



# **State Climate and Energy Technical Forum: Quantifying Emission Impacts of Clean Energy Initiatives**

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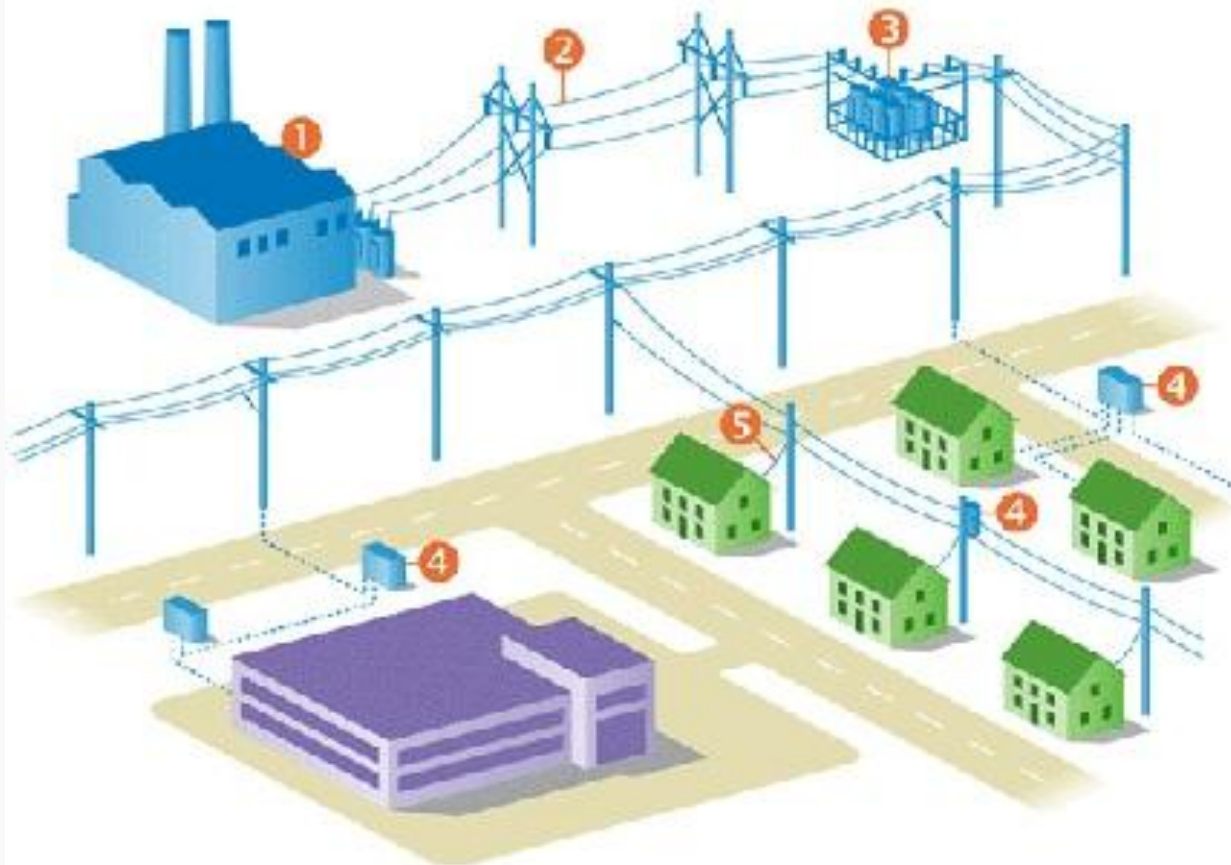
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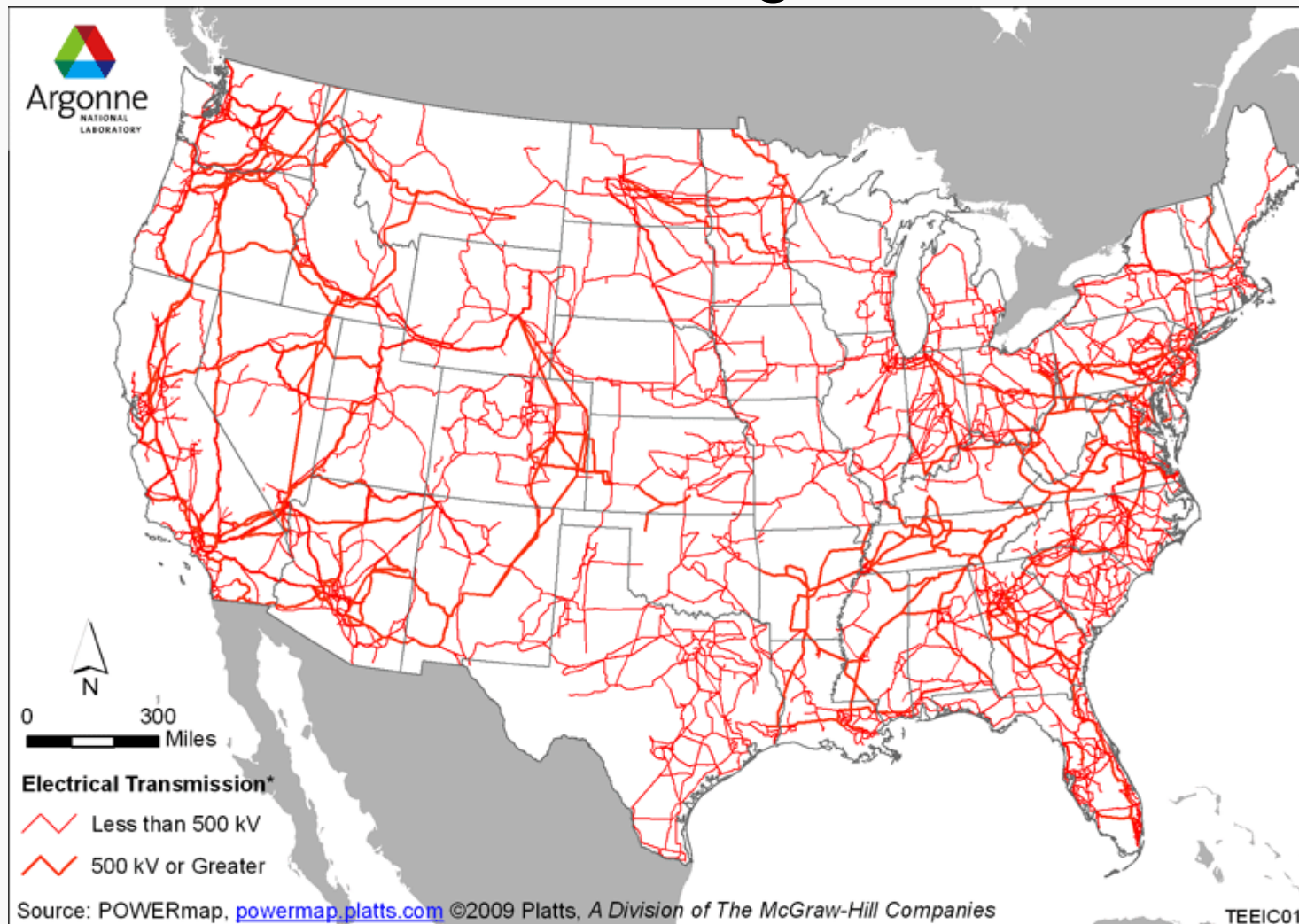
## Outline

- A brief overview of how electricity is dispatched and what a “marginal” unit is.
- How clean energy initiatives and air pollution control devices affect air emissions differently.
- Types of methods available to estimate emission reductions from clean energy.

# How the electric grid works



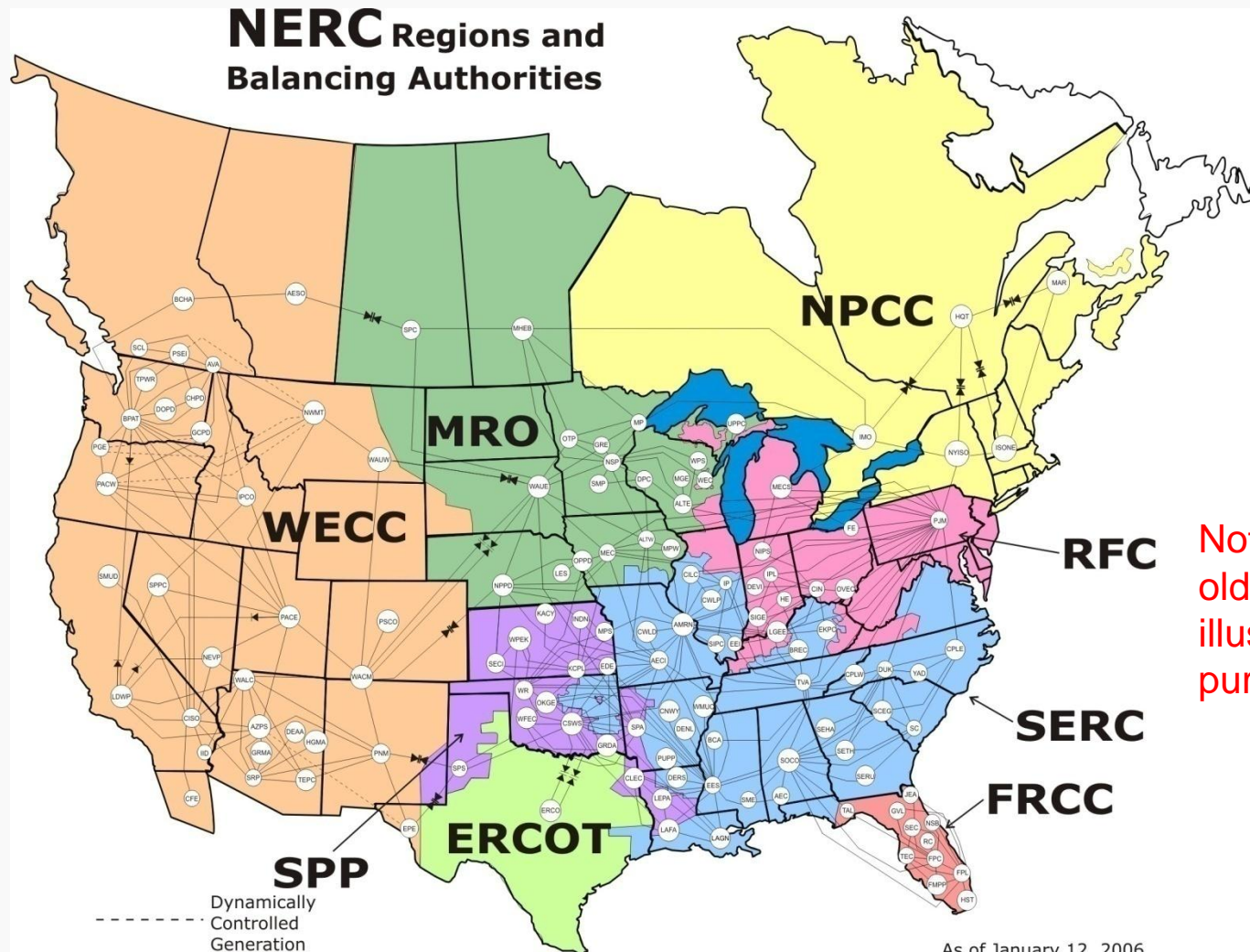
# How the electric grid works





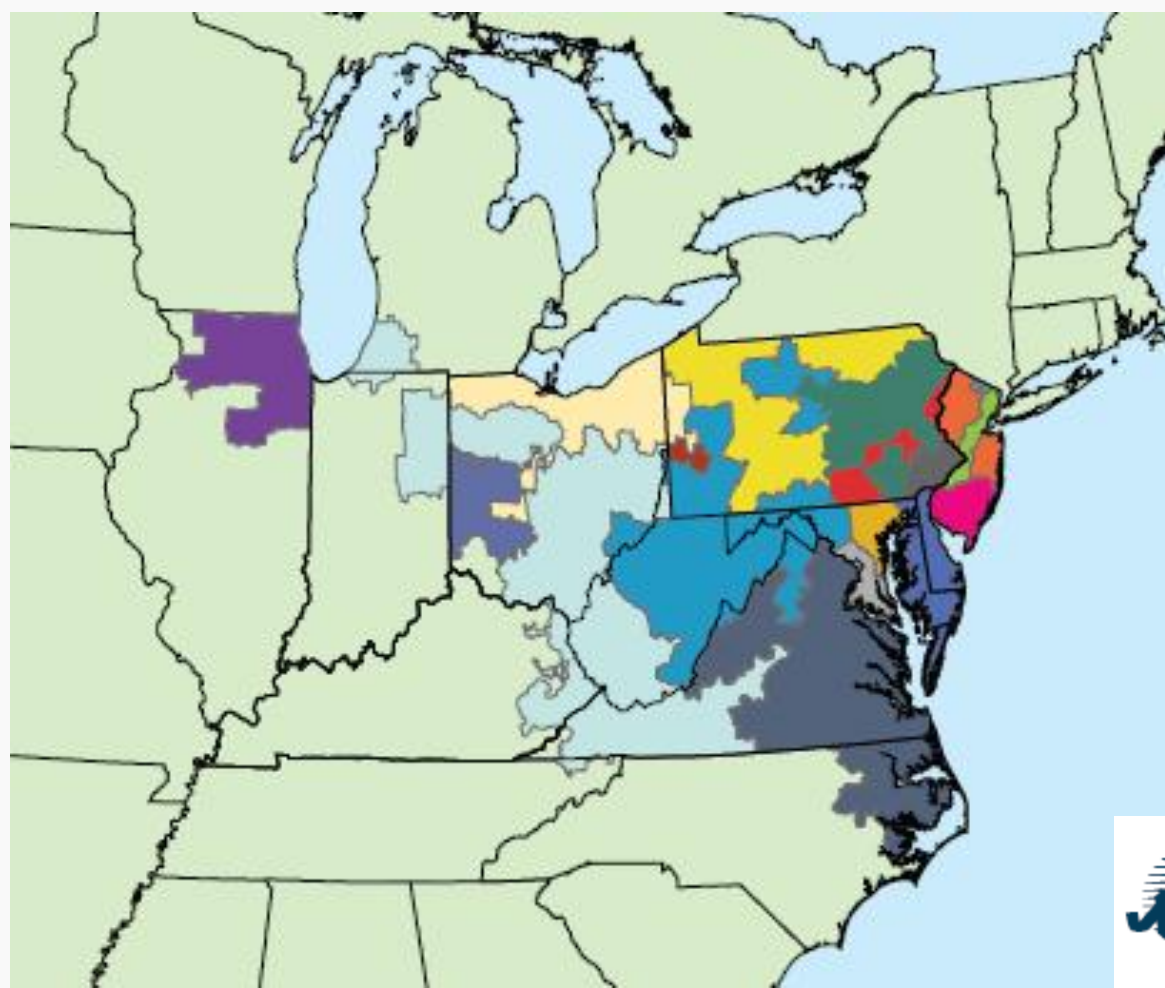


# Power Control Areas (a.k.a. balancing authorities)



Note: this is an old map for illustration purposes only.

# Example of PCA and Utility Territories



## Legend

### ZONE

-  Allegheny Power Systems
-  American Electric Power Co., Inc.
-  American Transmission Systems, Inc.
-  Atlantic Electric Company
-  Baltimore Gas and Electric Company
-  ComEd
-  Dayton Power and Light Co.
-  Delmarva Power and Light Company
-  Dominion
-  Duquesne Light
-  Jersey Central Power and Light Company
-  Metropolitan Edison Company
-  PPL Electric Utilities
-  PECO Energy
-  Pennsylvania Electric Company
-  Potomac Electric Power Company
-  Public Service Electric and Gas Company
-  Rockland Electric Company



# Power Control Areas (balancing authorities)



Electric Reliability Council of Texas (ERCOT) Control Room



PJM's Control Room in Pennsylvania

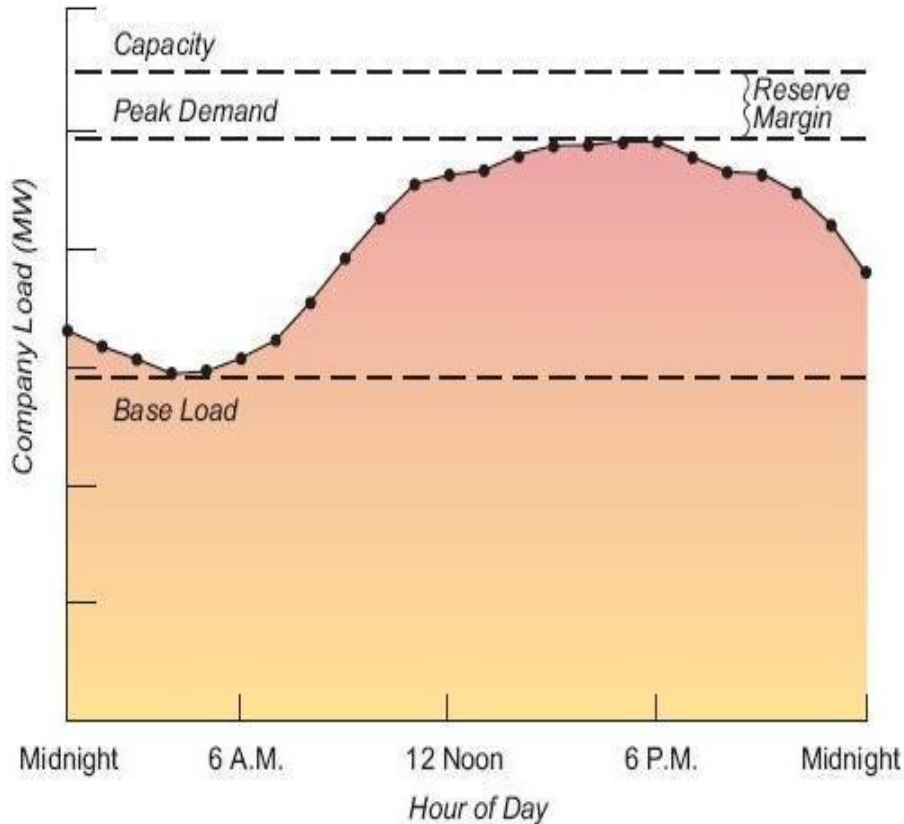


Independent System Operator – New England (ISO-NE) Control Room in Massachusetts



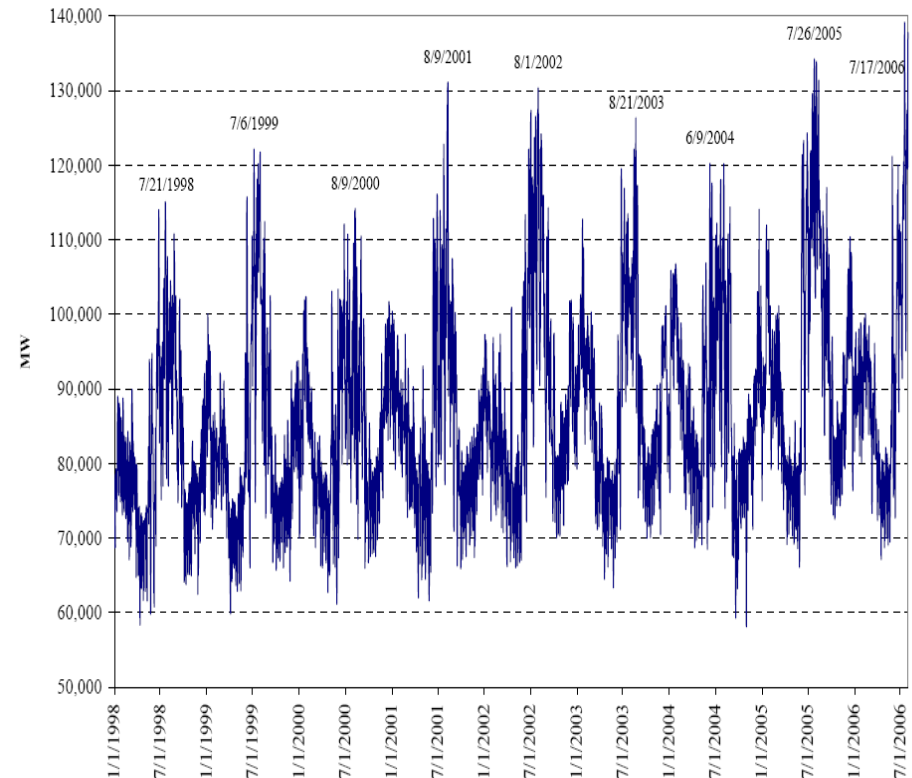
# A “marginal” unit is the last generator to be dispatched.

## Typical Daily Load Shape



## PJM Peak Loads 1/1998-7/2006 showing seasonal variation in load

### Non Coincident Daily Peak Load RTO

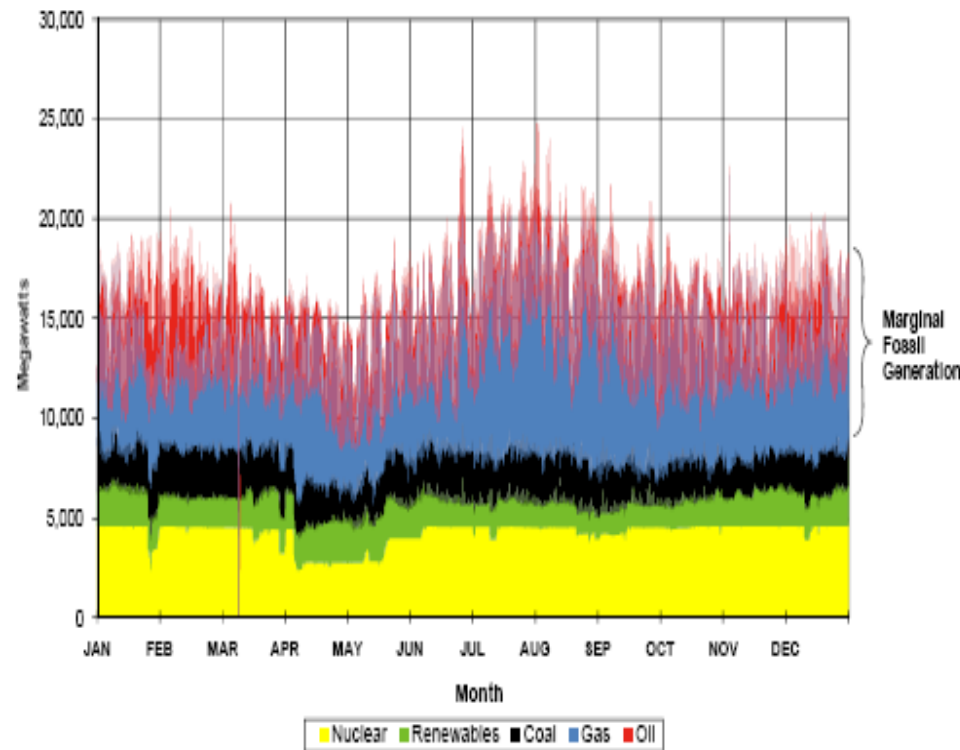




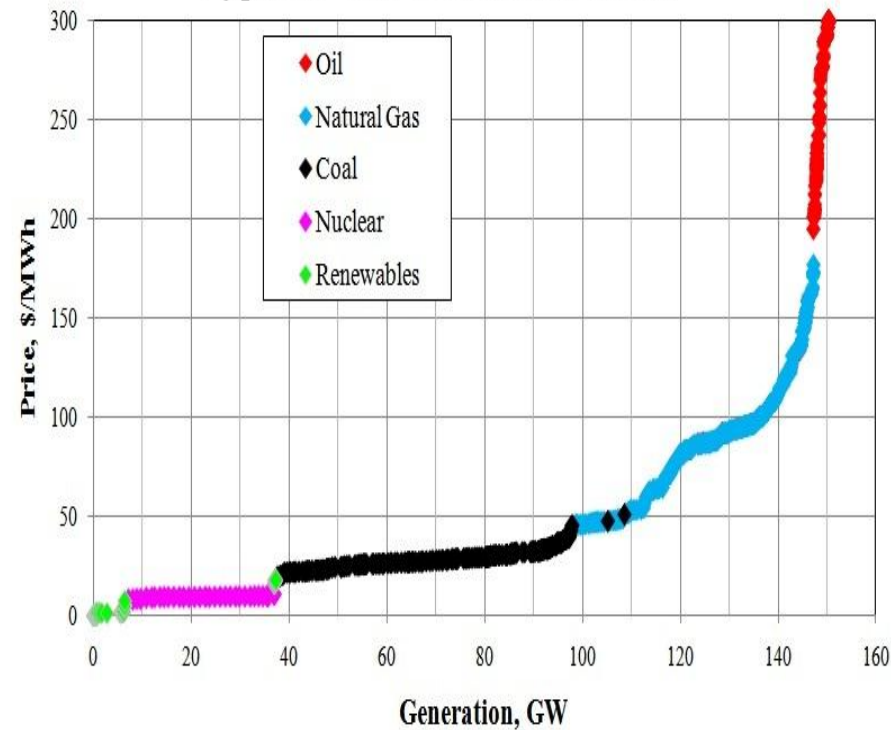


A “marginal” unit is the last (or next) generator to be dispatched.

Figure 3.1: New England 2007 Hourly Generation



Typical PJM Generation Stack





# How Clean Energy is Different from Air Pollution Control Devices

- Air Pollution Control Devices or “end of pipe” controls
  - Reduce the rate and mass of emissions designed to be removed.
  - Certainty/enforceability in air permits and monitoring requirements.
- Clean Energy = Pollution Prevention
  - Any significant amount of clean energy will reduce the generation from the marginal unit at that time.
    - Marginal units are usually combustion units.
    - Less fuel burned = fewer emissions.
    - Fewer emissions are directionally correct for air quality improvement.
  - ALL air pollutants reduced at the same time
  - But where & how much ?



# Options for estimating emission reductions from Clean Energy

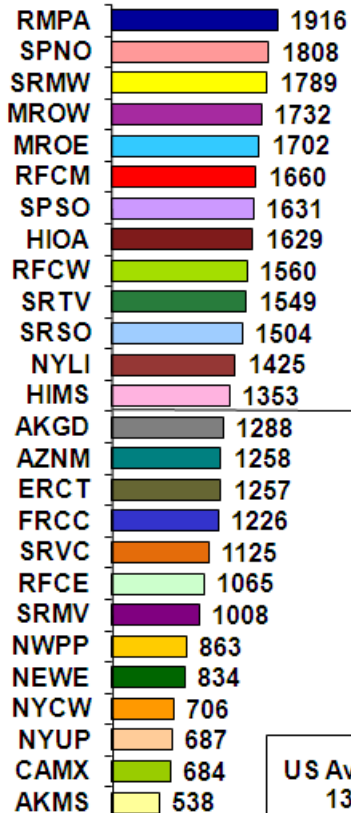
- Simple estimates (without geographic distribution) such as:
  - eGRID subregion non-baseload output emission rates ([see 3/31/2011 Tech Forum Webinar Archives/Podcast](#))
  - ISO-NE marginal emission rate report
- Less simple estimates (with geographic distribution), e.g.:
  - Capacity factor as dispatch surrogate approach – akin to a deep marginal emission rate weighted more heavily during peak times – as used in Texas’ “Estimation of Annual Reductions of NOx Emissions in ERCOT for the HB3693 Electricity Savings Goals”
  - Load Duration Curve approach
- Electric system models, e.g.:
  - Dispatch Models: e.g. PROSYM used in the California Energy Commission Study
  - Capacity Expansion Models: e.g. IPM, NEMS
  - Other advanced electric system methods: e.g. RSG’s Time Matched Marginal (TMM) emissions methodology



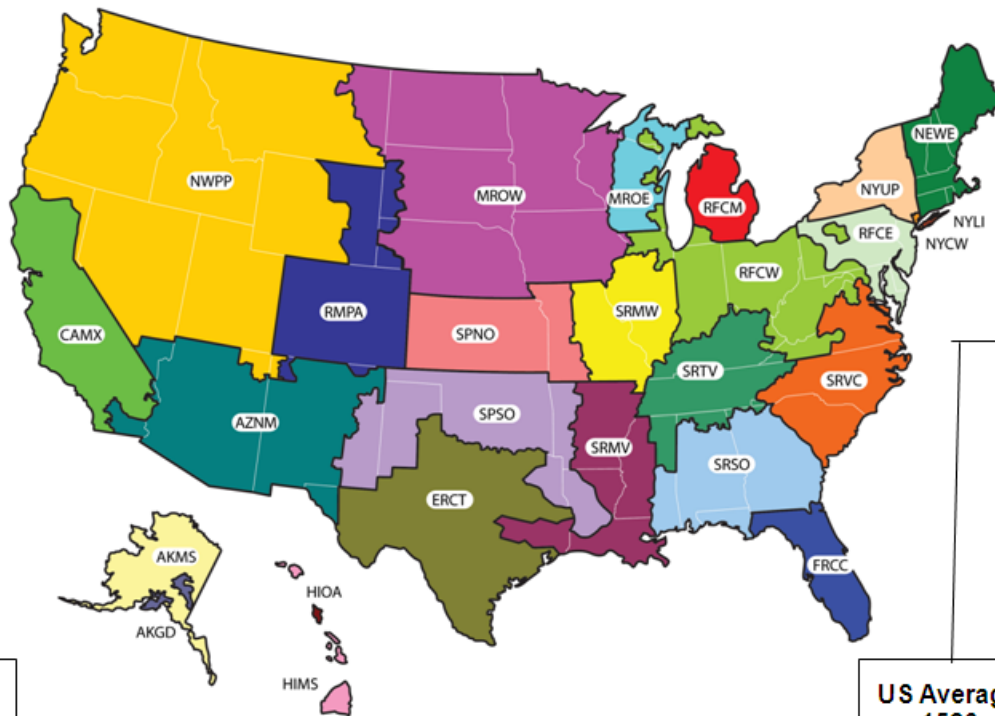
## 2007 eGRID Subregion Annual CO<sub>2</sub>e Output Emission Rates (lb/MWh)

**Total**

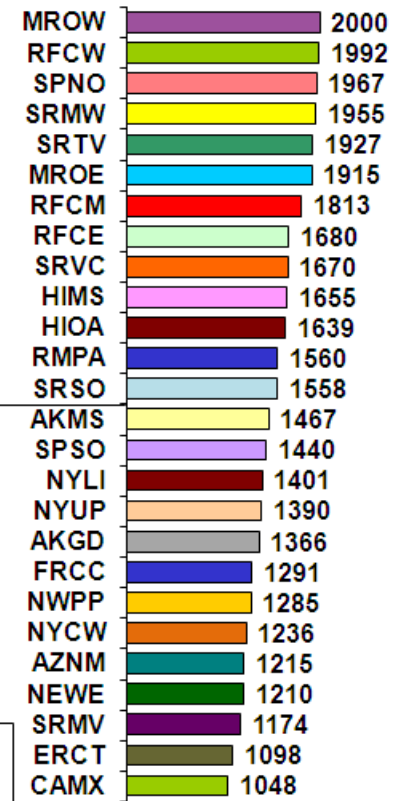
**Non-baseload**



US Average  
1300




US Average  
1526





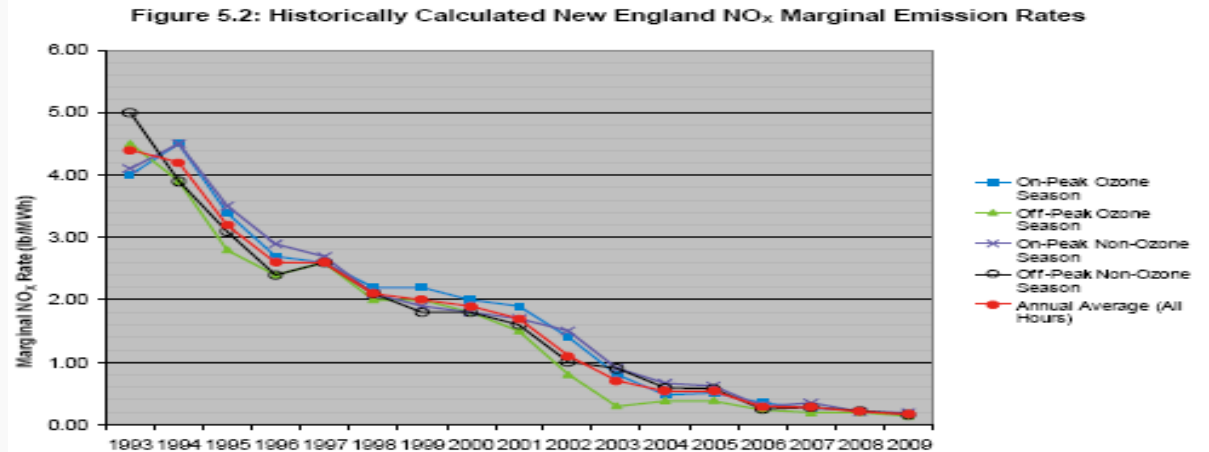


# Note about interaction with regulatory programs

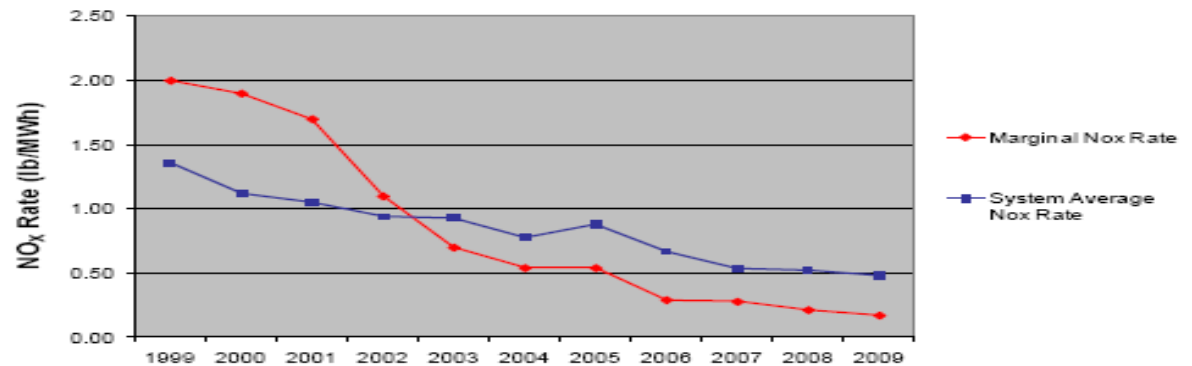


2009 ISO New England  
Electric Generator Air Emissions Report

System Planning Department  
ISO New England Inc.  
March 2011



**Figure 5.5: 1999 – 2009 Calculated New England Annual Average System NO<sub>x</sub> Emission Rate vs. Marginal NO<sub>x</sub> Emission Rate (lb/MWh)**



<http://www.iso-ne.com/>

Click -> Generation & Resources, Reports, Emission Reports