



Council of Enviro Excellence

Date: 01 October 2024

Venue: Hyatt Centric, Janakpuri,
New Delhi

FLEXIBLE OPERATIONS IN THERMAL POWER PLANT

FLEXIBLE OPERATION of coal fired power plants

Mr Bikash Chandra Mallick
Central Electricity Authority (CEA)

FLEXIBLE OPERATION

of coal fired power plants.....

B. C. Mallick
Principal Chief Engineer-II, CEA

PRESENT INSTALLED CAPACITY AND GENERATION

Fuel Type	Year,2023-24			
	Installed capacity		Generation	
	GW	(%)	MU	(%)
Coal and lignite	217.59	49.36	1,294,072	75.26
Hydro	46.93	10.65	134,054	7.80
Small Hydro and Biomass	16.00	3.48	12,902	0.75
Nuclear	8.18	1.86	47,817	2.78
Solar and Wind	134.28	28.97	199,360	11.59
Gas	25.04	5.68	31,302	1.82

Non-fossil: 205GW 46(%)

Non-fossil: 394134MU 23(%)

TARGET 2029-30

292 GW Solar and 100 GW Wind capacity by 2029-30

Likely installed capacity by the end of 2029-30: 777144 MW

Solar Capacity: 292566 MW

Wind Capacity: 99895 MW

PRESENT AND ANTICIPATED INSTALLED CAPACITY

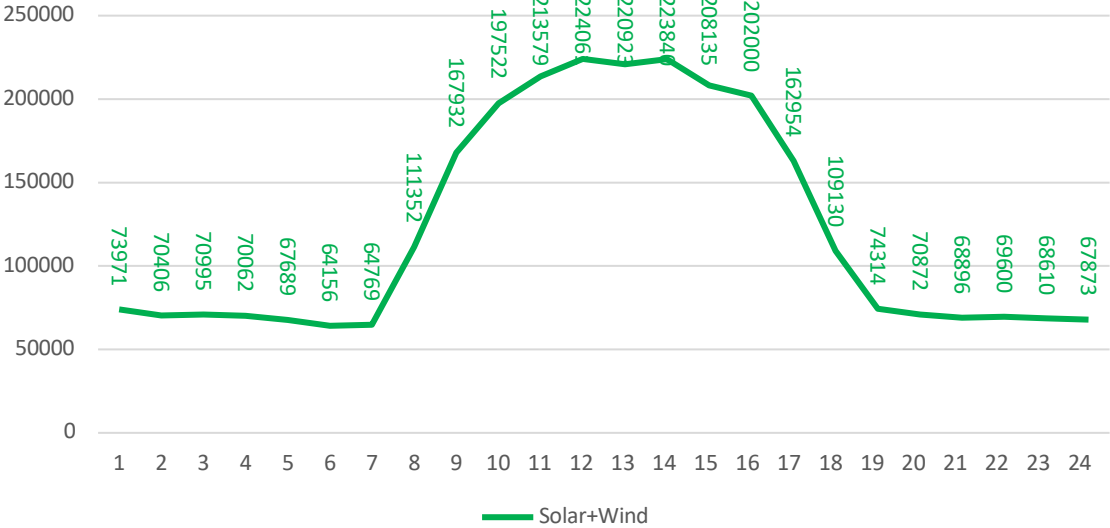
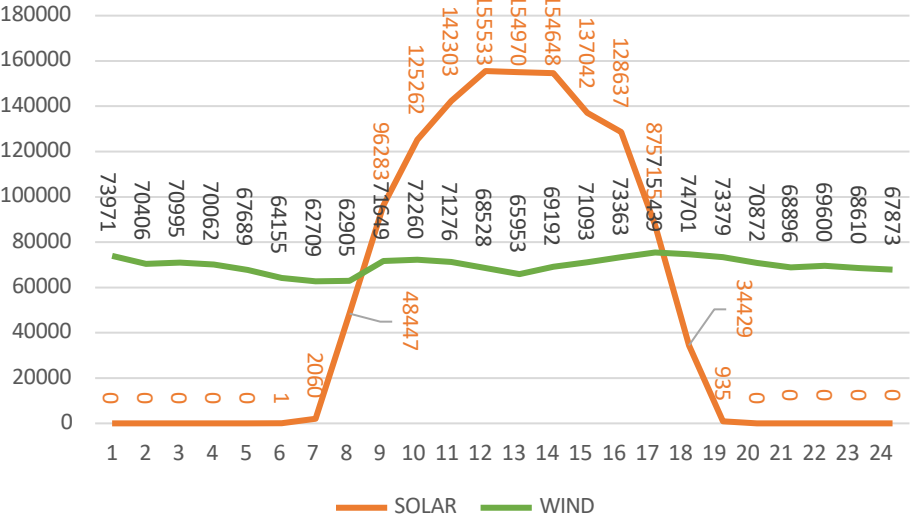
Fuel Type	Actual		Target	
	As on 31.03.2024		As on 31.03.2030	
	GW	(%)	GW	(%)
Coal and lignite	217.59	48.57	252	33.20
Hydro	46.93	10.47	54	7.11
Small Hydro and Biomass	16.00	3.57	20	2.64
Nuclear	8.18	1.83	15	1.98
Solar and Wind	134.28	29.97	393	51.78
Gas	25.04	5.59	25	3.29

Non-fossil (2024): 205GW 46(%)

Non-fossil (2030): 482GW 64(%)

MOST CRITICAL DAY IN 2029-30

Most Critical day: As projected the most critical day situation will be occurred in the grid in July, 2029 when flexible power requirement will be maximum for balancing the grid. The maximum renewable (Solar plus Wind) generation on the critical day will be 224 GW at 12 pm and minimum generation will be 64 GW at 6 am. The grid maximum and minimum demand will be 289178 MW and 250177 MW respectively.



Most Critical Day

	70% MTL	55% MTL	40% MTL	40% MTL + 2-shifting
	Capacity	Capacity Difference	Capacity Difference	Capacity Difference
Max. Coal Gen. (flexible plants+CFBC+Old TPPs in MW)	113310	120255	126750	131310
Synchronised coal capacity (MW)	123678	131186	138208	143137
Coal Capacity needed (MW)	145503	154336 8833	162598 17094	168397 22893
Ramp up rate (MW/Min.)	235	427	479	479
Ramp down rate (MW/Min.)	306	459	459	531
BSS Power (MW)	56802	46675 -10127	34816 -21987	22679 -34123

POTENTIAL FLEXIBLA POWER IN THE GRID

- Coal based power plants capacity will be about **276 GW** in the year 2029-30
- Generating unit of 240 GW capacity may operate at 40% MTL
- Very old units of **30 GW** having difficulties in lowering load below 55% may opt for 2-shift operation.
- **CFBC capacity of 6 GW** may continue to operate at 55% due to their technical constraint.

Coal based capacity:	276.00 GW
40% Flexing capacity:	240.00 GW
2-shifting (proposed):	30.00 GW
CFBC:	6.00 GW

POTENTIAL FLEXIBLE POWER BY 40% FLEXING

I. Lowering the minimum technical load of 240 GW

80% of available capacity 240 GW:	192 GW
55% generation (Ex-bus):	97.15 GW (APC 8%)
40% generation: (EX-bus):	70 GW (APC 9%)

Lowering MTL (minimum technical load) of 240 GW capacity from 55% to 40% shall have potential of **27 GW** flexible power in the grid

II. 2 shift operation of old coal power plants

Capacity for 2-shift operation:	30.00 GW
70% of available capacity:	21.00 GW
Flexible power available:	18.90 GW (APC 10%)

In the year, 2029-30 about 144 units of 30 GW total capacity having age more than 40 years may operate in 2-shift mode. The capacity of 30 GW have potential to supply 18.90 GW flexible power in the grid by 2-shifting.

POTENTIAL FLEXIBLE POWER

III. Thus coal power plants have the potential of providing 46 GW flexible power by lowering 40% MTL along with 2-shift operation of old TPPs. (27.26 GW from lowering technical minimum load to 40% and 18.90 GW from 2-shifting).

However, the availability of flexible power in the grid at any instant depends on followings:

- ✓ Grid demand at that time
- ✓ Solar and wind generation at that time
- ✓ Coal capacity synchronised (on bar) at that time
- ✓ Other generation available in the grid at that time and their flexing capability

CAPEX.

		Year 2030 capacity (MW)		Capital Cost till 2070										
		Coal Power Plants Capacity	Battery Capacity	Addl. Coal Power Plants					Battery					Total capex for coal plants and battery (Cr.) (7+12)
				Increased capacity (MW)	Increased Capex. (Cr.)	Capex for flexing (Cr.)	Increased Capex for R&M (Cr.)	Capex for (Cr.) (4+5+6)	Year 2030 Battery Cost (Cr.)	Year,2040 Battery replacement cost (Cr.)	Year,2050 Battery replacement cost (Cr.)	Year,2060 Battery replacement cost (Cr.)	Capex for Battery (Cr.) (8+9+10+11)	
		1	2	3	4	5	6	7	8	9	10	11	12	13
Peak Demand Day														
1	55% Flexing without 2-shifting	226818	46626	11818	100453	4610	41363	146426	349695	303069	256443	233130	1142337	1288763
2	40% Flexing (actual 58.97%)	233813	34816	18813	159913	16085	65846	241844	261120	226304	191488	174080	852992	1094836
3	40% Flexing (actual 56.38)	249725	22679	34725	295159	16732	121536	433427	170093	147414	124735	113395	555636	989062
Max. Solar Day														
1	55% Flexing without 2-shifting	248162	46626	33162	281876	5044	116066	402986	349695	303069	256443	233130	1142337	1545323
2	40% Flexing without 2-shifting (actual 45.59%)	261262	34816	46262	393227	10620	161917	565764	261120	226304	191488	174080	852992	1418756
3	40% Flexing with 2-shifting (actual 44%)	275744	22679	60744	516321	17790	212603	746714	170093	147414	124735	113395	555636	1302349
Most Critical Day														
1	55% Flexing without 2-shifting	154336	46626	0	0	3137	0	3137	349693	303067	256441	233129	1142330	1145467
2	40% Flexing without 2-shifting	162598	34816	0	0	13190	0	13190	261117	226302	191486	174078	852983	866173
3	40% Flexing with 2-shifting	168397	22679	0	0	13426	0	13426	170096	147416	124737	113397	555647	569072

- A. Coal Power Plants

i). Coal plants life 40 year with intervention of R&M

ii). Capital cost for coal power plantsR&M cost =

8.5 (Cr./MW)

iii). R&M cost =

3.5 (Cr./MW)

iv). Capex. for 40% MTL =

20.0 (Cr./ Unit)

v). Capex. for 2-shifting =

60.0 (Cr./ Unit)
- B. Battery Storage

i). Battery Life is 10 years

ii). Capital cost (6 hrs.)

year

20307.5 (Cr./MW)

20406.5 (Cr./MW)

20505.5 (Cr./MW)

20605.0 (Cr./MW)

REGULATION ON TECHNICAL MINIMUM LOAD

CEA has also notified a Regulation regarding Flexible operation of coal based Thermal Power Generating Units on 30.1.2023.

1. The 55% minimum load and 2% ramp rate operating requirement shall have to be implemented by all thermal generating units (Central/State/Pvt) within one year of the notification of the regulation.
2. Power plants shall implement measures, if required, as per the phasing plans by the respective power plants owners to operate thermal unit at 40% minimum load with following ramp rate:
 - 1% per minute - 40% to 55% and 55% to 40% load
 - 2% per minute - 55% to 70% and 70% to 55% load
 - 3% per minute - 70% to 100% and 100% to 70% load

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
	Capacity (MW)	5850	54380	53365	27375	35080	20687	196737

BALL & TUBE	UNITS	34
	CAPACITY(MW)	8950
CFBC	UNITS	54
	CAPACITY(MW)	6001
2 - SHIFTING	UNITS	6
	CAPACITY(MW)	378
GRAND TOTAL	UNITS	587
	CAPACITY(MW)	212066

INCREASE IN TRAIFF

I. Capital Expenditure (CAPEX): One-time expenditure to be incurred in retrofitting of various measures to make the plant capable of low load operation.

II. Operational Expenditure (OPEX):

- i. Cost due to increase in Net Heat Rate
- ii. Cost due to Increased Life Consumption (damage costs)
- iii. Cost due to additional oil consumption for additional EFOR

TARIFF IMPACT

Likely increase in tariff considering capital investment of Rs. 30 crores, increase of O&M cost, variable cost and EFOR cost

Unit Size (MW)	Loading (%)	Coal price Rs 2000.00 per ton	Coal price Rs 3300.00 per ton	Fixed Tariff increase (Paisha/kWh)		EFOR compensation (Paisha/kWh)	Total tariff (fixed & variable) increase (Paisha/kWh)	Total tariff (fixed & variable) increase (Paisha/kWh)
		Variable Tariff increase (Paisha/kWh)	Variable Tariff increase (Paisha/kWh)	Increased O&M cost	Increased capital cost		Coal price Rs 2000.00 per ton	Coal price Rs 3300.00 per ton
200	<55 to 50	13.68	22.57	6.70	7.68	1	29.06	37.95
	<50 to 45	17.78	29.34	10.42	7.68	1	36.88	48.44
	<45 to 40	21.89	36.11	14.88	7.68	1	45.45	59.67
500	<55 to 50	14.66	24.20	4.57	3.07	1	23.30	32.84
	<50 to 45	18.30	30.19	7.11	3.07	1	29.48	41.37
	<45 to 40	21.53	35.52	10.16	3.07	1	35.76	49.75
660	<55 to 50	11.17	18.42	4.12	2.56	1	18.85	26.10
	<50 to 45	15.27	25.20	6.40	2.56	1	25.23	35.16
	<45 to 40	18.74	30.92	9.14	2.56	1	31.44	43.62
800	<55 to 50	10.65	17.57	3.70	1.92	1	17.27	24.19
	<50 to 45	14.86	24.52	5.76	1.92	1	23.54	33.20
	<45 to 40	18.58	30.65	8.23	1.92	1	29.73	41.80

Thank You

THANKING YOU!
ON BEHALF OF



Council of Enviro Excellence