Grid Code amendment in respect of slope tolerance

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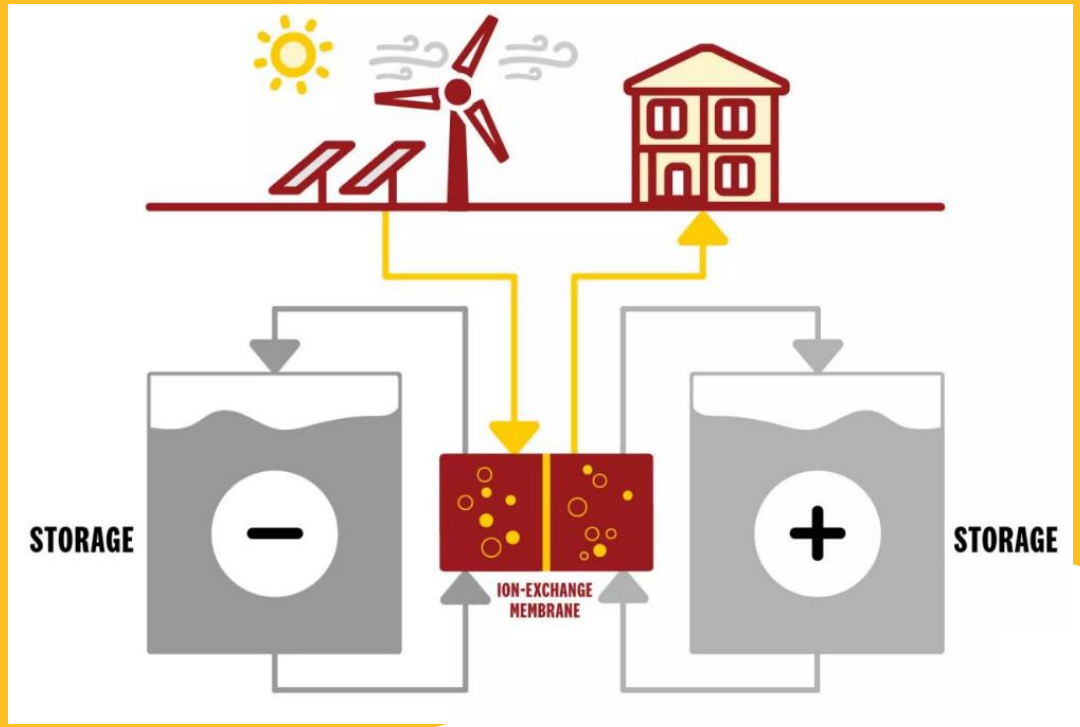

Background

CC.A.7.2.2.2 The continuously acting automatic control system shall be capable of operating to a **Setpoint Voltage** between 95% and 105% with a resolution of 0.25% of the nominal voltage. For the avoidance of doubt, values of 95%, 95.25%, 95.5% … may be specified, but not intermediate values. The initial **Setpoint Voltage** will be 100%. The tolerance within which this **Setpoint Voltage** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.25% and a **Setpoint Voltage** of 100%, the achieved value shall be between 99.75% and 100.25%. **The Company** may request the **GB Generator** to implement an alternative **Setpoint Voltage** within the range of 95% to 105%. For **Embedded GB Generators** the **Setpoint Voltage** will be discussed between **The Company** and the relevant **Network Operator** and will be specified to ensure consistency with CC.6.3.4.

ECC.A.7.2.2.3 The **Slope** characteristic of the continuously acting automatic control system shall be adjustable over the range 2% to 7% (with a resolution of 0.5%). For the avoidance of doubt values of 2%, 2.5%, 3% may be specified, but not intermediate values. The initial **Slope** setting will be 4%. The tolerance within which this **Slope** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.5% and a **Slope** setting of 4%, the achieved value shall be between 3.5% and 4.5%. **The Company** may request the **EU Generator** or **HVDC System Owner** to implement an alternative slope setting within the range of 2% to 7%. For **Embedded Generators** and **Onshore Embedded HVDC Converter Station Owners** the **Slope** setting will be discussed between **The Company** and the relevant **Network Operator** and will be specified to ensure consistency with ECC.6.3.4.

Key information

With a tolerance of 0.5% and a Slope setting of 4%, the achieved value between 3.5% and 4.5% should be accepted.

Battery Connection (data from the on-site test results)

Test 1 export mode

	Voltage setpoint	Actual Voltage	Normal Voltage	dv	MVAR output	Base MVAR	dq	droop
1%	33.33	33.19131	33	0.004202727	1.74626514	16.4	0.10648	0.03947
-1%	32.67	32.78459	33	-0.003472424	-1.43471338	16.4	-0.08748	0.039693
2%	33.66	33.4002	33	0.007872727	3.2611748	16.4	0.198852	0.039591
-2%	32.34	32.59039	33	-0.007587576	-3.17021387	16.4	-0.19331	0.039252

Test 2 import mode

	Voltage setpoint	Actual Voltage	Normal Voltage	dv	MVAR output	Base MVAR	dq	droop
1%	33.33	33.0958	33	0.00709697	2.87596737	16.4	0.175364	0.04047
-1%	32.67	32.69345	33	-0.000710606	-0.27769312	16.4	-0.01693	0.041967
2%	33.66	33.29178	33	0.011158182	4.51835505	16.4	0.275509	0.0405
-2%	32.34	32.49141	33	-0.004588182	-1.91651489	16.4	-0.11686	0.039262

Windfarm (data from the on-site test results)

Circuit 1

	Voltage setpoint	Actual Voltage	DV	dv	MVAR output	Base MVAR	dq	droop
1%	277.75	279.146	-1.396	-0.005076364	-12.1637	100	-0.12164	0.041734
-1%	272.25	277.467	-5.217	-0.018970909	-48.6	100	-0.486	0.039035
4%	283	280.556	2.444	0.008887273	41.1891	100	0.411891	0.021577
-4%	261	269.511	-8.511	-0.030949091	-152.593	100	-1.52593	0.020282

Circuit 2

	Voltage se	Actual Vol	Normal Vc	dv	MVAR out	Base MVA	dq	droop
1%	277.75	279.297	-1.547	-0.00563	14.7685	100	0.147685	-0.03809
-1%	272.25	277.77	-5.52	-0.02007	-49.74	100	-0.4974	0.040355
4%	280.5	280.556	-0.056	-0.0002	0.5	100	0.005	-0.04073
-4%	269.5	277.551	-8.051	-0.02928	-72.4007	100	-0.72401	0.040437

Circuit 3

	Voltage se	Actual Vol	Normal Vc	dv	MVAR out	Base MVA	dq	droop
1%	277.75	275.688	2.062	0.007498	18.9	100	0.189	0.039673
-1%	272.25	274.312	-2.062	-0.0075	-18.53	100	-0.1853	0.040465
4%	281	280.019	0.981	0.003567	18.3734	100	0.183734	0.019415
-4%	260	270.384	-10.384	-0.03776	-188.316	100	-1.88316	0.020051

HVDC (data from the on-site test results without improvement)

exporting								
	U_ref	Uact	U_base	dv	Q	Q_ref	dq	slope
1%	401.0328	398.486	400	0.006367	56.4	340	0.165882	0.038383
2%	405.0035	399.688	400	0.013289	112.2141	340	0.330041	0.040264
-1%	393.0917	396.132	400	-0.0076	-62.68	340	-0.18435	0.041229
-2%	389.121	394.93	400	-0.01452	-113.36	340	-0.33341	0.043557
Importing								
1%	405.0933	402.194	400	0.007248	57.84164	340	0.170122	0.042606
-1%	397.071	399.833	400	-0.00691	-57.3984	340	-0.16882	0.040902
2%	409.104	403.386	400	0.014295	115.7	340	0.340294	0.042008
-2%	393.061	398.633	400	-0.01393	-114.66	340	-0.33724	0.041306

Manufactory believes the tolerances were caused by the following reasons:

a). The slow voltage controller
This controller adopted a slow voltage controller located at PCC and a fast voltage control at primary side of the converter transformer. The slow voltage controller compensates for the voltage drop over the a.c. cables and adds a reference to the fast voltage controller.

b). The Measurement Tolerances
In FAT, VT used to measure the voltage at the PCC has a 0.2 accuracy class and a 400kV VT at site has an accuracy of +/-0.8kV. The measurement tolerances caused the error when calculating the voltage droop.

c). The voltage droop is set to 4.0%. For this HVDC link, the voltage droop uses the convention of kV/MVAR. In the HMI this is restricted to integer numbers, the closets integer settings is 0.047 kV/MVAR corresponds to a droop of 4%.

HVDC (data from the on-site test results with improvement)

	U_PCC	U_REF	DV	Q_PCC	Q_BASE	DQ	SLOPE
export -1%	400.953	396.02	0.0123325	104.32	340	0.306824	0.040194
export 2%	404.112	408.02	0.00977	82.66	340	0.243118	0.040186
export -2%	399.43	392.02	0.018525	156.42	340	0.460059	0.040267
export 1%	402.845	404.0202	0.002938	25.1055	340	0.07384	0.039789
import 1%	401	404	0.0075	63	340	0.185294	0.040476
import -1%	395.998	399.545	0.0088675	75.45	340	0.221912	0.03996
import 2%	408	402	0.015	125.8	340	0.37	0.040541
import -2%	398.2	392	0.0155	130	340	0.382353	0.040538

Issues

The current defined tolerance will cause :

1. Unachievable reactive power support from the connection

2. Lost opportunity to engage with manufacturer to improve controller’s performances

Option 1

CC.A.7.2.2.3 / ECC.A.7.2.2.3

The Slope characteristic of the continuously acting automatic control system shall be adjustable over the range 2% to 7% (with a resolution of 0.5%). For the avoidance of doubt values of 2%, 2.5%, 3% may be specified, but not intermediate values. The initial Slope setting will be 4%. The tolerance within which this Slope shall be achieved is specified in BC2.A.2.6.

The Company may request the EU Generator or HVDC System Owner to implement an alternative slope setting within the range of 2% to 7%. For Embedded Generators and Onshore Embedded HVDC Converter Station Owners the Slope setting will be discussed between The Company and the relevant Network Operator and will be specified to ensure consistency with ECC.6.3.4

BC2.A.2.6

Instruction Name	Description	Type of instruction
slope	Where a Non-Synchronous Generating Unit, DC Converter or Power Park Module or HVDC Converter is instructed to a specific Slope, the Generator must achieve the default droop setting or agreed with Company. The Generator must maintain the specified Slope target until an alternative target is received from The Company. The Generator will not be required to implement a new Slope setting in a time of less than 1 week from the time of the instruction.	SLOPE

Option 2

CC.A.7.2.2.3 / ECC.A.7.2.2.3

The Slope characteristic of the continuously acting automatic control system shall be adjustable over the range 2% to 7% (with a resolution of 0.5%). For the avoidance of doubt values of 2%, 2.5%, 3% may be specified, but not intermediate values. The initial Slope setting will be 4%. The tolerance within which this Slope shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.2% and a Slope setting of 4%, the achieved value shall be between 3.8% and 4.2%. The Company may request the GB Generator to implement an alternative slope setting within the range of 2% to 7%. For Embedded GB Generators the Slope setting will be discussed between The Company and the relevant Network Operator and will be specified to ensure consistency with CC.6.3.4

	Instruction Name	Description	Type of instruction
BC2.A.2.6	slope	Where a Non-Synchronous Generating Unit, DC Converter or Power Park Module or HVDC Converter is instructed to a specific Slope, the Generator must achieve that Slope within a tolerance of ±0.2% (or such other figure as may be agreed with The Company). The Generator must maintain the specified Slope target until an alternative target is received from The Company. The Generator will not be required to implement a new Slope setting in a time of less than 1 week from the time of the instruction.	SLOPE

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