IMPLEMENTING CLEAN COAL TECHNOLOGY THROUGH GASIFICATION AND LIQUEFACTION – THE INDIAN PERSPECTIVE

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Coal Energy in India

Emission from a power plant depends on

- total generation
- fuel consumption efficiency, and
- fuel quality

Coal constituents:

- Organic and Inorganic material

- Mineral Matter in Coal:
  - Inherent
  - Extraneous

Clean coal technology is important because:

- Coal is abundant and will remain a major source of energy for future years
- Emission from coal based generation is a matter of serious concern

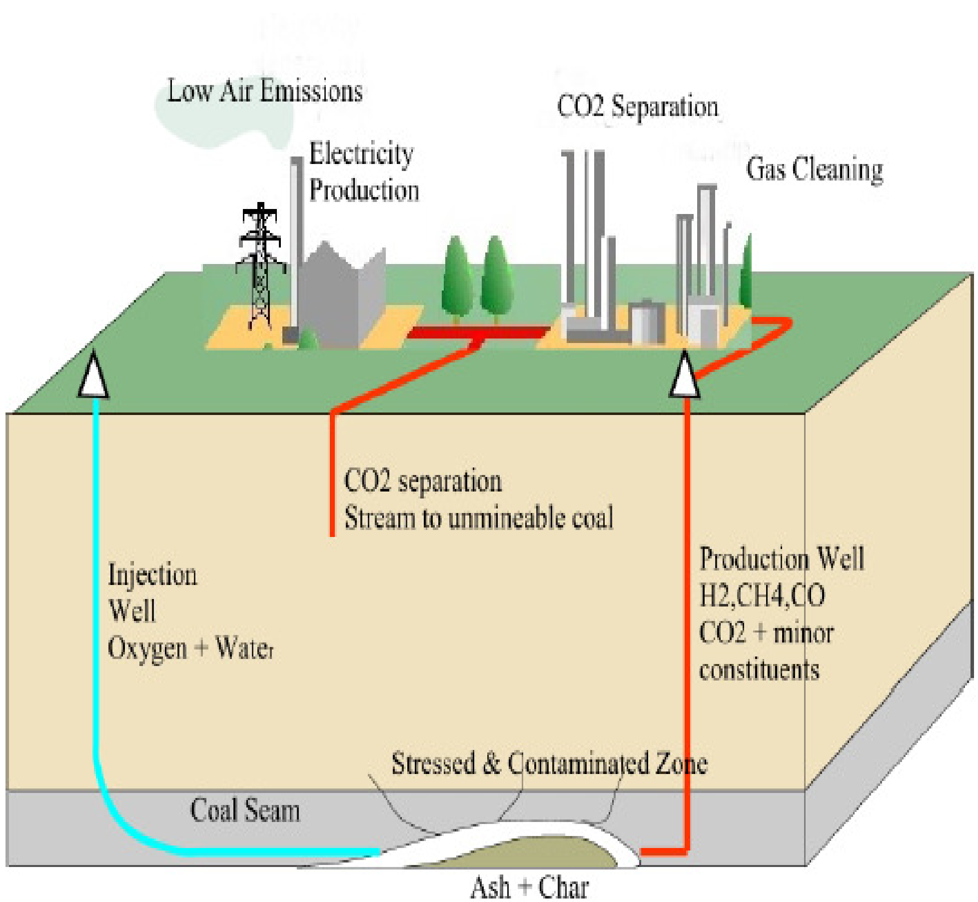
Surface Coal Gasification

- Coal put in gasifier with oxygen and steam where heat and pressure are used to form a synthetic gas, known as "syngas"
- CO_2 can then be captured
  - Before combustion (IGCC)
  - After combustion (Pulverized Coal plants)

Product: Syngas

- Composition – Carbon Monoxide and Hydrogen
- Potential Uses
  - Power Generation (IGCC)
  - Fertilizers & Methanol
  - Natural Gas
  - Gasoline & Diesel Fuels

UNDERGROUND COAL GASIFICATION



WHY UCG ?

- ✓ UCG eliminates much of the energy waste associated with moving waste as well as useable product from the ground to the surface.

- ✓ UCG produces less greenhouse gases and has the advantage for geologic carbon storage. The well infrastructure for UCG can be used subsequently for geologic CO_2 sequestration operations. It may be possible to store CO_2 in the reactor zone underground as well as adjacent strata.

- ✓ No surface gasification systems are needed; hence capital costs are substantially reduced.

- ✓ UCG is particularly advantageous for deep coal deposits and steeply dipping coal seams since at these conditions less gas leakages to the surroundings and high pressures favour methane formation.

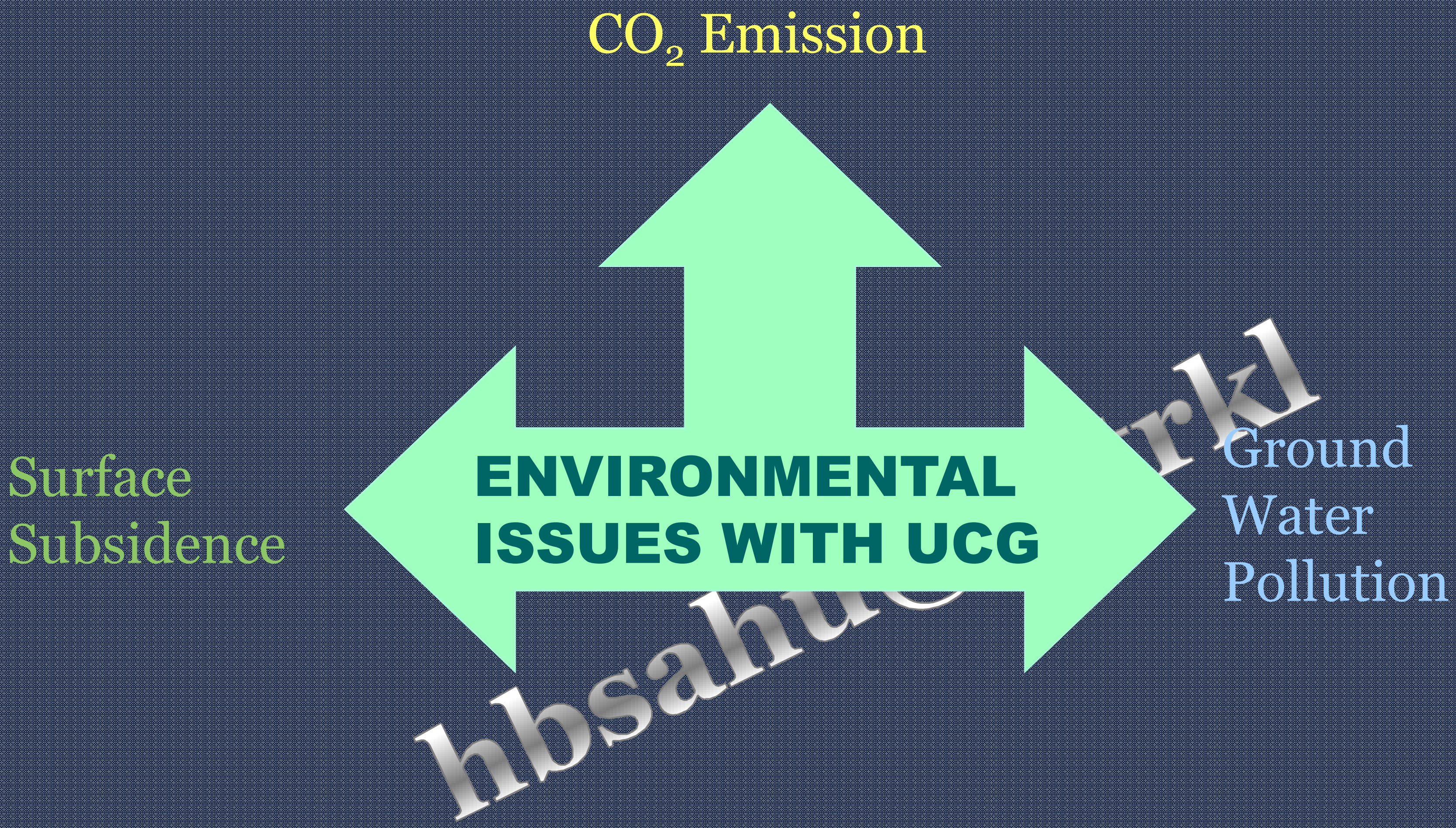
UCG potential

Coal and Lignite reserves in India (in Billion Tonnes)

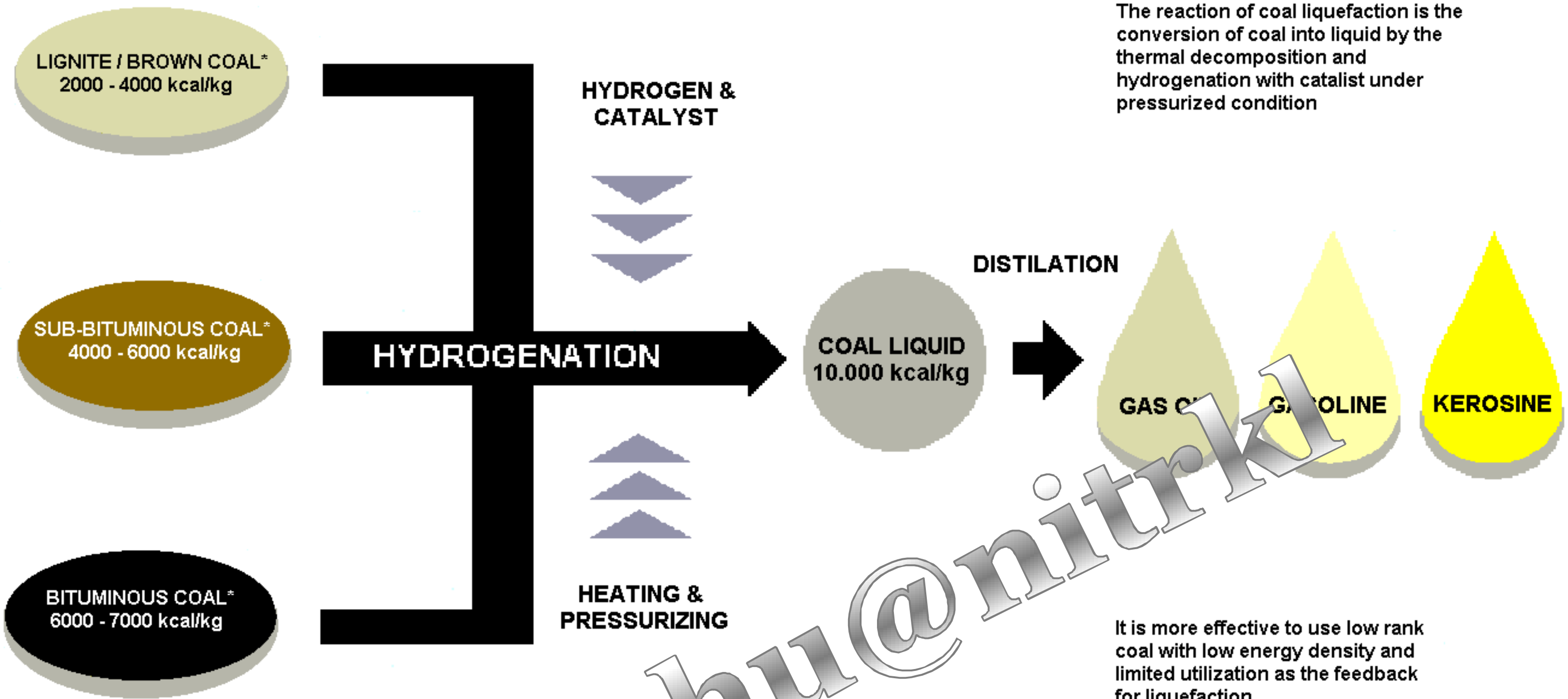
	Proved	Indicated	Inferred	Total	Extractable	Un-extractable
Coal	114.002	137.471	34.39	285.862	45.231	240.631
Lignite	6.146	25.794	8.966	40.906	5.7816	35.1244
Total	120.148	163.265	43.356	326.768	51.013	275.755

POTENTIAL USE OF UCG IN INDIA

Location	Reserve, million tonnes	Deposit	Depth, m
Mehsana and Shobhasan areas in Gujarat	63,000	Ligno-bituminous coal	700 to 1700
Lapanga (Chordhara), South Karanpura Coalfield	111	Bituminous coal	100 to 500
Palana - Merta Road, near Bikaner city in Rajasthan	23.57	Lignite	100 to 200
South Sayal, South Karanpura Coalfield	199	Bituminous coal	300 to 540


CO_2 Emission
Surface Subsidence
ENVIRONMENTAL ISSUES WITH UCG
Ground Water Pollution

COAL LIQUEFACTION



*Moisture and ash containing basis

Methods

1. Direct Liquefaction:
   - Dissolves coal in a solvent at elevated temperature and pressure
   - Combined with hydrogen gas and a catalyst

2. Indirect Liquefaction:
   - Involves first gasifying coal, followed by reacting carbon monoxide and hydrogen together

$$nCO + (2n+1)H_2 = C_nH_{2n+2} + nH_2O$$

Comparison of Processes

DIRECT LIQUEFACTION

- Adds hydrogen to break down the coal
- Dissolves in a solvent followed by hydrocracking
- Operates at 450 C and 170 bars
- Light products are distilled
- Medium and heavy distillates obtained from vacuum distillation
- Liquid yields of 70% of the dry weight of coal feed
- Further upgrade is needed for use as transportation fuels

INDIRECT LIQUEFACTION

- Complete breakdown of coal with steam and oxygen
- Sulfur is removed from the syngas
- Syngas reacted over catalyst at 300 C and 20 bars
- Produces a lighter suite of products; high quality gasoline and petrochemicals
- Oxygenated chemicals

Conclusion

- Coal gasification with carbon capture and storage (CCS), surface or underground, also offers a practical medium-term option for the continuing use of coal and a bridging strategy to eventual energy production with zero emissions, i.e. renewable energy and the hydrogen economy.
- The gaseous and liquid fuels, thus produced, may help to reduce our import dependence.
- UCG can utilize low grade coals in India that are available in Gujrat, Rajasthan and Tamil Nadu economically.
- Though less polluting still many challenges exist which have to be tackled.
- Extensive pilot studies are required in different categories of mines in India to suit the technology.
- Indian mining industry and research institutes should come forward in a big way to take Gasification and Liquefaction activity forward in India.

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