Annual Energy Outlook 2014
1st Coal Working Group

Coal and Uranium Analysis Team
July 22, 2013| Washington, D.C.
Topics for discussion

• *Recoding to AIMMS; otherwise, no changes to Coal Market Module (CMM) structure or equations from AEO2013*

• Legislation and regulations

• Retirements and additions

• Pollution control retrofits

• Coal productivity trends

• Projected consumption (CTL), production, exports, and prices

• Side cases
Key results for the AEO2013 Reference case

• Coal remains the leading fuel for U.S. electricity generation, but coal’s share of total generation decreases over time to 35% in 2040 (from 42% in 2011)

• Coal producers in both the Interior and Western regions see their shares of total U.S. coal production increase over the projection period, while Appalachia's share declines. From 2011 to 2040, the Appalachian region's share of total coal production (on a Btu basis) falls from 38 percent to 32 percent.

• Nearly all of the 49 GW of coal-fired capacity retirements (28 GW planned) occur by 2016 largely because of the combination of MATS, relatively low natural gas prices, and relatively low electricity demand
Key results for the AEO2013 Reference case

- Expanding development of shale gas resources drive increased production and competitive prices for natural gas.

- Coal consumption declines by 119 million short tons between 2011 and 2016. Between 2016 and 2040, coal consumption rises due to more intensive use of remaining coal plants as natural gas prices rise, but it never reaches the record 2007 level.

- 9 GW of additions (6 GW planned)

- Delivered coal prices increase gradually through 2040 at an average rate of 0.9% per year due to declining coal mine productivity and increasing transportation costs.
Legislation and regulation assumptions

• Current laws and regulations addressed in the AEO2014 Reference Case
  - Clean Air Interstate Rule (CAIR)
  - Mercury and Air Toxics Standards (MATS) by 2016
  - State Renewable Portfolio Standards (RPS)
  - California’s cap-and-trade program and the Northeast’s RGGI program
  - Uncertainty with respect to CO$_2$ policy addressed through a 3% higher cost of capital for new coal-fired power plants and capital investment projects at existing coal-fired power plants

• Issues not addressed in the AEO2014 Reference Case
  – CO$_2$ New Source Performance Standards (NSPS)
  – Cooling water intake regulations per section 316(b) of the Clean Water Act
  – Regional haze
  – Coal combustion residuals
Planned (reported and unconfirmed) annual coal-fired capacity retirements in the electric power sector

megawatts, net summer

Almost 24 GW of coal-fired capacity has been reported to EIA as planned to retire between 2013 and 2022 with an additional 11 GW of capacity reported in trade press but not yet confirmed by plant owners and operators.

Sources: Reported retirements were collected on U.S. Energy Information Administration Form EIA-860, “Annual Electric Generator Report;” Unconfirmed retirements were collected from various trade press. EIA-860 data for 2012 are preliminary.
Preliminary AEO2014: Planned Coal-Fired Capacity Additions (megawatts)

<table>
<thead>
<tr>
<th>FACILITY CODE</th>
<th>PLANT NAME</th>
<th>GENERATOR ID</th>
<th>STATE</th>
<th>PLANT TYPE</th>
<th>ENERGY SOURCE</th>
<th>START YEAR</th>
<th>START MONTH</th>
<th>SUMMER CAPABILITY</th>
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<tbody>
<tr>
<td>2721</td>
<td>Cliffside*</td>
<td>6</td>
<td>NC</td>
<td>PC</td>
<td>BIT</td>
<td>2012</td>
<td>12</td>
<td>825</td>
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<tr>
<td>56564</td>
<td>John W Turk Jr Power Plant*</td>
<td>1</td>
<td>AR</td>
<td>PC</td>
<td>SUB</td>
<td>2012</td>
<td>12</td>
<td>609</td>
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<tr>
<td>56611</td>
<td>Sandy Creek Energy Station</td>
<td>S01</td>
<td>TX</td>
<td>PC</td>
<td>SUB</td>
<td>2013</td>
<td>5</td>
<td>911</td>
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<tr>
<td>1004</td>
<td>Edwardsport</td>
<td>ST,CT1,CT2</td>
<td>IN</td>
<td>IGCC</td>
<td>BIT</td>
<td>2013</td>
<td>6</td>
<td>571</td>
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<tr>
<td>57037</td>
<td>Kemper County IGCC Project</td>
<td>1A,1B,1C</td>
<td>MS</td>
<td>IGCC</td>
<td>LIG</td>
<td>2014</td>
<td>5</td>
<td>593</td>
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<tr>
<td>7570</td>
<td>Spiritwood</td>
<td>1</td>
<td>ND</td>
<td>PC</td>
<td>LIG</td>
<td>2014</td>
<td>6</td>
<td>62</td>
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<tr>
<td>55360</td>
<td>Two Elk Generating Station</td>
<td>GEN1</td>
<td>WY</td>
<td>PC</td>
<td>WC</td>
<td>2016</td>
<td>12</td>
<td>275</td>
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</tbody>
</table>

To be included as planned capacity additions in AEO2014:
3,846

* Units that come on-line in December are reported in NEMS as planned additions for the next calendar year.

**Note:** Three coal-fired generating units that came on-line in 2012, with a combined generating capacity of 2,214 MW, were included as planned capacity additions in the AEO2013. These units will be included as existing capacity in the AEO2014. The three units were Prairie State Generating Station’s units PC1 (812 MW) and PC2 (817 MW) and Virginia City Hybrid Energy Center’s unit 1 (585 MW).

**Source:** U.S. Energy Information Administration, Form EIA-860 “Annual Electric Generator Report”
EIA-860: Coal-Fired Capacity Reported as Planned but Not Yet Under Construction (megawatts)

<table>
<thead>
<tr>
<th>FACILITY CODE</th>
<th>PLANT NAME</th>
<th>GENERATOR ID</th>
<th>STATE</th>
<th>PLANT TYPE</th>
<th>ENERGY SOURCE</th>
<th>START YEAR</th>
<th>START MONTH</th>
<th>SUMMER CAPABILITY</th>
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<tr>
<td>56453</td>
<td>Robinson Power Company LLC</td>
<td>1</td>
<td>PA</td>
<td>PC</td>
<td>BIT</td>
<td>2016</td>
<td>4</td>
<td>132</td>
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<tr>
<td>56452</td>
<td>Medicine Bow Fuel &amp; Power LLC</td>
<td>1</td>
<td>WY</td>
<td>CTL</td>
<td>BIT</td>
<td>2016</td>
<td>12</td>
<td>350</td>
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<tr>
<td>56675</td>
<td>Plant Washington</td>
<td>1</td>
<td>GA</td>
<td>PC</td>
<td>SUB</td>
<td>2018</td>
<td>4</td>
<td>850</td>
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<tr>
<td>56454</td>
<td>Taylorville Energy Center</td>
<td>MAIN</td>
<td>IL</td>
<td>IGCC</td>
<td>BIT</td>
<td>2018</td>
<td>6</td>
<td>533</td>
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<tr>
<td></td>
<td>Total Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>1,865</td>
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</table>

**Note:** Because these units are reported as not yet under construction on the EIA-860, these units are not included as planned capacity additions in the AEO2014.

**Source:** U.S. Energy Information Administration, Form EIA-860 “Annual Electric Generator Report”
# Electric Net Summer Generating Capacity by Fuel, 2008-2040 (gigawatts)

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Coal</td>
<td>311</td>
<td>318</td>
<td>301</td>
<td>278</td>
<td>277</td>
<td>277</td>
<td>278</td>
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<tr>
<td>Electric Power Sector</td>
<td>308</td>
<td>314</td>
<td>297</td>
<td>275</td>
<td>273</td>
<td>272</td>
<td>273</td>
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<tr>
<td>End-Use Sectors</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<td>Natural Gas</td>
<td>335</td>
<td>359</td>
<td>379</td>
<td>380</td>
<td>390</td>
<td>519</td>
<td>566</td>
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<tr>
<td>Petroleum</td>
<td>115</td>
<td>103</td>
<td>99</td>
<td>97</td>
<td>88</td>
<td>68</td>
<td>66</td>
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<td>Nuclear Power</td>
<td>101</td>
<td>101</td>
<td>104</td>
<td>106</td>
<td>111</td>
<td>109</td>
<td>113</td>
</tr>
<tr>
<td>Renewable Sources</td>
<td>117</td>
<td>143</td>
<td>171</td>
<td>175</td>
<td>178</td>
<td>208</td>
<td>245</td>
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<tr>
<td>Other (includes pumped storage)</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1004</strong></td>
<td><strong>1050</strong></td>
<td><strong>1079</strong></td>
<td><strong>1061</strong></td>
<td><strong>1068</strong></td>
<td><strong>1206</strong></td>
<td><strong>1293</strong></td>
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</table>


*MATS compliance assumed to begin*
Electricity Sector Net Summer Generating Capacity by SO$_2$ Control Type and Region, 2011 and 2020 in AEO2013

Note: Scrubbed capacity includes capacity equipped with flue gas desulfurization (FGD) equipment and coal plants employing integrated gasification combined (IGCC) cycle or circulating fluidized bed (CFB) combustion technologies.

Average Delivered Price of Coal and Natural Gas to the Electric Power Sector, 1980-2040

2011 dollars per million Btu

Coal production by region, 1970-2040

Source: **History**: U.S. Energy Information Administration (EIA), *Annual Coal Report*;  
**Projections**: EIA, *Annual Energy Outlook 2013*, Reference Case

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Coal and Uranium Analysis Team  
Washington, DC, July 22, 2013
Coal production, 2040 (and 2012) (million short tons)

3 (2)**
476 (388)*
8 (13)
34 (45)
32 (30)
73 (36)
31 (28)
1 (2)
170 (130)
183 (127)
87 (148)
13 (20)
55 (48)

U.S. Total: 1,167 (1,016)

* Includes production from all mines in Wyoming’s Powder River Basin.
** Includes production from mines in both Alaska and Washington.

Average annual growth in coal mining labor productivity for selected supply regions (percent)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Northern Appalachia</td>
<td>5.4</td>
<td>5.5</td>
<td>-2.5</td>
<td>-1.2</td>
<td>-3.6</td>
</tr>
<tr>
<td>Central Appalachia</td>
<td>7.3</td>
<td>4.4</td>
<td>-6.1</td>
<td>-3.6</td>
<td>-3.8</td>
</tr>
<tr>
<td>Eastern Interior</td>
<td>4.8</td>
<td>3.7</td>
<td>-1.4</td>
<td>-0.6</td>
<td>5.8</td>
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<tr>
<td>Gulf Lignite</td>
<td>2.6</td>
<td>2.4</td>
<td>-2.7</td>
<td>-2.3</td>
<td>-4.2</td>
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<tr>
<td>Dakota Lignite</td>
<td>6.0</td>
<td>1.0</td>
<td>-3.3</td>
<td>-0.9</td>
<td>-4.5</td>
</tr>
<tr>
<td>Western Montana</td>
<td>4.6</td>
<td>2.0</td>
<td>-3.0</td>
<td>-1.7</td>
<td>-11.7</td>
</tr>
<tr>
<td>WY, Northern Powder River Basin</td>
<td>7.5</td>
<td>3.2</td>
<td>-3.0</td>
<td>-1.7</td>
<td>-5.8</td>
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<tr>
<td>WY, Southern Powder River Basin</td>
<td>7.2</td>
<td>4.9</td>
<td>-2.7</td>
<td>-1.7</td>
<td>-6.6</td>
</tr>
<tr>
<td>Rocky Mountain</td>
<td>7.8</td>
<td>5.5</td>
<td>-3.3</td>
<td>-1.9</td>
<td>2.9</td>
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<tr>
<td>U.S. Average</td>
<td>7.1</td>
<td>6.2</td>
<td>-2.7</td>
<td>-1.4</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Average minemouth coal price by region, 1980-2040

2011 dollars per short ton

History 2011 Projections


Appalachia

Interior

Western (including WY PRB)

U.S. Average

WY PRB

Note: Historical price data for Wyoming’s PRB is represented by data for Campbell county.
Source: History: U.S. Energy Information Administration (EIA), Annual Coal Report;
Projections: EIA, Annual Energy Outlook 2013, Reference Case
Coal consumption by sector, 1970-2040

Electricity Generation by Fuel, 1980-2040

billion kilowatthours

<table>
<thead>
<tr>
<th>Year</th>
<th>History</th>
<th>2011</th>
<th>Projections</th>
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<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2040</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Short Term Energy Outlook, July 2013

Note: Includes generation from plants in both the electric power and end-use sectors.

Source: History: U.S. Energy Information Administration (EIA), Annual Energy Review;
Electricity generation by fuel, 1990-2040

Source: U.S. Energy Information Administration, Annual Energy Outlook 2013, Reference Case
Average Capacity Utilization Rate for Coal-Fired Generating Capacity in Five Cases, 2005-2040

U.S. Coal Exports, 1995-2040

Source: History: U.S. Energy Information Administration (EIA), Quarterly Coal Report;
Projections: EIA, Annual Energy Outlook 2013 (AEO2013), Reference Case
Coal exports by major coal-producing region, 2010-2040

Uncertainty is explored with numerous alternative cases
## Key differences between alternate cases

<table>
<thead>
<tr>
<th></th>
<th>AEO2013 Reference</th>
<th>Low Economic Growth</th>
<th>High Economic Growth</th>
<th>Low Coal Cost</th>
<th>High Coal Cost</th>
<th>High Oil and Gas Resource</th>
<th>Low Oil and Gas Resource</th>
<th>GHG15 (CO2 fee of $15 in 2014 increasing to $53 in 2040)</th>
<th>GHG25 (CO2 fee of $25 in 2014 increasing to $89 in 2040)</th>
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<tbody>
<tr>
<td>GDP growth (avg. annual change from 2011)</td>
<td>2.5%</td>
<td>1.9%</td>
<td>2.9%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Electricity demand (avg. annual change from 2011)</td>
<td>0.9%</td>
<td>0.6%</td>
<td>1.2%</td>
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<tr>
<td>Delivered natural gas price to the electricity sector, 2040 (2011 dollars per million Btu)</td>
<td>$8.38</td>
<td></td>
<td></td>
<td>$5.13</td>
<td>$10.55</td>
<td>$11.01*</td>
<td>$11.10*</td>
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<tr>
<td>Delivered coal price to the electricity sector, 2040 (2011 dollars per million Btu)</td>
<td>$3.20</td>
<td>$1.88</td>
<td>$5.68</td>
<td></td>
<td></td>
<td>$7.71*</td>
<td>$9.45*</td>
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<td>Minemouth coal price, 2040 (2011 dollars per short ton)</td>
<td>$61.28</td>
<td>$33.90</td>
<td>$128.09</td>
<td></td>
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<tr>
<td>Western coal transportation rates (percent change from 2011, constant dollar basis)</td>
<td>0.0%</td>
<td>-24%</td>
<td>27%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Coal mining productivity (avg. annual change from 2011)</td>
<td>-1.4%</td>
<td>0.9%</td>
<td>-4.3%</td>
<td></td>
<td></td>
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<tr>
<td>Coal with CCS in power sector, 2040 (gigawatts)</td>
<td>0.9</td>
<td></td>
<td></td>
<td>2.6</td>
<td>3.9</td>
<td></td>
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<td>NGCC with CCS in power sector, 2040 (gigawatts)</td>
<td>0.0</td>
<td></td>
<td></td>
<td>5.8</td>
<td>49.9</td>
<td></td>
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</tbody>
</table>

*Includes CO₂ fee
U.S. Coal Production, 2020 and 2040

Coal production by region, 2040

2040 electricity generation shares


Coal and Uranium Analysis Team
Washington, DC, July 22, 2013
Cumulative coal-fired capacity retirements, 2012-2040

Cumulative coal-fired capacity additions, 2012-2040


Coal and Uranium Analysis Team
Washington, DC, July 22, 2013
For more information

greg.adams@eia.gov, (202) 586-7343
ayaka.jones@eia.gov, (202) 586-0998
diane.kearney@eia.gov, (202) 586-2415
michael.mellish@eia.gov, (202) 586-2136
vlad.dorjets@eia.gov, (202) 586-3141

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