Impact of the Clean Power Plan
Annual Energy Outlook 2016 Reference/Alternative Cases

Energy Bar Association
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by
Thaddeus J. Huetteman, Team Lead, Electricity Analysis
Overview: Impact of Clean Power Plan

• Key conclusions: range of potential impacts of Clean Power Plan (CPP)

• Logic behind Clean Power Plan (CPP) implementation

• Projected impact of CPP on:
  – Electric sector CO2 emissions
  – Electricity sales
  – Generation mix
  – Regional shifts in generation
  – Generating capacity additions/retirements

• Pollution control retrofit updates

• Caveat: AEO2017 scheduled to be released January
Key conclusions: variety of potential impacts of Clean Power Plan (CPP) in AEO2016- Reference Case vs. Alternatives

- How the states implement the Clean Power Plan influences its impact on the power sector

- CO2 emission reduction requirements under Clean Power Plan accelerate a shift in generation mix already underway

- Pressure on coal continues even in absence of Clean Power Plan, leading to natural gas as predominant utility fuel

- Significant level of coal retirements expected even without CPP
Logic behind Clean Power Plan (CPP) implementation in AEO2016 Reference case

• Familiarity: selected mass-based as apparent preferred option

• Uniformity: all states assumed to follow same program type

• Avoid regulatory pitfalls: applied budgets covering existing units and new source complement (no “leakage”)

• Minimize rate impacts: assumes allocation to load-serving entities
# How states choose to implement CPP influences its impact on power sector

<table>
<thead>
<tr>
<th>Case</th>
<th>What type of target to set?</th>
<th>What level of cooperation w/ other states?</th>
<th>To whom to allocate CO2 allowances?</th>
<th>General impact vs. Reference</th>
<th>Avg retail electricity price impact per yr vs No CPP 2022-2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>Mass</td>
<td>Intra-regional (EMM level)</td>
<td>Load-serving entities</td>
<td>N/A</td>
<td>2.8%</td>
</tr>
<tr>
<td>No CPP</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Stable coal generation</td>
<td>N/A</td>
</tr>
<tr>
<td>CPP Rate</td>
<td>Rate</td>
<td>Intra-regional</td>
<td>N/A</td>
<td>More renewable generation</td>
<td>2.9%</td>
</tr>
<tr>
<td>CPP Interregional Trading</td>
<td>Mass</td>
<td>Inter-regional (Interconnect level)</td>
<td>Load-serving entities</td>
<td>More renewable generation, fewer coal retirements</td>
<td>2.5%</td>
</tr>
<tr>
<td>CPP Allocation to Generators</td>
<td>Mass</td>
<td>Intra-regional</td>
<td>Generators</td>
<td>Higher electricity prices</td>
<td>4.3%</td>
</tr>
<tr>
<td>CPP Extended</td>
<td>Mass</td>
<td>Intra-regional</td>
<td>Load-serving entities</td>
<td>More coal retirements, gas, renewables</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

**Source:** EIA, Annual Energy Outlook 2016
By 2040, CPP electric sector CO2 emissions are 32-36% below the 2005 level vs. a 19% reduction in No CPP and 45% drop in Extended case

Source: EIA, Annual Energy Outlook 2016
CPP increases retail electricity prices between 4% - 7% in 2030 due to higher fuel and capital costs and allowance treatment

average electricity price
2015 cents per kilowatthour

Source: EIA, Annual Energy Outlook 2016
Electricity demand is 2% lower in 2030 in the Reference case than in the No CPP case, reflecting both CPP compliance actions and higher prices.

Source: EIA, Annual Energy Outlook 2016
CPP reduces coal- and increases renewable and gas-fired generation; mass-based standards result in more gas and less renewables vs. rate-based targets

Cumulative difference from No Clean Power Plan case, 2016-40 trillion kilowatthours

<table>
<thead>
<tr>
<th></th>
<th>AEO Reference case</th>
<th>CPP Rate case</th>
<th>CPP Interregional Trading Case</th>
<th>CPP Extended case</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural gas</td>
<td>2.6</td>
<td>4.5</td>
<td>3.4</td>
<td>3.5</td>
</tr>
<tr>
<td>renewables</td>
<td>2.9</td>
<td>-6.0</td>
<td>1.1</td>
<td>3.4</td>
</tr>
<tr>
<td>coal</td>
<td>-7.2</td>
<td>-6.0</td>
<td>-6.0</td>
<td>-8.6</td>
</tr>
</tbody>
</table>
CPP reduces coal- and increases renewable and gas-fired generation; mass-based standards result in more gas and less renewables vs. rate-based (cont. ’)}
Low- and zero-emitting generating capacity grows more rapidly under rate- vs. mass-based programs; little change in coal retirements
91 GW of pollution controls added due to MATS from January 2015-May 2016, majority in the form of ACI

Total coal capacity (GW)
299 GW Jan 2015
272 GW May 2016

Pollution controls added January 2015-May 2016
- activated carbon injection: 77.6 GW
- baghouses and SCR: 17.4 GW
- sorbent systems: 17.0 GW
- scrubbers: 12.9 GW
- other compliance strategies: 8.3 GW

Several plants added multiple systems to comply with MATS

Source: EIA 860
Gas generation falls through 2021; both gas and renewable generation surpass coal by 2030 in the Reference case, only gas does in No CPP case.

**Source:** EIA, Annual Energy Outlook 2016
Regional implications of Clean Power Plan (CPP) in AEO2016-Reference Case vs. Alternatives

- Coal-dependent regions have greater reduction requirements and larger shifts in generation mix
  - while lower-emitting regions are generally expected to increase power imports and in mass-based programs, make additional allowance sales.

- Some regions have apparent advantages relative to others, including higher renewable resource quality

- These interregional differences affect calculation of regional cost impacts but are unlikely to be significant at a national level
Flexibility under Clean Power Plan shifts emission reductions between lower and higher emitting regions.

[Bar chart showing CO2 Emission Reductions by Region vs No CPP (million short tons).]

- **AEO 2016 Reference Case**
  - Higher-emitting regions: (242) million short tons
  - Mid-range regions: 6 million short tons
  - Lower-emitting regions: (186) million short tons

- **CPP Trading Case**
  - Higher-emitting regions: (169) million short tons
  - Mid-range regions: 6 million short tons
  - Lower-emitting regions: (184) million short tons

**Net power exports: lower to higher emitting regions**

- Higher-emitting regions
- Mid-range regions
- Lower-emitting regions

**Net allowance sales: lower to higher emitting regions**
Contact Information

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Credit Implications for Coal Generators

Andy DeVries, CFA
adevries@creditsights.com

Greg Jones
gjones@creditsights.com
California Insurance Commissioner’s Coal Divestiture Policy

- Called for Insurance Companies to divest of utilities that source 30% of generation from coal power
- Potential Selling pressure on coal heavy utilities/IPPs
- Potentially increases cost of capital for coal heavy utilities
- Utilities are responding, SO, DUK, and DTE all announcing coal retirements/renewable/gas investments

Source: SNL, EIA
Case Study: FirstEnergy Solutions ~60% Generation from Coal

- Nearly all of FirstEnergy Solutions generation comes from coal or nuclear power plants

- FES fleet sits directly on top of cheap Marcellus shale gas in PA & Ohio

- Parent Company announced it would not support the Genco w/equity

- Coal Plant $/kW valuations (~$100-150/kW) based on recent M&A deals show FES assets don’t cover debt outstanding and imply write downs ahead or worse

- 3Q16 earnings call (last Friday) FE mentioned bankruptcy as an option for FES
FirstEnergy: Market Ignoring $1.8bn of Putable Muni Bonds?

We saw a disconnect between FirstEnergy Solutions (FES) backed muni bonds @ 85 – Par vs its corporate bonds @ 64-75c

$2.3 bn of muni bonds guaranteed by FirstEnergy Solutions will be put back or mature from 2017-2022

FES has been externally financing (rolling) the cash demands required to fund these put backs. (we confirmed w/ DTC)

During 3Q16 $470 million of munis were put back to FES

All of this summer’s put backs were remarketed but at EEI FE acknowledged remarketing as an incremental risk.
FirstEnergy Solutions Bonds Plummet, Low Coal $/kW Valuation

FES 2039s
FirstEnergy Solutions Bonds Plummet Low Coal Valuations

FES 2021s
Talen Energy: Coal Operator LBO’ed by PE Partner

- PPL mgmt spun out merchant generation unit into TLN
- TLN became a mainly coal/nuclear IPP
- Majority of generation foot print sits on top of Marcellus shale
- TLN equity dropped over 70% from spin off date
- PPL looked like the smartest mgmt team vs peer group
- The market quickly considered TLN subscale and highly exposed to nat gas prices
- 35% PE owner Riverstone LBO’ed TLN for no money down
Talen Energy Mainly Coal Operator LBO’ed by PE Partner
Exelon: We like the Parent; Avoid the LT Genco Bonds

Why are spreads so wide? (+130)
- Large Genco, 35-40% of cash flows
- Earnings decline @ Genco (table below, somewhat offset by contango pricing)

<table>
<thead>
<tr>
<th>Gross Margin Category (SM)</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Gross Margin (including South, West &amp; Canada hedged GM)</td>
<td>$4,450</td>
<td>$5,350</td>
<td>$5,800</td>
</tr>
<tr>
<td>Mark-to-Market of Hedges</td>
<td>$2,650</td>
<td>$1,150</td>
<td>$400</td>
</tr>
</tbody>
</table>

- Retiring nukes: cash ↓ earnings ↑
- Large holdco debt (~24%)
- EXC-Gen deleveraging pushed back

CreditSights View
- Continued negative headlines on the nuclear closures
- Lower Genco earnings offset by growing regulated so parent okay
  - Watch Pepco rate cases for closing ROE gap
- Utility opcos all fine but not much yield
- EXC-Gen near-term bonds (17s, 19s, 20s) are fine; 5% Yield on long bonds is nuts
Bull Case

- ~70% of 180 GW PJM market is coal/nuke and “vast majority” unprofitable right now (DYN CEO, biased); should lead to significant retirements

- Next auction is full capacity performance, so losing 10 GW of supply from demand response

Bear Case

- Actual retirements are minimal, Texas has $3-5/MWh cheaper prices and even those aren’t seeing retirements

- New combined cycle gas continues to be built; 23 GW by 2020, 15 already under construction

- Previous auction had highest reserve margin ever: 22% for 2019/20

CreditSights View: We are in the bear-camp, even with the last auction down 40% to $100/MWd

Nobody is actually retiring significant net generation and nuke bailout potential (6 GW) hurt the bull-case

### PJM Power Combined-Cycle Gas (CCGT) Under Construction

<table>
<thead>
<tr>
<th>Power Plant</th>
<th>Unit Nameplate Capacity (MW)</th>
<th>Year Unit in Service</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caithness Moxie Freedom</td>
<td>1,050</td>
<td>2018</td>
<td>PA</td>
</tr>
<tr>
<td>Carroll County Energy Center</td>
<td>700</td>
<td>2017</td>
<td>OH</td>
</tr>
<tr>
<td>Cove Point LNG Terminal (CC)</td>
<td>222</td>
<td>2017</td>
<td>MD</td>
</tr>
<tr>
<td>CPV St. Charles Energy</td>
<td>725</td>
<td>2017</td>
<td>MD</td>
</tr>
<tr>
<td>Greensville Power Station</td>
<td>1,588</td>
<td>2018</td>
<td>VA</td>
</tr>
<tr>
<td>Lackawanna Energy Center</td>
<td>1,480</td>
<td>2018</td>
<td>PA</td>
</tr>
<tr>
<td>Lordstown Generating Station</td>
<td>940</td>
<td>2018</td>
<td>OH</td>
</tr>
<tr>
<td>Middletown Energy Center</td>
<td>475</td>
<td>2018</td>
<td>OH</td>
</tr>
<tr>
<td>Oregon Clean Energy Project</td>
<td>869</td>
<td>2017</td>
<td>OH</td>
</tr>
<tr>
<td>Panda Hummel Station</td>
<td>1,124</td>
<td>2017</td>
<td>PA</td>
</tr>
<tr>
<td>PSEG Keys Energy Center</td>
<td>755</td>
<td>2018</td>
<td>MD</td>
</tr>
<tr>
<td>Sewaren Gas Power Plant</td>
<td>540</td>
<td>2018</td>
<td>NJ</td>
</tr>
<tr>
<td>St. Joseph Energy Center</td>
<td>703</td>
<td>2018</td>
<td>IN</td>
</tr>
<tr>
<td>Stonewall Combined-Cycle</td>
<td>778</td>
<td>2017</td>
<td>VA</td>
</tr>
<tr>
<td>Westmoreland Generating ST</td>
<td>925</td>
<td>2018</td>
<td>PA</td>
</tr>
<tr>
<td>Wildcat Point Generation</td>
<td>1,000</td>
<td>2017</td>
<td>MD</td>
</tr>
<tr>
<td>York 2 Energy Center</td>
<td>874</td>
<td>2017</td>
<td>PA</td>
</tr>
<tr>
<td><strong>Total (MW)</strong></td>
<td><strong>14,748</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Texas: New Wind + Solar > Coal Plant Retirements

- ERCOT wind, solar, gas additions by 2018:
  - *Wind*: 7-11 GW (19-30 million MWh)
  - *Solar*: 2 GW (3.5 million MWh)
  - *Gas - CCGT*: 1 GW (5.5 million MWh)

- ERCOT at-risk *coal* retirements:
  - 6.2 GW (25.5 million MWh)

- This equates to at least 2.5~8 million MWh of excess generation

- **CreditSights View**: Coal plant retirement bull-case is overstated
California: Utility Scale Solar

### 2017 Peak / Off Peak Spreads

<table>
<thead>
<tr>
<th>Region</th>
<th>$/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT North</td>
<td>15.25</td>
</tr>
<tr>
<td>Houston</td>
<td>16.00</td>
</tr>
<tr>
<td>PJM East</td>
<td>14.35</td>
</tr>
<tr>
<td>PJM West</td>
<td>13.60</td>
</tr>
<tr>
<td>Calif.</td>
<td>4.85</td>
</tr>
</tbody>
</table>

Coming Soon to a Power Mkt Near You (e.g. NEE CFO 1Q16 call comments)

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May 2013

May 2016
Best U.S. solar resources are in the Southwest...

...Germany and Japan have highest solar installations however, solar irradiation is comparable to Maine and Alaska.

Utilities costs are mostly fixed, yet revenues are mostly volumetric, leading to fixed charges in solar states.

**RENEWABLE ENERGY RISES WITH THE SUN**

We are helping Arizona become the "Solar Capital of America".

Germany and Japan are among countries with highest installed solar capacity, yet have solar conditions far inferior to Arizona.

Arizona ranks 1st in the U.S. for solar electricity capacity per capita installed in 2013*

Massive Rooftop Solar Growth = “It’s a Replacement Mkt”

CreditSights View: Stagnant Load Growth + Solar Capacity Growth = Older Capacity Not Needed
Utility Scale PPA Prices Getting Competitive

Source: Berkeley Lab, DOE Sun Shot Program
State Policies Will Cont. to Drive Renewables Investment

Renewable Portfolio Standards Create Baseline Demand for Incremental Wind/Solar Generation

RPS Policies Exist in 29 States and DC
Apply to 56% of Total U.S. Retail Electricity Sales

Red = Recent revisions to target level and year
Source: Berkeley Lab
Notes: In addition to the RPS policies shown on this map, voluntary renewable energy goals exist in a number of U.S. states, and both mandatory RPS policies and non-binding goals exist among U.S. territories (American Samoa, Guam, Puerto Rico, U.S. Virgin Islands)

Politicians Overwhelmingly Strengthen RPS Targets When They Get The Chance

RPS-Related Bills Introduced and Enacted in 2016

<table>
<thead>
<tr>
<th></th>
<th>Strengthen</th>
<th>Weaken</th>
<th>Neutral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduced</td>
<td>37</td>
<td>9</td>
<td>32</td>
<td>78</td>
</tr>
<tr>
<td>Enacted</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

Data Source: EQ Research
Notes: Includes legislation from 2016 sessions and from 2015-2016 sessions active in 2016, as well as pre-filed legislation for 2017. Companion bills in both chambers are counted as a single bill.

Source: Berkeley Lab
Only 57% of Renewables Growth from State Mandates

Source: Berkeley Lab
Burgeoning Voluntary Mkt for Renewables

Source: Rock Mountain Institute
CreditSights View: Mostly debt funded acquisitions driven by management teams taking advantage of low rates and hit to their stock if/when rates rise

Also driven by solar fears as mgmt teams seek gas LDCs, with no risk from solar
  • Mgt denials in trade pub interviews
IPP Bondholder Positives / Fully in Consensus

- Hard assets with strong capacity factors
- Simple business model; used by most of the country every day; recession proof
- Actual free cash flows (FFO/debt ~13%, (CFO – capex)/debt ~5%)
- No large maturities until 2018-20
- Strong recoveries in prior bankruptcies until TXU in 2014
- PowerGen investors universally bullish on 2017/18 gas prices

<table>
<thead>
<tr>
<th>IPPs: Free Cash Flow -- CFO less Capex</th>
<th>LTM, $ in mil.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CFO</td>
</tr>
<tr>
<td>Calpine</td>
<td>964</td>
</tr>
<tr>
<td>Dynegy</td>
<td>432</td>
</tr>
<tr>
<td>NRG Energy</td>
<td>1,724</td>
</tr>
<tr>
<td>Talen Energy</td>
<td>743</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IPPs, Free Cash Flow -- FFO less Capex</th>
<th>FFO</th>
<th>Capex</th>
<th>FCF</th>
<th>FCF / Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calpine</td>
<td>1,186</td>
<td>(509)</td>
<td>677</td>
<td>6%</td>
</tr>
<tr>
<td>Dynegy</td>
<td>367</td>
<td>(390)</td>
<td>(23)</td>
<td>0%</td>
</tr>
<tr>
<td>NRG Energy</td>
<td>2,049</td>
<td>(1,322)</td>
<td>727</td>
<td>4%</td>
</tr>
<tr>
<td>Talen Energy</td>
<td>1,126</td>
<td>(441)</td>
<td>685</td>
<td>16%</td>
</tr>
</tbody>
</table>

**IPP Average** 6%

*FFO here is after interest exp. and before working cap.*
CreditSights View: There is no margin of safety for the wind/solar/solar threat; EV/EBITDA <7.5x vs. leverage at >6x

Any upside goes directly to equity holders; strong historical basis for this view
Forward Power is Disconnecting from Rise in Gas Prices

Summer 2016 peak demand but lack of price spikes finally showing market the power of renewables
- CPN/DYN down 30-40% since Spring

2017 Forward Power Price Summary

<table>
<thead>
<tr>
<th>Region</th>
<th>Current</th>
<th>4 Week</th>
<th>YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT North</td>
<td>30.50</td>
<td>7%</td>
<td>12%</td>
</tr>
<tr>
<td>Houston</td>
<td>32.25</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>PJM East</td>
<td>35.55</td>
<td>2%</td>
<td>-9%</td>
</tr>
<tr>
<td>PJM West</td>
<td>34.10</td>
<td>2%</td>
<td>-3%</td>
</tr>
<tr>
<td>Calif.</td>
<td>34.35</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Avg.</strong></td>
<td><strong>4%</strong></td>
<td><strong>4%</strong></td>
<td><strong>6%</strong></td>
</tr>
</tbody>
</table>

2017 Peak Power Prices

<table>
<thead>
<tr>
<th>Region</th>
<th>Current</th>
<th>4 Week</th>
<th>YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT North</td>
<td>37.00</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Houston</td>
<td>39.35</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>PJM East</td>
<td>43.10</td>
<td>2%</td>
<td>-10%</td>
</tr>
<tr>
<td>PJM West</td>
<td>41.10</td>
<td>2%</td>
<td>-2%</td>
</tr>
<tr>
<td>Calif.</td>
<td>36.80</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Avg.</strong></td>
<td><strong>4%</strong></td>
<td><strong>4%</strong></td>
<td><strong>2%</strong></td>
</tr>
</tbody>
</table>

2017 Offpeak Power Prices

<table>
<thead>
<tr>
<th>Region</th>
<th>Current</th>
<th>4 Week</th>
<th>YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCOT North</td>
<td>24.75</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Houston</td>
<td>26.05</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>PJM East</td>
<td>29.00</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>PJM West</td>
<td>27.95</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Calif.</td>
<td>31.25</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Avg.</strong></td>
<td><strong>5%</strong></td>
<td><strong>5%</strong></td>
<td><strong>3%</strong></td>
</tr>
</tbody>
</table>

Natural gas prices

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>4 Week</th>
<th>YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-month strip</td>
<td>3.40</td>
<td>8%</td>
<td>36%</td>
</tr>
<tr>
<td>2017 Strip</td>
<td>3.41</td>
<td>8%</td>
<td>22%</td>
</tr>
<tr>
<td>2018 strip</td>
<td>3.09</td>
<td>4%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: Bloomberg, CreditSights

Marcellus gas continues to crush PJM (Mid-Atlantic) coal and nuclear plant economics; recent DYN/IPH debt concessions were under $100/KW
CO₂ Regulations and Coal

PRESENTED TO
Energy Bar Association - Ongoing Climate Imperative

PRESENTED BY
Metin Celebi

November 10, 2016
Agenda

CO₂ Regulations in U.S.

Market Developments

Coal Generation Trends

Coal Plant Retirements

Coal Industry Bankruptcies
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 additional environmental regulations (mainly CO₂ standards, but also Regional Haze and tightening emission standards for criteria pollutants such as NOx and SO₂) will continue to challenge coal generation and mining industry, with possible upside from increasing gas prices.

![Coal Generation](#)

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal Generation (Million MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2,000</td>
</tr>
<tr>
<td>2011</td>
<td>1,500</td>
</tr>
<tr>
<td>2012</td>
<td>1,000</td>
</tr>
<tr>
<td>2013</td>
<td>500</td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>0</td>
</tr>
</tbody>
</table>

![Coal Plant Retirements](#)

<table>
<thead>
<tr>
<th>Year</th>
<th>GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>20</td>
</tr>
<tr>
<td>2013</td>
<td>30</td>
</tr>
<tr>
<td>2014</td>
<td>40</td>
</tr>
<tr>
<td>2015</td>
<td>60</td>
</tr>
</tbody>
</table>

Largest Coal Bankruptcies (Market Share in 2015)

- Peabody (2016): 23%
- Arch Coal (2016): 15%
US 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/tonne
  - Small emissions reductions to date
  - Expected to become more stringent post 2020
  - Complementary policies: RPS, EE
- Regional Greenhouse Gas Initiative (RGGI)
  - In 7th year of operation
  - 6/16 auction clearing price of $4.53/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.

Regional CO₂ markets form alternatives to CPP as well as potential implementation templates
CPP National Rate Targets, by Year

- The Final (8/15) CPP goals have a larger effect on coal from the start
- Compliance assumes “beyond the plant fence” measures and credit trading

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

- 2012 US Avg Fossil Steam Rate
- 2012 US Avg NGCC Rate
- Annual Fossil Steam Rate
- Annual NGCC Rate
CPP State Rate Standards from 2012 Baseline to 2030 Final

Rate reductions are phased-in from 2012 Baseline to 2030 goals. The largest reductions are in MT, ND and WY, while some others such as ME, CT, ID, CA and MS are already in compliance with 2022 goals.
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

Source: Historical spot prices and 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 near-term prices over the past few years
  - Deep shale reserves and low offtake capacity
  - Mothballed wells available for reopening will keep prices low
- Forward price curve has dipped, now almost flat over coming decade

**Average Annual Gas Spot and Futures Prices, 2008 – 2028**

Source: Historical natural gas spot prices from SNL Energy; futures as of October 2016 from SNL Energy (sourced from NYMEX) and AEO 2016 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.

**U.S. Electricity Demand Growth**
Underlying Causes: Gas, Growth, Renewables (III)

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
- 2015: 4,080 TWh

% of U.S. Net Summer Capacity by Technology

- 2015: 1,041 GW
- 2030: 1,091 GW

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 AEO2016 projections (w/o CPP) already show considerable displacement of coal capacity and lots of renewables:

With CPP, EIA projects 30 GW less coal and 40 GW more renewables by 2030.
Coal Plant Retirements

As of August 2016, 54 GW of coal fleet has either retired or announced to retire by 2020

- 39 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)
- With CPP, an additional 15 GW by 2020 and 24-33 GW by 2030.

EIA’s AEO2016 analysis:

- 87 GW coal retirements by 2020 and another 5 GW by 2030 with no CPP
- About 130 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>101</td>
<td>13,899</td>
</tr>
<tr>
<td>2016</td>
<td>45</td>
<td>6,455</td>
</tr>
<tr>
<td><strong>2012-2016</strong></td>
<td><strong>319</strong></td>
<td><strong>39,041</strong></td>
</tr>
<tr>
<td><strong>Announced</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>10</td>
<td>1,729</td>
</tr>
<tr>
<td>2017</td>
<td>31</td>
<td>6,654</td>
</tr>
<tr>
<td><strong>2016-2017</strong></td>
<td><strong>41</strong></td>
<td><strong>8,382</strong></td>
</tr>
<tr>
<td>2018</td>
<td>18</td>
<td>3,477</td>
</tr>
<tr>
<td>2019</td>
<td>14</td>
<td>2,143</td>
</tr>
<tr>
<td>2020</td>
<td>10</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>Total 2012-2020</strong></td>
<td><strong>402</strong></td>
<td><strong>54,243</strong></td>
</tr>
</tbody>
</table>

Projected Coal Plant Retirements
Impact of SCOTUS CPP Stay on Coal

- Coal stocks jumped briefly after Supreme Court stay on 2/9/16...
- But market hope for coal stocks did not last long:

![Coal Stock Intraday Prices](chart)

Bankrupt as of Apr 2016
Stock price recovered to double its Feb value
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. Future coal prices: some recovery expected near-term, but beyond 2020 looks dim due to lack of load growth, renewables penetration, environmental regulations and CO₂ reduction goals.
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.

The views expressed in this presentation are strictly those of the presenter(s) and do not necessarily state or reflect the views of The Brattle Group, Inc.
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