February 2026

All-Island Grid Forming Strategy

EirGrid SONI

List of Abbreviations

AC	Alternating Current
AEMO	Australian Energy Market Operator
BESS	Battery Energy Storage System
CEN	Coordinador Eléctrico Nacional
CIGRE	The International Council on Large Electric Systems
DC	Direct Current
DSO	Distribution System Operator
EMT	Electro-Magnetic Transient
ENTSO-E	European Network of Transmission System Operators for Electricity
ESPS	Energy Storage Power Station
E-STATCOM	Energy-storage enhanced Static synchronous Compensator
FACTS	Flexible Alternating Current Transmission System
FRT	Fault Ride Through
GFL	Grid Following
GFM	Grid Forming
HVDC	High Voltage Direct Current
IBR	Inverter-Based Resource
IEEE	Institute of Electrical and Electronics Engineers
LCIS	Low Carbon Inertia Services
NESO	National Energy System Operator
NIE	Northern Ireland Electricity
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer
POD	Power Oscillation Damping
PPM	Power Park Module
PV	Photo Voltaic
RES	Renewable Energy Sources
RES-E	Renewable Energy Sources-based Electricity
RfG	Requirements for Generators
RMS	Root Mean Square
RoCoF	Rate of Change of Frequency
SG	Synchronous Generator
SOEF	Shaping Our Electricity Future
STATCOM	Static synchronous Compensator
TRL	Technology Readiness Level
TSO	Transmission System Operator
VSC	Voltage Source Converter
IGD	Implementation Guidance Document

Table of Contents

EirGrid SONI

Background & Context

Background & Context

EirGrid and SONI are at the forefront of managing the integration of non-synchronous renewable generation. As total All-Island RES-E generation capacity, including onshore wind, offshore wind and solar PV, grows from around 10.2 GW in 2025 to around 18.6 GW in 2030, the system's reliance on conventional synchronous generation is declining. Guided by the Operational Policy Roadmap 2025–2035, this transition is increasing the need for advanced control capabilities from renewable sources. Grid-forming (GFM) technology offers the potential to support power system operation at higher renewable levels.

GFM refers to advanced control techniques that enable PPMs and HVDC systems to operate in weak system conditions and to enhance power system stability when operating with a high share of renewables. These technologies have the potential to provide essential system services equivalent to those traditionally delivered by conventional synchronous machines. While not widely deployed at scale, the maturity of GFM technologies has increased significantly in recent years, with a growing number of projects globally (see Appendix B). Upcoming ENTSO-E guidance is expected to introduce requirements for the implementation of GFM capabilities across member states in the coming years (RfG 2.0 & HVDC 2.0).

This document outlines the EirGrid and SONI strategy for the implementation of GFM capabilities in Ireland and Northern Ireland. The strategy provides a pathway for the integration of advanced control capabilities within PPMs and HVDC systems, enabling the provision of essential system services to ensure the stability and resilience of the All-Island power system at higher levels of renewable penetration. The strategy follows significant industry and stakeholder engagement over an eight month period in 2025 and is aligned with forthcoming European legislation (RfG 2.0 & HVDC 2.0) and international best practice.

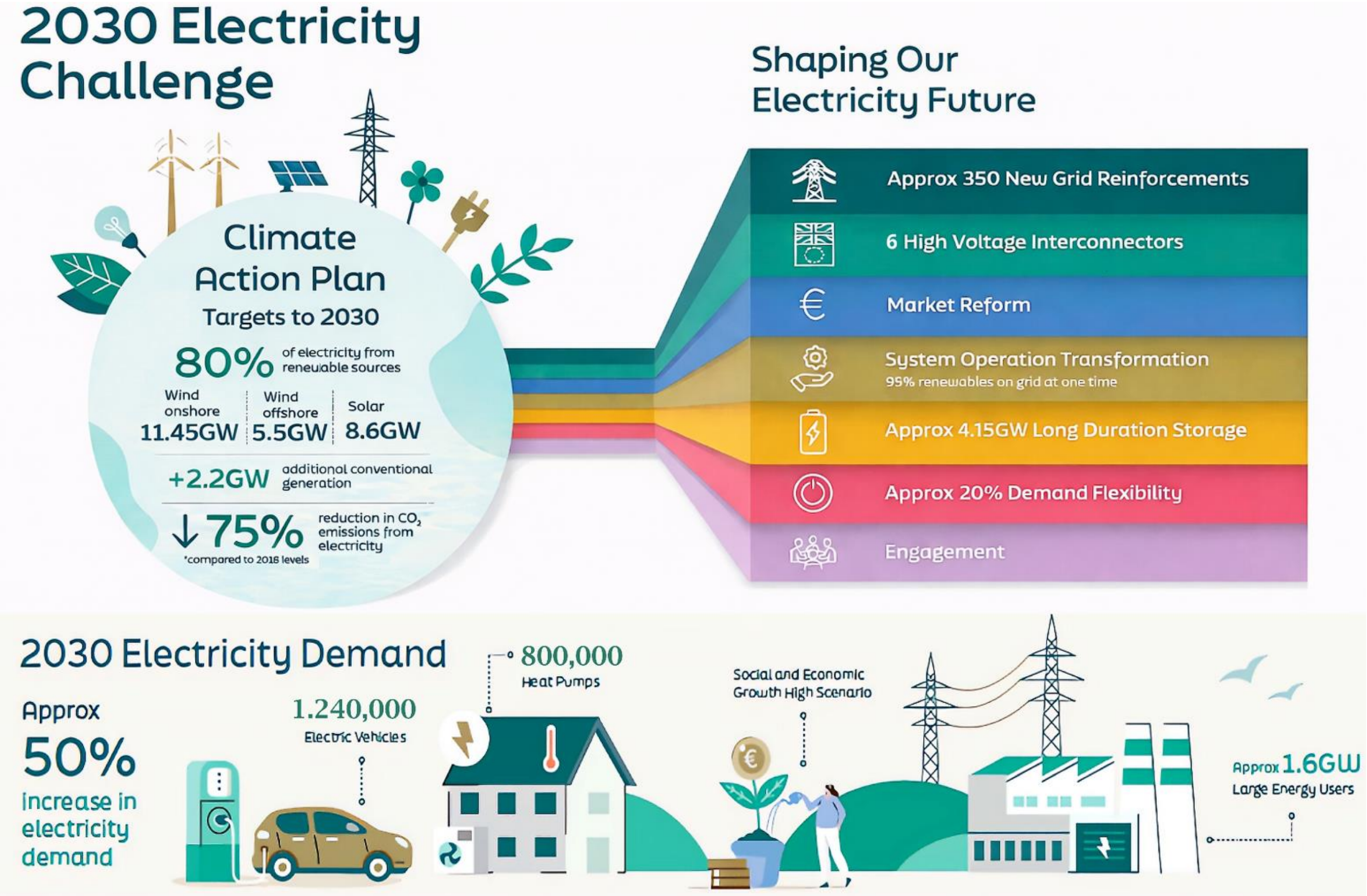
The strategy will be reviewed periodically to reflect updates and developments in European guidance on GFM technologies and our experience with integrating GFM technologies. This may include consideration of inverter-based loads, such as data centres and electrolysers, as the technology matures and ENTSO-E guidance on Demand Connection Code evolves.

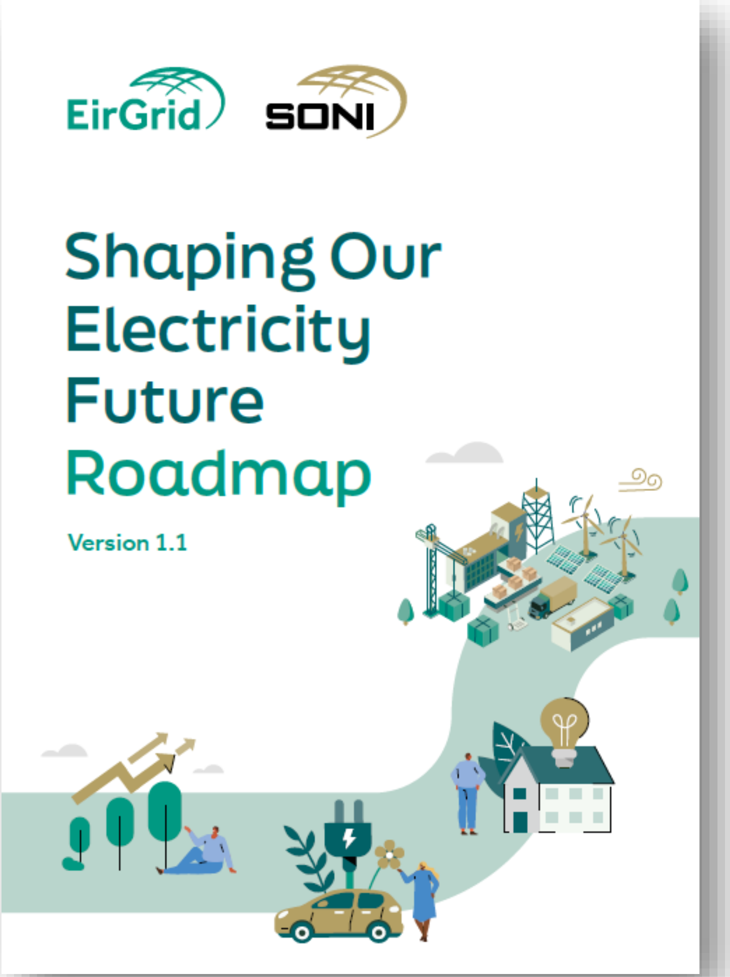
Draft RfG 2.0: ACER_Recommendation_03-2023_Annex_1_NC_RfG

Draft HVDC 2.0: ACER recommendation_01-2024_Annex_1_NC_HVDC

Background & Context

GFM will support our vision to meet Ireland and Northern Irelands renewable ambitions





SOEF: https://www.eirgrid.ie/shaping-our-electricity-future

Objective of the Grid Forming Strategy

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Objective of the Grid Forming Strategy

Establishing a framework to integrate GFM technologies into the All-Island power system

Challenges

- Transitioning towards a converter-based power system brings stability and operational challenges.
- High shares of renewables challenges conventional stability mechanisms.
- A decrease in the minimum number of online synchronous generators brings reduction in synchronous torque and damping.
- Decaying system strength and inertia, driving new oscillatory phenomena.
- Reduction in available fault current.
- Maintaining adequate power quality.
- Adequacy of simulation tools and fidelity of models for stability analysis.

Approach

- Facilitate integration of new technologies capable of providing essential stability services and enhancing the reliability and security of the All-Island system with high levels of renewables.
- Industry and stakeholder engagement over an 8-month period during 2025.
- Extensive interviews with experts from EirGrid, SONI, OEMs, developers, and international TSOs.
- A comprehensive review of international experience and requirements for GFM.
- Technical Support by international leading experts from EPRI and Guidehouse. Project management was supported by Accenture.
- Participation in ENTSO-E activities and other international expert forums (e.g. CIGRE, ISON).

Solution

- Development of a strategic pathway for the staged integration and trialing of advanced control capabilities in PPMs and HVDC systems that will enable provision of essential system services to ensure the stability and resilience of the All-Island power system with high level of renewables.
- Continuous industry and stakeholder engagement.
- Continuous enhancement of modelling and simulation capabilities.
- Supporting evolution of operational policy.
- Paving the way for implementation of upcoming EU regulation (RfG 2.0 & HVDC 2.0).

New enhanced control capabilities in PPMs and HVDC systems will support the continued secure operation of the All-Island power system as we integrate more renewables.

Objective of the Grid Forming Strategy

How we developed the GFM strategy

Evidence gathering

Extensive industry and stakeholder engagement with:

- Peer TSOs
- OEMs
- Developers
- DSOs in Ireland and N. Ireland

Literature study, including review of publications from (appendix C):

- ENTSO-E
- TSOs
- IEEE
- NREL
- ESIG
- IEA
- ACER
- OEMs
- CIGRE
- NERC
- EPRI

Strategy development

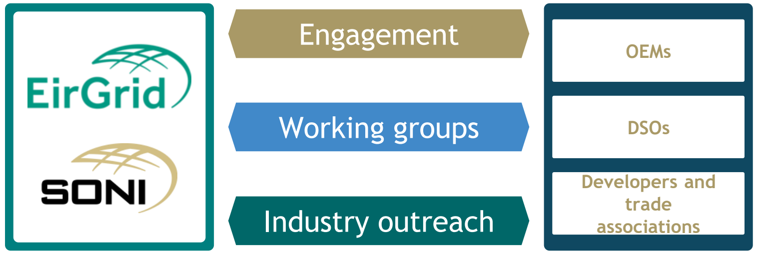
Consolidation of results: documentation of the GFM technology capabilities, stakeholders' views, strategic choices and implementation paths.

Application to IE and NI context: developing an all-island strategy, tailored to specific operational needs in Ireland and Northern Ireland, that facilitates staged integration and trials of advanced control capabilities to enable secure and reliable operations with high levels of renewables and ensuring alignment with European regulations.

Dissemination

Industry interviews highlighted the strong need for continuous engagement with stakeholders.

This publication is a **first step in a wider stakeholder engagement strategy.**



Why Grid Forming?

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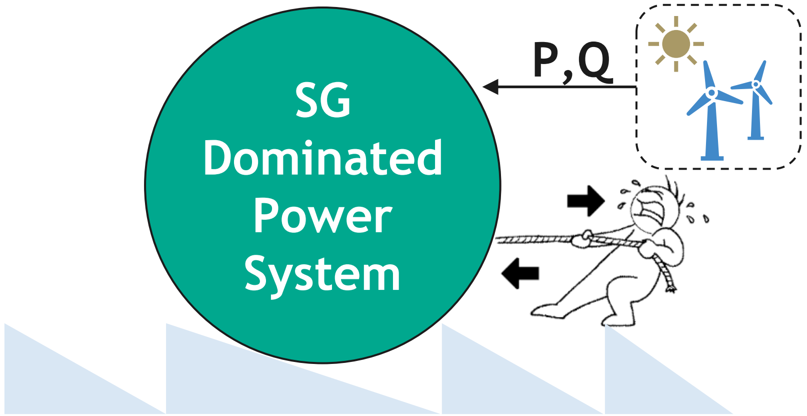
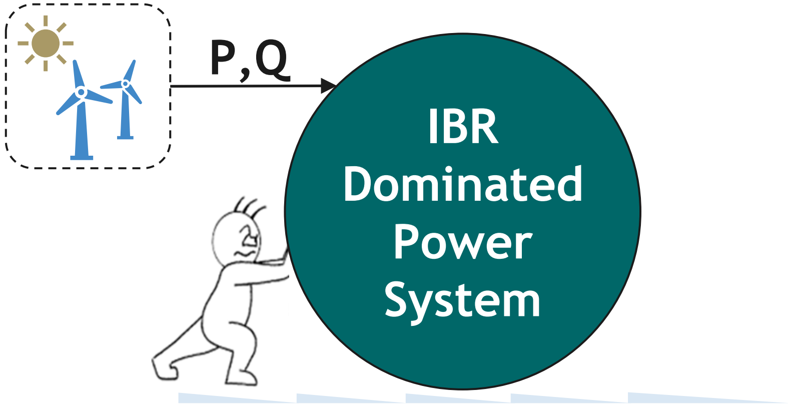
Why Grid Forming?

The power system is transitioning from synchronous generation to more inverter-based resources



P = Active Power
Q = Reactive Power



Majority of today's inverter-based resource (IBR) and distributed energy resource (DER) control is designed to work in a "strong" power system.

- Changes in IBR injected current do not 'move' the stiff system
- Changes in power system cause the IBR to 'move' in tandem

This behaviour is commonly referred to as ***grid following***, a control strategy where IBRs require stiff/strong grid frequency and voltage to synchronise their output.

An IBR dominated power system with few or no synchronous generators results in the following system behaviour:

- Increased elasticity in the grid
- Changes in IBR injected current will 'move' the power system
- This movement in system will itself cause the IBR to 'move' in tandem

This increased interaction **can de-stabilise the power system.**

Grid Forming behaviour strengthens an IBR/DER dominated system by replacing lost synchronous generator characteristics with advanced control strategies that stabilise voltage, frequency, and dynamic behaviour.

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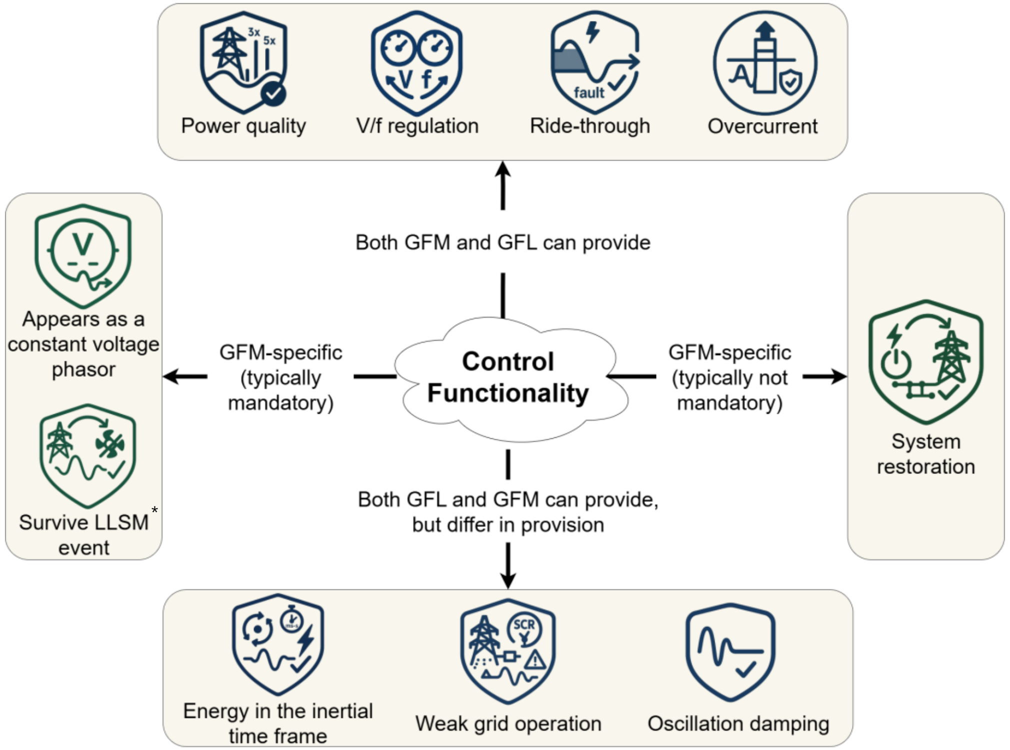
Note: The content of this slide is from EPRI "Grid Forming Inverters: EPRI Tutorial", Oct 24, 2025.
The sawtooth pattern in the figures above represents system strength. High system strength results in a hard-to-move grid; a low strength system is easier to disturb.

Why Grid Forming?

GFM and GFL devices have overlapping functionalities, but GFM can offer unique services

Comparison of Grid Following and Grid Forming capabilities



*GFM offers the ability to survive islanding in case of Loss of Last Synchronous Machine (LLSM)

Function	Grid Following (GFL)	Grid Forming (GFM)
High level definition based on specific control design		
Basic control objectives in the sub-transient time frame	Maintain a specified amount of power to an energized grid	Control and regulate terminal voltage and frequency
Output quantity controlled in sub-transient time frame	Active and reactive power	AC voltage magnitude and frequency
Require a stiff and stable voltage at the terminal?	Yes	No
Synchronization elements present	Compulsorily has an explicit and dominant synchronization loop	May contain implicit synchronization loops with more degrees of freedom
Power System Restoration Capability	No	Depending on implementation and type of energy source
Definition based on response at different time scales		
Sub-transient	Prioritizes current to meet fixed P/Q	Prioritizes current to meet fixed V/f control
Transient	Prioritizes P/Q control	Prioritizes V/f control
Steady State	May follow the same droop characteristics for controlled V/f response	

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GFL and GFM both provide different levels of support services to the grid, but only GFM can independently establish a grid reference. This unique ability to "form" the grid, combined with functions unique to GFM, will support the integration of higher levels of renewable energy while maintaining system stability.

Background to European Legislation

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Background to European Legislation

Connection Network Codes

Connection Network Codes (CNC) are pan-European regulations (legislative requirements) that define the necessary **technical capabilities** of power generating modules, distribution systems connected to transmission systems, demand facilities, and HVDC systems during normal and disturbed system operating conditions.

- NC RfG: Requirements for Grid Connection of Generators
- NC DCC: Demand Connection Code
- NC HVDC: Requirements for Grid Connection of High Voltage Direct Current Systems

They are binding rules that govern electricity networks' connection requirements in European Member States in an effective and transparent manner.

In 2023, ACER proposed amendments to NC RfG and NC DCC. In 2024, ACER proposed amendments to NC HVDC.

The proposed amendments to NC RfG and NC HVDC incorporate provisions for GFM capabilities.

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Background to European Legislation

Amendments to RfG: Timeline and stakeholder engagement

- The technical capabilities requirements for power generators are defined in **Regulation (EU) 2016/631** (NC RfG).
- In September 2022, the EC asked ACER to propose amendments to the NC RfG to reflect the latest developments in the sector.
- In December 2023, following public consultation, ACER submitted to the EC its recommendation for amending NC RfG 2.0. These amendments include **non-exhaustive mandatory Grid-Forming (GFM) requirements** for certain PPM types.
- The process of finalising the adoption of the updated regulation is now the responsibility of the EC, with an expected publication in early-2026. Six months later, ENTSO-E will release an Implementation Guidance Document (IGD).
- To advance the work on this IGD, ENTSO-E published in May 2024 a technical report (Phase I) providing recommendations on:
  - The exhaustive definition of GFM connection requirements for PPMs
  - The compliance verification procedure for GFM requirements in PPMs
- To address the stakeholders' comments on the **Phase I** technical report, ENTSO-E established a **Technical Group on Grid Forming Capability (TG GFC)** in June 2024 to:
  - Develop and express a common understanding among EU stakeholders on grid forming technical requirements
  - Publish a second consolidated version of the technical report (Phase II) considering the stakeholders' feedback (CENELEC, EASE, EU DSO entity, SolarPower Europe and Wind Europe). The updated technical report, supported by all associations, was published in October 2025.
- After the publication of the NC RfG 2.0, ENTSO-E will release an IGD on exhaustive GFM requirements.

Background to European Legislation

Amendments to HVDC: Timeline and stakeholder engagement

- The technical capabilities requirements for high voltage direct current systems are defined in **Regulation (EU) 2016/1447** (NC HVDC).
- In September 2022, the EC asked ACER to propose amendments to the NC HVDC to reflect the latest developments in the sector.
- In December 2024, following public consultation, ACER submitted to the EC its recommendation for amending NC HVDC 2.0. These amendments include **non-exhaustive non-mandatory Grid-Forming (GFM) requirements** for HVDC systems.
- The process of finalising the adoption of the updated regulation is now the responsibility of the EC.
- After the publication of the NC HVDC 2.0, ENTSO-E will release an IGD on exhaustive GFM requirements.

Source: **ENTSO-E**

Grid Forming Definition

Grid Forming Definition

Overview of International Descriptions for Grid Forming

ACER – European Union Agency for the Cooperation of Energy Regulators	Within the power park module's current and energy limits, the power park module shall be capable of behaving at the terminals of the individual unit(s) as a voltage source behind an internal impedance (Thevenin source), during normal operating conditions (non-disturbed network conditions) and upon inception of a network disturbance (including voltage, frequency and voltage phase angle disturbance). The Thevenin source is characterized by its internal voltage amplitude, voltage phase angle, frequency and internal impedance. (**LINK:** ACER_Recommendation_03-2023_Annex_1_NC_RfG)
AEMO – Australian Energy Market Operator	A Grid Forming (GFM) inverter maintains a constant internal voltage phasor in a short time frame, with magnitude and frequency set locally by the inverter, thereby allowing immediate response to a change in the external grid. On a longer timescale, the internal voltage phasor may vary to achieve desired performance. (**LINK:** Voluntary_Specification_for_Grid-forming_Inverters)
NESO – National Energy System Operator	Grid Forming Capability is (but not limited to) the capability a Power Generating Module, HVDC Converter (which could form part of an HVDC System), Generating Unit, Power Park Module, DC Converter, OTSDUW Plant and Apparatus, Electricity Storage Module, Dynamic Reactive Compensation Equipment or any Plant and Apparatus (including a smart load) whose supplied Active Power is directly proportional to the difference between the magnitude and phase of its Internal Voltage Source and the magnitude and phase of the voltage at the Grid Entry Point or User System Entry Point and the sine of the Load Angle. As a consequence, Plant and Apparatus which has a Grid Forming Capability has a frequency of rotation of the Internal Voltage Source which is the same as the System Frequency for normal operation, with only the Load Angle defining the relative position between the two. (**LINK:** NESO_Grid_Code issue 6)
Hawaiian Electric	GFM controls set an internal voltage waveform reference such that an inverter with the GFM control shall be able to synchronize with the grid and regulate active and reactive power generation appropriately, regardless of the grid's strength, or operate independently of other generation. An inverter with GFM control shall immediately respond to grid disturbances to support stability of the grid and maintain its own control stability during the system disturbances. (**LINK:** Technical_Model_Requirements_and_Review_Process)
FINGRID	Based on its control mode, the converter acts as a voltage source connected in series with the source impedance. Grid-Forming Control (GFC) aims to help maintain a constant angle of the voltage source presented in the converter's control system, when changes occur rapidly. Grid-Forming (GFM) generally refers to the control features of the Grid-Forming Converter (GFMI or GFI). (**LINK:** Grid_Code_Specifications_for_Grid_Energy_Storage_Systems_SJV2024)
NERC – North American Electric Reliability Corporation	Grid Forming Control for BPS-Connected Inverter-Based Resources are controls with the primary objective of maintaining an internal voltage phasor that is constant or nearly constant in the sub-transient to transient time frame. This allows the IBR to immediately respond to changes in the external system and maintain IBR control stability during challenging network conditions. The voltage phasor must be controlled to maintain synchronism with other devices in the grid and must also regulate active and reactive power appropriately to support the grid. (**LINK:** Grid_Forming_Functional_Specifications_for_BPS-Connected_Battery_Energy_Systems)

There is no international consensus on a single definition of Grid Forming. However, most approaches converge towards a high-level description of voltage source behavior complemented with measurable performance requirements for different types of disturbances.

Grid Forming Definition

EirGrid & SONI adopt a performance-based definition for Grid Forming aligned with international best practice

Explicit Description

*"The expected requirement for a device with GFM characteristics is for it to be capable of appearing at the connection terminal as a **passive source** such that, following a disturbance, it results in the injection of current, **within its current capability limits**, in the sub-transient and transient frame (sub-cycle up to tens of cycles) in a manner that helps **oppose the impact of the disturbance**."*

<u>Clarifications to the explicit description</u>

Appearing as a passive source (within a defined frequency range) means that the device does not interact negatively with the rest of the network (e.g. grid resonances) or other devices (e.g. control interactions).

Capability limits: GFM behaviour is expected until current limits are reached.

Opposing the impact of the disturbance improves power system strength and stability.

Note: The response of the GFM device to a system disturbance (voltage phase, magnitude or frequency) is expected to **flow naturally**, without explicit control actions or delays.

Performance-Based Definition (solution agnostic)

1. Appear as a voltage source
2. Voltage phase and magnitude jump response capability
3. Energy injection in inertial time frame (synthetic inertia)
4. Weak grid operation / Surviving the loss of the last synchronous connection (self synchronisation)
5. Oscillation damping / Impedance scans / Avoidance of control interactions / Passivity / Small signal disturbance response
6. Fault current contribution
7. Power system restoration (optional performance if required)
8. Voltage phase and magnitude jump withstand capability
9. Unbalanced voltages / Negative sequence response
10. Expected behaviour when reaching current limits
11. Power Quality / Active Filtering (optional performance if required)

Parameterized using All-Island power system studies

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GFM definition is performance-based and specific control architecture agnostic

Grid Forming Roadmap & Strategy

Grid Forming Roadmap & Strategy

A staged approach to the introduction of GFM capabilities in the All-Island power system to enhance security and reliability of supply

1. Introduction of **voluntary GFM requirements** for HVDC and PPMs in grid codes
2. **Technology trial** for HVDC (CELTIC) and PPMs (facilitated through Qualification Trial Process QTP)
3. Introduction of **mandatory GFM requirements** in grid codes, informed by trials, stakeholder feedback and detailed system studies, in compliance with European Network Codes

No inverter oversizing required: EirGrid and SONI do not plan to specify oversizing of converters or provision of additional energy beyond inherent energy storage of the plant in the grid codes.

Fairness: The focus is on utilisation of available performance capabilities provided by GFM controls without incurring unreasonable costs to developers.

Performance based requirements: The requirements introduced in the grid codes will define expected performance and will be agnostic on specific GFM control implementation.

No retrospective application: New mandatory GFM requirements will not apply retrospectively to existing connections unless they are subject to a significant modernisation.

Grid Forming Roadmap & Strategy

3 key steps to a grid code that facilitates Grid Forming control in the All-Island power system

1 EirGrid / SONI Voluntary Requirements for GFM

Introduce **voluntary GFM requirements** for PPMs and HVDC in EirGrid and SONI grid codes and develop appropriate testing protocols.

This is an early, **voluntary framework** for new projects and trials to demonstrate GFM capabilities to provide essential system services. **It is not retrospective** and does not impose immediate obligations for new or existing connections.

2 Technology Trials

Trial operation for GFM will include:

- HVDC trial for the Celtic interconnector between Ireland and France
- PPM trial through the Qualification Trial Process

Both are expected to commence in 2026.

3 Mandatory GFM Requirements

Mandatory requirements for GFM capability will eventually be introduced in the grid codes, and testing protocols will be updated. These requirements will not apply retrospectively to existing connections unless they are subject to a significant modernization.

These grid code changes will be aligned with European Connection Network Codes (RfG 2.0 and HVDC 2.0).

These changes are further informed by:

- Learnings from the technology trials
- Learnings from international experience
- All-Island system studies
- Industry and stakeholder engagement
- ENTSO-E IGDs

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Grid Forming Roadmap & Strategy

Applicability of voluntary GFM requirements

As a first stage, **voluntary GFM requirements** will be introduced in the grid codes for:

1. **HVDC**
2. **PPMs (wind, solar and BESS) of types (*):**
   - Type D.
   - Type C with capacity of 10 MW that are connected below the 110 kV voltage level to a feeder dedicated to one or more PPMs connected to a substation with direct transformation to 110 kV or above.

(*) Refer to Appendix D for Power Park Module Types

Purpose	Introducing voluntary requirements into Grid Codes will enable trialing the capabilities of GFM technology to support the stability of the All-Island power system.

Note: The voluntary GFM requirements will be subject to standard Grid Code Review Panel process and Regulatory Authority approval.

Grid Forming Roadmap & Strategy

Applicability of mandatory GFM requirements: Implementation of RfG 2.0 and HVDC 2.0

Entry into force of RfG 2.0

Within 2 years →

TSO and DSO will jointly **develop a national implementation roadmap to assess a roll out of GFM capabilities** for PPM types A, B and C (except type C of 10 MW with direct export to transmission system). This will include an assessment of the benefits and challenges of implementation and the development of a joint, coordinated solution.

Within 3 years →

Mandatory GFM requirements will be introduced in the grid codes for PPMs of the following types (*):

- Type D.
- Type C with capacity of 10 MW that are connected below the 110 kV voltage level to a feeder dedicated to one or more PPMs connected to a substation with direct transformation to 110 kV or above.

(*) timelines for roll out of GFM mandatory requirements for other PPM types will be determined by the joint DSO/TSO national roadmap

Entry into force of HVDC 2.0

Within 3 years →

Mandatory GFM requirements will be introduced in the grid codes for HVDC (**).

(**) While GFM requirements are non-mandatory in HVDC 2.0, this capability is deemed essential for the All-Island power system)

Expected entry into force: 2026 and 2027 for RfG 2.0 and HVDC 2.0, respectively

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Note: The mandatory GFM requirements will be subject to standard Grid Code Review Panel process and Regulatory Authority approval.

Grid Forming Roadmap & Strategy

Discrete tasks planned along time horizons

Current state (Completed)

Assessment of Current GFM Capabilities and best industry practice: based on literature review and industry engagement.

GFM Definition: an explicit high-level description and comprehensive performance-based definition.

Develop Roadmap for implementation of GFM Strategy.

Support ENTSO-E publication of report on **technical requirements for GFM capabilities of PPMs** (*)

Near-term (2026)

Introduce GFM voluntary requirements in grid codes and develop testing protocols: To support trials of GFM capabilities for PPMs and HVDC projects.

Commence GFM Trial Operation: Celtic HVDC interconnector trial and QTP for PPM.

Support **ENTSO-E development of GFM** IGD associated with RfG 2.0

Commence System Studies to inform GFM performance requirements.

Commence development of national roadmap with DSO to assess roll-out of GFM capability at distribution level.

Medium term (2027-2029)

Publish **national roadmap** with DSO for roll-out of GFM capability at distribution level.

Updates to grid codes (PPM) in alignment with European Network Code RfG 2.0:
Technical performance requirements (mandatory) informed by trials, system studies, stakeholder engagement and ENTSO-E IGD.

Update GFM testing protocols for PPMs.

Long term (2030+)

Updates to grid codes (HVDC) in alignment with European Network Code HVDC 2.0:
Technical performance requirements (mandatory) informed by Celtic Interconnector trial, system studies, stakeholder engagement and ENTSO-E IGD.

Update GFM testing protocols for HVDC.

Technology agnostic roll out of grid code compliant GFM within the All-Island power system.

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(*) Link: Grid forming capability of power park modules
(**) Assumed RfG 2.0 entry into force in 2026 and HVDC 2.0 in 2027

Grid Forming Roadmap & Strategy

Key activities to support GFM implementation

Stakeholder Engagement

An active stakeholder engagement to ensure that the many internal and external stakeholders have an opportunity to:

1. Understand the outputs of the strategy once applied
2. Provide input at the task of the strategy being developed

Enhanced Modelling

Detailed EMT modelling and simulation is required to better understand the complex dynamic behavior and interactions of advanced controls in IBR-dominated systems. EirGrid and SONI have developed a roadmap for implementation of EMT modelling and simulation capabilities and have published EMT model specifications applicable to all connections.
Engagement with OEMs is ongoing to gain access to propriety GFM EMT models for accurate assessments and improved understanding of operational capabilities and/or challenges related to GFM.

Operational Policy

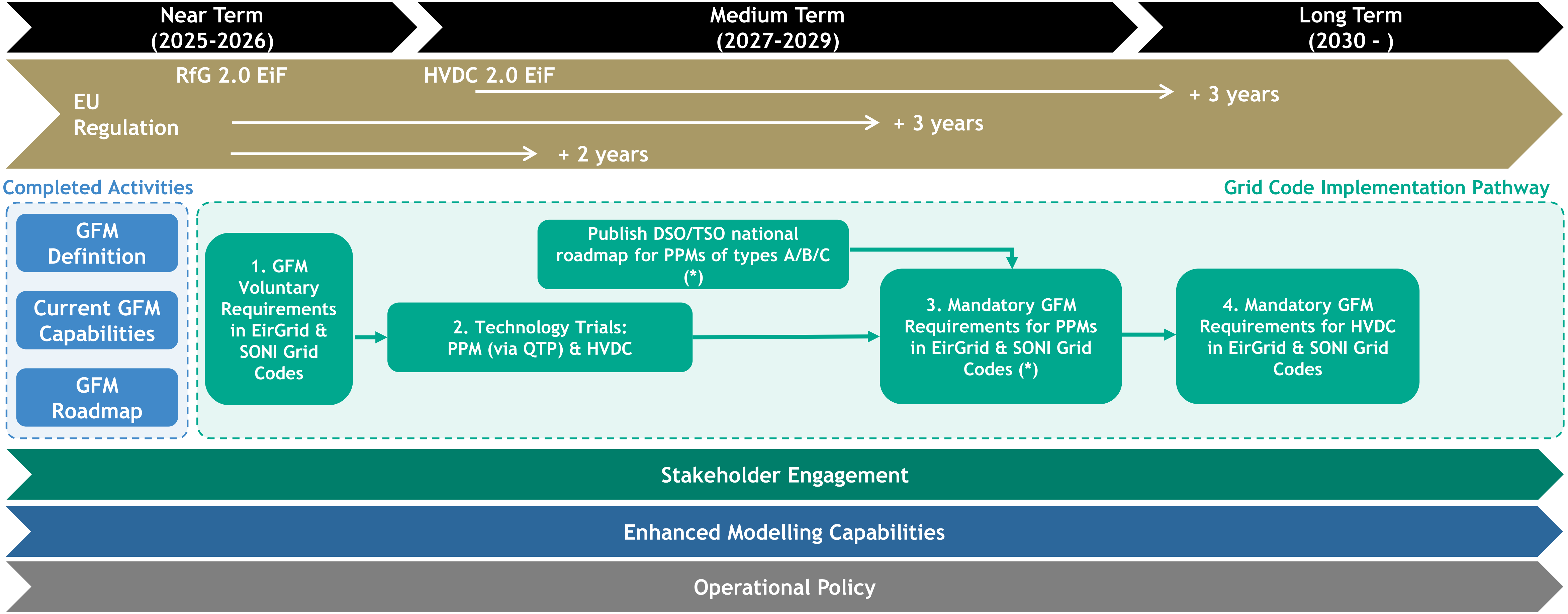
Integration of GFM capabilities will support the evolution of operational policy, as outlined in the Operational Policy Roadmap 2025-2035*. Considerations on:

- Guidance on how GFM devices should be considered by operators and their supporting staff
- System strength calculations and operating the grid with low system strength
- Impact on power system restoration

(*) Link: Operational Policy Roadmap 2025-2035

Grid Forming Roadmap & Strategy

The roadmap defines discrete and continuous actions across various timeframes; it includes a carefully designed grid code modification pathway



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(*) roll out of GFM requirements for PPM types A, B and C (with exception of type C of 10 MW connected below the 110 kV voltage level to a feeder dedicated to one or more PPMs connected to a substation with direct transformation to 110 kV or above) will be determined by the joint DSO/TSO national roadmap

Expected Entry into Force (EiF) of 2026 and 2027 for RfG 2.0 and HVDC 2.0 respectively

Summary

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Summary

- GFM capability is an important enabler for enhancing power system stability when operating with a high share of renewables.
- The EirGrid and SONI strategy for GFM defines the route for integrating the forthcoming European Network Code updates, RfG 2.0 and HVDC 2.0, into grid code requirements via three steps: voluntary provisions, technology trials, and finally mandatory requirements.
    - Voluntary Grid Code requirements are planned to apply initially to HVDC, all type D PPMs and type C PPMs with capacity of 10 MW that are connected below the 110 kV voltage level to a feeder dedicated to one or more PPMs connected to a substation with direct transformation to 110 kV or above.
    - Mandatory Grid Code requirements will be introduced within 3 years of RfG 2.0 entry into force for the same PPM categories and within 3 years of HVDC 2.0 entry into force for HVDC.
    - A national TSO–DSO roadmap will be developed within 2 years after RfG 2.0 enters into force to assess the benefits and rollout of GFM capabilities for other distribution connected PPM types.
- GFM requirements will be specified in grid codes by measurable performance at the point of connection rather than by a prescribed hardware or control topology, supporting technology agnostic requirements while also signalling that compliance is expected within existing plant capability limits, without unnecessary converter oversizing or additional energy provision beyond inherent capability.
- EirGrid and SONI will enable an active stakeholder engagement process to incorporate industry feedback into implementation decisions and facilitate GFM adoption as the strategy progresses through its implementation stages.
- EirGrid and SONI will review the strategy periodically to address rapid developments in GFM technologies. This can include future considerations for large inverter-based loads, such as data centres and electrolyzers, as ENTSO-E guidance on the Demand Connection Code evolves.

Appendix

A. International TSO experience
B. Examples of Grid Forming Worldwide
C. Selected Bibliography
D. Power Park Modules Types

Appendix A

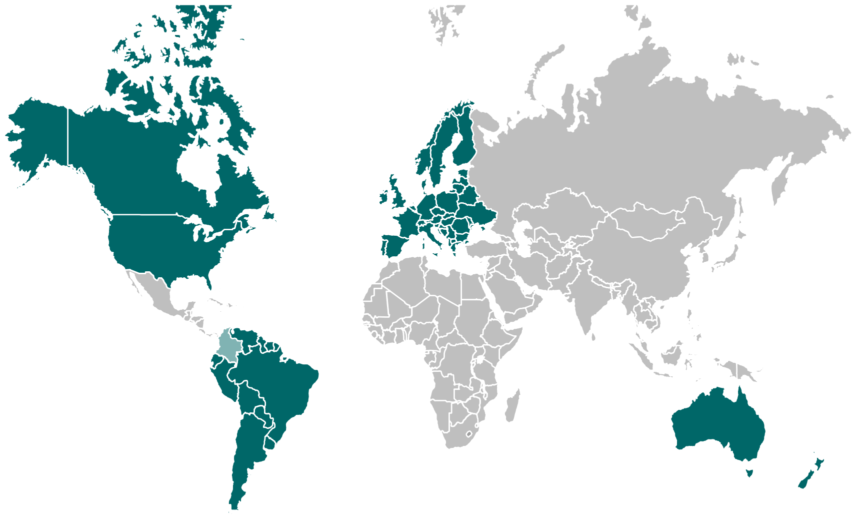
International TSO experience

Information exchange

As part of the strategy development exercise, we hosted interviews with **eight TSOs abroad** and facilitated informal information exchange with two other TSOs.

We spoke to TSOs from **continental Europe, the United Kingdom, and the Nordics, as well as Oceania, North America and South America.**

Continental coverage of TSO review



Discussion items

- No single, universally accepted **definition of GFM** among TSOs. Most favour performance- or function-based, but some still provide explicit definitions. The trend is towards specifying required system performance.
- Most TSOs are moving towards technology-agnostic **grid code requirements**, aiming for a level playing field across BESS, HVDC, wind, and solar. Early adoption and grid code changes focus on technologies with higher TRL.
- Some have made GFM **mandatory** for certain technologies or new connections, while others currently use **voluntary** or market-based approaches, with a clear trend towards mandatory requirements in the medium term.
- BESS and HVDC are the most mature and **widely adopted GFM technologies** internationally. STATCOMs are also being deployed. Wind and solar GFM capabilities are emerging, with pilots and early commercial projects underway.
- Focus on detailed modelling and simulation requirements. Broad agreement that both **EMT and RMS models** are necessary for compliance and system studies. EMT models for transient and weak grid studies, with RMS models used for broader system analysis.

TRL: Technology Readiness Level

Appendix B

Examples of Grid Forming Projects Around the World

Technology	Technology Readiness Level[1]		Examples: Project	Location	Size	Year	More Info
HVDC (VSC)	8	System prototype demonstration in an operational environment	Johan Sverdrup Project	Norway	300 MW	2022	https://zenodo.org/records/4701508
			Celtic	Ireland	700 MW	2028	https://www.eirgrid.ie/celticinterconnector
FACTS (STATCOMS)	8	System prototype demonstration in an operational environment	Opladen Station	Germany	±300 MVar	2023	https://www.amprion.net/Presse/Presse-Detailseite_57216.html
			South Fork Wind	USA	± 75 MVar	2024	https://southforkwind.com/
BESS	8	System prototype demonstration in an operational environment	Blackhillock, Phase I	Great Britain	200 MW/400 MWh	2025	https://www.neso.energy/news/great-britains-first-grid-forming-battery-connects-scotland
			Hornsdale Power Reserve	Australia	150 MW/194 MWh	2020	https://hornsdalepowerreserve.com.au/
Wind	7	System prototype demonstration in an operational environment	Dersalloch	Great Britain	69 MW	2020	https://www.neso.energy/document/226951/download
Hybrid Solar PV + GFM BESS	8	System complete and qualified	Gertse PV Plant	China	30 MW PV + 6 MW/24 MWh	2025	https://solar.huawei.com/en/cases/utility/grid-forming-tech-hits-milestone-green-power-goes-commercial-at-high-altitudes/
			Gemini Solar + Storage Project	USA	690 MW PV + 380 MW/1400 MWh	2024	https://www.primergygemini.com/project-overview

[1]Research, Development and Innovation Committee (RDIC), "Guidelines on Technology Readiness Level (TRL) used for ENTSO-E Technopedia," ENTSO-E, March 2025

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Appendix C

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HECO: Model Energy Storage Power Purchase Agreement

REE: Especificación_Técnica_Capacidades_Grid_Forming_ET-GFM

CEN: Requisitos Técnicos Mínimos para Recursos Basados en Inversores Grid-Forming

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Appendix D
Power Park Module Types

Requirements for PPMs will be considered based on the Registered Capacity, as categorized in the table below as per RfG:

Type	Registered Capacity
A	800 W up to 0.09 MW
B	0.1 MW up to 4.9 MW
C	5 MW up to 10 MW
D	Greater than 10 MW

(Note all generation connected at 110 kV or above is automatically considered Type D)

RfG : *establishing a network code on requirements for grid connection of generators*

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