Comments on "Proposed Framework for Forecasting, Scheduling & Imbalance Handling for Renewable Energy (RE) Generating Stations based on wind and solar at Inter-State Level", 2015

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1. **Variability of Wind and Solar:** As the share of renewable energy generation in the power system increases in future there would be significant challenges to maintain the stability and security. 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. The complexity of weather related factors and geographical features make it difficult to predict wind velocity and potential for electricity generation at a location to be more challenging task. Solar irradiance at a location, is influenced by a number of factors, which include time of the day, temperature, cloud cover and particulate matter in the air. It is possible to predict solar energy generation with greater confidence. Although matter of forecasting for wind as well as solar energy are improving, accuracy of the forecast would remain a challenge. The accuracy improves with closeness to the time block. Studies suggest that forecasting accuracy can improve up to the range of 10% or less with a one-hour ahead forecast, and it can go beyond 20-30% range for a forecast horizon of 12 hours or more.

   It would be desirable to have a differential range of forecasting accuracy for wind and solar energy generation, based on experience for the same.

2. **Range for forecasting accuracy:** 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+/- 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.

	Year 1	Year 2	Year 3 onwards
Wind	25%	20%	15%
Solar	20%	15%	12%

Note: A differential treatment may be given to the wind and solar energy forecasting due to the reasons mentioned above.

3. **Applicability of the Proposed Framework:** The proposed framework should be applicable for plants of all capacities and even be applicable for those connected with the intra-state grid. Since generators often use the services of forecasting agencies based on capacity/schedule energy, it would not impose significant additional cost for plants of smaller size. Presence of number of small capacity owners in a large wind farm or solar power is not ruled out entity, and a single entity may take the responsibility of forecasting and scheduling generation from such plants.

4. **Pricing of Deviation for scheduled RE generation:** The variation in grid frequency, and the ability of the conventional generators to respond in short duration of time are the two main concerns arising out of the variable RE generation. The erstwhile RRF mechanism priced the deviations beyond +/-30% as per the prevailing UI charges. The proposed framework fixes a predefined price for deviations (below)

	Rs./ kWh	Cost of shortfall of RECs	Total cost of under-injection
Wind (88% - 100%<)	3.00	1.50	4.50
Solar (88% - 100%<)	3.00	3.50	6.50
Wind (88% <)	4.00	1.50	5.50
Solar (88% <)	4.00	3.50	7.50

	Rs./ kWh	Revenue from excess RECs	Total cost of under-injection
Wind (>100%-112%)	4.00	1.50	5.50
Solar (>100%-112%)	4.00	3.50	7.50
Wind (>112%)	0.00	1.50	1.50
Solar (>112%)	0.00	3.50	3.50

The above proposal essentially does not provide room for inaccuracy in forecasting of wind and solar energy generation, respectively. 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.

Delinking of the deviation charges from the system frequency defeats the original argument for the need of more accurate scheduling, due to the need for grid stability. Now, it is possible that a RE generator may actually be paying much higher (lower)

penalty for deviation from schedule than that which is reflected from the prevailing UI Charges.

5. **Role of Ancillary Services and Hedging Instruments:** 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. Ancillary services could allow system operator to seek system support at shorter notice after hour ahead schedule forecast is provided by RE generators. It should be possible to design hedging instruments to cover for uncertainty in forecast of RE schedule as well as the deviation charges to be applicable for the same. However, such instruments should only be available initially to RE generators exposed to risk rather than being an instrument for financial speculation.

6. **Socialising a range of scheduling deviation:** The proposal not to compensate the RE generator for generation beyond hundred and 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.

7. **Fulfillment of RPO and Issuance of RECs:** 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, and issue of RECs for excess generation adequately would ensure adequate RPO compliance.

8. **Responsibility of forecasting:** 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). If the forecast provided by the REMCs/RLDCs could be used by the RE generators, there should also be incentive for more accurate forecasting by the REMCs/RLDCs. The REMCs should work to improve the forecasting accuracy and be paid for the services accordingly. In fact, REMCs may be in a position to provide a better forecast due to access to data for a larger number of sites.

9. **Data Availability:** 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.

10. **Number of Revisions:** The efficiency of forecasting improves closer to the time horizon. It is reported that a one hour ahead forecasting is feasible and more reliable, and hence would merit revision in the schedule up to one hour in advance. This would mean that the number of revisions for RE generators should actually go up to 24 for a given day.