Grid-Forming Technology and System Flexibility: ENTSO-E's Perspective

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ESIG
ENERGY SYSTEMS
INTEGRATION GROUP

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ENTSO-E

500.000 km of transmission lines

520 million citizens

- ENTSO-E, established in **2009,** represents **40 TSOs from 36 countries**
- ENTSO-E is the Association for the **cooperation of TSOs**, entities with **public service** and EU **mandates** on:

- Security of **power system**
- Optimal functioning and development of **electricity markets**
- **Climate-neutrality** by 2050

EUROPEAN NETWORK CODES/GUIDELINES:
THE FOUNDATIONS OF THE INTERNAL ENERGY MARKET

Provides the legal basis for requirements to be applied across Member States supported by all European TSOs

3 CONNECTION CODES

Requirements for:

- Generators
- Demand side
- HVDC connections

3 MARKET CODES

Rules for:

- Capacity calculation
- Day ahead / Intraday
- Forwards
- Balancing

2 OPERATIONAL CODES

Rules for:

- System Operation
- Emergency situations

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Requirements for Generators 2.0

System Challenges

- Loss of Inertia
- High RoCof events
- Voltage control and stability concerns
- Black start and system restoration

The system is changing fast!

What RfG 2.0 Proposes?

Core Elements

- Grid-forming baseline
- Storage & EVs included
- Aligned with HVDC
- Supports decarbonisation

From connection to integration

What Grid-Forming Means in Practice?

CREATE SYSTEM VOLTAGE

⟶ Set voltage & stabilise weak grids

INERTIA CONTRIBUTION

⟶ Slow down frequency swings

CONTRIBUTE TO FAULT CURRENT

⟶ Ride through & support protection

SYSTEM SURVIVAL DURING SPLITS

⟶ Operate in island mode

Grid-forming = behaving like the backbone of the grid

Balancing Ambition & Feasibility

Ambition is non-negotiable — but feasibility matters

SYSTEM NEEDS

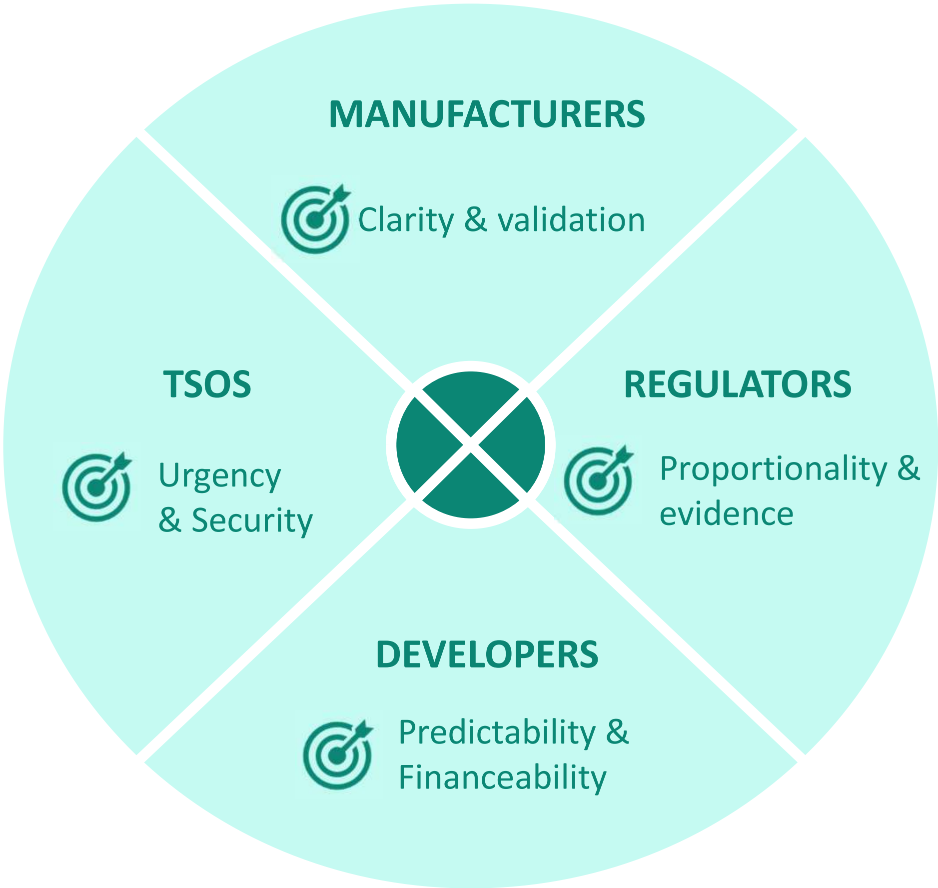
Stability, black-start,
RoCoF, harmonisation

FEASIBILITY

Cost, tech readiness,
rollout timeline

European Stakeholder Committee – Connections

Different perspectives, one common goal



Attention! ENTSO-E's Key Considerations for the Amendment of the EU Connection Network Codes

Requirements for new loads of significant capacity

RoCoF withstand capability of type D synchronous power generating modules

Low Frequency Demand Disconnection (LFDD) in DSO connected demand facilities of significant size

RfG 2.0

2020

Report on high penetration of converters

2023

ENTSO-E Task Force & interim report

2024

Technical Group with stakeholders

2026

EC Consultation

Implementation Guidance Documents

RfG 2.0 - Connection Network Codes Amendment Process

Link to the existing IGDs on ENTSO-E website

Amendment process of the Connection Network Codes (CNC)

Background:

- ✓ December 2024: ACER published its recommendation to the European Commission on the Network Code High Voltage Direct Current Connection amendments.

Focus in 2026:

- ✓ ENTSO-E waits for the "Have your say" consultation on the amended Network Code Requirement for Generators in 2026;
- ✓ Focus on developing Implementation Guidance Documents (IGDs), especially on grid forming capability and forced oscillations.

Dependencies:

- ✓ ENTSO-E's work on CNC implementation depends on the adoption timeline from the European Commission.
- ✓ The consultation on the amended Network Code on Demand Connection will follow the Requirement for Generators*.

CNC-related deliverables

- **Implementation Guidance Documents (IGDs)**
  - ✓ Development of IGDs for new topics, e.g. on grid forming capability:
    - Drafting, consultation and publication by 6 months after the entry into force of the amended Network Code Requirement for Generators.
  - ✓ Update of the appx. 30 CNC-related IGDs that are already published on ENTSO-E website, according to the available resources.
- **Network Codes monitoring information:**
  - ✓ Collection and delivery of relevant information to ACER.

* The timeline of the European Commission has not yet been announced.

Looking Ahead to…a fully decarbonized Europe in which…

Every new connection (generation/demand) can enhance system stability and security

Offshore connections built on harmonised rules and benefit 'whole system' needs

Fit for purpose requirements for connected Grid Users (mutually beneficial)