

The Climate / Waste Connection

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What is Waste?

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



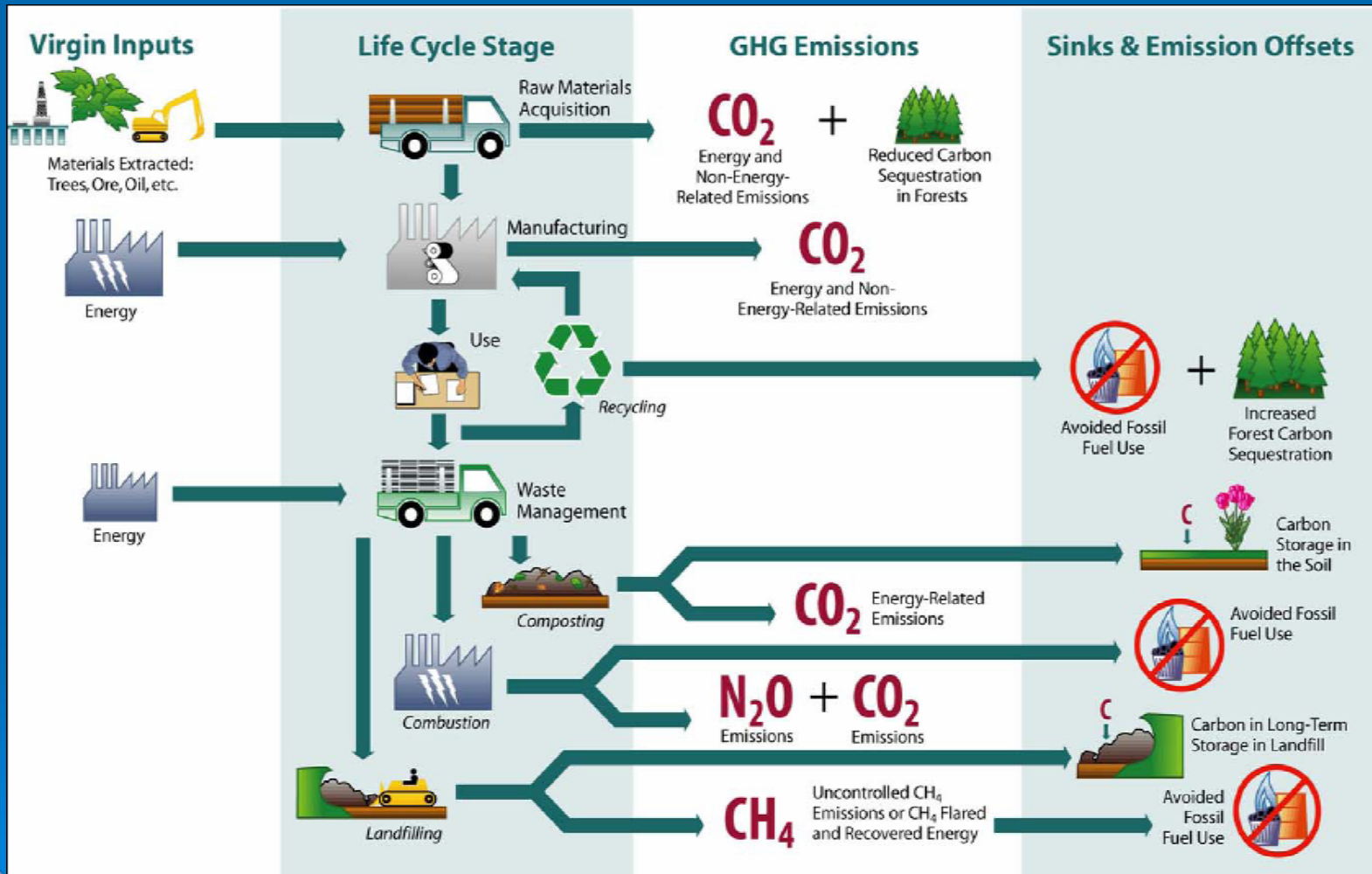
What is the Life Cycle?

➤ 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 are managed as waste



Product Life Cycle



GHG Emissions

- There are many Greenhouse Gases (GHG) associated with the product life cycle (CO₂, CH₄, N₂O, 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 CO₂ (GWP of CO₂ =1)
 - for example, GWP for CH₄ = 21 and for NO₂ = 310
 - emissions of 1 million metric tons of CH₄ and NO₂ are equivalent to emissions of 21 and 310 million metric tons of CO₂, respectively
- Normalized GHG data are expressed as carbon dioxide equivalent, or CO₂e



The Energy & Climate Connection to MSW

- Products that enter the waste stream have energy impacts and associated GHG emissions at each stage of their life cycle.
 - acquisition of raw materials,
 - manufacture of raw materials into products,
 - product use by consumers, and
 - product disposal.



The Energy Climate Connection: Upstream Links

- Energy CO₂ emissions 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 storage increases when wood products are source reduced & recycled
- Carbon storage increases when organics are composted and added to soil



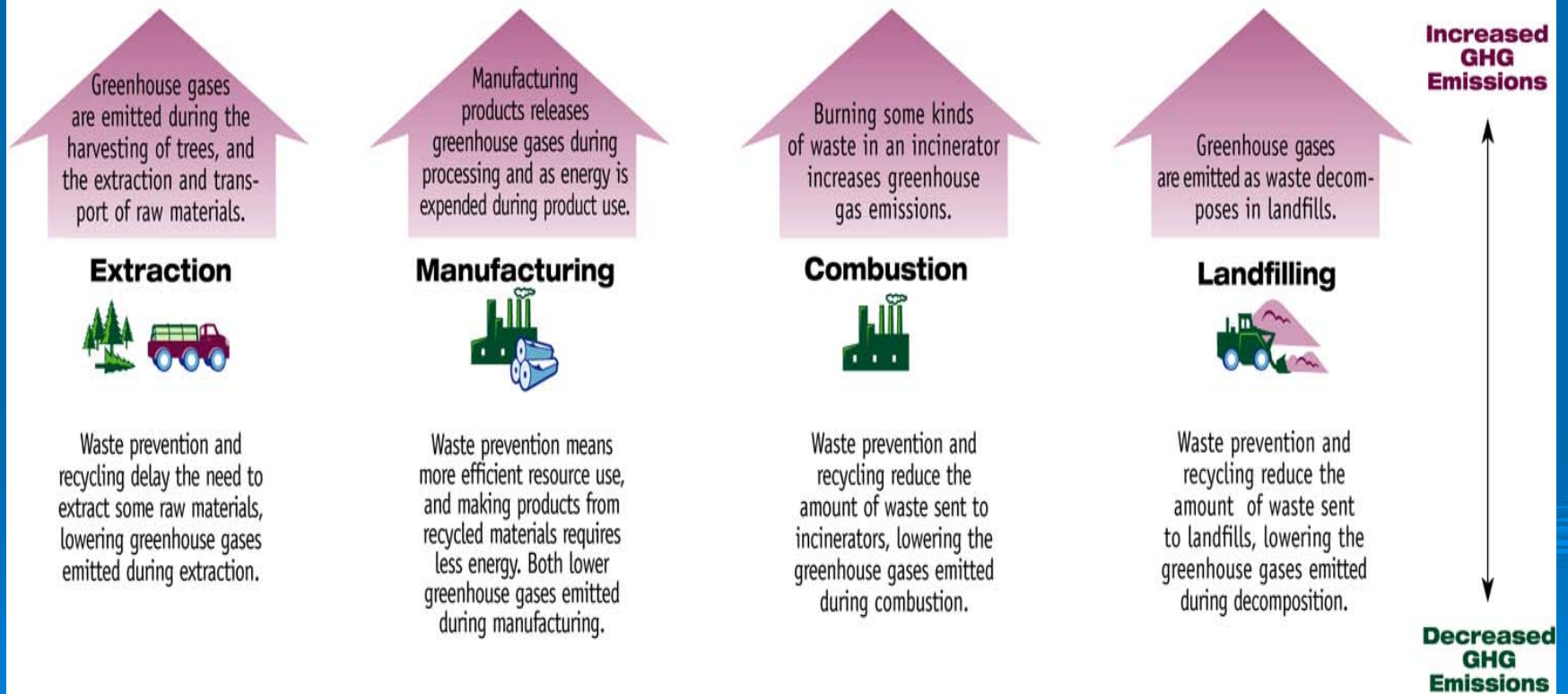
The Energy Climate Connection: Downstream Links

- Landfill CH₄ emissions avoided through source reduction & recycling
- Combustion CO₂ emissions avoided through source reduction & recycling



What is the Link?

The Link Between Waste Management and Greenhouse Gases



What is the Impact?

- Waste activities account for approximately 3% of total U.S. GHG emissions
- In 2006, the U.S. recycled 32.5 % (81.8 million tons) of MSW
 - Avoided emissions of 49.7 million metric tons of carbon equivalent (MTCE)
 - Energy benefit of 1.3 quadrillion BTUs



How big is the impact?

- Waste activities account for approximately 3% of total U.S. GHG emissions
- According to the Department of Energy, residential site energy consumption in the US is stable at about 10 quadrillion BTUs/year. (<http://www.eia.doe.gov/>)
 - 1.3 quadrillion BTUs represents ~>10% of US residential site energy consumption



How big is the impact?

1 quadrillion BTUs is equal to the annual energy output of 40 power plants (1,000 MW per power plant)

<http://www.aia.org/SiteObjects/files/architectsandclimatechange.pdf>

1.3 quadrillion BTUs represents ~50 power plants that we didn't have to build



How do we calculate the benefits?

The Waste Reduction Model (WARM)

http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

- 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



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

New in 3rd edition:

- 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/SWMSGHGreport.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 are currently under development



Does EPA have other tools?

- <http://epa.gov/climatechange/wycd/waste/tools.html>
 - Recycled Content Tool (ReCon)
 - Waste Reduction Model (WARM)
 - Durable Goods Calculator (DGC)
 - Greenhouse Gas Equivalencies Calculator

