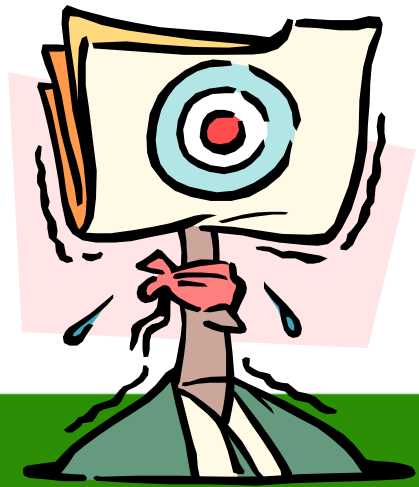
Greenhouse Gas Emissions and Sources – Amy Banister, Sr. Dir. Air Programs

Introduction

- Waste Industry Emission Sources
- Inventorying GHG Emissions
- Status of Climate Change Programs
- Issues and Challenges



What is the Big Picture?

- Landfill CH_4 emissions are estimated to be the largest source of anthropogenic CH_4 emissions in the United States.

- However, the waste industry is estimated to be a relatively small contributor to GHG emissions:
  - Globally <5%[1]
  - US ~3%[2]
  - Canada ~4%[3]

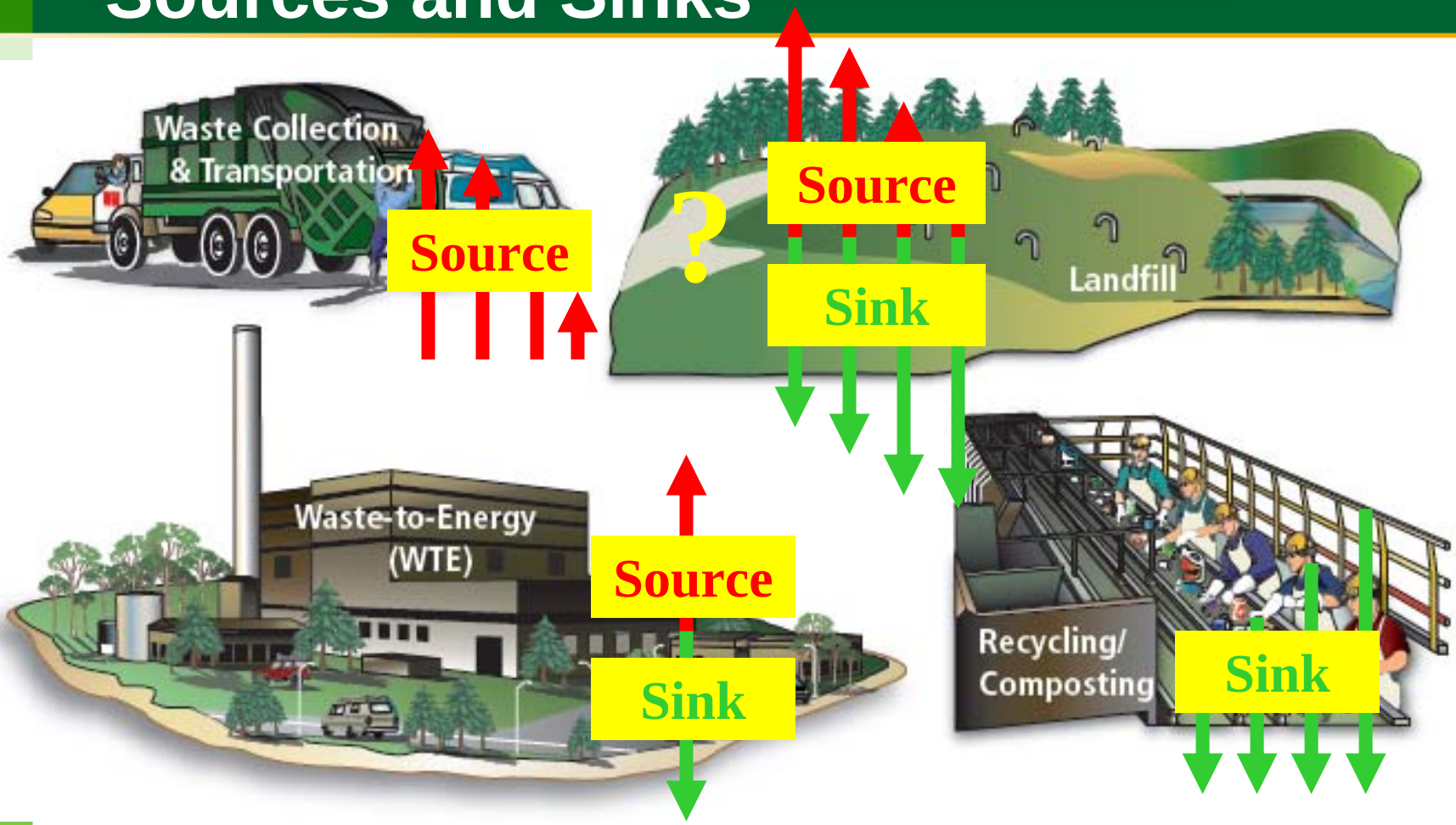
[1]IPCC, AR4, WGIII, 2007
[2] NSWMA, 2006
[3]Environment Canada, 2006

GHG Pollutants and Global Warming Potential (GWP)

Common GHGs and their Global Warming Potentials (GWP)			
Name	GHGs	GWP	Primary Source(s)
Carbon dioxide	CO_2	1	Fossil fuel combustion (transportation, energy production, and industry)
Methane	CH_4	23*	Landfills, coal mines, agriculture, animal wastes, wastewater
Nitrous oxide	N_2O	310	Fertilizers used in agriculture, combustion in vehicles, wastewater treatment, and waste combustion
Hydrofluorocarbons	HFCs	140-11,700	Industrial chemicals used as substitutes for ozone-depleting substances
Perfluorocarbons	PFCs	6,500-9,200	Aluminum smelting, semiconductor manufacturing, electric power transmission
Sulfur hexafluoride	SF_6	23,900	Aluminum smelting, semiconductor manufacturing, electric power transmission

Source: Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, 2001
* Some reports/programs use the figure of 21, from the IPCC's Second Assessment Report

Solid Waste Management GHG Sources and Sinks



Calculating GHG Emissions

- Fuel Consumption (on and off road)
  - Fuel supplier records
  - Site-level fuel purchase records/Controller tax reports
  - Emission factors based on type of fuel
- Energy Consumption
  - Electricity, heat and steam (Kwh usage or MMBtu usage)
  - Utility Bills
  - Emission factors based on usage rates and generation type
- Recycling (avoided emissions)

Calculating GHG Emissions

- Combustion (and Electric Power Transmission?)
  - WTE
    - Site records of waste tonnage, default emission factor
    - Site records of electricity sold
  - LFGTE and Flaring
    - Site records of LFG flow and methane concentration
    - Site records of electricity sold

Calculating GHG Emissions

- Landfill Fugitive Emissions
  - Site records of LFG flow and methane concentration
  - LFG generation is modeled (e.g., LANDGem)
  - Default factors for methane oxidation and fugitives
  - Published/on-going research on measuring net emissions (oxidation, sequestration, fugitive)

Emerging Regulatory Programs

- Voluntary or Mandatory GHG Inventorying
- Capping GHG Emissions for Selected Sectors
- Carbon Taxes
- GHG Offset or Allowance Trading
- Biofuels or Engine Mandates
- Incentives for New Technology & Renewable Energy

US Legislation

- Eleven Bills proposed
- “America’s Climate Security Act of 2007” (Lieberman and Warner) – sent to full Senate Environment and Public Works Committee on November 1, 2007
  - Proposes to cut US GHG emissions 15% below 2005 levels by 2020
  - References The Climate Registry

Environment Canada Climate Plan

- Plan aims to curb intensity through baseline-and-credit system
- Offset credit system / trading – not defined
- Possibly purchase international credits via Kyoto's CDM program
  - Up to 10% of compliance deficit
- Anticipate proposed regulations for review in 2008

Regional Programs

- **Western Climate Initiative** - British Columbia, Manitoba and AZ, CA, NM, OR, UT and WA set GHG reduction goal. Ontario, Quebec, and Saskatchewan observing. (www.westernclimateinitiative.org)

- **The Climate Registry** – More than 40 states, tribes, and Canadian provinces creating uniform standards and GHG emissions reporting system. (www.theclimateregistry.org)

Western Climate Initiative

- Regional Goal: Aggregate reduction of 15% below 2005 levels by 2020.
- Multi-sector market-based mechanisms
- All sectors targeted - includes transportation, waste management and energy supply
- By August 2008, design recommendations for regional cap-and-trade program
- Stakeholder input via 5 subcommittees: reporting, scope, electricity, allocations, and offsets.
  - Teleconference 12/6/2007
  - Public workshops starting 2008

The Climate Registry

- THE CLIMATE REGISTRY is a collaboration between states, provinces and tribes aimed at developing and managing a common greenhouse gas emissions reporting system to support reporting and reduction policies for members and reporting entities
  - British Columbia, Manitoba, and Quebec provinces are members

The Climate Registry – General Reporting Protocol (GRP)

- GRP for voluntary emissions reporting
  - All 6 GHGs annually
  - Entity-wide emissions from North American operations at facility level
  - Direct, indirect emissions AND Biogenic emissions
  - Above de minimis (>3%)
- Third Party verification required
- Public disclosure of facility-level data

The Climate Registry – General Reporting Protocol (GRP)

- Third Party verification required
- Public disclosure of facility-level data
- Public comments due November 30 on GRP and companion Verification Protocol
- Anticipate Final GRP Board review January 2008

Alberta Regulation 251/2004: Climate Change and Emissions Management Act

- Effective July 1, 2007, Alberta facilities that directly emit more than 100,000 tonnes of CO2e/year must:
- Submit certified annual inventory reports; and
- Reduce emissions intensity by 12%.
  - Operating improvements
  - Buy Alberta-based credits; or
  - Contribute to the Climate Change and Emissions Management Fund.
- Biomass CO2 emissions excluded

California Global Warming Act of 2006 (AB32)

- Reduce GHG emissions to 1990 levels by 2020 and 80% below 1990 levels by 2050
- Requires statewide cap on GHG emissions starting 2012
- CARB to establish mandatory reporting system
- By 1/1/2008, CARB must define 1990 GHG emissions baseline

CARB Landfill Inventory Protocol

- CARB inventory protocol for landfills:
  - Uses LFG recovery data and default collection efficiency to determine uncollected gas (75%)
  - Default methane oxidation factor (10%) applied to uncollected gas
  - All LFG combustion devices are assumed to have the same destruction efficiency regardless of type (99%)
  - Considers CO_2 biogenic
  - Includes carbon sequestration as in informational item only; does not consider actual emission reduction

Overview of SWICS Inventory Methodology for Landfills

- Solid Waste Industry for Climate Solutions (SWICS)
- Follows CARB methane emission calculation equation but different defaults based on site data and research values
- Collection Efficiency
  - Based on cover type and (Subtitle D) liner
  - Allows for adjustment based on site monitoring data and system performance
  - 50% default assumed where no GCCS installed

Collection Efficiency Criteria

Cover Type	Subtitle D Liner?	Collection Efficiency
Daily	Yes	95%-99%
Daily	No	50%-85%
Intermediate	Yes	95%-99%
Intermediate	No	85%-99%
Final	Yes	95%-99%
Final	No	85%-99%

Overview of SWICS Inventory Methodology for Landfills

- Methane Oxidation Factors
  - Based on cover type per area
    - Daily, intermediate, final, and biocovers
  - Account for increased oxidation from improved covers like biocovers
  - Expressed as percentage and g/m2/day (

SWICS Oxidation Rates

Cover Type	Oxidation Factor
Daily	22.70%
Intermediate	32.08%
Final	35.63%
Biocover	55.33%

Cover Type	Oxidation Rate
Daily	45 $g/m^2/day$
Intermediate	86 $g/m^2/day$
Final	104 $g/m^2/day$
Biocover	181 $g/m^2/day$

SWICS Methane Destruction Efficiency

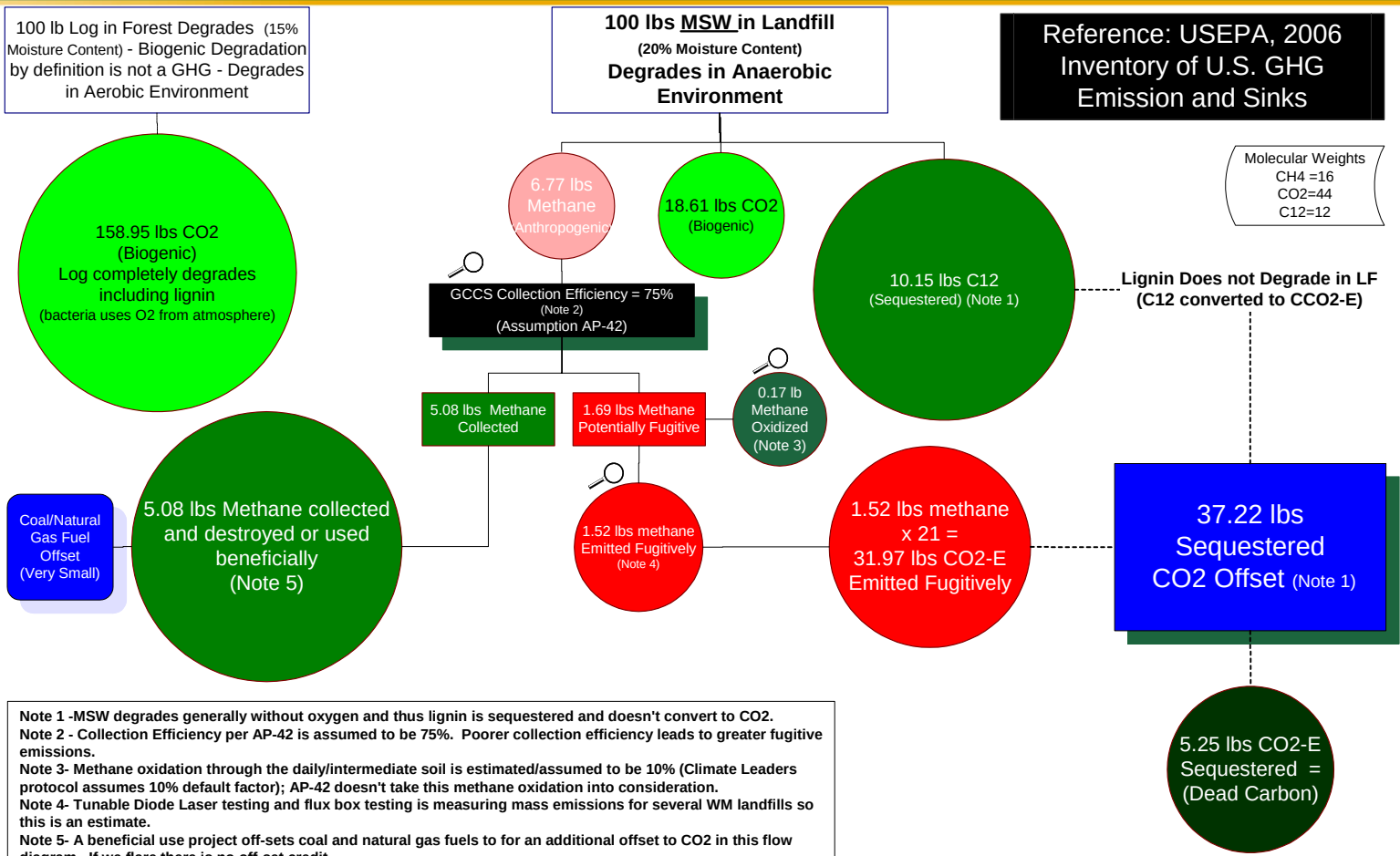
- Uses values based on source tests from 2003 to 2007 of flares, engines, and turbines
- Based on type of control device (flare, engine, or turbine)

Device Type	Destruction Efficiency
Flare	99.96%
Engine	98.34%
Turbine	99.97%

SWICS Carbon Sequestration Methodology

- Reflects carbon mass balance for the landfill
- Can use site specific waste characterization data if available or statewide data
- Uses carbon storage factors specific to each refuse component
- Includes factors for more than just wood waste
- Suggests inclusion as emission reduction or avoided emissions

Carbon Storage Potential



Note 1 -MSW degrades generally without oxygen and thus lignin is sequestered and doesn't convert to CO2.
Note 2 - Collection Efficiency per AP-42 is assumed to be 75%. Poorer collection efficiency leads to greater fugitive emissions.
Note 3- Methane oxidation through the daily/intermediate soil is estimated/assumed to be 10% (Climate Leaders protocol assumes 10% default factor); AP-42 doesn't take this methane oxidation into consideration.
Note 4- Tunable Diode Laser testing and flux box testing is measuring mass emissions for several WM landfills so this is an estimate.
Note 5- A beneficial use project off-sets coal and natural gas fuels to for an additional offset to CO2 in this flow diagram. If we flare there is no off-set credit.

Comparison of Values

Parameter	CARB Default Value	SWICS Value
Methane capture efficiency	75%	50%-99%
Methane oxidation in cover	10%	22.70%-53.33%
Methane destruction efficiency	99%	98.34%-99.97%
Carbon storage value	Combination of EPA, IPCC, and CEC factors. 50% of degradable organic carbon for most waste	Several waste dependant storage factors

Issues and Challenges

- Will inventory rules be fair and efficient?
- Policy/perception is outpacing technical data
- Protocols not defined or representative for certain waste activities; no global agreement on inventory protocols
- Will landfills get “credit” for carbon sequestration & methane oxidation?
- Time critical to develop/validate methods for estimating landfill fugitive emissions
  - TDL, methane flux, and carbon storage research

Issues and Challenges

- Time line is accelerating; CA AB 32 and Alberta Rules in place, regional registries formed
- Consistent technical strategy and messaging not in place
- Trade Associations not strategically positioned
- Does “What happens in CA stay in CA” ?

In Closing . . .

- *GHGs will Drive Recycling and Waste Reduction Initiatives*
- *Biogenic emissions reported?*
- *Protocol for Assessing GHG Recycling Credits?*
- *New protocol/models for fugitive landfill emissions*
- *Credit for LF sequestration?*
- *Additional regulatory requirements likely: early collection and maximum capture & use of landfill gas*