ENTSO-E Amendment proposal for inclusion of Grid Forming Capability in Network Code Requirements for Generators (NC RfG)

This presentation is developed by ENTSO-E Steering Group of Connection Network Codes

Disclaimer: The requirements presented in this slides reflect only the proposal of ENTSO-E as it was submitted to the public consultation of ACER in November 2022. This material **should not** be interpreted as final legal text revision of the NC RfG as the amendment process is ongoing and changes may evolve during this process. More information on content can be found here.

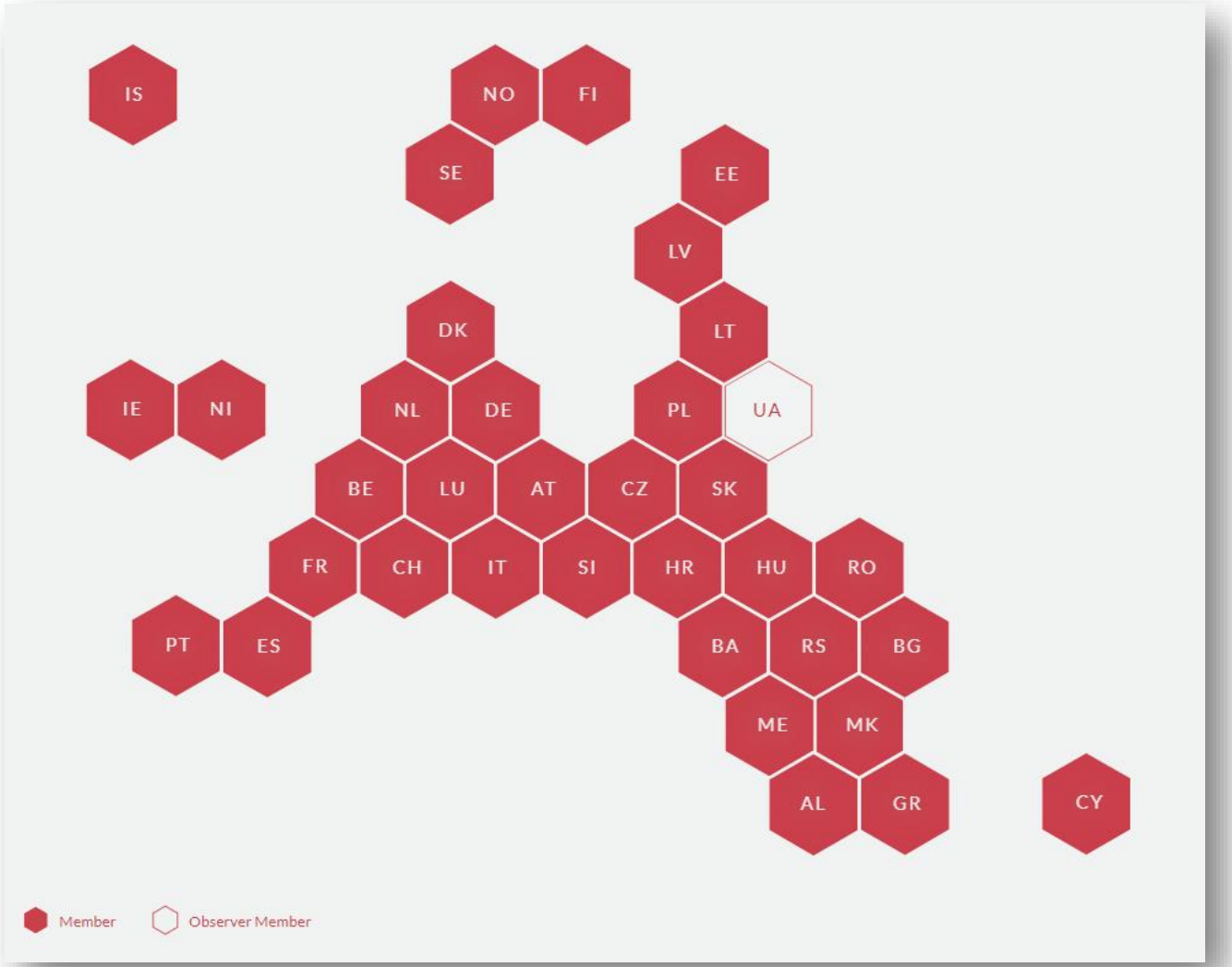
Presented on behalf of ENTSO-E by Mario Ndreko, TenneT TSO GmbH

entsoe
Reliable Sustainable Connected

About ENTSO-E

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). **The 39 member TSOs representing 35 countries** are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.



ENTSO-E approach for updating Connection Network Codes – stakeholder input

Stakeholder input of key importance

GC ESC Expert Groups Recommendations

New system needs

Experiences from national implementation

Feedback from GC ESC & technical groups

Alignment between NCs

Potential issues with current CNCs

Must-have Amendments

Nice-to-have Amendments

Low-Priority Amendments

Implementation Guiding Documents

Initial draft proposed by ENTSO-E experts

Ongoing ENTSO-E amendments drafting

Ongoing ENTSO-E IGD drafting (new and revisions)

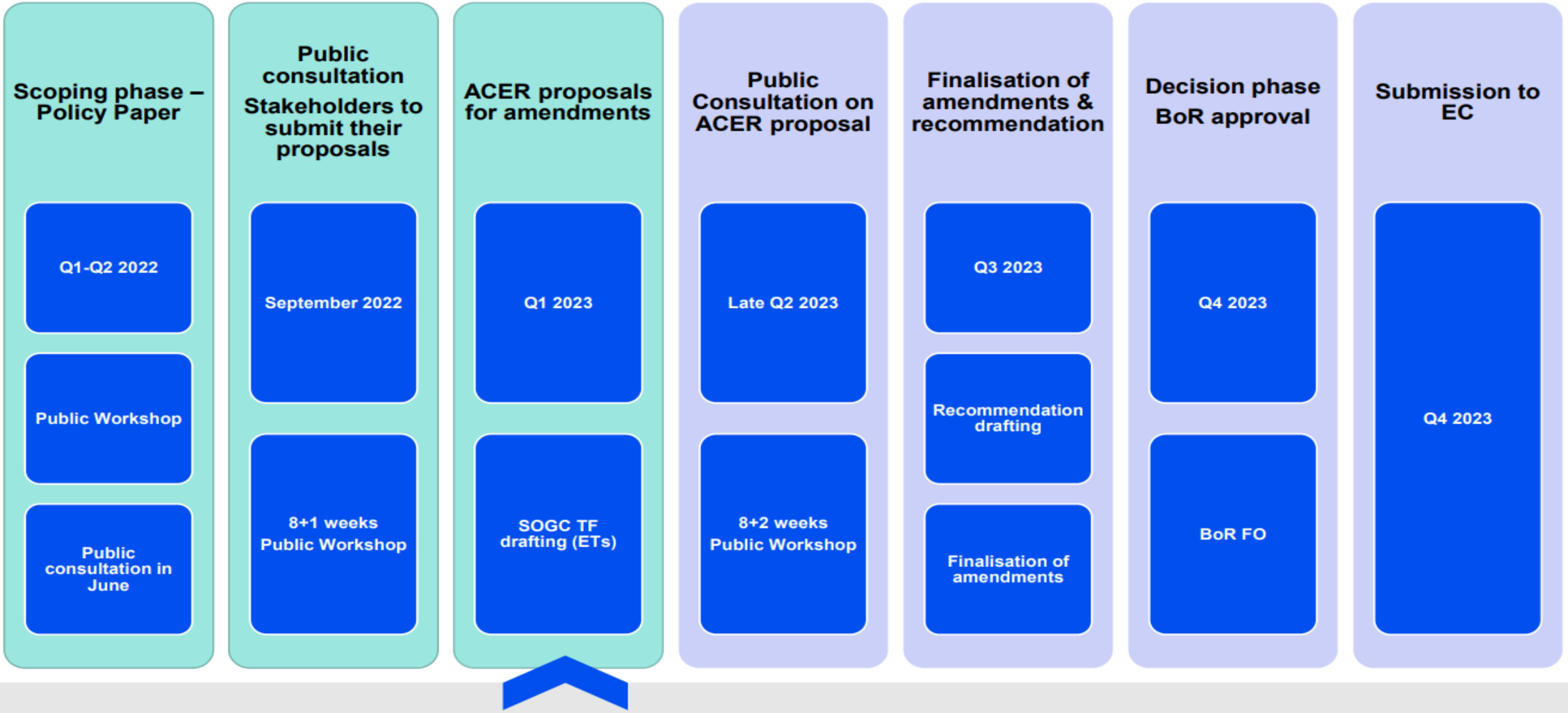
ENTSO-E Amendment proposals for CNC (material discussed in this presentation)

IGD proposals

Stakeholder consultation & discussion

- "Must-have" amendments without which secure operation of the power system would be increasingly compromised
- "Nice-to-have" amendments which would provide cost-effective overall benefits to society
- "Low-priority" amendments which can be taken on board where opportunity allows

Process of NC RfG Amendment followed by ACER



This is still work in progress !

Power Park Module (PPM) capabilities in the current version of NC RfG

- Frequency ranges
- Voltage ranges
- Reactive power capability
- FRT
- Fast Fault current injection

- FSM
- LFSM-O / U
- Power quality
- Voltage control – steady state
- Voltage control – dynamics
- Power Oscillations Damping

Towards RfG 2.0

- NC RfG 2.0 need to include all the needed capabilities to **safeguard an energy transition under high penetration of RES while ensuring stable and reliable power system.**

- Grid forming capabilities for power park modules (PPMs) are required to ensure stable operation with the high penetration of non-synchronous generation in a 2030-2040 horizon.

Determination of Significance in NC RfG and association with Grid Formring Capability

Limits for thresholds for type B, C and D power-generating modules

Synchronous areas	Limit for maximum capacity threshold from which a power-generating module is of type B	Limit for maximum capacity threshold from which a power-generating module is of type C	Limit for maximum capacity threshold from which a power-generating module is of type D
Continental Europe	1 MW	50 MW	75 MW
Great Britain	1 MW	50 MW	75 MW
Nordic	1,5 MW	10 MW	30 MW
Ireland and Northern Ireland	0,1 MW	5 MW	10 MW
Baltic	0,5 MW	10 MW	15 MW

NC RfG 2.0 / Grid forming new Article / Legal Text

Article Y
(new article, to be placed before current Article 20):

Requirements for type A power park modules

a. **Within the power park module current limits, the power park module shall be capable of behaving at its connection point as a voltage source behind an internal impedance** (Thevenin source), during the normal operating conditions (non-disturbed grid conditions) and quasi immediately after a grid disturbance (including voltage, frequency and voltage phase angle disturbance). The Thevenin source is characterized by its voltage amplitude, voltage phase angle, frequency and internal impedance.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article Y (new article, to be placed before current Article 20)

Requirements for type A power park modules

b. **During the first instant following a grid disturbance** and while the power park module capabilities and current limits are not exceeded:

(i) **the instantaneous AC voltage characteristic**s of the Thevenin source according to paragraph (a) shall be capable of not changing its amplitude and voltage phase angle while voltage phase angle steps or voltage magnitude steps (in positive and in negative sequence) are occurring at the connection point (grid side). The positive and the negative sequence current exchanged between the power park module (power park module side) at the connection and AC grid shall flow naturally according to grid and converter impedances.

(ii) The relevant system operator shall specify a minimum time dependent current profile for which the grid forming capability of the power park module is required.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article Y (new article, to be placed before current Article 20)

Requirements for type A power park modules

[…]

c. **During the disturbance period (voltage magnitude, frequency and voltage phase angle disturbance) and after the first instant**,

(i) The internal voltage magnitude and voltage phase angle of the power park module shall be adapted according to a predefined dynamic performance.

(ii) The power park module active and reactive current adjustment shall always respect the minimum and maximum power park module capability and current limits.

(iii) The TSO may specify additional requirements in the case that current limitation is necessary.

(iv) The power park module shall be capable of stable and smooth transition when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph (b)(ii) as soon as the limitations are no more active.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article Y (new article, to be placed before current Article 20)

Requirements for type A power park modules

[…]

d. The required energy to deliver the minimum capability in paragraph (a) to (b) shall be ensured through the whole active power operating range of power park module.

e. The required dynamic performance of the power park module for the paragraphs (a) to (d) and its associated performance parameters shall be specified by the relevant TSO.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article 20

Requirements for type B power park modules

4. The relevant TSO shall have the right to request grid forming capability at its connection point from type B PPM as listed in Article Y. After a transitional period of maximum 3 years after entering into force, a type B PPM shall be capable of providing grid forming capability requirements at its connection point listed in Article Y. Member states shall have the right to shorten this transitional period based on system needs and urgency.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article 21

Requirements for type C power park modules

5. […]

a) If applicable according to Article 15.4.(b), **the power park module shall be capable of supporting system survival by means of stable and smooth transition towards and from island mode of system operation (islanding),** without interruption, in a continuous manner performing the needed active and reactive power adjustments.

NC RfG 2.0 / Grid forming new Article / Legal Text

Article 21
Requirements for type C power park modules

5. [..]

b) The relevant system operator **may specify that a study is required (including its scope) in order to ensure that no adverse control interactions occur** during the normal operating conditions (non-disturbed grid conditions), quasi immediately after a grid disturbance, during grid fault conditions and during the post fault operation where voltage and frequency profiles have returned to normal operating conditions.

c) If grid forming capability as prescribed in Article Y is requested and if specified by the relevant system operator, in coordination with the relevant TSO, the power park module shall be capable of **limiting the transient frequency deviation** both in low and/or high frequency regimes. In that case the relevant TSO shall specify the contribution to inertia in Article (Y) paragraph (6)(e).

Thank you very much for your attention

Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.

EXCELLENCE

We deliver to the highest standardss. We provide an environment in which people can develop to their full potential.

TRUST

We trust each other, we are transparent and we empower people. We respect diversity.

INTEGRITY

We act in the interest of ENTSO-E

TEAM

We care about people. We work transversal and we support each other. We celebrate success.

FUTURE THINKING

We are a learning organisation. We explore new paths and solutions.

We are ENTSO-E