



Workshop on
“Flexible Operation of Thermal Power Plant:
A Bridge to Decarbonized Energy System”

GRID MANAGEMENT

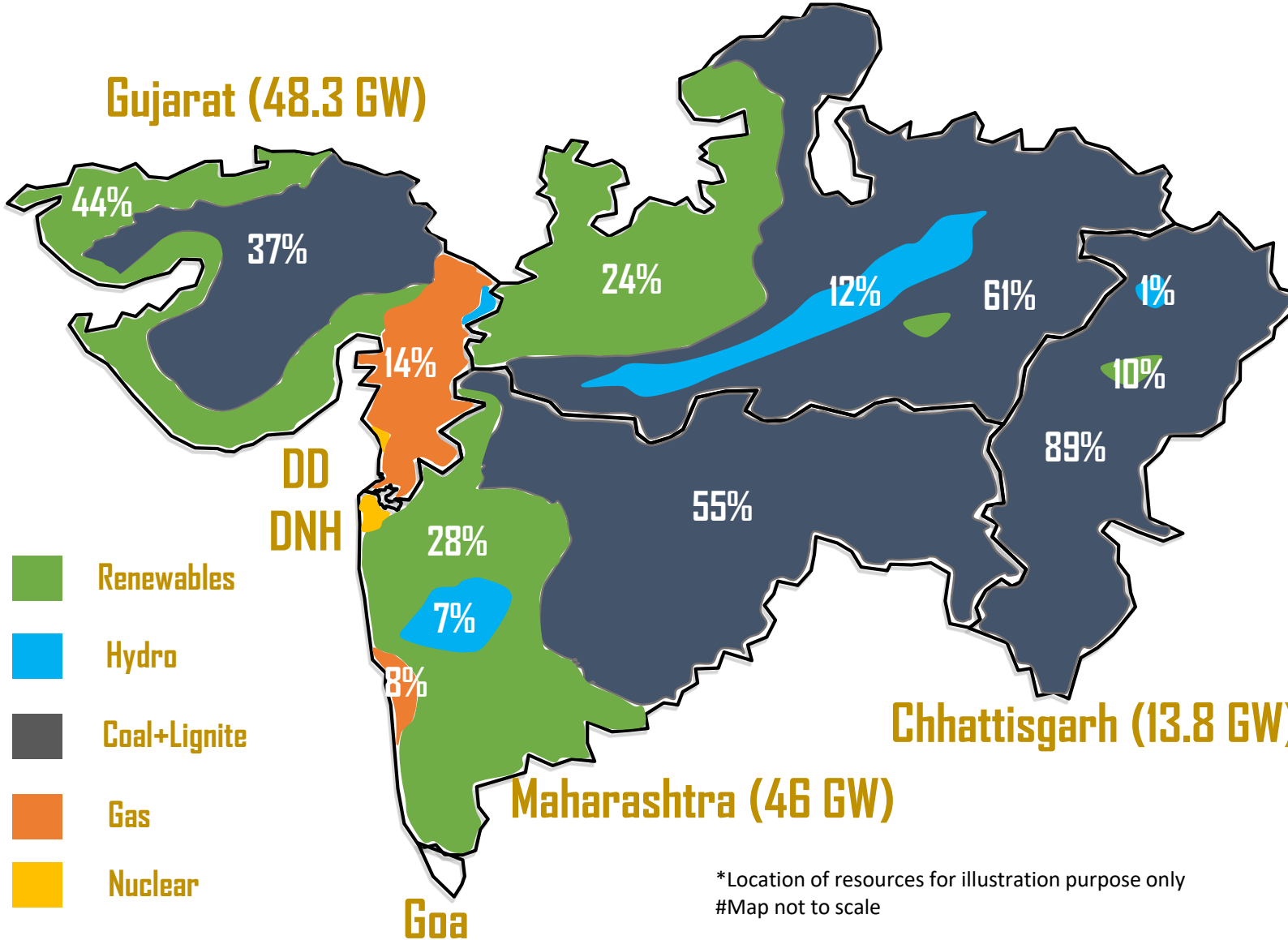
WRLDC

At the bottom of the slide, there are several horizontal bars in shades of pink, blue, and teal, serving as a decorative footer.

WR Installed Capacity

Madhya Pradesh (25.9 GW)

Gujarat (48.3 GW)



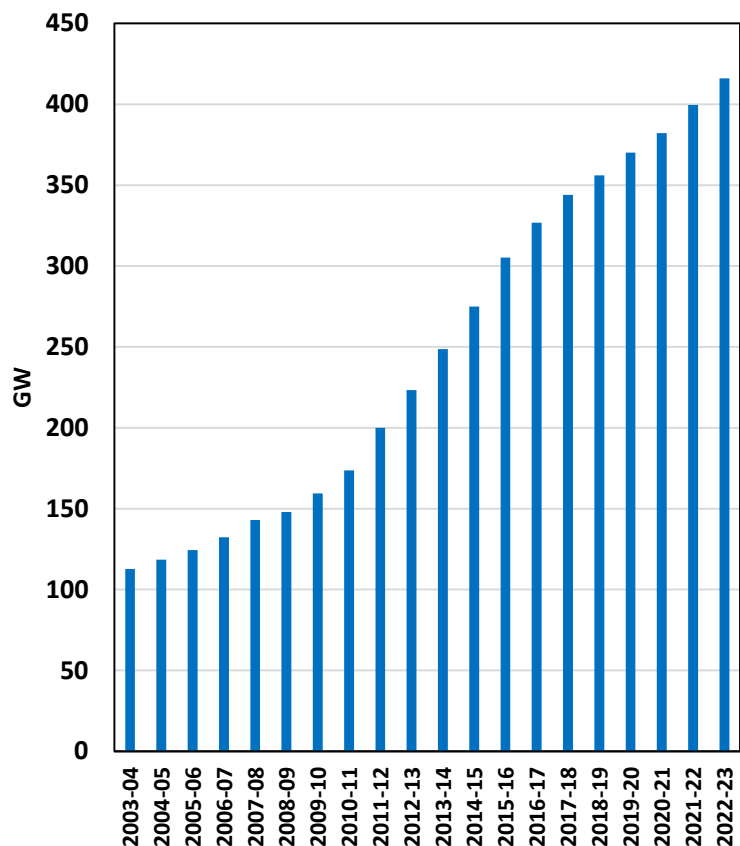
Type	WR Installed Capacity		All India Installed Capacity	
	GW	%	GW	%
Renewables	42.06	30	131.5	31
Hydro	7.56	5	46.9	11
Coal+Lignite	76	55	212.5	50
Gas+Diesel	10.8	8	25.4	6
Nuclear	2.54	2	7.5	2
Total	139	100	424	100

*Location of resources for illustration purpose only
#Map not to scale

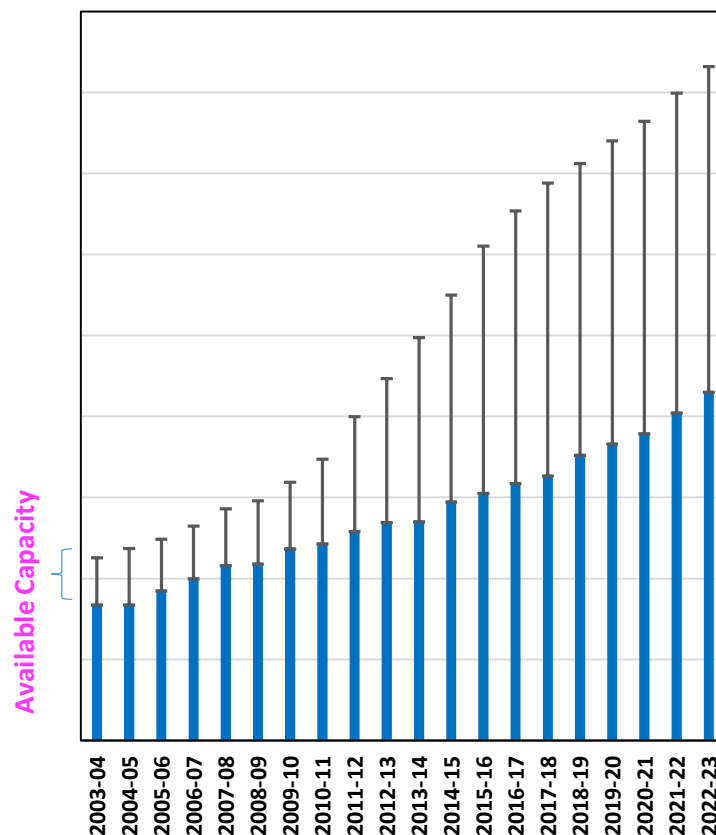
*Aug'23

Capacity and Demand

Installed Capacity



Peak Demand



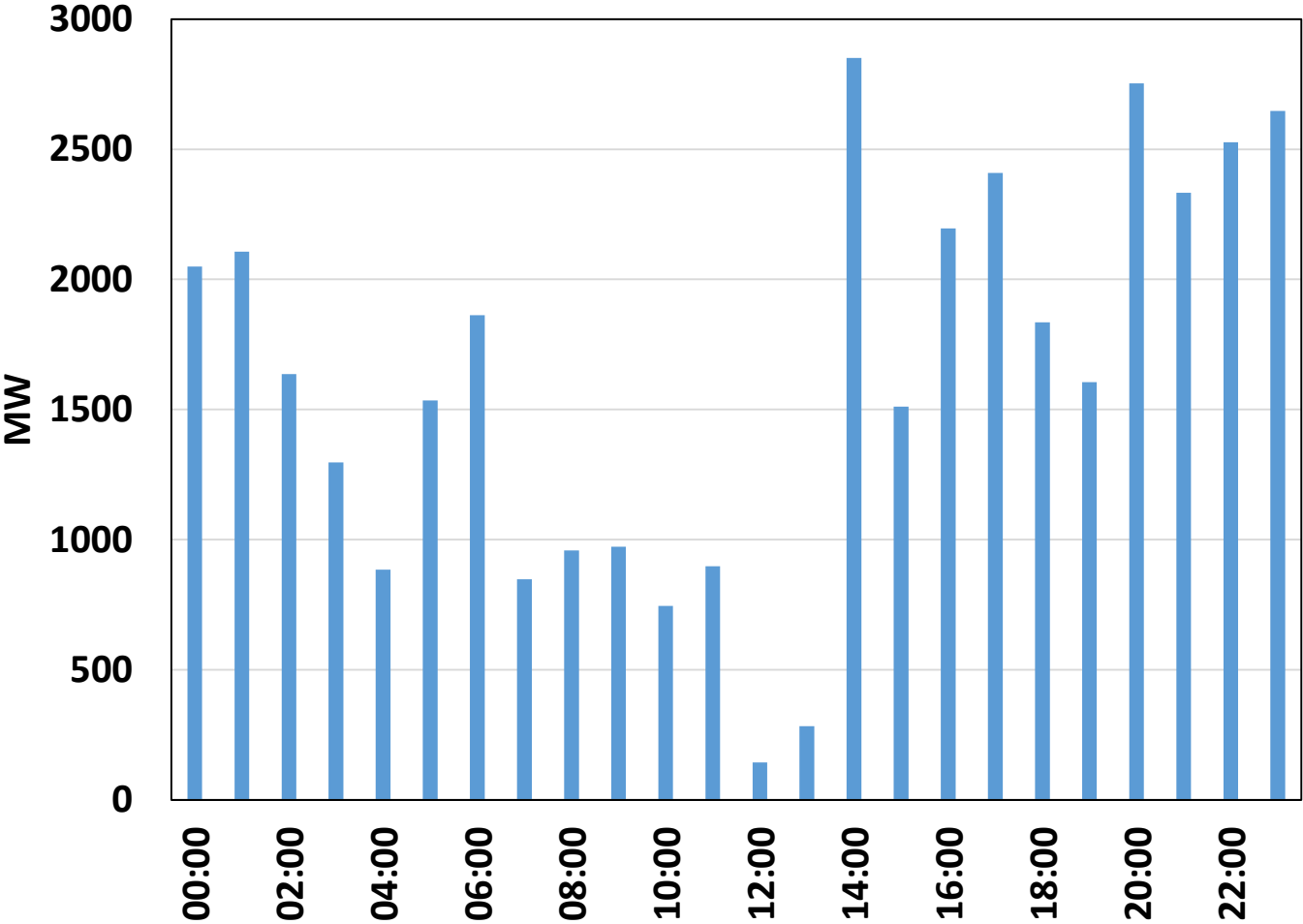
CEA 2023-24 LGBR

“As per this LGBR, the country is likely to experience energy surplus of 3.6% and peak surplus of 0.7%. ”

“The estimated surplus would reasonably take care of any contingency arising out of increase in power demand under impact of the weather conditions and any unforeseen outage of generating units.”

Power Cuts

WR Hourly Shortage on 2 Sep 23 (Highest Demand)



Power Cuts

“The country saw a record peak shortage of 9.11 gigawatts (GW)—or over 4% of the peak demand—On 21 August, when peak demand was 226GW. Generation outage, or the unoperational generation capacity, stood at 51.65GW that day.

A few days ago, on 17 August, peak demand hit a record 234GW, with a peak shortage of over 7GW.”

30 Aug 23, livemint

Contributing factors



Spike in Demand

- Power Demand growing rapidly
- Strong Economic growth
- Max demand has hit 240 GW and above

Hydro & Wind

- Sudden spike in electricity during monsoon
- Low rainfall lead to share of plunging of hydro power
- Intermittency of wind

Gas Capacity

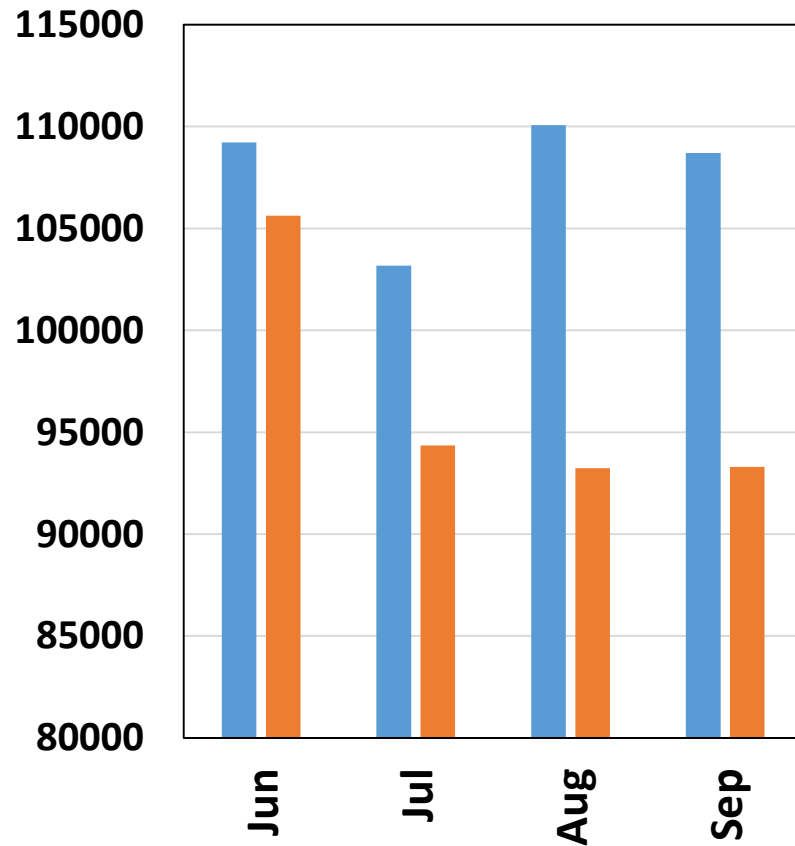
- Requirement of additional volumes of natural gas
- Bids to supply gas fired stations to address unusually high electricity demands
- Onus of meeting Non-solar hour demand on coal stations

Thermal and Hydro

Thermal and Hydro Injection

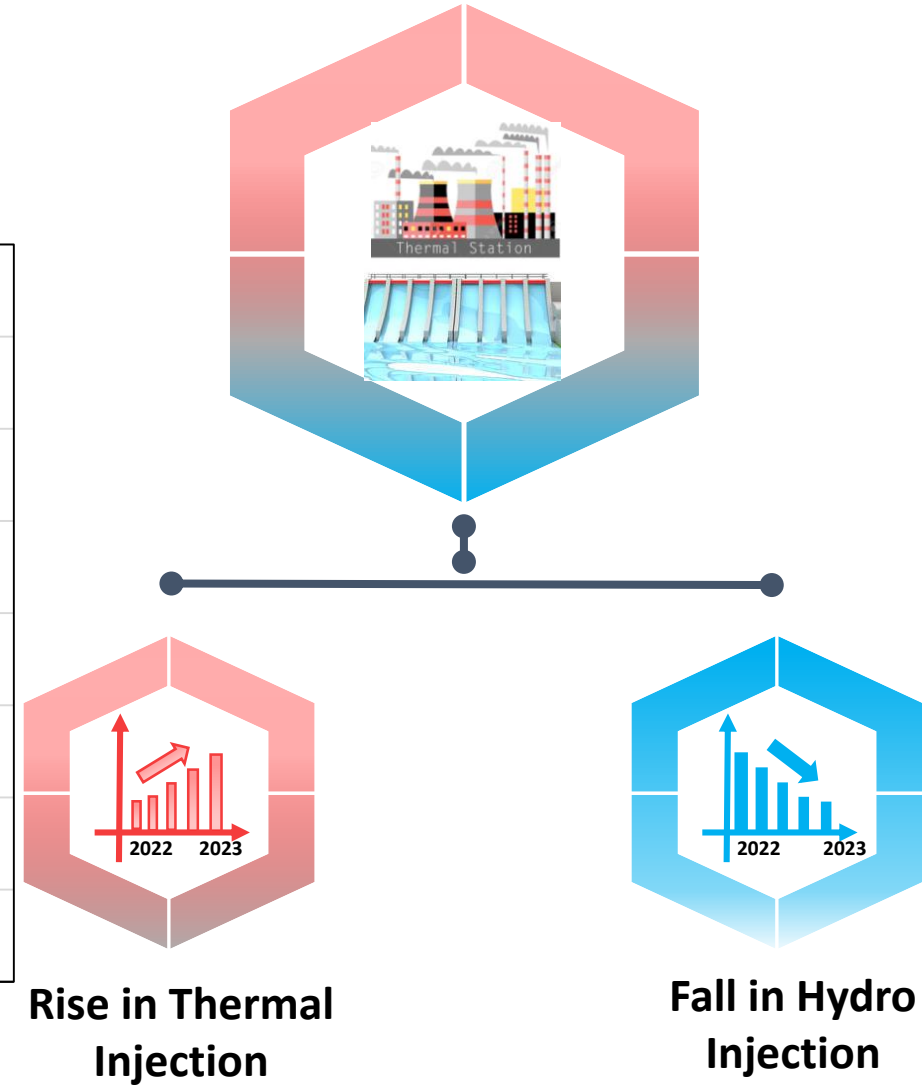
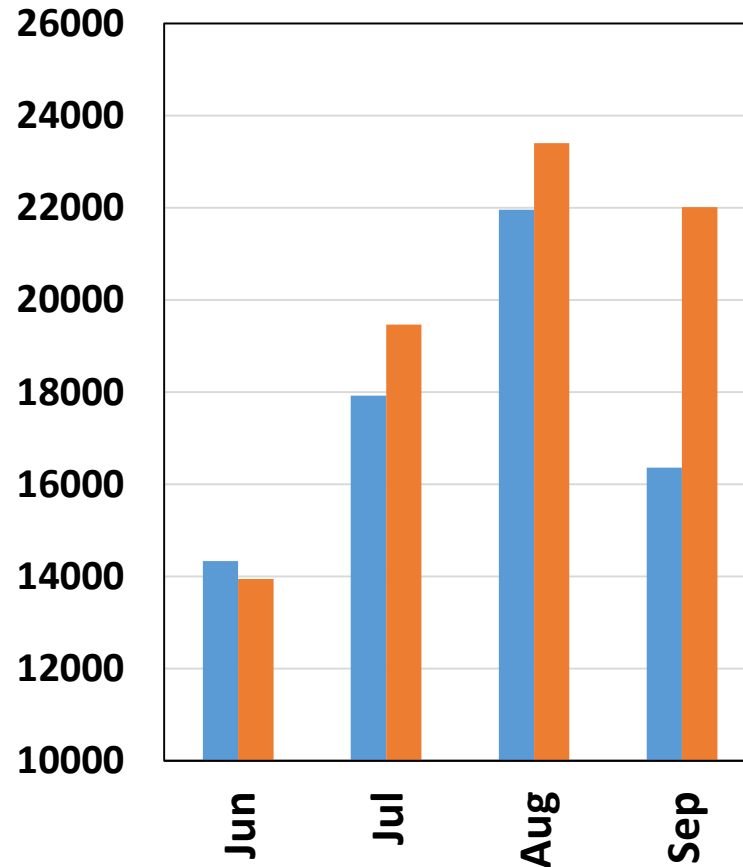
All India Thermal Injection

- Thermal Generation 2023
- Thermal Generation 2022



All India Hydro Injection

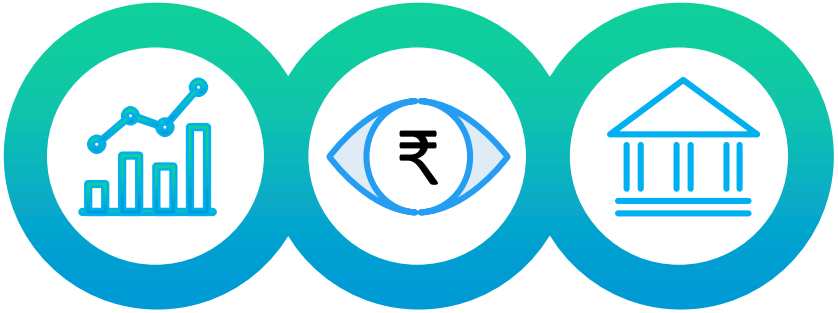
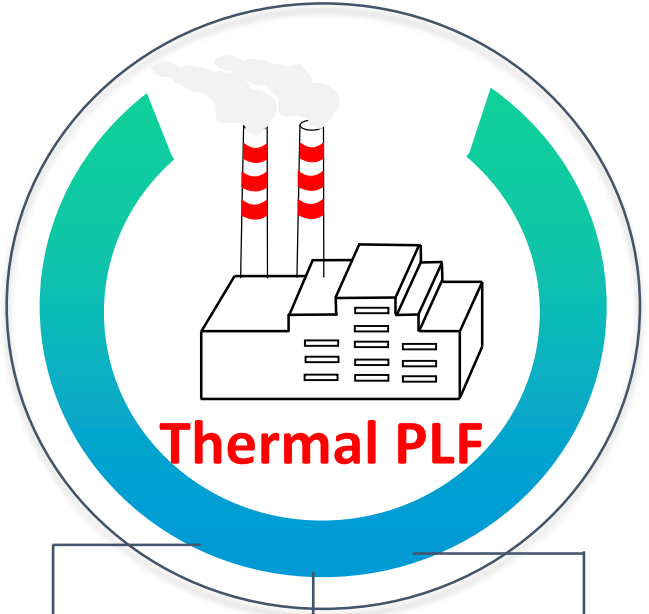
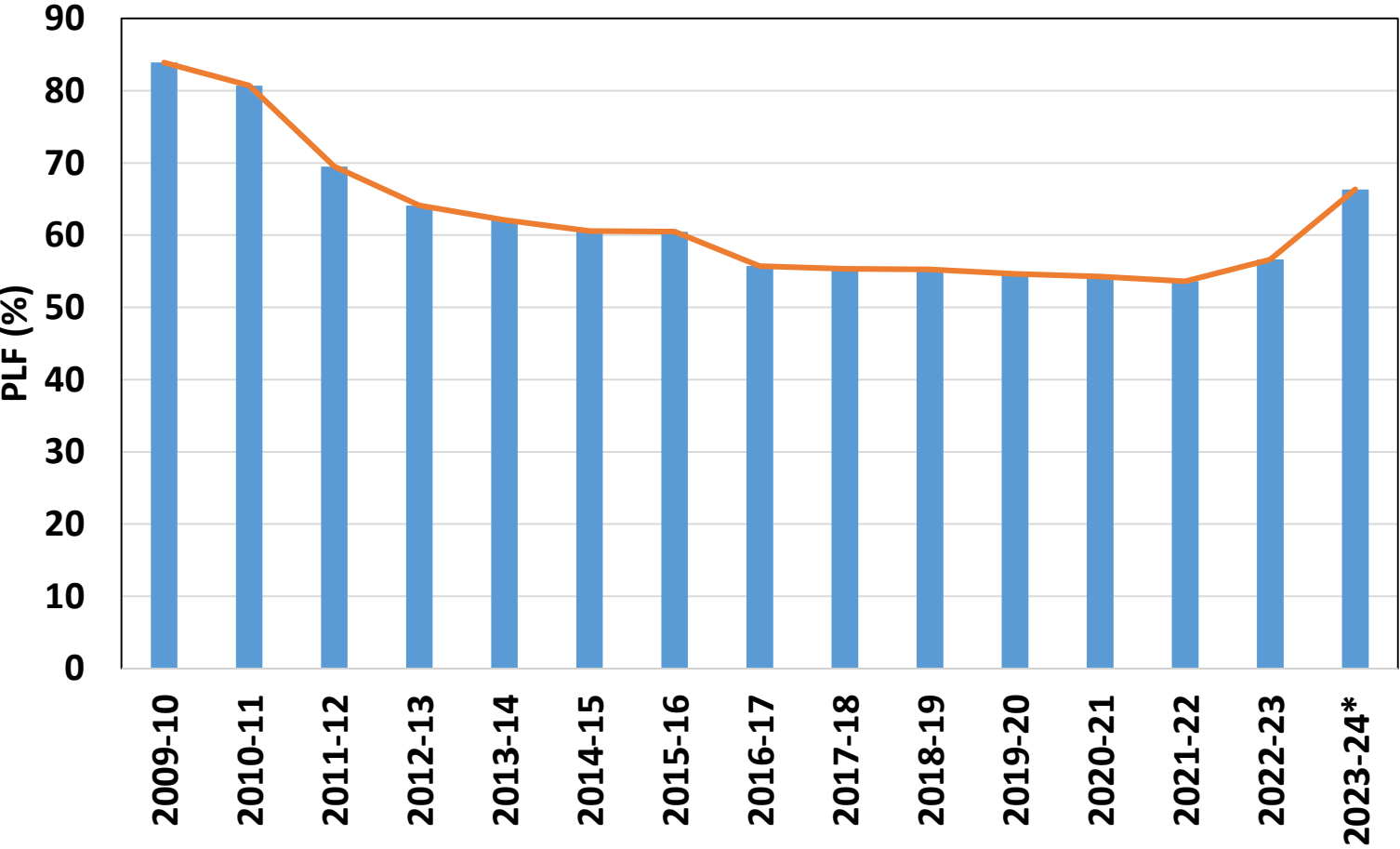
- Hydro Generation 2023
- Hydro Generation 2022



Thermal PLF

PLFs of Thermal Generation

PLF of Thermal Generation



Low PLFs
aren't
constant

Thermal
remains
Cheapest &
reliable

Base Load
from
Thermal
apart from
Nuclear

Flexibility

Flexibility of Thermal Generation

Load Curve of NTPC Thermal Generation (WR)
High Demand Day in WR_1 Sep 23

Ramp per minute NTPC_Gen



Load Curve of NTPC Thermal Generation (WR)
High Wind Day in WR_7 Aug 23

Ramp per minute NTPC Generation



- **Comparison of Load curves on thermal generation on high wind day and high demand days**
- **On High demand day: Loading ~ 90-100% of on bar capacity, Ramp rate: 1% of on bar capacity**
- **On High wind day: Loading ~ 60-80% of on bar capacity, Ramp rate: 3-4% of on bar capacity**

Flexibility of Thermal Generation

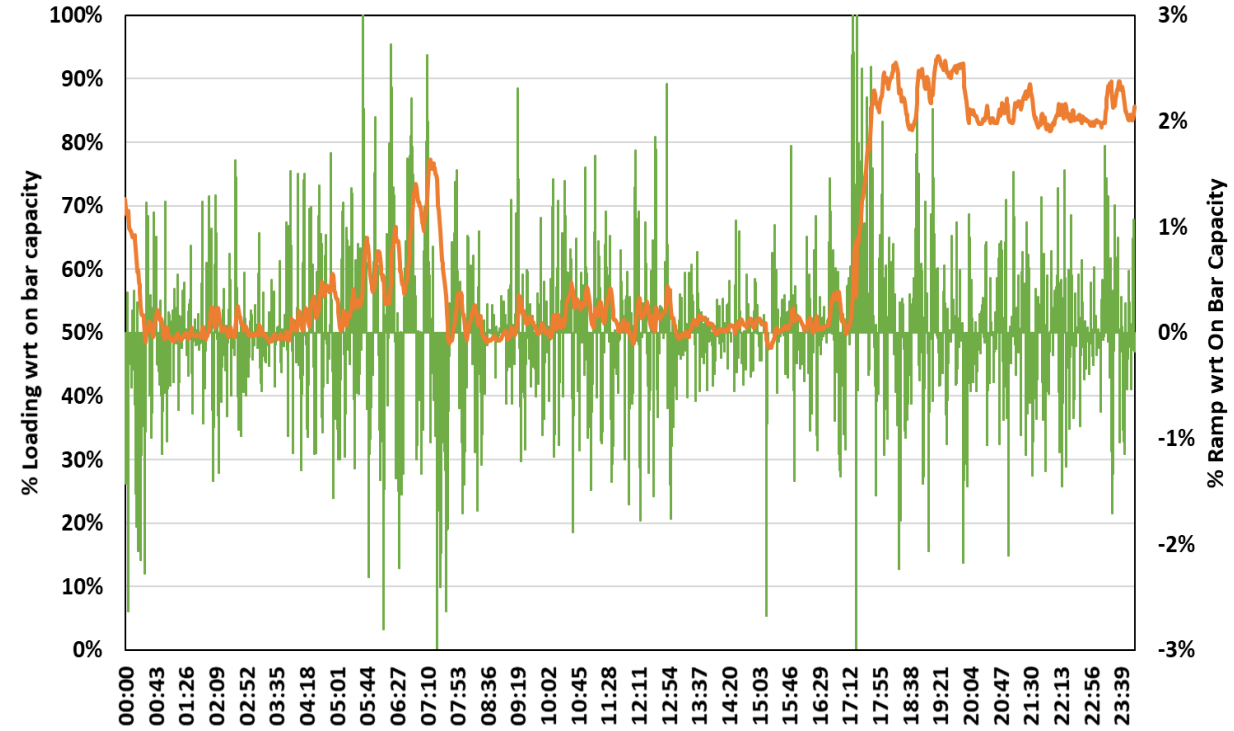
Load Curve of Mouda Generation (1000MW)
High Demand Day in WR_1 Sep 23

Ramp per minute Mouda Generation_01 Sep 23



Load Curve of Mouda(1000 MW)
High Wind Day in WR_7 Aug 23

Ramp Rate Mouda Generation_07 Aug 23

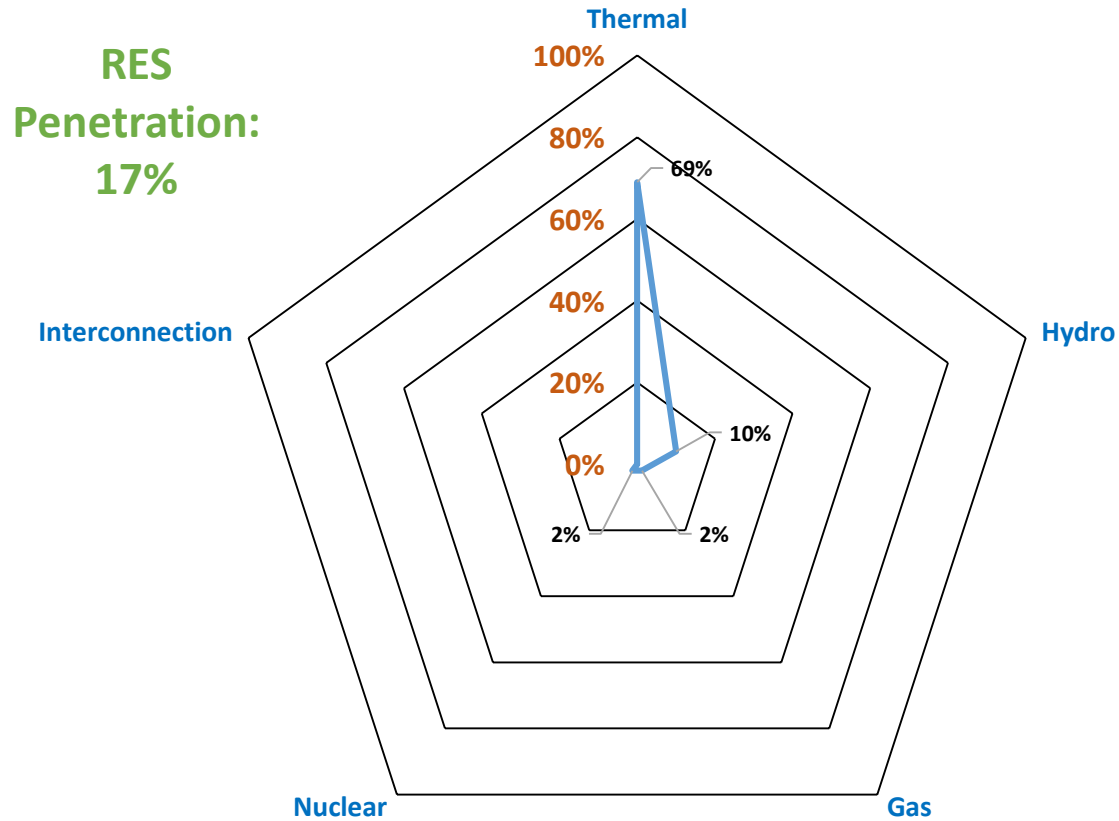


- Comparison of Load curves on Mouda-I generation on high wind day and high demand days
- On High demand day: Loading ~ 90-100% of on bar capacity, Ramp rate: 1-3% of on bar capacity
- On High wind day: Loading ~ 55-90% of on bar capacity, Ramp rate: 3-4% of on bar capacity

Flexibility Chart

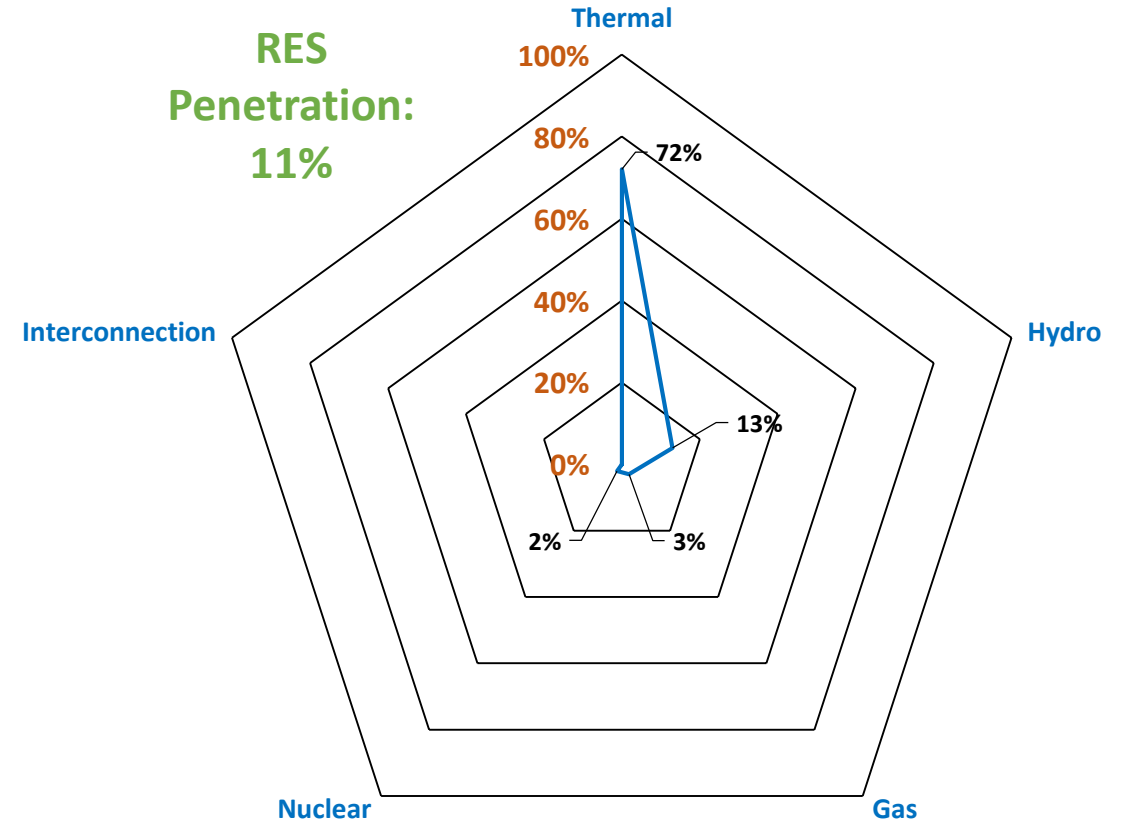
Flexibility Chart

14 Jun 23 (Highest RES Penetration)



Flexibility Chart

02 Sep 23 (Highest Demand Day)



*Plots are based on all India energy Resources

- These charts highlights potential flexibility sources available to handle variability
- Thermal power is the mainstay of electricity generation in India
- Not expected to change drastically in the near future

Regulatory Provisions

Technical Minimum, Partial Load and Start/Stop

Central Electricity Authority (Flexible Operation of Coal based Thermal Power Generating Units) Regulations, 2022

“The coal based thermal power generating units shall have flexible operation capability with minimum power level of forty percent”

“The coal based thermal power generating units shall have ramp rate capability of minimum three percent per minute for their operation between seventy percent to hundred percent of maximum continuous power rating

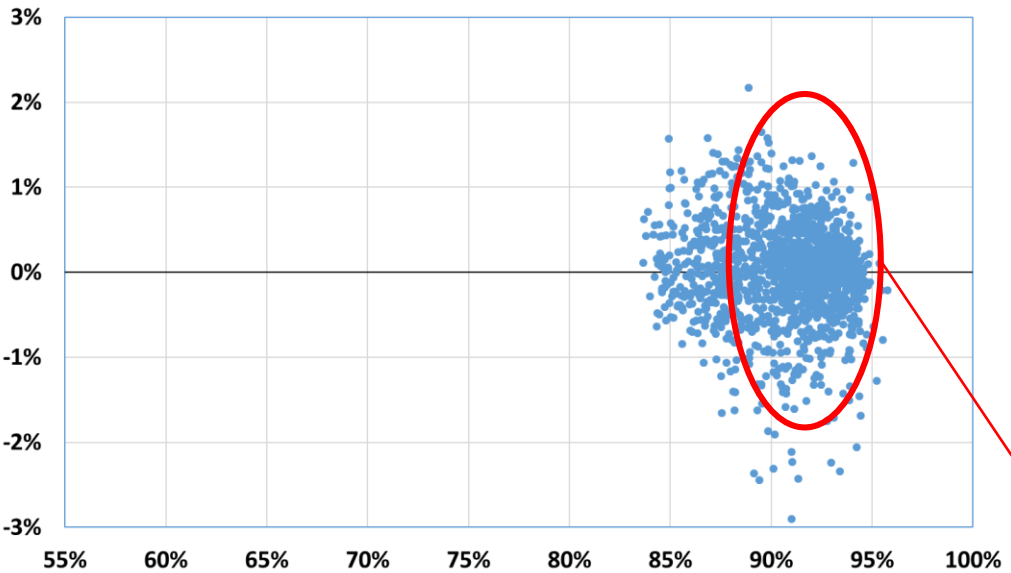
and

shall have ramp rate capability of minimum two percent per minute for their operation between fifty-five percent to seventy percent of maximum continuous power rating”

Mechanism for Compensation for Degradation of Heat Rate, Aux Consumption and Secondary Fuel Oil Consumption, due to Part Load Operation and Multiple Start/Stop of Units

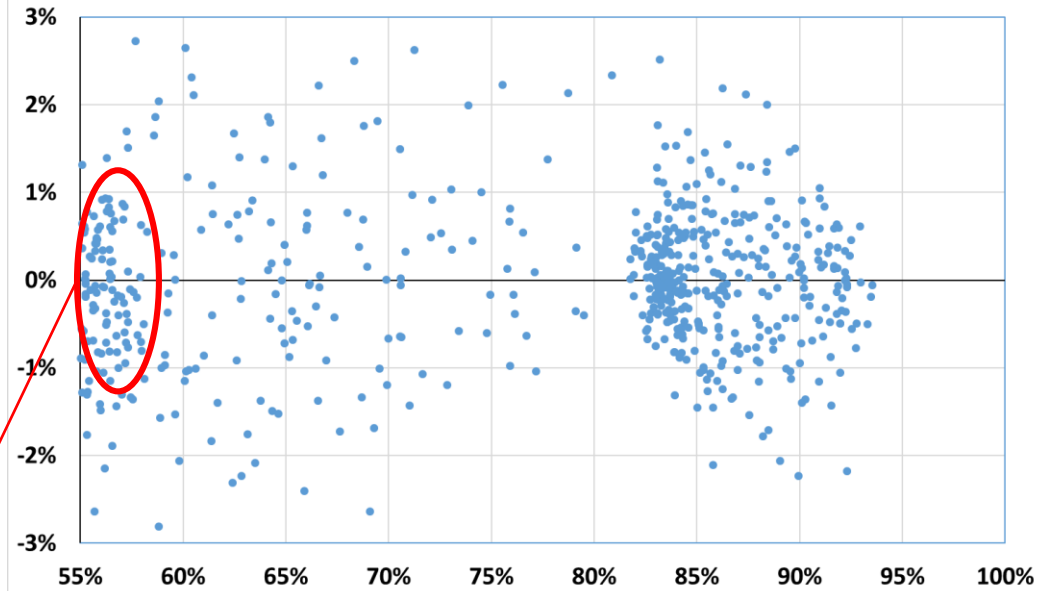
Already in force under the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 shall continue to be in operation

Mouda-I Ramp vs Load
High Demand Day in WR_1 Sep 23

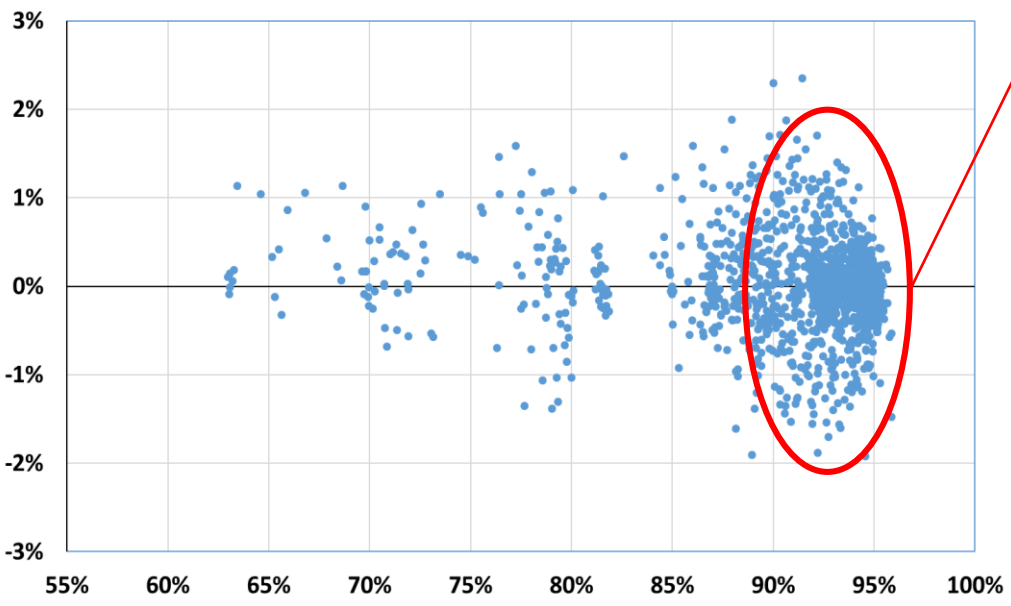


More concentration of Ramp rates of >1% for operation between 55% to 70%

Mouda-I Ramp vs Load
High Wind Day in WR_7 Aug 23

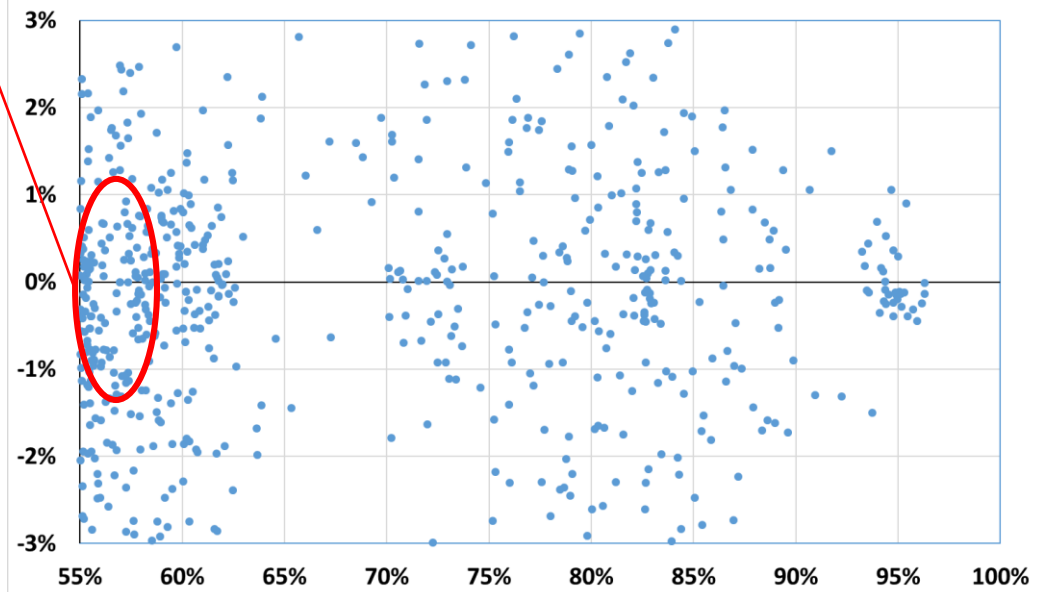


Solapur Ramp vs Load
High Demand Day in WR_1 Sep 23



More concentration of Ramp rates of >2% for operation between 70% to 100%

Solapur Ramp vs Load
High Wind Day in WR_7 Aug 23



Ramp Rate

IEGC-2023, Clause 9

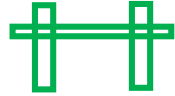
Ramping Rate to be Declared for Scheduling:

(a) The regional entity generating station shall declare the ramping rate along with the declaration of day-ahead declared capacity in the following manner, which shall be accounted for in the preparation of generation schedules:

- (i) ***Coal or lignite fired plants shall declare a ramp up or ramp down rate of not less than 1% of ex-bus capacity corresponding to MCR on bar per minute;***
- (ii) ***Gas power plants shall declare a ramp up or ramp down rate of not less than 3% of ex-bus capacity corresponding to MCR on bar per minute;***
- (iii) Hydro power plants shall declare a ramp up or ramp down rate of not less than 10% of ex-bus capacity corresponding to MCR on bar per minute;
- (iv) Renewable Energy generating stations shall declare a ramp up or ramp down rate as per CEA Connectivity Standards

Expectations and Necessities

Expectations from Thermal Plants



- **A bridge for transition from conventional to renewable**



- **Frequent start/stops**
 - **Shorter start-up time & lower start-up costs**



Expectations

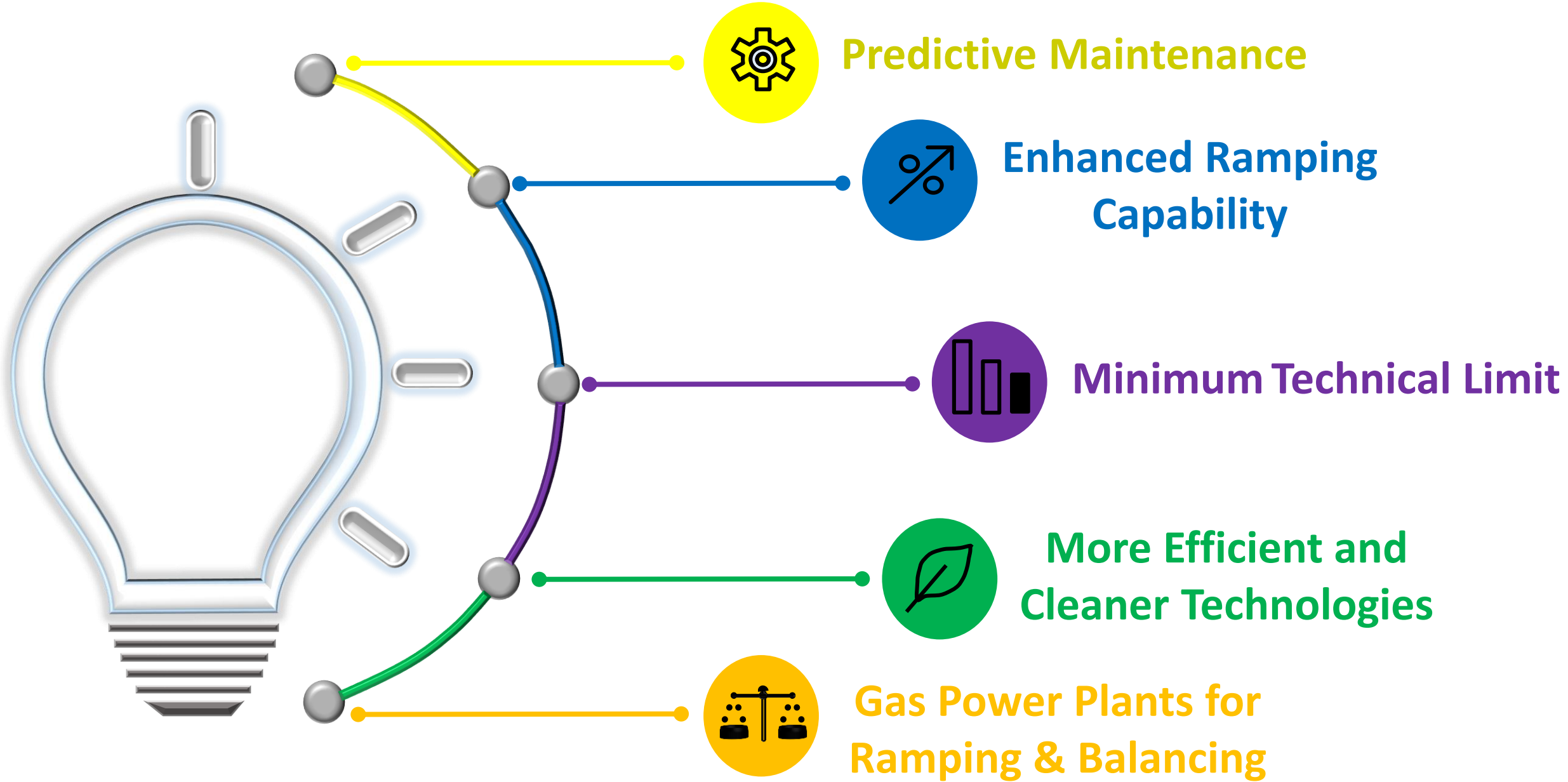


- **Higher ramping rates during loading and unloading**



- **Backing down and cyclic loading**
 - **Lower minimum load & improved part-load efficiency**

Necessities in Future





ग्रिड-इंडिया
GRID-INDIA

Thank You !