Thrust Areas in R&D for Zero Emission Coal Based Technology in the Indian context

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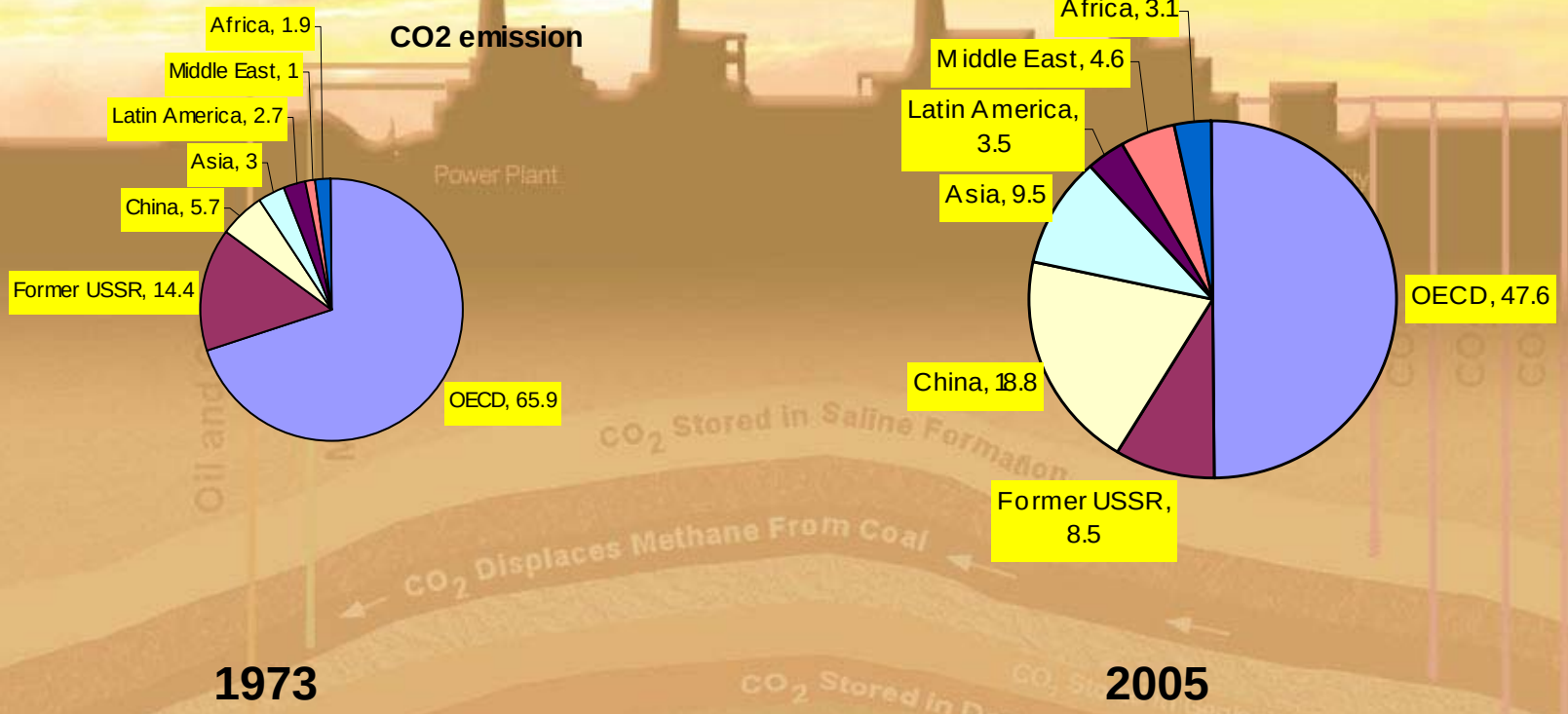
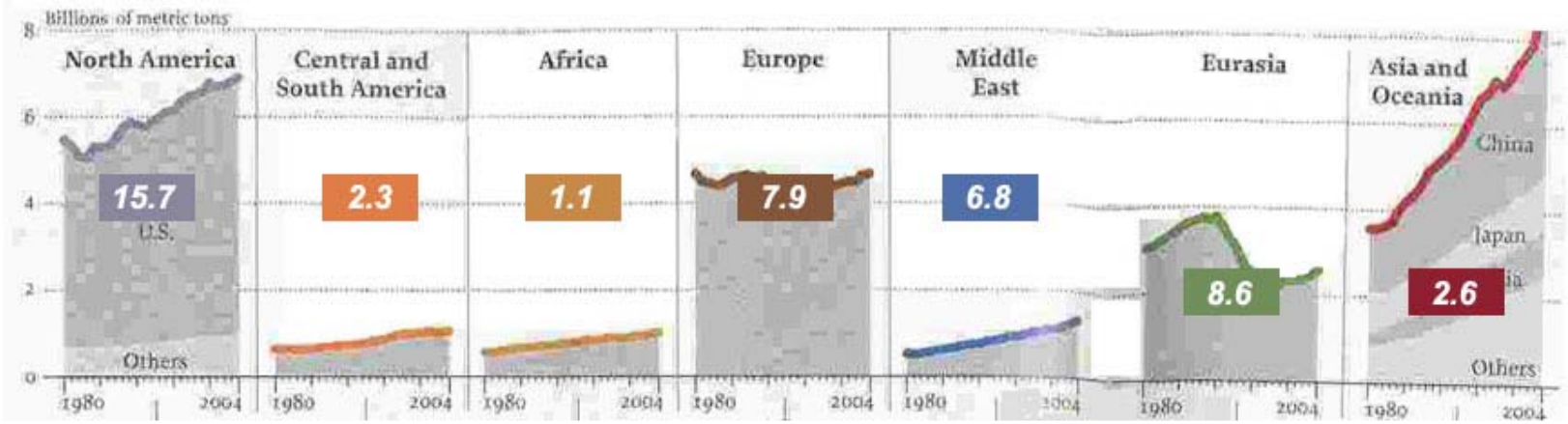
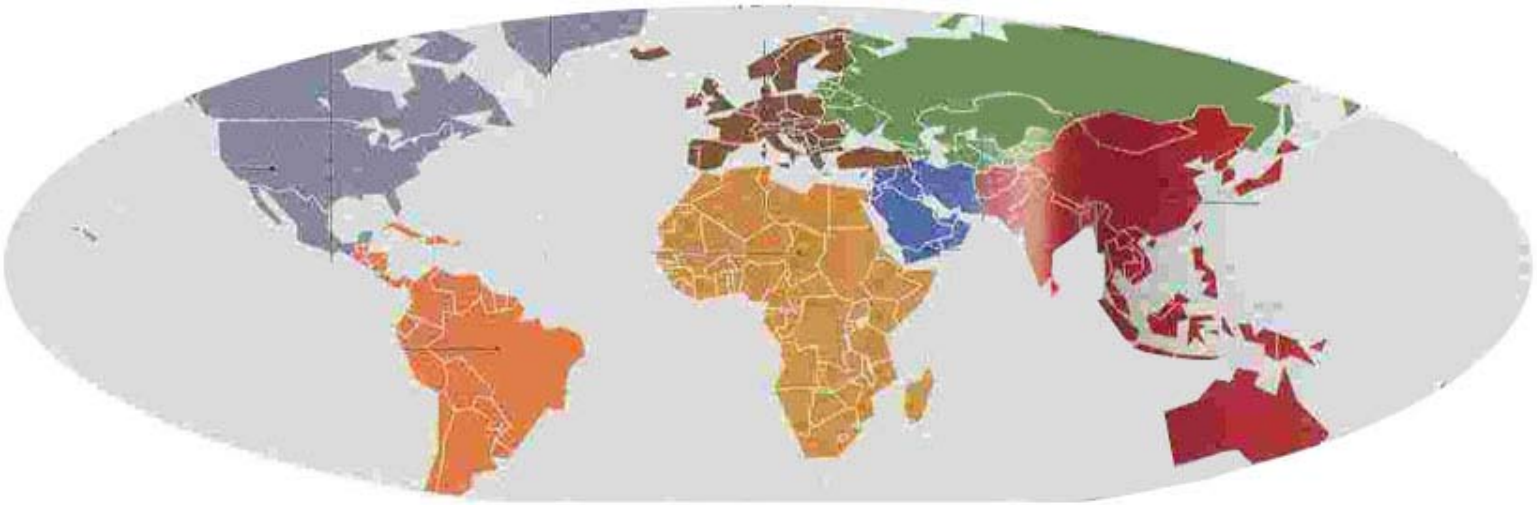
INCREASING CO2 EMISSIONS – REGION WISE DISTRIBUTION



TOTAL CO2 EMISSIONS AND PER CAPITA FROM ENERGY SECTOR





ENERGY TECHNOLOGY AND CLIMATE CHANGE

- **The environment and climate change consequences of energy technology are becoming most critical issues before the mankind in 21st century.**
- **Energy - climate change policies are being examined world wide for promoting sustainable development. Protocols/ international mechanisms are being introduced.**
- **Coal Based Energy Technology is rapidly moving from Low emissions towards Very low- Ultra low – Zero emission.**
- **In India enormous thrust to renewables has been given to achieve zero emission energy production. While it contributes to sustainable development, the success in the long-run would depend on the reliability and cost reductions**

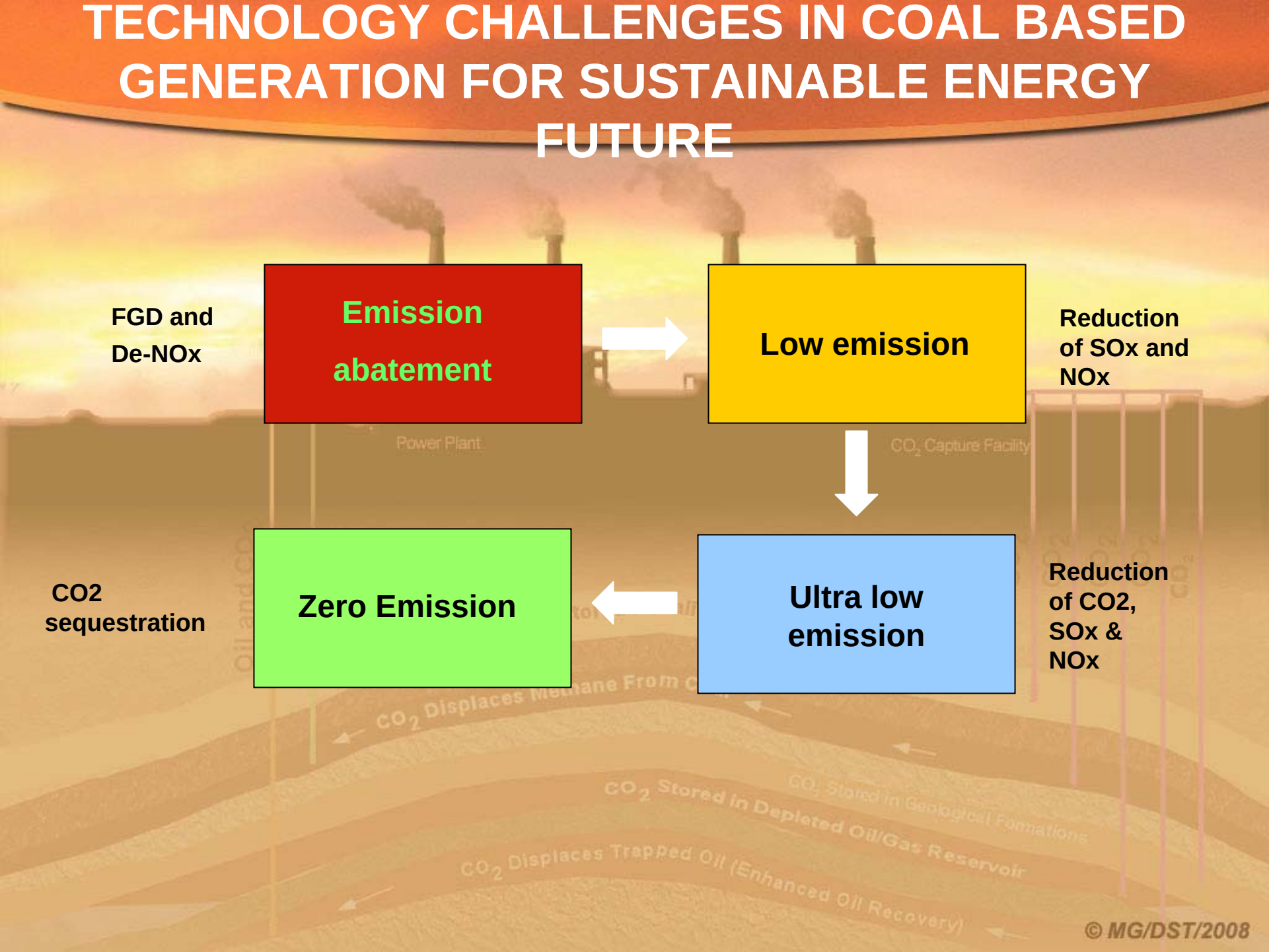
CO2 MITIGATION PATHWAYS IN ENERGY TECHNOLOGY

- **Adoption of high efficiency in thermal power generation through fuel and boiler technology**
- **Increasing use of renewable energy sources**
- **Growing nuclear power production**
- **Improving Energy efficiency in end-use sectors**
- **Promotion of clean coal technology**

RATIONALE FOR ZERO EMISSION COAL BASED GENERATION

- **Fossil fuels will continue to have major share in primary energy fuels globally**
- **Coal is dominant fuel meeting and 30 % of global Energy demand and 69% of nation's current commercial energy demand**
- **Emerging CCS options would make coal based thermal power generation environmentally friendly**
- **With over 260 GW capacity addition planned till 2030, sustainable use of coal will be promoted**
- **Energy needs are directly linked to socio-economic development. Challenge is how to address this issue in the growing India's Energy Scenario and chalk out an Energy Path characterized by high level of efficiency, effective use of new technology.**

TECHNOLOGY CHALLENGES IN COAL BASED GENERATION FOR SUSTAINABLE ENERGY FUTURE



CARBON CAPTURE AND STORAGE RESEARCH

Carbon Sequestration offers many scientific and technological challenges to be addressed dealing with

- **Carbon Capture**
- **Carbon Transport**

Cost intensive, processes known

- **Carbon Storage**
- **Carbon Abatement**

Research Intensive, processes not fully understood

CO2 SEQUESTRATION PATHWAYS IN COAL BASED GENERATION

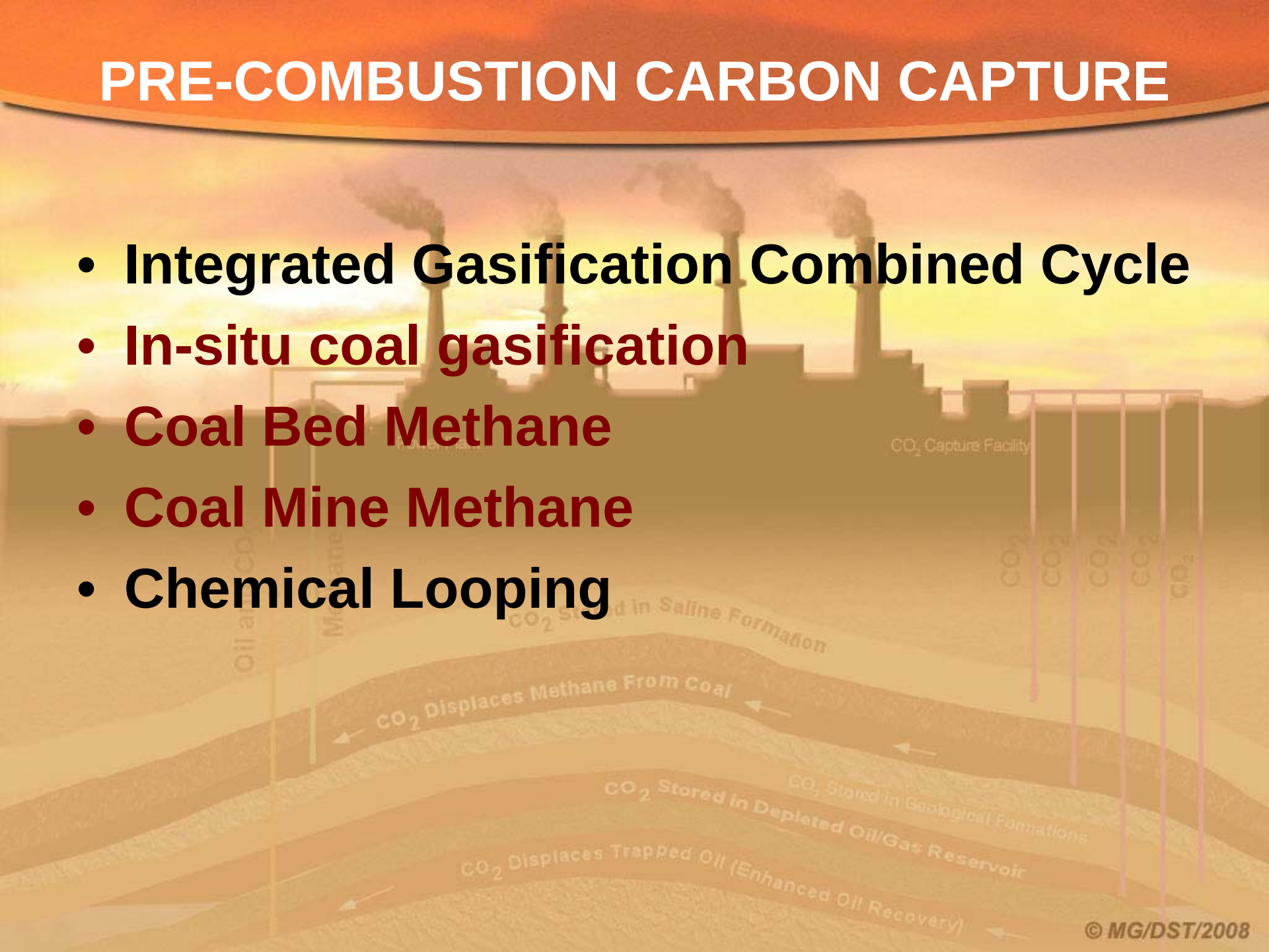
- Pre-combustion CO2 Capture
- CO2 Separation from flue gas
- Terrestrial Sequestration
- Geological Sequestration
- Enhanced Hydrocarbon Recovery
- Bio – Fixation methods
- Advanced Concepts

A ZERO EMISSION CONCEPT PROPOSAL

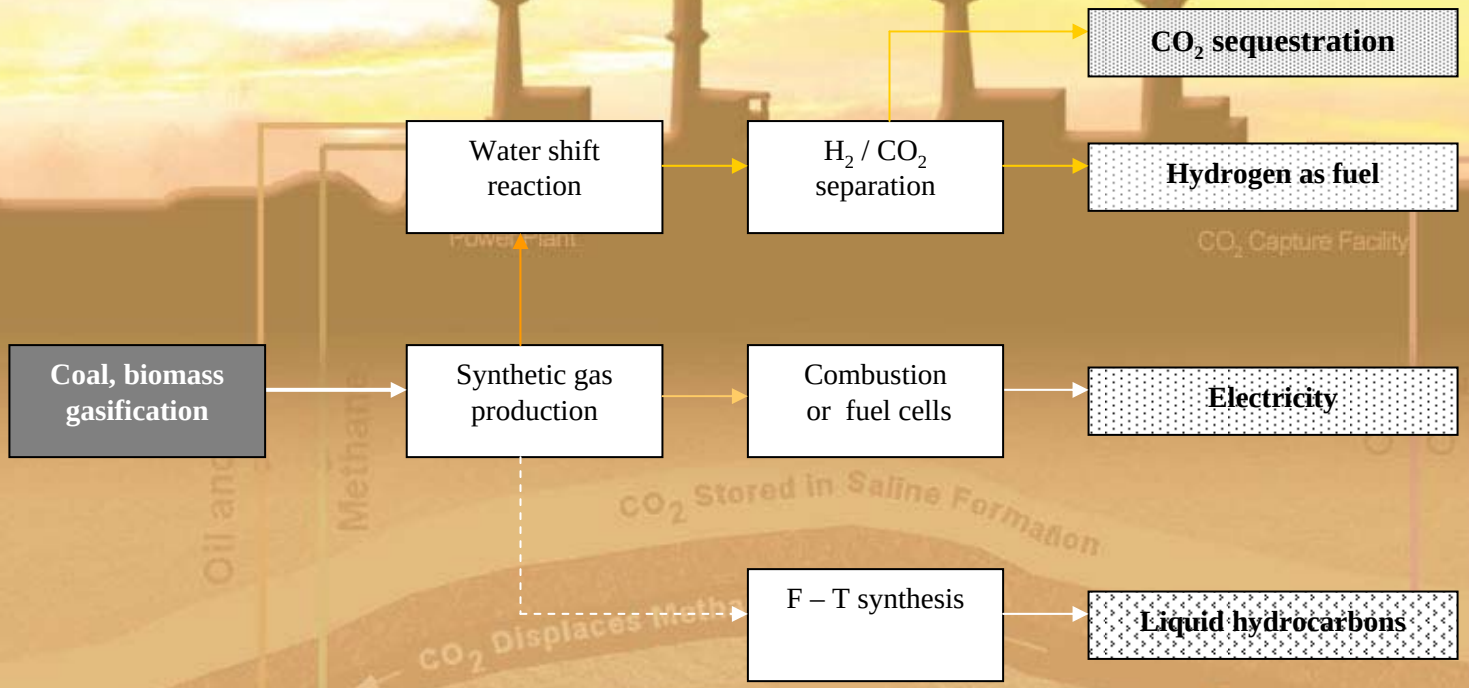
- **Selection of Technology**
  - **Pre-combustion Carbon Capture**
  - **Oxy fuel Carbon Capture**
  - **Post Combustion Carbon Capture**

PRE-COMBUSTION CARBON CAPTURE

- Integrated Gasification Combined Cycle
- In-situ coal gasification
- Coal Bed Methane
- Coal Mine Methane
- Chemical Looping

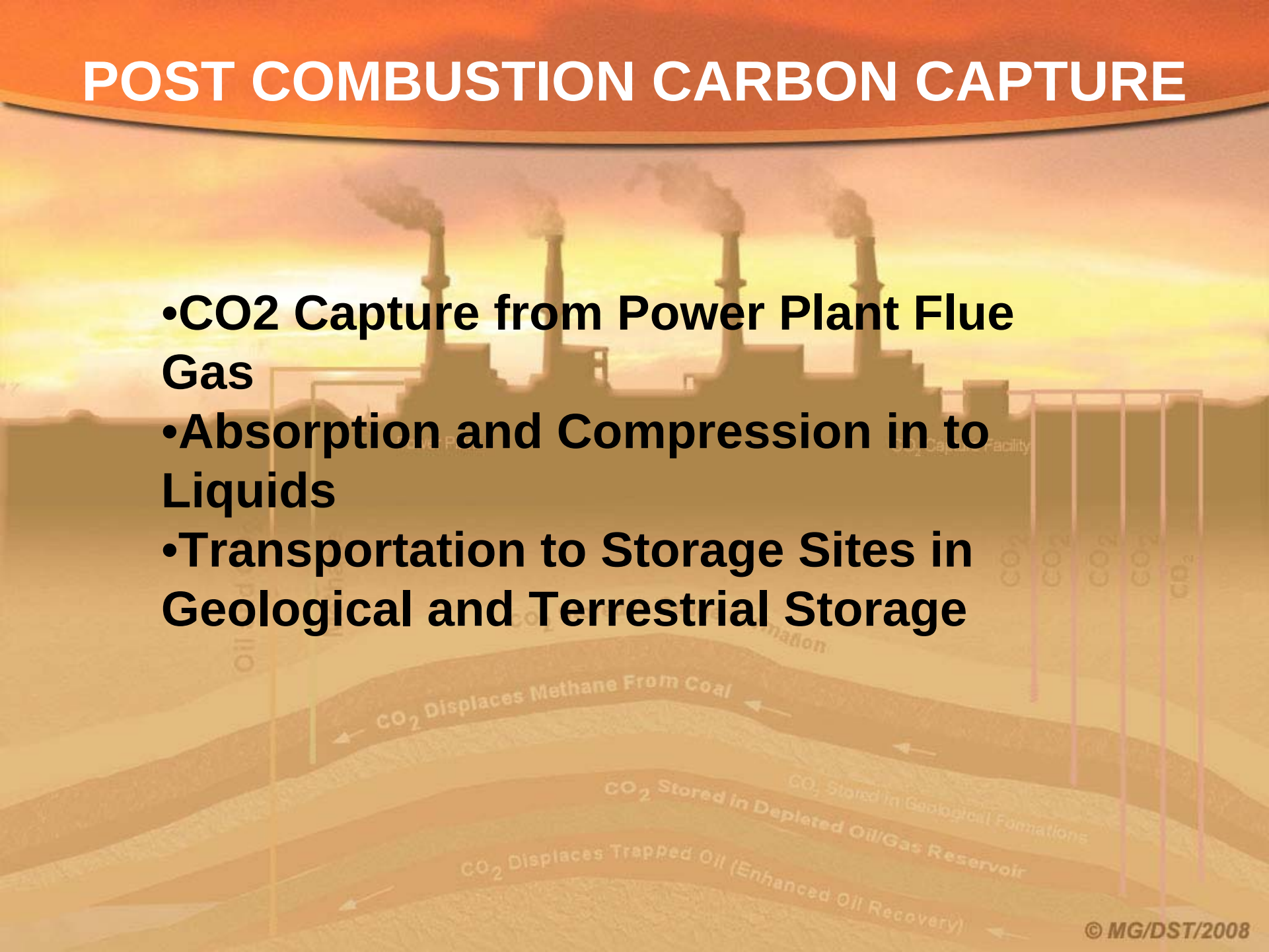


ZERO EMISSION COAL POWER - IGCC ROUTE



POST COMBUSTION CARBON CAPTURE

- CO_2 Capture from Power Plant Flue Gas
- Absorption and Compression in to Liquids
- Transportation to Storage Sites in Geological and Terrestrial Storage



OXYFUEL COMBUSTION

- Coal fired Oxy fuel commercial was first demonstrated in 1982 to generate CO2 for enhanced oil recovery.
- Coal Combustion takes place in presence of 100% Oxygen
- Suitable for near Zero emission Technology
- Nitrogen is removed before combustion and not required to be separated from flue gas
- Lower Commercial and Less Technical risk for CO2 capture as compare to Coal Gasification Technology.
- Can be implemented for retrofitting in old plants.
- Low SOx and NOx emission compare to PF.

OXYFUEL - DRIVERS

- Reduced combustion product volume/mass
- Increased condensable vapors
- Increased radiant heat transfer
- Multistage for advanced control
- Increased boiler efficiency

OXYFUEL IN COMPARISON WITH IGCC

IGCC

- **IGCC with molten ash removal system need flux additions to maintain a molten slag.**
- **High ash coal need high level of flux because of high fusion temperature and this has significant impact all the operating costs and efficiency.**
- **The heat losses in the slag are significantly higher**
- **Low availability.**

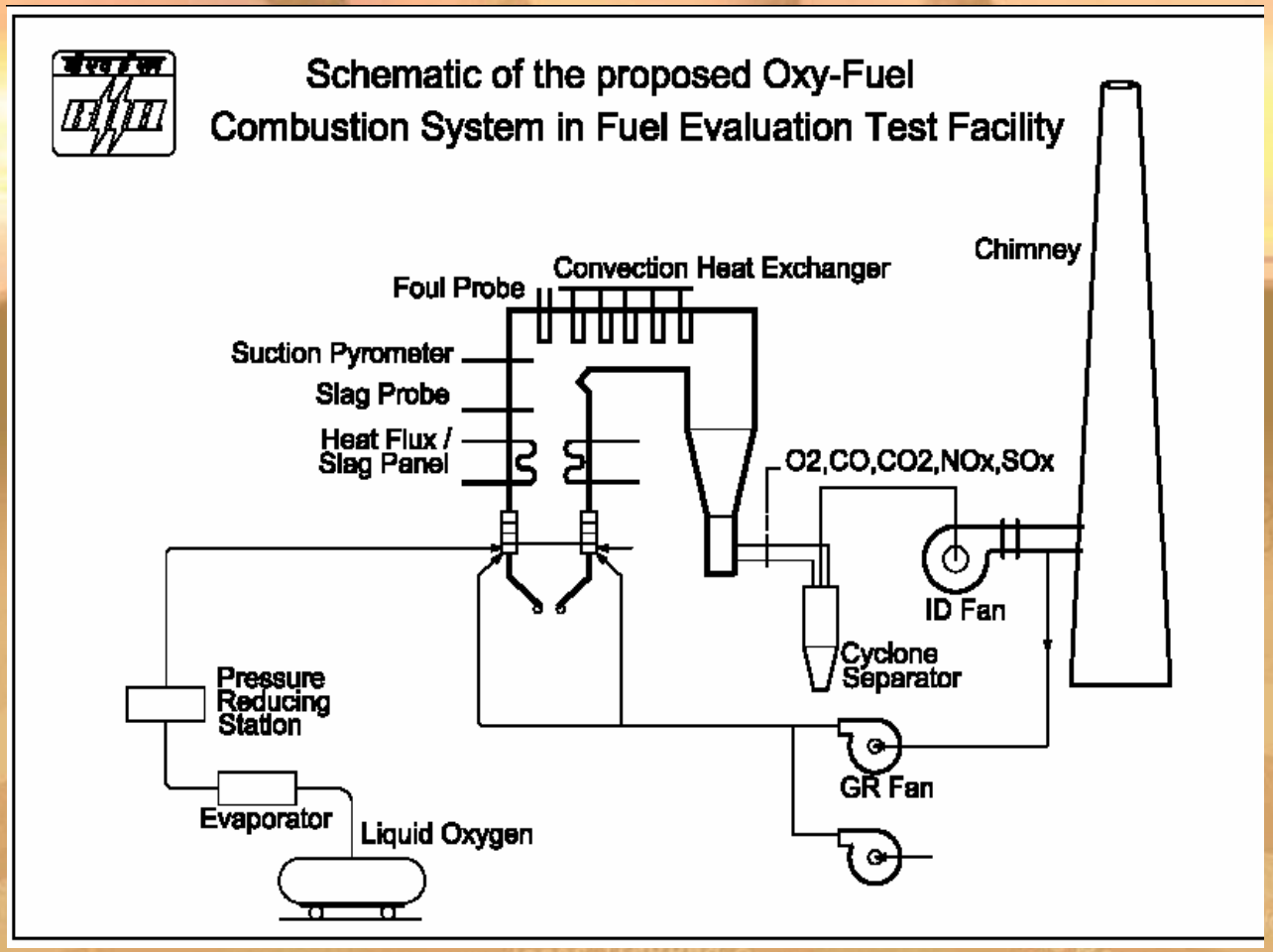
Oxy Fuel

- **High Ash Coal tends to have low slagging and fouling propensities which reduces the quantity of ash retained within the boiler.**
- **100% Oxygen would produce temperature that damage the boiler components. To decrease the frame temperature it is necessary to dilute the oxidizing scheme by re-cycling CO2 in to the boiler**
- **Up to 90 % CO2 in flue gas makes it easier to capture.**

OXYFUEL IN COMPARISON

Technology	Cost of CO2 reduction 2010
IGCC	44
IGCC25% CCS	45
IGCC 75% MEA-CCS	42
Oxy-fuel -95% CCS	26
NGCC	22
USC	18

PRELIMINARY STUDIES AT BHEL



STUDIES AT BHEL

Effect Of Temperature Zones Along Gas Path On Heat Flux Reduction

S No	Observation	% Heat Flux Reduction (240 Minutes)
01	Burner Zone	65%
02	Furnace Exit	55%
03	Radiant SH Zone	20%
04	Convection Zone	10%

OXY FUEL R&D NEEDS

- Numerical studies have shown that re-circulated CO2 not only reduces temperature but leads to increasing CO formation that modifies oxidative roofs.
- Further Laboratory work and Feasibility studies required for understanding design parameters and operation issues.
- Removal of Nitrogen from flue gas or removal of Nitrogen from air before combustion
- Requires oxygen separation plant which is cost intensive.
- Understanding of coal combustion process including ignition, burnout and emissions.
- Assessment of SOx removal with coal in India
- Assessment of retrofit for electricity cost and cost of CO2 capture.

THANK YOU VERY MUCH

‘O Earth, O Mother, dispose my lot
in gracious fashion that I be at ease.
In harmony with all the powers of Heaven
Set me, O Poet, in grace and good fortune!’