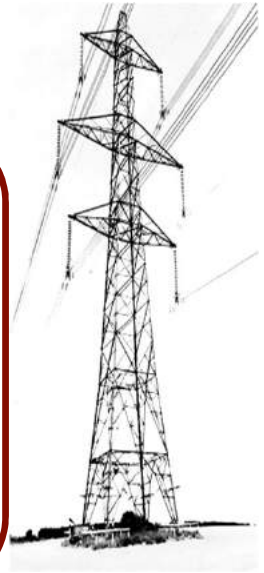
Flexible Operation – NTPC'S Approach



Presented by
A.K.Sinha,
NTPC Ltd,
India

Outline


Changing Power Sector Scenario
Scenario in 2022
Impact of Variable Renewable power
Barriers of Flexibilisation
Benchmarking and Preparation
Leveraging Digitalization for flexibility
Cycling Costs
Operation and Maintenance Strategy
Initiatives with International Cooperation

Changing Power Sector Scenario

	Today	Target
Installed capacity	~346 GW	~ 948 GW by 2032
Generation (in Bus)	~1294 BUs	~1552 BUs by FY 19
Peak Load Demand	~171GW	~229 GW (by FY 19)
Per capita consumption	~ 1122 kWh	~ 3026 kWh (World average)
Renewable capacity	~66 GW	175 GW (by 2022)
AT & C Losses	~20.26%	15% by FY 19

1. Government's focus on attaining affordable "24x7 Power for All" by 2019.
2. Energy Sector growing at a CAGR of ~7%-8%.
3. Big push to Renewable Energy- to grow from ~66GW presently to 175GW by 2022.

Source: MOP, CEA

Although coal will remain the mainstay of energy security in India, there will be a fundamental change in the business model of coal based stations.

Preparation and management of Flexible Operation of Fossil based plants will be a critical factor for survival in the Changed Business Environment and will need Realignment of Strategies .

Flexibilisation: Why Bother?
Or Why should I get ready?
…What to do?

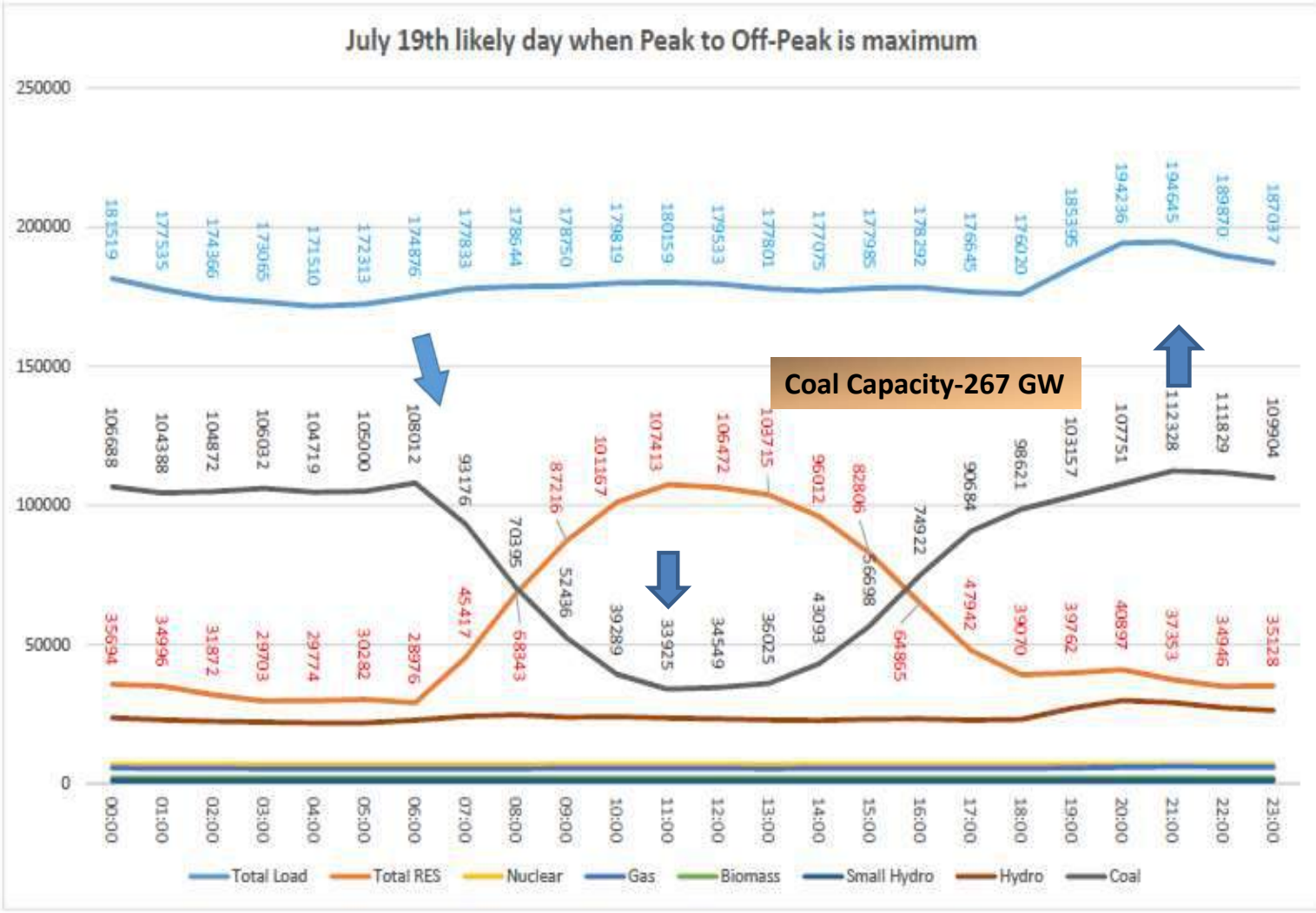
Grid Evolution,
Baseload ⇨ Cycling

Impacts of Plant Cycling on Damage Rates and the ultimate Costs of providing power

Critical risks of process safety, increased costs, higher probability of equipment failure and reduction in unit life associated with cycling will need effective management

Building a Business Case for Flexibilisation

All India Demand Vs Net demand from Coal on a typical day in 2022



Impact of Variable Renewable power

The Variability, Uncertainity,and the Geographically Confined VRE will be challenging for the grid operators as well as generators.

Impact on System

- Difficulty in load frequency control
- Difficulty in scheduling of tertiary reserves
- Requirement of enhanced transmission network and its under utilisation
- Increase in requirement of ancillary services and hence increased system operation cost
- Increase in transmission cost due to all above factors

Impact on existing Plant

- Lower PLF due to ducking of load curve
- High ramping requirement
- Two shifting and cycling of plants
- Increased forced outage and O&M cost
- Equipments life time reduction
- Poor heat rate and high Aux. Power

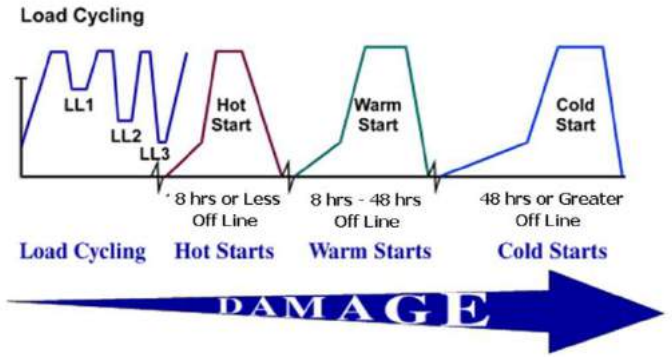
Cost of Flexibilisation

System Costs

- **Variability**
- **Uncertainity**

Generator Costs

- **Opex**
- **CAPEX**

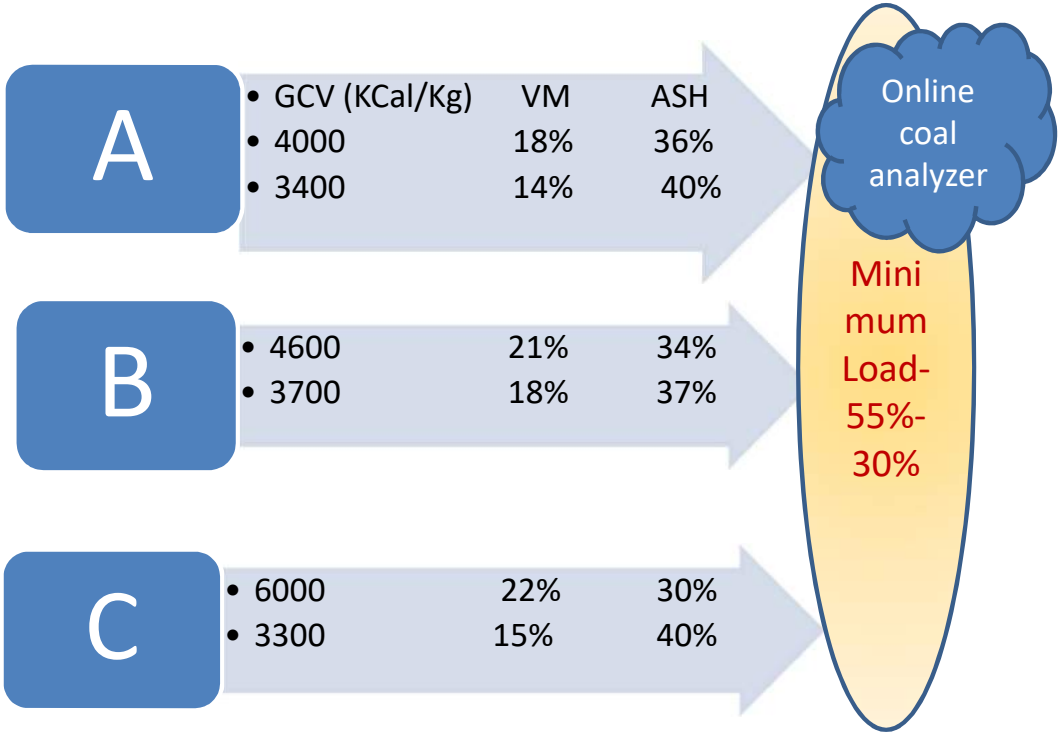


Key Facts of Cycling

- Almost any unit can be cycled.
- This can be done with minimal capital investment.
- However, we have to account for:
  - Long term penalty of increased wear & tear damage and reduced reliability.
  - Short term penalty of higher heat rate, increased O&M, training requirements, and equipment efficiency.
- Component Damage can be determined
- Understand amount of damage present
- Rate of accumulation
- Total damage before failure
- Cycling a power plant is more difficult operating mode thanbaseload operation.

Barriers to Flexiblisation

Varying Coal Quality posed a major challenge to flexibilisation



Regulatory Framework to support Flexible Operation

In India Market participation is limited
(Net Traded Energy is < 5%)
Largely under Long Term Contract arrangements(PPA)
PPAs have limited flexibility
Incentivization through regulation or market needed.

Geographical Concentration of Renewable

Transmission constraints
Curtailment of RE

Limited participation

Most of the state Utilities yet to reduce minimum load levels

Need for Capacity Building

Simulators

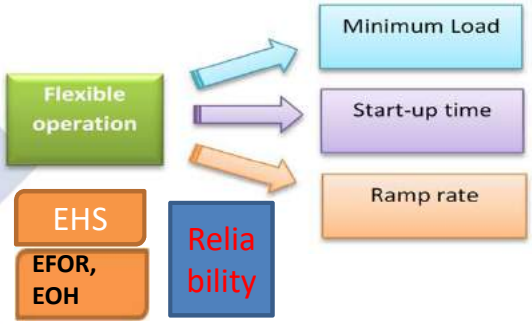
Flexibilization: Benchmarking and Preparation …for what level?

Defining
- Defining from different perspectives

Measuring
- Metrics
- Quantifying

Operational -isation
- Sources, options
- Preparedness for Coal based plants

Compensation/ Incentivisation
- Regulatory framework
- Market structure and mechanisms



Merit order based on?
- Variable Cost
- Heat Rate
- Emissions

Mechanisms for operationalization Ancillary service, DSM, AGC

Knowing the component-wise cycling costs is necessary for deciding maintenance schedules

Maintenance schedule … Retrofits/R&M..

Choosing which units to flex?

- **Units on base load**-Energy supply sources stacking to meet the total state energy need are classified as sources that will always have demand and hence shall run on max. allocated share …base load operation.
- **Flexible Units on low load & evening peak-** Daily in the evening generation from Solar would come to zero and this energy need would be satisfied by units on merit, who would run on min. load and support his evening need + portion of the demand peak.
- **Flexible Units-Daily start & peaking-** If the peak is not met by the low load and peaking units up in the merit order, then new sources shall be started daily till the balance peak need is met.

COST OF CYCLING

	Typical 500 MW Unit at present level of cycling			Typical 200MW Unit	
	Best Estimate Rs Cr	% of Normative O&M Costs (2017-18) w.r.t. Best Estimate		Best Estimate	% of Normative O&M Costs (2017-18) w.r.t. Best Estimate
Cold Start	2.6	**2.73**		0.9	**1.51**
Warm Start	1.5	**1.58**		0.5	**0.85**
Hot Start	1.25	**1.28**		0.38	**0.63**
Significant Load Follow (Recent)	0.03	**0.03**		0.5 Lakhs	**0.01**

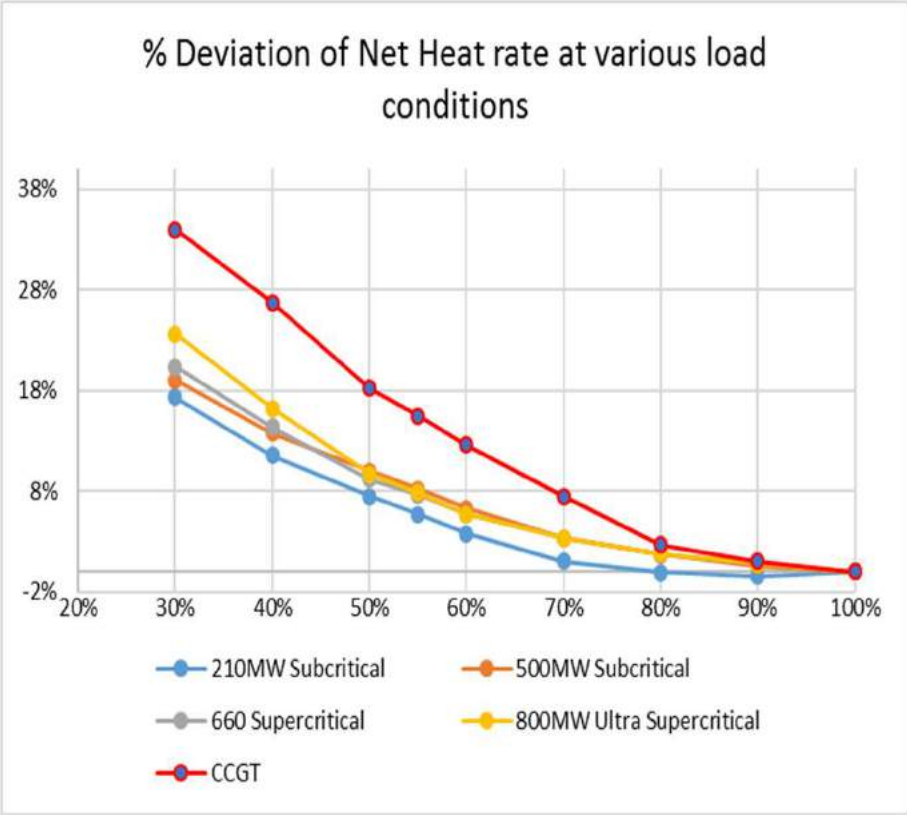
Idealized Hot Start (1 EHS) - 50 lakhs

Idealized Hot Start- 15.38 lakhs

These costs will increase significantly in the future scenario of increased cycling (with increased load ramps

COST OF CYCLING

Unit Level



Source: GE

Additional……. System Level Costs

Details of calculation for All India scenario for 2022

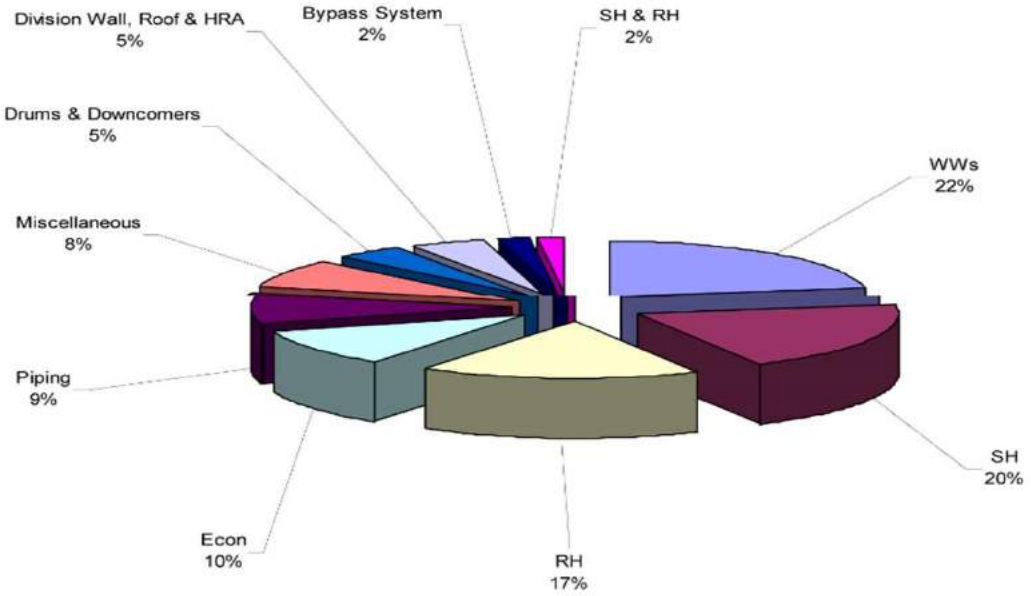
Item No.	Balancing Cost	Rs./Unit
1	Total balancing charge for Gas based station (fixed +fuel charge)(Rs/kWh)-Spread over renewable generation	0.04
2	Impact of DSM per unit- Spread over renewable generation	0.30
3	Impact on tariff (Rs/kWh) for All India discom for backing down Coal based generation assuming solar and wind at Rs. 2.50/kWh and tariff of coal based generation at Rs. 3.50/kWh- Spread over renewable generation	0
4	Stand by charge (Rs/kWh)- Spread over renewable generation	0.50
5	Extra transmission charge (Rs/kWh)- Spread over renewable generation	0.26
	Total Impact- Spread over renewable generation (Rs/kWh)	1.11

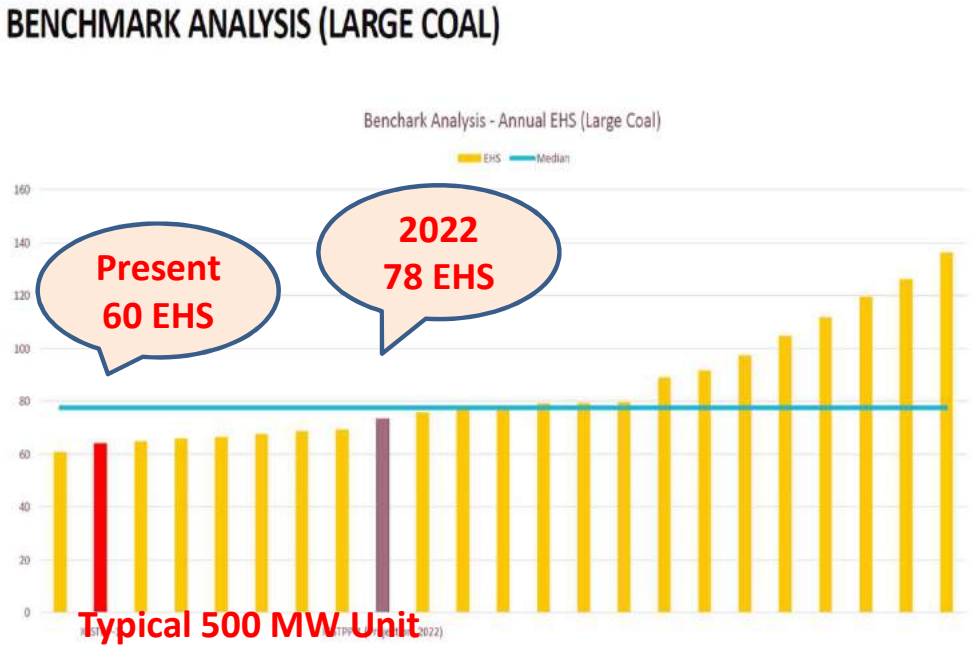
Source: CEA

Operational practices for minimising cycling damages

- Modifying start-up/shutdown ,ramping procedures to lower the component fatigue stresses
- Plant lay-up procedure
- Operations like forced cooling of boiler must be based on economics rather than maintenance requirement
- Modified chemistry monitoring
- Use of nitrogen blanketing
- Ensure deaerater heating and SCAPH during start-up
- Modifying inspection plans around cycling plants
- Tuning of auto control loops
- Judicious use of HP/LP bypass
- Sliding pressure operation
- Taking oil guns for short run may be worthwhile instead of jeopardising the integrity of
- assets
- Ensure operation of dampers,dranis and vents

Cycling Damages in boiler components-Global Benchmark





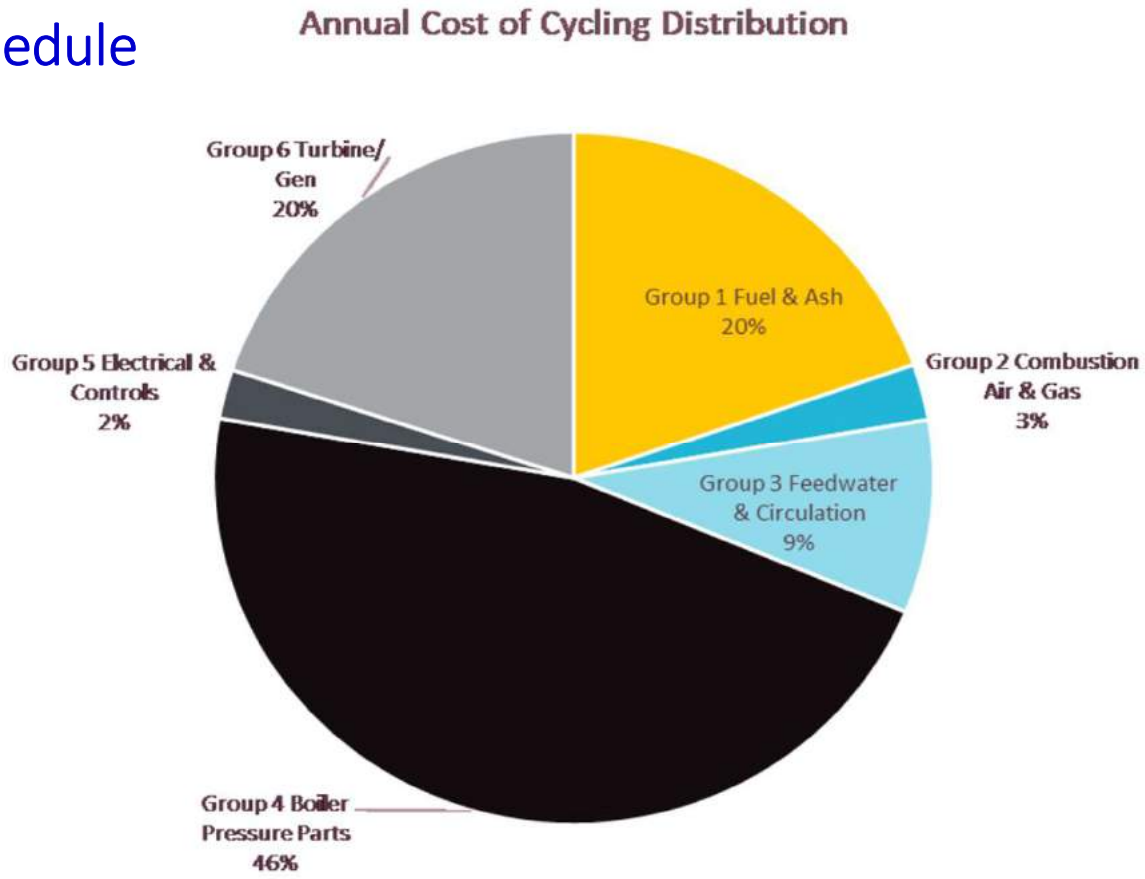
The future maintenance strategy will be required to address the increasing cycling damages. It will be based on:

- **Cycling frequency and age of unit**
- **Boiler Component/Damage ranked on most affected by cycling**
- **Inspections schedules/Corrective Actions(**anticipated repairs, and Replacements)
- **Cost benefit analysis**

Identification of the damage mechanism by examination and monitoring.
The state of knowledge of the underlying mechanism and root cause
Self-calibrating incremental damage models that can be used to forecast the effect of frequency and severity of cycling, including failure rates

Maintenance Planning, scope and schedule

- Systematic records of all components
- Optimise maintenance expenditure
- Overhauling duration, timing and scope-Greater OH frequency in later years of life and cycling
- **Failure statistics**
- **Failure faults-independent of operation**
  - Due to construction,design,operating errors etc.
- **Predictible faults and dependent on service time**
  - Wear and tear of ageing component
  - Corrosion,erosion and distortion
  - Creep and fatigue damage
  - Cycling



It is necessary to tailor the overhauling and maintenance intervals for the particular unit on the basis of data available. The analysis of component-wise cost data is important

Metrics of equivalent operating hours,EHS is helpful.

Component-wise maintenance decisions can be taken on the importance,redundancy,safety etc.

Leveraging Digitalization for supporting flexibility

Fleet wide strategy based on dynamic requirements will require require digitization of the entire commercial operations, maintenance strategy

Digitization will be essential for bringing down the levelized system cost of flexible power ,based on forecasting and AGC

- Process automation/Boiler auto tune
- Online Predictive tools for predicting failures, providing maintenance advisory, tube leakages- by profiling critical parameters
- Combustion stability advanced monitoring system
- Lifetime Monitoring and Control
- Lifetime Assessment
- Strategic Maintenance
- On line coal analyser
- Fleet monitoring
- Predictive tool for predicting Cycling costs –Enable least cost Fleet strategy
- Digitalization for additional safety
- Digitalisation of Training resources

Initiatives with International cooperation

IGEF-Task Force(coordinated by EEC)

- Studies at Dadri and Simhadri
- Test run at Dadri for 40% minimum load

USAID-GTG

- Pilot studies at Ramagundam(210 MW) and Jhajjar(500MW)

The Pilot has been structured to be conducted in two phases:

- I. Phase 1: Techno Economic Assessment and Business Case for Regulatory Approval
- II. Phase II: Implementation Process and Monitoring III.

Objective of the studies

- To enable NTPC to identify techno-economic viability of a range of plant specific, feasible options for achieving the desired levels of flexibility.
- Recommend the changes required in the power plant
- To estimate the cost of achieving flexibility including the initial capital investments required and the operations and maintenance expenses
- To provide insights to CERC on compensation for generation units as flexible units.

Collaborating with OEM/OED

- Study of start-up optimization by BHEL at Dadri
- Condensor throttling –Siemens
- Study at Talcher(Kaniha) – GE

NTPC

- Study by Engie Lab at Dadri and Farakka
- NTPC & POSOCO
- Implementation of AGC at Dadri and four other stations (NTPC & POSOCO)in process of implementation.

Conclusion

- Any unit can be flexibilised
- Moderate amount of flexibilisation can be achieved with modification of operational practices
- Higher level of flexibilisation can be achieved with retrofits and the decision should be taken on case to case basis as in some cases the retrofit cost may be prohibitive.
- R&M along with flexibility retrofits should be considered for Older Units
- The providers of flexibility must be motivated by incentivisation
- The true cost of flexibilisation must be known and benchmarked
- Broader policy and regulatory approaches to improve generation and access to thermal flexibility and ultimately energy security.
- Market and operational rules affect access to thermal flexibility
- The Stakeholders engagement including International cooperation is critical at every step

Thank You

A.K.SINHA
sinha.anjan@gmail.com
Mob:+91 9650992971