National Electric Power Regulatory Authority
Islamic Republic of Pakistan

Registrar

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No. NEPRA/DG(M&E)/LAT-01/ 25833 – 41 December 2, 2019

Managing Director,
National Transmission & Despatch Company,
414-WAPDA House,
Lahore

Subject: **Grid Code Addendum No. 2 (Revision-1) for Grid Integration of Photovoltaic (PV) & Concentrated Solar Power (CSP) Plants**

Enclose please find Grid Code Addendum No. 2 (Revision-1) for Grid Integration of Photovoltaic (PV) & Concentrated Solar Power (CSP) Plants approved by the National Electric Power Regulatory Authority (NEPRA) subject to exclusion of clause 12 (f), 13 (ii) & its associated clause 13 (iii) and clause 13 (iv) as an applicable document of NEPRA.

DA/Addendum No.2 (Revision-1) (16x Pages)

02 12 19.

(Syed Safeer Hussain)

CC (along with copy of approved Addendum No.2 (Revision-1) to the Grid Code)

1. Principal Secretary to the Prime Minister, Prime Minister Secretariat, Islamabad.
2. The Secretary, Cabinet Division, Cabinet Secretariat, Islamabad.
3. The Secretary, Ministry of Energy, A-Block, Pak. Secretariat, Islamabad.
4. The Secretary, Ministry of Environment, (Climate Change Division), 3rd Floor, Local Government and Rural Development Complex, Near State Bank, Sector G-5/2, Islamabad
5. Secretary, Energy & Power Department, Government of Khyber Pakhtunkhwa, First Floor, A-Block, Abdul Wali Khan Multiplex, Civil Secretariat, Peshawar.
6. Secretary, Energy Department, Government of the Punjab, 8th Floor, EFU House, Main Gulberg, Jail Road, Lahore
7. Secretary, Energy Department, Government of Sindh, 3rd Floor, State Life Building No. 3, Opposite CM House, Dr. Zia-ud-Din Ahmad Road, Karachi.
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10. Managing Director, Power and Infrastructure Board (PPIB), Plot No. 10, 2nd Floor, Emigration Tower, Mauve Area, Sector G-8/1, Islamabad

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12. CEO, Central Power Purchasing Agency Guarantee Limited (CCPA-G) Shaheen Plaza, 73-West, Fazl-e-Haq Road, Islamabad.

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15. CEO, Peshawar Electric Supply Company (PESCO) WAPDA House, Shami Road, Peshawar.

16. CEO, Tribal Area Electric Supply Company (TESCO), WAPDA House, Shami Road, Peshawar.

17. CEO, Islamabad electric Supply Company (IESCO), Street # 40, G-7/4, Islamabad.

18. CEO, Gujranwala Electric Power Company (GEPCO), 565/A, Model Town GT Road, Gujranwala.

19. CEO, Lahore Electric Supply Company (LESCO), 22-A, Queen's Road, Lahore.

20. CEO, Faisalabad Electric Supply Company (FESCO), Canal Road, Abdullah Pur, Faisalabad.

21. CEO, Multan Electric Power Company (MEPCO), MEPCO Complex, WAPDA Colony, Khanewal Road, Multan.

22. CEO, Hyderabad Electric Supply Company (HESCO), WAPDA House, Hussainabad, Hyderabad.

23. CEO, Quetta Electric Supply Company (QESCO), Zarghoon Road, Quetta.

24. CEO, Sukkur Electric Power Company (SEPCO), Administration Block, Thermal Power Station, Old Sukkur.

25. CEO, K-Electric Limited (KE), House No. 39-B, Sunset Boulevard Phase-II, Defense Housing Authority, Karachi.

26. CEO, Central Power Generation Company Ltd. (CPGCL) Guddu, Thermal Power Station, Guddu (Kashmore).

27. CEO, Jamshoro Power Company Ltd. (JPCL) Thermal Power Station, Mohra Jabal, Dadu Road, Jamshoro.

28. CEO, Northern Power Generation Co. Ltd. (NPGCL) Thermal Power Station Mahmood Kot Road. Muzaffargarh.

29. CEO, Lakhra Power Generation Co. Ltd. (LPGCL) 150 MW FBC Power Station Lakhra Sehwan Road, near Manzoor Abad Lakhra, Khanot, District Jamshoro.

30. Member (Power), WAPDA, WAPDA House Lahore.

31. General Manager (HYDEL), WAPDA, WAPDA House Lahore.

32. Member (Power), Pakistan Atomic Energy Commission, Islamabad.

33. The World Bank, 20-A, Shahrah-e-Jamhuriat, Sector G-5/1, Islamabad.

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35. USAID Pakistan, American Embassy, Ramna 5, Diplomatic Enclave, Islamabad.

36. Chief Executive Access Electric (Pvt.) Limited C/o Horwath Hussain Chaudhry & Co. 25-E, Main Market, Gulberg, Lahore.

37. Company Secretary, AJ Power (Private) Limited 127-S, Quaid-e-Azam Industrial Estate, Township, Kotlakhpat, Lahore.

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39. Authorized Representative, Best Green Energy Pakistan Limited House No. 29-B, Tech Society, Canal Bank, New Campus, Lahore.

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44. Director First Solar (Pvt.) Limited House No. 10-B, Street No. 26, Sector F-8/1, Islamabad.

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46. Company Secretary, Harappa Solar (Private) Limited, 1485/C-2A, Asad Jan Road, Lahore Cantt, Lahore.

47. Chief Executive Officer, Helios Power (Private) Limited, G-30/4, KDA Scheme No. 5, Block-8, Clifton, Karachi.

48. Chief Executive Officer, HNDS Energy (Private) Limited, G-30/4, KDA Scheme No. 5, Block-8, Clifton, Karachi.

49. Chief Financial Officer, Lalpir Solar Power (Private) Limited, 1-B, Aziz Avenue, Canal Bank, Gulberg-V, Lahore.

50. Chief Executive Officer Ourson Pakistan Limited, 10 All Block, New Garden Town, Lahore.

51. Chief Executive Officer Quaid-e-Azam Solar Power (Pvt.) Limited 3rd Floor, 83-A, E/1, Main Boulevard, Gulberg III, Lahore.

52. Project Director, Ramzan Energy Limited 55-K Model Town, Lahore.

53. Director Energy Projects Roshan Power (Private) Limited 10-11 Gurumangat Road, Gulberg-III, Lahore.

54. Director Safe Solar Power (Pvt.) Limited House No. 28, Street No. 24, Sector F-8/2, Islamabad.

55. Managing Director, Sanjwal Solar Private (Limited), Wah Industries Limited, Quaid Avenue Wah Cantt.

56. Director Shams Power (Private) Limited, Al-Maalik Building, 19-Davis Road, Lahore.

57. Chief Executive Officer Siachen Energy Limited (SEL), 4th Floor, Plot 36-C, Lane 13, Bukhari Commercial Area, Phase VI, DHA, Karachi.

58. Chief Executive Officer Zhenfa Pakistan New Energy Company (Private) Limited. 6th Floor, 10-C, Liberty Gate Plaza, MM Alarn Road. Gulberg III, Lahore.

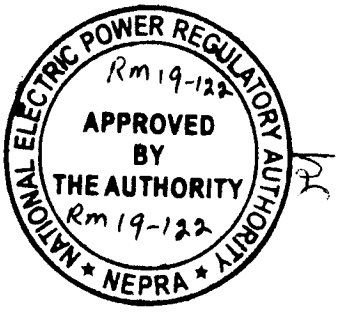
59. Country Manager, Zorlu Solar Pakistan (Private) Limited, C-1 17, Clifton, Block 2, Karachi.

National Transmission and Despatch Company Limited (NTDC)

Grid Code Addendum No.2 (Revision-1)

For
Grid Integration
of
Photovoltaic (PV) & Concentrated Solar Power (CSP) Plants

NOVEMBER, 2019



NTDC Grid Code Addendum No. 2 (Revision-1) for Grid Integration of Photovoltaic (PV) and Concentrated Solar Power (CSP) Plants

1. General

(i) This addendum is applicable only to grid-connected PV/CSP power plants.

(ii) This addendum becomes part of the Grid Code with immediate effect.

(iii) All other clauses of Grid Code, which are not covered by this addendum, if otherwise applicable as such, shall be applicable to Grid-connected PV/CSP Power Plants.

(iv) All relevant clauses of Grid Code, which are covered through this addendum, shall be treated as amended as per this addendum.

(v) Any provisions of this addendum which have not been previously provided in the Grid Code, shall now form part of the Grid Code, applicable to PV/CSP Power Plants including already Grid-connected PV/CSP power plants.

(vi) NEPRA may approve any subsequent modification to this addendum proposed by NTDC through the Grid Code Review Panel (GCRP). However, a Grid-connected PV/CSP Power Plant may operate, for its full EPA term, in compliance to the Grid Code prevailing at the time of its financial closing.

(vii) Notwithstanding anything contained in this Grid Code Addendum No. 2 (Revision-1) for PV/CSP Power Plants, the Regulator may review, amend, modify or change the Addendum from time to time.

2. Definitions

2.1 Black Start

As defined in the Grid Code.

2.2 Concentrated Solar Power Plant

An installation, with the capability of converting solar heat into steam to run steam turbine and generate electricity. The generator is a conventional synchronous generator and its technology is same as already covered in Grid Code.

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2.3 CSP unit
The basic generating unit in a CSP Plant that converts solar heat into electrical energy. A CSP Plant may have one or more CSP units.

2.4 Energy Purchase Agreement
The agreement, along with all schedules and annexures attached therewith, by and between the Seller and the Purchaser, for the purposes of sale and purchase of electrical energy from a power project.

2.5 Financial Closing
As defined in the relevant Energy Purchase Agreement (EPA).

2.6 Forecasting Error Rebate
This is the rebate that Seller would pay to purchaser against the error of forecasted Net Delivered Energy for a specified period as percentage of the Energy Payment invoiced by the Seller for the same period.

2.7 Grid Connected Power Plant
A power plant which can deliver electrical energy to the National Grid System /DISCO Systems.

2.8 High Voltage Ride Through (HVRT)
The capability of a generator to withstand the impact of high voltage swell, for a certain transient time, to remain connected to grid without being damaged, in case of external fault conditions.

2.9 Hybrid Generating System
A generating system in which the power plant utilizes more than one input power resources in order to overcome deficiencies in one or all resources.

2.10 Islanded Operation
Operational mode of a power plant in which it stands alone in generating electrical power and feeding a particular load with no other generator running in parallel.

2.11 Low Voltage Ride Through (LVRT)
The capability of a generator to withstand the impact of low voltage dip, for a certain transient time, to remain connected to grid without being damaged, in case of external fault conditions.

2.12 Net Delivered Energy
This is the net energy delivered to the grid at the Point of Common Coupling.

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2.13 Point of Common Coupling (PCC)

The point of connection for off-take of power from a PV/CSP Power Plant to the network of Transmission /Distribution Company. It may also be termed as Point of Connection (POC).

2.14 Purchaser

As defined in Energy Purchase Agreement (EPA).

2.15 PV Solar Power Plant

An installation, with the capability of converting solar light energy into electrical energy through photovoltaic (PV) cells/panels/modules.

2.16 PV/CSP Farm Controller

Master controller of entire PV/CSP Farm having supervisory control on all PV/CSP unit's local controllers and also controls all outputs/inputs to/from the Grid at Point of Common Coupling as shown in Figure-1

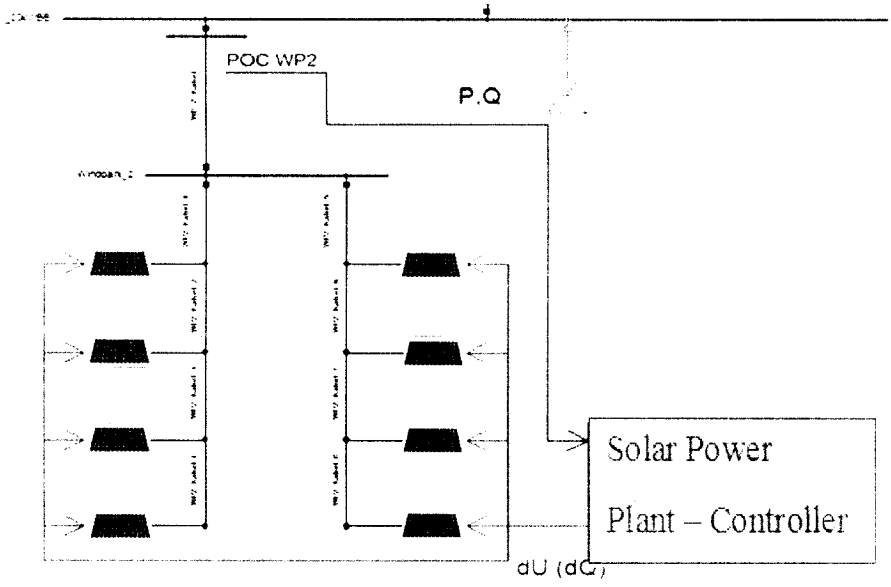

Figure-1

2.17 PV unit

Basic building block in a PV Solar Power Plant that may comprise one inverter or a set of inverters converting DC from PV panels to AC at low voltage (LV)

2.18 Ramp Rate

Upper limit of a generator in terms of rate of increase of real power (MW/min).

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2.19 Regulator
National Electric Power Regulatory Authority (NEPRA) established under Section 3 of NEPRA Act.

2.20 Retained Voltage
The value of voltage, normally in percentage of normal rated voltage, which persists at a particular point of a grid system in case of fault conditions.

2.21 Seller
As defined in Energy Purchase Agreement (EPA).

2.22 Strategic Generation Expansion Plan
Strategic Generation Expansion Plan covering all types and technologies of generation including all renewable resources and considering overall energy policies/priorities of Government.

2.23 Stuck Breaker Case
A case of fault condition at a grid system, in which the fault is not cleared by operation of the concerned breaker, being stuck, and is therefore cleared by the breaker(s) at zones other than faulty zone.

2.24 System Operator (SO)
The System Operator is National Transmission and Despatch Company (NTDC).

2.25 Term
The total period of Energy Purchase Agreement for sale and purchase of electrical energy.

3. PV/CSP Technology Requirements

(i) The criteria of PV/CSP unit selection shall be based on compatibility with the National Grid System/DISCO Systems, improved operating performance, and optimal efficiency.

(ii) Sizing and siting of a solar park would be carefully determined in view of techno-economic viability of grid interconnection and radiance levels.

4. Solar Power Plant Data Requirements

(i) A PV Solar Power Plant will be required to provide its data applicable to Grid side interface in terms of voltage, current, frequency, active and

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reactive power, and power quality related issues of harmonics, flicker and unbalance.

(ii) Data requirements of generators in CSP power projects would be the same as already mentioned in the Grid Code for conventional synchronous generator. However the solar thermal capabilities in terms of site specific heat radiance, thermal units (BTU or else), heat rates and efficiency etc. would be provided in addition.

5. Black Start and Islanded Operation Requirements

(i) A PV/CSP power plant is exempted from Black Start and Islanded Operation for full Term of Energy Purchase Agreement.

(ii) In case of blackout, PV Power Plants will be required to be disconnected from the Grid. The PV Inverter will have anti-islanding protection built in; it will inject small pulses that are slightly out of phase with the AC electrical system in order to cancel any stray resonances that may be present when the grid shuts down.

6. Synchronization / De-Synchronization

(i) A PV/CSP Power Plant shall, through appropriate necessary equipment be capable of managing, without feeling jerk(s) on the National Grid System / DISCO Systems, the following:

(a) Smooth synchronization
(b) Smooth de-Synchronization

7. Active Power and Frequency Control

(i) Grid-connected PV/CSP Power Plants shall be exempted from the responsibility of frequency regulation and controlfor the "Frequency Sensitive Mode" which is defined by the range between 49.8Hz and 50.2Hz according to OC 4.8.1 (c, ii) of the Grid Code.

(ii) Above 50.2Hz, when frequency enters "Tolerance Frequency Band", with upper range defined as 50.5Hz according to OC 4.8.1 (c, iii), of the Grid Code, all the Grid-connected PV/CSP Power Plants should contribute to a frequency stabilization by reducing active power as described in Figure-2 below:

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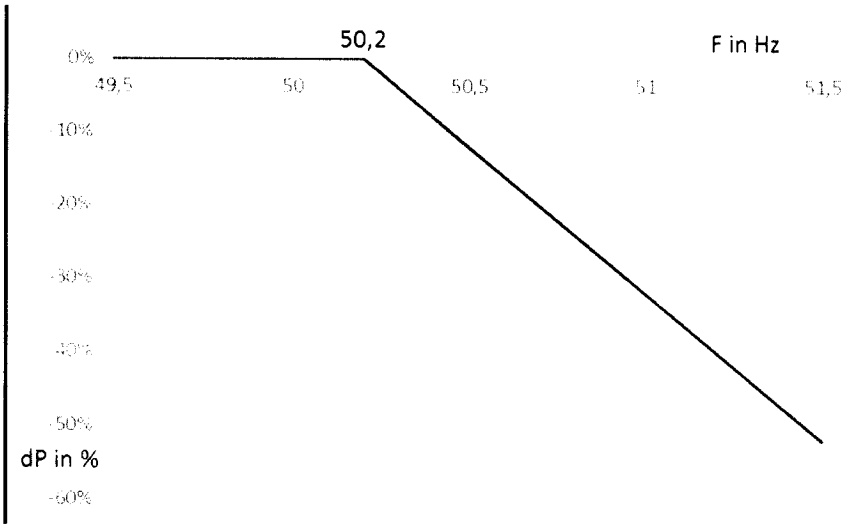

Figure-2

(iii) For under-frequency dips when frequency enters "Tolerance Frequency Band", with lower range defined as 49.5Hz according to OC 4.8.1 (c, iii), of the Grid Code, the Grid-connected PV/CSP Power Plants of sizes of 49 MW and above should have the technical capability for primary and secondary control and contribute to frequency stabilisation by maintaining appropriate active power reserve in proportion to available power of Plant dependent on availability of light at the instant when such variations would occur.

(iv) For steady state frequency regulation, all Gird connected PV/CSP Power Plants, shall be capable of managing the following, as per dispatch instructions by System Operator (NPCC/RCC/or Any Licensed Dispatcher):-

(a) Increasing or decreasing of active power output in steps of 10 % of the rated power i.e. at a Ramp Rate of 10% of plant installed capacity per minute.

(b) There can be 4 or 5 or any set points agreed with NTDC such as 100%, 70%, 50%, 30% and 0% etc. which the PV Plant must achieve from any instantaneous operating point in any operation mode.

(c) Both (a) and (b) would be subject to appropriate availability of light at the instant when such variations are required.

8. Reactive Power and Voltage Control

APV/CSP Controller must be able to operate in either power factor, reactive power or voltage control as follows:

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(i) Power Factor:

A PV/CSP Power Plant shall manage at the point of interconnection the reactive power control to maintain the power factor within the range of 0.95 lagging to 0.95 leading, over the full range of plant operation, as per dispatch instructions and/or voltage adjustments/requirements within the above range of power factor.

(ii) Reactive Power

A PV/CSP Power Plant shall manage at the point of interconnection the reactive power control within the setpoints of Qmin and Qmax as Per Unit of full output of Plant as shown in Figure-3. The setpoints of Qmin and Qmax would be as follows:

Qmin = -0.33 P.U. of Full Output
Qmax = + 0.33 P.U. of Full Output

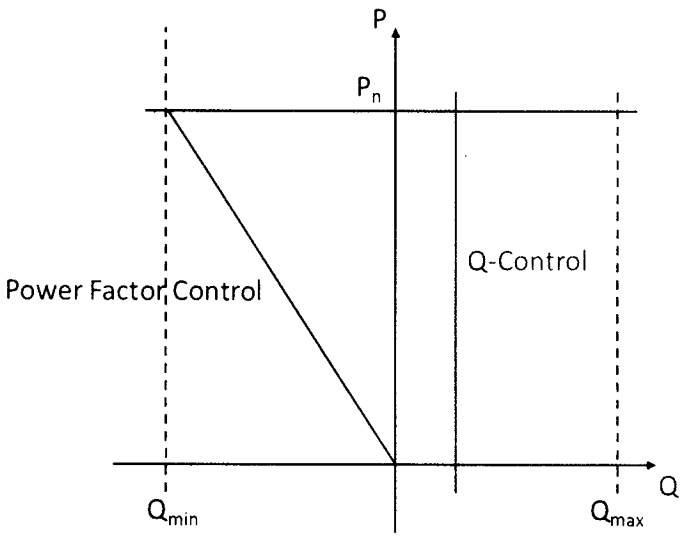

Figure-3

(iii) Voltage Control

A PV/CSP Power Plant must control voltage at POC along a voltage vs. reactive power characteristic as shown in Figure 4. The following parameters are set as

- Voltage offset: ±5 % under normal operating conditions and ± 10 % during contingency conditions.
- Reactive power offset: ±0.33 PU of Full Output of Plant.
- Droop (5% of nominal voltage at max. reactive power).

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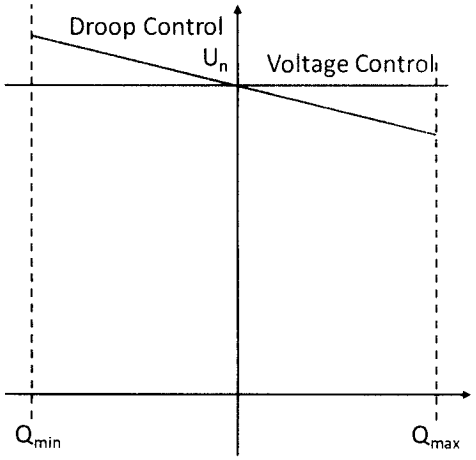

Figure-4

9. Power Quality Requirements

(i) Power quality parameters, of power output of a PV/CSP Power Plant shall be governed, for full Term of Energy Purchase Agreement, by latest relevant IEC Standards(IEC 60904, 61850 and any other relevant to PV or batteries, amended time to time) prevailing at the time of Financial Closing.

(ii) The Seller shall, as part of Grid Interconnection Study before, establish the fact that harmonic emissions from the Plant and other Power Quality indices will be complied as per IEC Standards.

(iii) Power Quality parameters, for implementation of clause 9(i) shall be observed at the Point of Interconnection of the grid connected PV/CSP Power Plant with the National Grid System/DISCO Systems.

(iv) For continuous monitoring of power quality parameters, a PV/CSP Power Plant shall install and maintain necessary monitoring equipment, at Point of Interconnection.

10. LVRT/HVRT Requirements

(i) A PV/CSP Power Plant must stay connected for transient short duration low voltage dips with slow recovery i.e. called Low Voltage Ride Through (LVRT), and short duration high voltage swells i.e. called High Voltage Ride Through (HVRT).

(ii) A PV/CSP Power Plant must have the LVRT/HVRT capability as indicated in Figure-5. The PV/CSP units are required to stay connected

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in the voltage envelope below the HVRT curve and above the LVRT curve.

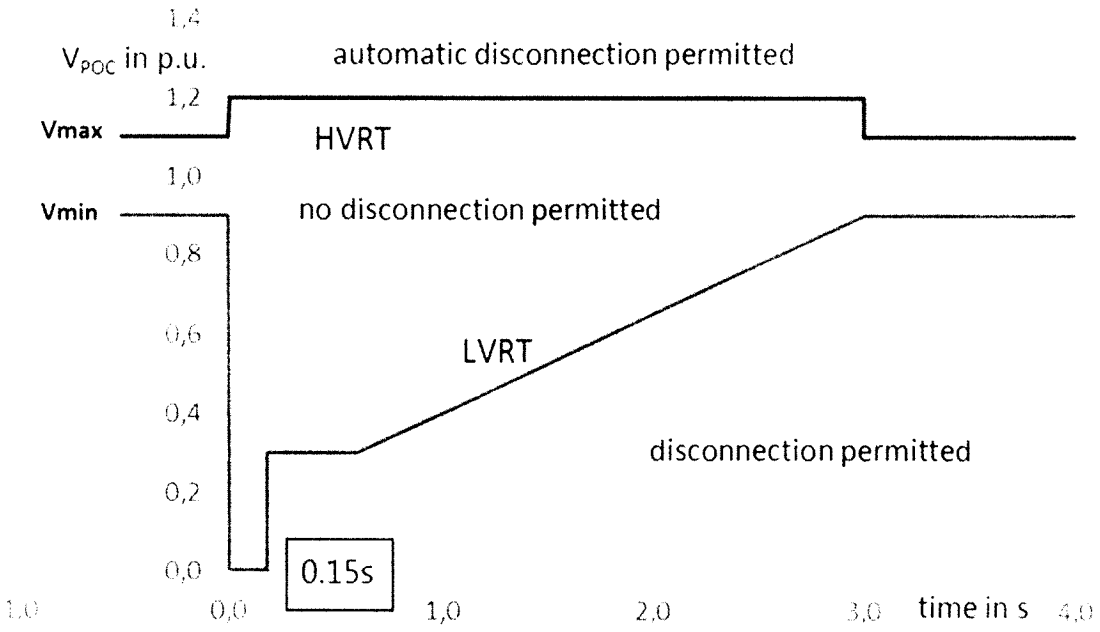

Figure-5

(iii) LVRT Requirements:

PV/CSP units must stay connected for

(a) Zero Voltage i.e. Zero Voltage Ride Through (ZVRT) for the initial duration of 150 ms.

(b) Recovered/Retained Voltage of 30 % for the next duration of 0.5s.

(c) Slow voltage recovery upto 0.9 PU in 3 seconds after occurrence of fault.

(d) PV/CSP units may disconnect if the voltage dips below these limits for longer durations as specified in the envelope.

(iv) HVRT Requirements:

(a) Voltage swell upto 1.2 PU for the duration of 3s.

(b) Voltage recovers to 1.1 PU in 3 seconds after occurrence of fault.

(c) PV/CSP units may disconnect if the voltage swells higher than this limit or for longer duration as specified in the envelope.

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(v) Reactive current support during LVRT/HVRT situations:

In order to actively support voltage during low voltage situations (LVRT-situations), a PV/CSP Plant must inject additional reactive current into the grid.

Likewise, in order to actively reduce the voltage and help keep the voltage within reasonable limits during high voltage conditions, a PV/CSP Power Plant must absorb reactive current. The characteristics of reactive current support are indicated in Figure-6.

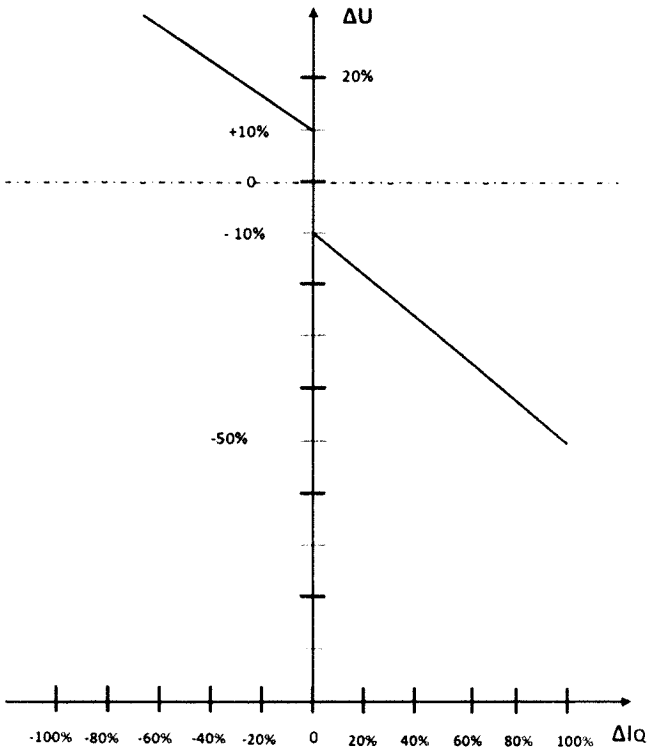

Figure-6

According to this diagram, a PV/CSP unit will inject an additional reactive current (DIq in addition to the pre-fault reactive current) into the grid if the difference between post-disturbance and pre-disturbance voltage (DU) goes below -10%.

In the case that DU goes above 10%, a high voltage condition is identified and a DI will be absorbed in order to stabilize the voltage.

It is further recommended that DI is defined as being in proportion to DU (the factor of proportionality is then named "K").

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Besides this, the definition of reactive current support shall include the following:-

(a) It applies to both, symmetrical and asymmetrical.

(b) Voltage and Current means, deviation of positive sequence voltage and currents post-fault from pre-fault values.

(c) The support is required at the generator terminals and not at POC because POC is almost impossible to implement.

(d) The value of is settable, 0<=K<=10 -> reactive current support can be disabled).

(e) Dynamic performance requirement for this support is 60ms, well below minimum fault clearing times.

(f) The accuracy of reactive current injection within the tolerance band of +/-20% of the given value.

(g) The limitation of this current would be absolute current value to rated current.

(h) The minimum voltage threshold for the applicability of the reactive current support would be 10%, meaning that below a retained voltage of 10%, reactive current injection is not required.

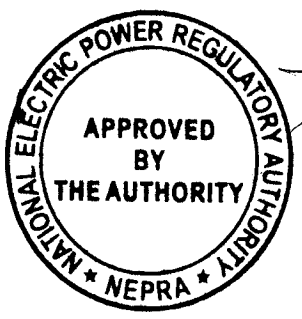
(vi) The PV/CSP Power Plant shall manage active power restoration, after the voltage recovery, at a rate of at least 20% of nominal output power per second, subject to availability of adequate light at site. However active power recovery must not be faster than a rate of 50% of nominal power per second. The active power has to be ramped up to pre-fault level (or maximum available power), or at least to 90% of pre-fault level.

(vii) The PV/CSP Power Plant must manage reactive power restoration, after voltage recovery, such that post-fault reactive power must not be below pre-fault reactive power with a minimum tolerance of 10 % and maximum delay time of 200 ms after fault clearance.

11. Signalling and Control

A PV/CSP Power Plant shall establish bi-directional communication link with NPCC which would be interfaced with NPCC SCADA system.

In order to allow the System Operator to monitor actual and forecasted power outputs of PV/CSP power plants and for ensuring that active power can be curtailed for congestion management and plants can be tripped in emergency



situations, bi-directional communication links between the NPCC and the plant operator must be put in place and interfaced with the NPCC SCADA System.

In addition to active power control signals, voltage/reactive power control modes and setpoints have to be exchanged. For this purpose, clear standards with regard to communication technology, interfaces with the System Operator's system etc. have to be specified in the EPA.
A signalling List is attached as Appendix-1

12. Power Generation Capability Forecasting Requirements

Forecasting of Net Delivered Energy from the PV/CSP Power Plant would be carried out as follows:

(a) For and following the Commercial Operations Date, the Seller shall provide the forecasts of Net Delivered Energy to the Control Centre and to the Purchaser through the Forecasting Arrangement using state-of-the-art methodology as follows:

(i) **Hourly Forecast**: Not later than four (4) hours before the start of each hour, a forecast of Net Delivered Energy for the said hour, provided, the Seller may revise once, and only once, the forecast for the said hour no later than three (3) hours prior to the commencement of the hour for which the forecast is revised;

(ii) **Four Hourly Forecast**: Not later than eight (8) hours before the start of each four (4) hour period, a forecast of Net Delivered Energy for such four (4) hour period, provided, the Seller may revise once, and only once, the forecast for any four (4) hour period no later than six (6) hours prior to the commencement of the four (4) hour period for which the forecast is revised;

(iii) **Day Ahead Forecast**: Not later than twelve (12) hours prior to the beginning of each Day, the Seller shall notify the Purchaser (or revise any such information previously given) of the estimated net output of the PV/CSP Power Plant in MWh which is likely to be generated for each hour of such Day;

(iv) **Month Ahead Forecast**: Not later than one (1) Week before the beginning of each Month, the Seller shall notify the Purchaser (or revise any such information previously given) of the Month ahead forecast of estimated net output of the PV/CSP Power Plant in MWh which it is likely to generate for each Week of such Month; and

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(v) **Year Ahead Forecast**: not later than thirty (30) Days before the beginning of each Agreement Year, the Seller shall notify the Purchaser (or revise any such information previously given) of the year ahead forecast of estimated net output of the PV/CSP Power Plant in MWh which it is likely to generate for each Month of such Agreement Year.

(b) The Hourly Forecasts (as may be revised in accordance with Section 12(a)(i)) shall be binding on the Seller.

(c) The Hourly Forecast Error shall be determined using the following formula:

$$(Hourly\ Forecast\ Error_h) = \left(\frac{((NDE_h + X) - (Forecast\ Energy_h))}{Contract\ Capacity \times 0.98}\right) \times 100$$

where;

$Hourly\ Forecast\ Error_h$	=	Hourly Forecast Error for the hour "h"
NDE_h	=	Net Delivered Energy for the hour "h"
$Forecast\ Energy_h$	=	forecast energy for the hour "h"
X	=	forecast energy not generated due to Non Project Events in the hour "h"

(d) The Monthly Mean Absolute Error shall be determined using the following formula:

$$(Monthly\ Mean\ Absolute\ Error_m) = \frac{\sum_1^n (Hourly\ Forecast\ Error_h)}{n}$$

where;

$(Monthly\ Mean\ Absolute\ Error_m)$	=	Monthly Mean Absolute Error for the Month "m"
$(Hourly\ Forecast\ Error_h)$	=	Hourly Forecast Error for the hour "h" during the relevant Month "m"
n	=	*Number of Hourly Forecast Error$_h$ values during the relevant month "m"*

(e) The Annual Mean Absolute Error shall be determined using the following formula:

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$$(Annual\ Mean\ Absolute\ Error_y) = \frac{\sum_1^n (Monthly\ Mean\ Absolute\ Error_m)}{n}$$

where;

$(Annual\ Mean\ Absolute\ Error_y)$	=	Annual Mean Absolute Error for the relevant Year "y"
$(Monthly\ Mean\ Absolute\ Error_m)$	=	Monthly Mean Absolute Error for the Month "m" during the relevant Year "y"
n	=	*Number of Monthly Mean Absolute Error$_m$ values during the relevant Year "y"*

13. Limitation on Total Grid Connected Solar Power Capacity

(i) This addendum allows integration of PV/CSP Power Plants to National Grid /DISCO Systems upto a maximum total power limited to a value that does not deteriorate the overall quality of power of Grid Systems beyond international IEC Standards.

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Appendix-I

Signal List 1 – General

(1) The PV/CSP power plant operator shall make the following signals available at a System Operator designated communication gateway equipment located at the plant site:

(a) Actual sent-out (MW) at the POC
(b) Active Power Ramp rate of the entire PV/CSP power plant
(c) Reactive Power Import/Export (+/-Mvar) at the POC
(d) Reactive power range upper and lower limits
(e) Power Factor
(f) Voltage output
(g) Echo MW set point
(h) Echo Mvar set point
(i) Echo Voltage set point
(j) Protection relay operations
(k) Alarms, indicators and event updates

Signal List 2 – PV/CSP Plant Availability Estimates

(1) PV/CSP power plant operator shall make available the following signals at System Operator designated communication gateway equipment located at the PV/CSP power plant site:

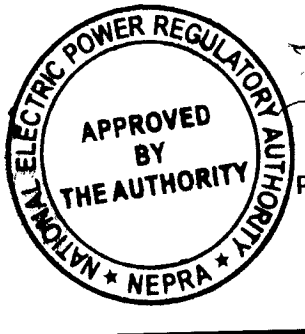
(a) Available MW and forecast MW for the next 24 hours updated hourly on the hour (alternatively: 15min).

(b) Available range of Mvar capability for the next 24 hours updated hourly on the hour (alternatively: 15min).

Signal List 3 – PV/CSP Plant MW Curtailment Data

(1) The PV/CSP power plant operator shall make the following signals available at a System Operator designated communication gateway equipment located at the PV/CSPpower plant site:

(a) MW Curtailment facility status indication (ON/OFF) as a double bit point. This is a controllable point which is set on or off by the SO. When set "On" the power plant shall then clarify and initiate the curtailment based on the curtailment set point value below.



(b) Curtailment in progress - digital feedback. This single bit point will be set high by the power plant while the facility is in the process of curtailing its output.

(c) MW Curtailment set point value (MW- feedback).

(2) In the event of a curtailment, the SO will pulse the curtailment set point value down. The power plant response to the changed curtailment value will be echoed by changing the corresponding echo MW value. This will provide feedback that the power plant is responding to the curtailment request.

Signal List 4 – Frequency and Voltage response system settings

(1) The PV/CSP power plant operator shall make the following signals available at a SO designated communication gateway equipment located at the power plant site:

(a) Frequency Response System mode status indication (ON/OFF) as a double bit point.

(b) Voltage control system mode status indication (ON/OFF) as a double bit point.