FORUM OF REGULATORS

Model Guidelines

for

Management of RE Curtailment

for

Wind and Solar Generation

November 2022

Forum of Regulators

MODEL GUIDELINES FOR MANAGEMENT OF RE CURTAILMENT

1 General

1.1 Preamble

As a part of India's green energy initiatives, Government of India has announced a target of 50% share of cumulative electric power installed capacity from non-fossil fuel based energy sources by 2030[1]. A dominant part of non-fossil fuel capacity addition would comprise variable renewable sources such as wind and solar. With increase in variable RE capacity into grid which is intermittent in nature, complexities of power system operations and grid management challenges are expected to increase.

The Load Despatch Centre (LDC) needs to maintain the load-generation balance by maintaining the system parameters within the limits specified by the Grid code. Despite improving accuracy of forecasts (demand and supply), forecast errors and the load variation in the real time would continue and the LDC needs to maintain the generation to maintain the system frequency within the permissible band as per Grid Code. The LDC while balancing the generation, as per the load the variation in the wind and solar generation adds to the complexity in balancing the generation through other resources like thermal or gas or hydro generation. In case, when wind or solar generation far exceeds the forecasts and all other measures managing grid frequency and voltage/congestion management for reliable and safe grid operation are exploited, the LDC may need to manage grid by way of RE generation curtailment, as last resort in the interest of Grid security.

The Indian Electricity Grid Code, 2010 (IEGC) in Regulation 5.2(u) casts a statutory duty on the SLDC/RLDCs to make all efforts to evacuate available solar and wind power. As per IEGC, RE generation is considered as, "Must Run" subject to the grid security and the security of personnel and equipment and Curtailment of RE generation needs to be avoided. The LDC is expected to exercise the other options such as flexibility in the conventional generation available with LDC before initiating Curtailment of RE. The planning should be such that the necessity for curtailment is the least and even when it happens, RE power plants are preferably the last ones to get affected.

However, there have been instances where RE generation was curtailed for several reasons other than grid security. The matter was pleaded before the Tamil Nadu Electricity Regulatory Commission (TNERC) and subsequently before the Appellate Tribunal of Electricity (APTEL). The APTEL vide its Judgement dated 02-08-2021, in the Appeal No 197 of 2019 & IA No. 1706 of 2019 directed Forum of Regulators (FOR) to formulate guidelines in relation

[1] *Source: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812*

to management of curtailment of RE and suggested certain boundary conditions and contours to operationalise the same, until Guidelines for management of RE Curtailment are framed by FOR.

The FOR, in its 77th meeting held on 17th December 2021 deliberated on the requirements to comply with directions outlined under the APTEL Judgement dated 02-08-2021for minimizing curtailment of power generated from RE sources and streamlining modalities through guidance framework in the event curtailment is necessary due to grid security considerations.

After deliberation it was decided to constitute a Working Group (WG) to formulate guidelines with respect to management of RE curtailment. The Terms of Reference for the WG are as under:

a) Examine the provisions of IEGC, and State Grid Codes in respect of curtailment of renewable energy generation in different states.

b) Assessment and analysis of guiding factors stipulated in the APTEL judgment for grid security.

c) Assess the consequences of renewable energy curtailment for reasons other than technical and grid security requirement, and the need for compensation thereon.

d) Based on the above, suggest guidelines for curtailment of generation from renewable energy project in the Indian power system.

e) Any other matter related and incidental to the above.

The Working Group deliberated several aspects associated with the RE generation management in compliance to the directions of the APTEL. The Working Group has also reviewed the detailed Report on RE curtailment prepared by the Power System Operation Corporation Limited (POSOCO) in compliance to the directions of the APTEL and other relevant documents prepared by some of the SLDCs for issuing instructions for RE curtailment management.

The Working Group has considered the following aspects while devising the model guidelines:

i. Grid Security and other conditions;

ii. Defining roles & responsibilities of stakeholders like LDC, Tx licensee, RE Generators and QCAs/Lead Generator);

iii. Communication framework and modalities (pre & post event) and recording of events;

iv. Curtailment and Restoration protocol;

v. Curtailment management modalities (inter-se parity and priority);

vi. Scheduling and Energy Accounting during curtailment period;

vii. Compensation requirement in case of RE back-down;

viii. Treatment for non-compliance of instructions and remedial measures.

The FOR, in its 83rd Meeting held on 18th November 2022 appreciated the report and stated that the guidelines are quite comprehensive and has taken care of all the aspects. The Forum deliberated on the model guidelines for management of RE curtailment and endorsed the report with the following modifications

a) On the issue of RE curtailment in view of under-drawal by State at State-periphery, it was recommended that the event of under-drawal by a State at state-periphery by more than 300MW for more than two successive time blocks even when the frequency ranges between 49.90 Hz to 50.05 Hz, should be considered as a grid security reason warranting RE curtailment.

b) It should be clarified that the compensation in the event of RE curtailment for non-grid-security reasons, will be borne by the distribution companies and that such compensation paid shall not be allowed as a passthrough in tariff. This will act as a true deterrent against curtailment of RE for commercial considerations.

c) The Forum also highlighted the relaxation provided for Wind and Solar Generating station for estimating the deviation in percentage based on the Available capacity instead of Scheduled Generation. It was stated that as the Wind and Solar sector has matured now, there need not be a special relaxation for calculating the deviation in percentage.

Accordingly, these model guidelines have been developed for Management of RE curtailment which may be referred by the States to prepare their state specific procedures for management of RE curtailment, if necessary, subject to Grid Code.

1.2 Objective of the Management of RE Curtailment (MRC) Guidelines:

The objective of the management of RE curtailment (MRC) guidelines, is to lay down a comprehensive framework for managing the curtailment of variable RE generation for grid security while keeping the impact of curtailment on RE to the minimum. The model guidelines also lay down the roles and responsibilities of the various stakeholders like Load Despatch Centres (LDCs), State Transmission Utility (STU), Transmission Service Providers, RE Generators and Qualified Coordinating Agencies (QCAs)/Lead Generator. It also aims to classify the various types of situations which call for curtailment of generation based on which, methodologies for curtailment and restoration have been designed.

The MRC Guidelines are also aimed to maintain transparency in the instructions issued by LDCs and process followed for curtailment management and restoration as per the grid requirement.

1.3 Scope and Applicability

This management of RE curtailment Guidelines (hereinafter referred to as MRC Guidelines) shall be applicable to all Wind and Solar Energy Generators and RE hybrid (Wind, Solar and/or Storage) Generators connected to the Inter-state and Intra-State Transmission System,

including those connected through Pooling Sub-Stations and using the power generated for self-consumption or sale within or outside the State.

2 Important definitions and concepts

2.1 Definitions and Key concepts associated with Curtailment

2.1.1 **"Available Capacity" (or "AvC")** of Wind or Solar Energy Generators means the cumulative capacity rating of the Wind turbines, Solar inverters or Solar thermal generators that are capable of generating power in a given time block as declared by such Generators or QCA/Lead Generator, as the case may be;

2.1.2 **'Available Transfer Capacity'** means power transfer capacity of the transmission system or transmission element between inter-connection points across state transmission network available for scheduling transactions in a specific direction, considering the network security declared by the concerned load despatch centre;

2.1.3 **"Congestion"** means a situation where the demand for transmission capacity exceeds the available transfer capacity, a condition that arises on the transmission system when one or more restrictions prevents the [economic dispatch] of electric energy from serving loads. Economic dispatch means meeting system demand at the lowest possible cost.

2.1.4 **"Curtailment"** means a reduction in the output of a generator from what it could otherwise produce given available resources, typically on an involuntary basis. The term curtailment is broadly used to refer to the use of less wind or solar power than is potentially available at that time;

2.1.5 **"Dedicated Evacuation network"** means the dedicated EHV, HV, LV network designed and developed for evacuation of generation through specific Generating Station or a group of Generating Stations.

2.1.6 **"Electricity Grid Code" means** the Indian Electricity Grid Code notified by the CERC as amended from time to time or the State Electricity Grid Code notified by the SERC as the case may be;

2.1.7 **"F&S Regulations"** means the Forecasting, Scheduling & Deviation Settlement for Solar & Wind Generation Regulations, specified by the State Electricity Regulatory Commission or the Central Electricity Regulatory Commission as the case may be.

2.1.8 **Grid Reliability** – The degree to which the performances of the elements of the electric system result in power being delivered to consumers within accepted standards and in the amount desired.

2.1.9 "**Plant Operators**" means the agency or a company which is appointed by the Wind & Solar Generators for operating the Generating Plant on behalf of them, such as Developers, OEMs, etc.

2.1.10 **"Pooling Sub-Station" (or "PSS")** means a Sub-Station consisting of a step-up transformer and associated switchgear to the Low Voltage (LV) side of which several Wind or Solar Energy Generators are connected:

Provided that, where a Generating Unit is connected through a common or an individual feeder terminating at a Sub-Station of a Distribution Licensee, the State Transmission Utility or the- Central Transmission Utility, such Sub-Station shall be treated as the Pooling Sub-Station for such Wind or Solar Energy Generator for the purposes of these Regulations;

2.1.11 **"Qualified Co-ordinating Agency" (or "QCA" or Lead Generator)** means the agency appointed by the Wind or Solar Energy Generators connected to a Pooling Sub-Station, or by an individual Generator connected directly to a Sub-Station, to perform the functions and discharge the obligations specified under IEGC or Regulations for Forecasting & Scheduling of variable RE (wind, solar or hybrid) generating stations, as the case may be;

2.1.12 **Restoration** – Allowed to re-establishment of the output of a generator to the original levels prior to the curtailment order after the reason for curtailment ceases to exist.

Save as aforesaid and unless repugnant words and expressions used in these guidelines and not defined, but defined in the Act, or the CERC (Indian Electricity Grid Code) Regulations or Regulations of the Central Electricity Authority (CEA) or any other Regulations of the State Commission shall have the meaning assigned to them respectively in the Act or IEGC or any other Regulations as the case may be.

3 Specifying the parameters for ascertaining Grid safety /Security:

3.1 Grid Security:

IEGC 2010 Clause 5.2(u) specifies as under:

"System operator (SLDC/ RLDC) shall make all efforts to evacuate the available solar and wind power and treat as a must-run station. However, System operator may instruct the solar /wind generator to back down generation on consideration of grid security or safety of any equipment or personnel is endangered and Solar/ wind generator shall comply with the same. For this, Data Acquisition System facility shall be provided for transfer of information to concerned SLDC and RLDC."

The "Draft central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2022" has outlined the definition of the Grid Security as below;

***"Grid Security**" means the power system's capability to retain a normal state or to return to a normal state as soon as possible, and which is characterized by operational security limits;.*

[Explanation: Normal state means the state in which the system is within the operational parameters as defined under IEGC.]

Above definition of Grid Security shall be incorporated in the respective State Grid Codes alongwith stipulation of following parameters and conditions thereof as Grid Security Parameters to ascertain the boundary conditions, breaching of which could potentially affect reliable and safe Grid operations and hence warranting appropriate actions on part of System Operator to initiate RE curtailment, as under:

Sr.No.	Parameter	Specific Conditions
1	Operating Frequency band	Average frequency for two or more successive time-blocks exceeds 50.05 Hz
2	State Volume Limits[2] as per CERC Regulations	Under-drawal by State at state periphery outside the range of 250

[2] *Concept of Volume Limits at State periphery has been done away as per CERC DSM Regulations, 2022. However, date of effectiveness of these Regulations and Procedures thereunder are yet to be notified. At present, Volume Limits at State periphery continue.*

<table>
<tr><th>Sr.No.</th><th>Parameter</th><th>Specific Conditions</th></tr>
<tr><td></td><td></td><td>MW[3] for two or more successive time-blocks.</td></tr>
<tr><td>3</td><td>Technical Minimum Margin for TPS % of MCR or Installed Capacity</td><td>In case all intra-state thermal generating stations are operating at technical minimum of 55% (or as per State Grid code subject to conditions for specific generating units, as approved by State Commission) and no further limit for backing down any thermal generation unit exits.</td></tr>
<tr><td>4</td><td>Thermal limit of Transmission lines</td><td>Permissible maximum Loading limit on transmission line shall be its thermal loading limit as stipulated under [4]CEA (Manual of transmission planning criteria), 2022</td></tr>
<tr><td>5</td><td>Transformer/ICT loading limits</td><td>Loading limit for Inter-connecting transformer (ICT) shall be its Nameplate Rating as stipulated under [5]CEA (Manual of transmission planning criteria), 2022</td></tr>
<tr><td>6</td><td>Operational voltage limits</td><td>The steady state operating voltage limits under Normal conditions shall be within operating range as specified under Table-1, Clause (b) of Regulation 3 of CEA (Grid Standards) Regulations, 2010 and amendments thereof,
<table>
<tr><th>Operating Voltages</th><th>IEGC/CEA limits</th></tr>
<tr><td>765kV</td><td>728-800 kV</td></tr>
</table>
</td></tr>
</table>

[3] *Revised to 200 MW for RE rich states (with installed RE > 1000 MW) as per CERC DSM Regulations, 2022. However, date of effectiveness and Procedures yet to be notified.*

[4] Ref. *clause 4.2.2. and elaborated under Table-II Annexure-V for different types of line configurations employing various types of conductors as specified under CEA (Manual of transmission planning criteria), 2022*

[5] Ref. *clause 4.2.4 of CEA (Manual of transmission planning criteria), 2022*

Sr.No.	Parameter	Specific Conditions	
		400kV	380-420 kV
		220kV/ 230kV[6]	198-245 kV
		132kV	122-145 kV
		110kV	99-121 kV
		66kV	60-72 kV
		33kV	30-36 kV

Above parameters shall be considered as operational parameters with boundary conditions for safe and reliable Grid operations and System operator (SLDC/ RLDC) shall make all efforts to evacuate the available solar and wind power to the maximum extent so long as grid parameters are within the above stipulated limits and shall not resort to RE curtailment.

However, in case of breach of any of the boundary conditions as outlined in respect of above grid parameters and if in the opinion of System Operator, the continued injection of variable RE power is likely to further worsen the situation to affect reliable and safe grid operations, System operator may instruct the solar /wind generator to back down generation on consideration of grid security or to ensure safety of any equipment or to ensure that no personnel is endangered and Solar/ wind generator shall comply with the same. In case of curtailment of solar/wind generation, the protocol as prescribed in clause(4) infra shall be followed.

[6] *For nominal voltage of 230 kV the limit range shall be +/-10% of nominal voltage.*

4 Protocol for curtailment

4.1 General Provisions

4.1.1 In-spite of having 'MUST RUN' status for Wind & Solar Generation, during real time operations there is a possibility for issuing curtailment instructions to RE generators by LDCs.

4.1.2 The need for RE curtailment may arise due to occurrence of events concerning Grid Security or Grid element such as outlined below but not limited to following events;

i. Planned/forced outages on the evacuation infrastructure

ii. Over-voltages on transmission line/evacuation infrastructure

iii. Over-loading of transmission line and/or associated evacuation infrastructure (incl. ICT)

iv. Demand crash in the State with heavy under-drawal from ISTS & all the thermal generators are running at technical minimum with grid frequency crossing beyond higher permissible limits (>50.05Hz).

v. State's under-drawal is far below the volume limits specified by the CERC DSM Regulations and there are limitations/constraints to minimise the schedule of generation from Interstate Generating Stations.

4.2 Management of Curtailment for Frequency Management

4.2.1 The operating frequency is resultant of the load-generation balance at national level in interconnected power system operating in synchronous frequency mode. Reduction in generation below the schedule and/or increase in the demand results in the dropping of frequency below the permissible limits and reduction in demand below the schedule and/or increase in the generation results in increasing the frequency above permissible limits.

4.2.2 As per Grid Code the operational frequency band is specified as [49.90 Hz to 50.05Hz or as may be amended from time to time.] The System Operator is expected to operate the system to maintain the frequency within the specified frequency band.

4.2.3 In case frequency exceeds the over-frequency limits, the RLDC is expected to back-down the hydro generation [except for constrained hydro generation projects such as run-of-river hydro projects, irrigation linked hydro generation projects or storage hydro factoring spillage considerations] followed by thermal generation to technical minimum considering the scheduled demand in subsequent time blocks and ramp requirement to meet the scheduled demand.

4.2.4 SLDC may instruct Discoms to reduce the requisition from their contracted Inter-State Generating Stations (ISGS) through revision of Schedules. Also, Discoms, may be advised to withdraw demand curtailments, if issued any.

4.2.5 SLDC may request RLDC for backing down the interstate generation schedule to State.

4.2.6 If the State has the hydro resource like Pumped Storage Hydro project (PSH), the SLDC shall instruct the PSH to operate in Pumped mode subject to capacity constraint and spillage considerations to provide the load to the system for reduction of the frequency. The operation of PSH in pump mode at this frequency shall store the energy which may be wasted in curtailment.

4.2.7 If hydro generation (excluding run off river) is in operation, the SLDC shall reduce or stop the hydro generation to provide require relief considering its higher ramp down rate and avoiding the wastage of water resources.

4.2.8 The Technical Minimum of all the Thermal Power Stations (TPS) in the State shall be considered as 55% as per the IEGC provisions. Only in case of specific generating units, higher technical minimum condition can be considered subject to adequate technical justification and with the consent of the Appropriate Commission. Suitable provisions shall be made in the State Grid Code by the Appropriate Commission.

4.2.9 SLDC shall instruct the thermal generating station to back down the generation upto the notified technical minimum, which shall normally be not higher than 55% of its rated capacity i.e. upto Technical Minimum considering the Merit Order Principles.

4.2.10 In case of demand crash due to tripping or break-down or manual opening of the electrical network, concerned transmission & distribution licensee shall be directed to restore the network elements on priority so as to restore the demand.

4.2.11 Besides implementing all the above measures, if the necessary relief is not achieved and frequency continues to rise beyond the upper limit of 50.05 Hz for two or more consecutive time-blocks, the RLDC may instruct the Wind /Solar Generation to curtail the generation connected to ISTS and also instruct SLDCs to curtail the generation connected to InSTS as last option for maintaining the frequency within limits.

4.2.12 For the purpose of frequency management and upon exhausting all measures as outlined above, the RLDC/SLDC shall issue instructions to PSS to back down/curtail the RE generation to that extent in order to seek desired relief in the best interest of grid operations.

4.2.13 While curtailing for the purpose of frequency management, RLDC/SLDC would ensure to avail required relief with minimum curtailment. In such instances, curtailment instructions shall be given to all PSSs on pro-rata basis of 'Available Capacity', for the time-block immediate prior to issuance of curtailment instructions.

4.3 Curtailment for relief from Transmission Congestion

4.3.1 No Transmission Line outage shall be availed without approval from SLDC. Also, no planned outages of Transmission Line shall be considered if not submitted at least (2) days prior to the date of Outage.

4.3.2 The incidences resulting in curtailment of Wind/Solar Generation which shall be intimated to SLDC are as follows:

- Planned / Forced Outages on Evacuation infrastructure,
- Tripping of any transmission elements/Evacuation infrastructure,
- Overloading of any transmission elements/Evacuation infrastructure.

4.3.3 In case of tripping of any Transmission element/Evacuation Infrastructure/PSS resulting in curtailment/backing down of RE generation, it shall be the responsibility of concerned Transmission Licensee and affected RE Generator(s) (for their respective Pooling Sub-Stations) through their QCA/Lead Generator or separately to intimate the same immediately to SLDC for required modifications in the Schedules along with tentative time for restoration.

4.3.4 In case of planned outages, the Transmission Licensee shall plan the outage period so as to avoid curtailment of Wind/Solar generation.

4.3.5 All the events of Planned/Forced Outages of Transmission Lines resulting in the backing down/curtailment of Wind & Solar Generation shall be submitted to SLDC through Web-based portal developed by SLDC, which would cover information about event duration, affected location(s) of grid elements, RE capacity. cause of outage, likely restoration/rectification time.

4.3.6 In case of any bottleneck in the ISTS/InSTS network, the RLDC/SLDC shall require to initiate the load relief on the specific transmission lines connected to the Wind/Solar PSS. The RLDC/SLDC may issue instructions to PSS to back down/curtail the RE generation to that extent in order to seek desired relief in the best interest of grid operations.

4.3.7 While curtailing to mitigate the congestion, RLDC/SLDC would target the specific PSS to get required load relief with minimum curtailment. However, RLDC/SLDC shall also ensure that, the same PSSs are not receiving frequent curtailments. In such cases curtailment instructions may be given on pro-rata basis of 'available capacity' at PSSs in that area, for the time-block immediately prior to issuance of curtailment instructions.

4.4 Maintaining the Volume Limits[7] at State Periphery

4.4.1 CERC DSM Regulations have specified the volume limits (+/- 250 MW[8] for RE rich states – hereinafter referred to as 'Threshold Limit at state periphery) for deviation of drawal from the schedule at the State periphery. The SLDCs are mandated to take all measures to maintain the State Drawal within the Volume Limits specified by the CERC.

---

[7] *Concept of Volume Limits at State periphery has been done away as per CERC DSM Regulations, 2022. However, date of effectiveness of these Regulations and Procedures thereunder are yet to be notified. At present, Volume Limits at State periphery continue.*

[8] *Revised to 200 MW for RE rich states (with installed RE > 1000 MW) as per CERC DSM Regulations, 2022. However, date of effectiveness and Procedures yet to be notified.*

4.4.2 The SLDCs may initiate the Backing down or Curtailment in case under-drawal of State is beyond the Threshold Limit at the state periphery. The SLDCs shall also take into consideration the Grid Frequency while acting on the volume limits.

Table 1: Representation of Curtailment Decisions by SLDC

[RE Curtailment only after exercising other measures as outlined under Cl. 4.2.3 to Cl. 4.2.10]

	Curtailment for maintaining Volume Limit (Under-drawal) at State Periphery	
	For Deviation <= 250 MW (or threshold limit as specified)	For Deviation > 250 MW (or threshold limit as specified)
F < 49.90 Hz	No	**No**
F >49.90 and < 50.05 Hz	No	**Yes**
F > 50.05 Hz	**Yes** ([9]Provided Grid Frequency exceeds 50.05 Hz for two or more successive time-blocks.)	**Yes** (Provided Under-drawal by State at state periphery is outside the range of 250 MW[10] for two or more successive time-blocks.)

[9] *Subject to revision in future with operationalization of state level ancillary service or storage participation*

[10] *Revised to 200 MW for RE rich states (with installed RE > 1000 MW) as per CERC DSM Regulations, 2022. Date of effectiveness and Procedures yet to be notified.*

5 RE Curtailment Implementation modalities

5.1 RE Curtailment Instructions by RLDC/SLDC and its Implementation

5.1.1 RLDC/SLDC shall monitor the grid frequency, State periphery under-drawal condition, over-loading of transmission lines, over-voltage/evacuation constraints (if any) in line with conditions stipulated under Clause 3.1 of these Guidelines and shall initiate curtailment as required to maintain system balance.

5.1.2 Quantum of required curtailment shall be assessed by RLDC/SLDC official based on the real time system conditions in accordance with the provisions of the Grid code, Regulations and provisions of these guidelines.

5.1.3 While curtailing the concerned RE Generator(s) the SLDC shall issue despatch/curtailment instructions to concerned RE Generator(s) through QCA/Lead Generator and accordingly revise the schedule provided by the QCA/Lead Generator and intimate the QCA/Lead Generator about such revision. Such revision in schedule shall take place with immediate effect from the next time-block counting the time-block as 1st time-block in which such curtailment instructions have been issued.

5.1.4 Injection schedule shall be restricted to limit the loading on evacuation network which is in service, within thermal loading limits as per CEA Grid standards and other relevant Regulations.

5.1.5 In case multiple generators connected to a PSS (Pooling Sub-Station) or group of PSSs are concerned, curtailment instructions shall be issued on pro-rata basis of 'available capacity' amongst the affected PSS without any preference in a non-discriminatory manner subject to transmission capacity constraint.

5.1.6 While issuing the curtailment instructions, RLDC/SLDC may indicate the likely time duration (in time blocks) for curtailment and indicate the restoration time block.

5.1.7 The QCA/Lead Generator shall further instruct the RE generators within the PSS to reduce/curtail the generation on a pro rata basis considering the declared 'available capacity' by RE Generators as per provisions of F&S Regulations.

5.1.8 Curtailment Instructions shall contain the following information:

i. Name of PSS
ii. Quantum of Generation to be curtailed or Quantum to which generation is to be restricted
iii. Time Blocks from which curtailment to be implemented and likely to be withdrawn
iv. Reason for Curtailment
v. Wind & Solar Generation Schedule for the State for period of curtailment
vi. Grid Frequency
vii. Drawl condition by the State at state periphery
viii. Confirmation towards operation of Thermal Units at Technical Minimum level

ix. Details of Transmission Constraint along with loading conditions

5.1.9 Transmission Licensee, RE Generators and QCAs/Lead Generator shall follow the instructions issued by the SLDC and implement the curtailment instructions as issued.

5.1.10 The instructions from RLDC/SLDC shall be communicated to the Nodal Officer/Control Room of respective Transmission Licensee, RE Generator & QCA/Lead Generator for implementation telephonically (being real time operations), which shall be confirmed through mail as immediately as practical but not later than 24 hours.

5.1.11 RLDC/SLDC, Transmission Licensee, Generator and QCA/Lead Generator shall maintain a log-book for recording such instructions and actions taken thereof for implementation of such instructions. The log-book shall be made available for verification on request by the authority approved by the Commission.

5.2 Pre-curtailment Communication Protocol

i. RLDC/SLDCs shall communicate the QCAs/Lead Generator/ RE generators about the curtailment using standard procedure/formats. The formats shall be made available for all stakeholders in advance along with state specific MRC guidelines.

ii. The RLDC/SLDCs shall use both automated and manual mode for communication with Nodal officer of QCA/Lead Generator/RE Generators through (telephonic/email) communication.

iii. Telephonic communications shall be followed by Email communication as immediately as practical but not later than 24 hours.

iv. SLDC shall impose restrictions on maximum permissible Schedule & Generation through SLDC/REMC Scheduling Software (wherever available) during the curtailment period.

v. SLDC's shall also develop web based application portal for communication of curtailment instructions and recording the instructions issued to RE generators /QCAs/Lead Generator.

5.3 Post curtailment protocol

i. RLDC/SLDC's shall maintain records of PSS-wise curtailment events with (a) details of time, (b) duration of curtailment instructions issued, (c) quantum of RE curtailment instructed, (d) actually relief received, (e) details of restoration instructions issued and (f) actual restoration of the generation capacity thereof pursuant to restoration instructions. Such information shall be compiled on monthly basis and published on the website of the concerned RLDC/SLDC.

ii. RLDC/SLDCs shall also record the cause of curtailment instructions issued and remedial measures initiated to mitigate such cause.

iii. The recorded data can be used for post-facto analysis.

iv. RLDC/SLDC shall also certify the curtailment events, loss of generation, etc. due to grid security and other than grid security considerations for further compensation modalities.

6 Functions, Roles and Responsibilities of Stakeholders

6.1 Role of RLDC

6.1.1 RLDC shall be the implementing agency for the MRC Guidelines at regional level for RE generation connected to inter-state transmission system.

6.1.2 RLDC shall forecast the daily region-wise RE generation forecasts on day ahead basis through REMCs and/or by aggregating RE Generation forecasts provided by the SLDCs and other sources.

6.1.3 RLDC shall monitor the power system parameters such as frequency, line loadings, voltage parameters, state periphery drawal, etc. as per the provisions of Grid Code and issue the necessary instructions to the SLDCs for maintaining the Grid Parameters within the permissible limits specified by the Grid Code.

6.1.4 RLDC shall develop the web-based application software for management of RE curtailment in accordance with the Grid Code and provisions outlined under MRC Guidelines

6.2 Role of SLDC

6.2.1 SLDC shall be the implementing agency for the management of RE Curtailment in accordance with these guidelines at state level for RE generation connected to intra-state transmission system.

6.2.2 SLDC shall develop a web-based application Software for:

- Uploading of Day ahead and Week ahead RE Generation Forecasts
- Uploading of the revisions in Schedules in accordance with RE F&S Procedures and Regulations.
- Communication of Grid Constraints, and curtailments if any and restorations thereof.
- Maintaining the data of Load-Generation balance in real time and the deviation of State at State periphery and transmission line loading in real time.

6.2.3 SLDC shall be responsible for scheduling, communication, coordination with QCAs/Lead Generator for RE generation.

6.2.4 SLDC shall undertake RE generation forecast on the basis of the weather data provided by Indian Meteorological Department (IMD) with the objective of ensuring secure grid operation.

6.2.5 SLDC shall monitor congestion situations in the intra-state transmission network and shall be responsible for issuance of remediation measures for the same.

6.2.6 SLDC shall maintain records and accounts of the time block-wise Schedules, the actual generation injected and the deviations, for the Pooling Sub-Station and the individual Generator(s) separately.

6.2.7 SLDC shall maintain records of curtailment events alongwith causes for such curtailment. SLDC shall certify the events of curtailment, duration of curtailment to facilitate RE Generators/QCAs/Lead Generator to estimate loss of generation. However, it is clarified that the claims for loss of generation and methodology for computation of such loss shall be as per the terms of the PPA and/or Guidelines issued by Central Government from time to time.

6.3 Role of CTU/ISTS transmission licensee

6.3.1 CTU/ISTS transmission licensee shall be responsible for evacuating and transmitting the power generated by RE generators and involved in planning transmission systems and operations.

6.3.2 ISTS transmission licensee shall be responsible for maintaining and monitoring logbook, event recording, installing and maintaining protection systems.

6.3.3 ISTS transmission licensee shall be responsible for ensuring maximum availability of the transmission lines.

6.3.4 ISTS transmission licensee shall undertake any scheduled maintenance activity on the ISTS with prior approval of the RLDC.

6.3.5 During the times of natural calamities or events that cause damage to the transmission infrastructure the CTU/ ISTS transmission licensee to inform the RLDC of such failure and endeavour to restore the connections in shortest time possible.

6.4 Role of STU / Transmission Service Providers

6.4.1 STU/Intra-state transmission licensee shall be responsible for transmitting the power generated by RE generators and involved in planning transmission systems and operations at intra-state level.

6.4.2 Intra-state transmission licensee shall be responsible for maintaining and monitoring logbook, event recording, installing and maintaining protection systems and notifying SLDC about the position of protection relay.

6.4.3 Intra-state transmission licensee shall be responsible of ensuring maximum availability of the transmission lines.

6.4.4 Intra-state transmission licensee shall undertake any scheduled maintenance activity on the InSTS with prior approval of the SLDC.

6.4.5 During the times of natural calamities or events that cause damage to the transmission infrastructure the STU/Intra-state transmission licensee shall inform the SLDC of such failure and endeavour to restore the connections in shortest time possible.

6.5 Role of RE Generator

6.5.1 RE Generators shall submit all the Technical parameters such as installed capacity, make, model, hub-height, rotor diameter, wind curve specified by OEM, Inverter capacity, Performance Ratio, AC/DC capacity, etc to the SLDC through QCA/Lead Generator for uploading into REMC.

6.5.2 RE generators shall appoint the QCA/Lead Generator as per F&S Regulations of Appropriate Commission for their Pooling Stations.

6.5.3 RE Generators shall provide following real time data for power generation parameters (at Pooling Sub-Station level) and real time generation data (turbine and inverter level) and weather data wherever available to SLDC through QCAs/Lead Generator:

A. Wind turbine generating plants:

i Turbine Generation (MW/MVAR)

ii Wind Speed (meter/second)

iii Generator Status (on/off-line)- this is required for calculation of availability of the WTG

iv Wind Direction (degrees from true north)

v Voltage (Volt)

vi Ambient air temperature (^{o}C)

vii Barometric pressure (Pascal)

viii Relative humidity (in percent)

ix Air Density (kg/m3)

B. For Solar generating Plants:

i Solar Generation unit/ Inverter-wise (MW and MVAR)

ii Voltage at interconnection point (Volt)

iii Generator/Inverter Status (on/off-line)

iv Global horizontal irradiance (GHI) (Watt/m2)

v Ambient temperature (^{o}C)

vi Diffuse Irradiance (Watt/m2)

vii Direct Irradiance (Watt/m2)

viii Sun-rise and sunset timings

ix Cloud cover (Okta)

x Rainfall (mm)

xi Relative humidity (%)

xii Performance Ratio

6.5.4 In case of non-availability of Real Time Data (at turbine level /inverter level), QCA/Lead Generator in coordination with Generator shall maintain and provide time block wise generation data at (turbine and inverter level) and weather data on Weekly basis:

i. For wind plants, at the turbine level: Average wind speed, Average power generation at 15-min time block level.

ii. For solar plants, for all inverters*>=1 MW: Average Solar Irradiation, Average power generation at 15-min time block level. (*if a solar plant uses only smaller string inverters, then data may be provided at the plant level.)

6.5.5 The RE generator shall provide all the necessary details for communication such as contact details of Nodal person/Control Room, telephone (including mobile) nos. and Email ID to their respective QCA/Lead Generator.

6.6 Role of QCAs/Lead Generator

6.6.1 The QCA/Lead Generator shall establish a Control Centre round the clock and shall have complete control over Wind/Solar injection feeders connected to Pooling Sub-Stations. The Control Centre shall have facilities of voice communication with RLDC/SLDC and Wind/Solar Generators with voice recording facilities and internet connection available for all the 24 hours.

6.6.2 The QCA/Lead Generator shall establish protocol for communication with individual generators to implement the instructions of RLDC/SLDC.

6.6.3 The QCA/Lead Generator shall comply the instructions of the RLDC/SLDC in normal condition as well as during emergencies, appropriate decisions taken by the RLDC/SLDCs in view of Grid security and safety.

6.6.4 The QCA/Lead Generator shall be responsible for submitting all the technical details of RE Generators to RLDC/SLDC.

6.6.5 QCA/Lead Generator shall submit day ahead RE schedule to the RLDC/SLDC as per the provisions of the F&S Regulations and procedure thereunder. QCA/Lead Generator may also revise the schedules during intra-day operation considering the weather data the forecast provided by the forecasting tools as per the provisions of the F&S Regulations.

6.6.6 QCA/Lead Generator in consultation with generators within Pooling Station shall establish a protocol for implementation of the curtailments& restoration instructions issued by RLDC/SLDC and ensure implementation of the instructions of SLDC. The curtailment instructions may be implemented on pro-rata basis of 'Available Capacity' to RE generators within the PSS.

7 Restoration

7.1 Restoration would occur once the cause of the problem that prompted curtailment subsides. Depending on the prevalent situation the RLDC/SLDC may decide whether to restore the schedule partially or completely.

7.2 Situations that would lead to restoration of generation:

7.2.1 if the frequency remains below 50.05 Hz continuously for two or more number of consecutive time blocks.

7.2.2 if the under-drawal at state periphery is within threshold limit (ie. < 250 MW) continuously for two or more number of consecutive time blocks.

7.2.3 if any of the boundary conditions as stipulated under Clause 3.1 of these MRC Guidelines that triggered such curtailment no longer persists for two or more number of consecutive time-blocks.

7.2.4 This restoration shall be done as far as practical in First Out First In (FOFI) fashion. This means that the first generator curtailed shall be the first generator to be restored. The degree of restoration would be decided by RLDC/SLDC considering system stability.

7.3 RLDC/SLDC shall issue restoration instruction via automated signal /web-based portal followed by manual (telephonic and email) communication and maintain the record of instructions issued.

7.4 QCAs/Lead Generator /RE Generators shall follow the restoration instructions issued by RLDC/SLDC within stipulated timelines.

8 Information/Data sharing and Reporting Requirements

8.1 SLDC on either on receiving instructions from RLDC or on its own judgement initiates curtailment based on triggering events mentioned earlier, such events and reasons thereof shall be recorded.

8.2 Each curtailment instruction and each restoration instruction would be issued separate 'unique code' that would be recorded and referred in all future correspondence as regards such curtailment event.

8.3 SLDC shall record the precise conditions that led to issuance of the curtailment order.

8.4 SLDC shall record the status of all thermal generators (whether backed down to thermal limits) and their generation data prior to issuance of the command and after issuance.

8.5 SLDC shall record the generation data of RE Generators prior to issuance and after implementation of the curtailment order.

8.6 SLDC shall take all possible steps to restrain RE curtailment and shall take remedial measures like spreading out RE generation over regional grids.

8.7 SLDC shall upload above mentioned on monthly basis on its website for the purpose of maintaining transparency.

8.8 RLDC/SLDC may issue separate Procedures for implementation of these MRC Guidelines or amend existing Scheduling Procedure and Energy Accounting Procedures in line with these MRC Guidelines.

9 Energy Accounting and Treatment

9.1 For Curtailment Instructions

9.1.1 Once curtailment instruction is issued by the RLDC/SLDC, the revised generation target would become the schedule for the RE Generator.

9.1.2 The schedule would become effective immediately from the next time block (t+1) counting time-block (t) as first-time block in which curtailment instructions are issued.

9.1.3 The Deviation of RE generator (PSS) vis-à-vis revised schedule (generation target given by SLDC for that PSS) shall monitored as per RE F&S Regulations and shall be settled as per the provisions of RE F&S Regulations.

9.2 For Restoration Instructions

9.2.1 SLDC would strive to minimize curtailment and restore generation as soon as safe operation of grid is restored.

9.2.2 Once restoration instruction is issued by the RLDC/SLDC the earlier schedule of PSS submitted by QCA/Lead Generator for PSS (Despatch instructions issued by RLDC/SLDC before issuing curtailment instructions) shall be restored. In case, QCA/Lead Generator wants to revise its schedule, the same shall be done as per the provisions of F&S Regulations.

9.2.3 The revised schedule as instructed by RLDC/SLDC would become effective immediately from the next time block.

10 Compensation in case of Loss of Generation due to Curtailment

10.1 Compensation in case of curtailment for grid operational safety/security

10.1.1 No compensation shall be payable to the RE generators in case of RE curtailment is initiated by RLDC/SLDC for grid operational safety and grid security conditions as discussed in the para 3.1of these guidelines.

10.2 Computation in case of loss of generation due to grid unavailability[11]

10.2.1 In case of non-availability of grid or transmission element for duration of less than a period as defined in power/energy purchase agreement (PPA/EPA), no compensation shall be payable to the RE Generators. In case the PPA has no such definition this period will be 50 hours a year or as may be specified by Appropriate Commission.

10.2.2 In case of non-availability of grid or transmission element for a duration more than the minimum period as defined in 10.2.1, the loss shall be computed as specified in the PPA/EPA. If there is no specific provision in the PPA/EPA to determine generation loss due to non-availability of grid or transmission element, the generation loss shall be computed as per formulation outlined below;

Generation loss per hour = Avg. Generation per hour during contract year x no. of un-availability hours of grid or transmission element.

Where,

Average Generation per hour during the contract year (kWh) = [Total generation in the contract year (kWh)] ÷ [8766 hours less total hours of grid unavailability in a Contract year].

10.2.3 This excess generation by RE generator equal to generation loss shall be procured at PPA tariff so as to offset loss in succeeding 3 contract years.

10.2.4 The above provisions shall be applicable to Wind and Solar Generation only. As per the provisions of the Tariff Based Competitive Bidding guidelines for Grid Connected Wind Solar Hybrid Projects, no compensation shall be payable for grid or transmission element un-availability on account of grid operational safety and grid security conditions. However, if the backdown/curtailment is on account of considerations of Grid security/safety, such backdown would be recorded and reported to SLDC/RLDC/NLDC. SLDC/RLDC/NLDC will examine the issue of grid safety/security and give a finding that the issue of grid safety existed.

10.2.5 The RLDC/SLDC shall record the reasons of non-availability of grid and shall make the same available to stakeholders on its web-portal.

[11] *Ref: Cl. 4.10.1 of SECI WPD-PPA Tranche XIII and Cl. 4.10.2 of SECI Standard SPD PPA*

10.3 Computation for loss of generation due to curtailment for reasons other than grid security[12]

10.3.1 RE generators shall be compensated for the loss of generation due to the curtailment instructions issued by RLDC/SLDC for reasons other than the grid operational parameters and grid security conditions discussed in Para 3.1 of these guidelines.

10.3.2 For computation of loss of generation for Wind Energy projects, the provisions outlined under PPA shall prevail and where no such provisions are covered in the PPA, the guidelines for Tariff based Competitive bidding process as notified by the Ministry of Power (MoP) and as amended from time to time shall be applicable, in case of wind power projects, solar power projects, RE Hybrid (Wind-Solar) projects, as the case may be.

10.3.3 Subject to conditions outlined under Clause 10.3.1 and Clause 10.3.2 above, the computation of loss of generation and compensation thereof due to curtailment for reasons other than grid security reasons shall be determined as per following formulation:

Particulars	**Formulation for computation of loss of generation and compensation thereof**
For Wind Energy projects	**Wind Generation Compensation = 50% x (Average Generation during the month corresponding to the capacity backed down) x PPA Tariff** Where, Average Generation during the month corresponding to the capacity backed down (kWh) = (CUF during the month) x Σ (Backed down capacity in MW x corresponding time of back down in hours x 1000) The loss of generation compensation as calculated above will be limited to the extent of shortfall in annual generation corresponding to the maximum CUF permitted and the same shall be settled on yearly basis.
For Solar Energy projects	**Solar Generation Compensation = 100% of [(Average Solar Generation per hour during the month) X (number of backdown hours during the month)] X PPA tariff**

[12] [12] *Ref: Cl. 4.10.2 of SECI WPD-PPA Tranche XIII and Cl. 4.10.3 of SECI Standard SPD PPA*

	Where, Average Generation per hour during the month (kWh) = Total generation in the month (kWh) ÷ Total hours of generation in the month.
For RE Hybrid (Wind-Solar) projects	**Minimum Generation Compensation = 100% of [(Average Generation per hour during the month) x (number of back down hours during the month) x PPA Tariff]** Where, Average Generation per hour during the month (kWh) = Total generation in the month (kWh) ÷ Total hours of generation in the month.

10.3.4 Further, the compensation in the event of RE curtailment for reasons other than grid security, shall be borne by the distribution companies/ buyers and that such compensation paid shall not be allowed as a pass-through in tariff.

11 Non-Compliance of Instructions and Remedial Measures

11.1 QCA/Lead Generator would have complete control over wind/Solar Injection Feeders. QCA/Lead Generator has to ensure that generators have made efforts to comply with the revised schedule in pursuance of the curtailment or restoration instructions, as the case may be.

11.2 QCA/Lead Generator would monitor the adherence to the curtailment/restoration order by the RE Generator. If gross non-compliance is observed it may direct to cut-off/open the feeder(s) of the concerned generator, upon issuance of the adequate notice and allowing sufficient time for concerned QCA/ Lead Generator/RE Generator to undertake remedial measures.

11.3 SLDC shall monitor compliance of instructions at Pooling Station level. When gross non-compliance at the part of the QCA/Lead Generator at the PSS level is observed it may instruct the Transmission Licensee/Distribution Licensee to cut-off/open the inter-connection point granted to the PSS of the concerned QCA/Lead Generator and de-register/black-list concerned QCA/Lead Generator, upon issuance of adequate notice and allowing sufficient time for concerned QCA/Lead Generator/RE Generator to undertake remedial measures.

11.4 Non-submission of information by QCA/Lead Generator/RE Generator

11.4.1 In case of non-submission of information such as PSS-wise Generator details to SLDC by QCAs/Lead Generator/RE generators, or not establishing communication infrastructure/protocol for implementation of curtailment instructions of RLDC/SLDC, the RLDC/SLDC shall issue show cause notice to the concerned QCA/Lead Generator/RE generator.

11.4.2 In case of continued failure to comply the instructions of RLDC/SLDC and non-submission of requisite information/data or non-establishment of communication links for more than 3 months, RLDC/SLDC shall direct concerned Transmission/ Distribution Licensee to open the EHV or 33 kV inter-connection of the respective Generator and disconnect the generator from the grid.

11.4.3 Such generator shall not be compensated for any loss of generation during disconnection period and concerned RE generator shall be solely responsible for any cost/commercial implications raised out of it till default is rectified.

11.5 Non-compliance of curtailment instructions by QCA/Lead Generator/RE Generator

11.5.1 In case of non-compliance/implementation of the curtailment instructions issued by the RLDC/SLDC or shortfall in adherence to terms and conditions of the RE curtailment management guidelines or failure to comply with any other directives of the RLDC/SLDC by the QCA/Lead Generator/RE Generator, appropriate action shall be taken based on the provisions of the Electricity Act, IEGC, State Grid Code & relevant regulations, as amended from time to time.

11.5.2 As per the provisions of Section 29 and Section33 (Compliance of Directions) of the EA,2003 RLDC/SLDC shall issue prior notice and direct QCA/Lead Generator/RE Generator to present case before RLDC/SLDC and such continued non-compliance of RLDC/SLDC instructions shall be liable to the attract penalty as stipulated under Section 29 and Section 33 of EA 2003.

11.5.3 In case QCAs/Lead Generator/ RE generators fail to address/rectify the breach, generators will be disconnected from grid, till default is rectified and/or attract levy of penalty/fines for non-compliance as per provisions outlined under Section 142 and Section 146 of EA 2003.

12 ANNEXURES

ANNEXURE - 1

Format of Curtailment event for SLDC

			Curtailment			Actual	
Sr. No.	Date	Name of PSS	Period		Reason for Curtailment	Generation at the time of Curtailment	System Parameters (*)
			From Time Block	To Time Block			

ANNEXURE - 2

Format of Curtailment event for QCA / Lead Generator

			Curtailment			Actual
Sr. No.	Date	Name of generator	Period		Reason for Curtailment	Generation at the time of curtailment
			From Time Block	To Time Block		