The Low Carbon Role for Coal

Why Carbon Capture Utilization & Storage (CCUS) Must be a Part of Resource Planning

NARUC Summer Meeting
Indianapolis, Indiana
July 22, 2019
The Low Carbon Role for Coal

DISCUSSION OUTLINE

• The Difference Between “Safe” and “Clean”
• Carbon Reductions are Not all Created Equal
• Status of and Business Case for CCUS
• CCUS in Resource Planning
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• **The Difference Between “Safe” and “Clean”**
• Carbon Reductions are Not all Created Equal
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Then and Now: 50 Years of Success - We Internalized the Externalities of Pollution

Declining National Air Pollutant Emissions

Source: U.S. EPA National Emissions Inventory 2014 ver. 2
Then and Now: 50 Years of Success -
We Internalized the Externalities of Pollution

Declining National Air Pollutant Concentration Averages

- Pb (3-month)
- CO (8-hour)
- NO2 (annual)
- NO2 (1-hour)
- O3 (8-hour)
- PM2.5 (annual)
- PM2.5 (24-hour)
- PM10 (24-hour)
- SO2 (1-hour)
Comparison of Growth Areas and Declining Emissions
1970-2018

- Gross Domestic Product
- Vehicles Miles Traveled
- Population
- Energy Consumption
- CO₂ Emissions
- Aggregate Emissions (Six Common Pollutants)
We Made our Air Safe with Technology, Not Anti-Fossil Fuel Ideology

Sources: Environmental Protection Agency, Air Trends Report 2018; Energy Information Administration, Total Energy Data Browser
CASE STUDY: OZONE NONATTAINMENT

Nonattainment Areas for the 2015 8-hour Ozone Standard
Ozone 2015 NAAQS NAA
State Level
- Maintenance
- Nonattainment
Power Plants No Longer Drive Nonattainment

NO$_x$ Emissions

Source: U.S. EPA National Emissions Inventory 2014 ver. 2
EXAMPLE – DFW: Power Plants Have Not Driven Attainment Status for over a decade

Future Case Contributions to DFW Ozone
Task 20 - APCA Analysis of 2009 Baseline Impacts

Source: July 13, 2006
TCEQ Presentation to Senate Natural Resource Committee

Very Small Local & Regional Power Plant Contribution
CASE STUDY: PM$_{2.5}$ NONATTAINMENT

Nonattainment Areas for the 2012 Annual Fine Particle (PM2.5) Standards

PM2.5 Annual 2012 Nonattainment Areas
- Maintenance
- Nonattainment
CASE STUDY: U.S. PM$_{2.5}$ – 6x below global average
(7x below China, & much lower than Europe)
For Non-GHG, When Ambient Air Quality is “Safe,” We Should NOT Count Benefits for “Cleaner”

- Per the FCAA, NAAQS are based on what is considered a “safe” level of constituents for humans (plus a margin of safety).
- Only NAAQS nonattainment remaining in the U.S. is NOT being driven by power plants (natural/foreign/mobile sources).
- Thus, it is inappropriate to continue assuming “benefits” from lowering power plant emissions down to absolute zero.
- Yet, 99% of “benefits” of EPA air rules assumed by the prior administration were derived from reducing ambient levels below the NAAQS “safe” levels.
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• The Difference Between “Safe” and “Clean”
• *Carbon Reductions are Not all Created Equal*
• Status of and Business Case for CCUS
• CCUS in Resource Planning
Not All Carbon Reductions are Created Equal

• Early retirement of well-controlled coal units rarely economically justified.

• State & Federal subsidies and mandates for renewables has already been a significant internalizing function of carbon as an externality.

• Because carbon captured from a dispatchable fossil fuel plant innovates CCUS & provides baseload low-carbon power, it is a much more valuable low-carbon asset (to the grid & the world) than intermittent wind or solar.

• If we are serious about mitigating anthropogenic CO2 & ensuring market transparency, regulatory approvals/planning must ensure that ratepayers know the true and total cost (and benefits) of their low-carbon options.
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DON’T FORGET THE MATH: The World Needs our Technology, Not Anti-Fossil Fuel Ideology

2050 IMPACT OF DECARBONIZING ELECTRICITY:
• NO COAL FLEET = 2.06 ppm (0.4%) reduction in CO$_2$ concentration.
• NO FOSSIL FLEET = 3.3 ppm (0.7%) reduction in CO$_2$ concentration.
• Modeled global temperature reduced by a mere 0.016°C.

2050 IMPACT OF DECARBONIZING ENTIRE U.S.:
• 10.4 ppm (2.2%) reduction in CO$_2$ concentration.
• Modeled global temperature reduced by 0.053°C.

<table>
<thead>
<tr>
<th>CO2 Emissions</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>30,834</td>
<td>34,972</td>
<td>36,398</td>
<td>39,317</td>
<td>42,771</td>
<td>+38.7%</td>
</tr>
<tr>
<td>U.S.</td>
<td>5,571</td>
<td>5,260</td>
<td>4,839</td>
<td>4,867</td>
<td>5,071</td>
<td>-8.9%</td>
</tr>
</tbody>
</table>

Petra Nova:

Power Generation:
- Gas CT/peaker for parasitic load

Carbon Capture:
- Post-combustion amine solvent
- 90% of 250 MW slip stream
- 1.65 short tons of CO$_2$ annually

Product Delivery and Utilization:
- CO$_2$ EOR via 80-mile pipeline
- West Ranch oil recovery up from 500 to 5,000-10,000 Barrels Per Day
Path to success – Improving CCUS Economics

Year

$/MCF

2017

CCS with 4% Cost improvement P.A.

2019

SOURCE: David Greeson, Project Manager, Petra Nova
CASE STUDY: CO & NM Units that Could be Retrofitted with CCUS Rather than Retired
DOE STUDY: Demonstrates Viability of CCUS Retrofit Rather than Retire & Replace with Wind/Solar/Storage (Tax Equity Owner reduces cost to the consumer even more!)
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• Status of and Business Case for CCUS
• **CCUS in Resource Planning**
Factors That Regulators Should Address When Comparing CCUS & Renewable Energy

<table>
<thead>
<tr>
<th>WIND/SOLAR/STORAGE</th>
<th>KEY CONSIDERATIONS</th>
<th>CCUS RETROFIT</th>
</tr>
</thead>
</table>
| • Low Capacity Factors  
  • Transmission Additions  
  • Reliability & Resilience Penalty | **True & Total LCOE** | • High Capacity Factors  
  • No New Transmission  
  • High Reliability & Resilience |
| • Bird Strikes  
  • Habitat Destruction  
  • Lithium/Cobalt Mining for Batteries  
  • Rare Earths for Turbines & Solar | **Non-GHG Externalities** | • Air Quality Not Impacted > Known “Safe” Levels (NAAQS)  
  • Successful & Established Coal Reclamation Programs |
| • Backup Power Emissions  
  • Life-Cycle GHGs From Construction & Land Use  
  • Missed R&D opportunity | **GHG Externalities** | • No Backup Power Required – (24/7 carbon-free resource)  
  • R&D Drives Down Future Costs (global game changer) |
| • Dependence on Minerals & Products Not Mined/Made in US | **Economic Impact & Geopolitical** | • Domestic fuels (coal & gas) + export commodity (oil & tech) |
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QUESTIONS?
“Converting Carbon to a Commodity” Video

https://www.youtube.com/watch?v=TIIVvAOQBjc
APPENDIX: Why U.S. Power Markets are NOT Transparent

1. The premise of U.S. RE moving the needle on global climate change is fundamentally flawed.
   • Even if we were to eliminate all U.S. power sector emissions by 2030, it would only reduce 2050 global concentrations by .7% (3.3 out of 480.3 ppm)

2. PTC/ITC subsidies are hidden from consumers.

3. All fuels receive subsidies but there is massive disparity in Return on Investment (in $/MW).

4. Direct/Indirect Subsidies Distort Markets:
   • Transmission socialized across entire markets.
   • Growing costs of balancing wind & solar.
   • Stranded costs & lack of market signals for capacity.

The Lack of Transparency in American Power Markets Leads to “Grid Parity” Claims & and “100% Renewable” Mandates that Mislead Ratepayers & Endanger Grid Resilience.
Comparing the ROI of Federal Energy “Subsidies”

Many claim that all forms of energy receive “subsidies,” but wind & solar deliver far less return on investment (ROI).

Production tax credit subsidies for existing renewable energy technologies do not promote innovation.

Subsidies per Unit of Electricity Generated (2017 USD/MWh, 2003 - 2017 Average)

Sources: Office of Management and Budget, Analytical Perspectives; Joint Committee on Taxation, Estimates of Federal Tax Expenditures; Department of Energy, Statistical Tables by Appropriation; Census Bureau, Consolidated Federal Funds Report; Department of the Treasury, Section 1603 List of Awards; Energy Information Administration, Electricity Data Browser
Transmission Costs of Integrating Renewables

Case Study: ERCOT
Off-Peak Exuberance vs. On-Peak Reality:

**OFF-PEAK EXUBERANCE:**

Houston Chronicle headline, “Texas wind generation breaks record, ERCOT reports”  
(19,168 MW Wind on 12/14/18 when entire grid needed only 36,760)

**ON-PEAK REALITY:**

Wind underperformance from 7/10-7/13/19 on & off peak.

Installed Wind:
~24,000 MW

Average from 12 to 6 PM:
2,704 MW (11% capacity factor)
The Imputed Cost of Wind on (& off) the Grid is NOT Being Adequately Reflected in Market Designs –

Note the Forecasting vs. Actual Generation
And it’s Not Just Texas in the Summer!

Max Gen Event Declaration
## PJM Bomb Cyclone

### Case Study in Energy Resilience

**How is it Again that America is Going to Live Without Coal?**

<table>
<thead>
<tr>
<th>Fuel</th>
<th>12/1-12/26</th>
<th>12/27-1/8</th>
<th>Positive Delta Total</th>
<th>Percentage Change</th>
<th>Share of Positive Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>746</td>
<td>1,113</td>
<td>367</td>
<td>49%</td>
<td>73%</td>
</tr>
<tr>
<td>Gas</td>
<td>607</td>
<td>619</td>
<td>12</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Renewables</td>
<td>127</td>
<td>122</td>
<td>-5</td>
<td>-4%</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear</td>
<td>846</td>
<td>851</td>
<td>5</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Oil</td>
<td>6</td>
<td>117</td>
<td>112</td>
<td>1994%</td>
<td>22%</td>
</tr>
<tr>
<td>Multiple fuels</td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>383%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,334</strong></td>
<td><strong>2,832</strong></td>
<td><strong>504</strong></td>
<td><strong>21.6%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: DOE/NETL 2018
Globally, More Renewable Energy Means More Expensive Power

Electricity costs (cent per kilowatt hour)

Trend = 0.02 cent/kilowatt hour per additional kW of capacity
Expensive Energy Hurts the Poor the Worst

Civil Rights Suit Exposes California’s Regressive Green Energy Agenda

Superior Court of the State of California
County of Fresno
Unlimited Civil Jurisdiction

Verified Petition for Writ of Mandate; Complaint for Declaratory and Injunctive Relief


Case No. ______________________

THE TWO HUNDRED, an unincorporated association of civil rights leaders, including LETICIA RODRIGUEZ, TERESA MURILLO, and EUGENIA PEREZ,

Plaintiffs/Petitioners,

v.

CALIFORNIA AIR RESOURCES BOARD, RICHARD COREY, in his Official Capacity, and DOES 1-50,

Respondents/Defendants.

"... the “net zero” GHG threshold would operate unconstitutionally so as to disproportionately disadvantage low income minorities in need of affordable housing relative to wealthier, whiter homeowners who currently occupy the limited existing housing stock..."

"CARB’s VMT reduction scheme and its ongoing efforts to intentionally increase congestion are an assault on the transportation mobility of people, which disparately harm minority workers..."

"Since most of the world’s energy is still produced from fossil fuels, energy consumption is still highly correlated to economic productivity and per capita incomes ...

“California’s climate change policies ... have caused and will cause unconstitutional and unlawful disparate impacts to California’s minority populations ..."
ENERGY DENSITY = ENVIRONMENTAL STEWARDSHIP

### Density of U.S. Energy Resources

<table>
<thead>
<tr>
<th>Power Source</th>
<th>W/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>307</td>
</tr>
<tr>
<td>Coal</td>
<td>182</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>101</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>22</td>
</tr>
<tr>
<td>Solar</td>
<td>8</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>1.7</td>
</tr>
<tr>
<td>Wind</td>
<td>1.0</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.3</td>
</tr>
</tbody>
</table>


### Land Requirements for a 1000 MW Power Plant

- **Nuclear**: 27 mi²
- **Coal**: 2 mi²
- **Natural Gas**: 3 mi²
- **Solar**: 1 mi²
- **Wind**: 115 mi²


Amount of land required for 5,000 GWh of annual production, assuming 60% capacity factor for nuclear, coal, and natural gas, 20% for solar, and 34% for wind. Land requirements for wind include spacing between turbines. Values for wind and solar do not include land for transmission lines or energy storage to ensure equal reliability to dispatchable power.