Northeast Forum on Climate-Waste Connections

Make Materials Management Count: Tools & Techniques

June 24, 2009

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WARM
the Waste Reduction Model

Sara Hartwell
U.S. EPA
Office of Resource Conservation and Recovery
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- WARM is a life-cycle perspective tool which reflects impacts that occur upstream and downstream from the point of use.
  - Upstream = before you acquire it
  - Downstream = after you discard it
- WARM is a “relative” tool, that provides an account of the net impact of waste management choices to the environment.
- WARM is not appropriate for use in inventories.

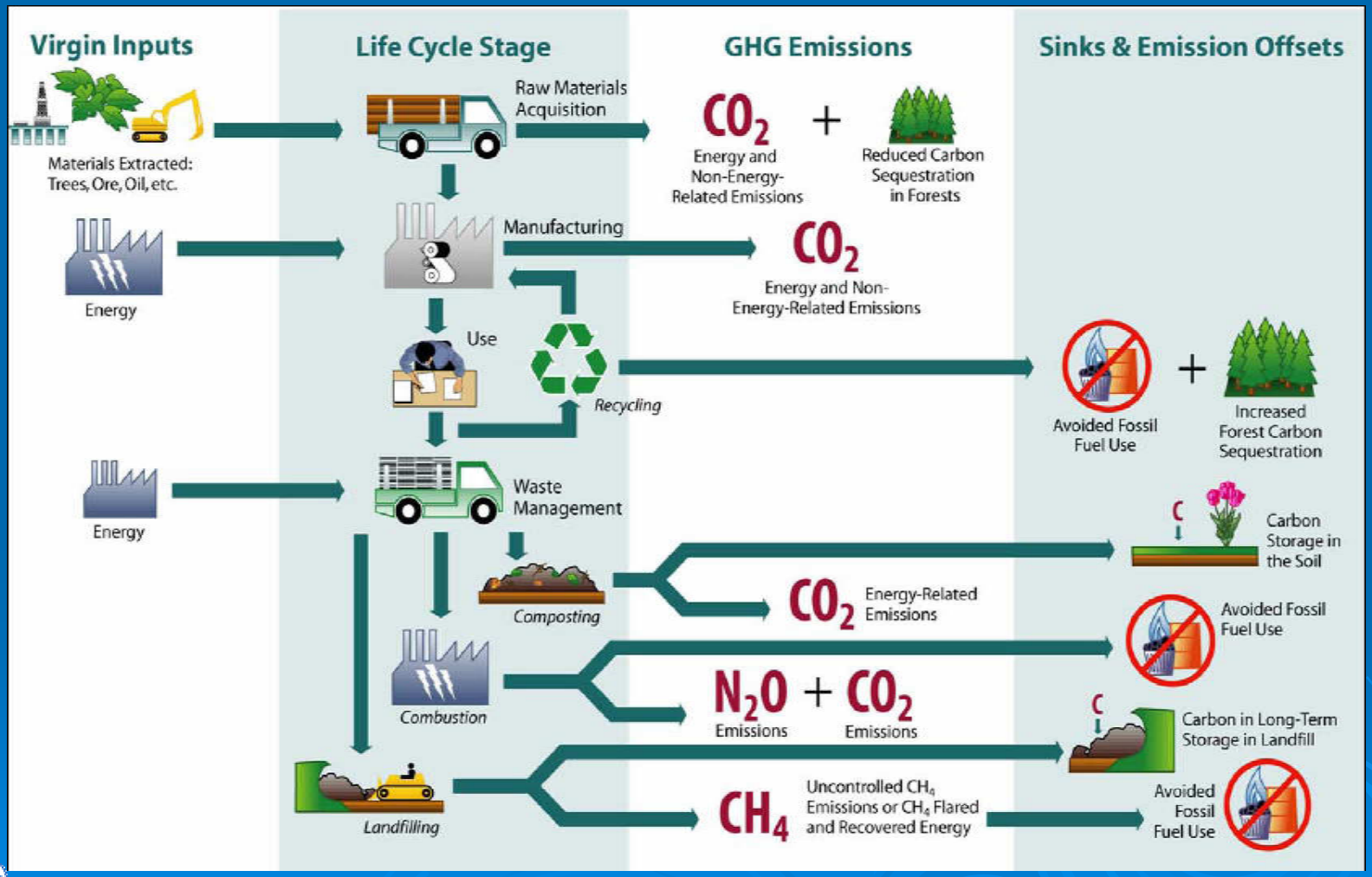
What is Waste?

- For the purposes of this discussion, waste comprises products at the end of their life cycle:
  - Packaging
  - Newspapers
  - Food waste
  - Construction and Demolition waste
  - Everything else that we discard

What is the Life Cycle?

- The simplified version:
  - Raw material extraction (bauxite mining, tree harvesting, oil pumped from underground, etc.)
  - Raw materials are processed into manufacturing inputs (trees made into paper, etc.)
  - Products are made from manufacturing inputs
  - Products are used
  - End-of-life products (and other discards) are managed as recyclables or waste

Product Life Cycle



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

Greenhouse Gases (GHG)

- There are many Greenhouse Gases (GHG) associated with the product life cycle (CO_2, CH_4, N_2O, etc.),
- Each GHG has a different impact on global warming
- We normalize the data using Global Warming Potentials (GWP)
  - a relative scale which compares the impact of the GHG to the impact of the same mass of CO_2 (GWP of CO_2 =1)
  - for example, GWP for CH_4 = 21 and for N_2O = 310
  - emissions of 1 million metric tons of CH_4 and N_2O are equivalent to emissions of 21 and 310 million metric tons of CO_2 , respectively
- Normalized GHG data are expressed as carbon dioxide equivalent, or CO_2 e

The Energy & Climate Connection:
Upstream Links

- GHG emissions associated with energy production are avoided through source reduction & recycling
  - Replacement of discarded materials requires energy to extract, transport, and process raw virgin materials.
  - Manufacturing products from recycled materials typically requires less energy than manufacturing from virgin materials.

The Energy & Climate Connection:
Upstream Links

- Forest carbon sequestration increases when wood products are source reduced & recycled

- Carbon storage increases when organics are composted and added to soil

The Energy & Climate Connection: Downstream Links

- Source Reduction and Recycling Avoids:
  - CH_4 emissions from landfills
  - CO_2 emissions from waste combustion

How do we calculate the benefits?

The Waste Reduction Model (WARM)

http://epa.gov/warm

- WARM was designed to provide waste managers with a simple tool to help them understand and evaluate the greenhouse gas implications of their waste management decisions

WARM is Based on a Life-Cycle Approach

- Incorporates the full range of GHG effects through a material's life cycle
- Uses Intergovernmental Panel on Climate Change (IPCC) accounting methods for GHG emissions and sinks
- Uses US life-cycle data and landfilling/transporation assumptions

What WARM Does:

- Assess GHG and energy impacts of waste management scenarios:
  - Landfilling
  - Recycling
  - Incineration (w/ energy capture)
  - Source Reduction
  - Composting
- Accepts user-specific inputs and provides individualized results
- Available for use online or as a downloadable spreadsheet

Materials in WARM:

- Emissions factors for 26 material types and 6 categories of mixed materials (paper, metals, plastics, organics, MSW, and recyclables)

- Aluminum Cans
- Branches
- Corrugated Cardboard
- Dimensional Lumber
- Food Scraps
- Glass
- Grass
- HDPE
- LDPE
- Leaves
- Magazines
- Medium Density Fiberboard
- Newspaper
- Office Paper
- PET
- Phonebooks
- Steel Cans
- Textbooks
- Yard Trimmings
- Brick
- Carpet
- Concrete
- Copper
- Fly Ash
- PCs
- Tires

Background on WARM

Solid Waste Management and Greenhouse Gases: A Life-cycle Assessment of Emissions and Sinks describes the WARM methodology, and provides background on the emissions factors

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

- There have been three editions of the report *(*1998, 2002, and 2006*)*
- The methodology presented in the 1998 report and reflected in the earliest versions of WARM has remained largely unchanged
- Data have been updated at multiple intervals
- New data (revised emission factors for current materials, new emission factors for materials not yet included) are currently under development

Using WARM

- Step 1 – Baseline Scenario
- Enter total **Tons Generated** for each material type.
- Enter tons managed in current management method(s) (**Recycled**, **Landfilled**, **Combusted**, **Composted)**
- Use as many waste management scenarios as you like, but the total must = **Tons Generated**
- Enter alternative scenario, assumptions, and select outputs

Step 1. Baseline Scenario

Please describe your current (or baseline) waste management scenario by entering the tons of each materi
generated and disposed.

Material	Tons Generated	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum Cans					N/A
Steel Cans					N/A
Copper Wire					N/A
Glass					N/A
HDPE					N/A
LDPE					N/A
PET					N/A
Corrugated Cardboard					N/A
Magazines/third-class mail					N/A
Newspaper					N/A
Office Paper					N/A
Phonebooks					N/A
Textbooks					N/A
Dimensional Lumber					N/A
Medium Density Fiberboard					N/A
Food Scraps		N/A			
Yard Trimmings		N/A			
Grass		N/A			

- It is NOT necessary to know the total tons of the solid waste stream or every element of the waste stream. For example, if you have started a newspaper collection program and want to evaluate its results you can input only newspaper numbers.

- If you collect data on all your material streams you may use multiple categories.

- If you don't have information on specific waste streams, there are mixed categories available in WARM. The mixed categories assume the relative distribution of material (generation and recovery rates) in the US in 2003.

Using WARM

- Step 2 – Alternative Management Scenario
- Enter tonnage directed to each alternate waste disposal scenario. For example, in the previous step you may have landfilled the total tonnage and in this scenario you decide to recycle half of the total and landfill the remaining half.
- Verify the totals are equal to the values entered in the previous step. (You do not enter a generation amount in this step.)

Step 2. Alternative Management Scenario

Please describe your alternate waste management scenario by entering the tons of each material type that is
or disposed. Please note that the baseline generation tonnages will stay the same as those entered in Step

Material	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum Cans					N/A
Steel Cans					N/A
Copper Wire					N/A
Glass					N/A
HDPE					N/A
LDPE					N/A
PET					N/A
Corrugated Cardboard					N/A
Magazines/third-class mail					N/A
Newspaper					N/A
Office Paper					N/A
Phonebooks					N/A
Textbooks					N/A
Dimensional Lumber					N/A
Medium Density Fiberboard					N/A
Food Scraps	N/A	N/A			
Yard Trimmings	N/A	N/A			
Grass	N/A	N/A			

Using WARM

- Step 3 – Landfill Characteristics
- You have the option to enter information about the landfill where waste will be managed.
- If you do not know details about the landfill where the waste will go – use the default values.
- The default values are based on EPA data about US landfills (national averages).

Using WARM

- Step 4 – Waste Transport Characteristics
- You have the option to enter values for transportation distances to management options.
- Underlying transportation data assume that waste/recyclables travel by truck (not by rail or sea).
- If you do not know transportation details – use the default values.

Step 3. Landfill Characteristics

The emissions from landfilling depend on whether the landfill where your waste is disposed has a landfill gas (LFG) control system. If you do not know whether your landfill has LFG control, select "National Average," which calculates emissions based on the proportions of landfills with LFG control in 2004. If your landfill does not have a LFG system, select "No LFG Recovery." If a LFG system is in place at your landfill, select "LFG Recovery" and click one of the indented buttons to indicate whether LFG is recovered for energy or flared.

- (•) National Average
- ( ) No LFG Recovery
- ( ) LFG Recovery
- ( ) Recover for energy
- ( ) Flare

Step 4. Waste Transport Characteristics

Emissions that occur during transport of materials to the management facility are included in this model. You may use default transport distances, 20 miles, or provide information on the transport distances for the various MSW management options.

- (•) Use default distance
- ( ) Define distance

Management Option	Distance (miles)
Landfill	20
Combustion	20
Recycling	20
Composting	20

Using WARM

- Step 5 – Results Output
- Choose your output metric: Carbon equivalent, Carbon Dioxide equivalent, or energy
- Pay attention to units !

Step 5. Results Output

- (•) Metric Tons of Carbon Equivalent (MTCE)
- ( ) Metric Tons of Carbon Dioxide Equivalent (MTCO2E)
- ( ) Units of Energy (million BTU)

The following inputs are optional and may be used to customize your summary report.

Organization: [ ]

Name: [ ]

Reporting Period: [ ] / [ ] / [ ] To [ ] / [ ] / [ ]

[Create Summary] [View Emission/Energy Factors]

[Clear Worksheet]

GHG Emissions Analysis -- Summary Report

(Version 9.01, 3/09)

Analysis of GHG Emissions from Waste Management

GHG Emissions from Baseline Waste Management (MTCO2E): 4

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E
Aluminum Cans	0	100	0	N/A	4

GHG Emissions from Alternative Waste Management Scenario (MTCO2E): -1,367

Material	Tons Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E
Aluminum Cans	0	100	0	0	N/A	-1,367

Total Change in GHG Emissions: -1,371 MTCO2E

Note: A negative value indicates an emission reduction; a positive value indicates an emission increase.

a) For an explanation of the methodology used to develop emission factors, see EPA report: Greenhouse Gas Emissions from Manageme available on the Internet at http://www.epa.gov/climatechange/wycd/waste/reports.html Please note that some of the emission factors u due to recent additions and/or revisions.

b) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives.

c) Total emissions estimates provided by this model may not sum due to independent rounding.

Back to WARM | View Emission Factors

Energy Analysis - Summary Report

(Version 9.01, 3/09)

Analysis of Energy Use from Waste Management

Energy Use from Baseline Waste Management (million BTU): 53

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Million BTU
Aluminum Cans	0	100	0	N/A	53

Energy Use from Alternative Waste Management Scenario (million BTU): -20,642

Material	Tons Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Million BTU
Aluminum Cans	0	100	0	0	N/A	-20,642

Total Change in Energy Use: -20,695 million BTU

This is equivalent to...

193 Households' Annual Energy Consumption
3,568 Barrels of Oil
166,511 Gallons of Gasoline

Note: A negative value indicates an emission reduction; a positive value indicates an emission increase.
a) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives.
b) Total emissions estimates provided by this model may not sum due to independent rounding.

Back to WARM | View Emission Factors

How do we talk to people about these benefits?

- WARM calculates equivalencies for energy
- The GHG Equivalencies Calculator calculates equivalencies for GHG reductions http://www.epa.gov/cleanenergy/energy-resources/calculator.html
- Do NOT add together energy and GHG benefits – they are interrelated

Greenhouse Gas Equivalencies Calculator

UPDATED February 17, 2009. This calculator was updated to include the eGRID2007 Version 1.1 annual non-baseload CO_2 output emission rates (year 2005 data). See the revision history page for more details.

Did you ever wonder what reducing carbon dioxide (CO_2) emissions by 1 million metric tons means in everyday terms? The following equivalency calculator can help you understand just that.

For example, it can be difficult to visualize what a "metric ton of carbon dioxide" really is. This calculator will translate rather difficult to understand statements into more commonplace terms, such as "is equivalent to avoiding the carbon dioxide emissions of X number of cars annually."

This equivalency calculator may be useful in communicating your greenhouse gas reduction strategy, reduction targets, or other initiatives aimed at reducing GHG emissions.

What's the impact of recycling on GHG emissions?

- In 2007, the U.S. recycled 33 % (85 million tons) of MSW[1]
  - Avoided emissions of 193 million MTCO2e
    - Equivalent to the annual GHG emissions of 35 million passenger vehicles (about 14 percent of passenger vehicles registered in the U.S.)

http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm

What's the impact of recycling on energy conservation?

- In 2007, the U.S. recycled 33 % (85 million tons) of MSW[1]
  - Energy benefit of 1.3 quadrillion BTUs
    - Residential site energy consumption is stable at about 10 quadrillion BTUs/year[2]
    - Recycling emissions benefits = 1.3 quadrillion BTUs [3]

[1] http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm
[2] http://www.eia.doe.gov/
[3] http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm

Sara Hartwell

US EPA

Office of Resource Conservation and Recovery

hartwell.sara@epa.gov

703-308-7285

Making Materials Management Count: Tools & Techniques

Exploring the First Order Decay Model

Courtney Forrester – ICLEI Program Officer

Presentation Overview

- *Introduction to ICLEI*
- *Greenhouse Gas Inventory Basics*
- *Calculating Emissions from Solid Waste*
- *ICLEI Tools and Resources*

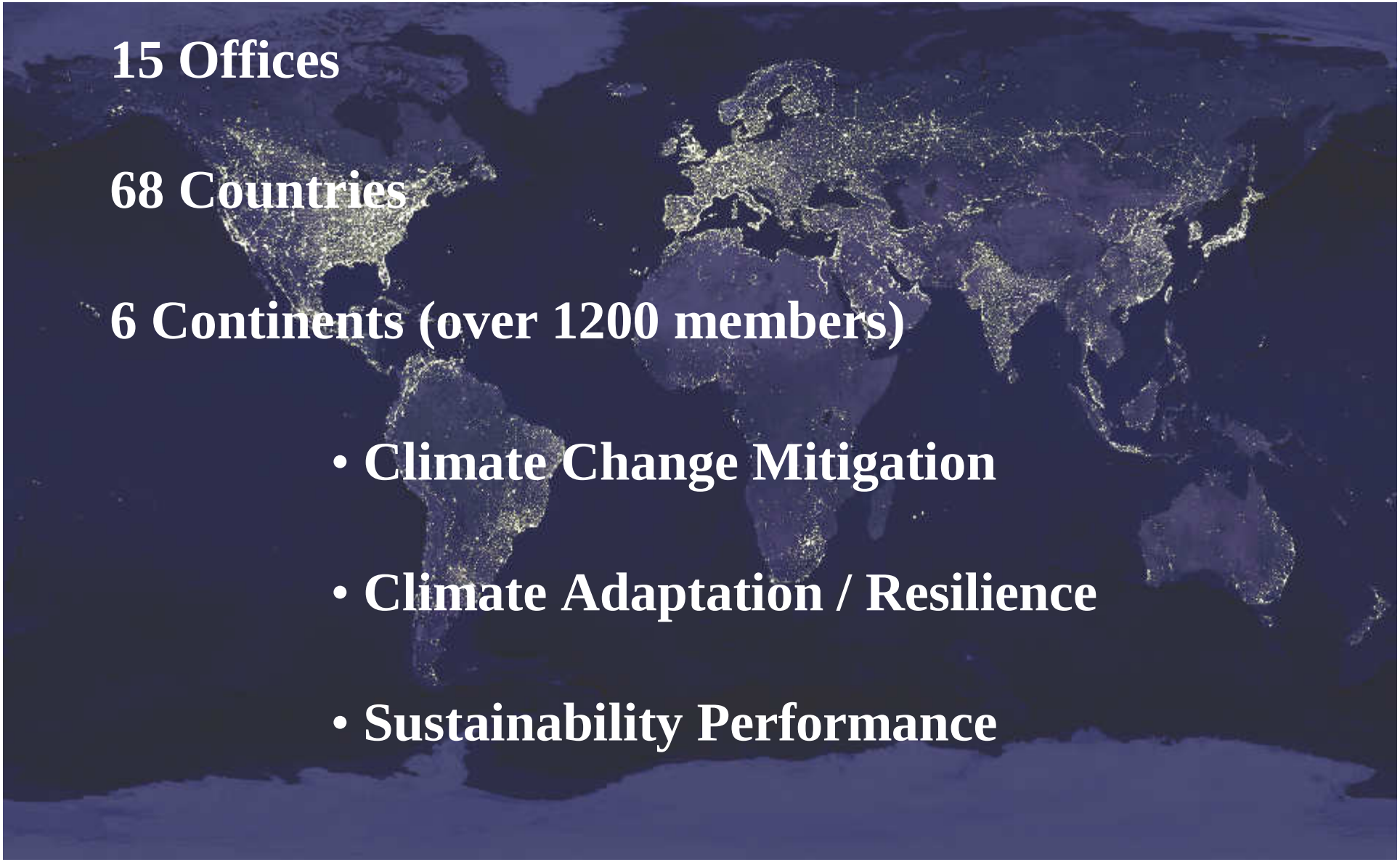
ICLEI Local Governments for Sustainability USA

Mission

Our mission is to build, serve, and drive a movement of local governments to advance **deep *reductions in greenhouse gas emissions*** and achieve tangible ***improvements in local sustainability***.




ICLEI - A Worldwide Movement of Local Governments



15 Offices

68 Countries

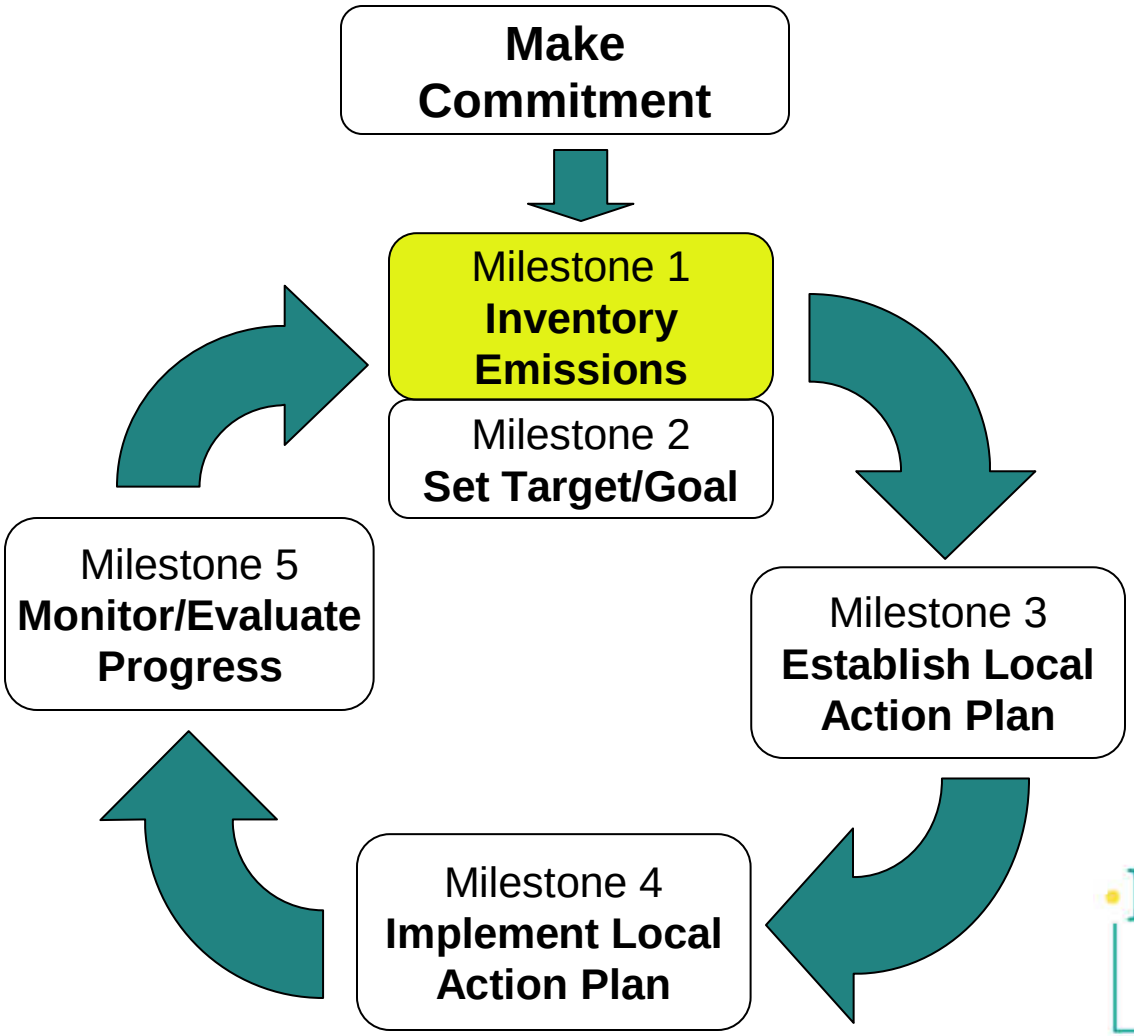
6 Continents (over 1200 members)

- **Climate Change Mitigation**
- **Climate Adaptation / Resilience**
- **Sustainability Performance**

Benefits of Local Climate Protection

- Improve air quality
- Reduce municipal operating costs
- Save money
- Reduce traffic congestion
- Create local jobs
- Protect public health
- Improve the quality of life
- Creates legacy of leadership

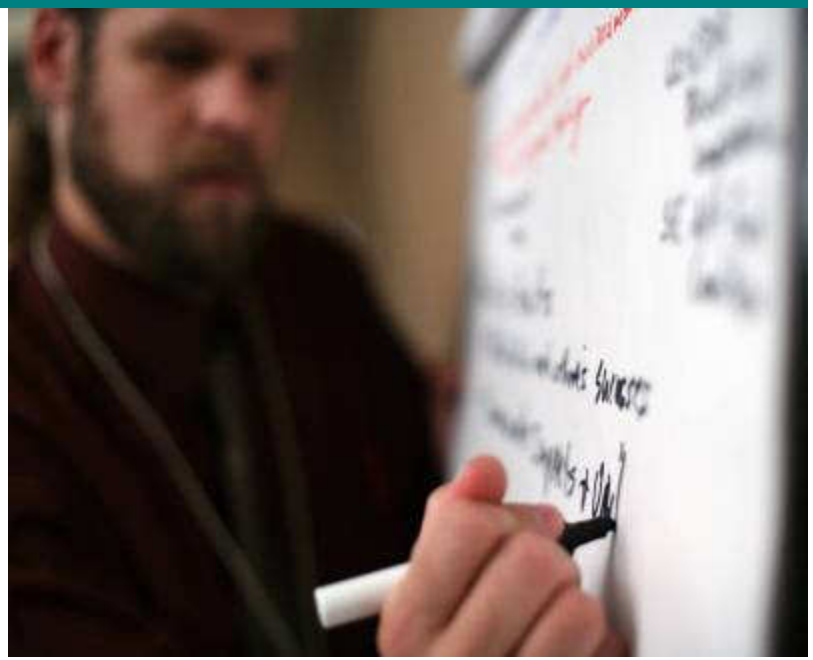
The Five Milestones for Climate Mitigation



ICLEI Local Governments for Sustainability USA

Greenhouse Gas Inventory

An assessment of energy use & associated emissions



- Assess baseline performance
- Compare alternative scenarios
- Illustrate opportunities
- Set attainable goals
- Prioritize projects
- Demonstrate progress toward emission reduction goals
- Obtain quantification of emissions profile

You can’t effectively reduce what you don’t measure.

Inventory Basics

- Report on a calendar year basis
- Base year should be reliable, reflective, and complete. Consider:
  - Regional consistency
  - 'Traditional year'
  - Completeness – need all data
- Identify things within your Operational Control - Wholly owning an operation, facility or source, or having the ability to make changes in the facilities you lease.
- Scopes
- Always take complete notes!!!

Sectors Analyzed

Community Inventory

- Residential
- Commercial
- Industrial
- Transportation
- Solid Waste
- Other Process and Fugitive Emissions

Government Op. Inventory

- Buildings
- Vehicle Fleet
- Streetlight and Traffic Signals
- Water/Sewer/Wastewater
- Ports/Airports
- Solid Waste
- Employee Commute
- Mobile Equipment
- Other Process and Fugitive Emissions


Clean Air and Climate Protection 2009 Software ©
Settings
Help
Community Analysis
Community Measures
Government Analysis
Government Measures
CACP 2009
Clean Air & Climate Protection Software
A Greenhouse Gas Accounting System to Support the Local Government Operations Protocol
ICLEI
Local Governments for Sustainability
USA
In collaboration with
NACAA
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Local Government Operations Protocol

- Details best-in-class practices for conducting an inventory of GHG emissions from local government operations
- Comprehensive and allows for standardized inventorying and reporting practices
- Community Protocol being developed now

Calculating Emissions From Solid Waste

First Order Decay (FOD)	EPA's WARM
Looks at actual emissions from landfill (what is already in the landfill and what is being added this year)	All emissions from waste disposed of in a given year at a landfill are attributed to that year
Requires data for every year that landfill has been in operation	Requires data on waste generated in your inventory year

FOD - DATA NEEDED
Solid Waste (Landfills)

Activity Data

- Total amount of waste collected each year since opening
- Year landfill opened and closed, if applicable
- Waste characterization (percent by waste type … newspaper, glass, etc.)*
- Annual rainfall – in ranges
- Percentage of methane collected
- Destruction efficiency of methane based upon system*
- Collection efficiency of LFG collection system*
- Surface not covered by landfill gas collection system (square feet)
- Surface covered by landfill gas collection system (square feet)

* Default Available

FOD - DATA NEEDED
Solid Waste (Incineration)

Activity Data

- Annual tonnage of waste generated
- Percent of waste that is incinerated
- Composition of waste stream (X% paper, X% metal, etc.)

Data Sources

- Incinerator operator
- Solid waste collectors
- State records

Implementation Tools

<u>"How-To Guidebooks"</u>

- Outreach and Communications
- Recycling and Solid Waste
- Environmentally Preferable Purchasing

STAR Community Index

- Globally recognized green standards system for cities
- Accountability in data and actions
- Prioritized and informed decision making
- A roadmap for cities to track and achieve climate and sustainability goals
- Peer-to-peer learning among communities and citizen engagement

ICLEI Local Governments for Sustainability USA

U.S. Green Building Council

Center for American Progress

Questions?

Courtney Forrester
Program Officer
Courtney.Forrester@ICLEI.org

617.960.3404

www.icleiusa.org

ICLEI Local Governments for Sustainability USA