Country Overview

- Developing economy
  - GDP growth rate of about 8-9%

- Power shortages
  - Energy & peak shortages of about 6 to 10%

- Rapidly expanding power sector
  - 11th Plan (2007-12) ~62 GW
  - 12th Plan (2012-17) ~80 GW
  - 13th Plan (2017-22) ~100 GW

- Pursuing eco-friendly development path
Coal at The Centre Stage

- Being Abundantly available indigenously, Coal will remain the main fuel for power.
- Indian coal - High ash content, Slow burning, & Highly abrasive ash.
- PC technology – the current workhorse perfected gradually through learning curve.
- Any new technology for India must cope up with realities of Indian coal.
Policy Initiatives For Clean Power

- Energy conservation and demand management
  - National Mission on Enhanced Energy Efficiency
  - PAT (Perform Achieve & Trade) mechanism
  - End Use Efficiency (Appliance Labeling Standards, Energy Efficient buildings, CFL lamps etc.)

- Priority to GHG free generation
  - Thrust on Renewables & Hydro
  - Expediting statutory clearances & Implementation for Hydro Projects
  - Obligatory Renewables Purchase Obligations & trading provisions of REC
Policy Initiatives For Clean Power

• GHG Reduction in Generation from Fossils
  – Preference to Gas over coal
  – Introduction of Advance Technologies- Supercritical
  – CEA regulations on plants with mandatory minimum efficiency
  – R&D for technology development- A-USC, IGCC

• R&M or Selective Retirement of old units
  – Targeting large no of 200/210 MW Units LMZ designs
  – 5 – 7% improvement envisaged
Power Sector Development
Total Installed Capacity = 182,689 MW

As on 31-10-2011
<table>
<thead>
<tr>
<th>Size</th>
<th>Steam Par.</th>
<th>Eff.</th>
<th>Year</th>
<th>Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>ata/C/C</td>
<td>(%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-50</td>
<td>60/ 482</td>
<td>~31</td>
<td>1950s</td>
<td>4400</td>
</tr>
<tr>
<td>60-100</td>
<td>90/ 535</td>
<td>32-33</td>
<td>1960s</td>
<td>12000</td>
</tr>
<tr>
<td>110 to150</td>
<td>130/ 535/535</td>
<td>35-36</td>
<td>1970</td>
<td>35000</td>
</tr>
<tr>
<td>200/210</td>
<td>130,150/535/535</td>
<td>36.3,37.8</td>
<td>1977</td>
<td>35000</td>
</tr>
<tr>
<td>250</td>
<td>150/535/535</td>
<td>38.3</td>
<td>1995</td>
<td>11000</td>
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<tr>
<td>500</td>
<td>170/ 538/538</td>
<td>38.5</td>
<td>1984</td>
<td>28500</td>
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<tr>
<td>500</td>
<td>170/535/565</td>
<td>38.7</td>
<td>2010</td>
<td>2000</td>
</tr>
<tr>
<td>660</td>
<td>247/535/565</td>
<td>~39.5</td>
<td>2010</td>
<td>2000</td>
</tr>
<tr>
<td>660/800</td>
<td>247/565/593</td>
<td>40.5</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Efficiency - Gross on HHV
Total Coal Capacity- 100,098
## Supercritical Unit Sizes

<table>
<thead>
<tr>
<th>Unit Size (MW)</th>
<th>Parameters</th>
<th>Design Efficiency * Gross on HHV</th>
</tr>
</thead>
<tbody>
<tr>
<td>660</td>
<td>247 kg/cm² 538/565 °C</td>
<td>39.5 %</td>
</tr>
<tr>
<td></td>
<td>247 kg/cm² 565/593 °C</td>
<td>40.5 %</td>
</tr>
<tr>
<td>800</td>
<td>247 kg/cm² 565/593 °C</td>
<td>40.5 %</td>
</tr>
</tbody>
</table>

Expected Efficiency Gain of ~ 5% over Present 500 MW Units (170 kg/cm² 535/535 °C)
Supercritical technology in India - Historical Perspective

• Periodic Reviews of Technology needs by MoP & CEA
• CEA Expert Committee -2001
  – Optimal Unit Size & Supercritical Steam Cycle Parameters
• Issues considered by The Committee
  – Global scenario- Technology, Unit sizes & operating experience
  – Country’s Capacity addition programme
  – Power System capability & grid related issues
  – Steam parameters, Cycle configuration & Cost economics
  – Environmental & Cost benefits
  – Indigenous capacity building
    • Manufacturing, Transportation, Human Resource
  – Strategy for technology induction
Expert Committee Recommendations

- Supercritical a matured technology
  - Large Numbers Operational Reliably worldwide
- Seed capabilities for introducing Supercritical Units exist in the Country
- No grid constraints for units upto 1000 MW
- Units of 800 to 1000 MW should be adopted
- Higher steam temperatures of 568 °C to 593 °C
  - Depending on site specifics economics
Expert Committee Recommendations – Issues to be addressed

- Operating Practices And Skills Improvement To Achieve Design Performance
- Reliable And Proven Technologies and Stringent Quality Control at each Stage for Quick Stabilization
- Efforts to rapidly indigenize manufacturing
- Bulk order of 8-10 Units for rapid indigenization and lower cost
- Adequate measures for supply of consistent/good quality Coal
- Group to evolve basic design features of Supercritical units optimized for Indian conditions
Supercritical Technology Progress & Plans

- First Supercritical unit of 660 MW commissioned in Dec-2010
- 4 Units with total capacity 2640 MW operating
- ~4000 MW supercritical capacity to be operational in 11th Plan (March -2012)
- Supercritical to constitute 50-60% coal fired capacity addition in 12th Plan (2012-17)
- 100% coal fired capacity addition in 13th Plan and beyond to be supercritical
Promoting Supercritical Technology

- Preference to supercritical units in coal allocation
- Promoting indigenous manufacturing for super critical equipment
- Bulk orders for Super Critical units with Phased Indian Manufacturing
  - 11x660 MW Bulk order for NTPC and DVC
  - 9x800 MW for NTPC
- Why Requisite Indigenous Manufacturing Capacity
  - Considerably Aid Lifetime Support For Services/Spares
  - Know How & Know Why
  - Specific Problem Solving & Customization
Indigenous Manufacturing Capacity Building

• BHEL Technology tie ups for supercritical Tech
  – Boiler - Alstom, TG - Siemens
  – Capacity Augmentation – Up to 20,000 MW

• New Joint Ventures for Supercritical units
  – Supercritical Boiler ~ 14000 MW +
  – Supercritical TG ~ 15000 MW +
  – More Joint Ventures in the pipeline

• International manufacturers involved
  – MHI Japan, Toshiba, Alstom, Ansaldo, Hitachi, Babcock Hitachi
The Road Ahead – Performance

• **Performance Objectives**
  – Availability
  – Efficiency
  – Safety

• **Determinants of Performance**
  – Design & Sizing
  – Supply & Construction
  – Quality Control
  – Operation & maintenance
  – Trained man power, spares and services, standard operating procedures

• **Advancements/Improvements**
  – Project implementation & Operation
Design & Sizing

• Appropriate designs for Indian conditions
  – Furnace sizing – Indian Coal/Blended Coal
  – Range of coal quality including blending
  – BFP configurations –
    – MDBFP Vs TDBFP,
    – Size & Nos
  – Fans Type- Axial vs. Radial
  – APH – 4 Bi Sector Vs. 2 Trisector
  – By Pass System Sizing

• Common Acceptable Criteria being Evolved
  – Utilities, Manufacturers and Consultants on D&E Philosophy

• “Standard technical features of Supercritical units” being
developed by CEA – Draft Under Discussion
Erection and Commg

• **Transport of Heavy Equipment**
  - Specially for higher size units 800 MW and above
  - Constraints in Rail transportation & Ports

• **Implementation Schedules**
  - Current 48 months for 660 MW
  - Explore Possible optimization

• **Areas Needing Attention**
  - Equipment /machinery/infrastructure required for faster project implementation
  - Standard Optimal Schedules
High Efficiency Technology Options
High Efficiency .. Indian Context

- High CW temperature 33 -36 deg C
- High Ambient temperature
- Poor Coal Quality
  - High Ash
  - Slow burning
  - Abrasive

- High Heat Rate (Low Efficiency) & High Aux Power

Estimated impact - ~ 2-4 percentage points

Efficiency Computations made on Gross Generation and GCV of Coal
Pre-Requisites for Technology Adoption

- Proven and Mature Technology
  - Demonstrated Successful & Reliable Operation
    • Commensurate Scale & Operating Conditions
- Requisite Availability of Suppliers
- Tangible Potential Benefits
- Sound Well Adapted Designs
- Core manufacturing, Implementation & Service Support Arrangements
- Technoeconomics
- Phased & Structured Introduction
Equipment Quality/Performance

- Appropriate Design/Sizing important for Performance
- Suitability of equipment for specific site to be ensured
- Indian Design Practices
  - Emphasis on Reliability
  - Conservative Designs with adequate margins
  - Varying Ambient Conditions
  - Frequency Variations
  - Indian Coal Characteristics
  - Maintenance Provisions
The Road Ahead on Technology

• Quest for Higher Efficiency is Ongoing & Continuous
• Options for High Efficiency
  – Supercritical Technology
  – Ultra supercritical Technology
  – Advanced Ultra supercritical Technology
  – IGCC
  – Coal Beneficiation
• CFBC
Technology Options

- Supercritical Technology
  - Already Adopted
- Ultra supercritical (USC) technology
  - International Experience ~ 280 bars 600 deg C.
  - Experience limited mainly in Japan, Europe and few countries
  - International Developments under watch
  - Higher Steam Parameters Contemplated Based On Feed Back Of Operating Supercritical Units
Technology Options

• **Advance Ultra Supercritical Technology**
  - Efforts underway for indigenous development of 700 deg C technology
  - MoU between IGCAR, NTPC & BHEL
  - Indigenous design and manufacturing of materials proposed

• **Circulating Fluidised Bed Combustion (CFBC)**
  - Being Adopted for High Sulphur Lignite
  - Several 125 MW units operational
  - 250 MW CFBC units being installed
IGCC

- Limited International experience & with low ash coals
- Fluidised bed gasifier considered suitable for Indian coals not proven Internationally
- High Capital and operating Cost
- IGCC technology for Indian coal requires indigenous development through R&D
  - Feasibility studies done by Nexant, USA & BHEL
    - Indicate Low efficiency and low availability
  - BHEL MOU with APGENCO for IGCC demo project
  - NTPC desirous of setting up IGCC demo plant through International cooperation
Coal Beneficiation

- Indian coal – high ash 40-45%
- Open cast mining → Impurities
- Coal Beneficiation - Benefits
  - Savings in Transport cost
  - Better use of Transport infrastructure
  - Advantages in O&M
- Issues
  - Low Washing Yields
  - Problem of Rejects Disposal/use

Presently Washing Has Been Found Economical For Load Centre Stations
To Conclude

- Impressive Start on Supercritical Technology
  - Large number of units under construction
- Efforts of Indigenous Capacity Building Bearing Fruits
  - Several International manufacturers setting manufacturing Facilities in India
- Efforts to improve Project Implementation Timelines & Remove Infrastructure Bottlenecks Continuing
- Optimal Design & Performance is Need Of The Hour
- Preparedness and Desire for Further Technology Improvement & Indigenization
  - Ultra Supercritical On the radar
  - National R&D for Advance Ultra Supercritical Technology & IGCC
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