



Blue Hydrogen: Coal gasification linked with Carbon sequestration

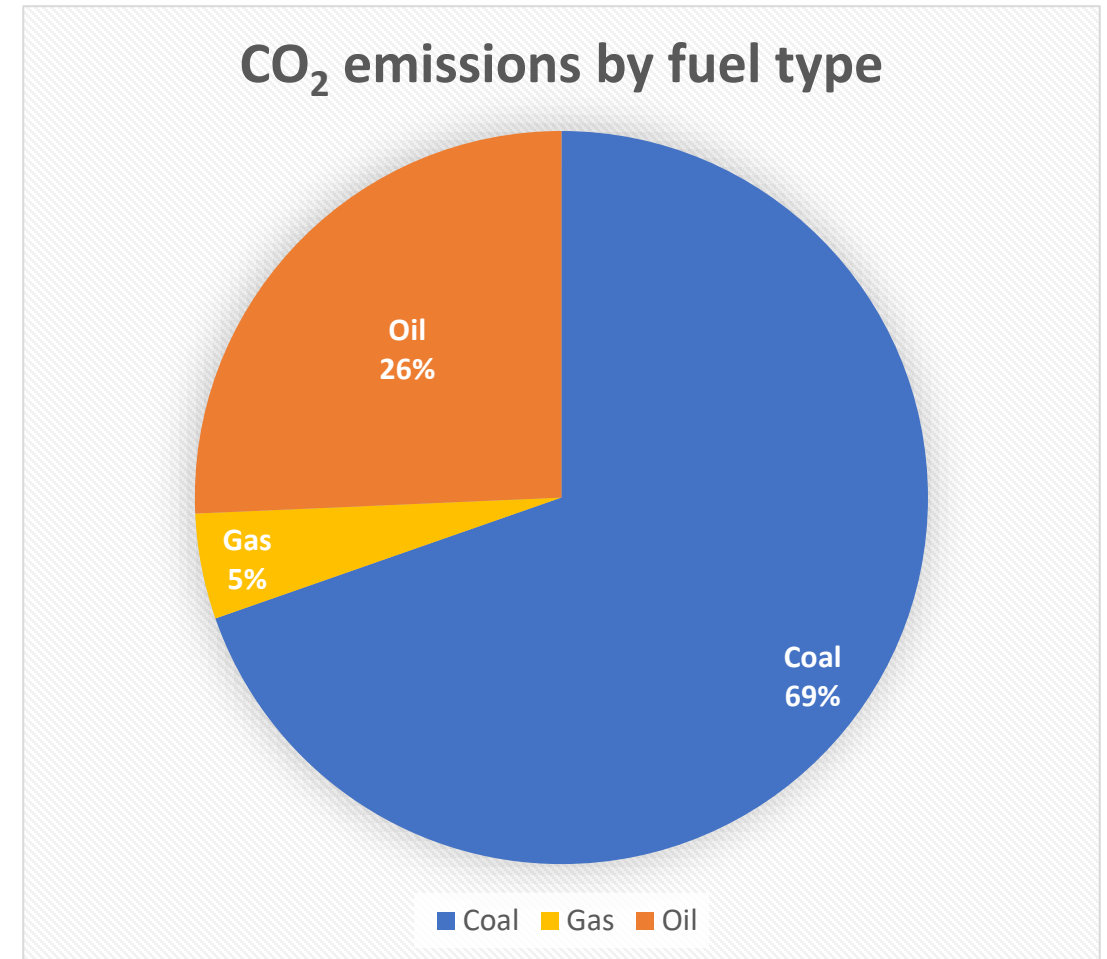
**Dr. Yashvardhan Verma
Prof. Vikram Vishal**

National Centre of Excellence in Carbon Capture and Utilization

**Department of Earth Sciences
Indian Institute of Technology Bombay, Mumbai**

Need of CCUS with Underground Coal Gasification

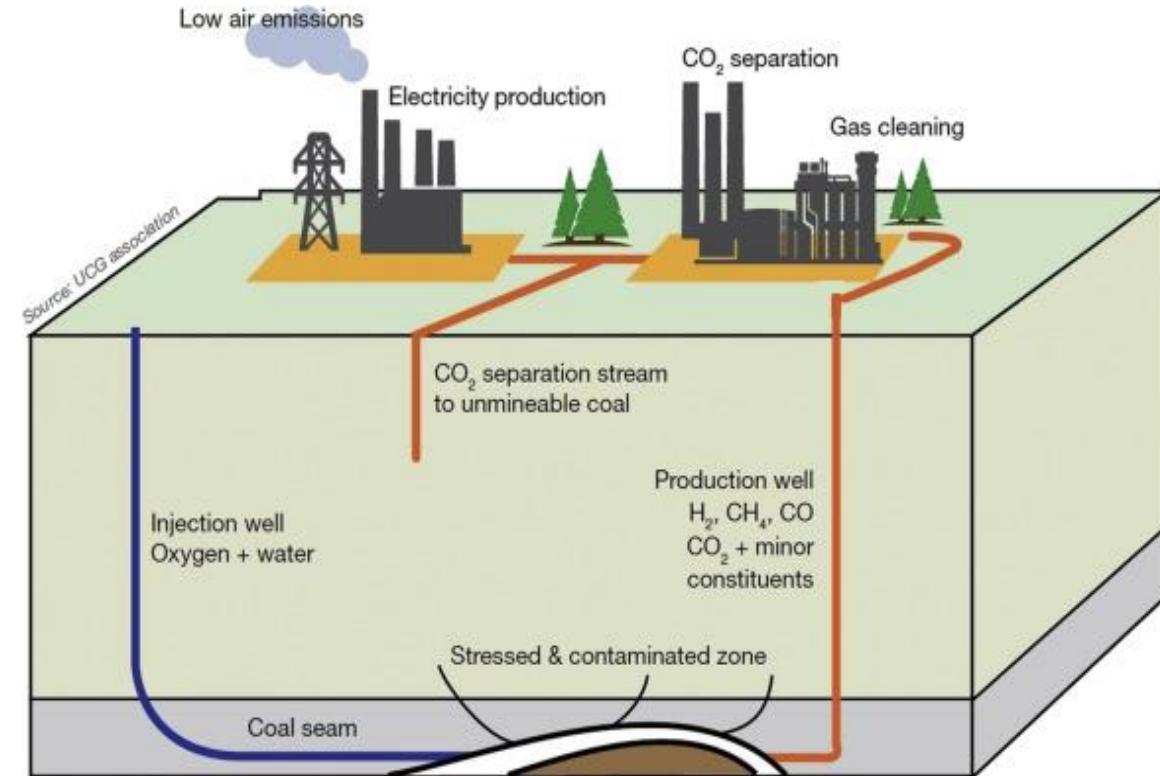
- Coal combustion in India produced 1.85 billion metric tons of carbon dioxide (GtCO₂) in 2022
- India's National Coal Gasification Mission of 100 Mt by 2030 will introduce carbon sequestered in unminable coal seams to the atmosphere.
- CO₂ emissions of UCG are comparable to coal, e.g. 708 kg/MWh for power generation.
- However, UCG creates massive space for CO₂ storage in the form of increased sorption capacity.
- Full integration of CCS into UCG operation will put it in a more competitive place in a carbon-conscious world.



CO₂ emissions from different fuels in India
(Andrew and Peters, 2023)

CO₂ sequestration with Underground Coal Gasification

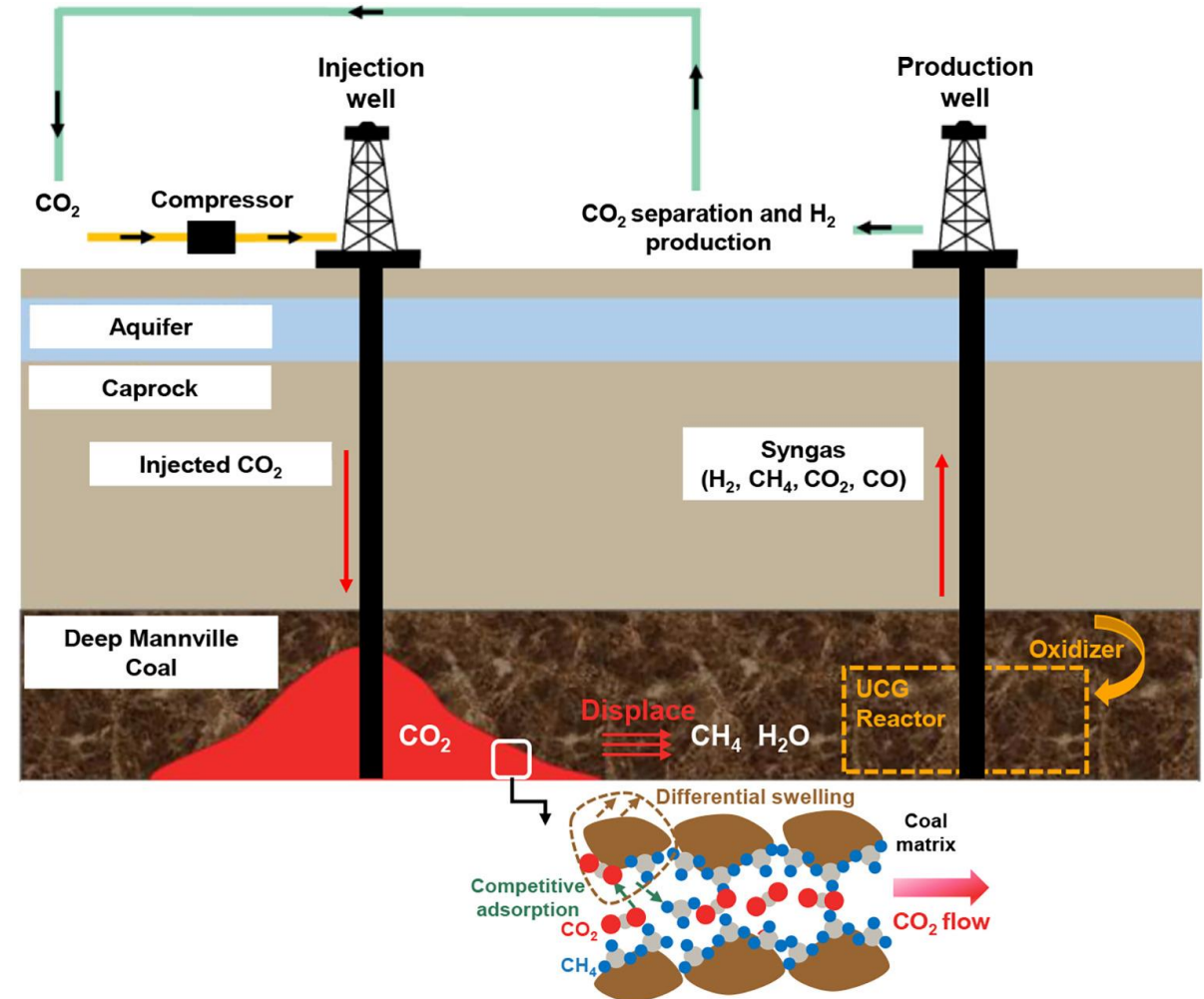
- CCUS with UCG entails injecting and storing the CO₂ produced in the underground gasification process and as a by-product of the shift reaction in which the CO in the extracted synthetic gas is reacted with steam to produce hydrogen and CO₂.
- The storage capacity for CO₂ is much higher than the extracted coal volume because of the increased permeability of the rock strata as well as the remaining coal between the UCG cavities and between gasification channels.
- More than 40 % increase in sorption capacity after gasification is observed (Kempka et al., 2011)



Integration of carbon capture and storage (CCS) in UCG

Blue hydrogen production with UCG

- Blue hydrogen: production of hydrogen from coal/natural gas combined with CCS.
- Enhanced hydrogen recovery (EHR) process integrates UCG with CO₂ sequestration to produce hydrogen-rich syngas.
- The life cycle GHG emissions are calculated to be **0.91 kg-CO₂-eq/kg-H₂** in H₂ production from UCG with CCUS (Verma & Kumar, 2014)
- More economic, as water electrolysis would cost 600 Rs/kg of H₂ while blue hydrogen would cost **180 Rs/kg** of H₂



Conceptual diagram illustrating the EHR process using vertical (CO₂) injection and (syngas) producing wells (Yang et al., 2023)

THANK YOU