

# 2<sup>nd</sup> International Conference on Large-Scale Grid Integration of Renewable Energy

## Development of Mechanisms to Incentivize Inter- state Exchange of Renewable Energy

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Greening the Grid (GTG) Program

A Partnership between USAID/India  
and Government of India



# Contents

## 1. Introduction

## 2. Key drivers of RE capacity addition in India

## 3. Issues in inter-state RE exchange

- **Regulatory**
- **Transmission**
- **Markets & Commercial**

## 4. Interventions

## 5. Conclusion

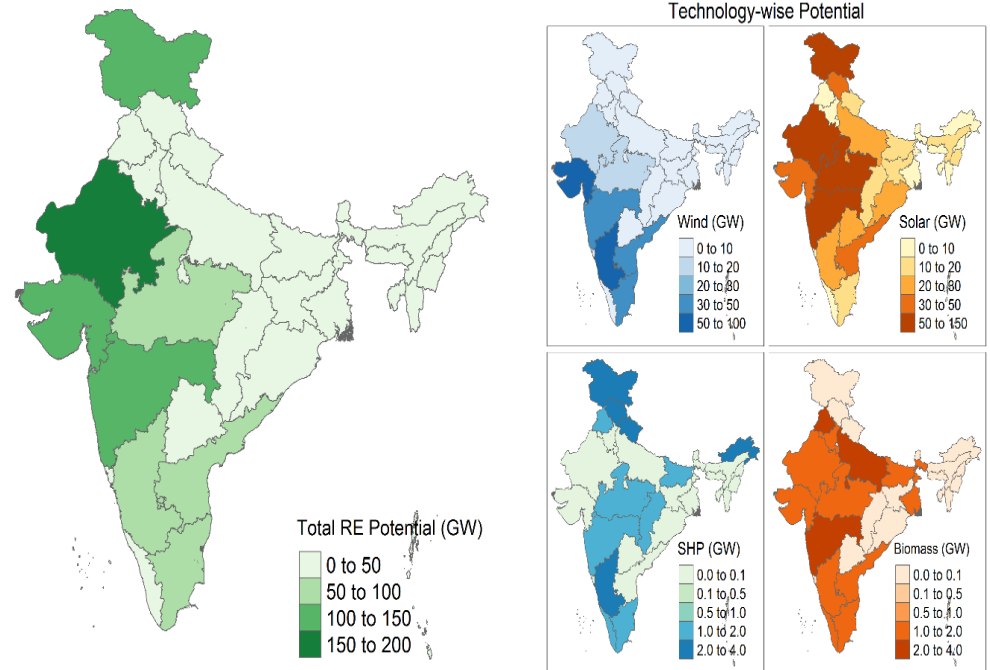
# Introduction

- Identify factors that currently inhibit trading/exchange of RE across the states
- Critical review of existing regulatory, policy, commercial, and infrastructural constraints to identify key challenges and potential measures that need to be addressed
- Suggesting measures to create an eco-system for sustainable inter-state exchange of RE

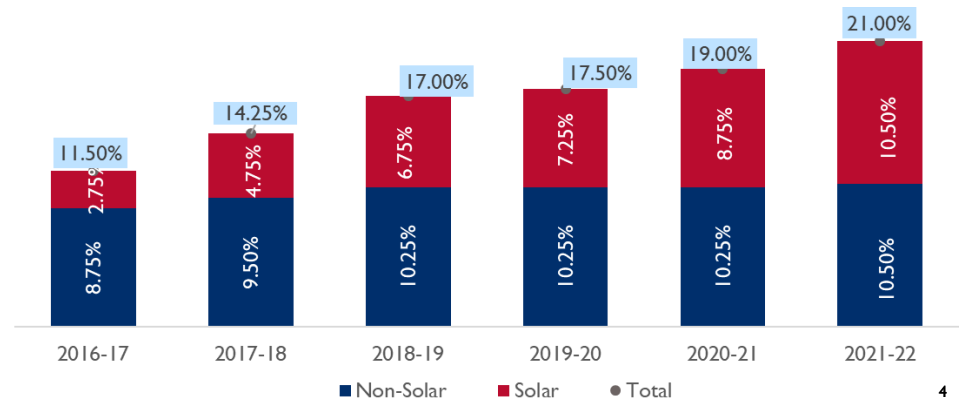


# Key drivers of RE capacity addition in India

- High RE potential in country (Solar 750 GW; Wind 302 GW)
- Eight states have over 60% & 90% of the total solar and wind potential in the country
- Uneven geographical distribution of the potential results in RE rich and deficit states
- Government incentives
- **RPO Targets by SERCs**
- Declining cost of RE generation boosting affordability



Source: GOI Energy Statistics-2018



## Issues in inter-state RE exchange

- **Regulatory**
- **Transmission**
- **Markets & Commercial**

# Issues in Promoting Inter-state RE Exchange

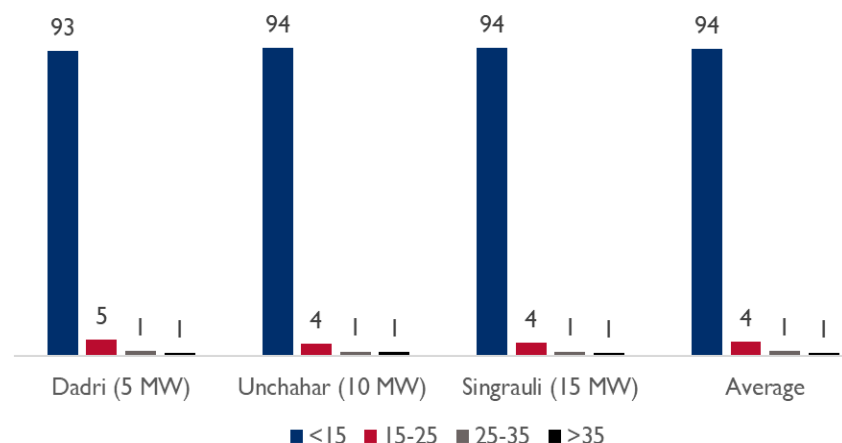
Effective RE Grid Integration is Prerequisite for Promoting Inter-state RE Exchange

	Regulatory	Transmission	Market & Commercial
Issues	<ul style="list-style-type: none"><li>Operational &amp; commercial impact of Regulations</li><li>Misalignment in regulations</li></ul>	<ul style="list-style-type: none"><li>Unavailability of transmission network</li><li>Exemption of inter-state transmission charges</li></ul>	<ul style="list-style-type: none"><li>Incentivization to Flexible Operations of TPPs</li><li>Handling of load generation imbalance through DSM</li></ul>
Analysis Performed	<p>Analysis of regulations pertaining to,</p> <ul style="list-style-type: none"><li>RE generation forecast error</li><li>Deviation in state's drawl from regional grid</li><li>Ancillary services</li></ul>	<ul style="list-style-type: none"><li>Review of planned transmission network</li><li>Cost recovery mechanism of planned transmission network</li></ul>	<ul style="list-style-type: none"><li>Compensatory framework for flexible operation of thermal power plant</li><li>Imbalance market to incentivize the flexible energy sources</li></ul>



# Regulatory Issue Analysis

## Different RE Forecasting Penal Mechanisms

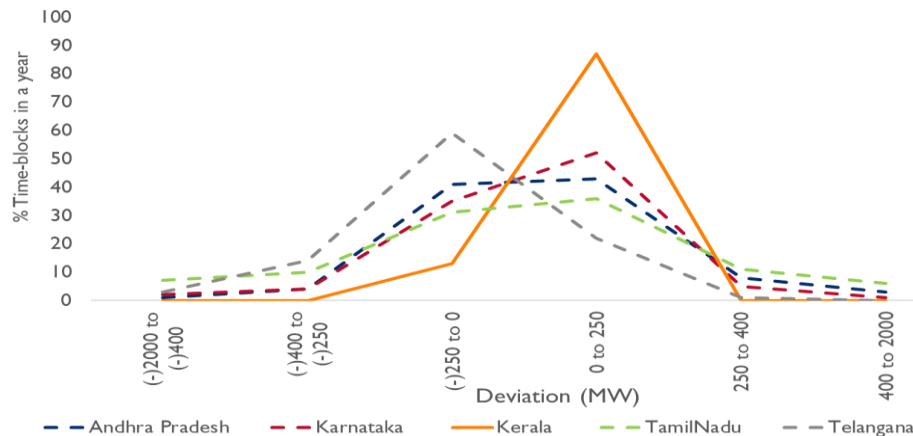
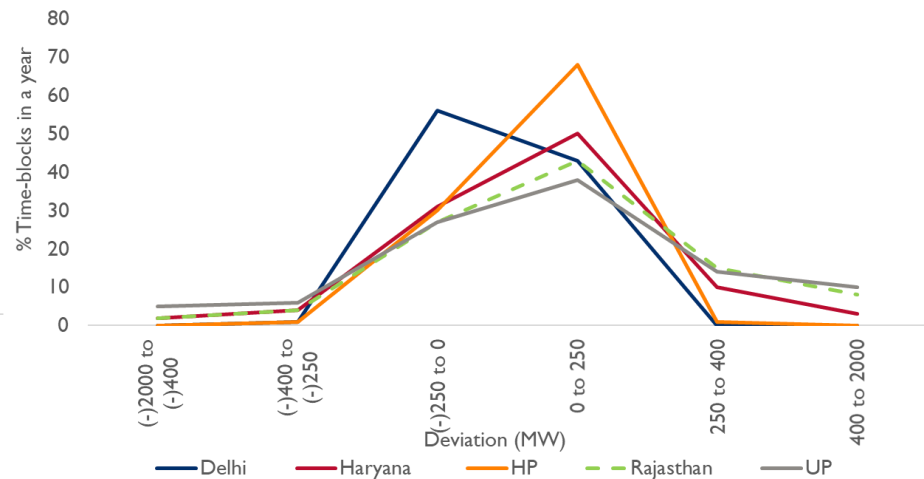
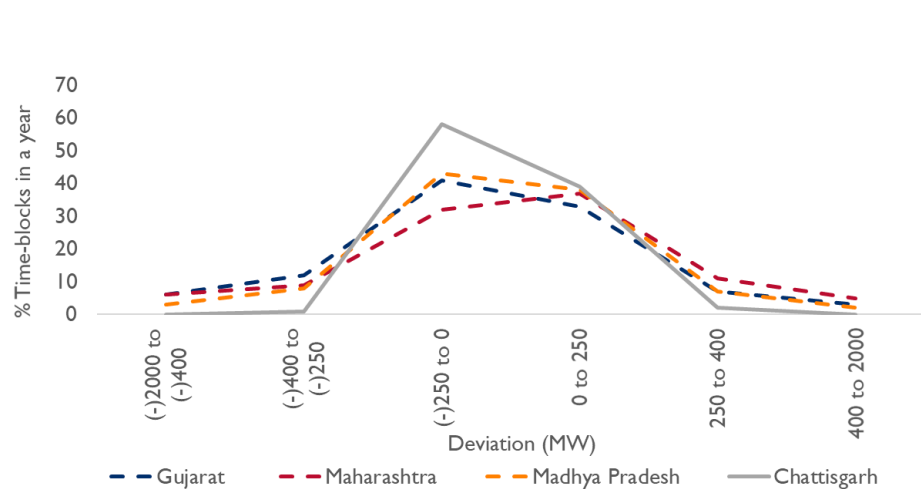


Particulars	Inter-State Generator	Intra-State Generator
Generator Capacity (MW)	1	1
Annual Generation (MU)	1.66	1.66
PPA Rate (INR/kWh)	2.76	3.93
Forecast Error Penalty (INR)	43,171	2,06,336
Impact on Revenue	0.95%	3.16%

- RE forecasting error (as per F&S Regulation) is within  $\leq 15\%$  for around 90% times of predicted value
- Different penal mechanism at inter-state (PPA linked) & Intra-state (absolute value)
- Fix rate based penalty is deterrent for new low-cost RE developer connected to state's network, more impact on revenue

# Regulatory Issue Analysis

## State-wise Deviation Profiles in Western, Northern & Southern Regions in MW (FY2018-19)



Data Source: Respective Regional Load Dispatch Centre

- In the Northern region, deviation for states of RJ, UP, & Hr is high as compared to other states.
- Low RE penetrated states like UP & Hr having wider deviation range as compared to RJ.
- State with high RE penetration e.g. RJ, TN, KA encountering problem, in managing load-generation imbalance.





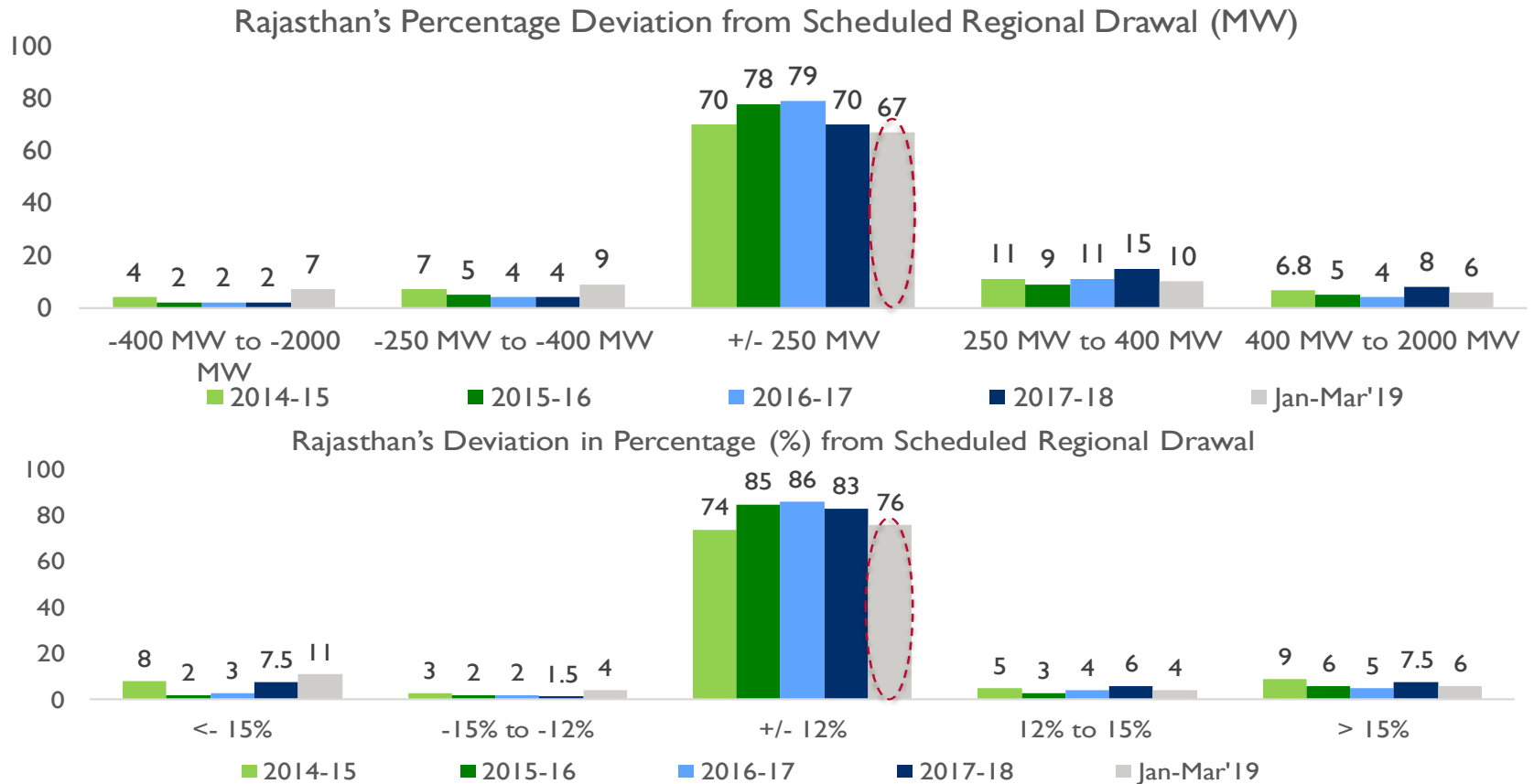
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# Rajasthan Case Study

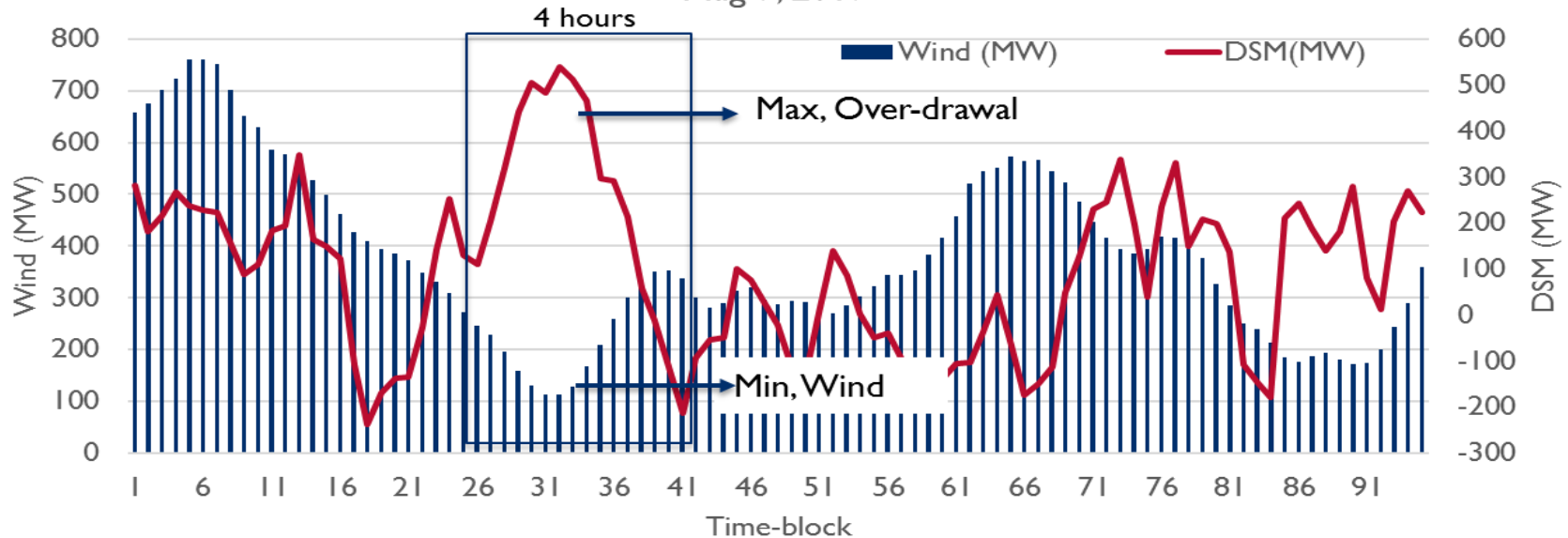
# Trend of Rajasthan State's Deviation Profile



- Rajasthan's schedule deviation stays within  $\pm 12\%$  of schedule, the MW deviation from schedule drawal can be above 250 MW, which leads to additional deviation penalties.
- During Jan-March'19, average monthly over-drawal quantum decreased & under-drawal quantum increased.

# Negative Correlation Between Wind & Regional DSM – Typical Day

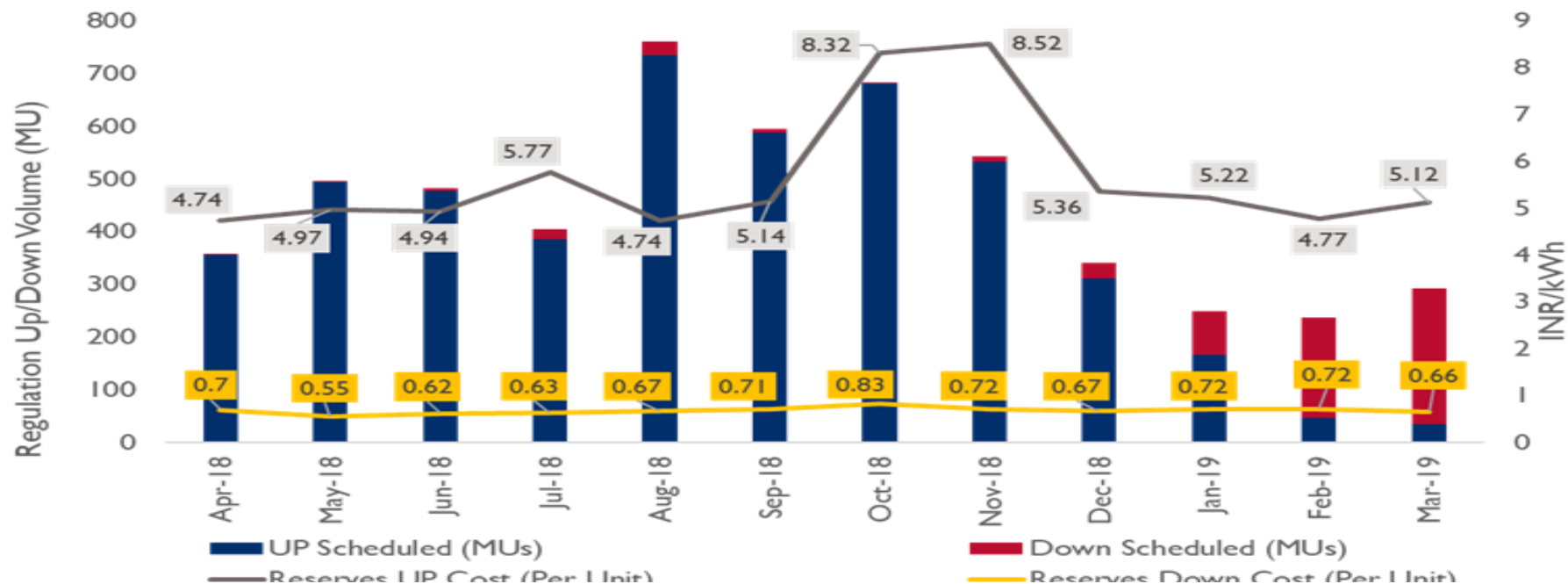
Aug 7, 2017



- Impact of wind variability on state deviation DSM is visible. Similar instances of occurrences are spread across the year (for 23% time blocks of 4 hours each)
- Peak deviation i.e. over-drawl, as seen in the example has crossed 500 MW which is far beyond the permissible level of 250 MW for RE rich states
- Rajasthan need to equip with more flexible generating resources to minimize imbalances

# Regulatory Issues Analysis

## Ancillary Service Deployment for Grid Reliability



- Market linked DSM price impacted Ancillary Service Deployment.
- Since January 2019, ancillary service deployment for regulation-up, decreased substantially, while regulation-down service increases.

# Issues in Transmission Infrastructure

## Transmission Planning for RE Evacuation

Sr No	Region	Phase – I	Phase - II	Total
		Capacity (GW)	Capacity (GW)	Capacity (GW)
<b>1</b>	<b>Western Region</b>			
A	Gujarat	7	9	16
B	Maharashtra	1	6	7
C	Madhya Pradesh	2.5	2.5	5
	<b>Sub-Total (WR)</b>	<b>10.5</b>	<b>17.7</b>	<b>28</b>
<b>2</b>	<b>Northern Region</b>			
A	Rajasthan	10	10	20
<b>3</b>	<b>Southern Region</b>			
A	Tamil Nadu	1.5	1.5	3
B	Andhra Pradesh	4.5	3.5	8
C	Karnataka	2.5	5	7.5
	<b>Sub-Total (SR)</b>	<b>8.5</b>	<b>10</b>	<b>18.5</b>
	<b>Total</b>	<b>29</b>	<b>37.5</b>	<b>66.5</b>

- Planning to add transmission capacity to evacuate solar & wind capacity of 50 GW & 16.5 GW, respectively from **seven RE rich states**.
- Implementation of planned transmission capacity will require investment of INR 43,235 Cr.
- Funding to implement planned transmission network, will be contributed by project developers, solar park fund & socialization.

# Market & Commercial Issues

Review of issues associated with policies, regulations, transmission infrastructure and, market and commercial

## Market & Commercial

- Current PPAs & regulations do not have provisions for recovering financial losses due to flexible operations
- Commercial framework to compensate secondary ancillary services, from automatic generation control need to be developed
- Curtailment without compensation creates impact over project cash flow and debt-service cover ratio
- RE plants without PPAs do not participate in Day Ahead Market, as not allowed to revise schedule, leads to higher DSM penalties



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# Interventions



# Regulatory Interventions

Roadmap to address identified issues and facilitate inter-state RE exchange

## Immediate

1. Alignment in intra-state & inter-state RE forecasting penalty methodologies
1. Load forecasting regulations, for better grid discipline
2. Development of technical & Commercial provisions/guidelines to enhance flexible operation in thermal power plants
3. Development of AGC framework for secondary ancillary service response
4. Facilitating surplus RE exchange and RE Trading on Power Exchange

## Medium - Term

1. Implementation of gate closure
2. Development of imbalance market

## Long - Term

1. Mechanism for equitable cost allocation for transmission infrastructure required for RE

# Technology & Information System Interventions

Roadmap to address identified issues and facilitate inter-state RE exchange

## Immediate

1. Development of Central Data Repository to create an eco-system data driven policy formulations
2. Development of IT implementation strategy to optimize cost of software, hardware and cyber-security
3. Improve real-time connectivity of metering & communication infrastructure to improve RE forecasts

## Medium - Term

1. Implementation of communication & IT systems and its interfacing with different stakeholders for effective implementation of F&S regulation
1. IT application to implement RE curtailment instruction & monitoring of compliance of instructions



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# Conclusion

# Conclusion

- Based on stakeholder consultation, analysis focuses on addressing several challenges in relation to regulation, transmission infrastructure, & markets and commercial interventions
- To manage the complexity emanating from high RE share, technology and information system can play vital role
- It is envisioned that implementing these measures through a phased approach shall result in efficient grid integration of wind & solar power capacity
- An eco-system which addresses the operational & commercial issues will create an eco-system to promote inter-state renewable energy exchange
- Effective RE grid integration is critical for inter-state RE exchange in sustainable manner



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