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European Union Agency for the Cooperation of Energy Regulators

Grid Connection NC HVDC Amendments – update

Grid Connection ESC

27 June 2024

Brussels/Online

Public

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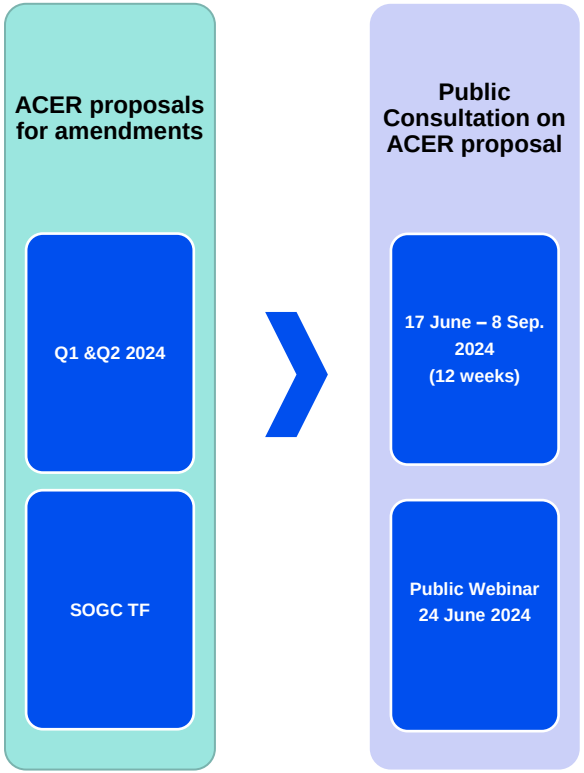
NC HVDC amendments - timeline

Public consultation on ACER draft proposal



- 12-week long public consultation
- Launched on 17 June 2024
- Stakeholders are invited to comment on ACER draft amendment proposals
- The Grid Connection European Stakeholder Committee's (GC ESC) Expert Group's on Connection Requirements for Offshore Systems (EG CROSS) proposal forms the basis for ACER's draft amendment proposal
- On 24 June public webinar to present key proposals

NC HVDC

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Grid Connection ACER views on aggregation of PGMs – NC RfG 2.0

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DISCLAIMER: The material set out in this slide deck is presenting current ACER views on the ACER recommendation to NC RfG, assessed at the working level, and is intended for discussion/informational purposes only. Furthermore, it is without prejudice to further communications and the Commission's final text.

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Aggregation of power generating units as per NC RfG 1.0

Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators

Aggregation of synchronous power-generating units

Recital (9)

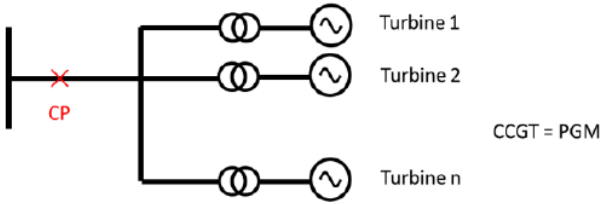
"*Synchronous machines should be classed on the **machine size** and include all the components of a generating facility that **normally run indivisibly**, such as separate alternators driven by the separate gas and steam turbines of a single combined-cycle gas turbine installation. For a facility including several such combined-cycle gas turbine installations, each should be assessed on its size, and not on the whole capacity of the facility.*"

- Two conditions needed to aggregate synchronous PGUs capacities:
  - *they should be classed on the machine size, and*
  - *include all the components of a generating facility that normally run indivisibly*

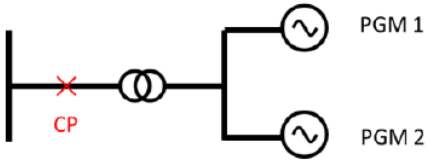
NC RfG 1.0 – Examples from TSOs

Answer to FAQ 29:
What are typical examples of a Power Generating Module and Power Park Module scheme, and how is the definition of Connection Point to be interpreted?

c. 1 Ensemble of synchronous units - Combined Cycle Gas Turbine



d. Ensemble of synchronous units – controlled separately and shared transformer. Because both are controlled separately, both are a PGM.



NC RfG 1.0 – Examples from TSOs

What is a Power Generating Module? Concept 1: Concept of "indivisible set of installations" for SPGM

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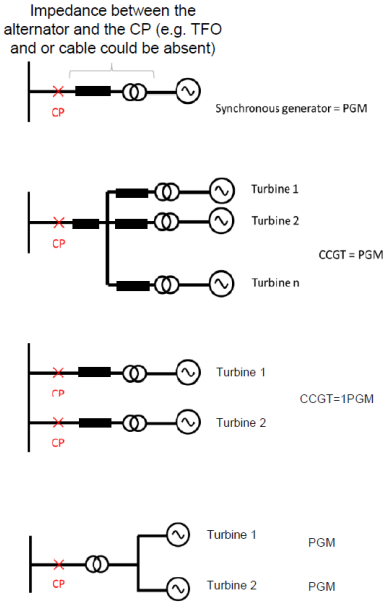

A single-shaft CCGT(only one generator with several turbines on the same shaft) , an hydro unit, a diesel, … is a single synchronous generating unit => 1PGM

Ensemble of synchronous units that cannot be operated independently from each other (e. g. multi-shaft CCGT where the steam turbine (ST) cannot be operated standalone, but together with at least one gas turbine (GT). => 1PGM

The case of a CCGT where the ST has a dedicated connection point. Obviously the ST itself will not be able to meet all relevant RfG requirements. In this case the concept of connection point should be understood in a flexible manner (the 2 physical points are the connection point)

Ensemble of synchronous units that are controlled separately even if have a shared transformer => 2 PGMs
=> Common equipment do not prohibit from operating one unit without the other.

Source: *Presentation by Elia in the 06/06/2016 Grid Connection Network Codes European Stakeholder Committee*

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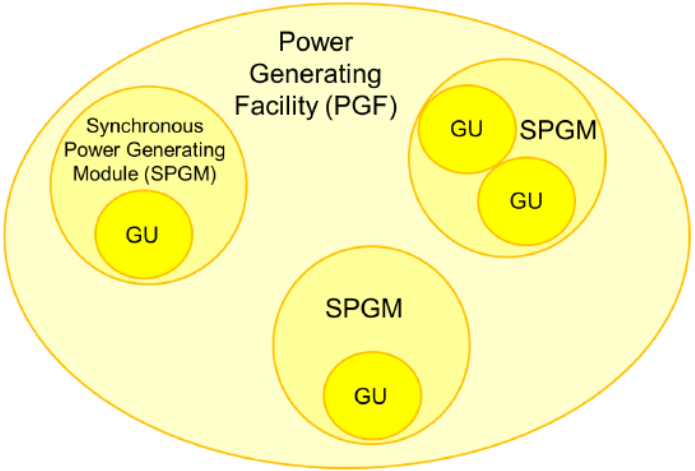
NC RfG 1.0 – Example from DSOs

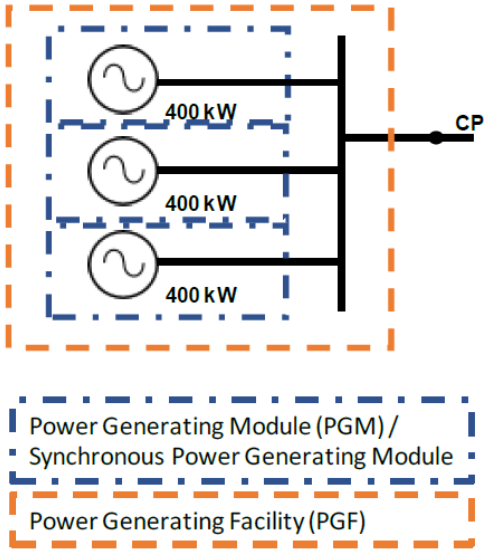
Synchronous Power Generating Modules (SPGM) are defined in EREC G99 as "an indivisible set of Generating Units (ie one or more units which cannot operate independently of each other) which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism." Where the generating units cannot run independently from each other – eg. if they have a common shaft – they form a Synchronous Power Generating Module.

Synchronous Power Generating Module – the classification of Type A to D is based on the capacity of **each** Power Generating Module (PGM) in the Power Generating Facility (PFG):



Source: *www.energynetworks.org, (non-profit industry body representing the companies which operate the electricity wires, gas pipes and energy system in the UK and Ireland), Distributed Generation Connection Guides: Engineering Recommendation G99 Type A - Full Version*

NC RfG 1.0 – Example from DSOs



(c) 3 x 400 kW **Type A Synchronous Power Generating Module**s
= 1.2 MW **Power Generating Facility**

Figure 4.2 Examples of Type A Power Generating Modules

Source: *www.energynetworks.org, ((non-profit industry body representing the companies which operate the electricity wires, gas pipes and energy system in the UK and Ireland), Engineering Recommendation G99 Issue 1 – Amendment 5, 5 November 2019, Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019*

NC RfG 1.0 – a few examples from SOs

What affects the aggregation of synchronous PGUs?

- Whether the units can be controlled and operated independently of each other
- Ownership of units

Synthesis

- **At least from the examples, there appears to be a consistent and uniform interpretation of the NC RfG 1.0 across different countries**

Aggregation of non-synchronously connected power-generating units

Recital (9)

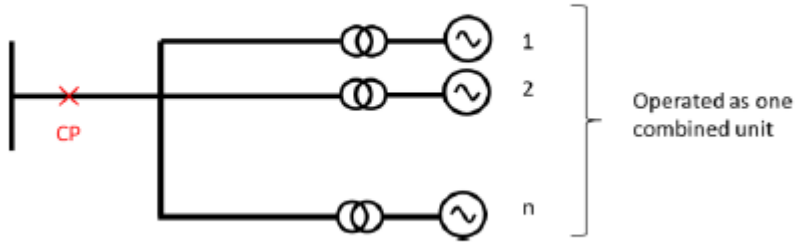
"*Non-synchronously connected power-generating units, where they are collected together to form **an economic unit** and where they have **a single connection point** should be assessed on their aggregated capacity*."

- Two conditions needed to aggregate non-synchronously connected PGUs capacities:
  - *they are collected together to form an economic unit, and*
  - *they have a single connection point*

NC RfG 1.0 – Examples from TSOs

Answer to FAQ 29:
What are typical examples of a Power Generating Module and Power Park Module scheme, and how is the definition of Connection Point to be interpreted?

1. Power Park Module
   a. Single PPM in a wind farm



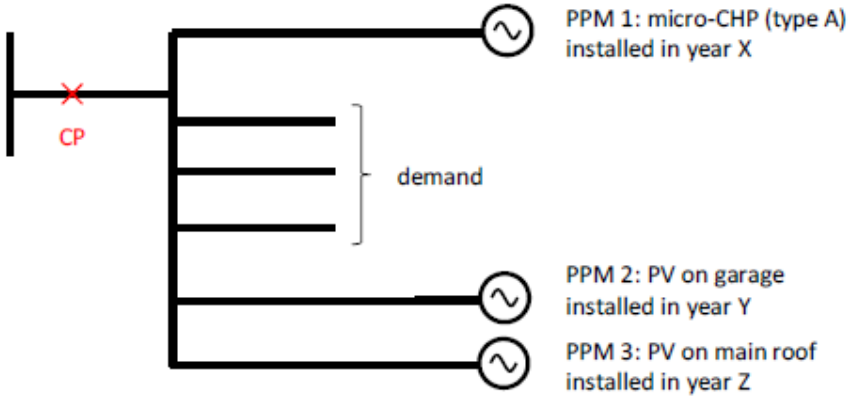
Source: *ENTSO-E, Network code for requirements for grid connection applicable to all generators – Frequently asked questions – 19 June 2012*

NC RfG 1.0 – Examples from TSOs

Answer to FAQ 29:
What are typical examples of a Power Generating Module and Power Park Module scheme, and how is the definition of Connection Point to be interpreted?

C. Illustration of multiple stages of domestic generation

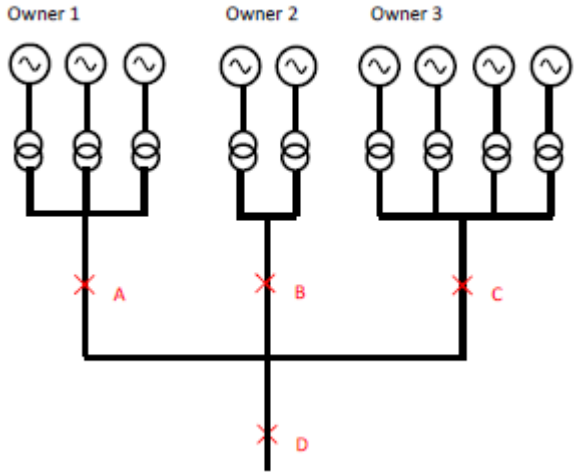
Three PPMs at residential level i.e. at LV: One Connection Point to the DSO. Note, each individual PPM has an operational notification process in line with Art. 25.



Source: *ENTSO-E, Network code for requirements for grid connection applicable to all generators – Frequently asked questions – 19 June 2012*

NC RfG 1.0 – Examples from TSOs

Answer to FAQ 29:
What are typical examples of a Power Generating Module and Power Park Module scheme, and how is the definition of Connection Point to be interpreted?



3. Several wind/PV farms sharing a connection to the DSO
   a. Option 1 - Individual connections: Owner 1, 2 and have Connection Points to the DSO at respectively interfaces A, B and C. The DSO owns the assets between A, B, C and D
   b. Option 2 - Joint ownership: Owners 1, 2 and 3 join as one company and trade as one. This company could then own the assets between A, B, C and D. They could however not be a Closed Distribution System Operator, because Art. 28 of Directive 2009/72/CE does not facilitate this.

Source: *ENTSO-E, Network code for requirements for grid connection applicable to all generators – Frequently asked questions – 19 June 2012*

NC RfG 1.0 – Examples from TSOs

What is a Power Generating Module? Concept 5: Shared Connections or Not

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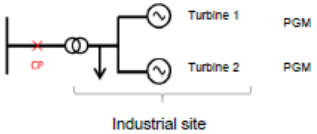
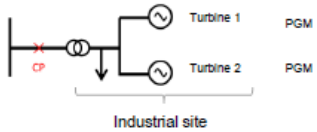
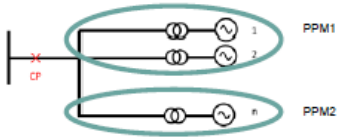


2 single (local) synchronous generating unit
⇒ 2 PGMs
⇒ One connection contract with the SO
Any ancillary service contracts are defined at the connection point and are to be agreed with the owner of the holder of the connection contract.



2 single (local) synchronous generating unit having a shared-connection
⇒ 2 PGMs
⇒ One connection contract with the SO but several parties known in the contract
Management of ancillary service contracts are defined in the shared-connection contract



Two PPMs in a wind farm operated separately, having a shared-connection and that can meet the grid code requirement even in the absence of the other wind farm.

Note that, if relevant, this concept can be generalized easily for PPM or SPGM

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Source: *Presentation by Elia in the 06/06/2016 Grid Connection Network Codes European Stakeholder Committee*

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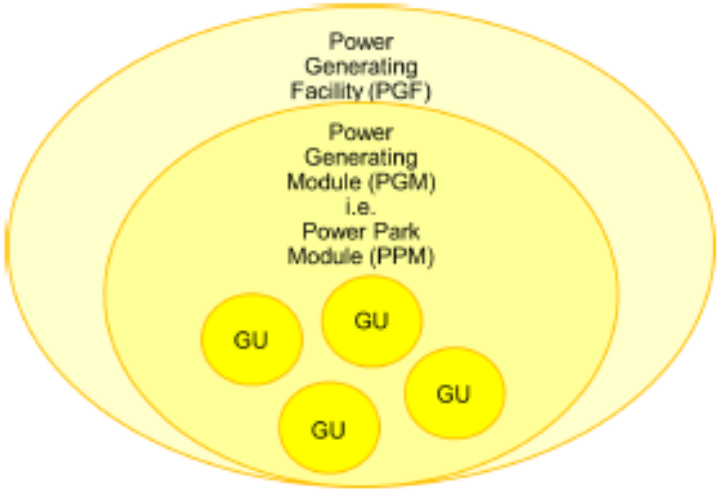
NC RfG 1.0 – Example from DSOs

Power Generating Modules are classified in EREC G99 as Power Park Modules (PPM) or Synchronous Power Generating Modules (SPGM). Both comprise one or more generating units, which is any apparatus that produces electricity.

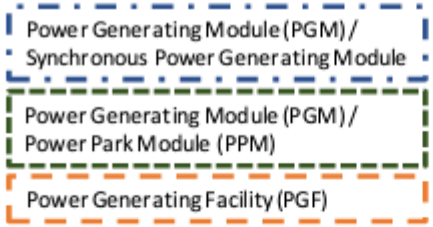
Power Park Modules (PPM) are connected to the network either through power electronics (eg. solar PV or electricity storage devices connected through an inverter) or asynchronously (eg. some wind turbines are induction or asynchronous generation). They have a single Connection Point to the distribution network.

Power Park Module - the classification of Type A to D is based on the capacity of the Power Generating Module (PGM), which is the total capacity of all generating units (GU) in the Power Park Module (PPM):



Source: *www.energynetworks.org, (non-profit industry body representing the companies which operate the electricity wires, gas pipes and energy system in the UK and Ireland), Distributed Generation Connection Guides: Engineering Recommendation G99 Type A - Full Version*

NC RfG 1.0 – Example from DSOs



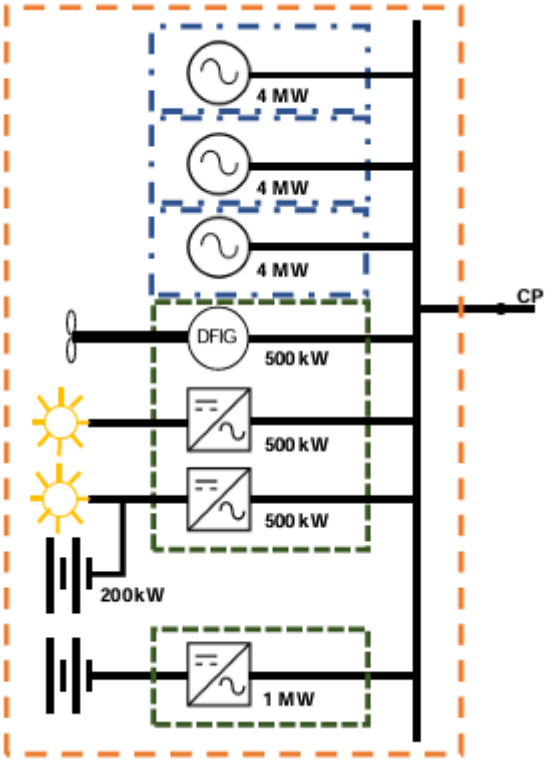
3 x 4 MW **Type B** Gas Engines plus 1 x 500 kW asynchronous **Generating Unit** plus 1 x 500 kW **Inverter** plus 1 x 500 kW **Inverter** with 200 kW Integral **Electricity Storage** plus 1 MW **Electricity Storage**

= 3 x 4 MW **Type B Synchronous Power Generating Module**s plus 1.5 MW **Type B Power Park Module** plus 1 MW **Electricity Storage**

= 14.5 MW **Power Generating Facility** (Large power station in North of Scotland)

Note the **Electricity Storage** device using the same **Inverter** as the PV does not contribute to the **Power Park Module Registered Capacity**, because the **Registered Capacity** is based on the **Inverter** rating. The **Electricity Storage** device using a dedicated **Inverter** is also a **Power Generating Module** but is excluded from some of the requirements of this EREC G99[5], but included in the **Power Generating Facility**.

Figure 4.6 Example of Connection of Electricity Storage with Type A and Type B Power Generating Modules in same Power Generating Facility



Source: *www.energynetworks.org, ((non-profit industry body representing the companies which operate the electricity wires, gas pipes and energy system in the UK and Ireland), Engineering Recommendation G99 Issue 1 – Amendment 5, 5 November 2019, Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019*

NC RfG 1.0 – a few examples from SOs

What affects the aggregation of non-synchronously connected PGUs?

- Units sharing a single connection point
- Whether the units are operated as one combined unit
- Whether the units have been installed at different instances in time
- Ownership of units

Synthesis

- **There doesn't seem to be a consistent and uniform interpretation of the NC RfG 1.0 across different countries**
  - Also raised by the stakeholders in the GC ESC meetings

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Aggregation of power generating units as per NC RfG 2.0

ACER Recommendation No 03/2023 of 19 December 2023 on reasoned proposals for amendments to the Commission Regulation (EU) 2016/631 of 24 April 2016 establishing a network code on requirements for grid connection of generators and Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a network code on demand connection

ACER amendment proposal - NC RfG 2.0

Aggregation of synchronous power-generating units

Recital (11)

"*Synchronous machines should be classed on the **machine size** and include all the components of a generating facility that normally run indivisibly. An installation containing a set of synchronous machines that **cannot be operated independently** from each other, such as combined-cycle gas turbine installation, should be assessed on the whole capacity of that installation.*"

Justification for the proposed amendment

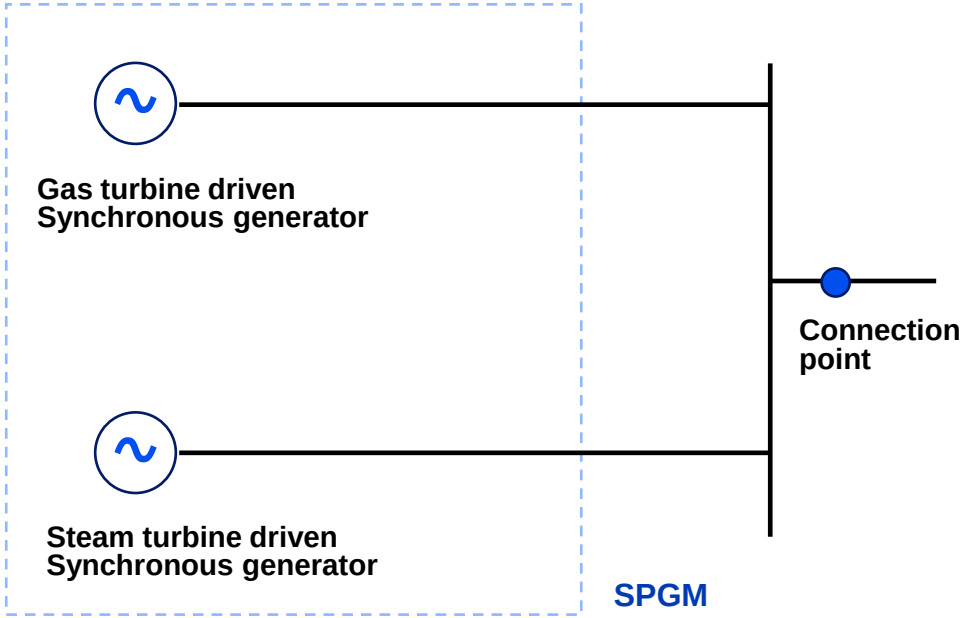
- To further clarify the aggregation of synchronous power generating units.

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of synchronous power-generating units

Example 1

A set of synchronous machines that cannot be operated independently from each other and where they have a single connection point



Assumptions:

- **All PGUs form a combined cycle gas turbine installation (CCGT).** They cannot be operated independently from each other. There is one owner.

Options:

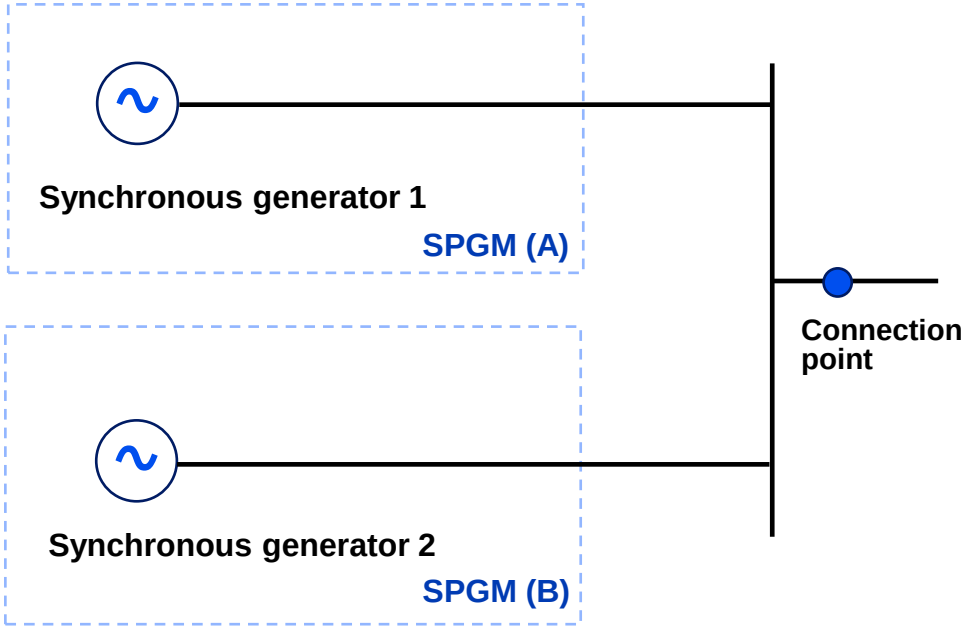
- **Single SPGM assessed on the aggregated capacity of the units**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of synchronous power-generating units

Example 2

Synchronous machines that can be operated independently from each other and where they have a single connection point



Assumptions:

- All PGUs can be operated independently from each other. There is one owner.

Options:

- **Two SPGMs assessed on the individual capacity of the units**

ACER amendment proposal - NC RfG 2.0

Aggregation of non-synchronously connected power-generating units

Recital (11)

"*Non-synchronously connected power-generating units of the same **underlying technology**, where they are collected together to form **an economic unit** and where they have **a single connection point** should be assessed on their aggregated capacity. Moreover, to ensure an appropriate harmonisation of rules for mass-market products, capacities of units of different underlying technology, for instance, photovoltaic, electricity storage, combined heat and power installations, or V2G electric vehicles, should not **necessarily** be aggregated for the purpose of the determination of significance **unless so agreed** between the relevant system operator and the power-generating facility owner, or determined by other appropriate means, where an agreement is not required*."

Justification for the proposed amendment

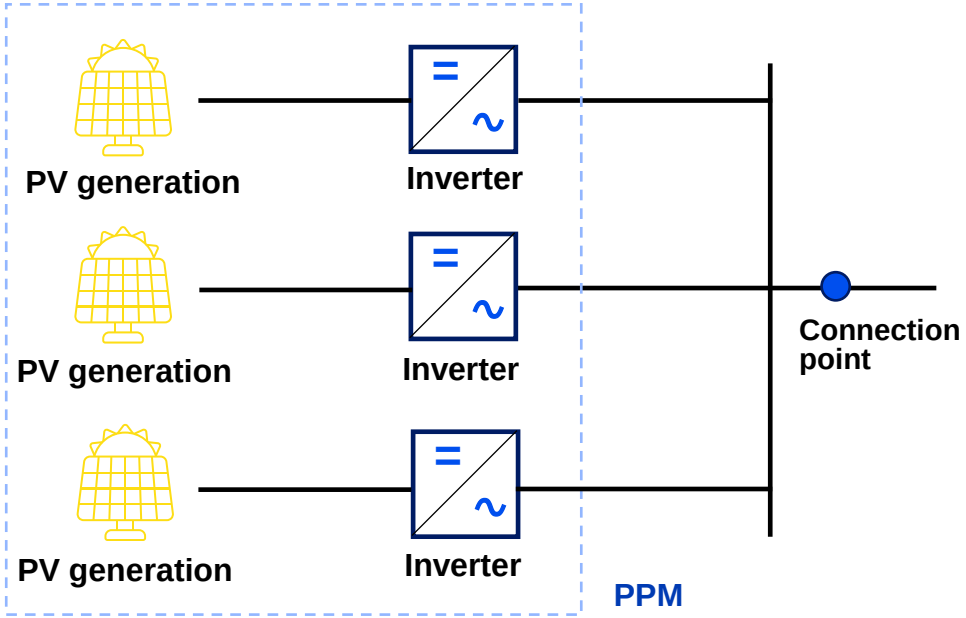
- prevention of automatic aggregation of capacities of units of different underlying technology to ensure harmonised rules for mass-market products;
- preventing the automatic aggregation of a large unit with a much smaller unit of different underlying technology;
- to allow for hybridisation of power generating facilities, units of different underlying technology can be aggregated if so agreed between the relevant system operator and the power-generating facility owner.

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 1

Units of the same underlying technology, where they are collected together to form an economic unit and where they have a single connection point



Assumptions:

- **All PGUs form an economic unit.** This implies a decision by the owner, as this is assumed to be an investment decision. They are operated as one combined unit (economic unit). There is one owner.

Options:

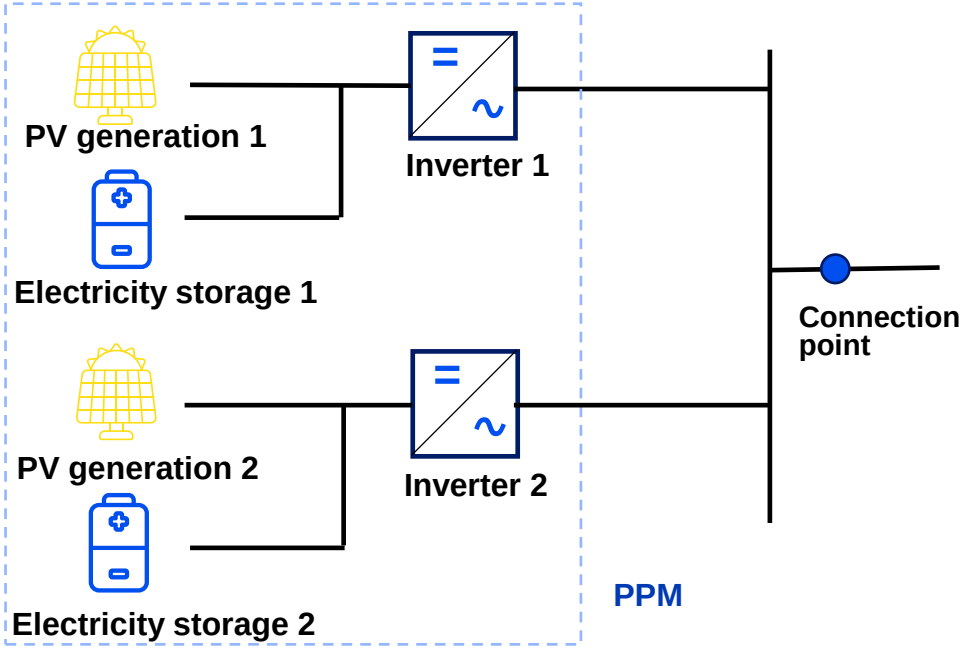
- **Single PPM assessed on the aggregated capacity of the units**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 2.1

Units of the same underlying technology, where they are collected together to form an economic unit and where they have a single connection point



Assumptions:

- PV generation and electricity storage units are comparable in capacities; the electricity storage is not used to meet the requirements of the Regulation
- **All PGUs collectively form an economic unit.** This implies a decision by the owner, as this is assumed to be an investment decision. They are operated as one combined unit. There is one owner.

Interpretation:

- DC collected sources do not constitute different underlying technology because they share the same converter. The capacity is based on the sum of the two inverter capacities and not the individual capacities of the PV and storage

Options:

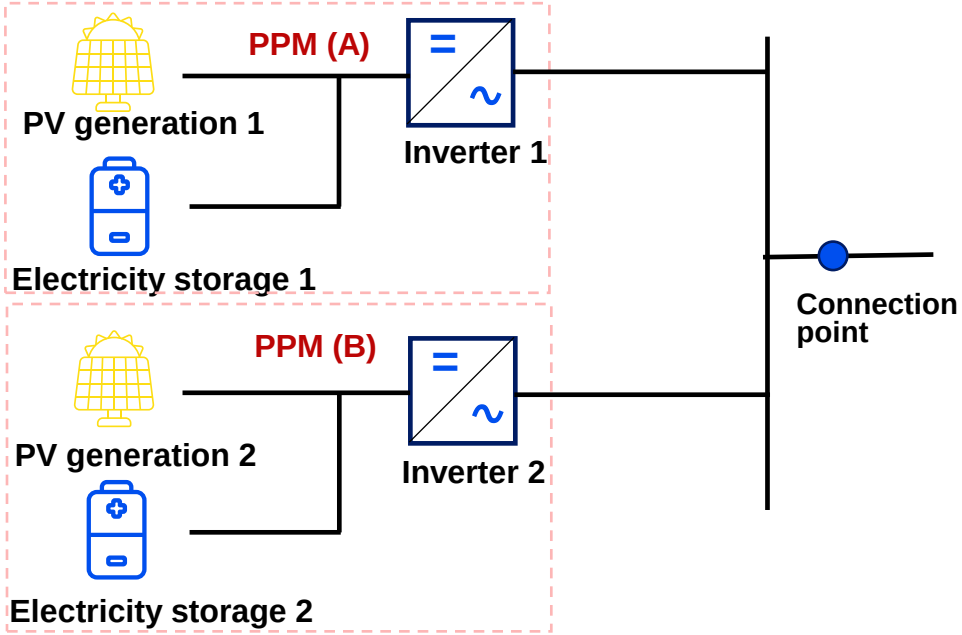
- **Single PPM (with the additional capabilities of an ESM) assessed on the aggregated capacity of the converter units**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 2.2

Units of the same underlying technology, where they are collected together to form an economic unit and where they have a single connection point



Assumptions:

- PV generation and electricity storage units are comparable in capacities; the electricity storage is not used to meet the requirements of the Regulation
- There is one owner for all units
- **PPM (A) forms a different economic unit from PPM (B) because it is intended to provide ancillary/local services whereas PPM (A) is not.**

Interpretation:

- DC collected sources do not constitute different underlying technology because they share the same converter. The capacity is based on the inverter capacity and not the individual capacities of the PV and storage

Options:

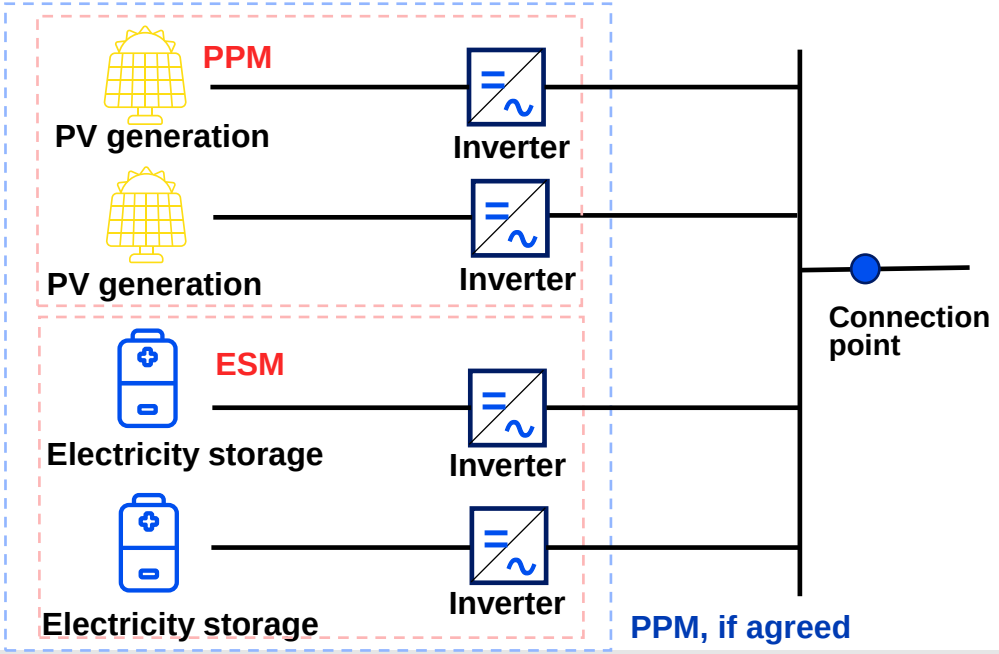
- **Two PPMs (with the additional capabilities of an ESM) assessed on the capacity of the respective converter units**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 3

Units of <u>different</u> underlying technology, should not necessarily be aggregated for the purpose of the determination of significance unless so agreed between the RSO and the PGF owner



Assumptions:

- There is one owner of all units

Interpretation:

- PV generation and electricity storage are different underlying technologies because they are not DC collected

Options:

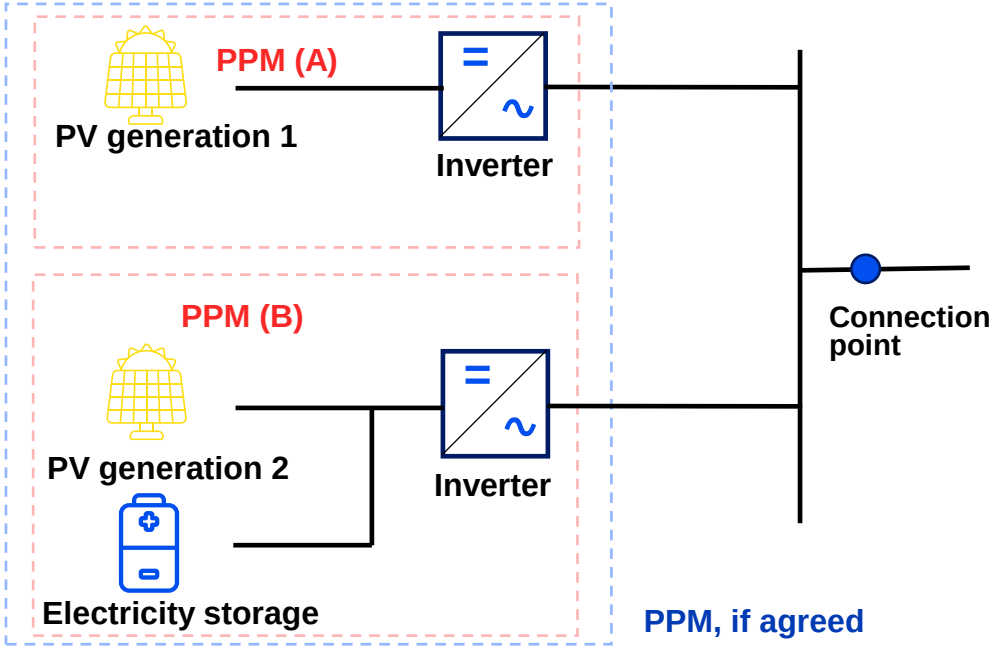
- **One PPM (with the two PV generation units) and one ESM (with the two electricity storage units)**
- **Single PPM (with the two PV generation units and the two electricity storage units), <u>if agreed</u> between the RSO and the PGF owner**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 4

Mixture of units of <u>different</u> underlying technologies



Assumptions:

- There is one owner of all units
- DC collected PV generation 2 and electricity storage are comparable in capacities; the electricity storage is not used to meet the requirements of the Regulation

Interpretation:

- DC collected do not constitute different underlying technology. The capacity is based on the inverter capacity and not the individual capacities of the PV and storage. PPM (B) has additional capabilities of an ESM.

Options:

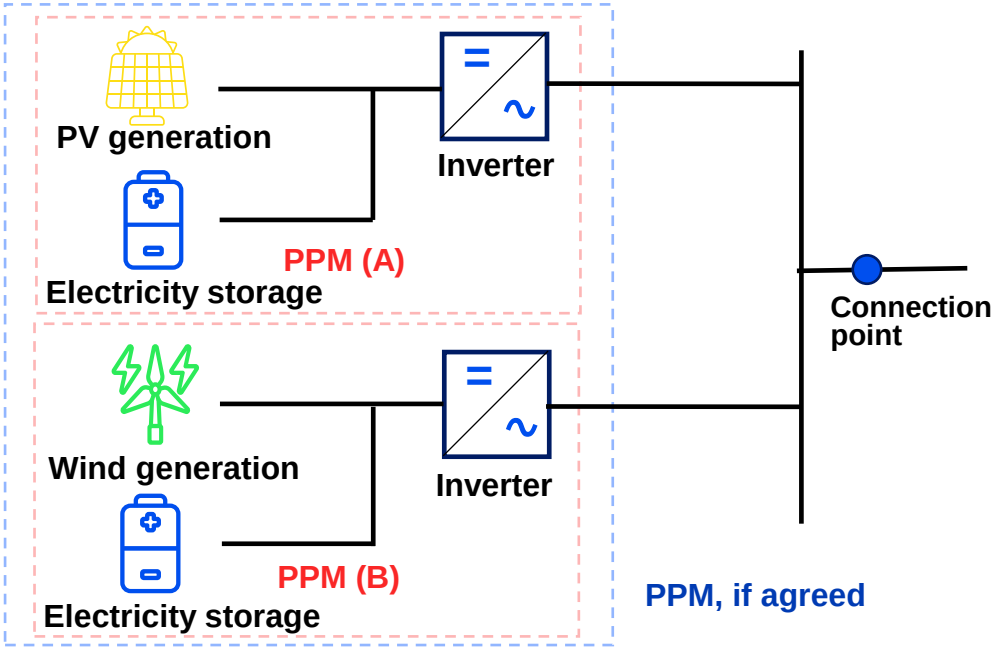
- **Two PPMs: one PPM, with PV generation unit 1, and one PPM (with additional capabilities of an ESM) with the DC collected PV generation 2 and electricity storage unit**
- **Single PPM: one PV generation unit 1 and the DC collected PV generation 2 and electricity storage unit, <u>if agreed</u> between the RSO and the PGF owner**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 5

Mixture of units of <u>different</u> underlying technology



Assumptions:

- There is one owner of all units
- DC collected PV/wind generation and electricity storage are comparable in capacities; the electricity storage is not used to meet the requirements of the Regulation

Interpretation:

- DC collected do not constitute different underlying technology. The capacity is based on the inverter capacity and not the individual capacities of the PV/wind and storage. PPMs have additional capabilities of an ESM.

Options:

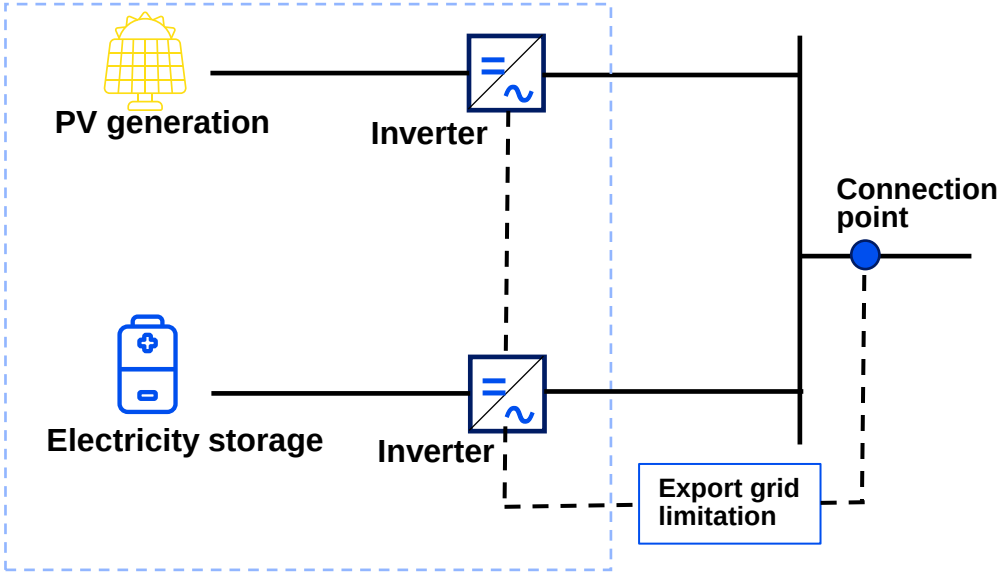
- **Two PPMs: one PPM (with the additional capabilities of an ESM) with the DC collected PV generation and electricity storage unit and one PPM (with the additional capabilities of an ESM) with the DC collected wind generation and electricity storage unit**
- **Single PPM: with the DC collected PV/wind generation and electricity storage units, <u>if agreed</u> between the RSO and the PGF owner**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 6

Units of different underlying technology, should not necessarily be aggregated for the purpose of the determination of significance unless so agreed between the RSO and the PGF owner – hybrid installation with export grid limitation



Assumptions:

- There is one owner of all units
- **The combined generating capacity cannot exceed the agreed capacity at the connection point**
- PV generation capacity is bigger than the electricity storage capacity; the electricity storage is not used to meet the requirements of the Regulation

Interpretation:

- PV generation and electricity storage are different underlying technologies because they are not DC collected

Options:

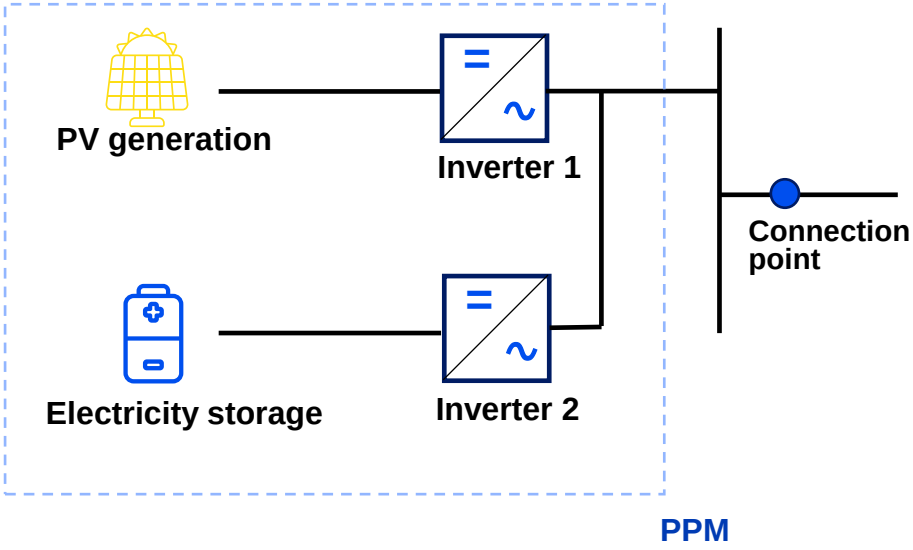
- **Single PPM (with the PV generation unit and the electricity storage unit), if agreed between the RSO and the PGF owner. Aggregated capacity according to the connection agreement**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of non-synchronously connected power-generating units

Example 7

Electricity storage integrated to a power-generating module used solely for the purpose of meeting the respective requirements of this Regulation should be considered as part of such module while its capacity should not count towards the power-generating module capacity.



Assumptions:

- There is one owner of all units
- Electricity storage is comparatively much smaller in capacity than the PV generation; the electricity storage is used to meet requirements of the Regulation

Interpretation:

- The capacity of the PPM is based only on the inverter capacity of the PV generation

Options:

- **Single PPM: the electricity storage is part of the module**

ACER amendment proposal - NC RfG 2.0

Aggregation of V2G electric vehicles and associated V2G electric vehicle supply equipment

Recital (11)

"*Also, when V2G electric vehicles and associated V2G electric vehicle supply equipment are connected to a V2G electrical charging park their capacities* ***should not be aggregated*** *for the purpose of the determination of significance.*"

Justification for the proposed amendment

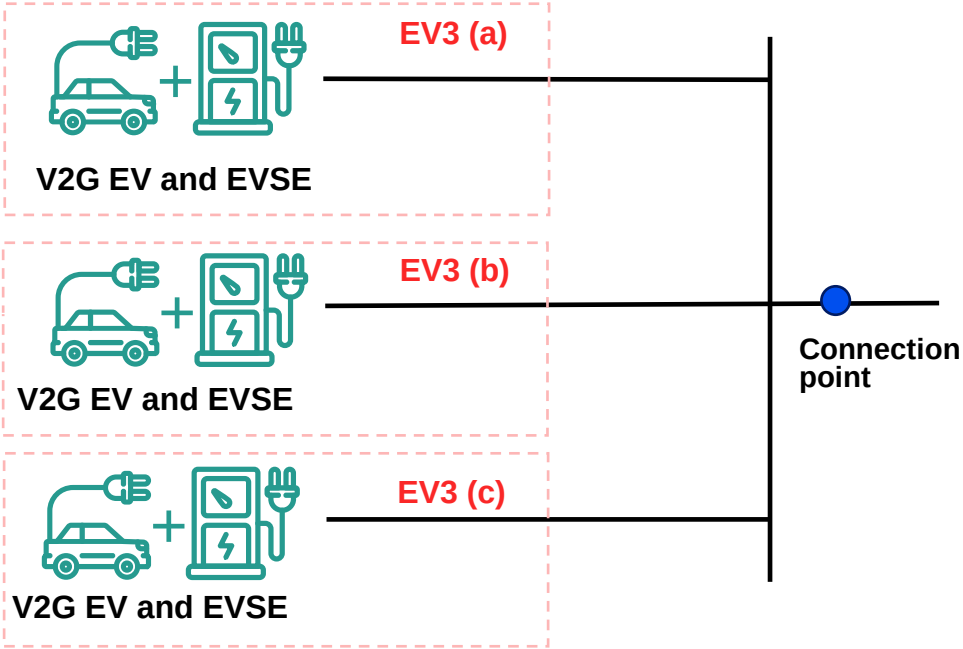
- To help harmonise requirements for the mass-produced V2G assets and aid their cross-border mobility as they will play an important role in the decarbonisation of the electricity sector.

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of V2G EVs and associated V2G EVSE

Example 1

A V2G electrical charging park with V2G EVs and associated V2G EVSE of the same type having a single connection point



Assumptions:

- There is one owner of the charging park
- Each V2G EV and the associated V2G EVSE have a capacity less than 1MW

Options:

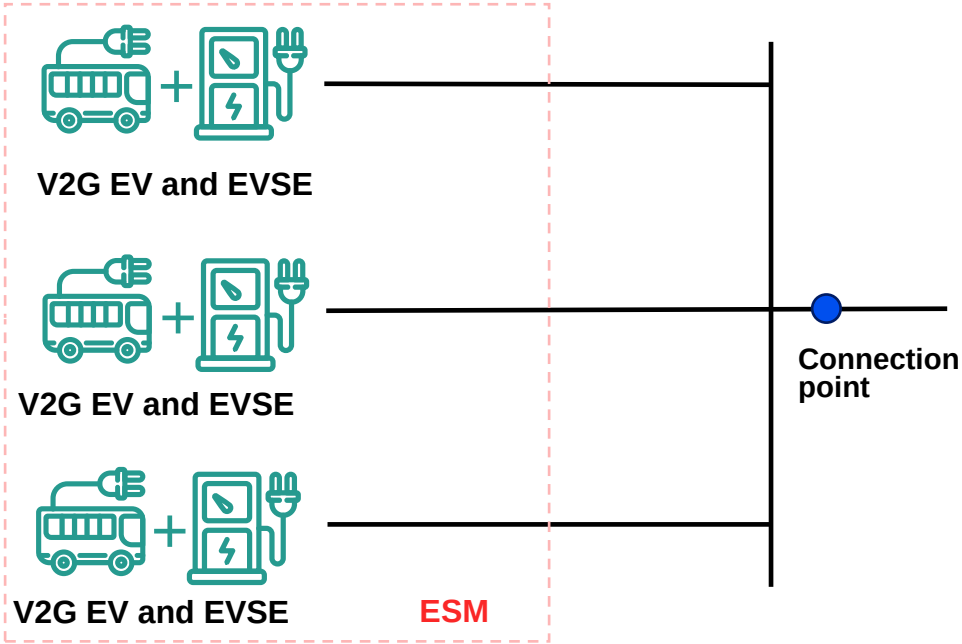
- **Three V2G type EV3s: the capacity of each V2G EV and associated EVSE is used for the determination of their individual significance**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of V2G EVs and associated V2G EVSE

Example 2

A V2G electrical charging park with V2G EVs and associated V2G EVSE with individual capacities more than 1 MW having a single connection point



Assumptions:

- There is one owner of the charging park
- Each V2G EV and the associated V2G EVSE have a capacity more than 1MW

Options:

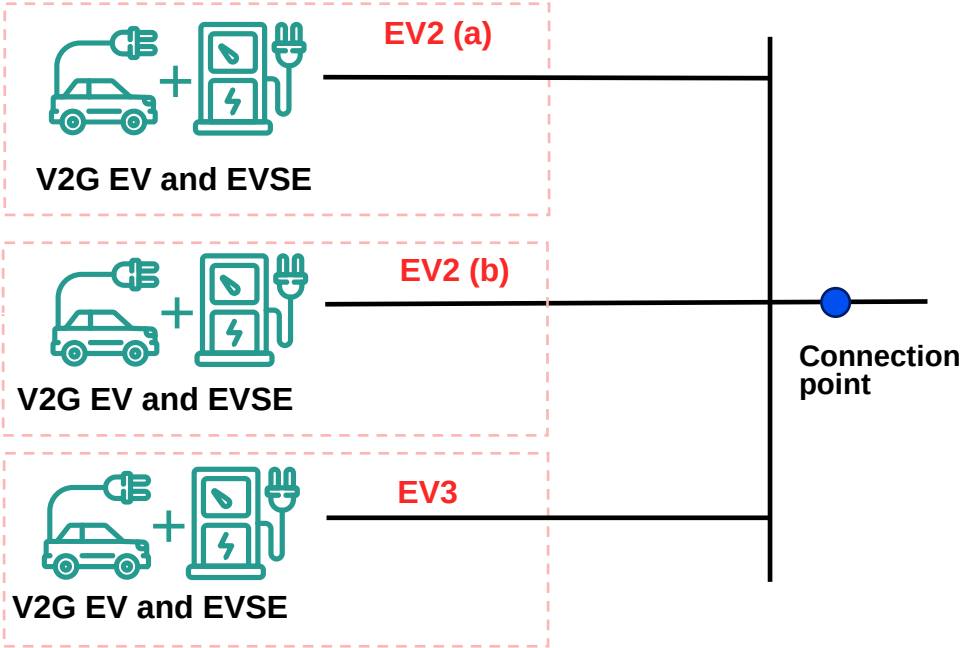
- **Single ESM: assessed on the aggregated capacity of all V2G EVs and associated EVSE. Beyond 1 MW, V2G EV and associated EVSE are regarded as electricity storage module (ESM)**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of V2G EVs and associated V2G EVSE

Example 3

A V2G electrical charging park with V2G EVs and associated V2G EVSE of different types having a single connection point



Assumptions:

- There is one owner of the charging park
- Each V2G EV and the associated V2G EVSE have a capacity less than 1MW

Options:

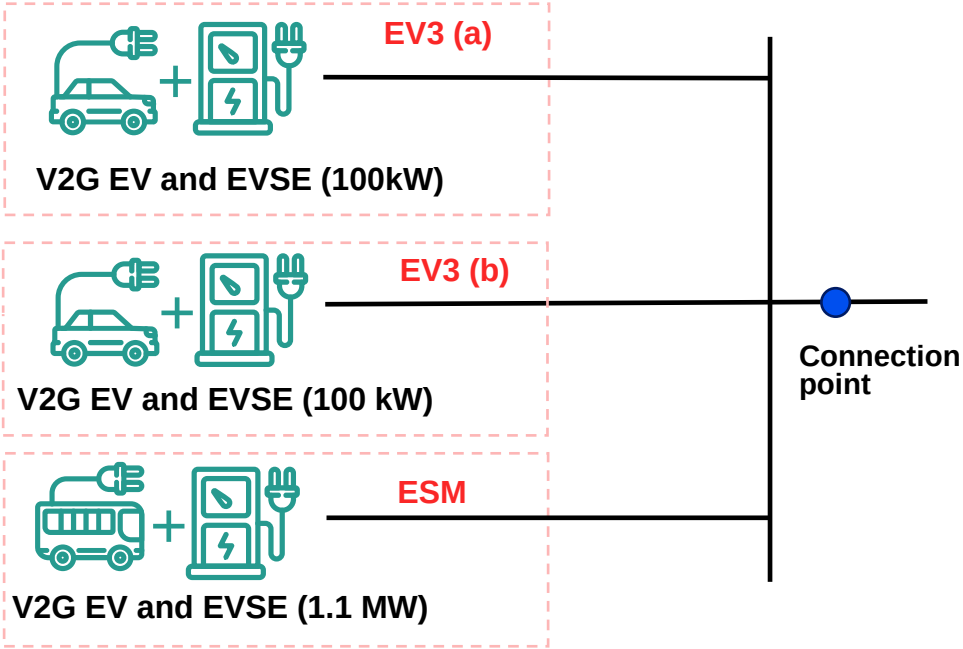
- **Two Type EV2 and one Type EV3: the capacity of each V2G EV and associated EVSE is used for the determination of their individual significance**

ACER amendment proposal - NC RfG 2.0

Non exhaustive examples of aggregation of V2G EVs and associated V2G EVSE

Example 4

A V2G electrical charging park with V2G EVs and associated V2G EVSE mixing capacities of less and more than 1 MW having a single connection point



Assumptions:

- There is one owner of the charging park
- Two V2G EVs and the associated V2G EVSE have a capacity less than 1MW and one V2G EV and the associated V2G EVSE has a capacity more than 1MW

Options:

- **Two Type EV3 and one ESM: the capacity of each less than 1 MW V2G EV and associated EVSE is used for the determination of significance, whereas the V2G EV and associated EVSE with capacity more than 1 MW is regarded as an ESM**

ACER
European Union Agency for the Cooperation of Energy Regulators

Summary - Aggregation of power generating units as per NC RfG 2.0

ACER Recommendation No 03/2023 of 19 December 2023 on reasoned proposals for amendments to the Commission Regulation (EU) 2016/631 of 24 April 2016 establishing a network code on requirements for grid connection of generators and Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a network code on demand connection

ACER amendment proposal - NC RfG 2.0

Principles

- **Synchronous PGUs that cannot be operated independently from each other should be aggregated**
- **Non-synchronously connected PGUs of the same underlying technology should fulfil the following conditions to be aggregated:**
  - they are collected together to form an economic unit, and
  - they have a single connection point
- **DC collected units do not constitute different underlying technology because they share the same converter unit which represents the interface with the AC networks**
- **Non-synchronously connected PGUs of different underlying technology should not be aggregated by default, unless so agreed between the RSO and the PGF owner**
- **When mixing units of the same and different underlying technologies the requirements for each should be followed**
- **For determining the significance of V2G EVs and associated V2G EVSE, with capacity less than 1 MW, their individual capacities should be used**
- **On a site specific and on a case-by-case basis additional requirements may be prescribed in the connection agreement respecting Article 7 of NC RfG 2.0**