

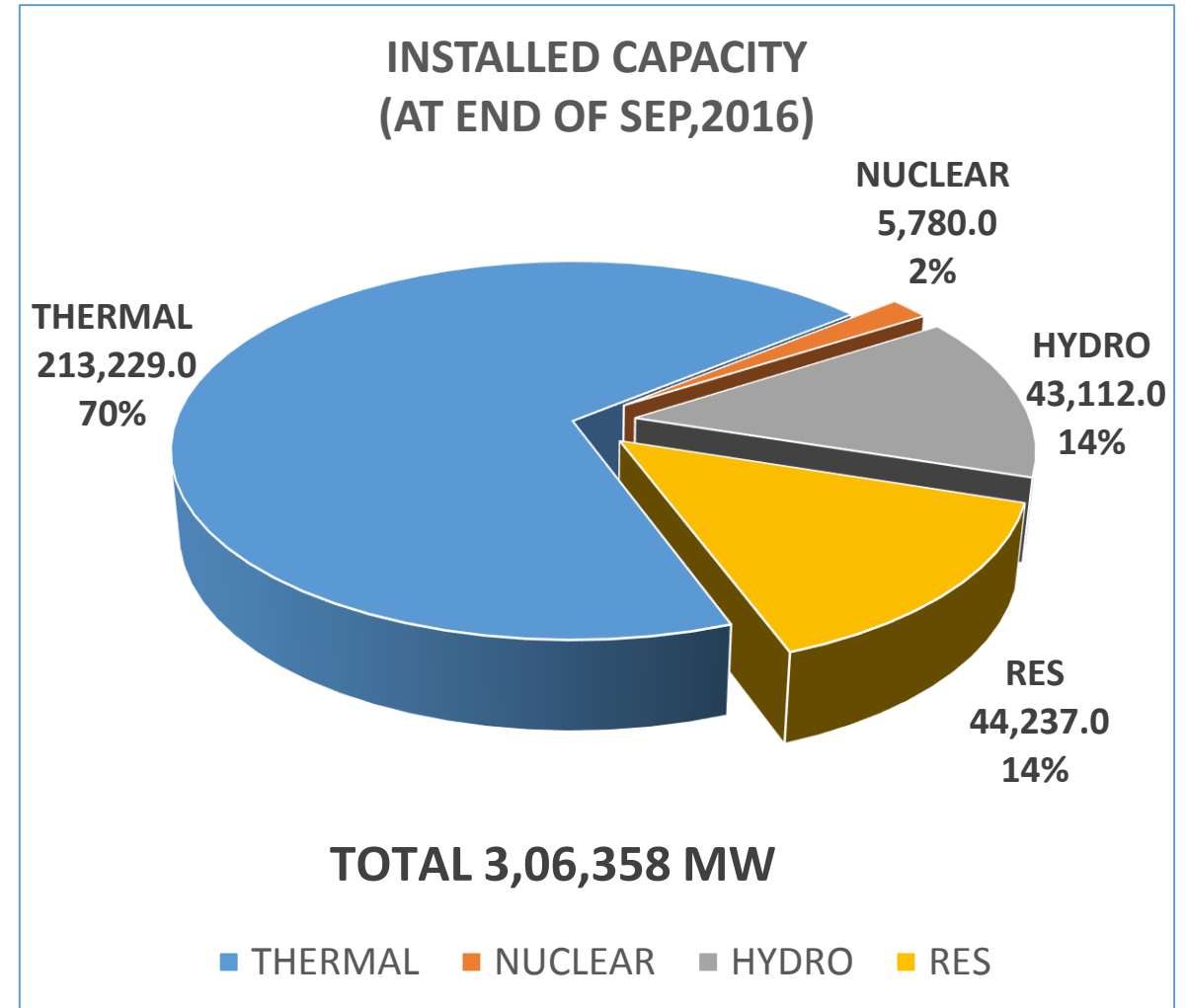
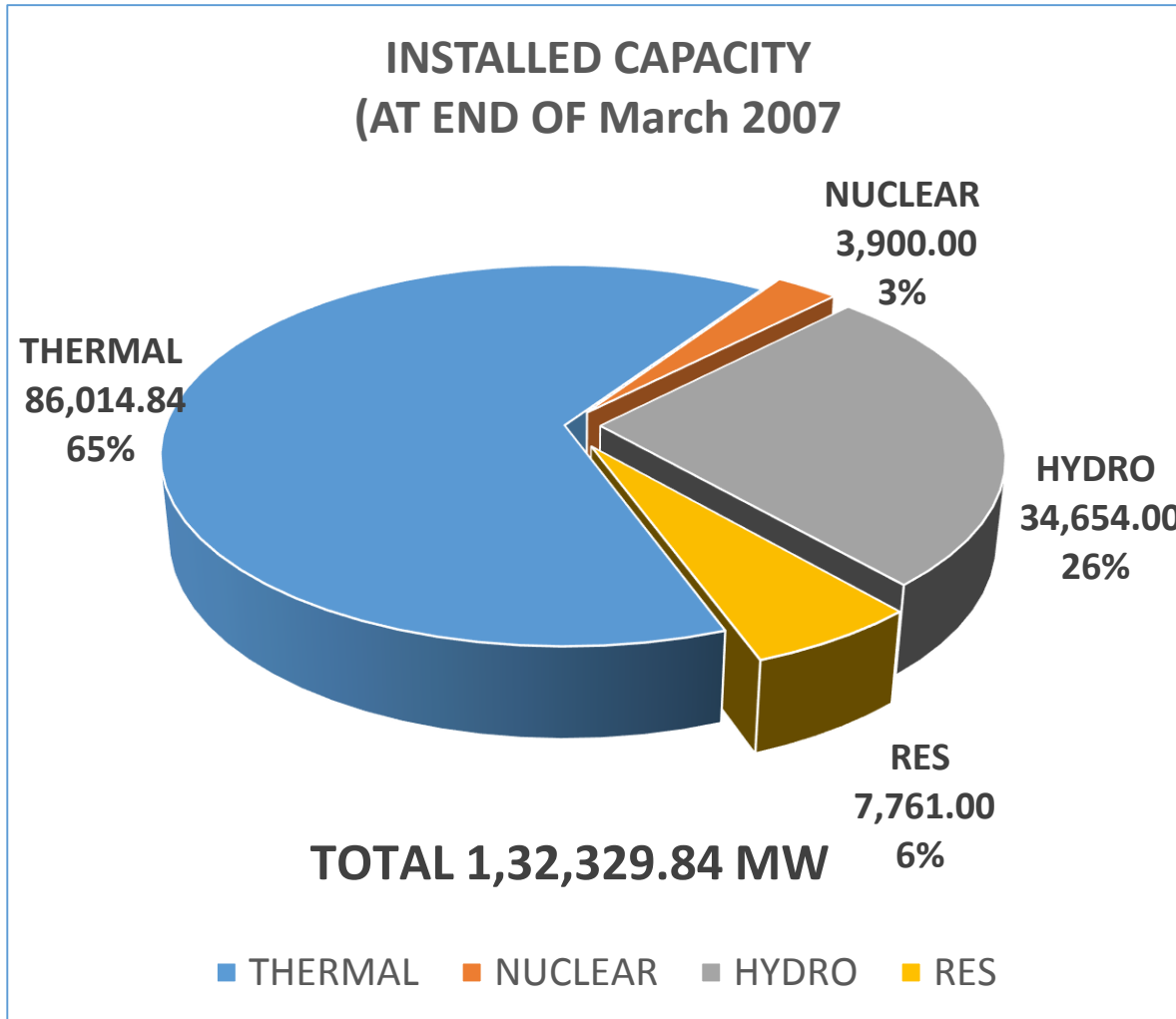
INDIAN POWER SECTOR ROAD MAP

NEW DELHI
16.12.2016

GROWTH SO FAR

GROWTH OF ALL INDIA INSTALLED CAPACITY(CATEGORY WISE)

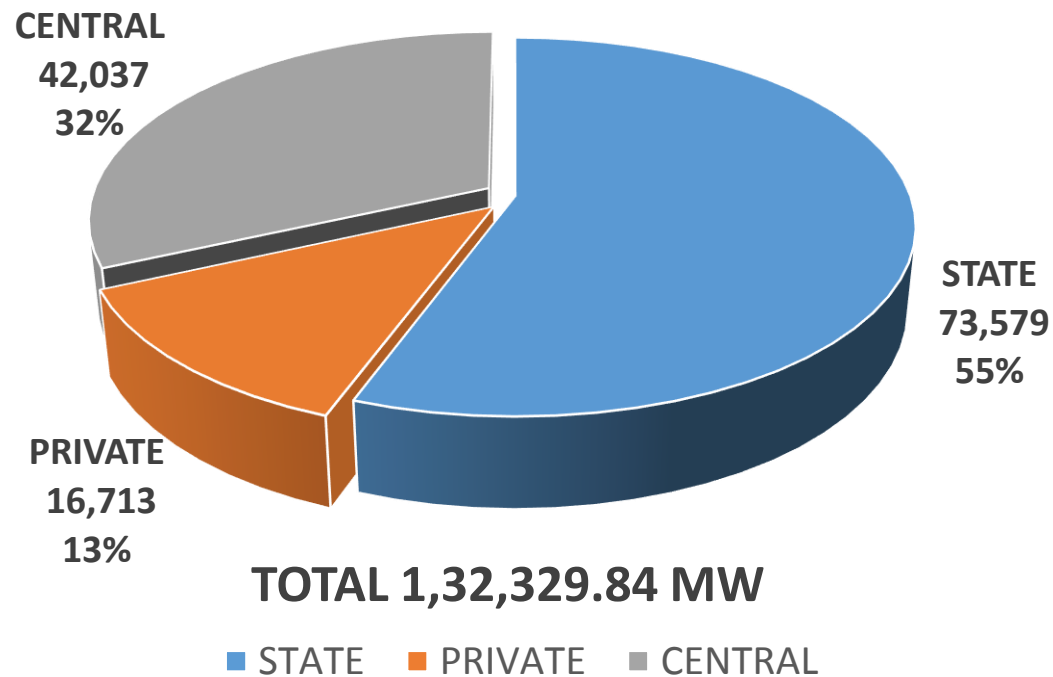
(FIGURES IN MW)



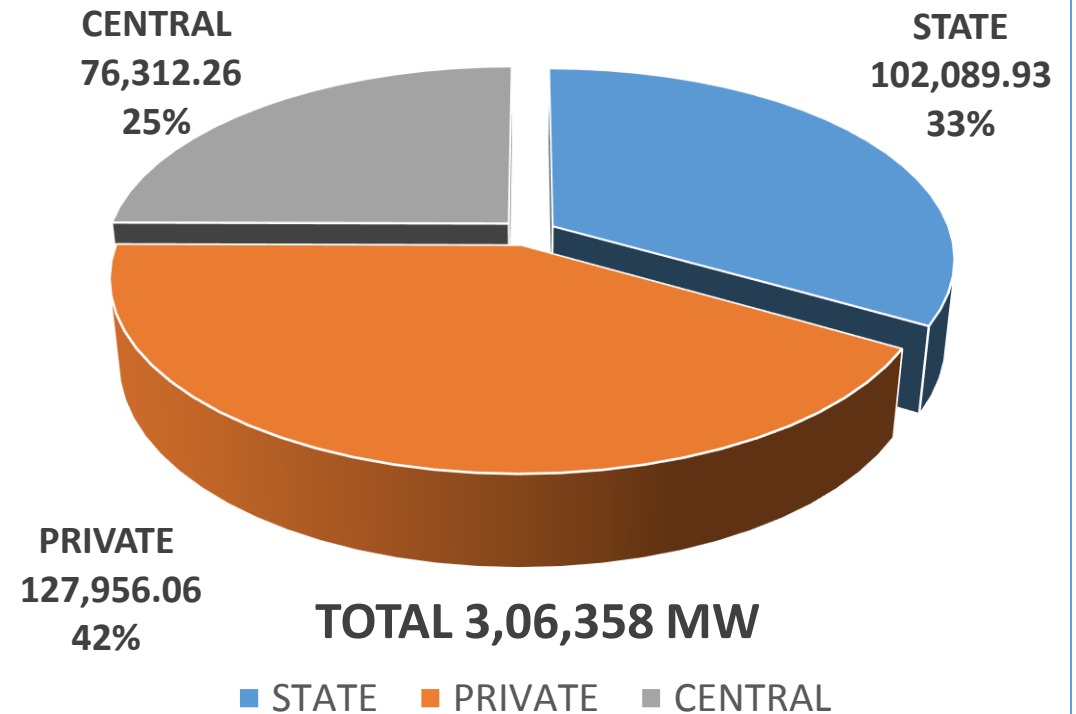
(FIGURES IN MW)

GROWTH OF ALL INDIA INSTALLED CAPACITY(SECTOR WISE)

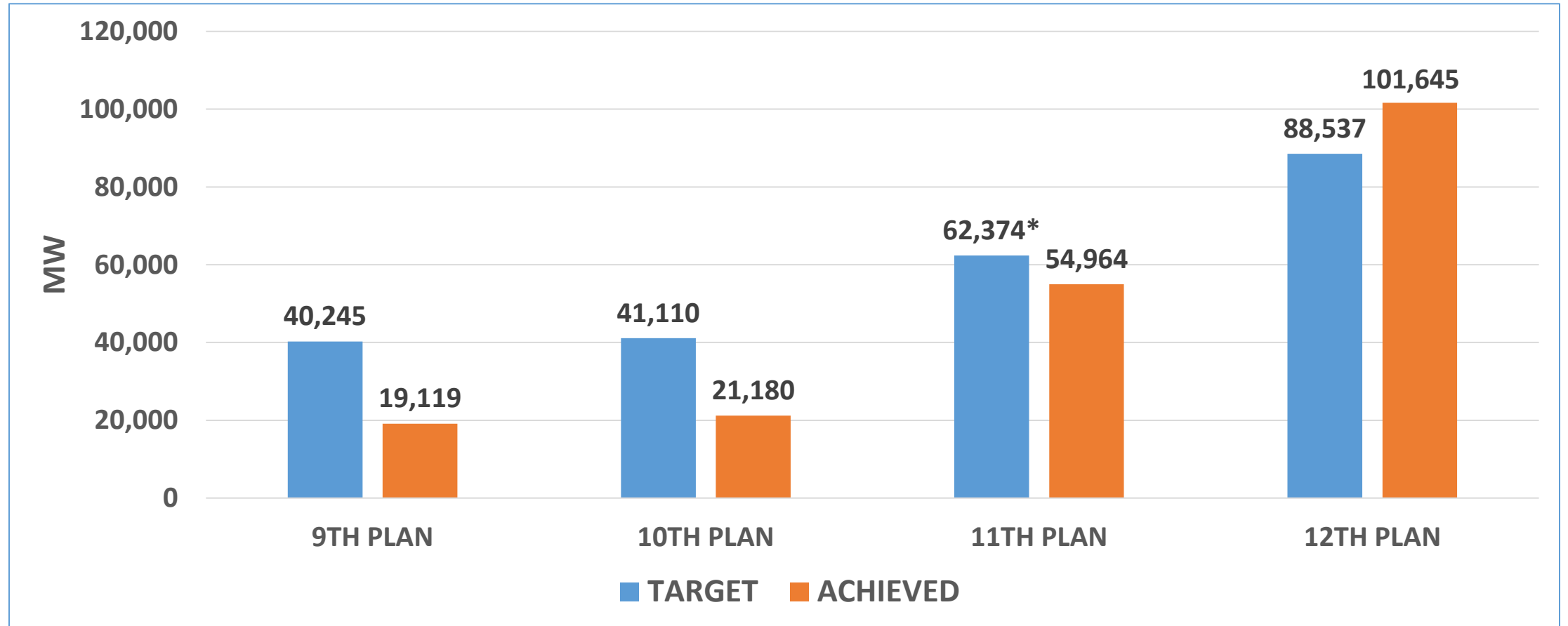
INSTALLED CAPACITY
(AT END OF March 2007)



INSTALLED CAPACITY
(AT END OF SEPTEMBER, 2016)



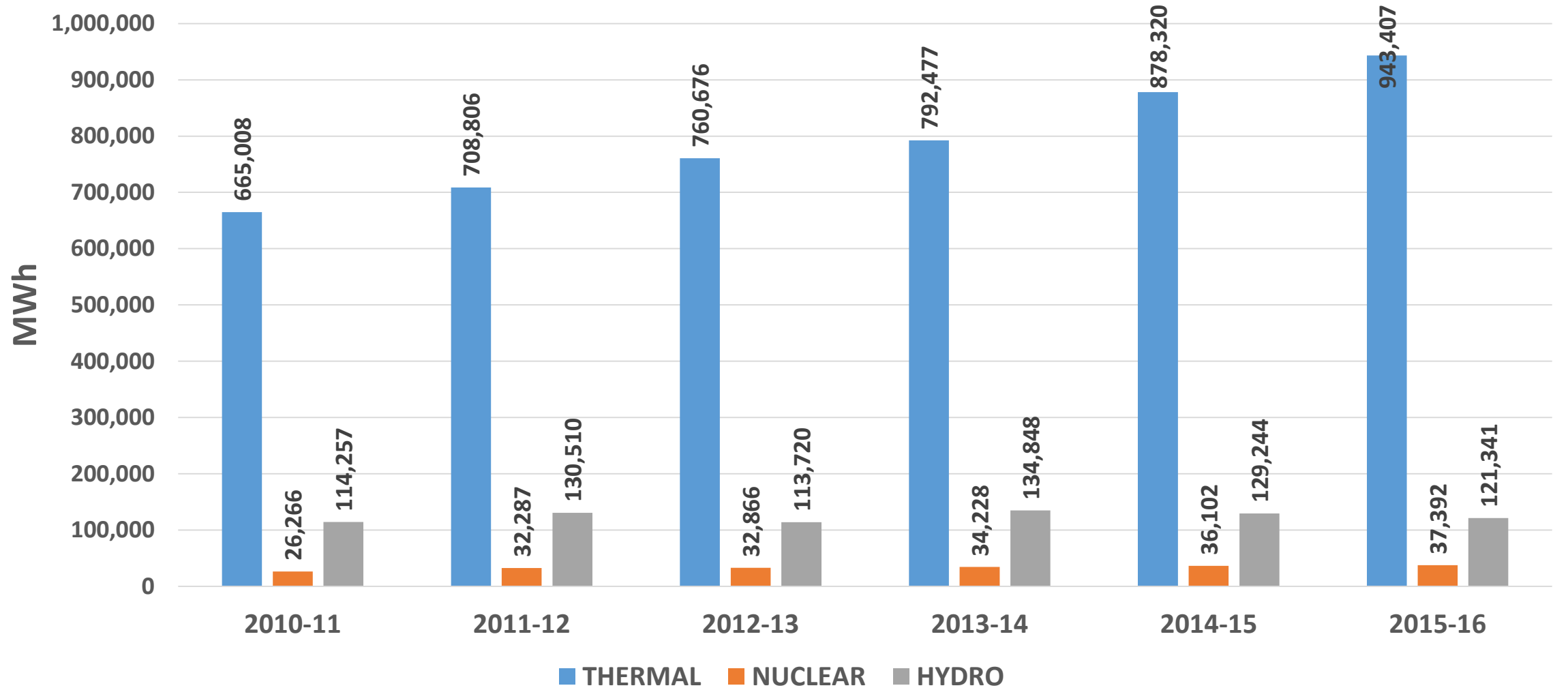
PLANWISE ALL INDIA CONVENTIONAL CAPACITY ADDITION TARGET VS ACHIEVEMENT



*AS PER MID TERM APPRAISAL

(FIGURES IN MW)

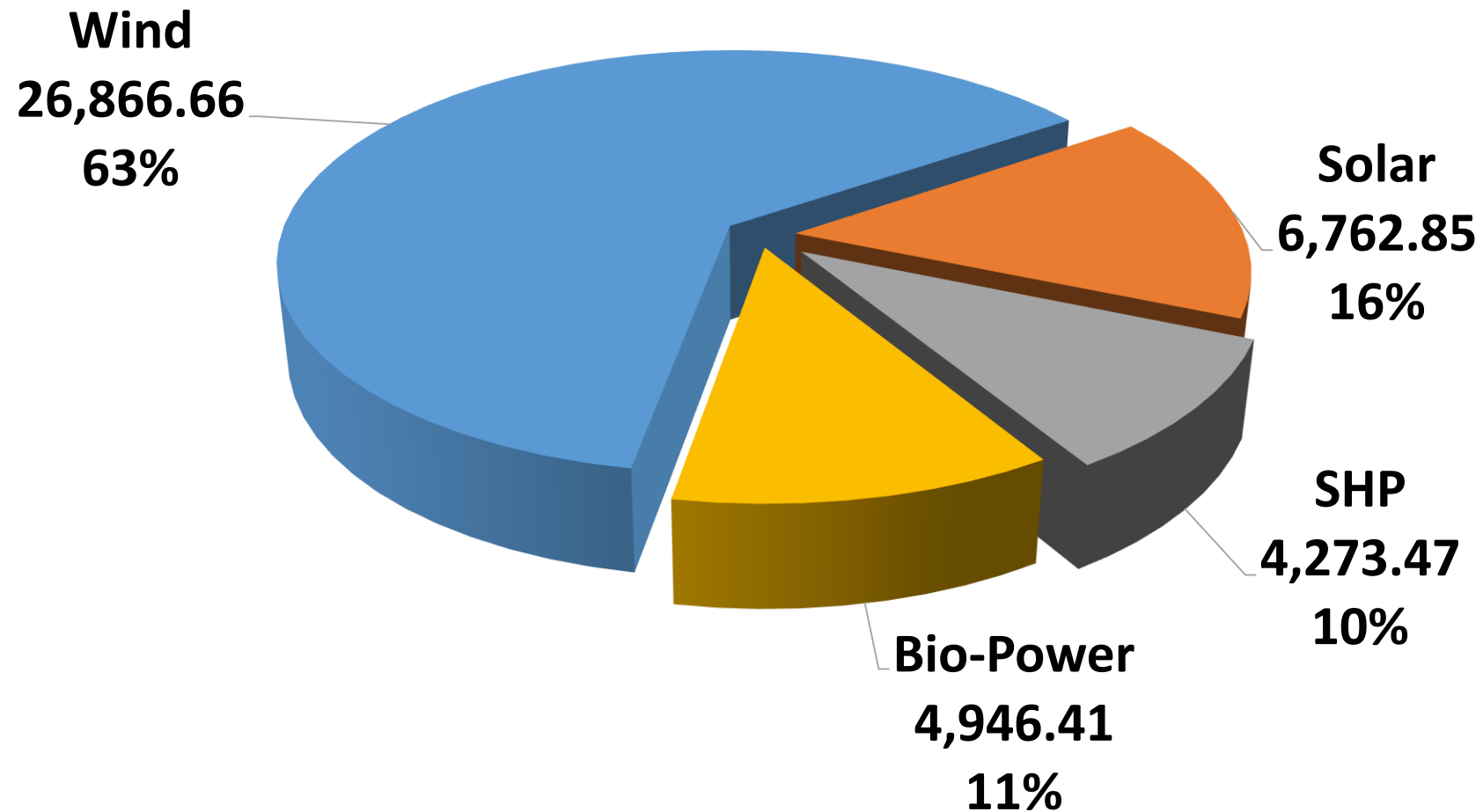
GROWTH OF ALL-INDIA CATEGORY WISE ACTUAL GENERATION



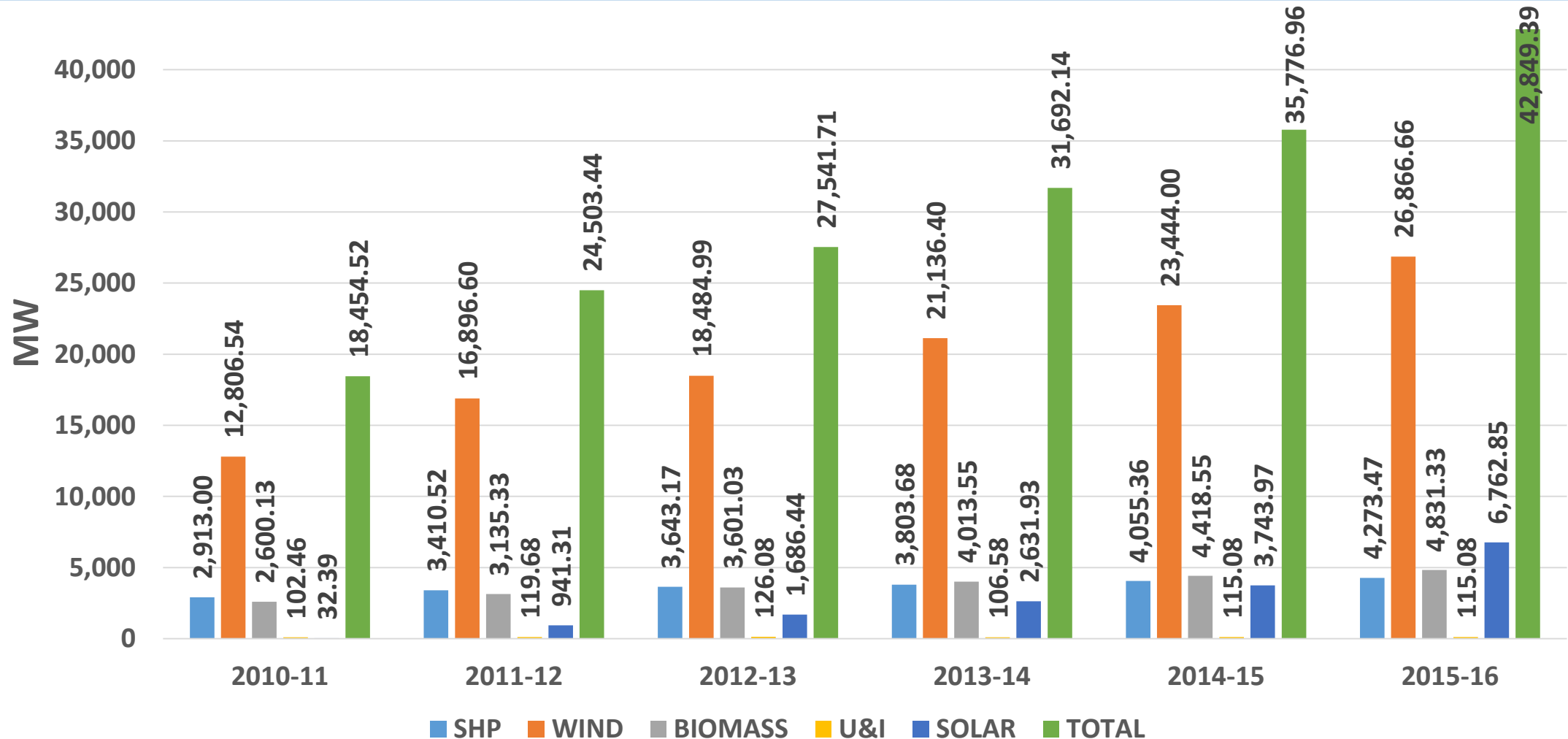
(FIGURES IN MWh)

INSTALLED CAPACITY OF RES (as on 31.03.2016)

ALL FIGURES in MW

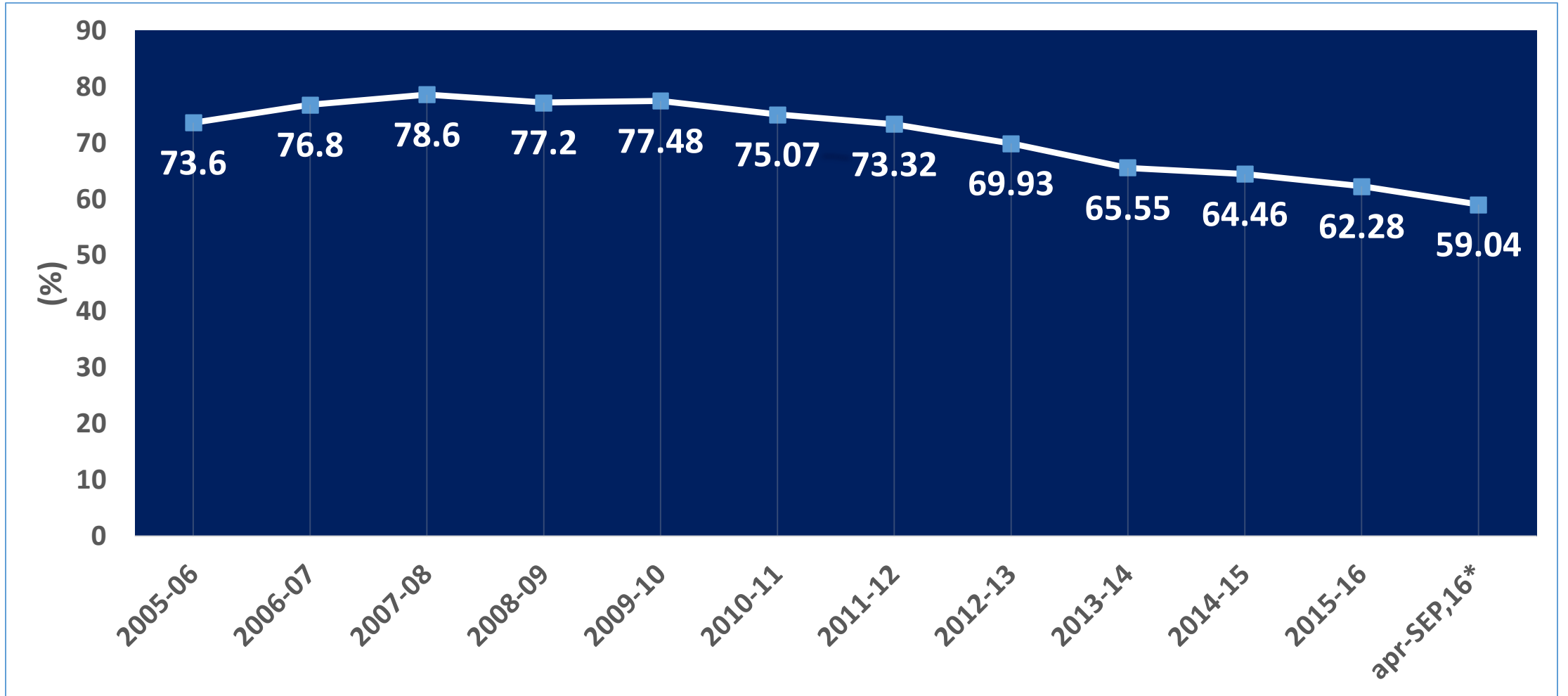


GROWTH OF ALL INDIA INSTALLED CAPACITY OF RES (CATEGORY WISE)



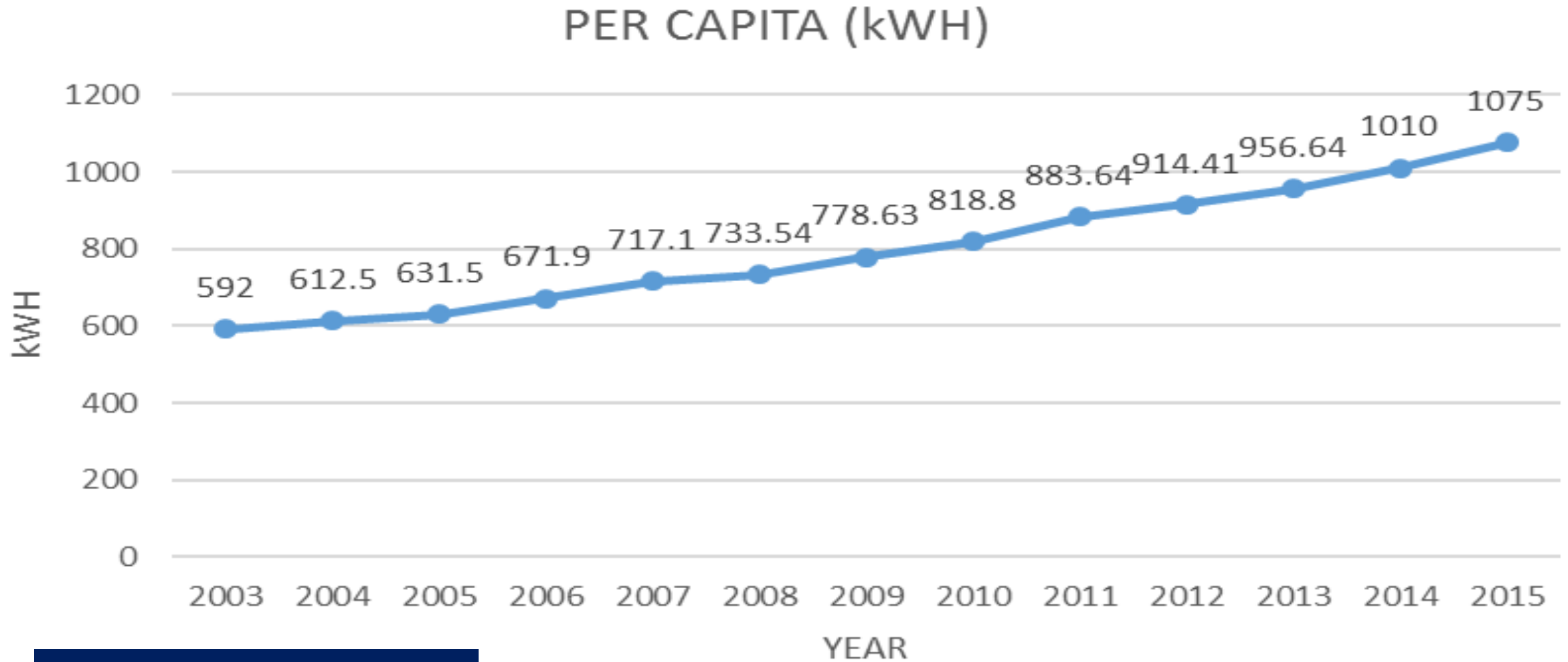
(FIGURES IN MW)

ALL INDIA THERMAL PLF (%)



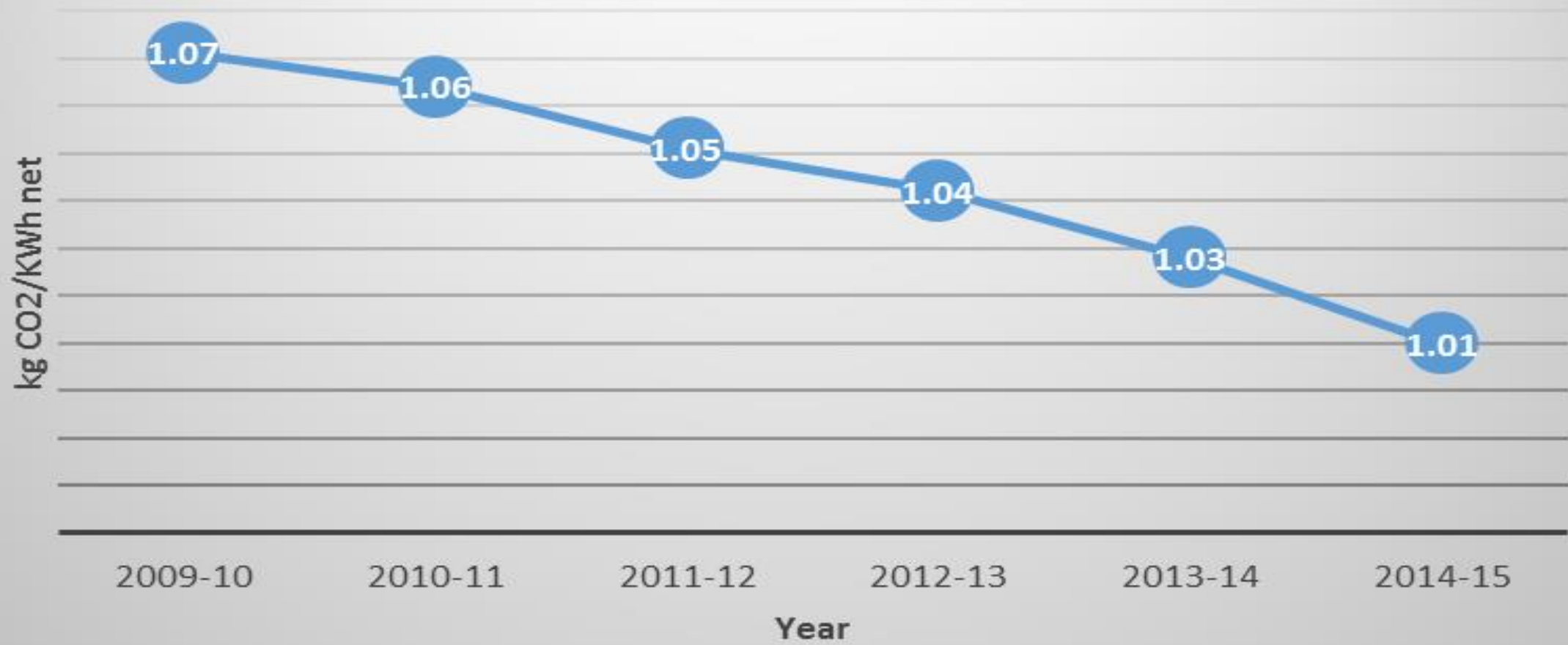
* PROVISIONAL

ALL INDIA ANNUAL PER CAPITA CONSUMPTION OF ELECTRICITY



16.3 in 1947

Average Emission rate from coal based power stations in kgCO₂/KWh net

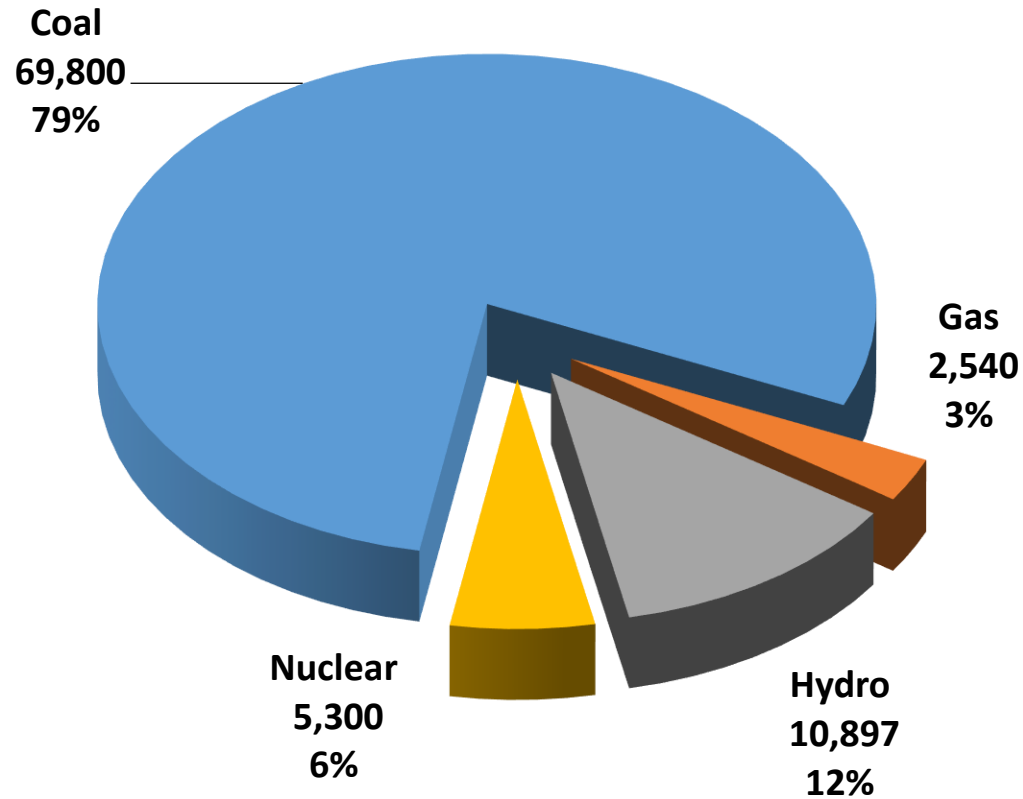


12th Plan Achievements

CONVENTIONAL CAPACITY ADDITION 2012-17 (Type wise)

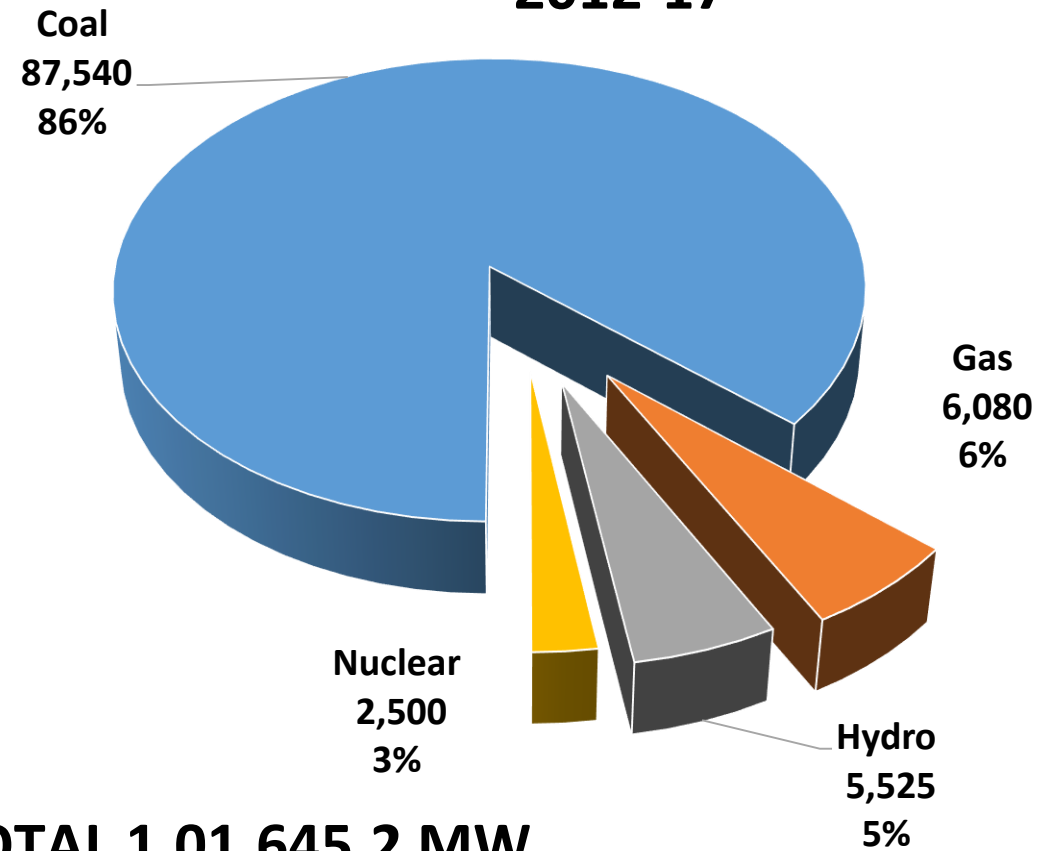
FIGURES in MW

12TH PLAN TARGET



TOTAL 88,537 MW

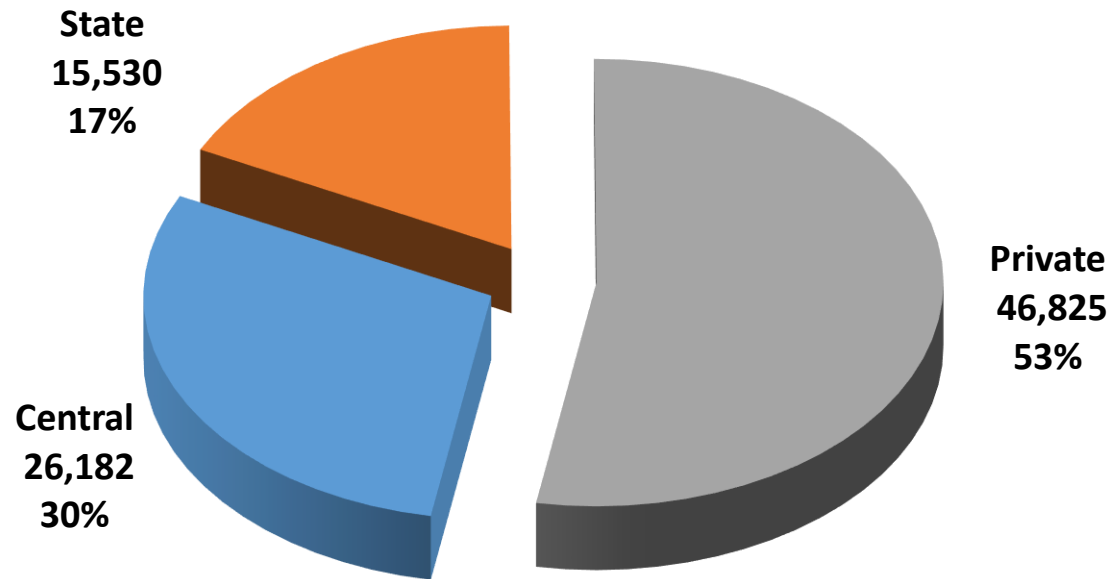
LIKELY CAPACITY ADDITION 2012-17



TOTAL 1,01,645.2 MW

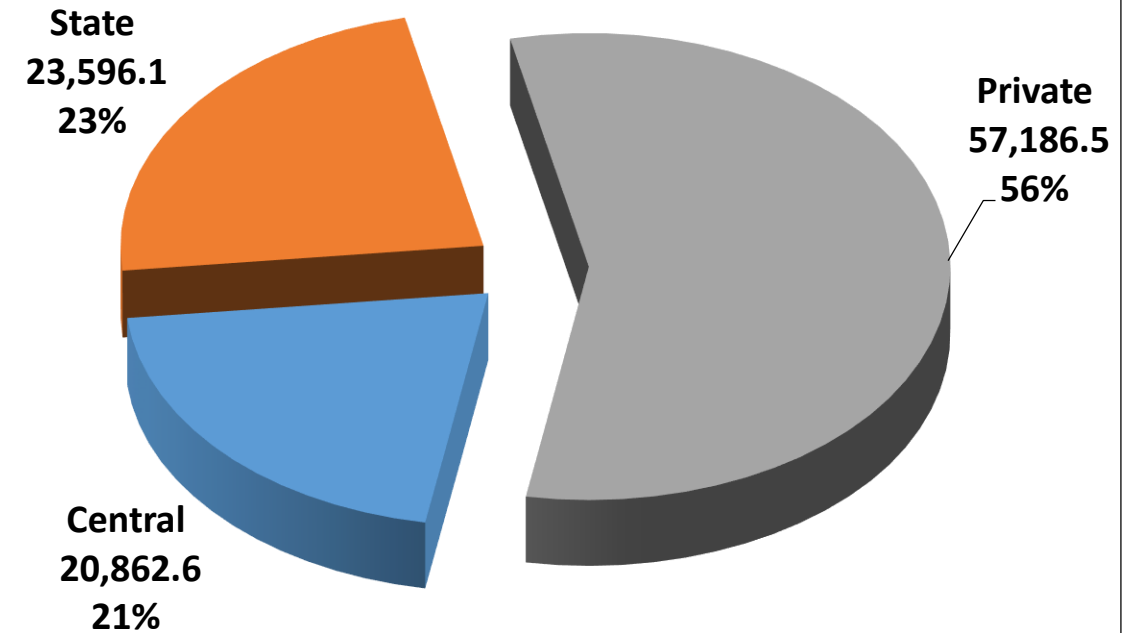
CONVENTIONAL CAPACITY ADDITION 2012-17 (Sector Wise)

12TH PLAN TARGET



TOTAL: 88,537 MW

LIKELY 12TH PLAN ACHIEVEMENT



TOTAL: 101,645 MW

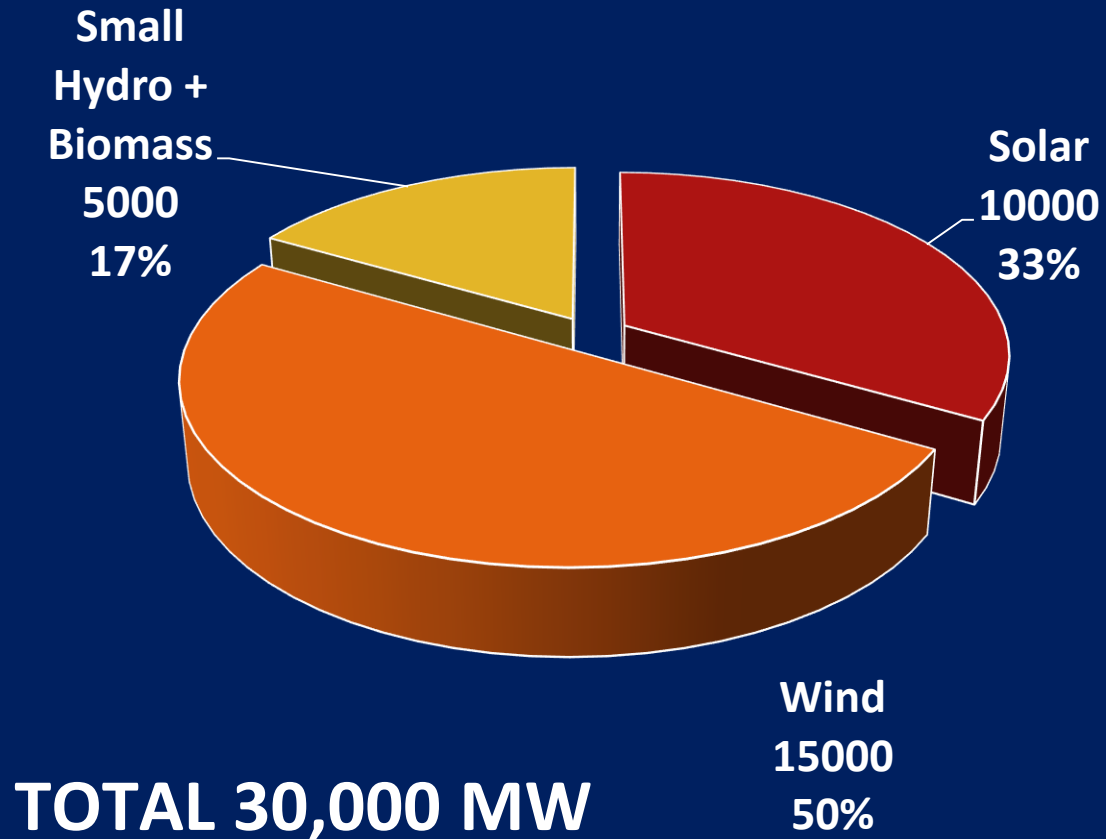
(FIGURES IN MW)



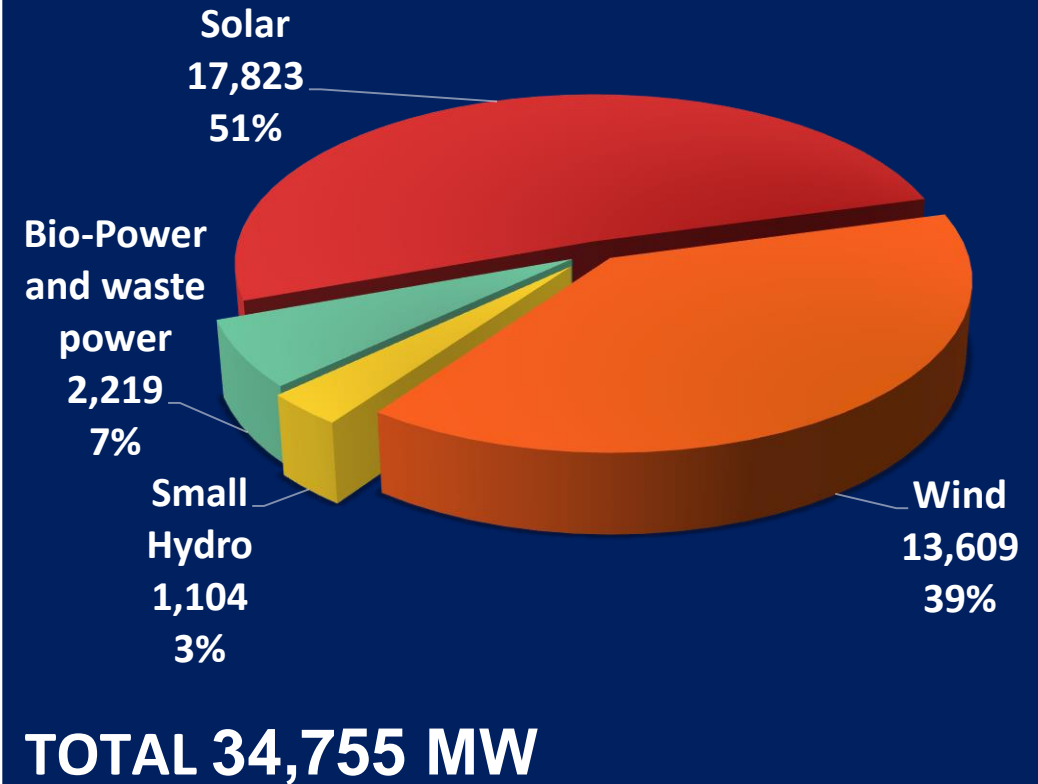
SUMMARY OF RENEWABLE CAPACITY ADDITION (2012-17)

FIGURES in MW

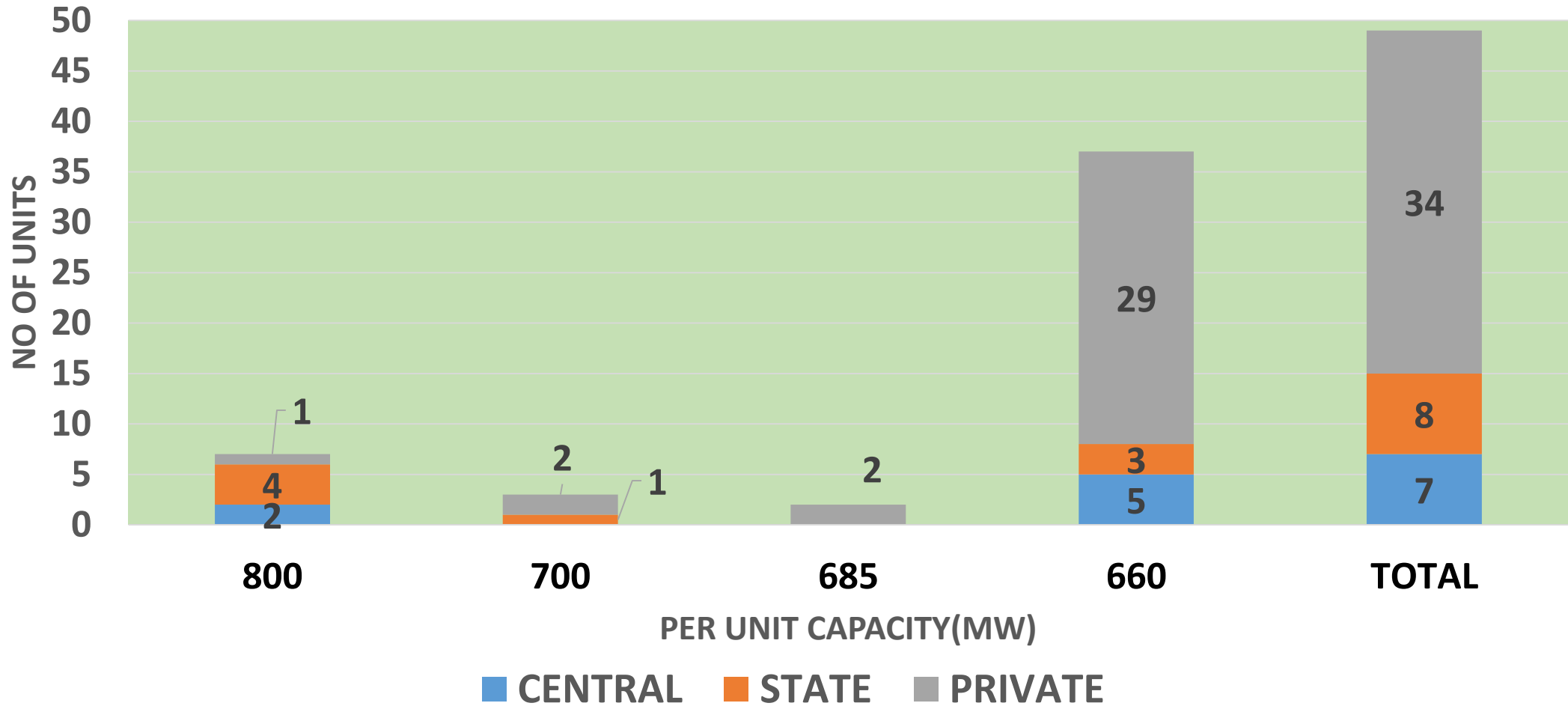
12th Plan Target



Likely 12th Plan Achievement



NO OF SUPER CRITICAL UNITS (SECTOR WISE) (likely in 2012-17)



FUTURE SCENARIO (2017-22)

ALL INDIA DEMAND PROJECTIONS (2021-22)

YEAR	ENERGY REQUIREMENT (BU)	PEAK DEMAND (GW)	REDUCTION DUE TO DSM		DEMAND AFTER DSM	
			ENERGY REQUIREMENT (BU)	PEAK DEMAND (GW)	ENERGY REQUIREMENT (BU)	PEAK DEMAND (GW)
2021-22	1748	244	137(7.83%)	9(3.68%)	1611	235

Committed capacity addition

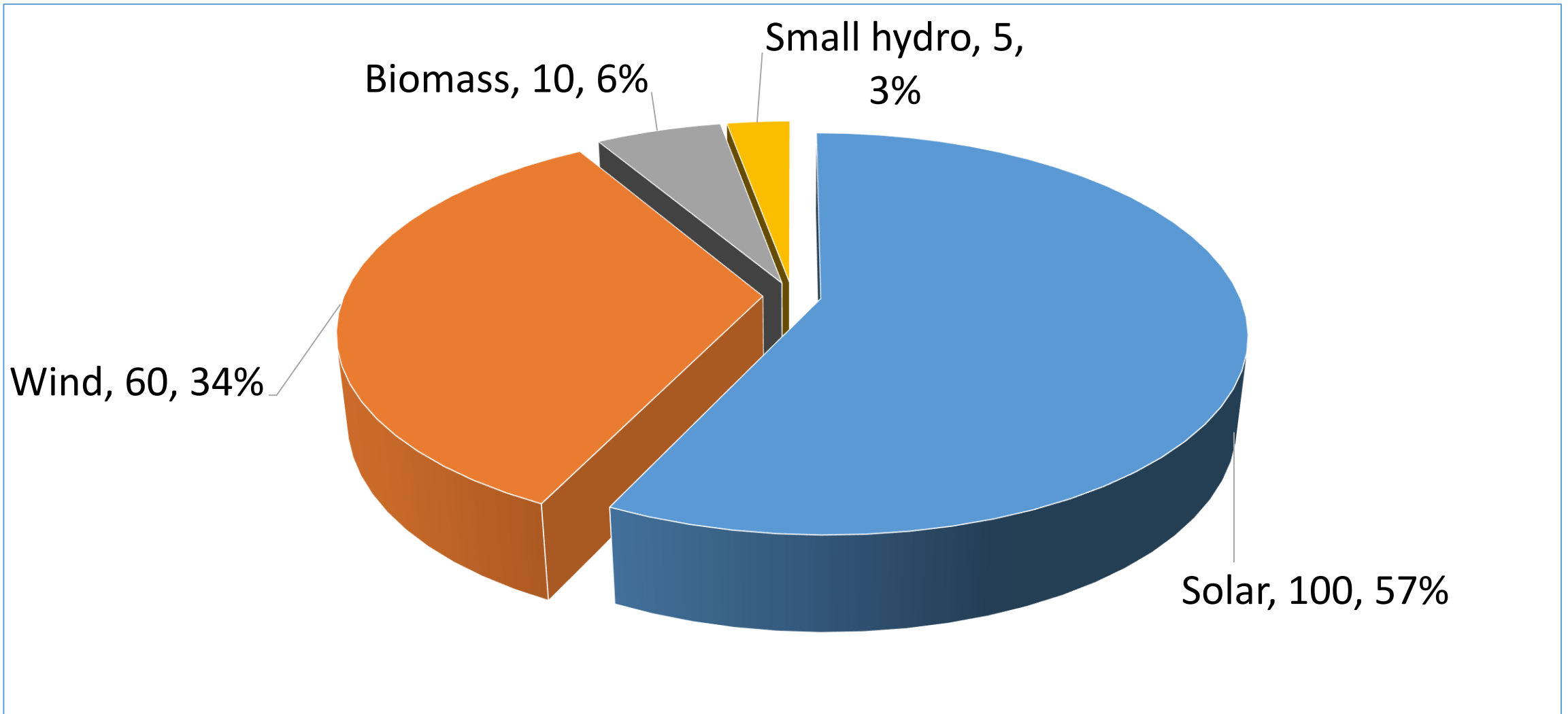
Conventional :

22470 MW (Hydro:15330 MW , Gas : 4340 MW, Nuclear:2800 MW)

Renewable:

175000 MW by 2022 (Solar : 100000 MW, Wind: 60000 MW, Biomass-10000 MW, Small Hydro :5000 MW)

RENEWABLE ENERGY TARGET BY 2022 (175 GW)



(FIGURES IN GW)

LIKELY ALL INDIA CAPACITY ADDITION AND PLF OF THERMAL PLANTS (2017-22)

Scenario (RES IC by 2022)	Committed Hydro (MW)	Committed Nuclear (MW)	Committed Gas (MW)	Additional Coal Based Capacity Required (MW)	Coal Based Generation (GWh) Gross (GWh) +++	PLF of Coal Based Plants (%)	RES Energy Contribution (GWh) in Total Energy requirement **
175GW	15330	2800	4340	0	1018	60.3* (47.9)	327 (20.3%)
150GW				0	1071	63.4 (50.4)	286 (17.7%)
125GW				0	1122	66.4 (52.8)	245 (15.2%)

• PLF has been computed based on the requirement of nil capacity addition from coal based power plants. Since a coal based capacity of 50,025 MW is under construction and likely to yield benefits during 2017-22., figures in bracket indicate PLF% including 50,025 MW.

+++ assuming Auxiliary Power consumption of coal stations as 6.5% ** Includes Solar, Wind, Bio mass and Small Hydro Generation

LIKELY CAPACITY ADDITION (MW) DURING THE YEARS 2017-22

HYDRO		15,330
THERMAL		
	COAL	50,025
	GAS	4,340
	TOTAL	54,365
NUCLEAR		2,800
RENEWABLES		115326
TOTAL		187821

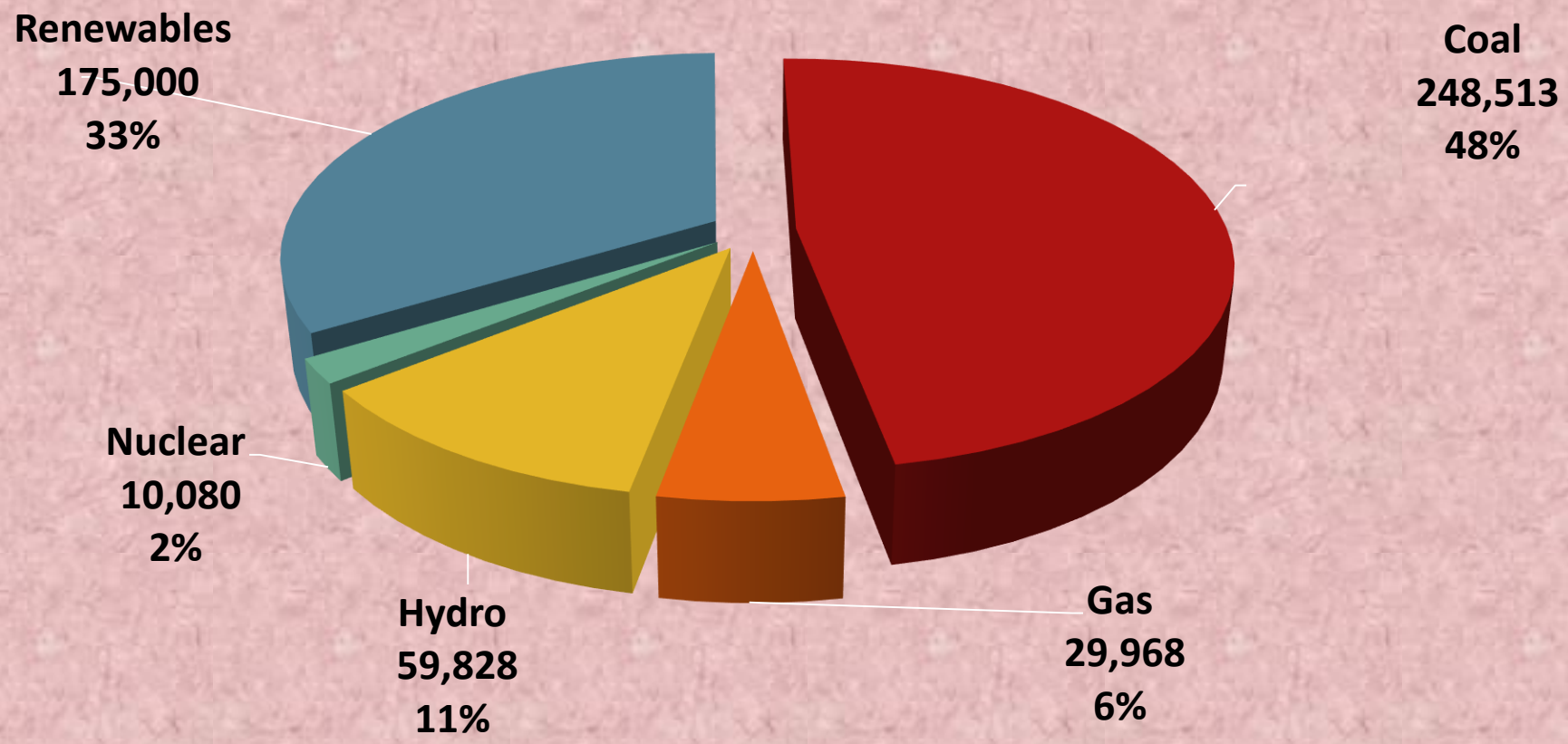


LIKELY INSTALLED CAPACITY

LIKELY INSTALLED CAPACITY BY END OF 2021-22

ALL FIGURES in MW

TOTAL 5,23,389 MW



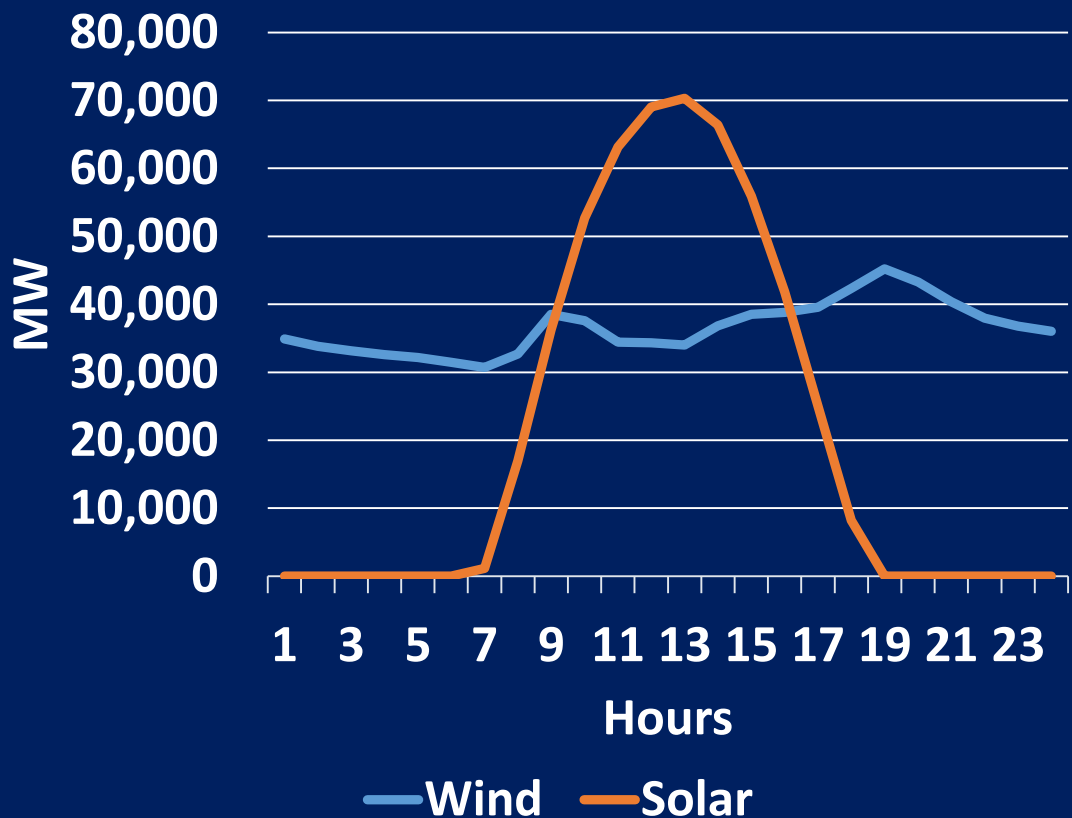
Including 50,025 MW of Coal based capacity addition currently under construction

Challenges in Integration of Renewables

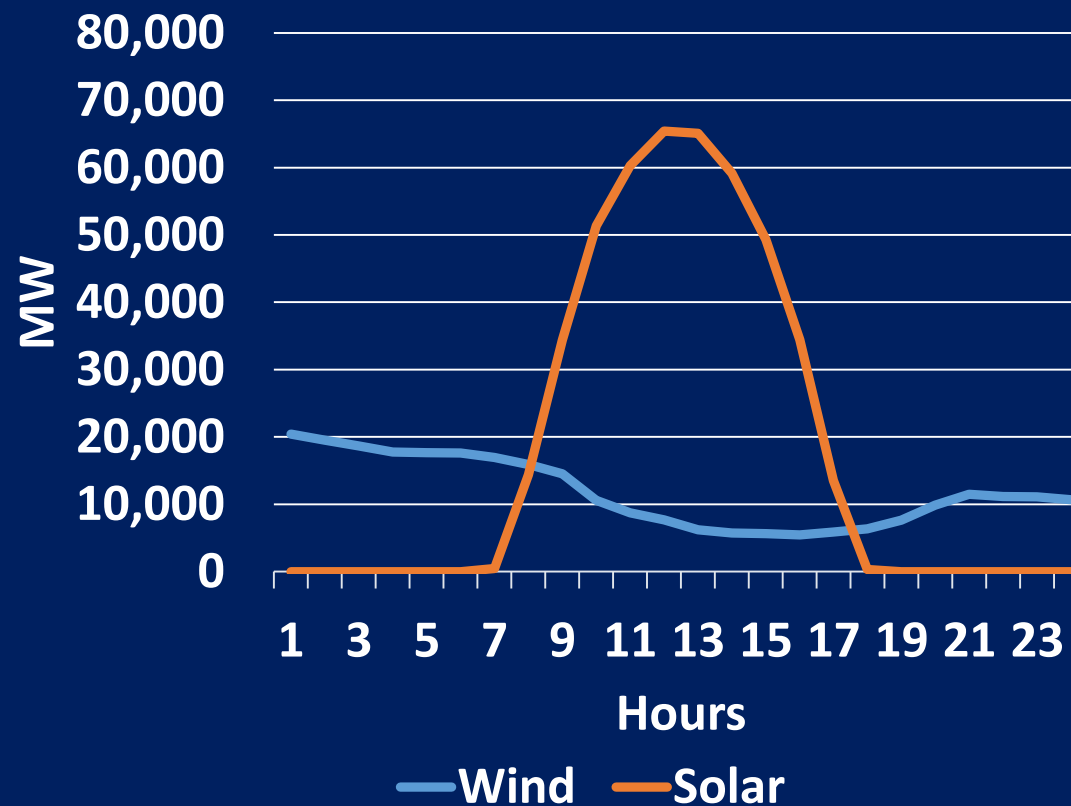


TYPICAL ALL INDIA GENERATION PROFILE OF SOLAR AND WIND GENERATION

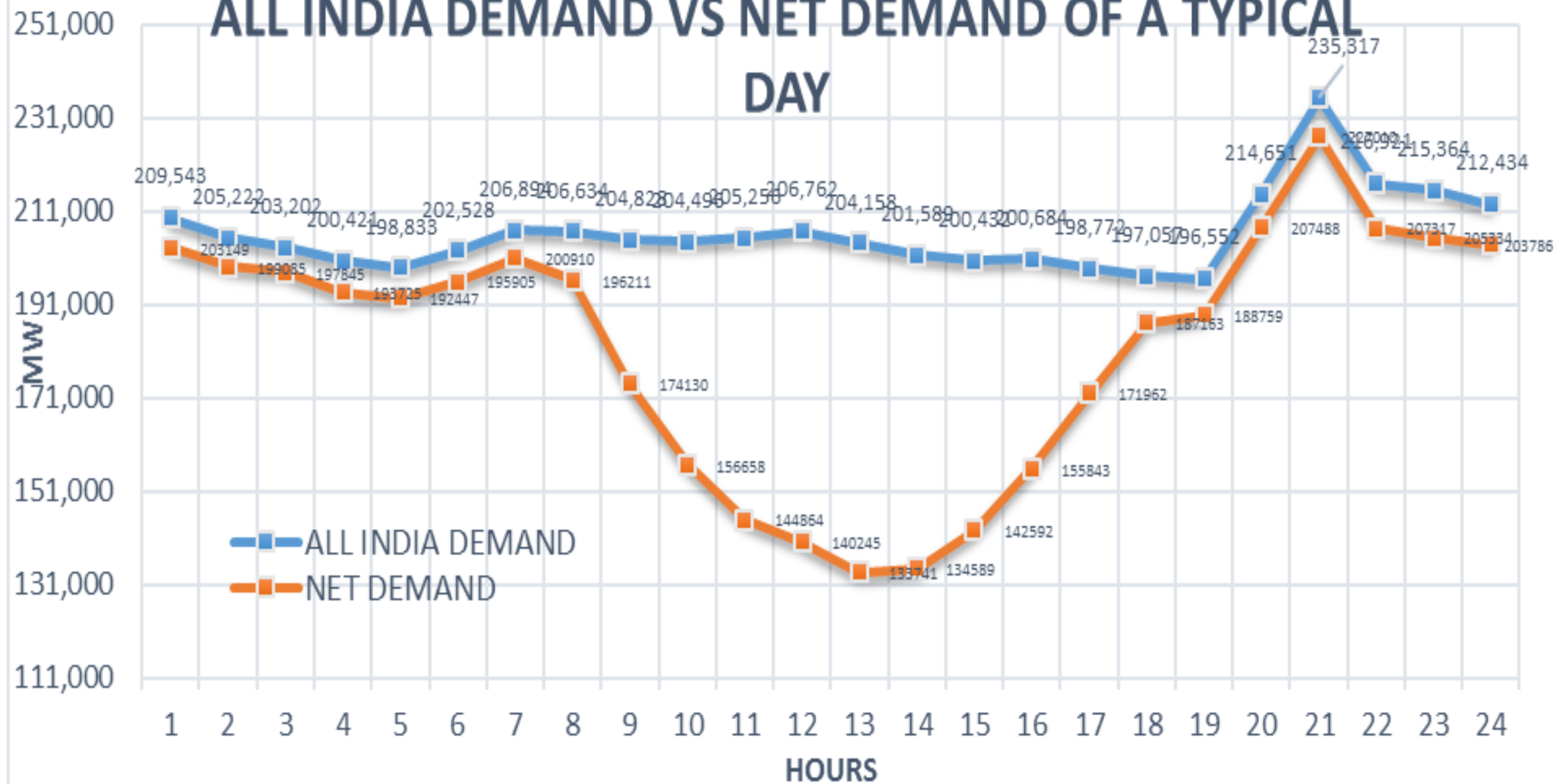
High Wind Months



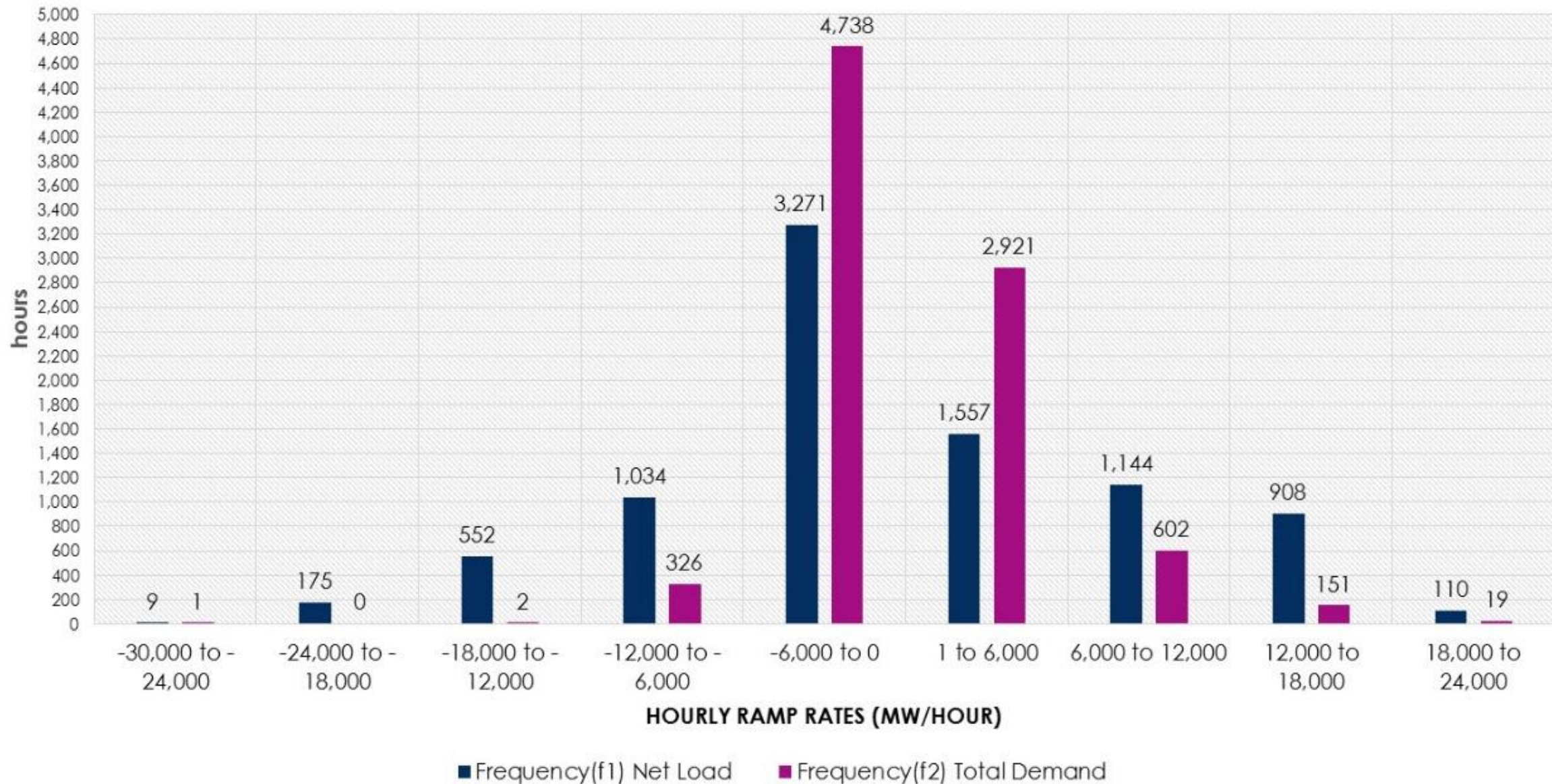
Low Wind Months



ALL INDIA DEMAND VS NET DEMAND OF A TYPICAL DAY



Frequency Distribution of Ramp over the year





PROJECTED CO₂ EMISSIONS FROM GRID CONNECTED POWER STATIONS

YEAR	Projected Total Carbon Emissions [#] (Million Tones)	Emission Rate* (KgCO ₂ /kWh)
2015-16	859	0.732
2021-22	983	0.581

* Including RES Generation.

Estimated

CARBON EMISSION INTENSITY FROM POWER SECTOR

India's Intended Nationally Determined Contribution (INDC)

- To reduce the emissions intensity of its GDP by 33% to 35 % by 2030 from 2005 level.

YEAR	2005	2022
Emission intensity from grid connected power stations (kgCO ₂ /Rs GDP)	0.0155479	0.0088617
Reduction in Emission Intensity (Base 2005)		43.00%

Note: The percentage may change depending on actual capacity addition and retirements.



LIKELY INSTALLED CAPACITY VS. SHARE OF FOSSIL FUEL

India's Intended Nationally Determined Contribution (INDC)

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

Year	Installed Capacity(IC) (GW)	IC of Fossil Fuel (GW)	IC of Non-Fossil Fuel (GW)	% of Non-Fossil Fuel in IC
March,2016	302.0	210.6	91.4	30.0%
March,2022 (likely)	523.4	278.5	244.9	46.8%

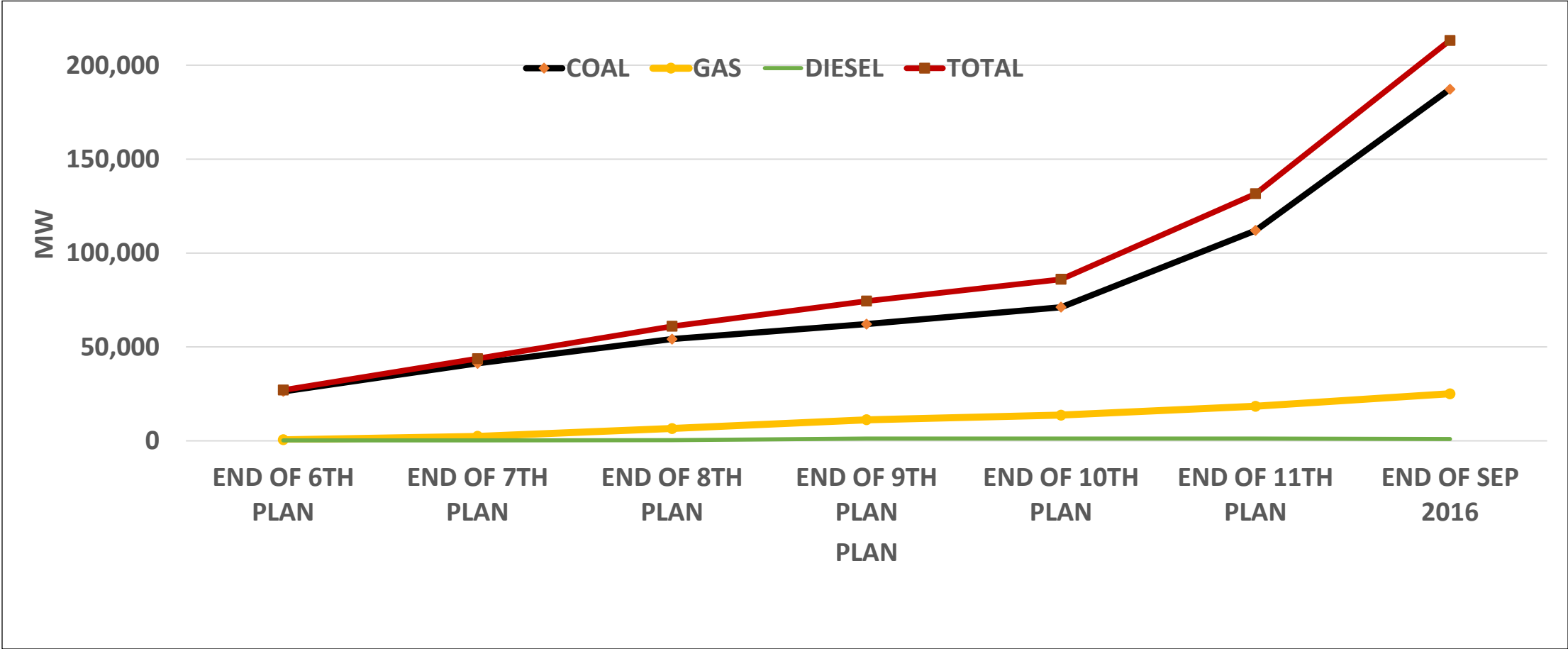
Note : 1. Non-Fossil fuels includes Hydro , Nuclear and RES sources.

2. The percentage share may change depending on actual capacity addition and retirements.

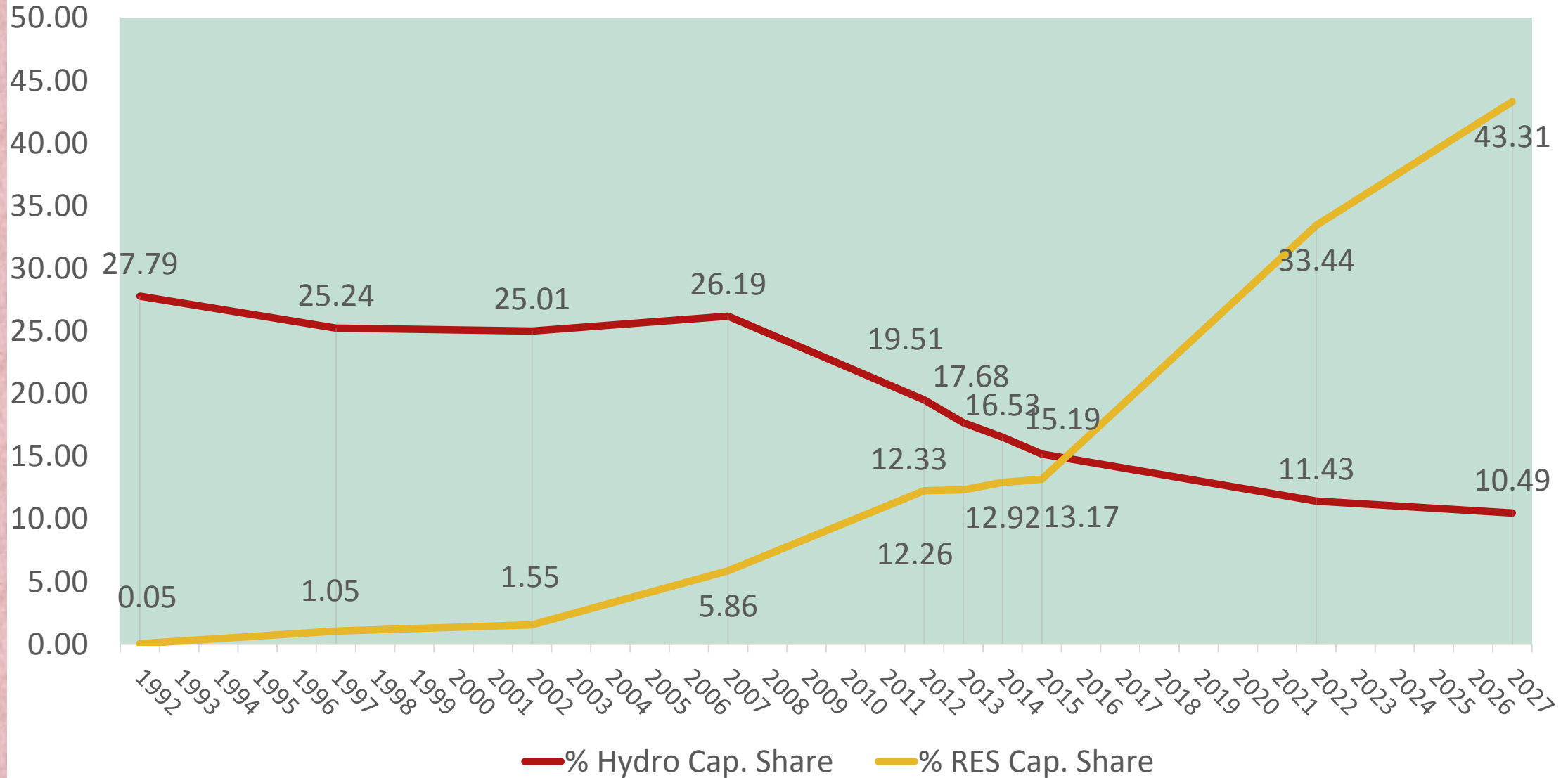
3. Includes 50,025 MW of Coal based capacity addition currently under construction and likely to yield benefits during 2017-22

THANK YOU

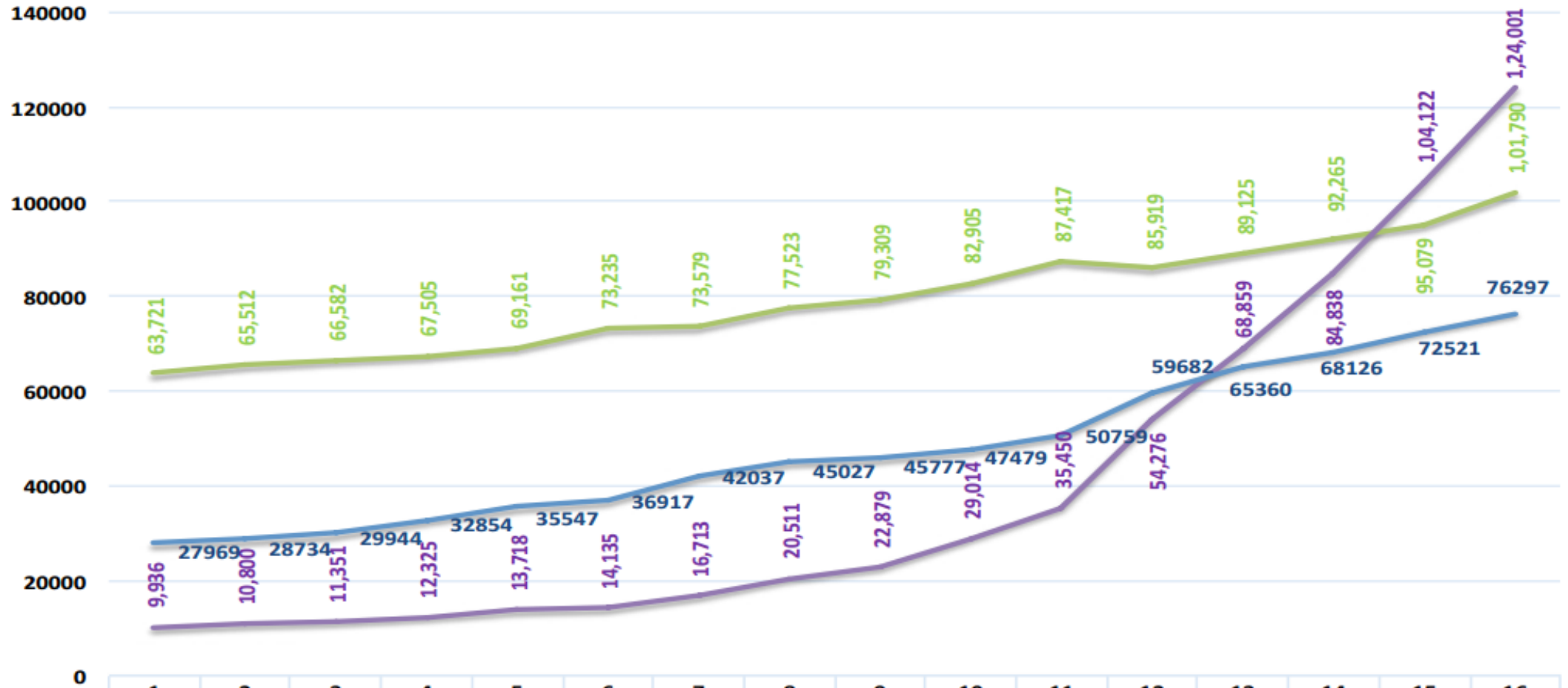
GROWTH OF THERMAL CAPACITY



% Capacity share of Hydro and RES in the Installed Capacity



GROWTH OF INSTALLED CAPACITY(SECTOR WISE)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
State	63721	65512	66582	67505	69161	73235	73579	77523	79309	82905	87417	85919	89125	92265	95079	101790
Private	9936	10800	11351	12325	13718	14135	16713	20511	22879	29014	35450	54276	68859	84838	104122	124001
Central	27969	28734	29944	32854	35547	36917	42037	45027	45777	47479	50759	59682	65360	68126	72521	76297

ALL INDIA INSTALLED CAPACITY AS ON 30.09.2016

(FIGURES IN MW)

SECTOR	HYDRO	THERMAL			NUCLEAR	R.E.S (MNRE)	TOTAL	
		COAL	GAS	DIESEL				TOTAL
STATE	28341.00	64210.50	7210.70	363.93	71785.13	0.00	1963.80	102089.93
PRIVATE	3120.00	71652.38	10355.60	554.96	82562.94	0.00	42273.12	127956.06
CENTRAL	11651.43	51390.00	7490.83	0.00	58880.83	5780.00	0.00	76312.26
TOTAL	43112.43	187252.88	25057.13	918.89	213228.90	5780.00	44236.92	306358.25
%	14.07	61.12	8.18	0.30	69.60	1.89	14.44	100.00

UNIT WISE BREAK UP OF INSTALLED CAPACITY (MW)

UNIT CAPACITY MW	BEFORE 31.03.2003 (MW)	NO OF UNITS	01.01.2004 ONWARDS (MW)	NO OF UNITS	TOTAL MW
60-110 MW	6875	77	258	4	7133
111-250 MW	39277	198	17211	81	56488
251-499 MW	0	0	12690	43	12690
500 MW	13500	27	27500	55	41000
>500 MW	0	0	61640	96	61640
TOTAL	59652	302	119299	279	178951

* UNITS BELOW 60 MW NOT INDICATED IN ABOVE TABLE

GROWTH OF INSTALLED CAPACITY(CATEGORY WISE)

PLAN/YEAR	THERMAL				NUCLEAR	HYDRO	RES (MNRE)	TOTAL
	COAL	GAS	DIESEL	TOTAL				
End of 9 th Plan	62130.88	11163.1	1134.83	74,428.81	2720	26268.76	1628.39	1,05,045.96
End of 10 th Plan	71121.38	13691.71	1201.75	86,014.84	3900	34653.77	7760.6	1,32,329.21
End of 11 th Plan	112022.38	18381.05	1199.75	1,31,603.18	4780	38990.4	24503.45	1,99,877.03
End of Sep,2016	187252.88	25057.13	918.82	2,13,228.83	5780	43112.43	44236.92	3,06,358.18

(FIGURES IN MW)

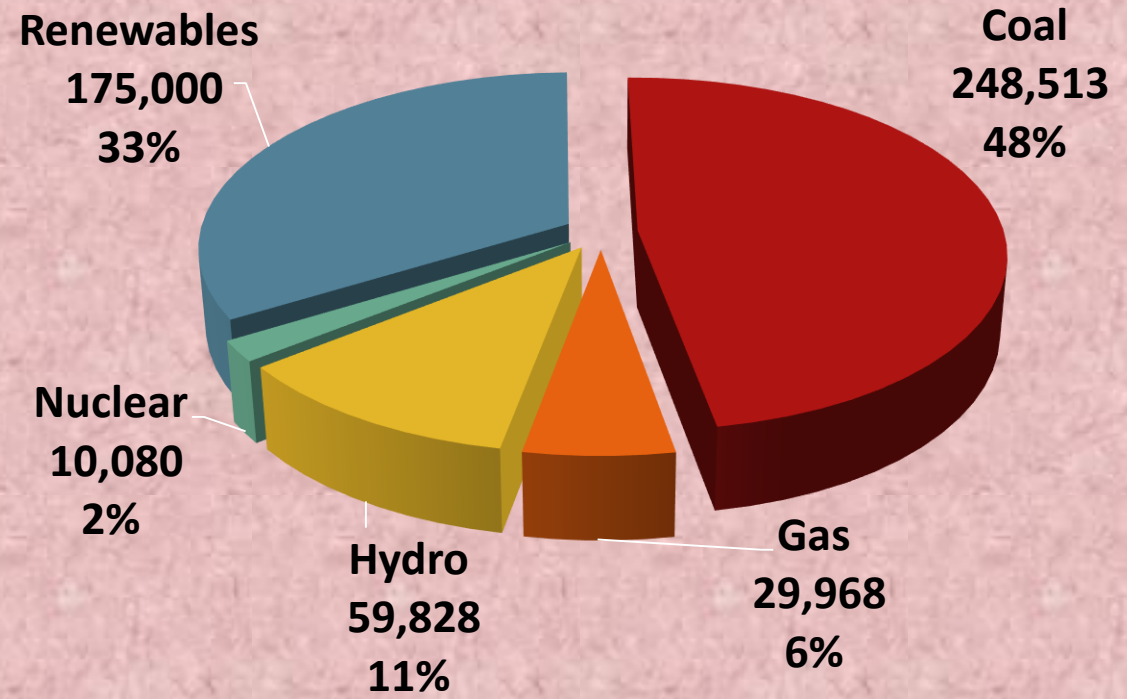


LIKELY INSTALLED CAPACITY

ALL FIGURES in MW

LIKELY INSTALLED CAPACITY BY END OF 2021-22

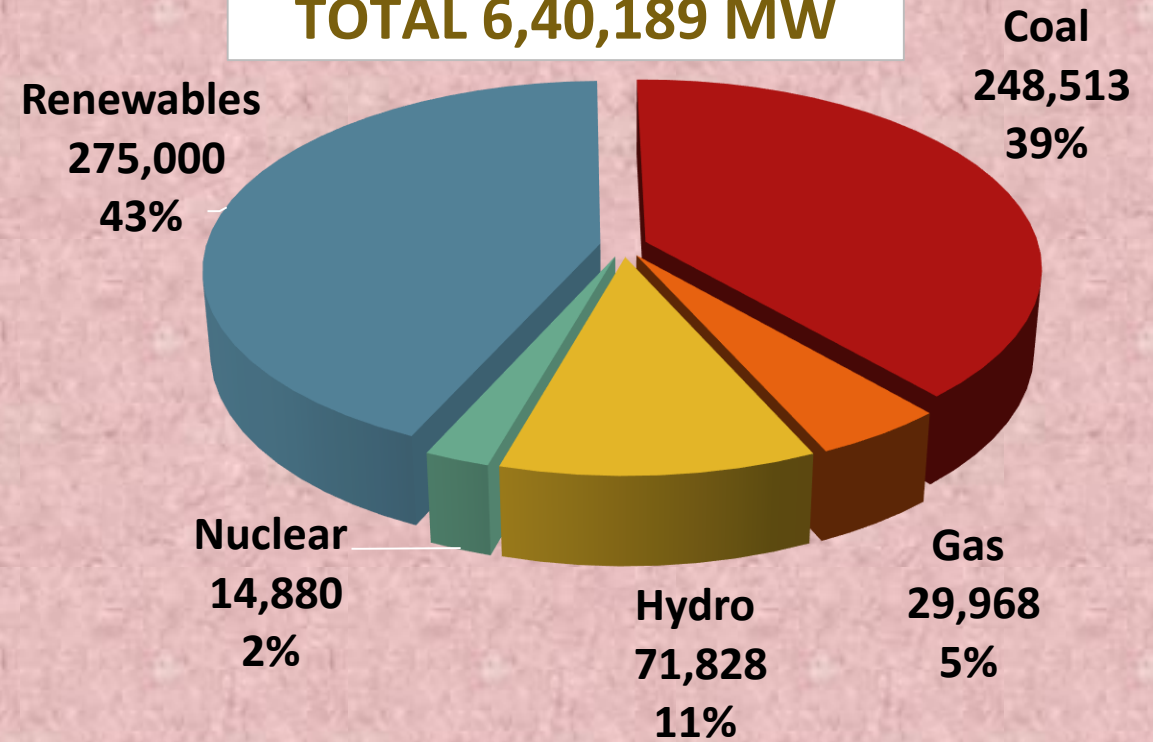
TOTAL 5,23,389 MW



Including 50,025 MW of Coal based capacity addition currently under construction

LIKELY INSTALLED CAPACITY BY END OF 2026-27

TOTAL 6,40,189 MW



Including 50,025 MW of Coal based capacity addition currently under construction and NO coal based capacity addition during 2022-27



SUMMARY OF LIKELY CAPACITY ADDITION DURING 12TH PLAN (2012-17)

FIGURES in MW

A	12th Plan Capacity Addition Target	88,537
B	Capacity addition as per target during 12th Plan as on 31.03.2016	57,721
C	Capacity likely to be added as per target during balance period (2016-17) of 12th Plan	9,420
D	Capacity likely to be slipped as per target during 12th Plan	21,386
E	Capacity addition outside target during 12th Plan as on 31.03.2016	27,270
F	Capacity Addition Likely during balance period (2016-17) of 12th plan outside capacity addition target	7,235
Total Capacity addition likely during 12th Plan as per target(B+C)		67,141
Total Capacity addition likely during 12th Plan outside target(E+F)		34,504
Total Capacity addition likely during 12th Plan (B+C+E+F)		1,01,645

PROJECTED PER CAPITA CONSUMPTION OF ELECTRICITY

YEAR	PER CAPITA CONSUMPTION (kwh/capita)
2015-16	1075
2021-22	1487

Generation Planning

FINDINGS

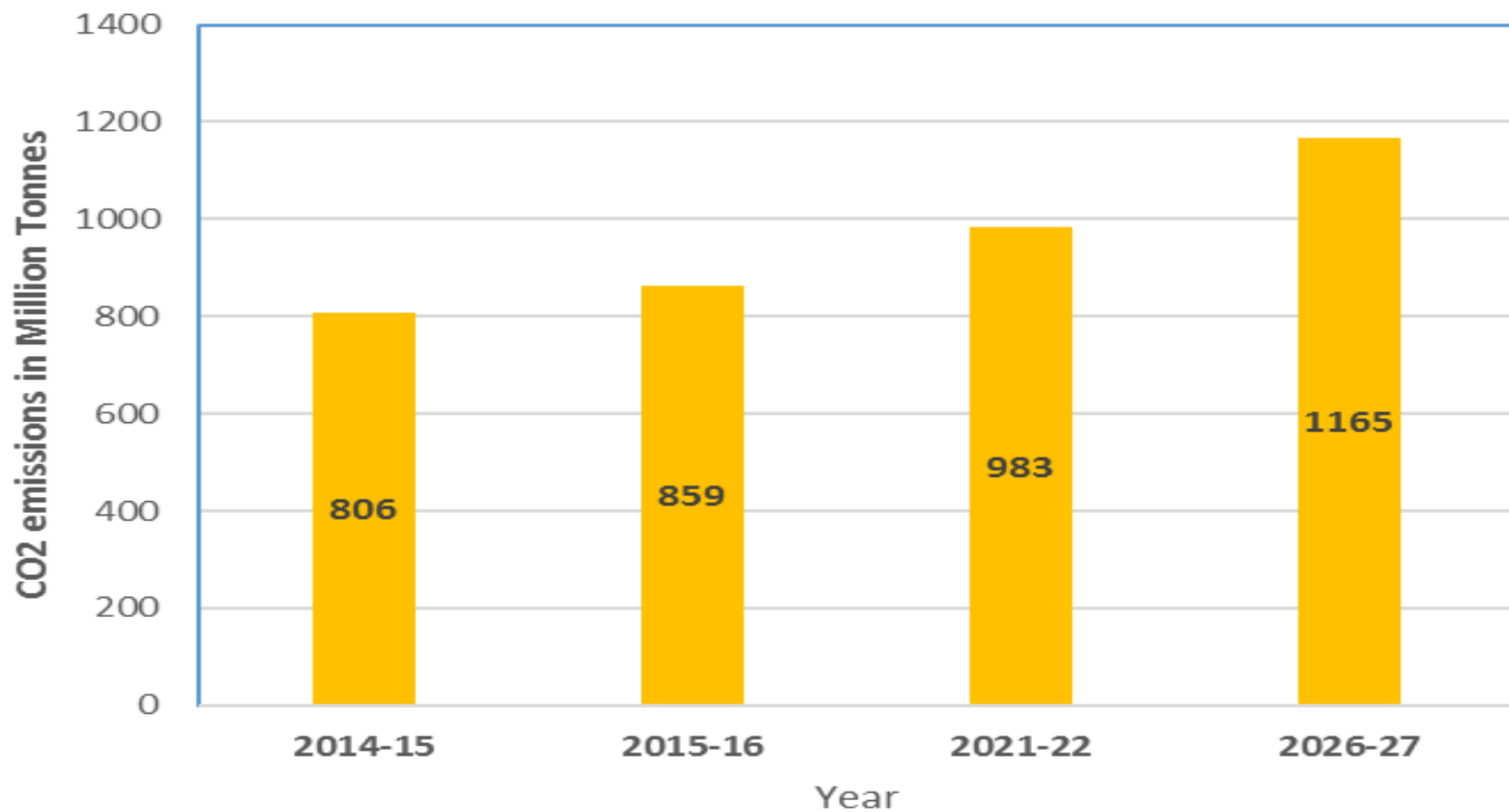
- With 50,025 MW of coal based capacity expected between 2017-22 along with the committed capacity of 22,470 MW from Hydro, Nuclear and Gas, there may not be any further requirement of additional capacity during 2017-22. Further, for 2022-27, capacity addition requirement will be assessed based on Mid term Review of Demand.
- The Plant load factor of the coal based power plants may vary between 50% to 60% depending upon variation in Electricity Demand and achievement in capacity addition from conventional and Renewable Energy Sources.
- Total coal requirement may be around 730-800 MT in 2021-22

Generation Planning contd.

FINDINGS

- Renewable Energy Sources to contribute around 20% of the Total Energy Requirement by 2021-22.
- Share of Non-fossil fuel installed capacity to increase to 47% by March,2022.
- Coal power plants need to have enhanced ramping capability
- Minimum technical limit for Coal power plants may have to be revised downward.
- Gas and Hydro Power Plants need to play a major role in meeting the ramping & balancing requirement

Total Projected CO2 Emissions in Million Tonnes



ALL INDIA INSTALLED CAPACITY (AT THE END OF 11TH PLAN)

SECTOR	HYDRO	THERMAL			NUCLEAR	R.E.S (MNRE)	TOTAL
		COAL	GAS	DIESEL			
CENTRAL	9085.4	39115	6702.23	0	4780	0	59682.63
STATE	27380	49457	4965.32	602.61	0	3513.72	85918.65
PRIVATE	2525	23450.38	6713.5	597.14	0	20989.73	54275.75
TOTAL	38990.4	112022.4	18381.05	1199.75	4780	24503.45	199877.03
%	19.51	56.05	9.20	0.60	2.39	12.26	100.00

(FIGURES IN MW)

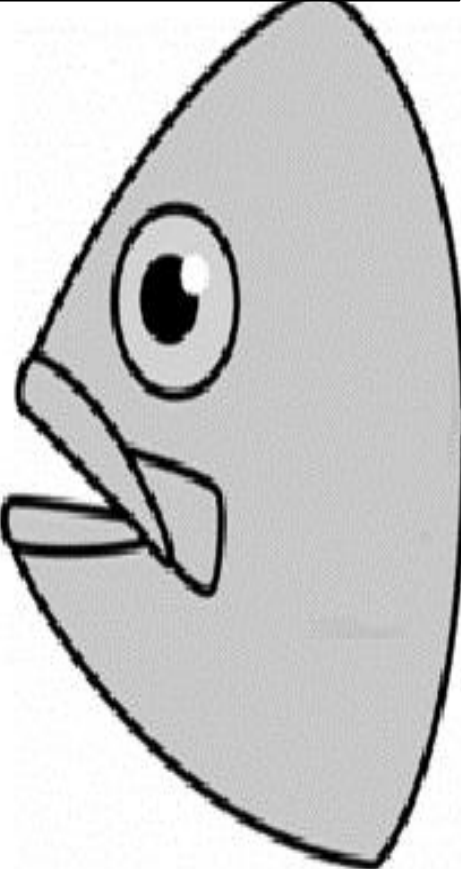
All- India Category wise Actual Generation

Category	2010-11		2011-12		2012-13		2013-14		2014-15		2015-16	
	Target (MU)	Actual Generation (MU)	Target (MU)	Actual Generation (MU)	Target (MU)	Actual Generation (MU)	Target (MU)	Actual Generation (MU)	Target (MU)	Actual Generation (MU)	Target (MU)	Actual Generation (MU)
Thermal	690857	665008.1	712234	708805.9	767275	760675.8	812737	792477.1	858603	878320.0	966700	943407.4
Nuclear	22000	26266.4	25130	32286.6	35200	32866.11	35200	34227.79	35300	36101.54	38000	37392.47
Hydro	111352	114257.4	112050	130509.5	122045	113720	122263	134847.5	124297	129243.7	128000	121341.1
Bhutan Import	6548	5610.9	5586	5284.5	5480	4794.50	4800	5597.90	4800	5007.74	4800	5244.74
All India (Total)	830757	811142.8	855000	876886.5	930000	912056.7	975000	967150.3	1023000	1048673	1137500	1107386

FISH BONE ANALYSIS

EFFECT

Low Capacity Addition Requirement in 2017-22



CAUSES

Low demand projections for 2021-22

39 GW lower Peak Demand than 18th EPS projections.
293 BU lower Energy Requirement than 18th EPS projections.

Excess Capacity Addition in 12th Plan (2012-17)

13GW from Conventional Sources.
4.75 GW from RES.

Increase from 30.5 GW to 115 GW

Additional Peak Contribution of about 5 GW

Revised Renewable Energy Sources target During 2017-22

Reduction in Peak Demand by 9 GW

Reduction in Energy Requirement by 137 BU

Demand Side Management & Energy Conservation Measures



