



SIEMENS



Gas Turbine Regulatory Drivers

# Building New Power Industry- Challenges and Opportunities

Feb. 5, 2015

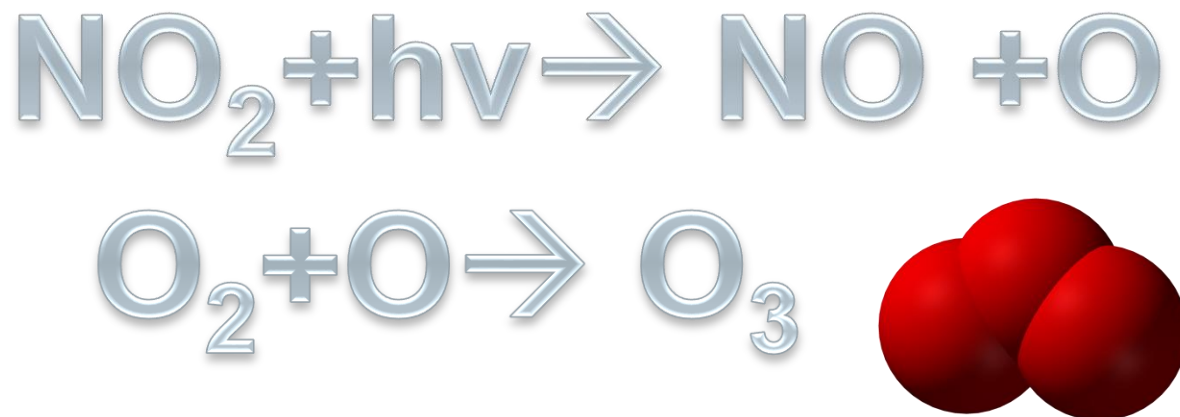
## Overview

- Air quality regulations in the United States are the most restrictive in the world. These regulations, evolved over 30 years, have solved some of the most persistent air quality problems at the time,
- Currently an array of new regulations are in various stages of implementation. Further complications come from the large number of court actions to affect the outcome or implementations of these rules
- Today's topic will be limited to two key areas impacting power plant siting and development:
  - Proposed changes to ambient ozone
  - GHG rules for new power plants



## Ozone

- Not a primary pollutant combustion
- Indirectly produced by atmospheric reaction between combustion generated  $\text{NO}_x$  (a mixture of  $\text{NO}$  and  $\text{NO}_2$ ), and unburned hydrocarbons (ethane, propane, butane and longer chain hydrocarbons).



- Creation of ozone is typically worse on sunny days. With significant regional  $\text{NO}_2$  sources, the impact on the ambient ozone can be significant.

## Proposed Ozone NAAQS Changes

In November, 2014, EPA proposed reducing the current standard of 75 ppb to a lower concentration.

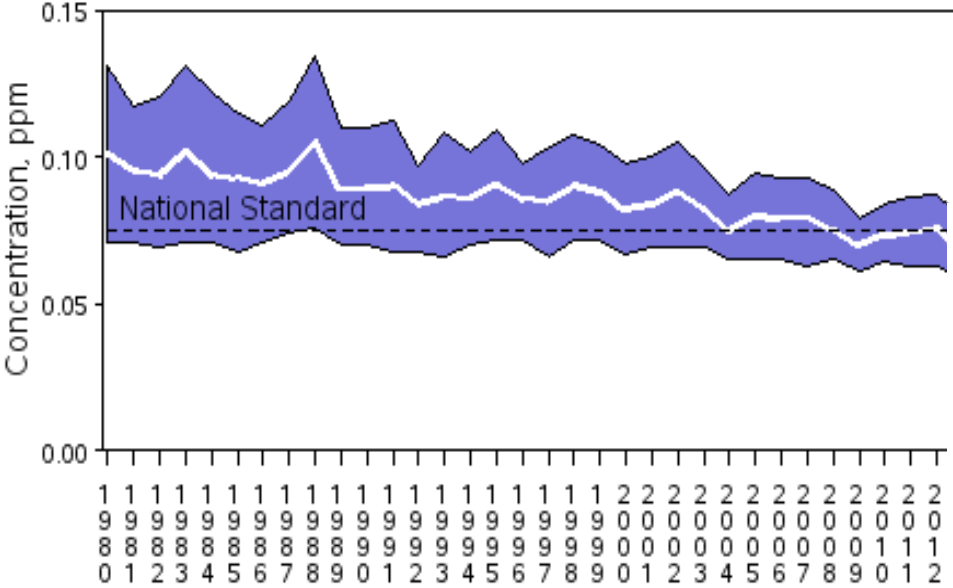
The current standard was established in 2008, after revision downward from a previous level of 80 ppb.

*“The EPA is proposing to revise the primary standard to a level within the range of 0.065 to 0.070 parts per million (ppm), and to revise the secondary standard to within the range of 0.065 to 0.070 ppm, which air quality analyses indicate would provide air quality, in terms of 3-year average W126 index values, at or below a range of 13-17 ppm-hours”*

*“The EPA is proposing this revision to increase public health protection, including for “at-risk” populations such as children, older adults, and people with asthma or other lung diseases, against an array of O<sub>3</sub>-related adverse health effects.”*

# Ozone Trends

**Ozone Air Quality, 1980 - 2013**  
 (Annual 4th Maximum of Daily Max 8-Hour Average)  
 National Trend based on 222 Sites



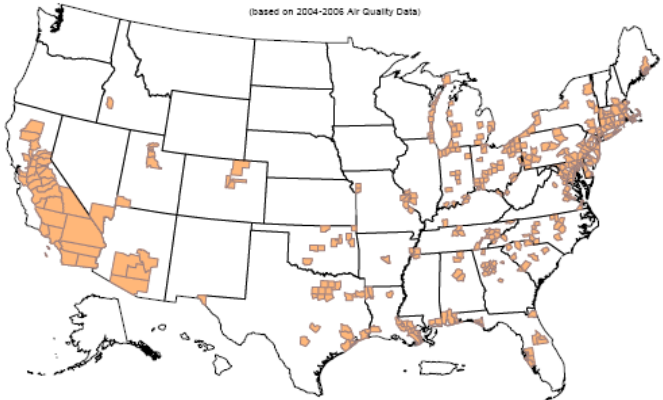
1980 to 2013 : 33% decrease in National Average

8-Hour Ozone Nonattainment Areas (1997 Standard)



Estimates are based on the most recent data (2004 – 2006). EPA will not designate areas as nonattainment on these data, but likely on data from 2006 – 2008 or later, which we expect to show improved air quality.

Counties with Monitors Violating the 2008 8-Hour Ozone Standard of 0.075 parts per million (ppm)



Notes:  
<sup>1</sup> 345 monitored counties violate the 2008 8-hour ozone standard of 0.075 parts per million (ppm).  
<sup>2</sup> Monitored air quality data can be obtained from the AQIS system at <http://www.epa.gov/air/aqis/aqis.asp>.

# Locating a Major Source Near a Class I Region

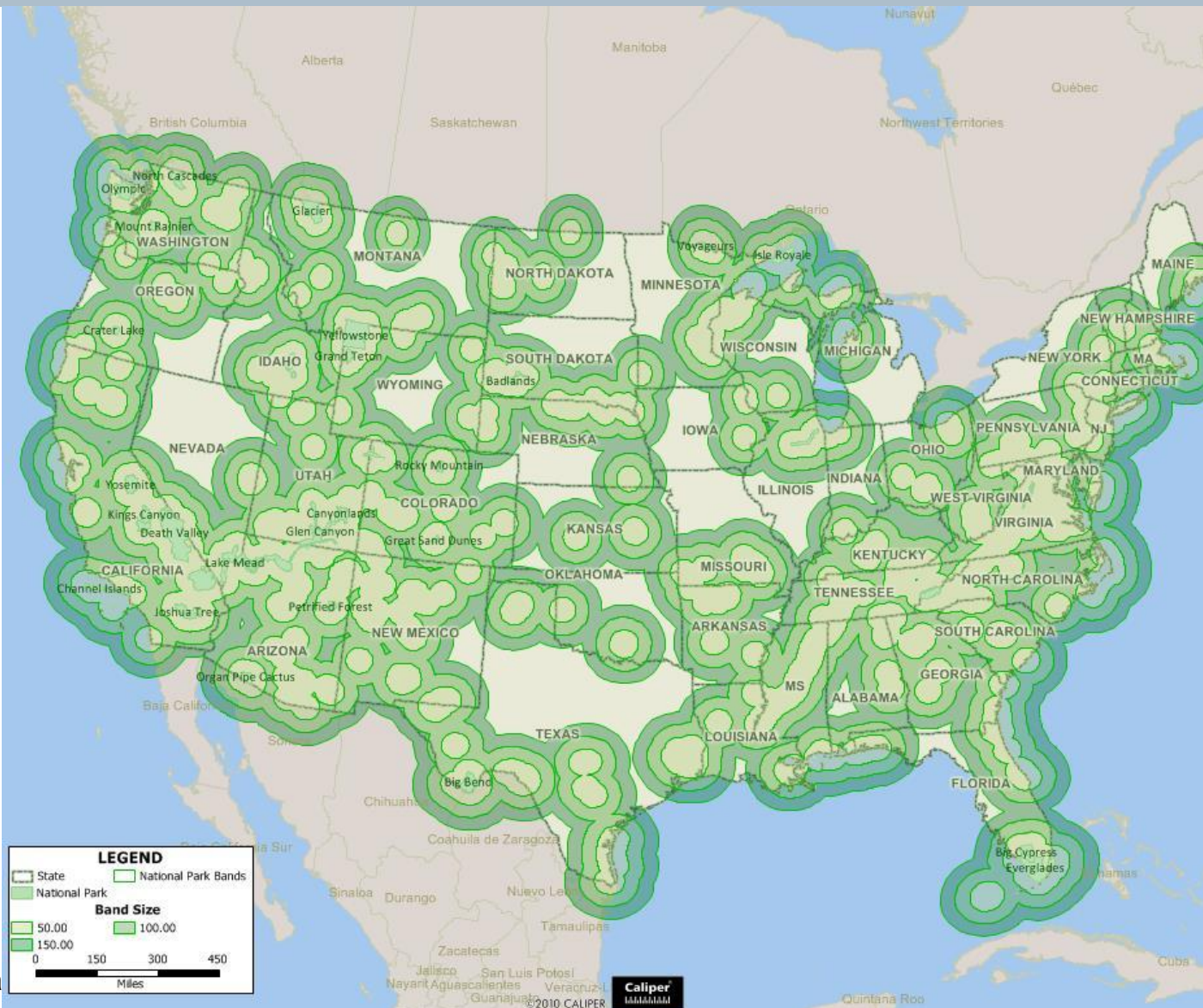
There are 158 Class I regions in the United States. These include

- 48 National Parks
- 21 Fish & Wildlife Sanctuaries
- 88 Forest Service Wildlife Reserves

Estimating the downwind impact of a source located near a Class I region.

Federal land managers may have some review oversight of any new sources with 300 km of a Class I region

Attached survey shows a radius of 50/100/150 km



## Proposed 1,100 lb/MWh CO<sub>2</sub> Regulation

- Only gas fired combined cycle turbines have the efficiencies to reach this threshold.
- But even these units cannot always achieve this emission level
  - Requires pipeline natural gas (not fuel oil)
    - Some shale gas composition variations could exceed 1,100 lb/MWh
  - Site conditions, part-load operation, design features, and operating hours all raise the emissions expressed on an output basis
- Simple cycle turbines cannot reach this threshold
- While new cycle design features continue to be introduced, pre-2006 turbine designs are still necessary to support customer and grid needs.

## GHG (CO<sub>2</sub>) Emissions (18 Jun 2014)

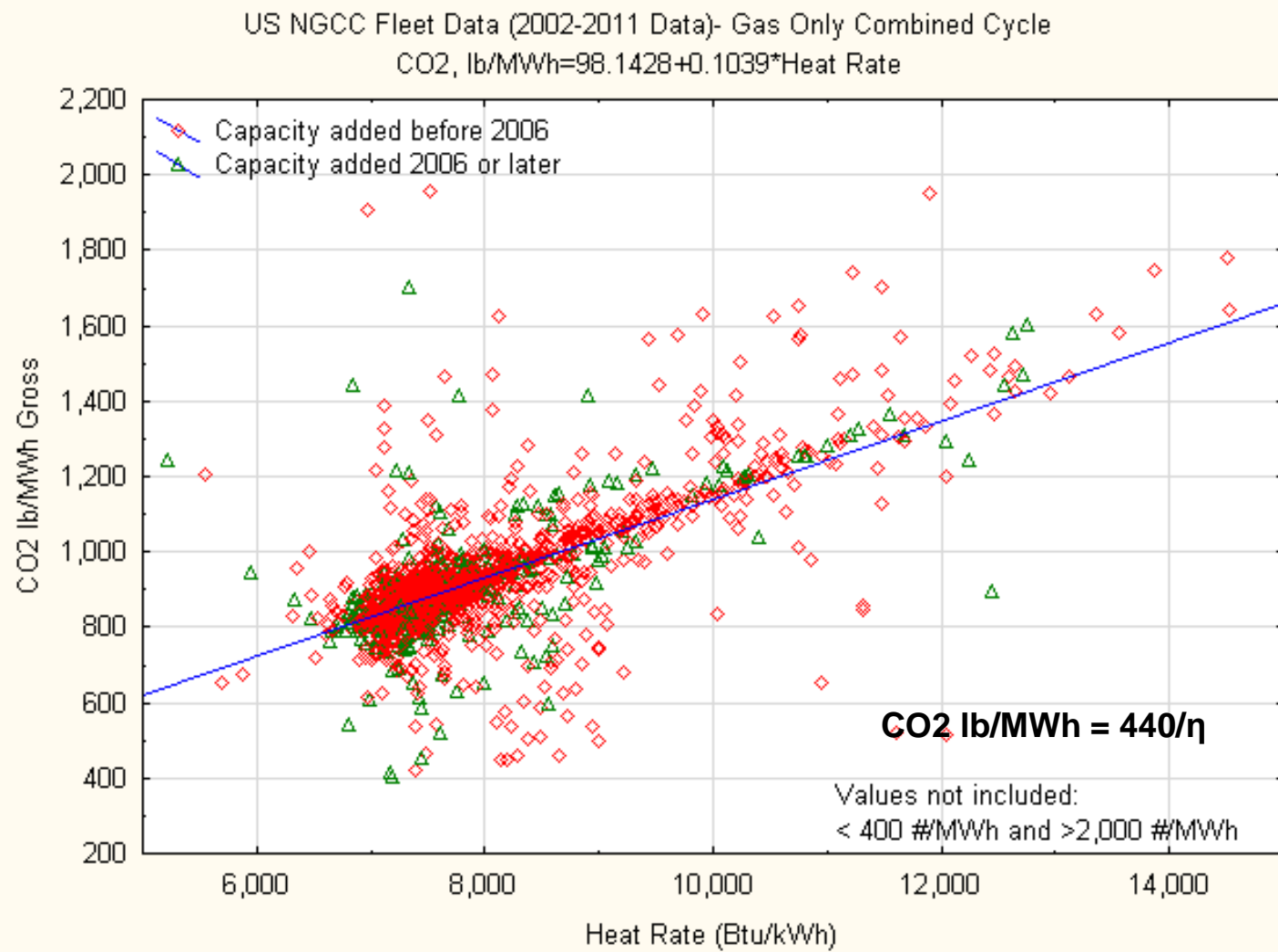
- **Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Proposed Rule**
  - Proposes regulatory benchmarks for each state to promote CO<sub>2</sub> reductions.
- **Carbon Pollution Standards for Modified and Reconstructed Stationary Sources: Electric Utility Generating Units; Proposed Rules**

**Proposes a standard for modified boilers and gas turbine systems:**

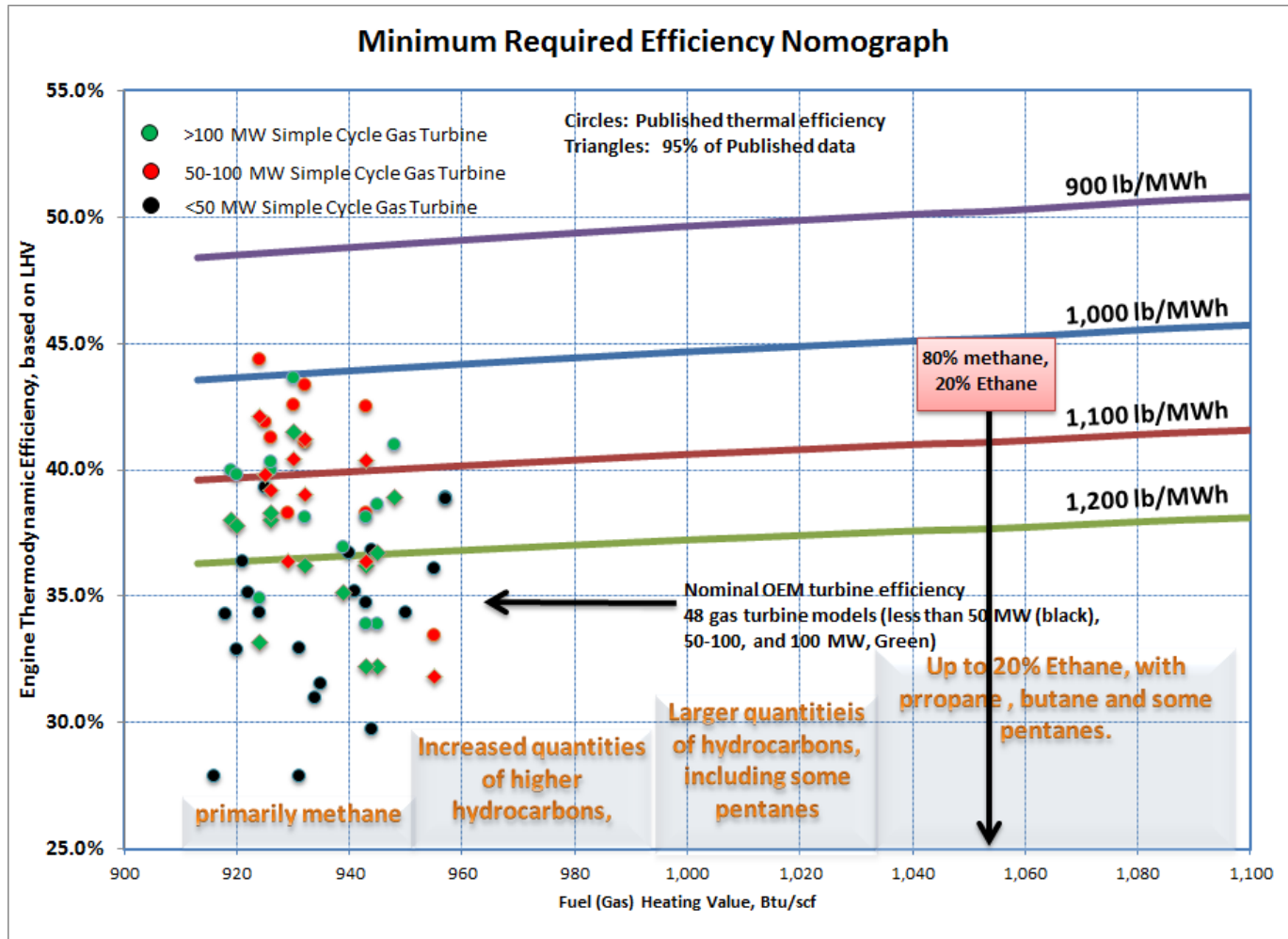
Modified Electric Utility Steam Turbine (EGU)	Modified Combustion Turbine or Combined Cycle
1,900-2,100 lb/MW	1,000-1,100 lb/MWh
Illinois No. 6 Coal at 10,300 HR = 2,400 lb/MWh	Requires a minimum cycle efficiency of 41% (LHV) to achieve this level



## Combined Cycle: CO<sub>2</sub>, lb/MWh Reported



# Fuel Type Impacts the Emission Factor Also



## Conclusions

- **There are a large number of more restrictive air (and water) quality standards in the queue (and in the courts).**
- **Just looking at two of the more challenging ones:**
  - **Revision of the ambient air quality standards for ozone from the current 75 ppb level.**
    - **Potentially making many more areas of the United States become non-attainment for ozone**
    - **This in turn will likely require even tighter emissions standards from industrial sources**
  - **Regulation of CO<sub>2</sub> emissions to a lb/MWh level.**
    - **It will be challenging for some power systems to meet this requirement. It essentially sets an efficiency standard for the source. And no viable, adaptable emission control.**