
# Estimating Greenhouse Gas Emissions from Electricity Consumption: EPA's New SIT Module

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# Overview

State Climate and Energy Program

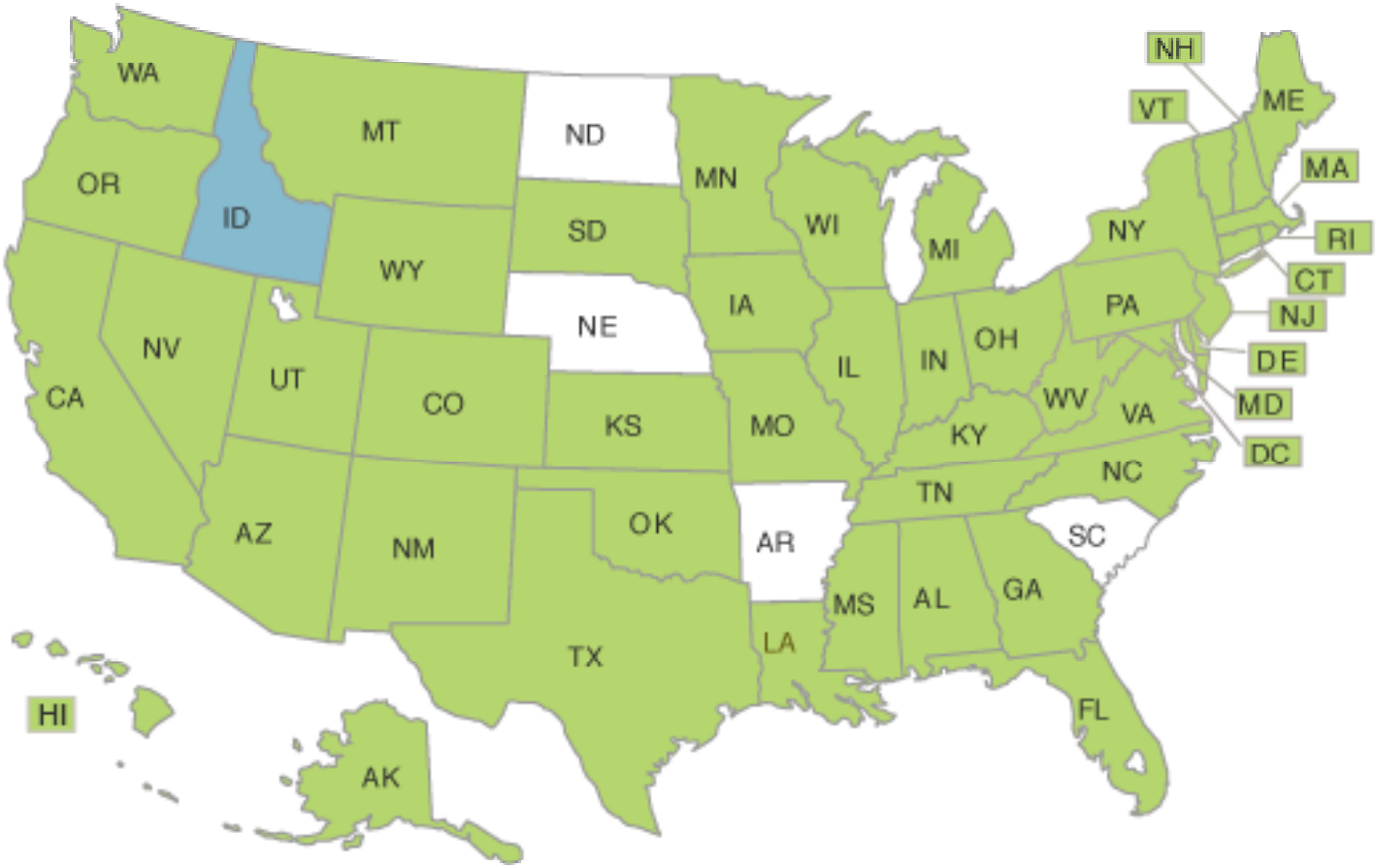
- What is the State Inventory Tool?
- How are Electricity Consumption Emissions Estimated?
  - Overview
  - Activity Data
  - Emission and Transmission Loss Factors
- How are Results Displayed?

# State Inventory Tool Background


- EPA's State and Local Program began in 1990s
- Developed the *State Workbook* for estimating state GHG emissions; later became Vol. VIII EIIP
- Inventories are time-intensive
  - Collecting the data
  - Identifying the correct emission factors
  - Setting up the infrastructure to calculate emissions
- Inventories for a single year in the 1990s are insufficient for mitigation planning in 2010
- Trends are a necessity: projecting emissions, identifying and prioritizing mitigation activities, setting targets, and creating action plans

# State Inventory Tool Background

State Climate and Energy Program



# Sector Modules

State Climate and Energy Program

- $CO_2$ from Fossil Fuel Combustion
- $CH_4$ and $N_2O$ from Stationary Combustion
- $CH_4$ and $N_2O$ from Mobile Combustion
- Natural Gas and Oil Systems
- Coal Mining
- Industrial Processes
- Agriculture
- Municipal Solid Waste
- Wastewater
- Land-Use Change and Forestry
- Electricity Consumption Module

# Electricity Consumption Module Overview


- Calculates *indirect* GHGs from electricity consumption
- Categorized into 4 main end-use sectors: industrial, transportation, residential, commercial
  - Activity data from publicly available resources
- Uses eGRID emission and transmission loss factors

***Indirect Electricity Emissions = Total State Consumption (kWh) × End-Use Equipment Consumption (%) × [Emission Factor (lbs $CO_2E$/kWh) × (1+ Transmission Loss Factor (%))]***

# Electricity Consumption Module Overview


- Direct vs. indirect GHG emissions
  - Direct emissions: combustion of fossil fuels at the electricity generating station
  - Indirect emissions: attributed to the point of use (e.g., residential electricity consumption), include transmission and distribution losses
- EPA encourages states to:
  - Include direct emissions in inventory totals
  - Include indirect emissions as a separate line item
    - To inform potential mitigation actions
    - To avoid double counting

# Electricity Consumption Module: Activity Data


- Input cells for total electricity consumption
  - Total consumption, by sector (residential, commercial, transportation, industrial)
  - Total consumption disaggregated to end-use equipment
  - Default data from EIA's State Energy Data System

*Indirect Electricity Emissions = **Total State Consumption (kWh)** × End-Use Equipment Consumption (%) × [Emission Factor (lbs $CO_2E$/kWh) × (1+ Transmission Loss Factor (%))]*

# Electricity Consumption Module: Activity Data


- Input cells for end-use equipment type, by sector
- Default data from publicly available resources
  - Residential, commercial, industrial: EIA surveys (RECS, CBECS, and MECS)
  - Transportation: Federal Transit Administration's National Transit Database (NTD)
- Regional consumption percentages for end-use equipment assigned to states

*Indirect Electricity Emissions = Total State Consumption (kWh) ×* ***End-Use Equipment Consumption (%)*** *× [Emission Factor (lbs $CO_2E$/kWh) × (1+ Transmission Loss Factor (%))]*

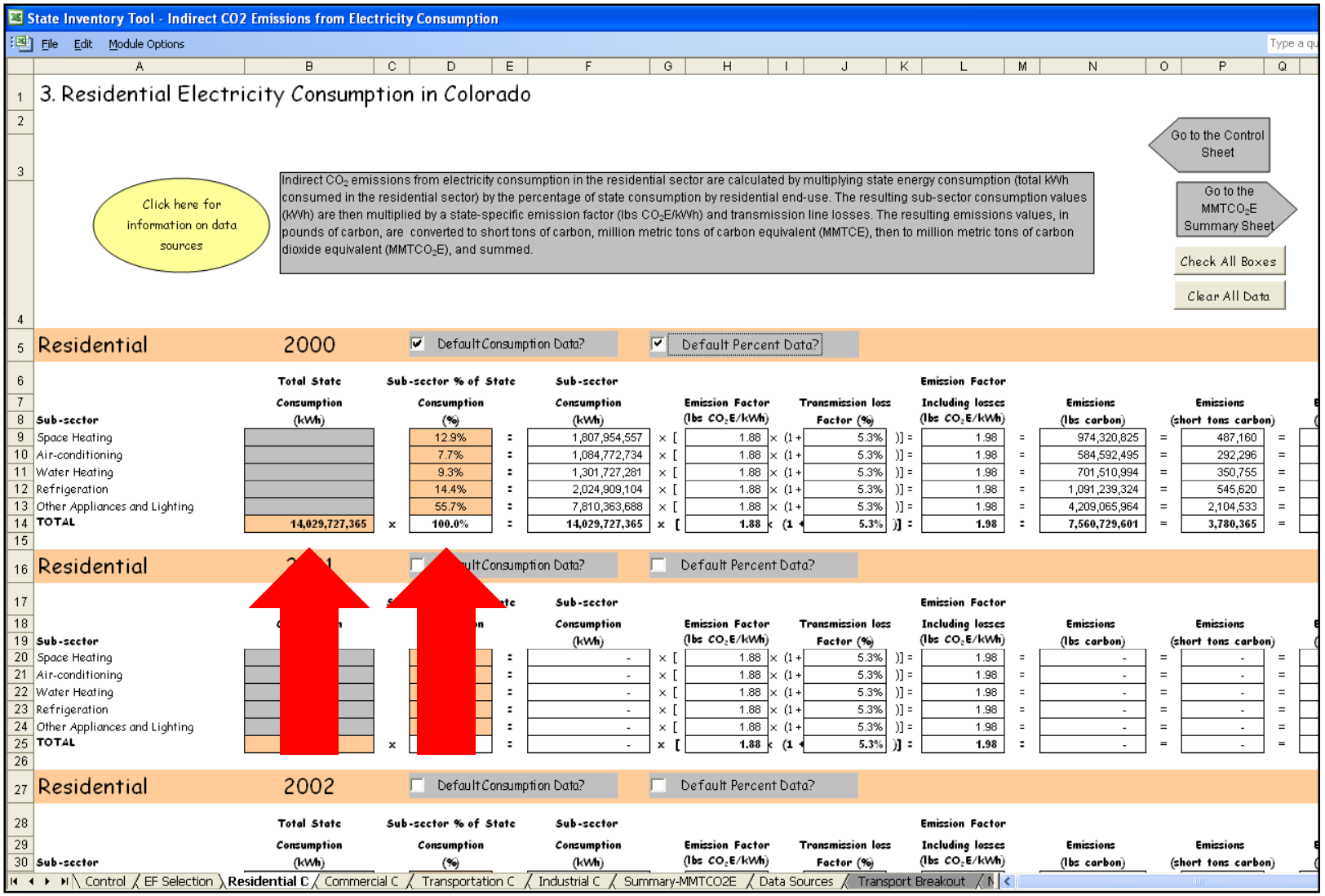
# Electricity Consumption Module: Activity Data

State Climate and Energy Program

| Sector | End-Use Equipment | |
|---|---|---|
| **Residential** | • Space Heating<br>• Air-conditioning<br>• Water Heating | • Refrigeration<br>• Other Appliances and Lighting |
| **Commercial** | • Space Heating<br>• Cooling<br>• Ventilation<br>• Water Heating<br>• Lighting | • Cooking<br>• Refrigeration<br>• Office Equipment<br>• Computers<br>• Other |
| **Industrial** | **Indirect Uses- Boiler Fuel**<br>• Conventional Boiler Use<br>• CHP and/or Cogeneration Process<br>**Direct Uses- Total Process**<br>• Process Heating<br>• Process Cooling and Refrigeration<br>• Machine Drive<br>• Electro-Chemical Processes | • Other Process Use<br>**Direct Uses- Total Nonprocess**<br>• Facility HVAC<br>• Facility Lighting<br>• Other Facility Support<br>• Onsite Transportation<br>• Other Nonprocess Use |
| **Transportation** | • Automated Guideway<br>• Bus (charged batteries)<br>• Cable Car<br>• Commuter Rail<br>• Heavy Rail | • Inclined Plane<br>• Light Rail<br>• Trolleybus<br>• Other |

# Electricity Consumption Module: Activity Data

State Climate and Energy Program



# Electricity Consumption Module: Electricity and Transmission Loss Factors

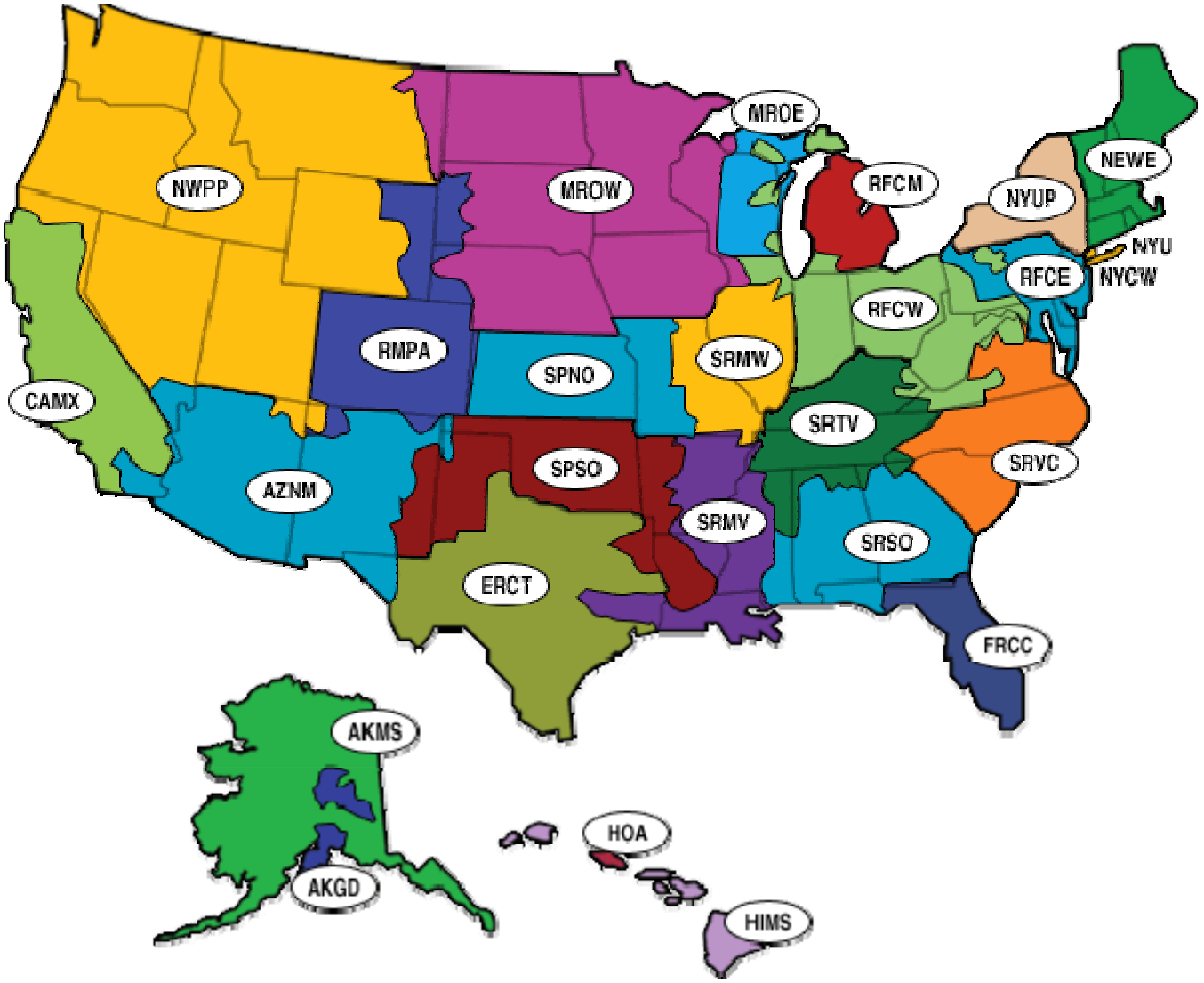
- Input cells for emission and transmission loss factors
  - Default state emission and transmission loss factors from EPA's Emissions & Generation Resource Integrated Database (eGRID)
  - Emission factor: plant-specific factors for U.S. electricity generating plants providing power to the electric grid
  - Transmission loss factor: accounts for transmission and distribution losses between the point of generation and the point of consumption

*Indirect Electricity Emissions = Total State Consumption (kWh) × End-Use Equipment Consumption (%) ×* ***[Emission Factor (lbs $CO_2E$/kWh) × (1+ Transmission Loss Factor (%))]***

# Electricity Consumption Module: Electricity and Transmission Loss Factors

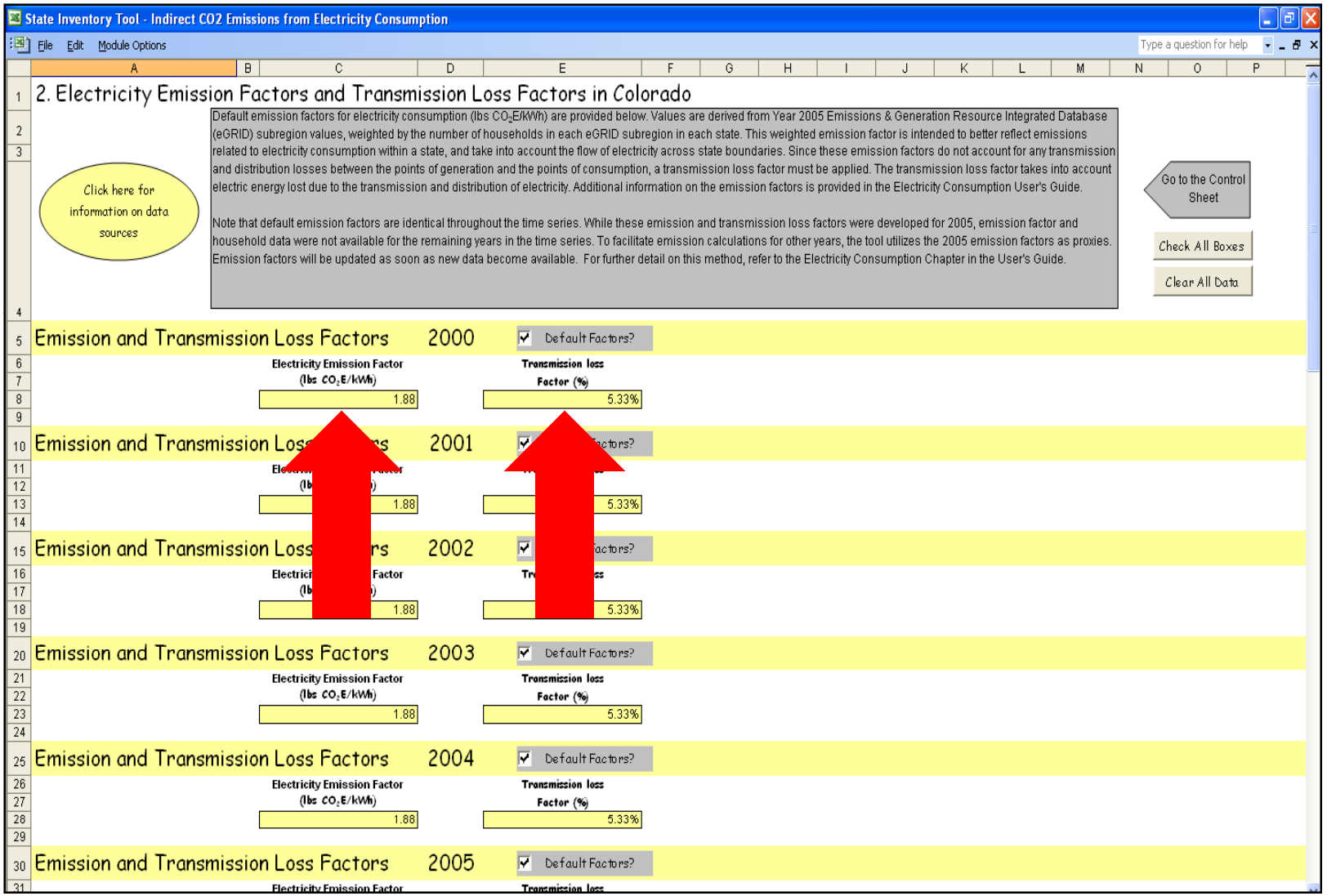
- Electricity emission factors (lbs $CO_2E$/kWh)
- Derived from 2005 eGRID subregion values
- Weighted by the number of households in each eGRID subregion in each state
  - To reflect emissions related to electricity consumption in a state
  - To account for the flow of electricity across state boundaries

# Electricity Consumption Module: Electricity and Transmission Loss Factors



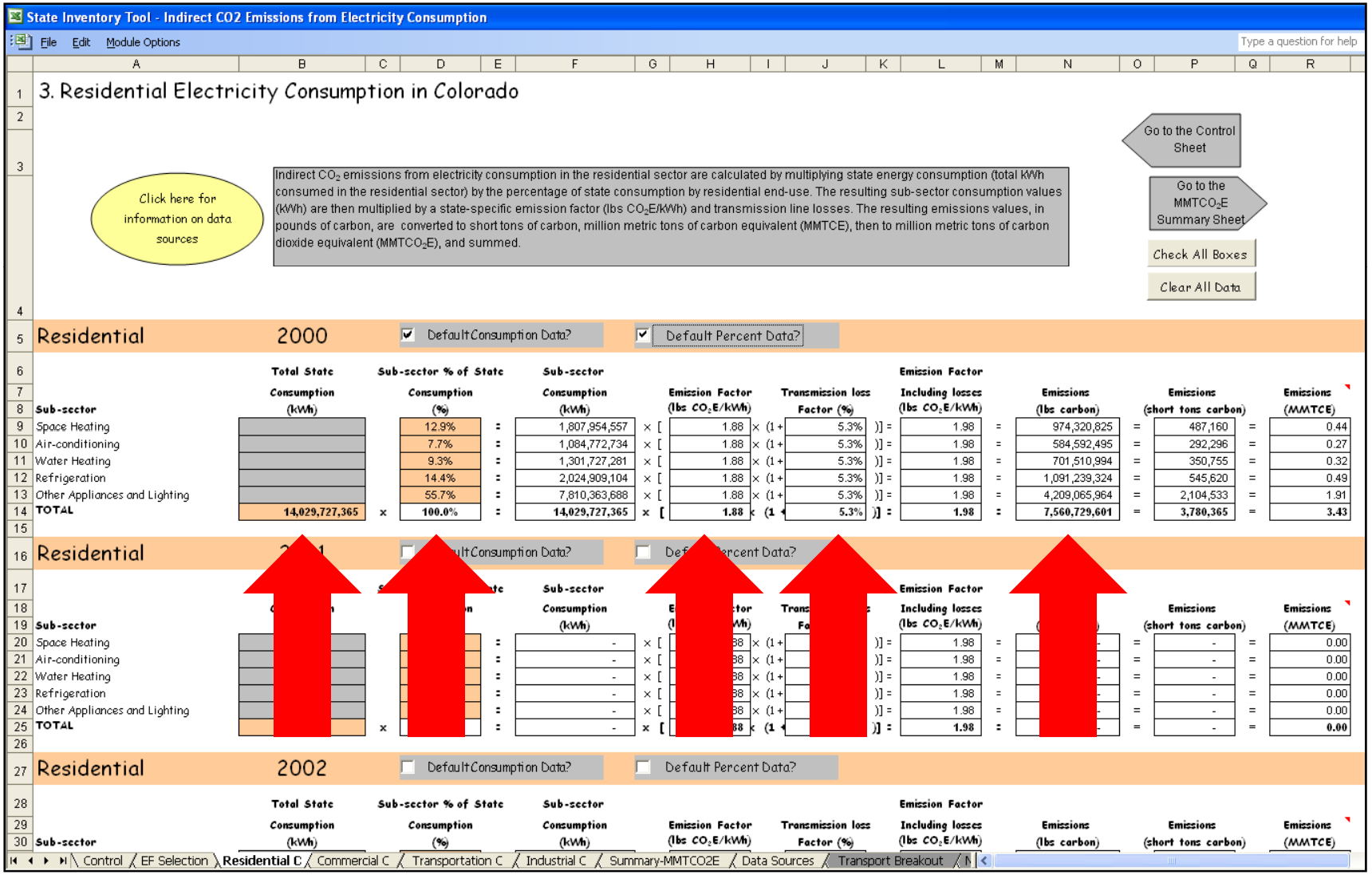
# Electricity Consumption Module: Electricity and Transmission Loss Factors

State Climate and Energy Program



# Electricity Consumption Module: Estimating Emissions

State Climate and Energy Program



# Electricity Consumption Module: Applications

State Climate and Energy Program

- Increases in EE funding
  - Total budgets for EE programs: $3.4 billion in 2009
  - States need to develop innovative program designs
- Analyze the GHG impact of EE efforts using the Electricity Consumption Module
  - To track decreased electricity consumption from EE programs and improved building codes
  - To illustrate the relationship between GHG emissions and EE funding

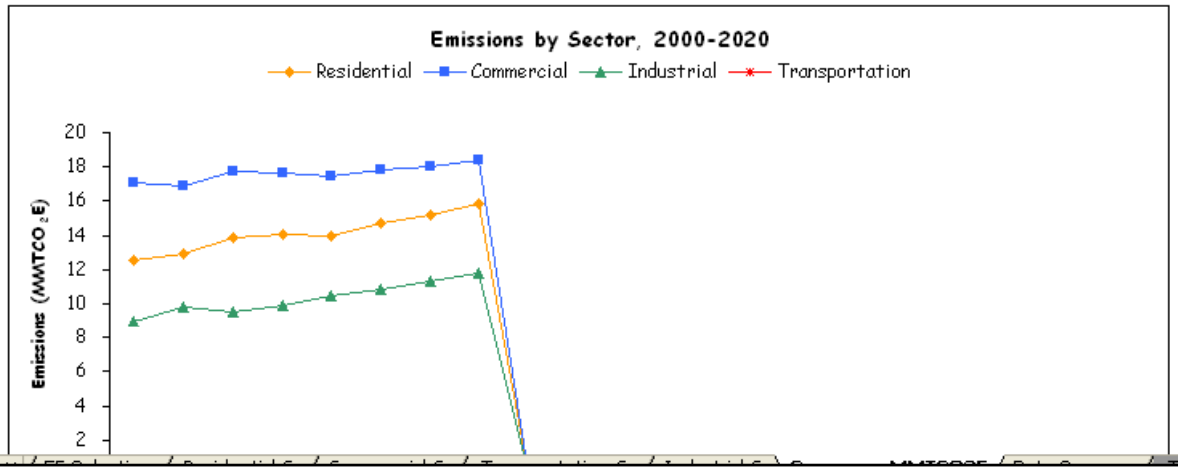
# Electricity Consumption Module: Summary Worksheet

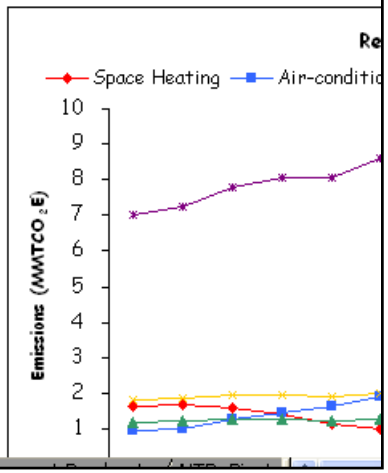
State Climate and Energy Program

## 7. Colorado Emissions Summary (MMTCO2E)

Go to the Control Sheet

| $MMTCO_2E$ | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 12.57 | 12.97 | 13.83 | 14.09 | 13.92 | 14.73 | 15.19 | 15.81 | - | - | - | - | - | - |
| Commercial | 17.06 | 16.88 | 17.75 | 17.62 | 17.48 | 17.79 | 18.06 | 18.38 | - | - | - | - | - | - |
| Industrial | 8.92 | 9.79 | 9.57 | 9.93 | 10.47 | 10.80 | 11.30 | 11.75 | - | - | - | - | - | - |
| Transportation | 0.01 | 0.01 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.04 | - | - | - | - | - | - |
| **TOTAL** | **38.56** | **39.65** | **41.18** | **41.68** | **41.88** | **43.34** | **44.58** | **45.98** | **-** | **-** | **-** | **-** | **-** | **-** |
| Residential | 12.57 | 12.97 | 13.83 | 14.09 | 13.92 | 14.73 | 15.19 | 15.81 | - | - | - | - | - | - |
| Commercial | 17.06 | 16.88 | 17.75 | 17.62 | 17.48 | 17.79 | 18.06 | 18.38 | - | - | - | - | - | - |
| Industrial | 8.92 | 9.79 | 9.57 | 9.93 | 10.47 | 10.80 | 11.30 | 11.75 | - | - | - | - | - | - |
| Transportation | 0.01 | 0.01 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.04 | - | - | - | - | - | - |



# Electricity Consumption Module: Summary Worksheet

State Climate and Energy Program

## 7. Colorado Emissions Summary (MMTCO2E)

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| MMTCO$_2$E | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | 12.57 | 12.97 | 13.83 | 14.09 | 13.92 | 14.73 | 15.19 | 15.81 | - | - | - | - |
| Space Heating | 1.62 | 1.67 | 1.57 | 1.38 | 1.15 | 0.99 | 1.02 | 1.06 | - | - | - | - |
| Air-conditioning | 0.97 | 1.00 | 1.25 | 1.46 | 1.62 | 1.91 | 1.97 | 2.05 | - | - | - | - |
| Water Heating | 1.17 | 1.20 | 1.26 | 1.25 | 1.21 | 1.25 | 1.29 | 1.34 | - | - | - | - |
| Refrigeration | 1.81 | 1.87 | 1.96 | 1.96 | 1.90 | 1.97 | 2.03 | 2.12 | - | - | - | - |
| Other Appliances and Lighting | 7.00 | 7.22 | 7.79 | 8.04 | 8.04 | 8.62 | 8.89 | 9.24 | - | - | - | - |
| Commercial | 17.06 | 16.88 | 17.75 | 17.62 | 17.48 | 17.79 | 18.06 | 18.38 | - | - | - | - |
| Space Heating | 0.83 | 0.82 | 0.86 | 0.85 | 0.85 | 0.86 | 0.87 | 0.89 | - | - | - | - |
| Cooling | 2.20 | 2.18 | 2.29 | 2.27 | 2.26 | 2.30 | 2.33 | 2.37 | - | - | - | - |
| Ventilation | 1.93 | 1.91 | 2.00 | 1.99 | 1.97 | 2.01 | 2.04 | 2.08 | - | - | - | - |
| Water Heating | 0.37 | 0.36 | 0.38 | 0.38 | 0.38 | 0.38 | 0.39 | 0.40 | - | - | - | - |
| Lighting | 6.60 | 6.54 | 6.87 | 6.82 | 6.77 | 6.89 | 6.99 | 7.12 | - | - | - | - |
| Cooking | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | - | - | - | - |
| Refrigeration | 1.56 | 1.54 | 1.62 | 1.61 | 1.60 | 1.63 | 1.65 | 1.68 | - | - | - | - |
| Office Equipment | 0.55 | 0.54 | 0.57 | 0.57 | 0.56 | 0.57 | 0.58 | 0.59 | - | - | - | - |
| Computers | 0.83 | 0.82 | 0.86 | 0.85 | 0.85 | 0.86 | 0.87 | 0.89 | - | - | - | - |
| Other | 2.11 | 2.09 | 2.19 | 2.18 | 2.16 | 2.20 | 2.23 | 2.27 | - | - | - | - |
| Industrial | 8.92 | 9.79 | 9.57 | 9.93 | 10.47 | 10.80 | 11.30 | 11.75 | - | - | - | - |
| *Indirect Uses-Boiler Fuel* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | *0.01* | - | - | - | - |
| Conventional Boiler Use | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | - | - | - | - |
| CHP and/or Cogeneration Process | - | - | - | - | - | - | - | - | - | - | - | - |
| *Direct Uses-Total Process* | *6.73* | *7.38* | *7.22* | *7.49* | *7.89* | *8.15* | *8.52* | *8.87* | - | - | - | - |
| Process Heating | 0.80 | 0.88 | 0.86 | 0.89 | 0.94 | 0.97 | 1.02 | 1.06 | - | - | - | - |
| Process Cooling and Refrigeration | 0.59 | 0.65 | 0.63 | 0.66 | 0.69 | 0.71 | 0.75 | 0.78 | - | - | - | - |
| Machine Drive | 4.49 | 4.92 | 4.81 | 4.99 | 5.26 | 5.43 | 5.68 | 5.91 | - | - | - | - |
| Electro-Chemical Processes | 0.80 | 0.88 | 0.86 | 0.89 | 0.94 | 0.97 | 1.02 | 1.06 | - | - | - | - |
| Other Process Use | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | - | - | - | - |
| *Direct Uses-Total Nonprocess* | *1.75* | *1.92* | *1.87* | *1.95* | *2.05* | *2.12* | *2.21* | *2.30* | - | - | - | - |
| Facility HVAC | 0.90 | 0.99 | 0.97 | 1.00 | 1.06 | 1.09 | 1.14 | 1.19 | - | - | - | - |
| Facility Lighting | 0.62 | 0.68 | 0.67 | 0.69 | 0.73 | 0.75 | 0.79 | 0.82 | - | - | - | - |

# For More Information

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# For More Information

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**Questions???**