Factors Influencing the U.S. Coal Industry

NCCI - The Coal Institute Spring 2011 Meeting
U.S. Coal - Reserves

- Total U.S. Coal Resources: 3,970 billion short tons
- Identified Resources: 1,730 billion short tons
- Demonstrated Reserve Base: 491 billion short tons
- Estimated Recoverable Reserves: 264 billion short tons
- Enough to last more than 200 years (based on current consumption).

~30% of Estimated World Coal Reserves
U.S. Coal Resource and Reserve Relationships

- Act Res: 18.8 Bst
- ERR: 264 Bst
- DRB: 491 Bst

Resource and reserve data are in billion short tons.
Coal Rank Relative to Production

• About 50% of the US production is bituminous
• Over 40% is sub-bituminous
• Nearly 7% is lignite
• A small amount of anthracite is produced from northeastern Pennsylvania
• Surface mines account for 67% of the total production and underground mines for the remaining 33%
• 200 – 300 companies operating 1,400 mines in 26 states spread across three coal-producing regions: Appalachian, Interior, and Western.

• Approximately 80,000 employees contribute over $200 billion annually to the economy.

• The U.S. coal production in 2010 was ~1.1 billion thousand short tons.

• U.S. coal production increased by ~1% despite a 5% increase in consumption.

• Coal accounts for ~25% of US energy consumption
• 94% of U.S. coal consumption is in the electric power sector

• 600 coal-fired power plants (>1400 generating units)

• Total coal consumption:
  • 22.7 quadrillion Btu in 2007
  • 19.7 quadrillion Btu in 2009 (1,000 million short tons)
  • 25.2 quadrillion Btu in 2035 (1,302 million short tons)

• 11 new coal-plants totaling 6,682 MW commissioned in 2010
  THE MOST IN 25 YEARS

• 1,599 MW of new capacity has been announced

• 6,418 MW have been canceled
Current Shift in Coal Production Sources

- The shift of coal production from the eastern coalfields to the western coalfields is the most important development affecting the coal mining industry and coal markets in the last 30 years.

- The main reasons for this production shift from east to west are:
  - the thick beds of low-sulfur coal
  - low mining costs, and
  - increasingly stringent restrictions on atmospheric emissions of sulfur dioxide at power plants.

- The development of railroads to transport western coal over long distances to power plants in the Midwest, South, and East, greatly enabled the increased share of Powder River Basin (PRB) coal consumed by the USA utility industry, from about 60 million tons in the early 1970s to 500 million tons today.
The Old Man Is Really Smart

“Everything should be made as simple as possible, but not simpler.”

Albert Einstein
The Character of Appalachia’s Coal Resource/Reserve Controls its Future

• Coal reserves in the Appalachian region have been extensively developed for the past 100 years.
• Substantial coal reserves and resources remain in the eastern USA.
• The remaining coalbeds are typically thinner, buried deeper, geologically encumbered, and impacted by multiple seam mining that collectively increase mining costs.
• The constantly changing regulatory environment hinders the development of surface mineable coal deposits in West Virginia and Kentucky.
• Appalachian production is predicted to gradually decline due to depletion of ‘good’ reserves
• It will remain a vital segment of domestic coal production due to coal quality and coal export potential
Appalachia: Thin Coal Beds Demand Complicated Surface Mining Systems

Cross-Ridge Styled Mountaintop Mining
- Direction of Mining
- Coal Bed Horizon
- Overburden Removal
- Coal Loading
- Future Backfill Site for AOC
- Haul Road Safety & Storm Water Runoff Control Berms

Valley Fill Under Construction
- Mining in Progress
- Valley Fill Bench in Construction
- Drainage Control
- Stabilizing Bench
- Vegetated Face
- Erosion & Sedimentation Controls at Toe

Backfilling in Mountaintop Mining
- Backfill Placement
- Drainage Controls
- Final Grade
- Initial Vegetative Cover

Backfilled & Graded to AOC (Prior to Reforestation)
- Post-Mining Land Use Road
- Drainage Control
- Temporary Animal (Grazers) Control Fencing
U.S. Coal Mining Productivity

• Much of the productivity growth of the 1980s and 1990s can be attributed to larger and more reliable equipment in both surface and underground operations.

• Although improvement in equipment technology continues today, it is not always possible to quickly overcome conditions and all of the challenges imposed on the industry.
USA Coal Mining Productivity: Still at World-Record Highs
Future Sources of Electrical Generation

Net electricity generation (trillion kilowatthours per year)

History

- Coal: 45%
- Natural gas: 23%
- Renewables: 10%
- Oil and other liquids: 20%
- Nuclear: 1%

Projections

- Coal: 43%
- Natural gas: 25%
- Renewables: 14%
- Oil and other liquids: 20%
- Nuclear: 17%

1990 2000 2009 2020 2035
Realities of Renewable Energy

• A March 2010 study\(^1\) by Environment America—a proponent of renewables—urges the US to “set the **ambitious goal** of obtaining **10 percent** or more of [the] total energy consumption from the sun by 2030.”

• The US Dept of Energy (DOE) conducted an analysis and reported in a July 2008\(^2\) that it was an **“ambitious” goal** for **20 percent** of the US electricity to be supplied by wind by 2030.

• Evergreen Solar, only operating at 40% capacity, reported to the Mass. DEP to have generated more than **1 million pounds of hazardous waste** (nitric acid, sulfuric acid, hydrogen fluoride, and sodium hydroxide) in producing its solar panels in 2008\(^3\).

• Solar panels’ useful lives have a range of up to 30 years. Due to the relatively short lifespan the US DOE reports\(^4\) that by “about 2020…this growing industry will produce a growing waste stream.”

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\(^1\)Environment America Research & Policy Center’s *Building a Solar Future: Repowering America’s Homes, Businesses* dated March 2010.


Land Area Requirements To Meet United States’ Annual Electricity Consumption

• In 2008, the United States consumed approximately 3.31 million megawatts (MW) of electricity¹.
  – Coal combustion provided almost half of the electricity consumed by the U.S.

Comparison of mountaintop-mined coal, solar-photovoltaic, and wind energy to determine which source is most “land area effective” based on the following assumptions²:

• Mountaintop-mined Coal: Considering an average thickness of five feet, an acre of coal equates to 9,000 tons---0.32 acres is needed to generate 1 MW of electricity.

• Solar-photovoltaic Energy: Based upon a review of relevant scientific literature, a baseline of 22.4 acres/MW was used for solar-photovoltaic energy.

• Wind Energy: Based upon a review of relevant scientific literature, a baseline of 54.64 acres/MW was used for solar-photovoltaic energy.

² Assumptions derived from research conducted by the Virginia Center for Coal and Energy Research and McDonald RI, et al. (2009) Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America.
## Area Requirements (in acres)
By Energy Source for the Year 2008

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Acres/MW</th>
<th>Acres Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>0.32</td>
<td>1,051,844</td>
</tr>
<tr>
<td>Solar-PV</td>
<td>22.4</td>
<td>74,144,346</td>
</tr>
<tr>
<td>Wind</td>
<td>54.64</td>
<td>180,841,863</td>
</tr>
</tbody>
</table>

![Mountaintop-mined Coal Energy](image1)

![Solar-Photovoltaic Energy](image2)

![Wind Energy](image3)
Drilling Down
A look at shale formations in the U.S., with data on the six largest.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Woodford</td>
<td>0.96</td>
<td>274</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>0.28</td>
<td>396</td>
</tr>
<tr>
<td>Barnett</td>
<td>5.16</td>
<td>585</td>
</tr>
<tr>
<td>Haynesville</td>
<td>3.81</td>
<td>703</td>
</tr>
<tr>
<td>Fayetteville</td>
<td>2.10</td>
<td>662</td>
</tr>
<tr>
<td>Marcellus</td>
<td>1.27</td>
<td>792</td>
</tr>
</tbody>
</table>

Sources: Energy Information Administration; IHS CERA; Lippman Consulting
Supply and Demand

Shale gas as a percentage of U.S. natural-gas production

Natural-gas prices per million BTU

Sources: Energy Information Administration; IHS CERA; Lippman Consulting
Fukushima Plant now a Level 7 Accident (Same Rating as Chernobyl)
BANISH VARICOSE VEINS — WITH NO PAIN!

Bush & Gore secret pact
$500-A-MONTH HIKE IN SOCIAL SECURITY!

Nostradamus stunning final warning...

YOU’LL BURN IN SCORCHING WEATHER HELL!

GLOBAL WARMING HORROR AS KILLER FIRESTORMS SWEEP U.S.
U.S. COAL - CO\textsubscript{2} Emissions

- More than a 1/3 of all CO\textsubscript{2} emissions in the U.S. come from energy transformations from coal resources, which are used to generate about 45% of the country’s electricity.

<table>
<thead>
<tr>
<th>Country or region</th>
<th>% of global total annual emissions</th>
<th>Tonnes of GHG per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>16 %</td>
<td>24.1</td>
</tr>
<tr>
<td>Indonesia</td>
<td>6 %</td>
<td>12.9</td>
</tr>
<tr>
<td>European Union-27</td>
<td>11 %</td>
<td>10.6</td>
</tr>
<tr>
<td>China</td>
<td>17 %</td>
<td>5.8</td>
</tr>
<tr>
<td>India</td>
<td>5 %</td>
<td>2.1</td>
</tr>
</tbody>
</table>
China Impact on CO₂

Great Wall on a Clear Day  Daning on a Clear Day
Options for reducing net CO$_2$

- **Reducing Energy Consumption**
  - Increasing the efficiency

- **Switching to Less Carbon Intensive Fuels**
  - Natural gas instead of coal

- **Renewable Energy Sources or Nuclear Energy**
  - Emits little or no net CO$_2$

- **Capturing and Storing CO$_2$**
  - Chemically or physically
Geologic Storage

1. CO₂ is captured, compressed, and piped to the storage site.

2. CO₂ is then injected under pressure via a well into the storage site.
Partial Listing of CCS Industry Partners

- Alpha Natural Resources
- CNX Gas
- CONSOL Energy
- Cumberland Resources
- Dart Oil & Gas
- Dominion
- EPRI
- Equitable Production
- Norfolk Southern
- Natural Resource Partners
- Penn Virginia
- Piney Land
- Pocahontas Land
- Praxair
Scenarios

Business as Usual

L4 (750 ppm)

L3 (650 ppm)

L1 (450 ppm)

L2 (550 ppm)
Reference Scenario

- BUSINESS AS USUAL: 
  - Annual Energy Outlook 2011
Scenario I

• L1 Mitigation Scenario:
Permitting Challenges

- Surface – Valley Fills, ACOE / 404 Permits / Buffer Zone
- Unknown time frame for permit approval
- Constantly changing regulations, guidelines, criteria
- Underground – Surface Subsidence
- Post-mining Hydrology
- Litigation by numerous environmental factions
- Stream mitigation
- Public perception of coal mining – especially MTR and Longwall
- Labor force – lack of technical personnel
- Environmental Impact Statement
- Larger and larger surface mines are targets for public scrutiny
Adverse Trend in Environmental Policies and Politics

- Environmental policies and requirements are changing, based on negative reactions of some elected or appointed officials to coal mining and coal utilization.
- Federal judges have issued temporary restraining orders (TRO) that impede coal production.
- The TROs are related to mining permits that have already been issued, which have been challenged by groups opposed to mining.
- This is causing uncertainty in the mining industry, impacting planned expansion of existing operations and potentially delaying the startup of new mines.
Conductivity

• Conductivity—All natural waters contained dissolved mineral and there is a relationship between the amount of dissolved mineral and the ability of water to conduct electrical current

• April 1, 2010 US EPA “Enforceable Guidance” for Conductivity
  – Limit not to exceed 500 microSiemens/cm—limit cannot be exceeded
  – Water in excess of 300 microSiemens/cm causes close & critical scrutiny of the mining operation’s permit conditions

• These values are extremely low and difficult to achieve
Putting Conductivity into Perspective
Putting Conductivity into Perspective
Putting Conductivity into Perspective
Land Disturbance Comparison: Boone and Fairfax Counties
Overview: Through a supervised image classification technique using LANDSAT multi-spectral satellite imagery collected in 2000 and 2007, we compared the areal extent of urban and industrial development in a major surface mining area (i.e., Boone County, WV) to a predominantly urban/suburban area (i.e., Fairfax County, VA and surrounding municipalities). To accomplish this, each satellite image was classified into land cover classes based upon densities of vegetation and urban/industrial activity. This supervised image classification involved an analysis of unique spectral signatures for distinguishable land cover sample areas and a maximum likelihood classification algorithm within the ESRI ArcGIS™ software environment.
Land Cover Classification – 2000: LANDSAT satellite imagery collected in 2000 revealed less than 10% of Boone County, West Virginia, was occupied by surface mining-related land cover (represented by the barren/earthen material and urban/developed land cover types). For that same time period, approximately 50% of Fairfax County and the adjoining municipalities were occupied by urban land cover types, such as buildings, roads, parking lots, etc.
Land Cover Classification – 2007: In 2007, surface mining-related land cover continued to hover around 10% in Boone County, West Virginia. For Fairfax County and the adjoining municipalities, urban/developed land cover occupied almost 60% of the total land area.
Land Cover Comparison 2000 to 2007: The graphs above illustrate the dynamic nature of surface mining and urban land uses over an eight year period. In Boone County, the amount of area occupied by surface mining-related activity remained relatively constant, hovering around 10% (based upon urban/developed and barren/earthen material land cover types). This reflects the fact that although surface mining activity continued during this time period in Boone County, previously mined areas were also being reclaimed.

For Fairfax County, vegetated land cover decreased and urban/developed land cover increased from 2000 to 2007. This transition of land cover types illustrates the nature of urban development as it occupies more and more of a finite area.
Conclusions

• This analysis shows that Coal should remain a vital part of the US energy portfolio.

• Renewables will be a limited part of the US energy portfolio unless substantial advancements are made in solar and wind efficiencies and the citizens accept large scale commercial development of wind and solar plants.

• Natural Gas should be a major source of energy as unconventional gas supplies are developed (Shale and CBM).

• The Nuclear future is encumbered by recent tragedies.

• Since the electricity sector plays a large role in reducing U.S. CO₂ emissions within the economy, CCS plays an especially important role as part of a diverse portfolio of mitigation technologies.

• We need to invest more FUNDING, FOCUS AND TIME in coal R&D, and especially in demonstration of commercial-scale CCS systems.

• The US EPA needs to focus on sound science and engineering practices prior to implementing regulations that are potentially harmful to the US economy.