Making Room for Coal Generation under the NSPS Rule

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Overview

• What are the cost and market parameters that would help advanced coal generation with carbon capture and storage (ADVPC-CCS) be more viable in the power markets under the new source performance standard* (NSPS)?

• Focus on investment tax credit (ITC), scenarios with and without the ITC, and:
  – ITC approach similar to renewable resources
  – Natural gas prices
  – Capital costs

• Are capacity markets structured to provide the necessary incentives for investing in high capital cost baseload capacity?

Best Sources of Emissions Reduction (BSER) for boiler generating units and integrated gasification combined-cycle (IGCC) is partial implementation of carbon capture and storage (CCS) to 1,100 lbs CO$_2$/MWh, gross output, for boilers and IGCC.

Based on the Regulatory Impact Analysis, EIA analysis and utility announcements*, “few if any” coal plants will be built in foreseeable future, and there is no expected impact on CO$_2$ emissions to 2022.

EPA suggests that new natural gas combined cycle (NGCC) will meet the standard and be the generation of choice for cost and emission reasons.

Modeling Assumptions

- **On-line year:** 2022, for all technologies, nominal dollars
- **ITC at 30% of capital cost:**
  - ITC Term is 5-years, credit realized in 2022-2026
  - i.e. $1 Billion capital cost x 30% ITC = $300 Million tax reduction (savings)
- **Financial Parameters:**
  - Cost of debt is 5%, after-tax cost of equity is 9%
  - Assume 60% debt to 40% equity, recognizing that actual costs could be lower or higher due to funding sources
- **Inflation for O&M at 2%**
- **Capital cost range based on available cost estimates**
- **Natural gas price sensitivity cases**
- **Heat rates for ADVPC-CCS and IGCC-CCS**
  - CCS On-and-off to meet 1,100 lbs CO₂/MWh
### Capital Cost Comparisons from Key Sources

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>ADVPC</td>
<td>$2,300 $/kW</td>
<td>$2,452 $/kW</td>
<td>$2,934 $/kW</td>
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<tr>
<td>ADVPC-CCS</td>
<td>$3,408 $/kW</td>
<td>$4,391 $/kW</td>
<td>$5,227 $/kW</td>
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<tr>
<td>IGCC</td>
<td>$3,101 $/kW</td>
<td>$2,969 $/kW</td>
<td>$4,400 $/kW</td>
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<tr>
<td>IGCC-CCS (Illinois #6 Case)</td>
<td>$3,682 $/kW</td>
<td>$4,086 $/kW</td>
<td>$6,600 $/kW</td>
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<tr>
<td>NGCC</td>
<td></td>
<td>$1,023 $/kW</td>
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</tbody>
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3. Updated Costs (June 2011 Basis) for Selected Bituminous Baseline Cases, NETL, August 2012. Costs are for super-critical pulverized coal and IGCC.
4. Costs are for advanced pulverized coal.
Kemper IGCC-CCS Schedule and Costs

• About 7 years from design to expected on-line date; about 5 years for construction

### Kemper IGCC-CCS

- **Installed Gross Capacity**: 582 MW
- **Total Cost**: $2,880,000 (000s)
- **Cost per kW**: $4,948 /kW
- **Current Total Cost Estimate (through May 2014)**: $5,551,600 (000s)
- **Current Cost Estimate**: $9,539 /kW

### Schedule - Overall Project

Source: Schedule and costs based on estimates in quarterly report through May 2014.
## Coal and NGCC Capital Cost Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2012 Cost, $/kW</th>
<th>Cost Esc. To 2022</th>
<th>2022 Total Finance Cost, $/kW</th>
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<tbody>
<tr>
<td><strong>ADVPC w/CCS</strong></td>
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<tr>
<td>NETL Baseline</td>
<td>$4,391</td>
<td>2.0%</td>
<td>$5,800</td>
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<tr>
<td>EIA 2014</td>
<td>$5,227</td>
<td>2.0%</td>
<td>$6,900</td>
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<tr>
<td>CCS Project Midpoint</td>
<td>$7,400</td>
<td>2.0%</td>
<td>$9,800</td>
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<td><strong>NGCC</strong></td>
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<tr>
<td>EIA 2014</td>
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<td>2.0%</td>
<td>$1,300</td>
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<tr>
<td>Growth</td>
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<td>5.5%</td>
<td>$1,700</td>
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<tr>
<td>High</td>
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<td>7.5%</td>
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Natural Gas and Coal Fuel Price Scenarios

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<tr>
<th>Scenario</th>
<th>2022 Price</th>
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<tbody>
<tr>
<td>NG High</td>
<td>$10.00</td>
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<tr>
<td>NG Growth</td>
<td>$9.00</td>
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<tr>
<td>NG Moderate</td>
<td>$8.00</td>
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<tr>
<td>NG AEO 2014</td>
<td>$6.20</td>
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<tr>
<td>Coal AEO 2014</td>
<td>$3.13</td>
</tr>
</tbody>
</table>

On-line Year Prices

Nominal $/mmBtu

2015 2017 2019 2021 2023 2025 2027 2029 2031 2033 2035 2037 2039 2041 2043 2045

NG High
NG Growth
NG Moderate
NG AEO 2014
Coal AEO 2014
As natural gas prices rise, gas generation capacity factors decrease.
Modeling Results for 2022

Outcomes for 2022 Levelized Cost of Electricity and Power Market Assumptions - No ITC

- **ADVPC-CCS**
  - $5,800/kW to $9,800/kW Capital Cost Financed
  - Levelized Cost of Electricity: $6,900/kW

- **IGCC-CCS**
  - $5,400/kW to $10,700/kW Capital Cost Financed
  - Levelized Cost of Electricity: $7,700/kW

- **NGCC**
  - $6.20/mmBtu
  - $8.00/mmBtu to $10.00/mmBtu
  - Capital Cost: $6,900/kW to $10,700/kW Capital Cost Financed
  - Levelized Cost of Electricity: $1,300/kW to $2,000/kW
Modeling Results for 2022

Outcomes for 2022 Levelized Cost of Electricity and Power Market Assumptions - with ITC

- **ADVPC-CCS**
  - $6.20/mmBtu
  - $8-9.00/mmBtu
  - $10.00/mmBtu
  - $5,800/kW to $9,800/kW Capital Cost Financed

- **IGCC-CCS**
  - $5,400/kW to $10,700/kW Capital Cost Financed

- **NGCC**
  - $1,300/kW to $2,000/kW Capital Cost Financed

Levelized Cost of Electricity, $/MWh
Status of RTO Capacity Markets

- Capacity markets provide a secondary stream of revenue for power plants in RTO markets.
- The ERCOT, MISO, PJM, and NE-ISO markets have 75-90 percent of power through self-supply and bilateral contracts:
  - Capacity markets acquire mostly marginal plants needed for reserves and peaking capacity
  - What happens to this situation when coal plants retire due to new environmental regulations?
- Predominantly marginal plants needed for reserves and peaking capacity have cleared the markets
- Incentives have not been sufficient to induce investors to build baseload (coal and nuclear) generation to enter these markets without contracts or regulated approval of capital costs.
Are Capacity Markets Structured to Enable Advanced Coal with CCS to Compete?

• Potential capacity market changes:
  – 3-year, 10-year, 20-year resource auctions for different purpose resources
  – Multi-lateral contracts as a vehicle that members of RTOs would use to subscribe to capacity commitments and spread risks to all capacity subscribers

• Would integrated resource planning (IRP) be a means to identify capacity auction generation objectives?

In addition to CCS being identified as BSER in NSPS, the IPCC and IEA has asserted CCS is needed in order to achieve GHG goals\(^1,2\).

Applying an ITC to coal generation could enable coal generation with CCS to be viable in electric power markets.

Competitive forces that could help enable coal with CCS include:
- Higher natural gas demand driving NG prices higher
- Higher demand for new NGCCs could increase capital cost growth more than for IGCC-CCS or ADVPC-CCS with R&D gained efficiencies

Identified alternative structures for capacity markets to meet the financial requirements of various resources for resource mix and diversity purposes.
- Different capacity auction commitment periods
- Multi-lateral contracts to spread risks across RTO members

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