

# केन्द्रीय विद्युत विनियामक आयोग

**CENTRAL ELECTRICITY REGULATORY COMMISSION** 



Gireesh B. Pradhan Chairperson No.10/5/2013- Statutory Advice/CER<sup>CERC</sup> Dated: 2<sup>nd</sup> November, 2015

## Sub: Roadmap for States to achieve reliable grid management and large scale integration of variable renewable energy sources

Dear Sansi Pajani,

I am writing to you in connection with the challenges facing secure grid management, and the suggested way forward, with specific reference to grid integration of variable renewable energy generation.

2. The Central Commission as part of its mandate under the Act has put in place a regulatory framework to ensure safe and secure operation of the grid while at the same time providing adequate room for market to operate in a seamless manner. The grid code notified by the Commission provides for rules and procedures for grid operation, while the deviation settlement mechanism puts in place commercial deterrent against grid indiscipline. As a complement, the regulations on power market, open access and transmission pricing create facilitative environment for competition and market.

3. In this context, several States have raised repeated concerns over managing their schedule deviations within the limit as prescribed in the Deviation Settlement Mechanism (DSM) Regulations 2014. It has been argued that the band of `150 MW or 12% of schedule, whichever is lower` is too tight, and renewable-rich states face challenges managing renewable energy variation within this limit. As an interim measure, the Commission has proposed to amend the regulations, wherein graded deviation limits between 50 MW and 250 MW may be assigned to the States based on their peak demand (Annexure- I).

4. Nevertheless, it must be appreciated that relaxation of deviation limit is not a long term solution. The grid does not generate electricity and as such cannot be relied upon for meeting real time energy needs. The solution lies in creating reserves and operationalising ancillary services for handling load generation imbalance. In this regard, the Commission has laid out a roadmap for operationalising reserves in the country, through suo-motu order dated 13<sup>th</sup> Oct 2015 (Annexure- II). The direction has been issued to identify and utilize with effect from 1<sup>st</sup> April, 2016, the spinning reserves available with the inter-state generating stations, to start with. Eventually, all regional level generating stations are required to operationalise Automatic Generation Control (AGC) along with reliable telemetry and communication by 1<sup>st</sup> April, 2017. NLDC and RLDCs should be ready with requisite software and procedures by the same date. In the long term, a market based framework is required for efficient provision of secondary reserves from all generators across the country. For this, POSOCO has been directed to put forth a proposal to the Commission for implementation w.e.f. 1<sup>st</sup> April, 2017.

5. Spinning Reserves, operationalised via AGC, are critical for maintaining loadgeneration balance and hence grid reliability, especially with increasingly variable load and generation. Installation of hardware and software for AGC would entail a one-time expense for the generators. In addition, communication infrastructure between SLDC/RLDC and the generator would also need investment. CEA has been requested by Ministry of Power to prepare an estimate for this implementation. Similar measures must be undertaken by State agencies to ensure planning and implementation of reserves as soon as possible. The existing generating stations may also be enabled to flex generation to balance the system variability. CERC has already proposed regulatory framework in this context, which can also be replicated at the State level.

6. Additionally, as a country we have to prepare our systems for meeting the renewable energy (RE) target of 175 GW by 2022 set by the Government. Taking cognizance of the variable and uncertain nature of solar and wind sources, the Commission notified the Framework on Forecasting, Scheduling and Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar) on 7<sup>th</sup> August, 2015 (Annexure-III). This framework is applicable for solar and wind generators that are regional entities. This Framework has opened up the country-wide market to such solar and wind generators.

7. However, presently almost all of the existing wind and solar generating stations are directly connected to the State grid, and thus fall under operational control area of the respective SLDCs. To enable the States to manage RE generating stations on the State grid, on request of Forum of Regulators, CERC has also evolved the State Model Regulations (Annexure-IV). This model framework outlines a methodology of how forecasting, scheduling and commercial settlement could be done for such intra-state RE generators. The exercise of forecasting and scheduling at the pooling station itself shall be a big step towards sustainable integration, as without this process the SLDC has no visibility into how much RE power may be injected into the grid.

8. Commercial impact of deviations caused by the RE generators, has been a major concern for the RE resource rich States. *The Commission believes that all States must, as a first step put in place the Availability Based Tariff (ABT) framework as mandated in the National Electricity Policy and Tariff Policy, or at the least the deviation settlement mechanism to clearly account for schedule, actual and resultant deviation in terms of generation and drawl in respect of all grid connected entities like conventional generators, RE generators, distribution companies, open access consumers etc. This will help the States identify the corresponding contribution of each entity to the overall deviation at the State periphery.* 

9. Ideally, deviation charges should be levied on each such entity based on the causer-pay principle. However, if as a result of special commercial dispensation for deviation by RE generators, there arises a deficit in the overall State pool at the end of the year, the State may approach a National Fund such as PSDF or NCEF to cover such deficit. This recommendation has been made with the objective that RE-rich states are not unduly commercially burdened due to integration of large scale variable RE, and the cost of balancing is socialized, to the extent not covered by payments from RE generators themselves. This facility of support from the National level fund for compensating the deficit may be made available till 31.3.2019, as recommended by the Forum of Regulators.

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10. To summarize, in pursuance of evolution towards reliable and secure operation of a large interconnected grid, and meeting the targets on renewable energy in a cost-effective manner, there is an urgent need for time-bound implementation of measures as discussed above. Consequently, the Central Commission in exercise of its powers under Section 79(2) of the Act, advises the Ministry of Power to:

- a) Issue an advisory to the States to execute detailed energy accounting of all generators and load entities connected to the State grid, create a Deviation Settlement Mechanism pool in the State, and implement Availability Based Tariff as urged in National Electricity Policy 2005 para 5.7.1, and reiterated in National Tariff Policy 2006 para 6.2. The procedures must be put in place latest by April 1<sup>st</sup>, 2016.
- b) Impress upon the States to ring fence the State Load Dispatch Centres (SLDCs) and evolve a special scheme for their capacity building. This is a sine qua non for effective grid management and integration of large scale renewable energy sources in States.
- c) Issue an advisory to the States to adopt/specify FOR evolved Model Regulations on Forecasting, Scheduling and Deviation Settlement for solar & wind generators, latest by April 1<sup>st</sup>, 2016.
- d) Deploy requisite funds from a central fund such as PSDF or NCEF, etc till March 2019 to cover yearly deficit, if any on deviation charges that are incurred due to variable RE sources, for RE rich states.
- e) Issue an advisory to the States to evolve a regulation on Ancillary Services & Reserves aligned with timelines of implementation delineated in CERC's order on Reserves, latest by April 1<sup>st</sup>, 2016.
- f) Approve one-time reimbursement of expenses incurred by generators and load dispatch centers for implementation of AGC.

With negands,

Encl: As above.

Cinca Pradram

Yours sincerely,

(Gireesh B. Pradhan)

Shri Pradeep Kumar Pujari Secretary Ministry of Power Shram Shakti Bhawan, Rafi Marg New Delhi- 110001

### CENTRAL ELECTRICITY REGULATORY COMMISSION

### **NOTIFICATION (DRAFT)**

## **New Delhi**, Dated 23<sup>rd</sup> October 2015

**No.-L-1/(3)/2009-CERC** - In exercise of powers conferred by section 178 of the Electricity Act, 2003 and all other powers enabling it in this behalf and after previous publication, the Central Electricity Regulatory Commission, hereby makes the following regulations, to amend Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Third Amendment) Regulations, 2015

#### CHAPTER 1 PRELIMINARY

#### 1. <u>Short Title and Commencement</u>

(1) These regulations may be called the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Third Amendment) Regulations, 2015

(2) These regulations shall come into force with effect from the date of their publication in the Official Gazette

#### 2. Amendment of Regulation 2 of the Principal Regulations:

(1) The following proviso shall be added below Regulation 2 (1) (h) of the Principal Regulations:

"Provided that deviation shall be calculated for the Regional Entities by concerned RLDC which shall be attributed to various entities embedded within State."

(2) The following clause shall be added after clause (n) Regulation 2 (1) of the Principal Regulations:

"(**n-i**)**Peak Demand:** The Peak Availability for each State /Union territory as published by CEA for year 2014-15 as provided in Annexure-III to this Regulation."

#### **3.** Amendment of Regulation 5 of the Principal Regulations:

(1) In clause (iii) of Regulation 5 (1) of the Principal Regulations, the words "12% of the schedule or 150 MW, whichever is less " shall be replaced by words "limits as specified in Annexure-III ".

(2) Clause (iv) of Regulation 5 of the Principal Regulations shall be substituted as under:

"The charges for the Deviation for the over-injection by the generating station in a time block in excess of 12% of the schedule or 150 MW, whichever is less, shall be zero, except in case of injection of infirm power, which shall be governed by the clause (5) of this Regulation:

Provided that in case schedule of a generating station in a time block is less than or equal to 400 MW, the charges for the Deviation for the over-injection in excess of 48 MW shall be zero:

Provided further that charges for deviation for over-injection by a seller (other than a generating station) in a time block in excess of limits as specified in Annexure-III, shall be zero.

Provided also that charges for deviation for wind and solar generators which are regional entities, shall be governed by sub-clauses (v) to (vii) of this regulation.

## 4. Amendment of Regulation 7 of the Principal Regulations:

- (1) The words "12% of its scheduled drawal or 150 MW, whichever is lower in Regulation 7(1) of these regulations shall be replaced by words "limits as specified in Annexure-III".
- (2) The following proviso under 7 (1) of the Principal Regulations shall be deleted:

"Provided that the limits on deviation volume and consequences for crossing these limits (including the additional charges for deviation) as stipulated under Regulation 7 shall not apply to wind and solar generators which are regional entities."

(3) Clause (2) of Regulation 7 the Principal Regulations shall be amended as under:

"(2) The under-injection / over-injection of electricity by a generating station during a time-block shall not exceed 12% of the scheduled injection of such seller or 150 MW, whichever is lower when grid frequency is "49.70 Hz and above and below 50.10 Hz":

Provided further that in case schedule of a generating station, in a time block, is less than or equal to 400 MW, under-injection / over-injection in a time-block shall not exceed 48 MW, when grid frequency is "49.70 Hz and above and below 50.10 Hz":

Provided that the limits on deviation volume and consequences for crossing these limits (including the additional charges for deviation) as stipulated under Regulation 7 shall not apply to wind and solar generators which are regional entities:

Provided that under-injection / over-injection of electricity by a seller (except generating station) in a time block shall not exceed limits as specified in Annexure-III, when grid frequency is "49.70 Hz and above and below 50.10 Hz":

(4) Table (1) under Regulation 7(3) shall be substituted as under:

## Table I: For a (buyer) / (seller except generating station)

(i)	For over drawal /underinjection of	Equivalent to 20% of the Charge for
	electricity above L MW and up to L+50	Deviation corresponding to average grid
	MW in a time block	frequency of the time block.
(ii)	For over drawal of electricity above	Equivalent to 40% of the Charge for
	L+50 MW and up to L+100 MW in a	Deviation corresponding to average grid
	time block	frequency of the time block.
(iii)	For over drawal of electricity above	Equivalent to 100% of the Charge for
	L+100 MW in a time block	Deviation corresponding to average grid
		frequency of the time block.

Note: "L " shall be as specified in Annexure-III of this Regulations.

## Table I-G: For a generating station

А	When 12% of Schedule is less than or equal to 150 MW			
(i)	For under injection of electricity in	Equivalent to 20% of the Charge for Deviation		
	excess of 12% and upto 15% of the	corresponding to average grid frequency of		
	schedule in a time block	the time block.		
(ii)	For under injection of electricity in	Equivalent to 40% of the Charge for Deviation		
	excess of 15% and upto 20% of the	corresponding to average grid frequency of		
	schedule in a time block	the time block.		
(iii)	For under injection of electricity in	Equivalent to 100% of the Charge for		
	excess of 20% of the schedule in a time	Deviation corresponding to average grid		
	block	frequency of the time block.		
В	When 12% of Schedule is more than 150	MW		
(iv)	For under injection of electricity above	Equivalent to 20% of the Charge for Deviation		
	150 MW and up to 200 MW in a time	corresponding to average grid frequency of		
	block	the time block.		
(v)	For under injection of electricity above	Equivalent to 40% of the Charge for Deviation		
	200 MW and up to 250 MW in a time	corresponding to average grid frequency of		
	block	the time block.		
(vi)	For under injection of electricity above	Equivalent to 100% of the Charge for		
	250 MW in a time block	Deviation corresponding to average grid		
		frequency of the time block.		

(5) Proviso below Table-II under Regulation 7(3) shall be substituted as under:

"Provided that when the schedule is less than or equal to 400 MW, the additional charges for deviation shall be based on percentage of deviation worked out with reference to schedule of 400 MW as per Table-I-G (A) and Table-II (A) above."

(6) In Regulation 7 (5) of the Principal Regulations, the words "Annexure-I and Annexure-II" shall be replaced with the words "Annexure I, Annexure I-A and Annexure-II, Annexure-II-A".

#### 5. Amendment of Annexure-I of the Principal Regulations:

- The heading of Annexure I shall be substituted as under:
   "Methodologies for the computation of Charges of Deviation and Additional Charges for deviation for each regional entity for crossing the volume limits specified for the under-injection by Generating Station"
- (2) The following proviso shall be added below the Table titled "Illustration "A":

"Provided that when the schedule is less than or equal to 400 MW, the additional charges for deviation shall be based on percentage of deviation worked out with reference to schedule of 400 MW."

(3) A new Annexure namely, Annexure-I-A shall be added after Annexure-I.

#### 6. Amendment of Annexure-II of the Principal Regulations:

(1) The heading of Annexure II shall be substituted as under:

"Methodologies for the computation of Charges of Deviation and Additional Charges for deviation for each regional entity for crossing the volume limits specified for the over-injection by Generating Station"

(2) Following proviso shall be added below para A and para B of Annexure-II of the Principal Regulations:

"Provided that when the schedule is less than or equal to 400 MW, 12% of schedule will be considered as 48 MW for the purpose of this clause."

(3) A new Annexure namely, Annexure-II-A shall be added after Annexure-II.

(Shubha Sarma) Secretary

Annexure-I-A

Methodologies for the computation of Charges of Deviation and Additional Charges for deviation for each regional entity for crossing the volume limits specified for the over-drawal / underinjection by Buyer / seller (except generating station)

- A. When D<sub>tb</sub> i.e. Deviation from schedule in a time block in MW is less than limits specified in Annexure-III, in each time block, D<sub>tb</sub> to be payable by the regional entity at normal Charges for Deviation;
- B. When D<sub>tb</sub> i.e. Deviation from schedule in a time block in MW is more than limits specified in Annexure-III , in each time block
  - (i)  $D_L = D_{tb} D_0$ Where
    - D<sub>0</sub> = Limit as specified in Annexure-III
    - D<sub>L</sub>= Deviation in excess of limits specified in Annexure-III , in each time block
  - (iii) The Charges for Deviation corresponding to  $D_{tb}$  shall be payable by the regional entity at normal Charges of Deviation; In addition, graded Additional Charges for the Deviation for  $D_L$  shall be payable by the regional entity for over drawal for crossing the volume limit on the basis of percentage term or MW terms as the case may @ 20%, 40%, 100% of Charge of Deviation for the incremental deviation in each slab. The same is illustrated as under:

## <u>Illustration</u>

Category	Additional Charges for Deviation	
D <sub>tb</sub> is above L MW and	50 x (D <sub>tb</sub> - L) x Charge for Deviation	
up to L+50 MW	corresponding to average grid frequency of	
	the time block	
D <sub>tb</sub> is above L+50 MW	(100 x (D <sub>tb</sub> -(L+50)) + 2500) x Charge for	
and up to L+100 MW	Deviation corresponding to average grid	
	frequency of the time block	
D <sub>tb</sub> is above L+100	(250 x (D <sub>tb</sub> - (L+100)) + 7500) x Charge for	
MW	Deviation corresponding to average grid	
	frequency of the time block	

2. When the grid frequency is below 49.7 Hz:

The charges for deviation corresponding to Dtb shall be payable by the regional entity at 824.04 Paisa/kWh. In addition, additional deviation charges for deviation for Dtb shall be payable by the regional entity at 824.04 Paise/kWh.

Methodologies for the computation of Charges of Deviation and Additional Charges for deviation for each regional entity for crossing the volume limits specified for the under drawal/over-injection by buyer/Seller (except generating station)

- A. When Dtb i.e. Deviation from schedule in a time block in MW is less than limits specified in Annexure-III in each time block, Dtb to be recievable by the regional entity at normal Charges for Deviation;
- B. When D<sub>tb</sub> i.e. Deviation from schedule in a time block in MW is more than Limit as specified in Annexure-III
  - $(i) \qquad D_L = D_{tb} D_0$

Where

- D<sub>0</sub> = Limit as specified in Annexure-III
- D<sub>L</sub> = Deviation in excess of limits specified in Annexure-III , in each time block
- (ii) The Charges for Deviation corresponding to  $D_0$  shall be receivable by the regional entity at normal Charges of Deviation or the ceiling rate whichever is lower; the regional entity shall not be entitled to any receivable for  $D_L$

C. Additional Charges for the Deviation  $D_L$  shall be payable by the regional entity for under drawal/ over injection when grid frequency is 50.10 Hz or above in accordance with clause 7 (4) of this Regulation.

#### Annexure-III

S.No	State	Peak Demand Met (MW)	Deviation Limits (MW)-"L"
1	Maharashtra	19,804	250
2	Gujarat	13,499	250
3	Tamil Nadu	13,498	250
4	Uttar Pradesh	13,003	250
5	Rajasthan	10,642	250
6	Punjab	10,023	200
7	Madhya Pradesh	9,717	200
8	Karnataka	9,549	200
9	Haryana	9,152	200
10	West Bengal	7,524	150
11	Telangana	6,755	150
12	Andhra Pradesh	6,784	150
13	Delhi	5,925	150
14	Odisha	3,892	100
15	Chattisgarh	3,638	100
16	Kerala	3,594	100
17	Bihar	2,874	100
18	DVC	2,590	100
19	Jammu & Kashmir	2,043	100
20	Uttarakhand	1,930	100
21	Himachal Pradesh	1,422	100
22	Assam	1,257	100
23	Jharkhand	1,055	100
24	Dadar Nagar Haveli	714	50
25	Goa	489	50
26	Meghalaya	367	50
27	Chandigarh	367	50
28	Puducherry	348	50
29	Daman & Diu	301	50
30	Tripura	266	50
31	Manipur	146	50
32	Arunanchal Pradesh	126	50
33	Nagaland	128	50
34	Sikkim	83	50
35	Mizoram	88	50

Note: For the Regional entities not covered above, the deviation limit (L) shall be equal to 2% of its (Long term Access+ Medium term open access + short term open access) subject to minimum of 50 MW and maximum of 250 MW.

## **Explanatory Memorandum**

## Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Third Amendment) Regulations, 2015

## Introduction

The Central Electricity Regulatory Commission (hereafter referred to as 'the Commission') notified the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, 2014 in January 2014, which were thereafter amended via the first amendment (notified in December 2014) and the second amendment (notified in August 2015). The objective of these regulations is to "maintain grid discipline and grid security as envisaged under the Grid Code through the commercial mechanism for Deviation Settlement through drawal and injection of electricity by the users of the grid".

Analysis of the grid frequency, which is a primary indicator of the health of the grid, suggests that the frequency has stabilized closer to 50 Hz over time. Progressive tightening of the frequency band, volume limits on deviation along with other deterrents and enforcement of DSM regulations are the factors contributing to this improvement in frequency profile. Currently as per the existing volume limits for deviation, the States may deviate from schedule up to 150 MW or 12% of schedule, whichever is lower, when the frequency is between 49.7 Hz and 50.1 Hz with a minimum of deviation allowed as 48 MW under CERC Order dated 20.1.2015 in Petition No. 6/RP/2015. Beyond these frequency limits, no deviations are permitted.

However, many states continue to deviate heavily from schedule on a consistent basis (Annexure I- 'Trends of Deviation' for a few states). This is primarily due to absence of or poor load forecasting, lack of planning, procedures for calling in reserves and nonadherence to schedule by grid-connected entities such as conventional generators and DISCOMs in the State. The plots also illustrate that deviations are irrespective of windy vs non-windy season, or whether the State has large renewable capacity installed or not. Additionally, volume of these deviations in the past has been shown to be statistically uncorrelated to renewable penetration for specific Renewable-rich states (Annexure II-Analysis on correlation of State boundary deviations with variation in wind and solar sources). Notwithstanding the above, several states have emphasized that managing renewables, especially wind, is posing a huge challenge, which is causing the States to deviate from schedule, and resulting in huge financial burden. In this context, several States have made presentations in meetings with CERC, Ministry of Power, MNRE, POSOCO, and other stakeholders, wherein it has been stated that the deviation limit is causing huge financial burden and preventing more renewable capacity being commissioned by the States. Subsequently, the Commission engaged in several rounds of discussions with all stakeholders, including renewable energy (RE) rich states.

## **Existing provisions of DSM Regulations**

Regulation 7 of the Deviation Settlement Mechanism Regulations as amended provides as under:

"7. Limits on Deviation volume and consequences of crossing limits:

(1) The over-drawal/under-drawal of electricity by any buyer during a time block shall not exceed 12% of its scheduled drawal or 150 MW, whichever is lower, when grid frequency is "49.70 Hz and above" and "below 50.10 Hz":

Provided that no overdrawal of electricity by any buyer shall be permissible when grid frequency is "below 49.70 Hz" and no under-drawal of electricity by any buyer shall be permissible when grid frequency is "50.10 Hz and above".

(2) The under-injection / over-injection of electricity by a seller during a time-block shall not exceed 12% of the scheduled injection of such seller or 150 MW, whichever is lower when frequency is "49.70 Hz and above and below 50.10 Hz":

Provided that -

no under injection of electricity by a seller shall be permissible when grid frequency is "below 49.70 Hz" and no over injection of electricity by a seller shall be permissible when grid frequency is "50.10 Hz and above".

any infirm injection of power by a generating station prior to COD of a unit during testing and commissioning activities shall be exempted from the volume limit specified above for a period not exceeding 6 months or the extended time allowed by the Commission in accordance with the Connectivity Regulations.

any drawal of power by a generating station prior to COD of a unit for the startup activities shall be exempted from the volume limit specified above when grid frequency is "49.70" Hz and above".

(3) In addition to Charges for Deviation as stipulated under Regulation 5 of these regulations, Additional Charge for Deviation shall be applicable for over-drawal as well as under-injection of electricity for each time block in excess of the volume limit specified in Clause (1) and (2) of this regulation when average grid frequency of the time block is "49.70 Hz and above" at the rates specified in the table A & B below in accordance with the methodology specified in clause (7) of this regulation:"

2. The limits as provided above were relaxed vide CERC Order dated 20.1.2015 in Petition No. 6/RP/2015 as follows:

"(a) In case of utilities having schedule of 400 MW or below, Deviation Charges shall be receivable:

for under-drawal upto 48 MW in relaxation of Regulation 5 (1) (iii) of the DSM Regulations, and

for over-injection upto 48 MW in relaxation of Regulation 5 (1) (iv) of the DSM Regulations.

(b) Proviso below Table II under clause (3) of Regulation 7 of DSM Regulations is relaxed to provide as under:-

"Provided further that when the schedule is less than or equal to 400 MW, the additional charges for deviation shall be based on percentage of deviation worked out with reference to schedule of 400 MW as per Table-I (A) and Table-II (A) above."

## **Concerns raised by States**

Several states have highlighted the problems they face with meeting the deviation limits as stipulated by the regulations. Specifically:

Madhya Pradesh has stated that the State presently has 1073 MW of wind and 667 MW of solar installed capacity. This is further expected to increase to 5800 MW and 3500 MW, respectively, by 2020. RE generators are outside the purview of DSM, and given that CERC has allowed 15% deviation to wind and solar generators, the State regulators are likely to follow the same. This would imply that the State has to absorb 15% deviation, resulting in negative impact on the intra-state entities and DISCOMs. They have requested for a mechanism to compensate RE rich states. In particular, Madhya Pradesh has suggested that:

- a) Volume limits for RE rich states could be 12% of schedule or 150 MW, whichever is higher; or
- b) 15% of total RE installed capacity, plus 2% of forecasting error
- c) States may be compensated from Regional DSM account for variation in RE generation at the State level, by determining the difference in deviation charges payable by intra-state generators, and frequency-based DSM charges levied by RPC.

Gujarat has pleaded that present deviation limit is too small for larger States. They have also emphasized the challenge of managing wind energy in their state.

- a) Additionally, they have objected to the new calculation of 'error' for RE generators. 15% tolerance band, on capacity of 4000 MW would imply an acceptable deviation of 600 MW, of which State has to bear financial loss for 600-150=450 MW.
- b) Gujarat has also stated that sale of RE power from one state to another should be covered under CERC regulations, so host state does not have to pay penalty for deviation by such generators under DSM.

- c) The State has recommended that deviation at the State boundary should exclude deviation on account of infirm generation, especially wind, in case of RE-rich states.
- d) It has been highlighted that a limit of 150 MW is just 1% for Gujarat having demand of more than 15,000 MW. The suggestion is this limit should be at least equal to capacity of single largest generating unit in the State, and that no penalty should be levied for 2 hours in case of outage of such a unit.

Maharashtra has underlined that large variation in demand while balancing and ramping capacity is limited makes it difficult to manage within 150 MW limit. E.g. even 2-3% variation in demand would result in over 400-600 MW deviation. Other issues include State generators do not have FGMO operation to provide primary response, mismatch between ABT meter and SCADA data, no visibility of RE, lack of proper demand forecasting by DISCOMs, etc. In addition, Maharashtra has argued that DSM limits are depriving the system from benefits of integrated grid operation in contingency situation, and that the rationale for fixing the limit at 150 MW is unknown.

Schedule below 400 MW	48 MW
Schedule between 401 to 1250 MW	12% of schedule or 150 MW, whichever is lower
Schedule between 1251 to 1500 MW	150 MW
Schedule greater than 1501 MW	10% of schedule or 400 MW, whichever is lower

Maharashtra has proposed the following graded scheme for States:

## Analysis of the suggestions of States

The Commission has in the Statement of Reasons (SOR) for the previous UI/DSM Regulations mentioned the rationale for introducing limits on deviation. In this context, following extract is quoted from the SOR to the Draft CERC UI Regulations 2009:

"In this context, the key issue is how to bring discipline among the beneficiaries, and at the same time, what measures should be taken for reducing the gaming practices? One of the solutions for handling this issue is that maximum limit for variation from scheduled drawal, should be specified. Imposing the over-drawal limit will serve both the purposes, as it will deter the beneficiaries from indiscriminate overdrawal and at the same time, lower over-drawal by such overdrawing beneficiaries will automatically result into lower under-drawal by other beneficiaries. However, several considerations need to be addressed in case limit (or volume cap) is sought to be imposed on beneficiaries, as outlined below:

• What should be over-drawal limit?

• Should it be specified in terms of MW for a particular time-block or daily limit in MWh terms or both?

• Should over-drawal limit (or volume cap) be specified for entire frequency range or only for the low frequency period?

In this regard, it also needs to be borne in mind that under the prevailing severe supply constrained environment, load management and control by beneficiaries, particularly distribution licensees is an extremely difficult task, and planned measures and initiatives of load management and control need to be rewarded. Further, short-term (or hourly) demand forecasting practices at distribution level are yet to be established in the country with little experience available with some distribution companies. Therefore, the variation limit should not be as stringent for beneficiaries. Further, there are several other factors beyond the control of distribution licensees that may be responsible for over-drawal, such as seasonal variation, change in climatic conditions, festive season, variation in agricultural load, etc. Therefore, it may not be proper to specify a static over-drawal limit. The overdrawal limit should be specified by the Commission from time to time considering various factors as discussed above. Based on above, it is considered that a volume cap of 12% of the schedule of beneficiary in MW terms (or 150 MW, whichever is lower), for any time block, particularly, when grid frequency is below 49.5 Hz, should be reasonable to be introduced. RLDCs should monitor beneficiaries' drawal below 49.5 Hz and exercise control to ensure overdrawing beneficiaries whose over drawal exceeds 12% in any time block and direct them to curtail their drawal first."

From the above, it is clearly evident that the Commission has been considerate of the various factors and accordingly the limits have been provided. The deviation limit was fixed with due regard to the supply constrained environment at that time, demand forecasting practices, load management & control by utilities, seasonal variation, change in climatic conditions, RE variability, etc. This was the overarching philosophy behind putting the DSM limit in 2014.

There are several potential models for fixing State boundary deviation limits that have been proposed in the meetings, and captured in comments above. Suggestions such as '12% of schedule or 150 MW, whichever is higher' or '15% of RE capacity + 2% of peak load' are impossible to implement from a grid management perspective. Such huge deviations, if allowed on the grid without proper automated controls (primary & secondary frequency controls), balancing measures and proper defense mechanisms, will certainly endanger grid stability.

Gujarat has also brought up the point of 'acceptable deviations' of RE generators. It is very important to note here that while the Commission has provided a framework where solar & wind regional entity generators are not penalized up to 15% of error, it is keeping in view their intermittent nature. However, this does not imply that the RLDCs should just let these deviations reflect as is on the grid. Instead, they must monitor forecasting accuracy to anticipate and deploy ancillary services to balance these deviations. To that extent, the cost of balancing these deviations would be socialized. Accordingly, the Commission has released Ancillary Services Operations Regulations in August 2015, and has notified suomotu Order on Reserves, on 13.10.2015. Both these steps are to enable the grid operators to deploy reserves for maintaining load-generation balance. Similarly, the States must draft regulations to operationalise a framework for spinning reserves and ancillary services in respective States. Furthermore, State grid operators must plan to balance variation due to RE

sources connected to the State grid, and not let those deviations pass through to the State boundary as is. For this, more accurate RE forecasting in addition to load forecasting and flexibility in the existing conventional generation is needed.

Gujarat has suggested that limit should be "at least equal to capacity of single largest generating unit in the State". International best practices suggest that this amount of spinning reserves should be planned for, in case of unexpected outage. Thus, this calculation should be utilized in planning for reserves by the State. The Commission reiterates that the grid does not generate electricity.

While the point on reaping benefits of a large interconnected grid made by Maharashtra is well taken, the approach here has to be real-time deployment of reserves as well as taking advantage of short-term transactions in the market to counter contingencies such as outage of generating units or transmission lines. Solution lies in pro-active contracting for balancing resources, and sharing of balancing resources across states, and not in allowing huge deviations for several hours, as that would certainly put burden on tie-lines as well as threaten grid stability due to frequency and voltage fluctuations.

Maharashtra has further proposed that for States with schedule over 1500 MW, DSM limit should be 10% of schedule or 400 MW, whichever is lower. For the 18 states which had a max schedule greater than 1500 MW during FY 14-15, this would imply a sum total of about 6000 MW of deviation allowed. If one adds deviation allowances of the remaining States, this would well exceed safe limits of grid operation.

Notwithstanding that errors in load forecasting are possible, as pointed out by Gujarat & Maharashtra, the States must ensure that load-serving entities are investing in improving load forecasting methods by analyzing accuracy of their forecasting algorithms over time. If a fairly good load forecast is made, the standard deviation of the forecast error is expected to be of the order of 2% or less and this is known upfront, i.e., before despatch. Such anticipated variations in the load need to be taken care of through deployment of reserves in the system. There are many states where scientific methods of load forecasting are yet to be put in place. Such States must first take the requisite steps, and then proceed to show the inadequacy of these processes, if any remains. Long, medium and short term load forecasting and generation planning, peak vs off-peak planning, streamlined energy accounting for all entities, RE forecasting and scheduling- these are critical and fundamental steps for sound grid management. There cannot be any excuse for not undertaking each one of these actions at the State level, and thereafter not taking responsibility for grid indiscipline that results due to absence of the above.

While the Commission is concerned about the lack of planning by stakeholders on dimensions stated above, it appreciates that putting these processes, hardware and software upgrades in place will take some time. Particularly, utilization of Free Governor Mode of Operation (FGMO) for generators to provide primary frequency response, and deployment of Automatic Generator Control (AGC) for secondary response, both these essential components must be planned for. Accordingly, in the suo-motu Order dated 13.10.2015, the

Commission has laid out a roadmap for operationalizing reserves for ISGS, briefly summarized as follows:

- To start with, a regulated framework in line with the Ancillary Services Regulations may be evolved for identification and utilising of spinning reserves and implemented with effect from 1<sup>st</sup> April, 2016. This framework may continue till 31<sup>st</sup> March, 2017. This can be initially for generating stations regulated by CERC, which could be started off with a manual process for secondary reserves.
- All generating stations that are regional entities must plan to operationalise AGC along with reliable telemetry and communication by 1<sup>st</sup> April, 2017. This would entail a one-time expense for the generators to install requisite software and firmware, which could be compensated for. Communication infrastructure must be developed in parallel, in a cost-effective manner.
- On the other hand, Regional Load Dispatch Centres (RLDCs) would need technical upgrades as well as operational procedures to be able to send automated signals to these generators. NLDC and RLDCs should plan to be ready with requisite software and procedures by the same date.
- In the long term, however, a market based framework is required for efficient provision of secondary reserves from all generators across the country. For this, POSOCO is directed to commission a detailed study and suggest a proposal to the Commission for implementation w.e.f. 1<sup>st</sup> April, 2017.
- The Commission has also re-iterated the importance of smart metering, telemetry, and separate scheduling/energy-accounting of all entities embedded inside the state, such as DISCOMs, open access consumers, conventional and RE generators, etc. by the concerned SLDC.

For large-scale integration of solar and wind generators into State grids, the Forum of Regulators (FOR) has evolved a State Model Regulation, which outlines a model for operational and commercial management of variable RE sources. The proposed framework for forecasting, scheduling, and deviation settlement of solar & wind generators is similar to that notified by CERC for regional entities in August 2015. However, it is pertinent to explicate the commercial arrangement suggested for the States. In the Model Regulation, it has been recommended that if the State DSM pool goes negative due to implementation of the regulation, the States may approach national funds such as NCEF or PSDF for covering the deficit. It has been underlined that this would be only to the extent of deficit caused by RE generators. Hence, to qualify for such compensation, the States must undertake separate scheduling and energy accounting of all entities, as explained in the document. The Commission feels that this will address a major part of the problem, as currently stated by the RE-rich states.

## **Proposed Way-forward**

#### Medium to Long term Solution

International experience from US and Germany suggests that managing a large interconnected grid, with or without renewables, is a tight-rope affair demanding high precision. Federal Commission in the US requires each balancing authority (BA) to operate such that average area control error (ACE) is less than specified limits ( $L_{10}$ ) for 90% of the time (explained further in Annexure- III). Example values for Eastern Interconnection, as a

10         2           50         5           100         7           250         12           500         17           1000         23           2500         37	L <sub>(10)</sub> (MW)	BA Size (MW)
50         5           100         7           250         12           500         17           1000         23           2500         37	2	10
100         7           250         12           500         17           1000         23           2500         37	5	50
250 12 500 17 1000 23 2500 37	7	100
500 17 1000 23 2500 37	12	250
1000 23 2500 37	17	500
2500 37	23	1000
2000 01	37	2500
5000 52	52	5000
10000 74	74	10000
15000 91	91	15000

function of balancing authority size, are as below:

It can be observed that while smaller BAs are allowed up to 10% limit, for larger BAs, the limit drops to 0.6%, with only ~90 MW for a BA of size 15,000 MW. This is designed keeping in mind that larger states also have access to a larger variety and pool of balancing resources.

In Germany, all generators and load-serving-entities are categorized into 'balancing groups', which are responsible for balancing within themselves perfectly, up to 15 minutes before dispatch. That is, each balancing group has to ensure its net schedule is zero, and has to manage the same up until 15

minutes before dispatch. Balancing costs for real-time corrections are recovered from the responsible entity, and can be very high. Balancing groups are a commercial construct, and balancing is achieved primarily through trades. This concept illustrates that it is feasible to balance even within much smaller balancing areas.

As a country, we aim to integrate large amounts of renewable energy on the grid, which is feasible only once a strong foundation is in place. The Commission appreciates the financial consequences of the unpreparedness of the States in the current scenario. Thus, the Roadmap below is being put forth for the States to plan for, with the objective of advancing towards reliable and sustainable grid operation:

- I. Load Forecasting: short, medium and long term
- II. Intra-State Deviation Settlement
  - a. Procedures for Scheduling, Metering, Accounting, Settlement- of all generators & buyers
  - b. Interface Metering for intra-state entities
  - c. Software Requirement for scheduling, metering, accounting and settlement
  - d. Capacity building of stakeholders

Timeframe for implementation for all this is estimated to be in the range of 3- 6 months.

- III. Forecasting & Scheduling of RE sources
  - a. Adopt Model Regulation for intra-state solar and wind generators
  - b. Process & software modifications at SLDC to implement frequent schedule changes, closer to dispatch
- IV. Regulation on Spinning Reserves and other Ancillary Services within the State
  - a. Timeline and directive to utilize FGMO on all generating units
  - b. Operationalize manual operation of secondary reserves by April 1st, 2016
  - c. Installation of AGC and associated communication infrastructure, software & procedures at SLDC, by April 1st, 2017
  - d. Market based framework for Ancillary Services by April 1st, 2017
- V. Process changes to enable frequent and faster intra-day trading at power exchanges
  - a. Current process takes too long for intra-day trades; States must examine procedures to shorten it
  - b. DISCOMs must align their decision-making processes with extended market session availability to correct for intra-day imbalances
- VI. Cooperation with neighbouring States for sharing balancing resources
  - a. States and Regional Power Committees should facilitate regional cooperation for sharing flexible generation and other balancing resources among the States

#### Transitional Arrangement

Taking into consideration the time required to put the above recommendations in place, and the difficulties of the States under existing DSM limits, the Commission is proposing a revised set of DSM limits for the States, as outlined below, as a one-time measure. It must be noted that these relaxations are being offered only until 1<sup>st</sup> April 2017, by which time the Commission expects the States to have attained significant progress on all dimensions of robust grid management, as summarized in the Roadmap above.

The Commission proposes to fix the State DSM limit according to the peak demand values of FY 2014-15. The model follows the L(10) model as briefly described above, wherein the limit as a percentage of peak load of the State reduces as the magnitude gets bigger. In the table below, the States with peak demand in the range of 6000-10,000 have a suggested limit which is approximately 2% of their peak demand met. This % increases as we go down the list of States with lower peak demands, and States with less than 1000 MW of peak demand

are assigned a deviation limit of 50 MW. Maximum limit allowed for the larger States is set to 250 MW. State-wise allocation of DSM limits (for the period from the date of notification of these amendments until 31.03.2017) shall be as follows:

S.No	State	Peak Demand Met (MW)	Revised DSM Limit:
1	Maharashtra	19,804	250
2	Gujarat	13,499	250
3	Tamil Nadu	13,498	250
4	Uttar Pradesh	13,003	250
5	Rajasthan	10,642	250
6	Punjab	10,023	200
7	Madhya Pradesh	9,717	200
8	Karnataka	9,549	200
9	Haryana	9,152	200
10	West Bengal	7,524	150
11	Telangana	6,755	150
12	Andhra Pradesh	6,784	150
13	Delhi	5,925	150
14	Odisha	3,892	100
15	Chattisgarh	3,638	100
16	Kerala	3,594	100
17	Bihar	2,874	100

18	DVC	2,590	100
19	Jammu & Kashmir	2,043	100
20	Uttarakhand	1,930	100
21	Himachal Pradesh	1,422	100
22	Assam	1,257	100
23	Jharkhand	1,055	100
24	Dadar Nagar Haveli	714	50
25	Goa	489	50
26	Meghalaya	367	50
27	Chandigarh	367	50
28	Puducherry	348	50
29	Daman & Diu	301	50
30	Tripura	266	50
31	Manipur	146	50
32	Arunanchal Pradesh	126	50
33	Nagaland	128	50
34	Sikkim	83	50
35	Mizoram	88	50

The limits have been arrived considering the security of the grid, the issues/concerns raised by the states and their suggestions in this regard. So far as the lower limit of 50 MW is concerned, this is in line with the earlier decision of the Commission taken in Petition RP/06/2014. It must however be borne in mind that secure and reliable operation of the grid is of paramount importance and rationality pre-supposes existence.

The Commission is being very liberal, and is going against international best practices, but it must be reiterated that this measure is meant as a one-time measure for a specified period. These limits have been relaxed only up to April 1<sup>st</sup>, 2017,. The States must plan to have sound grid management practices as well as firm up their strategy for maintaining load-generation balance in the wake of increasing share of renewables by then. The limits shall be revised towards more stringent norms post April 2017.

The draft amendment includes changes required to incorporate CERC Order in Petition No. 6/RP/2015 dated 20.1.2015 which is already effective from 1.2.2015.

It is also clarified that the limits as specified in Annexure-II to the draft amendment are not applicable to generating stations which shall continue to be governed under the limits of 12% of SG or 150 MW whichever is lower (subject to a minimum of 48 MW). These limits shall be applicable in case a generating station is making a transaction by itself or through a trader.

Accordingly Regulations 5(1) (iv) , 7(2), 7(3), Annexure-I, I-A, II, II-A has been modified to provide for limits for sellers except generating stations and sellers separately. In case State as a regional entity is selling in a particular block, it shall be treated as a seller and limits as specified in Annexure-III shall be applicable. These limits shall be applicable in case State is making a transaction by itself or through a trader.

Accordingly changes have been made wherever required in the CERC (Deviation Settlement Mechanism and related matters) and proposed vide the Draft CERC (Deviation Settlement Mechanism and related matters) (Third Amendment) Regulations, 2015.

## **Annexure I: Trends of Deviation of selected States**

## RAJASTHAN



HEAD	MAX (in MW)	MIN (in MW)	AVG (in MW)	
Schedule	5047	-17	2390	
Actual	5257	-161	2430	
Deviation	1202	-1324	-	
Note: +Ve indicates O/d & –Ve indicates U/d				

#### **UTTAR PRADESH**



HEAD	MAX (in MW)	MIN (in MW)	AVG (in MW)	
Schedule	7275	1903	4334	
Actual	8046	1472	4337	
Deviation	1613	-2291	-	
Note: +Ve indicates O/d & -Ve indicates U/d				

## TAMIL NADU



HEAD	MAX (in MW)	MIN (in MW)	AVG (in MW)	
Schedule	5073	903	3448	
Actual	5148	320	3376	
Deviation	546	-990	-	
Note: +Ve indicates O/d & –Ve indicates U/d				

## **GUJARAT**



HEAD	MAX (in MW)	MIN (in MW)	AVG (in MW)	
Schedule	4448	-259	2234	
Actual	4516	-766	2161	
Deviation	1174	-1162	-	
Note: +Ve indicates O/d & –Ve indicates U/d				

### MAHARASHTRA



HEAD MAX (in MW) MIN (in MW) AVG (in MW) Schedule 7804 909 4669 Actual 8001 561 4584 Deviation -2072 -1802 Note: +Ve indicates O/d & -Ve indicates U/d

## HARYANA



HEAD	MAX (in MW)	MIN (in MW)	AVG (in MW)	
Schedule	5695	281	3017	
Actual	5858	128	2970	
Deviation	1053	-2419	-	
Note: +Ve indicates O/d & –Ve indicates U/d				

## Annexure II: Analysis on correlation of State boundary deviations with variation in wind and solar sources

(As deliberated at the 49<sup>th</sup> Meeting of the Forum of Regulators, held at Ahmedabad, 27<sup>th</sup> June 2014)

Data analysis was conducted by POSOCO, wherein SCADA data for 2013-14 was taken at an interval of 5 minutes each for

- State's own generation in MW
- State's wind generation in MW
- State's drawal from the grid in MW
- State's demand in MW

Impact of variability on deviation was captured through Karl Pearson correlation coefficient.

5 minute changes in deviation, demand, conventional generation and wind generation taken for analysis (288 values for each day). The results for correlation of schedule deviations with change in demand vs change in conventional generation vs change in wind generation are given below. It was observed that there was little correlation of observed deviations on State boundary with change in wind generation, instead, much higher correlation was observed with demand change.

## **GUJARAT**

Month	Co-relation coefficient between				
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change		
April 2013	0.68	-0.16	-0.06		
May 2013	0.69	-0.19	-0.04		
June 2013	0.53	-0.15	-0.11		
July 2013	0.42	-0.13	-0.09		
Aug 2013	0.46	-0.13	-0.05		
Sep 2013	0.53	-0.20	-0.03		
Oct 2013	0.52	-0.17	-0.03		
Nov 2013	0.47	-0.21	-0.03		
Dec 2013	0.38	-0.16	-0.02		
Jan 2014	0.42	-0.18	-0.03		
Feb 2014	0.51	-0.17	-0.01		
Mar 2014	0.48	-0.27	-0.04		
Average	0.51	-0.18	-0.05		

Conclusions for Gujarat:

On an annual basis for Gujarat, based on 2013-14 data:

- Wind generation variability has negligible adverse effect on deviation from the schedule
- Conventional generation change affects deviation 4 times more than wind generation
- Demand changes affects deviation 10-11 times more than wind generation

## TAMIL NADU

Month	Co-relation coefficient between				
	Deviation change with demand change	Deviation change with conventional generation change	Deviation change with wind generation change		
April 2013	0.67	-0.15	0.01		
May 2013	0.58	-0.17	-0.07		
June 2013	0.52	-0.06	-0.10		
July 2013	0.52	-0.12	-0.15		
Aug 2013	0.33	-0.15	-0.09		
Sep 2013	0.53	-0.08	-0.05		
Oct 2013	0.52	-0.16	-0.06		
Nov 2013	0.67	-0.23	-0.01		
Dec 2013	0.59	-0.22	-0.06		
Jan 2014	0.57	-0.17	-0.15		
Feb 2014	0.62	-0.29	-0.03		
Mar 2014	0.67	-0.22	0.01		
Average	0.56	-0.17	-0.06		

Conclusions for Tamil Nadu:

On an annual basis for Tamil Nadu, based on 2013-14 data:

- Wind generation variability has negligible adverse effect on deviation from the schedule
- Conventional generation change affects deviation 2-3 times more than wind generation, though in high wind season, the two are comparable.
- Demand changes affects deviation 8-9 times more than wind generation, which drops to 3-4 times in high wind season.

## Annexure III- Balancing metrics used by NERC

The North American Reliability Council (NERC), USA uses the following standards as metrics for control area performance in terms of Area Control Error (ACE)<sup>1</sup>

- Control Performance Standard 1 or CPS1
  - Uses **1 minute averages** of ACE in the calculation.
  - Measure whether a Control Area is doing their part to help control frequency over the long-term.
  - CPS1 (in %) = 100\* [2 (a Constant)\* (frequency error)\*(ACE)]
- Control Performance Standard 2 or CPS 2
  - Uses **10 minute averages** of ACE in the calculation.
  - Measure how well a Control Area is balancing over a period of a month.
  - 90% of the 10 min. periods in a month must be within a certain limit  $(L_{10})$
  - CPS2 (in %) = 100 \* (periods without violations)/(all periods in month)
- Disturbance Control Standard or DCS
  - Uses two ACE readings (before and after).
  - Measures how well a Control Area or a group of Control Areas respond to sudden loss of supply.
  - Basically, a Control Area or reserve sharing group has 15 minutes to replace the sudden loss of supply.

In the Indian system, the volume limits are in line with the CPS1 standard. The zero crossing violation is in line with the CPS2 standard of NERC. The DCS could be based on the Frequency Response Characteristics (FRC) which factors both load and governor response. The Commission would like to introduce suitable provisions for DCS in the Indian Grid in the future as the system matures.

<sup>&</sup>lt;sup>1</sup> "Balancing and Frequency Control- A Technical Document", January 2011, NERC

#### CENTRAL ELECTRICITY REGULATORY COMMISSION NEW DELHI

## Petition No. 11/SM/2015

Coram: Shri Gireesh B. Pradhan, Chairperson Shri A.K. Singhal, Member Shri A.S. Bakshi, Member Dr. M.K. Iyer, Member

Date of Order: 13.10.2015

In the matter of Roadmap to operationalise Reserves in the country

## <u>ORDER</u>

The Electricity Act, 2003 entrusts on the Central Commission important responsibilities inter-alia of regulating the inter-State transmission of electricity, specifying grid code and also enforcing standards with respect to quality, continuity and reliability of service by licensees. Laying down of framework for effective and secure grid operation is thus one of the most important mandates of the Commission. The Central Commission has taken initiatives towards this end through regulations on Indian Electricity Grid Code and Deviation Settlement Mechanism and related matters. The Commission has also issued direction from time to time for enforcing grid discipline.

2. Over the period, reliance of the utilities on the grid for meeting their short term energy demand was increasing. This caused serious threat to grid security. The Commission, therefore, tightened the operating band of grid frequency and made deviation charges stringent enough to discourage the utilities from deviation from their schedule. This has started yielding the desired results in terms of operation of the grid

closer to 50 Hz. The Commission has reiterated time and again that un-scheduled inter-change (UI) mechanism cannot be used as platform for meeting the energy demand of the utilities. Last mile imbalances are inevitable, but for this reliance on grid is not desirable. This need be planned for, and adequate reserves need be contracted to address such last mile imbalances.

3. The National Electricity Policy (NEP) mandates that adequate reserves may be maintained to ensure secure grid operation:

"5.2.3 In order to fully meet both energy and peak demand by 2012, there is a need to create adequate reserve capacity margin. In addition to enhancing the overall availability of installed capacity to 85%, a spinning reserve of at least 5%, at national level, would need to be created to ensure grid security and quality and reliability of power supply."

4. However, creation of adequate system reserve margin and spinning reserves at national level has not yet materialised. In furtherance to the provisions relating to the requirement of Spinning Reserves in the Electricity Act, 2003, National Electricity Policy and Tariff Policy, and to facilitate-large scale integration of renewable energy sources, balancing, deviation settlement mechanism and associated issues, CERC constituted a Committee vide letter No, 25/1/2015/Reg. Aff. (SR)/CT.RC dated 29<sup>th</sup> May 2015, under the chairmanship of Shri A.S. Bakshi, Member CERC, to examine the technical and commercial issues in connection with Spinning Reserves and evolve suggested regulatory interventions in this context.

5. The Committee submitted its final report to the Commission on 17<sup>th</sup> September
2015 (annexed as Annexure-I). Major findings of the Committee are as under:

- (a) Spinning Reserves are required to be maintained of requisite quantum depending upon the grid conditions. Operation at constant frequency target of 50.0 Hz with constant area interchange should be the philosophy adopted.
- (b) The Spinning Reserve may be maintained, to start with at the regional level in a distributed manner.
- (c) The respective RLDC should be the Nodal agency at the regional level and NLDC at the country level.
- (d) Each region should maintain secondary reserves corresponding to the largest unit size in the region and tertiary reserves should be maintained in a decentralized fashion by each state control area for at least 50% of the largest generating unit available in the state control area. This would mean secondary reserves of 1000 MW in Southern region; 800 MW in Western regions; 800 MW in Northern region; 660 MW in Eastern region and 363MW in North-Eastern region (total approx. 3600 MW on an All India basis). Primary reserves of 4000 MW should be maintained on an All India basis considering 4000 MW generation outage as a credible contingency. The same should be provided by generating units in line with the IEGC provisions.
- (e) The reserve requirement may be estimated by the nodal agency on day-ahead basis along with day ahead scheduling of all available generating stations.
- (f) Implementation of AGC is necessary along with reliable telemetry and communication. The AGC may be planned to be operationalised in the power system from 1.4.2017.
- (g) It is essential that load forecasting is done at each DISCOM level, at each SLDC/State level and each RLDC/Regional level and finally at NLDC/country level.
- (h) It is also essential to forecast the generation from renewable sources of energy by the generators, and similarly by the DISCOMs, by the SLDCs and by the RLDCs.
- (i) To start with a regulated framework in line with the Ancillary Services Regulations may be evolved for identification and utilising of spinning reserves and implemented with effect from 1.4.2016. This framework may continue till 31.3.2017.
- (j) The reserves at the regional level, should be assigned to specific identified generating station or stations duly considering the various technical and commercial considerations including energy charges of the generating stations. The nodal agency should be empowered to identify the ISGS irrespective of type and size of the generating station for providing spinning reserve services and it should be mandatory for such generating stations to provide spinning reserve services.

- (k) The nodal agency may have the option of carrying such reserves on one or more plants on technical and commercial considerations and may withhold a part of declared capacity on such plants from scheduling. It could be in terms of % of declared capacity or in MW term as deemed fit.
- (I) A framework as specified in the Central Electricity Regulatory Commission (Ancillary Services Operations) Regulations, 2015 may be followed for the Spinning Reserve Services as well. The Central Electricity Regulatory Commission (Ancillary Services Operations) Regulations, 2015 may be amended to incorporate the necessary changes in this regard.
- (m)Going forward, a market based framework may be put in place from 1<sup>st</sup> April 2017 for achieving greater economy and efficiency in the system. A detailed study is required to be carried out before the market mechanism on spinning reserves is put in place. It is suggested that the NLDC be directed to commission study through a consultant in the context and submit a proposal to the Commission for approval.

The Commission has carefully considered and accepted the findings of the Committee.

6. One of the important components of ensuring grid reliability includes achieving adequacy of supply and maintaining the load-generation balance. This poses a challenge to grid operators on various time-scales: on a daily level as weather varies, for example, on an hourly level as load varies during the day, and on sub-hourly/timeblock level as there are errors in forecasting of load or unplanned outages of generating units or transmission lines. Sudden disturbances in the Power System can initiate a steep fall or rise in the frequency of the Power System, which can be detrimental to the Power System operation, if not contained immediately. Thus, to ensure 24x7 power supply and grid reliability, grid operators must have access to reserves at different locations and factoring transmission constraints, the system operators should be able to increase or decrease power supply on the grid at any time of the day.

7. Three types of reserves are generally considered depending on the timeline of initiation and functional need. Primary control refers to local automatic control available in all conventional generators, which delivers reserve power negatively proportional to frequency change. Such immediate automatic control is implemented through turbine speed governors, in which the generating units respond quickly to the frequency deviation as per droop characteristic of the units. However, this response to arrest frequency drop or rise lasts for short period of up to 30 seconds - 15 minutes, within which secondary control should come into play should the contingency last longer than that. IEGC section 5.2(i) specifies a provision for primary reserves, as under:

"The recommended rate for changing the governor setting, i.e., supplementary control for increasing or decreasing the output (generation level) for all generating units, irrespective of their type and size, would be one (1.0) per cent per minute or as per manufacturer's limits. However, if frequency falls below 49.7Hz, all partly loaded generating units shall pick up additional load at a faster rate, according to their capability."

However, this has not been adhered to fully by the generators.

8. Secondary control involves Automatic Generation Control (AGC) which delivers reserve power in order to bring back the frequency and the area interchange programs to their target values. For AGC, units as well as load dispatch centres have to be equipped with necessary communication infrastructure, as it involves sending automated control signals from the LDC to the generator based on grid conditions. AGC has been absent in the Indian power system. Very commonly, this results in 'load shedding' by DISCOMs in case generation is lagging load. The Indian power sector was beset with scarcity for a long time; however, now the scenario is changing and margin for reserves is feasible. With a large interconnected grid meeting a peak load of over 145 GW, both primary and secondary controls are essential components for reliable grid operation.

9. Tertiary control refers to manual change in the dispatching and unit commitment in order to restore the secondary control reserve, as loss of generator may cause a system contingency that lasts for several hours.

10. Traditionally, imbalance handling on the Indian grid has been done through the Unscheduled Interchange (UI) or the Deviation Settlement Mechanism (DSM) framework, in which the frequency-linked UI rate gave a signal to the grid participants to correct for instantaneous frequency deviations. However, it led to use not meant for, and further grid indiscipline besides stress/constraints in the transmission network. While measures like tightening of the operating grid frequency band and provision for deterrent deviation charges, have been resorted to and this has resulted in improvement of grid operation, the Commission feels that the power system operation in

the country still needs to mature further. Even now States have been deviating from schedule substantially. For instance, in 2014-15, Rajasthan deviated in the range of (+) 1202 to (-) 1324; UP in the range of 1613 to (-) 2291; Karnataka in the range of 945 to (-) 787 etc.; Tamil Nadu in the range of 546 to (-) 990; Gujarat in the range of 1174 to (-) 1162. These are not only undesirable but also a cause of serious concern. The DSM Regulations provide for a periodic review of the DSM rates and the Commission directs the Staff to undertake a review of the same and submit a proposal for consideration of the Commission.

11. The Commission would like to underscore that grid does not generate electricity and as such cannot be relied upon for meeting energy needs. Reserves and reserves alone can address this and the earlier the stakeholders realise this, the better it is for safe and secure system operation. Reserves assume greater significance additionally in the wake of the goal of integration of large scale variable renewable energy sources. With increasing penetration of variable and intermittent RE generation, flexible generation such as pumped storage hydro plants are needed. There is a need for more flexibility in the operation of conventional generation plants also and flexibility needs to be quantified, measured and duly compensated for. The Commission has already made a beginning in this direction by proposing amendment to the Indian Electricity Grid Code (IEGC) in respect of 'technical minimum' which is expected to be notified shortly. 'Ramp up' and 'ramp down' rates are other important parameters for flexibility which would gradually be introduced through Regulations. 12. The grid operator would now be required to undertake planning exercise to meet Net Load, which is defined as: Net load = Load – RE power. This quantum must be met with conventional generation with adequate flexibility at every point in time. To even begin an exercise of planning for ongoing load-generation balance, load forecasting is essential. It is also necessary to ensure conventional generators to generate as per the schedules. Forecasting and scheduling of solar and wind generating stations is the next critical step for the grid operators to estimate the amount of RE power they can anticipate to be injected into the grid, on a day-ahead and hour-ahead basis. Thus, the variability that can be predicted in the forecasts must be accounted for in planning flexible generation as well as tertiary reserves day-ahead and hour-ahead. Furthermore, balancing the uncertainty of RE power on a continuous basis necessitates a streamlined process for deploying spinning reserves. This would be effectively balancing the forecasting error in net load.

13. The Commission notified Central Electricity Regulatory Commission (Ancillary Services Operations) Regulations, 2015 on 19<sup>th</sup> August 2015 with the objective of utilizing un-requisitioned surplus in ISGS. These regulations are a first step towards the entire gamut of Ancillary Services, starting with tertiary frequency control services. Applicable to regional entities, the regulations outline a framework for both Regulation Up and Regulation Down service by Reserves Regulation Ancillary Services (RRAS) providers. NLDC along with RLDC, operating as the nodal agency, shall call for these services in varying situations, such as extreme weather events, loss of generating unit

or transmission line outage, load-generation imbalance, etc. The RRAS providers shall be paid from the Regional DSM Pools.

14. Furthermore, the Commission notified the Order on Extended Market Session on Power Exchanges on 8<sup>th</sup> April, 2015, and the power exchanges started operating extended hours for intra-day products by end of July. The trading window is now open round-the-clock for delivery of power on the same day, with a 3-hour delivery timeframe. This can enable to significantly correct for intra-day imbalances in a proactive manner, and not passively rely on the grid for the same. It is expected that the Distribution Control Centres (DCCs) of DISCOMs also operate in a 24 x 7 manner to reap the advantages from these extended market sessions. Depending on the market needs, there is a need for newer products in the electricity market to provide more opportunities to the participants to balance their portfolio. The Commission directs the staff to examine this aspect of market design and submit a proposal for consideration of the Commission.

15. It is also expected that with provision for reserves and harnessing the same through 'controls', the inter area power flows would be manageable and help in optimizing the Transmission Reliability Margin (TRM). This would benefit all stakeholders to a great extent.

16. In due recognition of the above factors, the Commission would like to chart out a road map for introduction of reserves in the country. Accordingly, the Commission directs as under:

- (a) For reliable and secure grid operation, to maintain continuous load-generation balance, to counter generation outages as well as unexpected load surges or crashes, and for large scale integration of variable renewable power, it is essential for the grid operators to have access to distributed Spinning Reserves which are dispatched taking due care of transmission constraints whenever required.
- (b) The Commission reiterates the need for mandating Primary Reserves as well as Automatic Generation Control (AGC) for enabling Secondary Reserves.
  - (i) All generating stations that are regional entities must plan to operationalise AGC along with reliable telemetry and communication by 1<sup>st</sup> April, 2017. This would entail a one-time expense for the generators to install requisite software and firmware, which could be compensated for. Communication infrastructure must be planned by the CTU and developed in parallel, in a cost-effective manner.
  - (ii) On the other hand, National/Regional/State Load Dispatch Centres (NLDC/RLDCs/SLDCs) would need technical upgrades as well as operational procedures to be able to send automated signals to these generators. NLDC /RLDCs and SLDCs should plan to be ready with requisite software and procedures by the same date.

- (iii) The Central Commission advises the State Commissions to issue orders for intra-state generators in line with this timeline as AGC is essential for reliable operation of India's large inter-connected grid.
- (c) To start with, a regulated framework in line with the Ancillary Services Regulations would need be evolved for identification and utilising of spinning reserves and implemented with effect from 1<sup>st</sup> April, 2016. This framework may continue till 31<sup>st</sup> March, 2017. This may only include generating stations regulated by CERC, which could be started off with a manual process for secondary reserves. The NLDC/POSOCO is directed to submit a detailed procedure in this regard for approval by the Commission within one month from the issue of this Order. The amendments required in various Regulations issued by the Commission would also need to be indicated. As the Renewable Energy (RE) penetration levels increase in the coming years, the impact on the quantum of reserves would need to be separately studied and provided for through further amendments.
- (d) In the long term, however, a market based framework is required for efficient provision of secondary reserves from all generators across the country. For this, NLDC/POSOCO is directed to commission a detailed study through a consultant and suggest a proposal to the Commission for implementation by 1<sup>st</sup> April, 2017, giving due consideration to the experience gained in the implementation of Spinning Reserves w.e.f. 1<sup>st</sup> April, 2016.

Order in Suo-Motu Petition No. 11/SM/2015

- (e) The States must undertake separate scheduling and energy accounting of all generating and load entities. Deployment of DSM framework shall greatly prepare the State to differentiate between and attribute deviations caused due to various entities involved. Recording of this data shall also give the State grid operator much needed clarity on which entities are responsible for schedule deviations, and to what extent.
- (f) Load forecasting must be undertaken by all DISCOMs. Combined with DSM, it is the foundation on which strong and reliable grid management can be built.
- (g) In order to ensure reliable and secure operation of the grid, in addition to compliance to standards and regulations, adequate defense mechanisms such as Under Frequency Relays (UFRs), df/dt (rate of change of frequency), System Protection Schemes (SPS), etc. must be put in place and which also need to be periodically reviewed and checked for healthiness.
- 17. The petition is disposed of in terms of the above directions.

sd/-(Dr. M.K. lyer) Member sd/-(A. S. Bakshi) Member sd/-(A.K. Singhal) Member

sd/-(Gireesh B. Pradhan) Chairperson

# Notification

# **New Delhi,** the 7<sup>th</sup> August, 2015

No. 1/14/2015-Reg.Aff.(FSDS)(i)/CERC - In exercise of powers conferred under clause (h) of sub-section (1) of Section 79 read with clause (g) of subsection (2) of Section 178 of the Electricity Act, 2003 (36 of 2003), and all other powers enabling it in this behalf, the Central Electricity Regulatory Commission hereby makes the following regulations to amend the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 including the first and second amendments thereof (hereinafter referred to as "the Principal Regulations"), namely:-

1. Short title and commencement - (1) These regulations shall be called the Central Electricity Regulatory Commission (Indian Electricity Grid Code) (Third Amendment) Regulations, 2015,

(2) These regulations shall come into force with effect from 1<sup>st</sup> November, 2015

2. Amendment of Regulation 1 of Part 1 of Principal Regulations: Sub-Regulation (v) under Regulation 1.4 of the Principal Regulations, shall be substituted as under:-

**"Part 6: Scheduling and Despatch Code:** This section deals with the procedure to be adopted for scheduling and despatch of generation of the Inter-State Generating Stations (ISGS) and scheduling for other transactions through long-term access, medium-term and short-term open access including complementary commercial mechanisms, on a day-ahead and intra-day basis with the process of the flow of information between the ISGS, National Load Despatch Centre (NLDC), Regional Load Despatch Centre (RLDC), Power Exchanges and the State Load Despatch Centres (SLDCs), and other concerned persons.

Most of the wind and solar energy generators are presently connected to intra-State network and in future are likely to be connected to the inter-state transmission system (ISTS) as well. Keeping in view the variable nature of generation from such sources and the effect such variability has on the interstate grid, and in view of the large-scale integration of such sources into the grid envisaged in view of the Government of India's thrust on renewable sources of energy, scheduling of wind and solar generators which are regional entities, has been incorporated in this code."

# 3. Amendment of Regulation 2 (Definitions) of Principal Regulations:

(i) Sub-Regulation (eee) of Regulation 2 of the Principal Regulations, shall be substituted as under:-

(eee) "Pool Account" means regional account for (i) payments regarding Deviation Charges (Deviation Charge Account) or (ii) reactive energy exchanges (Reactive Energy Account) (iii) Congestion Charge, as the case may be;

4. Amendment of Regulation 2 of Part 2 of Principal Regulations: Regulation 2.4.5 of the Principal Regulations, shall be substituted as under

"2.4.5 RPC Secretariat or any other person as notified by the Commission from time to time, shall prepare monthly Regional Energy Account (REA), weekly deviation charge account, reactive energy account, and congestion charge account, based on data provided by RLDC, and deviation charge account for wind and solar generators which are regional entities, based on data provided by SLDC/RLDC of the State/Region in which such generators are located and any other charges specified by the Commission for the purpose of billing and payments of various charges."

5. Amendment of Regulation 5.5 of Part 5 of Principal Regulations: Regulation 5.5.1 (b) of the Principal Regulations, shall be substituted as under :-

"A daily report covering the performance of the regional grid shall be prepared by each RLDC based on the inputs received from SLDCs / Users and shall be put on its website. This report shall also cover the wind and solar power generation and injection into the grid."

- 6. Amendment of Regulation 6.2 of Part 6 of Principal Regulations: In Regulation 6.2 of the Principal Regulations, the sentences "This code also provides the methodology for re-scheduling of wind and solar energy on three (3) hourly basis and the methodology of compensating the wind and solar energy rich State for dealing with the variable generation through a Renewable Regulatory charge. For this, appropriate meters and Data Acquisition System facility shall be provided for accounting of UI charges and transfer of information to concerned SLDC and RLDC." shall be substituted by the sentences "This code also provides the methodology for re-scheduling of wind and solar energy generators which are regional entities, on one and half hourly basis and the methodology of handling deviations of such wind and solar energy generators. Appropriate meters shall be provided for accounting of charges for deviation under DSM Regulations. Telemetry/communication system & Data Acquisition System shall also be provided for transfer of information to the concerned SLDC and RLDC."
- 7. Amendment of Regulation 6.4(2) of Part 6 of Principal Regulations: Regulation 6.4(2)(b) of the Principal Regulations shall be substituted as under:-

**"(b)** Ultra Mega Power Projects including projects based on wind and solar resources and having capacity of 500 MW and above"

8. Amendment of Regulation 6.5 of Part 6 of Principal Regulations: Regulation 6.5 (23) of the Principal Regulations, shall be substituted as under :-

"(i) Wind and Solar generators shall mandatorily provide to the concerned RLDC, in a format as prescribed by RLDC, the technical specifications at the beginning and whenever there is any change. The data relating to power system parameters and weather related data as applicable shall also be mandatorily provided by such generators to concerned RLDC in real time. The frequency and other details in this regard shall be provided in the Detailed Procedure to be prepared by NLDC and approved by the Commission.

(ii) Forecasting shall be done by wind and solar generators which are regional entities as well as the concerned RLDC. The concerned RLDC may engage forecasting agency(ies) and prepare a schedule for such generating stations. The forecast by the concerned RLDC shall be with the objective of ensuring secure grid operation. The forecast by the wind and solar generator shall be generator centric. The wind and solar generators which are regional entities will have the option of accepting the concerned RLDC's forecast for preparing its schedule or provide the concerned RLDC with a schedule based on its own forecast. Any commercial impact on account of deviation from schedule based on the forecast chosen by the wind and solar generator shall be borne by it.

(iii) The schedule by wind and solar generators which are regional entities (excluding collective transactions) may be revised by giving advance notice to the concerned RLDC, as the case may be. Such revisions shall be effective from  $4^{th}$  time block, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day.

(iv) The schedule of solar generators which are regional entities shall be given by the generator based on availability of the generator, weather forecasting, solar insolation/irradiance, season and normal solar generation curve."

9. Amendment of Annexure-1 of Principal Regulations: Regulation 4 of the Annexure-1 of the Principal Regulations, shall be substituted as under :-

"The wind and solar generators which are regional entities shall forecast renewable energy generation at the following time intervals:

(i)Day ahead forecast: Wind and solar energy generation forecast with an interval of 15 minutes for the next 24 hours for the aggregate generation capacity of 50 MW and above.

(ii) The schedule by such wind and solar generators which are regional entities, supplying inter-state power under long-term access or mediumterm open access or short-term open access may be revised by giving advance notice to RLDC. Such revisions shall be effective from 4<sup>th</sup> timeblock, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day."

10. Amendment of Annexure-1 of Principal Regulations: Para 5 of the Annexure-1 of the Principal Regulations, shall be substituted as under :-

"The charges payable for deviation from schedule by the wind and solar generators which are regional entities, shall be delinked from frequency and shall be accounted for and settled in accordance with the provisions of the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, 2014 as amended from time to time."

11. Amendment of Annexure-1 of Principal Regulations: Paras 6, 7 and 9 of the Annexure-1 of the Principal Regulations, shall be deleted.

(Shubha Sarma) Secretary

Note: Principal Regulations were published in Gazette of India, Extraordinary, Part-III, Section 4 at Serial No. 115 on 28.4.2010, the first amendment to the Principal Regulations were published in the Gazette of India, Extraordinary, Part-III, Section 4 at Serial No. 60 on 6th March, 2012 and the second amendment to the Principal Regulations were published in the Gazette of India, Extraordinary, Part-III, Section 4 at Serial No. 08 on 6<sup>th</sup> January, 2014.

### Central Electricity Regulatory Commission Notification New Delhi, the 7<sup>th</sup> August, 2015

No. 1/14/2015-Reg.Aff.(FSDS)(ii)/CERC - In exercise of the powers conferred under Section 178 of the Electricity Act, 2003 (36 of 2003), and all other powers enabling it in this behalf, and after previous publication, the Central Electricity Regulatory Commission hereby makes the following regulations to amend the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, 2014 (hereinafter referred to as the "Principal Regulations") namely: -

1. Short title and commencement - (1) These regulations shall be called the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Second Amendment) Regulations, 2015,

(2) These regulations shall come into force with effect from 1<sup>st</sup> November, 2015.

### 2. Amendment of Regulation 2 of Principal Regulations:

# (i) After sub-clause (a) under clause (1) of Regulation 2, new sub-clause (aa) shall be added as under:-

" (aa) 'Absolute Error' shall mean the absolute value of the error in the actual generation of wind or solar generators which are regional entities with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation– Scheduled Generation] / (AvC)

# (ii) After sub-clause (q) under clause (1) of Regulation 2, new sub-clause (r) shall be added as under:-

(r) 'Available Capacity (AvC)' for wind or solar generators which are regional entities is the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block.

- 3. Amendment of Regulation 5 of Principal Regulations: In clause (1) of Regulation 5 of the Principal Regulations, the words "and over-injection by the seller and shall be worked out on the average frequency of a time-block at the rates specified in the table below as per the methodology specified in clause (2) of this regulation" shall be substituted by the words "and over-injection by the seller, except for wind and solar generators which are regional entities, and shall be worked out on the average frequency of a time-block at the rates specified in the table below as per the methodology specified in time-block at the rates specified in the table below as per the methodology specified in the table below as per the methodology of a time-block at the rates specified in the table below as per the methodology specified in clause (2) of this regulation".
- 4. Amendment of Regulation 5 of Principal Regulations: Sub-clause (iv) to clause (1) of Regulation 5 of the Principal Regulations, shall be substituted as under:-

"the charges for the Deviation for the over-injection by the seller in a time block in excess of 12% of the schedule or 150 MW, whichever is less, shall be zero, except in case of injection of infirm power, which shall be governed by the clause (5) of this Regulation, and except for wind and solar generators which are regional entities, which shall be governed by subclauses (v) to (vii) below:

5. Insertion of new proviso under clause (1) under Regulation 5: After sub-clause (iv) to clause (1) of Regulation 5 of the Principal Regulations, new sub-clauses (v), (vi) and (vii) shall be added as under:-

"(v) The wind or solar generators which are regional entities shall be paid as per schedule. In the event of actual generation being less than the scheduled generation, the deviation charges for shortfall in generation shall be payable by such wind or solar generator to the Regional DSM Pool as given in Table -1 below:

Sr. No.	Absolute Error in the 15-minute time block	Deviation Charges payable to Regional DSM Pool
1	<= 15%	At the Fixed Rate for the shortfall energy for absolute error upto 15%
2	>15% but <= 25%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35% + 130% of the Fixed Rate for balance energy beyond 35%

Table – I: Deviation Charges in case of under injection

Where the Fixed Rate is the PPA rate as determined by the Commission under section 62 of the Act or adopted by the Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective RPC supported by copy of the PPA.

Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as may be determined by the Commission from time to time through a separate order. A copy of the order shall be endorsed to all RPCs.

(vi) The wind or solar generators which are regional entities shall be paid as per schedule. In the event of the actual generation being more than the scheduled generation, the Deviation Charges for excess generation shall be payable to the wind or solar generators which are regional entities from the Regional DSM Pool as given in Table – II below:

Sr. No.	Absolute Error in the 15-minute time block	Deviation Charges payable
1	<= 15%	At the Fixed Rate for excess energy upto 15%
2	>15% but <= 25%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy beyond 25% and upto 35% + 70% of the Fixed Rate for excess energy beyond 35%

Table – II: Deviation Charges in case of over injection

Where the Fixed Rate is the PPA rate as determined by the Commission under section 62 of the Act or adopted by the Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective RPC supported by copy of the PPA.

Fixed Rate for Open access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as may be determined by the Commission from time to time through a separate order. A copy of the order shall be endorsed to all RPCs.

(vii) In reference to clauses (v) and (vi) of this Regulation, for balancing of deemed renewable purchase obligation (RPO) compliance of buyers with respect to schedule, deviations by all wind and solar generators which are regional entities shall first be netted off for the entire pool on a monthly basis and any remaining shortfall in renewable energy generation must be balanced through purchase of equivalent solar and non-solar Renewable Energy Certificates (RECs), as the case may be, by NLDC by utilising funds from the Pool Account. For positive balance of renewable energy generation, equivalent notional RECs shall be credited to the DSM Pool and carried forward for settlement in future."

- 6. Amendment of Regulation 5 of Principal Regulations: In clause (2) of Regulation 5 of the Principal Regulations, the words "The Charge for Deviation shall be determined in accordance with the following methodology" shall be substituted by the words "The Charge for Deviation, except for wind and solar generators which are regional entities, shall be determined in accordance with the following methodology".
- 7. **Insertion of a new proviso to clause (1) under Regulation 7:** After the existing proviso to clause (1) of Regulation 7 of the Principal Regulations, a new proviso shall be added as under:-

"Provided that the limits on deviation volume and consequences for crossing these limits (including the additional charges for deviation) as stipulated under Regulation 7 shall not apply to wind and solar generators which are regional entities".

# (Shubha Sarma) Secretary

Note: The Principal Regulations were published on 7.1.2014 in the Gazette of India, Extraordinary, Part III, Section 4, Serial No. 06, corrigendum thereof was published (on 17.2.2014) in the Gazette of India, Extraordinary, Part III, Section 4 at Serial No.52 and the first amendment to the Principal Regulations were published in the Gazette of India, Extraordinary, Part-III, Section 4 on 18<sup>th</sup> December, 2014.

# (State) ELECTRICITY REGULATORY COMMISSION

No. ---/---/xERC

Dated: ....,2015

#### NOTIFICATION

**No.---/xERC.-** In exercise of the powers conferred under Section 181 of the Electricity Act, 2003 (36 of 2003), and all other powers enabling it in this behalf, and after previous publication, the (State) Electricity Regulatory Commission hereby makes the following regulations, namely:

#### 1. Short title and commencement

- (1) These regulations may be called the (State) Electricity Regulatory Commission (Forecasting, Scheduling, Deviation Settlement and Related Matters of Solar and Wind Generation Sources) Regulations, 2015.
- (2) These regulations shall come into force on x.x.2015.

#### 2. Definitions and Interpretation

(1) In these regulations, unless the context otherwise requires,-

(a) **'Absolute Error'** means the absolute value of the error in the actual generation of wind or solar generators with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation-Scheduled Generation] / (AvC) ;

(b) 'Act' means the Electricity Act, 2003 (36 of 2003);

(c) **'actual drawal'** in a time-block means electricity drawn by a buyer, as the case may be, measured by the interface meters;

(d) **'actual injection'** in a time-block means electricity generated or supplied by the seller, as the case may be, measured by the Interface meters;

(e) 'Available Capacity or AvC' for wind or solar generators means the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block;

- (d) 'beneficiary' means a person purchasing electricity generated from a generating station;
- (e) **'buyer'** means a person, including beneficiary, purchasing electricity through a transaction scheduled in accordance with the regulations applicable for short-term open

access, medium-term open access and long-term access;

- (f) **'CERC'** means the Central Electricity Regulatory Commission referred to in sub-section (1) of section 76 of the Act;
- (g) 'deviation' in a time-block for a seller means its total actual injection minus its total scheduled generation and for a buyer means its total actual drawal minus its total scheduled drawal;
- (h) 'gaming' in relation to these regulations, shall mean an intentional mis-declaration of available capacity or schedule by any seller in order to make an undue commercial gain through Charge for Deviations;
- (i) **'Grid Code'** means the Grid Code specified by (State Regulatory Commission) under clause (h) of sub-section (1) of Section 86 of the Act;
- (j) **'IEGC'** means the Grid Code specified by CERC under clause (h) of sub-section (1) of Section 79 of the Act;
- (k) **'interface meters'** means interface meters as defined by the Central Electricity Authority under the Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006, as amended from time to time;
- (1) **'Pool Account'** means state account for receipts and payments on account of deviation by buyers or sellers including wind and solar generators;
- (m) 'pooling station' means the sub-station where pooling of generation of individual wind generators or solar generators is done for interfacing with the next higher voltage level: Provided that where there is no separate pooling station for a wind / solar generator and the generating station is connected through common feeder and terminated at a sub-station of distribution company/STU/CTU, the sub-station of distribution company/STU/CTU shall be considered as the pooling station for such wind/solar generator, as the case may be;
- (n) **'Qualified Coordinating Agency or QCA'** means the agency coordinating on behalf of Wind/Solar Generators connected to a pooling station. QCA may be one of the generators or any other mutually agreed agency for the following purposes:
  - Provide schedules with periodic revisions as per this regulation on behalf of all the Wind/Solar Generators connected to the pooling station(s),
  - Responsible for metering, data collection/transmission, communication, coordination with DISCOMS, SLDC and other agencies.
  - Undertake commercial settlement of all charges on behalf of the generators, including payments to the State UI 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
  - Undertake commercial settlement of any other charges on behalf of the generators as may be mandated from time to time.

QCA shall be treated as a State Entity.

(o) 'scheduled generation' at any time or for a time block or any period means schedule of

generation in MW or MWh ex-bus given by the concerned Load Despatch Centre;

- (p) 'scheduled drawal' at any time or for a time block or any period time block means schedule of despatch in MW or MWh ex-bus given by the concerned Load Despatch Centre;
- (q) **'seller'** means a person, including a generating station, supplying electricity through a transaction scheduled in accordance with the regulations applicable for short-term open access, medium-term open access and long-term access;
- (r) **'State Commission'** means (State) Electricity Regulatory Commission established under sub-section 1 of Section 82 of the Act;
- (s) **'State Entity'** means an entity which is in the SLDC control area and whose metering and energy accounting is done at the state level;
- (t) **'State Load Despatch Centre or SLDC'** means Load Despatch Centre of the State, established under sub-section (1) of Section 31 of the Act, responsible for coordinating scheduling of the state entities in accordance with the provisions of the State Grid Code;
- (u) '**time-block**' means a time block of 15 minutes, for which specified electrical parameters and quantities are recorded by special energy meter, with first time block starting at 00.00 hrs;

(2) Save as aforesaid and unless repugnant to the context or the subject-matter otherwise requires, words and expressions used in these regulations and not defined, but defined in the Act, or the Grid Code or any other regulations of this Commission shall have the meaning assigned to them respectively in the Act or the Grid Code or any other regulation.

#### PART – 1 GENERAL

#### 1.1. Objective

The objective of these regulations is to facilitate large-scale grid integration of solar and wind generating stations while maintaining grid stability and security as envisaged under the Grid Code, through forecasting, scheduling and commercial mechanism for deviation settlement of these generators.

#### **1.2.** Applicability of the Regulations

a. All wind and solar generators connected to the State grid, including those connected via pooling stations, and selling power within or outside the State.

#### PART – 2 FORECASTING AND SCHEDULING CODE

**2.1.** This code provides methodology for day-ahead scheduling of wind and solar energy generators which are connected to the State grid and re-scheduling them on one and

half hourly basis, and the methodology of handling deviations of such wind and solar energy generators. Appropriate meters shall be provided for energy accounting. Telemetry/communication system & Data Acquisition System shall also be provided for transfer of information to the concerned SLDC.

- **2.2.** Wind and Solar generators, represented via Qualified Coordinating Agencies (QCAs), shall mandatorily provide to the concerned SLDC, in a format as prescribed by SLDC, the technical specifications at the beginning and whenever there is any change. The data relating to power system output & parameters and weather related data as applicable shall also be mandatorily provided by such generators to the concerned SLDC in real time.
- **2.3.** Forecasting shall be done by wind and solar generators connected to the State grid, or by QCAs on their behalf. The concerned SLDC is also mandated to undertake forecasting of wind and solar power that is expected to be injected into the State grid, by engaging forecasting agency(ies) if required. The forecast by the concerned SLDC shall be with the objective of ensuring secure grid operation by planning for the requisite balancing resources. The forecast by the QCA or wind and solar generator, as the case may be, shall be generator centric. The QCA or wind and solar generators will have the option of accepting the SLDC's forecast for preparing its schedule or provide the SLDC with a schedule based on their own forecast. The QCA shall coordinate the aggregation of schedules of all generators connected to a pooling station and communicate it to the SLDC.
- **2.4.** The QCA or the wind and solar generator shall submit a day-ahead and week-ahead schedule for each pooling station or each generating station, as the case may be. Day-ahead schedule shall contain wind or solar energy generation schedule at intervals of 15 minutes (time-block) for the next day, starting from 00:00 hours of the day, and prepared for all 96 time-blocks. Week-ahead schedule shall contain the same information for the next seven days.
- **2.5.** The schedule of wind and solar generators connected to the State grid (excluding collective transactions) may be revised by giving advance notice to the SLDC. Such revisions shall be effective from 4<sup>th</sup> time block, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day.
- **2.6.** The plan for data telemetry, formats of forecast submission and other details in this regard shall be provided in the Detailed Procedure to be prepared by SLDC and approved by the State Commission.
- **2.7.** Any commercial impact on account of deviation from schedule based on the forecast shall be borne by the wind and solar generator, either directly or transacted via the representing QCA.

#### PART – 3 COMMERCIAL AND DEVIATION SETTLEMENT

**3.1.** (a) The wind or solar generators connected to the State grid and selling power within the State shall be paid by the buyer as per actual generation.

(b) The wind or solar generators connected to the State grid and selling power outside the State shall be paid by the buyer as per scheduled generation.

- **3.2.** The wind and solar generator or the QCA, as the case may be, shall have the option of accepting the concerned SLDC's forecast for preparing its schedule or provide the concerned SLDC with a schedule based on its own forecast, and such schedule shall be used as reference for deviation settlement.
- **3.3.** The QCA shall undertake all commercial settlement on behalf of the generator(s) connected to the respective pooling station(s).
- **3.4.** In the event of actual generation of a generating station or a pooling station, as the case may be, being less or more than the scheduled generation, the deviation charges for shortfall or excess generation shall be payable by the wind and solar generator or the QCA, as the case may be, to the State DSM Pool, as given in Table I below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 10%	None
2	>10% but <=20%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 10% and upto 20%
3	>20% but <=30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for balance energy beyond 20% and upto 30%
4	> 30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for shortfall or excess energy beyond 20% and upto 30% + Rs. 1.50 per unit for balance energy beyond 30%

Table – I: Deviation Charges in case of under or over-injection, for sale of power within the State

Provided that the deviation charges payable for under or over injection by the wind or solar generator or the QCA, which has been commissioned prior to the date of effect of these regulations, shall be as under:

Table – II: Deviation Charges in case of under or over-injection for wind or solar generators commissioned prior to the date of effect of these regulations, and selling power within the State:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	None
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 15% and upto 25%
3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for balance energy beyond 25% and upto 35%
4	> 35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for shortfall or excess energy beyond 25% and upto 35% + Rs. 1.50 per unit for balance energy beyond 35%

Provided that deviation charges for under or over injection by wind or solar generator connected to the State grid and selling power outside the State shall be payable or receivable as per the framework provided in Appendix - I. The accounting for this purpose shall be done by the SLDC.

- **3.5.** The QCA shall also de-pool the energy deviations as well as deviation charges to each generator using one of the following options:
  - (a) In proportion to actual generated units for each time-block for each generator
  - (b) In proportion to available capacity of each generator
- **3.6.** The State shall maintain separate records and account of time-block wise schedules, actual generation and deviations for all generators, including wind and solar generators.
- **3.7.** Once the accounting procedures as above are put 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 above for wind and solar generators.
- **3.8.** Annual accounts as mentioned above shall be prepared by the SLDC. The illustration in this regard is at Appendix II to these regulations. In case there is deficit in the overall pool at the end of the year, the SLDC may approach the National Funds such as PSDF or NCEF to cover such deficit.

#### PART – 4 MISCELLANEOUS

#### 4.1. Power to Relax

The Commission may by general or special order, for reasons to be recorded in writing, and after giving an opportunity of hearing to the parties likely to be affected by grant of relaxation, may relax any of the provisions of these regulations on its own motion or on an application made before it by an interested person.

#### 4.2. Power to issue directions

If any difficulty arises in giving effect to these regulations, the Commission may on its own motion or on an application filed by any affected party, issue such directions as may be considered necessary in furtherance of the objective and purpose of these regulations.

> ( ) Secretary

# Appendix –I: Framework for deviation charges for under or over injection by generator connected to the State grid and selling power outside the State

The wind or solar generators connected to the State grid and selling power outside the State boundary shall be paid as per schedule.

a) In the event of actual generation being less than the scheduled generation, the deviation charges for shortfall in generation shall be payable by such wind or solar generator, or the QCA on their behalf, to the State DSM Pool as given in Table -1 below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	At the Fixed Rate for the shortfall energy for absolute error upto 15%
2	>15% but <= 25%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35% + 130% of the Fixed Rate for balance energy beyond 35%

Table – I: Deviation Charges in case of under injection

Where the Fixed Rate is the PPA rate as determined by the Appropriate Commission under section 62 of the Act or adopted by the Appropriate Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective SLDC supported by copy of the PPA.

Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as determined by CERC from time to time.

b) In the event of the actual generation being more than the scheduled generation, the Deviation Charges for excess generation shall be payable to the wind or solar generator, or the QCA on their behalf, from the State DSM Pool as given in Table – II below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable
1	<= 15%	At the Fixed Rate for excess energy upto 15%
2	>15% but <= 25%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy beyond 25% and upto 35% + 70% of the Fixed Rate for excess energy beyond 35%

Table - II: Deviation Charges in case of over injection

Where the Fixed Rate is the PPA rate as determined by the Appropriate Commission under section 62 of the Act or adopted by the Appropriate Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective SLDC supported by copy of the PPA.

Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as determined by the CERC from time to time.

c) In reference to clauses (a) and (b) as above, for balancing of deemed renewable purchase obligation (RPO) compliance of buyers with respect to schedule, deviations by all wind and solar generators which are selling power outside the State boundary shall first be netted off for the entire pool on a monthly basis and any remaining shortfall in renewable energy generation must be balanced through purchase of equivalent solar and non-solar Renewable Energy Certificates (RECs), as the case may be, by SLDC by utilising funds from the Pool Account. For positive balance of renewable energy generation, equivalent notional RECs shall be credited to the State DSM Pool and carried forward for settlement in future.

#### Appendix –II

#### 1. Metering, Energy and Deviation Accounting

Separate metering, schedule preparation, accounting of actual generation/drawl, accounting of energy deviations and deviation settlement shall be undertaken for different types of entities in the State. The complete accounting process will be operationalized in the following manner:



#### 1. Metering:

Interface Metering for intra-state entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM).

#### 2. Energy Accounting

Every intra-State grid connected entity shall be metered with a Special Energy Meter (SEM), and the energy accounting for each such entity shall be done in the following manner:-



#### 3. Deviation Settlement

Deviation settlement for the State shall be governed by the following provisions:

#### **Stage – 1: Transitional Arrangement**

#### 3.1 Computation of Deviation Charge

Deviation charges shall be computed in the following manner:-

- 3.1.1. Deviation Charge (D) payable/receivable for the State as a whole at the State periphery shall first be computed.
- 3.1.2. Deviation charge (R1) from the pooling stations/RE generators based on these regulations, shall be collected and pooled in the State DSM Pool.

#### 3.2 Settlement of deviation charge

Deviation charge as above shall be allocated to different grid connected entities in the following manner:-

- 3.2.1 Deviation charge shall be allocated (D) amongst the distribution companies/OA consumers/conventional generators/RE generators in proportion to their respective deviation viz., C1/C2/C3/C4
- 3.2.2 For RE generators, assuming (i) the share out of State level deviation charge as D4 and (ii) receipt of deviation charge from RE generators (Pooling station) based on the charges for deviation as per the model regulation, as R1 - actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

#### This amount (D4 - R1 if greater than zero) can be refunded to the State DSM pool

#### from PSDF/NCEF.

#### Stage – 2: Long-Term Arrangement:

#### 3.3 Computation of Deviation Charge

- 3.3.1 Compute Deviation Charge (D) payable/receivable for the State as a whole at the State periphery
- 3.3.2 Implement Deviation Settlement Mechanism(DSM) for conventional generators on lines of CERC DSM or any other variant, that is, determine in advance the deviation charge payable/receivable by all grid connected entities within the state
- 3.3.3 Implement DSM mechanism for RE generators on lines of model regulation and collect in the State DSM pool, deviation charge (R1) from the pooling stations/RE generators based on the said model

#### 3.4 Settlement of deviation charge

- 3.4.1 Compute for the distribution companies / OA consumers / conventional generators, the deviation charges payable/receivable by them in proportion to their respective deviation viz., C1/C2/C3 (this should be as per State level DSM)....(assume net balance as D1)
- 3.4.2 In respect of RE generators, collect deviation charge from the RE generators (Pooling station) based on the charges for deviation as per the model regulation (assume as R1)
- 3.4.3 Actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

#### If D is greater than (D1+R1), the differential be made good from the PSDF/NCEF.

#### EXPLANATORY MEMORANDUM DRAFT STATE FRAMEWORK FOR FORECASTING, SCHEDULING AND DEVIATION SETTLEMENT OF WIND AND SOLAR GENERATING STATIONS

#### 1. Background

The Central Electricity Regulatory Commission published the Framework on Forecasting, Scheduling and Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar) on 7<sup>th</sup> August, 2015. This framework is applicable for solar and wind generators that are regional entities, that is, their scheduling and settlement is handled by the respective Regional Load Dispatch Centre (RLDC). The framework is constituted of amendments to Grid Code and the DSM Regulations:

- Central Electricity Regulatory Commission (Indian Electricity Grid Code) (Third Amendment) Regulations, 2015.
- Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Second Amendment) Regulations, 2015.

This framework envisages that bulk of wind and solar capacity expected to come online over the next 7 years, in alignment with Government's target of 100 GW solar and 60 GW wind by 2022, shall be inter-state in nature. That is, these generating stations shall sell power within as well as outside the host state, and connect directly to the CTU grid. This will become essential as a few states are rich in solar and wind resources, whereas the Renewable Purchase Obligations (RPOs) shall ensure that the whole country takes advantage of renewable power, while marching towards the national goal of *universal electrification*. This Framework has opened up the country-wide market to such solar and wind generators that shall be under RLDC's jurisdiction.

However, presently all of the existing wind and solar generating stations are directly connected to the State grid, and thus fall under operational control area of the respective State Load Dispatch Centres (SLDCs). Presently, (....) MW of wind and (....) MW of solar is installed in the State of (....). The proposed regulations seek to address the grid integration aspects related to such wind and solar generators directly connected to the State grid.

#### 2. Objective & Scope

The objective of these regulations is to facilitate large-scale grid integration of solar and wind generating stations while maintaining grid stability and security as envisaged under the Grid Code, through forecasting, scheduling and commercial mechanism for deviation settlement of these generators.

It is essential that the grid operator has visibility into how much renewable energy (RE) is expected to be injected into the grid. This is especially critical for variable and uncertain sources such as wind and solar. Forecasting and scheduling of these generators is critical to anticipate balancing requirements and procure requisite reserves to maintain load-generation balance and grid reliability. At the same time, due to the intermittent nature of these sources, special provisions must be made so that the generators are not unduly penalized.

These regulations are intended to cover all wind and solar generators connected to the State grid, directly or via pooling stations. Majority of these generators are selling power within the State. Additionally, some wind and solar generators are connected to the State grid but selling their power wholly outside the State, or partly within the State and partly outside the State boundary. All solar and wind generators connected to the State grid fall under the purview of these regulations, irrespective of nature of transactions.

#### 3. Proposed Framework

#### 3.1. Introduction of Aggregators

The fragmented nature of the industry which is evident from the large number of owners of wind turbines poses a challenge of direct interaction of these generators with the respective SLDCs. This process can quickly become unwieldy due to the sheer number of turbine owners. Secondly, benefits of aggregation on forecasting accuracy are well documented. Keeping in view the above reasons, the Commission proposes to formalize a new aggregator entity, termed as Qualified Coordinating Agency or the QCA. This aggregator or the QCA shall coordinate all forecasting, scheduling and commercial settlement processes for all wind or solar generators connected to a pooling station. The QCA might aggregate one or more pooling stations, and several QCAs may come together to aggregate even at the State level for leveraging maximum benefit of aggregation. The QCAs shall interact with the SLDC (or RLDC, if required) on behalf of the generators. This significantly cuts down the complexity both for small generators as well as the SLDC, which now has to interact with a few number of agencies instead of thousands of generators.

The QCA might be a Principal Generator, as recognized in the Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) (Third Amendment) Regulations, 2013, or a third party. The proposed functions of the QCA are as follows:

- Provide schedules with periodic revisions as per this regulation on behalf of all the Wind/Solar Generators connected to the pooling station,
- Responsible for metering, data collection and transmission, communication, coordination with DISCOMS, SLDC and other agencies.
- Undertake commercial settlement of all charges on behalf of the generators, including payments to the State UI 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
- Undertake commercial settlement of any other charges on behalf of the generators as may be mandated from time to time.

The eligibility and empanelment of QCAs shall be outlined through a separate order.

It must be noted that this is not a compulsory requirement for the process. Some large solar or wind plants in future may encompass one or more pooling stations themselves. Such large generators may choose to interact directly with the respective SLDC, if desired.

#### 3.2. Data Telemetry

Weather and power system data at the turbine or inverter level is essential for the grid operator to have accurate visibility into the availability and performance of RE stations connected to the grid. Metering and communication of real time data at the turbine/inverter level are mandated. This data shall also help the QCA for improving forecasting accuracy. Thus, special energy meters and communication infrastructure must be installed by all generators, and as such, this should be a requirement for approval of connectivity going forward. Special Energy Meters should also be installed at the pooling station level, to meter the power injected into the grid in every time-block.

The SLDC shall have to prescribe a format for accepting this data into their system, and define an internal process to assimilate and deploy this data. While SLDC may only receive data at the pooling station level, the QCA shall have to process data at the turbine level for improved forecasting and pooling/de-pooling of schedules/deviations.

#### 3.3. Forecasting

Wind and solar sources are variable and uncertain in nature. Known variability such as high wind speeds during monsoon can be better predicted for large geographical areas, while uncertainty reduces closer to the time of injection. In fact, forecasting accuracy increases exponentially the closer it is to real-time.

Solar plants are now mandated to undertake forecasting. Notwithstanding the lack of indigenous experience, solar forecasting methodologies are quickly maturing worldwide and have higher accuracy levels than wind forecasting. While we are starting out and aiming for ambitious solar power targets, this is the opportune moment to ensure these plants connect to the grid in a sustainable and streamlined manner.

Forecasting should be done by wind and solar generators connected to the State grid, or by QCAs on their behalf. The concerned SLDC should also undertake forecasting of wind and solar power that is expected to be injected into the State grid, by engaging forecasting agency(ies) if required. The forecast by the concerned SLDC shall be with the objective of ensuring secure grid operation by planning for the requisite balancing resources. The forecast by the QCA or wind and solar generator, as the case may be, shall be generator centric.

The QCA or wind and solar generators will have the option of accepting the SLDC's forecast for preparing its schedule or provide the SLDC with a schedule based on their own forecast. The QCA shall coordinate the aggregation of schedules of all generators connected to a pooling station (or a cluster of pooling stations) and communicate it to the SLDC. Such schedule shall be used as reference for deviation settlement.

The wind and solar generator or QCA should submit a day-ahead as well as week-ahead schedule for each generating station or each pooling station, as the case may be. In case the QCA is coordinating for several pooling stations, it should submit an aggregate schedule as well. Day-ahead schedule should contain wind or solar energy generation forecast at intervals of 15 minutes (time-block) for the next day, starting from 00:00 hours of the day, and prepared for all 96 time-

blocks. Week-ahead schedule should contain the same information for the following seven days.

The accuracy of forecasting algorithm can be measured by computing the delta between scheduled and actual generation. Error may be defined as:

'Absolute Error' means the absolute value of the error in the actual generation of wind or solar generators with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation- Scheduled Generation] / (AvC) ;

where Available Capacity or AvC for wind or solar generators means the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block.

Mean Absolute Error or MAE can be determined by averaging the absolute error over a day or week or year, etc. MAE should be tracked over time to ensure that accuracy improves as more historical data is collected, and to benchmark against error % reported internationally.

The Central Commission, in the Statement of Reasons (SOR) accompanying the Framework on Forecasting, Scheduling and Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar), has noted that the definition of error, calculated w.r.t schedule, does not adequately address instances such as low/no generation cases, such as during low wind season, where close to zero schedules would result in high numerical errors but with no real impact on grid. Additionally, incentives to generators for better forecasting must be aligned with the objective of grid management, which is to minimize actual MW deviations from schedule. As commercial impact on generators is directly proportional to the error percentage, forecasting models will be designed to minimize MW deviations only if the denominator is a constant (and not a variable such as 'schedule'). This will ensure that the error quantity corresponds to the physical MW impact on the grid, and the error definition holds valid in all seasons.

#### 3.4. Scheduling

Once the day-ahead schedule is submitted, flexibility must be accorded to the QCA (or generators) to revise it as the accuracy of forecasting improves closer to real time. Keeping this in mind, 16 revisions per day have been allowed, to provide maximum opportunity to minimize deviations from schedule, and hence limit the commercial burden on the generator.

Hence, the schedule of wind and solar generators could be revised by giving advance notice to the SLDC. Such revisions shall be effective from 4<sup>th</sup> time block, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day.

The plan for data telemetry, formats of forecast submission and other details in this regard should be provided in the Detailed Procedure to be prepared by SLDC and approved by the State Commission.

Any commercial impact on account of deviation from schedule based on the forecast would have to be borne by the wind and solar generator, either directly or transacted via the representing QCA.

#### 3.5. Deviation Settlement

While forecasting accuracy increases over time with improved models and more reliable data, 100% accuracy is not possible to achieve given the uncertain nature of solar and wind sources. However, to incentivize investment in better forecasting methodologies and reliable data, deviation charges would be levied outside a tolerance band. Within this tolerance band, there will be no revenue impact on the generator. However, outside this band, a graded deviation charge can be applied. This will provide incentive to forecast as accurately as possible, utilizing the schedule revisions, and communicate accordingly with SLDC.

Currently, all wind and solar generators are being paid as per actual generation. This could be continued in all cases of 'single seller-single buyer' model, and where power is being sold within the State.

The Central Commission, while proposing the DSM amendments for solar & wind regional entities, considered simulations and analytical inputs from agencies engaged in wind forecasting. For various sites across India, based on one year of actual data, the error normalized to capacity was simulated (pertaining to case where Available Capacity = Installed Capacity). The results were plotted in graphs, a few of which are reproduced from CERC's SOR document below:





Figure 1: Site A 25.5 MW





Figure 2: Site B 24 MW



#### Figure 3: Site C 72 MW

The first two sets of graphs plot *simulation results* with 16 revisions, based on 50 weeks of actual recorded data, thus including both high wind and low wind seasons. The resulting accuracy is very high. The third plot is a *real-world example* of one year of forecasting algorithm that was run at the site based on previously allowed number of revisions, i.e. 8 per day. This pilot also reports a fairly high accuracy, with 87% of output energy within +/-10% error, and 94% within +/-15%.

The Central Commission, in view of simulation studies such as above, as well as international research reports on observed MAE, has put forth a framework for computing deviation charges
based on error, with a tolerance band of 15% initially, which shall be tightened over time as the ecosystem gains experience. The State Commission proposes the following, with a structure in line with CERC's framework; however, a tighter tolerance band for new projects, as it is felt that with the framework of aggregator (QCA) at pooling station, 10% accuracy (defined w.r.t available capacity) is quite achievable. For existing generators, the framework is more liberal, so as to ensure minimal financial impact on existing PPAs. The COD (Commercial Operation Date) may be considered w.r.t. the date this regulation is notified, to categorize the generators as 'existing' (COD before regulation notification date) or 'new' (COD after regulation notification date).

In the event of actual generation of a generating station or pooling station being less or more than the scheduled generation, the deviation charges for shortfall or excess generation shall be payable by the wind and solar generator or the QCA, as the case may be, to the State DSM Pool, as given in Table – 1 and Table – 2 below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	< = 10%	None
2	>10% but <=20%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 10%
3	>20% but <=30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for balance energy beyond 20% and upto 30%
4	> 30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for shortfall or excess energy beyond 20% and upto 30% + Rs. 1.50 per unit for balance energy beyond 30%

Table – 1: Deviation Charges in case of under or over-injection for New Generators

#### Table - 2: Deviation Charges in case of under or over-injection for Existing Generators

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	< = 15%	None
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 15% and upto 25%

3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for balance energy beyond 25% and upto 35%
4	> 35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for shortfall or excess energy beyond 25% and upto 35% + Rs. 1.50 per unit for balance energy beyond 35%

As in aggregation, the QCA should 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

RPO accounting can continue as per existing arrangement, and needs no change.

Symmetrical deviation charges around zero ensure that there is no perverse incentive for gaming or mis-declaration of schedule by the generator. Secondly, a tolerance band equivalent to 15% of installed capacity is quite wide, based on some simulations conducted by a couple of stakeholders on CERC's request. This is a good starting point to get the processes ironed out and get the ecosystem disciplined. As experience is gained, this zero-impact band might be tightened in future.

It must be noted that taking cognizance of variable and uncertain nature of these sources, the solar and wind generators have been exempt from the frequency linked deviation charges. The State Pool might be surplus or deficit depending on instantaneous DSM rate when solar or wind generators deviate vis-a-vis the deviation rate applicable on them. The State may then approach a national fund such as PSDF or NCEF in case the State DSM pool goes into deficit due to these regulations. Accordingly, the State shall create accounting procedures to track schedules and actual generation of all generators, including wind and solar generators, as well as deviation charges of solar and wind generators under a separate head, as detailed in Section 4 below.

#### 3.5.1. Case of generator selling power outside the State

The generators connected to the State grid, even if selling power outside the State, will remain under SLDC's jurisdiction. IEGC sub-clause 6.4(1) clearly demarcates responsibilities and control areas:

"The Load Despatch Centre of a control area therefore is responsible for coordinating the scheduling of a generating station, within the control area, real-time monitoring of the station's operation, checking that there is no gaming (gaming is an intentional misdeclaration of a parameter related to commercial mechanism in vogue, in order to make an undue commercial gain) in its availability declaration, or in any other way revision of availability declaration and injection schedule, switching instructions, [meter data processing], collections/disbursement of UI payments, outage planning, etc. The following clause gives the criteria for demarcation of control area jurisdiction."

Additionally, sub-clause 6.4(2)c(ii) states:

"If a generating station is connected only to the State transmission network, the SLDC shall coordinate scheduling, except for the case as at (a) above."

Thus, IEGC clearly specifies control area jurisdiction for different types of entities. Generators connected to the State network are monitored, metered and controlled by SLDC, even though nature of transaction might change over time (intra-state, inter-state, open-access etc).

For generators connected to the State grid and selling power outside the State, payment shall be made by the buyer as per schedule, in alignment with existing energy accounting practices at the regional level. This will ensure that wind and solar generators can seamlessly participate in the national market, which would benefit them in the long run. A brief summary of the deviation settlement rules is provided in the Appendix. The Commission underscores that the accounting shall be undertaken by State Load Dispatch Centre, and settlement shall be done with the State Pool. It should be noted that even though payment is made as per schedule, the settlement with the State Pool would effectively provide payment as per actual to the generators. Additional deviation charges shall be applicable if the error is outside the tolerance band.

Additionally, in schedule based payment, RPO is deemed complied on the basis of schedule. However, in case of under-injection for example, there would arise a need for balancing actual RE generation with RPO. This necessitates procurement of equivalent RECs for shortfall in RE generation. Similarly over-injection necessitates crediting REC towards such excess generation. As in the regional framework, all RE shortfalls and over-injections can be netted off (on a monthly basis) for the entire State pool first. In case of RE shortfall, RECs will be purchased by the nodal agency SLDC from exchange by using funds from the State DSM pool and the RECs so purchased shall stand extinguished. In case of RE surplus, notional RECs will be credited to the DSM pool as carry forward for the next cycle.

#### 4. Metering, Energy and Deviation Accounting

While integration of solar and wind generating stations presents unique challenges to grid management, several other mechanisms must be put in place to create a strong foundation for a reliable grid. Separate energy accounting, both for injection schedule as well as drawl schedule, is essential for ensuring grid discipline from all grid-connected entities, such as DISCOMs, open access consumers, conventional and renewable generators. To achieve this objective, separate metering, schedule preparation, accounting of actual generation/drawl, accounting of energy deviations and

deviation settlement shall be undertaken for different types of entities. The complete accounting process will be operationalized in the following manner:



#### 1. Metering:

Interface Metering for intra-state entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM).

### 2. Energy Accounting

Interface Metering for intra State entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM), and the energy accounting for each such entity shall be done in the following manner:-



As seen from the flowchart above, separate accounting shall be done for schedule, actual and deviations of all grid-connected entities. This will enable SLDC to accurately distribute the State boundary energy deviations (and associated commercial charges to RLDC) among different categories of generators and drawl entities.

#### 3. Deviation Settlement

Deviation settlement for the state shall be governed by the following provisions:

#### Stage – 1: Transitional Arrangement

#### 3.1 Computation of Deviation Charge

Deviation charges shall be computed in the following manner:-

- 3.1.1. Deviation Charge (D) payable/receivable for the State as a whole at the State periphery shall first be computed.
- 3.1.2. Deviation charge (R1) from the pooling stations/RE generators based on these regulations, shall be collected and pooled in the State DSM Pool.

#### 3.2 Settlement of deviation charge

Deviation charge as above shall be allocated to different grid connected entities in the following manner:-

- 3.2.1 Deviation charge shall be allocated (D) amongst the distribution companies/OA consumers/conventional generators/RE generators in proportion to their respective deviation viz., C1/C2/C3/C4
- 3.2.2 For RE generators, assuming (i) the share out of State level deviation charge as D4 and (ii) receipt of deviation charge from RE generators (Pooling station) based on the charges for deviation as per the model regulation, as R1 actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

# This amount (D4 - R1 if greater than zero) can be refunded to the State DSM pool from PSDF/NCEF.

### Stage – 2: Long-Term Arrangement:

### 3.3 Computation of Deviation Charge

- 3.3.1 Compute Deviation Charge (D) payable/receivable for the State as a whole at the State periphery
- 3.3.2 Implement Deviation Settlement Mechanism(DSM) for conventional generators on lines of CERC DSM or any other variant, that is, determine in advance the deviation charge payable/receivable by all grid connected entities within the state
- 3.3.3 Implement DSM mechanism for RE generators on lines of model regulation and collect in the State DSM pool, deviation charge (R1) from the pooling stations/RE generators based on the said model

#### 3.4 Settlement of deviation charge

- 3.4.1 Compute for the <u>distribution companies/OA consumers/conventional generators</u>, the deviation charges payable/receivable by them <u>in proportion to their respective</u> <u>deviation viz., C1/C2/C3 (this should be as per State level DSM)....(assume net balance as D1)</u>
- 3.4.2 In respect of RE generators, collect deviation charge from the RE generators (Pooling station) based on the charges for deviation as per the model regulation (assume as R1)
- 3.4.3 Actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

If D is greater than (D1+R1), the differential be made good from the PSDF/NCEF

The Commission directs the Staff to prepare relevant regulations, or amendments to existing regulations, to put in place procedures described above latest by April 1<sup>st</sup>, 2016.

## 5. Conclusion

The proposed framework deals with operational and commercial aspects of running wind and solar generating units on the grid. This regulation is a big first step for the State grid operator to be able to manage the variable power effectively. The Central Government's initiative towards facilitating centralized forecasting through establishment of Renewable Energy Management Centres (REMCs), co-located with SLDCs, is expected to help in capacity building at SLDCs, as well as development of better forecasting and more accurate scheduling methods.

Notwithstanding the issue of forecasting accuracy that is feasible, the next natural issue to address is that of balancing. The deviation from schedule is inevitable for RE generators as 100% accuracy is not possible to achieve, even with frequent revisions. To manage these uncertain deviations in real time, the grid operator must have access to reserves. The Commission directs its staff to work on Ancillary Services Regulations, including spinning reserves. Both primary and secondary reserves will assist the SLDC to maintain load-generation balance, and ensure grid reliability. Fast ramping resources such as pumped hydro or natural gas plants are natural options to be deployed for balancing. Backing down of thermal units will also be necessary.

As stated above, the State shall create accounting and settlement procedures to keep records of time-block wise schedules, actual generation and deviations for all generators, including wind and solar generators. Once this is put in place, all RE generators can 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 above for wind and solar generators. This aggregation at the State level will be advantageous, reducing the impact on the State as well as the generators.

Annual accounts as mentioned above shall be prepared by the SLDC. In case there is deficit in the overall pool at the end of the year, then the SLDC may approach the National Funds such as PSDF or NCEF to cover such deficit. This facility of support from the National level fund for meeting the deficit is expected to be available till 31.3.2019 as recommended by the Forum of Regulators.

# Appendix: Framework for deviation settlement of wind or solar generator, or QCA on their behalf, connected to the State grid and selling power outside the State boundary

The wind or solar generator, or QCA on their behalf, shall be paid as per schedule for a time-block. The error shall be defined w.r.t Available Capacity (AvC). If there is a deviation from schedule, the deviations shall be settled as below:

- If the Absolute (Abs) Error is less than 15%: no deviation charge shall be applicable on the generator. If the generator has under-injected (vs schedule given), the generator shall return to the State pool amount equivalent to (no. of units under-injected) x (PPA rate). On the other hand, if the generator has over-injected (vs schedule given), the generator shall receive from the State pool an amount equivalent to (no. of units under-injected) x (PPA rate). Thus, the net revenue of the generator within this tolerance band is equivalent to revenue as per actuals.
- If the Abs Error is greater than 15% but less than 25%: the generator shall settle the difference with respect to schedule, with the State pool at its PPA rate, as above. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

Deviation charge (I) = (no. of units outside 15% of AvC) x (10% of PPA rate)

- If the Abs Error is greater than 25% but less than 35%: the generator shall settle the difference with respect to schedule with the State pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:
  Deviation charge (I) = (10% of AvC) x (10% of PPA rate)
  Deviation charge (II) = (no. of units outside 25% of AvC) x (20% of PPA rate)
  Total deviation charge in this case = Deviation Charge (I) + Deviation Charge (II)
- If the Abs Error is greater than 35%: the generator shall settle the difference with respect to schedule with the State pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:
  Deviation charge (I) = (10% of AvC) x (10% of PPA rate)
  Deviation charge (II) = (10% of AvC) x (20% of PPA rate)
  Deviation charge (III) = (no. of units outside 35% of AvC) x (30% of PPA rate)
  Total deviation charge in this case = Deviation charge (I) + Deviation charge (II) +

Pictorially, this framework can be represented as follows (AvC: Available Capacity):

	-@130% PPA	-@120%PPA	- @110%PPA	- @PPA r	rate -	+@PPA rate	+@PPA -10%PPA	+@PPA-20%PPA	+@PPA-30%PPA
-									Actual kWh
	S-35%	6 of AvC S-2	5% of AvC S-19	% of AvC	S <s: schedul<="" td=""><td>S+15% (</td><td>of AvC S+25</td><td>% of AvC S+359</td><td>6 of AvC</td></s:>	S+15% (	of AvC S+25	% of AvC S+359	6 of AvC

The PPA rate mentioned above which shall be used for the purpose of Deviation Settlement shall be the PPA Rate as determined by the Appropriate Commission under Section 62 or as adopted under Section 63 of the Electricity Act 2003 through a separate order.

In case the RE generator has multiple PPAs at different rates, then the weighted average PPA rate shall be used for the purpose of Deviation settlement.

On the issue of Settlement for Open Access (OA) users and Captive Power Plants (CPPs), it has been felt that Settlement of OA (REC projects) and CPP poses a challenge, particularly for CPP where there is no PPA rate. All deviations from schedule by these entities must be settled at National APPC rate, as determined by CERC from time to time.