The Role for Coal

The Compelling Case for Coal in Light of the Needs of New Mexico, the Nation’s Electric Grid & Global Energy Demand

New Mexico Mining Association
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DISCUSSION OUTLINE

• Electric Grid Fundamentals
• Global Energy Demand Reality Check
• The Environmental Context
• Business Case for CCUS
• The Case & Path Forward for New Mexico CCUS
Electricity Grid Fundamentals
Electric Markets are Not Functioning Rationally Due to a Lack of Transparency

1. Markets depend on consumers knowing the true costs of what they are buying – that is NOT happening in electricity markets.
2. Subsidies are hidden from consumers in tax bills.
3. All fuels receive subsidies but there is massive disparity in return on investment (in $/MW).
4. Direct/Indirect Subsidies Distorting Markets:
   • Transmission socialized across entire markets.
   • Growing costs of balancing wind & solar.
   • Stranded costs & lack of market signals for capacity.
   • Costs escalate as RE market penetration rises
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

2002 to 2017

Massive (>100%) increase in ratepayers transmission & distribution cost

Significant (16%+) decrease in competitive charges (Energy)
ERCOT Experiment is Exposing Massive Imputed Cost of Wind

Note the Forecasting vs. Actual Generation

Legend:
- **GREEN**: Actual Wind Production
- **BLUE**: Day-of Wind Forecast
- **BROWN**: Day-Ahead Wind Forecast
2019 – Off-Peak Exuberance vs. 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)
A Week in Texas (Summer of 2018)

- New Record Consumption Every Day! (72-74 GW!)
- Gas, Coal, and Nuclear Meet the Challenge (69-71 GW)
- Wind No-Show & little Solar Results in < 5-8% of needs.

Gap Between Perception & Reality Remains Huge

2018 – Off-Peak Exuberance vs. Peak Reality
Even Optimistic Projections About the Coming Battery Boom Fall Short of “Closing the Peak Gap”

Global cumulative energy storage installations

200 GW x 4 hr. = 800 GWh/day

Source: BloombergNEF
Scale Matters: The Coming Battery Boom Cannot Close the Gap

Capabilities:
200 GW x 4 hr. = 800 GWh/day
The Mineral Implications of Massive Battery Storage are Mindboggling

For every 100 GW of new battery storage:

- Assuming 4 hours of energy/day = 29 million tons lithium
- 336x current production
- 10x improvement in density is still 33x current production
- 100% decarbonization of US grid would require an estimated 900 GW of total battery storage by 2050

Current lithium production

Lithium required for 100 GW battery storage (4 hrs/day)
Scientists have yet to discover, and entrepreneurs have yet to invent, anything as remarkable as hydrocarbons in terms of the combination of low-cost, high-energy density, stability, safety, and portability. In practical terms, this means that spending $1 million on utility-scale wind turbines, or solar panels will each, over 30 years of operation, produce about 50 million kilowatt-hours (kWh)—while an equivalent $1 million spent on a shale rig produces enough natural gas over 30 years to generate over 300 million kWh.

Solar technologies have improved greatly and will continue to become cheaper and more efficient. But the era of 10-fold gains is over. The physics boundary for silicon photovoltaic (PV) cells, the Shockley-Queisser Limit, is a maximum conversion of 34% of photons into electrons; the best commercial PV technology today exceeds 26%.

Wind power technology has also improved greatly, but here, too, no 10-fold gains are left. The physics boundary for a wind turbine, the Betz Limit, is a maximum capture of 60% of kinetic energy in moving air; commercial turbines today exceed 40%.

The annual output of Tesla’s Gigafactory, the world’s largest battery factory, could store three minutes’ worth of annual U.S. electricity demand. It would require 1,000 years of production to make enough batteries for two days’ worth of U.S. electricity demand. Meanwhile, 50–100 pounds of materials are mined, moved, and processed for every pound of battery produced.
Expensive Energy Hurts the Poor the Worst

Civil Rights Suit Exposes California’s Regressive Green Energy Agenda

"California’s climate change policies ... have caused and will cause unconstitutional and unlawful disparate impacts to California’s minority populations ..."

"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 ..."

"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..."

"... 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..."
A Video Review of the Limits of Renewables

- [https://youtu.be/ObvdSmPbdLg](https://youtu.be/ObvdSmPbdLg)
Globally, More Renewable Energy Means More Expensive Power
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Global Energy Demand Reality Check

1. As our history proves, human life is improved by affordable energy, and humans suffer without it.

2. U.S. fossil fuel/technology exports are critical to global efforts to eradicate energy poverty.

3. Therefore, developing nations need fossil fuels to lift 3.9 billion humans out of energy poverty.

4. International officials are misleading the world regarding the practicality of non-fossil energy.
WHAT WE HAVE DONE & WHAT WE STILL MUST DO

• Over Last 20 Years, 830 Million Get their First Electricity

• 1.3 Billion Still Living with no Access to Electricity

PUDONG (Shanghai) in 1990
PUDONG (Shanghai) Today
“Energy Poverty” Video

https://www.youtube.com/watch?v=nEovKjVkJUpc
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The World Does NOT Need Windmills in Wyoming & Texas— it Needs us to Commercialize CCUS Technology . . . NOW!

2050 IMPACT OF DECARBONIZING ELECTRICITY:
• NO COAL FLEET = 2.06 ppm (0.4%) reduction in CO₂ concentration.
• NO FOSSIL FLEET = 3.3 ppm (0.7%) reduction in CO₂ 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 CO₂ 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>
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MYTH: Shifting Away From Coal = Significant Health Benefits

FACT: American Air & Water is Already Safe

States in compliance with NAAQS have “safe air.”

Only junk science assumes benefits from reductions below the levels set in NAAQS.

False claims that reducing coal use in America will improve health further are based on an anti-coal belief system, not science.
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
Leading the World in Cleaning the Air While Growing our Economy

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1. Geopolitically, securing the long-term viability of American coal and oil production should be a national priority.

2. Many existing & potential markets for coal insist that we have a carbon mitigation strategy before committing to extending the life of existing plants or building new.

3. Rising demand for energy internationally makes any domestic decarbonization irrelevant unless commercializing and exporting CCUS technology is a central component of that strategy.

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**INVESTING IN CCUS IS AN INVESTMENT IN DOMESTIC ENERGY SECURITY & AN INTERNATIONAL COAL & CCUS MARKETING PLAN**
Petra Nova:

Power Generation:
• Gas Combustion Turbine/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 & Utilization:
• CO$_2$ EOR via 80-mile pipeline
• West Ranch oil recovery up from 500 to 5,000-10,000 Barrels Per Day
Example Project Structure

Project Structure Diagram:

1. **Developer**
   - Development Costs
   - 320 MW Export of Zero Carbon Power

2. **Sponsor**
   - Dev. Cost
   - Dev. Cost Reimbursement
   - Pymt for VOM & all services

3. **Tax Equity Fund**
   - Value of 45Q EOR=$35/tonne
   - Storage=$50/tonne

4. **Project Company, LLC**
   - 450 MWe Flue gas
   - 130 MWe steam power
   - 3.3 million tpy compressed CO2

5. **Midstream Company**
   - CO2 Purchase ($20-$25/ton)

6. **EOR OilCo**
   - Pipeline
   - 120 miles

7. **Coal Plant**
   - Clean-Affordable-Reliable-Energy (CARE)
   - Pymt for VOM & all services

8. **CCS**
   - 130 MWe steam power
   - water, labor, other

9. **PipelineCo, LLC**
   - Pipeline

10. **Sequestration Certification**
    - Sequest Site

11. **45Q Tax Credit**
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!)
Not All Carbon Reductions are Created Equal

• 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.
Retrofit Technologies Should be Central to Global Climate Discussions (IPCC already concedes this)
<table>
<thead>
<tr>
<th>WIND/SOLAR/STORAGE</th>
<th>KEY CONSIDERATIONS</th>
<th>CCUS RETROFIT</th>
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<tbody>
<tr>
<td>• Low Capacity Factors</td>
<td><strong>True &amp; Total LCOE</strong></td>
<td>• High Capacity Factors</td>
</tr>
<tr>
<td>• Transmission Additions</td>
<td></td>
<td>• No New Transmission</td>
</tr>
<tr>
<td>• Reliability &amp; Resilience Penalty</td>
<td></td>
<td>• High Reliability &amp; Resilience</td>
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<tr>
<th>Non-GHG Externalities</th>
<th>GHG Externalities</th>
<th>Economic Impact &amp; Geopolitical</th>
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<tbody>
<tr>
<td>• Bird Strikes</td>
<td>• Backup Power Emissions</td>
<td>• Dependence on Minerals &amp; Products</td>
</tr>
<tr>
<td>• Habitat Destruction</td>
<td>• Life-Cycle GHGs From Construction &amp; Land Use</td>
<td>Not Mined/Made in US</td>
</tr>
<tr>
<td>• Lithium/Cobalt Mining for Batteries</td>
<td>• Missed R&amp;D opportunity</td>
<td></td>
</tr>
<tr>
<td>• Rare Earths for Turbines &amp; Solar</td>
<td></td>
<td>• Domestic fuels (coal &amp; gas) + export commodity (oil &amp; tech)</td>
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<th>True &amp; Total LCOE</th>
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<th>GHG Externalities</th>
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<tr>
<td>• Air Quality Not Impacted &gt; Known “Safe” Levels (NAAQS)</td>
<td>• No Backup Power Required – (24/7 carbon-free resource)</td>
<td>• No Backup Power Required – (24/7 carbon-free resource)</td>
<td>• Domestic fuels (coal &amp; gas) + export commodity (oil &amp; tech)</td>
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<tr>
<td></td>
<td>• Successful &amp; Established Coal Reclamation Programs</td>
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“Converting Carbon to a Commodity” Video

https://www.youtube.com/watch?v=TIxVvAqQBjc
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2019-2022 IS NEW MEXICO’S DEFINING CCUS MOMENT:

• THE ENTRENCHMENT OF THE OTHER SIDE CAN ONLY BE OVERCOME WITH SUCCESS STORIES – NOW!

• With Every Premature Retirement of an Existing Coal Plant, we Lose Resilient Power, Employment and an Opportunity to Commercialize CCUS technology . . . FOREVER.

• Electric Grid Disruption from High Renewable Penetration is a Certainty Under Established Principles of Physics & Engineering.
2019-2020 IS NEW MEXICO’S DEFINING MOMENT (cont.):

IF NEW MEXICO ALLOWS PREMATURE COAL RETIREMENTS TO CONTINUE,

• Ratepayer investments in coal plants and environmental controls are stranded
• Tribes and State gives up coal-fueled plants, mines and the associated employment
• State foregoes the opportunity for significantly expanded oil recover (from EOR)
• State gives up state royalty and tax revenues associated with all of the above
• State loses out on leveraging 45Q window of opportunity
CLAIM #1:

“It overlooks how the deployment of carbon-capture technology around coal-fired generation remains a mostly academic, unaffordable exercise.”

FACT:

CCUS retrofits are neither academic nor unaffordable. The Petra Nova project is evidence of that and it pre-dates the extremely favorable economics of the 45Q tax credit. Ignoring Petra Nova and focusing on the Kemper project, which was a greenfield gasification project with complexities that have no relevance to New Mexico CCUS retrofits, is, at best, ignorant and, at worst, intentionally misleading spin.
CLAIM #2:

“It banks on the unlikelihood of being able to find a market in the distant Permian Basin oilfield for the carbon dioxide it would capture”

FACT:

The Permian has a 4 decade-long, established CO2 EOR market and is currently short on CO2 with several operators looking for additional supply, so the premise of this claim that the market is uncertain is a shameful fabrication.
CLAIM #3:

“It does not say where long-term project liabilities would lie.”

FACT:

Practicing law without a license is not journalism (and illegal, by the way). Concerns about liability associated with CCUS projects are vastly overstated and reflect ignorance about the regulatory treatment of the CO2 when used as a product in EOR.
Busting the Myths of Anti-CCUS Advocates

CLAIM #4:

“It does not address the inevitable rise in electricity costs owing to the parasitic load created by the installation of carbon-capture equipment.”

FACT:

There’s no proof that power prices will rise. As proven in Texas at Petra Nova, CCUS can be done with NO impact on the cost of electricity. And, remember, coal mines have load that bring down the cost of power for others.
Busting the Myths of Anti-CCUS Advocates

CLAIM #5:

“It plays up the importance of using newly enhanced tax credits for carbon capture to finance the project, while leaving out the fact that the credits would be available only if and when the project is operational, a highly unlikely outcome.”

FACT:

This claim screams out ignorance of how tax equity investment-driven project finance works. Leveraging tax credits prospectively to facilitate project finance is an established practice. If the premise of this claim were true, there would never have been investment in wind & solar projects.
NEW MEXICO’S DEFINING MOMENT

“Don’t Let Billionaires Tell Our State What to Do!”
To reframe the national discussion about energy sources – including fossil fuels - on the importance of reliable, abundant, affordable energy to the American quality of life and the advancement of the human condition.
RAISING AMERICA’S ENERGY IQ

Energy powers life… you can literally track the advancement of the human condition with the availability of abundant energy.

**Reliable** energy is central to our daily life.

Environmental policy should serve **humanity**, not the other way around.

**Domestic fossil fuel** are increasingly **clean** and exporting that to the rest of the world will improve lives and help the environment.

**America’s future** requires continued reliance on clean & abundant fossil fuel.
CENTERPIECE OF OUR EDUCATION CAMPAIGN!

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REACH OUT TO SUPPORT THE EFFORT!

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REMIND EVERYONE YOU KNOW HOW MUCH THEY DEPEND UPON AMERICAN FOSSIL FUELS IN THEIR DAILY LIVES!

”Fossil Fuels -Essential to Every Day Life” Video

https://www.youtube.com/watch?time_continue=1&v=mclv06jR_e0
QUESTIONS?

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INTERNATIONAL ENERGY AGENCY WORLD ENERGY OUTLOOK
https://www.iea.org/weo/
NATIONAL COAL COUNCIL’S POWER RESET (2018)
NATIONAL COAL COUNCIL’S COAL IN A NEW CARBON AGE (2018)
DEPARTMENT OF ENERGY OFFICE OF FOSSIL ENERGY
https://www.doe.gov/fossil
LIFE: POWERED POWERFUL FACTS
https://www.lifepowered.com
AMERICA’S POWER COAL FACTS
https://www.americaspower.org