



The New California Climate Action Registry: Development of Methodologies for Calculating Electricity-Related Greenhouse Gas Emissions

**Presentation at the Emission Inventory Conference
Atlanta, GA**

April 16, 2002

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California Climate Action Registry: Overview



- Voluntary registry for businesses, government agencies, and other organizations to document their GHG emissions
- Initially established in 2000 with clarifying legislation passed in 2001 - will take first participants Fall 2002
- Purpose: to assist California businesses and organizations in their efforts to inventory and document emissions in order to establish a baseline and to document early actions to increase energy efficiency and decrease GHG emissions
- State of California has committed to use its “best efforts” to ensure that entities that establish GHG emissions baselines and register their emissions will receive “appropriate consideration under any future international, federal, or state regulatory scheme relating to greenhouse gas emissions”

California Climate Action Registry: Overview



- Participants are required to register the GHG emissions of all operations in California, and are encouraged to report nationwide
- For the first three years of participation, the Registry will only require the reporting of carbon dioxide (CO₂) emissions although participants are encouraged to report the remaining five Kyoto Protocol GHGs (CH₄, N₂O, HFCs, PFCs, and SF₆).
- General protocol setting reporting rules developed by A.D. Little and based on WRI/WBCSD protocol
- Industry-specific protocols being developed
- Participants report annual direct and indirect emissions
- Participants can also report an emissions intensity metric

California Climate Action Registry: Reporting Guidelines



Participants report annual GHG emissions for:

- **Direct emissions:** emissions from applicable sources that are under control of an entity, such as
 - transportation emissions
 - emissions from on-site combustion
 - process emissions
 - fugitive emissions
- **Indirect emissions:** emissions that occur because of a participant's actions, but are produced by sources owned or controlled by another entity, such as
 - business travel on commercial aircraft
 - shipping using a delivery service
 - electricity consumption

California Climate Action Registry: Calculating Electricity-Related GHG Emissions



Step 1: Determine electricity consumption

Utility bills report monthly electricity consumption in kWhs

Step 2: Determine emission factors that apply to electricity used

Annual average state-wide emissions factors are published by various sources

Step 3: Determine the total yearly emissions

Multiply annual kWh electricity consumption by appropriate electricity emissions factor

Published Annual Average Electricity Emissions Factors for California



Source	Year(s)	Average Emission Factor (kgC/kWh)	Includes Utility-Owned In-State Generation	Includes Utility-Owned Out-Of-State Generation	Includes Non-Utility Generation	Includes Imported and Exported Electricity
Voluntary Reporting of GHGs – 1605(b)	1997-99	0.037	Y	N	N	N
Voluntary Reporting of GHGs – 1605(b)	1992	0.094	Y	N	Y	N
ICLEI – e-Mission: GHG Strategy Software	1998	0.125	Y	N	N	Y
U.S. EPA National GHG Inventory	1998	0.052	Y	N	Y	N
Emissions Inventory Improvement Program	1995	0.114	Y	Y	Y	Y
California Inventory of GHG Emissions	1994	0.093	Y	N	Y	N
E-GRID	1998	0.059	Y	N	Y	N

California Electricity Emissions Disaggregated by Source



- California electricity generation
 - In-state utility and non-utility generation: 63%
 - Out-of-state owned by California utilities: 14%
 - Imported: 23%
- California electricity-related CO₂ emissions
 - In-state utility and non-utility generation: 41%
 - Out-of-state owned by California utilities: 25%
 - Imported: 34%

Determining Electricity Emissions Factors for California



- Berkeley Lab (funded by the California Energy Commission) developed three methodologies to determine more precise electricity emissions factors for California that include:
 - Average emissions factors
 - Marginal emissions factors
 - Emissions factors by utility service district
 - Seasonal emissions factors
- These emissions factors include:
 - Utility-owned in-state generation
 - Utility-owned out-of-state generation
 - Non-utility generation
 - Imported electricity
 - Exported electricity

Determining Electricity Emissions Factors for California



Challenges:

- electricity can be generated from a number of different primary energy sources, many of which are major sources of CO₂ emissions (e.g., coal combustion) while others result in virtually no CO₂ emissions (e.g., hydro)
- the mix of generation resources used to meet electricity loads may vary at different times of day or in different seasons
- electrical energy is transported over long distances by complex transmission and distribution systems, so the emissions related to electricity usage can occur far from the jurisdiction in which that energy is consumed
- California's electricity market has undergone significant changes during the past decade

Determining Electricity Emissions Factors for California



Berkeley Lab developed and tested three methodologies:

- **Elfin Model:** widely-used forecasting tool for California power utilities in the 1980s and early 1990s
- **Public Data Sources:** based on publicly-available data from U.S. Energy Information Administration, California Energy Commission, and the Federal Energy Regulatory Commission
- **Load Duration Curve:** simplified, spread-sheet based load duration curve using U.S. Energy Information Administration's National Energy Modeling System (NEMS) data

Determining Electricity Emissions Factors for California



Method	Year	Average Emission Factors	Marginal Emission Factors	Includes Utility-Owned In-State Generation	Includes Utility-Owned Out-Of-State Generation	Includes Non-Utility Generation	Includes Imported and Exported Electricity
Elfin Model	1990	Yes	Yes	Yes	Yes	Yes	Yes
Public Data Sources	1999	Yes	No	Yes	Yes	Yes	Yes
Load Duration Curve	1999	Yes	Yes	Yes	Yes	Yes	Yes

Results: Total Electricity-Related CO2 Emissions



- California total
 - Elfin Model (1990): 26.1 MtC
 - Public Data Sources (1999): 29.0 MtC
 - Load Duration Curve (1999): 29.5 MtC
- California electric load grew by about 10% between 1990 and 1999, so differences in 1990 and 1999 estimates of total CO2 emissions are reasonable
- US total (1999): 612 MtC (CA = ~5%)
- US electricity-related CO2 emissions: 2.18 MtC/capita
- CA electricity-related CO2 emissions: 0.87 MtC/capita

Results: Total Electricity-Related CO2 Emissions (MtC)



	1990 Emissions Using Elfin	1999 Emissions Using PDS	1999 Emissions Using LDC
Los Angeles Department of Water and Power	4.7	5.0	5.2
Southern California Edison	11.8	12.9	12.9
San Diego Gas and Electric	2.2	2.6	2.8
Pacific Gas and Electric*	7.3	7.0	7.0
California Independent System Operator	21.3	22.5	22.7
California**	26.1	29.0	29.5

* LDC and PDS results for PG&E include Sacramento Municipal Utility District

** Includes irrigation districts and municipal utilities

Results: Annual Average Emissions Factors



- California average:
 - Elfin Model (1990): 0.110 kgC/kWh
 - Public Data Sources (1999): 0.108 kgC/kWh
 - Load Duration Curve (1999): 0.105 kgC/kWh
- CO₂ associated with electricity usage varies considerably among the utility service areas
- Values are lower for PG&E due to large share of carbon-free generation (hydro, nuclear) and predominantly hydro imports from the Pacific Northwest

Results: Average Emissions Factors



	1990 AEFs Using Elfin	1999 AEFs Using PDS	1999 AEFs Using LDC
Los Angeles Department of Water and Power	0.195	0.192	0.207
Southern California Edison	<i>0.132</i>	<i>0.132</i>	<i>0.131</i>
San Diego Gas and Electric	<i>0.132</i>	<i>0.140</i>	<i>0.146</i>
Pacific Gas and Electric*	<i>0.070</i>	<i>0.064</i>	<i>0.063</i>
California Independent System Operator			0.101
California**	0.110	0.108	0.105

* LDC and PDS results for PG&E include Sacramento Municipal Utility District

** Includes irrigation districts and municipal utilities

Results: Annual Marginal Emissions Factors



- Divergent MEFs for all utility service districts except LADWP
- MEFs significantly higher than the corresponding AEFs except LADWP
- Since the MEFs of the utility service districts other than LADWP range from 25% to over 200% greater than the corresponding AEFs, using AEFs to estimate CO₂ savings from reducing electricity usage would significantly underestimate actual savings from electricity-reduction projects

Results: Marginal Emissions Factors



	1990 MEFs Using Elfin	1999 MEFs Using PDS	1999 MEFs Using LDC
Los Angeles Department of Water and Power	0.191	N/A	0.199
Southern California Edison	<i>0.165</i>	<i>N/A</i>	<i>0.215</i>
San Diego Gas and Electric	<i>0.201</i>	<i>N/A</i>	<i>0.181</i>
Pacific Gas and Electric*	<i>0.153</i>	<i>N/A</i>	<i>0.140</i>
California Independent System Operator		N/A	0.193
California**			

* LDC and PDS results for PG&E include Sacramento Municipal Utility District

** Includes irrigation districts and municipal utilities

Seasonal Variation: 1999 Using PDS Approach



	AEF for May (kgC/kWh)	AEF for October (kgC/kWh)	Difference
PG&E	0.046	0.083	79%
SCE	0.122	0.132	8%
SDG&E	0.150	0.134	-11%
LADWP	0.192	0.184	-5%
CA	0.098	0.117	19%

Next Steps



- CEC will make recommendations to the Registry regarding methodology to use to determine electricity-related CO₂ emissions factors for California, which may include:
 - Move from utility service companies to CAISO and other large generators
 - Monthly emissions factors
 - Peak/off-peak emissions factors
- Need for balance between accuracy of emissions factors and simplicity of use for Registry

For Further Information



Climate Registry: <http://www.climateregistry.org/>

Marnay, C., Fisher, D., Murtishaw, S., Phadke, A., Price, L., and Sathaye, J., forthcoming. Estimating Carbon Dioxide Emissions Factors for the California Electricity Sector. Berkeley, CA: Lawrence Berkeley National Laboratory

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