SolarPower Europe Commenting on Grid Forming

Solar Power Europe's vision and steps to support the grid forming (GFM) developments

- The solar industry is committed to supporting grid stability in facing the challenge of integrating vast amounts of solar PV into the grid.
- The grid forming requirement should not be mandated for Type A modules or allowed only after establishing a clear impact assessment and an industrial roadmap in close consultation with the industry as long as the technology hasn't been proven.
- Concerning non-Type A PPMs, Solar PV can already and does already provide several 'grid supporting' services that should be sufficient to deal with today's system stability challenges
- The grid forming requirements should <u>not</u> require the addition of storage on solar plants, especially until specific system needs have not been clearly defined and a thorough cost-benefit analysis has not been conducted to determine the most cost-effective way of procuring the services, such as through a market-based approach.
- Where the grid operator identifies further needs for grid forming capabilities, that may require the addition of storage it should use a market-based procurement of grid forming services
- Where grid operators identify a need for a grid forming requirement that the market-based procurement cannot meet, the following steps shall be followed before introducing any requirement.

<u>The issue with the framework proposed by ACER on the 19 December 2023:</u>

- Grid forming requires grid operators to quantify their needs and ensure that there is the right quantity of grid services in the system. **Yet, the text at the moment does not provide this clarity: a number of elements will be defined closed-door (through an implementation guidance document) or at the national level (for some requirements), while some terminologies are unclear for the industry (the wording "within the capabilities" does not provide sufficiently neutral measurable acceptance criteria, e.g. ride through vs. unspecified vs. specified and firm inertial power contribution)).** We do not sufficiently understand how grid-forming capabilities will be derived from various technologies (beyond the definition of PPM/Types). Diverse technologies can offer vastly different capabilities, particularly concerning availability and independence from operating points, which may result in an overall behaviour that is hard to predict for the RSO. For instance, the inherent and unregulated provision of short-circuit currents from GFM PPMs may pose challenges within the network. Presently, there are regions where the short-circuit contribution from local PPMs exceeds the capacity of existing assets to manage.

- **In addition, the text does not offer perspective on how Solar inverters as such will not be able to provide the necessary grid forming services, unlike other technologies.** This is evidenced by the report ACCPM drafted within the expert group of ENTSO-E, by the energy industry member of the Grid Connection Expert Stakeholder Committee.
- **Some of the requirements under Type C and D may require owners of new PV systems to add storage to provide grid-forming services, without first clearly defining the system's needs and determining whether this is the most cost-effective way for the system to procure such needs, through a cost-benefit analysis or analogous.** Emerging technologies like BESS entail complex monetization strategies involving participation in multiple markets, which are virtually non-existent in most Member States - difficulty access to balancing markets, the impossibility of doing both energy arbitrage and receiving the CfD for the solar part of the asset, while the addition of BESS introduces extra costs. Solar developers undertake additional costs and risks only after identifying profitable opportunities amidst favourable regulatory and market conditions to ensure the investment put in the project during its lifetime. Therefore, requiring the mandatory installation of batteries deviating from the market base approach by offering a competitive framework, as endorsed on the Clean Energy Package, will result in higher CAPEX costs for solar projects without the opportunity to access revenues to compensate, increasing the LCOE for very limited use of additional capabilities if deployed on all solar plants.
- The compulsory imposition of GFM in network codes – especially within the given timeline – is not sufficiently justified and conflicts with the obligation to procure such capabilities through market-based grid services as outlined in the Market Design Directive (EU) 2019/944.
    - *Article 31 Paragraphs 6 and 7 (DSO)*
    - *Article 40 Paragraphs 4 and 5 (TSO)*

Detailed assessment of the RfG text proposed by ACER on December 2023:

Y7. *Where grid forming capability is specified by the relevant TSO in coordination with the relevant system operator in accordance with paragraph 5 or defined in Articles 20, 21 and 22, a power park module shall be capable of providing grid forming capability at the connection point as listed below, considering the sub-cycle character of the physical quantities where appropriate.*	
(a) 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.	
(a) shall be capable of not changing its amplitude and voltage phase angle while positive sequence voltage phase angle steps or voltage magnitude steps are occurring at the connection point. The current exchanged between the power park module and the network shall flow naturally according to the main generating plant and converter impedances and the voltage difference between the internal Thevenin source and the voltage at the connection point. (b) Upon inception of a network disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source according to paragraph	This requires devices to keep the current flow, but we don't know to which extent. The extent to which we should provide the service means different choices at manufacturing stage, so we need to know. The limits depend largely on the voltage / topology of the grid. If the limit depends on the grid location, difficult to certify a product for a manufacturer. How the IGD is intending to solve this is unclear for the industry. The limits for "letting the current flow naturally" are very tight for PV-only systems. There is a high probability that there is a lot effort for developing and qualifying the technology for only very few benefits for the network.
(c) After inception of a network disturbance in voltage magnitude, frequency or voltage	The notion of what is 'within power park module's capability" is not defined and leads

phase angle, the following shall apply within the power park module's capability, including current limits and inherent energy storage capabilities of each individual unit.	to uncertainties. We suggest that it refers to the capabilities of a power park module of the same underlying technology (which could also differ within the same technology due to their electronics topology), excluding battery storage. However, we also identify a high risk, that some manufacturers provide really as much as possible "within the capabilities", others do not, since there is no neutral acceptance criterion for "within the capability", which is a totally different approach compared to other requirements in the RfG which define clear, measurable performance criteria. This will lead to highly unpredictible / non-deterministic behaviour of the units in the overall system. In addition, for the evaluation of the capabilitiy, the evaluating entities like certifiers etc. may stipulate proofs by disclosing technological details.
(i) The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage stability.	
(ii) Where current limitation is necessary, the relevant system operator in coordination with the relevant TSO may specify additional requirements regarding contribution of active and reactive power at the point of connection.	This is too vague and imprecise. We need to have a robust cost-benefit analysis prior to introducing further requirements. The possibility for the RSO to define active and reactive power when reaching the current limits opens the door for a large variety of different requirements, especially at the edge of stability ("where current limitation is necessary")
(iii) The power park module shall be capable of stable operation when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph (b) as soon as the limitations are no longer active. If reaching the current limit, the grid forming behaviour must be	

maintained for responses as specified in paragraph (b) for disturbances that require the current to vary in the opposite direction of the current limitation.	
Inherent energy storage means an energy reserve available in physical components of a power park module, which has not necessarily been designed to suit the grid forming requirements of this Article, but may be used for such purposes, without affecting the design of the physical components of individual units.	Within the same physical component, it could be asked that a solar PV inverter work under its maximum capability to reserve a certain amount of operating power to respond with an increase in power if needed. This implies that a plant could be continuously curtailed during normal operation, producing less than expected. Such an approach should underlie strict regulation.

Our vision and steps to support GFM developments:

- **First of all, the solar industry is committed to supporting grid stability in facing the challenge of integrating vast amounts of solar PV into the grid.** For instance, French IPP Akuo Energy has been operating since 2014 in French non-interconnected islands (Corsica, La Réunion) several commercial plants collocate solar PV and Li-ion batteries and can provide bi-directional frequency response and support the grid through a better control of generation (in particular load shifting to night peak hours). On the Caribbean Island St. Eustatius, since 2017 Grid Following Solar PV + Grid Forming Battery Storage allow to operate the grid without the support of any synchronous machines. In Great Britain, grid-forming battery assets with several 100MW will be interconnected this year to the bulk power system and provide stability services, through market-base, such as inertia and short circuit power on top of energy shifting and traditional ancillary services.
- **The grid forming requirement should not be mandated for Type A modules or allowed only after establishing a clear impact assessment and an industrial roadmap in close consultation with the industry (article Y(5)),** as long as the technology hasn't been proven. The impact on product assessment and certification and the distribution system would also need to be assessed.
- **Concerning non-Type A PPMs, Solar PV can already and does already provide a number of 'grid supporting' services that should be sufficient to deal with today's system stability challenges.** Today the grid-supporting capabilities regarding PV technologies can be enhanced and may comprise the following: (i) Voltage control, (ii) Fast LFSM, (iii) defined robustness against sudden voltage angle changes. These functionalities are critical to support the grid, within the solar industry's reach, and two of them are already included in the RfG (Articles 13(3) - for ii and 13(10) for i)
- **The grid forming requirements should not require the addition of storage on solar plants, especially until specific system needs have not been clearly defined and a**

thorough cost-benefit analysis has not been conducted to determine the most cost-effective way of procuring the services, such as through a market-based approach. Currently, major barriers at some Member states level to the economic valuation of solar + storage plants (challenges in doing energy arbitrage when collocated with a solar plant, lack of access to the balancing market or capacity markets) still remain**.** This means that the wording 'within capabilities' should be clarified and understood in the case of solar PV as within the system of the same underlying technology, excluding storage.

- **Where the grid operator identifies further needs for grid forming capabilities, that may require the addition of storage it should use a market-based procurement of GFM services (such as inertia, SCL…)** that allows procuring capabilities according to the appropriate amount at appropriate locations with appropriate technologies. The demand for GFM can be covered efficiently and to a sufficient extent by market-based principles and support the lack of a storage framework.
- **Where grid operators identify a need for a grid forming requirement that the market-based procurement cannot meet, the following steps shall be followed prior to introducing any requirement:**
    - System Operators should conduct and transparently communicate a <u>grid stability assessment</u> to determine grid-forming and inertia requirements, pinpointing the specific areas and quantities of grid-forming/inertia necessary.
    - Following the system operator's assessment, conducting <u>a cost-benefit analysis of the available technologies and their capabilities</u> is essential to selecting the most suitable options that can effectively address the requirements of the identified areas. This should be done or approved by NRAs as solar industry manufacturers. The assessment should also <u>include an assessment of the economic impact on developers and identify the barriers remaining to further revenue streams of each technology</u> – in the case of storage if barriers for the economic value of storage have been sufficiently removed (participation to balancing market and capacity markets, possibility to stack services).
    - **If, following the assessment, it is found that further requirements for grid forming are necessary, the requirements should come with proper compensation. We suggest that the requirement is attached to CFDs for hybrid projects (PV+storage).** In such a case, part of the remuneration would come from supporting the grid stability. This would allow for faster deployment of flexible PV plants and speed up decarbonization through higher renewable energy penetration.
    - Simultaneously, in the long term, a grid-forming roadmap must be mandated to ensure the systematic development of mature and resilient grid-forming technology. Sufficient time should be allocated to implement agreed-upon standards with clear, objective acceptance criteria for the various technologies under consideration. This mandate should extend to all types, not solely Type A, implying that the aforementioned considerations should be incorporated into all types when integrating grid-forming capabilities. Additionally, all types should integrate an assessment step before the implementation of GFM.

<u>Key amendments:</u>

Framework for type A, B, C, and D PPMs

Y7. *Where grid forming capability is specified by the relevant TSO in coordination with the relevant system operator in accordance with paragraph 5 or defined in Articles 20, 21 and 22, a power park module shall be capable of providing grid forming capability at the connection point as listed below*, ***within its capabilities understood as the state of the art capabilities of a system of the same underlying technologies,*** *considering the sub-cycle character of the physical quantities where appropriate.*
(a) 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.
~~***(b) Upon inception of a network disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source according to paragraph (a) shall be capable of not changing its amplitude and voltage phase angle while positive sequence voltage phase angle steps or voltage magnitude steps are occurring at the connection point. The current exchanged between the power park module and the network shall flow naturally according to the main generating plant and converter impedances and the voltage difference between the internal Thevenin source and the voltage at the connection point.***~~
~~***(c) After inception of a network disturbance in voltage magnitude, frequency or voltage phase angle, the following shall apply within the power park module's capability, including current limits and inherent energy storage capabilities of each individual unit.***~~
~~***(i) The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage stability.***~~
~~***(ii) Where current limitation is necessary, the relevant system operator in coordination with the relevant TSO may specify additional requirements regarding contribution of active and reactive power at the point of connection.***~~
~~***(iii) The power park module shall be capable of stable operation when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph (b) as soon as the limitations are no longer active. If reaching the current limit, the grid forming behaviour must be maintained for responses as specified in paragraph (b) for disturbances that require the current to vary in the opposite direction of the current limitation.***~~
~~***Inherent energy storage means an energy reserve available in physical components of a power park module, which has not necessarily been designed to suit the grid forming***~~

~~requirements of this Article, but may be used for such purposes, without affecting the design of the physical components of individual units.~~
(new paragraph) If the designated entity identifies a need to require the services identified in points (a), (b), (c) further than within the PPM capabilities, it shall procure the services on a market basis, in line with article 31 and 41 of Directive 2019/944. This includes the following:
(b) Upon inception of a network disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source according to paragraph (a) shall be capable of not changing its amplitude and voltage phase angle while positive sequence voltage phase angle steps or voltage magnitude steps are occurring at the connection point. The current exchanged between the power park module and the network shall flow naturally according to the main generating plant and converter impedances and the voltage difference between the internal Thevenin source and the voltage at the connection point.
(c) After the inception of a network disturbance in voltage magnitude, frequency or voltage phase angle, the following shall apply within the power park module's capability, including current limits and inherent energy storage capabilities of each individual unit.
(i) The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage stability.
(ii) Where current limitation is necessary, the relevant system operator in coordination with the relevant TSO may specify additional requirements regarding contribution of active and reactive power at the point of connection.
(iii) The power park module shall be capable of stable operation when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph (b) as soon as the limitations are no longer active. If reaching the current limit, the grid forming behaviour must be maintained for responses as specified in paragraph (b) for disturbances that require the current to vary in the opposite direction of the current limitation.
Inherent energy storage means an energy reserve available in the physical components of a power park module, which has not necessarily been designed to suit the grid forming requirements of this Article but may be used for such purposes, without affecting the design of the physical components of individual units.
21.5: ~~5. With regard to grid forming capability type C power park modules shall fulfil the following additional requirements in relation to grid forming capability:~~

~~(a) The relevant TSO, in coordination with the relevant system operator, shall specify the contribution to synthetic inertia. The power park module shall be capable of contributing to limiting the transient frequency deviation under high and low frequency conditions.~~

~~(b) The relevant TSO may require the provision of additional energy beyond the inherent energy storage in coordination with the relevant system operator.~~