

**Framework on
Forecasting, Scheduling and Imbalance Handling for
Variable Renewable Energy Sources (Wind and Solar):**

STATEMENT OF REASONS

The Central Commission in its endeavor to strengthen the RE forecasting, scheduling and balancing framework and address the design issues affecting its implementation issued the Draft Framework for Forecasting, Scheduling & Imbalance Handling for Renewable Energy (RE) Generating Stations based on wind and solar at Inter-State level on 31.03.2015, inviting comments/ suggestions/ objections thereon. Last date of submission of comments / suggestions / objections was 30.05.2015. In response to the same, 41 stakeholders submitted their written comments / suggestions. A list of stakeholders who submitted written comments is enclosed as **Annexure-II**. Subsequently, public hearing was held on 12.06.2015 to hear views of all the stakeholders. In accordance with the provisions of section 178(3) of the Electricity Act, 2003 (the Act) read with Electricity (Procedure for Previous Publication) Rules, 2005, the Commission has considered the objections and suggestions received on the draft regulations which have been dealt with in the succeeding paragraphs.

2. APPLICABILITY OF REGULATIONS

2.1 Proposed Amendment:

2.1.1 It was proposed in the Central Electricity Regulatory Commission (Indian Electricity Grid Code) (Third Amendment) Regulations, 2015, inter alia that

“.....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 energy generators covered under the control area of RLDCs, has been incorporated in this code."

2.1.2 Further, it was proposed that Regulation 4 of the Annexure-1 of the Principal Regulations, shall be substituted as under :-

"The wind and solar energy generators whose scheduling is done by the RLDCs, 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.

....."

2.2 Comments received:

2.2.1 Indian Wind Energy Association (InWEA) has stated that there are multiple conditions stipulated at various places under IEGC (third amendment), which makes it difficult to comprehend which wind/solar generating stations would be covered under these regulations (Ref. Regulation 1 Part 1, 2.4.5, 6.4(2)(b) and Annexure-I Regulation 4). The criteria used to define eligibility condition range from Inter-State Generating Stations, Stations covered control area of RLDC, wind/solar power projects with installed capacity above 500 MW, stations with aggregate generating capacity of above 50 MW etc. On a similar note, GUVNL, Greenko Energies have stated that the RE projects connected with State transmission network may also supply power outside the state, in which case scheduling should be done by RLDC. However, the proposed framework has not provided any mechanism to deal with such projects. REConnect has suggested that the expression "wind and solar energy generators whose scheduling is done by the RLDCs" should be defined in the regulation so that the applicability of the proposed regulations is clarified. Further, it should be clarified if the captive and open access projects are covered in the proposed regulation. POSOCO has also argued that at present, an intra-state

generator may sell to a buyer outside the state in a bilateral transaction. In such case, the RLDCs also schedule in view of inter-state nature of the transaction. In the proposed amendments, it is mentioned that *“wind and solar energy generators whose scheduling is done by the RLDCs”* which may be misinterpreted. In order to bring clarity, POSOCO has suggested that the above phrase may be replaced by *“regional entity wind and solar energy generators”*. This will be in line with intent of the Commission as stated in the Para 2 *“.....scheduling of wind and solar energy generators covered under the control area of RLDCs, has been incorporated in this code.”*

2.2.2 SunEdison has endorsed with the Commission’s proposals pertaining to eligibility criteria i.e. aggregate 50 MW and above selling power through inter-State open access. However, the company has commented that the proposed framework does not have clarity on settlement mechanism with State UI pool in case of generator embedded in STU network and giving schedule to SLDC for inter-State transaction.

2.2.3 Manikaran and E&Y have agreed with the decision that Solar should be required to provide forecasting and scheduling as well as wind.

2.2.4 Some stakeholders (Gujarat SLDC, Alstom T&D, CEA, Tamil Nadu Transmission Corporation, Southern Regional Power Committee, GE, Indian Wind Power Association, MNRE, IEX, Dr Anoop Singh, MEIL, NREL) have stated that the proposed framework is for *inter-state wind and solar generators only*, of which presently there are none. It is also not sure to what extent wind generators would like to sell power outside the state. Handling of a large quantum of renewable injection into the grid has become one of the major challenges to the system operator. Between RLDC & SLDC all grid connected renewables should be covered in the scheduling process. Shri Vijay Meghnani has argued that CERC has valid jurisdiction even on intra-state generators, as the grid is common.

2.2.5 Kanchanjunga Power, Suryakant Hydro Energies, Greenko Energies have stated that this framework or similar appreciable framework should include small hydro power technology, as they are equally exposed to the vagaries of nature and

charges for deviation shall not be linked to frequency. Similarly IEX has also requested that RE sources other than Wind and Solar must also be included.

2.3 Decision of the Commission

2.3.1 The Commission has considered the comments received on the proposed amendment. Several stakeholders have recommended that intra-state generators should also be brought under the purview of this regulation, which would include most of existing wind generators. The argument made, is that the present regulation shall have limited applicability, possibly for only some of the solar capacities and would not include the existing wind capacities in the country. Secondly, some stakeholders have suggested that run-of-the-river hydro plants should also be covered under the proposed framework. Many stakeholders have highlighted that generators connected to intra-state transmission system and supplying power outside the state have not been covered under these regulations.

2.3.2 The Commission appreciates inputs on expanding the scope of these regulations. Indeed, the Commission is committed to helping states implement a framework for forecasting, scheduling and deviation settlement for intra-state RE generating stations as well. It may be noted that the framework proposed by the Commission fits well for an ABT compliant payment, scheduling and balancing system. Currently all States do not have ABT mechanism in place. As such, it would not be advisable to prescribe a one-size-fits-all framework. After instituting an inter-state framework, the Commission will also create an enabling framework and frame model regulations for the state level, which will be shared with the Forum of Regulators (FOR) for implementation/adaptation at the state level. The Commission maintains that the objective of this particular framework is to provide a platform for bulk of the wind and solar capacity that is expected to come online over the next few years, and which is expected to be inter-state in nature. In the present dispensation, the wind and solar generators which qualify as regional entities as per the IEGC are covered. For the sake of clarity, therefore, the Commission has decided to replace the words "wind and solar energy

generators whose scheduling is done by the RLDCs" appearing in the proposed amendments to IEGC Regulations, by the words "wind and solar generators which are regional entities".

2.3.3 As regards the RE projects connected only with the state transmission network but supplying power outside the states, it is clarified that such projects are presently treated as entities under SLDC control area and their scheduling is handled by SLDC. The intent of the current regulatory process is not to disturb the existing arrangement for such projects. In other words, such projects (connected only with the state transmission network but supplying power outside the state) shall, unless decided otherwise through separate regulatory dispensation, continue to operate within the control area of SLDC and their deviation settlement shall also continue to be governed by the State level deviation settlement mechanism.

2.3.4 The Commission also clarifies that all wind and solar generators which are regional entities whether supplying power to the distribution licensees under PPA, or through open-access to third party consumer or for captive consumption, are covered under the ambit of this regulation.

3. ISSUES INVOLVING EMPIRICAL DATA, TRIAL PERIOD, ETC.

3.1. Comments received:

3.1.1. MEIL has submitted that before imposing commercial mechanism, implication on the generators be assessed. WIPPA etc have also stated that REMCs should be in place to carry out the forecast at centralized level to have a forecast with better accuracy and consistency. In addition, forecast from individual generators should be collected through an online system and it be correlated with the centralized forecast data for arriving at the schedule. There can be a nominal charge distributed among all the generators for developing the online system and recurring cost of maintaining it. There could be penalty on the

generators who fail to submit their individual forecast within stipulated time. NTPC, Hindustan Power, OPGC have also argued that this framework may be implemented on trial basis first for about a year or two to study the technical feasibility and system improvement before coming up with any commercial impact on the generators for the lack of accuracy in forecasting.

3.1.2 NREL has stated that a robust forecasting program requires supporting analysis and justification for 1) determining RE forecasting bandwidth, 2) frequency of forecasting and basis for value of penalty or incentive payment terms, and 3) mechanisms behind settlement of deviations for wind and solar generation. The costs and benefits of proposed RE forecasting regulations by stakeholders should be addressed. Considerations should be given to market-driven incentives and penalties. The impacts of proposed RE forecasting regulations on existing PPAs, interconnection agreements, transmission agreements, and grid codes need to be addressed. Mechanisms or processes may need to be defined to ensure compatibility. An independent third party should conduct statistical modelling and analysis of existing wind energy forecasting to establish statistically sound (e.g. $\pm 2CV$ level band) forecasting variance band as the basis for RE forecasting requirements. These forecasting bands most likely will require revision, especially if a centralized RE forecasting system is implemented over the next few years. A timeline with appropriate milestones should be established for the statistical modeling to be administered by an independent third party. The schedule should allow between two to three years to achieve efficient, reliable and consistent forecasting mechanisms to be used by RE generators, system operators, and wholesale market participants. The validation of confidence levels of proposed forecasting for wind, solar and hydro resources may require two to three years. The impact of the proposed RE forecasting regulations and the mechanisms for frequency regulation/ancillary services should be evaluated.

3.1.3 IWTMA has recommended not to impose any penalty in case of variation from schedule during the initial stages at least for first 2 year as the Wind industry has no experience of inter-state power flow.

3.2. Decision of the Commission

3.2.1 The Commission has considered the observations of the stakeholders. A section of the stakeholders have opined that the regulations should be rolled out only after setting up of REMCs is complete, and thorough statistical analysis is conducted on data observed over two to three years. The Commission feels that sufficient time has been given to the ecosystem overall since 2010 for trial. The Commission is aware that wind plants of ~2500 MW aggregate capacity are already undertaking forecasting on a regular basis. The Commission has also received pilot results from several stakeholders in the country, and has also considered results of forecasting exercises conducted in other countries. Thus, the proposed variance band is based on empirical evidence. Forecasting models will evolve with roll out of the framework. Detailed Procedures shall take care of process and operational details. This is a first step, and regulations shall continue to evolve over the next few years as more data is gathered, and analytical evidence emerges.

3.2.2 Thus, different sections of stakeholders have to evolve in parallel. While REMCs are established at NLDC and RLDCs, industry must also undertake capacity building simultaneously. It is in the interest of wind and solar industry to have a proper forecasting and scheduling system in place, so as to enable seamless integration with the grid thereby encouraging state DISCOMs to procure infirm power. The proposed mechanism will also open up a new market for RPO compliance in RE-resource-deficit states. These states will now be able to procure wind and solar power from generators located in resource-rich states.

3.2.3 A preparatory window will, however, be provided for the generators to ensure installation of data measurement and telemetry equipment, and for

respective LDCs to prepare their systems and teams for receipt of regular data and schedules. Accordingly, the Commission has decided to make the final amendment regulations in the context effective from 1.11.2015. During this period the NLDC is directed to evolve the detailed procedure, solicit public comments and seek necessary approval of the Commission. This time must also be utilized to recruit external forecasting agencies (if required), and train the models for historical data for improved forecasting accuracy. As commented, at present, not much capacity is covered by the regulations, and therefore, the regulations should be seen as proactive interventions seeking to set clear rules thereby creating desired regulatory certainty for investment.

3.2.4 As regarding NREL's comments on the impact on existing PPAs and regulations, it is clarified that the existing PPAs or interconnection agreements shall not be impacted. Modifications to grid code and other regulations are already considered by the Commission.

4. FORECASTING FRAMEWORK

4.1 Proposed Amendments

4.1.1 The Commission had proposed amendments to Regulation 6.5 of Part 6 of IEGC regulations as under:

"

(ii) Forecasting would be done by the wind and solar generators as well as the concerned RLDC. The forecast by the concerned RLDC would be with the objective of secure grid operation. The forecast by the wind and solar generator would be wind-farm/solar facility centric and would form the basis of scheduling. The wind and solar generator will have the option of accepting the concerned RLDC's forecast for preparing its schedule or provide the concerned RLDC with a schedule. The concerned RLDCs may engage forecasting agency(ies) at the centralized level and prepare a schedule of inter-State renewable generating stations. Any commercial impact on

account of scheduling based on the forecast would, however, be borne by the wind and solar energy generator”

4.2 **Comments received:**

4.2.1 Lawrence Berkeley National Lab (LBNL) has commented that generators who provide real time data, expected outages and other data essential for forecasting to system operators (RLDC or SLDC) can get paid according to what they generate (not scheduled, but actual generation, based on their FiTs). This would act as an incentive for RE generators to provide real time data, that they will not be required to provide a schedule. These incentives are especially important to bring the intra-state RE generators on board. A variant of this option is that the individual RE generators can be assessed a deviation charge based on the aggregate (system level) deviation from the (system level) schedule.

Generators who do not provide real time data, (and those who are selling through Open Access) should provide a schedule. The financial arrangement proposed in this regulation could be applied to these generators for the short term. But in the long term, a real time market (or an hour ahead market) can enable these generators to make up for the day ahead forecast error, and ensure a total generation supply close to their original schedule.

4.2.2 POSOCO has submitted that there is a need for clarity on the intent of the regulation regarding forecasting and scheduling. Forecasting needs to be done by both RE generator and the concerned RLDC. Following change is therefore required. In Regulation 8(ii): Amendment of Regulation 6.5 of Part 6 of Principal Regulations, the words in the proposed Regulation 8 part (ii) “..... The concerned RLDCs may engage forecasting agency(ies) at the centralized level and prepare a schedule of inter-State renewable generating stations.” may be replaced with “..... The concerned RLDCs and RE generators may engage forecasting agency(ies) at the centralized and decentralized level respectively. RE generators may provide schedule to concerned RLDC for scheduling of inter-State renewable generating stations.”

4.2.3 InWEA, has stated that based on the recommendations of the task force, which was subsequently constituted under MNRE, it was recommended and accepted by Hon'ble Commission to consider the pooling s/s of wind project as a building block. With the proposed regulations we are going back to a situation where in individual generator would undertake scheduling. Proposed Approach of centralised forecasting and decentralized scheduling would not address the inherent risk for variable/intermittent generation. The concept of RLDC to do forecast using a forecasting service provider is good idea. However, it is not clear whether such forecast would be for the wind pooling s/s which may be embedded in STU/DISCOM grid or for a wind cluster or region or entire control area. It would have been a good concept if forecasting for entire state's RE generation is undertaken. It would have been appropriate to move towards decentralized forecasting and centralized scheduling model. It has been suggested (by stakeholders including InWEA, Vestas Wind Energy India Pvt Ltd etc) that IEGC amendment should recognise a role for Co-ordinating Agency at wind farm or Pooling S/S level which would be responsible for forecasting and De-pooling arrangements, interact with REMCs, SLDCs/RLDCs to facilitate intra-state or inter-state wheeling transactions. Thus, IEGC need to recognise Pooling S/S as basic building block for control area, forecasting and imbalance computation. This would be independent of the offtake arrangement or number of WTGs owners within given control area of pooling s/s.

4.2.4 SunEdison has welcomed the incentive mechanism for precise forecasting. This will encourage and motivate the schedulers to employ the best analytical hardware/software tools to derive at an ensemble forecast with lowest deviation results. SunEdison is in agreement with the Commission proposals pertaining to Day ahead forecasting in 15 minute time slots.

4.2.5 MNRE and Tata Power have argued that scheduling may be carried out at SLDC/RLDC level, based on the forecasts given by wind developers. The developers

may take services of an aggregator who may aggregate forecasts given by its members and forward the aggregated forecast to the scheduler. The penalties for the deviation may also be apportioned accordingly.

4.2.6 POSOCO has observed that in case of renewable energy generation, particularly in case of Wind Turbine Generators (WTGs), the ownership is quite fragmented and large capacity of WTGs is owned by small investors. In an earlier order, Hon'ble CERC has recognized the need of a nodal entity at the connection point, which shall be responsible for coordinating with SLDC/RLDC on behalf of all the developers/generators. Hence, a separate Institutional Entity e.g. Qualified Scheduling Entity (QSE) may be required to be put in place, which is recognized under regulatory framework and could be qualified/certified/registered with System Operator to undertake various activities associated with scheduling/commercial settlement/de-pooling/communication/data consolidation and management and co-ordination etc. Suitable definition may be incorporated in the appropriate regulations including Grid Code.

4.2.7 PRDC has suggested that it may be advantageous to perform cluster-level forecasting and scheduling for wind farms which enter into PPAs with distribution companies. In effect, SLDCs could treat all RE generators as one aggregate generator for each cluster. Concerned system operator could procure system-level forecasts from appropriate parties ("forecasting agencies or aggregators") under an appropriate mechanism –e.g. multiple vendors can be contracted and the most accurate forecast gets an additional incentive thereby creating a competitive environment for continued improvement in RE forecasts. The associated costs could be collected from the RE generators in the form of an annual fee.

4.2.8 Inox Wind Ltd has stated that the primary concern of the system operators, which hinges upon the safe and secure grid operation at central and state level, would be adequately addressed if the forecasting as well scheduling is done by one central agency at state and central level without any loss to the

developers. Only these central agencies would be in a position to continuously monitor and/or control the real-time grid stability limits and then accordingly revise the schedules keeping in view the spinning reserves and/or availability of ancillary service (in infancy now). The imbalances would be more practically handled by attaching fixed incentive/penalties to scheduling done within the specified deviation-band by a central agency. This incentive/ penalties may be socialized over the large stakeholders or may be kept on hold until the ancillary service market achieves operational maturity or may be met through NCEF. We appreciate that the proposed framework is delinked from the frequency based parameter..

4.2.9 Many stakeholders such as NTPC, Indian Wind Power Association, Sterling Agro Industries have recommended forecasting at the regional level that will result in better accuracy compared to an individual pooling station, which would result in variation to be likely within deviation limits. Cost of variation should be socialized among the states, as done previously via RRF.

4.2.10 Lawrence Berkeley National Laboratory (LBNL), USA has submitted that in the proposed framework, if two RE generators deviate in the opposite direction with no net deviation from the aggregate schedule, both generators are expected to be penalized depending on the extent of their individual deviation even though they may not impose any additional costs on the overall system. Their research shows that the aggregate variation (in percentage terms) over multiple sites is typically lower than the variation in output on one site; moreover, the forecasting accuracy is higher for aggregate forecast over multiple sites. Therefore, for scheduling purposes it is desirable to use the aggregate (total balancing area) level forecasts of RE generation. Additionally, the transactional costs of generator level forecasting would much higher than that of the aggregate system level forecast. Ultimately, these extra integration (penalties etc) or transactional costs would be passed on to the consumers either by RE generators (through an increase in the PPA price) or by the utilities. Hence, it is important to find the most efficient solution for minimizing the overall costs.

4.2.11 Dr Anoop Singh, IIT Kanpur has stated that the commercial risk of forecasting inaccuracy completely remains with the RE generators. Presence of multiple forecasts would not make the task of RLDCs easier. The task of RE generation forecasting could be centralised later with respective Renewable Energy Management Centres (REMCs). Centralized forecasting is followed internationally.

4.2.12 WIPPA, OGPCL and others have submitted that the centralised forecasting, covering large number of solar/wind plants spread across large geographical area would be a more suitable arrangement acceptable to generators and system operators.

4.2.13 IL&FS has stated that centralized wind and solar PV forecasting and scheduling needs to be done at state level, possibly at REMC level at each state (not at SLDC or RLDC). Alstom T&D has stated that for RLDC to be a forecast provider, technology deployed at RLDC should be capable of dealing with feeds from multiple forecast engines and blending the same for improved accuracy over time.

4.2.14 Several stakeholders such as Association of Power Producers, Sterling Agro Industries, Hindustan Power and Tata Power have commented that setting up of a reliable and workable mechanism for accurate forecasting and scheduling of RE power involves substantial investment in equipment for telemetry, SCADA, communications etc, and also in human resources and consultant fees. All this has an impact on the capital cost and therefore it is recommended that the generic tariff determined by the Commission should be revised appropriately to recover this cost.

4.2.15 Indian Wind Power Association has recommended that the concerned RLDCs should engage forecasting agency(ies) at the centralized level and prepare a schedule of all Wind Energy generating stations in the region.. The costs incurred for undertaking the forecasting and scheduling based on the forecast would, however, be borne by the wind and solar energy generator. RLDC should be vested with

the responsibility of scheduling. The host State shall be entitled to draw power as per the schedule provided by RLDC for wind installations and any variation in generation from schedule be handled by RLDC.

4.2.16 Kanchanjunga Power has stated that the regulatory penalty/incentive mechanisms are fully to the account of the developer. The same has to be factored into for open access sale tariffs especially for SHPs who do not enjoy subsidized penalties for deviations as Solar or Wind do. As per industry estimates, the impact of deviations works out to 15-20p/unit especially due to downtime of DISCOM/STU lines, forced outage due to high silt in monsoon season besides breakdowns etc.

4.2.17 Hindustan Power has commented that it would be unfair to penalize RE generator for any inaccurate forecasting as RE generation depends on nature. Instead RLDC may be entrusted with the responsibility of such forecasting, as being done proposed and RLDC may be compensated for additional costs instead of RE generator for forecasting. Any incentive/penalty for errors in such forecasting should be passed on to the beneficiaries as is being done for hydro stations. RE generator may be asked to give declaration of availability of plant for the purpose of forecasting.

4.2.18 NREL has recommended that a national agency (e.g. PGCIL or POSOCO) undertakes macro and micro level RE resource forecasting using a centrally-developed and administered forecasting modeling system for wind and solar resources. Historical and real time site-specific renewable energy data are also acquired by the said national agency. The agency then applies the model to produce RE generation forecasts for all generators. This centralized system will be able to generate short and medium term RE forecasting for site-specific grid-connected RE generators as well as aggregate forecasts for SLDC and RLDC.

4.2.19 The national agency mentioned above is responsible for acquisition and processing of macro and micro-level meteorological data, simulated forecasts, creating tailor-made models, and making the database and real-time forecast

available to all RE generators. The generators are required to undertake generation forecasting using in-house simulation models based on international best practice from a set of approved vendors. The generators will use the generation forecast to submit their scheduled nominations to the system operator and off-takers. The system operators (SLDC or RLDC as applicable) will then be able to use the scheduling from RE generators to optimize real-time net load balancing and ensure system reliability.

4.2.20 A national wind and solar resource standard should be set based on centralized renewable resource data collection, monitoring and forecasting (short-term <24 hours). Application to actual generation should be specific to each site and generation plant.

4.3 Decision of the Commission:

4.3.1 The Commission has noted the suggestions. Many stakeholders have emphasized the need for centralized forecasting. Some stakeholders have requested for socializing the cost of forecasting as well as balancing. The Commission would like to clarify that the proposed framework requires forecasting by RLDC as well as wind/solar generator. Centralized forecasting is relevant from a grid management perspective and is very important for assessing balancing needs. The objective of forecasting by the generator is primarily to minimize deviations from schedule.

4.3.2 Some stakeholders have suggested a framework as prevalent in some states in the US and in some countries in Europe, wherein the RE generators are allowed to generate as per resource availability and the cost of balancing the variability and uncertainty is socialized across all market participants. This is definitely a good alternative but needs a market design where all other participants also operate by similar rules and more importantly the system operator has enough reserves to handle the system imbalances caused either due to load variation or

variation on account of infirm renewable energy sources. Another pre-requisite for such a market is a centralized dispatch of all generation and possibly in some cases existence of a separate financial contract settlement system like contract-for-differences (CFD). Indian power market does not have these features at this moment. As such, we need to design a framework which fits into the existing market operating rules and can also provide a roadmap for optimum utilization of resources and a better balancing regime in future. The Commission has a vision to put in place a regulatory framework for spinning reserves as well as other ancillary services in the market. As the ecosystem develops on these lines, the system operators shall have flexible resources on their command to manage load-generation balance. It is with these realities in mind that the Commission has finalized the framework which seeks to address the requirements of the existing market structure and the need for large-scale integration of RE sources.

4.3.3 The Commission had already articulated in the Explanatory Memorandum that appropriate use of forecast for scheduling is also expected to reduce commercial impact for the wind and solar energy generators. It is understood that the Renewable Energy Management Centers (REMCs) are being established and these would be equipped with advanced forecasting tools. It would be prudent to have multiple forecast providers (both for REMC/RLDC & wind/solar energy generators) for better confidence levels/lower forecast errors. The RE generator will have the option of choosing between its own forecast or site level forecasting as done by the respective RLDC to provide its schedule. However, commercial impact of deviation from forecast would have to be borne by the RE generator. This will encourage grid discipline and will enable wind and solar generators to expand opportunities by participating in the existing market framework.

4.3.4 As regards the suggestion of treating the pooling station as the building block for forecasting, the Commission would like to underscore that since pooling station is the commercial metering point, forecasting and scheduling activities should naturally be conducted at this level. The 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, may undertake all operational and commercial responsibilities for the renewable energy generating station(s) in following the provisions of the Indian Electricity Grid Code and all other regulations of the Commission including DSM.

4.3.5 The Commission has validated that even with medium levels of aggregation, forecasting is not particularly expensive. Current costs in India are estimated to be in the range of INR 2000-2500 per MW of installed wind capacity per month. As the market matures, these costs are expected to come down further with competition among forecasting service providers. The developers may include their set-up costs as part of their capital cost in their proposals for tariffs.

4.3.6 For RE generators to participate in the existing grid framework and play by the existing rules for long term sustainability, they would continue to be paid on the basis of schedule + deviation settlement. The second component would be settled with the regional DSM pool, and to that extent socialized. It may also be noted that within the tolerance band (as explained in the next section) where there is no commercial impact on the generator, the impact of deviation is being socialized completely. Also, the difference between the nominal deviation charges and the instantaneous UI rate is being socialized with the regional pool. In effect, the impact on the generator is minimized, but to the extent of incentivizing them for better forecasting and scheduling practices, direct deviation charges are necessary.

4.3.7 On the issue of impact of deviation on host state, the Commission finds that as the framework talks of scheduling by entities in RLDC control area, there will be no impact on the host state.

4.3.8 The Commission clarifies that this regulation shall apply to wind and solar generators that are regional entities.

5. FREQUENCY OF REVISION OF SCHEDULE PER DAY

5.1 Proposed Amendment:

5.1.1. The Commission had proposed amendments to Regulation 6.5 of Part 6 of IEGC regulations as under:

“

(iii) The schedule by wind and solar power generating stations whose scheduling is done by the RLDCs (excluding collective transactions) may be revised by giving advance notice to the concerned RLDC, as the case may be. Such revisions by wind and solar energy generating stations shall be effective from 4th 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.”

5.2 Comments received

5.2.1 POSOCO has stated that the draft regulation has provided maximum of 16 revisions in a day for each fixed one and half hour time slot starting from 00:00 hours. It may be ensured that the upward/downward revision of the transaction does not cause congestion in the upstream/downstream corridor. Therefore, appropriate regulations may be made so that revisions in the schedule of RE generator are subject to congestion in the upstream/downstream corridor.

5.2.2 InWEA has stated that the efficacy of 8 revisions itself is not known. Besides, SLDCs may have a view on this from operational point of view and complexities of handling the revision in schedules for vast number of wind energy generators and multiple transactions.

5.2.3 Indian Wind Power Association, Dr Anoop Singh have submitted that the number of revisions per day can be made 24 to make forecasting more reliable. Such

revisions by RLDC shall be effective from 3rd time block, the first being the time-block in which notice was given.

5.2.4 MEIL, NTPC, IEX, SunEdison have welcomed the proposal of the Commission to increase the number of revisions in a day from 8 to 16. MEIL has requested that it should be real-time revision for 2 time blocks ahead.

5.2.5 REConnect has stated that the forecast can be revised on the basis of two potential inputs – weather data or real-time inputs from the wind turbines. Of this, the weather data input is critical in building a revised forecast. However, in most cases weather inputs are revised on a 6-hour basis (eg from IMD), i.e. 4 times in 24 hours. In such cases, 16 revisions in a 24 hour block are of very limited value to the project.

5.2.6 Draft CERC framework says: “There may be a maximum of 16 revisions for each fixed one and half hour time slot starting from 00:00 hours during the day”, and Draft Amendment to IEGC says: “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”. IWTMA has requested the Commission provide clarity and harmonise these two expressions.

5.2.7 NREL, USA has stated that in general, frequency of revising nomination by renewable generators should be consistent with what is used by System Operators to balance the system, which is already in place with other generators (thermal and hydro). In most US markets, the nomination revisions are at least hourly and many cases it is every 15 minutes for RE generator at specified nodal points.

5.3 Decision of the Commission:

5.3.1 The Commission has taken note of the comments. On the issue of frequency of revisions, the Commission recognizes that accuracy of forecasting improves as one gets closer to time of dispatch. This is borne out by plenty of research that is available on how forecasting accuracy improves as more updates are done aligned with shorter scheduling intervals. In the publication, “A Review

of Variable Generation Forecasting in the West, Widiss et al, NREL, July 2013-Jan 2014”, 14 Operating Entities (OEs) in the Western Interconnection in the United States were interviewed. Nearly all OEs were reported to have hour-ahead forecasts, the frequency of updating varying from every 10 minutes to hourly. The chart below, prepared by Alberta Electric System Operator (AESO), illustrates improving accuracy with decreasing forecast horizon:

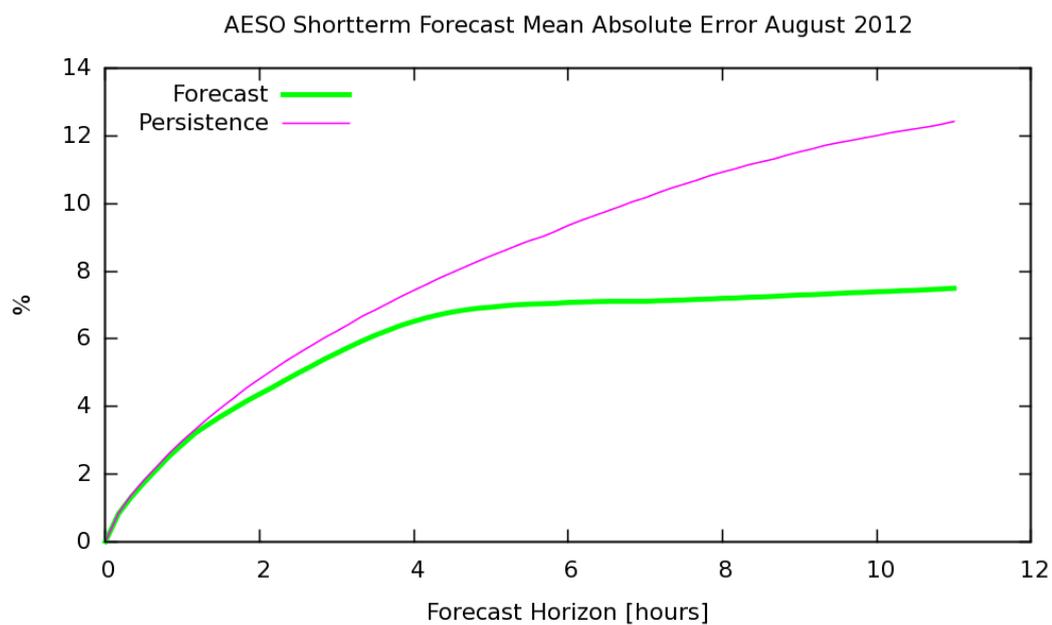


Figure 1. Plot of system-wide wind forecast error versus forecast time horizon, with error expressed as mean absolute error as a percentage of installed wind MW

Source: Courtesy of Jacques Duchesne, AESO, and prepared by WEPROG (Ahlstrom et al. 2013)

Most stakeholders have supported the proposal of doubling the number of revisions allowed, to 16 per day. Some have suggested even further increase to enable hourly revisions. The Commission is of the view that while increasing frequency of revision would enhance forecasting accuracy, it might be difficult for beneficiaries to manage contracts due to very frequent revisions. As such, the Commission has decided to retain the number of proposed revisions to 16.

5.3.2 Some stakeholders have requested for greater clarity on the provision relating to frequency of revision of schedules. The Commission feels that the provision proposed is adequate. The revisions would be effective from 4th time

block as proposed in the draft regulations, counting the time block in which the request for revision has been received by the RLDC to be the first one. The Commission clarifies that 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 a maximum of 16 revisions during the day.

5.3.3 As regards the observation of REConnect highlighting the limitation of weather inputs (on 6-hourly basis from IMD), the Commission feels that once the proposed framework is put in place, the capabilities of weather forecasting at shorter intervals would develop driven by the market forces, and the forecasting agencies would also align themselves with the regulatory requirement. If need be, the Commission could give statutory advice to ensure the IMD provides weather forecasting closer to real time.

6 DEFINITION OF FORECASTING ERROR

6.1 Comments received:

6.1.1 Sterling Agro Industries, WIPPA have opined that instead of incorporating absolute deviation in the proposed framework, CERC must consider internationally acceptable methods such as Root Mean Square Error or Mean Absolute Error method to make the framework more scientific and operable.

6.1.2 WIPPA, Manikaran and Ernst & Young, Sterling Agro, OGPCL, MNRE have averred that in cases of zero schedules / zero generation / low resource period, the deviation calculation change with forecasts, is high in non-peak times and infinitely large in zero forecast times. There should be a separate band (or exemption) for measurement of deviation in different seasons, i.e., different tolerance band for windy and non-windy season in case of wind and monsoon and rest of year in case of solar.

6.1.3 Vestas has argued that it is not feasible to maintain accuracy level with the current methodology of measurement. The accuracy is measured at normalised forecasted power.

Mean Absolute Error (MAE) relative to nominal forecast power

$$MAE = \frac{\frac{1}{N} \sum (|f(t) - p(t)|)}{f(t)}$$

f(t) = forecast for time t,

p(t) = measured park production at time t,

Vestas proposed the Forecast accuracy should be measured normalized to wind park capacity instead of normalised forecasted power as this is the way the forecast accuracy is measured globally.

Mean Absolute Error (MAE) relative to nominal park power

$$MAE = \frac{\frac{1}{N} \sum (|f(t) - p(t)|)}{P}$$

f(t) = forecast for time t,

p(t) = measured park production at time t,

P = nominal park power

6.2 Decision of the Commission

6.2.1 The Commission has reviewed the inputs of the stakeholders. The present error definition has been pointed out to be insufficient to handle varying seasons, especially very low or zero schedules, and not aligned with direct grid impact (MW deviations).

6.2.2 The Commission has noted that with the current definition, instances such as low/no generation cases cannot be covered. With due regard to these constraints and with a view to ensuring optimum and genuine forecasting, the Commission has decided to define the error percentage normalized to available capacity, instead of schedule. This will ensure that the error quantity corresponds to the physical MW impact on the grid, the forecasting models are aligned to minimize

the actual MW deviations, and the error definition holds valid in all seasons. Revised definition shall be:

$$\text{Error}(\%) = (\text{Actual Generation} - \text{Scheduled Generation}) / (\text{Available Capacity}) \times 100$$

Where, Available Capacity (AvC) is the cumulative capacity rating of the wind turbines/solar inverters that are capable of generating power in a given time-block. A suitable procedure along with appropriate format shall be developed by the NLDC for the submission of Available Capacity by the wind/solar generators to the concerned RLDC.

6.2.3 AvC would be equal to the Installed Capacity, unless one or more turbines/inverters are under maintenance or shutdown. Any attempt at mis-declaration, that is declaration of capacity when it is actually not available due to reasons of maintenance or shutdown etc would be treated as gaming and would be liable to action under appropriate provisions of the Act or the Regulations. Absolute value of the Error could then be computed as follows:

$$\text{Abs Error} = \text{absolute value [Error]}$$

For every time block, Abs Error may be determined and deviation settlement done accordingly. Mean of Abs Error, also called the Mean Absolute Error or MAE, can then be calculated by taking average of Abs Error over a month or year. MAE will give an indication of the forecasting accuracy over a longer period of time. Accordingly, suitable provision defining 'Absolute Error' has been made in the final amendments to DSM Regulations. The revised definition as above shall take care of low or zero schedule scenario in the off-peak season for wind as well as solar.

7 TOLERANCE LIMITS AND DEVIATION BANDS

7.1 Proposed Amendments:

7.1.1 The Commission had proposed the following amendments to the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, 2014 (hereinafter referred to as the "Principal Regulations"):

“3. 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 energy generators whose scheduling is done by RLDCs, which shall be governed by sub-clauses (v) to (vii) below:

4. 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) If the actual generation is in the range 88% to 100% of schedule, the wind and solar generator would pay to the Regional DSM Pool, for the shortfall energy at a fixed rate as may be determined by the Commission from time to time through separate order. In addition, the wind and solar energy generator will buy the Renewable Energy Certificates (RECs), equivalent to the shortfall energy and transfer them to the buyer to enable it to fulfil its RPO obligation. (vi) If the actual generation is below 88% of the schedule, the wind and solar energy generator would pay to the Regional DSM Pool, for the shortfall energy below 88% at such fixed rate as may be determined by the Commission from time to time through separate order. In addition, the wind and solar energy generator will buy RECs (equivalent to the shortfall energy) to ensure that equivalent renewable energy has been injected into the grid to enable the buyer to fulfil its renewable purchase obligations. The RECs so purchased shall be extinguished as per the provisions of the prevailing Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, as amended from time to time, and the

detailed procedure issued thereunder. (vii) If the actual generation is in the range of 100% to 112% of schedule, the wind and solar energy generator would be paid from the DSM Pool for such excess generation at such fixed rate as may be determined by the Commission from time to time. In addition, the wind and solar energy generator would also be issued RECs for such excess generation. For actual generation beyond 112% of the schedule, the wind and solar energy generator would be compensated by way of issuance of RECs only."

7.2 Comments received

7.2.1 Indian Wind Power Association (IWPA) has commented that as the deviation is w. r. t the schedule, +/-12% will be difficult to achieve at the farm level, and there would be revenue impact on the RE generators. Given that only 7 states are blessed with good or reasonable wind potential. It becomes necessary to keep expanding within these seven states to achieve the targets set by GOI. This would essentially mean that more and more penetration of wind would happen only in these 7 states and consequentially these 7 states would become susceptible for intermittency and variability in generation. In such a situation, the present deviation limit of 150 MW would be difficult to comply with by the Wind rich states and would be financially penalized for encouraging renewable. FIT just provides reasonable returns to the investor and if a generator has to take this risk of cost of variability, it would have an adverse impact.

7.2.2 InWEA has stated that the accuracy in wind is highly seasonal. The percentage deviation vis-a-vis forecast/schedule generation in non-windy season could be higher (or outside range of +/- 30% or +/-12%) but in absolute MW terms it is insignificant. Besides, the error computation in terms of schedule/forecast capacity as against installed capacity adds to fact that tightening of band from +/- 30% to +/-12% would render more generation outside this operating band. The doubling of number of revisions does not translate linearly in to doubling of accuracy. Further the +/-30% was at the pooling substation level whereas the proposed +/- 12%, is at the generator level wherein the accuracy will be further low.

Possibility of achieving accuracy +/- 30% is limited based on the experience till now of several pooling s/s in Gujarat and few in Maharashtra and Tamil Nadu.

7.2.3 Manikaran and Ernst & Young have submitted that to meet all the objectives of a desired operating band, we recommend that it be defined as 10% of installed capacity, or 10MW (or equivalent), whichever is smaller.

7.2.4 CEA has stated that the +/-30% band should be valid during the peak wind season, whereas this percentage could be higher during non-peak windy season (say +/-40%). Alternatively, this could be +/-20% for the whole year if the error (actual-schedule) is calculated w.r.t the installed capacity of the wind farm, rather than w.r.t the schedule.

7.2.5 NTPC, IEX, MNRE have stated that the tolerance band is too small, should be widened (eg from 12% to 20% or higher).

7.2.6 Del2Infinity has argued that for any forecasting method, the probability of being within plus/minus 12% error band when employing 16 intra-day revisions is higher than that for within plus/minus 30% band with 8 intra-day revisions. Interestingly, a total of 16 intra-day revisions improve the forecasting accuracy to unprecedented levels and Vayu-Sutra is capable of meeting the deviation band requirement (even up to as low as plus/minus 10%).

7.2.7 Association of Power Producers, US-India Business Council, IL&FS, Sterling Agro Industries, GE, WIPPA have stated that there is limited experience with forecasting for wind and solar PV in India. Few developers, who are undertaking the mock exercises of scheduling and forecasting are able to forecast with large errors up to +/- 50%. Currently, it is not possible to achieve the proposed accuracy of +/- 12% at most times during the year. Keeping this practical reality in mind, it is felt that the proposed band of +/- 12% is very stringent and there needs to be a gradual reduction in the operating band instead of a drastic reduction from +/- 30% to the proposed +/- 12%.

7.2.8 WIPPA has argued that it should not be a situation where developers don't have the capability of forecasting and due to inefficiency of RLDC doing accurate forecasting; the developers end up with paying for cost of forecasting and penalty due to forecasting errors. The commercial impact can be a dampener to investment in RE.

7.2.9 IL&FS, APP and GE have stated that as per current Draft Regulations, forecasting and scheduling has to be 100% accurate for no impact of penalty. Any error in the forecasting, penalty is proposed to be imposed on the developer and it seems there is no additional incentive for better forecasting. Further, the wind/solar generators are being penalized within this allowed band of +/- 12%: within the range of 88% to 100% of schedule, the solar/wind generator receives a net inflow of only Rs 0.5 per unit of energy generated. There should be no penalty for deviation within the operating band.

7.2.10 CEA, Indian Wind Power Association have submitted that for wind-rich states, this proposition is going to become very onerous since the deviation allowed for the state as a whole, in the net schedule, is +/- 12% or 150MW, whichever is lesser. For wind rich states like Tamil Nadu, with a peak generation of 3500 MW, presuming the state only has a deviation of +-12%, still a deviation of 420 MW will get reflected at state boundaries. This would dis-incentivize the state from allowing any more wind generator to be put up in the state, which would be a retrograde step and against government policy. It is felt that the older mechanism of socializing the deviation charges to a certain extent would be more acceptable.

7.2.11 LBNL, USA has stated that the proposed framework will benefit from a discussion on the rationale for the +/-12% deviation limit. A comparison of forecasting errors experienced in India with those seen in other countries at individual wind farm levels and the overall aggregate level will better inform the deviation limits. Further, a fixed +/- 12% deviation limit could be replaced by a gradient rather than a single step limit.

7.2.12 Hindustan Power has averred that the Commission's study for defining the operating band must be shared. Tightening of deviation band may be gradual and validated through data. Considering that nature plays a key role for RE sources therefore, the band may be provided only for bringing some discipline & with no consequent penalty to RE generator. There may be an intermediary band of 25% i.e. for deviation between the band of +/- 12%) 100% incentive, from deviation between +/- 12% to +/- 25%, 50% incentive, from +/- 25% to +/- 30%, no incentive.

7.2.13 REConnect has opined that the proposed error band of +/-12% is unrealistic at current capacity levels. Premise of the proposed regulation is that broadening the scope and aggregating a large number of wind and solar projects will bring about higher accuracy. However, as a result of low capacity for regional entity wind and solar generators, the permissible range of +/-12% appears unrealistic. International experience suggests that deviation range expected in the proposed regulations are achievable only when capacity for which forecast is developed is large. Experience in Germany: Similarly, over 98% of the wind capacity is covered under online monitoring and forecasting. This has resulted in deviation (Root Mean Square Error RMSE in percent of the installed capacity) between the (day ahead) predicted and actual occurring power of about 6-7% of the installed capacity. The forecast error for the total German grid amounts to 5-6%. Further, the above study also emphasis the fact that errors reduce over a period of time. The study says: "the accuracy of the operational wind power forecast has improved from an approximately 10% RMSE at the first implementation in 2001 to an RMSE of about 6.5% in 2005." The permissible deviation range should be kept at a larger number, to be narrowed over time as (a) a larger number of projects come in the inter-state markets and (b) state projects are also aggregated to calculate deviations. Without a larger aggregation, the projects will suffer significant financial burden.

7.2.14 Manikaran and Ernst & Young have appreciated the intentions behind the integration of the DSM pooling & REC mechanism for wind & solar forecasting. However, they feel that the desired operating band should be able to achieve the

following objectives: (a) to provide extra incentive for a wind/solar farm to achieve a forecast error within that band as often as they can; (b) to provide wind/solar farms with reduced penalties for near-accurate forecasts so that they can transition to providing good quality forecasts (if such a transition is required). The penalty rate can then be increased at a later date; (c) to represent the operating band that is desired from the perspective of power system operating and managing power system security.

7.2.15 SunEdison has expressed concern about Tight Tolerance band

7.2.16 OGPCL has observed that all WTGs should be under RLDC control area to socialise impact on host state and requested to remove the 150 MW variation limit. This will prevent wind generators from having to back down.

7.2.17 IWL has suggested that the regulations should have a clause to protect the generators when the WEGs are backed down forcibly by the State utility and as a result there is a variation in the schedule vs actual. The industry is involved in the scheduling and forecasting activity for the past July 2014. As on date no forecaster is able to give a guarantee for their forecasts in the range of earlier proposed deviation band of 30%. The deviation band of 12% proposed by the Hon'ble Commission is most likely to be exceeded by the generators. The deviation band may not be exceeded if the centralised forecasting and scheduling is adopted for the state and region level which could be further narrowed down to different wind-zone levels on the annual basis with respect to the installed capacity of the plants. This centralised forecasting would help not only addressing the grid security issue but also off-set the forecasting error along with timely intervention by the system operator managing the centralised forecasting.

7.2.18 Tata Power has stated that as wind is in-firm in nature, there shall be deviations from actual schedule. In the earlier mechanism a deviation of +/-30% was allowed to wind generators. All other charges were over and above the band of 30%, they have suggested that the DSM charges be imposed on deviations beyond the

band and not within the band. Tata Power, IWTMA have requested to initially consider the band of $\pm 30\%$ and gradually reduce it based on experience of inter-state power flow in open access as there is not a single transaction in practice.

7.2.19 Dr. Anoop Singh, IIT Kanpur Variability of Wind and Solar: The proposal to bring back the renewable energy generation into the region exercise is welcome. However, it is also important to note that uncertainty in renewable energy generation and the challenge to forecast it is higher in the case of wind energy than in the case of solar energy. It would be desirable to have a differential range of forecasting accuracy for wind and solar energy generation, based on experience for the same. A preliminary exercise at IIT Kanpur finds that forecasted wind energy and some of the locations in India vary significantly and goes beyond the accuracy limit of $\pm 30\%$ under the RRF mechanism. It is suggested to apply a rather modest limit on accuracy for the first year, and, gradually tighten it over the year as we learn from the experience. A differential treatment may be given to the wind and solar due to the above reasons.

7.2.20 NREL, USA has stated that the proposed band of $\pm 12\%$ variability for solar and wind should be backed with empirical or simulation modeling for at least representative regions of wind (Tamilnadu and Gujarat) and solar (Gujarat and Rajasthan), with seasonality taken into consideration. The exact band range has to be established separately for solar and wind while addressing a number of variables. Consider a 2-tiered mechanism to 1) allow the balancing of variance within a statistically acceptable band (e.g. $\pm 2CV$) over a defined period of time (e.g. monthly); and 2) to allow for a second mechanism for balancing variance outside of the $\pm 2CV$ variance band. A practical consideration would be the fact that not all forecast errors are adverse. For example, if wind is under forecast during a time when load is also under forecast, this could produce a net benefit to the system. Penalties should be commensurate with the effect on the system.

7.2.21 GE recommends that Operating band should be neutral (no penalty), and there should be gradient band on the either side. During tests, 79% of energy was

forecast within +/-30% with 8 revisions. Now, with 16 revisions, this comes out to be 71% within the prescribed error band of +/-12%.

7.2.22 Southern Regional Power Committee has suggested that range in MW also needs to be stipulated for maximum (150/200/250 MW) deviations as in DSM.

7.3 Decision of the Commission

7.3.1 The Commission has carefully considered the comments received in the context of desirable operating / tolerance band. Several stakeholders have expressed concern that it is impractical for the forecast to be accurate as per the proposed tolerance band of +/-12% with the existing error definition, and that generators will lose a lot of revenue outside this band. Some submissions have presented studies to show that they were unsuccessful in achieving accuracy even within a larger band. Others have questioned the basis for deciding the band limits.

7.3.2 On the issue of feasibility, from the references quoted by REConnect in their comments, the day-ahead MAE ranges between ~8% and 10% for PJM and ERCOT. With 16 revisions now allowed, the Abs Error could be even lower. As models get trained with real-world data, the accuracy is expected to improve over the first few years considerably.

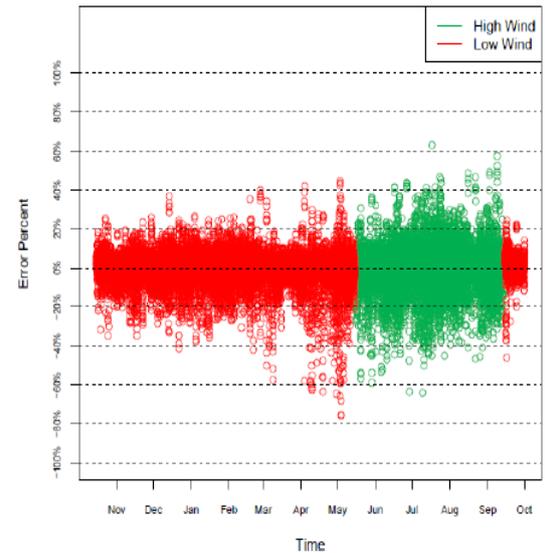
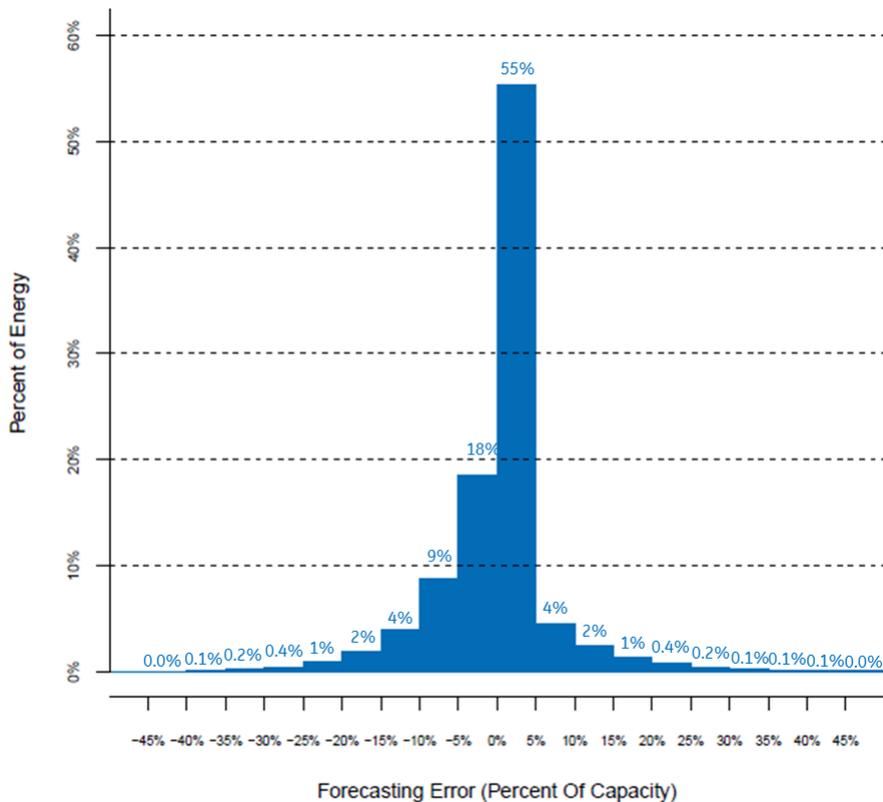
7.3.3 Various stakeholders have requested for studies in support of Framework for RE Forecasting and Scheduling. Therefore, some of the studies considered by the Commission in favour of the framework are as under.

7.3.4 The Commission received some simulation/analytical inputs from agencies engaged in wind forecasting- a generator and an aggregator. For various sites across India, based on one year of actual data, the error normalized to capacity has been simulated (pertaining to case where Available Capacity = Installed Capacity).

Agency #1: Generator

Wind sites of various sizes and scattered across the country for geographical diversity were selected. Results are based on 50 weeks of actual recorded data, thus including both high wind and low wind seasons.

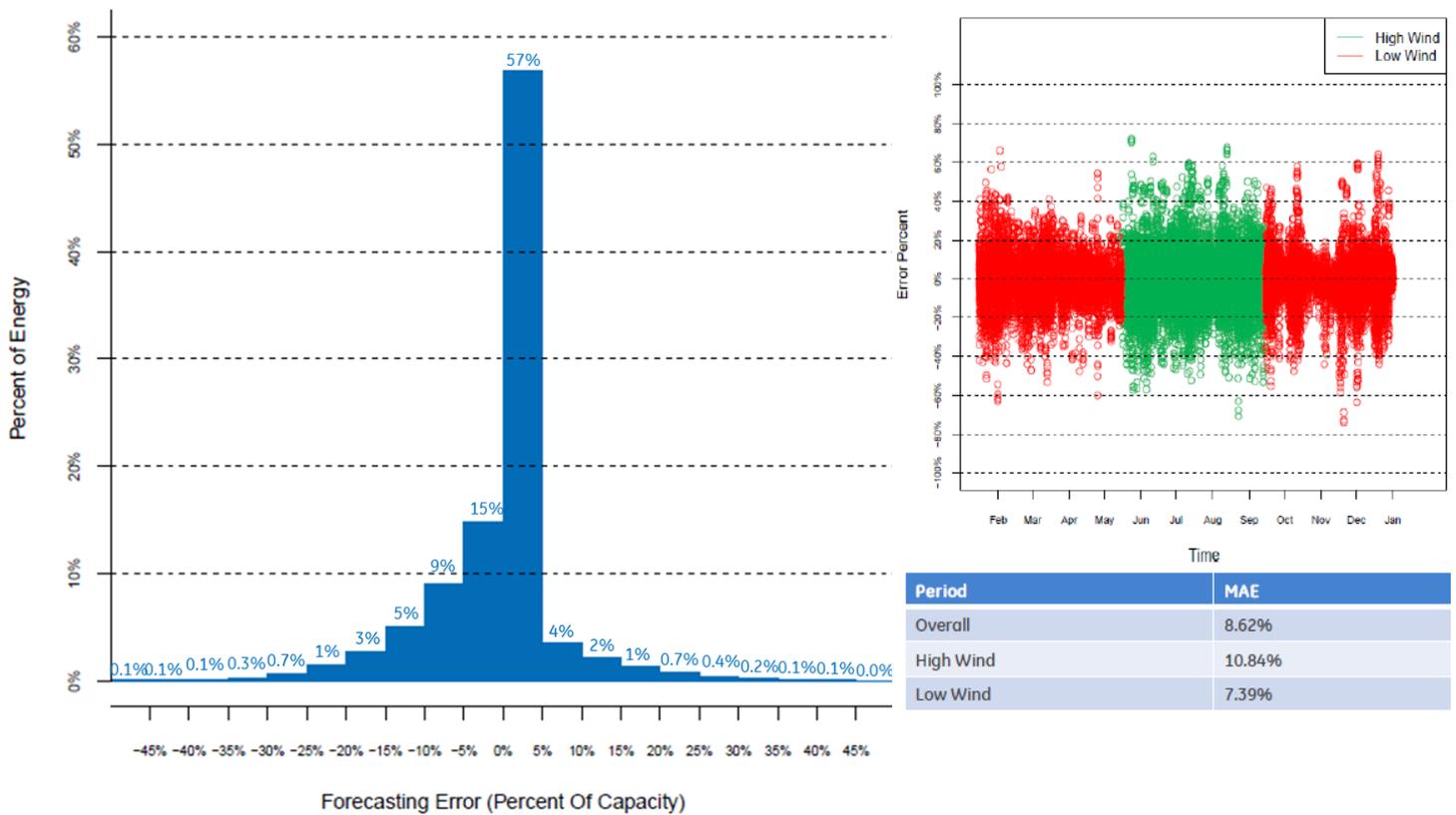
Site A: 25.5 MW



Period	MAE
Overall	6.21%
High Wind	8.22%
Low Wind	5.12%

7.3.5 The chart on the left shows % of energy generated (over the full period) that lies within the error band, with error normalized to installed capacity. The simulation was conducted assuming 16 allowed revisions per day. As per this simulation, % of energy generated at this site of 25.5 MW within +/-15% was 93%, i.e. if a tolerance band of 15% Abs Error were to be proposed, only 7% of generated energy was outside the range. On the right is the scatter plot of error observed for every time-block, over 50 weeks. Mean Absolute Error over the full period was 6.21%. This shows that with increased number of revisions, and the revised error definition, forecasting accuracy, as measured by MAE, can be quite high.

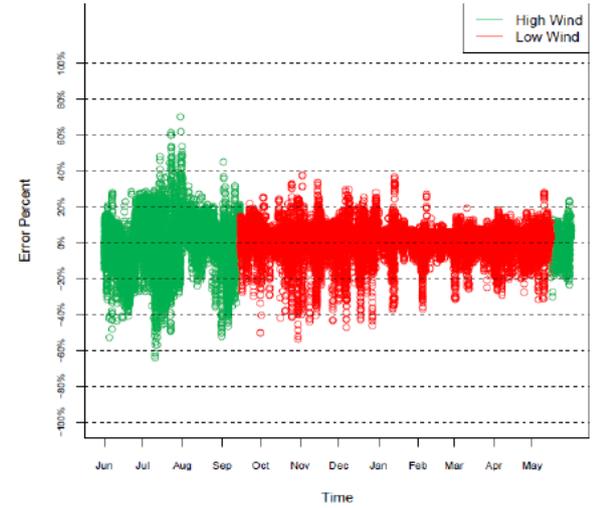
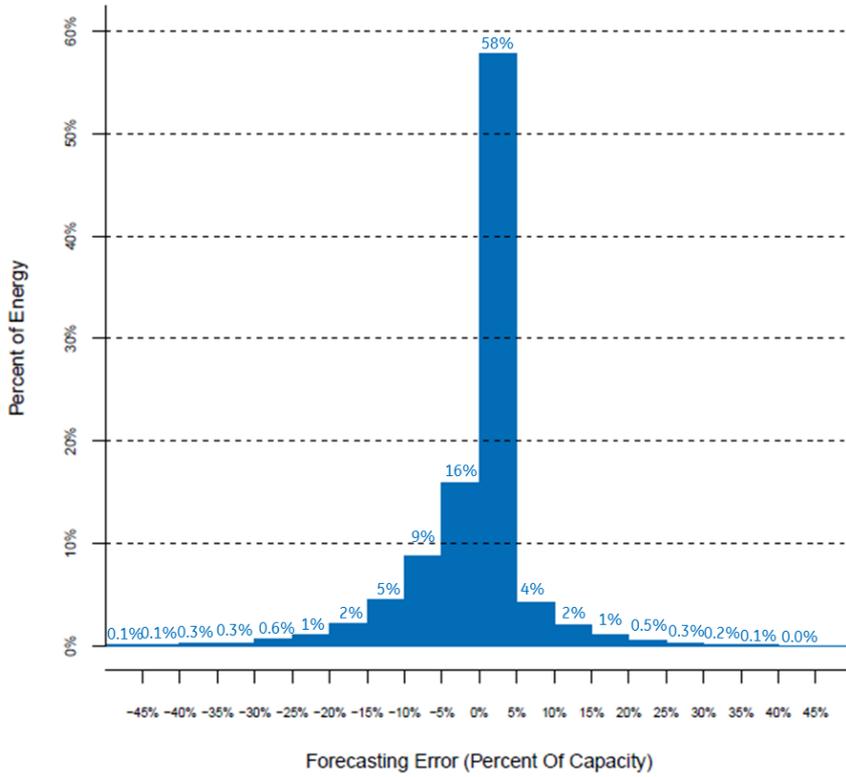
Site B: 24 MW



For this site, simulated with 16 revisions per day, 92% of energy generated was within the $\pm 15\%$ band, with an overall MAE of 8.62%.

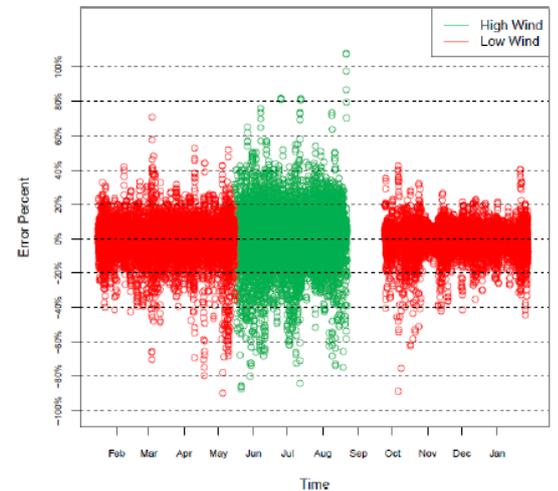
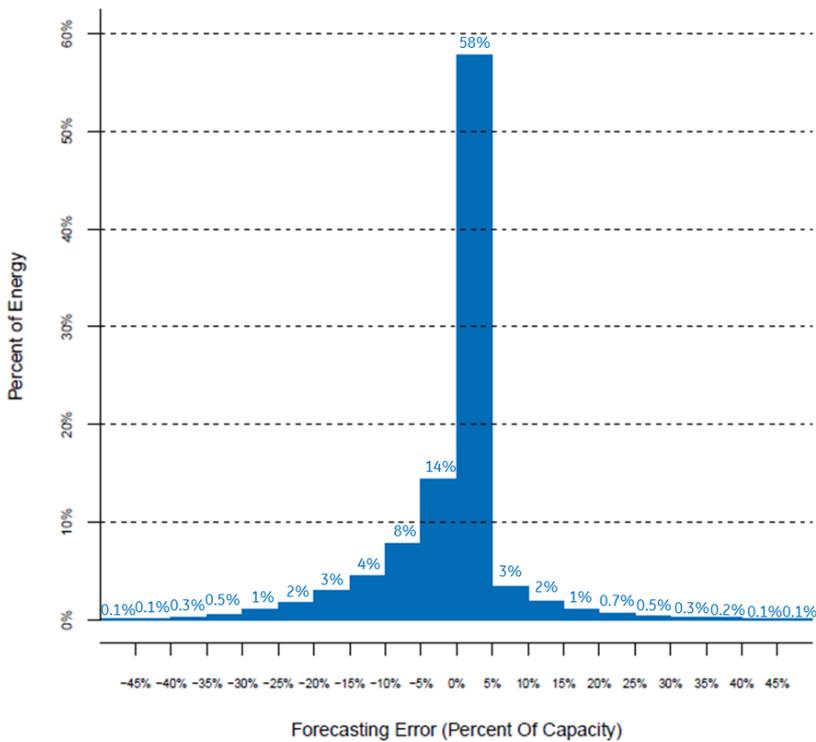
Site C- real time data- 72 MW

This 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. Here, 94% of generated energy lies within $\pm 15\%$ error band. This is a very relevant indication of what is possible with well calibrated forecasting algorithms even with only 8 revisions. The only factor that could have reduced accuracy if done remotely is non-availability (or intermittent availability) of turbine level (SCADA) data. Hence high data availability is critical to good forecasting.



Period	MAE
Overall	7.56%
High Wind	10.71%
Low Wind	5.97%

Site D: 51.2 MW



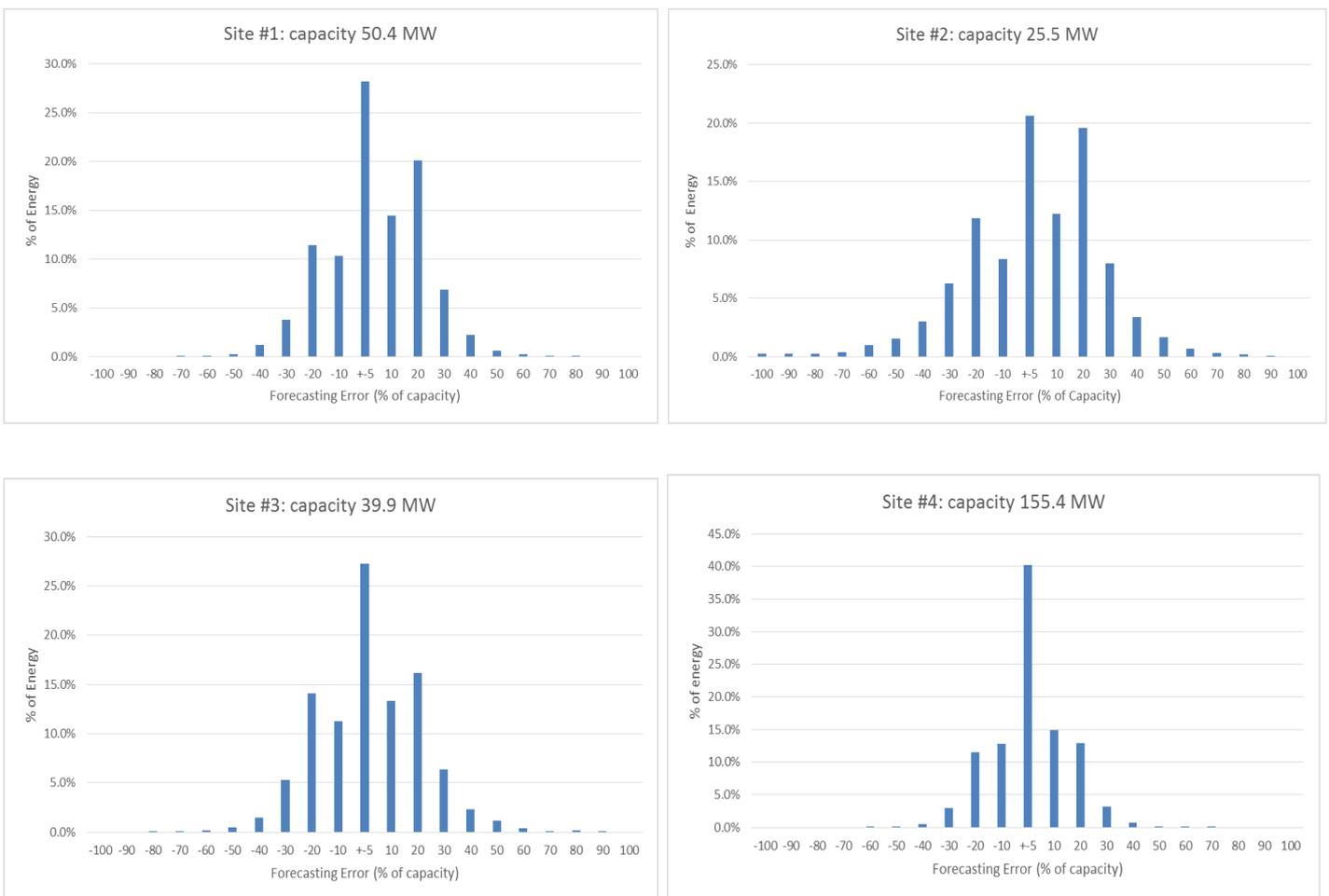
Period	MAE
Overall	7.78%
High Wind	12.12%
Low Wind	6.02%

For a larger site of capacity 51.2 MW, simulation resulted in 89% of energy generated in +/-15% band, and an overall MAE of 7.78%.

Agency #2: An aggregator based in Gujarat

Actual data recorded at the pooling sub-station level for calendar year 2014, for 4 different sites has been used for this analysis and is based on forecasting results received, with 8 revisions, for these sites for the calendar year 2014.

7.3.6 The charts below plot the total energy generated in time blocks for which the observed error was within the band corresponding to the value on the x-axis. Thus, percentage of energy that would lie outside the tolerance band (as per proposed deviation settlement methodology) would actually be lower.



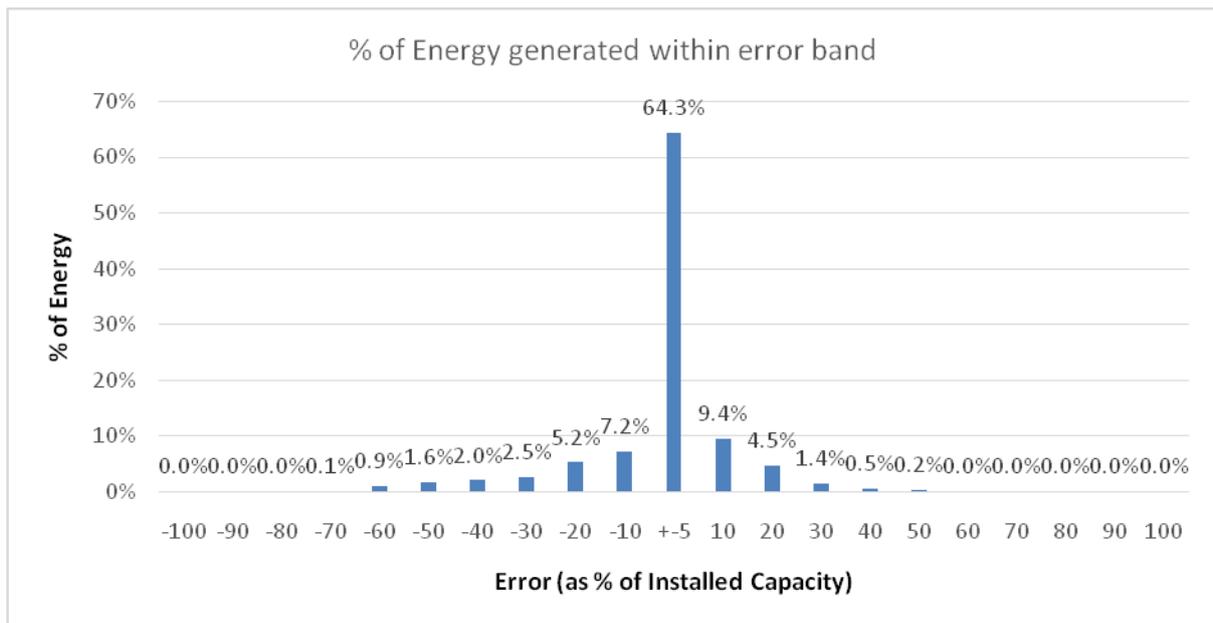
In the charts above, the % of energy observed within a +/-20% band varies between 72% and 92%, which is quite acceptable given 8 revisions per day.

7.3.7 Forecasting for solar power plants is a relatively new phenomenon. Solar power forecasting is comparable to wind power forecasting, but once the sun has risen, clouds are the main factor in the variability of solar power generation and the uncertainty of the solar power forecast. The short-term variability of a single PV plant can be high, although there are diversity benefits with multiple PV plants (“PJM Renewable Integration Study, Kevin Porter et al, November, 2012”).

7.3.8 In a solar forecasting benchmarking exercise conducted by Sacramento Municipal Utility District (SMUD), 4 commercial forecasters provided detailed forecasts of solar irradiance and power for 8 sites under a trial conducted from August 2012 to December 2013 (“SMUD Solar Forecasting Benchmarking Trial Experience and Lessons Learned”, Vargas et al, February 2015”). 1 year of forecast data analyzed for 3 forecasters and 6 months of data for the 4th forecaster saw a typical performance of 7-11% MAE for day-ahead forecasts.

7.3.9 An example of on-ground exercise conducted within India:

An aggregator has submitted these results (similar to charts above) for a solar site of 40 MW. As plotted, 80.9% of energy generated was during the time-blocks when the error was within the +/-10% error band, while 90.6% was for time-blocks within +/-20% band.



7.3.10 All the above inputs give the Commission confidence that with the error normalized to Available Capacity, and 16 revisions of schedule allowed, the generators shall be able to forecast well within a tolerance band of 15% for a high % of energy output.

7.3.11 With the altered error definition, this band is now determined with respect to Available Capacity (AvC). This itself makes the band much bigger, and keeps it mostly constant through the year (except during cases of maintenance or turbine outage). Within +/-15% band, there shall be no adverse commercial impact. While beyond 15%, a gradient band is proposed as follows:

<i>Abs Error (% of AvC)</i>	<i>Deviation Charge</i>
15%-25%	10% of PPA rate
25%-35%	20% of PPA rate
>35%	30% of PPA rate

Accordingly, suitable provisions have been made in the final amendments to IEGC and DSM Regulations.

As evident from the simulations above, negligible % of energy generated shall lie outside 25% band, and hence the commercial impact of deviation charges shall be minimal. In fact, the no-impact band of 15% is quite liberal and the Commission is allowing it consciously so as to get the processes and discipline of forecasting and scheduling in place. The Commission reiterates that as stakeholders get experience, and forecasting models mature, the tolerance band may be tightened over time.

7.3.12 Some stakeholders have also raised the issue of 150 MW deviation limit for the states. It should be appreciated that load-generation balancing is a pre-requisite for secure grid operation. As such, relaxing the 150 MW limit may not be the optimal solution. The Commission is already working on regulatory framework for Ancillary Services, Reserves and has also enabled extended 24x7 market session in the exchange, with a view to help states balance their portfolio.

It may, however, be noted that this issue (of 150 MW limit) is beyond the scope of the present regulation.

8 COMMERCIAL AND DEVIATION SETTLEMENT

8.1 Proposed Amendments

Commission had proposed insertion of new proviso under clause (1) under Regulation 5 of DSM Regulation: After sub-clause (iv) to clause (1) of Regulation 5, new sub-clauses (v), (vi) and (vii) shall be added as under:-

“(v) If the actual generation is in the range 88% to 100% of schedule, the wind and solar generator would pay to the Regional DSM Pool, for the shortfall energy at a fixed rate as may be determined by the Commission from time to time through separate order. In addition, the wind and solar energy generator will buy the Renewable Energy Certificates (RECs), equivalent to the shortfall energy and transfer them to the buyer to enable it to fulfil its RPO obligation.

(vi) If the actual generation is below 88% of the schedule, the wind and solar energy generator would pay to the Regional DSM Pool, for the shortfall energy below 88% at such fixed rate as may be determined by the Commission from time to time through separate order. In addition, the wind and solar energy generator will buy RECs (equivalent to the shortfall energy) to ensure that equivalent renewable energy has been injected into the grid to enable the buyer to fulfil its renewable purchase obligations. The RECs so purchased shall be extinguished as per the provisions of the prevailing Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, as amended from time to time, and the detailed procedure issued thereunder.

(vii) If the actual generation is in the range of 100% to 112% of schedule, the wind and solar energy generator would be paid from the DSM Pool for such excess generation at such fixed rate as may be determined by the Commission from time to time. In addition, the wind and solar energy generator would also be issued RECs for such excess

generation. For actual generation beyond 112% of the schedule, the wind and solar energy generator would be compensated by way of issuance of RECs only."

8.2 Comments received

8.2.1 CEA has supported that the charges for deviation from schedule for wind/solar energy have been de-linked from the frequency. The reason given is that these sources are must run and hence should not be linked to frequency. We find this to be in order.

8.2.2 Manikaran and Ernst & Young have also stated that the linking of deviation charges to the system frequency was a major issue with the IEGC 2010 framework. Secondly, IEGC 2010 rules provided different charges for under-injection and over-injection and this encourages generators to game the system rather than provide the most accurate forecast possible.

It has been argued that the wind/solar energy generators can not adhere to any specified limit for their forecast accuracy at all times due to the inherent uncertainty in their renewable resources. Hence, having a volume limit is a misleading aim to wind/solar generators. It has been suggested that the penalties should be lower within a desired operating band, as has been suggested in the proposed framework. But adhering to a specified limit should be the goal for wind/solar generators to achieve all the time –rather it should be something they aim to achieve as often as possible.

The penalties should be equal for the same volume of over-and under-injection, and dependent on the volume so that the total penalty increases the larger the forecast error.

8.2.3 NREL has commented that payment based on nomination (and not actual generation) for RE generators may lead generators to under or over-estimate generation forecasts to skew the cost of deviations under proposed regulations.

A more holistic approach to value excess generation or shortfall should be considered. The proposal does not provide payment from DSM Pool for generation in excess of 12% of scheduled generation. There may be cases in which generators

should not be disincentivized to generate excess of 112% of the nomination for the forecast period (particularly during peak demand). Beyond getting RECs for excess generation (above 12% of its forecast nomination), the RE Generator may be credited for excess energy production at market value at the time. If the generator produces below 88% of the nomination, the generator should face penalties to discourage under-estimation and/or gaming. Current proposal may run the risk of RE generators intentionally under-nominating to reduce penalty payments. Penalty may be based on market price of electricity during the shortfall period (vs. the proposed fixed rate).

8.2.4 The Indian Wind Energy Association (InWEA) has urged that the framework should be backed by study. The rationale for ad-hoc fixed rate payment for under-generation into DSM pool is not very clear. Such fixed rate is to be determined by the CERC through separate order from time to time. Even the principles/guidelines for determination of such fixed rate have not been stipulated thereby introducing significant element of regulatory uncertainty and revenue risk for the wind power projects.

If wind/solar are treated on par with conventional generation for the purpose of scheduling then, it would compete for off-take and prices for scheduled power in bilateral/power exchange is below Rs 3 per unit. Hence, commercial viability of wind power project assuming inter-state wheeling under proposed mechanism is doubtful.

The major shift is the settlement of energy payments based on scheduled generation. Such settlement, though being followed in conventional generation, creates complication of RPO accounting. This has necessitated "RPO balancing" through RECs adding a complication to the settlement mechanism. Thus, uncertainty of RECs has been introduced. In case of RECs the realisation of revenue may happen after a year or more. In case the RECs are to be transferred then REC mechanism would need further amendment and pen up the REC mechanism for bilateral transactions. Further, with such mechanism based on purchase of RECs by generator to

compensate shortfall in generation would cause difficulty in verification of RPO fulfilment.

It is thus suggested that the settlement on actual basis as per the existing provisions of IEGC may be continued. The energy imbalance thus can be handled as proposed in the present amendment i.e. through fixed rate (not linked with frequency).

8.2.5 US-India Business Council has stated that under these regulations, projects in states with tariffs lower than the assumed tariffs of Rs. 5/kWh and Rs. 7/kWh for wind and solar, respectively, will no longer be commercially viable, even if they are within the $\pm 12\%$ band. This mechanism will completely change the commercial structure of these projects and was not accounted for when regulators arrived at a feed-in tariff.

8.2.6 Mytrah Energy India Limited (MEIL) has suggested that commercial implication on generator for doing forecasting and scheduling should not be imposed. The commercial implication would make it difficult for the generators to achieve financial closure for renewable projects .

8.2.7 Gujarat Urja Vikas Nigam (GUVNL) has objected that the impact of variation is to be shared only by the states in the region where RE projects are located. This will put additional burden on states with good RE potential. It would be appropriate to apportion the deviation charges across the country or alternatively, it should be funded through National Clean Energy Fund or Power System Development Fund.

GUVNL has also highlighted that net realizable tariff for wind generator for over-injected energy within 12% is Rs 5.5/unit while generator with no deviation would have realizable tariff of Rs 5/unit. Realization by RE generator forecasting accurately should not be lower than project developer deviating by +12%.

8.2.8 Sterling Agro Industries and GE have highlighted that for the same amount and polarity (under or over generation) of deviation, the generator in two states could have a different impact on revenue. The amounts payable or receivable in case of various instances of deviation from schedule should be mentioned in terms of a percentage of the PPA rate such as 5% and not in absolute terms such as 3 Rs./unit.

8.2.9 Manikaran and Ernst & Young, NTPC, MNRE have recommended that penalties should be equal for the same volume of over-and under-injection.

8.2.10 MNRE has suggested that the rate should be state specific, to be discovered through market mechanism. It could be indexed with feed-in-tariff.

8.2.11 LBNL has highlighted that given the variations in the feed-in tariffs and other commercial arrangement across the different states, RE generators may face different incentives or disincentives to provide accurate forecasts and schedules.

8.2.12 Wind Independent Power Producers Association (WIPPA) has criticized that the generator is getting penalised asymmetrically for deviations from the schedule. For instance, in case of over injection beyond +12% band - the incentive available to the developer is minimal and in the form of RECs only which carries much lower commercial value than its normative value given the situation at REC market. This would certainly lead to a situation of potential gaming whereby the generator would tend to provide an aggressive forecast so to necessarily be making negative deviation from schedule.

8.2.13 Dr. Anoop Singh from IIT Kanpur has said that the erstwhile RRF framework allowed a room for inaccuracy in forecasting for scheduling of RE generation. The cost of deviations within the range of allowed inaccuracy of +/- 30% were socialised. The existing framework does not allow for any inaccuracy. Now, it is possible that an RE generator may actually be paying much higher (lower) penalty for deviation from schedule than that which is reflected from the prevailing UI Charges.

8.2.14 Tata Power has objected to the assumption that wind generators are selling power rate of RS. 5 / unit. In case of proposed excess generation of +12% the rate

offered is Rs. 4 / unit and above 112% there is no incentive proposed. On the other hand there is penalty of Rs. 3 / unit for generation below 88%. It is recommended that the same rate shall be proposed for generation above 112% as incentive with additional REC's.

8.2.15 PXIL has stated that due to infirm nature of wind/solar, generator is likely to over/under inject during the month, hence it is proposed that RLDC should undertake netting of over/under injection for the period and issue a final statement.

8.2.16 SunEdison is in agreement with the provision of payment to generator as per schedule instead on actual generation and delinking imbalance settlement mechanism from frequency Unscheduled Interchange Rate, Reference rate provisions of the existing mechanism which encouraged generators into gaming.

However, SunEdison has expressed concerns on the Commission's proposals :

- Rate payable to generator from the DSM Pool in case of excess generation in the range of 100% to 112% of schedule and rate payable to DSM pool by generators in case of under generation ;
- The Regulations should clearly specify the principles for determination of such rates payable from Regional UI pool to generator for over generation and rates payable to Regional UI pool to wind or solar generator for under generation.
- While specifying such rates, Regulations should also recognize vintages of generators. Wind and solar generators commissioned today have one levelled cost of generation which may reduce in future. Therefore, in future, if such rate determined based on such reduced cost of generation would result in to gaming as well as windfall gain/loss to some players.
- The purchaser of wind/solar energy shall pay to the wind/solar energy generator at contracted rate on scheduled generation basis. Net commercial impact on host State UI pool account, upon deviation from schedule by the inter-State wind Generator, need to be shared among all the constituents of the regional UI pool in the ratio of their peak demands in previous month based on the data published by CEA.

8.3 Decision of the Commission

8.3.1 The comments above highlight various important issues. Several stakeholders have opined that the impact of deviation should not burden the RE rich states. Various stakeholders have also expressed concerns regarding windfall gains or losses within the desired operating band as well. The Stakeholders have pointed out the possible arbitrage opportunities arising due to differences in contracted rate, reference rate, deviation settlement rates and asymmetrical deviation charges for over and under-injection. Stakeholders have also alluded to arbitrage opportunities and possibility of manipulation of schedule which arise in schedule based settlement system. It is also evident that with the same amount and polarity (under or over generation) of deviation, the generator in two states could have a different impact on revenue (with fixed deviation charge per unit). It has also been suggested that deviation charges be directly linked to the cost of balancing.

8.3.2 The Commission notes that moving towards market based price discovery for settlement of under-injection and over-injection is desirable. However, this would need detailed deliberation and major changes in requisite processes and market structures, which is beyond the scope of the present regulatory process. In addition, using a fixed reference rate as in the proposed framework may result in windfall gain or loss to generators based on their PPA tariff.

8.3.3 In due consideration of the concerns raised around fixed reference rate and with a view to ensuring fair play in forecasting and scheduling , the Commission has decided to index the deviation charge to PPA rate, as determined by CERC under section 62 of the Act or adopted by CERC under section 63 of the Act. This also takes into account vintage of generators, as commented by a stakeholder.

8.3.4 Additionally, the Commission is of the view that the mechanism should be aligned 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. It should be appreciated that operating in isolation will not be in the interest of the RE generators.

Notwithstanding the suggestion of payment as per actuals by some stakeholders, the RE generators have to integrate with existing grid framework for long term sustainability. It should be noted that the proposed framework acts in effect as “payment as per actuals”, while at the same time aligning it with the existing scheduling and deviation settlement framework which governs other regional participants as well.

8.3.5 In order to address the concerns expressed by the stakeholders, the Commission has decided to amend the proposed mechanism as under:

The generator 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 regional 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 regional 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 regional pool at its PPA rate, as above. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

$\text{Deviation charge (I)} = (\text{no. of units outside 15\% of AvC}) \times (10\% \text{ of PPA rate})$

- If the Abs Error is greater than 25% but less than 35%: the generator shall settle the difference with respect to schedule with the regional pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

$\text{Deviation charge (I)} = (10\% \text{ of AvC}) \times (10\% \text{ of PPA rate})$

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 regional 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)

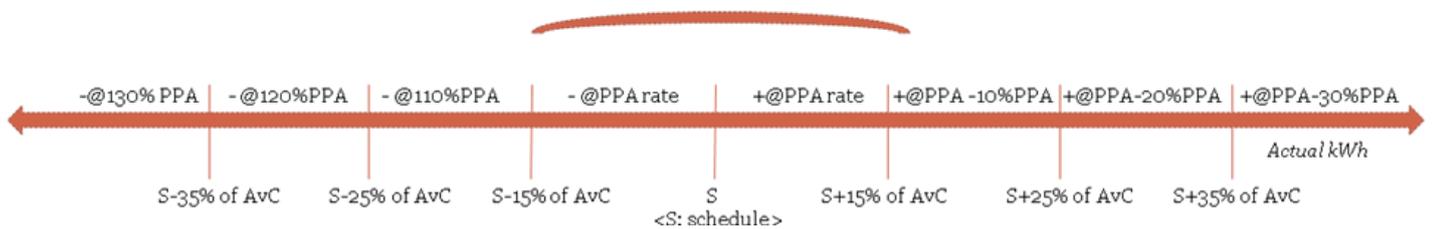
Deviation charge (II) = (10% of AvC) x (20% of PPA rate)

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) + Deviation charge (III)

8.3.6 The revised framework addresses the issues of lower realization for accuracy, asymmetrical penalties for over and under-injection, and different impact on generator revenue as was in the case of fixed deviation charges. The new model has also done away with the previous assumption of wind/solar tariff at Rs 5/7, and instead maps it to the corresponding PPA rate.

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



The PPA rate mentioned above which shall be used for the purpose of Deviation Settlement shall be the PPA Rate as determined by the 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.

Accordingly suitable provisions have been made in the final amendments to the IEGC and DSM Regulations.

Several examples of how revenue and deviation charges shall be calculated are provided in the Annexure. RPO compliance and REC related settlement is detailed out in the relevant part of this order.

8.3.7 As there would be positive return to a wind or solar generator for each unit of over-injection above desired operating band as well, there is sufficient incentive for an RE generator to maximize its generation and therefore the must-run status of RE generators will remain intact as long as there is marginal revenue for each marginal unit of generation.

8.3.8 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. Therefore a reference rate equal to Average Power Purchase Cost (APPC) at National level may be determined by CERC through order. All deviations from schedule by these entities must be settled at this APPC rate in the proposed framework.

Accordingly suitable provisions have been made in the final amendments to the IEGC and DSM Regulations.

8.3.9 In order to Index Deviation Charges to PPA Rates, the Commission hereby directs Regional Entity Wind and Solar Generators to submit on Affidavit to Regional Power Committee declaring their PPA rates with Beneficiaries.

8.3.10 The Commission also directs its staff to submit a proposal for approval of the Commission for determining the APPC at the National Level for FY 2015-16 which shall be valid from 01.11.2015. The Commission also directs its staff to annually review the National Level APPC.

9 POTENTIAL FOR GAMING

9.1 Comments Received

9.1.1 SunEdison has stated that prevailing Wind tariff across the country are in the range of Rs. 3.51 /kWh to Rs. 5.92/kWh. Similarly, solar tariff is also varied across the country depending upon the insolation level. We also suggest that the Regulation while specifying such rates should recognize the contracted rate at which payment would be made by the beneficiaries to generators as per scheduled generation. Difference in deviation settlement rates and contracted rate may encourage generators in to gaming akin to what happened while linking imbalance settlement with a Reference rate and UI rate . Therefore, we suggest that the Hon'ble Commission may consider some fixed penalty in paise/unit beyond the tolerance band based on the analysis of past 2-3 years' experience on wind forecasting and impact on the Return on Equity of wind energy generators.

9.1.2 Dr. Anoop Singh from IIT Kanpur has commented that the proposal not to compensate the RE generator for generation beyond 112% would give an incentive to not to underestimate the forecasted energy generation. Since the excess energy would be absorbed by the system at no cost, there are clear gains to the system constituents. To balance this, it would be advisable to allow a certain degree of uncertainty to be socialised on the negative side as well. Thus, a range for under-

injection be exempted from penalty for the energy generation part. However, RE generator should compensate the buyer by procuring RECs for the equivalent amount of under-injection of energy.

9.1.3 REConnect has stated that the primary reason the existing RRF mechanism incentivizing gaming was that the penalty for >150% was very punitive (loss of entire PPA revenue) - This skews behaviour towards only ensuring that in no case generation exceeds >150%, rather than focus on providing accurate forecasts. The recent high frequency scenario also enabled increase in revenue by under-injecting. Thus, the existing RRF mechanism enabled a positive RRF revenue and avoided the >150% scenario by deliberately over-scheduling generation.

The issue of 'steep fall in revenue' - the point where the generator loses his entire PPA rate in return for a very low rate is an issue remains in the proposed regulations. Thus, the incentive for the generator to deliberately over-schedule generation to avoid a steep loss has remained intact. In the existing mechanism, at >150%, the generator loses the entire PPA rate and is paid only Rs 1.65. In the current scheme, the generator also loses the entire PPA rate, and is given only an REC (valued at Rs 1.5, but with significantly delayed realization due to the demand-supply situation in the REC markets). In the proposed regulation, in the >112% scenario, the generator should be given APPC price + REC (just like any other REC based project)

Tariff assumptions of Rs 5 and Rs 7 are arbitrary: Variation in actual tariff may encourage gaming. An alternate approach could have a fixed penalty for all deviations below or above a limit. For example, all deviation below 30% or more than 150% of forecast could have a fixed penalty of Rs 0.40 (approximately 10% of contract rate). At the same time, there should be no penalty for being within the permissible range. Thus, for a perfectly accurate forecast, the only cost the wind farm will incur is the cost of forecasting. Over time the permissible range can be modified based on grid requirements and empirical analysis of generation and

deviation data. The amount collected from penalty levied can be distributed among host states in the proportion of UI incurred by them due to RE generation.

9.1.4 Inox Wind Ltd has stated that wherever there is differential treatment to the schedule and actuals for energy settlement for the intermittent sources of energy, there would always be probability for manipulation of schedule.

9.1.5 Manikaran and Ernst & Young and GE have commented that signals from the proposed framework are NOT enough to ensure the wind/solar energy generators do not game the system. This is because the penalties for positive and negative forecast errors are not equal.

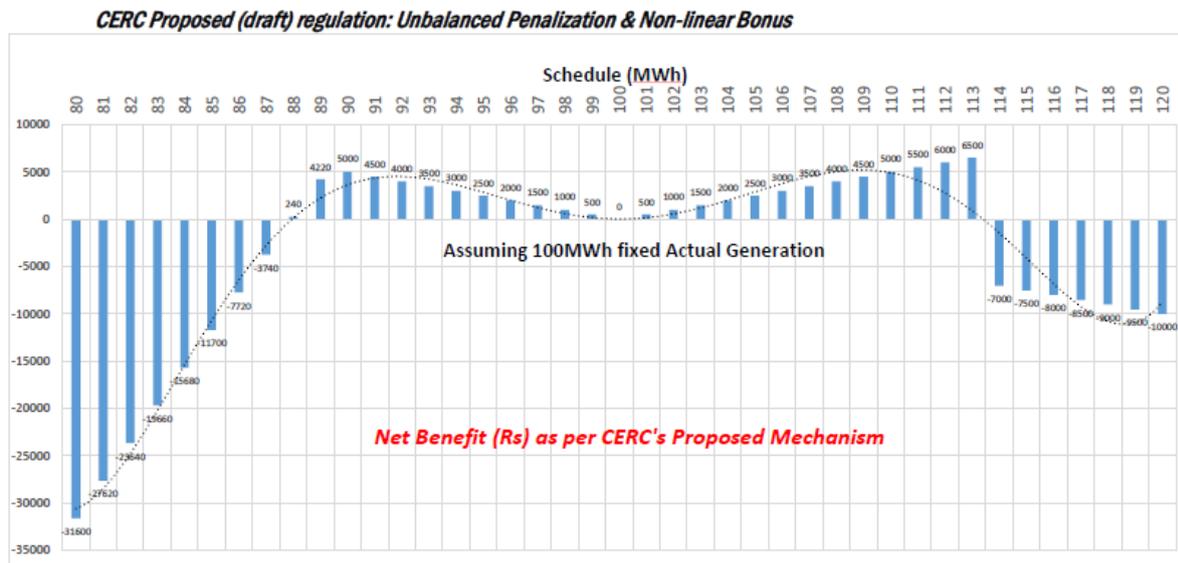
9.1.6 Greenko Energies has also commented that proposed scheme is likely to encourage gaming by conscious over-scheduling, because the penalty for under-injection is limited to Rs.4 + REC value, and yet the incentive for over-injection beyond 12% is only the REC (which in the current market is worth no value). This gaming may result in the DSM pool getting unduly penalized.

9.1.7 Southern Regional Power Committee has commented that if the actual generation is below 88%, RE Generator may continue to make profit if its negotiated rate is more than Rs.5.50 (Wind)/7.50 (Solar). Therefore the rate should increase (slope) if the accuracy goes beyond 88%. Beyond 12% on the positive side- to avoid this the RE Generator would try to under-inject than to over-inject. Therefore the rate should decrease (slope) if the accuracy goes beyond 112% and not abruptly end.

9.1.8 GUVNL has commented that tariffs of wind/solar are varying based on location, capacity and technology adopted for the project. Future tie-up of RE projects will also involve tariff discovery contingent to various parameters. It is necessary that pre-defined incentive/penalty should not give undue benefits to RE developers especially where RE tariff is very low.

9.1.9 Manikaran and E&Y have commented that penalties imposed on a wind generator (or solar generator) are much higher for over-injection than for under-injection. It has been observed that equal penalization on both sides of bias is not

linear and even the bonus between the +/-12% is not consistent, as the scheduler should receive the highest bonus for perfect forecasting and linearly decrease with increase in deviation. Moreover, the penalization on either side of deviation should be balanced which is not evident in the graph:



9.2 Decision of the Commission

The Commission has noted the comments highlighting the possibility of gaming in the proposed framework. The Commission feels following modifications, discussed in earlier part of the order would obviate the possibilities of gaming.

9.2.1 Indexing of Reference rate to the PPA rate- so that deviations are settled at contracted rate and payment is in effect at actuals. Additional disincentives for deviations beyond tolerance band are determined as a % of contracted rate. As this is specific to the generator and will ensure equitable burden for the same error among generators.

9.2.2 Symmetrical deviation charge for under and over-injection- which ensures there is no perverse incentive to over-schedule or under-schedule vs forecast. This also addresses the concerns around excess profit or loss on account of deviation

settlement rule. The charges for deviation are graphically represented below, and as seen, the absolute value is symmetrical around zero.

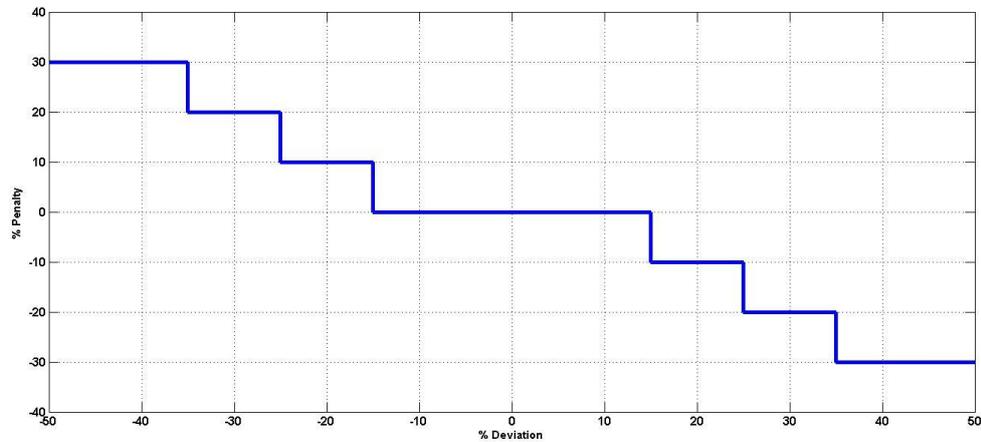


Figure 1: Representation of deviation charges vs error

9.2.3 It has to be noted that within the tolerance band, the revised framework is in effect payment as per actuals. Even beyond the $\pm 15\%$ band, the settlement mechanism in principle is payment as per actual minus deviation charges. This accomplishes the twin objectives of synchronizing the commercial mechanism of RE generators to existing inter-state practices in the country, enabling easy balancing and open-access transactions and, minimizing gaming possibilities as in effect, the framework is closely aligned with payment based on actual generation.

9.2.4 RLDC may also monitor for consistent patterns of over-scheduling or under-scheduling by wind/solar generator and report such actions to the Commission. If gaming is detected, the generators shall be penalized.

10 RPO FULFILMENT, REC ISSUANCE OR PROCUREMENT

10.1 Proposed Amendments

The Commission had proposed amendments to Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) as

follows: after clause (1A) of Regulation 5 of the Principal Regulations, a new clause (1B) shall be added as under:-

"(1B) Wind and solar energy generators whose schedule is done by RLDCs and who are governed by the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, as amended from time to time, for settlement of the deviation from schedule, shall be eligible for issuance of RECs based on the quantum of deviation from schedule as over-injection as per the deviation charge accounts prepared by the concerned Regional Power Committee (RPC)."

10.2 Comments Received

10.2.1 InWEA has opposed the proposed amendment stating that the risks are higher from generators point of view as apart from imbalance cost in terms of Rs 3 and 4 payable and receivable, the RECs received in the process may not even get sold. At present, there is an inventory of over 12.98 Million RECs unsold in the market. Besides, it is not possible for generator to purchase and pass on the RECs to buyers in case of under-generation as envisaged under the proposed framework.

The complexities of RPO compliance and monitoring framework would further increase and entire RPO compliance process would suffer, unless central registry takes responsibility for tracking of multiple transactions across the states. At present, RPO registry is not even registering the obligated entities and only registering the RE generators.

Proposed mechanism would require significant changes in the REC framework and RPO compliance mechanism. This necessitates wider consultation with state agencies including SERCs, state utilities, SLDCs and most importantly state nodal agencies which are responsible for RPO compliance monitoring in many states.

10.2.2 INOX Wind Ltd has commented that the figures (Rs 5 & 7) mentioned in the proposed new framework along with the variable REC-component seems workable for the CTU-connected projects. However they may not be workable

at the individual state level having yearly changing tariff or fixed tariff for few years, changing RPO-trajectory, different project mix at one site and large band of deviation at generator level. The REC market being stagnant and crumbling under huge inventory of over 12 million. So attaching this variable component with the RPO through DSM may not be acceptable to the utilities.

10.2.3 Mytrah Energy Ltd has commented that to enforce the RPO, a direct offset mechanism can be provided for under generation cases and let the generator inform the NLDC to direct offset the number of REC issued in generators account. There will be no need for the generator to register as seller as well as buyer. And same can be extended on all types of obligated entities such as utilities, captive, open access consumers. The power exchange floor price can be the reference price.

10.2.4 Hindustan Power has commented that the responsibility of RPO compliance should remain with Obligated Entity alone. The RE generator will also carry the risk at which price the RECs will be sold. The RE generator will have to manage the REC inventory also as time of REC will not be known to the generator and the present REC market, specially Solar REC, suggests that the solar REC have negligible buyers and expiring for want of buyer without getting sold off. Accordingly, the RE generator will carry double risk towards, over/under injection therefore, the same may be netted off by simple arithmetic and the resultant amount of deviation may be incentivized/penalized by way of proposed methodology.

10.2.5 SunEdison has supported the provision that in case of under generation, generator have to buy RECs, equivalent to the shortfall energy, to enable the buyer to fulfil its renewable purchase obligations However, SunEdison has expressed concerns on

- Issuance of RECs to the generators in case of over generation

- Issuance of only RECs for over generation beyond 112%

10.2.6 NTPC has sought clarification on whether the RECs would be settled in a week or in a month. Also, it is essential to take into the account of difficulty in selling the RECs if generator over generates and gets RECs in lieu of payment of energy charges and therefore the period of squaring off (credit) may be increased to (moving) five years. Further, settlement of RECs amongst various constituents of the same company should be allowed.

10.2.7 Dr. Anoop Singh of IIT Kanpur has supported the proposal to consider fulfillment of the RPO to the extent of 'scheduled energy' with compensation for shortfall by procurement of RECs by the RE generators. Issue of RECs for excess generation adequately would ensure adequate RPO compliance.

10.2.8 Indian Wind Turbine Manufacturers Association (IWTMA) has recommended to remove the clause related to REC as it may reduce the interest of investor due to an uncertain risk of REC trading. It may be introduced in later stage after successfully implementation of framework for applicable open access in inter-state.

10.2.9 Several stakeholders such as Tata Power, Tata Power Trading Company Limited, Association of Power Producers have stated that linking RPO obligation of DISCOM with Generator will be additional burden to generator. It is recommended that to make this scheme successful, the life of the RECs needs revision, the Commission may consider keeping the validity of 1 REC as 5 years. This validity might be revised again once the market is settled and RPO compliance is enforced.

It has been requested to set off/transfer the issued RECs from RE generator's account to buyer account firstly on Monthly/Quarterly basis. In case of further short supply, the RE Generators shall procure RECs from Power Exchanges. This would help the Generator to clear off his RECs which have been issued to him during excess generation.

10.2.10 Association of Power Producers has stated that projects which are registered under REC mechanism supply non-preferential power to Discoms and any shortfall in generation by these projects to the Discoms does not impact the RPO obligation of the Discom. It is requested to clarify on the applicability of the proposed framework for the developers whose projects are under REC mechanism.

10.2.11 Gujarat SLDC has demanded that time frame of purchase of REC due to imbalance must be clearly defined.

10.2.12 PXIL has commented that since RECs are extinguished when it's purchased by any entity, transfer of REC's by wind/solar generator to the beneficiary might not be necessary for RPO as the concerned beneficiary is already fulfilling the RPO based on its scheduled power.

10.2.13 US-India Business Council feels that there is simply no depth in the REC market to cater to the proposed forecasting and scheduling mechanism. Bilateral trading of RECs is not allowed, and so it is not clear how the relevant parties would secure and transfer RECs.

10.2.14 IL&FS has suggested that incentive and penalties may be payable in paise./kWh terms and instead of linking the balancing with RECs or linking to UI rates.

10.2.15 POSOCO has commented as follows: draft amendment regulations have provided that due to the deviations in the RE generation, the RE generators may buy/sell RECs depending on the under injection / over generation. Due to deviations, REC market may have sudden variations/fluctuations in the demand/supply of RECs which may have adverse impact on the price of RECs. It is suggested that netting of buy/sell of RECs may be done by that RE generator for the deviation account settlement on quarterly basis. Also, this would enable RE generator to adjust his generation according to his REC liability. Therefore, statement of Charges for Deviations including REC liability may be prepared by the respective Regional Power Committee on weekly basis. The financial settlement

may be done on weekly basis and RE generator may be responsible for adjusting his REC liability within the financial quarter i.e. 3 months.

10.3 Decision of the Commission

10.3.1 In schedule based payment, RPO is deemed complied on the basis of schedule (for beneficiaries contracting power under section 62 or section 63 of the Act). 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 REC for shortfall in RE generation. Similarly over-injection necessitates crediting REC towards such excess generation.

10.3.2 The Commission has noted suggestions made in this context. Many stakeholders have expressed concerns over risk of REC market, non-enforcement of RPO leading to low clearing volume in REC market, complications in accounting, manageability, verification of RPO compliance etc. Various stakeholders have expressed opposition of the proposed framework for some of these reasons. The Commission has taken cognizance of the concerns of the stakeholders and in order to address the same has decided to make amendments to the proposed framework as follows.

10.3.3 Instead of procuring or crediting REC for each case, all RE shortfalls and RE over-injections can be netted off (on a monthly basis) for the entire pool first. In case of RE shortfall, RECs will be purchased by the nodal agency NLDC from exchange by using funds from DSM pool and the RECs so purchased shall stand extinguished. In case of RE surplus, notional RECs will be credited to DSM pool as carry forward for next cycle.

10.3.4 With these modifications, no risk of REC market is borne by the generators and the entire risk is socialized and borne by the DSM pool. This will also minimizing transaction hassles and costs as the settlement will only happen once a month, and over the entire pool. This would be settled in one transaction with the REC market per month for all the participating generators in aggregate. No

bilateral trading will be required at this stage. RPO balancing for the system would therefore continue, and buyers will therefore not get credit for renewable power without actual procurement. It is also expected that RPO compliance will get a fillip because it is being ensured as per schedule of the buyer.

10.3.5 An example:

Let us say that accounting over a month yields:

Total RE Over-injections in pool = 10,090 MWh; Total Shortfall = 10,195 MWh

Net= Over-injections - Shortfalls = 10,090 -10,195= - 105 MWh

Then Central Agency (on behalf of DSM pool) purchases 105 RECs from market for shortfall.

Accordingly suitable provisions have been made in the final amendments to the DSM Regulations.

11 METERING AND SHARING OF DATA/TELEMETRY

11.1 Proposed Amendment

11.1.1 Proposed Amendment of Regulation 6.5 of Part 6 of IEGC: Regulation 6.5 (23) shall be substituted as under :-

".....In order to maximize the accuracy of forecasts, meteorological models must incorporate data about maximum possible RE generators in as high a resolution (spatial and temporal) as possible – e.g., wind turbine technical specifications, equipment failure, weather data (wind speed, temperature, pressure), etc. This data should be provided on a mandatory basis by the wind and solar generators to the concerned RLDC."

11.2 Comments Received

11.2.1 MEIL has suggested to define the model/class of SEMs as per the CEA metering regulations and such standard should not vary from state to state. We

request the commission to include all the costs involved in Forecasting and scheduling as a part of project cost /evacuation cost while determining the tariff, and all SERCs shall be guided by the same set of regulations.

11.2.2 IWTMA has requested clarity on who's authority is to provide Special energy Meters (SEMs) installation and weekly data transfer to RLDC. If Generator/Developer/Co-agency has to install this meter, whether they have the rights to receive the data in their system as real time for improve their forecast accuracy.

11.2.3 Several stakeholders such as Alstom T&D, Southern Regional Power Committee, IWPA and LBNL have supported that to enable forecasting by concerned RLDCs, it is imperative that RE generators share real time data like turbines in operation, outages, curtailments, output of each turbine, local weather sensor data, etc. Data telemetry should be done irrespective of whether the generator is taking advantage of the forecast schedules being done by RLDC.

11.2.4 MEIL has expressed doubt with reference to meter locations at boundary for metering, accounting and settlement, whether the SEMs are to be installed at the pooling station or at the wind turbine level. It is not necessary that all wind turbines would be connected to dedicated internal wind farm feeder. It is requested to standardize the data telemetry and communication facilities requirement of RLDCs.

11.2.5 Inox Wind Ltd has submitted that data telemetry and communication facilities is important for a secure grid operation and should be installed by the system operators itself. The generators are ready to provide any technical inputs for the same. The necessary fund for the same may be availed from national clean energy fund.

11.2.6 Dr. Anoop Singh, IIT Kanpur and IEX have commented that availability of reliable historical data is keen to develop methodologies for improving forecasting

of RE generation. The data about RE schedules (including revisions) and actual generation, along with necessary technical as well as climate related information be archived with RLDCs and easily made available through the web interface for further research and analysis. This should also include information on total rated capacity, greater availability during the period, breaking etc.

11.2.7 NREL has suggested that outputs of RE forecasting modeling system should be synchronized with the data acquisition and processing requirements of system operations facilities. Technical and operational requirements for metering and related telemetry demands from system operations should be addressed before the proposed regulations are finalized. It is recommended that the proposal or future regulations include more technical specifications for telemetry and communications facilities. These should be developed by POSOCO (RLDC) in conjunction with SLDCs.

11.3 Decision of the Commission

11.3.1 Various stakeholders- industry, load dispatch centers, academia- have strongly supported that generators should share performance metrics with respective LDCs in real time. Data telemetry should be done irrespective of whether the generator is taking advantage of the forecasting being done by RLDC. Welcoming these inputs, Commission has decided as under:

11.3.2 Data telemetry is hereby mandated at the turbine/inverter level. Parameters such as turbine availability, power output and real-time weather measurements (wind speed, temperature, pressure etc) must be provided by each wind generator. The details of data telemetry requirements for both wind and solar regional entity generators shall be outlined in the Detailed Procedure.

Accordingly suitable provision has been made in the final amendments to the IEGC Regulations

11.3.3 The suggestion on aligning the submission of revisions by generators with execution capacity of load dispatch centers is appreciated. It is evident that with

data being received from large number of generators and more frequent revision of schedules, automation of system operation and management processes would be required. The Detailed Procedure shall provide related requirements and framework for upgrading the systems.

12 OTHER ISSUES

12.1 Comments received

12.1.1 IL&FS and US-India Business Council have commented that for any successful forecasting and scheduling of variable wind/solar PV (RE) energy, there is need of mainly four market components

- Reserve capacity for balancing wind/Solar PV forecasting errors,
- Large power market platform with capacity to trade power forward & futures instruments
- The grid ancillary service market and
- Well connected large grid infrastructure

Only by implementing wind/solar PV forecasting and scheduling in itself would not be viable in the absence of balancing reserves, market platform for trading power forwards and futures certificates and vibrant grid ancillary service market in the medium term till 2019 in India for the desired results. On-site integration of energy storage system with wind/solar PV projects reduces variability of wind/solar power & smoothen the wind/solar power output and thus firms the variable wind/solar generation and ensures grid stability. Large penetration (>~10% on an annual basis and on an all India basis) of variable wind/solar energy in the grid would only be possible by integrating wind /solar projects with energy storage system.

Effects at the state level, particularly in those with high penetration of renewables, will be even more pronounced. The renewable energy generation mix in renewable energy-intensive states, including Rajasthan, Gujarat, Karnataka, and Tamil Nadu, already exceeds 20% during windy months.

Indian grid operators would face huge challenges due to frequent very high ramping up/down of generation needs and this would lead to huge disturbance in the grid operation and would bring similar challenges as in California (the Duck Curve syndrome though in India might be a Giraffe Curve) as no amount of Wind/Solar forecasting can help ease this situation.

On-site integration of energy storage system with wind/solar PV projects reduces variability of wind/solar power & smoothen the wind/solar power output and thus firms the variable wind/solar generation and ensures grid stability. Large penetration (>~10% on an annual basis and on an all India basis) of variable wind/solar energy in the grid would only be possible by integrating wind /solar projects with energy storage system.

12.1.2 Dr. Anoop Singh, IIT Kanpur, and IEX have commented that the absence of any ancillary services market and scheduling inaccuracy instrument for risk hedging for deviations would keep the RE generators exposed to the risk of scheduling inaccuracy.

12.1.3 MEIL has requested to introduce the concept of wheeling and banking for interstate sale of power from wind/solar. Such banking provision is a necessity for infirm generation like wind/solar the same concern has been shown by APTEL in its order dated 21 September, 2011 in Appeal No.53. 94 & 95 of 2010 that it would be impossible to set-up the Wind Energy Units without the banking facilities due to the very characteristics of such power generation. They have also requested to extend the exemption of transmission charges and losses (POC charges) for wind generators as the same is exempted for solar generators.

12.1.4 MEIL has suggested that detailed billing and payment reports should be made available on REA/RPC/RLDCs website for public view, and

standardize the software and hardware requirement for the purpose of forecasting and scheduling.

12.1.5 IWPA suggests a shorter gate closure time to make forecast and scheduling more accurate and reliable.

12.1.6 Southern Regional Power Committee has suggested that emails should be established as the medium for sending forecast communication across all states: Currently, different states adopt different media for communicating forecast information leading to IT security issues, inconsistency and complexity. In order to avoid this, it is recommended that emails should be established as the sole medium for sending forecast communication across all states.

12.1.7 Kanchanjunga Power has emphasized that force majeure conditions such as silt, breakdown of transmission lines, machinery breakdowns, low water availability etc. are specifically excluded and the entire risk thereof is to the account of the Developer. In fact, the tender stipulates penalties for drop in CUF as well as under-supply. While, it may not be possible to calculate and quantify the loading on this account, in general interaction with the bidders, it is understood that the risk on this account is considered as a major factor while preparing the bids. Some bidders indicated loading of about 7.5-10% on this account.

12.1.8 Kanchanjunga Power has commented that feed-in-tariffs are subject to a regulatory review from time to time. For example, the loss on account of floods in Uttarakhand in 2013 was factored in/compensated to the Generators supplying power to the local DISCOMs. Similarly, the regulator can be approached for truing up of various costs such as O&M etc. in addition to compensatory tariff for additional CAPEX. Such benefits are not available in competitive based bids adding to the risk perception and corresponding loading of tariff due to variable nature of the river discharges, hydrological changes, truing up of costs, changes in riparian flow etc. These scenarios/phenomenon has to be built in the current regulations so that RE generators selling in Open Access are not unduly distressed.

12.1.9 POSOCO has suggested that handling of the Infirm RE power before CoD, Trial Operation and Declaration of CoD may be clarified for the wind and solar energy generators connected to the ISTS system in the appropriate regulation.

12.1.10 NREL has commented that since additional costs of proposed telemetry requirements are estimated based on the PGCIL pilot project (RE Forecasting/REMC), cost recovery and allocation plans should be established. The proposal addresses wind and solar forecasting with limited references to thermal or load forecasting. An integrated approach would increase the effectiveness of RE generation forecasting.

12.1.11 Some stakeholders such as US-India Business Council, Continuum Wind Energy and IL&FS have recommended that CERC should introduce a provision for on-site interconnection of energy storage technologies with wind and solar projects, which will provide balancing power at the site and thus smooth output.

12.1.12 Tata Power has commented that the proposed Mechanism against “Must Run” status granted to Renewable projects: The RE sources which are currently under Must Run category will probably have to back down in certain circumstances if the proposed mechanism is implemented.

12.1.13 Manikaran and Ernst & Young have stated that RE should not be considered as must-run, it should however get priority over other generators with a higher variable cost, but may need to be constrained sometimes due to network issues, or if it is the marginal generator.

12.1.14 Southern Regional Power Committee has requested to address the issue regarding variability; revisions in bilateral transactions (STOA) for RE may be permitted within short time period 4-6 time blocks.

12.1.15 NTPC has commented that it is mentioned that reactive energy charges would be applicable; it may be modified as reactive energy charges to be applicable to those generators who would not be able to compensate the reactive energy loss.

Generators should be given the opportunities to either compensate the reactive or pay the applicable reactive energy charges; it will also help to stabilize the system.

12.2 Decision of the Commission

The Commission has noted the suggestions.

12.2.1 As per Regulation 6.5.18 of IEGC as amended on 06.01.14, the revision of schedule is effective from fourth time-block as against sixth time-block previously. The Commission will continue to review the gate closure time depending upon the schedule handling capacity of load dispatch centers. Detailed procedure shall cover issues related to formats for communication of data and schedules between generators and load dispatch centers.

12.2.2 Energy storage as a solution for firming up wind/solar power is an option available to the developers, and they are welcome to deploy the same if commercially viable.

12.2.3 Handling of infirm RE power before CoD during trial is beyond the scope of the present regulation.

12.2.4 Regulatory review for revision of tariffs or O&M costs is an issue beyond the scope of the current amendment process.

12.2.5 The Commission welcomes suggestions on how the Indian power sector should evolve over the next decade. Particularly, it is agreed that we need several components concurrently for successful integration of renewables into the grid. CERC staff is already working on regulations for Ancillary Services, which is expected to be notified soon. Round-the-clock power market has recently been introduced, which will allow generators to sell any excess power over the schedule in the market. For faster ramping up/down of thermal generators, the Commission has notified a draft amendment to reduce the technical minimum of thermal generating units. The vision is to integrate large quantities of infirm

sources such as solar and wind in a least cost manner, while taking care of grid stability and reliability, as well as preventing overburdening of RE rich states.

12.2.6 The Commission appreciates the need for load forecasting at intra State level, and as such this critical component has been taken up for discussion at various FOR meetings. The Commission continues to emphasize the importance of load forecasting, without which net load cannot be forecasted. Flexing of thermal generators is also being examined as an avenue for balancing, and the Commission is in discussion with stakeholders on this topic.

12.2.7 Some stakeholders have expressed apprehension that must-run status of wind and solar generators will be compromised under the proposed framework. The Commission believes that this mechanism will accommodate more RE generation without any backing down and hence retaining the must-run status of these generating stations.

12.2.8 Exemption of transmission charges and losses for wind generators, wheeling and banking for inter-state transactions is outside the scope of the present regulatory dispensation.

12.2.9 Revisions in bilateral STOA transactions as well as reactive energy charges are beyond the scope of the present regulation.

12.2.10 Addressing force majeure conditions is an issue of PPA structuring and regulatory review of tariff for competitive bids is similarly an issue of commercial process design which is outside the scope of the present regulation.

13 CONCLUSION

The Commission summarises its decisions on the framework on forecasting, scheduling, and deviation settlement of RE generation based on wind and solar as under: -

The objective of this framework is to provide a platform for bulk of the wind and solar capacity that is expected to come online over the next few years, and which is expected to be inter-state in nature. In the present dispensation, the wind and solar generators which qualify as regional entities as per the IEGC are covered. For the sake of clarity, therefore, the Commission has decided to replace the words “wind and solar energy generators whose scheduling is done by the RLDCs” appearing in the proposed amendments to IEGC Regulations, by the words “wind and solar generators which are regional entities”.

A preparatory window will be provided for the generators to ensure installation of data measurement and telemetry equipment, and for respective LDCs to prepare their systems and teams for receipt of regular data and schedules. Accordingly, the Commission has decided to make the final amendment regulations in the context effective from 1.11.2015. During this period the NLDC is directed to evolve the detailed procedure, solicit public comments and seek necessary approval of the Commission.

- Centralized Forecasting- The proposed framework requires forecasting by RLDC as well as wind/solar generator. Centralized forecasting is from a grid management perspective and is very important for assessing balancing needs. The objective of forecasting by the generator is primarily to minimize deviations from schedule. The RE generator will also have the option of choosing between its own forecast or site level forecasting as done by the respective RLDC, and provide its schedule. However, commercial impact of deviation from forecast would have to be borne by the RE generator.

- **Error Quantity**- The Commission has decided to define the error percentage normalized to capacity, instead of schedule. Revised definition shall be:

$$\text{Error}(\%) = (\text{Actual Generation} - \text{Scheduled Generation}) / (\text{Available Capacity}) \times 100$$

where Available Capacity (AvC) is the cumulative capacity rating of the wind turbines/solar inverters that are capable of generating power in a given time-block. AvC would be equal to the Installed Capacity, unless one or more turbines/inverters are under maintenance or shutdown. Any attempt at mis-declaration, that is declaration of capacity when it is actually not available due to reasons of maintenance or shutdown etc would be treated as gaming and would be liable to action under appropriate provisions of the Act or the Regulations.

Absolute value of the Error could then be computed:

$$\text{Abs Error} = \text{absolute value} [\text{Error}]$$

For every time block, Abs Error may be determined and deviation settlement done accordingly.

Mean of Abs Error, also called the Mean Absolute Error or MAE, can then be calculated by taking average of Abs Error over a day or a month. MAE will give an indication of the forecasting accuracy over a longer period of time. Accordingly, suitable provision defining 'Absolute Error' has been made in the final amendments to DSM Regulations.

- **Frequency of Revisions**- the Commission appreciates that increasing number of allowed revisions to the schedule will enhance forecasting accuracy. However, it would be difficult for beneficiaries to manage contracts due to too many revisions. In order to balance the advantages with logistical issues, the number of revisions shall be retained at 16 per day. Similarly, the revisions may be effective from 4th time block as proposed in the draft regulations. The Commission clarifies that 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 Commission has decided to specify the following framework of tolerance band and deviation charges :

- **Tolerance Band**- the Commission has decided to allow a tolerance band of +/-15%. Note that with the altered error definition, this band is now determined w.r.t. Available Capacity (AvC). This itself makes the band bigger, and keeps it mostly constant through the year (except during cases of maintenance or turbine outage).

- Within +/-15% band, there shall be no adverse commercial impact.

- Beyond 15%, a gradient band is proposed as follows:

<i>Abs Error (% of AvC)</i>	<i>Deviation Charge</i>
15%-25%	10% of PPA rate
25%-35%	20% of PPA rate
>35%	30% of PPA rate

Accordingly, suitable provisions have been made in the final amendments to DSM Regulations.

- Data telemetry is hereby mandated at the wind turbine/solar inverter level. Parameters such as turbine availability, power output and real-time weather measurements (wind speed, temperature, pressure etc) must be provided by each wind generator/aggregator. The details of data telemetry and communication requirements for both wind and solar regional entity generators shall be outlined in the Detailed Procedure. *Accordingly suitable provision has been made in the final amendments to the IEGC Regulations*

- The Commission has decided to index the deviation charge to PPA rate, as determined by CERC under section 62 of the Act or adopted by CERC under section 63 of the Act.

The mechanism shall work as outlined below:

The generator shall be paid as per schedule for a time-block. If there is a deviation from schedule, the deviations shall be settled as below:

➤ If the 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 regional 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 regional 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 same as 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 regional pool at its PPA rate. 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 regional 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 regional pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

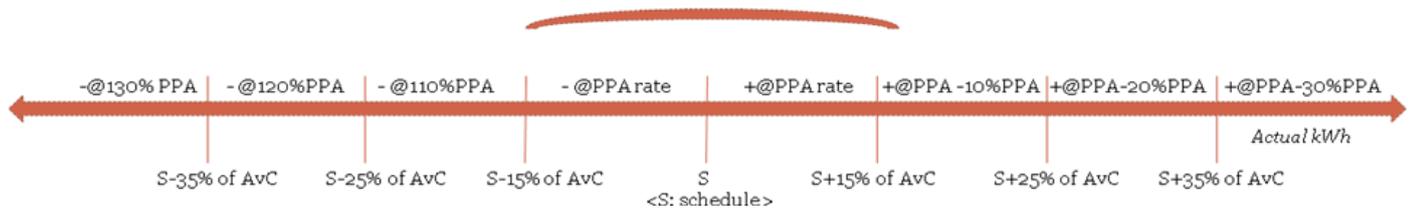
Deviation charge (I) = (10% of AvC) x (10% of PPA rate)

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) + Deviation charge (III)

The mechanism can be represented pictorially as follows (AvC: Available Capacity):



- 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.
- Accordingly suitable provisions have been made in the final amendments to the IEGC and DSM Regulations.
- Settlement for Open Access users and Captive Power Plants
 - Settlement of OA (REC projects) and CPP poses challenge, particularly for CPP where there is no PPA rate. Therefore a reference rate equal to APPC at National level may be determined by CERC through order.
 - All deviations from schedule by these entities must be settled at this APPC rate in the proposed framework.
 - Accordingly suitable provisions have been made in the final amendments to the IEGC and DSM Regulations.
- The Commission has decided in the context of RPO compliance as follows:-

- Instead of procuring or crediting REC for each case, all RE shortfalls and RE over-injections can be netted off (on a monthly basis) for the entire pool first. In case of RE shortfall, RECs will be purchased by the nodal agency NLDC from exchange by using the money from UI pool and the RECs so purchased shall stand extinguished. In case of RE surplus, notional RECs will be credited to DSM pool as carry forward for next cycle.

The Draft REC Amendment (Fourth Amendment) which was floated along with the framework is not required and hence stands withdrawn.

- The Electricity Act 2003 provides that State Grid Code shall be consistent with the Grid Code notified by CERC. Further, Tariff Policy also requires the State Commissions to implement the ABT mechanism in line with the framework specified by CERC.
- In pursuance of these provisions of the Act and the Tariff Policy, it is desirable that a framework on the above lines as formulated by CERC for grid integration of variable renewable energy sources of wind and solar, be also adopted by State Commissions.
- It is felt that the framework as above could be adopted immediately by the states which have already implemented the ABT mechanism.

Sd/-
(A.S. Bakshi)
Member

Sd/-
(A.K. Singhal)
Member

Sd/-
(Gireesh B. Pradhan)
Chairperson

1 ANNEXURE I: EXAMPLES OF NET REVENUE AND DEVIATION CHARGE CALCULATION FOR THE REVISED FRAMEWORK

Table 1: Example Calculations (Within Desired Band)

Example 1:			
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	Scenario I: Within band of -15%	Scenario II: Within band of +15%
	Actual Generation	90	110
	% Absolute Error	10%	10%
	Buyer Pays	$5 \times 100 \times 1000 = 500,000$	$5 \times 100 \times 1000 = 500,000$
	Seller Receives	500,000	500,000
Seller to DSM	Add: Seller Receives from DSM Pool	$5 \times (90 - 100) \times 1000 = (50,000)$	$5 \times (110 - 100) \times 1000 = 50,000$
	Add: Deviation Charge @ 10% for Deviation Between 15%-25%	-	-
	Add: Deviation Charge @ 20% for Deviation Between 25%-35%	-	-
	Add: Deviation Charge @ 30% for Deviation Beyond 35%	-	-
	Total Receipt from/(payment to) Pool	(50,000)	50,000
	Net Revenue of Generator	450,000	550,000

Table 2: Example Calculations (Within 15-25% Deviation)

Example 2:			
Schedule (MWh)	100		
PPA Tariff (Rs/Unit)	5		
Available Capacity (MWh)	100		
Scenario	Scenario III: Outside band between (-)15-25%	Scenario IV: Outside band between (+)15-25%	
Actual Generation	75	125	
% Absolute Error	25%	25%	
Buyer Pays	$5 \times 100 \times 1000 = 500,000$	$5 \times 100 \times 1000 = 500,000$	
Seller Receives	500,000	500,000	
Seller to DSM	Add: Seller Receives from DSM Pool	$5 \times (75 - 100) \times 1000 = (125,000)$	$5 \times (125 - 100) \times 1000 = 125,000$
	Add: Deviation Charge @ 10% for Deviation Between 15%-25%	$(5 \times 10\%) \times 10 \times 1000 = (5000)$	$(5 \times 10\%) \times 10 \times 1000 = (5000)$
	Add: Deviation Charge @ 20% for Deviation Between 25%-35%	-	-
	Add: Deviation Charge @ 30% for Deviation Beyond 35%	-	-
	Total Receipt from/(payment to) Pool	(130,000)	120,000
	Net Revenue of Generator	370,000	620,000

Table 3: Example Calculations (Beyond 35% Deviation)

Example 3:			
Schedule (MWh)	100		
PPA Tariff (Rs/Unit)	5		
Available Capacity (MWh)	100		
Scenario	Scenario V: Outside band....beyond -35%	Scenario VI: Outside band....beyond +35%%	
Actual Generation	60	140	
% Absolute Error	40%	40%	
Buyer Pays	$5 \times 100 \times 1000 = 500,000$	$5 \times 100 \times 1000 = 500,000$	
Seller Receives	500,000	500,000	
Seller to DSM	Add: Seller Receives from DSM Pool	$5 \times (60 - 100) \times 1000 = (200,000)$	$5 \times (140 - 100) \times 1000 = 200,000$
	Add: Deviation Charge @ 10% for Deviation Between 15%-25%	$(5 \times 10\%) \times 10 \times 1000 = (7500)$	$(5 \times 10\%) \times 10 \times 1000 = (7500)$
	Add: Deviation Charge @ 20% for Deviation Between 25%-35%	$(5 \times 20\%) \times 10 \times 1000 = (10000)$	$(5 \times 20\%) \times 10 \times 1000 = (10000)$
	Add: Deviation Charge @ 30% for Deviation Beyond 35%	$(5 \times 30\%) \times 5 \times 1000 = (7500)$	$(5 \times 30\%) \times 5 \times 1000 = (7500)$
	Total Receipt from/(payment to) Pool	(225,000)	175,000
	Net Revenue of Generator	275,000	675,000

2 ANNEXURE II: List of organizations/individuals that have submitted comments

Generators/Industry/Associations

- 1 Alstom T&D
- 2 Del2Infinity
- 3 GE
- 4 Green Planet Energy
- 5 Greenko Energies
- 6 Hindustan Power
- 7 IL&FS
- 8 INOX Wind
- 9 Kanchanjunga Power Company
- 10 Manikaran-Ernst & Young
- 11 Mytrah Energy India Ltd
- 12 Orient Green Power Company (OGPL)
- 13 Power Research & Development Consultants (PRDC)
- 14 Sembcorp Green Infra
- 15 Sterling Agro
- 16 SunEdison
- 17 Association of Power Producers (APP)
- 18 Indian Wind Power Association (IWPA)
- 19 Indian Wind Turbine Manufacturers Association (IWTMA)
- 20 Wind Independent Power Producers Association (WIPPA)
- 21 NTPC Ltd.
- 22 Vestas Wind Technology India Pvt ltd
- 23 Tata Power Trading Company Limited
- 24 Indian Wind Energy Association (InWEA)

Discoms/Load Dispatch Centers

- 25 Gujarat Urja Vikas Nigam Ltd (GUVNL)

- 26 TANTRANSCO
- 27 Tata Power
- 27 Gujarat SLDC
- 28 Southern Regional Power Committee (SRPC)

Statutory/trading institutions/Academia

- 29 Central Electricity Authority (CEA)
- 30 POSOCO
- 31 Power Exchange of India Ltd (PXIL)
- 32 Ministry of New and Renewable Energy (MNRE)
- 33 IEX
- 34 Lawrence Berkeley National Laboratory (LBNL)
- 35 National Renewable Energy Laboratory (NREL)
- 36 US-India Business Council (USIBC)
- 37 ReConnect

Individuals

- 38 Dr. Anoop Singh- IIT Kanpur
- 39 Ramesh S. (ex-CWET/Windworld India)
- 40 Shanti Prasad, ex-Chairman RERC
- 41 Mr. Vijay Menghani