



Idam Infrastructure Advisory Pvt. Ltd.

Roundtable Discussion on Forecasting, Scheduling and Deviation Settlement Framework for Wind & Solar Generation

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By

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Idam Infrastructure Advisory Pvt Ltd

- Context setting
- Regulatory development for introduction of F&S regime
- Comparative Analysis of F&S Framework of various states
- Implementation aspects for F &S framework at state level
- Discussion Points and Way forward

Context setting

- Need for F&S framework
- Regulatory developments for introduction of F&S regime

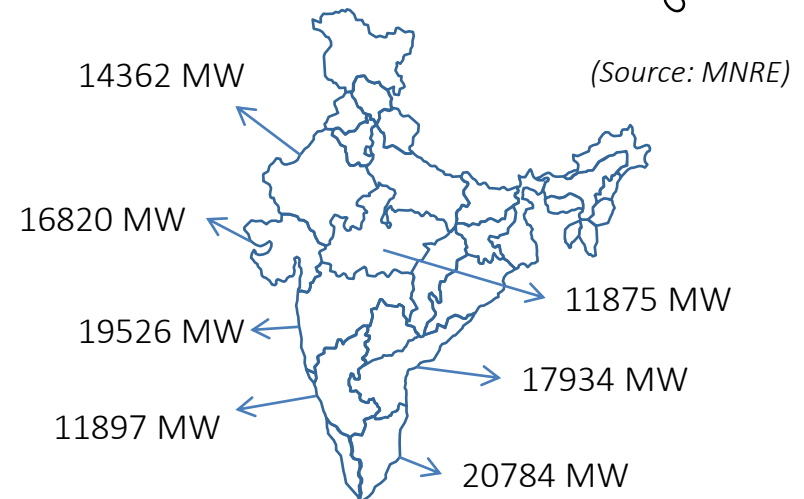
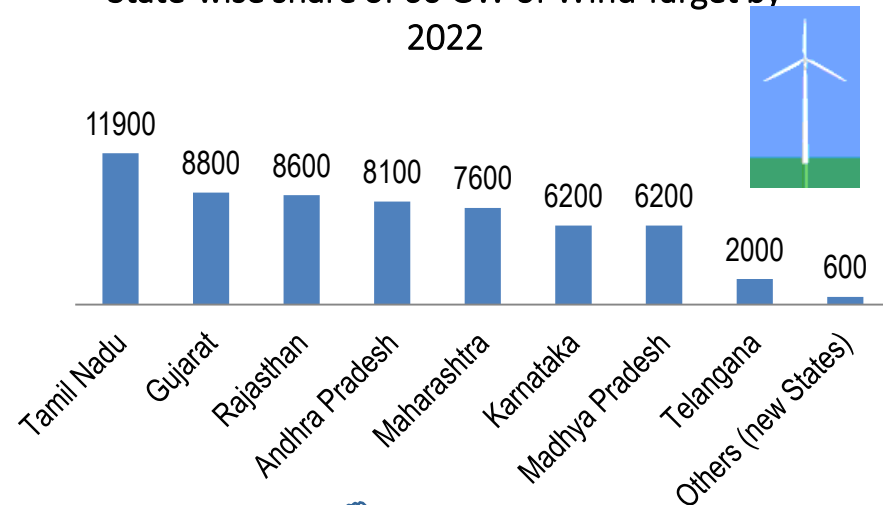
Significant variable RE integration (Wind -60 GW and Solar-100 GW) planned by 2022



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	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	Chandigarh	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	Chattisgarh	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	Telangana		36	Lakshadweep	4
19	Karnataka	5,697	All India		99,533

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

Greening the Grid Study : Key findings



Key Findings: 175 GW RE can be integrated to the grid.

- The 2022 power system with 100 GW solar and 60 GW wind can balance every 15 minutes of the year with minimal RE curtailment provided assumptions hold true in 2022
- The system can handle forecast errors, net load changes, and exchanges of energy between regions
- **Curtailment averages only 1%** nationally, based on no intrastate congestion
- Curtailment is highest in the **southern region** but still **less than 3%**.

Source : Greening the Grid study/POSOCO

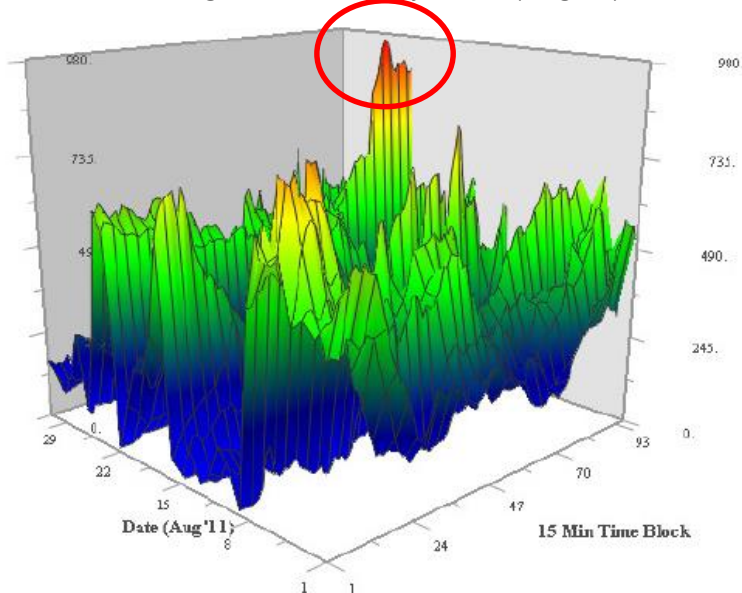
However, the enhanced RE Integration can be facilitated with following implications:

- **Net Load ramp** increases **28%** compared to a system with no new renewables, to almost **32 GW per hour**
- Coal units are **typically backed down midday** to accommodate RE
- Average **coal plant load factors fall 63% to 49%**, with over 19 GW of capacity that never starts*
- **Hydro & Pumped Hydro** Operation key to **flexibility**
- **Changes to operational** philosophy (from state to **regional co-ordination to national co-ordination**) leads to cost effective RE Integration.

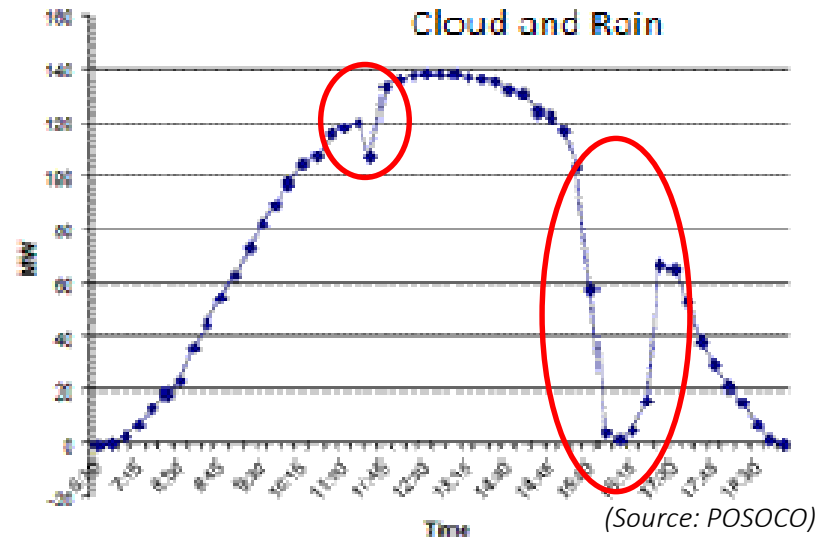
Source : Greening the Grid study/POSOCO

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

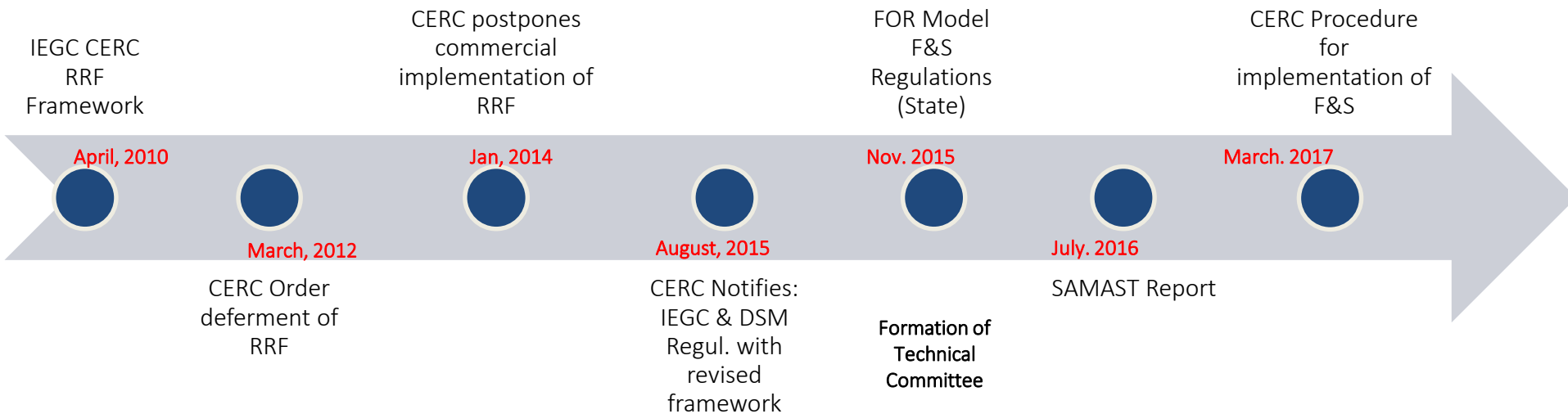
- To facilitate Inter-state RE Transactions, scheduling and energy accounting is pre-requisite.

Key components of F&S regime



- Forecasting
- Scheduling
- Load-Generation Balancing / Despatch management
- Deviation Settlement Mechanism
- Generator Payments

Regulatory Developments related to F&S regime for Variable RE Generation



- States like Karnataka, Tamil Nadu, Gujarat, Rajasthan, Andhra Pradesh came out with their Draft F&S Regulations in line with FOR Model F&S Regulations, 2015 during the period of November, 2015 to August 2016.
- Out of which only Karnataka State has started the implementation of F&S Regulations from June, 2017.

Comparative Analysis of F&S Regulations of States

- Status of F&S Regulations by States
- Comparative Analysis of F&S framework of States

Forecasting & Scheduling Regulations by States: Update (as on 21 August, 2017)



SERCs	Status	Date of Notification
Andhra Pradesh ERC	Final	21 August, 2017 (F&S and deviation accounting from 1st Jan.2018 and Commercial settlement from 1 st July,2018)
Chhattisgarh ERC	Final (Under DSM Mechanism)	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	Draft	Feb, 2016
Tamil Nadu ERC	Draft	13 February 2016
Tripura ERC	Final	24 June 2017
Uttarakhand ERC	Final (Under DSM Mechanism)	06 February 2017
Joint ERC (Manipur & Mizoram)	Final	09 August 2016

Final Notification: 7 States, Draft : 4 States

Comparison of State level F&S Framework – 1/3

Sr. No.	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)	GERC (draft)	APERC (Final)
1	Applicability	Wind and solar generators selling power within or outside the state	Wind generators combined capacity 10 MW and above . Solar generators capacity 5 MW and above within or outside the state	Wind and solar generators selling power within or outside the state	Wind and solar generators selling power within the state	Wind and solar generators selling power to discoms/third party sale/captive consumption through OA: >5MW connected to state grid	Wind/Solar generators connected to state grid	Wind/Solar generators connected to state grid
2	Forecasting Responsibility	Wind and solar generator or by QCA Or forecast by SLDC to be accepted	Wind and solar generator or QCA or aggregator Alternatively through REMC	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted
3	Scheduling Responsibility	Wind and solar generator or by QCA	Wind and solar generator or QCA or aggregator . Alternatively through REMC	Wind and solar generator or by QCA	Wind and solar generator or by QCA	Wind and solar generator or by QCA	Wind and solar generator or by QCA	Wind and solar generator or by QCA
4	Computation of Error Formula	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator

Comparison of State level F&S Framework – 2/3

Sr No	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)	GERC (draft)	APERC (Final)
5	Tolerance Band for DSM	10% new wind and solar generator. < = 15% existing wind and solar generator	± 15% for wind and solar generators	< = 10% new wind and solar generator , < = 15% existing wind and solar generator	< = 10% for wind generators. < = 5% for solar generator	± 15% for wind and solar generators	< = 12% for Wind Gen. < = 8% for Wind Gen, (CoD on or after 30/1/2010) < = 7% for Solar Gen.	± 15% for wind and solar generators
6	Scheduling Requirement	Weekly and day-ahead with maximum 16 revisions during a day	Weekly, day-ahead and intra-day with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	3 Day-Ahead & Day Ahead with max. Rev. for Wind : 16 Rev. Solar: 8 Rev.	Weekly and day-ahead with maximum Wind : 16 Rev. Solar: 9 Rev. during a day
7	Reference point for DSM	Pooling station	Pooling station/ Aggregator Level	Pooling station	Pooling Station	Pooling station	Pooling station	Pooling station
8	Apportion of Energy Deviations & DSM Charges among RE generators at a pooling S/S	In proportion to actual generated units or available capacity	No provision	In proportion to actual generated units or available capacity	In proportion to actual generated units or available capacity	In proportion to actual generation units	In proportion to actual generation units	In proportion to deviations of each generator

Comparison of State level F&S Framework – 3/3

Sr. No	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)	GERC (draft)	APERC (Final)
9	Telemetry and Communication Requirement & Responsibility for providing telemetry and Communication	Data relating to power system output and weather By Generator	Data relating to power system output and weather, turbine availability By Lead Generator/QCA or Aggregator	Data relating to power system output and weather By Generator	Data relating to power system output and weather By Generator	Data relating to power system output and weather By Lead Generator/QCA	Data relating to power system output, gen. outage, real time actual generation and its deviations. By Lead Generator/QCA	Data relating to power system output, outage, real time generation and its deviations. By Lead Generator/QCA or Aggregator
10	Procedure for Data Telemetry and Communication	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure by SLDC before 1 Dec,2017 and Wind/Solar Gen. /QCA to submit req. information to SLDC by 1st Jan,2018
11	DSM For Sale Outside State Specified	Yes	NA	Yes	No	No (stipulates that charges for DSM as per CERC DSM Regulations, 2014)	No (stipulates that charges for DSM as per CERC DSM Regulations, 2014)	Yes. SLDC shall provide separate Energy/ DSM accounts for inter-State to QCA.
12	Meeting Shortfall of DSM Pool	PSDF and NCEF	No provision	PSDF and NCEF	No provision	No provision	No provision (shortfall apportioned to RE Generators)	SLDC to devise framework before 1 st Dec,2017

Key Considerations for F&S Framework for State level

- Objectives, Scope and Applicability
- Implementation aspects of F&S framework

Key objections and suggestions received from stakeholders on state level F&S



Operational Issues

- Clarity on Qualifying criteria and Governance structure of QCA
- F&S framework should be implemented subject to implementation of Intra state ABT
- Metering and data collection shall be the responsibility of STU
- Data Telemetry at pooling S/S level instead of turbine/inverter level
- Standardisation of hardware and software required for forecasting and scheduling
- Grid code regulations be aligned with scheduling requirements
- Provisions for inter-state sale of RE power in line with F&S regulations

Strategic Issues

- Effective date to be fixed after 6 to 12 months
- Tariff to be revised to recover investments in in data telemetry/SCADA
- Tolerance band to be liberalised
- Applicability to cover only New Projects

Existing RE/New RE, Distinction between Wind/ Solar

Points for discussion:

- Applicability of F&S for Variable RE i.e. Wind and Solar
- Need not differentiate between existing and new variable RE project
- Need for distinction between Wind/Solar or Uniformity of rules

Minimum Capacity of RE

Points for discussion:

- Visibility of RE generator at SLDC is necessary
- Difficult to manage RE generation connected to Distribution feeder
- Embedded RE Generation to be excluded
- Pooling station with minimum installed capacity criteria (min. 5 MW)

Implementation Aspects of State level F&S framework



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Role of QCA and it's eligibility criteria

- a) Regulatory oversight of QCA in appropriate regulations
- b) Technical & Financial Criteria of QCA
- c) Governance mechanism of QCA
- d) Model Term sheet

Operation-alisation of Virtual pool within the state imbalance pool

- a) Mechanism of Operation of virtual pool.
- b) Entity responsible for operating the virtual pool

Mechanism of deviation settlement at pooling S/S level

- a) Principles of de-pooling of deviation charges
- b) Between RE generators at the pooling S/S

Funding deficit of the state imbalance pool

- a) Dependence on national level funds for long term and its sustainability.
- b) Need for creation of state level funds for funding deficit

Diverse sets of metering practises being followed across states

- a) Need for creating standardised metering points in all states
- b) Devising Uniform metering and energy accounting policy

DSM mechanism for RE Gen. connected to STU with inter-state transactions

- a) Treatment for RE Generators with multiple transactions at Pooling S/S level

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.

Issue-1 : Key considerations for QCA

Nos. of QCAs operating at a pooling S/S

- a. Single or Multiple QCA at a pooling S/S.
- b. Mechanism for selection and appointment of QCA (by RE Generators)
- c. Recognition of QCA by State Agencies (SLDCs/REMC). Mapping of QCAs vis-a-vis Pooling S/S.
- d. QCA to be single point of contact with the SLDC.
- e. Role of REMCs and data/information exchange between QCA and REMC

Institutional and Governance Mechanism

- a. Should QCA be a company or an association ?
- b. Is it necessary to get QCA registered? If yes, whether registered with SLDC, NLDC, RLDC?
- c. Can QCA be a Committee comprising of representatives of RE generators at the pooling S/S.
- d. Should it be a generator franchisee?
- e. Distinction of roles/responsibilities of QCA vis-à-vis Principal/Lead generator

Technical Criteria and Financial Criteria

- a. Technical Criteria would be guided by the roles entrusted to QCA.
- b. Should it be entrusted with the responsibility handling all commercial issues or only for Deviation settlement?
- c. Analysis of desired skill set/capabilities of QCA
- d. Assessment of QCAs ability to undertake financial transactions – Networth, Turnover, Solvency

Issue-1 : Qualified Coordinating Agency (QCA) : Suggestions



QCA: Coordinating agency on behalf of wind/solar generators connected to a pooling station.

➤ Modalities for engagement of QCA:

- QCA as Generator Franchisee is preferred.
- RE Generators at pooling substation can engage Third Party Agency to perform role of QCA.
- The decision for appointment of QCA with the majority (51%) of Wind/Solar Generator(s) in terms of installed capacity at Pooling substation.
- Every QCA need to intimate/register themselves with SLDC

➤ Number of QCA at Pooling S/S and Role of Aggregator

- Entrust the responsibility of pooling S/S to a single QCA. single QCA for each pooling S/S.
- undertake responsibility of multiple Pooling S/S , however, separate accounting for each Pooling S/S

➤ Responsibility for Commercial Settlement

- RE Generators shall directly settle energy charges with the off-takers.
- Settlement of Deviation Charges of the particular pooling S/S are to be handled by the QCA.
- QCA shall undertake de-pooling of 'Deviation Charges' alone.

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

- **Clause 3.7 (Virtual Pool):** Once the accounting procedures as above 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.
- **Clause 3.5 (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

Suggestions:

- SLDC shall be responsible for maintaining account of Virtual Pool for RE deviations at state level
- It needs to be decided whether Solar deviation and Wind deviations to be accounted for separately for the purpose of 'Virtual Pool' operation at state level, particularly, where different bands & deviation charges are applicable.

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



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
Grand Total	1520	950	970	180 (ABS) +20 (state)	12%	30,500

- 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

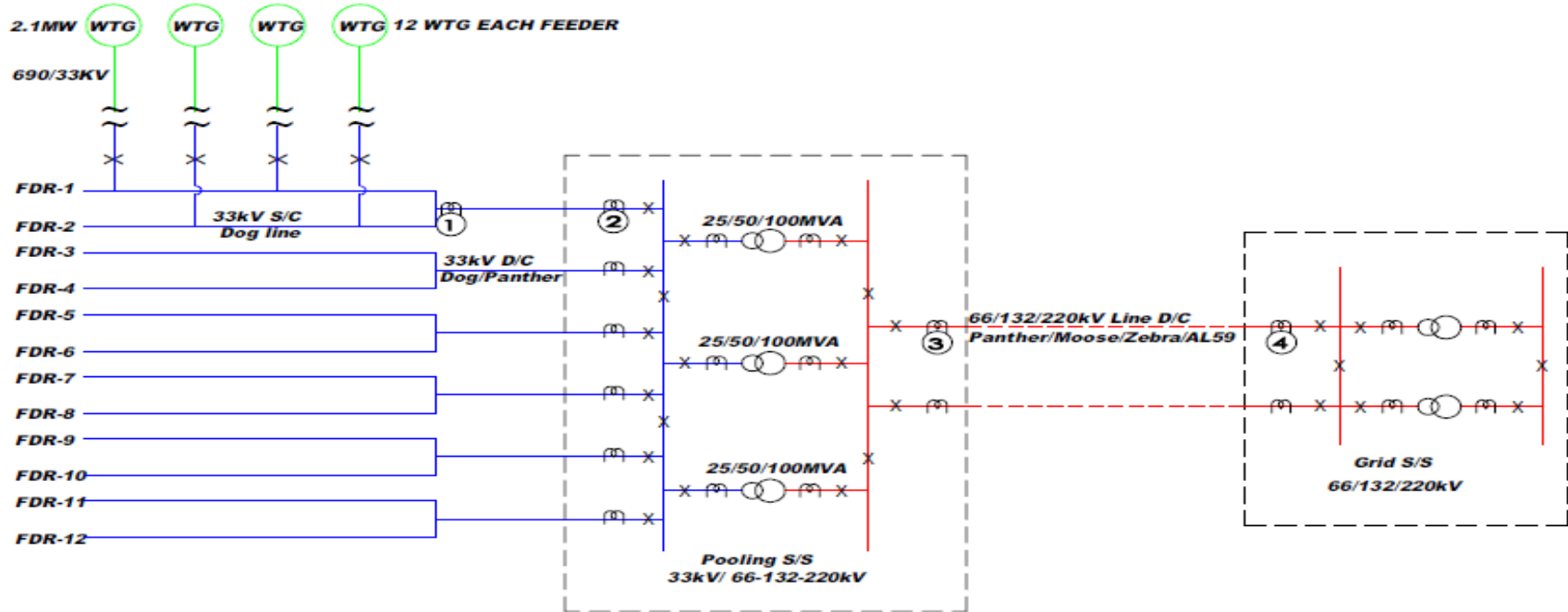
Pooling Station No (PS-5)	Available Capacity (MW)	Schedule (MW)	Actual Injection (MW)	Deviation (MW)	Deviation (%)	Dev. Charges payable by RE Generators (F)
	(A)	(B)	(C)	(D)	(E)	
RE Gen – 1	20		-			-
RE Gen – 2	50		10			3,250
RE Gen – 3	60		30			9,750
RE Gen – 4	40		20			6,500
RE Gen – 5	50		20			6,500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

- 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 (key consideration and suggestions)

- **Clause 3.8** - For covering the deficit in the overall pool, at the end of the year the SLDC may approach the National Funds such as PSDF or NCEF
 - Meeting the deficit from PSDF/NCEF on a long term basis may not be tenable.
 - Designing of state level Imbalance Pool with '**Non-Zero Sum**' features is crucial. **SERCs to address this requirement while formulating DSM Regulations at state level.**
 - In addition, SERCs to consider creating State level funding support mechanism to manage deficit
 - Levy of System Benefit charges (paise/MWh) on all TSUs
 - Regulatory charges for shortfall in RPO Compliance
 - Recovery through ARR of SLDC
 - Any other charges to be recovered through State Imbalance Pool
 - Allocation of shortfall to all RE Generators /Pooling Substations in proportion to deviation or actual RE generation. (amounts to RE subjected to full impact of DSM)

Issue-5: Standard Metering and Accounting practices



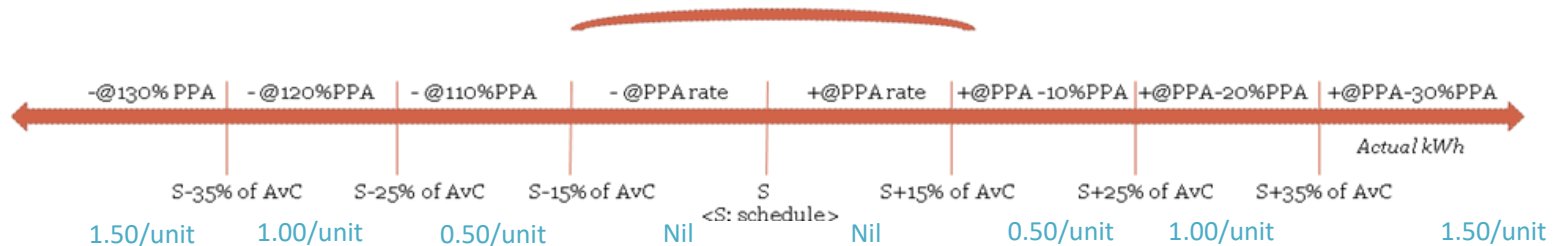
Suggestion:

- 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.

Issue-6 : Mechanism for DSM for inter-state transactions

- **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%):
 - 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.

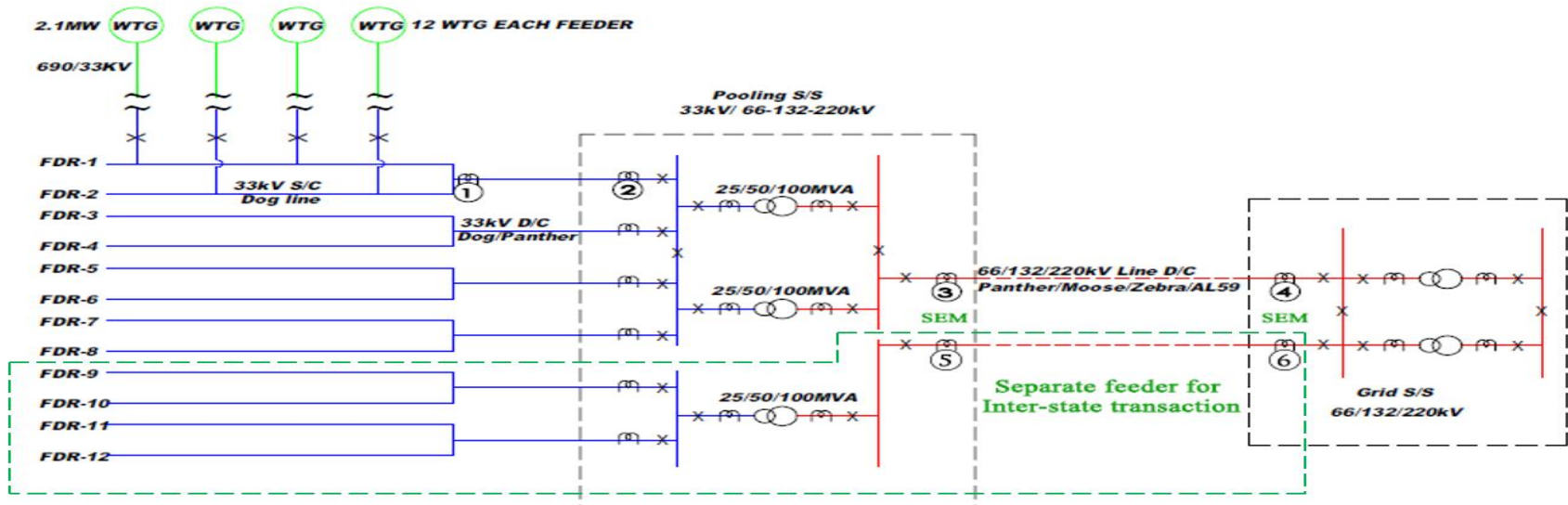
Issue-6 : Mechanism for DSM for inter-state transactions – 1/2



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).

- Addressing implementation aspects of F&S Framework is crucial from operationalising F&S for variable RE.
 - Institutional aspects of QCA to be recognised through suitable amendments in IEGC and State Grid Code. (*QCA as Registered Entity*)
 - **Model DSM Framework/Regulations** at State level to be formulated (*To address rules for virtual pool operationalisation, de-pooling arrangement, clarity on rules/treatment for intra-State and inter-state wheeling transactions of State Entities*)
 - **Clarity on Procedures/Rules** for claiming shortfall in State DSM Pool due to RE (*Treatment for funding deficit in state level DSM Pool or Amendment to existing Regulations to create State level funding support*)
 - **Model Procedures /Code** for Metering, Communication, Energy Accounting for RE to accomplish uniformity across states. (*To address Energy Accounting, Communication, Data telemetry, Metering and Loss accounting*)
- State specific Action Plan and Timelines to be finalised

Thank You



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