FEASIBILITY OF IGCC TECHNOLOGY FOR POWER GENERATION USING INDIAN COAL

Coal Based Power
Confronting Environmental Challenges
March 17-18, 2016

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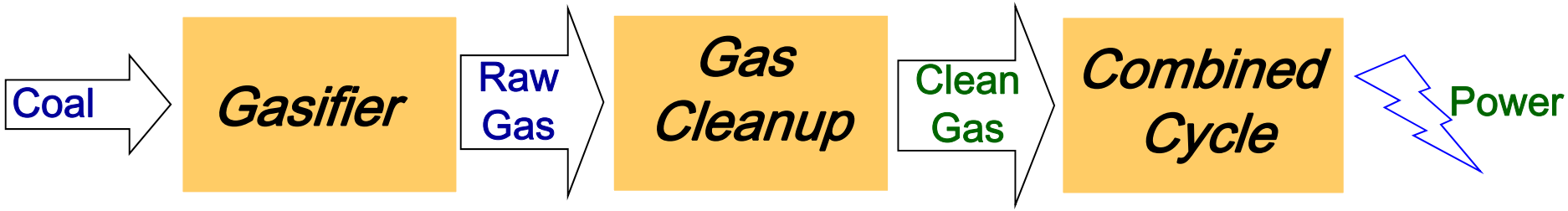
Presentation Outline

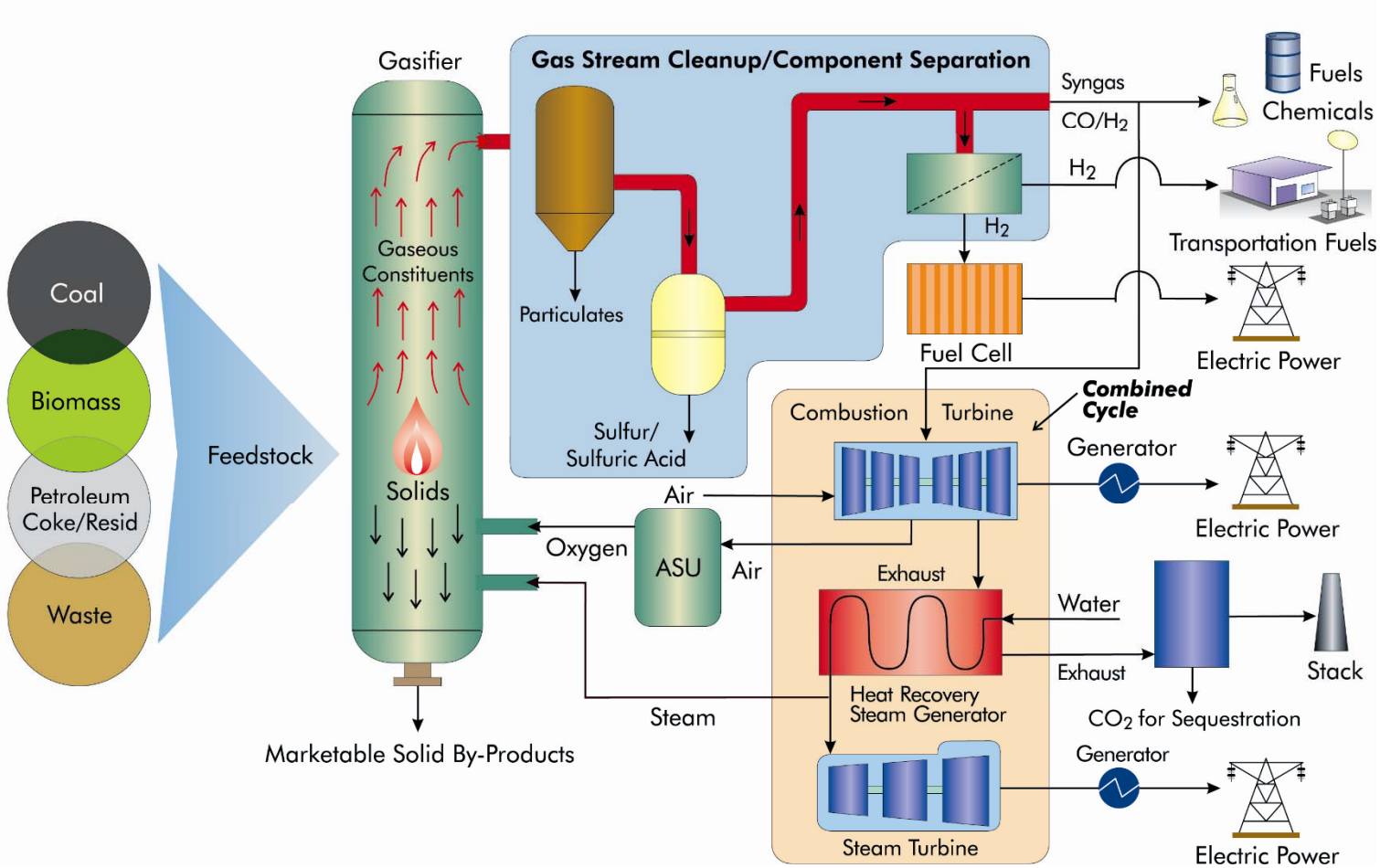
- Interest in Gasification
- Gasifier Types and Indian Coal Characteristics
- Gasification Technology choice for Indian Coal
- Roadmap

Reasons to Pursue IGCC in India

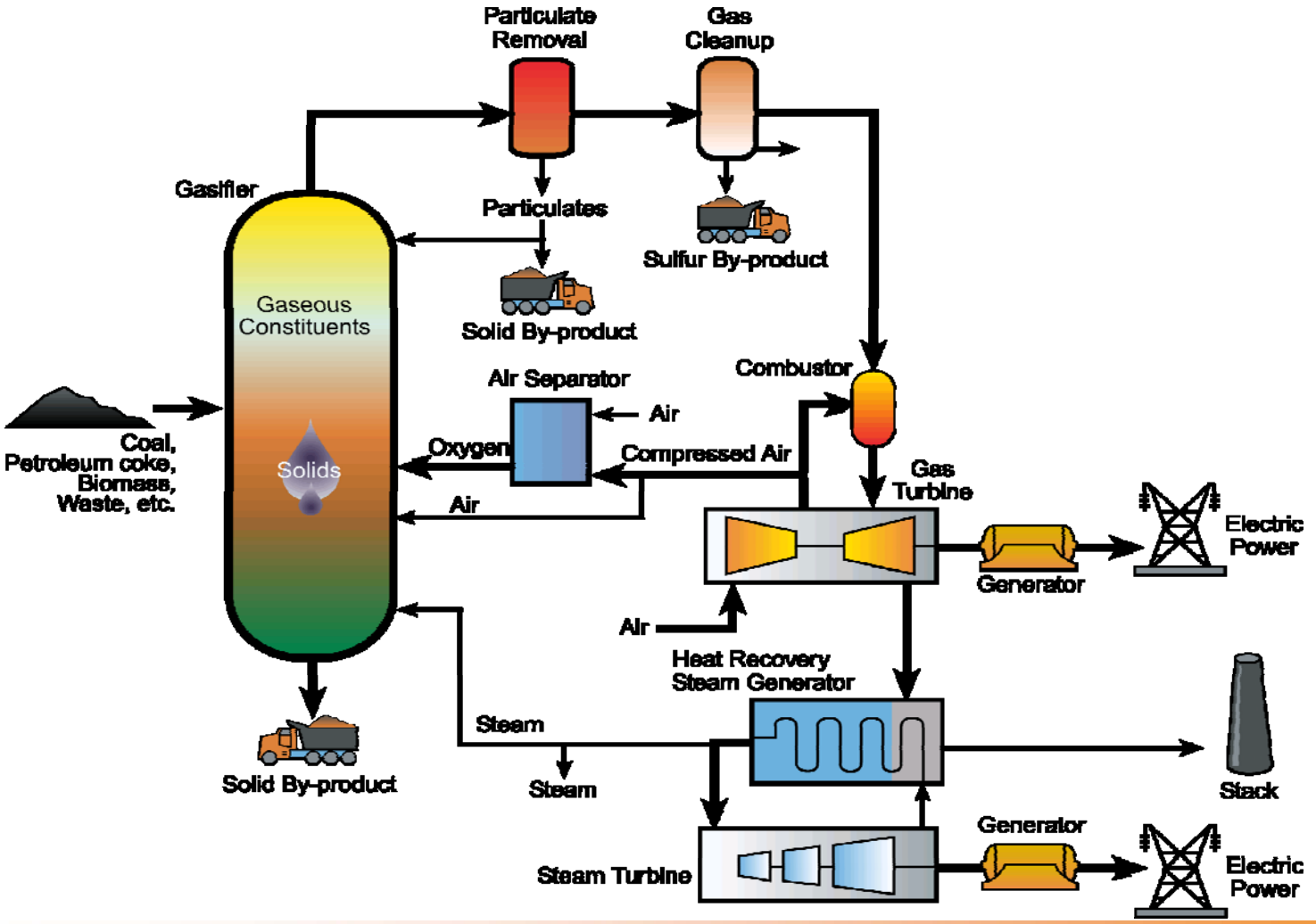


- Coal is the cheapest and major source of power generation in India
- India plans to significantly increase installed power generation capacity; 60% share from coal
- IGCC offers – low emissions, low water use while using coal as feedstock

Overview of Gasification



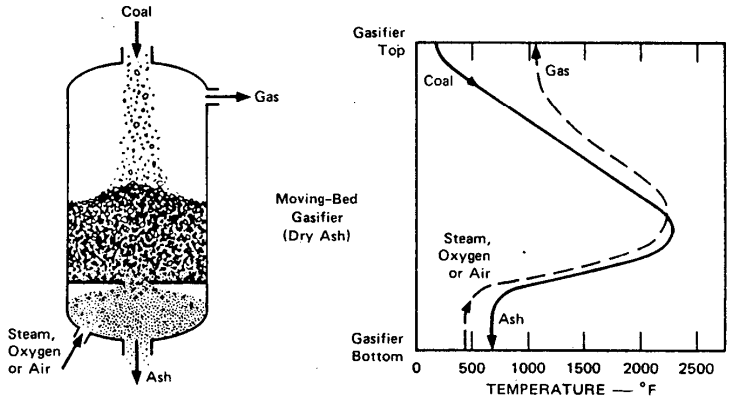
Integrated Gasification Combined Cycle (IGCC)



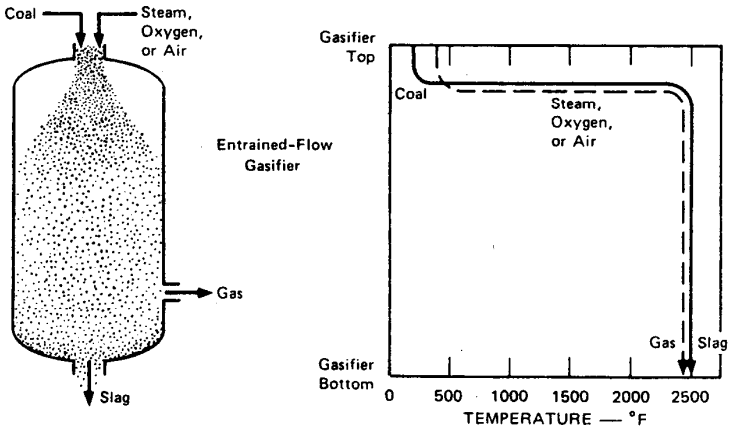
Gasifier Types and Indian Coal Characteristics

Major Types of Coal Gasifiers

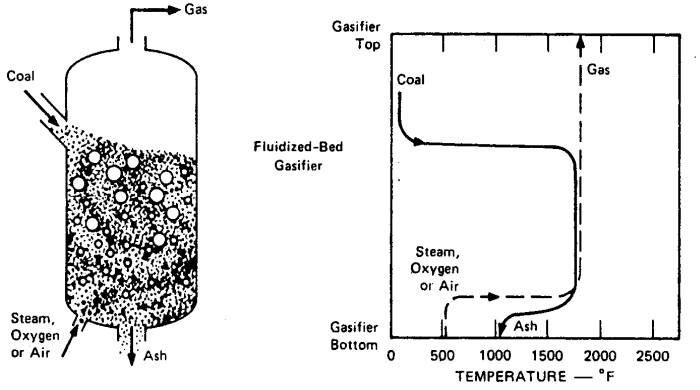
Moving Bed



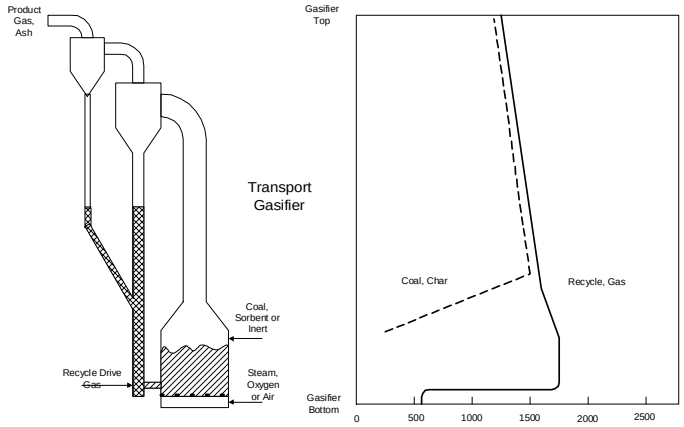
Entrained Bed



Fluidized Bed



Transport



Characteristics of India Coal

- High ash content (35-45%)
- High ash fusion temperature (>1500 C)
- High reactivity (sub-bituminous coal)
- Low sulfur content (0.5%)

Properties of Indian Coals

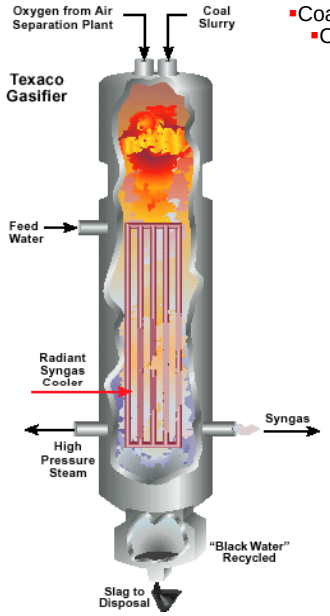
	N. Karanpura	N. Karanpura *washed*
Ultimate Analysis (as-received, wt%)		
Moisture	8.7	7.4
Carbon	40.3	46.0
Hydrogen	3.2	3.6
Nitrogen	0.9	1.0
Sulfur	0.5	0.5
Ash	38.2	33.0
Oxygen (by difference)	8.2	8.6
Proximate Analysis (as-received, wt %)		
Net Calorific Value (kcal/kg)	4,180	
Gross Calorific Value (kcal/kg)	3,692	4,228
Coal per unit of electricity (kg/kWh)	.7	
Ash Fusion Temperature (°C)	1,500	1,500

Chen, Tan-Ping, "Effects of Coal Ash Content on Cost of Generation for IGCC Power Plant

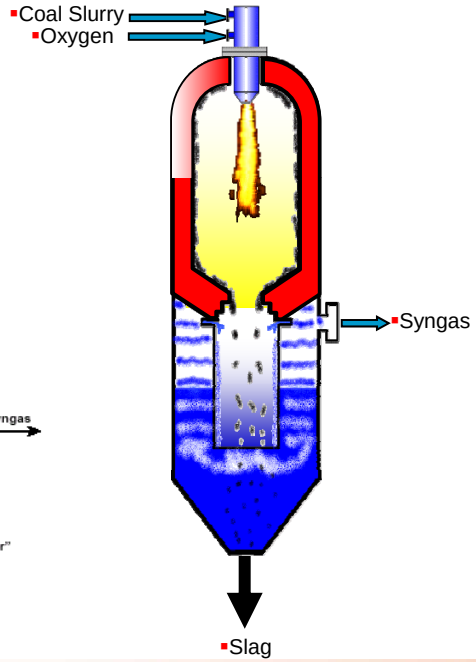
Gasifiers Not Suitable for India Coals

Slurry Feed

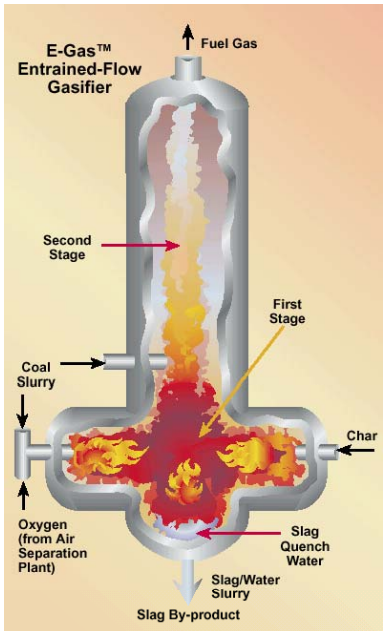
- GE gasifier (WHB)



- GE gasifier (quench)

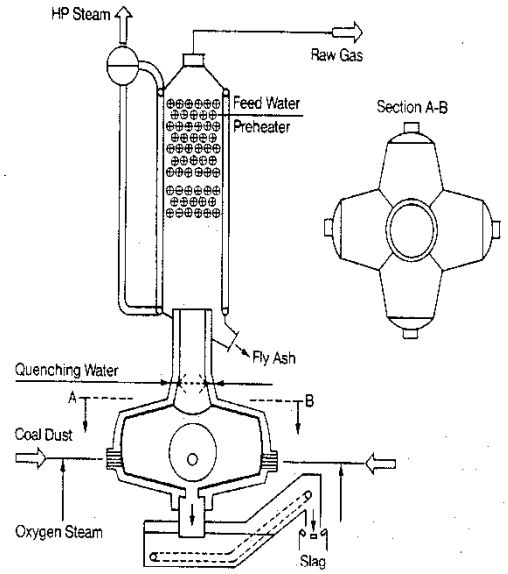


- E-Gas gasifier



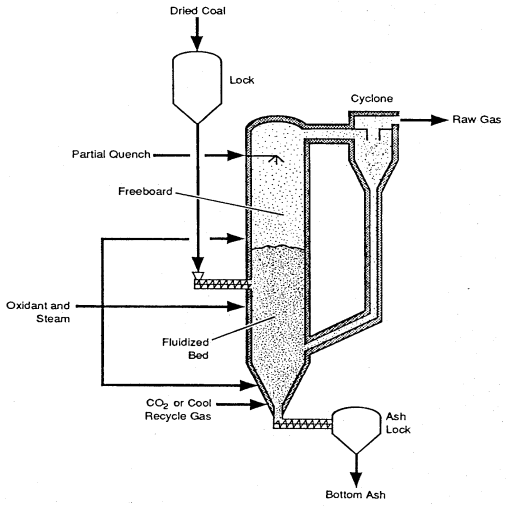
Dry Feed

- Shell/Prenflow/Noell gasifier



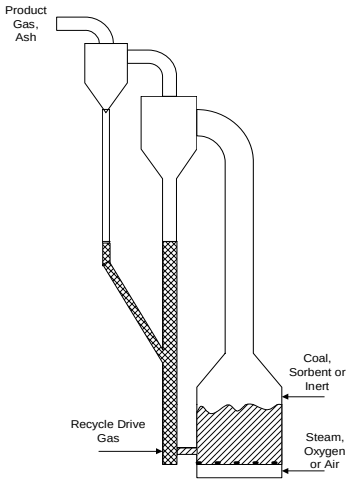
Suitable Gasifiers for India Coals

▪Fluidized Bed



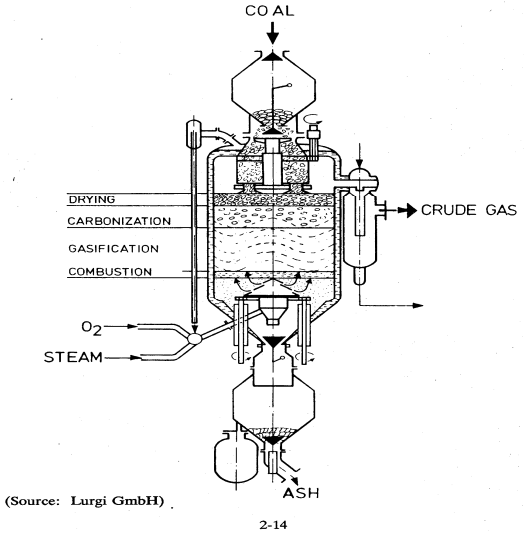
- U-Gas, HT Winkler gasifiers
- No slagging
- Medium oxidant use
- Medium cold gas efficiency

▪Transport



- KBR gasifier
- No slagging
- Medium oxidant use
- Medium cold gas efficiency
- High throughput

▪Moving Bed



- Lurgi gasifier
- No slagging
- Low oxidant use
- High cold gas efficiency
- Require lump coal

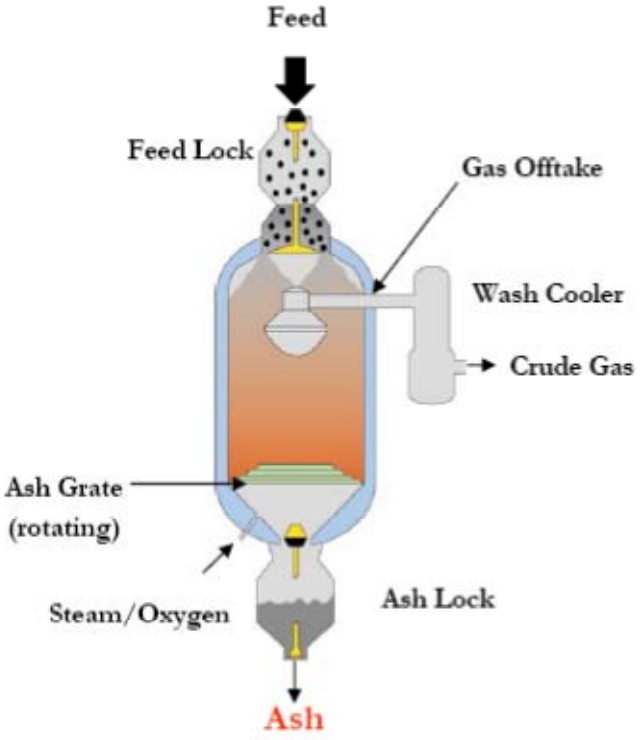
Gasification Technology Choice for Indian Coal

Coal Tests

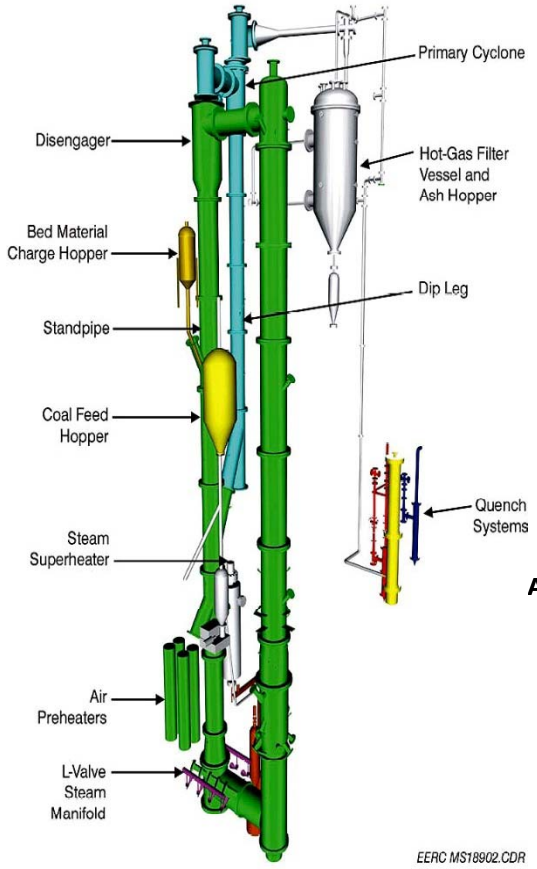
- 250 tons Run-Of-Mine (raw) and washed coals from N-Karanpura shipped to GTI, US; 100kg to Sasol, SA for testing
- GTI: 10-tons per day (tpd) U-Gas pilot plant in Chicago
- Sasol: coal characterization to predict gasifier performance
- Univ. North Dakota-EERC: 5-tpd transport gasifier pilot unit using Dadri coal shipped to US
- BHEL: 18-tpd fluid bed pilot at Hyderabad

Gasifiers for Low Rank Coal *cont.*

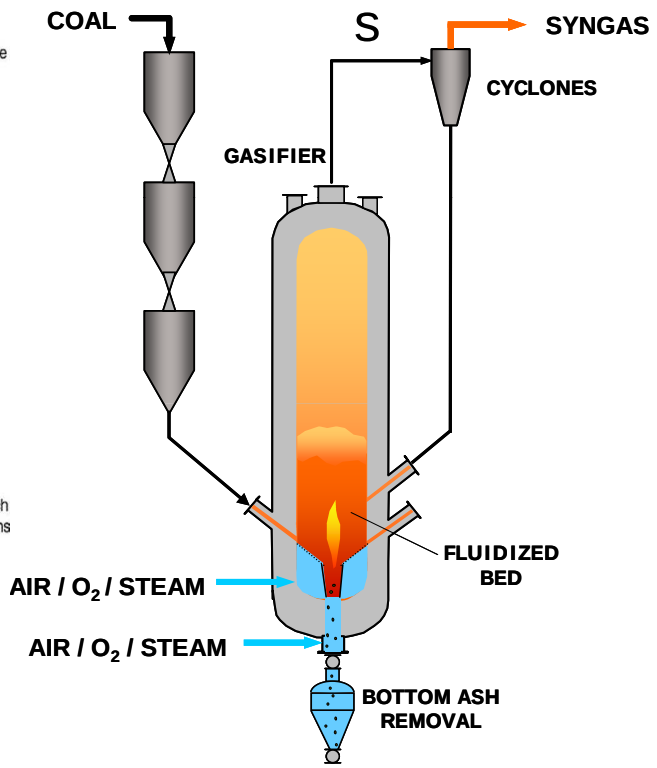
Lurgi



KBR Transport



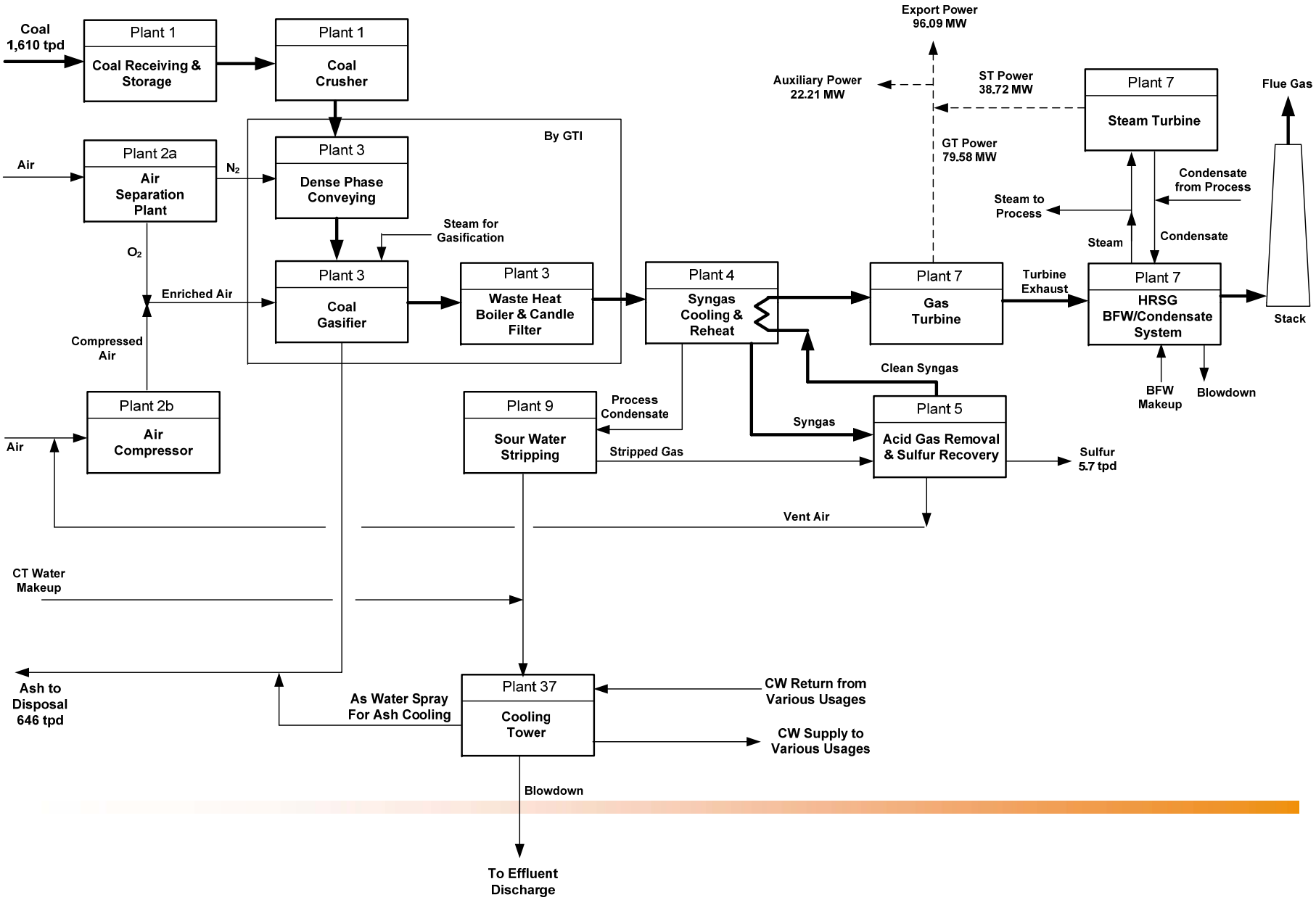
U-Gas



Test Result Summary

- Tests at GTI, EERC, and BHEL indicate fluid bed and transport systems can gasify Indian coals very well due to coal high reactivity
- Operating temperature need not to be high
- High-ash Indian coal did not present operation problems in operation of gasifiers
- Carbon conversion in fluid bed gasifier is 85-90%; can reach 95% if adjusted for heat loss and N_2 use

Configuration of 100 MW Plant



100 MW IGCC Plant Capital Cost

(Million US$, mid-2006 Pricing)

Description	Total
Coal Receiving, Storage and Preparation	5.56
Enriched Air Supply	18.89
Coal Gasification	21.42
Syngas Cooling and Re-heat	2.78
Acid Gas Removal and sulfur Recovery	5.00
Sour Water Stripping	5.56
Gas turbines with Auxiliaries	29.78
Waste heat recovery boiler w/ auxiliaries	9.33
Steam turbine with auxiliaries	7.56
Balance of Plant Facilities	35.98
Sub-total Equipment Cost	136.19
Initial Spares (@ 3% of equipment cost)	4.0
Custom Duties	7.42
Excise Duty, Freight and Insurance	Included in individual package cost
Total Equipment Cost	147.70
Erection Testing and Commissioning of Gas Turbine	2.98
Total Works Cost	150.7
Owner's cost, incl. license fee	4.56
Engineering (6% of total work cost and vendor support)	9.04
Contingency (5% of total work cost)	7.53
Total Capital Requirement excluding IDC	171.8
Interest During Construction	20.49
Total Project Cost including IDC	192.3

Future of Coal Gasification In India

- The demo plant high cost ($1,900-2,000/kW) are not indicative for commercial plants
- Efficiency can increase to 40% when large gas turbines (9F or 9H class) are used in commercial plants
- The commercial plant cost can reduce to $1,200-1,300/kW (under Indian condition)
- IGCC is a young technology with large room for improvements; while sub- & super-critical PC is mature
- New technology and product developments, need to be tracked for integration with the IGCC for Indian coal

IGCC Roadmap in India

- More coal tests - gasifiers suitable for Indian coals are not fully developed; also need to monitor new technology developments
- Construct and operate demo plant – R&D flavor, learning, gaining operational experience to operate commercial plant
- Policy changes – more stringent emission standards for power plants, tax credits or other incentives for using IGCC, soft loans for building IGCC plants
- Local technology ownership - major power /chemical plant equipment suppliers and engineering/construction firms get involved; develop standardize Plant Design
- Gasification technology demonstrated for IGCC can be extended to other sector transportation fuels, fertilizers, and petrochemicals – attractive option and

PROTOCOL OF INTENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND
THE GOVERNMENT OF THE REPUBLIC OF INDIA

THIS PROTOCOL OF INTENT sets forth certain areas of mutual cooperation and collaboration in the energy sector and is made between the Government of the United States of America (represented by the United States Agency for International Development ("USAID") and the United States Department of Energy ("USDOE")) and the Government of India (represented by the Ministry of Power ("MOP") and the National Thermal Power Corporation Limited, India ("NTPC"), and collectively with the MOP, USDOE and USAID, the ("Parties") on this 13 day of September, 2000.

WHEREAS, in a Joint Statement on Cooperation in Energy and Environment signed at New Delhi on March 22, 2000 ("Joint Statement"), the Government of the United States of America and the Government of India articulated their desire to increase cooperation in energy and the environment.

WHEREAS, in pursuit of the collaborative goals set forth in the Joint Statement and subject to applicable law, USAID and USDOE intend to cooperate with the MOP and NTPC to support the development of advanced power generation technologies in India.

WHEREAS, as a first step towards this cooperation, USAID will collaborate with MOP and NTPC in conducting a detailed technical and economic feasibility study for setting up a commercial scale integrated gasification combined cycle (IGCC) demonstration power plant at one of the NTPC power plant sites. The study will seek to establish: (i) the most suitable IGCC technology for Indian coal and environmental conditions; (ii) explore possible financing structures to make the technology most competitive for India; (iii) and develop a time-bound implementation plan for technology demonstration in India.

RESOLVED, that as one of the next steps in the Joint Statement, the Parties will cooperate and collaborate to achieve the objectives set forth herein.

A.K. Basu
Secretary
Ministry of Power

A. Palit
Director
National Thermal Power Corporation

T.J. Glauthier
Deputy Secretary
U.S. Department of Energy

Harriet Babbitt
Deputy Administrator
USAID

125 MW Demonstration Plant

- BHEL and APGENCO have signed an agreement to setup 125 MW IGCC plant at Vijaywada (in the state of A.P.)
- Using U-Gas gasifier and GE 6FA gas turbine
- India ROM coal is the design coal
- Technical details being discussed
- Financial structuring yet to be decided

THANK YOU

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