CAUSE 2003: From Industrial Revolution to…

Industrial Ecology

with Amish, Eric, and Lauren

History of IE

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History of IE

- A system that "would maximize the economical use of waste materials and of products at the ends of their lives as inputs to other processes and industries."

  -Frosch, 1992

- Essentially mimics natural systems

Types of Industrial Ecosystems

- Local, Regional, National, Global
- Industrial Symbiosis
- The Eco-Industrial Park

An Eco-Industrial Park in Devens, Massachusetts

DEVENS
ENTERPRISE • COMMISSION

"We should leave to the next generation a stock of 'quality of life' assets no less than those we have inherited."

-Devens Enterprise Commission

- Local opinion
- Government action

View of Devens, Massachusetts

Major Characteristics of the Devens Eco-Industrial Park

- Material, water, and energy flows
- Companies within close proximity
- Strong informal ties between plant managers
- Minor retrofitting of existing infrastructure
- One or more anchor tenants.

Examples of IE

Common Sense IE:

Saving resources
Recycling
Be efficient when possible

Why?

Fewer resources consumed
→ lower operational costs

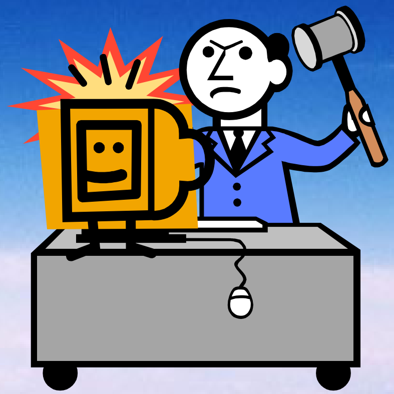
Less waste/trash
→ lower disposal costs

Examples

- Liberal plans
- Using renewable resources
- Wastes become new resources
- Efficient production
- Long-lasting design of systems

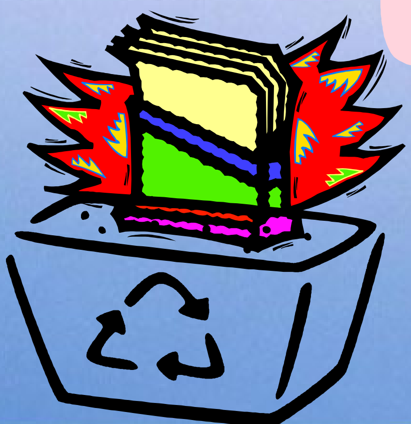
PSU Dining Commons

- Computer software



- Batch Cooking

- Napkins



Kalundborg, Denmark

- Industries exchange wastes
- Companies made agreements 70s – 90s
- Asnaes – Coal-fired power plant
- Statoil – Oil Refinery
- Gyproc – plasterboard company
- Novo Nordisk – biotechnology company

Coal Power Plant

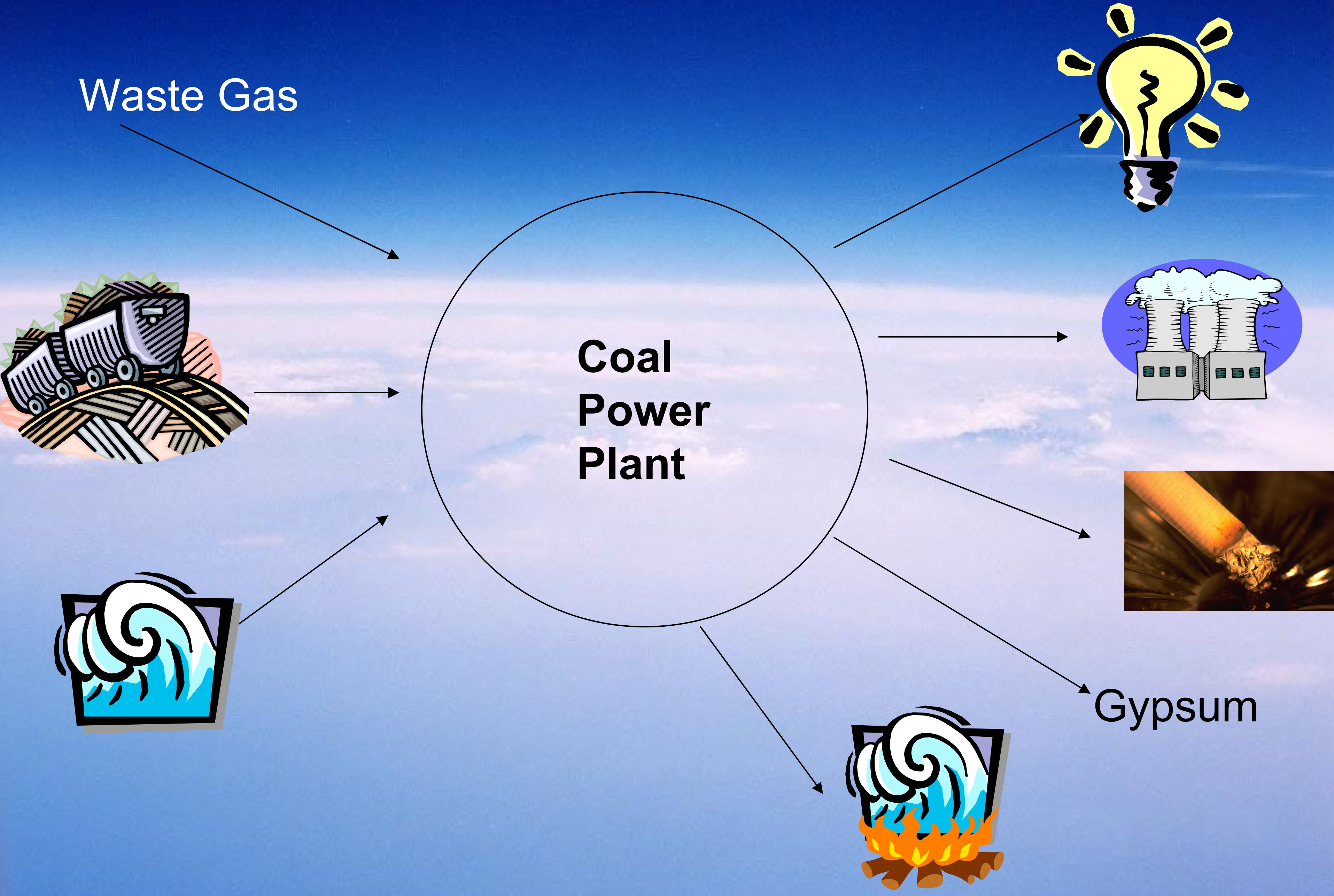
Inputs:

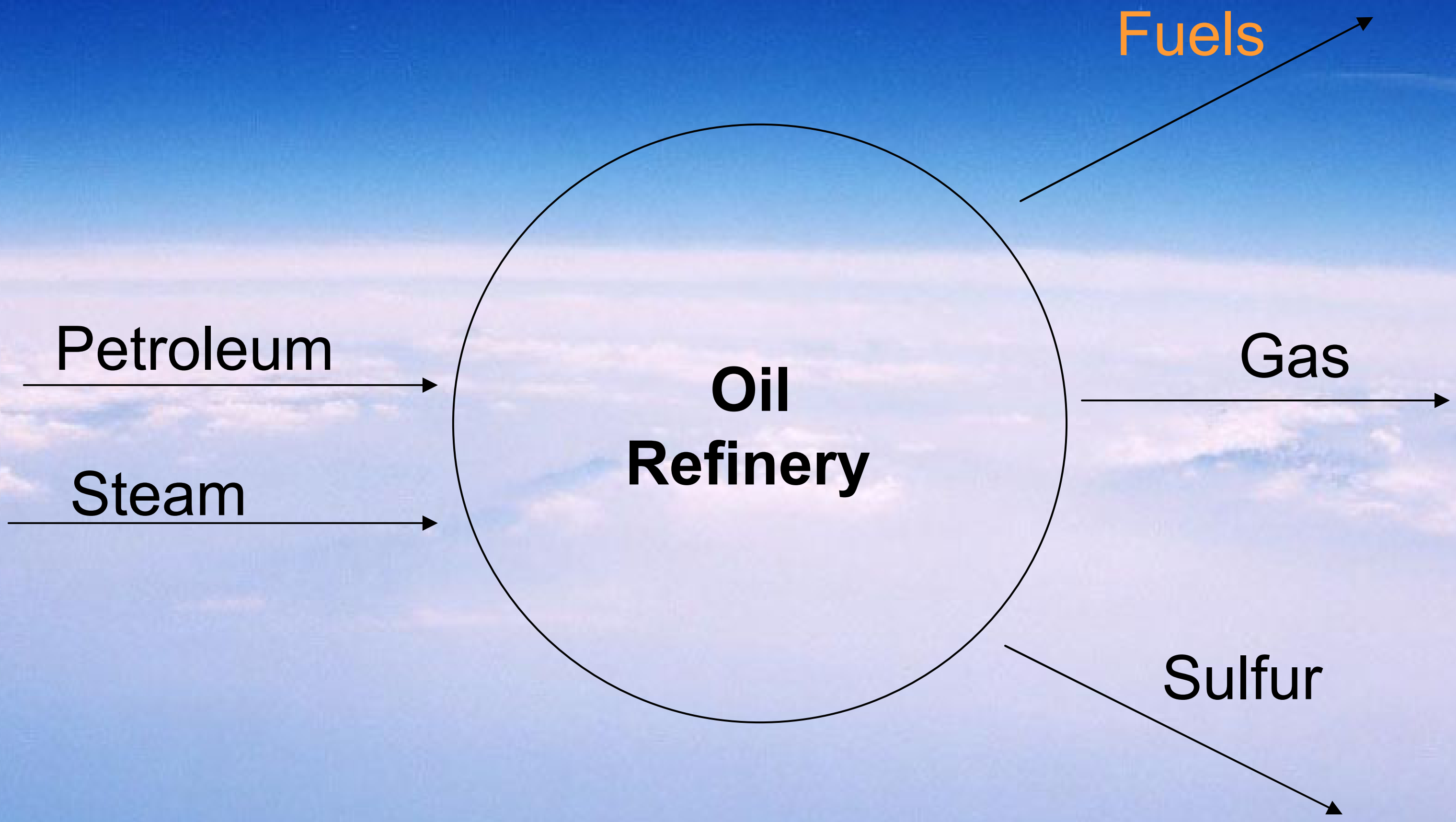
- Coal
- Surplus gas from nearby refinery
- Cool Salt Water

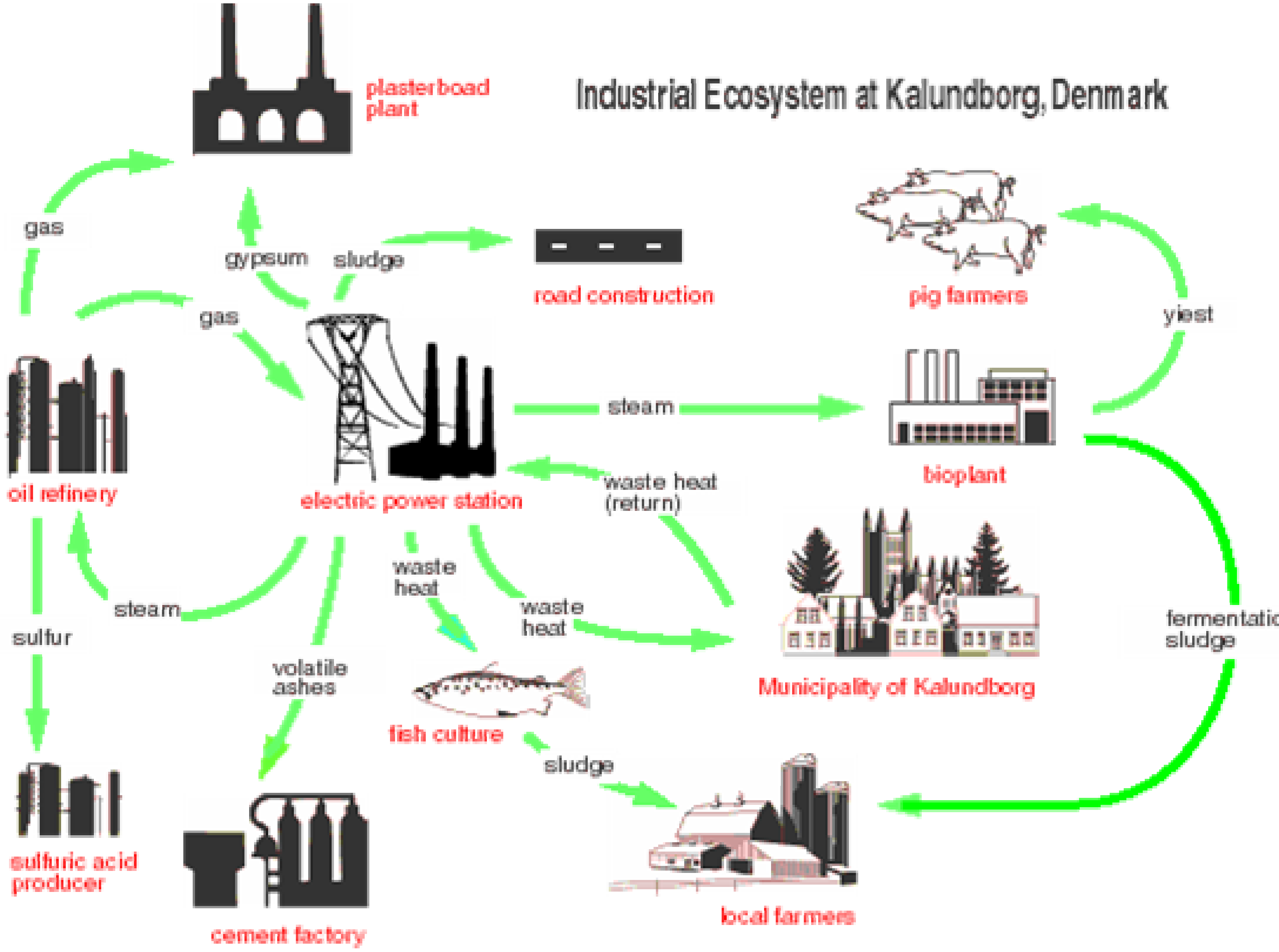
Products

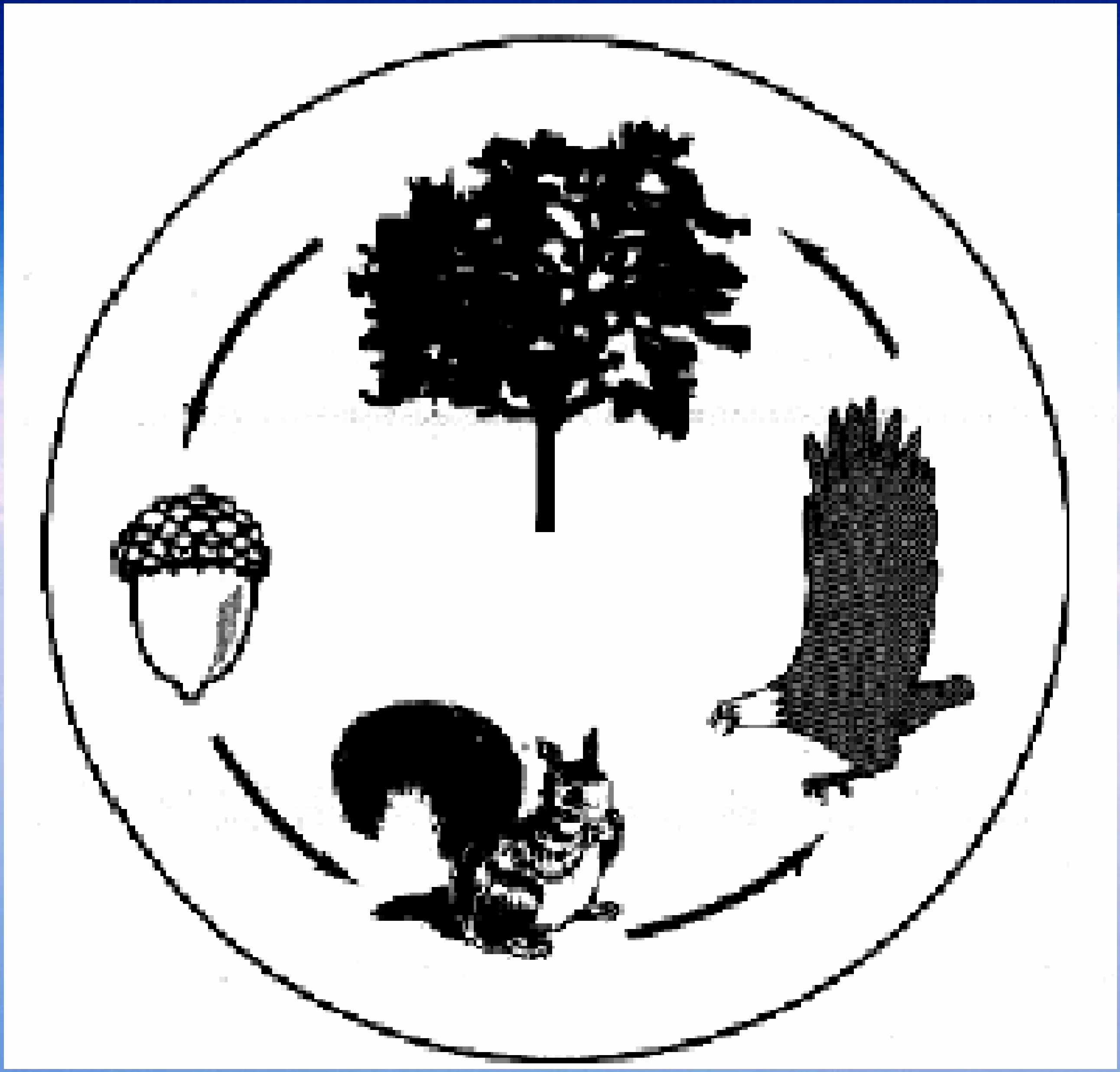
- Electricity
- Steam + Heat
- Hot Salt Water
- Ash
- Gypsum

http://www.indigodev.com/Kal.html


Waste Gas
Coal
Power
Plant
Gypsum


Fuels
Petroleum
Oil Refinery
Gas
Steam
Sulfur


Industrial Ecosystem at Kalundborg, Denmark
plasterboad plant
gas
gypsum
sludge
road construction
pig farmers
yiest
gas
oil refinery
electric power station
steam
bioplant
waste heat (return)
steam
sulfur
waste heat
waste heat
Municipality of Kalundborg
fermentatio sludge
volatile ashes
fish culture
sludge
sulfuric acid producer
cement factory
local farmers

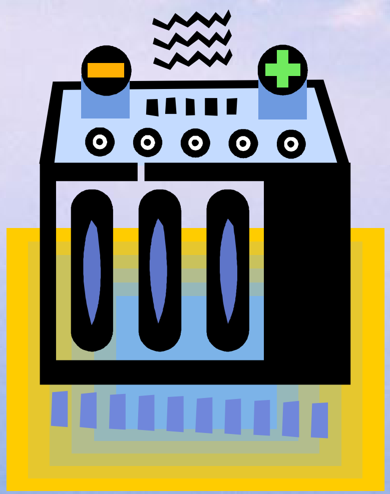


Industrial Ecology in Kalundborg

- Saves resources:
  - 30% better utilization of fuel using combined heat + power than producing separate
  - Reduced oil consumption
  - 3500 less oil-burning heaters in homes
  - Does not drain fresh water supplies
- New source of raw materials
  - Gypsum, sulfuric acid, fertilizer, fish farm

http://www.symbiosis.dk

Lead



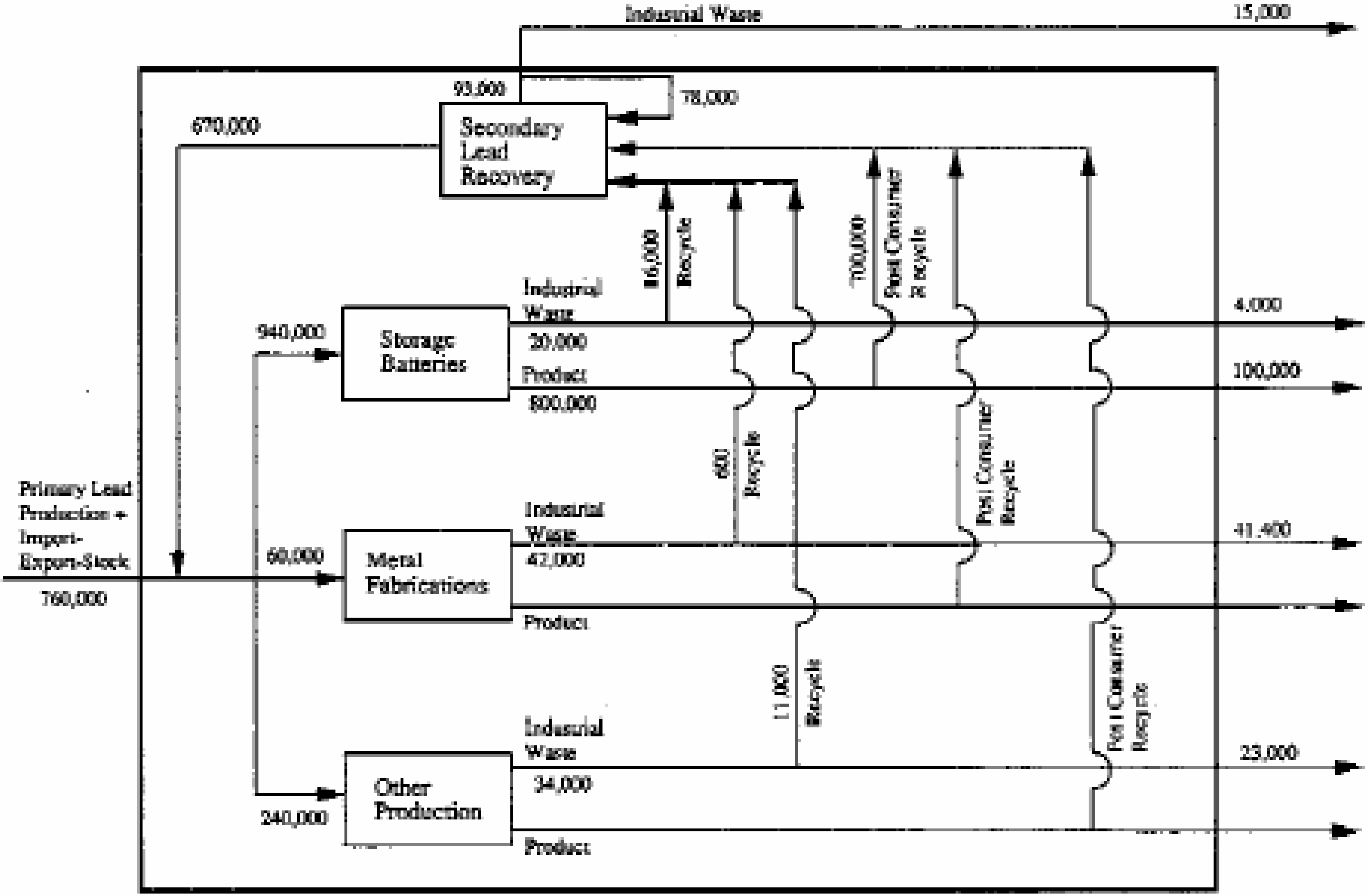


FIGURE 7 Simplified model of the industrial ecology of lead (amounts in tons per year). 1989 http://print.nap.edu/pdf/0309049377/pdf_image/77.pdf

Analysis of Lead, 1989, USA

- % Lead consumed for batteries = 78%
- In lead-acid batteries 700,000 tons out of 800,000 tons recycled, were re-processed and reused ~ (87%)

http://books.nap.edu/books/0309049377/html/77.html#pagetop

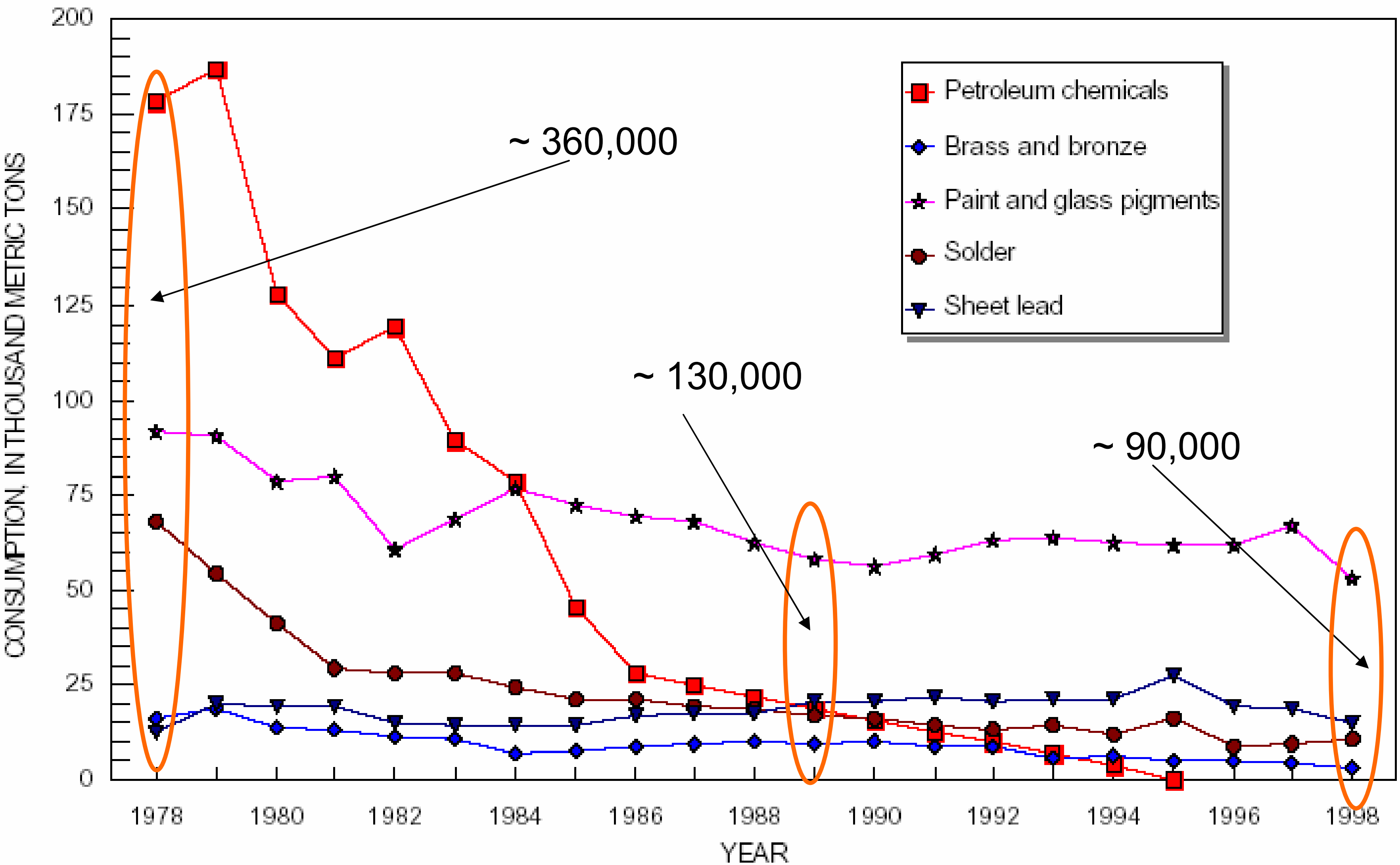


Figure 3. U.S. lead consumption, by end use, nonbattery uses, 1978-98.

Smith, Gerald. "Lead Recycling in the United States in 1998".

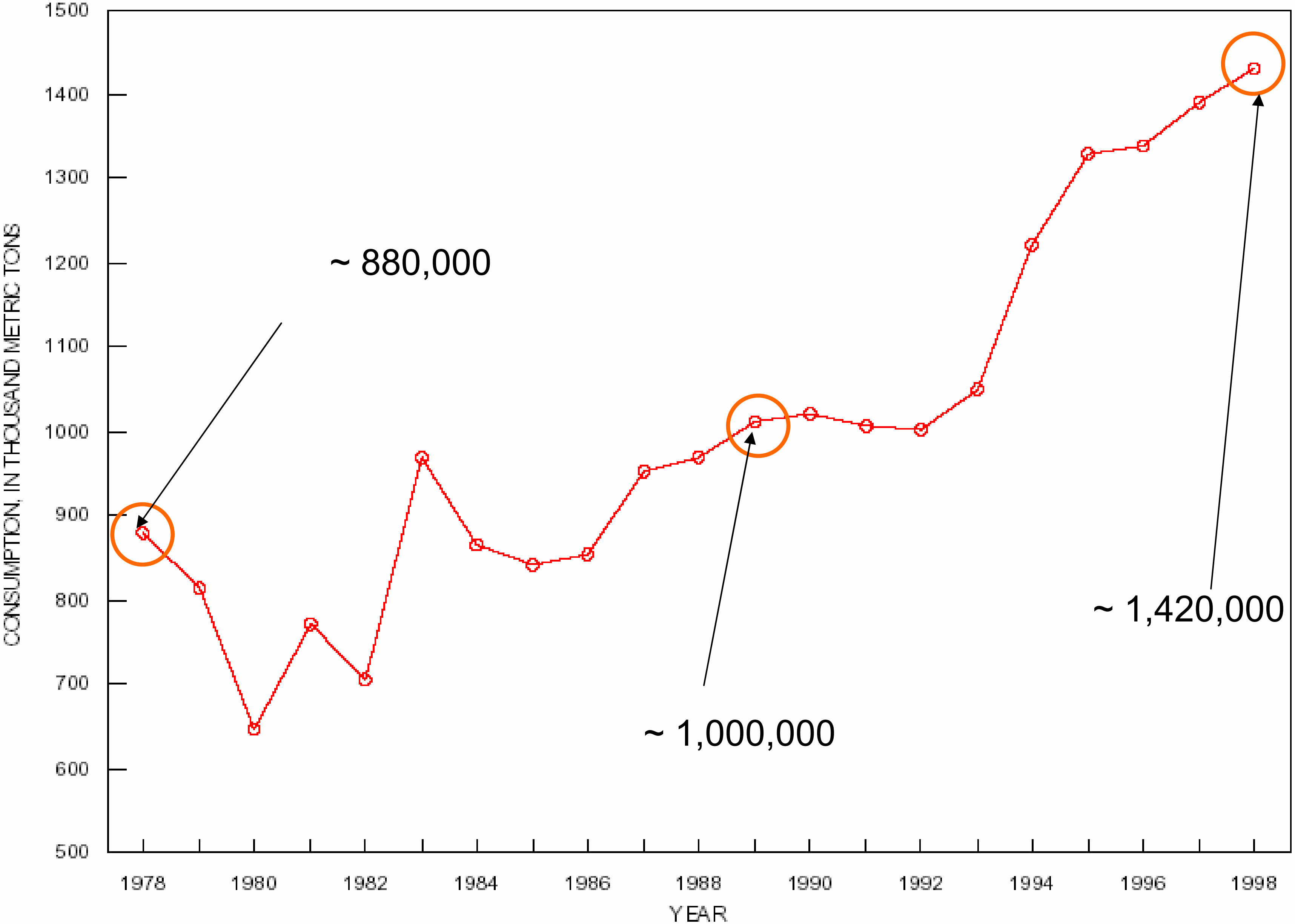


Figure 2. U.S. lead consumption in batteries, 1978-98.

Lead, 1998

- % Lead consumed for batteries = 88%
- 95% recycling efficiency

Automobile IE

- 65% of an automobile is comprised of iron and steel
- In 2001, 15 million tons of iron and steel were recycled from automobiles
- Can be used to produce 48 million steel utility poles

http://www.recycle-steel.org/cars/main.html

From the Junkyard

- Useable engines, tires, batteries, fluids, and other parts are removed for resale
- The body is shipped to a scrap yard
- Magnets separate iron/steels
- Scrap metal is sent to steel mills
- New car bodies are made with at least 25% recycled steel
- Other parts such tires can be shredded and reused

http://www.recycle-steel.org

Material used in cars

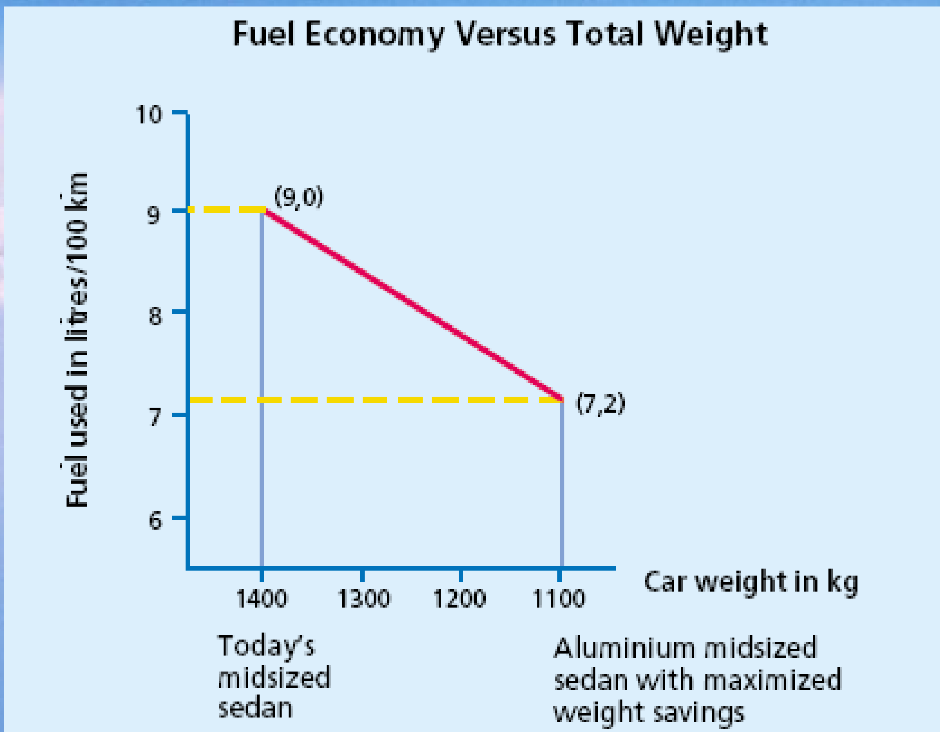
Characteristic	ca. 1950s	ca. 1990s
Plastics	0	101
Aluminum	0	68
Copper	25	22
Lead	23	15
Zinc	25	10
Iron	220	207
Steels	1290	793
Glass	54	38
Rubber	85	61
Fluids	96	81
Other	83	38
Total Weight	1901	1434

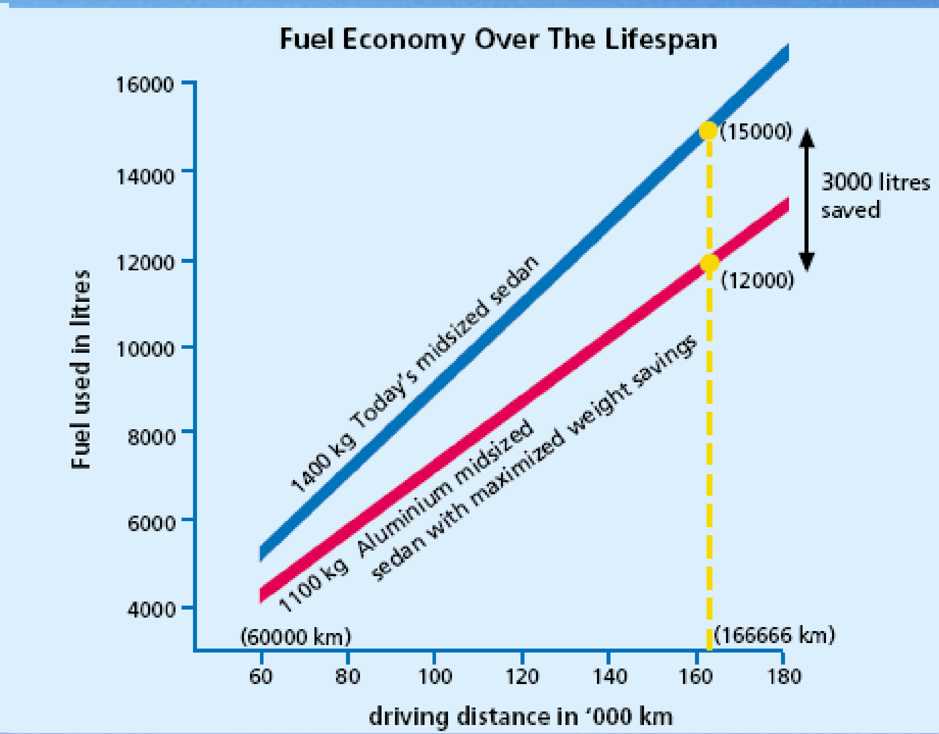
http://www.fes.uwaterloo.ca/u/jjkay/pubs/IE/

Why Aluminum?

- Can replace steel
- Less dense than steel
- Increased fuel economy due to lighter automobiles
- Less emissions
- rusting

Aluminum





European Aluminum Assocation
http://www.eaa.net/downloads/auto.pdf

Aluminum Production

- Aluminum requires large amounts of energy to extract ~ 6 – 8 times more than steel

- However, recyclable without much loss

Aluminum Cans

- In 1998 879,000 metric tons of Aluminum cans were recycled (63% of all Al cans)
- Cans comprise less than 30% of Al products
- In 1998, 3.4 million metric tons of Aluminum were processed from recycled Aluminum (37%).

http://www.aluminum.org/Template.cfm?Section=Recycling

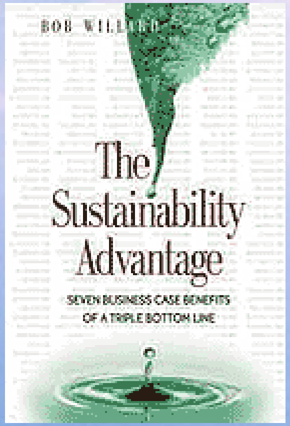
Summary of Autos

- Recycling steel and aluminum
- Replacing steel with aluminum

- Buying longer lasting automobiles with better fuel economy
- Using alternate means of transportation


IT'S
INTERMISSION
TIME, Folks!

The Economics of Ecology (or…covering your bottom line)



Pictures courtesy of http://pubs.wri.org/pubs_description.cfm?PubID=3786 and http://www.kbnp.com/bl.htm respectively.

Monterey Regional Waste Management District Regional Environmental Park

- “Reduce, Reuse and Recycle”
- Hazardous Waste Mitigation
- Reselling materials instead of dumping
- Landfill Gas Power Project

Cape Charles
Sustainable Technology Park

Create 400 Jobs in first stage of development for Local Area

* 27% below poverty line

Redevelop Brownfields

Government Subsidy

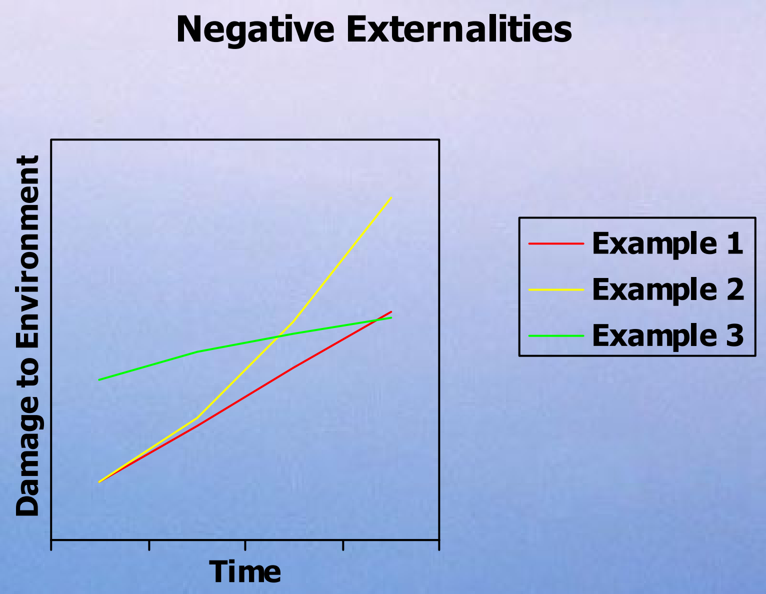
Natural Habitat and Infrastructure

Solar Building Systems, Inc.

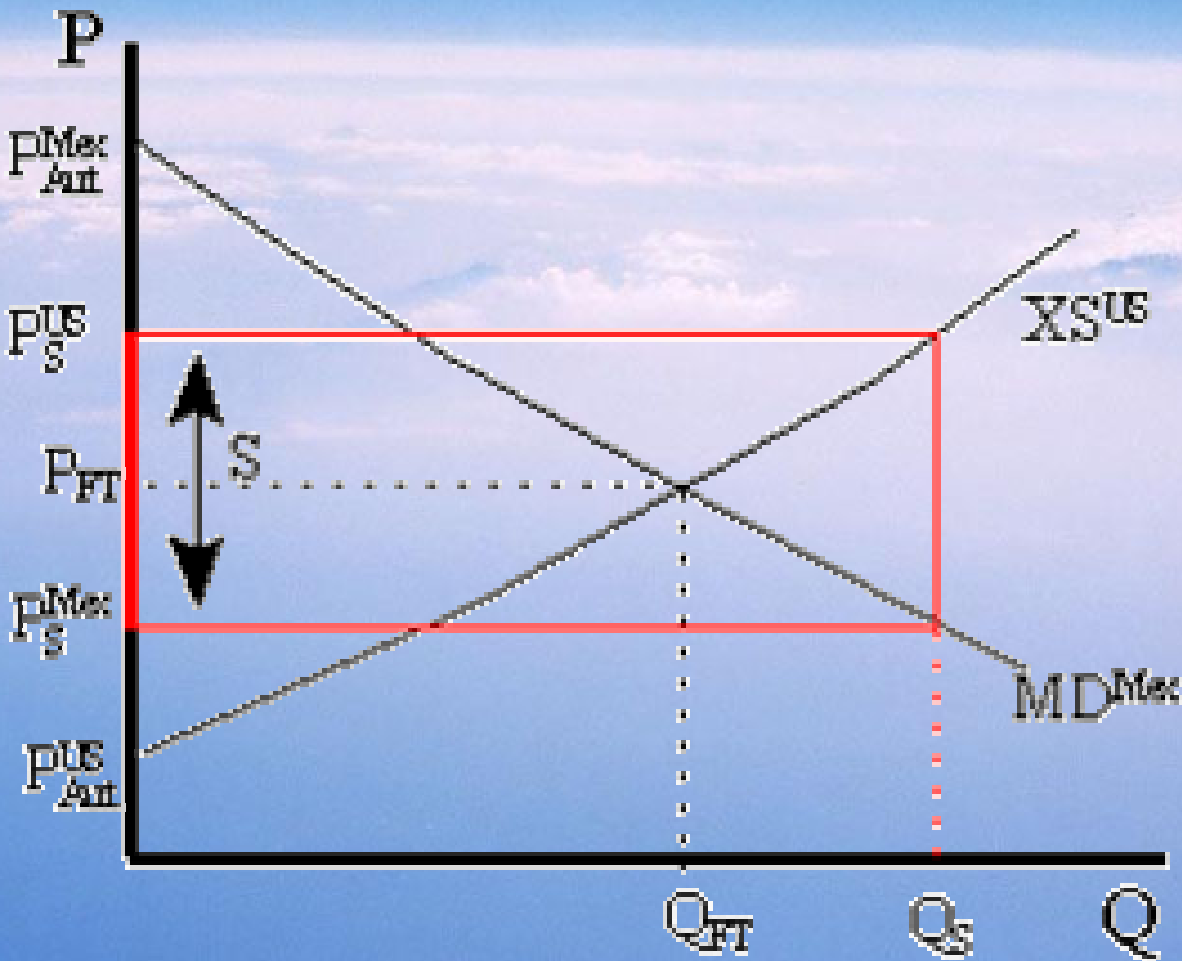
Energy Recovery

Market Failure
Negative Externalities

- Harm proportionate with output produced
- Harm increases at an increasing rate with output produced (synergistic effect)
- Harm significant initially, increases at decreasing rate with output produced



Market Failure Correction: Subsidies



Economic Benefits of IE

- Hidden Resource Productivity Gains
  - **Within Firm**: eliminating waste
    - Making plant more efficient
  - **Within Value Chain**: reducing costs
    - Synergies between production and distribution
  - **Beyond Production Chain**: closed loop
    - Eco-Industrial Parks and inter-firm relations

Benefits of IE to Corporation

- Revenue Generation
- Cost Savings
- Reduced Liabilities
- Competitive Edge of Regulatory Flexibility
- Enhanced Public Image
- Market Leader

Barriers to Development

- Suitability of materials to reuse
- High cost of recycling (internalize negative externalities)
- Information Barriers (must set up reciprocal relationships between sectors)
- Organizational Obstacles
- Institutional Barriers (need fiscal and regulatory government intervention)

Macro to Micro Scale of IE

- Macro: Industrial Processes as a whole
- Meso: Sector Interrelationships
- Micro: Individual Consumer/Producer Behavior
- "Conspicuous Consumption" and Conspicuous Waste

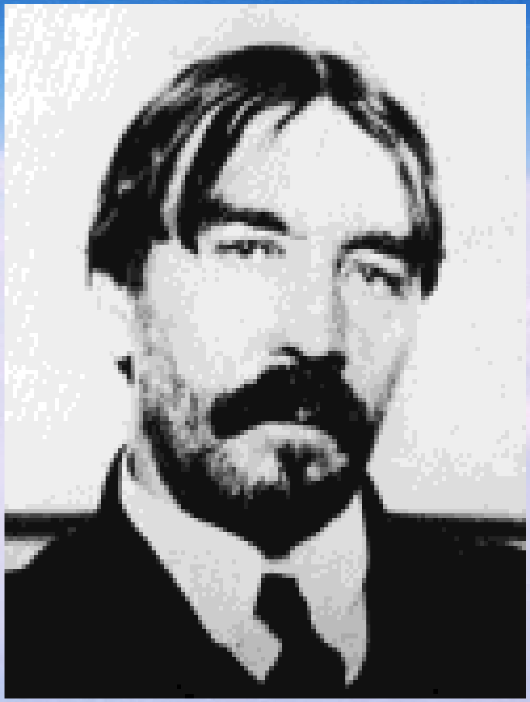


Photo courtesy of: http://www.cpm.ehime-u.ac.jp/AkamacHomePage/Akamac_E-text_Links/Veblen.html

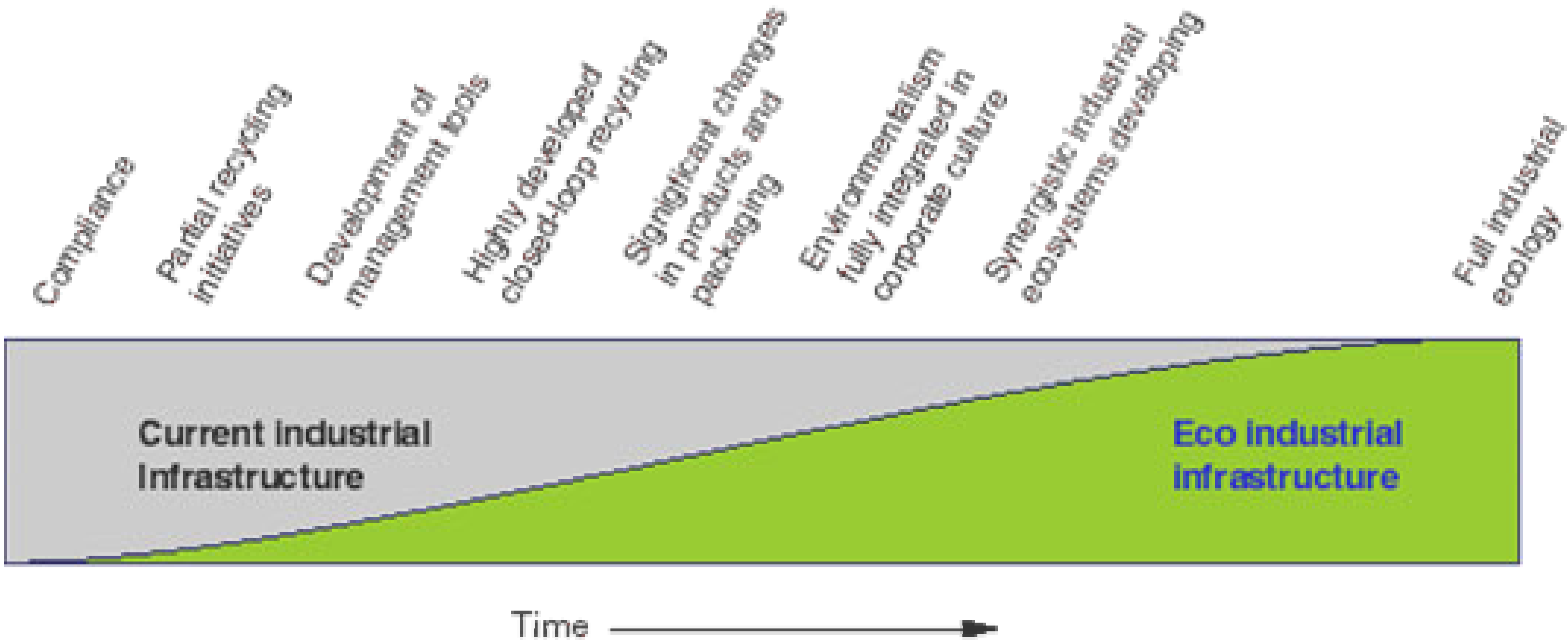
Jobs, Jobs, Jobs

- "President Bush is committed to increasing the productivity and wealth of the American economy and to ensure that all regions, states, and communities share in economic opportunity." ~ David A. Sampson, Assistant Secretary of Commerce for Economic Development

American Jobs
American Values
U.S. Department of Commerce

IE: Other Examples

The Future of IE



Iceland's Hydrogen Fueling Station

That One Guy

References

- http://www.is4ie.org//history.html
- http://www.devensec.com/sustain.html