Workshop on Gasification Technologies
June 8-9, 2004

Wabash River Coal Gasification Repowering Project Overview

Phil Amick, Technology Director - Gasification
Wabash Facility Location

Steam Turbine

Combustion Turbine

Gasification Plant

Oxygen Plant
Wabash River Coal Gasification Repowering Project

Coal / Coke → Gasification Plant → Syngas & Steam → Power Plant → Electricity

1991 Ownership

Public Service Indiana

2004 Ownership

NGC changed its name to Dynegy in June 98

NGC Corporation Purchased Destec from Dow in June 1997

Spun off from Dow in 1989, built Wabash River

Developed Technology, Proto Plants & LGTI 1973 - 1989
History Making Technology
Wabash River Energy Recognition

- Power Plant of the Year 1996 (Power Magazine)
- Power Plant Hall of Fame 2000 (Power Magazine)
- 1997 Certificate of Environmental Achievement from the National Awards Council for Environmental Sustainability
- 1998 Governor's Award for Excellence in Recycling
- Recognition in 2001 National Energy Policy
- Cover of DOE’s Study on Environmental Aspects of Gasification
- Cleanest Coal/Coke Fired Power Plant in the World
The nation is going to require significant new generation capacity in the next two decades. Depending on demand, the United States will need to build between 1,500 and 1,900 new power plants—or about one new power plant a week.


Clean Coal Technologies Up Close
The Wabash River Coal Gasification Project in Terre Haute, Indiana, is one of the cleanest, most efficient coal-burning facilities in the country. Partly funded by the Department of Energy (DOE) as part of its Clean Coal Technology Program, the 262-MW coal gasification facility is owned and operated by PSI Energy and Global Energy, Inc. Instead of being directly burned, the coal is gasified and then combusted in a combined-cycle gas turbine. This allows the coal to burn more efficiently—which means it gets more energy than a traditional plant out of the same amount of coal. The Wabash River Facility is over 20 percent more efficient than a typical coal-fired power plant.

The gasification process also allows many of the impurities in the coal to be removed before it is combusted to generate electricity. At the Wabash River project, over 99 percent of the sulfur is removed from the coal and marketed to industrial users of sulfur. Slag is also removed and is marketed to the construction industry. The plant’s design allows it to burn other fuels, such as petroleum coke.

DOE is currently working with Global Energy and other industry partners to see if the plant could also be used to co-produce chemical feedstocks and transportation fuels. Additionally, DOE and its partners are studying lessons learned from the project to design a less expensive, more efficient coal gasification facility that would be ready for commercial deployment by 2005.
WABASH RIVER REPOWERING
Wabash River Project Overview

- Coal Gasification Combined Cycle Repowering
- 262 MWe Net Output by repowering 100 MW 1953 PC Unit
- Operational since 1995
- Bituminous Coal and Petcoke, up to 7% S
- Heat Rate Improved by 20% (~ 8900 Btu/kWh HHV)
- Cleanest Coal/Coke Fired Power Plant in the World
- Highest demonstrated petcoke throughput of any gasifier
WABASH REPOWERING

Fuel Handling → Slurry Prep → Gasifier HTHR Filtration → Slag / Frit Handling

ASU → Sulfur Removal → Sulfur Recovery

GT HRSG → Water Treatment → Switch Yard → STG & Aux

Existing
WABASH RIVER IGCC PLOT ~ 20 ACRES
ADVANTAGES OF REPOWERING

INFRASTRUCTURE

• Transmission
• Coal Delivery & Handling
• Steam Turbine & Auxiliaries
• Roads, Security

PERMITTING

• River Water Cooling
• Reduced SOx, NOx, Particulates

SLIGHT CAPITAL COST REDUCTION ~ 8%
SAVED A YEAR OF DEVELOPMENT
ADVANTAGES OF REPOWERING

BUT FOR THE COMMUNITY

MORE JOBS

REDUCED EMISSIONS

STABLE ELECTRICITY COSTS

MAINTAIN TAX BASE
ENVIRONMENTALLY SUPERIOR
Wabash Air Emissions

• No Significant Particulate Emissions
  
  Dissolved solids in cooling tower drift is the most significant particulate emission in gasification.

• SOx
  
  97% - 98+% Sulfur Removal

• NOx
  
  25 ppm in 1993 permit
Solid Byproducts – not Wastes

• Sulfur - 99.99% pure
  100,000+ tons sold at Wabash

• Slag - Black, glassy sand like material
  Inert, passes TCLP & UTS
  Asphalt
  Construction backfill
  Landfill cover
Wastewater Emissions

Gasification Island Wastewater
• Mostly recycled back into slurry water
• About 150 gpm per train cycle blowdown
• Zero Liquid Discharge from Gasification Island at Wabash
## WABASH EMISSIONS COMPARISON

<table>
<thead>
<tr>
<th>Emissions, lb/MWh</th>
<th>SO2</th>
<th>NO x</th>
<th>CO</th>
<th>PM-10</th>
<th>VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1 before Repowering</td>
<td>38.2</td>
<td>9.3</td>
<td>0.64</td>
<td>0.85</td>
<td>0.03</td>
</tr>
<tr>
<td>IGCC (1999 annual average)</td>
<td>1.075</td>
<td>0.75</td>
<td>0.555</td>
<td>0.09</td>
<td>0.09</td>
</tr>
</tbody>
</table>

| Emissions Reduction TPY            | 5505| 1179 | (83)| 101  | (25)|

Comparing 100 MW PC unit running 35% availability and
262 MW IGCC running 75% availability
(5.6 X more megawatt hours produced)
REPOWERING EMISSIONS COMPARISON

SO2

NOx

Unit 1 Before Repowering
IGCC (1999 Annual Avg)

CO PM-10 VOC

Unit 1 Before Repowering
IGCC (1999 Annual Avg)
Cleanest Coal Fired Power Plant in the World

( How can he say that? )
## COAL FIRED POWER PLANT EMISSIONS

<table>
<thead>
<tr>
<th>Lb/MMBtu</th>
<th>SCPC WePower(^7)</th>
<th>PC Prairie State(^5)</th>
<th>CFB Indeck(^6)</th>
<th>IGCC WePower(^1)</th>
<th>IGCC Wabash(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>0.15</td>
<td>0.18</td>
<td>0.15</td>
<td>0.03</td>
<td>0.13(^3)</td>
</tr>
<tr>
<td>NOx</td>
<td>0.07</td>
<td>0.08</td>
<td>0.08</td>
<td>0.03</td>
<td>0.103</td>
</tr>
<tr>
<td>VOC</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.002</td>
</tr>
<tr>
<td>CO</td>
<td>0.12</td>
<td>0.12</td>
<td>0.11</td>
<td>0.03</td>
<td>0.045</td>
</tr>
<tr>
<td>PM/PM10</td>
<td>0.018</td>
<td>0.015</td>
<td>0.015</td>
<td>0.011</td>
<td>0.011</td>
</tr>
<tr>
<td>Hg (lb/10(^{12}) Btu)</td>
<td>1.12  ~ 2 estim</td>
<td>4.0</td>
<td>0.5</td>
<td>3.2(^4)</td>
<td></td>
</tr>
</tbody>
</table>

1. WePower SCPC and IGCC information from April 2003 Draft Environmental Impact Statement, Elm Road Generating Station, Volume 1, Public Service Commission of Wisconsin & Department of Natural Resources, Table 7-11, p. 157 (Pittsburgh 8 coal)
2. Wabash River Repowering Project, 1997 and 1998 average reported to IDNR, including fuel oil (Illinois 6 coal)
3. Wabash River has demonstrated 0.03 lb/MMBtu SOx, but operates nearer the 0.20 lb/MMBtu permit for economic reasons
4. Electric Utility Steam Generating Unit Mercury Test Program, USEPA, October 1999 (no controls)
5. “Project Summary for a Construction Permit Application from the Prairie State Generating Company, LLC”, Illinois Environmental Protection Agency. BOILER STACK ONLY
7. “Analysis and Preliminary Determination for the construction and Operation Permits for the proposed Construction of an Electric Generation Facility for Elm Road Generating Station”, October 2, 2003, Wisconsin Department of Natural Resources
GREENFIELD EMISSIONS COMPARISON
Based on Wisconsin DNR Air Permit

IGCC is Amine Based

SO2, NOx, CO, PM-10, VOC

lb/MMBtu

Supercritical
PC
IGCC

Hg

lb/Trillion Btu

Supercritical
IGCC

ConocoPhillips
### COAL FIRED POWER PLANT EMISSIONS

<table>
<thead>
<tr>
<th>Tons per Year</th>
<th>SCPC WePower(^1)</th>
<th>IGCC WePower(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>4331</td>
<td>1117</td>
</tr>
<tr>
<td>NOx</td>
<td>1905</td>
<td>698</td>
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<tr>
<td>VOC</td>
<td>189</td>
<td>79</td>
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<tr>
<td>CO</td>
<td>3248</td>
<td>564</td>
</tr>
<tr>
<td>PM/PM10</td>
<td>487</td>
<td>199</td>
</tr>
<tr>
<td>Hg (lb/10(^{12}) Btu)</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td>TOTAL, TPY (615 MW Basis)</td>
<td>10,160</td>
<td>3,173</td>
</tr>
</tbody>
</table>

1. WePower SCPC and IGCC information from April 2003 Draft Environmental Impact Statement, Elm Road Generating Station, Volume 1, Public Service Commission of Wisconsin & Department of Natural Resources, Table 7-11, p. 155 (Pittsburgh 8 coal)
## COAL FIRED POWER PLANT

### SOLIDS GENERATION

<table>
<thead>
<tr>
<th>Tons per year</th>
<th>SCPC WePower¹</th>
<th>IGCC WePower²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flyash</td>
<td>82,600</td>
<td></td>
</tr>
<tr>
<td>Bottom Ash</td>
<td>19,300</td>
<td></td>
</tr>
<tr>
<td>Synthetic Gypsum</td>
<td>124,400</td>
<td></td>
</tr>
<tr>
<td>Slag</td>
<td></td>
<td>100,000</td>
</tr>
<tr>
<td><strong>TOTAL, TPY</strong> (615 MW Basis)</td>
<td><strong>226,300</strong></td>
<td><strong>119,400</strong></td>
</tr>
</tbody>
</table>

1. WePower SCPC and IGCC information from April 2003 Draft Environmental Impact Statement, Elm Road Generating Station, Volume 1, Public Service Commission of Wisconsin & Department of Natural Resources, Table 7-11, p. 114 (615 MW plant)

2. WePower SCPC and IGCC information from April 2003 Draft Environmental Impact Statement, Elm Road Generating Station, Volume 1, Public Service Commission of Wisconsin & Department of Natural Resources, Table 7-11, p. 126 (515 MW plant)...sulfur not listed in this table
**SO WHY DID WISCONSIN PSC PICK SCPC?**

<table>
<thead>
<tr>
<th></th>
<th>SCPC(^1)</th>
<th>IGCC(^2)</th>
<th>IGCC(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>1385</td>
<td>1770</td>
<td>1312(^3)</td>
</tr>
<tr>
<td>$/kW EPC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Rate</td>
<td>8816</td>
<td>9200</td>
<td>8500(^3)</td>
</tr>
<tr>
<td>HHV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. WePower SCPC and IGCC information from April 2003 Draft Environmental Impact Statement, Elm Road Generating Station, Volume 1, Public Service Commission of Wisconsin & Department of Natural Resources, p. xx and p. 122

2. ibid, p. xx and p. 107

Wabash River

Still the Cleanest Coal Fired Power Plant in the World