

Conference :-  
Heat Rate  
Efficiency Summit 2023

Topic :  
Heat rate Efficiency of Coal based  
Power plants

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**Council of Enviro Excellence**

**3<sup>RD</sup> HEAT RATE  
EFFICIENCY  
SUMMIT 2023**

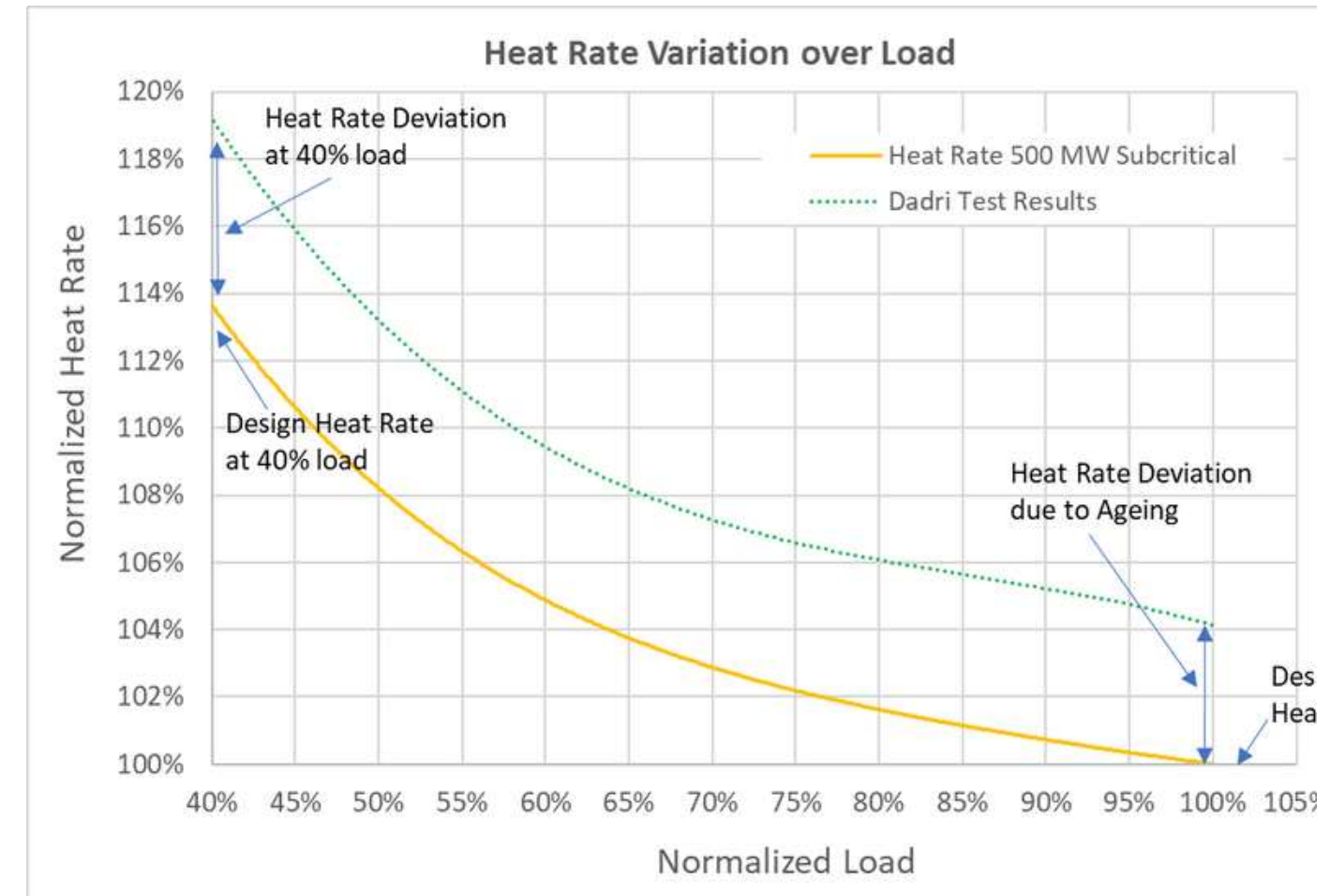


# Heat rate Efficiency of Coal based Power plants

# R&M/LE

## Objectives:

- Improve operating performance, reliability & availability to the original design values or better.
  - Increasing Boiler Efficiency.
  - Reducing Turbine Heat Rate.
  - Reducing Auxiliary Power Consumption
  - Reducing specific oil consumption
  - Improving the specific water consumption and implementation of ZLD
- Life Extension (LE) with or without uprating
- Enhancing safety requirements and Enabling cyber security
- Compliance of latest environment norms
- Flexible Operation for RE integration
- Biomass Co-firing capability as per prevailing policy/regulation



## Prerequisites

- R&M of Turbine, Boiler and all critical associated equipment shall be considered of a unit if,
  - Gross Heat rate deviations more than 15-20%,
  - higher specific fuel consumption,
  - higher auxiliary power consumption even after regular Annual Overhauling
- Feasibility of FGD retrofit and ESP modification to be ascertained.
- The cost of LE&U works shall not exceed 50% of the EPC cost of a new generating unit of indigenous origin (BHEL).
- The payback period may be limited to 7 to 8 years.

500MW		PLF= 70%			
Heat Rate	Sp. Coal	coal (kg)/day	coal saving (kg)day		
2390	0.68	5712000			
2300	0.6542	5495280	216720		
2200	0.6257	5255880	239400		
2100	0.5971	5015640	240240		
2000	0.5685	4775400	240240		

## R&M/LE Phasing Plan (148 units)

Sector	Sum of Capacity	Count of Unit No
Central Sector	17890	61
State Sector	18510	81
Private Sector	1750	6
<b>Grand Total</b>	<b>38150</b>	<b>148</b>

### Phase I (01.01.2024 to 30.06.2026)

Sector	Sum of Capacity	Count of Unit No
Central Sector	4930	20
State Sector	6480	31
Private Sector	500	1
<b>Total</b>	<b>11910</b>	<b>52</b>

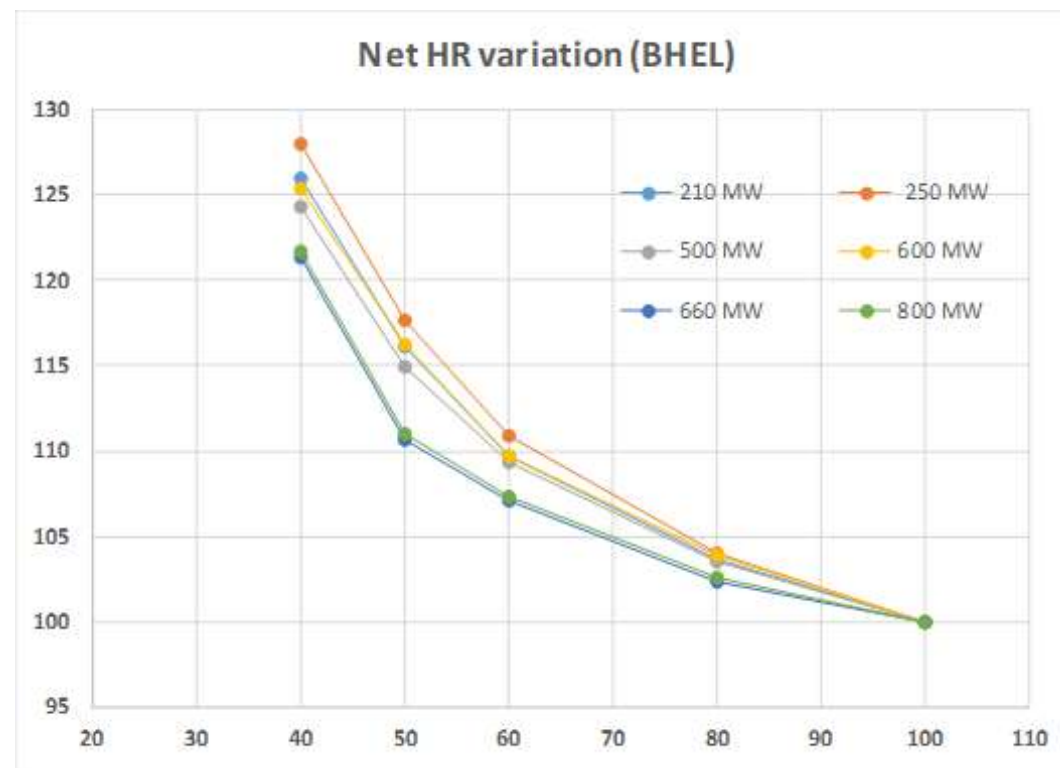
### Phase II (01.07.2026 to 31.12.2028)

Sector	Sum of Capacity	Count of Unit No
Central Sector	6940	22
State Sector	3940	16
<b>Total</b>	<b>10880</b>	<b>38</b>

Phase III (01.01.2029 to 30.06.2031)		
Sector	Sum of Capacity	Count of Unit No
Central Sector	3180	11
State Sector	5110	20
Private Sector	750	3
Total	9040	34
Phase IV (01.07.2031 to 31.12.2033)		
Sector	Sum of Capacity	Count of Unit No
Central Sector	2840	8
State Sector	2980	14
Private Sector	500	2
Total	6320	24

# Flexible Operation of Thermal Power Stations

- **CEA (Flexible operation of coal based thermal power generating units) Regulations, 2023** –Notified on 30<sup>th</sup> January, 2023
- A report on Flexiblization of coal fired Thermal Power Plants – A Roadmap for achieving **40% Technical Minimum Load** has been prepared, published and widely circulated, phasing plan for implementation is under finalization.
- 23 GW equivalent BSS capacity can be created by flexible operation
- **Compensation mechanism** for below 55% low load operation upto 40% -



Coal based capacity: 252.00 GW (as per CEA report)  
 Having difficulty below 40%: 16.00 GW (operate at 55% load)  
 2-shifting: 32.00 GW  
 Flexing of remaining capacity: 204.00 GW

## Lowering the technical minimum load of 204 GW

80% of available capacity 204 GW: 163.20 GW  
 55% generation (Ex-bus): 82.57 GW (APC 8%)  
 40% generation: (EX-bus): 59.40 GW (APC 9%)  
 Additional 23.17 GW flexible power will be available

Lowering the technical minimum load of 204 GW capacity from 55% to 40% shall provide additional 23.17 GW flexible power in the grid



# Compensation for operating a unit at 40% load

**1. Capital Expenditure:** One-time expenditure to be incurred for retrofitting of various measures to make the plant capable of low load operation. An estimated capital investment of Rs 10 crores to 30 crores for each unit shall be required depending on unit's age, size, existing plant's control & instrumentation system etc.

**2. O&M cost due to increased Life Consumption (damage costs):** Flexible operation leads to a higher rate of deterioration of plant's components. This is observed in increased failure rate and more frequent replacement of components.

**3. Cost due to increase in Net Heat Rate:** After analyzing the HBD report of major OEMs (BHEL/GE/Siemens) and actual test report of low load operation unit size wise Net Heat Rate increase including its tariff impacts has been prepared

**4. EFOR:** The additional EFOR due to regular low load operation of thermal generating units may increase specific oil consumption from 0.5 ml/kWh to 0.7 ml/kWh. Therefore 1.0 paisa per kWh may increase due to EFOR.

Unit size (MW)	Increase in tariff (paisa/kWh)			
	Capex =10 crores		Capex = 30 crores	
	Pit head	Non-pit head	Pit head	Non-pit head
200	40.33	54.55	45.45	59.67
500	33.71	47.70	35.76	49.75
660	29.73	41.91	31.44	43.62
800	28.45	40.52	29.73	41.80

## Flexibilisation phasing plan

		PILOT PHASE	PHASE I	PHASE II	PHASE III	PHASE IV		Total
			July,2024-Jun,2026	July,2026-Jun,2028	July,2028-Dec,2029	Jan,2030-Dec,2030		
		(40%)	(40%)	(40%)	(40%)	(40%)	2-shifting(age>40 yrs)	
CENTRAL	UNITS	5	28	27	11	43	36	150
	CAPACITY(MW)	2490	17510	11850	4730	16850	9910	63340
STATE	UNITS	4	27	23	34	45	49	182
	CAPACITY(MW)	2760	15910	10480	10590	11810	9915	61465
PRIVATE	UNITS	1	41	65	36	14	4	161
	CAPACITY(MW)	600	20960	31035	12055	6420	862	71932
TOTAL	TOTAL (UNITS)	10	96	115	81	102	89	493
	TOTAL (Capacity)	5850	54380	53365	27375	35080	20687	196737
					BALL & TUBE	UNITS		34
						CAPACITY(MW)		8950
					CFBC	UNITS		54
						CAPACITY(MW)		6001
					Opted for 2 shift Operation	UNITS		6
						CAPACITY(MW)		377.5
					GRAND TOTAL	UNITS		587
						CAPACITY(MW)		212065.5

# FGD Installation

<b>General Summary (MW)</b>													
S.No.	Sector	Total (MW)	CFBC	Claims SO2 compliance	Retired	Feasibility study not started	Feasibility Study started	Feasibility Study Completed	Tender specification made	NIT issued	Bid opened	Bid Awarded	FGD installed
1	Central	67250	750	0	430	0	210	0	0	1110	2390	58710	3650
2	State	67741.5	1075	0	1004	0	2437.5	10430	5050	19095	9940	18710	0
3	Private	76528	4101	1430	0	1370	6430	6395	5730	7240	11342	25540	6950
	Total	211519.5	5926	1430	1434	1370	9077.5	16825	10780	27445	23672	102960	10600
<b>General summary (No. of units)</b>													
S.No.	Sector	Total (No. of units)	CFBC	Claims SO2 compliance	Retired	Feasibility study not started	Feasibility Study started	Feasibility Study Completed	Tender specification made	NIT issued	Bid opened	Bid Awarded	FGD installed
1	Central	168	4	0	3	0	2	0	0	6	11	133	9
2	State	221	7	0	7	0	11	38	16	72	22	48	0
3	Private	211	42	6	0	2	24	16	13	18	29	46	15
	Total	600	53	6	10	2	37	54	29	96	62	227	24

# ESP Upgradation

<b>General Summary (MW)</b>							
<b>S.No.</b>	<b>Sector</b>	<b>Total (MW)</b>	<b>Retired</b>	<b>ESP upgradation planned</b>	<b>ESP upgradation under progress</b>	<b>Compliance expected post FGD installation</b>	<b>Complying</b>
1	Central	67250	430	750	1470	2000	62600
2	State	67741.5	1004	6955	4070	7800	47912.5
3	Private	76528	0	5689	500	11025	59314
	<b>Total</b>	<b>211519.5</b>	<b>1434</b>	<b>13394</b>	<b>6040</b>	<b>20825</b>	<b>169826.5</b>
<b>General summary (No. of units)</b>							
<b>S.No.</b>	<b>Sector</b>	<b>Total (No. of units)</b>	<b>Retired</b>	<b>ESP upgradation planned</b>	<b>ESP upgradation under progress</b>	<b>Compliance expected post FGD installation</b>	<b>Complying</b>
1	Central	168	3	4	7	4	150
2	State	221	7	30	14	31	139
3	Private	211	0	35	4	38	134
	<b>Total</b>	<b>600</b>	<b>10</b>	<b>69</b>	<b>25</b>	<b>73</b>	<b>423</b>

# Combustion Modification

<b>General Summary (MW)</b>							
<b>S.No.</b>	<b>Sector</b>	<b>Total (MW)</b>	<b>Retired</b>	<b>Feasibility study started</b>	<b>Combustion Modification Planned</b>	<b>Combustion Modification under progress</b>	<b>Complying</b>
1	Central	67250	430	15820	4660	1410	44930
2	State	67741.5	1004	8270	4740	7780	45947.5
3	Private	76528	0	5535	14289	2250	54454
	<b>Total</b>	<b>211519.5</b>	<b>1434</b>	<b>29625</b>	<b>23689</b>	<b>11440</b>	<b>145331.5</b>
<b>General summary (No. of units)</b>							
<b>S.No.</b>	<b>Sector</b>	<b>Total (No. of units)</b>	<b>Retired</b>	<b>Feasibility study started</b>	<b>Combustion Modification Planned</b>	<b>Combustion Modification under progress</b>	<b>Complying</b>
1	Central	168	3	24	13	3	125
2	State	221	7	16	17	24	157
3	Private	211	0	19	60	6	126
	<b>Total</b>	<b>600</b>	<b>10</b>	<b>59</b>	<b>90</b>	<b>33</b>	<b>408</b>

Thank you

## Heat rate = output (kWh)/ input (coal)

- Combustion efficiency
- Boiler efficiency
- Turbine efficiency
- Generator efficiency
  - Inadequate combustion
  - Inefficient heat transfer
  - Below optimal performance of turbine
  - Below optimal performance of generator

Heat rate or efficiency degradation may be due to many reasons:

- Ageing – go for R&M
- Increased auxiliary consumption – go for R&M
- Deterioration in quality of coal as compared to design coal – solution, wash coal
- Part load operation- flexible operation

An increase in heat rate means more coal consumption to produce 1kWh energy which is less efficient

## Objectives of R&M

### Guiding principles

Guidelines for choosing the candidate plants for R&M/LE

Viable Business Model

Preparation of Bidding Documents for R&M

### Time Taken/Schedule for Completion Of R&M works:

The following time frame may be adopted for implementing the R&M/LE with or without uprating works-

- Appointment of consultant by utilities & RLA/ Energy Audit – 3 to 6 months.
- Assessment study after RLA study and Preparation and approval of DPR Freezing the scope of work/activities and – 2 to 3 months
- Placement of order – 3 to 6 months.
- Engineering, Manufacturing and Supply – 12 to 15 months
- Shut down of unit – **3 to 8** months depending on the scope of work.
- Implementation time after Placement of order– **18 to 29** months.
- PG test of unit/boiler/turbine– within 3 months after successful commissioning of Unit.

**Best O&M practices** that enhance asset management and protect the life of power plant equipment to the desired life cycle of 25 to 30 years.

**O&M managers** need to be very careful about impact of frequent outage, cold startup, beyond the design limit operations etc.

**Water chemistry of plant assets:** maintaining & monitoring water parameter such as sodium, silica, pH, dissolved oxygen etc. If there are any deviation of water chemistry parameters, it may cause metal to overheat, corrosive wall thinning and localized pitting which may lead to premature boiler tube leakage.

Thanking You  
on Behalf of!



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