6th Annual Conference on Carbon Sequestration May 7-11, 2007, Pittsburg, USA

BARRIERS TO DEPLOYMENT OF CLEAN COAL TECHNOLOGY:

KEY ISSUES AND PERSPECTIVES

Presentation by Dr (Mrs) Malti Goel Adviser & Scientist 'G'
Department of Science and Technology
New Delhi, India.
Email:mlg@nic.in

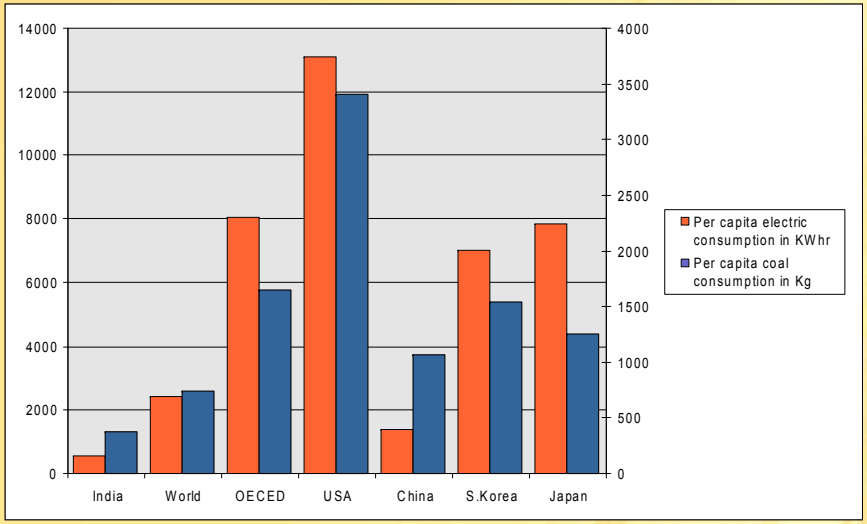
Outline

- INDIA'S ENERGY GROWTH AND SECURITY CHALLENGES
- INTERNATIONAL & NATIONAL INITIATIVES
- KEY ISSUES FOR APPLICATION OF CLEAN COAL TECHNOLOGY
- TECHNOLOGY PERSPECTIVES

INDIA'S ENERGY GROWTH AND SECURITY CHALLENGES

World And India

PER CAPITA ENERGY CONSUMPTION AND COAL CONSUMPTION FOR DIFFERENT COUNTRIES

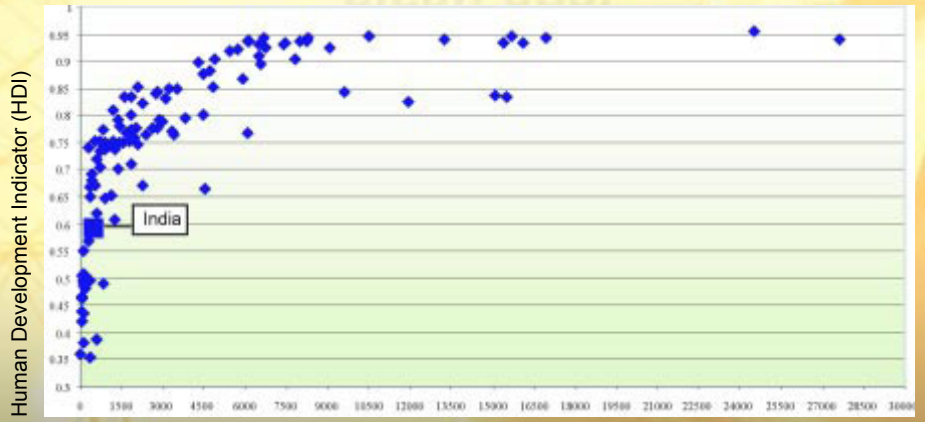


World average energy consumption per capita was 2429 kWhr in 2003

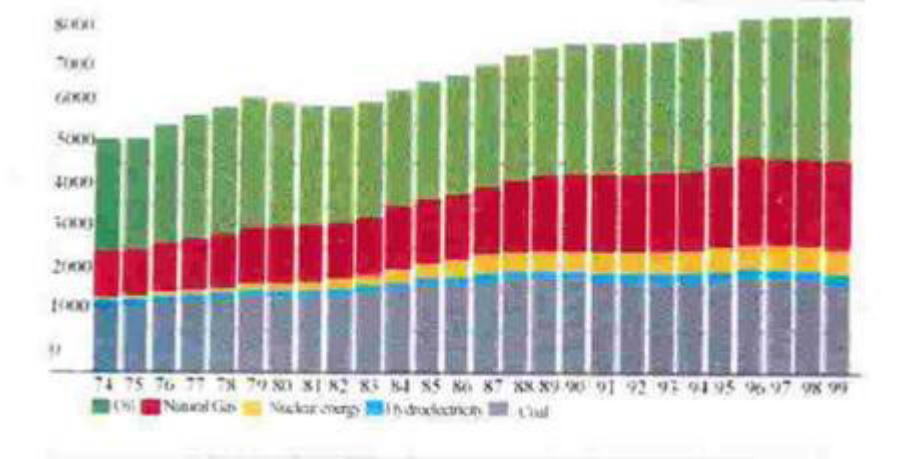
HUMAN DEVELOPMENT INDEX PROFILE OF THE WORLD

HDI for India 0.595 and Electricity consumption per capita 553 kWh.

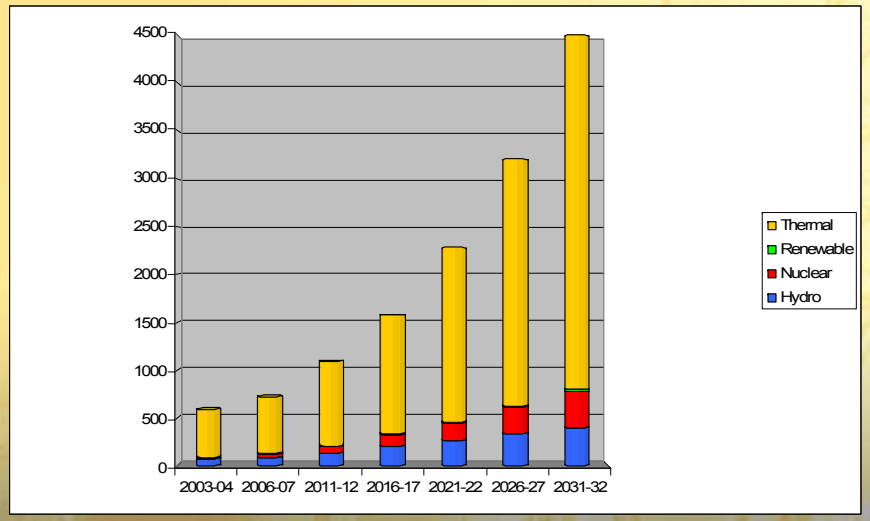
Source: United Nations Development Programme (UNDP-2004) and IEA (2004)



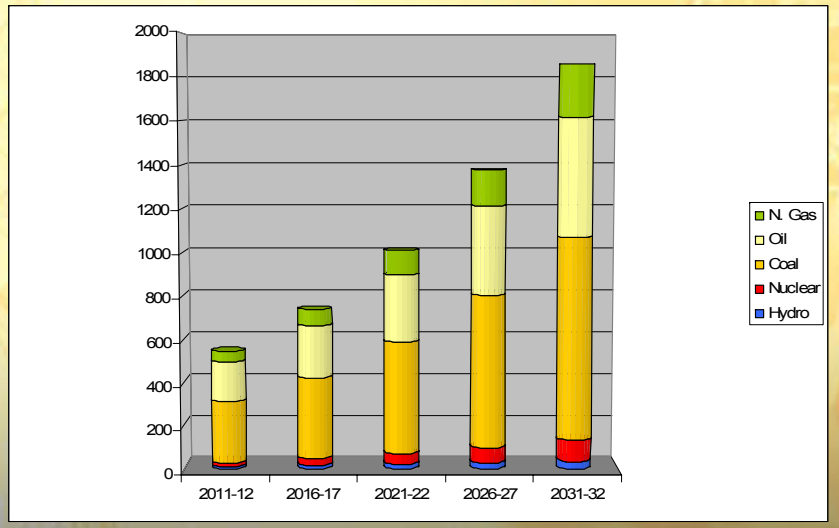
Projections For Future Growth And Fuel Scenario



Global Fuel consumption from 1974 to 1999



Projections of Electricity Generation

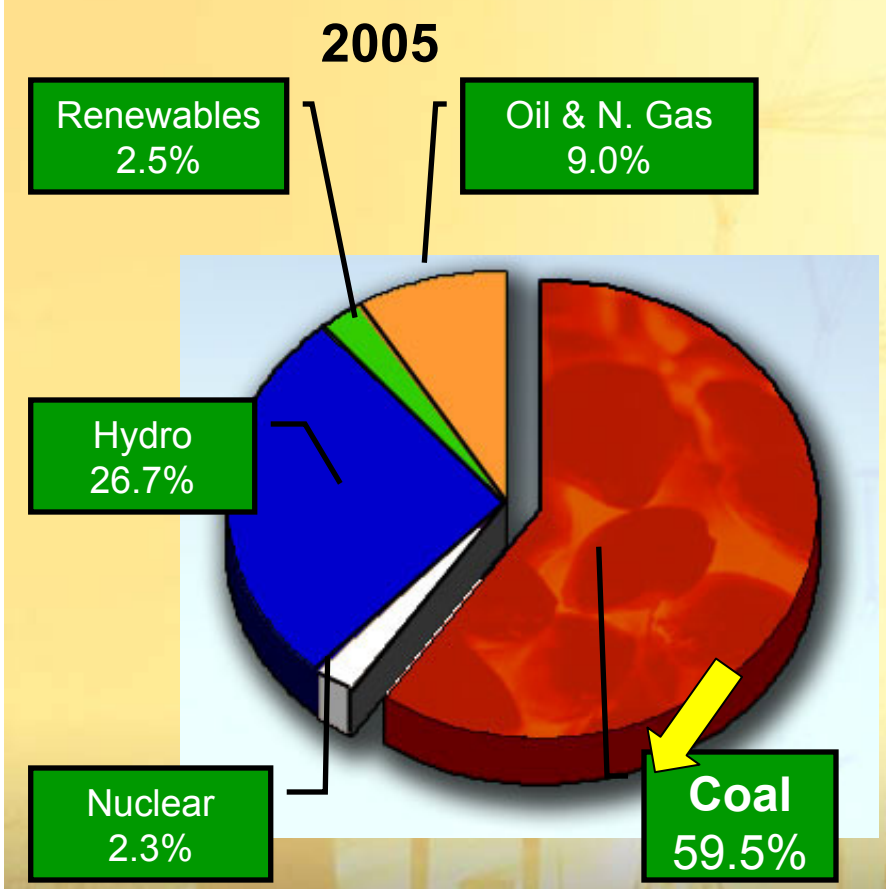


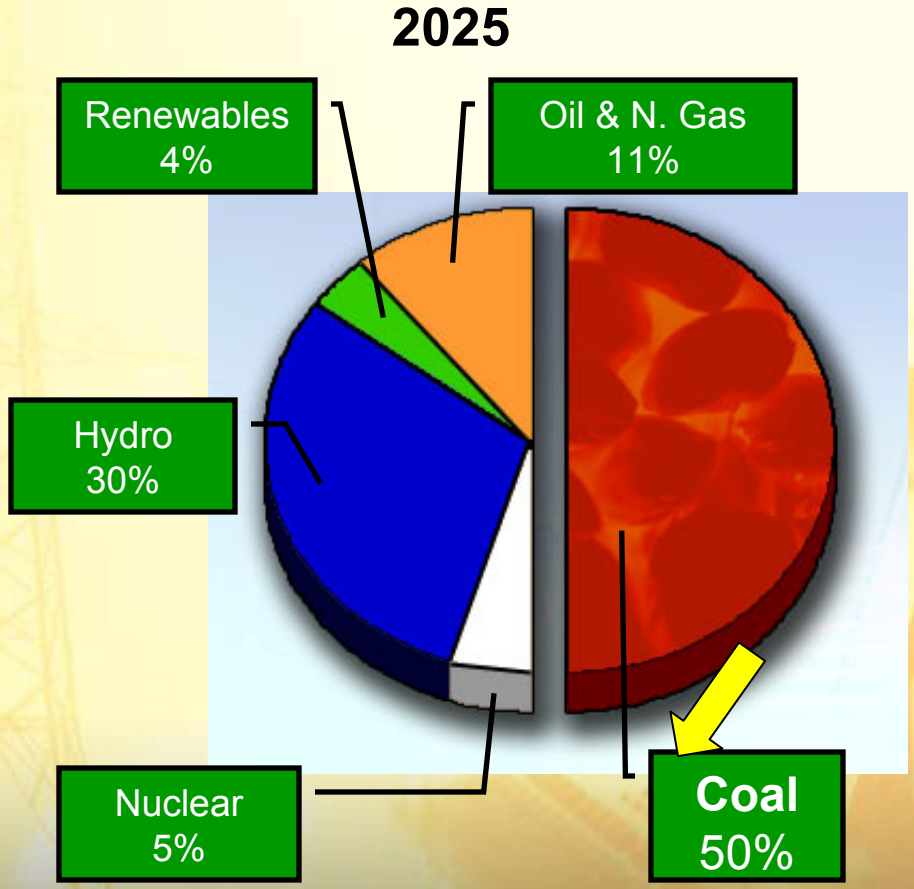
Fuel Scenario in India

Source: Integrated Energy Policy of India

Coal: Dominant Primary Energy Resource In India

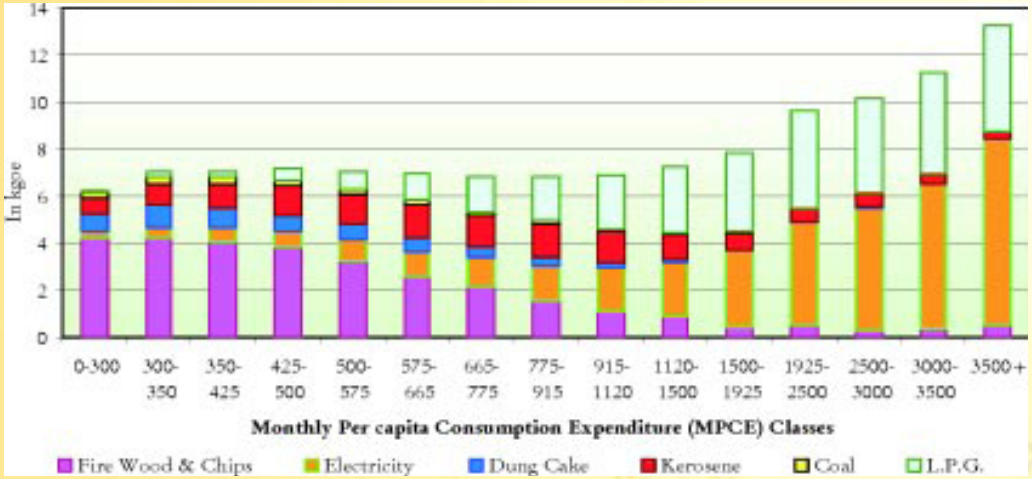
Share of different fuels in installed capacity



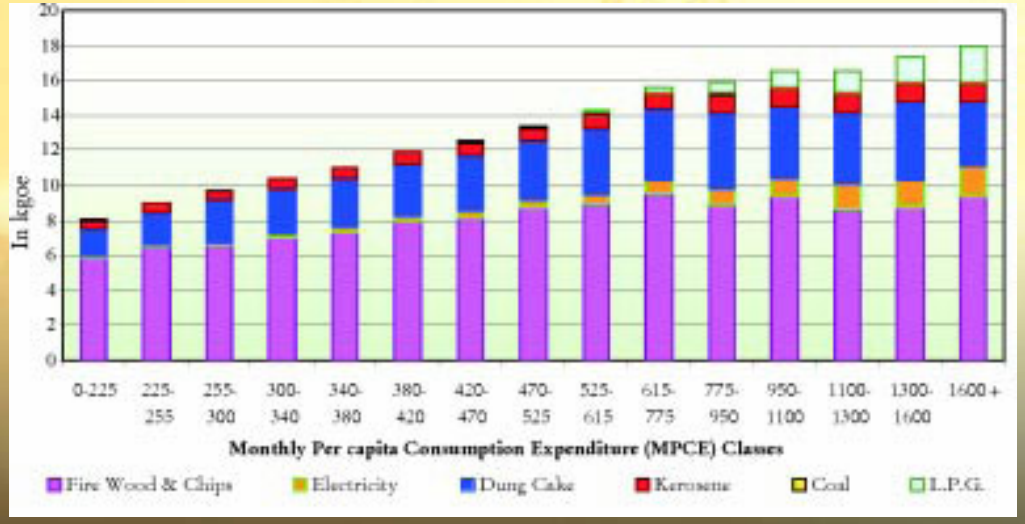


Source- CEA

Growth In Consumption Of Household Energy



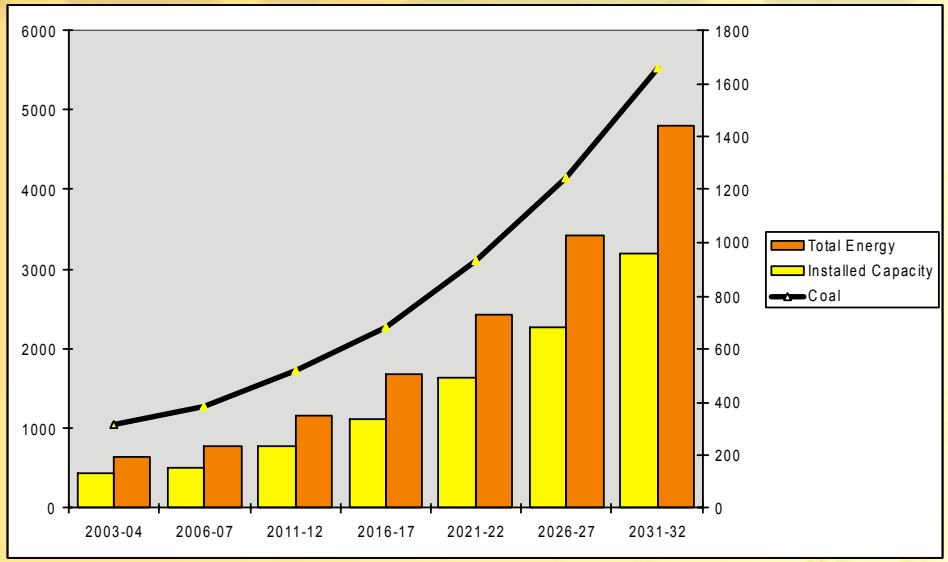
Household energy consumption in Urban India



Household consumption in Rural India

Source: Integrated Energy Policy of India

INDIA'S Energy Growth Scenario and CO2 Emissions and Projections

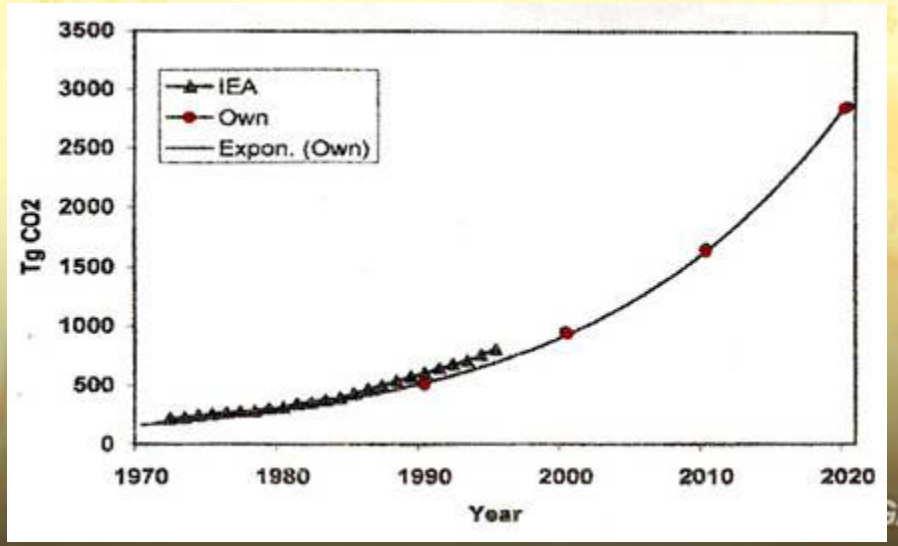


Energy security in 21st century will rely on environmentally friendly use of fossil fuels

Integrated Energy Policy

Current Coal Production in India is about 450 MT/ annum

Source: Center for Global Change, India



INTERNATIONAL AND NATIONAL INITIATIVES

International Initiatives To Address The Coal Use Issues For Energy Sector

- UN Framework Convention on Climate Change (UNFCCC) signed at the Rio Earth Summit in 1992. Ratified by India in 1993
- Kyoto Protocol introduced in 1997 and came into effect on 16TH Feb 2005
- US, DOE Initiative on Carbon Sequestration Leadership Forum launched in 2003, India is member among 22 countries
- Asia Pacific Partnership on Clean Development and Climate in 2005, US, Australia, China, Japan, India and South Korea as partners.
- World's first zero emission coal fired plant on FUTUREGEN, India joined in 2006 represented on Government Steering Committee
- Coal R&D programmes of other Nations include; CANMET, COAL2, EAGLE, ZECA, CCPC, CCTI

International Carbon Sequestration Leadership Forum

- A unique initiative of DOE for carbon capture and storage aiming at development of improved cost-effective technologies through R&D collaborations
- 16 Countries joined to form CSLF, at present 22 Countries are member of CSLF and participate in CSLF activities
- The programme is well structured into Policy Group and Technical Groups. India is represented as Vice- Chair to Technical Group
- Several Task Forces are constituted for assessing the Technology
- 19 collaborative research projects recognized worldwide, India participating in one CSLF project

Technology Perspectives For Carbon Management In India

- 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
- Initiated Joint Activities to be implemented under JI/ AIJ mechanisms
- Constituted National Clean Development Mechanism Authority for considering projects for availing carbon credits by eligible industry projects
- Research initiated on carbon capture and storage

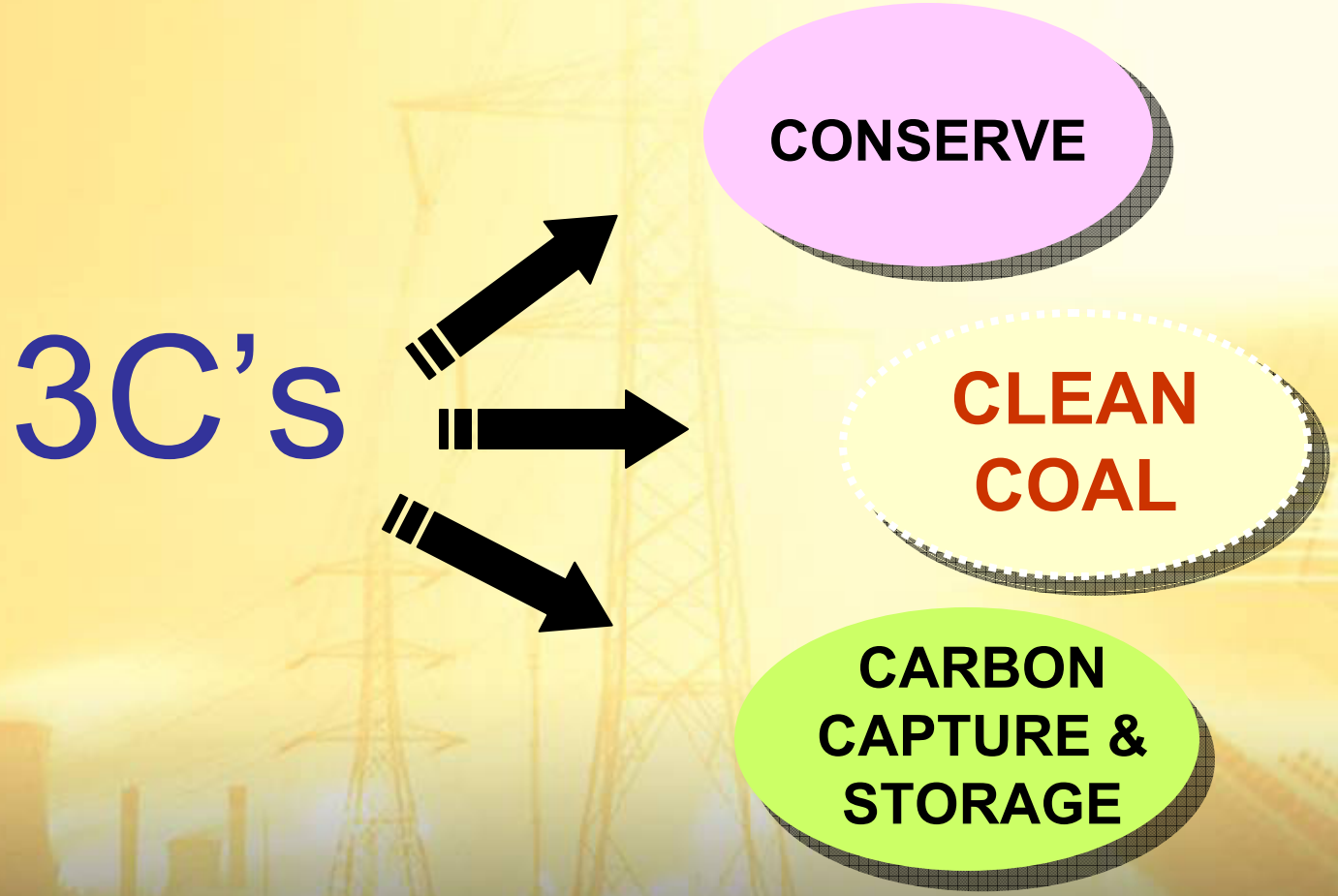
A Wind Farm

How Do We Want To Be As A Nation And Globally?

- **CAN WE STOP USING FOSSIL FUELS?**
- **USING FOSSIL FUELS WITH CARE?**
- **PRODUCING ENERGY FROM OTHER SOURCES?**

CO2 (problem) although global, (solution) unique to every country

Using Fossil Fuels With Care



Clean Coal – Building A Future Through Science & Technology

- NCST Report in Energy Sector in 1973
- Thrust to R&D on Coal Beneficiation, Coal Gasification, Liquefaction and IGCC in 1986
- Pre Combustion Technology Assessment Studies conducted by DST in 1996
- Policy guidelines in 1997 to use coal with < 34% ash in power plants at 1000km from pit head or in urban areas
- Gaseous emissions reduction using coal preparation, new guidelines for setting up coal Washeries in 2005
- Specific measures adopted by power companies and other major coal consuming industries like steel and cement for technology up-gradation

Recent National Initiatives on R&D in CCT

- DST commissioned an In Depth Study on Clean Coal Technology Initiative in 2006 to provide thrust to R&D
- The aim is to develop a future road map for clean coal technology in the entire Coal-Energy Chain
- Research undertaken in Laboratory on Impact Assessment of coal quality for clean power generation and Industry documented
- A Workshop held jointly with BHEL with the participation of stakeholders to discuss the findings in an open forum on Oct. 26-27, 2006.
- International Workshop on R&D Challenges in CCS Technology for Sustainable Energy Future organized by DST and NGRI on January 12-13, 2007.
- Research initiated on CO2 sequestration and Indian CO2 Sequestration Applied Research network launched for dissemination of information

KEY ISSUES FOR APPLICATION OF CLEAN COAL TECHNOLOGY

Key Technical Issues

- Clean Coal Technology has been advancing rapidly globally to achieve goals of zero emission technology.
- In India efforts towards clean coal technology development began almost two decades ago, has not kept pace with the developments
- Lack of Research to address Problems of Indian Industry in Academic Sector

Key Financial Issues

- Additional Cost involved To support Clean Coal Technology
- Key questions are Who Invest and Why Invest in clean coal technology development, is it the responsibility of coal producer or coal user?
- Inadequate R&D infrastructure in academic Institutions and National Laboratories

Key Policy Issues

- ✓ Policies have been introduced from time to time. Integrated Energy Policy 2006 suggests creation of R&D fund for Energy
- ✓ Appropriate marketing strategy needed for adoption of clean coal
- ✓ Need for Capacity Building which is always Changing

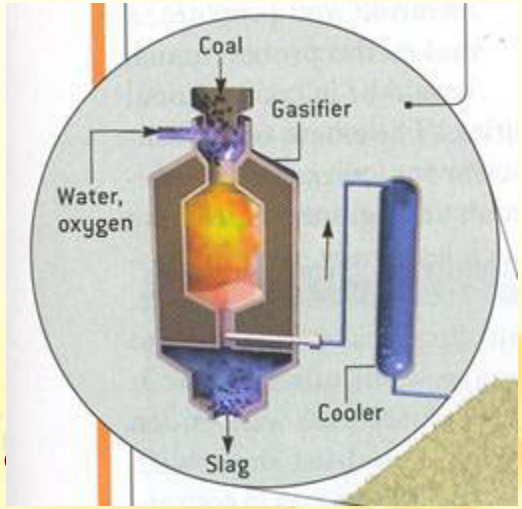
TECHNOLOGY PERSPECTIVES

Technology Where Capabilities Exist

- Preparation of Low Grade Coal
- Coal Washing
- Pulverized Fuel
- Electrostatic precipitator
- Fluidized bed combustion
- Fisher-Tropsch synthesis
- Super critical boiler
- Circulating fluidized bed coal combustion

Technology Where research has Begun- are in Commercial/ Demonstration Elsewhere

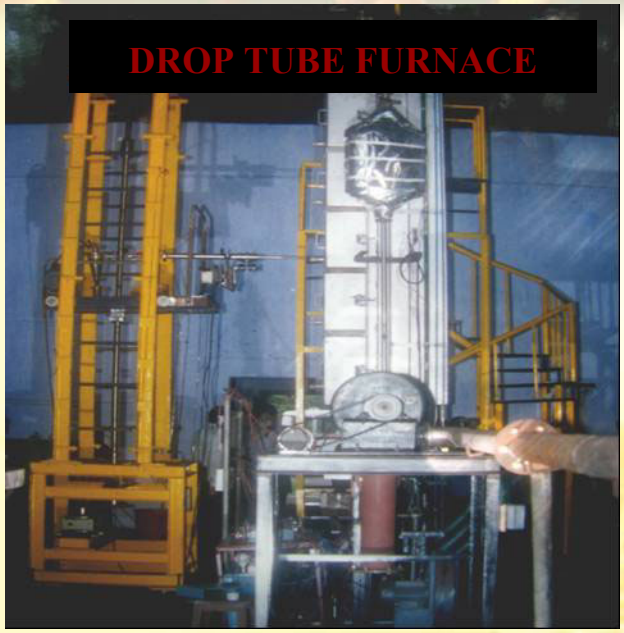
- Ultra supercritical boiler
- Pressurized pulverized coal combustion
- Integrated gasification coal combustion (IGCC)
- Pressurized fluidized bed co combustion
- Selective catalytic conversion (De-NOx)



Coal Gasification Research on Laboratory Scale

Fine Coal Treatment Pilot Plant

DROP TUBE FURNACE



GASIFICATION /DESULPHURISATION FACILITY

FUEL EVALUATION TEST FACILITY

Dry ash moving bed system and studies on coal liquefaction

Source: CFRI & IICT

Clean Coal Research In India - Achievements in Coal Gasification

Organization	Techniques	Size tpd	Status
BHEL, Hydrabad	MBG	24	Test
IICT, Hydrabad	MBG	24	Test
CFRI Dhanbad	FBG	2-4	Test
Ramagundam & Talcher	Entrained Bed	900	Commercial
BHEL	Air blown FB for coal with 40% ash	10	Test bed
NTPC, BHEL	IGCC	Plant size 125 MW	Proposed

Technologies of Future - are in Research Phase World wide

A CBM Field

- In-situ coal gasification
- Oxy fuel combustion
- Coal bed Methane
- Coal Mine Methane
- Integrated gasification fuel cell
- Carbon capture and storage

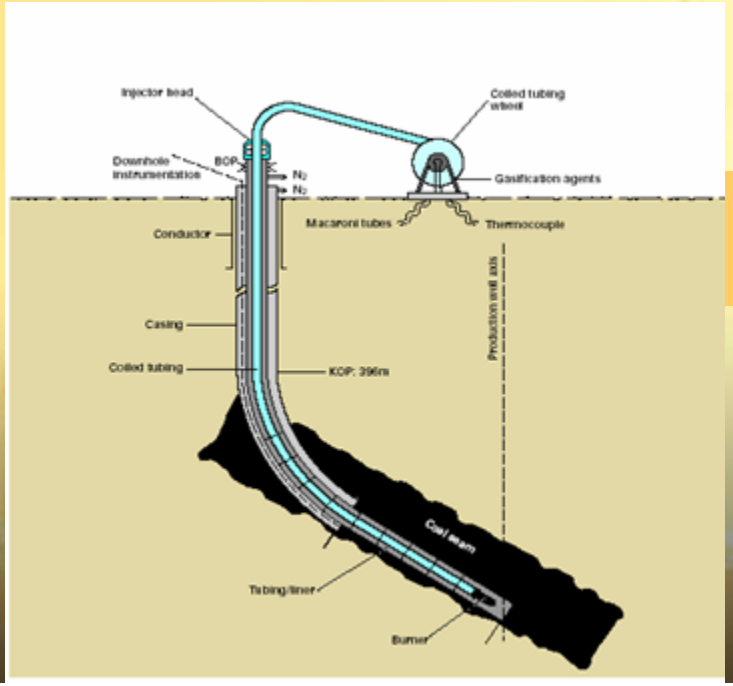
Part 2

In-situ Coal Gasification- 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 inseam injection well of UCG

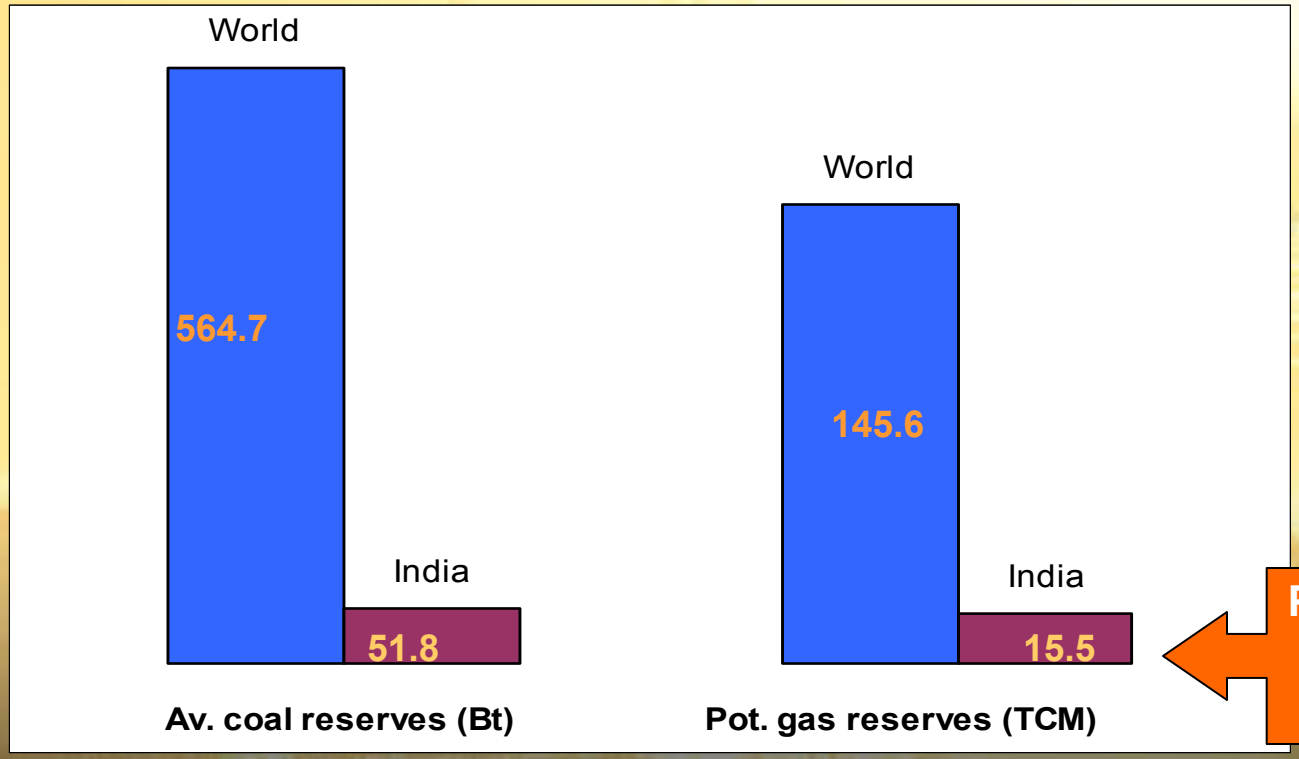
UCG and its utilization for power generation research studies in lignite deposits of Rajasthan initiated at NLC

An MoU signed between CIL and ONGC for a pilot project study on Underground Coal Gasification

Part 2

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



Carbon Capture Research Initiated

- Pre-Combustion
  - Coal gas separation
- Oxy-fuel Combustion
- Post Combustion or Industrial
  - Solvent
  - Cryogenic
  - Absorption
  - Adsorption

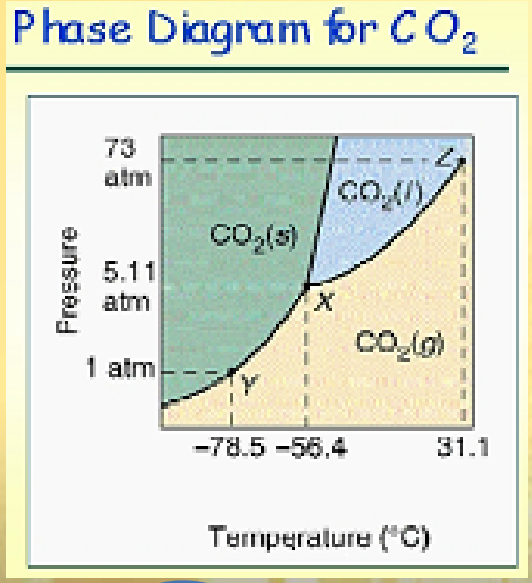
Third generation of clean coal technologies

Carbon Storage Research Projects

- Geological sequestration pilot study in Basalt formations of Western India
- Collaborative research on screening criteria development for geological sequestration in Saline Aquifers
- Feasibility Studies on CO2 injection proposed for EOR from Hazira gas. Scoping studies carried out
- CO2 Capture by Photosynthesis is most efficient process of CO2 Capture at Low Concentrations to enhance sequestration of CO2 In Terrestrial eco system proposed

Geological CO_2 Sequestration in Basalt Formations of India: A Pilot Study

Evaluation of Basalt Formations of India for environmentally safe and irreversible long time storage of CO_2



Partner Agencies: NGRI
PNNL
NTPC
DST

A CSLF Recognized Project

Impact of Other Technology on Coal Use - Nano Scale Catalysts

- Nanoscale catalysts open the way for numerous process innovations in the next few years to make many chemical processes more efficient and resource-saving in coal use
- Using a gel-based nanoscale catalyst, which improves the efficiency and reduces the cost has been tested for Coal Liquefaction and turn it into Gas.
- Organo-metallic nanocubes as ideal storage medium for hydrogen, as source of energy in electronic devices

Key Recommendations

- ✓ The coal quality, quantity and its utilization in power generation in an environmentally friendly manner need to be seen in an integrated manner.
- ✓ There are technological, financial and policy issues as well as opportunities for implementation of clean coal technology to achieve Carbon sequestration in India.
- ✓ New coal based energy generation technologies that produce higher concentration of CO_2 in flue gas would facilitate carbon capture and storage
- ✓ New breakthroughs on horizon such as Nanotechnology will impact energy costs significantly and change application scenario. Adequate thrust must be given to these.

Thank You Very Much!

For Further information: Email: mlg@nic.in

The views expressed here do not necessarily represent those of the organization