

# **Renewable Energy Mandates & the EPA**

## **A “Train Wreck” in the Making?**

**EPA**

**RES**



**Presentation to:**

**Society of Petroleum Evaluation Engineers, July 12, 2010**

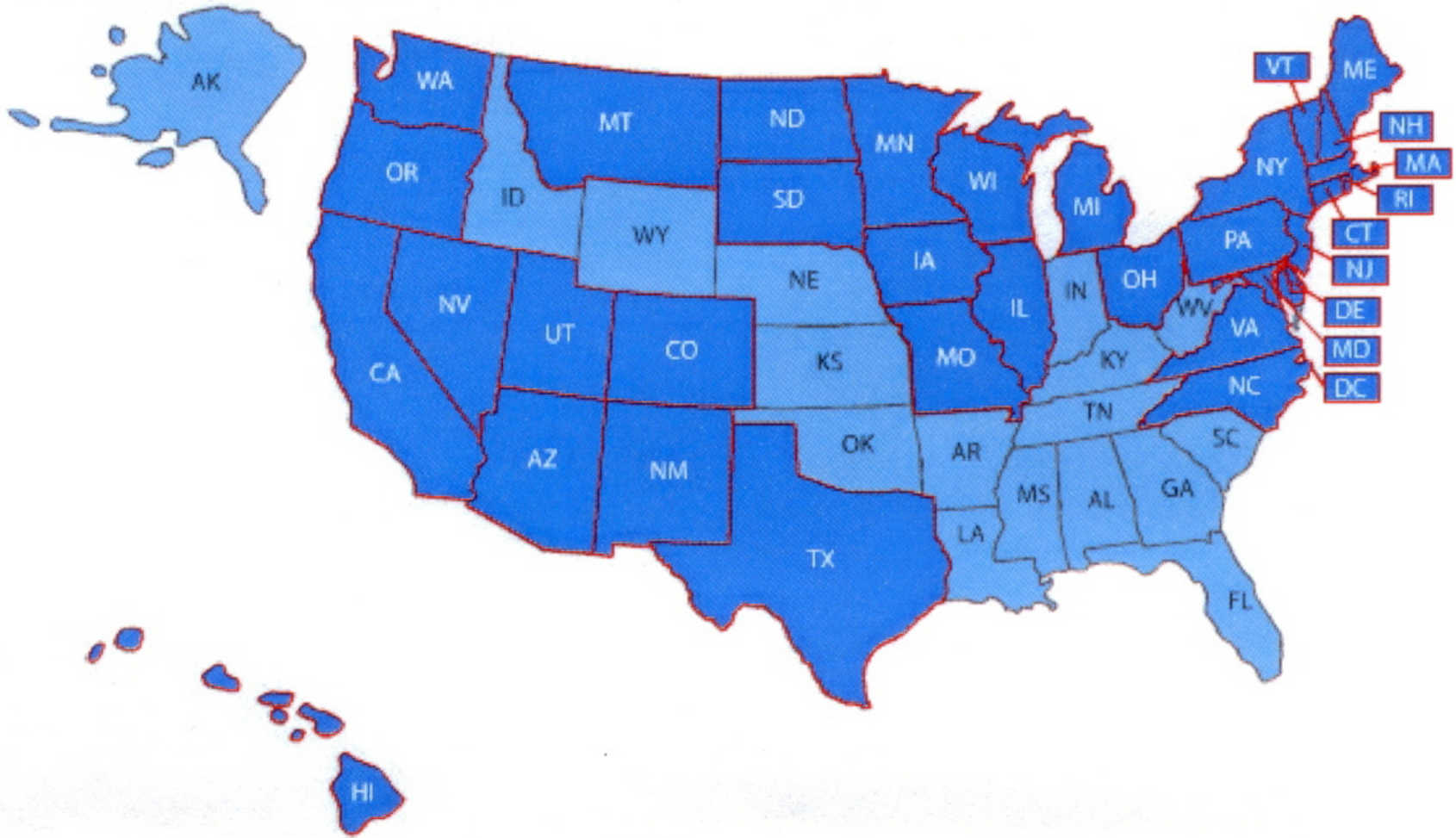
**By: John Harpole, Mercator Energy**

# The RES Train Has Left the Station





# States with Renewable Energy Standards



Source: U.S. Department of Energy – Energy Efficiency and Renewable Energy  
website: [http://apps1.eere.energy.gov/states/maps/renewable\\_portfolio\\_states.cfm](http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm)

# Where is the RES Train Headed?



# A National Renewable Standard?

- American Wind Energy Association (AWEA) Don Furman, Board President of AWEA on concept of a national renewable energy standard, **“to remain competitive, we’re going to have to have those policies.”**

Source: *Wind: Industry reports record year, pleads for renewable-power standard*, Peter Behr and Jenny Mandel, E&E reporters, 4/8/2010



# “29 Governors ask Obama and Congress for stronger wind power measures”

Tiffany Hsu, *The Los Angeles Times*, March 16, 2010



Photo: Robert Gauthier, Los Angeles Times

# The 2<sup>nd</sup> Train on the Track

## The EPA's Air Pollution Domain "Train"

EPA has promulgated National Ambient Air Quality Standards (NAAQS) for six pollutants:

- Ozone (1Hr & 8HR O<sub>3</sub>)
- Particulate Matter (PM<sub>10</sub>, PM<sub>2.5</sub>)
- Sulfur Dioxide (SO<sub>2</sub>)
- Nitrogen Oxide (NO<sub>2</sub>)
- Carbon Monoxide
- Lead (Pb)

# EPA's Effort to Tighten Air Standards

- Lisa Jackson at EPA is moving to change the 75 ppb standard for ozone to a new standard within the range of a 60-70 ppb.
- On January 6, 2010, EPA proposed to strengthen the NAAQS for ground-level ozone, the main component of smog.
- EPA will issue final standards by August 31, 2010.



Source: *Fact Sheet Proposal to Revise the National Ambient Air Quality Standards for Ozone*



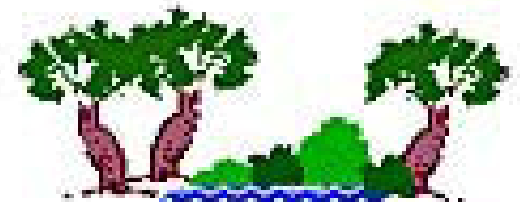
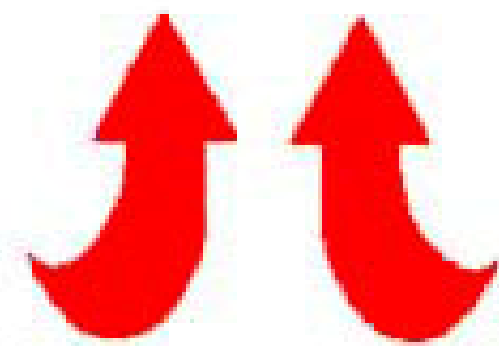
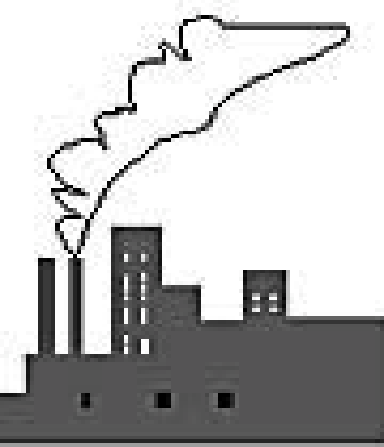
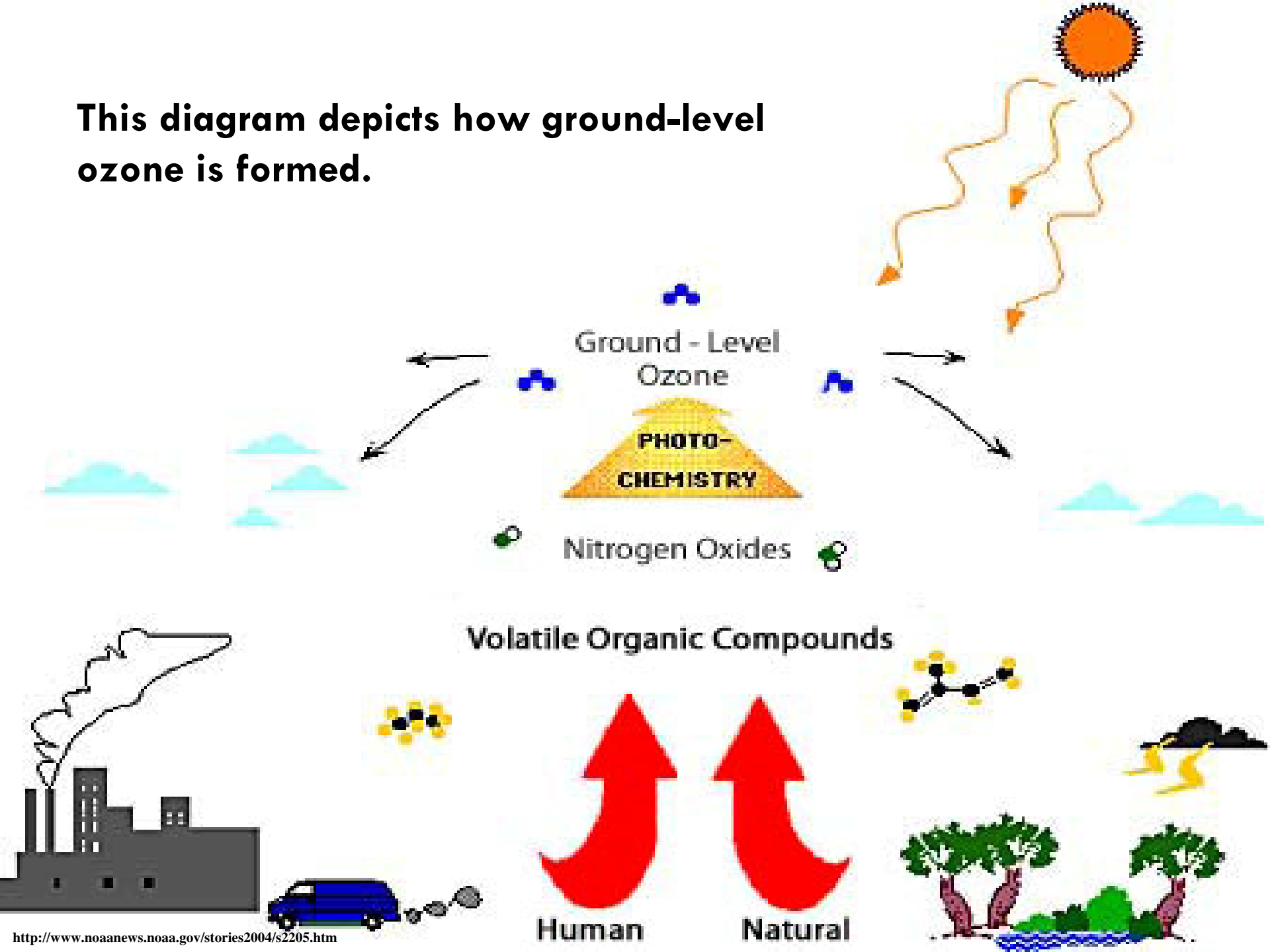
# EPA Effort (cont'd)

## Estimated Timeline for Implementing the Proposed Ozone Standards

- **January 2011:** States must recommend areas to be designated attainment, nonattainment or unclassifiable.
- **July 2011:** EPA makes final area designations.
- **August 2011:** Designations become effective.
- **December 2013:** State Implementation Plans (SIP), outlining how states will reduce pollution to meet the standards, are due to EPA.

Source: *Fact Sheet Proposal to Revise the National Ambient Air Quality Standards for Ozone*

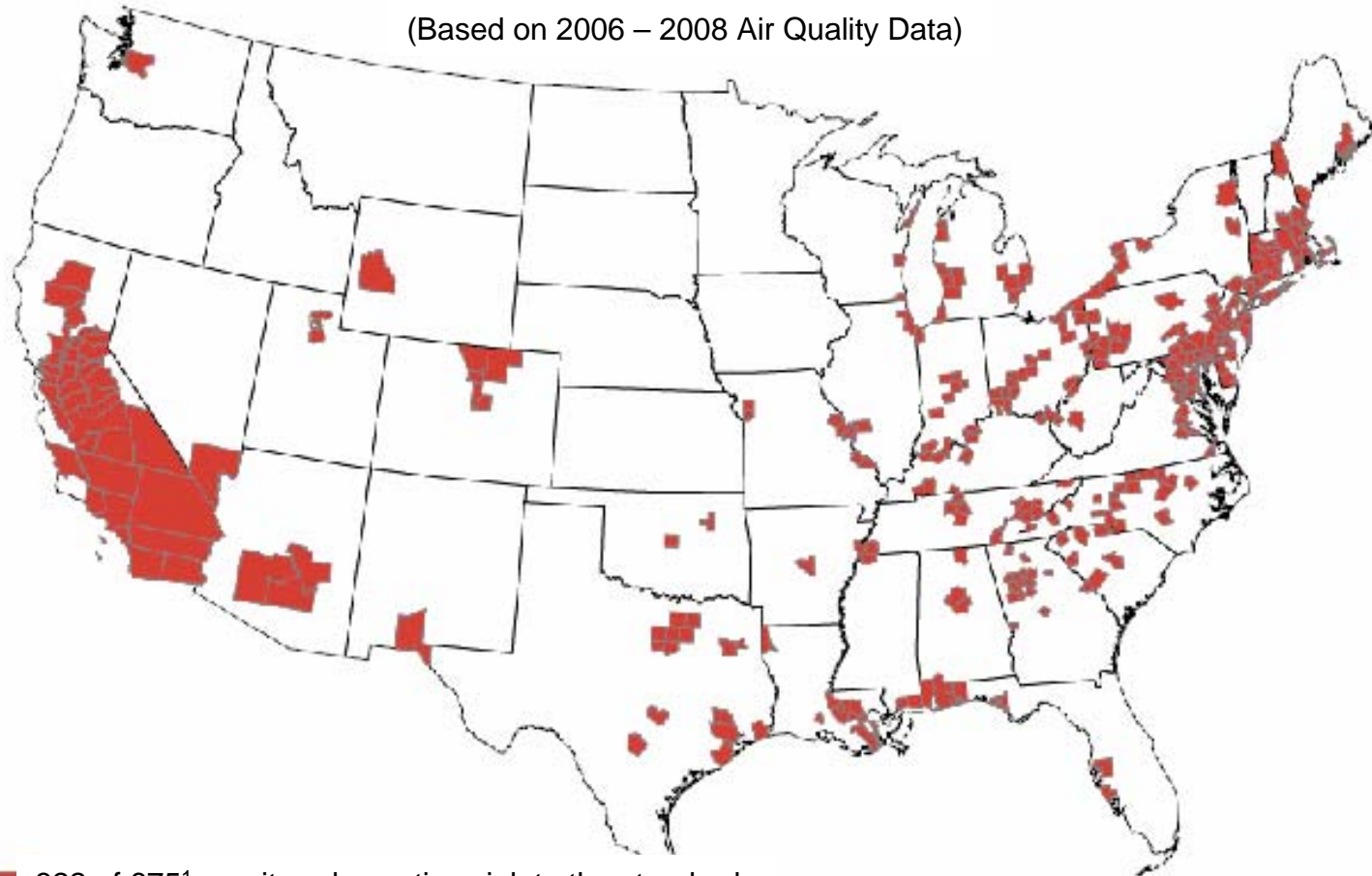
**This diagram depicts how ground-level ozone is formed.**



## Counties With Monitors Violating the March 2008 Ground-Level Ozone Standards

0.075 parts per million

(Based on 2006 – 2008 Air Quality Data)



322 of 675<sup>1</sup> monitored counties violate the standard

### Notes:

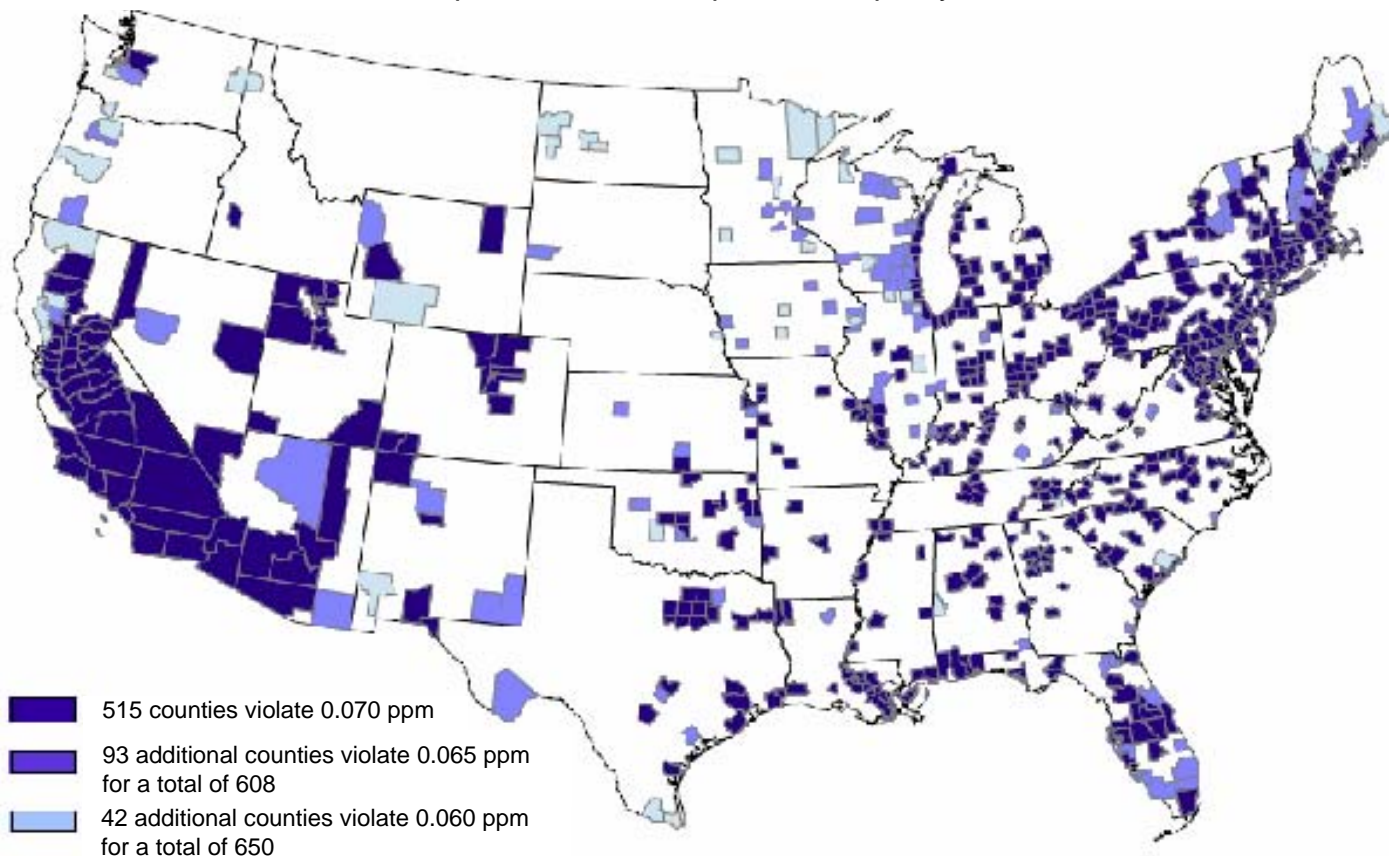
1. Counties with at least one monitor with complete data for 2006 – 2008
2. To determine compliance with the March 2008 ozone standards, the 3-year average is truncated to three decimal places.



## Counties With Monitors Violating Proposed Primary 8-hour Ground-level Ozone Standards

0.060 – 0.070 parts per million

EPA will not designate areas as nonattainment on these data, but likely on 2008 – 2010 data which are expected to show improved air quality.



### Notes:

1. No monitored counties outside the continental U.S. violate.
2. EPA is proposing to determine compliance with a revised primary ozone standard by rounding the 3-year average to three decimal places.

# Ozone First Stop for the EPA Train Then SO<sub>2</sub>, NO<sub>X</sub>, Mercury & Acid Gases

- April 2010, EPA will release new regs on SO<sub>2</sub> and NO<sub>X</sub> for eastern U.S., replacing the Clean Air Interstate Rule (CAIR).
- Pending EPA regs could require installation of expensive SO<sub>2</sub> scrubbers across the U.S. coal fired fleet.
- A retro-fit versus closure decision could cause a significant reduction in U.S. coal fired generation.
- March 2011, EPA will issue new regs on mercury and acid gases

Source: Bernstein Research, *Black Days Ahead for Coal* presentation, March 19, 2010

# Colorado - Tilting to the Left





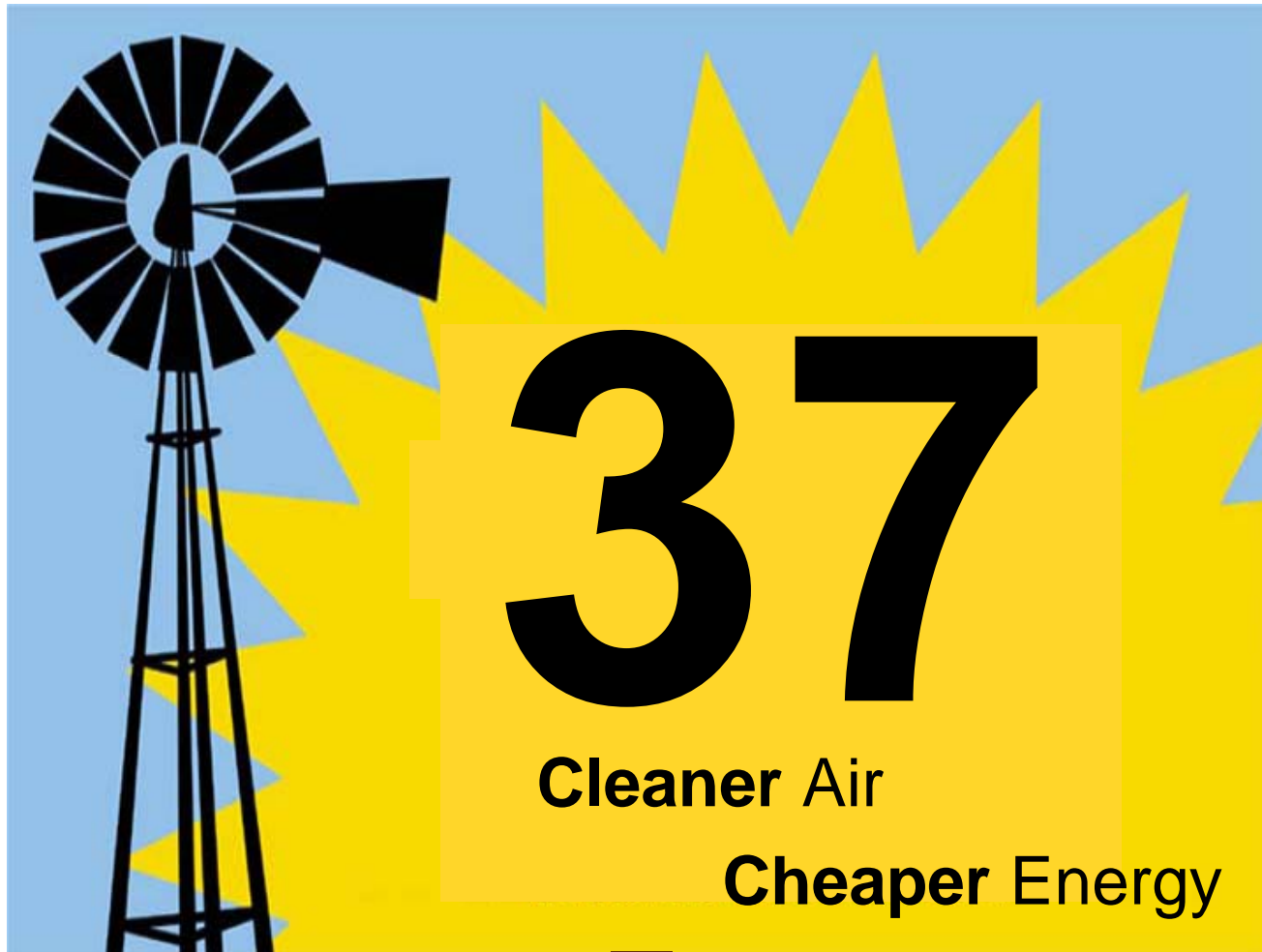
# Mandates for Renewables in Colorado

Does Colorado presage the national debate?

- Colorado's Amendment #37 – 1<sup>st</sup> state to adopt a Renewable Energy Standard by ballot
  - Passed November 2, 2004
    - For: 1,066,023 (53%)
    - Against: 922,577 (47%)
    - Margin of victory: 143,446 people

# Colorado as a Laboratory

## The Renewable Energy Standard Promise:



2004 Campaign Yard Sign

# Amendment 37 & Subsequent State Legislative Action – The Slippery Slope

- **Amendment 37: (effective 11/2/2004)**

3% for 2007-2010

5% for 2008-2010

6% for 2011-2014

10% for 2015 and thereafter

- **Legislative Change #1: (effective 7/2/2006)**

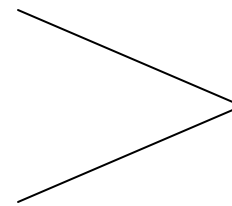
3% by 2007

5% for 2008-2010

10% for 2011-2014

15% for 2015-2019

20% for 2020 and thereafter



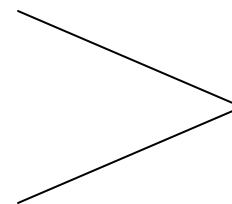
Dem Colorado Gov. Bill Ritter’s “New Energy Economy” is born.

- **Legislative Change #2: (effective 3/22/2010)**

12% 2011-2014

20% 2015-2019

30% 2020 and thereafter



HB 1001 party line vote not 1 House or Senate Republican voted yes



# Hang on Colorado...30% Renewables by 2020?



# Renewables Under the Microscope

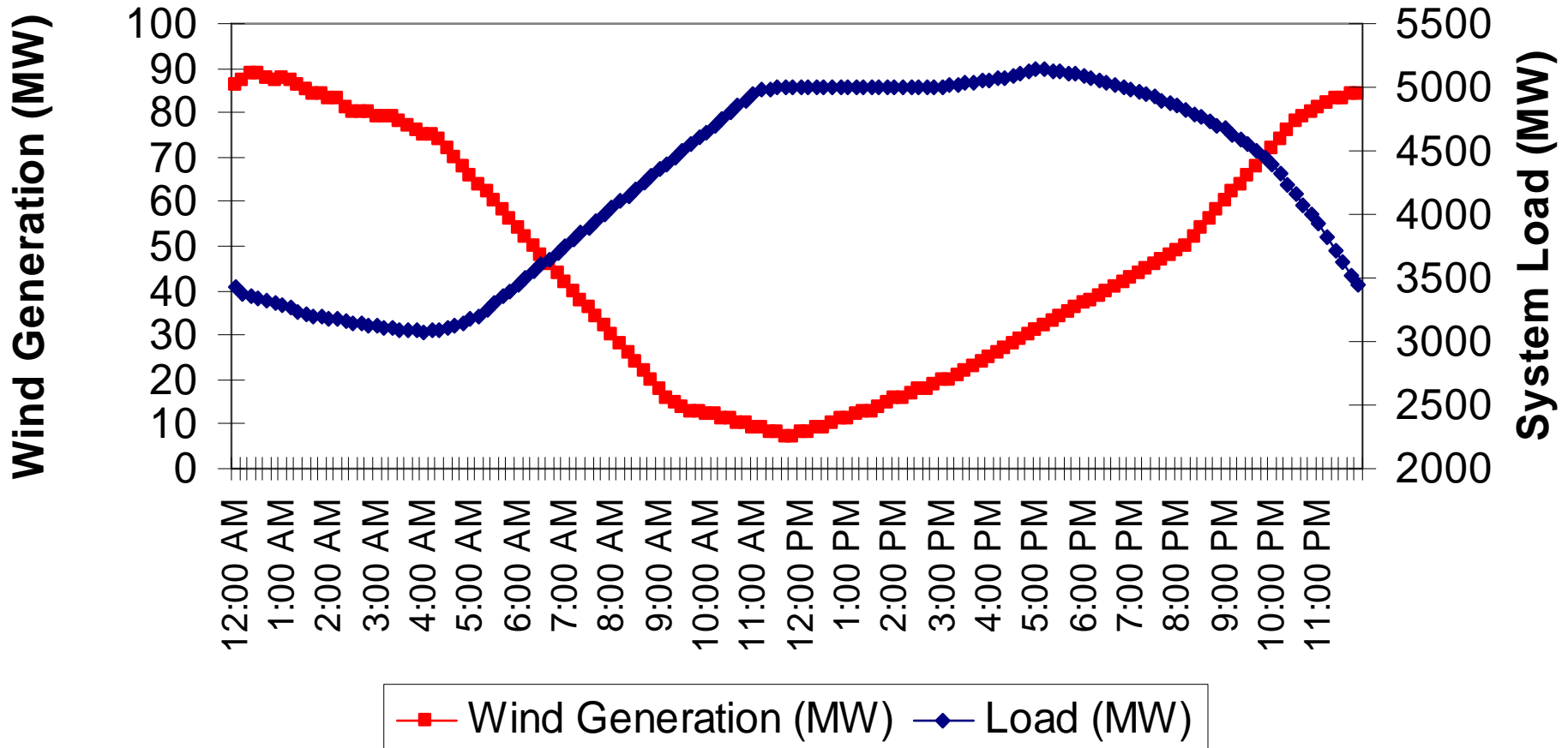
## The Colorado Wind Model

- 12.5% load factor (capacity credit)  
at peak hours\*  
(A nameplate 600MW facility is = to 75 MW  
at peak hours)

\*Source: Colorado PUC In the matter of the application of Public Service Company of Colorado for approval of its 2007 Colorado Resource Plan, Direct Testimony and exhibits of James F. Hill - The effective load carrying capability ("ELCC")

# Output is Not Correlated with Load

## Typical 100 MW Wind Plant Generation vs. Hourly System Load



# What is Economic Dispatch?

“The operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities.”

- EPC Act section 1234



# Levelized Cost of New Electric Generating Technologies

<b>Plant Type</b>	<b>Total System Levelized Cost (cents per kilowatt hour)</b>
Natural Gas Fired Advanced Combined Cycle	7.93
Natural Gas Fired Conventional Combined Cycle	8.31
Conventional Coal	10.04
Advanced Coal	11.05
Biomass	11.10
Natural Gas Fired Advanced CC with CCS	11.33
Geothermal	11.57
Advanced Nuclear	11.90
Hydro	11.99
Natural Gas Fired Advanced Combustion Turbine	12.35
Advanced Coal with CCS	12.93
Natural Gas Fires Conventional Combustion Turbine	13.95
Wind	14.93
Wind - Offshore	19.11
Solar Thermal	25.66
Solar PV	39.61

Source: Institute for Energy Research, Updated February 2, 2010

# 300 MW → 100 MWh



- 100 MW Wind Turbine



- 100 MW Wind Turbine
- 31 MW/h annual average
- 31% annual utilization rate

# 30% RPS → 90% Wind



## Wind Generation

- 300 MW/h average
- 900 MW wind capacity



## Total Demand

- 1,000 MW/h on average

## Total Generation

- 1600 MW/h average



## Coal & Gas Generation

- 350 coal, 350 gas capacity
- 700 MW/h average

# Amount of Wind on the Public Service Company of Colorado System

Q. Is it true that Public Service, when compared to other electric utilities in the United States, has among the highest hourly penetration levels of wind in the entire nation?

A. To the best of my knowledge, yes that is true. We have experienced hours in which 30% of our customer load was being served by wind generation.

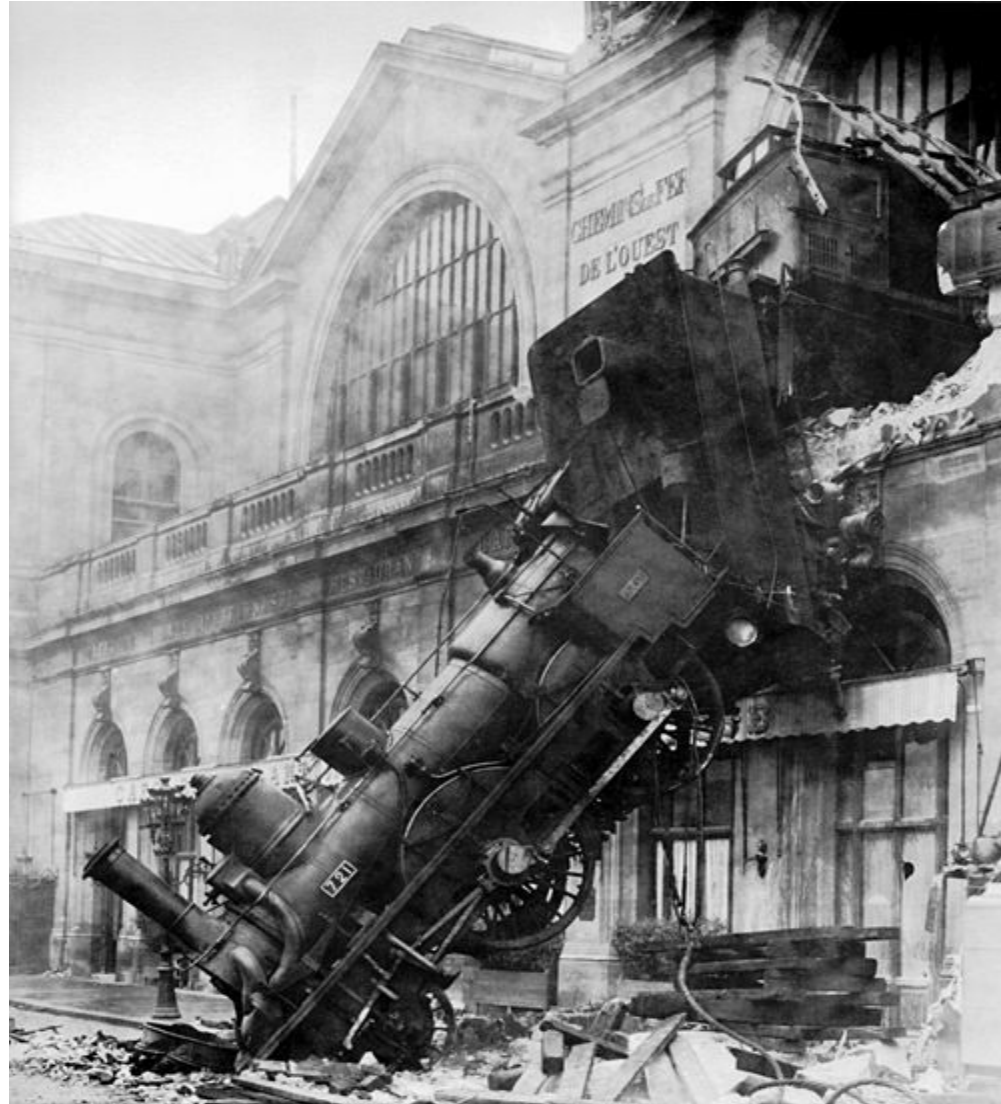
- Thomas A. Imbler

Source: Rebuttal Testimony and Exhibits of Thomas A. Imbler on Behalf of Public Service Company of Colorado, In the Matter of the Application of Public Service Company of Colorado for Approval of its 2007 Colorado Resource Plan, Docket No. 07A-447E, June 9, 2008



# The RES Train Has Left the Station

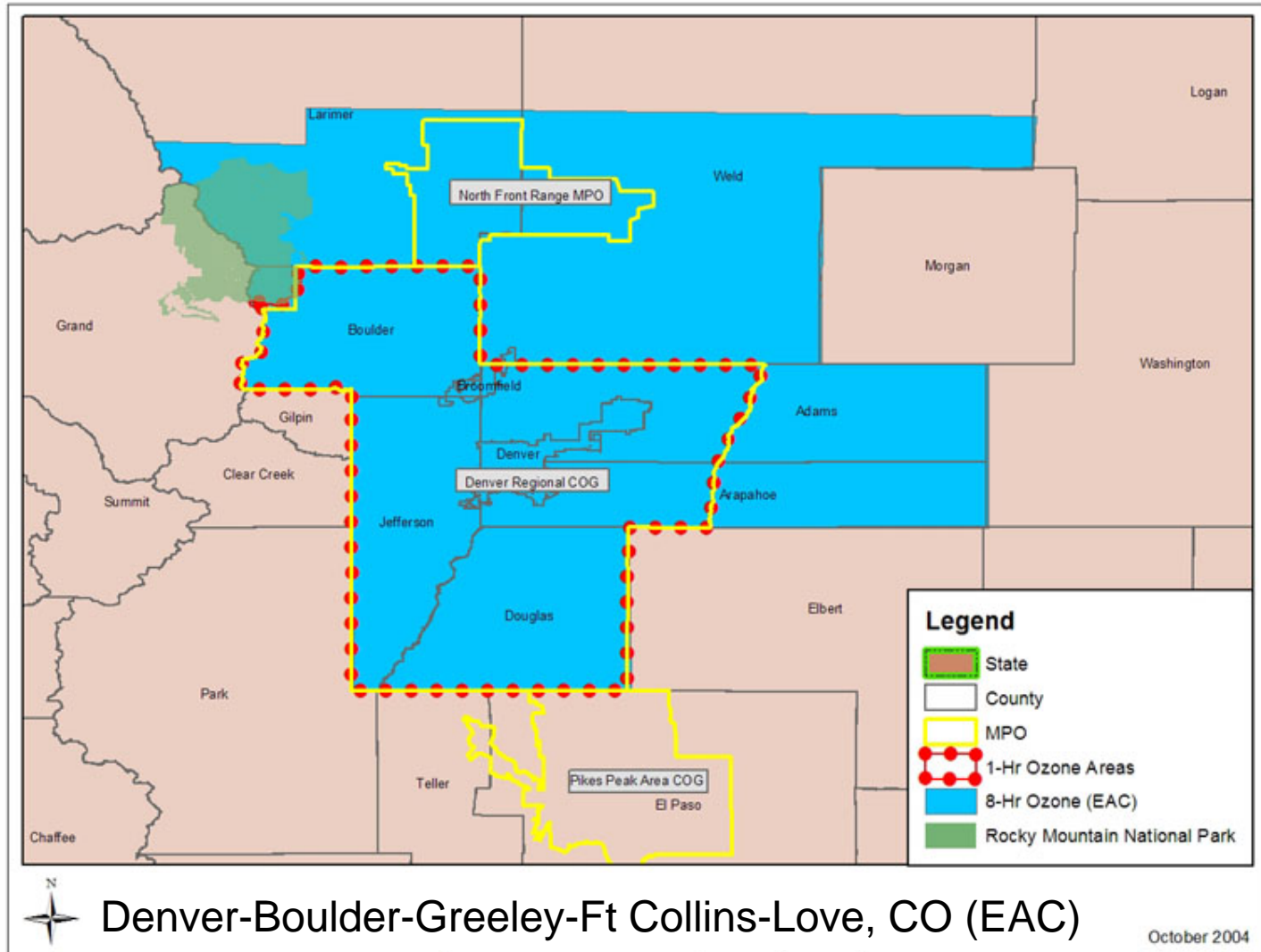
But is it in the right direction?



# Denver's Ozone Non-Attainment

Counties: Denver, Arapahoe, Jefferson, Douglas, Boulder, Broomfield, Weld and Adams

Total Population: approx. 2,626,000



# 3 Year Average of 4<sup>th</sup> Max. 8 Hour Ozone ppm – 0.085 ppm Std.

	Site Name	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009
1	Welby	0.064	0.066	0.066	0.068	0.069	0.070	0.071	0.072
2	Highland	0.076	0.081	0.079	0.081	0.077	0.078	0.071	0.067
3	S. Boulder Creek	0.073	0.077	0.076	0.075	0.075	0.081	0.081	0.078
4	Carriage	0.072	0.076	0.074	0.075	0.070	0.074	0.073	0.070
5	Chatfield State Park*	0.080	0.085	-	-	0.081	0.084	0.082	0.077
6	Arvada	0.074	0.076	0.073	0.075	0.075	0.079	0.078	0.074
7	Welch	0.067	0.070	0.069	0.067	0.069	0.075	0.078	0.074
8	Rocky Flats	0.083	0.087	0.084	0.080	0.080	0.085	0.086	0.082
9	NREL	0.081	0.085	0.083	0.082	0.078	0.082	0.081	0.076
10	Rocky Mountain National Park	0.078	0.081	0.082	0.078	0.074	0.076	0.076	0.074
11	Ft. Collins West	-	-	-	-	-	-	0.082	0.078
12	Ft. Collins	0.069	0.071	0.070	0.071	0.072	0.074	0.071	0.066
13	Greeley – Weld Tower	-	-	0.077	0.076	0.076	0.078	0.076	0.071

\*Chatfield Site Relocated in 2004

Red Shading Indicates Violation of Ozone Standard

# 3 Year Average of 4<sup>th</sup> Max. 8 Hour Ozone ppm – 0.075 ppm Std.

	Site Name	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009
1	Welby	0.064	0.066	0.066	0.068	0.069	0.070	0.071	0.072
2	Highland	0.076	0.081	0.079	0.081	0.077	0.078	0.071	0.067
3	S. Boulder Creek	0.073	0.077	0.076	0.075	0.075	0.081	0.081	0.078
4	Carriage	0.072	0.076	0.074	0.075	0.070	0.074	0.073	0.070
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\*Chatfield Site Relocated in 2004

Red Shading Indicates Violation of Ozone Standard

# The IPAMS/Bentek Study A Catalyst to Avoid a Train Wreck?

**EPA**

**RES**

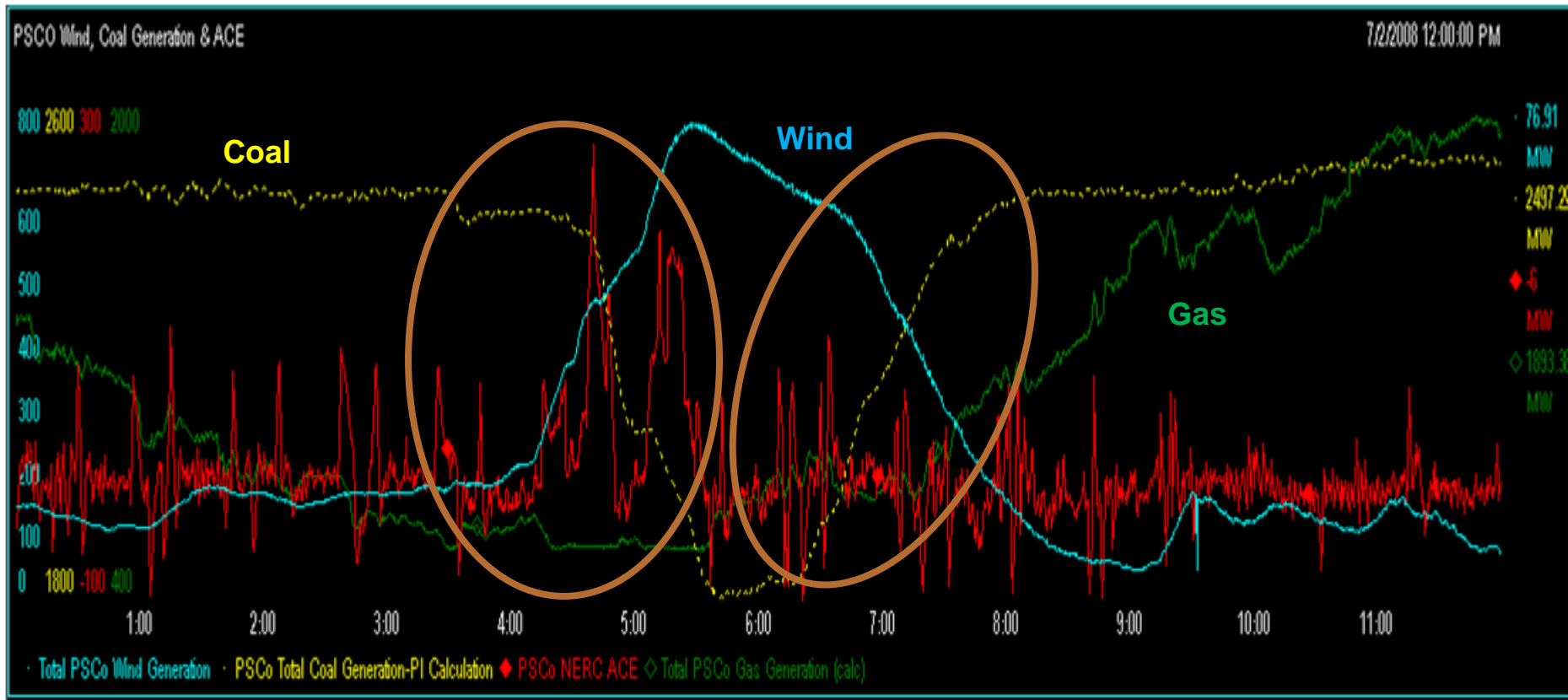


# The IPAMS/Bentek Study

- Wind is intermittent, not dispatchable
- Coal plants “cycle down” to accept wind into the grid
- “Cycling coal plants” are inefficient and produce more pollution than wind generation saves

# When Wind Blows At Night, Coal Gen Ramps Down

Xcel Defined Wind Event:  
7/2/2008



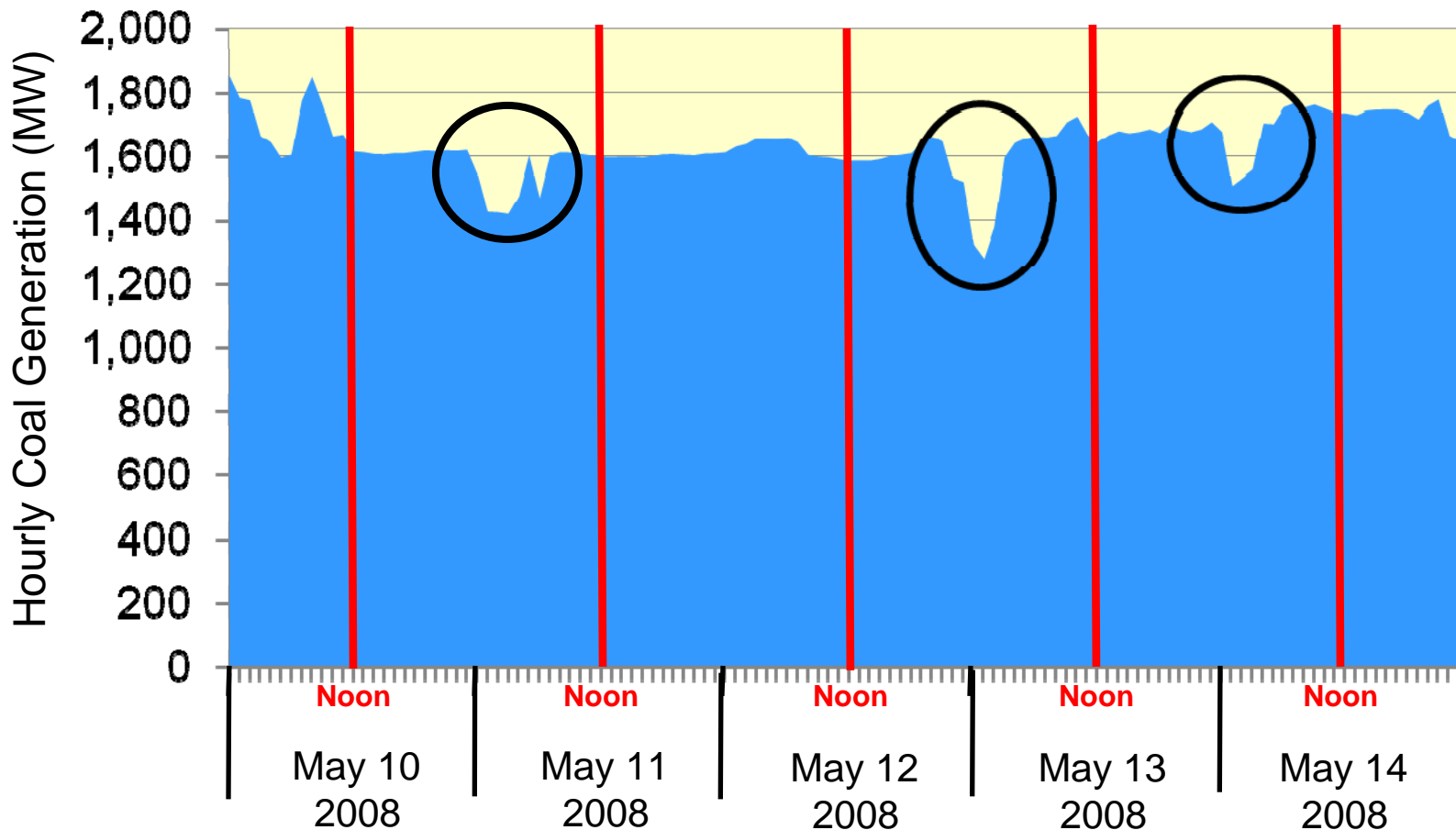
4:00 AM

8:00 AM

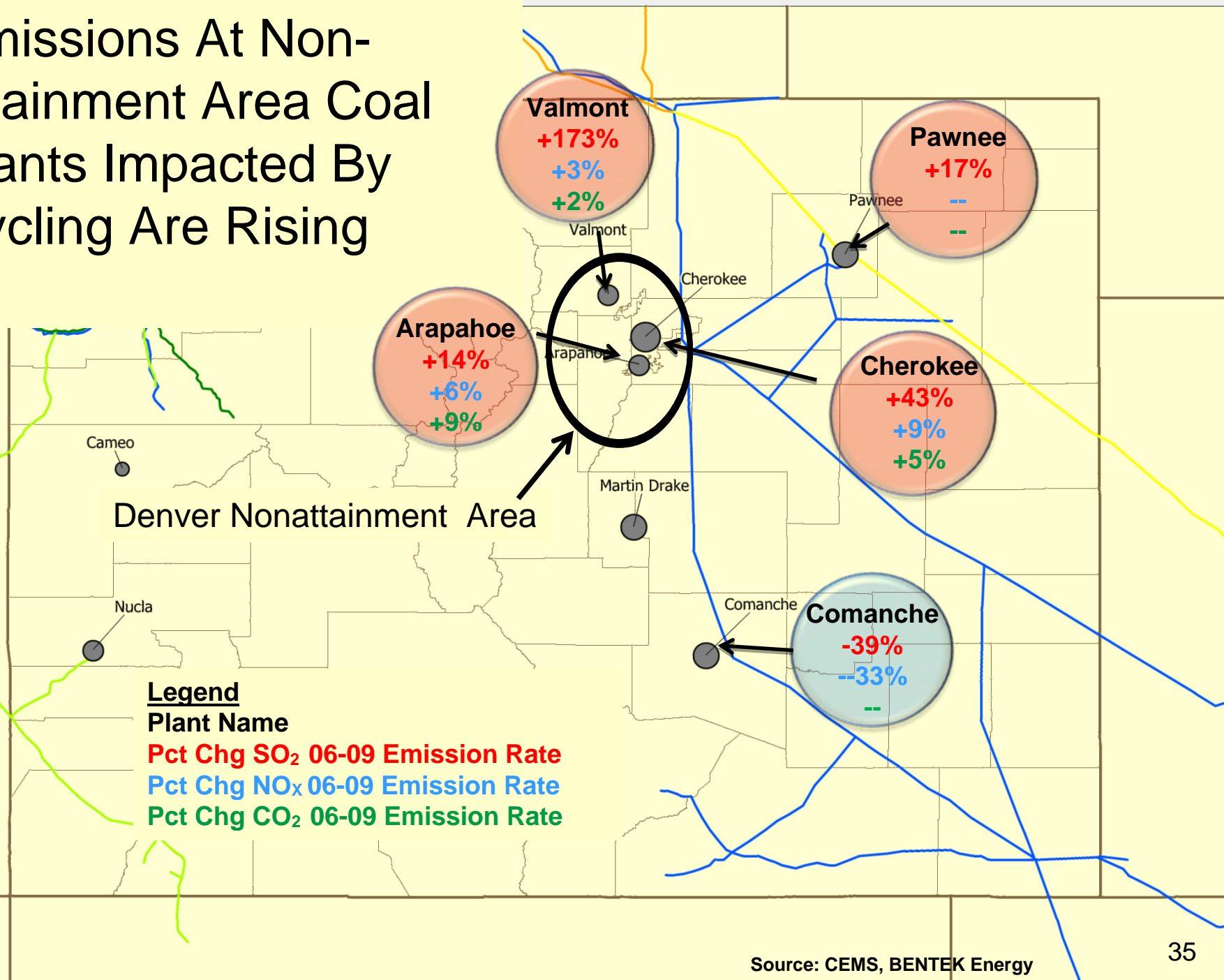


# The Problem Lies In The Interaction Between Wind and Coal Generation

Wind Causes PSCO To Cycle Its Coal Plants, Which Raises Emissions



# Emissions At Non-attainment Area Coal Plants Impacted By Cycling Are Rising



**Legend**  
**Plant Name**  
**Pct Chg SO<sub>2</sub> 06-09 Emission Rate**  
**Pct Chg NO<sub>x</sub> 06-09 Emission Rate**  
**Pct Chg CO<sub>2</sub> 06-09 Emission Rate**

# Clean Air Act Violation?

- The Clean Air Act defines “net emissions increase” as “any increase in actual emissions from a particular physical change or **change in method of operation** at a stationary source.”\*
- Does cycling a coal plant to integrate wind create a Section 114 violation?

\*Source: 40 C.F.R. 52.21 (B) (3) (i)

# Two of the Thresholds for a Section 114 CAA Violation

- 40 tons **per year** of sulfur dioxide (SO<sub>2</sub>) emissions
- 40 tons **per year** of oxides of nitrogen (NO<sub>x</sub>) emissions

According to Bentek's analysis, cycling at PSCO's Cherokee Power Plant on July 2, 2008 (one cycling event) caused

- 32.8 tons of excess NO<sub>x</sub> emissions
- 19.1 tons of excess SO<sub>2</sub> emissions

Source: Bentek Report Figure IV-5, page 41

# **1365 Requirements Complement Ongoing Air Quality Planning**

- **Federal requirements, especially for Regional Haze and ozone, call for large pollutant reductions**
  - **The 70-80% NO<sub>x</sub> reduction requirements in 1365 will make a very significant contribution towards meeting the standards**
- **Colorado's mercury reduction requirements and potential federal greenhouse gas reduction requirements will also drive large emission reductions**
- **1365 will allow us to achieve or make significant progress for subject facilities in a coordinated manner**
- **These air quality improvements can be achieved with a combination of emission control technology, retirement, and repowering with natural gas and low- or non-emitting sources**



# Electric Generating Unit Repowering



## Coal-Fired Power Plant (550 MW)

- NOx ~ 9,326 tons/year
- SO2 ~ 5,837 tpy
- CO ~ 411 tpy
- VOC ~ 48 tpy
- PM ~ 173 tpy
- Hg ~ 106 pounds
- Pb ~ 63 pounds
- CO2 ~ 4.3 million tpy

## Natural Gas-Fired Power Plant (550 MW)\*

- NOx ~ 355 tons/year
- SO2 ~ 13 tpy
- CO ~ 177 tpy
- VOC ~ 20 tpy
- PM ~ 59 tpy
- Hg ~ 0
- Pb ~ 0
- CO2 ~ 1.2 million tpy

*\* 75% Capacity Factor*

# A Growing Awareness of the Irony

“The nature of electricity markets, instantaneous matching of supply and demand, means that intermittent technologies are not perfect substitutes for any one of dispatchable technology.”

Source: *Government Support for Intermittent Renewable Generation Technologies*, Arthur Campbell, April 6, 2009, MIT Department of Economics

# A Growing Awareness of the Irony

“Hot Air? When Government Support for Intermittent Renewable Technologies Can Increase Emissions”

-Arthur Campbell, MIT

“Wind Integration: Incremental Emissions from Back-up Generation Cycling”

-Kent Hawkins\*

\*<http://www.masterresource.org>

# Getting Back on a Clean Air Track with Natural Gas



# Colorado's HB 1365

## A legislative template for the future?

- Supported by a coalition of environmental groups, natural gas producers, Colorado Dept. of Health and Governor's office
- Creates a "preference" for natural gas when measured against additional pollution controls on existing coal plants
- Guarantees cost recovery for utilities that enter into long-term fixed price natural gas supply contracts

\*will be signed into law on Monday, April 19, 2010



# Is there enough gas?

## NEW SHALE PLAYS IN NORTH AMERICA

### - “A Game Changer”



Source: America's Natural Gas Alliance website

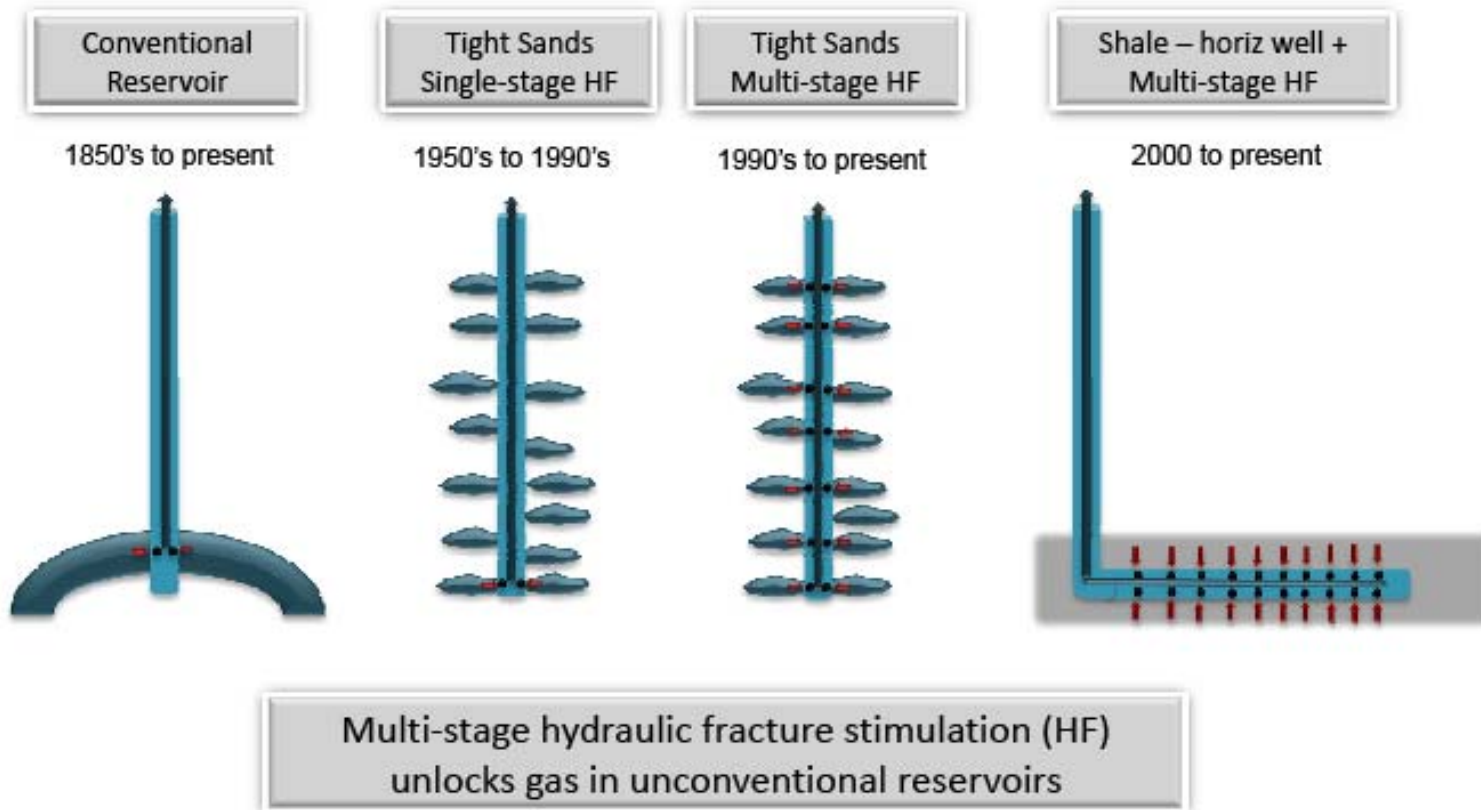


# Why Natural Gas?

- Natural gas virtually eliminates sulfur-dioxide emissions
- Lowers nitrous oxide emissions by 81%
- Lowers carbon dioxide emissions by 58%
- Produces no mercury, sludge or waste ash

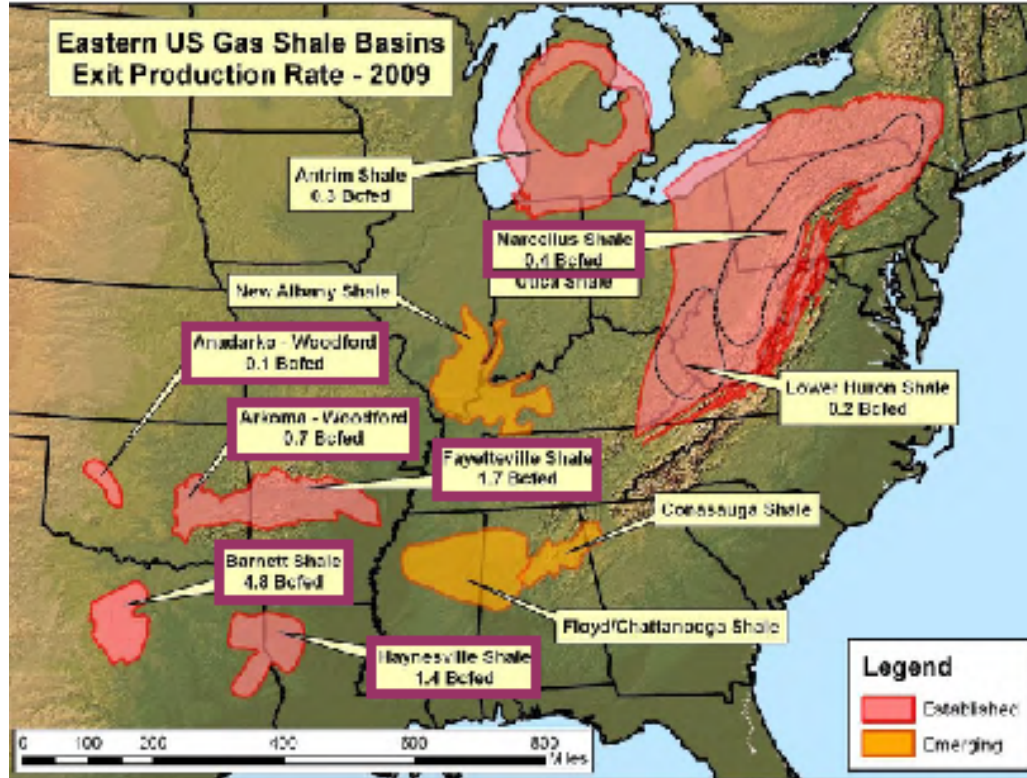
Source: *New Energy Economy backfired, time to move on*; Denver Post, John Harpole, 3/7/2010

# EVOLUTION IN GAS WELL COMPLETION TECHNOLOGY - THE KEY TO TODAY'S NATURAL GAS REVOLUTION





## Eastern U.S. Gas Shale Basins



Source: Advanced Resources International

Five of the “Magnificent Seven” gas shale plays are in the Eastern U.S.

	Resource Endowment (Tcf)	Produced/ Proved Reserves (Tcf)*	Undeveloped Recoverable Resource (Tcf)*
Barnett	250	19	40
Fayetteville	320	3	50
Woodford	300	2	30
Haynesville	790	1	130
Marcellus	1,760	-	220
<b>Total</b>	<b>3,420</b>	<b>25</b>	<b>470</b>

\*As of end of 2008.

U.S. Proved Natural Gas Reserves as of 2005: 192.5 Tcf



# Coal to Gas?

“Barclays Capital analysts estimate 27,000 megawatts of production, or more than 2% of U.S. [coal fired electric] generating capacity, could close in four to five years.”

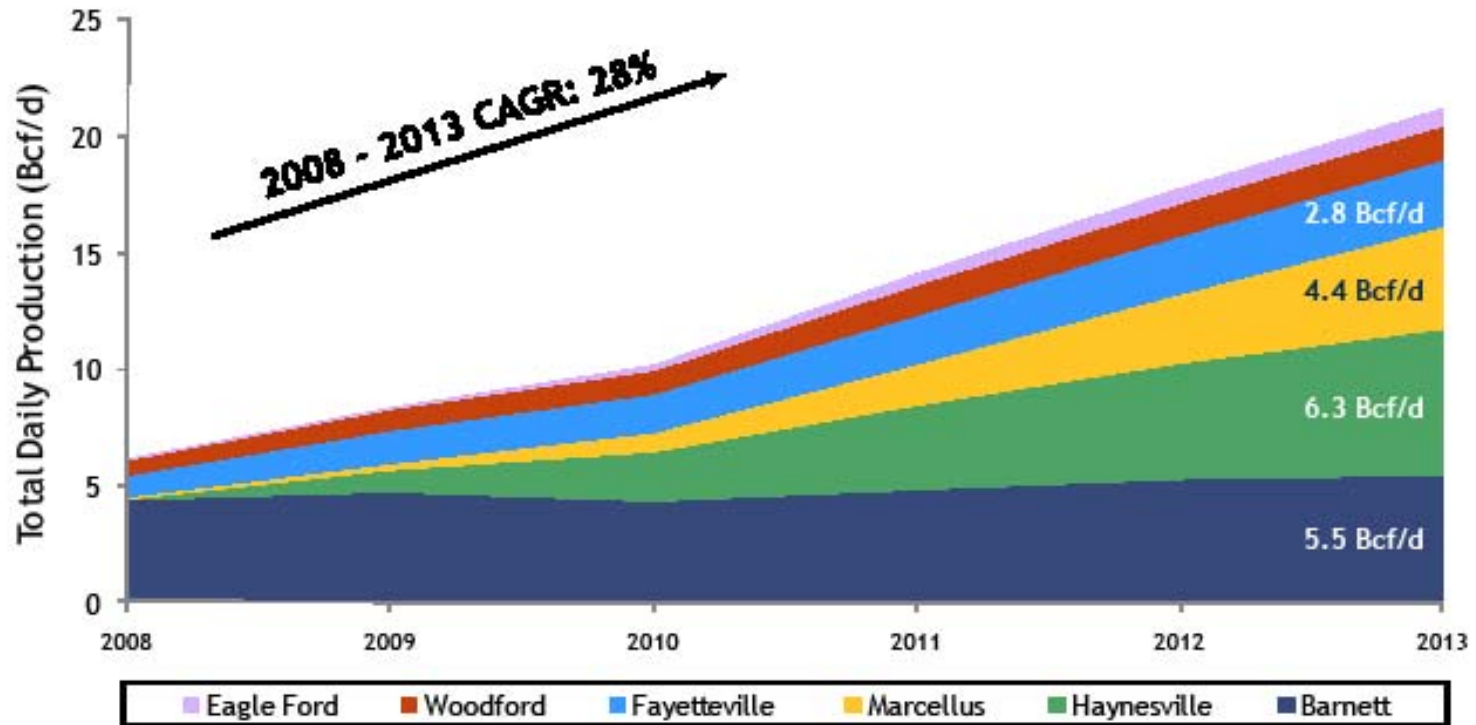
Source: *Coal Plants Face Tight Pollution Regulations*, Mark Peters, The Wall Street Journal, 2/10/2010

# Bernstein Research Forecast

- Existing coal fired generation plants are expected to decline by nearly 400 million MWh by 2015.\*
- Model assumes all coal fired power plants must install SO<sub>2</sub> scrubbers to meet EPA emissions standards for mercury and acid gases.\*
- U.S. gas consumption would have to increase by at least 2.1 Tcf per year.
- This implies a 10% increase in U.S. consumption of natural gas by 2015.

\*Source: Bernstein Research, *Black Days Ahead for Coal* presentation, March 19, 2010

# Shale Forecast by Basin



# Getting it Right

Rhode Island Public Utility Commission says “No” to Offshore Wind Project

- March 30, 2010: Three RI Commissioners reject power-purchase agreement between Deepwater Wind LLC and National Grid
- 24.4¢ per KW wind cost did not qualify as “commercially reasonable”



Source: *PUC rejects Deepwater contract on price*, Chris Barrett and Ted Nesi, PBN Staff Writers, 3/30/2010

Natural gas: not just a bridge to renewables.  
It's a way to avoid a train wreck.





# Conclusions & the Future

- The integration of wind energy forces the cycling (the ramping up and down) of baseload coal fired electric generation plants.
- Cycling coal plants causes additional air pollution.
- Wind energy will only exacerbate more restrictive EPA air pollution control efforts.
- Natural gas fired generation should be considered as an alternative solution in an EPA “command and control” approach that currently only considers coal pollution control technologies.

# Citations for Report

All of the information utilized for this report is a compilation of information pulled from the following data sources:

Bentek Energy

Institute for Energy Research (IER)

Energy Information Administration (EIA)

Bernstein Research

Arthur Campbell, MIT

Kent Hawkins, Master Resource.org

Scott Moore, Anadarko Petroleum

Brett Oakleaf, Invenergy LLC

Mike Beasley, 5280 Strategies

Paul R. Tourangeau, Colorado Dept. of Public Health & Environment

Electric Power Research Institute (EPRI)

America's Natural Gas Alliance

Train pictures: <http://www.darkroastedblend.com/2009/03/train-wrecks.html>

# Contact Information

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# RES Summary

State	Amount	Year
Arizona	15%	2025
California	33%	2030
Colorado	20%	2020
Connecticut	23%	2020
District of Columbia	20%	2020
Delaware	20%	2019
Hawaii	20%	2020
Iowa	105 MW	
Illinois	25%	2025
Massachusetts	15%	2020
Maryland	20%	2022
Maine	40%	2022

# RES Summary (cont'd)

<b>State</b>	<b>Amount</b>	<b>Year</b>
Michigan	10%	2015
Minnesota	25%	2025
Missouri	15%	2021
Montana	15%	2015
New Hampshire	23.8%	2025
New Jersey	22.5%	2021
New Mexico	20%	2020
Nevada	20%	2015
New York	24%	2013
North Carolina	12.5%	2021
North Dakota*	10%	2015



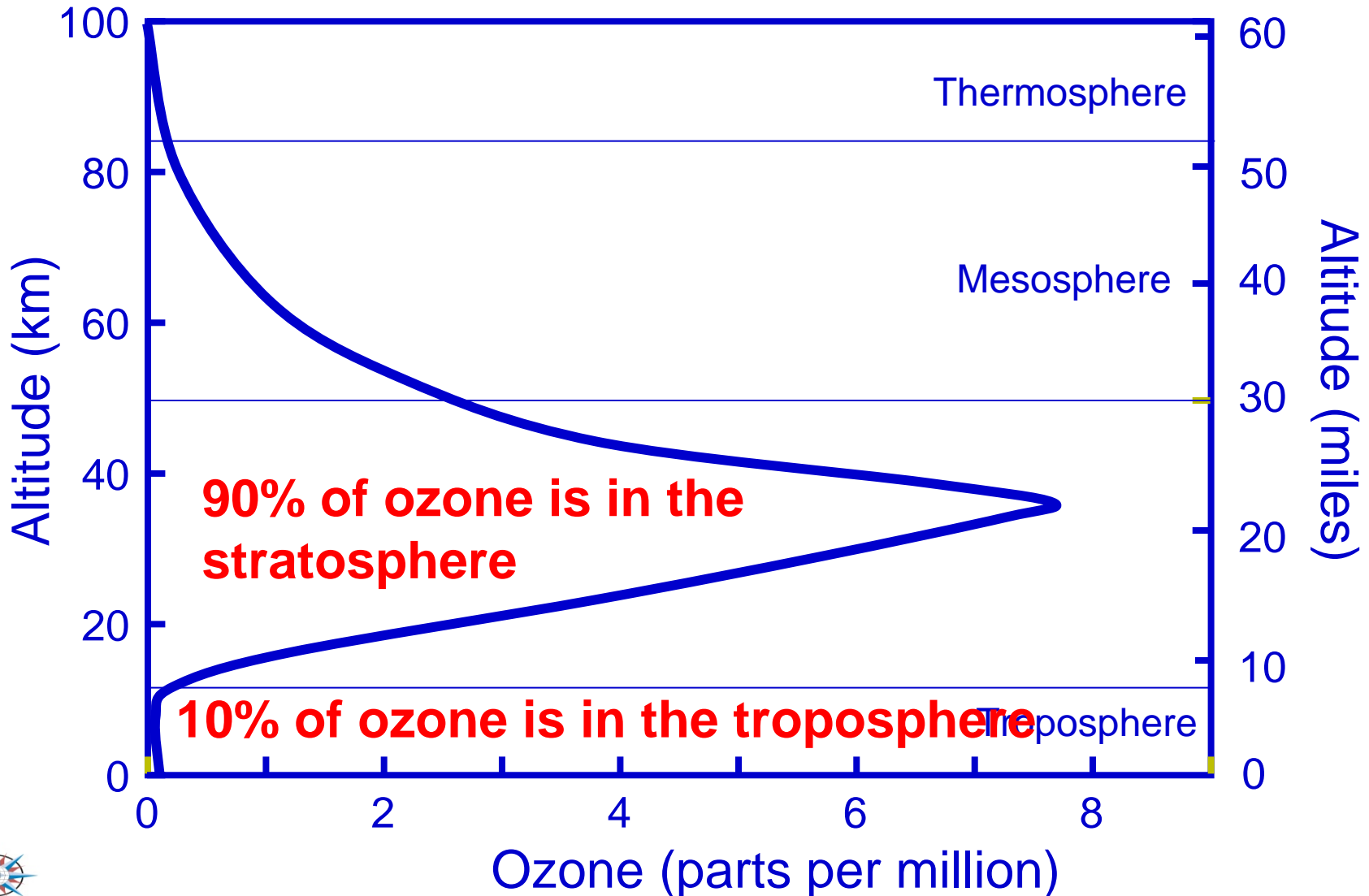
# RES Summary (cont'd)

State	Amount	Year
Oregon	25%	2025
Pennsylvania	8%	2020
Rhode Island	16%	2019
South Dakota*	10%	2015
Texas	5,880 MW	2015
Utah*	20%	2025
Vermont*	10%	2013
Virginia*	12%	2022
Washington	15%	2020
Wisconsin	10%	2015

\*Five states, North Dakota, South Dakota, Utah, Virginia and Vermont have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.

# Ozone Facts

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.



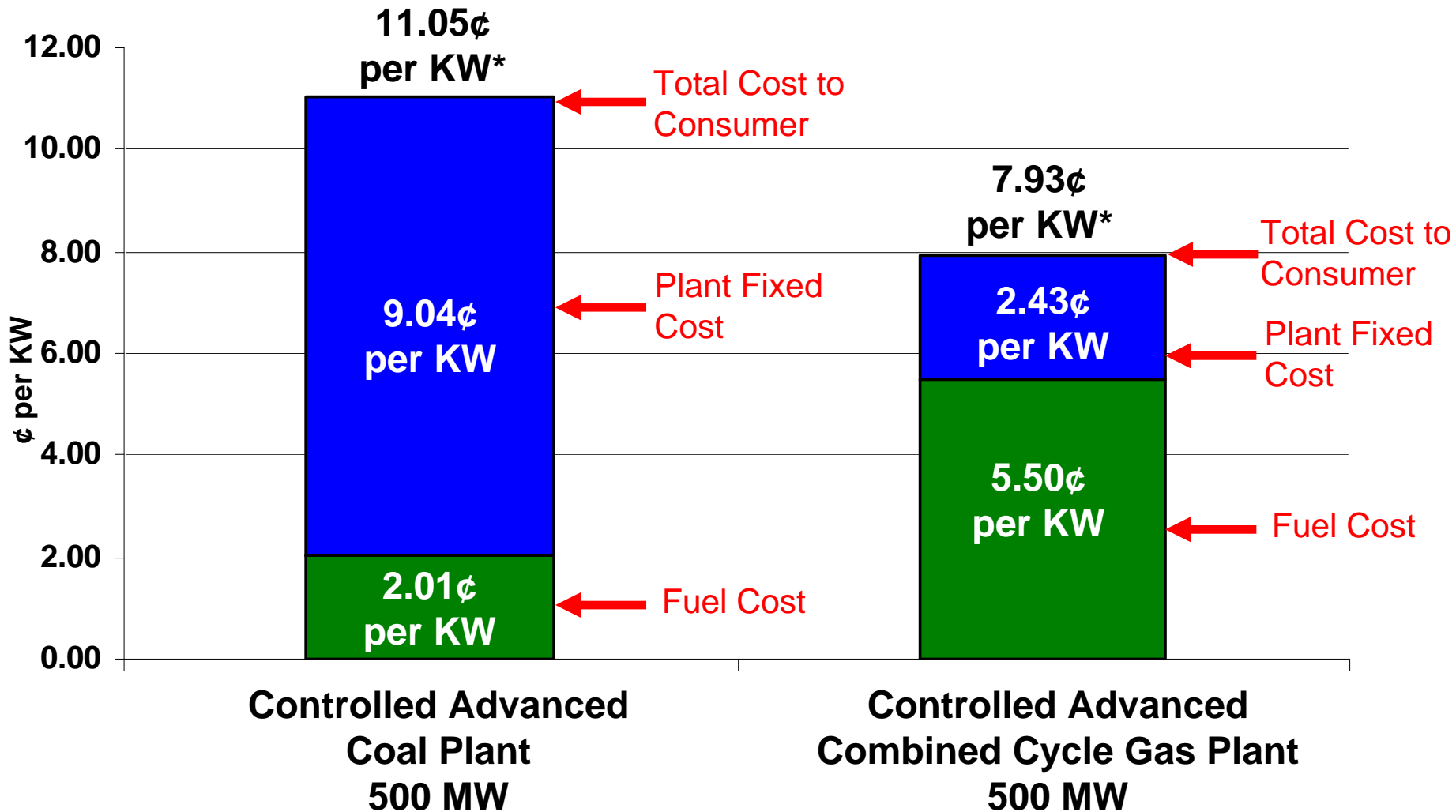
# Summary of Actual Denver Ozone Non-attainment Days at Historical & Proposed levels

<b>Parts per million*</b>	<b># days in 2007</b>	<b># days in 2008</b>	<b># days in 2009</b>	<b>Average</b>
<b>&gt;0.085</b>	<b>6</b>	<b>1</b>	<b>1</b>	<b>3</b>
<b>&gt;0.080</b>	<b>12</b>	<b>5</b>	<b>4</b>	<b>7</b>
<b>&gt;0.075</b>	<b>24</b>	<b>19</b>	<b>8</b>	<b>17</b>
<b>&gt;0.070</b>	<b>53</b>	<b>42</b>	<b>18</b>	<b>38</b>
<b>&gt;0.065</b>	<b>89</b>	<b>79</b>	<b>43</b>	<b>70</b>
<b>&gt;0.060</b>	<b>126</b>	<b>120</b>	<b>80</b>	<b>109</b>

\* 3 year average of the 4<sup>th</sup> max. 8 hour ozone

# Coal vs. Gas

## The 50 Year “Unlevel Playing Field”



\*Source: Institute for Energy Research, Levelized Cost of New Electricity Generating Technologies, Updated February 2, 2010; Energy Information Administration, Annual Energy Outlook 2010, [http://www.eia.doe.gov/oiaf/aeo/electricity\\_generation.html](http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html)

# The Rub – The Footprint of Renewables

Typical natural gas  
well site =  $\frac{1}{2}$  acre

Energy Output =

- 300 acre wind farm
- 402 acres of biomass
- 46 acres of solar panels





# Can Wind Replace Natural Gas in Colorado?

## Colorado Natural Gas

Production = 3.7 Bcfd

Producing Wells = ~25,000



## Equivalent Wind Farm

- 62,000 turbines
- 3,500 square miles

More area than Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties combined

