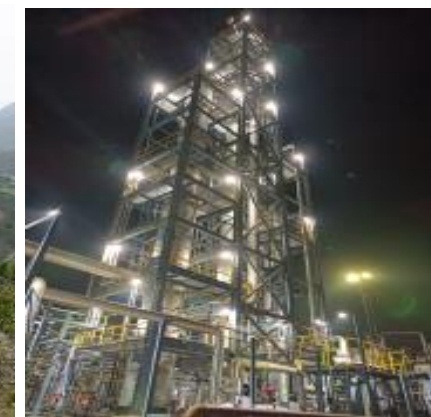




Sectoral Challenges and Opportunities for CCUS in Power Sector



By Ujjwal Kanti Bhattacharya, Director (Projects), NTPC Ltd.

Follow us on:



- **Analyzing Energy & Economy Scenario**
- **Pathways for decarbonization to Net Zero for Power (Thermal) Sector**
- **Sectoral Challenges & Opportunities for CCUS in Power Sector**
- **Overcoming the Challenges**
 - Decade long R&D in CO₂ Capture
 - Conceive, designed, engineered CO₂ to Methanol R&DD Plant at NTPC Vindhyachal
- **Going Forward**
 - Provision for Scale up in new Coal based Plants
 - Expanding CCU Product base
 - CCU to CCUS
- **Fast Forwarding the transition**



ANALYZING ENERGY & ECONOMY SCENARIO



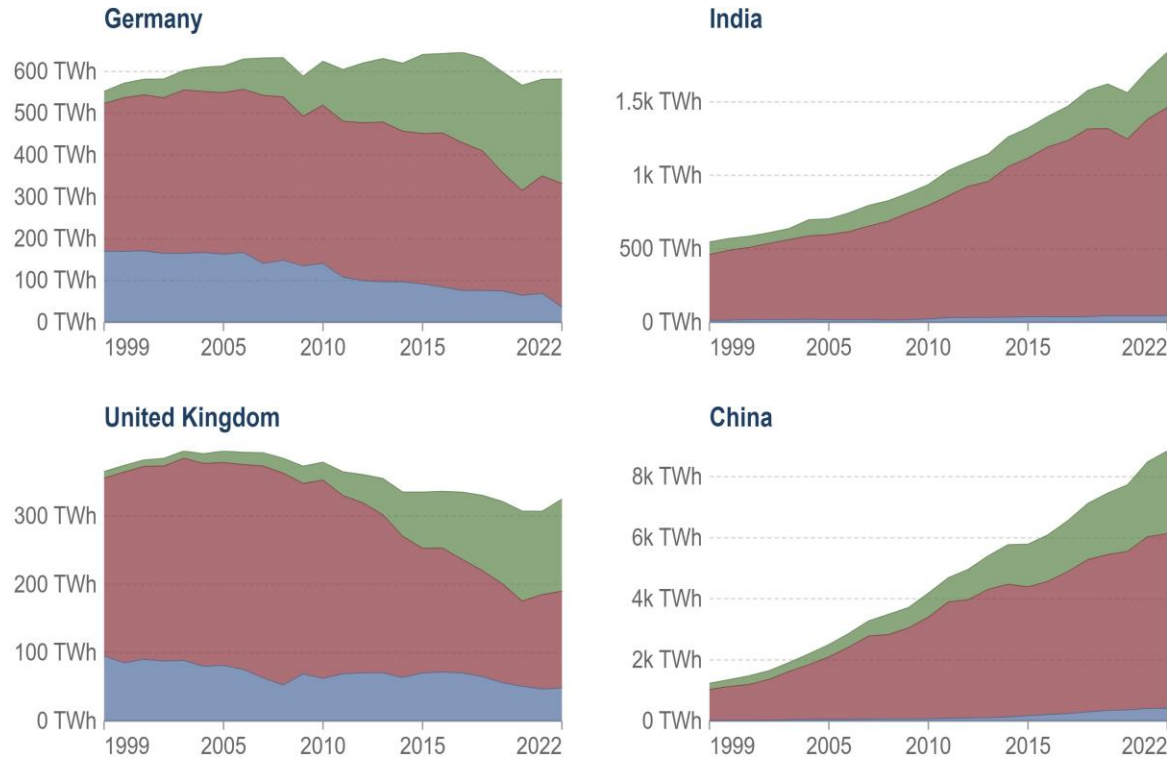
- **India's Commitment in COP 26 in Glasgow**
 - **Progressive decarbonization to reach net zero by 2070**
- **NDC setting quantifiable targets for Climate Action Plan till 2030**
 - Reduce carbon intensity of our GDP by 45% wrt 2005 level.
 - ~50 % of installed electricity capacity from non fossil fuel sources
- **COP27- Sector specific action plan**
 - Decarbonize Power, transport and steel, Scale up H2 technologies
 - Accelerate the shift to sustainable agriculture



Electricity production from fossil fuels, nuclear and renewables

Our World in Data

■ Renewables ■ Fossil fuels ■ Nuclear



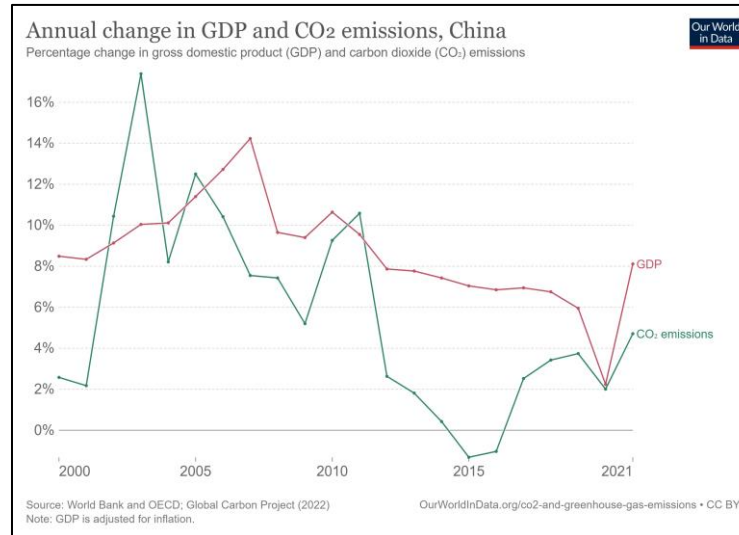
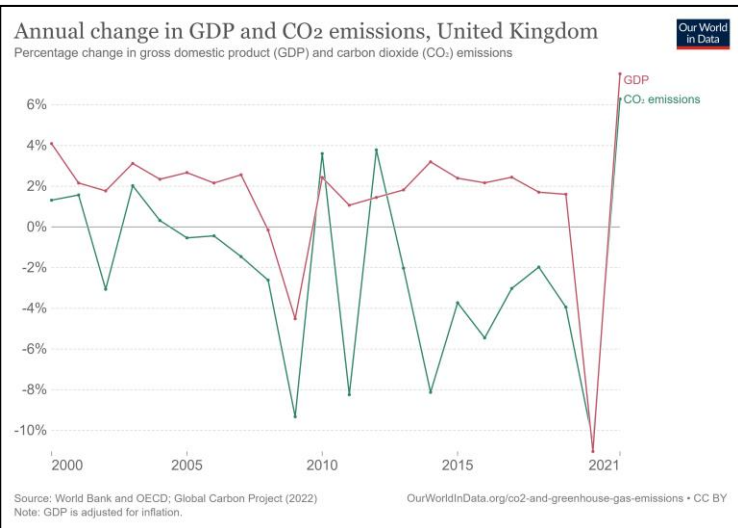
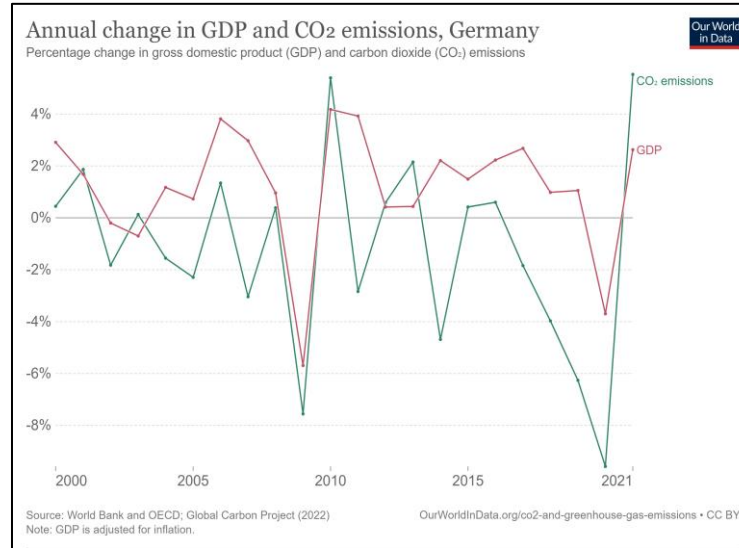
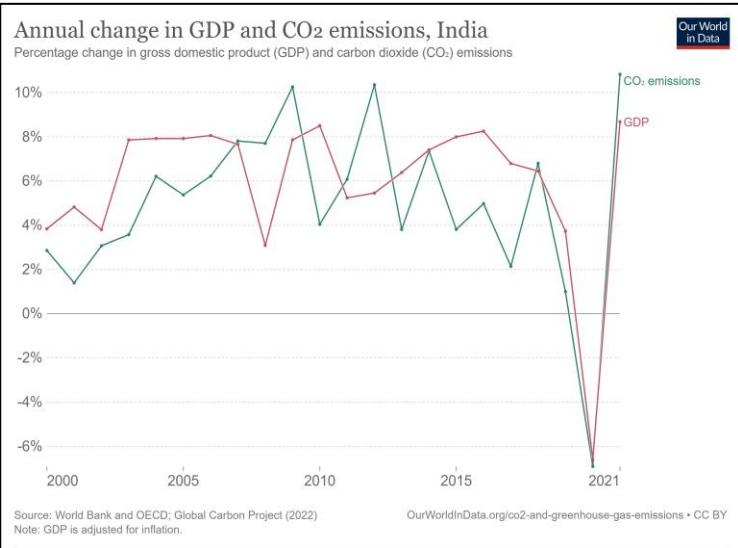
Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy
OurWorldInData.org/energy • CC BY

Some Observations:

- Generation increases post covid for all economies
- Fossil fuel generation supported the economic recovery
- In most economies the share of fossil fuel electricity decreased as renewable increased
- In absolute terms, fossil fuel generation increased
- This trend will continue till affordable storage becomes a reality



CO2 Emission & GDP trend in Selected Economies

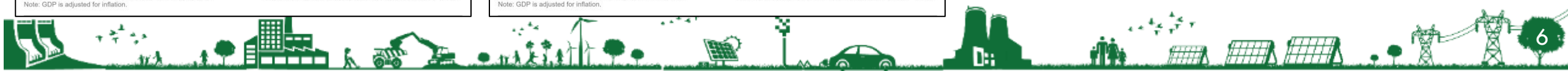


Observations

- **GDP increasing**
- **Fossil fuel consumption increasing**
- **So is CO2 emission**

Strategy for decoupling of economic growth from GHG emission is required

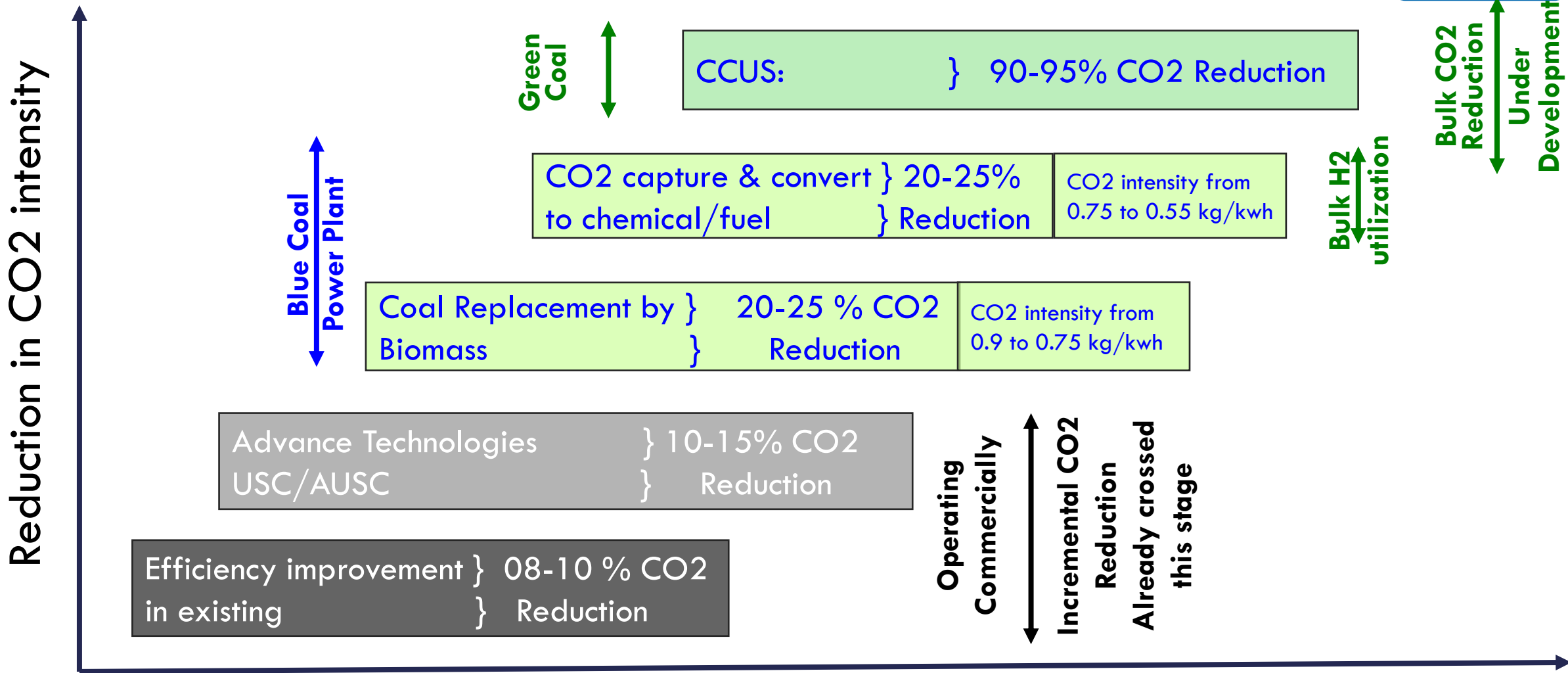
Pathways for Decarbonization of fossil generation becomes important



PATHWAYS FOR DECARBONIZATION TO NET ZERO FOR POWER SECTOR



Pathways for decarbonization for Net Zero in Power Sector



SECTORAL CHALLENGES & OPPURTUNITIES FOR CCUS



Sectoral Challenges & Opportunities for CCUS

For Power Sector: CCUS A transition from Utility to Chemical/Process domain

Challenges

- CCU/S Technologies: Availability/Cost
- CCU: Production and market are apart
- CCUS: Sources & Sinks are distant
- Space constraint in power plant after FGD
- Safety Standards and Guidelines
- Utility to Chemical: Matching competencies
- Financing the transition
- Policy initiatives

Opportunities

- Indigenous R&D-Innovation & IPR
- Skill Set Enhancement
- Scale up/Demonstration: Signal to market
- New entity for aggregating demand/supply
- Hub/Cluster model
- Business model for market creation/sustenance
- Policy Changes
 - Increasing Land allocation
 - Allow change in land use
 - Introduce Carbon Taxation/Incentive



Overcoming the Challenges

15 years of R&D in CO₂ Capture by NTPC



NTPC Approach: From Challenges to Opportunities in CCU



2004-2017:

- **Aim:** Development and evaluated of different CO₂ Capture Technologies
- **Methodology:** Industry-R&D Collaborative approach
- **Results:** Engineering input for 10 TPD CO₂ to Methanol R&DD Plant at NTPC Vindhyachal



NTPC NETRA

PSA BASED CO₂ CAPTURE



NTPC Faridabad

Micro-algal CO₂ CAPTURE



NTPC NETRA

AMINE BASED CO₂ CAPTURE

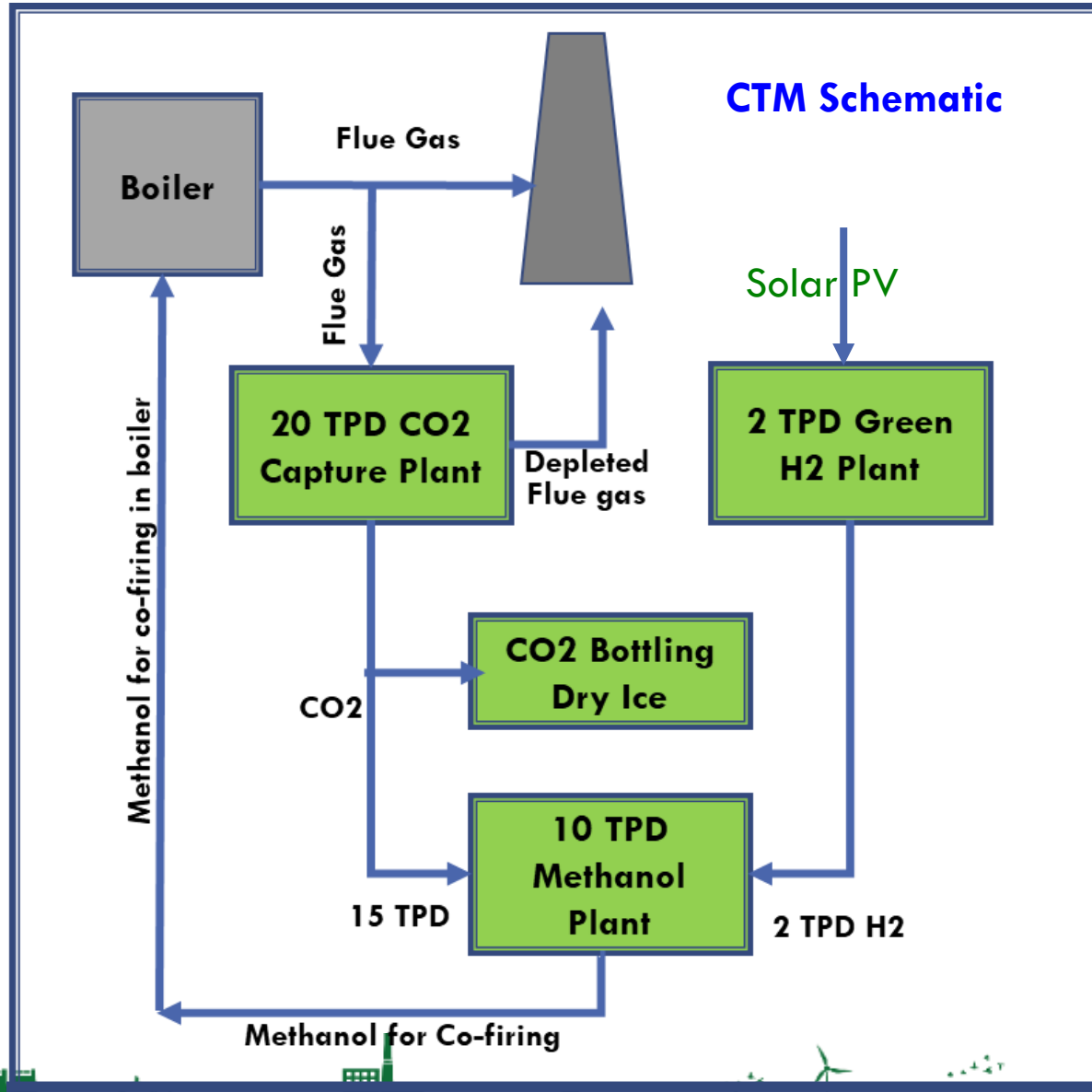


Overcoming the Challenges

Conceive, design, engineered, set up of 10 TPD CO₂ to Methanol (CTM) Plant



10 TPD CO₂ to Methanol (CTM)



Converting Challenges to Opportunities

- In house engineering and integration
- Competency building
- Developed partners for execution
- Competitive bidding
- Discovered CAPEX-Cost competitive
- CTM R&DD Plant:
 - Skill enhancement Centre
 - A set up for further R&D/experimentation
 - Planned- CO₂ liquefaction/food grade
 - H₂ interconnection with main plant

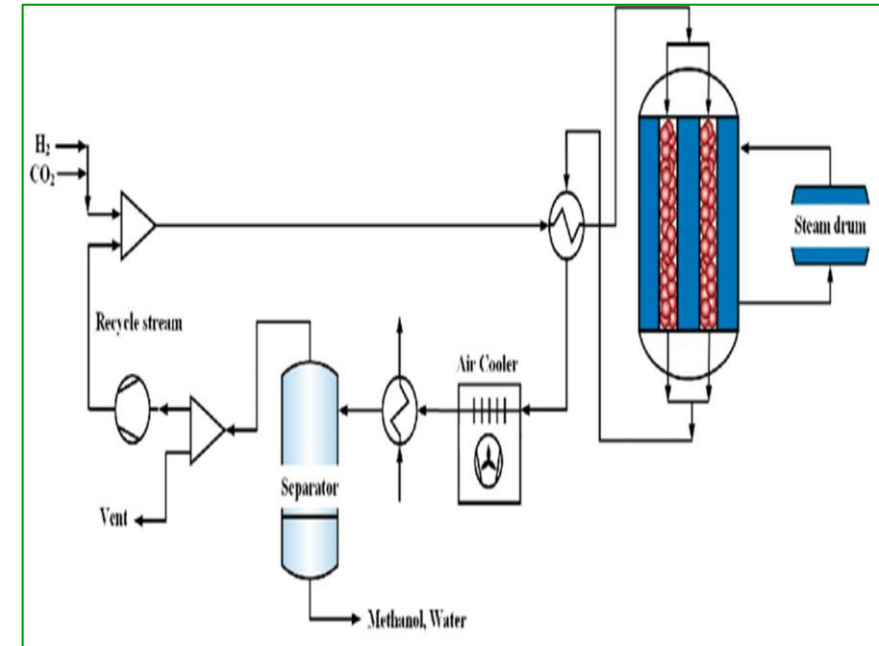
CO2 to Methanol (CTM)-Project at a Glance



	1	2	3	
	CO2 Block	Green H2 Block	Green Methanol Block	
			3(A)	3(B)
Package	20 TPD CO ₂ Capture Plant	2 TPD H ₂ Generation Plant	Technology Package: Reactor, Catalyst, Technology	EPC Package: 10 TPD Methanol
Technology	Solvent Absorption	Proton Exchange Membrane	Hetero Catalytic Hydrogenation	Based on Engineering of Technology Package
Status	Awarded (March'21) & Commissioned	Awarded (July'21) and Under Execution	BDEP* Awarded(Sept'21) Engineering completed	Awarded on 24.02.2023
Price	14.14 Cr	49.5 Cr	3.64 Cr	~58 Cr
Contractor	Green Power, India + Carbon Clean Solutions, UK	Technip, India + Plug Power, US	Toyo Engineering(India+ Japan)	Jakson India
Completion	Commissioned on 15.08.2022	Commissioning by 3rd Qrt 23-24	Based on PDEP in-house Engineering done by Mar 22	Q4 FY 23-24



10 TPD CO₂ to Methanol (CTM)



**20 TPD CO₂ Capture Plant
Running**

**2 TPD PEM based H₂ Electrolyser
Planned Commissioning 3rd FY 2023-24
Presently largest PEM Electrolyser in India**

**10 TPD Methanol Synthesis
Planned Commissioning 3rd Qrt FY 2023-24**



- CO₂ Capture from flue gas: 86.9vol%
- Purity of captured CO₂: 99.95vol% (dry)
- Steam Demand: 1.42 Ton/Ton CO₂
- Solvent Consumption: 0.285 kg/Ton CO₂
- Power Consumption: 80-100 kW



GOING FORWARD

Scale up
Expanding CCU product base
CCU to CCUS



▪ Expanding the Product base from CO₂

- Pilot Project for CO₂ to Ethanol
- Pilot Project for CO₂/N₂ from FG to Green Ammonia/Urea
- Evaluating Non H₂ based Product using CO₂

▪ Keeping Provision for scale up in new Plants

- FGD implementation is going on in all NTPC Plants
- All existing plants will be ready for CO₂ Capture
- Provision for Space & Utility in all upcoming coal-based plant for 20% CO₂ Capture
- Scale up data from 10 TPD CTM shall be used

▪ CCU to CCUS

- CCU may not be sufficient for decoupling
- NETRA just commissioned a study for CO₂ Storage
- Efforts to understand geology, storage , detection etc



FAST FORWARDING THE TRANSITION



- **Technology:** Collaborative approach for competency matching and fast transition
- **R&D Demonstration in CCU & CCUs:**
 - Generating data for scale-up, policy formulation, standards, confidence building, corrective measures
- **Development of Clear, balanced legal framework**
 - Utility Organization will now involve in Chemical production and Supply
 - Conversion of Land Use: Producing Chemical product in Power/Metal/cement industries
 - Taxation of new product from CO₂ utilization from Power/Metal/cement etc industries
- **System/Organization:** System for Infrastructure, Controller, Aggregator, Standards, Monitoring
- **Funding for new projects as Market is not developed**
 - Funding for new projects, grant, project/viability funding
- **Creating/Developing market for green products**
 - Creating and supporting market for green product
 - Tax Relief
 - Carbon tax/Carbon incentive



Thank You



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