Gasification: The Enabling Technology

State Clean Energy-Environment Technical Forum
IGCC & Carbon Storage
Part 1: Technology

James Childress
Executive Director
Gasification Technologies Council
GTC Mission

Promote greater use of gasification technologies in environmentally superior manner.

Priority Activities – Educate & Inform

Industry – customers (and their customers)

Government –
  – Federal level on national priorities & policies
  – State level officials in the U.S. affecting siting decisions for gasification-based plants
The Message: It’s Not Just IGCC

- Gasification is a commercial technology, widely used around the world and is poised for significant worldwide growth.

- IGCC cleanest coal/residue-based alternative for power generation, reducing natural gas dependency for electricity.

- Gasification also opens the way for coal to compete with natural gas and petroleum to produce value added products.  
  - Chemicals  
  - Fertilizers  
  - Fuels (pipeline gas & F-T liquids)

- Gasification adds value to U.S. coal reserves and other “distressed” fuels/feedstocks.

World Gasification Survey: Summary Operating Plant Statistics 2004

117 Operating Plants
385 Gasifiers
Capacity~45,000 MWth
Feeds
  Coal 49%, Pet. Resid. 36%
Products
  Chemicals 37%, F-T 36%, Power 19%
Growth Forecast 5% annual
Geographical Distribution of World Gasification Capacity, 2004

(MW\textsubscript{th} Equivalent)

- **Europe + Asia/Aust.:** 28%
- **Afr/ME:** 34%
- **Asia/Aust.:** 22%
- **North America:** 15%
- **C&S America:** 1%
World Gasification Capacity Growth 2000-2010

(MWth Equivalent)

Source: 2004 World Gasification Survey
U.S. Gasification Drivers

- High natural gas & petroleum prices affecting transport, power and manufacturing sectors
- Increasing demand for clean electricity from coal with expectations of CO₂ limits
- Demand for cleaner, non-petroleum fuels (refinery H₂, F-T diesel)
- Strong technology providers, alliances & guarantees (ConocoPhillips, GE Energy, Shell, Siemens)
- Federal & state financial & regulatory incentives
What is the current technological status of IGCC?

- Demos of 1990’s running in commercial mode (Wabash, Polk, Nuon)
- Polk plant first dispatched on TECO system
- Basis for plants now in development
- Latest IGCC, Negishi, fully commercial plant
What is the current technological status of IGCC/carbon capture and sequestration (CCS)?

Great Plains

Regina
Weyburn
Saskatchewan
Canada
Manitoba
USA
North Dakota
Montana
Beulah

CO₂
Pernis
USA

www.gasification.org
What are the key outstanding issues related to using carbon capture with IGCC? With geologic sequestration?

- Cost, not technology
- Suitable geologic formations
  - EOR lowest threshold + revenues
- Proven long term retention of CO$_2$/Liability
- CO$_2$ Concentration not an issue with gasification to products w/shift; done today commercially
- Issue with IGCC, “H$_2$ Ready” Turbine
  - BP Carson Refinery
What are the environmental implications of IGCC? Part 1

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>IGCC Bituminous</th>
<th>Subcritical PC Bituminous</th>
<th>Subcritical PC Subbituminous</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>0.049</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>SO(_2)</td>
<td>0.043</td>
<td>0.086</td>
<td>0.065</td>
</tr>
<tr>
<td>PM/PM(_{10})</td>
<td>0.007</td>
<td>0.012</td>
<td>0.012</td>
</tr>
<tr>
<td>VOC</td>
<td>0.0017</td>
<td>0.0024</td>
<td>0.0027</td>
</tr>
<tr>
<td>CO</td>
<td>0.03</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

All emissions in lb/MMBtu. IGCC NOx based on 15 ppmvd/15% O2 and with no SCR. An SO2 removal of 87% reflects a very low coal sulfur content (0.22%).

Source: S. Khan, U.S. EPA
What are the environmental implications of IGCC?

Part 2

<table>
<thead>
<tr>
<th>Parameter*</th>
<th>PC Plant</th>
<th>IGCC Plant</th>
<th>% less for IGCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid waste, bituminous coal, tpd</td>
<td>1,090</td>
<td>430</td>
<td>60</td>
</tr>
<tr>
<td>Solid waste, subbituminous coal, tpd</td>
<td>480</td>
<td>280</td>
<td>42</td>
</tr>
<tr>
<td>Solid waste, lignite, tpd</td>
<td>2,080</td>
<td>1,600</td>
<td>23</td>
</tr>
<tr>
<td>Plant makeup water, gpm</td>
<td>9,340</td>
<td>6,030</td>
<td>35</td>
</tr>
<tr>
<td>Wastewater discharge, gpm</td>
<td>2,910</td>
<td>1,960</td>
<td>33</td>
</tr>
</tbody>
</table>

Note: gasification slag included in solid waste; only recovered sulfur considered non waste.

Source: S. Khan, U.S. EPA
What are the environmental implications of IGCC?  
Part 3

Comparative Cost of Hg Removal

Source: U.S. DOE from industry data
What are the economic implications of IGCC and of IGCC/CCS?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>IGCC Plant</th>
<th>PC Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ capture, %</td>
<td>91</td>
<td>90</td>
</tr>
<tr>
<td>Unit output derating, %</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Heat rate increase, %</td>
<td>16.5</td>
<td>40</td>
</tr>
<tr>
<td>Capital cost increase, %</td>
<td>47</td>
<td>73</td>
</tr>
<tr>
<td>COE increase, %</td>
<td>38</td>
<td>66</td>
</tr>
</tbody>
</table>

Source: S. Khan, U.S. EPA
What are the economics of IGCC co-production (electricity & other products such as hydrogen, Fischer-Tropsch fuels)?

Value of Peabody Energy Coal reserves as...

- Coal: $288
- Electricity: $700
- SNG: $1,800
- F-T Diesel: $3,600

Source: Peabody Energy

www.gasification.org
Which Federal Agencies are facilitating R&D and implementation of IGCC?

DOE Fossil Energy R&D Program

Annual DOE Gasification Budget
(Millions of Dollars)

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY01</td>
<td>$30</td>
</tr>
<tr>
<td>FY02</td>
<td>$35</td>
</tr>
<tr>
<td>FY03</td>
<td>$38</td>
</tr>
<tr>
<td>FY04</td>
<td>$45</td>
</tr>
<tr>
<td>FY05</td>
<td>$40</td>
</tr>
<tr>
<td>FY06</td>
<td>$50</td>
</tr>
</tbody>
</table>
Which Federal Agencies are facilitating R&D and implementation of IGCC?

- EPACT -- ~$5.4 billion authorized for cost sharing, grants, investment tax credits
- 80% Loan Guarantees
- +50 cent/gallon tax credit – F-T diesel from coal
- F-T Offtake agreements with DoD?
GTC Activities Assisting States

- Resource for papers, contacts, information to state government personnel
- Workshops for state, local personnel dealing with gasification siting issues
  - Bismarck, ND. June 28-29
    - “Gasification 101”
    - Environmental Permitting Issues
    - PUC Perspectives & Approaches
    - Incentives – Financial & Regulatory
    - Expenses Reimbursed

Go to [http://www.gasification.org](http://www.gasification.org)
Questions?

For further information:  http://www.gasification.org

or

Google “gasification”

Mark your calendars

October 1-4

2006 Gasification Technologies Conference

Washington, DC
WASHINGTON, D.C.

www.gasification.org

Gasification – The Enabling Technology

Save the Dates
OCTOBER 1–4
JW MARRIOTT HOTEL

Gasification TECHNOLOGIES 2006
CONFERENCE

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