Agenda

CO₂ and Other Environmental Regulations in U.S.

Market Developments

Coal Generation Trends

Coal Plant Retirements

Coal Industry Outlook

Conclusions
What’s Happening to Coal?

U.S. coal generation and the mining industry have been under distress over the last few years, as evidenced by reduction in output, plant closures, and bankruptcies.

- So far, the main drivers have been low natural gas prices, increasing penetration of renewable generation, lack of load growth, and environmental regulations (mostly MATS).

Going forward, further increase in renewable generation and low gas prices will continue to challenge coal generation and mining industry, though offset by reduced pressure from likely weaker/delayed environmental regulations and possible upside from increasing gas prices.
Environmental Regulations

Over the last several years the EPA has enacted a number of regulations that have negatively impacted existing coal generators, but that trend will likely slow down under the new administration.

- Mercury and Air Toxics Standards (MATS) caps emissions of mercury and other air toxics at coal and oil fired plants
  - Some coal plants required expensive FGDs/scrubbers, baghouses, ACI, or DSI equipment
  - Possible overturn of MATS by the new administration would decrease future operating costs
- The Cross State Air Pollution Rule (CSAPR) placed state level and regional limits on SO$_2$ and NO$_x$ emissions
  - Applies to both coal and gas generators, but bigger impact on coal
  - Future tightening of CSAPR caps are unlikely under the new administration
- Regional Haze regulations have particularly impacted coal plants in the West, but also will impact Texas going forward
  - Likely slowing down implementation of Regional Haze rule under new administration
- Clean Power Plan (CPP) would impose CO$_2$ limits on existing power plants
  - CPP could take form of a mass cap or a rate limit; either compliance vehicle would favor natural gas relative to coal generation
  - CPP’s future in doubt in light of recent election outcome
U.S. Carbon Overview

EPA’s Clean Power Plan
- Finalized in August 2015
- Target: electric CO₂ emissions 32% below 2005 levels by 2030
- State targets:
  - Lower coal heat rates
  - Gas substitution for coal
  - More zero-emission generation
- Flexible approaches (i.e., trading) encouraged and enabled
- State plans due: 2016 – 2018
- Compliance: 2022 – 2030
- Mutually reinforcing with Paris Climate Agreement

Regional CO₂ Programs
- **AB32 Cap and Trade Program (CA)**
  - In 4th year of operation
  - Auction prices at $12-13/ton
  - Small emissions reductions to date
  - Expected to become more stringent post 2020
  - Complementary policies: RPS, EE, Low Carbon Fuel Standard, etc.
- **Regional Greenhouse Gas Initiative (RGGI)**
  - In 7th year of operation
  - Dec 2016 auction clearing price of $3.55/ton, lower than 2015 high of $7.50/ton

Supreme Court Stay: 2/9/16
- Oral Argument at Court of Appeals
- September 27, 2016
- Possible decision by early 2017.
- Trump administration will likely retract/delay CPP

Regional CO₂ markets form alternatives to CPP as well as potential implementation templates for other states

Possible additional state/regional initiatives in the future, such as Washington carbon tax
CPP National Rate Targets, by Year

- CPP goals have a larger effect on coal from the start, less so on NGCCs
- Compliance assumes “beyond the plant fence” measures and credit trading
- CO₂ emissions in 2016 already below the 2022 CPP mass target for U.S. as a whole, largely due to low gas prices and increased renewables.

*Category Specific Rate Standards based on BSER (lbs/MWh)*

![Graph showing category specific rate standards based on BSER (lbs/MWh)]
Power Markets Outlook

Low wholesale energy prices persist due to economic pressures and policy goals

- Low electricity demand following recession and low natural gas prices (often setting the market clearing price for power as the marginal fuel)
- Forward power markets indicate continuing future low prices

Average All-Hours Spot and Forward Prices, 2008 – 2019 ($/MWh)

Source: Historical spot prices and Jan 2017 forward prices from SNL Energy.
Underlying Causes: Gas, Growth, Renewables (I)

Low natural gas prices are a primary driver of low energy market prices

- Steady decrease in spot gas prices over the past few years
  - Deep shale reserves and low offtake capacity
  - Mothballed wells available for reopening will keep prices low in the near-term
- Forward price curve has dipped, now almost flat over coming decade, but EIA projects increasing gas prices over the long-term.

![Average Annual Gas Spot and Futures Prices, 2008 – 2028](image)

Source: Historical natural gas spot prices from SNL Energy; futures as of January 2017 from SNL Energy (sourced from NYMEX) and AEO 2017 reference case.
Recent history with low demand growth and expected continuation of that trend reflect increased focus on energy efficiency and distributed generation.

- Trend will be exacerbated by declining costs of end-use energy management technologies—though those will eventually require expensive system reconfiguration, controls, and data systems for integration.
- Possible future upside on load growth from electrification of transportation.

U.S. Electricity Demand Growth
Natural gas and renewables’ share of generation is growing, while coal is falling behind

- From 2000 – 2015, gas generation nearly doubled while coal cut by more than one-third
- Although total generation is increasing, efficiency is improving (in terms of GWh/$GDP)

% of U.S. Net Generation by Technology

2000: 3,802 TWh
- Nuclear 19.8%
- Gas 15.8%
- Hydro 7.1%
- Other 3.4%
- Coal 51.7%

2015: 4,080 TWh
- Nuclear 19.5%
- Gas 32.8%
- Hydro 7.2%
- Other 1.4%
- Coal 33.1%

% of U.S. Net Summer Capacity by Technology

2015: 1,032 GW
- Nuclear (incl. Hydro) 16.9%
- Renewable 2.2%
- Gas 44.5%
- Coal 26.9%

2030: 1,082 GW
- Nuclear (incl. Hydro) 25.2%
- Renewable 2.2%
- Gas 43.3%
- Coal 20.4%

U.S. Electric Generation/$GDP

1995: 330 GWh/ $billion
2005: 285 GWh/ $billion
2015: 249 GWh/ $billion

(in billions of chained 2009 dollars)

Market Developments: Renewables

EIA’s AEO2017 projections (w/o CPP) already show considerable displacement of coal capacity and lots of renewables:

With CPP, EIA projects 34 GW less coal and 32 GW more renewables by 2030.

Source: AEO 2017 reference case.
Coal Plant Retirements

Since 2012, 56 GW of coal fleet has either retired or announced to retire by 2020

- 41 GW already retired since 2012
- 8 GW announced to retire by the end of 2017
- Another 7 GW announced to retire by 2020

EPA’s IPM analysis:
- about 100 GW coal retirements by 2020 with no CPP (most of it by 2016), relative to fleet in 2012
- With CPP, an additional 15 GW by 2020 and 24-33 GW by 2030.

EIA’s AEO2017 analysis:
- 72 GW coal retirements by 2020 and another 11 GW by 2030 with no CPP, relative to fleet in 2012
- About 114 GW by 2030 with CPP

Brattle’s recent analyses:
- 65 GW coal likely to retire by 2020 and another 6 GW by 2030 with no CPP, relative to fleet in 2012
- CPP adds another 10 GW by 2030, and low gas prices another 55 GW for a total of 135 GW.

U.S. Actual and Announced Coal Plant Retirements

<table>
<thead>
<tr>
<th>Year of Retirement</th>
<th>Number of Units</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actual</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>88</td>
<td>9,085</td>
</tr>
<tr>
<td>2013</td>
<td>46</td>
<td>5,696</td>
</tr>
<tr>
<td>2014</td>
<td>39</td>
<td>3,906</td>
</tr>
<tr>
<td>2015</td>
<td>102</td>
<td>14,148</td>
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<tr>
<td>2016</td>
<td>53</td>
<td>7,843</td>
</tr>
<tr>
<td><strong>2012-2016</strong></td>
<td><strong>328</strong></td>
<td><strong>40,678</strong></td>
</tr>
<tr>
<td><strong>Announced</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>41</td>
<td>7,622</td>
</tr>
<tr>
<td>2018</td>
<td>20</td>
<td>3,033</td>
</tr>
<tr>
<td><strong>2017-2018</strong></td>
<td><strong>41</strong></td>
<td><strong>10,656</strong></td>
</tr>
<tr>
<td>2019</td>
<td>13</td>
<td>2,171</td>
</tr>
<tr>
<td>2020</td>
<td>16</td>
<td>2,413</td>
</tr>
<tr>
<td><strong>Total 2012-2020</strong></td>
<td><strong>398</strong></td>
<td><strong>55,918</strong></td>
</tr>
</tbody>
</table>

Projected Coal Plant Retirements
Outlook for Coal Generation Largely Depends on Natural Gas Prices, Less on CPP

- Brattle forecasts coal generation likely recovering relative to the 2016 levels even with CPP, largely due to increasing gas prices.

- Combination of CPP and low gas prices would result in steady decline in capacity and generation.

- With high natural gas prices and no CPP, coal generation increases and there is little further capacity decline.
Coal Industry

- About 40% of coal sold in 2015 from bankrupt companies, and 15% from companies at risk for bankruptcy.
- Spot coal prices fell to very low levels in 2015/2016, with a slight uptick in the second half of 2016.

Coal Sales in 2015 (Total 747 Million tons)

- 46%
- 15%
- 39%

Spot Minemouth Coal Prices

Source: SNL.

Source: SNL Physical Markets Survey.
Make Coal King Again?

It may be possible to halt US coal’s production slide, but not likely to reverse it. Some plants could probably be saved by moderating or undoing CPP, the Effluent Guidelines, and not updating CSAPR.

Gas competition was and is the major factor for the decrease in coal sales, with likely increasing pressure from new renewable generation.

A potential upside for coal is increased exports:

- Most PRB coal is already mined on federal land; opening up more land could increase production
  - Federal leasing has been on hold and increased royalty payments have been suggested
- But increased production would need new markets (domestic power is not going to recover)
- Increased exports via one or more new terminals in the Pacific Northwest would support increased exports, subject to competition from other suppliers
  - The probability of having one or more terminals built increases significantly with the election
Dr. Celebi provides expertise in electricity markets and analysis of environmental and climate policy. He has consulted primarily in the areas of electricity spot pricing and market design, and has experience in developing and analyzing climate policies, resource planning, power plant valuation, cost/benefit analyses for joining RTOs, LMP modeling, and merger analysis.

Dr. Celebi received his Ph.D. degree in Economics at Boston College, M.A. degree in Economics at Bilkent University, Turkey, and B.Sc. Degree in Industrial Engineering at METU, Turkey.

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Electric Power

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