

CSLF Technical Group Meeting on November 14-15, 2006 in UK

ICOSAR

Introduction and Review of Possible
Projects in CO₂ Sequestration
Collaborative Research

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PRESENTATION ON NOVEMBER 15, 2006, LONDON, UNITED KINGDOM

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OVERVIEW OF PRESENTATION

PART 1

Item 18 of the Agenda of CSLF Technical Group Meeting

INTRODUCTION AND REVIEW OF POSSIBLE PROJECTS

PART 2

Possible Projects proposed

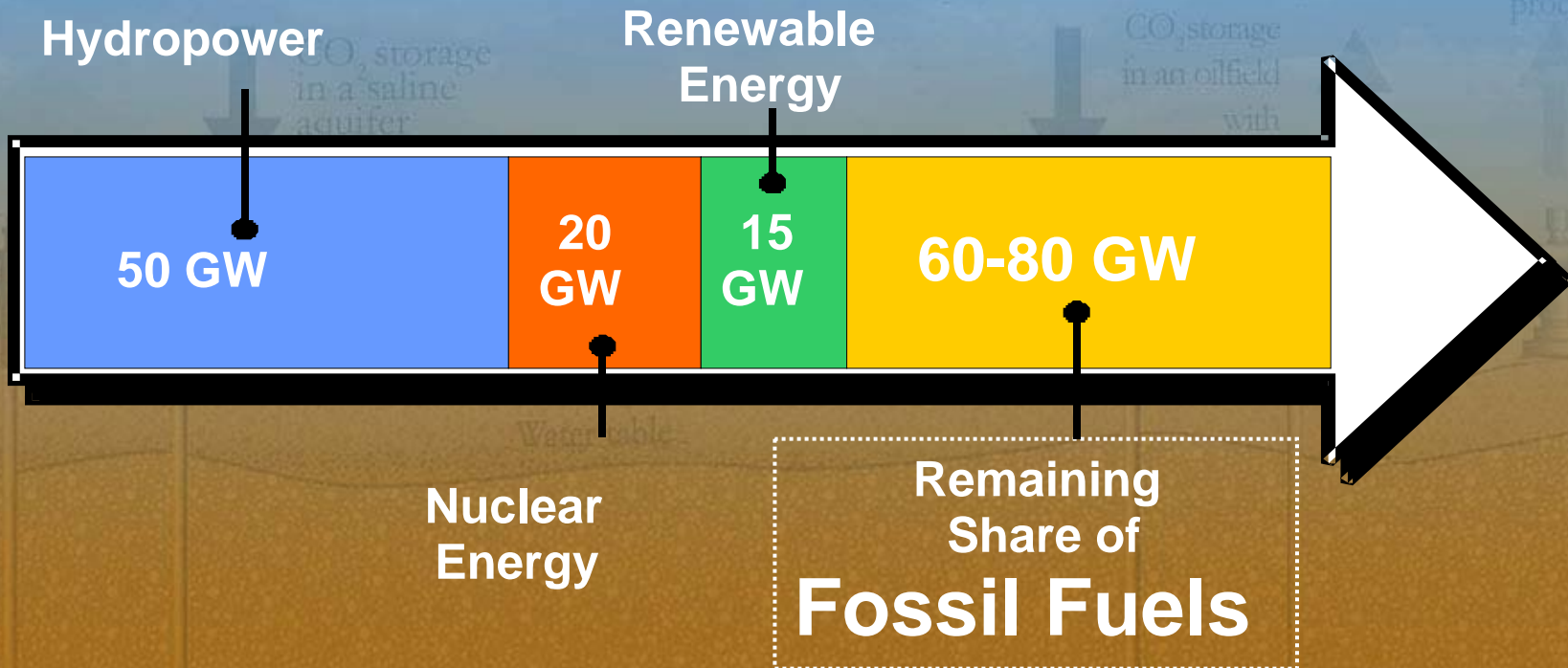
- CCS AND INDIA
- CSLF AND PERSPECTIVES IN CCS
- R&D PROJECTS AND PROJECT UPDATE

Part 1- INTRODUCTION AND REVIEW OF POSSIBLE PROJECTS

- CSLF Members are invited to propose new RD&D Collaborative projects on their priority areas
- Seventeen now, should add more in next three years so that they can be completed before the Charter ends in 2013
- Four projects were presented during the last Technical Group meeting as possible projects, to be discussed
- PIRT has discussed Project Submission guidelines and invited CSLF project data sheet template - Annual review proposed

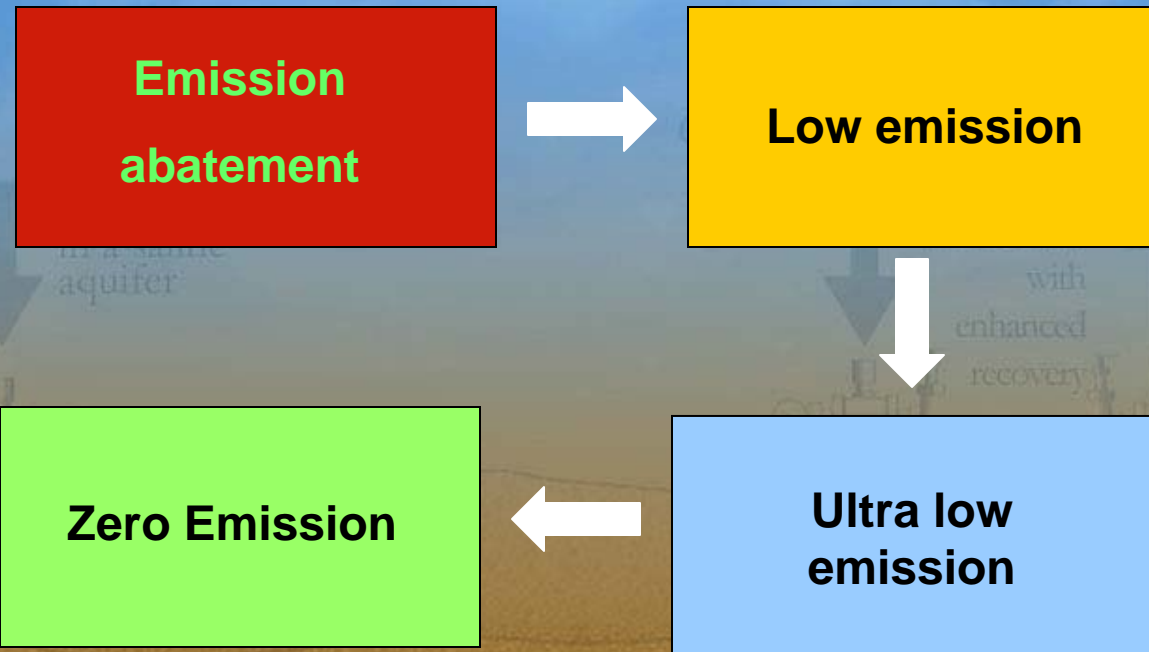
Part 2 - CCS AND ENERGY IN INDIA

Anticipated Capacity Addition at the end of 11th Plan 160GW



Coal is dominant primary energy resource having a share of 60 % and will continue to be predominant

CCS AND INDIA - TECHNOLOGY CHALLENGE FOR SUSTAINABLE ENERGY FUTURE



India has signed the Framework Protocol with USA in FutureGen project aimed at sharing experience and expertise in zero emission coal based energy generation

INDIA'S APPROACH TO CLIMATE CHANGE RELATED ENERGY SECURITY

- Adoption of high efficiency in thermal power generation through fuel and boiler technology
- Increasing use of renewable energy sources
- Growing nuclear power production
- Energy efficiency in end-use sectors
- Promotion of clean coal technology
- Constitution of National Clean Development Mechanism Authority for considering projects for availing carbon credits
- **Member to Carbon Sequestration Leadership Forum**
- Member to Asia Pacific Partnership in Clean Development and Climate

INTERNATIONAL CARBON SEQUESTRATION LEADERSHIP FORUM

- A unique climate initiative for carbon capture and storage aiming at development of improved cost-effective technologies through R&D collaborations
- 22 Advanced and Emerging Economies are member of CSLF and participate in CSLF activities
- CO₂ Sequestration holds promise both to reduce CO₂ emissions from point sources and to remove CO₂ from air
- The objective of Indian Participation is to develop cost-effective technologies by organizing collaborative R&D within legal, financial and regulatory framework of CSLF
- From India one collaborative research project out of seventeen projects recognized by CSLF

GOVERNMENT SUPPORT TO CCS RESEARCH

- Research Projects undertaken in Academic Institutions and R&D Laboratories
- International Workshop on R&D Challenges in CCS Technology for Sustainable Energy Future planned for January 12-13, 2007 - A Joint Session on Sharing of UK Experience proposed
- In roadmap of collaboration within Joint Innovation Council with UK, Climate Change is suggested as one of the topic
- In Depth Study on Clean Coal Technology Initiative undertaken to provide thrust to R&D
- National Clean Coal Technology Center proposed

Possible project 1 - OXY FUEL COMBUSTION

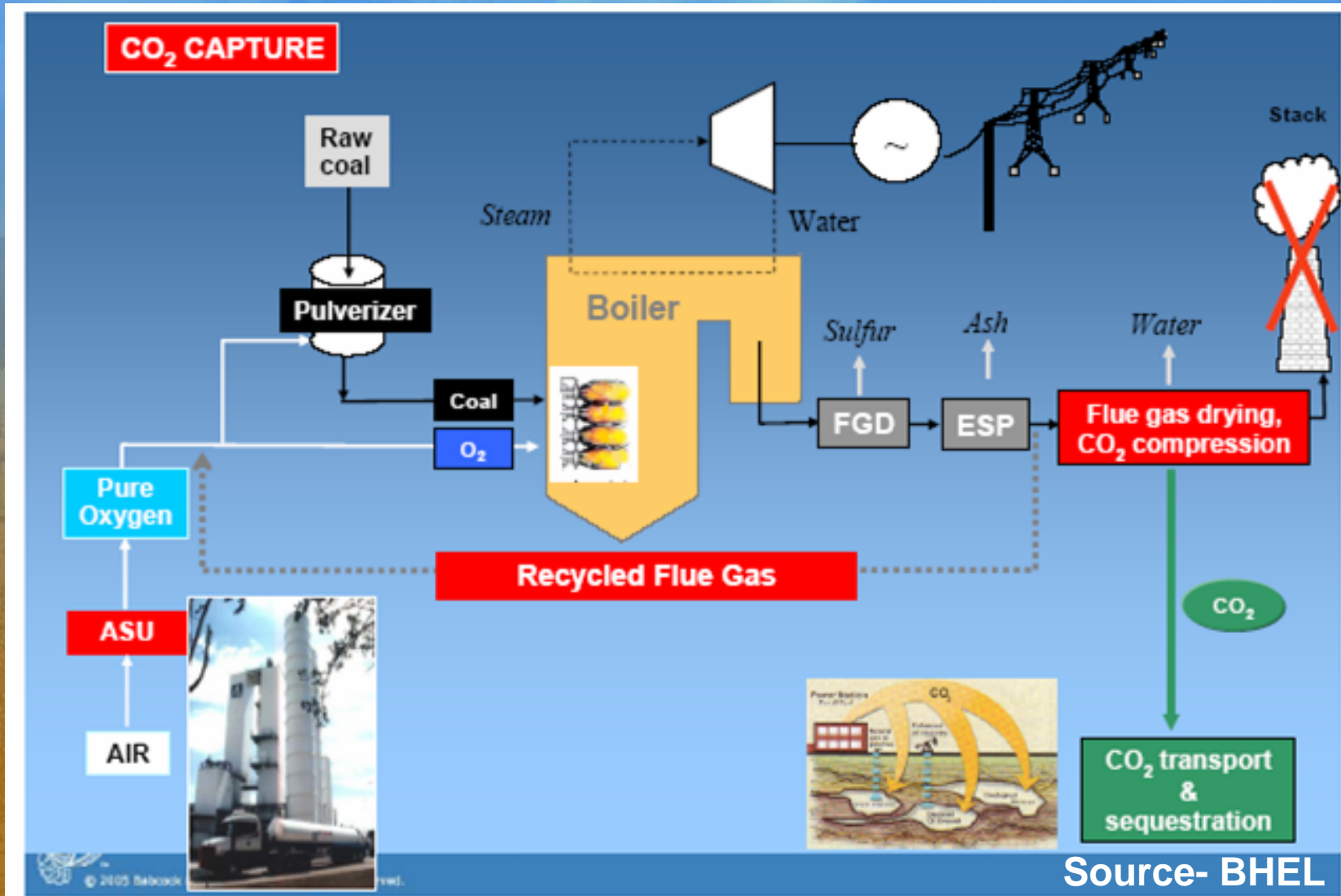
PROPOSED

- Establishment of Oxy-Fuel combustion test rig at BHEL, Tiruchirapalli through R&D support with objective to study the suitability of Indian coals while using this technology for PF combustion and change in boiler efficiency

PREMISES

- Coal combustion at higher oxygen concentration increases boiler efficiency
- Depending on the level of oxygen enrichment the concentration of CO₂ reaches 55-60% with significant reduction in NO_x emissions
- Technical challenges include investigation of flame stability, heat transfer, level of flue gas clean up for CO₂ and corrosion due to elevated concentrations of SO₂/SO₃ and H₂O in flue gas

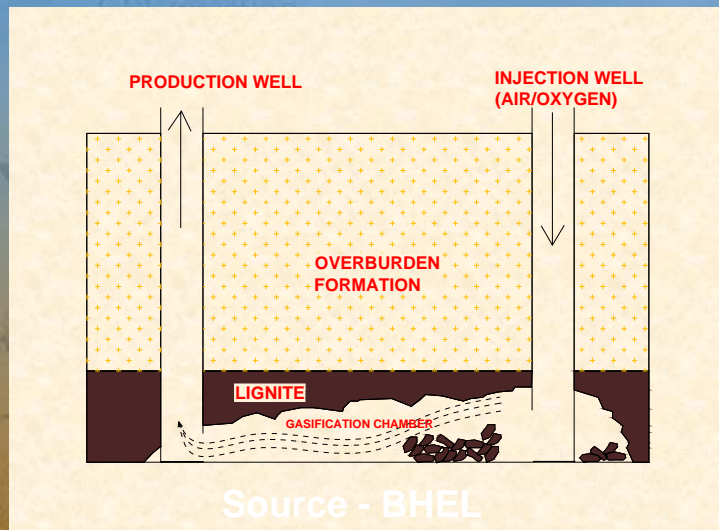
Oxy-combustion Technology in PC Boilers



Possible Project 2- Feasibility Study of UCG

Underground Coal Gasification operation is initiated by

- Drilling two adjacent boreholes into the coal seam
- Injecting pressurized oxidants like hot air, oxygen or steam into the coal seam
- Igniting the coal seam and recovering the combustion gasses through the adjacent borehole
- The connectivity between the injection and producer wells are made using special techniques

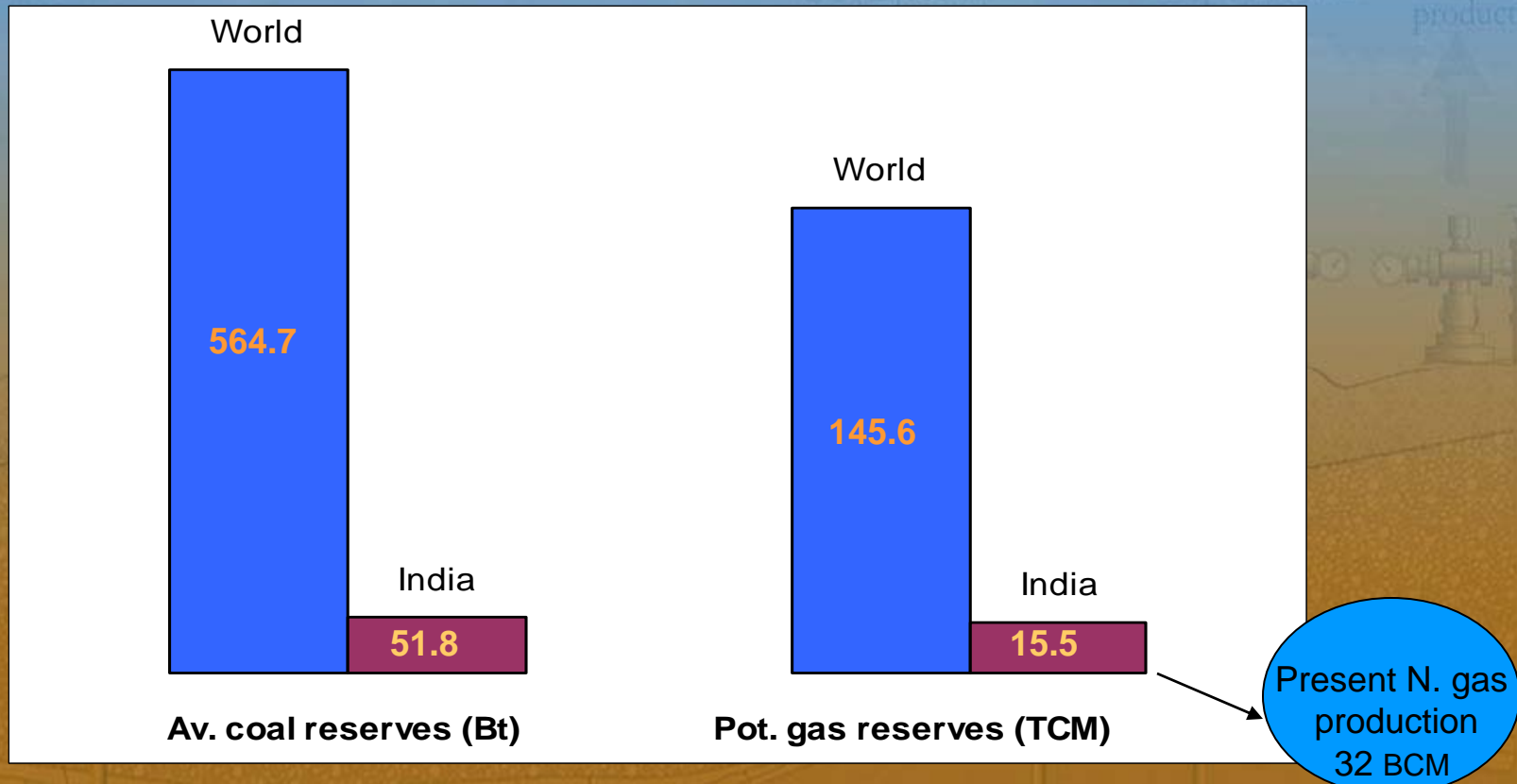


WHY GO FOR UCG?

- ♣ CO₂ capture from producer gas can be either from flue gas after surface combustion or from gas produced in underground coal gasification (UCG)
- ♣ The goal of UCG is to reduce CO₂ emissions during Power Generation by Converting in-situ coal seams into a combustible clean gas
- ♣ The coal reserves in India are 253 billion tonnes and lignite are 37 billion tonnes as on 1st January 2006. Recoverable coal reserve are estimated as 95 billion tonnes. Large deposits of deep seated coal and lignite not amenable to extraction by conventional mining methods can be tested
- ♣ The UCG offers emission free utilization of coal/ lignite reserves, as much as 20% of un mineable reserves can be utilized thus enhancing the energy security. In India research initiated by ONGC, GAIL, NLC, BHEL and others

UCG POTENTIAL – INDIA AND WORLD

TECHNOLOGY IS DEVELOPING WORLD WIDE, USA HAS HIGHEST POTENTIAL FOR UCG AS 138 BT OF COAL AMENABLE FOR 41.4 TCM OF GAS POTENTIAL, IN INDIA UCG POTENTIAL IS ESTIMATED AS 15.5 TCM



BHEL Consortium Approach

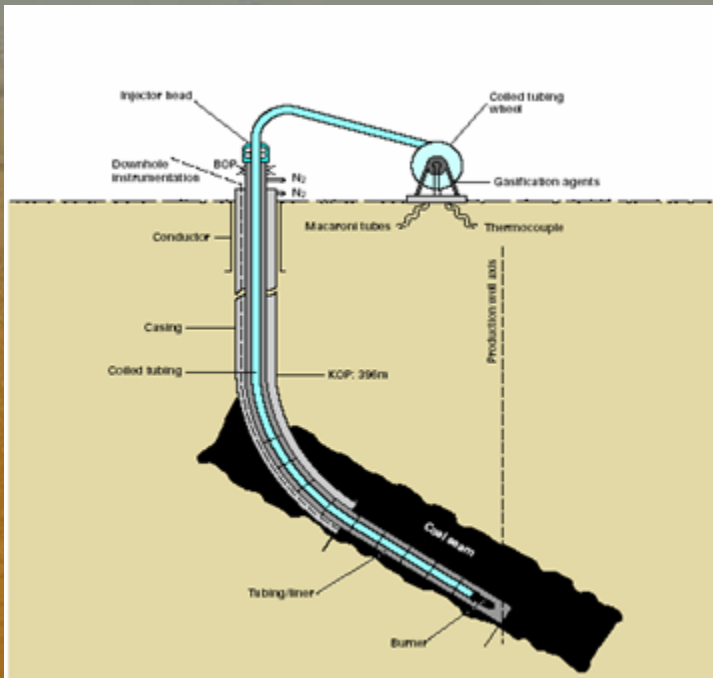
A Consortium of several organizations

viz.

BHEL, SCCL, CMRI and ISM proposed



IGCC demonstration unit at Truchy



Controlled Retractable Injection Procedure (CRIP) in the in-seam injection well of UCG

Possible Project 3 – 700°C MATERIAL DEVELOPMENT FOR USC

- Total Power Generation in India approaching 145 GW
- Most Power Production Units are based on Pulverized Coal Combustion
- New Capacity Additions planned
 - **Three Supercritical coal pulverization units of 660 MW proposed**
 - **Seven Ultra Mega Power Projects Proposed**
- Supercritical coal firing offers promise of environmentally friendly technology
- More than 400 supercritical plants are in operation worldwide

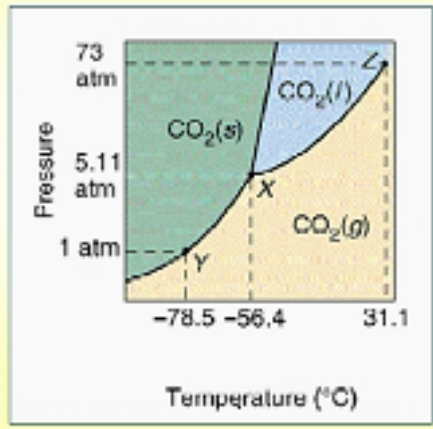
Possible Project 3 at POWER RESEARCH INSTITUTE

- ❑ Supercritical power plants operate at higher temperatures and pressures than traditional coal-fired plant, which results in higher efficiencies – up to 50% for ultra supercritical
- ❑ Plant Operating Parameters
 - SC - 24.8 MPA at 565-593 °C
 - USC- 35 MPA at > 600 °C
- ❑ By adoption of USC the efficiency of power generation is expected to be up by 10-15%, thus lower emissions including CO₂
- ❑ Erosion and Corrosion related issues in existing alloys pose serious problems
- ❑ Research initiated in R&D Laboratories and Industry

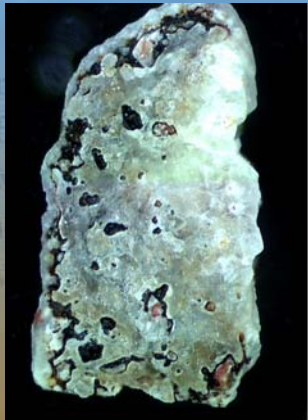
Project Update – PILOT STUDY ON CO₂ STORAGE IN BASALT FORMATIONS IN WESTERN INDIA

Initiated in collaboration with PNNL USA, the results on mineral trapping Studies would also be useful for other countries having similar formations.

Phase Diagram for CO₂



CO₂ is injected in basalt formations above its critical temperature and pressure



Calcite deposition on basalt (Source: PNNL)

Trapping mechanisms at a minimum depth 800 m

Hydrodynamic Trapping

Solubility Trapping

Mineralisation

Source - NGRI

Structural & stratigraphic trapping
Residual gas trapping

PROJECT UPDATE

Site identification studies in Progress

Reconnaissance field work carried out by NGRI scientists in the area during October 2006 and representative samples of vesicular, zeolitic and massive basalts were collected for detailed petrographic, geochemical and physical property studies

Detailed fieldwork for geological mapping and surface geochemical surveys is proposed during Nov -Dec 2006

Future studies planned in laboratory using satellite imagery and existing data for delineating regional structural features and outcrop patterns controlling the local topography and drainage patterns etc.

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CO₂ injection

CO₂ injection

Oil production

Methane

Thank you very much!

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