

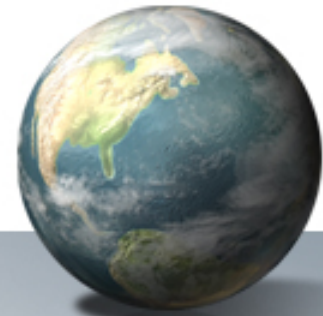
# Climate Change 101



**Ben Machol**  
**U.S. Environmental Protection**  
**Agency, Region 9**  
**June 23, 2009**



# Outline

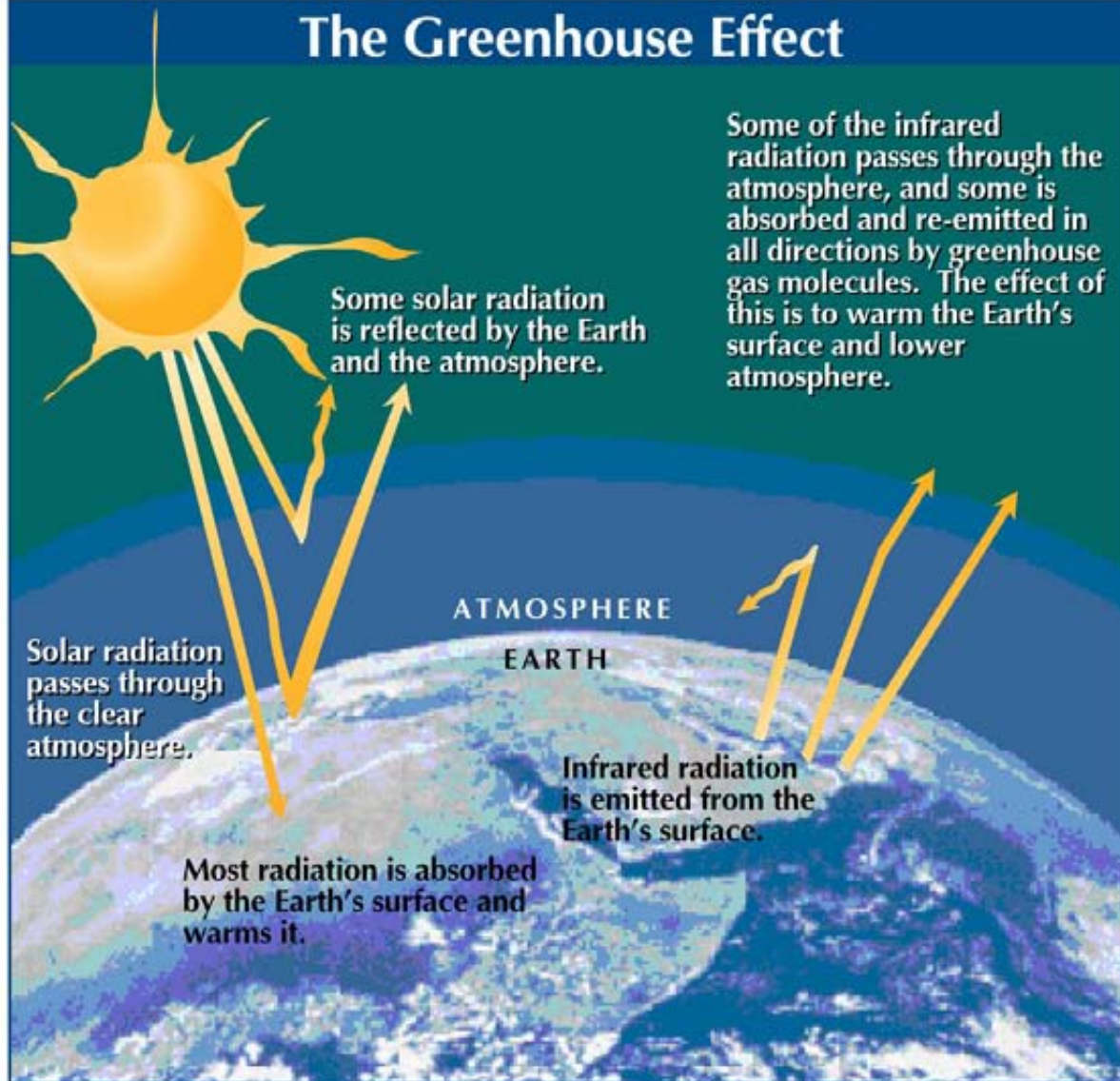


- Climate Change Impacts (video)
- Greenhouse Gases
- Energy and Energy Consumption
- Life Cycle Assessment
- What Can You Do?

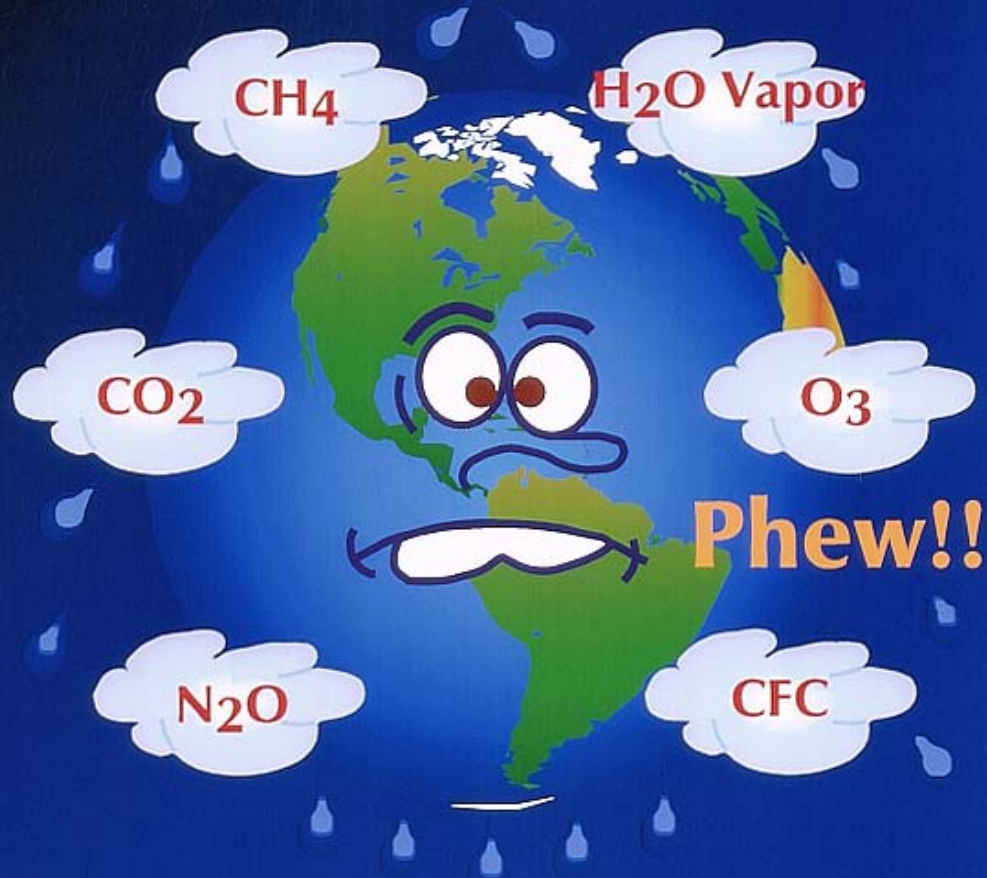




## The Greenhouse Effect



# The Greenhouse Gases



**Abnormal Levels Influenced  
by Man's Actions**



CI IMGRA91 1296-2b





# How Strong Are the Greenhouse Gases?

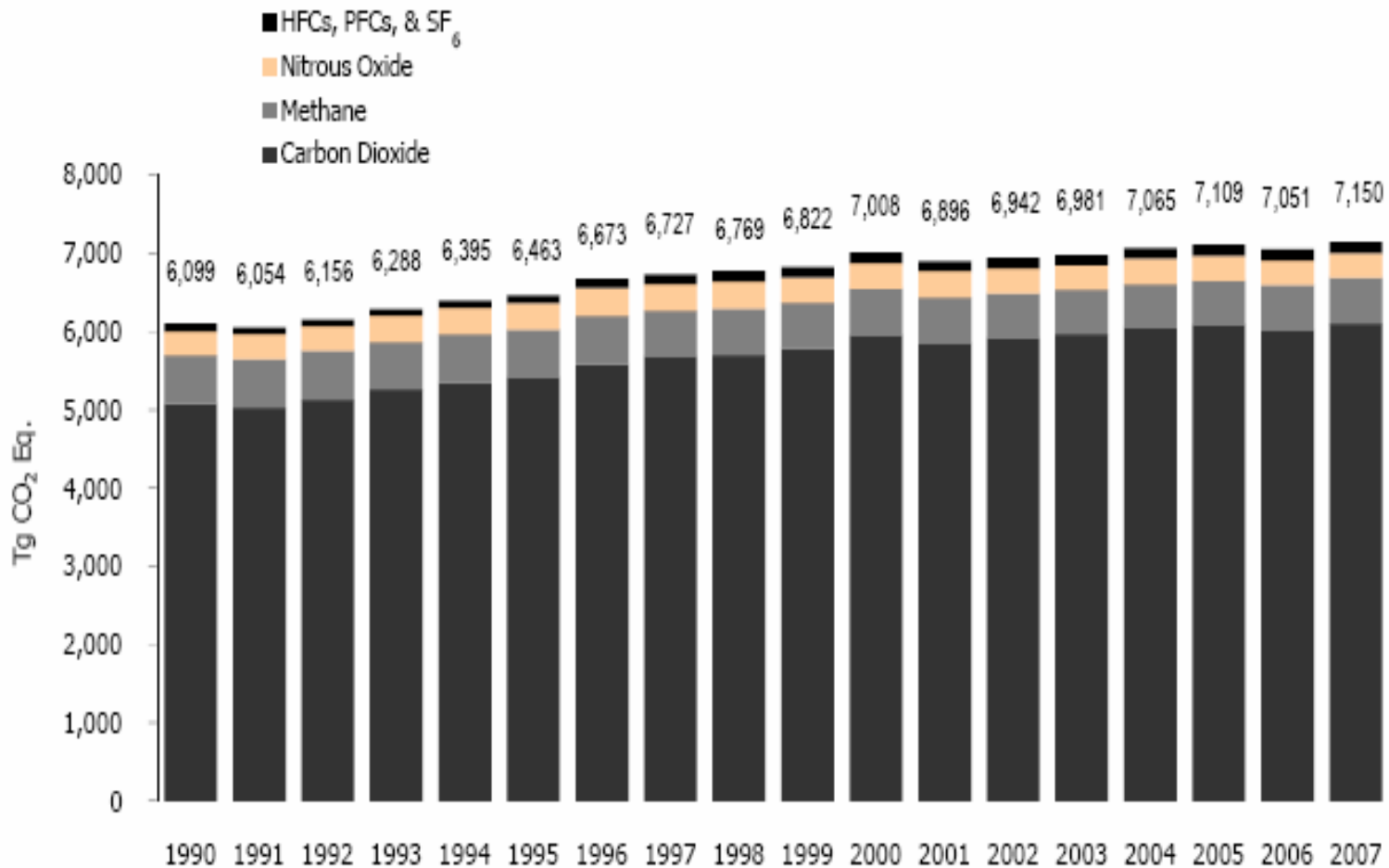


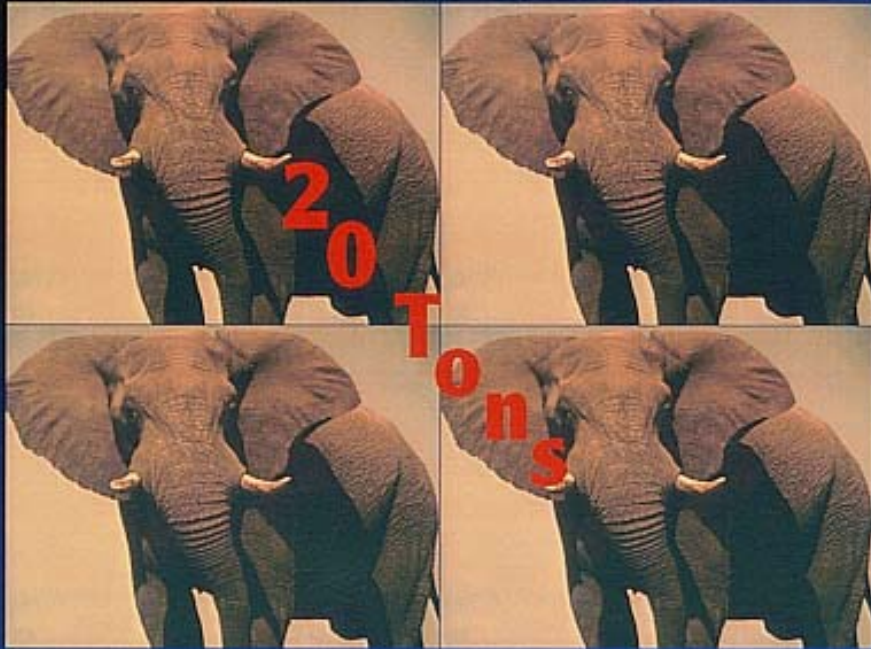
## CO<sub>2</sub> Equivalency (Warming Potential)

- Carbon Dioxide, CO<sub>2</sub> **1 x CO<sub>2</sub>**, **≈ 100 year life**
- Methane, CH<sub>4</sub> **23x CO<sub>2</sub>**, **12 year life**
- Nitrous Oxide, N<sub>2</sub>O **296x CO<sub>2</sub>**, **114 year life**
- High Global Warming Potential Gases (Fluorinated Gases)
  - Hydrofluorocarbons, HFCs **Up to 12,000x CO<sub>2</sub>**
  - Perfluorocarbons, PFCs **Up to 11,900x CO<sub>2</sub>**
  - Sulfur Hexafluoride, SF<sub>6</sub> **22,200x CO<sub>2</sub>**  
**3,200 year life!!**



# U.S. Greenhouse Gases – By Gas





**Each year, 20 tons of carbon in the form of carbon dioxide - roughly the mass of four adult elephants - are added to the atmosphere for each person in the United States.**

Source - The Greenhouse Trap, Francesca Lyman,  
World Resources Institute, 1990



# U.S. Greenhouse Gases – By Economic Sector

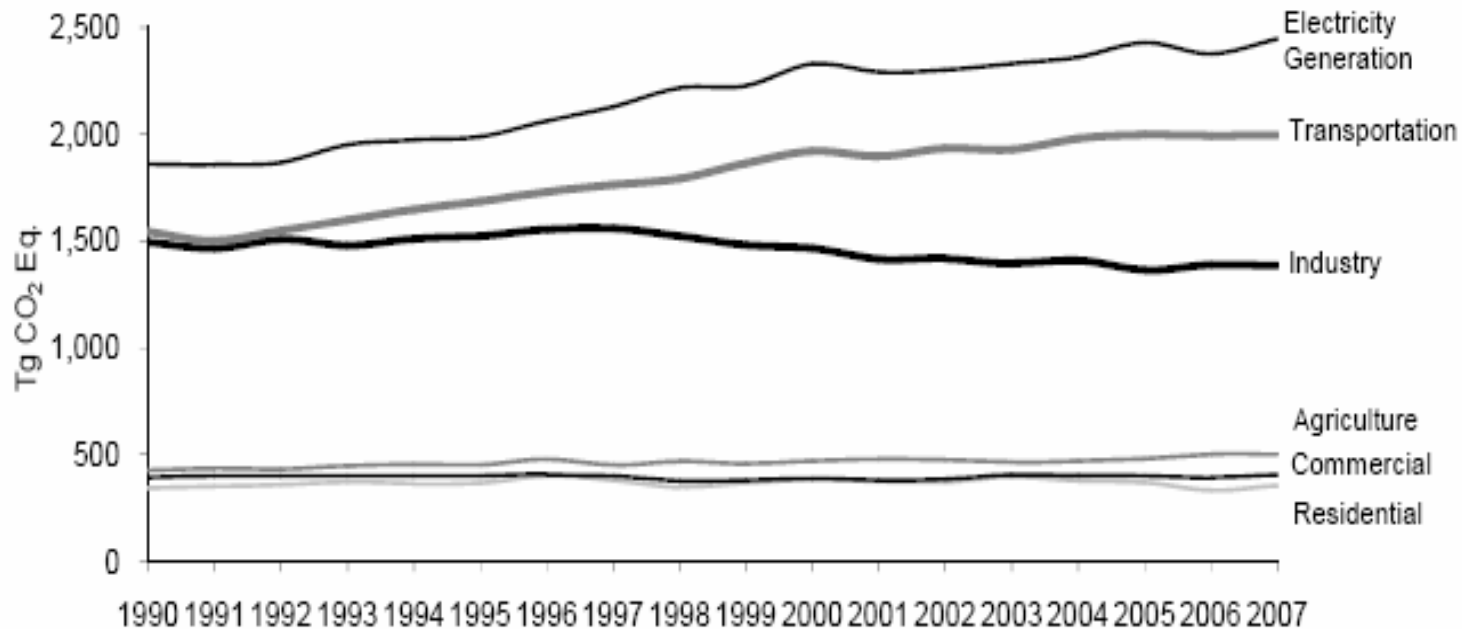


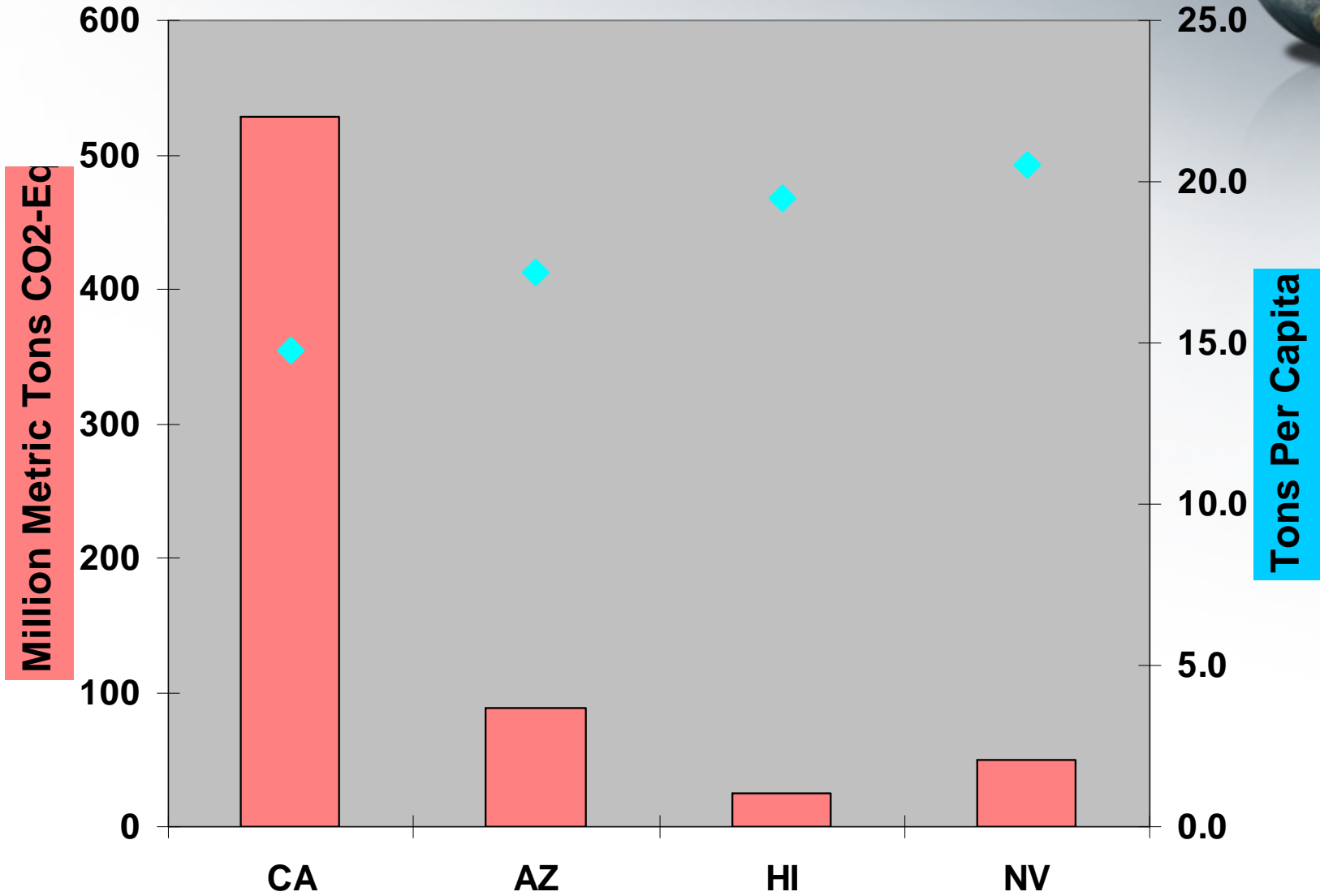
Figure 2-12: Emissions Allocated to Economic Sectors

Note: Does not include U.S. Territories.

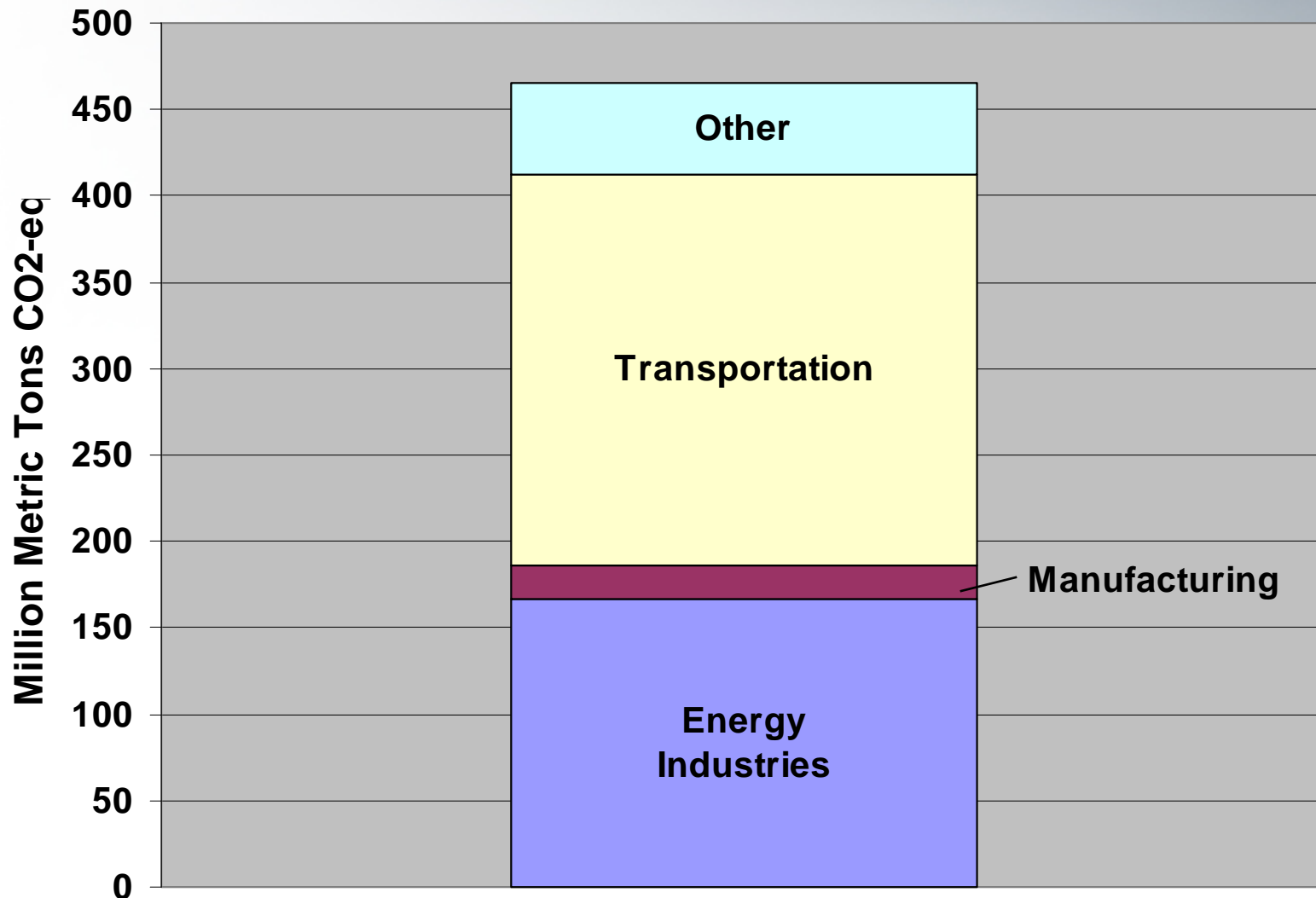




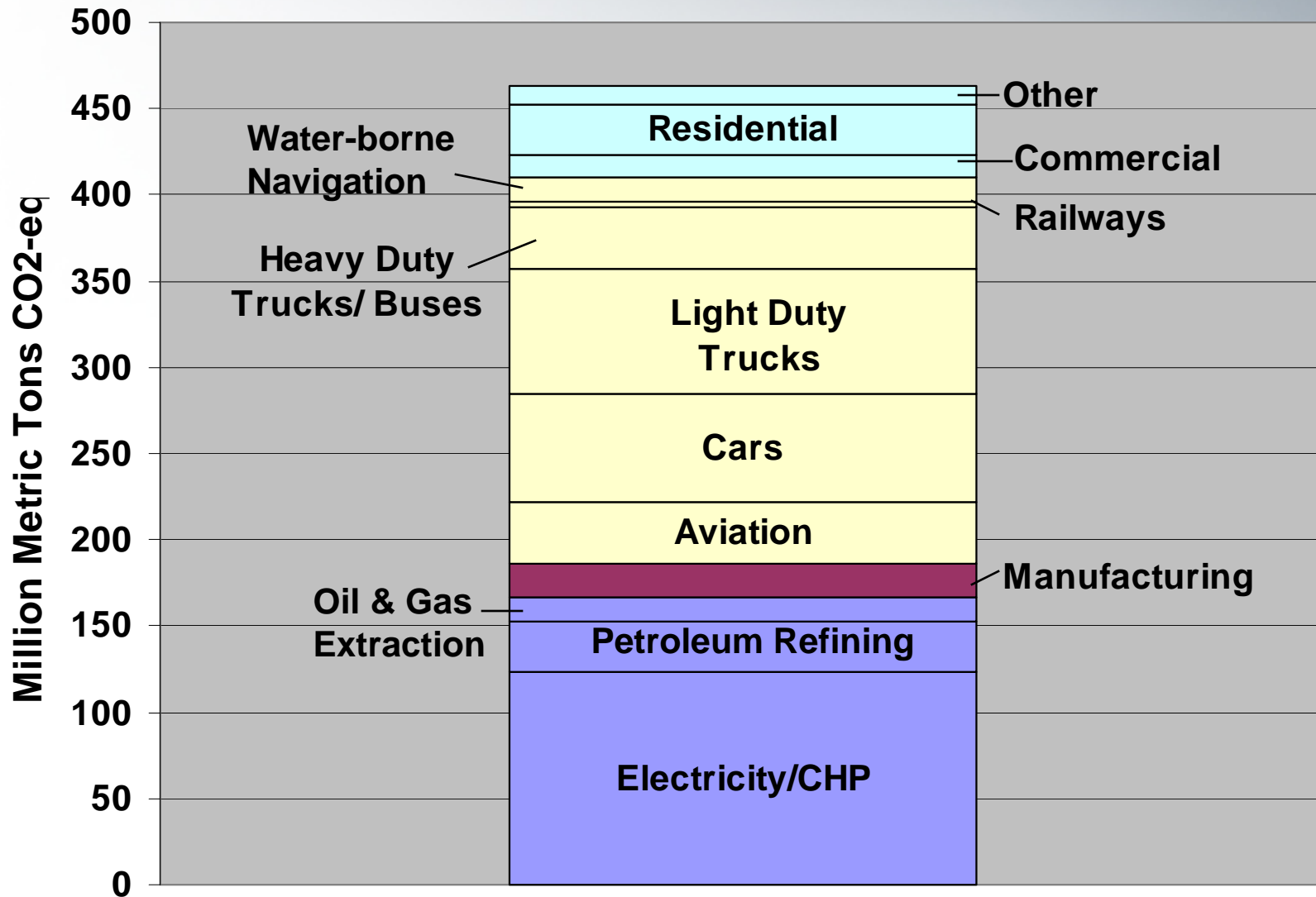
# EPA Region 9 GHG Emissions



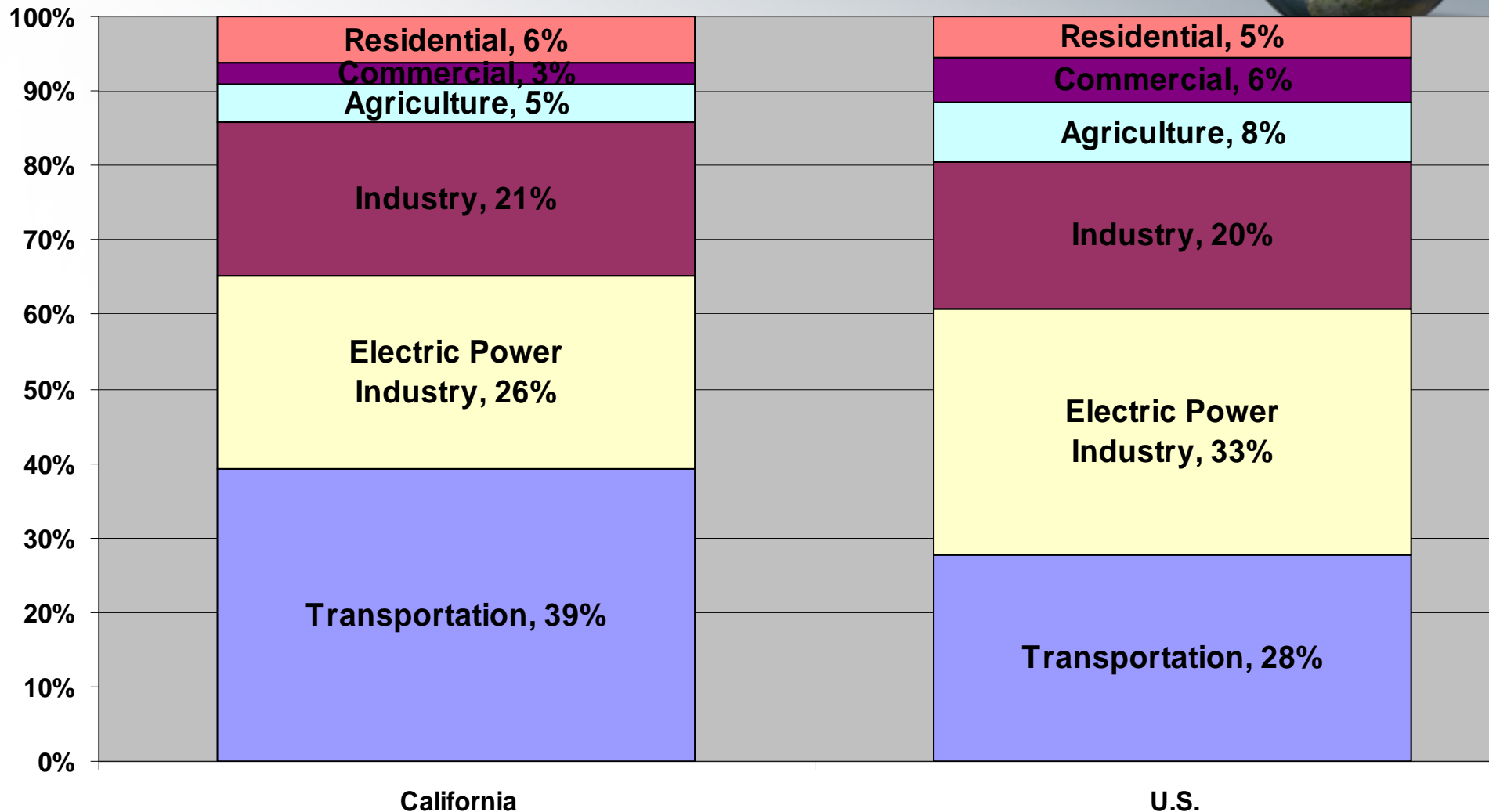
# California GHG Emissions – Energy Sector



# California GHG Emissions



# Proportional Emissions - California vs. U.S.





# National GHG Emissions

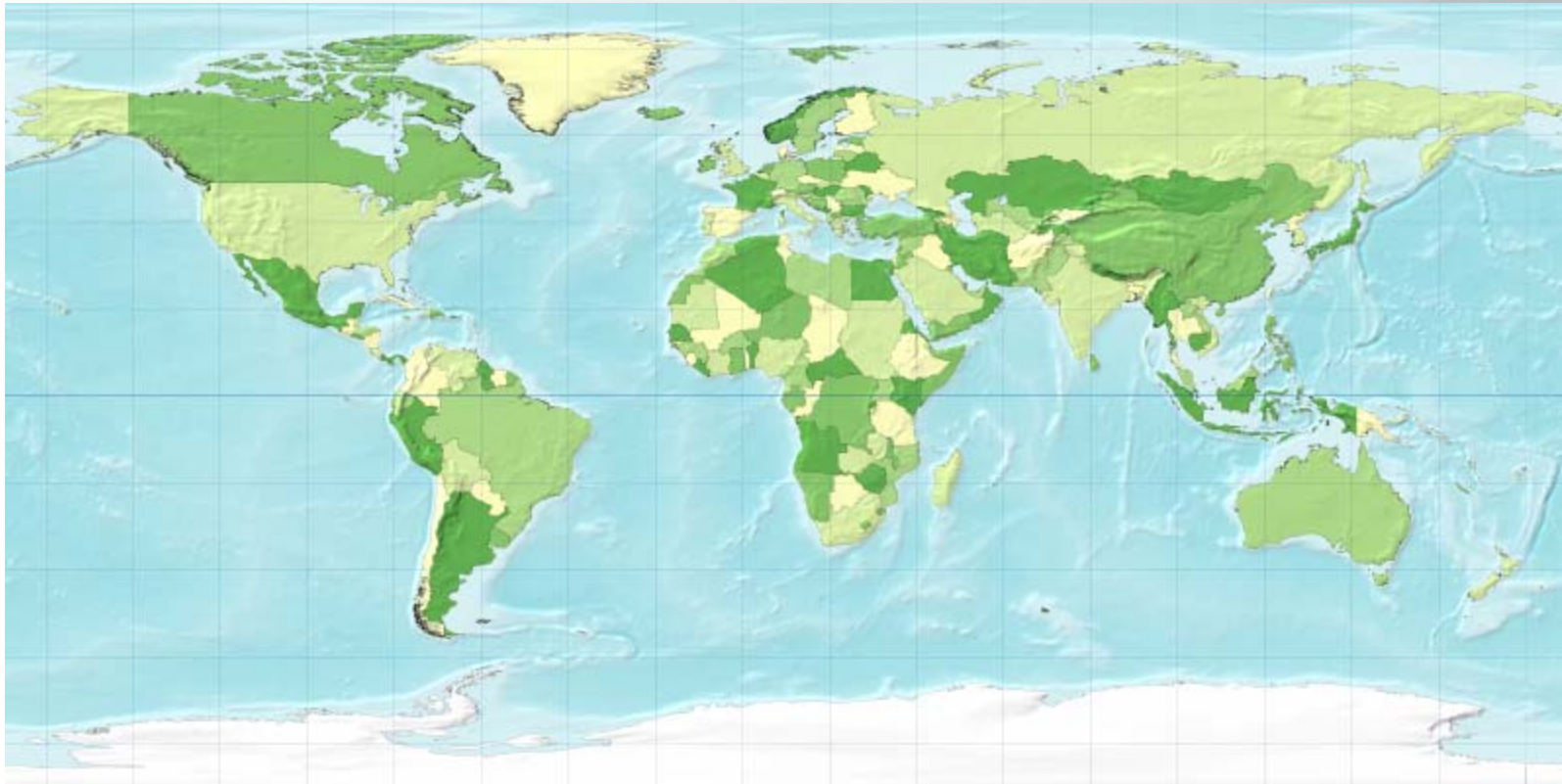


Table 2-14: U.S Greenhouse Gas Emissions by Economic Sector and Gas with Electricity-Related Emissions Distributed (Tg CO<sub>2</sub> Eq.) and Percent of Total in 2007

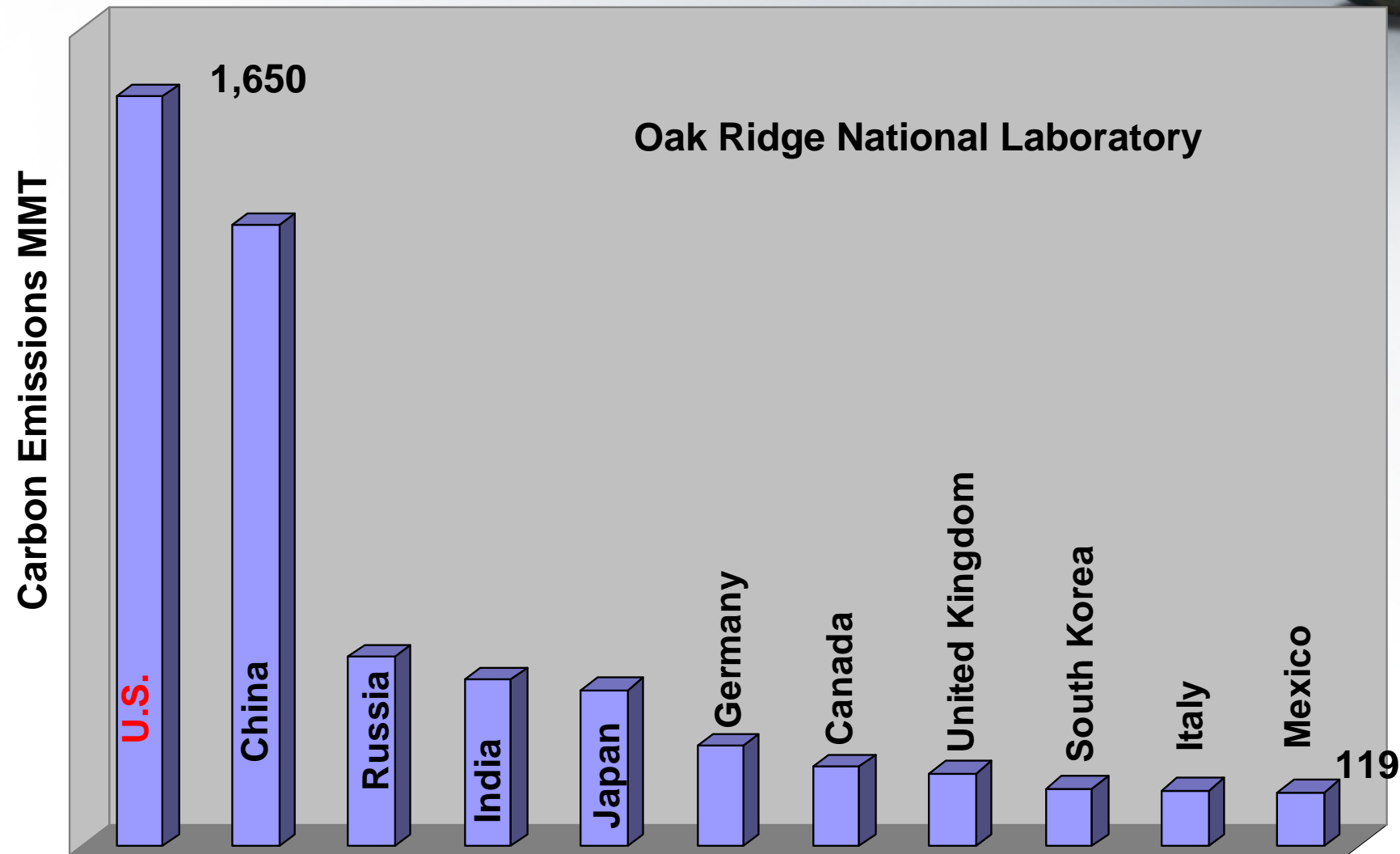
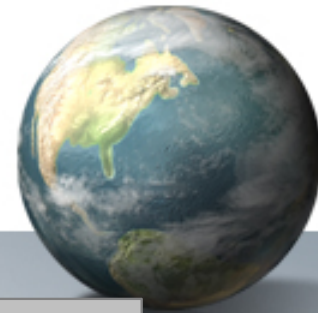
Sector/Gas	1990	1995	2000	2005	2006	2007	Percent <sup>a</sup>
<b>Industry</b>	<b>2,166.5</b>	<b>2,219.8</b>	<b>2,235.5</b>	<b>2,081.2</b>	<b>2,082.3</b>	<b>2,081.2</b>	<b>29.1%</b>
Direct Emissions	1,496.0	1,524.5	1,467.5	1,364.9	1,388.4	1,386.3	19.4%
CO <sub>2</sub>	1,097.9	1,141.7	1,118.3	1,070.1	1,095.8	1,086.4	15.2%
CH <sub>4</sub>	291.1	277.8	262.5	230.4	230.2	229.1	3.2%
N <sub>2</sub> O	43.6	48.4	37.2	33.1	32.8	36.2	0.5%
HFCs, PFCs, and SF <sub>6</sub>	63.3	56.6	49.6	31.3	29.6	34.7	0.5%
Electricity-Related	670.6	695.3	767.9	716.3	693.8	694.9	9.7%
CO <sub>2</sub>	657.6	684.4	759.3	708.8	686.7	688.0	9.6%
<b>Agriculture</b>	<b>459.2</b>	<b>489.7</b>	<b>503.2</b>	<b>511.7</b>	<b>530.0</b>	<b>530.1</b>	<b>7.4%</b>
Direct Emissions	428.5	453.7	470.2	482.6	502.9	502.8	7.0%
CO <sub>2</sub>	38.9	44.4	47.2	55.3	57.3	56.9	0.8%
CH <sub>4</sub>	176.1	192.6	201.3	199.8	218.2	219.2	3.1%
N <sub>2</sub> O	213.5	216.7	221.7	227.5	227.4	226.7	3.2%
Electricity-Related	30.6	36.0	33.0	29.0	27.0	27.3	0.4%
CO <sub>2</sub>	30.0	35.5	32.6	28.7	26.8	27.0	0.4%
CH <sub>4</sub>	+	+	+	+	+	+	+
N <sub>2</sub> O	0.1	0.2	0.1	0.1	0.1	0.1	+
SF <sub>6</sub>	0.4	0.4	0.2	0.2	0.2	0.1	+
<b>U.S. Territories</b>	<b>34.1</b>	<b>41.1</b>	<b>47.3</b>	<b>60.5</b>	<b>62.3</b>	<b>57.7</b>	<b>0.8%</b>
<b>Total</b>	<b>6,098.7</b>	<b>6,463.3</b>	<b>7,008.2</b>	<b>7,108.6</b>	<b>7,051.1</b>	<b>7,150.1</b>	<b>100.0%</b>

➔ <sup>40</sup> Emissions were not distributed to U.S. territories, since the electricity generation sector only includes emissions related to the generation of electricity in the 50 states and the District of Columbia.

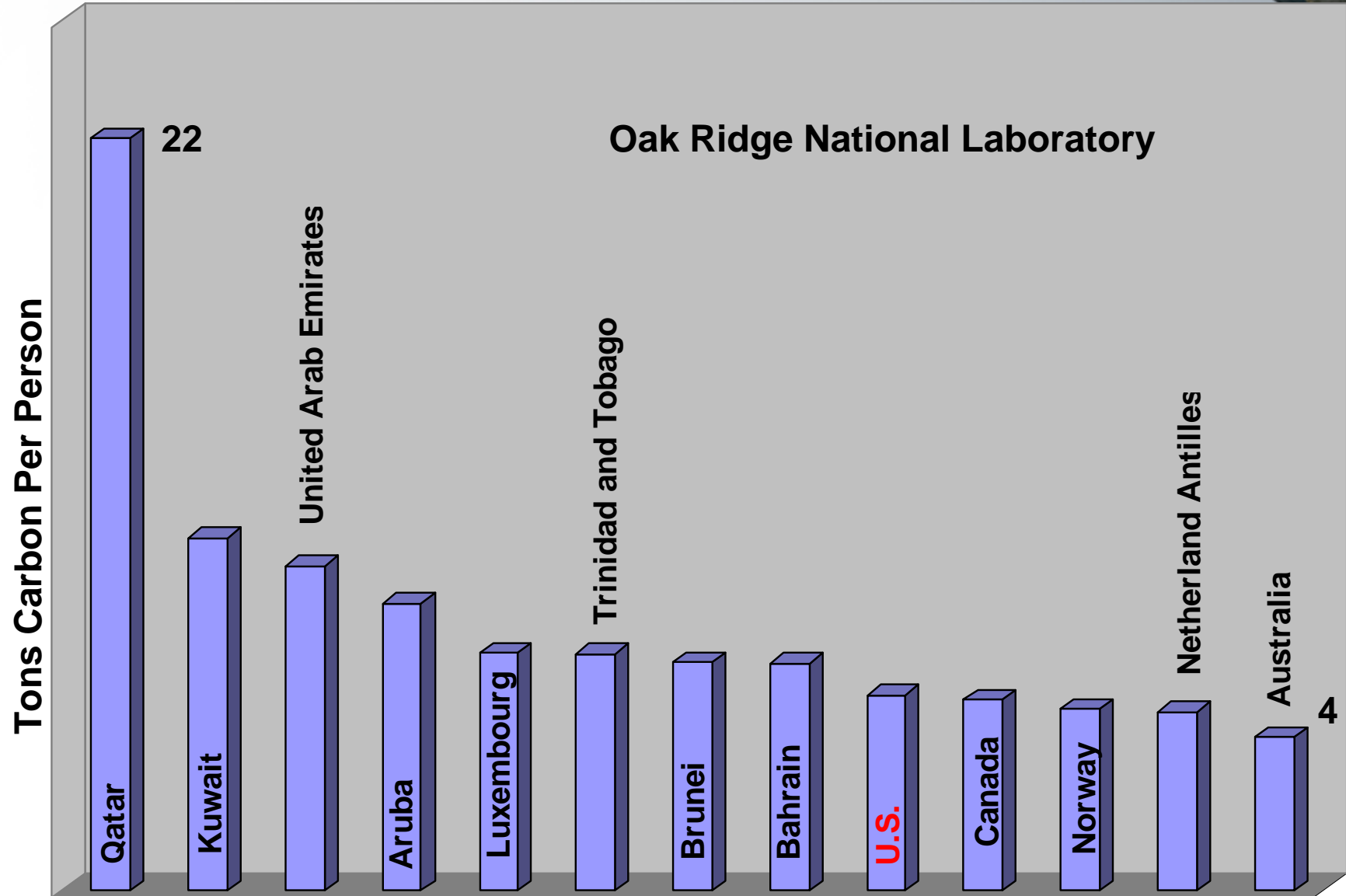
# International Emissions



# Top Emitters by Country

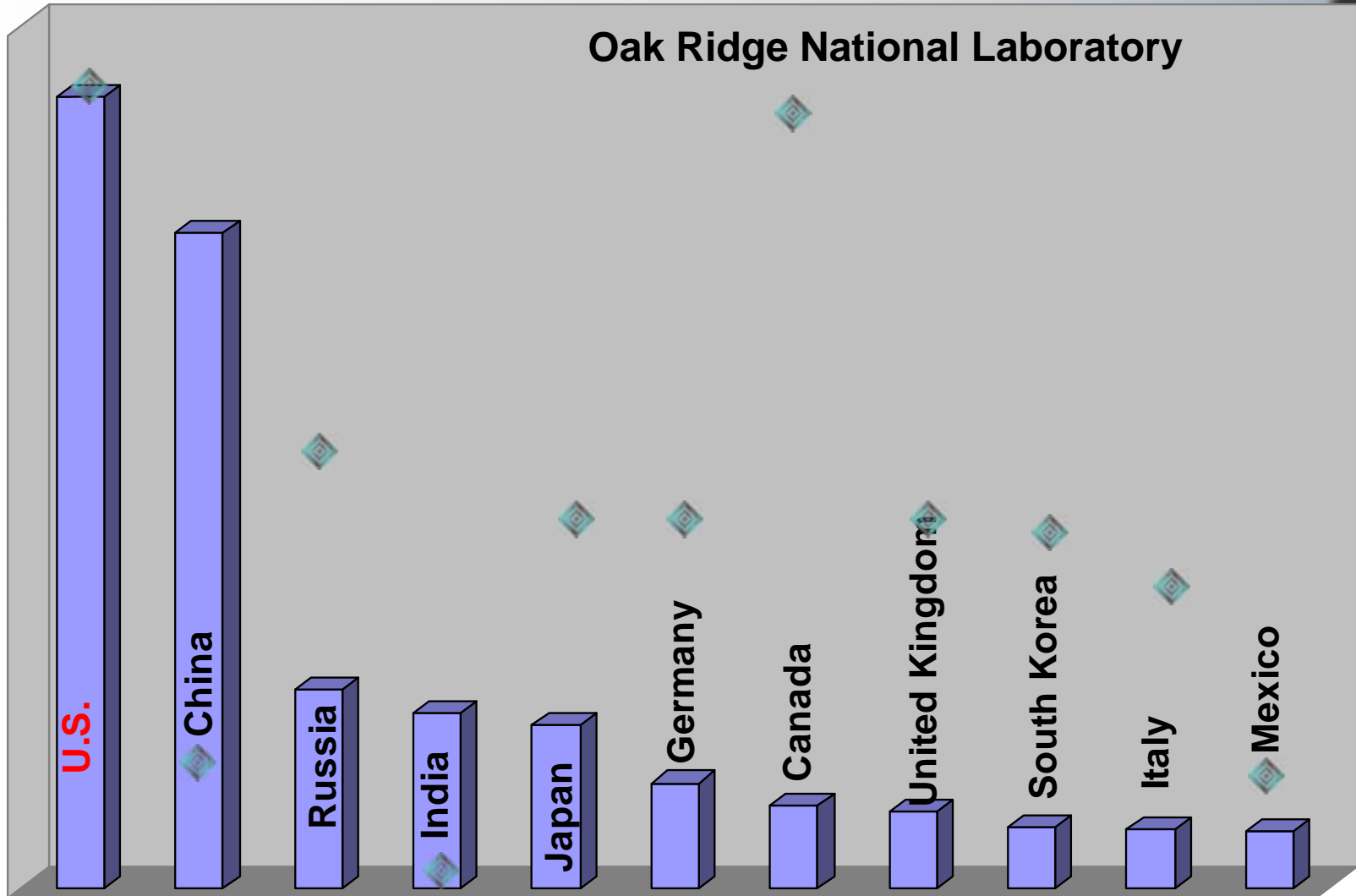


# Per Capita Emissions by Country





# Total + Per Capita Emissions by Country



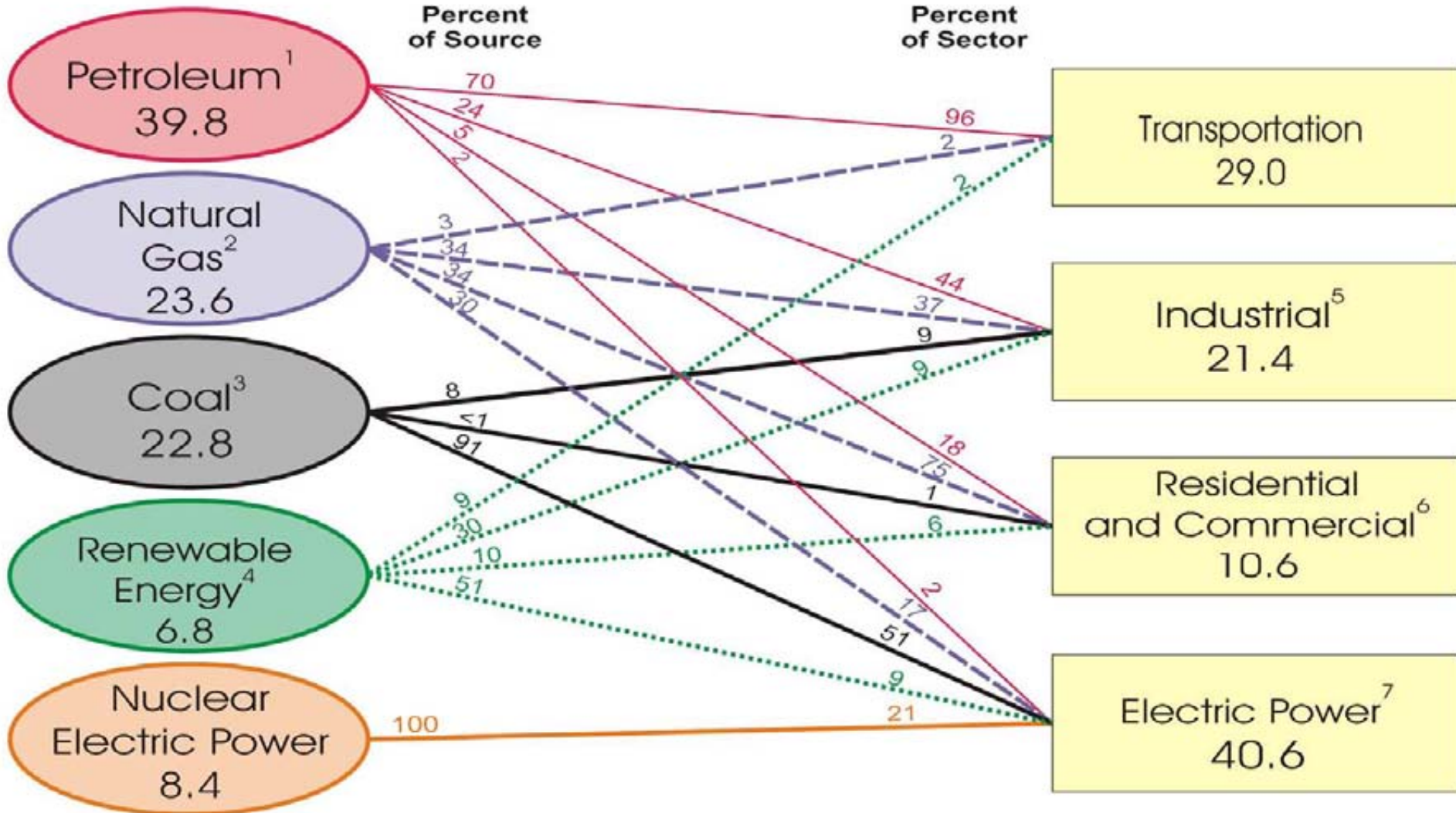


# Energy and Energy Consumption



# U.S. Primary Energy Consumption by Source and Sector, 2007

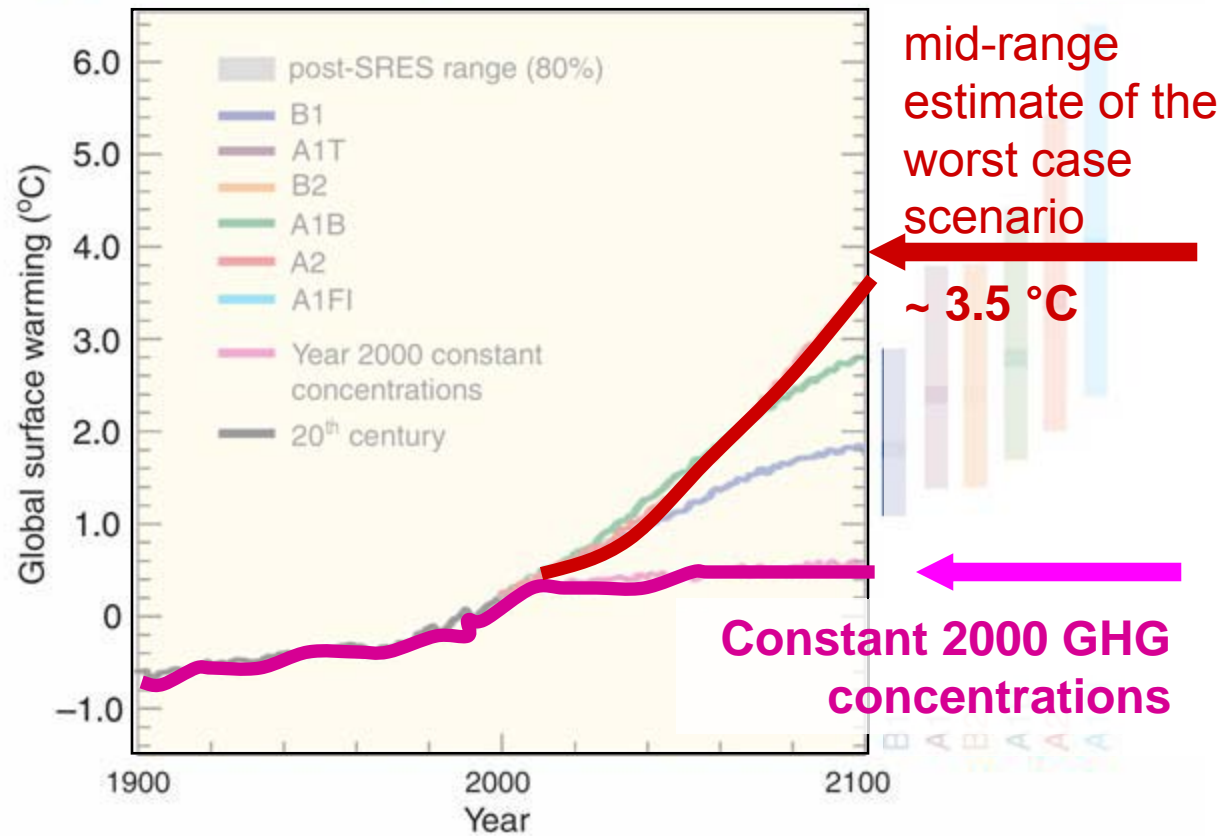
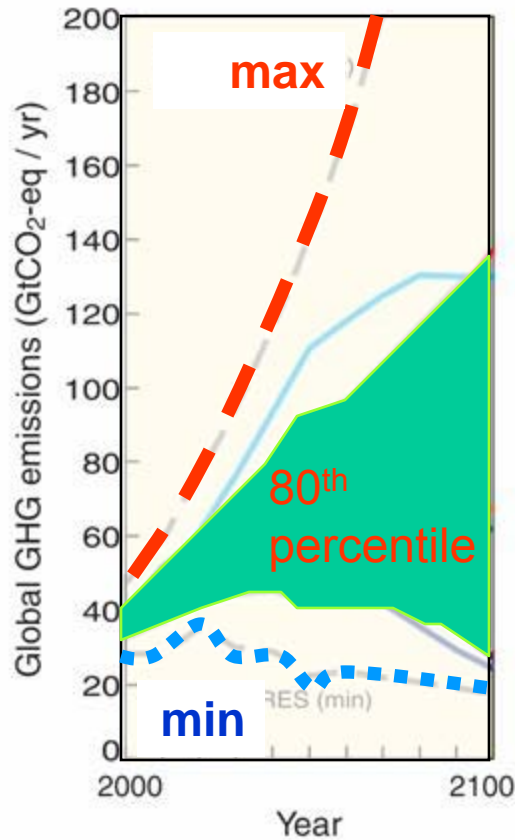
(Quadrillion Btu)



# Scenarios: GHG and °C



Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures





# Necessary Emission Reductions



<b>CO<sub>2</sub>-eq Levels in Atmosphere (ppm)</b>	<b>Average Global Temperature Increase (°C)</b>	<b>% Change in 2050 Compared to 2000 Emissions</b>
<b>445 – 490</b>	<b>2.0 – 2.4</b>	<b>-85 to -50</b>
<b>535 – 590</b>	<b>2.8 – 3.2</b>	<b>-30 to +5</b>
<b>855 – 1130</b>	<b>4.9 – 6.1</b>	<b>+90 to +140</b>

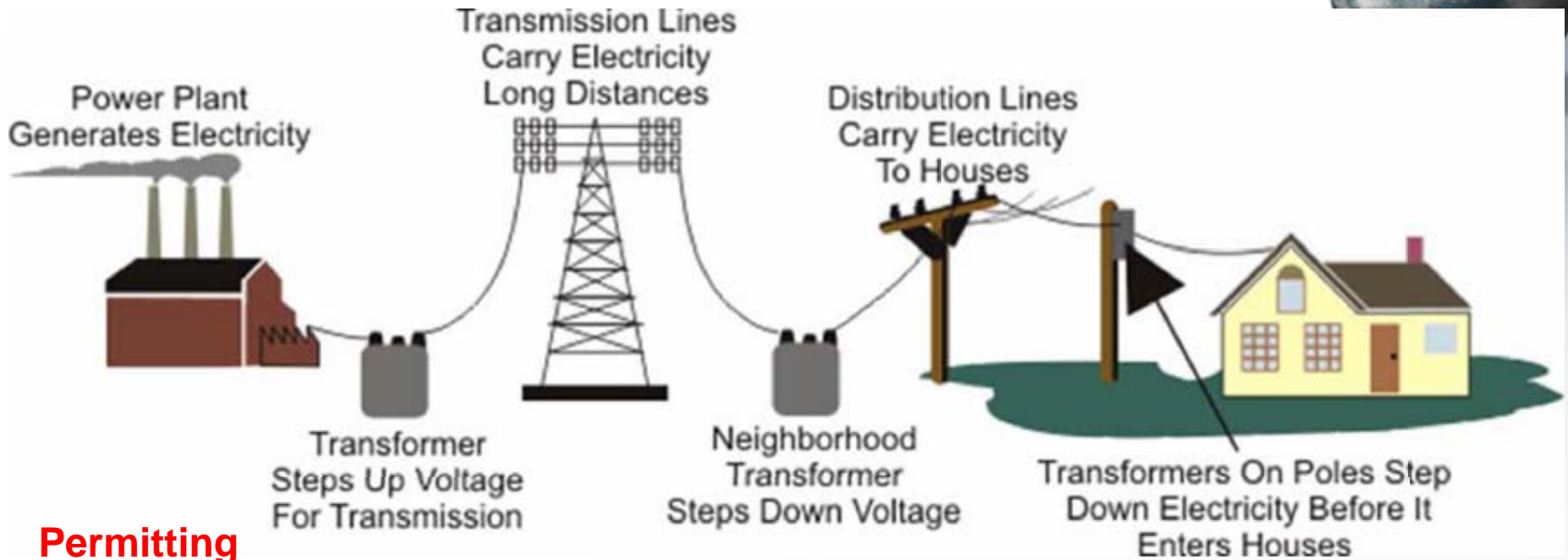
# Impacts Beyond Greenhouse Gas Emissions



- Air: Electricity is Source of
  - 67% of U.S. SO<sub>2</sub> Emissions
  - 23% of U.S. NO<sub>x</sub> Emissions
- Water: Electricity Consumes 3 Billion Gallons Per Day
- Land: 470,000 Petroleum Releases From Underground Storage Tanks



# Electricity Systems



**Permitting  
Enforcement  
Standards  
TRI**

**NEPA Reviews (Federal Land)  
Toxics (PCBs in Transformers)**

**??**

**Traditional Environmental Agency Role**

# Environmental Opportunities: Promotion of Clean Energy



- Energy Efficiency
- Combined Heat and Power
- Renewable Energy



Photo by Eric Vance



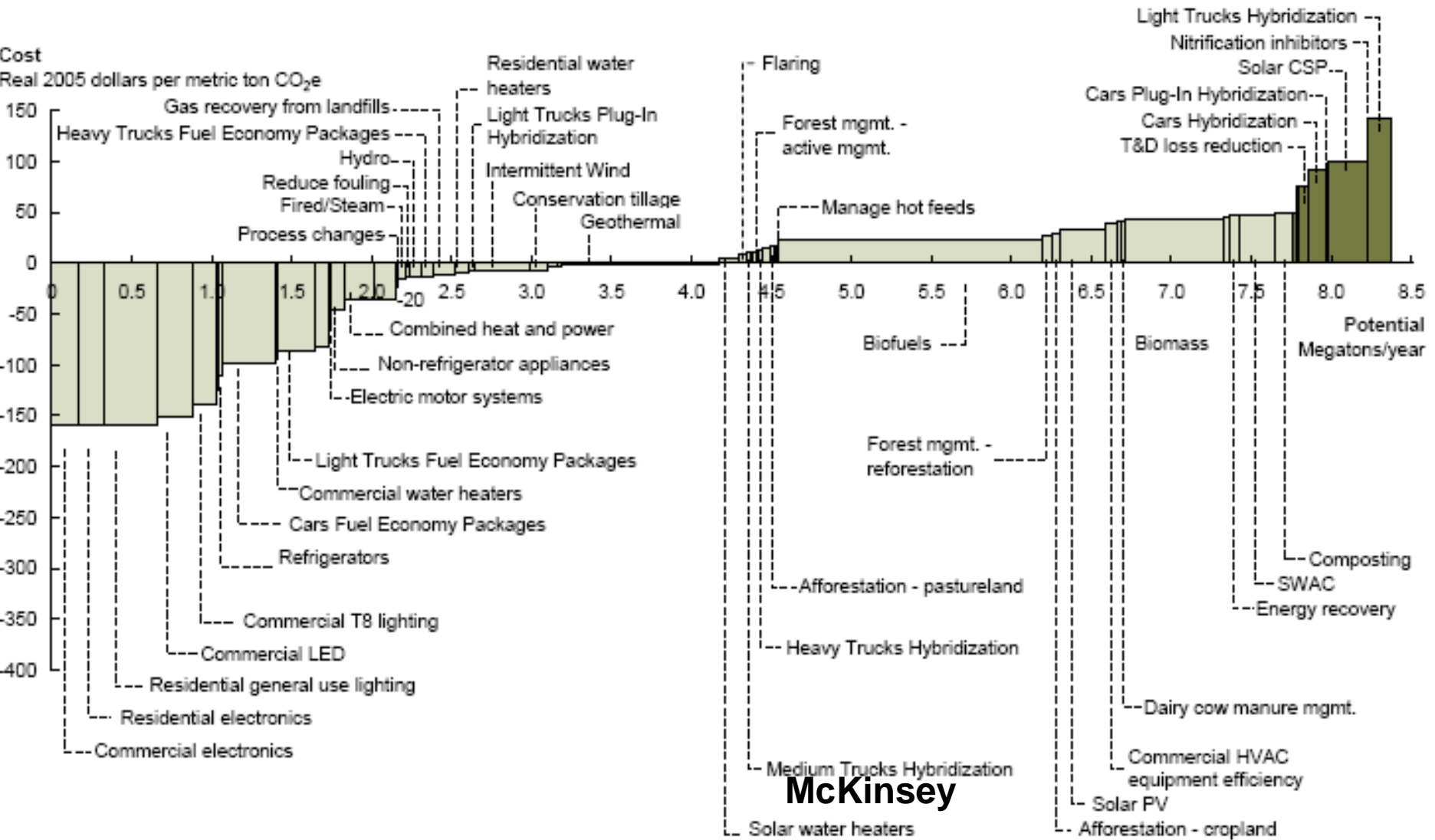
# Energy Efficiency



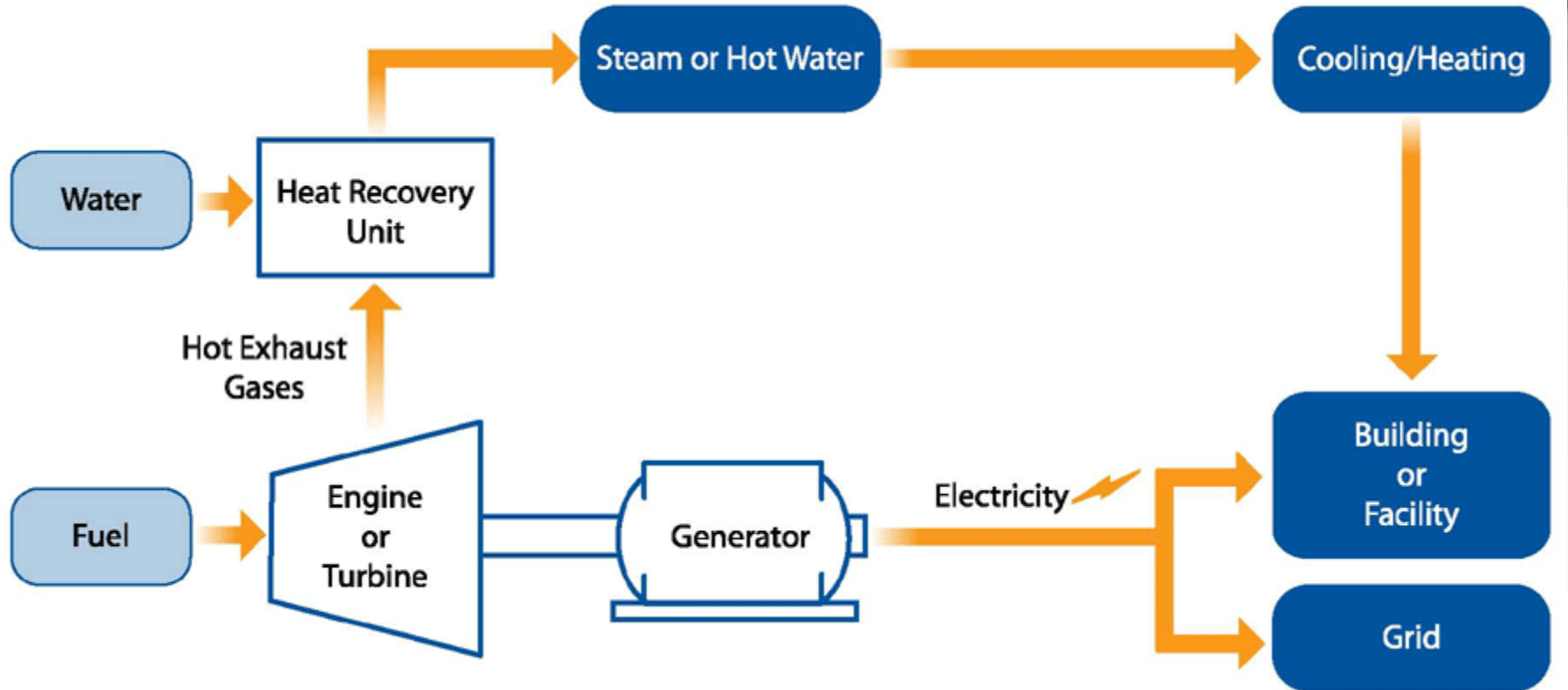
- Residential: Weatherization, Lighting, Appliances, Building Codes
- Commercial: Lighting, Cooling, Building Codes
- Industrial: Pumps, Lighting, Compressed Air
  
- Programs: EnergyStar, Save Energy Now!, Utilities



# Hawaii Cost Abatement Curve



# Combined Heat and Power



- Island Hotels
- DoE Grant Now Open: Deployment of CHP, District Energy, and Waste Energy Recovery Systems, [www.fedconnect.gov](http://www.fedconnect.gov)
- EPA: Combined Heat and Power Partnership

# Renewable Energy - Solar

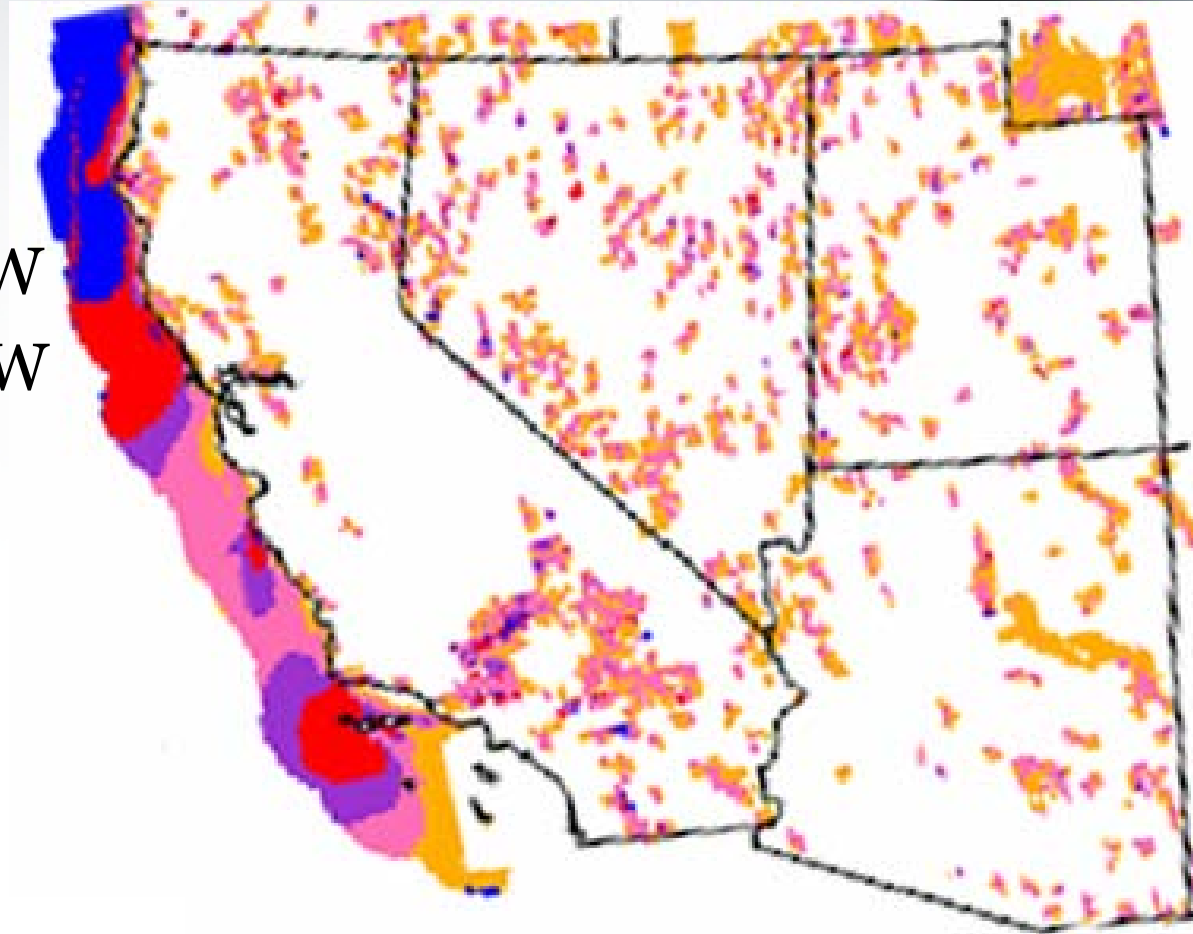
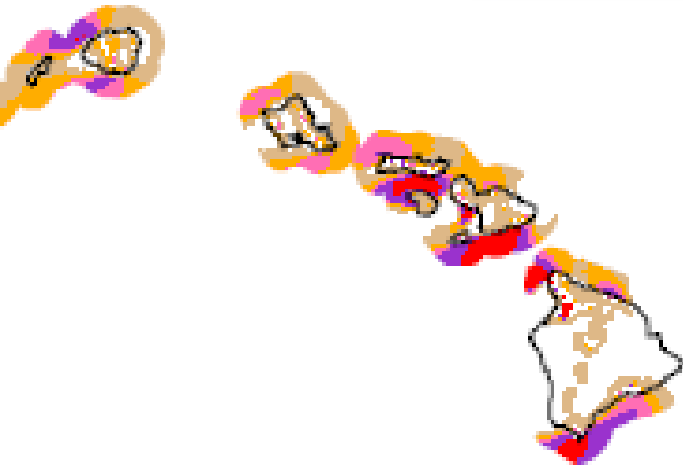


- Utility Scale Solar Thermal
  - Mojave Solar Park 553MW
- Photovoltaic
  - CA Solar Initiative:
    - Smaller Units: Up-Front Rebates (per watt)
    - Larger Units: Production Incentives (per kWh)
  - Federal: 30% Tax Credit
- Solar Heating, Solar Lighting

# Renewable Energy - Wind



- U.S. 2001: 3,900 MW
- U.S. 2005: 8,700 MW





# Other Clean Energy Opportunities



- **Biogas (Dairies, Landfills, Wastewater)**
- **Biomass (woody material, solid waste)**
- **Geothermal: 2,300 MW existing**
- **Wave/Tidal Energy: Study Development**



# Life Cycle Assessment



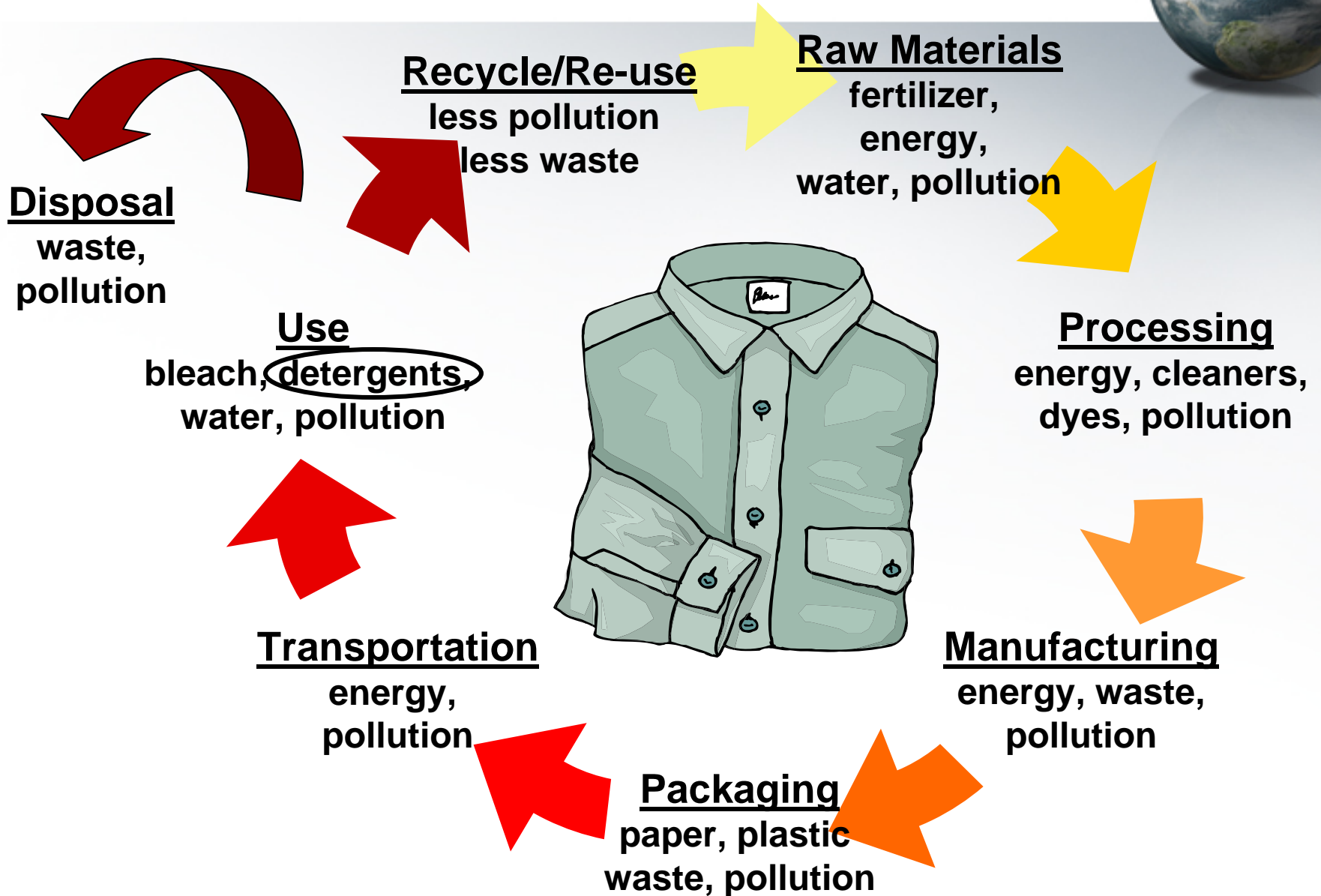
# Life Cycle Assessment



- **Quantify Total Environmental Impact**
- **Consider production, distribution, use, recycling, treatment, and/or disposal**
- **May include economic and/or environmental cost-benefit analysis**



# Life Cycle Inventory of a Shirt



# Inventory Analysis



GOAL DEFINITION AND SCOPE

INVENTORY ANALYSIS

INTERPRETATION

IMPACT ASSESSMENT

**Identify and quantify energy, water and materials usage, and environmental impacts.**

➤ **Inputs - materials, energy, chemicals**

➤ **Outputs - air and water emissions, solid waste**





# LCA Example: Romic East Palo Alto



- 14-acre hazardous waste management facility
- Soil and ground water contaminants are VOCs (such as TCE and PCE)
- Area of contamination to a depth of 80 feet

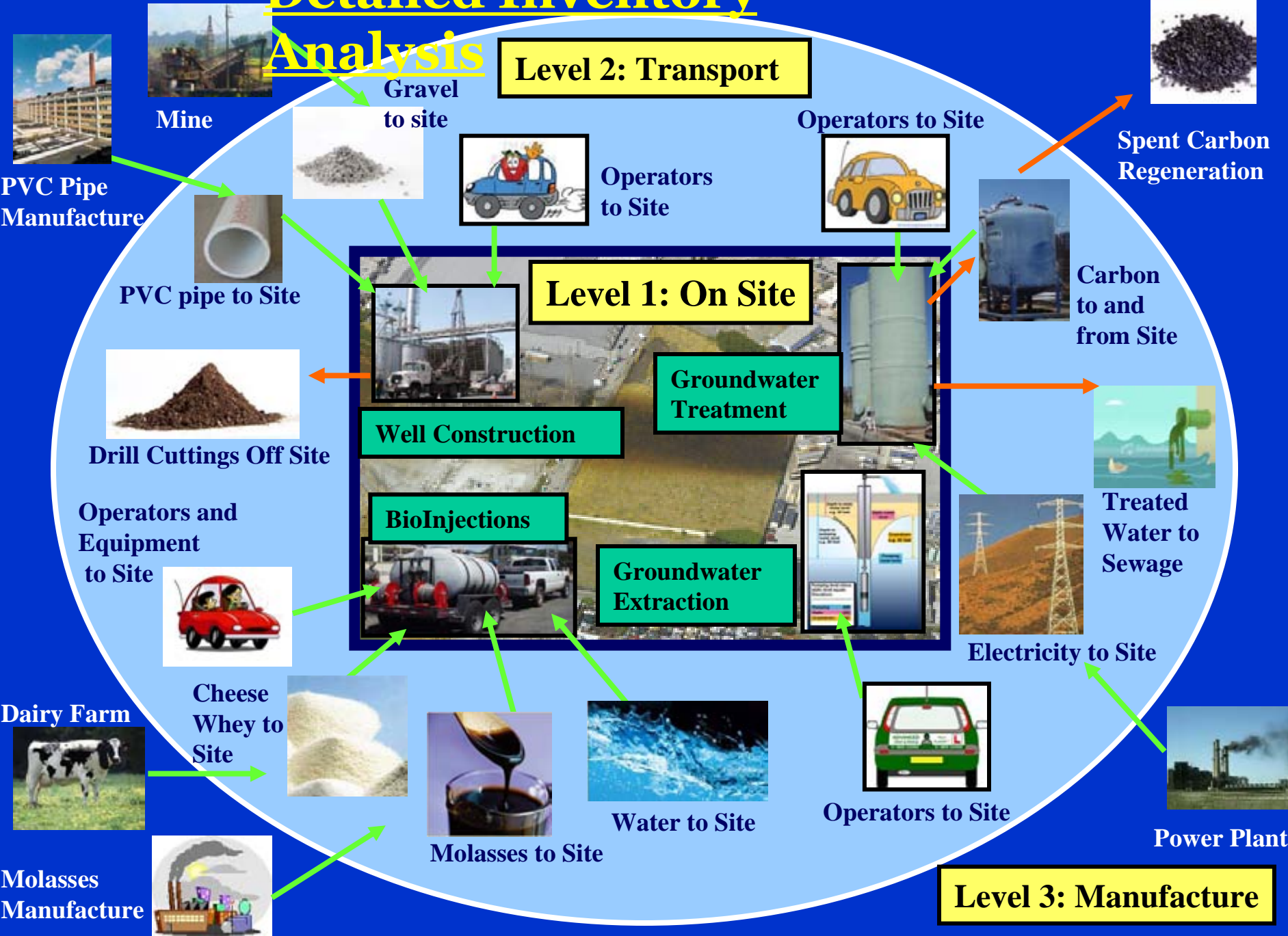


- LCA to compare the environmental effects of the 3 alternative remedies
  - Hybrid (bioremediation and P&T)
  - Bioremediation
  - Pump and Treat

# Detailed Inventory

## Analysis

### Level 2: Transport



# Life Cycle Analysis in Your Daily Life



- How do you choose products and services?
- Example: Not all water is created equal
  - Perrier Bottled Water
  - Fiji Bottled Water
  - Calistoga Bottled Water
  - Tap Water



- Example: PG&E Climate Smart
- Example: printing double sided (R9 reduced CO<sub>2</sub> emissions by 194,000 lbs/yr)



# What Can You Do?



# Saving Energy At Home



- Change Light Bulbs
  - Save \$30 Over Lifetime of Each Bulb
  - Uses 75 percent Less Energy
  - Lasts 10 Times Longer
- Look for the Energy Star Logo
  - Appliances
  - Heating and Cooling
  - Water Heaters

**(And Look for Rebates!)**



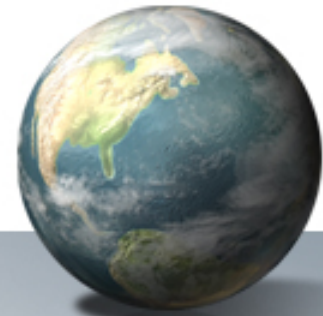


# More Savings At Home



- Heat and Cool Smartly
  - Clean Air Filters
  - Keep Equipment Tuned
- Seal and Insulate Your Home
  - Attic/Basement Air Leaks
  - Windows and Doors
  - Air Ducts
- Audit Your Energy Use  
(Home Energy Yardstick: [www.energystar.gov](http://www.energystar.gov))

# Even More Savings At Home

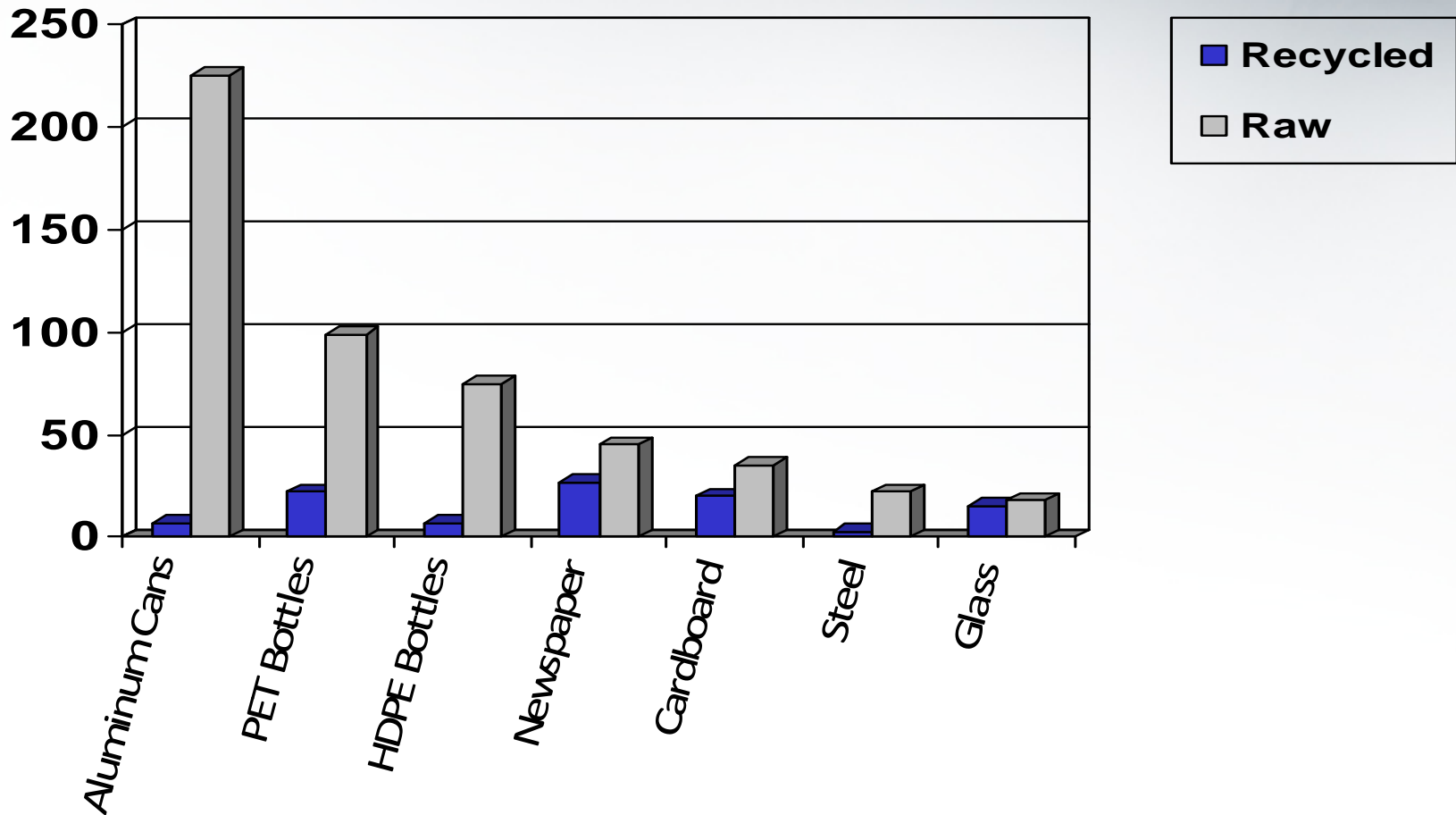


- Use Water Efficiently
  - Avoid Energy Needed to Move and Treat and Heat Water
  - Faucet Running For 5 Minutes = 60W Bulb On For 14 Hours
  - Look for WaterSense Label



- Recycle
  - Using Recycled Materials Avoids Energy Needed to Extract, Transport, and Process Raw Materials

# Energy Use: Recycled vs. Raw Content Products (Million BTUs/ ton)



# Impacts from the National Recycling Rate

32.5% recycled in 2006

**39 million  
cars off the road**



**22 million  
homes heated/  
year**



**50  
power plants  
avoided**



**400 million  
barrels of oil  
conserved**



# Saving Energy At The Office



- Manage Office Equipment Energy Use
  - Idle & Standby
  - Power Management Features
  
- Look for the Energy Star Logo
  - Computers
  - Copiers
  - Printers





# Saving Energy On The Road



- Buy Smart
  - EPA Clean Vehicle Guide  
<http://www.epa.gov/greenvehicles>
  - EPA/Department of Energy Fuel Efficiency Guide  
<http://www.fueleconomy.gov/>
- Drive Smart
  - Avoid Aggressive Driving: 5 – 33% Fuel Savings
  - Observe Speed Limit: 7 – 23% Fuel Savings
  - Reduce Idling (= 0 MPG)

# More Savings On The Road



- Vehicle Upkeep
  - Engine – 4% Fuel Savings
  - Tire Inflation – 3% Fuel Savings
- Remove Excess Weight From Vehicle



# Challenges



- Lack of detailed U.S. Territories GHG Emissions Data
- Development of Emissions Inventory
- Identify Reduction Areas/Opportunities and Establish Reduction Targets



# For More Information



Visit EPA's Climate Change Web site at  
<http://www.epa.gov/climatechange>

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