



एनटीपीसी
NTPC
A Maharatna Company

Corporate
Centre

Flexible Operation in Coal based Stations



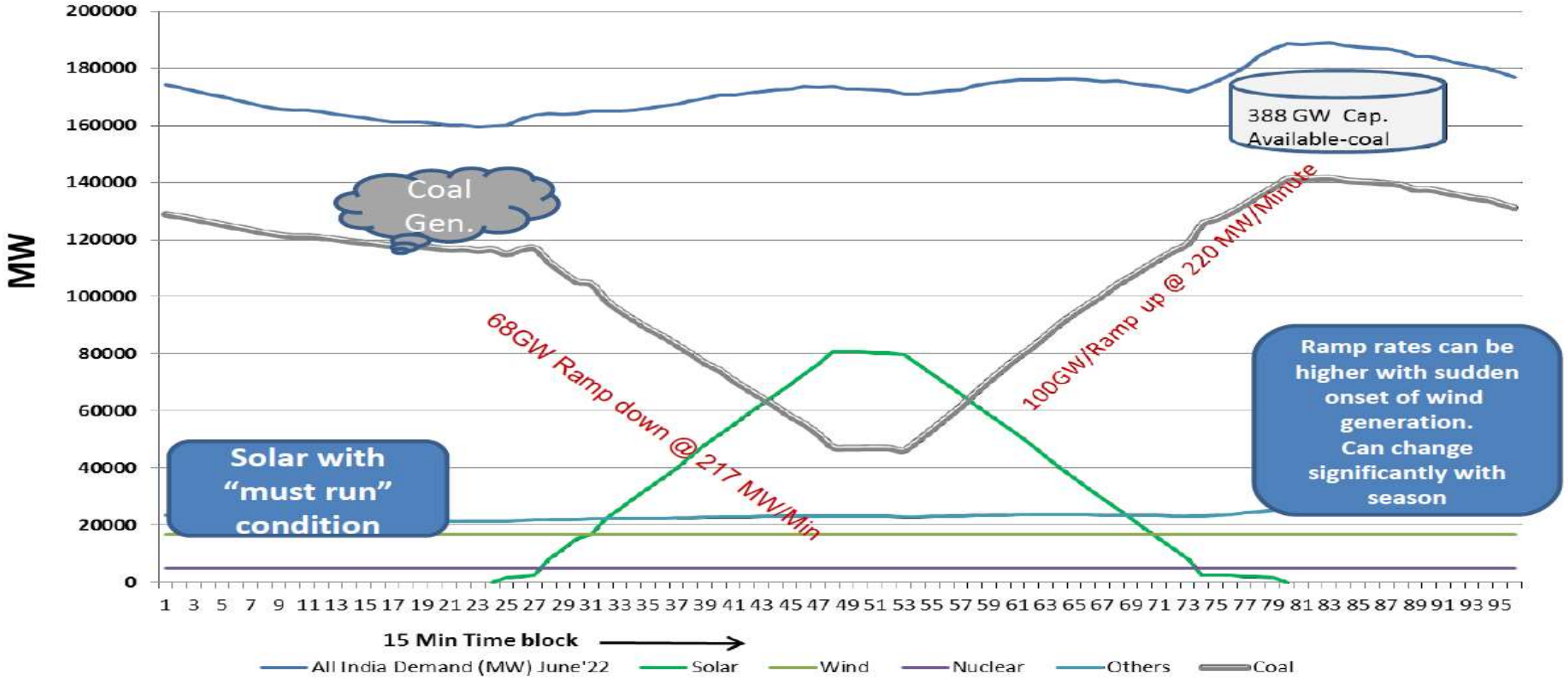


Need for Flexible Operation for Coal Station

- Growth in Renewable Energy expected from ~70GW presently to 175GW by 2022.
- Generation of Renewable Energy is unpredictable to different weather conditions.
- Limited availability of Hydro, Pumped Storage & availability of Gas for Gas based Station.

Anticipated Indian Scenario in 2022

with 100 GW Solar & 60 GW Wind



Background of flexible operation

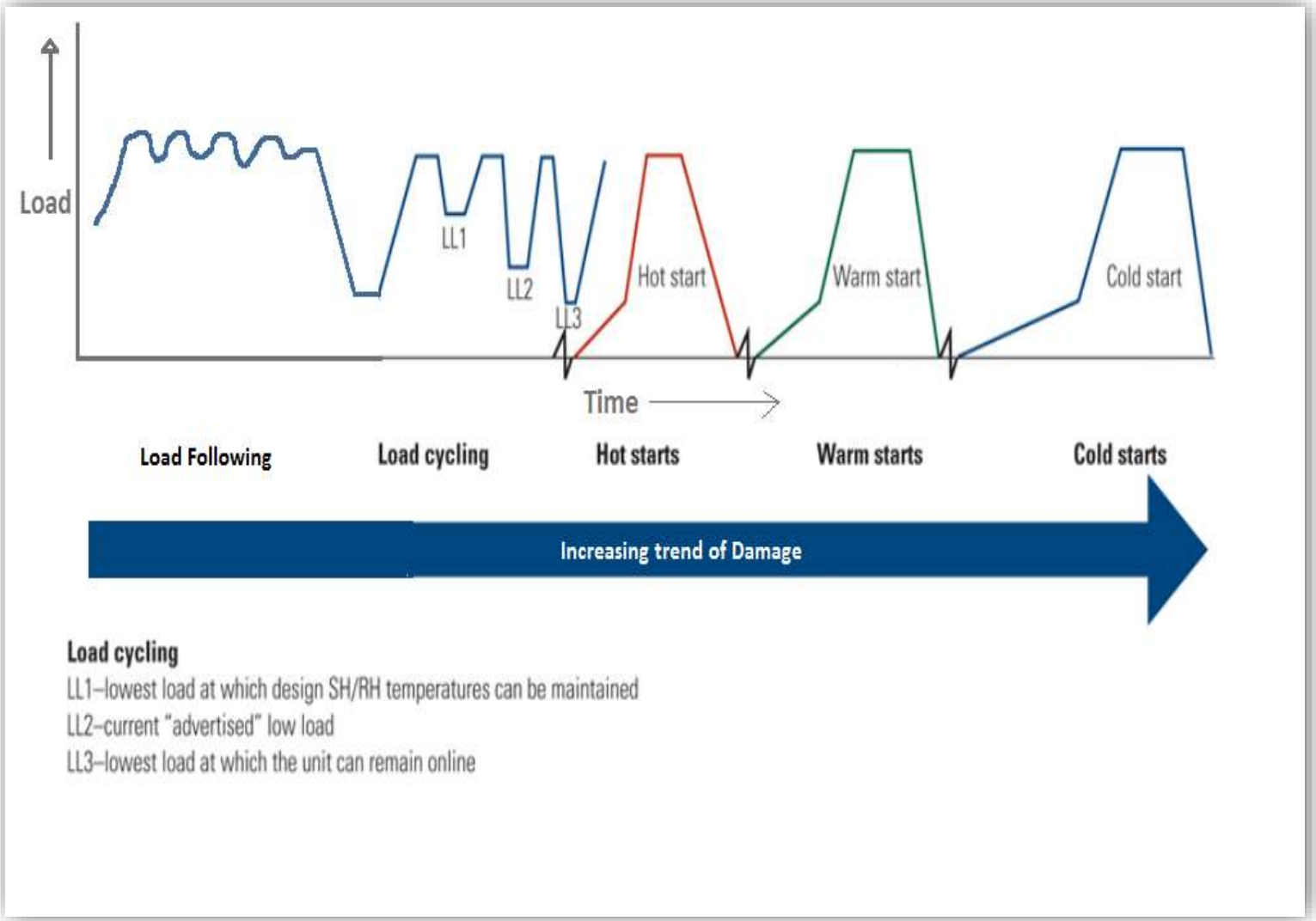
1. Limited flexible operation/Capabilities available in the present system.
    a. Coal Plants provides flexibility to grid by lowering load up to 55 % (Technical Minimum as per CERC) without compromising on performance parameters but at a much slower ramp rate of 0.5% per min. For a 500 MW unit.
2. Limited ancillary Services available for grid operation
    a. Pilot Project of AGC implemented at Dadri & Simhadri only.
    b. Present primary response reserves are not adequate. It is being followed only in ISGS Generating Stations.
    c. Present ancillary services focus mainly on Frequency Control (No regulatory measures for Voltage & MVAR).
    d. No ancillary services based market product available in exchange.
3. No Consideration of emission changes from flexible operation of plants in existing emission regulations

Type of Cycling on Thermal Plants

What is Cyclic operation ?

- Start up/Shut down (Hot/Warm/Cold)
- On load cycling (LL1,LL2,LL3)
- High frequency load variations (RGMO/AGC)

- Thermal fatigue combined with creep is the main cause of damage.
- Cyclic load variations within SH/RH temp. control range may be tolerable
- Start/stops are the severest in terms of life consumption



Test Run at Dadri Station for low load Opeartion

- A team of experts from EEC, Siemens and VGB carried out test runs in unit 6 of the NTPC Dadri power plant jointly with the local operations team.
- The aim of the tests to run 500 MW block with a minimum load of 40% & it was successfully demonstrated by running the unit safely for five hours with a load of 200 MW.
- The test team was also able to drive load ramps of 15 MW/min (3% ramp rate) successfully in the range of 200 to 500 MW.

Systematic Ramp down

LOAD(%) RAMP DOWN	MAJOR ACTION TAKEN	OBSERVATION	REMARK
420 MW(84%)	One Mill Cut Out	MS TEMP maintaining high Eco outlet o2% =3.1%	Steam temp fluctuation
330MW(66%)	2ND Mill Cut out	HRH steam temp maintaining low	Steam temp fluctuation
280MW(55%)	4 Mill in service	One TDBFP recirculation valve opened and due to Feed water flow imbalance Drum level dipped HRH steam temp maintaining low Flame intensity <35%	Drum level fluctuation Steam temp fluctuation
250MW(50%)	One TDBFP was withdrawn	Super heater temp after de-superheater is less than Sat temp(alarm) Delta T left and right after de-superheater >20degc	Flame intensity stable Steam temp fluctuation
230MW(46%)	3RD Mill was cut out	Flame intensity improved, Flue gas temp after APH was <113 deg C at SAH and <108degc at PAH outlet	Flue gas temp of 108°C is below the acid dew point which is approx. at 122°C as per a sulfur content of 0.3%. This situation will lead to corrosion within the flue gas duct and ESP
200 MW(40%)	O2% increased to 4.3% to improve mill outlet temp and windbox to furnace DP Single BFP and 3 mills in service	Mill outlet temp improved >70 degc Flame intensity remaining the same	**FW Flow and drum level fluctuation , flue gas temp running below acid dew point causing potential for corrosion** **Steam temp parameter fluctuating**

Recommendation given by M/S Siemens in I&C

- **Automatic Mill Operation (Mill Scheduler)**
- **Main Steam Temperature Control**
- **Reheat Steam Temperature Control**
- **Automated Start of Fans and Pumps**
- **Flue Gas Temperature Control**
- **Modulating Recirculation Valve Across Boiler Feed Pump**

Condition Monitoring System

- **Thermal feasibility study and Fatigue monitoring**
- **Condition monitoring**

  Boiler Fatigue Monitoring System

  EOH (Equivalent Operating Hours)

  ESH (Equivalent Start up Hours)

Optional Activities

Recommended to improve the operability of the power plant in the long term.

- **Advanced Unit Control**

  Condensate throttling is a proven measure for Primary Frequency Control, enabling a quick increase in turbine power in case of a steep reduction of grid.

  This concept already has been successfully implemented in the Dadri power plant. The response time of 20 seconds for 7% power increase at 100% load has been achieved through condensate throttling at NTPC Dadri.

- **Combustion Optimization using an Online Coal Flow Measurement**

  Imbalances occurring during minimum load operation can be detected and balanced.
  Optimized air/fuel ratio in all load conditions can be ensured at all load conditions.

Optional Activities

Blade Vibration Monitoring System

- To prevent damage by nforming and warning the operator about the stressing operating condition so as to avoid it.
- For calculating the remaining service lifetime of each blade at nominal speed.

- **Efficiency Improvement Through Top Heater**

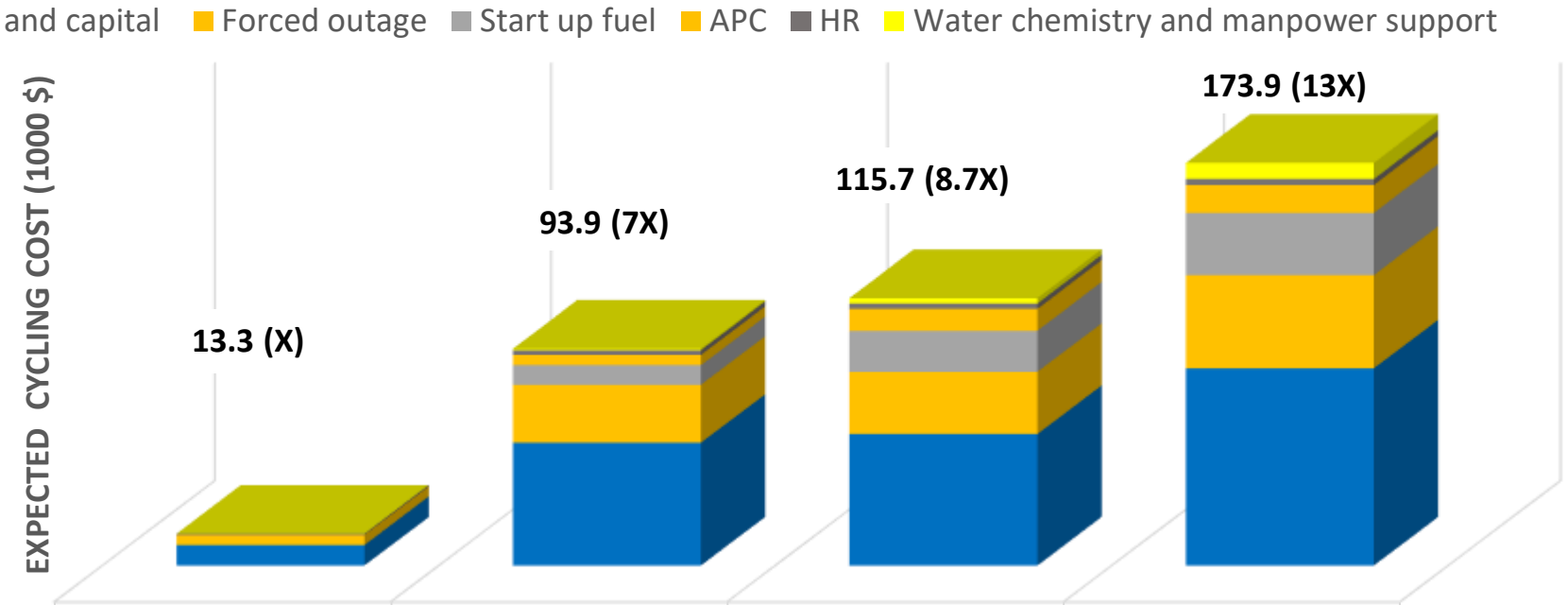
  The installation of a top heater on top of the existing preheater would help maintain the final feed water temperature at higher levels and would improve the performance. The heater gets activated in part load.

Cost of cycling to Generating Companies

- Modification cost required for making units cyclic ready
- Loss of useful life
- Increased O&M expenses
- Start up fuel cost
- Loss of availability due to forced outage
- Poorer heat rate
- Increased Aux. Power Consumption

Comparison : Cost to Cycle a Unit, Per Operation

Warm and cold starts are the most damaging for units. Whereas load following up to technical minimum is the least damaging.



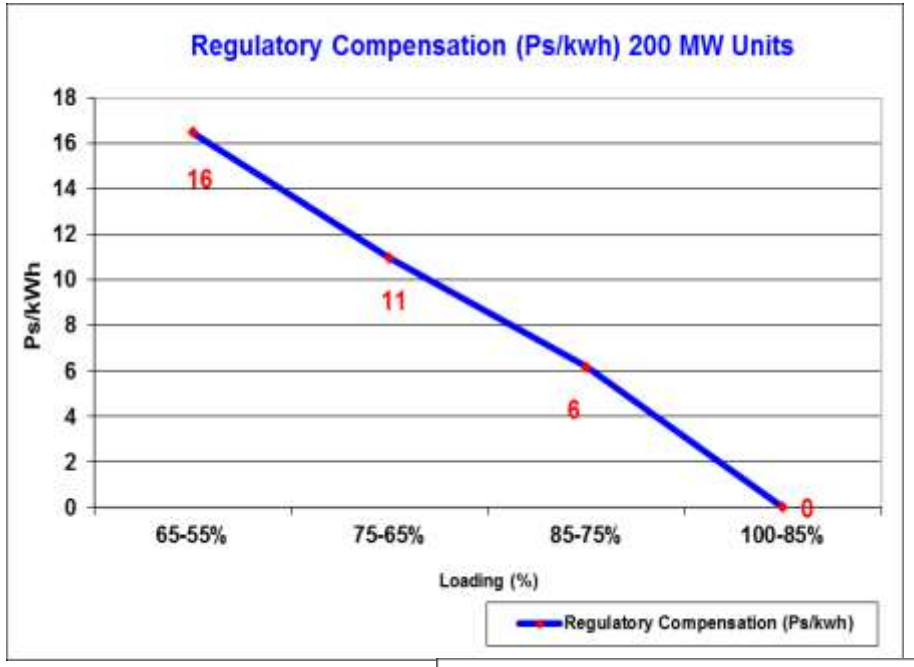
	Load follow down to 180MW	Hot Start	Warm Start	Cold Start
Water chemistry and manpower support	0	0.6	2.3	6.9
HR	0.5	2.1	2.3	2.6
APC	0.5	4.4	9.4	12
Start up fuel	0	8.5	17.8	26.8
Forced outage	3.9	25.1	26.9	40.2
Maintainance and capital	8.9	53.2	57	85.4

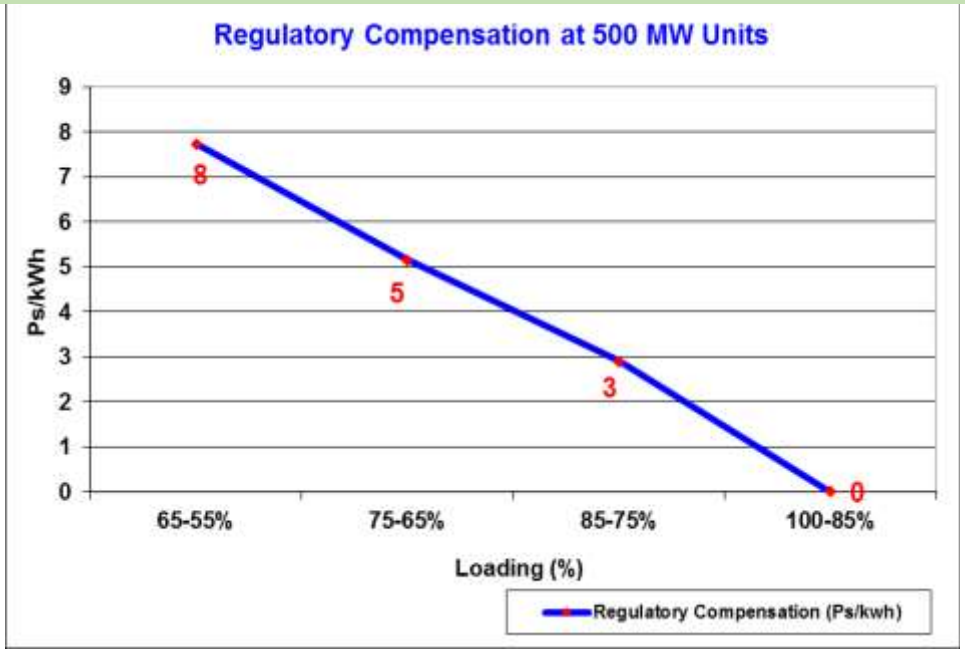
Capex – One time cost for minimum load operation

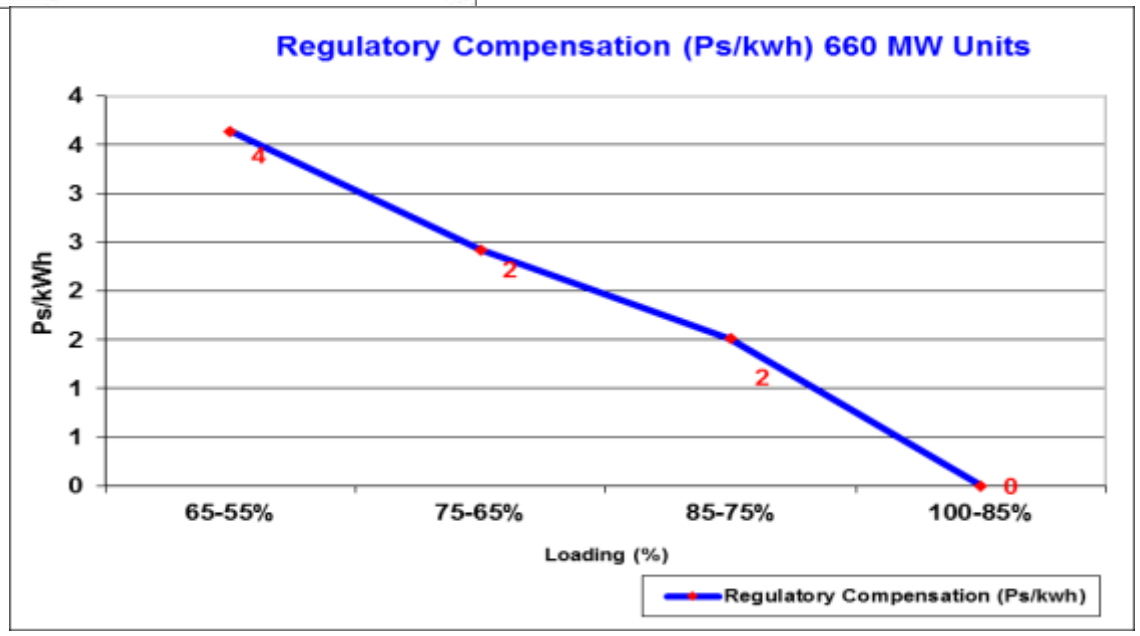
At NTPC Dadri (500 MW) 40% Technical minimum: Rs. 6.8 to 18 Crore per Unit (as per IGEF Study)
Cost of interventions for below 40 % load will be significantly higher.

Based on OED's Proposal (SIEMENS and GE) for implementation of measures of flexibilisation is
Approximately 20 to 50 Crores based on the interventions required

Present Regulatory compensation on OPEX







Conclusion

Actual Cost of Generation(Cyclic Load)= Cost of generation (Base load) + Integration Cost

- **Assessment of true cost of cyclic damages of equipment**
- **Cyclic cost along with higher fuel cost impact the generators at part load**
- **Units ranked poor in merit order may be subjected to higher frequency of cycling**
- **Regulatory compensation provision is inadequate at present**