### Hydrogen: India's Moment

Energy security, clean climate, economic development and energy access demands Hydrogen from multiple sources and blue hydrogen from coal is one major option for India



Solar in PV and, Coal in gasification primary resources

Water electrolysis and Coal gas to hydrogen convertors

*Hydrogen as fuel for transport and industry as clean carbon free energy* 

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Coal gasification and its Criticality of Blue Hydrogen for India, 9 June 2023

# India's net zero pathway has seven key levers: In that Hydrogen and CCUS form the major two. Blue hydrogen is a product of this.

#### India's GHG emissions<sup>1</sup>



#### LoS scenario

- Implementation of India's NDC, existing and currently announced policies
- Technology advancement as per current trajectory
- Shift in demand to sustainable alternatives in selected areas, e.g., EV

#### Accelerated scenario

- Adoption of **new policies** such as carbon pricing
- **Technology breakthroughs,** e.g., CCUS and faster implementation of existing levers
- Accelerated shift to sustainable consumption, e.g., EV, alternative materials, coarse cereals, green steel

More than 80% of abatement can be achieved through 7 key levers.

#### Cumulative emissions reduction between LoS and Accelerated scenarios, 2020-70, $GtCO_2e$



Why coal hydrogen with CCUS is a critical cog in India's energy security and climate change obligations?

Simple facts

- 1. India's energy needs will go from current 10,000 TWR or 30,000 TWH by 2070 as we scale our economy from 3 trillion \$ to 30 trillion \$.
- 2. This energy cannot come from renewable energy alone. Best case scenario, Renew can meet about 7500 TWH (about 23% of our energy needs. Rest will have to come from nuclear (?), biomass (2000 TWH) and COAL. So, coal by 2050 will still form 35% of our energy mix though in percentage its share will come down from current 54% to 35%- but in absolute terms it will go up from current 1 Billion Tons (BT) of coal to 2 BT.
- 3. And the best option the coal will present is hydrogen (or hydrogen carrying products). Via gasification route.

If hydrogen must become all pervading carbon free energy carrier, we need hydrogen from renewable and coal for India

Hydrogen map:



We must recognise that hydrogen by itself generate lower CO2 for every kWh energy delivered at the user's end. Hence hydrogen irrespective of its genesis, delivers green energy.

Compare coal delivering traction energy via electricity to same coal delivering similar energy via hydrogen.

Coal combustion to power	Power transmission and distribution	Battery driven EV	
35%	90 %	85%	
Coal gasification to hydrogen	Hydrogen transport	HFC based e- mobility	
80%	95%	70%	

For a 1 kWh transmission needed at the vehicle end, the generation end power and coal energy will be 3.57 kWh. (35% power plant and 80% other losses)

For a 1 kWh transmission needed at the vehicle end, for HFC the coal needed for gasification is just about 1.78 kWh. (95% gasification and 60% HFC)

This needs to be understood why coal – hydrogen becomes a low CO2 emission system. And we can then make it zero emission by CCUS

### The overall energy flows will look like the following: India's roadmap



### Requirements of solar and coal for the above:

Coal consumption will for above will be 1000 Million TPA of coal

Renew electricity will be GW (and 4.8 million Ha land)

How does coal hydrogen with CCUS compare with renewable hydrogen (water electrolysis)?

- 1. Water electrolysis consumes 50 kWh energy for one kg of hydrogen.
- 2. Coal hydrogen consumes 25 kg of coal for one kg of hydrogen (major hydrogen is again from water!) ultimately it is thermolysis vs electrolysis with water as a source of hydrogen. Need to CCUS 30 kg of CO2 to make it carbon free hydrogen (blue)
- Cost wise, water electrolysis using say solar PV and electrolyser would cost 600 Rs/kg of hydrogen while coal hydrogen would cost 120 Rs/kg without CCUS and 180 Rs/kg with CCUS

So, from cost, availability and land point of view, coal hydrogen offers the best decarbonization strategy for India.

So, the leading conclusions so far are

- 1. Coal is needed to meet India's hydrogen mission
- 2. Coal to hydrogen with or without CCUS, still delivers hydrogen at 1/3 rd cost
- 3. The desired quantity of hydrogen can only be delivered by using hybrid coal and renewable energy
- 4. The technologies for CTH is available indigenously

Now let's talk a little bit on coal to hydrogen technology

### Units in coal gasification plant: Technology developed by IIT D-Thermax and BHEL



# Overview on indigenous coal gasification technology and its extension to hydrogen:



**Methanol Production from Indian Coal:** 

## The next step post successful demonstration of technology in Feb 2022



**Department of Chemical Engineering** 

## The glimpse of 6 TPD Coal to Methanol (CTM) Plant: World class efforts.



Pilot plant at Thermax, Pune: Commissioned on Feb. 01, 2022

### Critical deliverables: Impressive

- We have achieved uninterrupted operations since last 16 months under different quality of coal feeds.
- Consistently achieved 90% Carbon conversion and 68% CGE and design capacity of methanol. All boxes tick marked.
- We are now poised to scale this up for large scale methanol / DME project in the range of 500-1500 TPD scale
- Ready to integrate CCUS box so that the plant will be zero emission
- Ready to integrate hydrogen from synthesis gas to showcase the most costeffective hydrogen



What we propose is to convert the existing coal to methanol plant to coal to hydrogen and CO2 to methanol configuration

Currently IIT D is working on taking our work further so that we will generate hydrogen from the coal gas (synthesis gas) and convert CO2 to methanol using CCUS.

The schematic is at an early stage of evaluation, and we will integrate this with existing pilot plant.

This will perhaps deliver lowest cost of hydrogen and green methanol using India's high ash coal

Under development: Coal gasification with Hydrogen-Methanol via CCUS architecture Three goals in one large pilot scale demonstration cum deployment



The discussions synchronize very well with our Hon PM vision on hydrogen mission and 100 MTPA of coal gasification:

#### **India's Decarbonization Blueprint**







500 GW Renewable Energy Capacity by 2030.50% of energy requirement with RE by 2030

Rapid expansion of Green Hydrogen production

#### **Increasing RE Penetration**

- Commencement of **offshore-wind** Power Projects
- Creation of Domestic Manufacturing Hub for RE with PLI
- Storage of Excess RE to stabilize and balance Grid with:
  - Hydrogen energy storage technologies
  - Pumped storage plants (PSP)
  - Battery energy storage systems (BESS)
- Promotion of Innovative **Technologies for Biomass, waste to energy** etc. through selective R&D

India should focus on twin track of quick deployment at large pilot scale as well as working on deep tech ideas in this field

Coal hydrogen, nuclear hydrogen using many new concepts like photo chemical conversions, co-electrolysis, nano catalysts etc. are critical areas.

Cost of hydrogen should be under 90 Rs/kg. and we should build all round capabilities in all sub systems.

Hydrogen end use applications for industry and transport needs also a quick scale-up. Fuel cells – hydrogen ICE – hydrogen carriers for enhancing storage and transport capabilities while safety is assured are also equally critical

#### LET THE WISDOM PREVAIL .....

We must learn to happily progress together or miserably perish together. Man can live individually but can survive only collectively *Atharva Veda*