Wyoming Coal’s Role in the World-Recent Past, Present and Future

Morgantown, WV
2015 Gasification Systems and Coal-Biomass to Liquids Workshop
August 10, 2015
• WY produced the most coal on federal and Indian lands in FY2013 accounting for 80% of the total
• Two mines in WY accounted for 20% of U.S. coal production by tons in 2012
• ~720 gallons of water are transported per 1000 tons of WY coal
• Development of Wyoming Coal Economy
• Present Day Challenges
• Tomorrow’s Opportunities
• Wrap Up
Wyoming's growth in coal production has been driven by several factors including the low sulfur composition of the coal, lower production costs due to the coal's proximity to the surface, and recoverable coal seams.
Reclamation goes beyond just restoring contours and reseeding native plant species. Reclamation specialists strive to build sustainable natural ecosystems using innovative methods and new techniques to further enhance reclaimed areas.

Mine reclamation aligns with Wyoming heritage of ranching and love for wildlife and outdoor recreation

Source: Wyoming Mining Association
Wyoming Coal Mines
• Development of Wyoming Coal Economy
• Present Day Challenges
• Tomorrow’s Opportunities
• Wrap Up
U.S. & Wyoming Coal Production on a Declining Trend

Data source: U.S. Energy Information Administration
The state of Washington has required:

- a global greenhouse (GHG) climate change environmental impact assessment
- under State Environmental Protection Act (SEPA)
- review of permit applications for coal export terminals in Washington

U.S. Army Corps of Engineers determined that a GHG LCA is beyond scope of the National Environmental Protection Act (NEPA)

What is a GHG LCA?

• Mining Operations to End-Use Consumption
Outline

• Development of Wyoming Coal Economy
• Present Day Challenges
• Tomorrow’s Opportunities
• Wrap Up
Market Changes = Opportunities

- Environmental Regulations
  - Mercury Air Toxic Standards (MATS)
  - Regional Haze
  - CO₂
  - Greenhouse Gas (GHG) Life Cycle Analysis
  - Ozone
- States, Business and Investment Community out ahead of Federal Gov’t
- Sustainability Movement Progressing
- Maximize Flexibility and Optionality
## Coal / Natural Gas Value-Added Products

<table>
<thead>
<tr>
<th>Gasification</th>
<th>Product/Volume/Prices*</th>
<th>Revenue / t of coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 t coal (sub-bituminous)</td>
<td>1,600 Nm³ Syngas (CO + H₂)</td>
<td>420 Nm³ SNG** (@ 3.5 USD/mmBtu)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.4 MWhₑ Power (@ 60 USD/MWh)</td>
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<td></td>
<td></td>
<td>420 Nm³ SNG** (@ 15 USD/mmBtu)</td>
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<tr>
<td></td>
<td></td>
<td>0.19 t Polypropylene (@ 1.580 USD/t)</td>
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<tr>
<td></td>
<td></td>
<td>0.72 t Methanol (@ 450 USD/t)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 gal Gasoline (@ 3.5 USD/gal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.98 t Ammonia (@ 450 USD/sh tn)</td>
</tr>
</tbody>
</table>

* Applied end-product market prices may differ to actual prices** SNG = Substitute Natural Gas

Source: Siemens
# Wyoming Coal Spot Price Advantage

## Average weekly coal commodity spot prices

*dollars per short ton*

<table>
<thead>
<tr>
<th>Coal commodity regions</th>
<th>Week ended</th>
<th>Wyoming PRB Low-Sulfur Coal Price Advantage % $/Btu basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Appalachia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12,500 Btu, 1.2 SO₂</td>
<td>$54.90 $49.95</td>
<td>67.2%</td>
</tr>
<tr>
<td>Northern Appalachia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13,000 Btu, &lt;3.0 SO₂</td>
<td>$53.20 $52.25</td>
<td>67.3%</td>
</tr>
<tr>
<td>Illinois Basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,800 Btu, 5.0 SO₂</td>
<td>$34.35 $34.35</td>
<td>54.9%</td>
</tr>
<tr>
<td>Powder River Basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8,800 Btu, 0.8 SO₂</td>
<td>$11.55 $11.55</td>
<td>61.2%</td>
</tr>
<tr>
<td>Uinta Basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,700 Btu, 0.8 SO₂</td>
<td>$39.35 $39.55</td>
<td></td>
</tr>
</tbody>
</table>

Source: U.S. Energy Information Administration, Coal News & Markets
Wyoming Subbituminous Coal

Wyoming Coal – a Water-Rich Resource, too!

Wyoming Subbituminous Coal

An Untapped Water, Oxygen & Hydrogen Rich Natural Resource

24% to 30% H₂O

~720 Gallons in 1,000 Tons of PRB Coal
~300 Million Gallons per Year from Wyoming
**CO₂ Use and Reuse Opportunities**

Wrap Up

• Aim for long-term environmental regulation targets versus present day interim targets
  • Target Ultimate Goal – Sustainable Energy Systems and Industries
  • Recycle CO₂ for products needed for sustainable societies

• Energy-Water Efficiency, Conservation-Recycle Strategies
  • Utilize water in low rank coals
  • Devise integrated multi-plant schemes that avoid/minimize plant temperature ramping damage/degradation costs and inefficiencies
  • Maximize operating at peak efficiency/peak profitability

• Maximize product value-density vs. shipping impacts
  • Achieves lowest energy, water, emission LCA level per unit of economic good (GDP)
WIA Energy Conference Invitation

October 8th 8:30am - 9th 12:00pm Jackson Hole, Wyoming

There is no fee to attend thanks to our sponsors.

Venue: Snow King Resort, Jackson Wyoming
Registration: RSVP to Holly.Martinez@wyo.gov
Snow King Resort: 800.522.5464 ask for WY Infrastructure Authority rate.
http://wyia.org/events/board-meetings/
Power and Transportation

CO₂ Emissions Today

Traditional Sources of CO₂ Emissions

Equivalent Fleet CO₂ Emissions Trade-off

Reduced Supply of Imported Oil as CO₂ Source

Biodiesel Transportation Fuels

Oil Imports
CO\textsubscript{2} to Transportation Fuel

LCA CO\textsubscript{2} drops 40-50%