



**Idam Infrastructure Advisory Pvt. Ltd.**

## **Intra-state DSM Mechanism: Comparison across States**

**A Three-day Residential Course on “Power Market and Impact of Renewables and Electric Vehicles” at IIT Kanpur**

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- DSM framework at regional level : historical developments
- Intra-state Balancing & Settlement : Mandate and status update
- Objectives of DSM mechanism at State level
- Important Steps for implementation of DSM at state level
  
- Why RE Forecasting & Scheduling?
- Regulatory development for introduction of F&S regime
- Central level development of F&S Framework
- Status update on F&S Regulations for RE rich states
  
- Discussion Points and Way forward

## Context setting

- Basics of ABT / DSM mechanism
- Objectives of ABT
- Key Considerations for ABT

# Availability Based Tariff (ABT) / Deviation Settlement Mechanism (DSM)



## - Basics:

- ABT /DSM comprises 3 Part tariff i.e. Fixed Charges, Energy Charges and Deviation charges
- Segregation of accounting of generation and Distribution business is prerequisite for 3 part Tariff.
- Segregation of Account: Station-wise Fixed Cost Comp. for capacity charge determination

## Enabling Provisions :

- S. 32 of the EA, 2003 ,
- S. 5.7.1 (b) of NEP, 2005, S. 6.2 (1) of Tariff Policy 2006 & 2016,
- Reg. 6.4.1 of IEGC 2010,
- Recommendations of the FoR – June 2006 and 2008,

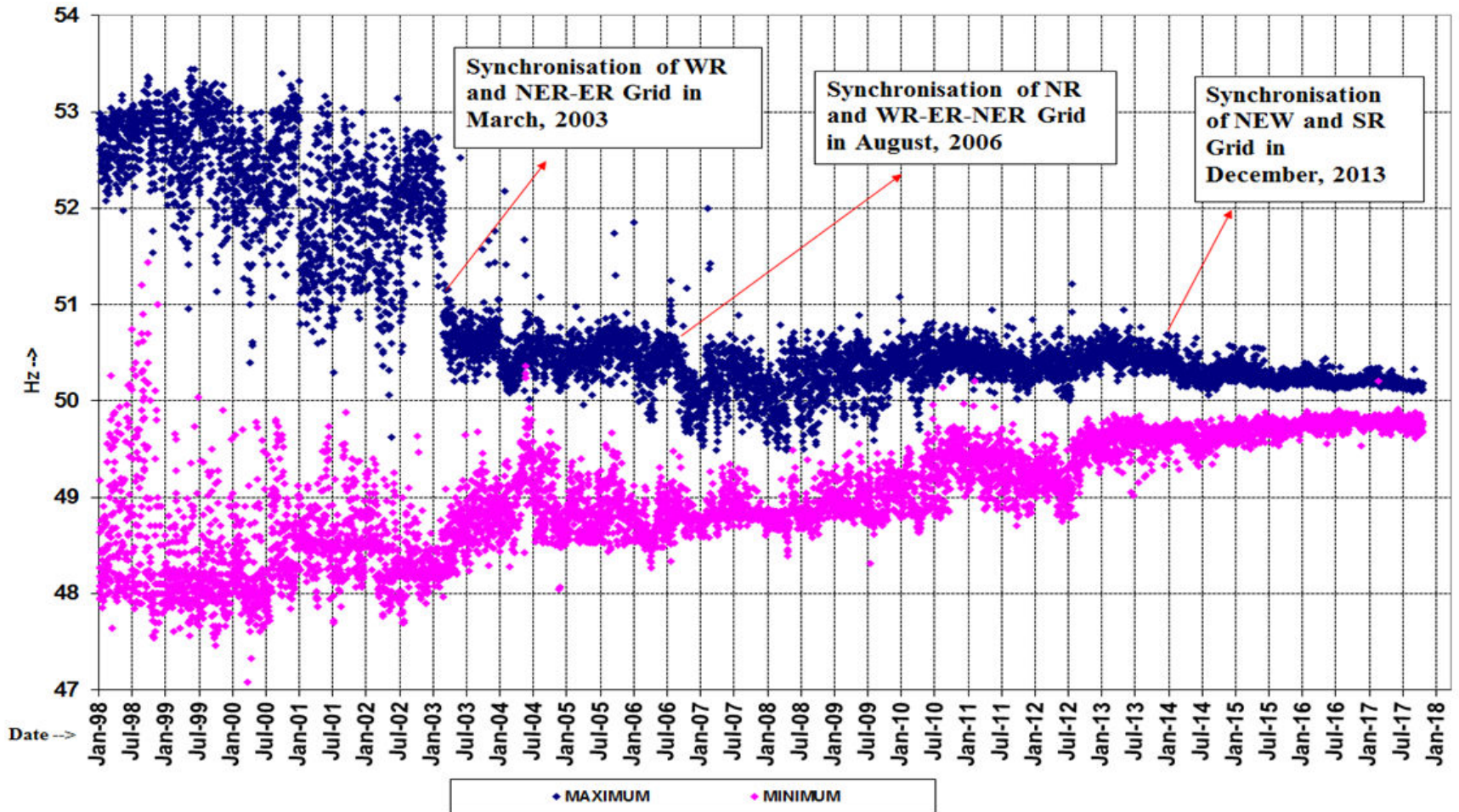
## - Objectives

- **Secure and reliable grid operations**
- Encouraging higher availability of Generation
- Instill **forecasting and load management discipline** amongst Discoms, load serving entities and OA consumers
- Ensure **despatch discipline amongst generators** based on economic/ merit order principles
- **Serve as a balancing mechanism** within the state
- **Facilitate energy accounting and deviation settlement** in transparent manner

## Applicability and Coverage :

- Generating Stations – Thermal, Hydel, Renewable
- Distribution Licensees, Deemed Distribution Licensees (SEZs, Railways)
- Open Access Users (TOAUs / DOAUs) and (Full OA Users and Partial OA Users)
- Captive Users (Captive Wheeled, In-Situ)

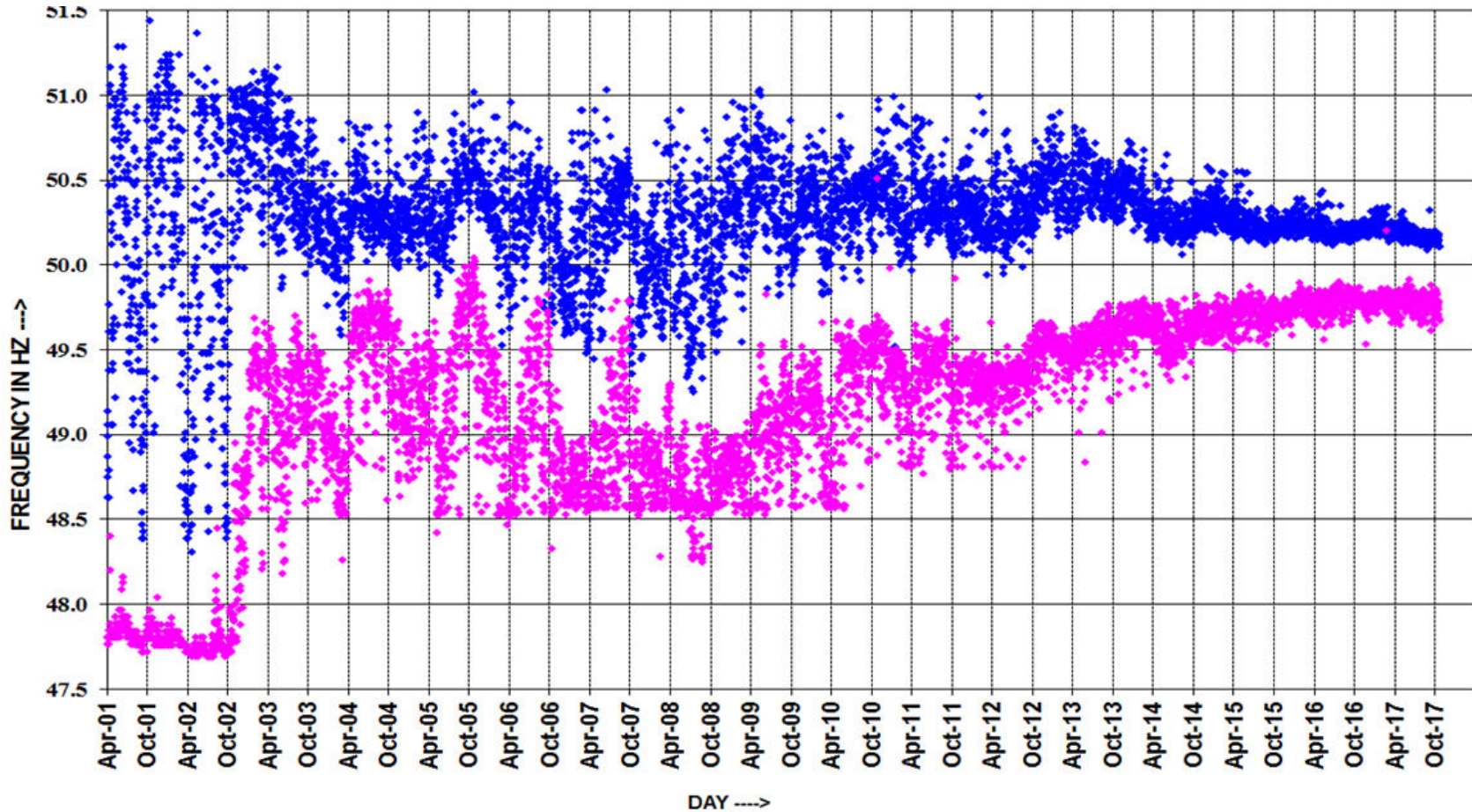
# Maximum and Minimum Frequency Profile<sup>7</sup>



<sup>7</sup> – Based on ER / NEW Grid Data  
Source : POSOCO and CERC



# Maximum and Minimum Frequency Profile Southern Region<sup>8</sup>



<sup>8</sup> – Based on SR Grid Data till Dec'14 and All India Grid data thereafter

Source : POSOCO and CERC

# Key Basics of Availability Based Tariff (ABT) / Deviation Settlement Mechanism (DSM)



## – Key Considerations

- **Ensuring Grid discipline** – Share of scheduled capacity mgmt at state periphery is ~ 18% to 40% of total capacity/volume handled for intra-state entities. Deviation management (by Volume) for intra-state entities is crucial.
- **Cost Principle** – Should not have significant impact on Cost of power in the state power system as a whole.
- **Market Development Principle** – The new system (balancing & settlement) should promote the development of market, i.e., encourage participation by many buyers and sellers
- **Quality and Efficiency Principle** - Quality of supply and the efficiency of various entities/institutions should improve.
- **Should not be prone to Gaming** – The devised mechanism should not be favourable to any Participant.

## – Key Steps for ABT implementation:

- Identification of Intra-State Entities (SGS, IPPs, CPP/Merchant, DISCOMs, OA Users)
- Identification of interface boundary points (inter-utility and intra-utility, G<>T and T<>D)
- Establishment of metering and communication infrastructure.
- Enabling forecasting, scheduling and load generation balancing systems
- Establishment of IT systems for data acquisition
- **Development of Energy Accounting and Settlement systems**
- Managing deviations of intra-State entities within volume cap and enabling flexible resources / demand response.

- **Introduced in various regions in stages -Western & Northern (2002), Southern & Eastern (2003) and North-Eastern (2003)**
- **Key benefits - Improved grid frequency, Reduced frequency variations, Reduction in interruptions/grid failures**

## State level DSM

- DSM Status Across the States



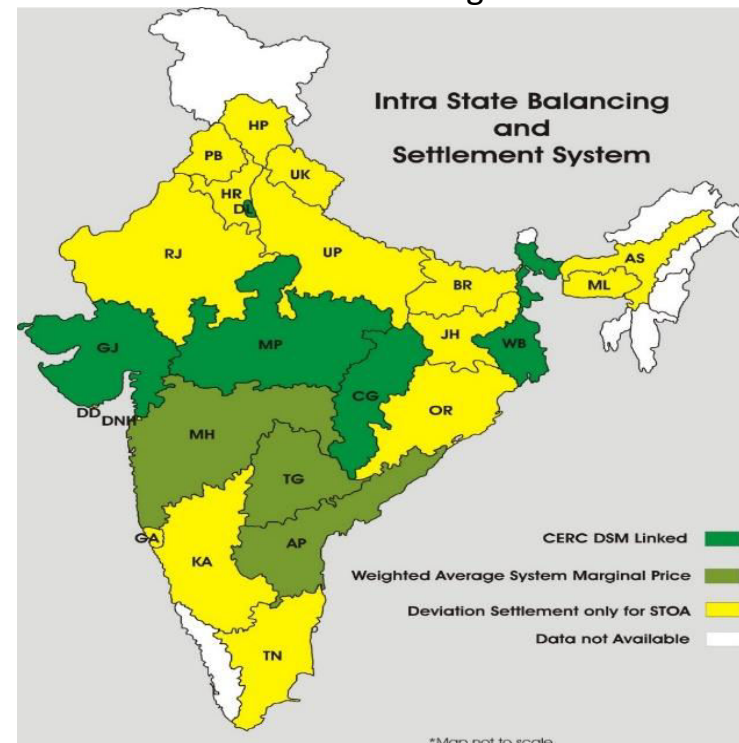
# DSM Status across the States

## SAMAST Category:

- Intra state deviation settlement system for all the intra-state entities within a State/UT has been introduced only in seven (7) States. **(Category-A)**
- Some of the States have Partially implemented deviation settlement system for limited entities. **(Group B)**
- Tamil Nadu is only in **Category C** which has provision of determination of Fixed Charge and Energy Charge within combined utility TANGEDCO. TNERC is in a process of implementation of full DSM
- All other States are under **Category D**

- Delhi - 01.04.2007
- Madhya Pradesh - 30.10.2009
- West Bengal - 01.04.2008
- Gujarat - 05.04.2010
- Chhattisgarh - 01.11.2014
- Maharashtra - 17.05.2007
- Andhra Pradesh & Telangana

| Groups         | Details  |
|----------------|--|
| <b>Group A</b> | SLDCs having the first-hand experience of all the aspects of intra State accounting and settlement system – Delhi, Maharashtra, Gujarat, Madhya Pradesh, West Bengal and Chhattisgarh  |
| <b>Group B</b> | Deviation settlement system has been introduced for a few intra-state entities or mock exercises have been undertaken by SLDC – AP, Telangana, Karnataka, Kerala, UP, Punjab, Rajasthan, Haryana, Uttarakhand, Odisha and Meghalaya. |



# Intra-state entity profiles and deviation management at regional periphery



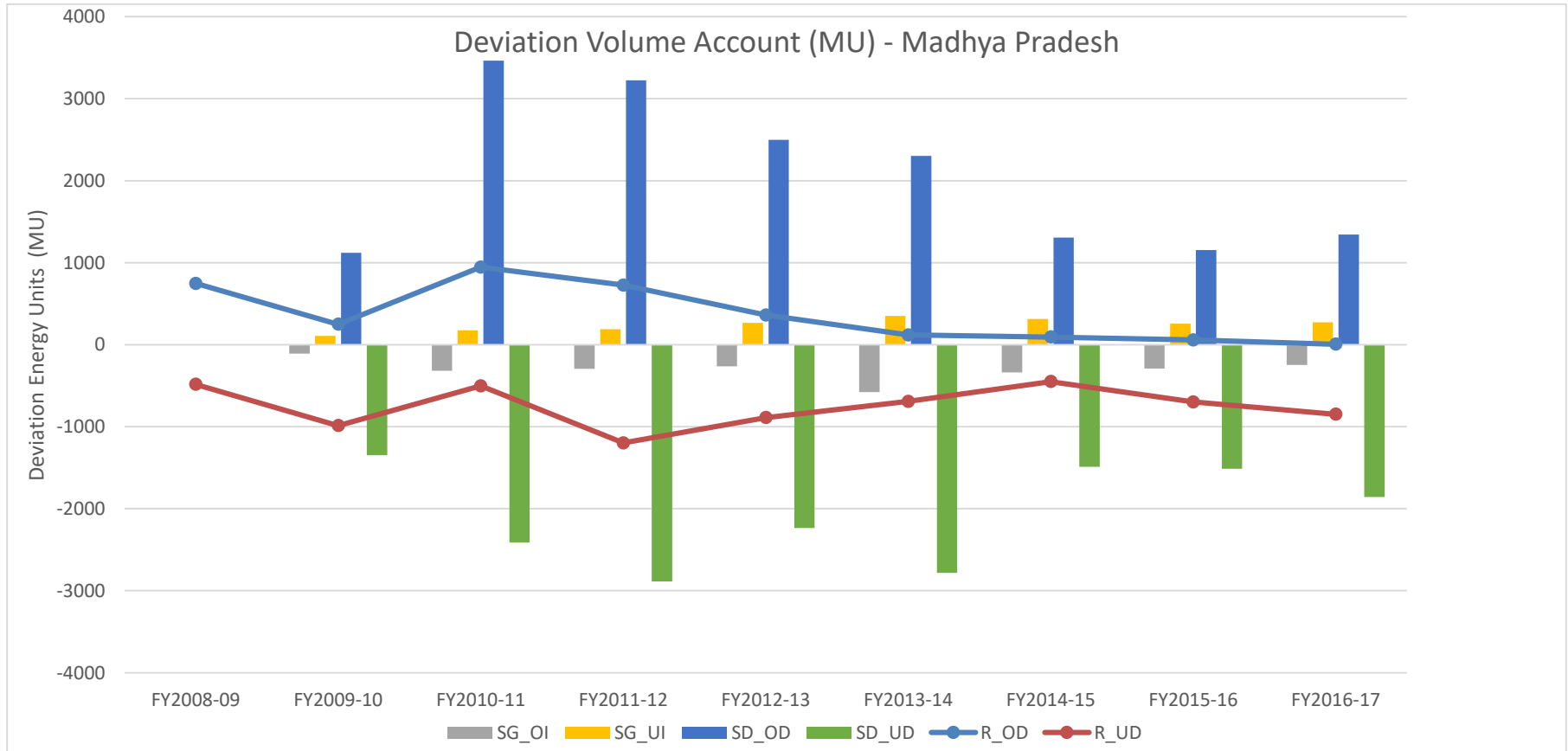
| State       | Deviation Limit | No. of Intra-State Entities<br>(as per SAMAST Report) | Intra-state Entity Profile  |
|-------------|-----------------|---|---|
| Maharashtra | 250 MW          | 423   | <ul style="list-style-type: none"> <li>SGS (10592 MW), Hydel (3332 MW), IPP (12364 MW), RE (6670 MW)</li> <li>ISGS share (7026 MW)</li> <li>Peak Demand: MSEDCL (15657 MW), Rinfra (1359 MW), TPC-D (887MW), BEST (658 MW), Railways (211 MW), MBPPL (13 MW)</li> </ul> |
| Gujarat     | 250 MW          | 389   | <ul style="list-style-type: none"> <li>SGS (7542 MW), Hydel (772 MW), IPP (12702 MW), RE (5437 MW)</li> <li>ISGS share (3872 MW)</li> <li>Peak Demand: DGVCL (2304 MW), UGVCL(2869 MW), PGVCL(3885 MW), MGVCL(1258 MW), T-SEC(627 MW), T-AEC (1576 MW)</li> </ul>       |
| Rajasthan   | 250 MW          | 275   | <ul style="list-style-type: none"> <li>SGS (5794 MW), Hydel (1730 MW), IPP (3196 MW), RE (5555 MW)</li> <li>ISGS share (1809 MW)</li> <li>Peak Demand: JVVNL (5011 MW), JdVVNL (4008MW), AVVNL (3507 MW)</li> </ul>   |
| Tamil Nadu  | 250 MW          | 790   | <ul style="list-style-type: none"> <li>SGS (5294 MW), Hydel (2182 MW), IPP (3865 MW), RE (10118 MW)</li> <li>ISGS share (5142 MW)</li> <li>Peak Demand: TANGEDCO (13775 MW),</li> </ul>   |
| Karnataka   | 200 MW          | 428   | <ul style="list-style-type: none"> <li>SGS (4348 MW), Hydel (3600 MW), IPP (2167 MW), RE (5466 MW)</li> <li>ISGS share (2104 MW)</li> <li>Peak Demand: BESCO(4191 MW), HESCO(1257 MW), GESCOM(974 MW), MESCOM(718 MW), CESC(1137 MW)</li> </ul>                         |

# Overview of State Experience: Entities, Deviation Mgmt and costs – MP Experience (since 2009)



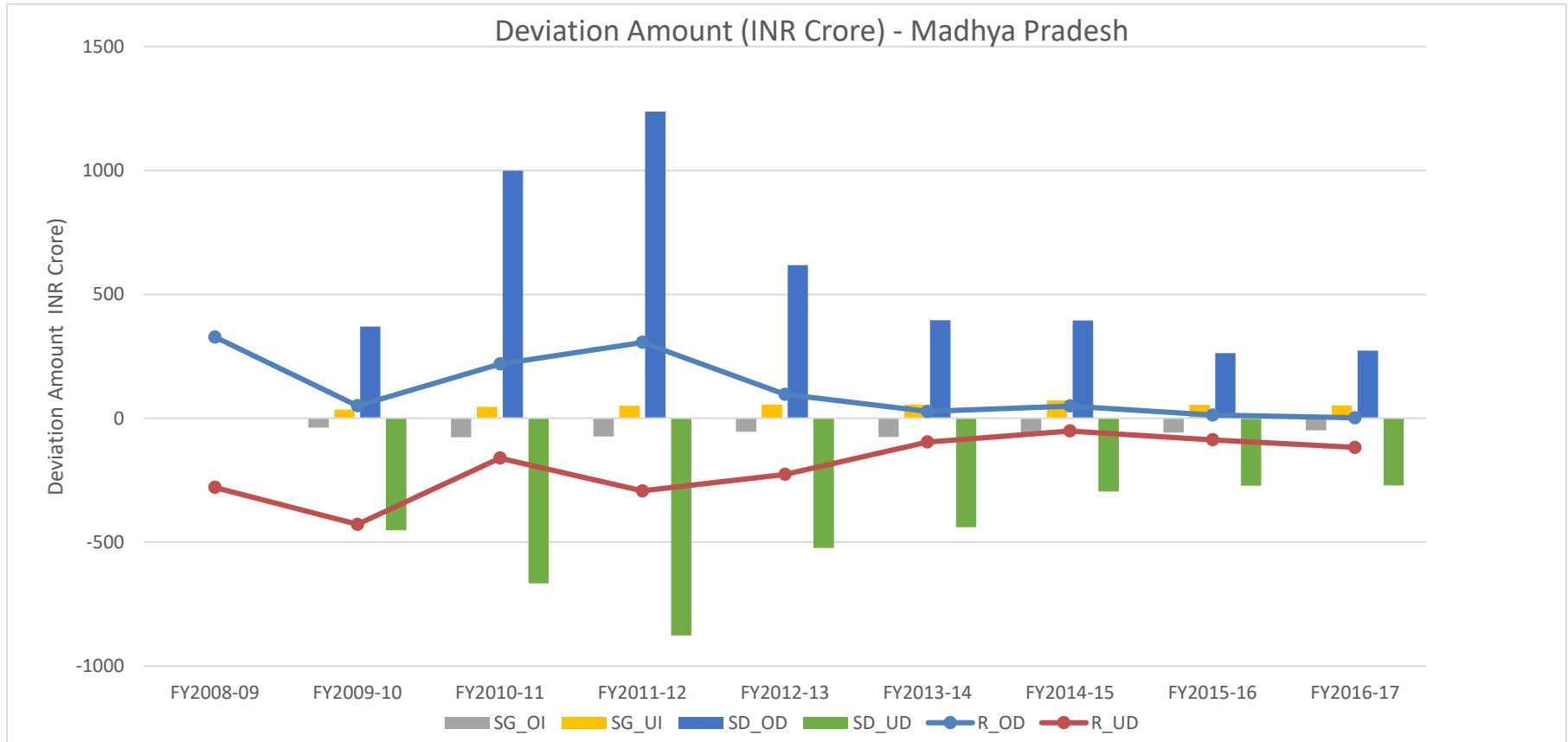
| State   | Madhya Pradesh   |
|---|--|
| Introduction of ABT at State level                          | Nov 2009   |
| Intra-State Entity Profile                                  | SGS (4080 MW), Hydel (3223 MW), Private generators (9390 MW), RE (3800 MW) |
| No. of Intra State Entities (As per SAMAST Report)          | 214  |
| Peal Demand FY16-17 (in MW)                                 | 11512  |
| Power share from CGS/ISGS (in MW)                           | 5033 (43.76%)  |
| Deviation limit   | 150 MW   |
| Total ARR for FY 16-17 (INR Crore)                          | 26,508   |
| Net Deviation Charges for FY16-17 (INR Crore)               | (120.56)   |
| Total Deviation charges payable for FY 16-17 (INR Crore)    | 3.14   |
| Total Deviation Charges Receivable for FY 16-17 (INR Crore) | (123.66)   |

# Madhya Pradesh : Deviation Account (MU) FY09 to FY17



- Pre DSM and Post DSM (at state level) : significant improvement over the period
- Improvement in Balancing/Deviation management by Intra-state entities over the period
- Share of energy units handled at state periphery is ~ 35% of total energy units handled for intra-state entities

## Madhya Pradesh : Deviation Amount (INR Cr) FY09 to FY17

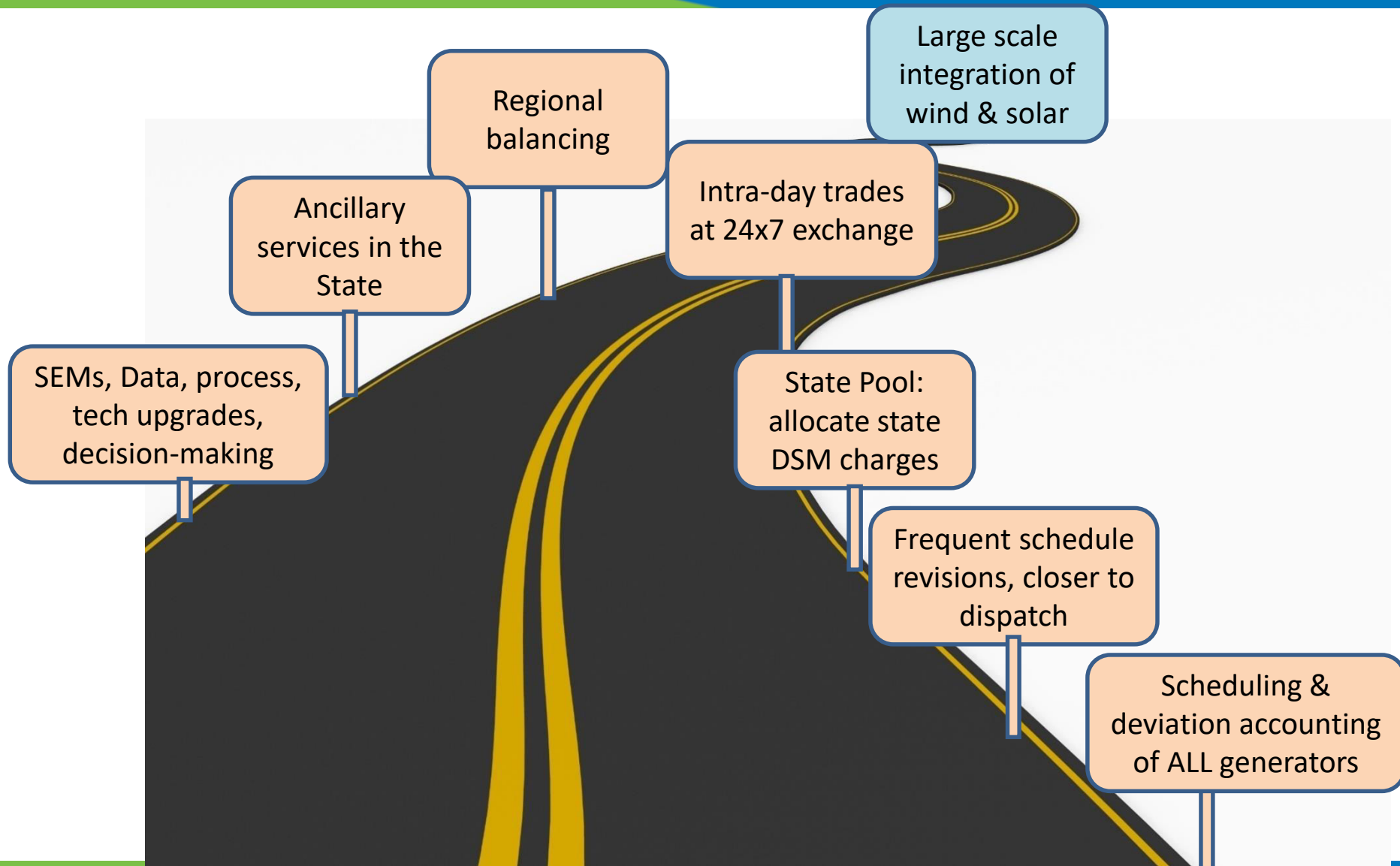


- Pre DSM and Post DSM (at state level): Improvement in Regional UI (payable/receivables) management
- No significant cost implications for Intra-state entities.
- Causer pays principle well established.

- With introduction of ABT at state level, there has been overall improvement in system operations and it has facilitated SLDCs to ensure **secure and reliable grid operations** while bringing in more generation in the system
  - It has helped SLDC to instill **forecasting and load management discipline** amongst Discoms, load serving entities and OA consumers
  - **Cost implications** for the sector is not significant as it has ensured **despatch discipline amongst generators** based on economic/ merit order principles. *(SGS deviations receivables/payouts are not significant, Regional Deviation Cost management has improved)*
  - DSM framework at state level has **served as a balancing mechanism** within the state
  - It has facilitated **energy accounting and deviation settlement** of transactions in transparent manner.
- **DSM at State Level helps the States to manage overall Load-Generation balance**
  - **DSM at State Level also help in maintaining Regional Load-Generation balance**
  - **For Large scale RE integration, DSM of RE generation is necessary.**
  - **Rules of DSM for conventional Generation and Variable RE ( wind and Solar) generation needs to be different, Hence, RE DSM needs to be designed separately**



# Roadmap for Large Scale RE Integration

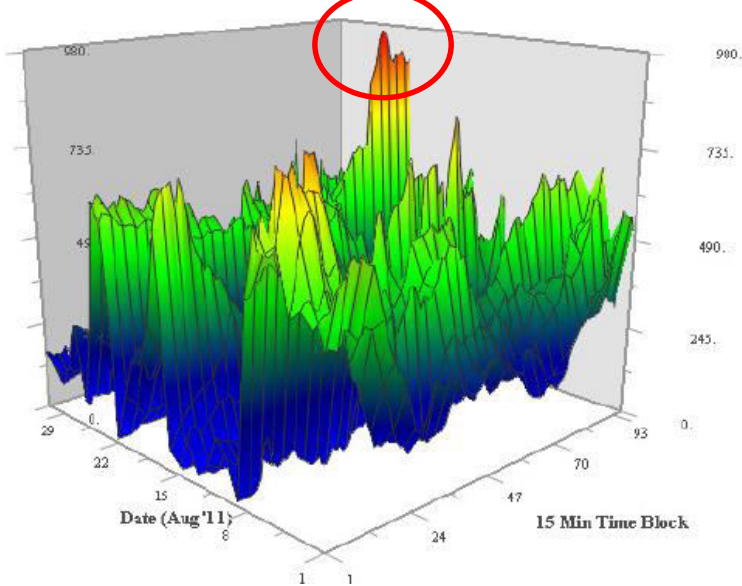


## Forecasting, Scheduling and DSM Framework for Wind and Solar Generators

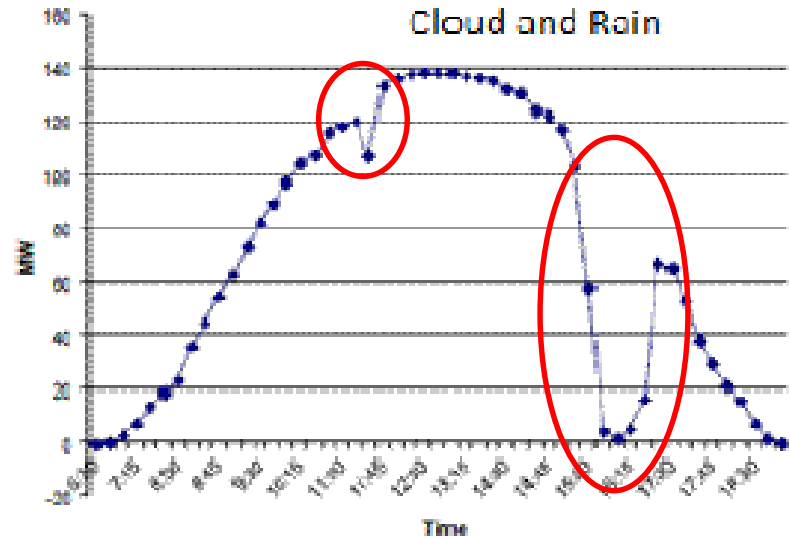
- Need of variable RE F&S and DSM
- Large scale RE capacity addition
- Key Regulatory Development
- Development at National level

# Why RE Forecasting & Scheduling?

### Wind generation in Rajasthan (August)



### Solar generation (Charanka) in Gujarat (April)



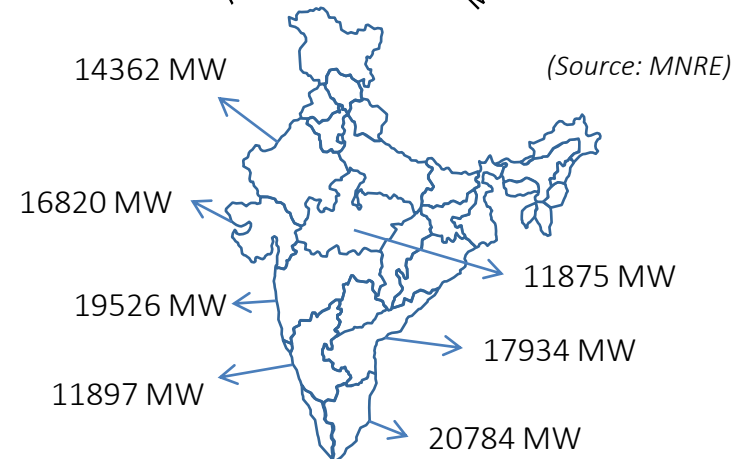
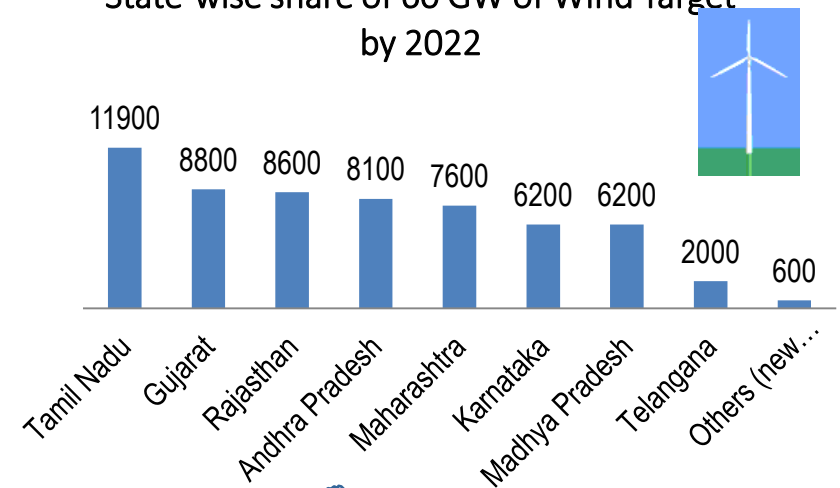
- 1 • Seasonal and diurnal variation of Wind/Solar generation, Challenges for System Operator
- 2 • Lack of regional balancing (lack of inter-State, inter-regional corridor)
- 3 • Low availability of hydro power (PSS) , gas fired TPS for balancing( high cost)
- 4 • Limited ability to back-down thermal generation (limitation due to technical minimum)
- 5 • To facilitate Inter-state RE Transactions, scheduling and energy accounting is pre-requisite.

# Significant variable RE integration (Wind -60 GW and Solar-100 GW) planned by 2022

State-Wise share of 100GW of Solar Targets by 2022

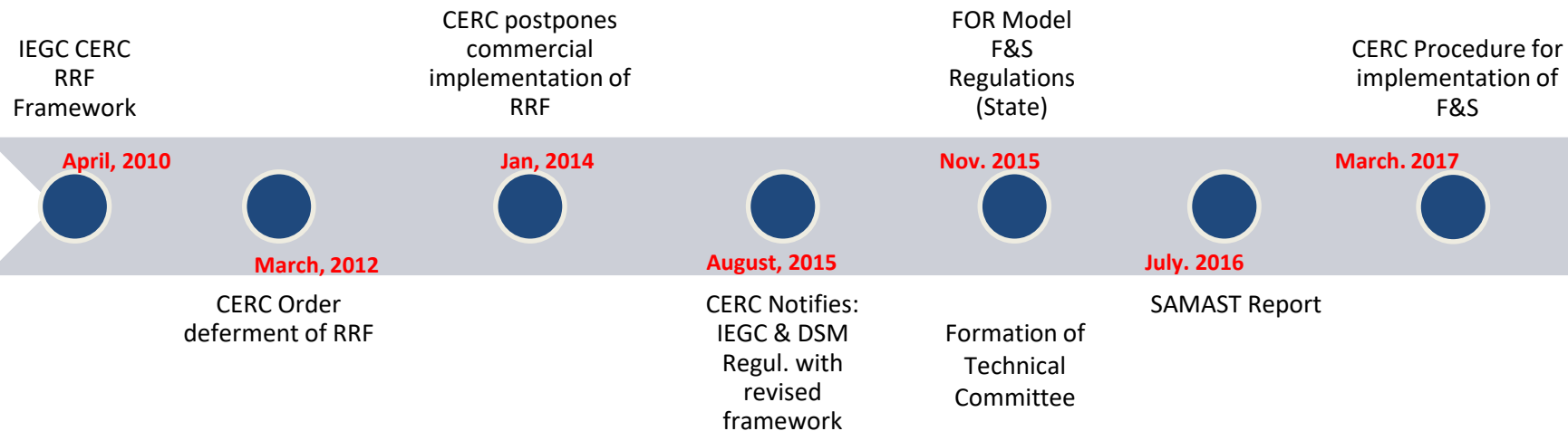
|                        |                  |               |                             |                   |               |
|------------------------|------------------|---------------|-----------------------------|-------------------|---------------|
| 1                      | Delhi            | 2,762         | 20                          | Kerala            | 1,870         |
| 2                      | Haryana          | 4,142         | 21                          | Tamil Nadu        | 8,884         |
| 3                      | Himachal Pradesh | 776           | 22                          | Puducherry        | 246           |
| 4                      | J&K              | 1,155         | <b>Southern Region</b>      |                   | <b>26,531</b> |
| 5                      | Punjab           | 4,772         | 23                          | Bihar             | 2,493         |
| 6                      | Rajasthan        | 5,762         | 24                          | Jharkhand         | 1,995         |
| 7                      | Uttar Pradesh    | 10,697        | 25                          | Odisha            | 2,377         |
| 8                      | Uttarakhand      | 900           | 26                          | West Bengal       | 5,336         |
| 9                      | Chandigargh      | 153           | 27                          | Sikkim            | 36            |
| <b>Northern Region</b> |                  | <b>31,120</b> | <b>Eastern Region</b>       |                   | <b>12,237</b> |
| 10                     | Goa              | 358           | 28                          | Assam             | 663           |
| 11                     | Guajarat         | 8,020         | 29                          | Manipur           | 105           |
| 12                     | Chattisgargh     | 1,783         | 30                          | Meghalaya         | 161           |
| 13                     | Madhya Pradesh   | 5,675         | 31                          | Nagaland          | 61            |
| 14                     | Maharashtra      | 11,926        | 32                          | Tripura           | 105           |
| 15                     | D&N Haveli       | 449           | 33                          | Arunachal Pradesh | 39            |
| 16                     | Daman & Diu      | 199           | 34                          | Mizoram           | 72            |
| <b>Western Region</b>  |                  | <b>28,410</b> | <b>North Eastern Region</b> |                   | <b>1,205</b>  |
| 17                     | Andhra Pradesh   | 9,834         | 35                          | Andaman Islands   | 27            |
| 18                     | Telangana        |               | 36                          | Lakshadweep       | 4             |
| 19                     | Karnataka        | 5,697         | <b>All India</b>            |                   | <b>99,533</b> |

State-wise share of 60 GW of Wind Target by 2022



Large scale integration of Variable (Solar & Wind) energy is envisaged in the coming years in the Indian Grid

# Regulatory Developments related to Wind and Solar F&S framework



- States like Karnataka, TN, Gujarat, Rajasthan, AP, PB, HR, Telangana, Maharashtra came out with their Draft /final F&S Regulations in line with FOR Model F&S Regulations, 2015.
- Out of which only Karnataka State has started the implementation of F&S Regulations from June, 2017.

## **CERC**

- The CERC specified its F&S Framework for Solar and Wind energy at the national level through the CERC (Indian Electricity Grid Code) (Third Amendment) Regulations, 2015 and CERC (Deviation Settlement Mechanism and related matters) (Second Amendment) Regulations, 2015.
- The CERC has amended its IEGC and DSM Regulations to incorporate this F&S Framework.
- NLDC has formulated a detailed F&S procedure defining the roles and responsibilities of the entities involved and the procedures to be followed by them in pursuance of the CERC Framework.

## **FOR**

- FOR circulated Model Regulations on forecasting, scheduling and deviation settlement for Solar and Wind Generating Stations at the State level to the SERCs in November, 2015.
- However, various issues were raised by stake-holders regarding such Frameworks at the Regional and State levels. In order to address these issues, a Technical Committee was constituted on 18 November, 2015 by the FOR.
- The Technical Committee has proposed revisions to the FOR Model Regulations to facilitate implementation at the State level.



## CERC Framework for Forecasting, Scheduling and DSM Framework for Wind and Solar Generators

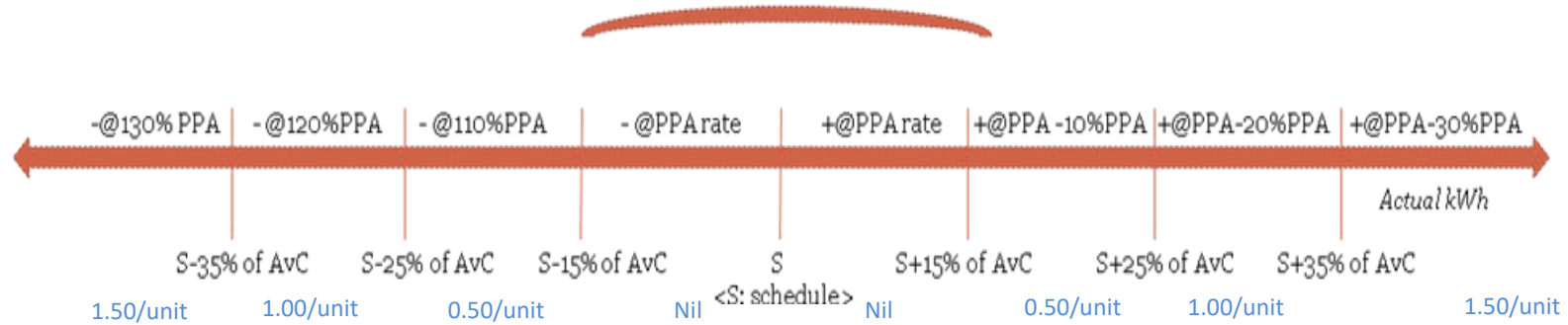
- CERC Framework for RE F&S and DSM

# CERC F&S and DSM Framework for Solar and Wind Generators



| Sr. | Particulars                                      | Description   |
|-----|--|---|
| 1   | <b>Objective</b>                                 | To maintain grid discipline and grid security as envisaged under Grid Code through commercial mechanism for deviation settlement through drawal and injection of electricity by users of the grid.  |
| 2   | <b>Applicability</b>                             | Applicable to Solar and Wind Generators which are Regional entities, whether supplying power to the distribution licensees under PPAs, or through open-access to third party consumers or for captive consumption.  |
| 3   | <b>Forecasting</b>                               | Multiple forecasting by both the RLDC/REMC and Solar and Wind Generators for better confidence level/lower Forecast Errors.   |
| 4   | <b>Frequency of revision of schedule per day</b> | One revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to a maximum of 16 revisions during the day.  |
| 5   | <b>Definition of Forecasting Error</b>           | $\text{Error (\%)} = \frac{\text{Actual Generation} - \text{Scheduled Generation}}{\text{Available Capacity}} \times 100$ Where Available Capacity is the cumulative capacity rating of the Wind turbines/Solar inverters that are capable of generating power in a given time block. |
| 6   | <b>Tolerance Limit</b>                           | Within +/-15% band  |
| 7   | <b>Data Telemetry</b>                            | Data relating to power system output and weather provided by Solar and Wind Generator   |
| 8   | <b>Generators Payouts linked to</b>              | <ul style="list-style-type: none"> <li>• On Schedule basis (inter-state)</li> <li>• On Actual basis (intra-state)</li> </ul>  |
| 9   | <b>Deviation Pricing</b>                         | <ul style="list-style-type: none"> <li>• Linked to Fixed Rate/PPA (inter-state)</li> <li>• PU INR 0.50, 1.0, 1.50 (intra-state)</li> </ul>  |

# Mechanism for DSM for intra/inter-state transactions



- Error definition:  $[(\text{Actual generation} - \text{Scheduled generation}) / \text{Available Capacity}] \times 100$
- Payment as per schedule @PPA Rate
- Deviation Settlement within tolerance band (+/- 15%):
- Receipt from/payment to pool @PPA rate (i.e. in effect, payment as per actuals)
- Beyond 15%, a gradient band for deviation charges is proposed as follows:

| <i>Abs Error (% of AvC)</i> | <i>Deviation Charge</i> | <i>Deviation Charge</i> |
|-----------------------------|-------------------------|-------------------------|
| 15%-25%                     | 110% or 90% of PPA rate | 0.50/unit               |
| 25%-35%                     | 120% or 80% of PPA rate | 1.00/unit               |
| >35%                        | 130% or 70% of PPA rate | 1.50/unit               |

- 16 revisions allowed, one for every one-and-half-hour block, effective from 4th time-block (starting from 0.00 Hrs)

## Key Design parameters for Forecasting, Scheduling and DSM Framework for Wind and Solar Generators

- Key components of F&S Framework

- **Forecasting**
- **Scheduling**
- **Load-Generation Balancing / Despatch management**
- **Absolute Error Formula**
- **Deviation Settlement Mechanism**
- **Generator Payments**

## Objective

### Key Considerations:

- Increasing capacity of Variable RE in the Grid
- Very high Ramp up and Ramp down of Variable RE
- Difficult for System operator to schedule the conventional generation
- Transmission capacity availability

### Key Design Points

- To facilitate large-Scale RE grid integration
- For grid stability as per IEGC
- Comm. mechanism for deviation settlement of variable RE

## Existing RE/New RE, Wind /Solar

### Key considerations

- Applicability of F&S for Variable RE i.e. Wind and Solar
- Need not to differentiate between existing and new variable RE project
- Existing RE projects may have more visibility based on historical data

### Key Design Points

- Applicable to Wind & Solar
- No discrimination between Existing and New RE projects

## Minimum Capacity of RE

### Key consideration

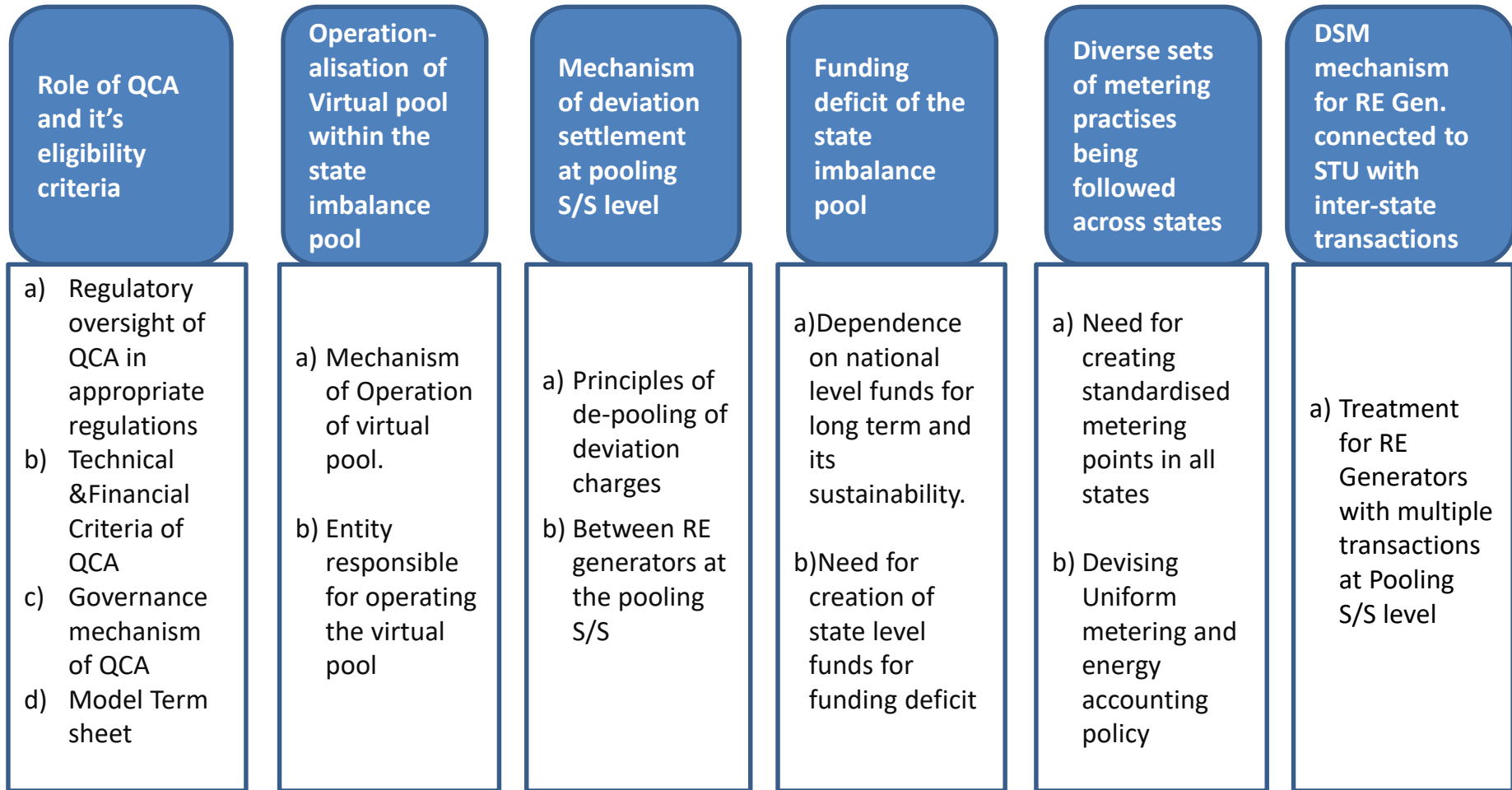
- Visibility of RE generator at SLDC is required
- Difficult to manage RE generation connected to Distribution feeder
- Pooling stn with minimum installed capacity criteria

### Key Design Points:

- Pooling stn. Connected to InSTS
- Min. Installed capacity
- RE generators connected to InSTS with interstate transactions



# Implementation Aspects of State level F&S framework



Implementation of Intra-state DSM mechanism, Adopting Standardised IT/communication protocol, Enhanced visibility of RE generators at SLDC Level will provide a facilitative mechanism to the above

# Issue-1 : Role of QCA (as per FOR Model F&S Regulations and recommendation of FOR Technical Committee)



- **Provide schedules with periodic revisions** on behalf of all the Wind/Solar Generators connected to the pooling station(s),
- **Responsible for coordination with STU/SLDC** for metering, data collection/transmission, communication.
- **Undertake commercial settlement** on behalf of the generators, of such charges pertaining to generation deviations including payments to the Regional/State pool accounts through the concerned SLDC.
- **Undertake de-pooling of payments** received on behalf of the generators from the State UI Pool account and settling them with the individual generators on the basis of actual generation.

## Nos. of QCAs operating at a pooling S/S

- Multiple Pooling S/S and Aggregator

## Institutional and Governance Mechanism

- Modalities of engagement
- Contracting arrangement

## Technical Criteria and Financial Criteria

- Responsibility for settlement
- De-pooling principles

## Issue-2: Operationalising Virtual Pool and De-pooling amongst Generators at Pooling S/S --- 1/2



- **Virtual Pool:** Once the accounting procedures are in place, all RE generators shall be treated together as a ‘virtual pool’ within the State Pool. Deviations for and within this virtual pool could be settled first at the rates and methodology stipulated for wind and solar generators.
- **De-pooling:** The QCA shall also de-pool the energy deviations as well as deviation charges to each generator using one of the following options:
  - In proportion to actual generated units for each time-block for each generator;
  - In proportion to available capacity of each generator

### **Preferred approach:**

- SLDC shall be responsible for maintaining account of Virtual Pool for RE deviations at state level
- Virtual Pool socialise the RE Deviation at State Level which may reduce overall impact of Deviation on RE generators
- No separate Deviation accounting for Solar and Wind deviations for the purpose of ‘Virtual Pool’ operation at state level.
- De-Pooling by QCA at Pooling Station level based on actual energy generation of each Wind/Solar generators as actual energy generation is the only data available to all Stakeholders for verification purpose.

## Issue 2 : Computation of Deviation Charges at Pooling S/S and Virtual Pool Operation ---- 2/2



| Pooling Station No | Available Capacity (MW) | Schedule (MW) | Actual Injection (MW) | Deviation (MW)                   | Deviation (%) | Dev. Charges payable by Individual Pooling Stations (F) |
|--------------------|-------------------------|---------------|-----------------------|----------------------------------|---------------|---|
|                    | (A)                     | (B)           | (C)                   | (D)                              | (E)           |   |
| P.S. – 1           | 140                     | 100           | 130                   | 30                               | 21%           | 4,500   |
| P.S. - 2           | 320                     | 200           | 210                   | 10                               | 3%            | -   |
| P.S. - 3           | 480                     | 300           | 360                   | 60                               | 13%           | -   |
| P.S. - 4           | 360                     | 200           | 190                   | -10                              | -3%           | -   |
| P.S. - 5           | 220                     | 150           | 80                    | -70                              | -32%          | 26,000  |
| <b>Grand Total</b> | <b>1520</b>             | <b>950</b>    | <b>970</b>            | <b>180 (ABS)<br/>+20 (state)</b> | <b>12%</b>    | <b>30,500</b>   |

- Mechanism of operationalisation of the virtual pool within the state imbalance pool.
- QCA to undertake settlement of only Deviation Charges at Pooling S/S with State Imbalance Pool.
- Settlement of Actual /Schedule injection directly between Buyer and Seller.

## Issue 3- De-pooling of Deviation Charges

| Pooling Station No<br>(PS-5) | Available Capacity (MW) | Schedule (MW) | Actual Injection (MW) | Deviation (MW) | Deviation (%) | Dev. Charges payable by RE Generators (F) |
|------------------------------|-------------------------|---------------|-----------------------|----------------|---------------|---|
|                              | (A)                     | (B)           | (C)                   | (D)            | (E)           |   |
| RE Gen – 1                   | 20                      |               | -                     |                |               | -   |
| RE Gen – 2                   | 50                      |               | 10                    |                |               | 3,250                                     |
| RE Gen – 3                   | 60                      |               | 30                    |                |               | 9,750                                     |
| RE Gen – 4                   | 40                      |               | 20                    |                |               | 6,500                                     |
| RE Gen – 5                   | 50                      |               | 20                    |                |               | 6,500                                     |
| <b>Grand Total</b>           | <b>220</b>              | <b>150</b>    | <b>80</b>             | <b>-70</b>     | <b>-32%</b>   | <b>26,000</b>                             |

- a. QCA to provide energy credit statement (monthly / weekly).
- b. De-pooling of Deviation Charges amongst RE Generators on 'Actual' injection instead of 'Av. Capacity'
  - Report for Energy Credit Statement with actual injection by each RE Generator is readily available.
  - Average Available capacity over deviation settlement period (weekly or monthly) need to be ascertained.
  - Certification of Available Capacity over settlement period would be challenge.

## Issue-4 : Funding deficit in state imbalance pool

- There will be always gap between the Deviation Charges payable on account of RE deviation at State level and the Deviation Charges to be collected by RE generators based on the fixed charge as proposed in the Regulations.
- Different options are discussed as for meeting the shortfall.

### FOR Model F&S Regulations

#### Key Considerations:

- Model F&S Regulations envisages that, PSDF/NCEF Funding would be made available for meeting shortfall
- State specific provision of PSDF/NCEF funding is required to consider such option in the Regulations.

#### Key Design Points

- Long term availability of Funding needs to be ensured

### SLDC Fees and Charges

#### Key considerations

- The Shortfall may be passed on through the SLDC's ARR approval process.
- The Commission needs to make specific provision for the same in SLDC ARR
- The RE deviation impact passed on to all the consumers in the State.

#### Key Design Points

- In case of Inter-state transactions, the Deviation charges of Generators will be passed on to the consumers of the State, but power will be utilised by consumers out of the state.

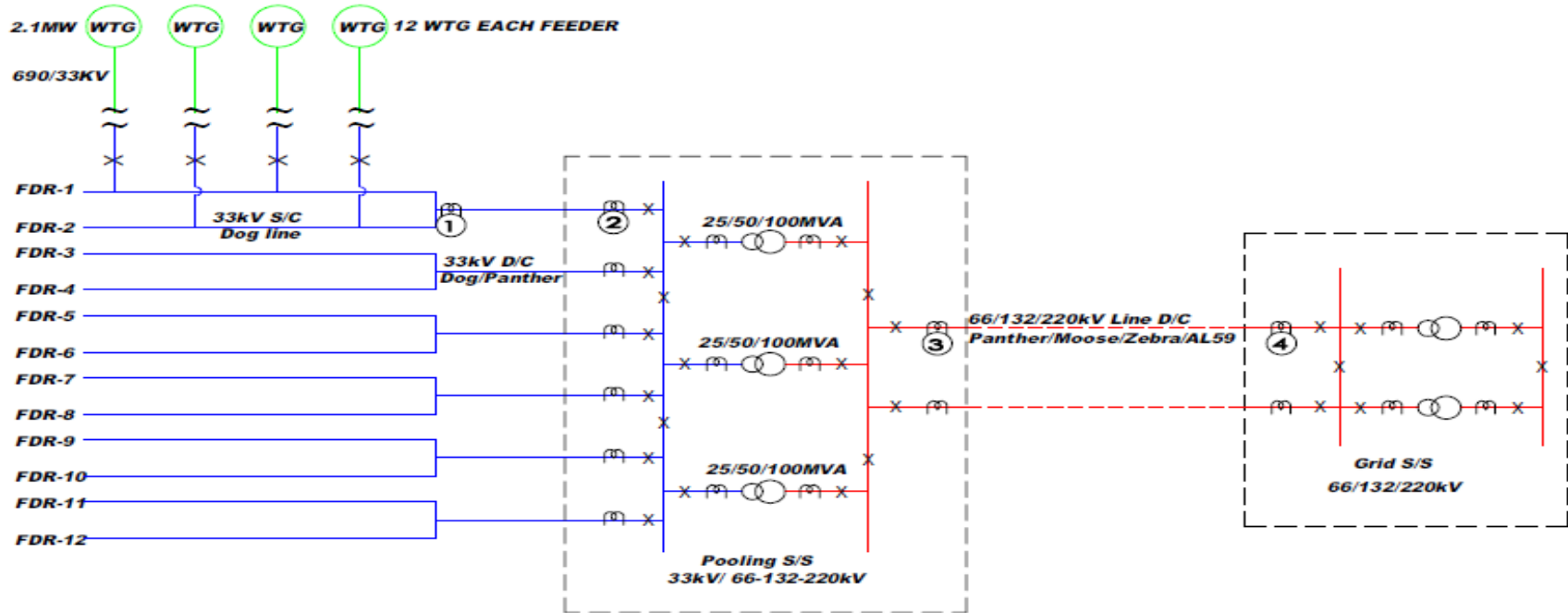
### Zero- Sum approach

#### Key consideration

- The Deviation on account of RE needs to be accounted separately and to be collected from RE generators only
- Shortfall in Deviation Charges will be apportioned back to all RE generators within the Pooling station

#### Key Design Points:

- Zero-Sum ensures long term sustainability of DSM mechanism
- Cast the responsibility on RE generators to maximise the efforts for accurate Forecasting and Scheduling



## Suggestion:

- All the parameters, namely, Schedule Generation, Actual Injection, Deviations, Deviation Charges shall be monitored and accounted for within State Imbalance Pool with reference to Interconnection Point at pooling substation.
- Establish Communication infrastructure and online real time data/information sharing facility to share requisite data/information with SLDC.

- **Payments to RE Generators** are made on the following basis:

- Inter-state transactions- Scheduled energy basis
- Intra-state transactions- Actual energy basis

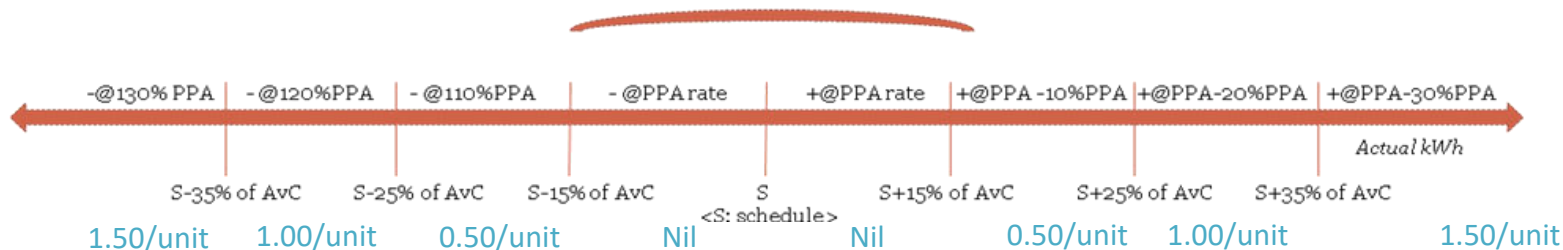
- **Rates for deviation settlement** for RE generators undertaking **inter-state transaction** is based **percentage of PPA Rate or APPC (i.e. 90%, 80% and 70%)** in steps.
- **Rates for deviation settlement** for RE generators undertaking **intra-state transaction** is based on **fixed amount (Rs 0.50, Rs 1.00 and Rs 1.50/kWh)** in steps

- **Deviation Charge settlement** on the following basis:

- Inter-state transactions:
  - For Over-injection – Receipt from DSM Pool
  - For Under-injection – Payment into DSM Pool
- Intra-state transactions:
  - For Over-injection – Payment into DSM Pool
  - For Under-injection – Payment into DSM Pool



# Issue-6: Mechanism for DSM for intra/inter-state transactions



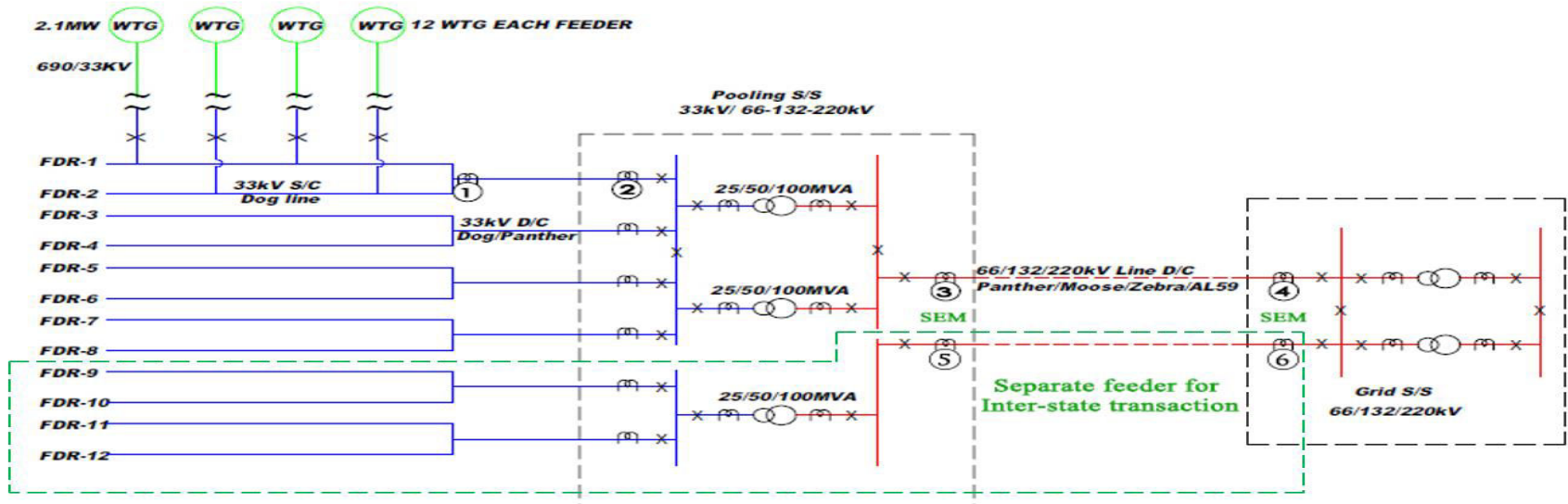
- Error definition:  $[(\text{Actual generation} - \text{Scheduled generation}) / \text{Available Capacity}] \times 100$
- Payment as per schedule @PPA Rate
- Deviation Settlement within tolerance band (+/- 15%) or (+/- 10%):
  - Receipt from/payment to pool @PPA rate (i.e. in effect, payment as per actual)
- Beyond 15%, a gradient band for deviation charges is proposed as follows:
 

| <i>Abs Error (% of AvC)</i> | <i>Deviation Charge</i> | <i>Deviation Charge</i> |
|-----------------------------|-------------------------|-------------------------|
| 15%-25%                     | 110% or 90% of PPA rate | 0.50/unit               |
| 25%-35%                     | 120% or 80% of PPA rate | 1.00/unit               |
| >35%                        | 130% or 70% of PPA rate | 1.50/unit               |
- 16 revisions allowed, one for every one-and-half-hour block, effective from 4th time-block.

### **Key Issue for Discussion**

- Some RE generators connected to a particular pooling S/S may undertake intra-state transaction while others may wish to undertake inter-state transactions
- As schedules are prepared at pooling S/S level, carrying out deviation settlement poses challenge.
- Rules for Treatment for such transactions needs to be defined.

# Issue-6 : Mechanism for DSM for inter-state transactions – 2/2



## Suggestions:

- All inter-state generators at a pooling S/S may be connected through separate feeder.
- Deviations for Inter-State transactions at Pooling S/S to be accounted for separately.
- Virtual Pool Accounting at State level to exclude such inter-State transactions
- SLDC/State Energy Account to provide separate Energy/DSM accounts for inter-State and intra-state transactions to QCA.
- QCA to separately settle Deviation Charges with RE Generators for inter-State and intra-State transactions.
- Reference rate for Deviation Charge computation of inter-State transactions may be APCC of host State.
- In case of shortfall in amount at QCA level or for variation in weekly/monthly cycle, QCA may set rules for pro-rata settlement of inter-State and intra-state transactions of RE Generator(s).

- RE Generators, QCA and SLDC are key entities in implementation of F&S and DSM Regulations.

## RE Generator

### Key Considerations:

- Primary responsibility of implementation of Regulations
- Appointment of QCA with majority principle
- Submit the technical details and PPA details to SLDC
- Monitoring the output of QCA

### Key Design Points

- Compliance of F&S Regulations

## QCA

### Key considerations

- Forecasting & Scheduling for each PSS
- Meter reading and data collection and communication, and co-ordination with the SLDC and other agencies
- Settlement of Deviation Charges on behalf of RE gen,
- De-Pooling of Deviation Charges within PSS

### Key Design Points

- QCA is single point contact for SLDC for each PSS

## SLDC

### Key consideration

- Aggregation of Schedule received from each PSS
- Preparation of L-G balance
- Computation of Deviation impact of RE at State periphery
- Computation of Deviation charges receivable from each PSS
- Design the data communication requirement

### Key Design Points:

- Overall implementation of F&S Regulations to ensure the objectives of Regulations

# FOR Model F&S Framework for Solar and Wind Generators



| Sr. | Particulars                                      | Description   |
|-----|--|---|
| 1   | <b>Objective</b>                                 | Facilitate large-scale grid integration of Solar and Wind Generating Stations while maintaining grid stability and security   |
| 2   | <b>Applicability</b>                             | All Solar and Wind Generators connected to the State grid, including those connected via Pooling Sub-Stations, and selling power within or outside the State        |
| 3   | <b>Forecasting</b>                               | Solar and Wind Generator or QCA, or forecast by the MSLDC to be accepted  |
| 4   | <b>Frequency of revision of schedule per day</b> | Weekly and day-ahead, with maximum 16 revisions during a day.   |
| 5   | <b>Definition of Forecasting Error</b>           | The formula for computation of the Error is: $100 \times \left\{ \frac{\text{Actual Generation} - \text{Scheduled Generation}}{\text{Available Capacity}} \right\}$ |
| 6   | <b>Tolerance Limit</b>                           | <ol style="list-style-type: none"> <li>1. 10% for new Solar and Wind Generator.</li> <li>2. <math>\leq 15\%</math> for existing Solar and Wind Generator</li> </ol> |
| 7   | <b>Data Telemetry</b>                            | Data relating to power system output and weather provided by Solar and Wind Generator   |
| 8   | <b>Generators Payouts linked to</b>              | In proportion to actual generated units or available capacity   |
| 9   | <b>Deviation Pricing</b>                         | <ul style="list-style-type: none"> <li>• Linked to Fixed Rate/PPA (inter-state)</li> <li>• PU INR 0.50, 1.0, 1.50 (intra-state)</li> </ul>                          |

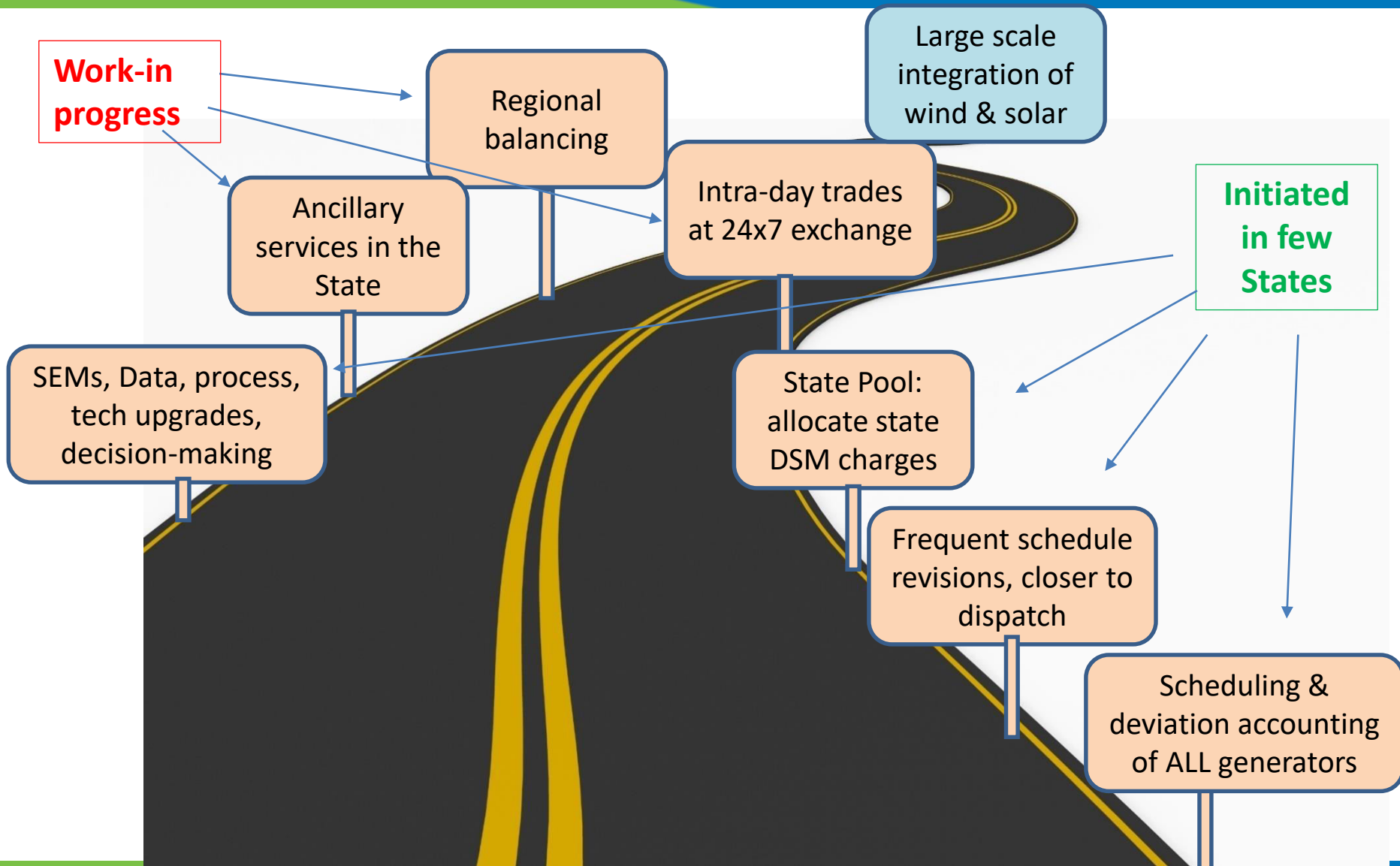
# Forecasting & Scheduling Regulations by States: Updated (as on 19 April, 2018)



| SERCs                         | Status             | Date of Notification  |
|-------------------------------|--------------------|---|
| Andhra Pradesh ERC            | Final              | 21 August, 2017 (Commercial settlement<br>1 <sup>st</sup> July,2018)  |
| Chhattisgarh ERC              | Final (Under DSM ) | 07 November 2016  |
| Gujarat ERC                   | Draft              | 13 January 2017   |
| Jharkhand ERC                 | Final              | 08 December 2016  |
| Karnataka ERC                 | Final              | 31 May 2017   |
| Madhya Pradesh ERC            | Draft              | 25 May 2017   |
| Rajasthan ERC                 | Final              | 14 September, 2017 (Comm. Settlement<br>1 <sup>st</sup> January,2018) |
| Tamil Nadu ERC                | Draft              | 27 January 2018   |
| Tripura ERC                   | Final              | 24 June 2017  |
| Uttarakhand ERC               | Final (Under DSM ) | 06 February 2017  |
| Joint ERC (Manipur & Mizoram) | Final              | 09 August 2016  |
| Haryana ERC                   | Draft              | 17 January, 2018  |
| Punjab ERC                    | Draft              | 17 January, 2018  |
| Telangana ERC                 | Draft              | 19 February 2018  |
| Maharashtra ERC               | Draft              | 31 March,2018   |
| Orissa ERC                    | Draft              | 23 September 2015   |

**Final Notification: 8 States, Draft : 8 States**

# Way forward for Large Scale RE Integration (evolution of framework in continuum . . .)



# Thank You



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