windergy INDIA 2017

WIND POWER FOREVER

INTERNATIONAL CONFERENCE & EXHIBITION

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THE ASHOK,
NEW DELHI

## Theme Presentation

On

# "Wind & Solar Energy Operating Together"

Idam

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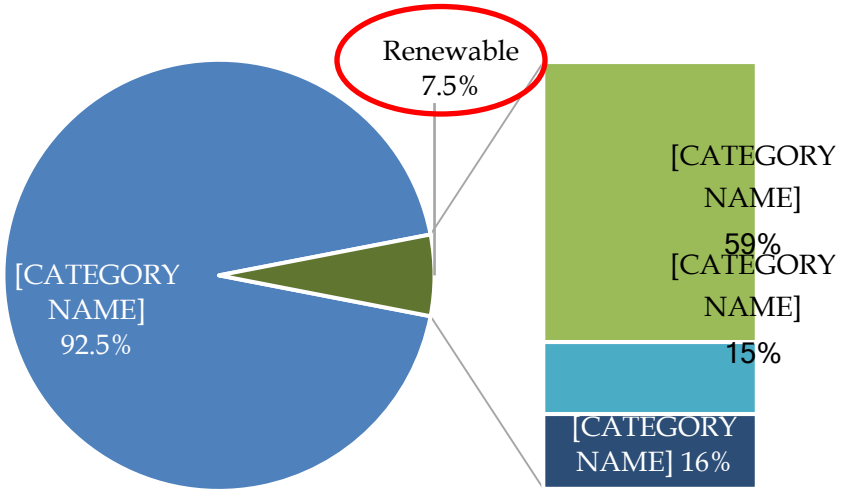
**Idam Infrastructure Advisory Pvt. Ltd.**

# Outline of the theme

- RE Proliferation – present and expected
- Wind and Solar Generation – Pattern analysis
- Energy Demand – Pattern analysis
- Addressing the challenge of Generation Demand Balance - Options
  - Solar and Wind Hybrid
  - Role of Energy Storage
  - Pumped Storage
  - Role of Electric Vehicles
- Grid Operational Challenges with High Penetration of Wind and Solar
- Strategies to improve RE integration & points for discussion

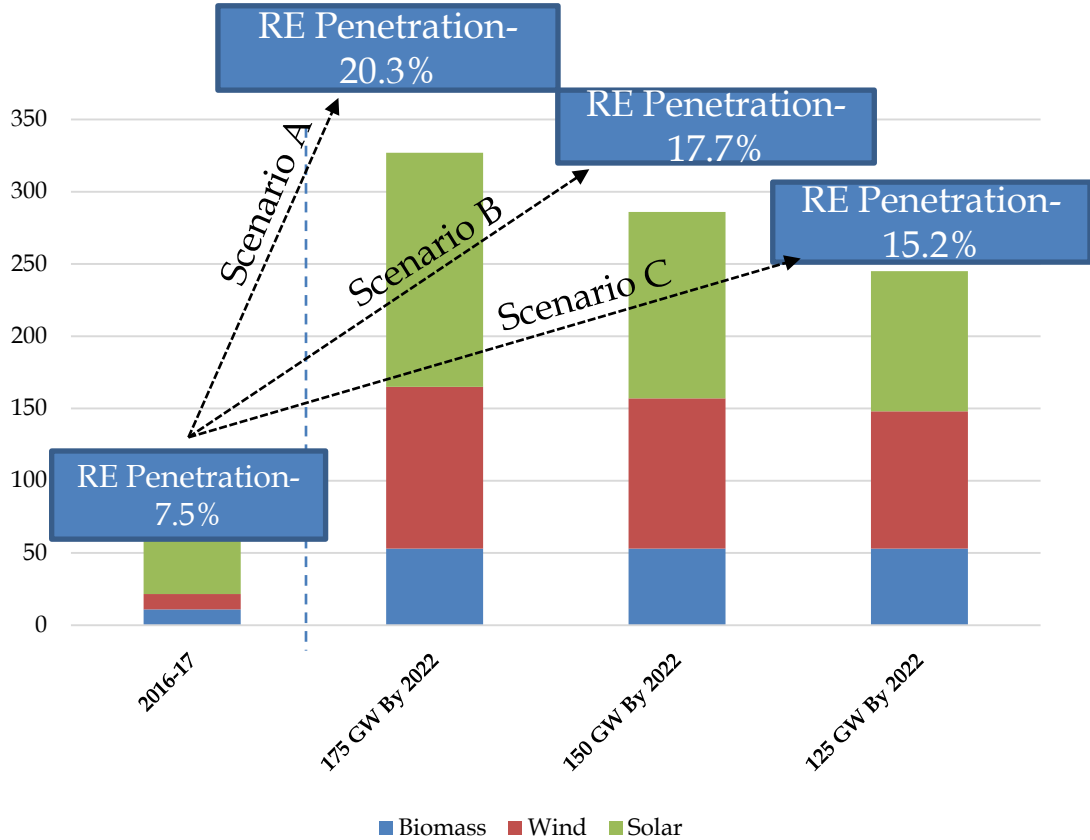
# RE Share – present and expected

Generation Breakup (in MUs)
2017-17



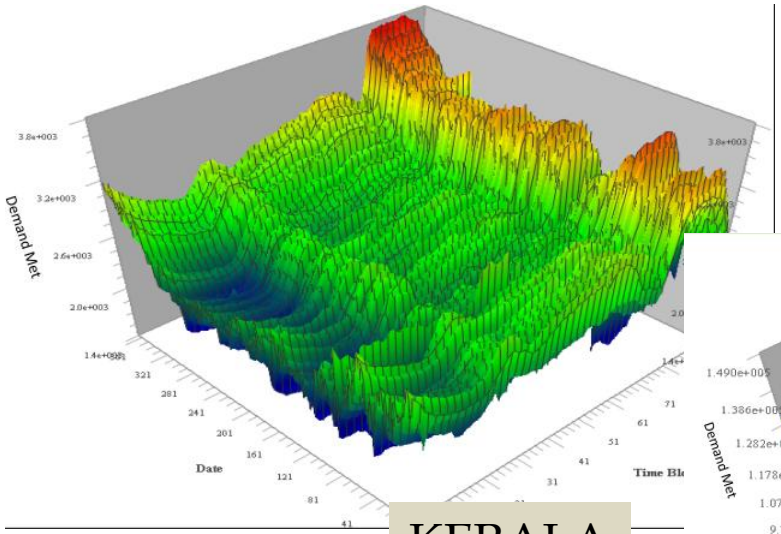

*Source: CEA and NEP*

Generation Projection in BUs under various scenarios

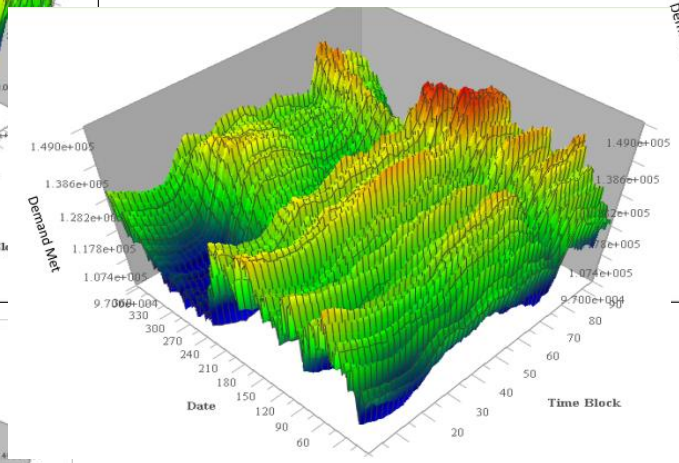



- Current level of RE Penetration is only 7.5% but, by 2022, RE Penetration expected to be between 15 - 20%.
- Wind Energy contribution towards RE Generation is about to come down from 59% to the range of 35 - 40%.
- Solar Generation is likely to increase in a big way in coming years.
- Need for commensurate demand growth with matching demand profile is a challenge

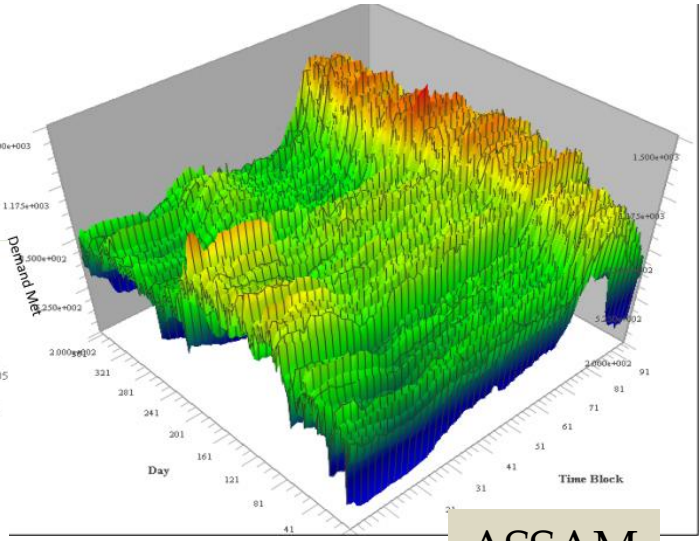
# Annual Demand Pattern 2015-16 -States & All India



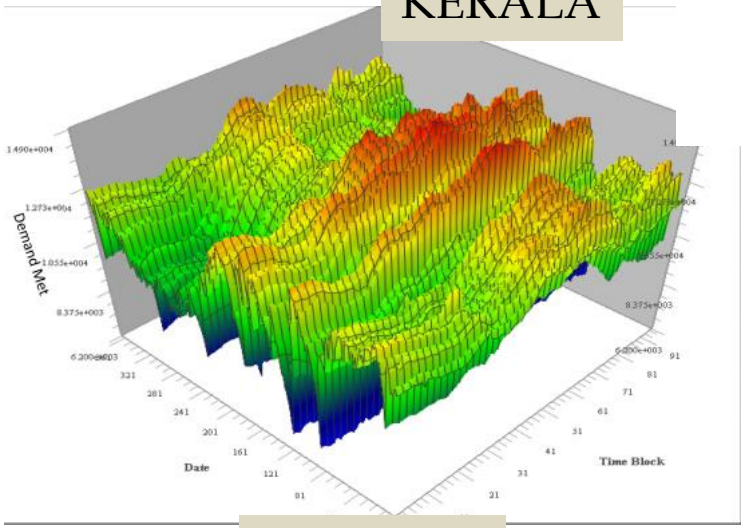

KERALA




ALL INDIA



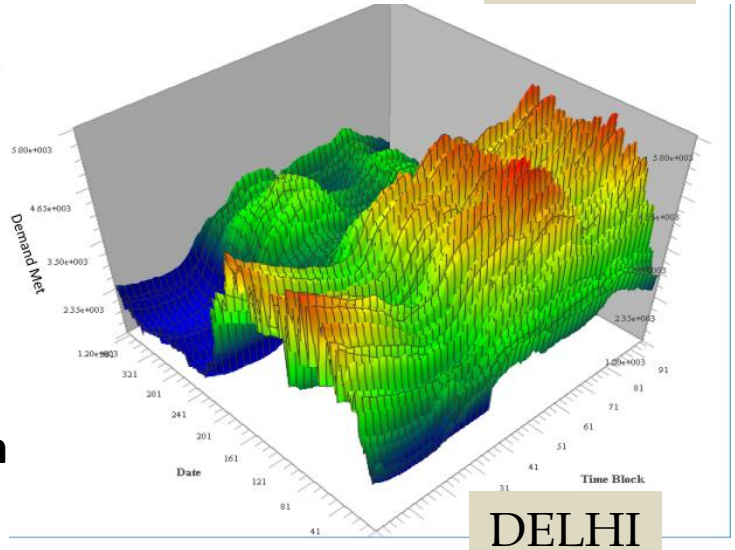

ASSAM




GUJARAT

*Source: POSOCO*

**Demand Pattern vary from State to State**

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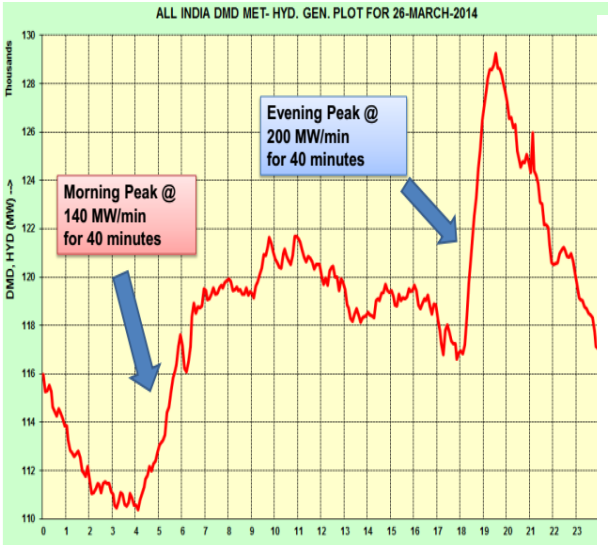
# All India Demand, Effect of Solar capacity addition & Probable Duck Curve Scenario

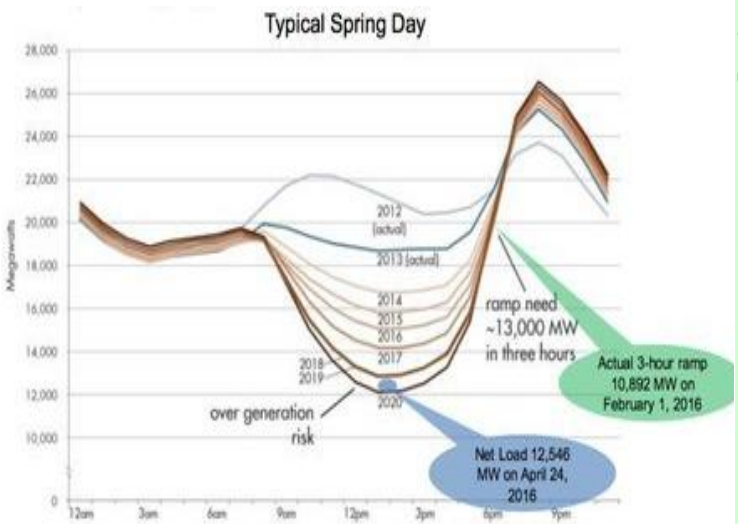
## All India Demand Curve




Present day demand with one morning peak and one evening peak

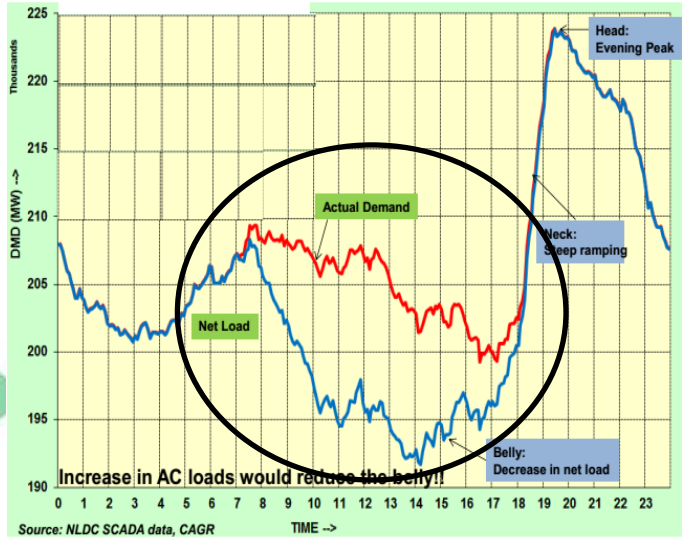
- Morning Ramp up Rate: 140MW/min
- Evening Ramp up Rate: 200 MW/min

## California Duck Curve (Expected due to Solar addition)




- Duck Curve Scenario Projected till 2020 by CAISO
- Duck belly to grow in the future years causing increase in ramp up rate to large extent

## Probable Duck Curve in Indian Scenario

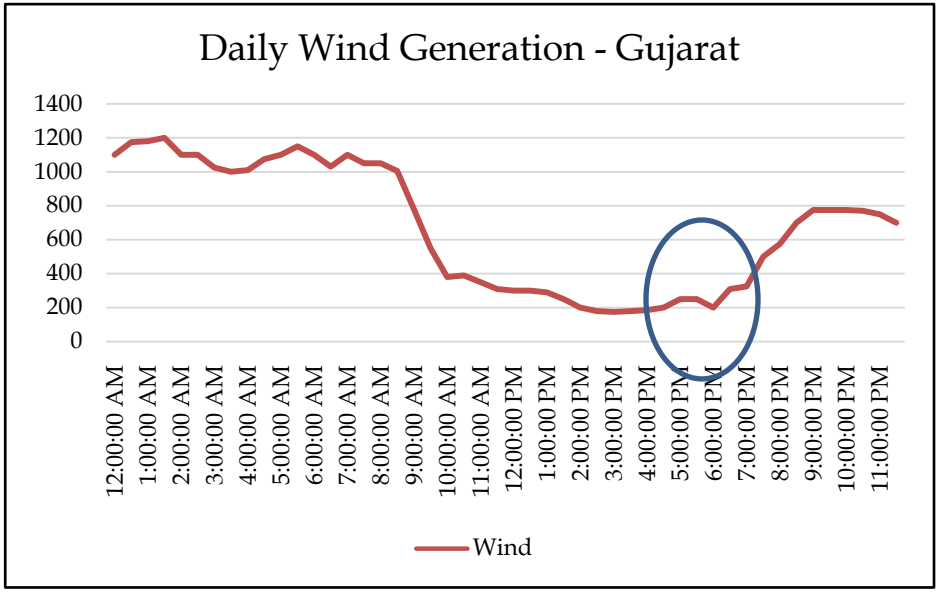


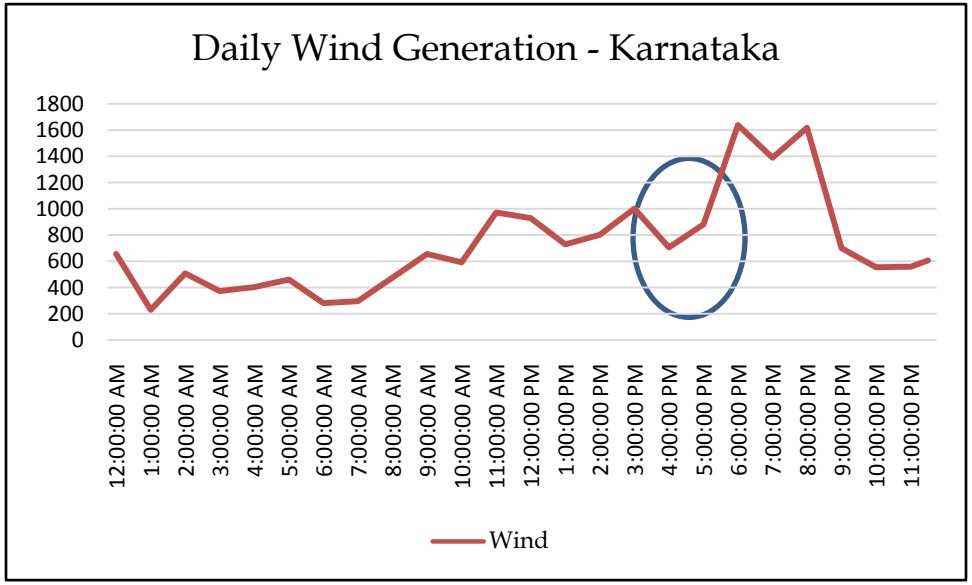

Duck scenario projected considering 20000 MW Solar Capacity

- Higher Evening Ramp up Rate: ~300MW/min
- With 100 GW solar, the Ramp up rate expected to multiply

# Addressing the challenge (1/2)

## -Wind Energy generation to reduce evening ramp-up rate requirement

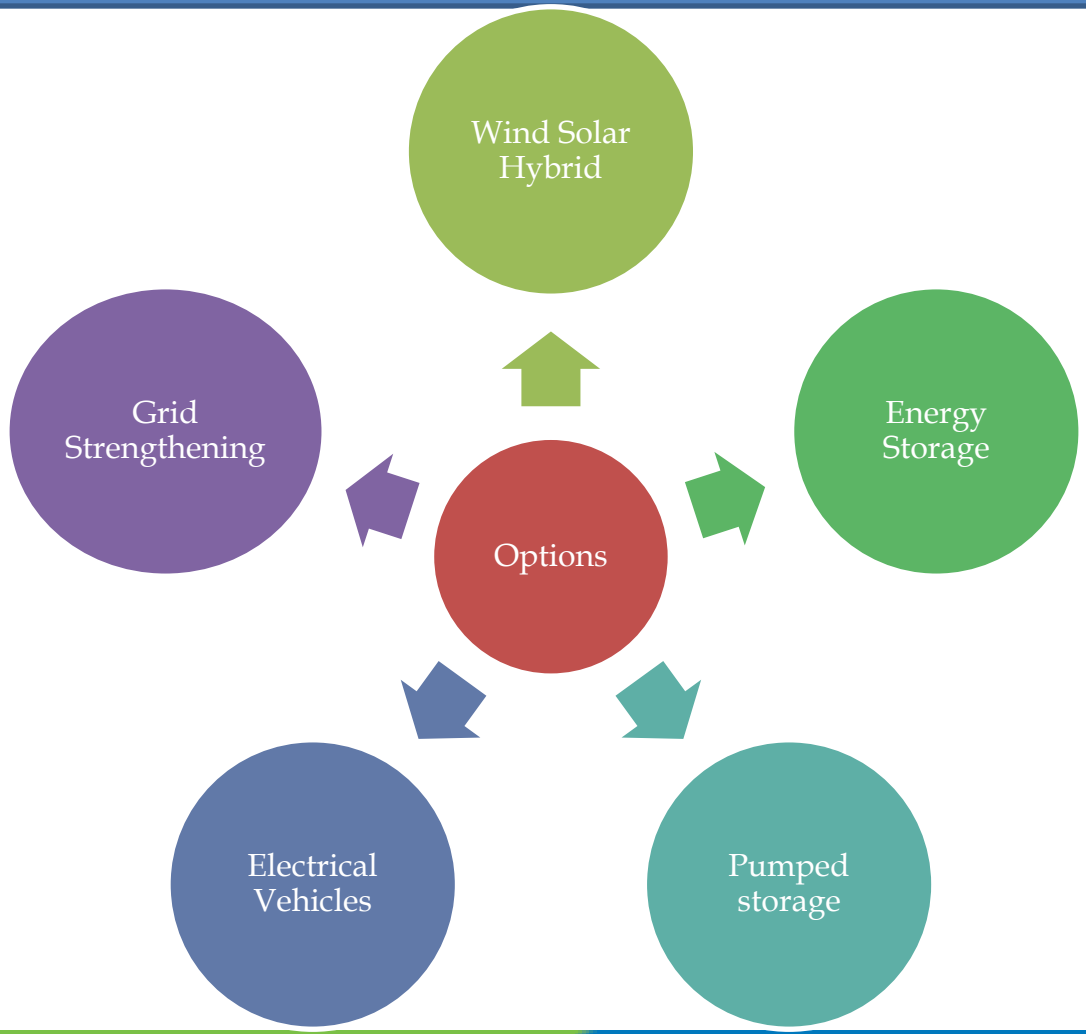



From the above wind generation profile, it can be observed that wind generation peaks in the evening when Solar generation recedes and thus reduces the duck curve impact (of high ramp up requirement) on the grid. This very feature establishes the need for promoting wind hand-in-hand with Solar

# Addressing the challenge (2/2)

**Various Options for addressing the duck curve challenge to be explored**



# Wind-Solar Hybrid (1/2)

**Wind and Solar generation to complement with improved profile**

- Wind energy picks up during evening peak when solar generation falls
- Reduces the ramp up rate requirement in the evening.
- Helps in addressing duck curve impact
- Better management of Variability

## Improved Land Usage

- Combined Land requirement for Wind and Solar is less than 2.5 Ha/MW


## Shared Evacuation Infrastructure

- Optimal Planning and better utilization of upstream evacuation Infrastructure
- Excess Generation capacity of ~ 30 to 40% at pooling Substation and ROW optimization

## Shared Operation

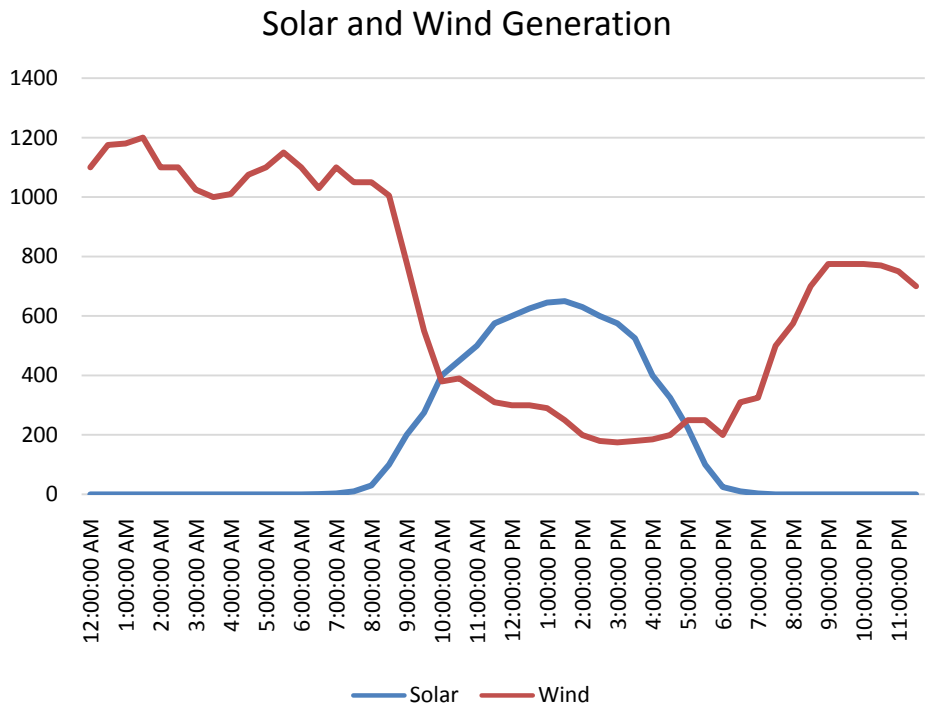
Benefits of Shared Operations and infrastructure

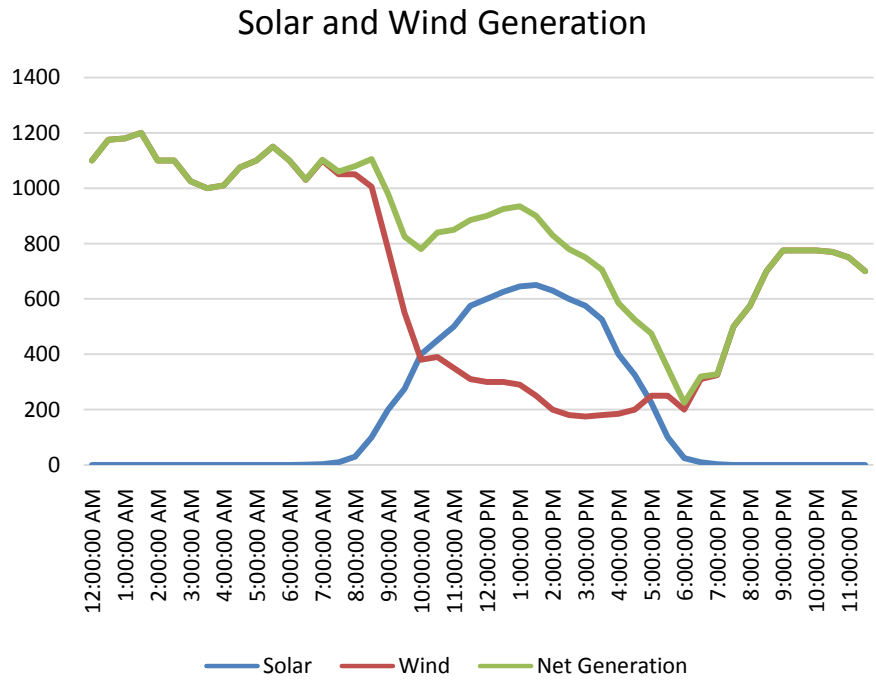
(roads, manpower, security and metering)

Large scale deployment of such project require adequate policy and regulatory support

# Wind and Solar Generation
# - Case study with Gujarat data (2/2)

**Hourly generation pattern of Solar and Wind generation in Gujarat on 01/01/2016.**




*Source: Gujarat SLDC*

- The highest generation of solar on the day was 650 MW at 12:30 Hrs, while the Wind generation fluctuated between 1200 MW(max) and 50 MW (min).
- The energy produced from other RES is negligible.
- The maximum demand catered is 12762 MW in 12 Noon and the minimum demand of 9902 MW occurs at 00:00 Hrs

# Grid Operational Challenges due to High RE Penetration (1/4)

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**Challenges**

- Grid Instability
- Managing Resource Variability & Intermittency
- Forecasting and Scheduling
- Impact on Conventional Generators

**Grid Stability becomes a major issue especially when there is high penetration of Renewable Energy**

- Understanding the dynamics of variability of these sources and taking immediate recourses to maintain grid stability
- Safe, Secure and Optimal operations of the overall grid
- Direct visibility of RE generators to SLDC
- Improving operation coordination with conventional generators as well as SLDC
- Reactive Power Management of the Grid
- Most of the wind plants installed are not Fault ride through (FRT) capable, leading to collapse of large chunk of RE generation at a time in grid fault situations.

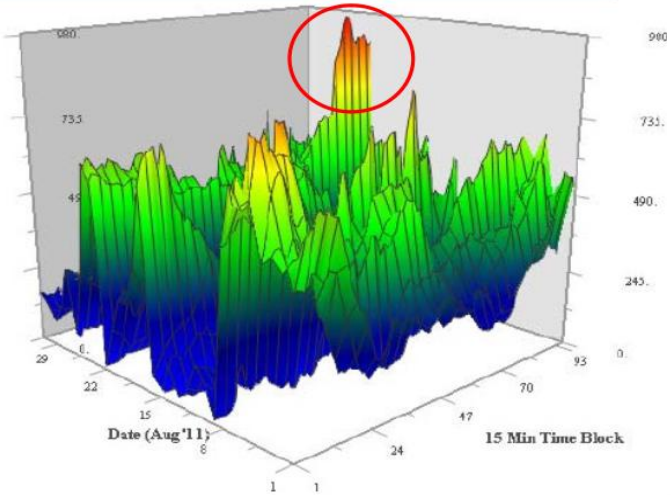
# Grid Operational Challenges due to High RE Penetration (2/4)

Challenges

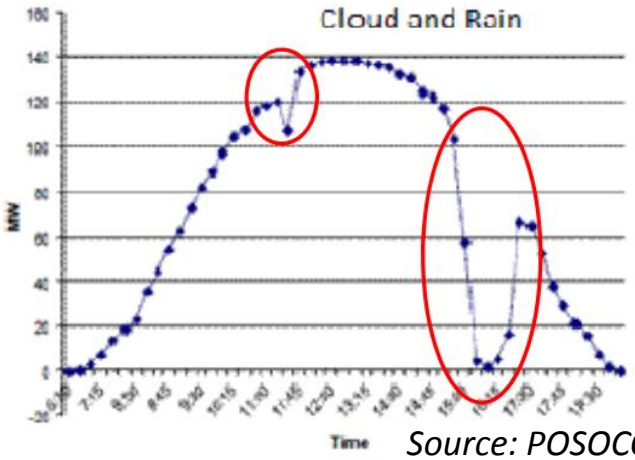
- Grid Instability
- Managing Resource Variability & Intermittency
- Forecasting and Scheduling
- Impact on Conventional Generators

Large scale RE integration has significant challenges both technical and economic in nature
System operators finds it difficult to balance the grid with sudden rise or fall of RE in the grid

Wind generation in Rajasthan (August)




Solar generation (Charanka) in Gujarat (April)




*Source: POSOCO*

- Limited ability to back-down thermal generation (limitation due to technical minimum)
- Low availability of Hydro Power for Balancing
- Low availability of gas fired thermal power (low availability, high cost)
- Lack of regional balancing (lack of inter-state, inter-regional corridor)

The practice of forecasting RE generation and scheduling the same can be a potential solution to tackle the issues posed by resource intermittency and will facilitate better balancing of the grid.

# Grid Operational Challenges due to High RE Penetration (3/4)

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## Challenges

- Grid Instability
- Managing Resource Variability & Intermittency
- Forecasting and Scheduling
- Impact on Conventional Generators

FOR has published model **state level framework** for Forecasting and Scheduling. However, implementation of such mechanism at **state level** would be quite challenging

**Roles and Responsibility**

| Centralized Model | De-Centralized Model | Composite Mechanism |
|---|---|---|
| • State Level F&S done by SLDC | • Generator level F&S done at Pooling Substation | • Scheduling done by SLDC<br>• Forecasting done at Pooling Substation |

**Participants**

| | |
|---|---|
| Volume of Generators & Generating Stations | *More than 25000 WTGs, > 24 GW of WTG installations* |
| | *More than 9000 Generators/Owners /project site locations* |
| Number & types of transactions | *Different off-take arrangements* |
| | *Flexibility to change off-take over Useful life* |
| Coverage and applicability | *Existing and New and Upcoming* |
| | *Inter-State and Intra-State* |
| | *Hybrid RE* |

**Composite model** combines the advantage of earlier models and safeguards generators against individual forecast risk . A solution that fits for all permutations & combinations for **all participants** has to be developed

# Grid Operational Challenges due to High RE Penetration (4/4)

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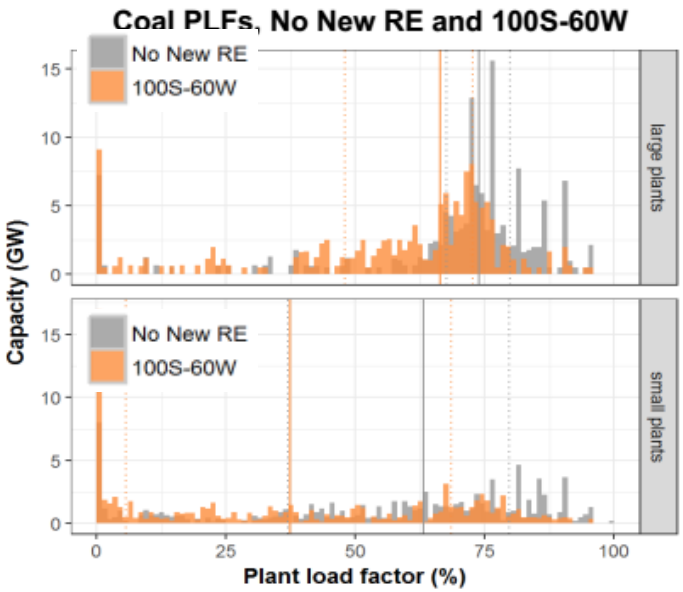
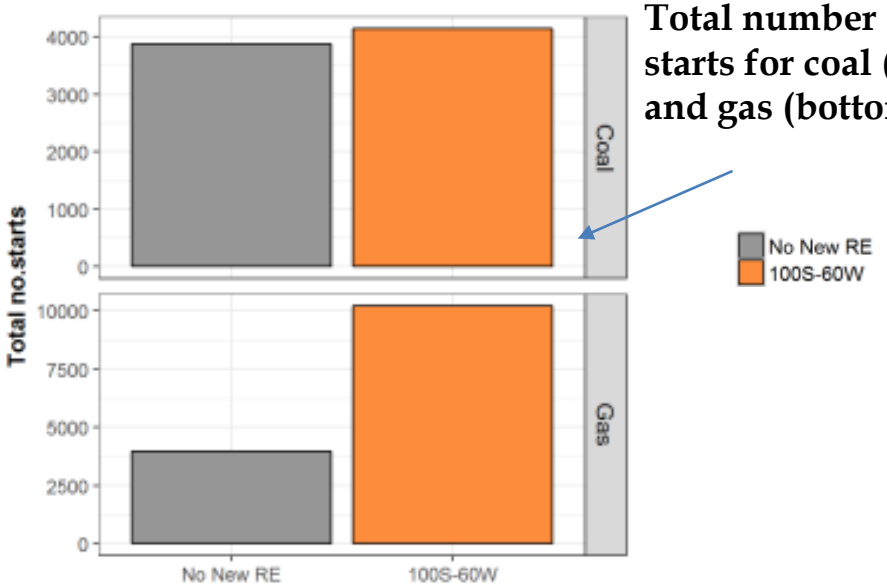
## Challenges

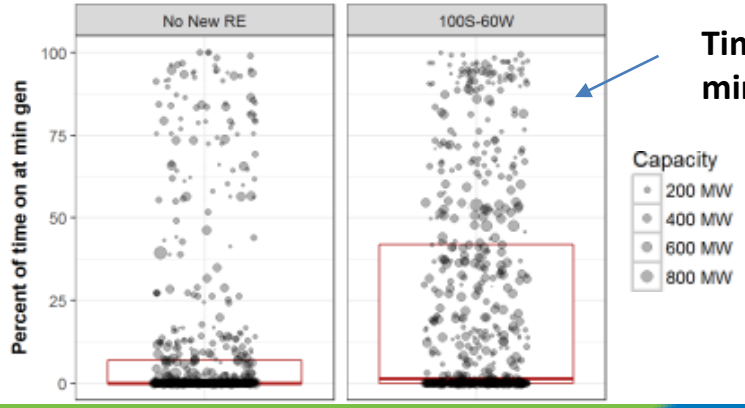
- Grid Instability
- Managing Resource Variability & Intermittency
- Forecasting and Scheduling
- Impact on Conventional Generators

**Adverse Impact on Thermal Generation due to Less Generation, Lower PLF, More starts and more time at minimum generation**




**Total number of starts for coal (top) and gas (bottom)**




**Time subcritical coal plants spend at minimum stable level when online**

*Source: GTG Review Committee Report*

In 100S 60 W compared to no RE capacity addition,

- Average Coal and Gas Plant Load Factor drastically Falls
- Gas Plants and Coal Plants face more starts and spend more time at minimum generation

# Strategies to improve RE integration

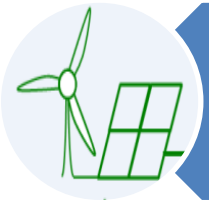
## Issues for Discussion

**Forecasting, Scheduling and Despatch**

- Deployment of REMCs- Real-time monitoring of grid connected Solar and Wind Generators & enhancing netload forecasting ability of Discoms
- Operationalizing Intra-state DSM

**Ancillary Services**

- Development of Ancillary Market Services- Implementation of AGC, Building reserves capacity
- Battery storage for ancillary services- Development of multiple pilot /demonstration storage projects
- Encouraging Electric Vehicles



**Optimal Utilization of Resources**

- Development of Hybrid RE solutions- Amendments to Codes to address Technical challenges for hybrid RE
- Valuing hydro dispatch for optimization
- Retiring old Coal power plants that inturn increases the average PLF
- Reduction in Coal minimum generation by moving from state to regional level coordination

**Institutional capacity building at SLDC**

- Training and Capacity Building initiatives and National level under the aegis of NLDC/FOLD

# Thank You

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