Coal Gasification
Opportunities and Challenges for India

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Gasification India: 2016
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- Need for clean coal
- Why gasification?
- Importance for India
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Need for clean coal

- Coal – prime fossil fuel in India
  - Abundant reserves
  - Vital for Energy Security

- Mostly available in low quality, high ash
- Environmental issues

Clean Coal Technologies

Beneficiation (pre combustion)
- Practical challenges in achieving desired levels
- Disposal issues

Coal Conversion
- Coal Gasification
- Coal to Liquid
Why gasification?

In order to overcome uncertain natural gas supply, unlocking domestic coal gas potential a need

- Increasing demand for natural gas in India; driven by growing economy – resurging industrial production & infrastructure development

- Current natural gas shortage estimated at 14.1 million tons; increasing dependence on imports; price volatility

- Urea shortage estimated at around 7-8 million tons
Importance for India

Government Benefits
- Savings in foreign exchange
- Revenue generation – taxes, duties, royalty, etc.
- Employment generation

Potential areas for utilization
- Urea
- Steel
- Chemical
- Refinery
- Petrochemical

Coal Gasification
Syn Gas (use as feed/ fuel)

Recent examples

<table>
<thead>
<tr>
<th>Company</th>
<th>End Use</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>JSPL</td>
<td>DRI</td>
<td>Operating</td>
</tr>
<tr>
<td>GAIL, RCF, CIL, FCIL</td>
<td>Urea</td>
<td>JV formed, initial studies underway</td>
</tr>
<tr>
<td>Adani</td>
<td>Urea, Methanol, SNG</td>
<td>MoU signed with State Governments</td>
</tr>
</tbody>
</table>

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Importance for India

Optimization of coal reserve

<table>
<thead>
<tr>
<th>Reserves (as on 1 April 2014)</th>
<th>Proved</th>
<th>Indicated</th>
<th>Inferred</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-300 m</td>
<td>96.3</td>
<td>69.5</td>
<td>10.5</td>
<td>176.3</td>
</tr>
<tr>
<td>300-600 m</td>
<td>13.6</td>
<td>58.7</td>
<td>16.5</td>
<td>88.8</td>
</tr>
<tr>
<td>0-600 m*</td>
<td>13.8</td>
<td>0.4</td>
<td>0.0</td>
<td>14.2</td>
</tr>
<tr>
<td>600 – 1200 m</td>
<td>2.2</td>
<td>13.9</td>
<td>6.1</td>
<td>22.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>125.9</strong></td>
<td><strong>142.5</strong></td>
<td><strong>33.1</strong></td>
<td><strong>301.5</strong></td>
</tr>
</tbody>
</table>

*Jharia coal field

All quantities in billion tons

- Abundant reserves
- Ranked 3rd in non coking coal and lignite ore deposits
- Potential to generate ~ 2500 m3 of syn gas per ton of coal

Technical Advantages

- Low emissions
- Low ash disposal
- Low water consumption
- Improved efficiency
- No land degradation, landscape changes
- No R&R issues
- Increased safety
- Saleable by-products
Importance for India

Captive energy resources – select economies

- Largest energy consuming economies - China, USA and India
- Both China and India have limited oil & gas reserves and large coal reserves for exploitation
- While China has invested significantly in coal gasification with more than 100 operating plants, India is under exploratory phase – only one operating plant of JSPL
China story

• Volume of coal gasified: ~ 250,000 tons per day
• More than 107 plants operating and about 40 plants to be commissioned between 2015-19 (coal consumption of 600,000 tons per day)

Coal gas based production (million tons)

<table>
<thead>
<tr>
<th>Product</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>96.3</td>
<td>66</td>
</tr>
<tr>
<td>LPG</td>
<td>13.6</td>
<td>5</td>
</tr>
<tr>
<td>DME</td>
<td>13.8</td>
<td>20</td>
</tr>
<tr>
<td>Olefin</td>
<td>2.2</td>
<td>15</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>1.7</td>
<td>NA</td>
</tr>
<tr>
<td>Oil products</td>
<td>2.4</td>
<td>30</td>
</tr>
<tr>
<td>Urea</td>
<td>60</td>
<td>NA</td>
</tr>
</tbody>
</table>

Product wise distribution of coal based plants (no. of plants)
Opportunity areas

Limited technical capabilities present domestically

Global pioneers for technology collaborations
- Technology Suppliers
- Equipment Providers
- Project Management Consultants

Project Developers/ Investors
- Collaboration/partnership for bidding jointly/in consortium for coal blocks
- Independent bidding for coal blocks
## Key challenges

<table>
<thead>
<tr>
<th>Risk Areas</th>
<th>Challenges</th>
<th>Possible Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>• Indian coal quality – high ash</td>
<td>• Investment in R&amp;D</td>
</tr>
<tr>
<td></td>
<td>• Lack of proven expertise</td>
<td>• Use of CO2 - Manufacture products which can consume CO2 e.g. Urea. Possibility of use for EOR of nearby O&amp;G fields</td>
</tr>
<tr>
<td></td>
<td>• Plant configuration challenge</td>
<td>• Sale of by products</td>
</tr>
<tr>
<td></td>
<td>• By products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CO2 emissions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Larger requirement of water &amp; land</td>
<td></td>
</tr>
<tr>
<td><strong>Financing</strong></td>
<td>• Relatively higher capital costs as compared to natural gas based projects</td>
<td>• Government support</td>
</tr>
<tr>
<td></td>
<td>• Long gestation period and development concerns</td>
<td>• Ownership of block with plant located at proximity</td>
</tr>
<tr>
<td></td>
<td>• Economic viability concerns</td>
<td>• Economies of scale</td>
</tr>
<tr>
<td><strong>Regulatory</strong></td>
<td>• Resistance to coal use</td>
<td>• Close participation of Government and Private sector required</td>
</tr>
<tr>
<td></td>
<td>• Coal blocks bidding not allowed for coal gasification</td>
<td>• Need for a separate regulatory framework</td>
</tr>
</tbody>
</table>

Though need of self reliance on energy supply is critical, price competitiveness will play a major role
Economics – key driver for coal gas developments

Indicative price gap (natural gas – coal)* (USD/ mmbtu)

- Price gap between gas and coal is higher in Asia as compared to US
- For India, which is dependent on imported LNG, the gap may be able to cover conversion cost of gasification

* Coal prices in USD/ MT converted into equivalent prices in USD/ mmbtu. Doesn’t include conversion cost of coal gasification. Prices are illustrative.

** Japan reference price
In China a Coal To Gas plant costing $630-950 million for every BCM of gas capacity estimated to breakeven at a gas price of $6.5-8 per mmbtu.
Economics – An illustration: Production of Urea

- Preliminary studies suggest cost of syn gas production from coal could be cheaper by up to 30% compared to natural gas.

- Indicative cost of production (fixed plus variable) of Urea:

  ![Graph showing the cost of production](image)

  - **UREA - COST OF PRODUCTION**

  - **Cost through coal gasification**

  - **Indicative Capital Cost (1.3 MMTPA) Urea Plant**
    - Natural gas based: USD 0.9 – 1 billion
    - Coal gas based: USD 1.2 – 1.4 billion

*Delivered washed coal cost @ ~ INR 2,000 / MT*
Way forward…

“In countries like India, there are vast opportunities for those wishing to invest in clean coal technology, since our dependence will not reduce very soon.” – Narendra Modi, Hon’ble Prime Minister of India

Given the infrastructure development needs and significant coal reserves, investment in coal gasification needs to grow in coming years ….