Technologies for Power Generation and Sustainable Energy Availability: World Standards in Indian Thermal Power plants

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USAID / India

Indian Power sector – Present status

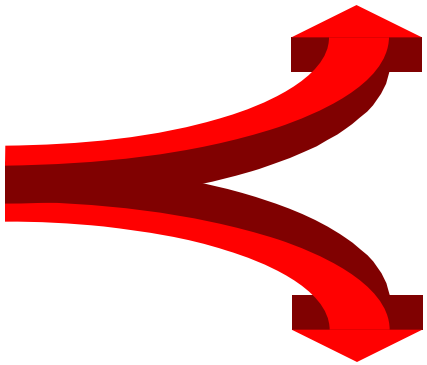
- **Big boom in Indian power sector**
- **Present installed capacity - 1,35,781 MW**
  - **Thermal - 87,225 MW - 64.2%**
  - **Hydro - 34,260 MW - 25.2%**
  - **Nuclear - 4,120 MW - 3.1%**
  - **Renewable - 10,125 MW - 7.5%**
- **Significant gap between demand and supply**
  - **Energy deficit - 8.3 %**
  - **Peak demand shortage - 12.5 %**

Capacity addition planned

- **Capacity addition planned during 11th plan – 78,530 MW**
  - **Thermal - 58,597 MW**
  - **Hydro - 16,553 MW**
  - **Nuclear - 3,380 MW**
- **More than 60% of the energy requirement met through thermal power**
- **Thermal power plants will continue to be the major contributor**
- **Achieving world class standards in Thermal Power plants essential**

Achieving world class standards - Approach

A two pronged approach



Existing Power plants

Up Coming Power plants

- Existing & Upcoming power plants face different issues with respect to
  - Technology
  - Fuel
  - Environment

World class standards - Existing Power plants

- **All are sub critical with various capacity, technology & vintage**
- **Few issues**
  - **Operating performance**
    - **Availability, Reliability, Efficiency, Cost of power generation etc**
    - **Coal Quality**
  - **Environment performance**
    - **SPM, Sox, Nox,Carbon emissions, Fly ash utilisation etc**
  - **Safety**
  - **Resource Utilisation etc**

Existing Power plants – Performance improvement

- **Comparison between one of the best performing units and average performance**

Description	A Best performing unit	Avg performance
Forced outage %	4.44	8.74
Planned maintenance %	1.03	9.48
Operating availability factor %	93.6	81.78
Plant load factor	98.5	73.71
Specific fuel oil consumption	1.20	1.77
Auxiliary power consumption	7.53	10.00

- **Potential for Performance Improvement significant**

Efficient Power Generation

- **Typically, an average increase of 1% in the efficiency of thermal power plants in India would result in:**
  - **1.2% CO2 reduction per annum (approx.10 million tons per annum)**
  - **Coal savings of approx. 6 million tons per annum**
  - **Fuel cost savings worth Rs. 3700 million approx.**
  - **Higher productivity from the same resources, which is equivalent to capacity addition**
  - **Lower generation cost per kWh**

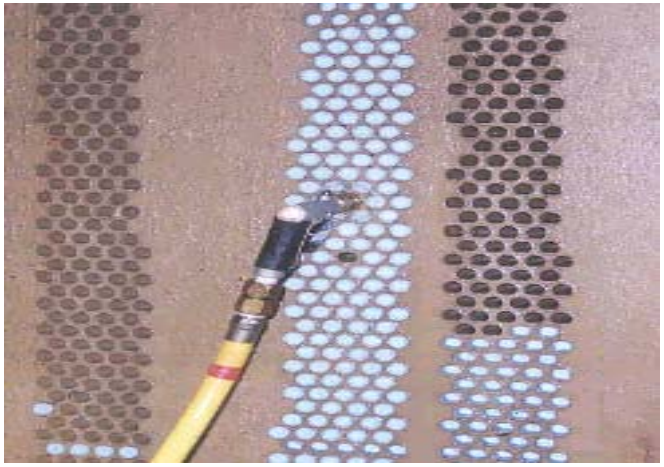
Efficient Power Generation

- **According to a study of Ohio Supercomputer Center and National Physical Laboratory:**
- **1% heat rate efficiency improvements in India's coal fired power plants can annually reduce**
  - **CO2 by 3.97 million tons**
  - **SO2 by 0.03 million tons**
  - **NOx by 1967 tons**
- **Summary report on :**

  www.osc.edu/pcrm/emissions/india.pdf

Approach for Performance Improvement

- **Two pronged approach for performance improvement**
  - **Through Regular operation & Maint improvements**
  - **Technology up-gradation**
- **Periodic performance improvement studies & Energy audits**
- **Technology up-gradation – Use of VFDs, High efficiency equipment etc**
- **Learning by sharing – Information sharing among thermal power plants**



Environment improvement

- **Fly ash utilisation**
  - Achieving 100% utilisation critical
  - Mixing with cement major opportunity
  - Bricks manufacturing, Laying roads, Concrete blocks consume small quantity
  - Innovative mechanism needs to be developed to increase consumption
- **Emission reduction**
  - Pollution control board standard for SPM – 150 mg/NM^3
  - Best plants operating with < 50 mg/Nm^3
  - Ammonia Injection , Water spray in ESPs major opportunities

Environment improvement

- **Sox emission**
  - Plants operating with Indian coal – Sulphur emission is within intl. norms
  - More dependence on Imported coal may increase SOX emission
  - Installation of desulphurisation units will become essential
    - Increases the auxiliary power consumption by 2 %
- **Nox emission**
  - Low Nox burner available for minimizing NOx
  - Catalytic converters – High investment & increased operating cost

World class standards – Upcoming power plants

- Presently Coal fired thermal power plants are the major contributors to GHG emissio

- Few issues
  - Selection of Technology
  - Design performance
  - Environment protection
  - Availability of coal – Desired quality & Quantity etc

Latest technologies for Upcoming Power plants

- **Selection of super critical power plants – For increased efficiency by design**
  - **Super critical plant eff - 39-41%**
  - **Sub critical plants eff - 33-36% (max)**
- **Utilisation of latest technologies for reducing the auxiliary power consumption**
  - **Incorporating variable frequency drives (HT) by design**
  - **Selection of high efficiency equipment by design**
  - **Selection of higher grade materials**

RWE – Super Critical thermal power plant in Germany

Latest technologies for Upcoming power plants

- **Integrated Gasification & Combined cycle (IGCC)**
  - **Excellent opportunity for increasing conversion efficiency**
  - **Pilot plant operating efficiency - 43%**
  - **Potential for increasing eff - 50-60%**
  - **Significant reduction in Sox & Nox emissions**
    - **Sulphur removal > 97 %**
    - **Nox reduction > 90%**

PSI Energy Wabash River IGCC Power Plant

Why IGCC in India?

Gasifier	*Gas Cleanup*	*Combined Cycle*

- **High efficiency: due to CC**
- **Potential for even higher efficiency: advanced GT , FC,**
- **GHG reduction: due to high efficiency; easy CO2 removal**
- **Low SOx, NOx, Hg : H_2S vs. SO_2, GT has low NOx, small gas volume**
- **Low water consumption: 2/3 power from GT**

Coal Based IGCC Plants

Project/ Location	Combustion Turbine	Gasification Technology	Net Output MW	Start-Up Date
Wabash River, IN	**GE 7 FA**	**Global Egas** (formerly Destec)	**262**	**Oct 1995**
Tampa Electric, FL	**GE 7 F**	**Texaco**	**250**	**Sept 1996**
Demkolec (now Nuon), Buggenum Netherlands	**Siemens V 94.2**	**Shell**	**253**	**Jan 1994**
ELCOGAS Puertollano Spain	**Siemens V 94.3**	**Krupp-Uhde Prenflo**	**310**	**Dec 1997**

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Wabash IGCC Plant

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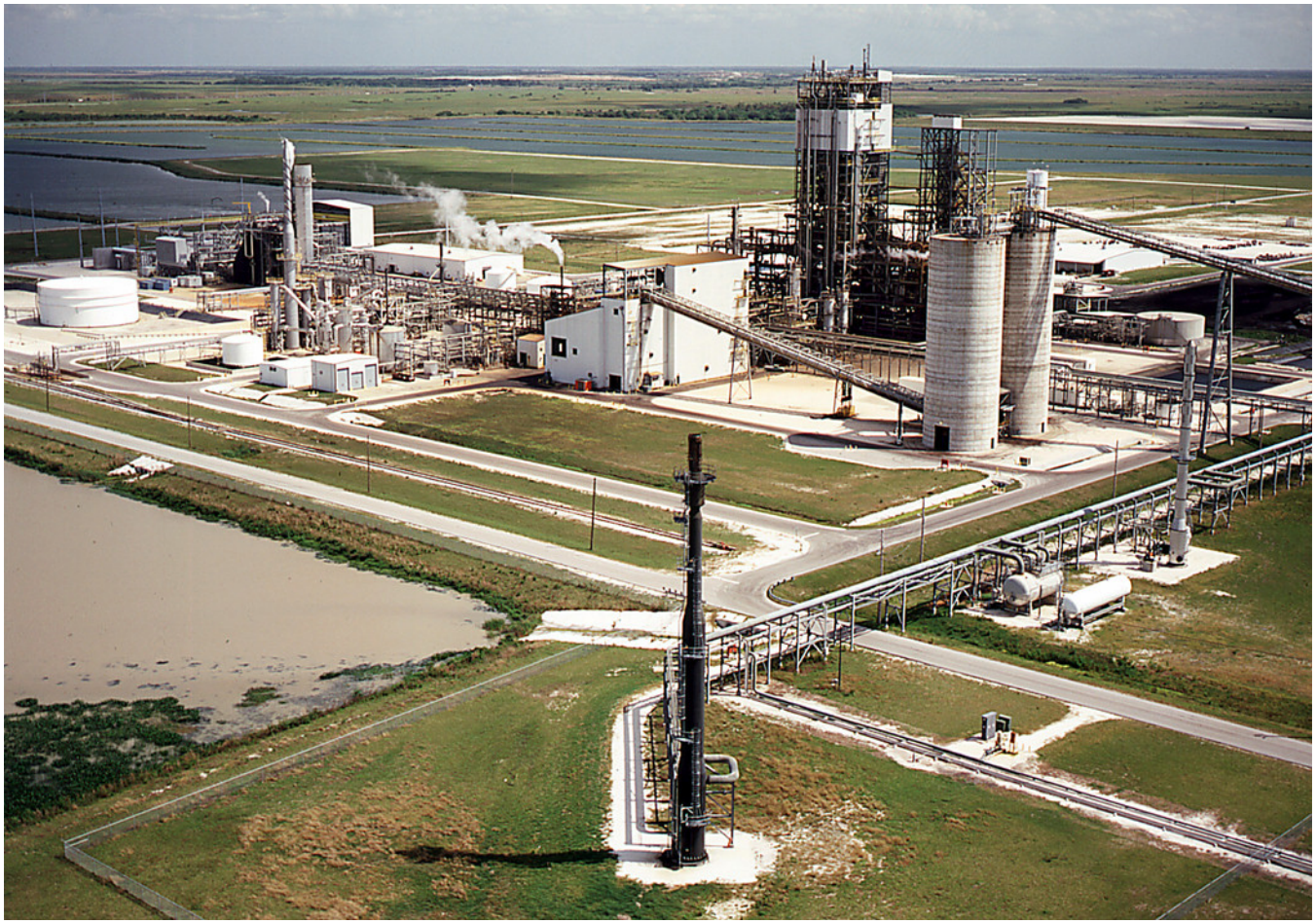
Tampa Electric IGCC Plant



Outline of the USAID-Nexant IGCC Study

- **Phase A (4Q, 2002)**
  - **IGCC Technology Survey**
  - **Comparison with competing technologies**
- **Phase B**
  - **Selection of two candidate gasifiers (4 Q, 2002)**
  - **Coal testing (1st & 2nd Q, 2003)**
  - **Final gasifier selection (3rd Q, 2003)**
  - **System optimization (4th Q, 2003)**
- **Phase C (1st & 2nd Q, 2004)**
  - **Detailed design of 100 MW demo unit**
  - **Cost estimate of the demo unit & roadmap**

Major Difference from Previous USAID Funded India IGCC Study

- **Include extensive IGCC technology survey to probe into commercial experience and technical/economic issues**
- **The technology comparison is not just with subcritical PC but also with supercritical PC, CFBC, and PFBC**
- **Include the use of washed coal in addition to ROM coal to see effects of coal washing; also include petcoke in case the gasifier cannot handle high ash coals**
- **Include extensive coal test for better gasifier selection and design/cost estimate of a 100 MW demo**
- **More extensive demo design/cost estimate with system optimization**
- **More extensive IGCC commercialization roadmap efforts**

Screening Study Summary

- **For India coal, IGCC has 10-13% higher COG than PC + FGD but this can be easily overcome by future technology advancement**
- **IGCC will become a very important technology when future stringent emission and GHG reduction are required in India; so, IGCC needs to be taken seriously in India**
- **Reduced ash content in washed coal does not offer net cost benefit but this conclusion needs to be verified after coal test**
- **Unfortunately, the two most suited gasifiers (fluid bed and moving bed) are not fully proven for IGCC application**
- **These gasifiers need to be validated and further developed in India to use high ash coals**
- **Recommend technology transfer to home grow the appropriate gasifier before marching into commercial demo**

To Sum Up…for Efficient Thermal Generation and Sustainable Availability

- Achieving world class standards in Indian thermal power plants is key
- A two pronged focused approach
  - Existing power plants
  - Upcoming power plants
- Incorporation of Latest technologies & information sharing among existing power plants vital
- IGCC Technology Demo vital for India

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