# Form for seeking amendment(s) in the Saudi Arabian Grid Code

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| King Abdullah City for Atomic and Renewable Energy (K.A.CARE) | 26/Jan/2014 New version after 22nd GCSC Meeting dated 29/05/2014 | - 14A048  
- K.A.CARE Amendment 13 |

**Detail of the Applicant:**

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**Sections(s)/clauses of the Code to be affected by the proposed modification:**

GLOSSARY AND DEFINITIONS
2.5.5 New requirement to be added preferably after 2.5.5.10  
5.4.1 New requirement to be added preferably after 5.4.1.3  
5.4.2.2

**Brief description of the proposed modification:**

Color code: **Blue** = original GC text / **Orange** = submitted proposal January 2014 with enhancements from two workshops with all stakeholders / **Green** = enhanced proposal based on pending comments

The following amendments are proposed:

**GLOSSARY AND DEFINITIONS**

**Active Power Gradient Limitation of a Renewable Resource Generation**
A control mode of the Renewable Resource Generation which limits the maximum speed by which the Active Power output can be changed in the event of changes in Available Active Power or changes in the Active Power setpoints.

**Active Power Delta Regulation of a Renewable Resource Generation**
A control mode of the Renewable Resource Generation which constrains the Active Power output to a required constant value in proportion to the Available Active Power.

**Absolute Active Power Limitation of a Renewable Resource Generation**
A control mode of the Renewable Resource Generation which constrains the Active Power output to a predefined power MW limit.

**New Clause 2.5.5.14** *(Note: the affected existing clauses shall be adjusted accordingly, wherein existing clause 2.5.5.11 shall then become clause 2.5.5.15, and then the others shall be renumbered accordingly, please see Proposed Amendment Nos. 14A044 and 14A047).*

The Active Power output of the Renewable Resource Generation connected to the Network shall be controllable as long as technically feasible based on the Available Active Power.

i. The Renewable Resource Generation shall be capable of receiving a Dispatch Instruction containing a required setpoint of Active Power output, of Absolute Active Power.
Limitation of Active Power Delta Regulation and of Active Power Gradient, manually or through automatic remote control system.

ii. Generation shall be able to manually or automatically take into account the Dispatch Instruction.

iii. As long as the Active Power Output is not limited by the Available Active Power, the accuracy of the control performed and of the setpoint shall not deviate by more than 2% of the setpoint value or by 0.5% of the rated power, depending on which yields the highest tolerance and shall be reached in less than 10 minutes after the reception of the Dispatch Instruction.

5.4.1.4

The following modifications are proposed:

5.4.2.2 Dispatch Instruction given by the TSP to a non-Renewable Resource Generator for a specific Generating Unit may involve a change in the Active Power output, a change in the Reactive Power output, Synchronizing and De-synchronizing time (if appropriate), a change to the mode of operation, or to provide one or more of the contracted System Services. Dispatch Instruction to Renewable Resource Generation, shall be given by the TSP through the Saudi Sustainable Energy Control Center. Generation Dispatch Instructions for Active Power (sections 5.4.2, 5.4.3 and 5.4.4) of Renewable Resource Generation are limited to participation in Frequency Regulation. Active Power output, Absolute Active Power Limitation, Active Power Delta Regulation and Active Power Gradient as specified in Chapter 2: Connection Code.

Justification of the proposed modification (clearly state the reasons for proposing the modification. Attach additional supporting information, if necessary):

In order to be able to operate a power system with a large share of renewable, some capabilities are needed for each transmission connected renewable resource generation

- Curtailment of active power (operation at reduced power)
  - in case other power plants (must runs for desalination, nuclear or needed to provide specific ancillary services) are operated at minimum active power output in low load situation
  - in order to anticipate a large solar or wind variation (sand storm, solar eclipse, ...)
  - in order to progressively reconstruct of power system after a back-out
- Participation in secondary frequency control or in congestion management
- Limitation of active power variation which can solicitate primary reserve and/or create frequency variations.

It needs to be emphasis that requirement 2.5.5.10a is added in the connection code, therefore, it does not imply that RRG will be curtailed in normal operation conditions and will not be given injection priority. These are measured needed for the TSO to guarantee system security in all expected context.

An example of the typical expected capability is shown in figure below [South Africa and Denmark grid codes]:

[Signature]
Similar requirements are present in other grid codes or in bilateral agreements.

Some of these actions should be implemented by automatic control system depending on the need of the TSP identified for the operation of its grid.

The format of the instruction to be received by the RRG is defined in the "dispatching and scheduling code" and requirement 5.4.1 is modified to be inline with the connection code.

It is to be noted that the wording used for "maximum gradient of the Active Power Output" is equivalent as "maximum ramping of Active Power Output".

**Benchmarking of other grid codes.**

Similar requirements are requested in the south African and Danish grid code. Furthermore, T. Ackermann, "Wind Power in Power Systems", John Wiley & Sons, 2005 recommends the use of such terms.

In addition, EWEA, the European Wind Energy association, recommends, in "Generic Grid Code Format for Wind Power Plants", 2009, the definition of the following control options:
"Level of details"
It also needs to be noted that the philosophy of the Saudi Arabian Grid Code, shared by many grid code in the world (Germany, Belgium, Denmark, Philippines, ...), is
- result-oriented: This allows to accommodate for innovation proposed by manufacturers. The grid code should not detail the way a user will satisfy the requirements of the NC but should describe the minimum expected behavior as needed at the connection point. Therefore, one should not specify, in the definition or in any other requirements chosen the approach to be chosen by the power plant owner for its internal control modes.
- positive: Definition should describe main features of the term considered and not specify what it is not.
- safeguarding: The level of details specified in the code should guarantee that the cost allocation of both CAPEX and OPEX as well as the allocation of technical responsibilities can justified. Any other matter such as detail of the process or means for information exchange which do not noticeably influence the above mentioned allocations and which might evolve with the system needs should not be written in the text. This allows easier maintenance of an up-to-date version of the text. However, these aspects need to be detailed in connection agreement. This is specified in section 2.1.2.

"2.1.2 In addition to this Connection Code, there may be additional provisions in the individual Connection Agreements between the TSP and the Users, defining, in greater detail and in more specific terms, the mutual obligations of each party."

Benchmarking of the other grid code for level of details of "Active power gradient", "Active power delta", "Active power limitation":
- Danish Grid Code or South African Grid Code

5.2.2 Constraint functions
A wind power plant must be equipped with constraint functions, i.e. supplementary active power control functions. The constraint functions are used to avoid imbalances in or overloading of the public electricity supply network in connection with the reconfiguration of the public electricity supply network in fault situations or the like.
The required constraint functions are described below.
5.2.2.1 Absolute production constraint
An absolute production constraint is used to constrain the active power from a wind power plant to a predefined power limit in the point of connection. An absolute production constraint is typically
used to protect the public electricity supply network against overloading. If the frequency control setpoint for the absolute production constraint is to be changed, such change must be commenced within two seconds and completed not later than 30 seconds after receipt of an order to change the setpoint. The accuracy of the control performed and of the setpoint must not deviate by more than ±2% of the setpoint value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

5.2.2.2 Delta production constraint (spinning reserve) A delta production constraint is used to constrain the active power from a wind power plant to a required constant value in proportion to the possible active power. A delta production constraint is typically used to establish a control reserve for control purposes in connection with frequency control.

If the setpoint for a delta production constraint is to be changed, such change must be commenced within two seconds and completed not later than 30 seconds after receipt of an order to change the setpoint. The accuracy of the control performed and of the setpoint must not deviate by more than ±2% of the setpoint value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

5.2.2.3 Power gradient constraint A power gradient constraint is used to limit the maximum speed by which the reactive power can be changed in the event of changes in wind speed or the setpoints for a wind power plant. A power gradient constraint is typically used for reasons of system operation to prevent changes in active power from impacting the stability of the public electricity supply network.

If a setpoint for the power gradient constraint is to be changed, such change must be commenced within two seconds and completed not later than 30 seconds after receipt of an order to change the setpoint. The accuracy of the control performed and of the setpoint must not deviate by more than ±2% of the setpoint value or by ±0.5% of the rated power, depending on which yields the highest tolerance.

The active power constraint functions are illustrated on Figure 10.

![Figure 10: Drawing of active power constraint functions](image)

**Implications if the proposed modification is not accepted:**

Without this requirement (added in the Grid Code or in each connection contract, the maximum penetration level of renewables has to be limited in the power system and/or higher flexibility would be needed for conventional power plants and storage systems. This could lead to higher operating costs.

**Proposals should be submitted to GCSC Chairman at the following address:**
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