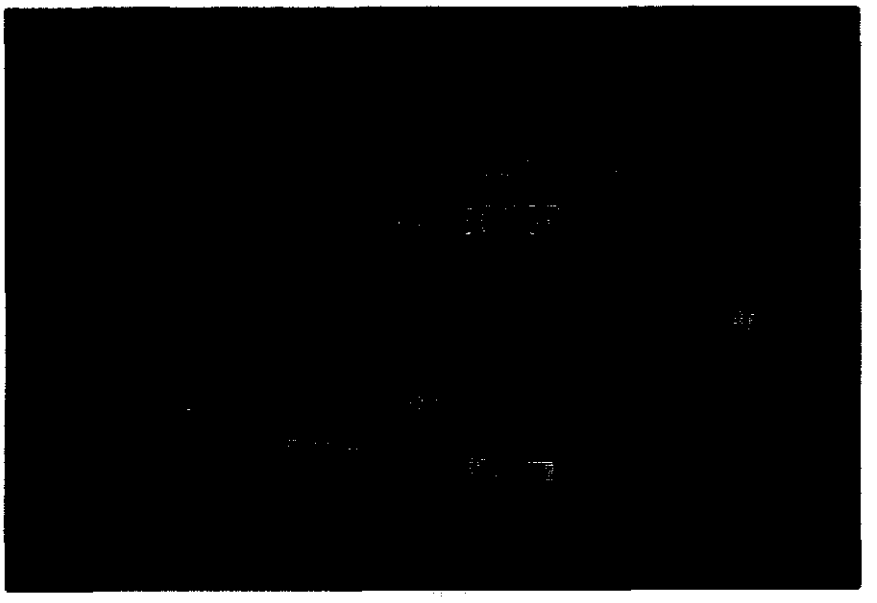
PN-ACY-767

United States Agency for International Development
Green house Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Senior Policy Roundtable

Task 5B

Report on Clean Power -A Roundtable on Strategy for the Power Sector.



By
The Louis Berger Group,Inc
C- 6/7 Safdarjung Development Area
New Delhi 110016.

May 30, 2001

THE Louis Berger Group, INC.
2300 N Street, NW
Washington, DC 20037 USA

The Louis Berger Group, Inc
Contract No. 386-C-00-00-00058-00
Sandeep Tandon, CTO

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2

I. BACKGROUND 4

II. ORGANIZATIONAL PREPARATION 6

III. ROUNDTABLE AGENDA, TOPICS AND DELIBERATIONS 7

IV. ROUNDTABLE OUTCOMES – RECOMMENDATIONS 9

V. NEXT STEPS TO PROMOTE CLEAN ENERGY TECHNOLOGY AND GHG MITIGATION IN THE UTILITY SECTOR 13

Appendices

Appendix 1 - Acronyms
Appendix 2 - Background Paper
Appendix 3 - Roundtable Participant List
Appendix 4 - Roundtable Agenda
Appendix 5 - Faculty and Presenter Backgrounds
Appendix 6 - Presentation
Appendix 7 - Photographs

EXECUTIVE SUMMARY

The Louis Berger Group (LBG) is implementing the Greenhouse Gas Pollution Prevention Project – Climate Change Supplement (GEP-CCS) on behalf of the U.S. Agency for International Development (USAID). LBG implements key goals of the project through a variety of outreach activities aimed to improve dialogue and stimulate action among key stakeholders in India who can affect change that reduces the total volume and/or rate of growth of greenhouse gas (GHG) emissions in India. One of these outreach vehicles is a series of roundtables among specific stakeholder groups. LBG, through the Confederation of Indian Industry (CII) held a Utility Roundtable on May 9, 2001, with the title, "Clean Power: A Roundtable on Strategy for the Power Sector" for the purpose of building awareness and defining courses of action within the sector for addressing GHG mitigation in that sector through adoption of clean energy technologies.

The Roundtable was attended by diverse interests in the utility sector and by other key interests that can facilitate clean technology investments and choices within the sector. Discussions focused on a number of clean technology applications and GHG linkages including clean power generation, transmission and distribution and financing. Clean technology options within these components were discussed and debated.

The participants discussed that future choice of technology for power generation would crucially depend on current and future trends of environmental regulations, availability of low-cost fuel on a long-term basis, plant efficiency and costs of technologies. Various short-term technology options for power generation in India include super critical technologies, circulating fluidized bed combustion, pit-head power generation, power generation from small hydro, gas, renewables, nuclear and co-generation. In the long-term it is believed that integrated gasification combined cycle could be the dominant technology for power generation. Other long-term options would be ultra supercritical boilers, underground coal gasification and electricity from coal bed methane. There should also be sufficient R&D efforts for the development of technologies like integrated gasification humid air turbines, integrated gasification molten carbonate fuel cell, development of hot gas cleanup system, high temperature air pre-heaters, new material for ultra-supercritical boilers, etc.

On the transmission and distribution (T&D) front, it is believed that establishment of national grid, higher distribution voltage line (11 KV and above), distribution circuit phase balancing and installation of energy efficient distribution transformers like amorphous core transformers would reduce the various technical and non-technical losses in the system. Higher emphasis should be given on demand side management to reduce the wastage of electricity by introducing the policies for promoting sustainable markets for energy efficiency, removing subsidies in agriculture and domestic sector,energy efficient appliances, labeling and benchmarking of appliances, 100 per cent metering for all consumers combined with utility and information management system and electronic metering system for time of day metering.

The above mentioned clean technology options can only be realized with support from financial institutions who are sensitised and made capable of evaluating risk in funding these projects. Great expertise is required by the funding agencies in analyzing and accessing these projects. The funding agencies would have to take greater initiatives in making clean energy projects realizable.

Throughout the dialogue, the link between clean technology options and emissions generation, including CO_2 emissions, was noted. LBG also opened and closed the Roundtable by noting the assistance that can be provided to project developers in this sector in structuring projects to position them to capture potential future benefits of carbon off-sets that may be generated by implementing clean energy technology options.

This report summarizes the proceedings and outcomes of this first Roundtable event conducted for the utility/power sector.

Note: For a list of acronyms used in this report, please refer to Appendix 1.

I. BACKGROUND

India is one of the largest and fastest growing energy consumers among the developing countries in the world. As such, USAID launched GEP-CCS to address two primary focus areas, "Climate Change Initiatives for Sustainable Development" and "Linking Urban Development and Climate Change." LBG implements the GEP-CCS project for USAID.

The GEP-CCS project engages the utility/power sector on the issue of clean energy technology and GHG mitigation opportunities for a number of reasons. First and foremost is the fact that approximately 71% of the power generated in India comes from thermal power sources that utilize fossil fuel, primarily low grade coal. Hence, there is tremendous opportunity in this sector to utilize clean energy technology as a means for reducing GHG emissions from existing power generation and T&D sources. This potential rises significantly when India has acknowledged its need to double its electricity generation capacity over the next few years in order to meet growing demand and that coal is recognized as the primary source of fuel for power generation for this purpose. It also is acknowledged that T&D losses ranging to about 20% are highly problematic and that T&D technologies hold great promise for reducing energy supply demands and indirectly, GHG emissions generation. Background information on the utility sector in India and on the various clean energy technology options that have been discussed for use in the sector, please refer to Appendix 2, Background paper.

The GEP-CCS project includes a number of components designed to address climate change in India. "Communication and Information Outreach" is one of these components. Activities within this component are intended to improve understanding and dialogue among key stakeholders in India that have the ability to contribute to India's progress towards a less intense GHG emissions generation path. "Senior Policy Level Roundtables" are one tool used by LBG to create a forum for dialogue and exchange of ideas on clean energy technologies and GHG emissions reduction opportunities. Roundtables are also planned for the industrial sector, municipalities, renewables sector (renewable energy options) and for a combined multi-sector event.

The purpose of the Roundtables is to stimulate discussion among key stakeholders in the noted sectors and disseminate information on approaches to using clean energy technologies as a means to mitigate GHG emissions generation. The Roundtables are designed to include presentations on key issues in the sector and through these and the discussions they create, result in:

- Enhanced understanding of the role of the sector in climate change;
- New or broader perspectives on the role of clean energy technology in reducing air and GHG emissions;
- Recommendations from participants on policy or implementation guidelines or actions for promoting the use of clean energy technology in the sector; and
- Collaboration between GEP-CCS, project developers, the Government of India (GOI), financial institutions and other interests to promote clean energy technologies.

The substantive orientation of the Roundtable was on clean energy technology options for the sector. Both CII and LBG felt that sector stakeholders, especially utility operators and project developers, would be more engaged by discussing technology options as a primary topic than from focusing first on the issue of climate change and the role of the sector in climate change. Why? Because India faces such a daunting power supply deficiency, it was felt that clean energy solutions to enhancing supply are of the greatest interest to these stakeholders. Given that use of clean energy technology inherently leads to GHG mitigation, the two are inextricably linked. Hence, clean energy technology serves as a proxy for GHG mitigation. The link was highlighted and discussed during the Round table.

II. ORGANIZATIONAL PREPARATION

As a partner to LBG in implementing GEP-CCS, CII hosted the first of the Roundtables conducted under GEP-CCS for the utility/power sector. CII is the representative body of Indian industry. CII is actively involved in promotion of clean and environmentally benign technologies and has constituted committees on energy and climate change, which are represented by several key industries. CII also houses a Climate Change Center assisted by USAID under an earlier program. CII helped facilitate the Roundtable by identifying various experts its utility sector constituents for participation, preparing a background paper and managing the organizational administration.

The event, entitled, " Clean Power – A Roundtable on Strategy for the Power Sector" was held on May 9, 2001 at the Habitat Center in New Delhi. CII was asked to host the event because its existing access to and dialogue with various private and public sector stakeholders and because of CII's expertise in examining energy related issues among its many utility and industrial sector stakeholder constituents. With LBG's assistance, CII invited over 80 organizations to attend the Roundtable. These organizations represented a diverse range of private interests within the sector; government related institutions including State Electricity Boards (SEBs) and ministry representatives of the GOI such as the Ministry of Power; financial institutions, private project developers; equipment suppliers; non-governmental organizations (NGOs); international utility experts, etc. The individuals and organizations that attended the Roundtable are listed in Appendix 3, Roundtable Participants. A number of these included sector "Champions" previously identified by GEP-CCS, including NTPC, BSES, and ICICI.

LBG/GEP invited two experts in the electric utility sector. Mr. Kenneth R.Gudger, a renowned expert having long experience with a large U.S. electric power utility was one of the speakers. Ken is currently the CEO of Global Energy Partners, a joint venture of the Electric Power Research Institute, Palo Alto and Gas Research Institute Chicago. Ken brought experiences from his vast knowledge of power generation, distribution and clean technologies that he has closely worked with. The other expert was Mr. Nitin Pandit, President of IIEC, a not for profit organization of the Civil Engineering Research Foundation. IIEC has had a presence in India for the last 4 years, wherein they have studied the impact of improvement of distribution transformer technologies.

CII invited Mr. A. K. Basu, Secretary, Ministry of Power (MOP) Government of India to inaugurate the conference. MOP is taking several initiatives in improving the environmental performance of the power sector at the same time balancing the increasing power needs of the country. CII also invited other prominent speakers from NTPC, UNDP-GEF and ICICI. A list of the faculty/presenter CVs is located in Appendix 5.

III. ROUNDTABLE AGENDA, TOPICS AND DELIBERATIONS

The Roundtable consisted of five main sessions, including: Inaugural, Clean Power Technologies, Transmission and Distribution for Clean Energy, Financing and Investment in Clean Technology, and a Valedictory Session. Given the focus on clean energy technology, CII, in consultation with various stakeholders and LBG, proposed an agenda that emphasized presentations and discussion in three primary areas in which clean technology could be applied to reduce GHG emissions: power supply and T&D. In addition, the financial institution perspective on risk management for clean energy technologies was included as a key topic for presentation and discussion. Please refer to Appendix 4 for a copy of the Roundtable Agenda. Mr. V. Raguraman, Senior Energy Advisor at CII served as the overall Roundtable moderator and facilitator. Summaries of each session are as follows:

Inaugural Session: The Inaugural featured a presentation by Secretary Basu, Ministry of Power, in which he summarized the Ministry's and the GOI's perspectives on key issues in the utility sector. Mr. Raguraman opened the session with an overview of issues in the sector, especially the roles of clean technology in addressing the widening gap between energy demand and supply in India. Mr. Richard Edwards, the Director of USAID's Energy, Environment and Enterprise section then presented an overview of USAID's activities in the utility sector which addressed key opportunities and challenges for India in moving towards a market-based, sustainable energy policy, especially in regards to the sectoral reform process. Mr. Ron Sissem, Chief-of-Party of the GEP-CCS project then discussed the project's activities, the link between the utility sector and GHG emissions issues in India, and identified opportunities and partnerships that can be created between stakeholders in the utility sector and GEP-CCS for the purpose of promoting clean energy technologies.

The ensuing discussion was lively. Participants asked many questions of Secretary Basu across a range of issues. Participants were quite keen to seek clarification that would help them understand the Ministry of Power's perspective and positions on topics ranging from clean energy technology policy to resolutions on very specific problems related to reform. Secretary Basu stated that he is happy that stakeholders in the sector have gathered to provide input to the Ministry and expressed his desire to receive inputs and recommendations from the Roundtable as a means to help inform the Ministry.

Clean Technologies for Power: The "Clean Technologies for Power" session opened with an interesting overview of technology options for the Indian utility sector based on experiences in the U.S. LBG brought Mr. Kenneth Gudger, CEO of Global Energy Partners in the U.S. to the event to present a U.S./International perspective on issues and current technology options. Mr. Gudger keyed on several technology options in the supply, T&D and end use arenas and their potential applicability to the India context. The next two speakers addressed current approaches to clean coal technology, as coal will continue to be the primary fossil fuel on which India will depend. Mr. Chandan Roy, General Manager, at NTPC then discussed "Efficient Coal Conversion Technology" and

Mr. B.C. Misra, Advisor and consultant to the UNDP-GEF presented on "Coal Bed Methane – Prospects for India & Utility for the Power Sector."

Again, the ensuing discussion was active, focusing on the important technical merits, and the financial, structural, and policy opportunities and obstacles in implementing clean coal technologies. Mr. Gudger was asked to elaborate on experiences in the U.S. relative to particular technology applications that he presented. The U.S. experience appeared to be of interest to a number of participants and served as a pseudo benchmark in some technologies for pointing out possibilities for technology uptake and applications in India.

Transmission and Distribution Systems For Clean Energy: The third session "Transmission and Distribution Systems for Clean Energy" was perhaps the most lively of the day. Participants and presenters recognized the great potential for closing the gap between electricity supply and demand by reducing T&D losses through a variety of technology and improved system management techniques. Speaking on "Transmission and Distribution Technologies for Efficiencies and Emission Reduction," Mr. Gudger described an array of technology and systems management issues that have successfully been applied in the U.S. and which appear to have direct application in India. Mr. Nitin Pandit, Executive Director of IIEC in the U.S. spoke on "Distribution Systems for Energy Efficiency." He noted additional technological approaches and systems management approaches for improving efficiency in the T&D area. Mr. Sanjaya Singhal's talk on "Efficiency Improvement & Metering Systems" drew great interest from the participants. The advantages and disadvantages of metering and metering technologies were debated and the practical constraints in utilizing metering systems were thoroughly discussed.

Financing and Investment in Clean Energy Technology: To bring some perspective to the potential for securing financing for clean energy technologies, Mr. Amitabh Bhargava, Chief Manager at ICICI Ltd., spoke on "Risk Analysis and Management of Clean Technology for the Power Sector." Mr. Bhargava thoroughly explained the process for investment decision making in clean technologies and pointed out areas of uncertainty, such as technology unfamiliarity or lack of proven record of performance, that confront financial institutions and add to their perception of risk with such technologies. He also pointed out the fact that as an institution, ICICI has shown interest in clean energy technology investing. He did acknowledge the GEP-CCS effort to train FIs in clean technology and GHG mitigation project finance and structuring.

Valedictory Session: Each of the session participants, Mr. Raguraman, Mr. Sissem, Mr. Bargava, Mr. Pandit and Mr. Gudger, gave brief synopses of key points raised during the day, especially in regard to ideas and recommendations made during the day. Mr. Raguraman solicited input from the participants and an involved discussion ensured. Participants provided ideas and recommendations for implementing or creating an enabling environment for utilizing clean energy technologies that were discussed during the day. Out of this discussion and from summaries of key participant comments made during the day, a list of technology recommendations for promoting clean energy technologies was developed. The results are reported in the following section.

IV. ROUNDTABLE OUTCOMES – RECOMMENDATIONS

The overall objective of the GEP-CCS Roundtables is to promote GHG awareness on GHG emissions reduction, obtain active stakeholder participation in related discussions and facilitate the development or recommendations or guidelines for integrating clean energy technology into policy and economic and project development plans. Active stakeholder participation was achieved during the Roundtable.

The extensive discussions held throughout the event and the focused dialogue on promoting clean energy technology conducted during the Valedictory session provided the foundation for a series of recommendations by participating stakeholders. The recommendations can serve as a basis for creating a common approach or unified dialogue within the sector for promoting clean energy technology and by doing so, move the sector towards a lower GHG emissions generation path. The following is a summary of the key technology recommendations and positions expressed as an outcome of the Roundtable:

Generation of Electricity

It is expected that coal will continue to dominate as a primary fuel for power generation. But burning of coal creates a host of serious environmental problems requiring emission control. The World Bank norms also indicate that the power generation would have to follow much stringent emission norms. To comply with this and in the interest of India's potential participation in international agreements on climate change and GHG mitigation, it is expected that the *conventional coal fired power plants with sub-critical boilers* may phased out gradually.

Future choice of technology is expected to be determined by current and future trends of environmental regulations (including possible incentives for GHG emissions reductions that may evolve through international negotiations on climate change), availability of low-cost fuel on a long- term basis, plant efficiency and costs of the technology.

Recommendations for technology approaches to closing the power supply/demand gap and for addressing environmental externalities of power generation have been divided into short-term and long-term approaches. The following criteria were used to define short-term approaches; longer-term approaches are seen to fall outside of the criteria framework:

- Implementation Time Frame: short-term approaches can be implemented in one-two years;
- Investment Costs: short-term approaches are least cost and of lower capital intensiveness;
- Technology Risk: short-term approaches use technologies that are demonstrated;
- Augmentation: short-term approaches can be used to augment existing power generation units for improved efficiency and environmental performance, including GHG mitigation;

- Clean Power Production: short-term approaches prioritize clean energy production using untapped natural resources;

Because of their immediate application potential and potentially lower cost, priority should be given to creating an enabling environment for implementing the shorter-term options. Longer-term approaches are also critical to improving functional and environmental performance in the power sector. Actions for creating an enabling environment to promote these options should and must run concurrent to those that support shorter-term technology approaches.

Short-Term Technology Choice

- Use of **beneficiated coal to pit head plants** could be promoted.
- **Circulating Fluidized Bed Combustion (CFBC)** should be adopted for renovation to generate power and for modernization projects with plant size up to 125 MW. It can also be used to generate power from coal washing and refinery residues.
- Distributed generation which includes cogeneration, power from renewables, micro-turbines etc., should be promoted as a significant source of supplementing power generation and supply.
- More emphasis should be given to exploit the huge untapped potential of **hydro** for clean power generation.
- Facilitation of power generation from gas is a preferred cleaner technology option.
- Super critical technologies should be a dominant option in the short-run. The optimal plant size should be 500 MW and above for green field plants.

Long-Term Technology Choice

- **Ultra supercritical boilers:** The technology is under various stages of development and is expected to commercially available within 10-12 years. It offers the sector distinct opportunities though lack of availability in the short term is an issue. Nevertheless, policy and awareness building should be built to better inform the sector of the technology and its advantages.
- **Integrated Gasification Combined Cycle (IGCC)**
  - IGCC is not yet commercially matured although it is believed that it would be the dominant technology for future power generation because it is

expected that IGCC in combination with fuel cells can reach a thermodynamic efficiency above 70 per cent.

- IGCC plants need to be developed specifically for high ash Indian coal.
- Considerable research work needs to be done for developing gasifiers suited to Indian coal.

- **Underground coal gasification** is a potential clean technology option that should continue to be investigated and promoted. Incentives are needed to do so.

- **Coal Bed Methane (CBM)**
  - India has 400 Billion Cu. M. of CBM with heat value 8500-9000 K Cal/ Sq. Cu. M. CBM, a clean fuel for power generation, is currently being wasted during coal mining. This release not only creates safety hazards in coal mines but also causes global warming when released in the atmosphere. There is a need to explore this wasted potential. Different strategies should be worked out for unexplored and explored coal mines depending on the quality and quality of CBM available.

- Other long term measure includes CBM **scaling up commercial coal bed methane plants to 500-600 MW.**

Research & Development: Proper attention should be given to R&D efforts for the improvement of new technologies like:

- integrated gasification humid air turbine
- integrated gasification molten carbonate fuel cell
- development of hot gas cleanup system
- development of high temperature air pre-heater
- development of new material for ultra-supercritical boiler and
- development of new design for oxygen plant.

Transmission and Distribution

India has high T&D losses of about 23 per cent. These losses in some states are as high as 50%. Estimate shows that India could have saved 20,000 MW just from improving efficiencies of distribution transformers in T&D systems. Major policy recommendations are as follows:

- Transmission & distribution should be given equal importance as Generation in terms of a approach for saving energy and therefore closing the gap between supply and demand

- Integrated resource planning should be supported with greater Inter Grid Connectivity

- Distribution voltage should be increased from 440V to11KV to reduce technical and non-technical distribution losses.

- Distribution Circuit Phases should be better balanced through efficient balancing and grid management systems such as SCADA etc.

- Energy efficient distribution transformers like amorphous core transformers have maximum potential for energy savings and are easy to retrofit. Such equipment's while procurement should be seen for least cost over 10 year of operation.

- Emphasis should be given to Demand Side Management to reduce the wastage of electricity and smoothening the load curve through:

    - Policies for promoting sustainable markets for energy efficiency.

    - Removing subsidies in agriculture and domestic sector.

    - Energy efficient lighting, HVAC, refrigeration, motors, agriculture pumps and process improvements in the end-use sectors.

    - Labeling and benchmarking of appliances.

    - 100 per cent metering for all consumers combined with utility and information management system for promoting energy conservation and reduction of theft.

    - Electronic metering system for time of day metering

- **Metering** can support conservation if proper action is taken instantaneously and meter information in monitory equivalent terms placed in the vicinity of the consumer.

Financing

Awareness and expertise amongst FI's in assessing cleaner energy/GHG mitigation projects needs to be substantially improved. There is a need to:

- Provide training to FIs on assessment and risk handling for clean energy projects
- Demonstrate to FIs the various success stories of cleaner energy project financing to improve confidence level amongst FIs
- Facilitate greater involvement and participation of international funding for financing/co-financing cleaner energy projects in India. India needs to leverage funds from these sources as a means to develop demonstration models of clean technology Investment processes and benefits to FIs.

V. NEXT STEPS TO PROMOTE CLEAN ENERGY TECHNOLOGY AND GHG MITIGATION IN THE UTILITY SECTOR

The Utility Roundtable served to stimulate discussion among the relevant stakeholders consistent with the intent of this activity. The event has built momentum for addressing clean technology and GHG mitigation reduction in the sector. The question now becomes one of maintaining or building on this momentum.

The Recommendations from the Roundtable provide ample opportunities for follow-up activities to promote clean technology among various stakeholders. GEP-CCS has several programmatic plans and tools for doing the same. GEP-CCS can use the Recommendations as a guideline for targeting its activities in a manner consistent with the ideas and views of stakeholders in the sector, thereby enhancing dialogue and exchange among them. The following is a brief listing of proposed follow-up actions to be pursued by GEP-CCS for this purpose:

Policy Level Dialogue: It is clear that GEP-CCS can play a role in promoting policy at key GOI Ministries. There is room to work as an advocate of clean energy technologies that result in GHG emissions reductions by meeting with representative decision makers and policy makers to promote their understanding of the benefits of such technologies and means by which the GOI can translate policy to enable these benefits to be realized. This is an activity that GEP-CCS has already undertaken, but which needs to be continued and broadened where possible.

Clean Technology Demonstration Projects: Participants noted that there are insufficient models of successful clean technology operations in India. As a core of GEP-CCS's activities, development of demo projects is a priority. GEP-CCS should work with CII and other potential project developers to bring financial closure to projects that can be shown to be a benefit to the utility sector in supplementing supply or reducing losses. GEP-CCS will need to communicate successful outcomes throughout the utility stakeholder community and keep this community abreast of new developments at the international, national, and state levels that could serve as incentives for sector interests to pursue such technologies.

Demonstrating Potential Financial Incentives for Clean Technology that Creates Carbon Off-Sets: Many stakeholders in this sector may not have a working or hands on familiarity with the nascent market for carbon or how this market could work as an incentive for pursuing clean energy technology projects. GEP-CCS should demonstrate the change in economics for clean energy projects with the inclusion of carbon component so that this evolving incentive can be made known to project developers. A possible action for doing so may be to invite key utility stakeholders to trainings for FIs or for other GEP-CCS target groups such as the project developers or CCCs on the status of and process for positioning projects for potential carbon off-set benefits.

Improving FI Awareness of and Linkage to Clean Technology Project Economics: As Mr. Bargava of ICICI acknowledged, Indian FIs are not yet familiar with the financial

risk issues related to clean energy technologies. To date, this has been a barrier for project developers and acts as a disincentive for then to pursue clean technology projects. GEP-CCS is already working to remove this barrier through its FI trainings. In the next round of FI trainings, it will be necessary for GEP-CCS to continue to pinpoint key FI stakeholders whose improved awareness will maximize the penetration of information on clean technology within the FI community. GEP-CCS plans to conduct a one-day training for FI CEO level officials for precisely this purpose.

Addressing Technology Issues In Subsequent GEP-CCS Roundtable Events: The multi-sector Roundtable event which GEP-CCS will conduct in the future will provide another platform for facilitating dialogue and creating added momentum behind clean energy technology project development in the utility sector. GEP-CCS will take the lessons learned from this Utility Roundtable event and incorporate them into a strategy for the multi-sector Roundtable (that will also include industrial and municipality stakeholders as well as renewable energy interests and proponents). A key strategy for maximizing impact of the multi-sector roundtable may be to focus on prime opportunities and constraints for implementing clean technologies for each of the sectors and to look for commonalities among sectors as a means for building consolidated momentum across interests.

APPENDIX 1 – ACRONYMS

ACRONYMS

CERF	Civil Engineering Research Foundation
CFBC	Circulating Fluidised Bed Combustion
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
FGD	Fuel Gas Desulphuristion
GEP-CCS	Greenhouse Emission Prevention – Climate Change Supplement
IGCC	Integrated Gastiction Combined Cycle
IGHAT	Integrated Humid Air Turbine
IIEE	International Institute of Energy Efficiency
kv	Kilovolt
KWh	Kilowatt Hour
LBG	Louis Berger Group
LD	Liquidity Damage
MW	Megawatt
NGCC	Natural Gas Combined Cycle
NW	Negawatt (Negative Wattage)
O & M	Operation & Maintenance
PC	Pulverized Coal
PFBC	Pressurized Fluidized Bed Combustion
PPA	Power Purchase Agreement
T&D	Transmission & Distribution
USAID	United State Agency for International Development

APPENDIX - BACKGROUND PAPER

INDEX

Contents **Page No.**

Clean Power & the Greenhouse Pollution prevention project 1

Section I: Introduction 2

Section II: Clean Power Generation 3

2.1 Power Generation from Clean Coal . . . 3
2.2 Clean Power from Renewables 8
2.3 Gas Based Power Plants. 9
2.4 Cogeneration.. 10

Section – III: Transmission & Distribution . . . 11

Section IV: Demand Side Management 16

Section V: Clean Energy Projects- Risk Associated & Financing 17

Section VI: Conclusion 21

Annexure 22

Sources 25

Clean Power and The Greenhouse Gas Pollution Prevention Project

The U.S. Agency for International Development (USAID) launched the Greenhouse Gas Pollution Prevention (GEP) project in 1995 to help India increase the efficiency of its coal-fired power plants and promote year-round cogeneration of power in the sugar industry. The Climate Change Supplement (CCS), initiated in 2000, expands on this effort by focusing on the links between climate change and urban and sustainable development. The Louis Berger Group, Inc. (LBG), based in Washington D.C., is implementing the project activities on behalf of USAID.

The primary objectives of GEP-CCS are to:

- Attract and channel private and international financing into clean energy technology and greenhouse gas (GHG) emission reduction projects.
- Promote GHG reduction pilot projects to test the efficacy of clean energy technology and its emission reduction characteristics.
- Develop human and institutional capacity to design and implement policies and projects that reduce greenhouse gas emissions.
- Increase technical cooperation between U.S. and Indian entities to reduce the GHG emissions growth rate in India.
- Create public-private partnerships to reduce greenhouse gas emissions.
- Collaborate closely with bilateral, multilateral, and private funds to leverage a larger pool of resources for project implementation.

GEP-CCS is working with a wide array of interests in India, including the Government of India (GOI); the utility/power sector, industry, and municipalities; financial institutions, local governments, NGOs, etc., to further understanding of the relationship between energy use and climate change and to facilitate actions that promote clean energy supply or use that result in reduced GHG emissions. Why? As may be well known to those working in the sector, India is currently the world's sixth largest and second fastest growing source of global GHG emissions. The utility sector is the largest generator of GHG emissions in India. Therefore, there is great potential to work within this sector to promote clean energy technologies and projects that are economically viable and that result in reduced GHG emissions. In this way, India can reduce the total volume and rate of increase in GHG emissions it generates and contribute to global efforts to combat the effects of climate change.

This Clean Power Roundtable is part of GEP-CCS's Outreach activities. Its purpose is to stimulate discussion among key stakeholders in the utility sector and disseminate information on approaches to using clean energy technologies for the purposes mentioned above. GEP-CCS hopes that the presentations and discussions will result in:

- Enhanced understanding of the role of the sector in climate change;
- New or broader perspectives on the roll of clean energy technology in reducing air and GHG emissions and methodologies that can be pursued for doing so;
- Recommendations from participants on policy or implementation guidelines and actions for promoting the use of clean energy technology in the sector; and
- New collaboration between GEP-CCS, project developers, the GOI, CII, and other interests to design and acquire financial closure on clean energy technology projects that result in reduced GHG emissions.

dominates its share in future. But burning of coal creates host of serious environmental problems requiring emission control and waste disposal.

Since India cannot live without coal, so one of the solution is to **adopt clean coal technologies for power generation**, which would not only reduce pollution, but also have higher thermodynamic efficiencies. Huge untapped potential of **hydro and renewable** sources should be exploited to ensure **energy security** and to bridge the future demand-supply gap at a much lower cost of pollution. Emphasis should also be given to reduce **T&D loss** and proper **Demand Side Management (DSM)**.

Section 2: Clean Power Generation

2.1 Power Generation from Clean Coal

In India, the poor quality coal poses problems in design, operation and maintenance of the power plant equipment. The high ash percentage (35 per cent and above) of Indian coal demands high level of performance from electrostatic precipitator in order to keep the pollution of the surroundings by fly ash at acceptable levels. The low calorific value due to high ash content of the coal also creates problems in start-up and flame stabilization in the boiler and needs continues addition of the secondary fuel (oil) which is very expensive. The high abrasive nature of the ash due to its high silica and alumina content leads to severe erosion of the equipment.

Various clean coal technologies for power generation are outlined in the following sections.

2.1.1 Pre Combustion Pollution Control

2.1.1.1 Physical coal cleaning

This involves crushing the coal and screening it into different-sized particles to separate out impurities that are not chemically bound to the coal. Water sprayed over the coal particles loosens the mineral matter. Coal is separated from other impurities through specific gravity differences. Physical **cleaning typically removes 10-30% of the sulfur and 60% of the ash-forming minerals.**

2.1.1.2 Coal Drying

Sometimes sub-bituminous and lignite coals have lower heat contents and high moisture contents. These coals can be upgraded by drying the coal. This process is very popular in China.

Pre-combustion coal treatments reduce ash disposal requirements, SO_2 and particulate emissions, transportation costs, equipment wear and tear, and operation and maintenance cost.

Cost:

The feasibility of coal cleaning depends upon the characteristics of the coal and the requirement of the user. Capital costs of the preparation plant range from $25,000 to $100,000 per metric ton per hour of cleaning capacity. Related non-fuel O&M costs range from $1-5/metric ton of coal cleaned. Coal washing in China was estimated to increase the value of the coal from $5.05 per ton to $8.45 per ton. According to CPCB, pit-head coal washing in India will increase the cost by 2 to 3 per cent.

Problem Areas

Coal cleaning and drying increases the cost of coal
Due to changes in the ash resistivity, there are potential problems with collection of fly ash using electrostatic precipitators.
Require large quantity of water.

2.1.1.3 NO_x Emission:

Reburning (controlled injection of coal or natural gas in the boiler can reduce NO_x emissions by 50-70%)

Low-NO_x burners (LNB) (creation of a fuel-rich flame for efficient combustion and NO_x can be reduced by 40-50%), and

Advanced overfire air (injection of air in the combustor to reduce NO_x emissions by 10-25%).

2.1.2 Clean Coal Combustion Technologies

2.1.2.1 Power from conventional pulverized coal

- It is the most widely used method for power generation.
- Combustion takes place at temperatures from 1300-1700°C
- All commercial sizes are available.
- Thermal efficiency can reach up to 45 per cent with modern designs and supercritical steam.
- 99 per cent fly ash, 90-97 per cent of SO_x emission and 70 per cent of the NO_x emission can be recovered from the flue gas.

2.1.2.2 Pulverized coal technologies using supercritical steam conditions

- Operating successfully in many countries
- Temperature and pressure of the steam should be more than 248 bar and 566 °C.
- Efficieacies of 45 per cent is already being achieved and subject to the new material development, efficiency can go up to 55 per cent in future
- Less CO_2 emission as less fuel is used per unit of electricity generated.

2.1.2.3 Atmospheric Fluidized bed Combustion

- Useful for coal with high ash
- Burns low grade fuels like lignite
- Low NO_x and SO_x emissions
- Higher efficiency (around 44 per cent)

Two forms are used

1) **Bubbling Fluidized Bed Combustion** (BFBC)
2) **Circulating Fluidized Bed Combustion** (CFBC)

- <u>Size</u>

10 to 100 MW equivalent for industrial boilers, 75 to 350 MW for electric utility applications.

- <u>Cost</u>

AFBC (200 MW): $1,500-2,000/kW
AFBC (repowering): $500-$1,000/kW

2.1.2.4.Integrated Gasification Combined Cycle (IGCC) with Cold Gas Clean-up.

This includes low-temperature removal of oxides of sulphur and particulates from the coal syngas, sulphur byproduct recovery and syngas moisturization to reduce NO_x formation in the gas turbine.

The main advantages claimed for IGCC plants as compared to the conventional steam plants are as follows:

- Higher overall thermal efficiency
- Minimum air pollution
- Reduced NO_x and SO_x emission.
- Possible independent operation of the gas turbine without operation of steam turbine.
- Quick start-up
- Less cooling water requirement per unit of electrical output.
- Less expensive recovery of CO_2 than conventional system
- Lower capital and operating cost, resulting in lower net electricity costs to consumers.
- Greater flexibility of expansion due to modular design.
- Flexibility of accepting different types of feed-stocks including lignites to petroleum coke
- Over 99 per cent of the sulfur present in the coal can be removed for sale as a chemically pure sulfur.

2.1.2.5 Pressurized Fluidized Bed Combustion

- Operates at pressures 6 to 16 times higher than normal atmospheric pressure.
- PFBC systems can achieve higher thermal efficiencies (nearly 50%) and Carbon emission reduction of 34% compared to conventional steam coal plants currently in operation.
- The current PFBC demonstration units are all about 80 MWe

- **Cost**

PFBC (demonstration): $1,900-$3,200/kW
PFBC (commercial): $1,000-$1,500/kW (expected)

2.1.2.6 Integrated Gasification Combined Cycle (IGCC) with Hot Gas Clean-up.

This system eliminates the need for syngas cooling prior to particulate removal and desulphurization. This improves the plant efficiency and reduces the need for heat exchangers and process condensate treatment.

- **Features**

40% efficiency (demonstration plants)
45% efficiency (first generation commercial plant)
50% efficiency (second generation plant)

- **Cost**

$1,200-3,000/kW for demonstration plants
$1,200-$1,900/kW for first generation plants
Less than $1,000/kW (projected) for second generation plants

2.1.2.7 Integrated Gasification Humid Air Turbine (IGHAT)

- Can achieve efficiencies higher than those of conventional IGCC
- Effective for base load electricity production
- Exhaust gas contains high moisture, which is particularly suitable for direct heating.

2.1.2.8 Air Blown Gasification Cycle

- This uses a Pressurized Fluidized Bed Gasifier to provide fuel gas for a gas turbine and an Atmospheric Circulating Fluidized Bed Combustion unit to provide steam for a steam turbine.

- Expected to achieve a short-run efficiency of 45% and more than 50% in the long-run.

2.1.2.9 Hybrid Combined Cycles

Use coal in a two-stage process. The first stage gasifies the majority of coal and runs a gas turbine, the second stage combusts the residual char to produce steam.
Expected efficiency more than 50%.

2.1.2.10 Co-firing Coal with Biomass or Wastes

- *Burning or gasifying* biomass or wastes together with coal.
- Reduction of CO_2, NO_x & SO_x emissions relative to coal-only fired plants.
- Recovery of useful energy from biomass and wastes at high efficiencies without the need for building dedicated plant.
- It can support renewable energy and waste industries.

2.1.2.11 Other <u>Combined Cycles</u> which are under the stage of development include

- **Cascade Humidified-air Turbines (CHAT)**
- **Direct Injection of Steam into the Gas Turbine (STIG)**
- **Heat Recovery *using Endothermal Reforming* plus Steam Injection (CHRISTIG)**
- **Heat Recovery using an Ammonia-water Working Fluid (Kalina Cycle)**
- **Direct Coal fired Combined Cycle (DCCC)**

2.1.3 Post Combustion Pollution Control:

Scrubbers are commonly used to remove up to 90% of SO_2 in stack gases. ***Advanced scrubbers*** use finely ground lime or limestone slurries to convert more than 95% of the SO_2 in flue gases to gypsum and other byproducts.

NOx emission can be reduced by converting it to nitrogen and water vapor by combining the (flue gas) waste stream with ammonia, urea or other compounds. The *most effective currently* available technology is **Selective Catalytic Reduction (SCR).** SCR injects ammonia in the presence of a catalyst; this reduces NOx by 80-90%.

Selective Non-Catalytic Reduction (SNCR), used for smaller boilers, injects a reagent into the flue gas at temperatures of 900-1100° C without using a catalyst. This achieves 30-50% NOx reductions. at a cost of from $10-20/kW.

<u>Cost:</u>

SCR: $100-200/kW. (retrofit capital cost)
SNER: 10-20/kW.

2.2 Clean Power from Renewables

India, like many other developing countries has been a net importer of energy with more than 25 per cent of its primary energy needs being met through imports of crude oil and other petro-products. The huge energy import bills not only hamper India's economic growth, but also make energy security issue a danger.

Fortunately, India is abundantly endowed with renewable energy resources. India being a tropical country enjoys abundant sunshine. India's topography also provides sufficient wind energy and small hydro. India's vast land resources can sustain the production of significant quantities of biomass. Now-a-days, several renewable technologies are not only commercially available, but are also economically viable in comparison to the fossil fuels, particularly when the environmental costs associated with the fossil fuels are taken into account.

Govt. of India attaches a lot of importance to the development and deployment of renewable energy and India has been one of those pioneering countries which has set up an exclusive ministry for renewable energy and it is being called the **ministry of non-conventional energy sources (MNES)**. With a strong industrial base and successful commercialization of technologies in wind, solar photovoltaics, solar thermal, small hydro and bio-energy, India today is in the forefront in international effort to harness renewable energy resources.

In the area of power generation about 3000 MW power-generating capacity based on renewable energy has already been installed in the country. This constitutes about 3% of our total installed capacity.

In **wind power generation**, India has been recognized as wind superpower and with 1268 MW of wind power capacity we now rank 5th in the world and first among developing countries.

In **solar photovoltaics**, Japan, Germany and the US are ahead of India. Over 8 lakh solar photovoltaic systems have already been deployed covering 36 different applications. Solar lanterns and home lighting systems are now being used in about 4,50,000 homes thus contributing substantial saving of kerosene in rural households and use of diesel fuel in generators. Nearly 2 lakh rural radio telephones are being powered by solar energy. A unique 140 MW integrated solar combined cycle power project is planned to set up near Jodhpur in Rajasthan. This will be the largest such projects and first of its kind in the world.

Solar energy has also been increasingly used for water heating in homes, institutional buildings and industrial and commercial establishments.

Hydropower is another clean and economically cheap source of energy. Hydro stations are best choice for meeting the peak demand. Hydroelectric projects have long useful life (nearly 50 years), which help in conserving scarce fossil fuel. Despite hydroelectric projects being recognized as most preferred source of electricity, the share of hydroelectricity has been going down. At present the hydro thermal mix stands at 25:75 as against the ideal mix of 40:60.

The present installed hydro capacity is 22,438 MW, which constitutes only 15 per cent of hydro potential. 7 per cent of the hydro potential is under the various stages of development. Thus remaining 78 per cent of the potential remains untapped so far.

About 46 per cent of total energy consumption in India is estimated to be met from various biomass sources like firewood, agricultural residue, animal dung etc. There are three routes through which biomass can be converted into electricity:

1. **Biomass Combustion:** It produces heat to generate steam, which drives a conventional steam turbine. The biomass combustion is considered to be environmentally neutral as far as CO_2 emission is concerned. Biomass combustion also produces lesser amount of NO_x and SO_x compared to the coal combustion.

2. **Biomass Gasification:** The process involves the combustion of biomass in a controlled oxygen environment in order to produce a gas, which is a mixture of CO, CO_2, CH_4 and H_2. The gaseous output can then be burnt directly in a gas turbine to produce electricity.

3. **Co-firing of Biomass and Coal:** This has already discussed in section 2.1.2.10

MNES and IREDA (Indian Renewable Energy Development Agency) have been providing various fiscal and financial incentives in terms of subsidies, exemption of taxes etc to promote renewable energy.

India is planing to add about 12,000 MW power generating capacity from renewables by the end of 11th. Plan, almost half of it will come from wind, 3500 from biomass and 2000 MW from small hydro. For creation of attractive environment for evacuation and purchase, wheeling and banking of electrical energy generated from renewable energy sources, the Ministry has issued a set of guidelines to all the States. It has suggested that States should announce general policies for purchase, wheeling and banking of electrical energy generated from all renewable energy sources. Fourteen States have so far announced such policies in respect of various renewable energy sources.

Renewables can play a major role in rural electrification. In India, 80,000 villages which are not electrified as of now, 18,000 of such villages are going to be electrified by using renewable resources since they are not economically viable to connect through conventional grid system.

2.3 Gas based Power Plants

Gas based power plants are rapidly gaining market share worldwide. The advantages of gas turbine include

- higher thermodynamic efficiency and lower level of pollution relative to coal based power plants
- lower capital cost and short gestation period
- quick start-up and modular design.

Because of low domestic availability of natural gas, they have to rely on imported fuel like naphtha or Liquefied Natural Gas (LNG). A list of India's private gas based power projects, which have fully commissioned is given in Annexure 2 and list of private power projects under construction is given in Annexure 3.

Various upcoming technologies in this field include Advanced Gas Turbine (expected efficiency more than 60 per cent) and Aeroderivative Gas Turbine for base load power generation.

2.4 Cogeneration

A cogeneration facility is one that simultaneously produces two or more forms of useful energy such as electric power and steam. Either conventional or alternate source of energy can be used for cogeneration. There are two types of cogeneration plants

1. Topping Cycles kind where the primary fuel is used to produce electricity and the thermal energy, which is the by-product is then used for process heating. The exact method and design of this kind depends on the quality of the fuel used. When the fuel is a clean liquid or gas, it may be burnt directly in an engine to produce power, and the waste heat from engine exhaust may be recovered for further use. For dirty fuels – whether solid, liquid or gas – it is usual practice to burn the fuel in a boiler to produce high pressure steam to run a steam turbine to produce power, and finally recover the turbine exhaust for process heating. This method is often used in sugar mills utilizing bagasse fuel, in pulp mills using digester and wood wastes and in municipal waste disposal, which consumes garbage fuel.

2. Bottoming Cycle type where the primary fuel is used to produce high-temperature thermal energy. The steam, which results from this, is used to produce electrical energy through a waste heat recovery boiler and turbine generator.

   This cycle is less common. It has been found to be useful with metallurgical or chemical plants where there is considerable heat of reaction. The efficiency of bottoming cycles is typically low.

Benefits of cogeneration are as follows.

- It reduces wastes
- It reduces energy costs and offers fuel flexibility.
- It provides a company good quality power and protect the company from the effect of power cuts.
- It reduces greenhouse gases by offsetting coal-fired thermal generation.
- A cogeneration plant reduces the immediate release of waste heat from the power station to the environment.

For India, biomass cogeneration holds great promise as an eco-friendly source of power, especially for decentralised applications. A task force, constituted by the Ministry of Non-Conventional Energy Sources(MNES), has projected a surplus power

generation potential of around 3,500 MW if all the 430 sugar mills in the country switched over to cogeneration. The potential from bagasse is about 1,000 MW each in Maharashtra and UttarPradesh, 350 MW in Tamil Nadu, 300 MW in Karnataka, 200 MW each in Bihar, Andhra Pradesh and Gujarat and the rest in Punjab and other states.

Section 3: Transmission & Distribution of Clean Power

The all India average T&D losses are around 22 – 23 % for the last few years. As per CEA recommendation, the T&D losses should be aimed at 8% and maximum could be around 15%. These losses in different states are as high as 50% in some state to as low as about 16% in other states.

Unfortunately, the aspect of T&D Loss reduction has not received the attention it deserves despite the fact that one of the reasons for mounting financial deficits of SEBs is the high T&D losses boosting up the cost of supply. Even the figures mentioned above are much lower than actual, as it is well known that the data are manipulated to show lower losses.

Reduction of these losses with improvement of availability, reliability and quality would reduce considerable demand for new power plants in the country thus benefiting not only in terms of cost but also in reducing the environmental impact due to the avoided plant.

In fact improvement in quality especially in terms of Number of interruptions in a year, Total duration of interruptions, Voltage at consumer end also gets translated to better and efficient utilization of power and also reduction of losses at consumer end.

The losses can be categorized into Transmission & distribution losses. The transmission losses are comparatively much smaller and are in the range of 3 to 4% compared to 19-20% losses at distribution end. The distribution end losses can be further classified as Technical & commercial losses.

Reduction of Transmission losses

Certain measures, which can reduce the transmission losses, are indicated below:

a) Rationalisation and increase in Transmission voltages

With the increase in load, the transmission voltages should be augmented and if possible, multiple voltages eliminated. For instance in South Korea, the transmission voltages of 154 kv, 66 kv and 22 kv have been rationalised to 345 kv and 154 kv reducing the losses from 11.18% to 3.4%.

b) Elimination of Intermediate Transformers

In high-density area, 132 or 110 kv can be directly stepped down to 22 or 11 kv instead of having an intermediate voltage of 66 or 33 kv. Transmission losses will be reduced in two ways i.e. by eliminating one transformation stage and making more power flow on 132 or 110 kv instead of, on 66 or 33 kv.

c) Line tap sub-station

In certain areas load exists and 66 kv or 33 kv line passes nearby but installation of a regular 66/11 kv or 33/11 kv sub-station is not techno-economically justified. In such cases load can be met by installing a line tap substation with fuse protection instead of drawing 11 kv line from long distance.

d) VAR(reactive power) compensation, which is basically used to control reactive power flow, will also result in loss reduction. Proper techno-economical evaluation is however necessary before venturing into it, being an expensive proposal.

Advanced Transmission systems Technologies

It is necessary that the transmission network is utilised to full capacity to ensure space saving and full utilisation. For this purpose many sophisticated technologies have been developed, as outlined below :

i) 800 kv Transmission System

With increase in bulk of power even 400 KV transmission system may not remain optimal and higher voltage e.g. 800 KV class may have to be chosen. For long distance high volume transmission, a choice between 800 KV AC or 500 KV DC system is to be made on techno-economical consideration and each case is to be studied in detail.

ii) Series Compensation and Static VAR Compensation (SVC)

For compensation against reactive load or to counteract induction in long EHV lines, these technologies will have to be introduced in a big way. SVC consists of a pack of capacitors and a pack of reactors either or both switched through thyristor valves to the desired control philosophy. This will allow compensation to the exact extent needed and will increase system capacity. This will also bring stability of system, damping oscillations.

iii) Phase Shifting Transformers

These are used to adjust power flow in parallel circuits so as to maximise capacity along a corridor. This will obviously ensure economy by utilising line capacity to maximum extent.

iv) Flexible A.C. Transmission

generation potential of around 3,500 MW if all the 430 sugar mills in the country switched over to cogeneration. The potential from bagasse is about 1,000 MW each in Maharashtra and UttarPradesh, 350 MW in Tamil Nadu, 300 MW in Karnataka, 200 MW each in Bihar, Andhra Pradesh and Gujarat and the rest in Punjab and other states.

Section 3: Transmission & Distribution of Clean Power

The all India average T&D losses are around 22 – 23 % for the last few years. As per CEA recommendation, the T&D losses should be aimed at 8% and maximum could be around 15%. These losses in different states are as high as 50% in some state to as low as about 16% in other states.

Unfortunately, the aspect of T&D Loss reduction has not received the attention it deserves despite the fact that one of the reasons for mounting financial deficits of SEBs is the high T&D losses boosting up the cost of supply. Even the figures mentioned above are much lower than actual, as it is well known that the data are manipulated to show lower losses.

Reduction of these losses with improvement of availability, reliability and quality would reduce considerable demand for new power plants in the country thus benefiting not only in terms of cost but also in reducing the environmental impact due to the avoided plant.

In fact improvement in quality especially in terms of Number of interruptions in a year, Total duration of interruptions, Voltage at consumer end also gets translated to better and efficient utilization of power and also reduction of losses at consumer end.

The losses can be categorized into Transmission & distribution losses. The transmission losses are comparatively much smaller and are in the range of 3 to 4% compared to 19-20% losses at distribution end. The distribution end losses can be further classified as Technical & commercial losses.

Reduction of Transmission losses

Certain measures, which can reduce the transmission losses, are indicated below:

a) Rationalisation and increase in Transmission voltages

With the increase in load, the transmission voltages should be augmented and if possible, multiple voltages eliminated. For instance in South Korea, the transmission voltages of 154 kv, 66 kv and 22 kv have been rationalised to 345 kv and 154 kv reducing the losses from 11.18% to 3.4%.

b) Elimination of Intermediate Transformers

In high-density area, 132 or 110 kv can be directly stepped down to 22 or 11 kv instead of having an intermediate voltage of 66 or 33 kv. Transmission losses will be reduced in two ways i.e. by eliminating one transformation stage and making more power flow on 132 or 110 kv instead of, on 66 or 33 kv.

c) Line tap sub-station

In certain areas load exists and 66 kv or 33 kv line passes nearby but installation of a regular 66/11 kv or 33/11 kv sub-station is not techno-economically justified. In such cases load can be met by installing a line tap substation with fuse protection instead of drawing 11 kv line from long distance.

d) VAR(reactive power) compensation, which is basically used to control reactive power flow, will also result in loss reduction. Proper techno-economical evaluation is however necessary before venturing into it, being an expensive proposal.

Advanced Transmission systems Technologies

It is necessary that the transmission network is utilised to full capacity to ensure space saving and full utilisation. For this purpose many sophisticated technologies have been developed, as outlined below :

i) 800 kv Transmission System

With increase in bulk of power even 400 KV transmission system may not remain optimal and higher voltage e.g. 800 KV class may have to be chosen. For long distance high volume transmission, a choice between 800 KV AC or 500 KV DC system is to be made on techno-economical consideration and each case is to be studied in detail.

ii) Series Compensation and Static VAR Compensation (SVC)

For compensation against reactive load or to counteract induction in long EHV lines, these technologies will have to be introduced in a big way. SVC consists of a pack of capacitors and a pack of reactors either or both switched through thyristor valves to the desired control philosophy. This will allow compensation to the exact extent needed and will increase system capacity. This will also bring stability of system, damping oscillations.

iii) Phase Shifting Transformers

These are used to adjust power flow in parallel circuits so as to maximise capacity along a corridor. This will obviously ensure economy by utilising line capacity to maximum extent.

iv) Flexible A.C. Transmission

The concept of flexible AC transmission envisages control of A.C. transmission to transmit power as ordered from remote stations to optimise the capacity of all the available alternative routes through fast acting solid state Thryistor valves using shunt and series compensation, phase shifting transformers and solid state dynamic reactors and adjusting tap of transformers. The technology is being developed for optimum utilisation of the transmission network. Minor additional cost of transmission line will improve the reliability and availability of power and the system is expected to form an essential component of modern load dispatch centre.

v) Inter grid transmission-National Transmission Grid

Some of the grids in the country are power surplus at times and others are power deficit. Also the hydro thermal mix in all states differs and this in turn leads to operating thermal plants at lower efficiency levels. The deficiency of power at some grids also leads to added capacity to meet the deficit. In such a scenario inter grid linkages can play a vital role in reducing additional power plants required at the individual grids and also help in operating power plants at optimal efficiency.

Such a grid would also require back-to-back HVDC for stable links, load dispatch center, communication links and advanced compensation systems and management.. It is envisaged that a national grid could lead to avoiding 12000 MW additional of power by year 2012.

Reduction of Distribution losses

Since maximum losses occur in the distribution system, major attention needs to be paid in this area.

Technical losses

The technical losses in distribution system can be reduced by certain well-defined means and in all the cases, the benefit / cost ratio would be attractive.

- Re-conductoring

In many cases, the distribution losses can be substantially reduced by increasing the size of conductor thus reducing the loading. The optimum loading for overhead line conductor is about 25% of thermal capacity. World Bank study shows benefit / cost ratio ranging from 1.5 and 15 by making investment in increasing size of conductor or laying seperate line to reduce loading.

- Installation of Shunt Capacitors

Installation of capacitors on a distribution system with low power factor is one of the most beneficial means of loss reduction. The other advantages are :

- Improved voltage profile.
- Release capacity to serve other existing loads.

As per study conducted by POWER GRID in northern regional grid, installation of 1300 MVAR of capacitor would reduce peak losses by 150 MW and the cost will be paid back in 13/14 months. Benefit cost ratio could range between 3 and 15 as per World Bank Study.

- Use of high voltage distribution system

Use of high voltage distribution system in place of conventional low voltage distribution system is another highly beneficial way of loss reduction.

This system based on practice adopted by Latin American countries are being widely used by South Korea, Japan, Thailand etc. With switching over from current system to high voltage distribution system significant achievements can be made in bringing down peaking loss and improvement in voltage profile. It is estimated that, the cost of high voltage system is only about 15% higher but the annual saving in losses is quite high.

In fact, some countries have adopted 22 kv as the primary distribution voltage and the line is taken upto cluster of 4/5 consumers and a small 22 / 0.4 kv transformer installed for them, thus reducing distribution losses to as low as 3%.

- System Improvement

The distribution system in most of the states is characterised by unsatisfactory standard of quality and high degree of losses. This is because expansion of the system is being made somewhat in ad-hoc manner to meet new groups of consumers rather than carry out systematic planning and execution of schemes.

Conducting optimum planning and addition of sub-stations or lines in a planned way will improve reliability and reduce losses. Such work is, however, to be done to meet increased load rather than reduce losses only. When such expansion is not done regularly the losses are bound to go up due to over loading apart from causing frequent break downs and low voltage profile.

- Smoothening the load pattern

Demand side management, time of day metering etc could lead to smoothening of the load curves and thus avoiding operation of plants at lower efficiencies,

Commercial losses

The reduction of these losses can be achieved mostly by strong administrative measures because these losses are due to human factors and theft/pilferage. These losses just do not lead to loss of revenue but upset the overall planning of the transmission system leading to improper cable, transformer, projection system capacities thus leading to higher technical losses also.

Following actions will reduce the commercial losses considerably.

- Providing certain features in the meters to make them pilfer proof.
- Providing properly sealed electronic meters for high voltage consumers.
- Granting connections liberally as not providing such connections forces the public to resort to theft / pilferage.
- Rotating the meter readers every few months.
- Fixing responsibility of area in charge to account for input energy with energy billed.
- Announcing proper incentives for loss reduction.

Card operated meters

This is a system of prepaid meter with built-in miniature circuit breaker. The supply shall be 'ON' when a card with magnetic code is inserted in the meter. The code is fed into the card against payment in cash counter of the utility. After energy is used equivalent to the amount paid, the meter will stop automatically and the card is to be taken to cash counter for fresh feeding of code against payment.

This will be a good arrangement for reducing the commercial losses. It may not be a profitable solution immediately due to high price of these meters which are to be imported . But with indigenous production, the cost may come down and the proposal may become viable.

Advanced Distribution Systems Technologies

i) SF6 and Vaccum Type switchgear

It is well known that oil circuit breakers both bulk oil and minimum oil types need regular maintenance causing down time and are also fire hazards. Considering the cost of outage and maintenance including carrying spares inventory, the expenses over the life cycle may be less in case of SF6 / Vaccum switchgear. The other advantages are Long contact life, Freedom from fire hazards, Short clearing time in case of fault reducing chances of damage to other equipment's, No exhaust oil fumes, Freedom from environmental effect, Higher interruption capacity etc.

With the increase in generation and transformation capacity, the fault levels are rising which may make existing oil switchgear irrelevant. The advantages with Vaccum / SF6 interruptor is that in such event, it can replace only the oil interruptor and use existing fixed portion i.e. housing, cable boxes, CT, PT etc thus needing minimum expense.

ii) Amorphous core (AM) Transformers

Normal steel is having crystalline structure. The technology of Amorphous steel had been developed by USA which is completely crystal free i.e. uniform in the molecular structure. This is manufactured by the process of sudden cooling of molten steel.

The iron loss in case of transformer with core made of amorphous steel was found to be 30 percent of the losses of transformers having core of Cold Rolled Grain Oriented (CRGO) silicon steel of Grade M41.

AM transformer is therefore widely used in USA. Use of these transformers could reduce the total transformer losses in the country.

iii) Dry Type Transformers

Dry type transformer is another modern technology. These are completely cast in epoxy and have the following advantages:

- Completely maintenance free
- Free from fire or explosion hazard due to absence of oil or any liquid.
- Require much less space
- Environ friendly

Where space is a constraint particularly in congested locality, dry type transformer is ideal.

iv) Secondary Distribution

In the low-voltage side, the basic technology is unchanged. Modern cable connection technology i.e. heat shrinkable or premoulded type reduces the installation and down time for repair and improves the reliability. On the protection side the stress is towards compact and maintenance free circuit breakers, which are being widely used in advanced countries.

v) Distribution Automation

For AC voltages at 33 kv and above, the trend is controlling all circuit breakers remotely via a SCADA system. In higher voltage substations, even the isolators, transformer taps etc. are also controlled by SCADA.

Section 4: Demand Side Management (DSM)

DSM can be looked upon either traditionally as a tool, to be used to reduce the demand for energy or more generally as a tool for optimal use and distribution of the scarce resources for the society. DSM projects are of two types; energy efficiency, which basically focuses on modification of end use technologies and energy conservation.

Energy conservation is synonymous with energy generation and conservation is cheaper than production. For example, one MW of power generation costs as much as 3 to 4 crore whereas same power can be saved with less investment. In India, there is a huge scope for energy conservation as energy intensity, which is energy consumption per unit of GDP, is one of the highest in comparison to other developed and developing countries. For example, it is 3.7 times of Japan, 1.55 times of USA, 1.47 times of Asia and 1.5 times of World average. According to a study conducted by Gopinath & Raghuraman in 1992, DSM measures could lead to 19.5 per cent reduction of demand.

Energy conservation and efficiency improvement in the Indian power sector requires special attention since the sector has been suffering from chronic supply shortage, financial sickness and environmental problems associated with the coal based power-plants. High T&D loss mainly because of power theft and high auxiliary consumption further aggravate the situation. By reducing the electricity use through DSM, the supply associated with the additional demand can be avoided which in turn, eliminate the emissions that would have been produced by burning further fossil fuel.

DSM in domestic and commercial sector can substantially reduce the electricity demand for lighting, space heating and cooling, refrigeration, and electricity used for electronics and other equipment.

Results of industrial DSM programs can include: reduced capital requirements; reduced energy consumption; reduced spoilage/waste; flexibility of raw material base; greater control over production; improved product quality and yield; decoupling of production from fuel supply; increased competitiveness; increased production at less energy per unit produced; and reduced environmental impacts.

DSM in residential, commercial and industrial sector can be achieved through

- energy efficient end use appliances like compact fluorescent lamp, electronic ballast, highly efficient motor, centrifugal refrigeration compressors, variable speed devise, HVAC equipment, solar architecture etc.
- load management and good housekeeping practices
- fuel switching

Section 5: Clean Energy Project-
Risk Associated & Financing

A Clean Energy Project is not very different from conventional projects as far as risks involved in implementation. Thus there are thus two broad categories of risks from the perspective of sponsor, lender and the regulator. The Traditional project risks include

- Project Developers Risk – This is mainly related to the technical capability of the PD in system design, construction, cost estimation and system performance

- Credit Risk – The stakeholders like PD, Contractors (EPC, O&M etc.). Offtaker of the services (Utility, consumers etc.) have to be Creditworthy
- Construction Risk – This is associated with possible delays in construction and related cost overrun. These risks do not necessarily pass to the subcontractors
- Environmental Risk – Although the Clean Energy projects are mitigative, there are Environmental Risks associated with use and storage of hazardous wastes like biomass or damage of flora and fauna or risks to the allied services like the aviation from wind mills
- Currency Risks – For international investments and repatriation if any are susceptible to the availability of foreign exchange. The fluctuation of the conversion rate, exchange controls and devaluation of local currency also pose a major risk
- Country & Sovereign Risk – Political situation in the host country, public pressure of a political nature, preemption rights on fuel, raw materials and project outputs, restrictions on fund transfer due to economic problems are some of the political risks and sovereign risk like dishonoring of sovereign agreements by government also pose risk to the international investors
- Regulatory and Legal risk – The possibility of Change in laws of the host country relating to tariffs, production and consumption controls, tax policy, uncertainty of deregulation/law reform are key risks under this category

Apart from these standard risks, there are some additional risks associated with a Clean Energy Project. These are described below:

- Project Developer Risk – This emanates from the lack of knowledge of clean energy technologies, small size of projects associated with higher transaction costs, low energy intensity in some industrial sectors(applicable to the EE projects) and time and cost overruns
- Risks facing lenders – These include ability to assess:
  - The technology and measuring its real potential (as rewards are proportional to this risk)
  - The Project Developer's capabilities, resourcefulness etc.
  - End user's capabilities,
  - Underlying Project Agreements
- Carbon Credits Risk – These are associated with inability of achieving the projected Carbon reductions due to poor project performance, unanticipated leakage and external factors. Inability of setting a proper mechanism/ procedure in the host country could erode the quality of the carbon credits. One of the most critical risks here is the effectiveness of the international market based mechanisms.
- GHG Reduction Market Risks – These risks are associated with non-existence of proper standards for calculating project baselines, additionality, registration process etc. These are expected to diminish once the rules are set in
- GHG Reduction Price Risk – All the above mentioned risks culminate in possibility of discounting by the prospective carbon investors and may make the project unattractive as a whole.

It is very important that all the stakeholders of the Clean Energy Project evaluate the above risks properly. This would enable them to address the risk so as to minimize the

overall risk perception. A Risk should be allocated to the party that is best able to control it.

FINANCING

The clean energy project financing as any other financing exists with almost all FI's. Some of the FI's give importance to the Clean Energy projects and have special considerations for such projects. There is also international, multilateral funding available for Clean Energy Projects.

There is a need for evaluating these projects keeping the holistic picture in mind. The economics of such projects would greatly improve once;

- Pricing of energy is done keeping the environmental cost in mind
- Incentives such as economic, preference in biding process etc to project developers of cleaner energy projects
- Financial mechanism funds for promoting such projects

The Flexible mechanisms being evolved under the Framework Convention of the UN may offer opportunities of developing clean energy projects thorough the GHG emissions abated.

Some of the funding opportunities available are;

- **Normal project financing:** FI's such as IDFC, ICICI etc have been financing projects. But very few of them have special line of credit for Clean energy projects. In some case special consideration is given to clean energy projects.
- **Equipment financing: Export Credit** Agencies like Exim Banks of various countries offer financing for plant and machinery cost for the exported equipment.

Incremental / Barrier removal: Some of the multilateral funds such as UNDP, International Finance Cooperation, Global Environment facility, World bank offer the incremental cost financing, or barrier removal funds

- **Climate Change/ CER's Financing :** As the financing mechanisms under the UNFCCC are being finalized, carbon investors have begun showing an interest in buying early carbon credits. There are some private and multilateral funds available for developing countries. A list of such funds and details are given below;

Financing Mechanisms

Organizations and Programs	Target Investments	Types of Financing	Focus Regions	Required Approvals	Level of Funding (US$)
E&Co.	Energy efficiency & renewables	Loans and equity investments	Developing countries	None	Loans: and equity investment

Organizations and Programs	Target Investments	Types of Financing	Focus Regions	Required Approvals	Level of Funding (US$)
					s from $25,000 to $250,000
Environmental Enterprise Assistance Fund (EEAF)	Energy efficiency & renewables	Loans and equity investments	Developing countries	None	$100,000 - $750,000
GTZ (Germany)	Energy supply and conversion	Grants	Countries with high levels of GHGs	Host country government	$100,000 - $300,000
Global Environmental Emerging Fund (GEEF)	Clean energy or water projects	Equity investments	Global	None outside the GEEF (OPIC) Fund	Up to $18 million
Global Environment Facility (GEF)	Energy efficiency & renewables and other GHG reducing projects	Grants and loans	Countries eligible for funding under the World Bank	Host country focal points	All levels
International Climate Change Project Fund (ICCPF)	Energy efficiency, energy supply, renewables, offsets, and trading	Grants	Countries receiving USAID funding	Letters of agreement with host country and corporate commitment	Average of $300,000
International Finance Corporation (IFC)	Power sector reform, market development	Loans and equity investments	Global	Project specific	$100,000 and up
ICICI	Clean technology/GHG reduction in key industries	Loans and conditional grants	India	Fund specific	Max Rs 35 million
Oregon Climate Trust	Any GHG reducing projects	Open to project design	Global	With State of Oregon for CERs	Less than $500,000
Prototype Carbon Fund (PCF)	Complimentary to GEF projects (upto 2012)	Loans	Global	Host country	Estimated to be about $3-$15 million with maximum upto $ 36

Organizations and Programs	Target Investments	Types of Financing	Focus Regions	Required Approvals	Level of Funding (US$)
					million for a country
Triodos Bank	Renewable, energy efficiency, efficient building	Loans and equity investments	None	Unknown	All levels

Though the protocol is under negotiations the post protocol approval scenario could certainly see more funding from developed countries to corporates of developing countries, Equipment suppliers, and fuel suppliers through governments of countries with commitments (Annex B of the Protocol). Please see the January 2001 issue of CII- Global Climate change Newsletter for further details.

Section 6 : Conclusion

We have discussed various clean technologies for power generation and the financial mechanisms to promote these clean technologies. Nuclear power is certainly a cleaner option and India has adequate reserves of thorium and technical know how to produce nuclear power, however, it does come with safety and waste disposal problems associated with it. That's why, nuclear power option has not been discussed since before exploiting the option the safety and waste disposal concerns would have to be addressed.

In order to support a growth rate of GDP of around 7 per cent, the rate of growth of power supply needs to be over 10 per cent annually. It is expected that coal, which has highest CO_2 emission coefficient as compared to oil and gas, will continue to provide 60 per cent of total energy in future. Although per capita CO_2 emission in India is only 0.2 tons, it is world's sixth largest CO_2 emitter.

There are various options available with power sector for cleaner generation, transmission and distribution of power in an efficient and environmentally benign manner. But the major problem is in financing the clean projects. The financing agencies as well as the country would have to look at these projects in a long term, socially responsive perspective. Options such as the Clean Development Mechanism (CDM) included in the Kyoto Protocol can help in improving the financiablity as well as provide technological access to cleaner projects.

A proper strategy needs to be developed for exploiting the feasible options from generation to the end-use point of power. India should need to adopt clean technologies for power generation, reduce avoidable losses and demand side management for efficient utilization of power. This would not only reduce its future demand-supply gap but would also help in achieving sustainable growth path.

Annexure 1

STATUS OF REFORM AND RESTRUCTURING OF SEBs

		Arunachal Pradesh	Andhra Pradesh	Assam	Bihar	Delhi	Gujarat	Goa	Haryana	Himachal Pradesh	Jammu & Kashmir	Karnataka	Kerala	Meghalaya	Madhya Pradesh	Maharashtra	Manipur	Mizoram	Nagaland	Orissa	Punjab	Rajasthan	Tamil Nadu	Tripura	Uttar Pradesh	West Bengal
0	State's decision to reform power sector	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
0	SERC																									
2.1	Decision to set up SERC	★	★	★		★	★	★	★		★	★			★	★	★	★	★	★	★	★	★		★	★
2.2	Appointment of selection committee		★			★	★	★	★			★			★	★				★		★	★		★	★
2.3	Joining of chairperson / members of SERCs		★			★	★		★			★			★	★				★		★	★		★	★
2.4	Operationalisation of SERC		★			★	★		★			★			★	★				★		★	★		★	★
2.5	Move GoI to omit Section 43A(2) of E(S) Act, 1948		★						★			★				★				★			★		★	
2.6	Filing of tariff petitions before SERC		★						★			★				★				★			★		★	
2.7	Issuing tariff orders		★													★				★						
3.0	Unbundling / Corporatisation																									
3.1	Studies for unbundling / corporatisation		★	★	★	★	★	★	★		★	★	●		★	★				★	★	★	★		★	★
3.2	Reform Bill, enactment		★						★			★								★		★			★	
3.3	Unbundling / corporatisation implementation		★						★			★								★		★			★	★
3.4	Drawing up a financial restructuring plan including valuation of assets and liabilities (funded and unfunded)		★						★			★								★					★	
3.5	Distribution Reforms		★						★			★								★					★	
3 a	Initiated measures for reducing T&D losses		★						★			★								★					★	
3 b	Creation of distribution zones / companies		★				★		★											★					★	
1.5	Privatisation of distribution																			★						

★ indicates achieved

● profit centre approach

Figures as on 30.6.2000
Source: Power Line

41

Annexure- 2

LIST OF GAS BASED PRIVATE POWER PROJECTS FULLY COMMISSIONED

(project-wise- since 1991) as on 31.01.2001

1	Paguthan CCGT (M/s Gujarat PowerGen Energy Corp.), Gujarat	655
2	Hazira CCGT (M/s. Essar Power Ltd.), Gujarat	515
3	Baroda CCGT (M/s. GIPCL), Gujarat	167
4	Dabhol CCGT (M/s. Dabhol Power Co.), Maharashtra	740
5	Jegurupadu CCGT (M/s. GVK Industries), Andhra Pradesh	216
6	Godavari CCGT (M/s. Specturam Tech.), Andhra Pradesh	208
7	Basin Bridge DGPP (M/s. GMR Vasavi), Tamil Nadu	200
8	Kondapally CCGT(M/s Kondapally Power Corp Ltd.),Andhra Pradesh	350
Private Power Projects which do not require TEC from CEA		
9	Adamtilla GBPP (M/s DLF Power Co. Ltd.), Assam	9
10	Bansalandi GBPP (M/s DLF Power Co. Ltd.), Assam	15.5
11	Gurgaon CCGT (M/s Magnum Power), Haryana	25
12	Eloor CCGT (M/s BSES Kerala Power), Kerala	173

Source: Ministry of Power

Annexure- 3

PRIVATE GAS BASED POWER PROJECTS UNDER CONSTRUCTION (INCLUDING THOSE PARTIALLY COMMISSIONED)

Sl.	Name of Project	State	Cap. (MW)	Promoter	Comm. Expected	Present status
			Private Power Projects			
1	Dabhol CCGT-Phase II	Maha.	1444	ENRON	2001-2	Financial closure achieved on 6.5.1999.
2	PPNallur CCGT	TN	330.5	PPN Power Gen.Comp.	2000-01	Construction started. FC achieved.
3●	Peddapuram CCGT	A.P.	358.9	Gautami Power Ltd.	2001-02	The project was awarded through ICB. PPA signed. Work started in Sep' 1998. FC expected soon. Escrow pending.
4●	Peddapuram Samalkot CCGT	A.P.	200	BSES Andhra Power Ltd.	2000-01	Work started in July 1998. FC expected soon. Escrow pending.
5	Vemagiri CCGT (Naphtha)	A.P.	482	Ispat Power Limited	2002-03	Work started in October 1998. Escrow pending. FC is yet to be achieved.
6	Samalpatti DGPP	T.N.	108	Samalpatti Power	March 2001	Escrow agreement signed. Financial closure achieved.
7	Ratlam DGPP	M.P.	118	M/s GVK Industries Limited	14-17 months from financial closure.	Financial closure achieved on 26.5.2000. Infrastructure works completed at site.
8●	Belgaum DGPP(FO)	Kar.	81.3	M/s Tata Electric Companies	by end of 2001.	Rs. 159 crores already invested. GoK Guarantee and escrow facility are the critical areas.

Foot-Note:-

● Project does not require TEC of CEA.

Source: Ministry of Power

Sources

1. ***Handbook of Climate Change Mitigation Options for Developing Country Utilities and Regulatory Agencies***, Complied by USAID & USEA

2. ***CII Report on Reduction of Transmission & Distribution Losses,*** **1999**

3. Web Site of
   - **a) Ministry of Environment & Forest (http://envfor.nic.in)**
   - **b) Ministry of Power (http://powerin.nic.in)**
   - **c) Ministry of Non-conventional Energy Sources(http://mnes.nic.in)**
   - **f) Central Pollution Control Board (http://envfor.nic.in/cpcb/)**
   - **h) TERI (www.teriin.org)**
   - **i) Power Line (www.indiapoweronline.com)**
   - **j) The European Renewable Energy Exchange (www.eurorex.com)**

APPENDIX 3 – ROUNDTABLE PARTICIPANT LIST

Clean Power – A Roundtable on Strategies for Power Sector – 9th May, 2001

List of Participants

Mr P C Sharma Director - Marketing ALSTOM ENERGY LTD. Chandiwala Estate Maa Anand Mai Ashram Marg Kalkaji New Delhi 110 019 Ph. 6826100/6486 Fax. 6826278 pravin.ch.sharma@in.abb.com	Mr Sujit Dasgupta Chief Executive-Power BALLARPUR INDUSTRIES LTD 7 Sainik Farm II (South) Near N Block New Delhi 110 062 Ph. 6522858/59 Fax. 6523234/6524535 sujit.dasgupta@blit.sprintrpg.ems.vsnl .net.in	Mr A K Tooley Resident Director BENGAL EMTA COAL MINES LTD II Floor, Ganga Plaza 18/13 WEA, Karol Bagh New Delhi 110 005 Ph. 5813142/43 Fax. 5820732 aktooley@vsnl.com
Mr Stuart Edwards Director LNG BRITISH GAS INDIA PVT LTD 3rd Floor, Tower B 1st India Place, Sushant Lok Bhawan Mehrauli-Gurgaon Road Gurgaon 122 002. Ph. 91-6364064/65 Fax. 91-6364069 stuart.edwards@bg-group.com	Mr Pradeep Vijayan Commercial Manager BRITISH GAS INDIA PVT LTD 3rd Floor, Tower B 1st India Place, Sushant Lok Bhawan Mehrauli-Gurgaon Road Gurgaon 122 002. Ph. 91-6364064/65 Fax. 91-6364069 pradeep.vijayan@bg-group.com	Mr S Sarkar General Manager (Elec.) CONSULTING ENGG SERVICES (I) P LTD 5th Floor, 57, Nehru Place New Delhi 110 019 Ph. 6485284/6465484 Fax. 6460409 cesinter@vsnl.com
Cdr S K Chakraborty Senior Consultant CONSULTING ENGG SERVICES (I) P LTD 5th Floor, 57, Nehru Place New Delhi 110 019 Ph. 6485284/6465484 Fax. 6460409 cesinter@vsnl.com	Mr Sanjay Jain Dy.Project Co-ordinator DCM SHRIRAM CONSOLIDATED LTD 2nd Floor, Kanchenjunga Bldg 18, Barakhamba Road New Delhi 110 001 Ph. 3316801/07/3319056 Fax. 3319062 dscpower@vsnl.com	Mr Y P Minocha Chief Engineer (Projects) DELHI VIDYUT BOARD Prgati Site, 220 KV I P Extn., Grid New Delhi 110 002 Ph. 3319990/3716347
Mr D P Singh Chief Engineer (Gen) DELHI VIDYUT BOARD Gas Turbine Power Station I P Station, Ring Road New Delhi 110 002 . 3318224 Fax. 3717347	Mr Arun Srivastava Sr. Executive Engineer DEPARTMENT OF ATOMIC ENERGY Anushakti Bhavan C S M Marg Mumbai 400 039 Ph. 022-2043041/2824354 Fax. 022-2048476	Mr Jitendra Singh Sr. Executive Engineer DEPARTMENT OF ATOMIC ENERGY Anushakti Bhavan C S M Marg Mumbai 400 039 Ph. 022-2043041/2824354 Fax. 022-2048476
Mr Kalipada Chatterjee Manager (Global Env.Sys.Grp) DEVELOPMENT ALTERNATIVES B-32, Tara Crescent Qutab Institutional Area New Delhi 110 016. Ph. 6967938/6565370 Fax. 6866031 tara@sdalt.ernet.in	Mr T V Balakrishnan Director DEVELOPMENT CONSULTANTS LTD 304, Ansal Bhawan 16, Kastruba Gandhi Marg New Delhi 110 001 Ph. 3310132/3311610 Fax. 3721709	Mr Vikram Shahi Asst. Manager HONEYWELL INTL. (I) PVT. LTD. Sector 36, Pace City II Gurgaon 122 004 Ph. 91-6371770 Fax. 91-6373132 vikram.shahi@honeywell.com
Mr Amitabh Bhargava Asst. Vice President I C I C I LTD ICICI Towers Bandra-Kurla Complex Bandra (East) Mumbai 400 051 Ph. 022-6536575/1414 Fax. 022-6531368/70	Mr Nitin Pandit Executive Director I I E C-INDIA 2131 K Street NW Suite 700 Washington DC 20037-1810 Ph. 202-785 6433 Fax. 202-833 2627 npandit@iiec.cerf.org	Mr Mahesh Patankar Project Manager I I E C-INDIA 602, Omega Hiranandani Gardens, Powai Mumbai 400 076 Ph. 022-5705859 Fax. 022-5702231 mpatankar@iiec.cerf.org

Mr Shekhar Borker Regional Manager-North INDIAN ALUMINIUM CO LTD UCO Bank Building Sansad Marg New Delhi 110 001 Ph. 3711411/3710301 Fax. 3710410 shekhar.borker@indal.co.in	Mr Vinay Deodhar Financial Analyst LOUIS BERGER C-6/7 Safdarjung Dev.Area Near IIT New Delhi Ph. 6532024/5/6 Fax.6532026 vinay_deodhar@yahoo.com / vdeodhar@satyam.net.in	Mr Amitava Banerjee Dy. General Manager LURGI INDIA LTD A-30,Mohan Cooperative Industrial Estate Mathura Road New Delhi 110 044 Ph. 6950035 Fax. 6950042/72 amitav_banerjee@lurgi.de
Mr Rajesh Sabharwal Vice President-Power MADHYA BHARAT ENERGY CORPN LTD M15, First Floor Greater Kailash - II Opp. Arya Samaj Mandir New Delhi - 110 048 Ph. 6468867/6239519 Fax. 6234111 ·becl@idel2.vsnl.net.in	Mr J K Bhatnagar Vice President (Works) MAGNUM POWER GENERATION Vill.Sihi Sihi-Sikandarpur Road P O Khedki Dhaula Gurgaon Ph. 91-6373628/6373630 Fax. 91-6373629 mgpl@bol.net.in	Dr B K Mahindra President MAHINDRA GROUP C-14, Chirag Enclave New Delhi 110 048 Ph. 6416003/4/5/7 Fax. 6467690/623396
Dr Mukesh Raizada Vice President MALANA POWER CO LTD LNJ Bhilwae Group Bhilwara Towers, A-12, Sector-1 Noida 201 301, NCR-Delhi Ph. 91-4541810 Fax. 91-4531648/4531745 iccs@ndf.vsnl.net.in	Mr R K Sachdev Former Advisor (Coal) MINISTRY OF COAL 1332, Sector A Pocket B, Vasant Kunj New Delhi 110 070 Ph. 6891186 Fax. 6136416 pedin@bol.net.in	Mr P K Modi Dy. General Manager NATIONAL THERMAL POWER CORPN LTD Engineering Office Complex A-8A, Sector 24 Noida 201 301 Ph. 91-4410218/4410333 Fax. 91-4410136/7 mechpk@ntpceoc.ernet.in
Mr Pankaj Kumar Gupta Asst.Chief Design Engineer NATIONAL THERMAL POWER CORPN LTD Engineering Office Complex A-8A, Sector 24 Noida 201 301 .t. 91-4410218/4410333 Fax. 91-4410136/7	Mr Shashank Andey Executive (Operations) NOIDA POWER CO LTD Commercial Complex (1st Floor) Block H, Alpha Sector II Greater Noida City, Dist Gautam Budh Nagar, Noida - 210 306 Ph. 91-4586559/60/61 Fax. 91-4586448 npcl.noida@ceec.sprintrpg.ems.vsnl.net.in	Mr S P Singh Managing Director PAN TRAEXO PRIVATE LTD D-19, Panchsheel Enclave New Delhi 110 017 Ph. 6495226 Fax. 6494961 pan1@ndl.vsnl.net.in
Mr N Balasubramanian Manager - Projects RPG POWER CORPN LTD Hemkunt Towers 12th Floor, 98 Nehru Place New Delhi 110 019 Ph. 6465557 Fax. 6479095	Mr Neeraj Sharma Sr. Manager (Power) SAIL Ispat Bhawan Lodi Road New Delhi 110 003 Ph. 4367481 Fax. 4368450 nsharma@sail.delhi.nic.in	Mr Deepak Gupta Sr Manager (Power) SAIL Ispat Bhawan Lodi Road New Delhi 110 003 Ph. 4368450 Fax. 4368450 dgupta@sail.delhi.nic.in
Mr Sanjaya Singhal Chairman & Managing Director SECURE METERS LTD P O Box 30 Pratap Ngr Industrial Area Udaipur 313 003 Ph. 0294-491875/492451-55 Fax. 0294-491946/384 sls.piudr@vsnl.com	Mr Promod K Diwan General Manager - Mktg SECURE METERS LTD VIPPS Centre 2, Local Shopping Centre Masjid Moth, Greater Kailash II New Delhi 110 048 Ph. 6440976/6412650/6426039 Fax. 6479769	Mr Alok Bhargava Sr Manager SIEMENS LTD Plot No.6-A, Sector 18 Maruti Industrial Area, Huda Gurgaon 122 015 Ph. 91-6349368 Fax. 91-6-345506 alok.bhargava@ggnl.siemens.co.in

Mr S K Grover Chief Executive Officer TALCHER MINING PVT LTD 13th Floor, Videocon Tower E-1, Jhandewalan Extn. Rani Jhansi Marg New Delhi 110 055 Ph. 3518477/3610124-29 Fax. 3619785/3616593 skgrover@vsnl.com	Mr M Sengupta Head-Corporate Affairs TATA ELECTRIC COMPANIES 'Jeevan Bharati' Tower 1, 10th Floor 124, Connaught Circus New Delhi 110 001 Ph. 3722723 / 3327072-76 Fax. 3326265 / 3326855	Mr HC Aggarwal Consultant TATA ELECTRIC COMPANIES 'Jeevan Bharati' Tower 1, 10th Floor 124, Connaught Circus New Delhi 110 001 Ph. 3722723 / 3327072-76 Fax. 3326265 / 3326855
Mr Shahid Hasan Research Associate TATA ENERGY RESEARCH INSTITUTE Darbari Seth Block India Habitat Centre Lodi Road New Delhi 110 003 Ph. 4682100/4682111 Fax. 4682144/4682145 hasan@teri.res.in	Mr B C Misra Advisor & Consultant UNDP C-543, Sarita Vihar New Delhi 110 044 Ph. 6954704 Fax. 6954703 bcm543@mantraonline.com	Mr Richard L. Edwards Director US AGENCY FOR INT'L DEVELOPMENT American Embassy Shantipath, Chanakyapuri New Delhi 110 021 Ph. 4198569 Fax. 4198612/8454 riedwards@usaid.gov
Mr P S Roy LOUIS BERGER C-6/7 Safdarjung Dev.Area Near IIT New Delhi Ph. 6532024/5/6 Fax.6532026	Mrs Prem Mahindra MAHINDRA GROUP C-14, Chirag Enclave New Delhi 110 048 Ph. 6416003/4/5/7 Fax. 6467690/623396	Mr S Padmanabhan Sr. Energy, Environment Adviser US AGENCY FOR INT'L DEVELOPMENT American Embassy Shantipath, Chanakyapuri New Delhi 110 021 Ph. 4198569 Fax. 4198612/8454
Mr Pankaj Gupta ACDE	Mr A K Basu Secretary – Power Ministry of Power Shram Shakti Bhawan Rafi Marg New Delhi 110 001 Ph. 3711316 Fax. 3721487	Mr Ron Sissem LOUIS BERGER C-6/7 Safdarjung Dev.Area Near IIT New Delhi Ph. 6532024/5/6 Fax.6532026
Mr Ashok Sarkar Proj. Management Specialist-Energy US AGENCY FOR INT'L DEVELOPMENT American Embassy Shantipath, Chanakyapuri New Delhi 110 021 Ph. 4198569 Fax. 4198612/8454	Mr Chandan Roy General Manager NATIONAL THERMAL POWER CORPN LTD Engineering Office Complex A-8A, Sector 24 Noida 201 301 Ph. 91-4410218/4410333 Fax. 91-4410136/7	Mr Kenneth R Gudger Chief Executive Officer Global Energy Partners, LLC Lafayette, California USA.
Ms Sauchita Barua LOUIS BERGER C-6/7 Safdarjung Dev.Area Near IIT New Delhi Ph. 6532024/5/6 Fax.6532026	Mr V Raghuraman Senior Adviser – Energy Confederation of Indian Industry Gate No.31, North Block Jawaharlal Nehru Stadium New Delhi 110 003 Ph.4365246/4366225 Fax: 4362136	Mr Sajal Ghosh Executive Officer Confederation of Indian Industry Gate No.31, North Block Jawaharlal Nehru Stadium New Delhi 110 003 Ph.4365246/4366225 Fax: 4362136

Mr Rahul Kshetrapal Executive Officer Confederation of Indian Industry Gate No.31, North Block Jawaharlal Nehru Stadium New Delhi 110 003 Ph.4365246/4366225 Fax: 4362136	Mr Shruti Bhatia Executive Officer Confederation of Indian Industry Gate No.31, North Block Jawaharlal Nehru Stadium New Delhi 110 003 Ph.4365246/4366225 Fax: 4362136	Mr Alimala Datta Roy Executive Confederation of Indian Industry Gate No.31, North Block Jawaharlal Nehru Stadium New Delhi 110 003 Ph.4365246/4366225 Fax: 4362136

APPENDIX 4 – ROUNDTABLE AGENDA

AGENDA

CLEAN POWER- A ROUNDTABLE ON STRATEGY FOR POWER SECTOR

9th May, 2001: New Delhi

Venue : Silver Oak, India Habitat Centre

0900-0930 HRS	**REGISTRATION**
0930-1030 HRS	**SESSION I: INAUGURAL** • ***"Welcome Address"*** Mr V. Raghuraman, Senior Adviser-Energy, CII • ***"Address"***, Mr. Richard L. Edwards, Director-Ecubed, USAID • ***"Address"*** Mr. Ron Sissem, Louis Berger Group Inc. • ***"Inaugural Address"*** Mr. A.K. Basu, Secretary, Ministry of Power • ***"Vote of Thanks"*** Mr V. Raghuraman, Senior Adviser-Energy, CII
1030-1050 Hrs	**Tea / Coffee Break**
1050-1230 HRS	**SESSION II : CLEAN POWER TECHNOLOGIES** • ***"Clean Technology Options for the Electric Utility Sector."*** Mr. Kenneth R. Gudger, Global Energy Partners, USA • ***"Efficient Coal Conversion Technology."*** Mr Chandan Roy, General Manager, NTPC • ***Coal Bed Methane – Prospects for India & Utility for power Sector*** Mr B C Misra, Advisor & Consultant, UNDP-GEF • **Discussion**
1230–1345Hrs	**Lunch Break**

1345-1515 HRS	**SESSION III: TRANSMISSION & DISTRIBUTION FOR CLEAN ENERGY** • ***"Transmission and Distribution Technologies for Efficiencies and Emission Reduction."*** Mr. Kenneth R. Gudger, Global Energy Partners Inc., USA • ***"Distribution Systems for Energy Efficiency."*** Dr Nitin Pandit, IIEC, USA • ***"Efficiency Improvement & Metering Systems."*** Mr Sanjaya Singhal, Secure Meters Ltd. • **Discussion**
1515–1530Hrs	**Tea / coffee Break**
1530-1610HRS	**SESSION IV: FINANCING & INVESTMENT IN CLEAN TECHNOLOGY** • ***"Risk Analysis & Management of Clean Technology for the Power Sector."*** Mr Amitabh Bhargava, Chief Manager, ICICI Ltd. • **Discussion**
1610-1700 HRS	**SESSION V: VALEDICTORY SESSION** **Panelist** • Mr. Kenneth R. Gudger, Global Energy Partners Inc, USA • Mr Chandan Roy, General Manager, NTPC • Mr Amitabh Bhargava, Chief Manager, ICICI Ltd. • Dr Nitin Pandit, IIEC, USA • Mr. V. Raghuraman, CII • Mr Ron Sissem, Louis Berger Group Inc.

APPENDIX 5 – FACULTY AND PRESENTER BACKGROUNDS

Mr. A K BASU
Secretary
Ministry of Power

Mr A K Basu is currently Secretary, Ministry of Power, Government of India.

He joined the Indian Administrative Service in 1965 and was allotted West Bengal Cadre. In Government of West Bengal, he has held several important positions, including Commissioner of Calcutta Municipal Corporation, Education Secretary, Labour Secretary, and Principal Secretary, Food and Civil Supply. He was the Chief Electoral Officer of the State from 1983 to 1987.

Mr Basu has worked in various capacities in Government of India. He was Deputy Secretary, Ministry of Home Affairs during 1976-77. He worked as Special Assistant to the Union Minister of Education, Social Welfare & Culture, during 1977 to 1980. He was Special Secretary, Ministry of Home Affairs, Government of India during 1996-97.

Mr Basu has a long association with industry and infrastructure sectors. He was Development Commissioner, Iron & Steel, and then Joint Secretary, Ministry of Steel, Government of India, during 1988 to 1993. He served as Additional Secretary & Advisory (Industry & Minerals), Union Planning Commission during 1995-96, dealing with Plans and Projects of nearly 20 economic and infrastructure Ministries of Government of India. He was Secretary, Ministry of Steel, Government of India, from August 1997 to May 2000.

Mr. V Raghuraman
Senior Adviser-Energy
Confederation of Indian Industry

As Senior Adviser (Energy) to the Confederation of Indian Industries (CII), Mr Raghuraman works with Policymakers, Indian Government Ministries and other National and International bodies on energy sector issues. He has over 32 years of experience in energy management, energy conservation, and industrial engineering and has served as a consultant, trainer and researcher on projects covering combustion, cogeneration and energy audits.

Mr Raghuraman has held various eminent positions such as Deputy Director General of the National Productivity Council, Secretary General of ASSOCHAM; Chairman, World Energy Efficiency Association, Washington, DC.; Member, Energy Research & Development Advisory Committees, ICICI; Board of Governors, National Institute of Industrial Engineering, PACER ERDACU/PRC; EMCAT Advisory Committee etc. He has led a team for Energy Code for Buildings sponsored by the Minitry of Non-Conventional Energy Sources (1991-92) ; helped identify ESCO opportunities as a member of EMCAT review committee.

As part of his work for CII, Mr Raghuraman draws up policy recommendations and convenes meetings to enhance the conservation of energy, promote the use of renewable energy and preserve the environment. He presented the Indian response to the Kyoto Protocol at the US-Japan Energy policy dialogue meeting in held in November 1998. Currently heads the CII Centre on Climate Change and developing CDM compatible projects. Conceptualised and initiated work on the Green Business Centre at Hyderabad.

Helped develop low air pressure oil burner standards, domestic kerosene wick stoves ; co-ordinating energy labelling standards for refrigerators, geysers and air-conditioners, awareness campaigns, metering, phasing out tax incentives and subsidies for low-efficiency technologies, and market-based energy conservation.

Mr Keneth R Gudger
Chief Executive Power
Global Energy Partners,LLC

Mr Kenneth R Gudger is an Electrical engineer & a Graduate in Management.

He is currently Chief Executive Officer, Global Energy Partners, LLC and is responsible for overseeing the operations of the company in Energy efficiency, Renewable, Environment Consulting and project Management Services.He is also responsible for Climate Change & energy efficiency operation of the company in Thailand and India & implementation of energy audits. The company is currently designing and installing an automatic load curtailment system for the state of California.

He has a vast experience in Electric engineering, Operations and management of transmission systems, energy end use efficiencies and environmental management.

He is also one of the founder of Edison Sources and had designed to bring energy efficiency and modern energy end use technologies to open market places.In 1993 President Clinton recognized him for his contributions to the US Administrations Global Climate Change action plan.

Mr Chandan Roy
General Manager
NTPC Ltd.

Mr Chandan Roy is a graduated in Mechanical Engineering from VRCE, Nagpur and thereafter received practical training with M/s. Babcock & Wilcox, UK at their establishment in London. Subsequently he also received training with the Tennesee Valley Authority, USA under the US and programme for advanced condition assessment technique for power plant components and component damage assessment for power plant components.

Prior to joining NTPC he joined the ACC Vickers Babcock Ltd. Where he was responsible for the design for steam generators and its components.

He started his carrier at NTPC in the Design Department where he was responsible for finalisation of specifications for the steam generators for various NTPC projects. He has since that time served in various capacities in NTPC including a stint at the Korba Super Thermal Power Station.

He is presently the General Manager of the Project Engineering Division of NTPC.

He has also authored a large number of technical papers related with power plant design & engineering for a number of leading technical journals and international conferences.

Mr B C Misra
Adviser & Consultant
UNDP-GEF

Mr B C Misra is an specialist in the field of exploration of coal; Planning, designing & implementation of projects of Coal Mines, Coal handling plants, Infrastructure of mines, Coal Washing, Clean Coal technologies, Coal utilization and Coal Bed Methane exploration & utilization.

He has a vast experience of over 42 years in planning, management and operation of these technologies both in India and abroad.

In the past he has held important technical possessions such as General Manager(New Technologies) , Coal India, Director (Tech) CMPDIL and then later Chairman CMPDIL.

Since 1997 he has been working as independent freelance consultant and chief Executive of B C Misra & Associates.

He has been consultant to various international organizations such as the World Bank, Asian Development Bank, African Development bank, UNDP & GEF in the field of clean technologies.

In 1998 he jointly with UN experts prepared docoument for Coal BED Methane in Indian Coal Mines for UNDP, GEF and Govt. of India. The project is currently under implementation. He is currently a Senior National Technical Consultant of UNDP on this project.

Dr Nitin Pandit
Executive Director
IIEC, USA

Dr. Nitin Pandit has his doctorate in public policy from George Mason University. He has done civil engineering from Birla Institute of Technology & Sciences & Master in Application of Artificial Intelligence & Geotechnical Engineering.

He is currently working with IIEC as Executive Director at Washington. He is responsible for operation in South America, South Africa America Asia and US. His prime role has been in developing complementary programs deriving synergies from technological and institutional innovations in engineering & sustainable energy.

Some of his projects include strategic leveraging of technologies for energy efficiency, remote monitoring, Carbon credits development and pollution prevention.

Mr Sanjaya Singhal
Managing Director
Secure Meters Ltd

Mr Sanjaya Singhal is an engineer from Pune University.

With a vast experience of over 12 years Energy metering he is today recognised as an expert in the area of metering and utility revenue protection and has published and presented many papers in this field.

He is currently the Managing Director of Secure Meters Ltd since 1988 and also the director of Polymeters response International Ltd, U.K.

He is also specialist in new business ventures such as pesticides, chemicals, Mineral processing and computer technology.

Mr. Amitabh Bhargava
Chief Manager
ICICI

Mr Amitabh Bhargava is a graduate in Chemical Engineering and a postgraduate in Business Management. He has more than 6 years of infrastructure financing & advisory experience in power sector at ICICI.

Mr Bhargava is currently working at the Infrastructure Industry Group of ICICI. Prior to his current position, he was working with the Advisory Services Division of ICICI for more than two years, where he gained extensive experience in the power sector. He handled a large number of advisory assignments with Rajasthan State Electricity Board, Gujarat Power Corporation Limited, Andhra Pradesh Electricity Board and Tamil Nadu Industrial Development Corporation in the power sector.

He is currently responsible for execution of the group's transactions in the power sector. He has been involved in appraisal, contract negotiations, and structuring for some of the large power projects in India.

APPENDIX 6– PRESENTATION

INAUGURAL

Overview of the Greenhouse Gas Pollution Prevention Project – Climate Change Supplement (GEP-CCS)

Implemented by the Louis Berger Group

Ron Sinorm
Chief of Party
Louis Berger Group,Inc

1

Background

- USAID Funded Project – Four year project initiated in May 2000
- Implementing a GOI supported strategic objective of increased environmental protection in energy, industry and cities
- CII as a key strategic partner in the GEP-CCS project

2

Purpose of GEP-CCS

- GEP-CCS aims to create an "enabling environment" for demonstrating the use of ***clean energy technology*** to reduce greenhouse gas (GHG) emissions"

- India is the world's six largest generator of greenhouse gas emissions with the second highest rate of growth in GHGs – a climate change "hotspot"

3

Key Project Activities

- <u>Facilitating Clean Energy Technology Demo Projects</u>
  - Facilitate clean energy projects that incorporate carbon off-sets as a potential means for improving project financials and potential for financial closure

- Many stakeholders involved
  - ***Utility/power sector***, industrial sector, municipalities
    - *Central and specific State government*
    - Financial Institutions
    - NGOs

4

Key Project Activities

- Communication and Outreach - understanding the clean energy technology/GHG emissions reduction link
  - Roundtables
  - Training FIs, project developers, DA/CII for capacity building
  - Policy/study exchanges to/from US.
- Facilitating Research
  - Costs of global warming to India and mitigation strategies for reducing costs. Public and stakeholder understanding.

5

Utility Roundtable – Why?

- Utility Sector a key player in Indian energy scenario;
- Very high potential to utilize clean energy technologies;
- Very high potential for reduced air emissions including GHGs and for structuring projects to position them to capture potential carbon off-set benefits

6

Desired Outcomes Of Roundtable

- Lively discussions on:
  - Using clean energy technology for improving supply/reducing loss and improving financial stability of the sector;
  - Lessons learned in the U.S. and India;
  - Relationship of clean energy technology to climate change

7

SESSION-II
CLEAN POWER TECHNOLOGIES

CLEAN TECHNOLOGY OPTIONS IN GENERATION

Mr. Kenneth R. Gudger
Chief Executive Officer
Global Energy Partners, LLC
Lafayette, California USA

CLEAN POWER
USAID GEP Program
New Delhi, India
May 9, 2001

Global Energy Partners LLC

The Louis Berger Group, Inc.

INTRODUCTION

- Power Supply
- Transmission
- Distribution
- Demand Side Management
- Retail Marketing Affiliate
- Energy Consultant
- CEO – Global Energy Partners
  - EPRI
  - GTI
  - DMJM

Global Energy Partners LLC

The Louis Berger Group, Inc.

THE NEED FOR CLEAN GENERATION

- TODAY:
  - 100,000 MW CAPACITY
  - 71% COAL
  - 24% HYDRO
  - 3% NUCLEAR
  - 2% WIND
- THE STRAIN OF FAST GROWTH:
  - PEAK LOAD SHORTAGES
    - 1999: 6.2%
    - 2000: 12.4%
  - DOUBLE CAPACITY IN 12 YEARS
    - Additional 100,000 MW

Global Energy Partners LLC

THE NEED FOR CLEAN GENERATION

- CLEAN COAL TECHNOLOGY
  - Pre Combustion Pollution Control
  - Clean Coal Combustion
  - Post Combustion Control
- RENEWABLES
  - Hydro
  - Wind
  - Solar Photovoltaics
  - Biomass
- NATURAL GAS FIRED PLANTS
- COGENERATION

Global Energy Partners LLC

69

THE NEED FOR CLEAN GENERATION

- Cogeneration.....A brief case study
- New Technology Or New Thinking?
- Why Should Utilities be Interested?
- Established Benefits:
  - Twice as Efficient
  - Reduced Carbon Emissions
  - Less Costly Energy
  - Industrial Modernization

Global Energy Partners LLC

The Louis Berger Group, Inc

THE NEED FOR CLEAN GENERATION

- Cogeneration .....A brief case study
- Encouraged Development:
  - By Regulators: Public Utilities Regulatory Policy Act (PURPA)
  - By Energy Consumers: Industrial Rates<=>Domestic Rates
  - By Equipment Suppliers/Installers
- Utility Threat:
  - "Bypass" Of Utility Service
  - Analysis of Potential
  - Response Strategy & Tactics

Global Energy Partners LLC

The Louis Berger Group, Inc

THE NEED FOR CLEAN GENERATION

- Cogeneration..... A brief case study
- New Utility Opportunities:
  - Perceived as "energy experts"
  - Own / Operate / Maintain
  - Business Opportunities
  - Generation Diversity
  - Customer Partnerships
- Distributed Resources

EFFICIENT COAL CONVERSION TECHNOLOGIES

DR. A. PALIT, DIRECTOR (TECHNICAL)
NATIONAL THERMAL POWER CORPORATION LIMITED

CLEAN POWER FOR POWER SECTOR
AT INDIA HABITAT CENTRE,NEW DELHI

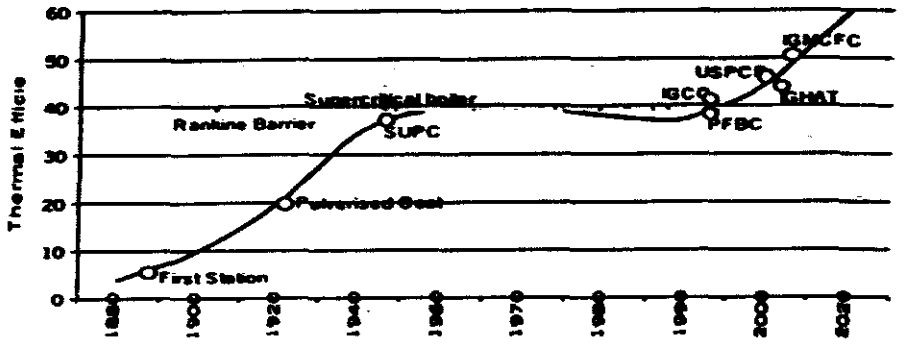
1

PRESENTATION AGENDA

- INTRODUCTION
- TRENDS OF ENVIRONMENTAL REGULATIONS
- FUEL SCENARIO
- VARIOUS TECHNOLOGY FOR COAL FIRED PLANT
- STATUS AND STRAGEGIES FOR ADVANCED COAL BASE TECHNOLOGY
- CONCLUSION

2

EFFICIENCY TREND OF COAL-FIRED PLANT



SUPC : Sub-critical Pulverised Coal Fired

PFBC : Pressurised Fluidised Bed Combustion

IGCC : Integrated Gasification Combined Cycle

USPCF : Ultra-Supercritical Pulverised Coal Fired

IGMCFC : Integrated Gasification Molten Carbonate Fuel Cell

IGHAT : Integrated Gasification Humid Air Turbine

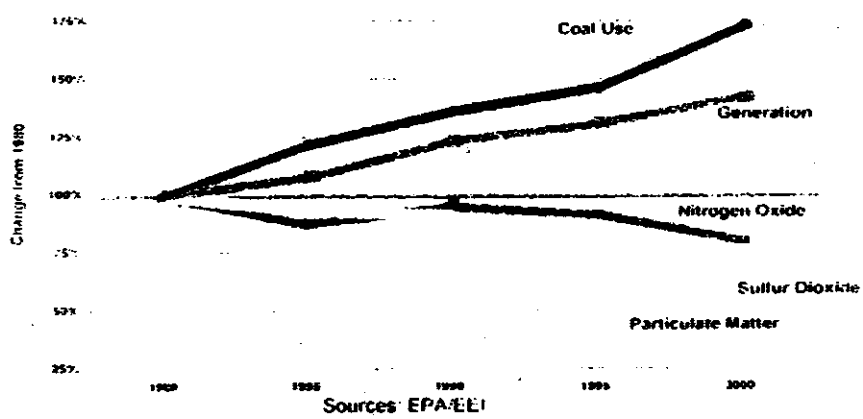
DRIVERS FOR FUTURE TECHNOLOGIES

- Current & Future trends of environmental regulations.
- Availability of low-cost fuel on a long term basis.
- Plant Efficiency
- Technology costs

TRENDS OF ENVIRONMENTAL REGULATIONS

5

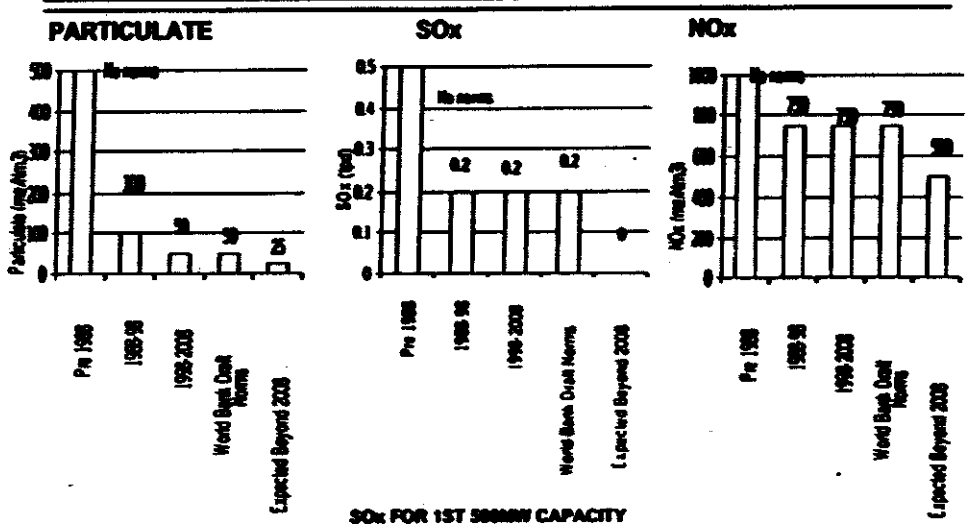
COAL UTILISATION AND ENVIRONMENTAL GOALS



ENVIRONMENTAL GOALS ARE BEING MET EVEN WITH INCREASED COAL UTILISATION.

6

TRENDS IN WORLD BANK ENVIRONMENT NORMS



Trends indicate that environment norms are being tightened.

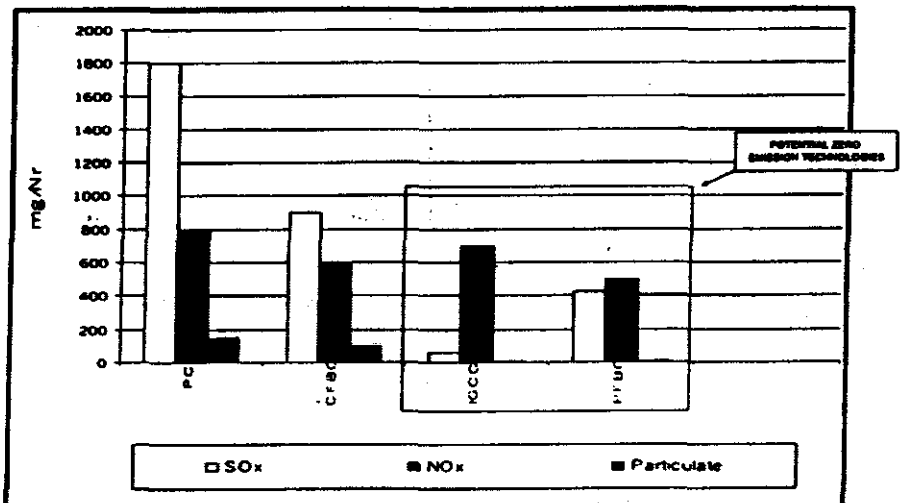
7

TRENDS IN ENVIRONMENT NORMS INDICATE

- ENVIRONMENTAL NORMS ARE BEING TIGHTENED.
- FUTURE TRENDS OF ENVIRONMENT NORMS MAY LEAD TO OBSOLESCENCE OF CURRENT TECHNOLOGIES LIKE PC BOILERS ETC.
- IGCC & PFBC NOT ONLY HAVE HIGHER PLANT EFFICIENCY BUT ALSO HAVE POTENTIAL FOR ZERO EMISSIONS AND THUS ARE THE TECHNOLOGIES FOR THE NEAR FUTURE (10-15 YEARS).

8

Comparative Emission Levels



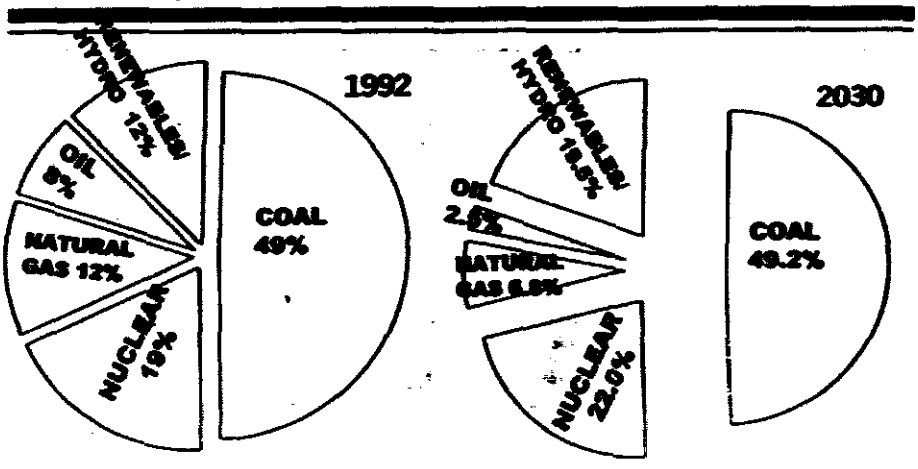
IGCC &PFBC ARE FUTURE TECHNOLOGIES FOR EFFICIENT COAL CONVERSION

FUEL SCENARIO

10

WORLDWIDE SOURCE OF ENERGY FOR POWER GENERATION

(SOURCE : NATIONAL ENERGY POLICY, USA)



COAL SHALL CONTINUE TO BE THE MAIN FUEL FOR POWER GENERATION IN THE FUTURE.

11

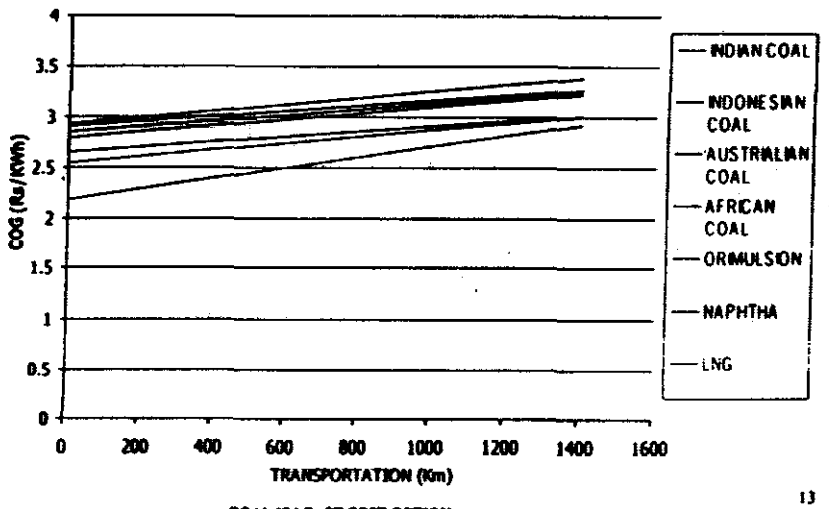
INDIAN FUEL SCENARIO

Sl. No.	FUEL	RESERVES	PRODUCTION 1997	PRODUCTION 2002	DEMAND 1997	DEMAND 2002
1.	Coal	205 bT (assessed) 73 bT(proven)	290 mT	385 mT	335mT	513mT
2.	Natural Gas	553 bm³	58 mcmd	64 mcmd	77 mcmd	83 mcmd
3.	Petroleum Crude	727 mT	33 mT		80 mT	98 mT
a)	Naphtha		6 mT			
b)	HFO/ LSHS/ HSD		32 mT			

COAL IS THE MAIN WORK HORSE

12

ECONOMICS OF FUEL-OPTIONS



COAL IS LEAST COST OPTION

13

INDIAN COAL PROPERTIES

COAL CHARACTERISTIC	TYPICAL RANGE
ASH	30%-45%
MOISTURE	10%-18%
ASH FUSION TEMPERATUE	1100-1200 C
SULFUR	0.2%-0.35%
VOLATILE MATTER	15%-20%
GCV	2800-3800

- HIGH IN ASH CONTENT
- EXTREMLY ABRASIVE ASH
- SLOW BURNING COAL (high incrtinne content)
- LOW IN SULFUR
- LOW SLAGGING/FOULING PROPENSITY

14

COAL FIRED BOILERS- NTPC EXPERIENCE

- LOW FURNACE ABSORPTION
- HIGH SUPERHEATER SPRAY 25%-35% OF M.S. FLOW
- HIGH SUPERHEATER TUBE METAL TEMPERATURE
- REDUCED OPERATIONAL FLEXIBILITY
- SLAGGING/CLINKERING TENDENCY INSPITE OF NON SLAGGING COAL
- EROSION LEADING TO TUBE FAILURE
- LOW WEAR LIFE OF COAL MILLS

15

VARIOUS TECHNOLOGIES FOR COAL FIRED PLANTS

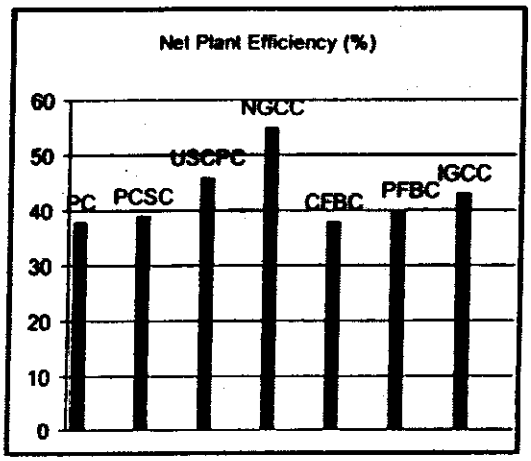
TECHNOLOGIES

1. PULVERISED COAL FIRED SUB CRITICAL 540/540°C STEAM PARAMETERS.
2. PULVERISED COAL FIRED SUPER-CRITICAL/ ULTRA-SUPERCRITICAL
3. CIRCULATING FLUIDISED BED COMBUSTION (CFBC)
4. PRESSURISED FLUIDISED BED COMBUSTION (PFBC)
5. INTEGRATED GASIFICATION COMBINED CYCLE (IGCC)

16

COMPARATIVE EFFICIENCIES OF VARIOUS TECHNOLOGIES

TECHNOLOGY	EFFICIENCY (%) Current	Future
PC	38	-
PCSC	39	-
USCPC	46	-
NGCC	55	62
CFBC	38	-
PFBC	40	50
IGCC	42	55



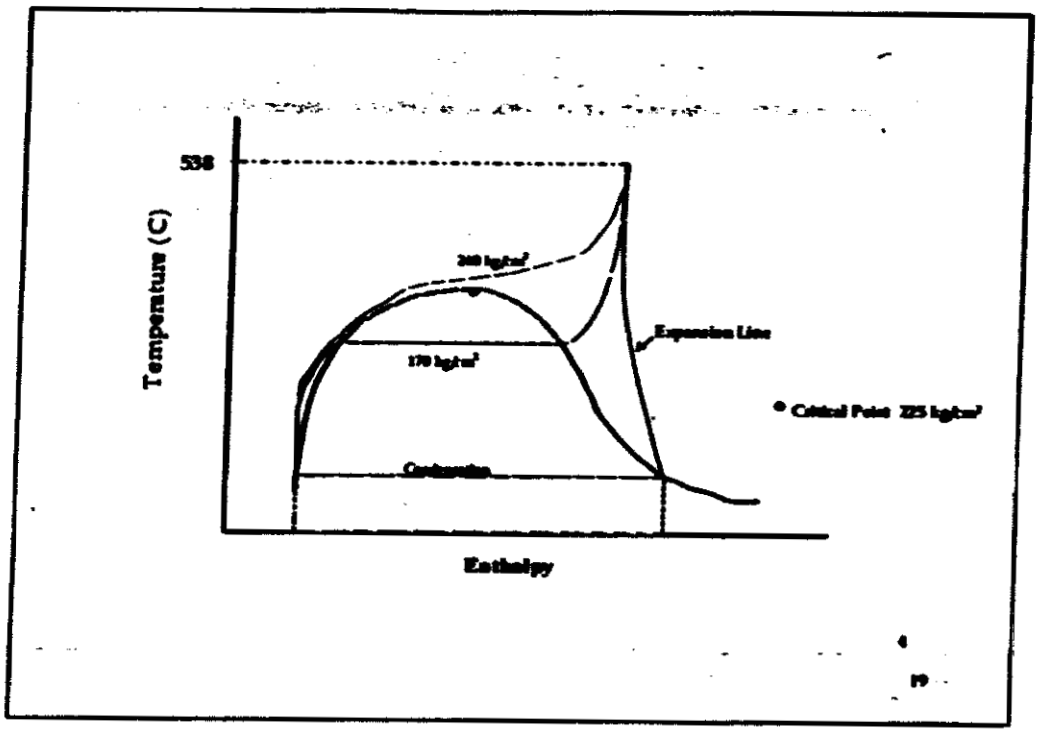
Source: Technical Papers of Indo-European Seminar on Clean Coal Technology, 1997

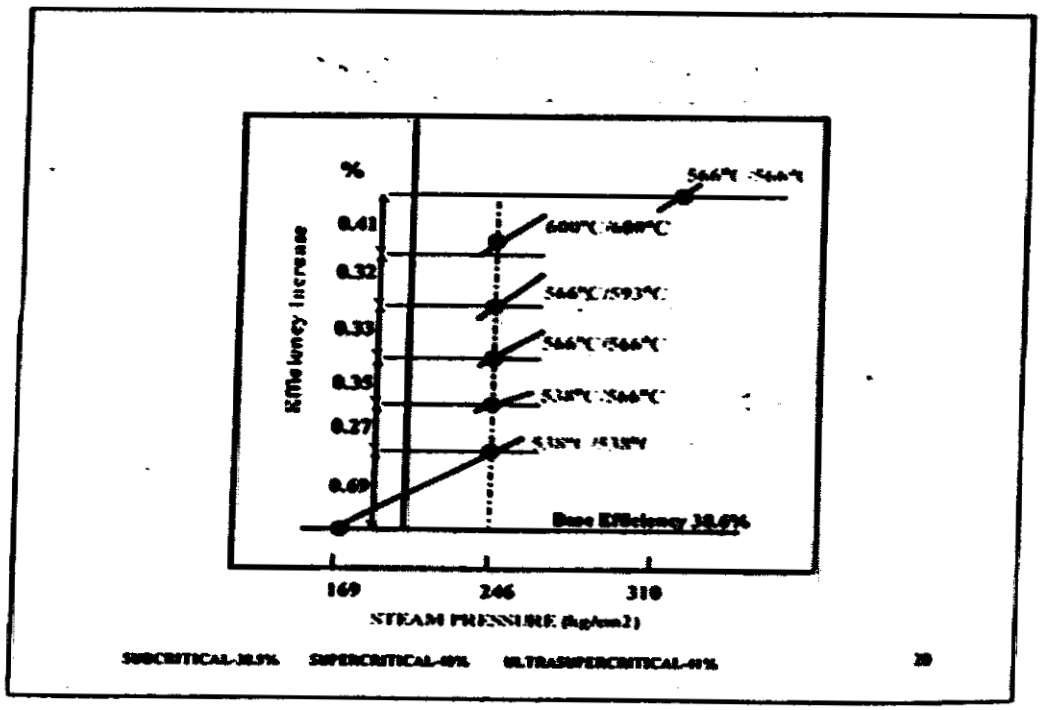
IGCC & PFBC HAS GOT HIGHEST POTENTIAL FOR HIGH EFFICIENCY

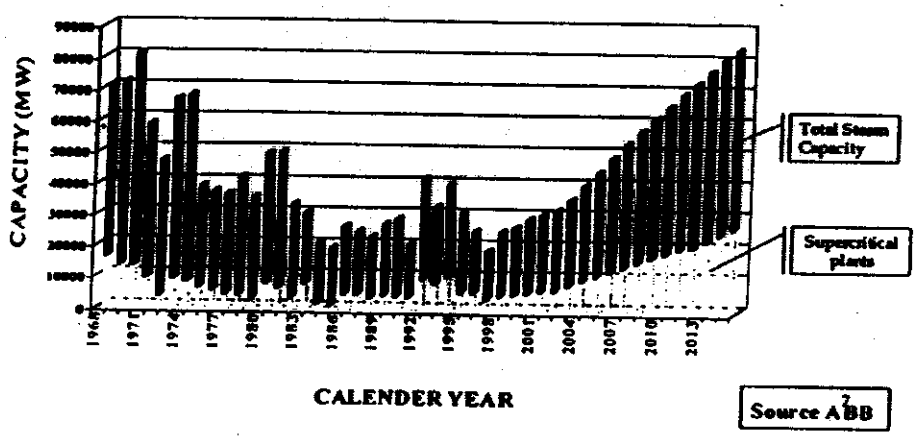
17

SUPERCRITICAL TECHNOLOGY

18


538
Temperature (C)
Expansion Line
Enthalpy


%
Efficiency Increase
0.41
0.32
0.33
0.35
0.27
169
246
310
STEAM PRESSURE (kg/cm2)
SUBCRITICAL-38.5%
SUPERCRITICAL-40%
ULTRASUPERCRITICAL-41%



INCREASING TREND OF SUPERCRITICAL PLANT IN FUTURE POWER PLANTS.

21

Enhancements

- Plant efficiency — 0.69% to 1.64%
- Fuel tolerance — More tolerant to coal quality changes

Reductions

- Coal Consumption
- Ash production
- CO_2
- SO_2
- Nox

} 1.79% to 4.24%

Improvements

- Startup time
- Sliding Pressure Operation
- Load following capability

22

- Reduction in CO_2, SO_2 and NO_x between 2.2% to 4.5%
- Reduction for 500 MW at 68.5% PLF per year is
  - CO_2 78300 tons
  - SO_2 365 tons
  - Nox 71 tons

22

23

FLUDIZED BED TECHNOLOGY

24

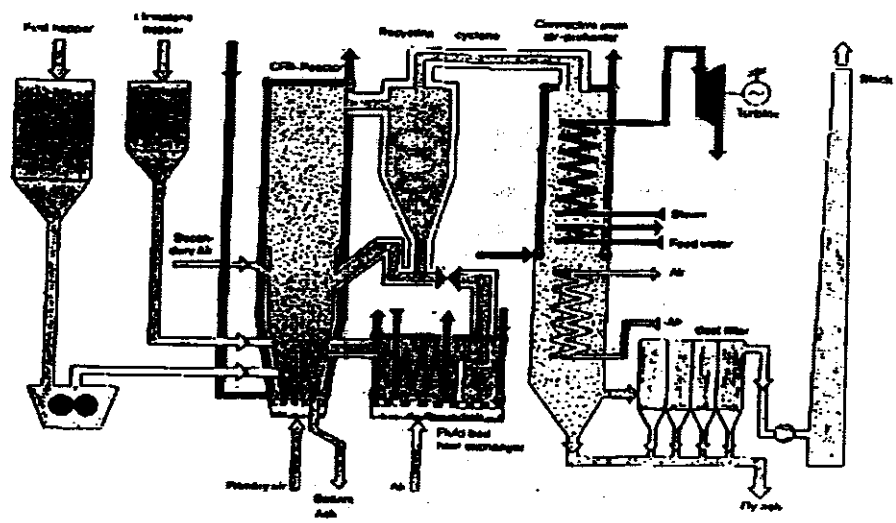
83

Types of fluidized bed boilers :

- CIRCULATING FLUIDIZED BED BOILER
- PRESSURISED FLUIDIZED BED BOILER

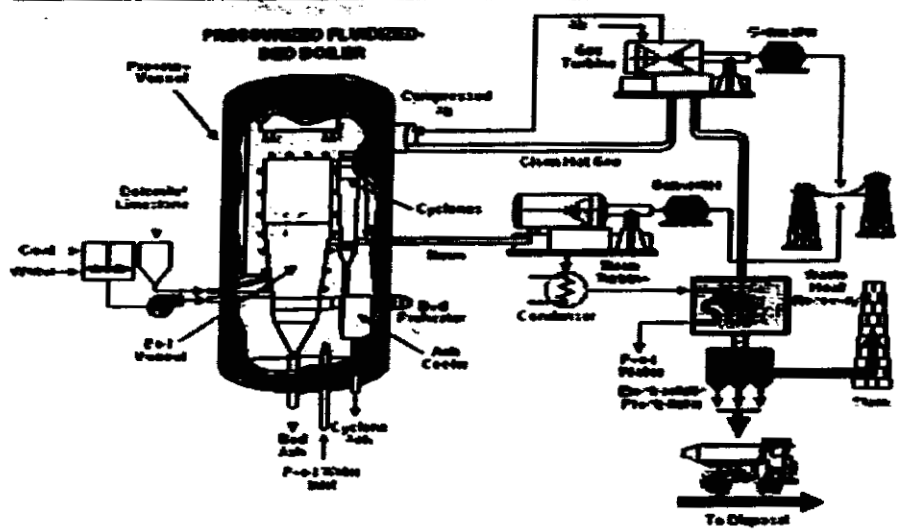
25

Circulating Fluidized Bed Combustion Scheme



26

Pressurized Fluidized Bed Combustion Boiler



27

Advantages of Circulating fluidized bed boilers :

- HIGH FUEL FLEXIBILITY
- EXCELLENT ENVIRONMENTAL PERFORMANCE
- LOW NOx EMISSIONS
- LOW SOx EMISSIONS
- HIGH COMBUSTION EFFICIENCY
- ABILITY TO BURN LOW GRADE FUELS

28

85

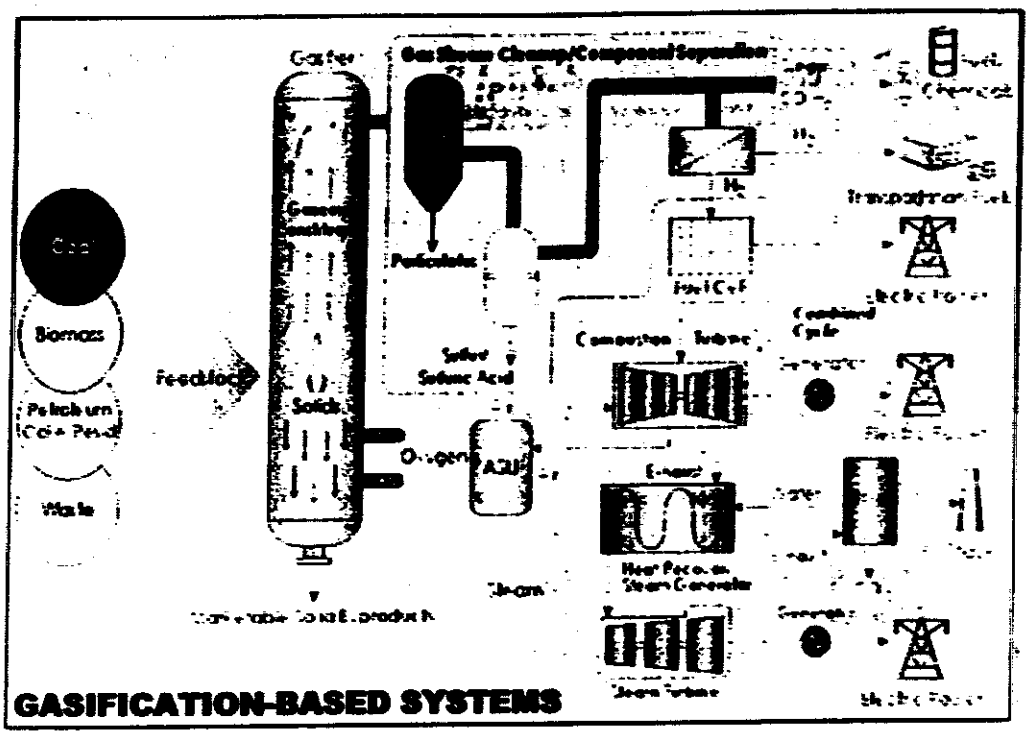
Circulating Fluidized Bed Combustion(CFBC) Boilers Worldwide Status:

- There are over 310 CFBC boilers operating worldwide
- Utility Scale Fluidized Bed Boilers have been in operation worldwide as early as 1987.
- Capacity of CFBC Boilers upto 125 MW is well established.
- Few 250 MW size CFBC units have also been demonstrated on commercial scale.
- In India industrial fluidized bed boilers of small capacity have been in service since 1977.
- Recently few CFBC based captive power plants of 20 to 125MW capacity have been commissioned at Renukoot, Bhadravati, Vizag & Surat.

29

INTREGRATED GASIFICATION COMBINED CYCLE

30



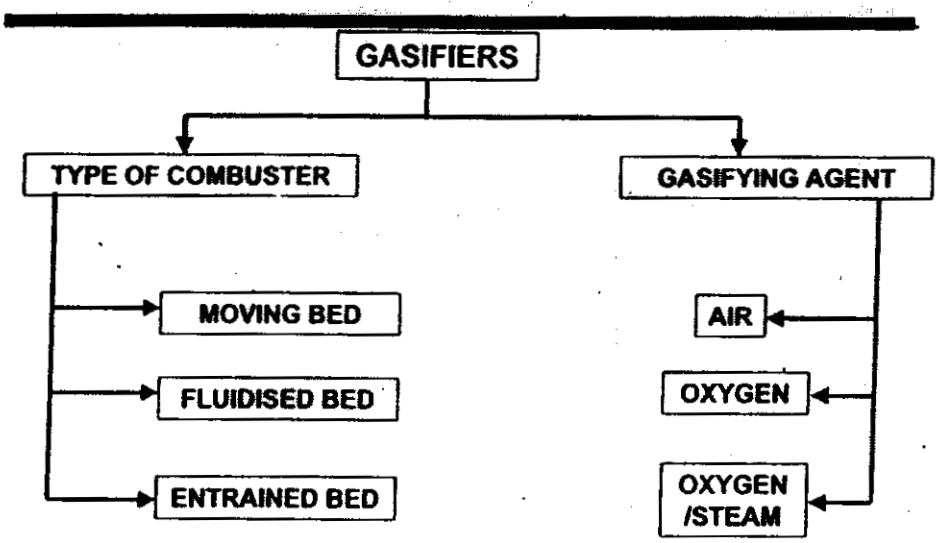
IGCC SUB-SYSTEMS

- GASIFICATION SYSTEM : TO PRODUCE RAW GAS
- RAW GAS HEAT RECOVERY SYSTEMS
- RAW GAS CLEANUP SYSTEM
- AIR SEPARATION PLANT(FOR OXYGEN BLOWN GASIFICATION)
- GAS TURBINE WITH HRSG
- STEAM TURBINE GENERATOR
- BYPRODUCT UTILISATION SYSTEMS
- EFFLUENT DISPOSAL SYSTEM

32

87

TYPES OF GASIFIERS



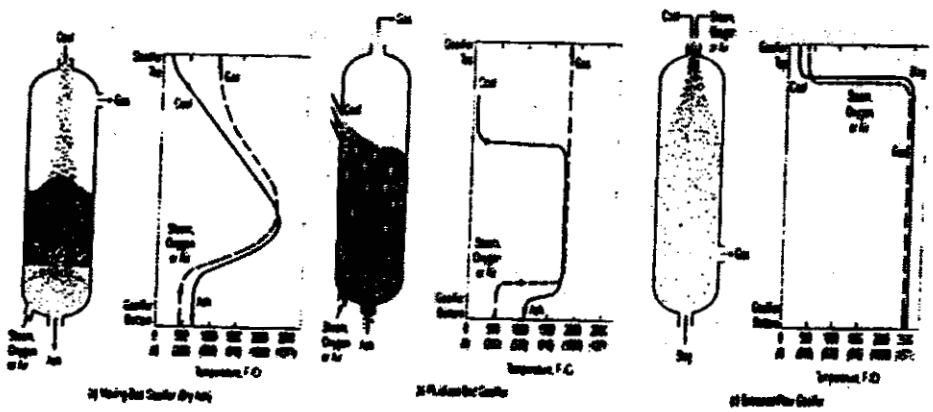
33

TYPES OF GASIFIERS

MOVING BED

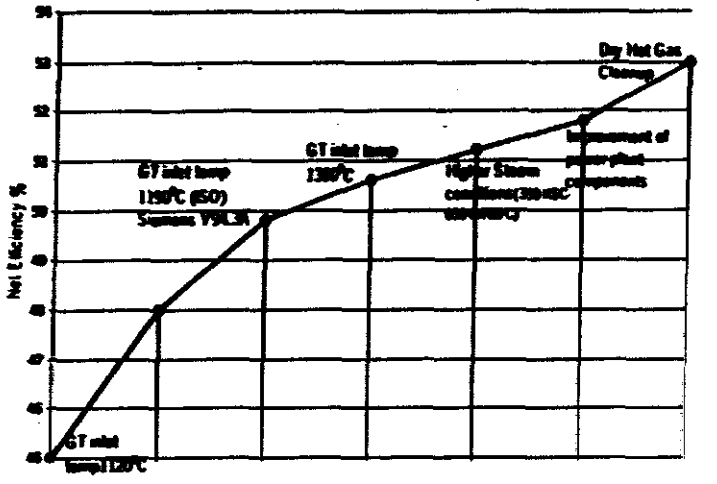
FLUIDISED BED

ENTRAINED BED



34

Expected Future Improvements in IGCC Efficiency



35

MAJOR IGCC PROJECTS UNDER OPERATION (COAL BASED)

PLANT	CAPACITY	DATE OF COMM/OPN.	PROCESS
LUNEN, GERMANY	170 MW	1972-77	—
COOLWATER PLANT USA	92 MW	1984-88	Texaco Gasifier
PLAQUEMINE PLANT USA	155 MW	1987	Dow Gasifier
BUGGENUM PLANT NETHERLANDS	250 MW	1993	Shell Gasifier
WABASH RIVER PLANT, PSI Energy Inc USA	262 MW	Nov,1995	Destec Gasifier - O_2 blown
POLK POWER PLANT Tampa Electric Co. USA	250 MW	Sept,1996	Texaco Gasifier - O_2 blown
PINON PINE PLANT Sierra Pacific, USA	100 MW	Feb,1997	KRW Gasifier - Air blown
PUERTOLLANO PLANT, Spain	335 MW	1998	Prenflo gasifier
TOTAL	1357 MW		

36

89

MAJOR IGCC PROJECTS UNDER OPERATION (REFINERY RESIDUE BASED)

PLANT	CAPACITY	DATE OF COMM/OPN.	PROCESS
Texaco El Dorado, USA	40 MW	September, 1996	Texaco
Shell Pernis, Netherlands	127 MW	November,1997	Shell
Schwarze Pumpe, Germany	40 MW	September,1996	Noell KRC (Lignite)
ISAB, Sicily Italy	520 MW	1999	Texaco
Sarlux, Sarroch, Sardinia, Italy	551 MW	2000	Texaco
API-Energia, Falconara, Italy	280 MW	2000	Texaco
Star, Delaware, USA	180 MW	2001	Texaco
TOTAL	1738 MW		

37

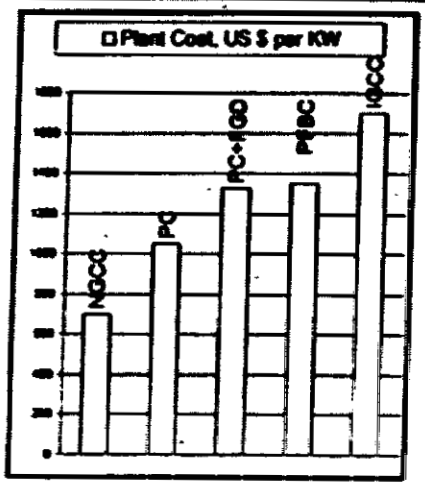
OTHER IGCC PROJECTS WORLDWIDE–UNDER CONSTRUCTION

PLANT	CAPACITY	FUEL	DATE OF COMM /OPN.	PROCESS
KoBra, Germany	312 MW	Coal	2001	HTW/ Rheinbraun AG
IBIL,Gujarat, India	53 MW	Lignite	—	Carbona/Enviropower
Fife Energy	109 MW	—	2001	British Gas/ Lurgi
EXXON, USA	40 MW	Pet coke	2001	Texaco
General Sekyu Kawasaki, Japan	540 MW	Vacuum residue	2001	Texaco
TOTAL	1054 MW			

38

COMPARATIVE COSTS & SCHEDULES OF VARIOUS TECHNOLOGIES

TECHNOLOGY	COST RANGE US$/kW	CONSTRUCTION SCHEDULES months
NGCC	700	24
PC	950 – 1150	42
PC+FGD	1100 – 1550	42
PFBC	1300 – 1500	36
IGCC	1400 – 2000	36



SOURCE: TECHNICAL PAPERS OF INDO-EUROPEAN SEMINAR ON CLEAN COAL TECHNOLOGY

NEW TECHNOLOGY STATUS

TECHNOLOGY	PILOT STAGE	DEMO STAGE	MATURE	REMARK
USC PLANTS			[	• Plants with parameters of 300 kg/cm2- 600 C-600 C operating
CFBC PLANTS			[	• Maximum capacity plant of 250 MW in France
PFBC PLANTS		[		• Development of hot gas cleanup system crucial • Capacity range 70-135 MW established
IGCC PLANTS		[		• Capacity range 80-335 MW established

ADOPTION OF ADVANCED COAL BASED TECHNOLOGIES IN INDIA

STATUS AND STRATEGIES

41

SUPER CRITICAL PLANT

- TECHNOLOGY ALREADY MATURED FOR LARGE SIZE OF COAL FIRED PLANT.
- NTPC INDUCTS POWER PLANT WITH SUPER-CRITICAL PARAMETER AT SIPAT-I (3X660 MW) AND FOR FUTURE PROJECTS

42

CFBC PLANT

- World wide Technology matured upto 250 MW plant size.
- In India Number of small size Industrial Boiler on the low grade fuel are operating.
- Two unit of 125 MW with lignite firing is operating since one year at Surat Lignite Power Project and One 80 MW captive power plant at Renukoot is operating.
- There are certain teething problem with large size CFBC boilers with indian coal which are to be sorted out.

43

IGCC PLANT

- IGCC IS ALREADY UNDER DEMONSTRATION IN 8 COAL FIRED PLANTS AND ANOTHER 6 PLANTS USING OTHER FUELS.
- IGCC PLANTS OF CAPACITY 100 TO 300MW ARE UNDER OPERATION SINCE 1984.
- SUITABILITY OF IGCC FOR HIGH ASH CONTENT INDIAN COAL IS YET TO BE ESTABLISHED.

44

ISSUES CONCERNING ADOPTION OF IGCC IN INDIAN SCENARIO

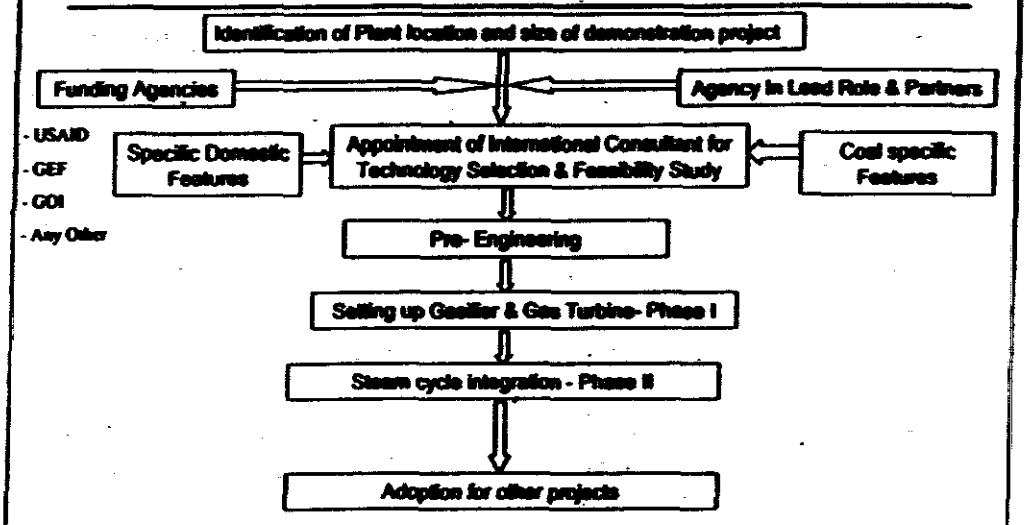
- MATURITY OF IGCC TECHNOLOGY WORLDWIDE.
- ADOPTING THE COAL GASIFICATION TECHNOLOGY FOR HIGH ASH INDIAN COALS.
- HOT GAS CLEAN-UP TECHNOLOGY NOT FULLY MATURE EVEN FOR WESTERN LOW ASH COAL.
- HIGHER CAPITAL COSTS (US$ 1700/KW) COMPARED TO CONVENTIONAL THERMAL POWER PLANTS.
- OPERATIONAL FEEDBACK FROM CURRENTLY OPERATING IGCC PLANTS NOT FREELY AVAILABLE.
- INADEQUATE R&D EFFORTS IN IGCC TECHNOLOGY - THE CURRENT INDIAN EXPERIENCE DOES NOT PROVIDE ENOUGH DATA FOR UPSCALING TO A LARGE SCALE DEMONSTRATION PROJECT.

45

ROAD MAP FOR ADOPTION OF IGCC BY NTPC

46

ROAD MAP FOR ADOPTING IGCC BY NTPC



CONCLUSION:

- INCREASE TREND IN POLLUTION NORMS SHALL MAKE CONVENTIONAL PC BASED OBSOLETE.
- IN INDIA COAL WILL CONTINUE TO BE PRIMARY WORK HORSE FOR THE POWER GENERATION.
- FUTURE CAPACITY ADDITION IN INDIA SHALL BE PREDOMINANTLY SUPER/ ULTRA SUPER CRITICALTECHNOLOGY.
- CFBC IS TECHNOLOGY PROVEN FOR LOW GRADE/ HIGH SULPHUR COAL UP TO 125MW. CFBC SHOULD BE ADOPTED FOR R&M PROJECTS FOR ENVIRONMENTLLY SENSITIVE AREAS.
- IGCC NOT YET COMMECIALLY MATURED. IGCC PLANTS NEEDS TO BE DEVELOPED SPECIFICALLY FOR INDIAN COAL FOR WHICH CONSIDERABLE WORK TO BE DONE ON NATIONAL LEVEL.

INDUCTION OF NEW TECHNOLOGIES

SHORT TERM

- BUILD SUPERCRITICAL UNITS FOR 500 MW AND ABOVE FOR GREEN FIELD PLANTS
- CFBC SHOULD BE ADOPTED FOR R&M PROJECT UP TO 125MW.
- EXTEND USE OF BENEFICIATED COAL TO PIT HEAD PLANTS (from economic and operational standpoint)

49

INDUCTION OF NEW TECHNOLOGIES

LONG TERM

- ALLOCATE ADEQUATE BUDGET FOR DEVELOPING INDIAN COAL SPECIFIC GASIFIER DESIGN FOR IGCC PLANTS.
- ESTABLISH TECHNOLOGY DEMONSTRATION PLANT IN INDIA FOR IGCC
- IDENTIFY SPECIFIC RESEARCH AREA FOR IMPROVEMENT OF TECHNOLOGY
  - DEVELOPING/PERFECTING HOT GAS CLEANUP SYSTEM
  - DEVELOPMENT OF HIGH TEMPERATURE AIRPREHEATER
  - GASIFIER DESIGN FOR INDIAN COALIASH
  - NEW DESIGN FOR OXYGEN PLANT
- FORM TASK FORCES COMPRISING LEADING R&D INSTITUTIONS, ACADEMIC INSTITUTIONS, UTILITIES, MANUFACTURER, ETC. R&D AGENCY TO TAKE LEAD ROLE
- BUILD AND INSTALL TECHNOLOGY DEMONSTRATION PLANT
- BUILD AND INSTALL COMMERCIAL PLANT UPTO100 MW
- SCALEUP TO COMMERCIAL PLANT OF 500-600 MW

50

THANK YOU
51

COAL BED METHANE-PROSPECTS FOR INDIA & UTILITY FOR POWER SECTOR

By B. C. Misra Consultant

1. Preamble

A safety hazard, with risk of explosion, during mining of coal and an environmental one, when released to atmosphere causing Global Warming, but a Clean Fuel when utilised as Energy Source, that is Coal Bed Methane now popularly called CBM. Now let us see how it is formed & how it remains in Coal Bed. CBM is a product of Coalification i.e. its conversion from Peat to Lignite, to Bituminous, to Anthracite stages of Coal. Substantial methane is produced during this process. Part of it remains ADSORBED into micropores of Coal Matrix as Non molecular layers under pressure from water. Coal has large internal surface area >100 cu. m./t of coal. Gas generated during coalification process far exceeds the capability of coal to hold it and excess migrates to porous surrounding strata. Gas, remaining in Coal Bed in adsorbed form under pressure is called COAL BED METHANE.

Gas exists in coal matrix on internal surfaces in ADSORBED FORM under pressure of water and sometimes of strata also. Gas remains ADSORBED unless pressure is lowered. On pressure being lowered due to mining , the Gas flows through porous network and into the mine atmosphere where it mixes with the mine ventilation air resulting in a mixture of air and methane. A methane percentage between the range of 4.5% to 14% with air forms an explosive mixture and can get ignited by any flame or electric or static spark resulting in Mine Explosion. To prevent this, larger quantity of ventilation air is required to be circulated in the mine to keep the methane diluted to a safe limit to prevent any explosion due to methane. Though the percentage of methane in mine air is reduced but not the total quantity of methane. This methane gets released into the atmosphere along with mine air. Being lighter it rises up affecting stratosphere and contributing to Global Warming. Other gasses being released as product of combustion etc. also contribute to Global Warming but Methane is 21 times more potent than Carbon di oxide.

The dilution of methane in the mine atmosphere, by circulating higher quantities of air does provide safety to mining operations, but in no way prevents the loss of this clean source of Energy or checks it release into the atmosphere. This methane released into the atmosphere contributes to global warming.

2. How CBM is different from Natural Gas

While both are product of decay of Vegetation and formation of Coal or Petroleum, Natural Gas and Petroleum are generated in Shale & Clay and migrate to porous Sandstone or Limestone strata, but CBM is generated in Coal bed and remains there. The coal is both a source and reservoir.

Further transport or migration of Methane in Coal Bed has three different stages: -
-Desorption from Coal surface due to release of pressure from Coal seams.
-Diffusion from Coal matrix from higher to lower concentration area depending upon natural characteristic of Coal.
-Flow through Coal seam fracture system. Cleat system provides natural permeability for flow through coal.
In Natural Gas there is only one of the above three i.e. Flow.
Thus CBM reservoir is an unconventional one. Consequently CBM exploitation technique is quite different from NG exploitation technique.

3. Reasons for lack of Exploitation & Utilisation of Mine Associated CBM in India

CBM exploitation and utilisation as a commercial source of Energy, the world over is of recent origin, say a decade and half old, and has been feasible due to advanced and state of art technologies developed in the west, primarily in U.S.A. Earlier commercial exploitation and utilisation of Mine associated coal bed methane was not considered economically viable. As a matter of fact two decades back CBM was not considered a source of energy as such but only a mining hazard. Further Indian Coals were considered to contain very low quantities of CBM. The mines being shallow and the rate of coal production/exploitation being low the yield was also low and of poor quality. Bore hole methane drainage (by underground drilling) technologies adopted were also not state of art, with resultant low quantity and quality yields. There was no supplementation of this methane drained from underground by drainage of additional quantity & rich quality CBM through surface bore holes ahead of the working coal faces. Thus available quantity & quality was not adequate for any significant commercial utilisation. *As a matter of fact lack of access to state of art Know-how, Technology, and Equipment and also lack of confidence in commercial viability of CBM recovery & Utilisation under Indian conditions has been responsible for lack of adequate and appropriate attempts being made in this sphere.*
Further, the awareness of CBM being a potential source of Energy and that too a clean source of Energy was lacking. The concern for preventing or controlling Global Warming was also not there. Last but not the least investment into an unknown field, which is yet to be commercially proved under Indian conditions was shy.

4. How this is being overcome

Under the above situation establishing commercial viability of Exploitation & Utilisation of Mine Associated Methane through an R & D Demonstration Project with state of art know how and technology was called for.
Therefore a joint demonstration project of Govt. of India, U.N.D.P. & Global Environmental Facility on Exploitation & Utilisation of Mine Associated Coal Bed Methane was formulated in 1997-98 and is being implemented by Ministry of Coal G.O.I. through C.M.P.D.I & B.C.C.L in Sudamdih & Moridih Coal mines in Jharia Coalfield. This is a positive step in this direction and the results will provide the data base & technological base for its further replication.

The main development objectives of this Project are: -

i) *To reduce the potential adverse impacts of methane on Global Climate Change by its being wasted and released into the atmosphere.*
ii) *To capture & utilise methane to provide a Clean Source of Energy providing (a) economic benefits to the mine & (b) replacing equivalent burning of Coal*
iii) *To improve mine safety and thereby Production, Productivity etc.*
iv) *To improve local & regional environment by use of wasted energy.*
v) *To Promote development of Indian expertise and enterprise in this sphere.*
vi) *To Establish/ demonstrate Commercial Viability, establish database, and establish CBM Clearing house to enable future replication and encourage National & International investment in this field.*

5. Opportunities of CBM recovery in operating Indian Coal Mines

There are reasonably good opportunities of recovery of mine associated CBM in Indian Coal Mines. Classified degree III gassy mines with an anticipated methane yield of about 10 cu. m / tonne of Coal are 25 in number. 27% of underground coal mines are classified as degree II gassy with an anticipated gas yield of 2- 10 Cu. m. / tonne of Coal. With passage of time the working depth of these mines is likely to increase and so also the gas yield per tonne of Coal and many of these degree II mines are likely to become potential for CBM exploitation and recovery. As per U.S. experience anything above 6 to 7 cu. m./ tonne should be targeted for exploitation.

6. Potential Coalfields for CBM

The potential Coalfields for CBM are: -
(i) South eastern part of Jharia coalfield.
(ii) South western part of Ranigunj Coalfield.
(iii) East Bokaro Coalfield at depths more than 500 m.
(iv) North Karanpura Coalfield at depths more than 500 m.
(v) Sohagpur Coalfield at depths
(vi) Mehsana Lignite Deposit.

7. Likely CBM content in potential Coalfields.

Based on various work done by CMPDI, CMRI, AMOCO, GEECL etc in the last decade the broad position of availability of CBM in potential Coalfields is as follows: -
(i) South eastern part of Jharia coalfield- Generally methane is likely to be >8 Cu. m./ tonne. Highest encountered is 14.93 Cu. m. / tonne in Parbatpur block at a depth of 795 meters.
(ii) Southwestern part of Ranigunj coalfield. - The potential is good and within productive range particularly the Dishergarh Seam. (6-7 Cu. m./ t). As per studies

maximum Sorption capacity is ranging from 9.15 to 11.18 s.cu.m/ t at 40 Kg./ sq. cm.

(iii) East Bokaro coalfield- Drilling Coal Samples away from operating mines at depths > 600 m have given results of 8 Cu. m. / t. However in area near working mine of Asnapani the figure is 5 Cu. m./t. Sorption capacity of Kargali Seam is 14 cu. m./t at 40 Kg./ sq. cm.

(iv) North Karanpura- Reserves anticipated at depths greater than 500 m are substantial.

(v) Sohagpur- At current level of shallow depths of operating mines the gas is limited (2- 3 cu.m./ t). However there is potential at greater depths and under certain geological set up. The area is to be further studied.

(vi) Mehsana- 7 cu. m./ t at 1400 m depth.

8. Global Methane emission, methane emission from Coal Mining, Methane emission from Coal Mining in India, Methane Reserves & Resources in India etc.

At the end of this talk I will like to give the figures of Global Methane Emission, Methane Emission from Coal Mining globally and in India to emphasize the impact of methane being released from Coal Mining operations and its impact on Global Climate Change. The broadly estimated figures of CBM resources & reserves are also indicated to bring out the potential of CBM as an available clean source of Energy. These are: -

(i)	Global Methane Emission-	530 mt.
(ii)	Global methane Emission due to Coal mining-	27 mt (5%)
(iii)	Indian Methane emission due to Coal mining-	2.5 mt (9% of Global due to Coal)
(iv)	Methane Resources in India	- 2 Trillion Cu. m.
(v)	Methane Reserves in India	- 400 Billion Cu. m.
(vi)	Heat value	- 8,500 – 9,000 K. Cal./ s. cu. m.

9. Utility for Power Sector

The utility of Coal Bed Methane that is like Natural Gas for Power generation is well known to this august gathering and I need not dwell upon the subject. The advantage of using Natural Gas or Coal Bed Methane is besides its being a Cleaner Source of Energy than Coal and Petroleum products is relative ease of setting up Power Plants with limited capital and in shorter gestation period. In initial stages of CBM exploitation, it may not be possible to set up large power stations at one go. But use of CBM or Natural Gas has the flexibility of conveniently adding additional units. CBM has many other environmental friendly uses like C.N.G., piped gas for local industry and L.N.G. etc.

SESSION III:
TRANSMISSION & DISTRIBUTION FOR CLEAN ENERGY

CLEAN TECHNOLOGY OPTIONS IN T & D

Mr. Kenneth R. Gudger
Chief Executive Officer
Global Energy Partners, LLC
Lafayette, California USA

CLEAN POWER
USAID GEP Program
New Delhi, India
May 9, 2001

Global Energy Partners LLC

THE NEED FOR CLEAN TECHNOLOGY IN T & D

- Transmission
- Sub Transmission
- Distribution
- Metering
- Energy End-Use

Global Energy Partners LLC

THE NEED FOR CLEAN TECHNOLOGY IN T & D

- System Operations
- Voltage Levels
- Transformation
- Metering Technologies
- Energy Theft
- Energy Efficiency

Global Energy Partners LLC

The Louis Berger Group, Inc

THE NEED FOR CLEAN TECHNOLOGY IN T & D

- T & D Losses
  - Life Cycle Cost
  - Function of Square of Current
- Voltage Level

	India	U.S.
- Bulk Power	400 KV-800 KV	500 KV - 1MW
- Transmission	220 KV	220 KV
- Sub-Transmission	33 KV	66 KV-115 KV
- Distribution	440 V	12 K - 33 KV

- Distribution
  - 11 KV Experience and Potential

Global Energy Partners LLC

The Louis Berger Group, Inc

THE NEED FOR CLEAN TECHNOLOGY IN T & D

- System Operation Technologies
  - Distribution Circuit Balancing
  - Distribution Voltage Regulation
  - Cost Effective for emission reductions

Transformation

  - Loss Reduction
  - Life Cycle Costing
  - Amorphous Core Transformation
  - Ease of Retrofit

Global Energy Partners LLC

THE NEED FOR CLEAN TECHNOLOGY IN T & D

- Metering
  - Pending Legislation in Parliament
  - Building/maintaining a secure metering technology system
  - India opportunity to jump Immediately to 3rd generation metering
- Theft
  - Culture / Management / Technology
  - Safety First
  - Neighbor Steeling From Neighbor
  - Technologies for Detection
    - Analytical
    - On Site

Global Energy Partners LLC

105

The Need of Efficient Energy Use

- Definition of Terms
  - Conservation
  - Load Management
  - Energy Efficiency
  - Demand Side Management (DSM)
  - Integrated Resource Planning (IRP)

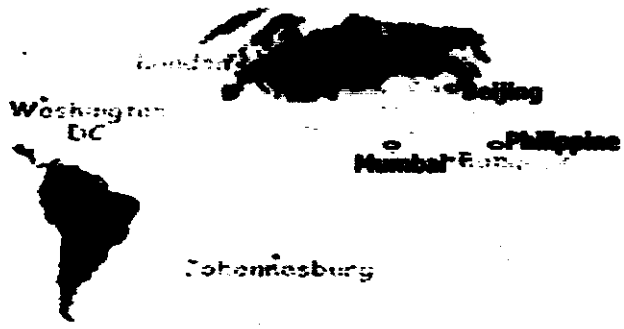
- Energy Efficiency
  - Industrial
  - Commercial
  - Domestic
  - Agricultural
    - Hydraulic Test
    - Hardware Retrofit (Variable Speed Drive)

Energy Efficiency in Distribution System

Nitin Pandit, Ph. D.
Executive Director
International Institute for Energy Efficiency (IIEC)

CLEAN POWER *New Delhi* *May 9, 2001*

IIEC - Organization



- Not-for-profit (NGO), Founded in 1984
- Over 70 employees worldwide
- Merged with the Civil Engineering Research Foundation (CERF) - September 1999

IIEC

IIEC/CERF - What do we do?

IIEC

- Strategic Focus
  - Energy Efficiency
  - Renewable Energy
  - Climate Change
- Sustainable Markets
  - Policy
  - Market Development
  - Financial Tools

CERF

- Serving the Design and Construction Industry
- Innovative Technology Assessment
- New Material Testing
- Market Assessments

Integrated and Innovative

IIEC

INDIAN POWER SECTOR

IIEC

High T & D Losses

- Projected economic growth: 7 %
- Present generation: 96,000 MW (approx.)
- Demand - Supply gap: 15 - 20 % (peak)

(Source: CEA)

- T & D Loss: 15 - 25 % (20,000 MW) (against 6 to 9 % internationally)

IIEC

EE DTs Would Ease Capacity Addition Targets

- Fresh capacity addition by 2012: 100,000 MW *(Source: Ministry of Power, India)*
- Additional investment: Rs. 400,000 Cr (USD 100 bn)
- EE = 20,000 - 25,000 MW *(Negawatt - NW)*
- Energy savings potential through EE DTS = 22 bn kWh in 20 years

IIEC

EE Opportunity: T& D Improvement

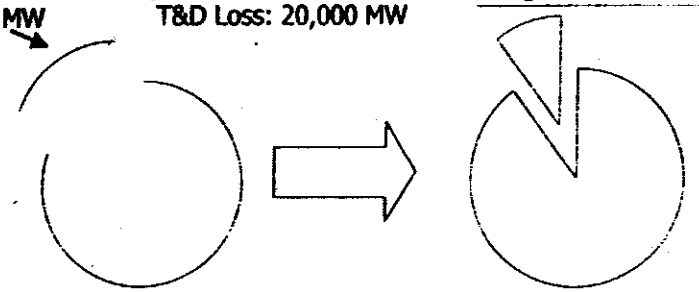
Power Generation - 2000

Supply - Demand Gap:
20,000 MW

T&D Loss: 20,000 MW

Power Generation requirement - 2010

Negawatts : 20,000 MW



Generation: 96,000 MW

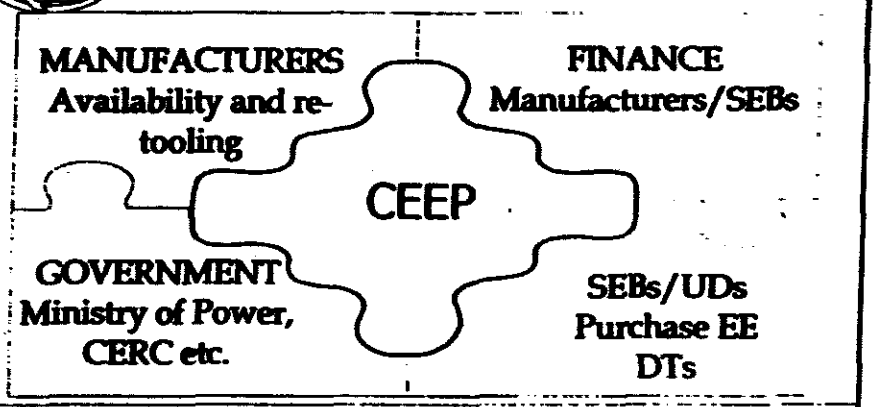
Required Generation: 196,000 MW

IIEC

CFC ENERGY EFFICIENCY PROGRAM (CEEP)
by
IIEC
in partnership with CFC/ICA

IIEC

The "Honest Broker" Role



Primary Focus on TOC based procurement

IIEC

Project Partners with Manufacturers, Utilities and Financial Institutions

MILESTONE

- **Market & Technology Assessment (Motors, Transformers & Ballasts)**
- **Distribution Transformers : Maximum potential for energy savings**
- **Market Transformation Efforts**
- **Information Dissemination**

STRATEGY

- **Life-cycle Cost Analysis and Vendor Evaluation in DT purchasing process**
- **Increase demand and availability of EEDTs**
- **Develop Innovative Financing Mechanisms**
- **Demonstrate benefits of "Economic" Purchase Decisions**

IIEC

Meets IIEC's Mission

- Free - up more power to industry / consumers
- Reduce GHG emissions due to losses in the system

By:

- Developing market for Energy Efficient Distribution Transformers
- Institutionalizing TOC based purchase
- Providing technological options

IIEC

Transformer Economics: TOC Makes Sense!

- Capitalization of losses places value on Energy Savings
- Exists for all SEB power transformers
- Some SEB's already use capitalization to evaluate cost of losses

Total Owning Cost Purchasing

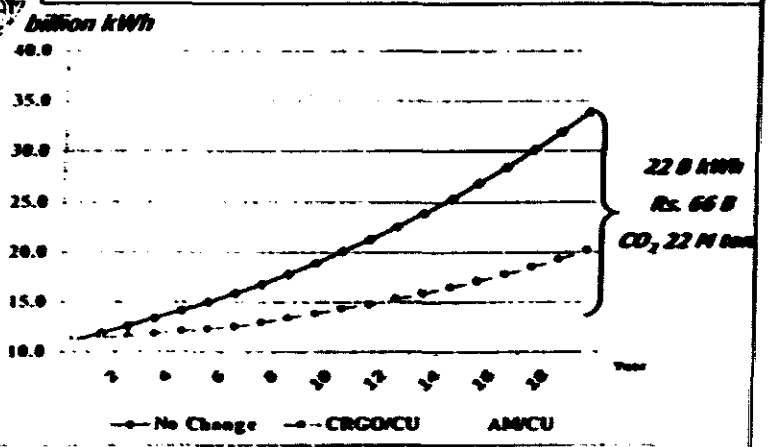
TOC = Initial Purchase Price + Cost of Future Energy Losses

Loss Evaluation Recognizes the Cost of Losses over the Life of the Transformer

IIEC

112

Energy Savings Potential Huge



Enormous Distribution Transformer Loss Value

IIEC

Renewables need Better Integration

- **Distributed power generation is increasing in India**
- **Renewables pose a good opportunity, which is being tapped**
- **Integration of this source with grid should be done in order to reduce**
  - System efficiency losses
  - Power outage

IIEC

PRI

Conserved Energy is the Cleanest Energy

Metering and Energy Conservation

Sanjaya Singhal
Managing Director
PRI Ltd, Winchester, UK

entity

PRI

This Presentation

- Energy conservation is clean energy
- Cognitive customer response and energy conservation
- Some experiences in utility metering and conservation abroad
- Metering systems in the Indian context

entity

A unit saved

- Impacts the consumer as a saving on his bill
  - Is that all?
- Impacts the distribution assets to 1.15 units
- Impacts generation by 1.21 units

entity

Conservation is an economic phenomenon

- Exhortations do not cause energy conservation
- Consumers need economic messages
- Tariffs determine customer economics
- Tariffs are administered by metering equipment

Theft too is an economic phenomenon!

entity

Some experiences in clean energy

- Micro-generation - London housing estate
  - 2 MW CHP synchronised with the grid
  - 75% of the electrivity and 100% of the heat
- Consumers get free heat and cheaper power
- Metering / billing administered by the estate
- Great for consumers but no thought on conservation of heat
  - Now installing heat meters to charge for heat

entity

Some experiences in conservation

- Domestic pre-payment meter deployment - UK
  - Meter with a "Kitchen Unit" which communicates with meter
  - Meter displays available credit in £s
  - Displays of the day's, week's, month's, previous month's etc. consumption,
  - Displays of time remaining based on present load
- Utility found 11% REDUCTION in energy use

entity

kWh is not an "Economic Message"

- A "Unit" of electricity is incomprehensible
- Consumers understand money
- Large volume of research establishes that:
  - Consumers WILL respond to economic messages
  - Consumers WILL make lifestyle choices
- Consumer behaviour CAN be modified by giving them the right messages AND leaving them the choice to act
- Man is the cognitive beast!

entity

Metering and economic messages

- Show money, not units
- Bring the metering information to the "center of activity" in the home
- Reduce the stimulus - response gap
  - Use today, pay in two month's time sends the wrong message altogether
  - Use today and have the debit accumulate in an unseen meter - sends no message at all
  - Use and see the money disappear instantly - causes quicker response!

entity

Some experiences in conservation

- Industrial and multi-site operations - UK
  - Utility dealing in energy, not electricity alone
  - On line information from utility meters to consumer (both on site and remote sites)
  - Regular energy use reports (produced by the utility) based on the monitoring and targeting programs of the customer
  - A multi-site retailer has completely out-sourced its energy conservation to the utility on a shared benefit basis

entity

Some experiences in load control

- Consumer load control - Florida
  - Utility controllable loads identified (air conditioning and swimming pool pumps)
  - Consumers offered small discount to allow controllable loads
  - 280 MW can be shed in 30 minutes
  - Delayed construction of peaking plant by two years

California cries out for load control now!

entity

Some experiences in load control

- Domestic storage heaters - UK
  - Controlled devices switched by the utility at appropriate times
  - Stored heat used when needed, stored when energy is cheap
  - Major shift in winter evening peak
  - Created a midnight peak! Diversity added to even night time load

entity

Relevance to India

- Our problem is losses due to theft
  - Thieves do not conserve!
- Socio-political structures demand subsidies
  - Subsidies do not encourage conservation
- Large parts of the population still not connected up
  - An opportunity to begin with a conservation message

entity

Metering and theft

- Good metering reduces theft - well proven in India
- GoI initiatives now demand and facilitate 100% metering.
  - This alone will not solve the problems
  - Investments in information and utility management systems is critical for the success of this initiative
- Investment in metering which promotes conservation is necessary

entity

Theft and clean energy

- The Indian vicious cycle:
  - Theft damages the utility's revenues
  - Low revenue leaves little for capital investment
  - Lack of investment creates shortages
  - Shortages promote captive power plants
  - Captive plants reduce utility revenues further!
- Distributed fuel oil based generation is not clean energy

entity

Load control

- Critical to make investments in this area
  - Urban areas like Delhi
  - Farm supplies
- Now is the opportune time - bundle load control with 100% metering initiative

entity

Indian farm sector and clean energy

- Shortages force use of diesel
- Crude pump technology is highly wasteful
  - One study showed excellent payback to utility from conservation by replacing all agriculture pumps free
- Eliminating subsidies and charging the true price will cause conservation
  - Needs political support
  - Farmers willing to pay fair price for good service (they pay for the diesel!)

entity

PRI

Conservation and unbundling

- Unbundling UK style - impacts the incentives for demand management / energy conservation
- Incentive lies in areas where constraints exist but the constrained party has no clear tariff mechanisms to incentivise demand control / energy conservation

entity

PRI

In summary

- Metering plays a vital role in conservation
- Conserved energy is the cleanest energy
- Adequate metering technology exists in the country
- For India the time is NOW

entity

SESSION IV:
FINANCING & INVESTMENT IN CLEAN TECHNOLOGY

ICICI

Risk Analysis & Management of Clean Technology for the Power Sector

May 9, 2001

Contents

- Risk Analysis & Mitigation for conventional projects
- Clean technologies for Power Sector
- Risk Analysis & Mitigation for Clean technologies - a comparison with conventional projects
- Conclusion

ICICI

Risks in Conventional Power Projects

- Construction Risk
- Operating Risk
- Fuel Risk
- Market Risk
- Foreign Exchange Risk
- Environmental Risk
- Legal & Regulatory Risk
- Political Risk

Basic Principle : Identify risks and allocate to participants best capable of managing it

ICICI

Construction Risk & Mitigation

- Extensive and potentially disastrous risk
- Cost overrun and Construction delay
- Performance Risk in the start up phase
- The Credit Risk of project parties bearing risk during construction period
  - Project Sponsors
  - Construction Contractors
  - Insurance Companies

ICICI

Fuel Risk & Mitigation

- Fuel Risk comprises
  - Fuel Availability
  - Fuel Price
- Fuel Availability
  - Fuel Supply and Transportation Contract
  - Adequate LDs for non supply of guaranteed quantity
- Fuel Price
  - Pass through under PPA (including take or pay)
  - Competitive variable charge under merit order dispatch
  - Quality Control

ICICI

Market Risk & Mitigation

- Market risk comprises
  - Volume risk
  - Price risk
  - Payment risk
- Both volume (offtake) and price are determined up front in the PPA
  - However, high emphasis will have to be laid on adequacy of demand-supply gap and competitiveness of tariff

ICICI

Construction Risk & Mitigation (contd.)

- Fixed Price Turnkey Contracts
- Experienced and Creditworthy Contractors
- Adequate LDs for construction delays and non compliance of performance standards
- Completion support from Sponsors
- Insurance package to mitigate Force Majeure Events
- Stringent due diligence on the capabilities of Sponsors, Contractors and Insurers
  - Requirement of minimum credit rating (international & domestic)
  - Bonds / Bank Guarantees to support financial obligations

ICICI

Operating Risk & Mitigation

- Performance during operation period
  - Availability
  - Station Heat Rate
  - Auxiliary Consumption
- O&M Contracts
  - Experienced contractor
  - Adequate LDs for non compliance of performance standards
  - Bonds /Bank guarantees to support financial obligations
- Insurance package to mitigate Force Majeure events
- Reserve accounts funded from project revenues, loan proceeds or LCs

ICICI

Market Risk & Mitigation (contd.)

- Three tier security structure under the PPA
  - Letter of Credit
  - Escrow Account
  - State Government guarantee
- Escrows limit expected capacity additions in each state to ensure earmarked revenue streams are available for each project
- Financial viability of SEBs is essential in the long run
  - reform based financing contemplated in some states
- Setting up of State/Central Electricity Regulatory Commissions likely to lead to rationalisation of tariffs

ICICI

Forex Risk & Mitigation

- Forex risk occurs if the financing is across currencies and the revenue is in local currency
- Imported fuel another source of forex risk
- Unavailability of forex due to Exchange Control
- Pass through of forex variation in the PPA
  - Indian projects are financed with a much lower foreign currency component - In Indonesia offshore funding has been more than 85%
  - Minimizing the forex element will be the key in mitigating this risk
  - hedging is possible

ICICI

Environmental Risk & Mitigation

- Risk are government penalties, liabilities to third parties
- Detailed EIA by competent agencies
- Responsibility of maintaining environmental parameters/standards with O&M Contractor with adequate LDs for non compliance
- Insurance package for environmental liabilities

ICICI

Legal & Regulatory Risks & Mitigation

- Risk that government will change the legal and regulatory frameworks after investments of funds
  - Import tariffs
  - Change in tax policies
  - Uncertainty of regulation
- Policy changes after investment of funds
  - Covered under "Change in Law" provisions
  - On-going risk faced by projects in any country
- Regulatory risks during the initial phase would likely to be higher

ICICI

Political Risk & Mitigation

- Political Risk
  - Change in governmental policy
  - Expropriation, Nationalization, frustration of contracts
- Change in government policy may affect the risk associated with the project in two ways:
  - Before investment of funds in the project
  - Post investment
- Policy changes prior to investment of funds
  - Lenders' investment is contingent upon resolution of all outstanding issues
  - Financial close of the projects might be delayed but it ensures viable projects

ICICI

Political Risk & Mitigation (contd.)

- A few examples where lenders refused to go ahead with projects till issues were resolved
  - Finalisation of bankable fuel supply and transportation agreements
  - Finalisation of escrow agreement
- Contractually, there exist termination provisions in the event of political force majeure and the lenders have a right to enforce the security
- Participation of foreign lenders/sponsors in the project acts as a deterrent for the Governments to renegotiate the contracts

ICICI

Clean Technologies for Power Sector

- Utility Sector
  - Flue gas Desulphurisation (FGD)
  - Circulatory Fluidized Bed Combustion (CFBC)
  - Integrated Gasification Combined Cycle (IGCC)
- Renewable Energy
  - Solar/Photovoltaic
  - Wind
  - Biomass cogeneration

ICICI

Risk Analysis & Mitigation for Clean Technologies - a comparison with conventional technologies

- Higher Construction Risk
  - Due to lack of proven record for technologies - track record limited to particular sizes
  - Compliance with performance standards at the time of [illegible] may be difficult for petcoke and other bottom residues
  - Mitigation of this risk will require higher LDs and warranties for non compliance of performance standards
  - IGCC technology has integration issues

ICICI

Risk Analysis & Mitigation for Clean Technologies - a comparison with conventional technologies

- Higher Operating Risk
  - Due to lack of proven record for technologies
  - Not tested in India
  - Compliance with performance standards may be difficult for petcoke and other bottom residues
  - higher involvement of equipment suppliers during operation phase
  - Operator's track record in operation of the relevant technologies

ICICI

Risk Analysis & Mitigation for Clean Technologies - a comparison with conventional technologies

- Fuel Risk
  - Supply and transportation risks not different from conventional project
  - Fuel price in case of petcoke and bottom residue- contentious subject
- Market Risk
  - Higher capital cost would make tariff unviable for SEBs
  - Lower fuel price in case of petcoke /bottom residue could be leveraged to make tariff competitive - favorable under merit order dispatch

ICICI

Risk Analysis & Mitigation for Clean Technologies - a comparison with conventional technologies

- Forex Risk
  - Indigenous (coal) vs Imported (fuels derived from crude)
  - Forex component in capital cost (?)
- Environmental Risk
  - Clean technologies enable better compliance
  - However, there may be other disposal issues
- Legal & Regulatory Risks
  - Withdrawal of special benefits for clean, technology
  - Transparency in regulatory framework

ICICI

Conclusion

- Clean technologies - risks involved not significantly different from conventional technologies
- Incremental risks are mainly due to
  - Absence of track record
  - Higher capital cost leading to higher tariffs
- Mitigated by
  - higher commitment from project participants particularly equipment/technology suppliers
  - government support to offset higher tariffs

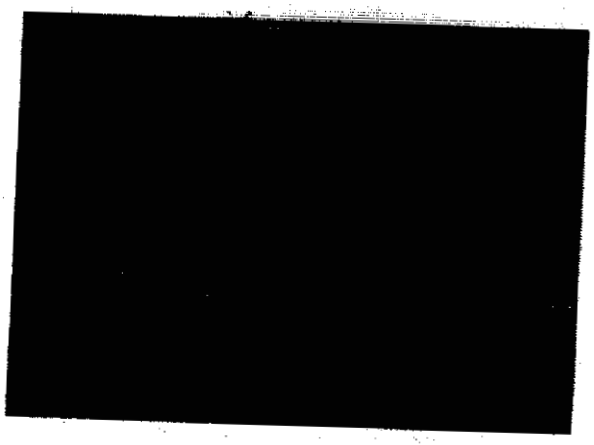
ICICI

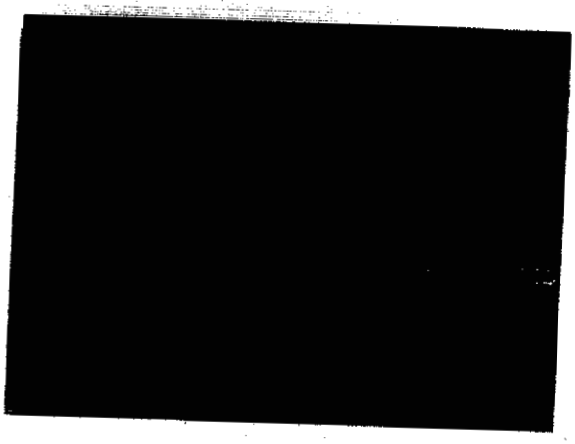
1C

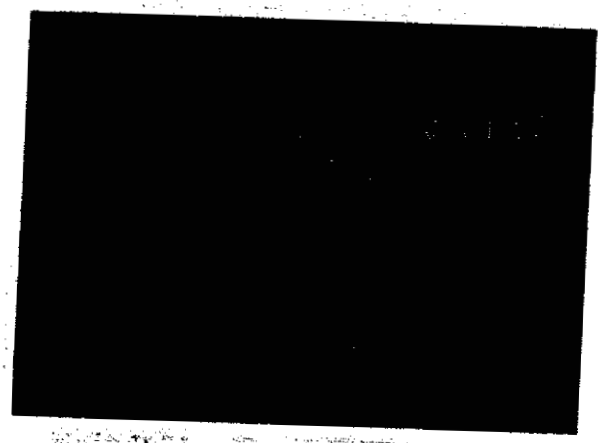
Thank You

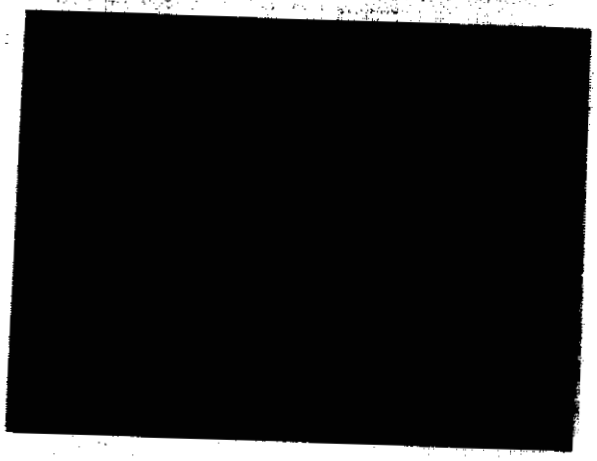
APPENDIX 7 – PHOTOGRAPH

PHOTOGRAPHS









BEST AVAILABLE COPY