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Integrating Renewable Energy (Policy & Regulatory support)

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Agenda

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A. Background to RE Industry in India
- ✓ Growth so far
- ✓ Capacity addition planned by 2022 and 2032
- ✓ RE Penetration level by 2022 and by 2032

B. Regulatory Framework for Grid Integration
- ✓ EA 2003
- ✓ CERC Grid Connectivity Regulations, 2009
- ✓ CEA Standard of connectivity (amendment) Regulations, 2013
- ✓ Indian Electricity Grid Code, 2010 and amendments
- ✓ State level regulatory framework for grid integration of RE

C .Key Challenges in RE Grid integration & mitigation measures
- ✓ Planning stage
- ✓ Construction stage
- ✓ Operation stage

D. Way forward

Background to RE Industry in India

- ✓Growth so far
- ✓Capacity addition planned by 2022 and 2032
- ✓RE Penetration level by 2022 and by 2032

RE Sector in India - Growth so far

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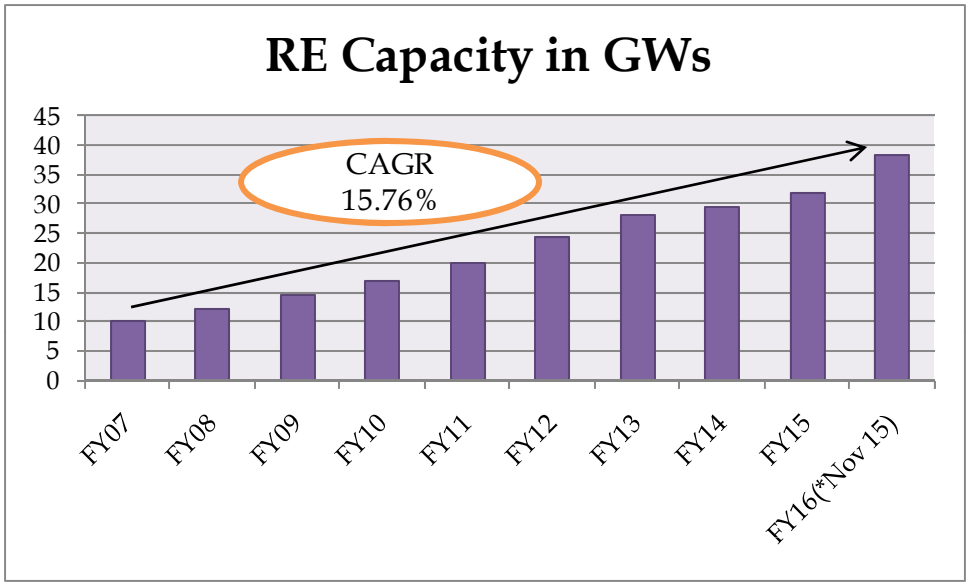

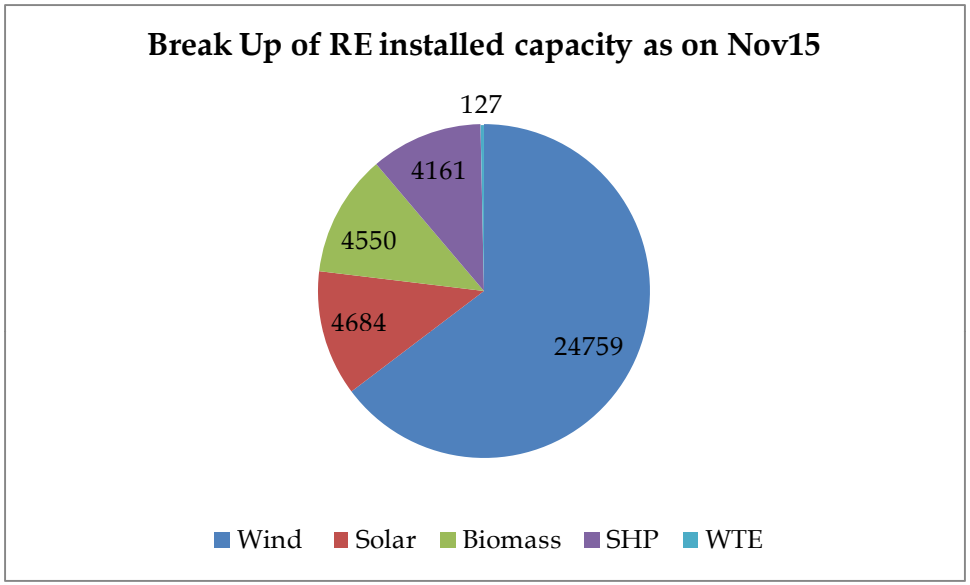

Key Statistics

- Cumulative capacity of 38,283 MW added as on November 2015
- RE capacity comprises 14% of total generation capacity of India
- Wind capacity has the lion's share among RE technologies (around 65%)
- RE generation contributes to ~6.5% of total generation of the Country

Key Drivers

- Policy of Accelerated Depreciation, concessional import duty
- FIT for RE projects (for both inter & intra State projects)
- GBI for encouraging generation and IPPs
- RPO and REC Mechanism
- JNNSM for solar capacity addition
- NAPCC with national level targets for RE procurement

RE Capacity Addition Targets

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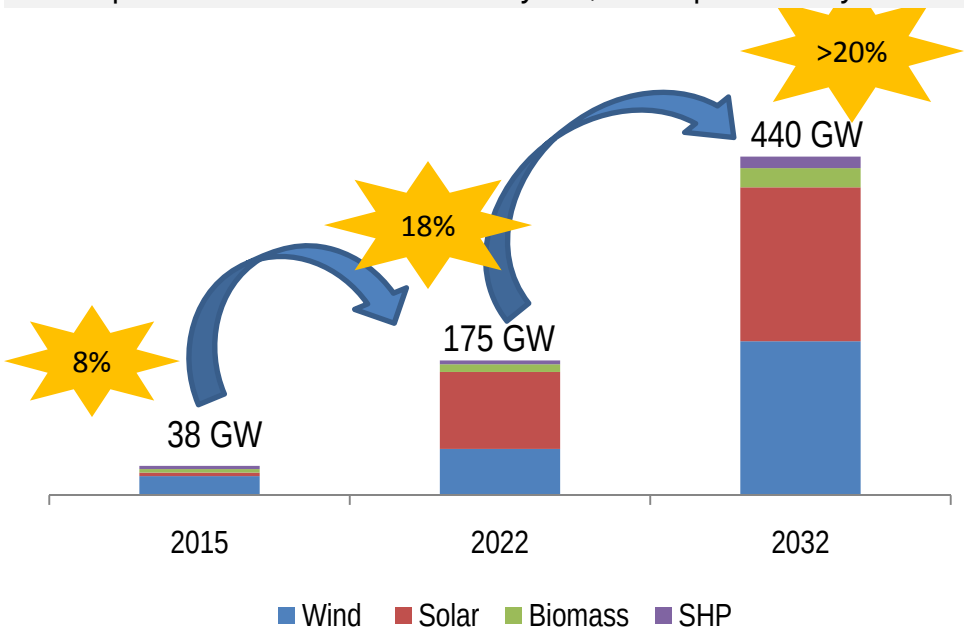
NAPCC

- NAPCC target of 5% for RE Procurement in 2010
- Target to increase by 1% each year to reach 15% by 2020

CEA perspective plan for FY 2032

- CEA has projected RE capacity additions till 2032
- RE penetration level to increase by 8%, 18% up to 20% by 2032



RE Invest 2015

- Targets 175 GW by 2022
- Includes **60 GW from Wind**, **100 GW from Solar** and 15 GW from other RE
- **90%** of the targeted RE capacity addition planned from Wind and Solar source which are inherently **variable in nature**

COP -21, Paris

- Reducing carbon emission intensity levels by 35% by 2030 compared to 2005 levels.
- INDCs Commitment- 40% of the total installed power generation capacity would be from non-fossil fuel sources by 2030.

NTP amendments

- 8% of electricity consumption shall be from solar energy by Mar'22 .
- RGO (Renewable Generation Obligation): New coal based plants to establish RE capacity
- Promotion of micro grids and ancillary services for RE

State-wise share of Solar and Wind Targets by 2022

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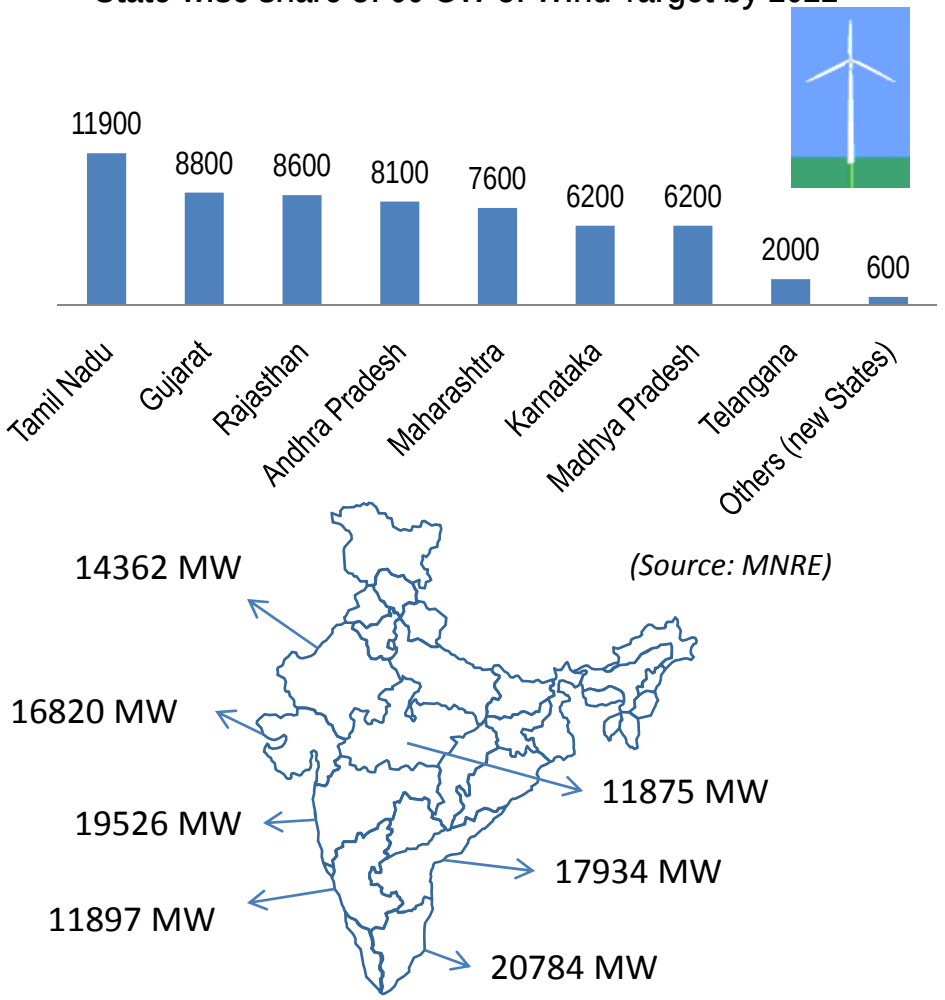
State-Wise share of 100GW of Solar Targets by 2022

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		Southern Region	26,531
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
	Northern Region	31,120		Eastern Region	12,237
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
	Western Region	28,410		North Eastern Region	1,205
17	Andhra Pradesh	9,834	35	Andaman Islands	27
18	Telengana		36	Lakshadweep	4
19	Karnataka	5,697		All India	99,533

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



(Source: MNRE)

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

Regulatory Framework for Grid Integration

- ✓EA 2003
- ✓CERC Grid Connectivity Regulations, 2009
- ✓CEA Standard of connectivity (amendment) Regulations, 2013
- ✓Indian Electricity Grid Code, 2010
- ✓State Level framework for grid integration of RE

Framework for Grid Integration

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Aspects of Tx system development	Planning	Construction	Operation
Entities	CEA, CTU and STU	CTU, STU	CERC, RLDC, SLDC
Governing Framework	National Electricity Plan, IEGC	CEA Regulations and Standards	IEGC and State Grid Code
Functions	• Long term & short term System Planning • Investment plan	• Construction of Transmission lines • Substations • Protection • Technical standards	• Scheduling • Despatch • Balancing & Control • Metering

Electricity Act 2003

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Responsibility of CEA - preparation of National Electricity Plan (Section 3)

- NEP includes transmission plan for five years
- NEP for 12th plan also provides insights on Integration of Renewable Energy (RE) Sources generation in National Grid.
- NEP for 12th plan deals with need for adequate transmission, Forecasting & scheduling, Energy Accounting, Load-Generation Balance, Energy storage & Registry for RES

Responsibility of STU & CTU (Section 38 & 39)

- Transmission Utility at the Central as well as State level, to be a Government company with responsibility for planned and coordinated development of transmission network. (Sections 38 & 39)

Responsibility of SERC (Section 86)

- Responsibility on State Electricity Regulatory Commission for promoting cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid.

CERC Grid Connectivity Regulations '09

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Eligible RE capacity for CTU connectivity 50 MW

7th September, 2010 (Second Amendment)

- RE Projects- Threshold capacity for connecting to inter-State grid reduced to 50 MW
- Capacity less than 50 MW - can collectively aggregate 50 MW and above for connectivity

Eligible RE capacity for CTU connectivity 5 MW

26th March, 2013 (Third Amendment)

- 5 MW to 50 MW - Renewable Capacity developed by a generating company in its existing generating station (conventional) is eligible for CTU connectivity
- Connectivity to the existing connection point with ISTS through the electrical system of the generating station

CEA Regulations and Technical Standards

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Wind generators to have LVRT capabilities

CEA (Technical Standards for Connectivity to the Grid) Amendment Regulations, 2013

- Wind Generators shall be capable of supplying dynamically varying reactive power support so as to maintain power factor within limits of 0.95 lagging to 0.95 leading.
- Wind Generating stations shall have fault ride through capability of not less than 300 milli-seconds so that grid is not destabilized due to sudden outage of renewable generation in the event of a grid disturbance.

Special Planning conditions for Wind & Solar projects by CEA

CEA Manual on Transmission Planning Criteria, 2013

- The 'N-1' criteria may not be applied to the immediate connectivity of wind/solar farms with the ISTS/Intra-STS grid.
- As the generation of energy at a wind farm is possible only with the prevalence of wind, the thermal line loading limit of the lines connecting the wind machine(s)/farm to the nearest grid point may be assessed considering 12 km/hour wind speed.

CERC IEGC Regulations ’10 and amendments

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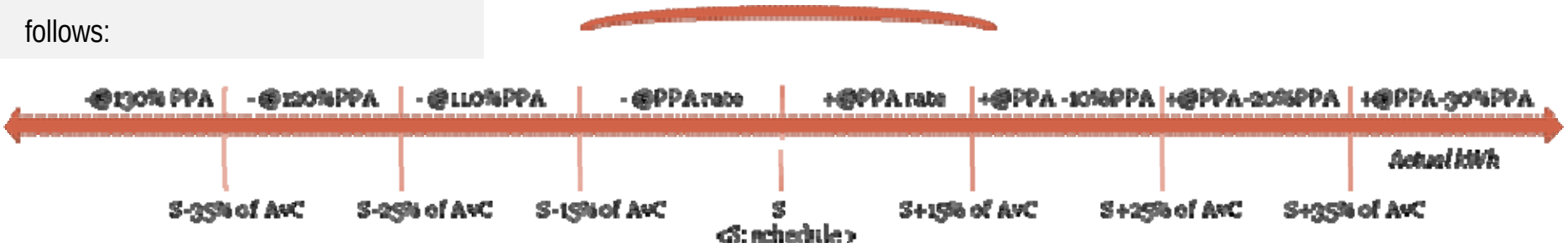
IEGC 2015
&
CERC DSM
Regulations, 2015

- Payment as per schedule @PPA Rate
- Deviation Settlement within tolerance band (+/- 15%)
- Beyond 15%, a gradient band for deviation charges is proposed as follows:

- **Forecasting responsibility:** Forecasting shall be done by wind and solar generators which are regional entities as well as by RLDC.
- **Scheduling Responsibility:** The responsibility of providing generation schedule lies with wind and solar generators. They have the option of accepting the concerned RLDC’s forecast for preparing its schedule or they can prepare schedule based on their own forecast.
- **Revision of schedules:** 16 revisions permitted
- Error (%) = 100*(Actual Generation-Scheduled Generation)

Available Capacity)



State level regulatory framework for grid integration of RE

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Gujarat

- GERC Grid Code Regulations,2013: provisions for Tx. planning of RE exist.
- Connectivity standards exist for wind and solar
- Schedules for RE are prepared by GSLDC

Tamil Nadu

- State grid code entails Scheduling of Wind Generators
- Forecasts are made as per NIWE model
- SLDC prepares Schedule based on the forecast
- Draft F&S and Intra state ABT regulations are in place

Maharashtra

- Grid code has not made distinction between conventional and RE Generation.
- Intra State ABT is operational
- Draft Regulations for F&S and DSM yet to be formulated

Madhya Pradesh

- Draft Forecasting and scheduling Regulations in place
- Draft MPERC (Ancillary Services) Regulation is in place

Karnataka

- State grid code does not take RE generators into consideration
- Draft forecasting and scheduling regulation is in place.

Key Challenges in RE Grid integration & mitigation measures

- ✓Aligning Grid Planning for RE
- ✓Need for Uniform Approach For Interconnection Processes Across States
- ✓Managing Variability And Non-firm Nature of RE Generation

Issue-1: Aligning Grid Planning for RE(1/2)

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Transmission planning – As is Status

- The Central Electricity Authority (CEA) formulates a National Electricity Plan, of which the National Transmission Plan is a crucial component.
- Activity of transmission planning has been aligned with conventional generation and its evacuation requirements both at the state and central level. STUs rarely take RE into consideration owing to low utilisation factor of transmission assets.

Transmission planning – Implication on RE

- Inadequate infrastructure for RE evacuation
- No avenue for inter-State power transfer during excess RE generation
- Even poor evacuation infrastructure exists at the intra state level to absorb RE Generation.
- Results in Backing down of Wind and Solar Plants

Transmission planning – Initiative So far

- Green Energy Corridors and Desert Power – Transmission plan of envisaged RE capacity – Study carried out by PGCIL
  - Total Rs. 42,000 Crore investment in transmission for 40 GW RE evacuation
  - Rs. 20,000 Crore for Intra-State TS strengthening
  - Rs. 22,000 Crore for Inter-State TS strengthening
- CEA Perspective Transmission Plan 2030
  - CEA perspective transmission plan was prepared considering the Wind and Solar potential estimates in the States viz.
    - ❑ Tamil Nadu,
    - ❑ Andhra Pradesh,
    - ❑ Karnataka,
    - ❑ Maharashtra,
    - ❑ Gujarat and
    - ❑ Rajasthan

Unless the process for planning transmission capacity incorporates a long-term vision of planned RE capacity additions at both levels and involves RE stakeholders at the planning stage, it is expected that bottlenecks in RE evacuation capacity will remain.

Issue-1: Aligning Grid Planning for RE (2/2)

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Transmission planning – Issues for Discussion

- What should be the **institutional arrangement** to address concerns of evacuation and Tx planning for RE projects?
- What should be role of **SNAs** for inputs to perspective long term capacity development plans and submit them to STUs considering mismatched timelines for construction of RE projects and evacuation corridors?
- How should **STUs be mandated** to project and achieve their investment plans to evacuate RE Power?
- Is there a need for creation of **RE transmission planning authority** or a stand-alone RE Transmission Plan?

Transmission planning – Suggestions

a. Amending Central and **State Grid Code**

b. STUs in **co-ordination with State Nodal Agencies** to prepare perspective plan for RE evacuation (short term and long term)

c. Ample **representation of the renewable sector** during transmission planning stage (Central & State level)

d. Updating **Green Energy Corridor** to consider higher target and longer time horizon till 2032

e. **Reserving buffer transmission** capacities and additional circuits in the planned networks for future by STU and CTUs

f. **Planning of balancing generation / complementing** resources with wider control area to handle imbalances on account of variability.

Issue-2: Need for Uniform Approach For Interconnection Processes Across States(1/2)

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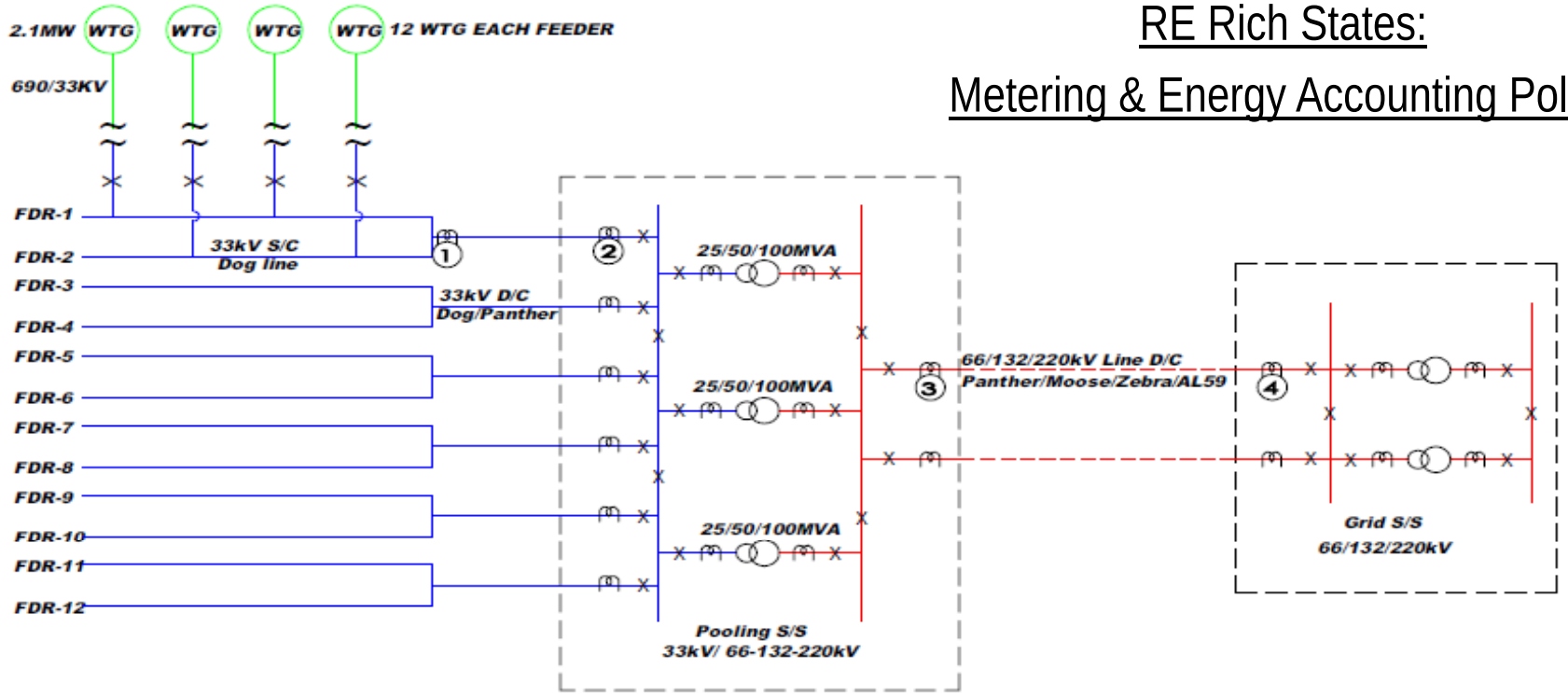

RE Rich States:

Metering & Energy Accounting Policy

State	AP	GJ	KN	MH	MP	RJ	TN
Billing Meters Position	3&4	3	4	2&3	1	2&4	0&1

- Different practices of connectivity & metering across States, complicates reference point for Deviation computation.

Issue-2: Need for Uniform Approach For Interconnection Processes Across States

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Interconnection practices – Issues for Discussion

- What are the options for funding and sharing the evacuation infrastructure among RE generators, transmission utilities, transmission system users, etc.?

Interconnection practices – Suggestions

a. Develop a **standard, or model interconnection** procedure(s) for interconnection of various RE technologies at the national level, for similar voltage levels (low, medium, high), which states could adopt

b. Appropriate **model for sharing responsibility** among RE developers and transmission and distribution utilities, for development and construction of evacuation infrastructure.

c. Define "**Connectivity and construction standards** for RE Projects

Issue-3: Managing Variability And Non-firm Nature Of RE Generation (1/2)

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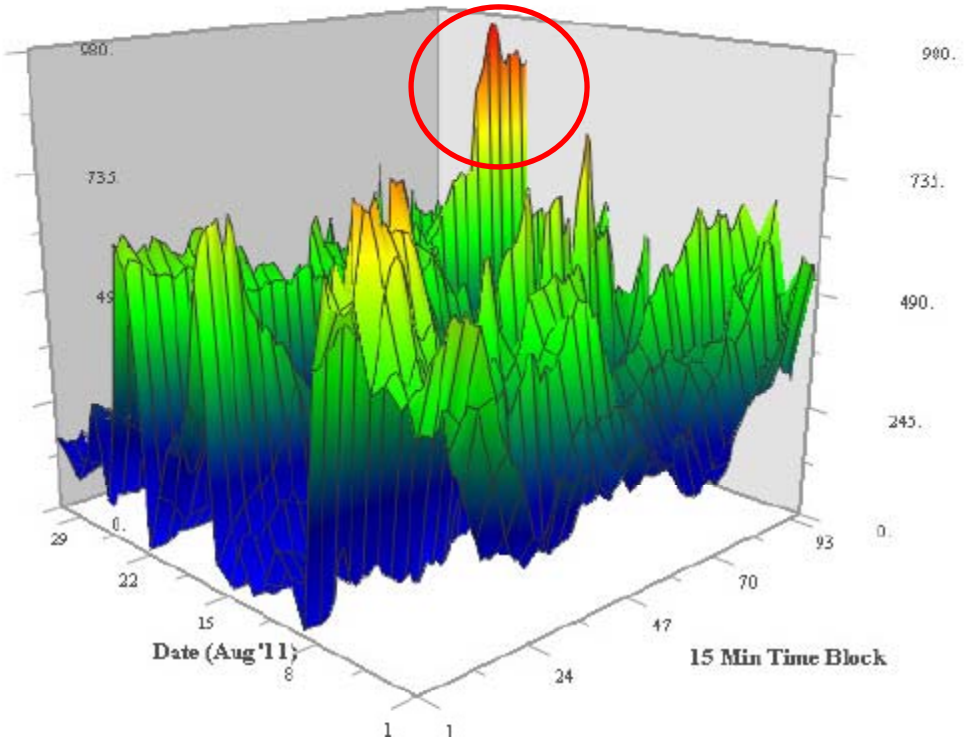
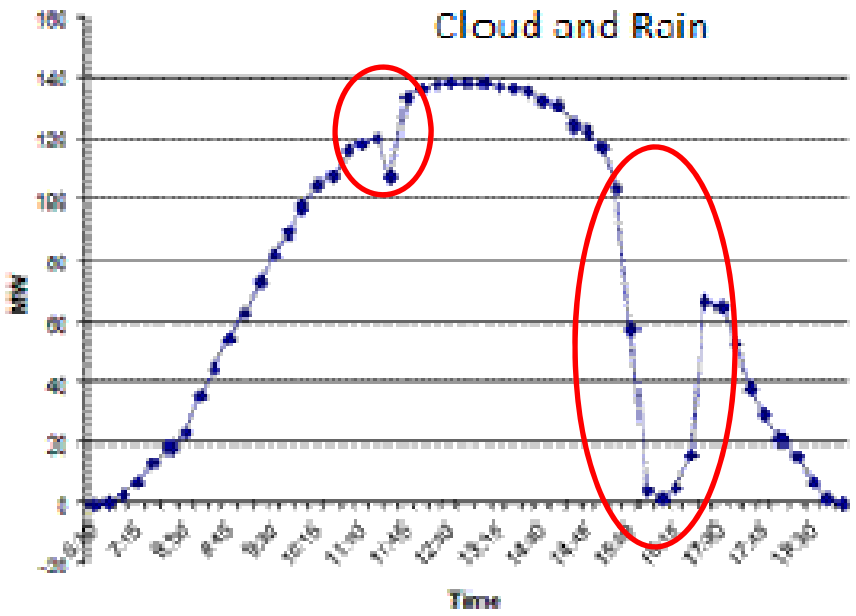
- Large scale RE integration has significant challenges both technical and economic in nature
- System operators finds it difficult to balance the grid with sudden rise or fall of RE in the grid

Wind generation in Rajasthan (August)



Solar generation (Charanka) in Gujarat (April)



(Source: POSOCO)

Issue-3: Managing Variability And Non-firm Nature Of RE Generation

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- In addition, there exist inherent challenges for balancing grid in India.

1. Limited ability to back-down thermal generation (limitation due to technical minimum)
2. Low availability of hydro power for balancing (low share of pumped storage)
3. Low availability of gas-fired thermal power (low availability, high cost)
4. 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.

Regulatory Development

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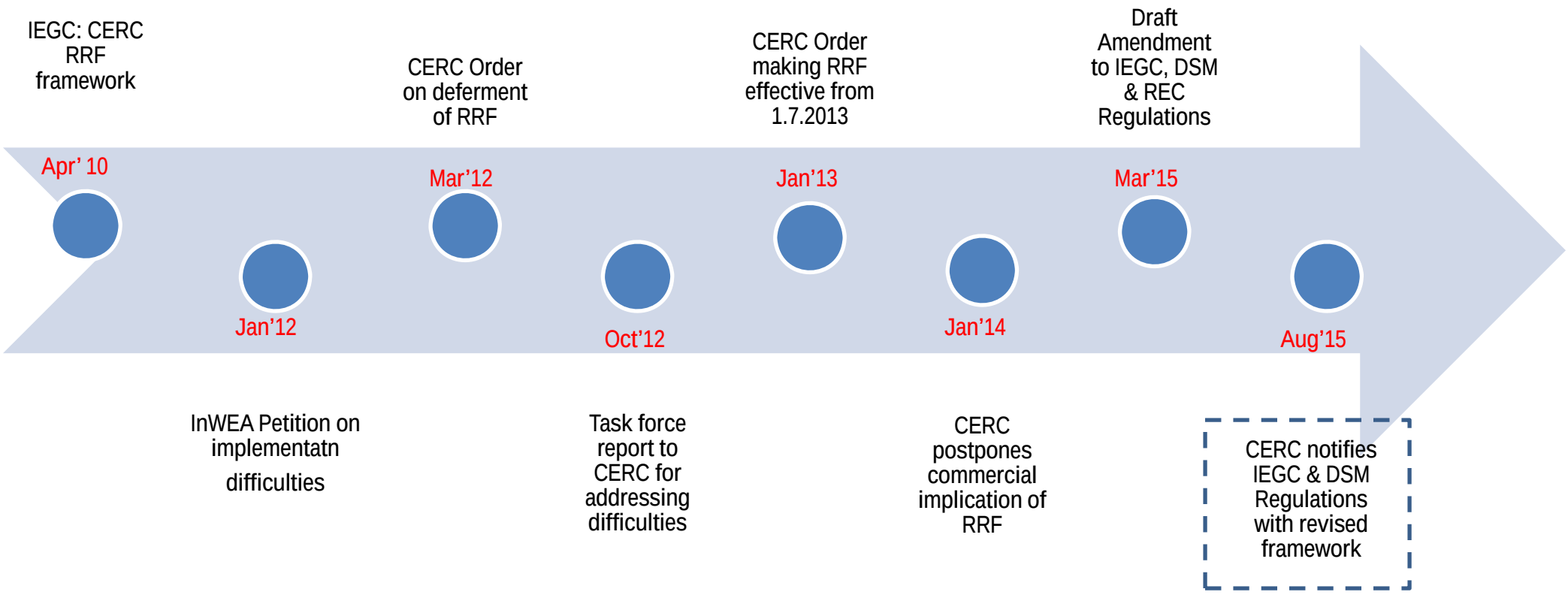

- FOR has published model state level framework for forecasting and scheduling;
- However, implementation of such mechanism at state level would be quite challenging

Options for F&S regime at State level – 1/2

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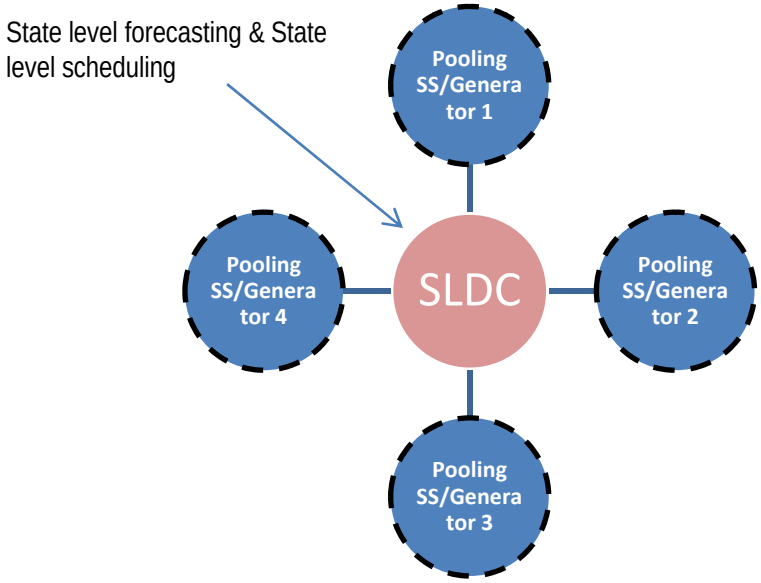
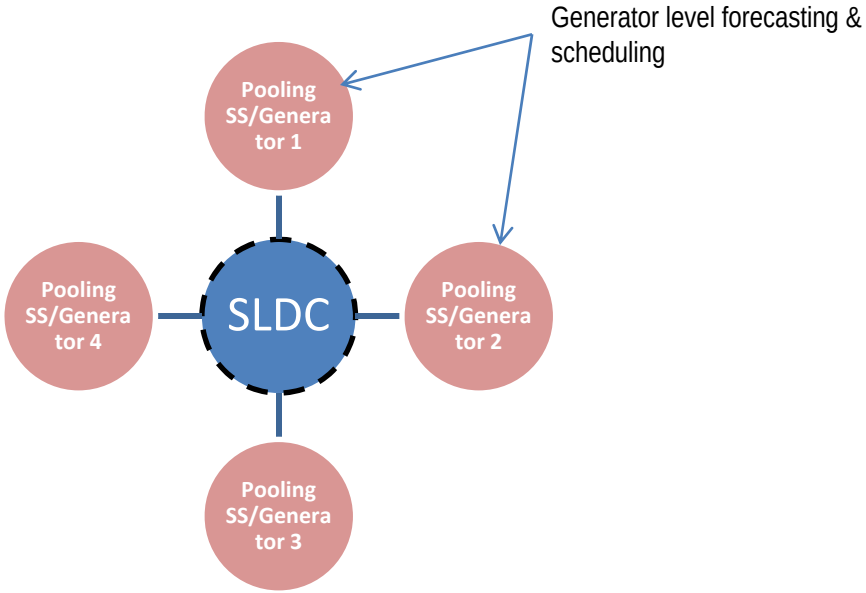
- Key options in terms of responsibility of Forecasting & Scheduling
  - Centralized Forecasting and Scheduling
  - De-Centralized Forecasting and Scheduling

"Centralized" model (NIWE model)



"De- Centralized" model (CERC / IEGC 2010 model)



- However, each option need to be critically evaluated to see the implication on generators and the risk involved for the Generator

Options for F&S regime at State level – 2/2

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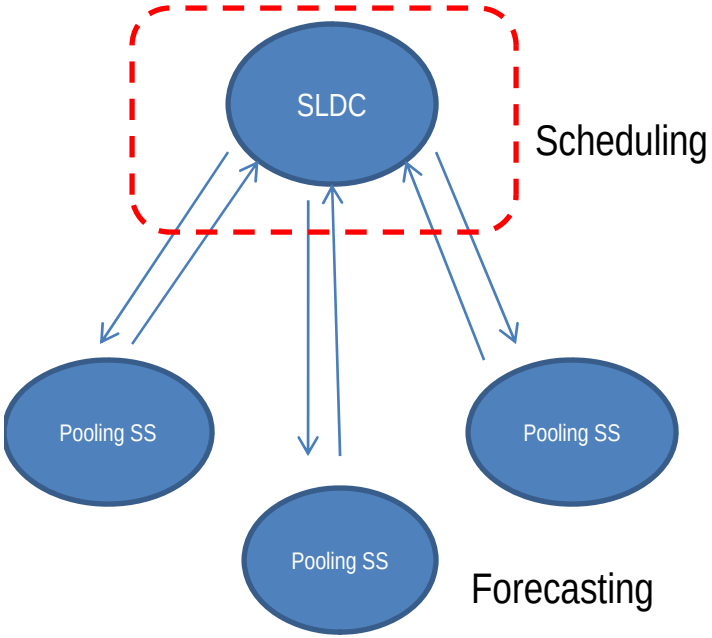
Composite Mechanism

Decentralized forecasting & Centralized scheduling



Composite Mechanism

The Mechanism

- Forecasting at pooling station (Decentralized forecasting)
- Scheduling by SLDC (Centralized scheduling)

Features

- Pooling sub-station level forecast to be prepared and sent to SLDC
- SLDC to aggregate forecast and prepare schedule for State as a whole
- Deviations to be de-pooled based on ratio of actual generation

Advantages

- Minimal deviation due to State level aggregation
- Consequently, commercial implication to be lower
- Risk of forecast error at one pooling station gets socialized as deviation is arrived at aggregate level
- Ease of de-pooling of Penalty/Incentive with individual generator

- Composite model combines the advantage of earlier models and safeguards generators against individual forecast risk

Key challenges for State level implementation

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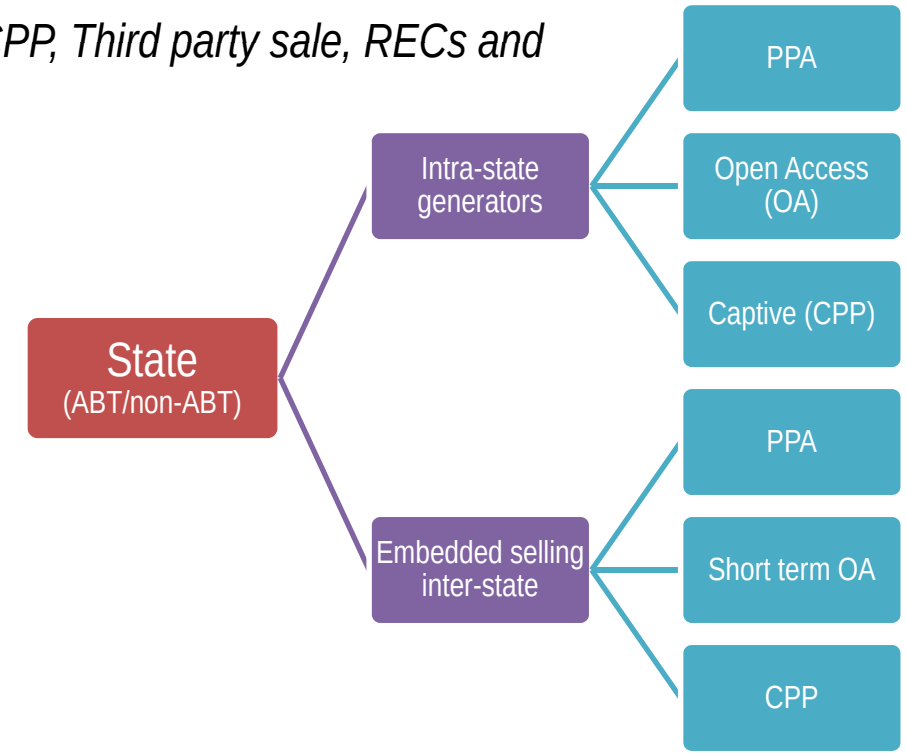
- Volume of Generators & Generating Stations
  - *More than 25000 WTGs, > 24 GW of WTG installations*
  - *More than 9000 Generators/Owners/project site locations*
- Number and types of transactions
  - *Different off-take arrangements (Sale to Discom, CPP, Third party sale, RECs and combination thereof)*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



A solution that fits for all permutations & combinations has to be developed

Guiding principles for State level framework

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- Encouraging scheduling discipline
- Ease of implementation (simplicity)
- Compatible with state/regional /national framework
- Scalable and flexible
- Uniform application across States
- Minimal commercial implications for participants
- Enforceable
- Continuation of existing transactions without significant modifications

FOR Model F&S regime at the state level : Implementation challenges

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Issues in deviation/imbalance settlement

- State Imbalance Pool will not be 'zero sum' and host state will have to bear shortfall to be claimed annually from PSDF/NCEF.
- The proposed deviation settlement scheme is dependant on availability of funds NCEF/PSDF at national level. Payments to the DSM pool on account of deviation (excess generation) takes away significant amount of incentives that generator was supposed to get.

Operationalisation of Institutional Framework and roles/responsibilities

- Eligibility conditions for QCA and rules for empanelment need to be clarified.
- Contractual framework for QCA and its interface with SLDC pool to be clearly established.

No detailing of IT /Communication infrastructure to be developed

- Robust Telemetry system is vital for developing F&S mechanism
- Responsibility for installation of RTUs, metering infrastructure and sharing the costs thereof, needs to be clarified.

Way Forward for implementation for F&S at State level

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- Need for visibility:
  - Additional IT infrastructure to be established for visibility of pooling stations
  - Pooling S/S: Gujarat (52), Rajasthan (18), Maharashtra (43), Tamil Nadu (120)
- Robust communication facility:
  - Need for establishing communication facility for tracking real-time generation of pooling station at SLDC
  - Who would install? Who would bear the cost for establishing the communication network
- Need for uniform settlement mechanism:
  - Different practices for generator payment exist in different States. Except Maharashtra settlement made on schedule generation basis
  - Institutional Set up and deviation Settlement mechanism.

Implementation Roadmap

Thank You

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