



Opportunities for New Technology in Coal Mining and Beneficiation

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Disclaimer

This presentation contains statements, estimates and projections which are forward-looking statements (as defined in Section 21E of the Securities Exchange Act of 1934, as amended). Statements that are not historical are forward-looking, and include, without limitation, projections and estimates concerning the timing and success of specific projects and the future production, revenues, income and capital spending of CONSOL Energy, Inc. ("CEIX") and CONSOL Coal Resources LP ("CCR," and together with CEIX, "we," "us," or "our"). When we use the words "anticipate," "believe," "could," "continue," "estimate," "expect," "intend," "may," "plan," "predict," "project," "should," "will," or their negatives, or other similar expressions, the statements which include those words are usually forward-looking statements. These forward-looking statements involve risks and uncertainties that could cause actual results to differ materially from those statements, plans, estimates and projections. Accordingly, investors should not place undue reliance on forward-looking statements as a prediction of future actual results. Factors that could cause future actual results to differ materially from the forward-looking statements include risks, contingencies and uncertainties that relate to, among other matters, the following: whether the operational, strategic and other benefits of CEIX's separation from CNX Resources Corporation ("CNX") can be achieved; whether the costs and expenses of CEIX's separation can be controlled within expectations; deterioration in economic conditions in any of the industries in which our customers operate may decrease demand for our products, impair our ability to collect customer receivables and impair our ability to access capital; volatility and wide fluctuation in coal prices based upon a number of factors beyond our control including oversupply relative to the demand available for our products, weather and the price and availability of alternative fuels; an extended decline in the prices we receive for our coal affecting our operating results and cash flows; the risk of CEIX debt agreements, CEIX's debt and changes in interest rates affecting CEIX's operating results and cash flows; the effect of the affiliated company credit agreement on CEIX's cash flows and the restrictions contained therein on CCR's business; foreign currency fluctuations that could adversely affect the competitiveness of our coal abroad; our customers extending existing contracts or entering into new long-term contracts for coal on favorable terms; our reliance on major customers; our inability to collect payments from customers if their creditworthiness declines or if they fail to honor their contracts; our inability to acquire additional coal reserves and other assets; our inability to control the timing of divestitures and whether they provide their anticipated benefits; the availability and reliability of transportation facilities and other systems, disruption of rail, barge, gathering, processing and transportation facilities and other systems that deliver our coal to market and fluctuations in transportation costs; a loss of our competitive position because of the competitive nature of coal industries, or a loss of our competitive position because of overcapacity in these industries impairing our profitability; coal users switching to other fuels in order to comply with various environmental standards related to coal combustion emissions; the impact of potential, as well as any adopted environmental regulations including any relating to greenhouse gas emissions on our operating costs as well as on the market for coal; the risks inherent in coal operations, including our reliance upon third party contractors, being subject to unexpected disruptions, including geological conditions, equipment failure, delays in moving out longwall equipment, railroad derailments, security breaches or terroristic acts and other hazards, timing of completion of significant construction or repair of equipment, fires, explosions, seismic activities, accidents and weather conditions which could impact financial results; decreases in the availability of, or increases in, the price of commodities or capital equipment used in our coal mining operations; obtaining, maintaining and renewing governmental permits and approvals for our coal operations; the effects of government regulation on the discharge into the water or air, and the disposal and clean-up of, hazardous substances and wastes generated during our coal operations; the effects of stringent federal and state employee health and safety regulations, including the ability of regulators to shut down our operations; the potential for liabilities arising from environmental contamination or alleged environmental contamination in connection with our past or current coal operations; the effects of mine closing, reclamation and certain other liabilities; defects in our chain of title for undeveloped reserves or failure to acquire additional property to perfect our title to coal rights; uncertainties in estimating our economically recoverable coal reserves; interest rates; labor availability, relations and other workforce factors; defaults by CEIX under its operating agreement, employee services agreement and affiliated company agreement; changes in CCR's tax status; conflicts of interest that may cause CCR's general partner or CCR's sponsor to favor their own interest to CCR's detriment; the requirement that CCR distribute all of its available cash; the outcomes of various legal proceedings; exposure to employee-related long-term liabilities; failure by Murray Energy to satisfy liabilities it acquired from CNX, or failure to perform its obligations under various arrangements that CNX guaranteed and for which CEIX has indemnification obligations to CNX; information theft, data corruption, operational disruption and/or financial loss resulting from a terrorist attack or cyber incident; operating in a single geographic area; certain provisions in our multi-year coal sales contracts may provide limited protection during adverse economic conditions, and may result in economic penalties or permit the customer to terminate the contract; the majority of the common units that CEIX holds in CCR are subordinated, and CEIX may not receive distributions from CCR; the potential failure to retain and attract skilled personnel; the impact of CEIX's separation and risks relating to CEIX's ability to operate effectively as an independent, publicly traded company, including various costs associated with operation, and any difficulties associated with enhancing its accounting systems and internal controls and complying with financial reporting requirements; unfavorable terms in CEIX's separation from CNX, related agreements and other transactions and CEIX's agreement to provide certain indemnification to CNX; any failure of our customers, prospective customers, suppliers or other companies with which we conduct business to be satisfied with our financial stability, or our failure to obtain any consents that may be required under existing contracts and other arrangements with third parties; a determination by the IRS that the distribution of CEIX's common stock or certain related transactions should be treated as a taxable transaction; our ability to engage in desirable strategic or capital-raising transactions; the existence of any actual or potential conflicts of interest of CEIX's directors or officers because of their equity ownership in CNX as a result of the separation; exposure to potential liabilities arising out of state and federal fraudulent conveyance laws and legal dividend requirements as a result of the separation and related transactions; uncertainty with respect to CEIX's common stock, including as to whether an active trading market will develop for CEIX's common stock, potential stock price volatility and future dilution; the existence of certain anti-takeover provisions in our governance documents, which could prevent or delay an acquisition of us and negatively impact the trading price of our common stock; and other unforeseen factors. Additional factors are described in detail under the captions "Cautionary Statements Regarding Forward-Looking Statements" and "Risk Factors" in our public filings with the Securities and Exchange Commission. The forward-looking statements in this presentation speak only as of the date of this presentation; we disclaim any obligation to update the statements, and we caution you not to rely on them unduly.

About CONSOL Energy Inc.

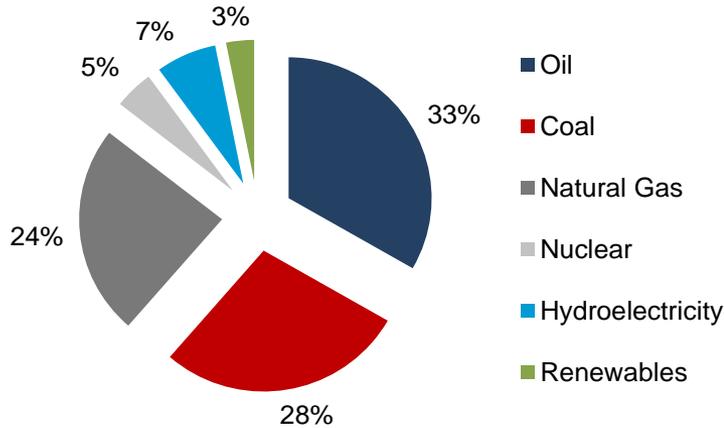
- Publicly-traded (NYSE:CEIX) coal producer and exporter based in Canonsburg, PA
- Successfully spun off from CNX Resources Corporation's E&P business in November 2017
- Assets include:
 - ~90% economic ownership of the Pennsylvania Mining Complex (PAMC)⁽¹⁾
 - 100% ownership of CONSOL Marine Terminal (CMT) in Baltimore, MD
 - 1.6 billion tons of undeveloped coal reserves⁽²⁾ in the Northern Appalachian, Central Appalachian, and Illinois Basins
- PAMC is the largest underground mining complex in North America, consisting of the Bailey, Enlow Fork, and Harvey mines and related infrastructure
 - 735 mm tons of reserves in the Pittsburgh No. 8 coal seam⁽³⁾
 - Five longwalls and 15-17 continuous mining sections
 - Central prep plant (8,200 raw tons/h) and rail loadout (9,000 clean tons/h)
 - 2017 production = 26.1 mm tons
 - 2017 domestic sales = 17.8 mm tons / export sales = 8.3 mm tons
 - 2017 customers included 32 US power plants located in 15 states, and thermal and metallurgical end-users located on five continents
- CMT exported a record 14.3 mm tons of PAMC and third-party coal in 2017



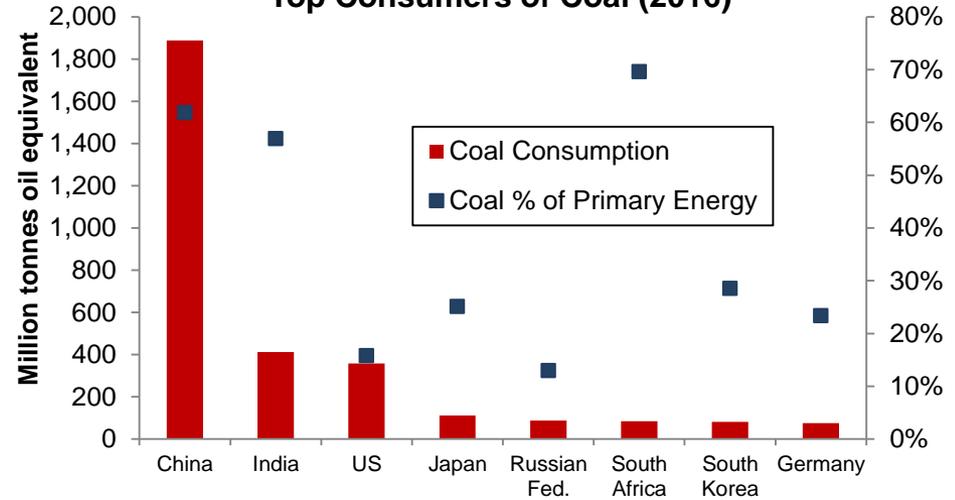
(1) Consists of 75% undivided interest in PAMC, plus GP ownership and ~60% LP interest in CONSOL Coal Resources LP (NYSE:CCR), which owns the remaining 25% interest in PAMC.
(2) Undeveloped reserves do not include any of the 735 million tons of reserves associated with PAMC.
(3) As of December 31, 2017.

The U.S. Coal Reserve Base Remains a Valuable, Strategic National Resource

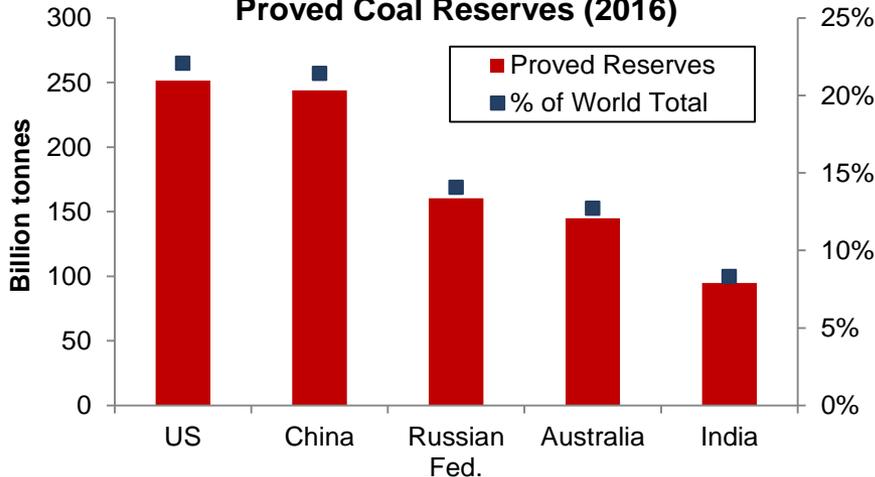
World Primary Energy Consumption (2016)



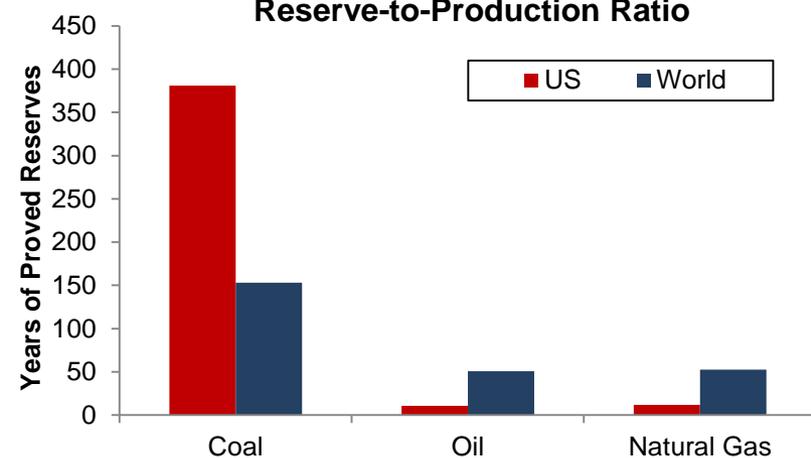
Top Consumers of Coal (2016)



Proved Coal Reserves (2016)

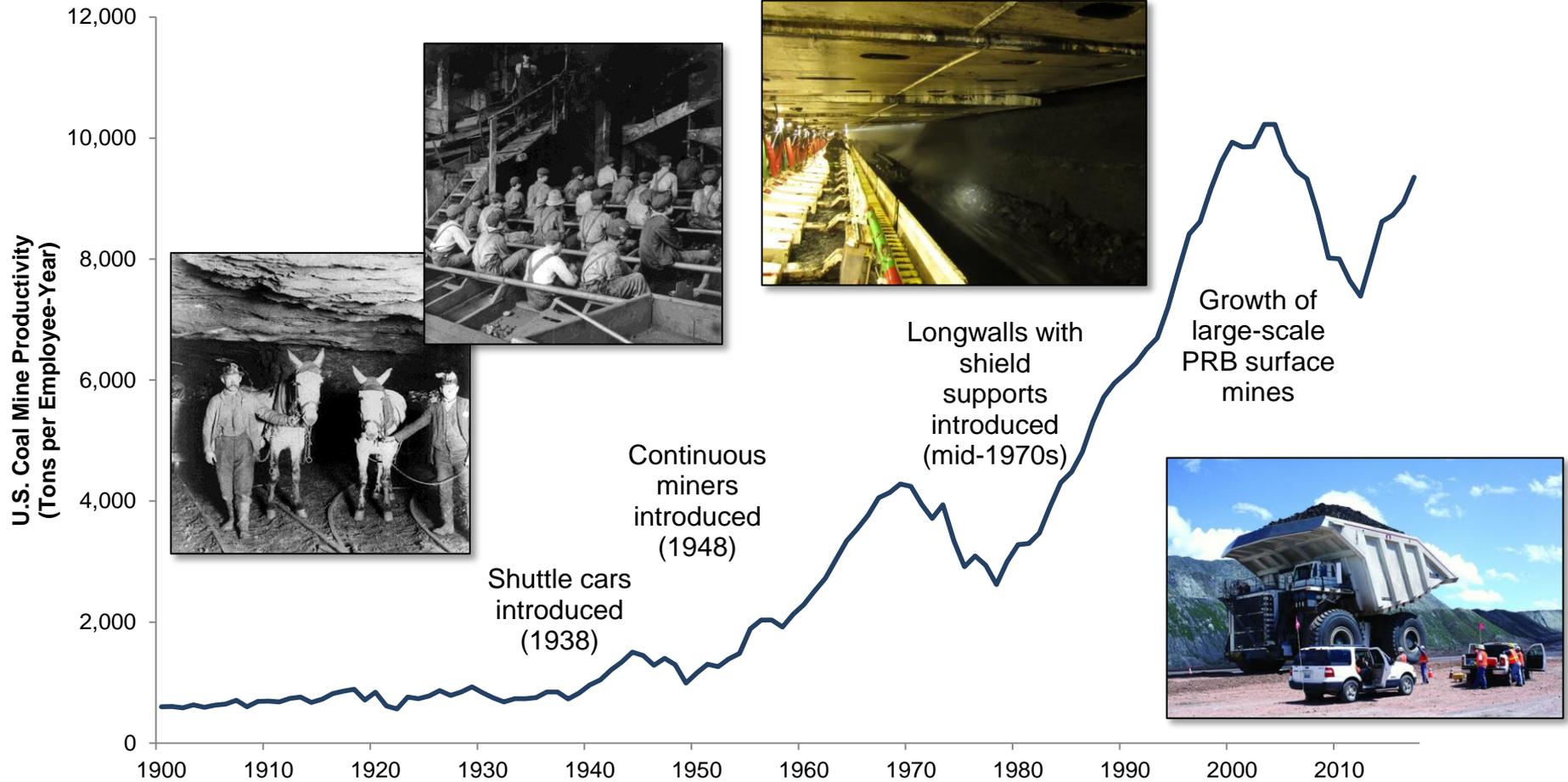


Reserve-to-Production Ratio



Coal remains the second largest primary energy source in the world, and the U.S. holds the world's richest coal reserve base. We must ensure that technology is in place to make coal a centerpiece of the U.S. quest for "energy dominance."

Technological Advances Have Played a Huge Role in the Evolution of the Coal Industry ...



In 1900, the U.S. produced 270 million tons with 449,000 employees (601 tons/employee-year)
In 2017, the U.S. produced 775 million tons with 83,000 employees (9,353 tons/employee-year)
Coal mining fatalities decreased from 1,489 in 1900 to 15 in 2017

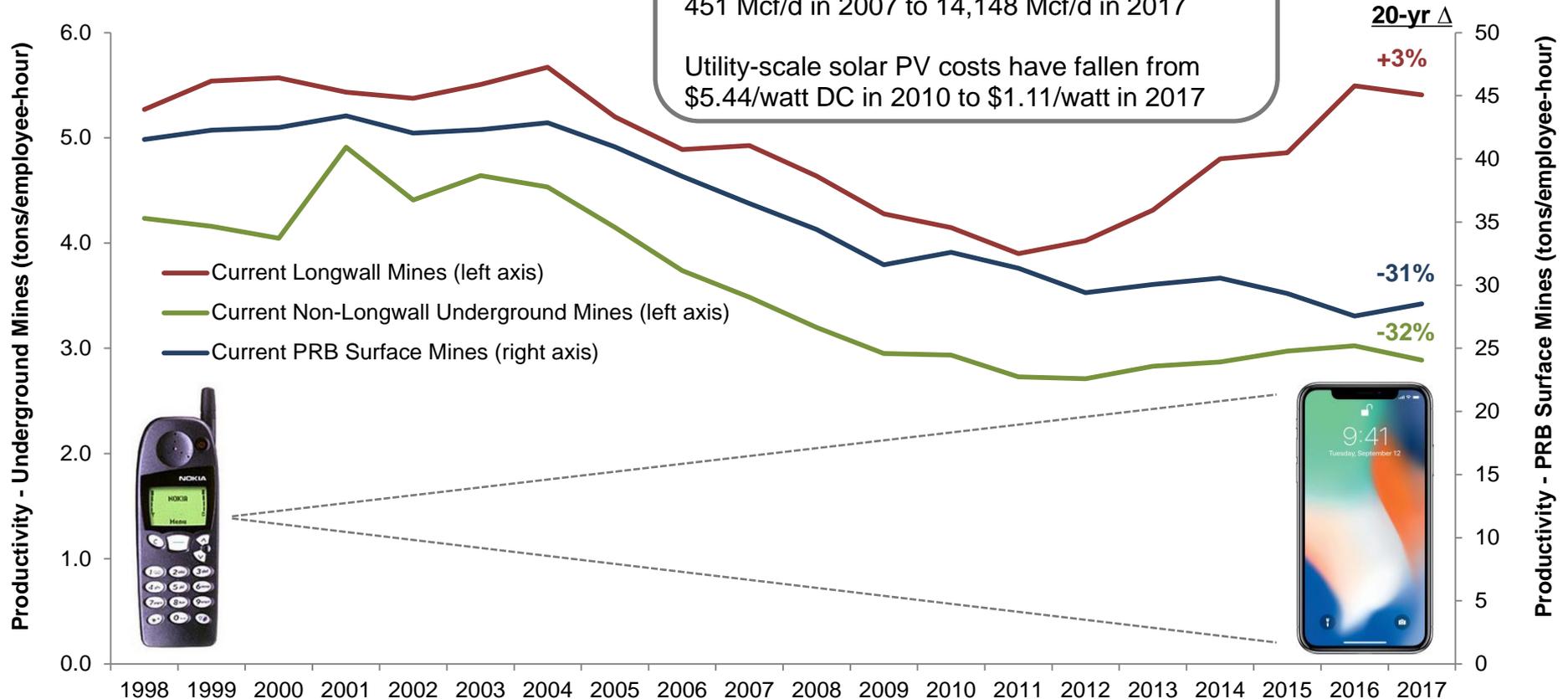
Source: MSHA, EIA, ALFRED, Library of Congress, *Modern American Coal Mining Methods and Applications*

... But Recent Years have been Relatively Stagnant

In Comparison ...

New natural gas well productivity per rig in the Appalachian Region has increased from 451 Mcf/d in 2007 to 14,148 Mcf/d in 2017

Utility-scale solar PV costs have fallen from \$5.44/watt DC in 2010 to \$1.11/watt in 2017

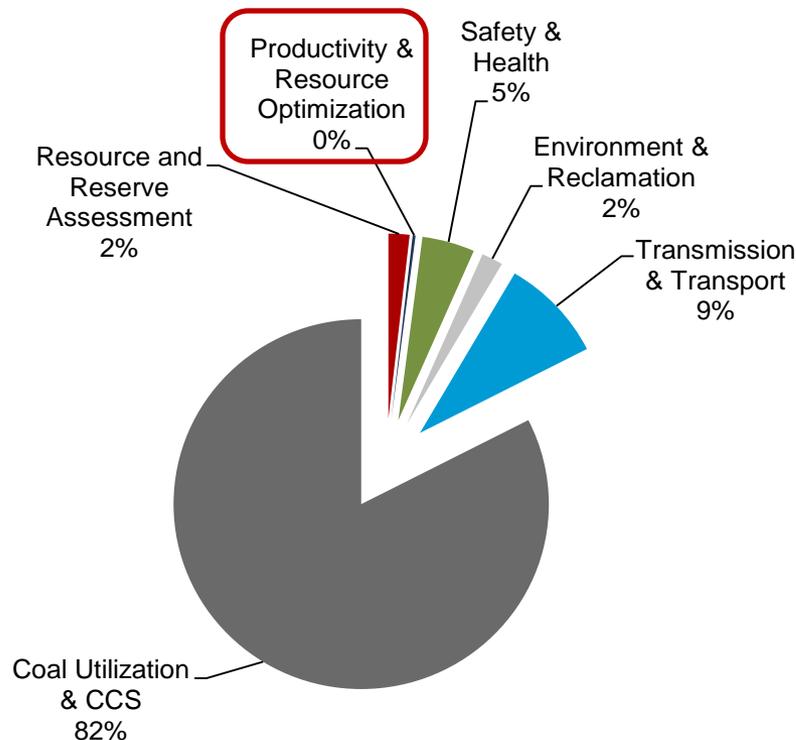


Coal industry needs to keep pace with rapidly evolving new technology development/implementation.

Source: ABB Velocity Suite, MSHA, NREL, EIA. Only includes mines that operated in CY 2017.

Breakdown of 2005 Federal Funding for Coal-Related R&D by Focus Area

(Source: National Research Council)

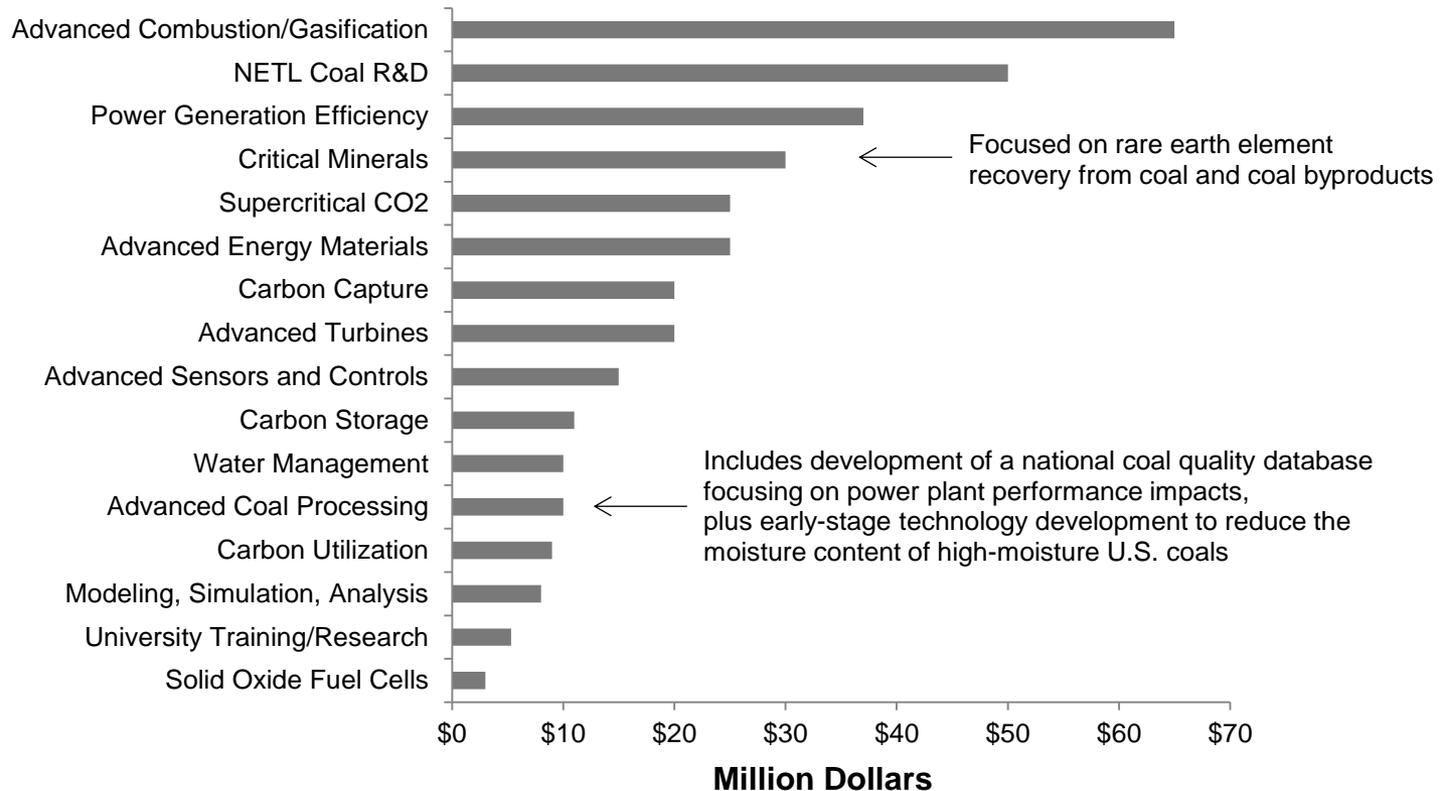


NRC Recommendation (2007): There should be renewed support for advanced coal mining and processing research and development to optimize use of the nation's coal resources by increasing the amount of coal that is economically minable through technological advances that accommodate health, safety, and environmental requirements. The focus of this R&D should be on increased integration of modern technology in the extraction and processing phases of coal production, with particular emphasis on emerging advances in materials, sensors, and controls; monitoring; and automated mining systems.

Only \$1.3 million out of \$538 million was directed toward coal mining and processing productivity/optimization.

Source: National Research Council. Includes funding provided by the U.S. Department of Energy, Environmental Protection Agency, Mine Safety and Health Administration, National Institute for Occupational Safety and Health, National Science Foundation, Office of Surface Mining Reclamation & Enforcement, and U.S. Geological Survey.

Advanced Coal Energy Systems & CCUS

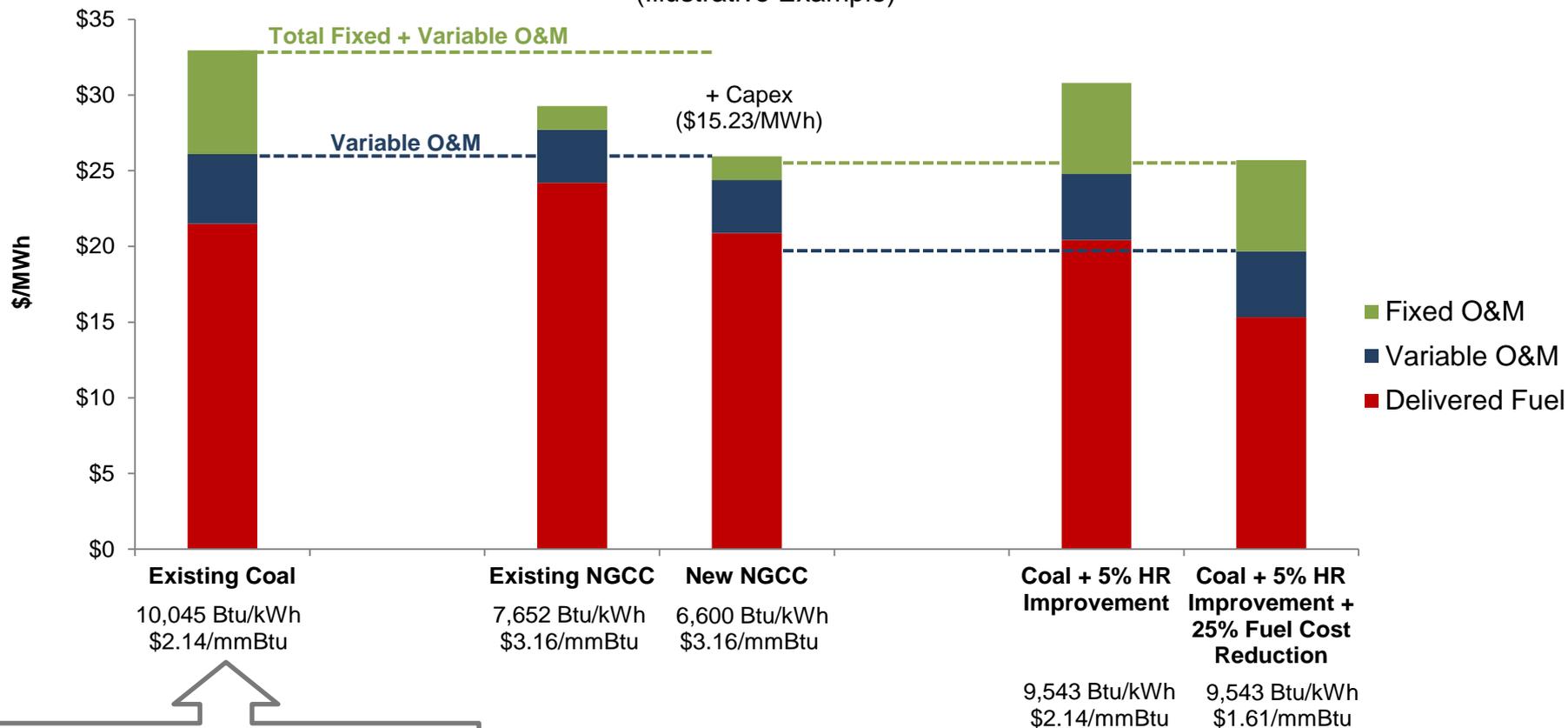


Recent federal research spending on coal (and associated industry cost share) has been dominated by end-use applications, with little attention given to the economics and efficiency of mining/producing the fuel itself.

Source: U.S. Department of Energy FY 2019 Congressional Budget Justification

Fuel Cost is a Critical Component of the Overall Value Proposition for Coal

Power Plant Operating and Maintenance Cost
(Illustrative Example)



Fuel cost (mine + transportation) accounts for the majority (~2/3) of the plant's total O&M cost, and an even greater amount (>80%) of its variable (dispatch) cost

A transformational reduction in fuel costs would also bolster the economics of new HELE coal plants and aid the competitiveness of U.S. coals in the global marketplace.

NGCC = natural gas combined cycle. HR = heat rate. All cases assume 80% capacity factor. Fuel prices based on the average delivered coal and natural gas prices to U.S. power generators in 2015-2017, as reported in EIA's March 2018 Short Term Energy Outlook. Heat rates for existing coal and existing NGCC based on the average tested net heat rates for the U.S. fleet reported in EIA's 2016 Electric Power Annual (released 12/7/2017). Heat rate for new NGCC, fixed O&M, non-fuel variable O&M, and capital cost assumptions based on EIA's Capital Cost Estimates for Utility Scale Electricity Generating Plants (November 2016).

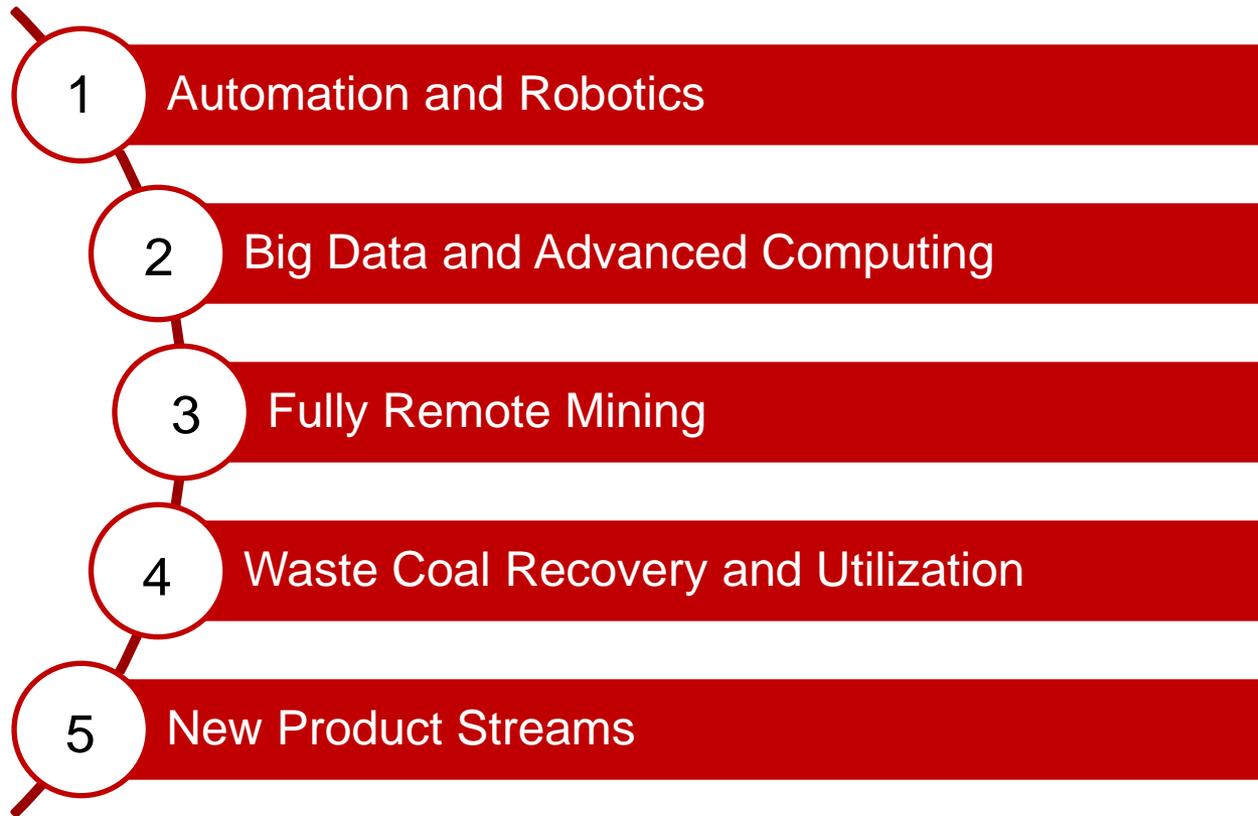


The U.S. needs to invest in new technology development for coal mining and beneficiation in order to fully realize the value contained in its vast coal reserve base.

- Reinvent a prosperous but mature U.S. industry
- Preserve coal as a reliable, resilient, low-cost source of domestic electricity
- Bolster the economic competitiveness of U.S. coals in growing export markets
- Improve the economics of alternative end-uses of coal
- Create high-tech jobs in the mining space
- Fund research and innovation opportunities across a wide variety of disciplines
- Further improve safety and reduce employee exposure
- Protect U.S. energy security, and further the administration's goal of energy dominance

Keeping coal competitive requires unlocking value across the entire supply chain, beginning with the mine.

Potential Technology Opportunities in Coal Mining and Beneficiation

- 
- 1 Automation and Robotics
 - 2 Big Data and Advanced Computing
 - 3 Fully Remote Mining
 - 4 Waste Coal Recovery and Utilization
 - 5 New Product Streams

These are only examples. We need to engage the brightest minds to take mining technology to the next level.

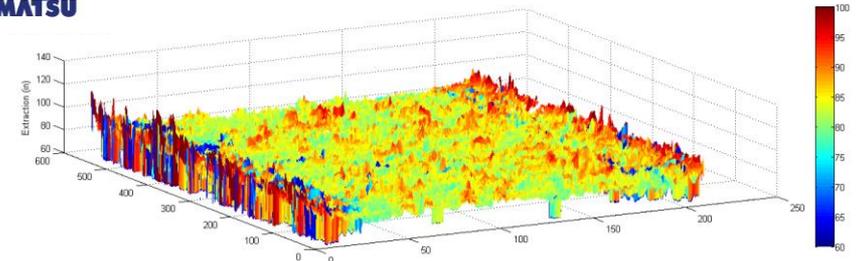
Example #1 – Automation and Robotics

- Longwall technology is current state-of-the-art in underground mining
- 40 longwalls contributed 62% of U.S. underground coal production (170 million tons) in 2017, with a productivity more than 85% better than other underground mines⁽¹⁾
- OEMs largely focused on developing automation for key LW components
 - Advanced shearer automation maintains face alignment and allows the longwall operator to program automated cutting profiles, including gate turnarounds
 - Remote operations center can be used to run the shearer from a remote location (underground or surface)
 - Longwall automation technology options also offered for roof supports, drives, etc.



- Advantages
 - Improved cut cycle efficiency (potential for 10%+ productivity improvement)⁽²⁾
 - Less out-of-seam dilution (~\$0.10/clean ton reduction in cost for every 1" less roof rock mined)⁽³⁾
 - Reduced equipment wear and maintenance downtime
 - Less employee exposure (dust, noise)
- Horizon detection/control remains an area of need
- Integration and employee acceptance are also challenges

KOMATSU

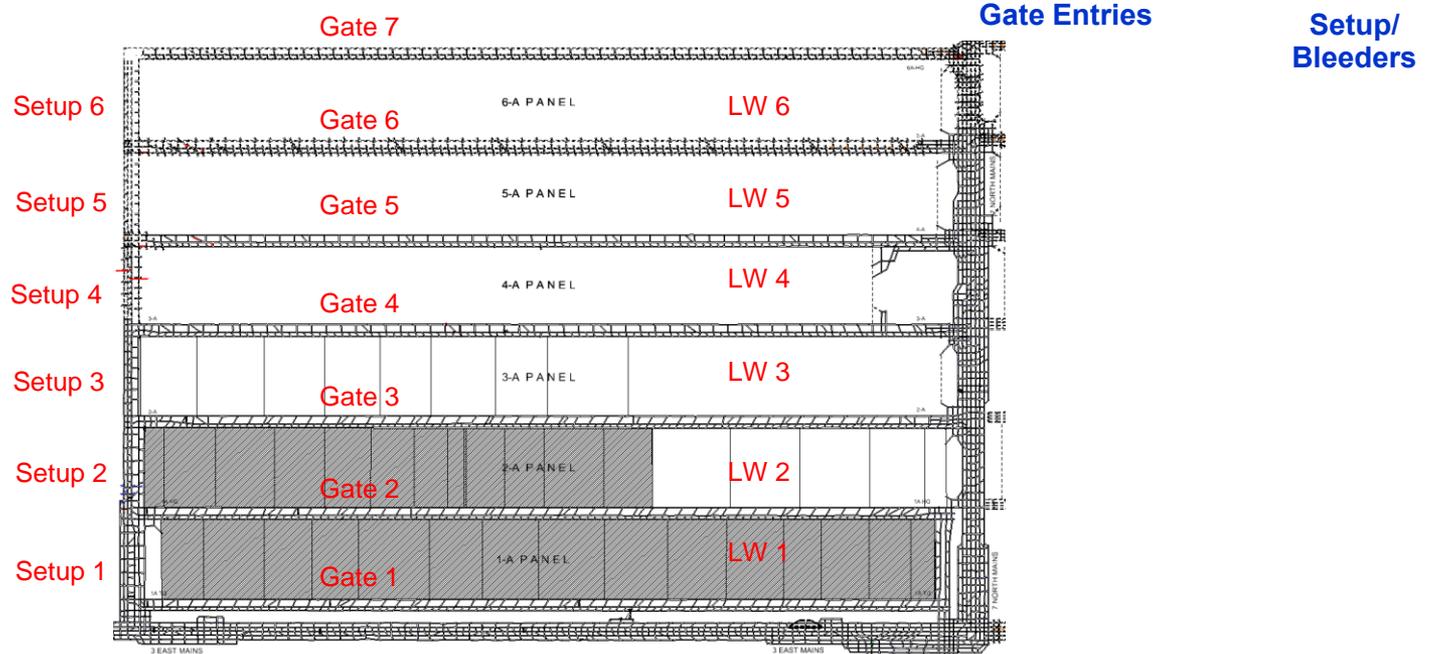
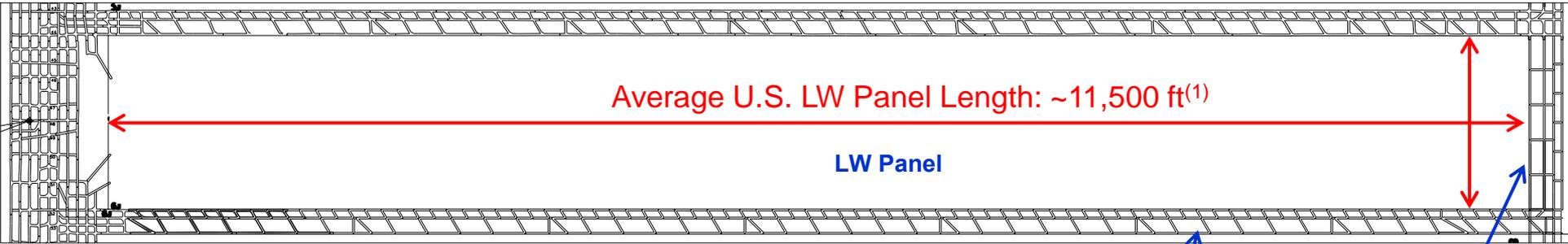


Substantial progress has been made in automating the longwall itself ...

... But the More Pressing Area of Need Today (even for LW Mining) is the Continuous Miner

Mains

Average U.S. LW Panel Width: ~1,200 ft⁽¹⁾



In general, each 1 foot of longwall advance requires 6+ feet of continuous miner (CM) advance, depending on mine plan geometry, number of entries, mains configuration, etc.

(1) Source: Coal Age 2018 U.S. Longwall Census

What Does it Take to Mine a Foot? (Illustrative Example)

Longwall

Crew

- 2 Shearer Operators
- 1 Shieldman
- 1 Head Gate Operator
- 3 Longwall Support/Utility
- 1 Mechanic
- 1 Foreman

TOTAL = 9 people

Consumables

- Bits
- Oil
- Rock dust
- Cans or Cribs (floor-to-roof support)
- Electricity

Clean Tons per Foot ~ 350
Feet per Shift ~ 25
Clean Tons per Shift ~ 8,750

Continuous Miner-Bolter

Crew

- 1 Miner Operator
- 2 Miner Bolters
- 2 Rib Bolter/U Man
- 2-3 Haulage Operators
- 1 Center Bolter
- 1 Mechanic
- 1 Foreman

TOTAL = 10-11 people

Consumables

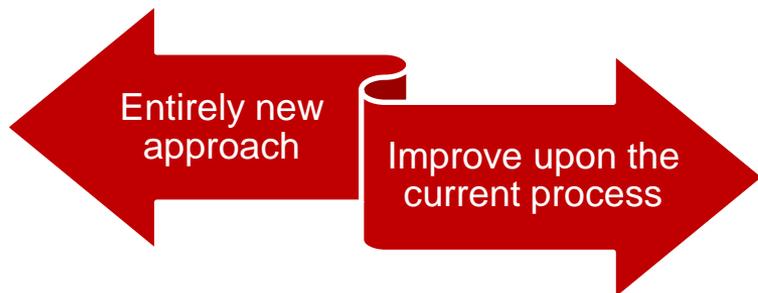
- Roof bolts/support
- Roof mesh
- Rib bolts
- Rib mesh
- Bits
- Oil
- Rock dust
- Curtain
- Electricity

Clean Tons per Foot ~ 4
Feet per Shift ~ 100
Clean Tons per Shift ~ 400

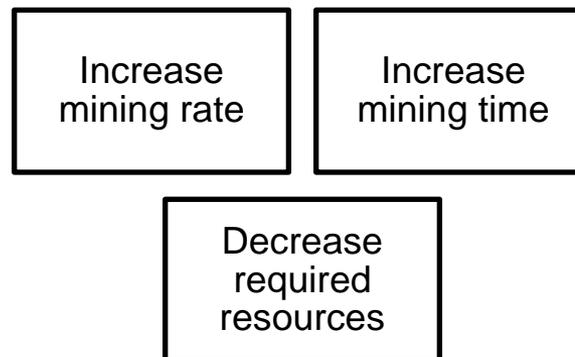
~20x
difference in
productivity

As a general rule, the continuous miner mines at a loss to enable the longwall to mine at a profit.

What Can Be Done to Improve CM Productivity and Cost Performance?



Three Fundamental Options:

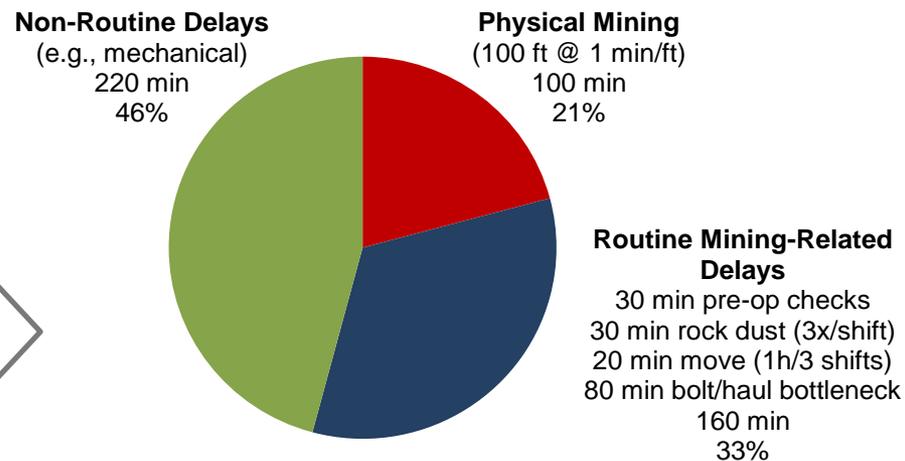


Example: Increase Mining Time⁽¹⁾

- CMs are capable of cutting ~1 ft/minute
- There are 480 minutes in an 8-hour shift
- In theory, a CM machine can mine ~480 ft/shift
- In practice, CM advance rates are much less than this



Illustrative CM Shift



While transformational approaches should be considered, there are great opportunities to apply technology to improve upon the traditional CM mining process.

(1) Illustrative example shown for a continuous miner-bolter as opposed to a place change miner.

CM Technology Development: Where Do We Go Next?

Opportunities

- Fully or partially automate:
 - Mining
 - Roof/rib bolting and meshing
 - Hauling
 - Rock dusting
- Advanced equipment monitoring and predictive analytics for preventative maintenance to reduce delays
- Intercommunication among equipment to reduce bottlenecks



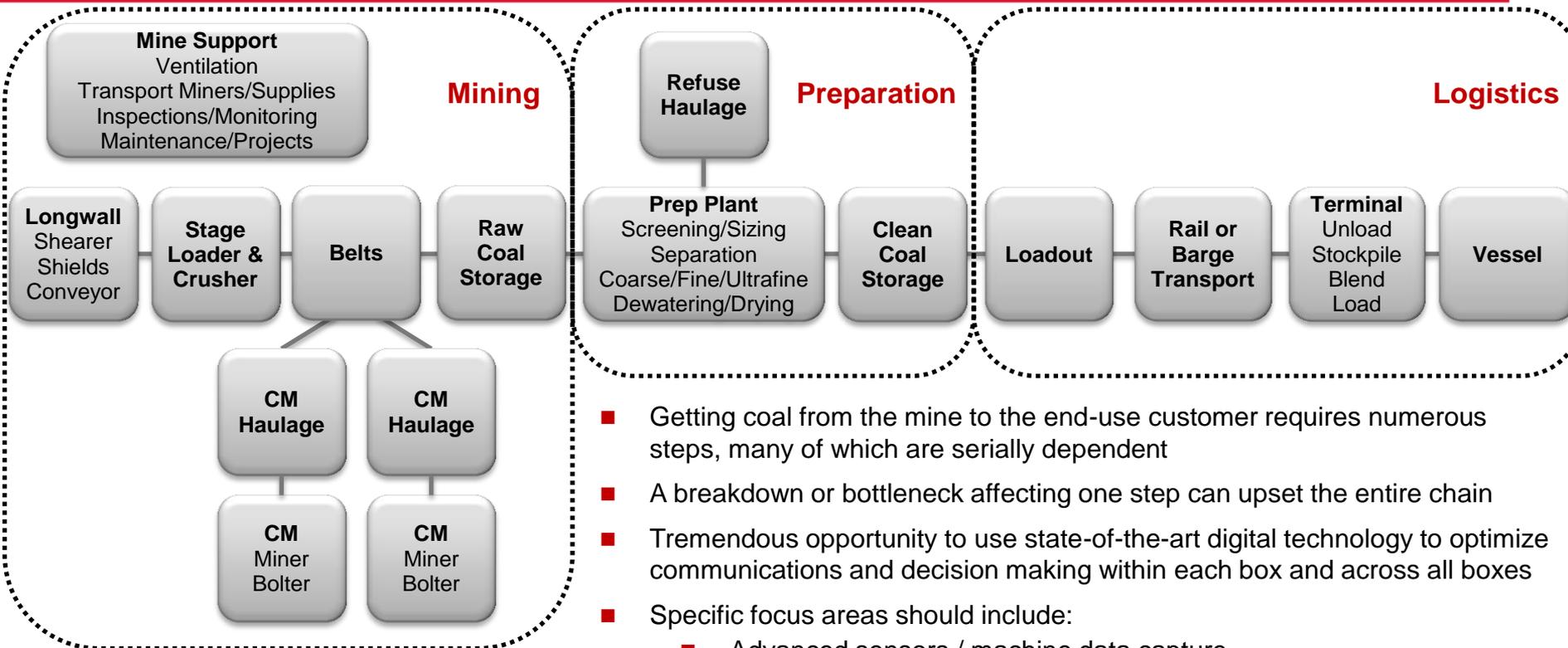
Challenges

- Coal seam detection / horizon control
- GPS ineffective underground
- Adjusting for adverse conditions
- Harsh operating environment (e.g., roof falls, methane)
- Constraints on space/maneuverability/wireless connectivity
- Stringent MSHA/mining rules slow new technology introduction
- Workforce acceptance/cultural change



Advances in CM technology would also benefit non-longwall underground mines, including many metallurgical coal mines.

Example #2 – Big Data and Advanced Computing



- Getting coal from the mine to the end-use customer requires numerous steps, many of which are serially dependent
- A breakdown or bottleneck affecting one step can upset the entire chain
- Tremendous opportunity to use state-of-the-art digital technology to optimize communications and decision making within each box and across all boxes
- Specific focus areas should include:
 - Advanced sensors / machine data capture
 - Next-generation underground networks/communications
 - Consolidated data platforms
 - Real-time analytics and optimization
 - Advanced control systems
 - Artificial intelligence and machine learning
 - Predictive maintenance / RAM analysis

Development and adoption of intelligent processes enabled by digital technology is critical for the sustainability of the coal mining industry.

Example #3 – Fully Remote Mining

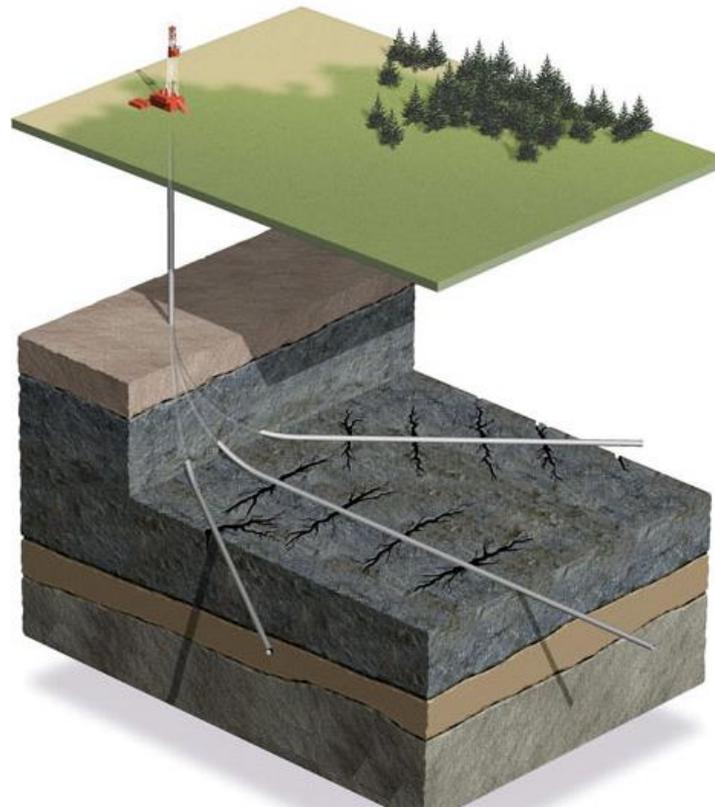


Is it really possible to drill for coal?

One company thinks so ...

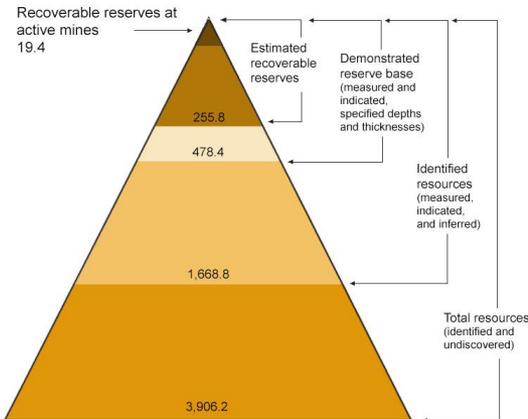


CRAZY HORSE COAL, LLC



- Concept is initially directed toward accessing deep seams (2,000-12,000 ft) and resources that are uneconomic to mine with current technology
- Need to also explore the potential to significantly improve upon the economics of existing, shallower operations
- Has potential to transform the entire mining process, from permitting to preparation

U.S. coal resources and reserves
billion short tons as of January 1, 2015



Source: U.S. Energy Information Administration, *Annual Coal Report* (March 2016)



Novel concepts and out-of-the box thinking need to be considered and pursued if we are going to realize a transformational change in the coal mining industry.

Source: Crazy Horse Coal

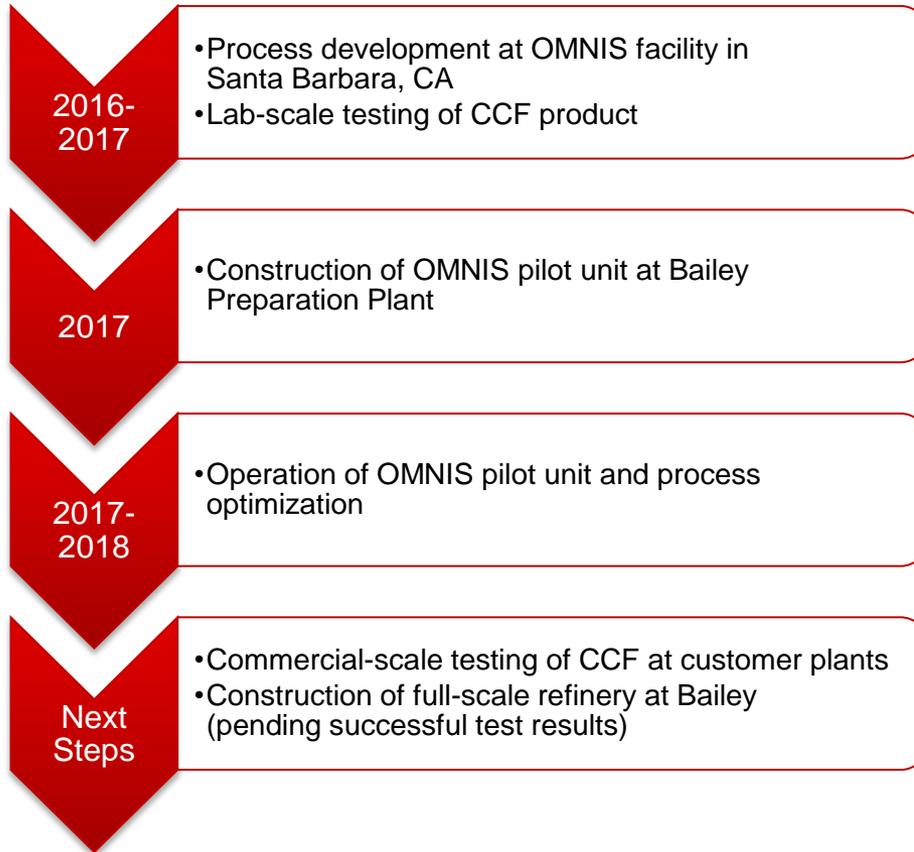
Example #4 – Waste Coal Recovery and Utilization

- Bailey Preparation Plant produces a substantial quantity (~6,800 gpm) of thickener underflow containing ~20-30 wt % solids, including coal fines
- Currently disposed in fine coal refuse impoundments
- The opportunity:
 - Recover solids from the thickener underflow stream
 - Refine to produce a Clean Carbon Fuel (CCF) product with quality characteristics (heat content, ash, sulfur) better than typical Bailey coal product
 - Improve overall product yield from the mining operation by >5%
 - Generate a solid byproduct for use in agricultural applications or disposal as coarse refuse
 - Reduce or eliminate the need for future fine coal refuse impoundments



CONSOL partnered with OMNIS to pursue development of a technology solution in response to this opportunity.

OMNIS Project Progress and Path Forward



OMNIS's technology incorporates innovations in each of the three key coal fines recovery steps – flotation, pelletization, and drying – with a goal of providing improved process performance and product quality vs. conventional technologies

The OMNIS project is designed to turn a waste stream into a revenue stream, while reducing the environmental footprint of the mining complex.

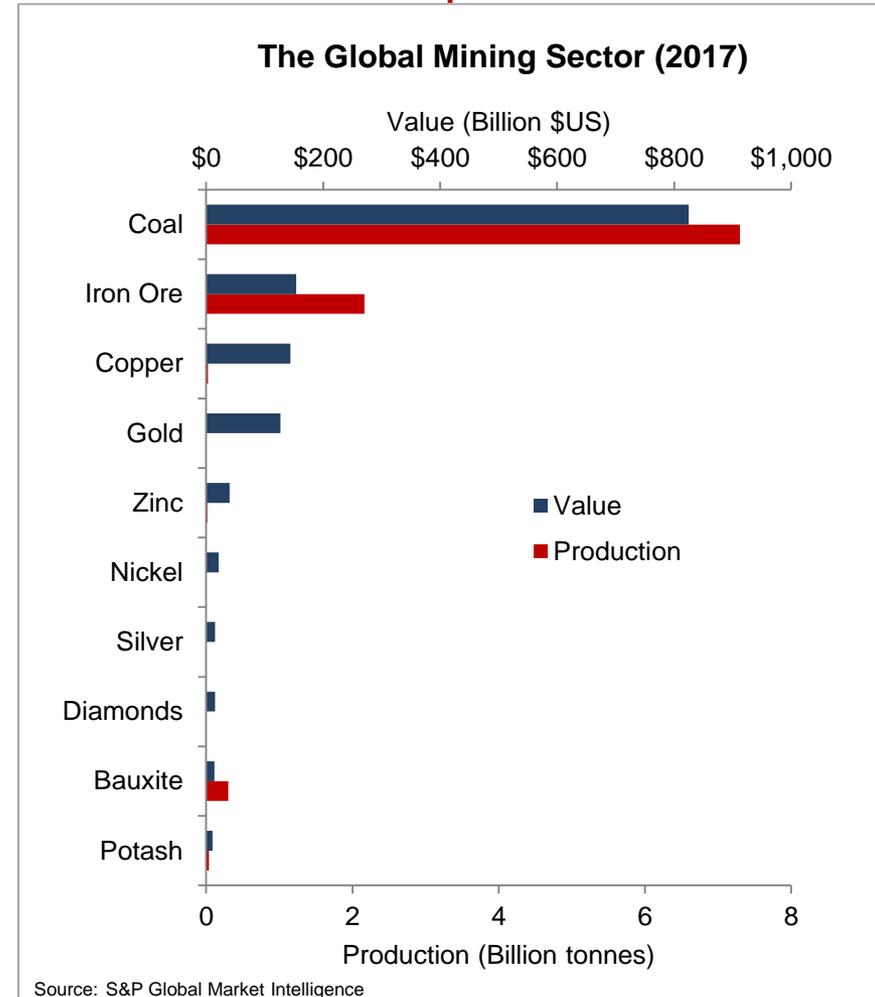
Example #5 – New Product Streams

Numerous Concepts and Potential Products ...

- Rare Earth Elements
- Critical/Strategic Minerals
- Aggregates
- Chemicals
- Agricultural applications
- Carbon fiber composites, structural materials
- Graphene
- Carbon-based electrodes (photovoltaics, batteries)
- Other?



... Scale Remains an Important Consideration



New product streams provide attractive opportunities for improving the value proposition at the mine; however, it will be challenging to find a new product/application that can replicate the scale of the coal industry as we know it today.

Recommended Next Steps

-
- Initiate focused dialogue among key industry stakeholders (e.g., producers, equipment manufacturers, transportation providers) to prioritize areas of greatest need / potential impact
 - Automation/robotics (with a particular focus on CMs)
 - Big data/advanced computing
 - Fully remote mining
 - Waste coal recovery
 - New products
 - Others???

 - Obtain input from other industries that have succeeded in implementing analogous technology solutions

 - Work with DOE and other government/funding agencies to define needs and explore funding opportunities

 - Work with MSHA to streamline the approval process for new underground technologies

 - Incorporate mining productivity/cost improvement goals into roadmapping for the future of coal

 - Fund research targeting high-priority mining and beneficiation technologies to reengage academia and attract students across a variety of disciplines (e.g., electrical and mechanical engineering, computer science, robotics, etc.) to bring a new wave of interest and innovation to the coal mining space
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Questions?

