EXPERT GROUP
“BASELINE FOR TYPE A POWER GENERATING MODULES”
EG BftA

FINAL REPORT – SEPTEMBER 2021

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0. SUMMARY

On 11 September 2019, the Grid Connection European Stakeholder Committee (GC ESC) decided to establish an Expert Group (EG BftA) to review the baseline for type A power generating modules (PGMs). All relevant stakeholders are represented in the EG .

The EG started its work in September 2020, based on the Terms of Reference (ToR), approved by the GC ESC on 4 June 2020.

The outcome of the EG's work is documented in this report which will be addressed to the GC ESC for consideration and acknowledgement in September 2021. The final report can be the basis for official introduction of relevant amendments to NC RfG.

The ToR include a number of topics for consideration of the EG:

- Considering different banding values implemented by the Member States (MS) across the EU, the requirements that have already been imposed on type B, should they also be declared on type A?
- Are there any new or additional items or requirements that should be added to type A based on the evolving system needs and taking into the account the requirements provided in the EN 50549-01 and EN 50549-02?
- Based on the expected growth in population size, should type A requirements differs for Power Park Modules (PPMs) and Synchronous Power Generating Modules (SPGMs) just like it is with type B?
- Any new insight and method of determining the certification obligations for type A and possible harmonisation.
- Assessment of possible benefits from harmonising the thresholds between type A and B PGMs.

This report starts with an overview of the type A PGM requirements in the NC RfG and an overview of the thresholds defined by Member States and more specifically the A/B-threshold which is of interest for this exercise.
Since it was very important for the EG's work on possible future modified type A requirements, information on installed capacity for different type A generator technologies and also the installed capacity and prognosis in Europe was gathered from the industry and can be found in this report.

A detailed assessment of possible future modified type A requirements resulted in the following recommendations:

- The following requirements, already imposed on type B PGMs, are also declared on type A PGMs: fault ride through (FRT), post fault active power recovery (PFAPR) and active power control (APC).
  FRT and **PFAPR** requirements for type A PGMs can however not be met by some technologies.
  Two possible distinct solutions, being supported by different stakeholders, have been suggested to incorporate the FRT and PFAPR requirements properly into an amended NC RfG:
  - Introduce both requirements for PPMs as mandatory and for SPGMs as non-mandatory, and for technologies that cannot meet these requirements (class) derogations would still be available.
  - Introduce both requirements for PPMs as mandatory and for SPGMs as non-mandatory but immediately excluding certain technologies (i.e. µCHP and possibly µHydro) ≤ 50kW.

Whichever solution is taken forward, the EG notes that consideration needs to be given to extending the content of Title IV of the NC RfG to ensure the compliance requirements for FRT are specified appropriately.

- For **APC** two broad approaches are possible to implementing this requirement and dealing with any exceptions that might be needed in practice. The first approach is to bring the requirements of Article 14.2 into Article 13.6, but recognise exceptions (e.g. possibly CHP ≤ 50kW) at the drafting stage and include the exclusions in the formulation of the new article. The second approach recognises that Article 14.2 describes in point (a) the inclusion of an interface and in point (b) the use of that interface to receive instructions to modulate the active power. All new type A PGMs shall be equipped with the communication interface and capability to modulate active power. The use of the interface can be a local tool or a solution of the RSO if agreed nationally when the relevant system operator demonstrates the need and benefit for enabling the use of this interface. To that point the RSO will have to recognise

any technology constraints, which of course need to be justified, and taken into account by the national implementation.

- Regarding reactive power control (**RPC)** the EG reached the conclusion that the status quo, i.e. not introducing any changes for type A PGMs in this regard is the most appropriate response at this time.

- **No new or additional requirements** apart from the ones mentioned above have been nominated to be added to type A PGMs based on the evolving system needs and the requirements provided in the **EN 50549-01 and -02.**

- Although the NC RfG does not give much guidance to the creation of a **certification regime**, it is still open to the use of certificates. Before making changes to NC RfG, the existing possibilities should also be assessed. The IGDs and standards should also be viewed for this purpose. The EG does not have enough depth of expertise in legal assurance schemes to propose a compelling solution at this time, hence there is a recommendation for more work on this topic.

- The EG recommends to define a **minimum level for the A/B-threshold at 50kW** in addition to the existing thresholds defined by Member States. Without a defined level on the low end of the A/B-threshold, manufacturers which are active in several or even most of the European countries, are forced to include various type B capabilities due to different selected A/B-thresholds which make their products too expensive and reduces the market significantly.
  Considering that Italy and Slovenia currently have lower thresholds than 50kW between type A and B PGMs, this proposal should be properly addressed so as not to create a conflict with the NC RfG implementation in these two countries.

The draft report only contains a limited proposal for amended NC RfG texts in its current version. Due to time constraints the EG did not manage to 'translate' all of the above-mentioned recommendations into amended text proposals for the NC RfG for the time being, since this is considered a time consuming exercise, and needs specific legal expertise input. For the same reason the EG did not assess any possible implications to other NCs/GLs of the proposed revisions to NC RfG.

Disclaimer: for the perfect reading and understanding of this document, when declaring additional requirements for type A PGMs this needs to be understood as applicable to all 'new' type A PGMs. The date as from when a type A PGMs has to be considered as new needs also to be written down within the transitional requirements of the amended NC RfG.

1. HISTORY OF THE EXPERT GROUP BASELINE FOR TYPE A PGMs

On 11 September 2019, the Grid Connection European Stakeholder Committee (GC ESC) decided to establish an expert group (EG) to review the Baseline for type A power generating modules (BftA). The creation of this EG was proposed by ENTSO-E to elaborate on connection network code (CNC) issues which have been raised by stakeholders representing both generation and demand during the CNC implementation. The ENTSO-E proposal was based on a stakeholder survey to identify priority topics for which future revisions to the CNCs could be considered. As most of type A Power Generating Modules (PGMs) are connected to distribution systems, DSOs volunteered to chair the EG.

The EG started its work in September 2020. The outcome of the EG is documented in this report which will be addressed to the Grid Connection European Stakeholder Committee (GC ESC) for consideration and acknowledgement. The report can be the basis for official introduction of relevant amendments to ACER.

The Terms of Reference were approved by the GC ESC on 04 June 2020.

The immediate issues for consideration include:

1. Considering different banding values implemented by MS across the EU, the requirements that have already been imposed on type B, should they also be declared on type A?
2. Are there any new or additional items or requirements that should be added to type A based on the evolving system needs and taking into the account the requirements provided in the EN 50549-01 and EN 50549-02?
3. Based on the expected growth in population size, should type A requirements differs for PPMs and SPGMs just like it is with type B?
4. Any new insight and method of determining the certification obligations for type A and possible harmonisation.
5. Assessment of possible benefits from harmonising the thresholds between type A and B PGMs

As a feedback from the current NC implementation process, it is important to highlight that the thresholds of type A in all Member States are not equal. Therefore, in one Member State, any potential requirement for a type B provision from a type A PGM might already exist in a particular type A PGM if it is also marketed in another Member State with a lower A/B-threshold.

2. LEGAL BACKGROUND

2.1. TERMS OF REFERENCE

The Terms of Reference were approved by the GC ESC on 04 June 2020.

1. Considering different banding values implemented across the EU, the requirements that have already been imposed on type B, do we also want to declare them on type A?
2. Are there any new or additional items or requirements that we want to add to type A based on the evolving system needs and taking into the account the requirements provided in the EN 50549-01 and EN 50549-02?
3. Based on the expected growth in population size, should type A requirements differs for PPMs and SPGMs just like it is with type B?
4. Any new insight and method of determining the certification obligations for type A and possible harmonisation.
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As a feedback from the current NC implementation process, it is important to highlight that the thresholds of type A in all Member States are not equal. Therefore, in one Member State, any potential requirement for a type B provision from a type A PGM might already exist in a particular type A PGM if it is also marketed in another Member State with a lower A/B threshold.

2.2. NC RFG RECITALS

There is no direct reference to the NC RfG recitals in the ToR of the EG BtfA, but the EG decided that it is useful to keep the recitals in mind during the exercise since they provide the necessary context and frame the overarching objectives and considerations of the Regulations.

Recitals (3) (harmonisation), (4) (system security), (5) (secure system operation) and (26) (compliance testing) all interact with the ToR and are therefore important to consider:

> *(3) Harmonised rules for grid connection for power-generating modules should be set out in order to provide a clear legal framework for grid connections, facilitate Union-wide trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, increase competition and allow more efficient use of the network and resources, for the benefit of consumers.*
>
> *(4) System security depends partly on the technical capabilities of power-generating modules. Therefore, regular coordination at the level of the transmission and distribution networks and adequate performance of the equipment connected to the transmission and distribution networks with sufficient robustness to cope with disturbances and to help to prevent any major disruption or to facilitate restoration of the system after a collapse are fundamental prerequisites.*
>
> *(5) Secure system operation is only possible if there is close cooperation between power-generating facility owners and system operators. In particular, the functioning of the system under abnormal operating conditions depends on the response of power-generating modules to deviations from the reference 1 per unit (pu) values of voltage and nominal frequency. In the context of system security, the networks and the power-generating modules should be considered as one entity from a system engineering point of view, given that those parts are interdependent. Therefore, as a prerequisite for grid connection, relevant technical requirements should be set for power- generating modules.*
>
> *(26) Appropriate and proportionate compliance testing should be introduced so that system operators can ensure operational security.*

2.3. TO WHAT LEVEL ARE THE PROPOSALS DEVELOPED?

The scope and objectives of this EG (as for all EGs under the GC ESC) are governed by the Terms of Reference for the EGs under the Grid Connection European Stakeholder Committee[1] (ToR EG GC ESC). According to this, the EGs create a knowledge base which will remain publicly available and may be used as input information in potential amendment processes to the CNCs, if appropriate. The EGs do not initiate any process to amend the CNCs and the recommendations do not establish any legal rights or legal obligations and do not constitute a statement of the law, legal advice or legal act, and any outcomes should not be construed as having such effects. Any legal texts will not constitute a formal proposal for amendments of network codes under Article 60 of Regulation (EU) 2019/943.

Considering the above, it is not completely clear yet how any amendment proposals coming from the EGs under the GC ESC will be used or/and followed up on. It is worth mentioning that the GC ESC itself cannot officially submit amendment proposals rather than elaborate them. The GC ESC (via its EGs) only facilitates the possible amendments through ex-ante collaboration and agreement between most stakeholders.

[1] Terms of Reference for the Expert Groups under the Grid Connection European Stakeholder Committee (2019) https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/GC%20ESC/GC_EGs_ToR_revised.pdf

3. LIST OF PARTICIPANTS

Chair and vice-chair:

- Florentien Benedict, Expert Regulation at Stedin DSO, CEDEC.
- Søren Stig Abildgaard, Mechanical Engineer at EC Power, COGEN Europe.

Changes in the list of participants:

- ENTSO-E had both a withdrawal and an addition in their representation over the duration of the EG.

Name	Organisation	Representation at GC ESC
Dan-Eric Archer	CHECKWATT	SolarPower Europe
Florentien Benedict (chair)	STEDIN	CEDEC
Alberto Bridi	EDYNA	CEDEC
Fleming Brinch Nielsen	ENERGINET	ENTSO-E
Martin Bruns	VOITH	VGB
Naomi Chevillard	SOLARPOWER EUROPE	SolarPower Europe
Eric Dekinderen	VGB	VGB
Santiago Gallego	IBERDROLA	E.DSO
Adrian Gonzalez	ENTSO-E	ENTSO-E
Mike Kay	ENA	GEODE
Carmen Longás Viejo	REE	ENTSO-E
Marc Malbrancke	CEDEC	CEDEC
Simon Minett	CHALLOCH ENERGY	COGEN Europe
Juan Pena De Juana	SMA	SolarPower Europe
Volker Schulz	AMPRION	ENTSO-E
Eckhard Schwendemann	BDH	CENELEC
Søren Stig Abildgaard (vice-chair)	EC POWER	COGEN Europe
Mansoor Ali Syed	FGH	EFAC
Ioannis Theologitis	ENTSO-E	ENTSO-E
Vincenzo Trovato	ACER	ACER
Alexandra Tudoroiu-Lakavice	COGEN EUROPE	COGEN Europe

Table 1 – Participants list

While the EG members represent different parties with very different interests and views on the needs and possibilities for grid connection of type A generators, the EG has still strived to find common ground and to put together a report that could be acceptable to all parties. It was not an easy job, but the EG is happy to reach this result. This also means that the report reflects as much as possible all different views, but that it cannot be used as a source to know the position of one single stakeholder. For specific positions of stakeholders we refer to their own position papers, statements and/or announcements.

4. TIMELINE AND COURSE OF MEETINGS

The EG has met several times on the following dates:

Meeting dates
07 September 2020
29 October 2020
17 November 2020
15 December 2020
21 January 2021
01 March 2021
08 April 2021
18 May 2021
03 June 2021
15 June 2021
23 June 2021
29 June 2021
2 July 2021
31 August 2021

Table 2 – Meeting dates

In addition, the EG, through its chair, has updated the GC ESC at its 17 September 2020, 10 December 2020 and 09 March 2021 meetings, presenting its preliminary results to the GC ESC on 10 June 2021.

The final draft report was prepared for submission to the GC ESC at the start of July 2021 for review and with a view to acknowledgement at September's 2021 GC ESC meeting.

5. OVERVIEW OF THE THRESHOLDS IN THE MEMBERS STATES

Regarding the A/B-threshold, the maximum threshold for the CE synchronous zone is 1MW and for the Nordic synchronous area it is 1,5MW. Sweden is the only MS that selected the maximum A/B-threshold in the Nordic region. An extract from ENTSO-E Monitoring report on connection network codes implementation -16/12/2019 can be found in Annex 1 of this report.

Figure 1 gives an overview from the A/B-thresholds in EU.

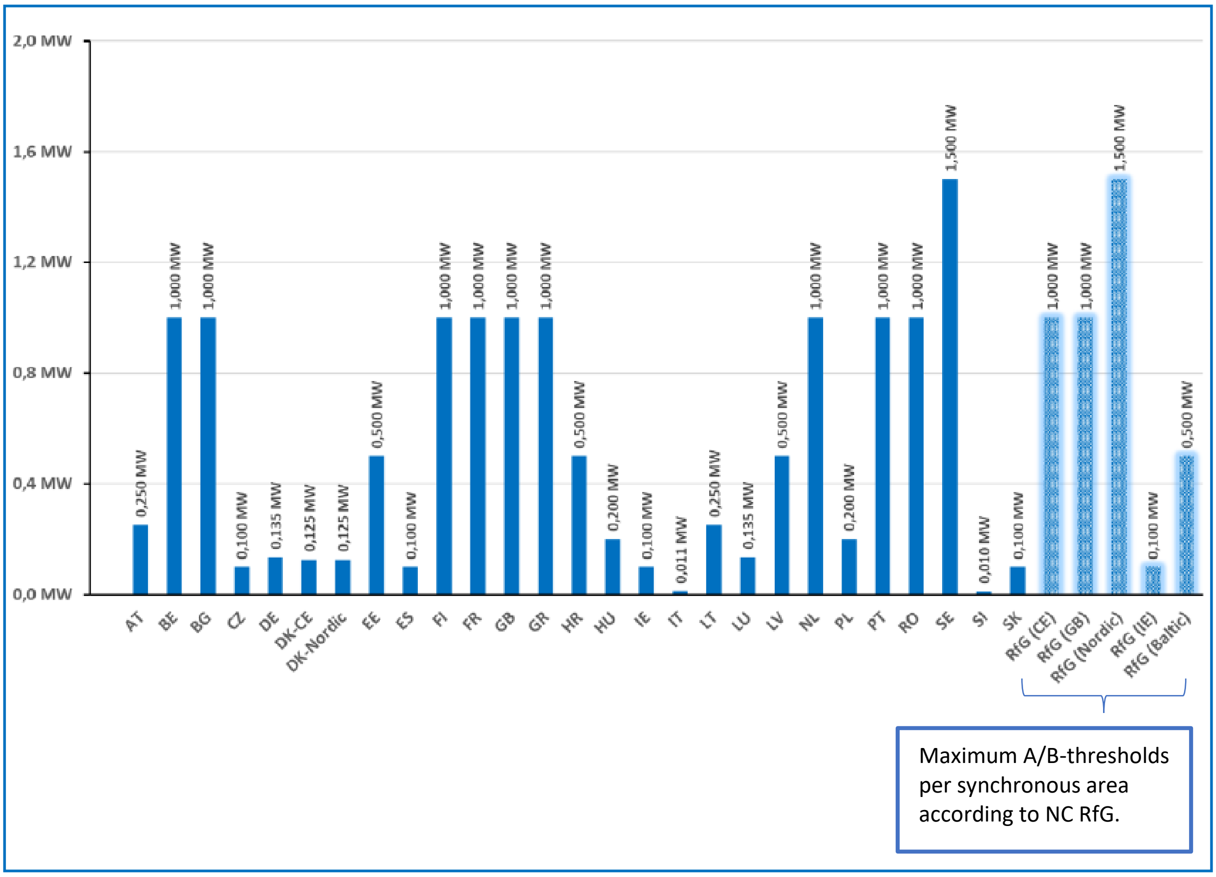

Figure 1. A/B-thresholds in EU – from ENTSO-E monitoring report – December 2020[2]

[2] Monitoring Report on Connection Network Codes Implementation, ENTSO-E report (2020). https://eepublicdownloads.azureedge.net/clean-documents/Network%20codes%20documents/CNC/201201_-_Implementation_Monitoring_Report_2020%20-%20Final%20Version.pdf

6. OVERVIEW OF THE ACTUAL REQUIREMENTS FOR TYPE A PGMS IN THE NC RFG

The EG provided an overview of the actual requirements for type A PGMs in the NC RfG, shown in Table 3.

Requirement	Article from NC RfG
Frequency ranges / wider frequency ranges	13.1.a.i / 13.1.1.ii-iii
RoCoF	13.1.b
LFSM-O	13.2.a-e
Continuing operation	13.2.f-l
Constant output	13.3
Maximum active power reduction at under frequency	13.4-5
Logic interface (input port)	13.6
Automatic connection	13.7.a-b

Table 3 – Actual requirements for type A PGMs – cf. NC RfG

7. TYPE A PGMS TECHNOLOGIES/INSTALLED CAPACITY AND PROGNOSIS

7.1. OVERVIEW OF THE RELEVANT TECHNOLOGIES AND THEIR INSTALLED CAPACITY

The NC RfG concerns power generation facilities. However, a power generation plant does not produce electricity without the:

- input from an energy source;
- an energy conversion technology to convert the energy source into a durable form of energy (work energy) of the chosen electric generator;
- the electric generator technology that forms the actual connection to the grid.

The EG has learned that among the small PGMs of type A, many different technology-combinations exist and each can impose a different practical limit on the electric generation plants' capabilities to support the functioning of the grid.

Therefore, it is not reasonable to use an inherent capability of one kind of PGM, say PV, as an argument to add a requirement to type A in general. Other sorts of PGM may not have this inherent capability, and there may actually be substantial problems in meeting the same requirement.

The table 4 which has been drawn up by the EG, shows the possible combinations of energy conversion technologies and electric generator technologies, known to the members of the EG.

Energy source	Energy conversion technology	Electric generator technology
Solar	PV	Inverter
Fuel	CHP – rotary machinery	Asynchronous generator Inverter Synchronous generator (above ~50 kW)
Fuel	CHP – Fuel Cell	Inverter
Hydro	Turbine (various)	Asynchronous generator Inverter Synchronous generator (above ~50 kW)
Wind	Turbine	Inverter Asynchronous generator Synchronous generator (above ~50 kW)
Wave and tidal	Various mechanical	Inverter Asynchronous generator Synchronous generator (above ~50 kW)
Storage	Various	Inverter

Table 4 – Today's combinations of energy conversion technologies and electric generator technologies – information gathered by the EG BftA

GENERATORS – SPGM/PPM

In the NC RfG, a distinction is made between two types of energy generation, regardless of the primary energy: SPGMs and PPMs. Due to the different technologies, the requirements for both types of generation differ in some cases.

SPGMs and PPMs have many different characteristics that are supportive for grid operation and stability. For example, due to less inertia smaller SPGMs in contrast to bigger SPGMs do not have as good capabilities for fault ride through (FRT) compared to inverter-technologies. The benefit of distinguishing the requirements for SPGMs and PPMs is to find the right compromise, whereby those technologies that can support grid operation do so, whilst respecting those technologies that cannot or have limited capabilities.

ENERGY CONVERSION TECHNOLOGY - PV

PV is always connected to the grid via an inverter. It has been indicated that for 20kW and more inverters already comply with type A and type B requirements. For smaller ones, redesign of inverters is needed, but some of the type B requirements would generally not increase the product´s cost, such as, FRT and Q capability.

State of the art inverters and energy management systems already today are equipped with the hardware for communication interfaces[3] for monitoring and plant control, even those offered for residential application. However, a communication tool (including all safety and cybersecurity issues) to modify inverter´s active power output may increase the system´s cost.

ENERGY CONVERSION TECHNOLOGY - CHP

Gas fuelled CHP for domestic use has been discussed extensively. The most relevant technology consideration in relation to NC RfG capabilities here is the gas safety system, which is common to both rotating engines and fuels cells.

Due to gas safety reasons, gas appliances are only allowed to operate where every aspect of the system is in a safe and stable mode. Loss of mains is outside of the safety boundaries, and thus the system has to shut down in the event of what appears to be a loss of electric power. This is in direct opposition to FRT requirements, and therefore gas-fuelled µCHP are prohibited from providing FRT in their current design[4].

CONSUMER PRODUCTS OR “EXPERT” INSTALLATIONS

A final remark is on the domestic product nature of type A generators. Small type A devices, being connected in millions across the EU, are typically mass produced, type tested and type certified products for the domestic market. According to applicable EU harmonisation legislation, the manufacturers place those products on the EU market as CE marked products. Also, the end users / type A owners in general have little or zero understanding of the NC RfG and any other technical requirements. This leaves DSOs with a challenge in potentially checking out at an appropriate level of detail each individual type A connection for a non-certified product or for a product with an unknown certificate.

[3] When the text mentions ‘communication interface’ we are not referring to the communication lines themselves which might be needed to use the interface. NC RfG is limited to the possibility to connect the communication lines.
[4] COGEN Europe position paper, CHP up to 50kWe is unsuitable for FRT (2021), https://mcusercontent.com/4f2cf878a38d152a781d97560/files/275f9a44-7dfa-488d-b240-50f983fed095/COGEN_Position_Paper_FRT_for_CHP_final_2021_02_26.pdf

Both due to the numbers and due to the nature of a mass-consumer market, domestic PGMs present very different problems and possibilities compared to PGMs that are assembled by “experts” from parts and approved for the specific site installation.

ENTSO-E has been working over the last years together with relevant standardisation bodies and the IECRE to define the minimum content of the equipment certificates (EqC) in order to demonstrate compliance to some of the CNC requirements. An implementation guidance document (IGD) has been developed by ENTSO-E, consulted on, and soon to be published, that will aim at giving guidance to the system operators.

No authorised certifier has developed a harmonised set of procedures and verification requirements except for unit certificates (type certificates for a single wind turbine or solar power inverter) that could be a part of the compliance verification process and currently it is up to the generation owner to decide how to comply with the RSO requirements of compliance verification.

The above mentioned IGD does not argue explicitly for the harmonisation of type A requirements; rather it supports a harmonised compliance verification and certification approach that should be in place either we have harmonised technical requirements or not.

7.2. OVERVIEW OF THE AMOUNTS AND PROGNOSIS OF TYPE A PGMS

PROGNOSIS OF PV

Solar Power Europe published in December 2020 the document “EU Market Outlook for solar power 2021-2024”, which provided an in-depth overview of the expected PV market growth until 2024 throughout Europe.

The history of PV installations, which you can find in Figure 2. and which is an extract from that document, shows a quite unstable market, with the top selling year being 2011.

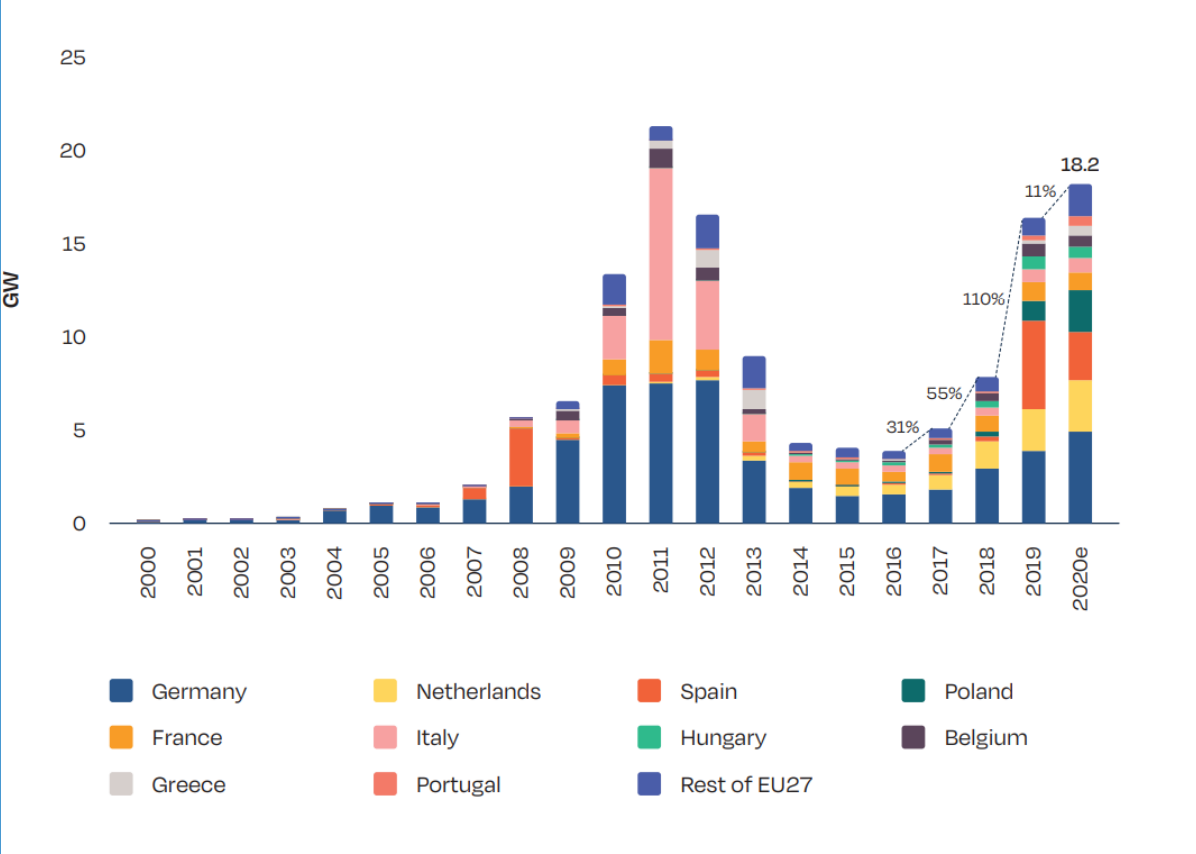

Figure 2: History of PV installations – Annual solar PV installed capacity 2000-2020[5].

The analysis shows that the Top 10 EU solar markets will install 98.5GW from 2021 until 2024 and divided equally to three sub-segments based on the following system size:

- Residential (<10 kW);
- Commercial (<250 kW);
- Industrial (<1000 kW).

In 2019, each sub-segment had about one third of the rooftop capacity and we could assume that these shares will remain similar in the near future.

[5] SolarPower Europe (2020): EU Market Outlook for Solar Power 2020-2024
https://www.solarpowereurope.org/wp-content/uploads/2020/12/3520-SPE-EMO-2020-report-11-mr.pdf?cf_id=24087

Year	2020	2021	2022	2023	2024
% Residential	33%	33%	33%	33%	33%
MW residential (up to 10kW)	3.465	3.630	4.290	4.818	5.181
Avg residential (MW)	0,007	0,007	0,007	0,007	0,007
# Residential	495.000	518.571	612.857	688.286	740.143
% Commercial	33%	33%	33%	33%	33%
MW commercial (up to 250kW)	3.465	3.630	4.290	4.818	5.181
Avg commercial (MW)	0,04	0,04	0,04	0,04	0,04
# Commercial	88.625	90.750	107.250	120.450	129.525
% Industrial	33%	33%	33%	33%	33%
MW industrial (up to 1MW)	3.465	3.630	4.290	4.818	5.181
Avg industrial (MW)	0,4	0,4	0,4	0,4	0,4
# Industrial	8.663	9.075	10.725	12.045	12.953

Table 5 - EU solar markets divided equally to three sub-segments – cf. SolarPower Europe report[6]

(MW = maximum capacity of the invertor)

PROGNOSIS OF µCHP

The prognosis of µCHP has been analysed only for systems up to 50kW. Those systems are installed at locations where the excess heat can be used directly.
The market for ICE (Internal Combustion Engine) has been stable over the past 10 years, although with a peak in 2013-2014 (Germany is the major market and figures can be found through the link in the footnote). An overview is given in Table 6.

Commissioning year / Electrical CHP output	2009 MW_{el}	2010 MW_{el}	2011 MW_{el}	2012 MW_{el}	2013 MW_{el}	2014 MW_{el}	2015 MW_{el}	2016 MW_{el}	2017 MW_{el}	2018 MW_{el}	2019 MW_{el}
≤ 0,002 MW	0,12	0,26	0,72	1,56	2,10	1,56	1,12	1,05	0,95	1,39	1,48
> 0,002 ≤ 0,01MW	17,29	9,20	10,32	11,38	12,92	14,38	11,72	10,93	9,18	6,45	6,33
> 0,01 ≤ 0,02 MW	14,47	10,53	14,65	16,06	18,27	25,00	16,81	16,19	13,17	9,49	10,20
> 0,02 ≤ 0,05 MW	23,43	20,86	26,62	24,79	31,36	43,34	27,21	33,50	26,11	22,39	22,02

Table 6 – New installed capacity of µCHP in Germany, registered by BAFA[7].

The scheme below shows the expected new installed capacity per year until 2030 and was developed for this EG BftA with input from major µCHP manufacturers. Here µCHP is further divided into three segments.

[6] SolarPower Europe (2020): EU Market Outlook for Solar Power 2020-2024

[7] Zulassung von KWK-Anlagen nach dem Kraft-Wärme-Kopplungsgesetz (KWKG), BAFA Ref 526 – Kraft-Wärme-kopplung (2020) *(Registration of CHP plants according tot he (German) Combined Heat and Power Act)*
https://www.bafa.de/SharedDocs/Downloads/DE/Energie/kwk_statistik_zulassungen_2009_2019.pdf?__blob=publicationFile&v=17

Those segments are

- Fuel cell below 5kW,
- Fuel cell from 5 to 50kW,
- Internal combustion engines (ICE) below 50kW

Fuel cell (FC) technologies are expected to grow in the future and become the dominating CHP technology. See Figure 3.

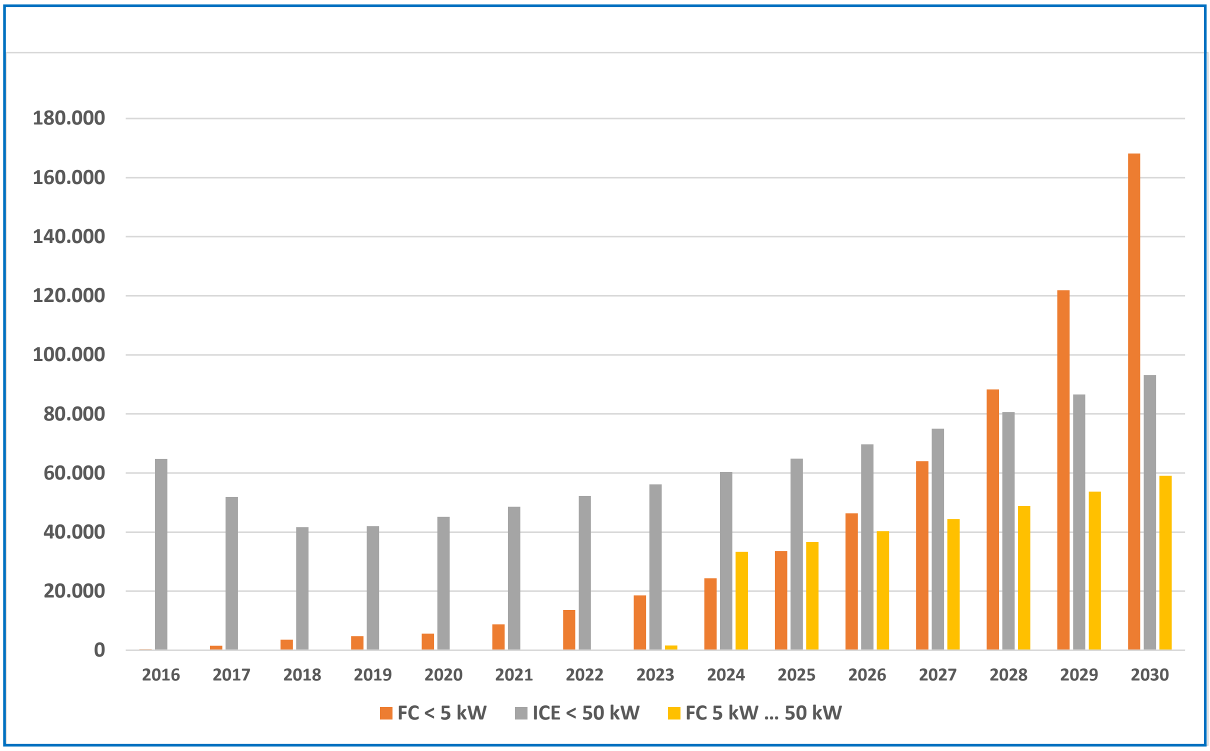

Figure 3. - µCHP <50kW PPM - until 2020 effective ... until 2030 prognosis for Europe [kW yearly installed]
Source: Leading manufactures, members of BDH and/or IBZ

8. DETAILED ASSESSMENT OF POSSIBLE FUTURE MODIFIED TYPE A REQUIREMENTS

In order to consider the possible requirements that may be applied to new type A PGMs the EG split the assessment into five distinct topic areas (cf. ToR). One of these topics had three sub-topics.

The topics the EG considered were:

1. Considering different banding values implemented across the EU, the requirements that have already been imposed on type B, should they also be declared on type A?
    - Fault-ride-through (FRT) and post-fault active power recovery (PFAPR)
    - Active power control (APC)
    - Reactive power control (RPC)
2. Are there any new or additional items or requirements that should be added to type A based on the evolving system needs and taking into the account the requirements provided in the EN 50549-01 and -02?
3. Based on the expected growth in population size, should type A requirements differ for PPMs just like it is with type B?
4. Any new insight and method of determining the certification obligations for type A and possible harmonisation.
5. Assessment of possible benefits from harmonising the thresholds between type A and B PGMs.

The rest of this section of the report examines each of the topics, and subtopics in detail and makes recommendations based on the EG's analysis. In undertaking the analysis, the EG reflected a range of opinions on the strategic implications of the work. In general consensus has been achieved, particularly on the overall recommendations. However there do remain some differences of opinion in relation to some of the finer points of detail.

8.1. TOPIC 1: DECLARATION OF TYPE B REQUIREMENTS ON TYPE A PGMS

Considering different banding values implemented across the EU, the requirements that have already been imposed on type B, should they also be declared on type A?

8.1.1. SUBTOPIC A: FRT AND PFAPR

INTRODUCTION

The NC RfG includes only the minimum requirements on type A PGMs that were envisaged when the NC RfG was conceived well over a decade ago. At that time only the need to withstand the expected worst case frequency ranges and to provide a limited response to over-frequency were envisaged. The case for FRT and PFAPR was not thought to be extendable to type A PGMs at that time, and the requirements were not applied for PGMs below type B.

BACKGROUND

FRT

For system security reasons, like preventing large-scale loss of generation, it is proposed to extend the FRT requirement to type A PPMs. This requirement demands the capability of the PPM to remain connected to the system during faults within a defined voltage-time profile, and thus avoiding disconnection of the power generating module. The FRT requirement is defined for type B generating modules in article 14.3 of the enacted version of the NC RfG.

The enacted version of NC RfG includes ranges of voltage and time that have led to a wide variety of national FRT profiles, depending on the protection schemes predominant at the national level where the distributed installed capacity also needs to be considered carefully.

Acknowledging the mass production of type A generating modules, the recommendation for type A PPM FRT capabilities is an exhaustive requirement as a harmonised and predefined voltage-time profile as illustrated in figure 4 below.

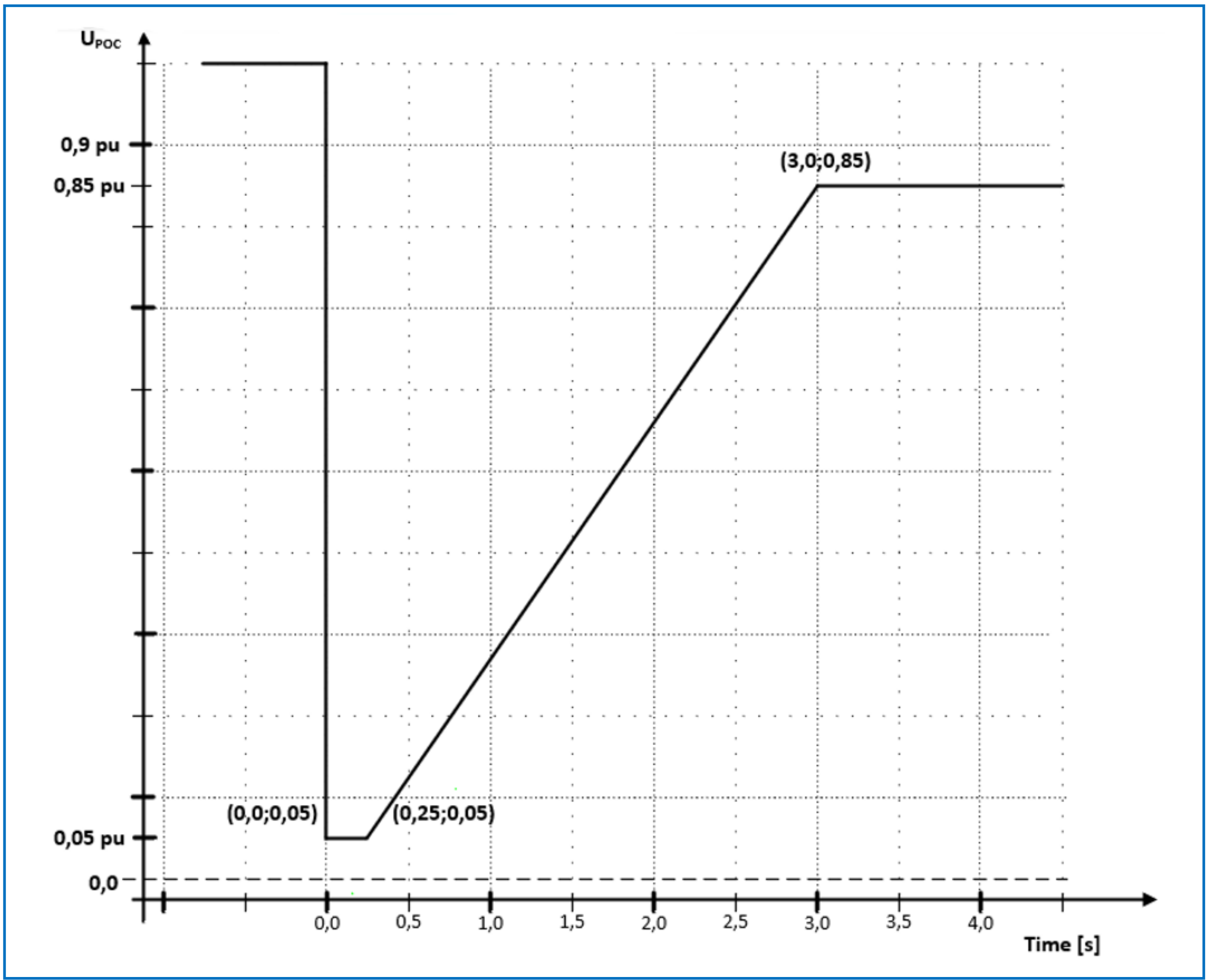

Figure 4. Proposed minimum requirement for the harmonised FRT profile.

The proposed harmonised FRT profile is to be understood as a minimum requirement, like the principle behind the already known NC RfG minimum requirement i.e., the PPM has to be able to stay connected down to at least 0,05pu retained voltage at the connection point and for a minimum duration of 250ms. The same principle is applicable for the rest of the profile. Any better PPM performance is also accepted.
A harmonised profile is considered as the easiest solution for all involved. If the solution with a harmonised profile is not possible, the recommendation is a non-exhaustive TSO requirement which would be an expansion of the profile required of type B PPMs.

PFAPR
In combination with the FRT requirement, it is essential that the maximum time in which the active power from the PPMs affected by a fault shall recover, understanding that even if they stay connected, they may reduce their active power during, and just after, the clearance of the fault.
Hence, it is proposed to extend the requirement from article 20.3.a (i.e. applicable now to type B, C and D PPMs) to be applicable for PPM type A.

Taking into account the massive production of type A equipment, it is recommended to define a PFAPR requirement as an exhaustive requirement with a harmonised predefined profile/characteristic, which could be expressed like the following:

When the network voltage resumes, after the end of a fault, to a value within the voltage range of 0,85pu – 1,1pu, the PPM shall recover its active power output level to its pre-fault value. The recovery time shall not exceed a maximum of 1s.

A harmonised profile would however be considered as the easiest solution for all involved. If the harmonisation of the profile is not possible, the recommendation is a non-exhaustive TSO requirement, i.e. a copy of the requirement applied to type B PPMs.

DESCRIPTION AND JUSTIFICATION

Technical reports

In absence of a general study at the European level, there are different studies at the national level that help to understand the problem, and thus contribute to justify the need for the FRT requirement in order to avoid the widespread tripping of generation in case of a fault occurring on the transmission system. Besides the need for the capability to stay connected (FRT) the need for post-fault active power recovery is also very important in order to recover the pre-fault active power of the generation as soon as possible to recover the network stability. Fast recovery of the network stability will also minimise the activation of reserves from other generators, and not cause what it is known as a frequency-dip induced by voltage dip.

In Annex 2. the technical reports from France, Spain, Great Britain and Germany are included.

Prognosis for PV and other technologies future installation

The need of the proposed requirements with the expected growth in population of PPMs, as well as SPGMs, is supported by an overview of the expected growth.
See also the prognosis in chapter 7.2. 'Overview of the amounts and prognosis from type A PGMs'.

POSSIBLE SOLUTIONS

When FRT and PFAPR requirements for new type A PGM's are required, there will be some technical problems for some technologies. The proposed requirements cannot be met by some technologies.
Hence it has been discussed in the EG that there is the need for new requirements for type A PGMs, and also an implementation that recognises where the requirements cannot be complied with by certain technologies because of e.g. safety.

Considering the above, two possible distinct solutions, being supported by different stakeholders, have been suggested to properly incorporate the FRT and PFAPR requirements into an amended NC RfG.

Solution 1: Introduce both requirements for new PPMs as mandatory and for new SPGMs as non-mandatory
This solution still allows the use of derogations/class derogations to be applied for any technologies that cannot meet the requirements. Such derogations should be carefully prepared, justified and sensibly time-bounded.

Solution 2: Introduce both requirements for new PPMs as mandatory and for new SPGMs as non-mandatory excluding certain technologies (i.e. µCHP and possibly µHydro) ≤ 50kW
Such exclusions should be carefully prepared and justified.
An ENTSO-E IGD including an explanation on these exclusions could also be considered and guide system operators on any particular technology specificities, technology developments etc. Such an IGD could be helpful irrespective of which of the above two solutions might be incorporated in an amended NC RfG.

RECOMMENDATIONS

Since neither of the two solutions presented above is unanimously supported by the members of the EG, different recommendations are proposed. **Solution 1** which is particularly supported by the TSOs and would recommend introducing FRT and PFAPR to all type A PPMs in a mandatory manner and to all type A SPGMs in a non-mandatory manner. That will allow capturing the capabilities from the expected high volumes of small PPMs in all countries and the potential growing volumes of small SPGMs in certain Member States.

Using exclusions is seen a less efficient and rather restrictive option, especially for Member States that may need to rely on such capabilities from all technologies in the future – provided that technological advancements can allow for it. What is more, when exclusions are introduced because of current technological shortcomings or detrimental cost impact, the only way to consider requirements from such technology families as the penetration grows, an appropriate technology maturity level is achieved and market entry challenges are solved, is to rely on future amendments to the legislation. With the number of different technologies that exist (and will exist in the future) such method of continuous amendments will be problematic, if not unworkable. The derogation approach is a well-defined tool in the regulations, which is already available.

On the other hand, **solution 2** which is supported by several mass product manufacturers, would recommend applying FRT and PFAPR to all type A PPMs, except for µCHP and possibly µHydro ≤ 50kW for the reasons that are described in the previous section "description and justification". FRT is particularly challenging for µCHP as the gas safety systems, required by (EU) 2016/426 together with the harmonised standard EN 13611, interpret the voltage dip as loss of supply and shut off the gas supply for safety reasons.

Regarding type A SPGM, it is recommended to make FRT non mandatory or to exclude them from the requirements.

The support on exclusions in comparison to derogations is also an upshot of the challenges and uncertainties that the derogation process has created in certain Member States. Manufacturers of mass products require sufficient regulatory stability to support their business model i.e. design their products and meet the demand cost-efficiently.

From the discussions in the EG, it is acknowledged that there is no optimal solution when it comes to derogations versus exclusions and all parties have presented valid justifications in favour or against those options. The nature of the topic escapes from the purely technical boundaries and expertise of this EG – the balancing of the differing interests becomes a political decision - and the final solution will definitely require further insights e.g. from future public consultation, guidance from ACER/Regulators, EC/Member States.

Whichever solution is taken forward, the EG notes that consideration needs to be given to extending the content of Title IV of the NC RfG to ensure the compliance requirements for FRT are specified appropriately.

8.1.2. SUBTOPIC B: APC

BACKGROUND

Already many type A PGMs, particularly those that are toward the upper end of the maximum type A range, i.e. hundreds of kW (up to 1,5MW) are in some MS now being connected on flexible connection contracts where the generation owner and the DSO have agreed a connection contract whereby the DSO can reduce the PGM output to avoid DSO (and even TSO) network overloading.

In some cases, the avoidance of overload is initiated by a discrete signal from the DSO, in other cases it is initiated by autonomous equipment owned by the customer, but set to manage current flows across, or voltages at, the connection point as agreed with the DSO.

There is also growing need to integrate domestic scale generation (and storage) in domestic energy management schemes, where modulation of the generation output is a key feature. In these applications, it is desirable to regulate the active power output of generation, to manage, for example the voltage and the current flows at the customer's connection point, rather than switching the generation off or on.

Type B PGMs need to have an interface that enables them to reduce active power generation (Article 14.2(a)). The specific requirements when such capability is used are quoted in Article 14.2 (b). Those can be defined at national level when proposed by the RSO.

The equivalent type A requirement is to have a similar facility simply to cease all active power generation within 5s (Article 13.6). Clearly the type B flexibility is of greater benefit than the simple binary type A response.

It is worth noting that existing connection requirements in some jurisdictions are already causing manufacturers to provide these capabilities in domestic scale PGMs of a few kW. The request for this capability is based on different national reasons. As opposed to a harmonised type A requirement (exhaustive or non-exhaustive), remedies are available on a national level, e.g. by lowering the A/B-threshold. Nevertheless, when providing APC, the EG recognises that there would be benefits to the interconnected system.

DESCRIPTION – JUSTIFICATION

The majority of small generation installations use technologies that are believed to be able to control active power output with no significant technical constraints or drawbacks (e.g. PV, battery storage etc). Also note that as more and more batteries and other storage technologies are deployed, this fine control facility will become more and more valuable. It would also be helpful to signal this as a desirable feature to storage manufacturers as early as possible; certainly, in advance of the NC RfG formally including storage.

PV systems usually have no restrictions in modulating active power following an external command from an external device, although this could increase the overall cost for customers.

However, the EG has noted that there are currently examples of technologies (specifically µCHP ≤ 50kW) where the energy efficiency of this type of generator is stated by the manufacturer in compliance with the EU Energy Efficiency Regulations. Active power reduction (modulation) of those generators in normal operation may lead to significantly reduced energy efficiency (and there is a need to avoid the implications for owners of significant performance reduction, i.e. the owners finding the efficiency claims of manufacturers are not achievable due to inefficient operation at reduced electrical output).

Several companies are investigating the use of small turbine-generator sets instead of valves to reduce the pressure in fluids. Due to the fact that the cost of a valve is so low, the turbine-generator set has to be as simple

as possible. The turbine-generator set is controllable, but based on parameters at the fluid side, not at the electrical side to control the injected power.
As defined in this EG, this means that the turbine-generator set is not controllable. An exception for all SPGMs with a capacity lower than 50kW might be appropriate.

State-of-the-art inverters and energy management systems already provide the hardware for communication interfaces for monitoring and plant control, even those offered for residential application. Therefore, requiring the capability of active power modulation should utilise those existing standardised communication interfaces. There are several solutions available to provide a secure communication interface protocols by this means (e.g. Modbus/TCP Security, IEEE 2030.5, IEC 61850...etc) and standardised data models (e.g. Sunspec Modbus, EEBus, IEC 61850…etc.). The European wide standardisation of such an interface would help to minimise efforts and costs for all stakeholders, but should also take into account cybersecurity rules.

POSSIBLE SOLUTION(S)

The type B modulation of active power output as required in Article 14.2(a) should be extended to type A power generating modules.

Ideally this functionality should extend to all type A PGMs. However, it is necessary to recognise that there will be redesign costs for some manufacturers (and for some customers the necessity of using external equipment). In some cases, the redesign might be marginal/trivial (e.g. in general expected to be for PV inverters typically < 10kW) to include this functionality in the PGM control system. However, in other cases, achieving such modulation will need the redesign of the prime mover power delivery system (e.g. high temperature fuel cells).

The EG recognises two broad approaches to implementing this requirement and dealing with any exceptions that might be needed in practice:

- **The first approach** is to bring the requirements of Article 14.2 into Article 13.6, but recognise exceptions (e.g. possibly CHP ≤ 50kW) at the drafting stage and include the exclusions in the formulation of the new article.
- **The second approach** recognises that Article 14.2 describes in point (a) the inclusion of an interface and in point (b) the use of that interface to receive instructions to modulate the active power. All new type A PGMs shall be equipped with the communication interface and capability to modulate active power. The use of the interface can be a local tool or a solution of the RSO if agreed nationally when the relevant system operator demonstrates the need and benefit for enabling the use of this interface. To that point the RSO will have to recognise any technology constraints, which of course need to be justified, and taken into account by the national implementation.

When the text mentions 'communication interface' we are not referring to the communication lines themselves which might be needed to use the interface. NC RfG is limited to the possibility to connect the communication lines.

In both of the above approaches some consideration of exceptions might be required. The EG has considered the following approaches:

1. No exceptions:
    a. rely on class or individual derogations;
    b. no derogations (i.e. no exceptions);
2. Exempt all SPGMs or alternatively all PPMs;
3. List specific exempt technologies in the revised NC RfG;
4. List exemption criteria. Could include:
    a. Market penetration;
    b. Technical assessment of the difficulties of compliance;
    c. Relative cost of compliance versus base cost of existing technology (e.g. communication infrastructure and cabling, costs for extra maintenance (due to extra load changes, …);
    d. Valuable benefits of the technology which otherwise might be lost;

5. Allowing a specific period to register existing technologies as exempt (like the existing emerging technology drafting in the current NC RfG);
6. Allow TSOs and/or Member States to determine the approach.

The above are all possibilities, but are all less desirable than no exceptions; some particularly undesirable.
The EG has the following observations on these possible exceptions:

1. No exceptions at all may not be appropriate. It may make µCHP up to 50kW, for example, unviable.
2. Exempting all of either SPGMs or PPMs is disproportionate since most instances of both these technologies can meet these requirements; it would remove a lot of value from the basic requirement.
3. Lists of specific technologies etc is not future proof, and it does tend to limit the opportunity, or driver, for innovation in those technologies. However, it is noted in the recital 15 and Article 6 that CHP is recognised as presenting specific technical challenges. Also, the exception could be time limited.
4. Ensuring that individual technologies are not inadvertently excluded will be important – particularly those technologies that contribute to grid support and stability independent of time of day and weather conditions.
5. This is actually a complex approach, with a high administrative burden on many parties. It is not recommended.
6. This approach risks a spectrum of different approaches and works against harmonisation. It is particularly important for type A PGMs to try to harmonise as much as possible across the EU, which this option militates against.

RECOMMENDATION(S)

That leads to the following recommendations:

1. Cenelec TC8 should be asked to consider how standardisation of safe communication protocols can be achieved.

2. Article 13.6 should be rewritten such that <u>either</u>:
   a. It replicates Article 14.2 (with some rewording) but with specific technology exclusions; or
   b. It replicates Article 14.2 (with some rewording).

Draft Text Proposals

The following text shows how Recommendation 2.a could be implemented:

13.6 (a) The **power generating module** shall be equipped with an communication interface in order to reduce or modify **active powe**r output following an **instruction** being received at the communication interface. The **relevant system operator** shall have the right to specify requirements for equipment to make this facility operable remotely.

13.6 (b) Article 13.6 (a) shall not apply to [µCHP ≤ 50kW; possibly µHydro]. Such power generating modules shall be equipped with a logic interface (input port) in order to cease **active powe**r output within 5s following an **instruction** being received at the input port.

8.1.3. SUBTOPIC C: RPC

INTRODUCTION – BACKGROUND

The growth of small-scale distributed energy resources, especially photovoltaics, storage and electric vehicles, is both bringing new opportunities for system operators, and new stresses on distribution systems. At low voltage one of the key immediate and future challenges is the problem of voltage regulation, which is being exacerbated by the increasing power ratings of new loads (e.g. heat pumps and EV charging) and generation (including storage) connected to DSO's LV networks. Traditionally DSOs have not used the management of reactive power flows on the LV network as a tool to control voltage regulation, apart from generally insisting that all power factors (PF) are at or near unity.

EN 50549's default requirements for type A PGMs are for reactive power production to achieve PFs of 0,9 lag and lead, with control modes of PF control, reactive power, or voltage control. Exceptions are made for some technologies, particularly CHP < 150kW, to have either a narrower PF range (0,95) and/or less sophisticated reactive power control. EN 50549 leaves the exact specification to be agreed between the owner and the DSO.

It is also expected that most DSOs already have legal and contractual rights, dependent on the jurisdiction, to exercise some control over the production and management of reactive power for any/all customers' equipment connected to their networks.

The extent that DSOs need sources of reactive power for voltage support is also an emerging subject of discussion, with no obvious consensus at this stage. Whilst the old saying that reactive power does not travel remains true, it is also true that DSOs needs for reactive power have generally been supplied with the active power that flows from the transmission system. As long as TSOs are providing active power, and within the required voltage range, the reactive power will generally accompany it. In fact, the modulation of active power by the DSOs can have a significant effect on TSOs' needs to manage transmission system voltage as the capacitive gain at low demand can cause high voltage problems. Conversely the modulation of reactive power by type A PGMs at LV has negligible effect on either the reactive exchange at the transmission connection point, or on the voltage profile of the transmission system.

DESCRIPTION – JUSTIFICATION

DSOs have obligations to maintain the voltages to customers within certain limits. The emergence of relatively large loads or generation on the LV network challenges this and can also inhibit the connection of new customer loads and generation.

The traditional response to voltage issues in general is to either adjust the voltage at the source or to reinforce the network to reduce its impedance. For LV networks it is often very hard to change the source voltage as this is optimised at both local and intermediate transformation points for significant lengths of network and hundreds or thousands of connected customers. Hence for LV networks it is often necessary to reinforce, which is costly, slow and disruptive.

Given the huge increase in generation on distribution systems, DSOs are now able to make use of the reactive power capabilities of generation (and some demand devices). However, there is no overarching framework within which power generating facility owners and DSOs can interact. The current NC RfG does not specify reactive power capability and voltage control for type A PGMs.

In terms of materiality, it is worth comparing LV system voltage management with that of HV systems. The physical nature of LV circuits, and the absence of transformation at that one voltage level, the R/X ratio of LV network is much lower than HV systems, and hence reactive power flows have proportionally much less effect on voltage at LV than at HV. If the maximum LV voltage regulation range is typical 15% to 20% of the declared voltage, the management of reactive power flows on a moderately heavily loaded feeder is estimated to provide a correcting regulation of between 1% and 2%. Increasing reactive currents to either raise of lower voltages will contribute to increased system losses in both cases.

POSSIBLE SOLUTION(S)

There are a number of ways by which DSOs can gain access to the ability of modern devices to modulate reactive power production or absorption.

1. Lower the A/B threshold
2. Extend the type B NC RfG requirements to type A
3. Extend the type C NC RfG requirements to type A (and therefore to type B)
4. Make a direct or indirect requirement to implement the approach of EN 50549
5. Allow RSOs to specify their requirements, subject to NRA approval.

Taking each of these in turn:

1. Lower the A/B threshold

   This will have essentially no effect as DSOs generally already have pre-existing rights at least equal to those expressed in Articles 17.2 and 20.2(a).

   These requirements essentially allow the RSO to specify the reactive power requirements (with no limits). There is no detailed provision for reactive power or voltage control specified. A common harmonised solution with simple but specific requirements could have been a desired approach for voltage control, with the drafting focus more on the voltage stability of the PGM than voltage management of the network.

   Adopting this approach would achieve little as it will still lead DSOs to need to specify additional requirements.

2. Extend type B

   This is essentially the same as 1. above, as Articles 17.2 and 20.2(a) contain no specific requirements.

3. Extend type C

   The requirements for type C are contained in Articles 18.2 and 21.3.

   For SPGMs Article 18.2 essentially allows the RSO to specify reactive capability within limits.

   For PPMs Article 21.3 allows the RSO to specify reactive capability within limits and also the control mode.

   Adopting this approach would still lead DSOs to need to specify additional requirements for all PGMs, albeit with sensible constraints on that specification.

4. EN 50549

   EN 50549 provides a fairly complete set of requirements for a DSO to specific reactive power control to assist with voltage management. As indicated above, there are stated exceptions to the full capabilities for some technologies which recognise practical limitations of those technology.

   It is for debate whether relevant TSOs, RSOs and all manufacturers would welcome the NC RfG requiring the use of EN 50549, but if so, a generic reference of a justified requirement might be more appropriate than citing 50549 directly. Making references to mandate standards within Regulations is not necessarily a legislative option anyway [and is explored more thoroughly in Topic 4]. However, there is no obvious need to include such a reference in the NC RfG; RSOs have the legal ability to require compliance with EN 50549 in relation to reactive capability and voltage control if the RSO considers it necessary.

5. RSO Specification

   This is, actually, the existing situation. However, Article 13 could be modified to include a simple requirement for RSOs to specify the reactive power and reactive power control needs. In effect this will not be much different for what RSOs already have to do to make use of type B and C PGMs' reactive capabilities. Article 7 would be operative here, so the RSO would have to gain NRA approval for requirements of general application.

DISCUSSION AND RECOMMENDATION(S)

Having considered the options identified above, there seemed to be three clear possibilities for the EG to choose between:

(1) Taking into account the practical similarities between 1, 2 and 4 above, propose wording to Article 13 to implement 4, i.e. RSO specification of capabilities.
(2) Make reference to EN 50549, indirectly in Article 13 (if it were legally possible to do so).
(3) Do nothing.

In the case of either (1) or (2) it would also probably be appropriate to add this new part of Article 13 to the exclusions in Article 17.1 and 20.1.

The EG discussed these options and formed the view that whilst voltage management of DSOs' LV networks is becoming of increasing importance in the future, extending the range of requirements in the NC RfG is not necessarily particularly helpful.

This view is based on:

- the overall low materiality of reactive power flows on the voltage profile of LV networks;
- the lack of any useful prescription for reactive power capabilities for type B in the NC RfG;
- the pre-existing rules that most DSOs have for managing reactive power flows.

Taking the above into account the EG decided that the status quo, i.e. not introducing any changes to the NC RfG in this regard, in other words, doing nothing is the most appropriate response at this time.

8.2. TOPIC 2: OTHER NEW OR ADDITIONAL REQUIREMENTS FOR TYPE A PGMs

Are there any new or additional items or requirements that should be added to type A based on the evolving system needs and taking into the account the requirements provided in the EN 50549-01 and EN 50549-02?

INTRODUCTION AND BACKGROUND

No new or additional requirements apart from the ones proposed in topic 1 have been nominated to add to type A PGMs based on the evolving system needs and no new or additional requirements have been nominated taking into account the requirements provided in the EN 50549-01 and -02.

DESCRIPTION AND JUSTIFICATION

However, there has been discussion about the possibilities of certification with the aid of EN 50549-10. Can EN 50549-10 be used or be helpful for the certification process?

POSSIBLE SOLUTIONS AND RECOMMENDATIONS

The consideration and conclusions of that discussion have been added to topic 4 - Any new insight and method of determining the certification obligations for type A and possible harmonisation.

8.3. TOPIC 3: DIFFERENTIATION OF REQUIREMENTS BETWEEN TYPE A PPMs AND PGMs

Based on the expected growth in population size, should type A requirements differ for PPMs just like it is with type B?

INTRODUCTION – BACKGROUND

The topic can also be handled in the following way:
"type A requirements will naturally be applied differently to synchronous and non-synchronous PGMs as is the case for type B to D. Is there a case for any type B requirement that currently differs between synchronous and non-synchronous generators to be applied without such a distinction for type A PGMs?"

DESCRIPTION – JUSTIFICATION

It seems to make sense to make a distinction between type A PPMs and type A SPGMs, but instead of approaching this from a general perspective it makes more sense to look into the details of this possible split for each additional requirement that has been proposed to impose on type A PGMs and therefore to tackle the question when handling the topic 1 of the ToR.

POSSIBLE SOLUTION(S) AND RECOMMENDATIONS

Solutions and recommendations on splitting type A in PPMs and SPGMs will be provided for the technical requirements proposed in topic 1.

8.4. TOPIC 4: CERTIFICATION OBLIGATION FOR TYPE A AND HARMONISATION

Any new insight and method of determining the certification obligations for type A and possible harmonisation ?

For clarity "possible harmonisation" in the title refers to the possible harmonisation of the methods of the determination and assurance of compliance used by different RSOs in different Members States. It does not refer to the possible harmonisation of technical requirement themselves, or the type A/B threshold.

As written in topic 2, we will integrate the conclusions from that report into this question, because in frame of topic 2 there has been discussion about the possibilities of certification with the aid of EN 50549-10. In other words, can the EN 50549-10 be used or be helpful for the certification process?
Therefore, can it help address topic 4.

Topic 2 and topic 4 will be even more important now that in topic 1 the EG proposes FRT to be included for type A PGMs.

INTRODUCTION - BACKGROUND

1. Based on the range of unharmonised and non-exhaustive requirements across the EU, it does not make commercial sense for manufacturers to try to sell type A equipment that is universally compliant across all Member States.
2. Some non-compliant type A PGMs have been connected in error (and without derogations).
3. Although DSOs have a responsibility for compliance, DSOs in some jurisdictions do not have any associated rights or powers.
4. DSOs have not traditionally had the resources to be able to respond to compliance issues on an individual basis for mass market type A PGMs.

5. Generally, the smallest PGMs are connected without the DSO knowing in advance (as allowed in the Clean Energy Package for small PGMs).
6. We are proposing new FRT requirement for type A.
7. It is not possible to prove FRT compliance of type A on site: manufacturers' assurance of compliance is required.
8. The principal type A requirements of operating frequency range, LFSM-O and the future FRT are of key value to TSOs, so all system operators will benefit from improved compliance.
9. An assurance regime is desirable that is as common to all Member States as possible.

What remains difficult is how to achieve 9.

A few options have been discussed, but the EG has formed a definite agreement on the optimum approach:

1. A requirement that all equipment and/or information provided by manufacturers of type A PGMs (or components) is subject to an assurance scheme.
2. Should such a scheme be per RSO, or common per TSO, nationally, or throughout the EU?
3. Could it be based on EU harmonisation legislation[8]
4. Should it be based on 50549-10?
5. Should it be based on detail written into the NC RfG?

Although, there is no direct agreement, there is a common understanding between the stakeholders that the regime for certification and harmonisation must become more practical and should be improved and strengthened. There is a need to improve the compliance processes and the use of EqCs, to improve the harmonisation of the approaches, to work on a harmonised certification scheme and to ensure proper accreditation.

Although there is a common interest for improved certification and harmonisation scheme, each group of stakeholders has different reasons for the interest in the subject.

Many generators of type A are placed on the market as 'finished generators', especially those below 50kW. Others, and typically above 50kW, are placed on the market as 'unfinished generators'.
'Finished generators' are mass produced and type tested for the consumer market (according to applicable legislation like the EMC Directive). They are sold as "boxed"/"as-is" products, and not to be modified.

'Unfinished generators' are assembled on-site from parts, and compliance to the applicable legislation (including, for example, the EMC Directive) has to be verified at the installation site.

Both finished generators and unfinished generators have to comply to the NC RfG, and the NC RfG does not make a distinction between the two.

In the NC RfG, there is very limited guidance on how to ensure compliance of generators of type A (unlike types B, C and D). For finished and unfinished generators alike, there could be different routes for compliance testing, verification etc.

DESCRIPTION – JUSTIFICATION

There is a need for a certification regime for type A to:
- Make sure that only compliant generators are connected to the grid;
- Support and align certificate requirements with the compliance monitoring approaches that should ensure generator compliance until decommissioning;

[8] Free movement in harmonised and non-harmonised sectors, European Commission Homepage (as of Juli 2021), https://ec.europa.eu/growth/single-market/goods/free-movement-sectors_en

- Make it possible to have one type testing and one certificate for the 'finished generator' to cover all EU;
- Facilitate the notification procedure as it is envisaged in NC RfG;
- Result in certificates whereby the owner is assured that it will be accepted by the RSO;
- Result in certificates where the owner can take their validity for granted;
- Result in certificates which the RSO can rely on;
- Ensure that compliance is assured higher up the supply chain, and not relying on on-site testing;
- Ensure or support that non-compliant products will not be placed on the market;
- Support provisions to efficiently and effectively challenge a certificate if:
    - there are doubts to the validity;
    - there are doubts that generator type actually performs as stated in the certificate.

POSSIBLE SOLUTION(S)

Solutions:

- It might be relevant to make use of the IGDs that are under development. Or draft other IGDs to deal specifically with this issue.
- It might be relevant to make use of standards such as EN 50549.
- It might be relevant to amend the NC RfG to mandate compliance certificates for generator equipment that is issued by authorised certifiers.
- Specifically, for 'unfinished generators' it might further be relevant to amend NC RfG with a procedure for type A similar to type B, C and D.
- Specifically, for 'finished generators' it might further be relevant to amend NC RfG with provisions in line with the existing EU framework of Union harmonisation legislation and type testing.

RECOMMENDATIONS

Although the NC RfG does not give much guidance to the creation of a certification regime, it is still open to the use of certificates. Before changes to NC RfG, it should also be assessed which possibilities already exist. The IGDs and standards should also be viewed for this purpose.

The EG does not have enough depth of expertise in legal assurance schemes to propose a compelling solution at this time. Hence there is a recommendation for more work on this topic.

To complete topic 1, we also have to consider what additional requirements are required in Title IV of the NC RfG for the compliance assurance of FRT.

8.5. TOPIC 5: HARMONISATION OF THRESHOLDS BETWEEN TYPE A AND B PGMs

Assessment of possible benefits from harmonising the thresholds between type A and B PGMs.

INTRODUCTION

A high diversity exists between the national decisions of thresholds for the classification of type A and B PGMs (see chapter 5), the NC RfG establishing depending of the synchronous area, the upper limit between A and B at 100kW (Ireland & Northern Ireland), 500kW (Baltic), 1,0MW (CE and GB) or 1,5 MW (Nordic).

The NC RfG also establishes that *"proposals for maximum capacity thresholds for types B, C and D power-generating modules shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State. In forming proposals, the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the previous proposal."*

Subgroup topic 1 has tried to assess whether a more coherent scheme at the level of A/B-threshold harmonisation is needed, taking into account new requirements for type A PGMs, as a result of topic 1 (additional requirements for type A PGMs).

DESCRIPTION-JUSTIFICATION

The subgroup conducted an assessment of possible benefits from harmonising the thresholds between type A and B PGMs.

The main **advantage** observed is:

- A harmonisation of thresholds may lead to lower manufacturing costs and compliance costs. The different capacity thresholds defined by the Member States introduce a challenge for PGM manufacturers who plan to sell their products in several EU countries.

The main raised **concerns** are:

- Harmonisation of the threshold will remove the national liberty to make the decision according to Article 5 of NC RfG. MS have chosen the threshold according to their power system characteristics, penetration of RES in their system, historical size (type) of conventional generation.
- The mechanisms to change the thresholds by Member States is already established in Article 5.3.
- Imposing same thresholds in legislation will be extremely difficult to achieve since each Member State has recently implemented its own thresholds for type A generators.
- Harmonisation of the threshold will move the national stakeholder interaction to a European arena.

POSSIBLE SOLUTIONS

Two possible solutions could be envisaged:

Solution 1: Not to harmonise the thresholds for type A/B and to leave open to MS the possibility to make their choice according to the national situation.

The first 'solution' involves no work as nothing is done and the existing legal text remains as it is.

Including more requirements on type A generators could probably automatically lead to further harmonisation since some MS chose a very low threshold for type A generators to ensure that small generators can also deliver some characteristics that type B generators typically incorporate (e.g. FRT, communication, controllability, reactive capabilities etc, aspects that are also defined in other NCs/GLs such as SO GL).

In other cases, MS that now suggest additional requirements have in the past selected the maximum value in the threshold range and then realised that the larger type A generators do not have the desired capabilities.

Solution 2: Define a minimum level of the A/B-threshold at 50kW.

If the new technical requirements proposed (in Topic 1) are accepted to be included for type A PGMs, the proposal is to define a new minimum level of the A/B-threshold to 50kW, whilst retaining 100kW, 500kW, 1MW or 1,5MW as the upper threshold. This means that all PGMs between 800W and 50kW are of type A. The figure below shows graphically the proposal.

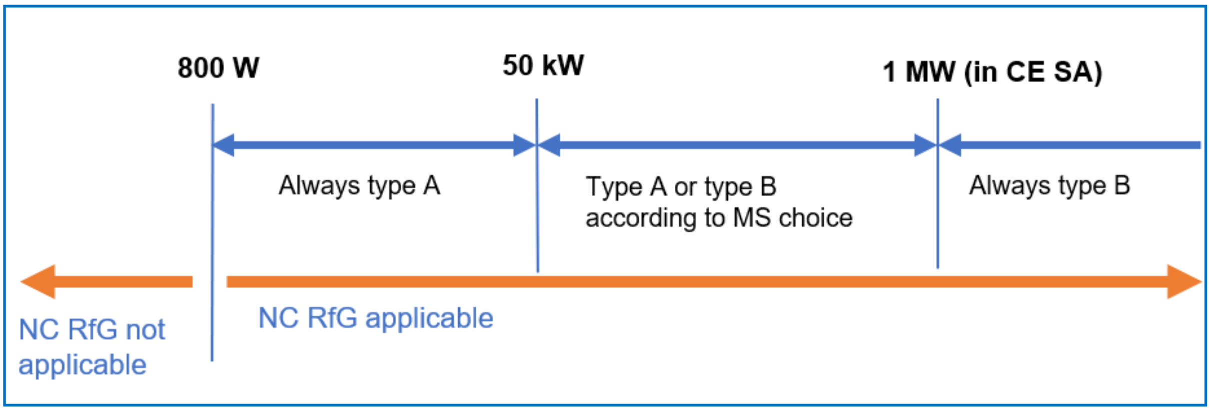

Figure 5. Graphical proposal 'all PGMs between 800W and 50kW are of type A'

The choice of the 50kW threshold has been chosen based on:

- The overall A/B-thresholds choices in the EU MSs: the 50kW is safely below most of the countries' choice for A/B-threshold (many maintaining a level around 100kW) so no immediate impact is assumed apart from two Members States: Italy and Slovenia.
- The consideration from Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, that imposes fast permit process for smaller units (less than 1 year).
- The consideration of other regulations such as the Energy Efficiency Directive 2012/27/EC that indicates a capacity of ≤ 50kW and, according to Article 15, Member States and NRAs are requested to support the connection of high energy efficiency CHP generators. Small CHP generators are not able to support all type B requirements if they are declared on type A PGMs.

RECOMMENDATION

We recommend that a minimum level for the A/B-threshold is defined at 50kW in addition to the existing thresholds to be defined by MSs, as is the case at the moment.

Without a defined level on the low end of the A/B-threshold, manufacturers which are active in several or even most of the European countries, are forced to include various type B capabilities due to different selected A/B-thresholds which make their products too expensive and reduces the market significantly.

Considering that Italy and Slovenia currently have lower thresholds than 50kW between type A and B PGMs, this proposal should be properly addressed so as not to create a conflict with the NC RfG implementation in these two countries.

ANNEX 1 – THRESHOLDS OF TYPE A/B/C/D IN MEMBER STATES AND THE UK

(extract from ENTSO-E Monitoring report on connection network codes implementation- 16/12/2019)

Country	A/B threshold	B/C threshold	C/D threshold
AT	250 kW	35 MW	50 MW
BE	1 MW	25 MW	75 MW*
BG	1 MW	5 MW	20 MW
CZ	100 kW	30 MW	75 MW
DE	135 kW	36 MW	45 MW
DK	125 kW	3 MW	25 MW
EE	0.5 MW	5 MW	15 MW
ES	100 kW	5 MW	50 MW
FI	1 MW	10 MW	30 MW
FR	1 MW	18 MW	75 MW**
GB	1 MW	10 MW	50 MW
GR	1 MW	20 MW	75 MW
HR	500 kW	5 MW	10 MW
HU	200 kW	5 MW	25 MW
IE&NI	100kW	5MW	10MW
IT	11,08 kW	6 MW	10MW
LT	250 kW	5 MW	15 MW
LU	135 kW	36 MW	45 MW
LV	0,5 MW	5 MW	15 MW
NL	1 MW	50 MW	60 MW
PL	200kW	10MW	75MW
PT	1 MW	10 MW	45 MW
RO	1 MW	5 MW	20 MW
SE	1,5 MW	10 MW	30 MW
SI	10 kW	5 MW	20 MW
SK	100 kW	5 MW	20 MW

*BE: In BE, the TSO has proposed a derogation for power generating modules of Type D with a maximum capacity of less than 25MW and grid connection at a voltage level above 110kV. Requirements applicable to Type A or B power generating modules shall apply to these power generating modules as well, as the case may be. The request for derogations has been submitted for regulatory approval.

**FR: national legislation requires power-generating modules above a defined installed capacity to be connected at the voltage level of 110 kV

Table 7 – Thresholds of type A/B/C/D in Member States and the UK

ANNEX 2 – FRT TECHNICAL REPORTS FROM FRANCE, SPAIN, GREAT BRITAIN AND GERMANY

Within the following sections, technical reports at some Member States are explained.
Based on the historical and ongoing penetration of PPMs as a natural outcome of integration of renewable electricity sources in the interconnected energy system, new system needs and fault scenarios are a rising and relevant concern of ENTSO-E and national TSOs. Having this in mind ENTSO-E proposes to expand the FRT and PFAPR requirement in a simplified solution to type A PPMs.

The automated response from both requirements is considered in line with the Recitals of the NC RfG where type A PGMs should be set at the basic level necessary to ensure capabilities of generation with limited automated response and minimal system operator control. They should ensure that there is no large-scale loss of generation over system operational ranges, thereby minimising critical events, and include requirements necessary for widespread intervention during system-critical events.

A fault on the transmission system will cause a voltage dip across the electrical network that may lead to the tripping of critical amount of generation that is not able to withstand this voltage dip, i.e. if PGMs do not have fault ride through capability. The voltage dip spread depends on the topology of the electrical network as well as on the rest of the generation sources connected in such a manner that the lower the short circuit power of the system is, the wider the voltage dip spreads.

Taking into account the above, the impact of a transmission fault in terms of disconnection of generation not being able to ride through the fault would depend on the generation mix, network topology and level of penetration of generation without FRT capability.

According to the NC RfG, type A generation does not have to provide FRT capability, which according to system operators view could become an issue for the network stability.

In absence of a general study at the European level, there are different studies at the national level that help to understand the problem, and thus contribute to justify the need for FRT in order to avoid the massive tripping of generation as a consequence of a fault on the transmission system. Besides the need for staying connected (FRT) the need for PFAPR is also very important in order to recover the pre-fault active power of the generation as soon as possible to re-establish the network stability. Fast recovery of the network stability will also lead to minimising the activation of reserves from other generators, to avoid what is known as a frequency-dip induced by voltage dip, and lead to a low activation of reserves from other generators connected.
Within the following sections, technical reports from some Member States are explained.

FRANCE

In 2019, a study aiming to identify the volume of type A generation with risk of disconnection from the grid was performed. The study took into consideration the best available information in 2019 concerning changes in consumption and the generation fleet, and several scenarios of installed power and capacity factor were studied.

As main hypothesis for the study, are the assumption that type A PV PGMs were considered as 50% of the total photovoltaic production, and type A PV PGMs were not able to stay connected when the voltage value was lower than 80% of the nominal voltage.

The below figure 6 illustrates an example of propagation of the fault in the 400kV western part of the French transmission system, in a scenario simulating year 2030 in terms of the projected supply estimate according to data available in 2019.

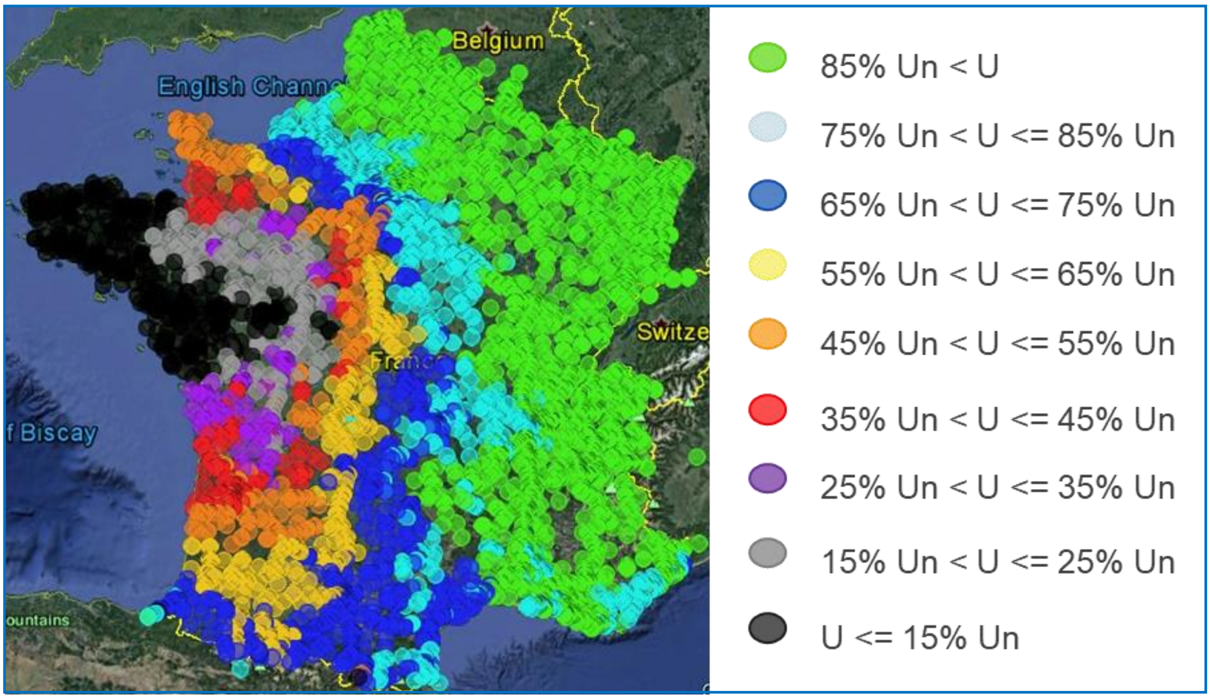

Figure 6. Example of propagation of the fault in the 400kV western part of the French transmission system

The figure illustrates how a single fault in the transmission system has an impact on voltages across the whole French system during the fault, which would lead to disconnection of generation without fault ride through capability. Several simulations were performed taking into account different active power installation hypothesis and its capacity factor. Taking into account that the loss of 3GW is the maximum admissible power loss, as it is the reference incident, the conclusion, using the median scenario, is that the risk of disconnecting 3GW of type A PGMs is reached in 2023 approximately. Therefore, this study illustrates the importance of having FRT requirements also for type A PGMs.

SPAIN

In Spain, the installed wind capacity dating December 2020 was circa 26,7GW of wind PPMs, and approximately 10GW of PV PPMs. The trends to install wind and PV generation PPMs continues and there is a strong compromise to achieve the national plans for energy in horizon 2030[9], which intends to have installed circa 50GW of wind power and 39GW of PV. From those numbers, a not negligible proportion of PV is expected to be associated to domestic loads, and therefore they will be probably categorised as type A PPMs, and according to the need for simplification of the connection procedures for these small generation together with the small scale of each of these facilities, it is expected that the system operator has a poor observability.

In terms of system security, robustness and resilience of the power system, from the system operator perspective it is especially worrying that there is a risk of massive disconnection of the generation without capability to withstand the fault ride trough.

Next figures illustrate the effect of a fault in the transmission system and its impact in terms of voltage dip across the electrical network during two different faults, affecting most of the Spanish electrical system.

[9] National plans elaborated by the Government to achieve climate goals.
https://www.miteco.gob.es/es/prensa/pniec.aspx
https://www.miteco.gob.es/images/es/pniec_2021-2030_borradoractualizado_tcm30-506491.pdf

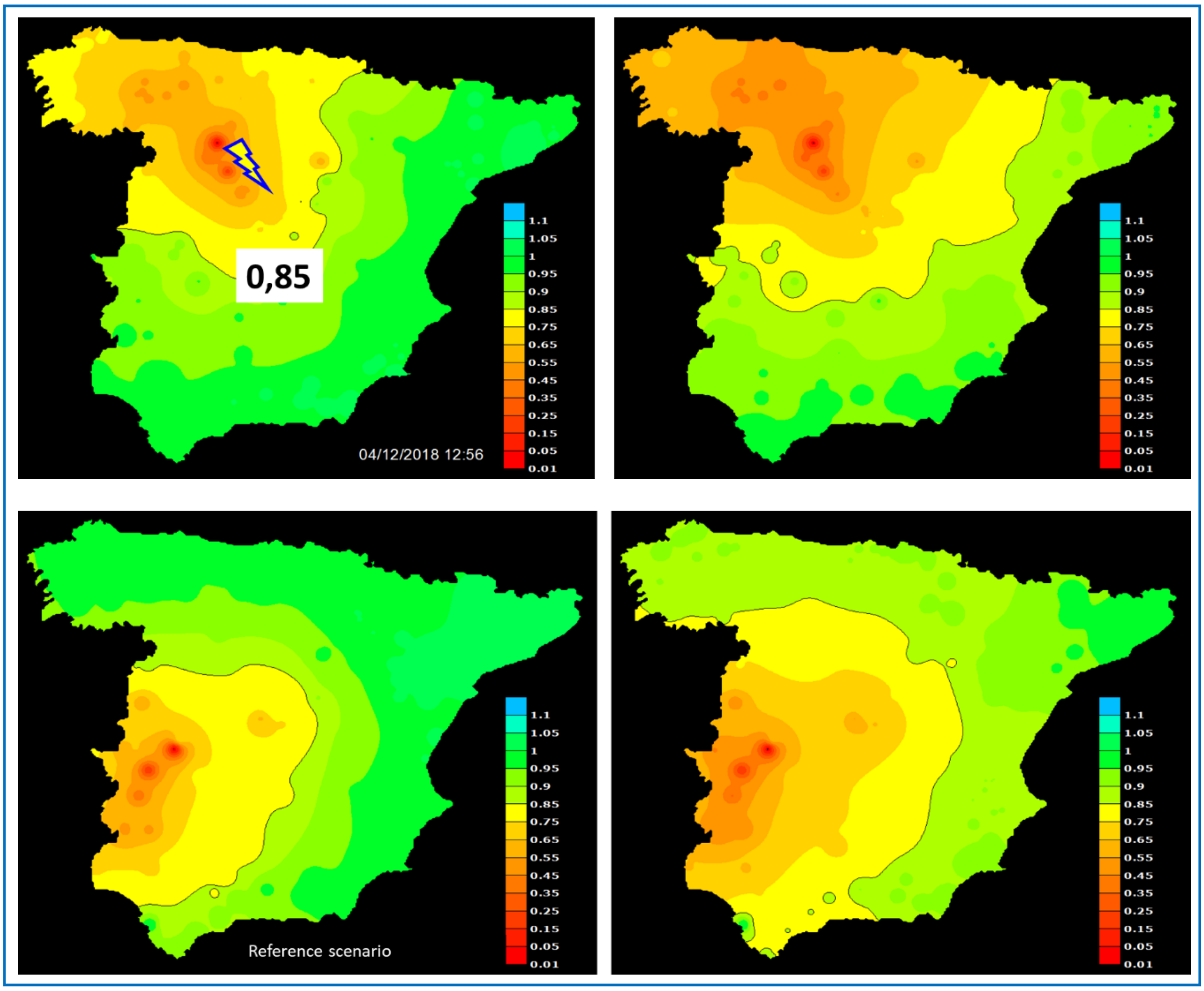

Figure 7. The effect of a fault in the transmission system and its impact in terms of voltage dip across the electrical network during two different faults, affecting most of the Spanish electrical system.

The figures also show the difference of how the voltage dip spreads depending on the generation mix, and in particular depending on the short circuit power: the lower the short circuit power is, the wider the voltage dip spreads across the electrical system.

The spread of the voltage dip may lead to the massive tripping of generation if they do not have FRT capabilities. In the scope of horizon 2030 operability studies performed by the transmission system operator, REE, some simulations of three phase faults in the transmission system lead to a loss of generation greater than 3.000MW, which is the reference incident in the Continental Europe area. Moreover, in the Iberian power system, it has to be taken into account that massive generation disconnection even less than 3.000MW can compromise system security such as to lead to overloads in the interconnections between Spain and France. Moreover, the poor observability expected from type A PGMs will translate into a lower ability to foresee system response in case of incidents in the system.

Taking into account that the expected growth of type A PGMs in Spain comprises mainly of PPMs, the FRT capability for type A PPMs is deemed necessary to ensure system security.

GREAT BRITAIN

In Great Britain the effect of transmission faults on the retained voltages at generation terminals has long been recognised and was specifically written into the GB requirements in 2004 for all generation of 50MW maximum capacity or greater, whether transmission or distribution connected.

One or two incidents on the GB system (May 2016 and August 2019) have shown how far transmission system fault disturbances can propagate to distribution connected generation, and which does underline the increasing importance of all generation however small being able to withstand the disturbances that accompany routine transmission faults.

GERMANY

In Germany, 53GW of photovoltaic capacity was installed at the end of 2020. Domestic installations accounted for 75% of this volume. According to the German Renewable Energy Act, installed PV capacity is expected to increase to 100GW by 2030. Photovoltaic generation will therefore be involved in the energy supply on an even larger scale. The behaviour of the system significantly shapes the security of energy supply.

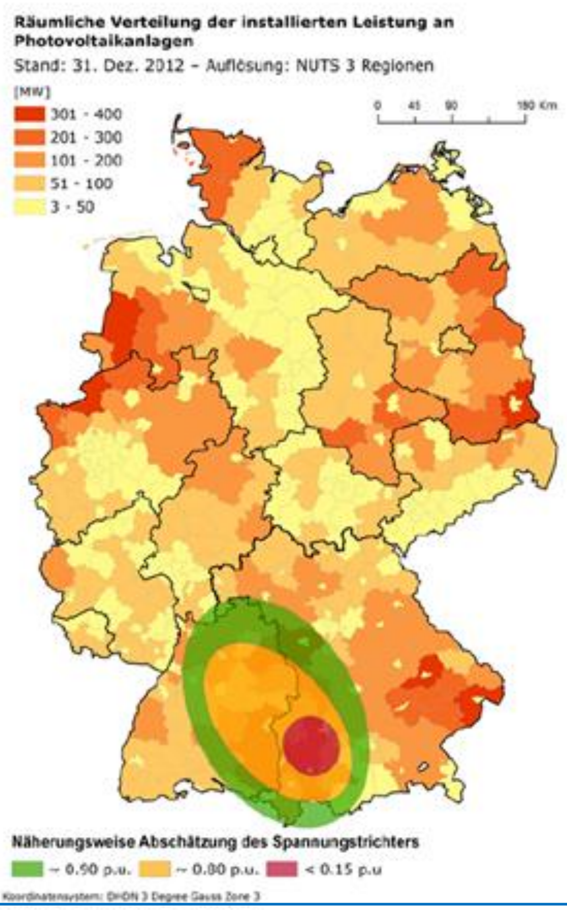

Figure 8. 2012: already 4GW installed capacity in regions < 80% Un

Already in 2012, with an installed photovoltaic capacity of 31GW, a study found that in the event of a short circuit in an extra-high voltage line, up to 4GW of photovoltaic capacity could be lost at the low-voltage level in some regions. The potential outage power is thus one-third higher than the balancing power in the entire Central Europe synchronous zone.

To be able to decide on suitable countermeasures, a study was therefore commissioned by VDE|FNN[10] in 2014 to investigate new requirements for generation plants in the low-voltage grid. Based on expansion targets for renewable energies, spatial distribution, and various load cases, grid models were used to investigate how plants in the low-voltage grid must behave in the event of a fault to guarantee system stability for the year 2022. The behaviour without additional requirements, as well as the behaviour with limited dynamic grid support and

[10] Forum Network Technology/Network Operation in the VDE

complete grid support, were examined. The limited grid support includes remaining connected to the grid in the event of a voltage dip, the return of the fed-in active power, and a minimum reactive power reference after the fault. In the case of full dynamic grid support, a reactive current is also fed in during the fault. The study also distinguished whether only the distribution generation on the HV/MV busbar fulfil the requirements for full dynamic grid support or whether all distribution generation in the medium voltage network provide full dynamic grid support.

Three load cases were investigated:

1) Warm summer afternoon;
2) Windy, cloudy autumn day;
3) Windy clear Sunday in spring.

By using the limited dynamic grid support, the number of plants that disconnect in the event of a fault can be reduced to up to 50%, as shown in figure 9.

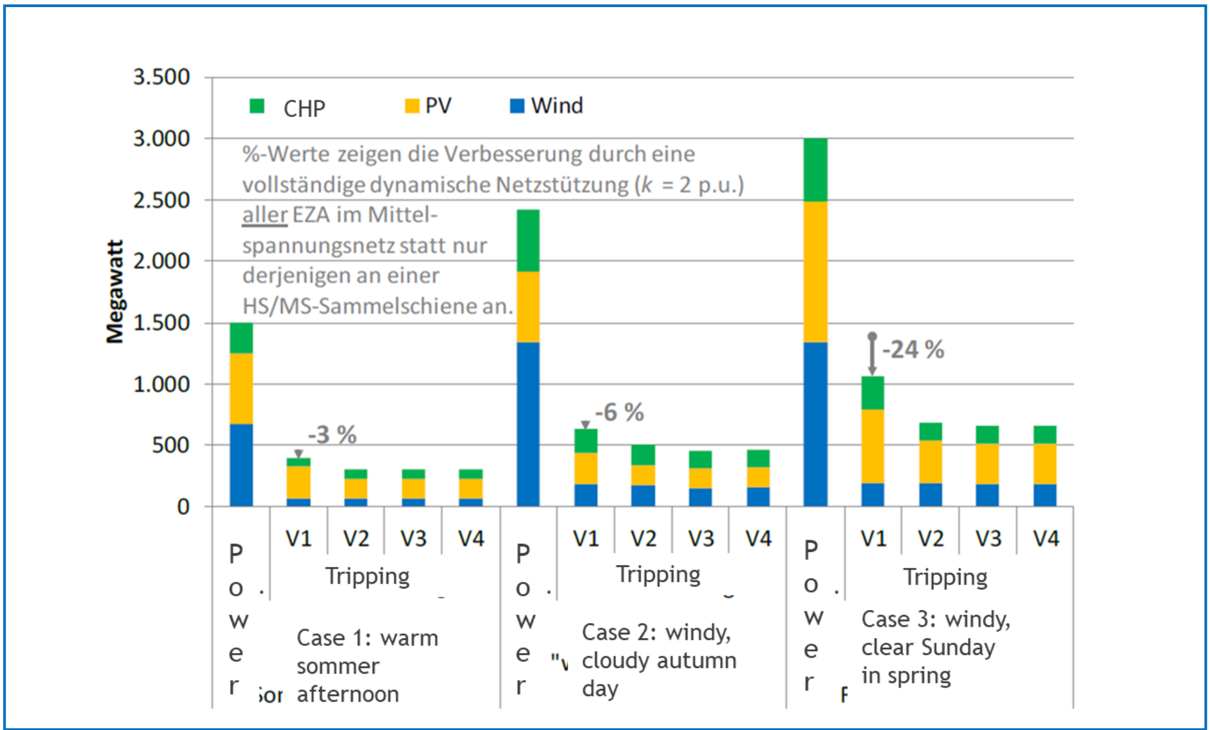

Figure 9. Dynamic grid support: V1: no, v2 limited, v3 full, v4: full plus active power. %-values: improvement of full dynamic grid support for whole distribution generation at MV network (not only the bus bar connected)

The results of the study were implemented in the new grid connection rules for low voltage (VDE-AN-R 4105) in such a way that the capability of limited dynamic grid support (FRT and PFAPR) is required for SPGM and PPM, although some exclusions have been made to some technologies, e.g. µCHP.

ANNEX 3 – ABBREVIATIONS

Abbreviation	Explanation
APC	Active Power Control
BftA	Baseline for type A (generators)
CE	Continental Europe (synchronous zone)
CE (Marking)	'Conformité européenne'
CHP - µCHP	Combined Heat & Power – micro Combined Heat & Power (cogeneration)
CNC	Connection Network Codes
DSO	Distribution System Operator
EG	Expert Group
EMC	Electromagnetic Compatibility
EqC	Equipment Certificat
EV	Electric Vehicle
FC	Fuel Cell
FRT	Fault Ride Through
GC ESC	Grid Connection European Stakeholder Committee
GL	Guideline
HV	High Voltage
ICE	Internal Combustion Engine
IECRE	IEC System for Certification to Standards Relating to Equipment for Use in Renewable
IGD	Implementation Guidance Document
LFSM-O	Limited Frequency Sensitive Mode at Overfrequency
LV	Low Voltage
MS	Member State, for the sake of this report Member State includes the UK due the fact the grids are integrated
MV	Medium Voltage
NC	Network Code
NC RfG	Network Code Requirements for Generators
NRA	National Regulatory Authority
PF	Power Factor
PFAPR	Post-Fault Active Power Recovery
PGM	Power Generating Module
PPM	Power Park Module
PV	Photo-Voltaic
Q	Reactive power
RoCoF	Rate of Change of Frequency
RPC	Reactive Power Control

RSO	Relevant System Operator
R/X	Resistance/Reactance
SO GL	System Operation Guideline
SPGM	Synchronous Power Generating Module
ToR	Terms of Reference
VDE | FNN	Verein Deutscher Elektrotechniker| Forum Netztechnik/Netzbetrieb *Association of German electrical engineers | Network technology/Network operation Forum*

Table 8 - Abbreviations