Energy For Sustainable Growth

Breakout Session 3: Coal Gasification

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India – Fuel Carbon Imports
(2018 data, approx.)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Import, MMT/yr</th>
<th>% C</th>
<th>Imported C, MMT/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Oil</td>
<td>220</td>
<td>85%</td>
<td>190</td>
</tr>
<tr>
<td>Coal</td>
<td>200</td>
<td>75%</td>
<td>150</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>15</td>
<td>77%</td>
<td>11.6</td>
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</tbody>
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**Demand Side Response**
- Reduce energy requirement (enhance efficiency)
- Reduce carbon requirement (non-carbon energy e.g. solar, wind, geothermal)

**Supply Side Response**
Find about 350 MMT of domestic carbon (on current basis) to replace our fuel / plastics carbon imports

*Need carbon security solutions within our control*
Indian Coal
Realizing Possibilities

- ~319 billion MT coal reserves down to 1.2 km depth (of which 149 BMT proven/measured)
- Mostly high ash, ~ 26% C, i.e. 38 billion MT C atoms (~100 years)
- Less suited to thermal power plants, but adaptable to gasification
- IGCC plants (gasification, gas turbine and waste heat steam turbine) can reduce GHG while raising power generation efficiency
- Coal utilization is associated with high GHG emissions – CCUS likely to be necessary for low-carbon commitments
- Domestic expertise exists in limited pockets but not end-to-end, and not at high TRL
- Parallel efforts worthwhile for assimilating international tech and building domestic capability
- Coupling high-ash-coal IGCC with syngas-to-methanol or syngas-to-chemicals may be a unique model for India

Coal Gasification solutions should be customized to national needs – not necessarily replicate Western models
Overview

• Objectives: Purity, Cost, Scale and Sustainability of Coal-to-Hydrogen via Gasification

• Constituent Modules: Coal preparation, Gasification, syngas clean-up and conditioning, hydrogen generation and purification, CCUS (and also ash utilization / disposal)
Success Metrics and Imperatives

• Syngas Purity: Specifications depend on application
  – Impurity profile depends on manufacturing process
  – Impurities determine cost of syngas clean-up
  – Domestic Technology available at low TRL – to scale up quickly

• Cost: Production, storage, transport
  – Blue hydrogen must ideally compete with NG-based H2
  – Value maximization for balance of Syngas

• Scale: Time bound scale up required with simultaneous alignment of Supply-side, capex, opex and demand-side considerations

• Sustainability: Coal based hydrogen requires energy integration and CCUS to offset Net GHG headwinds

• Ash disposal and other environmental impact must be factored into technology selection / project development
NITI Aayog entrusted **CSIR-CIMFR & CMPDIL** “Gasification Potential Mapping of Indian Coal” (Notification: 17/05/2018)

Completed mapping for **MCL** (13 mines, Ash: 20-46%), **CCL** (6 mines, Ash: 29-53%) and **ECL** (5 mines, Ash: 18-38%). Report submitted to **NITI Aayog** on 24th Dec, 2019

Developed Coal characterization matrix for Physico-chemical properties of coal/Ash essential for gasification.

Suggested **Matching gasification technology** vis-à-vis **Utilization pattern & gasification strategy** for gainful utilization of Indian coal resource.

**OUTCOME: Utilization Pattern & Gasification Strategy**

Inputs for selection of matching Gasifier according to coal properties.

High ash coal washing or blending with Petcoke to reduce ash content suitable for Entrained flow Gasifier (Shell) or Moving Bed gasifier (Lurgi FBDB) Gasifier.
Syngas Value Addition

How do we generate Syngas...?

How do we process Syngas..

Multi feedstock

Natural gas

Coal

Biomass

Petcoke

Multi purpose

Steam/Air/Oxygen

Reformer/Gasifier

CO₂

Syngas

LPG

Olefins

Butanol

DME

Gasoline

Diesel

Ethanol

BTX

MEG

Ethanol

Ac Acid

Power

SNG

Natural gas

Coal

Biomass

Petcoke

MSW

Multi-feed Gasification Adaptability with Multi-Product Downstream Slate Should be the Long-Term Vision
LCA and CCUS

• All projects must be rigorously assessed for effective carbon utilization, energy efficiency, carbon capture rate, CO2 emissions and environmental performance

• Any investments in demonstration units must be based on generation of sufficient real-time data at pilot scales on high-ash Indian coal

• Gasification, syngas clean-up and conditioning, hydrogen generation, CCUS and ash disposal modules should be evaluated both as independent and as integrated offerings
Thank You

Questions?