

# Climate Change and Materials Management Introduction State And Local Government Perspectives

## Webinar #1

West Coast Webinars on Climate Change, Waste  
Prevention, Recovery and Disposal 101



June 26, 2008

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# West Coast Forum on Climate Change, Waste Prevention, Recovery, and Disposal

## Materials Management, Climate and Waste: Making the Connections

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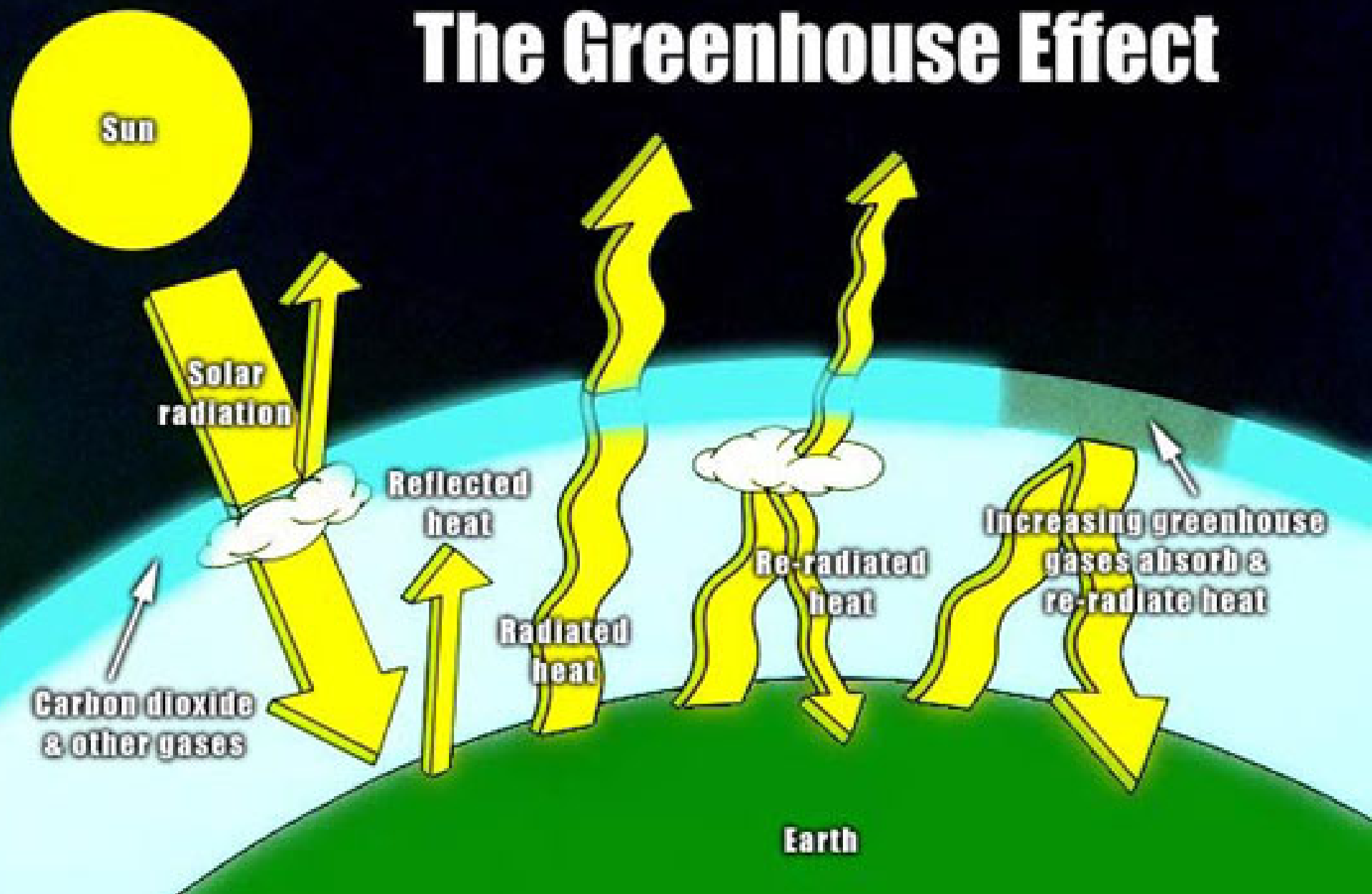
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# Overview

- The fundamentals
  - The primary greenhouse gases and “global warming potentials”
  - Life cycle thinking, emissions factors, and EPA’s “WARM” tool
  - Caveats
- Implications for “waste” policy and programs

# The Greenhouse Effect





# Greenhouse Gases and Global Warming Potentials

- Greenhouse gases of primary concern:
    - Carbon dioxide ( $\text{CO}_2$ )
    - Methane ( $\text{CH}_4$ )
    - Nitrous oxide ( $\text{N}_2\text{O}$ )
  - Greenhouse gases are typically expressed in terms of their global warming potential (GWP) or “carbon dioxide equivalent” ( $\text{CO}_2\text{e}$ ):
    - 1 kg  $\text{CO}_2$  = 1 kg  $\text{CO}_2\text{e}$
    - 1 kg  $\text{CH}_4$  (methane) = 21 kg  $\text{CO}_2\text{e}$
    - 1 kg  $\text{N}_2\text{O}$  (nitrous oxide) = 310 kg  $\text{CO}_2\text{e}$
- Note: These are 100-year equivalencies
- 20-year equivalencies (IPCC 4<sup>th</sup> Assessment Report, 2007):
    - 1 kg  $\text{CH}_4$  (methane) = 72 kg  $\text{CO}_2\text{e}$
    - 1 kg  $\text{N}_2\text{O}$  (nitrous oxide) = 289 kg  $\text{CO}_2\text{e}$

<http://www.ecocycle.org/zerowaste/climate/> for more on this topic 6

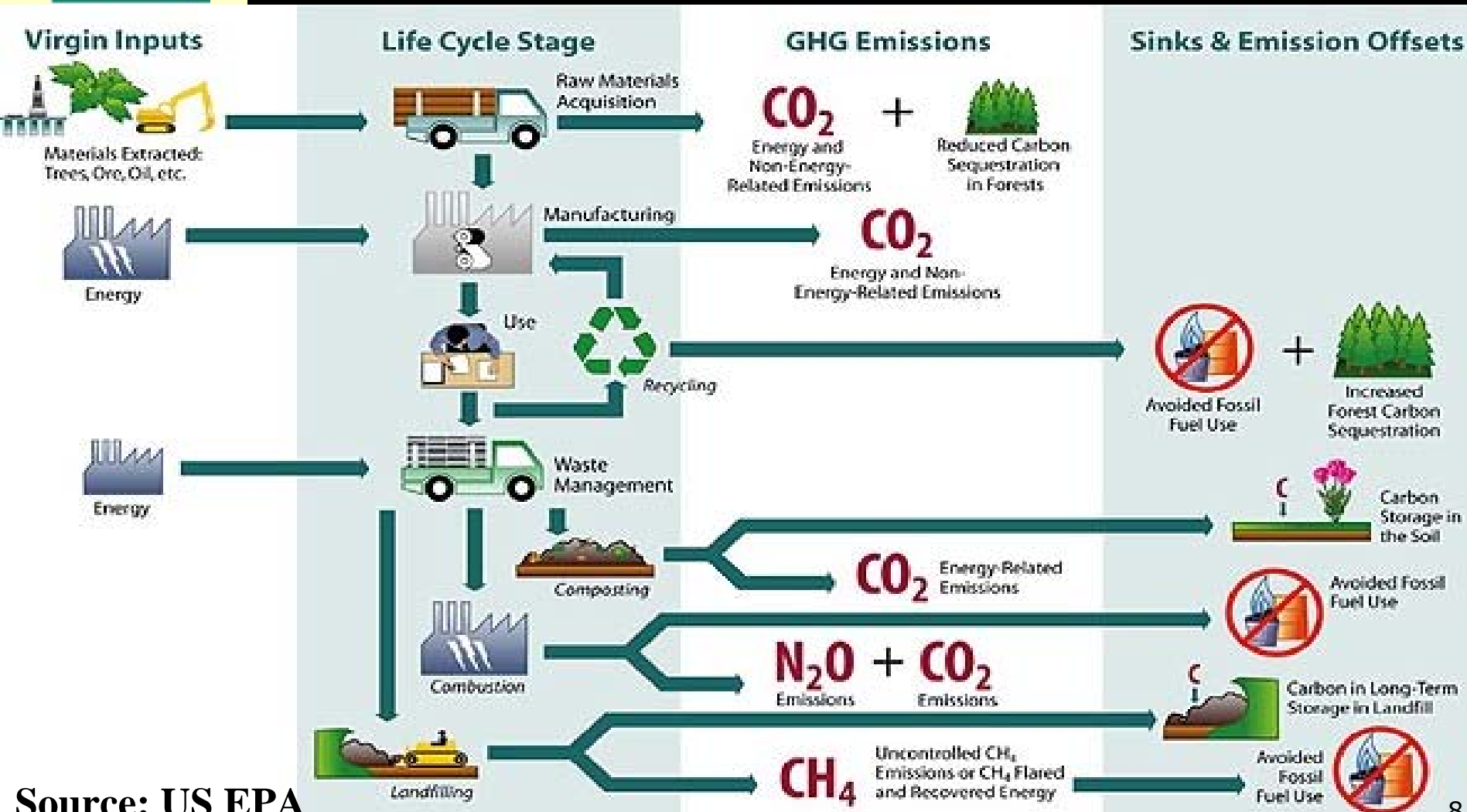


# Nomenclature Basics

- Emissions are sometimes reported as “carbon equivalent” (CE)
  - $1 \text{ g CO}_2\text{e} = (12/44) \text{ g CE}$
  - $1 \text{ g CE} = (44/12) \text{ g CO}_2\text{e}$
- Results should not be reported as “X units of greenhouse gases”
- “Biogenic”  $\text{CO}_2 \neq$  “Anthropogenic”  $\text{CO}_2$

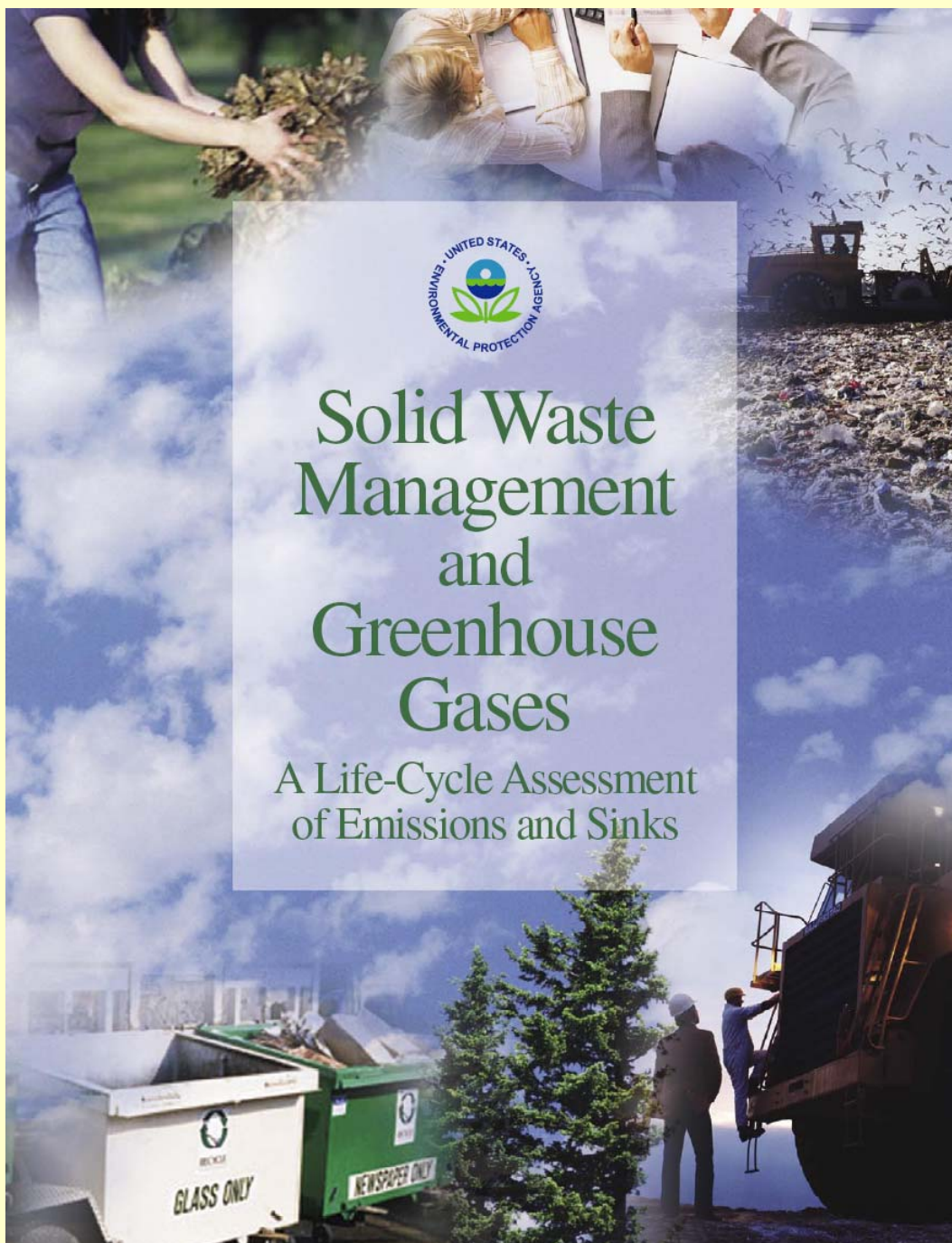


# Greenhouse Gas Sources and Sinks Associated with the Material Life Cycle



Source: US EPA





# EPA Climate Change and Waste Resources:

## Report:

<http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html>

## WARM (Waste Reduction Model) and other tools:

<http://epa.gov/climatechange/wycd/waste/tools.html>

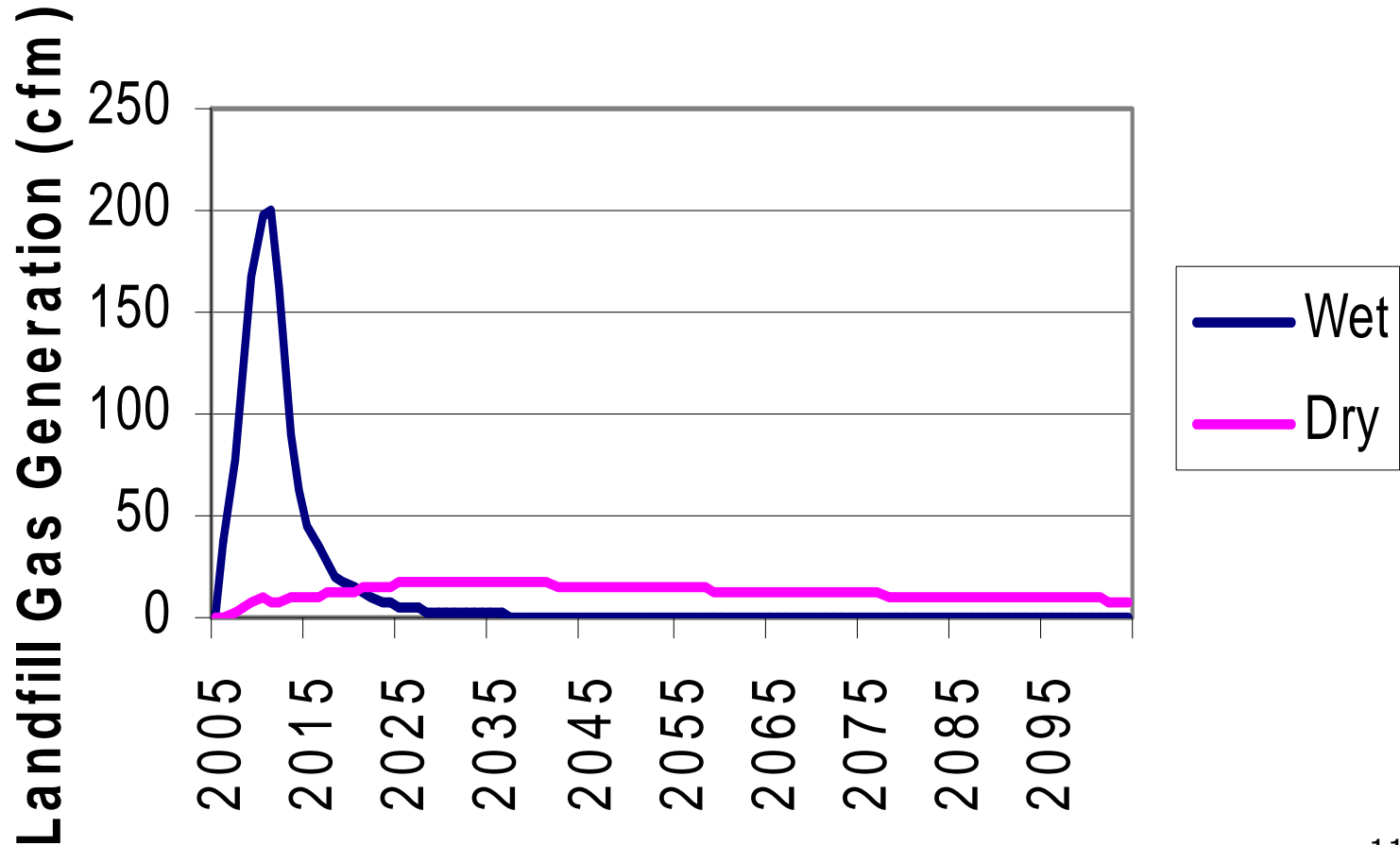


# A Few Landfill Issues

- Energy recovery benefits are of secondary importance to methane destruction
  - Fossil fuel displacement is debatable in states where landfill gas is included in a Renewable Portfolio Standard
- Carbon storage is a topic of significant debate
  - Direct emissions vs. lifecycle emissions
  - Inventories vs. alternatives analysis
- Timing of emissions are highly variable



# Landfill Gas Generation Curves (Mixed Waste)

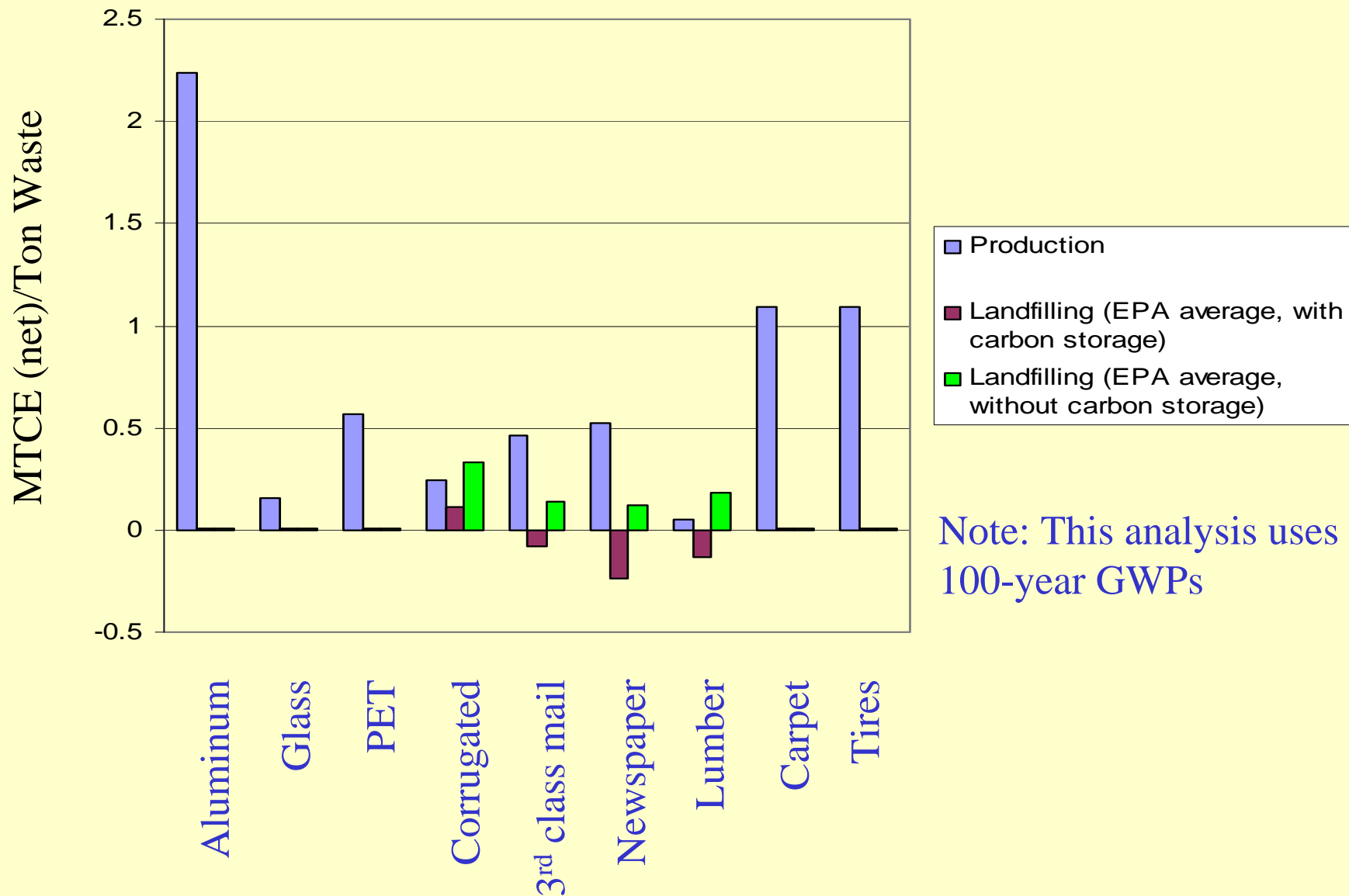




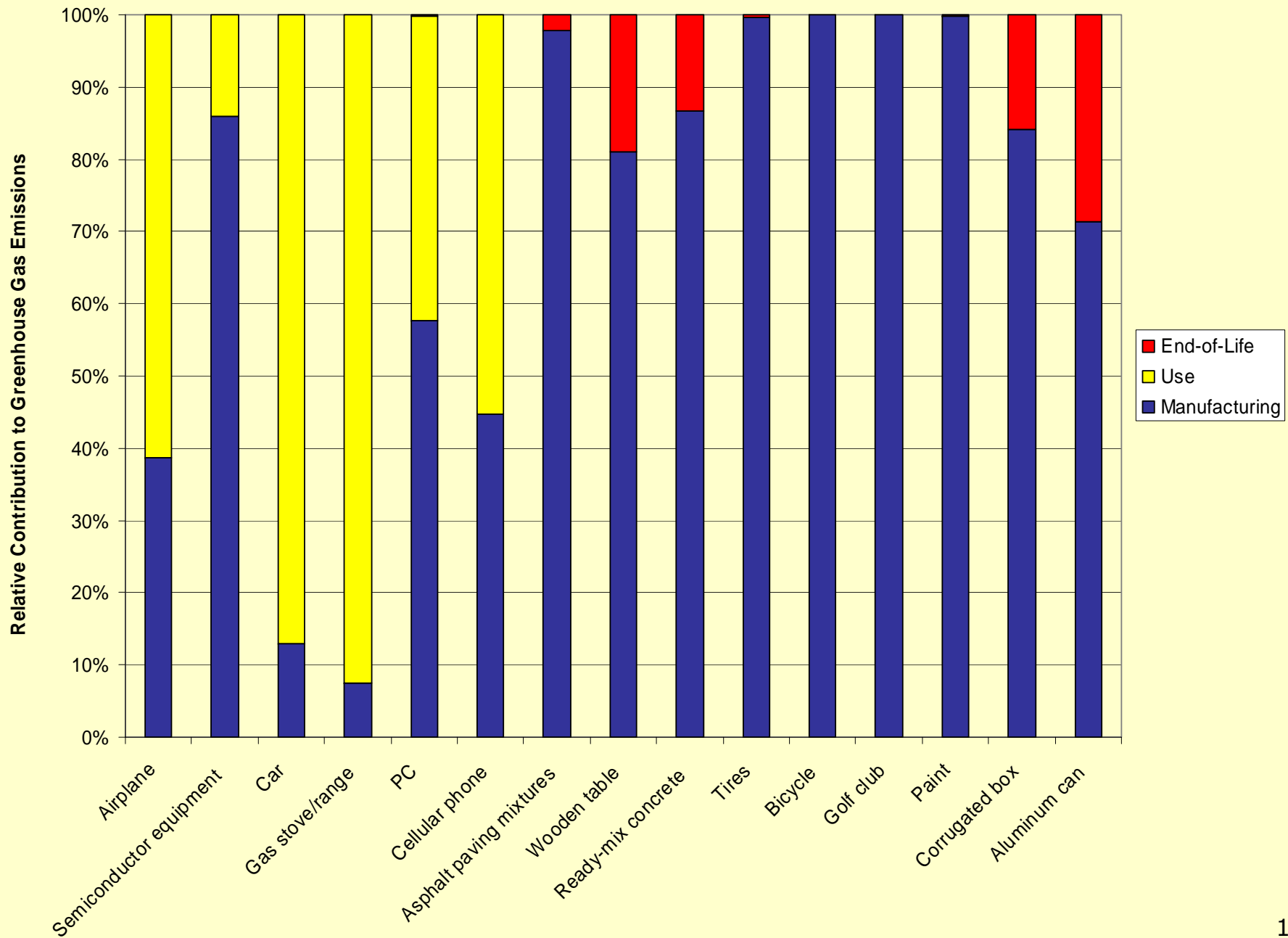
# EPA Emissions Factors (WARM): Some Caveats

- Significant uncertainty, variability:
  - Energy use/savings between individual end-markets, countries
  - Forestry-related benefits
  - Compost benefits
  - Quantity and timing of methane releases
  - Effectiveness of gas controls
  - Others

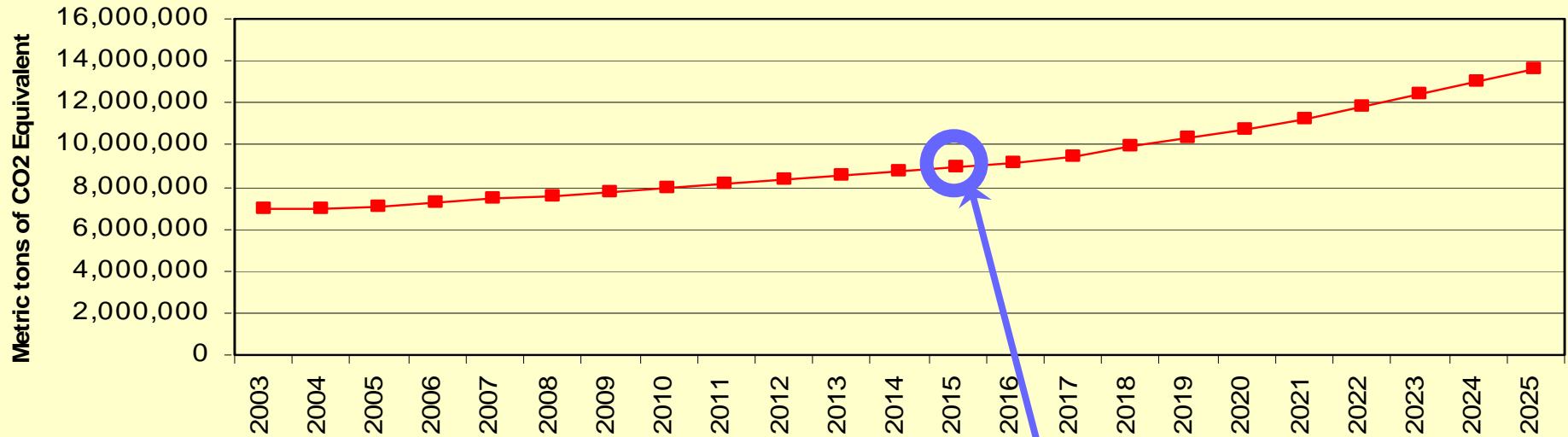
For many materials, production emissions > disposal emissions



# California/LBL Greenhouse Gas/Product Life Cycles (2004)



# Year 2004 “Business as Usual” Forecast of GHGs for Materials and Waste (Oregon)



Material Production

Recycling (manufacturing)

Recycling (forest related offsets)

Composting

Combustion (emissions)

Combustion (energy recovery)

Landfilling (gross emissions)

Landfilling (energy recovery)

Landfilling (carbon storage)

**Total (2015)**

10.9 MMTCO<sub>2</sub>E

-1.0 MMTCO<sub>2</sub>E

-2.1 MMTCO<sub>2</sub>E

-0.1 MMTCO<sub>2</sub>E

0.3 MMTCO<sub>2</sub>E

-0.6 MMTCO<sub>2</sub>E

2.6 MMTCO<sub>2</sub>E

-0.1 MMTCO<sub>2</sub>E

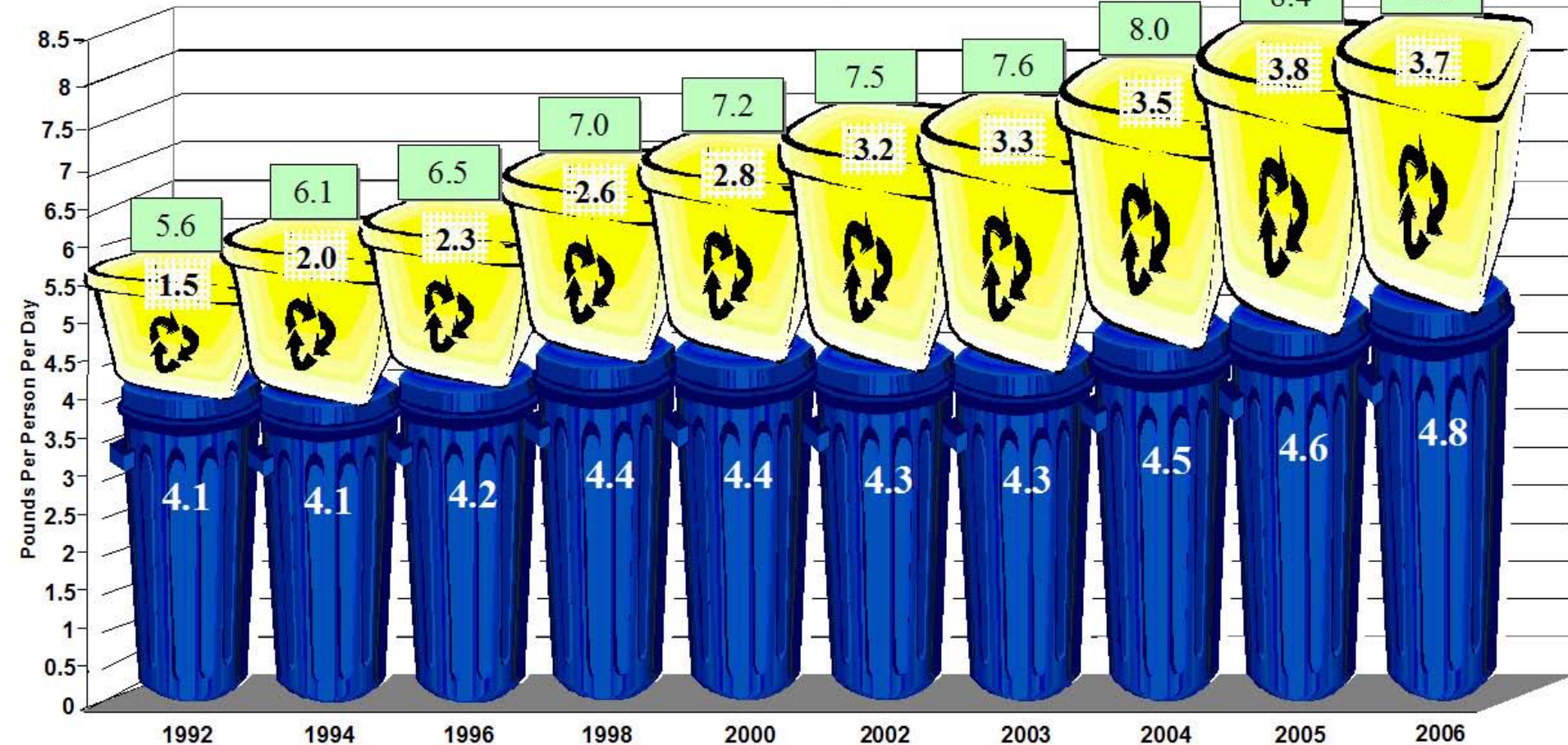
-1.1 MMTCO<sub>2</sub>E

**8.9 MMTCO<sub>2</sub>E<sub>15</sub>**



# Recycling is Up in Oregon, But So is Waste Generation

Total Solid Waste Disposed, Recovered, and Generated  
Pounds Per Person Per Day  
1992 - 2006



**Key**

0.0

= Generated



= Recovered



= Disposed

*Recovery + Disposal = Generation*





# Prevention and reuse are generally better than recycling

- Prevention: see [www.deq.state.or.us/lq/pubs/docs/sw/WPSBkgd02.pdf](http://www.deq.state.or.us/lq/pubs/docs/sw/WPSBkgd02.pdf)
- Reuse:
  - Reusing a personal computer saves 5 - 20 times more energy than recycling it.
  - Reusing a corrugated box saves 3 - 4 times more energy than recycling it.



# DEQ E-Commerce Soft Goods Packaging Study: Materials Evaluated

Corrugated box\* with:

**Void Fill (for boxes)**

Polystyrene loose fill\*  
Corn starch loose fill  
Molded paper loose fill  
Inflated “air pillows”\*  
Newsprint dunnage\*  
Kraft dunnage\*  
Shredded office paper  
Shredded boxes

Alternatives:

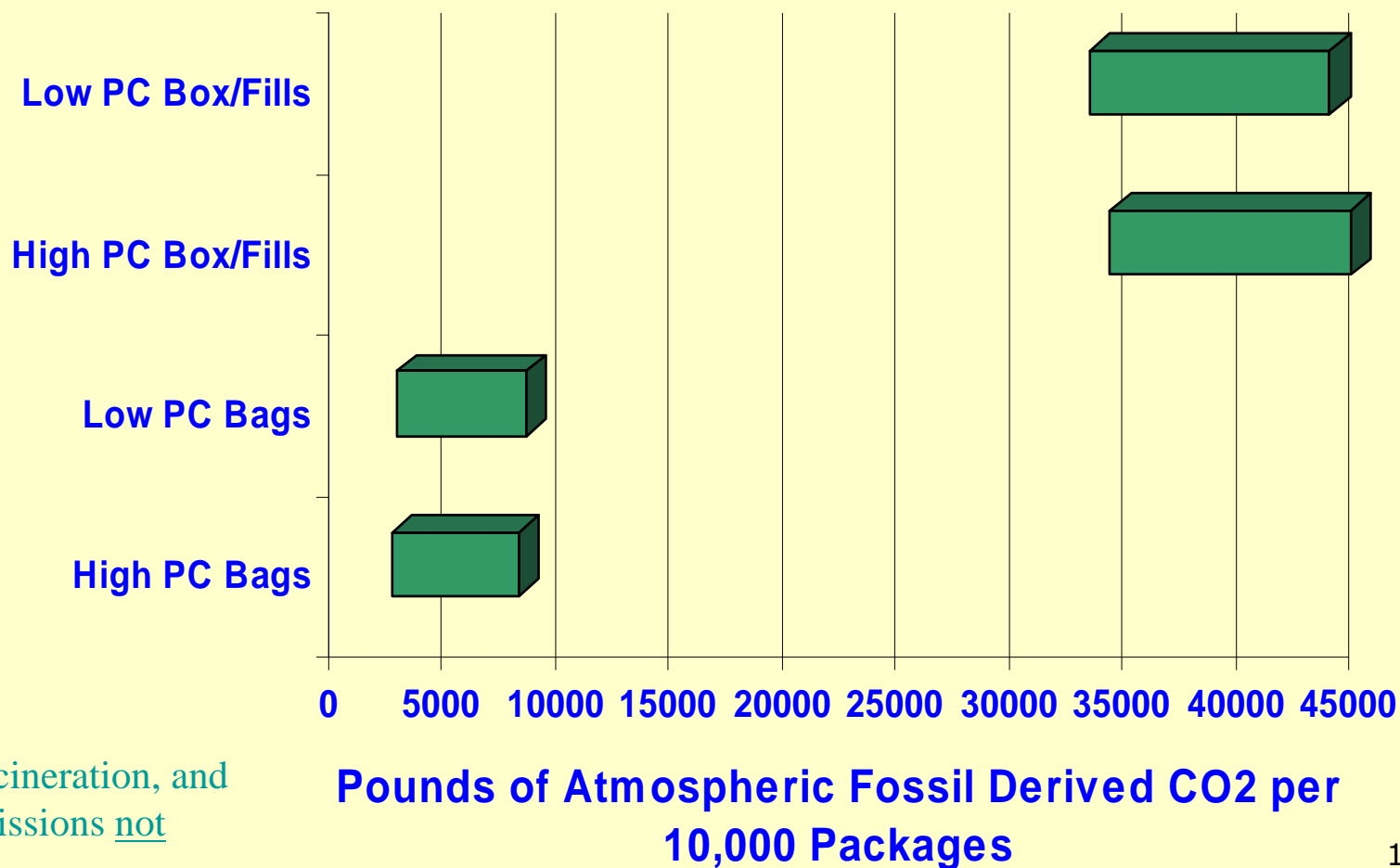
**Shipping Bags**

Unpadded all-kraft mailer\*  
Unpadded all-poly mailer\*  
Kraft mailer with ONP padding\*  
Kraft mailer with poly bubble padding\*  
Poly mailer with poly bubble padding\*

\*Different levels of post-consumer content also evaluated.



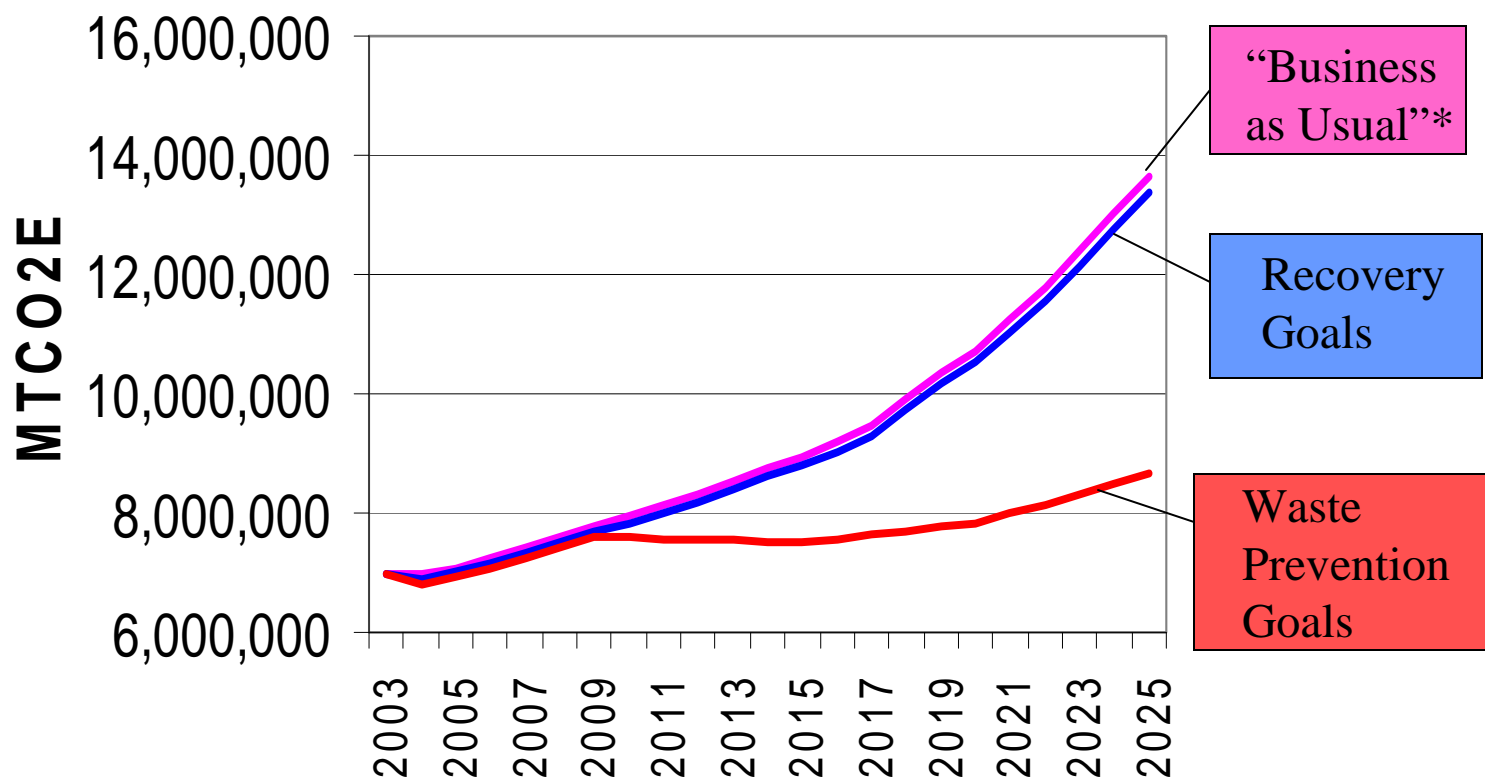
# E-Commerce Study Results: Atmospheric Fossil Derived Carbon Dioxide\*



\*Landfill, waste incineration, and forestry-related emissions not included.



# Year 2004 Forecast of Oregon's Materials-Related Greenhouse Gas Emissions



\*Per-capita waste generation continues to grow, recovery rate stays at 47%



# DEQ Waste Prevention Strategy

- Defines priorities for DEQ's work in waste prevention for the next 10 years.
- Short-term (3-year) workplan.
- Adopted December 2007.

[www.deq.state.or.us/lq/sw/wasteprevention/wpstrategy.htm](http://www.deq.state.or.us/lq/sw/wasteprevention/wpstrategy.htm)



# Greenhouse Gas and Energy Benefits of Recycling

- Recovery in Oregon in 2006 reduced greenhouse gas emissions by ~3.5 million tons of CO<sub>2</sub>e
  - ~5.1% of total statewide emissions
  - Equivalent of 740,000 “average” passenger cars
- Recycling in Oregon in 2006 saved ~27 trillion BTUs of energy
  - ~2.4% of total statewide use
  - Equivalent of ~214 million gallons of gasoline



# Evaluation of policy/program options: Frequency of recycling collection

100 tons of “average” curbside recyclables in Oregon:

## Collection Fleet

~ 4 MTCO<sub>2</sub>E **emissions** from  
on-route collection vehicles  
(and diesel production)

## Change from Weekly to Every-Other-Week Collection of Recyclables

Reduce emissions <50%

→ ~ 2 MTCO<sub>2</sub>E **decrease**  
in emissions



# Evaluation of policy/program options: Frequency of recycling collection

100 tons of “average” curbside recyclables in Oregon:

## Collection Fleet

~ 4 MTCO<sub>2</sub>E **emissions** from  
on-route collection vehicles  
(and diesel production)

## Displacement of Virgin Resources

~ 235 MTCO<sub>2</sub>E **savings** (net) when  
these recyclables displace virgin  
feedstock in production

## Change from Weekly to Every-Other-Week Collection of Recyclables

Reduce emissions <50%

→ ~ 2 MTCO<sub>2</sub>E **decrease**  
in emissions

Reduce tonnage recycled 9-20%

→ ~ 21 to ~47 MTCO<sub>2</sub>E **increase**  
in emissions

Less frequent collection (relative to garbage) increases global emissions





# What about self-haul (such as return to retail)?

- Self-haul can have significant impacts.
- Example:
  - Delivering 10 pounds of mixed plastics for recycling in an average car reduces GHG emissions equivalent to driving the car 17 miles.
- Strategies:
  - Increase quantity of materials collected per trip.
  - Decrease extra/additional trips/miles through co-location of collection points.

## Long-haul is not a limiting GHG factor for many recyclables

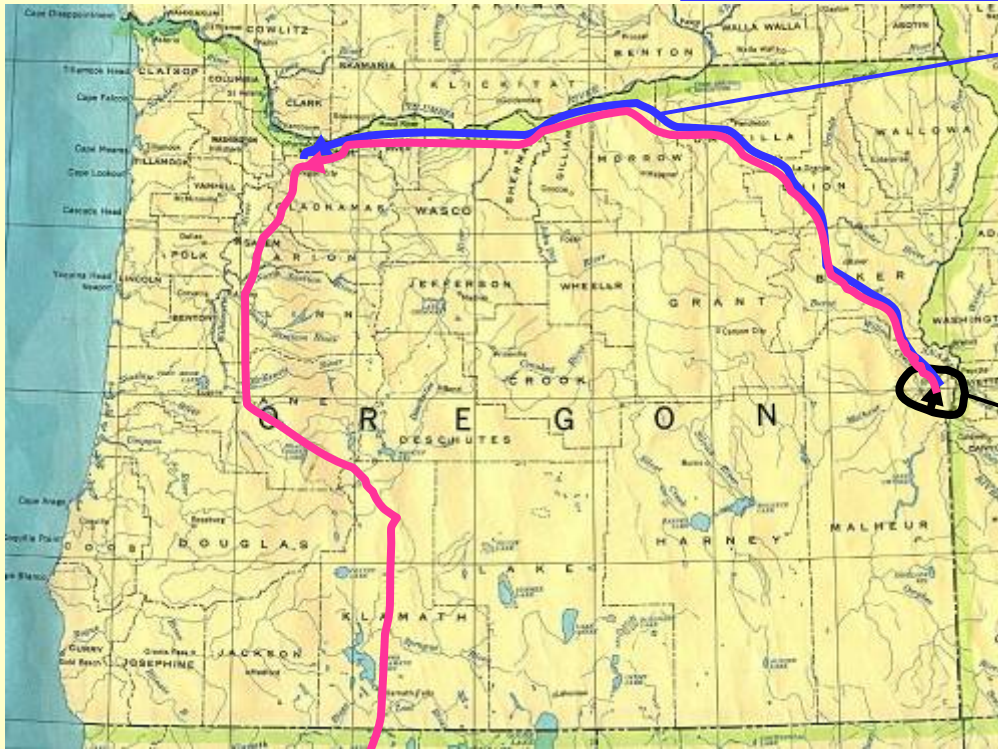
Material	Production & Forestry Savings (MTCE/ton collected)	<u>“Break-Even Point” (miles)</u>		
		Truck	Rail	Freighter
Aluminum	3.44	116,000	451,000	524,000
Corrugated	0.79	27,000	104,000	120,000
Newspaper	0.68	23,000	90,000	104,000
Steel	0.48	16,000	63,000	73,000
LDPE	0.36	12,000	47,000	55,000
PET	0.33	11,000	43,000	50,000
HDPE	0.30	10,000	39,000	45,000
Glass (to bottles)	0.07	2,000	9,000	11,000

“Break-Even Point” is where GHG emissions transporting the recyclables equals GHG emissions avoided when the recyclables displace virgin feedstocks.

Avoided disposal-related emissions are not included.

# End Markets Matter! (sometimes)

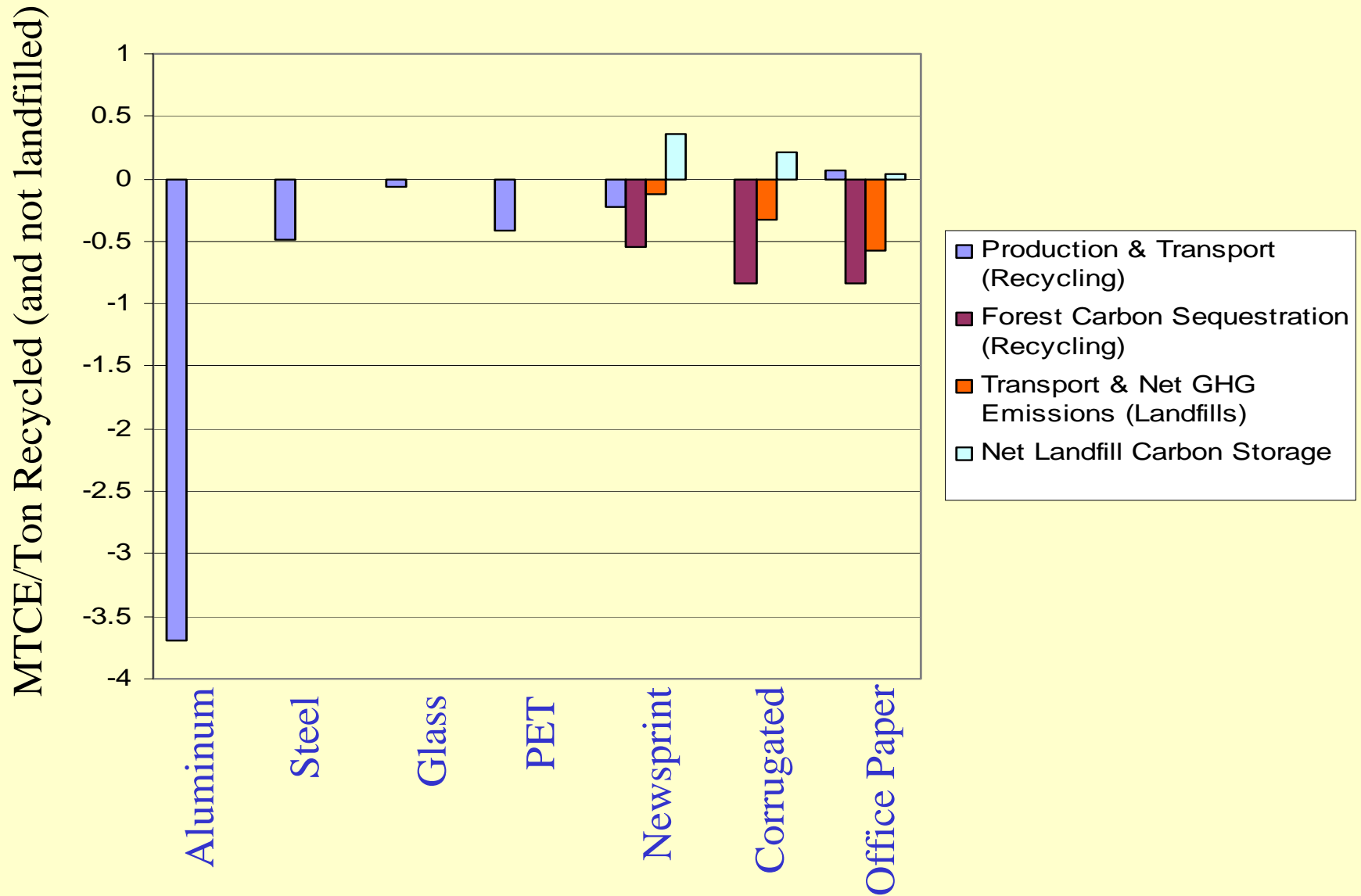
**Cullet to Bottle Recycling (Portland)**  
**Net Energy Savings: ~2.1 MMBTU/ton**



**Cullet to Aggregate  
Recycling (Local)**  
**Net Energy Savings:  
~0.2 MMBTU/ton**

**Cullet to Fiberglass Recycling (California)**  
**Net Energy Savings: ~3.2 MMBTU/ton**

# Recycling benefits vary by material





# Key Findings

- “Upstream” emissions dominate (for most materials/wastes)
- The impacts of goods is much larger than conventionally recognized by most GHG inventories . . . and these impacts are likely growing.
- Waste prevention is very important
- Recycling is beneficial
  - Collection-related emissions are surprisingly insignificant
  - So are long-haul transportation emissions
  - Benefits tend to be driven by virgin feedstock displacement (energy and forestry, not disposal avoidance)
  - Benefits can vary by end use



# Key Findings, continued

- Recycled content does not consistently correlate with reduced GHG emissions
- Composting can also have greenhouse gas reduction benefits (especially food waste)
- Recycling paper likely has (much) higher GHG benefits than composting it
- Among engineering controls, conversion of  $\text{CH}_4$  to  $\text{CO}_2$  provides a greater benefit than energy recovery . . .
  - . . . although energy recovery can add benefits.
- Public perception to the contrary, degradability in a landfill is not necessarily a good thing!
- GHG benefits are becoming much easier to estimate.



# Thank You!

For more information:

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# Recycling/Composting & Climate Change:

The Alameda County  
Climate Action Project

EPA Webinar

Debra Kaufman  
June, 2008







# About StopWaste.Org:

- Alameda County Waste Management Authority & Recycling Board
- JPA representing 14 cities and the County on recycling & waste
- Funded by landfill tip fee: \$7.57/ton
- Mission: Reduce the waste stream by 75%



# Alameda County, CA



- Fast Facts:
  - Population: 1.45 Million
  - 1.4 million tons annual to landfill
  - 14 incorporated cities including Oakland & Berkeley
  - Jurisdictions are both urban and suburban, varied sizes
- Leader in Many Environmental Areas
  - One of 12 launch partners of the Cool Counties Initiative
  - All 14 cities and the County following ICLEI protocols
  - All 14 cities and County conducted GHG inventory
  - #1 volume of food scrap recycling in the US
  - #1 in onsite solar power for Counties in the US



# Agency's Motivation:

- **Raise profile of Agency waste reduction programs.**
- **Ensure that recycling/composting are included in local govt. climate action plans.**
- **Ensure that landfill methane emissions are properly accounted for in inventories**



# Coordinated Alameda County Climate Change Activities

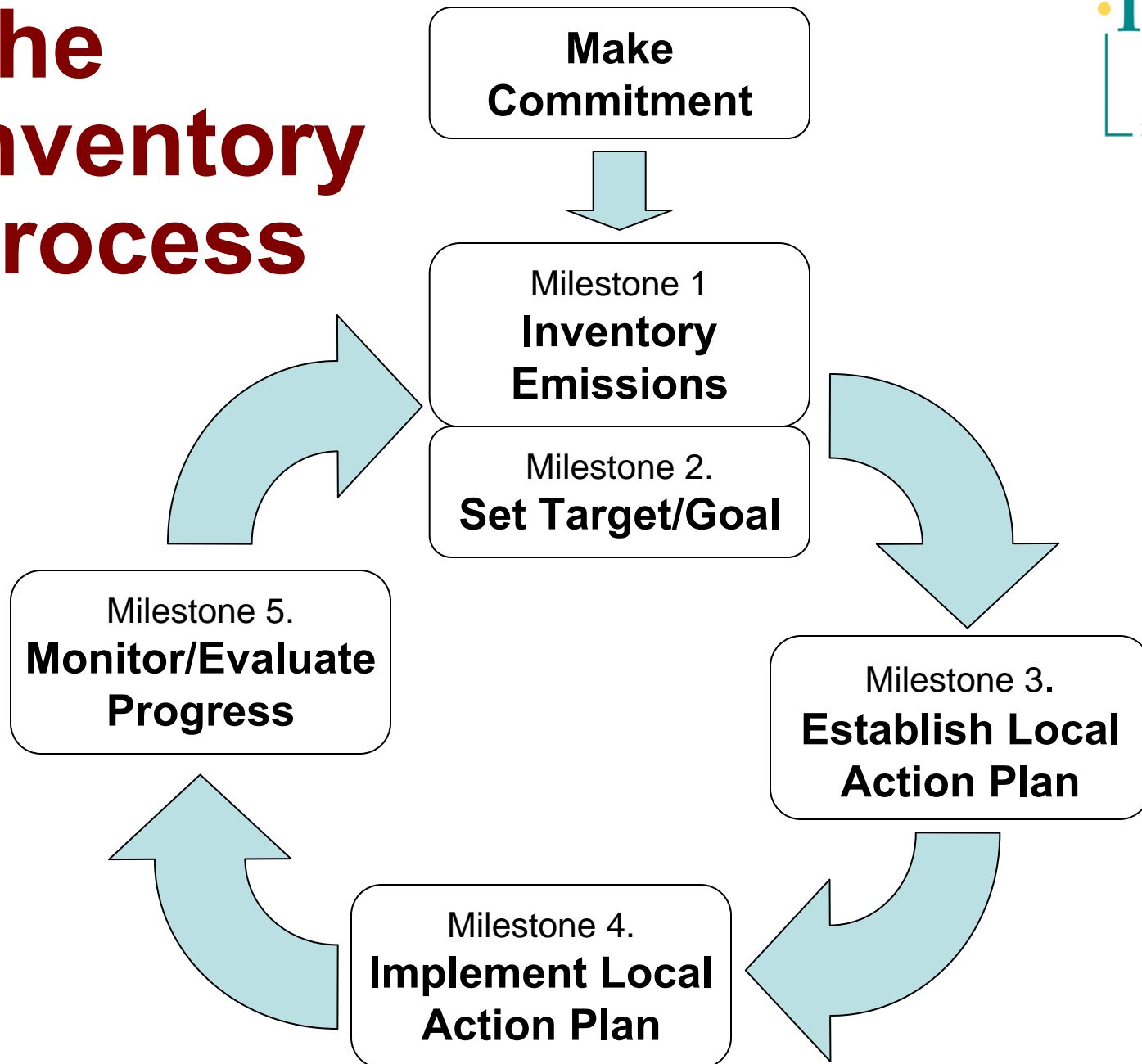
- **Emissions inventories:**
  - All 14 cities conducted municipal & community
- **Reduction target:**
  - 5 cities: 25% below 2005 levels by 2020.
- **Climate action plans:**
  - 3 complete; 7 underway; template complete

## **Funded via landfill tip fees:**

- Administered with master StopWaste.Org contract with ICLEI



# The Inventory Process



# Local Government Tools

## ICLEI Greenhouse Gas Inventory:

- Calculates GHG emissions
- Doesn't include emission reduction strategies



## EPA's WARM:

- Calculates emission reductions associated with recycling



**Both tools are important parts of  
Climate Action Planning.**



# ICLEI GHG Emissions Inventory

## What it Does:

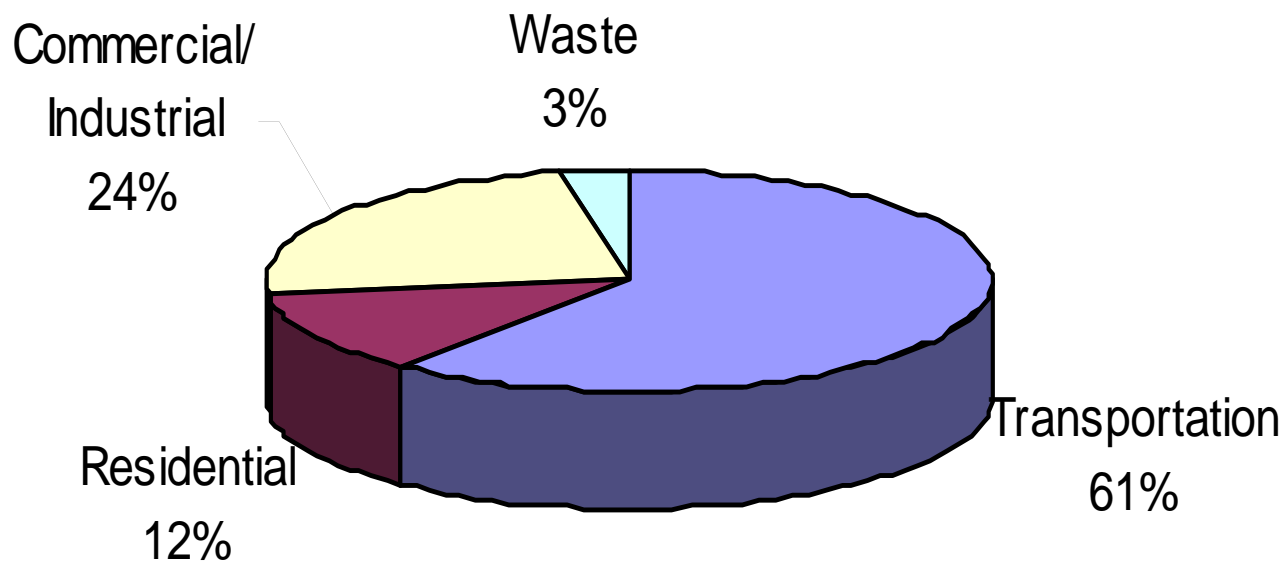
- **Calculates emissions** from 3 sources for government operations and community activities
  - Transportation (vehicle miles w/in jurisdiction)
  - Energy consumed
  - Waste (estimated landfill methane emissions)

## What It Doesn't do: (not intended to)

- **Does not Calculate emission reduction potential** from *any measures*, (eg, recycling, using CFLs) or from *emissions from materials consumed*



# Community-Wide GHG Emissions by Sector (Including State Highways) San Leandro 2005







# ICLEI GHG Emissions Inventory (continued)

## What the Inventory Excludes Re Waste Emissions:

1. Doesn't factor in emissions from energy used **elsewhere** in producing products
2. Fugitive emissions may be understated as model uses EPA 75% methane recovery rate which is subject to debate.

Rationale for excluding upstream energy emissions from creating products:

*The upstream energy emissions from local consumption and wasting of products is contained in the host community inventory*



# ICLEI GHG Emissions Inventory (continued)

## **Issues of Concern with the Inventory's Waste Methodology:**

- Waste related emissions look smaller than they actually are (if you consider upstream energy, transportation impacts)
- Energy and transportation emissions related to waste go in those categories, not in waste category
- By showing local emissions only, inventory yields a parochial approach where only actions that reduce emissions within one's own community are promoted
- If EPA 75% methane recovery rate is too high, landfill emissions underestimated

**Communities need a baseline to determine a reduction target; ICLEI inventory achieves that; needs tweaking**



# ICLEI Inventory Measures Landfill Emissions...

- Landfill emissions are a small part of the overall emissions related to creating waste.
- Emission reductions from LF's do not compare to the potential avoided emissions from not creating the waste in the first place
- Even at 100% LFG collection efficiency, we have still wasted the energy contained in 40 millions tons of resources by burying them
- Every ton of waste in landfills represents a lost opportunity to reduce multiple tons of emissions from recycling that material

# ...Not GHG Reductions from Recycling & Composting

- **Recycling** reduces GHG emissions from mining, transportation, processing, and manufacturing
- **Composting** reduces GHGs through methane avoidance and carbon sequestration
- **Compost application** reduces GHGs through decreased water demand and fertilizer / pesticide / herbicide use.





# EPA's WARM to the Rescue

## What WARM does:

- Calculates upstream emission reduction potential from recycling
- Translates energy savings from recycling into CO2 savings for a variety of materials (paper, alum, glass)
- Gives a rationale for prioritizing diversion policies
- Could include more upstream benefits of composting

**Very Useful Tool to Project CO2 Savings from Waste Diversion Measures in Climate Action Plans**



# Comparing Emission Reduction Measures for a Green Home Using WARM:

- 5.7 MTCO<sub>2</sub> C&D recycling
- 1.7 MTCO<sub>2</sub> : Energy Conservation measures
- .1 MTCO<sub>2</sub>: Water Conservation measures

**Adoption & implementation of C&D ordinance  
contributes nearly as much as traditional CO<sub>2</sub>  
reduction measures**

**Climate Action Plan should include projected CO<sub>2</sub>  
savings from recycling C&D waste from new housing  
and commercial construction.**



# Comparing Emission Reduction Measures for a School District Using WARM

Emission reductions from 3 different measures considered:

- Convert bus fleet (143 buses) to **biodiesel**: saves **582** tons MTCO<sub>2</sub>
- Add 32,000 square feet of **photovoltaics** saves **441** MTCO<sub>2</sub>
- Increase **recycling** rate from 30% to 35% saves **461** MTCO<sub>2</sub>

**Recycling is lowest cost alternative and uses existing infrastructure**

# Emissions Reduction Findings

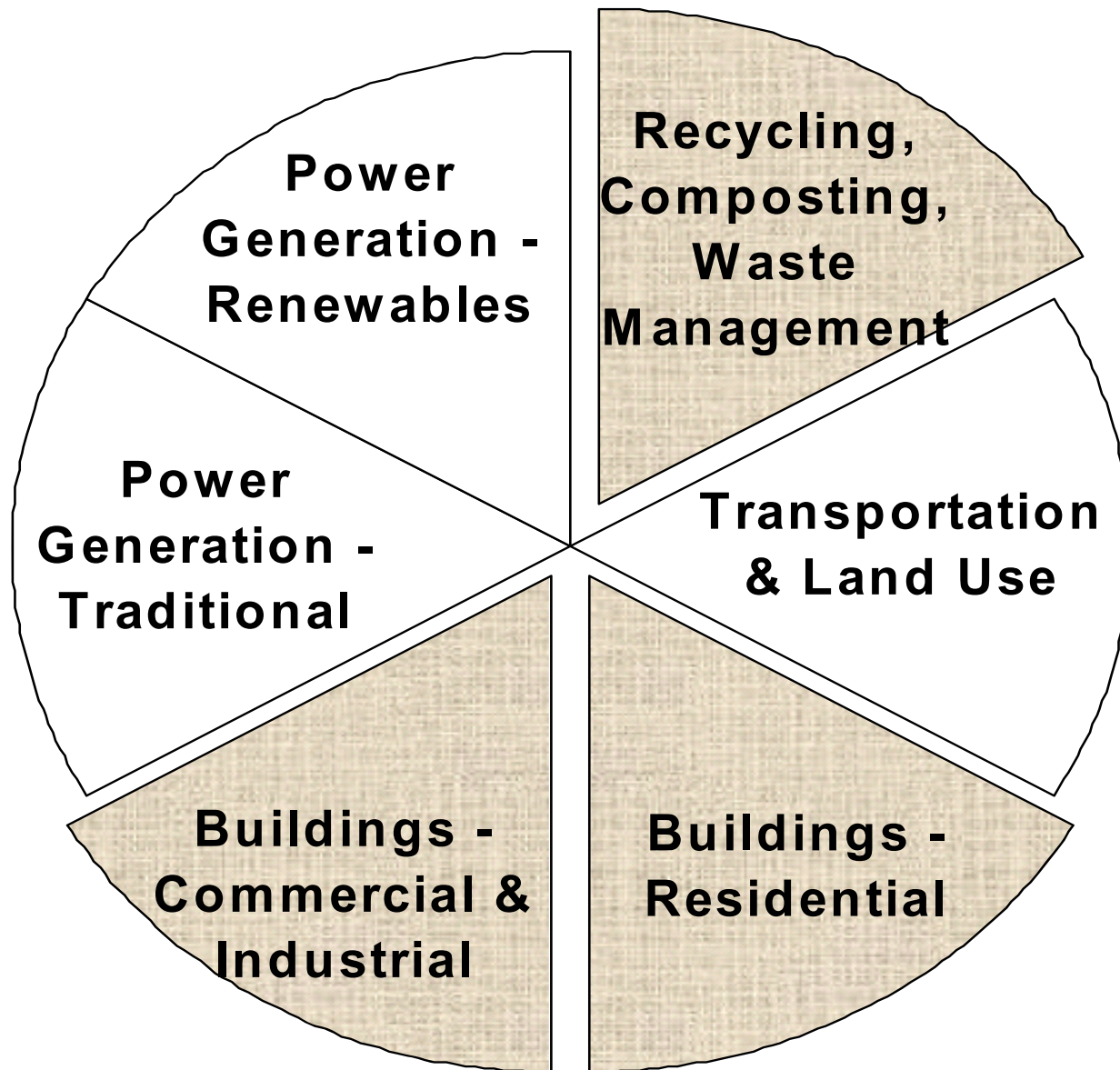


- Duplex copying 2000 reams  $\approx$  2 MTCO<sub>2</sub>
- Divert 1 Ton of food scraps from landfill  $\approx$  1 MTCO<sub>2</sub>
- Home built under a C&D ordinance  $\approx$  5.7 MTCO<sub>2</sub>
- Recycle 1 Ton of cardboard boxes  $\approx$  4 MTCO<sub>2</sub>
- Recycle 1 Ton of plastic film  $\approx$  2 MTCO<sub>2</sub>
- Recycle 1 ton of mixed paper  $\approx$  4 MTCO<sub>2</sub>
- Recycled content paper 20 cases  $\approx$  1 MTCO<sub>2</sub>





# Emissions Reduction Strategies: Our View





# Priority Materials: What's Left in The Average Waste stream?

**Half of landfilled materials = organics**

Food:	12%
Contaminated Paper:	8%
Wood:	9%
Recyclable Paper:	10%
Cardboard	5%
Yard debris:	7%

**Prioritize Getting Organics out of the Landfill**



# Composting Yields Lower Emissions than Landfilling

“There are *no plausible scenarios in which landfilling minimizes GHG emissions* from waste management; for *food waste, composting yields significantly lower emissions* than landfilling. For paper waste, landfilling causes higher GHG emissions than either recycling or incineration with energy recovery” (US EPA, 2000)

# Keeping Organics Out of Landfills

## Food Scrap Campaign

- Outdoor: Billboards, BART and Transit
- Indoor: Print ads, Cable TV, Radio
- Bill inserts
- Shopping carts





# Promoting Residential Food Scrap Recycling



Foodwaste is the most prevalent item in our waste stream and generates more methane in the landfill than any other material.







**HONEY, YOU MAY  
BE WILTED.  
BUT YOU'RE STILL WANTED.**



**FOOD SCRAP RECYCLING. MAKE IT SECOND NATURE.**

[WWW.STOPWASTE.ORG](http://WWW.STOPWASTE.ORG)



**I'LL TAKE  
WHAT'S BEHIND  
DOOR #2!**

**RECYCLE YOUR FOOD SCRAPS WHEN YOU CLEAN OUT YOUR FRIDGE.**

[WWW.STOPWASTE.ORG](http://WWW.STOPWASTE.ORG)





**TAKE ME  
TO YOUR  
LEFTOVERS.**



**FOOD SCRAP RECYCLING. MAKE IT SECOND NATURE. [WWW.STOPWASTE.ORG](http://WWW.STOPWASTE.ORG)**



**LEFTOVER,  
BUT NOT  
UNLOVED.**

**FOOD SCRAP RECYCLING. MAKE IT SECOND NATURE.**

[WWW.STOPWASTE.ORG](http://WWW.STOPWASTE.ORG)

The advertisement features a white pizza box with two slices of pizza on the left. A large white speech bubble with a black border points from the pizza box to a green recycling bin on the right. The bin is overflowing with various food scraps, including vegetables, fruits, and small cartons. The background is a solid orange color. At the bottom, a white arrow points from the text 'FOOD SCRAP RECYCLING. MAKE IT SECOND NATURE.' towards the green bin.



# Important Climate Protection Activities Related to Waste

- Get organics out of landfills
- Increase commercial & residential recycling
- Show that recycling, composting & waste prevention are very cost-effective GHG reduction measures via WARM
- Encourage development of recycling reporting protocol to include upstream emissions
- Ensure that Climate Action Plans include expanded waste recycling/composting/waste prevention programs



# Important Climate Protection Activities (continued)

- Urge EPA to use a more conservative methane recovery rate until there are better methods for estimating fugitive emissions
- Urge state agencies to incorporate recycling/composting activities into state Climate Action Plans
- Advocate for translating methane's global warming potential into a 20 year not 100 year timeframe
- Work to ensure that CEQA for new projects consider waste impacts and consider recycling mitigations
- Suggest improvements to WARM and inventory methodologies

# Resources

- **Environmental Protection Agency (EPA)**  
[www.epa.gov/climatechange](http://www.epa.gov/climatechange)  
The EPA has an excellent collection of resources for climate change protection including WARM.
- **International Council for Local Environmental Initiatives (ICLEI)** [www.iclei.org](http://www.iclei.org)  
Non-profit dedicated to helping cities with their GHG inventories

## **Californians Against Waste**

[www.cawrecycles.org](http://www.cawrecycles.org)

Non-profit dedicated to reducing the state's waste stream and promoting the GHG benefits of waste diversion.



# Resources

- **California Air Resources Board (CARB)**  
[www.arb.ca.gov/cc/cc.htm](http://www.arb.ca.gov/cc/cc.htm)  
CARB provides information about climate change program re: AB32.
- **California Climate Action Registry (CCAR)**  
[www.climateregistry.org](http://www.climateregistry.org)  
Voluntary greenhouse gas registry.
- **EcoCycle, GAIA and Institute for Local Self Reliance**  
[www.stoptrashingthecolimate.org](http://www.stoptrashingthecolimate.org)  
New joint report on impact of waste on climate change and reductions possible via waste reduction.

# Contact Information

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