Renewable Energy Mandates & the EPA
A “Train Wreck” in the Making?

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

website: 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\textsuperscript{nd} 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\textsubscript{3})
- Particulate Matter (PM\textsubscript{10}, PM\textsubscript{2.5})
- Sulfur Dioxide (SO\textsubscript{2})
- Nitrogen Oxide (NO\textsubscript{2})
- 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)

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.

Source: Air Quality Management Overview Presentation, RAQC Board Meeting, March 5, 2010, Paul R. Tourangeau
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.

Source: Air Quality Management Overview Presentation, RAQC Board Meeting, March 5, 2010, Paul R. Tourangeau
Ozone First Stop for the EPA Train
Then SO2, NOX, Mercury & Acid Gases

• April 2010, EPA will release new regs on SO2 and NOX for eastern U.S., replacing the Clean Air Interstate Rule (CAIR).
• Pending EPA regs could require installation of expensive SO2 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 – 1st 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:

Cleaner Air

Cheaper Energy

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**

- **Legislative Change #2**: (effective 3/22/2010)
  - 12% 2011-2014
  - 20% 2015-2019
  - **30% 2020 and thereafter**

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

- **Wind Generation (MW)**
- **Load (MW)**

Source: Brett Oakleaf, Invenergy LLC
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.”

- EPAct section 1234
# Levelized Cost of New Electric Generating Technologies

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<thead>
<tr>
<th>Plant Type</th>
<th>Total System Levelized Cost (cents per kilowatt hour)</th>
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<tr>
<td>Natural Gas Fired Advanced Combined Cycle</td>
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Source: Institute for Energy Research, Updated February 2, 2010
300 MW $\rightarrow$ 100 MWh

- 100 MW Wind Turbine

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

Source: Brannin McBee, Bentek Energy
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

Source: Brannin McBee, Bentek Energy
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

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

Legend:
- Green: State
- Yellow: County
- Blue: MPO
- Red circles: 1-Hr Ozone Areas
- Yellow lines: 8-Hr Ozone (EAC)
- Green: Rocky Mountain National Park

Prepared by FHWA - HEPN-40
October 2004
## 3 Year Average of 4th Max. 8 Hour Ozone ppm – 0.085 ppm Std.

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*Chatfield Site Relocated in 2004

Red Shading Indicates Violation of Ozone Standard

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Red Shading Indicates Violation of Ozone Standard

Source: Mike Beasley, 5280 Strategies
The IPAMS/Bentek Study
A Catalyst to Avoid a Train Wreck?
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

Source: PSCo Training Manual
The Problem Lies In The Interaction Between Wind and Coal Generation

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

Hourly Coal Generation (MW)

Source: CEMS data
Emissions At Non-attainment Area Coal Plants Impacted By Cycling Are Rising

Legend
Plant Name
Pct Chg SO₂ 06-09 Emission Rate
Pct Chg NOₓ 06-09 Emission Rate
Pct Chg CO₂ 06-09 Emission Rate

Source: CEMS, BENTEK Energy
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 (SO2) emissions
- 40 tons per year of oxides of nitrogen (NOX) 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 NOX emissions
  - 19.1 tons of excess SO2 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% NOx 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

Source: Informational Briefing before the Colorado Public Utilities Commission, HB10-1365, Clean Air/Clean Jobs Act Air Quality Implementation, Paul R. Tourangeau, Colorado Department of Public Health & Environment, April 26, 2010
### Electric Generating Unit Repowering

<table>
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<tr>
<th>Coal-Fired Power Plant (550 MW)</th>
<th>Natural Gas-Fired Power Plant (550 MW)*</th>
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<tbody>
<tr>
<td>• NOx ~ 9,326 tons/year</td>
<td>• NOx ~ 355 tons/year</td>
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<td>• SO2 ~ 5,837 tpy</td>
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<td>• CO ~ 411 tpy</td>
<td>• CO ~ 177 tpy</td>
</tr>
<tr>
<td>• VOC ~ 48 tpy</td>
<td>• VOC ~ 20 tpy</td>
</tr>
<tr>
<td>• PM ~ 173 tpy</td>
<td>• PM ~ 59 tpy</td>
</tr>
<tr>
<td>• Hg ~ 106 pounds</td>
<td>• Hg ~ 0</td>
</tr>
<tr>
<td>• Pb ~ 63 pounds</td>
<td>• Pb ~ 0</td>
</tr>
<tr>
<td>• CO2 ~ 4.3 million tpy</td>
<td>• CO2 ~ 1.2 million tpy</td>
</tr>
</tbody>
</table>

* 75% Capacity Factor

Source: Informational Briefing before the Colorado Public Utilities Commission, HB10-1365, Clean Air/Clean Jobs Act Air Quality Implementation, Paul R. Tourangeau, Colorado Department of Public Health & Environment, April 26, 2010
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
75 Worst Coal Power Plants

Percent of Total Pollution

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

Conventional Reservoir
1850’s to present

Tight Sands Single-stage HF
1950’s to 1990’s

Tight Sands Multi-stage HF
1990’s to present

Shale – horiz well + Multi-stage HF
2000 to present

Multi-stage hydraulic fracture stimulation (HF) unlocks gas in unconventional reservoirs

Source: America’s New Natural Gas, America’s Natural Gas Alliance
Eastern U.S. Gas Shale Basins

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 SO2 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

2008 - 2013 CAGR: 28%

Total Daily Production (Bcf/d)

- Eagle Ford
- Woodford
- Fayetteville
- Marcellus
- Haynesville
- Barnett

Source: Production Forecast TPH Estimates
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

Contact Information

John A. Harpole
President
Mercator Energy LLC
26 W. Dry Creek Circle, Suite 410
Littleton, CO  80120

www.mercatorenergy.com
(303) 825-1100 (work)
(303) 478-3233 (cell)
## RES Summary

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>15%</td>
<td>2025</td>
</tr>
<tr>
<td>California</td>
<td>33%</td>
<td>2030</td>
</tr>
<tr>
<td>Colorado</td>
<td>20%</td>
<td>2020</td>
</tr>
<tr>
<td>Connecticut</td>
<td>23%</td>
<td>2020</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>20%</td>
<td>2020</td>
</tr>
<tr>
<td>Delaware</td>
<td>20%</td>
<td>2019</td>
</tr>
<tr>
<td>Hawaii</td>
<td>20%</td>
<td>2020</td>
</tr>
<tr>
<td>Iowa</td>
<td>105 MW</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>25%</td>
<td>2025</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>15%</td>
<td>2020</td>
</tr>
<tr>
<td>Maryland</td>
<td>20%</td>
<td>2022</td>
</tr>
<tr>
<td>Maine</td>
<td>40%</td>
<td>2022</td>
</tr>
</tbody>
</table>

RES Summary (cont’d)

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

RES Summary (cont’d)

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon</td>
<td>25%</td>
<td>2025</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>8%</td>
<td>2020</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>16%</td>
<td>2019</td>
</tr>
<tr>
<td>South Dakota*</td>
<td>10%</td>
<td>2015</td>
</tr>
<tr>
<td>Texas</td>
<td>5,880 MW</td>
<td>2015</td>
</tr>
<tr>
<td>Utah*</td>
<td>20%</td>
<td>2025</td>
</tr>
<tr>
<td>Vermont*</td>
<td>10%</td>
<td>2013</td>
</tr>
<tr>
<td>Virginia*</td>
<td>12%</td>
<td>2022</td>
</tr>
<tr>
<td>Washington</td>
<td>15%</td>
<td>2020</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>10%</td>
<td>2015</td>
</tr>
</tbody>
</table>

*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

90% of ozone is in the stratosphere

10% of ozone is in the troposphere

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

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

* 3 year average of the 4\(^{th}\) max. 8 hour ozone

Source: Doug Blewitt
Coal vs. Gas
The 50 Year “Unlevel Playing Field”

Controlled Advanced Coal Plant
500 MW

Controlled Advanced Combined Cycle Gas Plant
500 MW

Total Cost to Consumer

Plant Fixed Cost

Fuel Cost

9.04¢ per KW

2.01¢ per KW

11.05¢ per KW*

2.43¢ per KW

5.50¢ per KW

7.93¢ per KW*

The Rub – The Footprint of Renewables

Typical natural gas well site = ½ acre
Energy Output =

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

Source: Scott Moore, Anadarko
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

Source: Scott Moore, Anadarko