Design of Sustainable Product Systems & Supply Chains

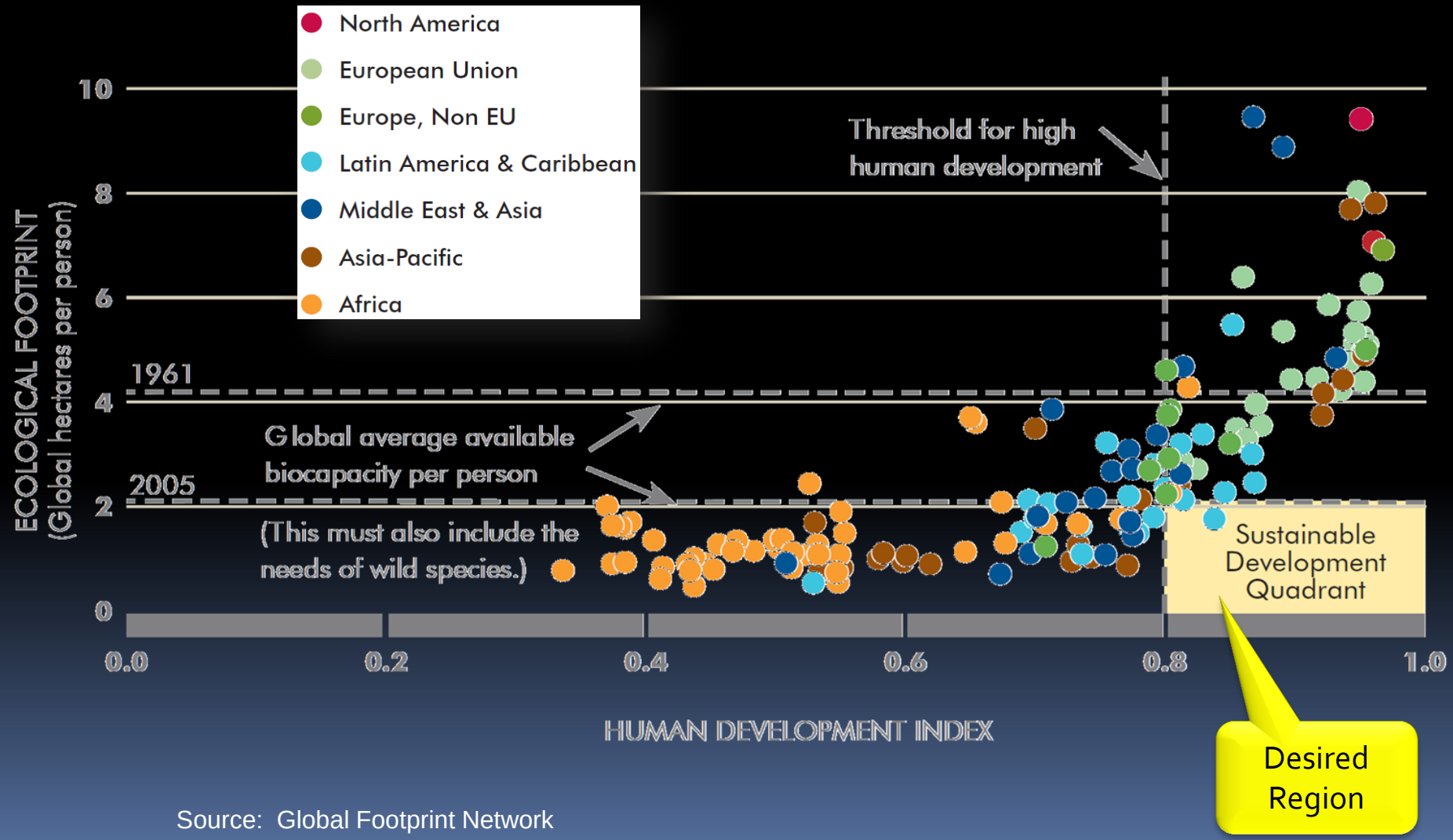
Joseph Fiksel

Sustainability Advisor, U.S. EPA
Office of Research & Development*

Executive Director, Center for Resilience
The Ohio State University, USA

*The content of this presentation reflects the views of the author and does not represent the policies or position of the U.S. EPA.

Trajectory of Human Progress

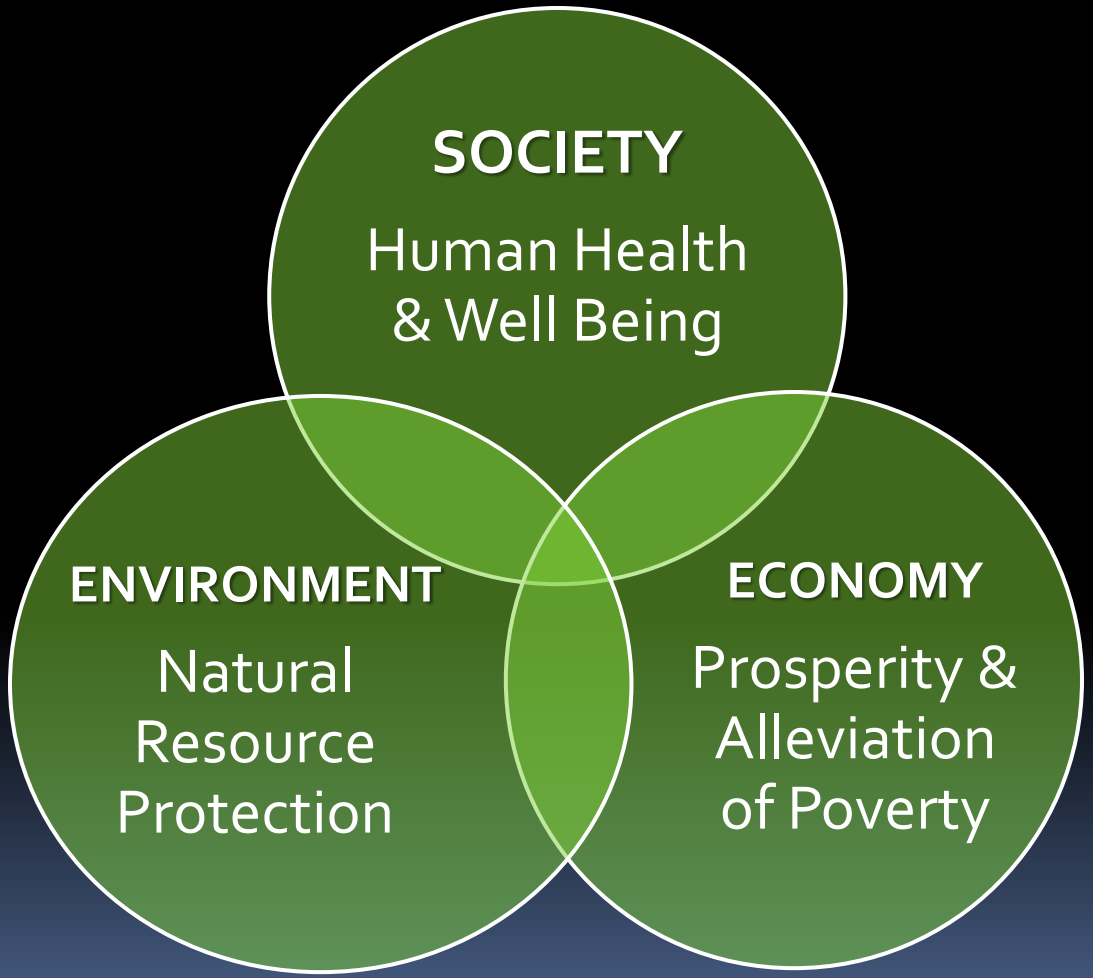


Source: Global Footprint Network

Sustainability Paradigm

"It is important for EPA to optimize all three pillars of sustainability… decisions that further one of the three pillars should, to the extent possible, further the other two."

—NRC Green Book, 2011



Changing the Game at U.S. EPA

- "The major challenges to sustainability, human health, and the environment…are not incremental problems, and they do not lend themselves to incremental solutions….Only by implementing **systems thinking and integrative approaches** to complement our traditional single-discipline approaches, will we be better able to solve these challenging problems."

  Paul Anastas, ORD Assistant Administrator

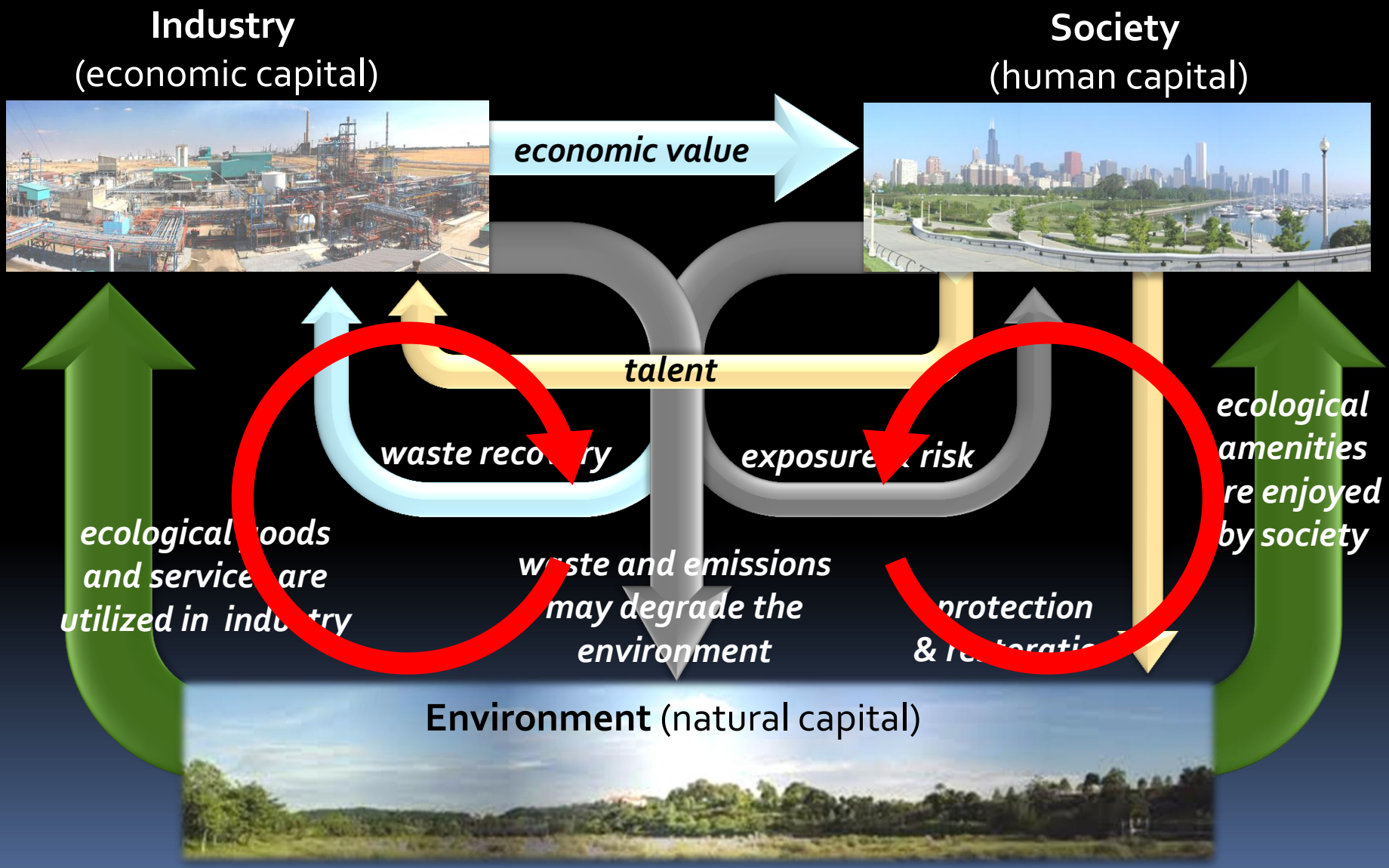
- "Well-conceived, effectively implemented environmental protection is good for economic growth."

  Lisa Jackson, EPA Administrator

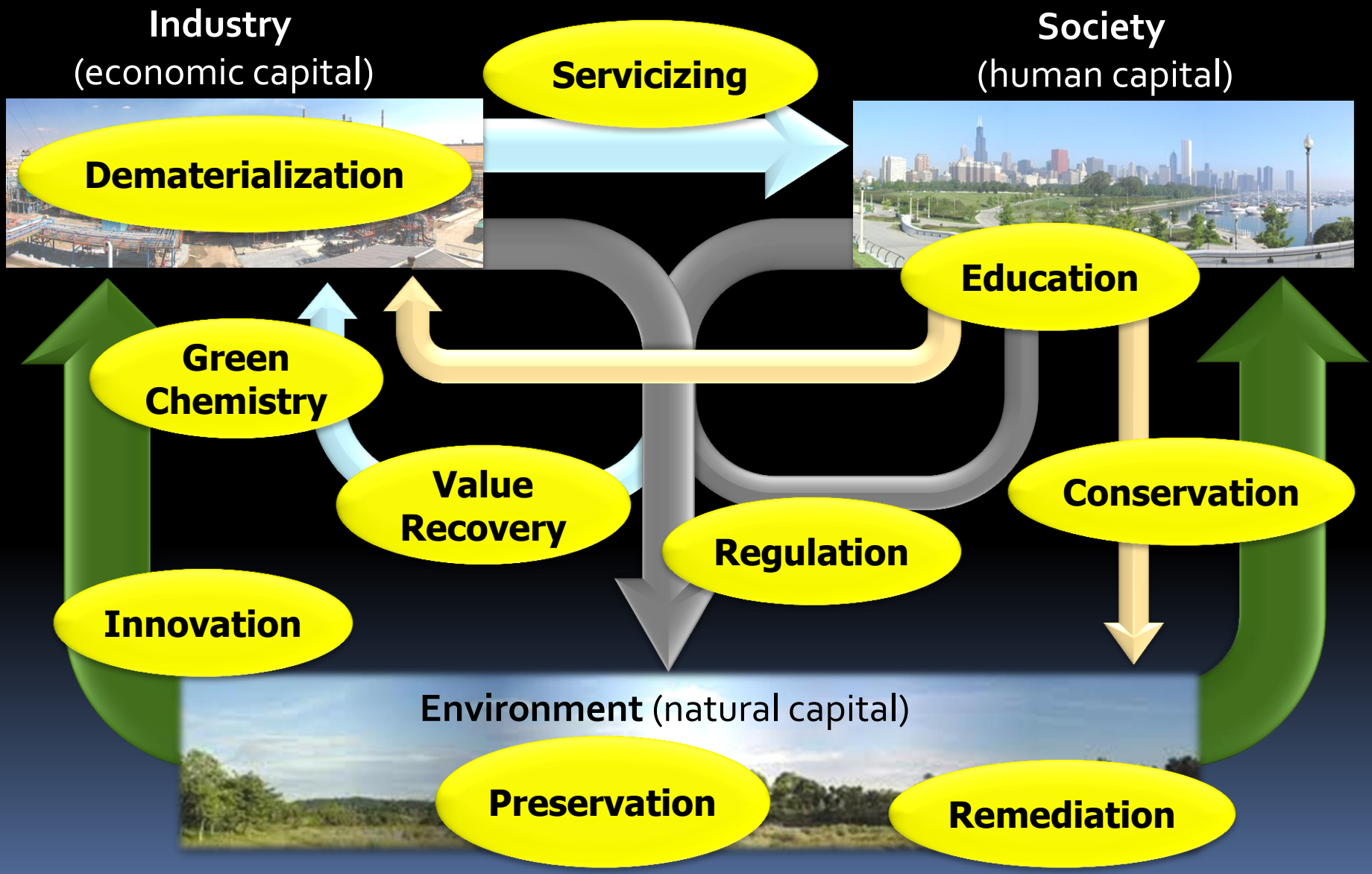
What is systems thinking?

- A holistic approach for understanding the interactions and feedback loops among
  - Economic systems—companies, supply chains….
  - Ecological systems—forests, watersheds….
  - Societal systems—communities, networks….
- Helps to consider the potential benefits and unintended consequences of human interventions, such as new policies, new technologies, and new business practices

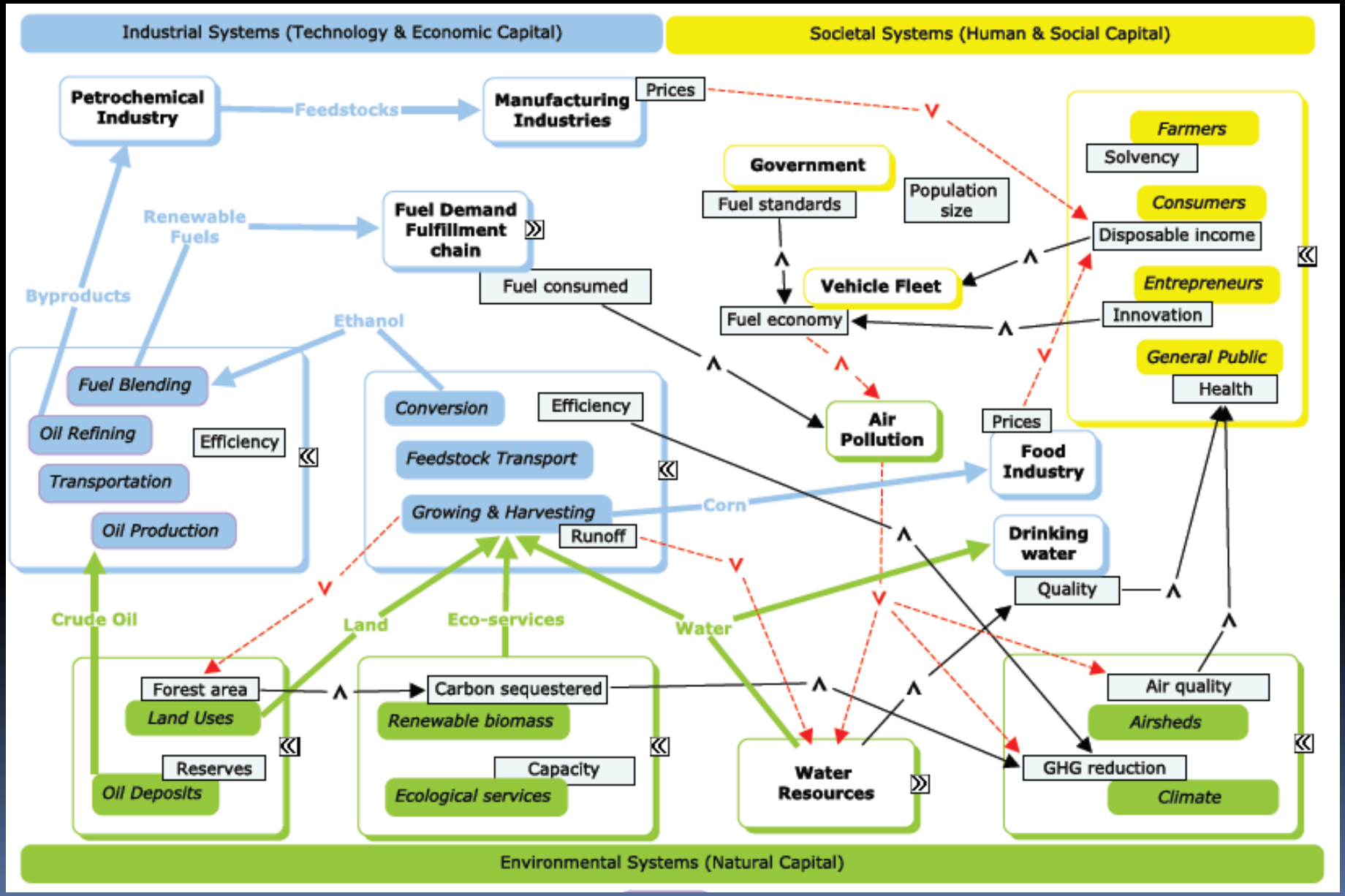
Systems Thinking: Triple Value Model



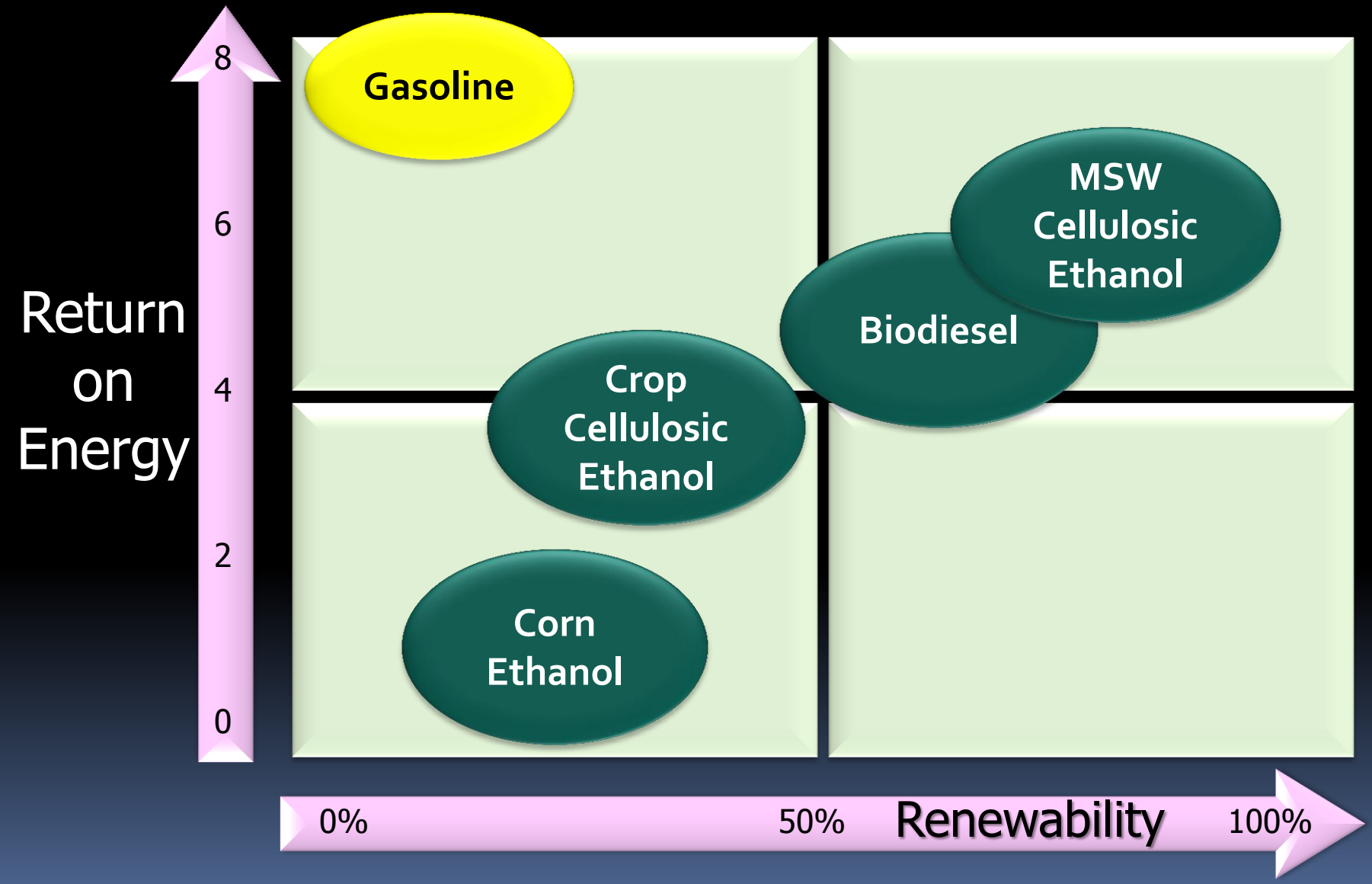
Opportunities for Intervention



Example: Corn Ethanol Product System

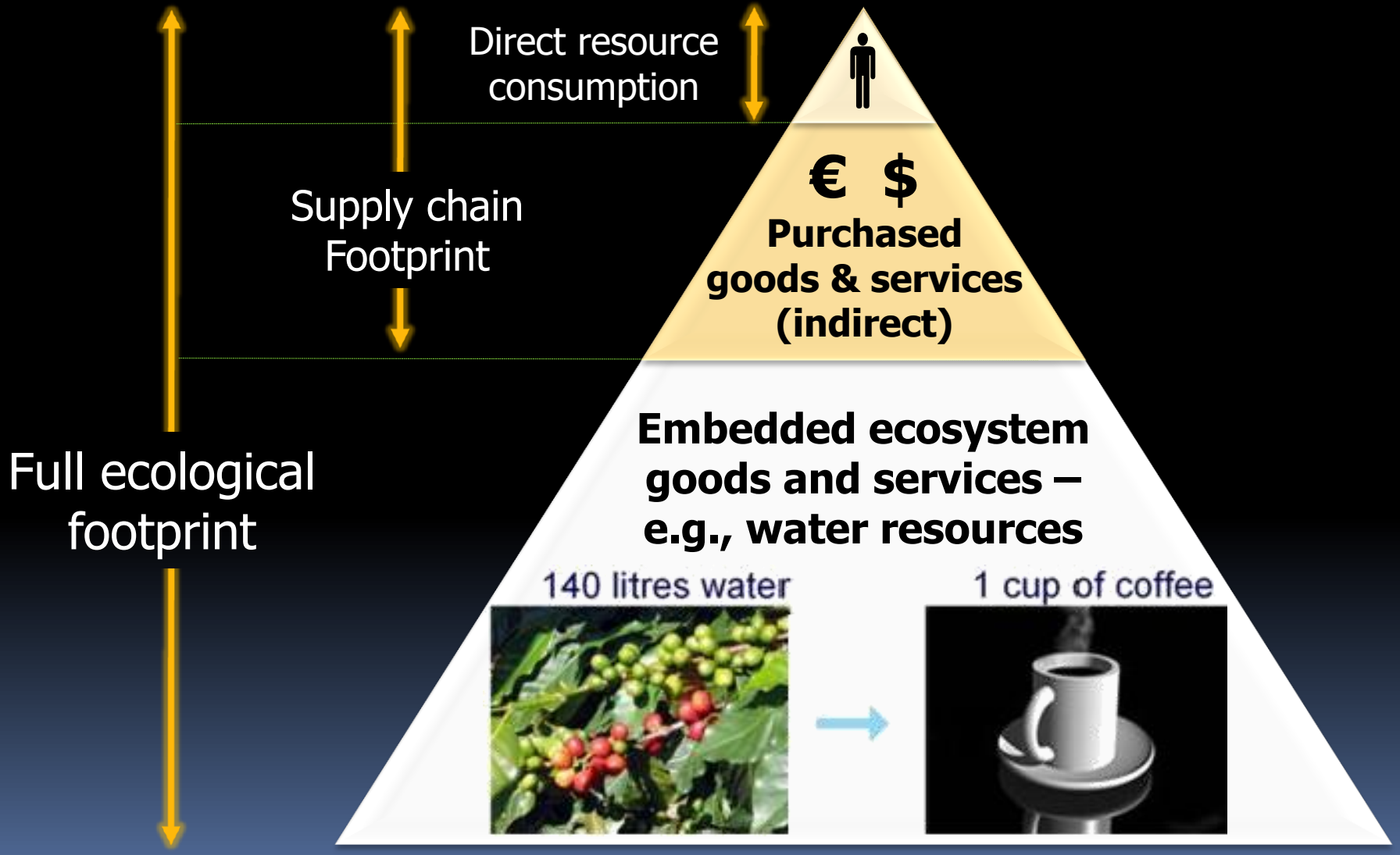


Biofuel Life Cycle Assessment



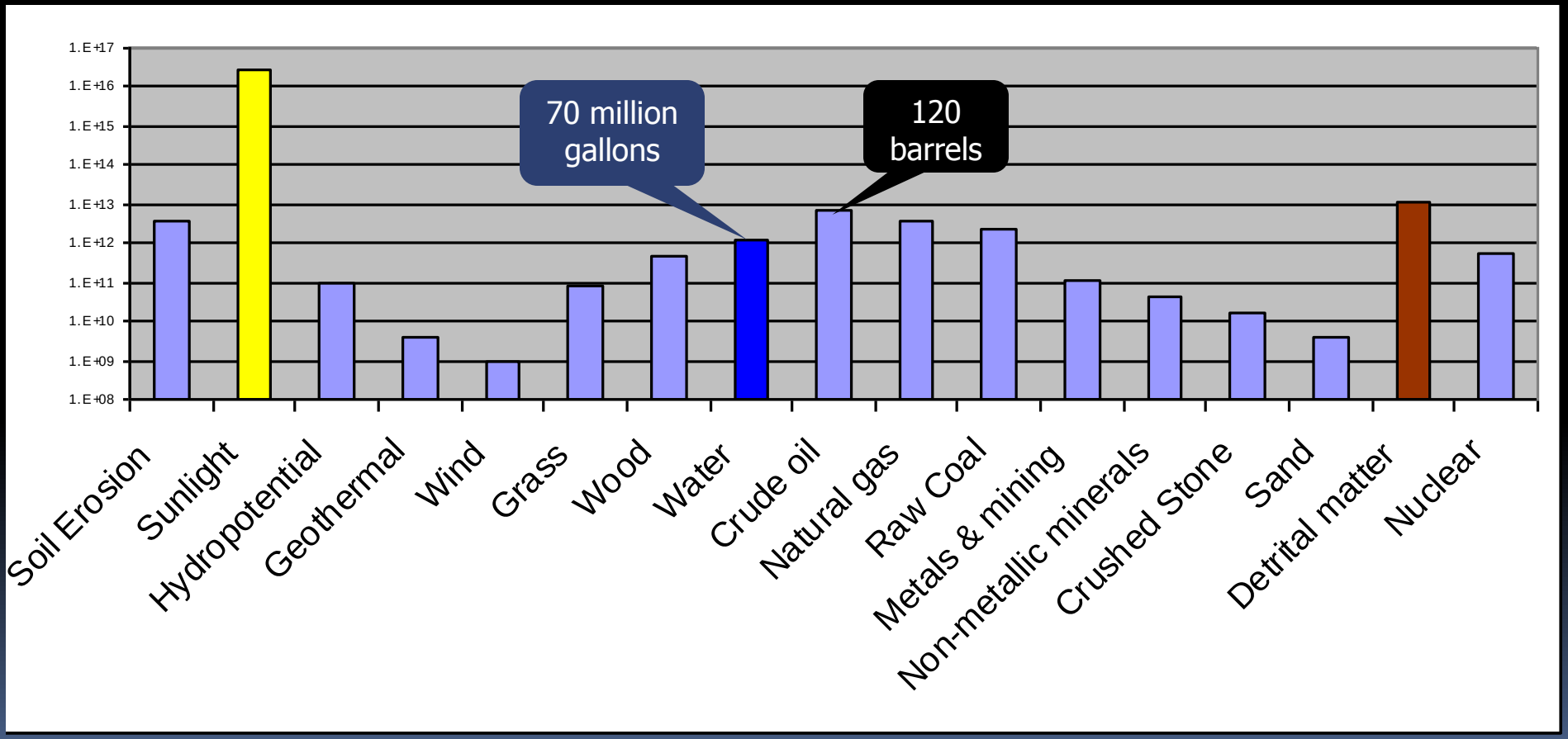
Source: A. Baral and B. R. Bakshi, "The Role of Ecological Resources and Aggregate Thermodynamic Metrics for Assessing the Life Cycle of Some Biomass and Fossil Fuels", Environmental Science and Technology, 2009

The Hidden Mountain of Resource Use



Example: Snack Food Industry

"Embedded" natural capital for a typical U.S. snack food supply chain, converted into energy equivalents (joules) per million dollars of economic output



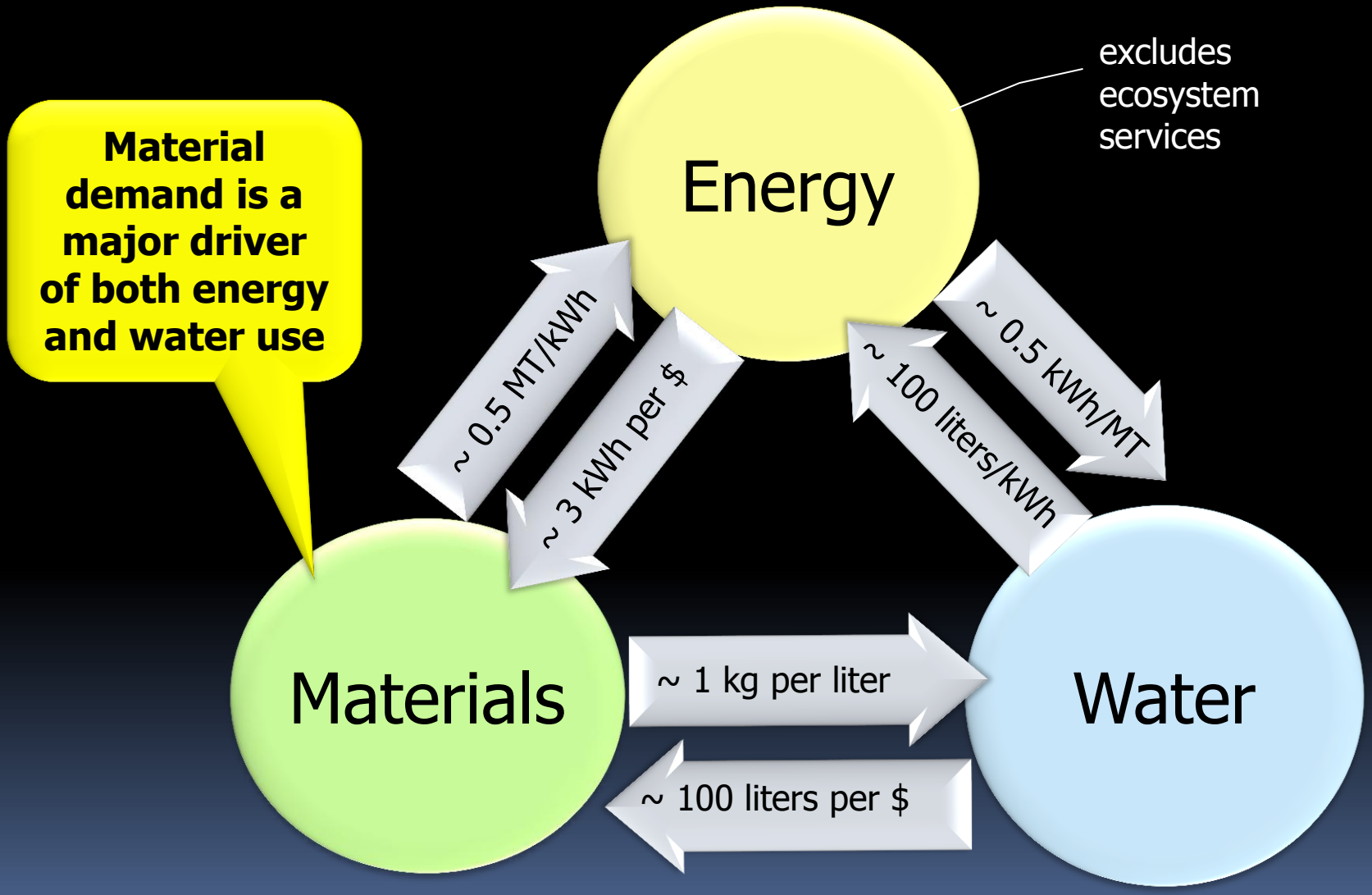
Source: OSU Center for Resilience **Eco-LCA™**

Sustainable Materials Management

"...an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity."

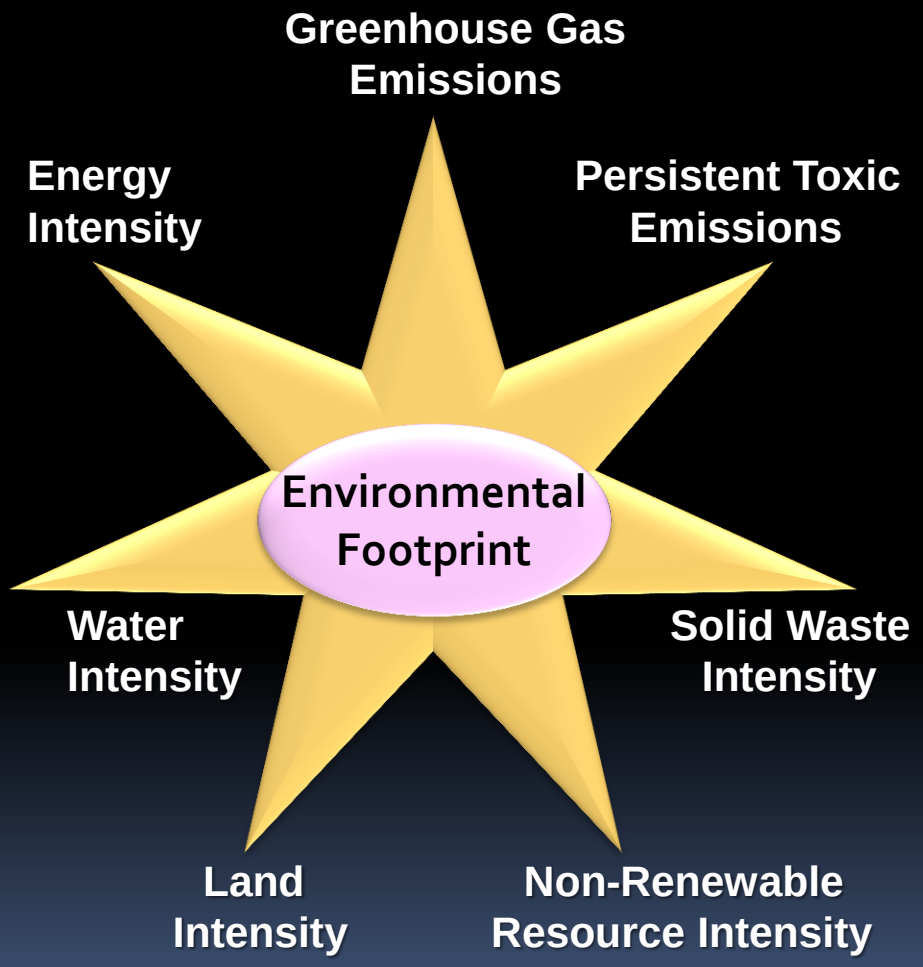
Working Group on Waste Prevention and Recycling

Material-Energy-Water Nexus



Source: J. Fiksel, "Evaluating Supply Chain Sustainability," *Chemical Engineering Progress*, May 2010.

Sustainability Progress Indicators



The Need for Collaboration

- **Incremental** improvements in supply chain efficiency will not be sufficient to offset global economic growth
- Transformational change in production and consumption patterns will require broad **collaboration** between government, industry, and civil society
- Companies are already collaborating with suppliers, customers, competitors, and environmental advocacy groups

Supply Networks: Robust and Fragile

Global imports to the UK

Source: New Economic Foundation

Sustainability and Resilience

- **Sustainability** is the capacity for long-term realization of human health and well being, economic prosperity, & environmental protection
- However, unforeseen conditions can lead to unintended and/or undesired consequences
- **Resilience** is the capacity to survive, adapt, and flourish in the face of changing conditions and potential disruptions
- In a complex and turbulent world, resilience is a **prerequisite** for realization of sustainability goals

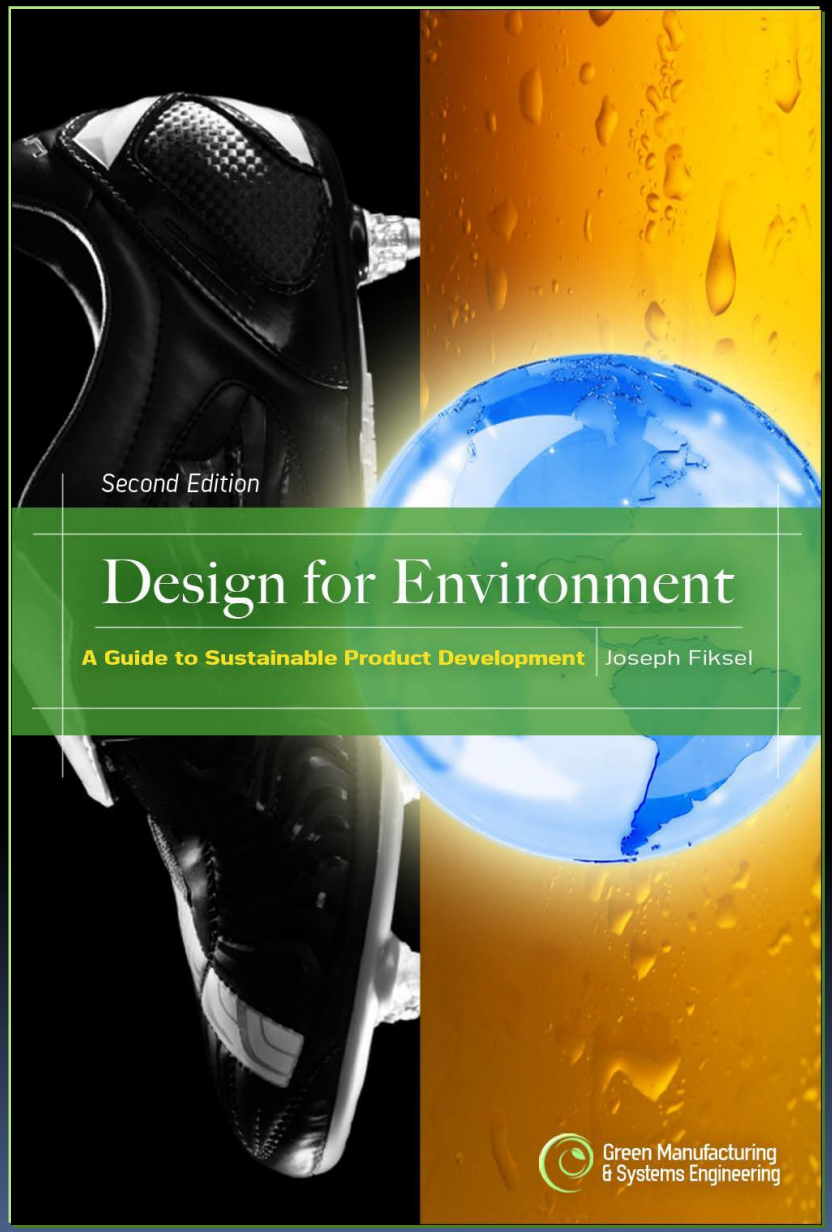
Design for Environment

Joseph Fiksel

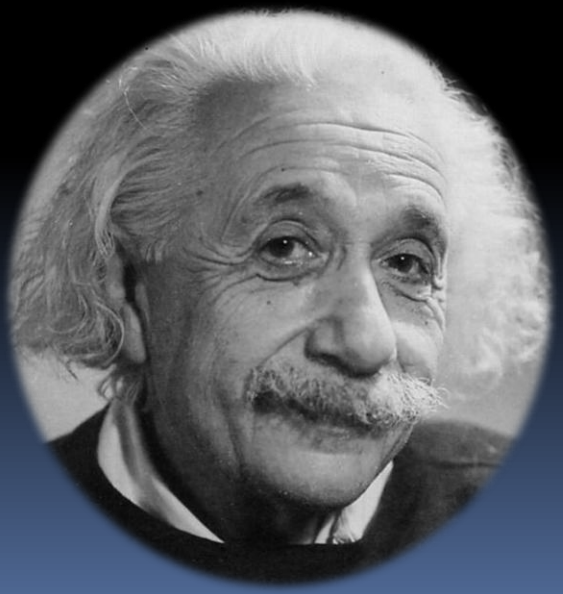
McGraw-Hill, July 2009

(Paperback edition 2011)

- Disruptive Innovation
- Product Development
- Process Eco-Efficiency
- Life Cycle Management
- Business Value Creation
- Supply Chain Sustainability



"We shall require a substantially new manner of thinking if mankind is to survive."



Albert Einstein

1879-1955