SPECIFIC TECHNICAL PRESCRIPTIONS REGARDING POWER-GENERATING PLANTS OPERATING IN PARALLEL TO THE DISTRIBUTION NETWORK

edition 2.1

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Legend color code in the margin (indicative)

No color code	Applicable to all power-generating plants, unless otherwise indicated in the text.
Blue margin	Applicable only to small power-generating plants (see definition in § 4.1.7).
Blue dotted margin	Not applicable to small power-generating plants (therefore applicable to all plants, except to small one according to the definition in § 4.1.7).
Orange margin	Applicable only to power-generating plants > 250 kVA.

1 General provisions

1.1 Subject

This document C10/11 lays down the technical requirements relating to the connection of power-generating plants capable to operate in parallel to the distribution network. The objectives of this document are the following:

- ensuring proper operation of the distribution networks;
- improving the safety of staff active in these networks;
- protecting the distribution network's infrastructure;
- and contributing to the general system stability.

1.2 Legal, normative and sectoral framework

This document is particularly based on the following reference documents:

- The European Regulation (EU) 2016/631 of the European Commission, dated 14 April 2016, also known as « NC RfG ».

  This document covers the national implementation of this European Regulation by the Belgian DSO's. Where a paragraph of this document is related to NC RfG, the corresponding article of NC RfG is mentioned in the title of this paragraph. This does not exclude that the requirements of that paragraph may sometimes be more stringent than what is required by the NC RfG, in particular in the context of the management of the local distribution network.

  The power limits considered for application in the scope of this regulation are the following :

  - Type A : $0{,}8\ \mathrm{kW} \leq P_{MAX}^{Capacity} < 1\ \mathrm{MW}$
  - Type B : $1\ \mathrm{MW} \leq P_{MAX}^{Capacity} < 25\ \mathrm{MW}$

- The standard EN 50549-1 : Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network – Generating plants up to and including Type B
- The standard EN 50549-2 : Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network – Generating plants up to and including Type B

In addition, other prescriptions apply, but these fall outside the scope of this document. Examples are:

- The Belgian GREI;
- Regional technical regulations regarding the distribution of electricity;[1]
- Normative documents, including:

[1] Bruxelles-Capitale Region : « Le règlement technique pour la gestion du réseau de distribution d'électricité en Région de Bruxelles-Capitale et l'accès à celui-ci »
Walloon Region : « Le règlement technique pour la gestion des réseaux de distribution d'électricité en Région wallonne et l'accès à ceux-ci »
Flemish Region : « Technisch Reglement Distributie Elektriciteit »

- HD 60364-7-712 : « Electrical installations of buildings – part 7-712 : Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems »;
- The Power Quality emission standards.

- The Synergrid prescriptions not specific to a power-generating plant. These may be obtained from the DSO and are also available on the Synergrid website (www.synergrid.be). The website is only available in Dutch and French. Within the context in this topic, the main prescriptions are as follows:
  - For a power-generating plant operating in parallel with the low-voltage distribution network:
    - C1/107 « Prescriptions techniques générales relatives au raccordement d'un utilisateur au réseau de distribution BT » (French) ; « Algemene technische voorschriften voor de aansluiting van een gebruiker op het LS-distributienet » (Dutch) ; [General technical prescriptions regarding the connection of a user on the LV distribution network].
    - C10/19 « Raccordement des charges perturbatrices en basse tension » (French) ; « Aansluiten van storende belastingen in laagspanning » (Dutch) ; [Connecting disturbing loads in low voltage].
  - For a power-generating plant operating in parallel with the high-voltage distribution network:
    - C2/112 « Prescriptions techniques applicables aux installations raccordées au réseau de distribution haute tension » (French) ; « Technische voorschriften voor aansluiting op het HS-distributienet » (Dutch) ; [Technical prescriptions reagrding connection to the HV distribution network].
    - C10/17 « Prescriptions Power Quality pour les utilisateurs raccordés aux réseaux haute tension » (French) ; « Power Quality voorschriften voor netgebruikers aangesloten op hoogspanningsnetten » (Dutch) ; [Power Quality prescriptions reagarding system users connected to high-voltage networks].

In case of contradiction between these Synergrid prescriptions C10/11 and a legislative document, the latter prevails. This rule applies also to all other Synergrid prescriptions referred to in the present document.

General remark: In the context of this document, it is assumed that the distribution system user (DSU) is also the owner of the installation concerned. The C10/11 prescription thus makes no distinction between both. Where this is not the case, the DSU is the unique point of contact for the DSO, and as such the only responsible party for the correct execution of this C10/11 prescription: the DSU must see to it that all impositions that apply on the owner of the installation are respected.

1.3 Derogations

1.3.1 Derogations from the NC RfG provisions

Derogations from one or more provisions from the NC RfG that were granted by the regulatory authorities according to the procedure foreseen in the Title V of the NC RfG may impact the application of the current C10/11. Indeed, such derogation will prevail.

Any derogation from the application of the NC RfG must be granted in accordance with the detailed procedure in the NC RfG, as well as the criteria set by the regional regulators[2].

1.3.2 Derogations other than the derogations from the NC RfG

The DSO may approve derogations from these technical prescriptions C10/11.

[2] These criteria are specified in the document « CRITERES POUR L'OCTROI DE DEROGATIONS AUX DISPOSITIONS DES CODES DE RESEAU RFG, DCC ET/OU HVDC » of the 4 Belgian energy regulators, dated 20 April 2017

These derogations must always be authorized in writing and may:

- relate to both new power-generating plant and modifications of existing power-generating plants;
- be of a general nature (eg. for specific power-generating technology) or be granted to a specific power-generating plant.

The applicant of the derogation must submit a written dossier to the DSO, giving a clear description of the deviation that is applied for, together with the necessary supporting documents for the application that may or may not be accepted by the DSO after consultation with Synergrid and approval by the regional regulators. The general principles governing the granted or refused derogation will be published on the website of the relevant DSO and / or Synergrid.

1.3.3 An emerging power-generating technology [NC RfG Art 66]

In application of Article 66 of the NC RfG, the power-generating modules making use of an emerging power-generating technology could obtain a transitional arrangement.

The resulting derogations will prevail on the relevant requirements of C10/11.

1.4 Additional prescriptions of the DSO

Every DSO can impose additional requirements in addition to the Synergrid prescription C10/11 which need tp be approved by the relevant regulator. Each DSO makes these “additional prescriptions of the distribution system operator (DSO)” available on its website. Furthermore, hyperlinks to these documents will be available on the Synergrid website (www.synergrid.be).

1.5 Additional prescriptions by the DSU

The DSU might want to take specific measures (for example, by installing additional protection devices) that may be needed to ensure proper operation of the power-generating plant, or to protect all or part of the latter..

If such specific measures contradict the prescriptions included in this document, these must be submitted to the DSO for approval.

2 Scope of application

2.1 General

Without prejudice to the specific cases mentioned in §2.2 hereunder, this document is applicable to all power-generating plants downstream from a connection to the distribution network:

- that is considered being new of adapted as described in chapter 3 ;
- which is technically capable to operate in parallel with the distribution network (without limitation regarding the duration of this operation in parallel) ;
- with a maximum power below 25 MW (which is de limit used to distinguish type B and type C plants according to the Belgian application of the European Regulation (EU) 2016/631 of the Commission[3]) ;
- without limitation regarding the nominal voltage level of the distribution network the plant is connected to ;
- without limitation regarding the voltage level with which the power-generating unit itself is connected to the local network of the distribution system user (DSU) (low-voltage or high-voltage) ;
- without limitation regarding the connection's energy balance ("net consumption from" or "net injection to" the distribution network ;
- without limitation regarding the possibility of actually injecting energy to the distribution network ; this means, for example, that this document is also applicable to power-generating plants equipped with a zero export relay. In fact, the latter operate in parallel to the distribution network and may therefore influence its operation, even if they do not physically inject energy to the distribution network ;
- without limitation regarding the nature of the energy source feeding the power-generating unit (a primary energy like oil, gas or biofuel, hydro energy, wind energy, solar energy, etc., or other sources such as batteries);
- without limitation regarding the technology used (rotating machinery, static conversion, etc.) ;

For the purposes of this document, energy storage systems (as specified in Chapter 4) that are technically capable of operating in parallel with the network are considered as full-fledged power-generating unit. Unless otherwise indicated, the totality of the requirements stated in this technical prescription is therefore applicable to them, whether or not they are associated with other electricity generating devices.

This document is not applicable to the following cases:

- Back-feeding loads (for example elevators or cranes) that are not in principle designed to generate electrical energy.
- Back-up power systems (including systems equipped with energy storage batteries) that are technically not capable to inject energy into the distribution network. These systems can therefore only feed loads that are downstream of the backup power system.
- Local island operation, both wanted and unwanted, where not a single part of the distribution network is involved.
- Off-grid power-generating units. These are power-generating units operating in a local islanding mode and therefore never operate in parallel with the distribution network. If they feed (a part of) the DSU plant that can be connected to the distribution grid, the transfer between on-grid and off-grid mode has to be realized using a break-before-make principle.

[3] According to decisions of the regional regulators. The references of these decisions are the following; DECISION-20181116-73 (Brugel), CD-18k16-CWaPE-0245 (CWaPE) et BESL-2018-108 (VREG)

- Power-generating modules of type C or type D according to the Belgian implementation of European Regulation (EU) 2016/631 of the Commission. Where appropriate, the connection to the distribution network of power-generating plants with type C modules will be dealt with on a case-by-case basis taking into consideration requirements defined by the TSO according to this Belgian implementation.

The following topics fall outside de scope of these technical prescriptions:

- The financial impact of the application, connection and exploitation of a power-generating plant; refer to the regional regulations for more information.
- The energy measurement; it is important to consult the Distribution System Operator (DSO) for more information.

2.2 Special cases

2.2.1 Backup power system [NC RfG Art 3 2.(b)]

A power backup system (as specified in § 4.1.9) will only operate in parallel with the distribution network for a short time in the following sporadic cases:

- During testing carried out during commissioning or during maintenance of the backup power system itself and of all the elements that may have an impact on the changeover to or from the island operation;
- For a short duration during normal operation of the distribution network.
- In case of an actual changeover to or from an island operation in case of network faults (make before break). This momentary in-parallel operation may occur in following situations:
    - Just before the island operation where the load is taken over by the backup power system. The backup power system is then first connected with the load which is still connected to the distribution network. After a short time, the combination of backup power system and load is then disconnected from the distribution network to enable island operation,
    - Just after the island operation when the load is again taken over by the distribution network. The island with the backup power system and its load are then first connected with the distribution network before the backup power system is disconnected from the distribution network.

The conditions for parallel operation are outlined in Table 1 below.

Moreover, each occurrence of operating in parallel must also be registered in a log that is to be made available to the DSO upon request.

Parallel operation during maintenance or commissioning tests [4]	Parallel operation while the distribution network is in normal operating state	Parallel operation in case of an actual changeover to or from an island operation following a disturbance on the network
• Maximum duration of in-parallel operation : 60 minutes[5] • Maximum frequency: monthly • No significant simultaneity if multiple backup power systems are tested. • No intentional simultaneity with disturbances on the network • No parallel operation in view of providing a service	• Maximum duration of in parallel operation : a total of 5 minutes per calendar month[6]	• Maximum 5 minutes per changeover

Table 1 – Conditions on parallel operation for backup power systems

In these technical prescriptions, where an exception is granted for such backup power systems or where specific technical requirements apply, this will be explicitly specified in the text by means of this icon in the marge.

If infringement of one or more of these requirements is determined, the DSO will give the DSU the option to choose between the following measures:

- The DSO will regard the power-generating unit as a regular power-generating plant without applying the exceptional measures that normally apply to a backup power system.
- In parallel operation of the power-generating unit with the distribution network is rendered impossible at all times.

2.2.2 Changeover to local island operation with critical loads

As described in ANNEXE D (in particular D.5 and D.6), a power-generating plant, operating in parallel with the distribution network during normal exploitation, is obliged, in case of certain disturbances on the network, to remain connected to the distribution network and to offer a certain degree of support to this network.

However, exceptions as described in the subsections hereafter may apply.

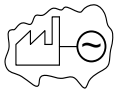
[4] These conditions are in line with those applied for backup power systems with combustion engine that are subject to Technical Instruction T013/IA « Veilig installeren en veilig gebruik van medische uitrustingen Deel IA : Elektrische aspecten : voorschriften voor het ontwerp en de realisatie van veilige elektrische installaties in medisch gebruikte ruimten » (Dutch) or « Guide de consignes de sécurité relatives à l'installation et l'utilisation des dispositifs médicaux Partie IA : Aspects électriques : Guide de consignes de sécurité pour la conception et la réalisation d'installations électriques dans les locaux à usage médical », (French). [Safe installation and safe use of medical equipment, Part IA : Electrical aspects : regulations regarding the design and realization of safe electrical systems on premises for medical use],edition 9/2014, available through www.ceb-bec.be, which are described in § 7.5.3 of this technical instruction.

[5] This also covers the annual durability test. The emergency group must have reached its nominal operating temperature within those 60 minutes with a load of 50% and 100% of its nominal power.

[6] This 5 minute value is in line with the criterion used in the NC RfG Art2. (b) to define the scope.

Note: notwithstanding authorization to disconnect from the distribution network in specific cases, the power-generating plant must comply with the technical prescriptions C10/11.

2.2.2.1 Critical industrial plants [NC RfG Art 6 3.]



In specific cases, the DSO, in coordination with transport system operator (TSO) can grant an exception and allow a power-generating module to disconnect from the distribution network in case of a network fault where support normally is required.

This derogation is granted only to power-generating modules that are disconnected from the distribution network to guarantee in island mode the supply of critical loads in order to maintain an industrial process on the relevant site.

A DSU who wants to apply for this exception must submit a written application for evaluation by the DSO in accordance with the TSO.

Upon acceptance, the eligibility conditions for disconnection will be determined in the connection contract between the DSU and the DSO.

2.2.2.2 Installations for medical use

A specific legal framework exists for installations for medical use.

More details on the conditions for a changeover to island mode of such installations can be found in the CEB-BEC technical note T 013/IA (in its 2014 edition, chapter 6.5.1).

2.2.3 Combined heat and power generation (CHP) in an industrial site [NC RfG Art. 6 4.]

In general, a CHP generating module falls within the scope of these technical prescriptions. Where such a power-generating module is concerned, special attention must be given to a number of requirements relating to the modulation of the power of the power-generating module.

Therefore, it is possible the DSU must take additional measures to ensure the power-generating plant complies with these requirements, particularly if the CHP facility has a rigid link between the demand for heat and the generation of electrical energy. Examples of such measures are the use of a buffer for heat storage or a brake chopper to dissipate any excess of electrical energy.

In line with article 6.4 of the NC RfG, some exemptions are applicable to CHP modules embedded in networks of industrial sites for which all of the criteria listed in this article 6.4. are met[7]. Within the scope of C10/11, the only Section affected is :

- D.9.2 Reduction of active power on set point [NC RfG Art 14 2.]

A DSU who wants to apply for this exception must submit a written application for evaluation by the DSO, in coordination with the TSO.

2.2.4 A power-generating unit connected to a closed distribution system (CDS)

Power-generating units that are connected to a closed distribution system (or an equivalent system according to the legislation in force) that, on its turn, is connected to a distribution network, are within the scope of these technical prescriptions C10/11. Indeed, such power-generating units operate in parallel to the distribution network.

However, a certain number of articles of the NC RfG address the role of the « relevant system operator » which is, in this specific case, the closed distribution system operator (CDSO) and not the DSO.

[7] The key criteria are:
– the CPH module's primary purpose is to produce heat for production processes of an industrial site
– heat and active power generation of this CHP module are inextricably interlinked.

If, in application of the NC RfG, the CDSO has introduced Requirements of General Application, a certain number of C10/11 requirements can be impacted. However, some of these capabilities are also needed by the DSO, for the management of the distribution network to which the CDS is connected, regardless of the requirements specified by the CDSO. This hereafter identifies the requirements that can be impacted and specifies the related minimal requirements as needed by the DSO.

2.2.4.1 NC RfG compliance assessment and related homologation

The NC RfG specifies it is the task of the CDSO to assess the compliance of a power-generating module with the NC RfG requirements.

The C10/11 homologation requirements are also applicable to power-generating plants connected to a CDS except for those aspects for which the CDSO has introduced diverging Requirements of General Application.

2.2.4.2 Settings RoCof-type LoM type protection (NC RfG Art 13 1. (b))

According to NC RfG art 13.1. (b), the CDSO may specify the Loss of Mains (LoM) protection triggered by Rate of Change of Frequency (ROCOF).

Nevertheless, as this setting also impacts the management of the distribution system, coordination with the DSO, who will do this in coordination with the TSO, is required.

The settings of the interface protection must comply with the requirements of the DSO, the requirements being the result of coordination between the DSO and the TSO.

In line with NC RfG Art 13 1. (b), additional Loss of Mains (LoM) protection triggered by Rate of Change of Frequency (ROCOF) can be required by the CDSO.

2.2.4.3 Allowance for automatic connection (NC RfG Art. 13 7.)

According to the NC RfG Art 13 7., the CDSO can specify whether automatic connection is allowed or not. The conditions that must be fulfilled for automatic connection are specified by the TSO.

As the DSO allows automatic connections and the conditions set by the TSO, have general application, there is no conflict with the distribution system management.

2.2.4.4 Allowance for automatic reconnection (NC RfG Art. 14 4.(b))

According to NC RfG Art 14 4.(b), the CDSO can specify whether automatic reconnection is allowed of not. The conditions that must be fulfilled for automatic reconnection are specified by the TSO.

As the DSO allows automatic reconnections and the conditions, set by the TSO, have general application, there is no conflict with distribution system management.

2.2.4.5 Protection schemes and settings (NC RfG Art. 14-5(b))

According to NC RfG Art. 14-5(b), the CDSO can specify the protection schemes and settings with relevance to the protection of the network.

As the requirements regarding the protection schemes and settings in C10/11 are defined with relevance to the distribution network, they must at least be complied with at the connection point with the DSO network, regardless of the settings and schemes specified by the CDSO.

2.2.4.6 Information exchanges (NC RfG Art. 14-5(d))

According to the NC RfG Art.14-5(d), the CDSO can specify the capabilities of the power-generating plant to exchange information.

As the requirements in C10/11 regarding communication and remote control are relevant for distribution network management, at least at the connection point with the DSO network, the power-

generating plant must comply with the requirements of C10/11 regarding communication and remote control, regardless of the requirements set by the CDSO.

2.2.4.7 Reactive power capabilities (NC RfG Art 17-2(a) and Art 20-2(a))

According to NC RfG 17-2(a) and 20-2(a), the CDSO has the right to specify the capabilities regarding reactive power.

Reactive power exchanges are also relevant for the management of the distribution network. If the requirements regarding reactive power exchange capabilities of the CDSO are less stringent than those of the C10/11 prescription, the latter must at least be respected at the connection point with the DSO network.

2.2.4.8 Fast fault current (NC RfG Art 20-2 (b et c))

According to NC RfG articles 20-2 (b) and (c), The CDSO has the right to specify the capabilities of non-synchronous power-generating module (Power Park Module) regarding fast fault current.

The activation of such capabilities must be done in coordination with the DSO.

3 Validity

This edition of C10/11 applies to:

- All new power-generating plants for which the reference date is after 01.11.2019 *[publication date of this document + 2 months]*. The 'reference date' is:
  - For a small power-generating plant (as specified in § 4.1.7) : the date mentioned on the inspection report of the authorized inspection body (see step 4 in of § 5.3 of this document) ;
  - For another plant: the date of the declaration of receptivity by the DSO of an in-principle application introduced by a DSU (see step 1 of § 5.2 of this document).
- All existing power-generating plants that are modified after 01.11.2019 *[Publication date of this document + 2 months]* (for example, expansion of the installed maximum power, or replacement of an interface protection, an inverter or another important part of the power-generating plant)[8]. In this case, the applicability of this edition of the technical prescription C10/11 is limited to the requirements to which this modification relates. Each modification must be notified to the DSO in writing, accompanied by the necessary documentation about the modification.

Exceptions :

1. For power-generating modules < 1 MW, an additional transition period will be granted for the paragraphs D.6.2, D.7.1 and D.8 (only for the requirements for reconnection after tripping of the interface protection relay): these requirements will only be mandatory for power-generating plants for which the reference date is 1 May 2020 or later.

2. For the power-generating modules ≥ 1 MW, an additional transition period will be granted only for paragraph D.6.2 : these requirements will only be mandatory for power-generating plants for which the reference date is 1 May 2020 or later.

3. For the homologation procedure in chapter 5 (i.e. step 1 for a Simplified process for a small power-generating plant in §5.3, or step 0 for the Standard process described in §5.2), an additional transition period is granted until and including 30 April 2020: A declaration of honor of the manufacturer will be accepted by Synergrid in anticipation of the introduction of the test reports established by an independent laboratory (accredited following ISO/IEC 17025) and/or the certificates issued by a certification instance following ISO/IEC 17065, and, if applicable, the necessary simulation reports.

   - This exception is not applicable to the underlying technical requirements: the power-generating plant itself must be compliant to the current edition of C10/11, barring the exceptions (1) and (2) aforesaid.
   - At latest on 1 May 2020, all necessary test reports and certificates must be in possession of the DSO without any exception.

4. The existing power-generating plants modified after 01.11.2019 *[Publication date of this document + 2 months]*, within 10 years after their first commissioning and where the modification relates to the replacement of an equipment by an identical or similar model (insofar it has no impact on the maximum power of the installation and that its technical characteristics remain at least on the sale level). In this case, these prescriptions C10/11 do not apply to the modified equipment, except for the settings in ANNEXE C. Modifications must be notified to the DSO in writing, accompanied by the necessary documentation.

[8] The replacement of an overcurrent protection (circuit breaker, fuse) is not covered here.

It is recommended to have existing power-generating plants, within the technical and economic possibilities of the power-generating plants, comply with the conditions specified in this document. Modifications must be notified to the DSO in writing, accompanied by the necessary documentation.

4 Definitions and acronyms

4.1 Definitions

4.1.1 Distribution network

An electrical distribution network managed by a distribution network operator.

> Note: in the context of this document, a local transport network, a regional transmission network and a closed distribution system (CDS) are not considered a distribution network.

4.1.2 Low-voltage (LV) distribution network

An electrical distribution network with a voltage whose nominal RMS value is Un ≤ 1 kV.

4.1.3 High-voltage (HV) distribution network

An electrical distribution network with a voltage whose nominal RMS is Un > 1 kV.

4.1.4 Power-generating plant

All of the power-generating modules connected to a same connection point to the distribution network, including auxiliaries and all equipment required for them to be properly connected to the distribution network.

4.1.5 Power-generating module

A power-generating module is:

- or a park of non-synchronous generators (Power Park Module), this is all the non-synchronous power-generating units connected to a common connection point ;
- or a synchronous power-generating module (synchronous generator), this is an indivisible set based on a synchronous power-generating power unit

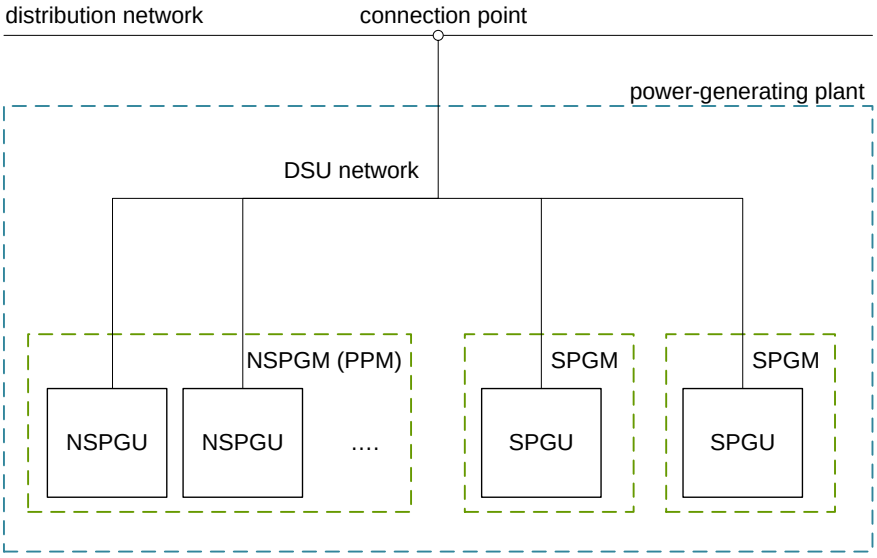
> Note: For individually operated synchronous power-generating units, each of the unit will be considered as a separate module. If more than one synchronous power-generating units are not individually operated (e.g. when common master controller is applied), they will be considered as being part of the same module.

4.1.6 Power-generating unit

Indivisible set of equipment that can generate electric energy independently and which can feed this energy into a distribution network

> Note 1: For example, a combined cycle gas turbine (CCGT) consisting of a gas turbine and a steam turbine, or an installation consisting of an internal combustion engine (ICE) followed by an organic Rankine Cycle (ORC) machine are each considered to be a simple power-generating unit.
>
> Note 2: When a production unit is a combination of technologies leading to different requirements, this must be settled on a case-by-case basis.
>
> Note 3: A power storage system operating in power-generating mode and connected on its AC side to a distribution network is considered to be a production unit.
>
> Note 4: A distinction is made between non-synchronous power-generating units (i.e. that are connected in a non-synchronous way to the distribution network) and synchronous power-generating units (i.e. that are connected in a synchronous way to the distribution network.

- Examples of non-synchronous power-generating units:
    - converter connected power-generating units (including DFIG)
    - asynchronous machines
- Examples of synchronous power-generating units:
    - directly coupled synchronous machines



with :
NSPGU: non-synchronous power-generating unit
SPGU: synchronous power-generating unit
NSPGM: non-synchronous power-generating module (PPM = Power Park Module)
SPGM: synchronous power-generating module

Figure 1 – Clarification of terms power-generating unit, module and plant

4.1.7 Small power-generating plant

A power-generating plant that meets all of the following conditions.

1. Power limit of power-generating units

   The sum of the maximum power of all the power-generating units cannot exceed the limits as indicated in the Table 2 hereunder.

	Connection to the low-voltage distribution network		Connection to the high-voltage distribution network
	Single phase connection to the distribution network	**Three-phase connection to the distribution network**	
Sum of the power of the power-generating units other than the possible energy storage systems	≤ 5 kVA[9]	≤ 10 kVA	≤ 10 kVA
Sum of the power of the energy storage systems	≤ 5 kVA[10]	≤ 10 kVA	≤ 10 kVA

Table 2 – Maximum power limits for a small power-generating plant

2. Automatic separation system

   Each power-generating unit must be equipped with an automatic separation system[10].

   This automatic separation system can be either integrated in the power-generating unit itself (which is generally the case), or external to it. When using an external system,

   - it must have a "single fault tolerance" according to EN 50549-1, and
   - it must be of a type approved by Synergrid, as listed in the C10/21 list of Synergrid published on the website www.synergrid.be in the section 'Homologated materials'.

   An external automatic separation system can protect different power-generating units, but this requires additional cabling.

3. If presence of an energy storage system: use of an EnFluRi sensor

   If the power-generating plant includes an energy storage system, an EnFluRi sensor must be provided to control the power injected on the distribution network. The EnFluRi sensor is a directional power sensor having a communication link with the energy storage system. The sensor and its control system have to be certified for their compliance with the relevant requirements in the FNN Hinweis 'Anschluss und betrieb von Speichern am Niederspannungsnetz[11]'.

   Note: As long as conformity assessment by a certified body is not available on the market, an assessment based on a manufacturer's declaration of compliance can be used.

4. No particular case

   The exceptions foreseen for particular cases as described in §2.2. do not apply to the power-generating plant.

4.1.8 Maximum power

Maximum AC power that the power-generating plant/module/unit could generate.

[9] Some DSO's allow a higher capacity. In that case the applicable limit will be clearly specified on the website of the DSO concerned.

[10] According to the GRIE, it is not necessary to provide a permanent accessible means of isolation to the DSO if an automatic separation system is used.

[11] This document can be downloaded on the website of VDE FNN (https///www.vde.com/de/fnn)

If this power is expressed in VA, it is the maximum apparent power. If this power is expressed in W, it is the maximum active power.

Unless otherwise indicated in the text:

- The maximum power of a power-generating plant is equal to the sum of the maximum power of all the power-generating units in the power-generating plant, including the energy storage systems.
- The maximum power of a power-generating module is equal to the sum of the maximum power of all the power-generating units that are part of it.

For a power-generating unit, the maximum AC power is indicated on its nameplate and/or its data sheet.

Examples:

- For a photovoltaic plant, this would be the maximum AC power the converter is designed for under normal operating conditions.
- For a motor-generator set, this would be the maximum apparent power of the generator.

Any limitation of the maximum power (e.g. by software of firmware) to a value other than the one indicated on the nameplate and/or in the data sheet, is not considered to determine the maximum power of a power-generating unit.

4.1.9 Backup power system

A power-generating unit that:

- is technically capable to operate in parallel with the distribution network,
- and whose sole purpose is to feed an island that is disconnected from the distribution network,
- but which must be able to operate in parallel with the distribution network for a short time in sporadic cases

4.1.10 Energy storage systems

A unit capable of extracting electrical energy from a network of an DSU or a distribution network, storing it and rendering it independently the nature of the technical implementation of that unit.

Note:

- An energy storage system that have the possibility to inhibit power injection into distribution network by software (with the exception of a non-parametric firmware out of the factory out of the factory) is considered being technically able to supply energy to the distribution network and therefore covered by this definition.
- A direct current connected energy storage system with another means of power-generation is considered a non-synchronous power-generating unit.

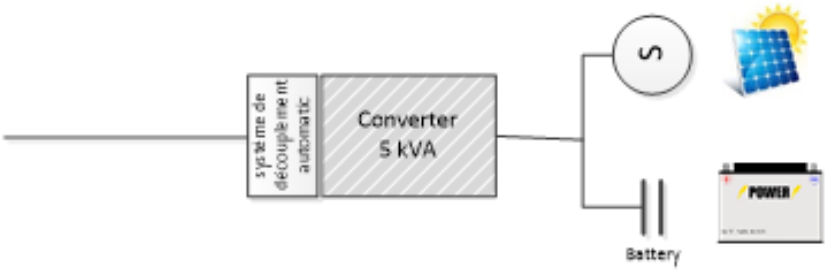


Figure 2 – Example of a DC-connected energy storage system

4.2 Acronymes

CEB	Comité Electrotechnique Belge [Belgian Electrotechnical Committee]
DFIG	Double Fed Induction Generator
EnFluRi	EnergieFlussRichtung = Direction of the energy flow
DSO	Distribution System Operator
CDSO	Closed Distribution System Operator
TSO	Transmission System Operator
LoM	Loss of Mains
NC RfG	Network Code on Requirements for Generators = European Regulation (EU) 2016/631
OVRT	Overvoltage Ride Through
PGMD	Power Generating Module Document
PLC	Power Line Communication
PPM	Power Park Module
CDS	Closed Distribution System
GREI	General Regulations for Electrical Installations
RoCoF	Rate of Change of Frequency = df/dt
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
RCS	Ripple Control Signals
DSU	Distribution System User
UVRT	Undervoltage Ride Through

Table 3 - Acronyms

5 Procedure for commissioning and decommissioning

5.1 General

This procedure covers in a more specific and goal oriented way the operational notification procedure provided in the NC RfG [article 30 for type A and articles 30 and 32 for type B].

For power-generating modules of type A, the installation document of the NC RfG is represented here by the technical dossier. For power-generating modules of type B, the power-generating module document (PGMD) from the NC RfG is also represented here by the technical dossier.

The use of conformity certificates, as mentioned in the NC RfG, is contained in the homologation procedure and thus the use of homologated material.

The standard process for commissioning and decommissioning is described in §5.2.

For the particular case of a small power-generating plant (as specified in § 4.1.7), it is recommended to apply the simplified procedure described in §5.3.

5.2 Standard process

The process from planning a new power-generating plant to effective commissioning, and ultimately decommissioning, is illustrated by the diagram below.

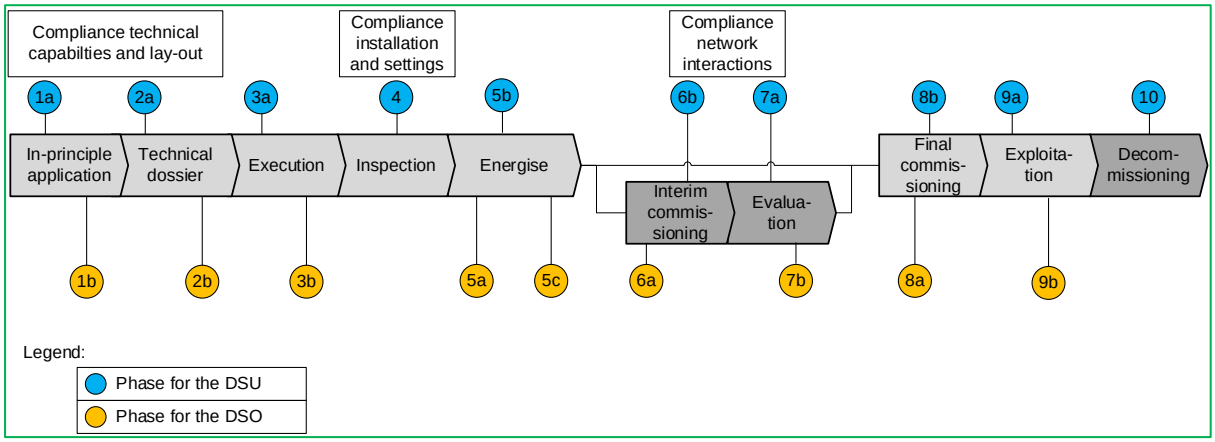


Figure 3 – Standard process for commissioning a power-generating plant

Before the power-generating plant is fully commissioned and operates in parallel with the distribution network, the DSU must have the DSO's written authorization. The authorization in the shape of a Final Operation Notification is required for each separate power-generating module. The process to be followed is illustrated in Figure 3 and is elaborated further in the following steps hereunder.

Steps 1 and 2 may be executed simultaneously. Steps 6 and 7 only apply in particular situations.

STEP 0 : Preliminary step – Generating units must have been homologated

The DSU must ascertain whether his power-generating unit type is included in the relevant list, published on the website www.synergrid.be under the heading « Gehomologeerde materialen » (Dutch) or « Matériels homologués » (French) [Homologated materials]. This list contains the various types of power-generating units for which the manufacturer has provided Synergrid with the official documents that are required where the homologation procedure is concerned.

If the type of power-generating unit has not (yet) been included in his list, the manufacturer or importer should follow the homologation procedure for inclusion on the relevant list of C10/26. More information about the homologation procedure is included in ANNEXE B.

STEP1 : In-principle application

The first step entails the DSU submitting an in-principle application in writing to the DSO (STEP 1a). The DSU fills in the appropriate (digital) application form that the DSO makes available on his website.

The completed application form must be submitted to the DSO. The information contains at minimum the following elements (non-exhaustive):

- Identification of the point of connection on the distribution network where the power-generating module is planned
- The planned commissioning date
- The maximum active power of the power-generating plant in kW
- The maximum apparent power of the power-generating plant in kVA
- The type of primary energy

- The maximum injection capacity desired by the DSU (and therefore also its possible intention to limit this power injected into the distribution network)
- The contact details of the DSU

The DSO evaluates each application separately and based on the specific circumstances. The evaluation is based on at least the following:

- the technical characteristics of the power-generating module (for example the maximum power);
- the characteristics of the connection of the DSU's system to the distribution network;
- the characteristics of the distribution network[12] with which the power-generating module would operate in parallel.

After analysis and upon acceptance, the DSO will provide the DSU with a written in-principle authorization for further elaboration of the requested project and the DSO provides the connection prescriptions determined by the regional regulations regarding the distribution of electricity[13].

Within the limits of the power foreseen in the regional technical regulation, the evaluation may result in the decision to connect the power-generating plant to another point of connection (for example to a high-voltage distribution network rather than low-voltage, or to a high-voltage distribution network with a higher voltage or direct connection to a transformer station or the local transport or transmission network).

If the request is denied, the DSO must notify the DSU of the reasoning behind the decision in writing, taking into account the provisions in the regional regulations. He will also notify the relevant regional regulator by transmitting to them a copy of the reasons of the refusal.

STEP 2: Technical dossier en network study

In this step, the DSU must supplement the data regarding the in-principle application with a set of mainly technical data. The DSU fills in the appropriate (digital) application form that the DSO makes available on his website.

The data of the in-principle application can be updated if necessary. The completed application form as well as any supplemental information must be submitted to the DSO. Supplemental to the data on the in-principle application, the information contains at minimum the following elements (non-exhaustive):

- the exact references of the Synergrid homologated material that will be installed, as they appear in the lists published on the Synergrid website (www.synergrid.be)
- the connection diagram indicating the connection of the power-generating unit(s) at the power-generating plant (including the measuring and control circuits of the protections and any applicable signaling and control circuits to the SCADA system of the DSO through the RTU).
- le cas échéant, les détails concernant les moyens techniques proposés pour limiter la puissance injectée dans le réseau de distribution.

[12] In addition to the characteristics of the network, the possible presence of other power-generating plants is a feature of the network. Consequently, for a request concerning several power-generating units (involving or not different connection points), the evaluation will concern both the individual and the common aspects.

[13] Walloon region: Le règlement technique pour la gestion du réseau de distribution d'électricité en Région wallonne et l'accès à celui-ci
Region Bruxelles-Capitale : Le règlement technique pour la gestion du réseau de distribution d'électricité en Région de Bruxelles-Capitale et l'accès à celui-ci
Flemish region : Technisch Reglement Distributie Elektriciteit

- an implementation diagram indicating all components of the power-generating plant up to the point of connection (for example in was of the presence of other buildings and/or more power-generating modules on the site, this diagram indicated on/in which building module(s) is(are) situated ;
- in the case of wind turbines, a simulation model of the electrical operation of the power-generating unit that meets de requirements of IEC 61400-27-1 ;
- for a connection to the high-voltage distribution network, the elements of the technical dossier as specified in the technical prescriptions C2/112 of Synergrid ;
- the contact details of the power-generating module installer.

The DSO evaluates each technical dossier separately and based on the specific circumstances. In addition to the criteria used where the in-principle application is concerned, this evaluation is based on:

- the power-generating plant's compliance with the requirements in these technical prescriptions C10/11.
- the power-generating plant's compliance with the special exploitation prescriptions imposed by the DSO.

Upon acceptance, the DSO will provide the DSU authorization for realizing the requested project in writing. The DSO will also provide:

- the settings for the protection equipment (interface protection relay, synchroscope);
- where appropriate, the means for limiting the injection into the distribution network and its settings.

If the dossier is incomplete or non-compliant, the DSO will specify to the DSU in writing the elements to be completed or modified in its technical file.

STEP 3: Execution

The DSU can take the necessary actions to have the power-generating module installed in accordance with the authorization provided by the DSO (STEP 3a).

During execution, the DSU must immediately notify the DSO in writing if the actual realization (as-built) deviates from the information included in the technical dossier. The appropriate supplemental technical information must also be submitted to the DSO. If necessary, the latter will re-evaluate the provided authorization for realizing the requested project.

In accordance with the authorization provided by the DSO, certain actions may have to be taken by the DSU during the execution (STEP 3b). These actions may for example relate to the setting parameters of the interface protection relay or, in some cases, to installation of material for remote signaling or monitoring through the RTU of the DSO.

When the technical realization has been completed, the DSU will notify the DSO in writing.

STEP 4: Inspection

The DSU must subject the power-generating plant to the following conformity inspections:

- Inspection of compliance with the General Regulations for Electrical Installations GREI). This inspection is performed by an authorized body. The list of authorized inspection bodies for electrical systems is available on the website of FPS Economy.

- Inspection of compliance with the DSO's connection prescriptions. This inspection is performed by the DSO or a party mandated by the DSO, the list of which is available on the Synergrid website (www.synergrid.be). The inspection will focus on:
    - o the major characteristics of the power-generating module (including the installed maximum power);
    - o compliance with the connection diagram;
    - o accessibility of the means of isolation ;
    - o evaluation of the interface protection system, entailing:
        - checking the characteristics (brand, type, correspondence of serial number with test report) and verification whether the real settings of the interface protection relay are in accordance with the setting values provided by the DSO;
        - checking correct operation of the interface protection relay for each of the functions (normal operation and backup operation), including reporting using a test report that complies with the model report available on the Synergrid website.

      To enable this review, the DSU will submit the connection diagrams of these protection devices to the body in charge of this inspection.
    - o where appropriate, review of the settings of the export protection relay;
    - o where appropriate, review of the injection limit value managed by the power control system;
    - o where appropriate, review of the settings of the power imbalance protection relay ;
    - o review of the system for parallel connection (where appropriate, including the present of the synchrocheck relay);
    - o other reviews relating to any specific exploitation conditions).

In case of any infringement, the power-generating plant shall be modified and then reinspected.

The inspection report free of infringements must be submitted to the DSO in order to complete the technical file.

STEP 5: Energize

The DSO evaluates whether the plant can be energized. (STEP 5a).

Upon acceptance, the DSO allows the DSU to energize his power-generating plant and any associated emergency equipment through the connection with the distribution network that has been determined as point of connection (STEP 5b).

If the authorization is denied, the DSO will notify the DSU in writing of the items to be modified in its plant.

When energized, the following checks will be performed under supervision of the DSO (STEP 5c) :

- a functional test of the interface protection system where, through (simulation of) interruption of the power supply, it will be ascertained whether the interface protection relay is activated and opens the interface switch;
- where appropriate, check of the settings of the synchrocheck relay;
- where appropriate, check of the remote control functions

If these checks have a positive result, the next step is a final authorization to commissioning (STEP 8) or an interim authorization (STEP 6) if additional evaluations are still required.

STEP 6: Interim commissioning

If additional evaluations are necessary, the installation procedure follows the optional track with an interim authorization delivered by the DSO (STEP 6a).

Examples of further evaluations are:

- Supplemental measurements or tests necessary to demonstrate the power-generating plant's compliance with the prescriptions. These measurements are supplemental to any submitted certificates when compiling the technical file.
- Evaluation of power quality emissions.

The interim authorization lists the elements that need further evaluation.

This interim authorization temporary authorizes the DSU to operate the power-generating unit (STEP 6b) in view of further evaluations.

STEP 7: Evaluation

For the purpose of this evaluation, the DSU must provide the DSO with the supplemental data (STEP 7a) determined in the interim authorization that will be evaluated by the DSO (STEP 7b). If this evaluation is positive, the next step is a final commissioning (STEP 8).

In the case of a negative evaluation, the DSO will have to notify the DSU in writing of the decision and the reasoning behind it. The DSO will also communicate its decision to prolong the interim authorization or to withdraw it.

STEP 8: Final commissioning

The DSO delivers a final authorization in writing to the DSU (STEP 8), authorizing the latter to commission the power-generating unit through the connection to the distribution network.

STEP 9: Exploitation
STEP 9a: Exploitation by the DSU

The power-generating plant must be managed in accordance with the technical prescriptions C10/11.

The DSU must immediately notify the DSO if the power-generating plant (even if temporary) does not comply with the prescriptions specified in these technical prescriptions C10/11. This may be the case when, for example, certain components fail.

The DSO will evaluate the non-compliance and agree on the appropriate measures with the DSU.

As described in chapter 3, the technical prescriptions C10/11 also apply to modifications of existing power-generating plants. Any change to the power-generating plant must, therefore, be submitted to the DSO in writing, accompanied by the necessary documentation. In the case of an expansion of the maximum power, the commissioning procedure must be followed.

STEP 9b: Check by DSO

In case of non-compliance of a DSU's power-generating plant or irregularities on the distribution network, the DSO reserves the right to check the proper operation and the operating modalities of the power-generating plant (or to have these checked).

If such a check shows that the (operation of the) power-generating plant does not comply with C10/11, then:

- the DSU will bear the costs of this check ;
- the DSO will notify the DSU in writing of the conditions for further operation of the power-generating module. A Limited Operational Notification may be granted or, in extreme cases, the authorization can be entirely withdrawn or suspended, in the respect of the regional regulation in force
- the DSU can take appropriate action(s) determined by the nature of the infringements and repeat the commissioning procedure.

STEP 10 : Decommissioning

When a power-generating module is permanently decommissioned, the DSU, or a by the DSU mandated third party, must notify the DSO in writing. This notification must be done within 15 working days following the decommissioning.

5.3 Simplified process for a small power-generating plant

This simplified process can be applied only to a power-generating plant that meets all the criteria of a small power-generating plant, as specified in § 4.1.7. If not, the general process described in § 5.2 above must be applied

The simplified process is illustrated in the figure below.

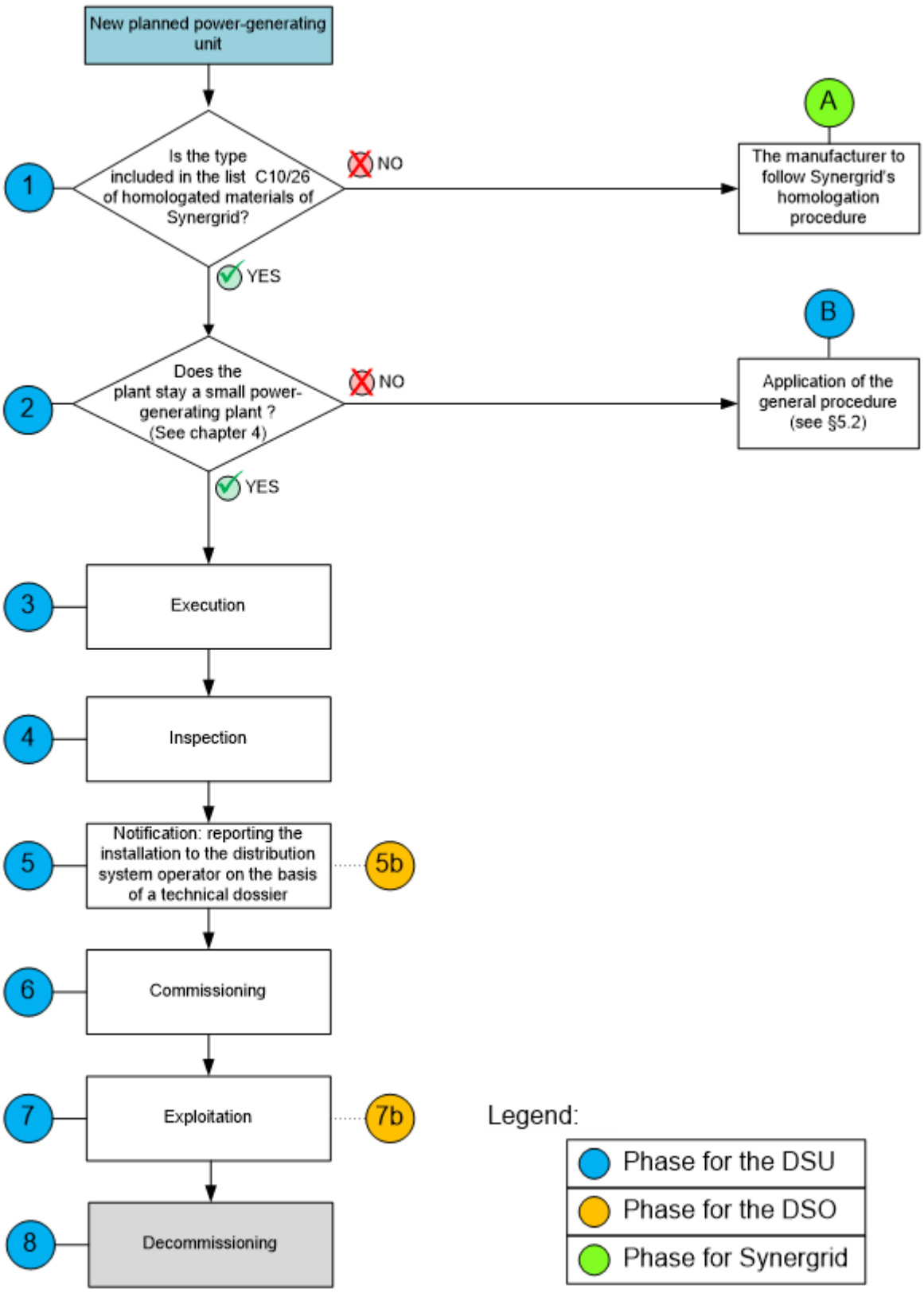


Figure 4 – Simplified process for commissioning a small power-generating plant

This process can be fully dealt with by the DSU without the DSO's intervention. After all, this process is based on the obligation to report the power-generating unit to the DSO before operating in parallel with the distribution network. This means no prior authorisation by the DSO is required.

If the power-generating plant has more than one power-generating unit, these can be grouped together in the same application of the procedure.

If a power-generating unit has been reported wrongfully, the DSO may inhibit its operation in parallel with the distribution network until the non-conformities have not been remedied.

STEP 1: Prior homologation of the power-generating units

The DSU must ascertain whether the type of each power-generating unit is included in the C10/26 list, published on the website www.synergrid.be under the heading « Gehomologeerde materialen » « (Dutch) or « Matériels homologués » (French) [homologated materials]. This list contains the various types of power-generating units for which the manufacturer has provided Synergrid with the official documents that are required where the homologation procedure is concerned.

If the type of the planned power-generating unit has (not) yet been included in this list, this simplified process cannot be applied. See STEP A in the figure above: The manufacturer or importer should follow the homologation procedure for inclusion on the C10/26 list. More information about the homologation process to be followed is included in ANNEXE B.

STEP 2: Verification that this is a small production plant

The DSU must ascertain that the planned power-generating plant meets all the requirements for a small power-generating plant. These requirements are outlined in the definition of 'Small power-generating plant' in § 4.1.7.

If all the requirements of a small power-generating plant are met, the DSU can continue with STEP 3 of the process.

STEP 3: Execution

The DSU can take the necessary actions to install the power-generating unit (or delegate this task) in accordance with these technical prescriptions C10/11. Particular attention should be paid to the following points.

Settings

During this step the following specific settings must be realized:

- The automatic separation system must be set in accordance with the requirements of these technical prescriptions (see ANNEXE C, § C.1). The installer must provide a declaration of honour confirming that the parameter setting of the automatic separation system is in accordance with the requirements of these technical prescriptions. This declaration must be added to the technical dossier that will be submitted to the DSO upon notification (see below)

- Within the required capabilities regarding reactive power exchange, the installer must set the control mode for reactive power in accordance with the guidelines the DSO publishes in its website. If the DSO does not publish a control mode, the power-generating unit must be set in accordance with § D.7.1.

- In the case of the presence of an energy storage system, the EnFluRi sensor must be set in accordance with § 7.11.2.1.

Phase imbalance (in the case of a 3-phase connection to the distribution network)

The power-generating plant must be designed in such manner that the imbalance occurring between the power generated on different phases never exceeds the limit of 5 kVA.

A multi-phased connection is mandatory for small power-generating plants with a maximum power exceeding 5 kVA[14,15], and highly recommended for power-generating plants with a maximum AC power exceeding 3,6 kVA.

The prescriptions for phase imbalance are specified in § 8.2.5.

In case of the presence of an energy storage system, refer to § 7.11.1

STEP 4: Inspection

The DSU must have the power-generating plant inspected by an authorized inspection body. The list of authorized inspection bodies for electrical systems is available on the website of FPS Economy[16].

The employee of the authorized body will check compliance of the power-generating plant with the GREI prescriptions.

Only an installation declared compliant may be notified to the GRD and put into service.

STEP 5: Notification

Based on a technical dossier the DSU must report the impending commissioning of a power-generating unit. The technical dossier must be submitted to the DSO.
The technical dossier consists on the one hand, of the (digital) notification form for a small power-generating plant that is available from the DSO's website, and on the other hand, of additional information. The latter will include at minimum:

- A single wire diagram indicating the power-generating unit's connection at the power-generating plant;
- The installer's declaration of honour confirming that the parameter setting o the automatic separation system is in accordance with the requirements of these technical prescriptions (see step 3);
- If the power-generating plant consists of a combination of an energy storage system, the installer's declaration of honour confirming that the EnFluRi sensor has been installed in line with the prescriptions of this document (see step 3) mentioning the set limit for the power injected in the distribution system.
- The inspection report of the authorized body mentioned in step 4 that, in addition to the proof of conformity of the plant to GRIE, contains the following information :
    - If an external automatic separation system is used (instead of a more common internal one), the type of the used automatic separation system is included in the C10/21 list. This list can be consulted on the Synergrid website (www.synergrid.be) under the heading « Gehomologeerde materialen » (Dutch) or « Matériels homologués » (French) [Homologated materials]. Only types homologated by Synergrid included in the C10/21 list are allowed.

[14] De energy storage systems are not included in this calculation if their cumulated power ≤ the total power of the other power-generating units. Otherwise, it is the sum of the maximum powers of these energy storage systems that is decisive in this calculation.

[15] Some DSOs allow higher power, the applicable limit being mentioned on the website of the DSO concerned

[16] At the time of the publication of this document C10/11, the list is available on the website : https://economie.fgov.be/en/themes/quality-and-safety/accreditation-belac/accredited-bodies/inspection-bodies-insp

  - The result of the shutdown test that must confirm the establishment of a galvanic separation after maximum 5 seconds.

- The reference of the homologation of the type corresponding to the relevant power-generating unit. This reference is specified in the C10/26 list of Synergrid. This list can be consulted on the Synergrid website (www.synergrid.be) , in the Homologated materials – Electricity – Other section.

STEP 6 may only be executed when a complete technical dossier has been submitted.

Note: A notification may give rise to other actions that fall outside the scope of of these C10/11 prescriptions (for example with regard to the energy measurement).

The DSO can review the technical dossier (STEP 5b). If the DSO ascertains infringements of the C10/11 prescriptions, the DSO will notify the DSU in writing that the power-generating unit may not be connected to the distribution network (any longer). The DSU will take appropriate action(s) determined by the nature of the infringements, for example adapting the power-generating plant to comply with C10/11.

STEP 6: Commissioning

Correct execution of the previous steps entails authorization by the DSO to connect the power-generating unit to the distribution network. The DSU can then put the power-generating unit into commission without explicit, written authorization by the DSO.

STEP 7: Exploitation

The power-generating plant must be managed in accordance with these C10/11 prescriptions.

In case of suspicion of non-compliance of a power-generating plant, the DSO reserves the right to check or to have checked the proper operation and the operating modalities of the power-generating plant (STEP 7b).

If such a check shows that the (operation of the) power-generating plant does not comply with these prescriptions C10/11, then:

- the DSU will bear the costs of this check.
- the DSO will notify the DSU in writing that the power-generating unit may no longer operate in parallel with the distribution network, in compliance with the regional regulations in force;
- the DSU must take appropriate action(s) determined by the nature of the infringements and repeat the commissioning procedure.

As described in chapter 3, these technical prescriptions C10/11 also apply to modifications of existing power-generating plants. Any change to the power-generating plant mentioned in chapter 3 must be submitted to the DSO in writing, accompanied by the necessary documentation. Where an expansion of the maximum power is concerned, the full commissioning procedure must be followed.

STEP 8: Decommissioning

When a power-generating unit is permanently decommissioned, the DSU, or a by the DSU mandated third party, must notify the DSO in writing. This notification must be done within 15 working days following the decommissioning.

6 Technical basic requirements regarding the power-generating plant.

Details of the basic technical requirements the power-generating unit must comply with, together with the default settings, are included in ANNEXE D. For these requirements, reference is made as much as possible to relevant international standards and more specifically to CENELEC EN 50549-1 and EN 50549-2. The conformity assessment to these requirements is realized during the homologation procedure and is generally based on a certificate of conformity.

In addition to the basic technical requirements, ANNEXE D also details the required settings.

In order to ascertain the power-generating unit is properly integrated in the power-generating plant, the following requirements relating to these basic technical requirements should also be met:

- The following protection functions take precedence over the required behavior of the power-generating unit:
    - The protection of the power-generating unit, including relating to primary energy;
    - The interface protection and the protection against disturbances in the power-generating plant itself.
- In the power-generating plant, there can be no element that could disconnect the power-generating unit from the distribution network (systematically), within the limits of :
    - Voltage:
        - 85% Un < U < 110% Un for a connection to the LV network, where Un = 230 V
        - 90% Uc < U < 110% Uc for a connection to the HV network, where Uc is the declared voltage
    - Frequency: 47,5 Hz < f < 51,5 Hz
    - The immunity to disturbances required of the power-generating unit, as shown in the figures in paragraph D.5

  Exceptions: consecutives disconnections to one of the protection functions mentioned above, or the disconnections effected in the scope of normal operation.
- Homologation:
    - In the case of a small power-generating plant, all basic technical requirements in ANNEX D must be covered by the homologation of the type applicable to the relevant power-generating unit.
    - For another (not small) power-generating plant, it is not excluded, if only exceptionally, that the evaluation of the elements that are not covered by the homologation should be carried out. This may for example relate to the support of the voltage via the reactive power if, for this purpose, addition (for example a capacitors bank) is added in addition to the power-generating unit.

7 Additional plant requirements

7.1 General

When integrating the power-generating module into the local network of the DSU, a certain number of aspects have to be taken into account. These are further elaborated in the following paragraphs.

As long as the voltage and frequency of the point of connection stay within the boundaries of the technical requirements set to the power-generating module itself (see ANNEXE D), in-parallel operation of the power-generating module with the distribution network may not be interrupted. This means that the power-generating plant may not include any element that could cause such premature disconnection. The only exceptions are as follows:

- Disconnection through activation of the interface protection relay, or, where appropriate, of the automatic separation system.
- A disconnection of the network in the scope of a normal operation of the power-generating module, that is in no way related (directly or indirectly) to the occurrence of a network disturbance.
- Changeover to local island operation with critical loads as specified in §2.2.2.1.

Figure 5 represents a schematic diagram of the main switching devices of a power-generating plant (this schematic diagram does not apply to small power-generating plants).

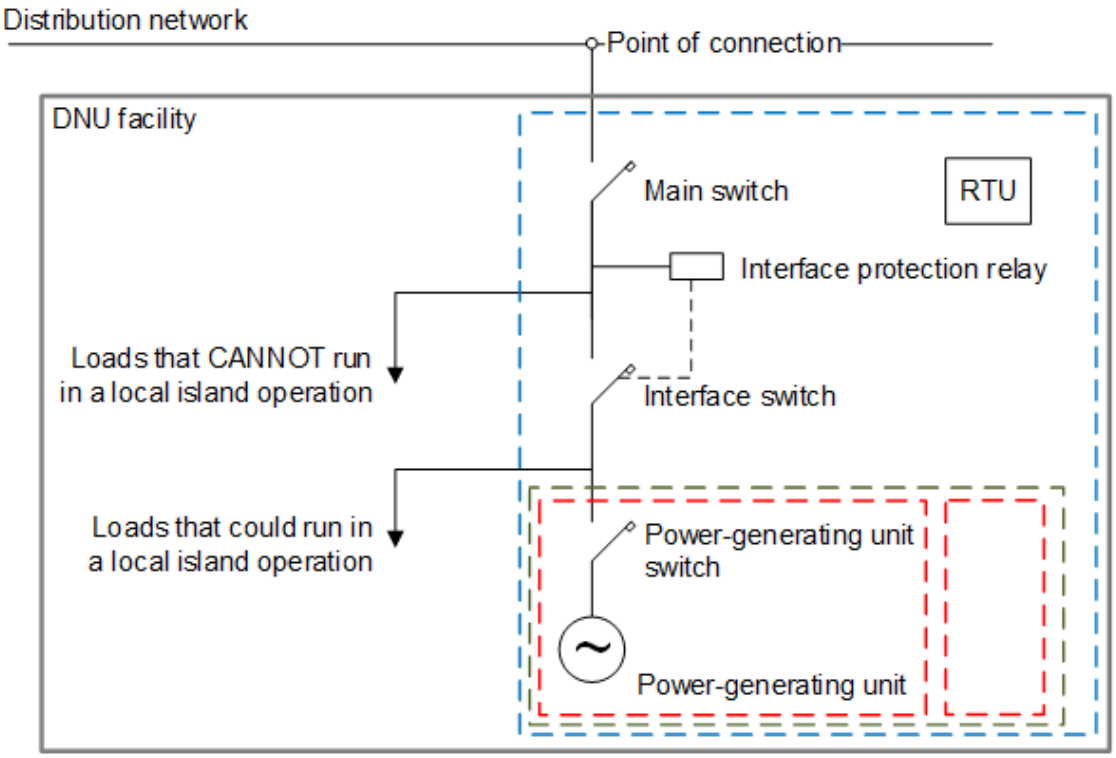


Figure 5 – base scheme of the switching devices of a power-generating plants

Reminder: a power-generating plant connected to the HV distribution network must also comply with the requirements of document C2/112 of Synergrid. Two scenarios are possible:

- The power-generating module is connected to a new enclosure; the requirements regarding new facilities as described in C2/112 apply.

- The power-generating module is connected to an existing enclosure: installation of a new power-generating module may result in the need to modify or renew all of part of the existing enclosure. Where appropriate, the measures to be taken are described in specific chapters[17] of C2/112.

7.2 Connection

The power-generating module must be connected to the DSU's electrical system by means of fixed cabling (that cannot be removed without tools).

It is therefore forbidden to operate a power-generating unit in parallel with the distribution network if it is connected by a (domestic) outlet[18]. If a URD wishes to connect such system to its electrical installation, it must replace the connection through an outlet by a fixed cable connection and follow the commissioning procedure as described in chapter 5 of this document.

7.3 Rotating field

In the case of a power-generating unit with three-phase connection, the DSU must ask the DSO for information about the direction of the rotating field. After installation, the terminals must indicate the sequence of the phases by means of unambiguous marking.

7.4 Grounding

The neutral conductor, where applicable, of the power-generating unit may only be grounded when galvanic separation from the distribution network is guaranteed using a transformer. If not, it is not permitted to ground the neutral conductor (if present) of the power-generating unit.

Note: A grounding connection can be realised when a power-generating unit that does not have the option of a galvanic separation operates in local island operation and not in parallel with the distribution network. This grounding connection has to be interrupted prior to operating in parallel with the distribution network. This situation has to be locked during in-parallel operation with the distribution network.

[17] Chapters 19 and 21 of the C2/112 (edition 25.03.2015)

[18] Often these are small portable inverters that can be connected to portable photovoltaic panels and that can power common applications (lighting, ventilation, computers, mobile phones, etc.) on 230 V AC or 12 V DC. These systems are currently marketed by various manufacturers. Except for the models that only operate off-grid, for example in places where the electricity distribution network is not available, other models are equipped with a standard household plug for connection to the household electricity system. The use of these systems with a household plug may present risks, as well for the operation of the distribution network as for the internal electrical installation and its users:

- The behavior of such systems during disturbances on the network (frequency or voltage variations, voltage dips, etc.) is unknown: it is unclear whether the necessary protections and settings have been integrated. (without homologation via the C10/26 list)
- If the converter with plug feeds back energy to the network, and a large consumer is connected to that same circuit, there may be larger currents locally circulating in the installation of the DSU than at the beginning of the circuit where its protection is located. The protection of that circuit may also be unable to detect these larger currents and, therefore, be unable to de-energize in time if the anticipated maximum value for that circuit were to be exceeded.
- There is also the possibility of internal circulation of large fault currents that compensate each other at the level of the differential protection to below the threshold level, as a result of which the differential protection may not respond correctly.
- If the equipment is not provided with an adequate de-energizing protection in the converter, the prongs of the plug may become charged, meaning there is a shock-hazard. The plug prongs in other sockets in the same circuit may also inadvertently and unexpectedly become charged.

7.5 Means of isolation

7.5.1 General

The power-generating plant must be provided with a lockable means of isolation and permanently accessible by the DSO (see GRIE).

If the power-generating plant is connected to the low voltage distribution network, this means of isolation must be accessible under the same circumstances as the DSU's electricity meter as specified in the technical prescriptions C1/107 of Synergrid (in edition 2017, see § 7.3).

If the power-generating plant is connected to the high voltage distribution network, this means of isolation must conform to the requirements of the technical prescriptions C2/112 of Synergrid (in the 2015 edition, see chapter 15).

The operator of the power-generating plant may also, for its own purposes, add a separate security lock to this means of isolation.

7.5.2 Specific rules for a power-generating plant ≤ 30 kVA, other than a small power-generating plant

There is no need to provide a means of isolation as described above if all of the following conditions are met:

- The maximum capacity of the power-generating plant is ≤ 30 kVA (existing + new)[19]
- Each of the power-generating units is provided with an automatic separation system with setting according to C.1 "settings of the automatic separation system (integrated or external)". If an external system is used, it must have a "single fault tolerance", in accordance to the standard EN 50549-1, and be of a type homologated by Synergrid.
- The type of each power-generating plant is homologated by Synergrid. See the relevant list, published on the website www.synergrid.be under the heading "Gehomologeerde materialmen" (Dutch) or "Matériels homologues" (French) [Homologated materials].

The power-generating plants meeting all these conditions are not required to be equipped with a interface protection system other than the automatic separation system(s) (seer §7.6.2).

7.5.3 Specific rules for a small power-generating plant

In the case of a small power-generating plant (as specified in § 4.1.7), automatic separation system (integrated or external) acts as a means of isolation (see GRIE). An additional means of isolation is therefore not required. However, special attention should be paid to the installation and settings of the automatic separation system.

7.6 Protection devices [NC RfG Art 14 5.(b)]

This section describes the protection functions as required in these prescriptions only and is not intended as protection requirements for the power-generating plant itself. The operator of the power-generating plant is free to integrate additional protection functions insofar as these do not contradict the provisions of the present technical prescriptions.

This section is not applicable to small power-generating plants, with the exception of §7.6.1.

Where explicitly indicated, only a protection relay of a type homologated by Synergrid may be used for protections functions imposed in these technical prescriptions. These relays are included in the

[19] Without prejudice to a possible stricter limit imposed by the GRIE

C10/21, C10/23, C10/24 or C10/25 lists published under the heading “Gehomologeerde materialmen” (Dutch) or “Matériels homologues” (French) [Homologated Materials] on the www.synergrid.be website. Refer also to ANNEXE B for more information on the homologation procedure.

Various protection functions can be combined in a single relay insofar as this is in accordance with above homologation requirement.

The protection devices, which are submitted to an inspection (seer § 5.2, Step 4) have to either be equipped with test terminals or be of the pull-out type, making the testing of the various functions possible.

7.6.1 Protection against internal malfunction

The diagram and the settings for the protection against an internal malfunction in the facilities of the DSU (for example, protection relay with maximum current function) have to be such that the correct operation of the power-generating plant with regard to the technical requirements included in these prescriptions is not compromised. Any conflict is to be submitted by the DSU to the DSO.

7.6.2 Interface protection system (C10/21 or C10/23)

The requirements in this section are applicable to:

- power-generating plants with a total power > 30 kVA ;
- power-generating plants with a total power ≤30 kVA and do not meet all the conditions described in §7.5.2.

7.6.2.1 Introduction

The power-generating plant must be equipped with an interface protection relay that must disconnect the power-generating unit from the distribution network under certain circumstances. It is allowed to use a single interface protection relay for multiple power-generating units.

The main objective of the interface protection system is to disconnect the power-generating unit from the distribution network in the following cases:

- the operation of the power-generating unit causes overvoltage in the distribution network;
- after detection of an unplanned situation of island operation in which a section of the distribution network remains energized;
- the voltage and/or the frequency of the distribution network deviates too much from the nominal values in order to bring the distribution network back to a controllable situation.

The interface protection system is not intended for:

- disconnecting the power-generating unit from the distribution network in case of malfunctions (for example, a short-circuit) internally in the power-generating plant and especially in the power-generating unit itself;
- preventing damage to the power-generating plant due to incidents (for example short-circuit) in the distribution network or of network switches, especially the automated switches as indicated in § 8.3.

7.6.2.2 Selection of interface protection relay and setting

The interface protection relay must be of the type homologated by Synergrid and included on the C10/21 or C10/23 lists of Synergrid. The protection functions of the interface protection relay have to be set according to the DSO guidelines. Please refer to C.2 Interface protection relay settings for more information on this topic.

The necessary measures will be taken to prevent unauthorized changes to the decoupling protection relay settings. This objective can be achieved by installing seals or by using a password.

The power-generating plants having a maximum power > 250 kVA need an interface protection relay with time stamped event-registers and recording values.

In order to select the right interface protection relay, following items are important:

- Because of backup operation (see §7.6.2.8), an interface protection relay with sufficient digital inputs and internal compare logic of backup-condition is strongly advised. With these features an extra relay and wiring can be avoided.
- Strong advice to have an interface protection relay that has logic circuits for comparing different measurement criteria (for example activation of a narrower frequency window based on local voltage criteria. See Figure 7 in ANNEXE C).
- If remote monitoring is required, ask the DSO for the requirements (e.g. protocol) and guidelines.

7.6.2.3 Measurement location of the interface protection relay

The general guideline is that the location of the measurement of the interface protection relay should be as near as possible to the point of connection to the distribution network. This prevents the e untimely interruption of the power-generating unit.
The measurement at high voltage is mandatory for power-generating modules with a maximum power of ≥ 1 MVA.

7.6.2.4 Monitored quantities

When measuring the overvoltage and the undervoltage (U>>, U>, U<, U<<) the following voltage quantities should be monitored unless otherwise imposed by DSO:

- If the power-generating plant is connected to a high voltage distribution network:
  - the three line voltages (between phases) when measuring at high voltage;
  - the three phase voltage (between phase and neutral conductor) when measuring at low voltage;
- If the power-generating plant is connected to a low voltage distribution network :
  - the three phase voltage (between phase and neutral conductor) if there is a neutral conductor
  - the three line voltages (between phases) if there is no neutral conductor.

Every voltage monitoring function is combined with a logical « OR » function: if at least one of the monitored voltages meets at least one of the switch off criteria, the interface protection relay must emit a disconnection command.

For frequency monitoring functions (f<, f> and df/dt) measuring of one the voltage is sufficient.

It's strongly advised to monitor the following local voltage quantities:

- the zero sequence component (code ANSI 59V0) ;
- the negative sequence component (code ANSI 59VI); and
- the positive sequence component (code ANSI 27Vd).

These quantities are crucial for local voltage unlock function in the island detection function that is recommended (see Figure 7 in ANNEXE C)

The zero sequence of the voltage (59V0) is required for power-generating plants with a maximum power > 250 kVA. For all the other power-generating plants it is strongly recommended.

Note: the calculation of the zero sequence component of the voltage (59V0) requires the measurement of the three voltages between phase and neutral or phase and earth when measuring at high voltage.

7.6.2.5 Accessibility of the interface protection relay

a. General requirements

The DSO always has the right to check the correct settings or the operation of the interface protection relay or to assign a third party to do so.

Therefore, the interface protection relay has to be accessible to the DSO according to the inspection rules for a plant, as specified in the technical regulation.

The interface protection relay shall be installed in such a way that its display and state of operation are visible without opening the complete cabinet.

b. Additional requirements for the plants connected to the high voltage distribution network

The location of the interface protection relay must be easily and safely accessible by the personnel of the DSO. In this way, the personnel of the DSO can have access to the interface protection relay without further education about the specific risks that are related to the operations of the DSU's premises. If this cannot be guaranteed, the interface protection relay must be placed in the high voltage station at the connection point.

If the interface protection relay is not installed in the high voltage station at the connection point, the DSU has to assist the DSO when accessing the interface protection relay:

- The DSU has to assist the personnel of the DSO to the place where the interface protection relay is installed. The DSU has to raise the awareness of the personnel of the DSO on all possible risks he can encounter on his way to the interface protection relay.
- The DSU has to make sure that there are no unacceptable risks on the way to the workplace and in the workplace itself.
- The DSU is at the disposal of the DSO for any periodical conformity check of interface protection relay.

7.6.2.6 Interface switch

The interface switch is a circuit breaker switch that is triggered by the deactivation command (Trip 1) of the interface protection relay. An indirect activation or deactivation command (for example via a Programmable Logic Controller, or PLC) is not allowed.

The opening of this circuit breaker is triggered by interrupting the voltage feeding its under-voltage trip coil that is continuously under voltage in normal operation. In order to avoid any impact of voltage dips on the distribution network, this disconnection circuit has to be supplied by a guaranteed energy supply.

The interface switch is located as near as possible to the power-generating unit, between the point of connection to the distribution network and the switch of the power-generating unit itself (see Figure 5 of 7.1). The option of a local island operation in the installations of the DSU can be taken into account when selecting the location of the interface switch.

In order to operate as interface switch, the circuit breaker switch has to at least meet the following characteristics:

- Making and breaking capacity of at least the maximum current produced by the power-generating unit (taking into account nominal current and the contribution to the short circuit power of the installation connected to the net via this switch);

- A short-term withstand capability for the short circuit current in case of a malfunction in the power-generating unit (taking into account the short circuit power available on the distribution network)[20].

Up to a line current of 375 A (at low voltage), a contactor may be used instead of a circuit breaker switch. The comment below is also applicable when using a contactor.

Note: if the maximum current protection (reacting to an over-current) and the interface protection (reacting to an under-voltage) trip different switches, the selective operation of one or the other in the event of an internal malfunction in the power-generating plant is not guaranteed. The DSU shall consider whether or not to dimension the interface switch for a "making and breaking capacity" that at least corresponds to the short current in the event of a malfunction in the power-generating plant itself (taking into account the short circuit power available on the distribution network). If, in the event of an internal malfunction, the interface switch opens before the malfunction is isolated by the maximum current protection device, the interface switch could be damaged if it has not been appropriately dimensioned.

7.6.2.7 Fail-safe principle

The structure of the protection circuits must be based on the fail-safe principle. The contact that aggregates the protection functions of the interface protection relay is connected in series with the Watchdog contact of the interface protection relay. The interruption of one of these contacts shall disconnect the power-generating unit because the under-voltage coil of the interface switch, that always has a voltage when the power-generating unit is operating as standard, has no voltage. In order to prevent untimely switching off (for example, in case of voltage dips in the DSU facilities) the minimum voltage coil is supplied by a guaranteed energy supply.

7.6.2.8 Back-up operation

The interface protection system shall include a backup operation system.

The backup system works as follows: in case of failure of the deactivation command sent by the interface protection relay to the interface switch, after 0.3 s a new deactivation command is sent to an upstream backup circuit breaker switch.

The first deactivation command is considered to have failed if no feedback is received from the interface switch within the set time. The second command is emitted by a relay system (or the interface protection relay itself) via a signal to the shunt trip coil of the backup switch. This backup switch is located between the point of connection to the distribution network and the interface switch, preferably just before the latter and in the worst case at the same location as the plant's main switch.

7.6.2.9 Local disconnection circuit and feedback

Following additional contacts have to be implemented in the interface protection circuit mentioned in section §7.6.2.7:

- A locally activated contact that can be locked with a key. When locked, this key lock shall block the interface protection circuit in the position 'disconnected' and the key must be accessible in the room where the interface protection relay is situated.

- If remote control is required according to § 7.13, a contact that assures a direct and fast disconnection of the power-generating module following a command remotely given by the DSO.

Auxiliary contacts of the interface switch and the back-up switch must be available for local feedback and feedback to the remote monitoring and control system if required by the DSO (see also § 7.13). In case of multiple power-generating units, a grouping of contacts is permitted applying following logic:

[20] In case of doubt, information can be obtained from the DSO about the short-circuit power available at the connection point.

- "Connected", if at least one of the power-generating units is connected;
- "Disconnected", if all of the power-generating units are disconnected.

7.6.3 Synchrocheck relay (C10/24)

The power-generating units which synchronize with the voltage on the distribution network (such as synchronous machines, island equipment …), have to be equipped with a synchrocheck relay (equipped with a synchroscope) of a type homologated by Synergrid. These type are listed in list C10/24 published under the heading 'Gehomologeerde materialen' (Dutch) or 'Matériels homologués ' (French) [homologated materials] on the www.synergrid.be website.

The output contact of the synchrocheck must be integrated in the the activation circuit of the power-generating unit, which prevents all connections when the actual circumstances do not match the settings of the synchrocheck.

The synchrocheck is set as follows unless determined otherwise by the DSO:

- Voltage difference < 5 %
- Phase difference < 5°
- Observation time = 0,5 seconds

If the power-generating unit has inherent fluctuating behaviour (e.g. emergency module with load, biogas-based unit), the observation time can be set to a lower value (e.g. 0,3 seconds) on condition a coupling switch with coherent quick response time is used.

The use of a synchrocheck is not mandatory for other types of power-generating unit, but the conditions as specified in § 8.2, should be adhered to.

7.6.4 Export limitation relay (Directional relay – power limitation) (C10/25)

The study provided by DSO also determines the modalities with regard to the limitation of injectable power.

If an export limitation relay is required, the power-generating plant should be equipped with a relay type that has been homologated by Synergrid. The C10/25 list of homologated relays is available on the website (www.synergrid.be) on the "Gehomologeerde materialmen" (Dutch) or "Matériels homologues" (French) [Homologated materials] page of the www.synergrid.be website.

1. Zero-watt relay:

   If no specific settings are provided by DSO, the export limitation relay can be set as follows:

   - Time delay: ≤ 10 s

     For a backup power system as specified §2.2.1, a time delay ≤60s instead of 10s can be used.

   - Threshold: ≤ 3 % of the contractual power in extraction (expressed in terms of current or power).
     Note: The objective of this threshold value is to maintain the stability of the connection of the power-generating unit and does not provide the right to inject into the distribution network (permanently or not).

   This setting is applicable in the specific case of a power-generating plant which cannot inject, at any time, the energy into the distribution network.

2. Relay to limit the injected power:

   There are 2 levels:

   - the highest level should guarantee the immediate disconnection with an accuracy of < 3% in relation to the imposed limit;
   - the lowest level is used as an alert level for actions to be taken in time in the installation of the DSU, to prevent , the aforementioned disconnection at the highest level.

If the prescribed settings for the export limitation relay are exceeded, the power-generating unit has to be disconnected immediately from the distribution network.

7.6.5 Phase interruption protection

In the event of a phase interruption, all 3-phasepower-generating units should be disconnected from the distribution network. The detection of the phase interruption can, for example, be based on the detection of a phase asymmetry of the generated power or the injected current.

7.6.6 Minimum voltage protection relay

If the power-generating plant has a maximum power higher than 250 kVA, the DSO may impose a minimum voltage protection relay to avoid impact on the distribution network and its operators. The minimum voltage protection relay's parameters (threshold and delay) have to be set in accordance with the instructions of the DSO.

Following situations can trigger the need for a minimum voltage protection relay:

- a new power-generating unit in a plant with existing power-generating units equipped with an older protection device with other protection principles;
- a plant with partial fail-safe and backup wiring or Loss of mains protection with poor effectiveness;
- poor accessibility of the relevant interface protection relay and the interface switch controlled by this relay.

7.6.7 Power imbalance protection relay

This clause is only applicable to power-generating plants with a 3-phase connection to the distribution network.

The installation of a power imbalance protection relay is required if the power-generating plant consists of multiple single phase power-generating units with the risk of having a power imbalance of more than 5kVA (see § 8.2.5).

The trip value of this power imbalance protection relay shall be set to a value of 5kVA unless the DSO allows a higher limit.

7.7 Voltage rise in the DSU's facilities

The local cabling within the DSU's facilities must comply with the requirements of the GREI.

When designing the cabling, the possible voltage rise in the DSU's installation caused by the power-generating unit must also be taken into account. The voltage rise between the principal meter and the terminals of the power-generating unit or, if applicable, the location where the interface protection relay measures the voltage must always be smaller than 1% of the nominal voltage.

7.7.1 Impact on operation of the interface protection

The automatic separation system (generally integrated into the power-generating unit), or, if applicable, the interface protection system has been set to the permissible voltage boundaries at the point of connection. Therefore, the voltage rise in the DSU's facilities may cause a disconnection of the power-generating plant earlier than strict necessary. To avoid this, the connection between the general distribution board and the terminals of the power-generating unit, or, if applicable, the location where the interface protection relay measures the voltage, must be realized in a sufficiently thick cable section, taking the length of this connection into account.

7.7.2 Impact on operation of other equipment

This provision is applicable only to power-generating plants connected to the low voltage network and provided of an interface protection relay.

Where overvoltage is concerned, the interface relay has been set to the permitted maximum voltage at the point of connection (110 % Un). If other consumption equipment has been connected between the location where the interface protection system measures the voltage and the power-generating unit, that equipment, in view of the voltage peak inside the DSU's facilities, may be subject to voltages higher than the maximum permitted voltage at the point of connection.

The NBN EN 60038 standard specifies that in the case of a standard consumption equipment, the highest voltage permitted at the plug is also 110% Un. It is therefore advisable to take this into account when designing the plant or the purchase and/or connection of equipment between the measuring location of the interface protection system and the power-generating unit.

7.8 Connection to a 3 x 230 V type distribution network

The DSU can ask the DSO for information about the type of network he is connected. If the distribution network to which the power-generating unit will be connected is of the 3 x 230 V type, the following specific requirements must be complied with:

- A multi-phase connected power-generating unit should be capable of being changed over for in-parallel operation with a distribution network of the 3 N 400 V type (with neutral conductor).
- A power-generating unit (with converter) that is being connected to a distribution network of the « 3 x 230 V without neutral conductor» type must in principle be connected using an isolation transformer, except when the power-generating unit has been specially designed to be able to operate without isolation transformer. The manufacturer's instructions regarding the parameter setting and connection of this type of power-generating unit must be carefully followed.

7.9 Interlocks

This provision is applicable only to power-generating plants connected to the high voltage network.

Depending on the structure of the DSU' internal network, it is technically feasible to have a power-generating unit operating in parallel with the distribution network at a location that is not appropriate (for example, bypassing of the interface via an alternative circuit). The DSO can apply interlocks to prevent unwanted parallel operation.

7.10 Transformer

This provision is applicable only to power-generating plants connected to high voltage networks.

7.10.1 Presence of a transformer

For power-generating plants with a maximum power > 250 kVA, the evaluation of the application to connect may result in the mandatory installation of a transformer between the power-generating unit and the point of connection to the distribution network (see also section 8.5). There are other reasons why a transformer may be a good option.

The transformer must meet the requirements specified in Synergrid technical prescriptions C2/112 which is available on the website www.synergrid.be, at « Technische Voorschriften Elektriciteit » (Dutch) or « Prescriptions techniques éléctricité » (French) [Technical prescriptions – Electricity].

The transformer can fulfil five different functions:

- Limiting the added short circuit power (see § 8.5).
- Transformation of the voltage range of the high-voltage distribution network (Uc-10 % to Uc+10 %) to the voltage range of the power-generating unit, using a transformer with at least 3 tap positions (-5 %, 0 %, +5 %). A lower secondary voltage can be set if the effect of the presence of the power-generating unit on the voltage is taken into consideration.
- Damping of fault currents or dynamic currents, in both directions.
- Separation of the grounding systems, due to which the grounding voltage in the high-voltage distribution network is not transferred to the power-generating unit.
- Preventing a direct current injection (for example, caused by a converter malfunction).

The inrush current has to be considered carefully for the following reasons:

- The interactions with the distribution network may require the limitation of the inrush current (see § 8.6).
- The settings of the overcurrent protection devices in the DSU facility have to be compatible with this inrush current without compromising the selectivity principle.

7.10.2 Without transformer

The following requirements are applicable if the DSU decides to implement a direct without a transformer:

- The insulation and electrical characteristics of the power-generating plant are equivalent to the characteristics of a high voltage transformer that is installed as standard on this network;
- Special attention to the effect of the grounding current that is provided by the high-voltage distribution network in case of a grounding malfunction in the power-generating unit.
- It is not permitted to ground the (virtual) starpoint of the power-generating unit (see § 7.4).

7.11 Energy storage systems

7.11.1 Phase imbalance

This section is applicable only to power-generating plants connection to low-voltage networks.

The power imbalance must be kept as small as possible and may not exceed the limit set in §8.2.5. In order to ensure that the power imbalance stays within this limit, special attention has to be paid to:

- the phase distribution of the energy storage system in combination with the other means of power-generation. For ex. when a single phase photovoltaic power-generating unit combined with a single phase energy storage system, they shall be connected to the same phase.

- the storage system's controls (especially when the energy storage system and the other means of power-generation are both in generation mode).

The respect of the imbalance limit can be guaranteed using different methods like:

- a communication link between the other means of power-generation and he the energy storage system limiting their combined generated power to this limit per phase (f. ex. In the case of a small power-generating plant).

- the measurement and control of the power injected in all of the phases individually at the point of connection limiting the imbalance to the authorized limit.

Remark 1: For consideration of the phase imbalance, a mean value over 1 min can be used.

Remark 2: When considering the imbalance of the power levels injected in the different phases, abstraction can be made of any loads in the DSU's premises.

7.11.2 Power control system

7.11.2.1 Requirements for a small power-generating plant

An EnFluRi sensor has to be installed in such a way that at any time the power injected into the distribution network is limited to the maximum power of the other means of power-generation. In case of absence of other means of power-generation in the power-generating plant, this maximum power is equal to zero.

> Remark : If, however, the URD wants to be able to inject into the network a power higher than the sum of the maximum powers of the other means of power-generation, the standard procedure for commissioning the installation, described in §5.2., should be applied

Failure of the EnFluRi sensor should result in system behavior preventing the injection limit being exceeded (if necessary, the injection will be stopped). The energy storage system can remain active to prevent possible damage to the system, for example due to a deep discharge.

7.11.2.2 Requirements for another (≠ small) power-generating plant

For situations where injection into the distribution network is limited, a power control system is required.

In order to optimize the power exchange with the distribution network, the energy storage system must have a power management system associated with a directional sensor that communicates with the energy storage system. The power management system and the sensor must prevent the power injected into the distribution network to exceed a specified limit. The following basic rules apply:

- The communication module for the sensor can be integrated in a central control unit,, provided that a clear assignment of the sensor to the energy storage system is guaranteed.

- Malfunction of the measuring system or the sensor must result in system behavior preventing the injection limit being exceeded (if necessary, the injection will be stopped). The energy storage system can remain active in order to prevent possible damages to the system, for example as a result of a total discharge.

- The technical characteristics of the power control system (settings, response time) must be minimum compatible with the settings and times of the export limitation relay (see §7.6.4).

- A type test is performed and a type report is drafted.

For this purpose, it is authorized to use an Enfluri type system, as described in the FNN standard Hinweis - Anschluss und Betrieb von Speichern am Niederspannunsnetz.

A manufacturer's declaration of conformity is sufficient as long as no conformity assessment procedure by a certified body is available.

In addition, during the study phase, the GRD may impose the placement of an export limitation relay (see §7.6.4) to avoid the risk of voltage or current congestion.

7.12 Special supplemental requirement regarding backup power systems

For a backup power system as specified in §2.2.1., the following additional requirements are applicable to guarantee that in-parallel operation is momentary and sporadic.

In the specific case of a functional check of a backup power system for an installation that is subject to CEB Technical Note T013 / IA, the DSU is obliged to keep an automatic register of all operations in parallel, with mention of time and duration.

In all other cases, the DSO may impose one of the two following systems after consultation with the DSU:

- remote monitoring to permanently evaluate the duration and sporadicity and provides the option to emit a deactivation command.
- a locally applied logical time-out lock of 60 minutes between the two switches involved in the transition from and to island operation. In this case, the DSU shall also keep an automatic register for all in-parallel operations, including time and duration.

7.13 Communications – remote monitoring and control

This section is applicable to:

- All power-generating modules with a maximum power ≥ 1 MW
- Power-generating plants with a maximum power > 250 kVA if required by the DSO, respecting the regional regulatory provisions.

A power-generating module[21] must be able to exchange information with the DSO or the transmission system operator in real time or periodically with a time stamp according to the specifications of the DSO or the transmission system operator.

As an initial guideline, a power-generating module must be able to at least activate the communication applications as listed hereafter. This list is indicative and not exhaustive. The DSU can request the complete list from the DSO :

- communication signals of the power-generating module to the DSO: see Table 4
- communications signals of the DSO to the power-generating module: see Table 5

Table 4 – Communication signals of the power-generating module to the DSO

Information	Nature	Max refresh time	Comment
Voltages at the point of connection	Measurement	1 s	

[21] In the case of a non-synchrone parc of generators composed of power-generating units whose primary energy sources are not identical (p.ex.solar and hydraulic energy) this requirement may have to be satisfied for each set of production units operating with the same primary energy source, if the regional regulation so provides.

Information	Nature	Max refresh time	Comment
Active poser at the point of connection	Measurement	1 s	
Reactive power at the point of connection	Measurement	1 s	
Active power on the terminals of the power-generating module	Measurement	1 s	Only required if at least one of the following conditions has been met: • $\frac{\text{local consumption power of the DSU}}{\text{P}_\text{n} \text{ of the power-generating module}} > 30\ \%$ • Local consumption power of the DSU >300 kVA
Reactive power on the terminals of the power-generating module	Measurement	1 s	Only required if at least one of the following conditions has been met: • $\frac{\text{local consumption power of the DSU}}{\text{P}_\text{n} \text{ of the power-generating module}} > 30\ \%$ • Local consumption power of the DSU >300 kVA
Unavailability of the communication system		1 s	Can be specific to the protocol used
Power-generating plant connected to the distribution network	Binary signal	1 s	For every disconnection breaker and backup disconnection breaker a signal must be given that indicates the status (open/closed) of the breaker.
Watchdog on RTU auxiliary energy source			

Table 5 – Communication signals from DSO to power-generating module

Operation parameter	Type of signal	Max. operation time[22]	Comment
Request for disconnect	Binary signal	1 s	1 = Request for disconnection 0 = End of request for disconnection
Limit for the request to limit the produced active power	Value	1 s	Value from 0 to 100 % of Pn
Value of fixed setpoint for reactive power	Value	1 s	-100 %..., 100 % of Pn
Selection of the reactive power control modus		1 s	No control (free use of reactive power capabilities by DSU) Q setpoint Q(U) Q(P) Cosϕ setpoint Cosϕ(P)

In addition to the specific communication requirements with the power-generating module, the DSO can impose additional communication requirements in relation to the power-generating plant. For example:

- Information on short-circuit detectors ;
- Remote control of switches in the power-generating plant.

The communication equipment and protocols must be according to the standard equipment at the DSO.

The DSO and the manufacturers of electrical systems strive to use a standardized protocol like 61850 or IEC 60870-5-104.

[22] The maximum operation time is the maximum duration between reception of reception of the command by the generating plant and the beginning and actuation.

8 Interaction with the distribution network

8.1 Impact on communication signals used by the DSO

The DSO also uses the distribution network as carrier for communication signals. Two types of signals can be used.

- Ripple control signals: These have a characteristic frequency in the frequency domain 110 Hz and 1 500 Hz. The used frequencies differ, depending on the location. Contact the DSO for more information about the used frequencies at the distribution network concerned.
- PLC signals: These have frequencies along the CENELEC A-band, which in accordance with EN 50065 is reserved for the DSO GRD (3 kHz – 95 kHz).

The power-generating plant may not interfere with the communication applications that are based on these signals. This must be assessed from 2 perspectives:

- The power-generating plant may not weaken the present signal level too much.
- The power-generating plant may not give rise to an interference level that is too high for these frequencies and neighboring frequencies.

In case of a proven disturbance, the operator of the power-generating plant may have to take measures to limit the impact, for example, by installing a blocking filter or an active filter.

8.1.1 Ripple control signals (110 Hz to 1500 Hz)

The interference voltages in the [f_c-5Hz, f_c+5Hz] frequency range caused by the power-generating plant must remain smaller than 0,1% of the reference voltage (Un for low voltage, Uc for high voltage) for each of the used communication frequencies f_c.

The interference voltages [f_c-100 Hz, f_c+100 Hz] frequency range caused by the power-generating plant must remain smaller than 0.3 % of the reference voltage (Un for low voltage, Uc for high voltage) for each of the used communication frequencies f_c.

8.1.2 PLC signals (3 kHz – 95 kHz)

For the maximum allowed disturbance level, please refer to the development of the international standardization regarding this issue. The IEC 61000-2-2 standard in particular will form a basis for establishing the emission limits that apply to power-generating plants.

8.2 Power Quality

8.2.1 Disturbances caused by operation in parallel

8.2.1.1 General requirements

Connecting to the distribution network is only allowed when the voltage and the frequency on the distribution network are within the margins specified in ANNEXE D (D.8)..

Moreover, as a general rule a parallel connection may not cause sudden voltage variations exceeding 4%. When the parallel connection is performed several times a day, the voltage variations, caused by parallel connections must be limited to the same values as described in section §8.2.2 « Rapid voltage changes ».

8.2.1.2 Additional requirements

The following addition requirements do not apply to small power-generating plants (as specified in chapter 4).

In the case of a rotating machine where synchronization with the voltage on the distribution network takes place, the disturbances and risk of damage are limited by using the synchrocheck relay (see §7.6.3).

With power-generating units connected without implementing such a synchrocheck relay, the transient currents when switching must be limited to the following limiting values:

- 150 % Inom (first sinus) and
- 120 % Inom (based on a measuring window of 200 ms)

If there are multiple power-generating units, the DSO may require them to be only enabled sequentially. These requirements will be included in the special exploitation conditions.

8.2.2 Rapid voltage changes

During operation, any sudden power variation may not influence the voltage level at the point of connection by more than 3%.

Depending on the frequency at which voltage variations occur (that may/may not originate from multiple power-generating units), the voltage variations must be limited to lower values to avoid disturbances for other DSU's connected to the same network. They may not cause flicker on the distribution network.

8.2.3 Flicker

Power-generating technologies driven by mainly variable force (such as wind turbines) in general result in fluctuating power flows and may, therefore, cause voltage variations and in particular the flicker phenomenon. The level of voltage changes and/or flicker, generated by the power-generating plant, may not exceed the relevant limits.

Also refer to the Synergrid technical prescriptions C10/17 or C10/19 depending on whether the power-generating plant is connected to the high voltage or low voltage distribution network.

8.2.4 Harmonics

The level of harmonics and inter-harmonics, generated by the power-generating plant may not cause disturbances in the distribution network.

Also refer to the Synergrid technical prescriptions C10/17 or C10/19 depending on whether the power-generating plant is connected to the high voltage or low voltage distribution network.

8.2.5 Unbalance

This clause is only applicable to power-generating plants with a 3-phase connection to the distribution network.

8.2.5.1 General requirements

A power-generating unit with a maximum power > 5 kVA must be connected to different phases and must be designed in such a way as to limit any imbalance between the powers produced on the different phases.

8.2.5.2 Additional requirement for a small power-generating plant

In case the power-generating unit connected to multiple phases, it must be ensured that the maximum power imbalance between the various phases is lower than 5 kVA.

If the power-generating plant consists of multiple single phase power-generating units, it must be ensured that the maximum power imbalance between the various phases is lower than 5 kVA. It should therefore be ensured that the power-generating units are optimally distributed across the three phas-

es. Compliance with this limit must be guaranteed by the design of the installation without having to install an imbalance protection relay as described in section §7.6.7.

Examples :

Phase 1	Phase 2	Phase 3	Autorised ?
		5 kVA	✓
	5 kVA	2 kVA	✓
3 kVA	3 kVA	3 kVA	✓
		3 kVA + 3 kVA	✘ Max. imbalance > 5 kVA
2 kVA 3 kVA	2 kVA	2 kVA + 1 kVA	✓
2 kVA	2 kVA	2 kVA + 4 kVA	✓
3 kVA	3 kVA	3 kVA + 2 kVA	✘ Sum > 10kVA *(the simplified procedure is not applicable because the plant is not a small power-generating plant)*

Table 6 – Examples of combinations of power-generating units

Note: in those examples, a power-generating unit with a three-phase connection is indicated by …… It is important that the power is distributed equally by the power-generating units across the three phases at all times.

8.2.5.3 Additional requirements for other (≠ small) power-generating plants connected to the low voltage distribution network.

In case the power-generating unit connected to multiple phases, it must be ensured that the maximum power imbalance between the various phases is lower than 5 kVA.

If the power-generating plant consists of multiple single phase power-generating units, it must be ensured that the maximum power imbalance between the various phases is lower than 5 kVA. It should therefore be ensured that the power-generating units are optimally distributed across the three phases.

If the number of single phase power-generating units is such that the respect of the abovementioned 5 kVA limit cannot be guaranteed at all time, the installation must be equipped with an imbalance protection relay as described in section §7.6.7.

8.2.5.4 Additional requirements for other power-generating plants connected to the high voltage distribution network

Also refer to the Synergrid technical prescription C10/17.

8.3 Momentary disconnections in the distribution network (due to automated switching operations in the network)

In order to limit disruptions in the distribution network as much as possible and, as a result, ensure continuity, this network performs fast automated switching operations. Examples are 'fast transfer'[23] and 'automated reconnection'[24].

As a result of such switching operations a section of the distribution network will be momentarily disconnected from the upstream network. When power-generating units are operating in parallel with this disconnected network, this will result in a transient form of island operation where a part of the distribution network is involved. This island will be reconnected to the upstream network through automated switching operations. At the moment of this connection, both parts of the distribution network may be asynchronous, due to the presence of power-generating units.

The switching operations referred to in this section may be regarded as 'special' (but not 'exception'). Their occurrence depends on the topology and exploitation method of the distribution network.

If the power-generating unit could sustain damage due to activation of these automated switching operations, it is the DSU's responsibility to take additional measures to avoid such damage. However, these measures shall not be in contradiction with the stipulations of these technical prescriptions, and can be determined after consultation with the DSO. The additional requirements concerning the protections (see higher) can also be useful for the protection of the power-generating plant in itself.

If the power-generating plant is not a small power-generating plant (as specified in section § 4.1.7), then:

- The DSU may obtain information from the DSO regarding the occurrence of these short term interruptions at the connection point.
- The DSU can determine in consultation with the DSO the additional measures mentioned above.
- Additional requirements for protection (see above) can also be useful for the protection of the power-generating plant itself.

23 In the power supply of some distribution networks 'fast changeover' (from the upstream transmission network) to various feed points is applied. Energization of the new feed point is slightly delayed in relation to disconnection of the old feed point, resulting in a momentary voltage interruption (island situation). This delay, which determines the duration of the interruption, is fixed at a value between 0,3 and 1,5 s.

24 In electrical or transmission networks with overhead connections, disconnection due to an electrical malfunction may be followed by automatic re-energization. The re-energization times are fixed at a value between 0,3 and approximately 30 seconds.

8.4 Evaluation of the point of connection

This section applies to all power-generating plants, except for the small power-generating plants (as specified in section § 4.1.7).

The DSO imposes the point of connection and the operating conditions in accordance with the connection power taking the regulation of each region into account based on the connection power and the technical criteria such as: the rating of the elements of the distribution network, the nominal power of the transformers and the expected increase in power at the other points of connection. The connection power is usually selected based on the maximum conceivable power transit ay the point of connection (the larger of these two powers: the maximum supplied power or the maximum demanded power). The operating conditions take, among other elements, the situations that could result in congestion into account.

8.5 Added short circuit power

This section applies to all power-generating plants, except for the small power-generating plants (as specified in section § 4.1.7).

8.5.1 General

The sum of short circuit power that is provided by the power-generating plant to the point of connection and the short circuit power available on the distribution network has to be in line with the actual ratings of the equipment of the distribution network.

In order to evaluate this compatibility and to determine whether the power-generating plant may or may not be connected and if so, under which conditions, the DSO takes the following into account.

By default, the short circuit power S_{SC} that is added by the power-generating plant[25] must be limited to the relevant value from the list hereafter. Nevertheless, if the study of the network by the DSO shows the necessity, a different limit may apply.

- 800 % of Sn for projects where Sn ≤ 400 kVA
- 600 % of Sn for projects where 400 kVA < Sn ≤ 1 MVA
- 500 % of Sn for projects where 1 MVA < Sn ≤ 4 MVA
- 400 % of Sn for projects where 4 MVA < Sn ≤ 10 MVA
- 300 % of Sn for projects where 10 MVA < Sn ≤ 15 MVA
- 150 % of Sn for projects where 15 MVA < Sn

For backup power systems as indicated in section §2.2.1, this requirement is relaxed to the following values:

- 300 % of Sn for projects where 10 MVA < Sn

The evaluation of the application to connect may result in the obligation for the DSU to:

- to take measures to limit the short circuit power supply
- to install a transformer with an adapted short circuit voltage between the power-generating unit and the distribution network (only for a power-generating plant with a maximum power > 250 kVA).

[25] If the power-generating project consist of several power-generating plants, the project will be considered as a whole, even if the individual plants have different points of connection to the distribution network (insofar as the connection points are situated in one and the same electrical zone) . When a scheduled power-generating unit or multiple units have a single point of connection, the power-generating unit or units are considered to be the power-generating project. When a generating project concerns power-generating units scheduled downstream various points of connection to the distribution network, the power-generating project is evaluated as a whole as well.

Moreover, the contribution of the power-generating project to the short circuit power should furthermore be smaller than the available margin[26] on the distribution network (Synchronous, asynchronous, connected using power electronic equipment).

The connection of the power-generating plant may, therefore require network upgrades.

8.5.2 Specific to synchronous power-generating units

This assessment is based on the resulting short circuit impedance calculated based on the saturated transient impedance X'd of the power-generating unit and, if the transformer is available, its short circuit voltage for synchronous power-generating units.

Example of a connection with or without transformer

The calculation example below gives the assessment of the short circuit contribution of a power-generating unit with the following characteristics:

S_{gen}= 2400 kVA with X'd = 17 %

In case of a direct connection, the short circuit contribution (588% Sn) exceeds the maximum allowed short circuit contribution (500% Sn).

If the power-generating unit is connected via a transformer of 3,6 MVA, the limit is respected if the transformer has ta short circuit voltage (Usc) of at least 4,5 %. The short circuit contribution is just limited to the allowed 500% with this value.

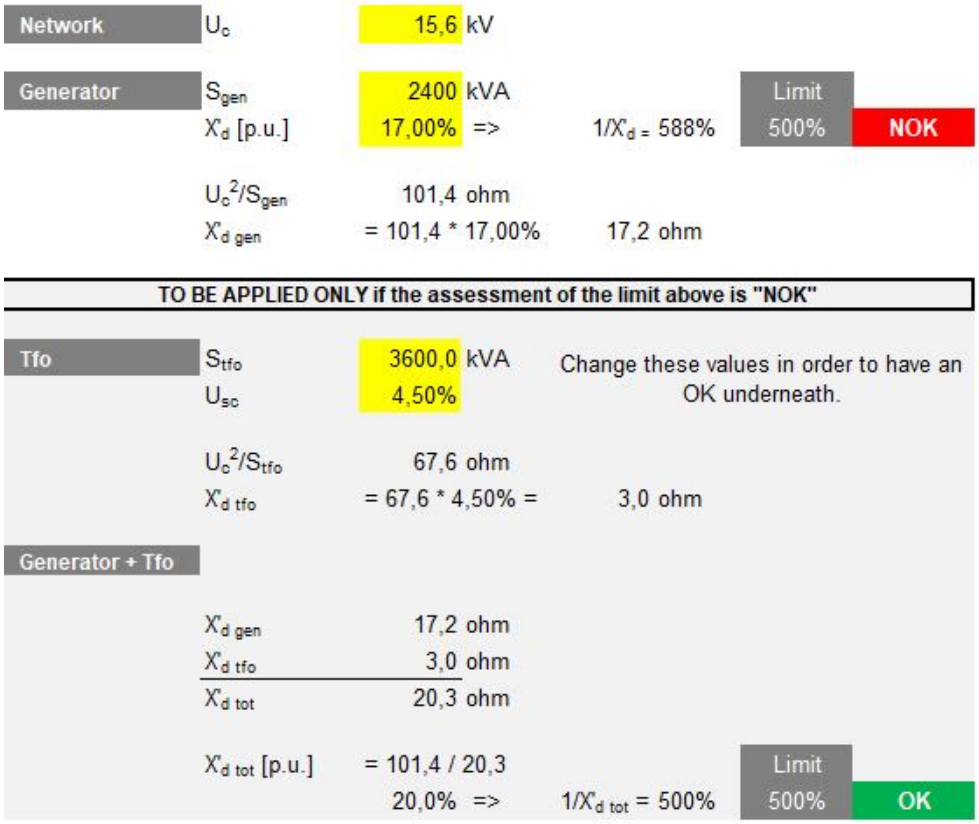


Figure 6 – Example of calculation of added short circuit power

[26] This margin is the surplus of the actual capacities of the equipment installed on the network with respect to the already existing short circuit capacity. The DSO checks this during the network study, given that only the DSO has the information of the installations connected to this network.

Example with multiple power-generating units in the power-generating plant:
Set two power-generating units with power S1 and S2 respectively, and transient impedance X'd1 and X'd2 respectively. The resulting transient impedance X'd will then be achieved as follows:

$$X'd = X'd1 \cdot X'd2 \cdot (S1 + S2)/(X'd1 \cdot S2 + X'd2 \cdot S1)$$

8.5.3 Specific to asynchronous power-generating units

The contribution to the short circuit power of the power-generating unit is calculated based upon the maximum contribution Ik to the short circuit current in permanent regime during a three-phase short circuit (also see IEC 60909).

The corresponding short circuit power Ssc is calculated as follows based on this value:

$$S_{SC} = \sqrt{3} \cdot U_n \cdot I_k$$

Remarks:

- I_k is the RMS value of the current after the transient phase that can occur at the beginning of the short circuit. IEC 60909 does not specify a start time for the steady state. Consequently, I_k must be regarded at the actual time of reaching the steady state that can be specific for the considered power-generating plant (for example 150 ms).
- Since the short circuit contribution also depends on the residual voltage during the short circuit, the maximum value of I_k is taken for the calculation. If, for example, different calculation scenarios are possible for the residual value of the voltage, the most negative scenario must be taken into account and, consequently, the highest value I_k for the calculation of short circuit power S_{SC}.

8.6 Impact of the distribution network's short circuit power on immunity against voltage dips [NC RfG Art 14.3 (iv-v)]

This paragraph is applicable to synchronous power-generating modules ≥ 1 MW (Type B according to NC RfG).

As specified in section D.5.2 of ANNEXE D, with some technologies the immunity to voltage dips can be influenced by the short circuit power available at the distribution network to which the power-generating plant is connected.

With such technologies the requirements in Section D.5.2 of ANNEXE D fully apply when the power-generating module's maximum power is not higher than 10% of the short circuit power available at the point of connection. If the power-generating module's maximum power is higher, the immunity requirement can be modified in consultation with the DSO, taking the real characteristics of the distribution network into account.

The minimum available short circuit power at the point of connection is calculated in accordance with the condition of the prescription C10/17. The following will be taken into account:

- 100 MVA as a minimum reference short circuit power at the secondary terminals of the transformer that connects the high voltage distribution network to a (local) transmission network or a distribution network that is exploited at a higher voltage level.
- The impedance between the transformer station specified above and the power-generating plant's point of connection.

Contact the DSO for more information.

8.7 Congestion situations

This section is applicable only to power-generating plants connected to the high voltage distribution network with a maximum power > 250 kVA.

In a (potential or proven) congestion situation of the network, for example an N-1 situation[27], the total power of the power-generating plants may not exceed the maximum admissible power of the network elements. Other obligations with regard to the power can be linked to the characteristics of the network upstream[28].

The connection prescriptions can determine that the power-generating plant may not operate in case of one of more congestion situations of the distribution network (or only with limited power), taking the specific regulations for each Region into account. In these cases, the specific operation requirements relating to remote control, measuring and/or monitoring are registered in the connection agreement after mutual consultation.

8.8 Voltage detector when there is a risk of island operation

This section is only applicable to power-generating plants connected to the high voltage distribution network with a maximum power > 250 kVA.

Notwithstanding the installed interface protection system (see §7.6.2), there is always a residual risk of island situations, involving a part of the high-voltage distribution network, which are not detected by the protection device. This can lead to a part of the high-voltage distribution network being be undesirably powered by the power-generating plant and not necessarily synchronous to the rest of the distribution network (or the network on which the distribution network is connected). To make sure no connection is possible between both parts of the network, it can be necessary to install a voltage detector at the point of connection[29],to prevent any (possibly asynchronous) reconnection. This mechanism is only mandatory for power-generating plants above a specific power level, which is determined by the DSO based on the local situation.

8.9 Parallel interconnections in the distribution network by the DSO

This section is applicable only to power-generating plants connected to the high voltage distribution network with a maximum power > 250 kVA.

During normal exploitation of the distribution networks, the DSO sometimes realizes parallel interconnections in the distribution network. The presence of power-generating plants may hinder such in-parallel operations or even make these impossible. That is why the operator of the power-generating plant with a maximum power > 250 kVA can be imposed by the DSO to momentarily limit the generated power and/or to apply a modified power factor.

8.10 Transformer inrush current

This section is applicable only to power-generating plants connected to the high voltage distribution network with a maximum power > 250 kVA.

If the power-generating module is connected to the network through a transformer, you must ensure that the inrush current remains restricted when switching on the transformer to ensure that the selectivity with regard to fault current is not put at risk and to limit network faults.

[27] The N situation is the situation of the distribution network with no malfunction elements, the N-1 situation is the situation of the network with one (1) malfunction element.

[28] Following the specific legislation of each Region.

[29] This usually starts from an injection location. The connection can also be realized at different locations on the distribution network. In that case the same mechanism is to be installed at each location.

Possible measures that the DSU can take to restrict the inrush current are, for example, realizing the magnetization of the transformer:

- by the power-generating module itself ; or
- through a series resistance from the distribution network; or
- synchronously with the zero crossings of the voltage on the distribution network.

The current surges always comply with the requirements specified in Synergrid technical prescriptions C10/17 (refer to §5.3.3, in the 2009 edition).

As from certain transformer capacities the inrush current must remain limited to 100% of the rated current (for all sinuses, even for the first one following energization). The applicable power limit depends on 2 elements:

- the nominal voltage of the high-voltage distribution network to which the power-generating plant is connected;
- whether the power-generating plant is connected to a loop of the high-voltage distribution network or is directly connected to a transformer station which is connected with a higher voltage level.

The default power limits are given in Table 7. Nevertheless, in function of the local network situation and/or where multiple transformers are used in parallel, more stringent limits may be imposed by the DSO.

Nominal voltage of high-voltage distribution network	**Limit value**	
	Connected to loop	**Connected to transformer station**
10 kV	3200 kVA	4900 kVA
11 kV	3500 kVA	5300 kVA
12 kV	3800 kVA	5700 kVA
15 kV	4800 kVA	7200 kVA
29,9 kV	9300 kVA	13900 kVA
36 kV	11200 kVA	16800 kVA

Table 7 – Lower power limit where the inrush current must remain limited to 100% of the rated current

ANNEXE A Summary of major equipment required (informative)

The hyperlink below gives access to a table summarizing, for information purposes, the main equipment required by these technical prescriptions, according to the following characteristics:

- Distribution network voltage to which the plant is connected (LV or HV)
- In low voltage: single phase or 3-phase connection
- Maximum power of the power-generating plant
- Presence or not of an energy storage system

In the event of a conflict between these C10/11 requirements and the table accessible via this link, these requirements shall prevail.

matrix

ANNEXE B Synergrid homologation procedure (for informal purposes)

All lists of homologated materials are available on the website www.synergrid.be, under the heading 'Gehomologeerde materialen' (Dutch) or 'Matériels homologués' (French) [homologated materials].

That page includes a general S1/01 procedure, describing the procedure for applying for homologation and extension of homologation of materials. This procedure applies to all materials that are homologated at Synergrid level and describes the steps to be taken by a manufacturer or importer to have the materials homologated by Synergrid.

The lists that are relevant to the C10/11 prescriptions have a code starting with C10/xx.

Where the lists are concerned for which the C10/11 prescriptions do not include technical requirements, technical specifications are available for each list including the technical requirements for homologation as well as specific conditions regarding the homologation procedure.

ANNEXE C Protection settings

C.1 Settings of the automatic separation system (integrated or external)

Whenever an automatic separation system is used in accordance with these technical specifications, the automatic separation system must be set in accordance with settings as specified in Table 8 here-under.

Function	**Trip setting**
Overvoltage 10 min mean	230 V + 10 % no delay*
Overvoltage	230 V +15 % no delay*
Undervoltage	230 V -20 % no delay*
Overfrequency	51,5 Hz no delay*
Underfrequency	47,5 Hz no delay*
LoM	according to EN 62116
** « No delay » means that no time delay is added to the intrinsic technical duration required to initiate the disconnection. The operate time may not exceed 200ms.*	

Table 8 – Settings of the automatic separation system

C.2 Interface protection relay settings

The table below includes an overview of the guidelines regarding the settings of the interface protection relay. Both the margin settings and the default settings are specified per protection function. The default settings may be used when the DSO does not provide specific settings. If the DSO does specify other settings values, these must be complied with.

Function	**Range settings** (Trip value Time delay*)	**Default settings** (Trip value Time delay*)
U>>	> 110 % U_n 0 s	115 % U_n 0 s
U>	≤ 110 % U_n 0 – 3 s	110 % U_n 1 s
U<	50 – 85 % U_n 0 – 1,5 s	70 % U_n 1,5 s
U<<	25 – 50 % U_n 0 s	25 % U_n 0 s
f>	51,5 Hz 0 s	51,5 Hz 0 s **
f<	47,5 Hz 0 s	47,5 Hz 0 s **
U_0 ****	20 % U_n 0 – 1,5 s	20 % U_n 1,5 s
At least 1 of the following island detection functions (based on the selected relay)		
df/dt (RoCoF)		1 Hz/s 200 ms **
Vector jump		7° (three-phase) 0 s
Activation of a narrower frequency window based on local voltage criteria.***		

* *A 0 s time delay means that no relay is added to the intrinsic technical duration required to initiate disconnection. The set delay is therefore the minimum value authorized by the tool used for programming the relay. The total duration of the shutdown may never exceed 0.12 seconds.*

** *Depending on the chosen protection relay, another time delay might be needed in order to assure the operate time is about*
- *100 ms for functions f< and f>*
- *300 ms for function RoCoF*

Remark: The term 'operate time' is clarified in Figure 8.

*** *This method complies with the description in the European standardization documents EN 50549-1 and EN 50549-2 of 'Example strategy 1' in their annex 'Examples of protection strategies' (see* Figure 7 *hereunder for the schematic diagram)*

**** *Only required when measuring at high voltage*

Table 9 – Settings of the interface protection relay

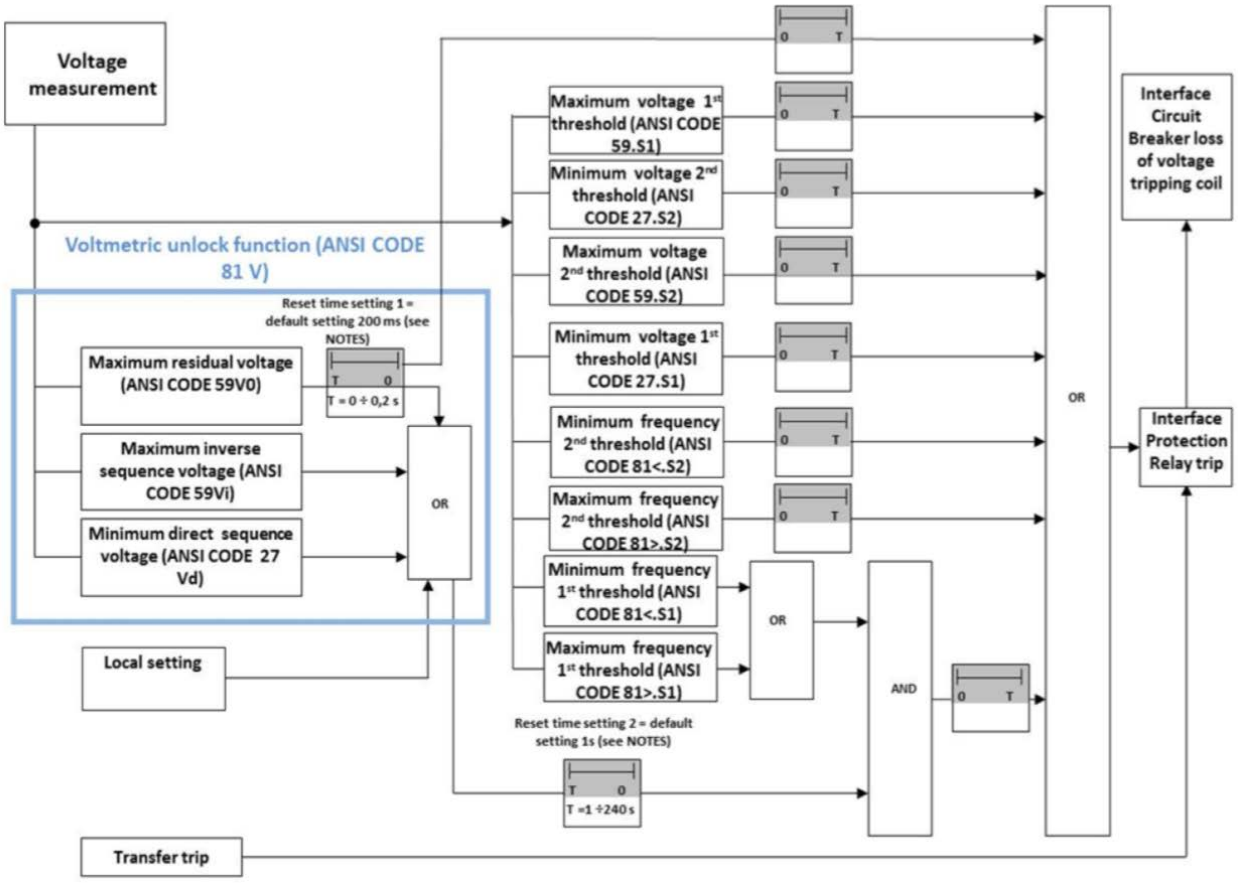


Figure 7 – Typical scheme for a island detection protection with the activation of a narrower frequency window based on local voltage criteria (source: EN50549-1 :2019 et EN50549-2 :2019)

Figure 8 hereunder illustrates the term ‘operate time’ used above. The figure clearly shows that the operate time is the sum of the following parts:

- the ‘start time’ determined by the operating principle of the protection relay
- the ‘time delay setting’ that corresponds to the above time delay.

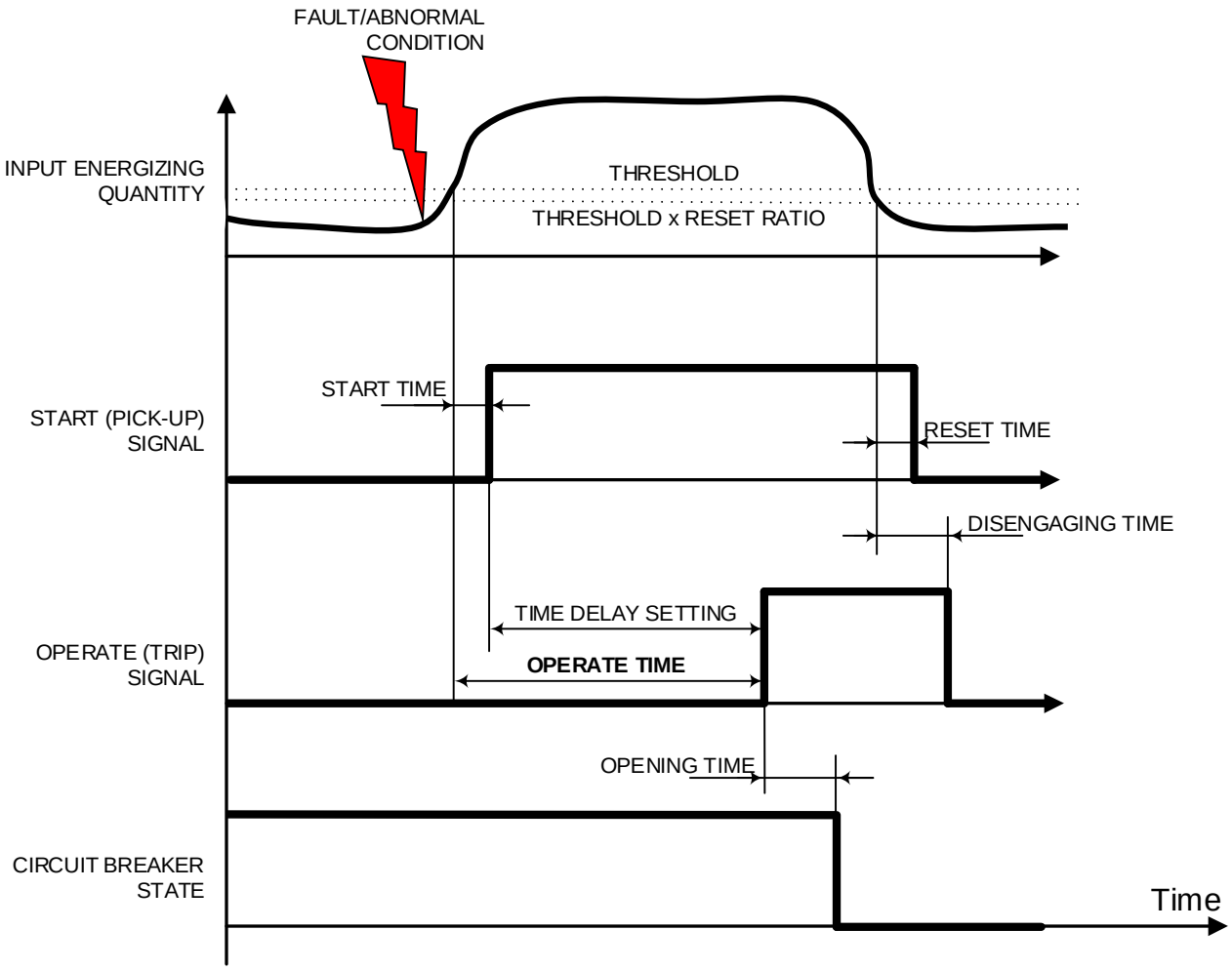


Figure 8 - Main durations that define the performance of the decoupling protection

ANNEXE D Technical basic requirements regarding the power-generating units

D.1 General

In line with the scope of these technical specifications as well as the CENELEC standards EN 50549-1 and EN 50549-2, these requirements are applicable to all kinds of generation of electrical energy, including energy storage systems.

In order to facilitate the reading of these requirements, some content of abovementioned CENELEC standards is given in a concise way in the frames marked in brown. This is only informative. For the correct and complete application of the requirements, the CELELEC standard itself must be consulted.

⊕ Just for information, the requirements in this annex that go beyond the default requirements covered in the CENELEC standard EN 50549-1: 2019 and/or EN 50549-2: 2019 are marked with the icon in the margin[30].

D.2 Order of priorities [NC RfG Art 13 2.(g) + Art 14 5.(c)]

If different requirements on the power-generating unit interfere with each other, the hierarchy listed in EN 50549-1 or EN 50549-2 shall be respected (in edition 2019, see clause 4.1 « General»).

In brief, the standard specifies following hierarchy:

1. Generating unit protection, including regarding the prime mover.
2. Interface protection and protection against fault within the power-generating plant;
3. Voltage support during faults and voltage steps;
4. The lower value of: remote control command on active power limitation setpoint from the DSO and local response to overfrequency;
5. Local response to underfrequency if applicable;
6. Reactive power and active power (P(U)) controls;
7. Other control commands on active power set point for e.g. market, economic reasons, self-consumption optimization.

Note: Item 4 in the hierarchy makes reference to a remote control command from the DSO on active power limitation. For power-generating plants where no such capability is required, this item only addresses the local response to overfrequency.

[30] When a new edition of the European standard is issued, a new evaluation should be carried out to identify to what extend the requirements go beyond the default requirements of this new edition.

D.3 Integrated automatic separation system

This clause is applicable to power-generating units with a maximum power ≤ 30 kVA.

An integrated automatic separation system is strongly recommended in order to facilitate the installation procedure. Indeed, if the power-generating unit is not equipped with such an integrated system, an external device must be used (see section § 7.5).

For the integrated automatic separation system, the requirements of this clause apply.

Following protection functions are required:

- Overvoltage 10 min mean
- Overvoltage
- Undervoltage
- Overfrequency
- Underfrequency
- A means to detect island situation (LoM) according to EN 62116.

All of these protection functions must comply with the relevant requirements in EN 50549-1 (in edition 2019, section 4.9.3 « Requirements on voltage and frequency protection »).

The integrated automatic separation system must have single fault tolerance according to EN 50549-1. (edition 2019, see clause 4.13 « Requirements regarding single fault tolerance of interface protection system and interface switch »).

The integrated automatic separation system must be set in accordance with the settings as specified in ANNEXE C (C.1).

D.4 Operating ranges

Generating plants shall have the capability to operate in the operating ranges specified below regardless of the topology and the settings of the interface protection.

D.4.1 Operating frequency range [NC RfG Art 13 1.]

This clause in not applicable to backup power systems as specified in § 2.2.1.

The power-generating unit must comply with the minimum requirements of the applicable standard EN 50549 or EN 5055-2 on the operating frequency range (edition 2019, see clause 4.4.2 « Operating frequency range »)

In brief, the requirements in the standard are as follows:

Frequency domain	Duration
47,5 Hz – 49,0 Hz	30 minutes
49,0 Hz – 51,0 Hz	Permanent
51,0 Hz – 51,5 Hz	30 minutes

Additionally, the DSO shall be informed about the capability of the power-generating unit to operate in the frequency range from 51,5 Hz and 52,5 Hz and, where appropriate, the maximum duration of operation in this frequency range.

The URD cannot without good reason refuse to apply wider frequency ranges or longer minimum operating periods than those specified above, provided that the technical and economic impact is limited[31],

[31] In case of disagreement of the DSU with the DSO's view about the degree of technical impact, the DSU has the possibility to launch an appeals procedure upon the regulatory authority.

D.4.2 Maximum admissible power reduction in case of underfrequency [NC RfG Art 13 4. + Art 13 5.]

No-break

This clause is not applicable to backup power systems as specified in §2.2.1.

In general, a power-generating unit must continue to operate in case of a reduction of the frequency at the point of connection. This means that, in underfrequency, the power-generating unit should reduce the output power as little as possible and at least being capable of staying above the limit specified hereafter.

Where the technical capabilities of the power-generating unit are influenced by ambient conditions, these technical capabilities may be demonstrated using the following reference conditions: :

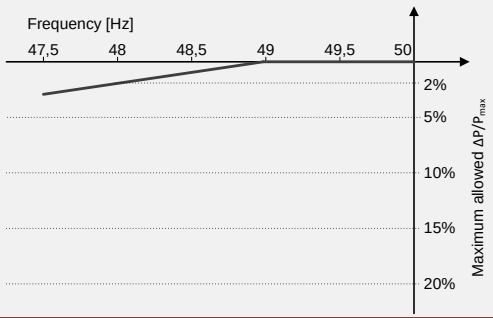
- Temperature : 0 °C
- Altitude : between 400 and 500 m
- Humidity : between 15 and 20 g H_2O/kg air

Remark: If the power-generating unit has the capability to raise the output in underfrequency situations, this is not forbidden but subject to specific requirements (see Section D.6.2 « Power response to underfrequency »).

D.4.2.1 Limit for non-synchronous power-generating technology (Power Park Modules)

The power-generating unit must comply with the most stringent requirement of EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.4.3 « Minimal requirement for active power delivery at underfrequency »).

In brief, the most stringent requirement in the standard is as follows :



The characteristics of the limiting curve are given in the Table 10.

Parameter	Value
Frequency threshold	49 Hz
Slope	2 %/Hz

Table 10 – characteristics of the limiting curve for the non-synchronous power-generating technologies

D.4.2.2 Limits for synchronous power-generating technology

In steady state (from t2 onwards), the power-generating unit must comply with the relevant default requirement of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see section 4.4.3 « Minimal requirement for active power delivery at underfrequency »).

Additionally, in the transient time (between t1 and t2), the power-generating unit must comply with the relevant most stringent requirement of EN 50549-1 or EN 50549-2. (In edition 2019 of the standard, the relevant requirements can be found in clause 4.4.3 « Minimal requirement for active power delivery at underfrequency »).

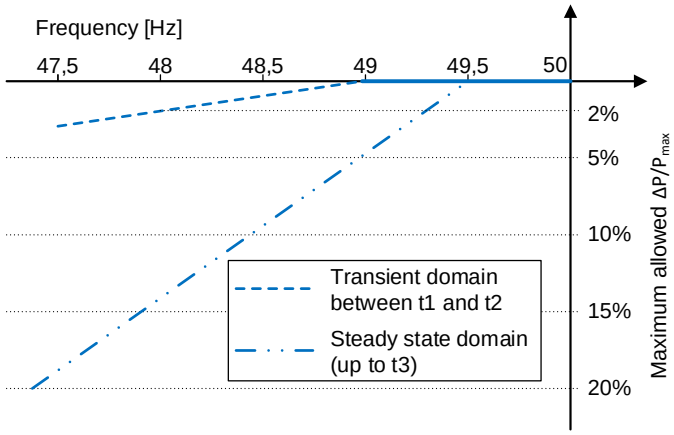


Figure 9 – Limits for the synchonous power-generating technologies

t1, t2 and t3 are given in the following table, together with the characteristics of the limiting curves.

	Parameter	Value
Transient domain	Frequency threshold	49 Hz
	Slope	2 %/Hz
	t 1	≤ 2 seconds
	t 2	30 seconds
Steady state domain	Frequency threshold	49,5 Hz
	Slope	10 %/Hz
	t 3	≥ 30 minutes

Table 11 – Characteristics of the limiting curves for the synchronous power-generating technologies

D.4.3 Continuous operating voltage range

The power-generating unit must comply with the relevant requirement of EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.4.4 « Continuous operating voltage range »).

In brief, the requirement in the standard specifies the power-generating plant should be capable to operate continuously when he voltage at the point of connection is within the following range :

- For a connection to the low voltage network: 85 % U_n < U < 110 % U_n where Un = 230 V
- For a connection to the high voltage network: 90 % Uc < U < 110 % Uc where U_c is the declared voltage.

It is also allowed to reduce apparent power in case of voltage is below respectively 95 % U_n or 95 % U_c.

D.5 Immunity to disturbances

Independent of the topology and the settings of the interface protection, a power-generating unit must have the following withstand capabilities.

D.5.1 Rate of change of frequency (RoCoF) immunity [NC RfG Art. 13 1.(b)]

No-break

This clause does not apply to the backup power systems as specified in §2.2.1.

The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see section 4.5.2 « Rate of change of frequency (RoCoF) immunity ») taking the additional modifications and information specified hereunder into account.

The power-generating unit shall have the capability to stay connected and operate when the frequency at the point of connection changes with the frequency against time profiles as depicted in the figures hereunder. When considering a sliding measurement window of 500ms, these profiles have a maximum RoCoF of 2 Hz/s.

+

For synchronous generating technology, this requirement is more stringent than the default value in the applicable standard EN 50549-1 or EN 50549-2 (2 Hz/s instead of 1 Hz/s) as, in contrast with the standard, no distinction is made between power-generating technologies.

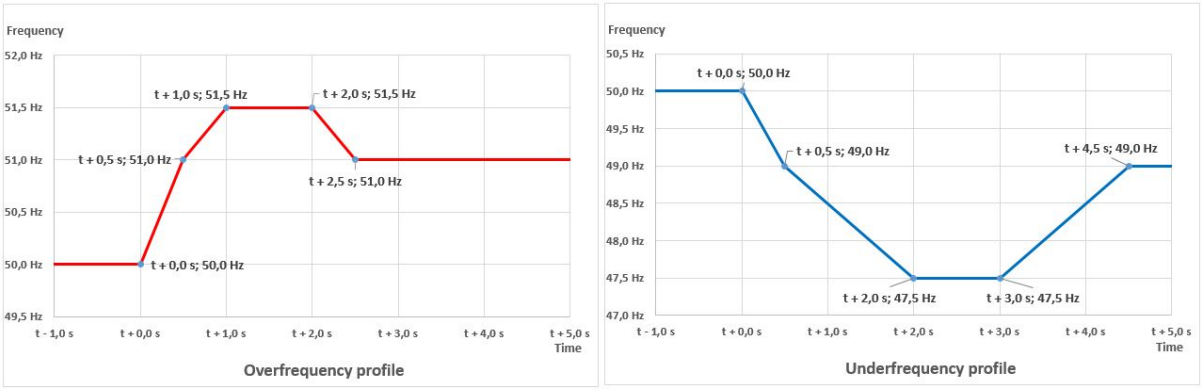


Figure 10 – Frequency against time profiles for rate of change of frequency immunity

D.5.2 Under-voltage ride through UVRT [NC RfG Art. 14 3.(a) + Art. 17 3. + Art. 20 3.(a)]

No-break

This section is not applicable to backup power systems as specified in §2.2.1.

For a power-generating unit that is part of a power-generating module with a power ≥ 1 MW (type B in accordance with NC RfG) this paragraph is mandatory.

For a power-generating unit that is part of a power-generating module with a power < 1 MW, this paragraph is non-mandatory and to be considered as a orienting capability, not as a hard requirement. However, the real withstand capability to voltage dips shall be provided during the homologation process.

The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.5.3 « Under-voltage ride through (UVRT) »), with the following change:

- The voltage-time profiles are to be replaced by the profiles hereunder.

As a consequence, for synchronous generating technology this profile is more stringent than the default requirement in EN 50549-1 or EN 50549-2.

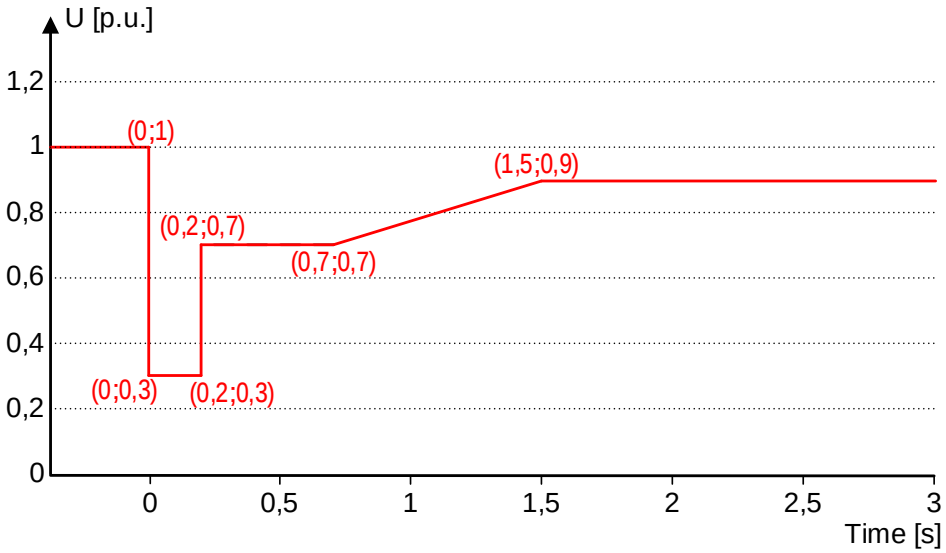


Figure 11 – Voltage-time profile for synchronous generating technology

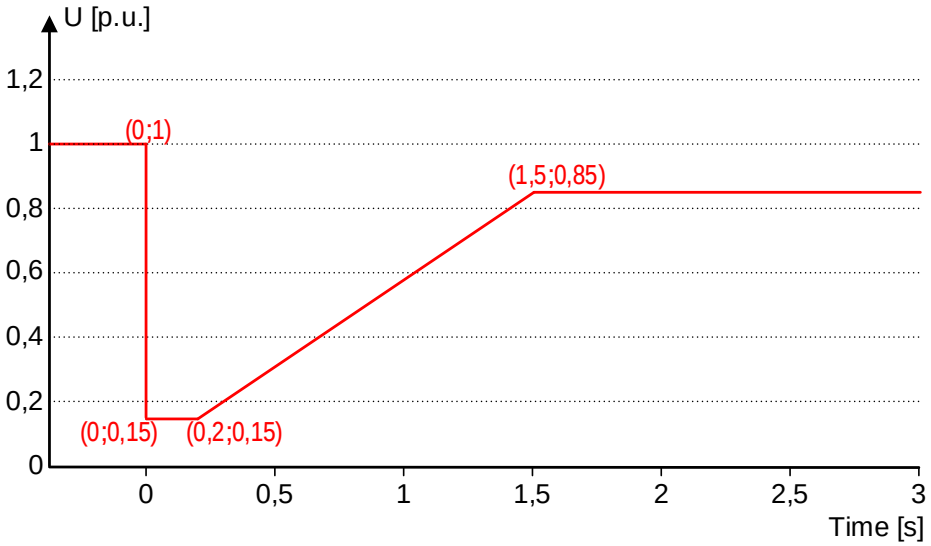


Figure 12 – Voltage-time profile for non-synchronous generating technology (Power Park Module)

For some power-generating technologies, the behaviour of the power-generating unit during and after voltage dips may be impacted by the short circuit power available at the point of connection.

For such technologies different cases can be considered:

- Compliance with this UVRT requirement can be demonstrated considering a ratio of 10 between the available short circuit power at the connection point and the maximum power of the considered power-generating module. In this case, no further checks are needed.

- If not, the manufacturer must declare the minimum short-circuit power conditions for which the UVRT-requirement can be complied with. This value shall be considered during the installation process.

In line with EN 50549-1 or EN 50549-2 at least 90% of the pre-fault power or 90% of the available power whichever is the smallest, shall be resumed as fast as possible, but at the latest within the following default time after the voltage returned to the continuous operating voltage range (85% Un < U < 110% Un for a connection to a low-voltage distribution network; 90% Uc < U < 110% Uc for a connection to a high-voltage distribution network):

- 3 seconds for a power-generating unit with synchronous generating technology
- 1 second for a power-generating unit with non-synchronous generating technology

Another site specific maximum allowed time is to be agreed during the commissioning process. This decision must be taken with the DSO in coordination with the TSO. .

No-break

For a backup power system connected to the high voltage distribution network as specified in §2.2.1, the general requirement is this clause may be relaxed, replacing the voltage-time profile by the figure underneath.

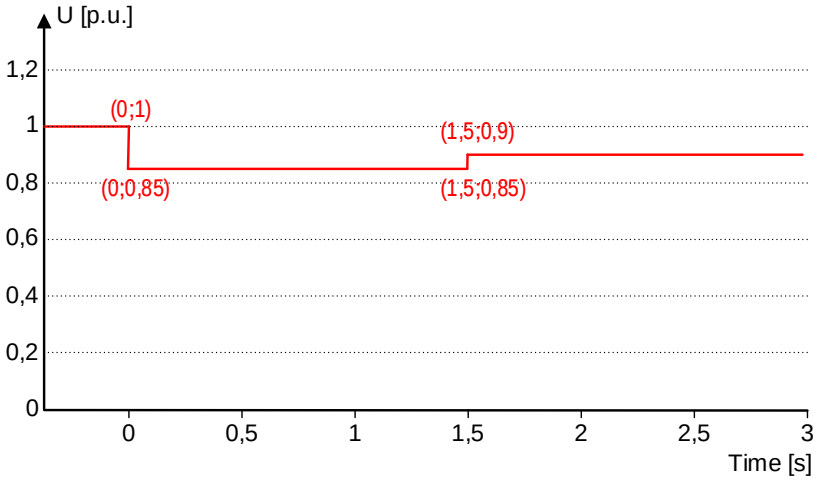


Figure 13 – Voltage-time profile for packup power systems

D.5.3 Over-voltage ride through (OVRT)

Requirement under consideration for a future edition.
No requirement in this edition.

D.6 Active response to frequency deviations

D.6.1 Power response to overfrequency [NC RfG Art 13 2.]

No-break

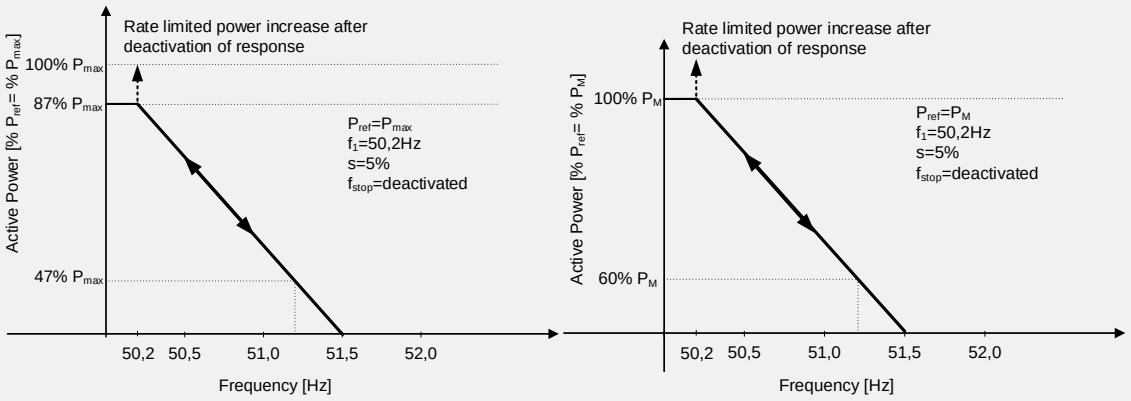
This clause is not applicable to backup power system as specified in section §2.2.1

The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see 4.6.1 « Power response to overfrequency ») taking into account the additional modifications and information specified hereunder.

In brief, the required behaviour in the standard is illustrated by the following examples:

P_{ref} is defined as following:

- P_{max} for synchronous power-generating technology or energy storage systems
- P_M for all other types of non-synchronous power-generating technology



Example with $P_{ref} = P_{max}$ Example with $P_{ref} = P_M$

With:

- P_{max} being the maximum power of the power-generating module
- P_M being the active power generated by the power-generating module at the instant the frequency rise reaches the threshold frequency

Instead of the default maximum step response time of 30s specified in the standards EN 50549-1 and EN 50549-2, the following dynamic step response characteristics are required:

- **For synchronous power-generating technologies**

Parameters	For power increase	For power decrease
Step response time	≤ 5 minutes for an increase of active power of 20 % Pmax *(please note that the response should be as fast as technically feasible, for example: a slow reaction is not applicable in the case of an increase shortly (few seconds) following a decrease phase)*	≤ 8 seconds for a decrease of active power of 45 % Pmax
Settling time	≤ 6 minutes for an increase of active power *(please note that the response should be as fast as technically feasible, for example: a slow reaction is not applicable in the case of an increase shortly (few seconds) following a decrease phase)*	≤ 30 seconds for a decrease of active power

Table 12 – Dynamic step response time characteristics (synchronous power-generating technologies)

For power-generating units base on a gas turbine or an internal combustion engine with technical specificities not allowing compliance with the prescriptions applied by default as described above, the following alternative prescription, relating to a minimum power gradient in increasing or decreasing frequency, is applicable:

- If P_{max} ≤2 MW at minimum 1,11 % P_{max} per second
- If P_{max} >2 MW at minimum 0,33 % P_{max} per second

- **For non-synchronous power-generating technology**

Parameters	For power increase	For power decrease

Step response time	<u>For wind generation:</u> ≤ 5 seconds for an increase of active power of 20 % Pmax *(please note that the response should be as fast as technically feasible, for example: at operating points below 50% of maximum power a slower reaction may apply, nonetheless, the response time shall not be more than 5 s)* <u>For the rest:</u> ≤ 10 seconds for an increase of active power of 50 % de Pmax	≤ 2 seconds for a reduction of active power of 50 % Pmax
Settling time	≤ 30 seconds for an increase of active power	≤ 20 seconds for a reduction of active power

Tableau 13 - Dynamic step reponse time characteristics (non-synchronous power-generating technologies)

The figure hereunder clarifies the terms « Step response time» and « Settling time». In this clause, the 'Value' is the active power and the tolerance is 10%.

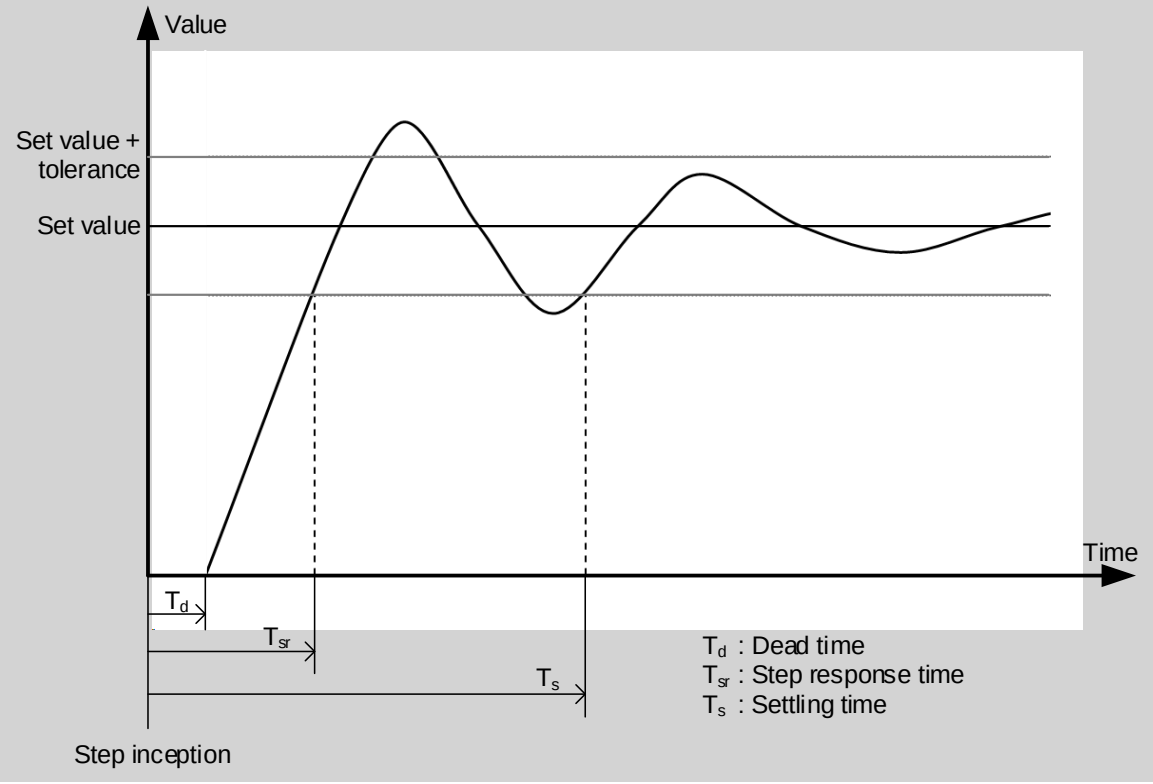


Figure 14 – Timing data for step response behaviour

In line with the default requirement of the applicable standard EN 50549-1 :2019 or EN 50549-2 : 2019, power-generating units reaching their minimum regulating level shall, in the event of further frequency increase, maintain this power level until a frequency decrease results in a power setpoint which is again above this level.

The optional deactivation threshold f_{stop} is not required. In case f_{stop} is implemented, it shall be deactivated.

At the time of deactivation of the active power frequency response (= frequency goes down below the threshold frequency f_1), the active power can be increased to up to the level of the available power. Nevertheless this shall be done respecting a power limit with a gradient of 10% P_{max}/min.

The parameter setting shall be as follows:

Parameter	Range	Setting
Threshold frequency f_1	50,2 Hz to 52 Hz	50,2 Hz
Deactivation threshold f_{stop} (optional)	50,0 Hz to f_1	Deactivated
Droop	2 % to 12 %	5 % (40 % P_{ref}/Hz)
Intentional delay	0 s to 2 s	0 s *
* *The actual default setting is 0 s. Nevertheless, for units without remote monitoring and control, this value could be reviewed as a result of the evaluation of the risk of having unintended island operations.*		

Table 14 – Parameter settings for power response to overfrequency

For energy storage systems with a connection to the high-voltage distribution network, the DSU might, for justified technical or security reasons, agree with the DSO on applicable minimum state of charge limits in his connection agreement.

The settings must be protected from unpermitted interference (e.g. by a password or seal).

Automatic disconnection and reconnection as alternative for the droop function [NC RfG Art. 13 2.(b)] are not permitted by default as per the TSO provisions.

D.6.2 Power response to underfrequency

The power-generating unit must comply with the relevant requirements of the applicable EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.6.2 « Power response to underfrequency ») taking additional modifications and information as specified hereunder into account.

This clause is applicable to energy storage systems. For justified technical or security reasons, the DSU might agree with the DSO (in his connection agreement is the power-generating plant is connected to the high-voltage distribution network) on applicable maximum state of charge limits in his connection agreement.

This clause is optional for all other power-generating units. When, in such units, the capability of activating active power response to underfrequency is activated, the power-generating units must comply with the requirements of this clause.

Instead of the default maximum step response time of 30s in EN 50549-1 and EN 50549-2, the required dynamic step response characteristics (step response time and settling time) are identical to those stipulated above regarding the power response to overfrequency, including the alternative approach for power-generating units based on a gas turbine or an internal combustion engine (see D.6.1).

If the function is enabled, the parameters shall be set as following:

Parameter	Range	Setting
Threshold frequency f_1	49,8 Hz to 46 Hz	49,8 Hz
Droop	2 % to 12 % **	For energy storage systems: 2 % (100% Pref/Hz) ** For all other power-generating units (if applicable): 5 % (40% Pref/Hz)
Intentional delay	0 s to 2 s	0 s *

* *The actual default setting is 0 s. Nevertheless, for units without remote monitoring and control, this value could be reviewed as a result of the evaluation of the risk of having unintended island operations.*

** *Considering the principles of the Art. 15.3 of the Emergency and Restoration Network Code[32], a droop if 1 % is requested for energy storage systems having a maximum power ≥ 1 MW. If this is technically not possible, alternatively a droop of 2% is accepted.*

In application of the article 15.3 (b) of the Emergency and Restoration Network Code, an energy storage system having a maximum power ≥ 1 MW shall disconnect prior to the activation of the automatic low frequency demand disconnection scheme (starting at 49Hz), if it is still in charging mode. The disconnection threshold can be fixed randomly within the range [49Hz 49,2 Hz].

Table 15 – Parameters settings for power response to underfrequency

The settings must be protected from unpermitted interference (e.g. by a password or seal).

D.7 Power response to voltage changes

D.7.1 Voltage support by reactive power [NC RfG Art 17 2.(a) + Art 20 2.(a)]

A backup power system as referred to in section §2.2.1, must not comply with the requirements of this clause. Instead, for such a system, the power factor must be as close to 1 as possible and may definitely not fall below the limit of 0.85 during in-parallel operation. No control mode at all for the reactive power is imposed by the DSO.

The power-generating plant must at least comply with the corresponding requirements of the applicable standard EN 50549-1 or EN 50549-2[33] (edition 2019, see clause 4.7.2 « Voltage support by reactive power ») taking the modifications and additional information specified hereunder into account. It is usually the power-generating unit itself that meets this requirement, which is assessed at the time of the homologation. In the other cases, if for example additional equipment such as a capacitor bank is necessary in combination with the power-generating unit, this will be evaluated by the DSO during the procedure for commissioning.

[32] Emergency and Restoration Network Code refers to COMMISSION REGULATION (EU) 2017/2196

[33] considering the default capacity range for Q from -0.33 PD to 0.33 PD if the power-generating plant is connected to the high-voltage distribution network

For a power-generating plant with a maximum power ≤ 250 kVA connected to the high-voltage distribution network, the DSU may decide to comply to the equivalent requirements of EN 50549-1 rather than those of EN 50549-2.

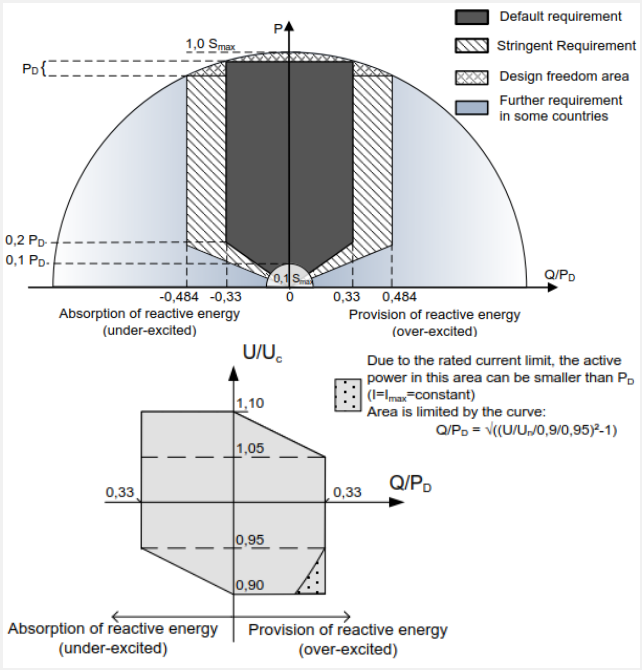
The reactive power capability shall be evaluated at the terminals of the power-generating unit (including, when applicable, the step-up transformer specific to the power-generating unit).

The real reactive power capabilities of the power-generating unit at the terminals should be communicated to the DSO. This can be done during the process of homologation.

If the capabilities exceed the minimum requirement, and as far as this has only limited technical and economic impact[34], the DSU is not allowed to refuse without justification the DSO to make use of the reactive power capability (this is not applicable to a small power-generating plant (as defined in chapter 4)).

In brief, the required capabilities in the standard are as follows:

EN 50549-2

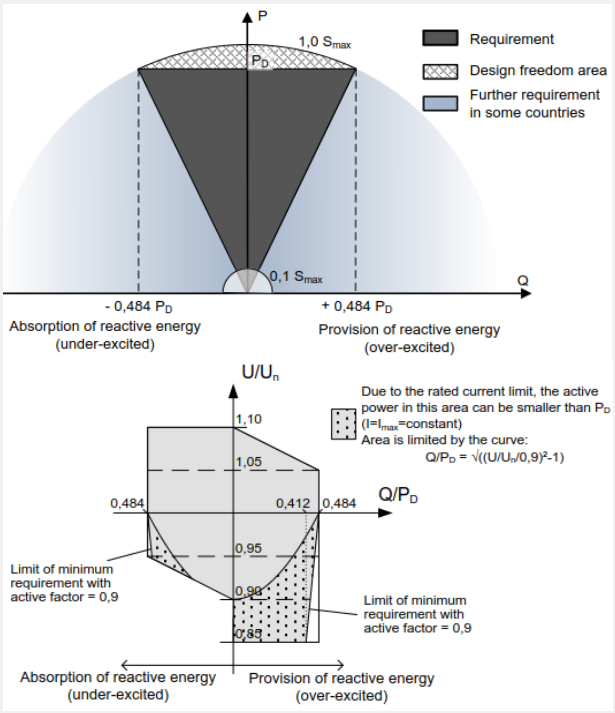


+ control modes: Q setpoint, Q(U), Q(P), Cos φ setpoint, Cos φ (P)

[34] In case of disagreement of the DSU with the DSO's view about the degree of technical impact, the DSU has the possibility to launch an appeals procedure upon the regional regulator.

EN 50549-1

General:



from 0,9 over-excited to 0,9 under-excited as defined by DSO

+ control modes: Q setpoint, Q(U), Cos φ setpoint, Cos φ (P)

Exceptions:

Technology	**Capability**	**Controls**
CHP up to 150 kVA	From 0,95 over-excited to 0,95 under-excited	See general
Induction generator up to 16 A	Operating with active power factor >0,95	No controls
Induction generator above 16 A	from 0,95 under-excited to 1	Only Cos φ setpoint at P_D
Linear generator	Operating with active power factor >0,95	No controls

The settings of the control mode must be protected from unpermitted interference (e.g. by a password or seal).

D.7.1.1 Specific for a small power-generating plant

By default, the power generation unit must operate according to the following rules:

- When the voltage ≤ 105 % Un : cos phi = 1 (Q=0)
- When the voltage > 105 % Un : free operation with 1 ≥ cos phi > $0{,}9_{\text{under-excited}}$. (no over-excited operation allowed)

D.7.1.2 Specific for another (not small) power-generating plant

If applicable, the details of the reactive power control mode to be activated in the power-generating unit shall be provided by the DSO during the installation procedure. This setting might be reviewed by the DSO during the lifetime of the power-generating module.

If the power-generating plant is connected to the high voltage distribution network, it may be necessary to use additional resources such as, for example, a capacitor bank to meet the previous requirements related to the supply of reactive power. If the power-generating unit is disconnected, they must be disconnected as well.

For a synchronous power-generating unit that is part of a power-generating module with a maximum power of ≥ 1 MW (type B according to NC RfG), the following specific requirement is also applicable [NC RfG Art 17 2 (b)] :

Alternatively to the Q(U) control mode specified above, a synchronous power-generating unit of type B (power ≥ 1 MW) shall be equipped with a permanent automatic excitation control system that can provide constant alternator terminal voltage at a selectable setpoint without instability over the entire operating range of the synchronous power-generating module. When the setpoint gives rise to a reactive power exchange beyond the capability requirements above, the reactive power exchange may be kept at the limits of the required capability.

The setpoint must be selectable in the continuous operating voltage range (see section D.4.3) and is given by the DSO.

The DSO can give the required instructions to make the selection of the setpoint possible remotely by the DSO's control center (see § 7.13), respecting the applicable regional legal framework.

D.7.2 Voltage related active power reduction P(U)

Voltage relating active power reduction is allowed and even recommended in order to avoid disconnection due to the operation of the overvoltage protection. When implemented, the power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN50549-2 (edition 2019, see clause 4.7.3 « Voltage related active power reduction »).

The figure below shows an example of the implementation of this function.

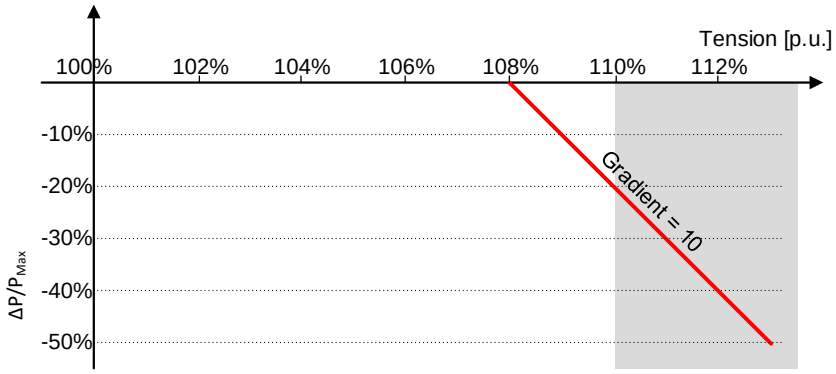


Figure 15 - Example curve for P(U)

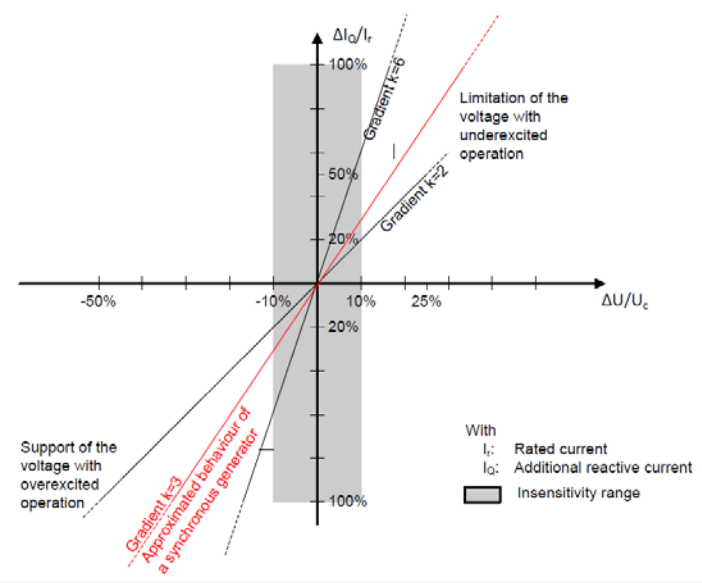
D.7.3 Provision of additional fast reactive current during faults and voltage steps [NC RfG Art 20 2.(b)]

This Section is only applicable to non-synchronous power-generating units connected to a high voltage distribution network and are not part of a small power-generating plant.

For power-generating units that are part of a power-generating module with a maximum power <1 MW, there is no capability requirement. However, if such a generating module has the capability to provide additional fast reactive current during faults and voltage steps, this function must be deactivated by default.

Power-generating units that are part of a power-generating module with a maximum power ≥ 1 MW must comply with the relevant requirements of the standard EN 50549-2 (edition 2019, see clause 4.7.4.2.1 « Voltage support during faults and voltage steps »), taking the additional information specified in this Section into account. By default, this function must be deactivated.

In brief, the required behaviour in the standard is illustrated by the following figure:



A directly connected asynchronous machine cannot provide voltage support in a controlled manner with regard to short circuit currents as a consequence of faults or when there are sudden voltage variations. The DSO will include these elements in its assessment of the demand for connection.

D.8 Connection and reconnection [NC RfG Art 13 7 + Art 14 4]

The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.10 « Connection and starting to generate electrical power ») taking the additional information specified hereunder into account.

Connection and reconnection after tripping of the interface protection relay is subject to the conditions listed in the table hereunder. These settings are different than the default settings of EN 50549-1 and EN 50549-2.

Parameter	**Reconnection after tripping of the interface protection relay**	**Normal operation starting**
Lower frequency	49,9 Hz	49,9 Hz
Upper frequency	50,1 Hz	50,1 Hz
Lower voltage	If connection to the LV distribution network: 85% U_n	If connection to the LV distribution network: 85% U_n
	If connection to the HV distribution network: 90 % U_c	If connection to the HV distribution network: 90 % U_c
Upper voltage	If connection to the LV distribution network: 110 % U_n	If connection to the LV distribution network: 110 % U_n
	If connection to the HV distribution network: 110 % U_c	If connection to the HV distribution network: 110 % U_c
Observation time	60 s	60 s
Maximum active power increase gradient	10 %/min*	20 %/min
** Power-generating units that have not the ability to apply a certain gradient shall take into account an additional delay.*		

Table 16 – Conditions for automatic connection and reconnection

The automatic connection and reconnection is allowed if the abovementioned conditions are met.

If, at the power-generating unit connected to the HV distribution network, no distinct sets of conditions can be applied, it is not possible to make a distinction between the two connection modes, the conditions must be chosen such as they meet both sets of conditions.

D.9 Ceasing and reduction of active power on set point

No-break

This clause is not applicable to the backup power systems specified in §2.2.1.

D.9.1 Ceasing active power [NC RfG Art 13 6]

The power-generating unit must comply with the relevant requirements of the applicable standard EN 5054-1 or EN 50549-2 (edition 2019, see clause 4.11.1 « Ceasing active power ») taking into account the additional information specified hereunder.

In brief, the requirements in the standards are the following :

For modules with a power > 800 W, a logic interface to cease the production of active power within 5 seconds after receiving the instruction is required.

Remote operation is optional

Respecting the regional regulatory provisions, the DSO can request additional equipment for a remote operation of this logic interface.

Unless defined otherwise by the DSO, this logic interface is based on a contact rather than using a communicated protocol.

D.9.2 Reduction of active power on set point [NC RfG Art 14 2.]

The requirement of this Section is applicable only to the power-generating units that are part of:

- a power-generating module with a maximum power of ≥ 1 MW
- a power-generating plant with a maximum power of > 250 kVA, if the DSO so requires, in accordance with the regional regulations.

The power-generating module must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.11.2 « Reduction of active power on set point ») taking into account the additional information specified hereunder. Generally, the power-generating unit complies with this requirement, which is assessed when homologated. Otherwise, if, for example, additional equipment such as a capacitor bank is required in combination with the power-generating unit, this will be evaluated by the DSO during the commissioning procedure.

In brief, the requirements in the standard are the following:

For type B modules:

The settings of the limit must be possible with a maximum increment of 10%.

Reduction of the power generation to the respective limit in a range of maximum 0,66 % Pn/ s and of minimum 0,33 % Pn/ s

Deconnection of the network is allowed when below minimum regulating level

Remote operation is optional

Depending of the modalities specified in section D.10 hereafter, the DSO can request additional equipment for a remote operation of this reduction.

D.10 Communication – Remote monitoring and control [NC RfG Art 14 5.d)]

The requirements of this Section are applicable only to the power-generating units that are part of:

- a power-generating module with a maximum power ≥ 1 MW
- a power-generating plant with a maximum power > 250 kVA, if so required by the DSO, respecting the regional regulatory provisions.

This paragraph is not applicable to backup power systems as defined in §2.2.1. However, special attention must be paid to § 7.12 Special supplemental requirement regarding backup power systems

The power-generating unit must have the necessary functionalities to meet the requirements of § 7.13 concerning the communication (remote control and monitoring).