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National Electric Power Regulatory Authority Islamic Republic of Pakistan

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No. NEPRA/R/SGC-01/7464-75²⁰

June 30, 2014

Managing Director
National Transmission & Despatch Co. Ltd. (NTDC),
414 WAPDA House, Shahrah-e-Quaid-e-Azam,
Lahore

Subject: Grid Code Addendum No. II for Grid Integration of Photovoltaic (PV) & Concentrated Solar Power (CSP) Plants.

Reference: Your letter no. COO/GM/CPA/CE-II/MT-IV/GCRP/2939-43 dated May 12, 2014.

Enclosed please find Grid Code Addendum No. II approved by the National Electric Power Regulatory Authority for Grid Integration of Photovoltaic (PV) & Concentrated Solar Power (CSP) Plants as an applicable document of NEPRA.

DA/Addendum No. II (05 Pages)

(Syed Safeer Hussain)

CC (along with copy of approved Addendum No. II 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 Water & Power, A Block, Pak. Secretariat, Islamabad.
4. The Secretary, Ministry of Environment, Government of Pakistan, Local Government Building, G- 5/ 2, Islamabad.
5. Managing Director, Pakhtunkhaw Hydel Development Organization (PHYDO), WAPDA House, Sakhi Chashma, Peshawar
6. Managing Director, Punjab Power Development Board, Government of Punjab, 1st Floor, Central Design Building, Irrigation Secretariat, old Anarkali, Lahore.
7. Chief Executive Officer, Alternative Energy Development Board, 2nd Floor, OPF Building, G-5/2, Islamabad
8. Managing Director, Private Power Infrastructure Board (PPIB), 50, Nazimuddin Road, F/7/4, Islamabad.

9. Secretary, Environment & Alternative Energy Department, Government of Sindh, Plot No. ST2/1, Sector 23, Korangi Industrial Area, Karachi
10. Secretary, Energy Department, Room No. 6, 2nd Floor, Block # 09, Civil Secretariat, Zarghoon Road, Quetta
11. Secretary, Energy Department, Government of Punjab, Irrigation Secretariat, Old Anarkali, Lahore
12. Secretary, Government of Khyber Pakhtunkhwa, Finance Department, Energy Monitoring Cell, 2nd Floor, Benevolent Fund Building, Peshawar Cantt
13. Secretary Energy Department, Government of Sindh, Barrack No. 8-A, Sindh Secretariat No. 4-A, Court Road, Karachi.
14. Managing Director, Pakistan Electric Power Company Ltd. (PEPCO), 189, WAPDA House, Shahrah-e-Quaid-e-Azam, Lahore
15. Chief Executive Officer, Islamabad Electric Supply Company (IESCO), Street No. 40, G-7/4, Islamabad
16. Chief Executive Officer, Gujranwala Electric Power Company (GEPCO), 565/A, Model Town G.T. Road, Gujranwala
17. Chief Executive Officer, Faisalabad Electric Supply Company (FESCO), Abdullahpur, Canal Bank Road, Faisalabad
18. Chief Executive Officer, Quetta Electric Supply Company (QESCO), 14-A Zarghoon Road, Quetta
19. Chief Executive Officer, Lahore Electric Supply Company (LESCO), 22-A, Queen's Road, Lahore
20. Chief Executive Officer, Multan Electric Power Company (MEPCO), MEPCO Complex, WAPDA Colony, Khanewal Road, Multan
21. Chief Executive Officer, Hyderabad Electric Supply Company (HESCO), WAPDA Water Wing Complex, Hussainabad, Hyderabad
22. Chief Executive Officer, Peshawar Electric Supply Company (PESCO), WAPDA House, Sakhi Chashma, Shami Road, Peshawar
23. Chief Executive Officer, Sukkur Electric Power Company Limited, SEPCO Headquarter
24. Old Thermal Power Station, Sukkur
25. Chief Executive Officer, Tribal Area Electricity Supply Company (TESCO), 213-WAPDA House, Shami Road, Sakhi Chashma, Peshawar
26. Chief Executive Officer, K-Electric, (*formerly Karachi Electric Supply Company Ltd.*)
27. KESC House, Phase-II, Sunset Boulevard, DHA, Karachi

28. Member (Power), WAPDA, 738 - WAPDA House, Shahrah-e-Quaid-e-Azam, Lahore
29. General Manager (Hydel), WAPDA, WAPDA House, Room No. 186, Lahore
30. Member (Power), Pakistan Atomic Energy Commission, P.O. Box No. 1133, Islamabad
31. Chief Executive Officer, Jamshoro Power Co. Ltd., Mohra Jabal, New Dadu Road, Jamshoro
32. Chief Executive Officer, Central Power Generation Co. Ltd. Guddu, Kashmore
33. Chief Executive Officer, Northern Power Generation Co. Ltd., Mahmood Kot Road
34. Thermal Power Station, Muzaffargarh.
35. Chief Executive Officer, Lakhra Power Generation Co. Ltd., 150 FBC Power Station Lakhra, Sehwan Road, Near Manzoor Abad, Lakhra, Khanot.
36. The World Bank, Sector G-5, Islamabad
37. Asian Development Bank, Hotel Serena, Islamabad
38. USAID Pakistan, American Embassy, Ramna 5, Diplomatic Enclave, Islamabad.
39. Director, Safe Solar (Private) Limited, House No. 28, Street No. 24, Sector F-8/2, Islamabad
40. Chief Executive, Access Electric (Pvt.) Limited, C/o Horwath Hussain Chaudhry & Co.
41. 25-E, Main Market, Gulberg, Lahore
42. Chief Executive, Access Solar (Private) Limited, C/o Horwath Hussain Chaudhry & Co.
43. 25-E, Main Market Gulberg, Lahore-54660
44. Managing Director, Sanjwal Solar Power (Private) Limited, Wah Industries Limited, Quaid Avenue, Wah Cantt.
45. Director, Buksh Energy (Private) Limited, 54, D-1, Sir Syed Road, Gulberg-III, Lahore
46. Phone: 042-35716401-406
47. Director, First Solar (Private) Limited, House No. 591, Ibn-e-Sina Road, Sector G-9/3, Islamabad
48. Director Energy Projects, Roshan Power (Pvt.) Limited, 10-11 Gurumangat Road, Gulberg-III, Lahore
49. General Manager, Realforce Ruba Pakistan Power (Pvt.) Limited, 8th Floor, Mega Tower,
50. 63-B, Main Boulevard, Gulberg-II, Lahore

51. Chief Executive Officer, Quaid-e-Azam Solar Power (Pvt.) Limited, 3rd Floor, 83-A, E/1,
52. Main Boulevard, Gulberg III, Lahore
53. Chief Executive Officer, DACC Power Generation Company (Pvt.) Limited, House No. 2-B, Street No. 14, Sector F-8/3, Islamabad
54. Director, Blue Star Energy (Private) Limited, House No. 37/B, Street 1, Askari 10, Lahore Cantt, Lahore
55. Chief Executive, Hydrochina Dawood Power (Private) Limited, 1900-B, Saima Trade Towers, I.I. Chundrigar Road, Karachi-74000
56. Managing Director, Global Solar (Pvt.) Limited, House No. 6, Street No. 3, Sector F-8/3, Islamabad

**NATIONAL TRANSMISSION & DESPATCH COMPANY LTD.
(NTDCL)**

GRID CODE ADDENDUM-II

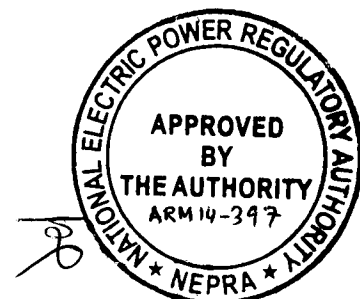
FOR

GRID INTEGRATION

OF

**PHOTOVOLTAIC (PV) & CONCENTRATED
SOLAR POWER (CSP) PLANTS**

JUNE, 2014



NTDC Grid Code Addendum No. 2 dated /06 /2014
for Grid Integration of Photovoltaic (PV) and Concentrated Solar Power
(CSP) Plants

1. General

- (i) This addendum is applicable to only Grid Connected PV/CSP power plants.
- (ii) This addendum becomes part of 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 Grid Code, applicable to PV/CSP power plants only.
- (vi) Regulator 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 Grid Code prevailing at the time of its financial closing.
- (vii) Notwithstanding anything contained in this Grid Code Addendum No.2 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

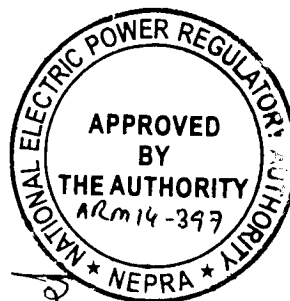
As defined in the Grid Code.

2.2 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 solar power project.

2.3 Financial Closure

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



2.4 Grid Connected Power Plant

A power plant which can deliver Electrical Energy to the National Grid System/DISCO systems.

2.5 PV/CSP Hybrid Generating System

A Generating System in which the power plant utilizes more than one input power resources.

2.6 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.

2.7 Low Voltage Ride Through (LVRT)

The capability of a Generator to withstand the impact of low voltage dip, for a certain time, to remain connected to Grid without being damaged, in case of external fault conditions.

2.8 Ramp Rate

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

2.9 Regulator

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

2.10 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.

2.11 Solar Inverter (Grid – Connected)

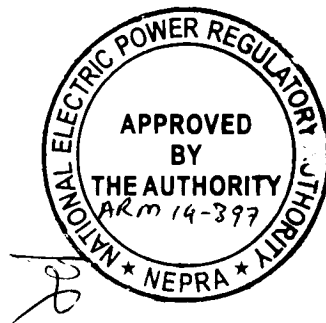
Device that converts variable Direct Current (DC) output of the Photovoltaic (PV) modules into the Alternating Current (AC) of Grid frequency with control system capability to deliver both active and reactive power, in synchronism with the three-phase system and matching with the sinewave of the grid.

2.12 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.

2.13 Term

The total period of Energy Purchase Agreement for Sale and Purchase of electrical energy.



2.14 PV Solar Power Plant

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

2.15 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.

3. Solar Power Technology Requirements in the Grid (Not Applicable for conventional synchronous generators in the existing Grid Code)

- (i) 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 (Refer to existing Grid Code Clause OC 4.6, and Appendix A Part-2 Clauses PC.A.3.3.1, 3.3.2 and 3.3.3)

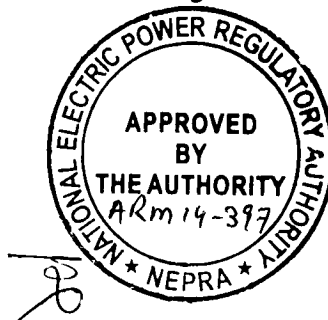
- (i) A PV Solar Power Plant will be required to provide its data applicable to Grid side interface in terms of voltage, current, frequency, active and reactive power, and power quality related issues of harmonics, flicker and unbalance.
- (ii) Data requirements of generators in CSP power projects would 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 (Refer to existing Grid Code Clauses OC 12.1.2, 12.3.6, OC 12.5, SDC 2.4.2.15, SDC 3.1)

- (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 (Refer to existing Grid Code Clause SDC 2.4.2.14)

- (i) A PV/CSP power plant will manage for :-



- (a) Smooth Synchronization
 - (b) Smooth De-Synchronization
- (ii) The above operations, achieved through appropriate equipment, will be without jerk(s).

7. Active Power and Frequency Control(Refer to existing Grid Code Clauses OC 1.2(a), SDC 1.4.3.3 (g), SDC 1.4.3.11, SDC 2.4.2.18, SDC 2.A.4 and SDC 3,

- (a) PV Solar Power Plant must be capable of 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.

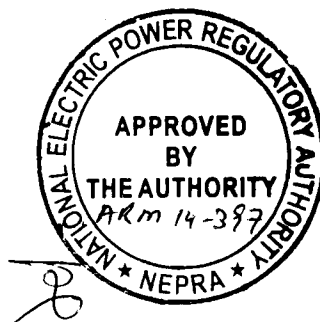
8. Reactive Power and Voltage Control (Refer to existing Grid Code Clauses CC 5.4 Technical, Design and Operational Data Clause e (ii)

A PV Solar Power Plant will manage the following at interconnection point.

- (i) Reactive Power Control to maintain the power factor within the range of 0.95 lagging to 0.95 leading, at full active power output, according to Dispatch Instructions/Voltage adjustment requirements.
- (ii) The provisions of clause 8(i) will be reviewed as and when required by GCRP

9. Power Quality Requirements (Refer to existing Grid Code Clause CC 5.4 Technical, Design and Operational Data Clause a (iii)

- (i) Power quality parameters, of power output of a PV Solar Power Plant, will be governed by relevant IEC Standards such as IEC 60904, 61850 and any other relevant to PV or batteries.
- (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) Monitoring of power quality parameters, for implementation of clause 9(i), will be observed at interconnection point of the PV Solar Power Plant.



- (iv) For continuous monitoring of power quality parameters, a PV Solar Power Plant will install and maintain necessary monitoring equipment, at site.
- (v) Clause 9(i), 9(ii) and 9(iii) will be applicable to the Grid Connected PV solar capacity except any related revision of Grid Code.

10. Low Voltage Ride Through (LVRT) Requirements (Not Applicable for conventional synchronous generators in the existing Grid Code)

- (i) A PV Solar Power Project must withstand a voltage dip down to 30% Retained Voltage for a duration of at least 100 ms for a normal clearing case and at least for 180 ms in case of Stuck Breaker.
- (ii) The PV Solar Power Project will manage active power restoration, after voltage recovery, at a rate of at least 20% of nominal output power per second.
- (iii) Revision of clause 10 will be necessary for any addition of Grid Connected PV Solar power capacity greater than the value stated in the Clause 3.

11. Power Generation Capability Forecasting Requirements (Refer to existing Grid Code Clause SDC 1.4.3.11, SDC 2.4.1.3 and SDC 3.7)

- (i) Power Generation Capability Forecasting will be managed by a PV/CSP solar power plant for the tentative estimation but it will not be binding as of conventional power plants.
- (ii) The forecasting, as required at 11(i), will be estimated by PV/CSP power plant through:
 - (a) Expected availability of plant during the period of forecast.
 - (b) Predicted value of irradiation at site based upon analysis of historic irradiation data available.
- (iii) The forecasting, as required at 11(i), will be on the basis of total PV and CSP power plant output and break-up for each solar module will not be required.

12. Limitation on Total Grid Connected PV/CSP Capacity (Not Applicable for conventional synchronous generators in the existing Grid Code)

- (i) In order to enable the Regulator to keep the total Grid Connected PV/CSP power capacity within allowed limit, no PV/CSP power plant will be connected to grid except after prior permission by NEPRA.

The End

