



21st Century Coal

Saving U.S. Coal with Technological Advances

Bluefield Coal Symposium

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Net-Negative CO₂ Baseload Power, Inc.

About us

- The Team



Steve Winberg, CEO



Ken Humphreys



Fred Palmer

- Not-profit coal education and advocacy organization founded in 2021
 - Affordable, reliable energy and materials from coal are essential to a clean energy future
 - 21st century coal technology investments, incentives, and energy policies that value affordability and reliability can unlock that future
- Our Members
 - CONSOL Energy
 - Peabody Energy
 - PFBC-Environmental Energy Technology, Inc.

Coal Consumption Trends

The Current Direction is Dire

Year	Coal Consumption (Million Tons)	Capacity (GW)
2007	1,045	313
2013	861	304
2023	582 44% decline	197
2030	234 ^(a) 78% decline	91 ^(b)
2030 w/OTR	175 ^(a) 83% decline	68 ^(b)

Sources: (a) EIA data; (b) America's Power est. based on announced retirements

- Could lose two-thirds of 2023 U.S. coal sales by 2030 if announced retirements occur
- Losses could be higher, if EPA's regulations survive court challenges
- Fleet continues to age and investment capital is focused on maintenance of production.

Coal Headwinds

Factors cooling coal's current and future markets

- Coal's opponents have used the climate issue to demonize coal and have gained significant public, shareholder, and policymaker acceptance of this demonization
- Climate concerns are increasingly acknowledged by pro-fossil fuel policymakers and conservatives
- Coal opponents are well-funded, getting "richer", and gaining allies
- The net effect of renewable tax credits, portfolio standards and other incentives are reducing coal plant dispatchability and degrading the investment returns on coal power projects
- EPA has ramped up its regulatory assault on coal – both production and use
- An Administration change will alleviate some anti-coal legislative and regulatory challenges, but this short-term relief is not a long-term solution
- Even regulations that are eventually overturned contribute to longer-term market uncertainties
- Power producers are moving away from coal

Facing Reality

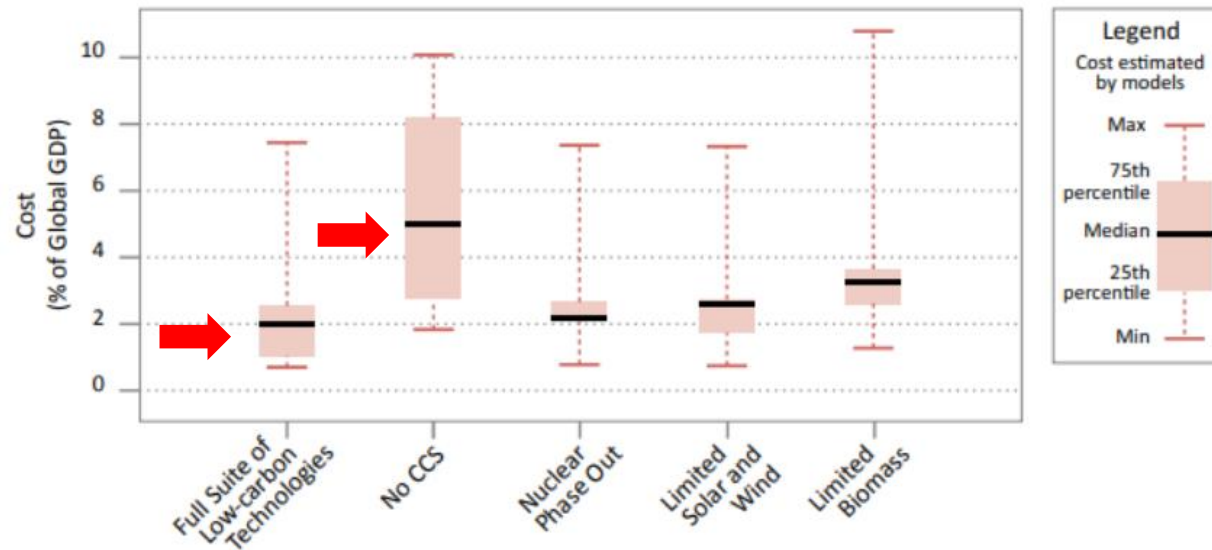
Going to require disruptive solutions

- The coal industry needs to continue its defense, but defending the status quo is not enough.
- It will take more than a few court victories, deferred retirements, and favorable election outcomes to arrest the downward trend
- Offense is needed – Coal needs to be “*For Something*”
- The elements of that solution need to be something pro-coal policymakers and the persuadable middle can get behind
- One of the prominent elements of a solution is 21st century coal technology:
 - In the short-term, provides a compelling, positive message about coal’s potential to provide:
 - affordable, dependable, clean electricity
 - through co-production of critical minerals alleviate risky U.S. dependencies on foreign supply chains
 - In the medium-term, supports repowering or retrofitting of select units in the existing fleet, and provides the time for other 21st century coal technologies to mature
 - In the long-term, provides the basis for brownfield and greenfield new builds

Coal's Tailwinds

Factors that could work in Coal's Favor

- “Affordable” Electricity is getting attention
 - In 2022, average electricity prices rose 14.3% -- more than double inflation.
 - Increasing press attention on high utility bills
 - Contributing to loss of manufacturing jobs
 - International Renewable Energy Agency estimates \$131 trillion cost to reach 1.5C by 2050.



Costs of Achieving a 2°C goal as a fraction of Global GDP (2010-2100)

(adapted from Krey et al., 2014)

Coal's Tailwinds

Factors that could work in Coal's Favor

- “Dependable” Electricity is getting attention
 - Hearings with FERC and NERC have raised reliability and resiliency concerns
 - NERC’s 2023 Long-Term Forecast: >70% of U.S. grid is at risk

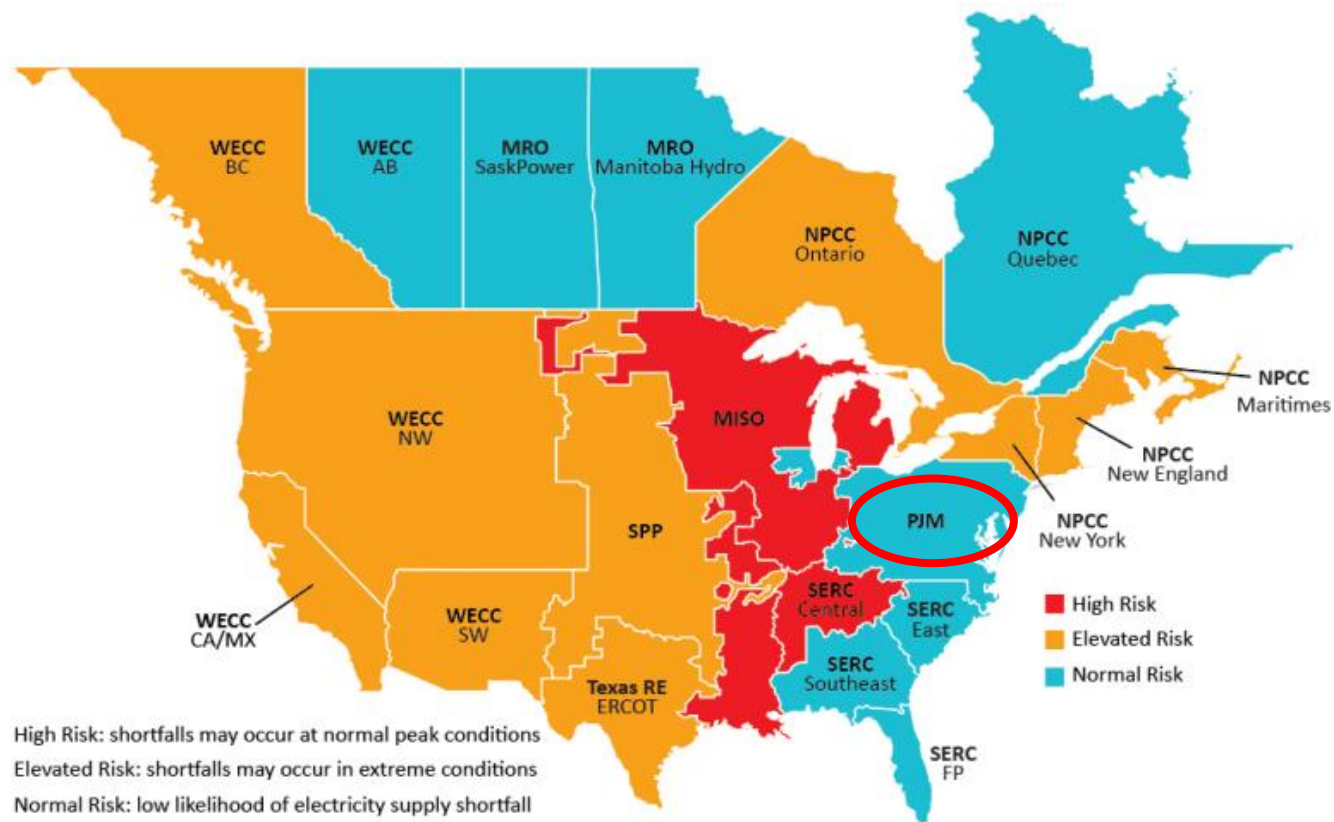


Figure 1: Risk Area Summary 2024–2028⁸

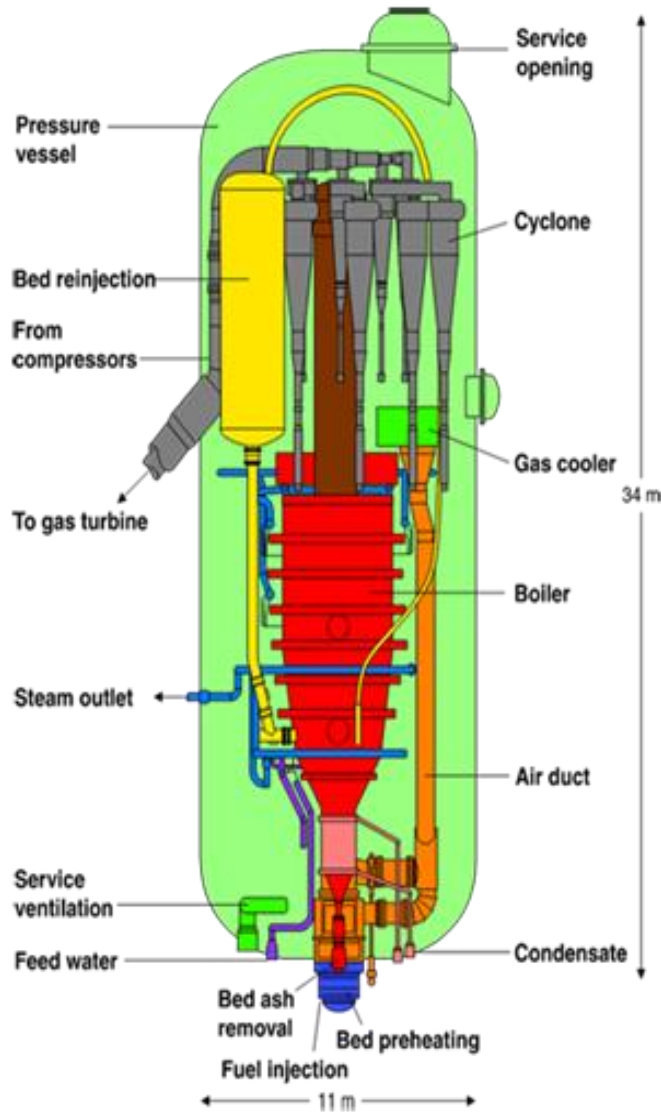
Coal's Tailwinds

Factors that could work in Coal's Favor

- “Clean” electricity remains misunderstood, but
 - Pro-coal policymakers are looking for positive ways to message coal’s role
 - Increasingly policymakers and energy consumers are waking up to the facts that “green technologies” are:
 - driving up the cost of energy
 - creating unacceptable dependencies on foreign supply chains
 - Internationally, coal remains vital to economic development, which is a counterforce to any U.S. Administration that attempts to drive an anti-coal agenda
 - Facts on coal’s side:
 - Coal is not the issue, CO₂ is the issue
 - Coal with biomass and CCS can provide electricity with net-negative CO₂ emissions 24x7
 - Coal can produce H₂ and ammonia – carbon-free energy carriers
 - Coal mining provides access to vast quantities of critical minerals and rare earth elements

Pressurized Fluidized Bed Combustion (PFBC)

First generation technology proven



- Pressurized Fluidized Bed Combustion (PFBC) is a clean and efficient technology for power generation
- PFBC has a successful commercial operating history
- Cycle efficiency greater than 45%, which is higher than traditional coal power plants
- Fuel flexibility includes opportunity fuels, such as biomass, waste coal, and petcoke
- Compact size of PFBC allows for the easy repower of existing coal-fired power plants already permitted
- Environmental compliance with low emissions of NO_x, SO_x, CO, and particulates
- Honeywell has a proven, commercial carbon capture technology for PFBC

Coal/Biomass Co-Firing

First generation co-firing technology for power generation is proven

- Drax Station in the U.K.
 - Began co-firing 5% biomass in 2003
 - Added direct injection in 2005
 - Ramped up co-firing percentage ultimately converting 4 units (2.6GW) to 100% biomass
 - Steam turbines and generators remain the same
 - Principally a material handling and injection retrofit
- RWE's Amerweg 1 Station in the Netherlands
 - Commissioned in 1993 as a 600-MWe CHP coal-fired plant
 - Converted to 80% biomass co-firing in 2019
- Soma Energy Park in Japan
 - MHI successfully demonstrated 35% co-firing on a 112-MW coal plant at rated load in 2018



Photo Credit: Drax



Photo Credit: RWE

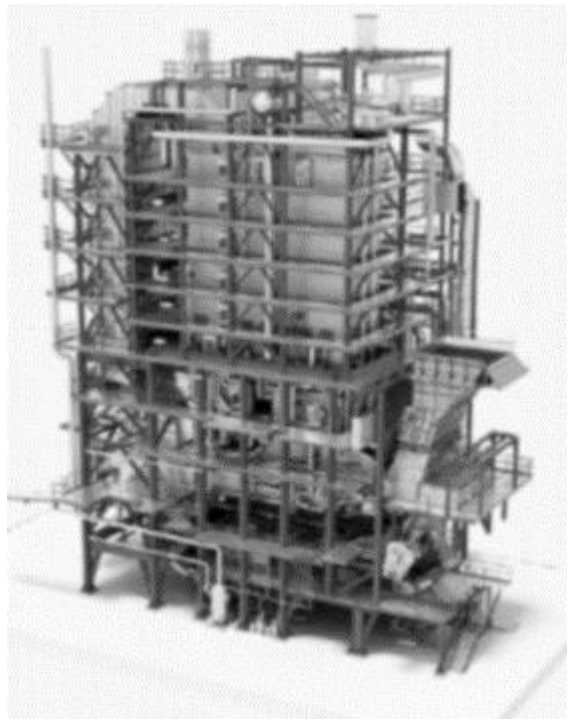
Staged Pressurized Oxy-Combustion (SPOC)

Pilot-scale Ready

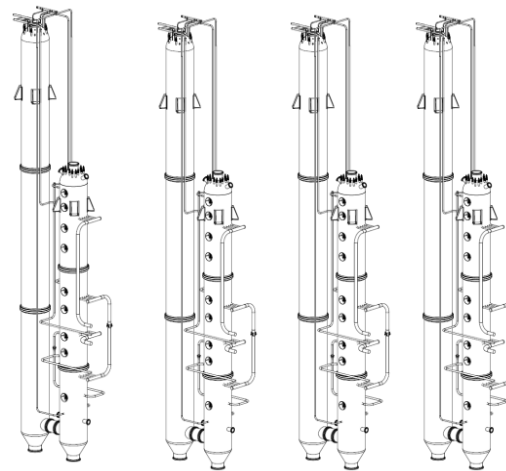
- **Dispatchable**
 - Flexible operation ensures grid remains reliable
 - Includes energy storage to help balance the grid
- **Modular design**
 - Low-cost factory fabrication and faster onsite construction
- **Low cost**
 - Electricity cost as low as 6¢ / kWh for retrofits
- **High Efficiency**
 - Superior to existing coal plants
- **Near carbon-neutral**
 - Carbon-negative when utilized with biomass
- **Reduces water consumption**

Boilers

Conventional

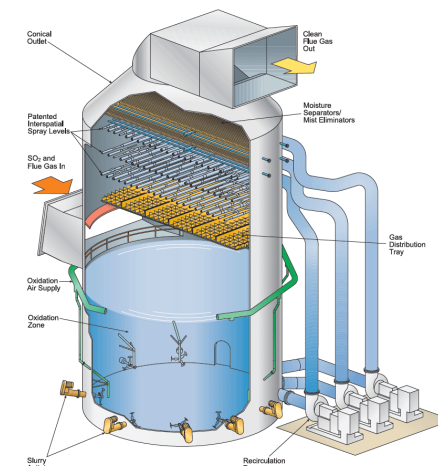


SPOC



Flue gas cleanup

Conventional



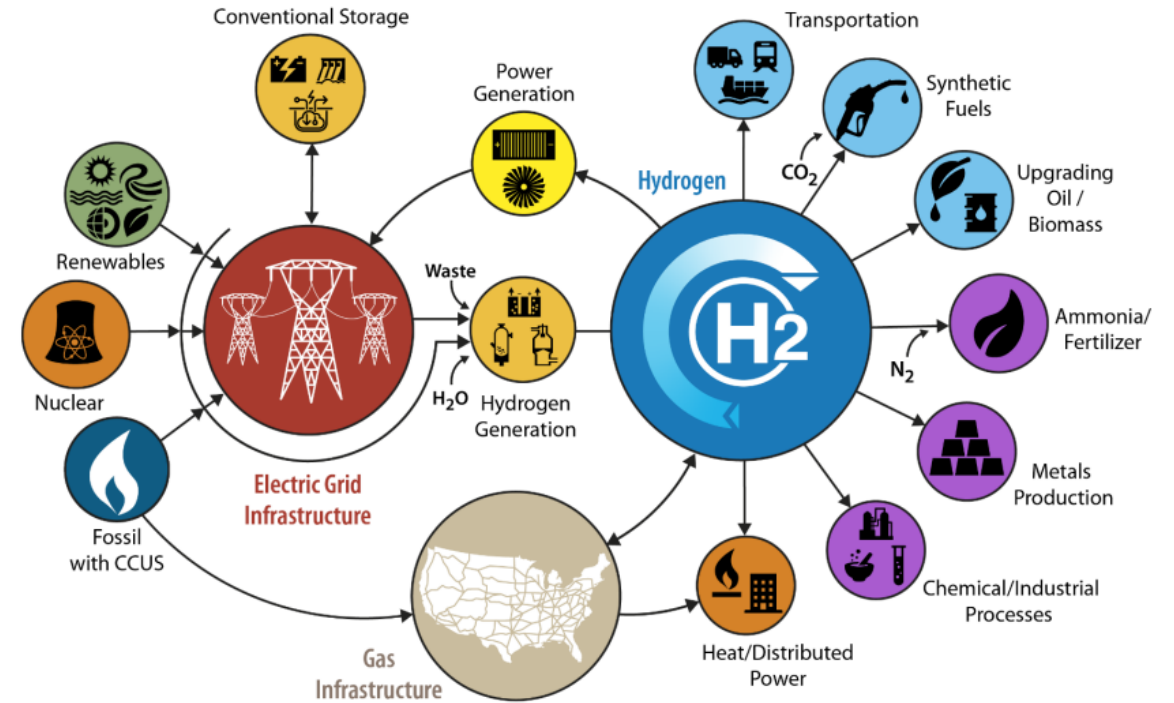
SPOC



Gasification Technology for Hydrogen Production

Coal is the scalable, low-cost producer

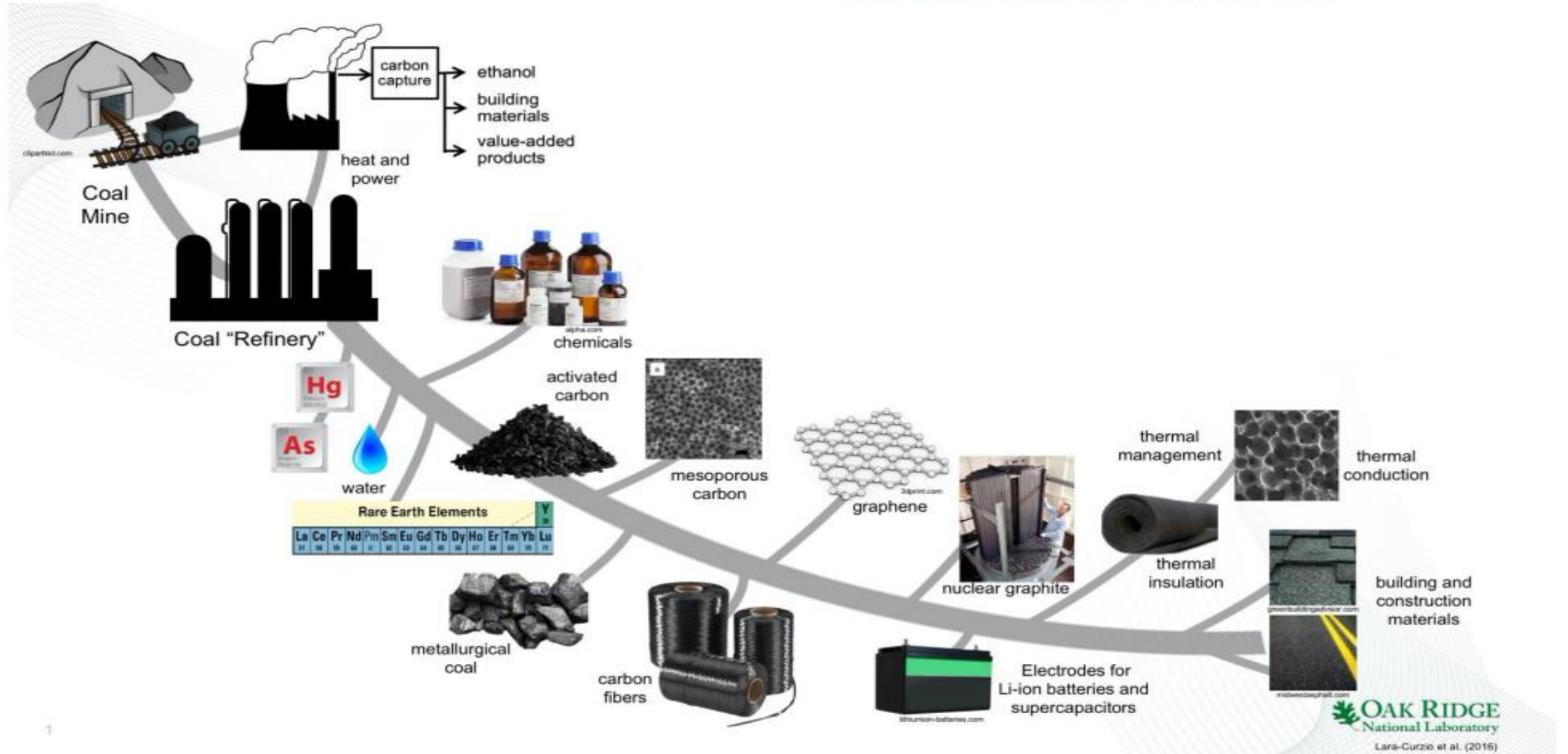
- H₂ from Coal w/CCS would be the least expensive on a levelized cost basis, but a coal/CCS based H₂ plant output would far exceed the “emerging” H₂ market demand
 - IF the H₂ market develops, coal can play an important role as a lower cost source
 - Coal’s potential not adequately considered by DOE
- DOE is funding 7 “Hydrogen Hubs” backed by \$8B of taxpayer money
 - None are considering coal-to-hydrogen
 - Natural gas/CCS and electrolysis are the technologies being considered



Coal to Products

Innovation has created the foundation for a new high-value products

The New Coal Tree



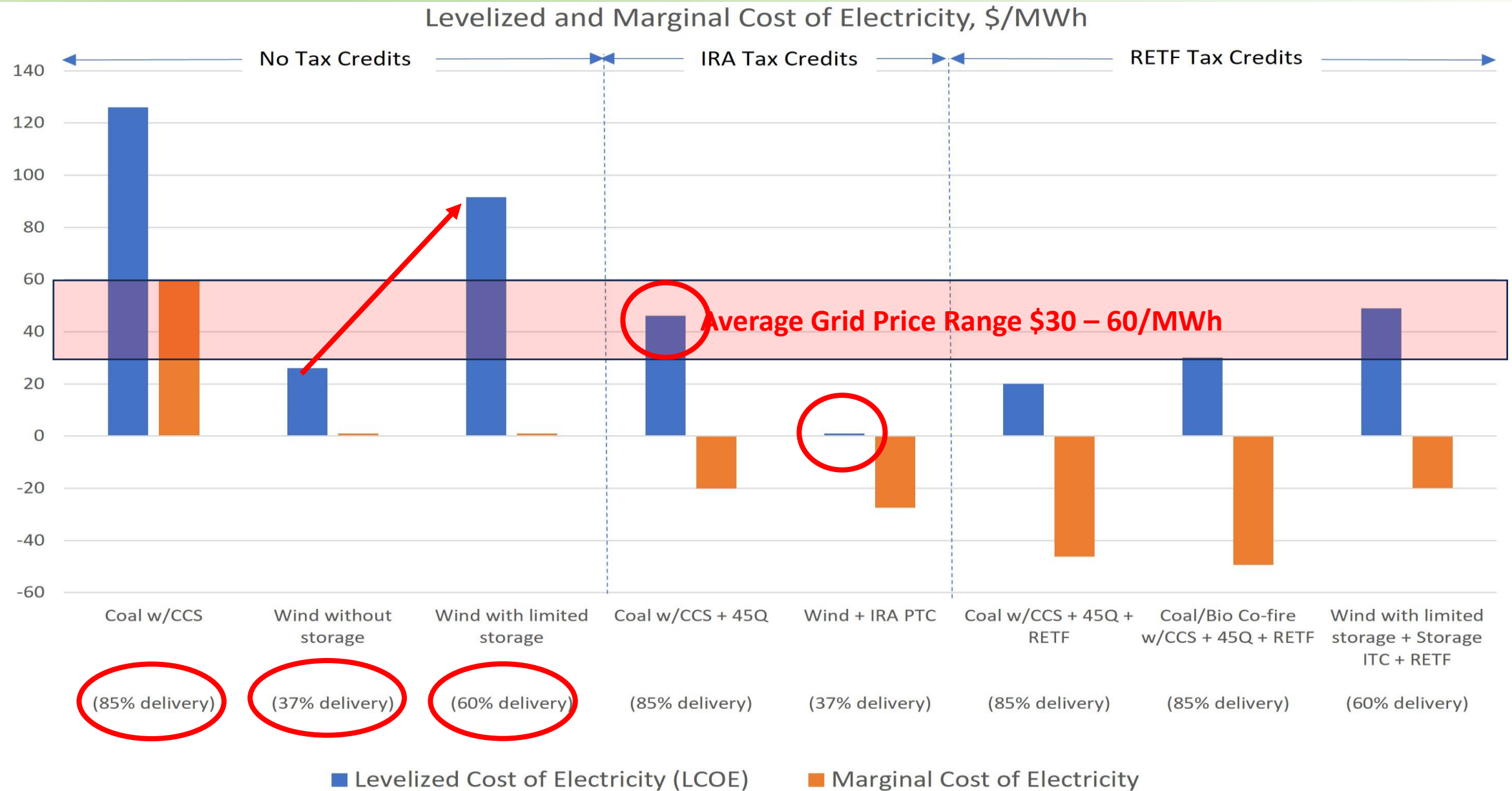
Touchstone Advanced Composites

Coal-based foam for high-performance materials to innovative building materials



Clean Energy Tax Credits

21st Century Coal Technology deployment faces an unlevel playing field, which must be addressed



Strategy to Save U.S. Coal

21st Century Coal Technology is a linch-pin in an affordable, dependable, clean energy future

- Protect the existing fleet
 - Keep EPA in check
- Rebalance federal spending
 - Going forward, rebalance annual DOE budget for renewable and fossil energy
 - Fossil energy provide 6X more energy to Americans than renewables
 - Renewable energy R&D budget is 4X the size of the budget for fossil
 - Where possible rebalance enacted Infrastructure Investment & Jobs Act and Inflation Reduction Act funding and incentives
- Enact permitting reform
 - NEPA, NSR, other reform
 - Accelerate state primacy for Class VI wells
- Tax Credit Parity – Create a Level Playing Field
 - If clean energy tax credits are repealed (unlikely), renewables will continue to undercut coal
 - If clean energy tax credits are restructured and coal's ability to deliver is appropriately valued, coal can effectively compete.



LET'S GO MOUNTAINEERS!

LET'S GO SAVE COAL!

Contact Information

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