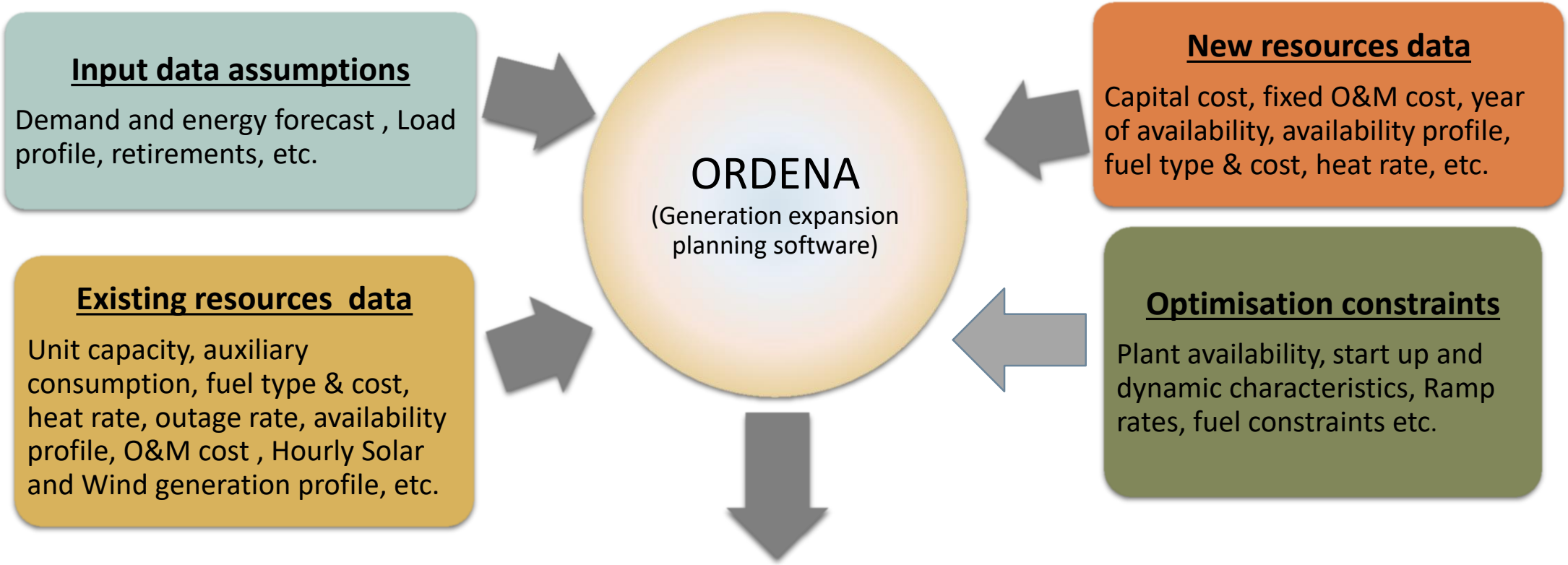
OPTIMUM GENERATION MIX IN THE YEAR 2029-30

Objective of the Study

To find out the least cost optimum generation mix in the year 2029-30 considering possible/feasible technology options, fuel constraints if any, intermittency associated with Renewable energy sources etc.

About the Model



Optimized resource plan

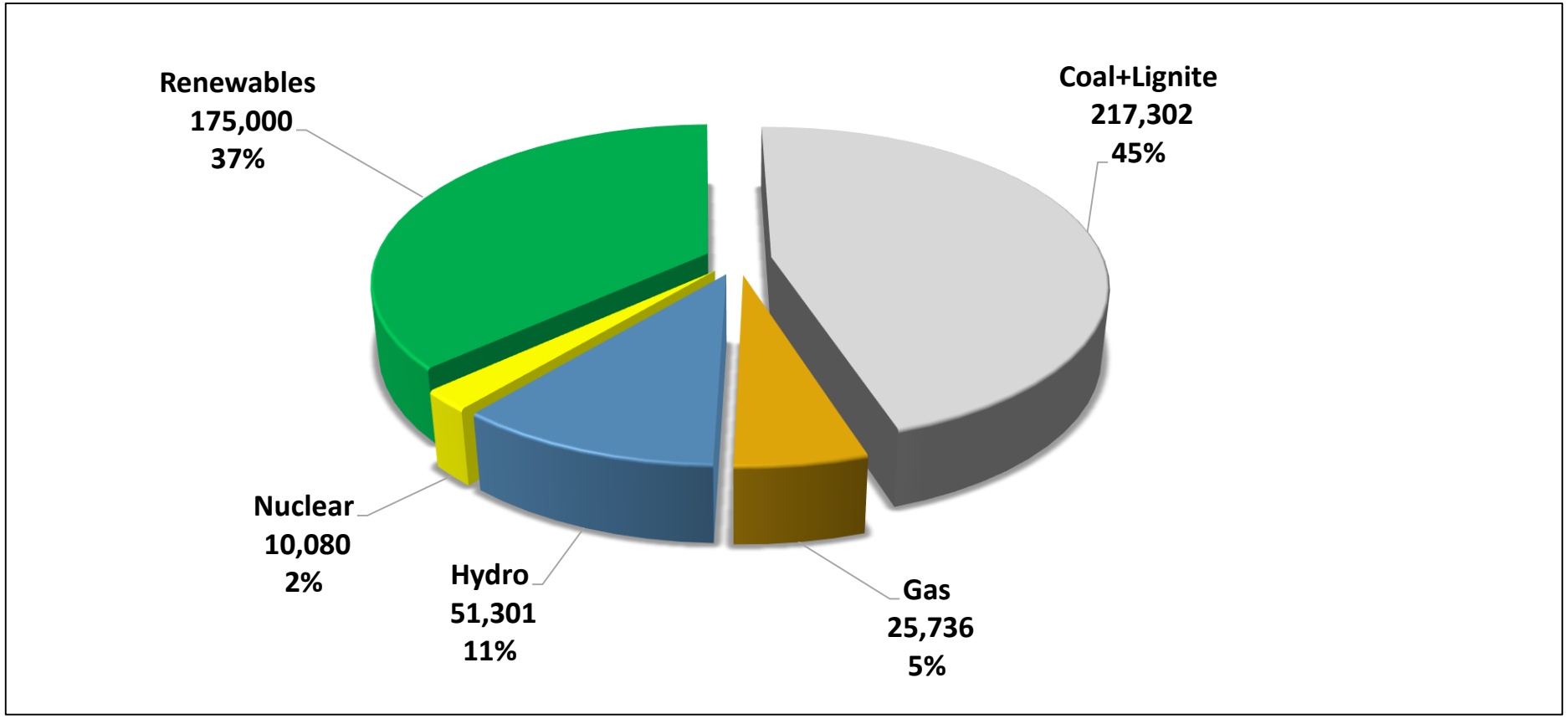
Long Term Planning:-Total system cost, annual system capacity requirement fuel wise.

Short term planning:-Hourly energy generation fuel wise to meet the hourly demand

Demand

Year	Electrical Energy Requirement (BU)	Peak Electricity Demand (GW)
2029-30	2400	340

Projected All India Installed Capacity (As per NEP) (As on 31.03.2022)



TOTAL 4,79,419 MW

TECHNOLOGIES CONSIDERED

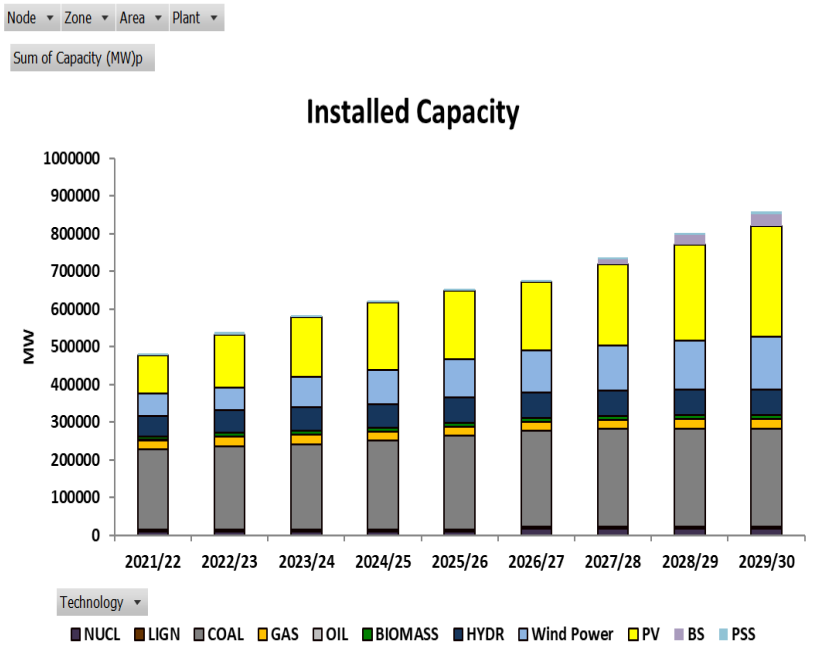
Thermal	Super critical based Coal (Pithead and Load center),Lignite, Combined Cycle Gas Plants
Hydro	Large Hydroand Small Hydro
Nuclear	Nuclear (LWR & PHWR)
Renewables	Solar, Wind, Biomass
Energy Storage	Battery Energy Storage System & Pump Storage Plants

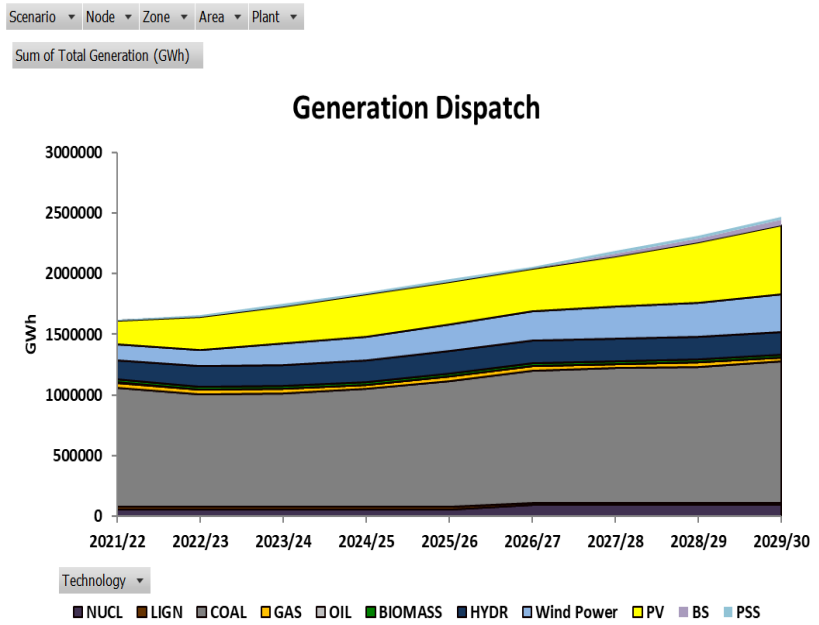
Broad assumptions considered for the Studies

- Installed capacity by 2021-22 as per NEP projections as base
- Planned capacity addition after 2021-22 : 13,762 MW of hydro, 6,800 MW of Nuclear and retirement of coal based units of 25,572 MW.
- No restrictions on candidate capacity of plants except Gas and wind
  - Maximum of 140 GW Wind by 2030 based on MNRE projections.
  - No additional gas-based capacity has been considered by 2030.
- Capital cost of technologies as per NEP
- Reduction of capital cost of solar and battery storage in future years
- MW scale Battery Energy storage system (4 hour) as candidate plants.
- Generation profile of solar and wind as per data made available by various agencies. Annual CUF of solar : 22% and Wind : 25.21%.

Generation Mix results in the year 2030

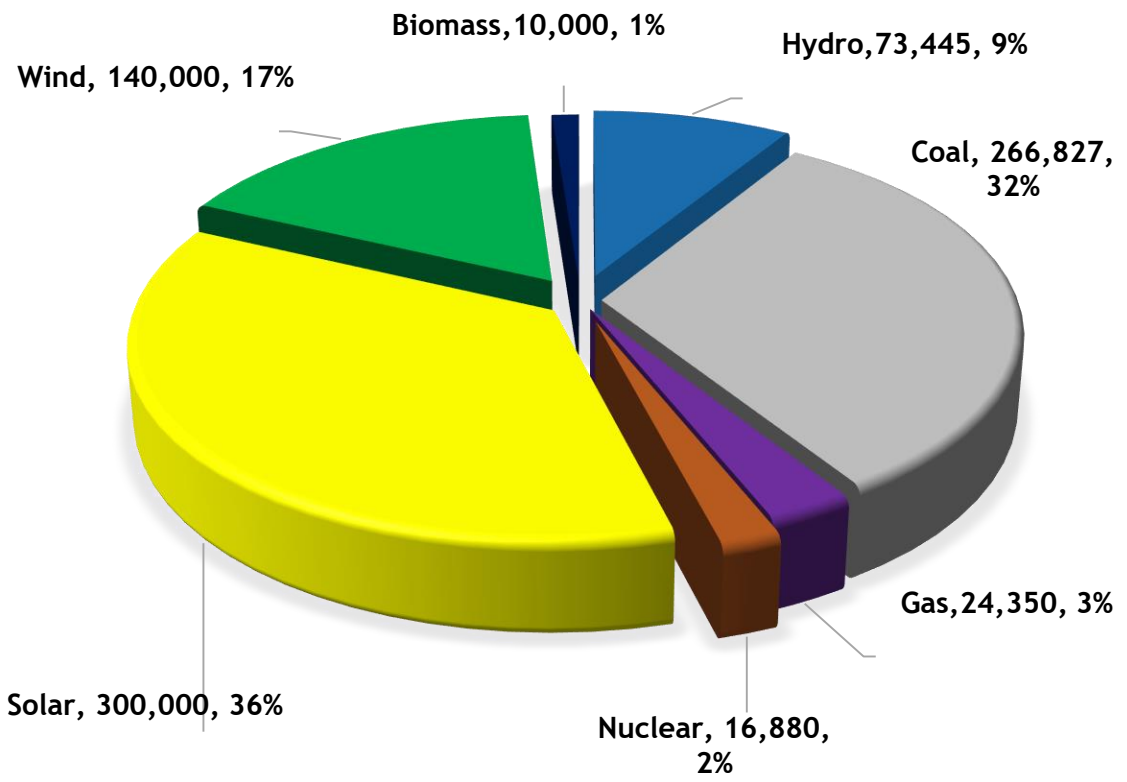
Fuel Type	Likely Installed Capacity (MW) in 2029-30	%
Hydro + Small Hydro+ Imports	73,445	8.8
Coal + Lignite	2,66,827	32.1
Gas	24,350	2.9
Nuclear	16,880	2.0
Solar	3,00,000	36.1
Wind	1,40,000	16.8
Biomass	10,000	1.2
Total	**8,31,502**	
Battery	34,000MW/136,000 MWh	





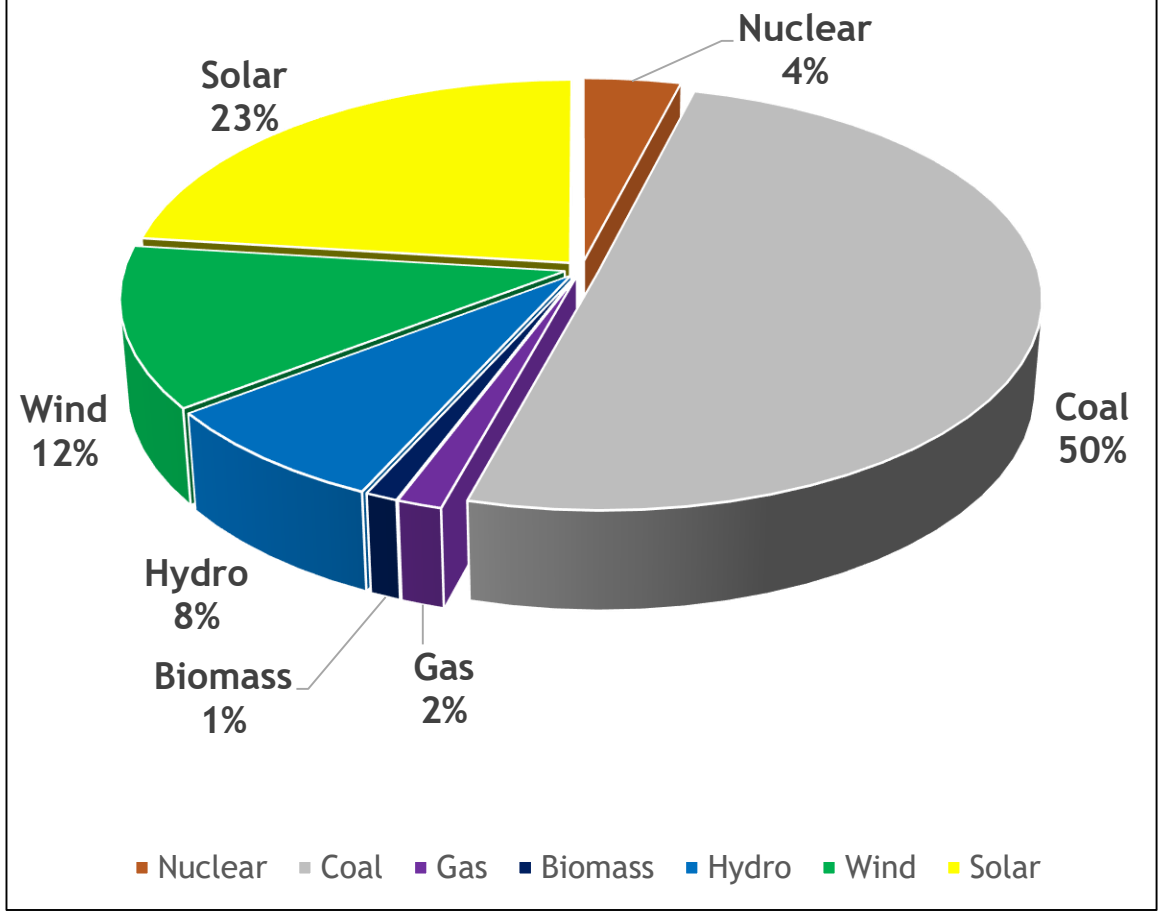
Likely Installed Capacity (MW) in 2029-30

TOTAL IC : 8,31,502 MW



Battery : 34,000MW/136,000MWh

Likely Gross Generation (MU) in 2029-30



Projected Achievements of INDCs by 2030

India's Intended Nationally Determined Contribution (INDC)

40 % cumulative power installed capacity from non-fossil fuels by 2030.

Likely Installed Capacity mix of Fossil and Non-fossil* fuels

Year	Installed Capacity (MW)	Installed Capacity of Fossil fuel (MW)	Installed Capacity of Non-Fossil* fuel (MW)	%of Non-fossil fuel in Installed Capacity
March,2030	8,31,502	2,91,177	5,40,325	64.9%

* Non-Fossil Fuel – Hydro, Nuclear and Renewable Energy Sources

Likely annual CO2 emissions from Power Sector by 2030

	Year 2021-22 (as per NEP)	Year 2029-30
CO_2 Emissions (Million Tonnes)	1026	1154#

#Actual CO2 emissions may vary depending on the RE generation, various technical constraints associated with coal plants.

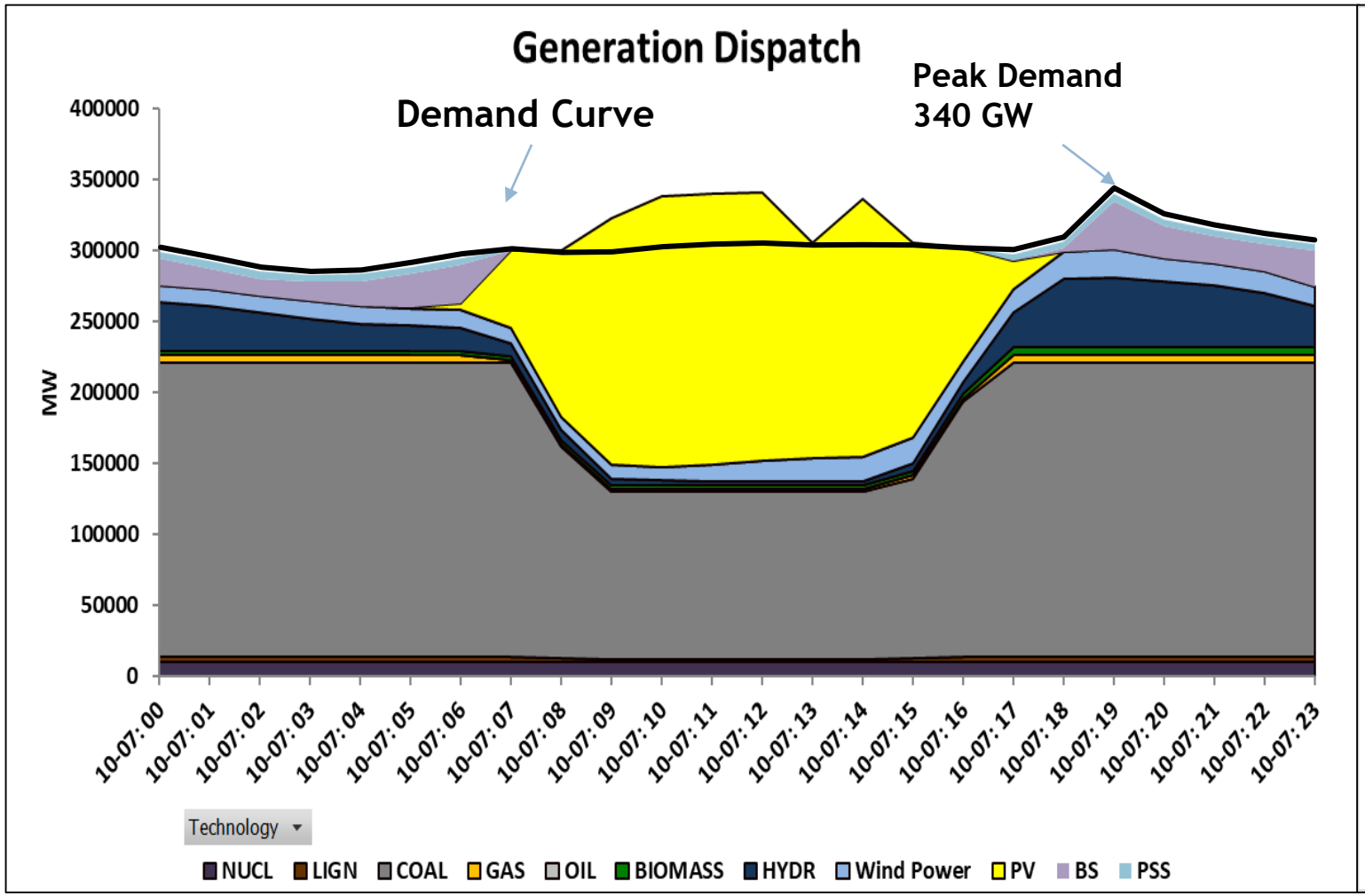
Short Term scenarios considered for typical days

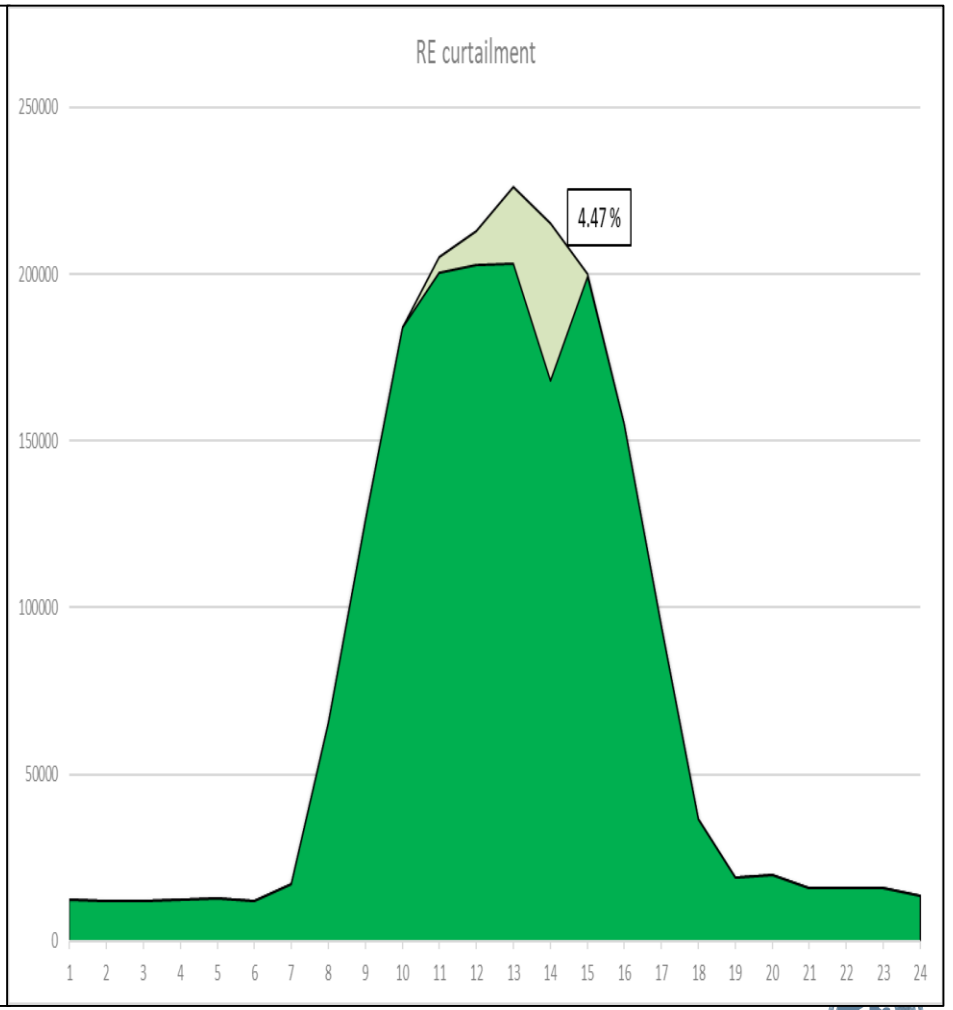
Scenario *	Day
Peak Day / Max Energy demand day	7th October, 2029
Maximum Variable RE (Wind+Solar) generation day	3rd July, 2029
Maximum Solar generation day	25th March, 2030
Minimum Solar generation day	8th August, 2029
Minimum energy demand day	14th December, 2029
Minimum Variable RE (Wind+Solar) generation day	1st February, 2030
Maximum variation in demand day	27th January, 2030

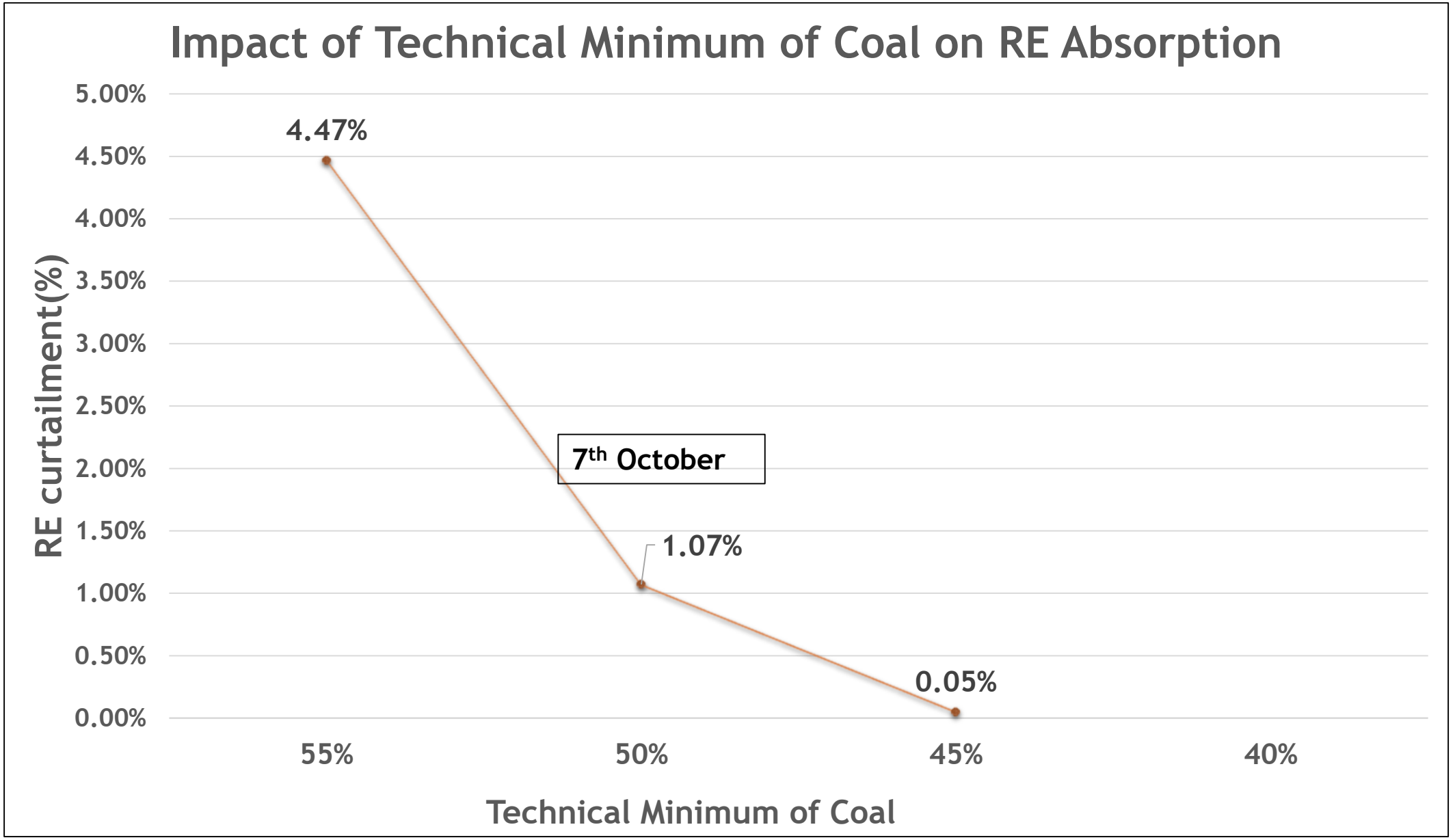
* Based on the projected Demand curve in 2029-30

Peak Demand/ Maximum Net Demand Day (7th Oct)

Peak Demand – 340 GW, Energy Req- 7.21 BU






Impact of Technical Minimum of Coal on RE Absorption
5.00%
4.50%
4.00%
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
RE curtailment(%)
4.47%
7th October
1.07%
0.05%
55%
50%
45%
40%
Technical Minimum of Coal

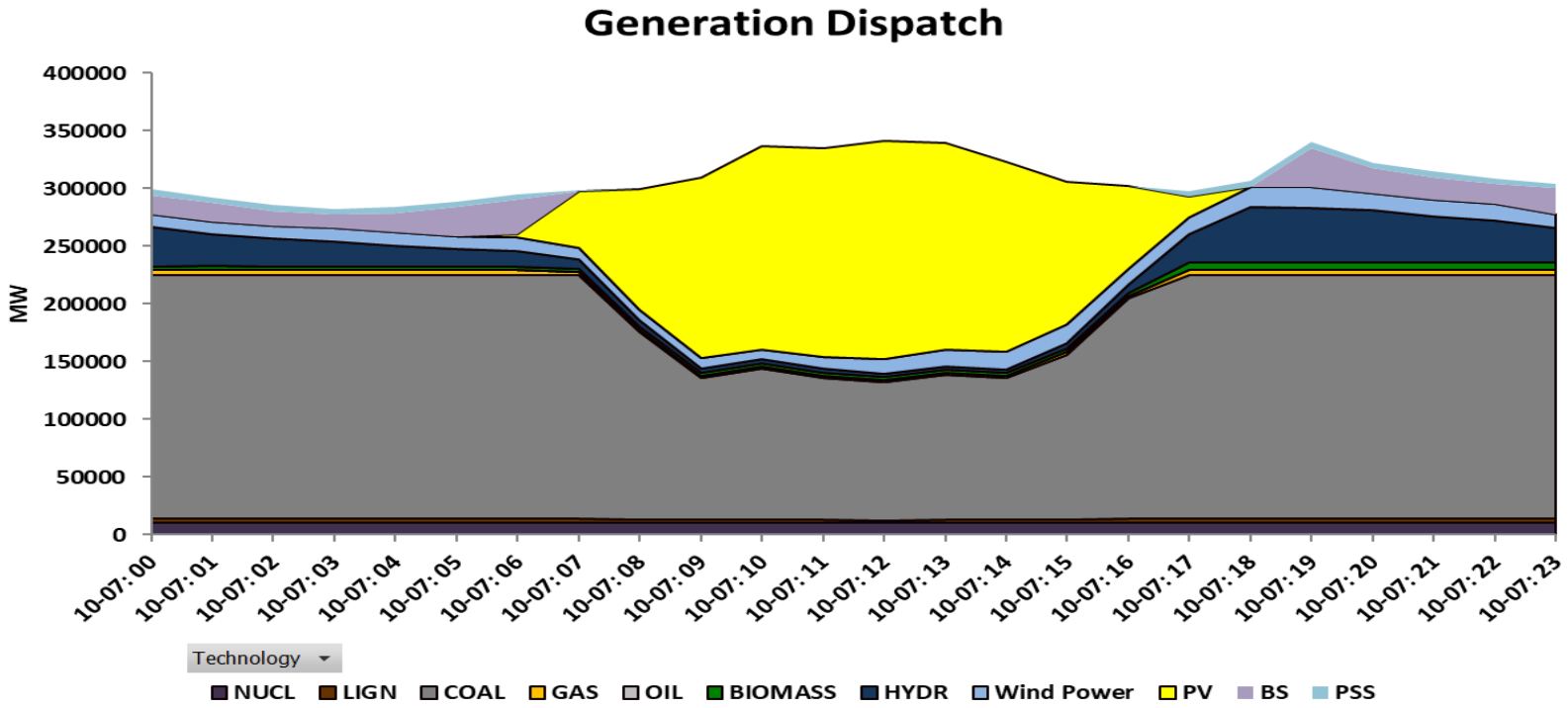
Sensitivity studies

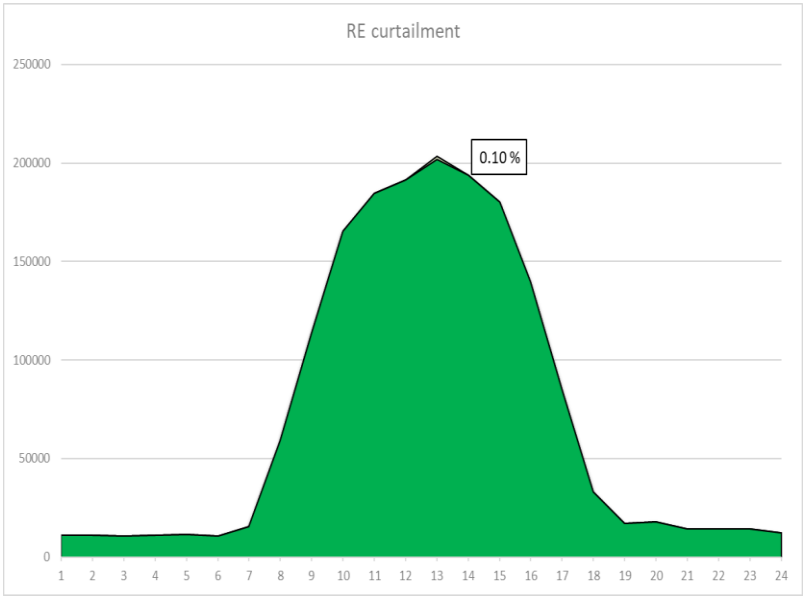
Scenario	Criteria
Maximum Demand Week (4-10th Oct 2029)	A)10% reduction in VRE (Solar+ Wind) generation
	B)6% reduction in hydro generation
	A+B) 10% reduction in VRE generation + 6% reduction in hydro generation
Minimum VRE Week (First week of February 2030)	10% reduction in variable RE (Solar+ Wind) generation

10% reduced variable RE generation & 6% reduced Hydro generation in October Results of 7th Oct

Scenario | Area | Zone | Node | Plant | Generator | Period

Sum of Total Generation (MW)





Block

Availability of coal based power plants has to be increased by only 1.5% to fulfill the demand

Short Term scenarios considered for typical days

Scenario *	Day	Remarks	Energy Requirement (BU)
Peak Day / Max Energy demand day	**7th October, 2029**	Peak Demand – 340 GW	7.21 BU
Maximum Variable RE (Wind+Solar) generation day	**3rd July, 2029**	CUF Wind 69.79% CUF Solar 24.56% RE Generation 4.1 BU	6.63 BU
Maximum Solar generation day	**25th March, 2030**	CUF Solar 28.00% Solar Generation 2.01 BU	6.88 BU
Minimum Solar generation day	**8th August, 2029**	CUF Solar 14.25% Solar Generation 1.02 BU	6.64 BU
Minimum energy demand day	**14th December, 2029**		6 BU
Minimum Variable RE (Wind+Solar) generation day	**1st February, 2030**	CUF Wind 10.54% CUF Solar –16.13 % RE Generation 1.5 BU	6.44 BU
Maximum variation in demand day	**27th January, 2030**	Max 320GW Min -231 GW	6.23 BU
Maximum variation in Net demand day	**26th October, 2029**	Max 284GW Min -124 GW	6.48 BU

* Based on the projected Demand curve in 2029-30

Impact on CO_2 emission due to part load operation of coal based power plant

- Estimated impact on CO2 emissions due to part load operation of coal based power plants in view of high RE penetration in the system and shape of the demand curve.
- The efficiency at different loading conditions modelled in the studies.
- A study of typical days, i.e. 7th October (peak demand day) and 3rd July (maximum RE generation day) carried out by considering no efficiency drop vis-a-vis efficiency drop due to part load operation.
- CO2 emissions may increase to the tune of 1% due to efficiency drop on part load operation of coal based power plant on 7th October and 1.2% on 3rd July.

Way Forward

- Modeling with transmission network
- Location wise RE installations
- Change in future demand curve – due to agricultural load shift.
- More scenario based on demand, battery cost etc.

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