Annual Energy Outlook 2014: Coal Supply and Demand Projections Through 2040

Diane Kearney

October 2, 2014 | Rail Energy Transportation Advisory Committee to the Surface Transportation Board, Washington, D.C.
The \textit{AEO2015} will be abridged compared to \textit{AEO2014}

- The U.S. Energy Information Administration is revising the schedule for production of the \textit{International Energy Outlook (IEO)} and \textit{Annual Energy Outlook (AEO)}. The IEO and AEO will alternate annually between full and short versions.

- The \textit{AEO2015} will be the first short version of the Annual Energy Outlook.
- The shorter version will include an abbreviated discussion and results from select cases.

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>\textit{International Energy Outlook}</td>
<td>Short Edition to be released summer 2014</td>
<td>Full Edition will be released in spring 2015</td>
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<tr>
<td>\textit{Annual Energy Outlook}</td>
<td>Full Edition released in spring 2014</td>
<td>Short Edition will be released by early 2015</td>
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</tbody>
</table>
Legislation and Regulations
AEO2014 legislation and regulation assumptions

- Current laws and regulations included in the AEO2014 Reference case
  - Clean Air Interstate Rule (CAIR)
  - Mercury and Air Toxics Standards (MATS) with full compliance by 2016
  - Regional Haze Rule plans are captured in annual reporting data
  - California’s cap-and-trade program (AB 32) and the Northeast’s Regional Greenhouse Gas Initiative (RGGI) program
  - Uncertainty with respect to CO₂ policy addressed through a 3% higher cost of capital for new coal-fired power and coal-to-liquids plants and capital investment projects at existing coal-fired power plants
  - State Renewable Portfolio Standards (RPS)
  - Renewable energy sunset provisions as specified in law, e.g., for production tax credits for wind the “effective expiration date” is 2015 for plants under construction by the end of 2013
Legislative and regulatory actions not addressed in the AEO2014 Reference case

- EPA’s CO$_2$ New and Existing Source Performance Standards per section 111(b) and 111(d) of the Clean Air Act, respectively
- EPA’s cooling water intake regulations per section 316(b) of the Clean Water Act
- EPA’s coal effluent guidelines and coal combustion residuals
- California post-2020 Greenhouse Gas (GHG) emissions target
- EPA’s tailoring rule for biomass carbon emissions
Review of AEO2014 Reference Case
Key results for the AEO2014 Reference case

• Coal is no longer the leading fuel for U.S. electricity generation in 2040. Coal’s share of total generation decreases over time to 32% in 2040 from 37% in 2012.

• Coal producers in the Interior region gain share while Appalachia loses share of total U.S. coal production. From 2012 to 2040, the Appalachian region's share of total coal production (on a Btu basis) falls from about 36% to 29%.

• Much of the 51 GW of coal-fired capacity retirements (33 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 AEO2014 Reference case

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

- A short-term recovery for coal occurs followed by a decline in consumption in 2015 and 2016 as MATS takes effect, resulting in a net gain of 26 million tons for coal in 2016 compared to 2012. After 2016, coal consumption rises, peaking in 2029 with a small decline thereafter.

- 2.6 GW of coal capacity additions (2.2 GW planned)

- Delivered coal prices increase gradually through 2040 at an average rate of 0.9% per year (on a per ton basis) due to declining coal mine productivity and slightly higher transportation costs.
Over time the electricity mix gradually shifts towards larger shares of natural gas and renewable generation.

Source: EIA, Annual Energy Outlook 2014
Electricity sales have decreased in 5 of the last 6 years; prior to 2008, sales declined only twice in 58 years.

Year over year generation has fallen five times since 2008.

Source: Energy Information Administration, Form EIA-923 and predecessor forms.
Delivered prices of natural gas and coal to the electric power sector in the Reference case

**Average delivered fuel prices to electric power plants, 2012 dollars per million Btu**

- **History**
- **Projections**

**Power generation fuel costs**
- 2012 dollars per megawatthour

- **natural gas combined cycle**
- **coal steam**

- **natural gas**
- **coal**

**Source:** AEO2014 Reference case (April 2014).
Shale gas leads U.S. production growth

U.S. dry natural gas production (trillion cubic feet)

Source: AEO2014 Reference Case (April 2014)
Non-hydro renewable generation more than doubles between 2012 and 2040

renewable generation
billion kilowatthours per year

Source: EIA, Annual Energy Outlook 2014
Average capacity utilization of natural gas combined cycle and coal generating capacity, 2008-2040

Source: AEO2014 Reference Case (April 2014)
Electricity Generation by Fuel, 1980-2040

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;
Average levelized electricity costs for new power plants, excluding subsidies, in the Reference case, 2020 and 2040

new power plant costs, 2012 cents per kilowatthour

Source: AEO2014 Reference Case (April 2014)
Gas-fueled units account for most projected capacity additions in the AEO2014 Reference case

U.S. electricity generation capacity additions

Source: Form EIA-860 & EIA Annual Energy Outlook 2014
Coal accounts for more than half of the projected capacity retirements in the AEO2014 Reference case.

U.S. electricity generation capacity retirements (gigawatts)

- **History**
  - 1985: 0
  - 1990: 0
  - 1995: 0
  - 2000: 0
  - 2005: 0
  - 2010: 0
  - 2015: 0
  - 2020: 0
  - 2025: 0
  - 2030: 0
  - 2035: 0
  - 2040: 0

- **Projections**
  - 2013-2040
    - Renewables/Other: 0.9
    - Nuclear: 4.8
    - Natural Gas and Petroleum: 40.3
    - Coal: 50.8

**Source:** Form EIA-860 and AEO2014 Reference Case (April 2014)
# Electric Net Summer Generating Capacity by Fuel, 2008-2040 (gigawatts)

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<tr>
<td>Coal</td>
<td>311</td>
<td>316</td>
<td>310</td>
<td>290</td>
<td>266</td>
<td>263</td>
<td>262</td>
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<td>308</td>
<td>313</td>
<td>307</td>
<td>286</td>
<td>263</td>
<td>259</td>
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<td>End-Use Sectors</td>
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<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Natural Gas &amp; Petroleum</td>
<td>450</td>
<td>463</td>
<td>469</td>
<td>477</td>
<td>486</td>
<td>488</td>
<td>575</td>
<td>684</td>
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<tr>
<td>Nuclear Power</td>
<td>101</td>
<td>101</td>
<td>102</td>
<td>99</td>
<td>100</td>
<td>98</td>
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<td>102</td>
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<td>Renewable Sources</td>
<td>117</td>
<td>143</td>
<td>159</td>
<td>189</td>
<td>192</td>
<td>195</td>
<td>208</td>
<td>242</td>
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<tr>
<td>Other (includes pumped storage)</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
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</tr>
<tr>
<td>Total</td>
<td>1004</td>
<td>1049</td>
<td>1066</td>
<td>1081</td>
<td>1070</td>
<td>1069</td>
<td>1168</td>
<td>1316</td>
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**Source:** AEO2014 Reference Case (April 2014)  
*MATS compliance assumed to begin  **Excludes natural gas and oil CC/CT generating capacity in the end-use sectors*
Coal production, AEO2014 in 2040 (vs. 2012) (million short tons)

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

Coal demand regions

Source: U.S. Energy Information Administration, Office of Energy Analysis
Net summer coal-fired generating capacity in the electric power sector by coal demand region, 2012 and 2040

gigawatts

Source: AEO2014 Reference Case (April 2014)
Cumulative net summer coal-fired capacity retirements by coal demand region, 2013-2040

gigawatts

<table>
<thead>
<tr>
<th>Region</th>
<th>01NE (CT,MA,ME,NH,RI,VT)</th>
<th>02YP (NY,PA,NJ)</th>
<th>03S1 (WV,MD,DC,DE)</th>
<th>04S2 (VA,NC,SC)</th>
<th>05GF (GA,FL)</th>
<th>06OH (OH)</th>
<th>07EN (IN,IL,MI,WI)</th>
<th>08KT (KY,TN)</th>
<th>09AM (AL,MS)</th>
<th>10C1 (MN,ND,SD)</th>
<th>11C2 (IA,NE,MO,KS)</th>
<th>12WS (TX,LA,OK,AR)</th>
<th>13MT (MT,WY,ID)</th>
<th>14CU (CO,UT,NV)</th>
<th>15ZN (AZ,NM)</th>
<th>16PC (AK,HI,WA,OR,CA)</th>
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<tr>
<td></td>
<td>0</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
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Source: AEO2014 Reference Case (April 2014)
Coal production by region, 1970-2040

Source: AEO2014 Reference Case (April 2014)
Average annual growth in coal mining labor productivity for selected supply regions (percent)

<table>
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<tr>
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<tbody>
<tr>
<td>Northern Appalachia</td>
<td>5.4</td>
<td>5.5</td>
<td>-2.7</td>
<td>-3.8</td>
<td>-4.9</td>
<td>-1.3</td>
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<tr>
<td>Central Appalachia</td>
<td>7.3</td>
<td>4.4</td>
<td>-5.9</td>
<td>-5.9</td>
<td>-3.8</td>
<td>-3.4</td>
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<tr>
<td>Eastern Interior</td>
<td>4.8</td>
<td>3.7</td>
<td>-0.8</td>
<td>-0.1</td>
<td>6.1</td>
<td>0.1</td>
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<tr>
<td>Gulf Lignite</td>
<td>2.6</td>
<td>2.4</td>
<td>-2.8</td>
<td>-4.5</td>
<td>-4.2</td>
<td>-1.0</td>
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<td>Dakota Lignite</td>
<td>6.0</td>
<td>1.0</td>
<td>-3.5</td>
<td>-5.2</td>
<td>-4.8</td>
<td>-1.0</td>
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<tr>
<td>Western Montana</td>
<td>4.6</td>
<td>2.0</td>
<td>-3.7</td>
<td>-6.6</td>
<td>-11.7</td>
<td>-1.3</td>
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<tr>
<td>WY, Northern Powder River Basin</td>
<td>7.5</td>
<td>3.2</td>
<td>-3.2</td>
<td>-5.0</td>
<td>-5.7</td>
<td>-1.7</td>
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<tr>
<td>WY, Southern Powder River Basin</td>
<td>7.2</td>
<td>4.9</td>
<td>-3.0</td>
<td>-4.1</td>
<td>-6.4</td>
<td>-1.7</td>
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<tr>
<td>Rocky Mountain</td>
<td>7.8</td>
<td>5.5</td>
<td>-2.7</td>
<td>-4.4</td>
<td>3.5</td>
<td>-2.5</td>
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<tr>
<td>U.S. Average</td>
<td>7.1</td>
<td>6.2</td>
<td>-2.4</td>
<td>-2.9</td>
<td>-0.2</td>
<td>-1.2</td>
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Source: History: U.S. Energy Information Administration (EIA), Annual Coal Report; and Mine Safety and Health Administration, Form 7000-2, “Quarterly Mine and Employment and Coal Production Report;”

Appalachian coal production, 1970-2040

Source: AEO2014 Reference Case (April 2014)

Except for Appalachian total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines
Interior coal production, 1970-2040

Source: AEO2014 Reference Case (April 2014)
Except for Interior total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines
Western coal production, 1970-2040

Source: AEO2014 Reference Case (April 2014)

Except for Western total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines
Average minemouth coal prices by region, 1980-2040

2012 dollars per short ton

Source: AEO2014 Reference Case (April 2014)
U.S. Coal Exports, 1995-2040

million short tons

Source: History: U.S. Energy Information Administration (EIA), Quarterly Coal Report;
Coal exports by major supply region, 2010-2040

EIA Data Browsers and Energy Mapping System

Electricity Data Browser - http://www.eia.gov/electricity/data/browser/

Coal Data Browser (Beta) - http://www.eia.gov/beta/coal/data/browser/

Nuclear Outage Browser (Beta) - http://www.eia.gov/beta/outages/


Short-Term Energy Outlook - http://www.eia.gov/forecasts/steo/query/


For more information

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24-hour automated information line about EIA and frequently asked questions.
Assessing Uncertainty: Side Cases
### Key differences between alternate cases

<table>
<thead>
<tr>
<th></th>
<th>AEO2014 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>GHG10 (CO2 fee of $10 in 2015 increasing to $34 in 2040)</th>
<th>GHG25 (CO2 fee of $25 in 2015 increasing to $85 in 2040)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP growth</strong></td>
<td></td>
<td>2.4%</td>
<td>1.9%</td>
<td>2.8%</td>
<td></td>
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<tr>
<td><strong>Electricity demand</strong></td>
<td></td>
<td>0.9%</td>
<td>0.6%</td>
<td>1.2%</td>
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<tr>
<td><strong>Delivered natural gas price to the electricity sector, 2040</strong></td>
<td>$8.16</td>
<td>$5.17</td>
<td>$10.82</td>
<td>$9.57*</td>
<td>$12.38*</td>
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<tr>
<td><strong>Delivered coal price to the electricity sector, 2040</strong></td>
<td>$3.19</td>
<td>$1.89</td>
<td>$5.36</td>
<td>$6.08*</td>
<td>$10.27*</td>
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<td><strong>Minemouth coal price, 2040</strong></td>
<td>$59.16</td>
<td>$32.29</td>
<td>$113.47</td>
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<tr>
<td><strong>Western coal transportation rates</strong></td>
<td>-0.4%</td>
<td>-25%</td>
<td>25%</td>
<td></td>
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<tr>
<td><strong>Coal mining productivity</strong></td>
<td>-1.2%</td>
<td>1.0%</td>
<td>-4.0%</td>
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<tr>
<td><strong>Coal with CCS in power sector, 2040</strong></td>
<td>0.9</td>
<td>8.5</td>
<td>3.9</td>
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<tr>
<td><strong>NGCC with CCS in power sector, 2040</strong></td>
<td>0.3</td>
<td>13.2</td>
<td>67.2</td>
<td></td>
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</tbody>
</table>

*Includes CO$_2$ fee

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October 2, 2014 | RETAC Washington, D.C.
U.S. Coal Production, 2020 and 2040

million short tons

Coal production by region, 2040

Million short tons


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October 2, 2014 | RETAC Washington, D.C.
2040 electricity generation shares


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October 2, 2014 | RETAC Washington, D.C.
Cumulative coal-fired capacity retirements, 2012-2040

Cumulative coal-fired capacity additions, 2012-2040

gigawatts

Reference | Low Economic Growth | High Economic Growth | Low Coal Cost | High Coal Cost | High Oil and Gas Resource | Low Oil and Gas Resource | No GHG Concern | GHG 10 | GHG 25