

**WORKSHOP ORGANISED BY IGEF-MNRE  
ON  
FORECASTING, BALANCING AND SCHEDULING OF RENEWABLE ENERGY  
IN INDIA**

**RAJASTHAN RENEWABLE ENERGY GRID INTEGRATION-  
Experience, Issues & Challenges**



**Rajasthan Rajya Vidyut Prasaran Nigam Limited**

**New Delhi**

**May, 5-6, 2014**

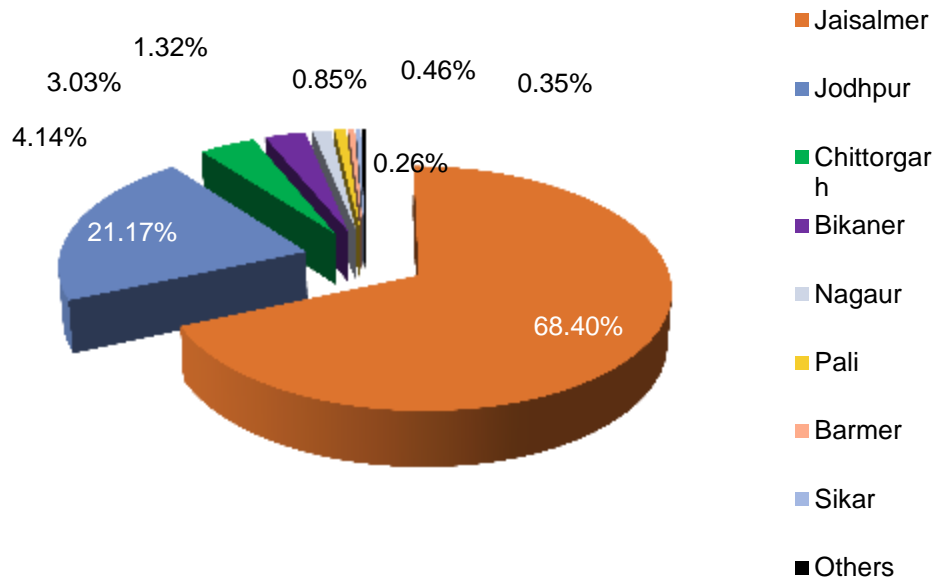
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# CURRENT STATUS OF WIND & SOLAR GENERATION IN RAJASTHAN

## Solar & Wind Installation 3310 MW



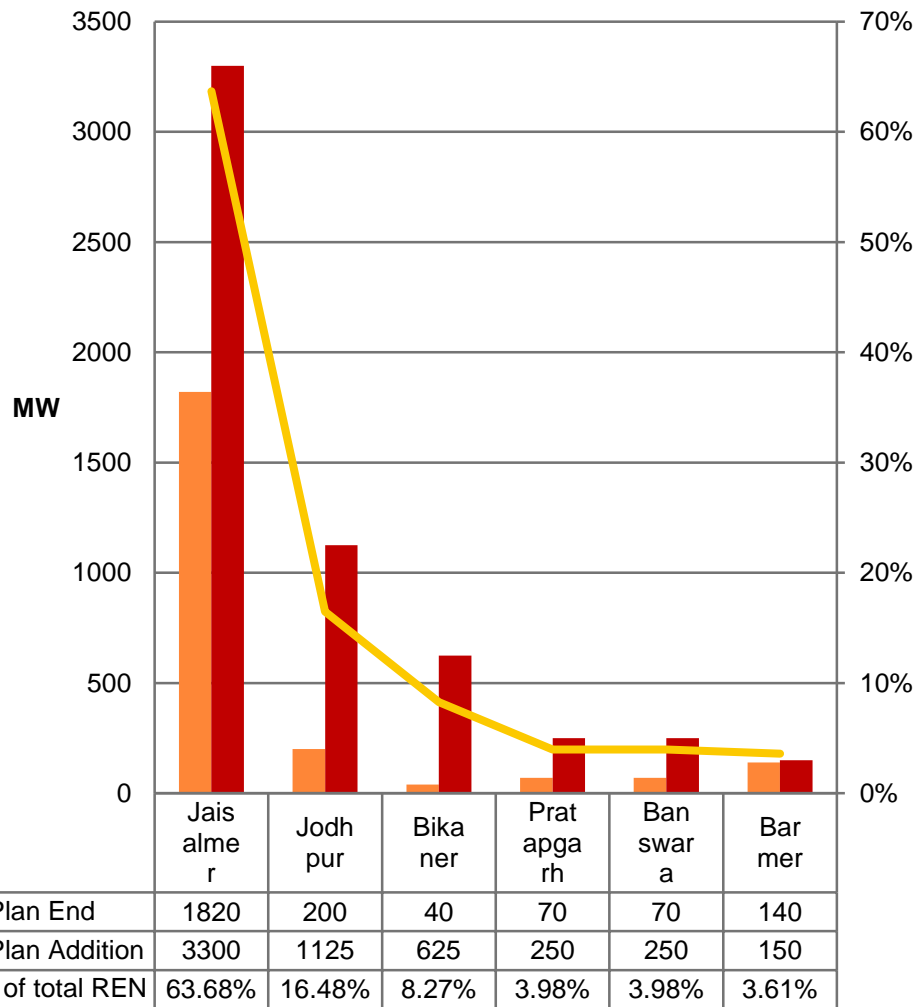
- ~3.3 GW Installed Base as on March 2014
- Wind/Solar/Biomass comprise ~9% of total installed gen as on 31<sup>st</sup> Mar 2014
- Jaisalmer & Jodhpur together account for 89.5% of Solar & Wind capacity
- Chittorgarh adds another 4.14% from Wind

## RRVNL Position:

- Power System Position for 2013-14,
  - Peak Energy (MU) Deficit: 15.1%
  - Peak Demand (MW) Deficit: 12.5%
- Peak Summer time demand is ever increasing,
  - 1701 LUs in May17 2013 (12.2% rise)
  - 1875 LUs in Sep 2013
- Only ~50 LUs mitigated thru Wind & Solar.
- RRVNPL exports ~450 MW to Punjab / Haryana during Kharif Season & imports during Rabi Season.
- 2013 Monthly UI balance varies bet (-38.7) & (-1545.5) LUs with average fairly well maintained at (-1200) LUs. However daily excursions do take place

# GRID CONNECTED WIND & SOLAR IN RAJASTHAN – END OF 12TH PLAN

## Solar & Wind Capacity (MW) in 2017



## Rajasthan Position – End of 12<sup>th</sup> Plan:

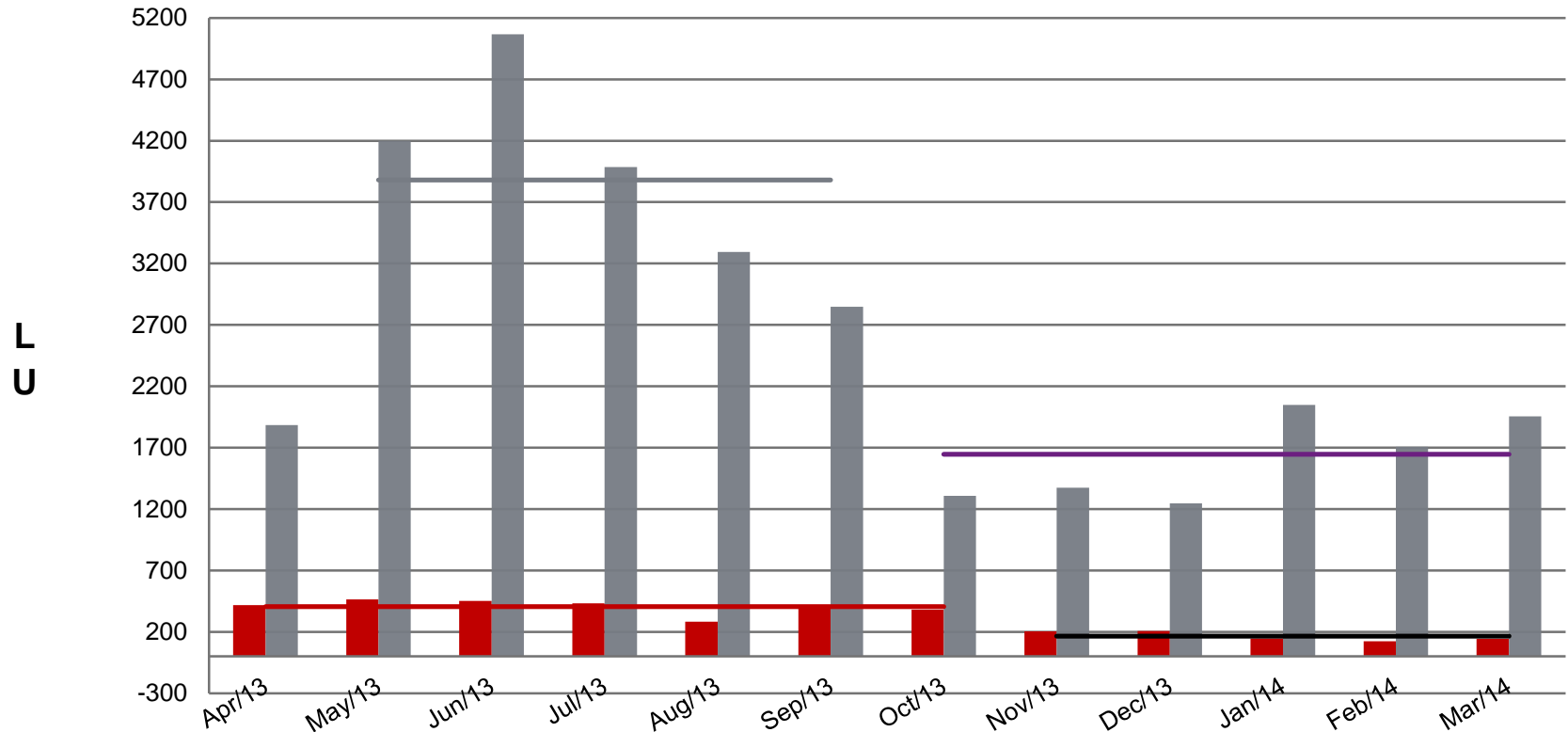
- 243.6% capacity addition in current five year plan
  - From 2.34 GW at end of 11<sup>th</sup> Plan
  - To 8.04 GW at end of 12<sup>th</sup> Plan
  - 65% contribution from Solar
  - Jaisalmer/Jodhpur/Bikaner to host 88.4% of Renewable installation
- All injections are at 400/220/132 kV levels
- Wind capacity penetration level to be maintained at 21%
- Projected RPO is 12% (2560 MW)
- End of 12<sup>th</sup> Plan, 1800 MW surplus RE in off peak period expected for sharing with RE deficit states

# GRID CONNECTED WIND & SOLAR IN RAJASTHAN – END OF 12TH PLAN (GEOGRAPHIC SPREAD)

## RAJASTHAN District Map



## DRAWL / CONSUMPTION PATTERN OF WIND & SOLAR IN RAJASTHAN (2013-14)



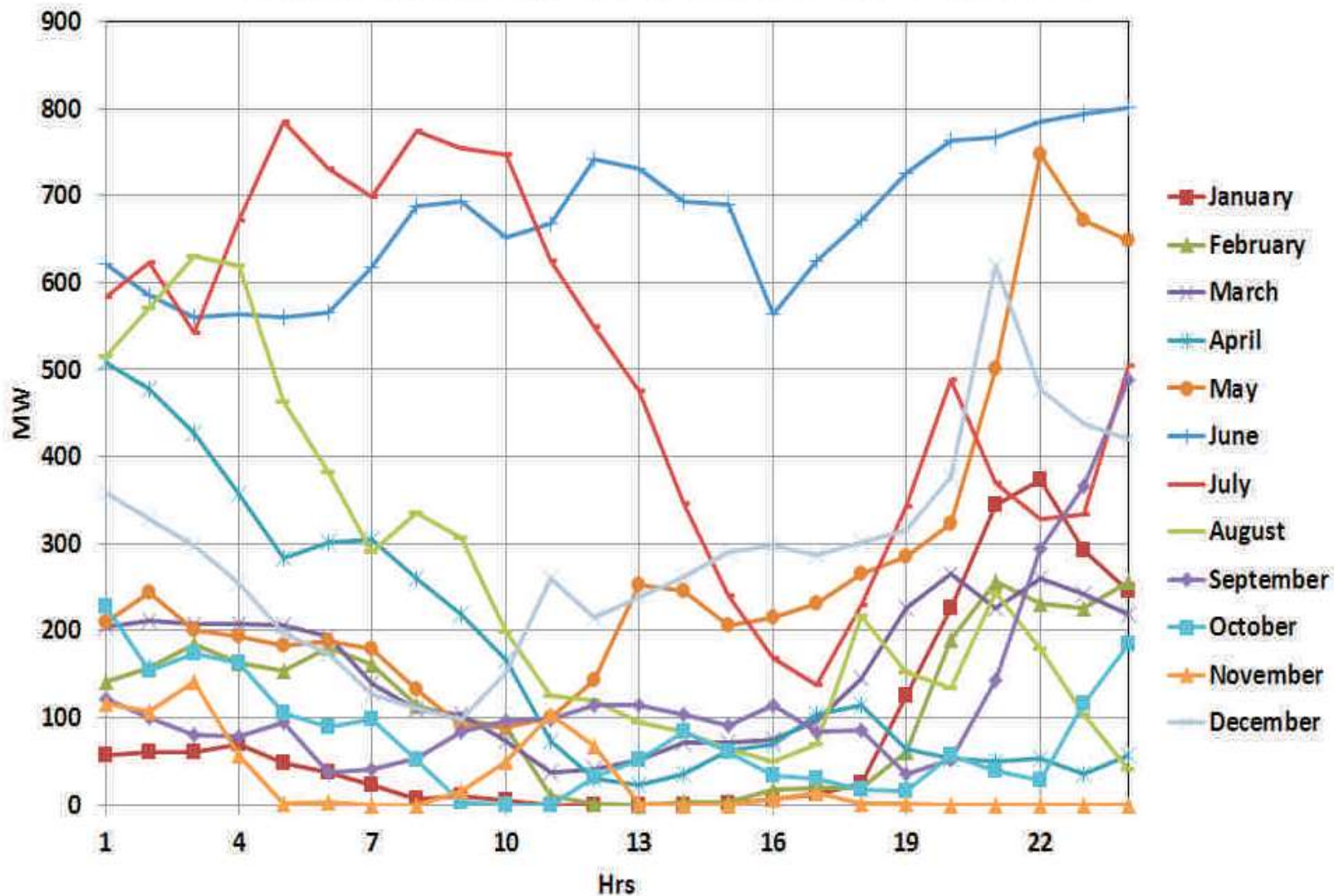
	Apr/13	May/13	Jun/13	Jul/13	Aug/13	Sep/13	Oct/13	Nov/13	Dec/13	Jan/14	Feb/14	Mar/14
<span style="color: red;">■</span> Solar	417.15	464.45	452.15	433.76	283.24	406.4	381.5	203.63	207.75	146.7	122.94	143.07
<span style="color: grey;">■</span> Wind	1885.45	4199.89	5067.81	3985.73	3292.95	2847.99	1309.18	1374.33	1247.77	2049.73	1707.16	1955.84
— Avg Hi Wind		3,878.87	3,878.87	3,878.87	3,878.87	3,878.87						
— Avg Lo Wind	1,647.07						1,647.07	1,647.07	1,647.07	1,647.07	1,647.07	1,647.07
— Avg Hi Solar	405.52	405.52	405.52	405.52	405.52	405.52	405.52					
— Avg Lo Solar								164.82	164.82	164.82	164.82	164.82

- **58%/59% Seasonal Variation in Wind /Solar Average Energy consumption**
- **25%/26% Annual Max Variation in Wind / Solar Energy consumption**



# WIND AND SOLAR GENERATION PATTERN/ CURVE IN RAJASTHAN- I

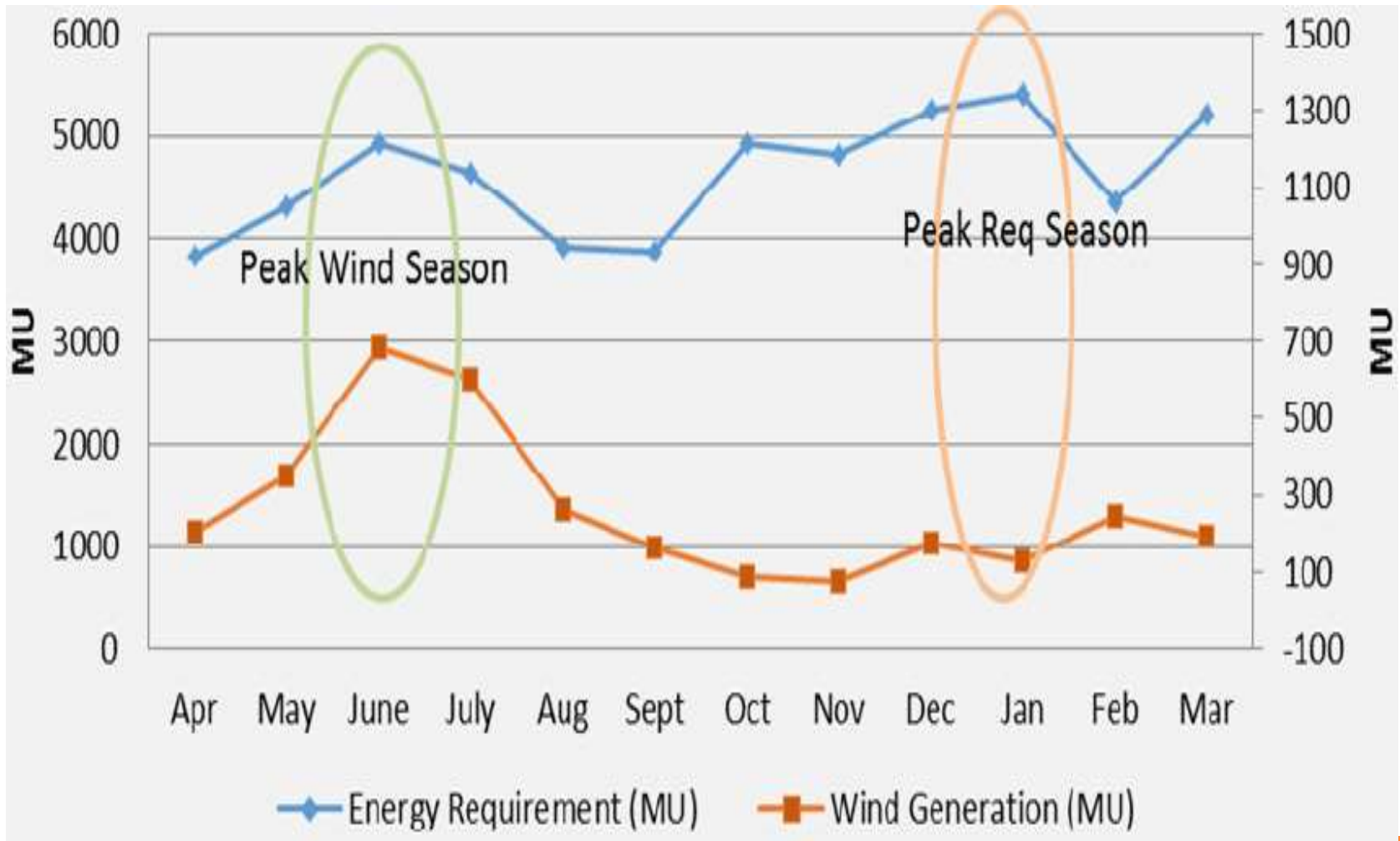
Rajasthan Typical Daily Wind Generation Pattern Month wise



- Unlike TN/Karnataka/Gujarat, Rajasthan wind generation starts to peak at 18:00 hours

## WIND AND SOLAR GENERATION PATTERN/ CURVE IN RAJASTHAN- II

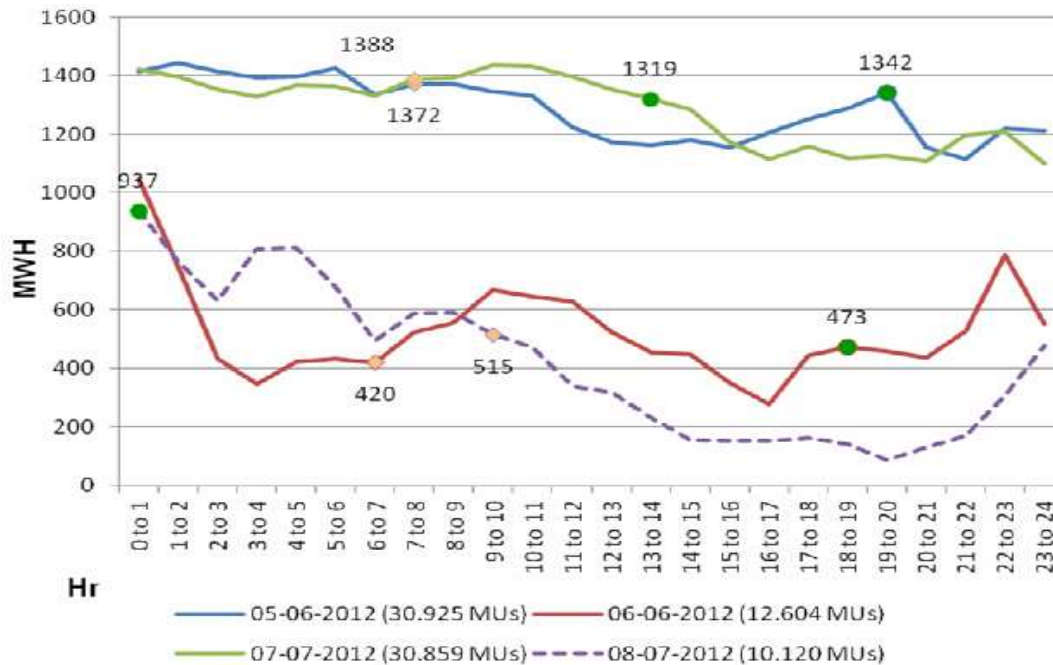
(2013-2014)



- High Wind season matches energy requirement profile



## VARIATION IN WIND GEN OVER CONSECUTIVE DAYS IN PEAK SEASON: AT RRVPNL

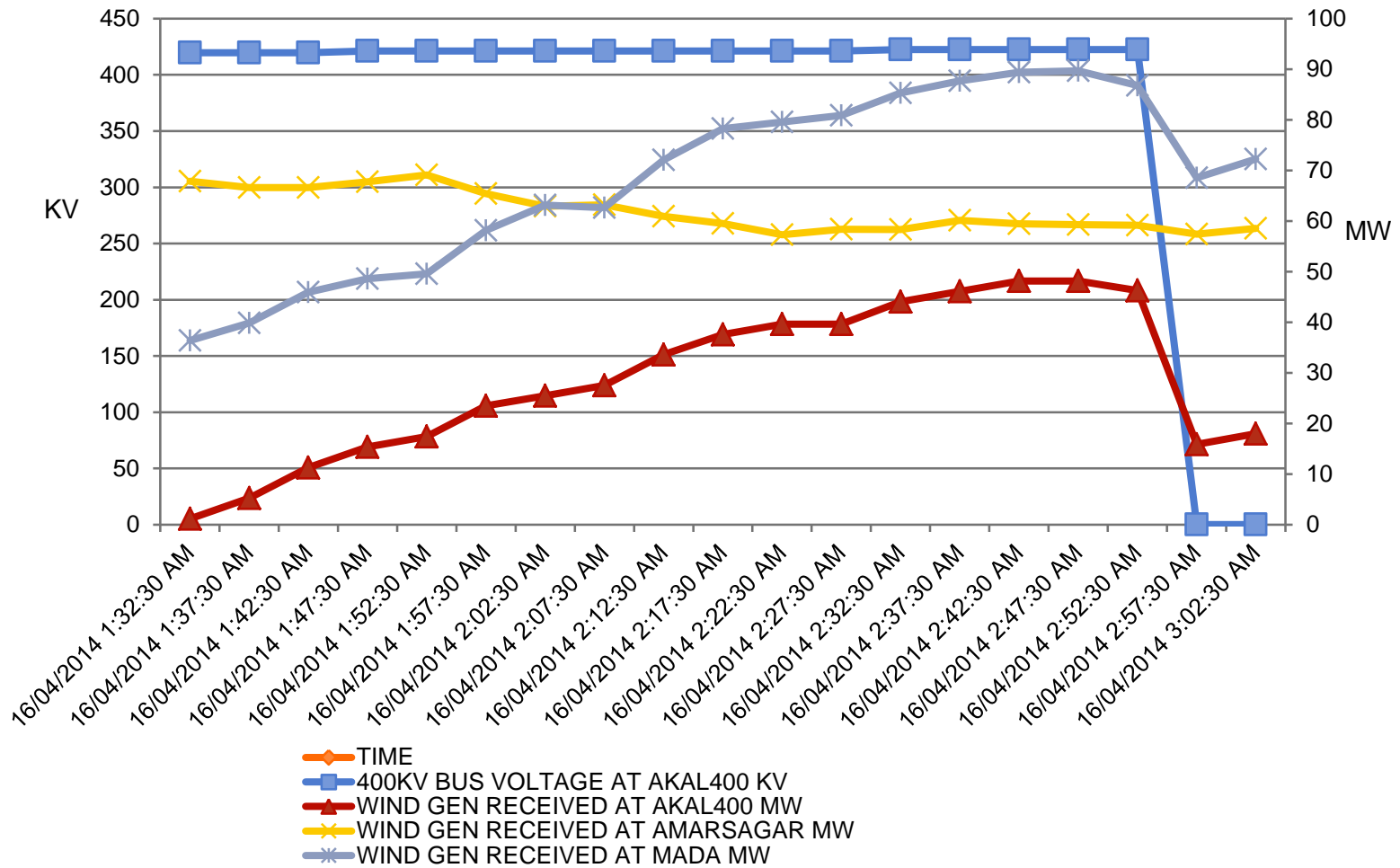


Variation Band in MW	No of Days
>500 <1000	154
>1000	11
1164	1

REN Gen	Solar	Wind
INR per Unit	7.40	3.65
PLF	24%	20%
Cap MW	670	2729.55
MUs Available	1,409	4,782
MUs Consumed	366.274	3092.383
MUs Unutilised	1,042	1,690
Rev Lost MINR	7,713	6,168

- Diurnal Wind variation of 1140 MW have been recorded
- Lack of VAR support from Wind Generators leading to over fluxing and tripping
- Coal & Lignite based plants used for balancing. Challenges in minimising oil support for steady flame in boilers
- Gas based plants (Ramgarh – 223 MW, Dholpur - 330MW) also used for balancing
- Approx. Estimates show for last calendar year ~ 617 / 771 Crore Rupee was lost on account of under utilisation of Wind / Solar generation respectively

# HIGH VOLTAGE CONDITIONS AT RVPNL 400 KV SUBSTATION, AKAL (JAISALMER)



## EXISTING SCHEDULING AND BALANCING METHOD USED

**Scheduling for Wind & Solar Plant Listed below is done by SLDC based on received forecasting data:**

S. No.	Name of Developer (Wind)	Name of pooling station	Installed capacity in MW
1	Inox Wind Infrastructures Services Ltd. (GFL)	Sadiya wind farm, Jaisalmer	25
2	SUZLON	Baori	59.4
3	SUZLON	Kaladoongar	90.3
4	LUDURWA_GAME SA	Jaisalmer	44.2
5	Wind World India Ltd's	Jajia	160.8
6	REGPL	Kangarh Pooling Substation , Dalot	85.5
7	SUZLON	Bhesada windfarm	39.9
8	REGPL	Clean Wind Power Devgarh Pvt Ltd.	37.5
9	Inox Wind Infrastructures Services Ltd.	Dangri	264

**Balancing is done by:**

- Backing down of Generation (Thermal & Gas station)
- Box-up of Thermal Generating units
- Hydro Generating units
- Day to day power purchase from Exchange, URS Power and other sources
- During critical situations RE generators are also advised to restrict their generation

S. No.	Name of Developer (Solar)	Installed capacity in MW
1	NVVN	470
2	RelianceDhanu, near Dechu	40
3	Giriraj Solar, Bap	33
3	Rajasthan Gums, Rani	30
4	Reliance, Khinwsar	5

## ISSUES TO BE ADDRESSED FOR RENEWABLE INTEGRATION IN GRID

- Large Variability of Renewable Energy Resources
- Accurate Forecasting Models and Tools
- Reactive Power Control
- Over-voltage in the Power System
- Grid Security and Stability Concerns
- Power Quality- Harmonics and DC injection
- Data Acquisition and Telemetry Requirements of Renewable Resources
- Ensuring Regulatory Interventions/ Compliances for/ by Renewable Energy Generators



## OPTIONS EXPLORED FOR MITIGATING RENEWABLE INTEGRATION ISSUES

- Forecasting

- Renewable Control Center
- Ensemble Forecasting from better Accuracy

REMC

- Scheduling & Balancing

- Reserve Capacity for Balancing Forecasting errors
- Regulatory Frameworks- Forecasting Accuracy, Type and Response Time of Reserve Capacity, Forecasting Time Frames
- Promoting the Distributed RE Generation
- Demand-Response Mechanism
- Voltage Ride Through Features in Solar Inverters
- Voltage Regulation, Reactive & Power Flow Control- Use of FACT Devices,
- Wide Area Monitoring for Grid Security and Stability
- Storage Technologies



## CHALLENGES

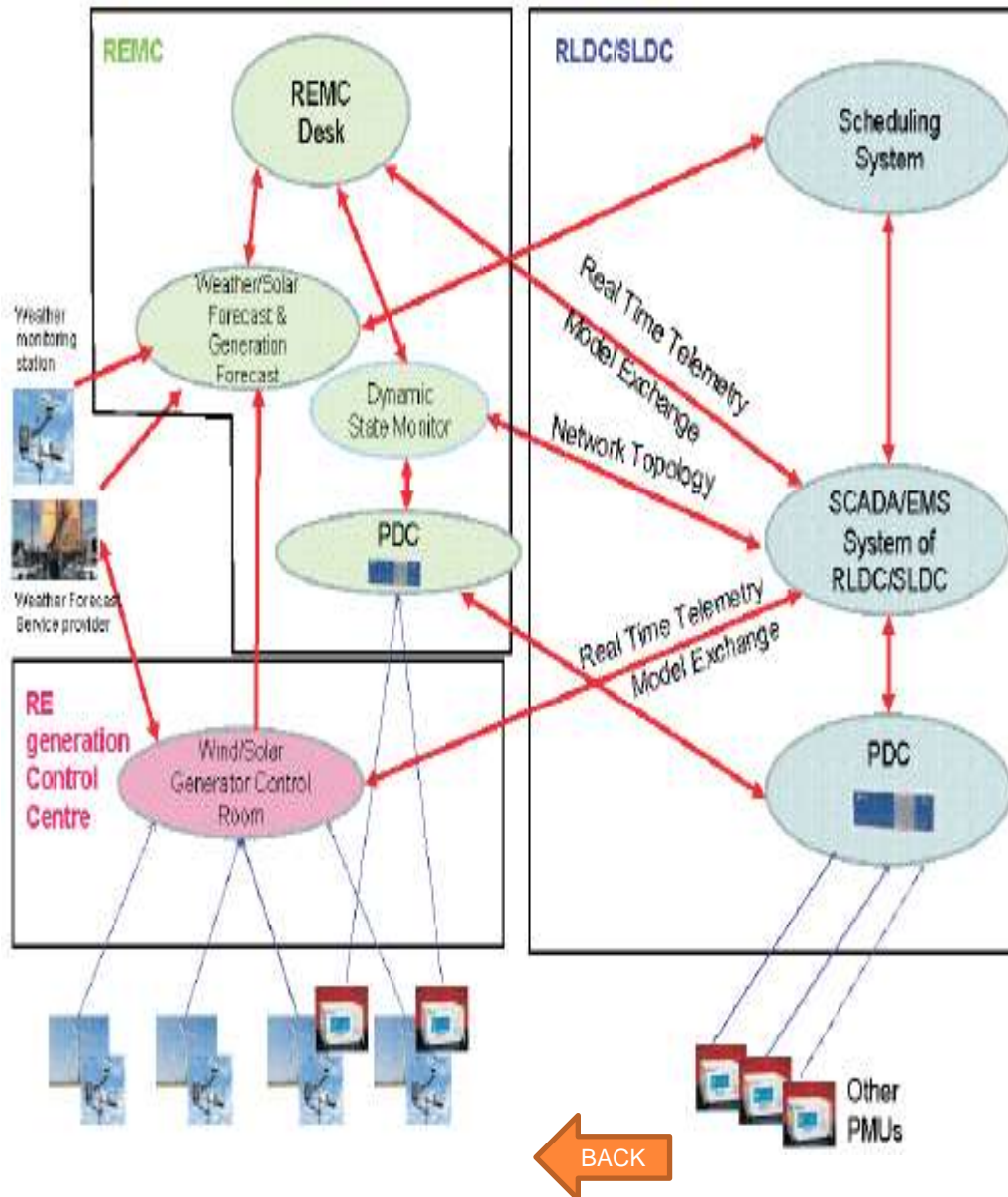
- Real Time Operation, Co-ordination and Control of Generators, Transmission and Distribution System Operators
- Seamless Data Integration and Communication Infrastructure for Real Time Operations
- Transmission & Distribution Infrastructure Upgrade- Implementation of Smart Grid Technologies
- Huge Investment Requirements for handling RE Integrations
- Regulatory Mechanism- Elaborated Regulations for Forecasting, Scheduling and Balancing of RE Generators, Responsibilities of Various Stakeholders and ensuring its compliances
- Development of Human Resources in Utilities: Training and Skill Developments for handling technologies/ Tools and infrastructure related to forecasting, scheduling and Balancing of RE Power



**THANK YOU**



# RENEWABLE ENERGY MONITORING CENTRE PLAN



- REMCs to be co-located at SLDC, RLDC and NLDC with separate REMC Desk
- SLDC of 7 RE rich States among 3 RLDCs to be involved at present,
  - SRLDC: AP, Tamil Nadu, Karnataka
  - WRLDC: Maharashtra, Gujarat
  - NRLDC: Rajasthan, Jammu & Kashmir
- REMCs to be integrated with SCADA / EMS at SLDC, RLDC & NLDC
- Functionality of REMCs,
  - Modelling RE Sources
  - Forecasting of RE generation from hour-ahead to month-ahead
  - Real time tracking of RE generation
  - Dynamic security assessment
  - Geo spatial visualisation
  - Coordination with respective LDCs for injection & control of RE generation for smooth grid operation
  - Performance indices of RE generators