Success stories:
Efficiency Improvement in Power plants

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Presentation Outline

- Indian Power sector: Challenges
- NTPC Overview
- Strategies for Efficiency Improvement
- Systems, Technologies & Practices
- Success stories
- Conclusion
Indian Power Sector: Challenges

- Efficiency Improvement
- APC reduction
- GHG Reduction
- O&M cost reduction & Optimization
- Coal quality
- Service providers
NTPC’s Capacity Addition Plan

Aggressive Capacity Addition Plans

Dec-2012  2032
Efficiency Improvement & GHG Reduction Program

CenPEEP

Global Concerns
- Pollution
- Global Climate
- GHG emissions
- Particulate emissions
- Ash pollution

Utility Concerns
- Sustainable growth
- Profitability
- Public image
- Efficiency
- Availability
- Reliability
- O&M costs
- Industry Norms

Harmony

Win-Win Strategy
Methodology

Approach

Technology Transfer

Technology Selection & acquisition

Technology demonstration / deployment

Training & Technology Dissemination

Success factors

• Demonstration
• Sustainability through systems, procedures & practices
• Institutionalization
• Thrust on low cost / high benefit technologies for sustainability
Technology & Practices

- Air-fuel ratio test
- Iso-kinetic PF Sampler
- In Situ Fly Ash Sampler
- High Velocity Traverse (HVT)
- Grid Sampling
- Primary Air Flow Calibration
- Oxygen Mapping
- Furnace Temperature Mapping
- Development of ANN based optimization tools
**Turbine Performance Optimization**

**FW Flow Measurement**
- FW Flow Measurement using high Temp Ultrasonic probe
- Validation of FW Flow

**Cooling Tower Performance**
- CT single cell performance test
- Effect of L/G ratio on CT performance
- CW flow measurement
  - Ultrasonic flow meter
  - Three hole pitot tube

**Turbine Perf. Assessment**
- Condenser performance
- Turbine cycle heat rate
- HP / IP Cylinder efficiency
- HP heaters performance
Strategies for Efficiency improvement

- Performance Tracking
- Performance Assessment & analysis
- Efficiency GAP Identification & Action planning
- Optimization
- Integration with Maintenance strategies
- Sustainability: Institutionalization & Implementation
Performance Pyramid

Focus on each sub-system & plant equipment

Periodic Audits to identify areas of degradation & gaps

NHR

Availability

Boiler Turbine

Air Pre Htrs HP& IP Turbine

Boiler Press parts BFP & HPH/ LPHs

Mills & Burners Condenser & CW System

Coal handling system Gen; X-mer & switchyard

Human Resource
Energy Efficiency Management System

Accurate Gap Assessment & Analysis

Development, Implementation of Action Plans

Capability Building

R & M Retrofits

Performance Improvement Projects (PIPs)

Focus on degradations in Individual Equipment
Energy & Efficiency Management System (EEMS)

Development & Implementation of EEMS

- Identification of Heat Rate gaps through monthly performance tests
- Trending performance indices & analysis of equipment degradations
- Development of Unit specific HR recovery action plans
- Restoration of equipment performance during overhauls
- Skill / knowledge enhancement through Dissemination workshops

Customized EEMS Document prepared based on learning's at CenPEEP and ‘Heat rate Improvement Guidelines’ issued earlier
Typical HR Performance Gaps

Major Heat Rate Loss Areas

- Condenser & CTs: 35%
- Turbine (HP/IP): 19%
- Dry Flue Gas Loss: 22%
- Unaccountables: 10%
- RH Spray: 7%
- Others: 7%

What can not be measured can not be saved!
Major Losses: Condenser

**Major Reasons**
- Dirty tubes/air ingress:
- Choking/fouling of condenser tubes
- Debris / Hyacinth growth
- Air ingress
- Ingress of ash / siliceous material
- Effectiveness of OLTCs
- High condenser loading
- Low CW flow

**Strategies**
- Accurate analysis – data validation, trending & analysis
- Absolute pressure transmitter & CW flow measurement
- Action Plan: condenser tube cleaning / replacement
- OLTCs / Debris filter:
  - Practice of opportunity cleaning
  - Identification and attending air ingress point
  - Passing of high energy drains
- Identification of engineering issues
- Chemical treatment of CW
Major Losses: DFG

Major Reasons

• AH performance deterioration
• Seal (circumferential) leakages
• Gaps between baskets, & diaphragms
• Baskets fouling
• Air ingress in Boiler / pent house / ducts
• High boiler loading
• Soot blowing in-effectiveness
• Engineering issues (design, modifications)

Strategies

• Accurate measurement – online & offline data, trending & up-gradation
• Action Plan & Restoration: Boiler & Air Pre heater
• Focus on preparedness: OPI
• Component upgrades : Air preheater & Pulverizer
• Identification of engineering issues
• Operational optimization
O&M Practices Adopted

Measurements for better control of combustion
- Relocation of T/Cs for Air & Flue Gas Temp Measurement
- Additional Zirconia probes in Gas ducts
- PF sampling from individual coal pipes
- Grid Sampling in Gas ducts using portable analyzers

Mills
- Dirty air velocity Tests
- Isokinetic coal sampling
- Assessment of PF balance amongst burners

Boiler & Air Heaters
- Performance assessment, trending & analysis
- Periodic AH Basket Cleaning & Replacement
- Air Ingress quantification by Oxygen traverse in Gas ducts
- Repair of Ducts & Replacement of Expansion joints
- Parametric optimization
- Tracking of differential pressure across APH
**Condenser**
- Periodic & Opportunity cleaning with Water powered cleaners
- Installation of absolute condenser pressure transmitter
- Comparison with expected condenser pressure
- Condenser air flow, depression & differential pressure tracking
- High Energy drain valve passing

**Cooling Tower**
- Introduction of CW Flow measurement technique
- Calculation of CT Capability instead of effectiveness
- CT capability test during July-Sept Period
- Cleaning of fills / cold basin
- Thrust on Chlorine dosing

**Turbine:**
- HP/IP Efficiency Offline Testing at VWO
- Pressure leg correction for accurate test assessment.
- Thrust on seal repair/replacement
- GTCHR Testing with use of Total Feed water flow
- Introduction of TD BFP Loss assessment
Multiple Technology Approach for Performance Improvement: Condenser

Reliability:
Failure mode analysis

Risk Analysis:
Impact on generation

SMART Catch:
Proactive approach

Gap Analysis:
Mitigation strategies

Math Modelling:
Parameter evaluation

Diagnostics:
Multiple technology usage

O&M approach:
Monitoring, control & optimization

Multiple Technology Approach for performance improvement
Case Study on Condenser Loss

Case: Observations/Problems

Both vacuum pump was running
Air suction temp depression Left/Right : 4/13 degree C
Variation of Condenser vacuum due to air ingress/dirty tube was 44 mm Hg.

On the basis of primary investigation, condenser air ingress test using Helium leak detector, acoustics and IRT was done by CenPEEP.

Findings:

During above test a hole (2”x 1’’) of size in CRH strainer drain to HP Flash box was found
Case Study on Condenser Loss

Hole in the CRH strainer drain line

Hole fixed up using clamp

Benefits of Testing:

1. Improvement in condenser vacuum by 16 mm Hg
2. Stoppage of one vacuum pump there by reducing in APC and increased operational reliability
1. Unit Heat rate improvement : 32 kcal / kWh
Case Study on Condenser

Air in leak observed from LPT parting plane surface & Bolt edges (Shown by arrow)
Temperature difference of appx. 6-7 degrees was observed in the surface of parting plane.
Devecon putty was applied to arrest the air in leakage from parting plane.

**Improvement in MW**

**CEP 2B** Suction strainer flange bolts showed bolts looseness & was recommended for re-tightening.
DO level reduced from 110 PPb to 10-15 PPb
10 no. bolts of Hotwell (A & B) were found loose having having air ingress from them to the system. All the bolts were retightened. Improvement in vacuum of 5-7 mmHG
Maintenance Strategies

Road map: **Knowledge Based Maintenance**

- Risk Evaluation & Prioritization (REAP)
- Reliability Centered Maintenance (RCM)
- Proactive Maintenance (PAM)
- Predictive Maintenance (PdM)
- Preventive Maintenance (PM)
- Corrective Maintenance (CM)
Reliability Centered Maintenance

**Re-visit of RCM**
- Ineffective tasks
- Modify tasks
- Add tasks

**RCM of all Systems**

**Identification of equipment of Concern**
High BD, New failure modes, repeat failures

**Change Reco.**
PM, PdM, OH

**Tracking of Maint.**
PM, BD, outages, trips

Imbibing RCM: Tool for maintenance rationalization and sustaining functional performance of equipment & systems
**Monitoring & Diagnostics**

**Infrared Thermography - New Applications**
- Air-in-leak in turbine cycle, condenser, manholes, flange joints, etc.
- Fast method for location identification

**Acoustics - New Applications**
- Condenser tube leak detection by acoustics
- Faster and accurate method, avoided forced outages

**Video Scope**
- Internal inspection without opening a machine (*like HT motors, turbine extraction lines*)
- Facilitates inspection and reduces human induced faults
Thermal Cycle Audit

Methodology
a) Cycle Modeling using PEPSE
b) Validation of measurements
c) Maximum Capacity Test (VWO)
d) Assessment of Eff. deterioration
e) MW check & Reconciliation of data
f) Heat rate & MW deviations

Benefits
a) Accurate performance analysis
b) Quantification of degradations
c) Validation of Process parameters
d) Identification of Component level degradations

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<th>HBD</th>
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<th>HR dev</th>
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### SMART Catch

#### Back Ground
- ✔ Ageing fleet
- ✔ Reduction in O&M cost
- ✔ Optimization of plant processes
- ✔ Limited experts in specific areas
- ✔ Reduction in GHG emissions
- ✔ De-regulation and Global competition
- ✔ Rapid growth in capacity, across the country
- ✔ Best practices get restricted to a Station

#### Objective
- ✔ To bring the real time data to Remote Places (Corporate Centre & Regional Centre)
- ✔ 24x7 Access to Specialized Domain Knowledge
- ✔ Deployment of State-of-the-art Software & Diagnostic Tools
- ✔ Advisories to Plant personnel
- ✔ Creation of “Knowledge Repositories.”
- ✔ Move Data, Not People
- ✔ Single point OEM interface
SMART Catch: Proactive Approach

Ramagundam U#3 Condenser Air Ingress

Air-ingress from CEP gland detected. Pump change over done and attended.

Condensate DO level dropped from 84 to 6 ppb

Capturing experiential learning & initiating advisories for operator guidance

Ramagundam U#7 Condenser Tube leakage

Increase in ACC (Suspected Cond Tube Leak)

Maintaining ACC with one CPU

Both CPU Taken to service

Load Reduction for tube leak attending

Air-ingress from CEP gland detected. Pump change over done and attended.

Condensate DO level dropped from 84 to 6 ppb
Pan-Indian Demonstration & Dissemination

- Comprehensive Performance assessment: Demo & Hands on training in 7 state utilities
- Performance assessment & workshops in 14 states utilities
- PdM demo in 14 states

Utility Support Mechanisms

- Trainings at PMI / SEB door steps
- Partnership in Excellence (PIE)
- Asia Pacific Partnership (APP)
- Customer Relationship Mgmt (CRM)
- Consultancy
Support to ‘Power Generation & Transmission Task Force” Activities

• Sustainable ‘Efficiency Improvement’ at 3 state utilities (Punjab, West Bengal, Tamil Nadu)
  - Workshops & Walk down visits with US Experts
  - Pre Outage Assessment Tests & support during overhauls
  - Post Outage tests on Boiler & Air heaters with M/S Storm and Turbine tests by CenPEEP – Hands on Training to station engineers

• Study Visits to U.S.utilities

Improvement Potential (kcal/kWh)

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<th>Kolaghat</th>
<th>Tuticorin</th>
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<tr>
<td>Boiler</td>
<td>105</td>
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<tr>
<td>Turbine</td>
<td>137</td>
<td>125</td>
<td>317</td>
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Some examples:

- Condenser tube cleaning (CONCO system)
- Condenser air-in-leak detection (helium leak detection)
- Eddy current turbine stud heating for stud removal
- Infrared Thermography as diagnostics – ‘coal yard to switchyard’; earlier limited to electrical;
- Acoustics as diagnostics: introduced for the first time
- Dirty Pitot for air-fuel ratio optimization
- Cooling Tower capability test (earlier limited to effectiveness)
- Service provider role: extended to optimization & performance test
International / National Recognitions

CTI’s World Climate Technology Award by CTI/IEA-Paris (2002)

International Gold Star for Quality Award by BID International- Madrid (2009)

USEPA Climate Protection Award (2003)

India Power Award by Council of Power Utilities, India (2008)
In Conclusion

- Skills / awareness for performance improvement
- Dedicated groups for Energy Efficiency & Reliability at Stations
- Comprehensive plans for performance enhancement
- Sustainability: Institutionalization & Implementation

- Ageing Fleets
  - Requirement of high investments
  - Dependence on OEM Suppliers
  - OEM focus on New capacity
- Reduced operating margins
- Availability of Expert Service Providers
- Financing of Efficiency Improvement projects

*Performance Improvement is a journey, not a destination*
Together we work for a greener world

Thank You