PROCEDURE FOR IMPLEMENTATION OF THE FRAMEWORK ON

FORECASTING, SCHEDULING AND IMBALANCE HANDLING FOR RENEWABLE ENERGY (RE) GENERATING STATIONS INCLUDING POWER PARKS BASED ON WIND AND SOLAR AT

INTER-STATE LEVEL

1. Preamble :

This Procedure is issued in compliance of Regulation 6.5 (23) of the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 and amendments thereof and Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) Regulations, 2010 and amendments thereof herein after called the 'Procedure for implementation of the framework on Forecasting, Scheduling and Imbalance Handling for Renewable Energy (RE) Generating Stations including Power Parks based on wind and solar at Inter-State level'.

2. Scope:

This Procedure shall be followed by National Load Despatch Centre (NLDC), all Regional Load Despatch Centres (RLDCs), Regional Power Committees (RPCs), and State Load Despatch Centres (SLDCs), regional entity Wind / solar generating stations including power parks, Principal Generators, Lead Generator.

This procedure shall be implemented with effect from the date of its notification by the Commission.

3. Definitions:

3.1 Lead Generator : The lead Generator shall be as termed in the CERC (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) (Amendment) Regulations, 2010 as follows:

> One of the generating stations using renewable sources of energy, individually having less than 50 MW installed capacity, but collectively having an aggregate installed capacity of 50 MW and above, and acting on behalf of all these generating stations, and seeking connection from CTU at a single connection point at the pooling sub-station under CTU or connecting at pooling substation within the Solar or Wind power park, termed as the Lead generator. Lead Generator shall formalize a written agreement/arrangement among all the associated generators to 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, such as grid security, scheduling and dispatch, collection and payment/adjustment of Transmission charges, deviation charges, congestion and other charges etc.

3.2 Principal Generator: The Principal Generator, shall be as recognized in the CERC (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) (Third Amendment) Regulations, 2013, as follows:

> The existing generating station which agrees to act as the "Principal Generator" on behalf of the renewable energy generating station(s) which is seeking connectivity through the electrical system of the existing generating station and formalizes a written agreement/arrangement among them to 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, such as grid security, scheduling and dispatch, collection and payment/adjustment of Transmission charges, deviation charges, congestion and other charges etc., and submit a copy of the agreement to the CTU, along with the application for connectivity, with copy to the respective RLDC in whose control area it is located.

3.3 **RE Generator** means (i) the Wind or Solar generators who are regional entities and (ii) Solar generators with installed capacity of more than 50 MW within a Solar Power Park (iii) Renewable energy projects based on wind or solar resources having capacity of 500 MW and above

3.4 **Connection Point:** A point at which Solar park, Renewable energy generating stations which are regional entities are connected to Inter-State/ Intra-State system

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

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

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

4. Applicability:

This procedure shall be applicable to:

a. All RE Generators, which are regional entities as defined in Grid Code , are covered under the ambit of this procedure.

b. RE Generators connected to ISTS and having aggregate generation capacity of 50 MW and above.

c. Any renewable energy generating station of 5 MW capacity and above but less than 50 MW capacity developed by a generating company in its existing generating station in accordance with the CERC (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) (Third Amendment) Regulations 2013, and connected to the existing connection point with inter-State Transmission System through the electrical system of the generating station.

d. Lead Generator

e. Principal Generator

f. Solar Power Park Developer

g. Wind Power Park Developer

5. Role of different entities

5.1 RE Generator

5.1.1. RE Generator or Lead Generator or Principal Generator or Solar Power Park Developer or Wind Power Park Developer shall submit one

time details to concerned RLDC as per Annexure-I. Further, if there is any change in the information furnished, then the updated information shall be shared with the concerned RLDC not later than 7 working days of the change.

5.1.2 RE Generator or Lead Generator or Principal Generator shall undertake the following activities.

a. Provide available capacity, Day ahead forecast (based on their own forecast or on the forecast done by RLDC) and Schedule as per Annexure-II through web based application maintained by RLDCs.

b. Provide real time availability (at turbine/inverter level) and generation data (at pooling station level) as per Annexure-III

c. Provide Monthly data transfer (as per Annexure – IV):

- For wind plants, at the turbine level- average wind speed, average power generation at 15-min time block level
- For solar plants, for all inverters* >=1 MW- average solar irradiation, average power generation at 15-min time block level

* if a solar plant uses only smaller string inverters, then data may be provided at the plant level

d. Be Responsible for metering and data collection, transmission and co-ordination with RLDC, SLDC RPC, CTU and other agencies as per IEGC and extant CERC Regulations.

e. Undertake commercial settlement of all deviation-settlement charges as per applicable CERC Regulations

f. Submit a copy of the agreement to concerned RLDC wherein it is mentioned that RE Generator or Lead Generator or Principal Generator shall undertake all operational and commercial responsibilities on behalf of generating stations as per the prevalent CERC Regulations. Further, RE Generator or Lead Generator or Principal Generator shall also submit the application for connectivity which was submitted to CTU to the respective RLDC in whose control area it is located.

g. Use Automatic meter reading technologies for transfer, analysis and processing of interface meter data.

h. Perform commercial settlement beyond the connection point (De-pooling arrangement) and technical coordination amongst the generators within the pooling station and upto the connection point as the case may be.

i. Shall furnish the PPA rates on notarized affidavit for the purpose of Deviation charge account preparation to respective RPC supported by copy of the PPA.

j. Keep each of the RLDCs indemnified at all times and shall undertake to indemnify, defend and save the SLDCs/RLDCs harmless from any and all damages, losses including commercial losses due to forecasting error, claims and actions including those relating to injury to or death of any person or damage to property, demands, suits, recoveries, costs and expenses, court costs, attorney fees, and all other obligations by or to third parties, arising out of or resulting from the transactions undertaken by the Generators.

5.2 RLDC

5.2.1 The concerned RLDC shall be responsible for scheduling, communication, coordination with RE Generators or Lead Generator or Principal Generator. Forecasting of the renewable energy generation shall be done by the RLDCs and the forecast will be available on the website of the concerned RLDC. The generation forecast shall be done on the basis of the weather data provided by IMD or on the basis of other methods used by the Forecasting Agency whose service may be availed by NLDC/RLDC. However, the forecast by the concerned RLDC shall be with the objective of ensuring secure grid operation.

5.2.2 The concerned RLDC will be responsible for processing the interface meter data and computing the net injections by each RE Generator or Lead Generator or Principal Generator or Solar Power Park or Wind Power Park as specified in Annexure- V.

5.2.3 RLDC may, appoint additional manpower for carrying out the additional responsibility assigned in these Procedures, if required.

6 **Forecasting**

6.1 Regional forecasting shall be done by the concerned RLDC to facilitate secure grid operation. The concerned RLDC may engage a forecasting agency to undertake forecasting for RE Generators/solar parks /wind parks which are regional entities.

6.2 RE generator shall provide the forecast to the concerned RLDC which may be based on their own forecast or RLDC's forecast as per Annexure-II. In case a generator is utilizing service of RLDC for

its forecasting, necessary fees shall be paid by generator to RLDC as approved by CERC.

6.3 The concerned RLDC shall consolidate and forecast based on various parameters as mentioned in the enclosed Annexures and weather data obtained from IMD or from any other forecast service provider (which could be different from that provided by generator)

6.4 RE Generators or Lead Generator or Principal Generator may prepare their schedule based on the forecast done by RLDC or their own forecast. Any commercial impact on account of deviation from schedule based on the forecast chosen by the wind and solar generator shall be borne by the respective generator.

7 **Connectivity**

7.1 The application for connectivity shall be made in accordance with the provisions of the Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) Regulations, 2009 as amended from time to time.

7.2 The Solar Power Park Developer (SPPD) or Wind Power Park Developer (WPPD) shall apply for Connectivity on behalf of Generators within the park. The SPPD / WPPD shall be responsible for registering the Solar Power Park with the respective RLDC/ SLDC as applicable as a User and shall submit Appendix-IV of CERC (Fees and Charges of Regional Load Despatch Centres and related matters) Regulations, 2015 before getting connected at the Connection point with the ISTS for the first time. SPPD /WPPD shall be responsible for complying with all the provisions of CEA

standards for Grid Connectivity and other relevant CERC or CEA regulations. The SPPD /WPPD shall act as the nodal and accountable entity at the connection point. SPPD / WPPD shall be responsible for sending the SCADA data to the RLDC and to the Renewable Energy Management Centre (REMC).

7.3 In a solar /wind power park, Lead Generator shall undertake all operational and commercial responsibilities for the solar energy generating station(s) for less than 50 MW aggregating to 50MW and above in following the provisions of the Indian Electricity Grid Code and all other regulations of the Commission, such as grid security, scheduling and dispatch, collection and payment/adjustment of Transmission charges, DSM charges, congestion and other charges etc., and submit a copy of the agreement and authorization documents to the respective RLDC in whose control area it is located

The RE generators, lead generator, principal generator, SPPD, WPPD shall keep each of the RLDCs indemnified at all times and shall undertake to indemnify, defend and save the SLDCs/RLDCs harmless from any and all damages, losses, claims and actions including those relating to injury to or death of any person or damage to property, demands, suits, recoveries, costs and expenses, court costs, attorney fees, and all other obligations by or to third parties, arising out of or resulting from the transactions undertaken by the Generators in the Solar power Park.

7.4 The commercial settlement within the solar park /wind park and between generators shall be as detailed in Annexure-IV

7.5 All the technical coordination amongst the generators, within the solar /Wind Park and upto the connection point shall be done by the Lead generator or Principal generator or the RLDC as the case maybe.

8 Scheduling and Despatch

8.1 Following alternatives exist for Scheduling and Despatch for Generators within Solar / Wind Power parks due to multiple generation developers within the Park injecting at various points with in the park and ultimately injecting at interface with ISTS,

Case-1: The concerned RLDC shall be responsible for the scheduling, communication, coordination with RE Generators of 50 MW and above and connected to Inter State Transmission System (ISTS).

Case-2: Lead generator or Principal generator shall be responsible for the coordination and communication with RLDC, SLDC, RPC and other agencies for scheduling of RE Generators individually having less than 50 MW, but collectively having an aggregate installed capacity of 50 MW and above and connected within the solar park.

8.2 A representative sketch showing the scheduling of RE generator power for both cases is attached as Annexure-IV.

8.3 RE generator or lead generator or principal generator, as the case may be, shall provide the schedule to the concerned RLDC, which may be based on their own forecast or RLDC's forecast as per Annexure-II.

8.4 RE Generators or lead generator or principal generator shall be responsible for coordinating with RLDC. It shall undertake various

activities associated with scheduling, commercial settlement, communication, data consolidation and management and coordination etc.

8.5 RLDC shall upload day ahead schedules of energy generation with an interval of 15 minutes for the 24 hours period commencing at 00:00 hrs. on the website of the concerned RLDC as per regulation 6.5 of the IEGC.

8.6 The schedule by RE generators or lead generator or principal generator may be revised by giving advance notice to the concerned RLDC, as the case may be. Such revisions 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.

8.7 Revision in schedules by RE Generator or lead generator or principal generator selling power through collective transactions shall not be allowed.

8.8 The scheduling jurisdiction (as provided in Regulation 6.4 of IEGC 2010), metering, energy accounting and deviation charges would be as per relevant CERC Regulations, as amended from time to time.

8.9 In the event of contingencies, transmission constraints, congestion in the network, threat to system security, the transactions of RE Generators already scheduled by RLDC may be curtailed as per provisions of IEGC for ensuring secure and reliable system operation.

9 **Metering**

9.1 Interface Energy Meters at interstate level shall be installed by the Central Transmission Utility as per CEA Metering Regulations, 2006 and amendments thereof.

9.2 Interface Energy Meters at intra state level shall be installed by the State Transmission Utility / SPPD /WPPD as per CEA Metering Regulations, 2006 and amendments thereof.

9.3 Interface Energy Meters with unique serial numbers and as per standard specification, would have to be placed in accordance with CEA Metering Regulations to facilitate boundary metering, accounting and settlement for RE Generators. Automated meter reading (AMR) system shall be used for communicating interface meter data at RLDCs. Internal Clock of the interface meter shall be time synchronized with GPS.

9.4 RE Generator or lead generator or principal generator shall provide data telemetry at the turbine/inverter level to the concerned RLDC and shall ensure the correctness of the real-time data and undertake the corrective actions, if required. Frequency of real-time data updation to be shared with concerned RLDC shall be 10 second or less as per prevailing practice followed by RLDCs. Further, turbine/inverter outage plan shall also be forwarded to the concerned RLDC. The suggested data telemetry requirement for RE Generators is enclosed at Annexure-III. Further, NLDC/RLDCs shall publish the requisite list of information in due course of time.

10 **Role of RPC: Energy Accounting of Wind or Solar generating Stations**

Energy Accounting related to the RE Generators irrespective of the size, shall be prepared by RPC on a weekly basis and shall be uploaded on the website of the respective RPC.

11. Treatment of RECs

11.1. Deviations by all RE Generators shall first be netted off by concerned RPC for the entire pool on a monthly basis and if Actual Generation is more than schedule generation, Notional RECs shall be credited to the respective Regional DSM Pool on Monthly Basis and carried forward for settlement in future. If after netting off, including any carried forwarded notional RECs, the remaining shortfall in renewable energy generation shall be balanced through purchase of equivalent solar and non-solar Renewable Energy Certificates (RECs) through Power Exchanges by RLDC/ NLDC by utilising funds from the respective Pool Account at the end of the financial year within three months of finalization of accounts by concerned RPC.

12. Commercial Settlement

12.1. The wind or solar generators which are regional entities shall be paid as per schedule In the event of deviation of actual generation from schedule, deviation charges shall be payable/receivable by such wind or solar generator to/from the Regional DSM Pool as per the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Second Amendment) Regulations, 2015 or amendment thereof. The deviation would be computed for each fifteen minute time interval on the basis of implemented schedule and energy meter recording at interface point. From 01.11.2015 the deviation settlement shall be done as per the DSM Regulations (second amendment) 2015 or amendment thereof.

12.2. All the commercial settlement among the generators beyond the connection point shall be done by the RLDC/SLDC/RE Generators or lead generator or principal generator as the case may be.

12.3. All the transactions shall be through ECS only.

13. **Application of Losses and Charges**

Transmission charges and losses for ISTS shall be applicable as per the IEGC and CERC (Sharing of Inter State Transmission Charges and Losses) Regulations, 2010 and amendments thereof.

14. **RLDC Fees and Charges**

14.1. RE Generators or lead generator or principal generator shall be registered as User with the respective Regional/State Load Despatch Centre responsible for scheduling, metering and energy accounting.

14.2. RE Generators or lead generator or principal generator shall pay RLDC fees and charges as per Hon'ble CERC's Regulation "Fees and charges of Regional Load Despatch Centre and other related matters", Regulation 2015 and further amendment thereof after getting registered with respective RLDCs as a User of RLDC.

15. Removal of Difficulties

15.1. In case of any difficulty in implementation of this procedure, NLDC may approach the Commission for review or revision.

15.2. Notwithstanding anything contained in this Procedure, NLDC/RLDCs may take appropriate decisions in the interest of System Operation. Such decisions shall be taken under intimation to CERC and the procedure shall be modified /amended, as necessary.

Annexure-I

Details to be submitted by the Wind/Solar generating stations which are regional entities/ lead generator, principal generator	
Type: Wind/Solar Generator	
Individual / on Behalf of Group of generators	
If on Behalf of Group of generators group of then details of agreement to be attached	
Total Installed Capacity of Generating Station	
Total Number of Units with details	
Physical Address of the RE Generating Station	
Whether any PPA has been signed: (Y/N)	If yes ,then attach details
Connectivity Details	Location/Voltage Level
Metering Details	Meter No. 1. Main 2. Check
Connectivity Diagram	(Please Enclose)
Static data	As per attached sheet
Contact Details of the Nodal Person	Name : Designation : Number: Landline Number, Mobile Number, Fax Number E - Mail Address :
Contact Details of the Alternate Nodal Person	Name : Designation : Number: Landline Number, Mobile Number, Fax Number E - Mail Address :

Data to be submitted by the RE Generator / lead generator, principal generator (Suggested List)

For Wind turbine generating plants

S No	Particulars
1	**Type**
2	Manufacturer
3	Make
4	Model
5	Capacity
6	commissioned date
7	Hub height
8	total height
9	RPM range
10	Rated wind speed
11	**Performance Parameter**
12	Rated electrical power at Rated wind speed
13	Cut in speed
14	Cut out Speed
15	Survival speed (Max wind speed)
16	Ambient temperature for out of operation
17	Ambient temperature for in operation
18	survival temperature
19	**Low Voltage Ride Through (LVRT) setting**
20	**High Voltage Ride Through (HVRT) setting**
21	lightning strength (KA & in coulombs)
22	Noise power level (db)
23	**Rotor**

24	Hub type
25	Rotor diameter
26	Number of blades
27	Area swept by blades
28	Rated rotational speed
29	Rotational Direction
30	Coning angle
31	Tilting angle
32	Design tip speed ratio
33	**Blade**
34	Length
35	Diameter
36	Material
37	Twist angle
38	**Generator**
39	Generator Type
40	Generator no of poles
41	Generator speed
42	Winding type
43	Rated Gen. Voltage
44	Rated Gen. frequency
45	Generator current
46	Rated Temperature of generator
47	Generator cooling
48	Generator power factor
49	KW/MW @ Rated Wind speed
50	KW/MW @ peak continuous
51	Frequency Converter

52	Filter generator side
53	Filter grid side
54	**Transformer**
55	Transformer capacity
56	Transformer cooling type
57	Voltage
58	Winding configuration
59	**Weight**
60	Rotor weight
61	Nacelle weight
62	Tower weight
63	**Over speed Protection**
64	**Design Life**
65	**Design Standard**
66	Latitude
67	Longitude
68	COD Details
69	Past Generation History from the COD to the date on which DAS facility provided at RLDC, if applicable
70	Distance above mean sea level

For Solar generating Plants

Static data points:

1. Latitude
2. Longitude
3. Turbine Power Curve
4. Elevation and orientation angles of arrays or concentrators
5. The generation capacity of the Generating Facility
6. Distance above mean sea level etc.
7. COD details
8. Rated voltage
9. Details of Type of Mounting: (Tracking Technology If used, single axis or dual axis, auto or manual)
10. Manufacturer and Model (of Important Components, Such as Turbine, Concentrators, Inverter, Cable, PV Module, Transformer, Cables)
11. DC installed Capacity
12. Module Cell Technology
13. I-V Characteristic of the Module
14. Inverter Rating at different temperature
15. Inverter Efficiency Curve
16. Transformer Capacity & Rating , evacuation voltage, distance form injection point

Annexure-II

Forecast and Schedule Data to be submitted by Wind/Solar plants/ Lead generator, Principal generator

FORMAT: A (to be submitted a day in advance)

15 Min time block (96 Block in a day)	TIME	Available Capacity (MW) - Day Ahead	Day Ahead Forecast (MW)	Day Ahead Schedule (MW)
1	00:00-00:15			
2	00:15-00:30			
3	00:30-00:45			
4	00:45-01:00			
.				
94				
95				
96				

Note: The forecast should ideally factor forecasting errors. As such schedule should ordinarily be same as forecast.

FORMAT: B (to be submitted on the day of actual generation, revision of availability and schedule, if any, shall be done as per CERC(IEGC) Regulations.

15 Min time block (96 Block in a day)	TIME	Day ahead schedule (MW)	Current Available Capacity (MW)	Revised Schedule (MW)
1	00:00-00:15			
2	00:15-00:30			
3	00:30-00:45			
4	00:45-01:00			
.				
94				
95				
96				

Annexure-III

Real-time Data Telemetry requirement (Suggested List)

Wind turbine generating plants

1. Turbine Generation (MW/MVAR)
2. Wind Speed(meter/second)
3. Generator Status (on/off-line)-this is required for calculation of availability of the WTG
4. Wind Direction (degrees from true north)
5. Voltage(Volt)
6. Ambient air temperature (^{o} C)
7. Barometric pressure (Pascal)
8. Relative humidity(in percent)
9. Air Density (kg/m^3)

For Solar generating Plants

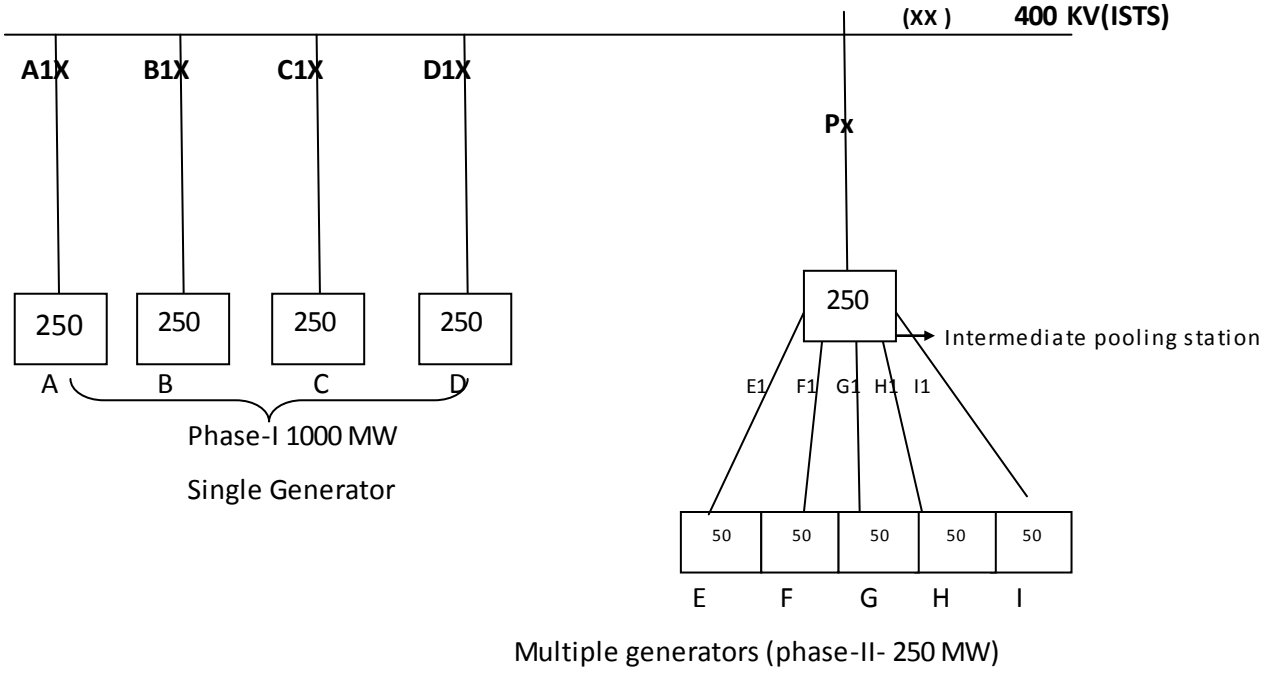
1. Solar Generation unit/ Inverter-wise (MW and MVAR)
2. Voltage at interconnection point (Volt)
3. Generator/Inverter Status (on/off-line)
4. Global horizontal irradiance (GHI)- Watt per meter square
5. Ambient temperature (^{o} C)
6. Diffuse Irradiance- Watt per meter square
7. Direct Irradiance- Watt per meter square
8. Sun-rise and sunset timings
9. Cloud cover-(Okta)
10. Rainfall (mm)
11. Relative humidity (%)
12. Performance Ratio-

ANNEXURE-IV

Sample for understanding the scheduling /forecasting procedure.

Block Diagram showing the case wise Scheduling and Forecasting considering a sample case

Case-I: 50 MW and above (Phase-I &II)



Phase-I – 1000 MW,

A single generator of 1000 MW capacity is developing the generating station in phase-1 in four blocks namely A,B,C & D of 250 MW capacity each and is directly connected to point A1,B1,C1& D1 respectively at ISTS. At the interface point scheduling and forecasting will be done by RLDC / SLDC (in case full share is allocated to host state as per IEGC).

Phase-II- 500 MW (Separate Generator/Entities)

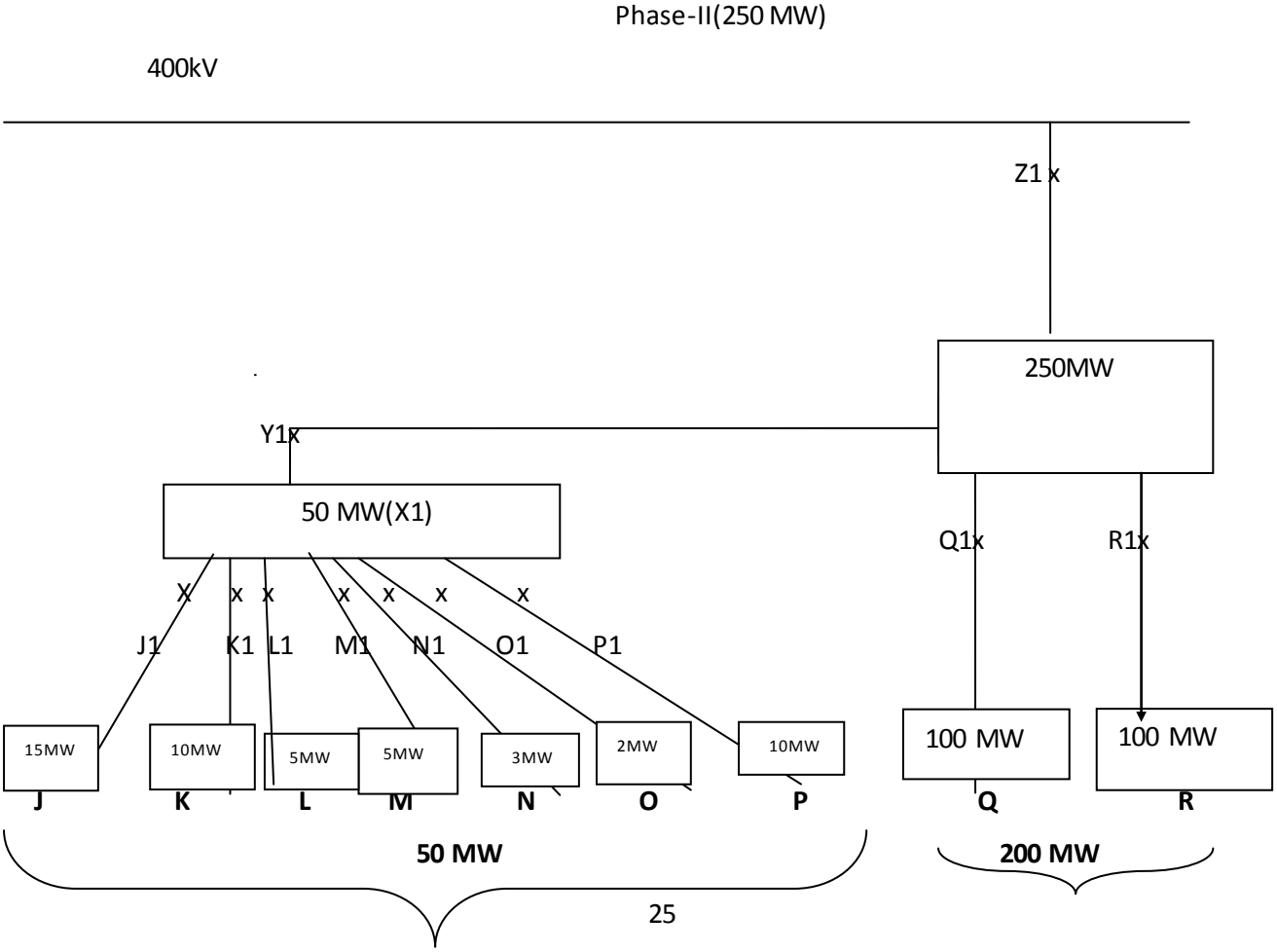
Let multiple generators of 50 MW each aggregating to 250 MW (5 Nos. Multiple Generator of 50 Mw each (as separate entities), be connected to inter mediate pooling stations.

In this case Solar generating station may be developed by single or Multiple generators. Here we have considered as multiple generators namely E, F, G, H & I each having the capacity of 50 MW each ,the RE generators are connected to interface point E1, F1, G1, H1& I1 and thereby connected to ISTS at XX point.

In such a case scheduling, accounting, forecasting for these generators needs to be segregated at point E1, F1,G1, H1, I1. Scheduling shall be done at point P and shall be segregated at E1,F1,G1,H1,I1 by RLDC.

Further there may be case where multiple generators less than 50MW (<50MW) capacity are connected to the intermediate pooling station are stated as under:-

Case-II Below 50 MW



For remaining 250 MW of Phase-II, let us consider, multiple generators of 7 Nos (J,K,L,M,N,O&P) each having capacity less than 50 MW but collectively having an aggregate installed capacity of 50 MW or more. Further Generators Q & R each of 100 MW are connected at Q1 & R1. All these generators are connected to ISTS at point Z1.

Scheduling and forecasting for the generators J,K,L,M,N,O& P shall be done at Point Z1, but need to segregated at Point J1, K1,L1, M1, N1,O1& P1 and for generators Q & R needs to be segregated at Q1 and R1. In this case, RLDC shall schedule at point Z1 and segregate at Y1,Q1& R1 . The lead generator shall provide aggregated schedule to RLDC at Y1. Further the lead generator shall do segregation of schedules and other operational & commercial activities for generators J,K,L,M,N,O,P at points J1, K1,L1, M1, N1,O1& P1.