Deciding an Approach for Quantifying Emission Impacts of Clean Energy Policies and Programs

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January 30, 2012
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Today's Presentation

- Overview of important terms
- Which electric generating units are generally displaced once a State, Local or third-party implements clean energy policies and programs
- Important factors when deciding which emissions quantification approach to use
- Overview of available emission quantification approaches and examples for when to use them
  - eGRID subregion nonbaseload emission rates
  - EGU capacity factor emission rates
  - Hourly emission rates
  - Energy modeling

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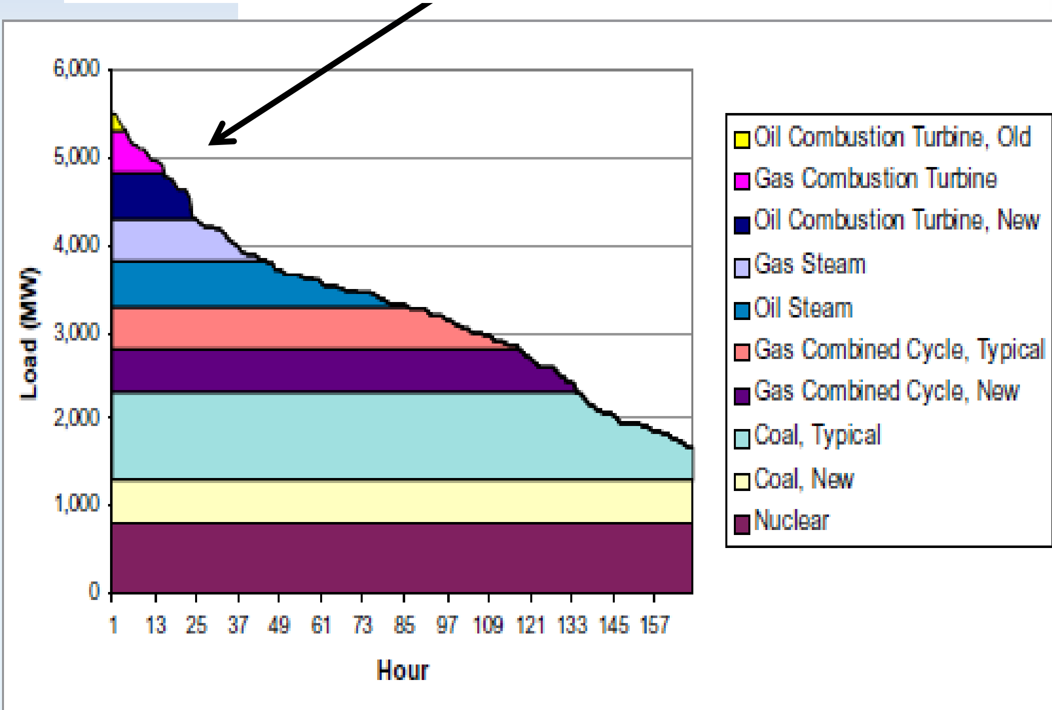
Common Terms and Abbreviations

- Clean Energy (CE): no-to-low emitting options to meet energy demand, such as energy efficiency, combined heat and power, and renewable energy
- Electric generating unit: (EGU) a power plant or generator that produces electricity and is connected to the grid.
- Baseload EGUs: operate near maximum capacity most hours of day. (E.g., nuclear, in most cases coal & hydro plants)
- Nonbaseload EGUs: fluctuate generation based on changes in demand (E.g., gas combined cycle, gas turbines, oil-fired plants)
- Peaking EGUs: only operate during the highest demand periods (older oil combustion turbines, gas combustion)
- Marginal Unit: the last (or next) EGU called upon to meet demand

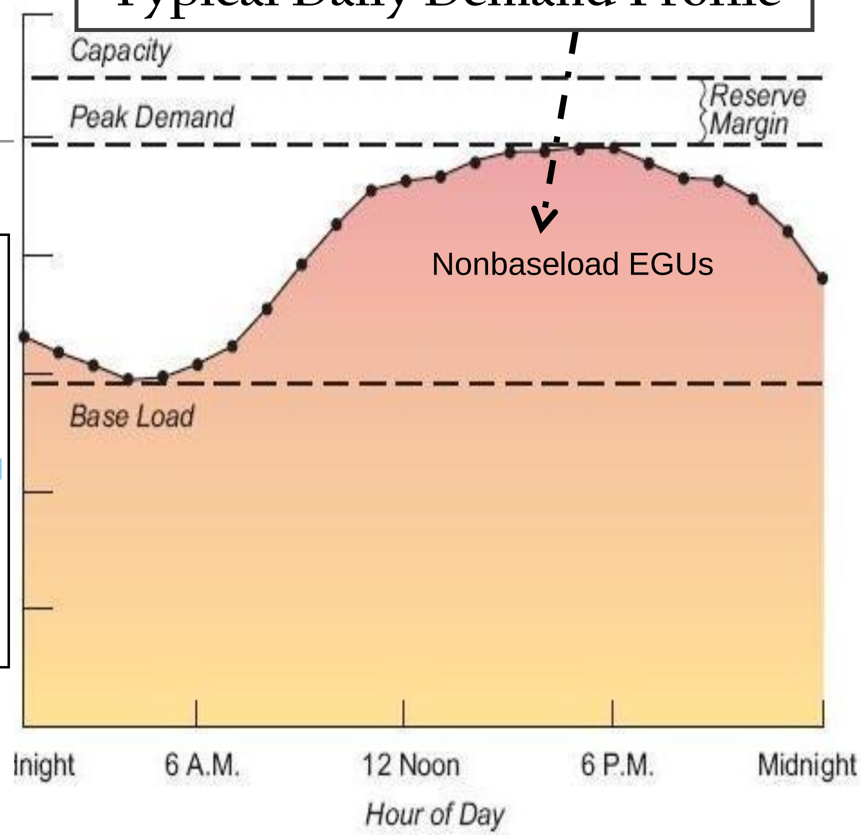
How do Clean Energy policies reduce emissions?

Generally, CE policies reduce emissions at nonbaseload EGUs, and the most expensive units are dispatched last

Hypothetical EGU Dispatch Curve (1 week)



Typical Daily Demand Profile



Types of Clean Energy Policies and Their Impacts

Examples of State Energy Efficiency Policies:

- Energy Efficiency Resource Standards
- Public Benefits Funded EE programs

Examples of State Renewable Energy Policies:

- Renewable Portfolio Standards (RPS)
- Renewable Energy Incentives (E.g., rebates)

Clean Energy policy impacts are estimated in Megawatt-hours (MWh).

- Capturing energy impacts of CE policies will provide the most emissions benefits.

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The *Clean Energy-Environment Guide to Action: Policies, Best Practices, and Action Steps for States* (April 2006) http://www.epa.gov/statelocalclimate/resources/action-guide.html

Available Data Sources for EGU generation and emissions

- EPA's eGRID (Emissions Generation Resource Integrated Database)
  - Annual emissions for NOx*, SO_2, Hg, CO_2, CH_4 and N_20
  - Different aggregation levels – boiler to subregions
  - Most recent data from 2007
- EPA's Clean Air Markets Division (CAMD) database
  - Monitored NOx, SO2, CO2 emissions for EGUs reporting to EPA
  - Emission unit level
  - Updated every quarter
- State emissions inventories
  - Emissions for EGUs permitted by State DEPs
  - Includes units not captured in EPA data collection
  - Scale of emissions varies depending upon permitting requirements and State regulations

*Ozone season emissions available for NOx

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Choosing The Method

- There are several key questions that can help narrow your options as you select a method:
  - What is the **purpose** of the analysis?
  - What types of **emissions** are you interested in?
  - What **scale** do you care about?
  - How much time and **resources** do you have?
- Match your answers to the methods.

Key Considerations When Selecting an Approach		Approaches			
		eGRID subregion nonbaseload	EGU Capacity Factor Approach	Hourly Emission Rates	Energy Modeling
PURPOSE	**Prelimary** Analysis	*	*		
	Voluntary Programs	*	*		
	General benefits Info	*	*		
	Regulatory or statutory requirement			*	*
EMISSIONS	**Emissions** of interest	NOx,SO_2,CO_2, (biogenic CO_2), CH_4, N_2O, Hg	NOx, SO_2, CO_2	NOx, SO_2, CO_2	NOx, SO_2, CO_2,Hg, varies
SCALE	**Geographical** - state vs. regional; import/export	eGRID subregion partially addressed	both partially addressed	both not addressed	electric grid region - fully addressed
	Source aggregation	boiler, generator, plant	plant	emission unit (boiler)	emission unit (boiler)
	Temporal - length of time ; historical vs.forecasted	annual & ozone season (NOx) historical	annual & ozone season (NOx) historical	Annual, monthly, hourly historical	annual, ozone season (NOx), hourly forecasted
RESOURCES	**Time**	low	low	medium	high
	Money	low	low	medium	high
	Staff expertise	low	low	medium	high

When to Use Emission Quantification Approaches

The chosen approach will be useful for different types of analysis:

- Basic approaches are useful when:
  - time or resources are limited
  - high-level or preliminary analyses are needed
  - a long list of options need to be shortened
- Sophisticated approaches are useful when:
  - policy options are well-defined
  - high degree of precision and analytic rigor is desired
  - sufficient time, data and financial resources are available.

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eGRID subregion nonbaseload emission rates approach

- **How it works:**
  - Uses emission rates that represent average emissions of nonbaseload units in an eGRID subregion.
- **Examples for when to use:**
  - Estimate emission reduction potential
  - Explain emission benefits to the general public
- **Advantages:**
  - Requires low resources – easy calculation
  - Great for annual emissions reductions, regional and national estimates
- **Limitations:**
  - Does not specify which power plant is reducing emissions
  - Most recent year of data: 2007

eGRID Subregions

CALCULATION USING eGRID

Energy saving of EE (MWh)

×

eGRID nonbaseload emission rate (lbs/MWh)

(Account for Grid loss factor)

=

emissions avoided by EE (lbs)

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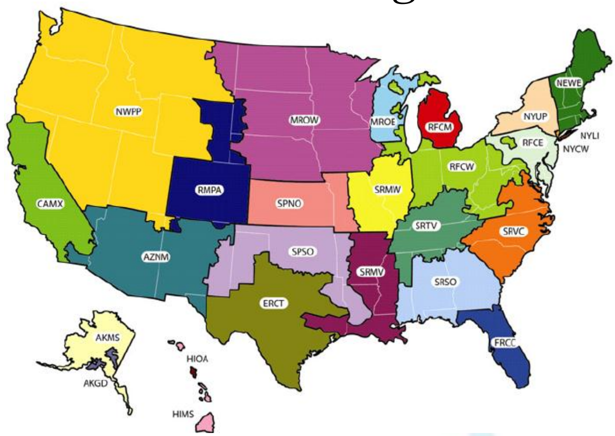
eGRID subregion nonbaseload emission rates approach

Informational resources:

- eGRID website:
  - http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html
- eGRID summary tables:
  - http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf
- eGRID overview presentation:
  - http://www.epatechforum.org/documents/2010-2011/March%2031/Diem-eGRID-2011-03-11.pdf
- New Mexico example using eGRID:
  - http://www.epatechforum.org/documents/2010 2011/March%2031/DeYoung_eGRID_3.31.11.pdf

eGRID Subregions



USERS of eGRID

- EPA's Power profiler
- EPA's CHP calculator
- Energy Star Portfolio Manger
- EPA's Personal GHG calculator
- EPA's GHG equivalency calc.
- EPA's Wastewise GHG calc.

(The emission rates may vary within each tool depending upon the purpose)

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EGU Capacity Factor Emission Rates Approach

How it works:

- An EGU's capacity factor is indicative of how much emissions could be displaced
  - EGUs with ~ high capacity factors are generally baseload EGUs
  - EGUs with ~ low capacity factors are generally nonbaseload EGUs
- Distribute emissions reductions to each EGU based on 1) displaceability 2) CE impacts 3) EGU emission rates

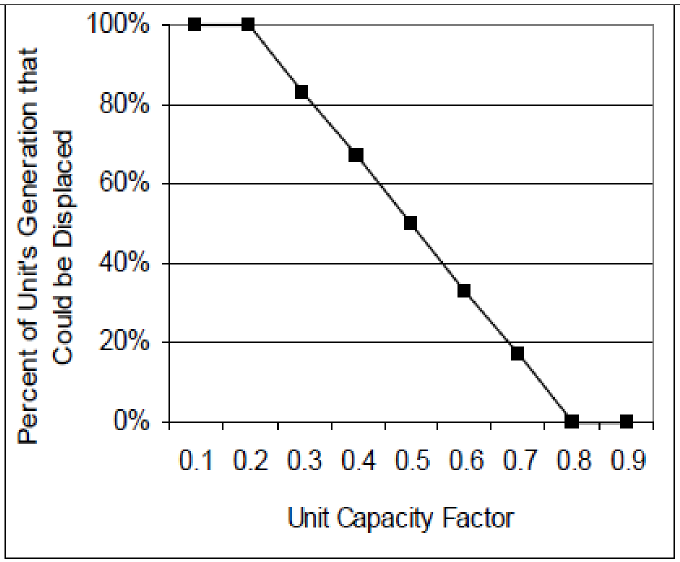
Examples for when to use:

- Understand which EGUs are nonbaseload and where emissions could most likely be displaced
- Identify specific areas where reductions could take place

AN EGU's CAPACITY FACTOR IS A RATIO:

$$\frac{\text{The actual electricity produced}}{\text{The available electricity production at maximum capacity}}$$

Capacity Factors Relationship to Emissions Displacement



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EGU Capacity Factor Emission Rates Approach

- **Advantages:**
  - Emissions can be distributed to each EGU
  - Relatively easy calculation
  - Great for preliminary analysis
- **Limitations:**
  - Capacity factors are approximate and don't account for maintenance, outages, etc.
  - Dynamics of electric grid not captured (E.g., exports, imports)
  - Most recent year available: 2007
- **Examples using this approach:**
  - Energy efficiency policy analysis in Texas (S.B. 5)
    - Estimated how much and where emission reductions occur within TX

Capacity Factors can be found in eGRID's excel workbooks

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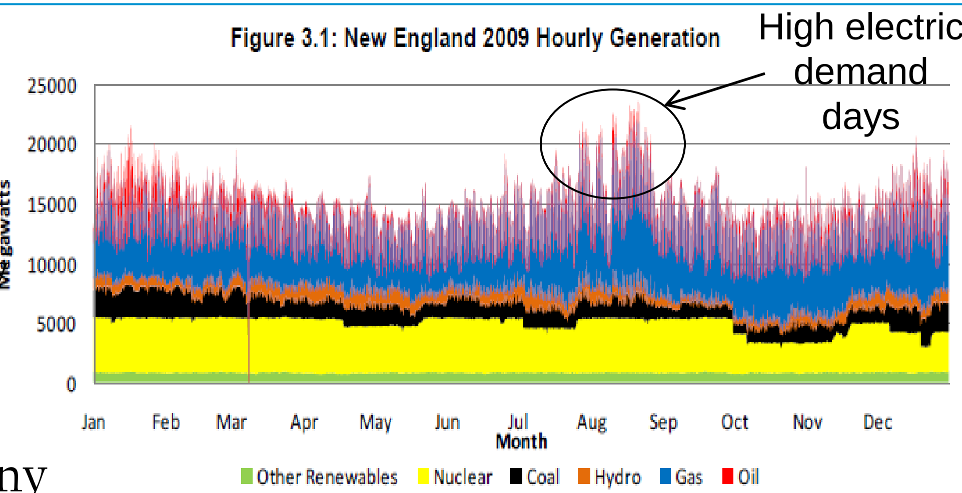
Hourly Emission Rates Approach

How it works:

- Use reported hourly generation and emissions information to derive hourly emission rates.
- Historical hourly emissions rates can be aggregated to any temporal scale to answer policy questions.
- **Examples for when to use:**
  - Regulatory analysis
  - Analyze high electric demand days
  - How RE technologies reduce emissions



ISO New England Report
March 2011

Reported Hourly Emissions information can be found at EPA's Clean Air Market's Division website: http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=iss.progressresults

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Hourly Emission Rates Approach

Advantages:

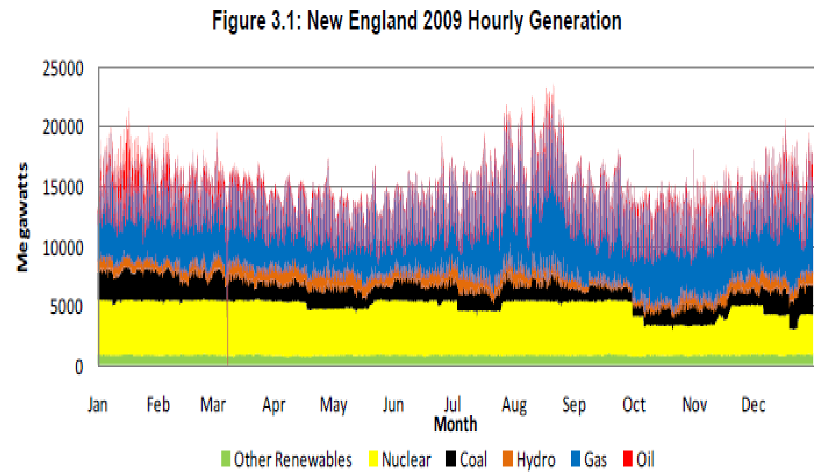
- Emission impacts at different times of day and year
- Continuous quarterly reporting to EPA at emission unit level

Limitations:

- Data intensive w/out infrastructure set up
- Hourly load impacts of energy programs are required

Examples of this approach:

- Washington Council of Governments calculator
  http://www.mwcog.org/environment/air/EERE/default.asp



ISO New England Report
March 2011

- Mid-Atlantic Regional Air Management Association Report
  http://www.marama.org/RegionalEmissionsInventory/2007hourlypoint/FinalDoc_mar2011_Analysis_of_Hrly_CAMD_Emissions_Data.pdf.

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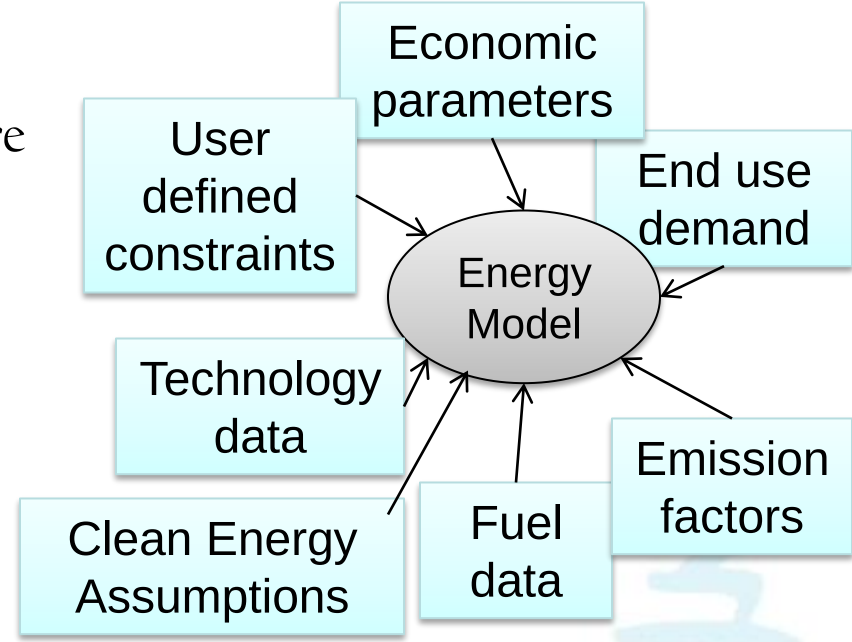
Energy Modeling Approach

- **How it works:**
  - Dynamic simulation models are used to forecast emissions
  - Models account for complex interaction of the electric grid
    - Dispatch Models
    - Capacity Expansion Models
- **Examples of when to use:**
  - Regulatory analysis
  - When policy assumptions are well defined and detailed input data is available



EPA uses the Integrated Planning Model (IPM) for all electric sector regulatory analysis

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*NEMS - National Energy Modeling System
**IPM - Integrated Planning Model includes dispatch capabilities
*** MARKAL - Market Allocation Model

Energy Modeling Approach

- Examples of this approach:
  - Energy Information Administration's (EIA) Annual Energy Outlook (AEO) Projections (NEMS) http://www.eia.gov/forecasts/aeo/
  - U.S. EPA's Regulatory Analysis (IPM) http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html
  - Emission reductions of clean energy policies in California's Air Management Districts (PROSYM)
    http://www.epatechforum.org/documents/2010 2011/June%2014/Fisher%206-14 2011%20EPA%20Tech%20Forum.pdf

Advantages and Disadvantages of Energy Models

Energy Model	Advantages	Disadvantages
<u>Dispatch Models</u> ■ Prosym, ■ Promod, ■ Ventyx	■Provides very detailed estimations about specific plant and plant-type effects within the electric sector. ■ Provides highly detailed, geographically specific, hourly data. ■ Model impacts of cap and trade programs	■Often lacks transparency. ■Requires technical experience ■Labor- and time- intensive. ■Often high labor and software licensing costs. ■Requires establishment of specific operational profile of the clean energy resource.
<u>Capacity Expansion Models</u> ■ NEMS, ■ IPM, ■ Energy 2020, ■ MARKAL	■Model selects optimal changes in generation mix based on assumptions and energy system (10–30 years). ■ Captures emission changes from new power plants and retirements ■May provide plant specific detail and perform dispatch simultaneously (IPM). ■Model impacts of cap and trade programs	■Often lacks transparency ■Requires significant technical experience ■Labor- and time- intensive. ■Often high labor and software licensing costs. ■Requires assumptions that have large impact on outputs (e.g., future fuel costs).

Contact Information

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