Modeling a Life-Cycle Approach to Solid Waste Management and Recycled Content Materials

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Overview

- Intro to EPA material life-cycle GHG tools
- What we mean by life-cycle GHG emissions
- Overview and demo of each tool
- Material proxies
- Upcoming updates
- Q&A

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Tools to measure life-cycle GHG and energy benefits

- Waste Reduction Model (WARM)
  - calculates the benefits of alternative materials management decisions (focusing on end-of-life perspective)
- Recycled Content Tool (ReCon)
  - calculates the benefits of alternative recycled content purchasing decisions
- individual WARM (iWARM)
  - calculates energy saved by recycling small quantities of common waste materials

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Materials management impacts on life-cycle GHG emissions

waste and landfill gas to energy

Increase recycling, **decrease** raw material acquisition

Increase waste and landfill gas recovery for energy, **decrease** fossil fuel extraction

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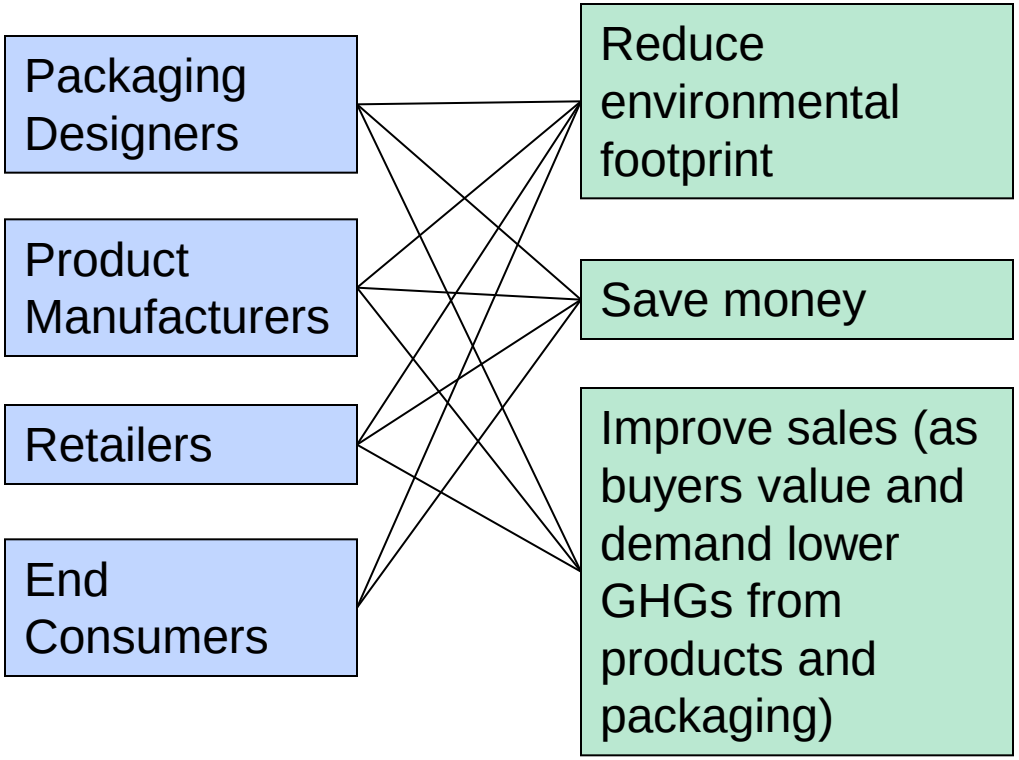
Why measure GHGs for material management practices?

Manage what you measure…



Provide insights to select materials management practices, materials, or products that

- require less energy for production and
- are lighter or more compact to reduce transport energy

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EPA's Waste Reduction Model (WARM)

online tool for quantifying the life-cycle climate and waste connections

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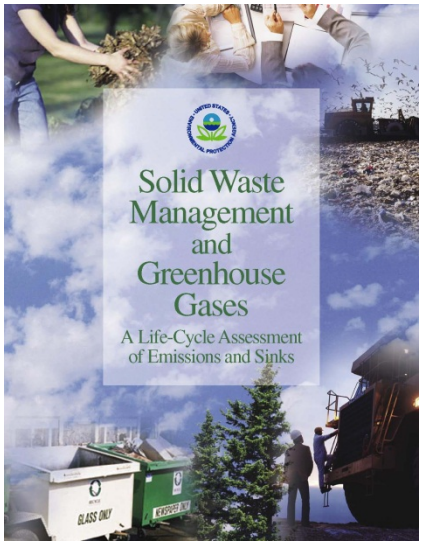
WARM Background

- 1990s efforts to expand the portfolio of reasons for alternative waste management practices
- 1994 Climate Change Action Plan contained source reduction and recycling initiatives
  - WW, PAYT, and grant projects assumed to yield GHG reductions
- Streamlined life-cycle approach designed and peer reviewed
- 1998 First Edition EPA MSW GHG Report
- WARM Released
- 2002, 2006, and 2012 major updates to Report/ Background Documentation and Model



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Purpose of WARM

- **Understand** the link between waste management practices and climate change
- **Incorporate** GHG impacts into decision-making processes
- **Communicate** GHG emission reductions to the public
- **Improve** materials management through incorporation into climate action plans at the municipal and state level

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Intended Audience and Scope

- Audience:
  - Solid waste managers, primarily from state and local governments who want to evaluate various waste management options
  - EPA source reduction and recycling program managers who are required to annually report GHG benefits of program activities
  - EPA source reduction and recycling program participants (e.g., WasteWise partners)
  - E3 Partners and supply chains
- Scope:
  - Source reduction, recycling, and composting are evaluated in comparison to combustion and landfilling
  - Emissions represent **baseline** versus **alternative** waste management scenarios (i.e., <u>not</u> absolute)
  - Currently covers over 40 material types

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Materials Included in WARM

Inorganics	Plastics	Paper and Wood	Other Organics	Composite Materials	Building Materials
Aluminum cans	HDPE	Corrugated cardboard	Food scraps	Carpet	Clay bricks
Aluminum Ingot	LDPE	Magazines/third-class mail	Yard trimmings	Personal computers	Concrete
Steel cans	PET	Newspaper	Grass	Mixed Recyclables	Fly Ash
Copper wire	LLDPE	Office paper	Leaves	Mixed MSW	Asphalt concrete
Glass	PP	Phonebooks	Branches		Asphalt shingles
Mixed Metals	PS	Textbooks	Mixed Organics		Drywall
Tires	PVC	Dimensional lumber			Fiberglass insulation
	PLA	Medium-density fiberboard			Vinyl flooring
	Mixed Plastics	Mixed Paper			Wood flooring

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Streamlined Life-Cycle Methodology

- Life-cycle assessment limited to GHG and energy impacts
- Focus on GHGs emitted, carbon stored, or utility energy displaced at following stages:
  - Raw material acquisition
  - Manufacturing
  - Waste management
  - Transportation of raw material and waste

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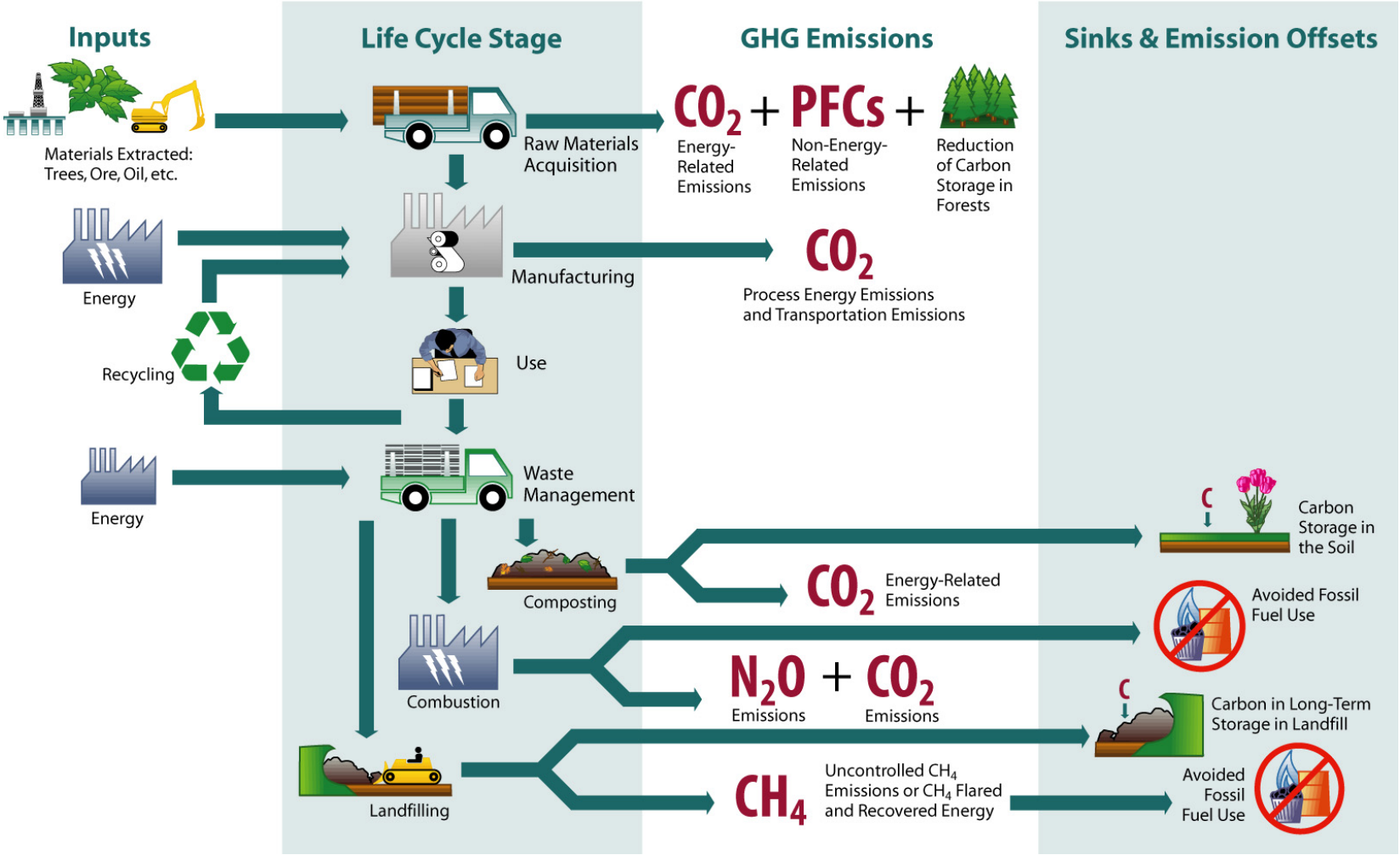
GHG Sources & Sinks Associated with the Material Life Cycle



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Using WARM → Demo

- WARM available at www.epa.gov/warm
- Users input:
  - Tonnage by material type for two scenarios: baseline and alternative
  - Landfill characteristics
    - LFG recovery status
    - Collection system efficiency
  - Transportation distances

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Implications

- Quantifying connections illustrates the varying, and sometimes unexpected, GHG impacts of different materials management practices.
- Understanding these impacts can help waste managers
  - maximize the GHG and energy benefits of diversion programs,
  - quantify program benefits, and
  - communicate climate-related waste reduction benefits to consumers and members of the general public.

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WARM Caveats

- Emission estimates are intended to support *voluntary* GHG measurement and reporting initiatives; not to be used for inventories
- Emission results are *relative* to alternative scenarios
- Factors do not reflect use phase emissions
- Not all waste management practices are currently included (e.g., anaerobic digestion)

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EPA's Recycled Content Tool (ReCon)

online tool for quantifying the GHG and energy benefits of recycled content decisions

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ReCon Background

- Developed by ICF with EPA's ORCR
- Purpose: to assist companies and individuals in estimating the life-cycle GHG and energy impacts of (a) purchasing, (b) manufacturing, and/or (c) increasing the recycled content of certain materials
- Approach:
  - uses a streamlined life-cycle methodology
  - measures GHG impacts throughout the material life cycle: raw material acquisition, manufacture, transport, and disposal; excludes use phase
  - includes forest and landfill C sequestration and avoided utility emissions from waste/landfill gas to energy
  - provides relative baseline vs. alternative scenario results

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Materials Included in ReCon

Metal and Glass Materials Aluminum cans, Steel cans, Copper wire, Glass, Misc. metals
Plastic Materials HDPE, LDPE, PET, Misc. Plastics
Paper and Wood Materials Corrugated cardboard, Magazines/third-class mail, Newspaper, Office paper, Phonebooks, Textbooks, Dimensional Lumber, Medium-density fiberboard

Textbook photo: www.emporia.edu/lifelong/geninfo/textbooks.htm;
Newspaper photo: www.norcalblogs.com/watts/2007/05/

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Using ReCon → Demo

- For online or Excel tool, go to: http://epa.gov/epawaste/conserve/tools/warm/ReCon_home.html
- Enter the amount of each material purchased or manufactured
- Enter the baseline (or current) and alternate post-consumer recycled content of each material
- Select to view GHG and energy outputs

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Applications of ReCon EFs

- **Wal-Mart** - using ReCon's factors in its "Packaging Scorecard" as a way to evaluate the sustainability (in this case, GHG implications) of packaging used by suppliers.
- **GreenBlue** and the **Sustainable Packaging Coalition** - using new industry LCI data in its Comparative Packaging Assessment Tool (COMPASS).
- Continuing efforts to analyze the GHG impacts of packaging materials from a life-cycle perspective and make this information available will **inform material management practices and packaging design.**

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EPA's individual Waste Reduction Model (iWARM)

online tool for quantifying the energy savings from recycling on a personal level

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Using iWARM → Demo

- For online or Excel tool, go to: http://www.epa.gov/epawaste/conserve/tools/iwarm/index.htm
- Enter the amount of each household item recycled
- Choose an appliance to see how long the energy savings from recycling would power that appliance

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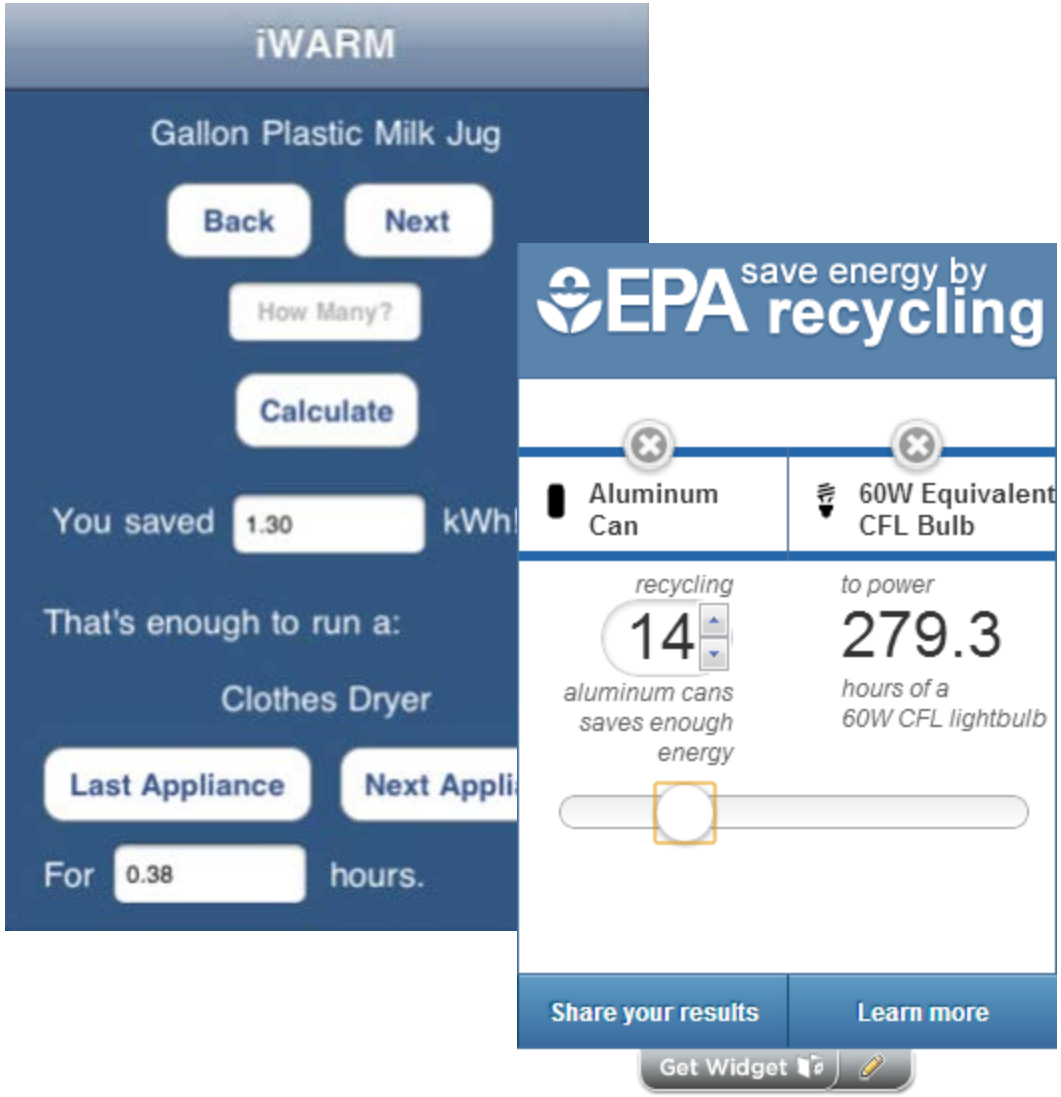
iWARM on the Go

- Also available as a widget for web pages or as a mobile phone application



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Use of Material Proxies

- In some cases, users may be able to apply WARM factors to materials not covered in WARM
- An accurate proxy should be similar to a WARM material type and share manufacturing processes, but also resemble it at **end-of-life**, including the manner in which materials are collected at end-of-life, and the materials and processes offset from recycling that material

When to Use a Proxy

1. To **model** a material not in WARM, but is *similar* to one already in WARM.
2. To model a **different recycling pathway** for an existing WARM material.
3. To model a different material that follows a **similar recycling pathway** to a material that is recycled in WARM.

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Example Material Proxies

Material	Existing WARM Factor	Applicable End-of-Life Pathway(s)	Suitability of Proxy
Aggregate	Concrete	All Available	Very Good
C&D Steel	Steel Cans	All Available	Acceptable
Wooden Cabinets and Doors	Wood Flooring	All Available	Acceptable
Electronics	Personal Computers	All Available	Acceptable
Wood for Fuel	Combustion factor for dimensional lumber	Combustion	Very Good

WARM Material Proxy Guidance available at:
http://epa.gov/epawaste/conserve/tools/warm/pdfs/Using_WARM_EFs_Materials_Pathways_111612.pdf

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Upcoming Updates to WARM

- Incorporating non-CO_2 emissions for the composting pathway
- Refining landfill gas collection efficiency modeling
- Developing food type-specific factors, including upstream GHGs
- Making other general updates to reflect more recent data

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For More Information…

- **WARM:** www.epa.gov/warm
- **ReCon:** www.epa.gov/epawaste/conserve/tools/warm/ReCon_home.html
- **iWARM:** www.epa.gov/epawaste/conserve/tools/iwarm/index.htm
- **Model Documentation:** http://epa.gov/epawaste/conserve/tools/warm/SWMGHGreport.html

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To receive notifications about future updates to these tools or documentation, send an email to: orcrWARMquestions@epa.gov.

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