How to use eGRID for Carbon Footprinting Electricity Purchases in Greenhouse Gas Emission Inventories

2012 International Emission Inventory Conference
Session 3: Greenhouse Gases

8/14/2012

Outline

- Summary of recommendations
- eGRID background
- Recommendations
- What's new in eGRID2012
- Trends
- Future eGRID updates
- Conclusions
- Questions and comments

Summary of recommendations

- EPA's Emissions & Generation Resource Integrated Database (eGRID) is the de facto source of data for carbon footprinting electricity in the U.S.
  - What level of data should I use? Electric Generating Company? State? NERC Region? U.S.? eGRID subregion level
  - Which emission rate should I use? Input? Total Output? Non-baseload output? Total output emission rates
  - What year data? Match years as best as possible
  - How to account for line losses? Use equations presented in paper
  - CO_2 only? Or also include methane (CH_4) and nitrous oxide (N_2O)? Conversion to CO_2 equivalent? Best practice to include CH_4 and N_2O. eGRID expresses the combined CO_2 CH_4 and N_2O output emission rates in CO_2 equivalent, for your use

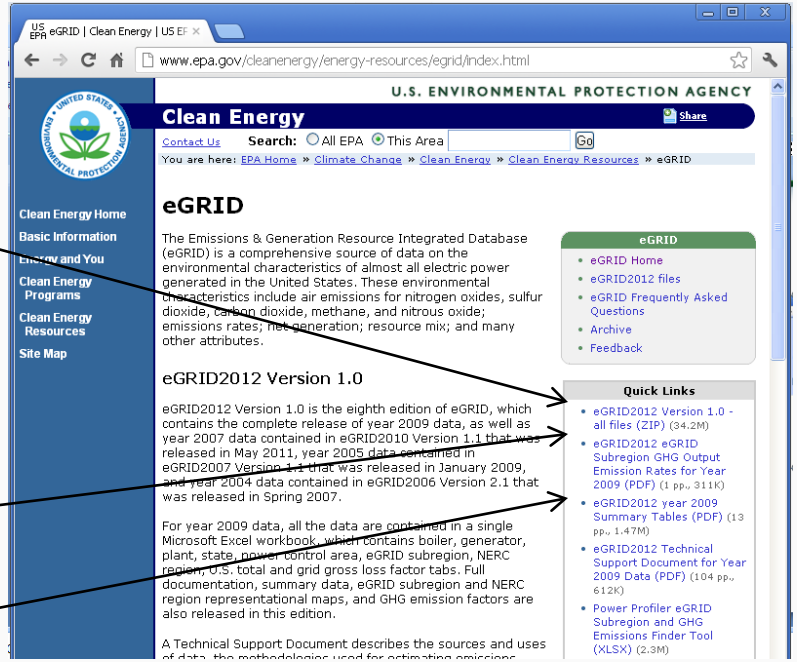
eGRID background

- **eGRID provides default greenhouse gas emission rates for use in scope 2 emission inventories in a transparent, credible, and consistent way.**
- Since 1998, eGRID is a comprehensive source of data on the environmental characteristics of U.S. power sector, uniquely integrating generation and emissions
  - Sources: EPA, EIA, FERC, NERC
  - Links electricity generation, air emissions and resource mix for virtually all U.S. power plants (5,400+ plants, 17,000+ generators, 5,500+ boilers)
    - Data years: 2009, 2007, 2005, 2004, & 2000-1996
    - GHG Emissions: CO_2 (all years), CH4, N2O (2005 forward)
    - Other Air Pollution: NO_x, SO_2 (all years), and Hg (1998-2000, 2004)
    - Heat Input, net generation, resource mix
    - Emissions rates data (total, non-baseload, fossil):
      - Input (lb/MMBtu), Output (lb/MWh)
    - Various levels of aggregation: Plant, State, Electric Generating Company, Parent Company, Power Control Area, eGRID subregion, NERC region, US Total.
    - State & U.S. import-export data (including grid gross loss factors)

Accessing eGRID

epa.gov/egrid

- Downloadable files:
  - Microsoft Excel Workbook (in zip file)
    - eGRID2012V1_0_year09_DATA.xls
  - Adobe PDF documents:
    - eGRID subregion GHG emission rates
    - Summary Tables
      - Emissions, output emission rates, resource mix, grid gross loss factors
      - eGRID subregion, NERC Region, State levels

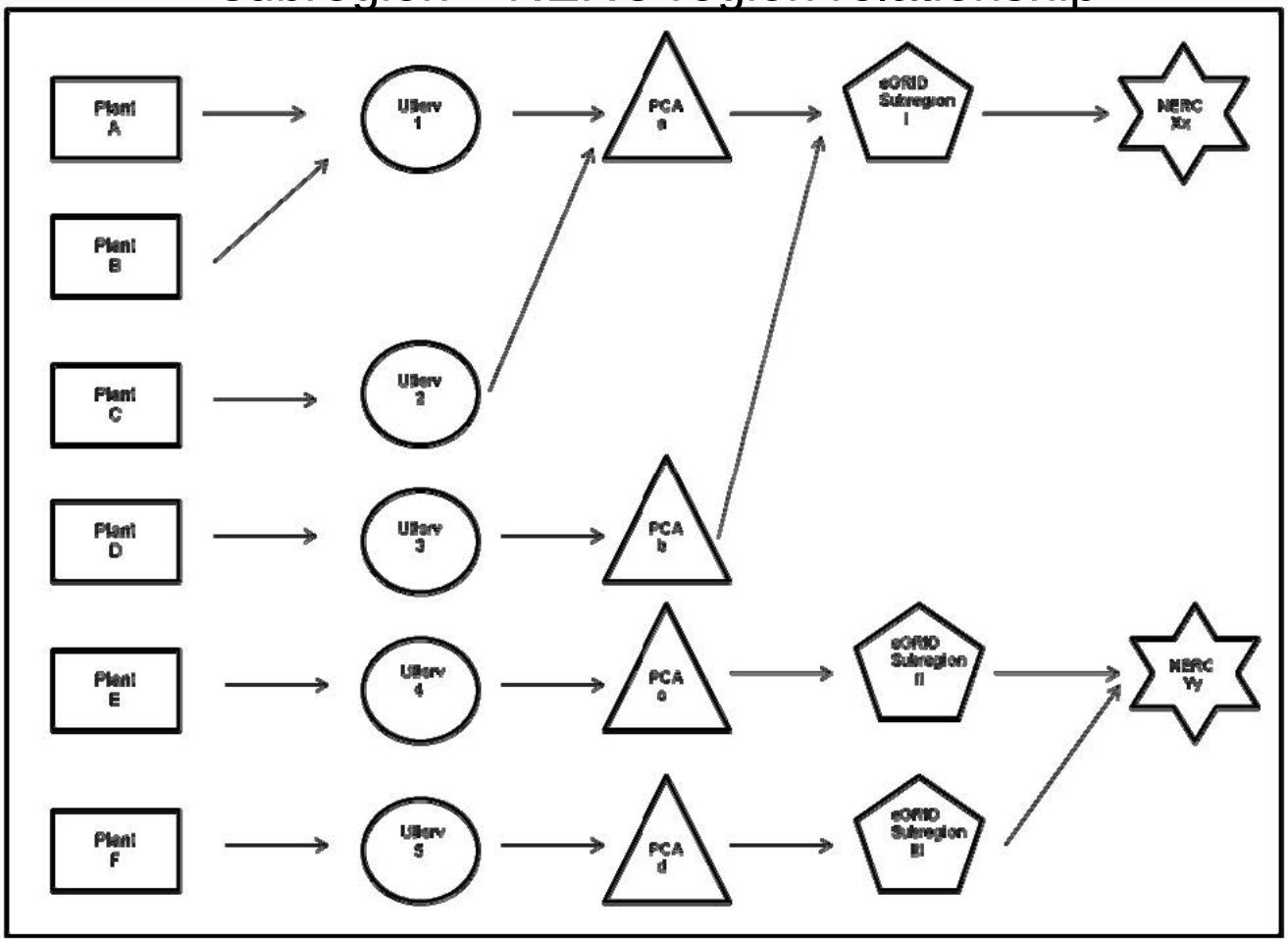


What's behind eGRID's GHG emission factors

- CO_2 emissions data reported to EPA per 40 CFR Part 75 (Acid Rain Program, Clean Air Interstate Rule, Regional Greenhouse Gas Initiative, etc.)
  - About 96% of CO_2 emissions are sourced from monitored emissions reported to EPA:
    - Continuous Emission Monitors (CEMS): CO_2 concentration, stack flow
    - For some oil/gas units: fuel flow monitors and measured carbon content (or default carbon content)
- CO_2 for other units, the same methodology for EPA's National GHG Inventory is applied to EIA-923 fuel use data
- N_2O & CH_4 derived from EPA National GHG Inventory methodology and EPA or EIA sourced fuel use
- See eGRID Technical Support Document for more details

What's behind eGRID's GHG emission factors

Plant – utility service area (Utlserv) – power control area (PCA) –eGRID subregion – NERC region relationship



Which rates to use? Which aggregation level?

For carbon footprinting generic, grid-supplied electricity:

- Use the <u>total</u> output emission rate (a.k.a. "system mix")
  - CO_2 in pounds per Megawatt-hour (MWh)
  - N_2O and CH_4 in pounds per Gigawatt-hour (GWh)
- Use the eGRID subregion aggregation level
  - This level strikes a balance between areas that are too big and areas that are too small.
    - U.S. level covers some irrelevant generation
    - State level boundaries are unrelated to electric grid boundaries
    - Power control area (PCA), a.k.a. balancing authority, level or Company (EGC) level may not address significant imported power

If purchasing directly from neighboring plant and transmission infrastructure is in place, then use plant specific rate

How to determine eGRID subregion

- Power Profiler
  - Online application www.epa.gov/powerprofiler
    - Enter ZIP code
    - Select from list of utilities
    - Your eGRID subregion and selected eGRID data are shown
  - Power Profiler eGRID subregion and GHG emission finder tool (spreadsheet)
    - Available on eGRID page under quick links
    - Decodes the eGRID subregion(s) for each ZIP code
    - If more than one eGRID subregion
      - Go to Power Profiler online application, OR
      - Use the eGRID subregion of the predominant utility for the ZIP code
    - Includes CO_2, CH_4, and N_2O eGRID subregion emission rates

Which data year to use?

- Use the “best match” between inventory year and eGRID data year at time of inventory preparation
  - More closely resembles emissions reflecting actual resource mix

Inventory Year	eGRID data year	eGRID edition to find data
1998	1998	eGRID2002
1999	1999	eGRID2002
2000	2000	eGRID2002
2001	2000	eGRID2002
2002	2000	eGRID2002
2003	2000	eGRID2002
2004	2004	eGRID2012
2005	2005	eGRID2012
2006	2005	eGRID2012
2007	2007	eGRID2012
2008	2007	eGRID2012
2009	2009	eGRID2012
2010	2009 (unless more recent exists at time of preparation)	eGRID2012
2011	2009 (unless more recent exists at time of preparation)	eGRID2012
2012	2009 (unless more recent exists at time of preparation)	eGRID2012

How to address line losses

- Line loss emissions estimate equation:

$$ER_{s3} = \frac{GGL \times ER_g}{(1 - GGL)}$$

$$where:$$

$$ER_{s3} = emission\ rate\ to\ estimate\ scope\ 3\ emissions\ from\ line\ losses$$

$$GGL = eGRID\ grid\ gross\ loss\ factor\ (decimal)$$

$$ER_g = eGRID\ generation\ based\ output\ emission\ rate$$

  - For example 1,000 MWh purchased in CAMX eGRID subregion in year 2010
    - eGRID subregion total output emission rate = 658.68 lb CO_2/MWh
    - Grid gross loss factor = 8.21% = 0.0821
    - Scope 3 line loss emissions =
      1000 MWh * 658.68 lb CO_2/MWh * 0.0821 / (1 – 0.0821) =
      58,914.5 lb CO_2

How to address line losses

- Equation combining line losses with generation emissions:

$$ER_c = \frac{ER_g}{(1 - GGL)}$$

where:

ER_c = *emission rate to estimate emissions from combined generation and line losses*

ER_g = *eGRID generation based output emission rate*

GGL = *eGRID gross grid loss factor (decimal)*

- For example 1,000 MWh purchased in CAMX eGRID subregion in year 2010
  - eGRID subregion total output emission rate = 658.68 lb CO_2/MWh
  - Grid gross loss factor = 8.21% = 0.0821
  - Emissions (including line losses) emissions = 1000 MWh * 658.68 lb CO_2/MWh / (1 – 0.0821) = 717,594.5 lb CO_2

Including CH4 and N2O -> CO2 equivalent

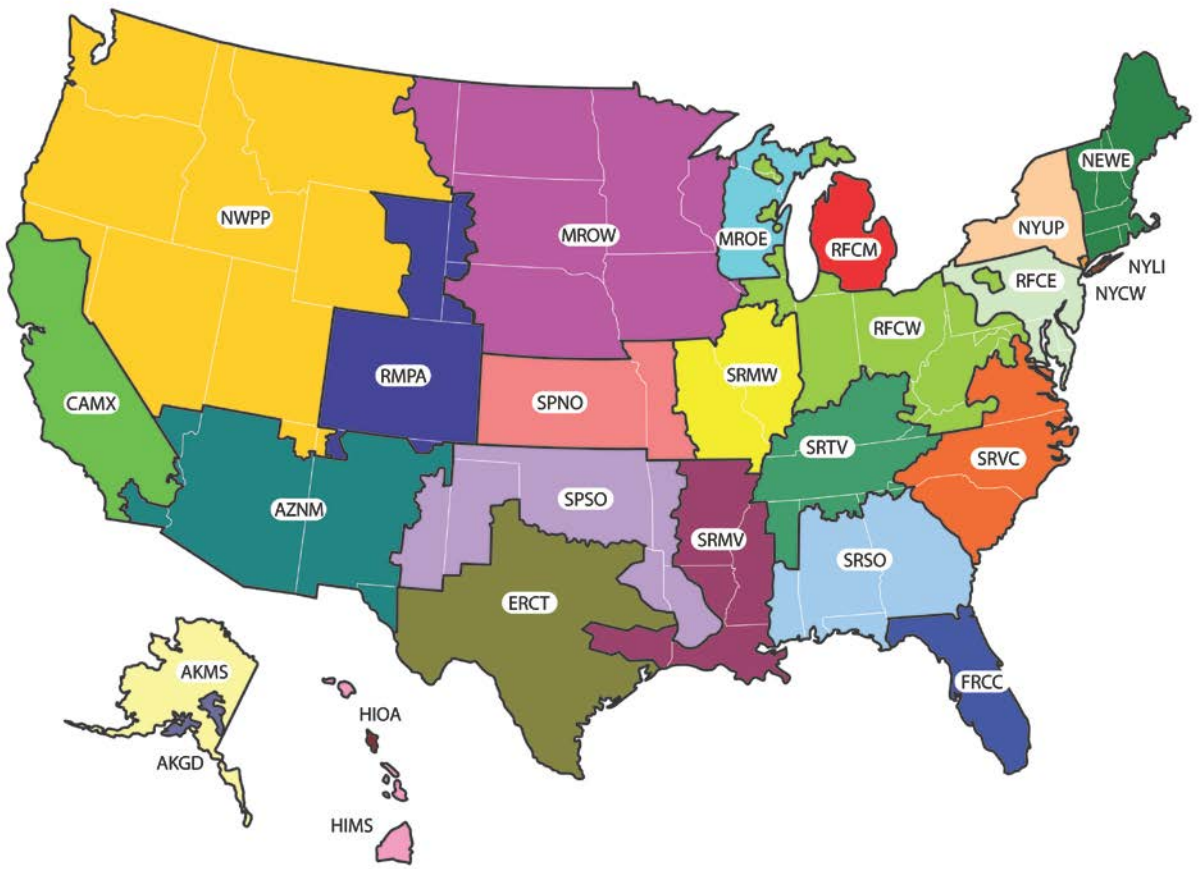
- Including CH_4 and N_2O from electricity purchases adds less than 1% CO_2 equivalent (CO_2e)
- Note that units for CH_4 and N_2O output emission rates in eGRID are in lbs per GWh, rather than lbs per MWh
- To convert to CO_2e, consistent with EPA's U.S. GHG Inventory, recommend using IPCC Second Assessment Report (SAR) Global Warming Potentials (See eGRID Technical Support Document for more details)
- eGRID displays separate total output emission rates for each of these GHGs, and also combines into a CO_2e value in the spreadsheets and summary tables

What's new in eGRID2012?

- Data not presented at the company or parent company level
- What used to be presented in three separate spreadsheets (PLANT, AGGREGATION, STIE_USGC) are now combined into one (DATA) with 10 tabs
- Improved methodology for grid gross loss factors
  - Used FERC-714 data for balancing authority interchanges rather than state based EIA estimates
- Plant coordinate improvements

What's new in eGRID2012?

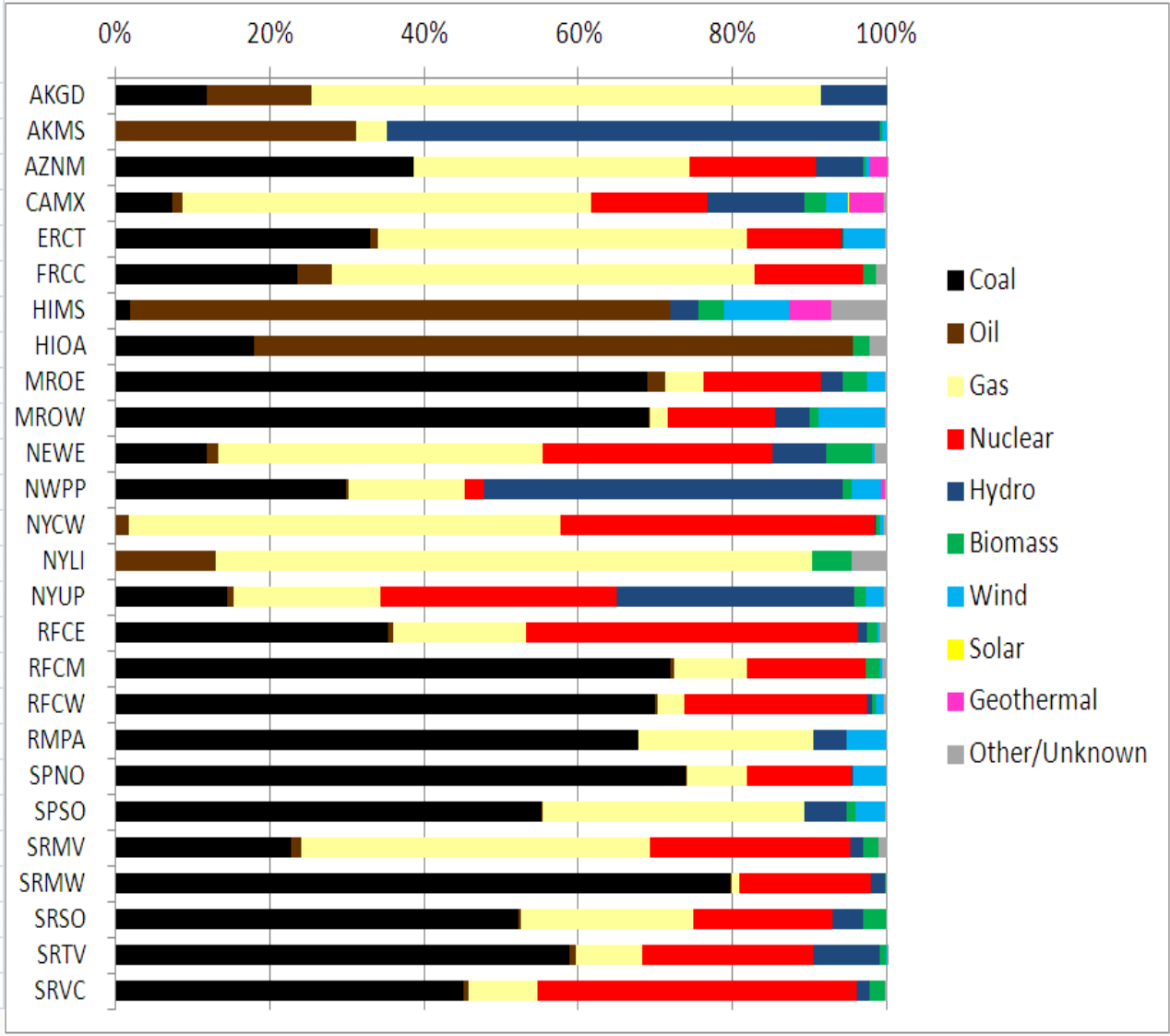
eGRID subregion acronym	eGRID subregion name	2009 CO2 Total Output Emission Rate (#/MWh)
AKGD	ASCC Alaska Grid	1,280.86
AKMS	ASCC Miscellaneous	521.26
AZNM	WECC Southwest	1,191.35
CAMX	WECC California	658.68
ERCT	ERCOT All	1,181.73
FRCC	FRCC All	1,176.61
HIMS	HICC Miscellaneous	1,351.66
HIOA	HICC Oahu	1,593.35
MROE	MRO East	1,591.65
MROW	MRO West	1,628.60
NEWE	NPCC New England	728.41
NWPP	WECC Northwest	819.21
NYCW	NPCC NYC/Westchester	610.67
NYLI	NPCC Long Island	1,347.99
NYUP	NPCC Upstate NY	497.92
RFCE	RFC East	947.42
RFCM	RFC Michigan	1,659.46
RFCW	RFC West	1,520.59
RMPA	WECC Rockies	1,824.51
SPNO	SPP North	1,815.76
SPSO	SPP South	1,599.02
SRMV	SERC Mississippi Valley	1,002.41
SRMW	SERC Midwest	1,749.75
SRSO	SERC South	1,325.68
SRTV	SERC Tennessee Valley	1,357.71
SRVC	SERC Virginia/Carolina	1,035.87



This is a representational map; many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.

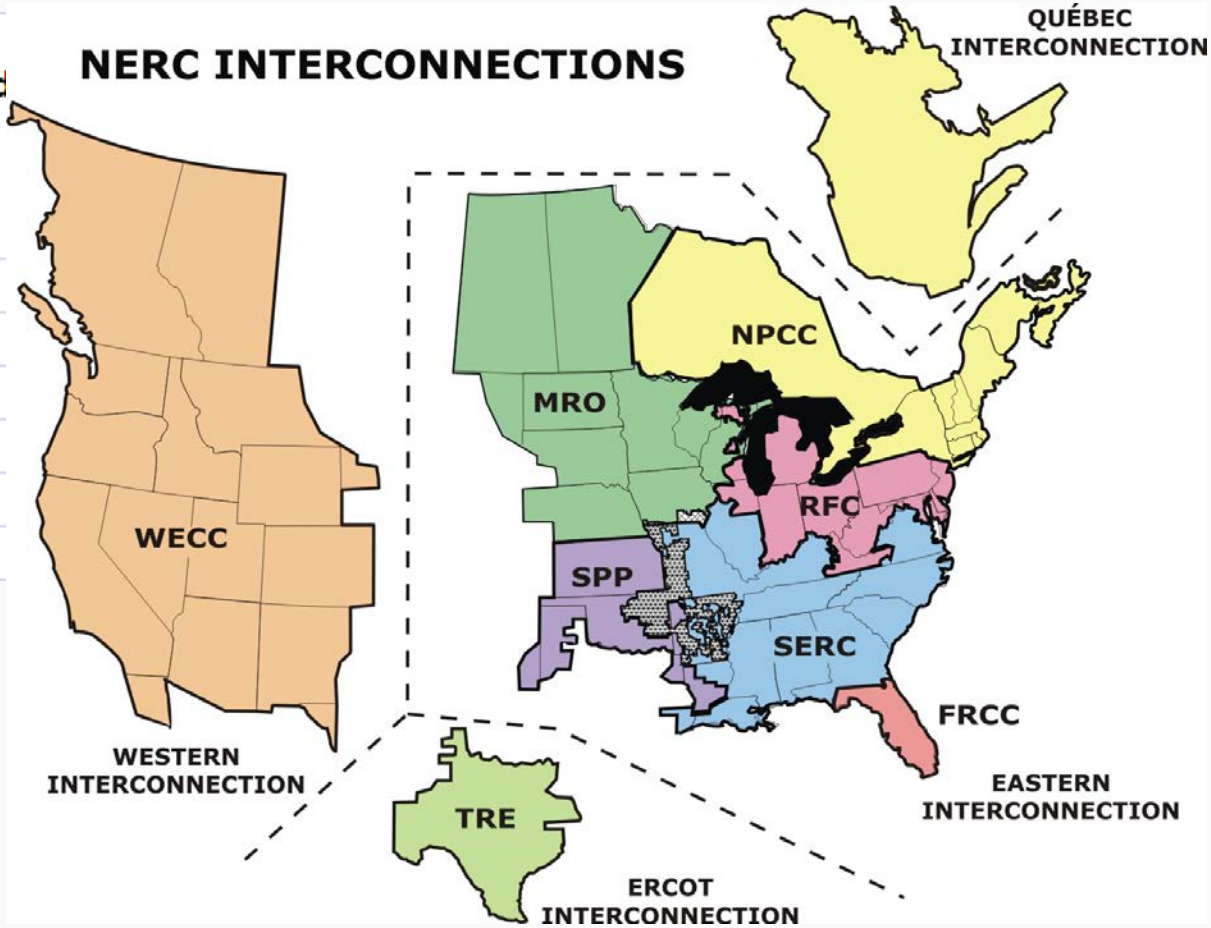
What's new in eGRID2012?

eGRID subregion acronym	eGRID subregion name	2009 CO2 Total Output Emission Rate (#/MWh)
AKGD	ASCC Alaska Grid	1,280.86
AKMS	ASCC Miscellaneous	521.26
AZNM	WECC Southwest	1,191.35
CAMX	WECC California	658.68
ERCT	ERCOT All	1,181.73
FRCC	FRCC All	1,176.61
HIMS	HICC Miscellaneous	1,351.66
HIOA	HICC Oahu	1,593.35
MROE	MRO East	1,591.65
MROW	MRO West	1,628.60
NEWE	NPCC New England	728.41
NWPP	WECC Northwest	819.21
NYCW	NPCC NYC/Westchester	610.67
NYLI	NPCC Long Island	1,347.99
NYUP	NPCC Upstate NY	497.92
RFCE	RFC East	947.42
RFCM	RFC Michigan	1,659.46
RFCW	RFC West	1,520.59
RMPA	WECC Rockies	1,824.51
SPNO	SPP North	1,815.76
SPSO	SPP South	1,599.02
SRMV	SERC Mississippi Valley	1,002.41
SRMW	SERC Midwest	1,749.75
SRSO	SERC South	1,325.68
SRTV	SERC Tennessee Valley	1,357.71
SRVC	SERC Virginia/Carolina	1,035.87

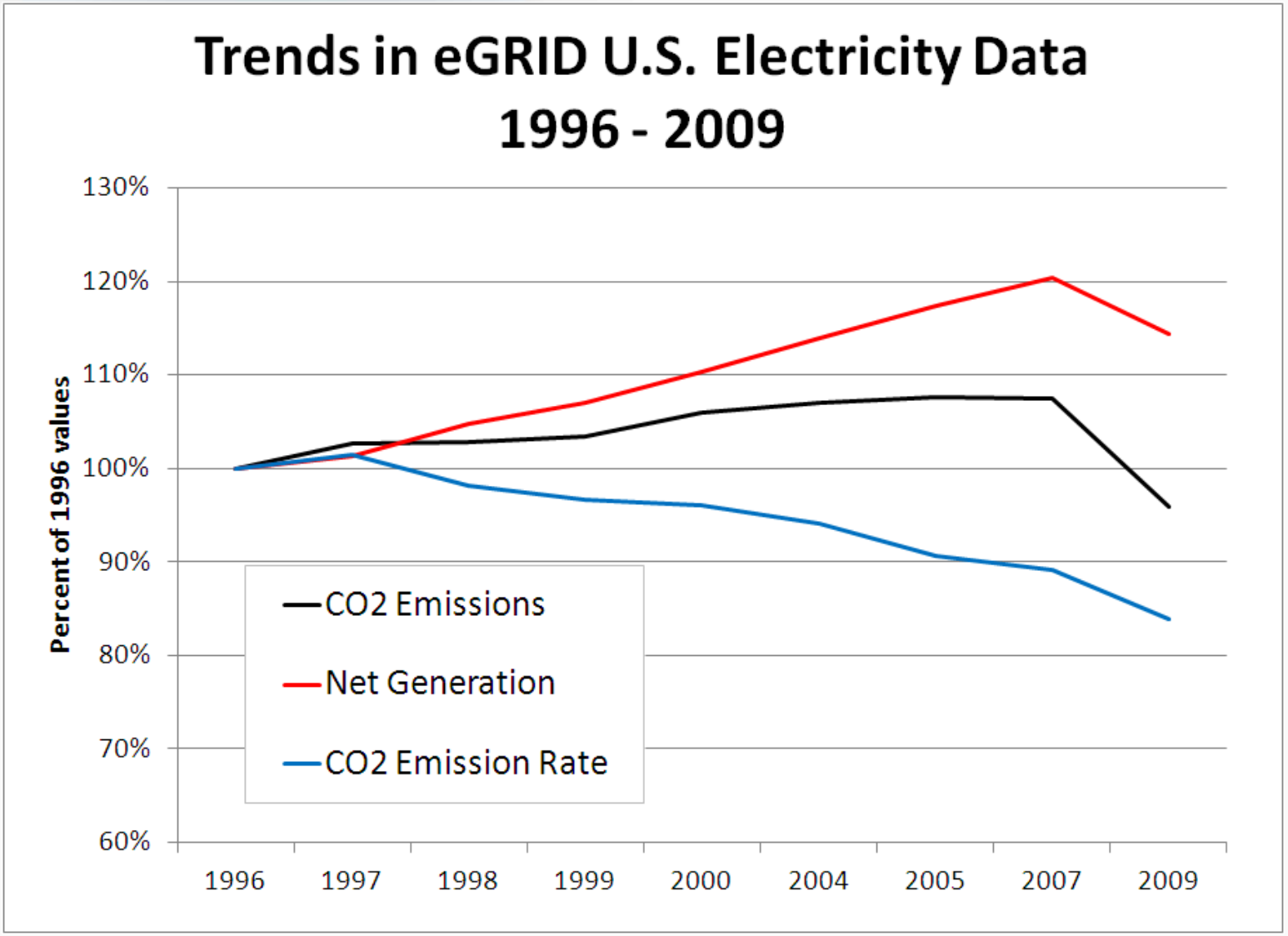


What's new in eGRID2012?

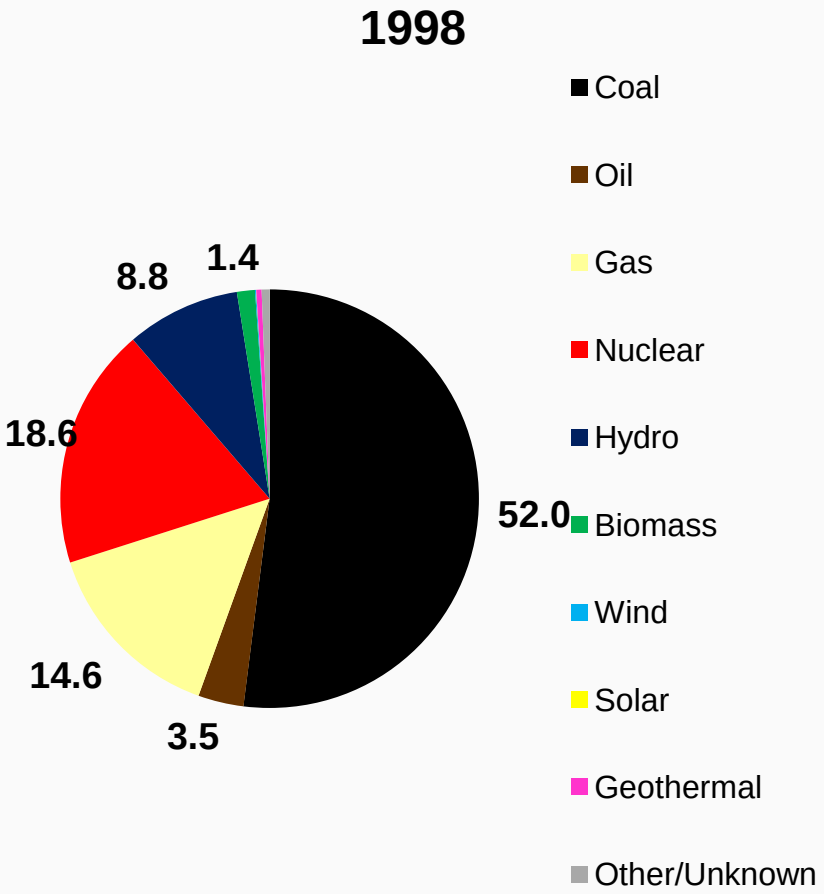
One of the three interconnect power grids in the U.S. (plus Alaska, Hawaii, and the entire U.S.)	The estimated regional grid gross loss as a percent
Eastern	5.82
Western	8.21
ERCOT	7.99
Alaska	5.84
Hawaii	7.81
U.S.	6.50

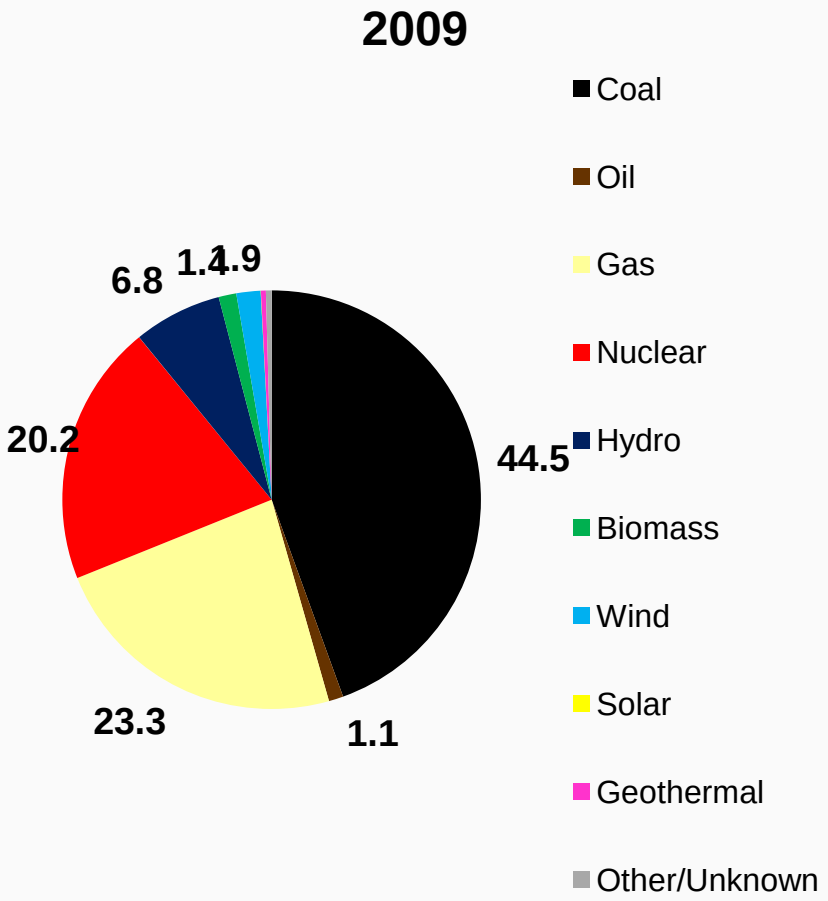


Trends

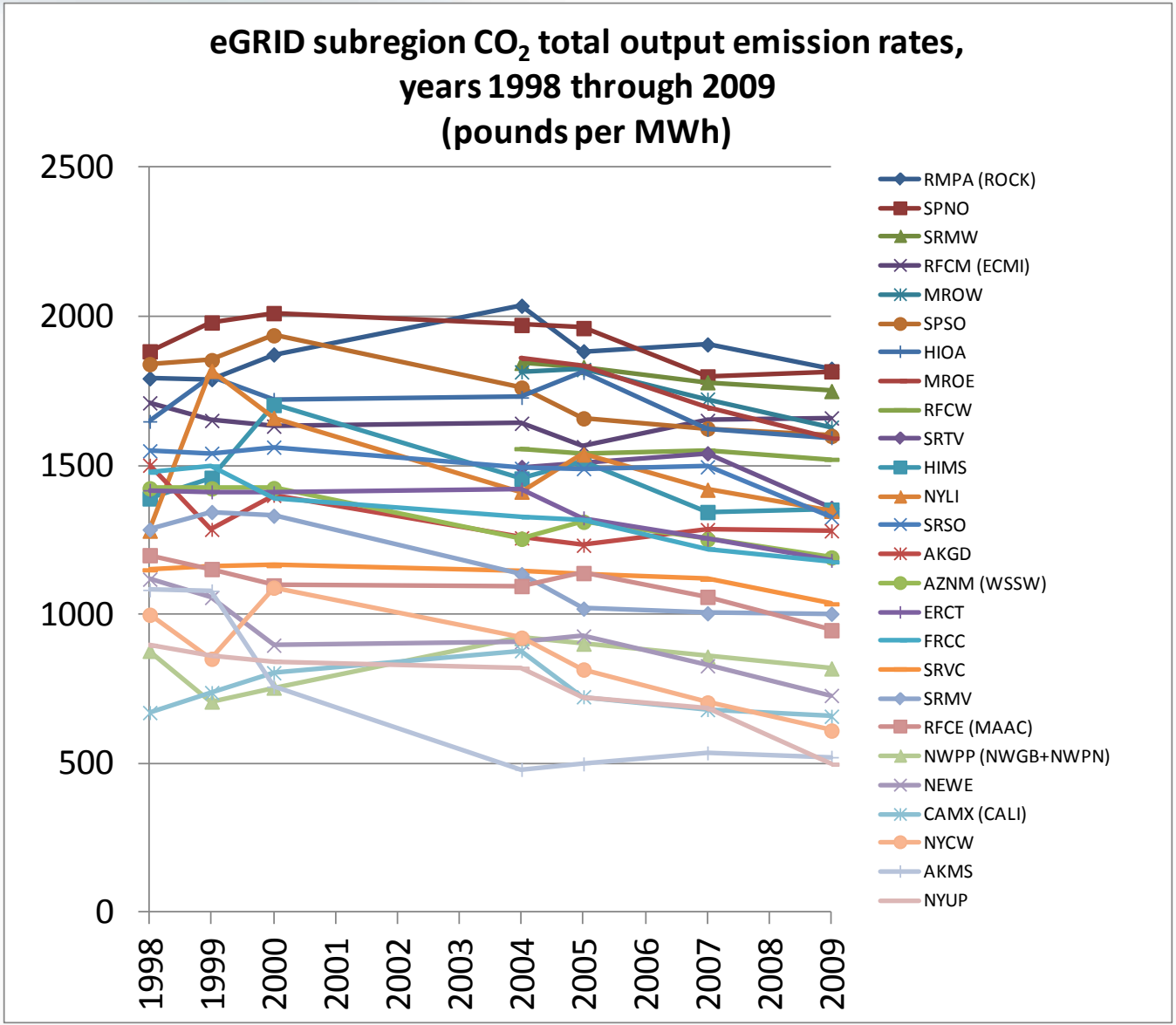

Trends in eGRID U.S. Electricity Data
1996 - 2009
Percent of 1996 values
130%
120%
110%
100%
90%
80%
70%
60%
1996
1997
1998
1999
2000
2004
2005
2007
2009
CO2 Emissions
Net Generation
CO2 Emission Rate

Trends: Resource mix

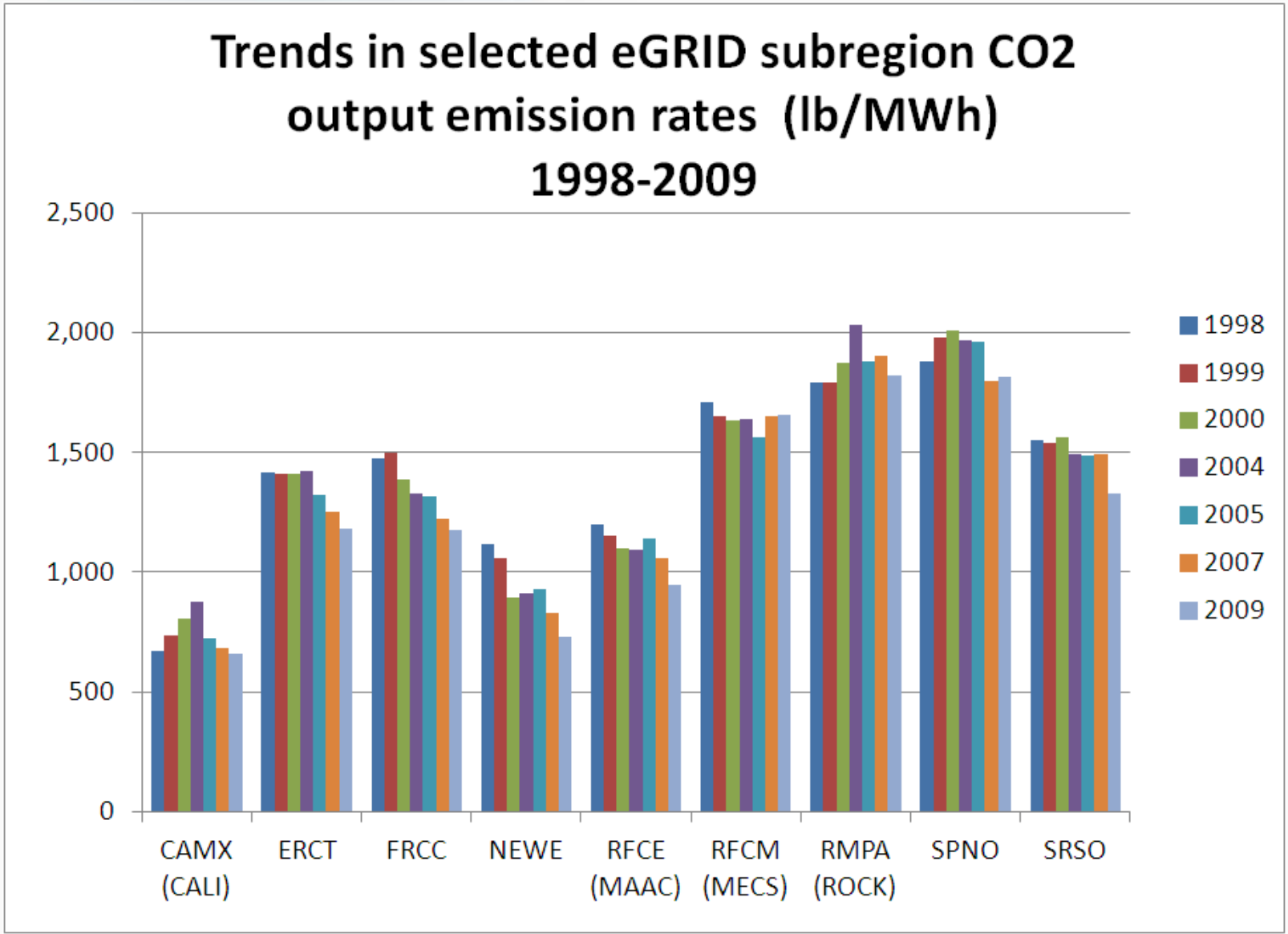




Trends: eGRID subregions



Trends: eGRID subregions



Future eGRID updates

- Currently processing year 2010 data, to be issued in a new edition as soon as possible
  - Rough estimate fall 2013

- To stay informed when any eGRID update occurs, please fill out eGRID feedback form:
  - www.epa.gov/cleanenergy/energy-resources/egrid/feedback.html

Conclusion

- What level of data should I use? Electric Generating Company? State? NERC Region? U.S.? eGRID subregion level
  - Which emission rate should I use? Input? Total Output? Non-baseload output? Total output emission rates
  - What year data? Match years as best as possible
  - How to account for line losses? Use equations presented in paper
  - CO_2 only? Or also include methane (CH_4) and nitrous oxide (N_2O)? Conversion to CO_2 equivalent? Best practice to include CH_4 and N_2O. eGRID expresses the combined CO_2 CH_4 and N_2O output emission rates in CO_2 equivalent, for your use

Questions and comments

epa.gov/egrid

Art Diem, Environmental Engineer
U.S. EPA
202-343-9340
diem.art@epa.gov

Cristina Quiroz
TranSystems|E.H. Pechan
703-245-4069
caquirozpacheco@transystems.com