

Electric Power Sector GHG Emissions Inventory



*A Focused Technical
Discussion of the
Statewide Electric
Power Sector GHG
Inventory*

**April 10, 2007
Sacramento**

Discussion Topics

- Introduction & Opening Remarks
- Background & Fundamentals
- Current Power Sector Inventory Estimates & Methods
- Improving Emissions Estimates
- Next Steps

Objectives

- Clarify difference between statewide and facility or entity-level inventories
- Review current statewide estimate of power sector GHGs
- Discuss anticipated areas for improvement
- Solicit input from working group

Background

California Global Warming Solutions Act of 2006 (AB32)

- Provides mechanisms to reduce greenhouse gas (GHG) emissions
- ARB is the state agency charged with monitoring and regulating sources of GHG emissions

Background

AB32 Inventory Requirements

- ARB required to use the best available scientific, technological, and economic information available to determine the 1990 statewide emissions level
- Establish 2020 statewide GHG emissions equivalent to the 1990 level
- Presented for Board consideration by Jan 2008

Background

Current Statewide Inventory

- Compiled by California Energy Commission
- Statewide inventory to ARB in January 2007 (AB1803)
- Covers 1990-2004 time series
- Top-Down (*Most sources fall here*)
 - Aggregated by industry
 - Based on national, regional, or state-level data
 - Surrogates used to scale to smaller area
- Bottom-Up (*In-State Electric Power data*)
 - Based on emissions data from individual sources
 - Facility specific
- Current approach is a mix of both Top-Down and Bottom-Up methods, but emissions based on the Top-Down method account for most of the inventory

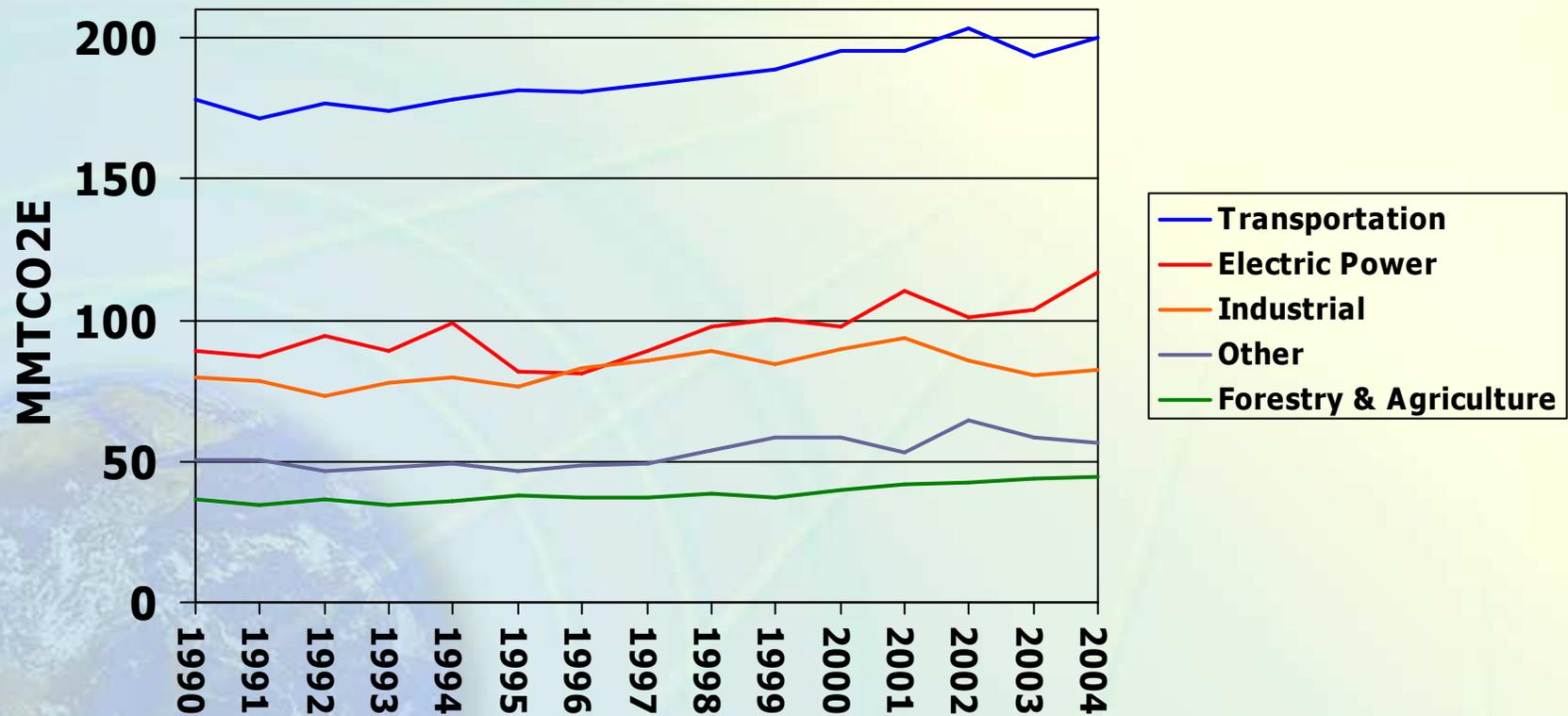
Background

Time Series Reporting

- Sequence of years beginning with 1990
 - Shows emission trends
 - Track the effect of reduction strategies over time
 - Comparable estimation methods across all years

Background

GHG Emissions Trend by Sector



Source: California Energy Commission; Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004

Background

2020 Emissions Limit

- Based of statewide emissions total
 - Aggregate of all sectors
 - Equivalent to 1990 statewide level
- 2020 forecast from energy, process projections
 - Current 1990-2020 difference: 174 MMTCO₂e*
 - Gap between 1990 and 2020 may change

**Source: March 2006 CAT Report*

Emissions Estimation Methods

- **Combustion Emissions (85% of total GHG emissions):**
 - Source Examples: Industrial fuel use; transportation
 - *Fuel Use x Heat Content x Oxidation x Emission Factor x GWP*
 - *Emission Models*
- **Fugitive Emissions (12% of total):**
 - Source Examples: Natural gas pipeline leaks; landfills; livestock
 - *Activity Data x Emission Factor x GWP*
 - *Mass Balance*
- **Process Emissions (3% of total):**
 - Source Examples: Cement production; nitric acid production
 - *Activity Data x Emission Factor x GWP*
 - *Process Models*

Emissions Uncertainties

■ **Combustion Emissions:**

- Uncertainty in fuel consumption, fuel heat content, and carbon content

■ **Fugitive Emissions:**

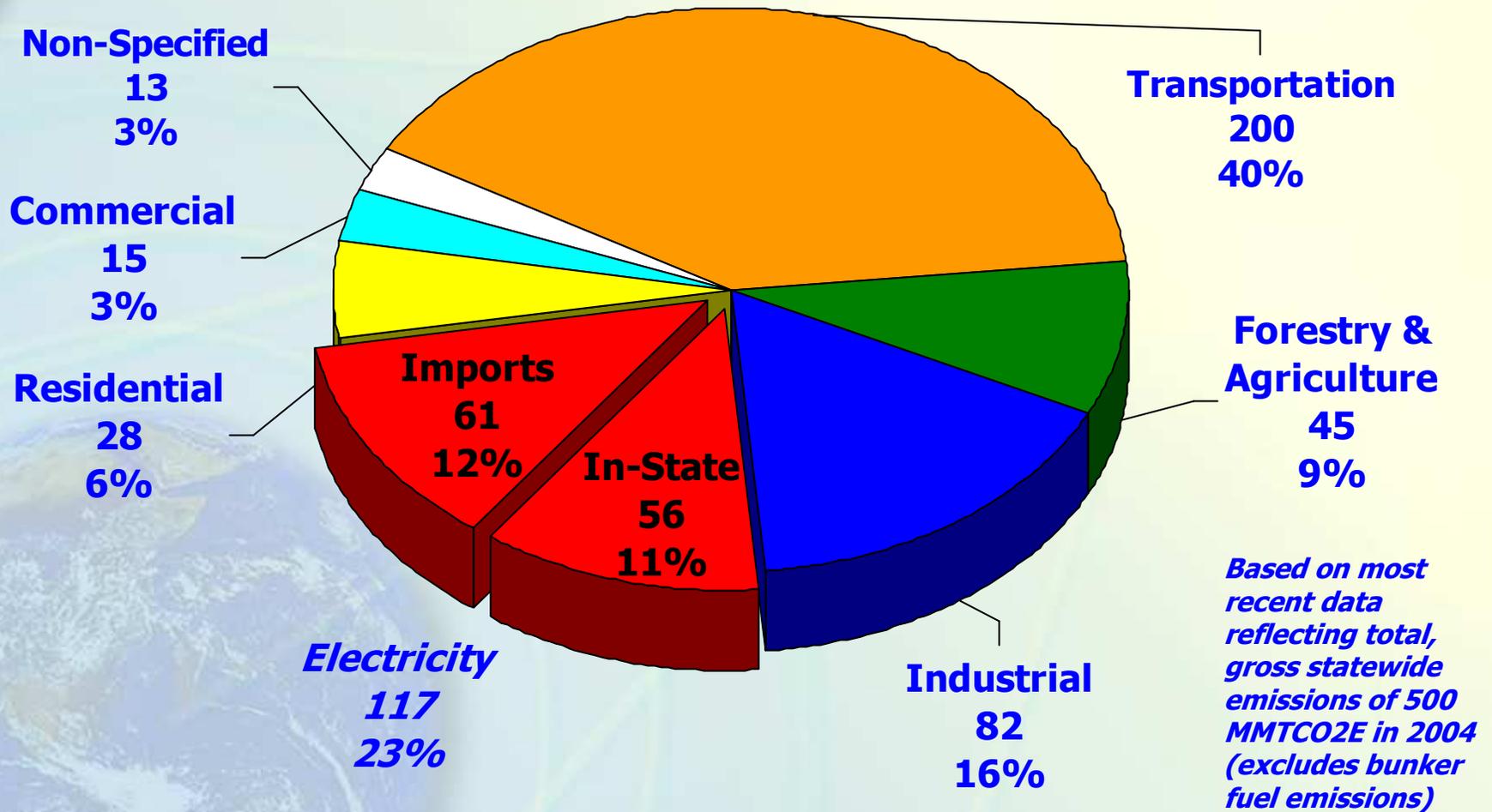
- Uncertainty in estimations vary by method (e.g., mass balance for determining SF₆ from electrical insulation)
- Uncertainty with measured losses, throughput, etc.

■ **Process Emissions:**

- Uncertainty varies by category estimation method (calculation v. process models)
- Measured uncertainty with reported raw material data or modeled data (e.g., model inputs)

Current Estimates

Sources of California's GHG Emissions in 2004



Source: California Energy Commission; Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004

Current GHG Emissions from Electric Power Sector

- CO₂ from fuel combustion
- CH₄ and N₂O from fuel combustion
- SF₆ from transmission & distribution

Electric Power Sector Inventory Estimate (In-State)

- In-state electricity generation emissions currently estimated using EIA data
- Emissions are categorized by Fuel (Natural Gas, Coal and Petroleum) and subcategorized by Generator (Utility, Industrial, Commercial, etc.)
- Heat content of fuels used reported by each generator

Electric Power Sector Inventory Estimate (Imported)

- Approach for current imported electricity emissions
 - Determine MWhrs imported from each region (Pacific SW, Pacific NW or out of state Utility Owned Coal Plants-Mohave & Intermountain Power)
 - Determine average fuel mix from each region
 - Determine average heat rate (10,000 BTU/kW currently used)
 - Ignore line losses
 - Determine SF₆ emissions associated with imported power
- CH₄ and N₂O emissions are currently ignored for imports

Current Methods

Electric Power Sector CO₂ Calculation

- CO₂ (MMTCO₂E) =
Fuel Combustion Heat (MMBTU) x
Percent Oxidation x
EF (lb/MMBTU) x
4.54 x 10⁻¹⁰ MMT/lb
 - Fuel Combustion Heat = Fuel Used x Heat Content of Fuel
 - Percent Oxidation: 99% for coal and fuel oils (residual or distillate/diesel) and 99.5% for natural gas and all other gaseous fuels
 - Emission Factors based on fuel type – *Source: IPCC*
 - Natural Gas (117.0 lbs CO₂/MMBTU)
 - Distillate (161.3 lbs CO₂/MMBTU)
 - Coal (208.2 lbs CO₂/MMBTU)

Current Methods

Electric Power Sector CH₄ & N₂O Calculation

- CH₄ or N₂O (MMTCO₂E) =
Fuel Combustion Heat (MMBTU) x
Global Warming Potential x
EF (lb/MMBTU) x
4.54 x 10⁻¹⁰ MMT/lb
- Fuel Combustion Heat = Fuel Used x Heat Content of Fuel
- GWP: 21 for CH₄ and 310 for N₂O – *Source: SAR (IPCC)*
- EF: is based on fuel type (lb/MMBTU) – *Source: IPCC*
 - Natural Gas (0.0002-N₂O, 0.0023-CH₄)
 - Petroleum (0.0014-N₂O, 0.0070-CH₄)
 - Coal (0.0033-N₂O, 0.0023-CH₄)
 - Wood (0.0093-N₂O, 0.0679-CH₄)

Current Methods

Electric Power Sector SF₆ Calculation

- SF₆ (MMT/CO₂E) =
MWhrs Consumed (in state) x
SF₆ emissions (nationwide lbs) /
MWhrs Consumed (nationwide) x
Global Warming Potential x
4.54 x 10⁻¹⁰ MMT/lb
 - MWhrs Consumed (in state) – *Source: CEC*
 - MWhrs Consumed (nationwide) – *Source: EIA*
 - SF₆ Emissions (nationwide lbs) – *Source: USEPA*
 - GWP: 23,900 for SF₆ – *Source: SAR (IPCC)*

Draft Electric Power Sector Inventory Improvements (In-State)

- Improve Combined Heat & Power (CHP) calculations by determining heat exported (i.e., any heat not used for electricity generation)
- Improve SF₆ emission estimates by using California-specific data from transmission line owners

Improved Estimates

Draft Electric Power Sector Inventory Improvements (Imported)

- Improve fuel-mix assumptions for Pacific Northwest and Pacific Southwest imports
 - Obtain known generation sources where available (e.g., specified contracts)
 - Obtain utility fuel-mix when power is delivered from a known out-of-state utility but specific generating unit is unknown
 - Improve estimates of system fuel-mix for all other unspecified imports where neither generating unit nor utility is known
- Update heat rate assumptions
 - Use actual heat rate when generation source is known
 - Use average utility heat rate when specific unit is unknown but power is delivered by a known out-of-state utility
 - Use average system heat rates for all other imports when both unit and utility are unknown

Draft Electric Power Sector Inventory Improvements (Imported) – *Cont.*

- Factor in “Line Losses” for electricity imports
 - Required under AB32 definition of statewide greenhouse gas emissions
- Include CH₄ and N₂O emissions from combustion associated with imported power
- Include CH₄ emissions from coal storage
- Include CO₂ from the control of SO_x emissions from coal (associated with the use of dolomite to control SO_x)

Electric Power Sector Emissions Inventory Contacts

Richard Bode – Chief
Emission Inventory Branch
rbode@arb.ca.gov
(916) 323-8413

Webster Tasat – Manager
Emission Inventory Analysis Section
wtasat@arb.ca.gov
(916) 323-4950

Larry Hunsaker – Staff Contact
Emission Inventory Analysis Section
lhunsake@arb.ca.gov
(916) 324-7168

ARB Climate Change Info.: www.arb.ca.gov/cc/cc.htm