Consumption - The Final Frontier:

Tracking Progress Using the Washington State Consumer Environmental Index (CEI)

Dr. Jeffrey Morris, Sound Resource Management
Dr. H. Scott Matthews, Carnegie Mellon University
Michelle Morris, Sound Resource Management
Dr. Frank Ackerman, Tufts University

Department of Ecology Presentation – July 9, 2007

FOR BETTER OR FOR WORSE
By LYNN JOHNSTON
PEEL PEEL PEEL PEEL PEEL
DUMP!
COMPOST QUEEN
TIE, TIE, TIE, TIE, TIE
RECYCLE
LOW ENERGY
THIS HOUSE SAVES WATER
BUS STOP
CONSERVE TAKE PUBLIC TRANSIT
BUSGO
BUSGO
5-27 www.fborfw.com
LYNN
© 2007 Lynn Johnston Productions Inc./Dist. By Universal Press Syndicate

Presentation Outline

1) Big picture reasons for CEI
2) CEI graphs preview
3) Life cycle analysis
4) Production, use and end-of-life phases in a product's life cycle
5) Categorizing environmental impacts & aggregating (rolling up) pollutants
6) Weighting climate change, human health and ecosystems toxicity into overall CEI
7) CEI limitations and data gaps
8) Measuring Elly's "What Ifs" with the CEI

Acknowledgements:

Washington State Department of Ecology,
CEI Project Steering Committee:

Dennis Bowhay
Chris Chapman
Cristiana Figueroa-Kaminsky
Ivor Melmore, Project Manager
Gretchen Newman
Cheryl Smith
Ken Zarker

Washington State Department of Ecology staff:

Ellen Caywood
Dan Farrell
David Nightingale
Sally Otterson
Robert Rieck

The Big Picture of Economics

1) Efficiency & Equilibrium – the magic of competitive markets (Adam Smith's invisible hand creates optimality).
2) Externalities – pollution from free disposal (If it doesn't have a price or cost the market ignores it).
3) Equity – dollar votes drive markets (Those without dollars don't get to vote; those with more dollars get more votes).

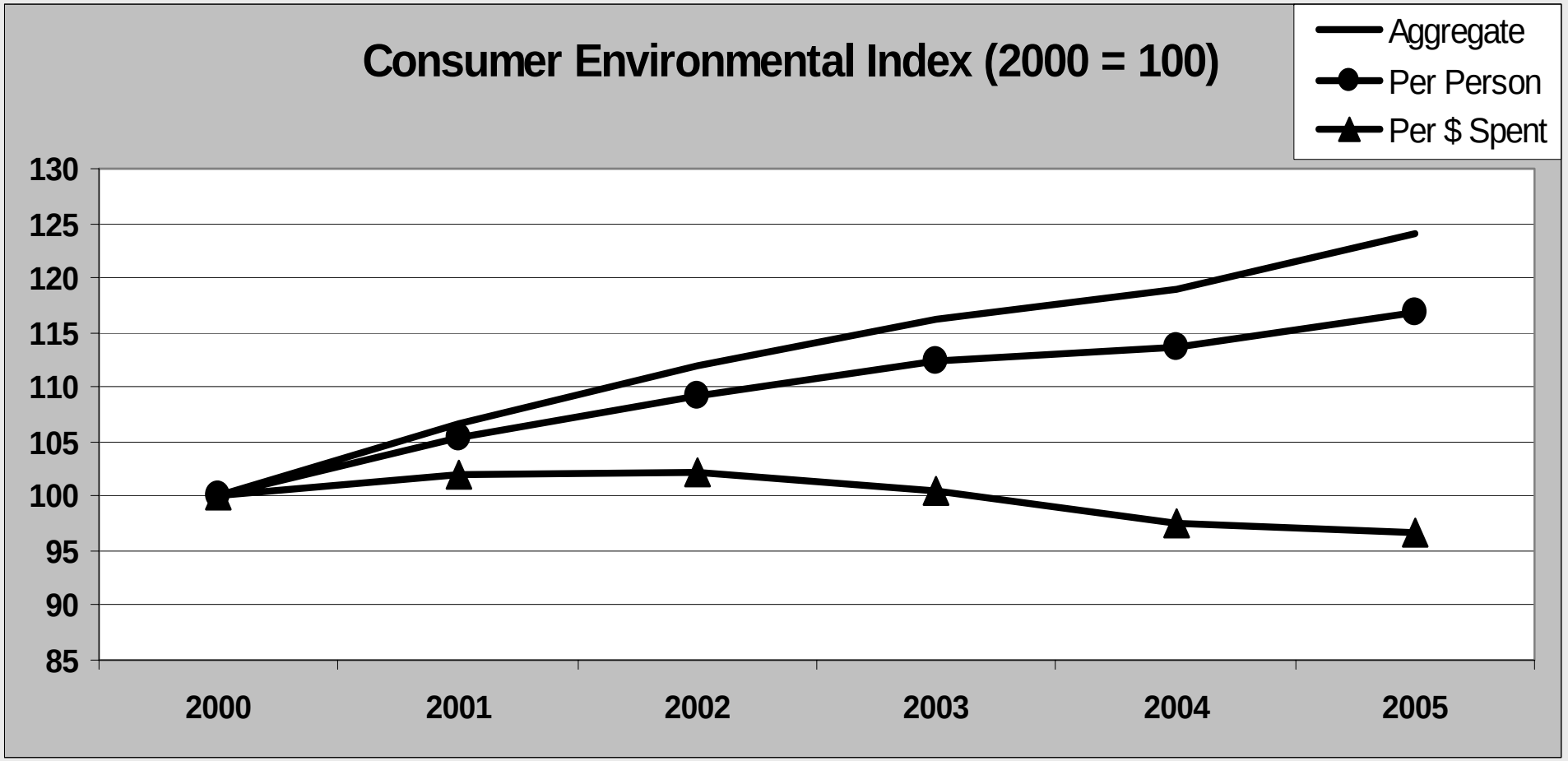
The Big Picture of Beyond Waste

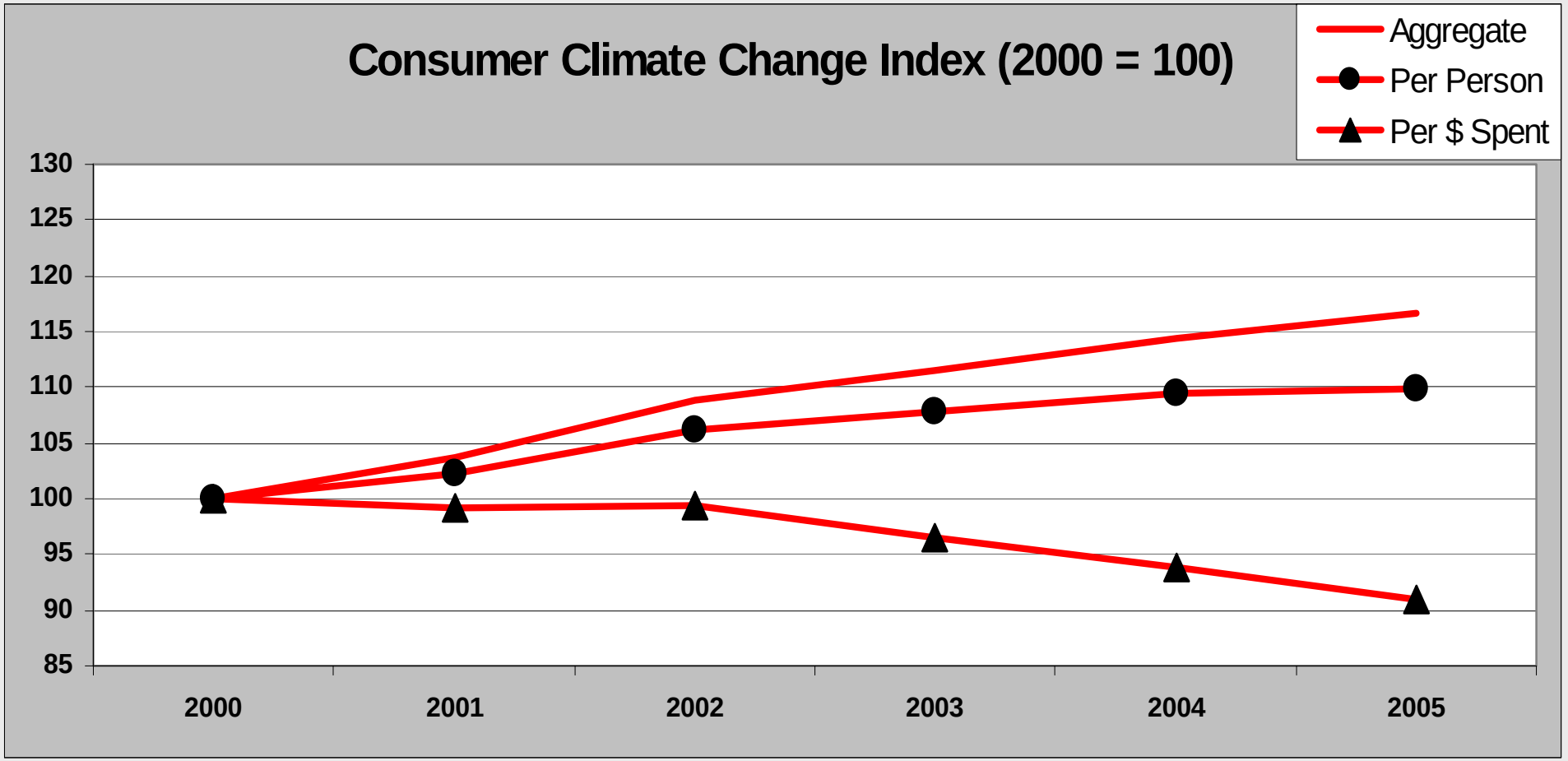
1) Transition to a society where waste is viewed as inefficient, and where most wastes and toxic substances have been eliminated.
2) Consumers demand products and services that have fewer harmful effects on the environment.
3) Develop “Basket of Goods” indicator to measure progress on Beyond Waste.

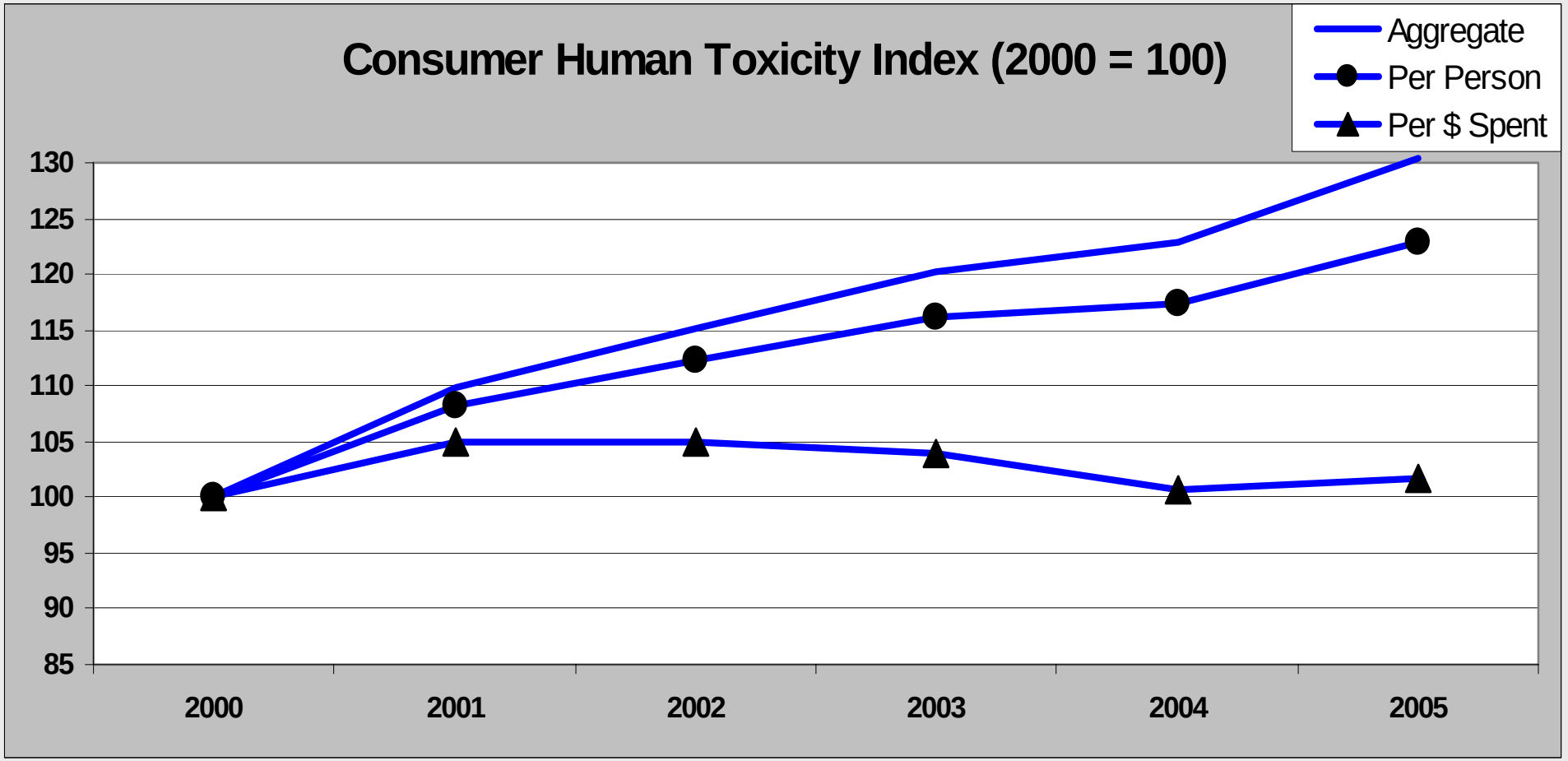
The CEI Solution

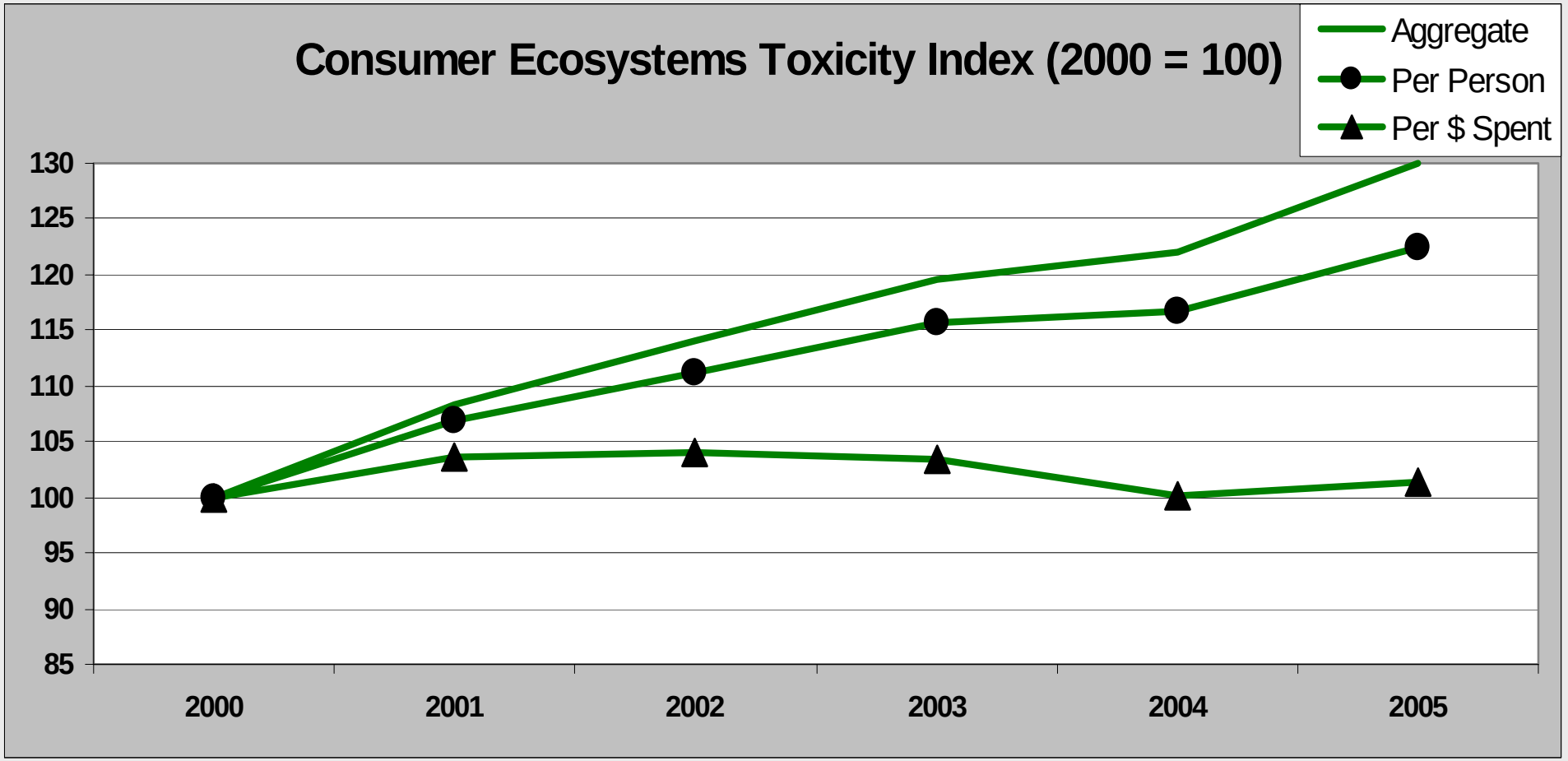
- An index like the CPI - except covers all consumer purchases, not just unchanging basket, and measures changes over time in environmental impacts, rather than prices.
- Tracks the environmental impact of consumer choices on (1) climate change, (2) public health, and (3) ecosystems health.
- Should decline when there are decreases in toxic substances, wastes and/or pollution associated with production, use, and disposal of the goods and services consumers demand.

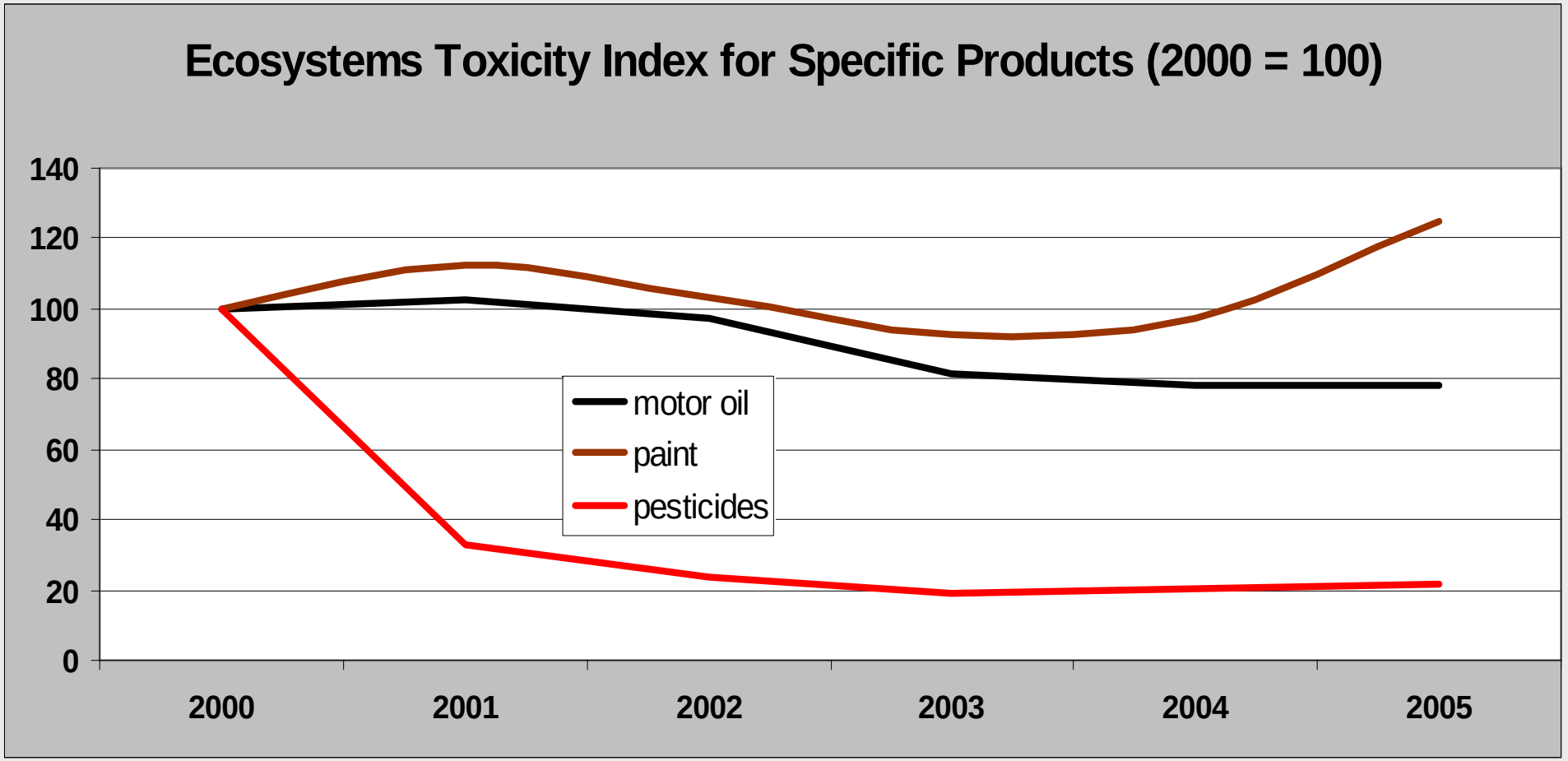
Previews of Coming Attractions


Consumer Environmental Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

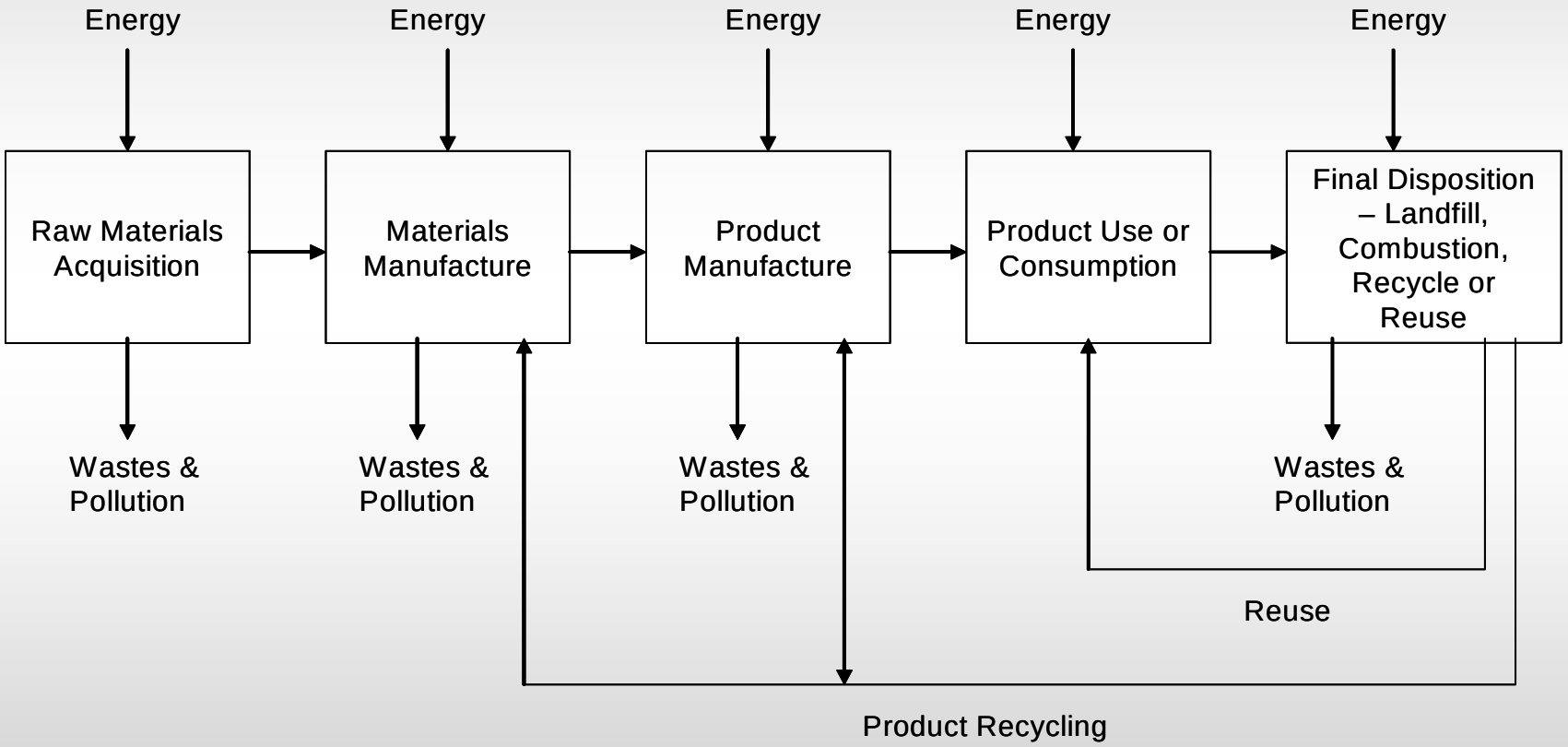

Consumer Climate Change Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Human Toxicity Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Ecosystems Toxicity Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Ecosystems Toxicity Index for Specific Products (2000 = 100)
140
120
100
80
60
40
20
0
2000
2001
2002
2003
2004
2005
motor oil
paint
pesticides

Life Cycle Analysis (LCA) to the Rescue



One or limited number of return cycles into product that is then disposed – open-loop recycling. Repeated recycling into same or similar product, keeping material from disposal – closed-loop recycling.

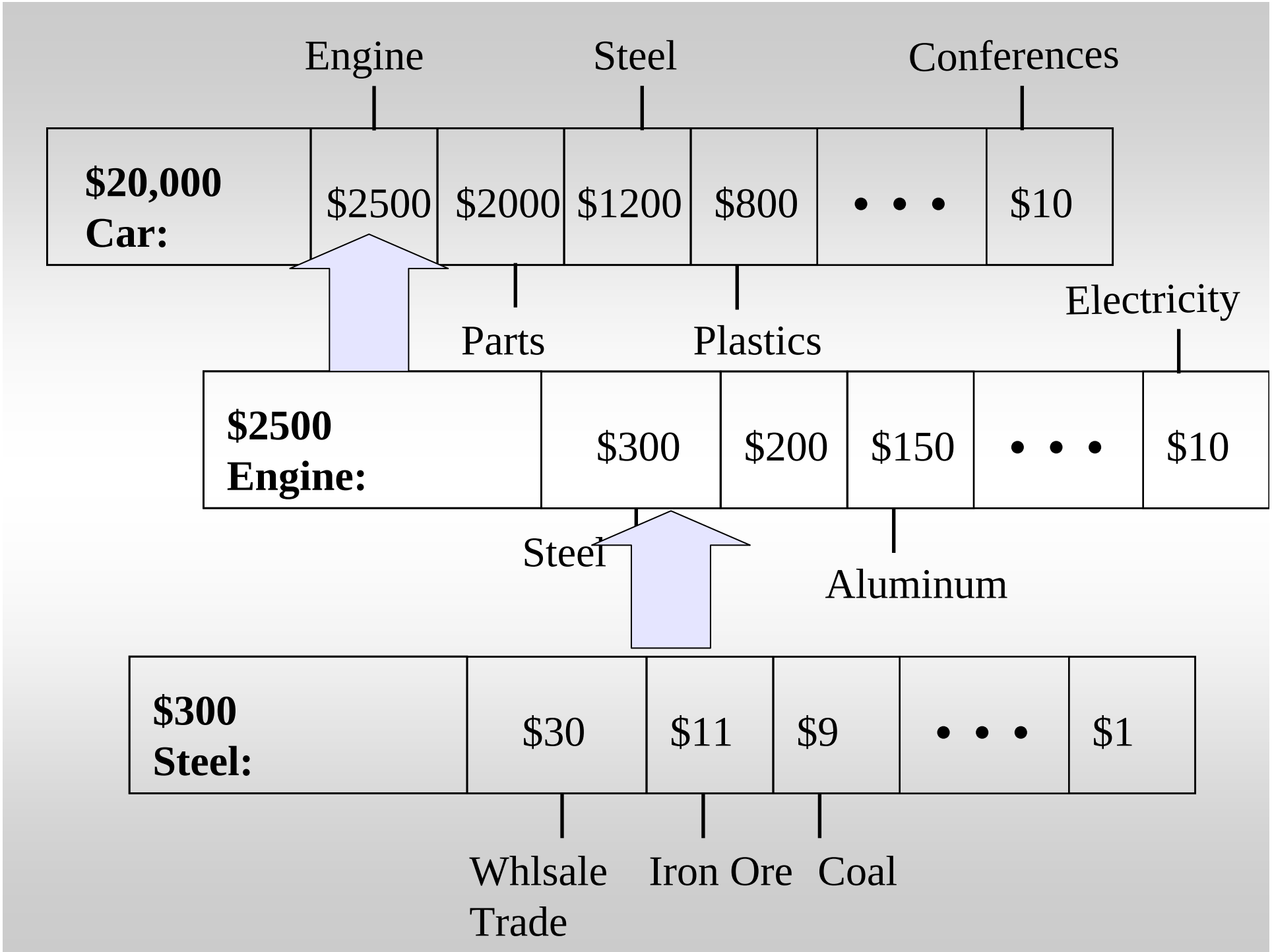
3 Phases to a Product's Life Cycle

1) Upstream - "cradle".
2) Use.
3) End-of-Life (EOL) - "grave", or if recycling rather than disposal is EOL fate, then "cradle".

Upstream LCA

Two Main Methods for LCA for Upstream Phase of Product Life Cycle

1) Process LCI – measure inputs and outputs by examining the processes in the supply chain that provide the feedstock for manufacturing a product.
2) Economic input-output LCI – measure inputs and outputs by examining the interrelationships among the sectors of the economy.


Engine
Steel
Conferences
$20,000 Car:
$2500
$2000
$1200
$800
• • •
$10
Parts
Plastics
Electricity
$2500 Engine:
$300
$200
$150
• • •
$10
Steel
Aluminum
$300 Steel:
$30
$11
$9
• • •
$1
Whlsale Trade
Iron Ore
Coal

Issue – What Include, What Exclude?

- Process LCA: ideally include all processes back through the supply chain.
- In a process LCA, time and financial constraints always prevent attaining ideal.
- IO-LCA: include the entire economy based on interrelationships among industrial sectors.
- In an IO-LCA, the products described by a sector are representing an average product not a specific one.

Advantages of Each Type LCA

Process LCA	EIO-LCA
• Detailed process-specific analyses • Specific product comparisons • Process improvements/weak point analyses • Future product development assessments	• Economy-wide, comprehensive assessments (all direct and indirect environmental effects included) • Sensitivity analyses/scenario planning • Publicly available data, reproducible results • Future product development assessments • Information on every commodity in the economy

Disadvantages of Each Type LCA

Process LCA	EIO-LCA
• System boundary setting subjective • Tend to be time intensive and costly • New process design difficult • Use of proprietary data • Cannot be replicated if confidential data are used • Uncertainty in data	• Some product assessments contain aggregate data • Process assessments difficult • Difficulty in linking dollar values to physical units • Economic and environmental data may reflect past practices • Imports treated as U.S. products • Difficult to apply to an open economy (with substantial non-comparable imports) • Non-U.S. data availability a problem • Uncertainty in data

EIO-LCA Model

- Implementation of US Department of Commerce published IO tables
  - Current benchmark: 1997 (2002 soon)
- Long-term project: 10 years in making
  - Free , online at www.eiolca.net
- Widely used for LCA research in the US
  - More than 100 peer-reviewed papers on development and application
  - More than 1 million uses of the model

EIO-LCA Implementation for Upstream

- Use EIO-LCA model data
  - 491 x 491 IO matrix from 1997 (BEA).
  - Links economic transaction data with public data on energy, environmental flows
    - e.g., if $200 B of electricity production emits 200 billion kg of CO2, then $1M of electricity emits 1 million kg of CO2

Use & EOL LCAs

What About LCA for Use and EOL Phases?

- Rely mainly on product specific emissions data for Use phase – e.g., Ecology data on emissions from home and vehicle fuels; product analyses for oil, paints and pesticides.
- Rely on process LCAs for EOL phase – e.g., US EPA/RTI/NCSU Decision Support Tool for MSW Management and US EPA WARM model.

LCA Impact Assessment:
Categorization of Impacts
&
Indexing of Pollutants

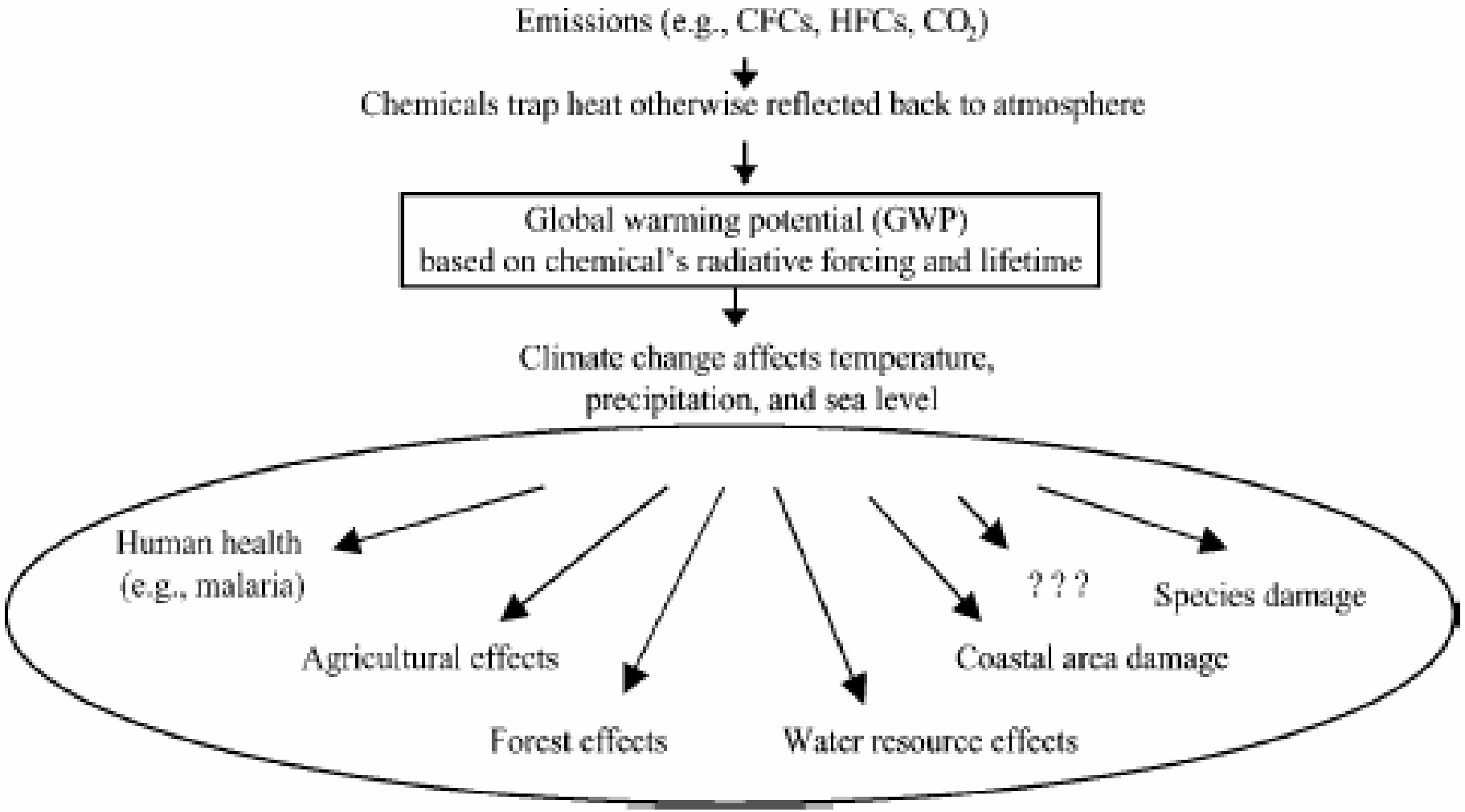
The Big Picture of LCA

1) Every waste and pollutant has impact.
2) Thousands/millions of chemicals in use by businesses & households.
3) Less than 600 pollutants tracked by EPA's Toxic Release Inventory (TRI).
4) Even a report card with 600 line items is mind boggling.

Impact Categories

1) Global warming
2) Human health – criteria air pollutants (particulates, SOx and NOx)
3) Human health – non-cancers (toxics)
4) Human health – cancers (carcinogens)
5) Ecosystem toxicity
6) Acidification
7) Eutrophication
8) Others - ozone depletion, smog formation, habitat alteration, resource/fossil fuel depletion, water consumption, indoor air quality

Midpoint Modeling for Global Warming Potential



Methods for Indexing Pollutants That Cause Environmental Impacts

1) Ecological Footprint
2) Monetization
3) Health Scores (DALYs and QALYs)
4) EcoIndicators99 (European)
5) US EPA's Risk Screening Environmental Indicators (RSEI)
6) US DOC NIST's BEES Model
7) US EPA's Tool for the Reduction and Assessment of Chemical Impacts (TRACI)
8) CalTOX Risk Assessment Model
9) UNEP-SETAC Harmonization Model

CEI Impact Categories & Their Indicator Pollutants (Numeraire)

1) Global warming (eCO2)
2) Human health - particulates, SOx and NOx (ePM2.5)
3) Human health – toxics (eToluene)
4) Human health – carcinogens (eBenzene)
5) Ecosystem toxicity (e2,4-D)

Interpretation:
Weighting the CEI Categories in order to Calculate a Single Index

3 Weighting Options from BEES

1) US EPA Science Advisory Board - 1990.
2) Harvard Kennedy School - 1992.
3) BEES Expert Meeting Consensus - 2006.

BEES 2006 Weights: CEI Impact Categories

1) Climate change: 45%
2) Human health - particulates, SOx and NOx: 14%
3) Human health – toxics: 7%
4) Human health – carcinogens: 13%
5) Ecosystem toxicity/habitat: 21%

Note: EPA SAB 1990 weights:

climate change = 27%

human health = 28

ecotoxicity/habitat = 45

CEI Limitations, Data Gaps & Uncertainty

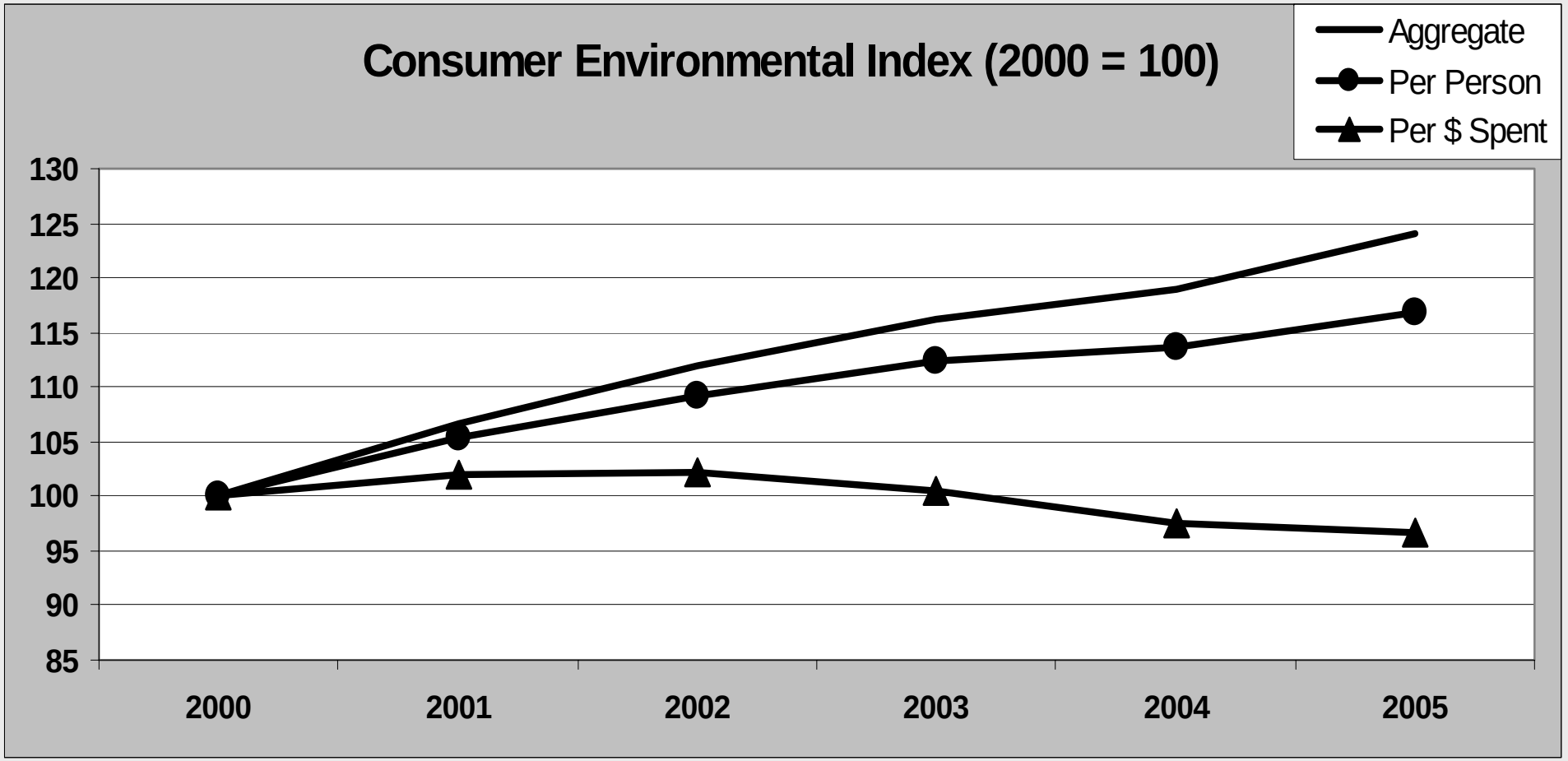
Important Issues for Project Team & Peer Reviewers

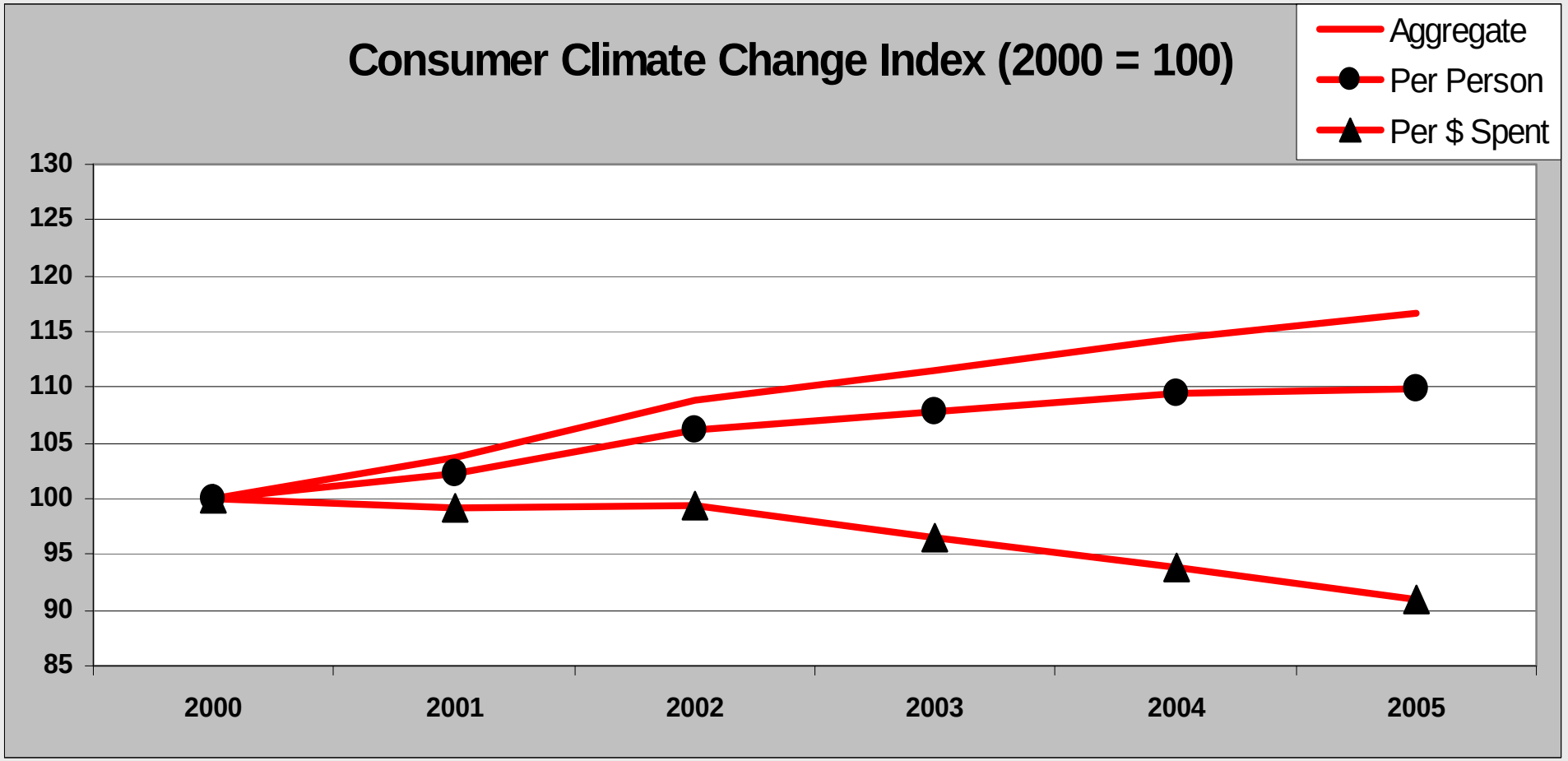
- TRI limitations - e.g., agriculture
- Impacts not covered – e.g., habitat and ecosystem services degradations
- Use phase coverage not complete – e.g., household cleaning/laundering products and pharmaceuticals
- New home construction not included
- Differential impacts of domestic vs. foreign production

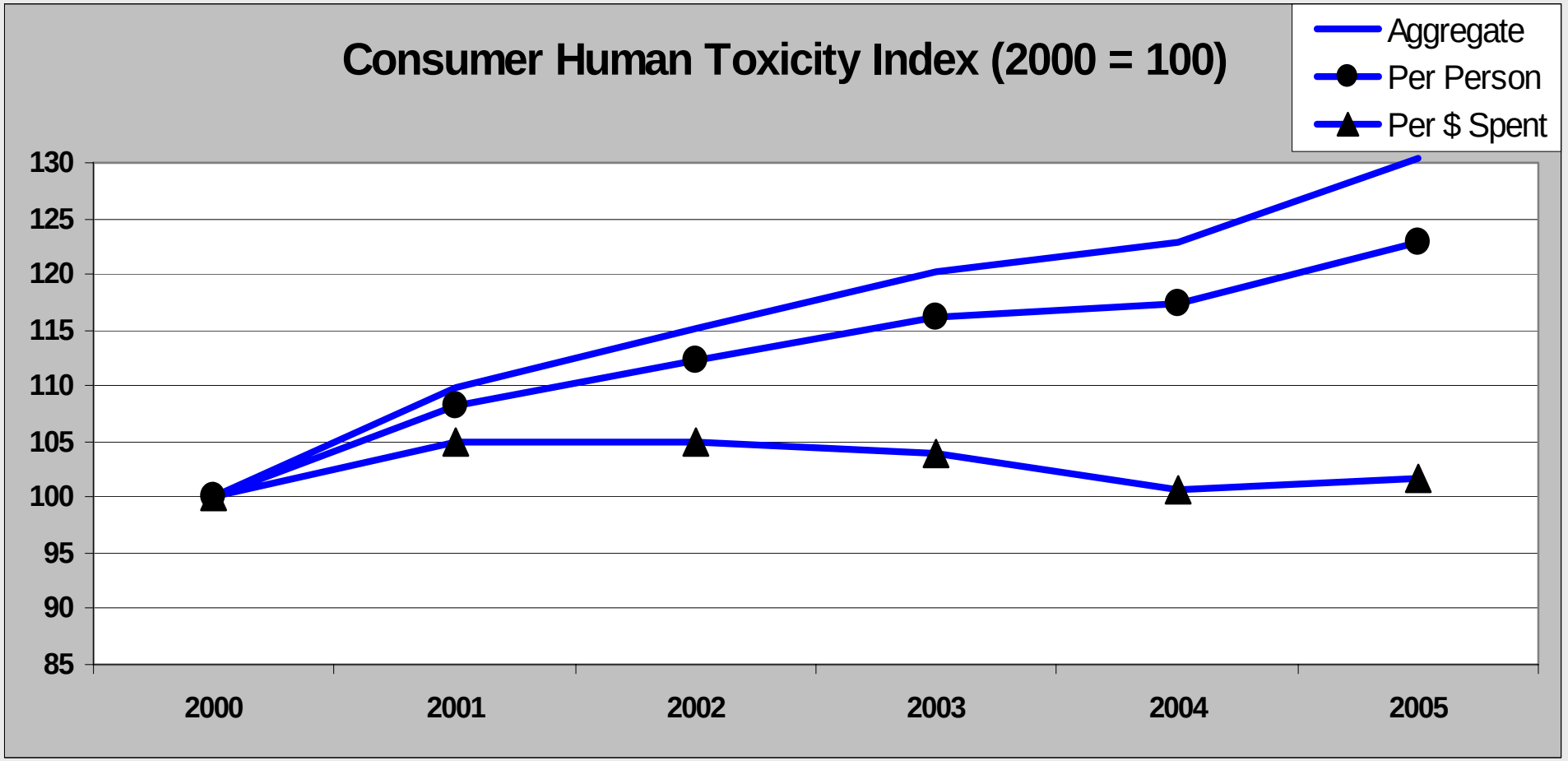
Imports as Example of CEI Robustness

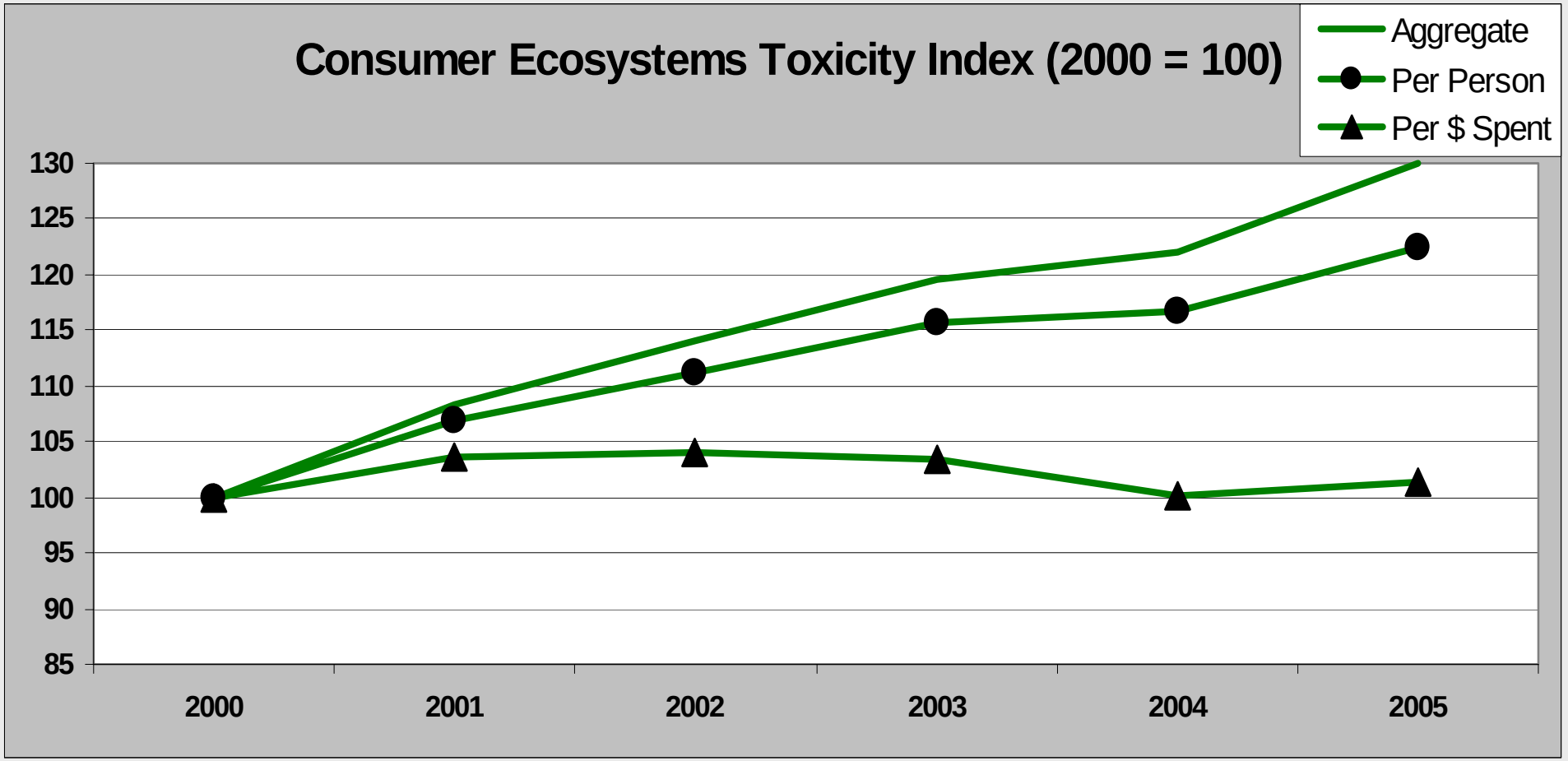
- Weber and Matthews study – US produced 22% of eCO2 in 2005, but US consumption accounted for 25-26%, about 15% more than production.
- This could mean that CEI model climate change impacts could be 15% higher.
- If 15% higher in all years 2000-2005, then CEI climate change component only up from 116.6 to 117.1, and overall CEI up from 124.1 to 124.3.

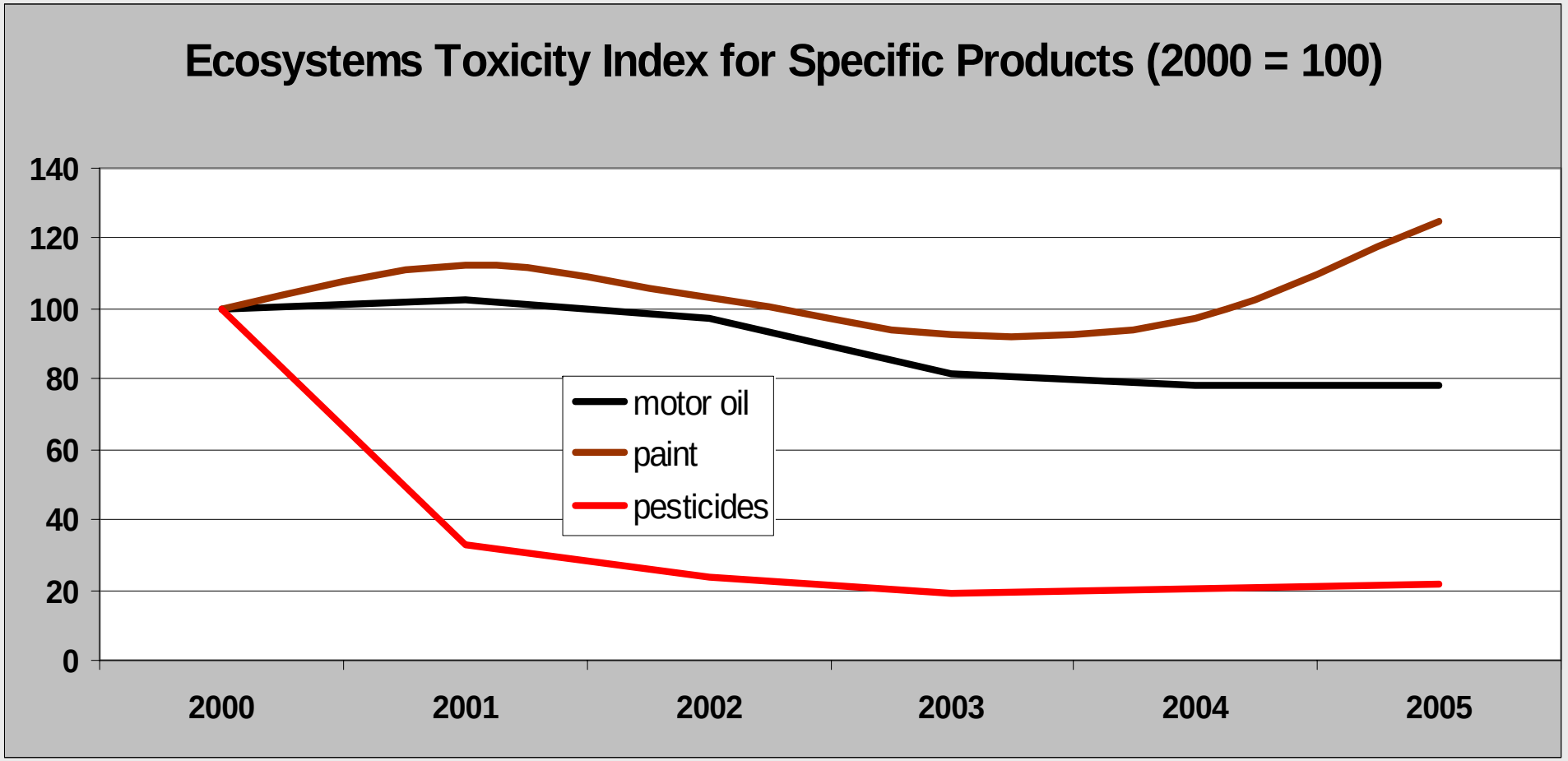
Results So Far


Consumer Environmental Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Climate Change Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

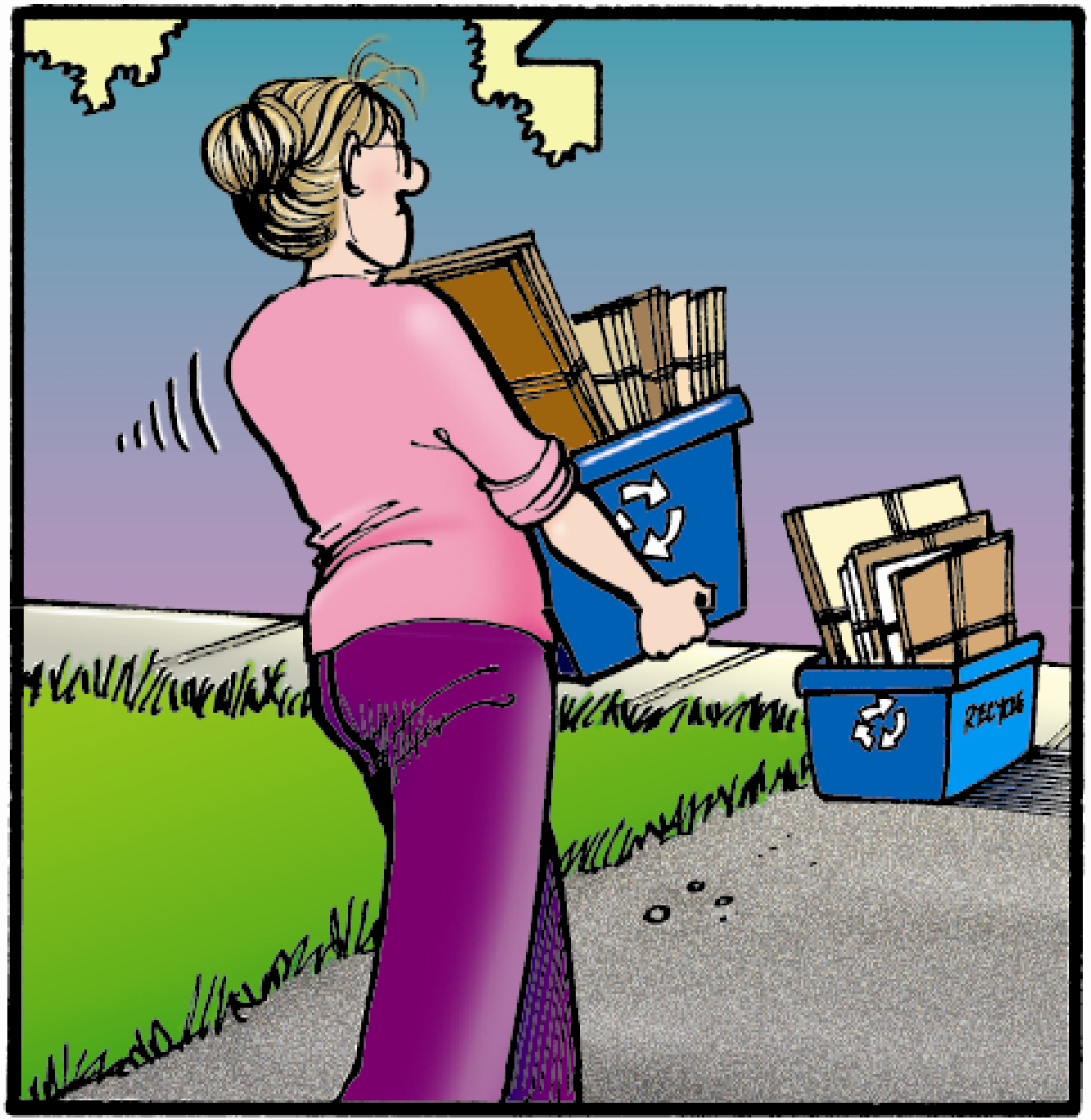

Consumer Human Toxicity Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Ecosystems Toxicity Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

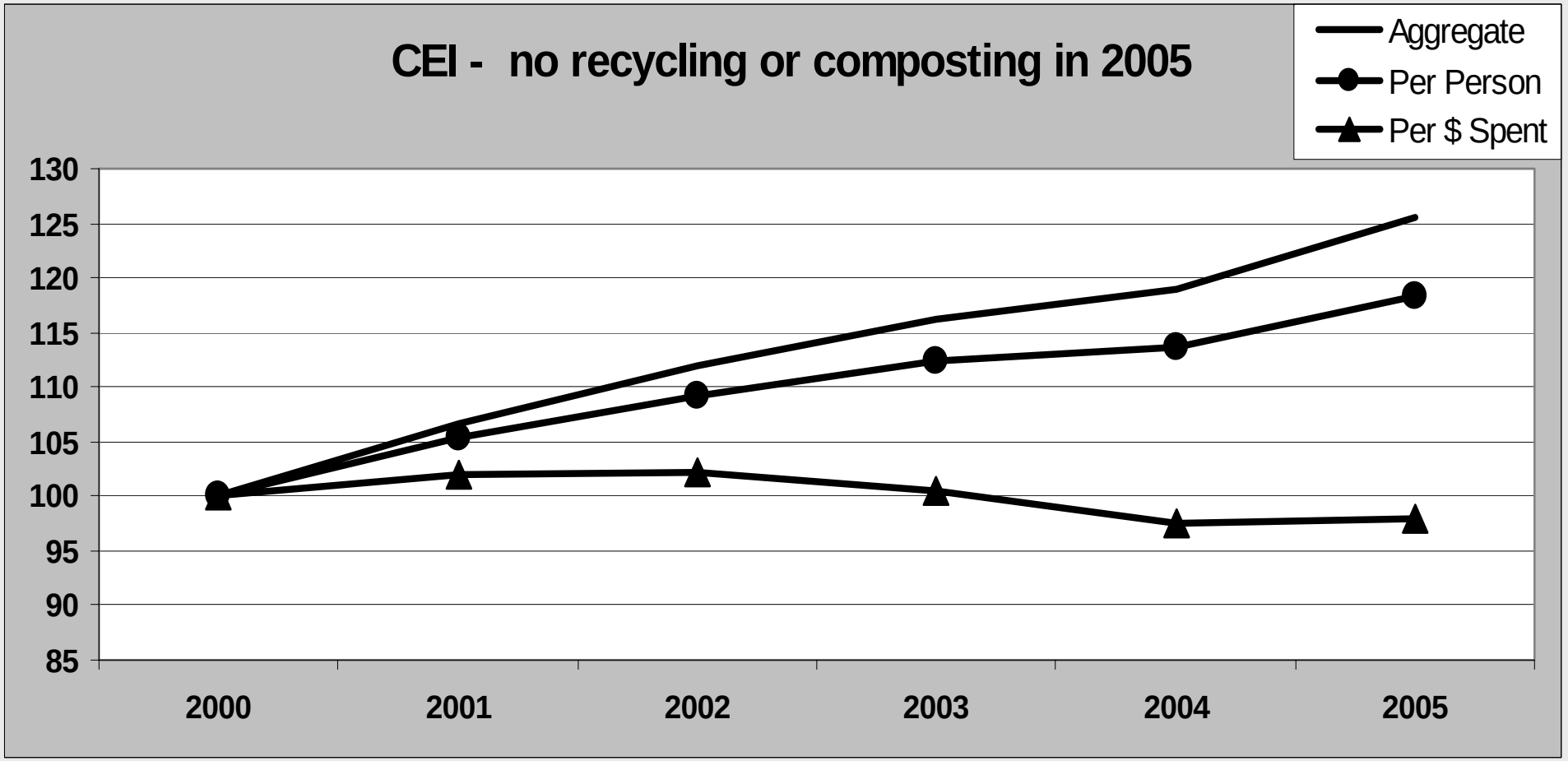

Ecosystems Toxicity Index for Specific Products (2000 = 100)
140
120
100
80
60
40
20
0
2000
2001
2002
2003
2004
2005
motor oil
paint
pesticides

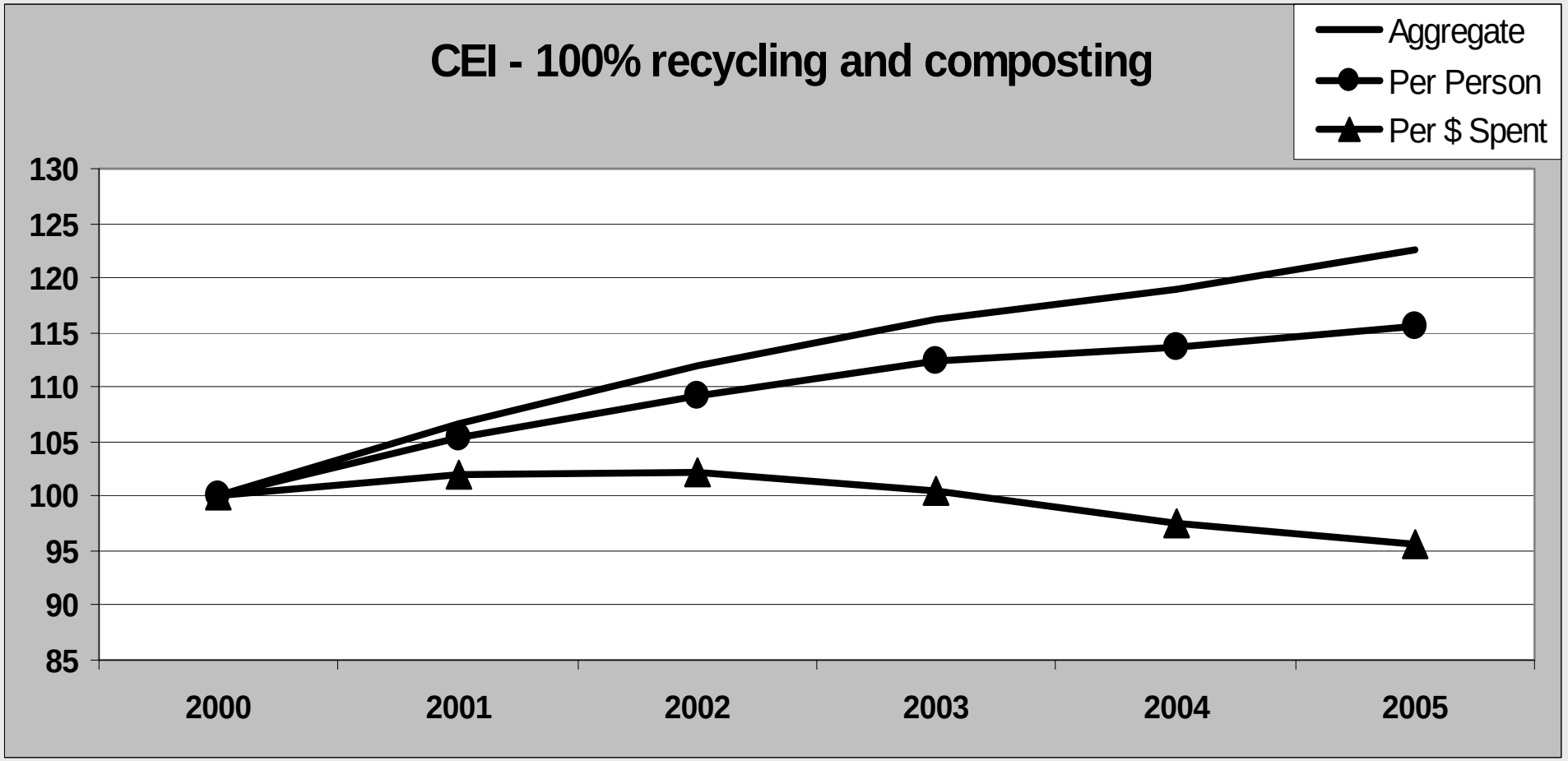
Some “What Ifs”

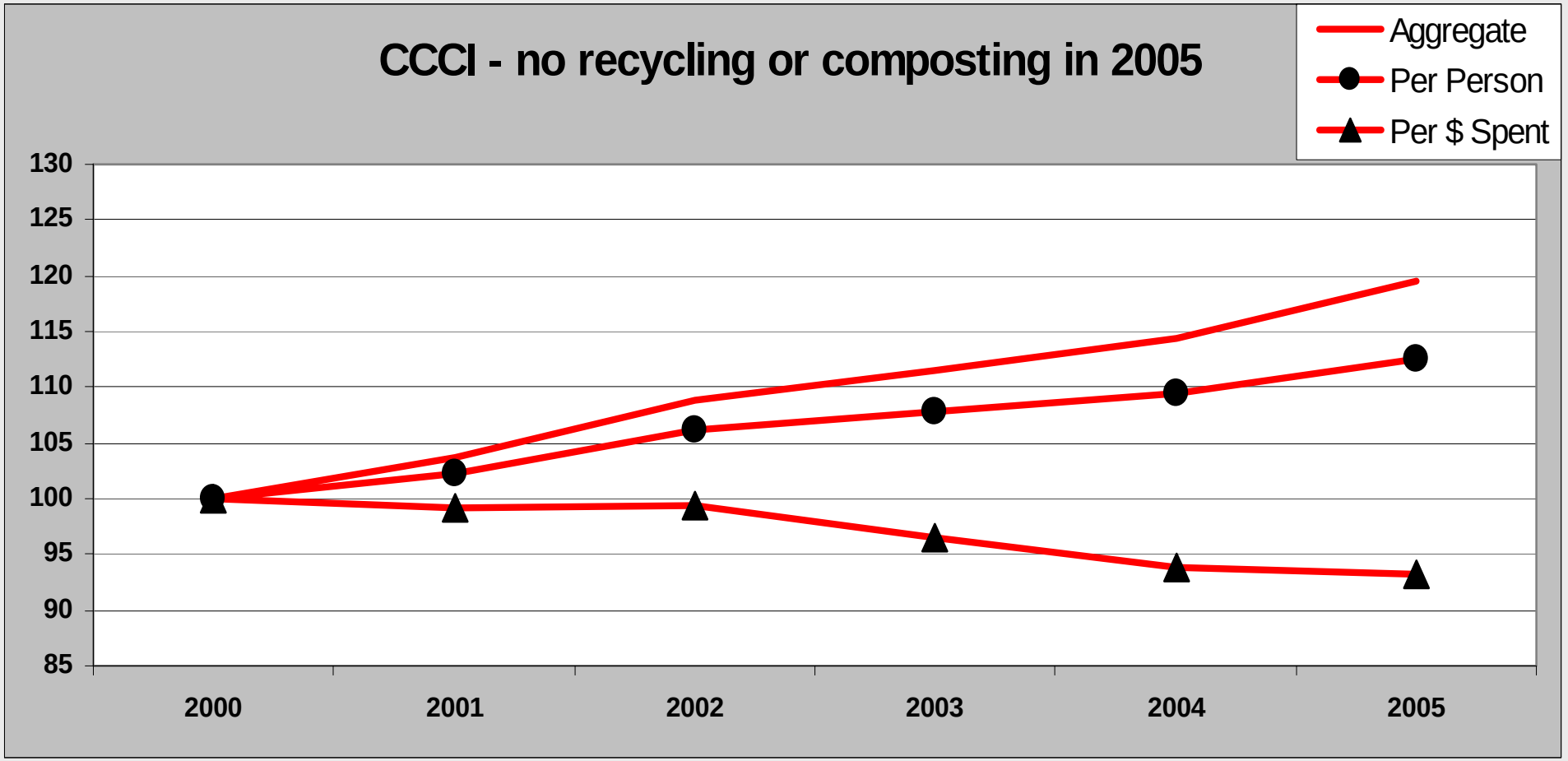
DUMP!
COMPOST
QUEEN

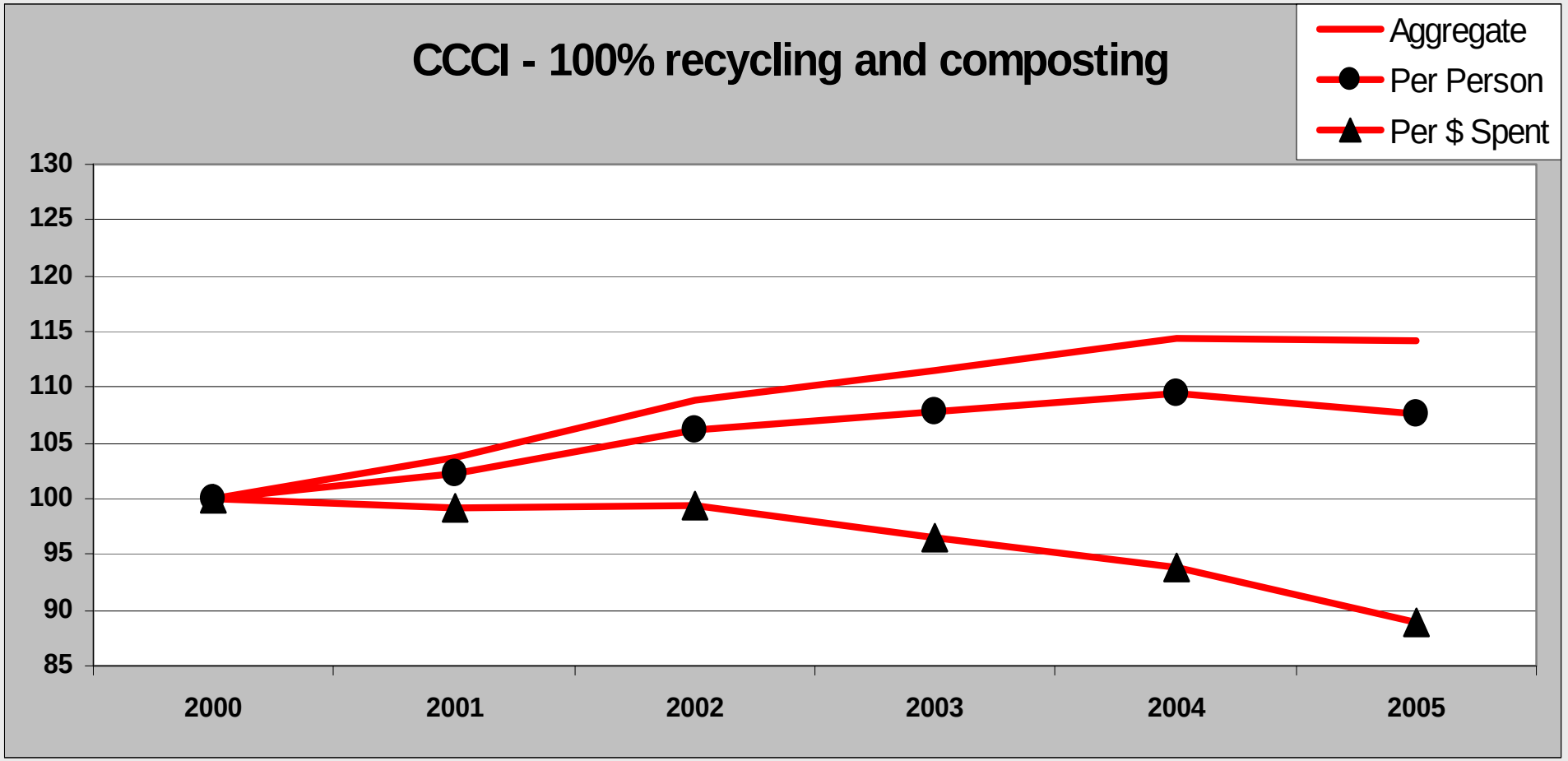


RECYCLE


CEI - no recycling or composting in 2005
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

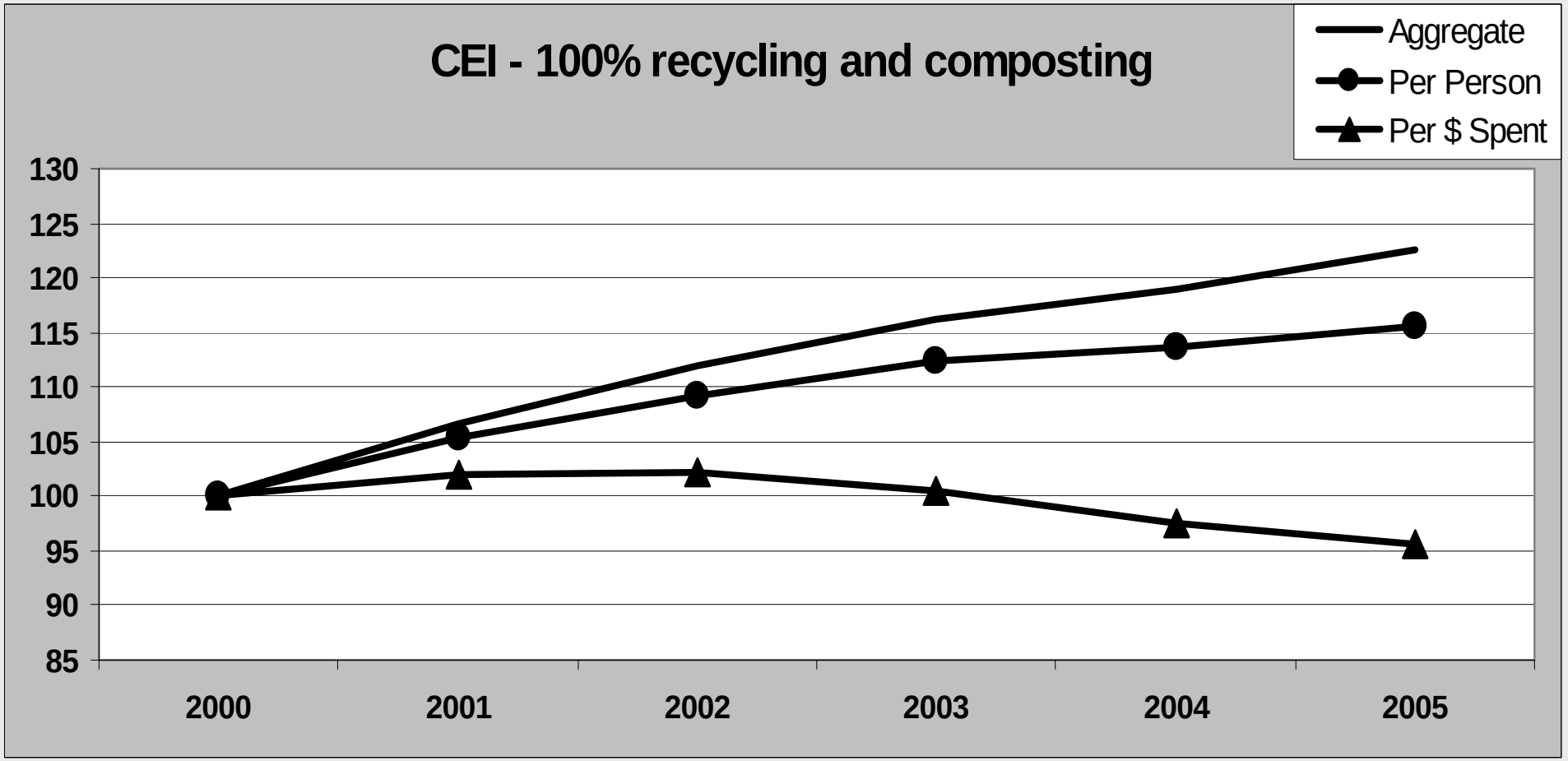

CEI - 100% recycling and composting
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

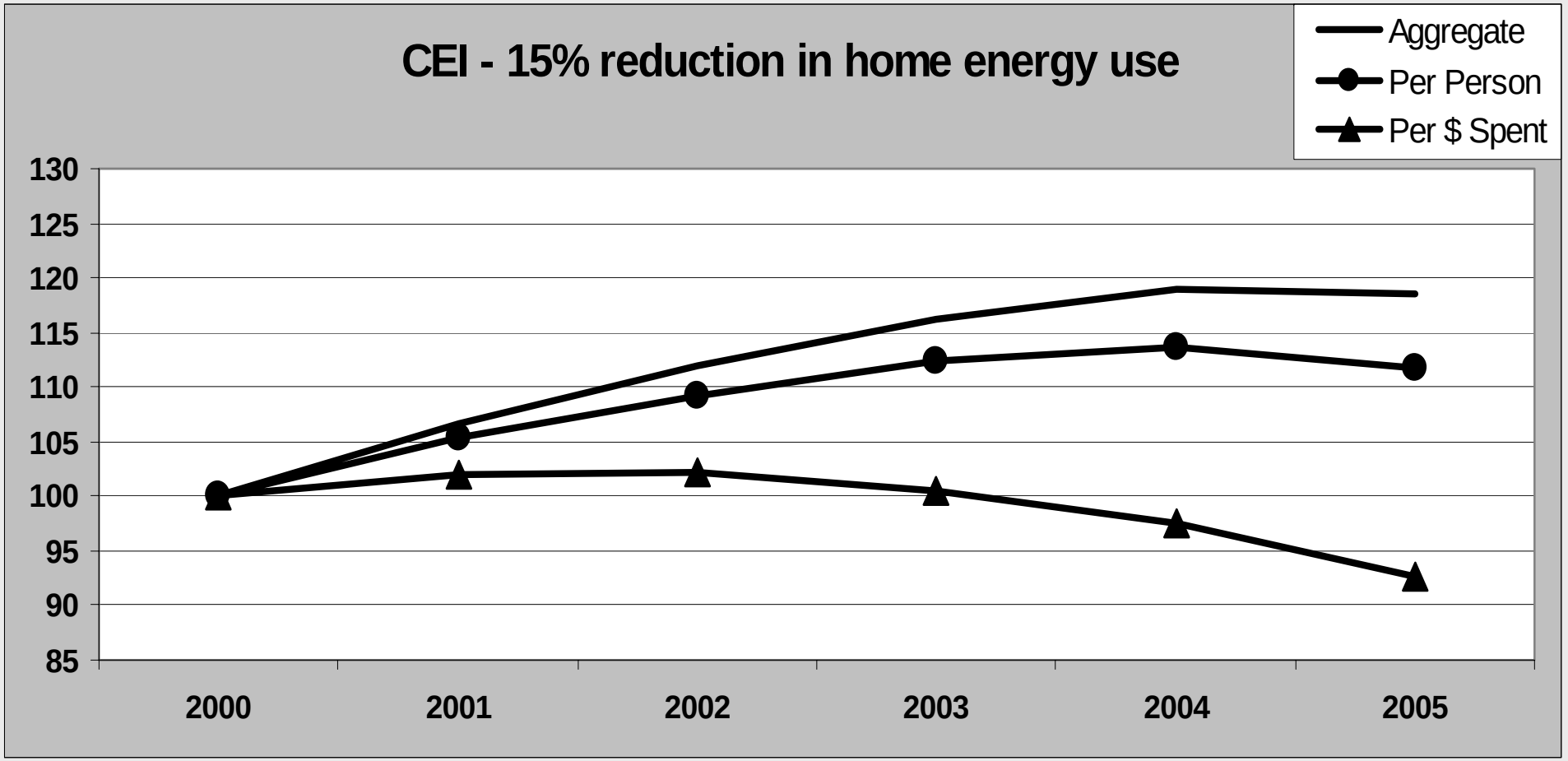

CCCI - no recycling or composting in 2005
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

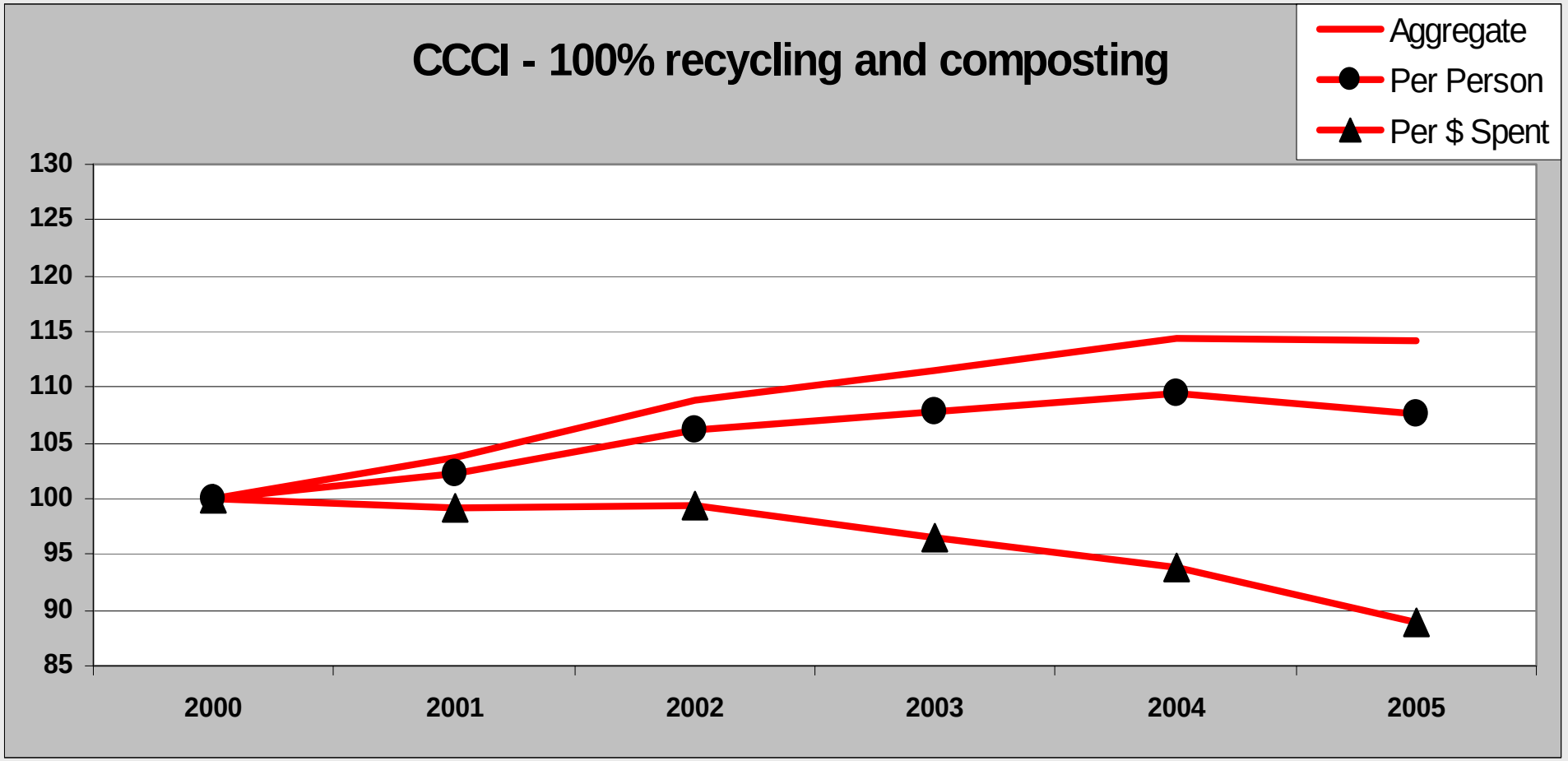

CCCI - 100% recycling and composting
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

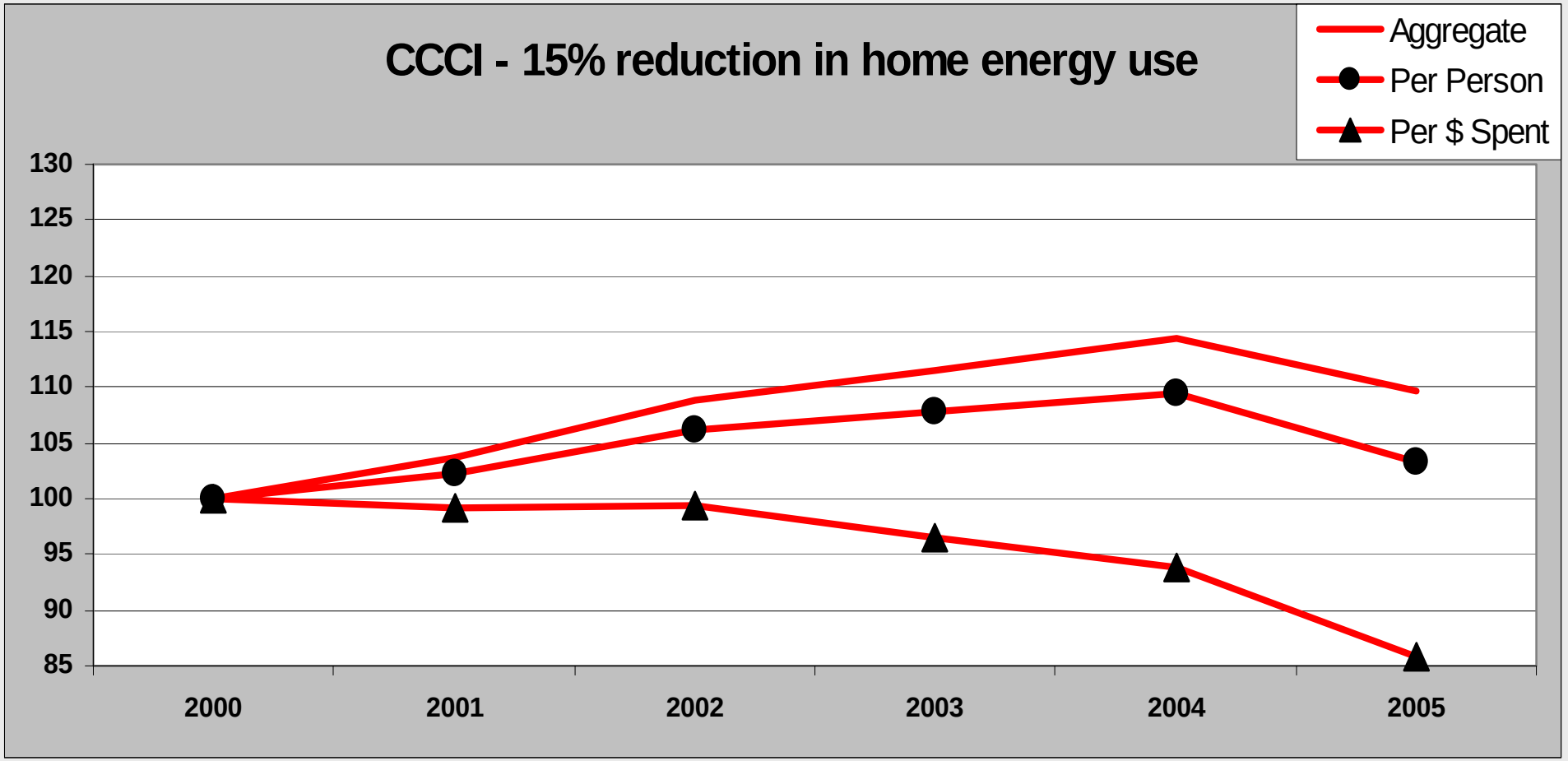
© 2007 Lynn Johnston Productions Inc./Dist. By Universal Press Syndicate

THIS
HOUSE
SAVES
WATER

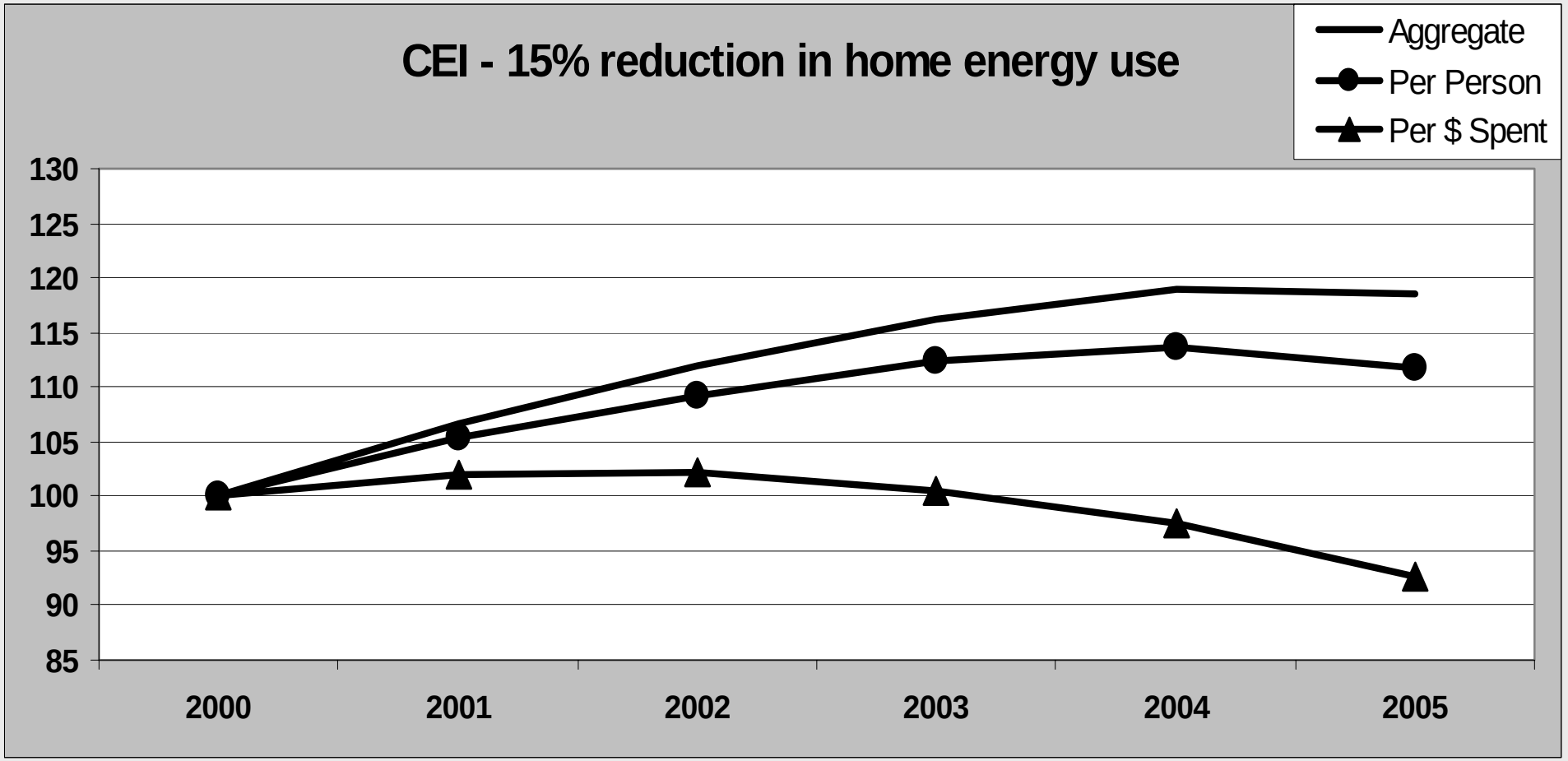

CEI - 100% recycling and composting
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

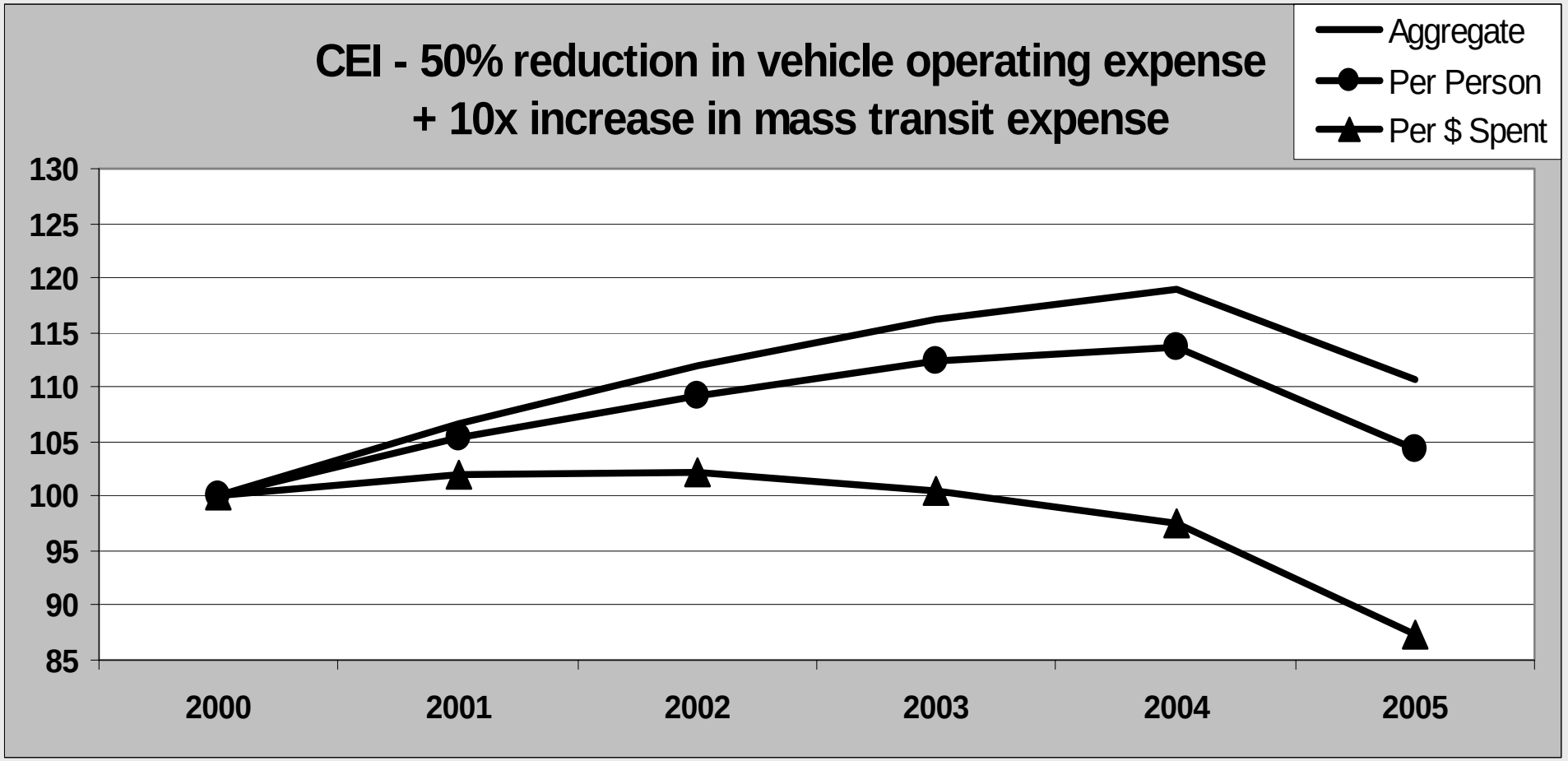

CEI - 15% reduction in home energy use
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

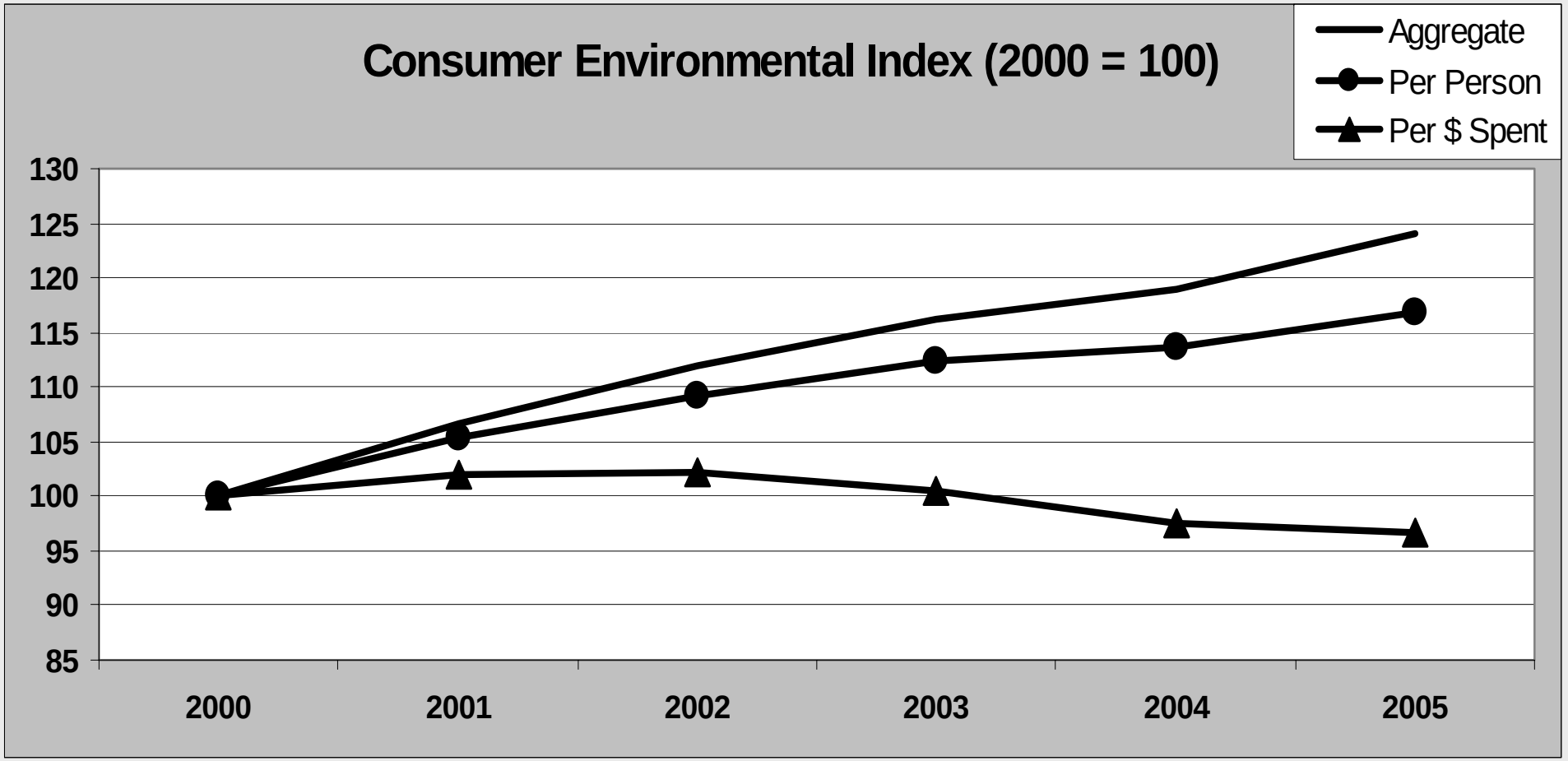

CCCI - 100% recycling and composting
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

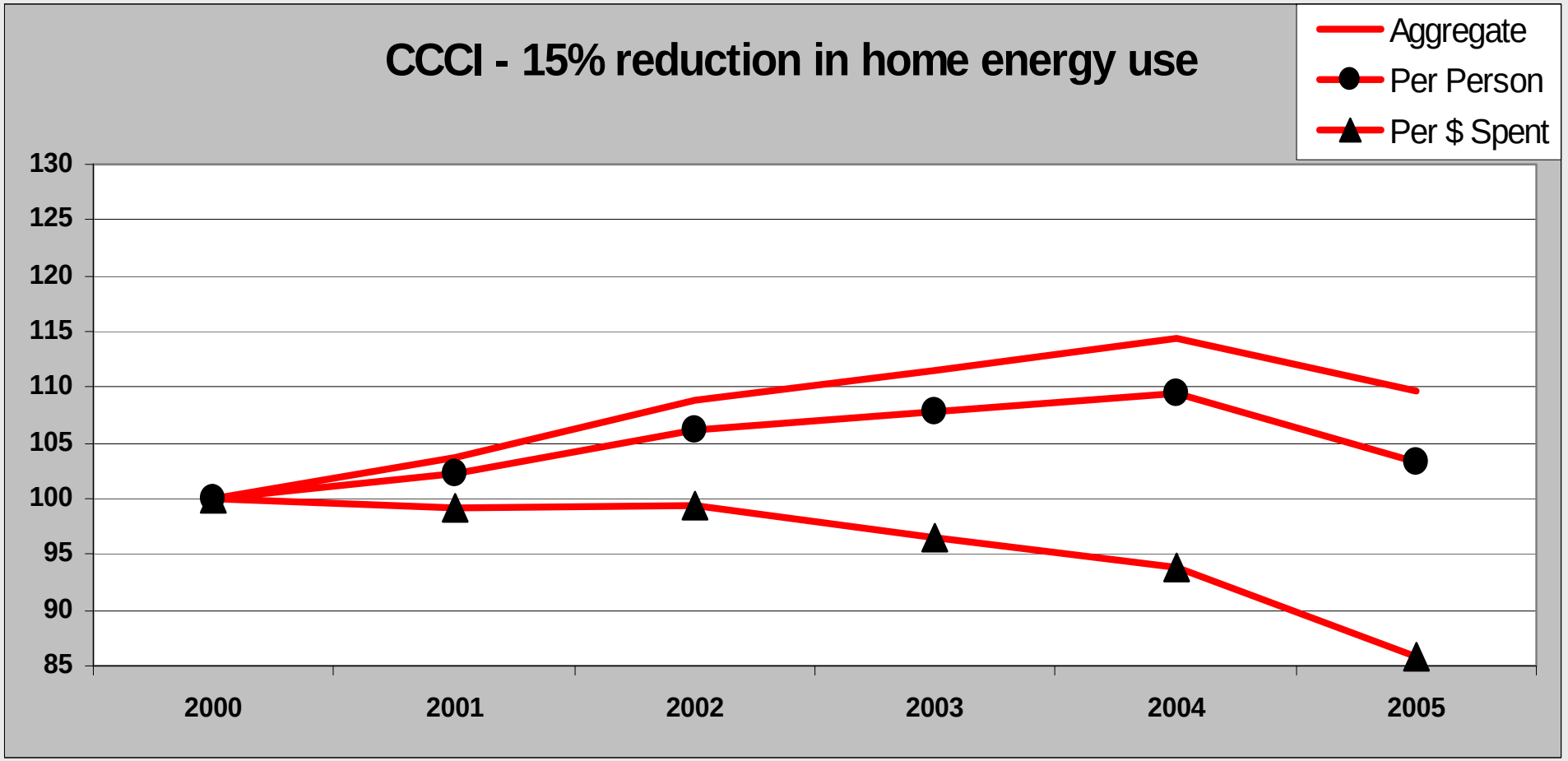

CCCI - 15% reduction in home energy use
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

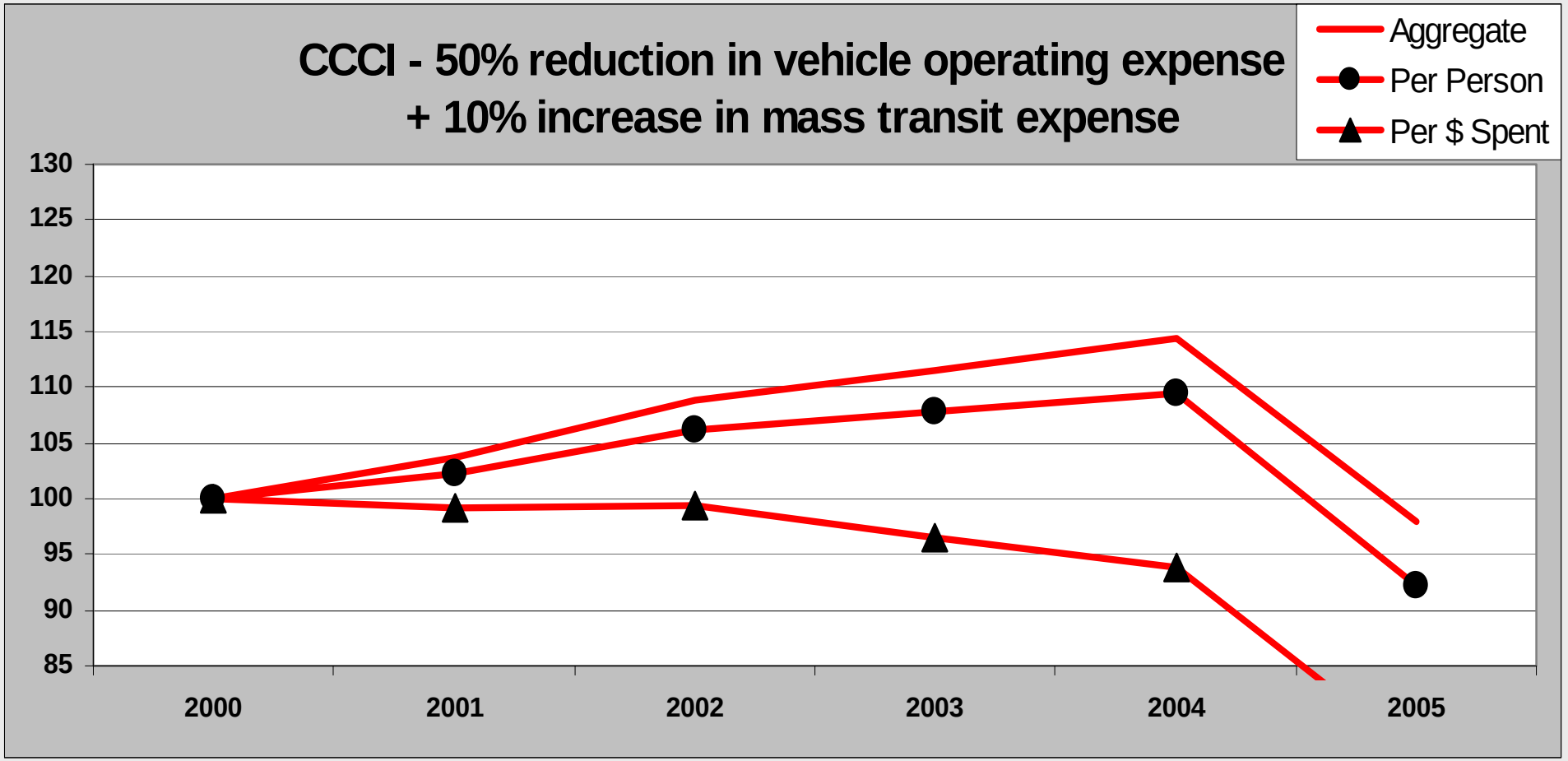
BUS
STOP
CONSERVE
TAKE PUBLIC
TRANSIT
BUSGO

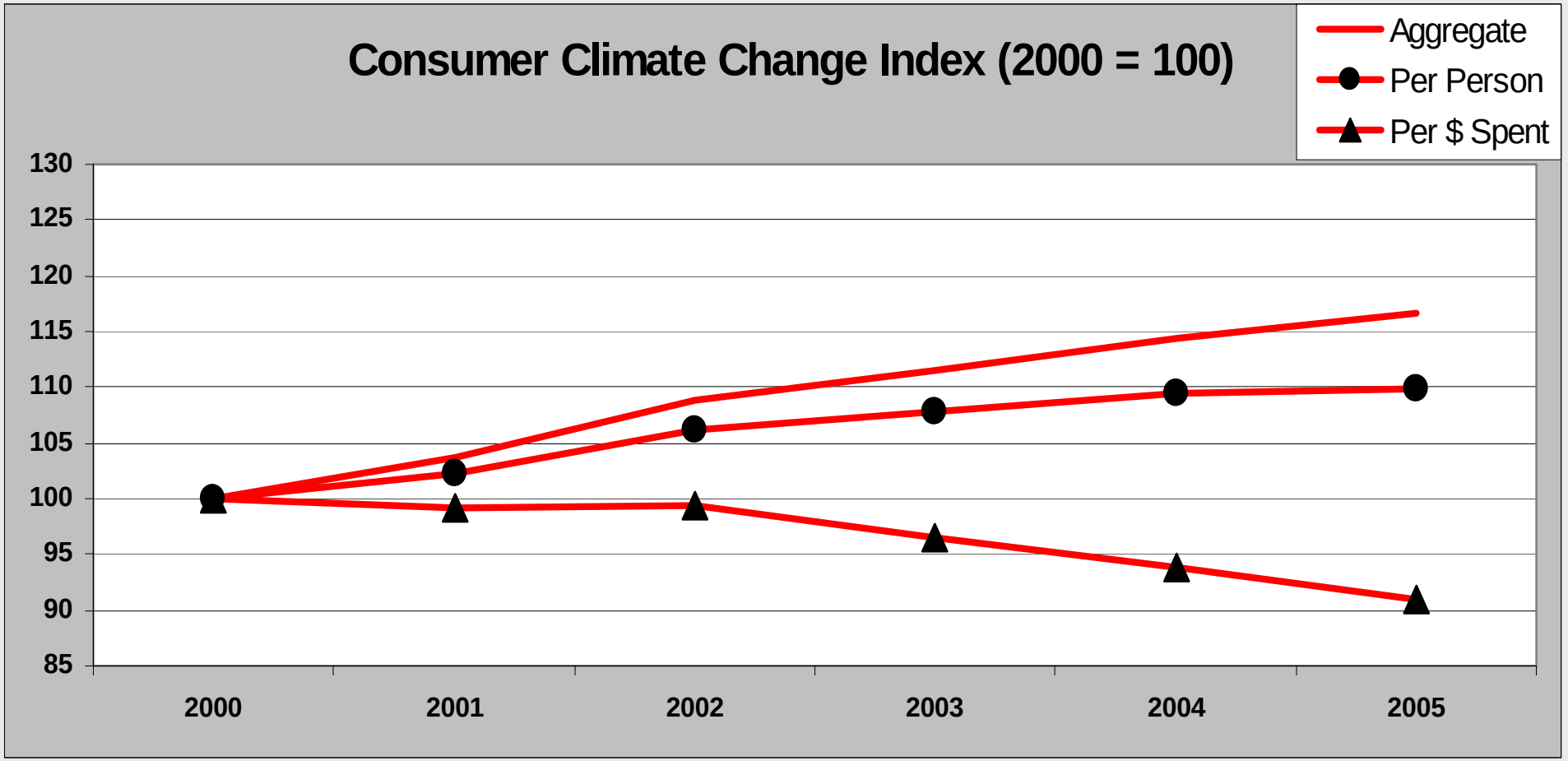

CEI - 15% reduction in home energy use
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


CEI - 50% reduction in vehicle operating expense
+ 10x increase in mass transit expense
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Environmental Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


CCCI - 15% reduction in home energy use
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


CCCI - 50% reduction in vehicle operating expense
+ 10% increase in mass transit expense
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005


Consumer Climate Change Index (2000 = 100)
Aggregate
Per Person
Per $ Spent
130
125
120
115
110
105
100
95
90
85
2000
2001
2002
2003
2004
2005

Possible Next/Future Steps

- Finish 2005 update.
- Update upstream data when CMU updates the EIO-LCA model.
- Update TRACI pollutant weights when EPA completes TRACI update.
- Add products to use phase.
- Add impact categories.
- Add new home construction.
- Add impacts from growth in imports.

The End: Thank you!