



NTPC Initiative in Greening the Coal

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NETRA



Follow us on:



- Introduction to NETRA- R&D Division of NTPC
- India's Commitment to Climate Action Plan
- Clean Energy Transition
- Pathways for Decarbonization of Thermal Generation
- CCUS
- Conclusion





ABOUT NETRA



Follow us on:



NTPC ENERGY TECHNOLOGY RESEARCH ALLIANCE R&D DIVISION OF NTPC

NETRA VISION

“Delivering sustainable technology solutions thru applied research and provide advanced scientific services for power sector”



Genesis:

Formed in 2009 by merging:

- R&D Centre-Set up in 1981: Testing & Analysis
- Energy Technology: Set up in 2004: Tech. Development

Credentials:

- **IPR:**
 - ✓ Patents : 79 Nos filed, 55 Nos granted
 - ✓ Copyrights : 30 Nos filed, 25 Nos Granted
- **Governmental Expert Panel:**
 - ✓ NITI Aayog: 7 Nos of committees/panels,
 - ✓ DST: 7 Nos of committees/panels,
 - ✓ CSIR Labs: 2 Nos of 'Research Advisory Council'
- **Certification & Recognition:**
 - ✓ DSIR recognition
 - ✓ Boiler Board certification
 - ✓ 11 Nos of NABL Accredited Laboratories



NETRA Main Building



NETRA in a Snapshot: NABL Accredited Labs



NABL Accredited Lab	
SN	Lab
1	Metallurgy & Material Science Lab
2	Creep Lab
3	NDE & Imaging Lab
4	Corrosion Analysis Lab
5	Analytical Lab
6	Water Treatment Tech Lab
7	Transformer Oil Lab
8	Tribology & Lub Oil
9	Coal & Combustion Lab
10	Environmental Science Lab
11	Electrical Lab
Advance Process Lab	
12	Advance Computing Lab
13	Computation Fluid Dynamics Lab
14	Robotics and sensor
15	Advanced Coal Characterization Lab



NETRA in a Snapshot: Knowledge Alliance



Alliances

- National Knowledge Alliance: 22
- International Knowledge Alliances: 08
- Collaborations: 09

INTERNATIONAL ALLIANCES

DLR Germany	Solar Thermal Lab
ISE Germany	Concentrated PV
VGB Germany	ESP Performance Improvement
Curtin University Australia	Boiler/Biomass Combustion
NETL USA	CFD based AI Modeling of Boiler
University of South California, US (*)	CO2 derived Liquid Fuel
ESB, Ireland (*)	Green Fertilizer & Fuel
(*) MoU in offing	

NATIONAL ALLIANCES

IISc, Bangalore	Carbonated Aggregate
CSIR – IIP	Methanol Catalyst
CSIR – CGCRI	Fiber Optic Sensor for APH FG temp.
CSIR – NML	Creep Damage Assess. of High Temp. Headers & Pipe
CSIR – SERC	Structure & Corrosion Assessment
IGCAR	A-USC
NCCBM	Fly Ash to Sand, RCC Structure-Audit and Survey
CIPET	Floating Solar
GSI	Prep. of DPR for Geo Thermal Resource Assessment
IIT B	Solar, Robotics, MEMS, Corrosion, CO2 Capture Amine
IIT K	Power Sys., Smart grid, Sensors,
IIT D	Simulation & Modeling, AI, CFD, Solar PV
IIT Gh	Metal Hydride based H2 Compressor, CO2 Capture Amine
MIDHANI	Development of erosion resistant component
IOCL	Micro-Algae based CO2 utilization
CPRI	Drop Tube Reactor, Fly ash bricks
EEC	ESP performance improvement using CFD Modeling
IOCL	Micro-Algae based CO2 utilization
C-DAC Pune	Computational hardware
Jadavpur Univ	Transformer health assessment
RGIPT	Hydrogen generation





Focus Area



Follow us on:



Focus Area:

In the new paradigm



1

Carbon Capture, Utilization
& Storage (CCUS)

2

Coal Gasification based
Synthetic Fuel & Chemical

3

Energy Storage

4

Green Hydrogen

5

Advanced Scientific Services





INDIA'S COMMITMENT TO CLIMATE ACTION PLAN



Follow us on:



- **Vision given by honorable PM in COP 26 in Glasgow**
 - **Precise and Quantified Target for Decarbonization**
 - **Progressive decarbonization to reach net zero by 2070**
- **NDC setting quantifiable targets for Climate Action Plan till 2030**
 - **Reduce carbon intensity of our GDP by 45% wrt 2005 level.**
 - **~50 % of installed electricity capacity from non fossil fuel sources**
- **Policy Enablers for Industrial decarbonization: Few examples**
 - **National Biomass Mission:**
 - **National Green Hydrogen Mission**
 - **National CCUS Mission**
 - **National Coal Gasification Mission**

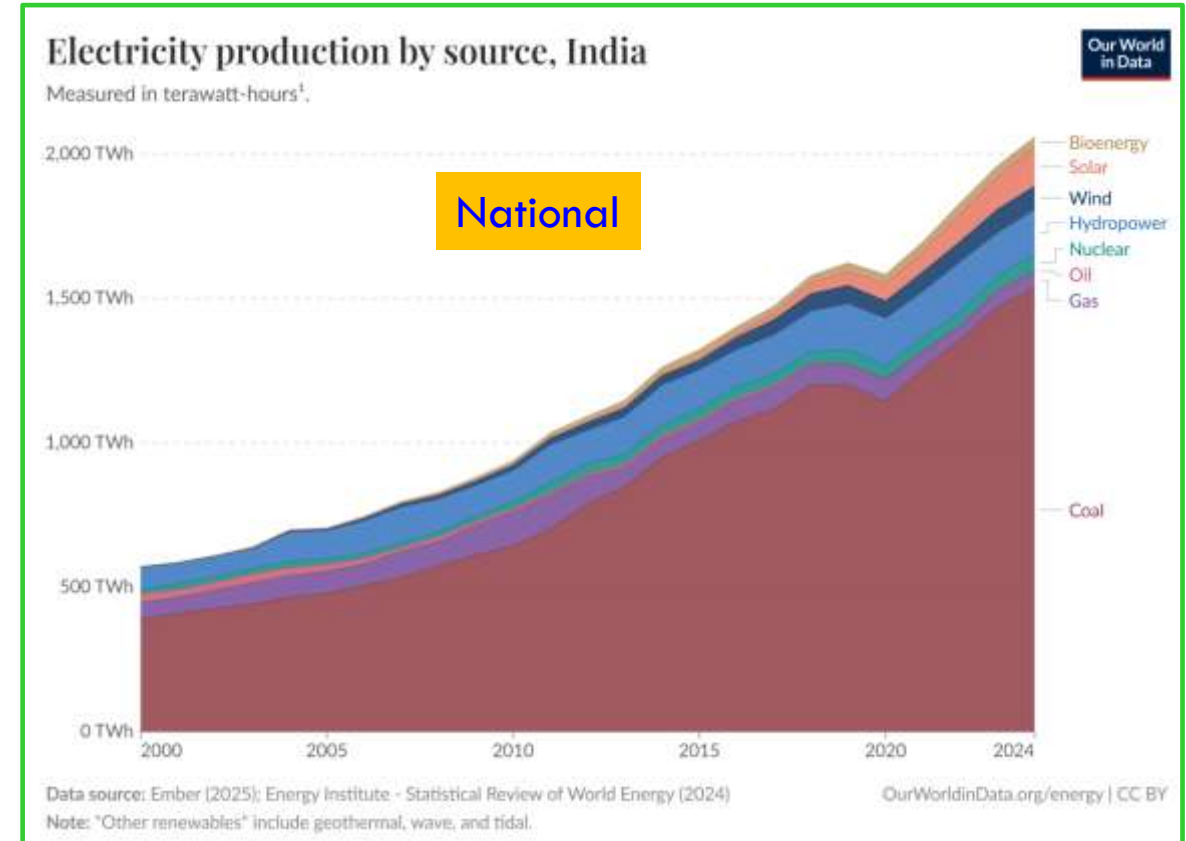
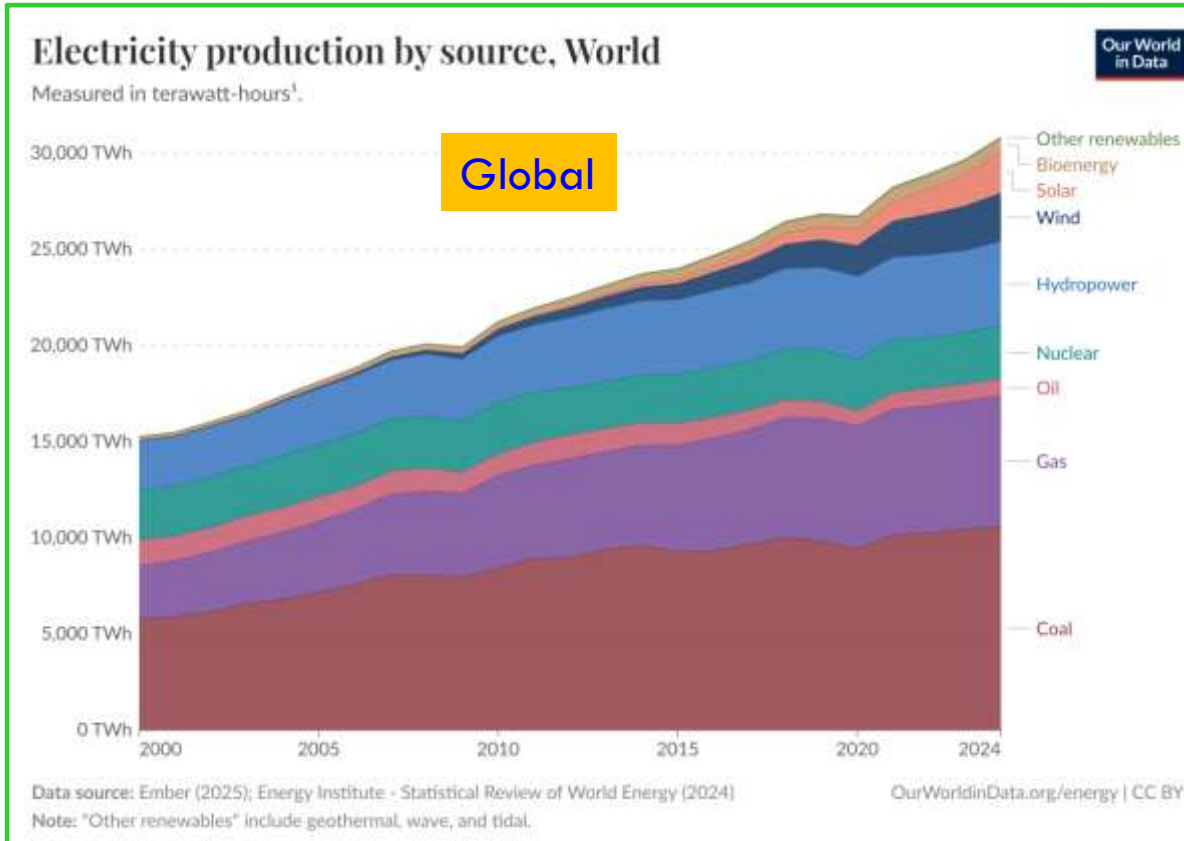


Transition towards a Clean & Secure Energy

Indian Scenario



COAL IN GENERATION MIX



Even with 50 % Installed capacity on Non Fossil, Country still rely on Generation from Coal



Low Carbon Transition - Indian Perspective



ECONOMIC & ENERGY SECURITY

1. PRIMARY ENERGY SOURCE:

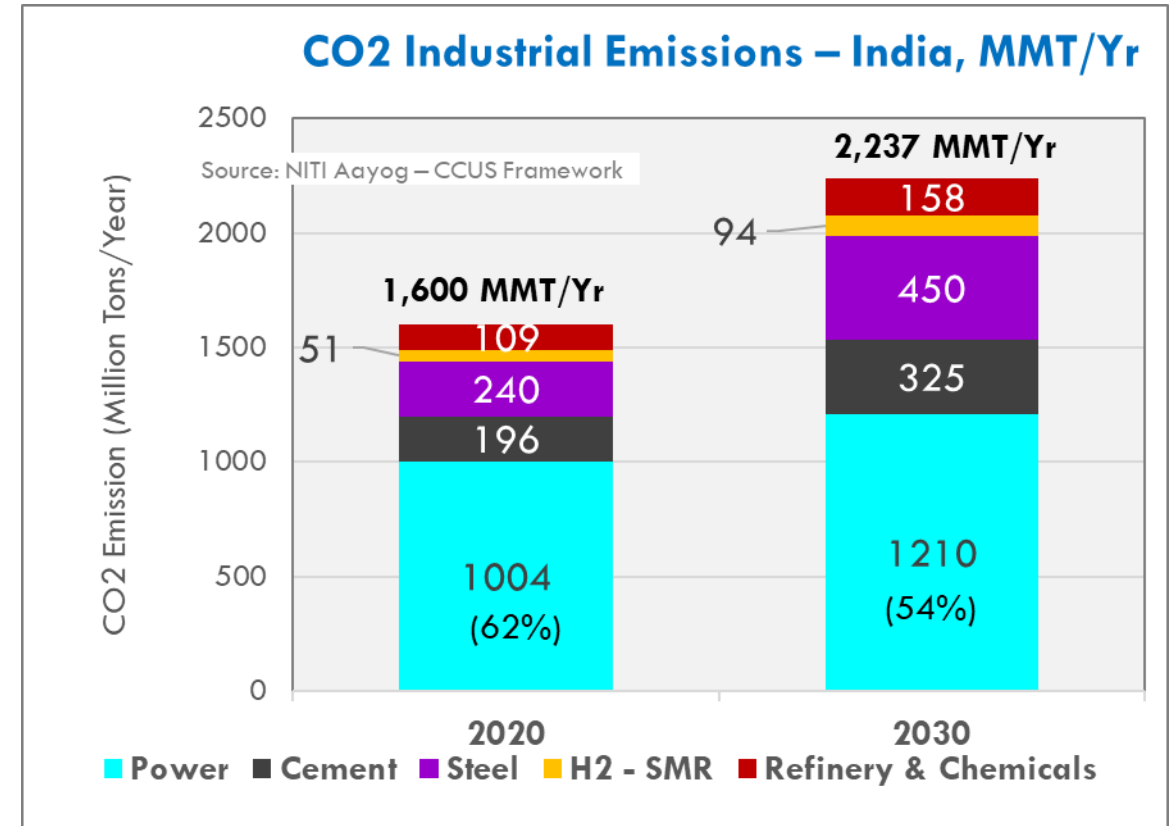
- India has 149/319 Billion Tons of 'Proven/Total Coal Reserve' (Ministry of Coal),
- Bulk (129/149) of it is 'Non-coking' variant – Used only in Power Plant (GOI-MOC),
- India does not have meaningful oil and gas reserve – bulk of it is imported. (Geo political Risk)

2. ECONOMY: Economy of many Indian States are critically dependent on coal mining. (i) Jharkhand: 91%, (ii) MP: 73%, (iii) Chhattisgarh: 66%, (TERI: Coal Transition in India)

3. EMPLOYMENT: Coal mining generates large quantum of employment – estimated 355,000 to 500,000 Nos – across various skillset (TERI: Coal Transition in India)

4. FINANCIAL INVESTMENT: Total investment made in coal power plants are in excess of 10 Trillion INR – this is a significant investment - needs to be handled carefully

ENVIRONMENTAL



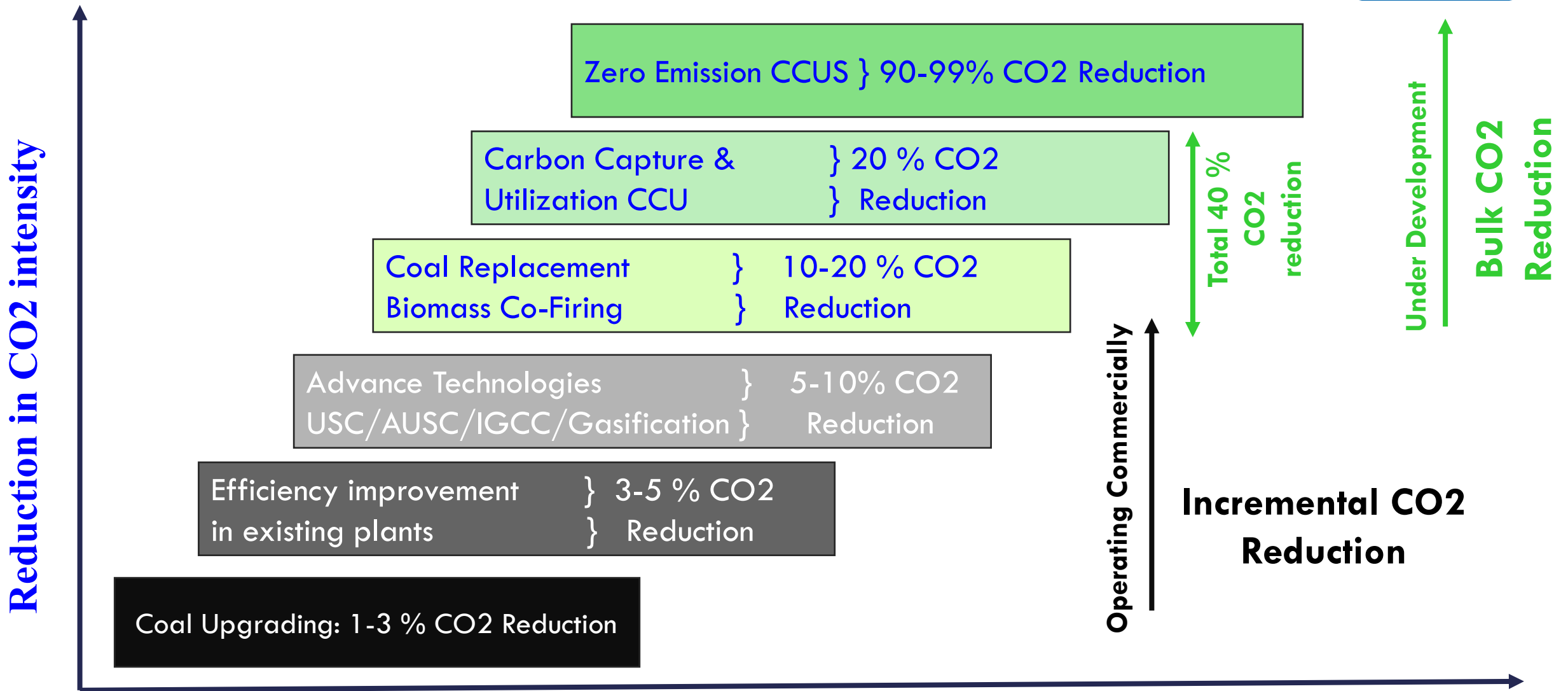
To meet economic demand coal generation has to be increased even with record RE injection

- **Coal is here to stay till Energy Storage becomes feasible and affordable**
- **Strategy Required for decoupling of economic growth from GHG emission**

Decarbonization of Coal Generation



Strategy for Decarbonization of Thermal Plant



Greening the Coal Biomass Cofiring

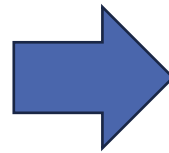


R&D to Commercial Operation

Biomass Co-firing R&D

Carried out in NETRA

- Detailed Characterization
- Biomass combustion
- Ash formation
- Effect of high VM in Biomass
- Effect of high alkali compound
- Combustion trial in NETRA
- Combustion trial at NTPC Dadri

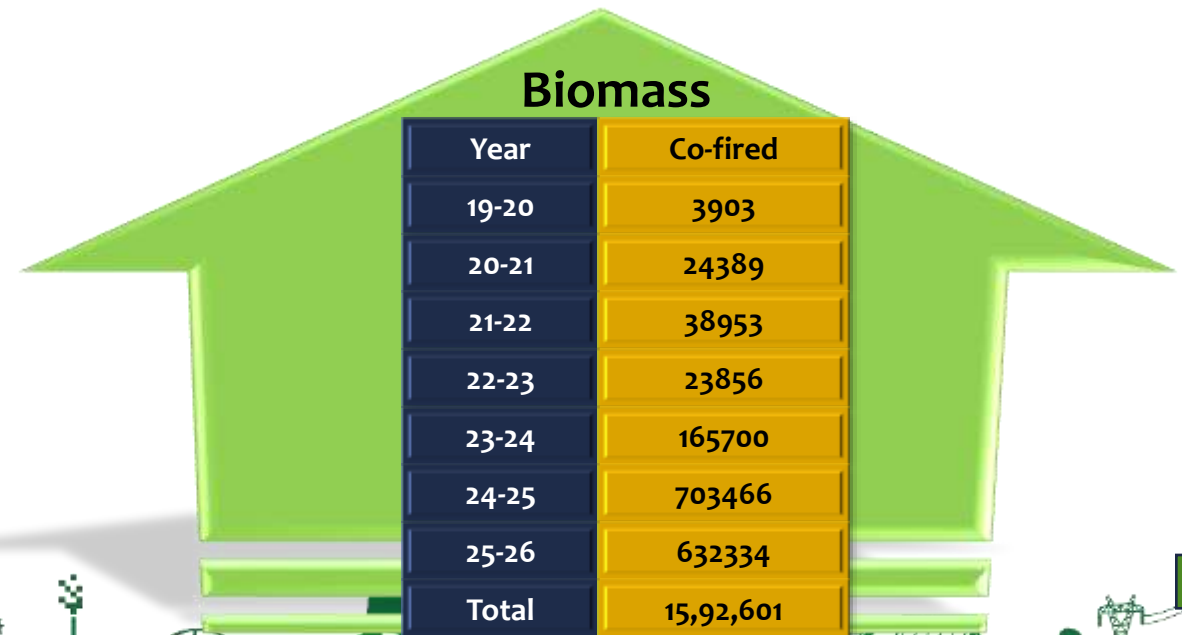


Biomass Co-firing

Biomass pellets in power plant as fuel

- Total Biomass fired : ~ 15.92 lakh MT (till date)
- Approx. 16 lakh MT CO₂ reduced
- Provision for 20% Bio-mass cofiring in new power plants

Each % Biomass co-firing proportionately reduces CO₂ emissions



Greening the Coal

Carbon Capture, Utilization & Storage



CO2 Capture Technology & Pilot Plants

Physical Route

Pressure Swing Adsorption

1 No of Pilot Plant

(Collaborative R&D Project of NETRA with 4 Institutes – CSMCRI, NEERI, IITB & IIP)



Chemical Route

Modified Amine

2 Nos of Pilot Plant

(Collaborative R&D Project with IIT Guwahati & IIT Bombay)



Biological Route

Micro Algae

1 No of Pilot Plant

(Collaborative R&D Project of NETRA with IOCL)



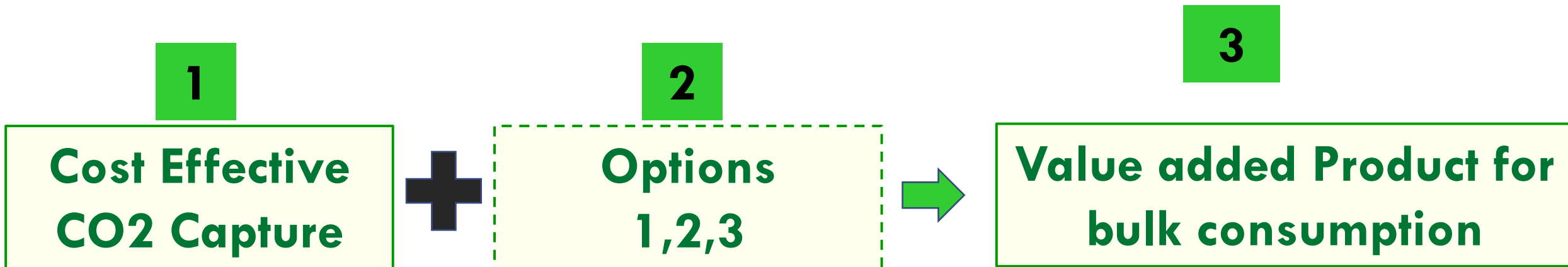
Completed

Gave us Confidence and data for scaling to Demonstration Plant

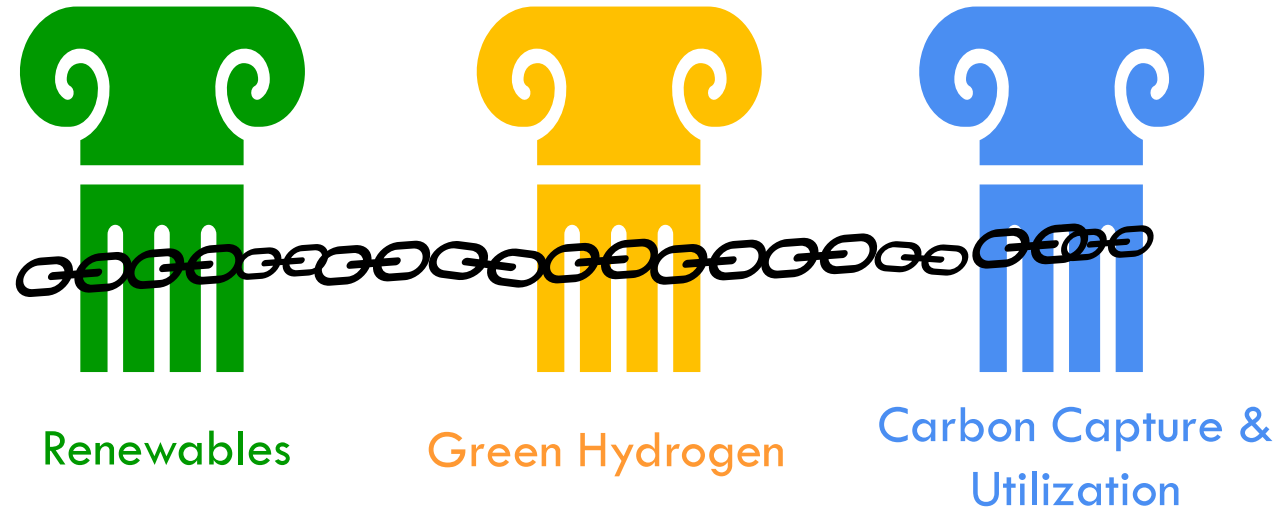


Our Thought Process back in 2015-16

- Now we have 1.
- What are the value-added products from utilizing CO2 ??
- What are best combinations of 2 & 3 for best utilization of CO2 ??



LOW CARBON TRANSITION THE INDIAN MODEL

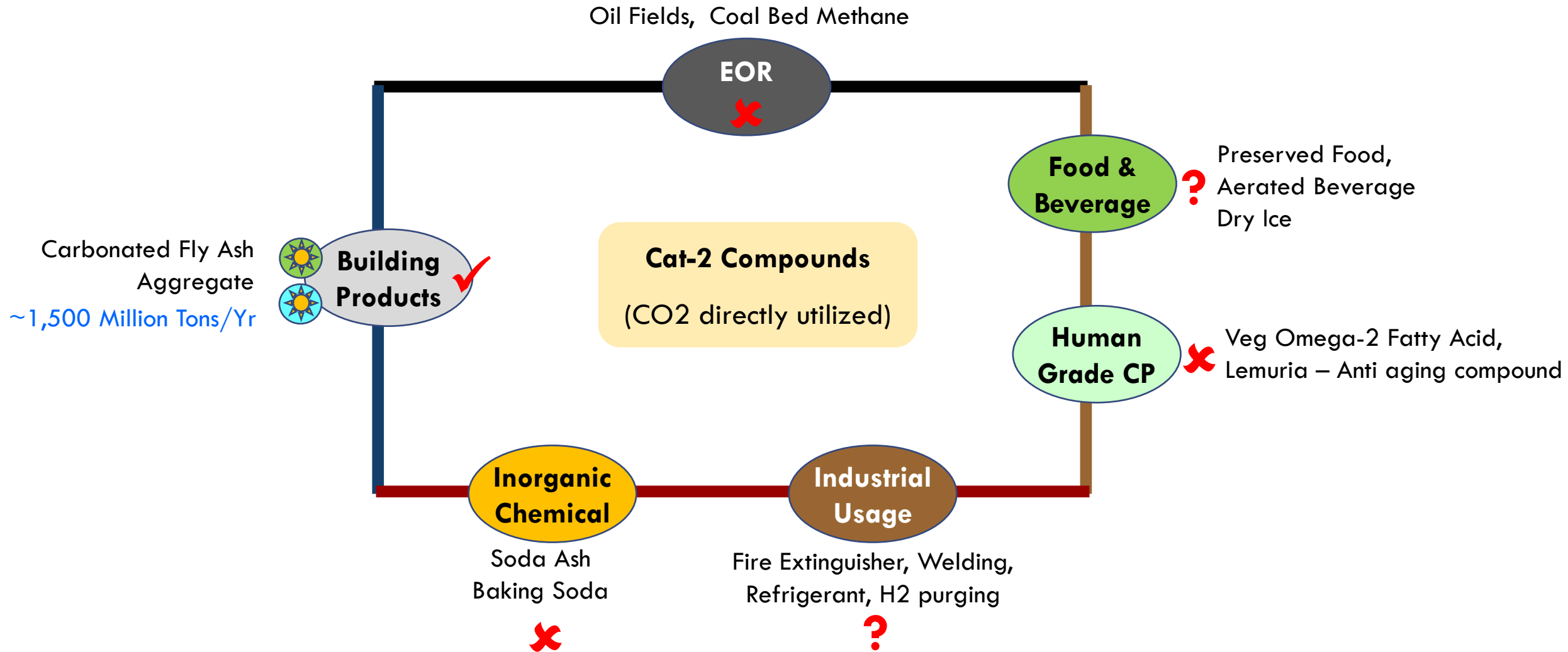


Inter-linking of 3-Green Pillars
(Renewables, Green Hydrogen & Carbon Capture and Utilization)

Every country needs to find its own unique path



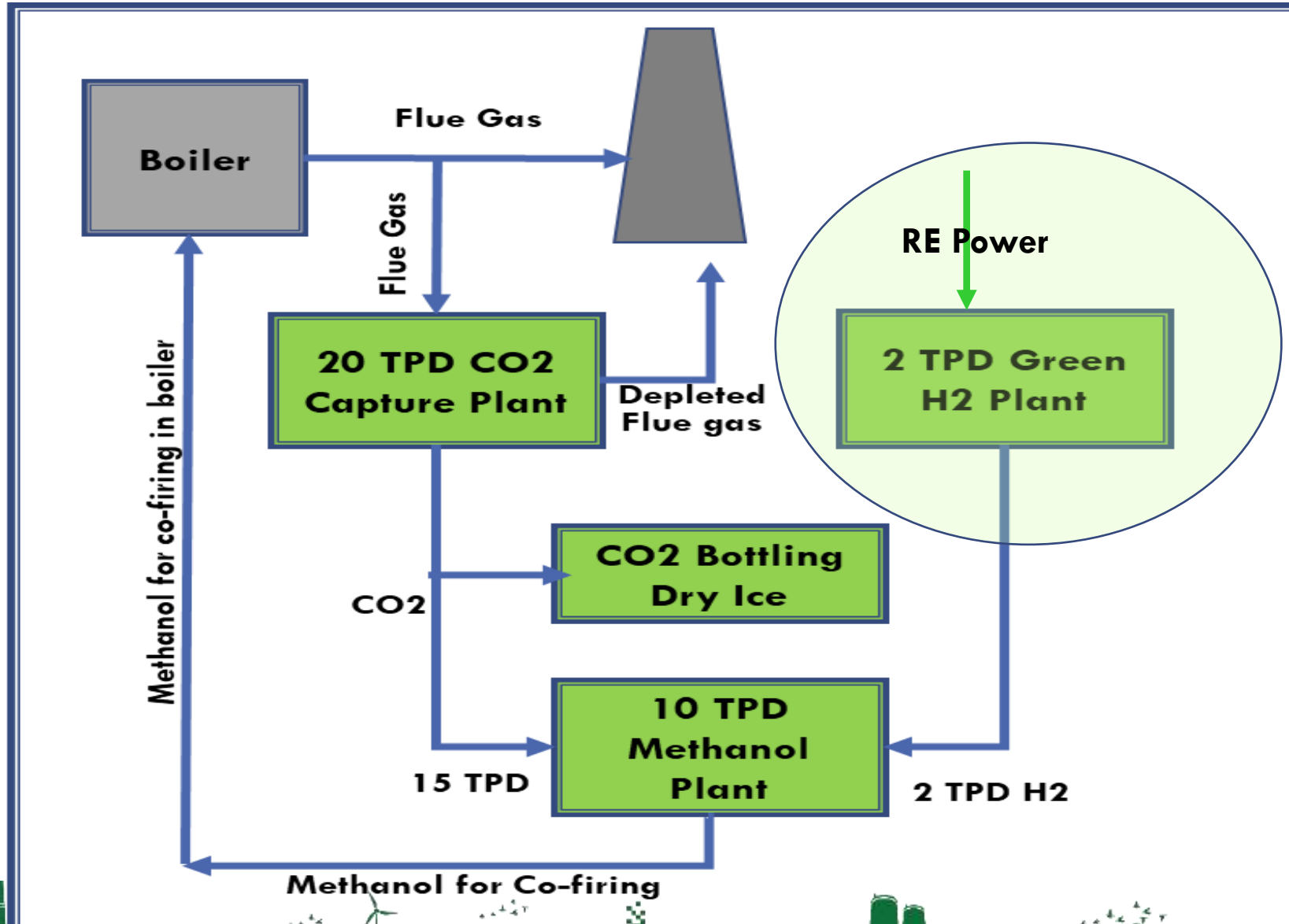
Carbon Capture & Utilization: Potential Avenues



Carbon Capture, Utilization & Storage Experience Sharing



10 TPD CO2 to Methanol (CTM)-Schematic



CO2 to Methanol- From licensing technology to indigenous development

Methanol-Licensed

3,300 TPA Plant at NTPC Vindhyachal



Commissioned

- 20 TPD CO2
- 2 TPD PEM Based H2
- 10 TPD Methanol synthesis
- 'First-Operation' completed on 7th Nov 2024
- Integrated Plant Operation on 3rd June 2025

Methanol-Indigenous

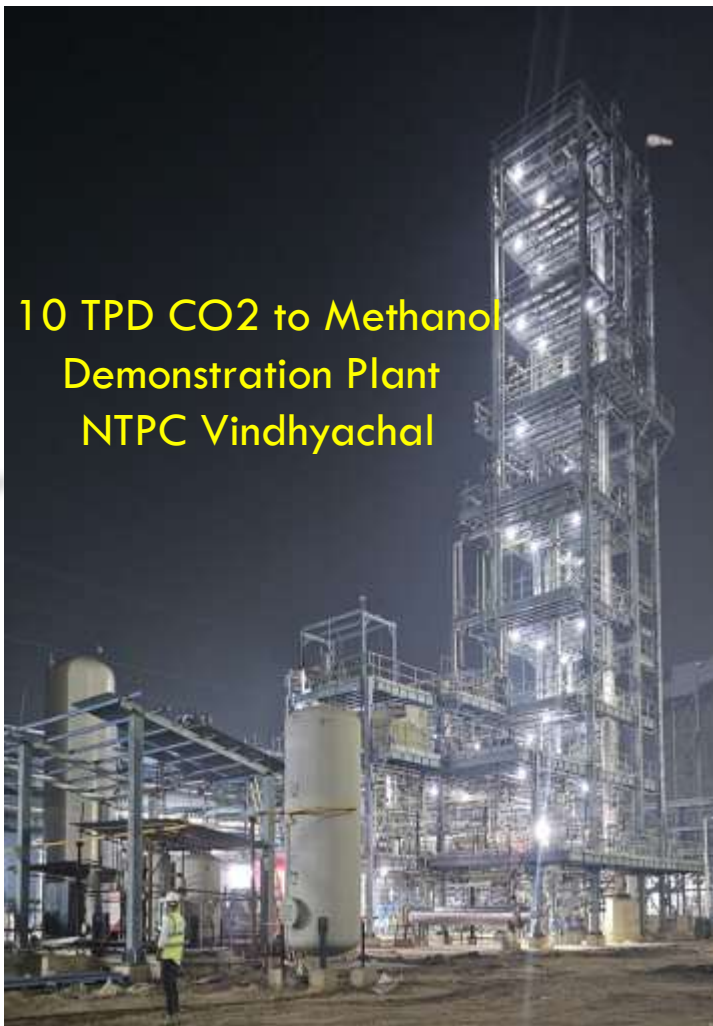
Indigenous Catalyst/Reactor Development



Completed

- With CSIR-IIP,
- 10 Kg/day Pilot at Netra
- Long term catalyst life testing under progress

10 TPD CO2 to Methanol Demonstration Plant NTPC Vindhyachal



10 kg CO2 to Methanol Pilot Plant At NETRA with indigenous reactor & catalyst



Carbon Capture, Utilization & Storage Scaling up the Technology



1. CCUS – NTPC Initiatives:

NTPC is working on all four (4) verticals of CCUS Technology – (i) CO₂ Capture, (ii) CO₂ Compression & Pipeline Transportation, (iii) CO₂ Utilization and (iv) CO₂ Sequestration

CO₂ Capture Hub (At NTPC Simhadri)

- 1x25 TPD Plant (Under Execution),
- 2x325 TPD Plant (Upcoming),
- 2x650 TPD Plant (Future),

CO₂ Compression & Pipeline Transportation

(From NTPC Simhadri to NTPC Pudimadaka)

- CO₂ Transportation in 'Supercritical Phase' (150 Bar, 40C),
- Configuration: (i) 1000 TPD (Upcoming), Distance: ~25 KM,
- **First CO₂ Pipeline in India**

CO₂ Utilization (At NTPC Pudimadaka)

- CO₂ to SAF: 1,800 TPA Plant,
- CO₂ to Green Urea – 50,000 TPA Plant,
- CO₂ to Green Methanol (Planned),
- **First CO₂ to Methanol, SAF, Urea Plants, globally**





Green Chemical Hub at Pudimadaka An Artistic view



**CCUS with Waste Utilization
Carbonated Bricks with Flyash
Demo Plant**



CCUS Technology Demonstration: 2 Lakhs/day Carbonated Brick Plant at NTPC Ramagundam

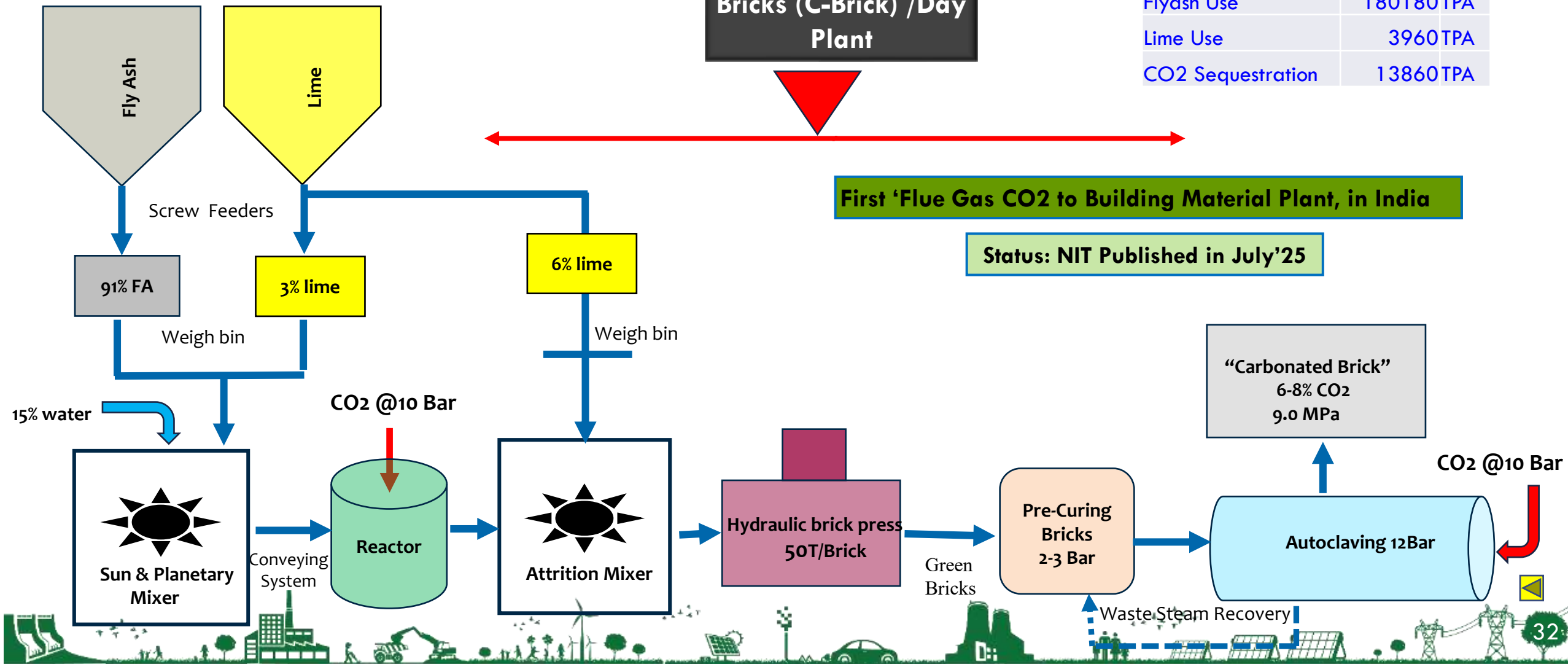


200,000 Carbonated Bricks (C-Brick) /Day Plant

Material Detail	
Flyash Use	180180 TPA
Lime Use	3960 TPA
CO2 Sequestration	13860 TPA

First 'Flue Gas CO2 to Building Material Plant, in India

Status: NIT Published in July'25



CCUS
Storing CO₂ in Depleted Coal Mines
Pilot



CCUS Technologies: R&D Initiatives



CCUS R&D Initiatives – CO₂ Storage:

CO₂ Emissions – The Big Picture:

- CO₂ emission from Coal Power Plant in FY 2024-25: ~ 1,110 Million Tons (@ 0.85 KgCO₂ /kWh, 1336 BU)
- CO₂ emissions reduction to match Gas Plant emissions: ~ 400 MT/Yr
- CO₂ emissions reduction thru CCUS: ~100-200 Million Tons/Yr
- CO₂ utilization in CCU technologies: ~50 Million Tons/Yr
- CCS will be compulsion – if Net Zero is to be achieved

Project-1:

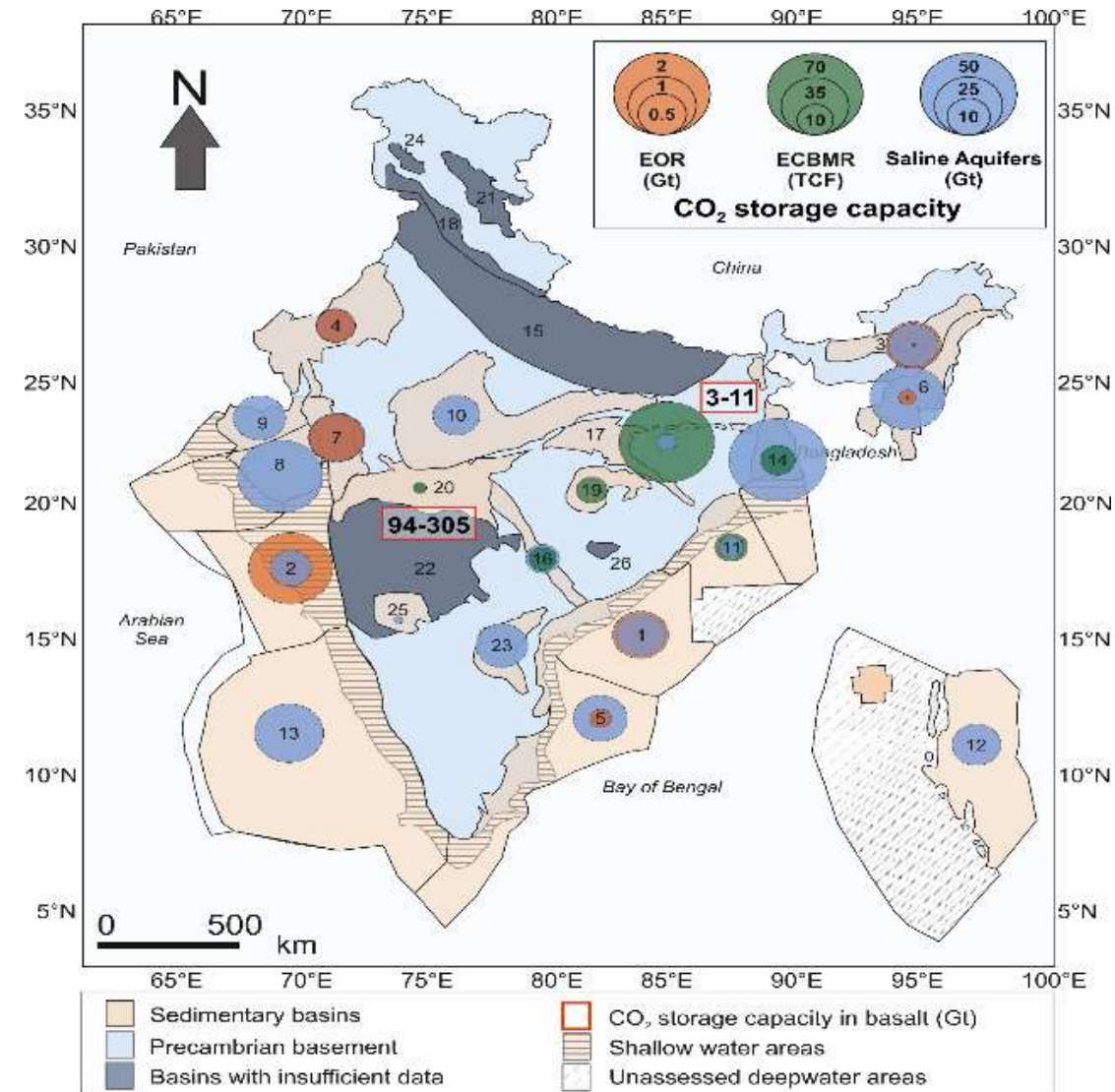
CO₂ Storage potential in 'Unusable Cat-1 Coal Seam' of NTPC

- First project of its kind, globally
- Collaborative Project with IIT Bombay,
- Completed in Jan'24

Project-2:

Drilling of 'CO₂ Injection Bore' and detailed Geological Studies

- Drilling Completed



Country's First CO2 Injection Borewell at Pakri Barwadih- Jharkhand.

Supported by NITI Aayog and based on IIT-Bombay and NETRA R&D Wing of NTPC studies, the site was identified for its high CO2 storage potential (4.3–15.5 million tons).

Two 1200-meter-deep borewell drilled

Lab Analysis:

- Core analysis
- Adsorption Isotherm
- Permeability Studies

Simulations:

- Dual Porosity Model: Fractured coal system
- Geo-Mechanical Coupling: Coal & permeability
- Injection Protocol

Actual Injection & Monitoring



CONCLUSION



- Energy Sector is going through a rapid transition
- India has chosen its path of Just Transition, where important principles are:
 - Energy Security & Sustainability
 - Technology and Innovation
 - Energy Access & Equity
- Coal plays a major role in Indian's Just energy Transition
- NTPC has taken a step forward to work on greening the coal.
- The Nation requires quick capacity development and projects on ground
- Knowledge Sharing & Collaborative Efforts can quicken the transition
- Congratulations to Organisers of 18th National Conference on Coal for organizing the workshop for wider discussion on different aspects of coal utilization
- Thanks and Gratitude for giving us a chance to share our experience



Thank You

