

High Ash Coal Gasification: CSIR-CIMFR's Achievement

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Road Show

Scheme of Financial Support to Surface Coal Gasification Projects

by

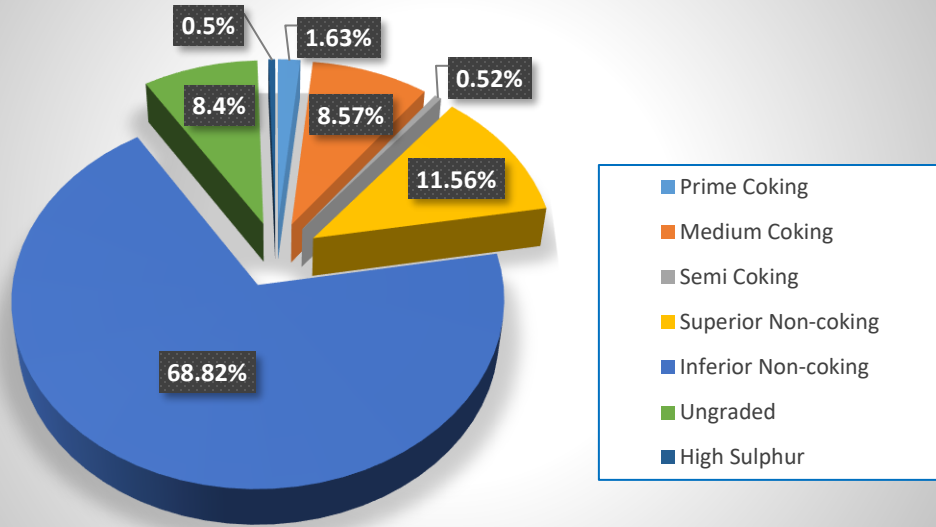
Ministry of Coal, GoI

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Hyderabad

INDIAN COAL SCENARIO

Type wise distribution of Indian coal



As on 01.04.2022

Estimated coal reserve in India is 361.41 BT (up to 1200 m)

Indian non-coking coal inventory: 185 BT (up to 300 m)

❖ Superior Grade non-coking coal: 11.73 % (G1 – G6, A + M : up to 29%)

❖ Inferior Grade non-coking coal: 84.64 % (G7- G17)

COAL & LIGNITE RESERVES IN INDIA

	Proved, BT	Indicated, BT	Inferred, BT	Total, BT
Coal	187.11 (52%)	147.25 (41%)	27.05 (7%)	361.41
Lignite	7.37 (16%)	25.72 (56%)	13.11 (28%)	46.20

COAL FIELD WISE COAL RESERVES

	Reserves Proved, BT	Coal with A+M <24%	Coal with A+M 24 - 34%	Coal with A+M >34%
ECL	22.4	11%	39%	50%
MCL	40.9	1%	5%	94%
CCL	16.8	4%	25%	71%
SECL	27.2	7%	19%	74%
WCL	9.4	5%	48%	47%

Non coking coal (A+M: 29–34 %) : 17.45% (G7 – G8)

Non-coking coal (A+M: 34-55 %) : 81.39% (G9 – G14)

Non-coking coal (A+M > 55 %) : 1.16% (G15 – G17)

❖ Ungraded non-coking coal: 3.63%

Source: MoC, Annual Report 2022-23

CSIR-CIMFR: Role in Indian Coal Gasification

- ❖ Member of NITI Aayog Technical Committee on Surface Coal Gasification (Notification Date: 19/10/2016)
- ❖ CSIR-CIMFR jointly with CMPDI was entrusted to carry out detailed analysis of the coal from potential operational mines/blocks with respect to Surface Coal Gasification (Notification Date: 17/05/2018)
- ❖ Member of Technical Expert Committee for Talcher Fertilizer Limited (TFL): (Notification Date: 14/06/2018).
- ❖ Member of Technical Standing Group for Indian Coal Gasification Mission (Notification Date: 8/05/2020)
- ❖ Nodal institution for *Resource Group for Gasification* (Ministry of Coal) (Notification Date: 3/07/2020)



GASIFICATION POTENTIAL EVALUATION & UTILIZATION STRATEGY

CSIR-CIMFR introduced coal characterization matrix considering its detailed physico-chemical properties

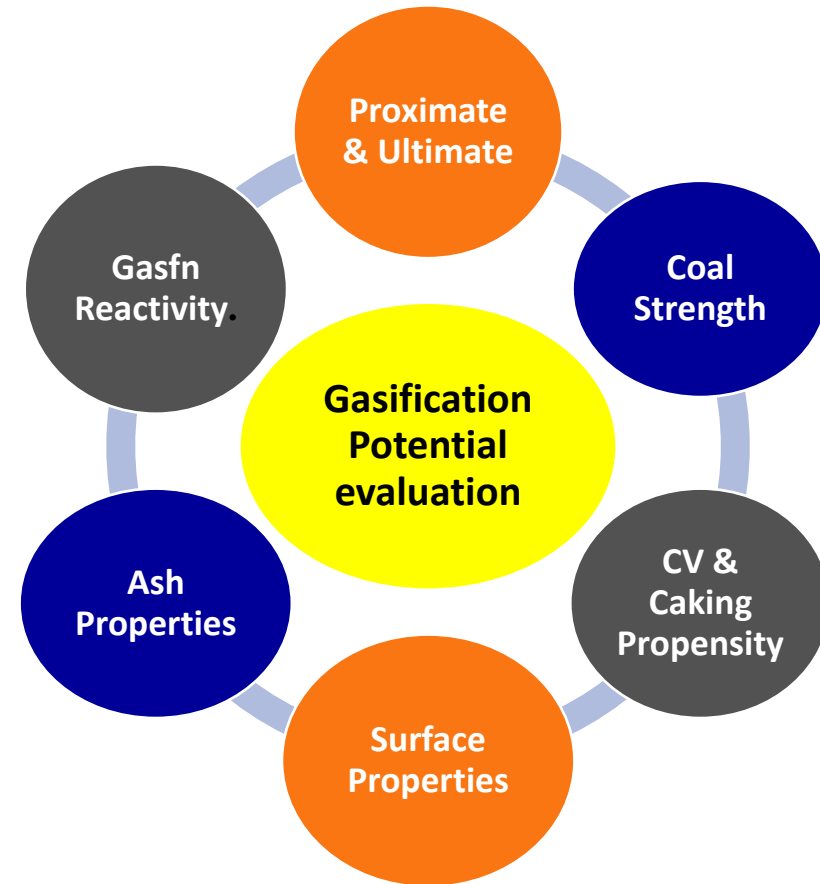
Benefits:

- Suitability of the feedstock matching with the gasifier
- Feed-specific Operational Philosophy
- Judicious utilization of Indian Coal Resource

Field implementation:

Completed Gasification potential evaluation of MCL, ECL and CCL subsidiaries and report submitted to NITI Aayog.

Targeted Coal (WCL, SECL, SCCL), Lignite and Biomass resource



CSIR-CIMFR DEVELOPMENT OF 0.5 TPD AIR BLOWN PFBG FACILITY



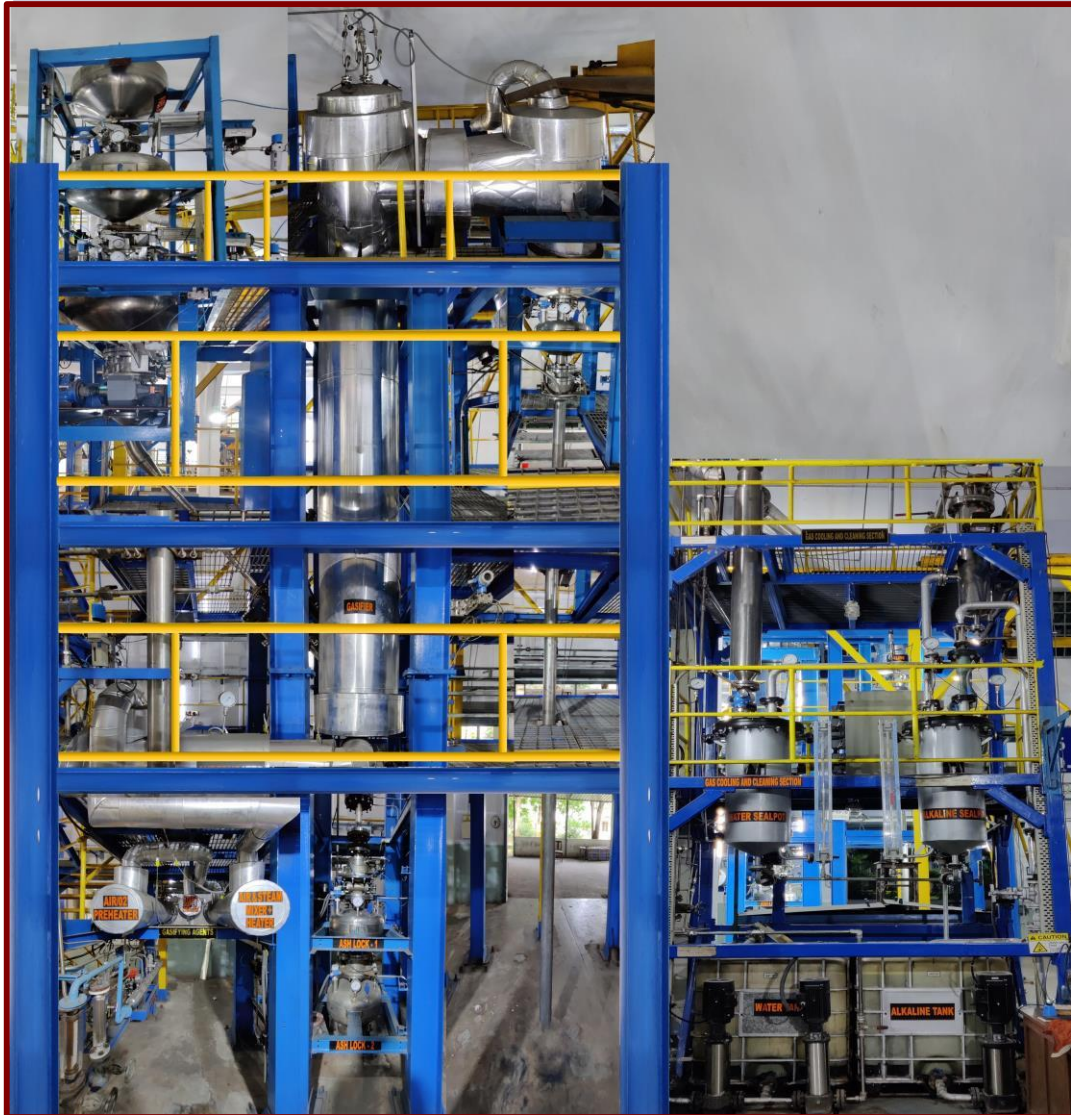
AIR BLOWN PFBG ACHIEVEMENTS

- ❖ Addressed operational issues: fuel feeding, ash agglomerates extraction
- ❖ Established operational philosophy for gasification in PFBG.
- ❖ Gasification performance of high ash coals, biomasses & blends.
- ❖ Patent No. 407551

- ❖ Electrically heated alloy reactor (TRL-5)
- ❖ Installed in 2008-09
- ❖ Fuel Feed Rate : up to 20 kg/h
- ❖ Temperature: up to 1000 °C
- ❖ Pressure : up to 3 kg/cm²

- ❖ Syngas Composition:
CO: 15-22, H₂: 15-20, CH₄: 1-2, CO₂: 10-12
- ❖ Heat Value: 1000-1200 kcal/Nm³
- ❖ Carbon Conversion: up to 93%
- ❖ Yield: 2.2-2.5 Nm³/kg of fuel

CSIR –CIMFR DEVELOPMENT OF 1.5 TPD OXY-BLOWN PFBG FACILITY

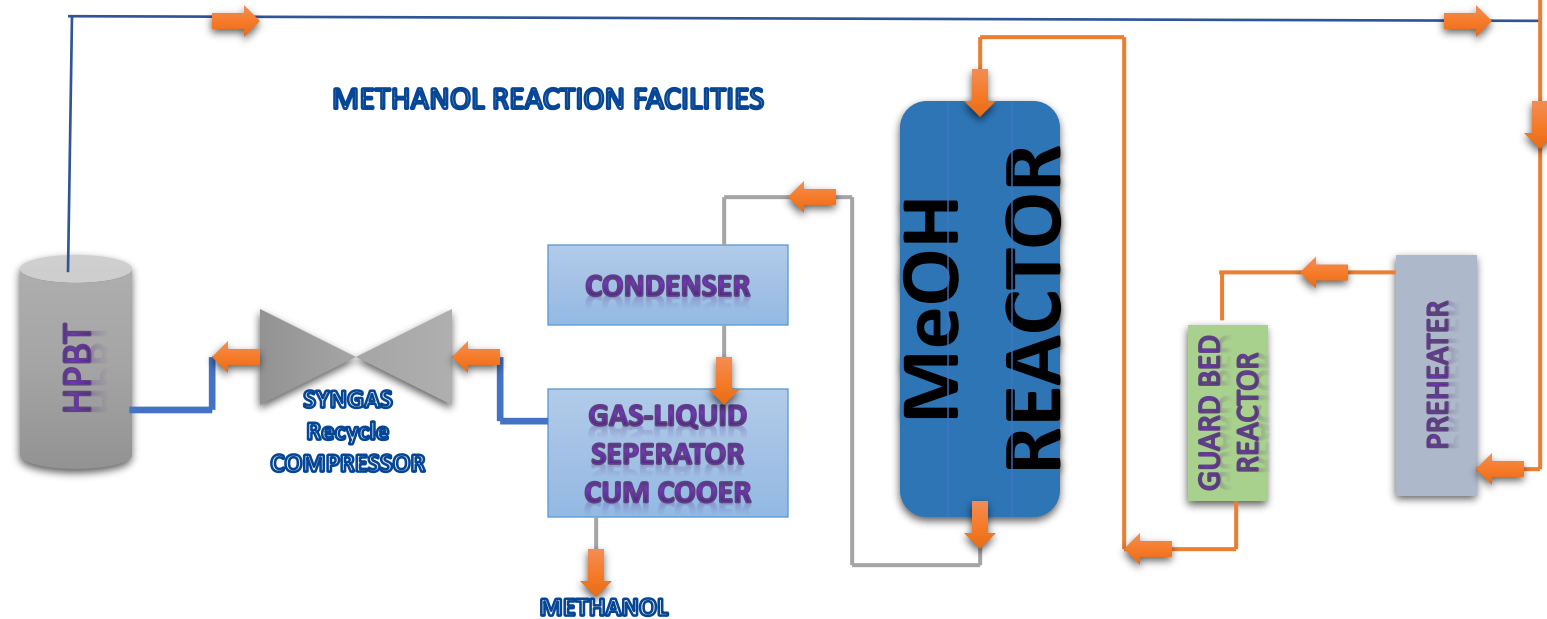
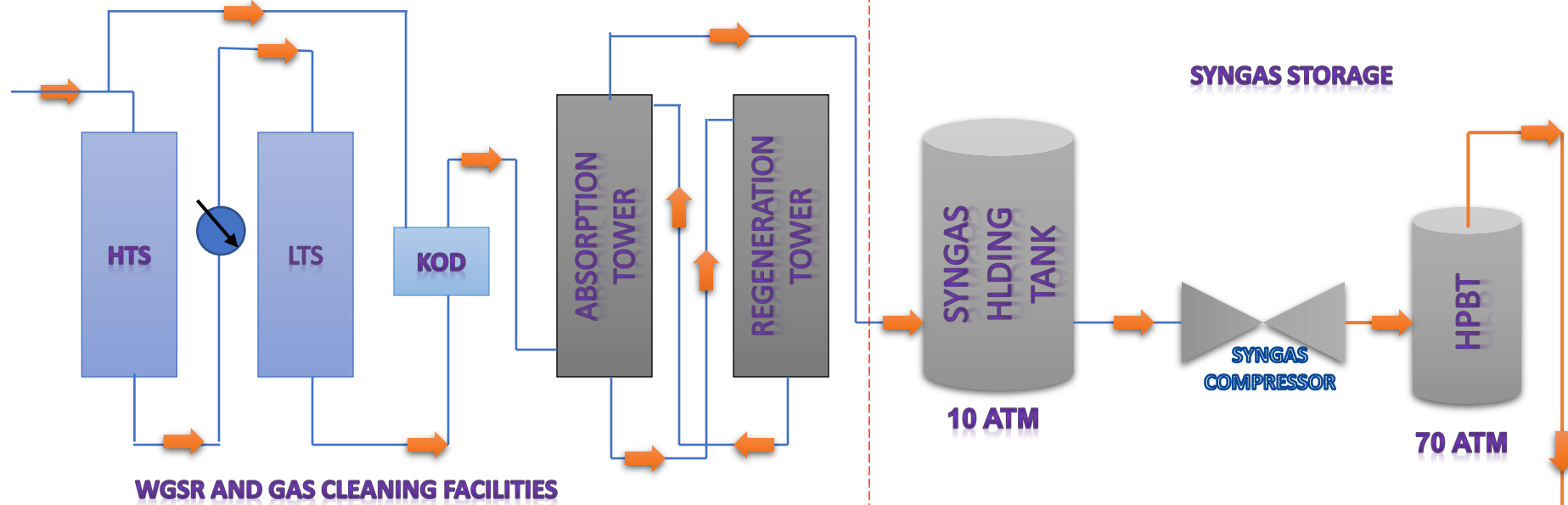


- ❖ CSIR-CIMFR design, Refractory Lined Gasifier
- ❖ Fuel Feed Rate : up to 1.5 TPD
- ❖ Gasifying Agents: Air/Oxygen & Steam
- ❖ Temperature: up to 1050 °c, Pressure : up to 10 kg/cm²
- ❖ Facility dedicated to the nation on 17/11/2020

ACHIEVEMENTS:

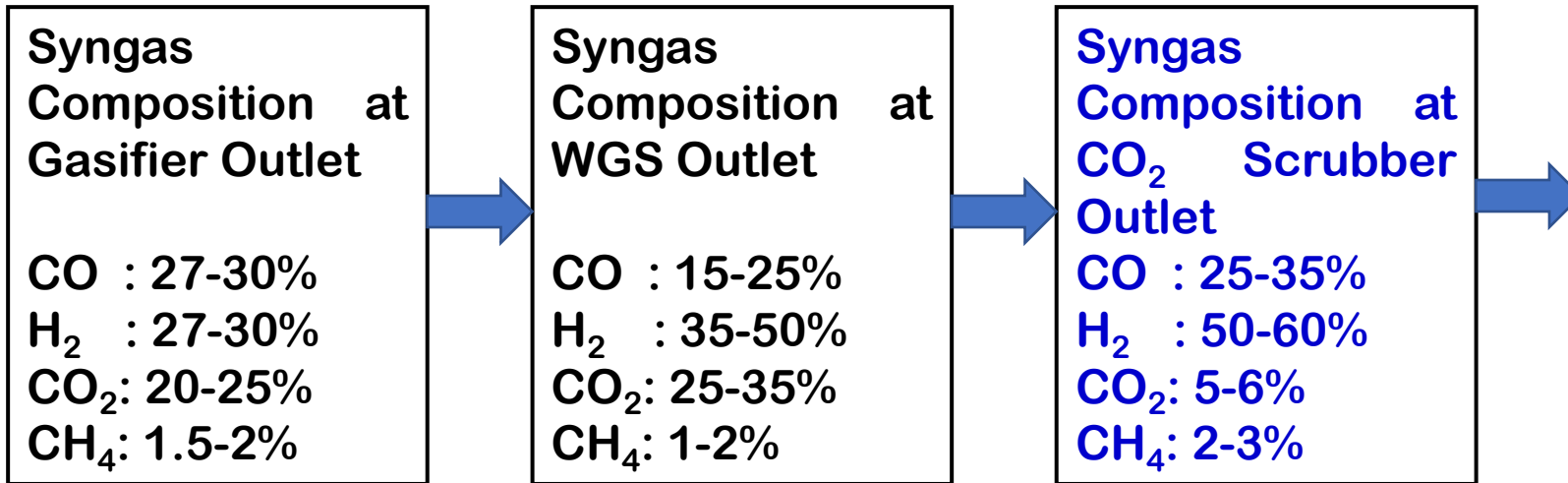
- ❖ Oxy-blown Gasification of ***MCL (Ash 36% & 42%), CCL (Ash 36%) with 92% Oxygen & Steam.***
- ❖ Cumulative operation: >500 hrs.
- ❖ Syngas Comp. Vol.%: CO: 25, H₂: 30, CH₄: 3.5, CO₂: 30,
- ❖ Carbon Conversion: >95%,
- ❖ Syngas Yield: 1.43-1.68 Nm³/kg fuel
- ❖ Patent Appl. No. 202211006577, Filing: 07/02/2022

Flow Diagram of 250 kg/day Syngas to Methanol Process AT CSIR-CIMFR



SYNGAS TO METHANOL BENCH SCALE REACTOR ACTIVITIES

- Conducted Syngas to Methanol conversion experiments in 100 ml Bench Scale Reactor
- Used Cu-Zn-Al based commercial catalyst
- Maintained syngas composition expected at the exit of WGS & CO₂ scrubber



Syngas Composition			
H ₂	CO	CO ₂	CH ₄
58	32	5.0	5.0

- Temperature: 200 -240 °C
- Pressure: 40 – 70 kg/cm²



BENCH SCALE SYNGAS TO METHANOL REACTOR

DEMO SCALE PFBG PLANT DEVELOPMENT AT STRATEGIC LOCATION

- Development of demo plant should be executed with a joint venture between R&D institutions, Engineering Houses, and Industries
- R&D Institution: CSIR institutions, IITs
- Engineering Houses: EIL R&D, Gurgaon; L&T, Mumbai; BHEL R&D, Tata R&D
- Industries: Coal producers, Fertilizer Sector, Steel Sector, Tiles/Refractory brick manufacturers, coal-based chemical and liquid/gaseous fuel producers, etc.
- All individual stakeholders have specific strengths at different levels of technology development and implementation
- Independent parallel program may not be effective.

Strategic Location

- Before going to commercial venture, demonstration plant (dedicated and retrofitted) may need significant modifications with respect to structure, components etc.
- Dedicated Demo plant location should be near to chemical industrial hub well linked to utility sectors.
- Availability of engineering components; chemical, electronic, electrical parts & IT components; skilled technical manpower
- Mine-mouth location may face difficulties during required modifications in terms of fast, effective, required responses, lead to increase in **VALUABLE TIME**, CAPEX and OPEX.
- Ideal location for Retrofitted PFBG Demo plant is methanol producing industry, such as, GNFC, Gujarat



CSIR ACTIVITIES FOR THE DEVELOPMENT OF DEMO SCALE PFBG PLANT

- Presentations are made before different Ministries to highlight the Oxy-blown PFBG Pilot Plant development & achievements related to the high ash coal/biomass gasification.
 - Detailed discussions were held in the first meeting under the chairmanship of DG, CSIR on September 21, 2021 & subsequent meetings, for a joint venture with BHEL, for the development and commissioning of a Demo Scale Gasification Plant.
 - Meeting held at NITI Aayog on October 13, 2021 for developing DPR for 300 TPD high ash coal gasification-based methanol production plant (Stakeholders- BHEL, RIL, CSIR, BHEL, Thermax, and IIT-D participated)
 - Review meetings on the ongoing Coal to Methanol (CoSynol) Program of CSIR-CIMFR under the CSIR Mission Directorate held under the chairmanship of Dr. V. K. Saraswat, Member (Science), NITI Aayog on November 17, 2021, June 7, 2022, December 8, 2022 & August 28, 2023
- Recently, Coal India signed MOU with BHEL for the implementation of the BHEL gasification technology for the Coal to Ammonium Nitrate project.

It is the right time for R&D institutions, Engineering Houses, and Industries to join hands.



Way Forward: Role of CSIR-CIMFR

- ❖ **Selection of matching Gasification Technology** using CSIR-CIMFR developed Coal Characterization Matrix and Selection Protocol
- ❖ **Adoption of the Commercially Proven Gasification Technology (EFG and MBG)**
 - ❑ Pre-processing of the feedstock to make it suitable for selected gasifier
 - ❑ Downstream processing of syngas for specific end application
 - ❑ Establishing feed-specific operational philosophy
 - ❑ Techno-economic feasibility analysis
- ❖ **Indigenous PFBG development for high-ash Indian coal**
 - ❑ **Knowledge Partner** to develop Demo-scale (100/300/500 TPD) PFBG at a strategic location
 - ❑ Establishing operational philosophy to gasify high ash coal
 - ❑ Techno-economic feasibility analysis of PFBG in comparison to EFG and MBG





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