Use of LCA Methods For The Recycling vs. Disposal Issue: Prices & Costs vs. Energy & Environmental Impacts

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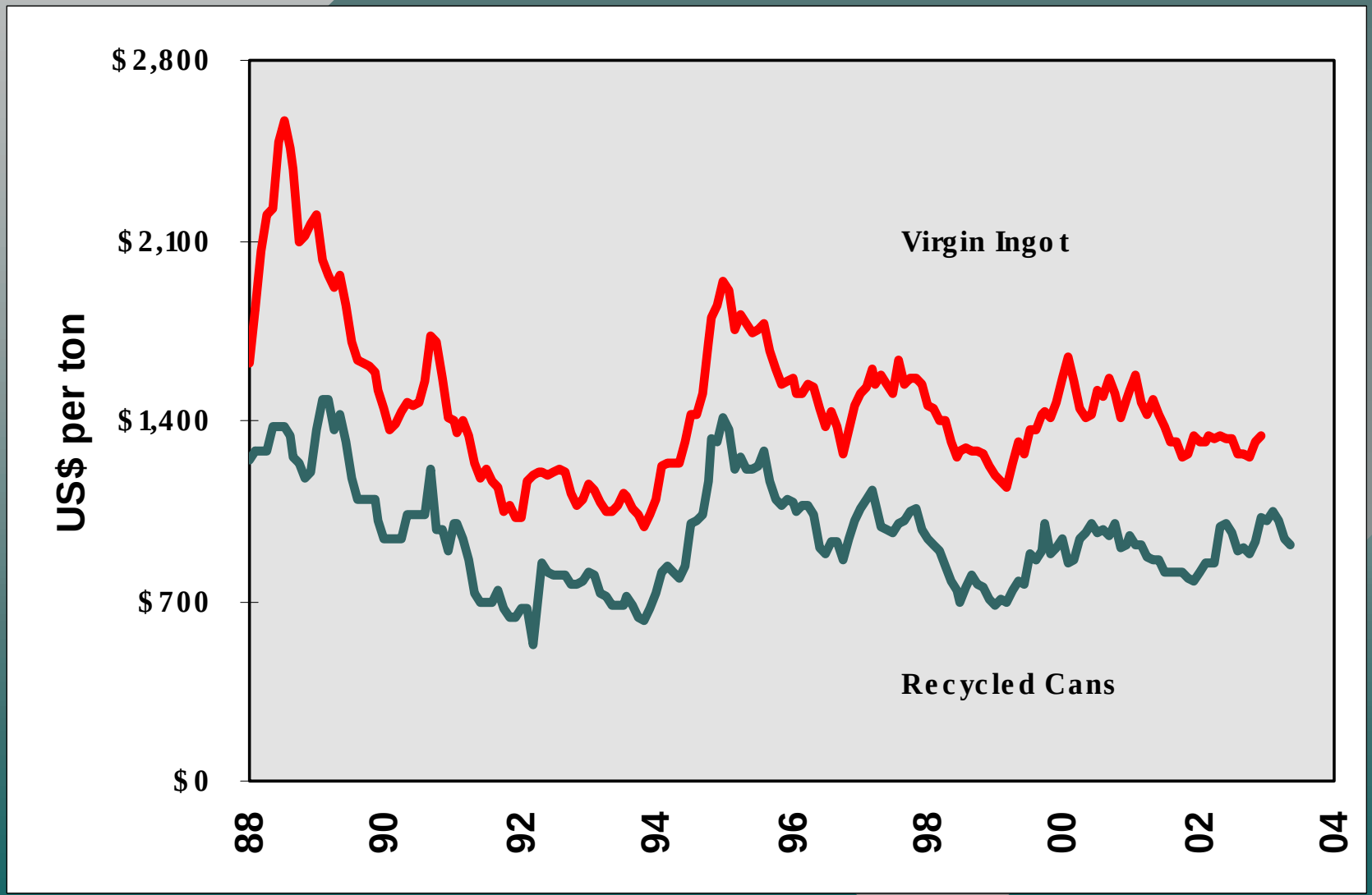
Prices for Refuse vs. Recycling, Virgin vs. Recycled Materials, & Virgin vs. Recycled Content Products Are Telling The Wrong Story

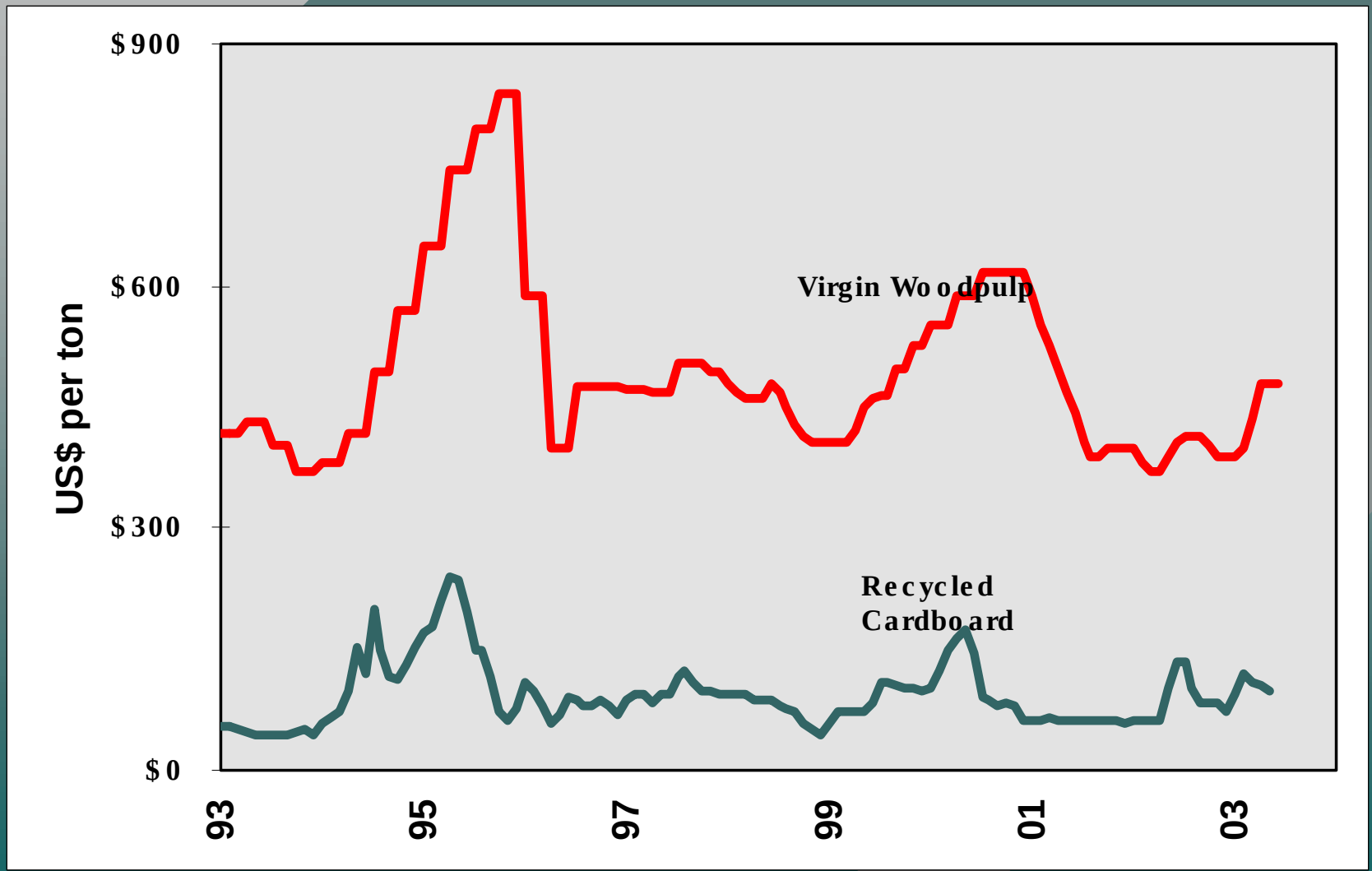
The Wrong Story

- Recycled-content products typically cost more than virgin-content products
- Recycled material prices are kept low by virgin material subsidies and virgin material prices that do not reflect public health and ecological impacts
- Total costs for recycling some waste and throwing the rest away are often greater than total costs for just throwing it all away.

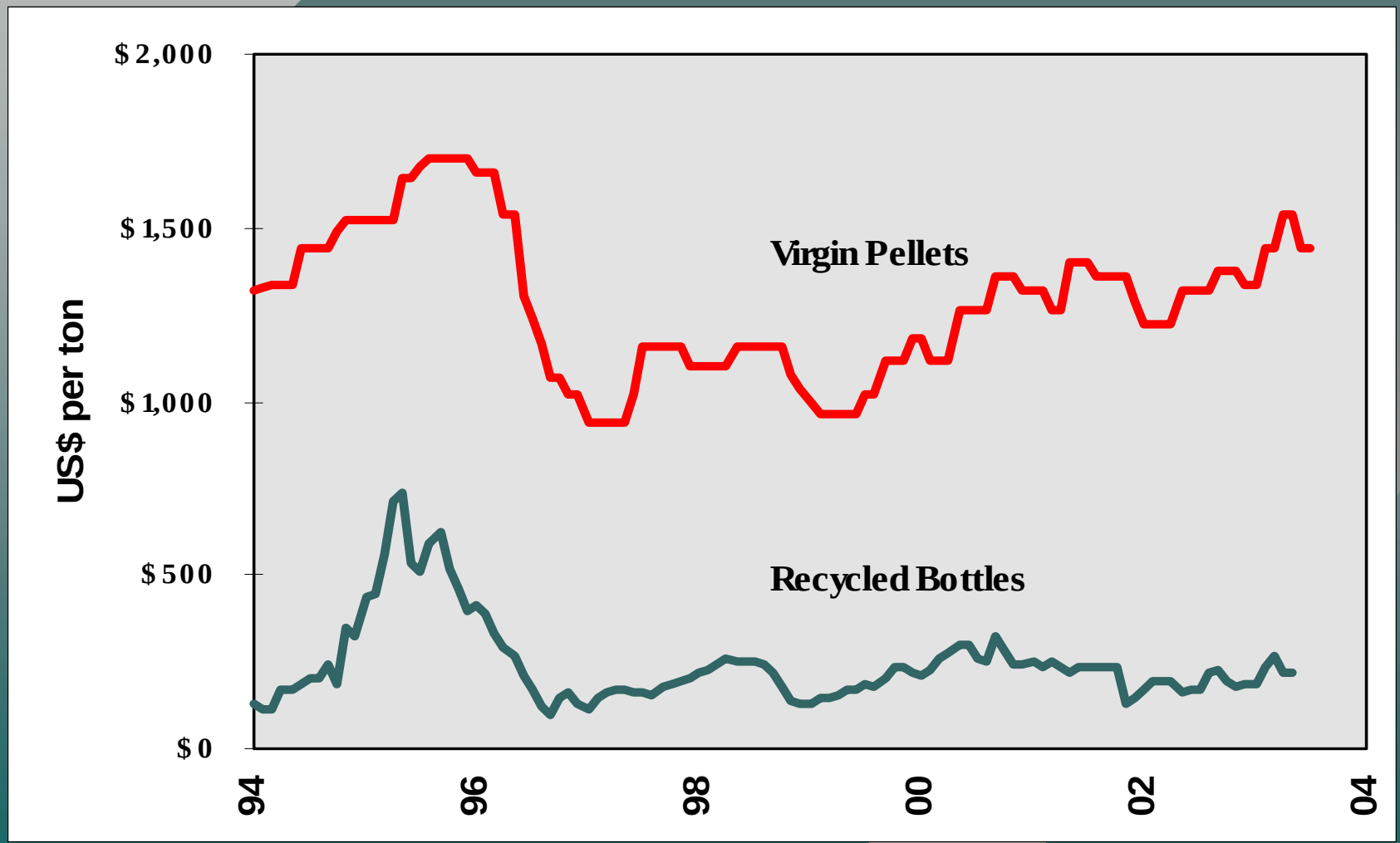
Aluminum Ingot vs. Recycled Cans



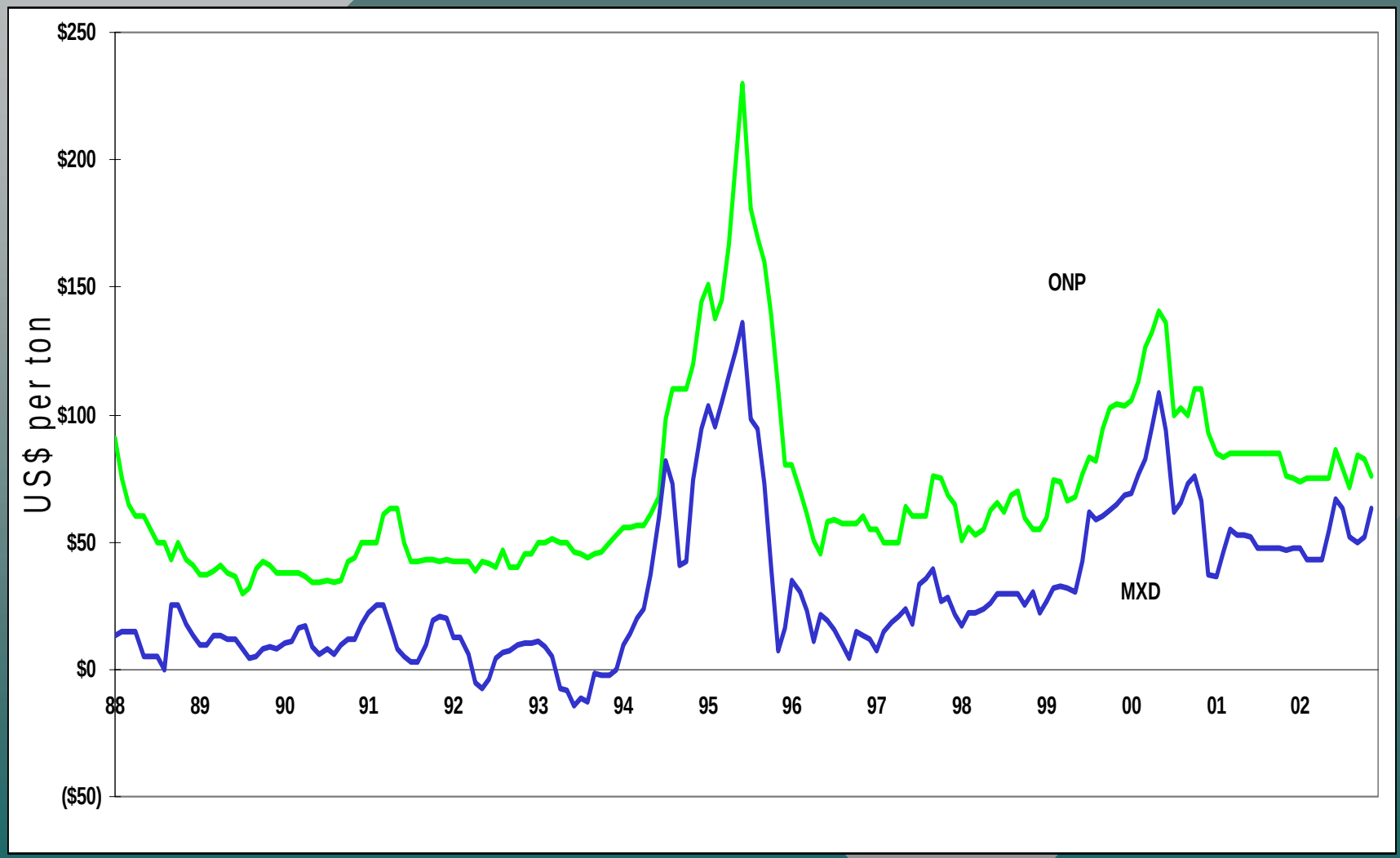
Unbleached Softwood Kraft Pulp vs. Recycled Cardboard



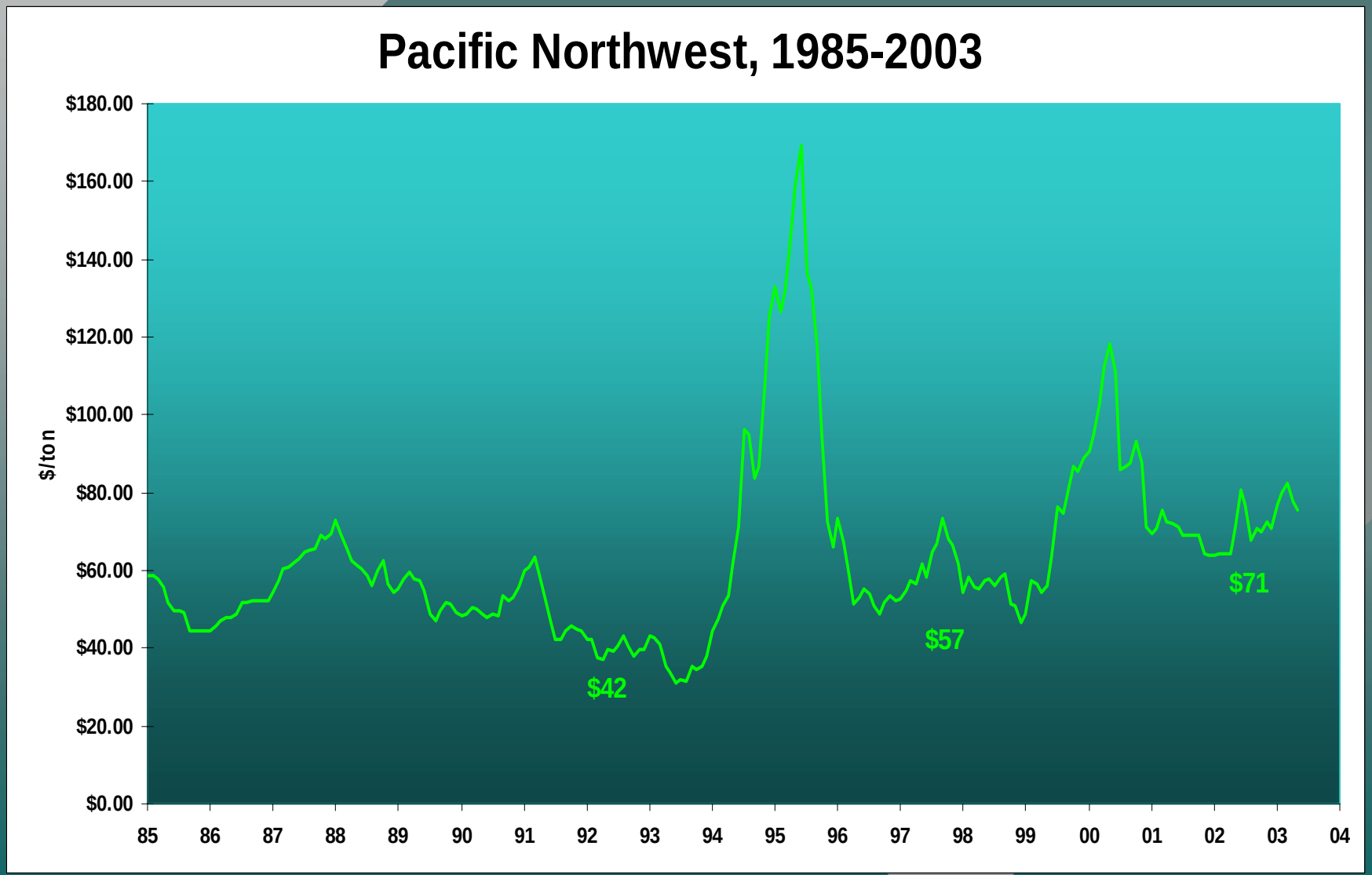
Polyethylene Terephthalate Pellets vs. Recycled PET Bottles



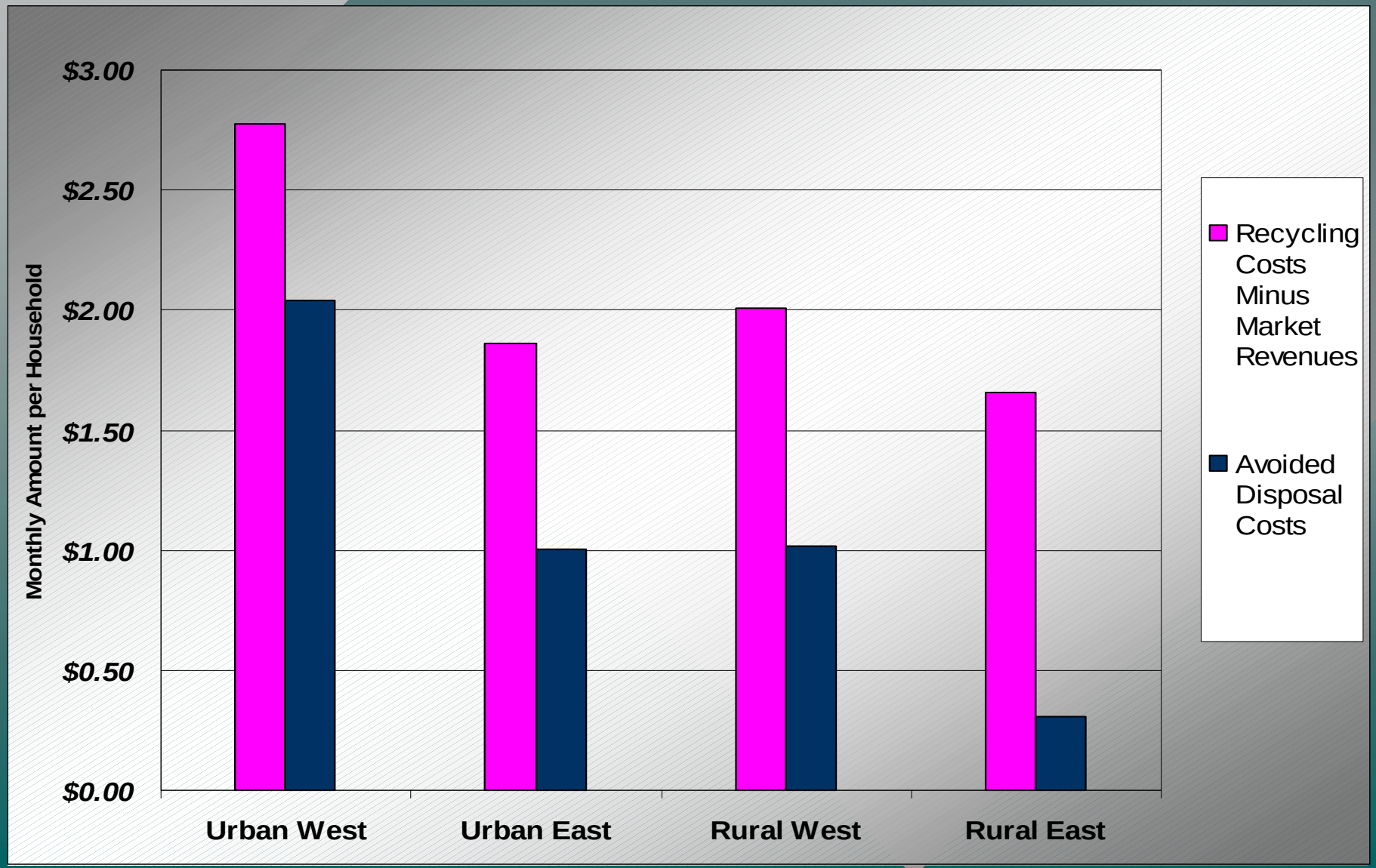
ONP (#8) & Mixed Paper



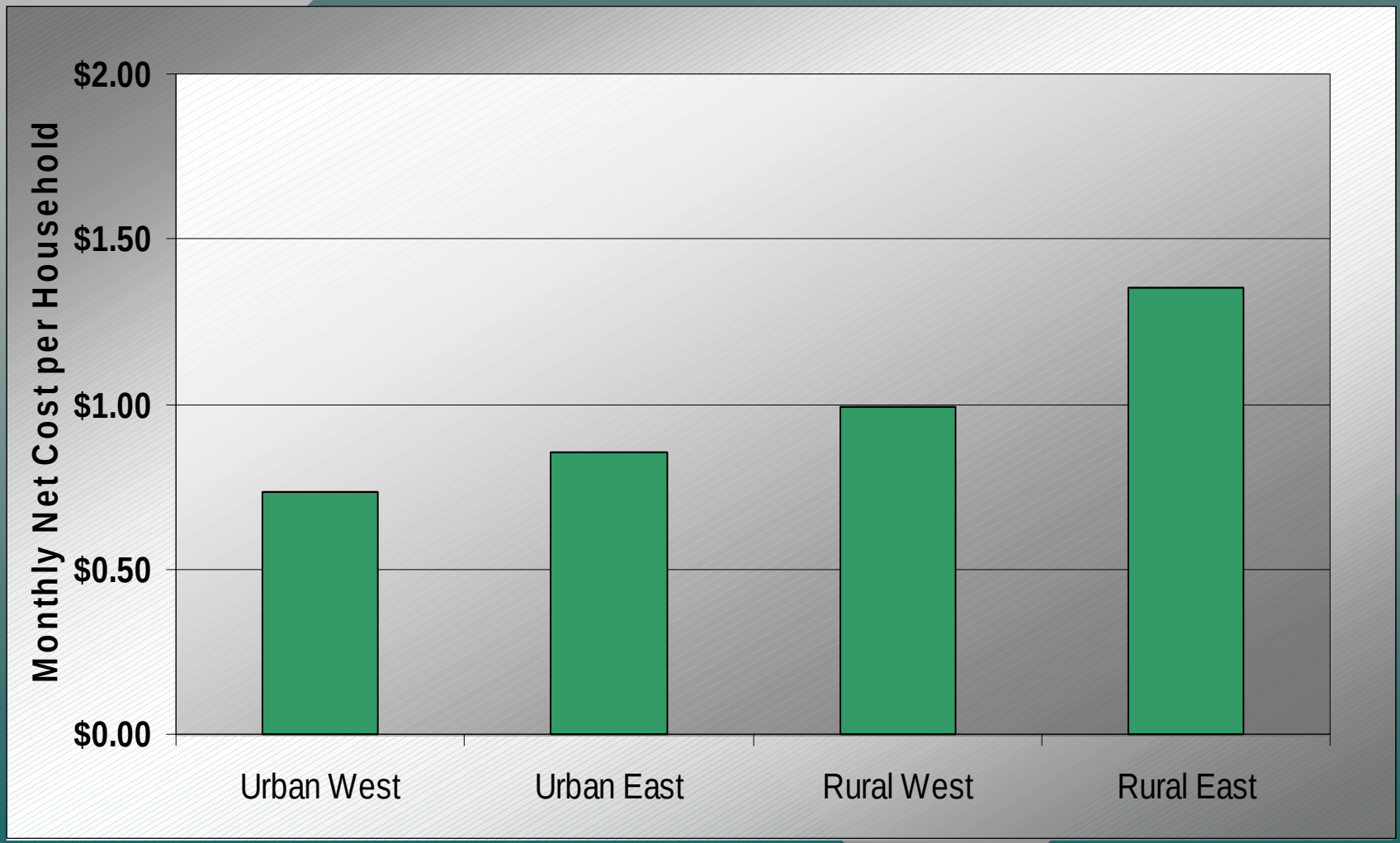
Average Value Per Ton for Curbside Recyclables



Curbside Recycling vs. Avoided Disposal Costs in Four WA Regions



Net Cost for Curbside Recycling in Four WA Regions

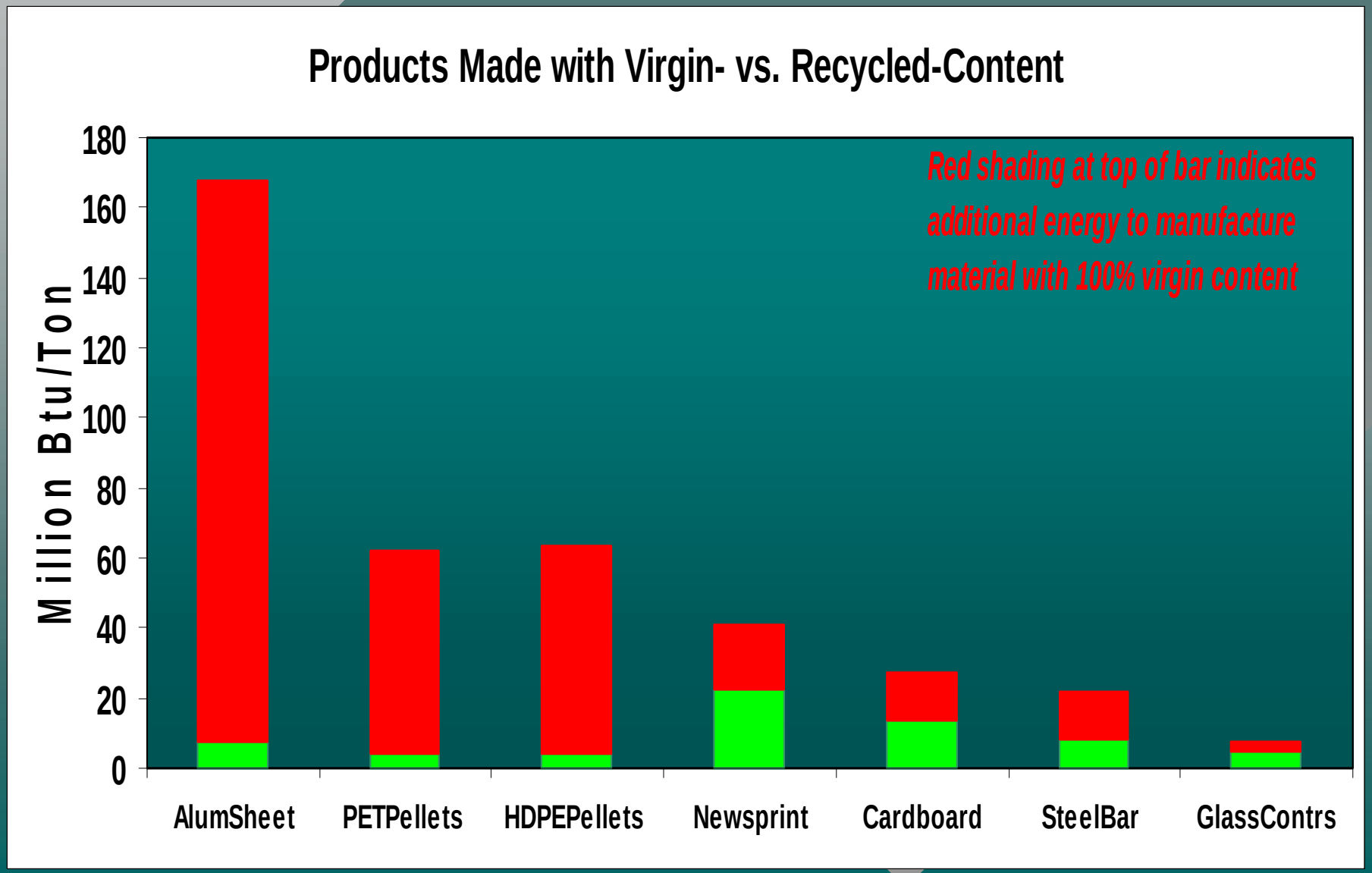


Three Stages of a Product's Life Cycle

- EXTRACTION/MANUFACTURING
- USE
- WASTE MANAGEMENT

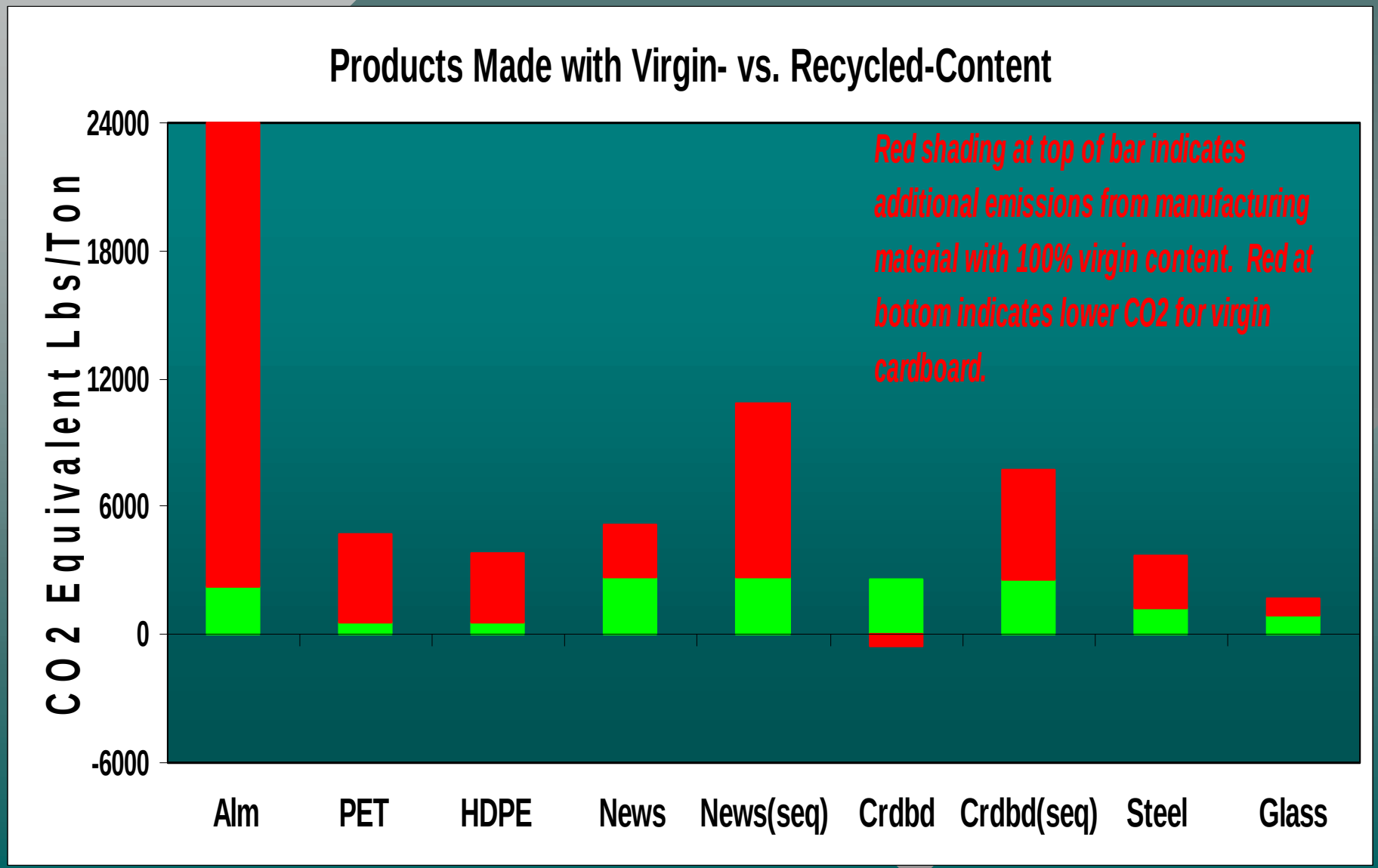
Virgin-Content Production Uses More Energy Than Recycled-Content Production

Energy Used for Resource Extraction & Product Manufacturing

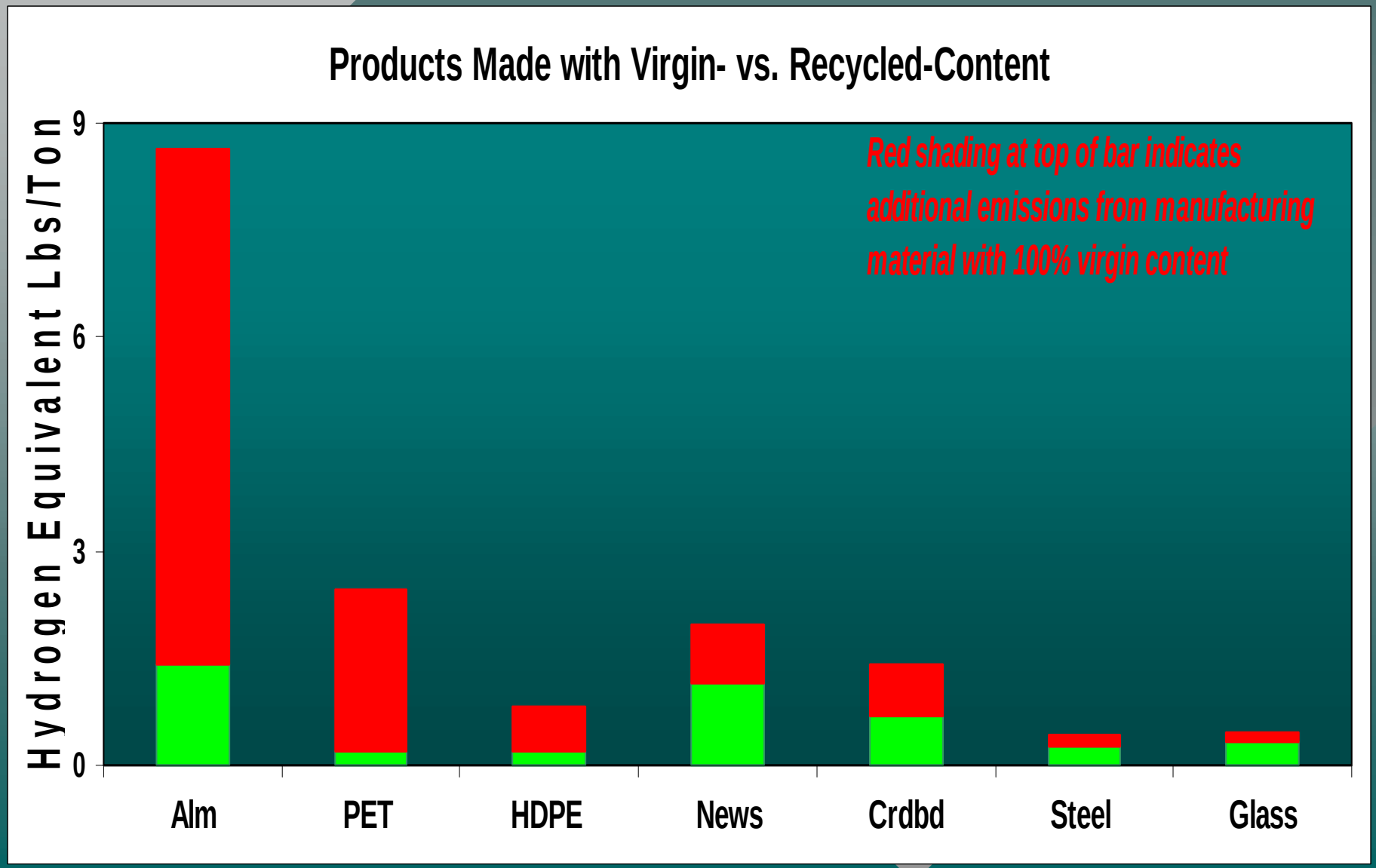


Virgin-Content Production Creates More Pollution Than Recycled-Content Production

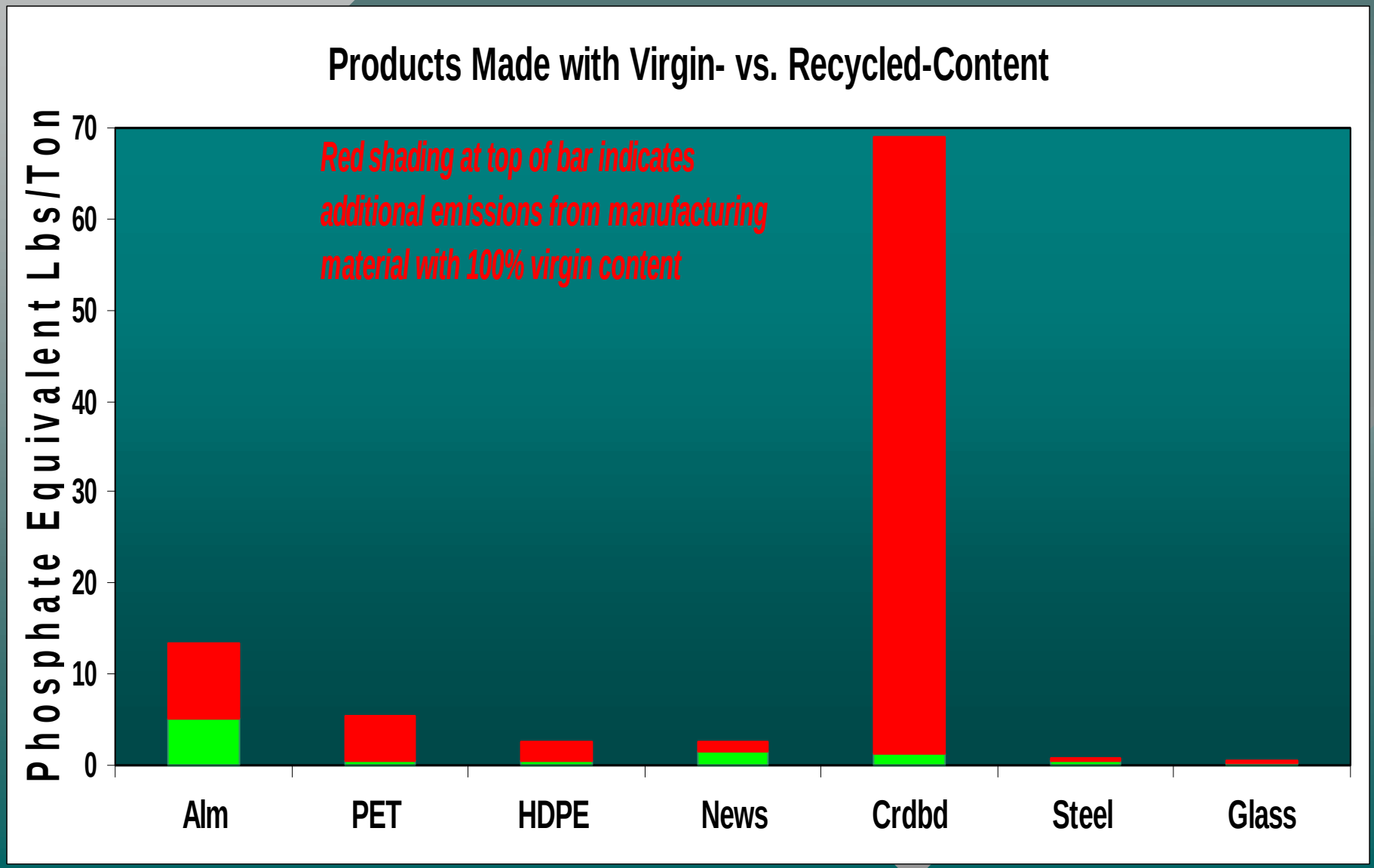
Greenhouse Gases from Resource Extraction & Product Manufacturing



Acidification from Resource Extraction & Product Manufacturing

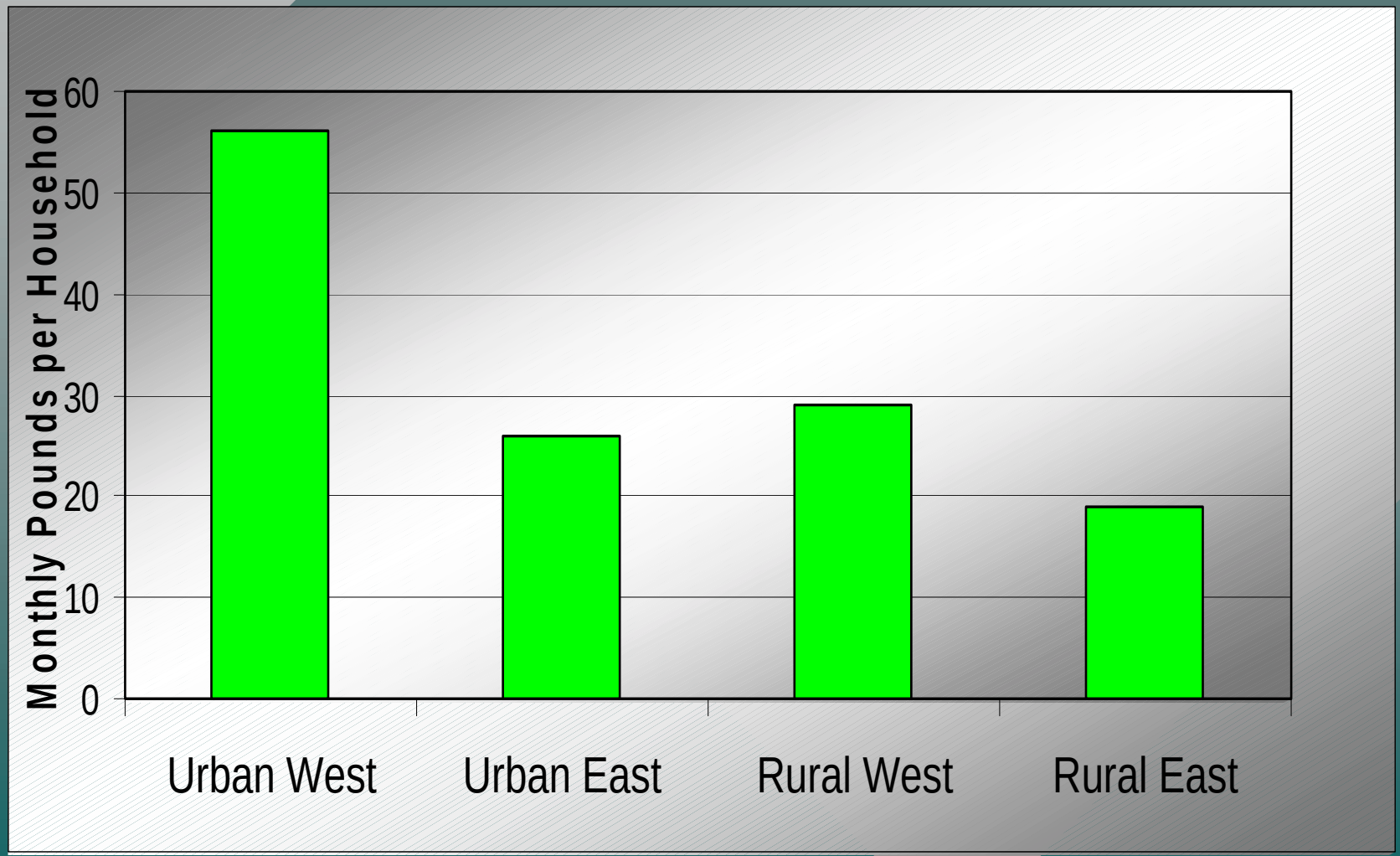


Eutrophication from Resource Extraction & Product Manufacturing

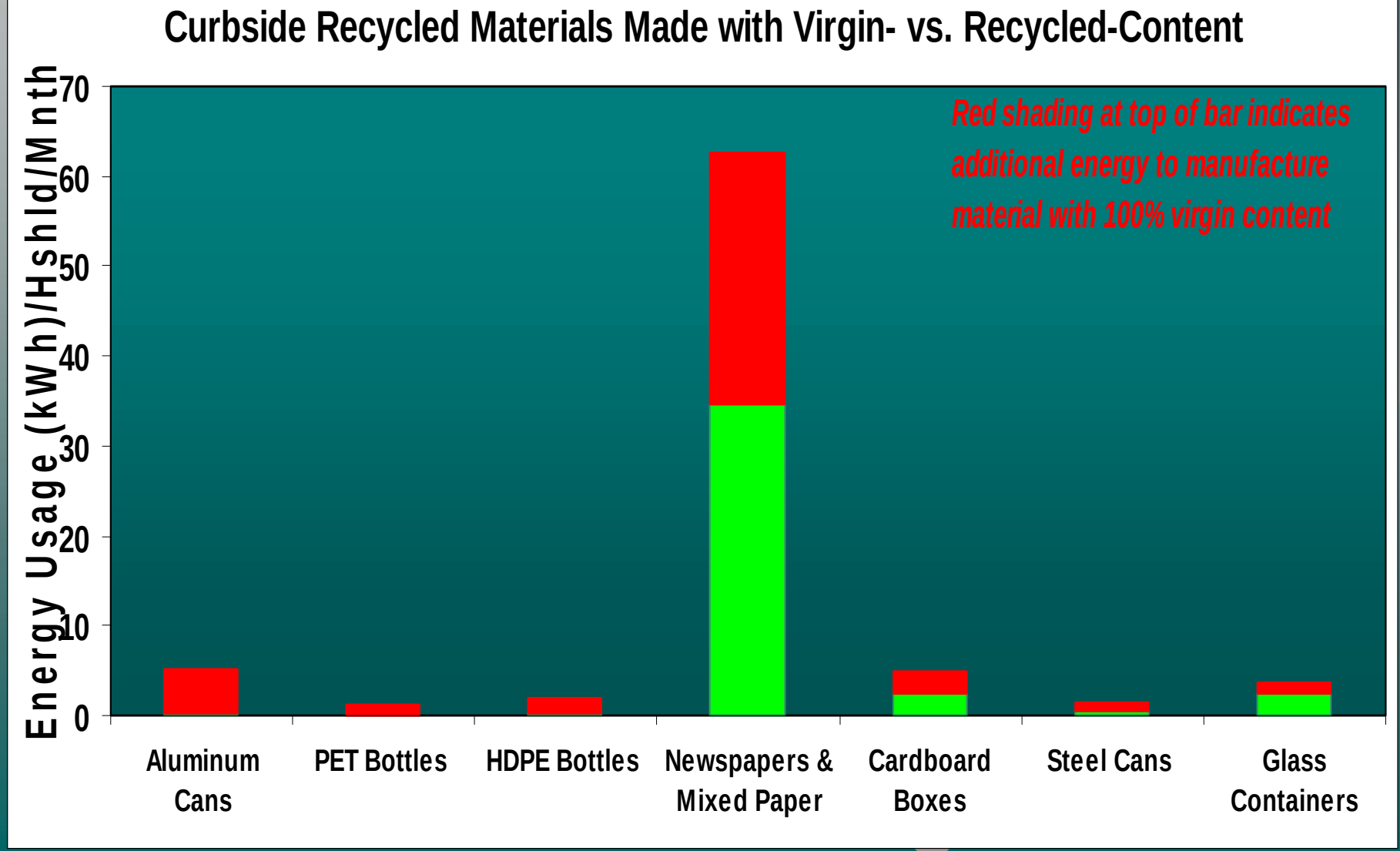


Additional Energy Use and Pollution from Curbside Recycling Trucks Are Overshadowed by Conservation of Energy and Reduced Pollution from Recycled-Content Production

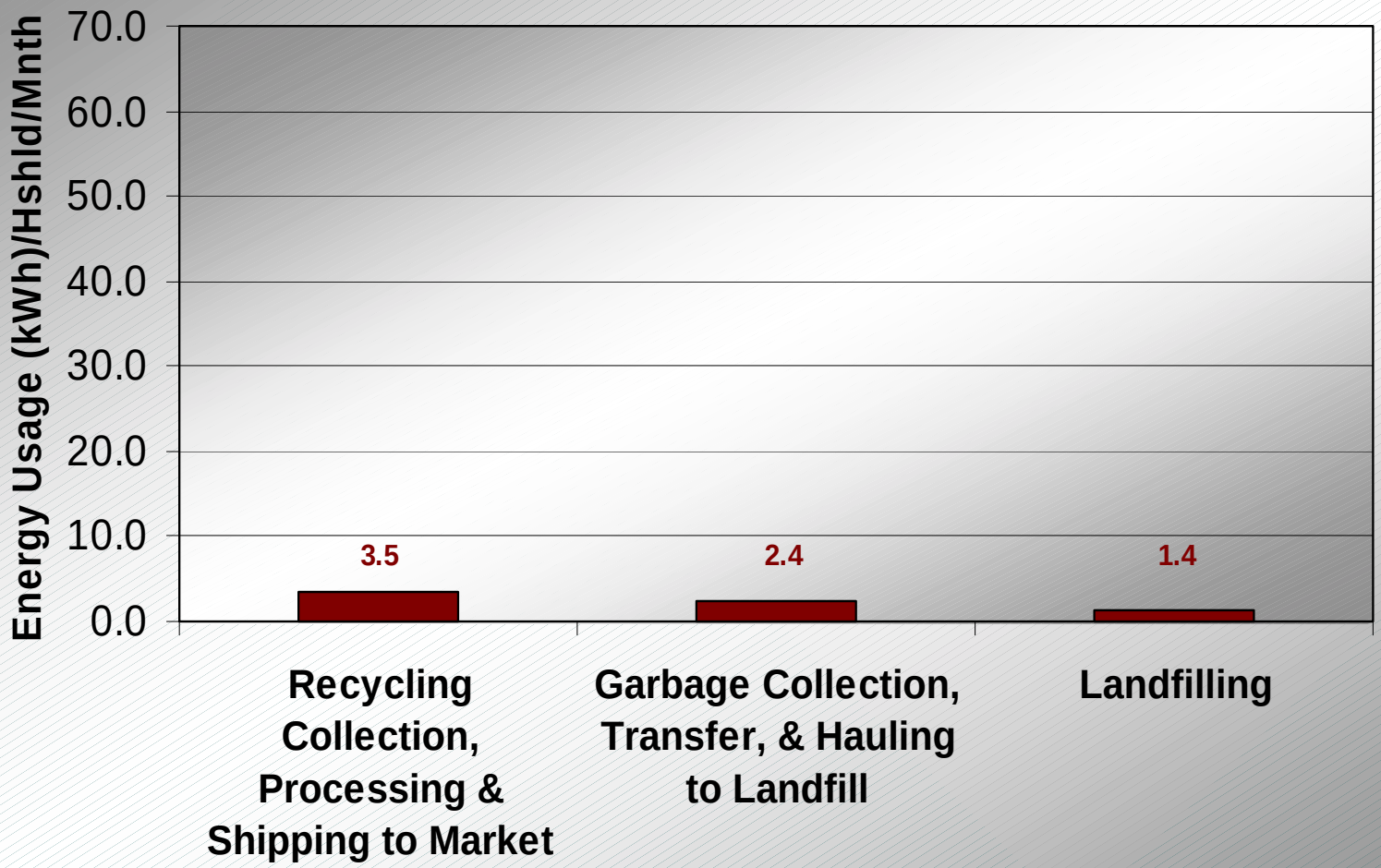
Recycling per Curbside Available Household in Four WA Regions



Energy Used for Extraction/Manufacturing of Materials Recycled in The UW Region



Energy Used for Waste Resources Management in The UW Region

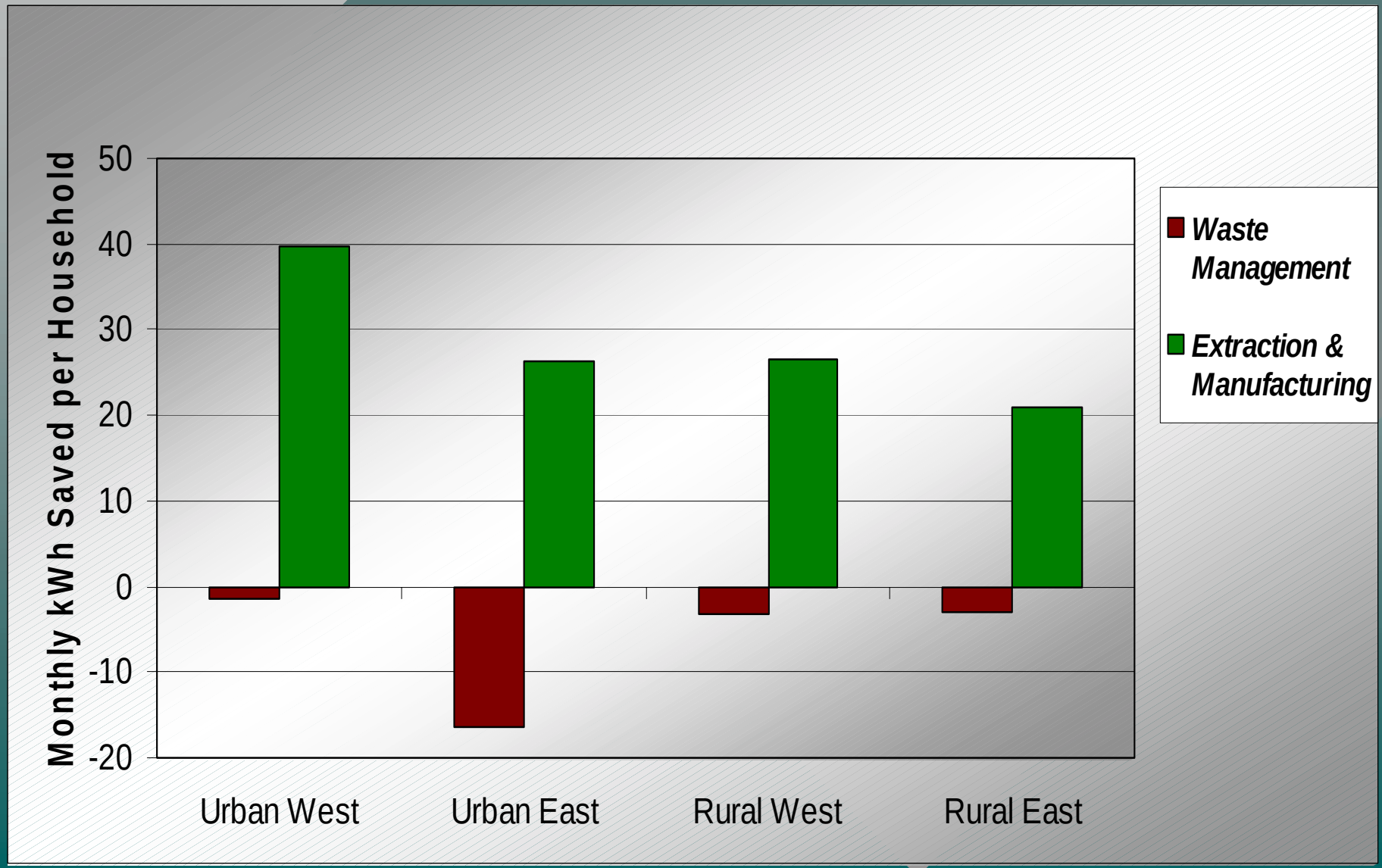


The Disposal Life Cycle Uses More Energy Than The Recycling Life Cycle

Disposal Methods in WA Regions

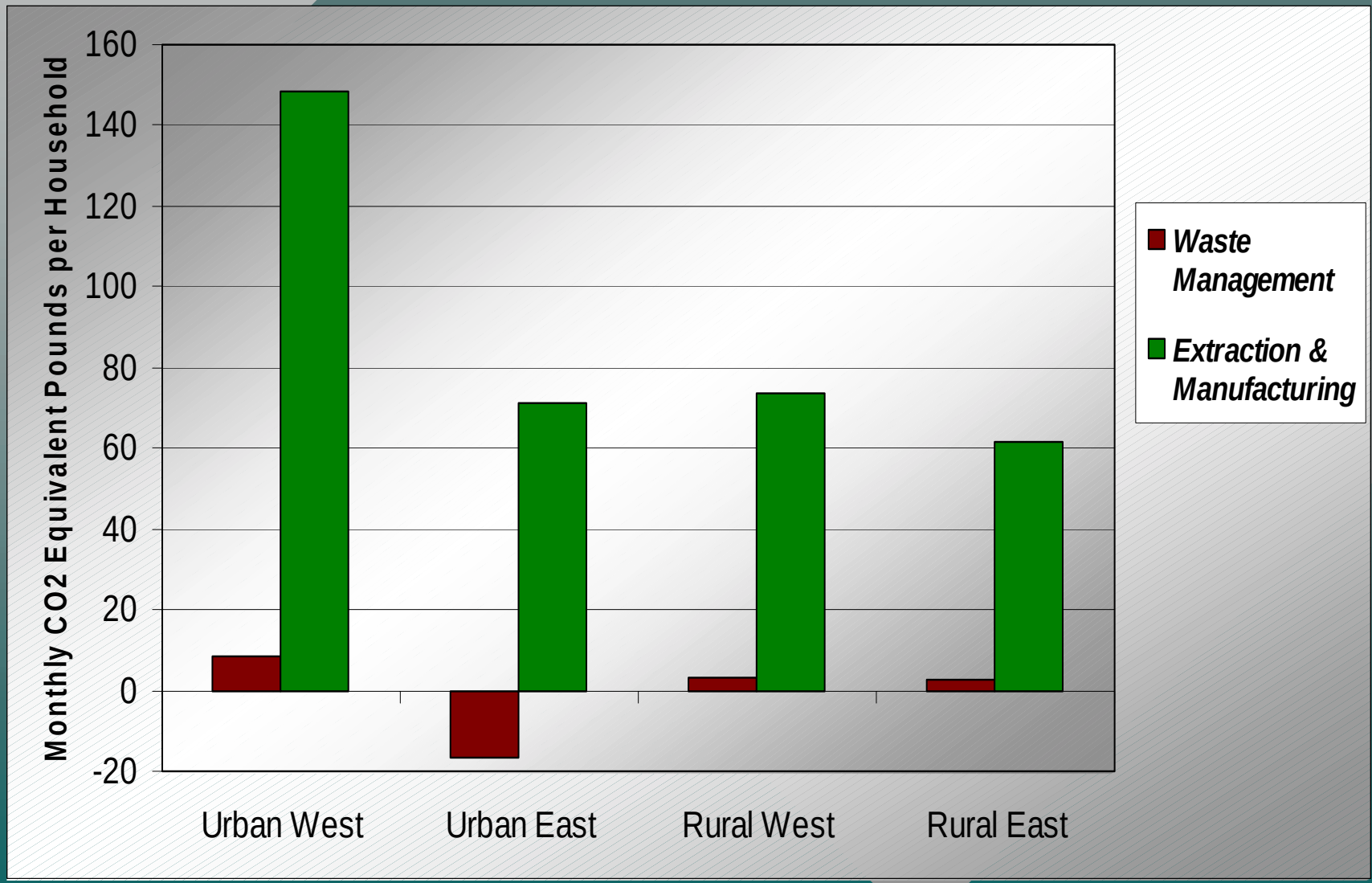
- Urban East – 90% waste-to-energy incineration
- All Other Regions – 100% landfill
- Landfill energy/environmental impact calculations assume 75% methane gas capture and flaring; in fact smaller, older landfills in WA do not have landfill gas capture systems. Also, 75% may be too high for actual landfill lifetime methane capture rate at most landfills.

Net Energy Use Reductions from Curbside Recycling in WA

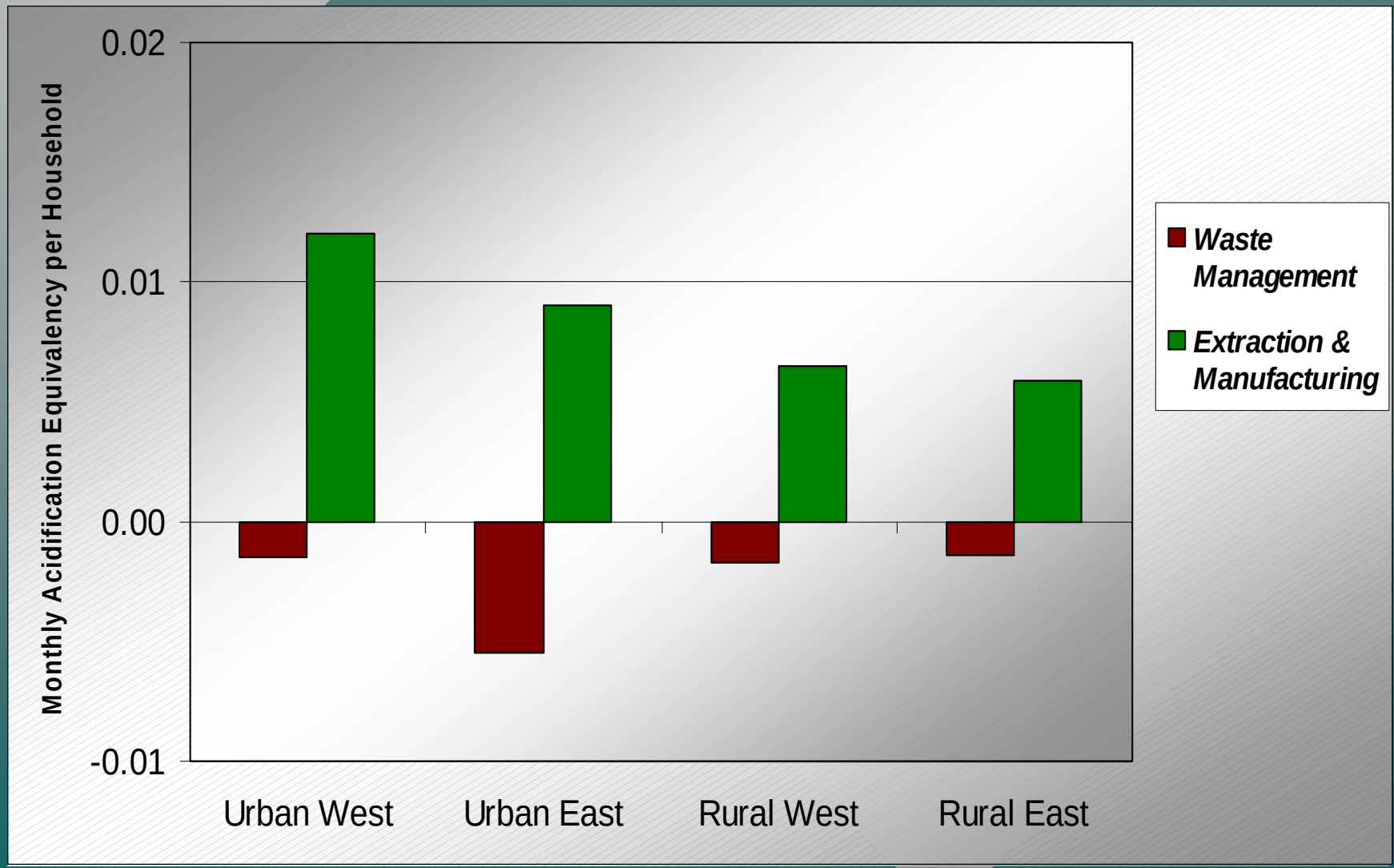


The Disposal Life Cycle Generates More Pollution Than The Recycling Life Cycle

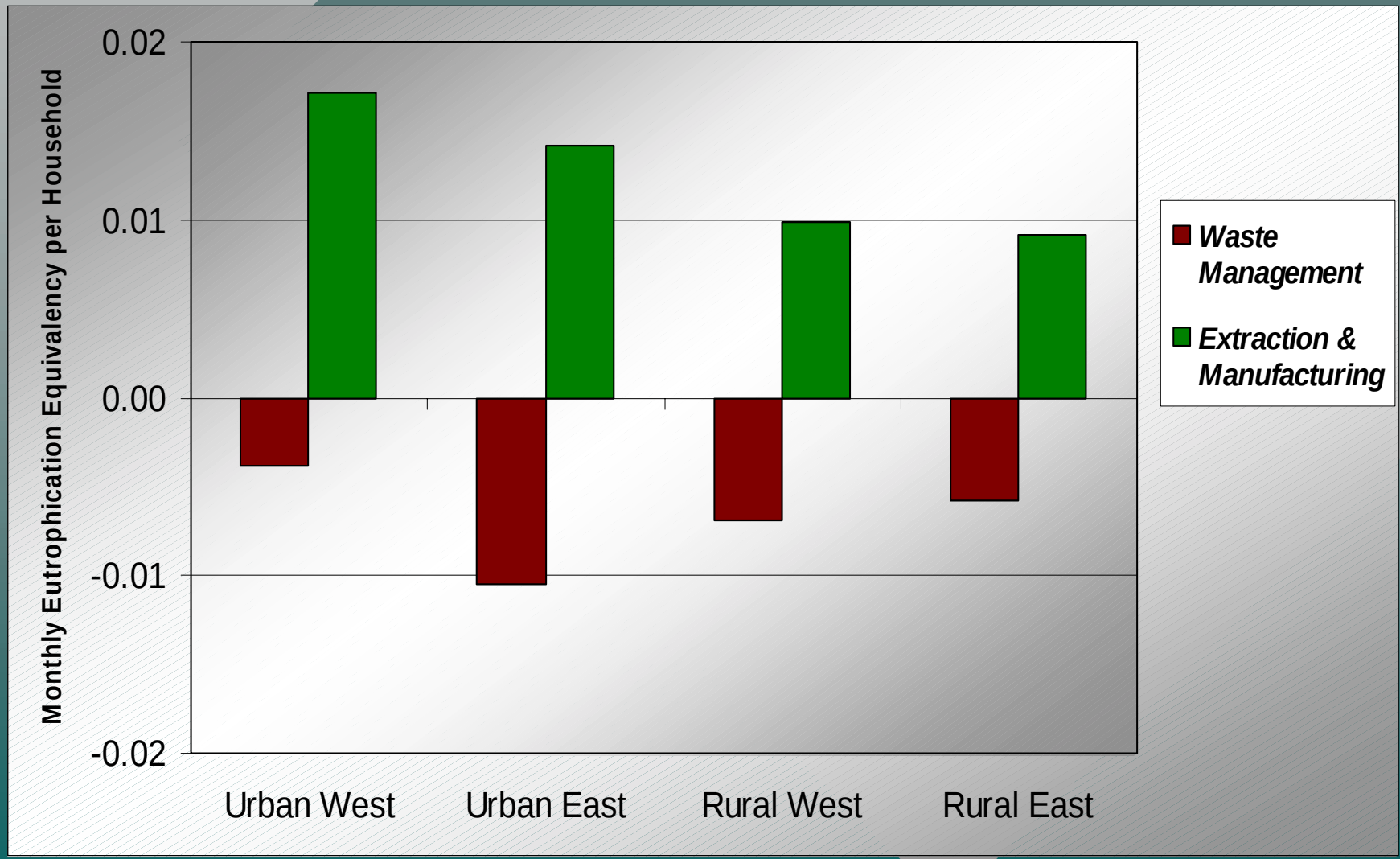
Net Greenhouse Gas Reductions from Curbside Recycling in WA



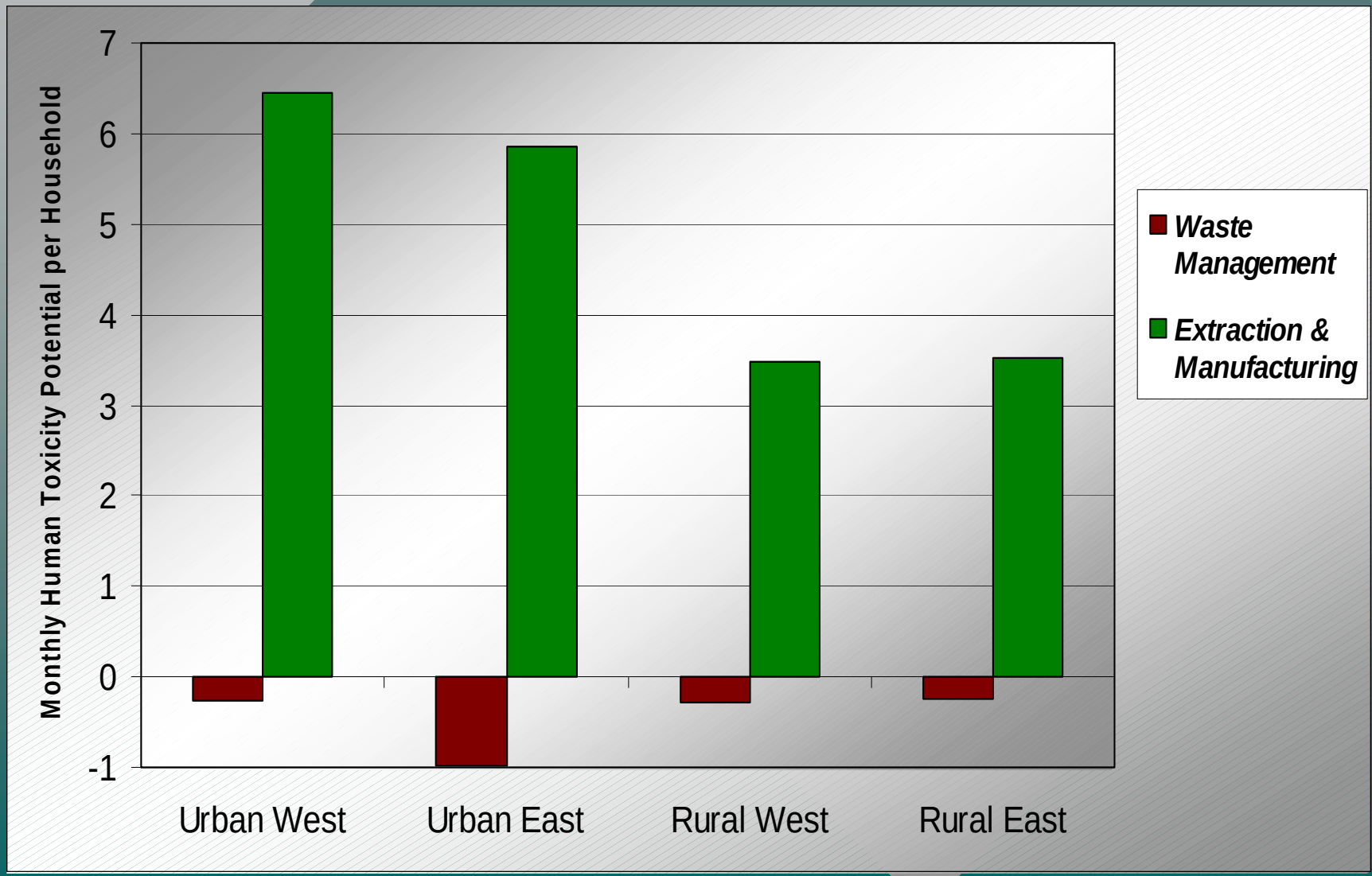
Net Acidification Potential Reductions from Curbside Recycling in WA



Net Eutrophication Potential Reductions from Curbside Recycling in WA



Net Human Toxicity Potential Reductions from Curbside Recycling in WA



How Do We Value/Compare Environmental Benefits Against Costs?

- Categorize Pollutants by Impacts – global warming, acid rain, smog, eutrophication of waterways, human toxicity, ecological toxicity, etc.
- Create Normalization Measures for Each Category
- Economic Costs vs. Weights Developed by Political Process or Other Methods (e.g., BEES 3.0)

Monthly Value per Household of Three Environmental Benefits from Pollutant Releases Avoided Thru Curbside Recycling in UW WA

	BEES Normalized Value of Avoided Impacts	Estimated Economic Value of Avoided Impacts
Global Warming	0.002851	$1.61
Acidification	0.000001	$1.05
Eutrophication	0.000095	$0.53

External Cost of Air Pollutants (US$ per pound)

Criteria Air Pollutants	**Low**	**High**
Carbon Monoxide (CO)	$0.01	$0.48
Nitrogen Oxides (NO_x)	0.41	4.53
Sulfur Oxides (SO_x)	0.07	2.23
Particulates (Total)	1.19	2.56
Lead (Pb)	0.19	528
Greenhouse Gases		
Carbon Dioxide (CO_2)	0.0002	0.012
Methane (CH_4)	0.01	0.38
Other Air Pollutants		
Hydrocarbons (non CH_4)	0.26	0.26
Ammonia (NH_3)	0.76	12.47
Hydrochloric Acid (HCL)	2.49	2.49

External Cost of Water Pollutants (US$ per pound)

	Low	High
Dissolved Solids	No est.	No est.
Suspended Solids	$6.23	$6.23
BOD	0.08	0.08
COD	0	0
Oil	0.26	303.69
Sulfuric Acid	0.12	0.12
Iron	0	0
Ammonia	0.76	1.84
Copper	9.59	19.9
Cadmium	215.78	1,606.34
Arsenic	11.99	7,477.29
Mercury	2,464.00	6,233.72
Phosphate	0.12	0.12
Selenium	0	70.00
Chromium	335.66	335.66
Lead	61.54	528.00
Zinc	0.56	3.70

Reasonable Estimates for the Costs of Pollution Indicate That Recycling Actually Costs Less Than Garbage

Australian Kerbside Study: Recycling Costs Amount to Just 38% of Dollar Value of Net Environmental Benefits

- Environmental Benefits:
  - 75% from upstream air & water pollution decreases
  - 21% from upstream land use reductions & future resource access improvements
  - 4% from global warming credits
  - 2% from reduced land use for landfills
- Environmental Costs:
  - 2% from increased truck traffic

CO_2 Value Per Ton Required to Offset Curbside Net Monthly Cost per Household in WA

	Recycling Per Month (lbs.)	Net Cost Per Month	CO_2 Savings Per Month (lbs.)	CO_2 Value to Offset Cost
Urban West	56	$0.73	157	$9
Urban East	26	$0.85	55	$31
Rural West	29	$0.99	77	$26
Rural East	19	$1.35	64	$42

What Will Make Recycling Profitable?

Policy Options to Correct Garbage Vs. Recycling Market Failures

1. Taxes/subsidies to change relative prices – e.g., no-additional-charge ("free" or "bundled" or "embedded") recycling for garbage collection subscribers – e.g., bundled commercial recycling decreases garbage disposal per employee by 10% to 20% and increases recycling by 10 percentage points.
2. Regulatory Actions – e.g., cap & trade and bans.
3. Extended Producer/Product Responsibility & Product Stewardship – e.g., deposit/refund systems.

Sulfur Dioxide Emissions Allowance Trading (average monthly prices)

Beverage Container Recycling Rates

- The 10 deposit/redemption states had a beverage container recycling rate of 71.6% in 1999 (redemption rates averaged 78%, varying between 69% and 95%)
- The 40 non-deposit/redemption states had a beverage container recycling rate of 27.9% in 1999