



European Network of
Transmission System Operators
for Electricity

NETWORK CODE FOR REQUIREMENTS FOR GRID CONNECTION APPLICABLE TO ALL GENERATORS

FREQUENTLY ASKED QUESTIONS

19 JUNE 2012

Disclaimer: This document is not legally binding. It only aims at clarifying the content of the final network code for "Requirements for Grid Connection applicable to all Generators". This document is not supplementing the final network code nor can be used as a substitute to it.

Foreword:

ENTSO-E has been instructed by Regulation (EC) N°714/2009 with the responsibility to draft network codes for providing and managing effective and transparent access to the transmission networks across borders, and to ensure coordinated and sufficiently forward-looking planning and sound technical evolution of the transmission system in the European Union, with due regards to the environment.

The elaboration process of the network codes is entirely a new legal tool which has not been experienced before. It should allow the European Commission to adopt a piece of legislation which will reflect the sound technical expertise and know-how of the European Transmission System Operators. ENTSO-E is in charge of drafting network codes upon request of the European Commission and in line with the framework guidelines specified by the Agency for the Cooperation of Energy Regulators (ACER). These network codes will then be submitted to ACER who will, if satisfied, recommend them to the European Commission for adoption via comitology. A more detailed description of the network code development process is provided in response to FAQ 2.

ENTSO-E is committed to ensure thorough public consultation on its draft network codes before submission to ACER and is seeking for your expert views. Since the development process of the network codes is quite complex and has been a learning experience for all involved parties, ENTSO-E has therefore prepared this FAQ document to clarify the network code for requirements for grid connection which is applicable to all generators and explains the reasoning supporting the proposed requirements.

Frequently Asked Questions

1. What are the “cross-border network issues and market integration issues”?
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As used in this paper, the capitalized words and terms shall have the meaning ascribed to them in the final network code.

Answer to FAQ 1:

What are the “cross-border network issues and market integration issues”?

Regulation (EC) 714/2009 Article 8 (7) defines that *“the network codes shall be developed for cross-border network issues and market integration issues and shall be without prejudice to the Member States’ right to establish national network codes which do not affect cross-border trade”*.

The terms “cross-border network issues and market integration issues” are not defined by the Regulation. However, ENTSO-E’s understanding of the terms has been derived from the targets of the EC 3rd legislative package for the internal electricity market:

- supporting the completion and functioning of the internal market in electricity and cross-border trade
- facilitating the targets for penetration of renewable generation
- maintaining security of supply

Based on these targets and in the context of the network codes for grid connection, the following interpretation of the terms “cross-border network issues and market integration issues” has been taken as a guiding principle:

The interconnected transmission system establishes the physical backbone of the internal electricity market. TSOs are responsible for maintaining, preserving and restoring security of the interconnected system with a high level of reliability and quality, which in this context is the essence of facilitating cross-border trading.

The technical capabilities of the users play a critical part in system security. TSOs therefore need to establish a minimum set of performance requirements for generators connected to their network. The performance requirements include robustness to face disturbances and to help to prevent any large disturbance and to facilitate restoration of the system after a collapse.

Secure system operation is only possible by close cooperation of power generating facilities connected at all voltage levels with the network operators in an appropriate way, because the system behavior especially in disturbed operating conditions largely depends on the response of Generating Modules in such situations. With respect to system security the transmission system and the Generating Modules need to be considered as one entity. It is therefore of crucial importance that Generating Modules are able to meet the requirements and to provide the technical capabilities with relevance to system security.

Moreover, harmonization of requirements and standards at a pan-European level (although not an objective in itself) is an important factor that contributes to supply-chain cost benefits and efficient markets for equipment, placing downwards pressure on the cost of the overall system.

To ensure system security within the interconnected transmission system and to provide an adequate security level, a common understanding of these requirements to power generating facilities is essential. **All requirements that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas and to achieving cost efficiencies through harmonization of requirements shall be regarded as “cross-border network issues and market integration issues”.**

Answer to FAQ 2:

What is the relationship between the framework guidelines and network codes – what are the responsibilities of both and what is the process of network code development?

The relationship between framework guidelines and network codes as well as the process for the establishment of network codes are defined by Article 6 of Regulation (EC) 714/2009.

The Agency for the Cooperation of Energy Regulators (ACER), on request of the European Commission (EC), shall submit to EC, within a reasonable period of time not exceeding six months, a non-binding framework guideline. This framework guideline will set out clear and objective principles for the development of network codes, covering cross-border network issues and market integration issues relating to the following areas and taking into account, if appropriate, regional specificities:

- network security and reliability rules including rules for technical transmission reserve capacity for operational network security;
- network connection rules;
- third-party access rules;
- data exchange and settlement rules;
- interoperability rules;
- operational procedures in an emergency;
- capacity-allocation and congestion-management rules;
- rules for trading related to technical and operational provision of network access services and system balancing;
- transparency rules;
- balancing rules including network-related reserve power rules;
- rules regarding harmonized transmission tariff structures including locational signals and inter-transmission system operator compensation rules; and
- energy efficiency regarding electricity networks.

Each framework guideline shall facilitate non-discrimination, effective competition and the efficient functioning of the market.

Based on such a framework guideline the EC shall request ENTSO-E to submit a network code which is in line with the relevant framework guideline to ACER within a reasonable period of time not exceeding 12 months.

If ACER assesses that the network code is in line with the relevant framework guideline, ACER shall submit the network code to the EC. The EC will then initiate the comitology process to give the network codes binding legal effect. It is likely that the network codes through the comitology process will become European Union (EU) regulations making the provisions of the network codes applicable in all Member States immediately without further transposition into national legislation.

The main objective of the framework guidelines is to highlight **which** emerging questions/problems should be solved, leaving the approaches on **how** to solve them to the related network code(s). Figure 1 provides an overview on the complete process of framework guideline and network code development.

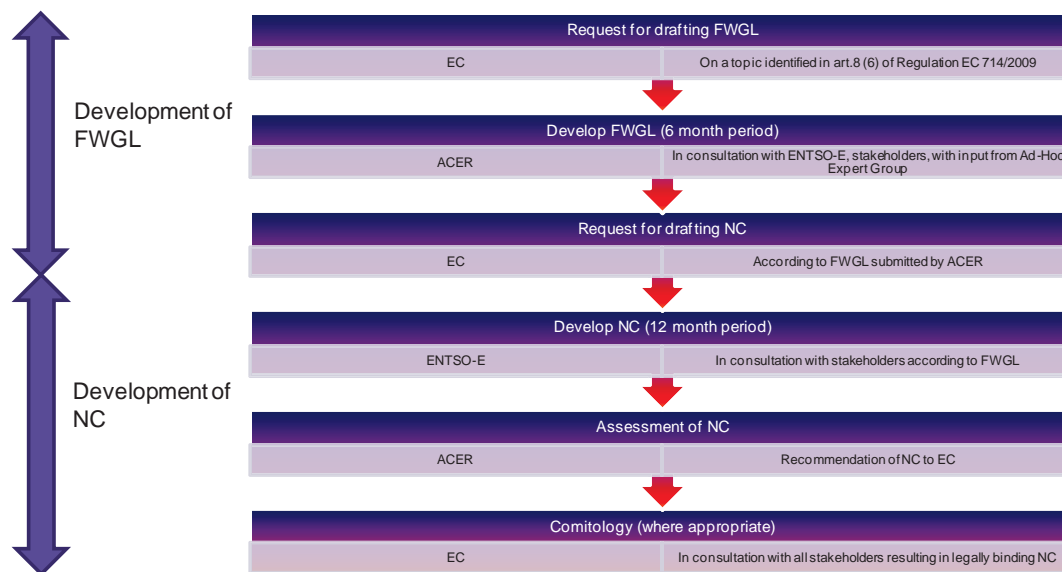


Figure 1: Framework guideline (FWGL) and network code (NC) development process

As reflected in the three year work program¹ which is regularly discussed by EC/ACER/ENTSO-E and consulted upon in the Florence Forum with all key stakeholders in the electricity sector, one or more network code(s) may correspond to a single framework guideline. The ACER framework guidelines on grid connections² were published on 20 July 2011. In total, four codes are anticipated in the coming years: connection of generation, connection of demand, connection of HVDC circuits and connection procedures. The formal twelve month mandate for the network code on demand connection started in January 2012. The mandate for the network code on HVDC connections is planned to commence in January 2013. For the fourth network code under these framework guidelines, regarding connection procedures, no starting date has been indicated so far.

In accordance with Article 10 of Regulation (EC) 714/2009, ENTSO-E shall conduct an extensive consultation process while preparing the network codes, at an early stage and in an open and transparent manner, involving all relevant market participants, and, in particular, the organisations representing all stakeholders. That consultation shall also involve national regulatory authorities and other national authorities, supply and generation undertakings, system users including customers, distribution system operators, including relevant industry associations, technical bodies and stakeholder platforms. It shall aim at identifying the views and proposals of all relevant parties during the decision-making process.

All output of the stakeholder interactions (bilateral meetings, workshops, user group meetings) during the formal development period of NC RfG can be accessed on the ENTSO-E website³.

¹ http://ec.europa.eu/energy/gas_electricity/codes/codes_en.htm

² http://www.acer.europa.eu/portal/page/portal/ACER_HOME/Public_Docs/Acts%20of%20the%20Agency/Framework%20Guideline/Framework%20Guidelines%20On%20Electricity%20Grid%20Connections/110720_FGC_2011E001_FG_Elec_GrConn_FINAL.pdf

³ <https://www.entsoe.eu/resources/network-codes/requirements-for-generators/>

Answer to FAQ 3:

Does the network code apply in non-EU member states or in respect to cross-border issues between a EU member state and a non-EU member state?

It is foreseen that the network codes will be adopted via the comitology process in the format of an EU regulation.

Therefore, they will become binding vis-à-vis non EU-countries in accordance with the following principles.

- 1) For the non-EU countries which are parties to the EEA Agreement (the European Economic Area Agreement), the EEA Agreement provides for the inclusion of EU legislation that covers the four freedoms — the free movement of goods, services, persons and capital — throughout the 30 EEA States. The Agreement guarantees equal rights and obligations within the Internal Market for citizens and economic operators in the EEA.
As a result of the EEA Agreement, EC law on the four freedoms is incorporated into the domestic law of the participating EFTA States. All new relevant Community legislation is also introduced through the EEA Agreement so that it applies throughout the EEA, ensuring a uniform application of laws relating to the internal market.
As energy legislation covering the functioning of the internal market falls within the scope of the EEA-Agreement, the entire body of future network codes will almost certainly be EEA relevant, and hence be applicable and binding after decision by the EEA Committee and national implementation. The regular implementation procedures will apply.
- 2) As Switzerland is not a party to the EEA Agreement, the enforceability of the NC transformed into EU Regulation will need to be assessed in the context of the pending negotiations between Switzerland and the EU. However, Swiss law is also based on the principle of subsidiarity. Under this principle, self-regulating measures can be taken by the parties of the sector if they reach the conclusion that these rules should become common understanding of the sector. Based on the subsidiarity principle it is currently considered by the Swiss authorities to introduce under Swiss law, new rules compliant to relevant EU-regulations by the parties of the sector.
- 3) For the countries that are parties to the Energy Community Treaty, the Ministerial Council of the Energy Community decided on 6 October 2011 that the Contracting Parties shall implement the Third Package by January 2015, at the latest. Moreover, it decided “to start aligning the region’s network codes with those of the European Union without delay”. The network codes will be adopted by the Energy Community upon proposal of the European Commission. The relevant network codes shall be adopted by the Permanent High Level Group which shall seek the opinion of the Energy Community Regulatory Board before taking a decision.

Answer to FAQ 4:

How will ENTSO-E efficiently and transparently perform stakeholder consultation?

Over the next few years ENTSO-E will be required to develop and consult on a series of network codes covering most aspects of the electricity market, and the operation and the development of the electricity system. The active involvement of all stakeholders, to be reflected in particular through their submission of comments during the formal consultation according to Article of 10 Regulation (EC) 714/2009, is considered to be crucial for the development of the network codes.

Each consultation will be composed of the following steps:

- preparation and announcement;
- stakeholders registration;
- comments gathering assessment and management including some statistical analysis; and
- Archiving.

Once the comments of stakeholders are assessed by ENTSO-E, they will be made publicly available, together with the corresponding answers/justifications. ENTSO-E will indicate how the comments received during the consultation have been taken into consideration and provide reasons where they have not been acted upon. All consultation material will remain publicly accessible for a period (envisaged to be at least one year) after the end of the consultation. Beyond this point, it will be archived by an ENTSO-E administrator so as to be available on request.

All ongoing, scheduled and finished consultations on draft network codes can be accessed at the ENTSO-E web consultation portal⁴.

The reader is referred for further information to the ENTSO-E publication “Consultation process”⁵ and the network code web sections⁶.

In addition to the formal consultation, ENTSO-E involves stakeholders in the network code development by

- bilateral meetings with European associations preferably in the early scoping phase
- stakeholder user group meetings predominantly in a more mature drafting stage
- public stakeholder workshops
- technical expert groups representing in particular distribution system operators

⁴ <https://www.entsoe.eu/consultations/>

⁵ https://www.entsoe.eu/fileadmin/user_upload/library/consultations/110628_Consultation_Process_Description.pdf

⁶ <https://www.entsoe.eu/resources/network-codes/>

Answer to FAQ 5:

What is the role of the subsidiarity and proportionality principle in the NC RfG?

One of the primary drivers for the network code is to set requirements for generators across the EU as part of the fulfilment of the 3rd legislative package that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas and to achieving cost efficiencies through technical standardization with a proper level of harmonization.

However, complete harmonisation of all requirements for Power Generating Modules is not a pragmatic or cost effective solution due to the geographic dispersion of generation and the variance (due to historical, topographic and geographic effects) of network designs across Europe.

In these cases the principle of subsidiarity is applied, with the high level harmonisation of the requirement, generally in the form of a range specified in the code, and the more specific details and/or parameters specified at a more local level. In this manner, only the harmonisation of aspects of the requirements which can only be achieved at a European level in practice by means of a European legislation (derived from a network code) is included in the network code, whilst maintaining the necessary flexibility in the details to apply these requirements more efficiently at a more local level.

Following this principle, the requirements in the code also apply the subsidiarity principle with the individual requirements in the code being applied to the type, size and connection point and their relevance at a European level. Aspects of this concept are discussed in detail in FAQ 6 and FAQ 18.

In line with the requirements in the Framework Guidelines on Grid Connections, the requirements for Significant Grid Users are categorised in the network code as follows:

- general requirements;
- specific requirements for Synchronous Power Generating Modules;
- specific requirements for Power Park Modules;
- specific requirements for AC connected Offshore Generation.

Each of these categories is divided into four types with thresholds in terms of installed capacity of the Power Generating Module and voltage level, which are defined at national level by the relevant TSO (while respecting the provisions of Article 4(3)), coordinated with adjacent TSOs and DSOs, and reviewed by the National Regulatory Authority.

Answer to FAQ 6:

What is the appropriate level of detail of the network code? Is it too broad or too detailed?

The level of detail and the scope of the network code are in line with the scope defined by the corresponding framework guidelines provided by ACER which read as follow: *“Furthermore, the network code(s) shall define the requirements on significant grid users in relation to the relevant system parameters contributing to secure system operation, including:*

- *Frequency and voltage parameters;*
- *Requirements for reactive power;*
- *Load-frequency control related issues;*
- *Short-circuit current;*
- *Requirements for protection devices and settings;*
- *Fault-ride-through capability; and*
- *Provision of ancillary services.*

(...)

The network code(s) shall set out how the TSO defines the technical requirements related to frequency and active power control and to voltage and reactive power management.”

The requirements in the network code have a system wide impact; however the appropriate level of detail for each requirement has undergone a case-by-case consideration of its purpose, taking into account the *extent* of the system-wide impact as a guiding principle. The relevant entity from the perspective of system security is predominantly the synchronous area (Continental Europe, Nordic States, Great Britain, Ireland and Baltic States).

For the requirements with immediate relevance to system security on the level of a synchronous area, besides a common level of methods and principles, common parameters and settings (thresholds, limits) are necessary to achieve a sustainable common set of requirements, since one of the aims of the network code is to harmonise requirements for Power Generating Modules throughout Europe to a reasonable extent to preserve system security in a non-discriminatory manner by applying the principle of equitable treatment. Other requirements of the network code are limited to the definition of common methods and principles and the details have to be provided by each TSO at national level (e. g. by explicit thresholds or parameter values). This allows consideration of specific regional system conditions (e. g. areas with different system strength, density of demand or concentration of Power Generating Modules). Therefore the level of detail of the requirements varies and the principles of subsidiarity and proportionality are applied.

Answer to FAQ 7:

Why do we need some requirements to apply even for domestic size of generation? Why are different categories of Power Generating Modules introduced and what are the criteria for specifying the categories?

Meeting the EU energy policy targets regarding integration of renewable sources implies that:

- I) Many medium and large scale renewable energy sources (RES) developments (e.g. wind) connect at high voltage and gradually extend to also cover offshore.
- II) Domestic level generation, e.g. photovoltaic (PV), in massive numbers (millions) appear within a short timeframe.

The domestic level generation (II), often called micro-generation, covers domestic combined heat and power (CHP) in addition to PV. These developments may arise in new houses or as replacement of gas central heating systems with gas based CHP, often with as little as 1kW or less generation.

Individually these developments (II) are not of significance with regard to maintaining security of supply. However, when a very large number of them respond similarly to a common stimulus (eg frequency changes) they quickly become a threat to security of supply through risk of mass tripping.

Frequency is shared within each of the five synchronous areas mentioned in FAQ 6. Any change in frequency is experienced immediately by micro-generation just as for large generators. To maintain security of supply, the generation industry is familiar with the requirement for all medium and large generators to remain connected during frequency disturbances, most obviously in the form of the frequency range requirements.

Large simultaneous loss of generation is a threat to frequency stability with potentially widespread consequences. In terms of the impact on the system, loss of a large generator, say 1000MW is no different from 200 000 domestic generators at 5kW each (e.g. from PV). Within a very short period, concentrations of PV units have reached a level where at certain times (sunny days) 15-25% of the total generation within some geographical areas comes from such sources. For example, in Germany more than 3000MW of PV was installed in a single month in 2011.

The consequences of not sufficiently addressing this issue (e.g. too narrow frequency range for some generators based on RES) has unfortunately already been experienced in Europe, which led to large scale customer disconnections.

Examples of this include:

- Greater demand disconnection in Central Europe during the system split 4th November 2006. GWs (millions of kW) of RES tripped at 49.5Hz resulting in a larger frequency disturbance and consequently in a similarly larger demand disconnection.
- On a smaller scale, but in a similar manner, an inadequate frequency range of smaller scale generation in GB (including RES) contributed to nationwide demand disconnection on 27th May 2008.

The requirements of this network code need to be forward looking. It will enter into force by means of European legislation, which means that it will be applicable for a rather long time and changes/amendments to them can only be implemented by running through extensive European legislative procedures. Therefore the anticipated mid- and long-term developments of the power generating portfolio need to be well considered and anticipated, which are, amongst others, clearly driven by rapidly increasing decentralised generation. Consequently it is undisputed, that smaller Power Generating Modules will need to have capabilities to support the power transmission and distribution system security, which are nowadays provided by bulk generation facilities only.

In order to reflect these developments, the approach has been chosen to introduce four categories of generation units in the network code by following the principle of subsidiarity and proportionality. The criteria for specifying the categories are the voltage level of grid connection and the installed capacity of a Power Generating Module.

The capacity thresholds are defined as upper limits of the lower threshold leaving the final determination of this threshold to the national level. The upper limits have been chosen from an estimation of having sufficient generation capacity of each category and the corresponding capabilities available for secure system operation.

Type A requirements are the basic level requirements, necessary to ensure capability of generation over operational ranges with limited automated response and minimal system operator control of generation. They ensure there is no wide scale loss of generation over system operational ranges, thereby minimising critical events, and requirements necessary for wide spread intervention during system critical events. Only essential requirements are included for Type A, limited to those aspects with potential system wide implications. For new installations, there is normally little or no additional cost in complying with these requirements once introduced as part of the standard product.

Type B requirements provide a wider level of automated dynamic response (generally with settings by the Relevant Network Operator) with higher resilience to more specific operational events to ensure use of this higher dynamic response and a higher level system operator control and information to utilise these capabilities. They ensure automated response to alleviate and maximise dynamic generation response to system events, greater generator resilience of these events to ensure this dynamic response and better communication and control to leverage these capabilities.

Type C requirements provide refined, stable and highly controllable (real time) dynamic response to provide principle balancing services to ensure security of supply. These requirements cover all operational network states with consequential detailed specification of interactions of requirements, functions, control and information to utilise these capabilities. They ensure real time system response necessary to avoid, manage and respond to system events. These requirements provide sufficient generation functionality to respond to both intact and system disturbed situations, and the need for information and control necessary to utilise this generation over this diversity of situations.

Type D requirements cover a wide area of control and range of operation. They ensure specific needs for higher voltage (equal to or greater than 110kV) networks and their operation and stability over wide areas, allowing the use of ancillary services from generation Europe wide. For this reason the requirements apply also for large generation connected at a lower voltage, but above a given capacity threshold.

Answer to FAQ 8:

Why is the option maintained to apply the network code requirements to Existing Power Generating Modules?

The option is maintained to apply the network code requirements to Existing Power Generating Modules because this principle is required by the ACER Framework Guidelines. The ACER Framework Guidelines provides that the network code requirements will apply to Existing Power Generating Modules if the relevant TSO has proposed an application to Existing Power Generating Modules and if this proposal has been approved by the National Regulatory Authority (see FAQ 9).

A network code requirement shall apply to an Existing Power Generating Module only if it is demonstrated by a quantitative cost-benefit analysis and that the costs to fulfil this requirement are in an acceptable relation to the benefits to the power system (see FAQ 11).

Currently the European power systems are changing rapidly: the internal market evolves, renewable generation increases, new transmission technologies, like FACTS (Flexible AC Transmission Systems), HVDC (High Voltage Direct Current) lines, etc. are introduced. In this situation there is a high uncertainty in anticipating the needs for power system security for the next 20 years. On the other hand, the requirements of this network code will be entered into force by means of European legislation, which means that they will be applicable for a rather long time and changes/amendments to them can only be implemented by running through extensive European legislative procedures. Hence, it is essential to have the possibility to apply network code requirements to existing plants. Such application will be pursued in very particular and reasonable cases and, with all the necessary safeguards and respecting the provision of ACER's Framework Guidelines.

Answer to FAQ 9:

Does the network code apply to Existing Power Generating Modules? What is the situation of Existing Power Generating Modules after the entry into force of the network code? Do existing derogations still apply after its enforcement or will they cease?

- Whether a Power Generating Module is defined as an Existing Power Generating Module in the context of this network code depends on the date of its connection or on the finality of binding contracts its owner may have on the purchase of the main plant and which can be confirmed. Detailed information on this is provided in FAQ 27.

As requested by the ACER Framework Guidelines, the network code shall apply to New Power Generating Modules. It shall apply to Existing Power Generating Modules as well, if this has been proposed by the relevant TSO on a national level and this proposal has been approved by the National Regulatory Authority. Depending on the proposal by the relevant TSO (and the regulator's approval) there can be a variety of application to Existing Power Generating Modules:

- All Existing Power Generating Module shall meet all requirements
- All Existing Power Generating Modules shall meet selected requirements
- Selected Existing Power Generating Modules shall meet all requirements
- Selected Existing Power Generating Modules shall meet selected requirements

Once approved and applied to a certain Existing Power Generating Module, this unit shall meet those requirements which are covered by this approval without any exemption, regardless whether it possesses a derogation from this requirement, which was issued on a national level *before* the network code entered in force. In respect of the network codes, such former derogations are invalid. Derogations will have to be sought specifically from the requirements of the network code by applying for them according to the procedure for derogation defined in the network code.

However, Existing Power Generating Modules, which are not covered by the network code, shall continue to be bound by such technical requirements that apply to them pursuant to legislation in force in the respective Member States or contractual arrangements in force. Consequently, existing national/ local derogations may remain in force as well, provided that they refer to a requirement not covered by the EU network code.

Although existing derogations are not suitable evidence of derogation from the network code in case of application to Existing Power Generating Modules, such documentation can however provide useful background information when preparing the derogation application regarding the network code.

Answer to FAQ 10:

Will further justifications of the requirements of the network code be provided?

According to the corresponding ACER framework guidelines further justifications of the requirements defined by the Network code should be provided in case these requirements deviate significantly from current standards and requirements, which may include a cost-benefit analysis.

However, the framework guidelines are missing two essential definitions in this context. They define neither the notion of “current standards and requirements”, which would be needed as a baseline to evaluate any significant deviation against, nor the notion of “significant deviation”, which would be needed as measurable criteria for such evaluation.

On the other hand the absence of such definitions allows for deriving appropriate criteria from the content and objectives of each individual network code. The requirements for Power Generating Modules can be distinguished in two categories:

1. Exhaustive Requirements

This category comprises those requirements, which define capabilities of Power Generating Modules by principle/methodology and by specified values of parameters. They leave no room for further specifications to be made on (usually) national level. Such requirements are thus exhaustively specified by this network code.

2. Non-exhaustive Requirements

This category comprises those requirements, which define capabilities of Power Generating Modules by principle/methodology only. They intentionally leave flexibility for further specifications to be made on (usually) national level, predominantly to enable to consider regional/national system characteristics properly which are essential for secure system operation. This is primarily indicated by references to “Article 4(3)” for further national decisions/agreements. Such requirements are thus not exhaustively specified by this network code. They become „exhaustive“ once the national choices are made.

About three quarters of the requirements of this network code can be classified as non-exhaustive. Most of these requirements already exist in each Member State by principle/methodology, but the detailed value and parameters may vary. The conclusion as such is, that in reality “current standards” can hardly be identified on European level.

Obviously, a deviation from current standards and requirements can reasonably be evaluated, once a requirement is exhaustively defined, i.e. when the national selections are available. Considering the before mentioned current situation in Europe, it is more than appropriate that further justifications for the non-exhaustive requirements can best be delivered on national level, when the national choices of parameters reveal a significant deviation from the so far existing national standards and requirements, which shall provide the baseline for these justifications.

Further justifications of requirements on European level supplementing the Network code consequently need to be provided in case exhaustive requirements deviate significantly from current European-wide standards and requirements. ENTSO-E has pursued such an investigation on the exhaustive requirements and its outcome is summarized in the supporting paper „NC RfG – Requirements in the context of present practices“. The main conclusion is that due to the absence of such European-wide standards and requirements a baseline for deviations is difficult to identify. Furthermore, it reveals that the parameter choices for these requirements in the network code are not the most onerous ones compared to the existing national standards and requirements. The appropriateness and diligence of the requirements in the network code is demonstrated thereby. In addition ENTSO-E has provided a document called „NC RfG - Justification Outlines“, which gives an outline of all requirements of this Network code by exposing their cross-border impact, the reasons for the approach chosen and possible alternatives and their consequences with focus on system security, cost-effectiveness and the EU policy targets.

Answer to FAQ 11:

How is cost-benefit analysis going to be applied to address the question of implementation of network codes for Existing Power Generating Modules?

The ACER Framework Guidelines define that “*The applicability of the standards and requirements to pre-existing significant users shall be decided on a national basis by NRA, based on a proposal from the relevant TSO, after a public consultation. The TSO proposal shall be made on the basis of a sound and transparent quantitative cost-benefit analysis that shall demonstrate socio-economic benefit, in particular of retroactive application of the minimum standards and requirements*”.

Before any Existing Power Generating Module is required to implement requirements of the network code, the relevant TSO will have undertaken a cost-benefit analysis, carried out a public consultation and the National Regulatory Authority (NRA) will have made the final decision based on information obtained from both the cost-benefit analysis and the consultation processes.

A cost-benefit analysis is an intensive process that requires resources from all market participants to collect the required data. To make best use of resources it is important to focus on cases of real merit. Therefore a filtering process is applied initially to identify these cases. This filtering consists of a high level analysis using a traffic light system. This method, applied by each TSO, evaluates if there is a reasonable prospect of justifying application to Existing Power Generating Modules with respect to each requirement defined in the network code.

The marginal cost for implementing each part of the network code to Existing Power Generating Modules is illustrated by the cost traffic lights. The socio-economic benefit of reducing the risk of disconnection of consumers and associated balancing services costs through implementation to Existing Power Generating Modules is evaluated by the benefit traffic lights.

- Costs
Following engineering review, an outline decision is made about the required modification:
 - Insignificant modification: Green
 - Significant modification: Red

- Benefits
Following engineering review, the reduction in demand loss and/or cost of balancing services is indicated:
 - No/low impact: Red
 - Significant impact: Green

In respect of requirements for which this filtering process demonstrates that there is no prospect of justifying the application to Existing Power Generating Modules (e.g. “red” on costs & “red” on benefits) for one class of Existing Power Generating Modules (e.g. Type A) or for all classes, then no further action will be taken. As a result, these requirements shall not be under the jurisdiction of this network code for Existing Power Generating Modules. However, the Framework Guidelines allows for a review of this significance evaluation at a later date, but not within a period of less than 3 years. This facility to review later is intended to, on the one hand, allow the TSO to avoid excessive application to Existing Power Generating Modules where this may prove unnecessary and, on the other hand, have a safety net for changes in circumstances.

If the filtering process demonstrates that there is a reasonable prospect of justifying application to Existing Power Generating Modules for a requirement for all or one class of Existing Power Generating Modules (e.g. benefit “green” and costs “green”) then the TSO can proceed on to a more detailed assessment, being assisted by the Power Generating Facility (PGF) Owners. Below is a high level summary of this:

- Cost-benefit analysis by the TSO for an item of the code on a national basis:
 - The PGF owners are required to co-operate by providing cost of retrofit.

- The TSO completes the cost-benefit analysis and prepares a report. The cost-benefit analysis is based on methodologies described in the network code and takes into account alternative solutions which may be network related
- If the outcome of the cost-benefit analysis is negative (application to Existing Power Generating Modules not justified) then there is no need for further action other than informing affected Stakeholders.
- Public Consultation:
 - If the outcome of the cost-benefit analysis is positive then the TSO undertakes public consultations.
 - If the outcome of the consultation is negative (application to Existing Power Generating Modules not justified) then there is no need for further action.
 - Following consultations resulting in “no further action” all affected parties and ENTSO-E are informed.
- NRA decision:
 - If the outcome of the consultation is positive then the TSO sends the report including results of the consultation to the NRA.
 - The NRA decides if the application to Existing Power Generating Modules is justified based upon the report.
- Implementation of application to Existing Power Generating Modules:
 - If the NRA decides to go ahead, the Relevant Network Operator issues a LON (as per Article 32 of the network code).
 - The PGF owners carry out retrofit and demonstrate full compliance in respect of the specified issue to the satisfaction of the relevant Network Operator.
 - If the result of the retrofit is satisfactory as evaluated, then the Relevant Network Operator issues a FON (as per Article 27a of the network code) to the Power Generating Facility Owner.

The TSO will provide information of the outcomes of the above processes to affected stakeholders in order to assist PGF owners and their associates with the degree of certainty as the process allows. A summary of the national decisions on application of network code requirements to Existing Power Generating Modules will also be shared with ENTSO-E, NRA and ACER.

Answer to FAQ 12:

Why does the network code not define certain requirements as paid-for ancillary services?

The ACER Framework Guidelines prescribe “(...) *Nothing in the network code(s) shall prevent commercial arrangements being used for the provision of ancillary services. (...)*”

The scope of this network code is to define the requirements for technical capabilities of Power Generating Modules which are needed for secure operation of electricity transmission and distribution systems.

Secure system operation is only possible by close cooperation of power generating facilities connected at all voltage levels with the network operators in an appropriate way, because the system behavior especially in disturbed operating conditions largely depends on the response of Power Generating Modules in such situations. With respect to system security the transmission system and the Power Generating Modules need to be considered as one entity from a system engineering approach. It is therefore of crucial importance that Power Generating Modules are able to meet the requirements and to provide the technical capabilities with relevance to system security.

The requirements of this network code need to be forward looking. Hence, the anticipated mid- and long-term developments of the power generating portfolio need to be well considered, which are, amongst others, clearly driven by rapidly increasing decentralised generation. Consequently it is undisputed, that smaller Power Generating Modules will need to have capabilities to support the power transmission and distribution system security, which are currently provided by bulk generation facilities only.

One objective of the network code is clearly specifying these capabilities in order to enable the industry to consider these features for future Power Generating Modules and to develop corresponding technical solutions. This approach has been expressively endorsed by the industry, because sufficient time for research and development is needed to be able to deliver the functionalities with future generation technologies. Moreover, the claims of other stakeholders to introduce such capabilities once the market demands for them have to be rejected. This inherently bears the risk, that at the time the market requests for these capabilities, they are not available and cannot be introduced at short notice causing a substantial risk to the security of the electricity transmission and distribution systems due to a lack of ancillary services.

It needs to be well distinguished between mandatory requirements of capabilities and the provision of ancillary services based on these capabilities. ENTSO-E agrees with stakeholders, that the provision of ancillary services is basically a market-related issue which needs to be appropriately remunerated. However, the introduction of remuneration provisions shall be subject to other network codes or arrangements.

Answer to FAQ 13:

Why does the network code not specify who pays for improvements of Existing Power Generating Modules to become compliant with the requirements? Who bears the costs for demonstrating compliance?

Cost allocation of improvements is not covered specifically by the framework guidelines on electricity grid connection issued by ACER. The ACER Framework Guidelines state that *“The network code(s) shall always require the system operators to optimise between the highest overall efficiency and lowest total cost for all involved stakeholders. In that respect, NRAs shall ensure, that, whatever the cost-sharing scheme is, the cost split follows the principles of non-discrimination, maximum transparency and assignment to the real originator of the costs.”*

Improvements of existing Power Generating Facilities and equipment to achieve compliance with the network code based on TSO proposal can only be mandated after a cost-benefit analysis which is performed on a socio-economic level (see FAQ 11) in line with the framework guidelines.

Nevertheless, in case of replacement/improvements/modernisation of existing Power Generating Facilities, it is required that the replaced/improved/modernised installations are compliant with the requirements of the network code, unless the Power Generating Facility Owner applies for a derogation from this obligation and this derogation is granted by the relevant Network Operator.

The responsibility on demonstrating compliance with the requirements established in the network code relies on the Power Generating Facility Owners. Consequently they shall bear their costs related to compliance tests and simulations. This should be done in alignment with the compliance principle set out in this network code and detailed further at a national level.

Answer to FAQ 14:

Why do TSOs impose requirements for connections to the distribution networks rather than the relevant DSO?

Secure system operation is only possible by close cooperation of Power Generating Facilities connected at all voltage levels with the Network Operators in an appropriate way, because the system behaviour, especially in disturbed operating conditions, largely depends on the response of Power Generating Modules in such situations (FAQ 1). For example, requirements for frequency stability are independent of the voltage level of the grid connection point of a Power Generating Module, because system frequency has global impact and the behaviour of Power Generating Modules at all voltage levels are affected equally by frequency.

Recent years are characterized by rapid development of dispersed generation, in particular renewable (wind turbines and photovoltaic panels). In some countries the level of installed capacity of renewable energy sources (RES) is close to the level of power consumption. In other countries where the current level of wind generation is relatively small, a strong growth is expected within the next 2-5 years. The generation portfolio has changed or will change across all countries within Europe. TSOs will not be able to ensure an appropriate level of system security without imposing requirements on Power Generating Modules connected to the distribution grid, that are comparable to those requirements, which Power Generating Modules connected to the transmission grid have to fulfil. The DSOs are responsible for system security as well, but only the TSOs have the ability to assess and control an entire area. It is therefore only the TSO that can comprehensively assess which requirements are needed from a systems engineering perspective and what requirements should be met by Power Generating Modules to maintain system security. It should be noted that some system security issues are dedicated exclusively to the TSOs, e.g. frequency control or system inertia. Experience has shown that the current technical and organisational solutions are inadequate and insufficient to meet future changes. The influence of dispersed generation connected to the distribution grid, due to the scale, is now much higher than in the past and new challenges occur. RES themselves become a source of noise in the system due to the fact that they are difficult to predict and are often sensitive to failures in the system. Besides, the risk of their disconnection due to certain system disturbances, such as frequency deviations or system faults, consideration needs to be given to the characteristics of new generation technologies (e.g. 25 000 MW PV panels installed in Italy and Germany which could automatically disconnect from the grid whenever the system frequency deviation would increase about 0.2 - 0.3 Hz).

Therefore, it is crucial that Power Generating Modules connected to the distribution system meet grid connection requirements which are relevant for system security as well. In addition, for some requirements, like those for frequency stability, it is important that the performance of all Power Generating Modules in a TSO's area of responsibility, or even in the entire synchronous area, are harmonised when they experience the same incident (e. g. a frequency deviation). TSOs need to define such requirements to be uniformly applied in the area of their responsibility to avoid the risk of varying requirements and performances resulting in a situation where the TSO is not in control of it. Ensuring system security by TSOs solely by technical capabilities of the Power Generating Modules connected to the transmission grid is hardly possible; therefore connection requirements for distributed generation need to be implemented in a coordinated way.

It is evident that DSOs need to be strongly involved in these issues. Therefore, during both the informal and the formal period for developing the network code, several bilateral meetings with experts from the four largest European DSO Associations (Cedec, Eurelectric DSO, Geode, EDSO4SG) have taken place in the context of this network code. Similar dedicated interactions continue in the development of other network codes.

Answer to FAQ 15:

Why does the network code not provide for dispute resolutions?

The settlement of dispute provisions is commonly used for contractual types of relationships which are outside the scope of this network code.

Therefore, in case a dispute regarding the application of a network code provision arises, it shall be referred to national courts - which are the ordinary courts in matters of European Union law - in accordance with national rules. Nevertheless, to ensure the effective and uniform application of European Union legislation, the national courts may, and sometimes must, refer to the Court of Justice and ask it to clarify a point concerning the interpretation of EU law (in the network code provisions).

The Court of Justice's reply takes a form of a judgment and the national court to which it is addressed is, in deciding the dispute before it, bound by the interpretation given and the Court's judgment likewise binds other national courts before which the same problem is raised. It is thus through references for preliminary rulings that any European citizen/ entity can seek clarification of the European Union rules which affect him.

Answer to FAQ 16:

Why do you not develop dedicated network codes for each type of generation?

The requirements for grid connection of Power Generating Modules have been developed from the perspective of maintaining, preserving and restoring the security of the interconnected electricity transmission and distribution systems with a high level of reliability and quality in order to facilitate the functioning of the EU-internal electricity market. Secure system operation is only possible by close cooperation of Power Generating Facilities of all types, connected at all voltage levels with the Network Operators in an appropriate way (FAQ 1).

Therefore Power Generating Facilities of all types have to be capable of providing services to the Relevant Network Operator to enable it to satisfy its security of supply obligations.

From a system engineering perspective these capabilities are independent from generation technologies to a large extent and cover:

- provision of information for system management
- system balancing / frequency stability
- voltage stability
- system wide angular stability including robustness of Power Generating Modules against perturbations
- system restoration after a disturbance.

Major differences in the capability requirements of Power Generating Facilities do not result from the primary energy source used (wind, solar, gas, coal, nuclear, hydro, etc.) for conversion into electricity, but from the type of generator connected to the network, in particular whether the generator is synchronously connected to the grid (like for the vast majority of conventional thermal Power Generating Modules) or via a power converter installation (like for wind farms or PV installations).

Therefore it is appropriate to distinguish between three categories of requirements:

- general requirements which shall apply regardless of the type of connection, because they are not influenced by it;
- specific requirements for synchronously connected Power Generating Modules;
- specific requirements for non-synchronously connected Power Generating Modules (so called Power Park Modules).

Keeping all these parts within a single network code aids the aim of the electricity market of equitable treatment for all Users by maintaining a consistent set of requirements for all developers and owners of Power Generating Facilities.

Developing a single code for each type of generation technology, based on the primary energy source, would have been highly inefficient in terms of keeping the network code as simple as possible. It should also be noted that the code needs to be adaptable in the future to address new generation technologies.

However, it should be noted that the requirements have been subject to detailed examinations by a number of leading experts, who have considered the impact on future generation technologies. Following these discussions, adjustments have been made in detail to prevent any technology from unreasonable treatment.

Answer to FAQ 17:

Does the network code consider specific conditions which may apply for some Power Generating Facilities, in particular in industrial sites?

Although the network code does remain technology-neutral, some specific provisions are included depending on the use of the Power Generating Facility.

Art. 3(6)g sets the general framework in which a Power Generating Facility Owner in an industrial site may conclude an agreement with the Relevant Network Operator and Relevant TSO on conditions for disconnection of a Power Generating Module. The objective of this agreement has to be securing sensitive/critical productions processes of the site in case of disturbed system conditions. Notwithstanding this possible agreement, the requirements of this network code shall apply to the Power Generating Module, unless a derogation is granted.

Art. 3(6)h sets the general framework in which Combined Heat and Power units may be exempted from requirements of this network code. An exemption is granted to type A, B or C Power Generating Modules for requirements related to the capability to maintain constant Active Power output or to modulate Active Power output other than Article 8(1) (c) and (e), in case:

- the primary purpose of these facilities is to produce steam for production processes of this industrial site; and
- the generation of steam and power are rigidly coupled to each other, i. e. any change of steam generation results inadvertently in a change of Active Power generation and vice versa.

For the avoidance of doubt, CHP units for which these conditions apply still need to comply with all other requirements of this network code, unless a derogation is granted. This exemption is restricted to rigidly coupled steam production and industrial sites as it is a justified usage-based constraint. An overall exemption to all types of customers and heat demand would imply an overall technology-specific exemption of all CHP units. In addition, for heat demand an inherent heat storage with longer time constant may be present in the facility. In case valid arguments remain present why a specific requirement should not be complied with, a derogation procedure can be invoked.

Answer to FAQ 18:

Do the requirements have to be considered as “minimum” or “maximum” requirements; what is the understanding of “minimum”/ “maximum” requirements?

“Minimum” relates to the request for defining the minimum set of requirements in the corresponding network code(s) which is necessary in order to achieve the objectives of the framework guidelines and consequently of Regulation (EC) 714/2009. The terms “minimum” (and “maximum” respectively) shall not be understood in the sense of defining minimum (or maximum) values for parameters, thresholds, ranges, etc.

The requirements established in the network code prevail over national provisions when implemented via EC Regulation, and if compatible with the provisions in the European network code(s), national codes, standards and regulations which are more detailed or more stringent than the respective European network code(s) should retain their applicability. Nevertheless, additional measures remaining within the scope of the network code can, as a matter of principle, be taken at the national level provided that they do not contradict the provisions of the network code.

The following theoretical examples attempt to clarify this principle:

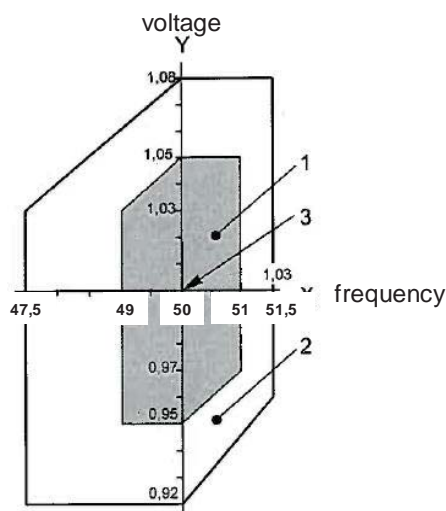
- Example 1: The network code determines the admissible operational voltage range for the 400 kV network to be limited between 380 kV (lower limit) and 420 kV (upper limit).
 - It is not admissible to define different limits on a national level.
- Example 2: The network code determines that the admissible operational voltage range for the 400 kV network shall be defined by the national TSOs with a minimum lower limit of 380 kV and a maximum upper limit of 420 kV.
 - It is not admissible to define ranges outside the minimum or maximum limit on a national level, but a range within these limits shall be defined by the national (relevant) TSO.
- Example 3: The network code does not determine an admissible operational voltage range for the 400 kV network.
 - It is admissible to define any kind of ranges on a national level, because it is not in conflict with the network code

Answer to FAQ 19:

Why do you need the wide frequency ranges for operation and do not comply with the relevant IEC standard 60034 for rotating electrical machines?

The capability of operating Power Generating Modules during deviations of the system frequency from its nominal value is of crucial importance from the perspective of system security. Significant deviations are likely to occur in case of major disturbance to the system, which come along with splits of normally synchronously interconnected areas due to imbalances between generation and demand in the then separated parts of the system. A rise of frequency will occur in case of generation surplus, while lack of generation will result in a drop of frequency. The volume of a frequency deviation not only depends on the amount of imbalance, but also on other conditions / characteristics of the system, such as the generation profile i.e. system inertia, spinning reserve and the frequency response speed. In this sense, the current massive displacement of conventional generation by renewable generation may decrease the system reliability in terms of maintaining a stable frequency. In general, smaller systems will usually be exposed to higher frequency deviations than bigger ones. In the same way, peripheral systems which are part of very large systems, such as the interconnected Continental European area, but are weakly interconnected to the main system will be exposed to substantial frequency deviations in case of disturbances that cause the trip of the interconnections with the main interconnected system. Therefore, the capability of operation of Power Generating Modules under such frequency conditions is a prerequisite to keep the system “alive” in order to be able to continue electricity supply and to restore a secure system state quickly.

During stakeholders interactions concerns were reiterated on the wide frequency ranges originally requested by the draft requirements of ENTSO-E claiming that they exceeded the provisions of the relevant IEC standard 60034 for rotating electrical machines, according to figures 1 and 2:



Area 1: Operation unlimited in time
Area 2: No specification of time limits

Figure 1: Frequency and voltage ranges for operation of rotating electrical machines according to IEC standard 60034-1

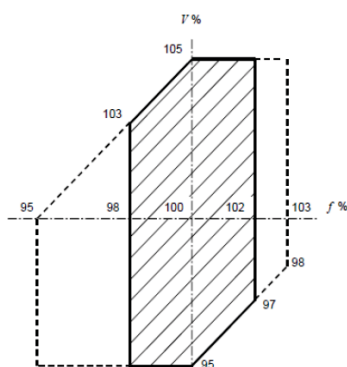


Figure 2: Frequency and voltage ranges for operation of synchronous generators driven by steam turbines or combustion gas turbines according to IEC standard 60034-3

Limited off-frequency operation is tolerated by both the turbine and generator, however the underfrequency limitations on the generator, are usually less restrictive than the limitations on the turbine.

IEC 60034 does not define a specific duration for time-limited operation (Area 2) because operation within an abnormal frequency range is time cumulative before turbine blade damage is probable and these characteristics differ from manufacturer to manufacturer. However, IEEE/ANSI C37.106-2003 Standard “Guide for Abnormal Frequency Protection for Power Generating Plants” provides some examples in which the time accumulated within each frequency range is shown in next figure:

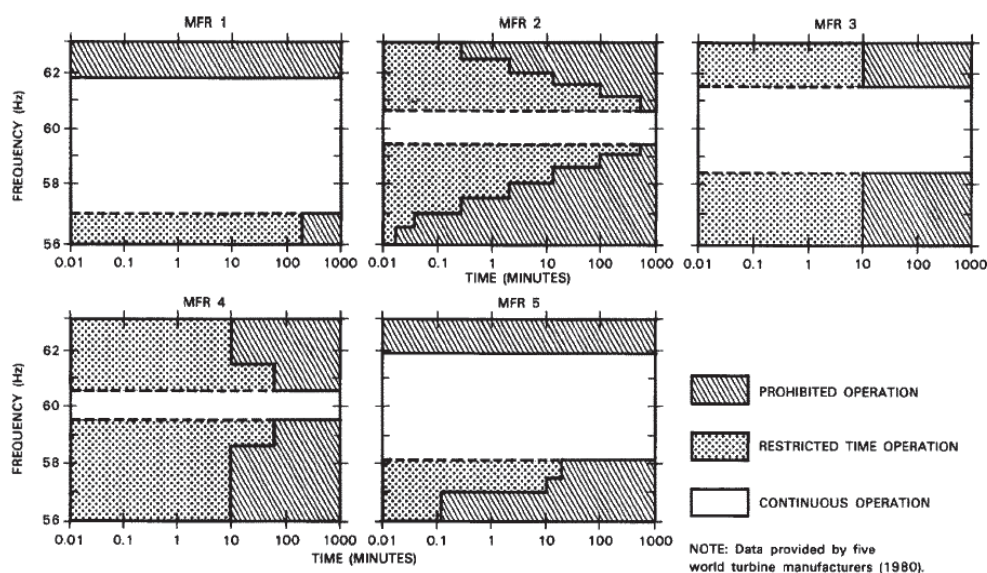


Figure 3: Examples of steam turbine limitations (different manufacturers) during abnormal frequency according to ANSI/IEEE C37.106-2003 standard

The network code is in line with IEC-60034 in the sense that unlimited time operation is required within the range (49 - 51 Hz). In the case of time limited operation (area 2 in Fig.1 and non-shaded area in Fig.2), ENTSO-E acknowledges that operation of Power Generating Modules cannot be generally required under these conditions, however situations in which the system frequency has been outside of the time-unlimited operation range have already occurred.

The system security and continuity of supply would be even more endangered if generation units were tripped and consequently would not assist system restoration. In this case, ENTSO-E considers that the time period for operation within 48.5 - 49 Hz will be established by the relevant TSO on a local/national basis, since each system topology has different needs on operation of frequency ranges for the Power Generating Modules. In the case of Continental Europe, and due to the existence of a large number of TSOs with different characteristics, the minimum time period for operation within the range 47.5 – 48.5 Hz, will be determined by each TSO.

ENTSO-E believes that a minimum operation period of 90 minutes is adequate for smaller synchronous areas in the ranges 47.5 – 48.5 Hz and 51.0 – 51.5 Hz, because situations where a frequency deviation to Area 2 of figure 1 may occur (even though countermeasures like low-frequency load shedding are implemented) in particular after severe disturbances which can be accompanied by a loss of communication and remote control infrastructure. Therefore a significant amount of time will be needed to prepare for system restoration under such conditions. In the future, it is expected that larger frequency excursions could take place following a disturbance due to the fact that a large volume of renewable energy (a non provider of system inertia), will be installed in the ENTSO-E synchronous areas.

As a conclusion, the frequency range requirements of the network code reflect the need for maintaining/restoring system security.

Answer to FAQ 20:

Why do you need the wide voltage ranges for operation?

1. Why is voltage a “cross-border issue”?

A change of voltage in a certain point in a network results in a change of the power flow in an interconnected system towards this point. The voltage may change due to loss of generation, loss of load, loss of transmission lines, or normal variations of connected demand.

If the voltage increases in a certain point, currents towards the point will decrease since demand depends on voltage and current. System losses will also decrease which will further increase system voltage. If the voltage increases over an acceptable value, the isolation of connected equipment is jeopardized.

If the voltage decreases in a certain point, currents towards the point will increase since demand depends on voltage and current. Reactive power losses will also increase, which will further decrease system voltage. This situation can result in loss of voltage stability and subsequently escalate to a large-scale disturbance (voltage collapse), if there is a lack of capacity to regulate voltage by static or synchronous equipment and depending on the proportion of static/ synchronous equipment. The distance between the regulation equipment and the affected point in the system also has an impact on the effectiveness of the compensation. It is therefore of crucial importance for system security that Power Generating Modules are capable of operating in a wide voltage range to be able to control voltage to preserve voltage stability and to prevent the system from voltage collapse. Indeed, most of the large-scale disturbances to electricity transmission system in the recent years were caused by a loss of voltage stability.

2. What do the international standards say about voltage range and duration?

Voltage is one of the basic parameters describing the state of the power system and cannot be omitted in the requirements for generators. According to the EN60034-1 standard (*Electrical machines*) as well as EN60034-3 the permanently permissible range of generator voltage variation is defined from 95% to 105% of rated voltage. For a limited time, generators ought to be capable of operating in a voltage range from 92% to 108% of rated voltage. The operation of a generator outside the permanently permissible range is possible but this operation should be limited in extent and duration due to the effects of temperature increase.

The duration of the time limited operation is not standardised and can be different depending on the type of generator as well as the needs of the local system. Without any additional equipment a generator should stay connected to the grid within the variation of $\pm 8\%$ of its rated voltage. It should be noted that the voltage range defined in standard EN 60034-1 refers to the generator voltage in contrast to this network code where the voltage range is defined at the Connection Point.

3. Possible measures for Power Generating Facility Owners to match different voltage ranges of international standards with ranges defined in this network code

Between the generator terminals and the Connection Point there will be at least one transformer and its parameter has essential influence on the capability of the Power Generating Module to operate at voltages below and above rated generator voltage. Therefore, to minimize adverse effects on the generator from operation outside the nominal parameters (e.g. reduction in life of the generator) additional countermeasures can be taken. To meet the voltage range as required by the network code and to increase the permissible range of Power Generating Module operation without negative effect on the grid voltage, on-load tap changers can be used. It makes the voltage range requirements compatible for the Power Generating Module and this is also the case for auxiliaries, *as auxiliary and standby transformers can also be equipped with on-load tap changers*⁷. Note that according to EN50160 standards under normal operating conditions voltage variations should not exceed $\pm 10\%$,

⁷ feedback received during the stakeholder dialogues.

and for remote users +10%/-15% of nominal voltage (refer to medium voltage) unless otherwise agreed with the grid users. Thus the voltage requirements defined in EN60034-1 standard cannot be treated as binding at the Connection Point for power Power Generating Modules, nor can it restrict the Network Operators to define Power Generating Module requirements (as a whole and not only the generator) to ensure system security. From this point of view these voltage range requirements are not in contradiction with IEC standards.

The wide voltage ranges of the Power Generating Module operations are very important during "normal" operation to ensure the technical capability of a Power Generating Module to retain synchronous operation and support the system when local voltage problems occur (e.g. to avoid voltage collapse). Across Europe, tripping of generation units from the meshed network to protect plant and equipment and to prepare to contribute to the restoration process is permitted if extreme voltage drops occur. In practice, the setting of these under voltage protections in terms of nominal grid voltage and time delay should be agreed with the Network Operators.

A wide voltage range of Power Generating Modules is furthermore highly desired during the system restoration process when extreme voltage conditions may occur, (e.g. during charging of long lines).

Answer to FAQ 21:

How should the combined effect of frequency and voltage ranges be interpreted?

For both frequency and voltage required operating ranges are defined in which immediate disconnection of a Power Generating Module is prohibited due to the deviation of the frequency or the voltage from its nominal value. These requirements also define the duration the generators are required to withstand the deviation from the normal value. In the IEC Standard 60034-1 for rotating electrical machines these two dimensions (ranges and times) are combined in a single diagram covering both voltage and frequency (see FAQ 19, Figure 1).

- Why does ENTSO-E not do the same?

The IEC standard covers requirements at the generator terminals. The network code covers requirements at the Connection Point. Therefore they are very different. The impact of the generator transformer possibly with an on-load tap changer as well the impact of the collection network in the case of a Power Park Module makes up this difference. The network code does not specify the voltage range at the generator terminals.

- If there is no diagram how should the situation of simultaneous deviation in frequency and voltage be interpreted?

Each requirement applies on its own. If the specified duration withstand capability is exceeded, then the Generator is entitled to trip. If both quantities vary at the same time, the quantity with the shortest duration criterion can initiate the trip.

Example for GB:

If 51.2 Hz (frequency limited time operation) and 1.07 p.u (voltage limited time operation) occurs for 20 min, what will happen?

- It is not allowed to trip on frequency (<90 min), however after 15 min, it would be allowed to trip for voltage (>1.05 for longer than 15 min).
- If the voltage threshold of 1.05 p.u. had not been exceeded until after 80 min of frequency at 51.2 Hz , then it would be allowed to trip on frequency after 80+10 = 90 min (voltage will then have exceeded its limit for 10 min only and therefore it is not allowed to trip on voltage criteria).

Answer to FAQ 22:

Why do you need the wide reactive power capability range?

The U-Q/P_{max}-profile is representing the Reactive Power Capability of a Power Generating Module at Maximum Capacity in context of varying voltage at the Connection Point. The U-Q/P_{max}-profile shall apply at the Connection Point.

Different types of networks (e.g. distribution or transmission purpose), different network topologies (degree of network meshing) and characteristics (ratio of infeed and consumption) need different ranges of Reactive Power. The provision of Reactive Power at a certain point in the network strongly depends on the local needs which are described in the sentence before. For instance, highly meshed and/or heavily loaded networks need more lagging Reactive Power (production), whereas remote networks with modest power flows and low consumption need more leading Reactive Power (consumption) in order to keep the network voltage within the permitted range.

The position and size of the fixed green envelope in the U-Q/P_{max}-diagram (Figure 4) define the outer limits of Reactive Power Capability which can be required by European TSOs. The green envelope shall hence be understood as an outer limitation and does not represent the actually required Reactive Power range.

For each synchronous area the size of an inner red envelope is specified by this Network Code in order to harmonize the Reactive Power Capability requirement. The exact position of the inner red envelope inside the green envelope shall be defined by each Relevant Network Operator in coordination with the Relevant TSO.

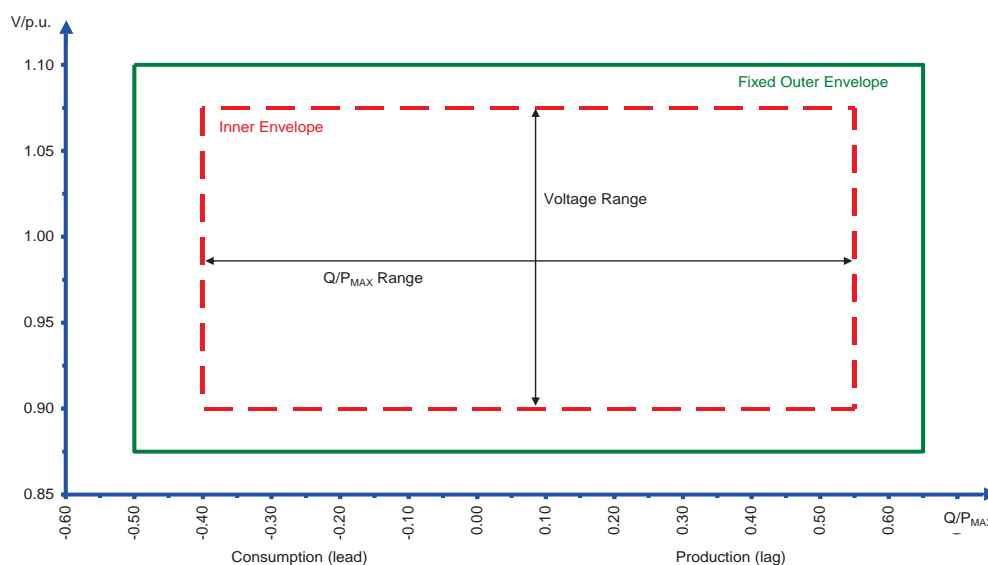


Figure 4: U-Q/P_{max}-diagram at Maximum Capacity

The final U-Q/P_{max}-profile shall be defined by each Relevant Network Operator in coordination with the Relevant TSO inside the inner red envelope. It can be of any particular shape (e.g. rectangle, parallelogram) with regard to its specific local needs.

The importance of a wide Reactive Power Capability range is defined by the constantly increasing necessity of effective voltage regulation in the whole network. Voltage regulation becomes more complex because of the continuous change of network topology and characteristics, in particular driven by increasing long-distance power flows due to changes in the generation portfolio and the emerging internal electricity market. Each Power Generating Module, must be capable of participating in voltage regulation.

The following example (Figure 5) illustrates the definition a specific U-Q/P_{max}-profile to specify the Reactive Power Capability of a Power Generating Module at Maximum Capacity in the Continental Europe synchronous area. The size of the red inner envelope is defined according to the Network code by a Q/P_{max}-range of 0.95 and a U-range

of 0.225 pu and it is positioned inside the red outer envelope. The shape and the position of the blue U-Q/P_{max}-profile is chosen by the Relevant Network Operator in coordination with the Relevant TSO and specifies the Reactive Power Capability at Maximum Capacity.

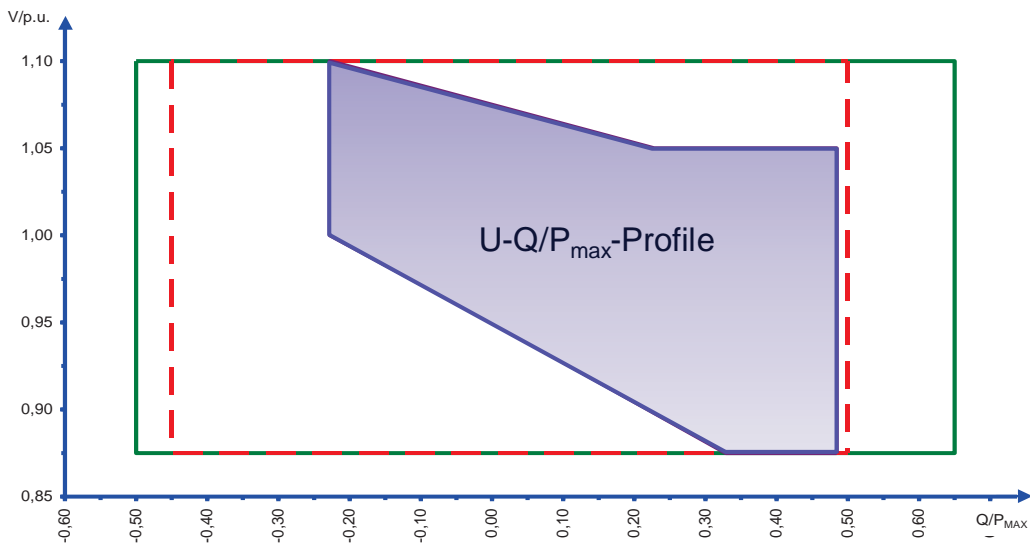


Figure 5: U-Q/P_{max}-profile of a Synchronous Power Generating Module at Maximum Capacity

The Reactive Power Capability of Power Park Modules at Maximum Capacity is defined following the same principle.

While the Reactive Power Capability for Synchronous Power Generating Modules below Maximum Capacity is defined by the possible operating points in the P-Q Capability Diagram of the Alternator a different approach is needed for Power Park Modules, for which a P-Q/P_{max}-diagram is introduced (Figure 6).

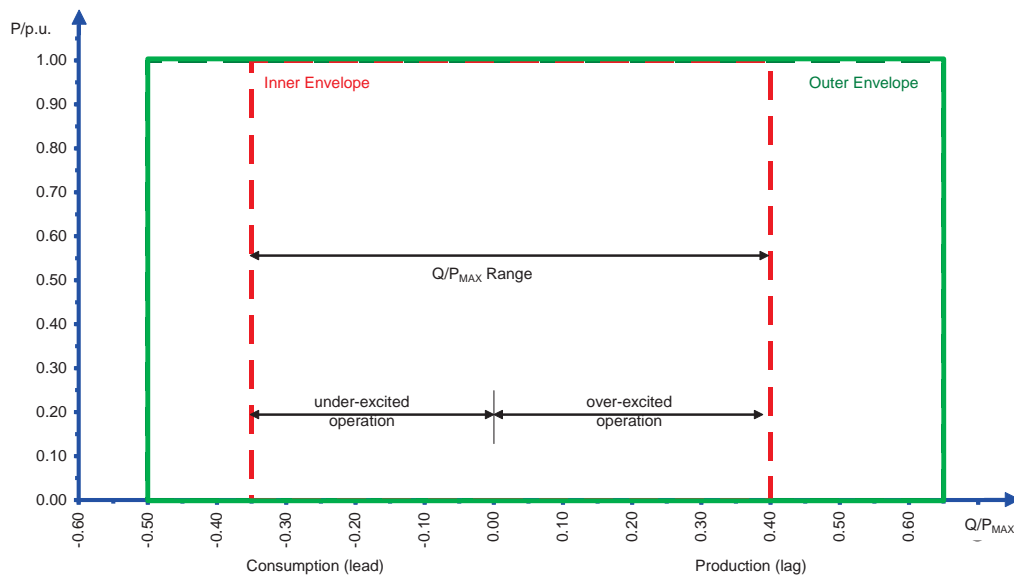


Figure 6: P-Q/P_{max}-diagram below Maximum Capacity

The same principle like above applies when defining the Reactive Power Capability by a specific P-Q/P_{max}-profile. The outer green envelope again shall be understood as an outer limitation and does not represent the actually required Reactive Power range. Within this outer envelope an inner envelope is defined per synchronous area. This inner envelope shall have a P-range of 1 pu and a Q/P_{max}-range as specified by the Network Code.

The final $P-Q/P_{max}$ -profile shall be defined by each Relevant Network Operator in coordination with the Relevant TSO inside the inner red envelope. It can be of any particular shape (e.g. rectangle, parallelogram) with regard to its specific local needs, but with a P-range of 1 pu at zero Reactive Power.

The following example (Figure 7) illustrates the definition a specific $P-Q/P_{max}$ -profile to specify the Reactive Power Capability of a Power Park Module below Maximum Capacity in the Continental Europe synchronous area. The size of the red inner envelope is defined according to the Network code by a Q/P_{max} -range of 0.75 and it is positioned inside the red outer envelope. The shape and the position of the blue $P-Q/P_{max}$ -profile is chosen by the Relevant Network Operator in coordination with the Relevant TSO and specifies the Reactive Power Capability below Maximum Capacity.

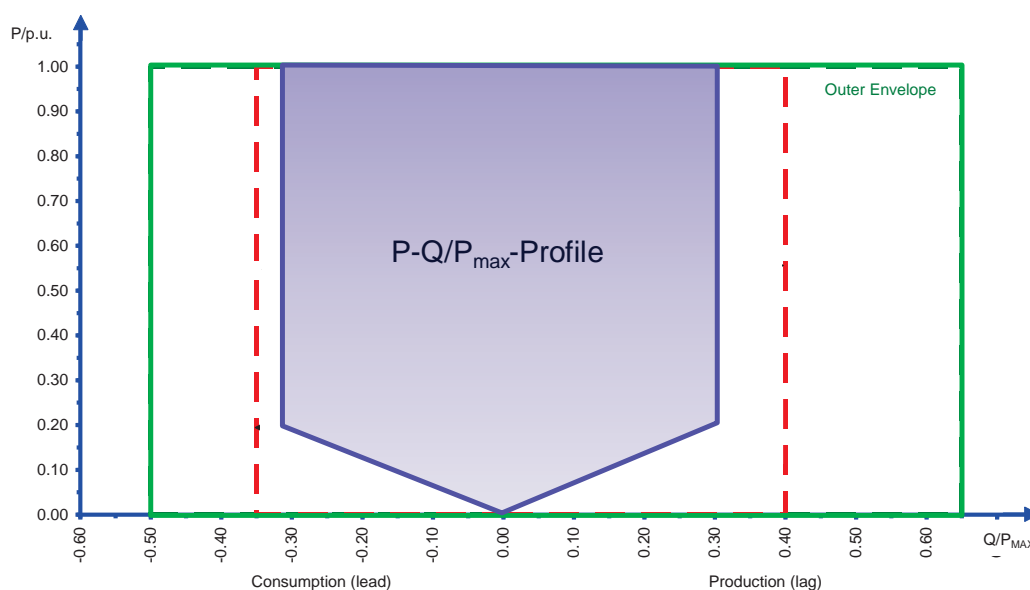


Figure 7: $P-Q/P_{max}$ -profile of a Power Park Module below Maximum Capacity

Answer to FAQ 23:

Why do you not refer to primary, secondary and tertiary response?

In the different synchronous areas in Europe different control schemes are implemented with the aim to maintain and restore system frequency to its nominal value. The Continental Europe synchronous area (former UCTE), for example, has established the provision of primary, secondary and tertiary response, which differs from the scheme applied in the Great Britain synchronous area. The different schemes have in common, that they make use of the capability of Power Generating Modules to operate in **“Frequency Sensitive Mode” (FSM)**⁸ and **“Limited Frequency Sensitive Mode” (LFSM)**⁹ respectively which are both included in the network code requirements. These define the capabilities of Power Generating Modules to increase or decrease active power output in response to frequency deviations from the nominal value to improve frequency stability. Therefore on this level the relevant capabilities can be determined for all synchronous areas regardless of the specific implemented control scheme.

⁸ Frequency Sensitive Mode (FSM) is a Power Generating Module operating mode which will result in Active Power output changing, in response to a change in System Frequency, in a direction which assists in the recovery to Target Frequency, by operating so as to provide Frequency Response

⁹ Limited Frequency Sensitive Mode (LFSM) – is a Power Generating Module operating mode which will result in Active Power output reduction/increase in response to a change in System Frequency above/below a certain value.

Answer to FAQ 24:

What is the technical background for setting the network code's Fault-Ride-Through requirements?

ENTSO-E recognizes the urgent need that both Synchronous Power Generating Modules and Power Park Modules (PPM) should remain stable and connected to the network when faults occur on the transmission network, in particular in order to avoid frequency instability. This is known as fault ride-through capability (FRT) and it is an emerging requirement, in particular for TSOs with a high penetration of distributed generation.

The FRT requirements are based on a voltage-against-time profile at the Connection Point, which reflects the worst voltage variation during a fault and after its clearance (retained voltage during a fault and post-fault voltage recovery) which is to be withstood. Power Generating Modules have to stay connected to the grid for voltages above these worst-case conditions and shall continue stable operation after a Secured Faults on the network. Specific provisions are given in the network on the coordination with the Power Generating Module's protection scheme.

Due to the limited impact of failures at the distribution levels on power system security, both Synchronous Power Generating Modules and PPMs have to fulfil less stringent requirements during the voltage drop. They will however have to withstand a voltage drop that results from a fault at the higher (transmission) voltage levels. Different voltage-against-time-profiles for Synchronous Power Generating Modules and PPMs are applied in order to make best use of the different technical capabilities of the generation technologies.

A number of reasons justify the FRT capability:

- Security of supply must be ensured. Every power system is designed to withstand a maximum sudden loss of generation capacity after system faults. However, if Power Generating Modules connected to healthy circuits do not remain connected and stable during and after a fault, a considerable amount of generation may be lost even after a secured fault. This results in the potential loss of generation connected to healthy circuits with the consequence of losing the maximum designed infeed loss, the impact being the collapse of system frequency.
- If FRT capability is not applied the ability to connect such generation sources to the system in the future becomes substantially limited.
- It must be ensured that as a result of a voltage drop and during the voltage recovery phase, the auxiliary and control supplies of the Power Generating Modules do not trip.
- An essential requirement is the ability of the generating plant to restore active power on fault clearance. Whilst the ability to remain connected is important it is essential that there is no significant drop in active power output exported to the system once the fault has been cleared.

Large scale wind power and other distributed generation integration into power system operation gives rise to new challenges for the entire system and for TSOs in particular. As certain forms of renewable generation emerges, there is an increased risk that faults on the transmission system (which lead to low voltages spread across large geographical areas around the point of the fault during the period of the fault) may lead to the disconnection of large amounts of generation. The massive loss of generation after a normal fault leads to more severe disturbances, i.e. frequency collapse in a synchronous area causing demand tripping and unexpected power flows resulting in overloads both on internal transmission lines and tie lines with neighbouring systems possibly leading to cascading tripping, system splitting, load shedding, major faults, brown outs and even black outs. It should be noted that power systems have been designed to withstand a maximum loss of generation (usually the largest unit, crucial interconnectors etc). Although, the transformers between the transmission and distribution system will limit the voltage drop seen on the distribution system for a transmission system fault, the effect of increased levels of distributed generation will need to be tolerant to system faults, especially where the total installed volume of embedded generation at a grid supply point exceeds the maximum designed generation loss.

In order to design and assess the FRT capability of the single Power Generating Module each TSO shall define

the pre-fault and post-fault conditions for the fault ride through capability in terms of:

- conditions for the calculation of the pre-fault minimum short circuit capacity at the Connection Point;
- conditions for pre-fault active and Reactive Power operating point of the Power Generating Module at the Connection Point and voltage at the Connection Point; and
- conditions for the calculation of the post-fault minimum short circuit capacity at the Connection Point .

The FRT requirements are defined at the Connection Point (CP). Therefore in principle compliance needs to be demonstrated at the CP. For some countries this may contrast with an existing compliance process in which FRT compliance is dealt with through a type testing process. The movement of focus to the CP could therefore lead to significantly more complex and hence costly engineering studies to prove compliance on a project by project basis.

To avoid this wherever possible, it is anticipated that type tests of single Power Generating Modules in a PPM will continue. The challenge is testing against what voltage profile, as none is defined in the network code for PPMs at the individual Power Generating Module level. It is possible to determine a worst case voltage withstand curve for an individual Power Generating Module in a PPM from the national chosen voltage withstand curve, taking into account the retained voltage across the minimum impedance between the CP and the Power Generating Module. All Power Generating Modules in a PPM compliant with this worst case curve can avoid the sometimes complex studies of calculating retained voltage up to the CP for the tested conditions.

As there is a degree of national choice in the withstand curve (tables 3.1, 3.2, 7.1 and 7.2) it is challenging to define testing at a European level. The details of the compliance process are determined at a national level rather than at a European level. Any manufacturer testing against the most challenging version of the voltage withstand envelope will however be compliant throughout Europe. Failure of a type of Power Generating Module in a PPM to achieve this most challenging requirement does not mean that it is not compliant. It only means it has more work to do to demonstrate compliance, maybe even for an individual project. Therefore more studies will have to be undertaken.

Example explaining FRT capability as required by the network code:

The FRT requirement for a Type B PPM is chosen. A TSO can specify a voltage-against-time profile for FRT capability based on a parameterized curve (Figure 8) as prescribed in Art. 9(3). A set of 8 parameters are to be set by the Relevant TSO which for a Type B PPM needs to be within the range of Table 3.2 of the NC RfG. This parameterization allows to create a voltage-against-time profile which is within the shaded area of Figure 9.

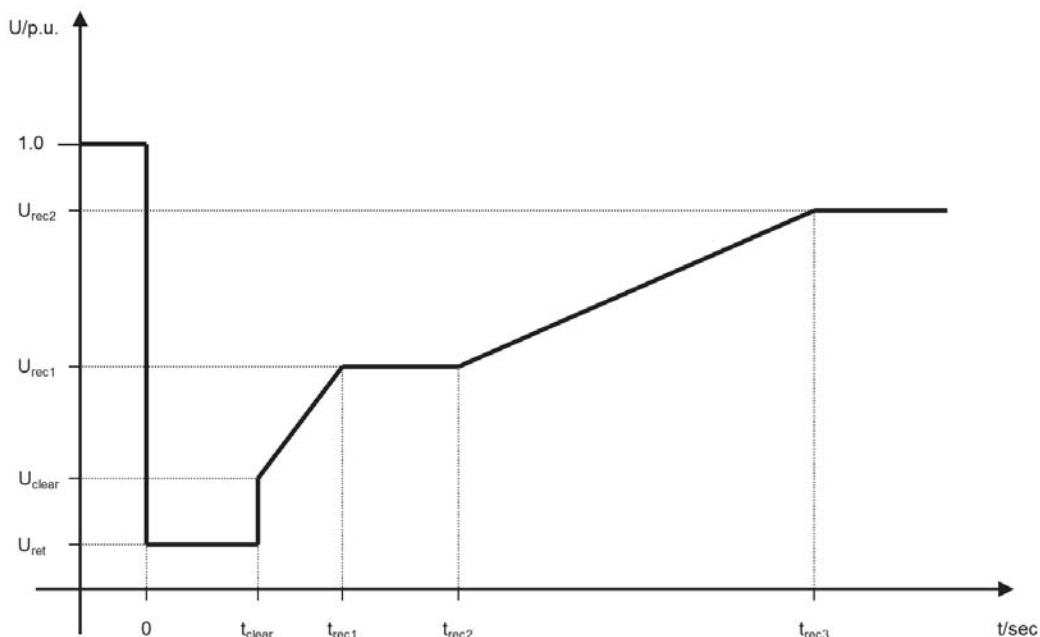


Figure 8: Generic voltage-against-time curve in the NC RfG FRT requirements based on 8 parameters

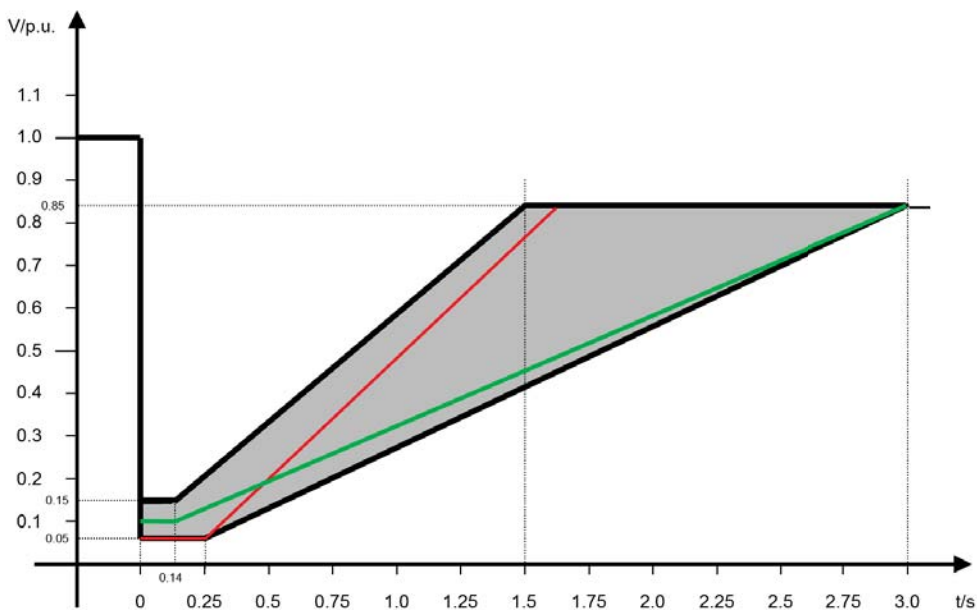


Figure 9: Area (grey) within which a voltage-against-time curve can be defined by the TSO for a Type B PPM, e.g. the given green or red curve

If we consider the green profile, the PPM shall stay connected to the network and continue stable operation when the actual course of one of the three phase-to-phase voltages on the network voltage level at the Connection Point which sustains the lowest retained voltage during a symmetrical fault (actual voltage recovery curve) remains above the green line.

In case of an actual voltage recovery curve of the shape given in the figure below, the PPM shall not disconnect because the voltage recovery curve remains above the voltage-against-time-profile defined by the TSO (Figure 10).

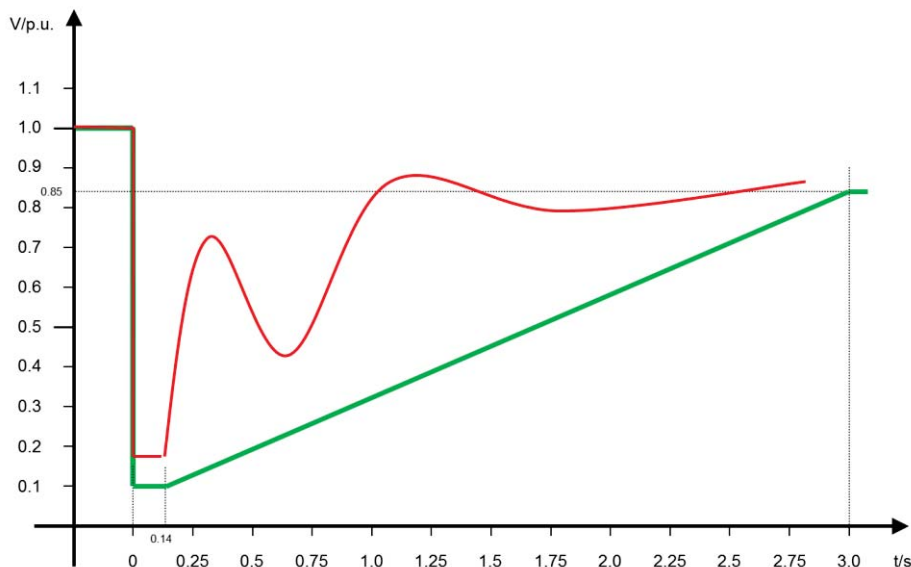


Figure 10: Case in which the recovery voltage (red curve) remains above the defined voltage-against-time curve (green curve) and because of which automatic disconnection of the Power Generating Module is not allowed.

In the second case given in Figure 11, the voltage recovery curve is below the voltage-against-time-profile. Hence, the PPM is allowed to disconnect from the grid in this case.

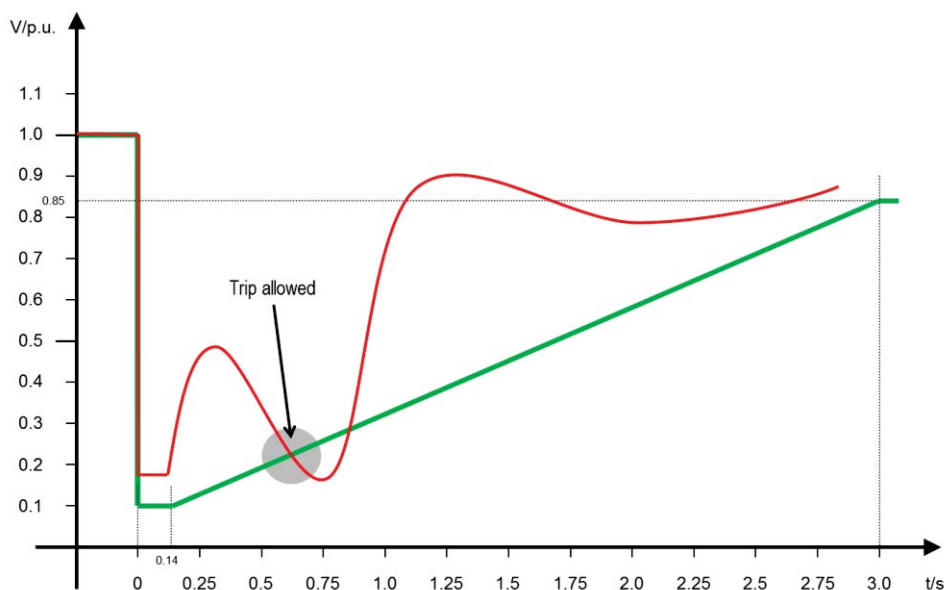


Figure 11: Case in which the recovery voltage (red curve) goes lower than the defined voltage-against-time curve (green curve) and because of which automatic disconnection of the Power Generating Module is allowed.

It has to be understood that the TSO is **not** requiring the actual voltage recovery curve to be of the shape of the voltage-against-time-profile. It needs to be clear that the actual voltage recovery curve will have a free controlled response during the post-disturbance recovery period that will strongly depend on both the PPM technology (e.g. full converter, doubly-fed...) and the short circuit power of the grid connection point. The voltage-against-time-profile just expresses the lower limit for the actual voltage recovery curve for FRT capability.

Answer to FAQ 25:

Why is synthetic inertia needed by some TSOs?

In meeting the EU energy policy targets regarding security of supply, frequency stability is a major topic. Maintaining frequency stability is particularly challenging when the balance between supply and demand is suddenly disturbed, for instance from a large change in available generation to support the demand. This can occur from the loss of a large generator which is reasonably common or a system split which is a lot less common.

In a system where synchronous generators are predominant, at the instance of a large generation trip, the remaining synchronous generation tends to resist the subsequent change in speed (inertia) to restore balance. Wind turbines under the most common configurations, as well as PV generation, do not contribute to this as their mechanical inertia is decoupled from the system. In high wind conditions, particularly when combined with modest demand, some synchronous zones either have already experienced or expect to experience in the foreseeable future based on planned / contracted connections a very high proportion of the total generation to be sourced from generation which is unable to contribute to System Inertia.

A major system study carried out for the Irish System Operator Eirgrid concluded that there is a limit to the instantaneous wind penetration while maintaining frequency stability. It defines this limit to be somewhere between 60 and 70% for the Irish system. As both the Irish and the Great Britain synchronous areas expect to experience conditions when wind generation alone exceeds total demand of the synchronous area on some days in the year, and most European countries are expecting particularly high penetration levels of wind generation in the coming years¹⁰, to maintain the security of the system three alternative options (from an engineering point of view) could be envisaged:

1. Put in place an upper limit for RES penetration (e.g. the capacity likely to give 60% instantaneous non-synchronous generation penetration).
2. During high wind periods, non-synchronous generation (pre-dominantly wind in most systems) should be constrained down/off and replaced through balancing services by synchronous generation constrained on.
3. Require a technical means of replicating the inertia of synchronous plant (fast supply, e.g. in 200ms of a large but short injection of power proportional to the severity of the disturbance). This means is described as synthetic inertia.

The first two options are very costly from a societal and financial point of view. The second one has been employed in some cases and should continue to do so where most economical (including adequate cost representation of greenhouse gas consequences). The TSOs in Ireland and GB have already contracted for connections which at certain times (unless constrained) will exceed 60% penetration. The network code allows for the third option. It is expected that synchronous areas with potential for such high instantaneous non-synchronous generation (e.g. >60%) will require such a solution. Therefore, early action should be taken to add an additional control function for the converters in order to deliver synthetic inertia and/or fast frequency response capability. The requirements have to be carefully balanced to avoid internal wind turbine stability issues. Work has been done with the wind industry towards this goal.

It is not suggested that this added level of complexity is justified for the smallest installations, such as those described in the network code as Type A and Type B.

The technical solution of implementing inertia requirements for those Power Generating Modules which do not naturally provide inertia¹¹ is still under development. The two main options under consideration are:

- A form of synthetic inertia providing a power increase proportional to the rate of change of frequency

¹⁰ See ENTSO-E's Ten-Year Network Development Plan at www.entsoe.eu

¹¹ In the context of this code, this refers to the technologies for which Alternator speed and system Frequency are decoupled.

- Delivering a fast frequency response in which the response starts early and in which the full response is delivered in a short time.

To facilitate the second option, should this become the preferred method of contributing to “inertia”, TSOs are allowed to specify reaction and delivery times shorter than what is required for frequency response, taking into consideration generation technologies without Inertia (see Table 5, t_1 and t_2).

Answer to FAQ 26:

Why is Power Quality out of the scope of this code?

The term power quality is related to the degree of the distortion of the real grid voltage from the ideal sinusoidal wave. If the real grid voltage has the shape of an ideal sinusoidal wave, power quality is best. The more it differs, the worse power quality becomes. Bad power quality means a high degree of harmonics, flicker and voltage dips. These distortions can lead to malfunctioning of some grid users, but do not bear the risk of a wide-spread danger to system security. In contrast to other issues (e.g. voltage or frequency stability), the impact of power quality problems is limited to local customers.

Countermeasures against power quality problems are for example the introduction of filters, grid separation into “dirty” and “proper” parts or the increase of short circuit power by modified topology. For all these countermeasures, local circumstances have to be considered carefully.

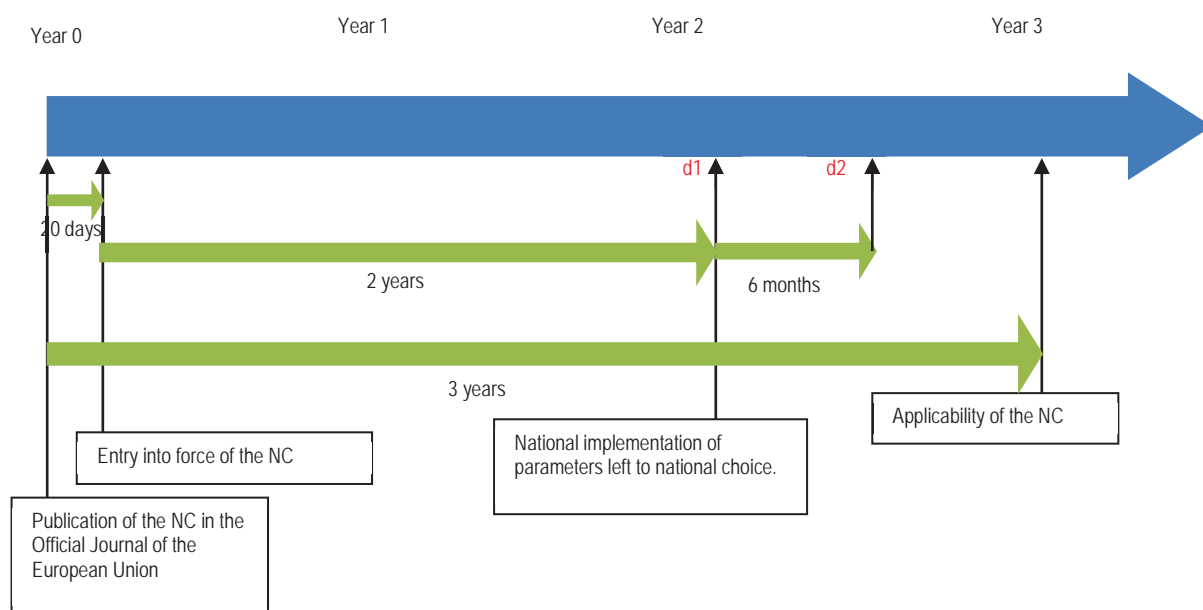
Both, the impact of and the countermeasures against power quality problems, can be solved on a local basis and therefore have to be considered as a local issue which is not covered by this code.

Answer to FAQ 27:

What happens after the entry into force of the code? Which users will be considered as new or existing?

This network code defines how its entry into force as well as its applicability will take place. To illustrate the process from publication to application, the diagram below has been made, focusing on the important dates:

- Publication
- Entry into force
- Implementation of national choices while respecting the provisions of Article 4(3)
- Applicability of the code to new users



Two dates are also illustrated in the diagram, **d1** and **d2**. These dates are highlighted because they are used as reference in Article 3(4) to make an unambiguous distinction between New and Existing Power Generating Modules.

The users can be divided into different categories:

- those who have **a connection before d1**, are considered as **existing**;
- those who have **a binding and final contract before d1**, who provide it to the RNO before **d2** and for whom the existence, relevance and finality of the **contract is validated by the NRA**, will be considered as **existing**;
- those who have a binding and final contract before **d1** and **do not provide it to the RNO before d2** will be considered as **new**; and
- those who **do not have any binding and final contract before d1** will be considered as **new**.

As written in the code, the provision of this network code generally applies to new Power Generating Modules only, see article 3(2) for application to existing Power Generating Modules.

Answer to FAQ 28:

Should nuclear power plants be exempted from parts of the NC RfG requirements in order to ensure nuclear safety?

Nuclear safety is paramount.

System security for the transmission network is one significant component in delivering nuclear safety. Noticeably, providing a firm electrical supply for cooling pump motors is one such example. The critical value in keeping these pumps running was highlighted at Fukushima in the 2011 event. It is therefore important that the electrical power system supports nuclear plant activity, even following rare but severe system events.

One successful example of this occurred in England when power supply to the nuclear cooling pump motors was maintained even when the system frequency fell below 47.5Hz in an islanded part of the GB system (South West) which included the nuclear power station.

To achieve continuity of electrical power supply including to nuclear power stations, it is essential that all generation plants including nuclear Power Generating Modules are designed to cope simultaneously with their network system security responsibilities as defined in this network code (supplemented at a national level) as well as their plant safety responsibilities.

The first new nuclear plants to be classified as new Power Generating Modules under this network code are according to EUR (the European LWR nuclear power plant owners' association) expected to continue to operate to 2080. The European political goals for energy in the longer term therefore have to be considered. The aspiration for a nearly CO₂ free electricity generation by 2050 is clearly relevant. This is expected to involve operation of entire synchronous areas for extended periods based on RES and nuclear plants alone. New nuclear Power Generating Modules therefore have to be capable of performing adequately (as defined by NC RfG) in the context of future system challenges. This includes greater variability in terms of the generation technology mix with time, including variations arising from wind and sun.

Nuclear based Power Generating Module designs must allow for compliance with the requirements of the NC RfG to ensure their status as "fit for purpose". In particular this has to include various forms of robustness (e.g. FRT capability) and balancing capability including that covered by the Frequency Sensitive Mode. Furthermore the nuclear site licences have to facilitate use of these capabilities.

Clearly, this design challenge has to be dealt with alongside the paramount challenge of nuclear safety. Stakeholders representing the manufacturers of nuclear plants (in particular their design experts) have been engaged in consideration of this network code.

It should also be noted that at the end of an extensive consultation period with deep and constructive engagement, recent feedback from manufacturers confirmed that the requirements of the network code are in general technically feasible. It is important that the developers / owners builds on this position, by specifying and delivering capabilities in line with the network code and ensuring appropriate nuclear site safety licensing are achieved.

Safety is critical for other types of Power Generation Plant as well, just like it is for the transmission system itself. Industry operational codes typically give the power plant owners the right to do what is needed to protect its plant and to ensure safety, shut down if necessary. For example a generator with major vibration on its rotor will be allowed to do what is necessary, which may mean unplanned shut down to ensure safety of personnel and plant. For nuclear power generation, the same principle applies, the necessary operational actions is facilitated by the industry framework.

The answer to the Frequently Asked Question is therefore:

General exemptions from this network code are not justified. The NC RfG capabilities must be delivered while designing for nuclear safety. For case specific arguments an in-depth analysis may be pursued via the derogation procedure.

Answer to FAQ 29:

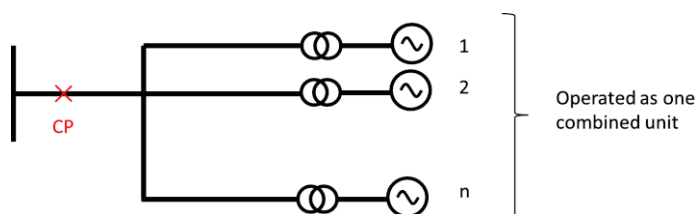
What are typical examples of a Power Generating Module and Power Park Module scheme, and how is the definition of Connection Point to be interpreted?

The NC RfG provides the following definitions:

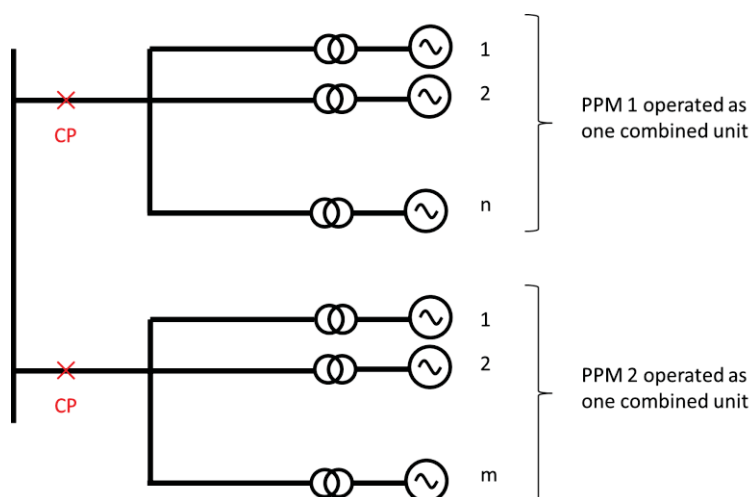
- **Connection Point** - is the interface at which the Power Generating Module is connected to a transmission, distribution or closed distribution Network according to Article 28 of Directive 2009/72/CE as identified in the Connection Agreement.
- **Power Generating Module** - is either a
 - Synchronous Power Generating Module, or
 - a Power Park Module.
- **Synchronous Power Generating Module** - a Synchronous Power Generating Module is an indivisible set of installations which can generate electrical energy. It is either a
 - a single synchronous unit generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network, or
 - an ensemble of synchronous units generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network with a common Connection Point, or
 - an ensemble of synchronous units generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network that cannot be operated independently from each other (e. g. units generating in a combined-cycle gas turbine facility), or
 - a single synchronous storage device operating in electricity generation mode directly connected to a transmission, distribution or closed distribution Network, or
 - an ensemble of synchronous storage devices operating in electricity generation mode directly connected to a transmission, distribution or closed distribution Network with a common Connection Point.
- **Power Park Module (PPM)** - any unit or ensemble of units generating electricity, which
 - is connected to the Network non-synchronously or through power electronics, and
 - has a single Connection Point to a transmission, distribution or closed distribution Network.

Some examples of PGM/PPM conceptual schemes with an indication of the most common understanding of the Connection Point are given for clarification. It is noted that the definition of Connection Point for avoidance of doubt refers to the Connection Agreement between Network Operator and Power Generating Module Owner for binding terms and is subject to national practices, rules and regulations.

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

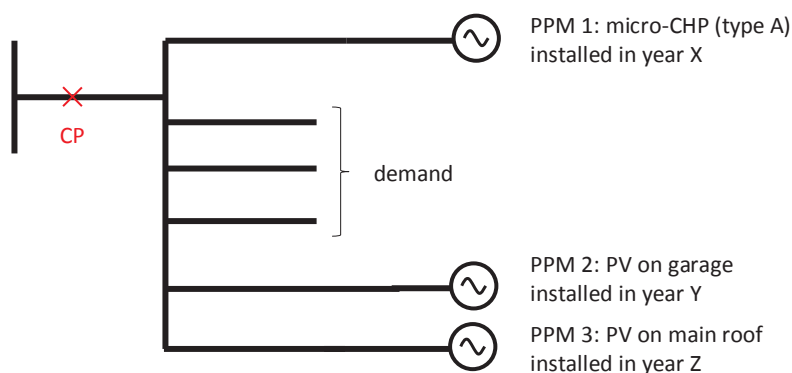


b. Two PPMs in a wind farm

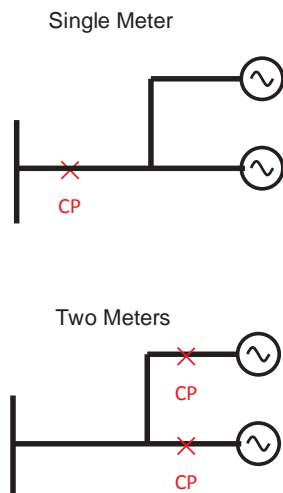


c. Illustration of multiple stages of domestic generation

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.

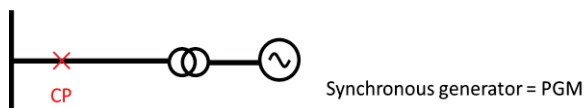


d. Illustration of one or two CPs for Household Facility:

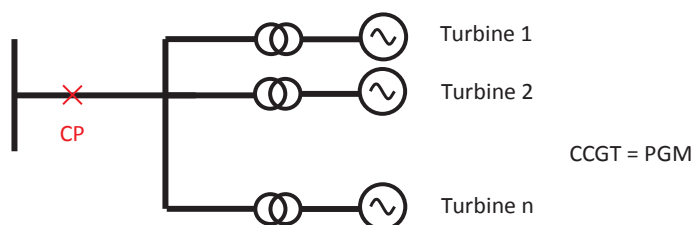


2. Power Generating Module

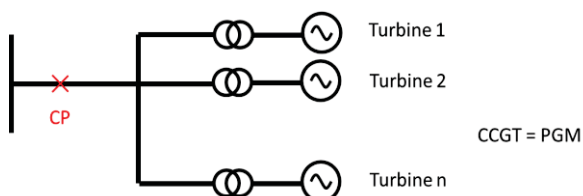
a. Synchronous generator



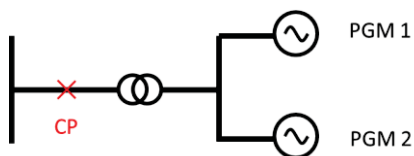
b. PPM



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

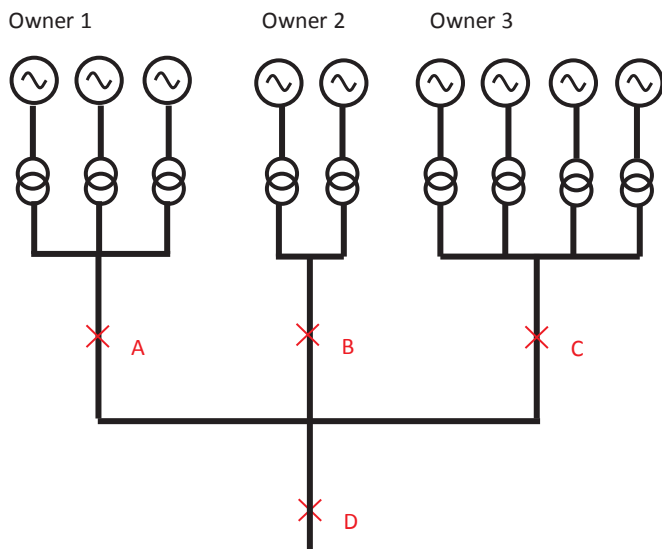


d. Ensemble of synchronous units – controlled separately and shared transformer. Because both are controlled separately, both are a PGM.

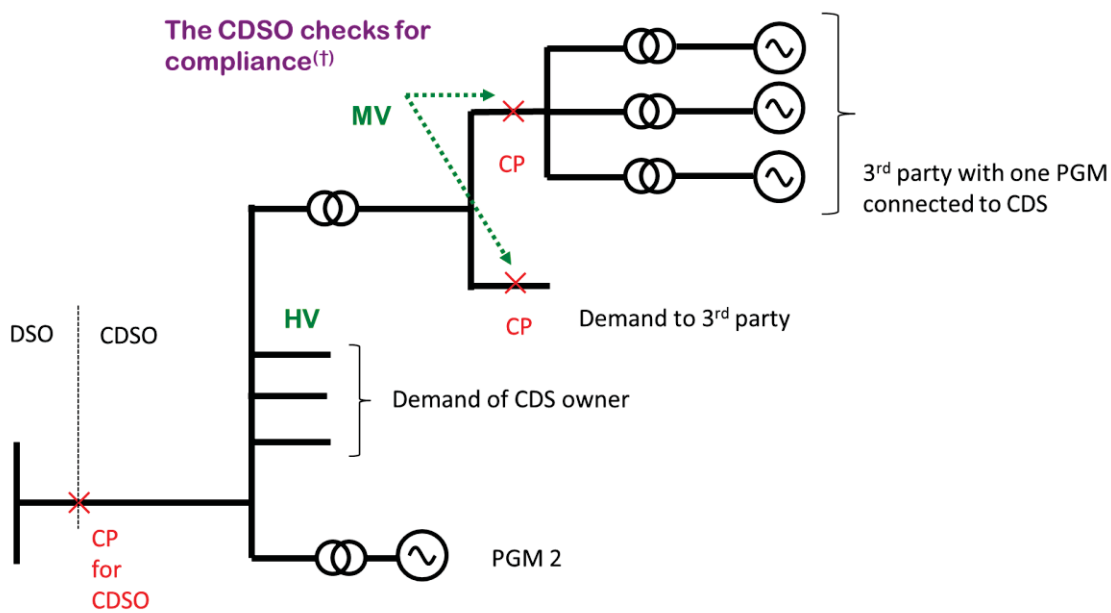


3. Several wind/PV farms sharing a connection to the DSO

- 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.



4. Closed Distribution System Operator (CDSO)



The DSO checks for the compliance^(*)

(*)The DSO checks for the compliance of PGM 2 against NC RfG and direct CDS owner demand against the Demand Connection Code

(†)The CDSO checks for compliance of third party generation against RfG and demand against the Demand Connection Code