The Future of Coal

Megan Parsons
Energy Development
Burns & McDonnell Engineering

February 16th, 2010
Design, Construction, and Permitting Schedules require several years....

......we need to think ahead!

**Drivers**
- 10-15% Demand Growth by 2020
- Many old coal units being retired

**Difficulties**
- Environmental Policy?
- Fuel Costs?
Current Baseload Generation Resources

EIA 2009 National Electric Utility

- Renewable 1%
- Natural Gas 14%
- Nuclear 18%
- Oil 1%
- Hydroelectric 10%
- Other 0%

Coal ≈ 70 % Baseload Generation

- Coal 56%

- Renewable generation represents wind, solar, biomass, MSW, and geothermal.
What Options are There?

Typical Baseload options considered today:

- Advanced Coal 600 MW
- Nuclear 1100 MW
- Natural Gas Combined Cycle 600 MW
- Woody Biomass 50 MW
- Wind w/ Natural Gas Backup 100 MW
  - 2.5 MW Wind Turbines w/ Reciprocating Engines
Generation Planning Considerations

- Electric Demand
  - Load growth, energy efficiency
- Fuel
  - Supply/Demand, forecasts, transportation, markets
- Capital and Operating Costs
  - Inflation, technology development
- Emissions Costs
- Power Market
- Regulatory Impact
- Etc...
Baseload Generation Costs

30-year Levelized Busbar Cost (2017$)

- Delivered fuel costs based on coal at $2.31/MMBtu, biomass at $5.80/MMBtu and gas at $7.32/MMBtu (2017).
- Costs based on Burns & McDonnell’s experience as an EPC contractor and publicly available information.
The Carbon Impact

30-year Levelized Busbar Cost vs Carbon Tax

- CO₂ tax applied to 90% of uncontrolled carbon emissions.
What are our COAL Options?

• Pulverized Coal (PC)
  – Low capital & operations
  – Proven, reliable
  – Advanced steam conditions

• Circulating Fluidized Bed (CFB)
  – Fuel flexibility, 100% pet coke and biomass blends
  – Units ~400 MW and smaller

• Integrated Gasification Combined Cycle (IGCC)
  – Flexibility – Coal to Gas or Power
  – Low emissions & least anticipated cost for CO2 Capture
Coal Generation Costs

30-year Levelized Busbar Cost (2017$)

- Coal costs based on coal price of $2.31 / MMBtu (2017).
- CO₂ capture equipment assumes 90% capture capability.
- Costs based on Burns & McDonnell’s experience as an EPC contractor and publicly available information.
### Historical

<table>
<thead>
<tr>
<th>Subcritical</th>
<th>Supercritical</th>
<th>Ultra-Supercritical</th>
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<tbody>
<tr>
<td>2500 psig</td>
<td>3700 psig</td>
<td>4250 psig</td>
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<td>1050 - 1100°F</td>
<td>1050 - 1125°F</td>
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### Today and Tomorrow

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Pulverized Coal Technology

PC Steam Cycle - Performance Comparison

% Improvement in Heat Rate

Operational Conditions

Base operation

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<tr>
<td>1050/1050</td>
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2520 2520 3690 3690 3690 3690 3690 4250
PC Coal Costs are Sensitive!

PC Steam Conditions Sensitivity Analysis

- **Base**
  - Subcritical
  - Supercritical
  - Ultra-Supercritical

- **Fuel +50%**
  - Subcritical
  - Supercritical
  - Ultra-Supercritical

- **$15/ton CO2**
  - Subcritical
  - Supercritical
  - Ultra-Supercritical

- **$30/ton CO2**
  - Subcritical
  - Supercritical
  - Ultra-Supercritical

- **Fuel +100%**
  - Subcritical
  - Supercritical
  - Ultra-Supercritical

Costs are Sensitive!
• Coal is a major part of our generation mix
• Pulverized Coal is low cost, proven, stable technology
• Coal technology continues to advance in efficiency
• Coal development is stalled by undecided environmental policy
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