BEST PRACTICES IN THERMAL POWER PLANTS
KEY OPERATING PARAMETERS IN THERMAL POWER PLANTS

- Heat Rate (indicator of fuel consumption per unit of power generation)
- Plant Load Factor (PLF)
- Auxiliary Power Consumption (internal consumption)
- Generation Efficiency
- GHG Emissions
## HEAT RATE

(2013-14)

<table>
<thead>
<tr>
<th>Category</th>
<th>National Average (kCals/KWh)</th>
<th>Indian Benchmark (Best Operating) (kCals/KWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 MW and below</td>
<td>2755</td>
<td>2528</td>
</tr>
<tr>
<td>150 MW to 240 MW</td>
<td>2592</td>
<td>2314</td>
</tr>
<tr>
<td>250 MW to below 500 MW</td>
<td>2430</td>
<td>2216</td>
</tr>
<tr>
<td>500 MW and above</td>
<td>2358</td>
<td>2278</td>
</tr>
</tbody>
</table>
# PLANT LOAD FACTOR (PLF)

(2013-14)

<table>
<thead>
<tr>
<th>Category</th>
<th>National Average (%)</th>
<th>Indian Benchmark (Best Operating) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 MW and below</td>
<td>54.66</td>
<td>92.8</td>
</tr>
<tr>
<td>150 MW to 240 MW</td>
<td>70.37</td>
<td>89.48</td>
</tr>
<tr>
<td>250 MW to below 500 MW</td>
<td>61.62</td>
<td>93.9</td>
</tr>
<tr>
<td>500 MW and above</td>
<td>56.12</td>
<td>83.8</td>
</tr>
</tbody>
</table>
# AUXILIARY POWER CONSUMPTION (APC) (2013-14)

<table>
<thead>
<tr>
<th>Category</th>
<th>National Average (%) (2013-14)</th>
<th>Indian Benchmark (Best Operating) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 MW and below</td>
<td>12.10</td>
<td>6.91</td>
</tr>
<tr>
<td>150 MW to 240 MW</td>
<td>8.30</td>
<td>7.02</td>
</tr>
<tr>
<td>250 MW to below 500 MW</td>
<td>8.78</td>
<td>6.41</td>
</tr>
<tr>
<td>500 MW and above</td>
<td>6.79</td>
<td>5.48</td>
</tr>
</tbody>
</table>
## EFFICIENCY (%)

(2013-14)

<table>
<thead>
<tr>
<th>Category</th>
<th>National Average (%)</th>
<th>Indian Benchmark (Best Operating) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 MW and below</td>
<td>31.22</td>
<td>34.02</td>
</tr>
<tr>
<td>150 MW to 240 MW</td>
<td>33.17</td>
<td>37.16</td>
</tr>
<tr>
<td>250 MW to below 500 MW</td>
<td>35.39</td>
<td>38.81</td>
</tr>
<tr>
<td>500 MW</td>
<td>36.46</td>
<td>37.75</td>
</tr>
</tbody>
</table>
## GREEN HOUSE GAS (GHG) EMISSION
(2013-14)

<table>
<thead>
<tr>
<th>Category</th>
<th>National Average (Tonnes CO₂/Million KWh)</th>
<th>Indian Benchmark (Best Operating) (Tonnes CO₂/Million KWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 MW and below</td>
<td>885</td>
<td>712</td>
</tr>
<tr>
<td>150 MW to 240 MW</td>
<td>865</td>
<td>768</td>
</tr>
<tr>
<td>250 MW to below 500 MW</td>
<td>757</td>
<td>678</td>
</tr>
<tr>
<td>500 MW and above</td>
<td>768</td>
<td>678</td>
</tr>
</tbody>
</table>
BEST PRACTICES FOR GHG EMISSION REDUCTION
Best Practices in Thermal Power Plants

⇒ Improvement in condenser vacuum

Possible Causes

- air ingress due to leakages
- fouling in condenser tubes
- Ejector performance
- Higher cooling water temperature
- Inadequate cooling water flow etc

Improvement Potential

7.57 tCO₂/Million Units (MU) for every 0.01 KG/CM² of Condenser Vacuum
Best Practices in Thermal Power Plants

⇒ Reduction in excess air ratio

- accepted excess air percentage is around 20%
- can be reduced to 14–15%

Improvement Potential

- 1% reduction in excess air results in 0.6% improvement in boiler efficiency
- Corresponding GHG Emission reduction 4.5tCO₂/MU
Best Practices in Thermal Power Plants

Reduction in the stack gas exit temperature

- normally in range of 160–200°C
- effective heat recovery and draft control can reduce fuel consumption
- should not be reduced so much that it results in condensation

Improvement Potential

- Every 22°C reduction in stack temperature results in 1% improvement in boiler efficiency
- Corresponding GHG Emission reduction 7.5tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Soot blower optimisation

- Soot sticks to the superheater tubes impeding heat transfer
- removed periodically through soot blowers
- normally predetermined and is operated once every shift

 Improvement Potential

- proactive approach could reduce steam consumption without affecting the boiler performance
- Corresponding reduction in Steam consumption of over 2 Tonnes per day
Best Practices in Thermal Power Plants

⇒ Steam leaks reduction

- common scenario in thermal power plants
- can be largely arrested

**Improvement Potential**

- checking and reducing the steam leakages can improve the efficiency by upto 1%
- Corresponding GHG Emission reduction 7.5tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Improvement In Hot Re–Heat Temperature

Possible reasons for reduced temperature
- fouling in reheat tubes
- reheat attemperation control valve leakage
- incorrect amount of reheater heat transfer area etc

Improvement Potential
- Every 10°C increase in reheat temperature is expected to improve the heat rate by 5Kcals/kWh
- Corresponding GHG Emission reduction 3tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Modification In Furnace Draft Control Logic

- Dynamic Vane and scoop control upper and lower limits
- Resulting in higher energy consumption in ID Fans

**Improvement Potential**

- Fan energy consumption reduced by 7–9% depending on the coal quality
- Corresponding GHG Emission reduction 0.45tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Reducing Slag formation in Boiler

- common practice of mixing imported coal for maintaining GCV, having lower Fusion temperature
- Resulting in increased slag formation

Improvement Potential

- injecting special slag reduction chemicals (a mixture of Magnesium oxides and phosphate salts) on fire side
- efficiency improvement of upto 0.18%
- Corresponding GHG Emission reduction 1.3tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Normalizing Feed Water inlet temperature to Economizer

- Observed in some cases, economizer inlet is being maintained lower than design
- holes due to erosion in the diaphragms (in HP Heater) causing partial bypassing
- Resulting in increased heat rate by 6 kCals/kWh

Improvement Potential

- Ensuring proper feed water heating by minimising leakages
- Approaching designed economiser inlet temp.
- Corresponding GHG Emission reduction 3.5tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Application of LT VFD for HT motors

- relatively small power plant auxiliary equipments such as CEP, Drip water pump etc
- actual output requirement is lower than the designed
- Installing HT VFD is a costly preposition

Improvement Potential

- using LT VFD drives with provision of stepping down and stepping up the voltages
- Energy saving of the tune of 20–40%
- Corresponding GHG Emission reduction 0.2tCO₂/MU (20% savings)
Best Practices in Thermal Power Plants

⇒ Blinding stages of HPBFP

- It is observed that pressure generated by BFP is much higher than the boiler drum pressure.
- Can be avoided by pressure reduction by stage removal.

Improvement Potential

- Every stage removal in BFP reduces energy consumption by about 8% (Assuming total 12 stages pump).
- Corresponding GHG Emission reduction 1.5tCO\textsubscript{2}/MU.
Best Practices in Thermal Power Plants

⇒ Optimising Air Preheaters

- pressure of fresh air being heated is higher than the pressure of hot flue gas duct
- possibility of air leaking into the flue gas path, due to improper sealing in the air heater or puncture in the tubes
- effects heat recovery and also increases load on ID and FD Fans

Improvement Potential

- Every 5% increase in air leakage
- Corresponding GHG Emission increase 0.5tCO₂/MU
Unburnts in fly ash contributes to heat loss in boilers

Regulating the combustion air supplied, depending upon the coal quality could reduce this loss

Improvement Potential

Every one percent reduction of unburnuts in bottom ash

Corresponding GHG Emission reduction 0.1tCO₂/MU

ensure that the losses in flue gas does not get compromised as a result
Cooling tower performance has an impact on the condenser vacuum

Possible factors for increased cooling water temperature
- Insufficient/excess cooling water flow
- Nozzle choking in the cooling tower basin resulting in uneven distribution of water
- Algae formation in Cooling tower

Improvement Potential
- Every 3°C increase in the cooling water temperature impacts condenser vacuum by 1 KPa (0.01Kg/CM²)
- Corresponding GHG Emission increase 0.1tCO₂/MU
Best Practices in Thermal Power Plants

⇒ Steam turbine refurbishment

- Performance of the steam turbine drops with time even after regular overhauls.
- Every 1% drop in turbine efficiency would result in additional coal consumption of 1.2%.

Improvement Potential

- Refurbishment may be considered after considerable loss of turbine efficiency.
- Corresponding GHG Emission reduction: 9tCO₂/MU.
Apart from improvement in energy performance of a plant, some general parameters also influence the effectiveness of operations and productivity of a plant.

- **Labor Productivity**
  - Manpower employed per MW (Executive & Non-Executive)
  - Manpower Cost per MW (Executive & Non-Executive)

- Training Need Assessment
- Housekeeping
- Waste Management
Productivity Improvement Techniques

- KAIZEN
- 5S
- SOPs
- Work Instructions
- Visual Controls
- Total Productive Maintenance (TPM)
- Inventory Management System
- Mistake proofing techniques
- Just in Time (JIT)
# Self Assessment of Losses

<table>
<thead>
<tr>
<th>Loss Assessment</th>
<th>No. of possible/apparent points or events</th>
<th>Amount per day/month</th>
<th>Monetary Losses (RS.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Wasteful/avoidable Consumption (kWh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam Leakages (KGs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressed air Leakages (CFM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine Breakdown (Numbers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal (Tonnes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Leakages (Tonnes or Litres)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Leakages (Litres)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THANK YOU