

Power Procurement Planning for Uttar Pradesh

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Power For All - A joint initiative of Central Government with the State Government

Objective - Provide 24x7 power

through:

- Village Electrification
- Capacity Addition
- Power Purchase Plan
- Strong T & D
- Encourage Renewable Energy
- Customer Centric Initiative
- Reducing AT & C Losses
- Reducing ACS to ARR difference

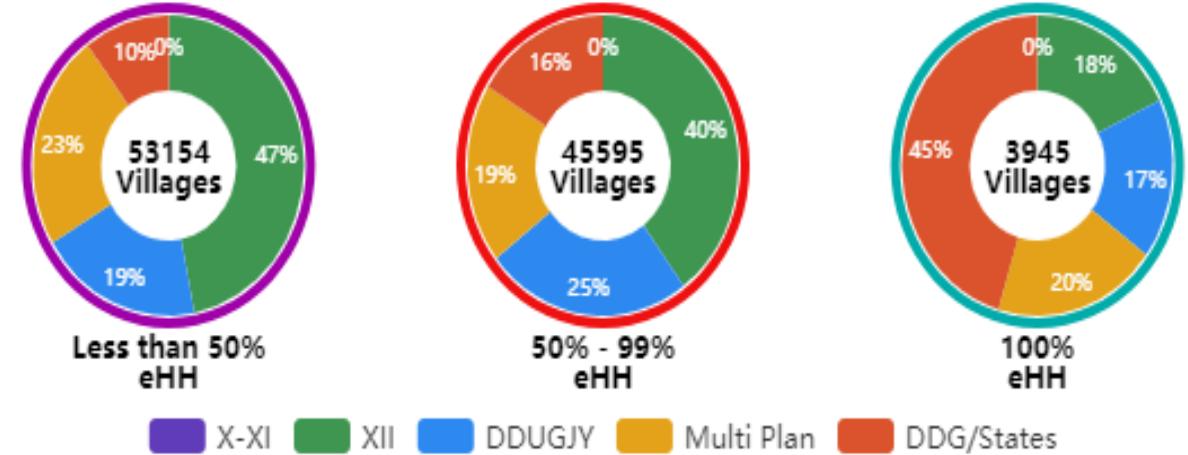
Currently, Average power supply *

Rural areas	18 hours
Tehsil towns and Bundelkhand	20 hours
District headquarters, cities and industries	24 hours

* Source -projections as per census, 24x7 Power for All document

Discom: Uttar Pradesh

Total Villages 102694
House Hold Electrified 50.13%



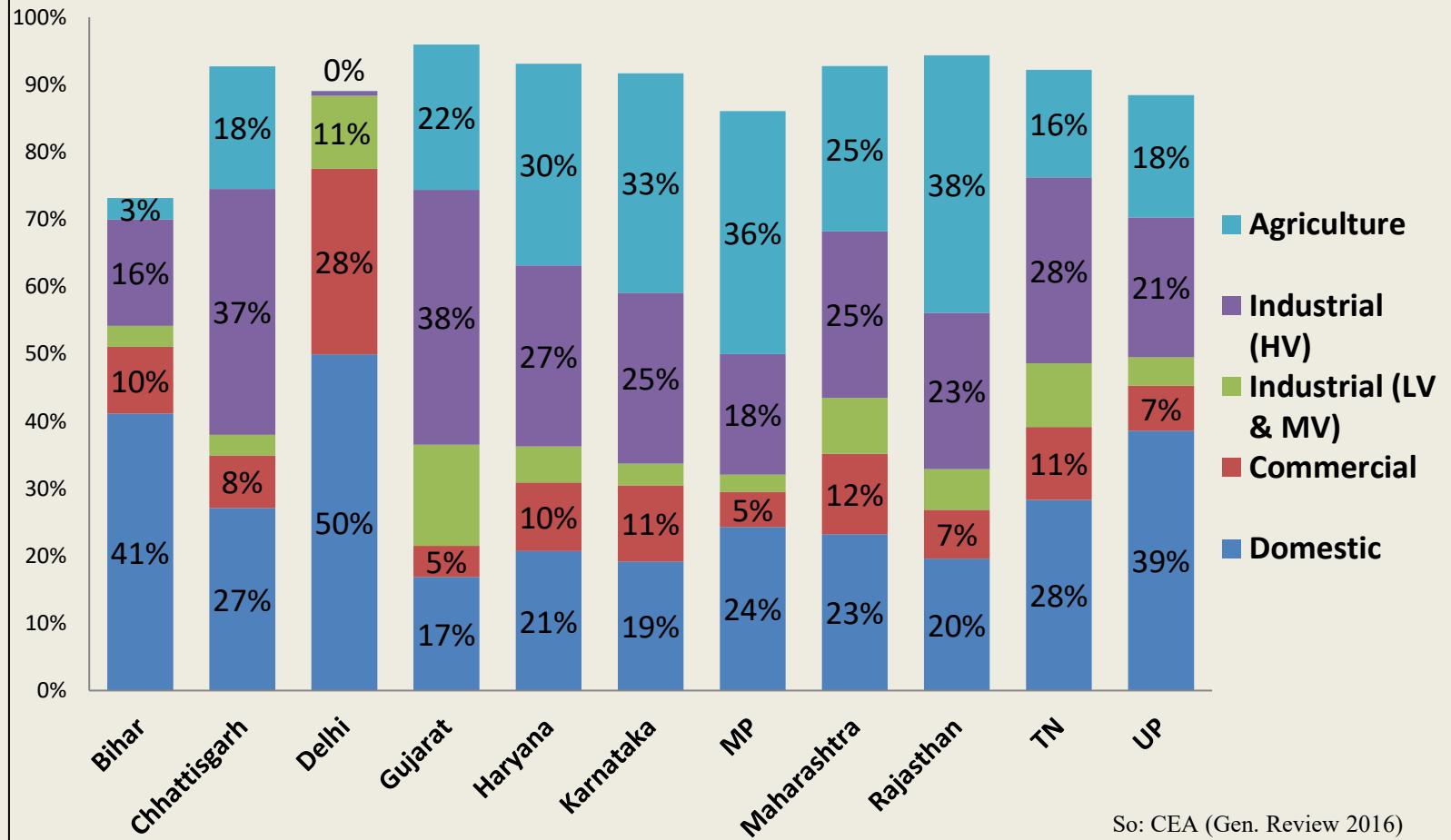
* Source - MOP –GARV Dashboard

Total Rural Households:	3,01,22,462	
EHH Up to 31st Dec16:	1,48,13,021	(49 %)
EHH from 1st Jan17:	2,86,587	(1%)
Total EHH :	1,50,99,608	(50%)

Power supply position in U.P.

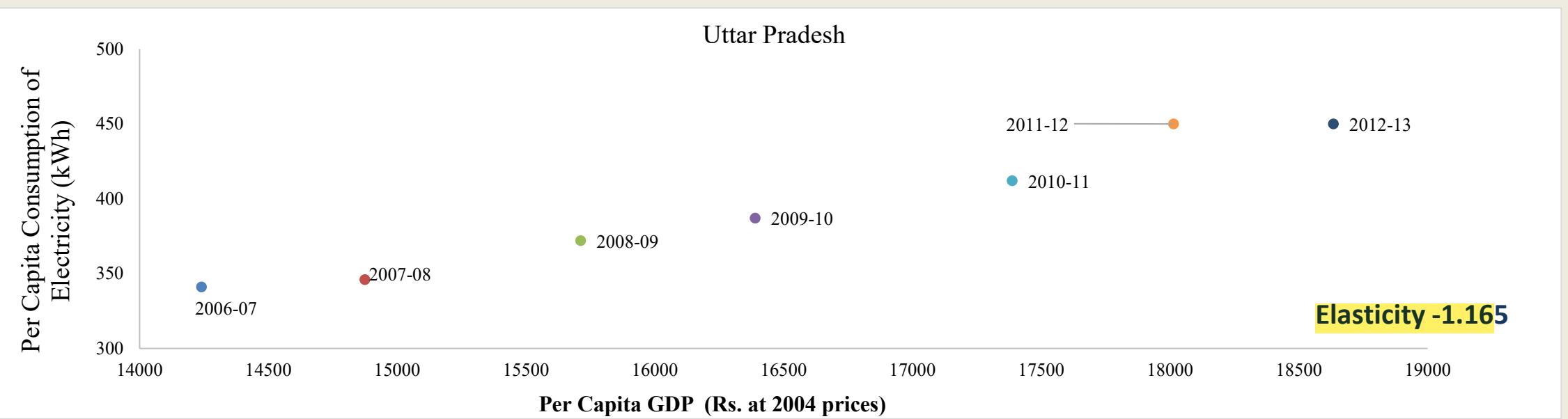
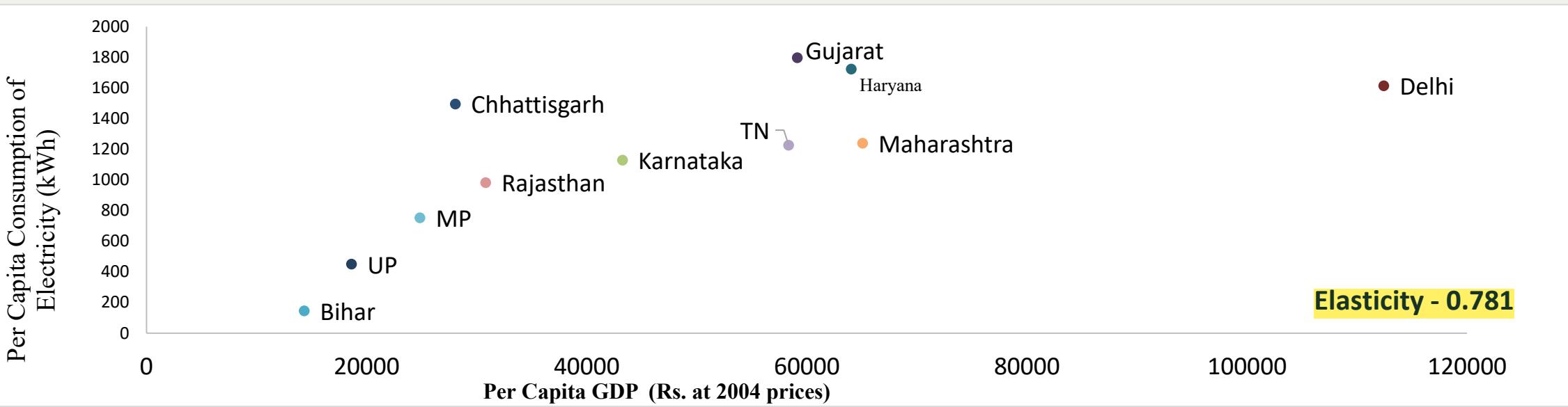
Key Metrics	
Max Unrestricted Demand (MW)	18,827 MW (05-06-2017, 22.00)
Max. Energy Requirement	391.9 MU (05-06-2017)
Maximum Energy Demand Met	388.29 MU (05-06-2017)

State category-wise consumption for year 2014-15 (in %)

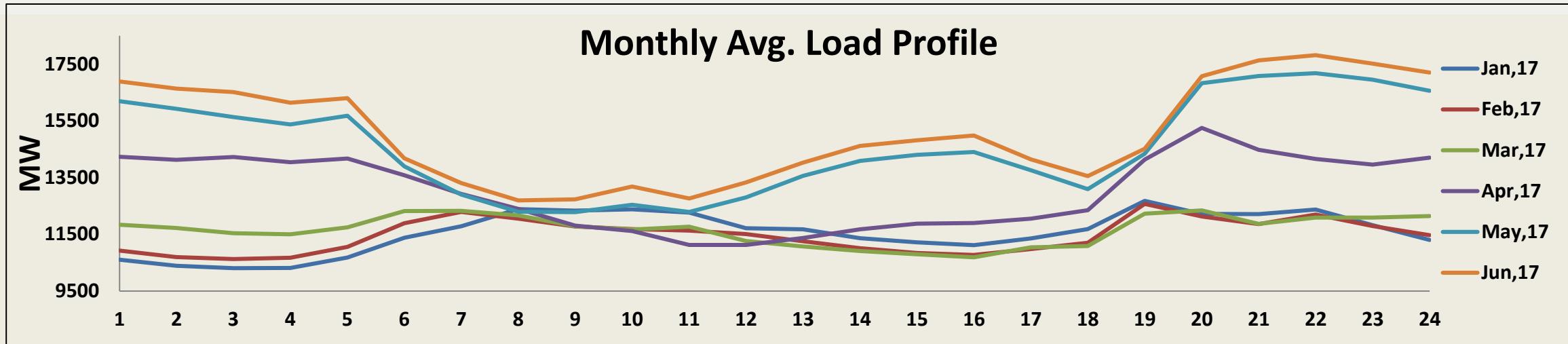


U.P. Category- wise connected load per consumer 2016-17 (kW)	
Domestic	1.69
Commercial	2.67
Industrial(Small & Medium)	10.28
Industrial(Large & Heavy)	381.33
Total (Overall)	2.59

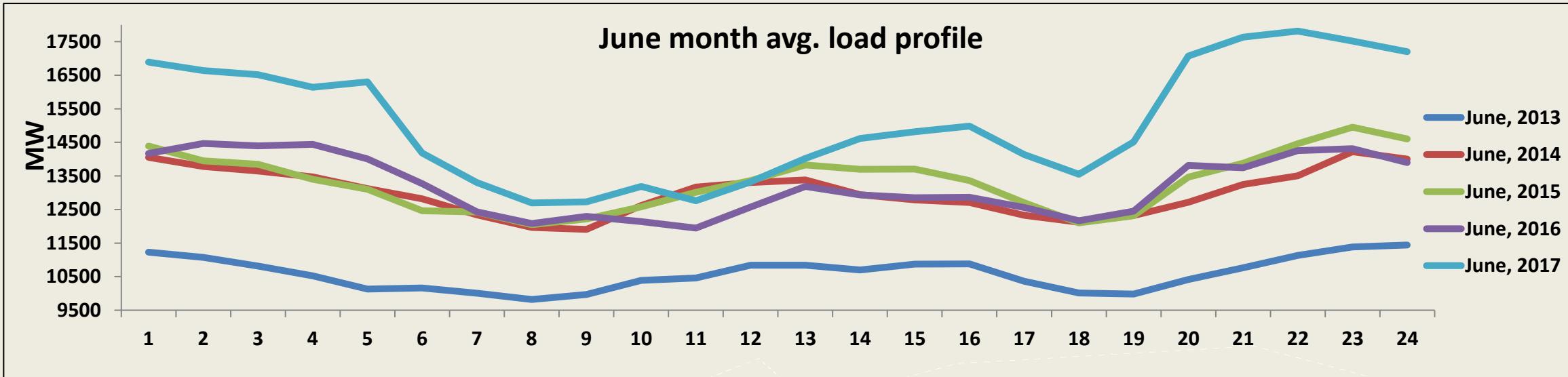
Electricity Consumption in UP (cross-section and time series)



Uttar Pradesh - Power supply position

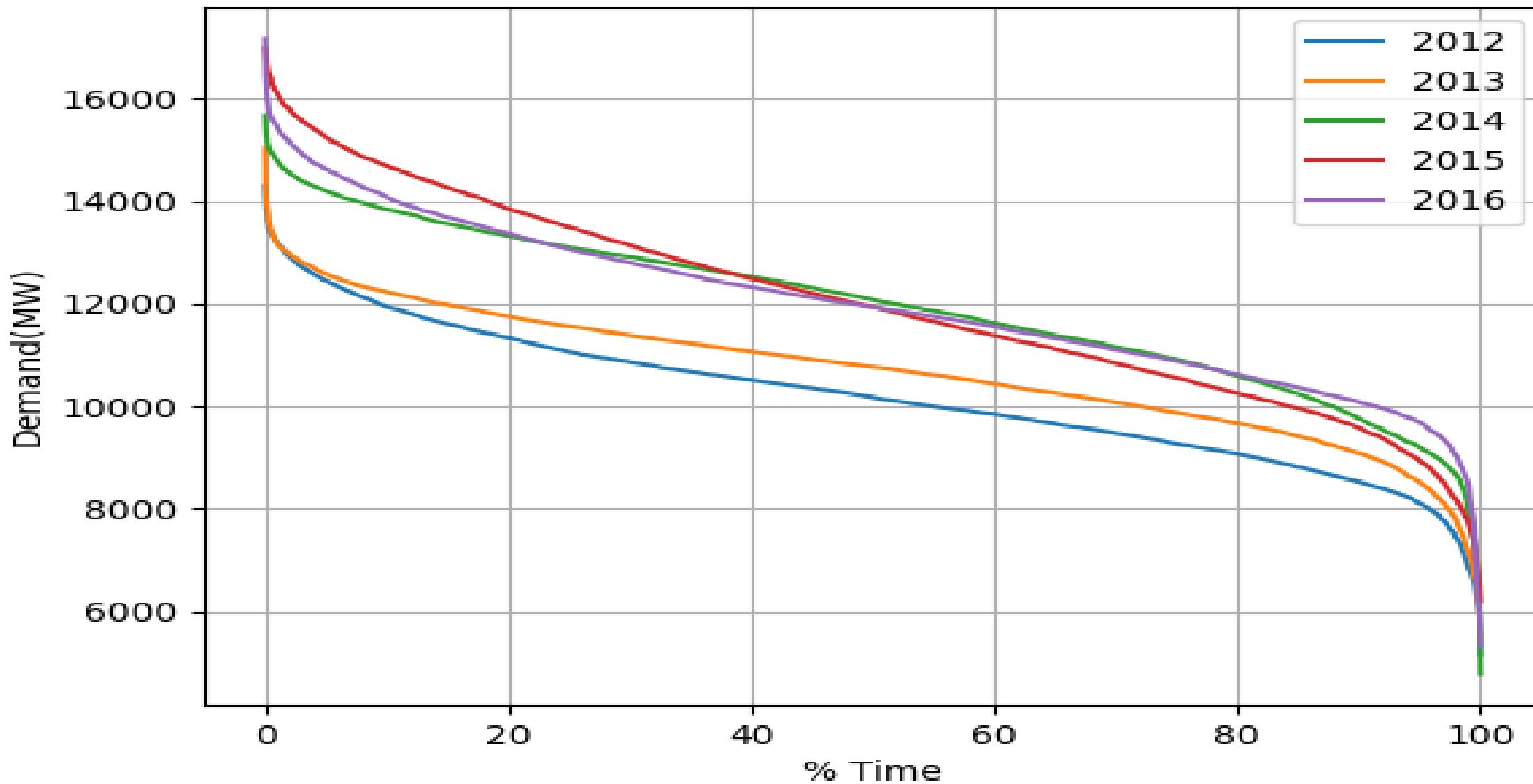


Source - Night Report ,UPPCL



Source - Night Report ,UPPCL

Load Duration Curve

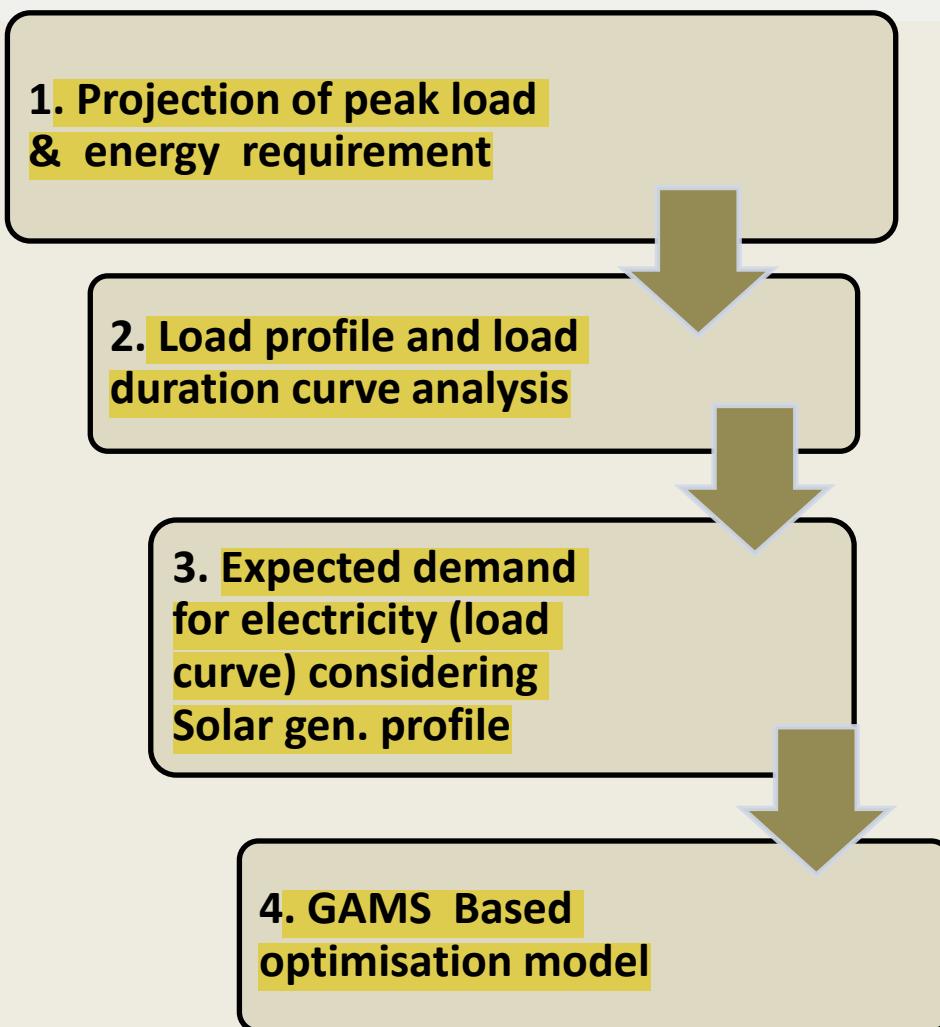


Long-Term Power Procurement Planning

Objectives

- ▶ Demand projection for the power requirement in Uttar Pradesh
- ▶ Assess the available, proposed and expected power procurement from conventional and renewable energy sources
- ▶ Optimize the power procurement to meet future peak load & energy requirement
- ▶ Develop a power procurement scenario with a mix of long-term, medium-term PPA and short-term power procurement

Methodology



1. Projection of peak load & energy requirement

Trend Analysis

- Study the past growth pattern

End Use method

- Study category-wise connected load, electricity consumption and growth pattern

Econometric Models

- Forecast considering economic change

2. Load profile and load duration curve analysis

- Inference from historical load profile and load duration curve

- Account for demand profile influenced by supply

- Projecting energy/peak load for future using statistical techniques

Methodology (continued)

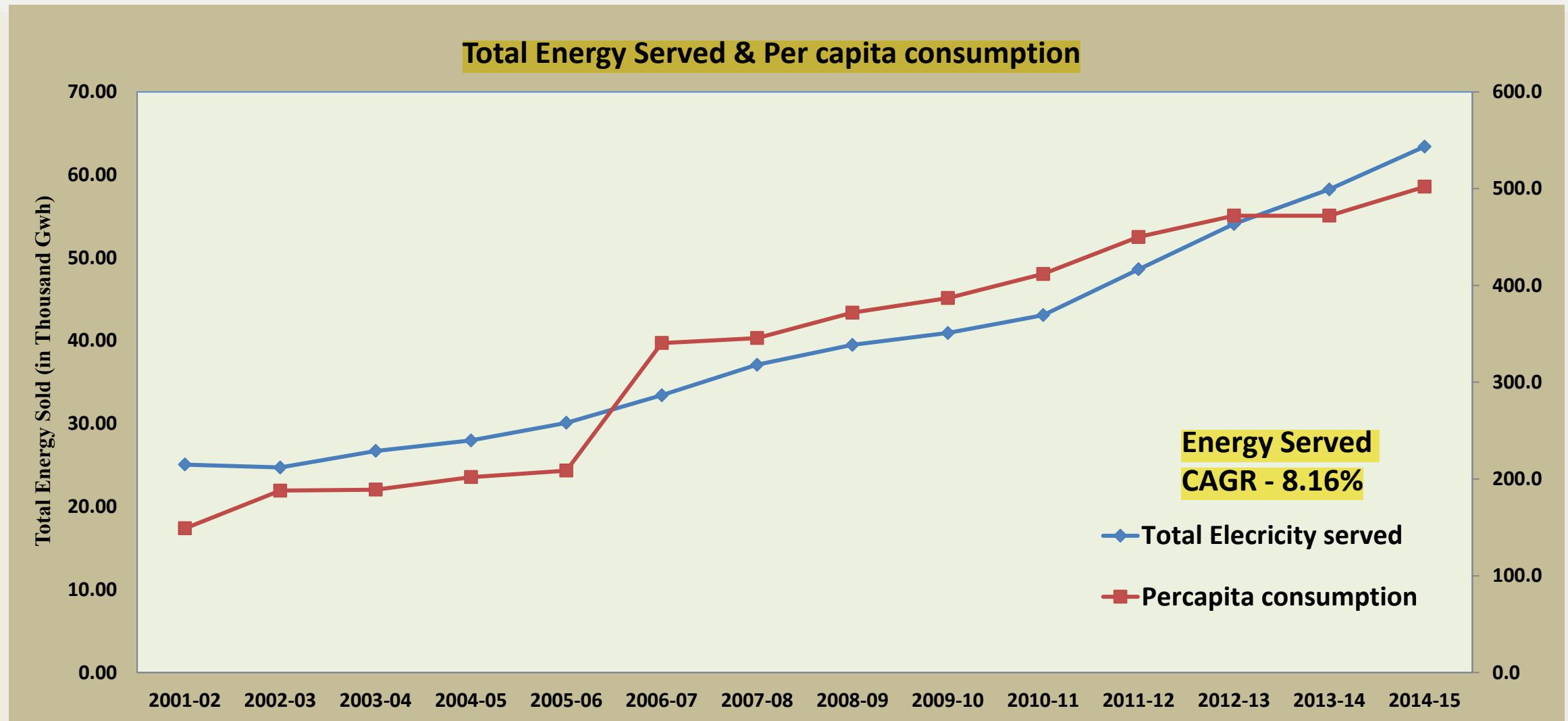
3. Expected demand and load profile

- Solar capacity and projected addition
- Solar generation curve and its effect on load profile
- Impact of ToD

4. GAMS Based optimisation model

- Projected Load profile
- Existing and candidate power procurement sources
- Cost of power procurement variables (base charge, Escalation factor, fixed & variable cost)
- Solar addition effect on load profile.

U.P. Electricity Consumption Behaviour



Econometric Method

Energy Require Estimation

Factors used for Per capita consumption of electricity estimation

- Per capita SGDP,
- Urbanisation ,
- % Share of Agri. & Allied , Industries and Trade & Services in GDP
- Price of electricity

Assumption

- a) Economic growth rate (High, Medium, Low and Realistic)
- b) Urbanisation projected
- c) % Share of different sector in GDP
- d) Price of Electricity

Econometric Model

Total Energy Required at Bus Bar

$$Q = f(D, G, U, P, S_p, S_s)$$

Where, Q = per capita consumption of electricity in kWh

D = Dummy variable for States (i.e. State = U.P or other than U.P.)

G = per capita SGDP in Rs

U = Urbanisation Ratio in state (Ratio of urban population to total population)

P = Price of electricity, Rs per kWh

S_p = Share of primary sector (Agri. & Allied services) in SGDP (Ratio)

S_s = Share of Secondary sector (Industries) in SGDP (Ratio)

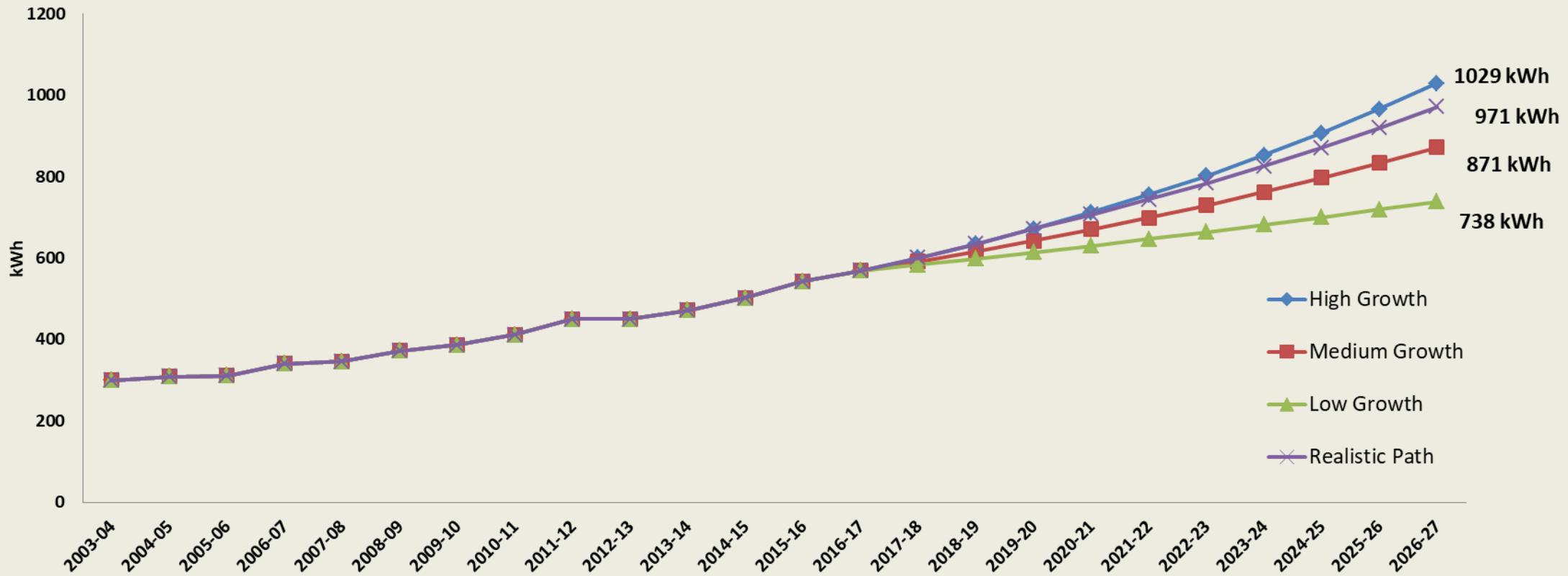
Total energy required = Per Capita Consumption x population (projected)

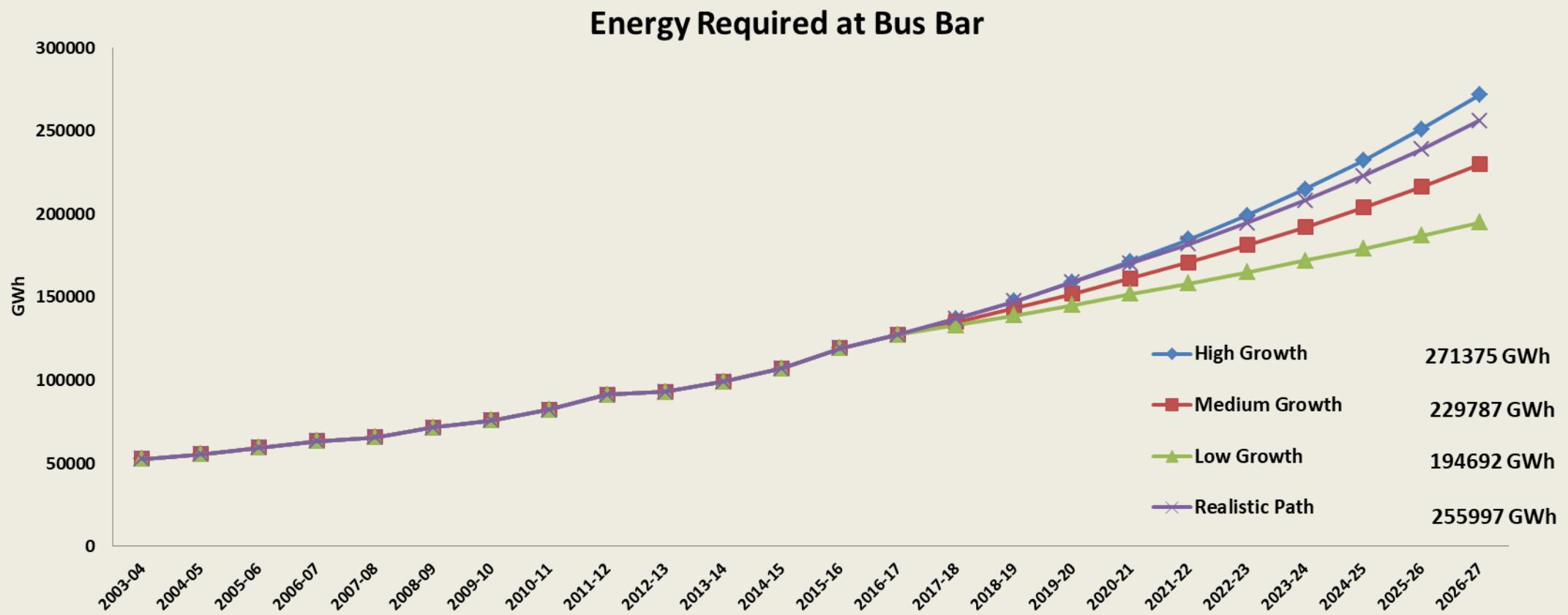
Regression Models

	Response Variable	Independent Variable					
Model 1	Log(Per capita consumption)	Intercept	log(Per capita SGDP)	% urban population	% primary share	% secondary share	Time
		-4.20 ***	0.861437 ***	0.013862***	2.631797***	2.711178***	-0.020524
Model 2	Log(Per capita consumption)	Intercept	log(Per capita SGDP)	% urban population	% primary share	% secondary share	
		-3.50 ***	0.77216***	0.01 ***	2.42 ***	2.797428***	
Model 3	Log(Per capita consumption)	Intercept	Per capita SGDP	% urban population	% primary share	% secondary share	
		3.83 ***	8.61E-06 ***	0.02 ***	2.81 ***	3.64 ***	
Model 4	Per capita consumption	Intercept	Per capita SGDP	% urban population	% primary share	% secondary share	
		-910 ***	7.36E-03 ***	10.97 ***	1853.00 ***	1788 ***	
Model 5	Per capita consumption	Intercept	Per capita SGDP	% urban population	P % primary share	% secondary share	Price
		-870 ***	1.10E-02 ***	8.02 ***	1682.00 ***	2098.00 ***	-41.69 *
Model 6	Log(Per capita consumption)	Intercept	Per capita SGDP	% urban population	% primary share	% secondary share	Price
		3.87 ***	1.40E-05 ***	0.02 ***	2.70 ***	4.11 ***	-0.07 **
Model 7	Log(Per capita consumption)	Intercept	log(Per capita SGDP)	% urban population	% primary share	% secondary share	Price
		-5.10 ***	0.94 ***	0.01 ***	2.18 **	3.24 ***	-0.06 **
Model 8	Log(Per capita consumption)	Intercept	log(Per capita SGDP)	% urban population	% primary share	% secondary share	log(Price)
		-4.90 ***	0.91 ***	0.01 ***	2.14 ***	3.29 ***	-0.12 *

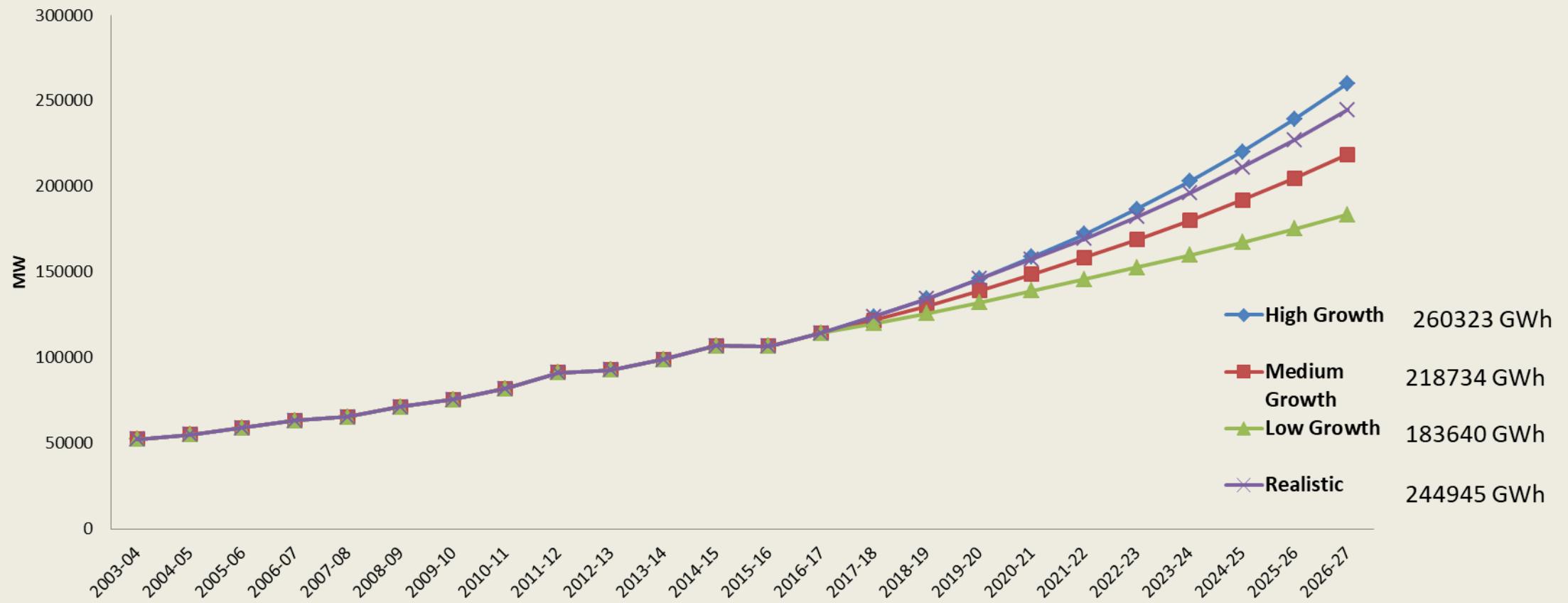
Uttar Pradesh Projected Values at bus bar (Econometric Model)

Uttar Pradesh Per Capita Consumption of Electricity (kWh)





Energy Requirement without Captive



Projected Energy Econometric Results Comparison With Other Reports

Compassion Projected Energy (19 th EPS vs Estimated Value) GWh					
FY	CEA	Econometric model results (IIT Kanpur)			
		19 EPS	Realistic	High	Medium
2016-17	108070	114512		114512	114512
2021-22	150797	163562		166115	153757
2026-27	195323	227838		244238	206808
					175223

Note: For utilities only

* Without Captive Generation

Projected Total sales (In MU)			
FY	PFA	Econometric Model	Δ %
2016-17	83,789	92882	11%
2017-18	95,131	101267	6%
2018-19	1,03,173	110511	7%
2019-20	1,16,385	120706	4%
2020-21	1,26,046	130958	4%
2021-22	1,36,700	141753	4%

Note: Energy sold

* With out Captive and losses

Data & Data Source

- CEA -General Review (2003-04 to 2014-15)
 1. Category-wise Connected Load, No. of Consumers and Consumption all states
 2. Per Capita Electricity Consumption
 3. No. of Pump set Energized, Mid Year Population
- CSO, MOSPI
 1. State Gross Domestic Product at Constant Price (base year 2011)
- PFC Reports
 1. Weighted Average Price of Electricity Sales (Price at base year 2011)
- Tariff Orders
 1. Power Procurement Cost over past years
- UPPCL & UPSLDC
 1. Night Reports, U.P. No. of consumers, Connected load and Consumption Category-wise
 2. PPA Information and Rate of electricity from power plants
 3. CS3 & CS4 Reports

Econometric Model Results

Per capita Consumption of electricity (Model 5)				
Year	High	Medium	Low	Realistic
2016-17	568	568	568	568
2017-18	600	592	583	600
2018-19	635	616	598	635
2019-20	672	642	614	672
2020-21	712	670	630	707
2021-22	755	699	647	744
2022-23	802	730	664	783
2023-24	853	762	682	826
2024-25	907	797	700	871
2025-26	966	833	719	919
2026-27	1029	872	739	971

Total Energy Required (GWh) (Model 5)				
Year	High	Medium	Low	Realistic
2016-17	127564	127564	127564	127564
2017-18	137274	135283	133293	137274
2018-19	147884	143546	139290	147884
2019-20	159484	152396	145570	159484
2020-21	172176	161878	152147	170852
2021-22	185529	171544	158576	182640
2022-23	200118	181885	165293	195388
2023-24	216064	192951	172312	209181
2024-25	233500	204799	179649	224109
2025-26	252571	217488	187319	240272
2026-27	273440	231083	195339	257778

Assumptions

Per Capita GDP Growth Rate				
Year	High	Medium	Low	Realistic Path
2015-16	7%	7%	7%	7%
2016-17	7%	7%	7%	7%
2017-18	8%	6%	4%	8%
2018-19	8%	6%	4%	8%
2019-20	8%	6%	4%	8%
2020-21	8%	6%	4%	7%
2021-22	8%	6%	4%	7%
2022-23	8%	6%	4%	7%
2023-24	8%	6%	4%	7%
2024-25	8%	6%	4%	7%
2025-26	8%	6%	4%	7%
2026-27	8%	6%	4%	7%

Year	Projected Population (in Million)
2015-16	219.72
2016-17	223.90
2017-18	227.98
2018-19	232.14
2019-20	236.37
2020-21	240.68
2021-22	244.36
2022-23	248.10
2023-24	251.89
2024-25	255.74
2025-26	259.65
2026-27	263.62

% Urban Population	
Year	%
2015-16	23.28
2016-17	23.52
2017-18	23.75
2018-19	23.99
2019-20	24.23
2020-21	24.47
2021-22	24.72
2022-23	24.96
2023-24	25.21
2024-25	25.47
2025-26	25.72
2026-27	25.98

As per Population foundation of India, Scenario B	
UP Population Growth (CAGR)	
2011-2021	1.82%
2021-2031	1.53%
2031-2041	1.22%

Assumptions (Contd.)

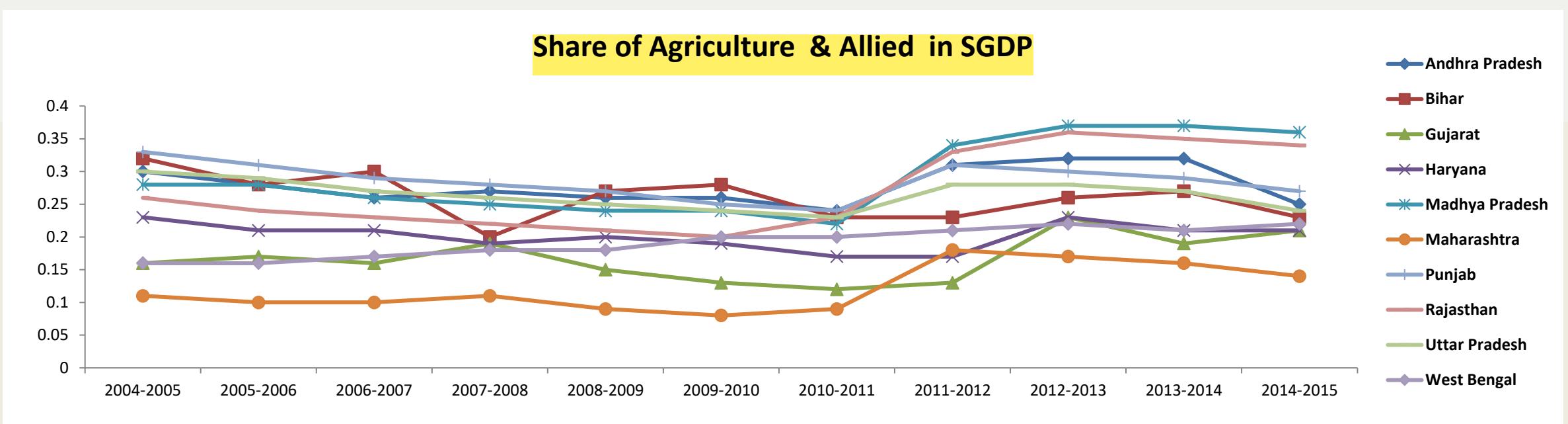
Price of electricity	
2014-15	3.85
2015-16	4.00
2016-17	4.16
2017-18	4.33
2018-19	4.50
2019-20	4.68
2020-21	4.87
2021-22	5.06
2022-23	5.26
2023-24	5.47
2024-25	5.69
2025-26	5.92
2026-27	6.16

% Share of Agri. & Allied Services in SGDP	
Year	Expected
2015-16	24.2%
2016-17	24.1%
2017-18	24.0%
2018-19	23.9%
2019-20	23.8%
2020-21	23.7%
2021-22	23.6%
2022-23	23.5%
2023-24	23.4%
2024-25	23.3%
2025-26	23.2%
2026-27	23.1%

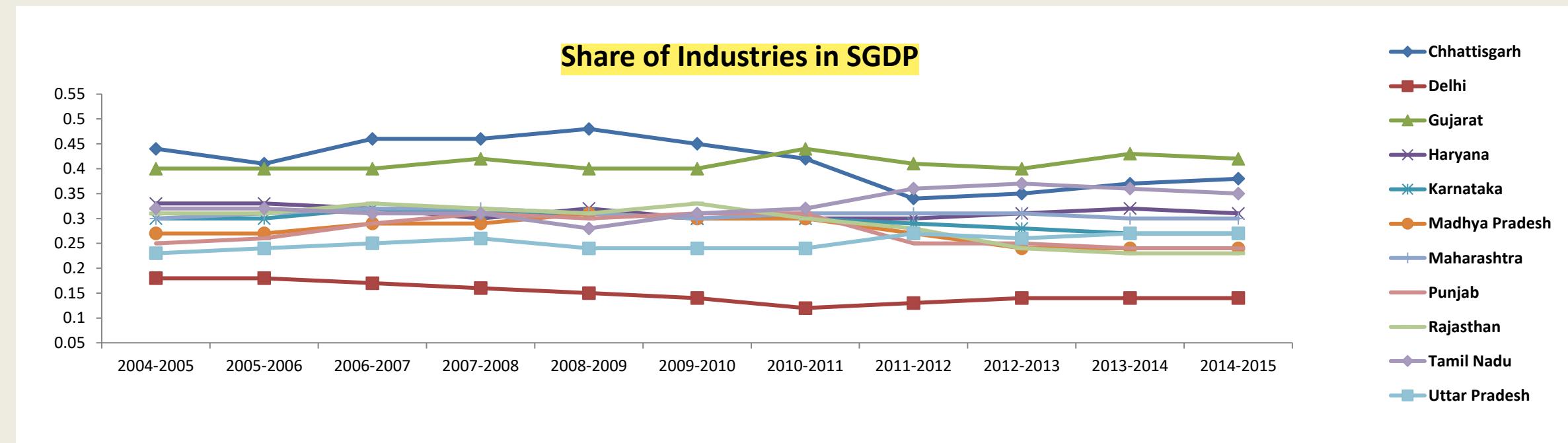
% Share of Industries in SGDP	
Year	Expected
2015-16	27.5%
2016-17	27.7%
2017-18	27.9%
2018-19	28.1%
2019-20	28.3%
2020-21	28.5%
2021-22	28.7%
2022-23	28.9%
2023-24	29.1%
2024-25	29.3%
2025-26	29.5%
2026-27	29.7%

Year	Per capita consumption (kWh)	Total Energy (GWh)
2015-16	542.30	119156
2016-17	568.28	127236
2017-18	600.26	136848
2018-19	634.75	147348
2019-20	671.93	158824
2020-21	706.64	170075
2021-22	743.72	181736
2022-23	783.34	194342
2023-24	825.68	207978
2024-25	870.94	222732
2025-26	919.33	238703
2026-27	971.09	255997

Share of Agriculture & Allied in SGDP

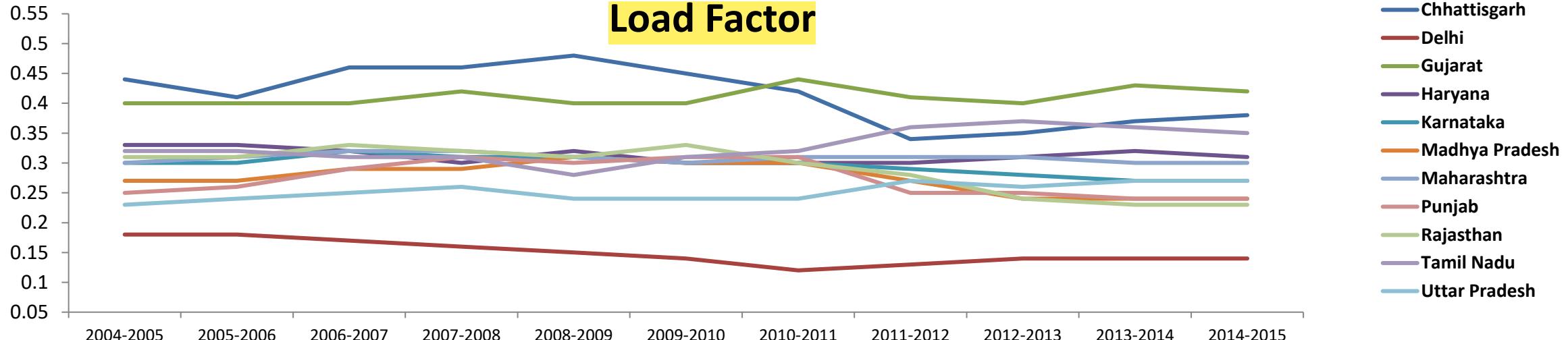


Share of Industries in SGDP

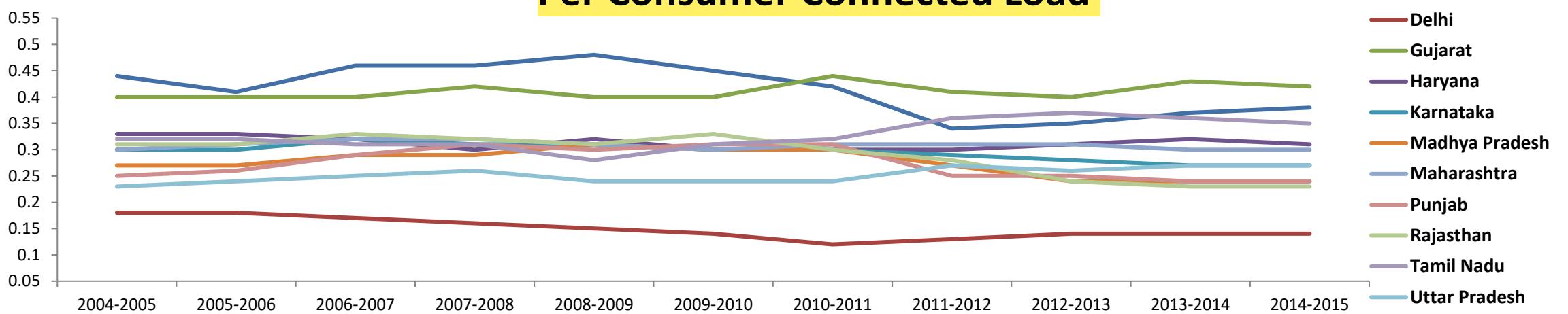


Partial End Use - State Level

Load Factor



Per Consumer Connected Load



Load Profiles

1. Energy requirement is the gross electricity required for state

Gross Electricity = Gross Generation of Utilities + Net Import + Gross Generation by self Generating Industries

Per capita consumption = Gross Electricity / Mid year population

2. Load profile is made using energy estimate for year.
3. Energy required estimation has been done at bus bar.
4. T&D losses are included in energy required estimation.
5. The Assumptions for load profile

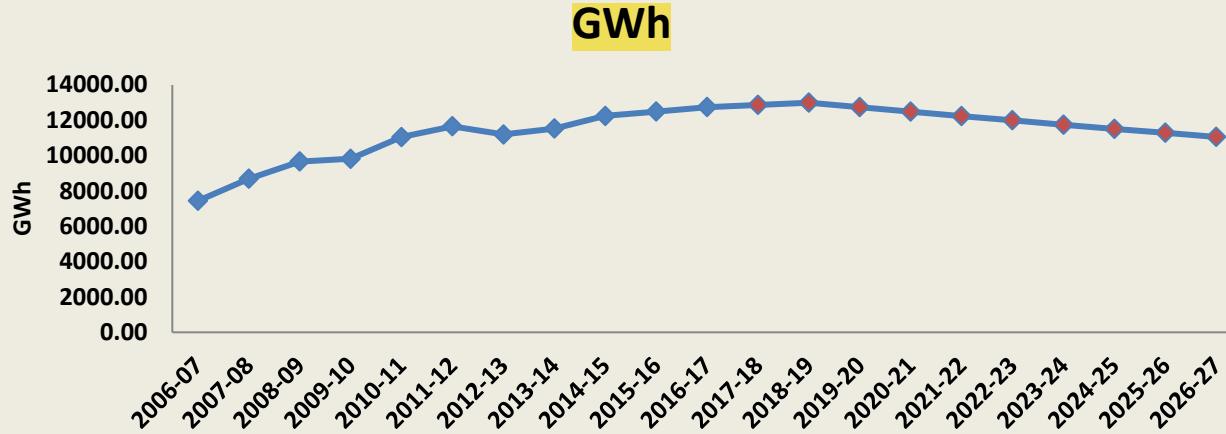
- Total energy (Per capita x Population) is equal to Area under load profile future years.
- Load profile (for 365 days) is sum of the energy required as estimated by regression model
- Shape of load profile is based on the historical load profile of UP and
- The revised profile for summer considering day time power supply to rural and agricultural consumers.

Captive Generation

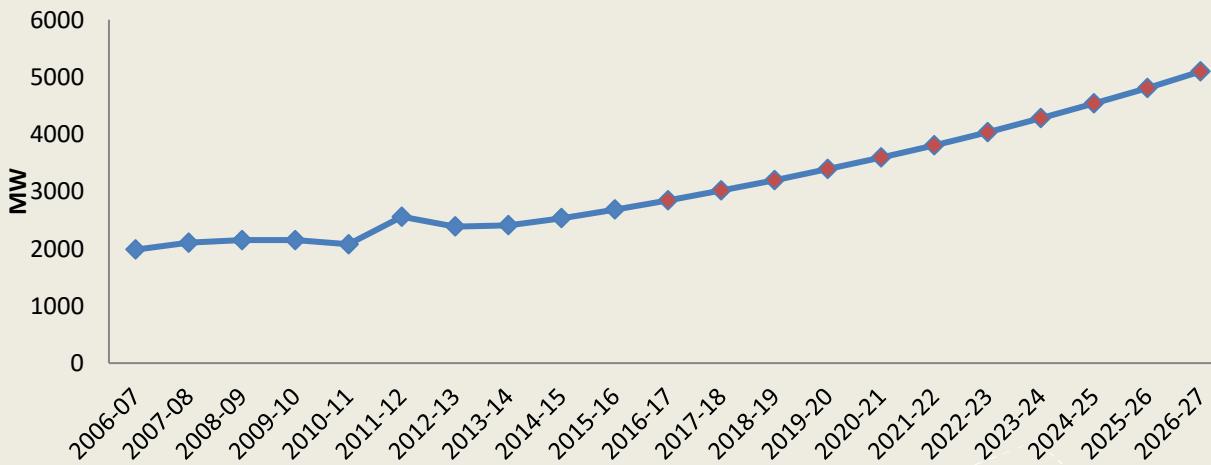
- Per capita consumption of electricity also accounts energy that is being generated by self generating industries.
- But utility does not procure this energy so it is separated from energy requirement for state.
- U.P has 11.4 % self generation of Total energy with load factor 0.55
- Past historical pattern of U.P. and other states also show decline percentage of self generation with growth in connected load
- It is assumed that if state has power reliable power supply position with comparative cost self generation will go down and requirement for these industries will fulfil by utility.

Assumptions Regarding Captive Generation

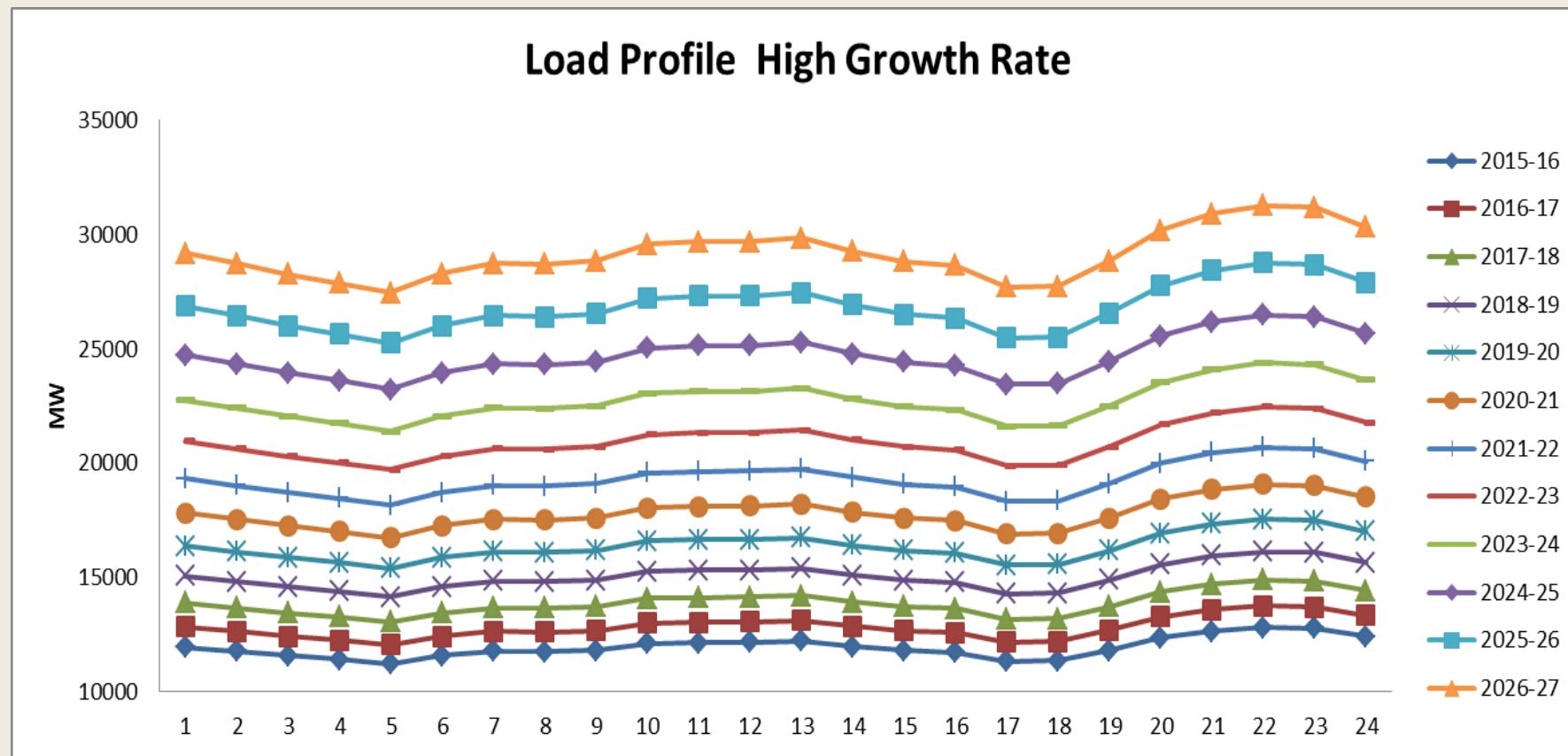
Gross Generation by self Generating Industries



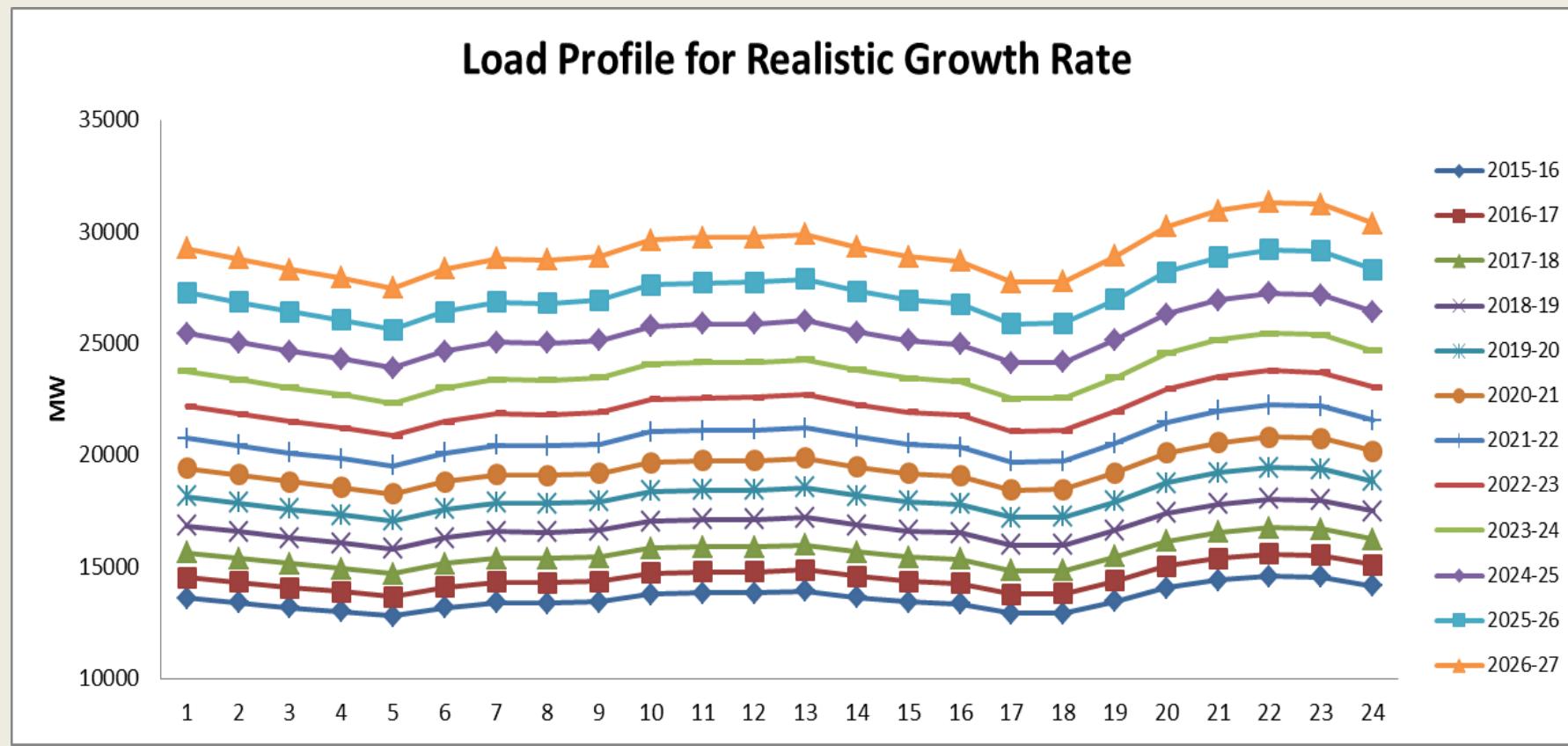
Self Generation Industries Connected Load



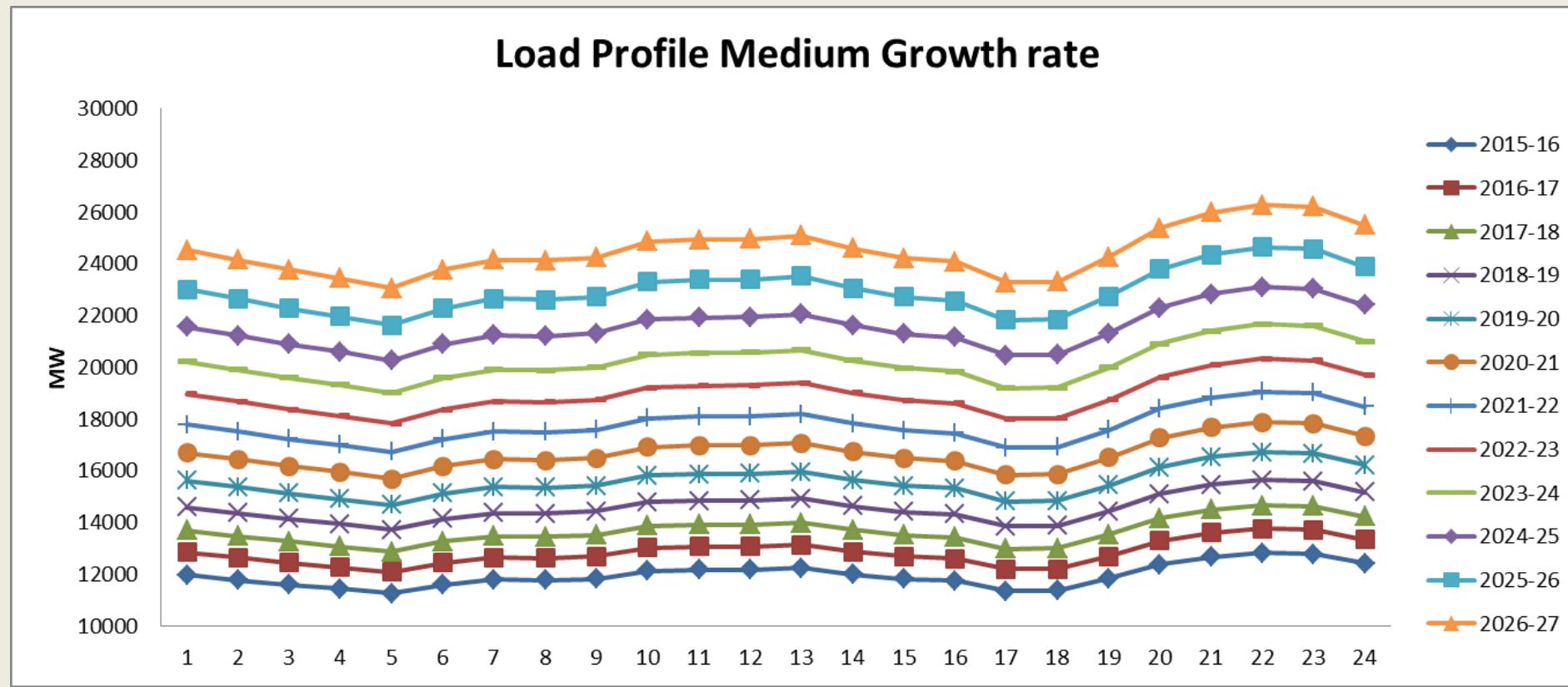
Projected Load Profile – High Growth



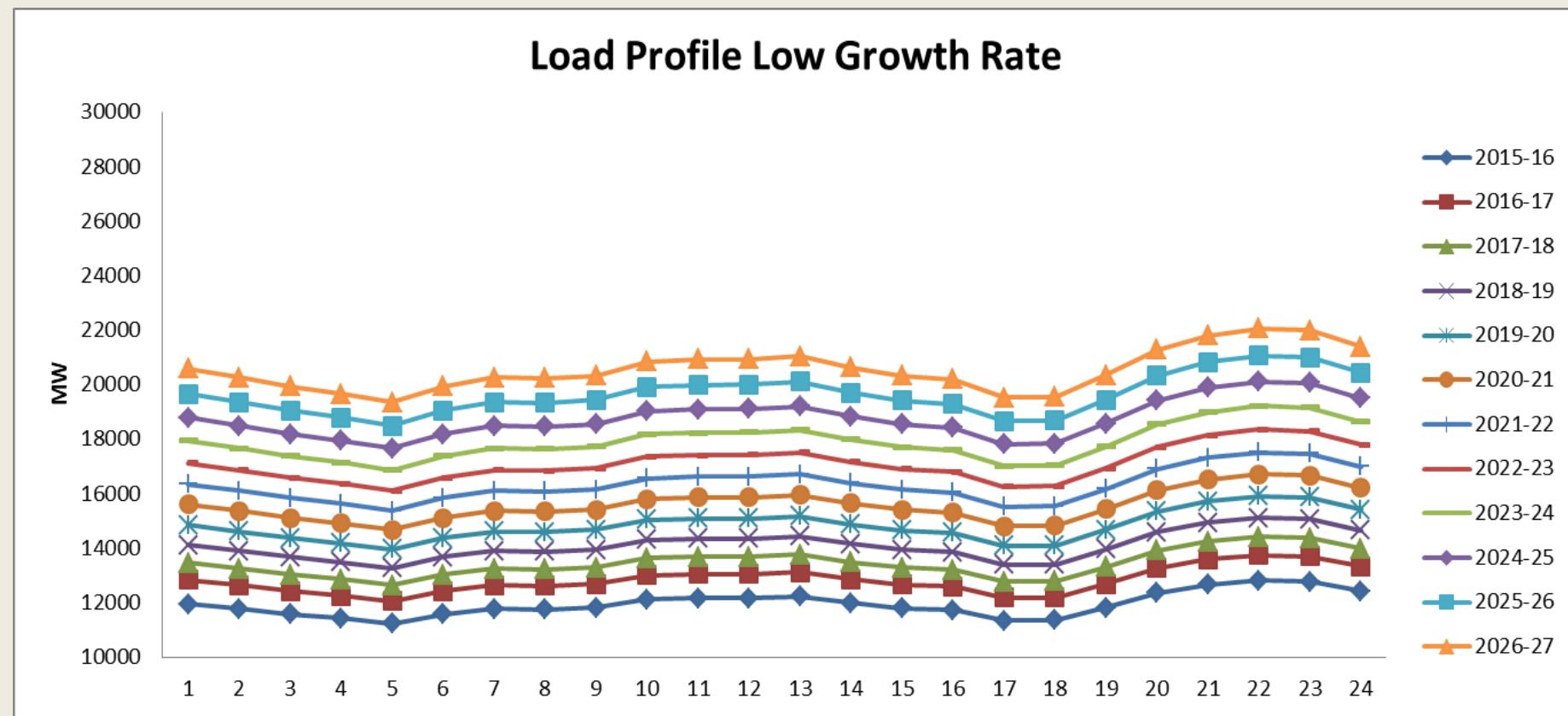
Projected Load Profile – Realistic Growth



Projected Load Profile – Medium Growth



Projected Load Profile – Low Growth



GAMS OPTIMIZATION MODEL

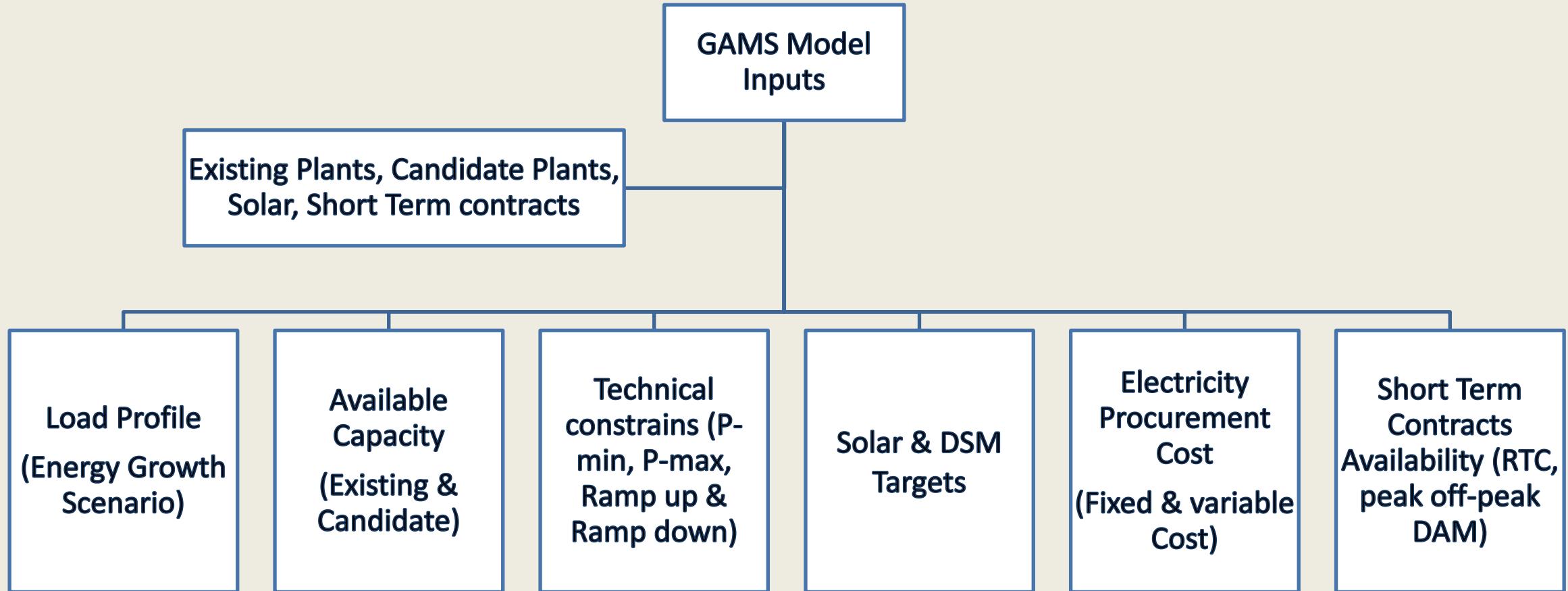
Objective:

1. Minimize total power procurement cost (Utility cost)
2. Optimum capacity utilization from available resources (Plant PLF)
3. Optimal position(year) for new capacity addition
4. Comparative study for different power procurement portfolio/scenario

GAMS MODEL INPUTS

1. Projected demand profiles (different scenarios)
2. Following information for existing plants and candidate plants
 - a) Available capacity (Min & Max. limits, Ramp up ,Ramp down)
 - b) Power procurement cost (fixed and variable cost)
 - c) Duration of PPA's
3. Solar projected values
4. Short term contract availability (RTC, peak off-peak DAM) and their prices
5. DSM (Policy targets & Realistic targets)

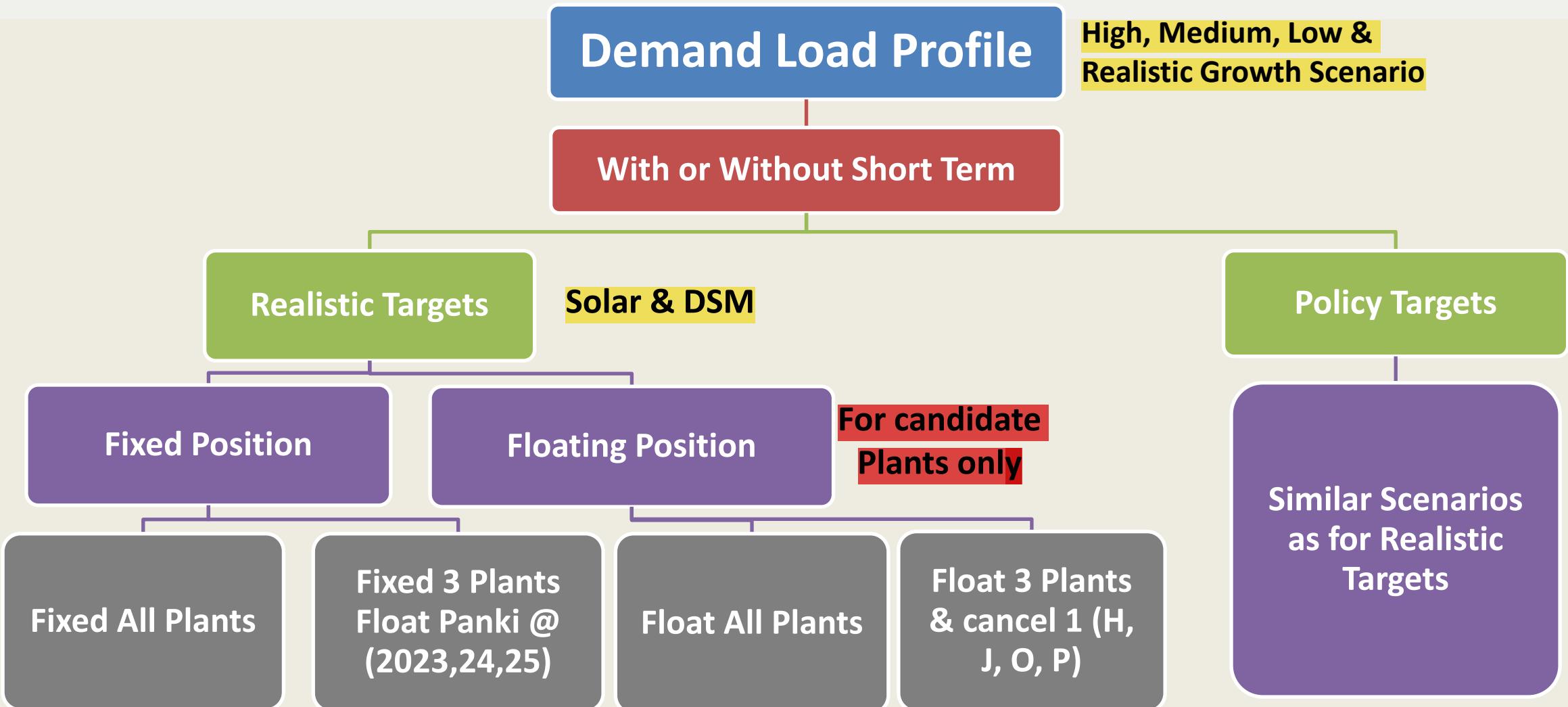
Input Variables



Assumptions cont..

Year	Solar Policy Targets (MW)	Solar Realistic Targets (MW)
2015-16	102	102
2016-17	200	200
2017-18	350	350
2018-19	2500	950
2019-20	5000	1750
2020-21	7500	2500
2021-22	10500	3500
2022-23	11000	5000
2023-24	11500	6000
2024-25	12000	7000
2025-26	13000	8000
2026-27	14000	9000

GAMS SIMULATION FOR DIFFERENT SCENARIOS



Scenarios Name

Load Profiles -with (or without Short Term)-DSM & Solar Policy-fixed (or float)

A. Load Profile (High, Medium, Low and Realistic Growth Scenario)

a) Policy Targets

i. With Short Term Contracts

- a) Fixed All Plants - Candidate plants appear as per PPA signed
- b) Fixed All Float Panki - Fix all (H,J,O) and float Panki for best position
- c) Fixed All & Panki @ (2023,24,25) - Cost comparison for Panki at different positions (year)
- d) Fixed All cancel one at a time –
- e) Float All Plants - Model to find best optimal positions for plants
- f) Float All cancel one at a time – Cancel one plant (H, J, O, P) and other be float

ii. Without Short Term Contracts

- ❖ All scenarios stated above without short term contracts

b) Realistic Targets

i. With short Term contracts

ii. Without short Term contracts

Key Assumptions

1. Discount rate 10%
2. Solar capacity addition (policy targets and realistic targets)
3. Candidate plants fixed cost - 2% decline, variable cost 5 % increase over the year
4. Existing plants cost change over the year based on their PPA status.

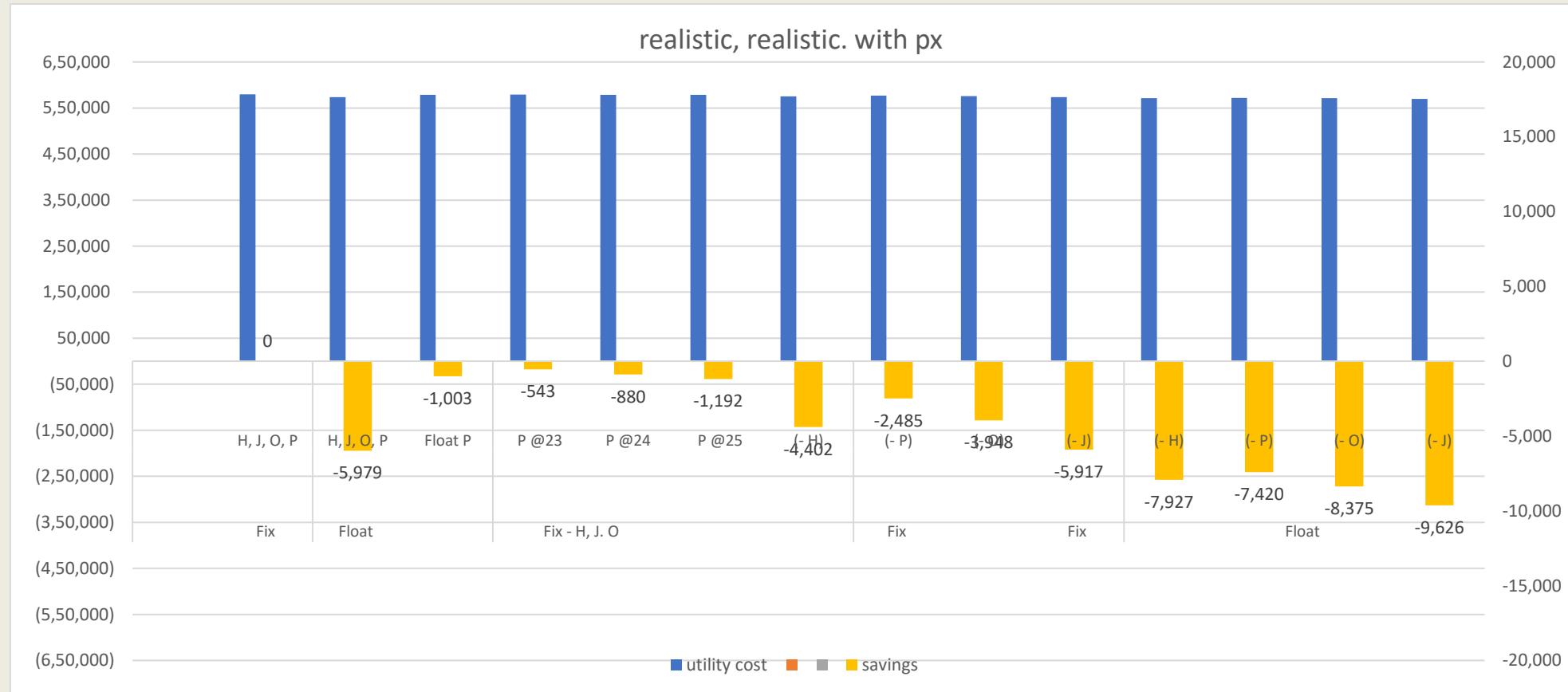
GAMS OUTPUT

- Demand & Generation Chart
- PLF of Plants
- Optimal position for candidate plants
- Utility Cost & Social Cost

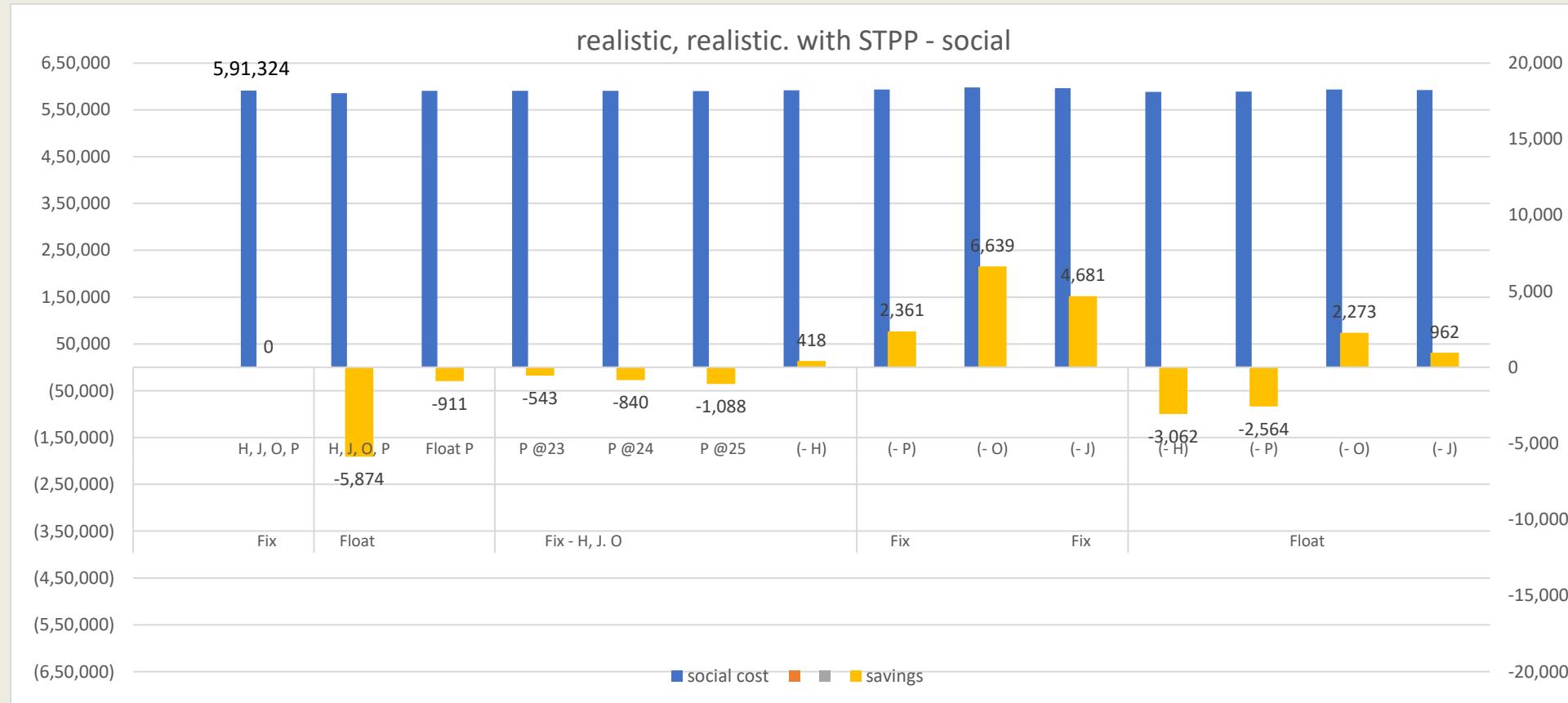
Short Term Contract	Price (Rs/MWh)	P min (MW)	P max (MW)	Availability	Duration/day
RTC 1	3200	10	500	Round the clock	24
RTC 2	3300	10	400	Round the clock	24
RTC DAM	3400	10	300	Round the clock	24
RTC 3	3400	10	300	Round the clock	24
Morning Shoulder	3000	10	300	5 AM to 9 AM	4
Morning Shoulder DAM	3300	10	250	5 AM to 9 AM	4
Morning Shoulder 2	3300	10	250	5 AM to 9 AM	4
Morning Peak 1	4000	10	300	9 AM to 12 PM	3
Morning Peak_2	4300	10	250	9 AM to 12 PM	3
Morning Peak DAM	4600	10	200	9 AM to 12 PM	3
Morning Peak 3	4600	10	200	9 AM to 12 PM	3
Shoulder 1	3000	10	300	12 PM to 6 PM	6
Shoulder DAM	3200	10	250	12 PM to 6 PM	6
Shoulder 2	3200	10	250	12 PM to 6 PM	6
Evening Peak 1	5500	10	300	6 to 11 PM	5
Evening Peak 2	5800	10	250	6 to 11 PM	5
Evening Peak DAM	6100	10	200	6 to 11 PM	5
Evening Peak 3	6100	10	200	6 to 11 PM	5
Off Peak 1	2000	10	300	11 PM to 5 AM	6
Off Peak DAM	2200	10	250	11 PM to 5 AM	6
Off Peak 2	2200	10	250	11 PM to 5 AM	6

Results – Realistic Demand with Realistic DSM & Solar

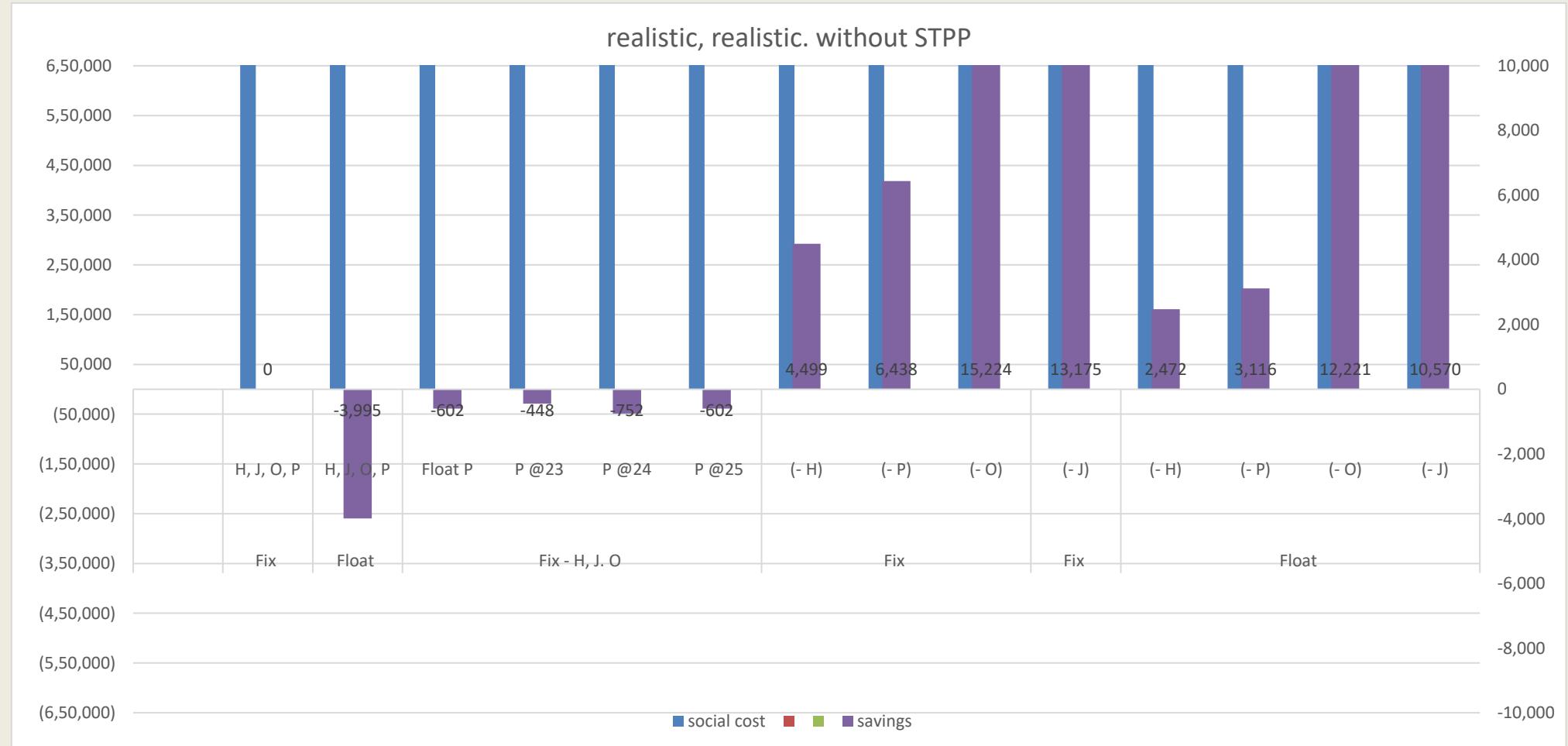
Utility Cost – Realistic Demand with Realistic DSM & Solar (with STPP)



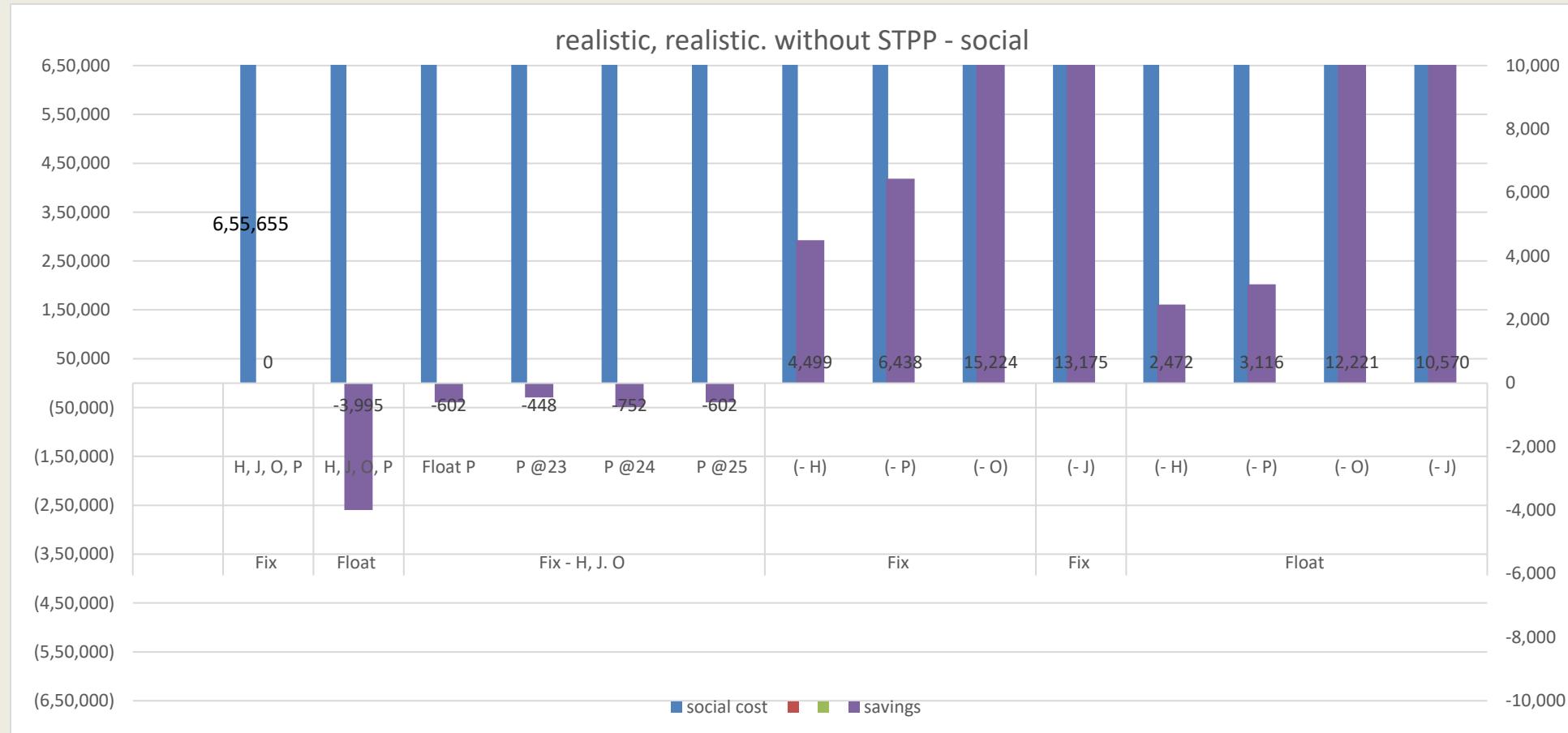
Social Cost – Realistic Demand with Realistic DSM & Solar (with STPP)



Utility Cost – Realistic Demand with Realistic DSM & Solar (w/o STPP)

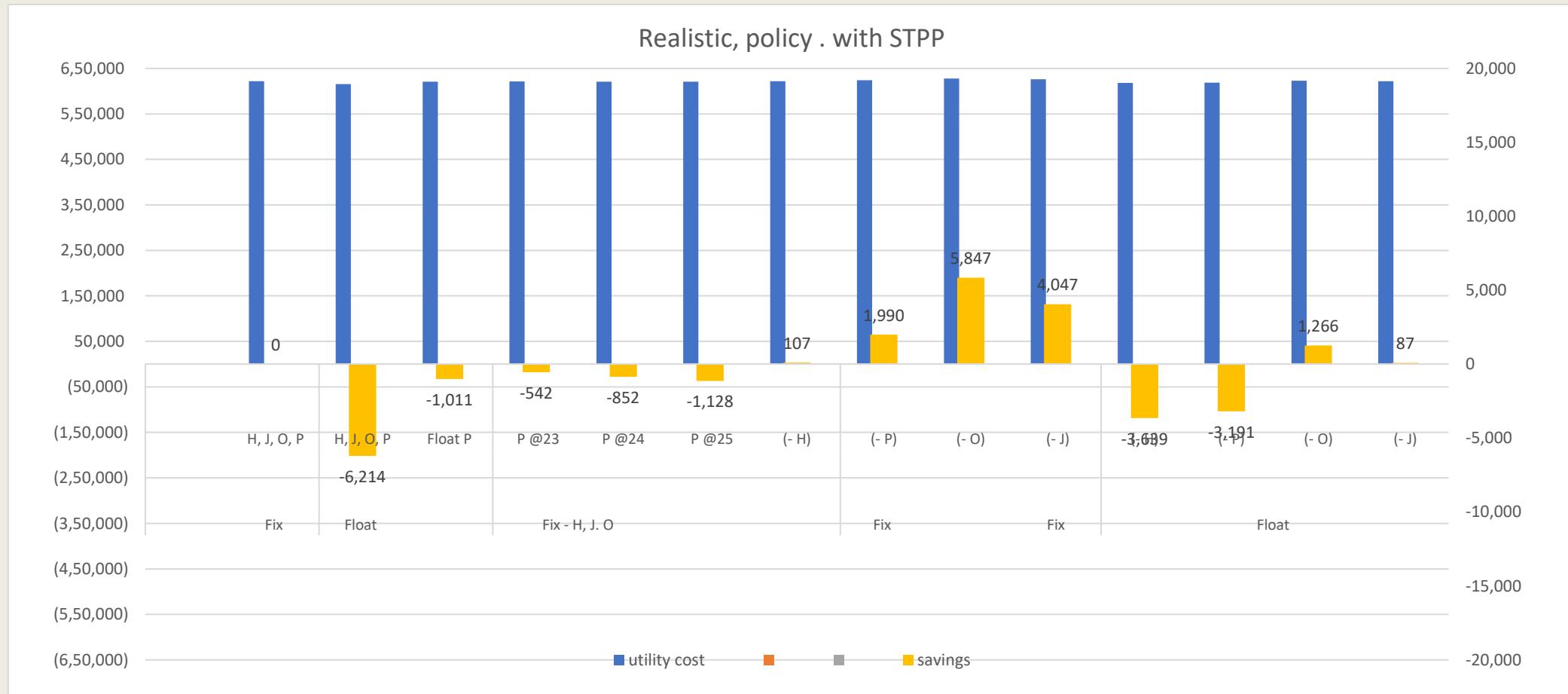


Social Cost – Realistic Demand with Realistic DSM & Solar (w/o STPP)

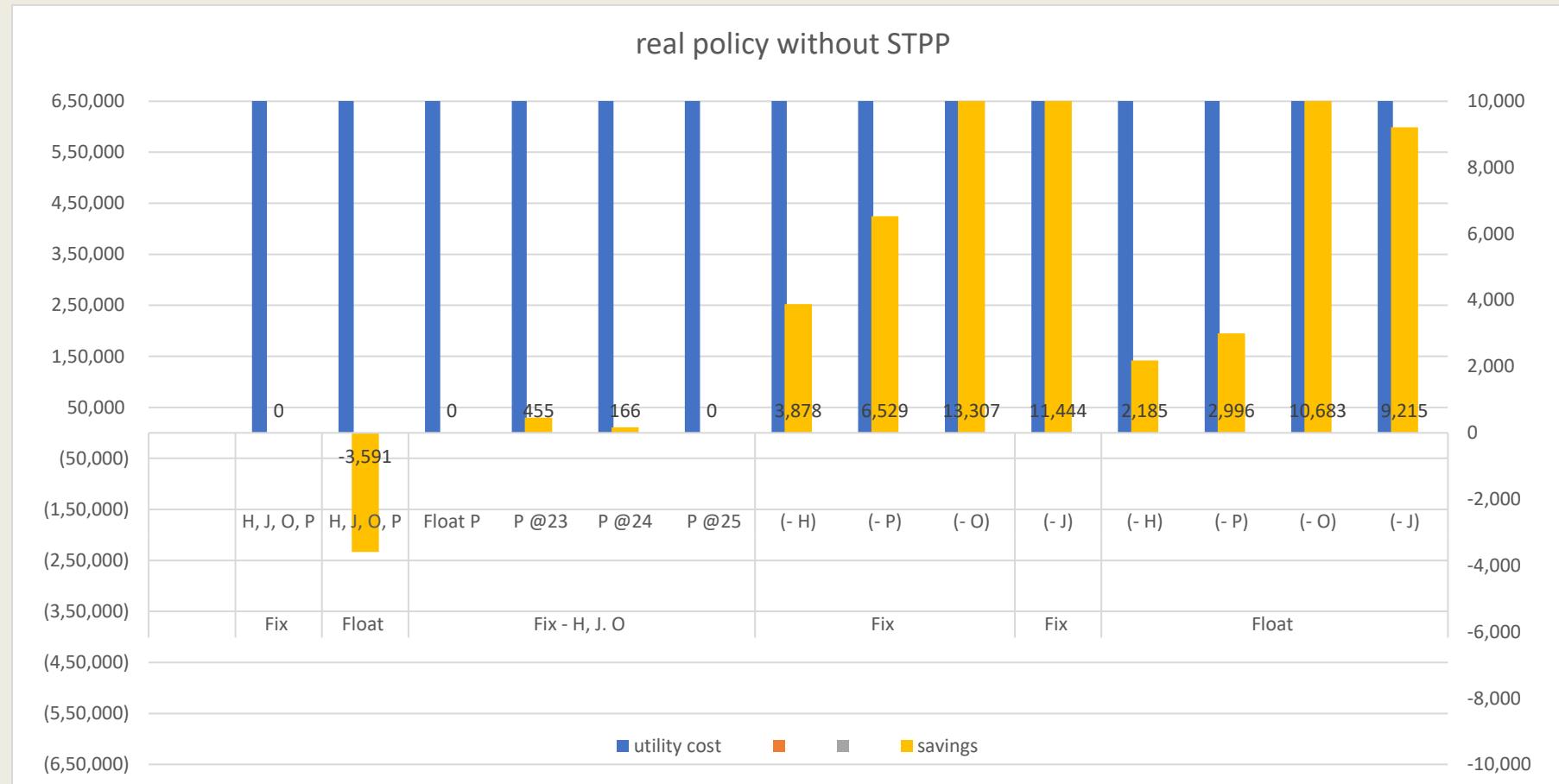


Results – Realistic Demand with Policy DSM & Solar

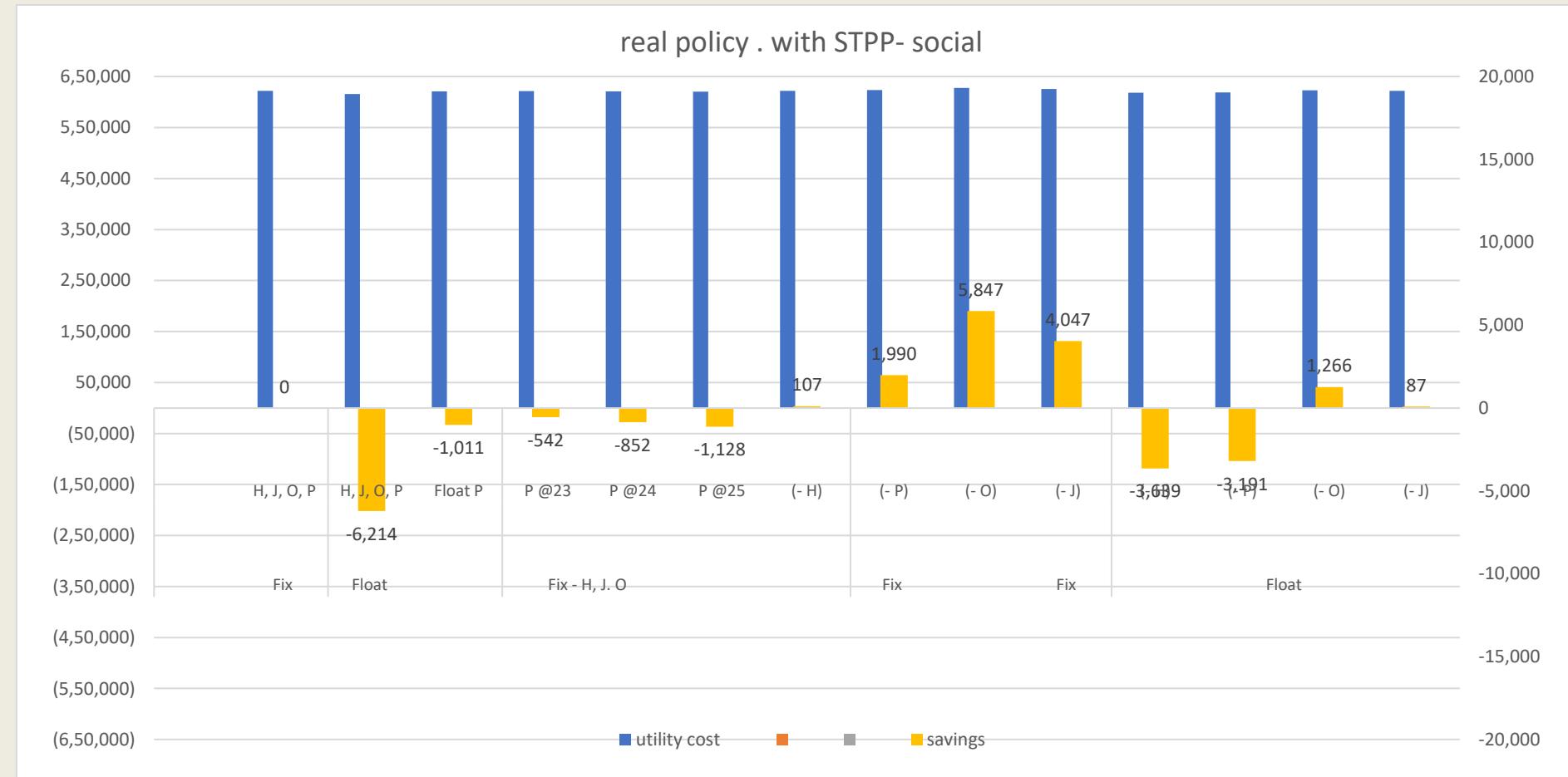
Utility Cost – Realistic Demand with Policy DSM & Solar (with STPP)



Utility Cost– Realistic Demand with Policy DSM & Solar (w/o STPP)



Social Cost– Realistic Demand with Policy DSM & Solar (with STPP)

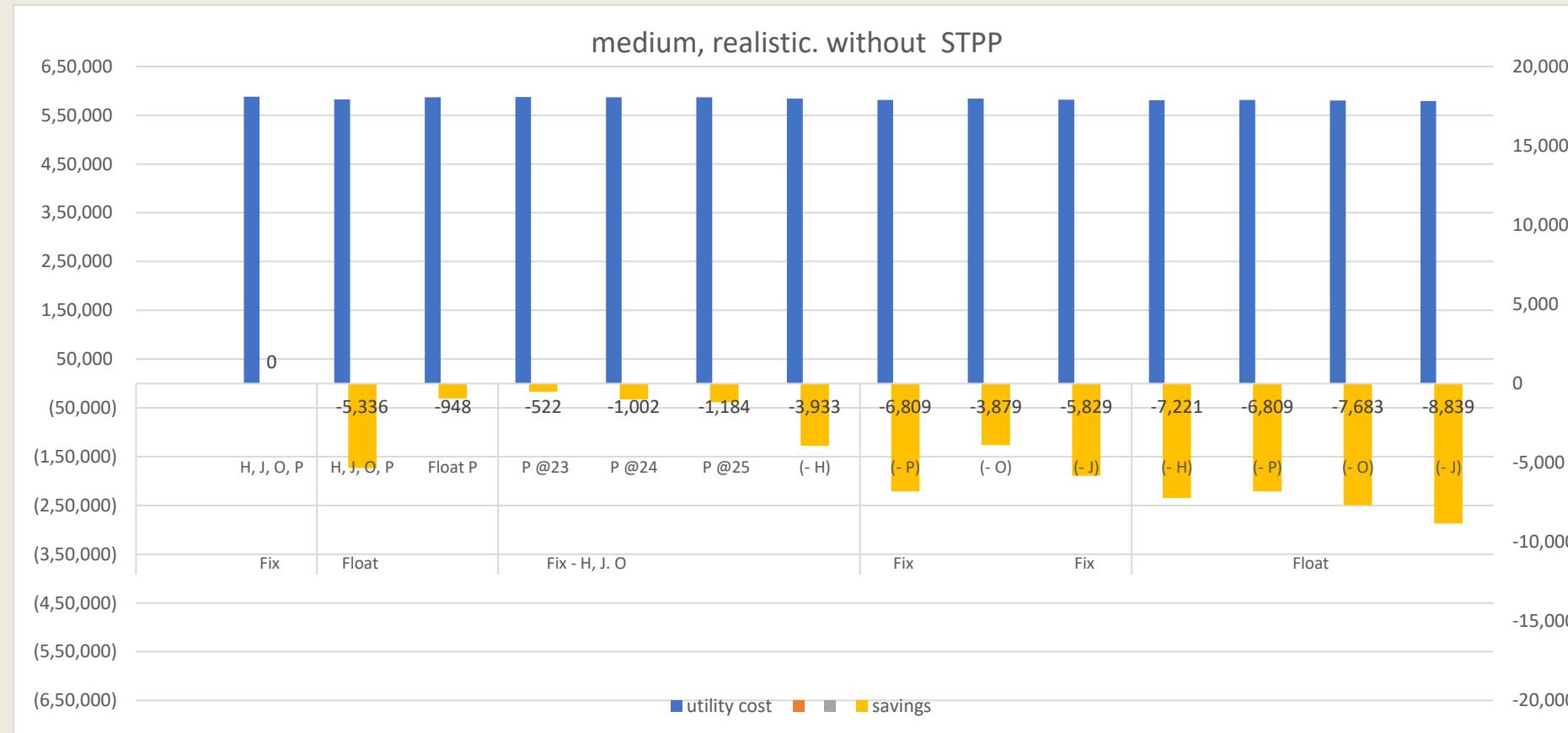


Social Cost– Realistic Demand with Policy DSM & Solar (w/o STPP)

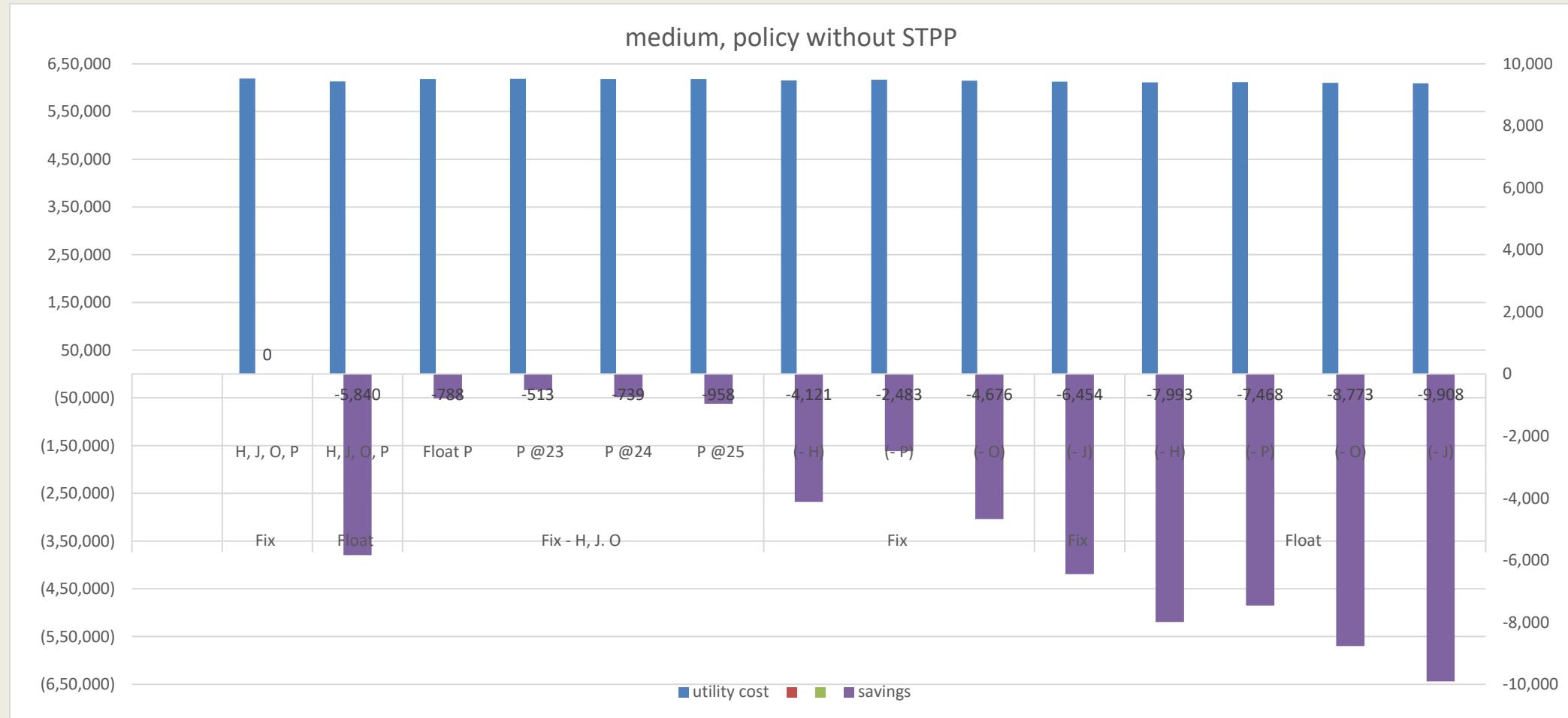


Results – Medium Growth Forecast

Utility Cost– Medium Demand with Realistic DSM & Solar (w/o STPP)

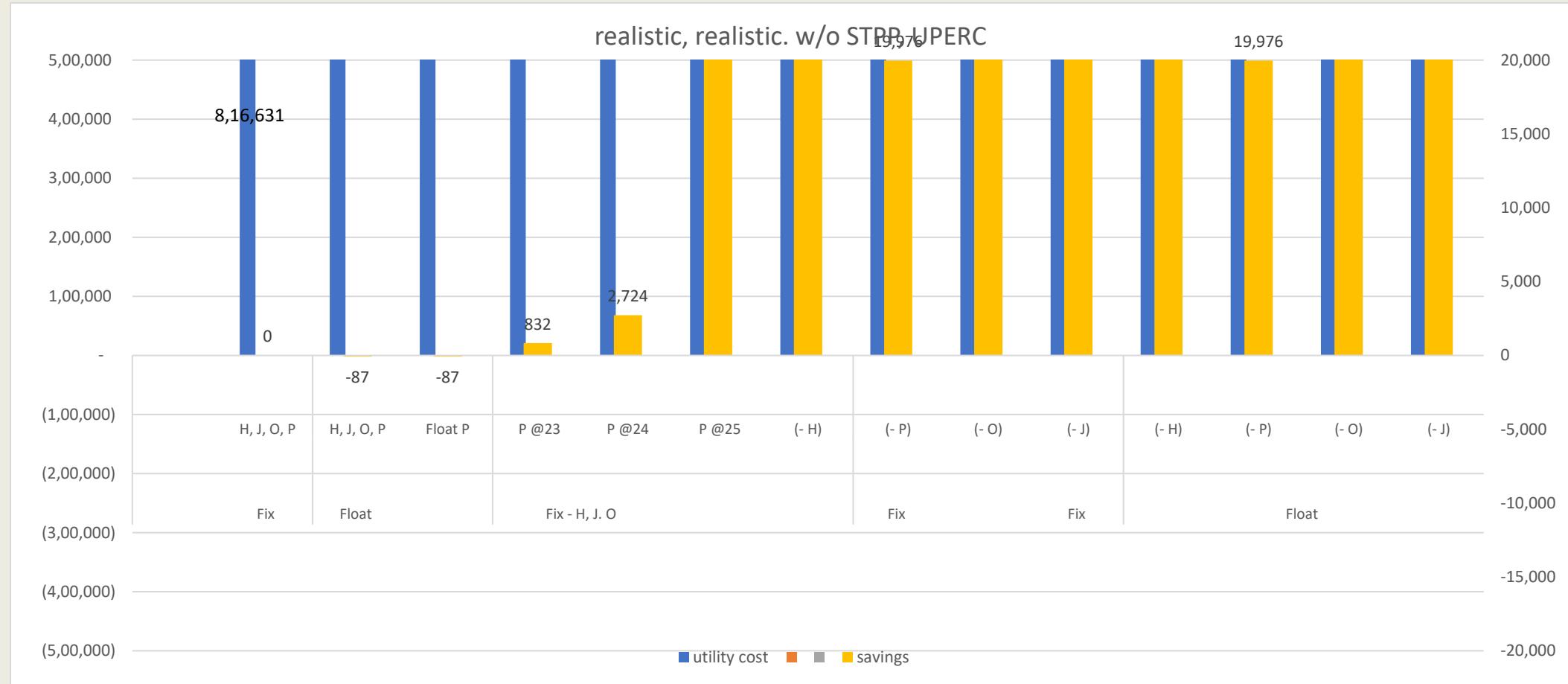


Utility Cost– Medium Demand with Policy DSM & Solar (w/o STPP)

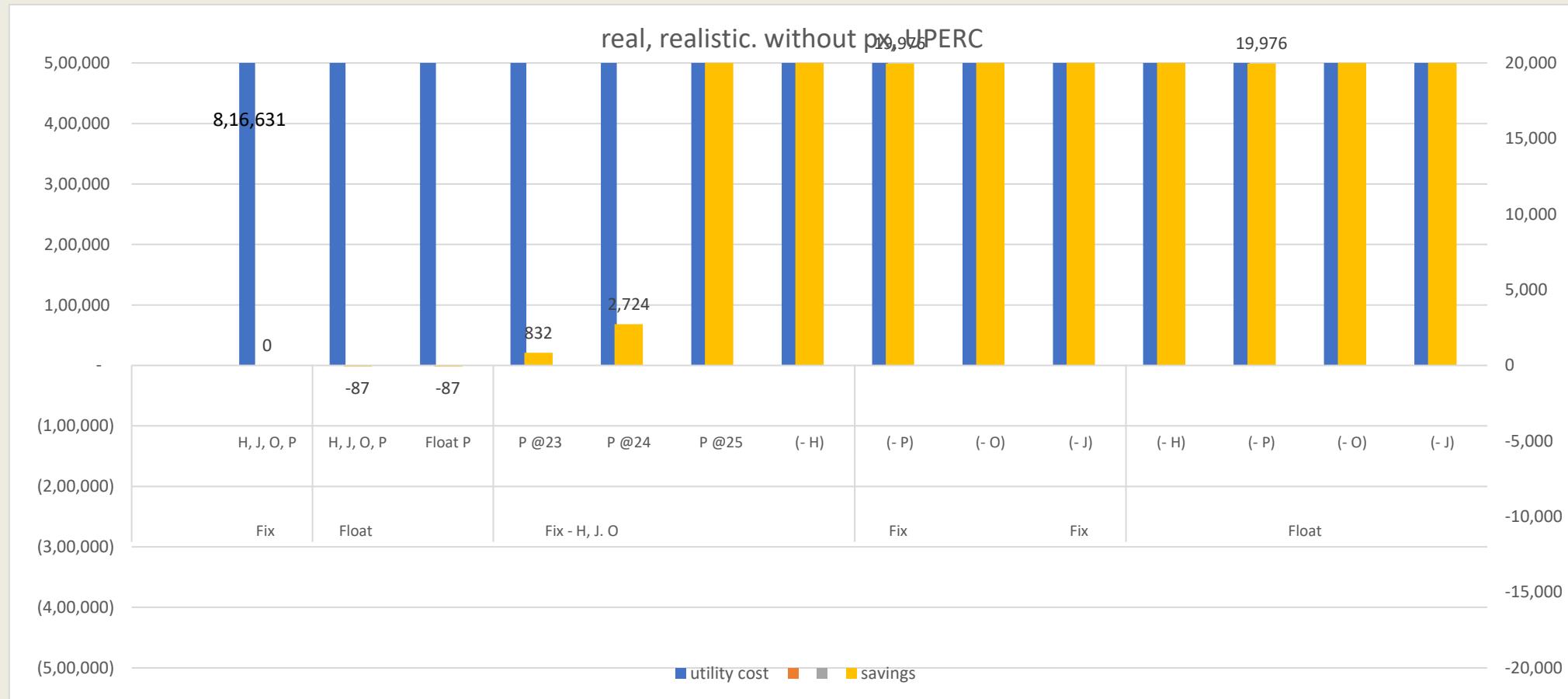


Results - Availability as per UPERC

Utility Cost – Realistic Demand with Realistic DSM & Solar (with STPP) – Availability as per UPERC



Social Cost – Realistic Demand with Realistic DSM & Solar (with STPP) – Availability as per UPERC



THERMAL PROJECTS WITHIN STATE

THERMAL PROJECTS WITHIN STATE				
SL. No	Project	Capacity of the Project in MW	Date of PPA Sign	U.P. 's Share (Expected) in MW
1	Meja Thermal Project (joint venture of NTPC & UPRVNL)	1320 (2x660)	30.09.2010	916
2	Meja TPP Stage-II (joint venture of NTPC & UPRVNL)	1320 (2X660)	05.01.2011	916*
3	Tanda Stage-II (NTPC)	1320 (2X660)	20.10.2010	943.45
4	Singrauli Stage-III (NTPC)	500 (IX500)	20.10.2010	182
5	Feroze Gandhi Thermal Project Staze-Iv (NTPC)	500	25.02.2011	173.14
6	Ghatampur TPP Goint venture of Nevelite Corporation & UPRVNL	1980 (3X660)	31.12.2010	1279
7	Bilhaur TPP (NTPC)	1320 (2X660)	31.12.2010	660 (50%)
8	Khurja STPP (THDC)	1320 (2X660)	31.12.2010	792*

HYDRO ELECTRIC PROJECTS IN OTHER STATES

HYDRO ELECTRIC PROJECTS IN OTHER STATES				
SL. No	Project	Capacity of the Project in MW	Date of PPA Sign	U.P.'s Share (Expected) in MW
1	Parbati Stage II (NHPC)	800 (4X200)	26.08.2004	160
2	Pekaldul*	1000 (5X200)	26.08.2004	200
3	Kotlibhel Stage-I A (NHPC)	195 (3X65)	27.01.2007	100
4	Kotlibhel Staze-I B CNHPC1	320 (4X80)	27.01.2007	Maximum possible
5	Kotlibhel Stage-II (NHPC)	530 (8X66.25)	27.01.2007	250
6	Vishnugad Peepalkothi HEP (THDC)	444 (4X111)	25.07.2007	177
7	Subansari Lower HEP (NHPC)	2000 (8X250)	04.10.2010	182
8	Lata Tapovan HEP (NTPC)	171	19.11.2010	44
9	Tapovan Vishnugad HEP (NTPC)	520 (4X130)	11.11.2010	131
10	Kameng HEP	NEEPCO(600 MW)	24.07.2017	56

THERMAL PROJECT IN OTHER STATE

THERMAL PROJECT IN OTHER STATE				
SL. No.	Project	Capacity or the Project in MW	Date or PPA Sign	U.P.'s Share (Expected) in MW
I.	Barh Stage-II (NTPC)	1320 (2X660)	20.11.2007	132
2	North Karanpura (NTPC)	1980 (3X660)	20.11.2007	98
3	Barethi STPP (NTPC)	3960 (6x660)	29.12.2010	1386 (35%)
4	Gidderbaha STPP (NTPC) (Punjab)	2640 (4X660)	29.12.2010	307*

Key Observations

- Given projected demand for Realistic Growth Scenario with Realistic DSM and Solar Policy Targets.....
- Significant savings for the floating scenarios across all forecast scenarios highlights the importance of long-term power procurement planning.
- Competitive Bidding should be preferable option for capacity addition/procurement in future.
- LT demand forecasting should undertake at the state level every 3-5 years to recalibrate demand projections and adjust power procurement through ST and MT procurement.
- Needs careful analysis of plant availability data – UPPCL Vs UPERC.
- Evaluate signed PPAs (not considered in the analysis) and progress thereof.

Key Observations (Contd.)

- Develop a Short-term /Medium-term Power Procurement Strategy – Increase in solar capacity addition may necessitate procurement for evening peak/evening off-peak through multi-year block based procurement
- Low PLF of some of the existing plants may suggest gain from cancellation if cost of cancellation is lower.
- ToD Tariff to be dynamic / linked to DAM. All consumers above 10kW could have ToD tariff. (The ToD tariff design needs more careful consideration.
- Significant growth in demand and energy supplied be accompanied with growth in ‘sanctioned load’ of consumers through new connections and revision of sanctioned load of existing consumers, where ever applicable. → Else, financial losses may grow further with increasing gap between CoS and ABR. Important to consider cost of ‘incremental power’ being procured in the ST and revenue growth.

Monthly Load Profile

Monthly Load Profile

- Energy distribution is different across month of year based on seasonal demand pattern.
- Energy distribution over months in a year, is calculated from past night reports (2012-2016) as percentage of total energy consumed in particular month
- Some months have similar load profile due to similar weather conditions.

Energy Consumption in Month

	2013-14	2014-15	2015-16	2016-17
Apr	8.2%	8.1%	7.4%	8.6%
May	9.3%	9.0%	9.1%	8.7%
Jun	8.0%	9.5%	9.0%	9.1%
Jul	8.9%	9.2%	9.0%	8.7%
Aug	8.7%	9.2%	9.5%	8.7%
Sep	9.0%	9.3%	9.6%	9.0%
Oct	8.1%	8.3%	8.8%	8.5%
Nov	7.7%	7.7%	7.2%	7.3%
Dec	8.3%	8.0%	7.5%	7.8%
Jan	8.4%	8.1%	7.8%	8.1%
Feb	7.4%	7.1%	7.4%	7.2%
Mar	8.1%	6.5%	7.9%	8.2%

Seasonal Profile & Energy Distribution

Seasonal Profiles	Months	% Average Energy Consumption in Month
Winter	January, February & December	8.26%
Autumn	March, April, October & November	8.30%
Summer	May & June	9.13 %
Man soon	July, August & September	7.92%

DSM Effect

A. Lighting Load

- LED's – Use of LED bulb has impact on night load during 7 PM to 10 PM .
- Calculation for load follows
- Total LED distributed – 15 Million
- Approx. LED in Operation – 5 Million
- Load Replace 30 W (Assuming LED of 10 W replace 40 W bulb)
- Load Impact = 150 MW during 7 PM to 10 PM

DSM (Contd.)

B. Agriculture DSM

- Per Pump set connected load - 6 kW
- Load saving due to new pump is 1.5 kW (25% of existing)
- No of operation hour - 12

* Agriculture Supply is 10 hour, for load distribution it is assumed 12 hour

Calculation:

Load saved = Total new pump set installed * Load saved due to new pump set

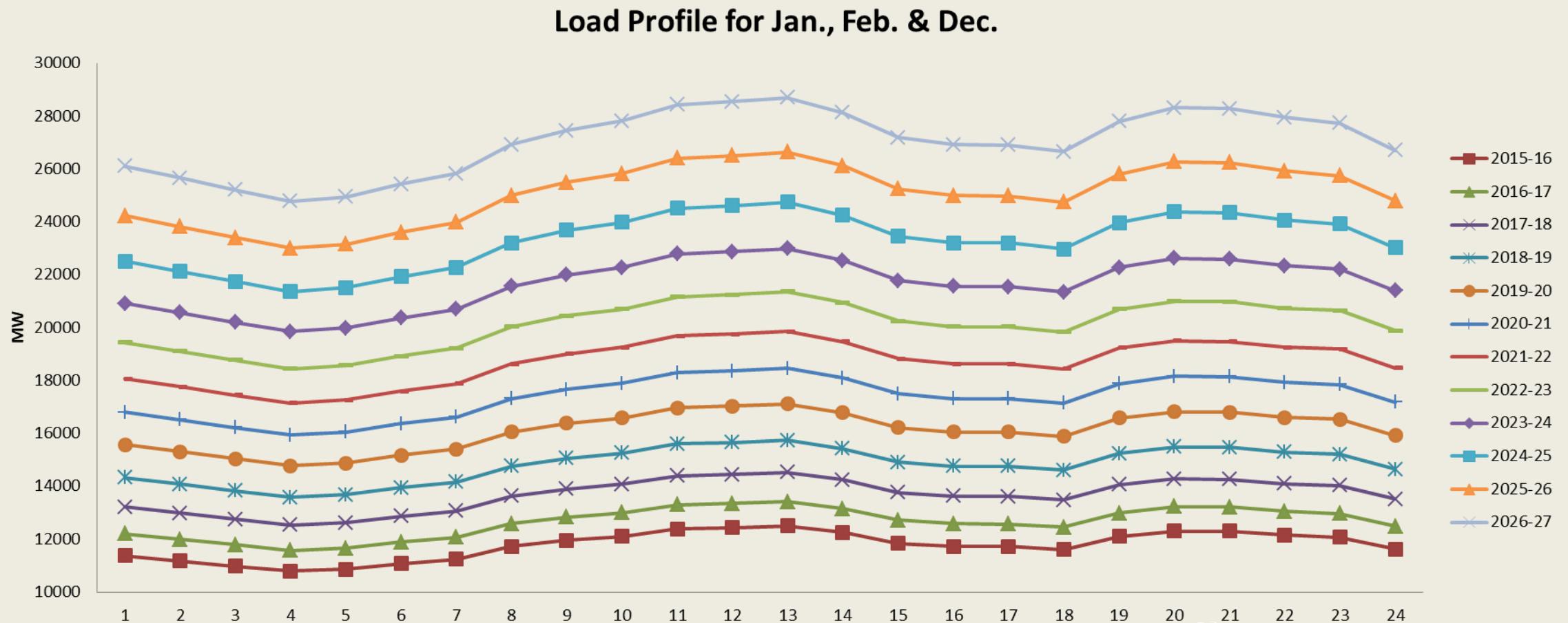
For year 2017-18

$$\begin{aligned} \text{Load saved} &= 100000 * 1.5 \text{ kW} \\ &= 150 \text{ MW} \end{aligned}$$

* Assuming All are not in operation at same time, distributed equally in two time frame.

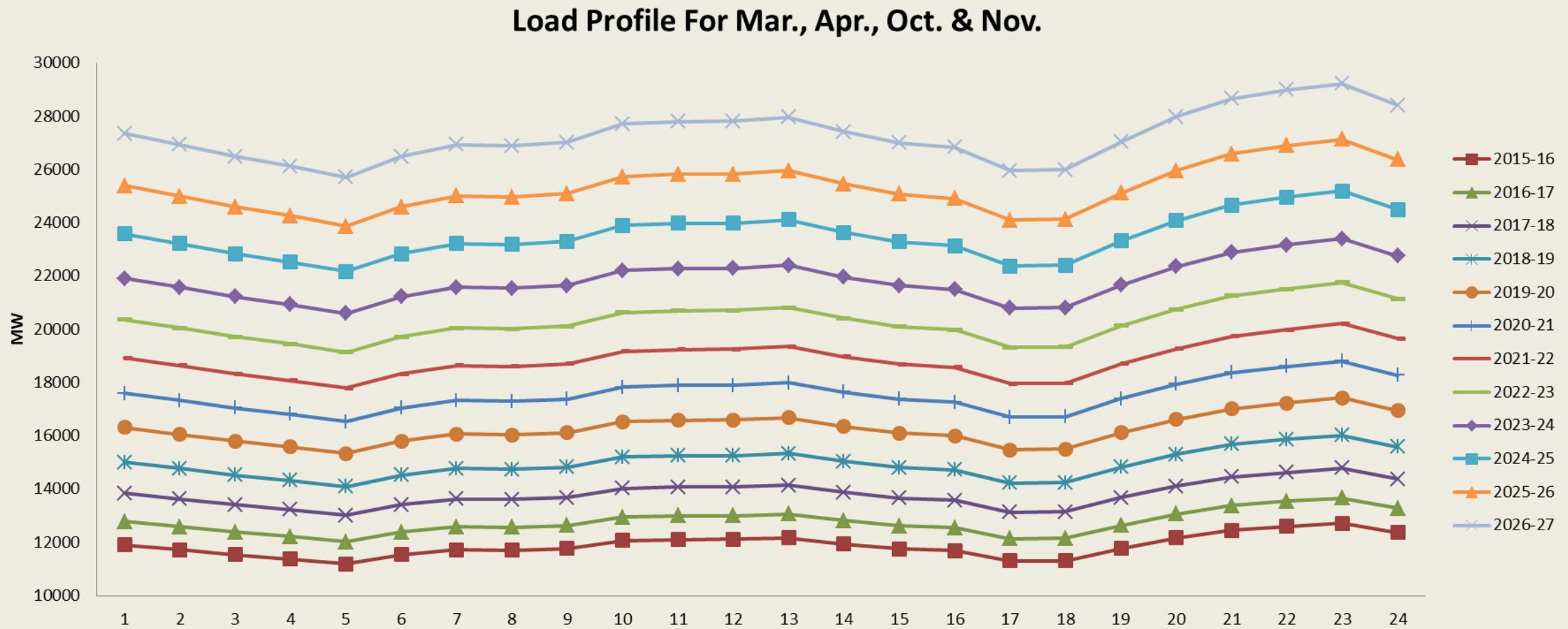
Year	No. of pump replaced in year	Total Pump set replaced	load effect	No. of hours operations	06.00 AM to 12.00 PM	12.00 PM to 6.00 PM
2016-17	10000	10000	15 MW	12	7.5 MW	7.5 MW
2017-18	90000	100000	150 MW	12	75 MW	75 MW
2018-19	300000	400000	600 MW	12	300 MW	300 MW
2019-20	300000	700000	1050 MW	12	525 MW	525 MW
2020-21	300000	1000000	1500 MW	12	750 MW	750 MW

Projected Load Profile – Realistic (Dec. – Feb.)

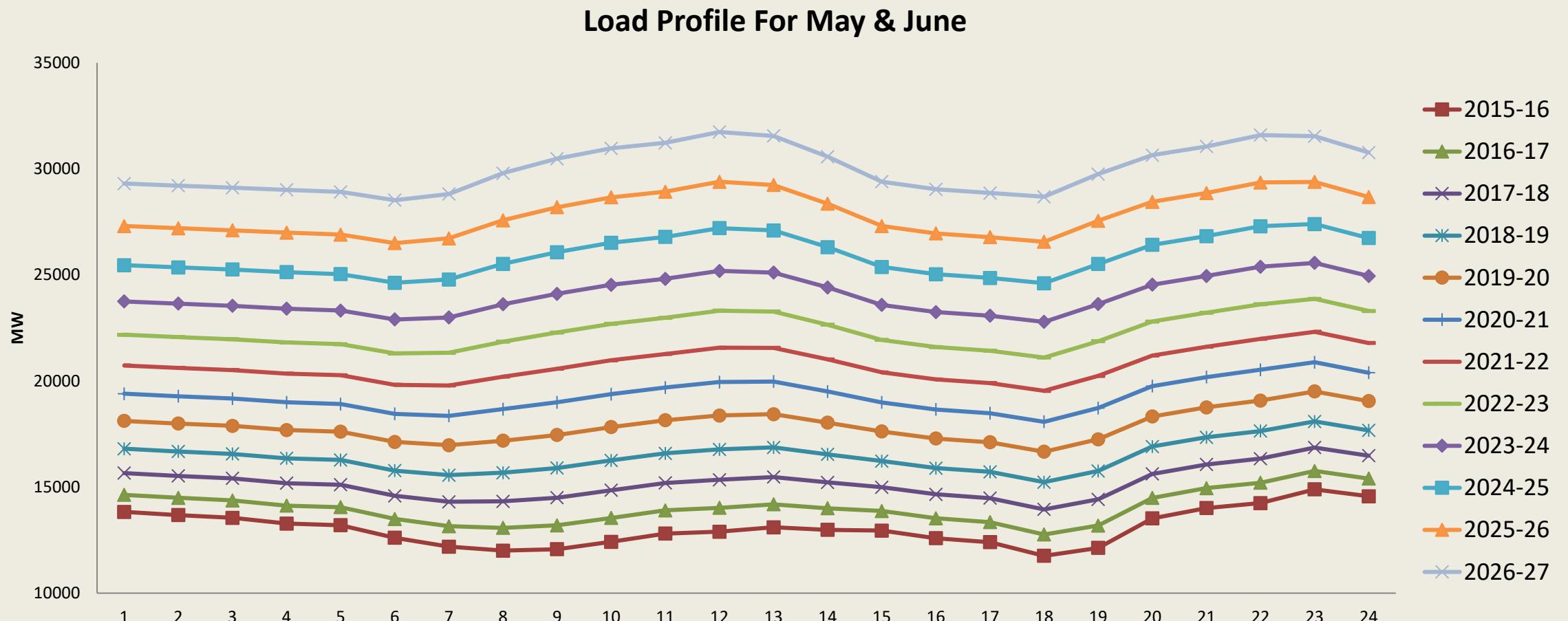


Projected Load Profile – Realistic

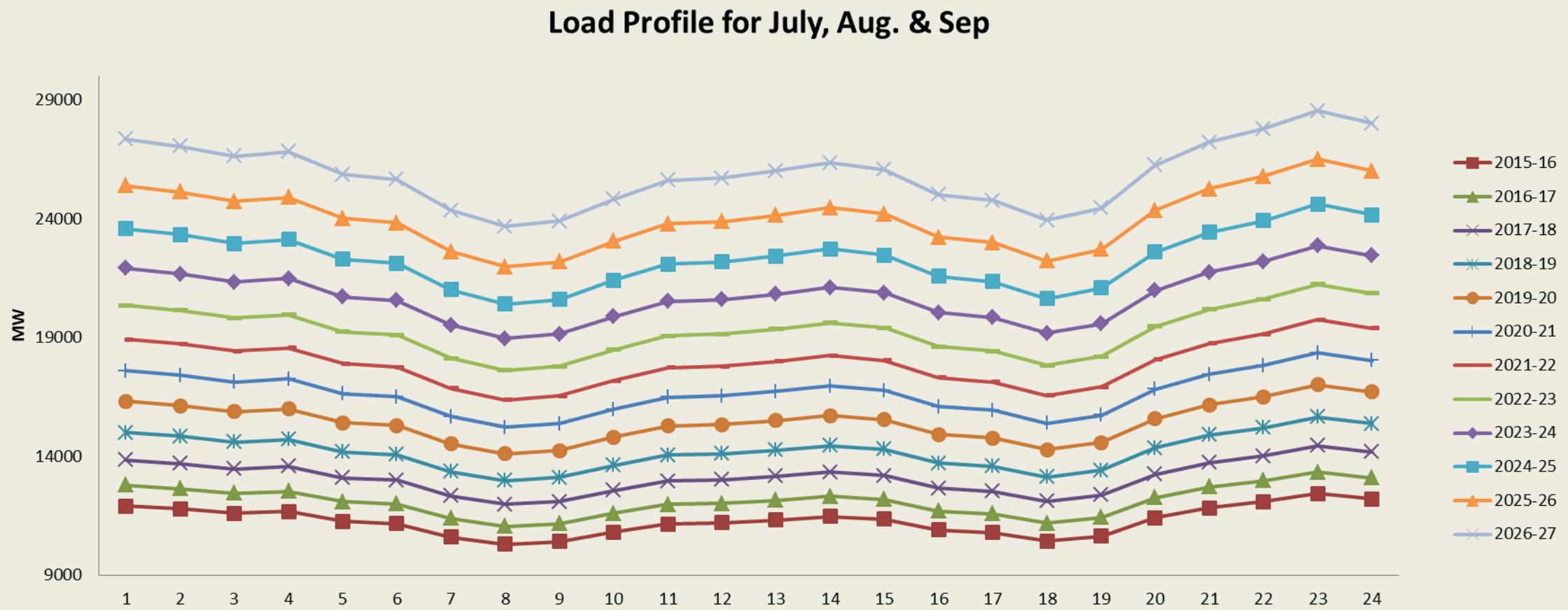
(Mar., Apr., Oct., Nov.)



Projected Load Profile – Realistic (May. – June)



Projected Load Profile – Realistic (July, Aug., Sept.)



Disruptive Changes in future

- Open Access
- Rooftop Solar
- Retail competition
- Metro & Electric Traction
- Electric vehicles
- Smart Grid
- Storage
- Franchisee (with exist clause for power procurement?)

Tasks Ahead

- Complete Data collection
- Construct Preliminary models
- Discuss and Freeze Assumptions – (Discussion with UPPCL)
- Develop Forecast – (Presentation at UPPCL)

References

1. Statistics-at-a-glance-2015-16 (<http://www.uppcl.org/pdf/staticks-at-a-glance-2015-16.pdf>)
2. 24 x7 Power for All Uttar Pradesh MOP
3. Data – UPPCL Night Report
4. Data – UPPCL Connected load , Nos. of consumer