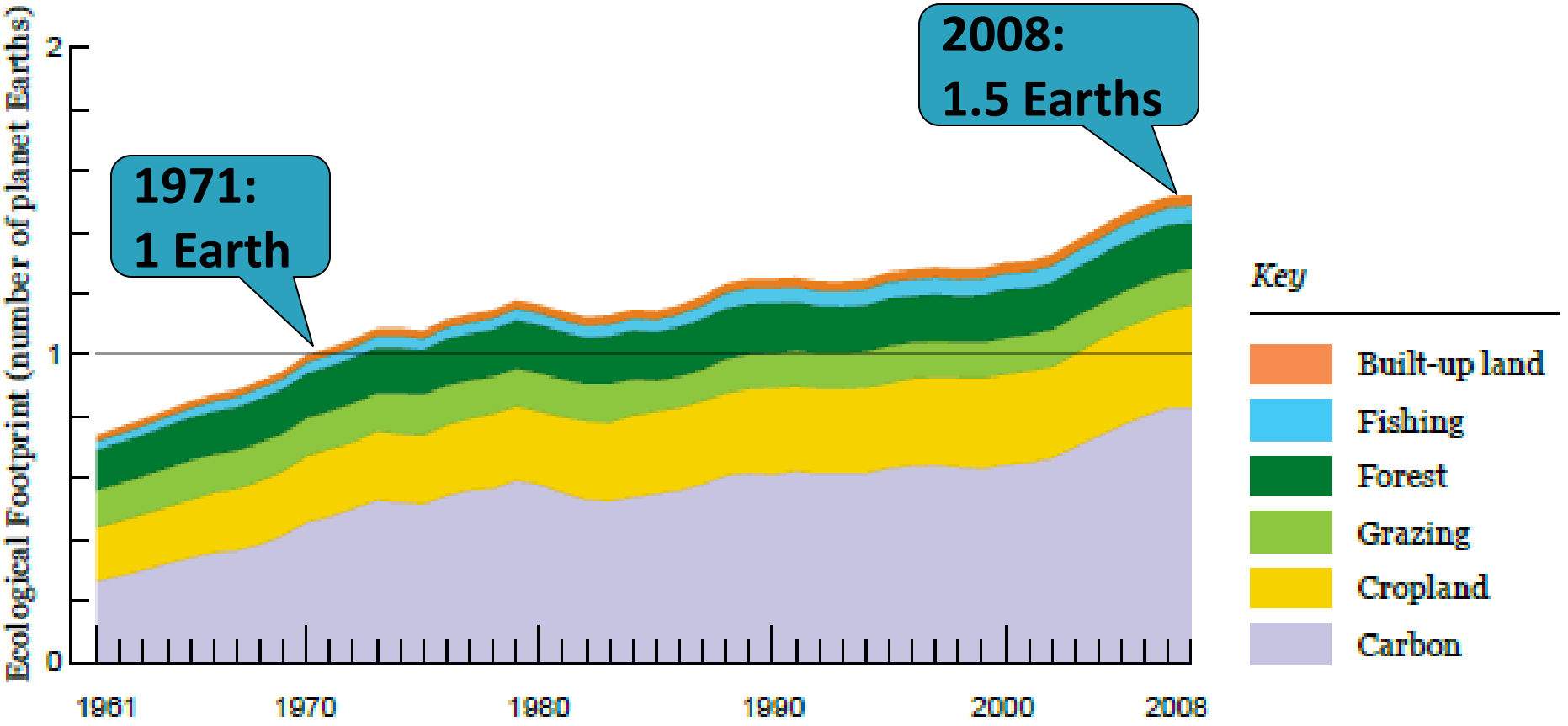
  (Brunner, 2013)

Ecological Footprint (Wackernagel, 1996)

- The area of land and ocean that would be required to support a person's lifestyle and assimilate the resulting wastes.
- How does the total ecological footprint of the human population compare to the available land and ocean area on Earth?

I. Sustainability Principles

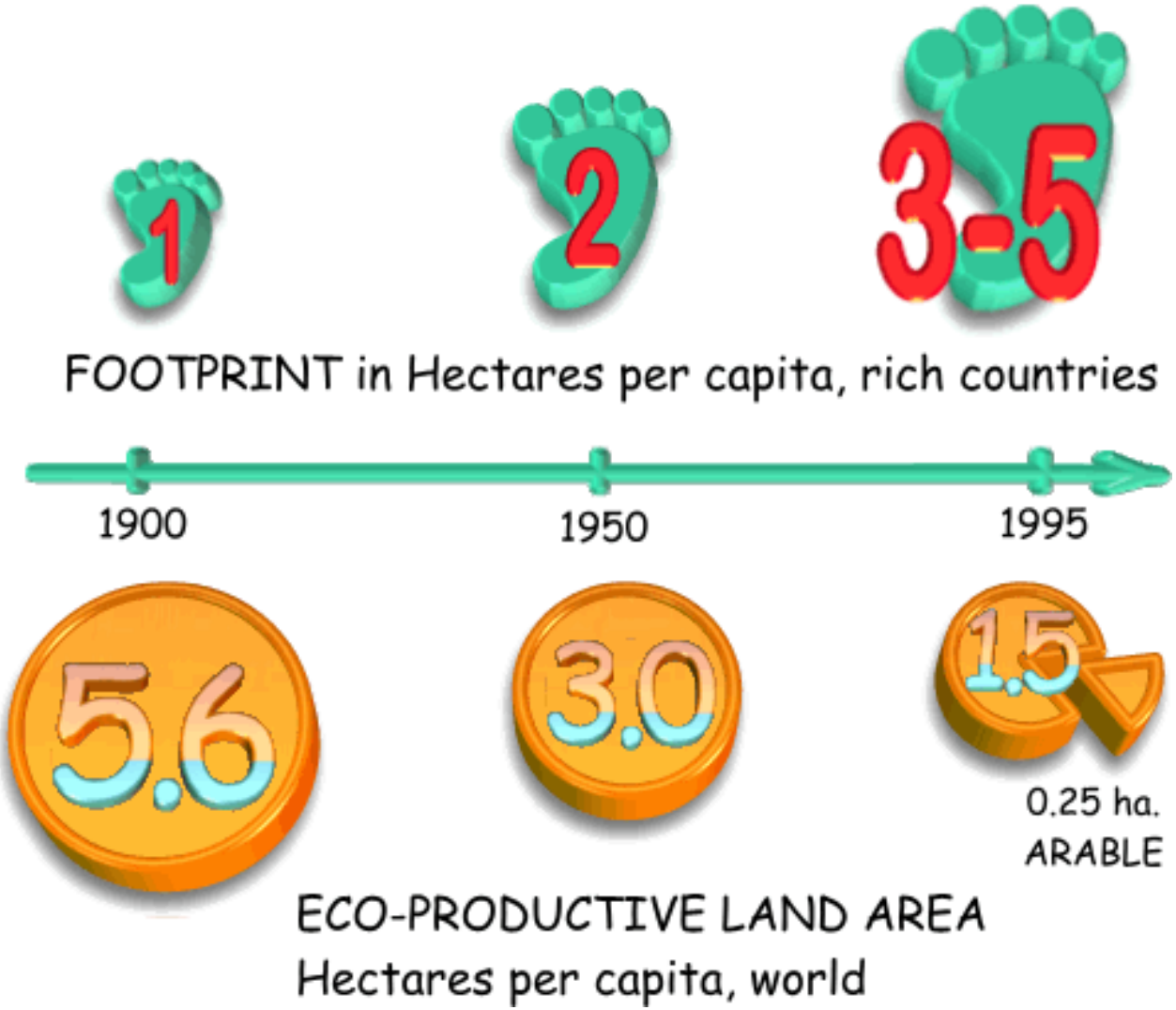
Ecological Footprint



Source: WWF Living Planet Report 2012

I. Sustainability Principles

Ecological Footprint

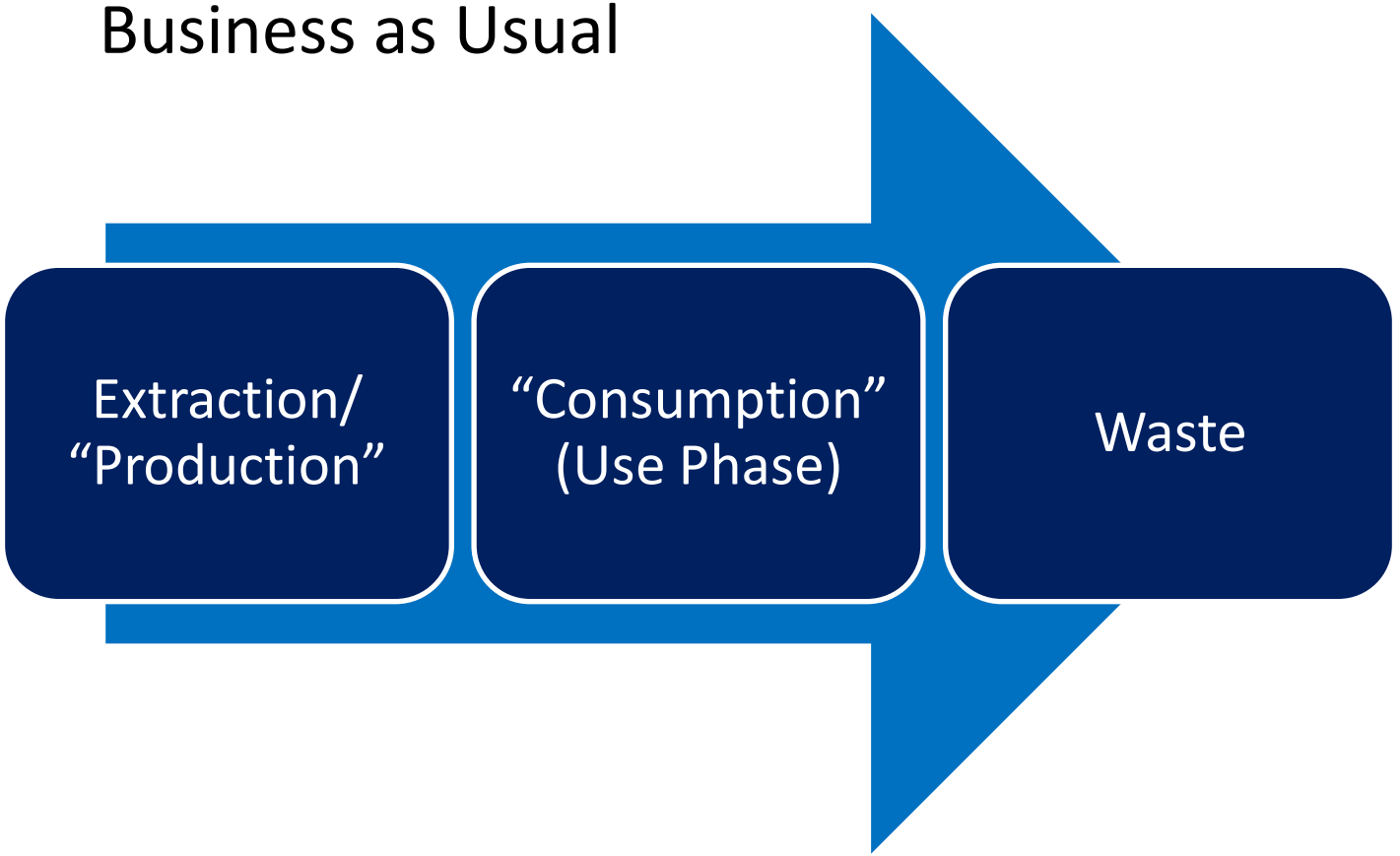


I. Sustainability Principles

Cradle-to-Grave Linear Process

Business as Usual

Sources



Sinks

I. Sustainability Principles
Cradle-to-Grave Linear Process

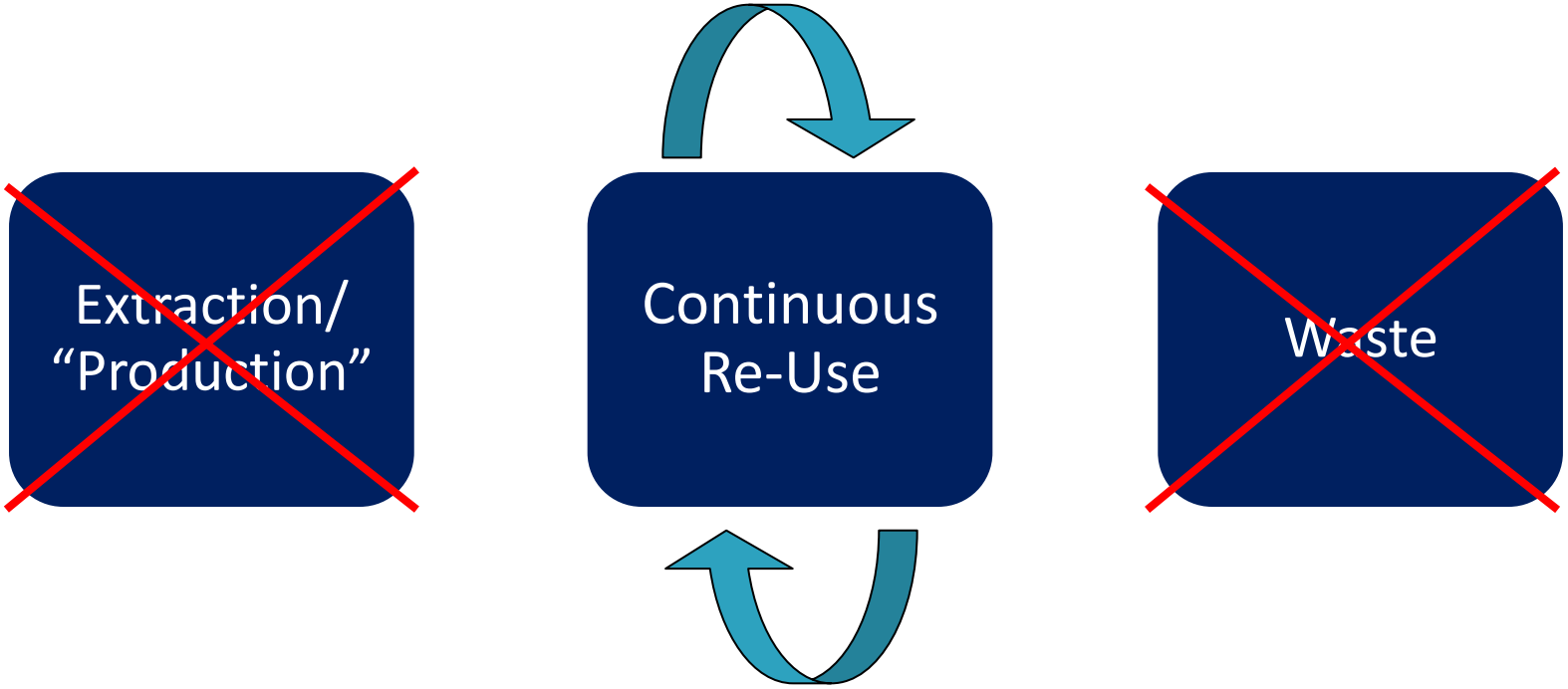
- One half to three quarters of annual resource inputs to industrial economies are returned to the environment as wastes within a year.

Source: Matthews et al., “The Weight of Nations,” World Resources Institute, 2000.

I. Sustainability Principles

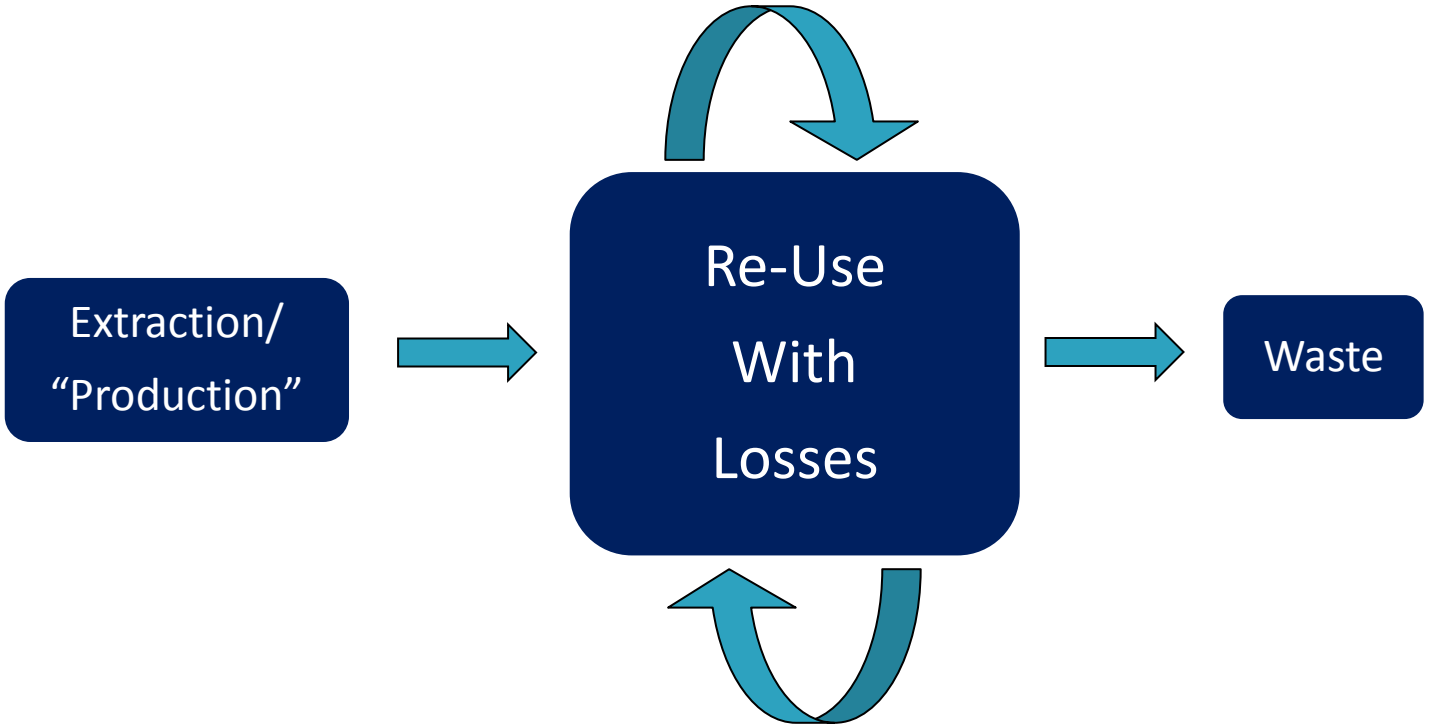
Cradle-to-Cradle Circular Process

The Zero Waste Ideal



I. Sustainability Principles

Achievable Low Waste Process

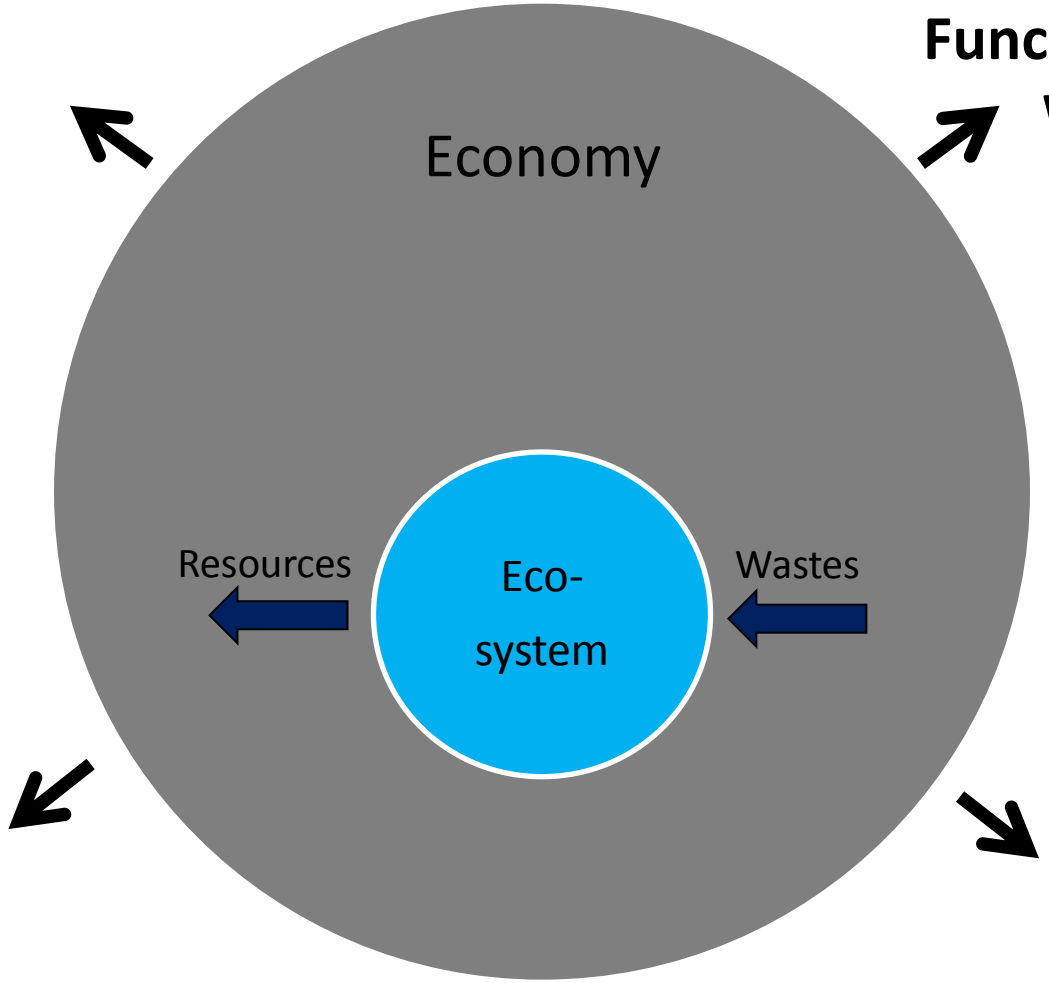


I. Sustainability Principles
Material Flow Concepts

- Industrial Ecology: Locating various industrial activities close together to achieve efficiencies of material and energy through…
- Byproduct Synergy: Using the “waste” or byproduct output of one process as a valuable input to another process, achieving a synergy.

I. Sustainability Principles

Economics



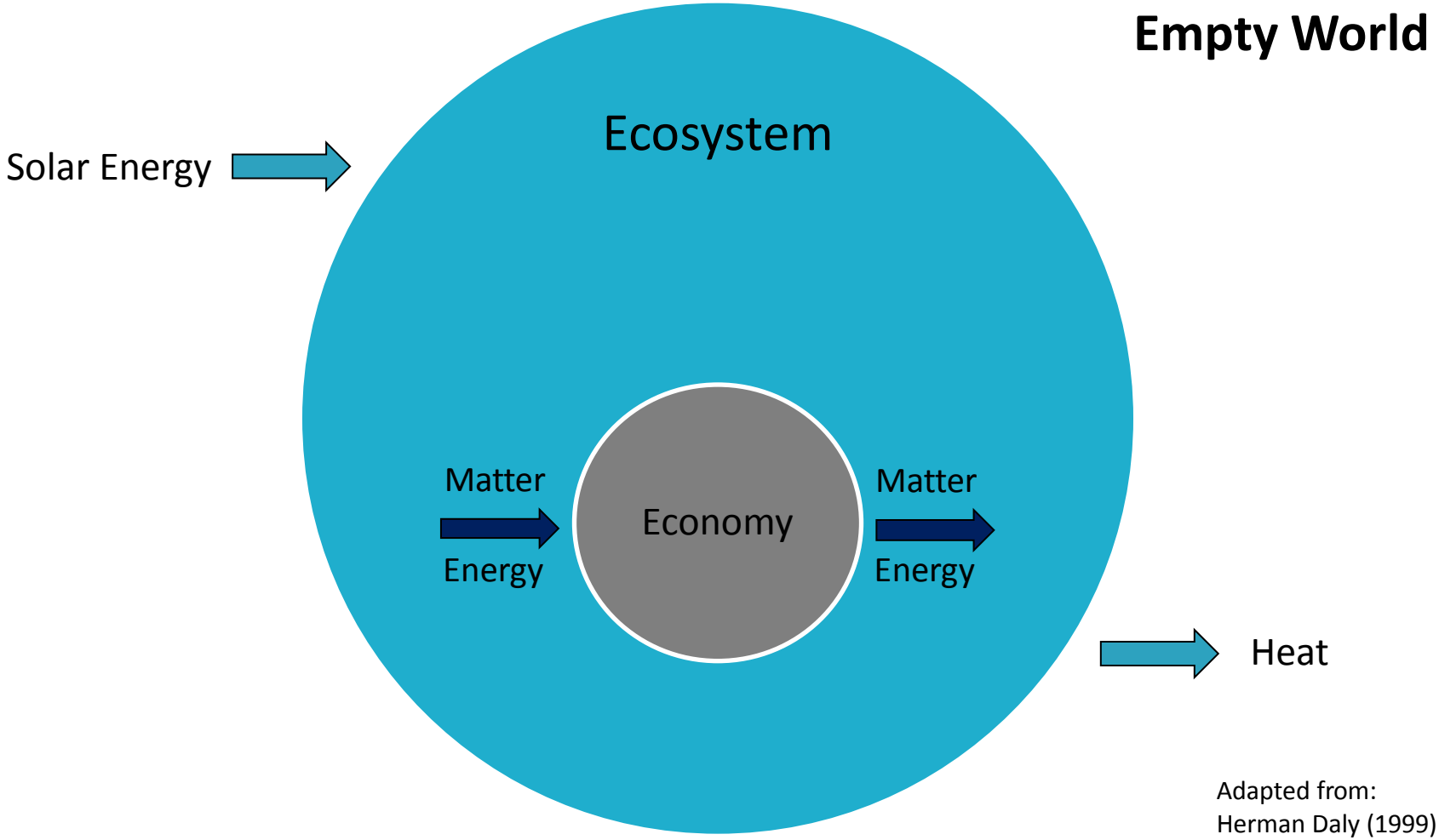
Functional Economic World View

Adapted from:
Herman Daly (1999)

I. Sustainability Principles

Economics

Empty World



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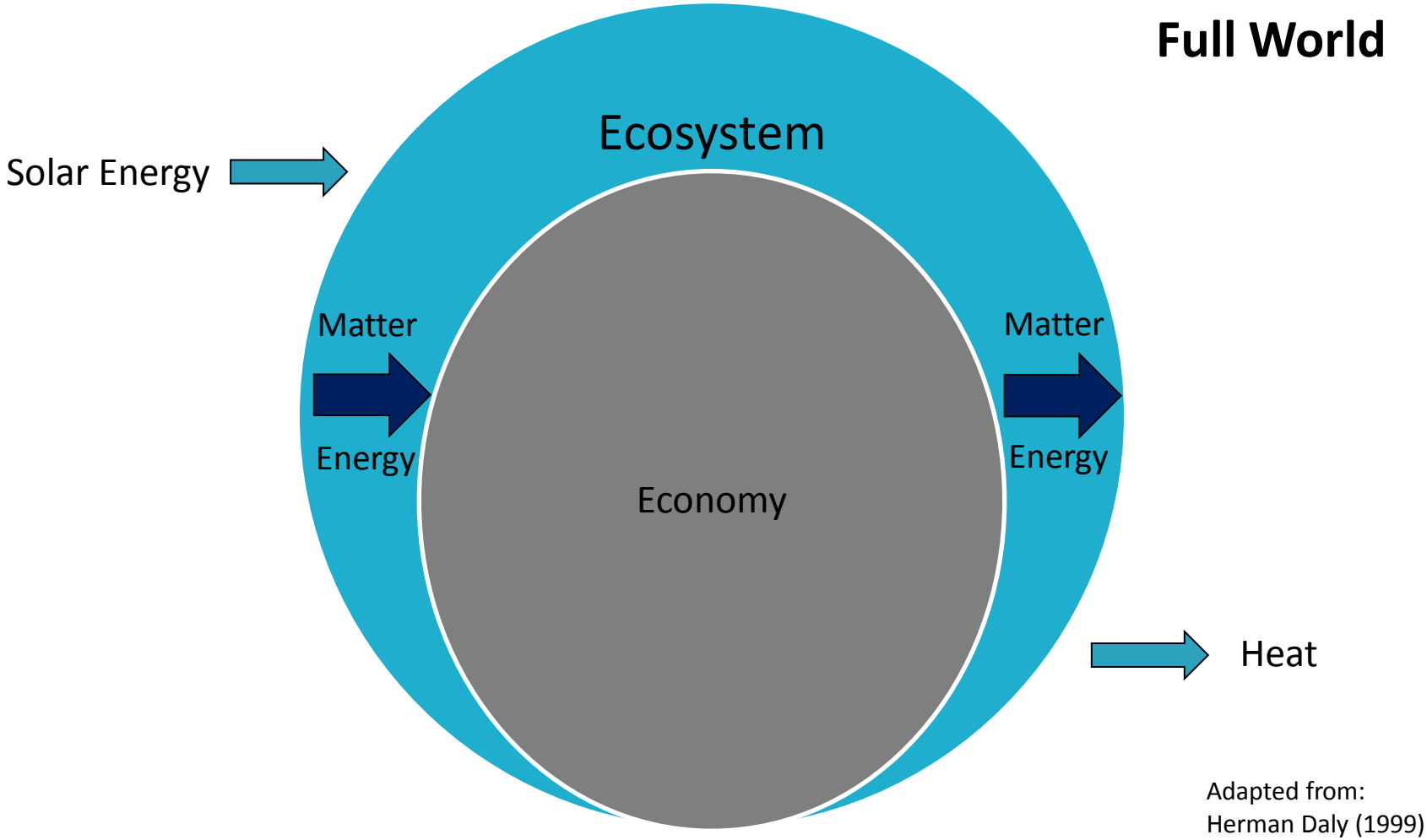
I. Sustainability Principles

Economics



Adapted from:
Herman Daly (1999)

I. Sustainability Principles

Economics

Uneconomic Growth

- Growth of the economy can be economic growth (producing net benefit) or uneconomic growth (depleting natural capital and producing net detriment). (Daly 2005)

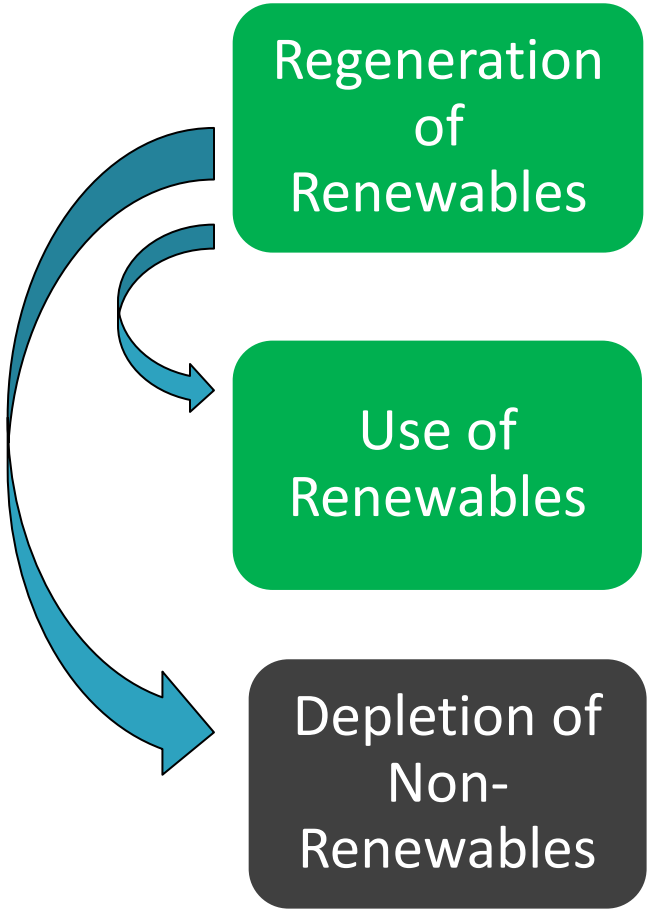
I. Sustainability Principles
Sustainable Material and Energy Flows

Herman Daly's Conditions for Sustainability:

- Renewable resources such as fish, soil, and groundwater must be used no faster than the rate at which they are regenerated by the ecosystem.
- Nonrenewable resources such as minerals and fossil fuels must be depleted no faster than renewable substitutes for them can be put into place.
- Pollution and wastes must be emitted no faster than natural systems can absorb them, recycle them, or render them harmless.

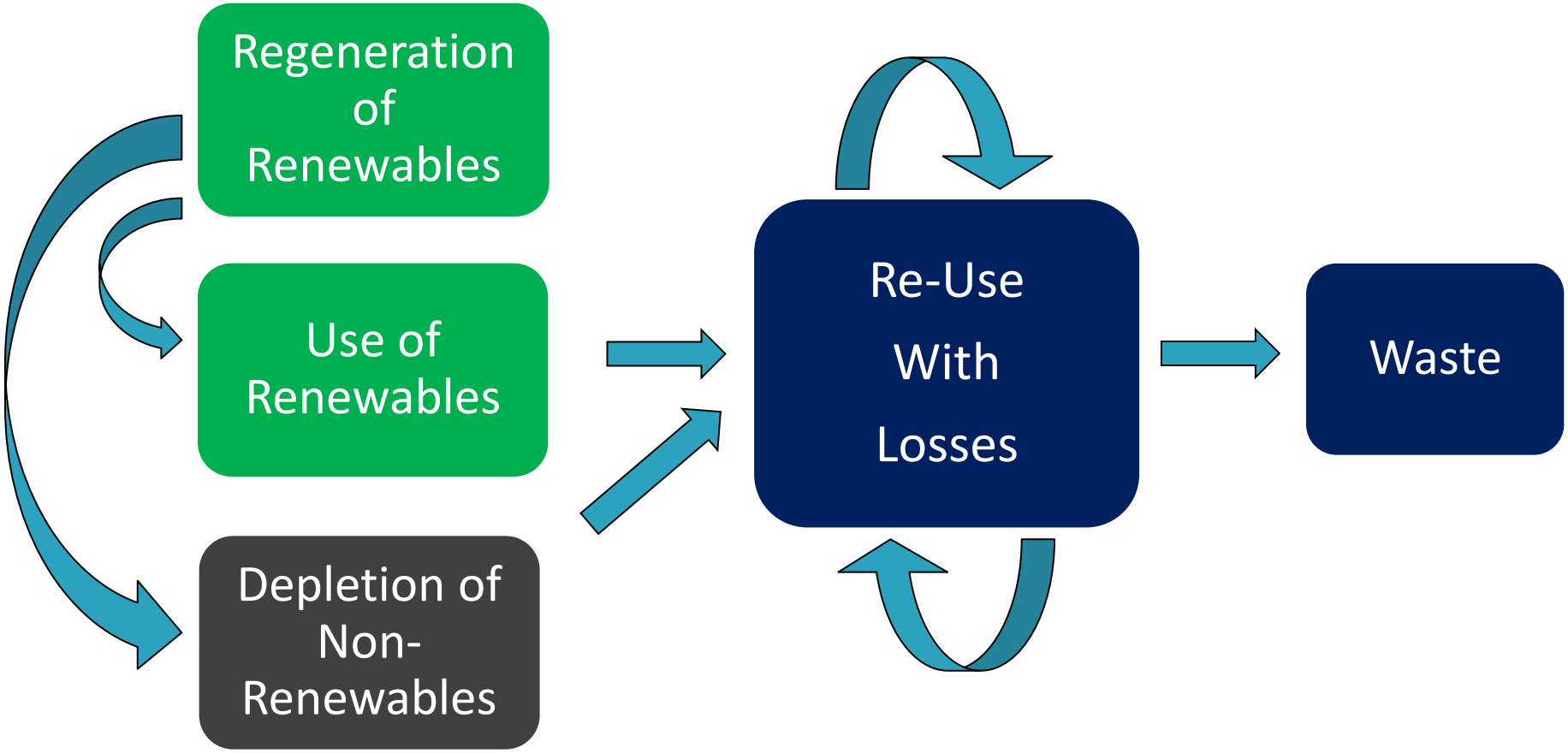
I. Sustainability Principles

Sustainable Material and Energy Flows



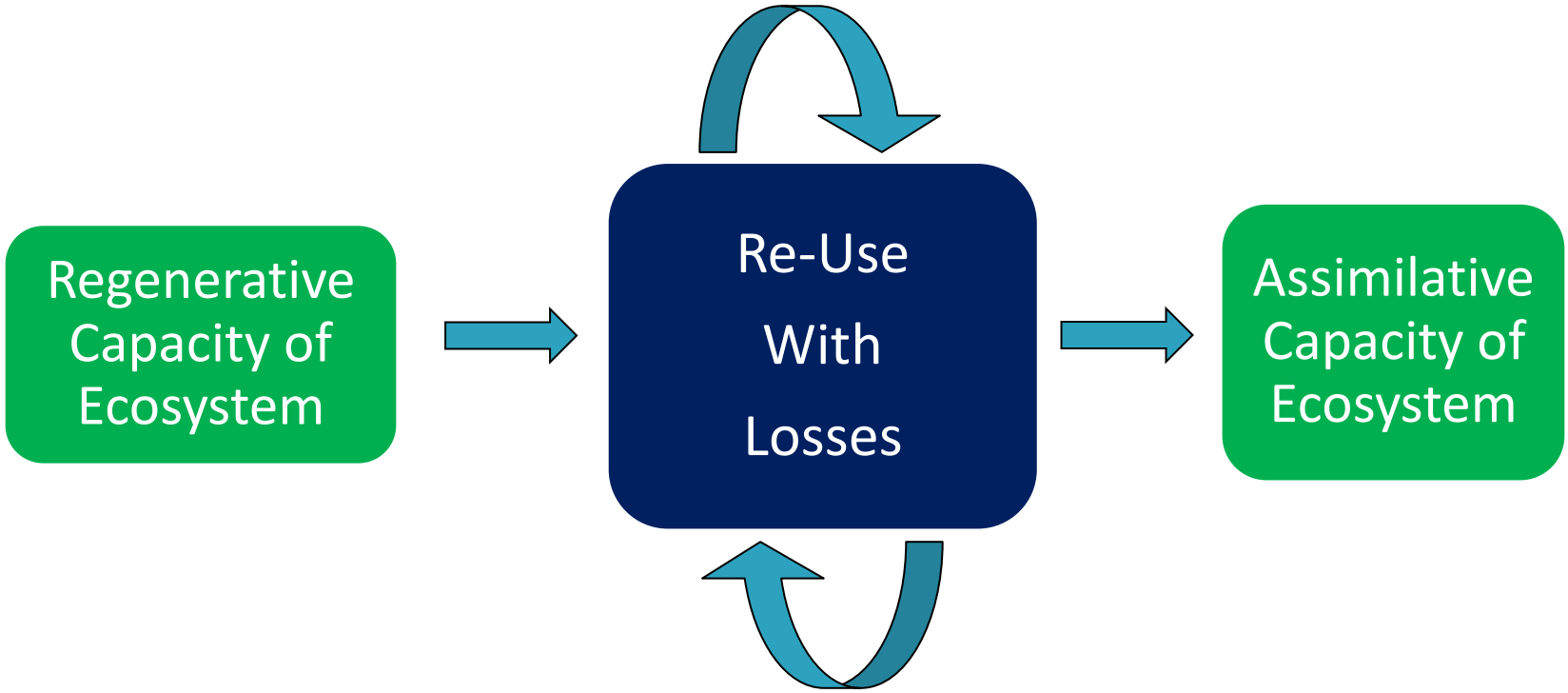
I. Sustainability Principles

Sustainable Material and Energy Flows



I. Sustainability Principles

Sustainable Material and Energy Flows



II. Material Management Hierarchy

- Origin of the concept

II. Material Management Hierarchy

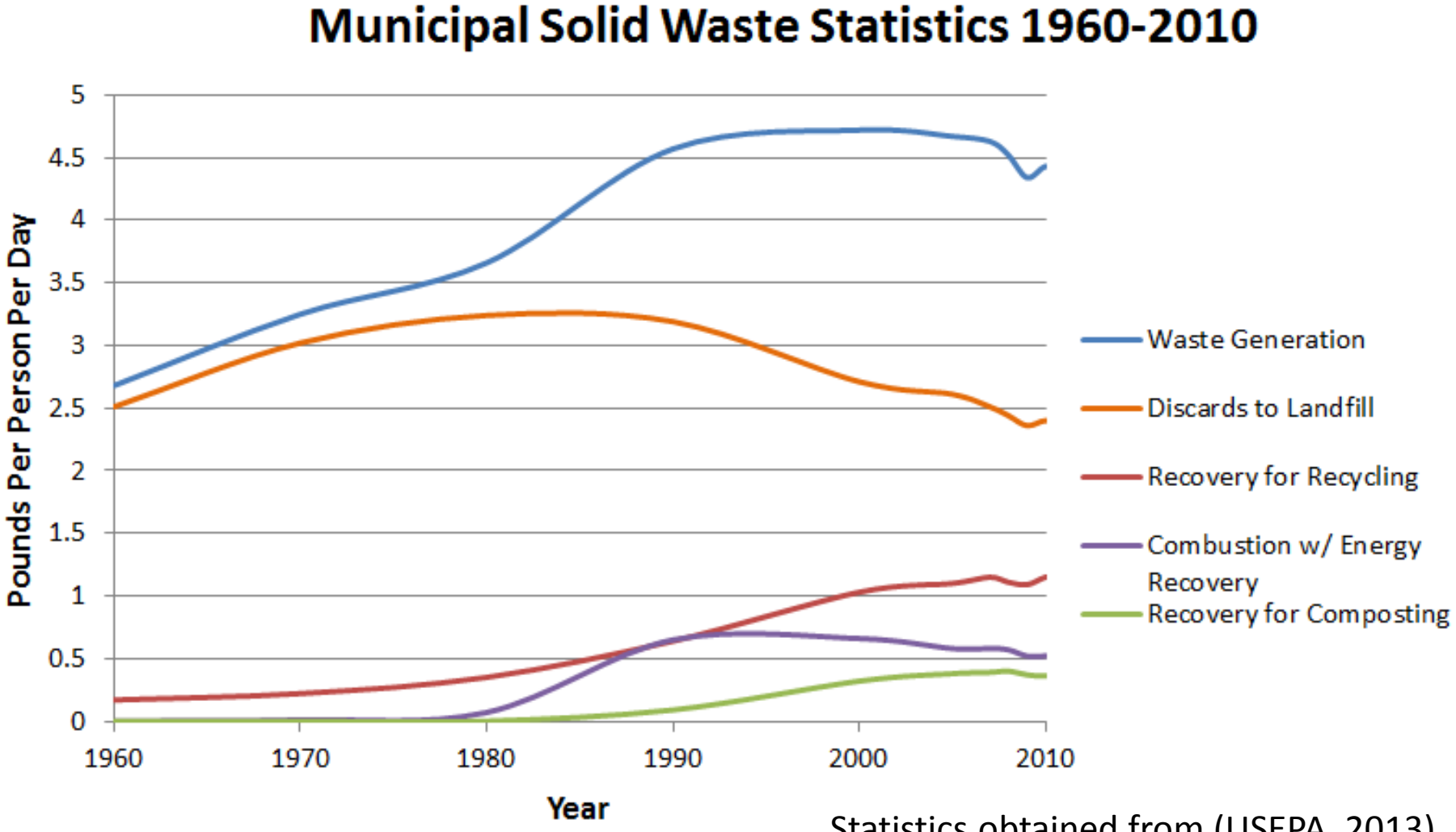
Objectives:

- To present a structure for discussion of material management options.
- To mention a wide variety of available material management options.

"If success or failure of this planet and of human beings depended on how I am and what I do... HOW WOULD I BE? WHAT WOULD I DO?" Richard Buckminster Fuller

II. Material Management Hierarchy

1980s Rapidly Rising Waste Generation



Statistics obtained from (USEPA, 2013).

II. Material Management Hierarchy

Original 1989 USEPA Integrated Waste Management Hierarchy

An Integrated waste management system will contain some or all of the following components:

- Source reduction (including reuse of products)
- Recycling of materials (including composting)
- Waste combustion (with energy recovery)
- Landfilling.

Every community can ''custom-design'' its integrated waste management system to emphasize certain management practices, consistent with the community's demography and waste stream characteristics.

Source: USEPA, *The Solid Waste Dilemma: An Agenda for Action*, February 1989, p. 16.

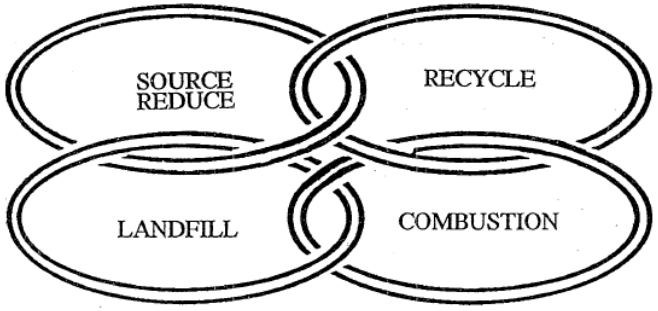
II. Material Management Hierarchy

Original 1989 USEPA Integrated Waste Management Hierarchy

Systems Thinking

II. Material Management Hierarchy

Original 1989 USEPA Integrated Waste Management Hierarchy



In an integrated waste management system, each component is designed so it complements, rather than competes with, the other components in the system. For example, combustors should be designed to handle a volume of waste with a certain Btu value after allowing for the effect of recycling on total waste volume and Btu values. Failure to do this can lead to a situation where materials which would otherwise be recycled are not because they are needed as fuel for the combustor.

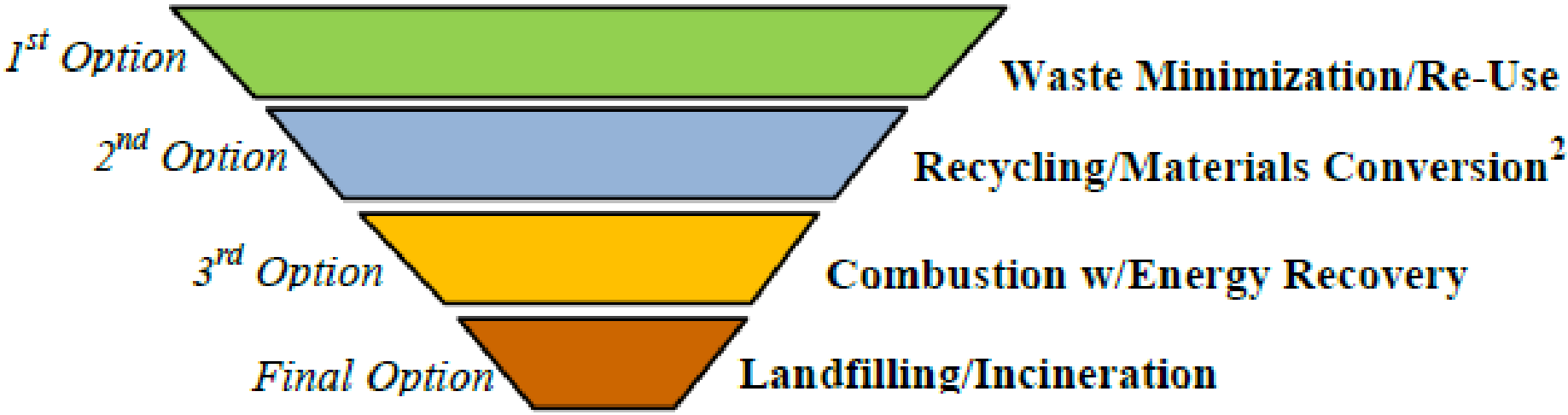
Source: USEPA, *The Solid Waste Dilemma: An Agenda for Action*, February 1989, p. 17.

II. Material Management Hierarchy
Possible Evaluation Criteria

- Social acceptability
- Incentivizing behavior promoting common good
- Reducing greenhouse gas emissions
- Reducing pollutant exposure or toxicity
- Achieving synergistic relationships
- Producing marketable products
- Economic factors
- Total system benefit (economic, environmental, social)

II. Material Management Hierarchy

EREF Management Hierarchy for Discarded Materials[1]



1. This hierarchy does NOT imply a priority or preference in funding research.
2. Materials conversion includes: composting, anaerobic digestion, conversion to biofuels/chemicals, and other technologies or processes that transform waste into useful end products.

II. Material Management Hierarchy
Level 1: Waste Minimization/Re-Use

- Reducing resource requirements
- Finding byproduct synergies
- Reducing product packaging
- Extended producer responsibility
- Re-use
- Deconstruction

II. Material Management Hierarchy

Level 1: Pay-As-You-Throw

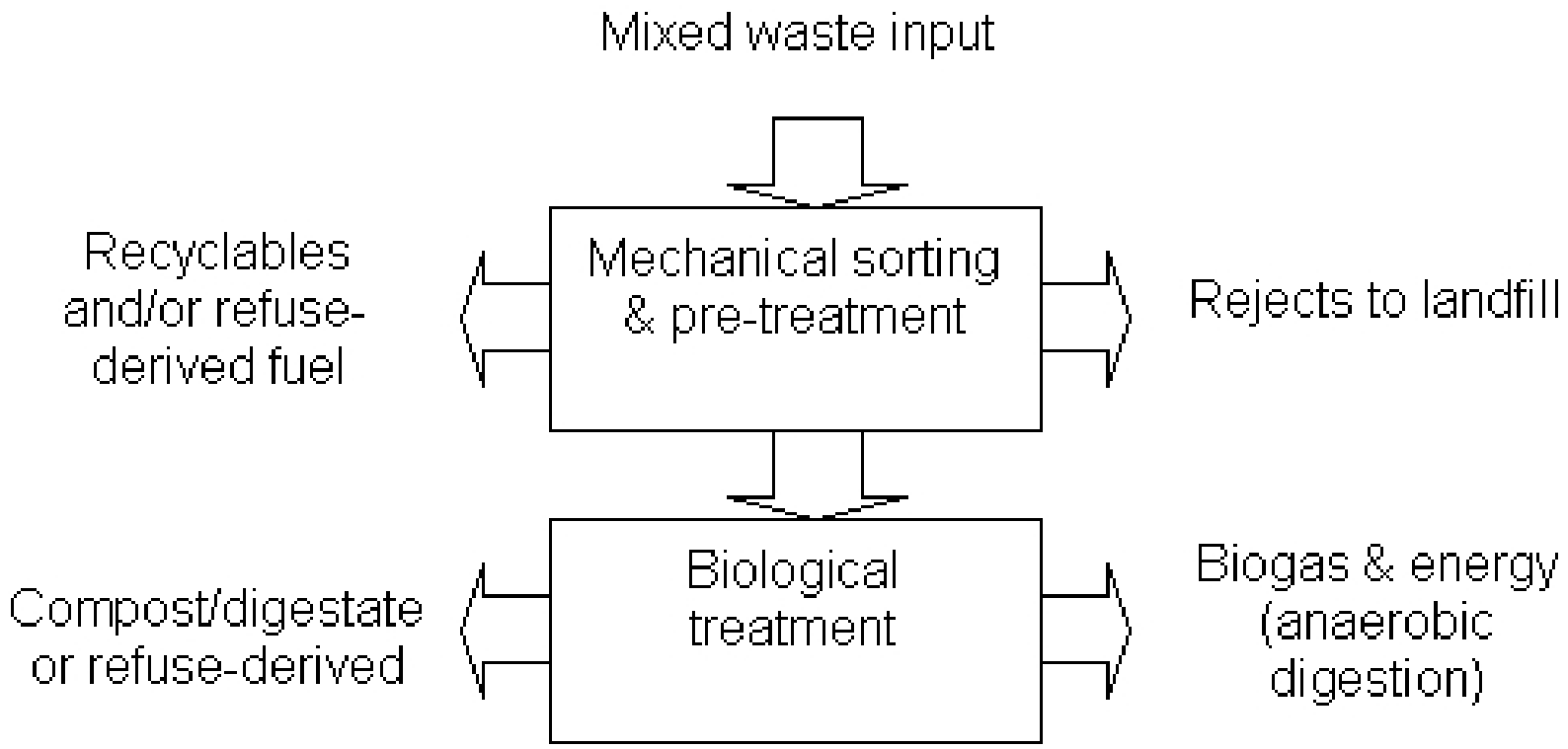
II. Material Management Hierarchy

Current USEPA Waste Management Hierarchy

II. Material Management Hierarchy

Level 2: Materials Recovery Facility

II. Material Management Hierarchy
Level 2: Mechanical Biological Treatment



II. Material Management Hierarchy
Level 2: Composting

II. Material Management Hierarchy

Current USEPA Waste Management Hierarchy

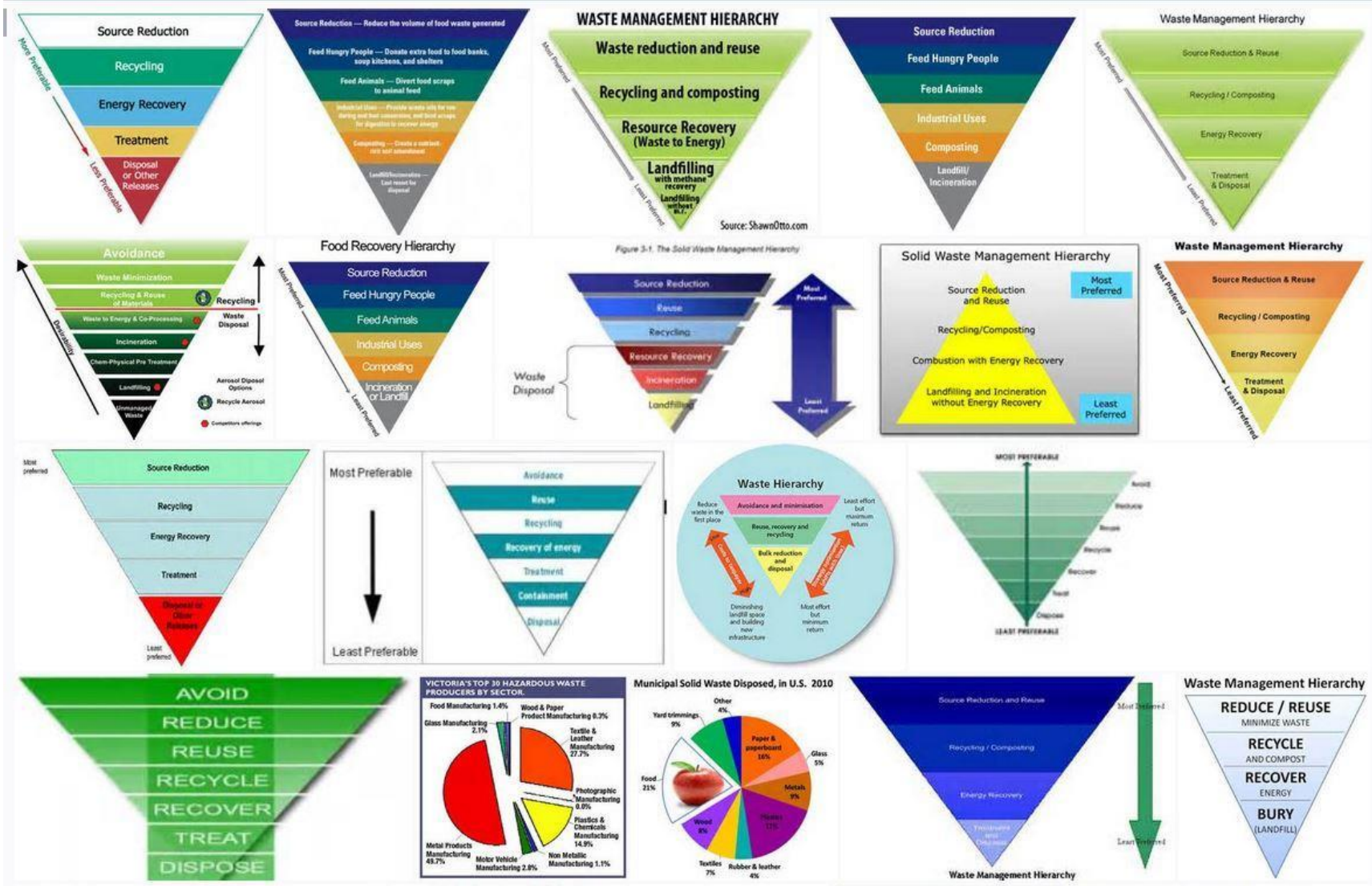
II. Material Management Hierarchy

Optimal Distribution of Materials Across the Levels of the Hierarchy

- Economic efficiency in the waste context is attained when the amount of waste generated and managed at each level of the hierarchy is optimal, that is, the cost of reducing waste by one unit is equal to the economic and environmental benefits of having one less unit of waste. (The Economics of Waste and Waste Policy, UK Department for Environment Food and Rural Affairs (DEFRA), 2011)

II. Material Management Hierarchy

Variations on a Theme

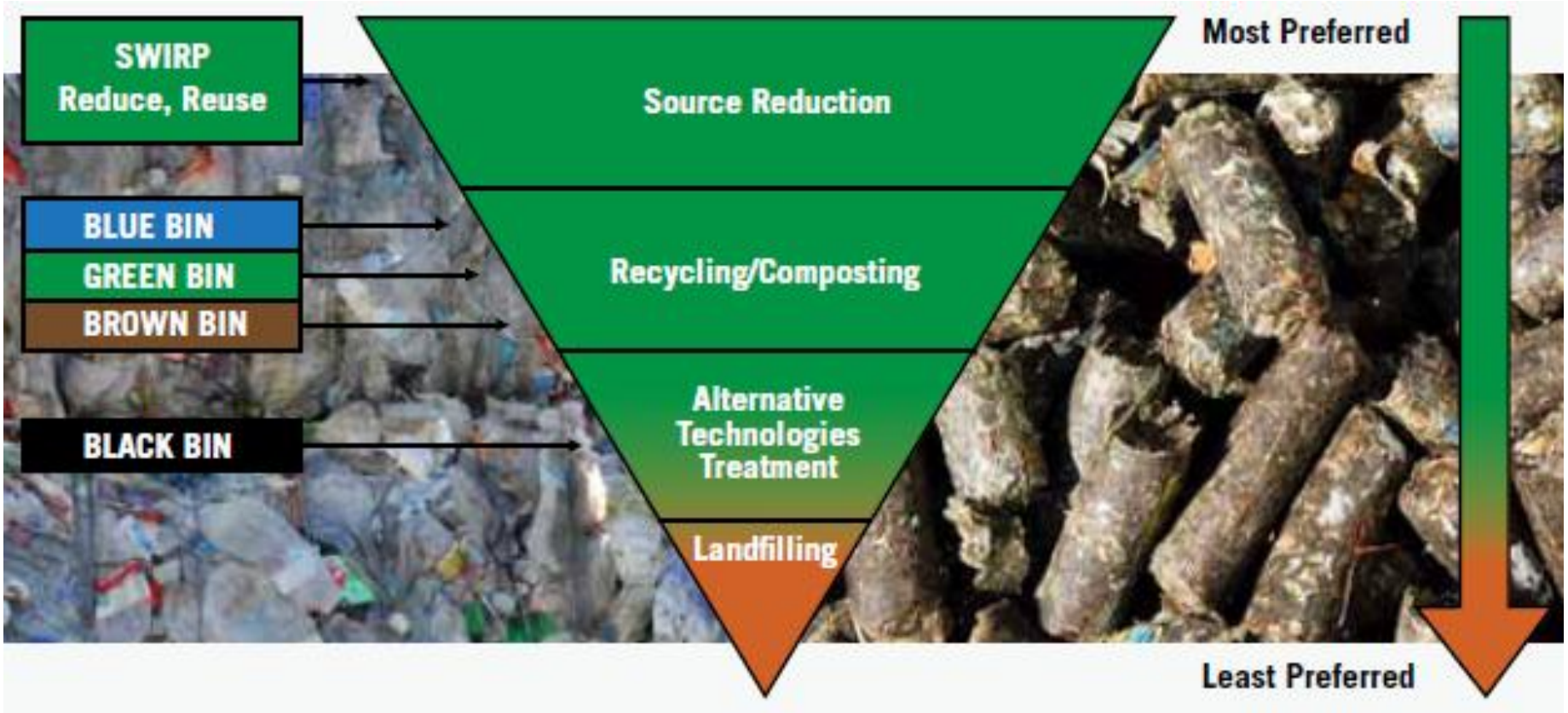


II. Material Management Hierarchy

A Positive Example

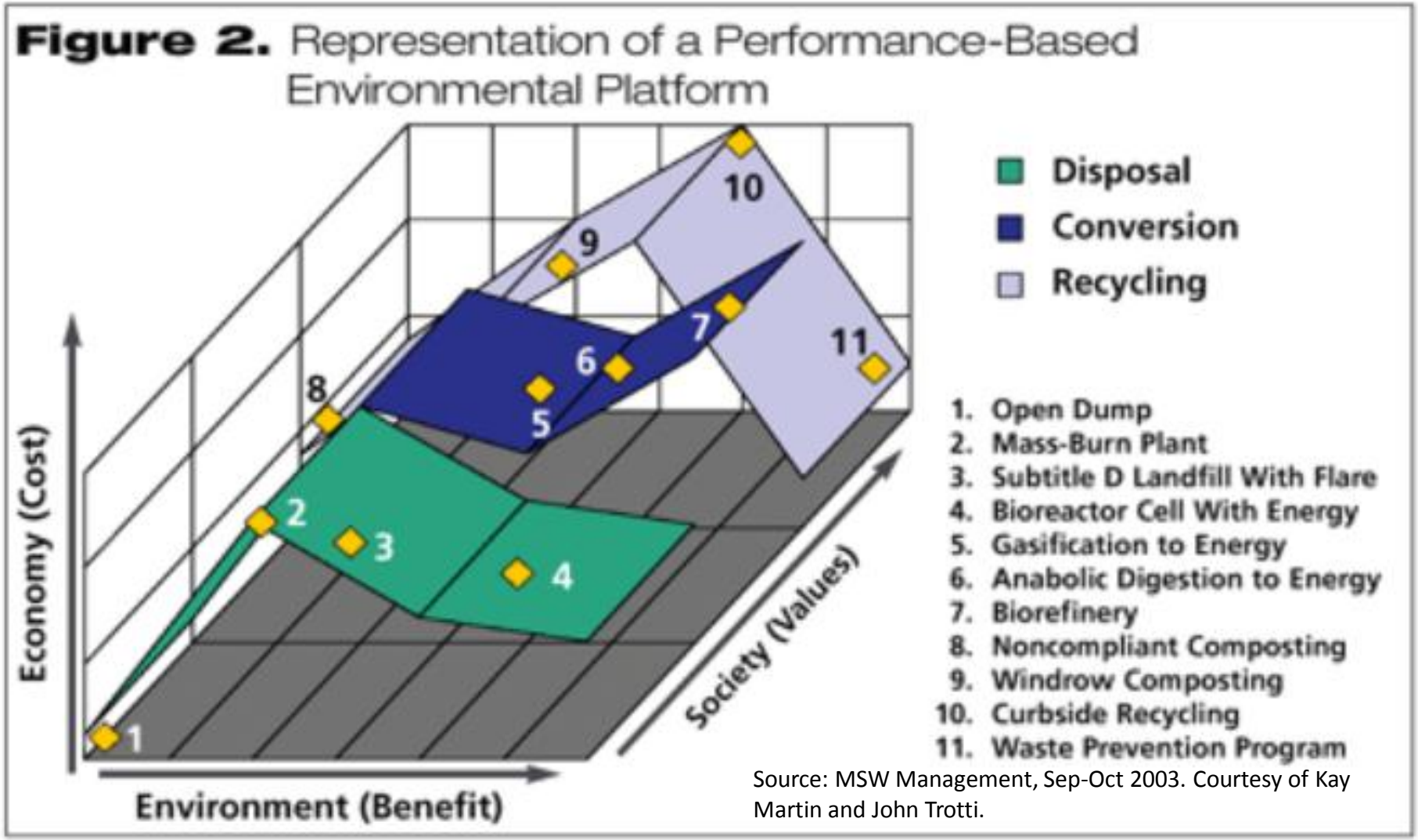
II. Material Management Hierarchy

A Positive Example



Source: City of Los Angeles Zero Waste Progress Report, March 2013, p. 15.

II. Material Management Hierarchy
A Performance-Based Evaluation Concept

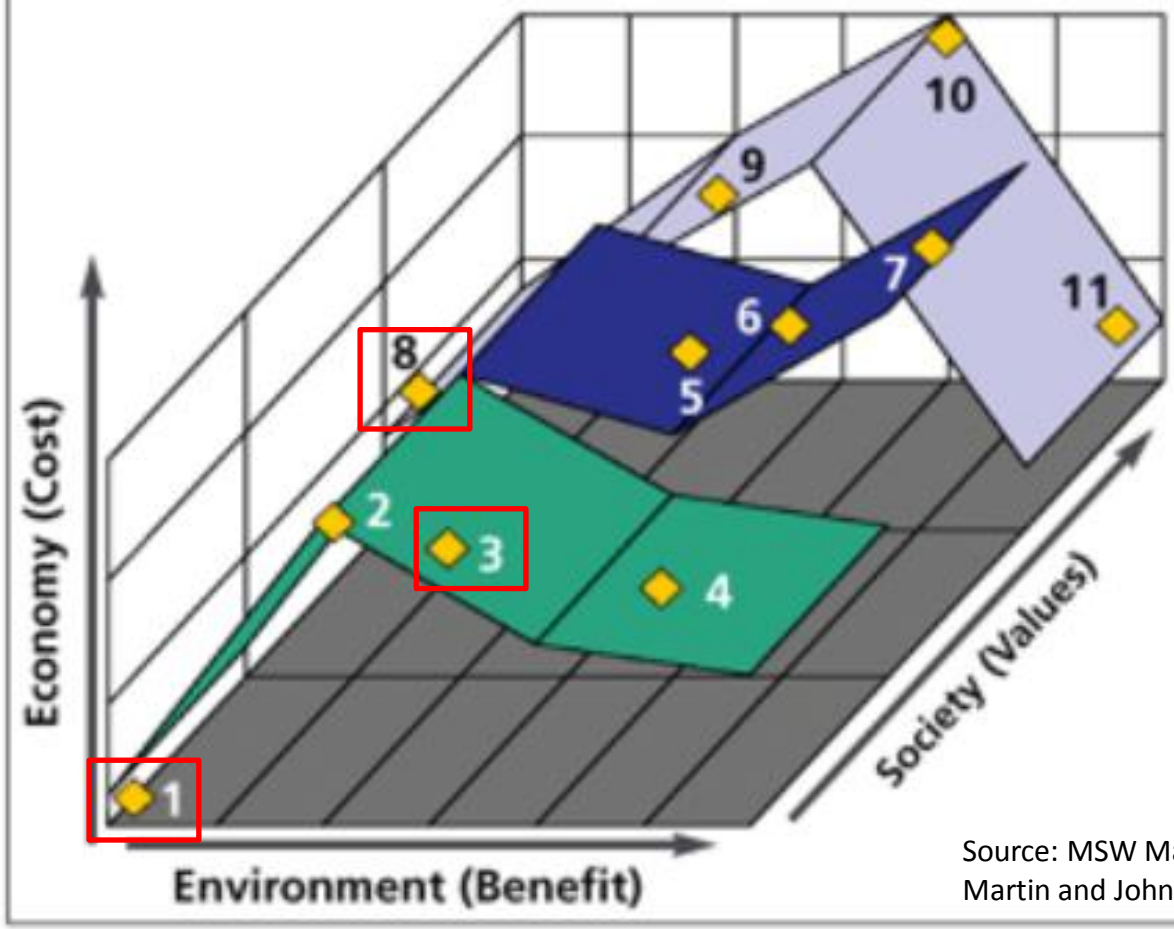


Source: MSW Management, Sep-Oct 2003. Courtesy of Kay Martin and John Trotti.

II. Material Management Hierarchy

A Performance-Based Evaluation Concept

Figure 2. Representation of a Performance-Based Environmental Platform

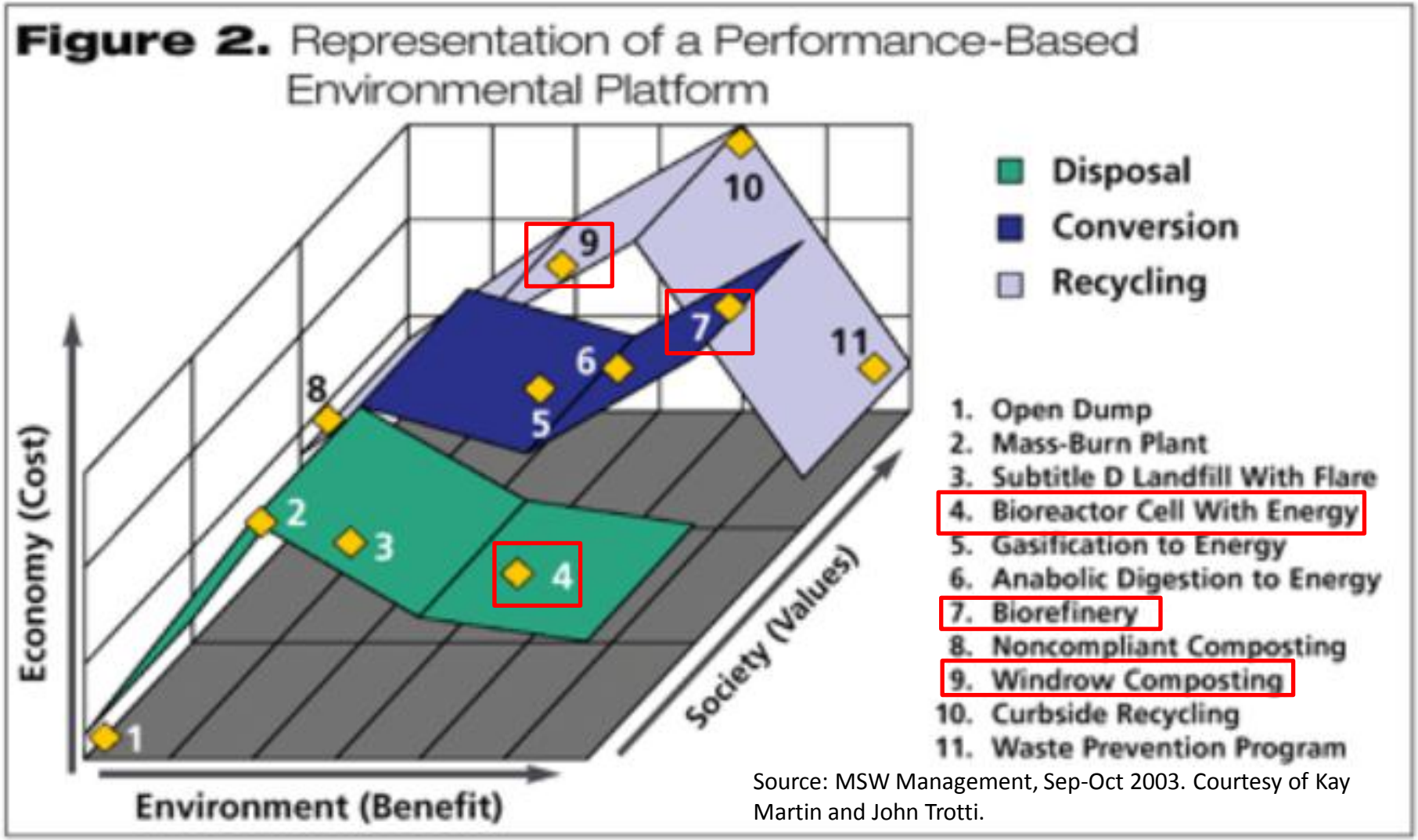


Disposal
Conversion
Recycling

1. Open Dump
2. Mass-Burn Plant
3. Subtitle D Landfill With Flare
4. Bioreactor Cell With Energy
5. Gasification to Energy
6. Anabolic Digestion to Energy
7. Biorefinery
8. Noncompliant Composting
9. Windrow Composting
10. Curbside Recycling
11. Waste Prevention Program

Source: MSW Management, Sep-Oct 2003. Courtesy of Kay Martin and John Trotti.

II. Material Management Hierarchy
A Performance-Based Evaluation Concept



Source: MSW Management, Sep-Oct 2003. Courtesy of Kay Martin and John Trotti.

Review of Part 1

- Sustainability
- Ecological Footprint
- Closed Loop Processes
- Industrial Ecology
- Economy is a Subset of Ecosystem
- Material Management Hierarchy

Framework for Change

Hierarchy Level	Change Strategies (Levers for Change)				
	Regulations	Economic Incentives	Education	Technology & Infrastructure	Institutional Structures
Reduction & Reuse					
Recycling & Composting					
Energy Recovery					
Treatment & Disposal					

Framework for Change

Hierarchy Level	Change Strategies (Levers for Change)				
	Regulations	**Economic Incentives**	**Education**	**Technology & Infrastructure**	**Institutional Structures**
Reduction & Reuse	Extended producer responsibility	Pub.: Reduced collection costs	EREF	Swap shops	Integrated waste management plans and clear performance metrics
Recycling & Composting	Landfill diversion requirements	Pub & Priv: Revenue from sales of recyclables & soil amendments		Drop off centers; curbside collection programs	
Energy Recovery	Renewable energy portfolio standards	Pub & Priv: Revenue from sales of fuel or electricity; Priv.: tax incentives		Net metering	
Treatment & Disposal	RCRA	Pay-As-You-Throw	Buffer land nature center	Accelerated landfill stabilization	

Reference List – Part 1

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Thank you

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