Factors that Affect the Design & Implementation of Clean Coal Technologies in Indiana (Interim Report)

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by

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The Project Team

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Scoping Study Vision

• How emerging Clean Coal Technology (CCT) solutions can be shaped & encouraged within Indiana

• Goal to increase environmentally responsible use of Indiana coal

• Focus on electric power generation, although chemical & other byproducts also considered
Clean Coal Technology (CCT)

- CCT ≈ methods for using coal with substantially reduced environmental emissions
- Includes Integrated Gasification Combined Cycle (IGCC) with near zero emissions
- What coal-fired & combinations to include?
  - Supercritical PC (high temp & pressure)
  - Circulating Fluidized Bed (input with limestone)
  - Flue Gas Recycling (using & concentrating effluent)
Difficulty of Defining CCT

Prairie State’s emissions will be one-fifth the U.S. coal plant average.
Two Dimensions

• Study considers two dimensions or issue bundles

• First is the technologies: how they work, history & maturity, preferred fuels, estimated costs, new & retrofit plants, pollution removal, reliability/availability, coke & chemical production, external R&D funding
Two Dimensions

• Second is the **Indiana environment**: Indiana coal types, utility regulation, environmental regulation & compliance, human infrastructure, electricity demand growth, legacy boiler population, power transmission network, gas transmission network, coal transportation infrastructure
Interim Report

• Summarizes Tasks 1 & 2 to collect relevant information about all the topics of both dimensions
  – As much as possible, get everything in one place

• Anticipate further interviews with experts & data search as the study proceeds

• Comments and additions from the Board are encouraged
## IGCC Cost Studies

<table>
<thead>
<tr>
<th>Tech</th>
<th>Whose Est?</th>
<th>Cap (MW)</th>
<th>CO₂ Cap?</th>
<th>Unit cost</th>
<th>Backup gasifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrained flow</td>
<td>1. Bechtel [5], [6]</td>
<td>1,000 (E-Gas)</td>
<td>No</td>
<td>$1099/ kW</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>2. EPRI [11], [12]</td>
<td>520 (E-Gas)</td>
<td>No</td>
<td>$1350/ kW</td>
<td>2 on 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>$1900/ kW</td>
<td>2 on 1</td>
</tr>
<tr>
<td></td>
<td>3. Flour [13]</td>
<td>1073</td>
<td>No</td>
<td>$1111/ kW</td>
<td>3 on 1</td>
</tr>
<tr>
<td></td>
<td>4. Harvard [14]</td>
<td>n/a</td>
<td>No</td>
<td>$1400/ kW</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>5. DOE</td>
<td>n/a</td>
<td>No</td>
<td>$1300/ kW</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 2.04c. Capital Cost and Efficiency Estimates for IGCC (near future).
## PC Cost Comparison

<table>
<thead>
<tr>
<th>Technology</th>
<th>Whose Est?</th>
<th>Capacity (MW)</th>
<th>CO₂ capture</th>
<th>Unit cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC or USC</td>
<td>1. Bechtel [15]</td>
<td>800 (SC) 600 (SC)</td>
<td>No</td>
<td>$1100/kW</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>$1950/kW</td>
</tr>
<tr>
<td></td>
<td>2. EPRI [11], [12]</td>
<td>600 (USC)</td>
<td>No</td>
<td>$1235/kW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>$2150/kW</td>
</tr>
<tr>
<td></td>
<td>3. Siemens [16]</td>
<td>600 (USC)</td>
<td>No</td>
<td>$1000/kW</td>
</tr>
<tr>
<td></td>
<td>5. DOE</td>
<td>n/a</td>
<td>No</td>
<td>$1300/kW</td>
</tr>
</tbody>
</table>

**Table 1.04d. Capital Cost and Efficiency Estimates for SC/USC-PC Plants (near future).**
EPRI Capital Cost Recap

<table>
<thead>
<tr>
<th></th>
<th>Without CO2 Cap</th>
<th>With CO2 Cap</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Super Critical</td>
<td>$1235/kW</td>
<td>$2150/kW</td>
<td>+74%</td>
</tr>
<tr>
<td>IGCC</td>
<td>$1350/kW</td>
<td>$1900/kW</td>
<td>+41%</td>
</tr>
<tr>
<td>Percent Change</td>
<td>+9.3%</td>
<td>-13.2%</td>
<td></td>
</tr>
</tbody>
</table>
Impact of Capacity Factor

Figure 1.04e. Estimated Cost of Electricity vs. Capacity Factor (no CO2 capture)

  - Levelized Fuel Prices (2003$):
    - Pittsburgh #8 Coal = $1.60/MBtu
    - Natural Gas = $5.00/MBtu

- Note: IGCC Capacity Factor without a Spare Gasifier is limited to about 82%
Impact of Coal Quality

Figure 1.03. Effect of coal quality on heat rate and capital cost
Upcoming Activities

- **Scenario Investigation**: analysis of how CCTs might evolve in the Indiana power context under alternative environmental regulation, cost & technology penetration hypotheses
- Hope to very roughly estimate implications for Indiana coal demand & electricity prices
- Also focus thinking about policy needs & research gaps
Final Report in November

• Summary of analysis to date
• **Public/Private Action Plan:** What can & should be done to enhance CCT & Indiana coal use in the state?
• **CCTR Research Plan:** What topics critical to CCT & Indiana coal use in the state require additional research?