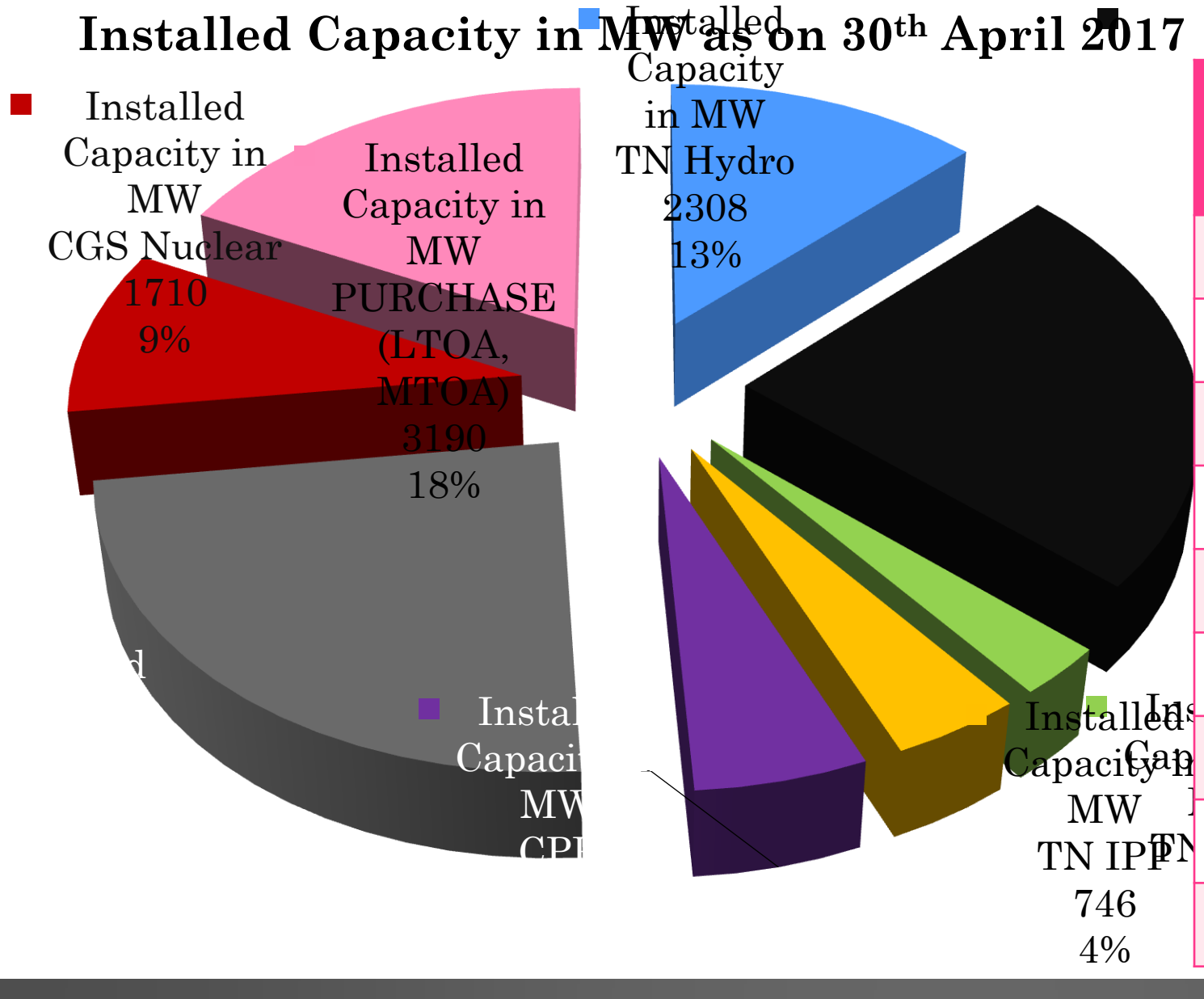


Presentation to CEA Technical Committee on Energy Storage Devices by SLDC, TANTRANSCO

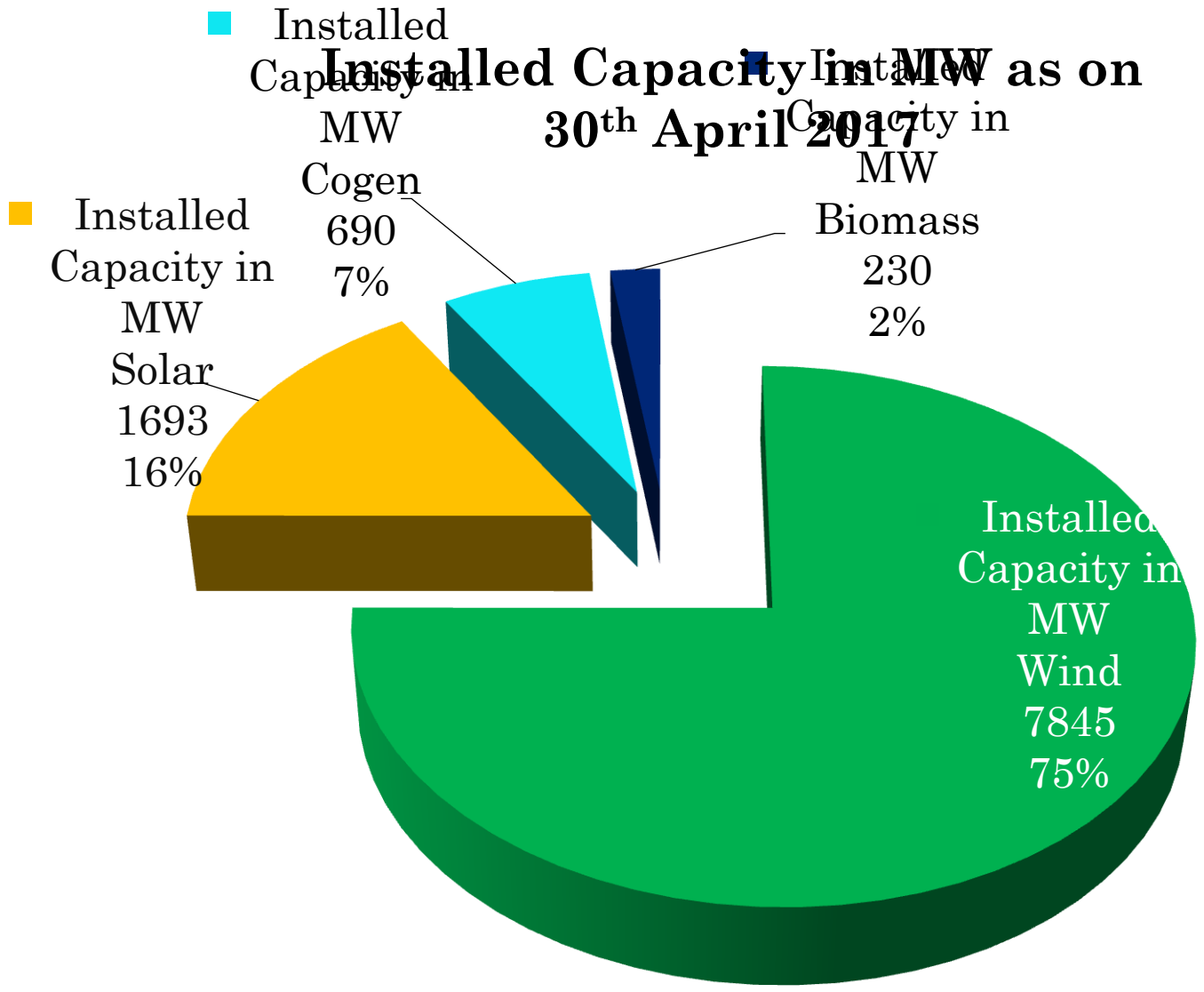
Tamil Nadu – Conventional Generation Mix

Installed Capacity in MW as on 30th April 2017



Conventional Generator	Installed Capacity in MW
TN Hydro	2308
TN Thermal	4320
TN Gas	516
TN IPP	746
CGS Thermal	4328
CGS Nuclear	1710
Purchase	3190
CPP	986
Total	18104

Tamil Nadu – Renewable Energy Generation Mix



Renewable Energy Generator	Installed Capacity in MW
Wind	7845
Solar	1693
Cogen	690
Biomass	230
Total	10460

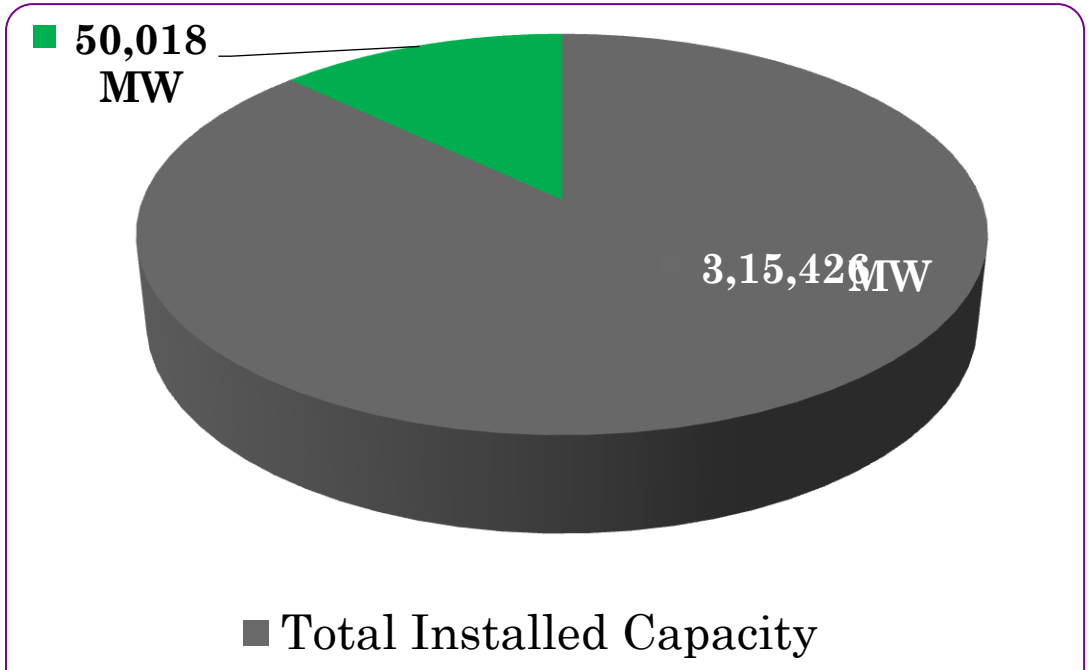
Tamil Nadu High Energy Consumption Details Achieved in a Day

Details	Achieved	On
Consumption	345.617 MU	29th April 2016
Demand	15343 MW	29th April 2016
Wind Energy	97.351 MU	16th August 2016
Wind Generation	4906 MW	29th August 2016
Solar Energy	9.4 MU	27th March 2017
Solar Generation	1498 MW	27th March 2017

All India Installed Capacity Scenario

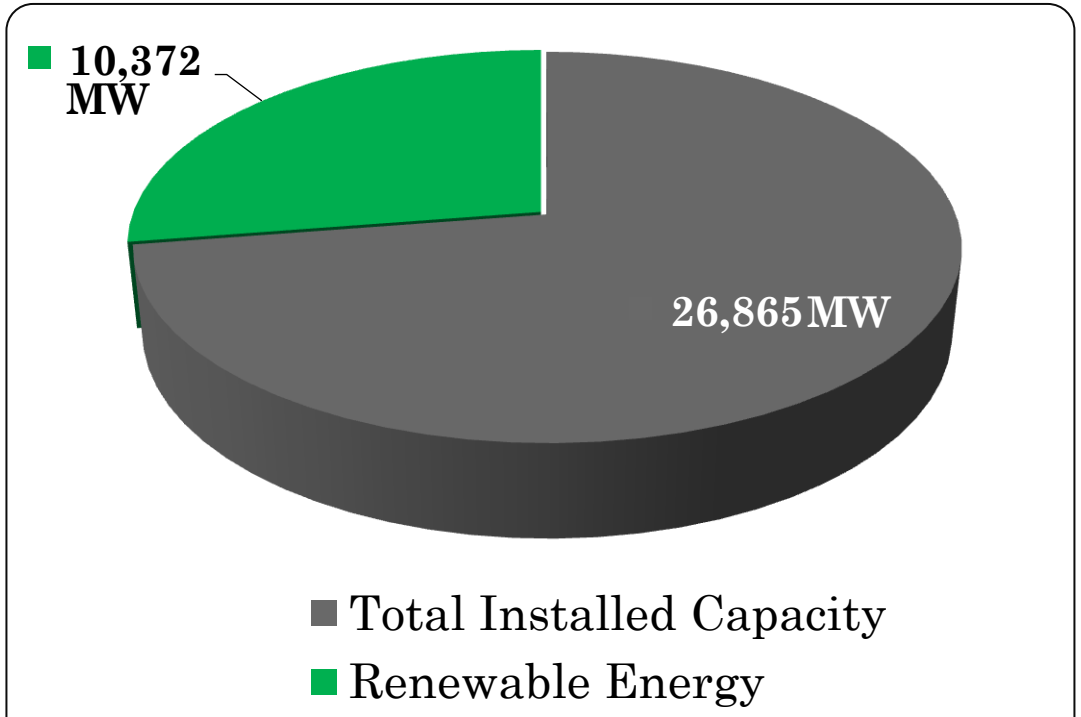
(as on 28th Feb 17 - source from CEA)

All India



RE penetration 15.85% of Total Installed Capacity

Tamil Nadu



RE penetration 38.5% of Total Installed Capacity

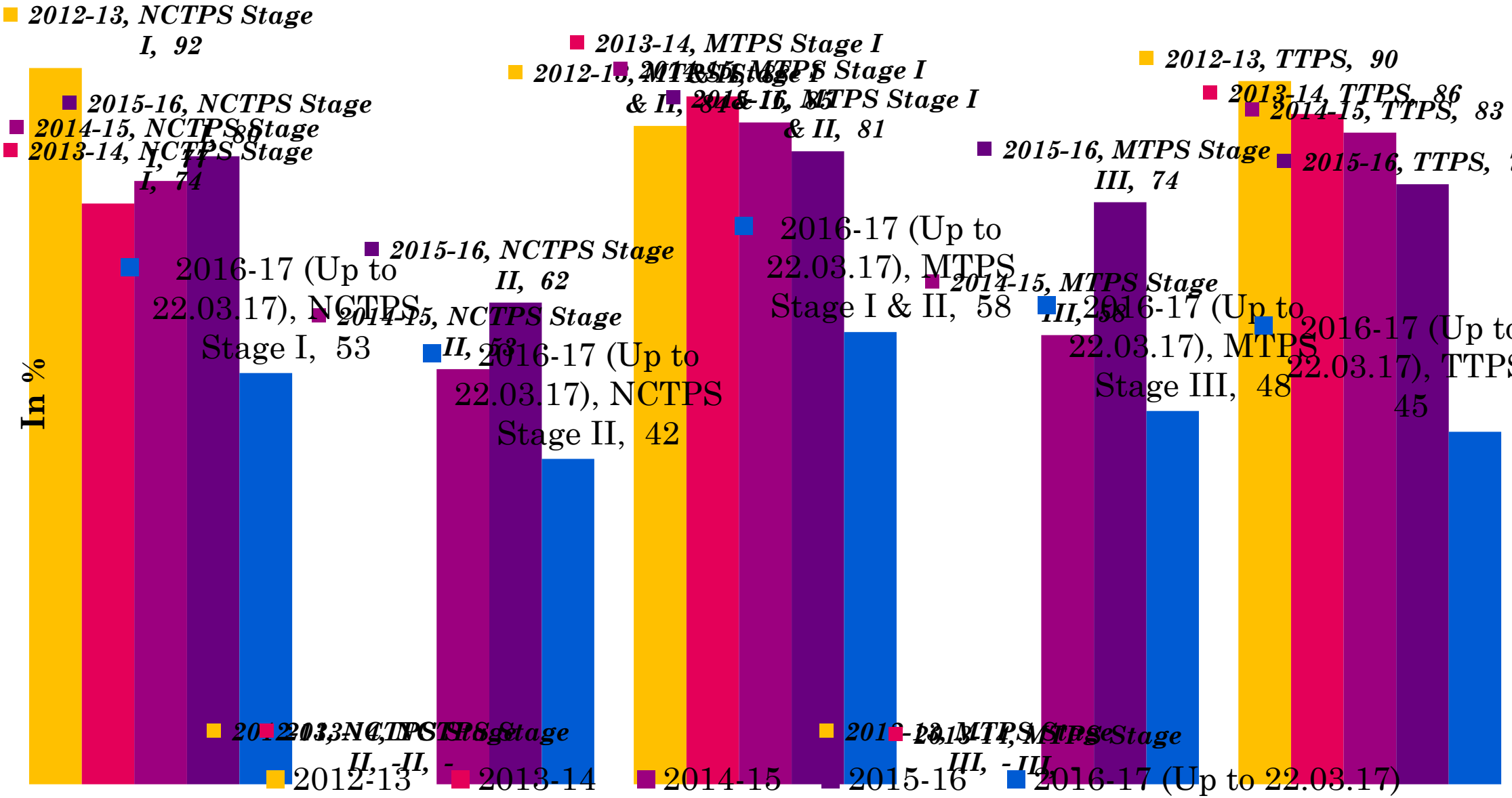
TN Contributes to 21% of country's RE installed capacity

Action taken

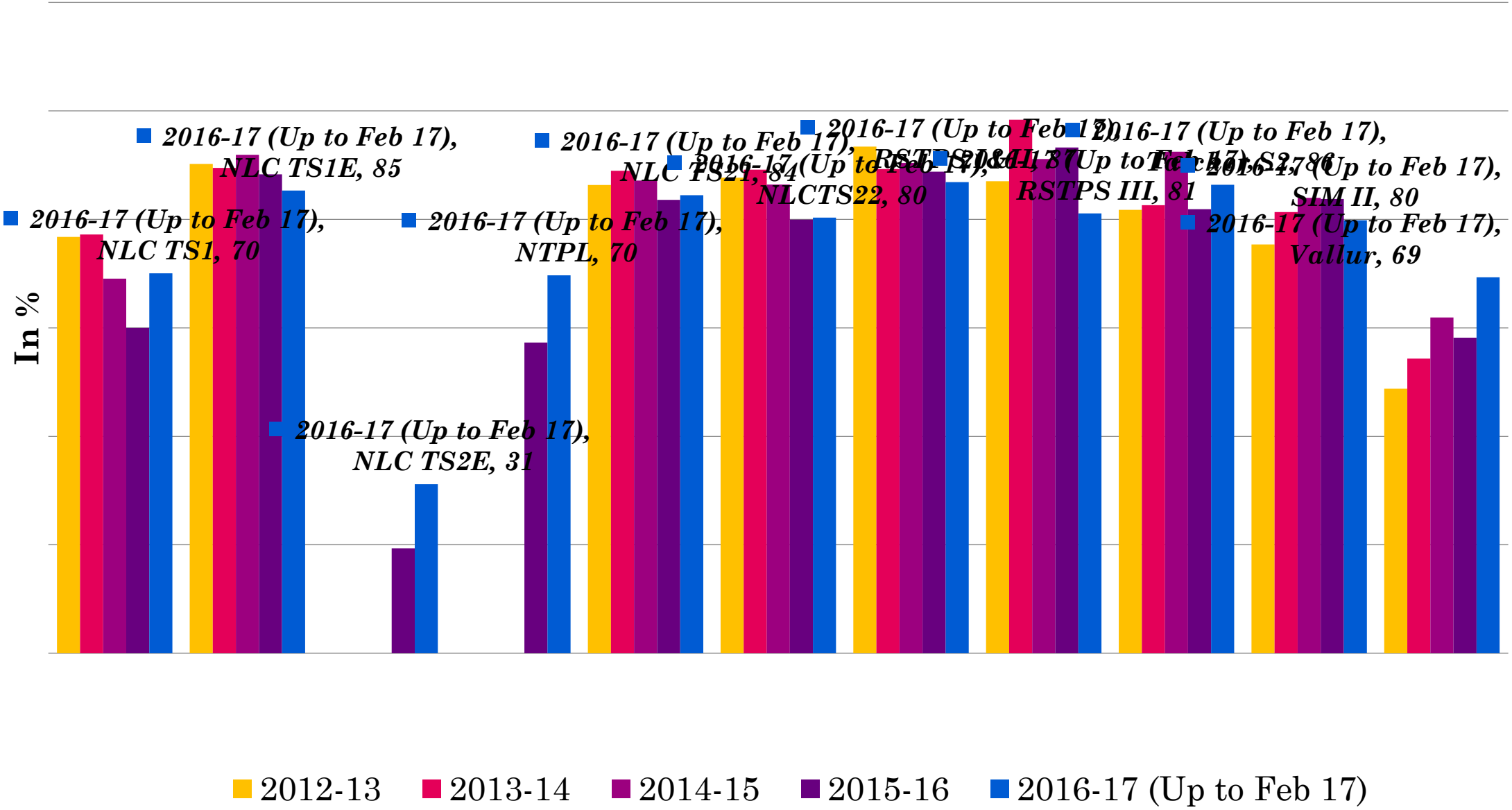
- **Load Shedding relaxed - 1st June 2014**
- **Restriction & Control measures relaxed - 5th June 2015**
- **AOH/COH for 2 to 3 TANGEDCO Thermal machines simultaneously- completed in June to September**
- **1 or 2 TANGEDCO Thermal Stations - Reserve Shut down**
- **AOH of CGS - Insisted in SRPC to complete in June to September.**
- **Sale of Power out the State - Resorted**

Thermal Stations PLF

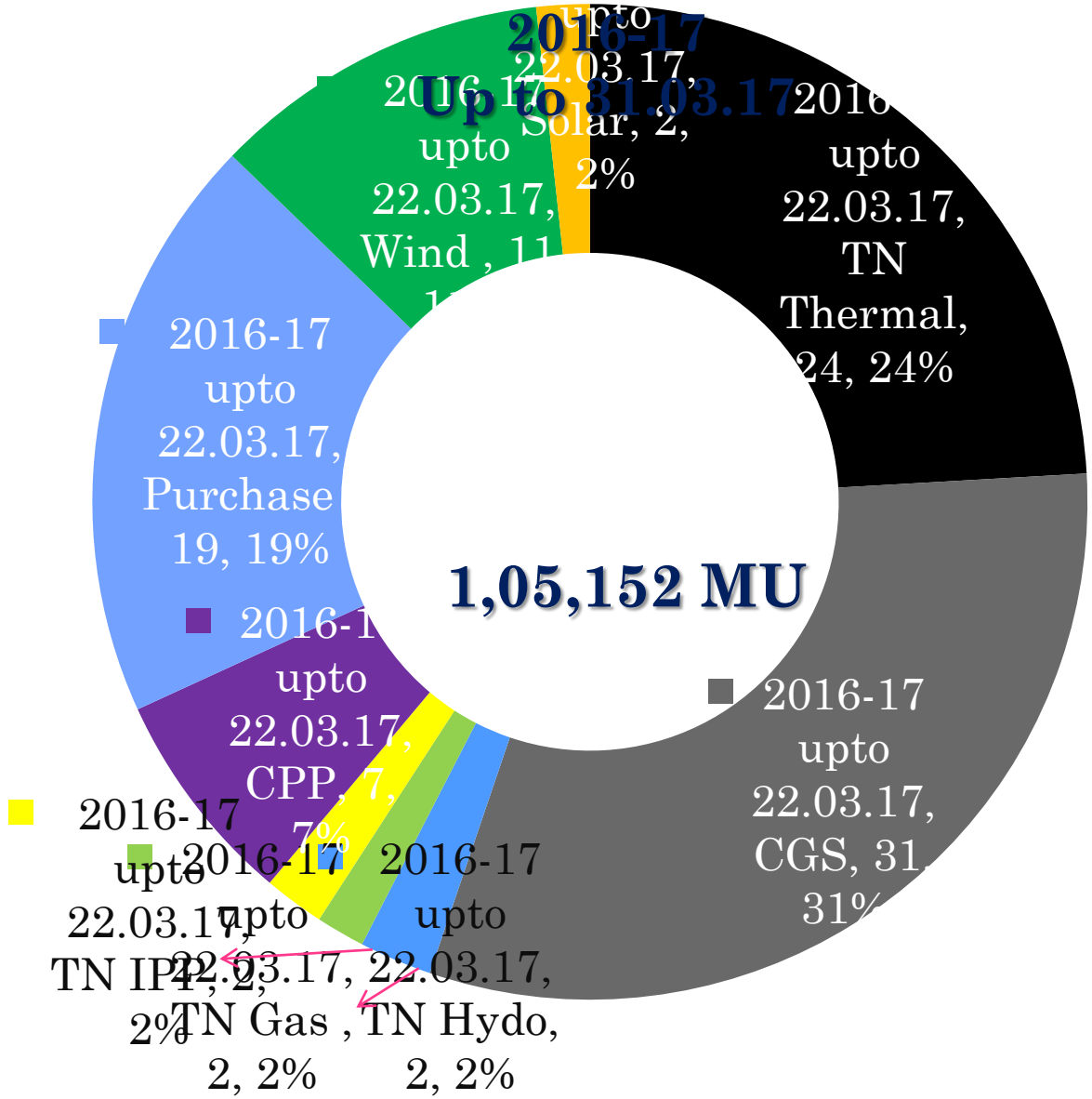
TNEB Thermal Power Stations PLF



CGS Stations PLF

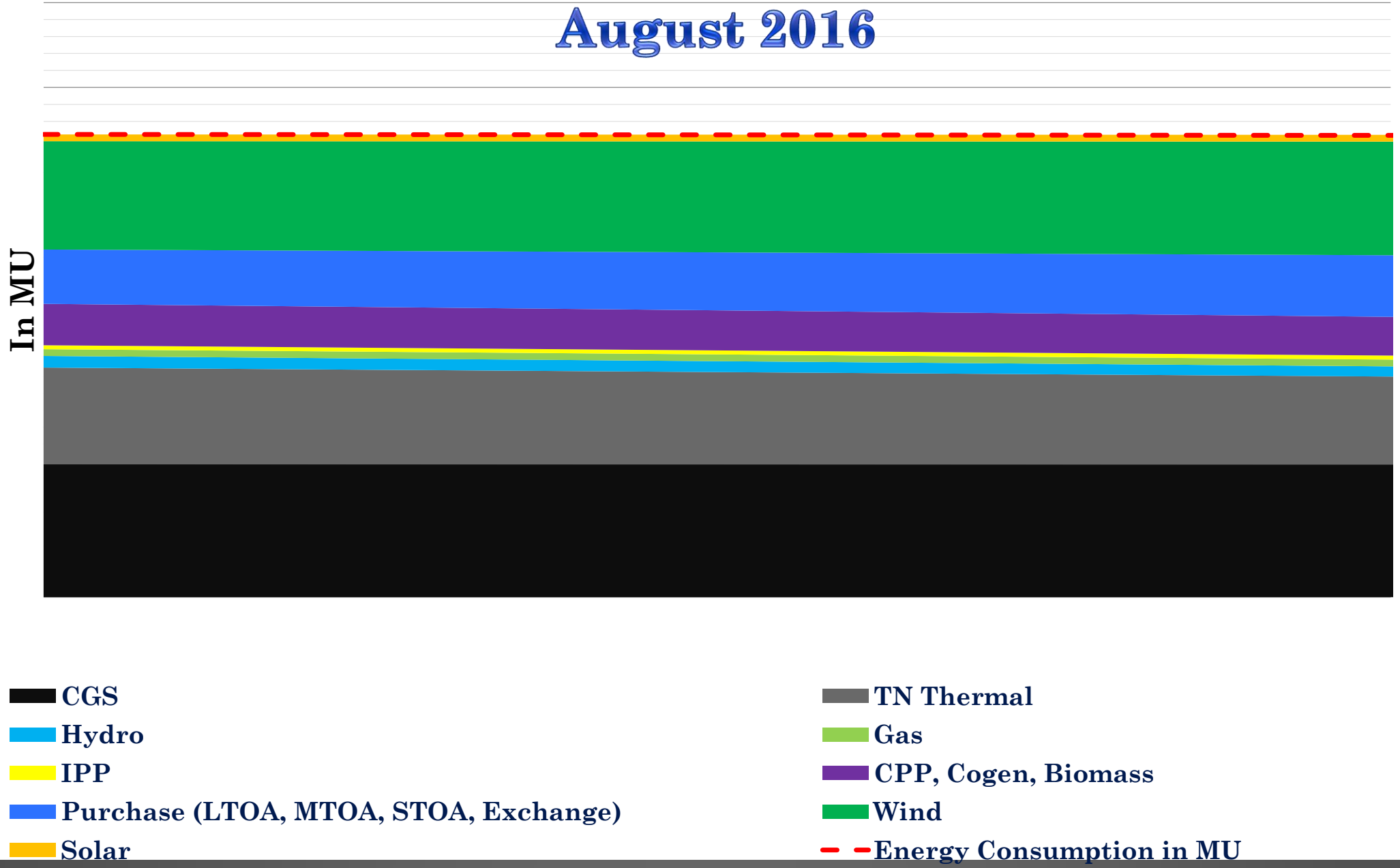


Year wise - % Contribution of Various Sources



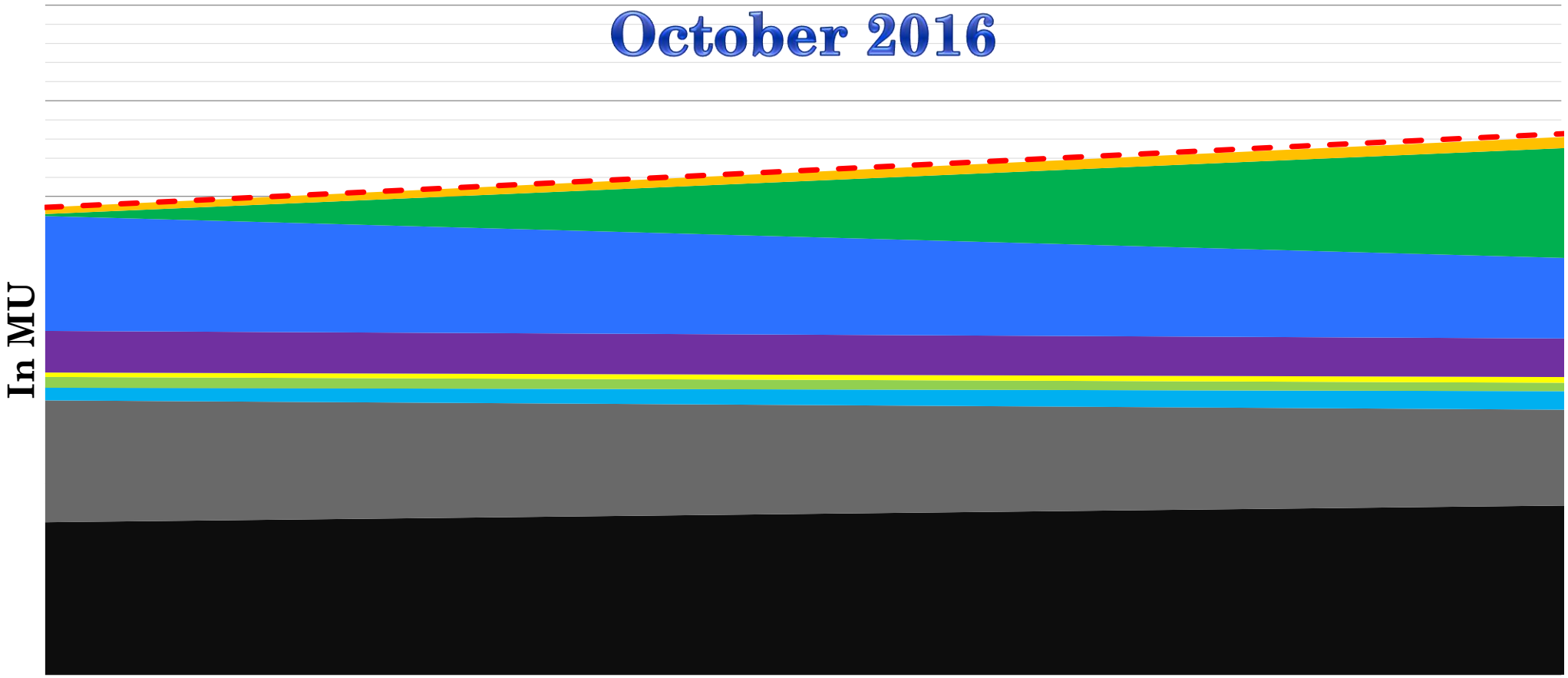
Energy Consumption Details and Category wise split up details

August 2016



Energy Consumption Details and Category wise split up details

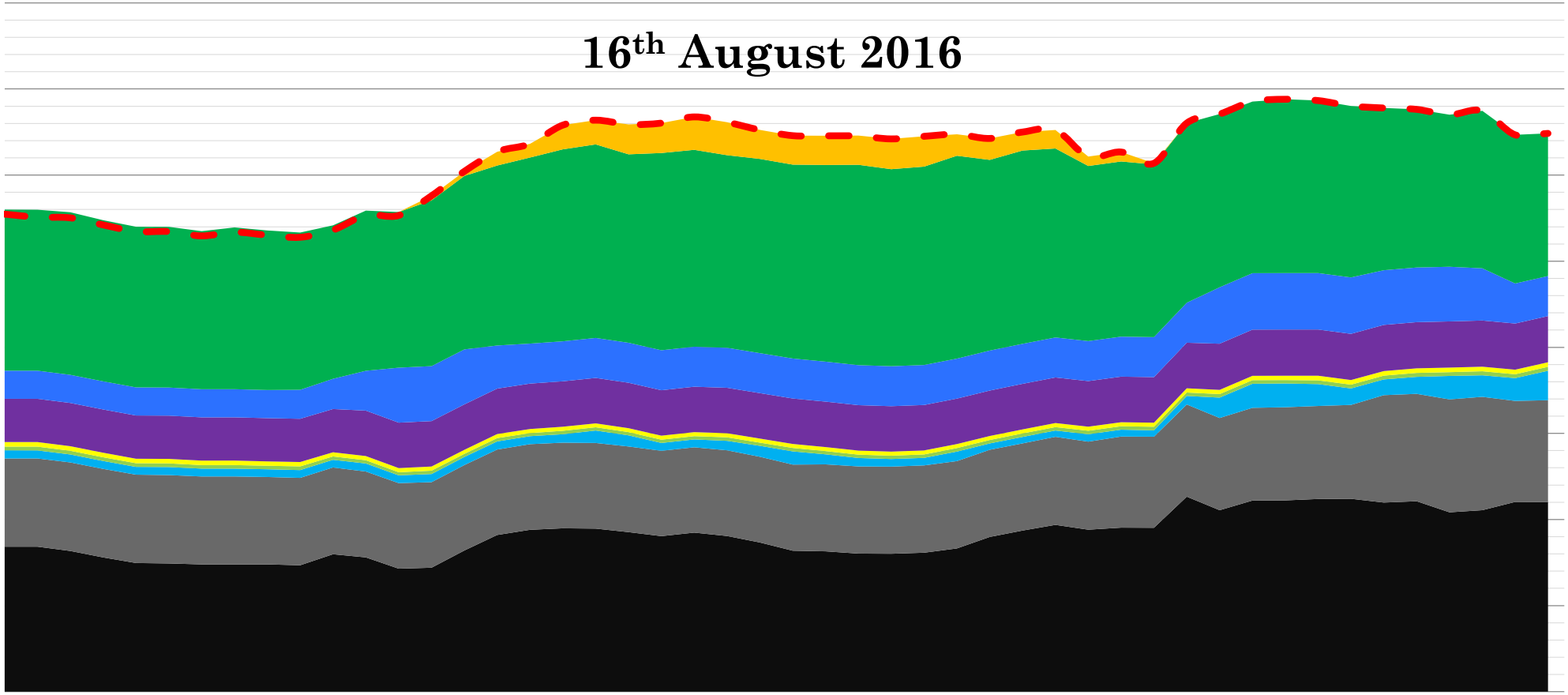
October 2016



Wind Accommodation – Effects on Other Sources of Generation in a day during

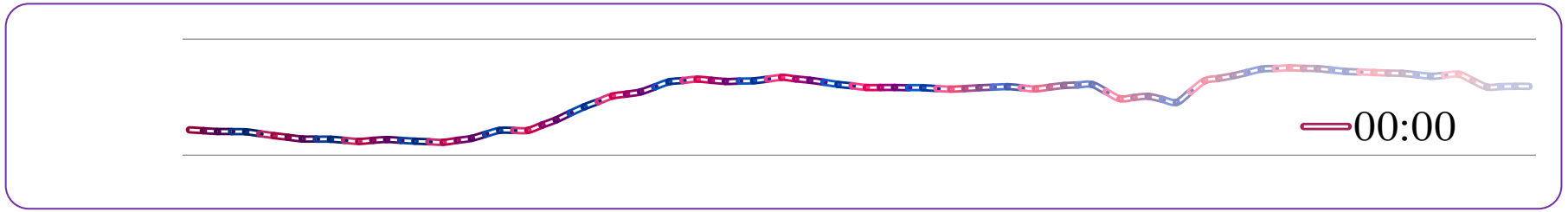
1. High Wind day – 16th August 2016
2. No/Low Wind day – 15th October 2016

Hourly Generation Split up – on High Wind Absorption day



CGS
Hydro
IPP
Purchase (LTOA, MTOA, STOA, Exchange)
Solar
TN Thermal
Gas
CPP, Cogen, Biomass
Wind
Demand

Day Consumption : 297.062 MU
Wind contribution : 97.351 MU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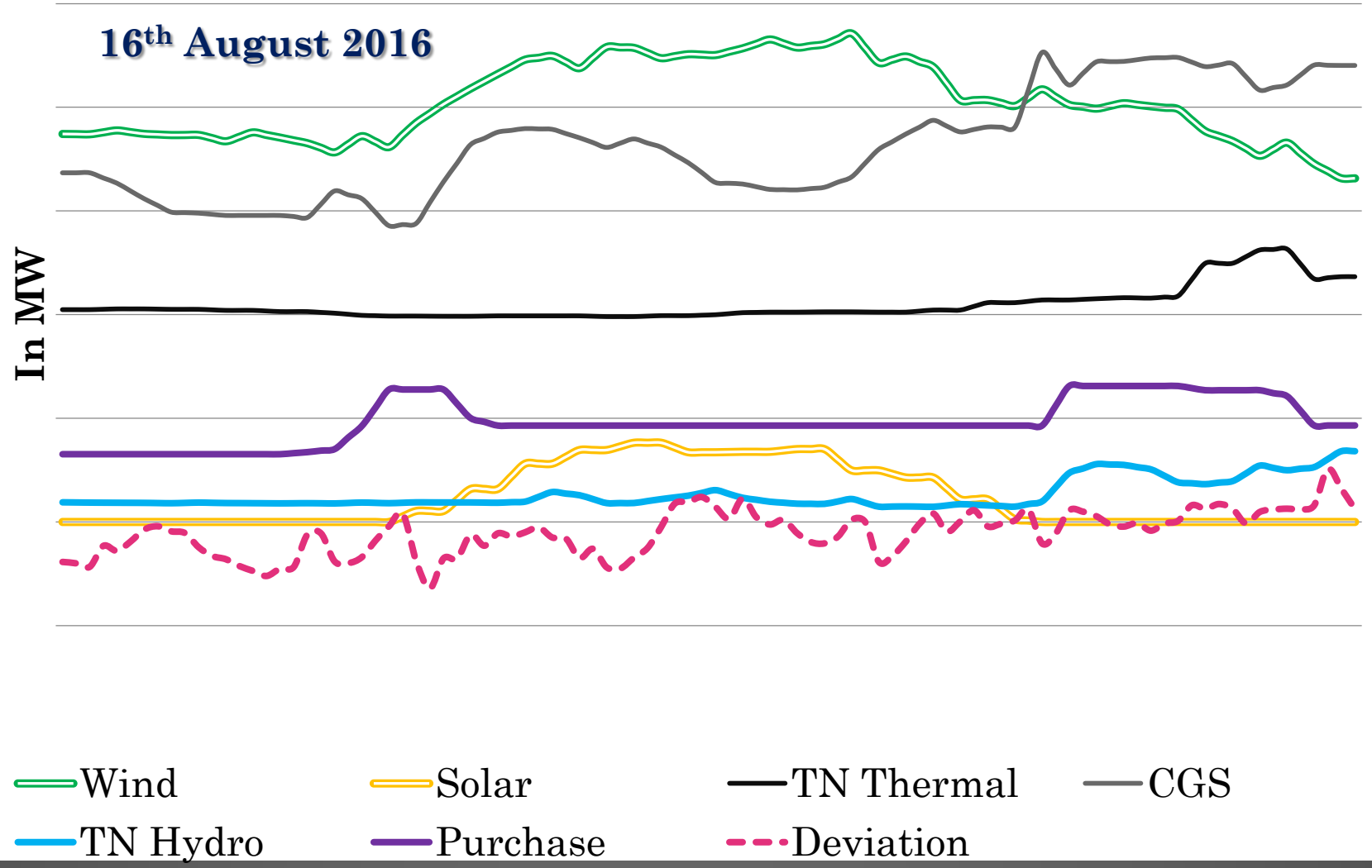
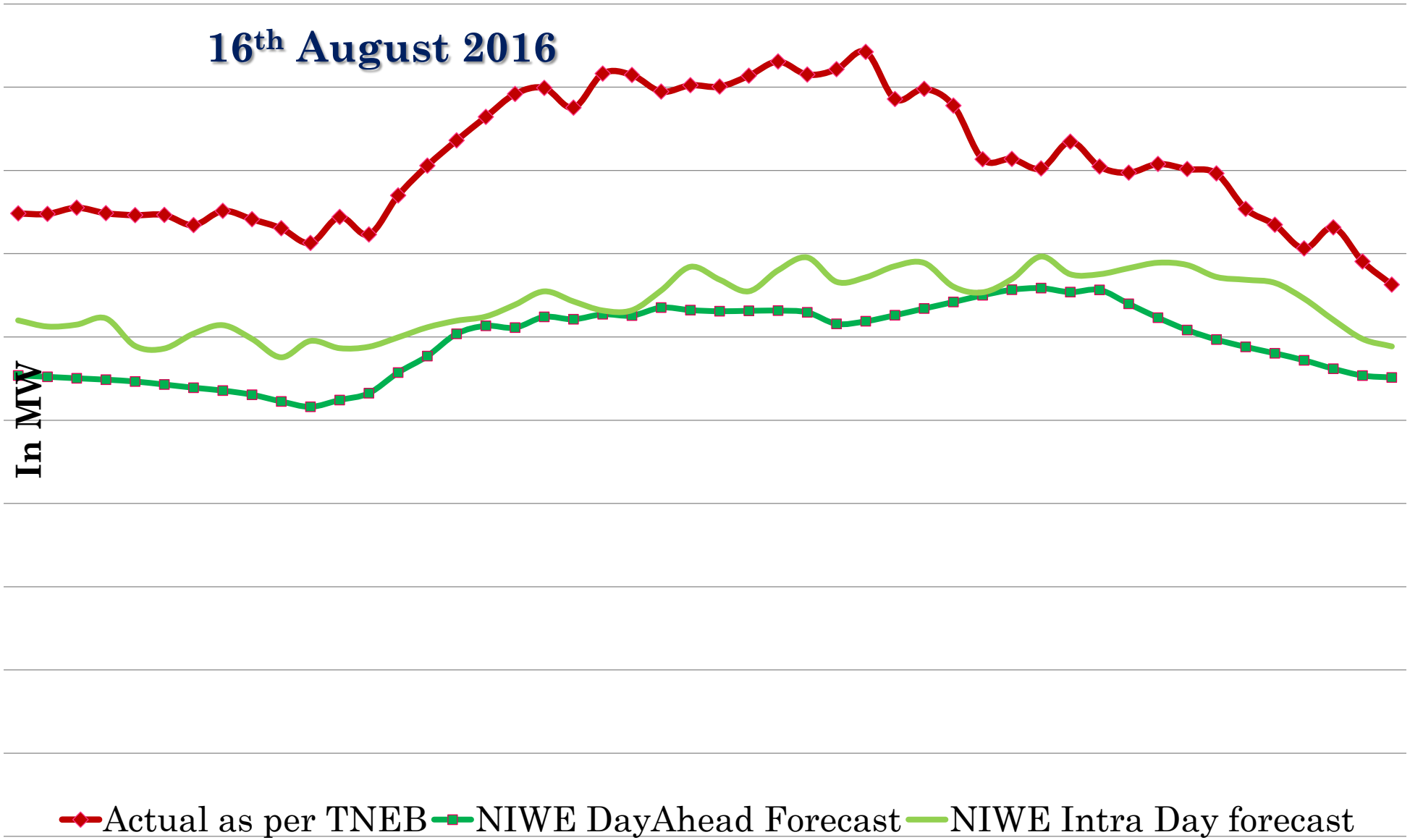
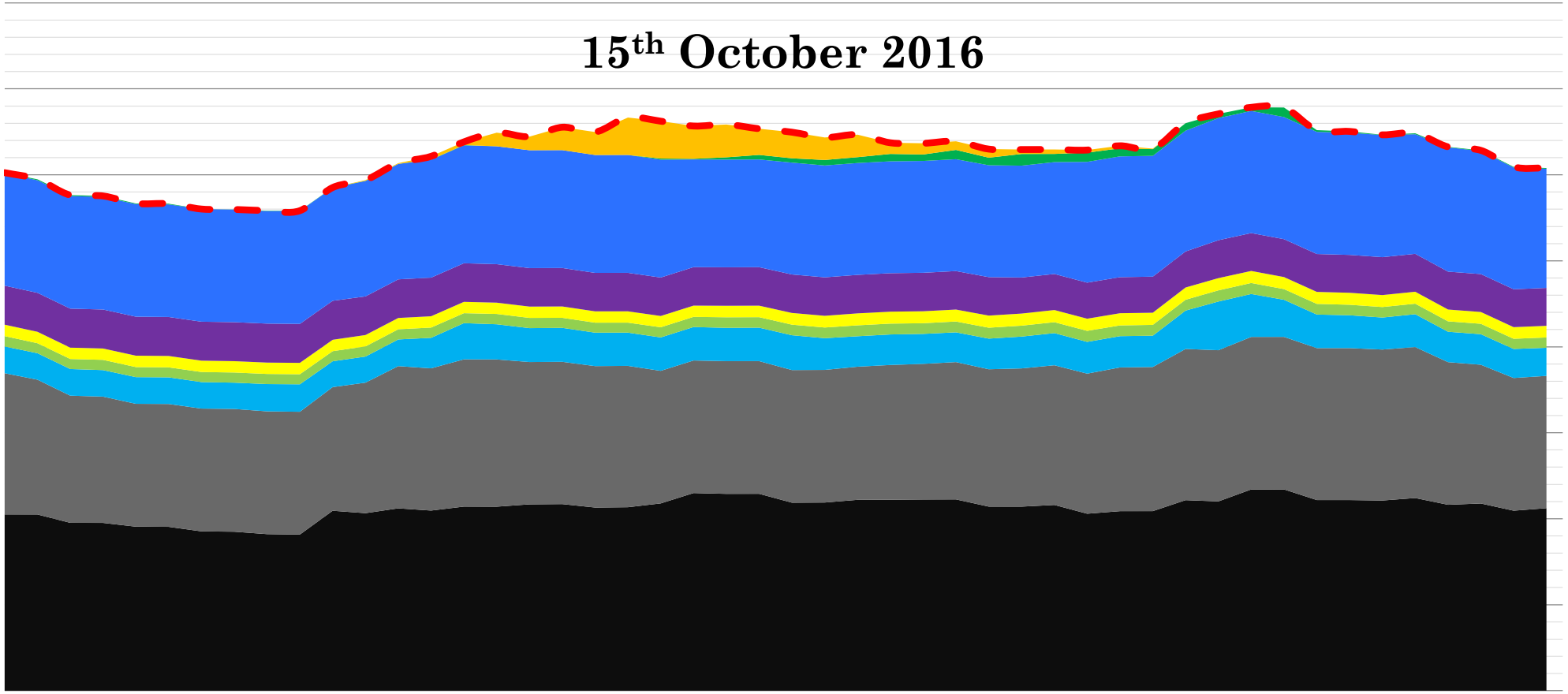
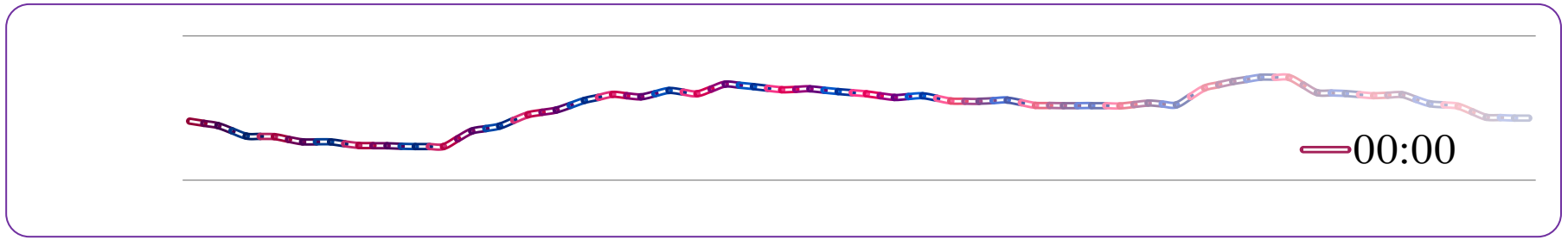

16th August 2016
In MW
Wind
Solar
TN Thermal
CGS
TN Hydro
Purchase
Deviation

NIWE Forecasting Vs Actuals During High Wind Season



Hourly Generation Split up – on Low Wind day

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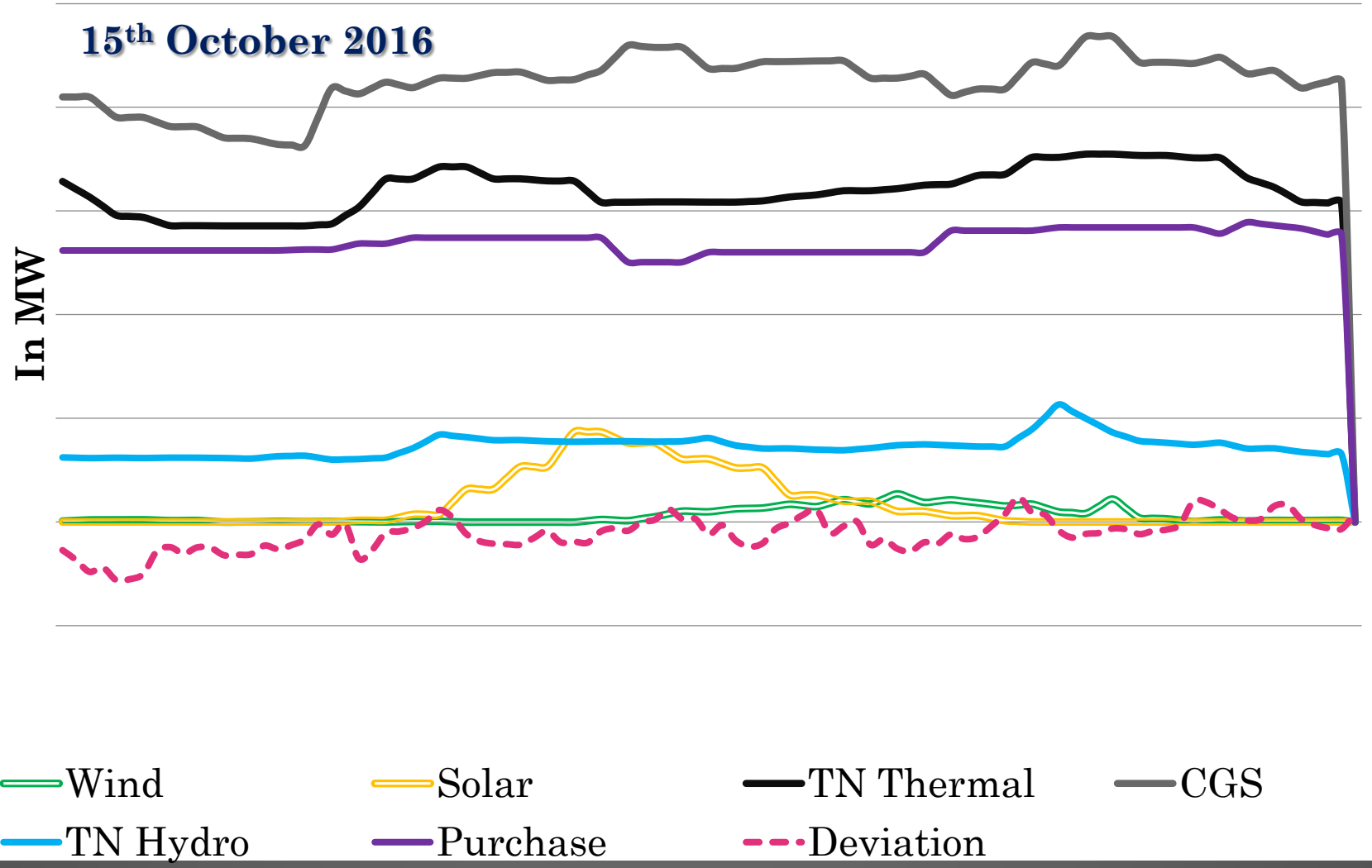
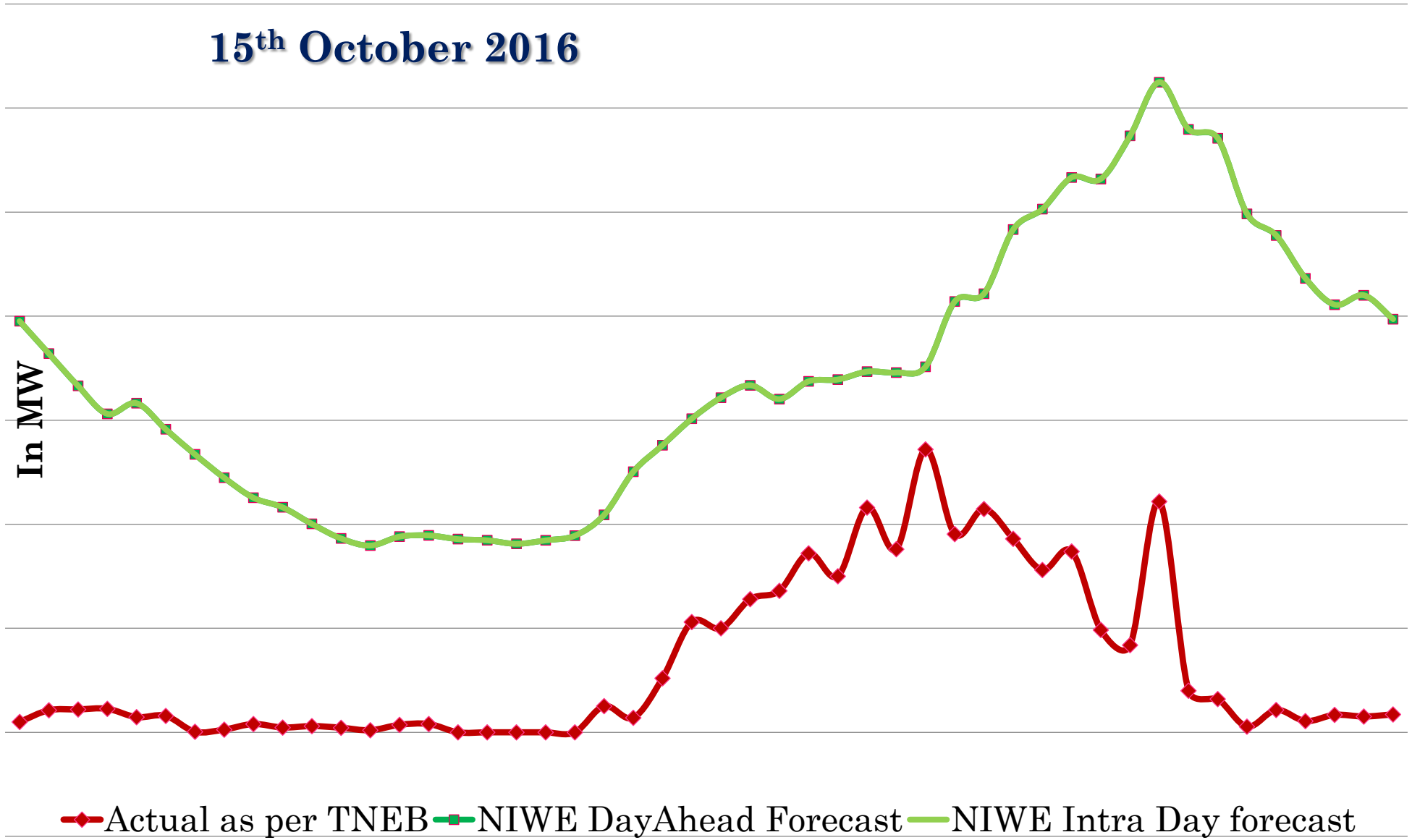

15th October 2016
In MW
Wind
Solar
TN Thermal
CGS
TN Hydro
Purchase
Deviation

NIWE Forecasting Vs Actuals During Low Wind Season



Energy Consumption Split up Details during

16th August 2016

Generator Details	Energy Consumption in MU	% of Contribution
TN Hydro	6.539	2.20
TN Thermal	50.398	16.97
TN Gas	1.963	0.66
TN IPP	2.365	0.80
CGS	85.263	28.70
Purchase	23.057	7.76
CPP	24.935	8.39
Wind	97.351	32.77
Solar	5.191	1.75
Total	297.062	

15th October 2016

Generator Details	Energy Consumption in MU	% of Contribution
TN Hydro	17.608	5.90
TN Thermal	76.832	25.74
TN Gas	5.820	1.95
TN IPP	6.516	2.18
CGS	101.599	34.04
Purchase	63.783	21.37
CPP	20.616	6.91
Wind	1.590	0.53
Solar	4.071	1.36
Total	298.435	

Additional Financial Burden

Accommodation of maximum wind generation results

- ***Deviation Settlement Mechanism***
- ***Surrendering of Central Generating Stations power.***
- ***Backing down power purchase from LTA/MTOA Generators.***
- ***Purchase of high cost power from IPPs.***
- ***Intraday purchase during sudden withdrawal of wind generation***
- ***Backing down the TANGEDCO Thermal Stations.***

On account of Banking

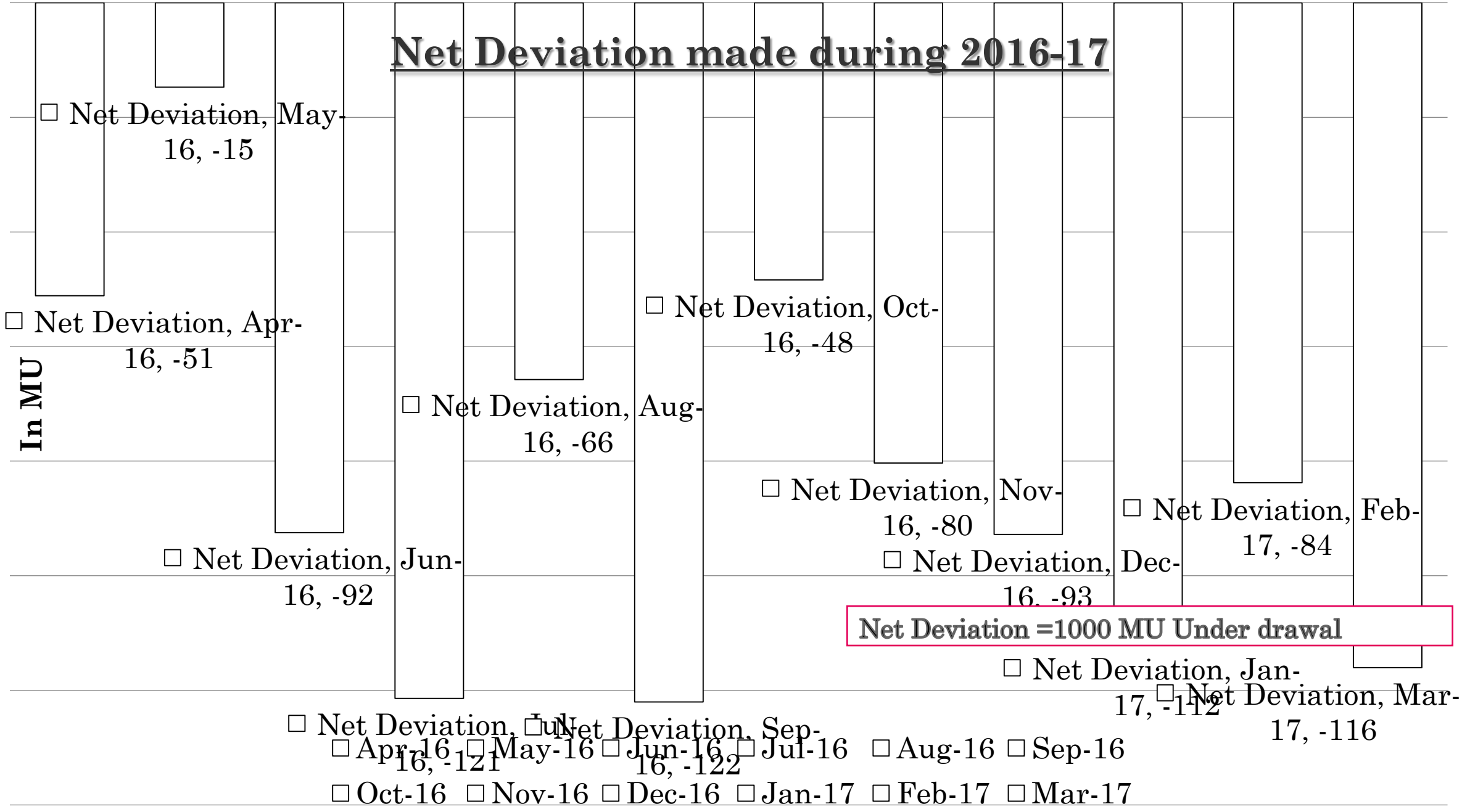
- **The unutilised energy generated during wind seasons at low cost are banked and allowed to utilise the same throughout the year from 1st April to 31st March of the following year and adjusted during non-windy season.**
- **The adjustment of banked energy during non wind season will lead to revenue loss to TANGEDCO.**
- **The balance energy as on 31st March of every year may be encashed at the rate of 75% of the respective applicable wind energy tariff Or 75% of the pooled cost notified by TNERC in the case of REC.**

TANGEDCO to accommodate wind generation by losing commercially on various accounts indirectly

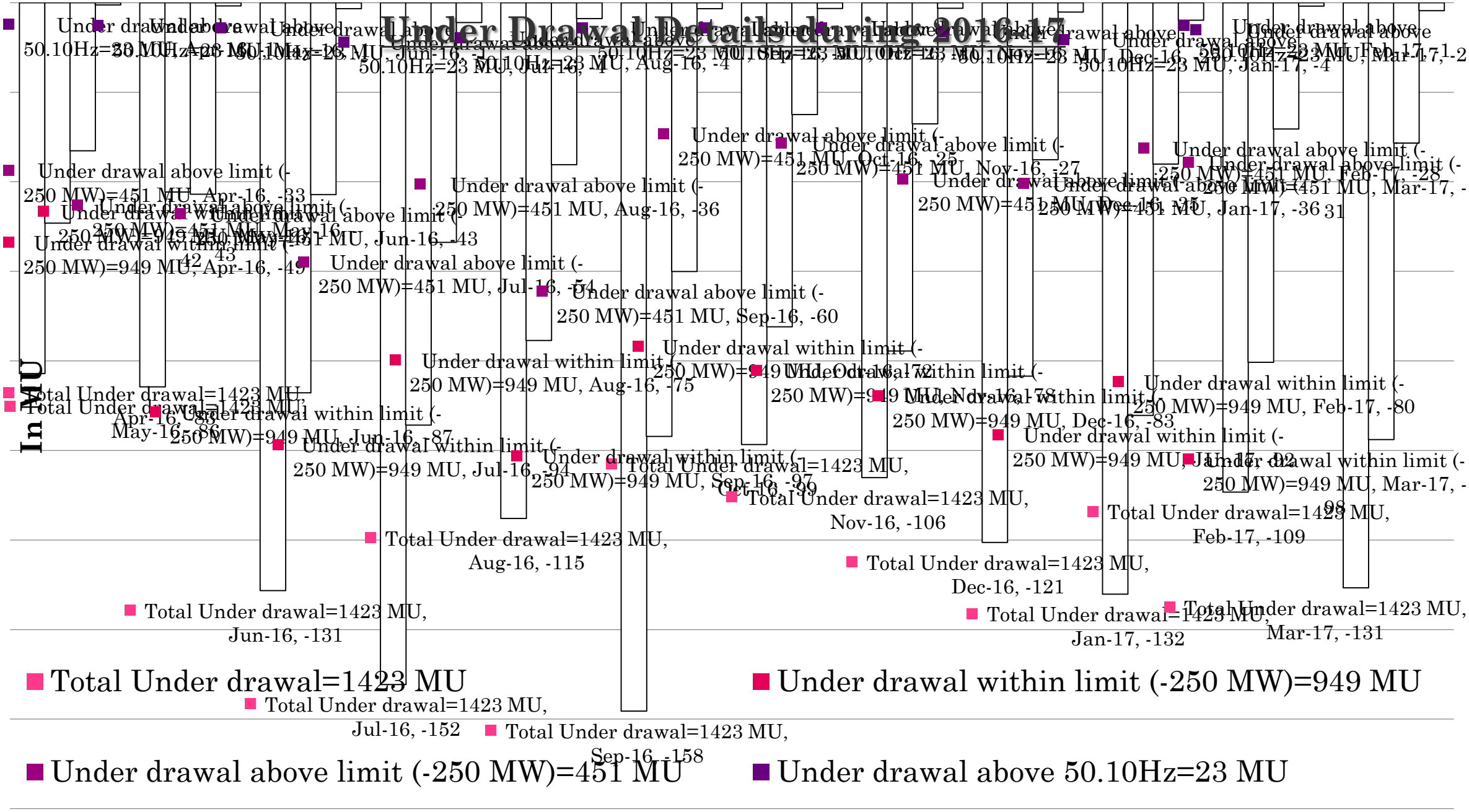
June to September 16

Sl. No.	Due to	Rs. In crores
1	On account of Deviation Settlement Mechanism as per CERC Regulations (for the period from 01/06/16 to 25/09/16)	68.17
2	On account of surrendering CGS power	181.30
3	On account of backing down the power from LTA/MTOA purchase	356.47
4	Generation from IPP utilized due to fall of Wind during the month	16.75
	Total amount	622.69

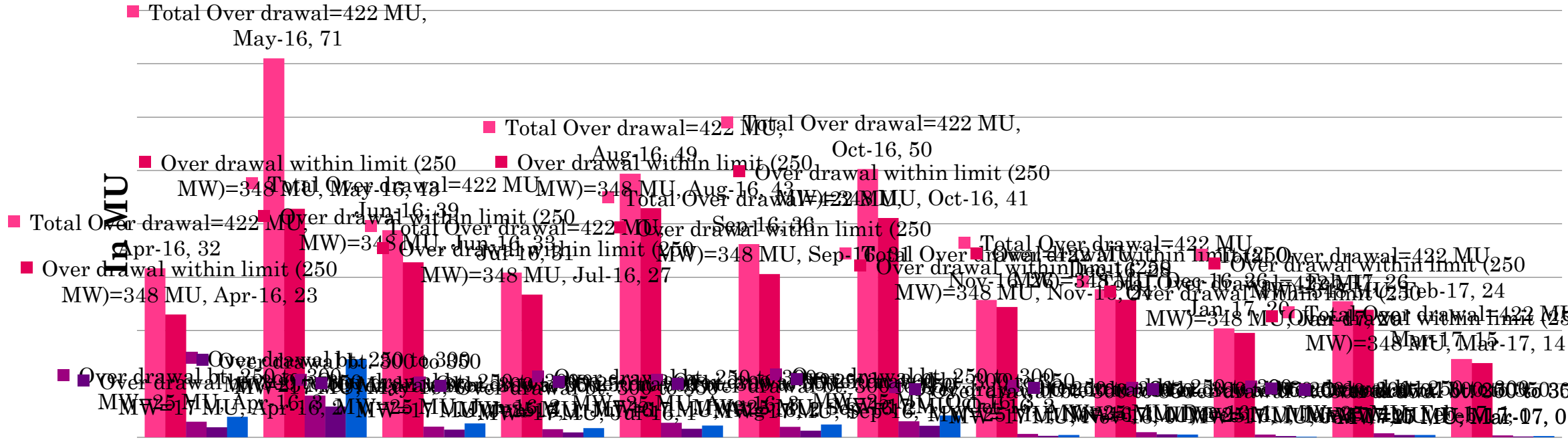
Net Deviation made during 2016-17



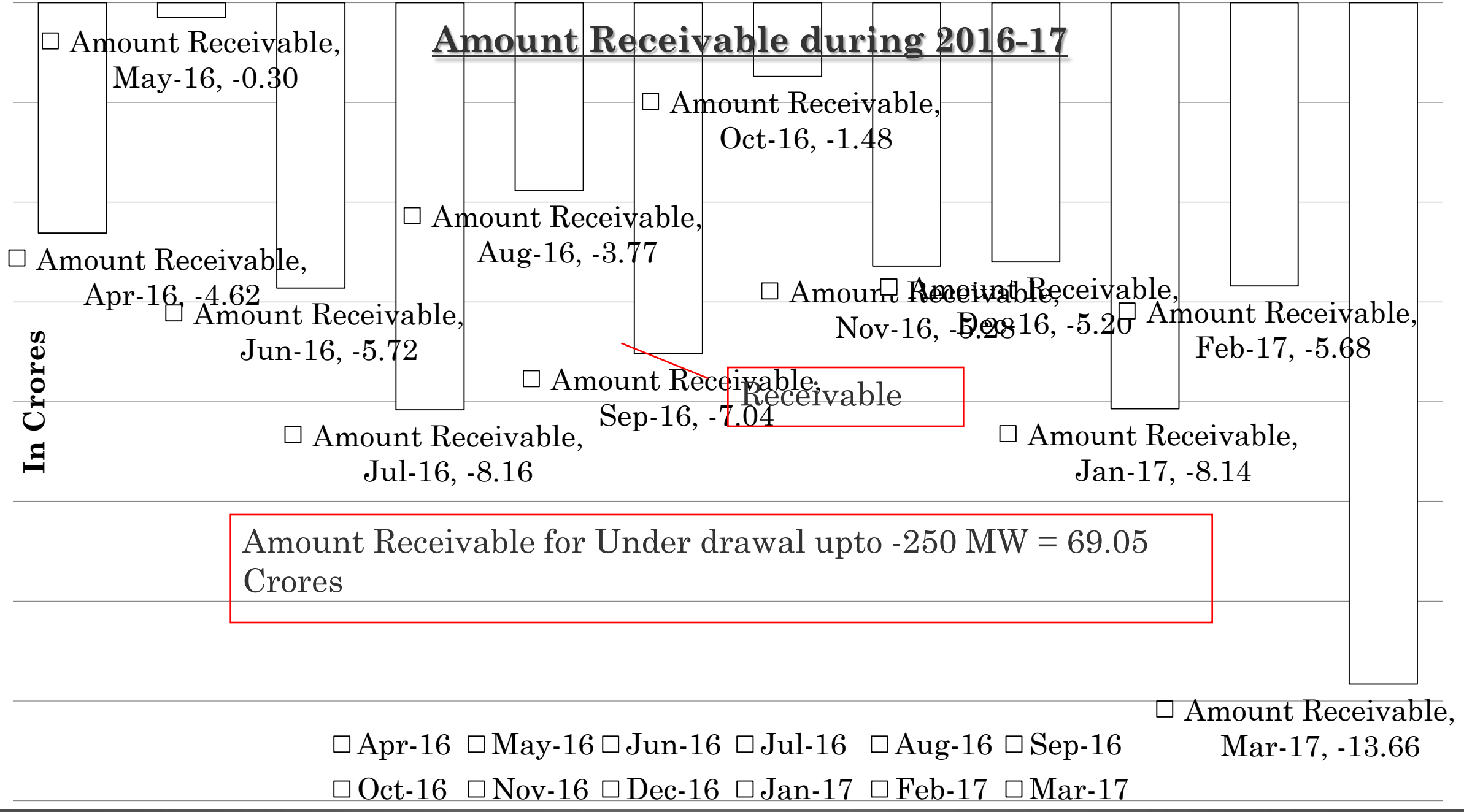
Net Deviation =1000 MU Under drawal


Under Drawal Details during 2016-17
In MU
Total Under drawal=1423 MU
Under drawal within limit (-250 MW)=949 MU
Under drawal above limit (-250 MW)=451 MU
Under drawal above 50.10Hz=23 MU

Over Drawal Details during 2016-17



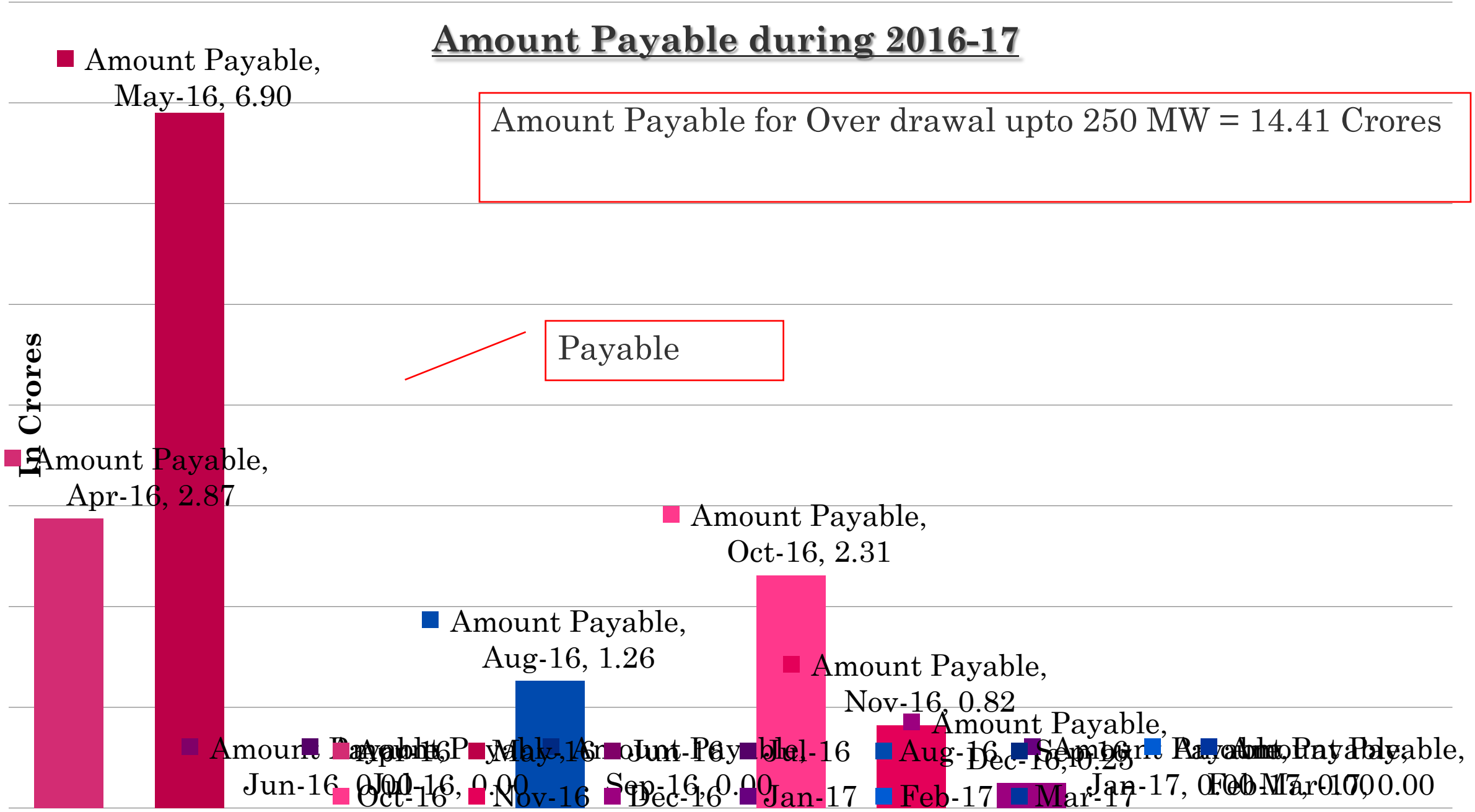
- Total Over drawal=422 MU
- Over drawal within limit (250 MW)=348 MU
- Over drawal bt. 250 to 300 MW=25 MU
- Over drawal bt. 300 to 350 MW=17 MU
- Over drawal above 350 MW=33 MU



Receivable

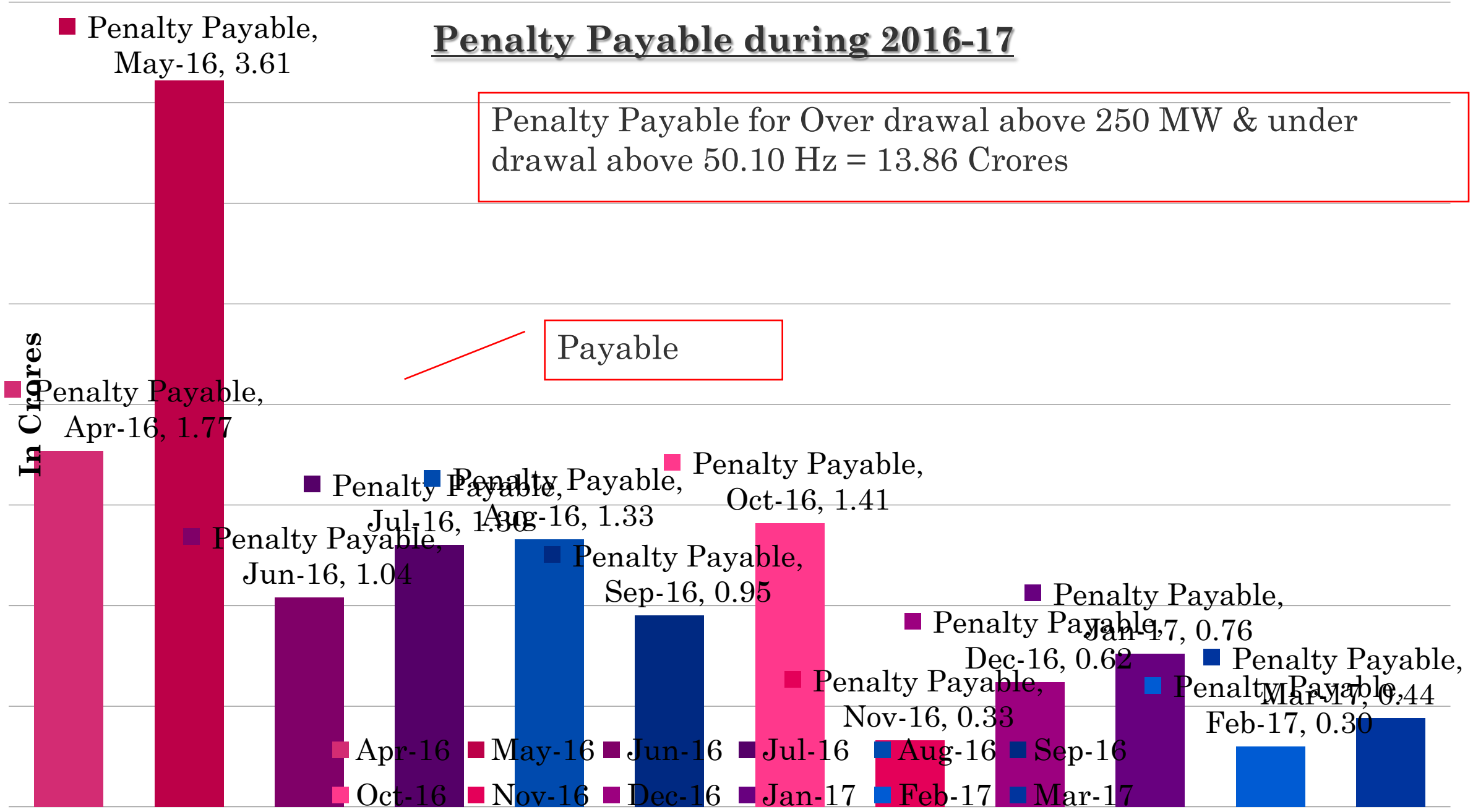
Amount Receivable for Under drawal upto -250 MW = 69.05 Crores

Amount Payable during 2016-17



Penalty Payable during 2016-17

Penalty Payable for Over drawal above 250 MW & under drawal above 50.10 Hz = 13.86 Crores



Developments in Transmission Corridor

- **TANTRANSCO developed the 400 KV Transmission corridors in order to accommodate the wind energy**

1. **Tamilnadu Backbone Network 1495 CKMS –** ***Rs.2186.15 crores***
2. **Tamilnadu Wind Power Corridor 846 CKMS –** ***Rs.1418.18 crores***
3. **Tamil Nadu Inter State transfer of Power 696 CKMS -** ***Rs. 993.43 crores***

Hydro – Pumped Storage Projects

To improve spinning reserve in Tamil Nadu control area, the following Hydro pumped storage projects are under pipeline.

- **Kundah – 500 MW (4 X 125 MW) – expected by 2020-21**
- **Sillahalla - 2000 MW (4 x 500 MW) – expected by 2021-22**
- **Mettur – 500 MW (4 X 125 MW)**

Constraints

- **Installed capacity of Renewable Energy in Tamilnadu control area is the highest in India.**
- **Balancing in Tamilnadu control area is not available**
- **Share from NPCIL 1147 MW – treated as infirm power**
- **To meet out the demand - Long term and medium term contracts**
- **Continuous variations – TANGEDCO Thermal Stations – Based on merit order – forced outages increased**

- **CGS power surrendered – LTA, MTOA generators not scheduled – Based on merit order.**
- **Some of the IPP not able to off take granted quantity of Fuel**
- **Intra State Generators are requested to back down their generation to technical minimum / shutdown resort legal action**
- **STOA Revision possible before 3 days**

Suggestions

1. **Forecasting and Balancing mechanism are the essential tools to aid the integration of the increasing amount of wind energy.**
2. **Reliable Forecasting would help us to make Renewable Energy appear more like a conventional power station.**
3. **Storage technology to store the renewable energy have to be cost effective.**
4. **Available Transfer Capability (ATC) margin between Regions to be revised practically**

5. **Compensation have to be considered by MNRE by way of integration charges for accommodating Renewable Energy in Tamilnadu control area for the following items**
   - **for maintaining thermal units at low PLF**
   - **Commercial losses to TANGEDCO on various accounts indirectly as given in table.**
   - **Expenditure made on to increase the Transmission corridor capability**
6. **Special Green Corridor to a quantum of 500 to 1000 MW immediately for SR to NR through WR & ER**


Thank
you

TS TRANSCO

TS SLDC

Solar and Wind Generation

- Presently in Telangana state 100.8 MW capacity of Wind generators and 1321 MW capacity of Solar generators are installed.
- Out of 1321 MW, 884 MW (132 KV and above 663 MW , 33kv & below 221 MW)capacity is integrated with SLDC.
- 1765 MW of Solar Plants are expected to be commissioned by the end of 2017.
- As wind generation is very low , adverse effects of variability of wind generation is not observed.
- Regulations on Forecasting, Scheduling & Deviation settlement mechanism for intrastate wind and solar generators are to be issued by Hon'ble TSERC.
- However, all wind and solar generators were addressed to submit Day-ahead and Week-ahead schedules for maintaining grid discipline and grid security as envisaged under the Grid Code.
- As solar generation in Telangana state is distributed in different districts, sudden variation of solar generation does not arise.
- However peak Solar generation is realized between 11.00 hours and 13.00 Hours. Agriculture Group supply timings are suitably modified to utilize this peak Solar generation for meeting peak demand.
- Day time solar generation is utilised for agricultural loads .

Month Wise Installed Capacity & Generation of Solar & Wind for the FY 2016-17

S.No.	Month	Solar		Wind	
		Installed Capacity (MW)	Generation in MU.	Installed Capacity (MW)	Generation in MU.
1	April-16	599.406	69.489	77.7	4.935
2	May-16	608.416	76.765	77.7	13.084
3	June-16	705.406	60.777	98.7	21.473
4	July-16	840.614	76.954	98.7	28.576
5	August-16	842.606	97.784	98.7	34.638
6	September-16	845.706	78.045	98.7	17.605
7	October-16	868.836	119.965	98.7	11.887
8	November-16	892.886	124.407	98.7	14.693
9	December-16	1014.886	124.711	98.7	17.595
10	January-17	1066.386	133.131	98.7	19.207
11	February-17	1224.386	162.316	98.7	13.412
12	March-17	1321.066	214.598	100.8	14.828
	Total Generation		**1338.942**		**211.933**

SOLAR & WIND
INSTALLED CAPACITY AS ON 24-04-2017

Sl.No	District	Solar(MW)	Wind(MW)	Total(MW)
1	Mahabubnagar	491.592	0	491.592
2	Medak	343.614	0	343.614
3	Nalgonda	73.73	0	73.73
4	Ranga Reddy	154.13	100.8	254.93
5	Nizamabad	61	0	61
6	Karimnagar	109	0	109
7	Warangal	15	0	15
8	Adilabad	73	0	73
	Total	1321.066	**100.8**	**1421.866**

INSTALLED CAPACITY IN MAHABOOBNAGAR DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	100	0	100
2	132 KV	155	0	155
3	33 KV	234.592	0	234.592
4	11 KV	2	0	2
Total		491.592	0	491.592

INSTALLED CAPACITY IN MEDAK DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	171.5	0	171.5
3	33 KV	171.364	0	171.364
4	11 KV	0.75	0	0.75
Total		343.614	**0**	343.614

INSTALLED CAPACITY IN NALGONDA DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	0	0	0
3	33 KV	72.73	0	72.73
4	11 KV	1	0	1
Total		73.73	**0**	73.73

INSTALLED CAPACITY IN RANGA REDDY DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	80	100.8	180.8
3	33 KV	73.13	0	73.13
4	11 KV	1	0	1
Total		**154.13**	**100.8**	**254.93**

INSTALLED CAPACITY IN NIZAMABAD DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	20	0	20
3	33 KV	41	0	41
4	11 KV	0	0	0
Total		**61**	**0**	**61**

INSTALLED CAPACITY IN KARIMNAGAR DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	**34**	0	**34**
3	33 KV	**75**	0	**75**
4	11 KV	**0**	0	**0**
Total		**109**	**0**	**109**

INSTALLED CAPACITY IN WARANGAL DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	0	0	0
3	33 KV	15	0	15
4	11 KV	0	0	0
Total		**15**	**0**	**15**

INSTALLED CAPACITY IN ADILABAD DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	48	0	48
3	33 KV	25	0	25
4	11 KV	0	0	0
Total		73	0	73

SOLAR & WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017

Sl.No	District	Solar(MW)	Wind(MW)	Total(MW)
1	Mahabubnagar	409	0	409
2	Medak	414.5	0	414.5
3	Nalgonda	266	0	266
4	Ranga Reddy	24	100	124
5	Nizamabad	347	0	347
6	Karimnagar	81	0	81
7	Warangal	99	0	**99**
8	Adilabad	115	0	115
9	Khammam	10	0	10
	Total	**1765.5**	**100**	**1865.5**

SOLAR & WIND CAPACITY
UNDER PROGRESS AS ON 24-04-2017
IN MAHABOOBNAGAR DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	200	0	200
2	132 KV	100	0	100
3	33 KV	109	0	109
Total		**409**	**0**	**409**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN MEDAK DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	45	0	45
2	132 KV	305	0	305
3	33 KV	64.5	0	65
Total		**414.5**	**0**	**414.5**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN NALGONDA DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	100	0	100
2	132 KV	98	0	98
3	33 KV	68	0	68
Total		**266**	**0**	**266**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN RANGA REDDY DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	0	100	100
3	33 KV	24	0	24
Total		**24**	**0**	**124**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN NIZAMABAD DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	50	0	50
2	132 KV	227	0	227
3	33 KV	70	0	700
Total		**347**	**0**	**347**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN KARIMNAGAR DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	66	0	66
3	33 KV	15	0	15
Total		**81**	**0**	**81**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN WARANGAL DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	87	0	87
3	33 KV	12	0	12
Total		**99**	**0**	**99**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN ADILABAD DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	100	0	100
3	33 KV	15	0	15
Total		**115**	**0**	**115**

SOLAR AND WIND CAPACITY UNDER PROGRESS AS ON 24-04-2017 IN KHAMMAM DISTRICT

Sl.No	Voltage level	Solar(MW)	Wind(MW)	Total(MW)
1	220 KV	0	0	0
2	132 KV	0	0	0
3	33 KV	10	0	10
Total		**10**	**0**	**10**

PROBLEMS ENCOUNTERED IN DEALING WITH VARIABLE AND INTERMITTTENT GENERATION FROM RENEWABLES

- Forecasting.
  - Weather data.
- Agricultural demand increased 25% in a year and depends on the monsoons.
- Demand side management. Adjusting Agl loads.
- Transmission connectivity.
- Storage.
- Effect of other states in regional grid.

Steps taken to handle the problem

- TS has only 100.8 MW wind generation.
- Better forecasting.
- Grid integrated solar ~1321 MW and coming ~1765 MW. Planned agriculture supply in the day time.
- Two pumped storage works are in progress.
- Initiate storage capacity addition in solar rich districts.
- To meet future demand building up transmission network.
- By increasing/decreasing Thermal and Hydel Generation as per requirement.

AVAILABLE PUMPED HYDRO PROJECTS

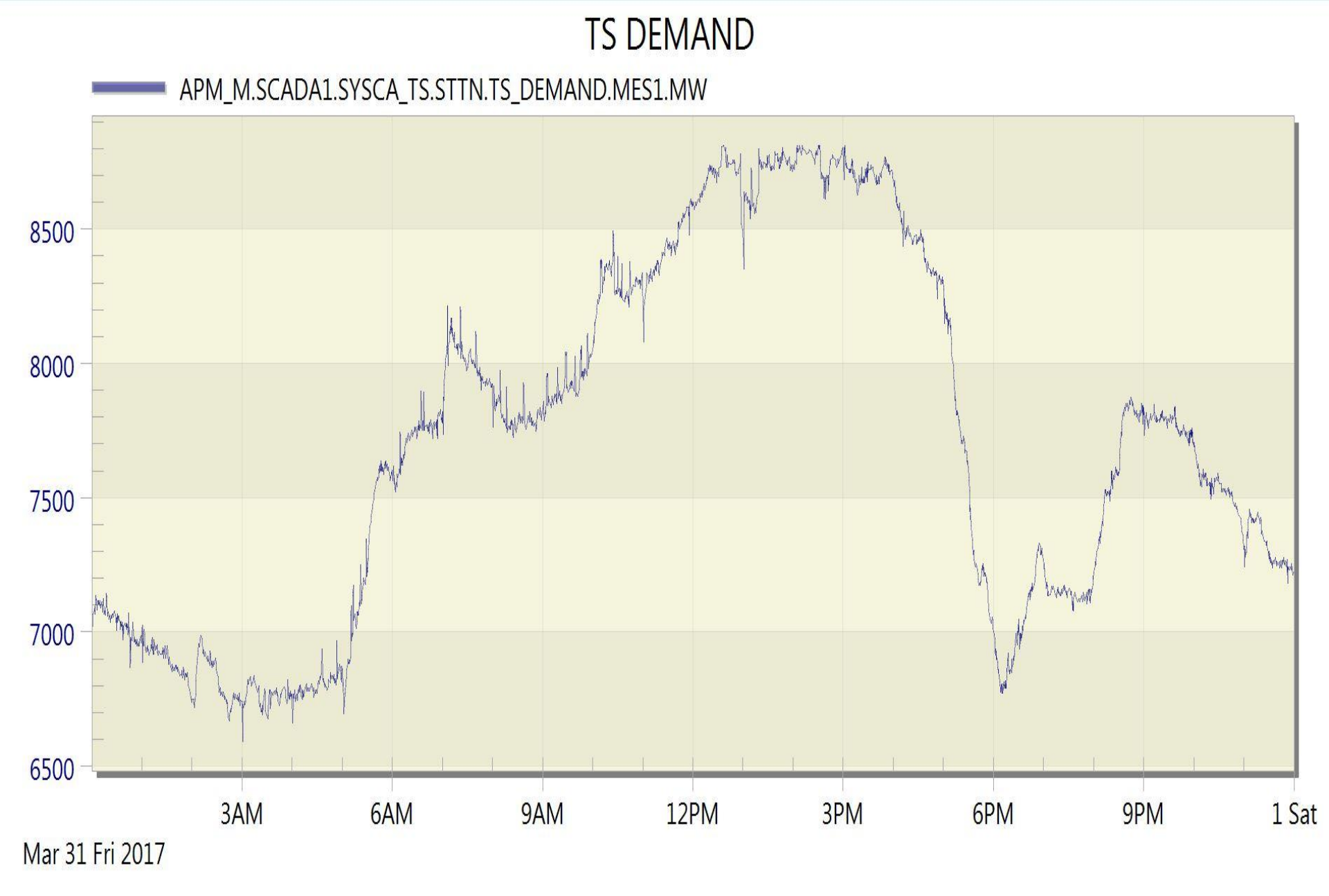
S.NO.	NAME OF THE STATION	UNIT WISE CAPACITY	CAPACITY IN MW
1	Srisailam Left Bank Power House(SSLM LBPH)	6x176MW	1056MW
2	Nargarjuna Sagar Power House	7x122MW	854MW

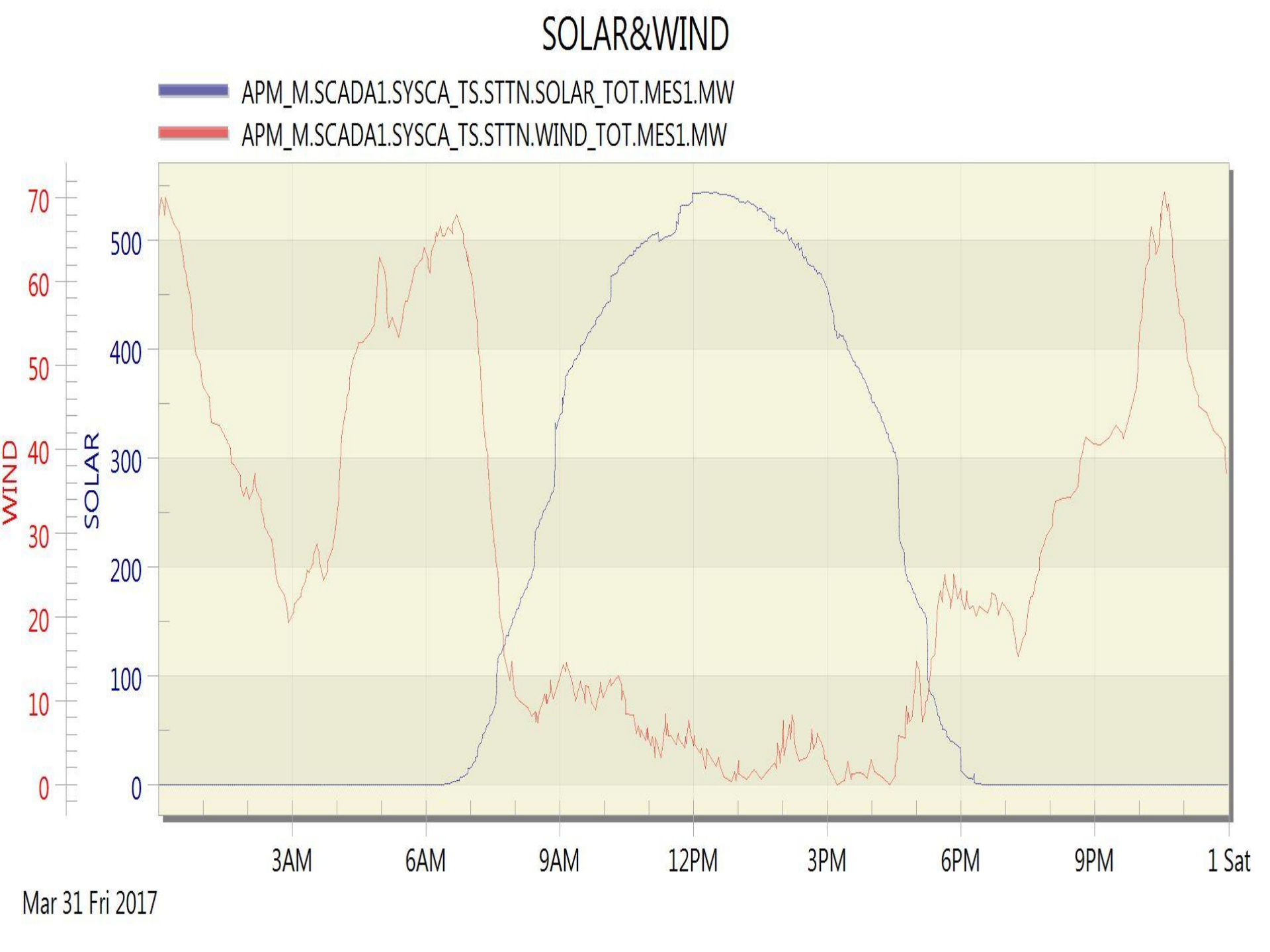
LIMITATIONS

- Srisailam Left Bank Power House (SSLM LBPH) will be available only when Nagarjuna Sagar reservoir level is above 540 ft (Net head should be more than 100 ft). If the Nagarjuna Sagar level is below this 540 ft, a Wear Dam is required which is under renovation.
- Nagarjuna Sagar Power House Pumps will be available only after completion of Tailpond works which are in progress.

Intra-state transmission/distribution system facing congestion due to RE generation

- Solar generation in TS is distributed.
- Wind only 100.8 MW.
- To meet additional solar, strengthening the transmission/distribution system.


TS DEMAND
APM_M.SCADA1.SYSCA_TS.STTN.TS_DEMAND.MES1.MW
8500
8000
7500
7000
6500
3AM
6AM
9AM
12PM
3PM
6PM
9PM
1 Sat
Mar 31 Fri 2017


SOLAR&WIND
APM_M.SCADA1.SYSCA_TS.STTN.SOLAR_TOT.MES1.MW
APM_M.SCADA1.SYSCA_TS.STTN.WIND_TOT.MES1.MW
WIND
SOLAR
70
60
50
40
30
20
10
0
500
400
300
200
100
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
1 Sat
Mar 31 Fri 2017

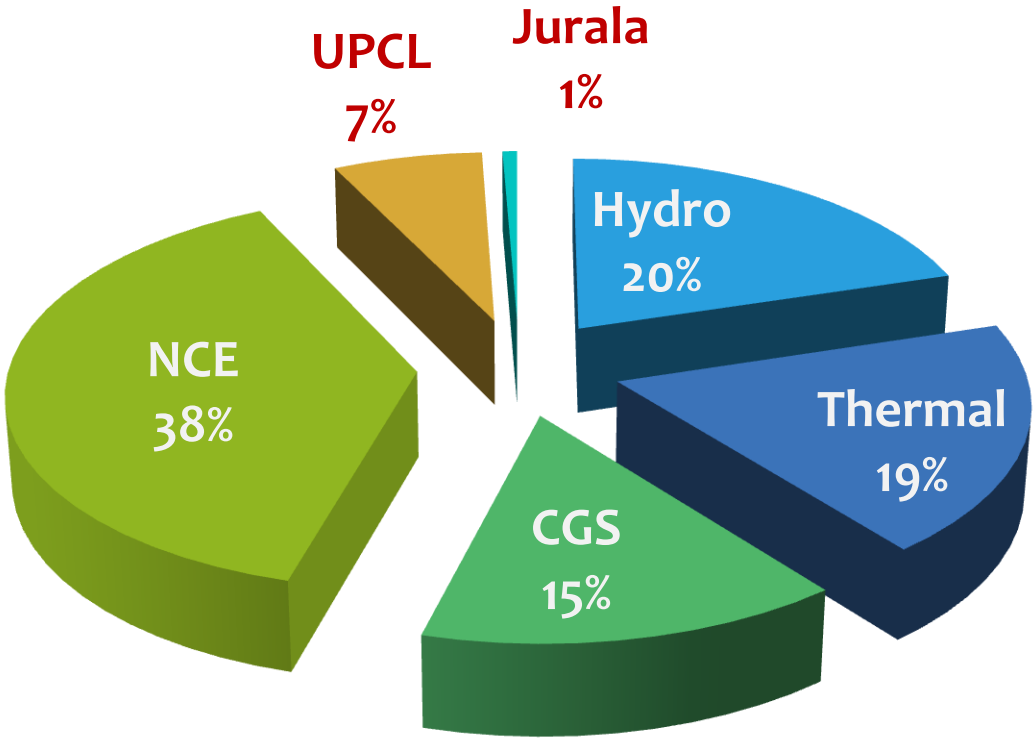
THANK YOU

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

09-05-2017

(i) Variability of Wind and Solar Generation

Source-wise Installed Capacity



Source	Inst. Cap. (MW)
Hydro	3670
Thermal	3445
CGS	2694
NCE	6972
UPCL	1200
Jurala	117
Total	18098

3

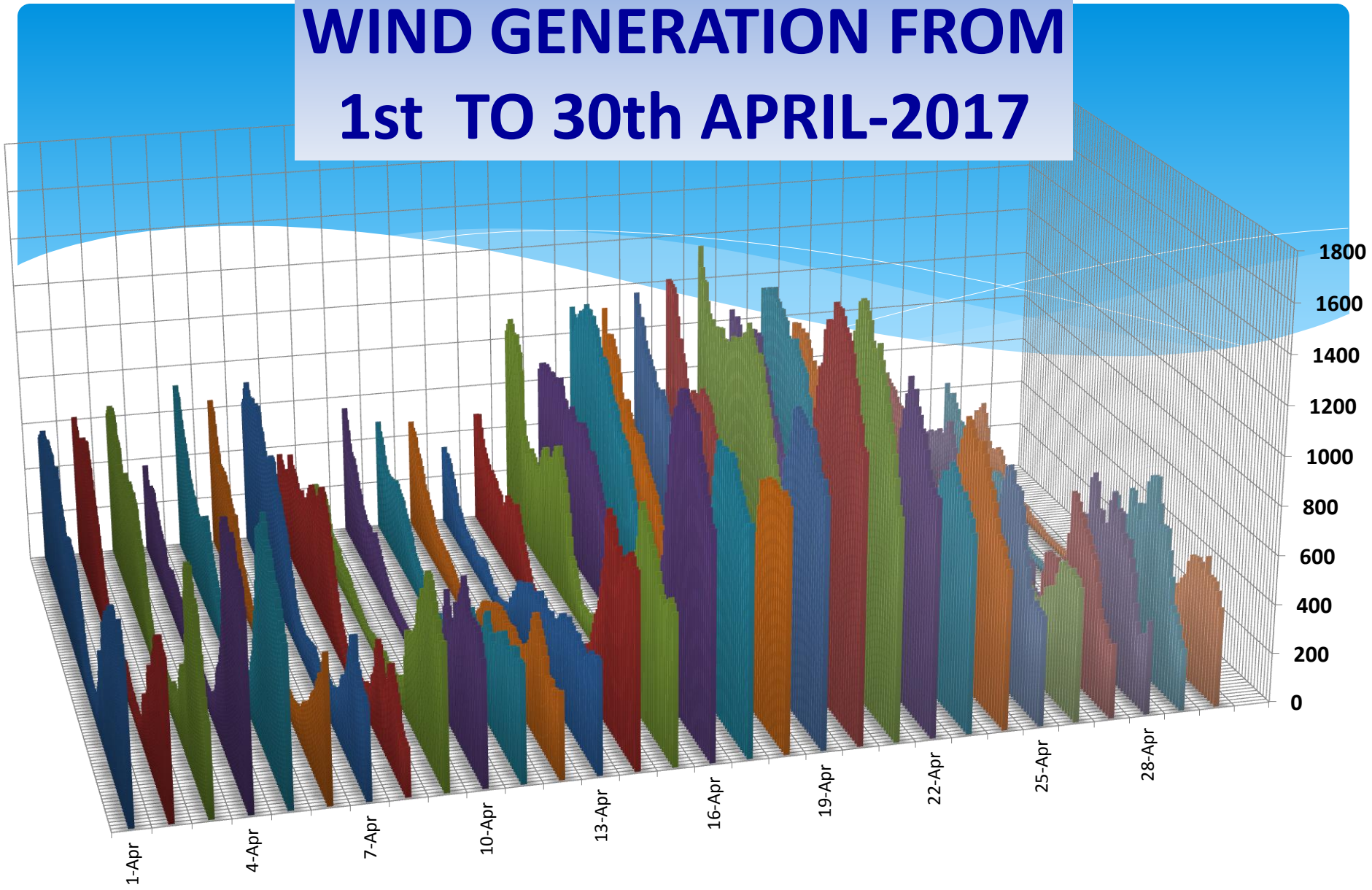
Renewable Energy Projects

Renewable Energy Source	Potential in MWs	Capacity Allotted in MWs	Capacity commissioned in MWs
Wind	13,236	12,752	3241
Small Hydro	3,000	2,893	843
Solar	10,000	203	507
Bio-mass	1,000	258	134
Co-generation	1,500	1,560	2246
Total	28,736	17,668	6972

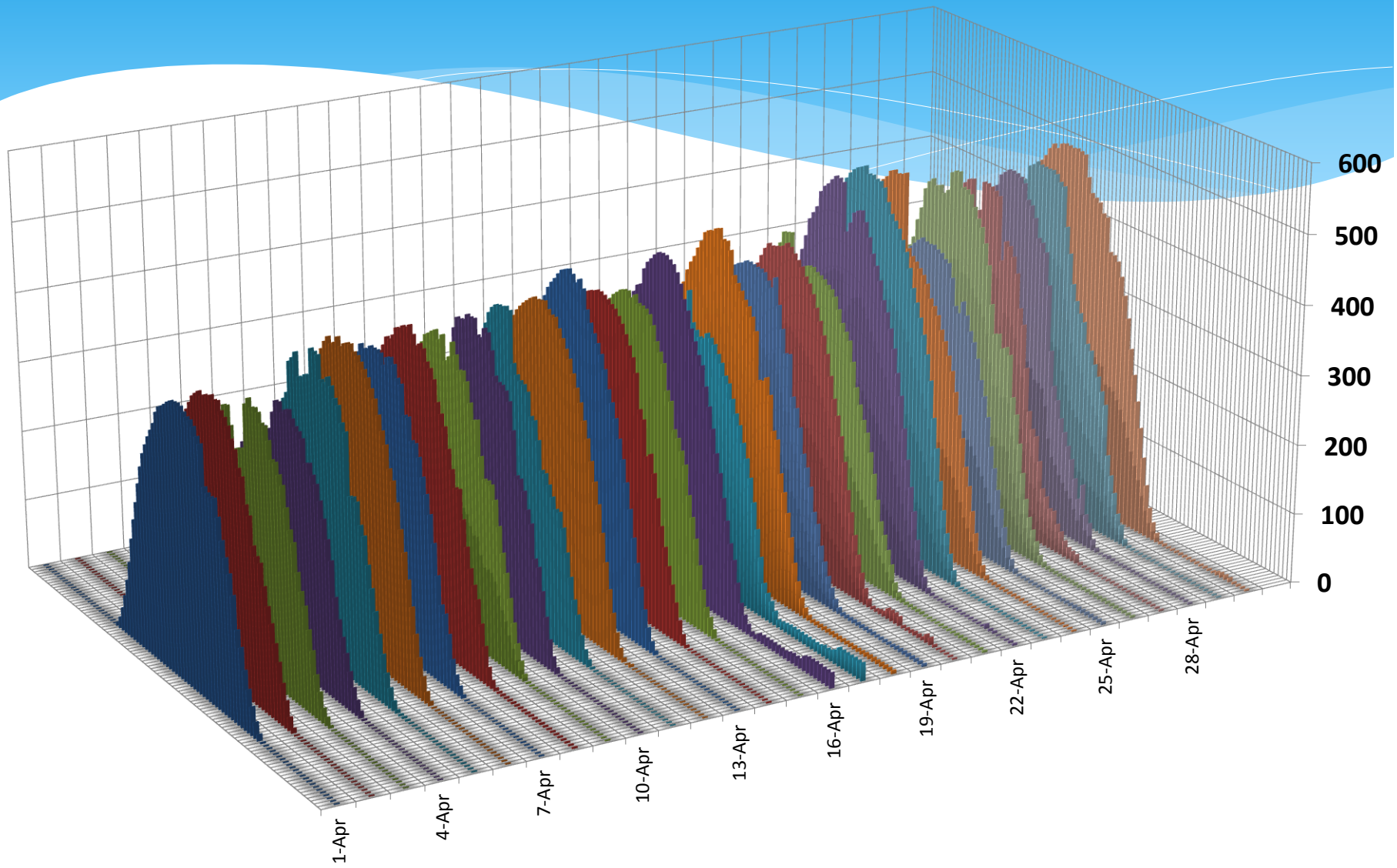
Power Supply Position as on 30.04.17

Details		Date	Time
Maximum Demand (MW)	**9987**	10-APR-17	11:00hrs
Minimum Demand (MW)	**6565**	29-APR-17	
Maximum Consumption (MU)	**225.05**	01-APR-17	
Minimum Consumption (MU)	197.93	16-APR-17	
Maximum Wind (MW)	**1621**	21-APR-17	20:42hrs
Maximum Wind (MU)	**19.15**	21-APR-17	
Maximum Solar (MW)	**537**	**23-APR-17**	**12:00hrs**
Maximum Solar (MU)	4.11	23-APR-17	
Load shedding in MU for the month of APRIL-2017	0		
RE installed Capacity in MW as on 30.04.2017	Wind: 3354.68 Solar: 1050	APRIL-17	

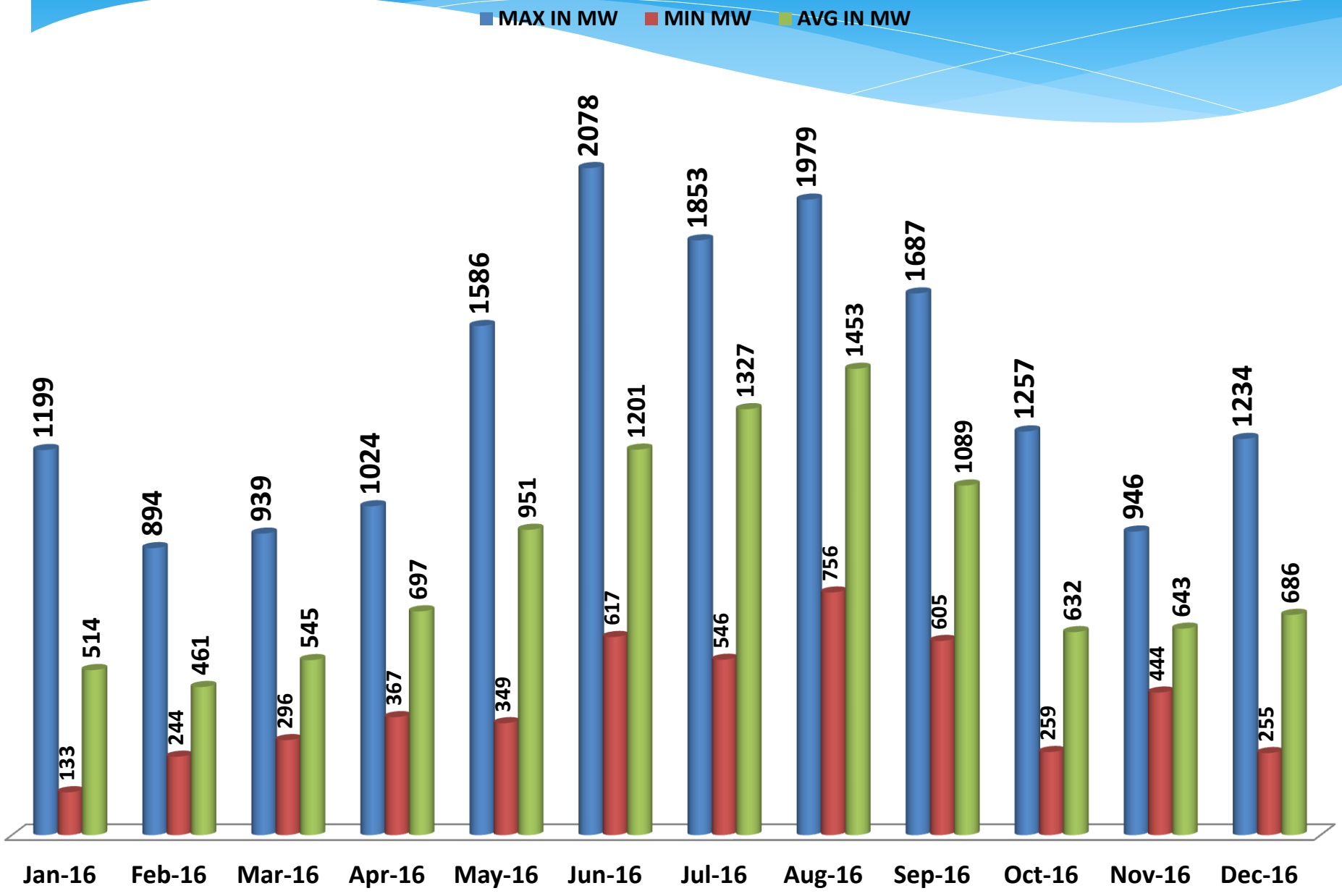
WIND GENERATION FROM 1st TO 30th APRIL-2017



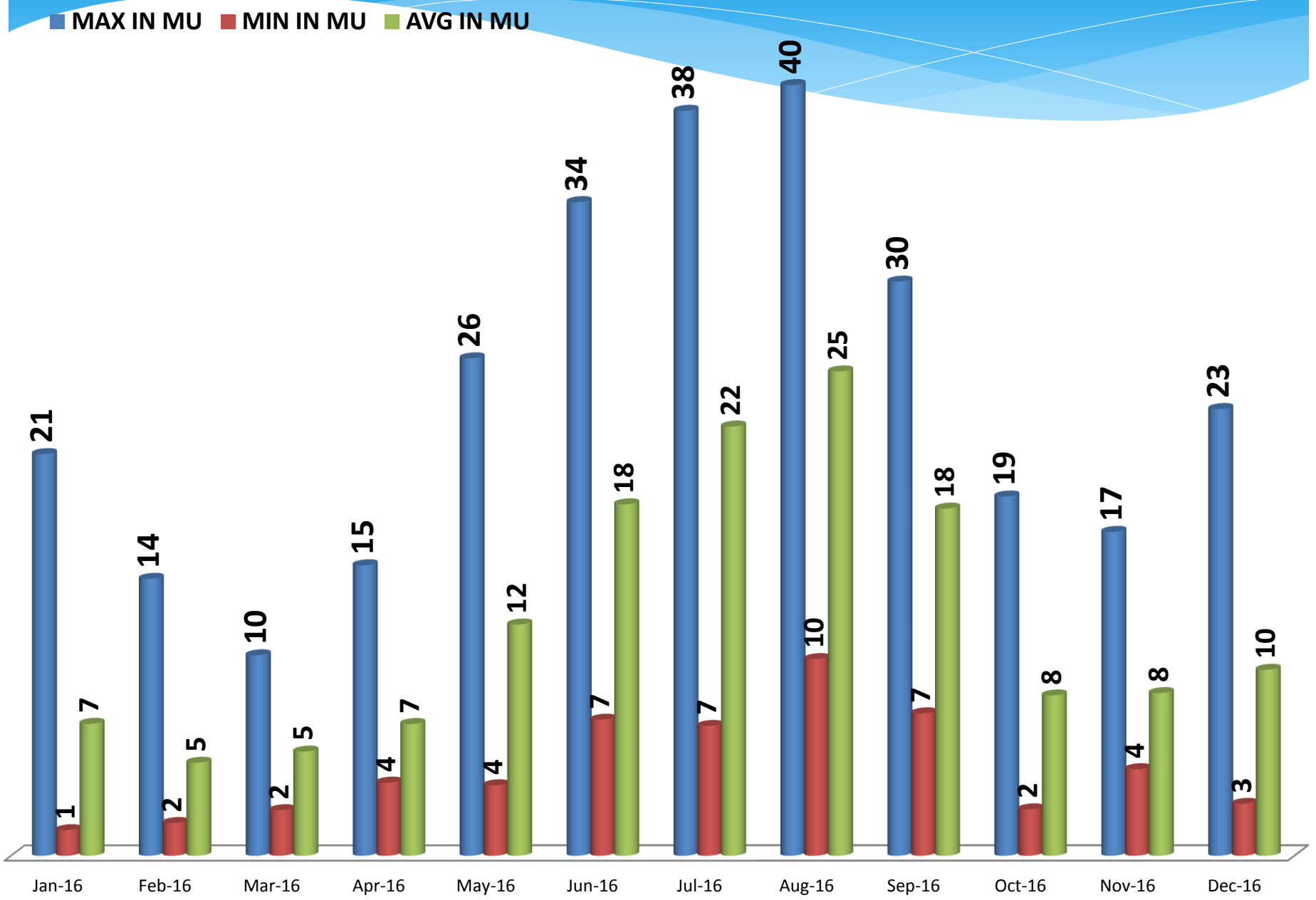
SOLAR GENERATION FROM 1st TO 30th APRIL-2017



2016-WIND IN MW



2016-WIND IN MU



(ii) Augmentation of Transmission Infrastructure

WORKS PROPOSED UNDER GREEN ENERGY CORRIDOR

Sl. No	Name of the Work	Amount Rs Lakhs
1	Establishing 2x500 MVA, 400/ 220 kV sub-station at **Gadag(Doni)** in Mundaragi Taluk, Gadag District	13249
2	A) Construction of 220 kV SC line on DC towers for a length of 15.168kMs from the existing 400kV PGCIL station at **Beerenahalli (Hiriyur) to existing 220/66/11kV KPTCL substation at Hiriyur** in Chitradurga District in existing corridor of 220kV SC line from Hoysalakatte to 220/66/11kV SRS at Hiriyur(partly in new corridor i.e from PGCIL point to link 220kV SC line from Hoysalakatte to 220/66/11kV SRS at Hiriyur. B)Construction of 220kV DC line on DC towers from existing 220/66kV substation **Chitradurga to existing 220/66kV substation Hiriyur** in Chitradurga District in existing corridor (partly MC between LILO point of Guttur-Hiriyur linr to 220kV substation Chitradurga in the existing corridor(5.255kMs)) for a length of 36.506kMs	3272
3	Establishing 2x500 MVA, 400/220 kV GIS Substation at **Jagalur** in Jagalur Taluk, Davanagere District with additional 220 kV DC line to Chitradurga	48436

WORKS PROPOSED UNDER GREEN ENERGY CORRIDOR

Sl. No	Name of the Work	Amount Rs Lakhs
4	Construction of 220kV DC line for a length of 26 kms from **220kV Bidnal** substation to LILO one of the circuits of 220kV Narendra-Haveri DC line, in Haveri and Dharwad districts	1544
5	Establishing 2x100 MVA 220/66 kV and 1x12.5MVA 66/11kV substation at **Hosadurga**, Hosadurga taluk, Chitradurga district with 220 kV DC line from proposed 400/220 kV CN Halli sub-station	7468
6	Establishing 2x100MVA, 220/66 kV and 1x8MVA 66/11kV substation at **Shivanasamudra**, Malavalli taluk, Mandya district.	9401
7	Establishing 2x100 MVA, 220/110 KV & 1x10 MVA, 110/11 KV Substation at **Mughalkod** in Raibag Taluk, Belgaum District with 220 kV DC LILO of Chikkodi –Ghataprabha line	7249
	TOTAL	**90619**

Works Proposed by KPTCL for RE evacuation

Sl. No	Name of the Work	Amount Rs Lakhs
1	Construction of 66kV DC line between PD Kote- Hariyabbe-Hiriyur	1500
2	Reconductoring 220kV DC line between Gadag-Dhoni-Lingapura by HTLS	18000
3	110kv 2nd circuit between Yelaburga- Kustagi	1000
4	2nd Circuit 220kV line LILO to 220kV Honnali Sub-station	1500
5	2nd Circuit 110kV line LILO to 110kV Shirahatti	250
6	2nd Circuit 220kV line LILO to 220kV Athani	2000
7	4th 100MVA, 220/110kV transformer at Gadag	600
8	66KV DC line with Drake to Nagalmadike sub-station	1800
	TOTAL	**26650**

(iii) To propose utilisation of States own balancing plants

HYDEL GENERATING STATIONS IN KARNATAKA

Sl. No.	Power Station	Capacity in MW	
1	Sharavathy	1035	Governable by SLDC during real time grid operation to an extent of 2500MW to accommodate wind Energy
2	Nagjhari	885	
3	Varahi	460	
4	Tailrace and Other Projects	674	
	Total	**3054**	

(iv) An assessment of the quantum of electric storage system for balancing, which could be placed near the RE generation sources

Pumped Storage

* KPCL has planned 2000 MWs pumped storage Plant in Sharavathy River basin
* 2000 MWs pumped hydro support during peak hour requirement.
* 2000 MWs power requirement during off peak hour.
* Target year of completion : 2021-22

(vi) Communication requirements for obtaining data of Wind and Solar Generators

SCADA in KPTCL

* KPTCL and ESCOMs have provided SCADA RTUs to every sub-stations in the State
* Wind and Solar injection in at all feeders of 11 kV upto 220 kV is available on real time
* The STU pooling stations are connected to the Main Control Centre of SLDC through a satellite network
* VSAT communication is provided to every station for voice and SCADA data.

Real time data of Wind and Solar Generators

* Real time data from every Wind and Solar Generator is available on SCADA
* As such, the Master Control Centre at SLDC can visualise all Renewable Generation and this data is also visible at all the Distribution Control Centres of ESCOMs.
* All panel meters at the pooling stations are connected to SLDC through VSAT network and Energy meter data at all injection points is also available.

IPPs -HESCOM

TOTAL IPP INJECTION: 317

SL NO	NAME OF IPP	KPTCL STN	VTG(kV)	ACTIVE	REACTIVE
1	**AMBEWADI 220kV TOTAL IPPs**	0.00 ↓			
	PARRY SUGAR(GMR)	HALIYAL 110kV	112.71	1.23 ↑	0.46 ↑
2	**ATHANI 220kV TOTAL IPPs**	6.39 ↓			
	RENUKA SUGARS	ATHANI110kV	109.45	0.32 ↑	0.11 ↓
	krishna sahakari sakkare karkhane niyamit	ATHANI 220kV	63.87	6.33 ↑	3.28 ↑
3	**BAGALKOT 220kV TOTAL IPPs**	0.00 ↓			
	SADASHIVA SUGARS	RAMPUR 110kV	111.33	0.16 ↑	0.13 ↓
	KBJNNL	RAMPUR 110kV	10.94	0.31 ↑	0.01 ↓
	GMR	RAMDURGA 110kV	0.00	0.00 ↓	0.00 ↓
	KEDARNATH	BAGALKOT-NEERBUDIHAL	0.00	0.00 ↓	
	ENERCON	KONNUR 110kV	0.00	0.00 ↓	0.00 ↓
	SHIVASAGAR SUGARS	SALAHALLI 110kV	109.72	0.10 ↑	0.21 ↓
4	**BB WADI TOTAL IPPs**	0.00			
	NANDI SAHAKARI SAKKARE KARKHANE	SHIRABUR 110kV	0.00	0.00 ↓	0.00 ↓
	JAMAKHANDI SUGARS(Hirebadasalagi)	TODALBAGI 110kV	113.75	0.35 ↑	0.10 ↑
	KPR SUGARS	ALMEL 110kV	108.46	0.10 ↑	0.20 ↓
	JAMAKHANDI SUGARS	ALMEL 110kV	108.46	0.09 ↑	0.34 ↓
	SRI BASAVESHWARA SUGARS	MALGHAN 110kV	0.00	0.00 ↓	0.00 ↓
5	**BELGAUM 220kV TOTAL IPPs**	9.76			
	GLOBAL ENERGY	MACHE 110kV	31.74	0.00 ↓	0.00 ↓
	SUZLON	KANABARGI LAYOUT 110kV	33.90	9.69 ↑	0.97 ↓
6	**BIDNAL 220kV TOTAL IPPs**	3.90 ↓			
	BPCL	NARAGUND 110kV	109.22	3.92 ↓	0.20 ↑
	DHARWAD BIO ENERGY	NAVALGUND 110kV	109.46	0.08 ↑	0.21 ↑
7	**CHIKKODI 220kV TOTAL IPPs**	36.42			
	DOODAGANGA SUGARS	CHIKKODI 220kV	107.90	0.23 ↓	0.16
	HIRA SUGARS(Kirloskar)-1	SANKESHWAR 110kV	106.01	0.26 ↑	0.35 ↑
	HIRA SUGARS(Kirloskar)-2	SANKESHWAR 110kV	106.01	0.00 ↓	0.02 ↓
	VENKATESHWARA POWER	SADALGA 110kV	108.66	0.16 ↑	0.10 ↓
	GIRAGOAN	CHIKKODI 110kV	33.17	0.00 ↓	0.00 ↓
	KABBUR	CHIKKODI 110kV	33.17	0.00 ↓	0.00 ↓
	DODDANAVAR WIND MILL	CHIKKODI 110kV	106.59	33.65 ↓	4.48 ↑
	VISHWANATH SUGARS	HUKKERI 110kV	105.41	0.81 ↑	0.17 ↑
	RSR POWER(GAMESA)	BHOJ 110kV	0.00	0.00 ↓	0.00 ↓
	SHIVASHAKTI SUGARS	ANKALI 110kV	111.01	0.19 ↑	0.22 ↓
8	**GADAG 220kV TOTAL IPPs**	121.81			
	SUZLON-1	DAMBAL 110kV	111.19	9.05 ↓	0.18 ↑
	SUZLON-2	DAMBAL 110kV	111.19	9.24 ↓	0.22 ↑
	ENERCON(Hirevadatti)	DAMBAL 110kV	111.19	14.02 ↓	0.86 ↑
	ENERCON-1(Bannikuppa)	BELLATTI 110kV	111.85	0.00 ↓	0.00 ↓
	ENERCON-2(Bannikuppa)	BELLATTI 110kV	111.85	23.05 ↓	1.97 ↑
	VICTORY GLASS WIND(Nagavi)	GADAG 110kV	31.74	0.08 ↑	1.34 ↑
	INDO WIND(Mallasandra)	GADAG 110kV	31.74	2.89 ↓	1.98 ↑
	TEJASWINI DEVELOPERS-1	GADAG 110kV	31.74	4.63 ↑	0.38 ↓
	TEJASWINI DEVELOPERS-2	GADAG 110kV	31.74	6.04 ↑	0.27 ↓

SHEET-
SHEET

IPPs -HESCOM

TOTAL IPP INJECTION: 317

SL NO	NAME OF IPP	KPTCL STN	VTG(kV)	ACTIVE	REACTIVE
	PIONEER(Bellatti)	GADAG 110kV	31.74	0.01 ↓	0.00 ↓
	KPCL WIND POWER(Kappath Gudda)	GADAG 110kV	31.74	0.82 ↑	2.20 ↓
	WIND-1	GAJENDRAGAD110kV	32.71	6.74 ↑	1.39 ↓
	WIND-2	GAJENDRAGAD110kV	32.71	6.49 ↑	1.32 ↓
	WIND-3	GAJENDRAGAD110kV	32.71	4.61 ↑	0.69 ↓
	WIND-4	GAJENDRAGAD110kV	32.71	6.95 ↑	0.59 ↓
	VIJAYA NAGARA SUGARS	MUNDARGI 110kV	109.29	0.62 ↑	0.26 ↓
	POINTEC	MUNDARGI 110kV	10.94	0.00 ↑	0.00 ↓
	ODANAVAR	NARAGAL 110kV	11.01	1.02 ↑	0.10 ↓
	BPCL	SHIRAHATTI 110kV	111.73	24.25 ↓	4.28 ↑
	MMCL	LAXMESHWARA 110kV	32.50	3.95 ↑	0.84 ↑
9	**GHATAPRABHA 220kV TOTAL IPPs**	19.67			
	KOLVI SUGARS	GOKAK 110kV	0.00	0.00 ↓	0.00 ↓
	SATISH SUGARS	P G HUNSYAL 110kV	105.37	0.00 ↓	0.00 ↓
	GAMESA	KABBUR 110kV	108.84	19.45 ↓	3.17 ↑
	GOKAK POWER & ENERGY	GHATAPRABHA 110kV			
	SOUBHAGYALAXMI SUGARS	MAMADAPUA 110kV	107.57	0.12 ↑	0.00 ↓
10	**HAVERI 220kV TOTAL IPPs**	27.89 ↓			
	GM SUGARS	HAVERI-220	110.20	0.23 ↓	0.20 ↑
	SUZLON-1(Haveri-Guttal)	HAVERI -GUTTAL	111.33	70.47 ↓	
11	**INDI 220kV TOTAL IPPs**	0.09			
	INDIAN SUGARS	CHADCHAN 110	108.35	0.09 ↑	0.07 ↓
	DSSS SUGARS	HIREBEVANUR 110	0.00	0.00 ↓	0.00 ↓
	KESARI GUJJARA	ATHARGA 110			
	MANALI SUGARS	MALGHAN-110	112.19	0.05 ↑	0.00 ↓

SL NO	NAME OF IPP	KPTCL STN	VTG(kV)	ACTIVE	REACTIVE
12	**KUDUCHI 220kV TOTAL IPPs**	0.00			
	UGAR SUGARS	UGAR KHUD 110kV	56.55	1.47 ↑	1.03 ↑
	ATHANI FARMERS SUGARS	AINAPUR 110	0.00	0.00 ↓	0.00 ↓
	SHIRUGUPPI SUGARS	KAGWAD110	65.72	0.22 ↑	0.00 ↓
13	**ML PURA 220kV TOTAL IPPs**	1.19			
	SRI PRABHULINGESHWARA	JAMAKHANDI -SHIROL	111.51	0.00 ↓	
	GODAVARI SUGARS-1	ML PURA 220kV	109.85	0.75 ↓	0.41 ↓
	GODAVARI SUGARS-2	ML PURA 220kV	109.85	0.00 ↓	0.00 ↓
	INDIAN CANE POWER LTD	UTTUR 110kV	105.98	0.29 ↑	0.00 ↓
	NIRANI SUGARS	Mahalingapura -Mudhol	109.85	20.01 ↓	
	BPCL	ITNAL 110	109.27	44.06 ↑	6.35 ↓
14	**RANEBENNUR 220kV TOTAL IPPs**	67.43 ↓			
	SUZLON	BYADAGI 110kV	111.01	27.69 ↓	2.61 ↑
15	**SOUDATTI 220kV TOTAL IPPs**	80.53			
	ENERCON-1	SOUDATTI 110kV	111.49	33.99 ↓	3.17 ↑
	ENERCON-2	SOUDATTI 110kV	111.49	34.12 ↓	3.41 ↑
	Tungabhadra Steel Producers Ltd-1	SOUDATTI 110kV	11.02	0.00 ↓	0.00 ↑
	Tungabhadra Steel Producers Ltd-2	SOUDATTI 110kV	11.02	0.00 ↑	0.00 ↑
	RENUKA SUGARS	SOUDATTI-YARAGATTI	109.57	2.16 ↓	
	SUZLON	SOUDATTI 110kV	34.41	8.39 ↑	0.22 ↑
16	**VAJRAMATTI 220kV TOTAL IPPs**	0.10			
	J K CEMENTS	VAJRAMATTI 220	0.53	0.00 ↓	0.00 ↓
	GEM SUGARS	KATARKI 110kV	108.02	0.10 ↑	0.11 ↓
	BILAGI SUAGRS 1	BILAGI 110kV	31.47	0.00 ↑	0.01 ↑
	BILAGI SUAGARS 2	BILAGI 110kV	31.47	0.10 ↓	0.02 ↓
	Rytara Sahakari sakkare Karkane	LOKAPURA 110kV	0.00	0.00 ↓	0.00 ↓
	DALMIA CEMENTS	LOKAPURA 110kV	0.00	0.00 ↓	0.00 ↓

IPPS ALL ZONES

	BIOMASS	CO-GENERATION	MINI HYDRO	WIND	SOLAR	TOTAL (Including 220kV IPPs)
IPPS_BESCOM	0.14	1.02	13.70	555.73	42.02	613.58
IPPS_MESCOM	0.00	0.00	94.79	49.77		141.87
IPPS_CESC	0.00	2.95	118.88	101.51	1.38	233.18
IPPS_GESCOM	0.14	30.61	30.50	213.98	9.97	291.06
IPPS_HESCOM	0.00	10.49	0.00	1053.80	2.81	1065.82
TOTAL_IPPS	0.34	42.36	258.02	1979.36	58.49	2344.25

ESCOM WISE STATION LOAD

Total Gen: 6199 MW
Total Load : 6127 MW

BESCOM LOAD:3463 UI:- 176

STATIONS NAMES	VTG	TR LOAD	IPP	NET LOAD
A'HALLI	213	50.3		
ANCHEPALYA	215	34.7	0.2	35.9
A STATION	211	85.8		
BEGUR	211	20.4		
BIDADI	204	49.6		
CHINTAMANI	226	65.6		
CHITRADURGA	218	- 154.6	196.5	52.2
DABUSPET	212	69.7		
DAVANGERE	220	33.3	76.6	112.7
D B PURA	215	56.2		
EAST DIV COMP	210	93.3		
EPIP	210	105.7		
G B'NUR	213	56.3		
HEBBAL	209	122.8		
HIRIYUR	222	- 100.1	129.1	39.6
HONNALI	222	2.7	12.8	15.8
HOODY	211	236.3		
HAL	211	155.2		
HOSKOTE	210	82.6		
HSR LAYOUT	205	226.0		
KANAKAPURA	203	24.9	13.7	38.1
KB'HALLI	214	28.5		
KHODAYS	206	13.0		
KOLAR	218	109.9	0.5	111.1
KIADB(D B PURA)	215	36.3		
MADHUGIRI	212	42.2	10.1	51.2
MALUR	216	73.5	1.4	74.5
NAGANATHPURA	197	96.0		
NEELGUNDA	219	- 36.0	20.9	- 14.9
NIMHANS	210	48.6		
NITTUR	218	15.8		
NRS 220	220	74.9		
SOMANAHALLI	203	160.7	0.7	161.8
S'PURA	207	120.7		
SARJAPURA	216	32.0		
SRS PEENYA	210	316.2		
T K HALLI	205		9.3	9.3
THALLAK	0	- 0.8	16.8	40.2
V'THI VALLEY	199	107.6		
Y D G PLANT	63	0.0		
YELHANKA	208	119.9		
Y'HALLI	212	188.8		
HAROHALLI	203	27.3		
TATAGUNI	220	26.3		
C P R I	209	10.4		
I T P L	211	7.8		
RAILWAYS	214	8.2		
TOYOTA	204	11.8		
IPPs/NCEP			510.2	
INTER ESCOM FLOW			- 0.9	

GESCOM LOAD:605 UI:- 281

ALIPUR	217	44.6	48.0	95.0
HALBURGA	227	36.8	2.6	43.6
HUMNABAD	223	27.9	2.8	30.9
ITTAGI	216	- 36.9	104.5	64.5
K'NI STEELS	212	32.5		
KAPNOOR	228	48.9	- 0.2	48.8
KUSHTAGI	229	60.9	- 8.8	45.4
LINGAPUR	214	0.0	11.2	26.3
L'SUGUR	218	- 74.1	100.7	26.7
MUNIRABAD	0	15.0		
RAICHUR	225	55.9	0.0	54.3
SEDAM	225	18.3	0.7	20.2
SHAHBAD	224	28.0	0.0	29.5
SHAHPUR	225	38.6	2.2	40.7
SINDHANOOR	0	46.3	0.0	47.3
IPPs GESCOM			277.6	
INTER ESCOM FLOW			- 16.3	

MESCOM LOAD:422 UI:- 221

C MANGLORE	222	17.4		
KADUR	221	- 2.0	42.5	41.3
KEMAR	223	42.2	36.1	78.2
KAVOOR	224	74.9	47.0	121.9
MSEZ	227	1.3		
PUTTUR	225	49.2	- 7.6	43.2
S'RAL KOPPA	217	62.7	- 21.4	40.0
SHIMOGA	224	46.7	49.2	98.7
LPH	110	0.2		
BHADRA	65	0.0		
MGHE JOG	109	9.0		
MANI DAM	110	0.1		
IPPs MESCOM			143.2	
INTER ESCOM FLOW			- 16.3	

HESCOM LOAD: 719 UI: 937

ATHANI	221	35.8	6.4	45.2
AMBEWADI	229	11.4	0.0	12.2
BAGALKOT	224	34.9	0.0	35.9
B BWADI	225	39.4	0.0	41.0
BELGAUM	225	78.0	9.4	86.2
BIDNAL	228	16.7	3.9	19.8
BIJAPUR	220	34.5		
CHIKKODI	225	- 0.3	36.4	38.6
GADAG	217	- 144.0	121.8	- 17.4
G'PRABHA	225	58.9	19.5	74.6
HAVERI	224	8.7	25.8	31.6
HUBLI	220	41.0		
INDI	220	30.0	0.1	30.1
KARWAR	226	32.6	12.7	45.4
KUDACHI	230	18.5	0.0	16.3
MKHUBLI	226	36.8	0.0	37.3
ML'PURA	226	29.6	1.2	29.4
NARENDRA	220	39.5		
R'BENNUR	221	- 30.6	67.4	42.5
SIRSI	228	5.7		
SOUNDATTI	229	- 42.6	80.5	38.1
VAJRAMATTI	221	66.2	0.1	63.1
SUPA	114	0.0		
G'PRABHA	11	0.0		
INDAL	225	7.1		
LIS BALUTI	225	0.2		
IPPs HESCOM			317.0	
INTER ESCOM FLOW			26.0	

CESC LOAD:907 UI: 135

ARASIKERE	220	25.1		
C R NAGAR	207	93.5	3.0	105.7
C.R.PATNA	218	25.5		
HASSAN	214	- 35.1	104.4	72.0
H'GALLI	211	103.5	21.0	127.9
HN PURA	217	26.7	4.2	30.3
K R PET	212	80.3	3.9	80.7
KADAKOLA	209	96.5	3.1	99.8
K'SHL NAGARA	214	49.1	5.6	54.6
M'HALLI	207	37.2	22.6	68.6
T K HALLI	205	46.6	23.3	73.4
TUBINAKERE	209	70.1	5.2	80.9
VAJAMANGLA	209	51.6	17.2	69.7
SHIMSHA	65	7.8		
S SAMUDRA	66	41.4		
IPPs CESC			182.4	
INTER ESCOM FLOW			- 3.3	
JINDAL-GUTTUR 400 kV				- 8.69
NELAMANGALA-GOOTY 400 kV				- 499.90

The Way forward - REMC

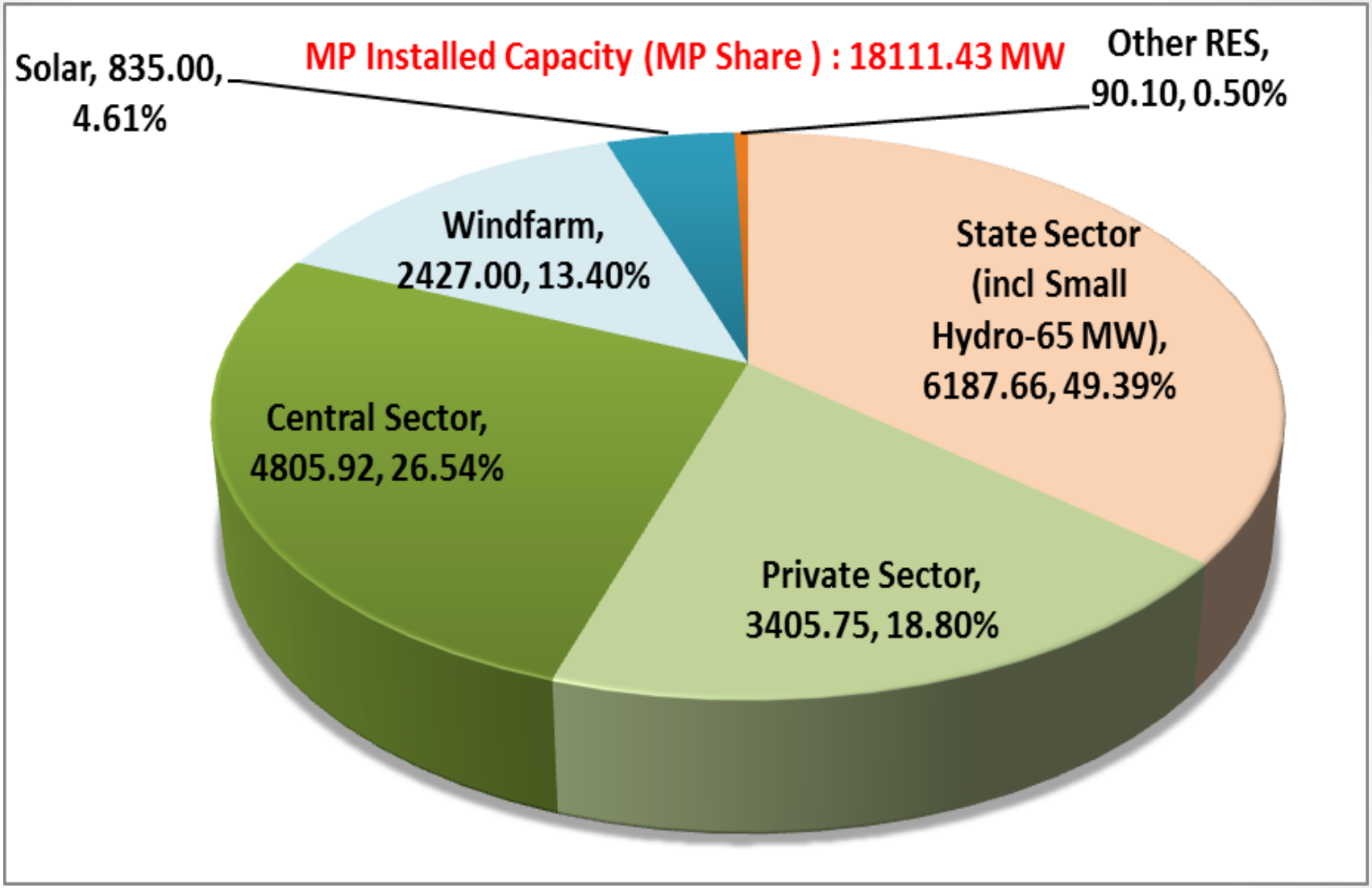
* **R.E.M.C will be set up adjacent to the SLDC**
* ***The REMC system will be integrated to the KPTCL SCADA system to facilitate flow of real time data from KPTCL system to REMC system and flow of day ahead schedules to the KPTCL system from the REMC system.***
* ***Communication between the two system will be on wired communication as the two centres will be adjacent to each other.***
* ***Bid evaluation is in progress for REMC system (PGCIL)***

The Way forward – KERC regulations

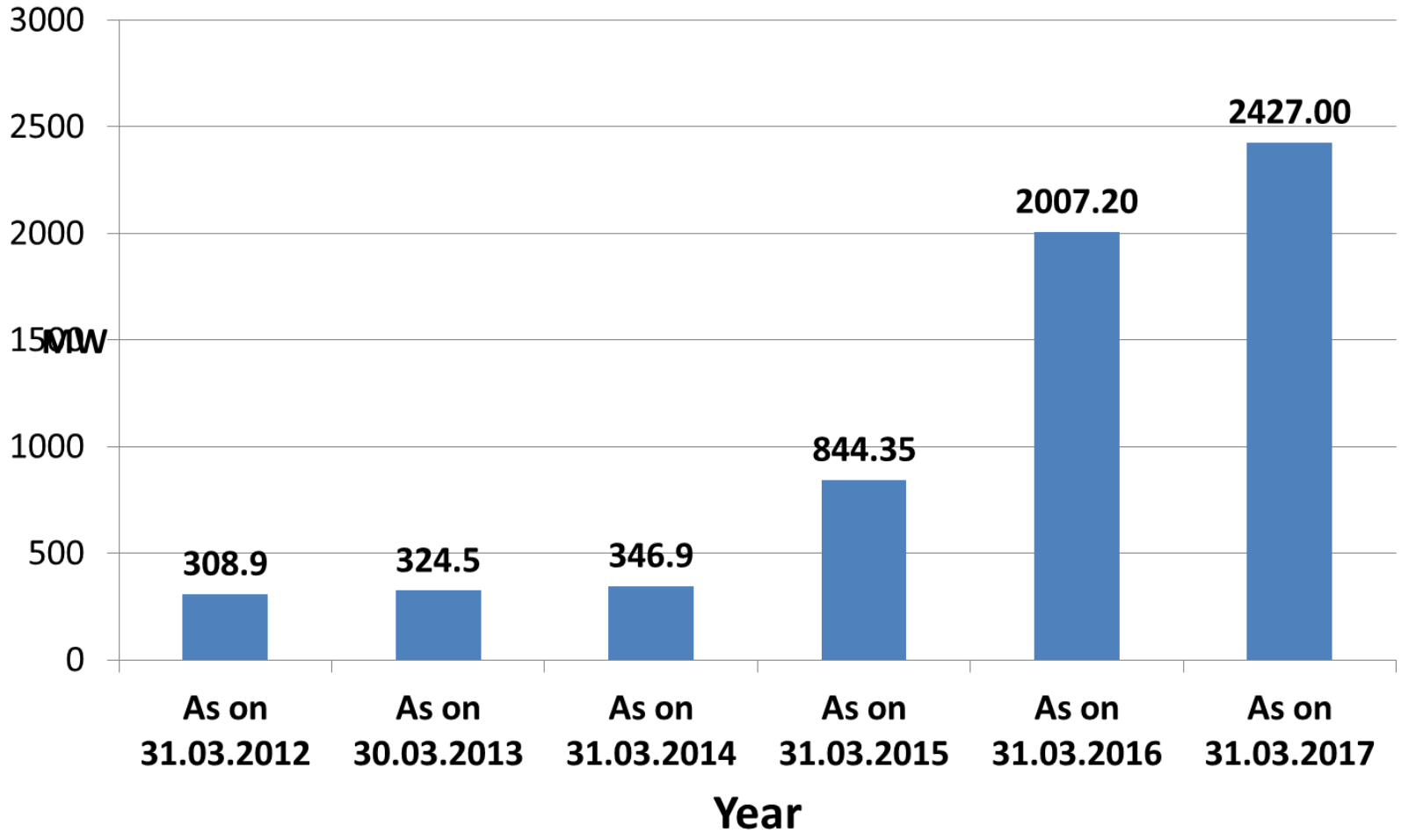
* ***Steps taken for implementation of the KERC regulations for wind and solar***
* ***Real time data from SCADA made available***
* ***Aggregators are providing schedules as a mock exercise for about 55% of the pooling stations.***
* ***About 90% Generators have provided static data of the turbines.***
* ***The Generators have been directed to provide real time data at turbine level to SLDC. Further discussions will be held to address this aspect.***

Thank You

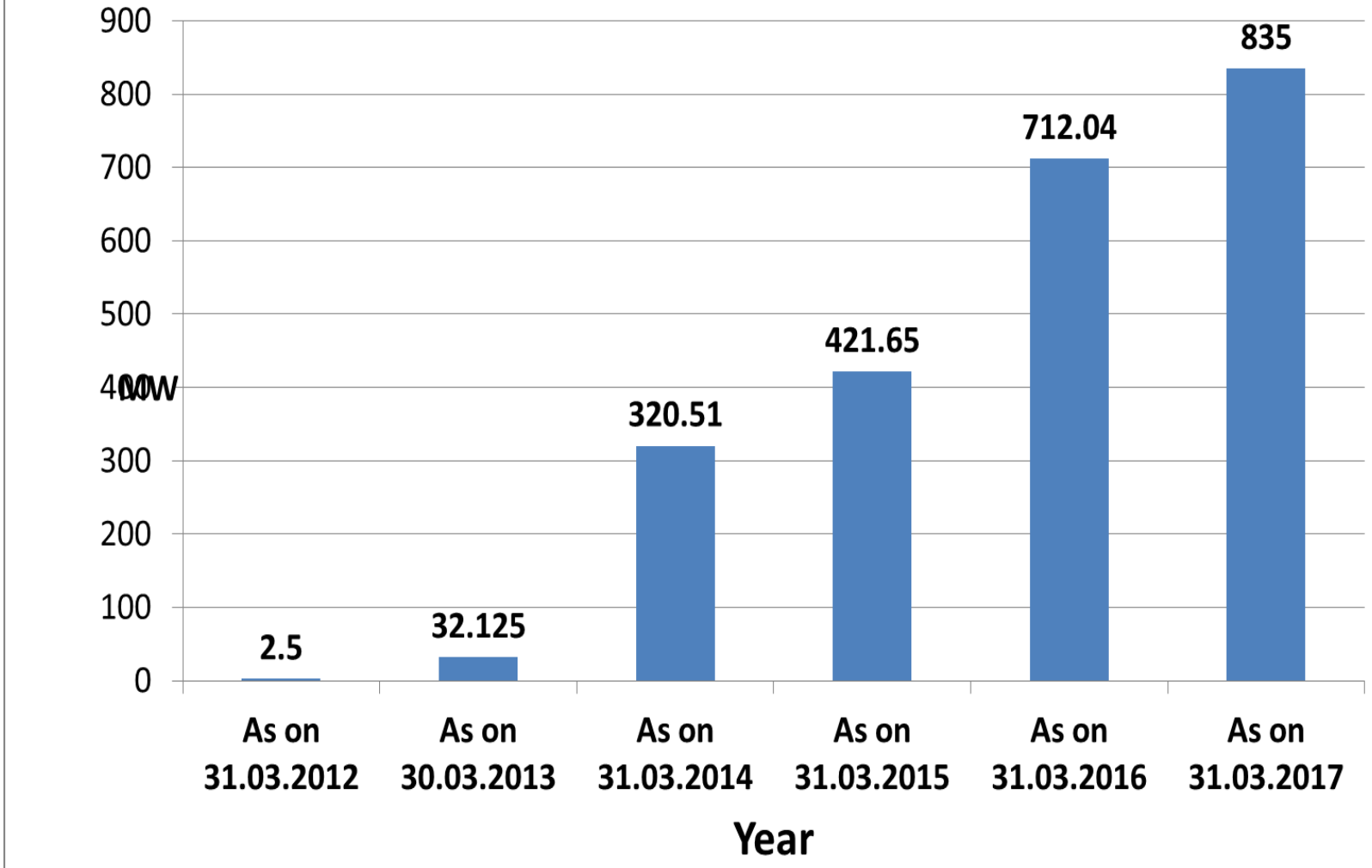
STATE LOAD DESPATCH CENTRE
MPPTCL, JABALPUR


MP Installed Capacity (MP Share) : 18111.43 MW
Solar, 835.00, 4.61%
Other RES, 90.10, 0.50%
Windfarm, 2427.00, 13.40%
State Sector (incl Small Hydro-65 MW), 6187.66, 49.39%
Central Sector, 4805.92, 26.54%
Private Sector, 3405.75, 18.80%

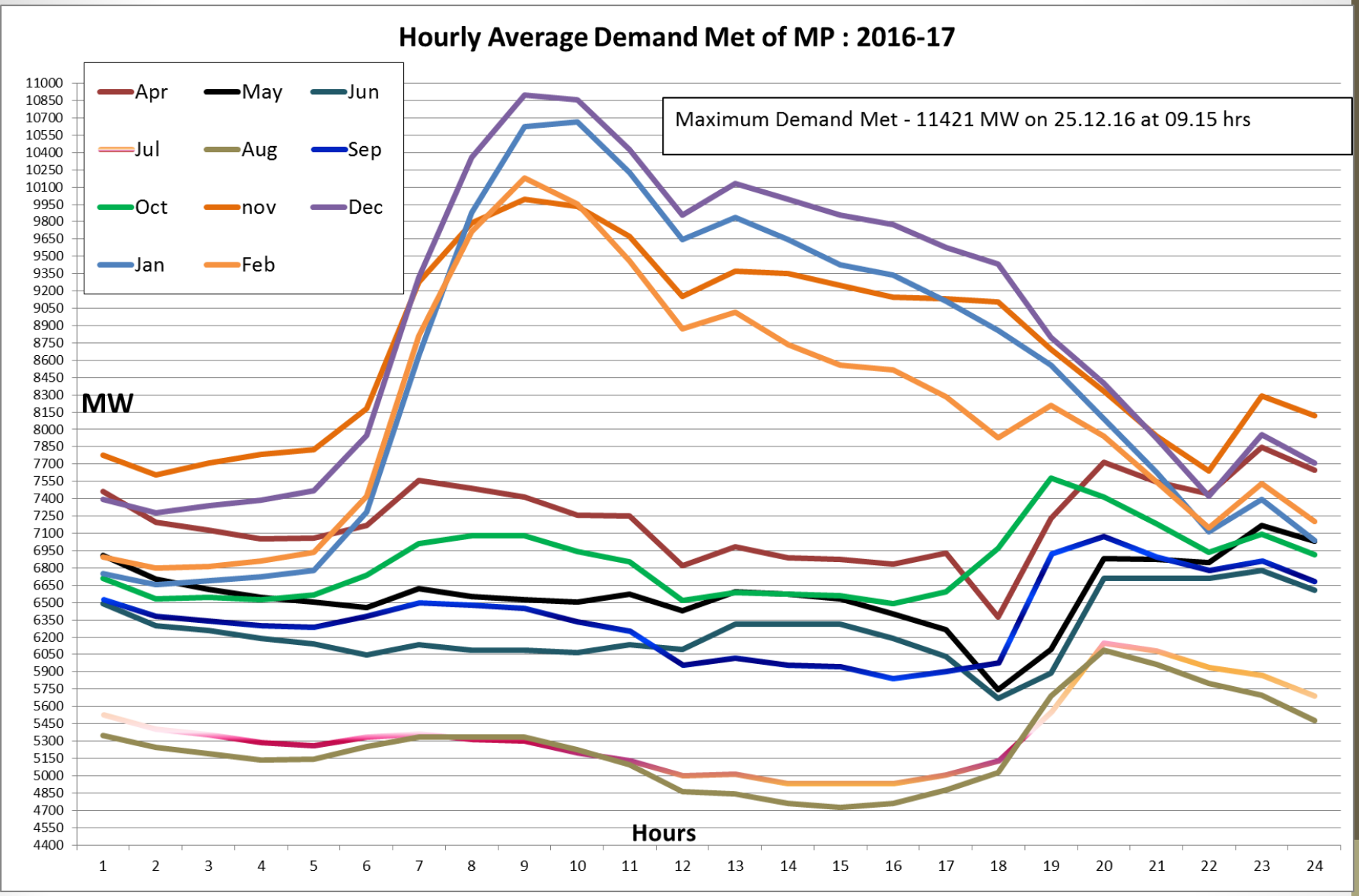
INSTALLED CAPACITY OF WIND IN MP



INSTALLED CAPACITY OF SOLAR IN MP

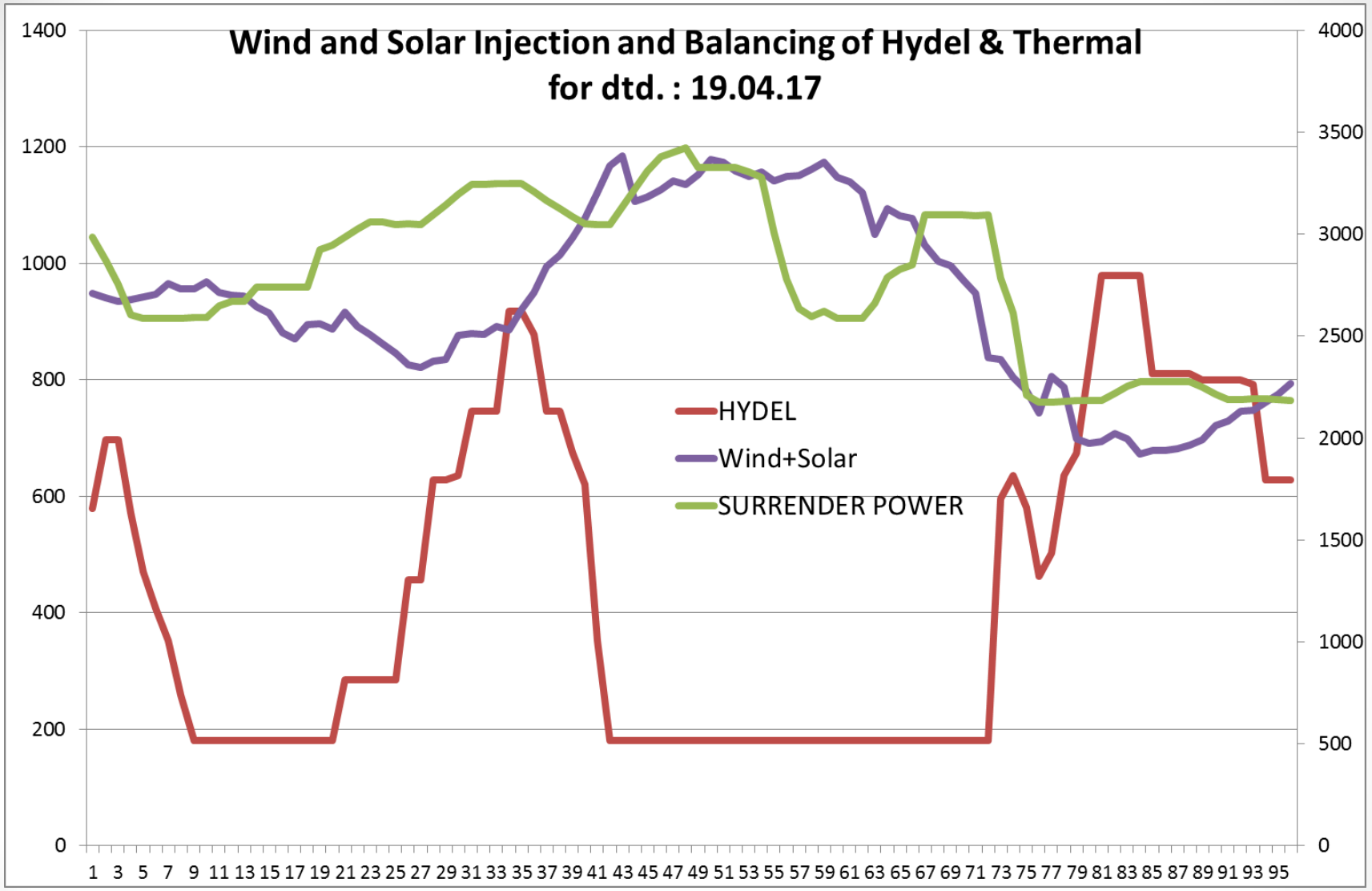


Hourly Average Demand Met of MP : 2016-17



Wind and Solar in MP

- The Developer / Generator submits the day-ahead forecasting of their generator at pooling stations to SLDC
- SLDC issues the injection schedule to each Developer / Generator on day-ahead basis based on their forecasting.
- In MP except SECI selling power to other states, no other RE Generators are doing real time forecasting in absence of regulatory framework for imbalance settlement
- New Generators are giving commissioning permission only after providing telemetry and compliance of all regulatory requirements.
- The guidelines to be followed by the RE generators for Metering, AMR, Telemetry etc. have been made available on MP SLDC website
- MPERC has notified draft Regulation on “Forecasting, Scheduling and Deviation Settlement of Wind and Solar Generators in the State level” which also addresses the issue of RE Generators selling power to other states through Open Access and yet to be notified.
- The Govt. of India is establishing “Renewable Energy Management Centres” (REMC) in National and Regional Load despatch centres as well as State Load Despatch Centres of RE rich states including MP. The REMC shall comprise of SCADA, Forecasting tool, RE Scheduling tool, Control reserve monitoring tool and WAMS for RE.


Wind and Solar Injection and Balancing of Hydel & Thermal
for dtd. : 19.04.17
HYDEL
Wind+Solar
SURRENDER POWER
1400
1200
1000
800
600
400
200
0
4000
3500
3000
2500
2000
1500
1000
500
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95

Status of Green Energy Corridor Project (Phase-I) Madhya Pradesh

RENEWABLE ENERGY POWER EVACUATION WORKS

- To evacuate power from anticipated RE capacity addition of about 5847MW in next five years, MPPTCL has conducted system studies & identified required transmission system strengthening and interconnection works for upcoming RE projects.
- **Estimated Cost of works proposed for RE Projects in MP**

(A) Transmission System Strengthening Works :**Rs.3575 Crore**

(Phase I: Rs 2100 Crore + Phase II: Rs 1475 Crore)

(B) Interconnection works :**Rs.1125 Crore**

Total Estimated Cost (A+B) :Rs.4700 Crore

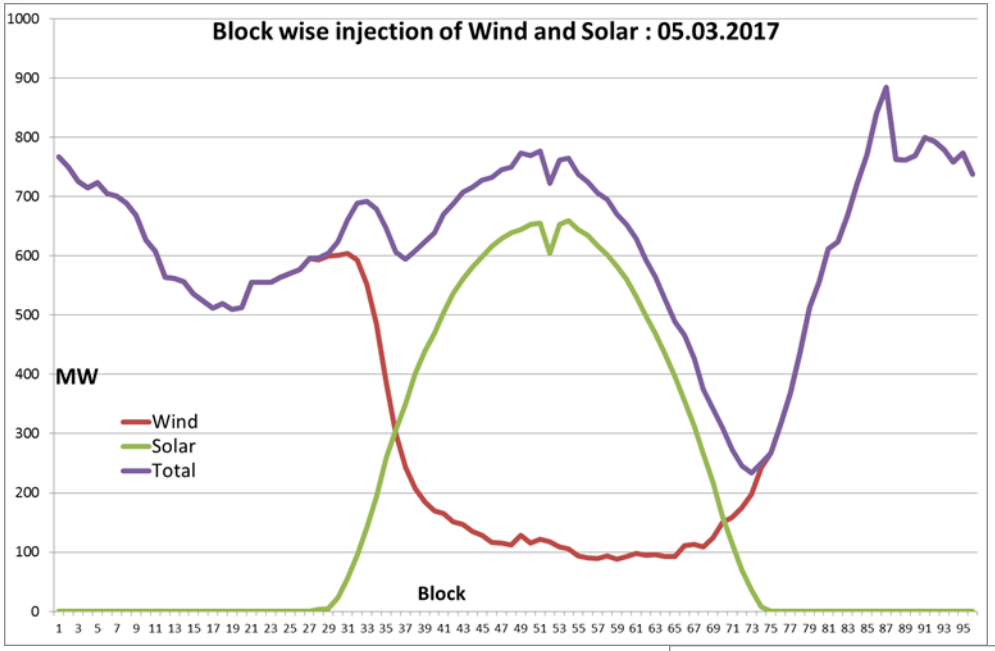
- Phase-I Transmission System Strengthening Works amounting to Rs. 2100 Crore are proposed to be completed within 3 year.

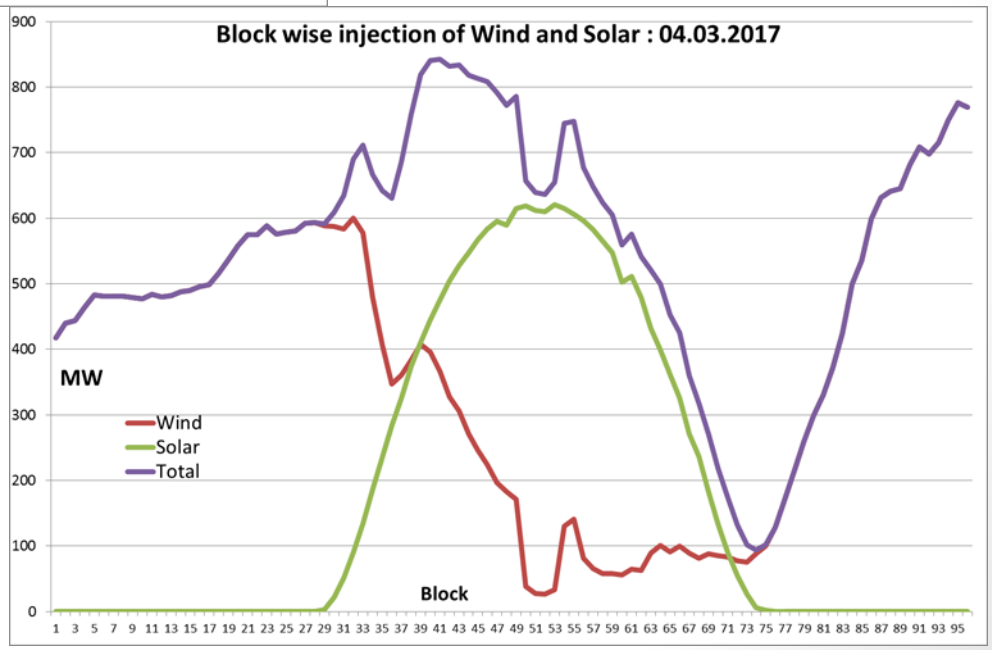
GREEN ENERGY CORRIDOR SCHEME (PHASE-I)

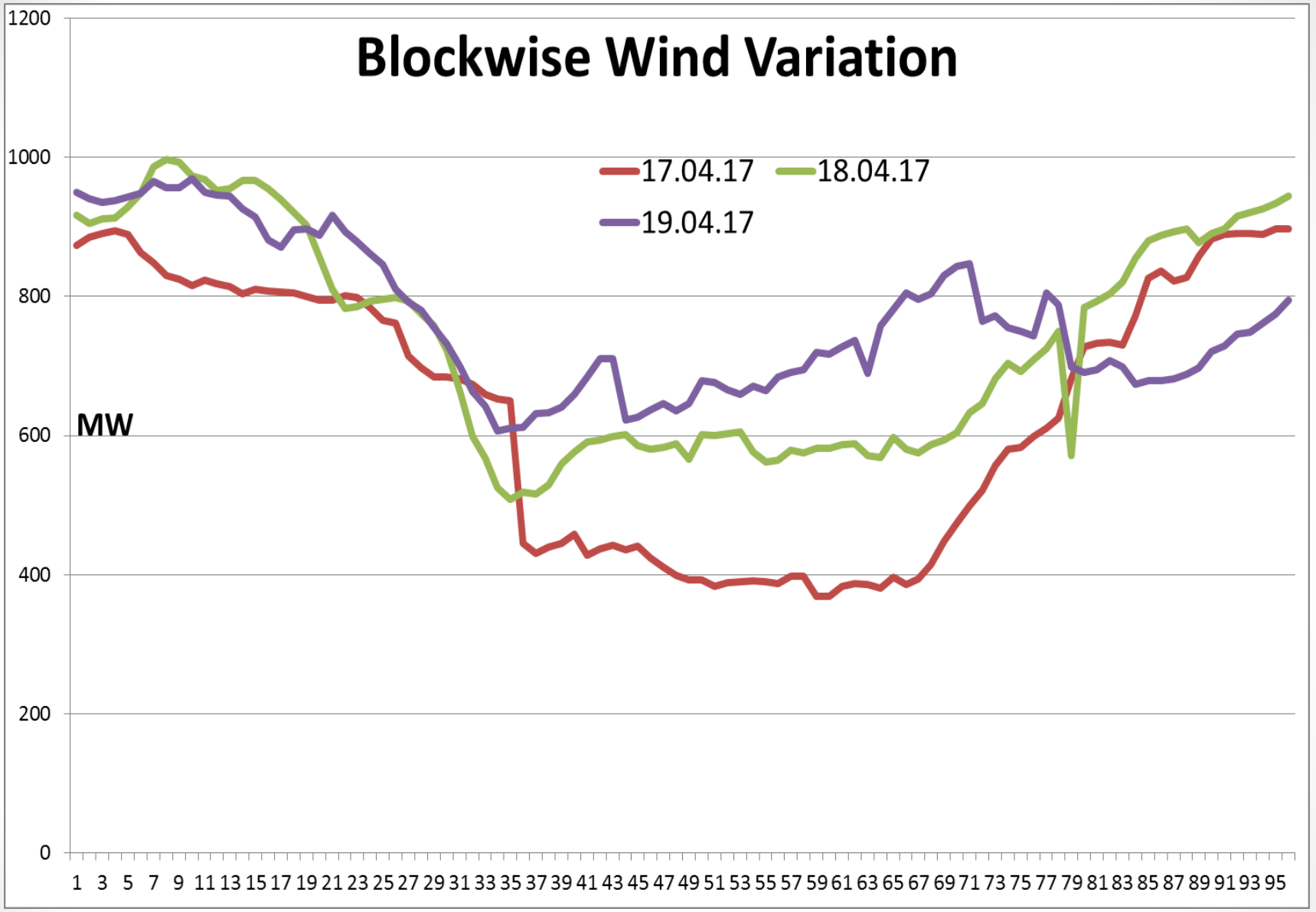
(ANTICIPATED COMPLETION YEAR 2018-2019)

- Loan No. : **201366483**
- Total Project Cost : **Rs. 2100 Crore (Revised 2027 Crore)**
- Grant from NCEF (40%) : **Rs. 840 Crore**
- KFW Loan Component (40%) : **Rs. 840 Crore (i.e. EUR 124.0 million)**
- GoMP Share (20%) : **Rs. 420 Crore**

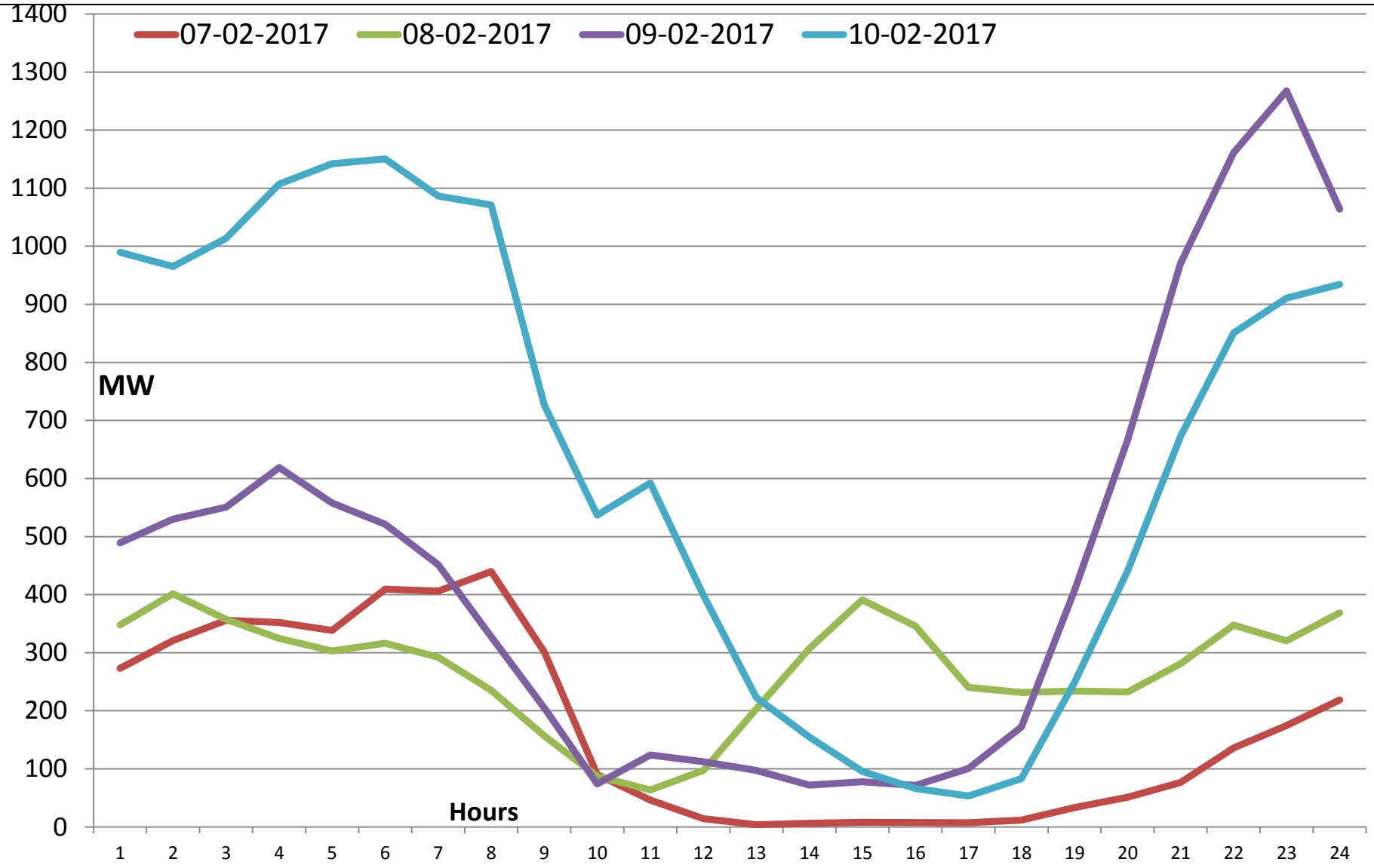
Sl.No.	Particulars	Nos./ Ckt. Km
1	400kV New Substations (Mandsaur, Sagar, Ujjain)	3 Nos.
2	400kV Line	690 Ckt. Km
3	400kV Reactors	3 Nos.
4	220kV New Substations (Sendhwa,Jaora,Gudgaon,Kanwan,Ratangarh, Susner,Sailana) (220kV S/s Suwasara excluded)	7 Nos.
5	220kV Line	1164 Ckt. Km
6	132kV Line	1128 Ckt. Km
7	132/33kV Addl. Transformer (Nalkheda, Vijaypur)	2 Nos.


Block wise injection of Wind and Solar : 05.03.2017
MW
Wind
Solar
Total
Block


Block wise injection of Wind and Solar : 04.03.2017
MW
Wind
Solar
Total
Block


Blockwise Wind Variation
17.04.17
18.04.17
19.04.17
MW
1200
1000
800
600
400
200
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95

Hourly Wind Variation



Thank You !

Technical Committee constituted by CEA for study of optimal location of various types of balancing energy resources/energy storage devices to facilitate grid integration of RES

SRPC secretariat

Chennai

09.05.2017

Ramp Rates of Wind

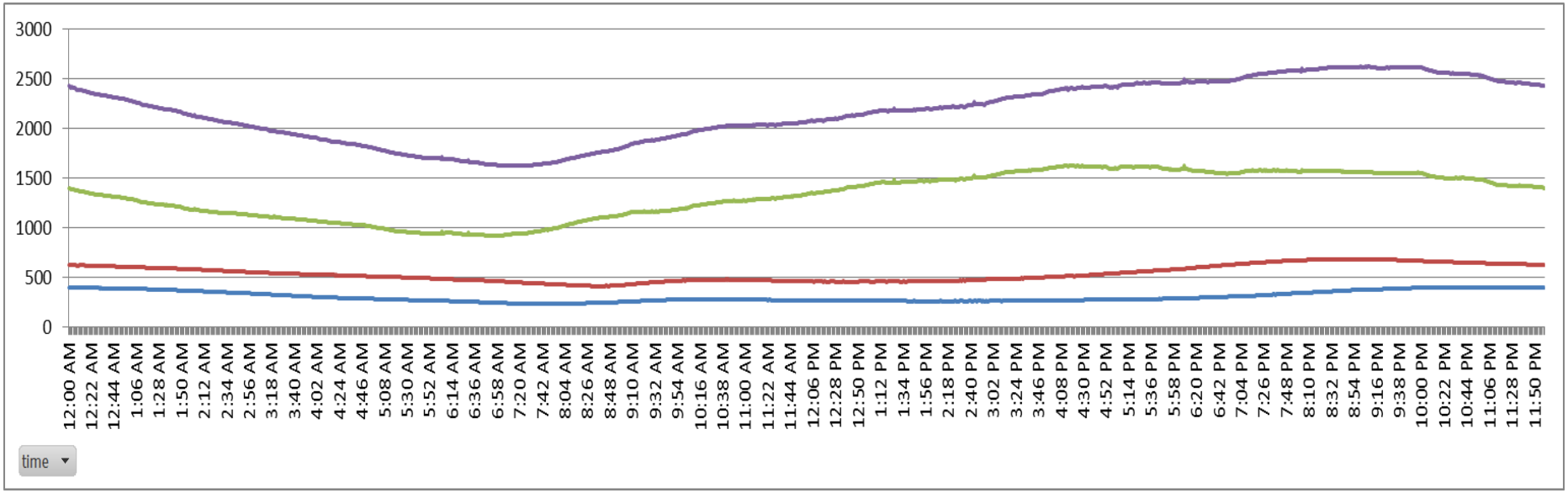
State	Generation Peak	1 Minute	5 Minute	15 Minute	Range
Andhra Pradesh	1300 MW	-20 to 10	-30 to 20	-60 to 40	95% W<500 90%W>500
Karnataka	2000 MW	-20 to 10	-30 to 20	-50 to 50	90% W<1000 80%W>1000
Tamil Nadu	4500 MW	-100 to 50	--100 to 50	-150 to 100	80% W<1000 75%W>1000
Southern Region	7500 MW	-100 to 50	--100 to 50	-200 to 150	80% W<1500 70%W>1500

Total Wind Variation is seen between -400 to +350 MW

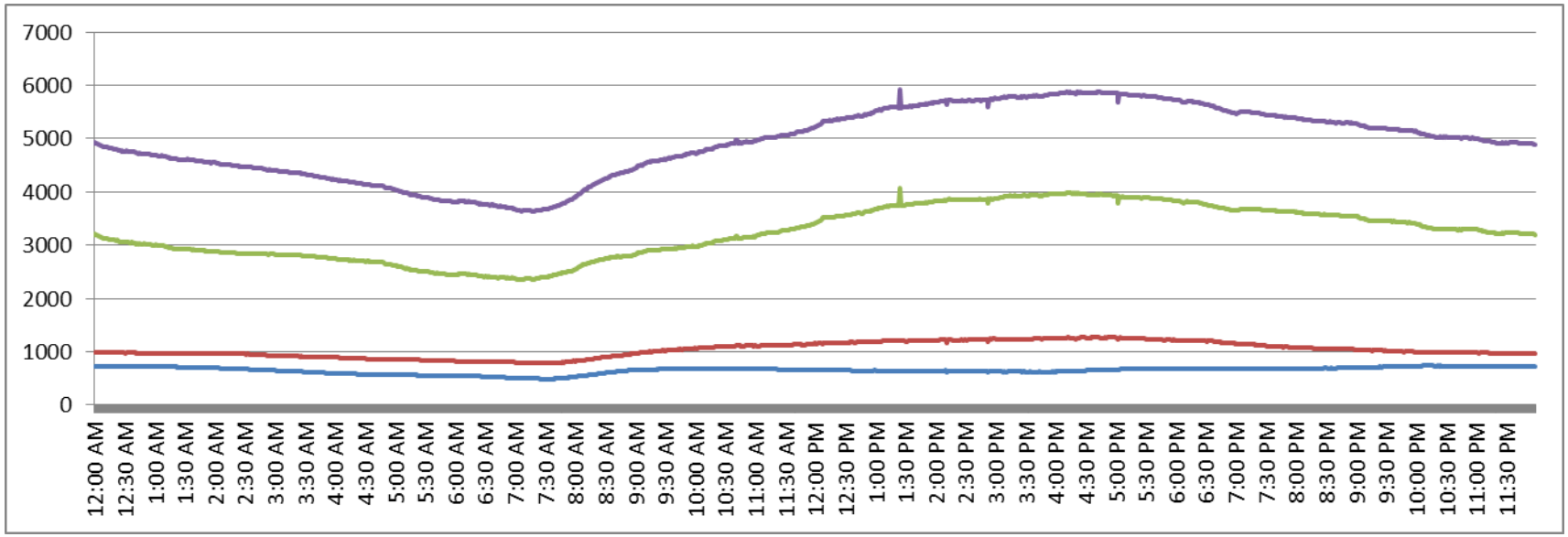
Ramp Rate TN Vs SR Wind

	15 Min	1 Hr	6 Hr
-100 to + 50	TN Var> SR Var		
-200 to 100		TN Var> SR Var	
-450 to 350			TN Var> SR Var

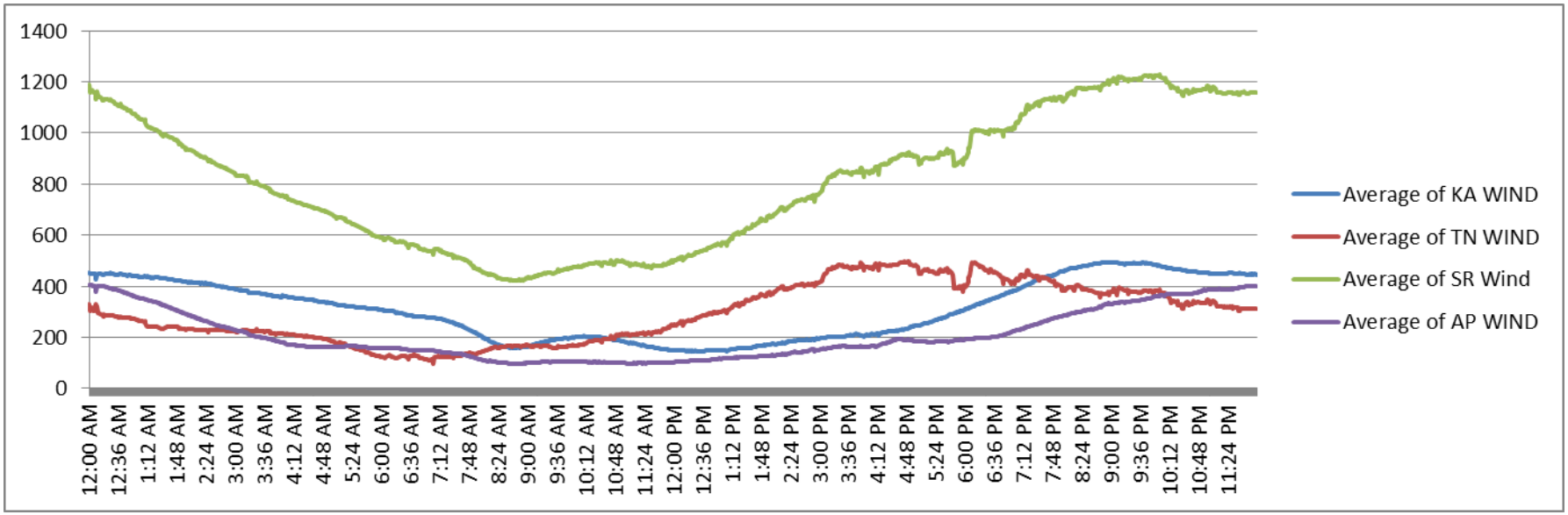
Wind Curve


3000
2500
2000
1500
1000
500
0
12:00 AM
12:22 AM
12:44 AM
1:06 AM
1:28 AM
1:50 AM
2:12 AM
2:34 AM
2:56 AM
3:18 AM
3:40 AM
4:02 AM
4:24 AM
4:46 AM
5:08 AM
5:30 AM
5:52 AM
6:14 AM
6:36 AM
6:58 AM
7:20 AM
7:42 AM
8:04 AM
8:26 AM
8:48 AM
9:10 AM
9:32 AM
9:54 AM
10:16 AM
10:38 AM
11:00 AM
11:22 AM
11:44 AM
12:06 PM
12:28 PM
12:50 PM
1:12 PM
1:34 PM
1:56 PM
2:18 PM
2:40 PM
3:02 PM
3:24 PM
3:46 PM
4:08 PM
4:30 PM
4:52 PM
5:14 PM
5:36 PM
5:58 PM
6:20 PM
6:42 PM
7:04 PM
7:26 PM
7:48 PM
8:10 PM
8:32 PM
8:54 PM
9:16 PM
9:38 PM
10:00 PM
10:22 PM
10:44 PM
11:06 PM
11:28 PM
11:50 PM
time

August 2016 Wind Curve



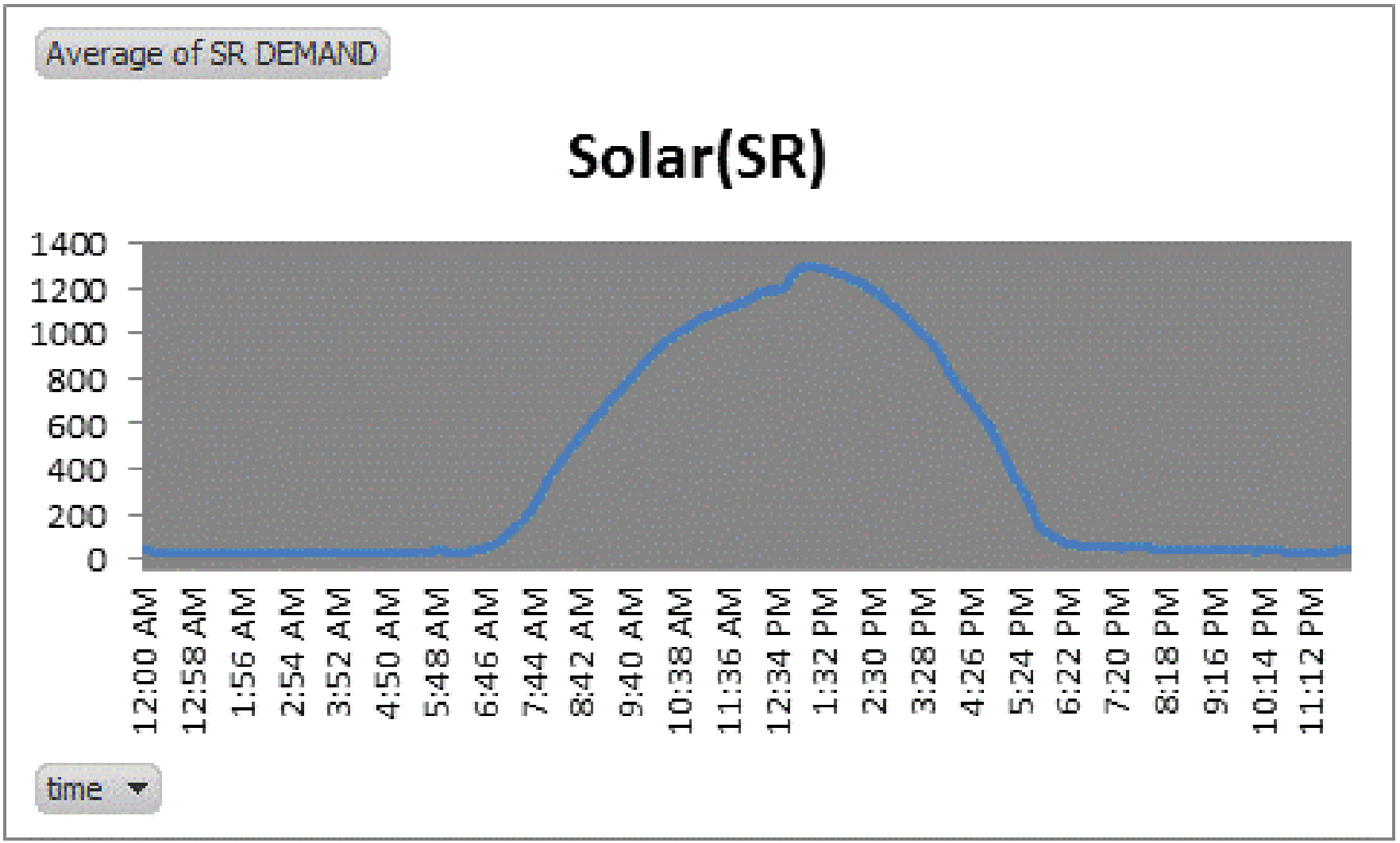
March 2017 Wind Curve

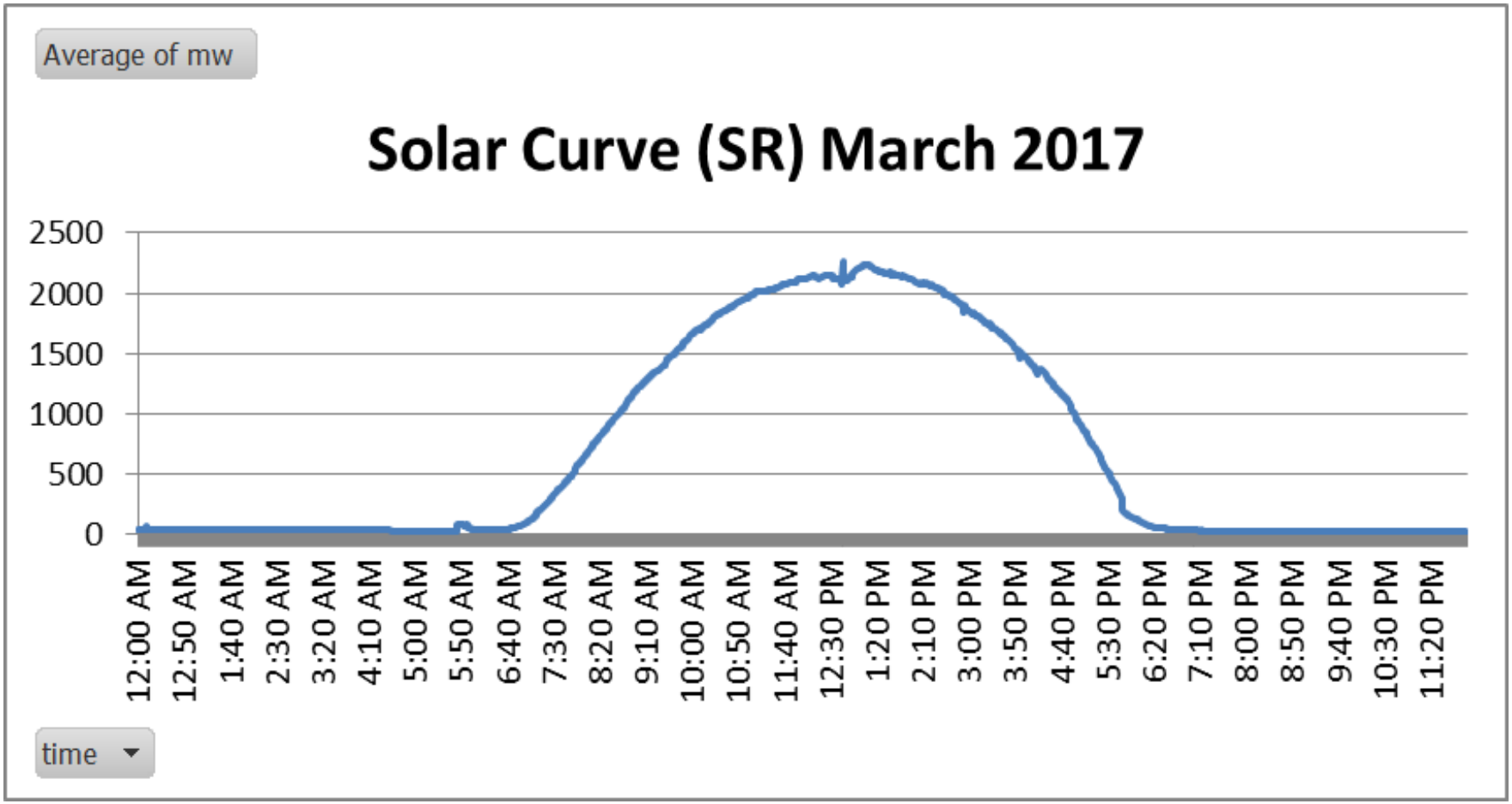


Ramp Rate Solar (SR)

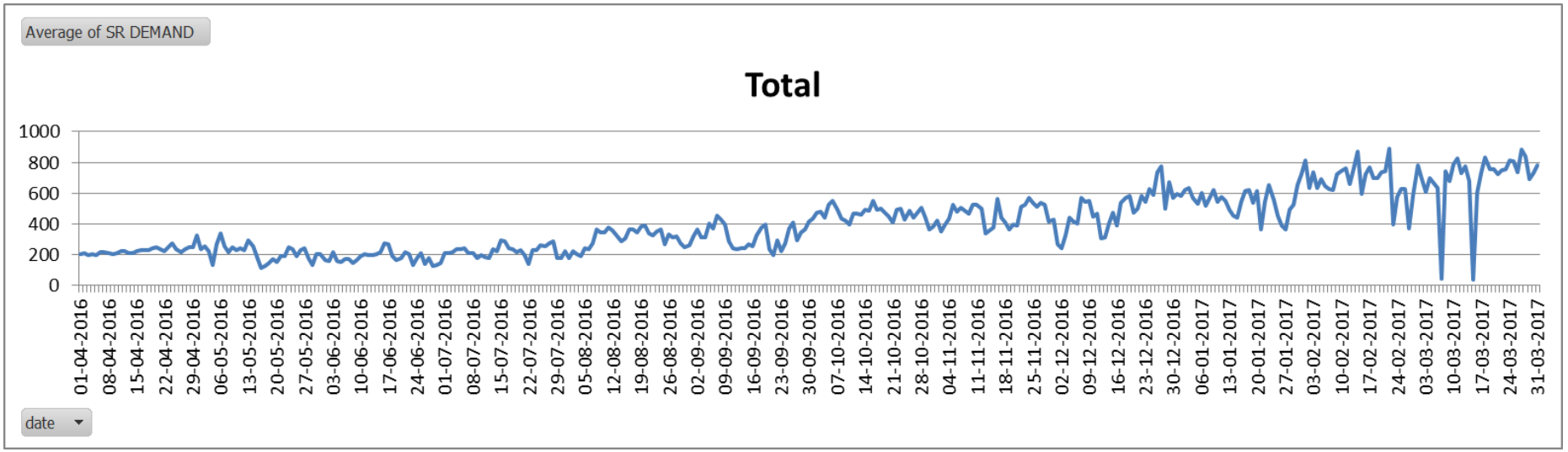
	15 Min	1 Hr	6 Hr
-100 to 100	85%	65%	50%
-300 to 300	98%	85%	70%
-650 to 650		98%	90%
-850 to 950			98%

Solar Curve


Average of SR DEMAND
Solar(SR)
1400
1200
1000
800
600
400
200
0
12:00 AM
12:58 AM
1:56 AM
2:54 AM
3:52 AM
4:50 AM
5:48 AM
6:46 AM
7:44 AM
8:42 AM
9:40 AM
10:38 AM
11:36 AM
12:34 PM
1:32 PM
2:30 PM
3:28 PM
4:26 PM
5:24 PM
6:22 PM
7:20 PM
8:18 PM
9:16 PM
10:14 PM
11:12 PM
time


Average of mw
Solar Curve (SR) March 2017
2500
2000
1500
1000
500
0
12:00 AM
12:50 AM
1:40 AM
2:30 AM
3:20 AM
4:10 AM
5:00 AM
5:50 AM
6:40 AM
7:30 AM
8:20 AM
9:10 AM
10:00 AM
10:50 AM
11:40 AM
12:30 PM
1:20 PM
2:10 PM
3:00 PM
3:50 PM
4:40 PM
5:30 PM
6:20 PM
7:10 PM
8:00 PM
8:50 PM
9:40 PM
10:30 PM
11:20 PM
time

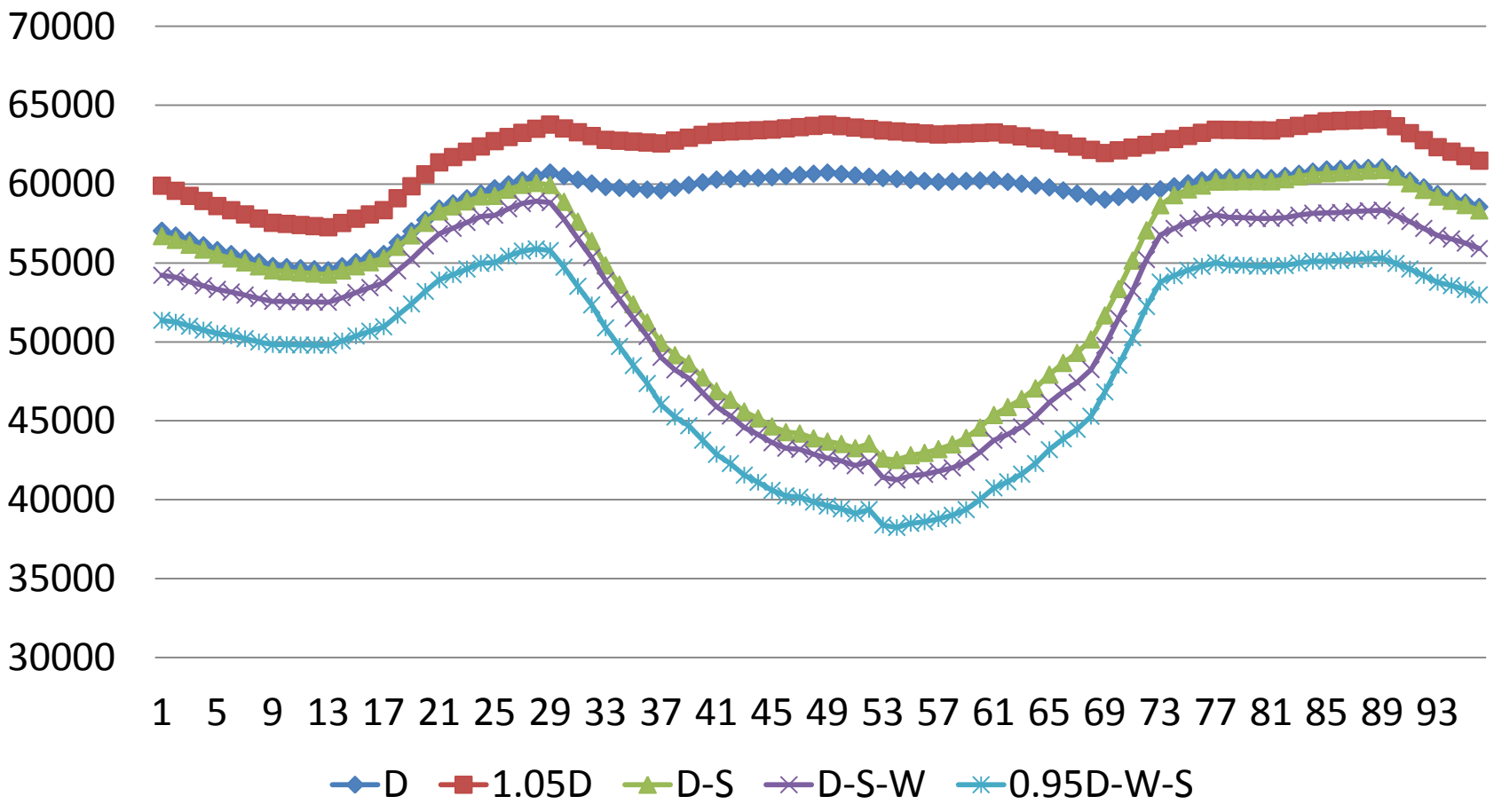
Solar Average Gen Day Wise



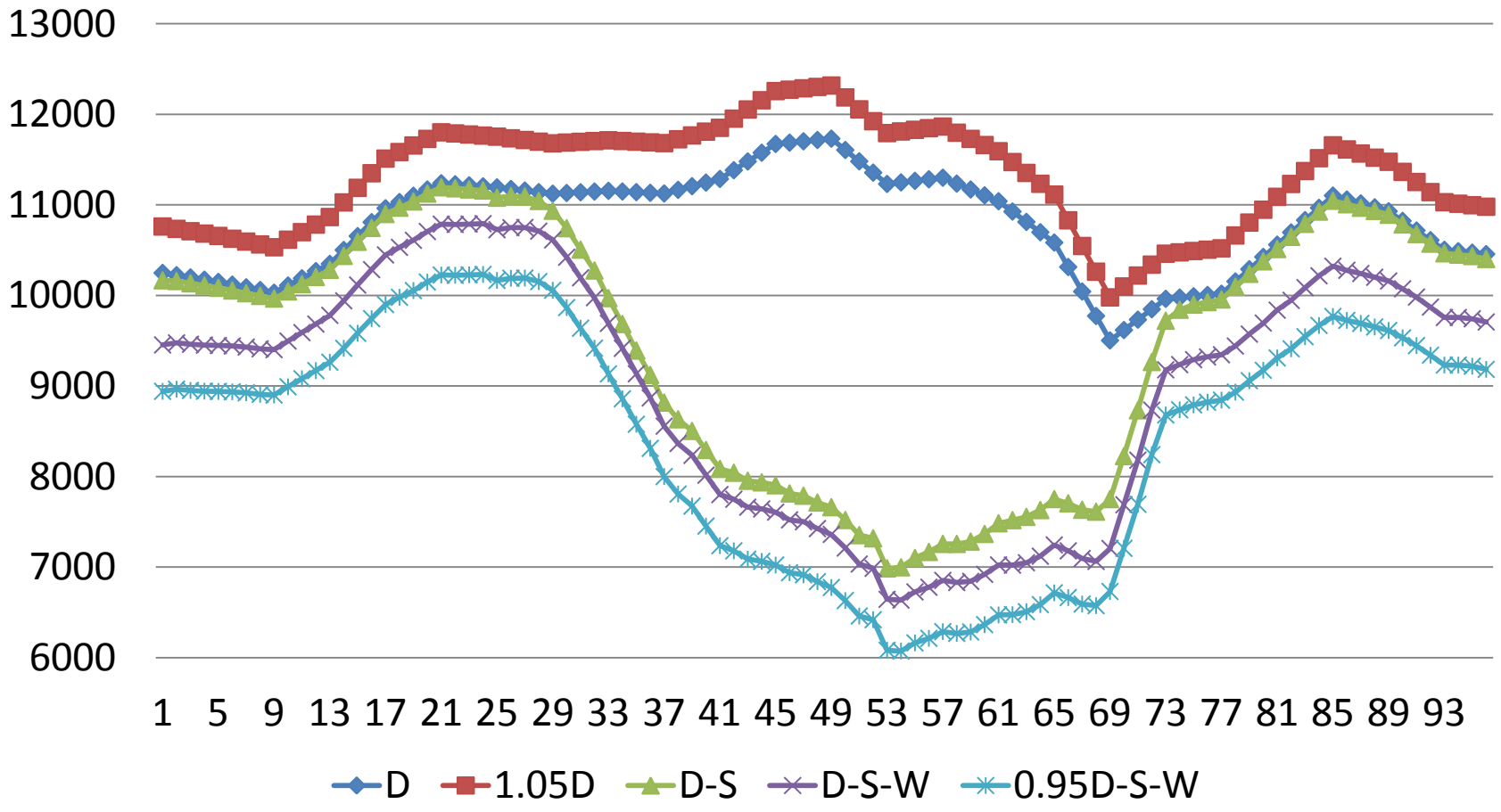
Deviation

	Range	97%
AP	-700 to +700	-300 to +300
KA	-1200 to 600	-400 to +400
TS	-700 to 500	-300 to +200
TN	-1200 to 800	-500 to +500
SR(Sum)	-2100 to 1400	-800 t0 +800

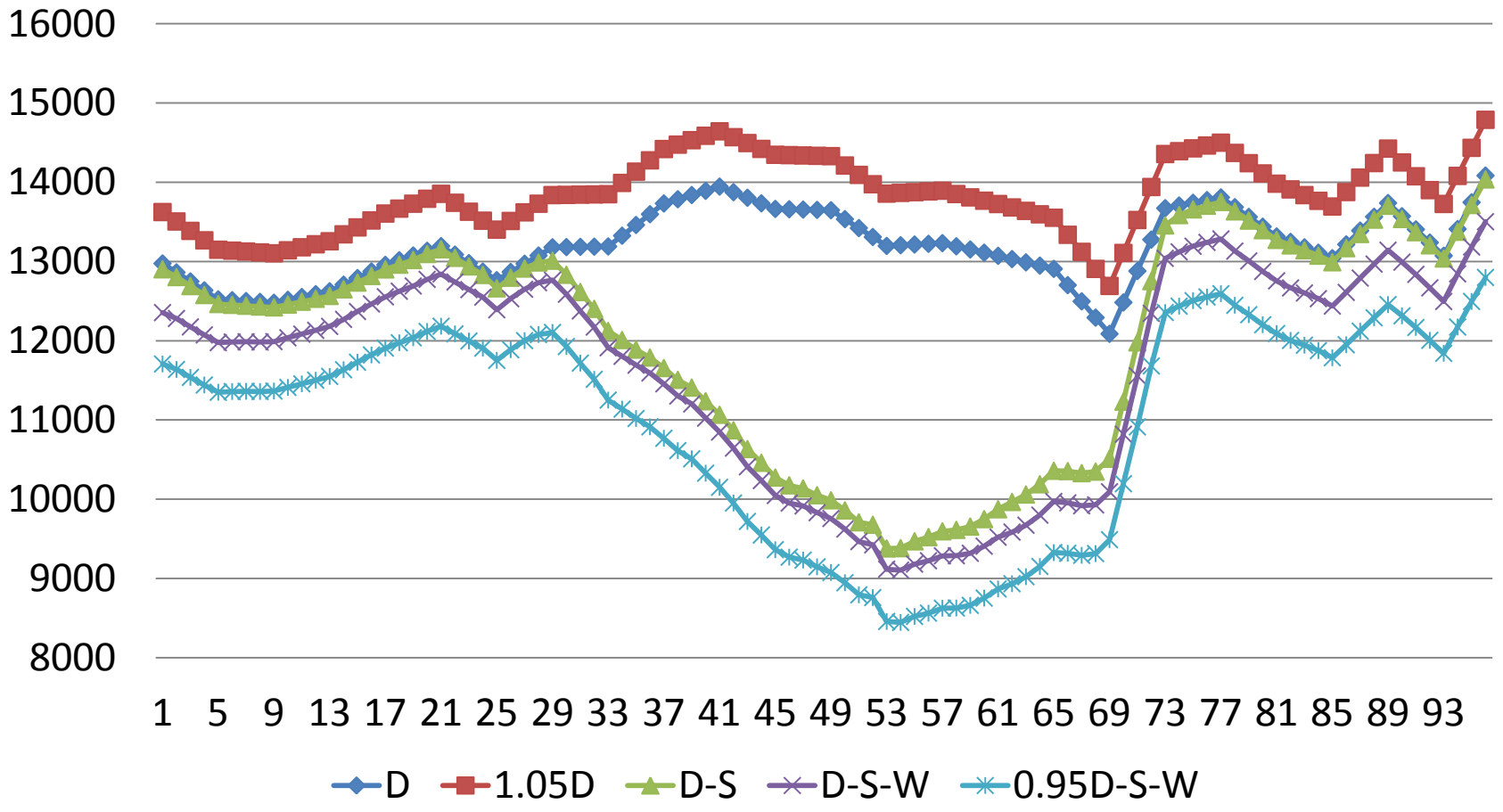
Southern Region Peak 2021-22



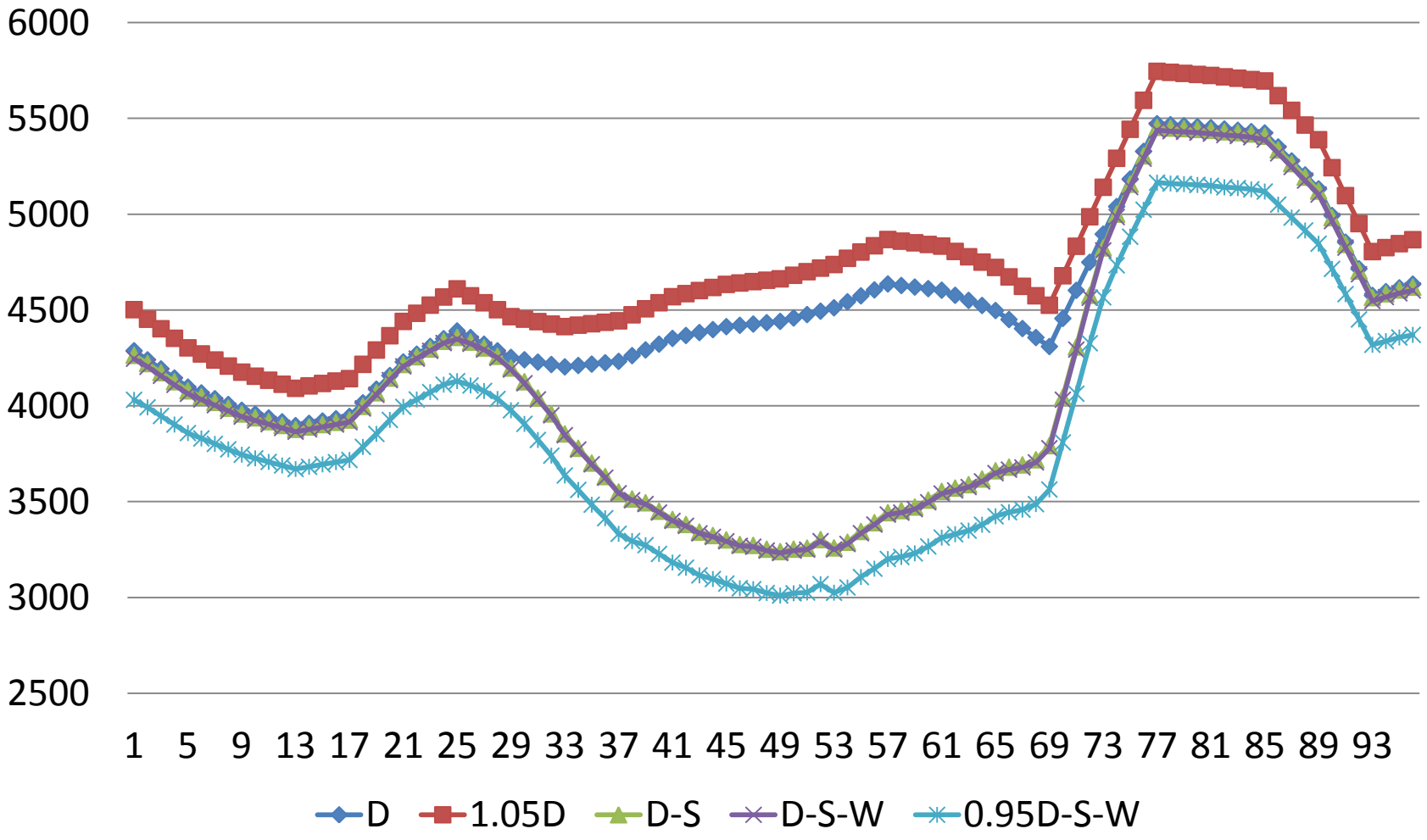
Andhra Pradesh Peak 2021-22



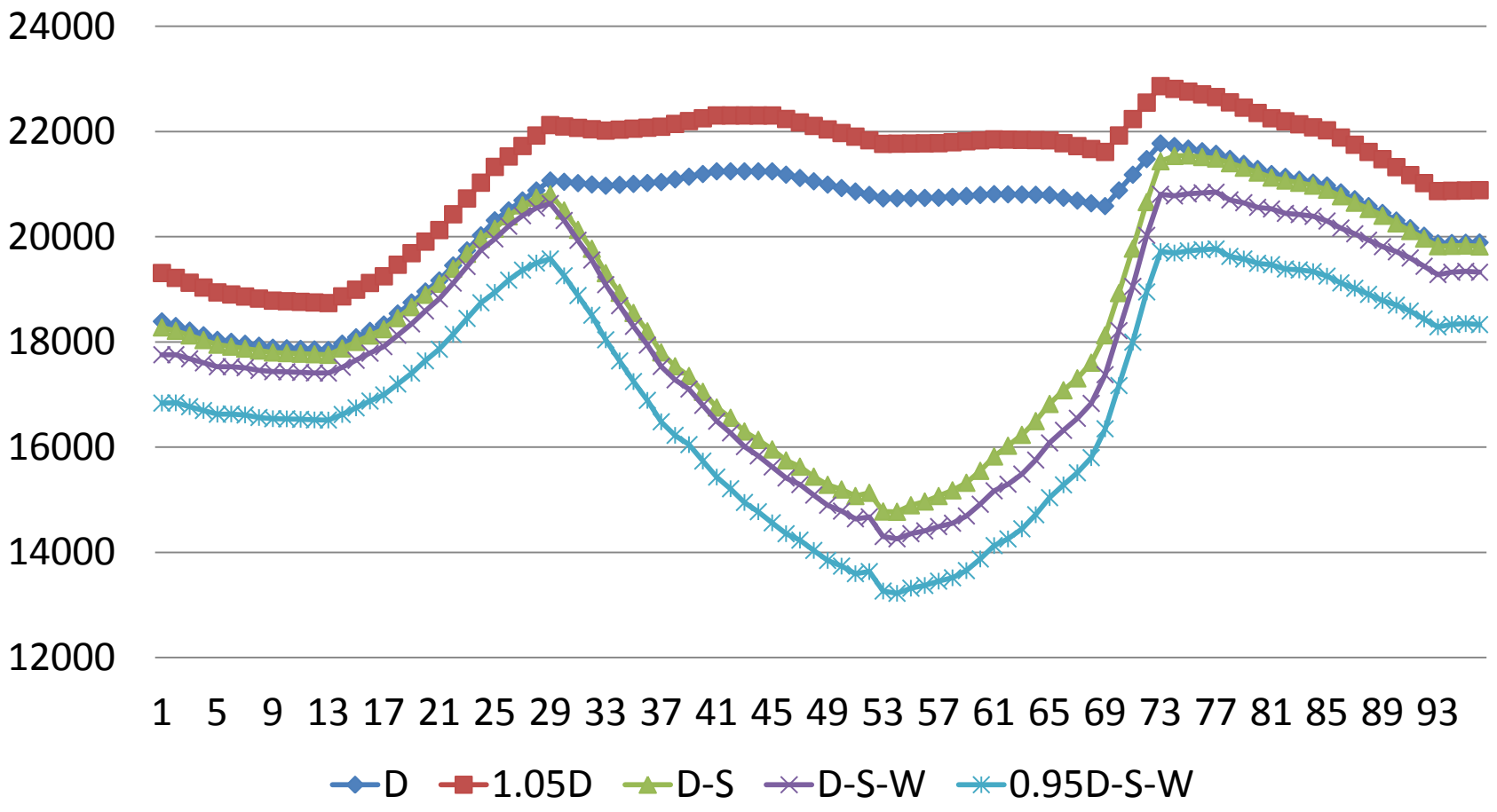
Karnataka Peak 2021-22



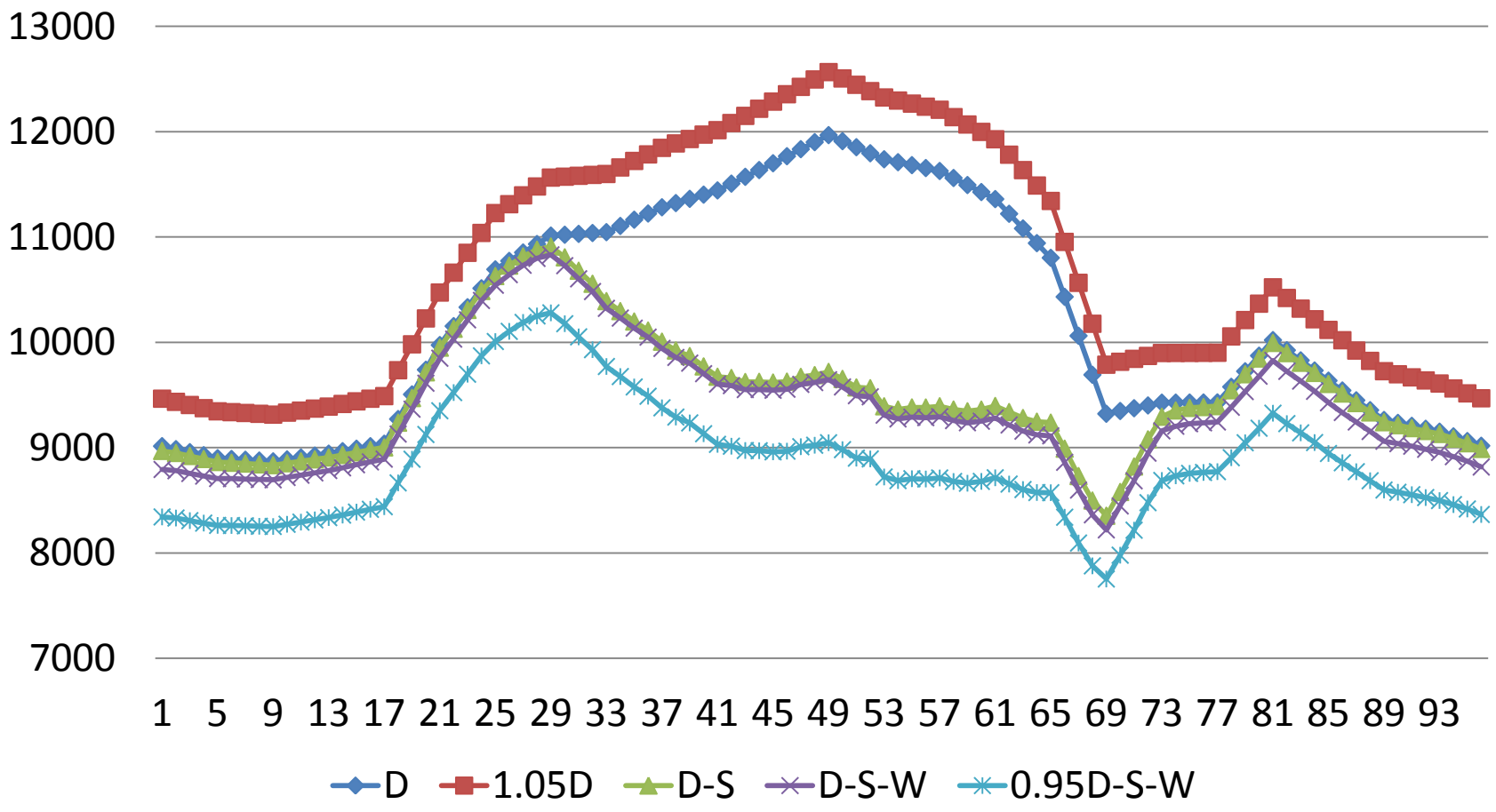
Kerala Peak 2021-22



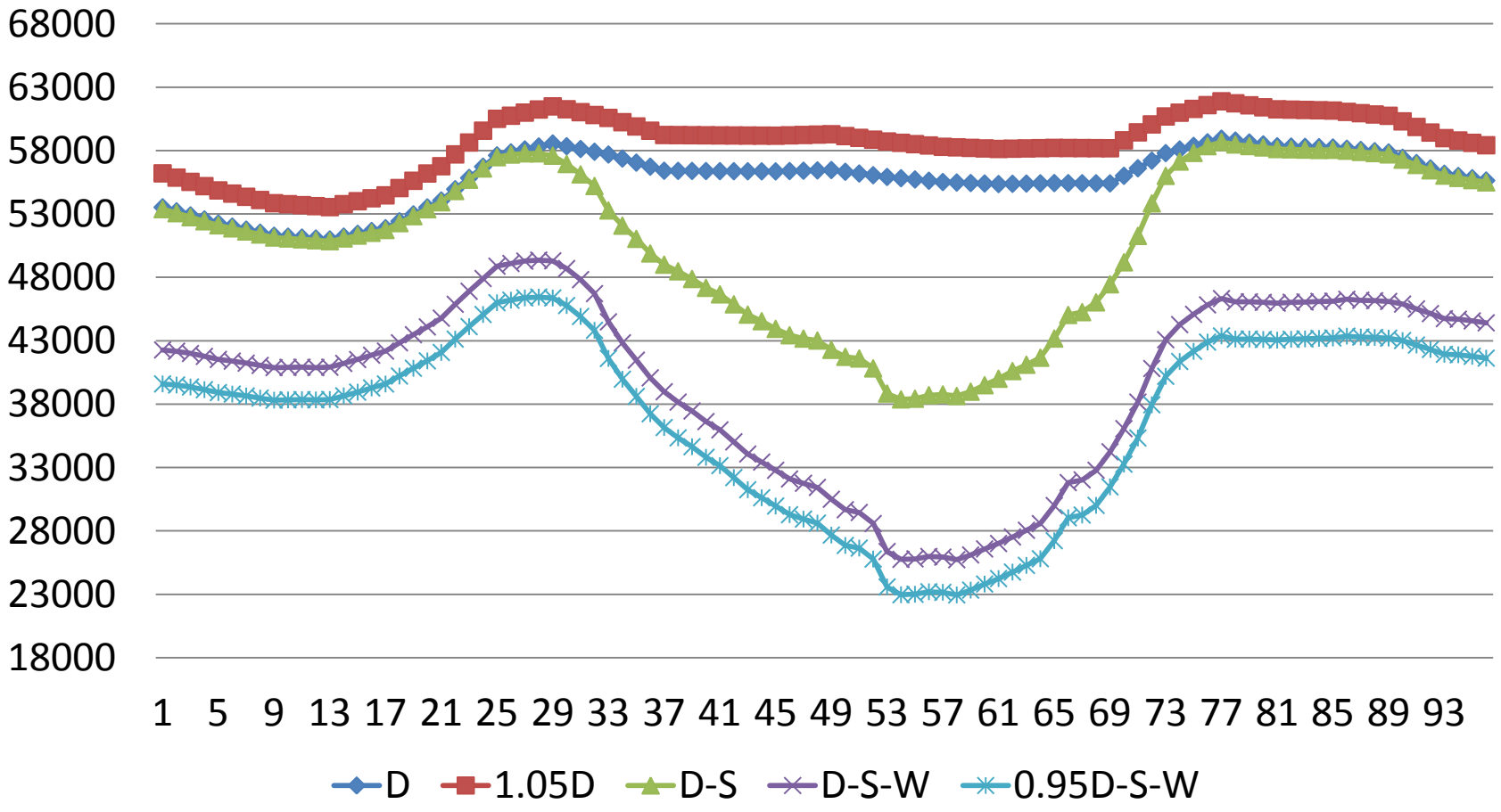
Tamil Nadu Peak 2021-22



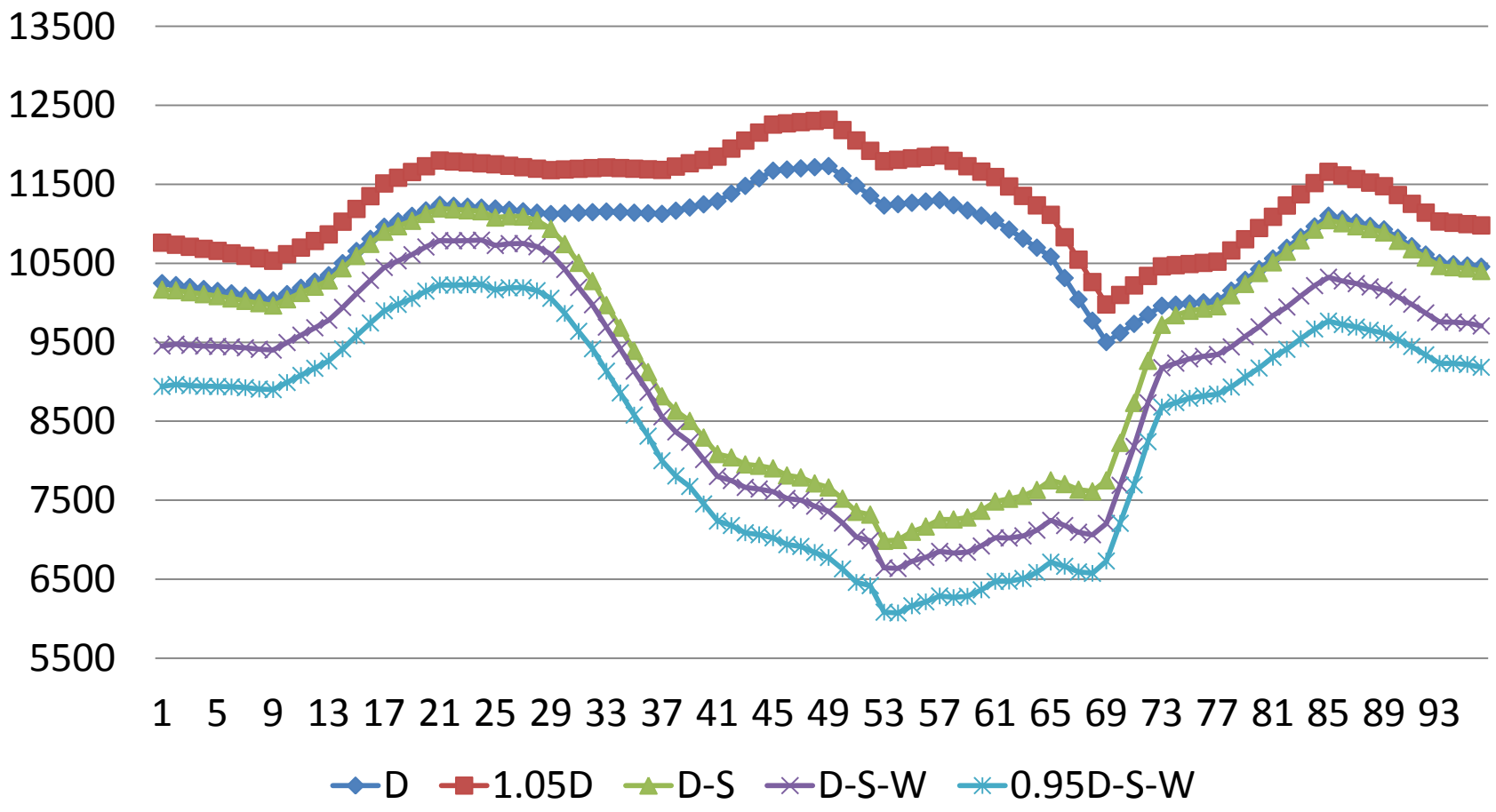
Telangana Peak 2021-22



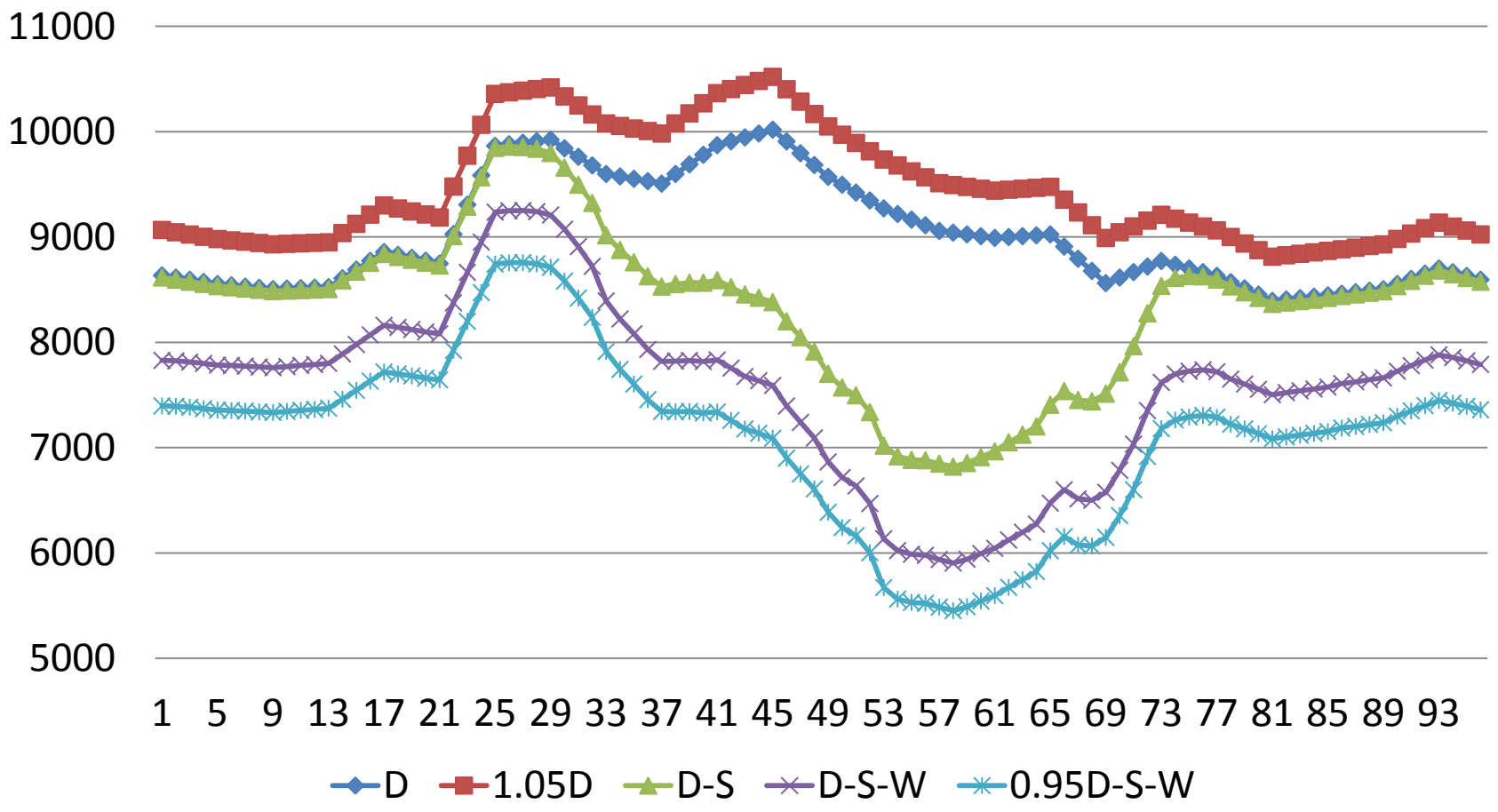
Southern Region Aug 2021-22



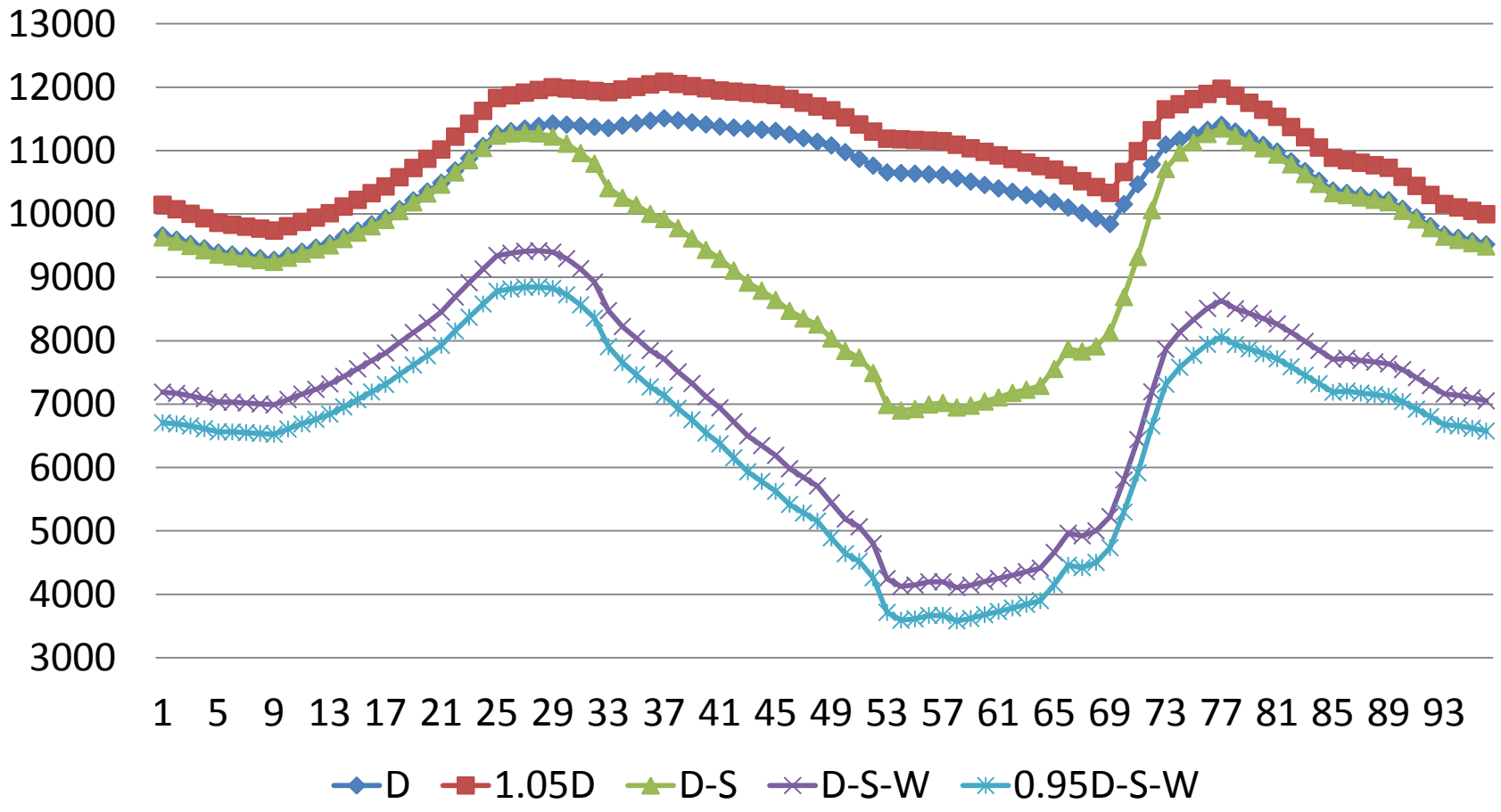
Andhra Pradesh Aug 2021-22



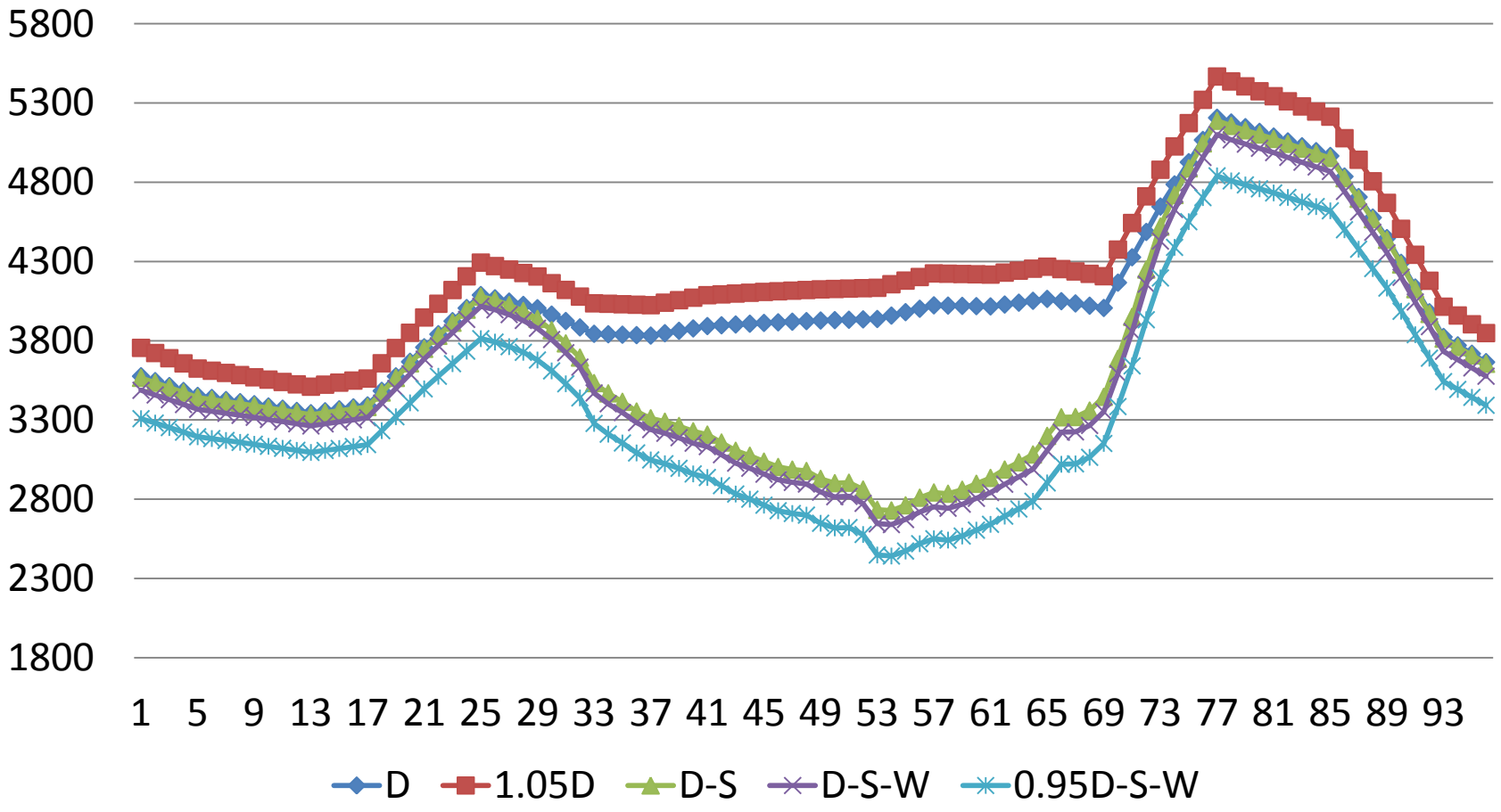
Telangana Aug 2021-22



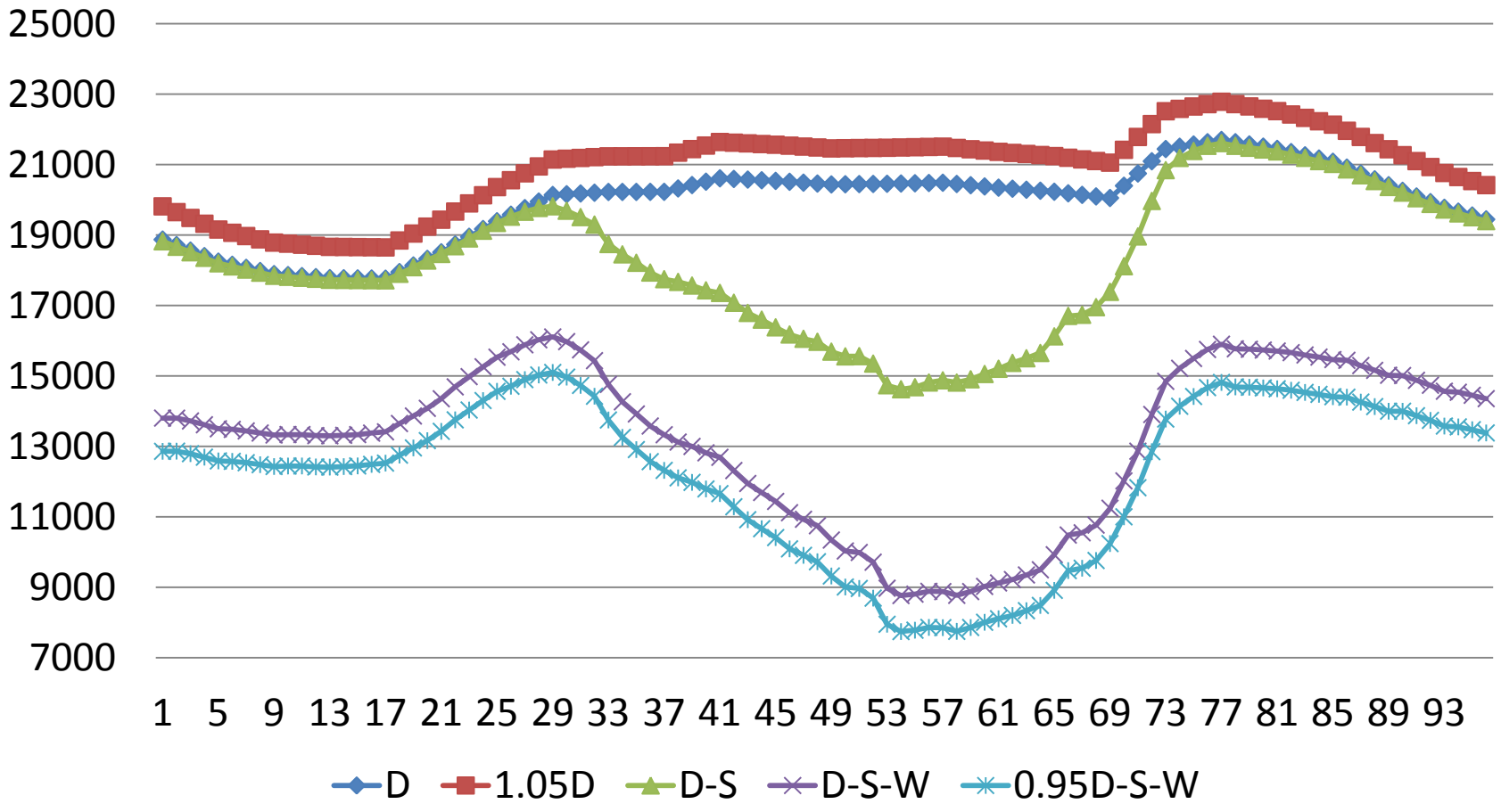
Karnataka Aug 2021-22



Kerala Aug 2021-22



Tamil Nadu Aug 2021-22



Ramp/Total Flexibility Requirement for peak 2021-22

	Ramp Up requirement			Ramp Down requirement			Max-Min
	15 min	1 hour	6 hour	15 min	1 hour	6 hour	
Peak 2021-22							
AP	547	1510	3303	-337	-859	-3974	4157
TS	261	725	2018	-245	-694	-1558	2611
KAR	768	2192	4137	-301	-677	-3647	4397
KER	263	763	2140	-132	-396	-1119	2206
TN	955	2603	6504	-467	-1261	-6314	6589
SR	1977	5413	16626	-1455	-3845	-17395	17656

Ramp/Total Flexibility Requirement for August 2021-22

	Ramp Up requirement			Ramp Down requirement			Max-Min
	15 min	1 hour	6 hour	15 min	1 hour	6 hour	
Peak 2021-22							
AP	538	1389	4406	-522	-1177	-5085	5548
TS	315	829	1661	-331	-677	-3041	3347
KAR	739	2016	4348	-547	-928	-5132	5310
KER	291	812	2392	-161	-444	-1230	2461
TN	1025	2775	6946	-742	-1514	-7224	7341
SR	2618	6927	20163	-2217	-5208	-22811	23630

(%Ramp & Total Flexibility /Max. Availability)for Peak 2021-22

	Ramp Up requirement			Ramp Down requirement			Max-Min
	15 min	1 hour	6 hour	15 min	1 hour	6 hour	
Peak 2021-22							
AP	5	14	31	-5	-11	-47	39
TS	2	7	19	-2	-6	-14	24
KAR	6	16	31	-2	-5	-27	33
KER	5	14	39	-2	-7	-21	41
TN	5	12	31	-2	-6	-30	32
SR	3	9	28	-2	-7	-30	30

(%Ramp & Total Flexibility /Max. Availability)for August 2021-22

	Ramp Up requirement			Ramp Down requirement			Max-Min
	15 min	1 hour	6 hour	15 min	1 hour	6 hour	
Peak 2021-22							
AP	7	18	57	-7	-15	-62	68
TS	3	9	18	-4	-7	-33	36
KAR	8	21	46	-6	-10	-54	56
KER	6	16	47	-3	-9	-24	48
TN	6	17	43	-5	-9	-45	46
SR	5	14	41	-4	-11	-46	48

Plan the Availability

Plan Max Availability & Ramp up requirements

- Costliest generators need to be partially loaded (upto technical minimum)
- Ramp up rates of each generator would determine the number of units required on bar to achieve the demand ramp rate
- Sudden and short duration ramp could be sourced by balancing energy sources (despatching gas/hydro units) /energy storage devices /purchase from market /pumps (in generation mode)
- Solar ramping down and load pick up

Plan the Availability

Plan Min Availability & Ramp down requirements

- Margins to kept in cheaper generators (Max - technical minimum)
- Ramp down rates of each generator would determine the number of units required on bar to achieve the demand ramp rate
- Sudden and short duration ramp down could be by not taking power from market for few blocks / Demand response (if possible) /Pump operation
- Solar ramping up /load fall

Additional Margins which may be required as per DSM

Range	Additional Reserve required	Backing down Reserve required
	AP	
100 %	1080	1116
95.45% variations (2sigma)	316	331
90 %	252	249
	TS	
100 %	659	1930
95.45% variations (2sigma)	254	281
90 %	203	217
	KAR	
100 %	916	1618
95.45% variations (2sigma)	376	498
90 %	315	350

Additional Margins which may be required as per DSM

Range of deviations	Additional Reserve required	Backing down Reserve required
KER		
100 %	474	319
95.45% variations (2sigma)	174	72
90 %	154	55
TN		
100 %	1090	1484
95.45% variations (2sigma)	405	619
90 %	314	502

Availability with Spinning Reserve

Availability with Spinning Reserve

- It would be under despatch of SLDC
- Quantum equal to largest unit size in the Control Area
- Margin could be kept in units with higher variable cost
- Would be used by SLDC during contingency, sudden fall in RE, sudden rise in demand, unit tripping, high OD etc
- Utilisation of balancing resources/energy storage devices
- Ancillary Market
- Spinning Reserves also to be restored by normal scheduling

Fall in Demand

Fall in Demand beyond margins available

- Sale through contingency market
- Trading mechanism among Regional states
- Mechanism to use pumps located in other states
- Go for RSD
- Market for Demand response/generation backing down

AP– Undispatched/Partial dispatched generators

Name	IC in MW	fuel	Dispatch	Reasons for Low Dispatch
Private Sector				
Jegrupadu I	216.82	Gas	Being dispatched as per requirement	
Jegrupadu II	220	Gas		No Gas
Spectrum	208.31	Gas	APERC – No dispatch	
Lanco Kondapalli	351.49		APERC – No dispatch	
Reliance BSES	220	Gas		No gas
GMR Vemagiri	370	Gas		
Gowthami	464	Gas		No Gas
Konaseema	444.08	Gas		No Gas

AP– Undispatched/Partial dispatched generators

- No Gas availability
- Few stations had run under PSDF scheme
- Evacuation Issues
- AP & TS both having PPA

Tamil Nadu – Undispatched/partial dispatched generators

Name	IC in MW	fuel	Dispatch	Reasons for Low Dispatch
State Sector				
Basin Bridge	120	Naptha	Peaking station – Rarely used	Cost is very high Naptha and open cycle
Kovil Kalappal	107.88	Gas	200 MW out of 400 MW	Gas being supplied around 40%
Valathur Stage -I	94	Gas		
Valathur Stage -II	92.2	Gas		
Kuttalam	101	Gas		

Tamil Nadu – Undispatched/Partial dispatched generators

Name	IC in MW	fuel	Dispatch	Reasons for Low Dispatch
Private Sector				
GMR Vasavi	196		PPA expired	
Samalpatty	105.66		PPA expired	Dismantled
Madurai PCL	105.66	LSHS	PPA expired	Costly
PP Nallur	330.5	Naptha		FSA under dispute, costly
Lanco ABAN	113.21	Gas		Gas being supplied around 50%
Pioneer	52.8	Gas		

Kerala/ISTS – Undispatched/Partial dispatched generators

Name	IC in MW	fuel	Dispatch	Reasons for Low Dispatch
Kerala State Sector				
Kayamkulam - NTPC	359.58	Naptha		Low on merit order
BSES	157		PPA expired	
Private Sector				
Lanco	1108	Gas		No Gas
Other generators in AP ready for commissioning	7000-8000 (reported)			No Gas

Reserves

Need for Market Based Reserves

Availability of Fuel

Mechanism to deploy these reserves – payment security mechanism – CERC/SERC

THANK YOU

Battery Energy Storage System in Puducherry

Power Grid Corporation of India Limited

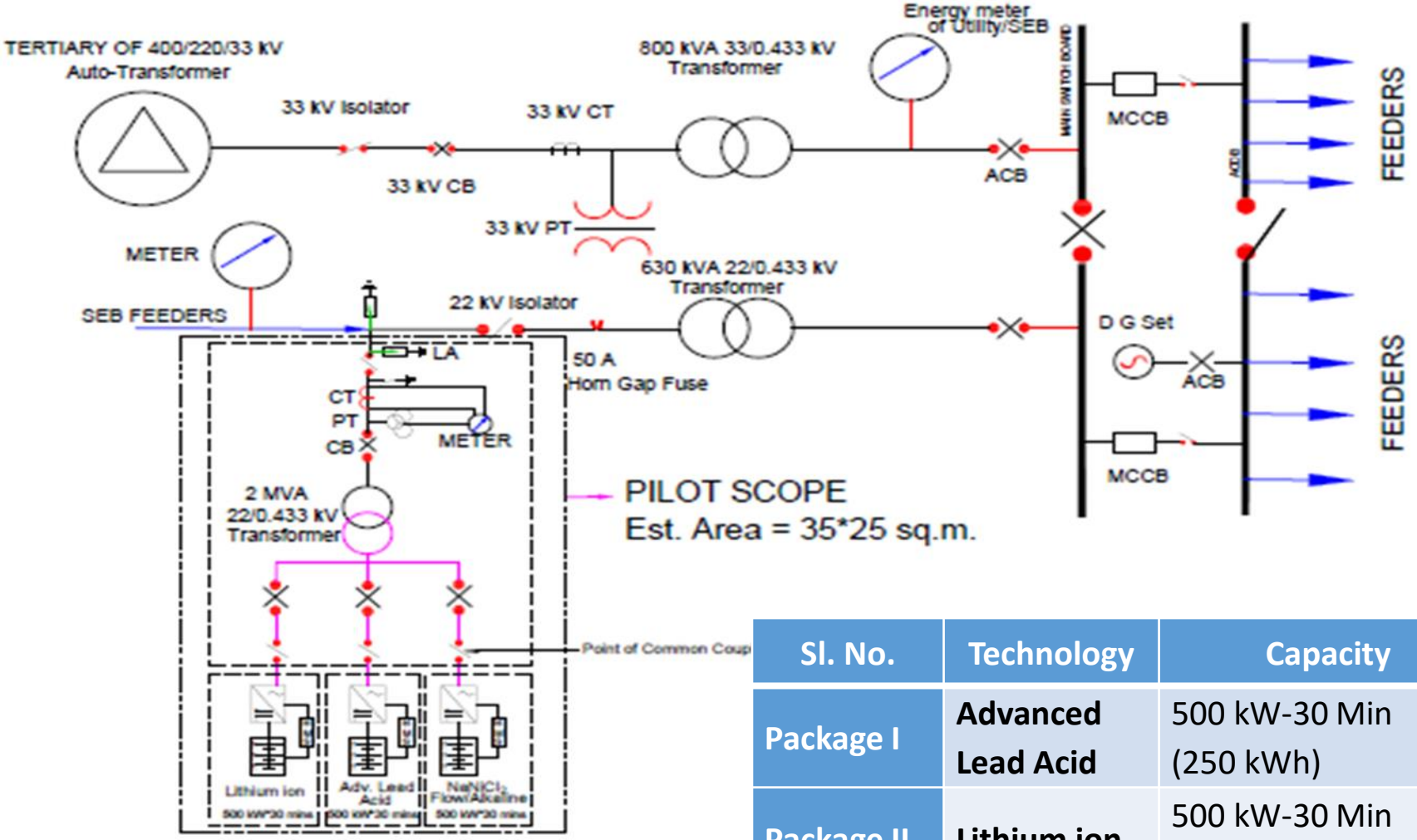
Drivers for Pilot Project on Energy Storage

- Balancing support needed for high Degree of Renewable Penetration (175 GW) by 2022
- Very less existing capacity of Grid scale energy storage in the form of Pumped Hydro storage
- High gestation period for Pumped hydro storage
- No experience of grid scale energy storage apart from Pumped Hydro

Why Battery Energy Storage Pilot ?

- Quicker installation period
- Higher ramp rate
- Lower response time
- Modularity in size
- Flexibility in transportation
- Options of many Chemistries

Size of the Pilot Project

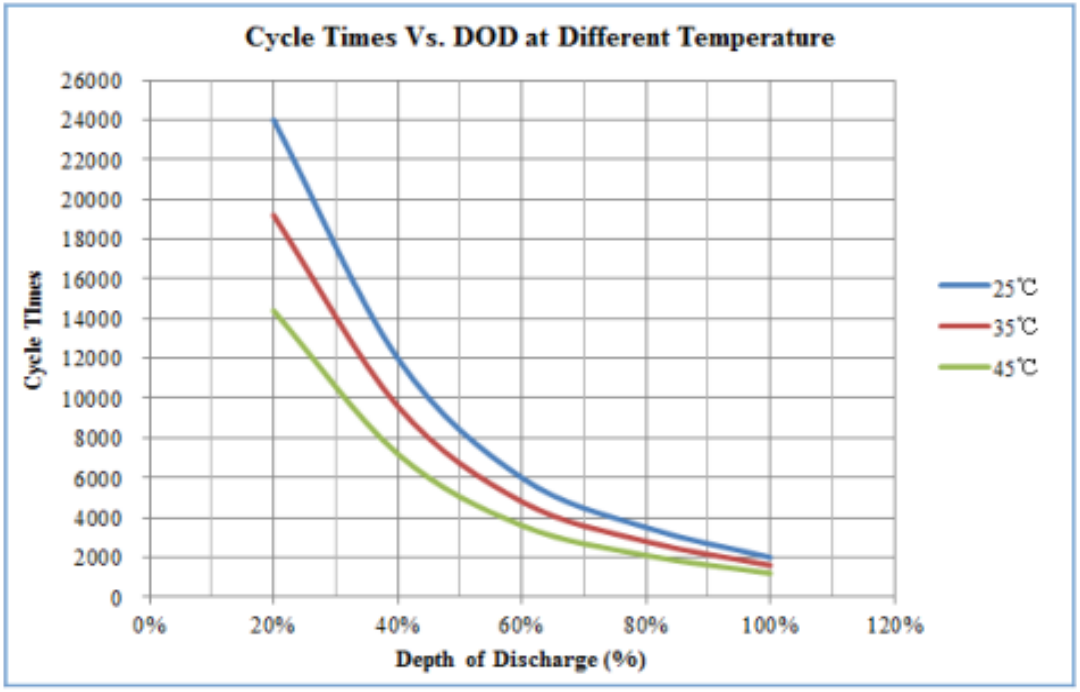


Sl. No.	Technology	Capacity
Package I	**Advanced Lead Acid**	500 kW-30 Min (250 kWh)
Package II	**Lithium ion**	500 kW-30 Min (250 kWh)
Package III	**Flow**	250 kW-4 hours (1000 kWh)

Technical Specifications

Parameters	Li-ion Battery	Advanced lead Acid Battery	Flow Battery
Charging rate	3 hrs. from rated DoD to Full Capacity	3 hrs. from rated DoD to full capacity	5 hrs. from rated DoD to full capacity
DC-DC Round-trip efficiency	>90%	>80%	>75%
Service Life	10 years	10 years	10 years
Life-cycle	4000 cycles (900 MWh)	3000 cycles (675 MWh)	3000 cycles (2700 MWh)

Lithium Ion Cycle Life

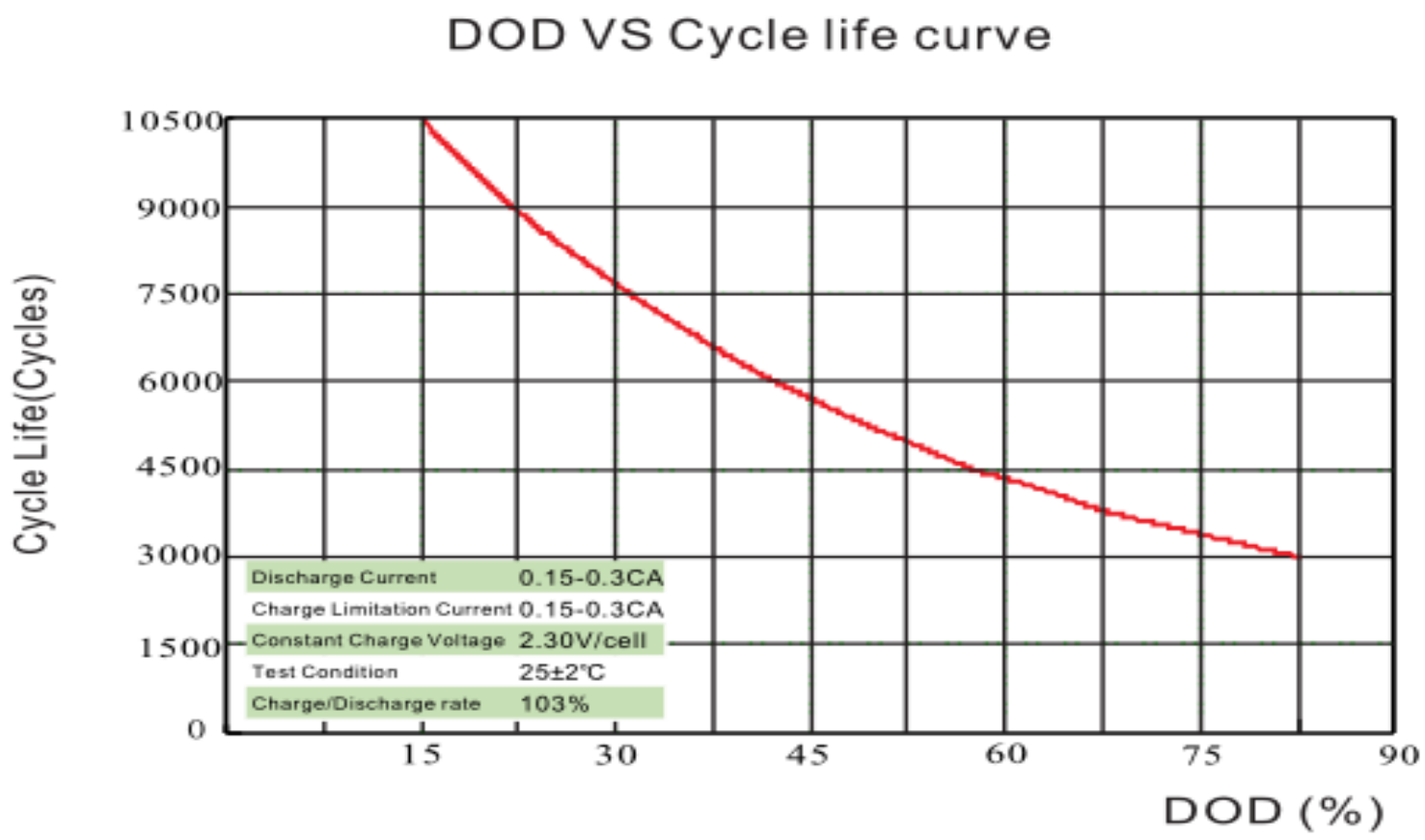


Graph 1 - Cycle life vs. DOD of NLC Series with Ideal Charge Mode

Table 1 Data of Cycle Number

Temp. (℃)	Depth of Discharge (%)				
	100%	80%	60%	40%	20%
25	2000	3500	6000	12000	24000
35	1600	2800	4800	9600	19200
45	1200	2100	3600	7200	14400

Advanced Lead Acid Cycle Life



Note: Application on single cell.

System Configuration: Adv. Lead Acid

Internal Chemistry: Cathode-PbO_2, Anode-(Lead+Carbon),Electrolyte-H_2SO_4

Details of Each Cell: 2V, 600 Ah

Configuration: Two strings are connected in parallel, each string comprises of 300 cells connected in series (total 600 cells)

PCS Efficiency: 96%

Total Capacity of Battery: 691.2 kWh (useful Capacity at 2C was found 384 kWh)

Rated DoD: 65.1%

System Configuration: Lithium Ion

Internal Chemistry: Cathode- Lithium Iron Phosphate, Anode- Carbon & Electrolyte - Lithium Hexafluorophate and solution of carbonates

Details of Each Cell: 3.2 V, 80 Ah.

Configuration: Battery Module -2 cells in parallel, 6 such units in series (19.2 V, 150Ah). One String-36 modules in series. (432 cells, 691.2 V & 150 Ah), 4 such strings in Parallel (1728 cells, 691.2 V, 600 Ah)

PCS Efficiency: 96%

Total Capacity of Battery: 398 kWh(useful capacity at 2C 357 kWh)

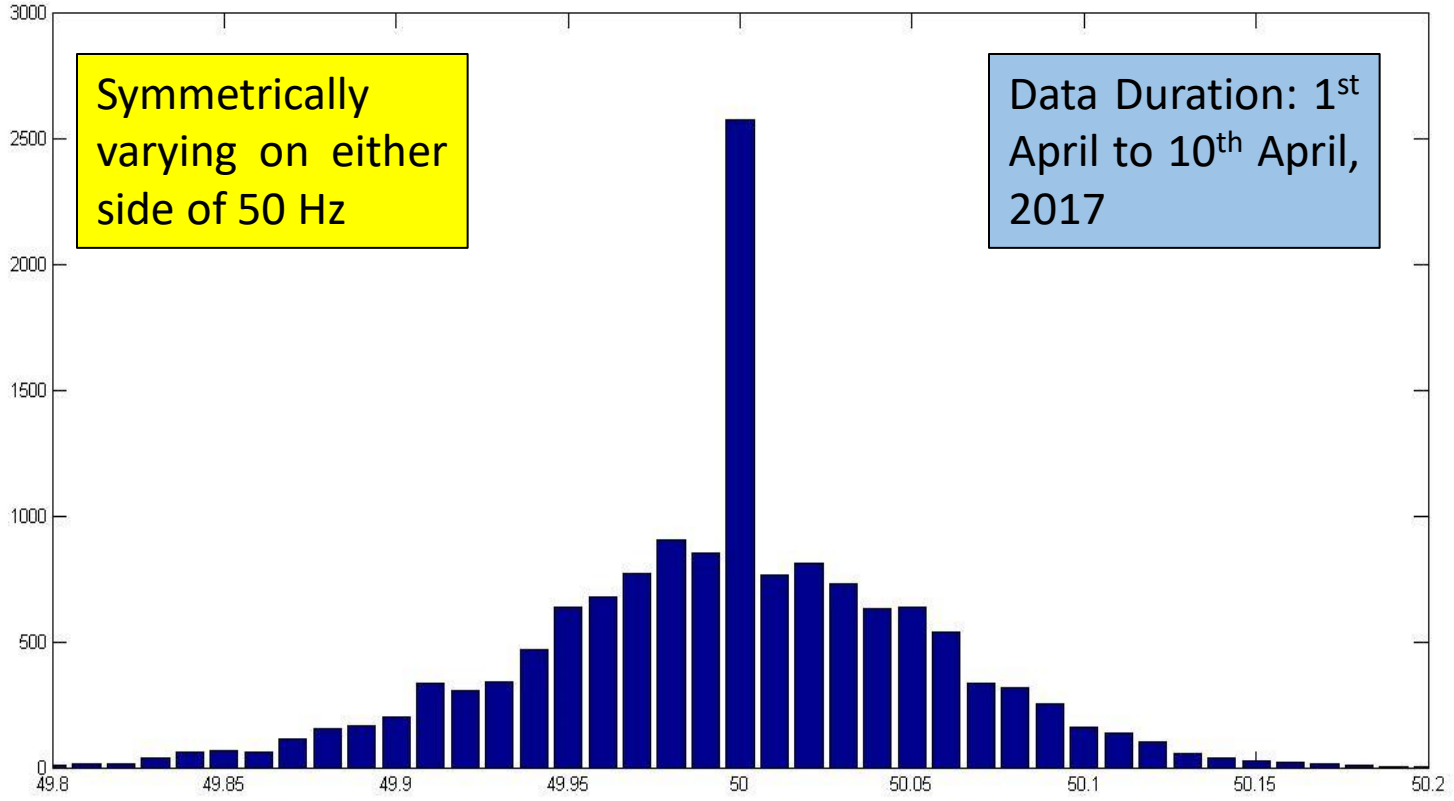
Rated DoD: 70%

Learnings

- Preparation of Technical Specification
- Life cycle of the battery
- Global standards for safety, testing etc.

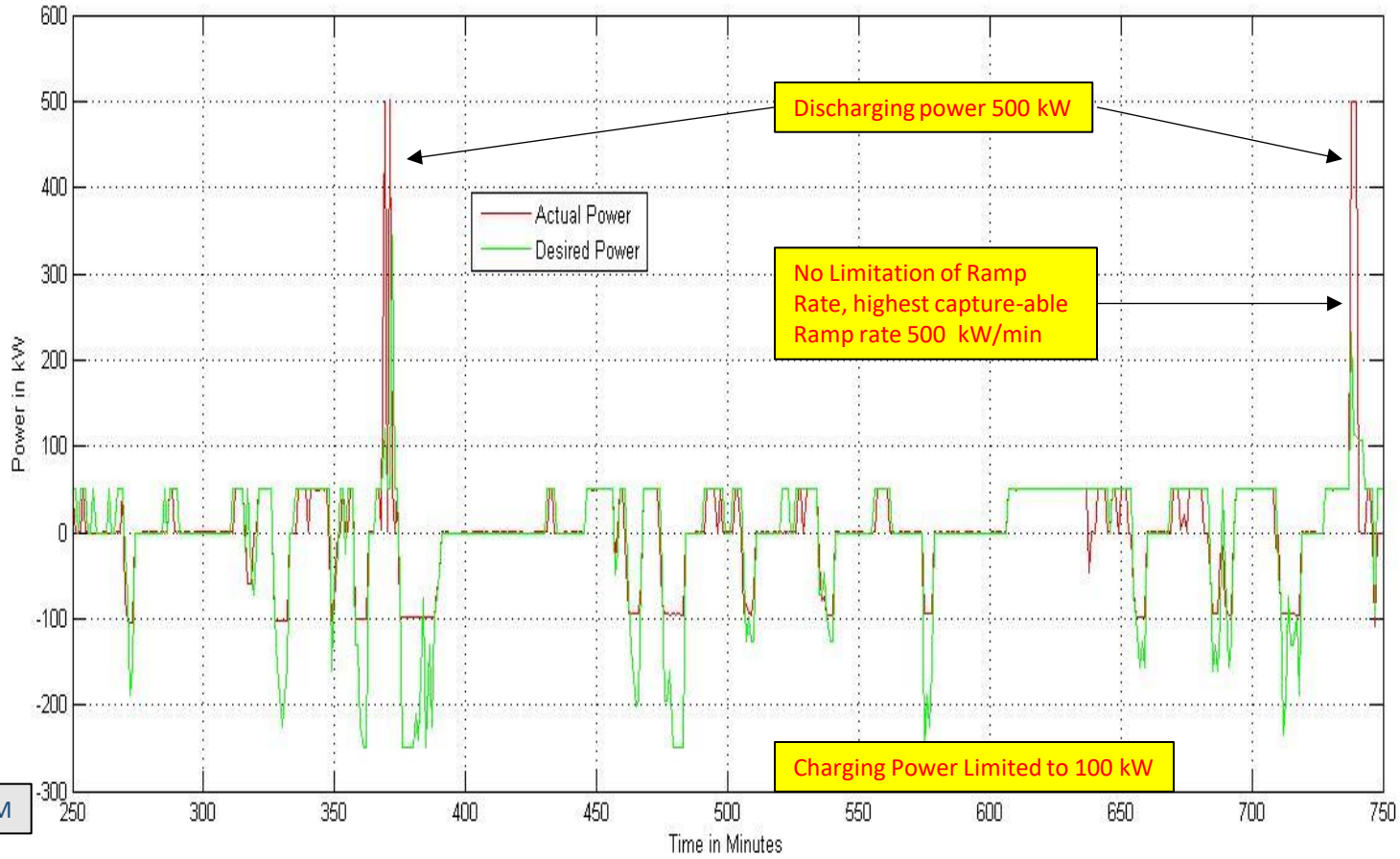
Parameter	Advanced Lead Acid	Lithium Ion
Delivered Size	250 kWh, 500 kW	250 kWh, 500 kW
Design Sizing	691.2 kWh	398 kWh
Nos. of Cells	600 nos.	1728 nos.
Rated DoD	65%	70%
Battery Footprint	One 40 ft. and one 20 ft. Container **Area Foot print: 45 sq. m.**	One 40 ft. Container **Area foot-print: 30 sq. m.**
Cost	-	1.5 times than Advanced Lead Acid

Histogram of Frequency of Indian Grid



Total Data Points	Number of 50 Hz points
14400	2572 (17.8%)

Power Desired and Power Actual: Analysis on Data of 1st April, 2017

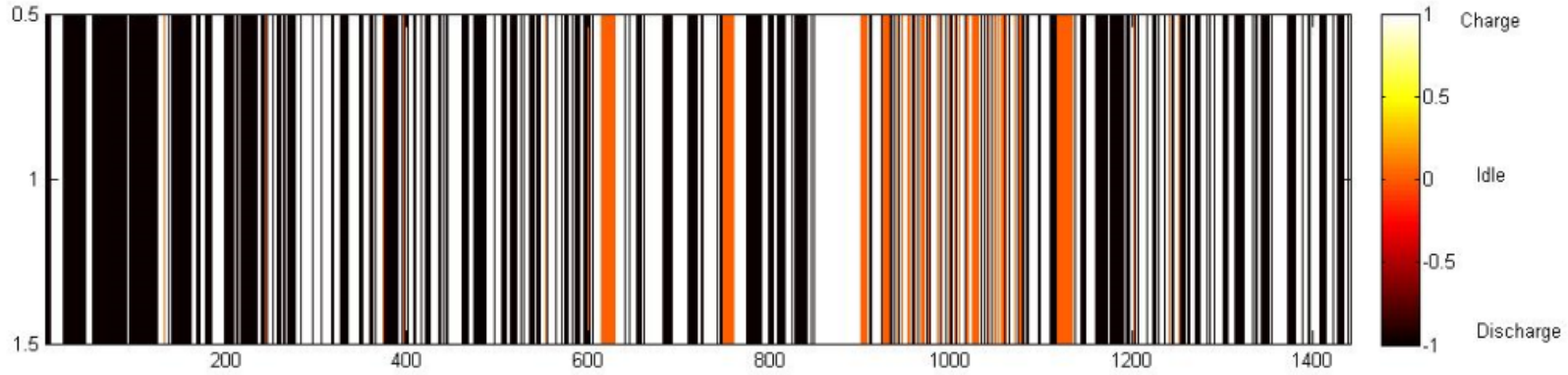


4.10 AM

12.30 PM

Charging and Discharging Characteristics should be symmetrical as the frequency histogram is symmetrical

Charge, Discharge and Idle Time of Battery: 1st April 2017



Discharging of Battery during night

Charging and idling during afternoon

Discharging of Battery during evening

Charging Time	Discharging Time	Idle Time
45.63%, 11 hrs	46.04%, 11 hrs	8.33%, 2 hrs

Frequency Regulation Operation

Frequency Regulation Operation


पावर ग्रिड कारपोरेशन ऑफ़ इंडिया लिमिटेड
पुदुच्चेरी
Power Grid Corporation Of India Ltd
Puducherry
प्रायोगिक परियोजना
Pilot Project
बैटरी ऊर्जा भंडारण प्रणाली
Battery Energy Storage System


Narada
Exicom
litlium-ion battery Energy Storage System
पावरग्रिड


Narada
Exicom
Advanced Lead Acid Battery Energy Storage System


Narada
Exicom
Storage Capacity: 250kWh
Rated Power: 500KW


Narada
Narada
Narada


पावरग्रिड

OrxaGrid

a SCOPE venture

SCOPE
Parent Company

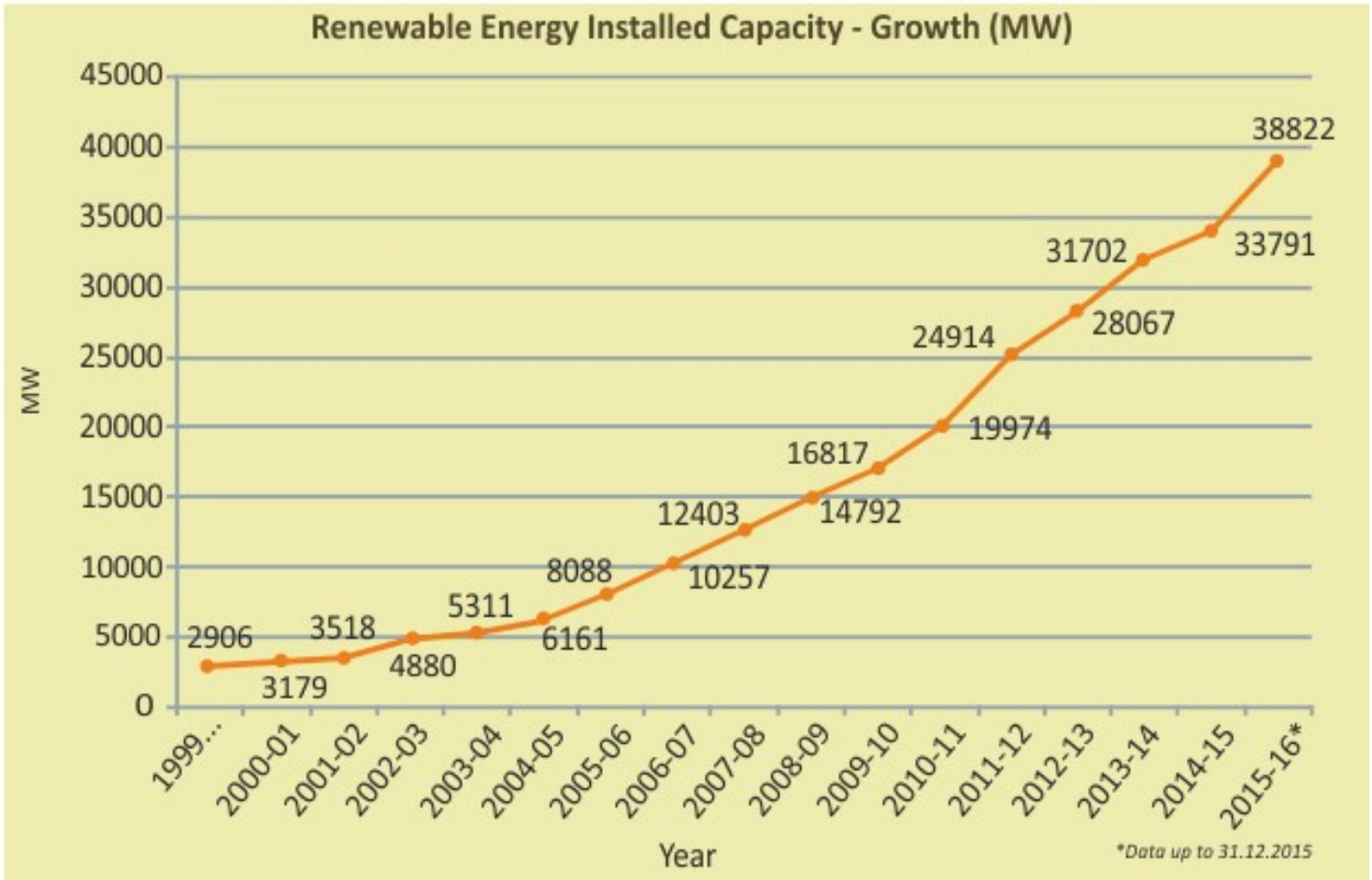
OrxaGrid

- Established in 1988
- Manufacturer of Test and Measurement Instruments for EHV Substation Equipment (CB, Transformers, LA, Isolators, etc)
- Dedicated 100+ Engineers for Testing & Commissioning Services
- Solution Provider in Protection and Automation (CRP & SAS, CSD, RTU & SCADA) Projects
- Group Manpower of 300+
- ISO 9001:2008
  (Certified by TUV Germany)

Growth Of Renewable Energy in India

and a Target of 175GW by 2022!!

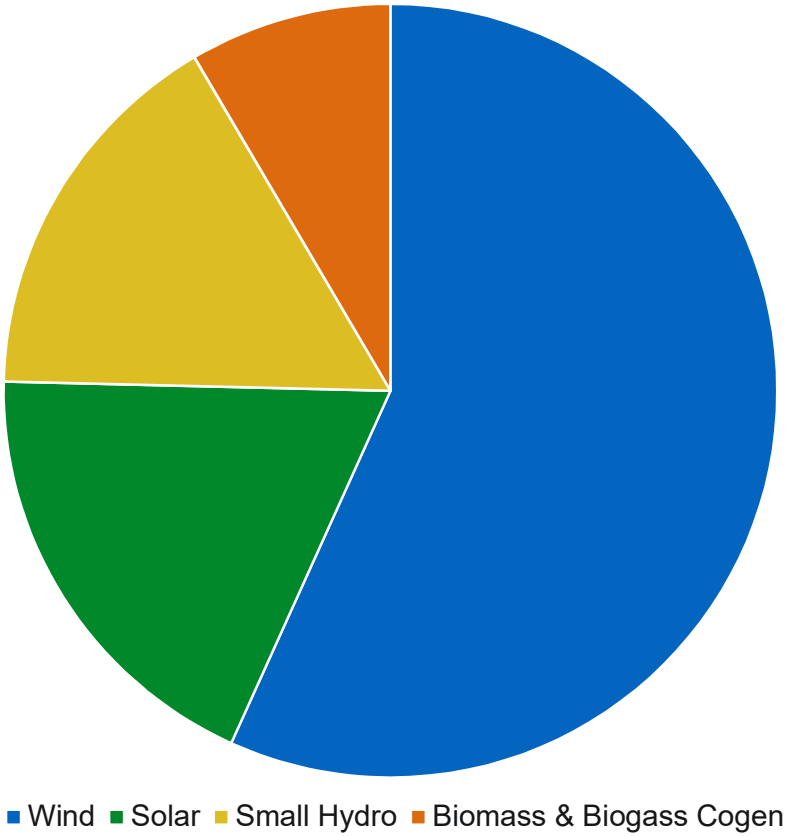
OrxaGrid



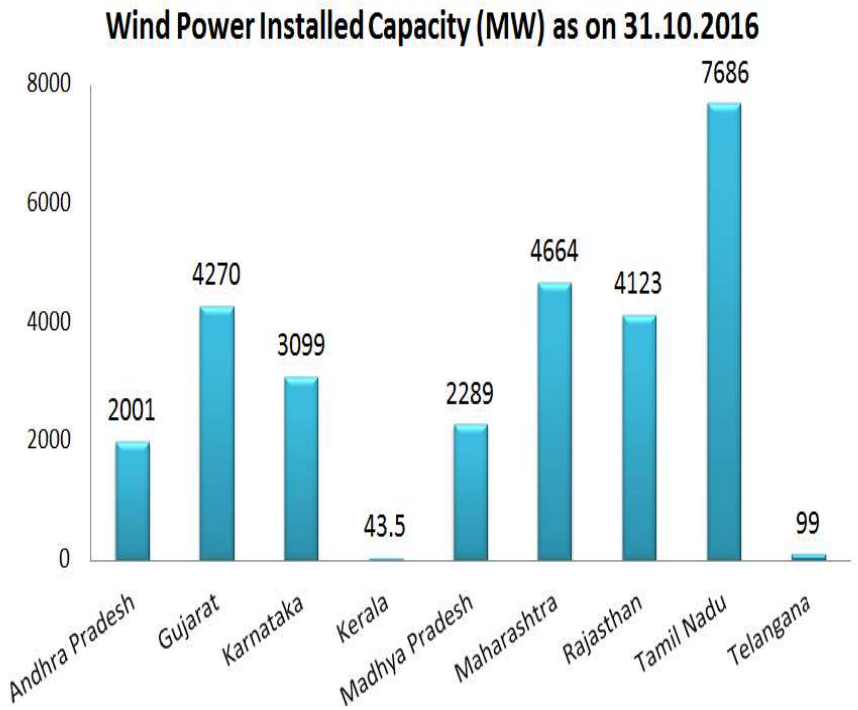
RE Current Scenario

OrxaGrid

Installed RE as on 31.3.2017

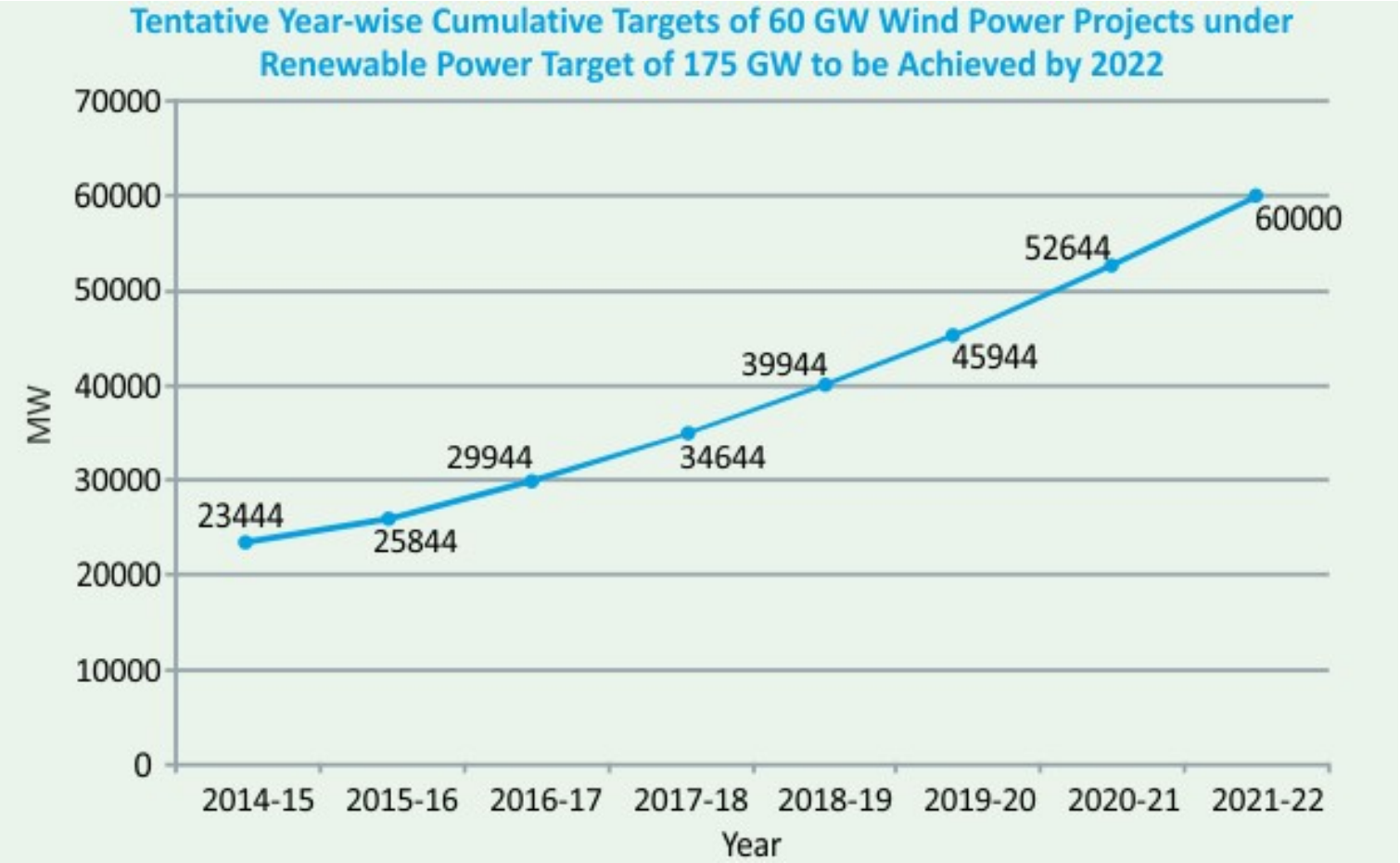


Major Windy States



Year 2022: 60 GW Wind Power

OrxaGrid



Year 2022: 100 GW Solar Power

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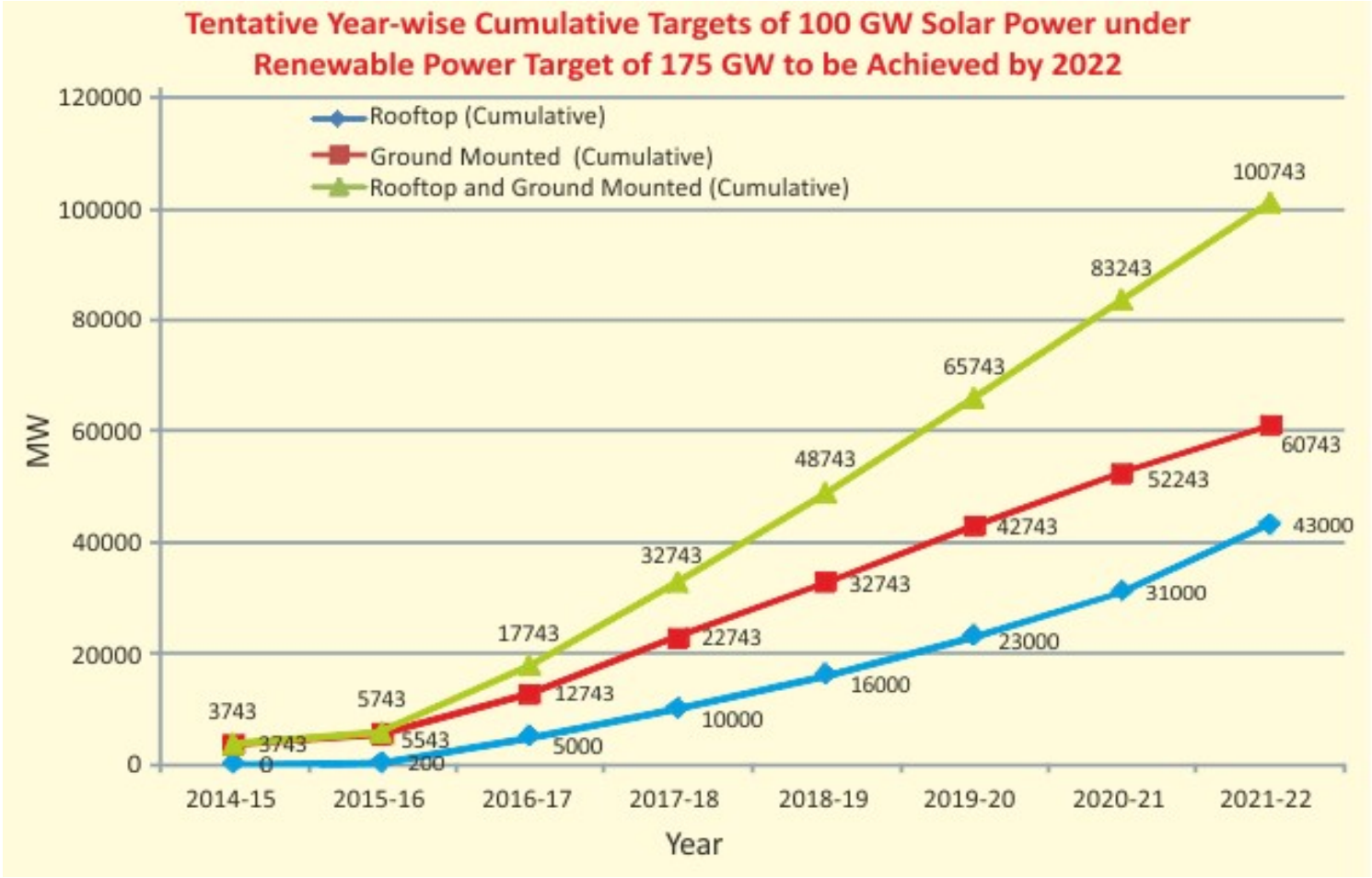


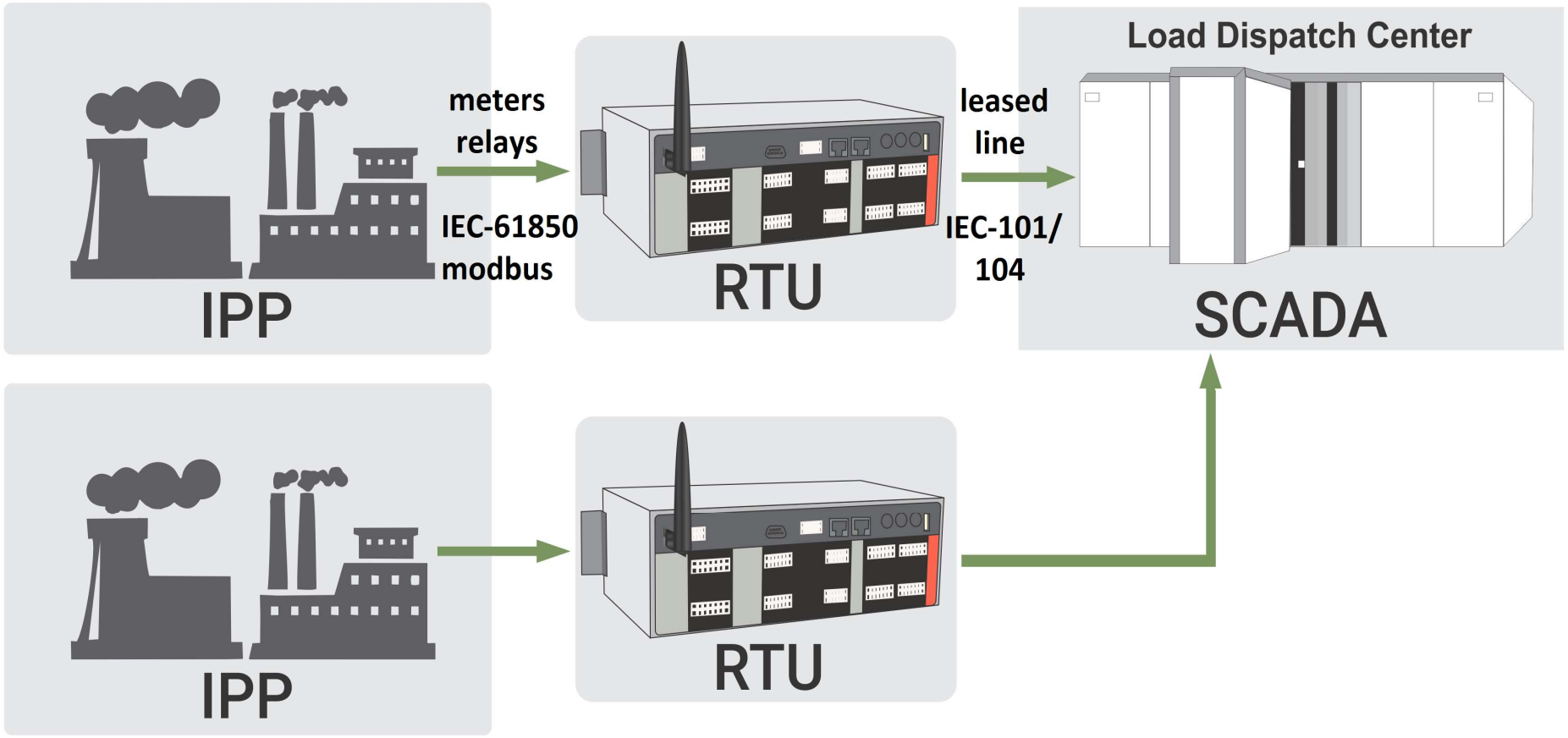
Challenges of Renewable Energy

OrxaGrid

1. **Variability** & **Uncertainty** not only of Renewables Integration but also of the Demand Load
   - "Uncertainty" refers to the lack of accurate knowledge about future RE generation
   - "Variability" is the known natural variation in RE generation
2. Lack of Primary & Secondary response in the Grid to support during sudden loss of Generation
3. Changing load curve
4. Increasing peak to off-peak ratio
5. Sharp changes and Steep Ramps in the load curve
6. Reactive Power Management
7. Frequency Control
8. Congestions in transmission networks (New patterns of Power Flow)

Current : Integration of IPP Data @SLDCs

OrxaGrid



Current: Integration of IPP Data @SLDCs

Major Cost Centres

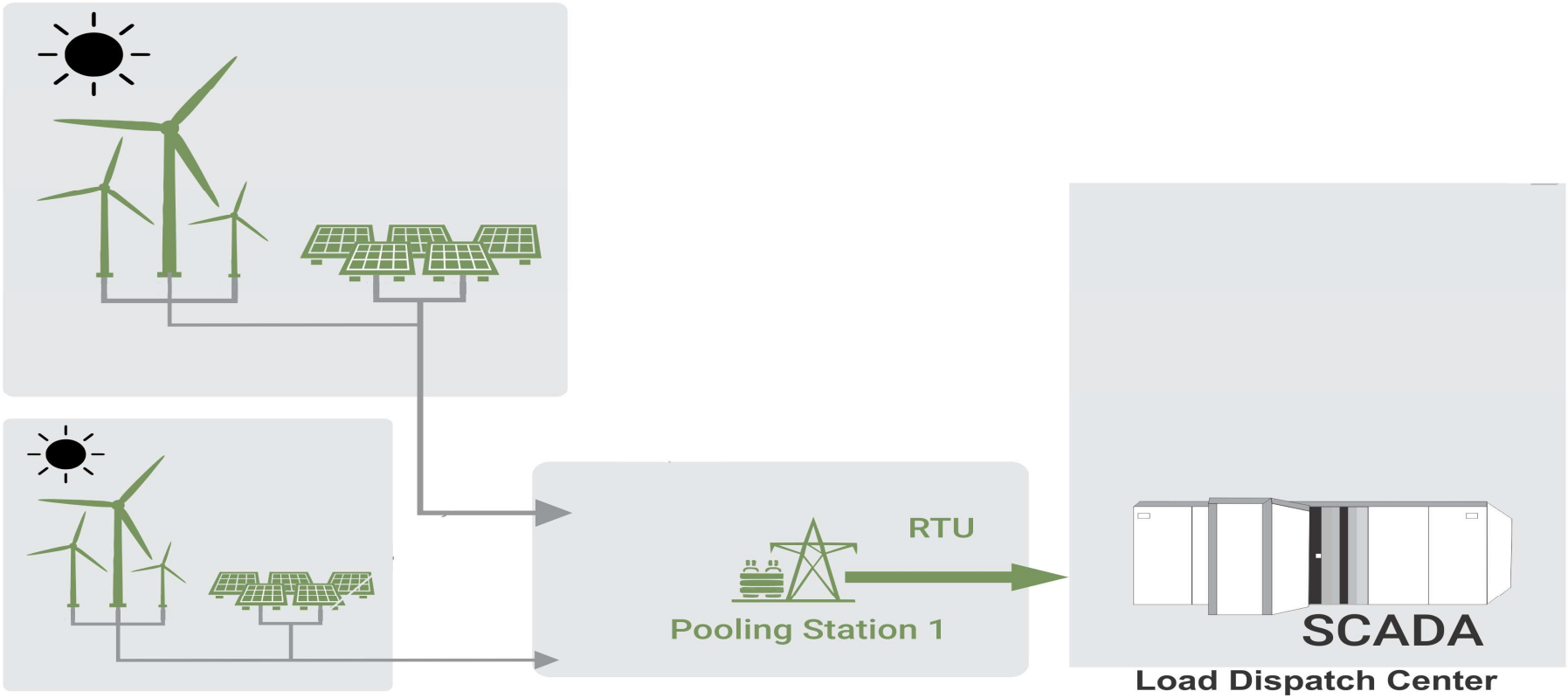
- In such integrations, the major cost areas are:
  - Leased Line for communication and required modems/routers
  - Devices with ready Communication Protocols (IEC 60870-101/104)
  - Cost of RTU
  - Integration charges from SCADA Supplier for addition of new IPP data points into SCADA server

- What we get from above costs:
  - Irms, Vrms, Real and Reactive Power, Energy, Frequency
  - Breaker, Isolator Status points
  - Reported at every couple of seconds or more to the central SCADA System

RE Integration

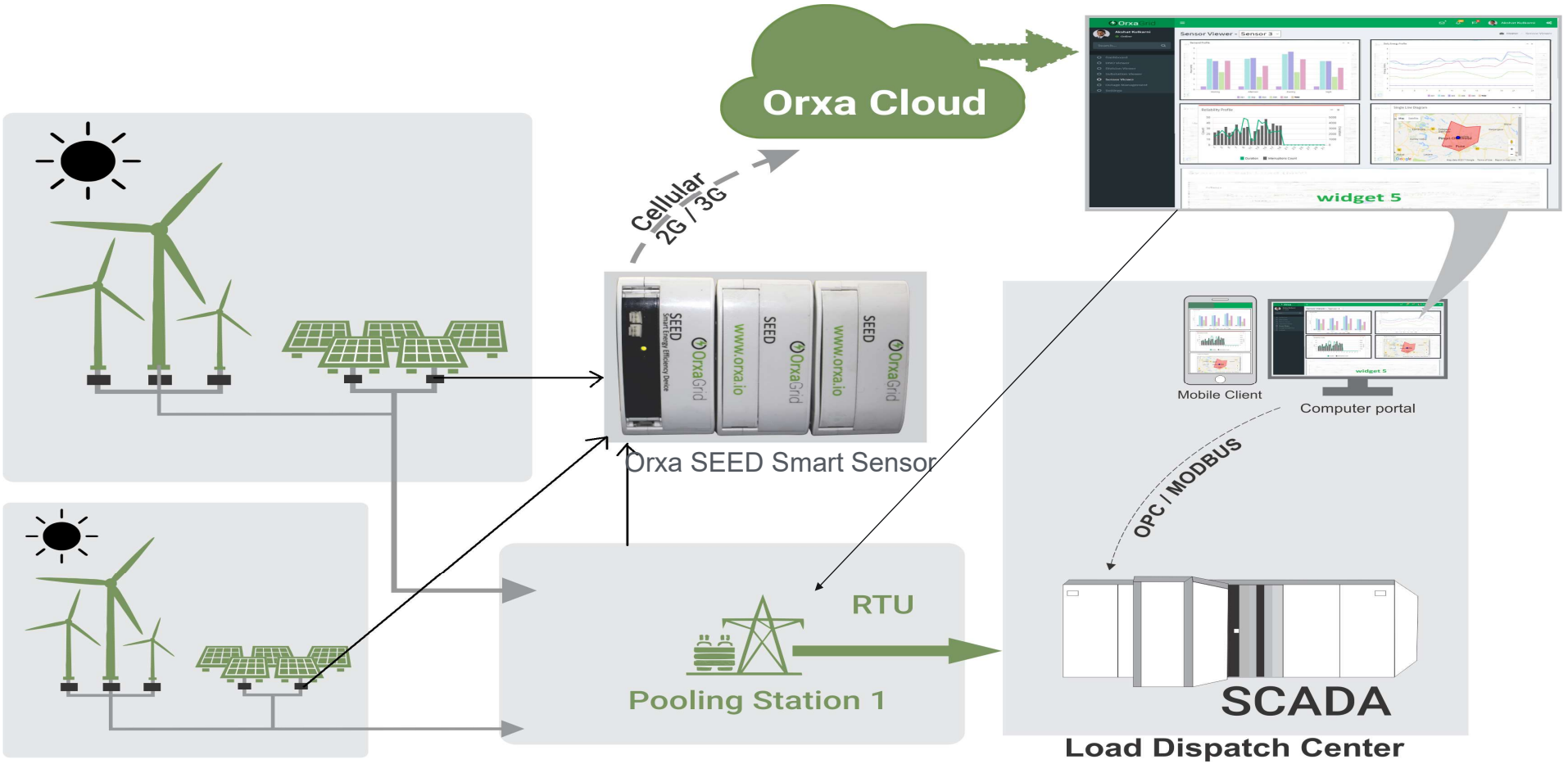
Current Plan

OrxaGrid



OrxaGrid Proposed Communication Solution

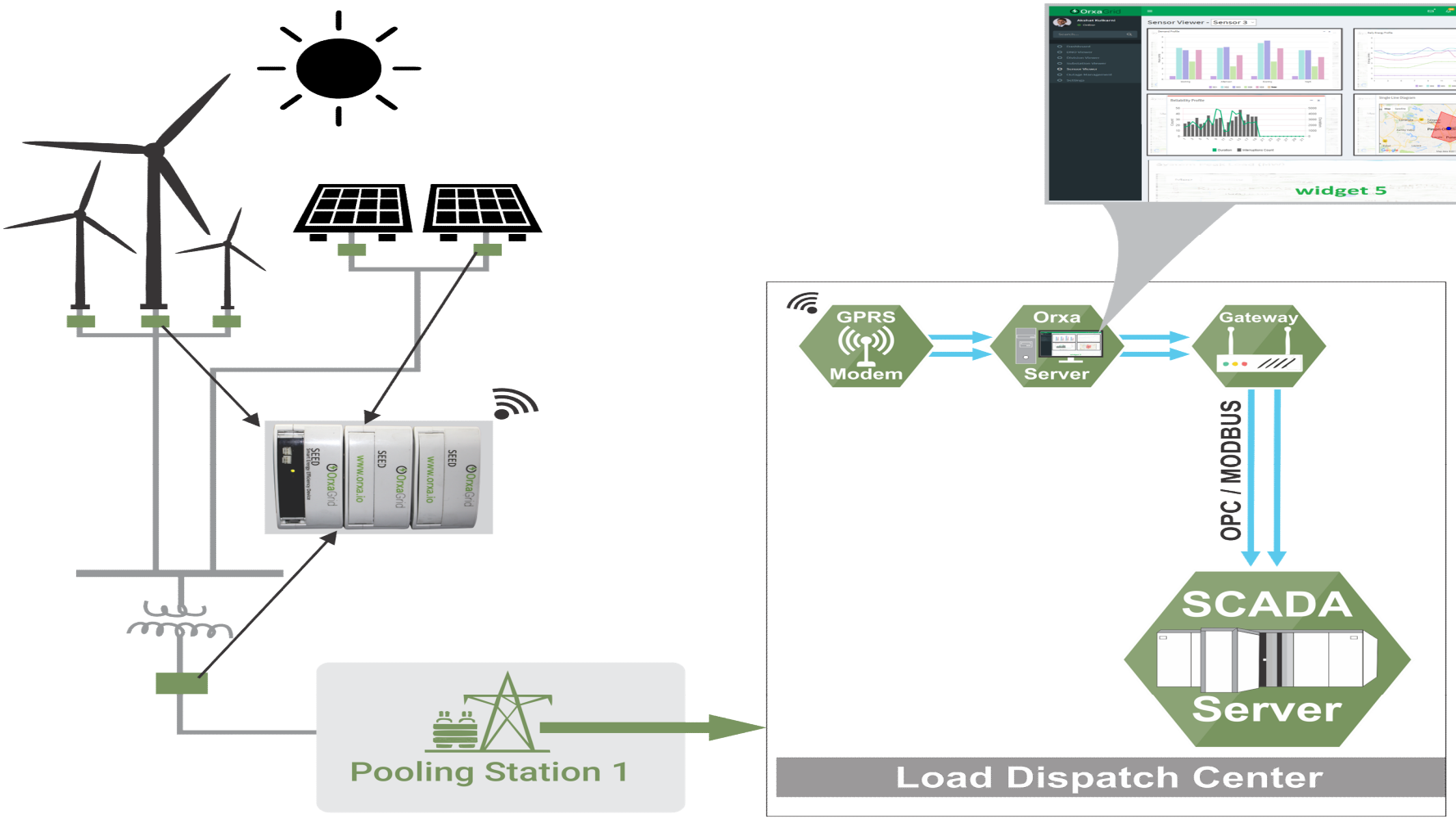
AWS Amazon Cloud Enabled Solution



OrxaGrid Proposed Communication Solution

Customer On Premise Solution

OrxaGrid



Benefits of OrxaGrid Solution

Cost Benefits

OrxaGrid

- 50% Cost Savings from Traditional Solution because
  - No need for Leased lines or PLCC and required associated hardware
  - No need for expensive communication protocols ready devices
  - No need for Data Concentrator Units
  - No Hidden Integration Charges
  - Interoperability over OPC or Modbus

Benefits of OrxaGrid Solution

Technical Benefits

- The Usual Parameters with GPS Time Synchronization
  - Breaker/Isolator Status Points + Electrical Parameters: RMS current, RMS voltage, Frequency and all standard energy information (W,VAR,VA, Whr, PF) with GPS Time Stamp
- MORE: Instantaneous Current and Voltage Sampled at 3.2kHz (64samples per cycle)
  - Disturbance Recording
  - Fault Waveform file capture for post-mortem analysis
- MORE: Power Quality Information with 0.2S class Accuracy
  - Harmonics
  - Voltage Sag and Swell (measured up to half a cycle)
  - Synchro-Phasor Information

“Not only Quantity of Power but Quality of Power”

SEED Specifications

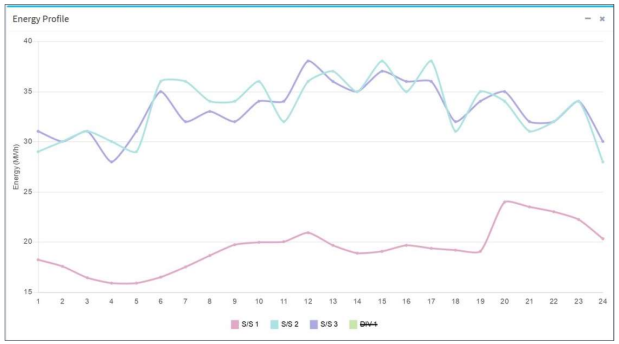
Inside a Windmill Panel….any Panel

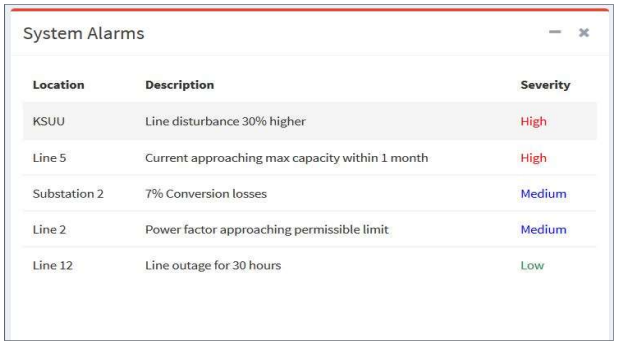
OrxaGrid

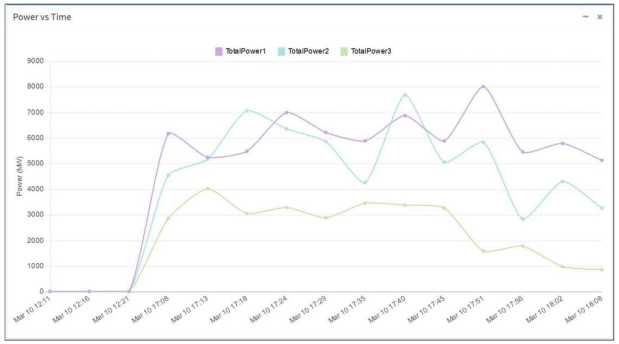
- Customized Analog Current and Voltage Module
- Customized Digital I/O Modules
- Customized Sensor Modules
- Qualcomm powered GPRS Modem, WiFi, and Bluetooth
- Qualcomm Snapdragon Processor
- GPS Time Stamping and Geo-location Tagging
- 4GB Inbuilt Memory for data loss prevention
- Compact & ergonomic Din Rail Mounted Enclosure

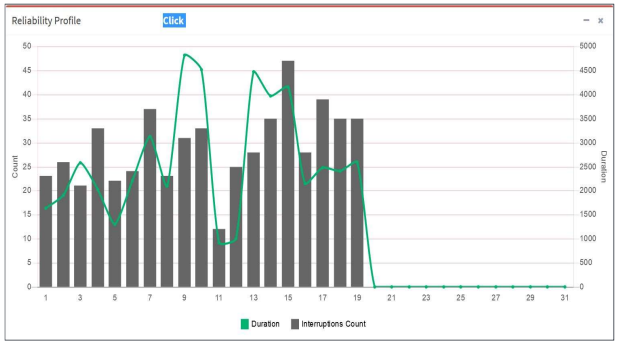
Orxa Dashboards for Renewables

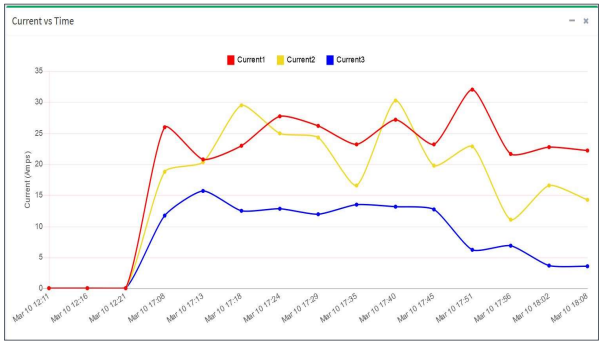
OrxaGrid









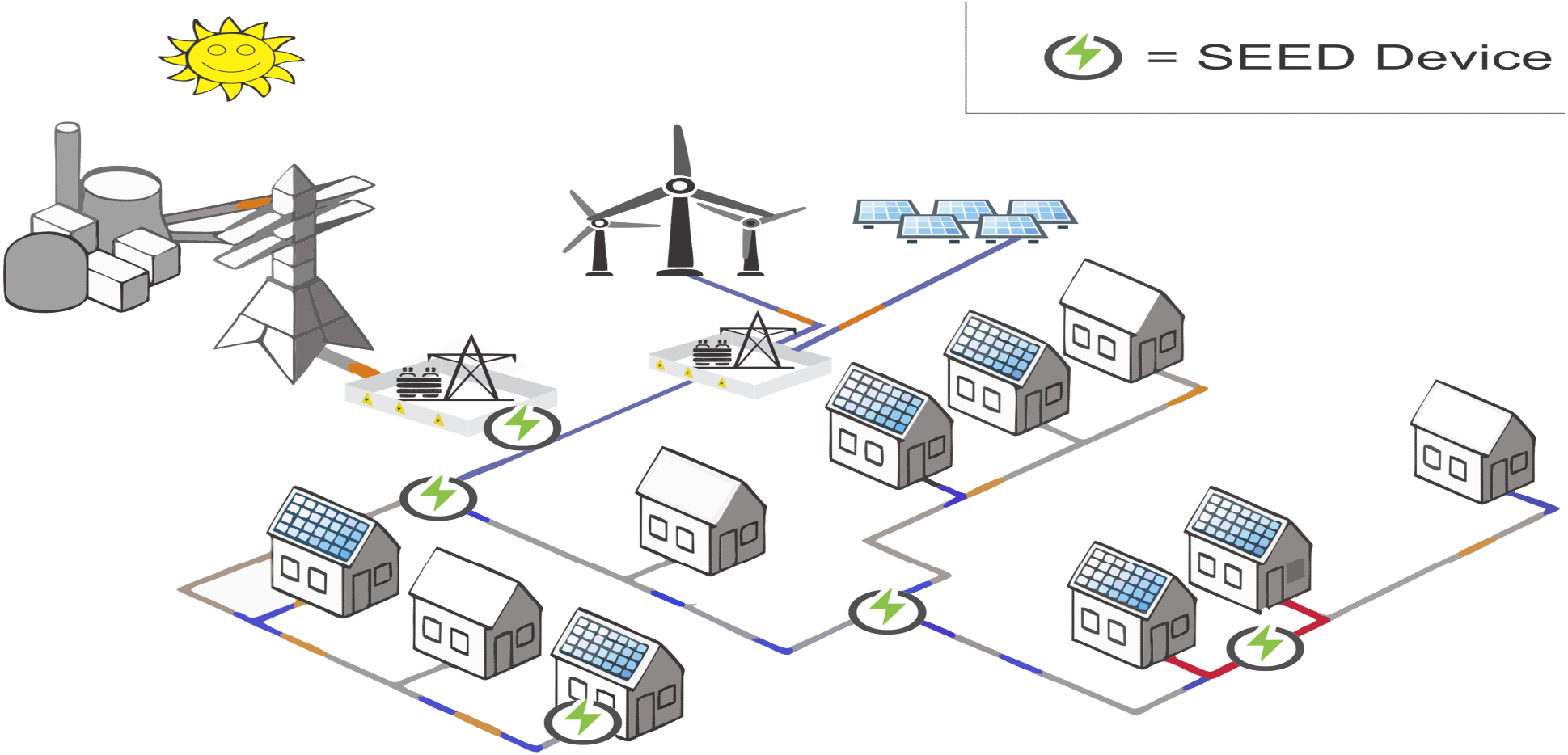


Link: http://orxa.io/pages/SensorViewer.php

Road Map: The Future of OrxaGrid Data Analytics Cloud

OrxaGrid

Rooftop Generations and Load Profiling



Q&A

THANK YOU

YASH KULKARNI

YASH.KULKARNI@SCOPETNM.COM

(+91) 7710099219

Thank you

Benefit of Cloud Solution over On Premise Solution:

OrxaGrid

1. No need for Capital Purchase of Server Racks
2. No need for ensuring continuous firewall and virus protection
3. AWS Guaranteed Data Security
4. Customer owned MySql Database with total control
5. Secured user login with 2step verification of customer accounts
6. Cloud enabled access of data for All & from Everywhere