Quantification Methods using eGRID State and Local Examples

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U.S. EPA
State Climate and Energy Program

Presentation Overview

Today's Examples -

- New Mexico:
  - Estimating the energy and emission impacts of Energy Efficiency Resources Standard
- Delaware Valley Regional Planning Commission
  - Quantifying electricity consumptions for Regional GHG emissions inventory and Electricity reductions from LED Change-Out Program

New Mexico's Interest in estimating EE/RE policy impacts

- EPA is focusing resources to help state and local governments incorporate EE/RE policies and programs in State Implementation Plans (SIPs)
- New Mexico expressed interest in exploring how to incorporate EE/RE Policies in their SIP (E.g., upcoming ozone standard)
- EPA staff from the Regional Office and Headquarters have come together to:
  - provide technical assistance to New Mexico and
  - estimate the potential magnitude of emission reductions NM may include in their upcoming SIP submittal

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New Mexico's Energy Efficiency Resources Standard (EERS)

In 2008, New Mexico adopted an amended version of the Efficient Use of Energy Act where:

- House Bill 305 requires Investor Owned Utilities to achieve a 10% reduction from 2005 total retail electricity sales by 2020.[1]

To estimate the energy impacts – directly refer to the EERS law, or state regulation to guide your analysis.

  - Connect with Public Regulatory Commission to ensure correct assumptions

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1) http://www.aceee.org/sector/state-policy/newmexico#Energy%20Efficiency%20Resource%20Standards

How to Estimate the Energy Impacts of NM's EERS

1.a Identify affected entities (e.g., Investor owned utilities, municipal utilities or cooperatives)	Investor Owned Utilities			
1.b Identify Investor Owned Utilities in NM	El Paso Electric	Public Service Company of NM	Southern Public Service Company	
2. Identify year of baseline sales	2005			
3. Determine total base year sales (2005)for each affected utility (Source: EIA's Electricity Sales, Revenue and Price Tables, 2005 Issue, Table 10. found at: http://www.eia.doe.gov/cneaf/electricity/esr/backissues.html)	1.5M MWh	7.7M MWh	3.7M MWh	TOTAL IOU sales in 2005: 12.9M MWh
4. Determine savings from EERS by 2020 (10% reduction of total 2005 sales)				TOTAL IOU sales reduction in 2020: 1.29M MWh

Obtain emissions and plant information from eGRID

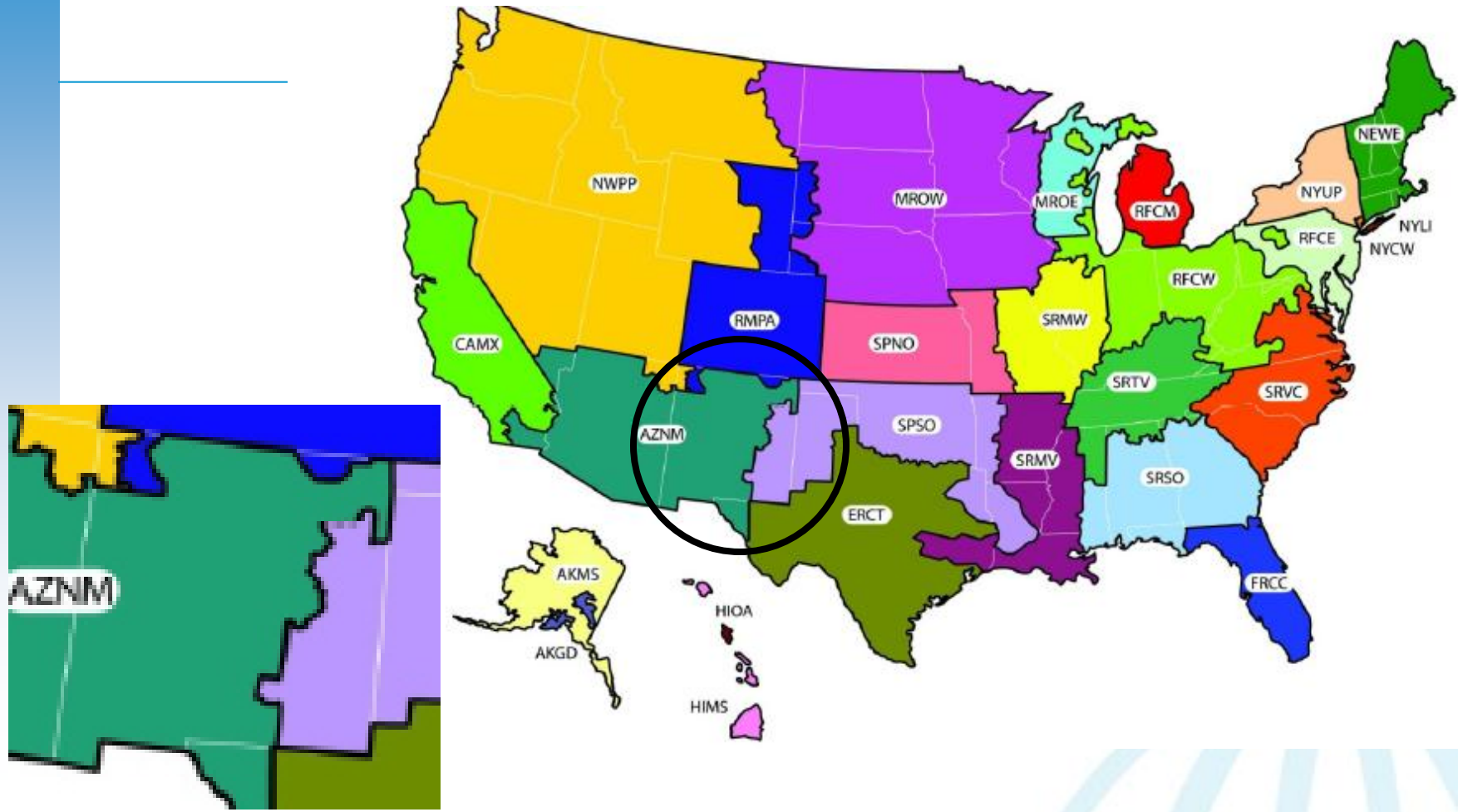
- Information in eGRID connects IOUs with each associated plant
- All plants are located in eGRID subregion AZMN (except Luna Energy Facility)

Investor Owned Utility (IOU)	El Paso Electric	Public Service Company of NM	Southern Public Service Company
# of plants associated with each IOU	One plant	Six plants	Three plants
Plant names:	Riogrande	Afton Generating Station Las Vegas Lordsburg Generating Reeves Luna Energy Facility* San Juan	Carlsbad Cunningham Maddox

Apply eGRID quantification approaches

- eGRID subregion average non-baseload emission rates
- eGRID plant-level data using “capacity factors”

eGRID subregions



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eGRID subregion AZNM
Non-baseload output emission rates

Criteria Air Pollutants

NOx : 1.04 lbs/MWh

SO_2: 0.4500 lbs/MWh

Greenhouse Gas Emissions

CO2: 1,211.84 lbs/MWh

CH4: 20.56 lbs/GWh

N2O: 9.31 lbs/GWh

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Source: Summary Tables: available at: http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_0_year07_SummaryTables.pdf

eGRID emission approach using AZNM subregion non-baseload emission rates

General Approach:

Electricity sales saved from EERS x eGRID emission rates x grid loss factor.

Units used in equation:

Energy saved (MWh) x emission rate (lbs/MWh) x 1/(1-grid loss factor) x tons/lbs conversion

$$1{,}290{,}810\ MWh\ x\ \frac{1.04\ lbs\ NOx}{MWh}\ x\ \frac{1}{(1-0.0484)}\ x\ \frac{1\ ton}{2000\ lbs} = 705.3\ tons\ of\ NOx$$

Helpful Conversions:

1GWh = 1000 MWh

1 short ton = 2000 lbs

1 metric ton = 2204 lbs

NM's emission results using eGRID AZNM subregion non-baseload emission rates

Displaced emissions from NM's EERS in 2020

Greenhouse Gas Reductions (metric tons)			Criteria Pollutant Reductions (tons)	
CO_2	CH_4	N_2O	NO_x	SO_2
745,829	12.65	5.72	705.9	277

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Benefits and Limitations to eGRID Average Emissions Rate Approach

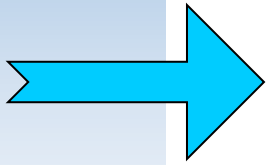
Benefits:

- Easy 'back of the envelope' estimate
- Non-baseload output emission rates reflect the plants that would most likely get displaced throughout eGRID subregion.

Limitations:

- Not all NM plants are included in analysis.
- Future looking power plant representation is absent.
  - Some plants in 2007 may have already shutdown or will shutdown in 2020.
- This approach does not show where or which EGUs will be displaced. It uses averages.
- eGRID approach assumes NM policies will affect all non-baseload plants equally.

Apply eGRID Quantification approaches



- eGRID subregion average non-baseload emission rates
- eGRID plant-level data using “capacity factors”

Capacity Factor Approach using eGRID

- The **Capacity Factor** of a generating unit is the ratio of "the electrical energy produced by a generating unit for a given period of time" to "the electrical energy that could have been produced at continuous full-power operation during the same period." [1]
- eGRID assigns a capacity factor for each power plant
  - EGUs with ≥ 0.80 capacity factor is considered a “baseload” plant and emissions would not be displaced
  - EGUs with a ≤0.20 capacity factor will be the first to be displaced (marginal units or peaking units)

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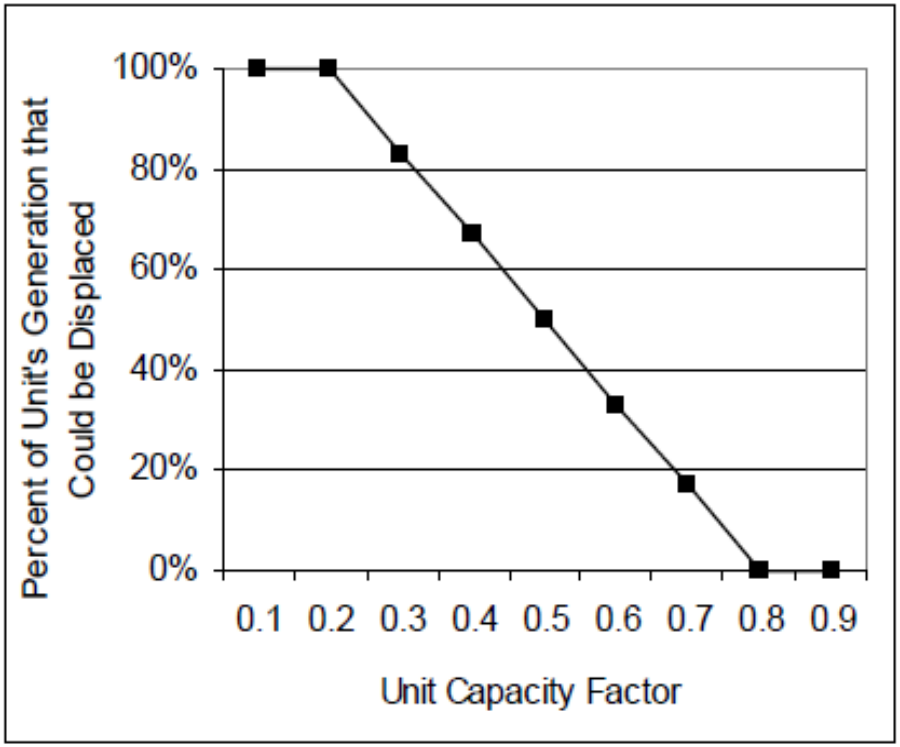
1) http://www.eia.doe.gov/electricity/page/prim2/charts.html

Capacity Factor Rule of Thumb



Plant Name	Capacity Factor in eGRID
Cunningham	**0.0002**
Afton Generating Station	**0.0003**
Maddox	**0.0650**
Las Vegas	**0.1138**
Carlsbad	**0.2580**
Luna Energy Facility	**0.2764**
Rio Grande	**0.3041**
Reeves	**0.4226**
Lordsburg Generating	**0.4620**
San Juan	**0.6174**

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**Note: This is a for explanatory purposes only, a complete capacity factor analysis would include all plants within multiple power control areas to properly capture the policy impacts within the electric grid

Benefits and Limitations of the capacity factor approach using eGRID

Benefits

- Emissions can be assigned to each power plant
- Relative easy calculation if infrastructure is set up

Limitations:

- This is a simplified approach assuming power plants have same capacity factor throughout the year
  - Doesn't account for maintenance, outages
- Exported power is not considered
- Assumes all energy savings or generation affect all peaking units first and do not affect any baseload generation
  - which is not always true with some EE programs or RE technologies (E.g., lighting programs, Wind power)

Delaware Valley Regional Planning Commission (DVRPC)

Quantify electricity consumptions for Regional GHG emissions inventory

and

Estimate predicted electricity reductions from LED Change-Out Program

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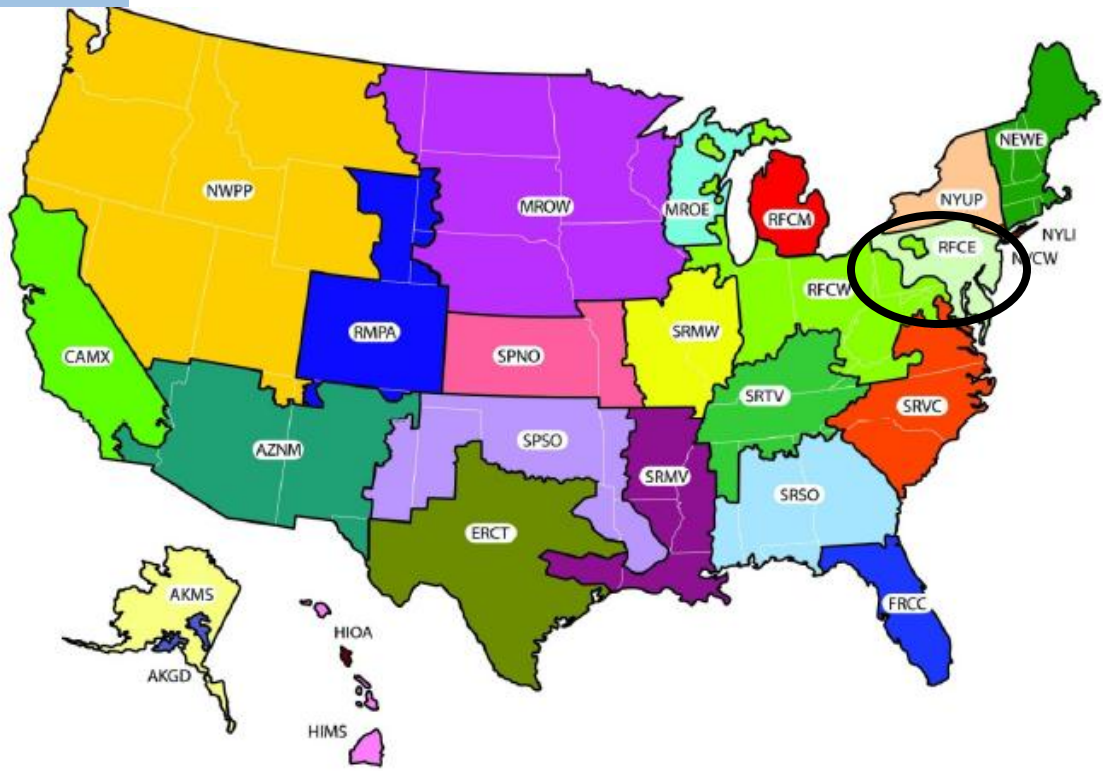
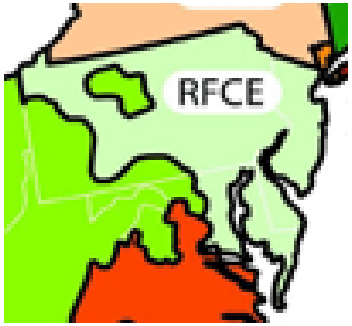
DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

DVPRC's Regional GHG Inventory

- 2005 GHG Inventory for a 9 county area in NJ and PA
- Entire region falls within eGRID's RFC East subregion





RFCE
GHG Total Average Emission Rates

CO2:	1,139 lbs/MWh
CH4:	30.3 lbs/GWh
N2O:	18.7 lbs/GWh

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Calculate indirect emissions from electricity consumption

- The indirect emissions for the residential, commercial and industrial sectors are estimated using the following equations:
- CO_2 emissions = Electricity consumption × Average RFCE eGRID subregion CO_2 Emission rate
- CH_4 emissions = Electricity consumption x Average RFCE eGRID subregion CH_4 Emission rate
- N_2O emissions = Electricity consumption × Average RFCE eGRID subregion N_2O Emission rate

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Steps to quantify emissions for DVRPC's 2005 GHG inventory – CO_2 equivalents

Equations to obtain CO_2 equivalent emission rates

- eGRID CO_2 emissions rate:1,139 lbs/MWh
- eGRID CH_4 emissions rate: 30.3 lbs/GWh
  - 30.3 lbs/GWh x (1GWh/1000MWh) x 21→ 0.63 lb CO_2e/MWh
- eGRID N_2O emissions rate: 18.7 lbs N_2O/GWh
  - 18.7 lbs N_2O/GWh x (1GWh/1000MWh) x 310 → 5.8 lbs CO_2e/MWh

*Net Emissions Rate = (1139+0.63+5.8) * 1/(1-0.064) = 1224 lbs* CO_2e/MWh

Important assumptions:
Transmission and Distribution loss factor: 6.4%

Global Warming Potentials
1 CH_4 = 21 CO_2
1 N_20 = 310 CO_2

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DVPRC's Regional GHG Inventory using eGRID emission rates

- DVRPC then calculated the total regional GHG emissions from electricity consumption of 54,224 GWh as follows:

$$54{,}224\ GWh\ x\ \frac{1000\ MWh}{GWh}\ x\ \frac{1224\ lbs\ CO2e}{MWh}\ x\ \frac{1\ metric\ ton}{2205\ lbs}$$

= 30.1 million metric tons CO_2e

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Helpful Conversions:

1GWh = 1000 MWh

1 metric ton = ~2205 lbs

DVRPC's LED Change-Out Program

- Working with counties and municipalities to change out 10,000 incandescent traffic lights for LEDs
- Projected electricity savings: 3000 MWh annually
- RFC East non-baseload CO_2 factor: 1671.96 lbs/MWh
- Estimated CO_2 savings as follows:

$$3000\ MWh\ x \frac{1671.96\ lbs}{MWh}\ x\ \frac{1\ metric\ ton}{2205\ lbs} = 2274\ mtCO2$$

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Next Technical Forum Webinars

- Three Part Series: Assessing the Multiple Benefits of Clean Energy:
  - Inter-workings of the electrical grid
  - Emissions quantification of clean energy policies and programs
    - Displaced emissions approaches
  - Estimating the economic benefits of clean energy policies and programs
    - Jobs, money saved/avoided

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EPA 2010. Assessing the Multiple Benefits of Clean Energy: A Resource for States. Available: http://www.epa.gov/statelocalclimate/resources/benefits.html

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Appendix A: Steps to quantify emissions for DVRPC's 2005 GHG inventory – CO_2 equivalents

General Approach to calculate CO_2 equivalents:

eGRID emission rates x energy conversion factor x Global Warming Potential [1]

Units used in equation:

emission rate (lbs/GWh) x energy conversion (1GWh/1000MWh) x Global Warming Potential

Helpful Conversions:

1GWh = 1000 MWh

Global Warming Potentials

1 CH_4 = 21 CO_2

1 N_20 = 310 CO_2

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1)These estimates are from the IPCC's Second Assessment Report (1996) . These are the values used internationally for reporting greenhouse gas (GHG) emissions to the United Nations. (EPA also uses them for the Inventory of U.S. Greenhouse Gas Emissions and Sinks.)

Appendix B: Steps to quantify emissions for DVRPC's 2005 GHG inventory – Quantify GHG emissions

General Approach to quantify CO_2e emissions:

eGRID emission rates* x electricity consumption x metric tons conversion factor

Units used in equation:

emission rate (lbs/MWh) x electricity consumption (MWh) x metric tons/lbs conversion

Helpful Conversions:

1GWh = 1000 MWh

1 metric ton = ~2205 lbs

*In this example we calculated CO2e emission rates before applying electricity consumption