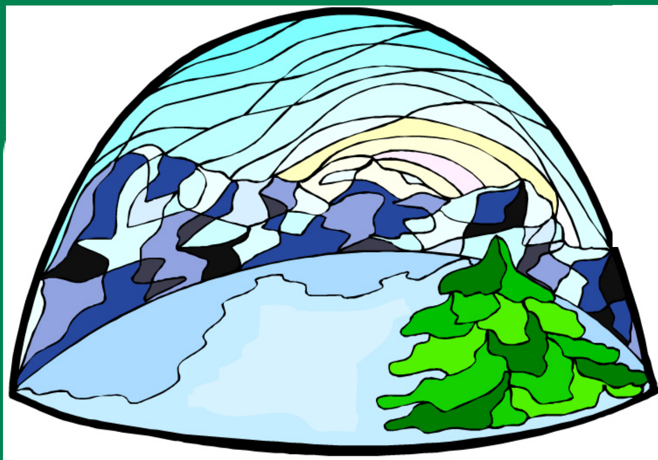


Climate Change, Biomass and Waste Management

Chuck White
Director of Regulatory Affairs -- WM West

California Biomass Collaborative
Sacramento, CA -- March 28, 2007

WASTE MANAGEMENT

What is: WASTE MANAGEMENT ?

Waste Management = Renewable Energy

- **Landfill Gas: 470 MW**
  - *400,000 homes*
- **17 Waste-to-Energy Plants: 650 MW**
  - *600,000 homes*
- **Recycling Energy Savings: 920 MW**
  - *138 Recycling Facilities*
  - *848,000 homes*

Was 2006 the year of . . .

Greenhouse Gas?

?

Well -- Just Wait for 2007 . . .

- **And . . .**

  2008 . . .

  2009 . . .

  2010 . . .

  2011 . . .

  2012 . . .

  2013 . . .

Climate Change

Emerging Programs:

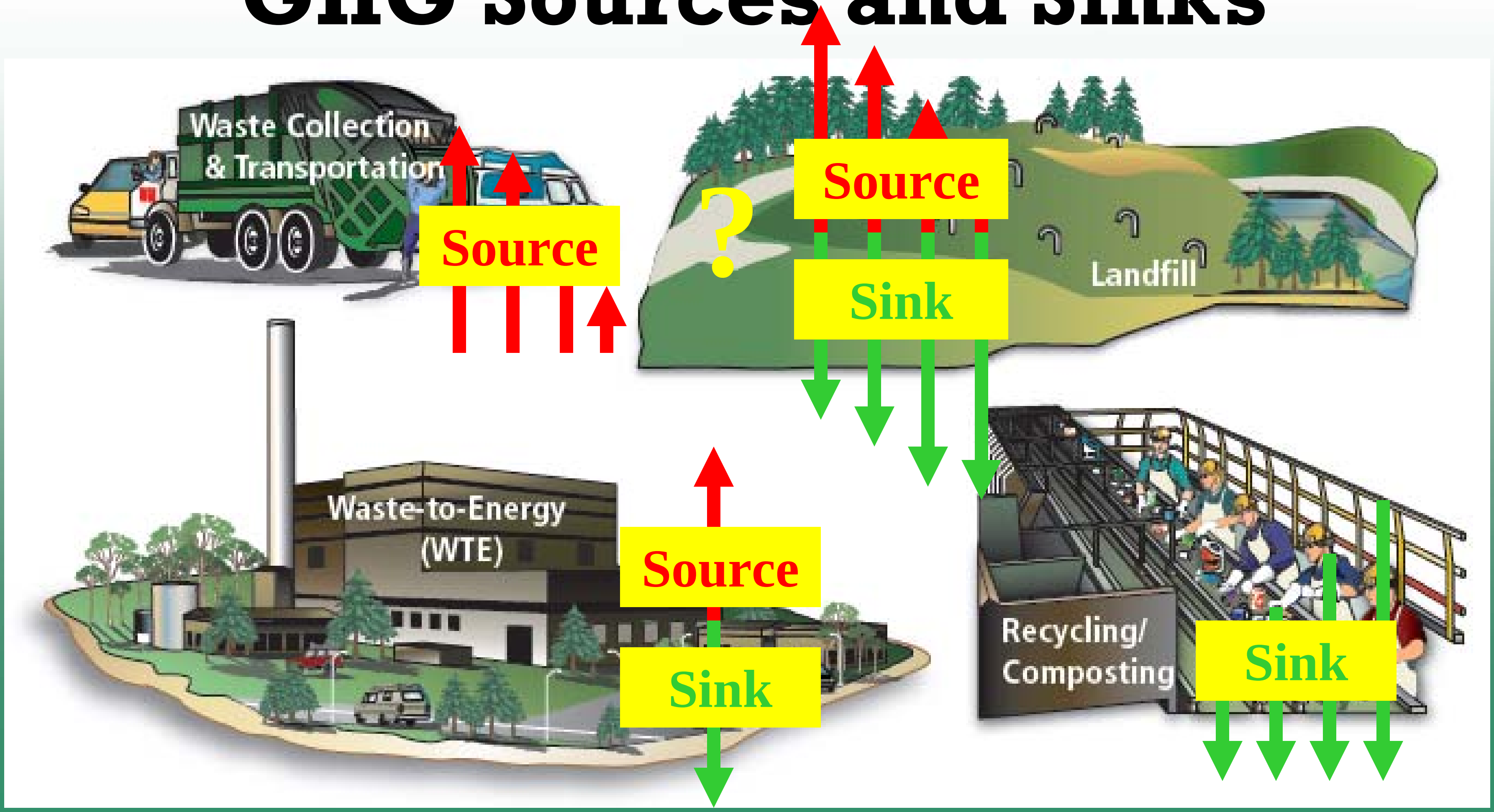
- Mandatory GHG inventorying
- Enforceable GHG emission caps
- GHG "offset or credit" trading
- Potential carbon taxes
- New fuel/engine mandates
- New technology incentives

Investing in Solutions to Climate Change

- **Tightening Trend: U.S. will likely follow the global trend to constrain carbon emissions**
- **Legislative Activity: There is a lot happening!**
- **Investment Opportunities: Companies selling products and services that address climate change could benefit significantly**
- **The Clean Dozen:**

. . . (+ 11 Others)

Solid Waste Management GHG Sources and Sinks



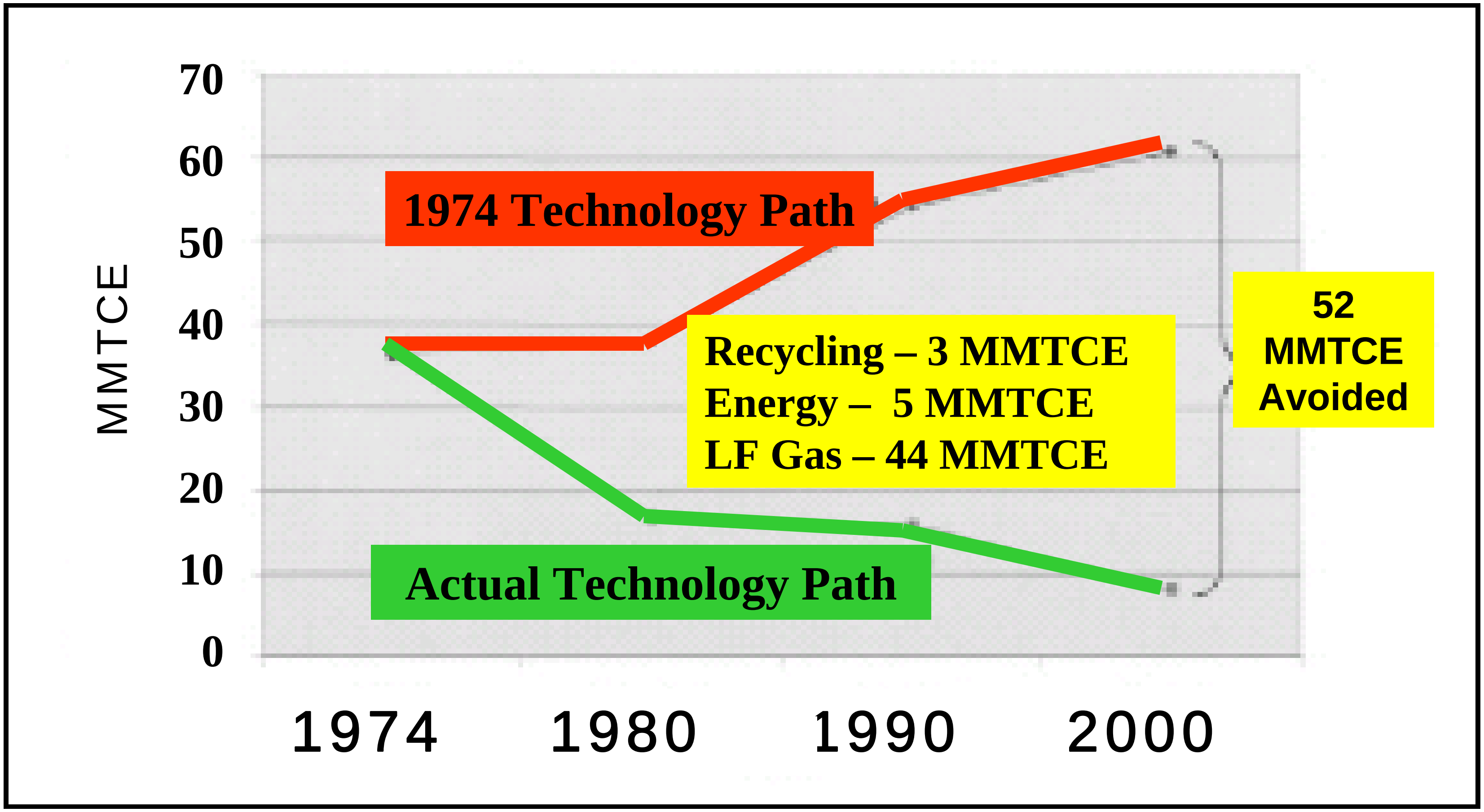
The History of Solid Waste Management in the United States*

- **Prior to the 1970s**
  - *Sanitary landfills rare*
  - *Wastes were dumped and burned to reduce volume*
  - *Waste incinerators had no pollution control or energy recovery*
  - *Minimal recycling or source reduction*

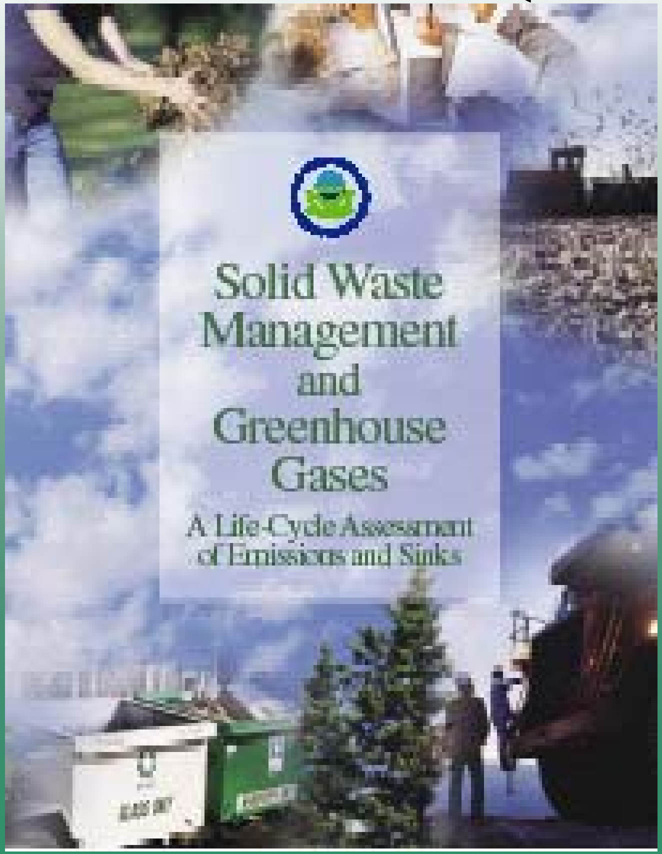
- **Major Changes Include**
  - *Source reduction & recycling*
  - *Composting of yard waste*
  - *Integrated and regional solutions for solid waste*
  - *"Waste-to-energy" facilities with minimal environmental burden*
  - *Adoption of "Sanitary" landfilling practice*
    - Control landfill gas
    - Leachate recirculation and other liquids to promote faster decomposition

***Weitz K.A. et al (2002) The Impact of Municipal Solid Waste Management on GHG Emissions in the United States**

Overall GHG Reductions for Solid Waste Management – All Sources

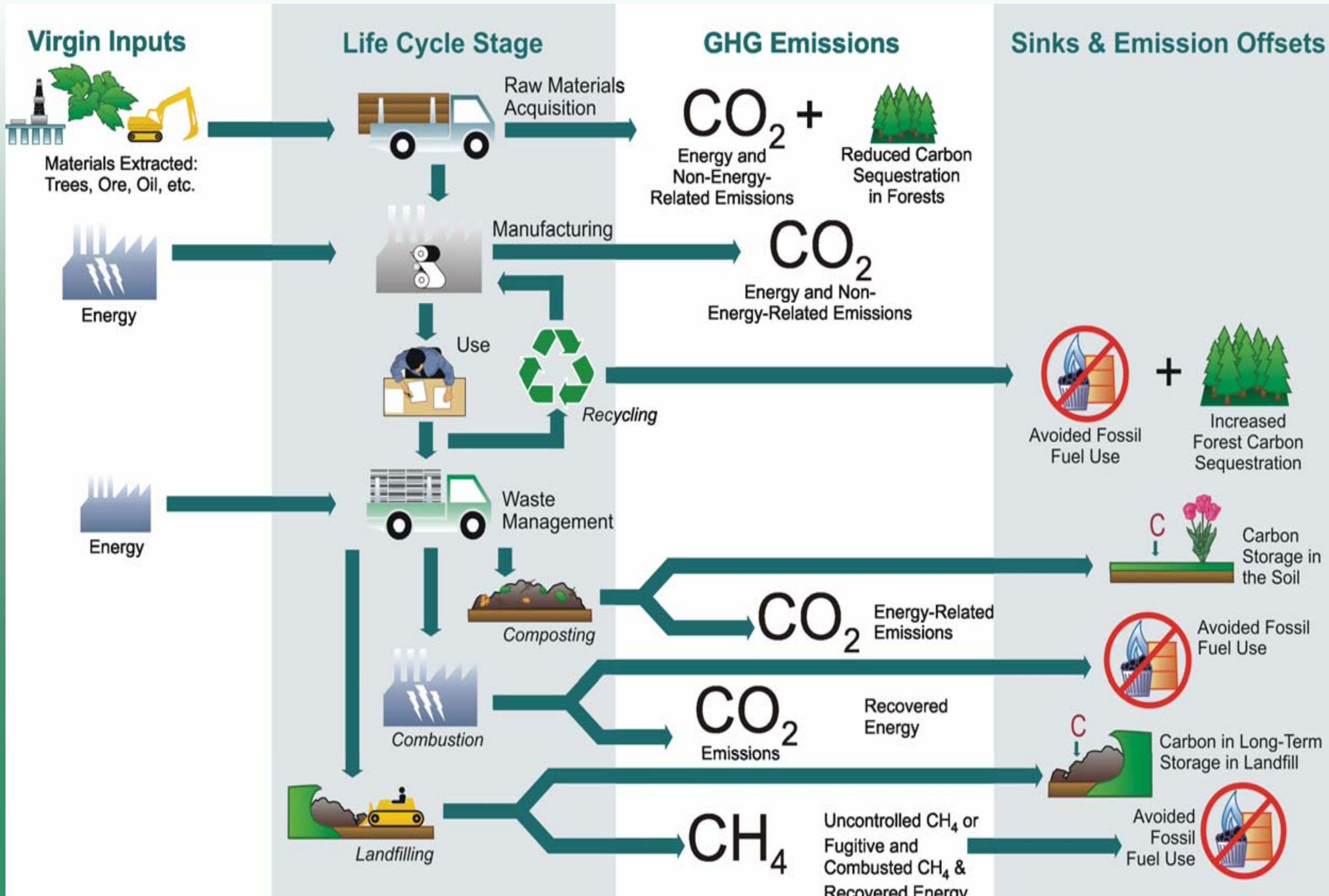


Solid Waste Management and Greenhouse Gases (EPA, 2006)

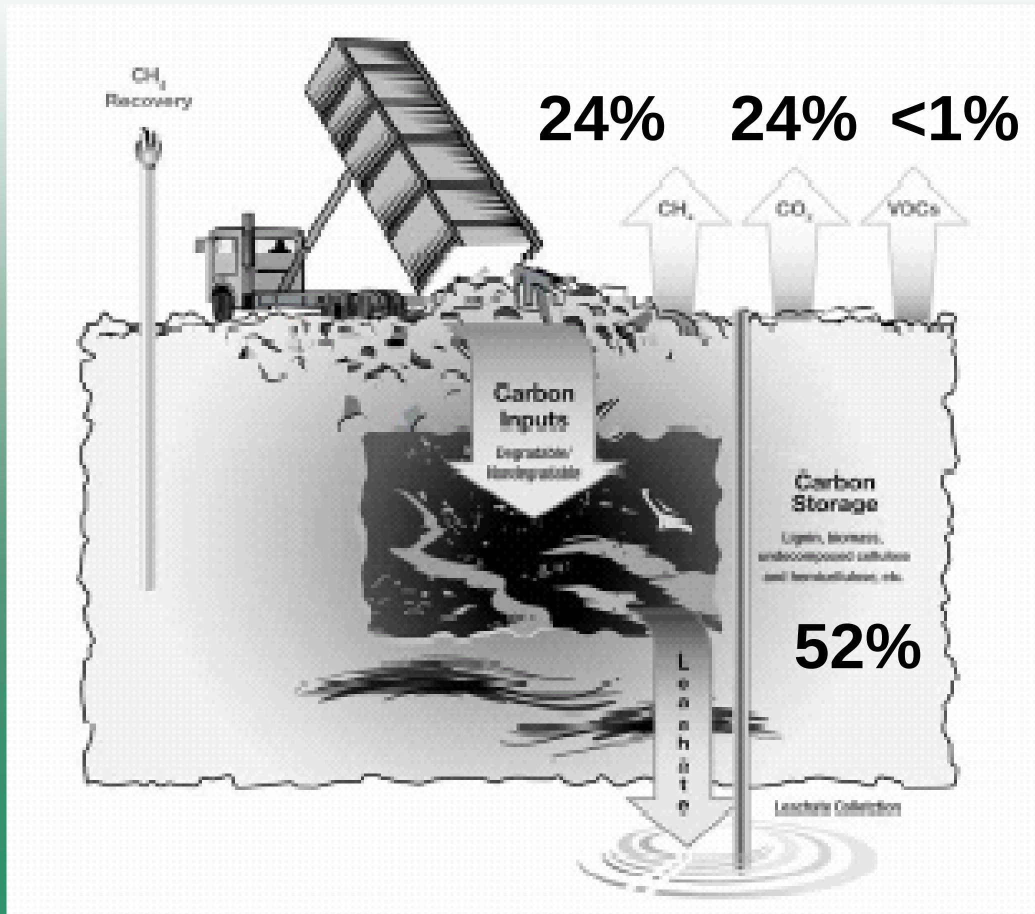


1. **Source Reduction**
2. **Recycling**
3. **Energy Recovery**
4. **Composting**
5. **Landfilling**

A Lifecycle Analysis of GHG Sources and Sinks



Carbon Inputs to Solid Waste Landfill



Landfill Carbon:

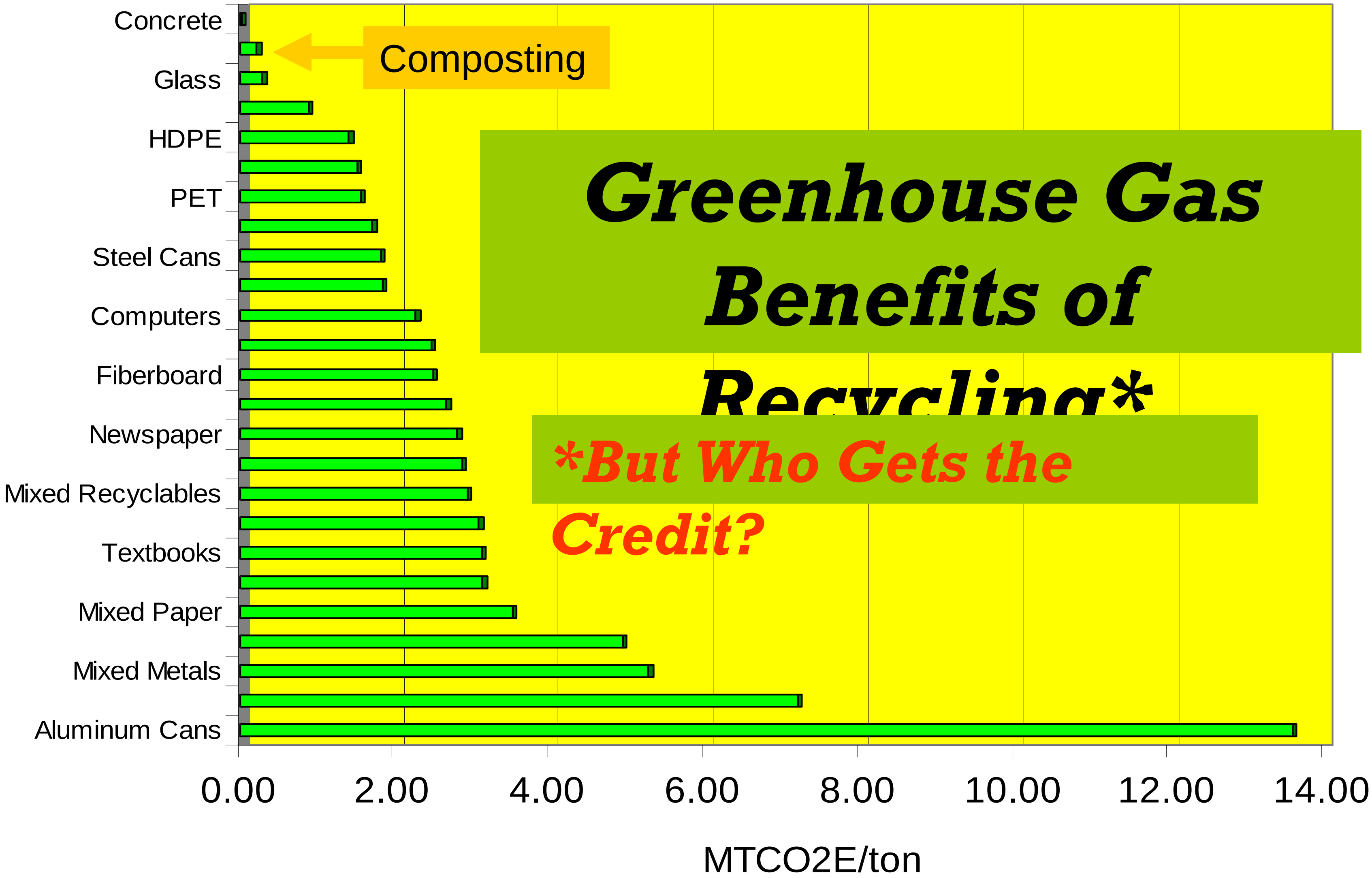
- **24% as CH4**
- **24% as CO2**
- **52% Storage (Lignins, Undecomposed Cellulose, and Hemi-cellulose)**

California Landfill Biomass and Greenhouse Gas Emissions

Waste Component	% of Waste Stream	2003 Tons Disposed	Landfill CH4 (MTCE/ton)	LF Carbon Storage (MTCE/ton)	Recycling & Composting (MTCE/ton)	Million BTUs/Ton	Avoided CO2 @ 20% Energy Eff. (MTCE/ton)
Various Papers	15.40	6,133,840	-0.40	0.22	0.65	14.3	0.22
Food	14.60	5,854,352	-0.44	0.02	0.06	4.7	0.07
Lumber	9.60	3,881,214	-0.32	0.38	0.06	18.8	0.26
Cardboard	3.60	2,312,147	-0.69	0.22	0.83	14.1	0.22
Leaves and Grass	4.20	1,696,022	-0.22	0.14	0.06	5.6	0.09
Prunings/Trimmings	2.30	920,356	-0.36	0.31	0.06	5.6	0.26
Branches/Stumps	0.30	119,754	-0.36	0.31	0.06	18.8	0.26
Total	52.00	20,917,685	-0.44	0.21	0.28	10.8	0.16
Total MSW Disposed	100.00	40,235,328					

Greenhouse Gas Benefits of Recycling*

***But Who Gets the Credit?**



From everyday collection to environmental protection, Think Green.℠ Think Waste Management.

Moving from Solid Waste Disposal to Materials Management in the United States*

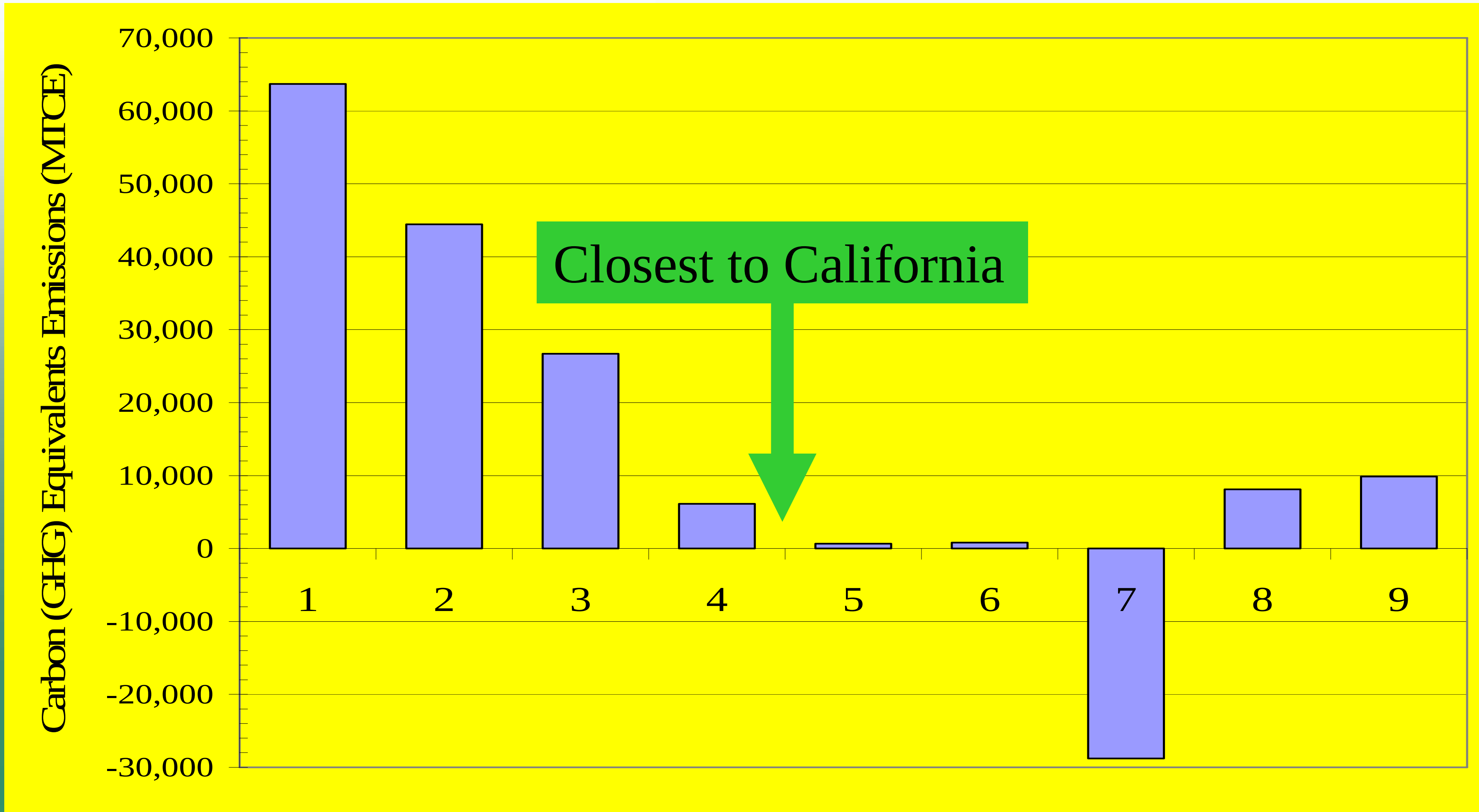
- **Size of community –**
  - *Population of 750,000*
  - *Waste generation per person per day – 2 kg (3.5 pounds)*
  - *Total waste being managed annually – 437,000 metric tons*
- **Key findings –**
  - *Need to balance costs and environmental tradeoffs*
  - *Landfill gas control and recycling achieve significant reductions*
  - *WTE was found to have lowest net carbon emissions (also lowest for acidification and smog impacts); however, also had highest cost*
  - *Impacts associated with transportation are important*

***Thorneloe et al, (2005)**

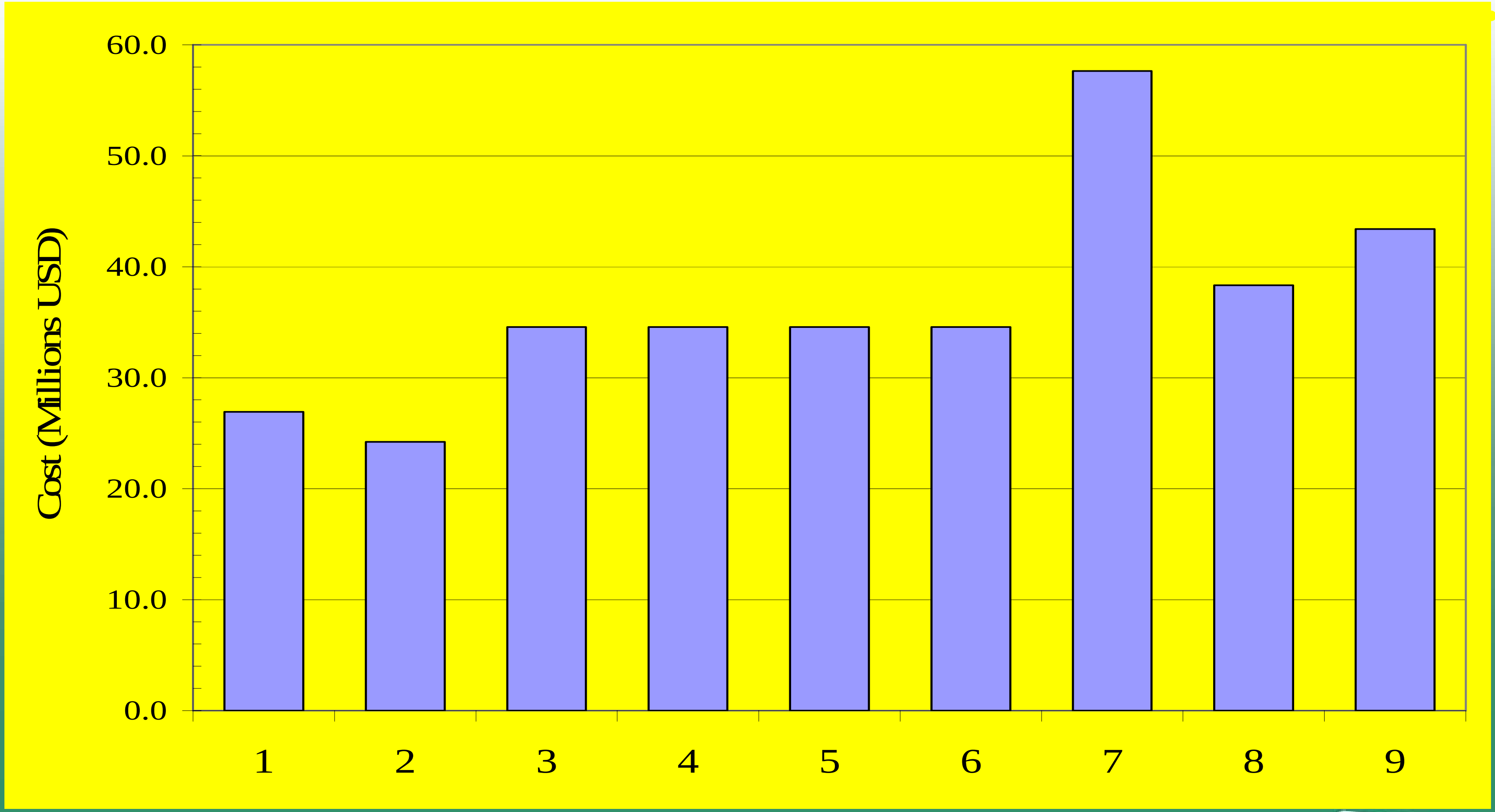
Description of Scenarios

	Scenario Description
1	10% recycling; 90% landfilling with no gas control
2	20% recycling; 80% landfilling with no gas control
3	30% recycling; 70% landfilling with no gas control
4	30% recycling; 70% landfilling with gas collected and flared
5	30% recycling; 70% landfilling with gas combusted using IC engines
6	30% recycling; 70% landfilling with gas piped to nearby industrial facility and combusted in boiler
7	30% recycling; 70% combusted using waste-to-energy facility (generating energy and recovery of metals)
8	Same as Scenario 5 except waste is collected and transported to transfer station and transported 800 kilometers (500 miles) to landfill using semi-tractor trailer
9	Same as Scenario 5 except waste is collected and transported to transfer station and transported 800 kilometers to landfill using rail

Net GHG Emissions (Tons of Carbon Equivalents)

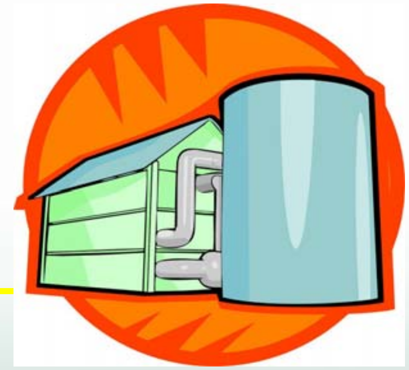


Net Annualized Costs



WM Priority: Cork Our Flares!!

Are There Other Options for Landfill Gas?



GHG Regulatory Drivers

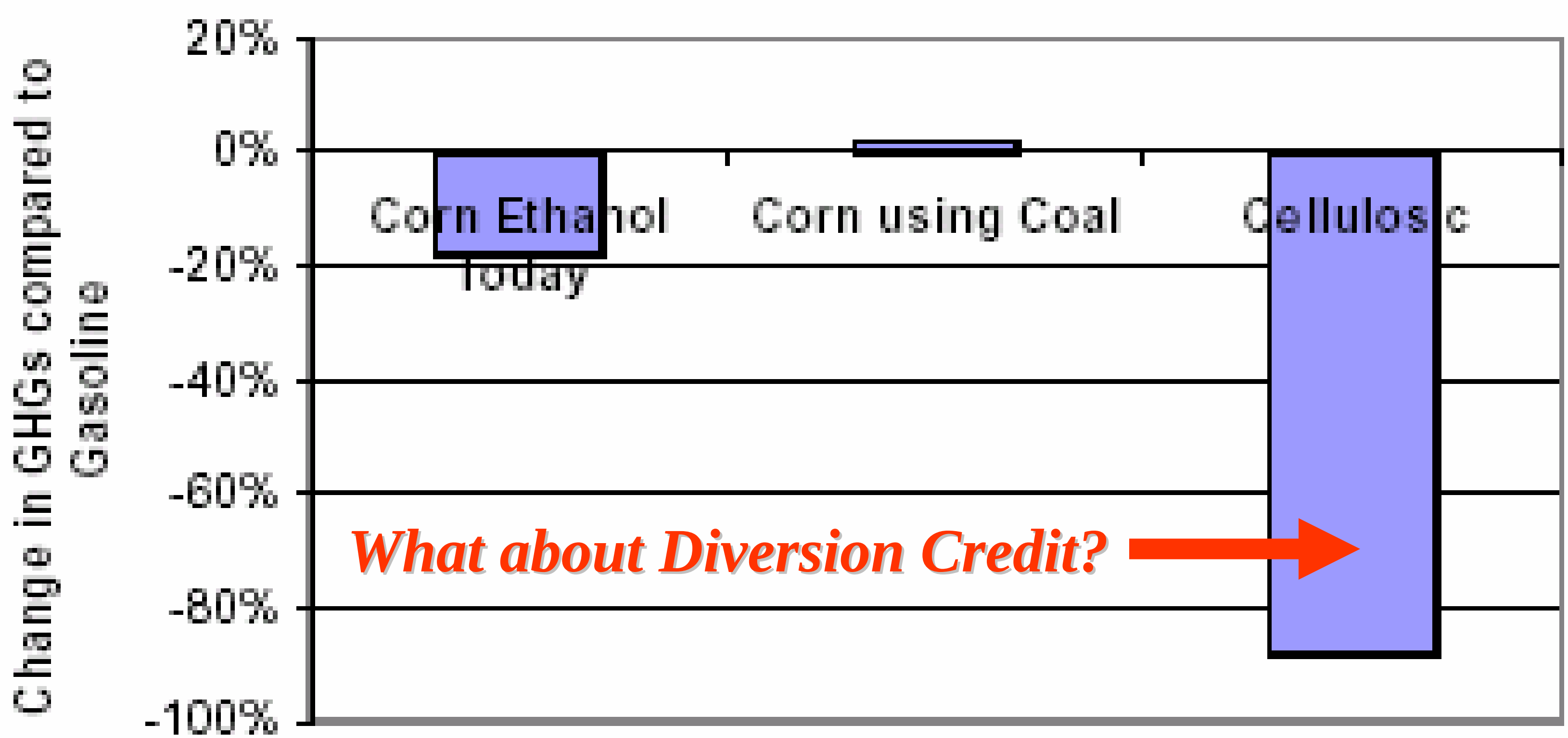
1. LF Gas Collection – currently 95%+ of WIP
2. Flaring – Methane Destruction (95%+)
3. Internal Combustion Engines (45
4. Boilers or Turbines (10%)
5. Refining LFG to Nat. Gas or Bio-diesel (0%)
6. Diversion of Organic Waste to Alternative Use (Compost, Conversion Tech, Fuel?)

NOx ?

Challenges to Landfill Methane Recovery & Use

- **Variability of Gas and Contaminants (e.g. Siloxanes)**
- **Expense of Equipment/Operations**
  - ***Compared to Low-cost Flaring of gas***
- **Criteria Pollutant Emission Standards**
  - ***SCAQMD Rule 1110.2 Amendments***
    - All new equipment would have to meet natural gas emissions
    - By 2012 would have have to upgrade existing equipment
  - ***Could lead to shut down of LFGTE project and a return to Flaring of LF gas – with no energy recovery or GHG benefits***

Relative GHG Emissions from Various Sources of



Source: Farrell et al., "Ethanol Can Contribute to Energy and Environmental Goals," *Science*, Jan 27, 2006.

Positive GHG Messages for Waste Industry

- **Waste-Related Emissions are small (neutral?)**
- **Progress to date has been Significant**
  - *50 – 80% reduction in GHG emissions*
  - *Increased recycling rates*
  - *Landfill Gas Controls (0% → 90+% capture!!!!)*
  - *Increased conversion to energy*
  - *Alternative fueled vehicles*
- **Landfill: LFG Control *and* Carbon Storage**
- **Opportunities for further Waste-to-Energy**

References

- **Weitz K.A., Thorneloe S.A., Nishtala S.R., Yarkosky S. & Zannes M. (2002) The Impact of Municipal Solid Waste Management on GHG Emissions in the United States, Journal of the Air and Waste Management Association, Vol 52, 1000-1011.**

- **Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, US EPA, Third Edition, 2006. The report explores the linkages between waste management, greenhouse gas (GHG) emissions, and energy and quantifies the emissions and energy use associated with source reducing, recycling, composting, incinerating, and landfilling a variety of materials and mixed material waste streams.**

- **Thorneloe S.A., Weitz K.A., & Jambeck J (2005) Moving from Solid Waste Disposal to Materials Management in the United States, Presentation at the tenth International Waste Management and Landfill Symposium in Cagliari, Italy on October 3-7, 2005. Cleared for publication in proceedings.**