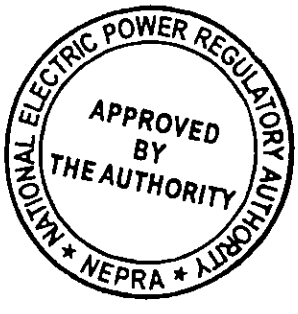
National Transmission and Despatch Company Limited (NTDC)

Grid Code Addendum No. 1

Grid Integration of Wind Power Plants

APRIL 2010



NTDC Grid Code Addendum No. 1
for Grid Integration of Wind Power Plants

1. General

(i) This addendum is applicable only to grid-connected wind 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 Wind 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 Wind Power Plants including already Grid-connected wind 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 Wind 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 any thing contained in this Grid Code Addendum No. 1 for Wind 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 Fixed Speed WTG
A WTG, whose rotor speed depends on wind speed with no arrangements to vary thus determined speed.

2.3 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.

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

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

2.6 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.

2.7 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.

2.8 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.

2.9 Pitch Control
The control which is capable of varying angle of blades of WTG thus changing energy perceived by WTG resulting in change of rotor speed.

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

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

2.12 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.

2.13 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.

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

2.15 Variable Speed WTG
A WTG having arrangements to vary its rotor speed.

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2.16 Wind Power Plant
An installation including equipment and devices attached therewith, with the capability of converting kinetic energy of wind into electrical energy.

2.17 Wind Turbine Generator (WTG)
A set of turbine, generator and other devices, capable of converting kinetic energy of wind into electrical energy.

3. Wind Turbine Generator Technology Requirements

The criteria of Wind Turbine Generator (WTG) selection shall be based on compatibility with the National Grid System/DISCO Systems, improved operating performance, and optimal efficiency.

4. Generator Data Requirements

A grid_connected Wind Power Plant shall be required to provide "Generator Data" applicable to the type of the Wind Turbine Generator (WTG) being installed. In addition, the Wind Power Plant shall provide Standard Planning Data as outlined in the Grid Code to the extent applicable.

5. Black Start and Islanded Operation Requirements

A Wind Power Plant is exempted from Black Start and Islanded Operation for full term of Energy Purchase Agreement.

6. Synchronization / De-Synchronization

A Wind 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 Wind Power Plants shall be exempted from the responsibility of frequency regulation and control.

(ii) Gird_connected Wind Power Plants, shall be capable of managing the following, through Pitch Control, disconnection/connection operations of the WTG or any other control, as per NPCC's dispatch instructions:-

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(a) Load adjustments in the range of zero to 100% of available power subject to availability of wind speed.

(b) A minimum Ramp Rate of 10% of plant available power per minute subject to availability of wind speed.

8. Reactive Power and Voltage Control

A Wind 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.

9. Power Quality Requirements

(i) Power quality parameters, of power output of the Wind Power Plant shall be governed, for full term of Energy Purchase Agreement, by latest relevant IEC Standards prevailing at the time of Financial Closing.

(ii) Power quality parameters, for implementation of clause 9(i) shall be observed at the Point of Interconnection of the grid_connected Wind Power Plant with the National Grid System/DISCO Systems.

(iii) For continuous monitoring of power quality parameters, a Wind Power Plant shall install and maintain necessary monitoring equipment, at its site.

10. Low Voltage Ride Through (LVRT) Requirements

(i) A Wind Power Plant must withstand a voltage dip down to 30% of Retained Voltage for a duration of at least 100 ms for a normal clearing case, and at least 180 ms in the case of a stuck breaker contingency event.

(ii) The Wind 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 wind speed at site.

11. Power Generation Capability Forecasting Requirements

(i) Power generation capability forecasting, of average power on an hourly basis, shall be provided by the Wind Power Plant, as required from conventional power plants, except provisions of clause 11(ii) & 11(iii) of this addendum.

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(ii) The forecasting, as required at 11(i), shall be estimated by Wind Power Plant through

(a) expected availability of plant during the period of forecast; and

(b) predicted value of wind speed at site based upon analysis of historic wind data available from the site.

(iii) The forecasting, as required at 11(i), shall be on the basis of total output from the Wind Power Plant, and the break-up for each WTG shall not be required.

(iv) The forecasted values shall not be binding upon the Wind Power Plant as actual wind speed may differ significantly from predicted values over short durations.

12. Limitation on Total Grid Connected Wind Power Capacity

(i) This addendum allows integration of Wind 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. Initially, this upper limit is set to be equal to 5% of the total installed grid_connected installed power (MW) capacity.

(ii) A modification to above-mentioned allowable limit of total grid_connected wind power capacity shall depend on the considerations including but not limited to the following:-

(a) data collected on operational behavior of grid_connected Wind Power Plants.
(b) power quality improvement with advances in wind power technology.
(c) the relevant methodologies successfully adopted at global level to facilitate Islanded Operation of Hybrid Generating Systems.
(d) increase/decrease in installed capacity of grid_connected conventional power plants.
(e) better forecasting approach by gaining operational experience and advancements in technology.
(f) report of a study conducted to amend the above limit.

(iii) In order to enable the Regulator to keep the total grid_connected wind power capacity within allowable limit, no wind power plant, irrespective of its capacity, shall be connected to the National Grid/DISCO Systems without prior authorization/approval by NEPRA.

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