

Charting a Course to Energy Independence

Providence, RI
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INTRODUCTION TO FEDERAL GREENHOUSE GAS MEASUREMENT: III

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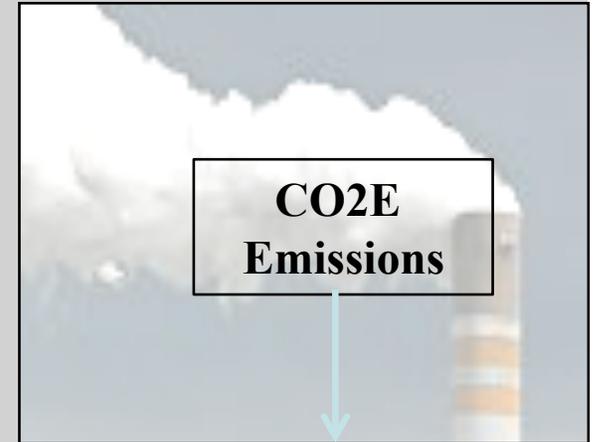
Sample Calculation - Energy

Grid Electricity

CO₂
Emissions

N₂O
Emissions

CH₄
Emissions



CO₂E
Emissions

$$\left(\frac{MWh}{year}\right) \left(2,054 \frac{lbsCO_2}{MWh} + 4.4 \frac{lbsN_2O}{MWh} (296) + 0.0131 \frac{lbsCH_4}{MWh} (23) \right) = 357,900 \text{ tonne } CO_2E$$

Grid
Electricity
Consumption

N₂O
GWP

CH₄
GWP

CO₂E = Carbon dioxide equivalent (includes N₂O and CH₄ based on their corresponding global warming potentials)



Sample Calculation - Energy

Grid Electricity



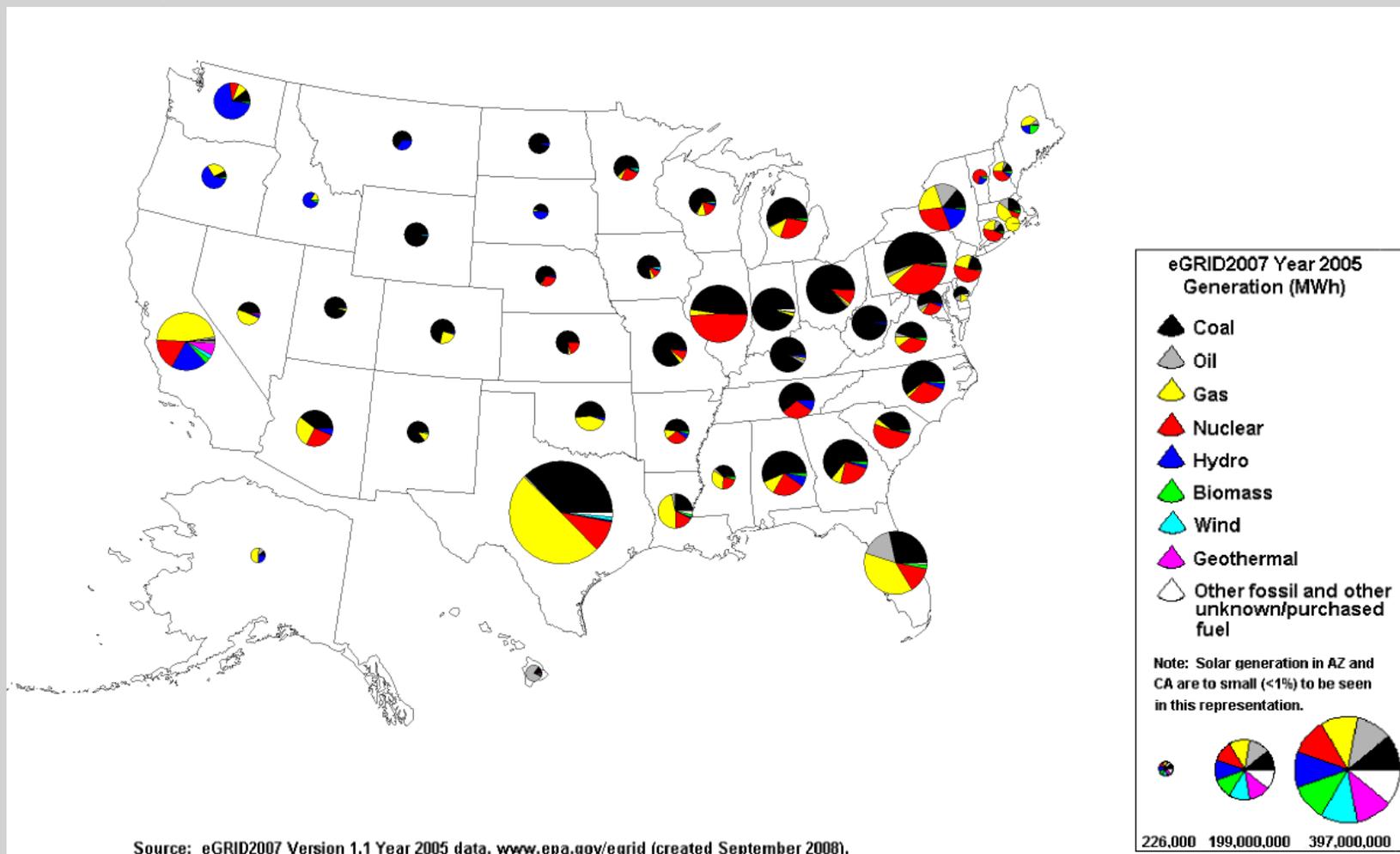
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The diagram shows the calculation with labels: 'Input' boxes above the terms and 'Constant' boxes below the terms. Arrows indicate the flow of information from the labels to the equation components.

CO_2E = Carbon dioxide equivalent (includes N_2O and CH_4 based on their corresponding global warming potentials)



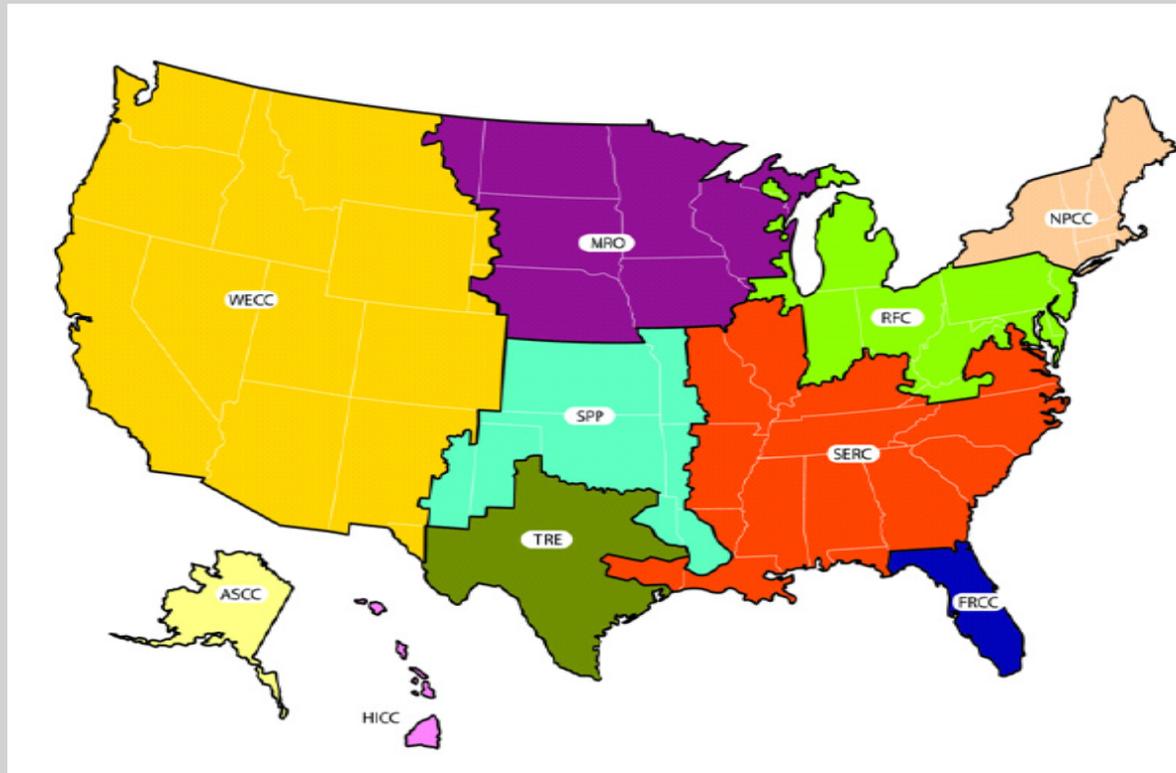
Electric Generation by Fuel Type



Source: eGRID2007 Version 1.1 Year 2005 data, www.epa.gov/egridd (created September 2008).



NERC Regions





eGrid Subregions





Sample of Constants

Established Values and Coefficients

- Atomic Mass
- Global Warming Potential (GWP)
- Gross Heat of Combustion
- Emissions Factors

Unit conversions

- Areas
- English to Metric
- Energy
- Volume
- Mass
- Time



Define Inventory Boundaries

Design

Calculate

Target

Reduce

Offset

Report

Areas included in PNNL's carbon inventory

Direct

Indirect Electricity

Other Indirect

Upstream Emissions

Production of Electricity Consumed



Corporate Emissions

On-site Fuel Combustion
(NG, propane)



PNNL Fleet Vehicles



Business Travel
(Air and Car Rental)



Employee Commuting



Downstream Emissions

Waste Transportation and Disposal





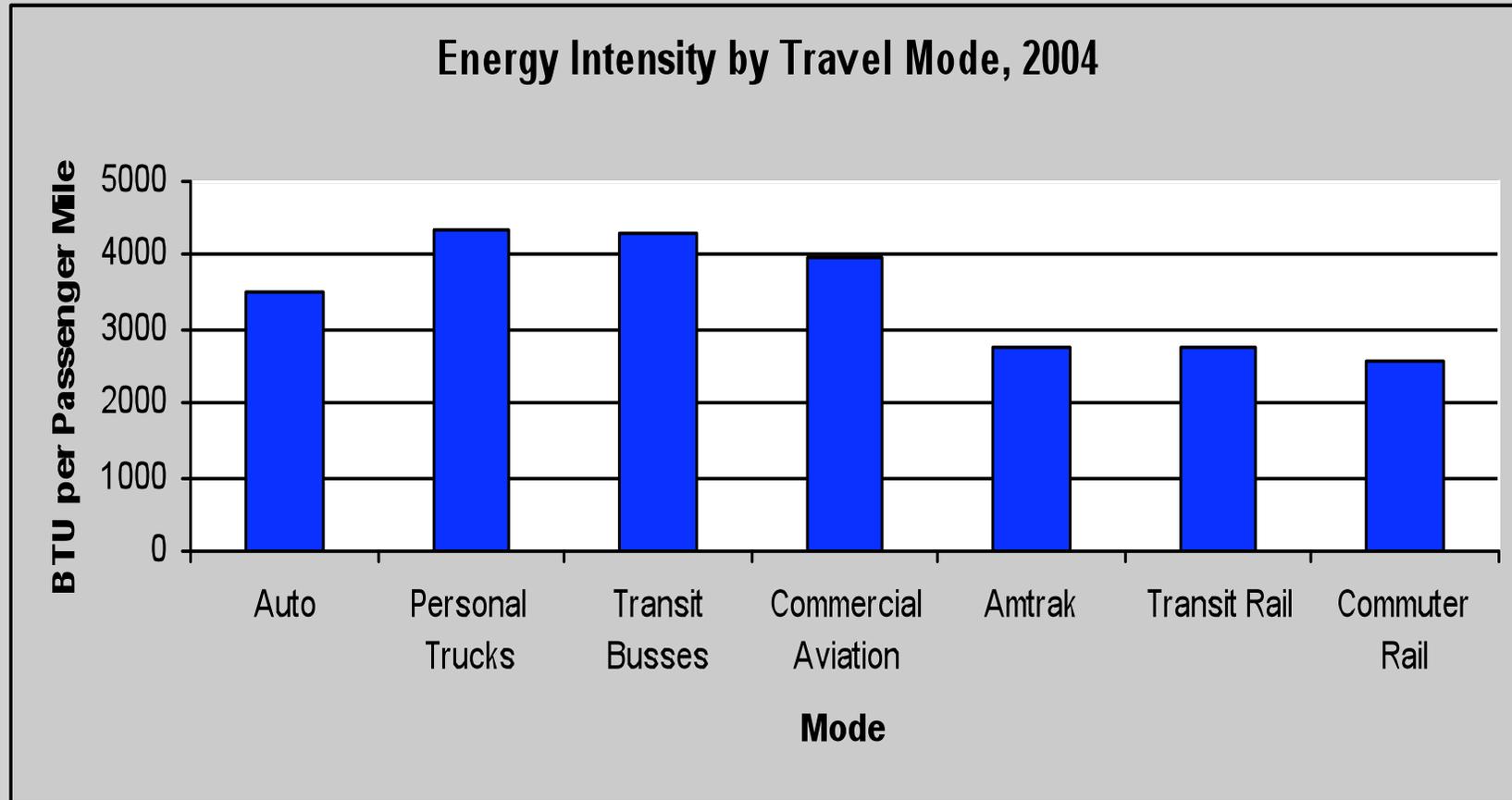
Collect Data



- Data provided by members of environmental management team, others
 - Electricity – kWh consumed by building
 - RECs – kWh of RECs purchased
 - Natural gas/propane use – total therms / gallons by building
 - Fleet vehicle fuel use – total gallons for fleet
 - Business travel – estimated miles traveled by air and rental car gas receipts from travel expense reporting system
 - Employee commuting – conservative estimate of “typical” employee
 - Waste/Recycling – estimated total pounds by waste category (e.g., office paper, cardboard, mixed plastics)



Comparative Energy Intensities



Source: U.S. DOE, "Transportation Energy Data Book, Edition 27 – 2008"



PNNL 2007 CO₂ Inventory

Design

Calculate

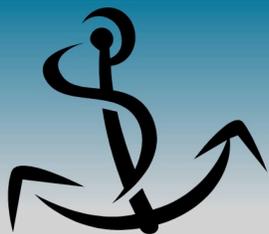
Target

Reduce

Offset

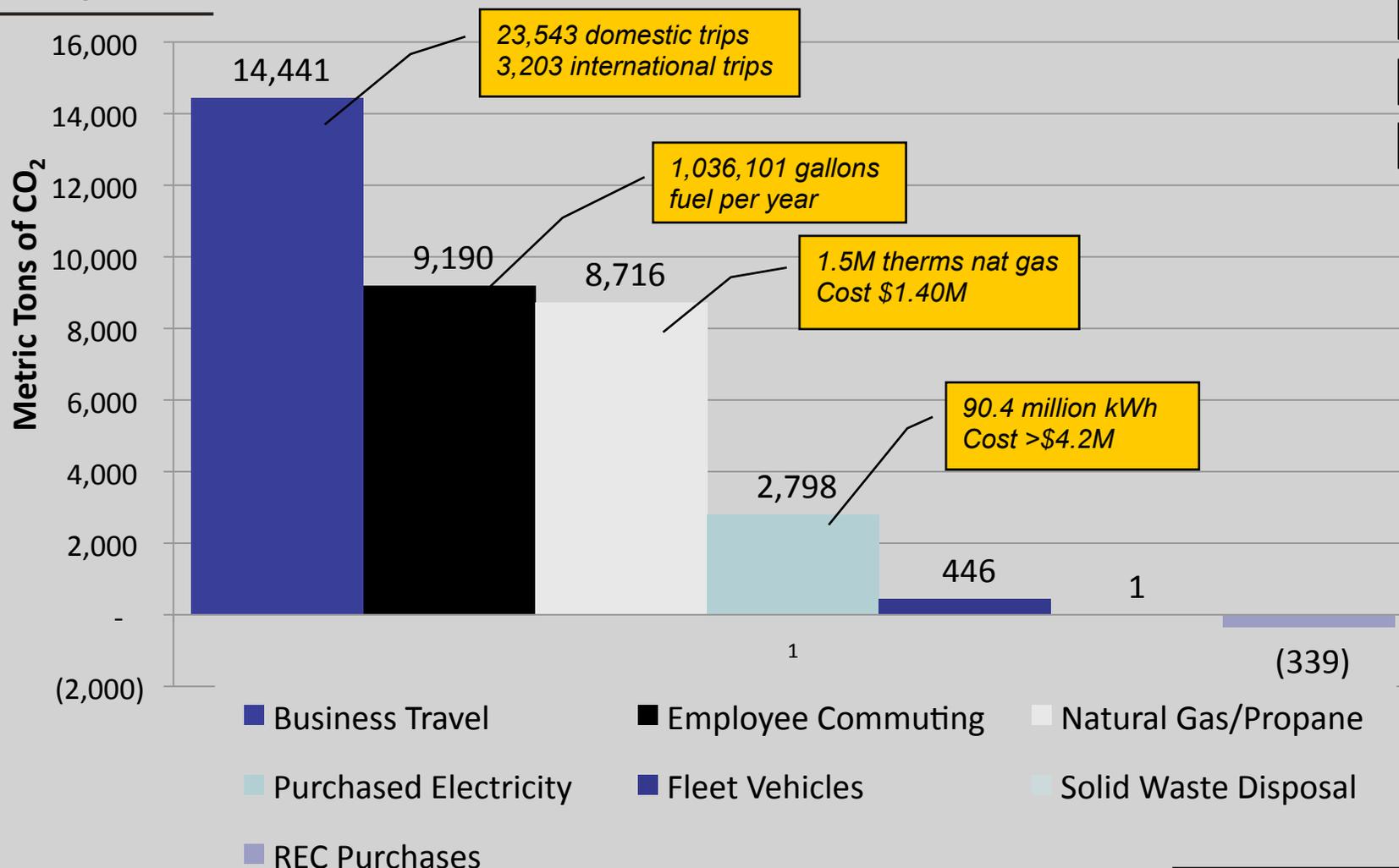
Report

Category of Emissions	2007 CO ₂ Emissions (metric tons)	Description
Direct	8,717	Nat Gas/Propane
	446	Fleet Vehicles
Subtotal	9,163	
Indirect from Purchased Electricity	2,798	Consumption of Purchased Electricity
	(339)	REC Purchases
Subtotal	2,459	
Other Indirect	14,441	Business Travel
	9,190	Employee Commuting
	786	Solid Waste Disposal
Subtotal	24,418	
Total CO₂ Emissions	36,378	
Net CO₂ Emissions	36,039	



PNNL 2007 CO₂ Inventory

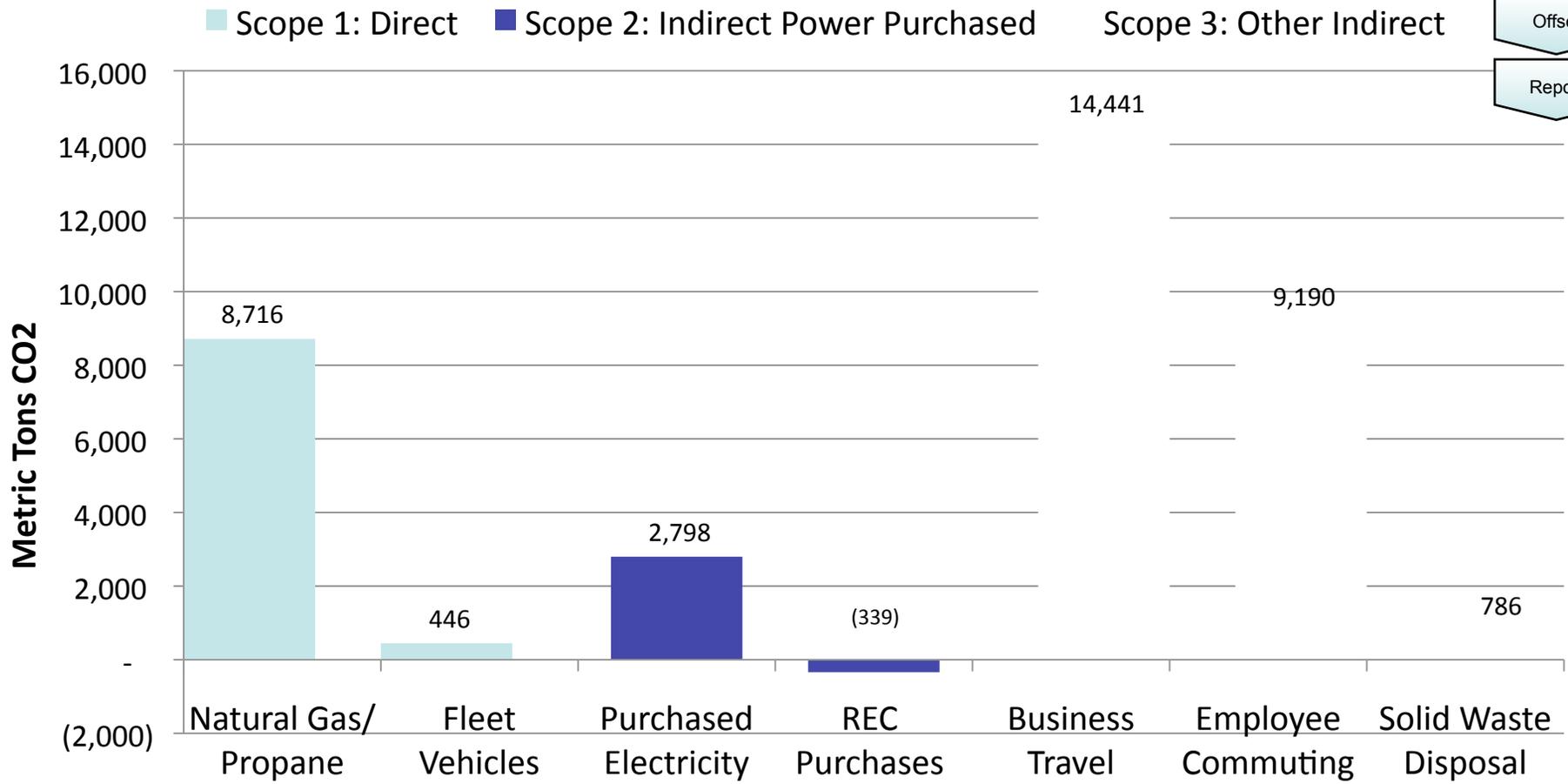
- Design
- Calculate
- Target
- Reduce
- Offset
- Report





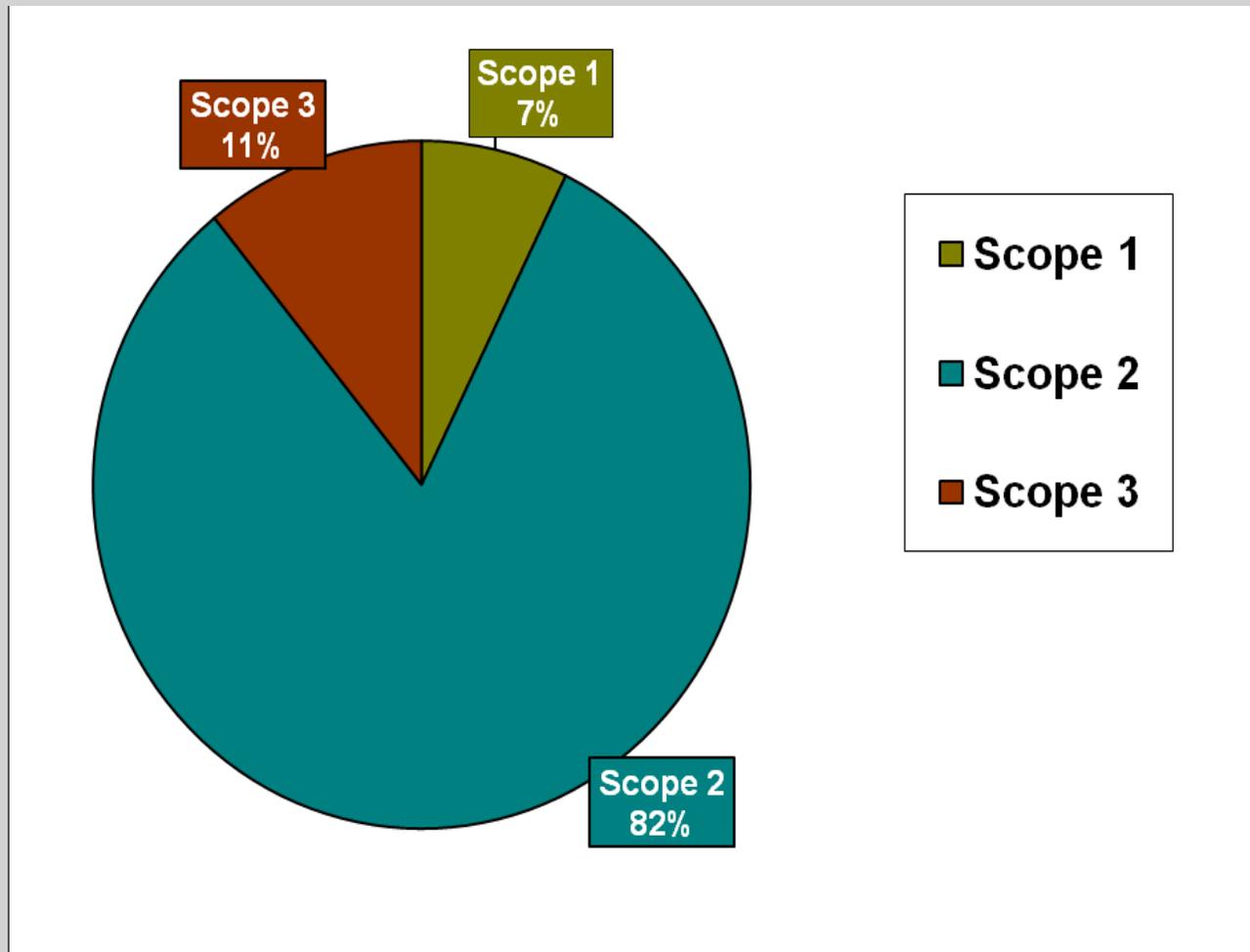
PNNL 2007 CO₂ Inventory

- Design
- Calculate
- Target
- Reduce
- Offset
- Report





Sandia National Lab Carbon Footprint by Scope





Different Grid Emission Factors Convey Different Risk Levels

Design

Calculate

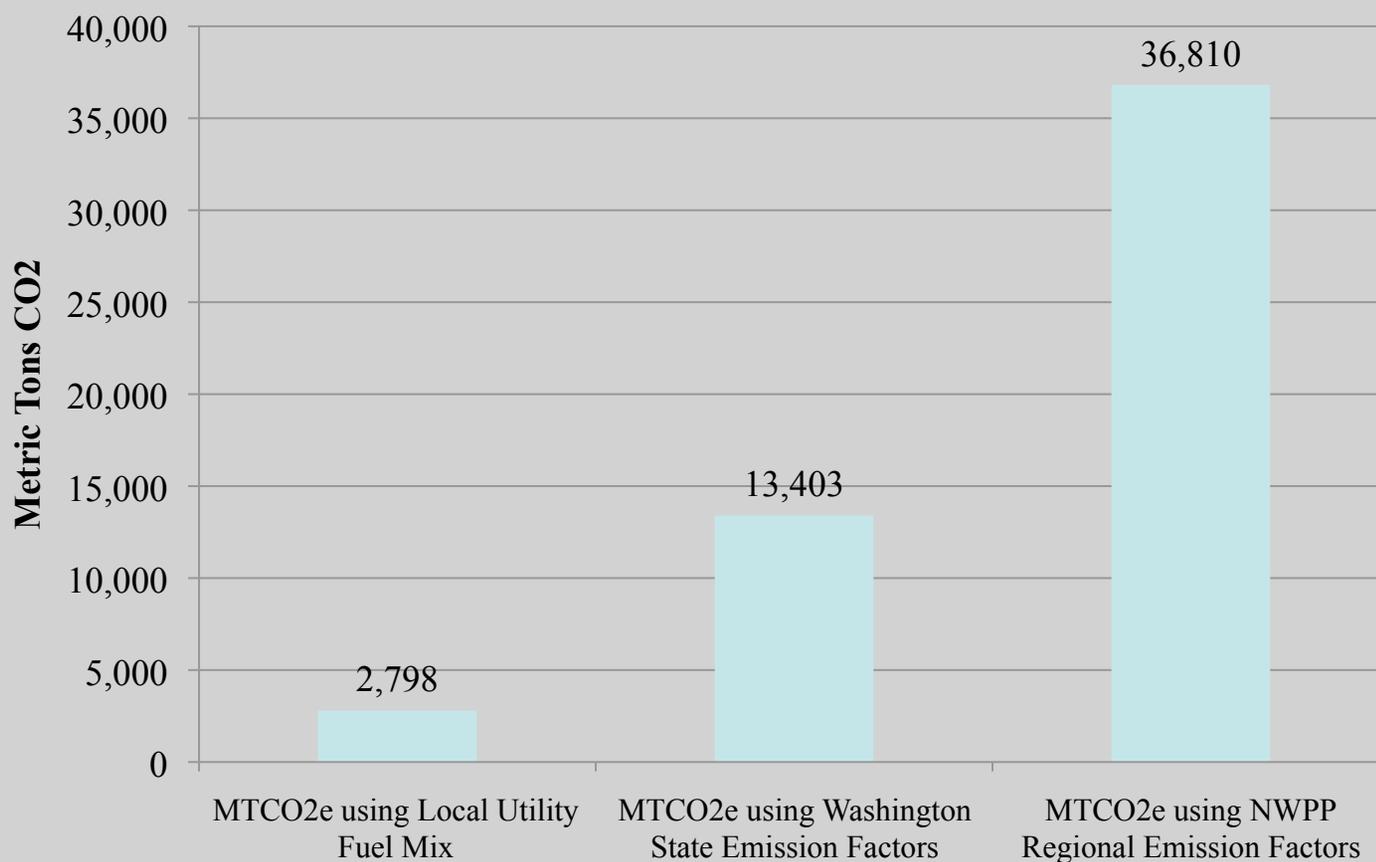
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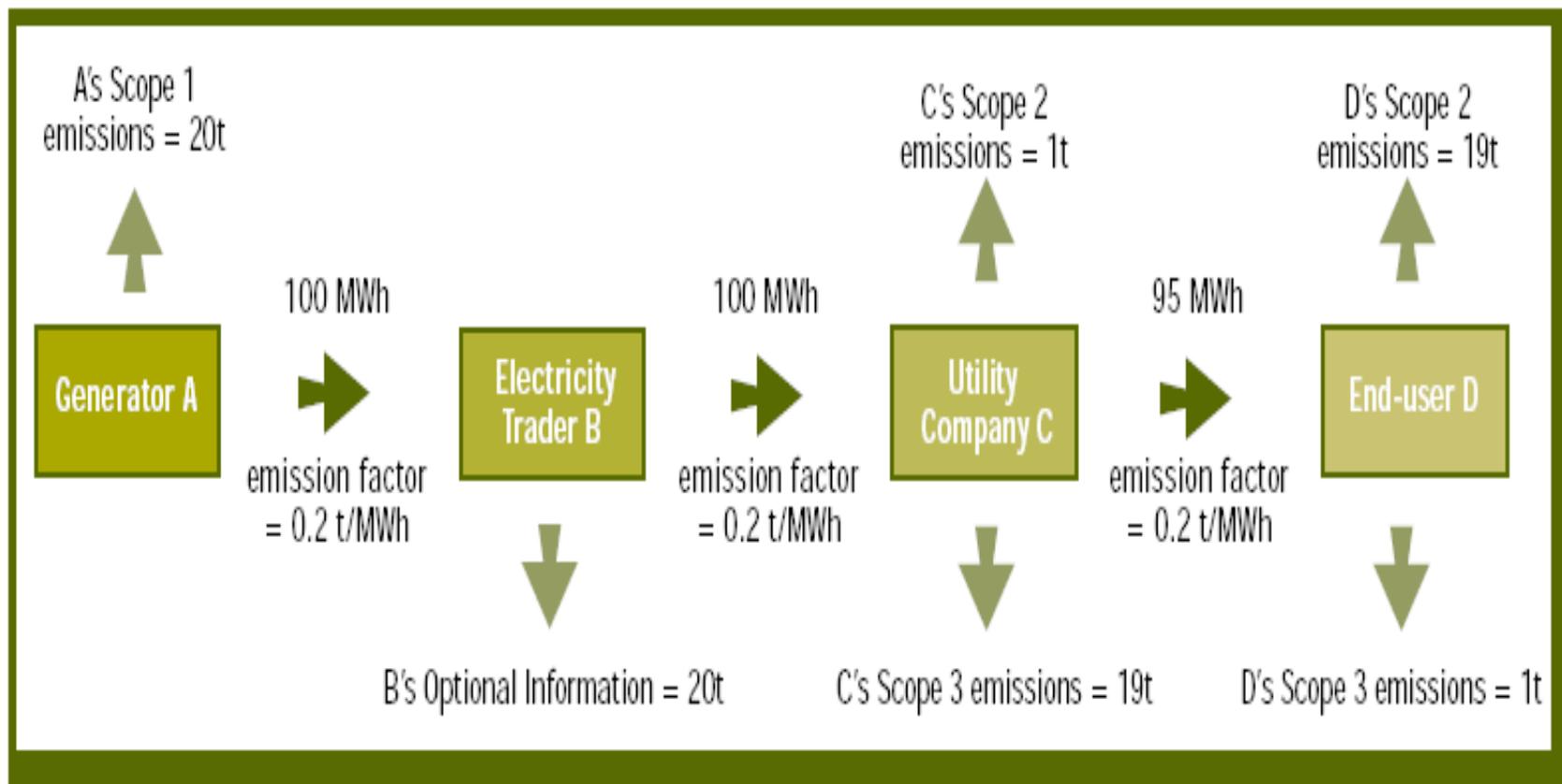
Report

2007 CO₂ Emissions from Electricity Use Based on Local, State,
and Regional Emission Factors



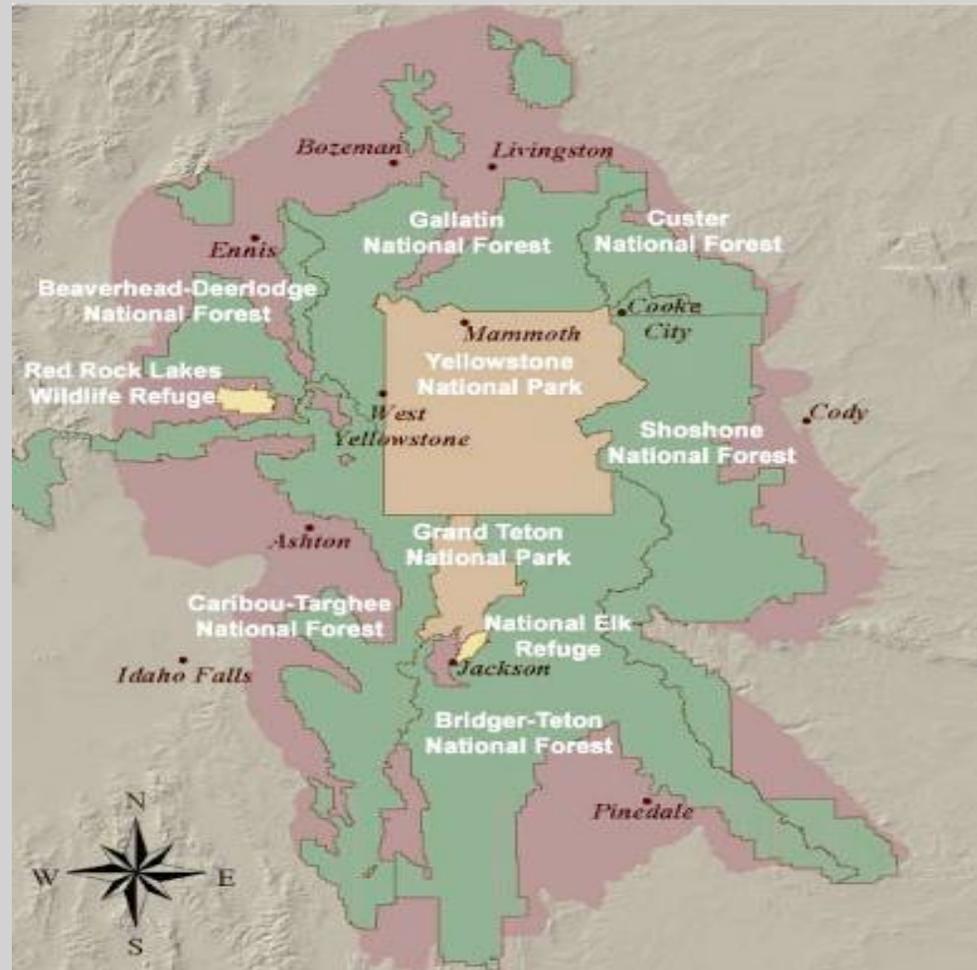


Calculating Emissions from Electricity





Greater Yellowstone Area





GYA Big Picture



- **EPA Climate Leaders partner – Fall 2007**
- **Inventory pilot for the agency**
- **Anthropogenic emissions of 3 GHGs**
- **Inventory and Report - April 2009**
 - NPS completed two inventories
 - USFWS completed a very DRAFT inventory



GYA Inventories Gathered



GYA Unit	Database Tool Used
6 National Forests ('07) (USDA)	EPA Climate Leaders Tool
2 USFWS Refuges ('07) (Interior)	EPA Climate Leaders Tool
Yellowstone National Park ('06, Interior)	CLIP Tool
Grand Teton National Park ('07, Interior)	CLIP Tool



GYA Approach



- **Basic inventory parameters**
- **Inventory tool/database**
- **Preliminary survey of GHG activities**
- **Data collection Implement QA/QC protocols**
- **Crunch, check, re-crunch, and re-check numbers**
- **Obtain peer, internal, and external review**



GYA Emission Sources



Included

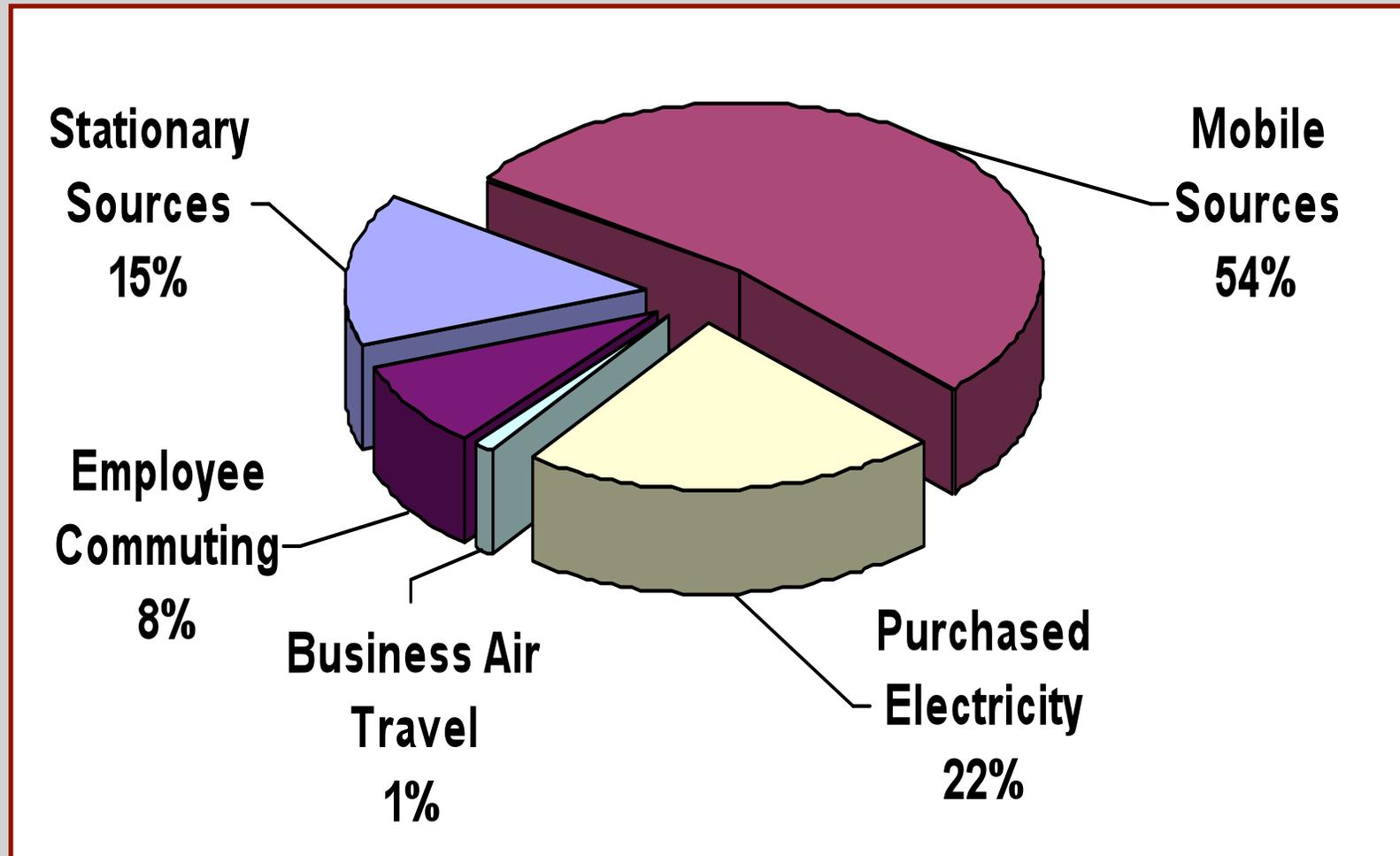
- **Mobile sources**
- **Stationary sources**
- **Electricity**
- **Employee air travel**
- **Employee commuting**

Not Included

- **Prescribed fire & wildfire suppression**
- **Refrigerants**
- **Fire extinguishers**
- **Gas waste stream**
- **Imported heat**
- **Product transport**
- **Off-site waste disposal**



GHG Emissions from National Forests in the GYA





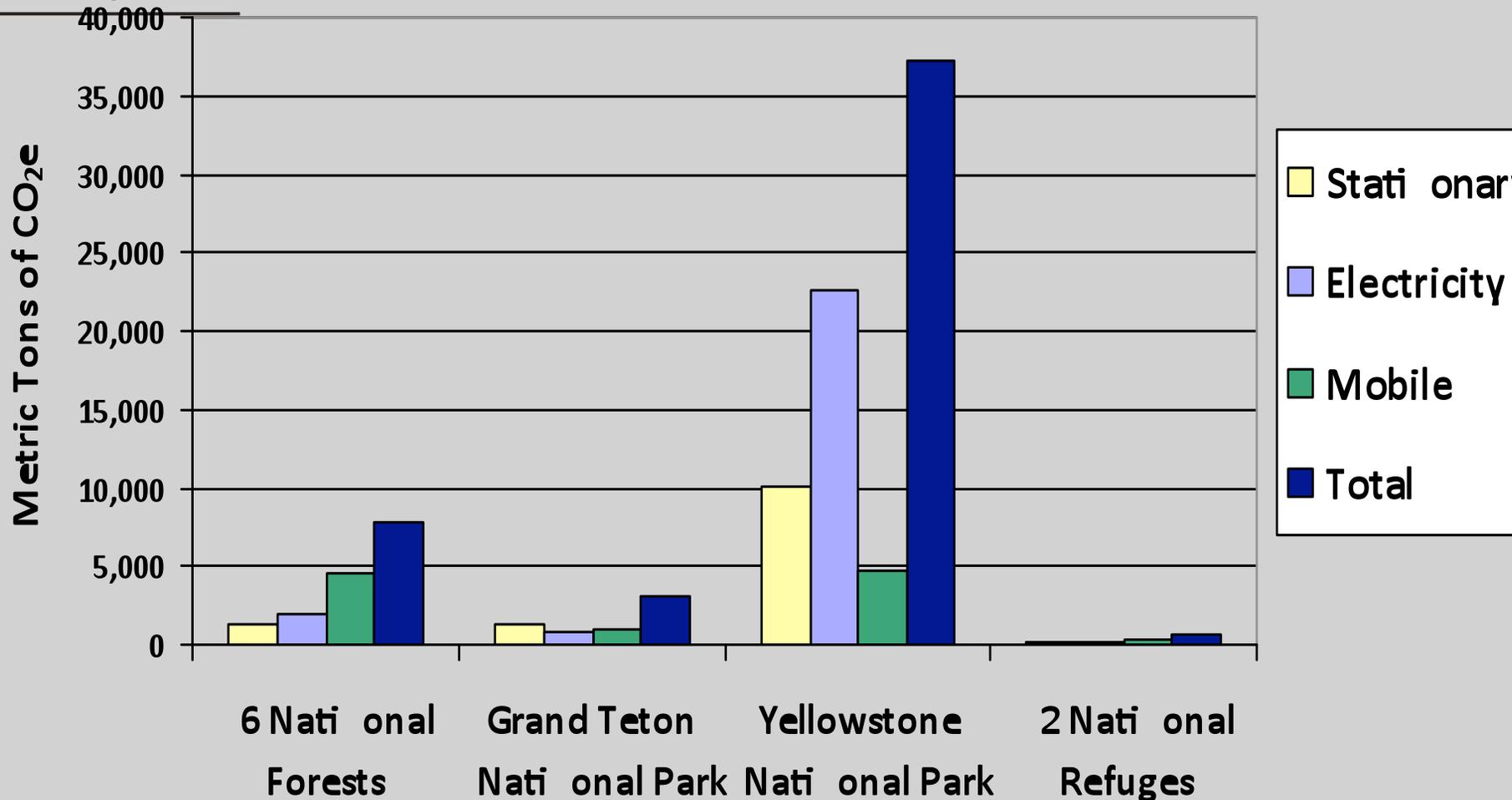
GYA Internal Agency Findings



- **Fleet fuel economy**
- **GSA data quality**
- **Building ownership**
- Forest level data sources
- Agency reporting and data storage systems
- Geographic boundary
- Wood emissions



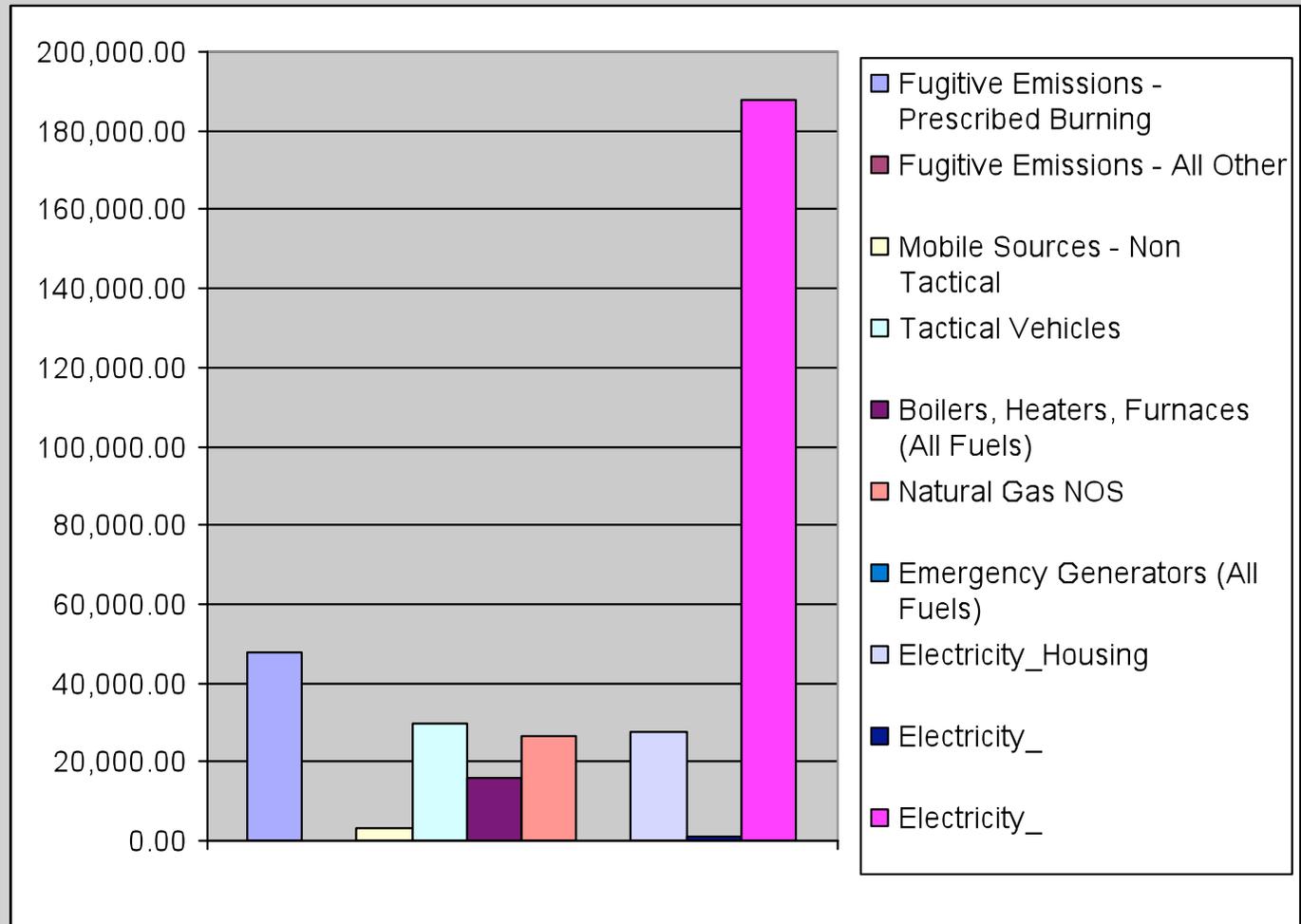
GYA Total GHG Emissions





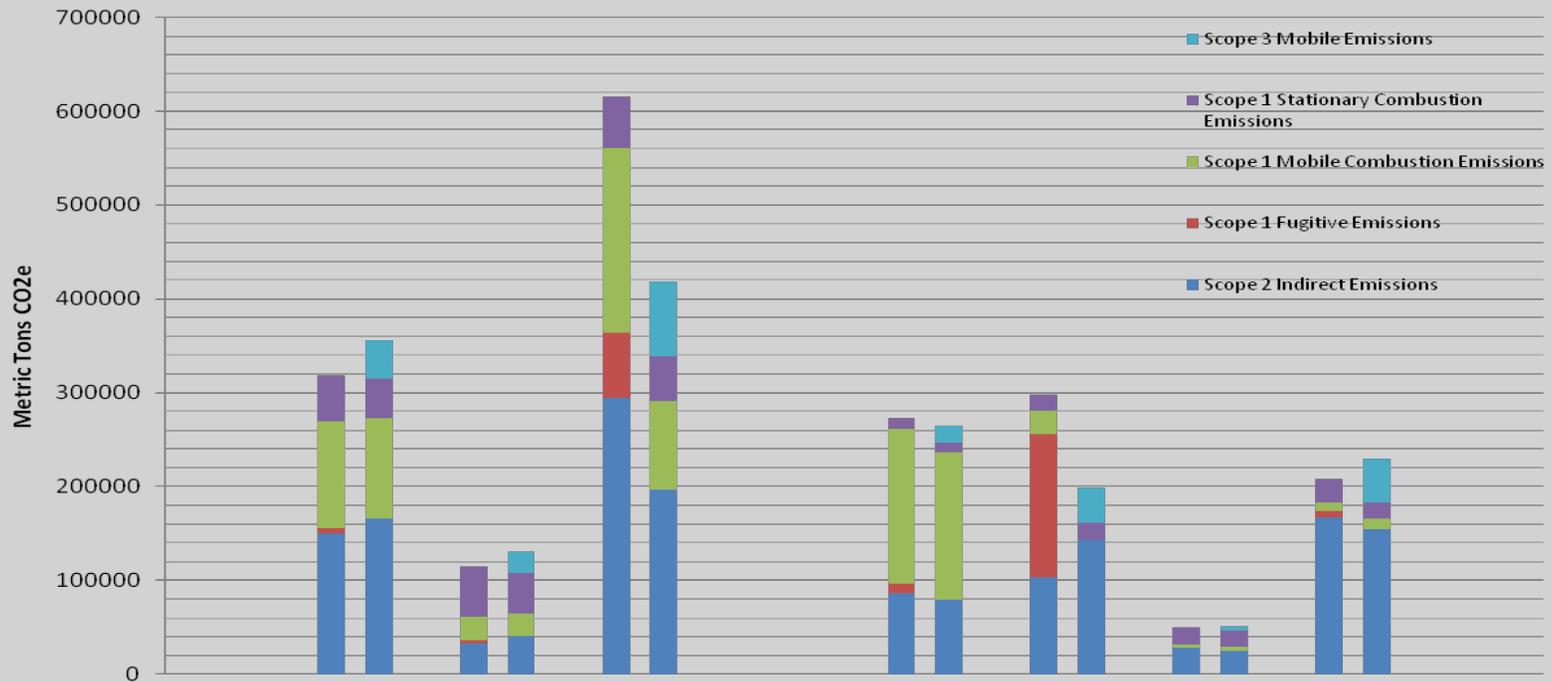
Agency X, One Location Emissions

GHG Emissions
by Source
Category
(Metric Tons
CO₂-e)





Estimated Agency X GHG Emissions (6 Installations)



Comparison of emissions estimates from facilities-level (left) and HQ-level (right) inventories for seven installations.



Agency X GHG Emissions

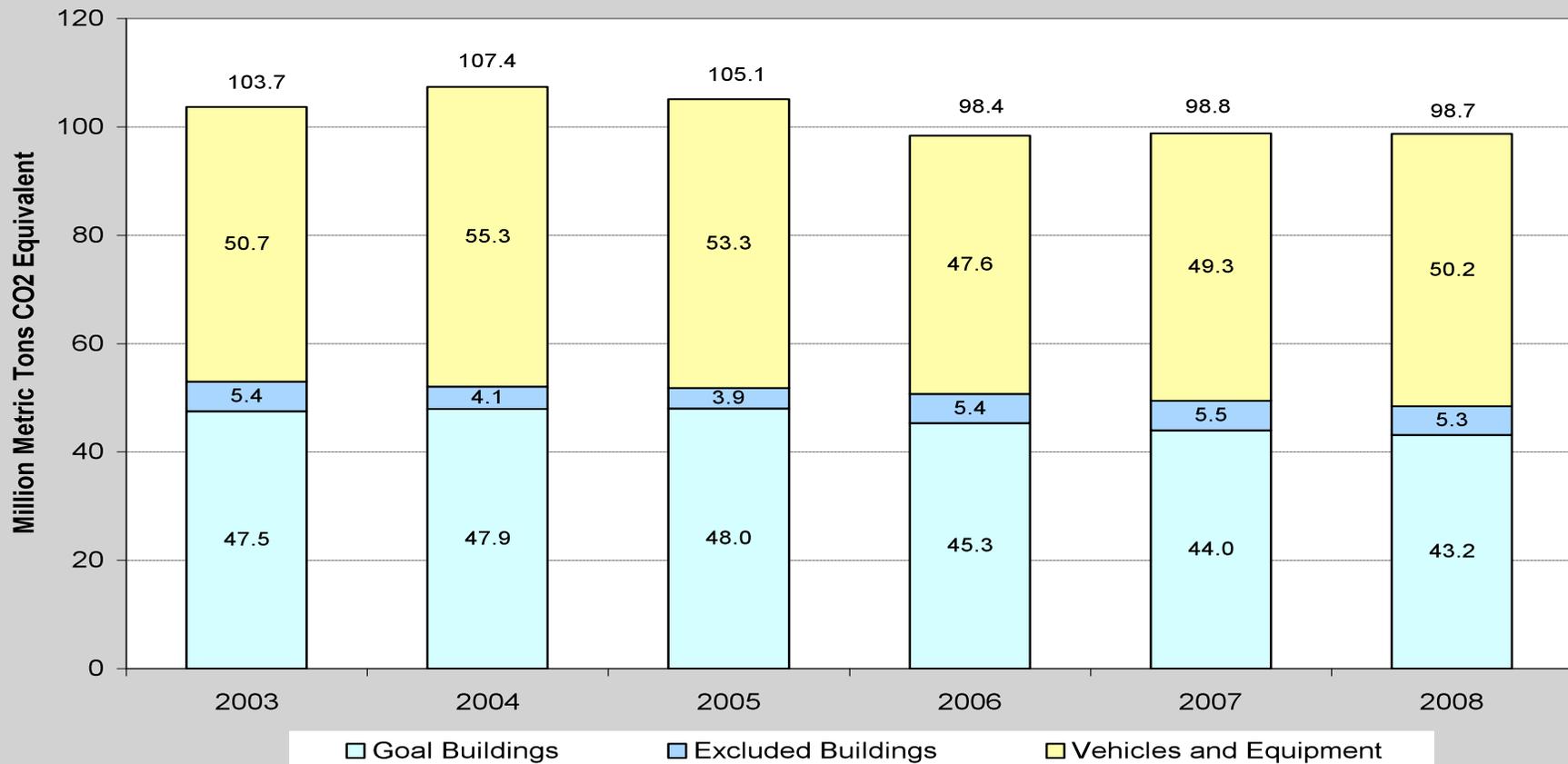
- FY2008 data, HQ level estimates
 - 134 sites

 - Emissions: 10.5 MTCO₂e
 - Sequestered: 9.2 MTCO₂e
-
- Net emissions: 1.3 MTCO₂e



Recent Federal GHG Emissions

Preliminary Estimated Federal Agency GHG Emissions Trends by End-Use Sector
(FY 2003-2008) (Carbon Dioxide, Methane and Nitrous Oxide)

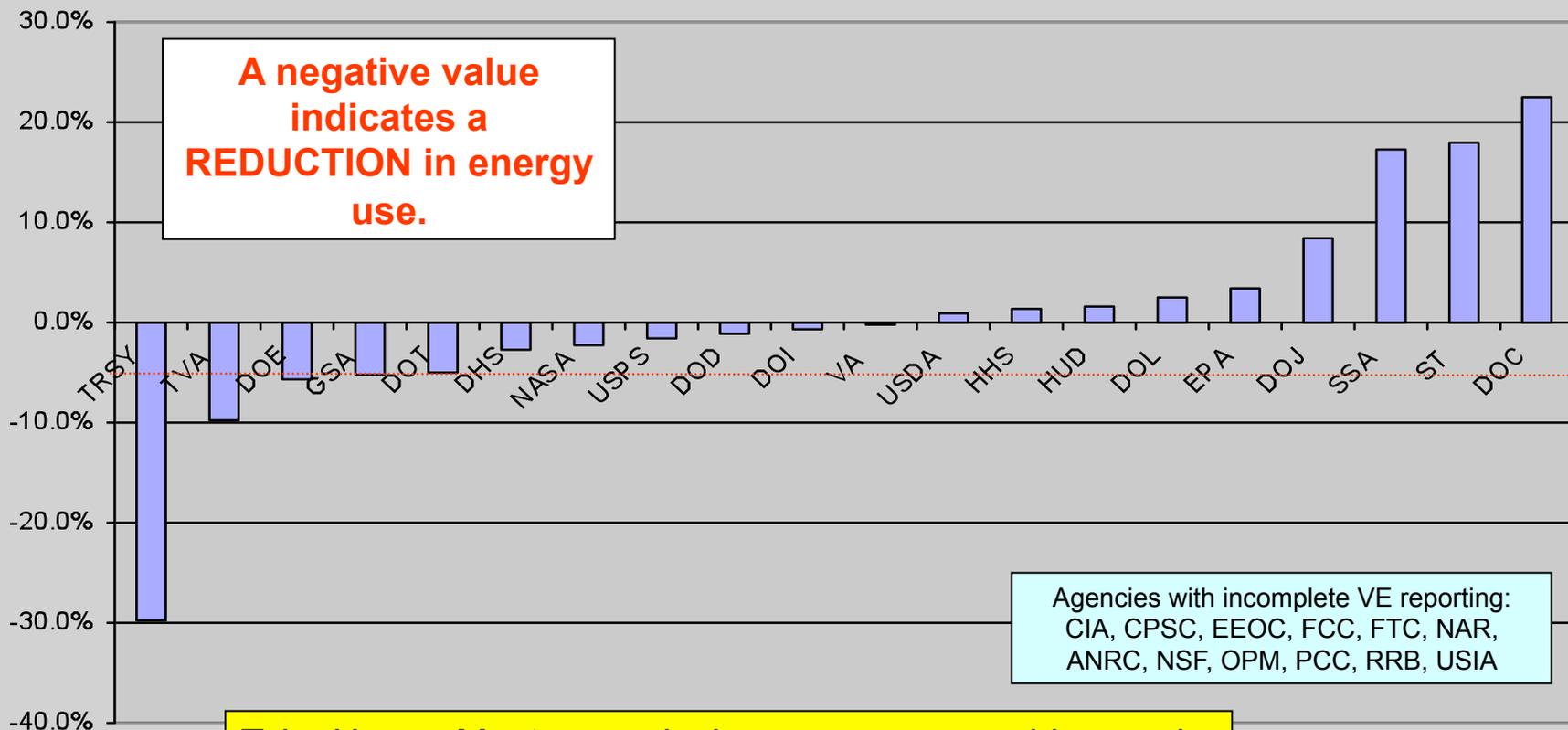




Vehicles and Equipment - % Change

FY08 Goal: 6%

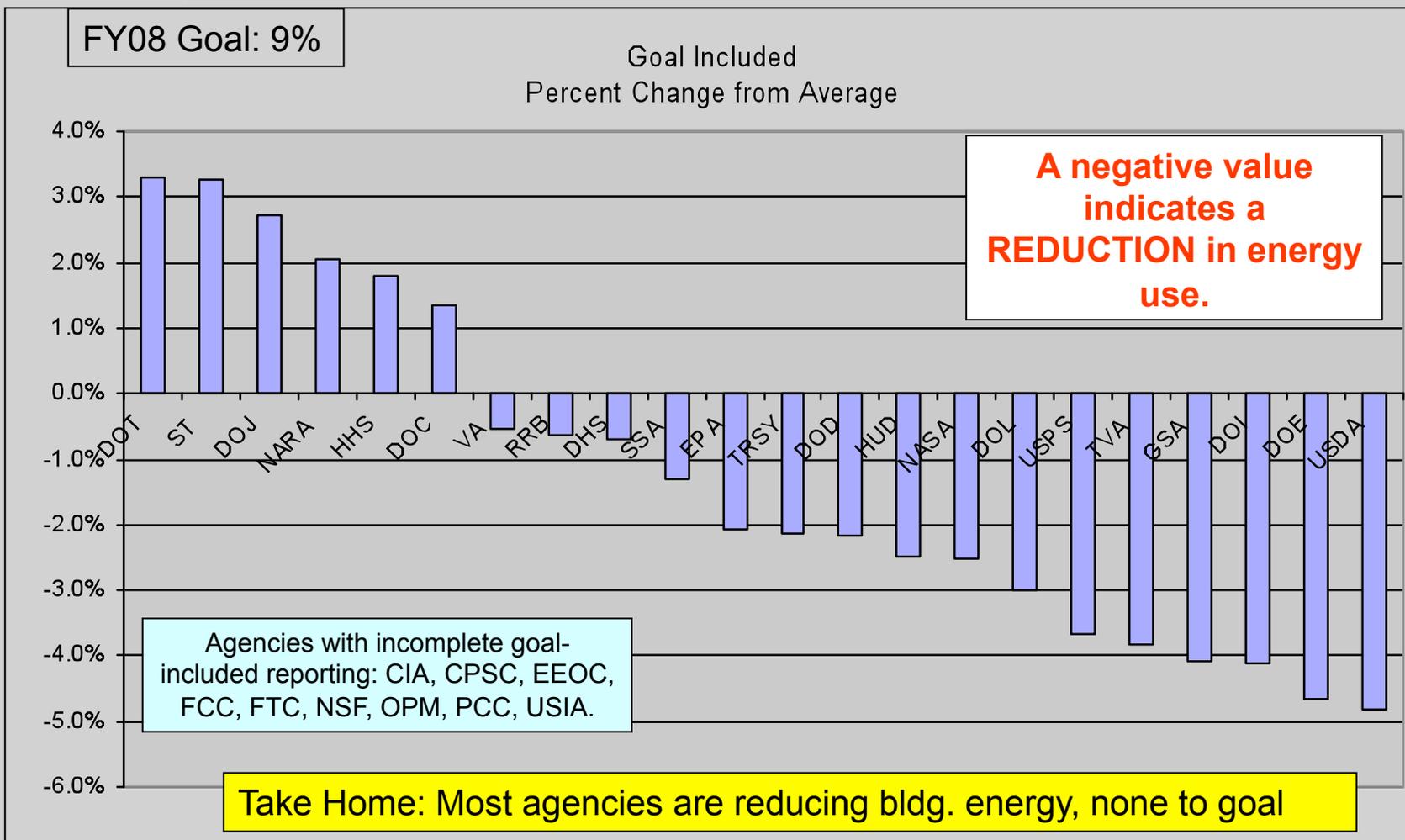
Vehicles and Equipment
Percent Change vs. Average



Take Home: Most are reducing, some are reaching goal



Goal Included - % Change

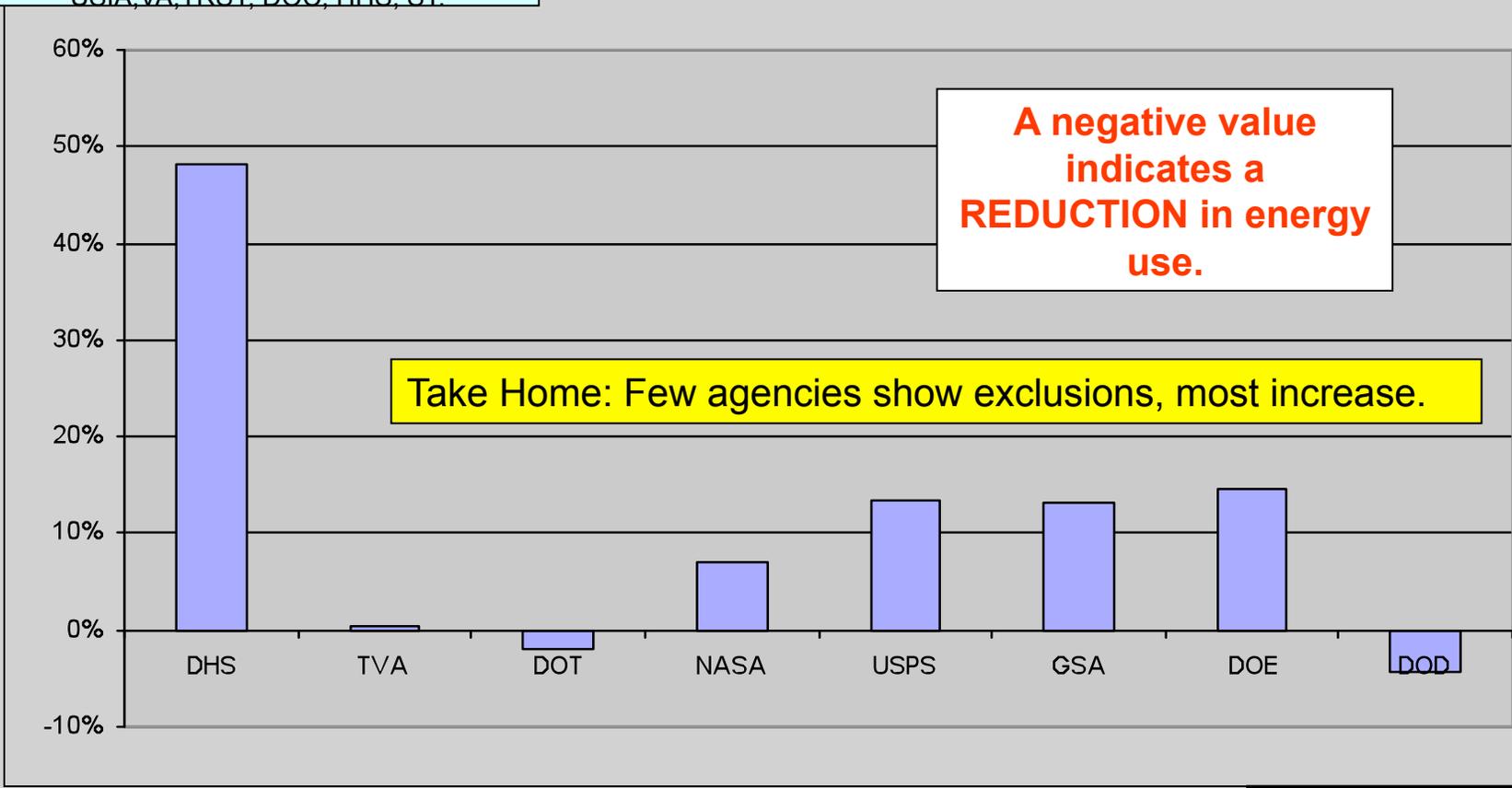




Goal Excluded - % Change

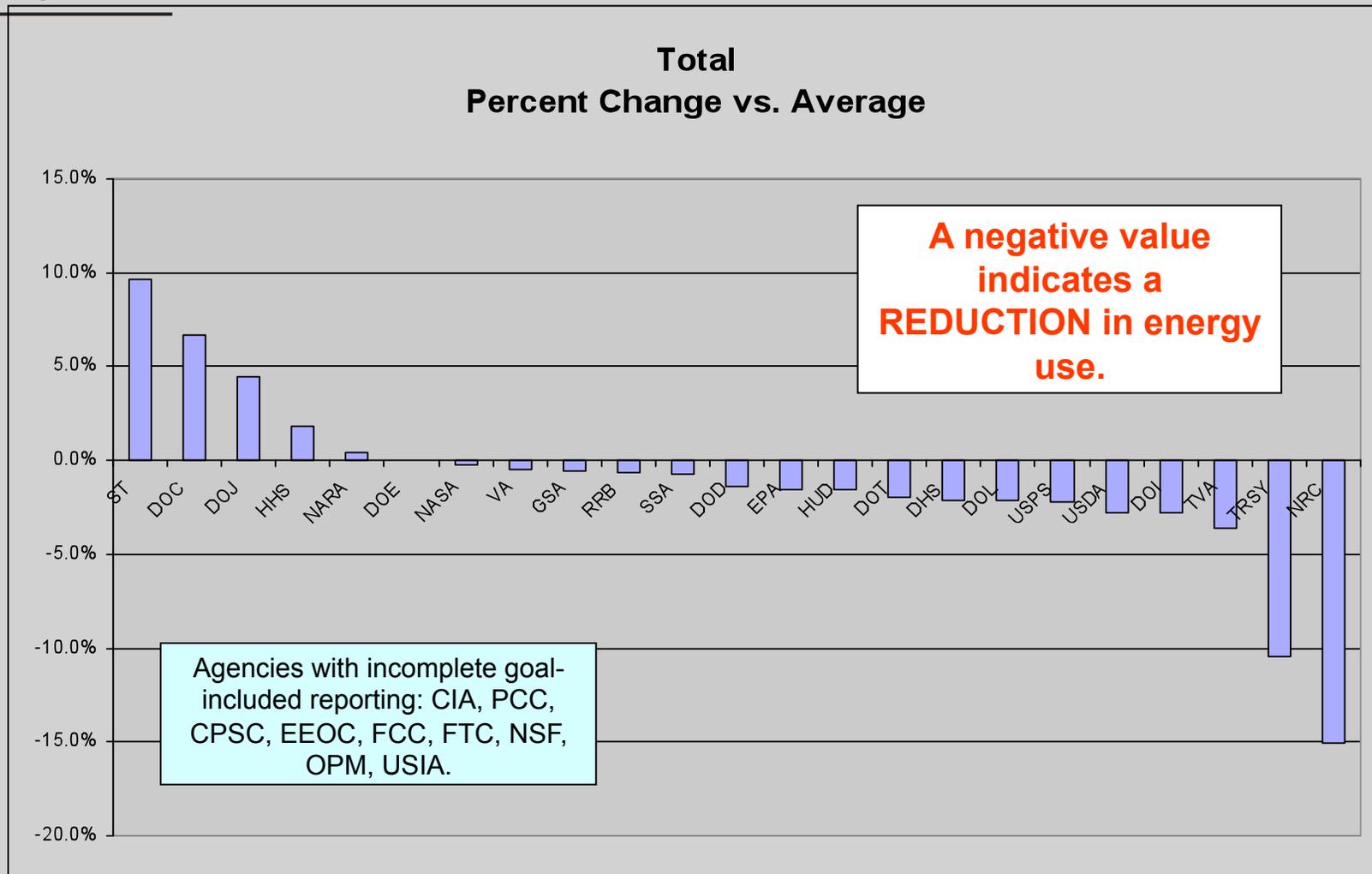
Agencies with incomplete goal-excluded reporting: CIA, PCC, CPSC, DOI, DOJ, DOL, EEOC, EPA, FCC, FTC, HUD, NARA, NRC, NSF, OPM, RRB, SSA, USDA, USIA, VA, TRSY, DOC, HHS, ST.

Goal Excluded
Percent Change from Average





Total - % Change





AN EXERCISE

- This will be on the final exam!



NREL Inventory Example

Handouts

- NREL Inventory Management Plan
 - Nuts and bolts of GHG Inventory
 - Emissions resources
 - Data sources
 - Includes inventory spreadsheets
- Developed for Climate Leaders program
- Climate Leaders Spreadsheet
 - Shows goals and progress toward goals



TOOLS

- EPA Climate Leaders Tool
- Climate Registry Information System (CRIS)
- CLIPP
- CA EMFAC (car emissions factors)
- **WARM**
- Egrid
- CA Carrot
- WRI



Materials in WARM

Aluminum Cans	Magazines/Third-class Mail	Food Scraps
Steel Cans	Medium Density Fiberboard	Yard Trimmings
Copper Wire	Corrugated Cardboard	Grass
Glass	Dimensional Lumber	Leaves
HDPE	Mixed Paper (3 categories)	Branches
LDPE	Mixed Metals	Carpet
PET	Mixed Plastics	PCs
Newspaper	Mixed Organics	Clay Bricks
Office Paper	Mixed Recyclables	Concrete
Phonebooks	Mixed MSW	Fly Ash
Textbooks		Tires



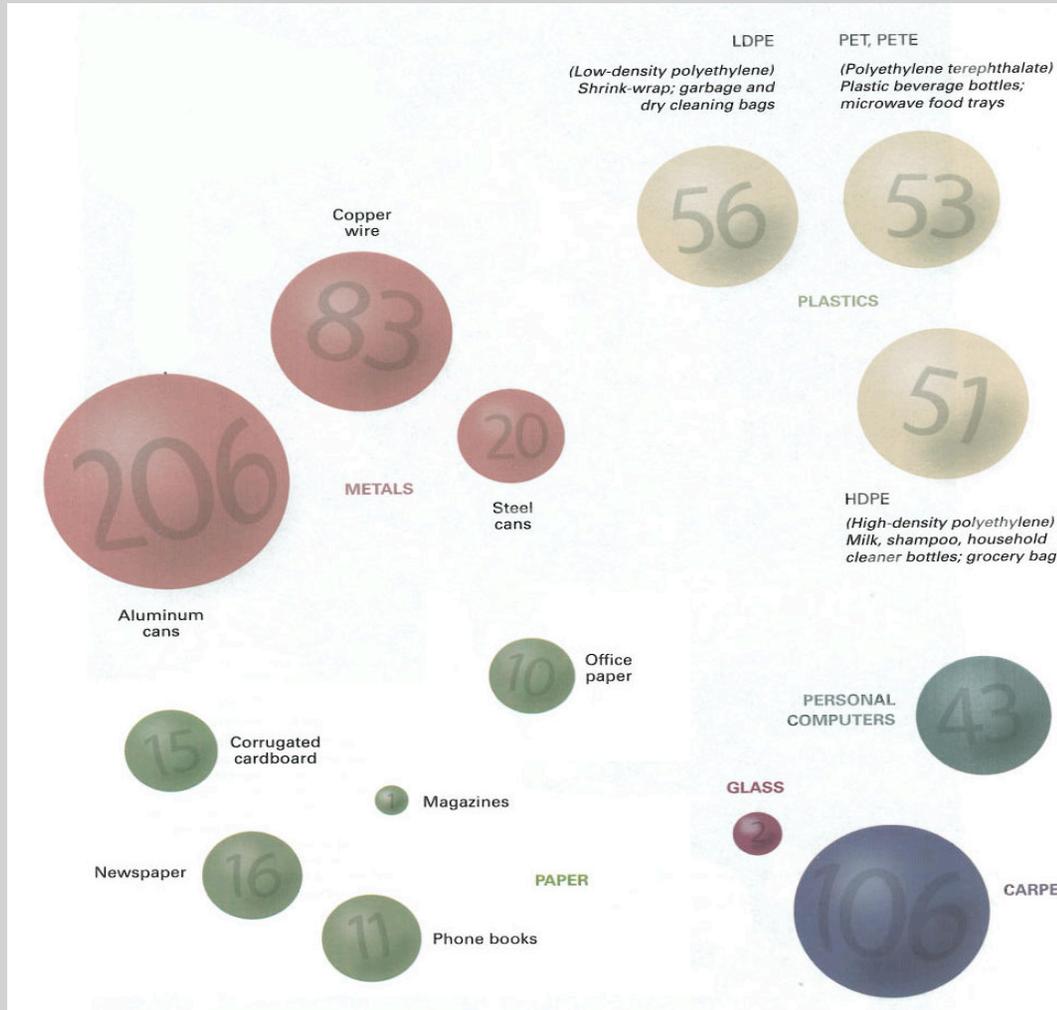
Potential Carbon Storage

Landfill carbon storage

- Some materials are not completely decomposed by anaerobic bacteria, so some of the carbon in these materials is stored in the landfill
- Counted as an anthropogenic sink since this carbon storage would not normally occur under natural conditions
- Included in factors for corrugated cardboard, magazines/third-class mail, newspaper, office paper, phonebooks, textbooks, lumber, fiberboard, food scraps, grass, leaves, branches



WARM Emission Factors (Billions of BTU)





EPA's WARM

The screenshot shows the EPA's WARM website in a Microsoft Internet Explorer browser window. The browser's address bar shows the URL: <http://www.epa.gov/climatechange/wycd/waste/tools.html>. The page title is "Climate Change - Waste". The navigation menu includes "Tools", "ReCon", "WARM", and "DGC". The "WARM" link is circled in black. The main content area is titled "Tools" and contains several tool descriptions: "Recycled Content (ReCon) Tool", "Waste Reduction Model (WARM)", "Durable Goods Calculator (DGC)", "Greenhouse Gas Equivalencies Calculator", "NRC Environmental Benefits Calculator", and "NERC Environmental Benefits Calculator". A "Returning User?" box on the right side of the page provides links to download spreadsheets for ReCon and WARM. The footer contains links for "About the Site", "Glossary", "EPA Home", "Privacy and Security Notice", and "Contact Us".



Waste Reduction Model (WARM)

Waste Home - Waste Reduction Model (WARM) | Climate Change - What You Can Do | U.S. EPA - Microsoft Internet Explorer

U.S. ENVIRONMENTAL PROTECTION AGENCY

Climate Change - Waste

Search: Go

You are here: EPA Home » Climate Change » What You Can Do » Waste » Tools » Waste Reduction Model (WARM)

Tools ReCon WARM DGC

Waste Reduction Model (WARM)

EPA created the Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices. WARM is available both as a [Web-based calculator](#) and as a [Microsoft Excel spreadsheet](#) (502 kb WinZip archive).

WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon equivalent (MTCE), metric tons of carbon dioxide equivalent (MTCO₂E), and energy units (million BTU) across a wide range of material types commonly found in municipal solid waste (MSW).

WARM is periodically updated as new information becomes available and new material types are added. Users may refer to the [model history](#) to better understand the differences in among various versions of WARM. WARM was last updated August, 2006.

WARM now recognizes 34 material types, which are presented in the table below; their emission factors are available for viewing in units of [metric tons of carbon equivalent \(MTCE\)](#) or [metric tons of carbon dioxide equivalent \(MTCO₂Eq\)](#). Note that the emission factors represent the GHG emissions associated with managing 1 short ton of MSW in the manner indicated. GHG savings should be calculated by comparing the emissions associated with the alternative scenario with the emissions associated with the baseline scenario, as opposed to simply multiplying the quantity by an emission factor. For instance, the GHG savings of recycling 1 short ton of aluminum instead of landfilling it would be calculated as follows:

$$(1 \text{ short ton} \times -3.70 \text{ MTCE/short ton}) - (1 \text{ short ton} \times 0.01 \text{ MTCE/short ton}) = -3.71 \text{ MTCE}$$

Note

ReCon and WARM were developed for purchasers and waste managers, respectively. ReCon calculates the benefits of alternative recycled content purchasing decisions. WARM, on the other hand, calculates the benefits of alternative end-of-life waste management decisions. Both tools calculate the benefits of an alternative scenario versus a business-as-usual scenario. The WARM and ReCon tools are based on a life-cycle approach, which reflects emissions and avoided emissions upstream and downstream from the point of use. As such, the emission factors provided in these tools provide an account of the net benefit of these actions to the environment. This life-cycle approach is not appropriate for use in inventories because of the diffuse nature of the emissions and emission reductions within a single emission factor.

Material Types Recognized by WARM		
Aluminum Cans	Branches	Carpet
Clay Bricks	Concrete	Copper Wire
Corrugated Cardboard	Dimensional Lumber	Fly Ash
Food Scraps	Glass	Grass
HPDE	LDPE	Leaves
Magazines/ 3 rd -Class Mail	Medium-Density Fiberboard	Mixed Metals
Mixed MSW	Mixed Organics	Mixed Paper (general)
Mixed Paper (primarily from offices)	Mixed Paper (primarily residential)	Mixed Plastics
Mixed Recyclables	Newspaper	Office Paper
Personal Computers	PET	Phonebooks
Steel Cans	Textbooks	Tires



WARM Results

Recycling helps reduce GHG emissions.

Commodity	Tons* Recycled	Tons* Landfilled	Total MTCO2E **
Aluminum Cans	2	-	(27)
Steel Cans	6	-	(10)
Corrugated Cardboard	290	-	(902)
Phonebooks	4	-	(12)
Dimensional Lumber	283	-	(696)
Mixed Paper, Office	168	-	(572)
Mixed Metals	1,268	-	(6,665)
Mixed Plastics	6	-	(8)
Mixed Recyclables	309	-	(899)
Mixed MSW	NA	11,040	17,552
Carpet	3	-	(24)
Personal Computers	29	-	(64)
Concrete	4,159	-	(32)
Tires	5	-	(9)
Total	17,570	11,040	7,632



GHG Inventory Software and Calculators

- ICLEI's Clean Air and Climate Protection Software
- Software for the 2006 IPCC Guidelines
- Climate Leaders in Public Places (CLIPP) tool
- ghgTrack Software
- HIS Greenhouse Gas Suite
- ESS GHG/Carbon Management Solution™
- California Climate Action Registry - CARROT



For Sequestration

- DOE National Energy Technology Laboratory
 - National Carbon Explorer <http://www.natcarb.org/>
 - Carbon sequestration program
 - http://www.netl.doe.gov/technologies/carbon_seq/index.html
 - Big Sky Carbon Sequestration Project
 - <http://www.bigskyco2.org/>



The Future



QUESTIONS?