Study about International Standards for the connection of Small Distributed Generators to the power grid

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To:
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Contents

Introduction

The purpose of this document is the presentation and comparison of international standards for interconnecting small distributed generation units to the public grid of different European countries (Germany, Italy and Spain) and the United States of America. From that recommendations for a simplified connection procedure in cohe-rence with net-metering are derived.

The at first glance simple task turned out to be relatively complex. The information desired is not written in a single document per country but distributed over many dif-ferent norms, guidelines and laws. E.g. only for Germany the following documents contain the necessary content:

- Renewable Energy Sources Act EEG (Erneuerbare Energien Gesetz)
- Energy Industry Act EnWG (Energiewirtschaftsgesetz)
- Ordinance on System Services by Wind Energy Plants SDLWindV (Systemdienstleistungsverordnung)
- Guidelines about generation units connected tot he low voltage grid (Erzeugungsanlagen am Niederspannungsnetz – Technische Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz)
- Diverse supplements to this guidelines
- Technical guidelines for interconnection with the low voltage grid (Technische Anschlussbedingungen TAB 2007 für den Anschluss an das Niederspannungsnetz)

All the information given in this report are derived from those documents and are not anymore referred to later in the text.

As a consequence for Germany the interconnection requirements will be displayed in detail within this document. For the other countries the author has been supported by TÜV Rheinland who has representatives in all of the countries discussed here. Namely this has been Willi Vaaßen, Marco Piva (Italy), Felipe Molinero (Spain), and Matthias Heinze (United States), respectively. For those countries the latest renewable energy policies are and laws are displayed and an overview about the technical interconnection requirements in table form is given. Unfortunately, for Portugal the author did not succeed. Neither in getting the necessary documents by internet research nor by the help personnel contacts.

In a separate document /appendix the most important documents about norms and guidelines from where the information displayed here has been gained are assem-bled. For establishing own codes and rules in Brazil it might be important to have more than just the numeric data.

When finalizing the report with recommendations (section 6) for an easy procedure for grid interconnection requirements first results from the EC project “PV Legal” are presented and a short overview about history of RE support schemes are given to explain how important reliable policy is for market development and cost efficient generation plant installations. Or – with other words – how important a net-metering regulation could be because it is independent of legislative processes and the here-with accompanying uncertainties (e. g. about the development of feed-in tariffs).

2 Interconnection of Distributed Generation to the Pubic Grid in Germany

In Germany, electricity from renewable sources is supported through a feed-in tariff. The criteria for eligibility and the amount of tariff are set out in the Act on Granting Priority to Renewable Energy Sources (EEG). According to this Act, operators of renewable energy systems are statutorily entitled against the grid operator to payments for electricity exported to the grid.

System operators are statutorily entitled to the immediate and preferential connection of renewable energy systems by the grid operators.

System operators are statutorily entitled against the grid operators to the purchase and transmission of all electricity from renewable energy sources supplied. Grid operators are not entitled to charge the system operators for the transmission of such electricity.

Upon the request of those interested in feeding in electricity, the grid operator is obliged to immediately optimise, boost and expand his grid in accordance with the best available technology in order to guarantee the purchase, transmission and distribution of electricity from renewable sources (§ 9 par. 1 EEG). The grid operator is not obliged to optimise, boost or expand his grid if this is economically unreasonable.

The legal framework in Germany is formed by the following laws:

- EEG (Renewable Energy Sources Act – general provisions on renewable energy)
- BiomasseV (Biomass Ordinance – ordinance defining the concept of biomass)
- StromNZV (Stromnetzzugangsverordnung – regulation on electricity exports to and electricity imports from supply grids)
- AusglMechV (Ausgleichsmechanismusverordnung - ordinance on the Further Development of the Nationwide Equalisation Scheme)
- SDLWindV (Systemdienstleistungsverordnung - ordinance on System Services by Wind Energy Plants)
- BioSt-NachV (Biomassestrom-Nachhaltigkeitsverordnung - ordinance on Requirements Pertaining to Sustainable Production of Bioliquids for Electricity Production)
- EnWG (Energy Industry Act – general provisions on the energy industry)
- KraftNAV (Ordinance on the Connection of Power Plants to the Grid)

All electricity generation units need to be operated in compliance with the guidelines of the grid operators. Among them are that generation unit operator and grid operator need to agree on a maximum apparent feed-in power. Apart from grid codes all relevant norms need to be followed, among them:

- DIN norms and especially the in the meantime European wide harmonized DIN VDE-0100-551

- Employment protection and accident prevention guidelines of employers associations of the respective countries
- Technical connection conditions of the grid operators
- Erection and grid connection of the generation unit need to be performed by registered electricians

2.1 Minimum protective system requirements and avoidance of islanding

The operator of a generation unit has to equip his installation with protection units for grid disconnection. The protection device has the task to disconnect the generation unit from the grid in case of forbidden voltage and frequency values. Therefore, the protection should assure safety of grid operator personnel who perform work at the grid assets. The protection should avoid unintended power feed-in by decentralized generation units into the low voltage grid that is separated from the rest of the distribution grid.

The requirements described here do not correspond to the protection of the generation unit itself. This kind of protection need to be done according to the norms that are valid in the respective countries. The generation operator must take action that switching activities in the grid, voltage deviations, automatic reconnection and other incidents in the grid will not damage his generation units.

The protection can either be realized as a separate device or as part of a programmable plant control unit. In case the power supply of the protection unit fails the section switch immediately has to disconnect the generation unit from the grid.

The protection functionality must be verifiable by the setting of analogue information. The generation unit therefore must be equipped with a respective interface, a so-called terminal-strip. This is not the case when applying a supervision unit according to E DIN VDE 0126.

Grid supervision units

Generation units are connected to the low voltage grid via an “always from grid operator personnel accessible switch with disconnection functionality” according to DIN VDE 0100-551. The term “always accessible” means

- Above ground level connection point of the house connection cable to the low voltage grid (cable connection board or transformer station)
- House connection box in case it is accessible to grid operator personnel without limitations

Especially for photovoltaic systems a unit for grid supervision with switching element according to E DIN VDE 0126 can replace the functions of a section switch and decoupling protection.

This supervision unit has been developed for photovoltaic systems with a nominal power of less than 4.6 kVA that feed power to the grid on a single phase. This supervision unit also can be used for all generator types and inverter based power generators up to a nominal power of 30 kVA and three phase connection. The unit can be integrated into an inverter or can be conducted as an independent protection device.

The protection device according to E DIN VDE 0126 contains voltage and frequency supervision and evaluates grid impedance leaps as additional criterion. Due to those three criteria and its redundant construction it fulfills the necessary safety requirements. Therefore, the normally requested switch with disconnection functionality that needs to be accessible by grid operator personnel and also the separate voltage and frequency supervision can be omitted.

The supervision unit requires having a test certificate that is issued by an accredited test laboratory.

The supervision unit requires having a voltage reduction protection in all three phases – although the feed-in is only single phase.

Section switch

The above described supervision unit is connected with a section switch. This section switch can be one of the following types:

- Circuit breaker / power switch
- Fuse switch
- Motor protection switch
- Welding-save relay with breaking capacity and upstream short-circuit protection

The section switch must assure an all-phase galvanic separation. The function of the section switch can be fulfilled with the above described supervision unit and therefore directly coupled with the section switch.

The section switch either can be

- A switch that connects the complete customer side with the grid, or
- A switch that connects the generation unit with the rest of the customer installation.

With generation units that are connected to the grid via frequency converters or inverters the section switch must be installed on the grid side of the power electronic device. It must not be affected in its functionality by a short-circuit within the converter.

The section switch must be designed for the maximum possible short circuit current and must trigger without delay.

Further remarks to protection issues

With three phase alternators that are connected to the grid imbalances of active power generation and active power consumption lead to speed changes and therefore to frequency changes. Imbalances of reactive power generation and reactive power consumption lead to voltage deviations. Therefore, when generation units with three phase alternators are connected to the grid both, frequency and voltage must be supervised. The corresponding voltage reduction protection must be performed in all three phases in order to also detect single phase voltage drops and as a consequence of that to disconnect the generation unit from the grid.

The stator of induction generators are excited from the grid. With asymmetric capacitive loads a single phase voltage increase can occur. Therefore, generation units that are connected to the grid via induction generators a three-phase voltage increase protection is required.

A delayed activation of the voltage drop or voltage increase protection is only possible in exceptional cases und must be of short time in order to avoid damages in case of fast voltage deviations at the generation plant itself or inside the customer installation. E.g. in case of self-excitation of an induction generator the voltage can reach high values in only few periods that damage at assets cannot be excluded.

Different from direct coupled three-phase alternators there is no direct coherence between active power balance and frequency deviation when the generation unit is connected via a power electronic converter. They do not necessarily react with speed changes in case of an unbalanced active power ratio. Three-phase alternators with frequency converter (e.g. wind power generators) are decoupled from the grid via the converter.

An active power imbalance results normally in a voltage deviation when the generation unit is connected via an inverter. A change in frequency of the inverter output voltage without a simultaneous change in its amplitude is almost impossible. Therefore, there is no need for separate frequency supervision as decoupling protection when the generation unit is connected via inverter. Nevertheless, inverters for operation in parallel with the public grid contain normally internal frequency measurements that also can be used for protection purposes and can be included into the protection system.

With large amounts of generation units with a corresponding high installed power that is connected to the highest voltage grid it would be counterproductive when those units would be disconnected too early by a frequency drop protection. In case of an error this would lead to an additional power deficit increasing the already existing one with the consequence that grid stability is endangered.

Out of this reason it is necessary that also this kind of generation unit contribute to the grid support – like conventional power stations do. Therefore, it is recommended to have a setting of the low frequency disconnect in high voltage grids at 47.5 Hz.

In low voltage grids the grid operation and grid support aspect is less dominant. Here, the problem of undesired islanding is dominant. Therefore, it is desirable to disconnect generation units in a more narrow frequency band. Recommended settings are within a band between 49 Hz and 51 Hz.

In medium voltage grids it is needed to decide case by case whether the generation unit is required to support grid stability or not.

Illustration 2.1.a summarizes the required and allowed protection units.

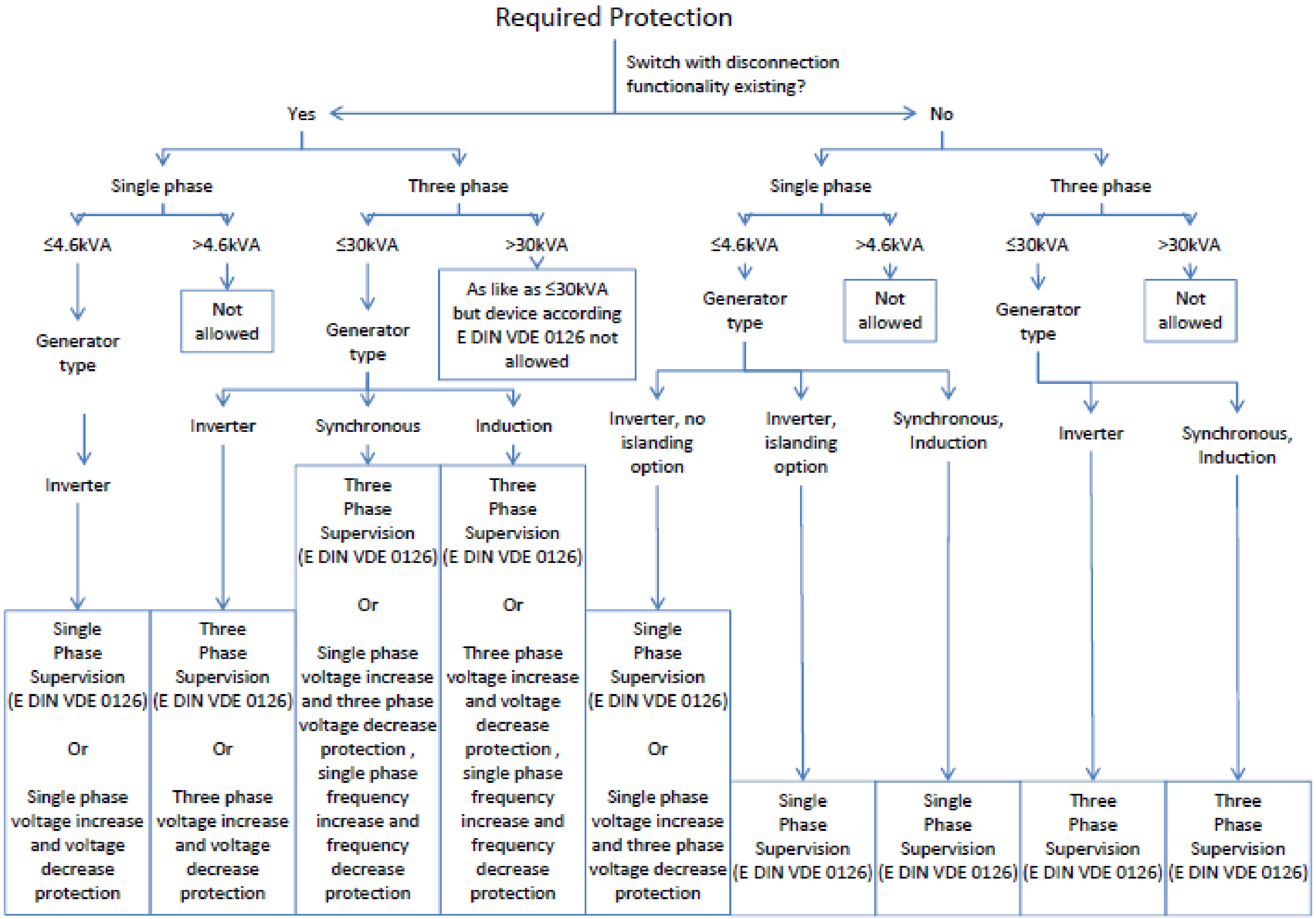


Illustration 2.1.a: Required Protection functionality for connection to the low voltage grid

2.2 Power quality

Power factor

Power factor of a customer installation including generation units has to be kept in the limits of 0.9 capacitive and 0.8 inductive for both, active power consumption and active power generation. Details can be negotiated bilaterally between customer and grid operator.

Reactive power consumed by a customer installation causes unnecessary grid losses and reduces the transmission capacity of the grid. Therefore it must be limited to a certain extent. Generally this is done by a capacitor installation.

Generation units up to a power of 4.6 kVA per phase do not need reactive power compensation units. For larger units the necessity of reactive compensation depends on the grid characteristics (short circuit power at connection point, cable or overhead line, etc.) and on the generation type. A consultation with the grid operator is required.

For dimensioning of the compensation unit operation mode of generation units and the resulting consequences to grid voltage have to be taken into account. With fluctuating inductive power requirements (e.g. wind generators with direct coupled induction generators) the compensation unit needs to be automatically controlled.

Capacitors are not allowed to be connected before the generation unit is connected to the grid. With disconnection of generation unit simultaneously the compensation unit must be disconnected.

Power factor of photovoltaic generators

So far photovoltaic generators feed to the low voltage grid with a power factor of one. Currently, the low voltage guidelines are under revision mainly due to the enormous developments photovoltaic installations in the last few years. Especially in rural grids problems are reported that the power quality requirements cannot any more be kept because of too high voltages.

The revised guidelines (VDE-AR-N 4105) will contain similar requirements that already exist in the medium voltage grid. That means that even photovoltaic generators connected to the low voltage grid must support the control of the voltage:

- PV generators < 3.68 kVA still can feed electricity to the grid with $\cos\varphi = 1$
- PV generators between 3.68 kVA and 13.8 kVA feed electricity to the grid according to a characteristic curve with $\cos\varphi \geq 0.95$
- PV generators above 13.8 kVA feed electricity to the grid according to a characteristic curve with $\cos\varphi \geq 0.9$

With those measures the installation capacity of PV generators in the low voltage grid can almost be doubled.

Harmonics

Inverters must be in accordance with EMC directive 2004/108/EC and the EC low voltage directive 2006/95/EC.

Generally, the following EMC standards are of importance whereas the in italics written ones are especially addressed in grid connection requirements:

Basic standards		
Measuring apparatus	EN 55016-1-X	Emission and Immunity
Measuring methods	EN 55016-2-X EN 61000-4-1	Emission Immunity
Immunity tests	EN 61000-4-2 EN 61000-4-3 EN 61000-4-4 EN 61000-4-5 EN 61000-4-6 EN 61000-4-7 EN 61000-4-8 EN 61000-4-9 EN 61000-4-11 EN 61000-4-15 EN 61000-4-30	Electrostatic discharge (ESD) Radiated, radio-frequency, electromagnetic fields Electrical fast transient (burst) Surge Conducted disturbances, induced by radio-frequency fields Harmonics and inter-harmonics Power frequency magnetic field Pulse magnetic field Voltage dips, short-term interruptions and voltage fluctuations Flicker Power quality
Compatibility levels for low-frequency conducted disturbances	EN 61000-2-2 EN 61000-2-4 EN 61000-2-12	Low-voltage power supply system Industrial plant Medium voltage power supply system
Limits of emission of harmonics and inter-harmonics	*EN 61000-3-2* *EN 61000-3-12*	*Equipment input current ≤ 16 A/phase* *Equipment input current ≤ 75 A/phase*
Limits of emission of flicker, voltage changes and voltage fluctuations	*EN 61000-3-3* *EN 61000-3-11*	*Equipment input current ≤ 16 A/phase* *Equipment input current ≤ 75 A/phase*
Generic standards		
Immunity	*EN 61000-6-1* *EN 61000-6-2*	*Domestic environments* *Industrial environments*
Emission	*EN 61000-6-3* *EN 61000-6-4*	*Domestic environments* *Industrial environments*
Product standards		
Emission and Immunity	EN 55011 EN 55022	Industrial, scientific and medical (ISM) devices Information and telecommunication equipment (ITE)
	EN 61800-3	Electric drives
	EN 50370-1/-2	Machine tools

In the low voltage directive the following is explicitly addressed:

Operation of generation units is generally permitted in case it fulfills the requirements according to EN 61000-3-2 or to EN 61000-3-12.

The proof can be made by an independent and accredited test laboratory or by a conformity declaration of the supplier.

In case there is no conformity declaration the limits of allowed harmonics are

$$I_{\nu,allowed} = i_{\nu,allowed} \cdot S_{kV}$$

The permitted harmonic currents $I_{\nu,allowed}$ at the connection point with the low voltage grid are calculated from the related harmonic currents $i_{\nu,allowed}$ of table 2.1.a multiplied with the short circuit power at the connection point S_{kV}.

*Table 2.1.a: Maximum permitted harmonic currents that can be fed to the low voltage grid by all generation units at one connection point (*integer and non integer in a bandwidth of 200 Hz).*

Harmonic number	Permitted harmonic current $i_{\nu,allowed}$ in A/MVA
3	4
5	2.5
7	2
9	0.7
11	1.3
13	1
17	0.55
19	0.45
23	0.3
25	0.25
>25	0.25 * 25/□

2.3 Paralleling conditions

Synchronous generation units that are directly coupled to the grid require a synchronizing device. It consists of a double frequency meter, a double voltage meter and a zero voltage meter. An automatic paralleling device is to be favored.

In case the generation unit does not contain a precision synchronizing device and as a consequence approximate synchronization cannot be avoided a bridgeable impedance for limitation of peak currents need to be installed.

2.4 Voltage regulation

The following protection functions need to activate the section switch and have to be adjustable in the following range:

Table 2.1.b: Adjustable protection ranges

Function	range
Voltage decrease protection	1.00 to 0.70 U_{rated}
Voltage increase protection	1.00 to 1.15 U_{rated}
Frequency decrease protection	50 to 47 Hz
Frequency increase protection	50 to 52 Hz

Voltage protections must be realized for any phase in which the generation unit feeds to. Frequency protection only needs to be realized once.

Generation units that feed the grid via inverter do not need to supervise the grid frequency.

Generation units that feed the grid via synchronous generator only need to have a voltage increase protection.

The protection functions can be realized in two ways:

- Separate or integrated protection unit
- Grid supervision unit according to E DIN VDE 0126

Voltage deviations caused by switching actions

Operation of generation units is generally permitted in case the requirements according to EN 61000-3-3 or EN 61000-3-11 are fulfilled.

This either can be proofed by an independent and accredited test laboratory or by a conformity declaration of the supplier.

In case this proof is not available the allowed voltage deviations at the connection point due to switching on and off the generation unit must not exceed

$$\Delta u_{\max} \leq 3\%$$

Those deviations are only allowed once within five minutes.

In case the switching frequency is very low (e.g. once a day) the grid operator can tolerate a larger voltage deviation in case a save grid operation is not endangered.

Depending on short circuit power S_{kV} of the grid and the nominal apparent power S_{nE} of the switched generation unit the voltage deviation can be estimated according to

$$\Delta u_{\max} = k_{i\max} \cdot \frac{S_{nE}}{S_{kV}}$$

The factor $k_{i\max}$ is named as “maximum switching current factor” and described the relation between the largest current during the switching action (e.g. startup current I_a) and the nominal current of the generation unit:

$$k_{i\max} = \frac{I_a}{I_{nG}}.$$

Results according to this calculation represent estimations for the upper limit. Therefore one will be on the secure side.

In case induction generators are connected to the gird (even when it is done almost with synchronous speed) voltage deviations can occur due to transients. This kind of voltage deviation is allowed to be double in size: 6%. But only in case the duration is not longer than two periods and the following voltage deviation does not exceed 3% of the original voltage level.

Long-term flicker

Operation of generation units is generally permitted in case the requirements according to EN 61000-3-3 or EN 61000-3-11 are fulfilled.

This either can be proofed by an independent and accredited test laboratory or by a conformity declaration of the supplier.

In case this proof is not available the allowed voltage deviations at the connection point due to flickers must not exceed

$$A_{lt} \le 0.1$$

or

$$P_{lt} \le 0.46$$

The long-term flicker disturbance factor A_{lt} as well as the long-term flicker intensity P_{lt} of a single generation unit can be estimated with plant flicker coefficient c according to

$$A_{lt} = \left(c \cdot \frac{S_{nE}}{S_{kV}} \right)^3$$

or

$$P_{lt} = c \cdot \frac{S_{nE}}{S_{kV}} \quad ,$$

with the short circuit power S_{kV} of the grid and the nominal apparent power S_{nE} of the generation unit.

2.6 Commissioning

The operator of a generation unit creates a request for commissioning to the grid operator. Within this request he/she confirms that the generation unit fulfills all the in this document mentioned guidelines and norms.

The first time when the generation unit is operated in parallel with the grid needs to be agreed with the grid operator. The procedure is as follows:

- Inspection of the installation
- Comparison of the installation with the planning documents
- Control of the accessibility of the disconnecting switch (in case it is not replaced by a supervision unit according E DIN VDE 0126)
- Comparison of the metering installation with the corresponding contractual and technical requirements
- Execution of a test of the meters for consumption and delivery

Additionally, a function test of the protection unit is performed. Here, a test facility provides simulated measurement values to the protection unit and it has to be proven that

- The protection unit operates correctly with the respective settings
- The given disconnection times are kept

In case a standardized type test exists for the disconnection unit of a certain generation unit and a test report can be provided, the commissioning test can be reduced to the proof of the protection unit.

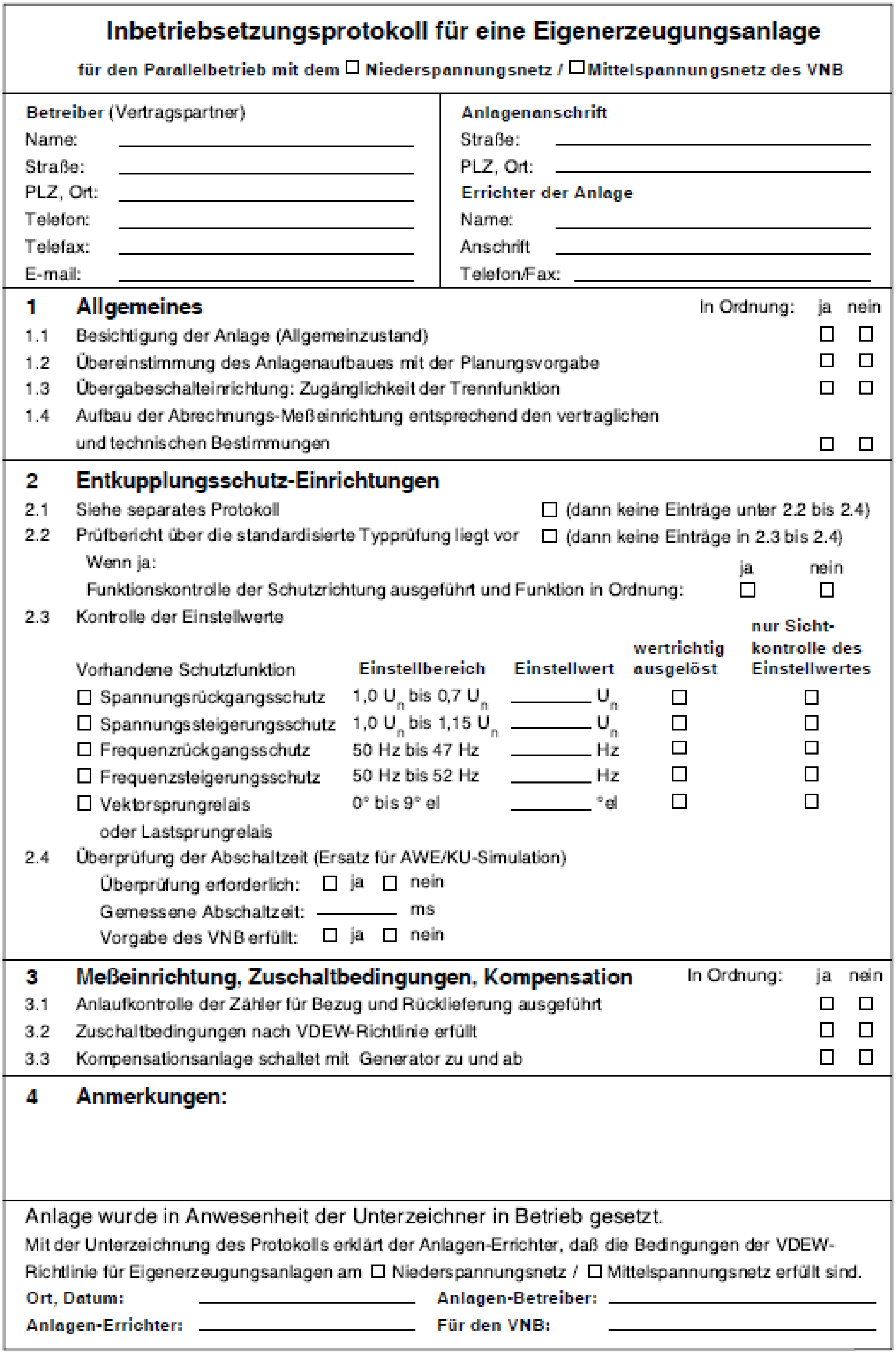
For generation units that are protected by a unit for grid supervision with switching element according to E DIN VDE 0126 a simplified proof is done:

- In parallel operation the phase of a single phase feed-in will be disconnected after this place had been bridged with a 0.5-Ohm resistor. Also with a three-phase generator a single-phase test is sufficient.
- It is controlled whether the section switch opens and the supervision device indicates the disturbance.

The grid operator might seal the protection device or protect it in an alternative way against undesired changes.

In case the generation unit is equipped with a compensation unit it will be tested if it switches on and off together with the generation unit.

The commissioning procedure will be fixed in a protocol. The protocol remains with the generation unit operator; illustration 2.6.a shows a standardized form.



Inbetriebsetzungsprotokoll für eine Eigenerzeugungsanlage

für den Parallelbetrieb mit dem ☐ Niederspannungsnetz / ☐ Mittelspannungsnetz des VNB

Betreiber (Vertragspartner)
Name: ____________________
Straße: ____________________
PLZ, Ort: ____________________
Telefon: ____________________
Telefax: ____________________
E-mail: ____________________

Anlagenanschrift
Straße: ____________________
PLZ, Ort: ____________________

Errichter der Anlage
Name: ____________________
Anschrift ____________________
Telefon/Fax: ____________________

	1 Allgemeines	In Ordnung: ja	nein
1.1	Besichtigung der Anlage (Allgemeinzustand)	☐	☐
1.2	Übereinstimmung des Anlagenaufbaues mit der Planungsvorgabe	☐	☐
1.3	Übergabeschalteinrichtung: Zugänglichkeit der Trennfunktion	☐	☐
1.4	Aufbau der Abrechnungs-Meßeinrichtung entsprechend den vertraglichen und technischen Bestimmungen	☐	☐

2 Entkupplungsschutz-Einrichtungen

2.1 Siehe separates Protokoll ☐ (dann keine Einträge unter 2.2 bis 2.4)

2.2 Prüfbericht über die standardisierte Typprüfung liegt vor ☐ (dann keine Einträge in 2.3 bis 2.4)

Wenn ja:

Funktionskontrolle der Schutzrichtung ausgeführt und Funktion in Ordnung: ja ☐ nein ☐

2.3 Kontrolle der Einstellwerte

Vorhandene Schutzfunktion	Einstellbereich	Einstellwert	wertrichtig ausgelöst	nur Sichtkontrolle des Einstellwertes
☐ Spannungsrückgangsschutz	$1{,}0\ U_n$ bis $0{,}7\ U_n$	________ U_n	☐	☐
☐ Spannungssteigerungsschutz	$1{,}0\ U_n$ bis $1{,}15\ U_n$	________ U_n	☐	☐
☐ Frequenzrückgangsschutz	50 Hz bis 47 Hz	________ Hz	☐	☐
☐ Frequenzsteigerungsschutz	50 Hz bis 52 Hz	________ Hz	☐	☐
☐ Vektorsprungrelais oder Lastsprungrelais	0° bis 9° el	________ °el	☐	☐

2.4 Überprüfung der Abschaltzeit (Ersatz für AWE/KU-Simulation)

Überprüfung erforderlich: ☐ ja ☐ nein
Gemessene Abschaltzeit: ________ ms
Vorgabe des VNB erfüllt: ☐ ja ☐ nein

	3 Meßeinrichtung, Zuschaltbedingungen, Kompensation	In Ordnung: ja	nein
3.1	Anlaufkontrolle der Zähler für Bezug und Rücklieferung ausgeführt	☐	☐
3.2	Zuschaltbedingungen nach VDEW-Richtlinie erfüllt	☐	☐
3.3	Kompensationsanlage schaltet mit Generator zu und ab	☐	☐

4 Anmerkungen:

Anlage wurde in Anwesenheit der Unterzeichner in Betrieb gesetzt.

Mit der Unterzeichnung des Protokolls erklärt der Anlagen-Errichter, daß die Bedingungen der VDEW-Richtlinie für Eigenerzeugungsanlagen am ☐ Niederspannungsnetz / ☐ Mittelspannungsnetz erfüllt sind.

Ort, Datum: ____________________
Anlagen-Betreiber: ____________________
Anlagen-Errichter: ____________________
Für den VNB: ____________________

Illustration 2.6.a: Commissioning Protocol

Connection of synchronous generators

When connecting synchronous generators the following synchronizing conditions must be kept:

- Voltage difference $\Delta U < \pm 10\% \, U_{rated}$
- Frequency difference $\Delta f < \pm 0.5 Hz$
- Phase angle difference $\Delta\varphi < \pm 10°$

Depending on the relation between short circuit power to generation unit power it can be necessary to apply stronger limits in order to avoid not allowed system perturbation.

Connection of induction generators

Induction generation units that are accelerated by the drive mechanism must be connected unexcited with a speed between 95 % and 105 % of the synchronous speed.

For generation units that have the ability to operate islanded, have self-excitation and are not connected in idle mode the conditions for synchronous generation units are applied.

Connection of generation units with inverter or frequency converters

For generation units with inverters or frequency converters it is distinguished whether the AC side of the converter is in idle mode or not. In case it is not in idle mode the same conditions apply as for synchronous generators.

Conformity declaration

To guarantee a fault-free grid operation only assets of generation units are allowed to be connected to the grid that fulfill the corresponding norms. Many customers are not in the position to proof this conformity. Therefore, the unit supplier can certify with a so-called conformity declaration

- that the assets to be connected to the grid fulfill the current DIN norms and VDE DIN norms and all the guidelines mentioned in this document.
- that in case there is a deviation from those norms the applied criteria at least cover the current DIN norms and VDE DIN norms

2.7 Short-circuit level

Through the connection of an additional generation unit to the low voltage grid and its operation the short circuit current – especially around the point of connection - of the low voltage grid will be increased by the value of the short circuit current of the generation unit. In case it is unknown the following values are assumed:

- eightfold with synchronous generators
- sixfold with induction generators
- single with inverters

of the sum of nominal generator currents. For a more detailed calculation, in addition impedances between generator and connection point need to be taken into account.

In case the short circuit current will be increased above the rated values of the grid infrastructure grid operator and generation unit operator must agree on measures to limit the short circuit current of the generation unit.

2.8 Safety for workers and devices

There are no specific norms dedicated to the security of workers and devices for generation units. Here, the same norms are applied that are generally valid for all electric installations: DIN VDE 0100.

Safety of power converters for use in photovoltaic power systems, general requirements are mentioned in IEC 62109-1:2010. The German version is EN 62109-1:2010 (the older version has been EN 50178).

Apart from that it is referred to chapter 2.1. Protection issues discussed there are mainly due to safety of grid operator personnel.

2.9 Grounding

The norms do not contain regulations concerning grounding!

Nevertheless, the topic “grounding of photovoltaic generators” is controversially discussed among experts. One could summarize the discussion:

- Conducting housings from e.g. connector boxes, metallic support structures or module frames need to be grounded, except
    - insulation of active parts correspond to IEC class II equipment
    - open circuit voltage is less than 120 Volt and does not have a galvanic connection towards the low voltage grid
- When inverters without transformers are applied grounding of module frames is recommended due to capacitor effects between inner and outer module parts. In case a module is damaged grid voltage could be applied to the module frame. In case the frame is grounded an error current could trigger an earth-leakage circuit breaker. Without grounding the error might be undetected.
- Grounding of active parts of the generator is seldom done.
    - Advantage: it provides the generator with a clearly defined potential which makes lightning protection easier.
    - Disadvantage: without additional protection (e.g. DC earth-leakage circuit breaker) the first earth connection represents a risk for personnel contact.
- Non-grounded active parts of the generator
    - Potential is not clearly defined but normally installed varistors cause an almost symmetric distribution of the voltage. The highly resistive earth connection allow leakage current detection.

  - Commercially available insulation controls can be applied.
  - A first earth connection fault will not cause a risk for personnel contact.

2.10 Evaluation procedures for distributed generation projects and required studies

Due to the renewable energy sources act there is no process that comes to a conclusion whether a distributed generation project will be eligible or not. Grid operator are obliged to connect a renewable energy based generation unit to the voltage level that is appropriate for the generation unit and at the connection point that is closest to generation unit. Grid operators need to connect the generation unit even if the grid requires optimization processes before the unit can feed electricity to the grid.

Nevertheless, every project requires a procedure for co-ordination between generation unit operator and grid operator.

Grid operator already should be involved into the project during the planning phase. Normally, the following documents have to be delivered to grid operator[1]:

- standardized form for connection of generation units to the low voltage grid (illustration 2.10.a and illustration 2.10.b)
- site map that indicates the position of the generation unit
- datasheet that contains the technical details of the installation
- circuit diagram (single phase illustration is sufficient)
- description of the used protection units with exact information about type, product, circuit and function and a conformity declaration
- information about the short circuit current of the generation unit
- for inverters and frequency converter: conformity declaration of supplier

Immediately after having received the request for connection of a generation unit grid operators need to answer with a schedule that contains:

- work steps of the grid connection
- further information required for the grid connection

After having received this information latest after eight weeks grid operators need to inform generation unit operators with:

- time schedule with instantaneous elaboration of the grid connection
- information about the connection point needed by the generation unit operator for the planning process
- cost estimate for the technical elaboration of the grid connection

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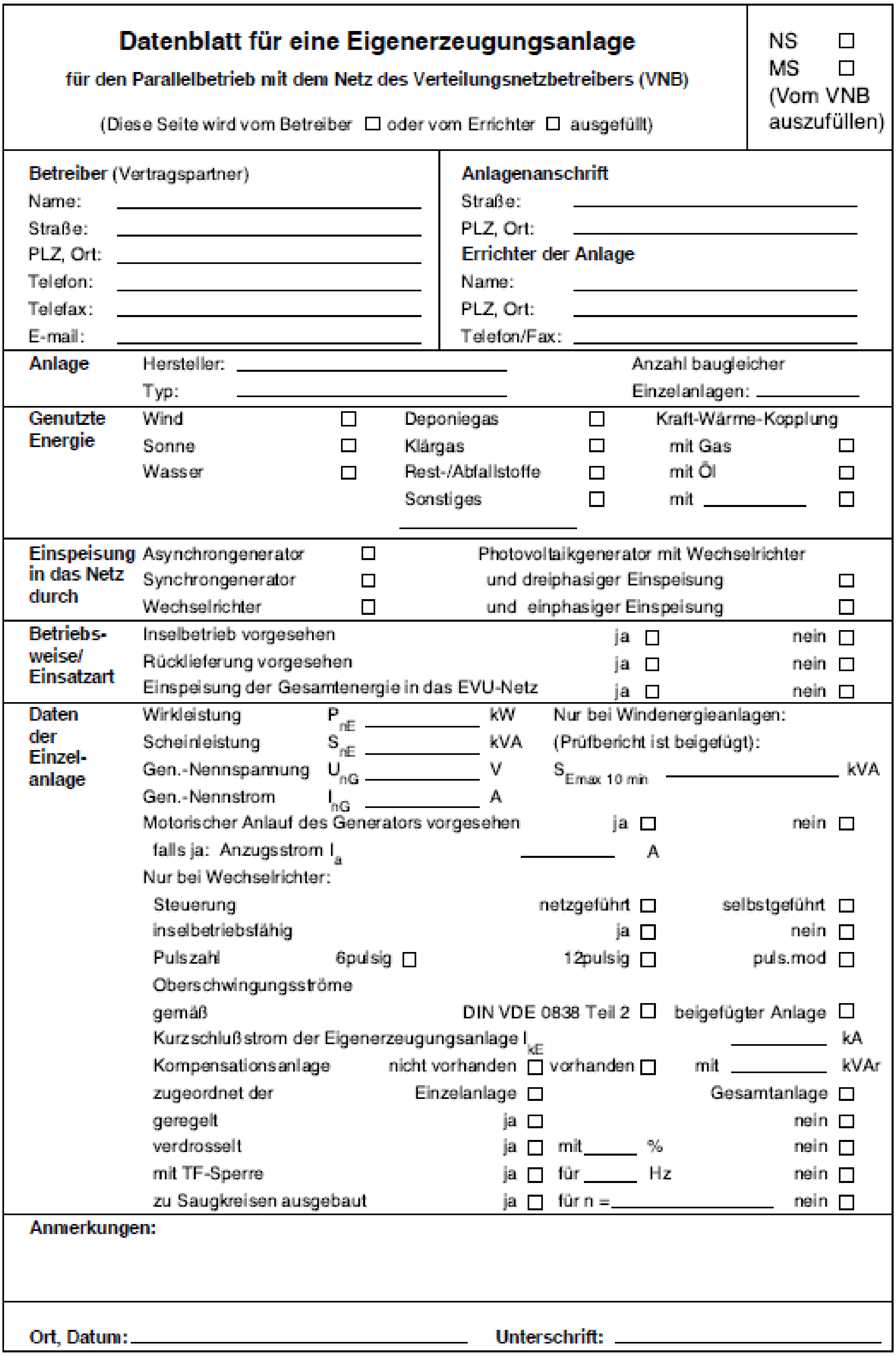
[1] For small PV systems more simple procedures are applied. They are described in section 7: Simplified procedures for grid interconnection of small generators and net metering



Datenblatt für eine Eigenerzeugungsanlage

für den Parallelbetrieb mit dem Netz des Verteilungsnetzbetreibers (VNB)

(Diese Seite wird vom Betreiber ☐ oder vom Errichter ☐ ausgefüllt)

NS ☐
MS ☐
(Vom VNB auszufüllen)

Betreiber (Vertragspartner)
Name: ______
Straße: ______
PLZ, Ort: ______
Telefon: ______
Telefax: ______
E-mail: ______

Anlagenanschrift
Straße: ______
PLZ, Ort: ______

Errichter der Anlage
Name: ______
PLZ, Ort: ______
Telefon/Fax: ______

Anlage
Hersteller: ______
Typ: ______
Anzahl baugleicher Einzelanlagen: ______

Genutzte Energie
Wind ☐
Sonne ☐
Wasser ☐
Deponiegas ☐
Klärgas ☐
Rest-/Abfallstoffe ☐
Sonstiges ☐
______
Kraft-Wärme-Kopplung
mit Gas ☐
mit Öl ☐
mit ______ ☐

Einspeisung in das Netz durch
Asynchrongenerator ☐
Synchrongenerator ☐
Wechselrichter ☐
Photovoltaikgenerator mit Wechselrichter
und dreiphasiger Einspeisung ☐
und einphasiger Einspeisung ☐

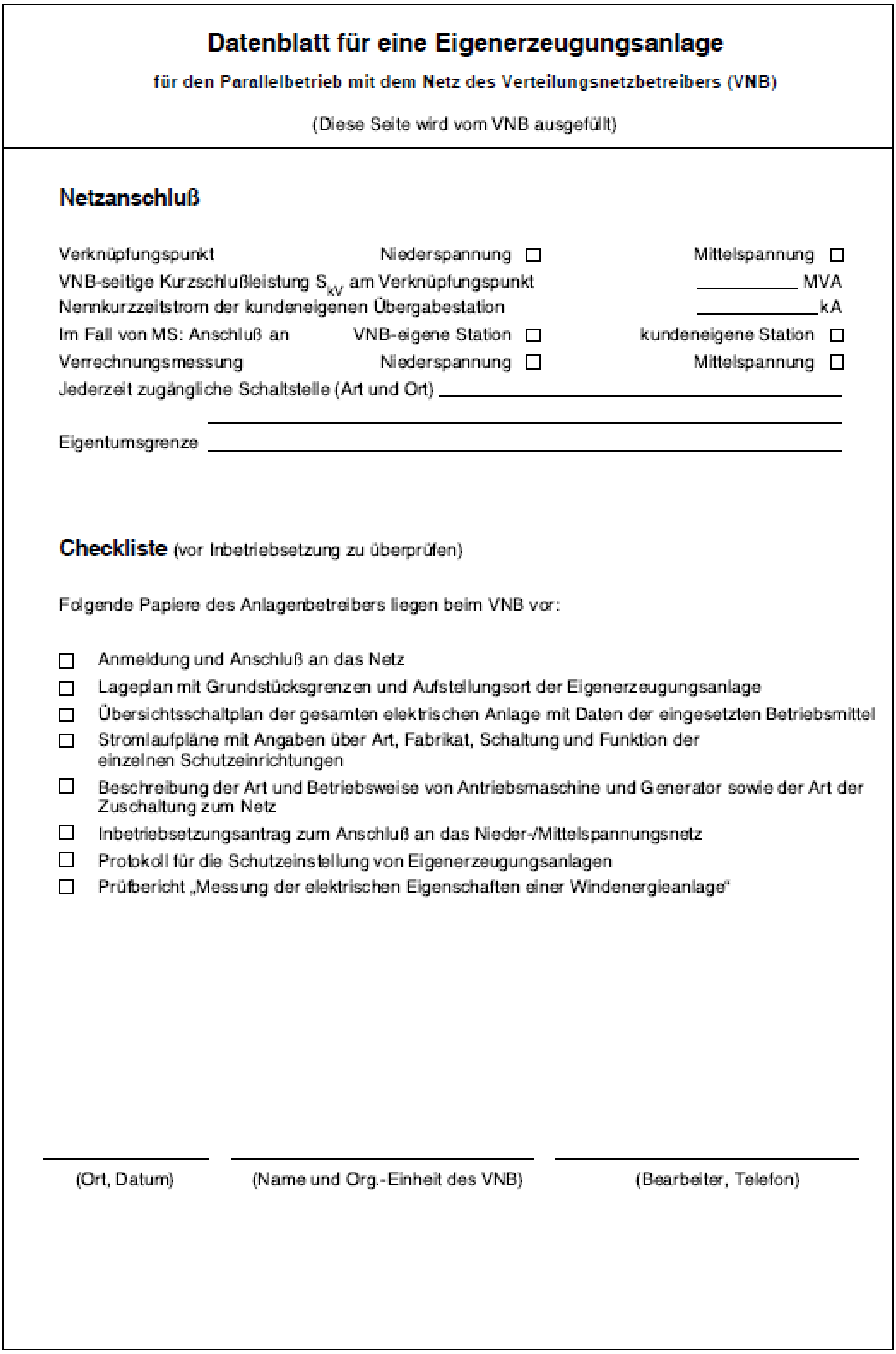
Betriebsweise/ Einsatzart
Inselbetrieb vorgesehen ja ☐ nein ☐
Rücklieferung vorgesehen ja ☐ nein ☐
Einspeisung der Gesamtenergie in das EVU-Netz ja ☐ nein ☐

Daten der Einzelanlage
Wirkleistung P_{nE} ______ kW
Scheinleistung S_{nE} ______ kVA
Gen.-Nennspannung U_{nG} ______ V
Gen.-Nennstrom I_{nG} ______ A
Nur bei Windenergieanlagen:
(Prüfbericht ist beigefügt):
$S_{Emax\ 10\ min}$ ______ kVA
Motorischer Anlauf des Generators vorgesehen ja ☐ nein ☐
falls ja: Anzugsstrom I_a ______ A
Nur bei Wechselrichter:
Steuerung netzgeführt ☐ selbstgeführt ☐
inselbetriebsfähig ja ☐ nein ☐
Pulszahl 6pulsig ☐ 12pulsig ☐ puls.mod ☐
Oberschwingungsströme
gemäß DIN VDE 0838 Teil 2 ☐ beigefügter Anlage ☐
Kurzschlußstrom der Eigenerzeugungsanlage I_{kE} ______ kA
Kompensationsanlage nicht vorhanden ☐ vorhanden ☐ mit ______ kVAr
zugeordnet der Einzelanlage ☐ Gesamtanlage ☐
geregelt ja ☐ nein ☐
verdrosselt ja ☐ mit ______ % nein ☐
mit TF-Sperre ja ☐ für ______ Hz nein ☐
zu Saugkreisen ausgebaut ja ☐ für n = ______ nein ☐

Anmerkungen:

Ort, Datum: ______ **Unterschrift:** ______

Illustration 2.10.a: Data Sheet for generation unit to be connected to the low voltage grid, page 1



Datenblatt für eine Eigenerzeugungsanlage

für den Parallelbetrieb mit dem Netz des Verteilungsnetzbetreibers (VNB)

(Diese Seite wird vom VNB ausgefüllt)

Netzanschluß

Verknüpfungspunkt Niederspannung ☐ Mittelspannung ☐
VNB-seitige Kurzschlußleistung S_{kV} am Verknüpfungspunkt ________ MVA
Nennkurzzeitstrom der kundeneigenen Übergabestation ________kA
Im Fall von MS: Anschluß an VNB-eigene Station ☐ kundeneigene Station ☐
Verrechnungsmessung Niederspannung ☐ Mittelspannung ☐
Jederzeit zugängliche Schaltstelle (Art und Ort) ________________

Eigentumsgrenze ________________

Checkliste (vor Inbetriebsetzung zu überprüfen)

Folgende Papiere des Anlagenbetreibers liegen beim VNB vor:

- ☐ Anmeldung und Anschluß an das Netz
- ☐ Lageplan mit Grundstücksgrenzen und Aufstellungsort der Eigenerzeugungsanlage
- ☐ Übersichtsschaltplan der gesamten elektrischen Anlage mit Daten der eingesetzten Betriebsmittel
- ☐ Stromlaufpläne mit Angaben über Art, Fabrikat, Schaltung und Funktion der einzelnen Schutzeinrichtungen
- ☐ Beschreibung der Art und Betriebsweise von Antriebsmaschine und Generator sowie der Art der Zuschaltung zum Netz
- ☐ Inbetriebsetzungsantrag zum Anschluß an das Nieder-/Mittelspannungsnetz
- ☐ Protokoll für die Schutzeinstellung von Eigenerzeugungsanlagen
- ☐ Prüfbericht „Messung der elektrischen Eigenschaften einer Windenergieanlage"

(Ort, Datum)	(Name und Org.-Einheit des VNB)	(Bearbeiter, Telefon)

Illustration 2.10.b: Data Sheet for generation unit to be connected to the low voltage grid, page 2

Studies required

Process in Brief: Small rooftop systems do not require planning permission. The grid operator is obliged to connect PV systems to the grid immediately and as a priority. The connection of the system must be applied for with the grid operator. The time for processing the application is not regulated by law and varies between one and several weeks. After receipt of the grid connection application, the grid operator conducts a connection study in order to assess the effects on the grid of the planned electricity feed-in and to allocate the technically and economically most favorable connection point. The closest connection point is usually also the most favorable. For systems with capacity of less than 30 kW_p, which are on a plot with already existing grid connection, it is legally defined that the connection point of the plot with the grid is regarded as the most favorable connection point. For systems with capacity of more than 30 kW_p, no best connection point is defined in the renewable energy act. The connection study ends with the allocation of a connection point. The system operator bears all costs incurred for the connection of the PV system to the connection point. The grid operator bears all costs (if incurred) from the connection point. The EEG foresees that grid operators must not make the fulfillment of their obligations conditional on the conclusion of an agreement. System operators must report the location and capacity of their PV system to the Federal Network Agency. An entitlement to renewable energy act and electricity feed-in tariff payments only applies if this notification is made.

Studies made

The grid operator needs to calculate that the connection of the generation unit does not endanger the safe and reliable operation of the grid. An additional generation unit can cause an increased loading of cables, transformers and other assets of the grid.

Apart from calculations presented in chapter 2.4 the grid operator will perform a calculation that the voltage in the low voltage grid will not be increased by more than $\Delta u \le 2\%$.

This implies the consideration of tolerances in voltage of upstream transformer stations where high voltage is transformed to medium voltage. In [ANEEL 2010[2]] this issue already had been discussed. There it has been described that the value most probably very soon will be changed to $\Delta u \le 3\%$ like in many other countries and that the limitation to such a low value is of a very theoretical nature.

To give estimation about the voltage increase the so-called short-circuit-power-relation k_{kl} is used:

$$k_{kl} = \frac{S_{kV}}{\sum S_{A\max}},$$

with S_{kV} as the short-circuit power of the grid at the connection point and $\sum S_{A\max}$ is the sum of the maximum short circuit power values of all generation units connected at this point to the grid.

The requirement for voltage increase is always fulfilled when the short-circuit-power-relation is

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[2] I. Stadler, et. al.: Implementation of small grid connected decentralized power generators using renewable energies

$k_{kl} \geq 50$.

A more accurate result for voltage increase at the connection point can be derived from the following calculation where Ψ_{kV} is the grid impedance angle and φ the phase angle between current and voltage of the generation unit at its maximum apparent power $S_{A\max}$:

$$\Delta u_{aV} = \frac{S_{A\max} \cdot \cos(\Psi_{kV} + \varphi)}{S_{kV}}.$$

In case $\cos(\Psi_{kV} + \varphi)$ is less than 0.1 this expression is set to 0.1 in order to be on the safe side and to eliminate uncertainties.

In the case of meshed grids it can become necessary to perform complex load flow calculations in order to determine the voltage increases.

Procedure in case grid needs improvement

Grid operators are committed to instantaneously adopt their grids to the state of the art, to strengthen and expand the grid in order to absorb and transmit the electricity produced by renewable energy generation units.

Only the costs for the grid connection of the generation units itself and the corresponding metering units need to be covered by the generation unit operator.

2.11 Limits for the integration of distributed generation

In Germany never a limit for the integration of distributed generation existed. Due to the enormous success of photovoltaics and the comparatively high costs a limit often has been discussed but never came into action.

The better way to adopt market developments to actual costs has been seen in reducing feed-in tariffs. Since 2010 the yearly degression rate for the PV feed-in tariff contains a component that takes into account the yearly new installed capacity. In case this number is bigger than 3.5 GW the degression rate increases. In case it falls below this limit the degression rate is decreased.

In Spain the law for feed-in started with very high tariffs resulting in enormous installation capacities. Then a hard limit has been implemented that stopped almost PV installations in Spain. Nowadays, a quota of installations to be accepted each three months has been introduced. it is called the "PREFO". The procedure can be consulted here online at: http://www.mityc.es/energia/electricidad/RegimenEspecial/Paginas/InstalacionesFotovoltaicas.aspx

Summary of interconnection requirements

Inverter connected	**< 4,6 kVA**	**≤ 30 kVA**	**> 30 kVA**
Protection devices	Sgl. phase ENS[3] or single phase voltage increase and three phase voltage decrease protection	three phase ENS or three phase voltage increase and voltage decrease protection	three phase voltage increase and voltage decrease protection plus switch with disconnection functionality
Voltage decrease protection value	$0.7 \cdot U_{rated}$ *to* $1.0 \cdot U_{rated}; \leq 0.2s$		
Voltage increase protection value	$1.0 \cdot U_{rated}$ *to* $1.15 \cdot U_{rated}; \leq 0.2s$		
Frequency decrease protection value	$47\,Hz$ *to* $50\,Hz; \leq 0.2s$		
Frequency increase protection value	$50\,Hz$ *to* $52\,Hz; \leq 0.2s$		
Reactive power provision, actual	$\cos\varphi = 0.9_{cap}$ *to* $\cos\varphi = 0{,}8_{ind}$		
Reactive power provision, future	$\cos\varphi = 1$ (<3,68 kVA)	$\cos\varphi \geq 0.95_{ind}$ (<13,8 kVA)	$\cos\varphi \geq 0.9_{ind}$ (≥13,8 kVA)
Harmonics	EN 61000-3-2 or EN 61000-3-12		
Voltage deviation during switching actions	$\Delta u \leq 3\%$		
Long-term flickers	EN 61000-3-3 or EN 61000-3-11		
Synchronization	None, in case AC side is in idle mode When not in idle mode: • Voltage difference $\Delta U < \pm 10\% \, U_{rated}$ • Frequency difference $\Delta f < \pm 0.5Hz$ • Phase angle difference $\Delta\varphi < \pm 10°$		
Short circuit level	One time rated current		
Grounding spec.	-		
Transformer spec.	-		

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[3] Especially for photovoltaic systems a unit for grid supervision with switching element according to E DIN VDE 0126 can replace the functions of a section switch and decoupling protection (see chapter 2.1

Synchronous generator connected	**< 4,6 kVA**	**≤ 30 kVA**	**> 30 kVA**
Protection devices	Single phase ENS	Three phase ENS or Single phase voltage increase and three phase voltage decrease protection , single phase frequency increase and frequency decrease protection	Single phase voltage increase and three phase voltage decrease protection , single phase frequency increase and frequency decrease protection
Voltage decrease protection value	$0.7 \cdot U_{rated}\ to\ 1.0 \cdot U_{rated}$		
Voltage increase protection value	$1.0 \cdot U_{rated}\ to\ 1.15 \cdot U_{rated}$		
Frequency decrease protection value	$47\,Hz\ to\ 50\,Hz$		
Frequency increase protection value	$50\,Hz\ to\ 52\,Hz$		
Reactive power provision, actual	$\cos\varphi = 0.9_{cap}\ to\ \cos\varphi = 0{,}8_{ind}$		
Reactive power provision, future	$\cos\varphi = 1$ (<3,68 kVA)	$\cos\varphi \geq 0.95_{ind}$ (<13,8 kVA)	$\cos\varphi \geq 0.9_{ind}$ (≥13,8 kVA)
Harmonics	EN 61000-3-2 or EN 61000-3-12		
Voltage deviation during switching actions	$\Delta u \leq 3\%$		
Long-term flickers	EN 61000-3-3 or EN 61000-3-11		
Synchronization	• Voltage difference $\Delta U < \pm 10\%\, U_{rated}$ • Frequency difference $\Delta f < \pm 0.5 Hz$ • Phase angle difference $\Delta\varphi < \pm 10°$		
Short circuit level	Eight times rated current		
Grounding	-		
Transformer specifications	-		

Induction generator connected	**< 4,6 kVA**	**≤ 30 kVA**	**> 30 kVA**
Protection devices	Single phase ENS	Three phase ENS or Three phase voltage increase and three phase voltage decrease protection , single phase frequency increase and frequency decrease protection	Three phase voltage increase and three phase voltage decrease protection , single phase frequency increase and frequency decrease protection
Voltage decrease protection value	$0.7\cdot U_{rated}\ to\ 1.0\cdot U_{rated}$		
Voltage increase protection value	$1.0\cdot U_{rated}\ to\ 1.15\cdot U_{rated}$		
Frequency decrease protection value	$47\,Hz\ to\ 50\,Hz$		
Frequency increase protection value	$50\,Hz\ to\ 52\,Hz$		
Reactive power provision, actual	$\cos\varphi = 0.9_{cap}\ to\ \cos\varphi = 0{,}8_{ind}$		
Reactive power provision, future	$\cos\varphi = 1$ (<3,68 kVA)	$\cos\varphi \geq 0.95_{ind}$ (<13,8 kVA)	$\cos\varphi \geq 0.9_{ind}$ (≥13,8 kVA)
Harmonics	EN 61000-3-2 or EN 61000-3-12		
Voltage deviation at switching actions	$\Delta u \leq 3\%$		
Long-term flickers	EN 61000-3-3 or EN 61000-3-11		
Synchronization	Speed 95 % to 105 % of the synchronous speed. With ability to operate islanded, self-excitation and not connected in idle mode: • Voltage difference $\Delta U < \pm 10\%\,U_{rated}$ • Frequency difference $\Delta f < \pm 0.5Hz$ • Phase angle difference $\Delta\varphi < \pm 10°$		
Short circuit level	Six times rated current		
Grounding spec.	-		
Transformer spec.	-		

3 Public Grid Interconnection: Summary for Italy

In Italy, electricity generated from renewable energy sources is mainly promoted through a quota system (certificati verdi). The quota system obliges all producers and importers of electricity to generate a certain quota of electricity from renewable sources or purchase a certain amount of green certificates. As an alternative, small systems and expensive technologies like photovoltaic generation can make use of various kinds of price regulation, which might be more cost-efficient than participation in the certificate system. The price regulation system provides for mechanisms like the feed-in tariff for systems generating less than 1 MW. Likewise, photovoltaic systems are promoted by a premium tariff "conto energia per il solare fotovoltaico“. Electricity may also be sold on the free market or within the regulatory system of “ritiro dedicato” (purchase by Gestore dei Servizi Elettrici at a guaranteed price). Under certain conditions, electricity producers can make use of "scambio sul posto" (net-metering, →see section 7).

In Italy, grid operators are obliged to give priority access to renewable energy systems in the operation of their grids. They are also obliged to give priority dispatch to electricity from renewable sources. System operators may request their grid operator to expand the grid if the connection of a system requires this expansion.

A system operator applying for connection is contractually entitled against the grid operator to a grid expansion, if the expansion is necessary to satisfy the claim for connection to the grid. As renewable energy systems must be given priority connection, a grid expansion necessary to connect such a system must also be given priority.

The legal framework in Italy is formed by the following laws:

- DL 28/11 (Decreto Legislativo 3 marzo 2011, n. 28. Attuazione della direttiva 2009/28/CE sulla promozione dell’uso dell’energia da fonti rinnovabili recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE - Legislative Decree 3 March 2011, n. 28. Implementation of directive 2009/28/CE on promotion of use of energy from renewable energy sources modifying and repealing directives 2001/77/CE and 2003/30/CE)

- L 99/09 (Legge 23 luglio 2009, n. 99. Disposizioni per lo sviluppo e l'internazionalizzazione delle imprese, nonché in materia di energia – Act on the Development of the Business and Energy Sectors)

- L 244/07 (Legge 24 Dicembre 2007, n. 244. Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato. Legge finanziaria 2008 – Budget Act of 2008)

- L 239/04 (Legge 23 agosto 2004, n. 239. Riordino del settore energetico, nonchè delega al Governo per il riassetto delle disposizioni vigenti in materia di energia - Act on the reorganisation of the energy sector)

- DL 79/99 (Decreto Legislativo 16 marzo 1999, n. 79. Attuazione della direttiva 96/92/CE recante norme comuni per il mercato interno dell'energia elettrica, „Decreto Bersani“ – Decree for the Regulation of the Electricity Market)

- DL 387/03 (Decreto Legislativo 29 dicembre 2003, n. 387. Attuazione della direttiva 2001/77/CE relativa alla promozione dell'energia elettrica prodotta da fonti energetiche rinnovabili nel mercato interno dell'elettricità – Decree for the Promotion of Renewable Energy)

- DPR 633/72 (Decreto del Presidente della Repubblica 26 ottobre 1972 n. 633. Instituzione e disciplina dell'imposta sul valore aggiunto – Act on the Value-Added Tax)
- DM 18/12/08 (Decreto 18 dicembre 2008. Incentivazione della produzione di energia elettrica da fonti rinnovabili. "Decreto Rinnovabili"- Decree on Renewable Energy)
- DM 14/03/03 (Decreto 14 marzo 2003. Attivazione del mercato elettrico, limitatamente alla contrattazione dei certificati verdi – Decree on the Green Certificates)
- DM 6/08/2010. (Decreto 6 agosto 2010. Incentivazione della produzione di energia elettrica mediante conversione fotovoltaica della fonte solare – Incentivation of the promotion of photovoltaic energy)
- AEEG 34/05 (Delibera n. 34/05. Modalità e condizioni economiche per il ritiro dell'energia elettrica – Conditions on electricity supply to the grid)
- ARG/elt 181/10 (Delibera n. 181/10. Attuazione del decreto del Ministro dello Sviluppo Economico, di concerto con il Ministro dell'Ambiente e della Tutela del Territorio e del Mare 6 agosto 2010, ai fini dell'incentivazione della produzione di energia elettrica mediante impianti fotovoltaici
- AEEG 280/07 (Delibera n. 280/07. Modalità e condizioni tecnico-economiche per il ritiro dell'energia elettrica – Conditions on electricity intakes)
- AEEG 348/07 (Delibera n. 348/07. Testo integrato delle disposizioni dell'Autorità per l'energia elettrica e il gas per l'erogazione dei servizi di trasmissione, distribuzione e misura dell'energia elettrica – Resolution on the transmission and distribution of electriciry)
- ARG/elt 74/08 (Deliberazione 3 giugno 2008 - ARG/elt 74/08. Testo integrato delle modalità e delle condizioni tecnico-economiche per lo scambio sul posto. "TISP" – Conditions for net metering)
- ARG/elt 1/09 (Delibera n. 1/09. Attuazione dell'articolo 2, comma 153, della legge n. 244/07 e dell'articolo 20 del decreto ministeriale 18 dicembre 2008, in materia di incentivazione dell'energia elettrica prodotta da fonti rinnovabili tramite la tariffa fissa onnicomprensiva e di scambio sul posto - Implementation of Art. 1, c. 153 of L 244/07 and Art. 20 of DM 18/12/08 as regards promotion of electricity produced by renewable energy sources through the fixed omnicomprehensive tariff.)

Summary of interconnection requirements

Inverter connected	**≤ 6 kW**	**≤ 20 kW**	**> 20 kW**
Protection devices	Automatic disconnection switch with intrinsic security, voltage supervision Might be integrated in converter	Automatic disconnection switch with intrinsic security, voltage supervision Might be integrated in converter	Automatic disconnection switch with intrinsic security, voltage supervision Must be an external device
Voltage decrease protection value	$0.8 \cdot U_{rated}, \leq 0.2s$		
Voltage increase protection value	$1.2 \cdot U_{rated}, \leq 0.1s$		
Frequency decrease protection value	$49 Hz \text{ to } 49.7 Hz$		
Frequency increase protection value	$50.3 Hz \text{ to } 51 Hz$		
Reactive power provision	$\cos\varphi \geq 0{,}8_{ind}$ between 20% and 100% of nominal power, normal operation is $\cos\varphi = 1$ Customer and grid operator can negotiate something different in case it is necessary for grid stability.		
Connectivity according power	Single phase	Three phase	Three phase for rated power ≤50kW, ≥70kW connection to medium voltage, in between to be negotiated
Harmonics	CEI EN 61000-3-2 or CEI EN 61000-3-12		
Voltage deviation during switching actions	CEI EN 61000-3-3 or CEI EN 61000-3-11		
Long-term flickers	CEI EN 61000-3-3 or CEI EN 61000-3-11		

Induction generator connected	**≤ 6 kW**	**≤ 20 kW**	**> 20 kW**

Protection devices	Automatic disconnection switch with intrinsic security, voltage supervision Must be an external device	Automatic disconnection switch with intrinsic security, voltage supervision Must be an external device	Automatic disconnection switch with intrinsic security, voltage supervision Must be an external device
Voltage decrease protection value	$0.8 \cdot U_{rated}, \leq 0.2s$		
Voltage increase protection value	$1.2 \cdot U_{rated}, \leq 0.1s$		
Frequency decrease protection value	$49 Hz \text{ to } 49.7 Hz$		
Frequency increase protection value	$50.3 Hz \text{ to } 51 Hz$		
Reactive power provision	$\cos\varphi \geq 0.9_{ind}$		
Connectivity according power	Single phase	Three phase	Three phase for rated power ≤50kW, ≥70kW connection to medium voltage, in between to be negotiated
Harmonics	CEI EN 61000-3-2 or CEI EN 61000-3-12		
Voltage deviation during switching actions	CEI EN 61000-3-3 or CEI EN 61000-3-11		
Long-term flickers	CEI EN 61000-3-3 or CEI EN 61000-3-11		

The Italian norms/guidelines do not mention synchronous generator connections to the low voltage grid.

4 Public Grid Interconnection: Summary for Spain

In Spain, the generation of electricity from renewable sources is mainly promoted through a price regulation. System operators may choose between two options: a guaranteed feed-in tariff and a guaranteed bonus (premium) paid on top of the electricity price derived on the free market. Furthermore, investments in systems and equipment required for the generation of electricity from renewable sources may be deducted from tax.

In Spain, systems that generate electricity from renewable energy sources are statutorily entitled to connection to and usage of the grid at a priority. System operators may be contractually entitled to an expansion of the grid, of which they are to bear the cost if the expansion is required for a system to be connected to the grid. Apart from that, the grid operator is obligated to expand his grid in compliance with the general provisions of energy law.

The legal framework in Spain is formed by the following laws:

- Plan de Energías Renovables en España 2005-2010 (Renewable Energy Plan)
- Real Decreto 661/2007 (promotes all renewable energy sources)
- Real Decreto 1578/2008 (feed-in tariff for photovoltaic systems)
- Real Decreto 436/2004 (promotes all renewable energy sources; may still be applied during a transition period)
- Ley 54/1997 (Electricity Sector Law)
- Ley 35/2006 (Law on the taxation of companies)
- Real Decreto Legislativo 4/2004 (Legislative decree on the taxation of companies)
- Real Decreto 1955/2000 (usage of the grid)
- Real Decreto 2019/1997 (sale of electricity)
- Real Decreto 2017/1997 (cost of usage of the grid)

Summary of interconnection requirements

Inverter connected	**≤ 5 kW**	**> 5 kW**	
Protection devices	Automatic disconnection switch with voltage supervision, Anti-islanding according UNE EN 50438	Automatic disconnection switch with voltage supervision, Anti-islanding according UNE EN 50438	
Voltage decrease protection value	$0.85 \cdot U_{rated}, \leq 1.2s$		
Voltage increase protection value	$1.1 \cdot U_{rated}, \leq 0.5s$		
Frequency decrease protection value	$48 Hz , \leq 3s$		
Frequency increase protection value	$51 Hz, \leq 0{,}2s$		
Reactive power provision	$\cos\varphi \approx 1{,}0$		
Connectivity according power	Single phase	Three phase	>100kW connection to medium voltage (>60kW in case of 127V grid)
Harmonics	UNE EN 61000-3-2 or UNE EN 61000-3-12 or UNE EN 61000-3-4		
Voltage deviation during switching actions	$\Delta u \leq 5\%$		
Long-term flickers			
Maximum power to be connected to low voltage grid	$\leq \pm 7\% \cdot U_{rated}$ in all the low voltage grid must to exceeded $P_{rated} \leq 5\%$ of short circuit power at point of connection $\sum P_{rated} \leq 5\%$ of short circuit power at transformer station		
Galvanic separation	Required between DC ad AC part of the installation, might be done in the inverter		

Synchronous generator connected	**≤ 5 kW**	**> 5 kW**	
Protection devices	Automatic disconnection switch with three-phase voltage supervision, Manual switch, accessible for grid operator personnel	Automatic disconnection switch with three-phase voltage supervision, Manual switch, accessible for grid operator personnel	
Voltage decrease protection value	$0.85 \cdot U_{rated}, \leq 1.5s$		
Voltage increase protection value	$1.1 \cdot U_{rated}, \leq 1.5s$		
Frequency decrease protection value	$47\,Hz\,, \leq 0{,}5s$		
Frequency increase protection value	$51Hz, \leq 0{,}5s$		
Reactive power provision	$\cos\varphi \geq 0{,}8$		
Connectivity according power	Single phase	Three phase	>100kW connection to medium voltage (>60kW in case of 127V grid), In case of wind generator ≤5% of short circuit power
Harmonics	UNE EN 61000-3-2 or UNE EN 61000-3-12 or UNE EN 61000-3-4		
Voltage deviation during switching actions	$\Delta u \leq 5\%$		
Long-term flickers	-		
Synchronization	• Voltage difference $\Delta U < \pm 8\% \, U_{rated}$ • Frequency difference $\Delta f < \pm 0.1Hz$ • Phase angle difference $\Delta\varphi < \pm 10°$		

Induction generator	**≤ 5 kW**	**> 5 kW**

connected			
Protection devices	Automatic disconnection switch with three-phase voltage supervision, Manual switch, accessible for grid operator personnel	Automatic disconnection switch with three-phase voltage supervision, Manual switch, accessible for grid operator personnel	
Voltage decrease protection value	$0.85 \cdot U_{rated}, \leq 1.5s$		
Voltage increase protection value	$1.1 \cdot U_{rated}, \leq 1.5s$		
Frequency decrease protection value	$47 Hz, \leq 0,5s$		
Frequency increase protection value	$51 Hz, \leq 0,5s$		
Reactive power provision	$\cos\varphi \geq 0,86$ at rated power		
Connectivity according power	Single phase	Three phase	>100kW connection to medium voltage (>60kW in case of 127V grid), In case of wind generator ≤5% of short circuit power
Harmonics	UNE EN 61000-3-2 or UNE EN 61000-3-12 or UNE EN 61000-3-4		
Voltage deviation during switching actions	$\Delta u \leq 3\%$ In case of wind generators: less than three switching actions per minute and $\Delta u \leq 2\% / s$		
Long-term flickers	-		
Synchronization	• Speed must be in-between 90% to 100% of synchronous speed		

5 Public Grid Interconnection: Summary for the United States of America

The market access requirements for PV equipment in the United States are segmented in two main areas - safety and performance - that are integral to each other in the overall construction. The focus of the UL standards is in providing requirements for materials, construction and the evaluation of the potential electrical shock and fire safety hazards. The focus of the IEC requirements is in terms and symbols, testing, design qualification and type approval.

UL certifies that PV equipment complies with the safety, environmental and other performance requirements of the appropriate standards. UL supports manufacturers with the compliance to both the UL and the IEC requirements utilizing a combined project or if needed, as individual evaluations.

In addition, UL provides balance of systems equipment certification to the standards identified illustration 5.1a. These certifications include materials (such as polymerics used for backsheets, encapsulants, and adhesives), components (like junction boxes and connectors) and end-products (for example, inverters and meters).

The only norms that contain information towards grid connection are UL 1741 and IEEE 1547.

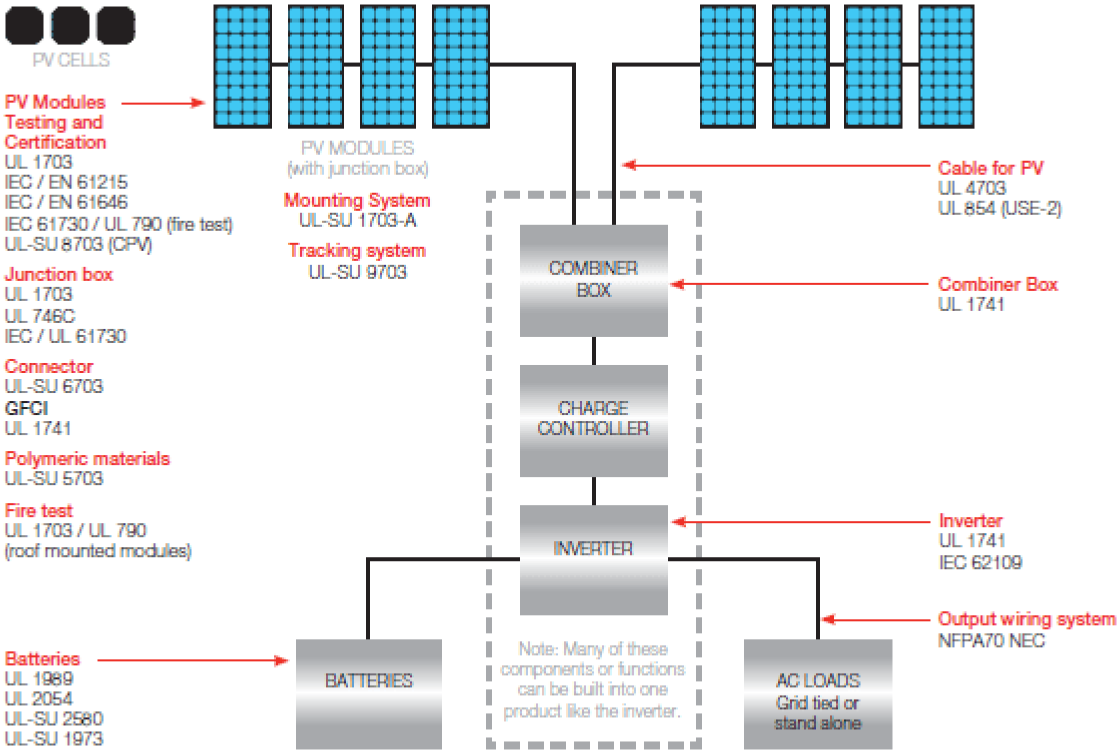
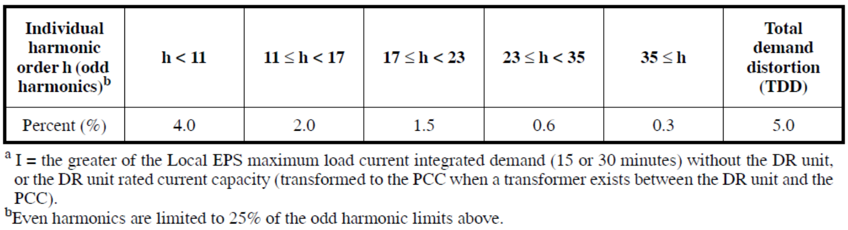
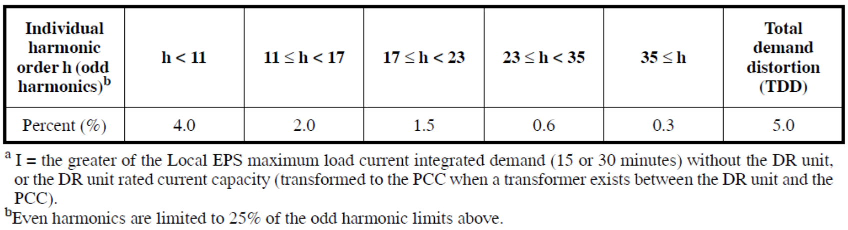


Illustration 5.1.a: Norms for PV systems in the US [Source: www.ul.com]

Inverter connected	≤30kW	>30kW

<table>
<tr><td>Protection devices</td><td colspan="2">Automatic disconnection switch, anti-islanding protection required, $\le 0.2s$</td></tr>
<tr><td>Voltage decrease protection value</td><td colspan="2">$< 0.5 \cdot U_{rated}, \le 0.16s$
$\le 0.88 \cdot U_{rated}, \le 2s$</td></tr>
<tr><td>Voltage increase protection value</td><td colspan="2">$> 1.1 \cdot U_{rated}, \le 1s$
$\ge 1.2 \cdot U_{rated}, \le 0.16s$</td></tr>
<tr><td>Frequency decrease protection value</td><td>$< 59.3Hz, \le 0.16s$</td><td>$< 59.8..57.0Hz, \le 0.16s$
adjustable between 0.16s and 300s
$< 57Hz, \le 0.16s$</td></tr>
<tr><td>Frequency increase protection value</td><td>$> 60.5Hz, \le 0{,}16s$</td><td>$> 60.5Hz, \le 0{,}16s$</td></tr>
<tr><td>Reactive power provision</td><td colspan="2">$\cos\varphi \ge 0{,}85$</td></tr>
<tr><td>Voltage deviation during switching actions</td><td colspan="2">$\Delta u \le 5\%$</td></tr>
<tr><td>Harmonics</td><td colspan="2">
<table>
<tr><th>Individual harmonic order h (odd harmonics)[b]</th><th>h < 11</th><th>11 ≤ h < 17</th><th>17 ≤ h < 23</th><th>23 ≤ h < 35</th><th>35 ≤ h</th><th>Total demand distortion (TDD)</th></tr>
<tr><td>Percent (%)</td><td>4.0</td><td>2.0</td><td>1.5</td><td>0.6</td><td>0.3</td><td>5.0</td></tr>
</table>
[a] I = the greater of the Local EPS maximum load current integrated demand (15 or 30 minutes) without the DR unit, or the DR unit rated current capacity (transformed to the PCC when a transformer exists between the DR unit and the PCC).
[b]Even harmonics are limited to 25% of the odd harmonic limits above.</td></tr>
<tr><td>Maximum power to be connected to low voltage grid</td><td colspan="2">≤10MVA</td></tr>
<tr><td>Galvanic separation</td><td colspan="2">Required between DC ad AC part of the installation. Devices, such as an isolation transformer, a blocking capacitor or a direct current sensor with high-speed disconnect switch are usable to limit the direct current flow.</td></tr>
<tr><td>Synchronization</td><td colspan="2">Only when the installation is not in idle mode before grid connection!
≤500kVA:
• Voltage difference $\Delta U < \pm 10\% \, U_{rated}$
• Frequency difference $\Delta f < \pm 0.3Hz$
• Phase angle difference $\Delta\varphi < \pm 20°$
≤1500kVA:
• Voltage difference $\Delta U < \pm 5\% \, U_{rated}$</td></tr>
</table>

	• Frequency difference $\Delta f < \pm 0.2Hz$ • Phase angle difference $\Delta\varphi < \pm 15°$ >1500kVA • Voltage difference $\Delta U < \pm 3\% U_{rated}$ • Frequency difference $\Delta f < \pm 0.1Hz$ • Phase angle difference $\Delta\varphi < \pm 10°$

<table>
<tr><th>Synchronous generator connected</th><th>≤30kW</th><th>>30kW</th></tr>
<tr><td>Protection devices</td><td colspan="2">Automatic disconnection switch, anti-islanding protection required, $\le 0.2s$</td></tr>
<tr><td>Voltage decrease protection value</td><td colspan="2">$< 0.5 \cdot U_{rated}, \le 0.16s$
$\le 0.88 \cdot U_{rated}, \le 2s$</td></tr>
<tr><td>Voltage increase protection value</td><td colspan="2">$> 1.1 \cdot U_{rated}, \le 1s$
$\ge 1.2 \cdot U_{rated}, \le 0.16s$</td></tr>
<tr><td>Frequency decrease protection value</td><td>$< 59.3Hz , \le 0.16s$</td><td>$< 59.8..57.0Hz , \le 0.16s$
adjustable between 0.16s and 300s
$< 57Hz , \le 0.16s$</td></tr>
<tr><td>Frequency increase protection value</td><td>$> 60.5Hz, \le 0,16s$</td><td>$> 60.5Hz, \le 0,16s$</td></tr>
<tr><td>Reactive power provision</td><td colspan="2">$\cos\varphi \ge 0,85$</td></tr>
<tr><td>Voltage deviation during switching actions</td><td colspan="2">$\Delta u \le 5\%$</td></tr>
<tr><td>Harmonics</td><td colspan="2">
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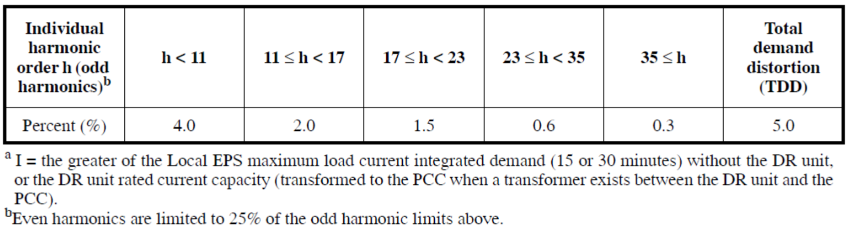
[a] I = the greater of the Local EPS maximum load current integrated demand (15 or 30 minutes) without the DR unit, or the DR unit rated current capacity (transformed to the PCC when a transformer exists between the DR unit and the PCC).
[b] Even harmonics are limited to 25% of the odd harmonic limits above.</td></tr>
<tr><td>Maximum power to be connected to low voltage grid</td><td colspan="2">≤10MVA</td></tr>
<tr><td>Galvanic separation</td><td colspan="2">-</td></tr>
</table>

Synchronization	≤500kVA: • Voltage difference $\Delta U < \pm 10\% \, U_{rated}$ • Frequency difference $\Delta f < \pm 0.3 Hz$ • Phase angle difference $\Delta \varphi < \pm 20°$ ≤1500kVA: • Voltage difference $\Delta U < \pm 5\% \, U_{rated}$ • Frequency difference $\Delta f < \pm 0.2 Hz$ • Phase angle difference $\Delta \varphi < \pm 15°$ >1500kVA • Voltage difference $\Delta U < \pm 3\% \, U_{rated}$ • Frequency difference $\Delta f < \pm 0.1 Hz$ • Phase angle difference $\Delta \varphi < \pm 10°$

Induction generator connected	**≤30kW**	**>30kW**
Protection devices	Automatic disconnection switch, anti-islanding protection required, $\le 0.2s$	
Voltage decrease protection value	$< 0.5 \cdot U_{rated}, \le 0.16s$ $\le 0.88 \cdot U_{rated}, \le 2s$	
Voltage increase protection value	$> 1.1 \cdot U_{rated}, \le 1s$ $\ge 1.2 \cdot U_{rated}, \le 0.16s$	
Frequency decrease protection value	$< 59.3Hz, \le 0.16s$	$< 59.8..57.0Hz, \le 0.16s$ adjustable between 0.16s and 300s $< 57 Hz, \le 0.16s$
Frequency increase protection value	$> 60.5Hz, \le 0{,}16s$	$> 60.5Hz, \le 0{,}16s$
Reactive power provision	$\cos \varphi \ge 0{,}85$	
Voltage deviation during switching actions	$\Delta u \le 5\%$	

<table>
<tr><td>Harmonics</td><td>
<table>
<tr><th>Individual harmonic order h (odd harmonics)[b]</th><th>h < 11</th><th>11 ≤ h < 17</th><th>17 ≤ h < 23</th><th>23 ≤ h < 35</th><th>35 ≤ h</th><th>Total demand distortion (TDD)</th></tr>
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</table>
[a] I = the greater of the Local EPS maximum load current integrated demand (15 or 30 minutes) without the DR unit, or the DR unit rated current capacity (transformed to the PCC when a transformer exists between the DR unit and the PCC).
[b]Even harmonics are limited to 25% of the odd harmonic limits above.</td></tr>
<tr><td>Maximum power to be connected to low voltage grid</td><td>≤10MVA</td></tr>
<tr><td>Galvanic separation</td><td>-</td></tr>
<tr><td>Synchronization</td><td>Voltage deviation must be $\Delta u \le 5\%$</td></tr>
</table>

6 Recommendations for simplified grid interconnection procedures of small generators and net metering

6.1 Recommendations for technical connectivity requirements

Recommendation 1: Not generation specific standards, guidelines and laws (e.g. for electrical installations) rather should be derived from existing Brazilian procedures than adopting those from European or US examples.

Explanatory Statement:

Generation units on the low voltage level might be a new topic for many countries but not electrical installations themselves. Services on electricity installations on the low voltage level are conducted by well educated personnel that is spread all over the countries.

To perform work on the low voltage level in every country rules, guidelines and/or laws exist in order to gurantee a secure system operation. Employers associations have led guidelines for accident prevention and safety of workers. There is no need to change well establihsed rules and procedures due to the fact that generation units are added to the low voltage grid.

Actually, those rules are similar to many country groups that may have its origin that they have adopted from or agreed in accordance with other countries. But there is no need to change them due to the new purpose.

Recommendation 2: Connectivity rules, guidelines and laws for connection to the low voltage grid rather should be derived from existing Brazilian procedures than adopting those from European or US examples.

Explanatory Statement:

Connection of a (small) generation unit does not differ a lot from the connection of a house. Different from a house a generation unit does not draw power from the grid but feeds power to the gird. When the installed power is low it only decreases the power drawn from the grid.

As a consequence, all the rules, guidelines and laws that are related to topics like power quality can be the same as for electricity consuming equipment (it does not play a role whether the harmonics, the voltage drop, etc. result from the refrigerator or the PV inverter).

Only in those aspects that have impacts due to the power generating nature of the unit, specific rules, guidelines or laws should be addressed. These are those aspects that address safety of workers from grid personnel and stability of grid operation.

Recommendation 3: Generation units require a protection unit that interrupts power feed-in to the grid and allows safe maintenance work at grid assets.

This protection device should be allowed to be an integral part of the generation system in order to avoid unnecessary costs.

Explanatory Statement:

The necessity of such a protection device is not up for debate. It is required to guarantee worker safety. For larger generation units or power plants a separate control unit and switching device does not matter and does not influence the overall cost of the installation.

As a first approximation a separate protection unit is constant in cost whereas the power generation unit is proportional to the installed capacity. Therefore, to insist on a separate device means especially for small generation units a significant cost factor decreasing its economic viability.

Therefore, it is a question of economic performance or even a question whether an installation can be economically justified or not that the protection can be an integral part of the generation unit.

Inverters (e.g. PV systems require for power feed-in) do the inverting of DC current by switching elements. To use them in order to fullfil grid safety requirements instead of installing a serarate device is a useful and important measure.

Recommendation 4: Extensive and therefore expensive on-site test procedures to find out the compliance with technical connectivity standards must be avoided to have economic small-scale power generation. Therefore, system/component suppliers should guarantee the compliance with required standards in Brazil by a conformidity declaration and the grid operator should be obliged to accept the declaration.

Explanatory Statement:

On-site test procedures are time consuming and equipment extensive and therefore expensive. That would immediately mean a considerable cost fraction for the overall installation and must be avoided.

The component that makes the grid connection in case of a small photovoltaic generator is the inverter. Inverters are nowadays a mass product and one is equal to the other. Therefore, it is a much more reasonable procedure that the inverter manufacturer tests his equipment with an accredited test laboratory and receives therefore a test certificate. With the conformidity declaration he then confirms that all his inverters are in accordance with the test.

Illustration 6.1 shows the test certificate and the conformidity declaration of an inverter manufacturer.

Bureau Veritas Consumer Products Services Germany GmbH
Businesspark A96
86842 Türkheim
Deutschland
+ 49 (0) 8245 96810-0
cps-tuerkheim@de.bureauveritas.com

Unbedenklichkeitsbescheinigung

Antragsteller: **Kaco new energy GmbH**
Carl-Zeiss-Str. 1
74172 Neckarsulm
Deutschland

Erzeugnis: **Selbsttätige Schaltstelle zwischen einer netzparallelen Eigenerzeugungsanlage und dem öffentlichen Niederspannungsnetz**

Modell: **Powador 3200, Powador 4400, Powador 5300, Powador 5300 supreme, Powador 5500, Powador 6600**

Bestimmungsgemäße Verwendung:

Selbsttätige Schaltstelle mit einphasiger Netzüberwachung gemäß DIN V VDE V 0126-1-1:2006-02 für Photovoltaikanlagen mit einer einphasigen Paralleleinspeisung über Wechselrichter in das Netz der öffentlichen Versorgung. Die selbsttätige Schaltstelle ist integraler Bestandteil der oben angeführten trafolosen Wechselrichter. Diese dient als Ersatz für eine jederzeit dem Verteilungsnetzbetreiber (VNB) zugängliche Schaltstelle mit Trennfunktion.

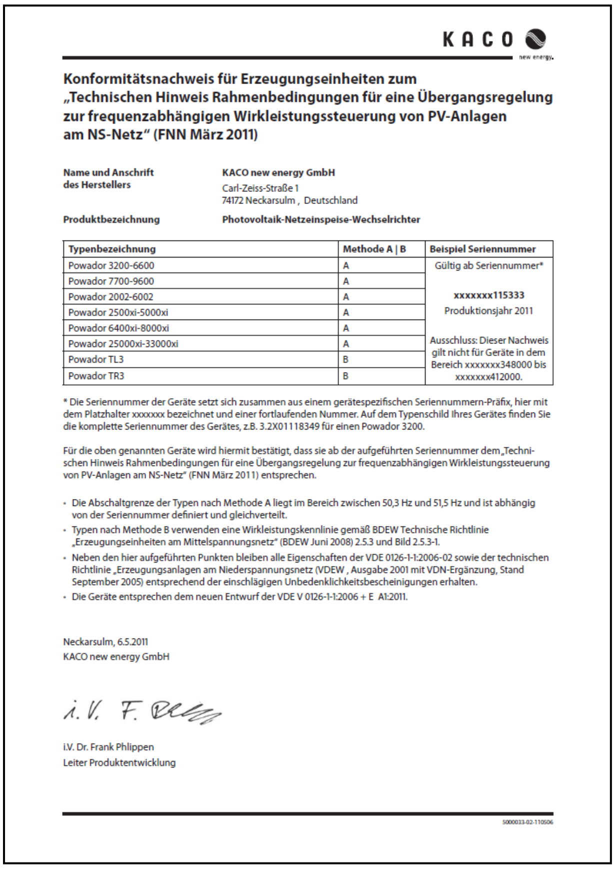
Prüfgrundlagen:

DIN V VDE V 0126-1-1 (VDE V 0126-1-1):2006-02 und „Eigenerzeugungsanlagen am Niederspannungsnetz, 4. Ausgabe 2001, Richtlinie für Anschluss und Parallelbetrieb von Eigenerzeugungsanlagen am Niederspannungsnetz" mit VDN Ergänzungen, Stand 2005 vom Verband der Elektrizitätswirtschaft (VDEW) und vom Verband der Netzbetreiber (VDN).

Ein repräsentatives Testmuster der oben genannten Erzeugnisse entspricht den zum Zeitpunkt der Ausstellung dieser Bescheinigung geltenden sicherheitstechnischen Anforderungen der aufgeführten Prüfgrundlagen für die bestimmungsgemäße Verwendung.

Bericht Nummer: **10TH0376-VDE0126**
Zertifikat Nummer: **U11-142**
Datum: **2011-02-21** **Gültig bis:** **2014-02-21**

Achim Hänchen



KACO new energy.

Konformitätsnachweis für Erzeugungseinheiten zum „Technischen Hinweis Rahmenbedingungen für eine Übergangsregelung zur frequenzabhängigen Wirkleistungssteuerung von PV-Anlagen am NS-Netz" (FNN März 2011)

Name und Anschrift des Herstellers **KACO new energy GmbH**
Carl-Zeiss-Straße 1
74172 Neckarsulm , Deutschland

Produktbezeichnung **Photovoltaik-Netzeinspeise-Wechselrichter**

Typenbezeichnung	**Methode A | B**	**Beispiel Seriennummer**
Powador 3200-6600	A	Gültig ab Seriennummer* **xxxxxxx115333** Produktionsjahr 2011 Ausschluss: Dieser Nachweis gilt nicht für Geräte in dem Bereich xxxxxxx348000 bis xxxxxxx412000.
Powador 7700-9600	A	
Powador 2002-6002	A	
Powador 2500xi-5000xi	A	
Powador 6400xi-8000xi	A	
Powador 25000xi-33000xi	A	
Powador TL3	B	
Powador TR3	B	

* Die Seriennummer der Geräte setzt sich zusammen aus einem gerätespezifischen Seriennummern-Präfix, hier mit dem Platzhalter xxxxxxx bezeichnet und einer fortlaufenden Nummer. Auf dem Typenschild Ihres Gerätes finden Sie die komplette Seriennummer des Gerätes, z.B. 3.2X01118349 für einen Powador 3200.

Für die oben genannten Geräte wird hiermit bestätigt, dass sie ab der aufgeführten Seriennummer dem „Technischen Hinweis Rahmenbedingungen für eine Übergangsregelung zur frequenzabhängigen Wirkleistungssteuerung von PV-Anlagen am NS-Netz" (FNN März 2011) entsprechen.

- Die Abschaltgrenze der Typen nach Methode A liegt im Bereich zwischen 50,3 Hz und 51,5 Hz und ist abhängig von der Seriennummer definiert und gleichverteilt.
- Typen nach Methode B verwenden eine Wirkleistungskennlinie gemäß BDEW Technische Richtlinie „Erzeugungseinheiten am Mittelspannungsnetz" (BDEW Juni 2008) 2.5.3 und Bild 2.5.3-1.
- Neben den hier aufgeführten Punkten bleiben alle Eigenschaften der VDE 0126-1-1:2006-02 sowie der technischen Richtlinie „Erzeugungsanlagen am Niederspannungsnetz (VDEW , Ausgabe 2001 mit VDN-Ergänzung, Stand September 2005) entsprechend der einschlägigen Unbedenklichkeitsbescheinigungen erhalten.
- Die Geräte entsprechen dem neuen Entwurf der VDE V 0126-1-1:2006 + E A1:2011.

Neckarsulm, 6.5.2011
KACO new energy GmbH

i.V. F.

i.V. Dr. Frank Phlippen
Leiter Produktentwicklung

5000033-02-110506

Illustration 6.1: Test certificate (left) and conformidity declaration (right) of inverter manufacturer KACO [Source: Kaco]

6.2 Recommendations for legal and adminstrative procedures

Before giving recommendations for the legal and administrative procedures a few remarks will be given. Especially for engineers determination of economics seems to be self-evident. Prizes of equipment for e.g. photovoltaic modules and inverters together with the solar resources available at a specific site determine the electricity generation costs.

Experiences in Europe show that the legal and administrative procedures have an enormous influence on project costs. Here, almost the same is valid like with the considerations made for recommendations 3 and 4. For a several GW installation administrative costs might be not of big importance but for installations with only a few kW they can become deciding.

<u>Recommendation 5</u>: Keep the administrative process as simple as possible!
A process with only two steps is recommended.

Explanatory Statement:

Countries like Spain and Italy have significantly higher solar resources than e.g. Germany. At the same time feed-in tariffs in those countries are even higher than in Germany and nevertheless market developed much better in Germany. The journal "PHOTON" recently wrote about Spain[4]: "You want to go to hell? Then try to plan a PV system in Spain […]. 30 hurdles from the legislative body have to be taken […]. First a safety charge of 50 €/kW has to be deposited […]. Then go for licenses of the city planning administration, environment protection administration, monument protection administration and of the building authority. Then you require a business license and afterwards a registration for business tax. Then go for a pre-entry into a special installation register that later has to be confirmed. Then the grid operator needs to be conducted."

The EC project PV Legal[5] investigates non-technical aspects in photovoltaic developments in all European countries. Some results are cited here:

The German PV market stakeholders confirmed the reputation that this market represents the best practice at European level. This leadership is in fact not only confirmed by the copious yearly PV power installed and the lowest market prices – widely known facts in the PV market – but also by the lowest share of administrative costs, the shortest project development durations and waiting times and, finally, by the most moderate labor requirements in all the considered market segments, as reported by the interviewed stakeholders.

Instead, other markets that are affected by more severe legal-administrative barriers show quite clearly the impact of these barriers in terms of longer project durations, higher costs, longer waiting times and more demanding labor requirements.

These effects are scattered unevenly across countries and market segments depending on local factors, but some results seem to emerge clearly enough to allow for a basic analysis:

- France and Spain show very long project development durations across all 3 market segments[6]. For France this is a confirmation that the unclarity of the administrative framework contributed to the delay of the market ramp-up that in fact only happened in 2009. For Spain, this is a confirmation that the new framework set up by RD 1578/08 has de facto slowed down PV deployment after the 2008 boom.
- Developing a PV project in Bulgaria is extremely complicated, requiring excessive labor to comply with its administrative processes.
- The share of administrative costs in Italy, Spain, Greece, Czech Republic and a few other countries appears to be disproportionate and efforts should be made in order to reduce them.

Illustrations 6.2.a to illustration 6.2.d show the legal-administrative requirements in hours required, the waiting time in weeks for administrative decisions, the overall project duration in weeks and the legal-administrative costs as share of the overall project development costs in different European countries.

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[4] PHOTON, 4/2011

[5] www.pvlegal.eu

[6] Segment A: up to 20 kWp, segment B: up to 2 MW building integrated, segment C: large ground-mounted installations

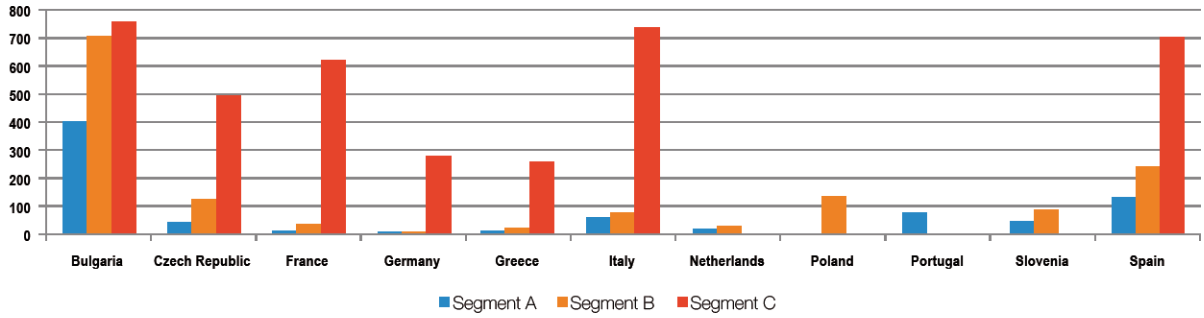


Illustration 6.2.a: Compliance with legal-administrative requirements: Overall Labor (hours) [Source: PV Legal]

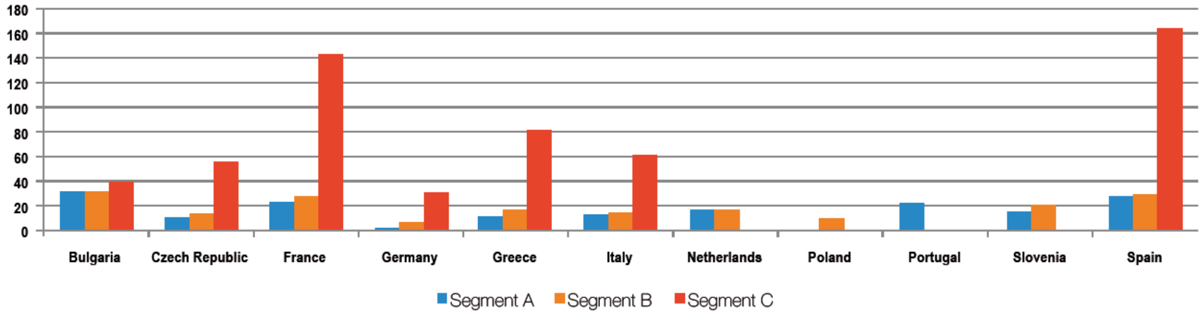


Illustration 6.2.b: PV project development process: Overall Waiting Time (weeks) [Source: PV Legal]

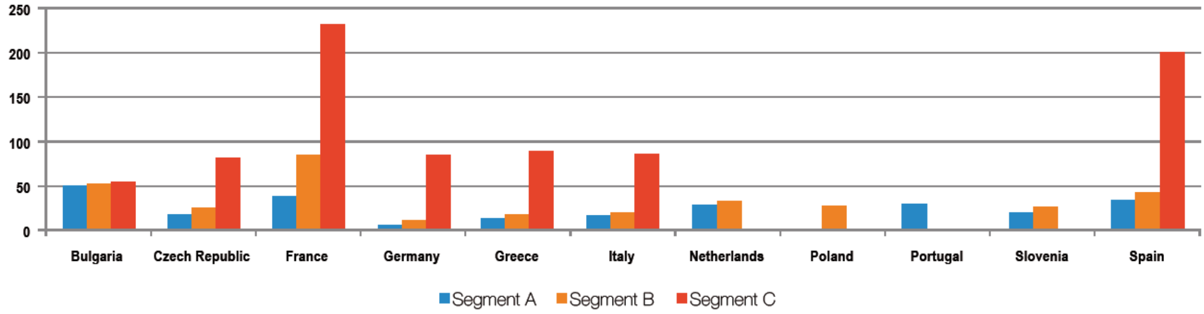


Illustration 6.2.c: PV project development process: Overall duration (weeks) [Source: PV Legal]

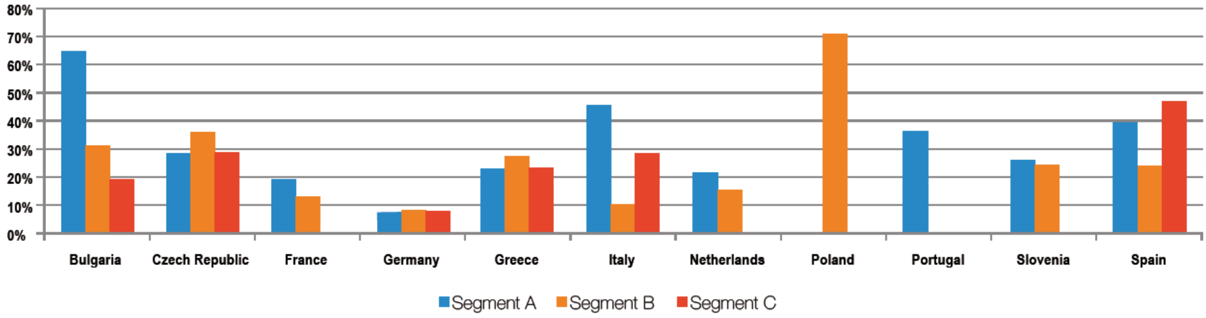


Illustration 6.2.d: Legal-administrative costs as a share of overall project development costs (excluding PV equipment) [Source: PV Legal]

Recommendation 6: Administrative step 1: Provide a standardized form / fact sheet for grid operators. Generation plant operator has to fill in the standardized form with specific information about the small scale power plant to be connected to the grid. On the bases of that information the grid operator needs to guarantee a reliable grid operation.

Explanatory Statement:

A standardized form avoids that each grid operator has to develop his own scheme about the information required and also avoids that grid operators develop mechanisms that counteract the possibility of generation units on the low voltage level, e.g. to protect the market that is dominated by its own generation units.

Appendix A shows the example from the German standardized form. Here, a summary of the information required is given:

- Name and address of plant operator, plant installer and electrician who will do the grid connection
- Address of the plant site
- Rated power of modules
- Rated power of inverter
- In case it is a plant enlargement, the rated power of the old installation
- Connection to the grid already existing (yes/no)
- Several information related to the peculiarities of the German renewable energy act
- Signature of plant operator (and of land owner if different)

Recommendation 7: In order to avoid unnecessary administrative delays it is recommended that the grid operator is given a maximum period for answering. This time span should not exceed three months.

Explanatory Statement:

Not answering to an application for feed-in by a plant operator is another preferred measure by grid operators to avoid installations in distribution grids. This has shown to be practice in many European countries. Although Germany is generally a “good practice example” in administrative handling of power feed-in the legislative body did not consider such a maximum period and regularly complaints about this topic is reported in Germany.

The grid operator needs to have time to proof whether the grid is capable to absorb the power fed by a generation plant. In practice, with very small generation plants grid operators do not perform calculations as those small (up to a few kW) plants just reduce power consumption but do not cause a reverse power flow. Starting with about 10 kW some rough calculations are performed that can be done in a very short time. Only with bigger plants (several tens of kW) more detailed calculations are performed that maybe justify a longer period.

Therefore, a three month period should be the maximum.

> Recommendation 8: Administrative step 2: the second required administrative step is the plant commissioning. Again a standardized procedure with standardized forms is recommended. For small generation plants inspection of grid operator personnel is not required.

Explanatory Statement:

When the breakthrough of decentralized generation is aimed and a boom will be started there is a need for an easy procedure. With respect to cost efficiency on the grid operator side it is decisive to have a slim administrative procedure where grid operator personnel not necessarily need to travel to every site.

A slim commissioning procedure reduces overall costs!

In the following the German standardized forms are explained. They are shown in appendix B:

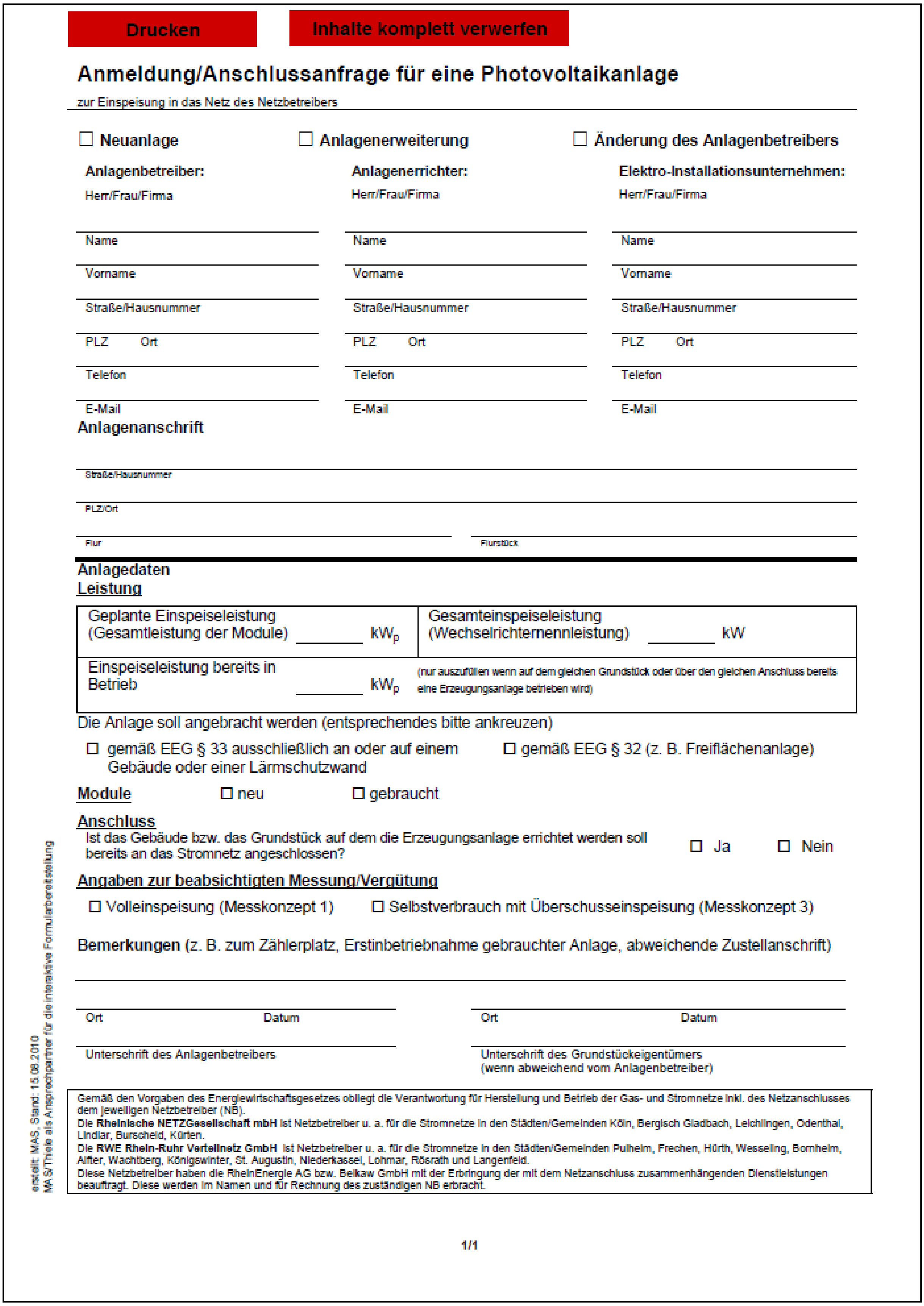
- Name and address of plant operator and electrician
- Address of plant site
- Rated module power
- Rated inverter power
- Electricity counter number
- Meter reading at time of commissioning
- Several information related to the peculiarities of the German renewable energy act
- Commissioning date
- Signature of responsible electrician

The commissioning protocol contains the following information (page 2 of standardized form):

- Module data (manufacturer name, type, number, nominal power)
- Inverters (manufacturer name, type, number)
- The form “Electricity commissioning” (appendix B1, normally used for house connections to the grid, not really necessary) with the following information:
    - Name and address information
    - Type of plant
    - Metering equipment (e.g. single phase, three phase, type of transducer)
    - Place of meter installation
    - Signature of electrician
- Standardized form “measurement concept” (appendix B2) is dedicated to the different possibilities of the German feed-in law and is not of relevance for net metering.
- Circuit diagram of the installation
- Data sheet of modules

- For the inverter:
    - Data sheet
    - Conformidity declaration
- Copy of Registration form for regulatory body database
- Photo of system
- In case not a meter from the grid operator is chosen:
    - Meter form (appendix B3)
    - Photo that shows the meter reading at time of commissioning

Appendix A: Standardized Application Form



Anmeldung/Anschlussanfrage für eine Photovoltaikanlage

zur Einspeisung in das Netz des Netzbetreibers

☐ Neuanlage	☐ Anlagenerweiterung	☐ Änderung des Anlagenbetreibers
Anlagenbetreiber:	**Anlagenerrichter:**	**Elektro-Installationsunternehmen:**
Herr/Frau/Firma	Herr/Frau/Firma	Herr/Frau/Firma
Name	Name	Name
Vorname	Vorname	Vorname
Straße/Hausnummer	Straße/Hausnummer	Straße/Hausnummer
PLZ Ort	PLZ Ort	PLZ Ort
Telefon	Telefon	Telefon
E-Mail	E-Mail	E-Mail

Anlagenanschrift

Straße/Hausnummer

PLZ/Ort

Flur
Flurstück

Anlagedaten

Leistung

Geplante Einspeiseleistung (Gesamtleistung der Module) ________ kW_p	Gesamteinspeiseleistung (Wechselrichternennleistung) ________ kW
Einspeiseleistung bereits in Betrieb ________ kW_p	(nur auszufüllen wenn auf dem gleichen Grundstück oder über den gleichen Anschluss bereits eine Erzeugungsanlage betrieben wird)

Die Anlage soll angebracht werden (entsprechendes bitte ankreuzen)

☐ gemäß EEG § 33 ausschließlich an oder auf einem Gebäude oder einer Lärmschutzwand
☐ gemäß EEG § 32 (z. B. Freiflächenanlage)

Module ☐ neu ☐ gebraucht

Anschluss

Ist das Gebäude bzw. das Grundstück auf dem die Erzeugungsanlage errichtet werden soll bereits an das Stromnetz angeschlossen? ☐ Ja ☐ Nein

Angaben zur beabsichtigten Messung/Vergütung

☐ Volleinspeisung (Messkonzept 1) ☐ Selbstverbrauch mit Überschusseinspeisung (Messkonzept 3)

Bemerkungen (z. B. zum Zählerplatz, Erstinbetriebnahme gebrauchter Anlage, abweichende Zustellanschrift)

Ort Datum
Unterschrift des Anlagenbetreibers

Ort Datum
Unterschrift des Grundstückeigentümers
(wenn abweichend vom Anlagenbetreiber)

erstellt: MAS, Stand: 15.08.2010
MAS/Thiele als Ansprechpartner für die interaktive Formularbereitstellung

Gemäß den Vorgaben des Energiewirtschaftsgesetzes obliegt die Verantwortung für Herstellung und Betrieb der Gas- und Stromnetze inkl. des Netzanschlusses dem jeweiligen Netzbetreiber (NB).
Die **Rheinische NETZGesellschaft mbH** ist Netzbetreiber u. a. für die Stromnetze in den Städten/Gemeinden Köln, Bergisch Gladbach, Leichlingen, Odenthal, Lindlar, Burscheid, Kürten.
Die **RWE Rhein-Ruhr Verteilnetz GmbH** ist Netzbetreiber u. a. für die Stromnetze in den Städten/Gemeinden Pulheim, Frechen, Hürth, Wesseling, Bornheim, Alfter, Wachtberg, Königswinter, St. Augustin, Niederkassel, Lohmar, Rösrath und Langenfeld.
Diese Netzbetreiber haben die RheinEnergie AG bzw. Belkaw GmbH mit der Erbringung der mit dem Netzanschluss zusammenhängenden Dienstleistungen beauftragt. Diese werden im Namen und für Rechnung des zuständigen NB erbracht.

1/1

Appendix B: Commissioning Protocol

Inbetriebnahmeprotokoll für eine Photovoltaikanlage

für den Parallelbetrieb mit dem Netz des Netzbetreibers

☐ Neuanlage ☐ Anlagenerweiterung

Anlagenbetreiber:
Herr/Frau/Firma

Name
Vorname
Straße/Hausnummer
PLZ Ort
Telefon
E-Mail

Elektro-Installationsunternehmen:

Name
Verantwortliche Fachkraft
Straße/Hausnummer
PLZ Ort
Telefon Mobil
E-Mail

Anlagenanschrift:

Straße/Hausnummer
PLZ/Ort
Flur
Flurstück

Anlagedaten
Leistung

installierte Einspeiseleistung (Gesamtleistung der Module) ________ kW_p	Gesamteinspeiseleistung (Wechselrichternennleistung) ________ kW
Bei Erweiterung der Anlage waren bereits in Betrieb kW_p Zählernummer Z_E ____________________	(nur auszufüllen wenn auf dem gleichen Grundstück oder über den gleichen Anschluss bereits eine Erzeugungsanlage betrieben wird) Zählerstand Z_E ____________________ kWh

Die Anlage ist angebracht (entsprechendes bitte ankreuzen)

☐ gemäß EEG § 33 ausschließlich an oder auf einem Gebäude oder einer Lärmschutzwand ☐ gemäß EEG § 32 (z. B. Freiflächenanlage)

Die Module sind: ☐ neu ☐ gebraucht

Der Aufbau der Messung erfolgt gemäß dem beigefügten Messkonzept (Bitte immer beifügen)!

Wurde ein kundeneigener Zähler eingebaut ☐ ja ☐ nein

Vergütung für den Selbstverbrauch gemäß § 33 Abs. 2 EEG: ☐ ja ☐ nein

Zählernummer des Zählers für den Strombezug Z_1/Z_H ____________________

Die Anlage wurde am __ __. __ __. 2 0 1 __ gemäß den Anforderungen des §3 Abs. 5 EEG in Betrieb genommen.

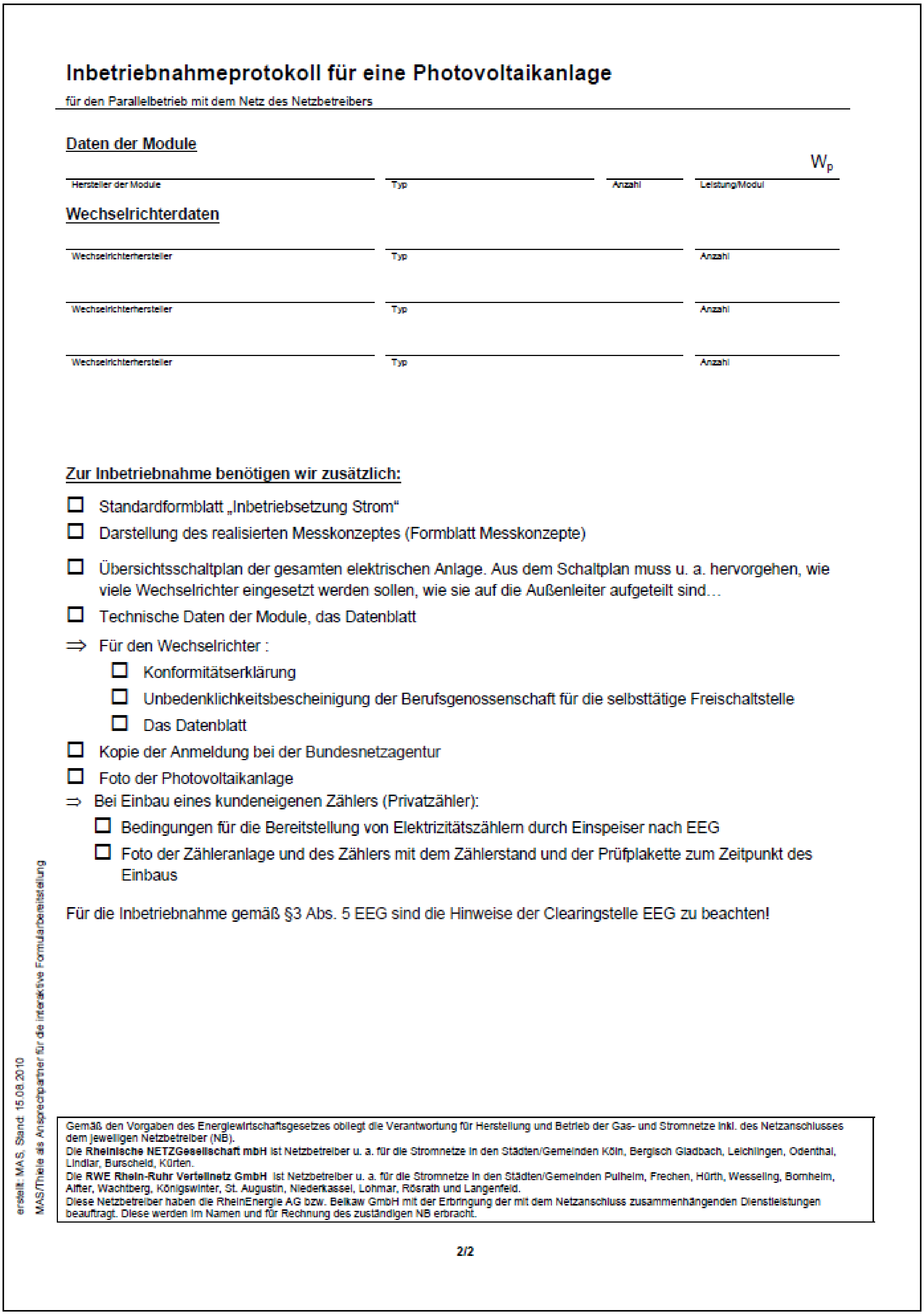
Der Netzparallelbetrieb der Anlage darf erst nach Zustimmung des Netzbetreibers erfolgen!

Für die zuvor beschriebene Anlage bestätige ich hiermit, die integrierte selbsttätige Freischaltstelle (mit Impedanzmessung, dreiphasige Spannungsüberwachung oder mit Schwingkreistest gemäß DIN VDE 0126-1-1) in der o. g. Photovoltaikanlage mit den zuvor genannten Leistungswerten auf ihre Funktionsfähigkeit gemäß VDEW/VDN Richtlinie „Eigenerzeugungsanlagen am Niederspannungsnetz" überprüft zu haben.
Bei einer Anlagenleistung größer 30 kVA wurde eine jederzeit zugängliche Schaltstelle mit Trennfunktion gemäß der VDEW Richtlinie „Eigenerzeugungsanlagen am Niederspannungsnetz" eingerichtet.
Mit Unterzeichnung dieses Inbetriebnahmeprotokolls erklärt die verantwortliche Elektrofachkraft, dass die anerkannten Regeln der Technik, wie z. B. die DIN/VDE-Vorschriften; die VDEW/VDN-Richtlinie „Eigenerzeugungsanlagen am Niederspannungsnetz" mit den ggf. ergänzenden Hinweisen, sowie die Technischen Anschlussbedingungen (TAB) etc., in der jeweils aktuell gültigen Fassung eingehalten werden.

Ort, Datum

Unterschrift der verantwortlichen Fachkraft und Stempel des Elektro-Installationsunternehmens

1/2



Inbetriebnahmeprotokoll für eine Photovoltaikanlage

für den Parallelbetrieb mit dem Netz des Netzbetreibers

Daten der Module

Hersteller der Module	Typ	Anzahl	W$_p$ Leistung/Modul

Wechselrichterdaten

Wechselrichterhersteller	Typ	Anzahl
Wechselrichterhersteller	Typ	Anzahl
Wechselrichterhersteller	Typ	Anzahl

Zur Inbetriebnahme benötigen wir zusätzlich:

- ☐ Standardformblatt „Inbetriebsetzung Strom“
- ☐ Darstellung des realisierten Messkonzeptes (Formblatt Messkonzepte)
- ☐ Übersichtsschaltplan der gesamten elektrischen Anlage. Aus dem Schaltplan muss u. a. hervorgehen, wie viele Wechselrichter eingesetzt werden sollen, wie sie auf die Außenleiter aufgeteilt sind…
- ☐ Technische Daten der Module, das Datenblatt
- ⇒ Für den Wechselrichter :
  - ☐ Konformitätserklärung
  - ☐ Unbedenklichkeitsbescheinigung der Berufsgenossenschaft für die selbsttätige Freischaltstelle
  - ☐ Das Datenblatt
- ☐ Kopie der Anmeldung bei der Bundesnetzagentur
- ☐ Foto der Photovoltaikanlage
- ⇒ Bei Einbau eines kundeneigenen Zählers (Privatzähler):
  - ☐ Bedingungen für die Bereitstellung von Elektrizitätszählern durch Einspeiser nach EEG
  - ☐ Foto der Zähleranlage und des Zählers mit dem Zählerstand und der Prüfplakette zum Zeitpunkt des Einbaus

Für die Inbetriebnahme gemäß §3 Abs. 5 EEG sind die Hinweise der Clearingstelle EEG zu beachten!

erstellt: MAS, Stand: 15.08.2010
MAS/Thiele als Ansprechpartner für die interaktive Formularbereitstellung

Gemäß den Vorgaben des Energiewirtschaftsgesetzes obliegt die Verantwortung für Herstellung und Betrieb der Gas- und Stromnetze inkl. des Netzanschlusses dem jeweiligen Netzbetreiber (NB).
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Die **RWE Rhein-Ruhr Verteilnetz GmbH** ist Netzbetreiber u. a. für die Stromnetze in den Städten/Gemeinden Pulheim, Frechen, Hürth, Wesseling, Bornheim, Alfter, Wachtberg, Königswinter, St. Augustin, Niederkassel, Lohmar, Rösrath und Langenfeld.
Diese Netzbetreiber haben die RheinEnergie AG bzw. Belkaw GmbH mit der Erbringung der mit dem Netzanschluss zusammenhängenden Dienstleistungen beauftragt. Diese werden im Namen und für Rechnung des zuständigen NB erbracht.

2/2

Appendix B1: Commissioning Electricity

Inbetriebsetzung Strom

RheinEnergie

Kunde/Abnahmestelle:

Name, Vorname
Telefon.-Nr.
Geburtsdatum (nur bei Privatperson)
HR-Nr./-Gericht bei Kaufleuten
Straße, Hausnummer (der Abnahmestelle)
Geschoss
Postleitzahl
Ort
Stadtteil
Wohnungs-/Laden-Nr., Lagebezeichnung
Name und Anschrift des Hauseigentümers

☒ Ich/Wir wünsche(n) die Inbetriebsetzung des Netzanschlusses bis zum Zählerplatz
(z. B. durch das Einsetzen der Hausanschlusssicherung)
☐ Die Zählerstellung erfolgt durch einen dritten Messstellenbetreiber

Unterschrift des Kunden

Anschrift des Kunden falls von der Abnahmestelle abweichend!

Angaben des Kunden

Daten zur elektrischen Anlage

☐ Neubau
☐ Anlagenerweiterung (zusätzlicher Zähler)
☐ Erzeugungsanlage
Art

☐ Wiederinbetriebnahme
☐ Anlagenänderung (Zählerwechslung/-umbau)
der Zähler Nr. ________________ ist abzuholen

Bedarfsart

☐ Haushaltsbedarf / landwirtschaftlicher Bedarf
☐ Allgemeinstrom
☐ Gewerblicher, beruflicher u. sonstiger Bedarf
☐ Baustrom ☐ sonstiger kurzzeitiger Bedarf
☐ Wärmespeicher ☐ mit Aufladeregelung
☐ Wärmepumpe ☐ monovalent ☐ bivalent

gewünschte Messeinrichtung

☐ Wechselstromzähler ☐ Drehstromzähler
☐ Doppeltarifzähler ☐ Mit Rundsteuerschaltung
☐ 2 Energierichtungszähler (nur bei Erzeugungsanlagen)
☐ Lastgangzähler
☐ Messwandler ______ V _____ / ____5 A

Zählerstandort ________________

Leistungsbedarf

☐ Gewerblicher, beruflicher u. sonstiger Bedarf

	bisher	neu
Leistungsbedarf in kW (mit gf)		

Berücksichtigter Gleichzeitigkeitsfaktor gf ________________
Art des Gewerbes ________________
Voraussichtlicher Jahresverbrauch ________________

☐ Haushaltsbedarf/landwirtschaftlicher Bedarf

Wohneinheit(en)	bisher	neu
mit elektr. Warmwasserbereitung		
ohne elektr. Warmwasserbereitung		
kW für **besondere Geräte** (vgl. Rückseite)		

Hinweise des Installateurs/Kunden (Terminwunsch, Ansprechpartner für eine Terminabstimmung, Telefonnr. für die Fernablesung, Messstellenbetreiber etc.)

Erklärung des Installateurs (Fertigstellungsanzeige)

Eingetragen unter Nr. ____________ **bei** ________________

Name der verantwortlichen Fachkraft ________________

Die Anlage wurde von mir/uns nach den anerkannten Regeln der Technik und Technischen Anschlussbedingungen bzw. den Richtlinien des Verteilungsnetzbetreibers (VNB) errichtet, geändert, erweitert, geprüft und somit fertiggestellt. Das Prüfergebnis ist dokumentiert.
Es wurde berücksichtigt, dass sich der zum Errichtungszeitpunkt der Kundenanlage gemessene Wert der Schleifenimpedanz durch Änderungen im Netzaufbau verändern kann. Mir/Uns ist bekannt, dass die Schleifenimpedanz daher vom VNB weder angegeben noch garantiert werden kann.
Der Anschluss reicht für die Versorgung des Gebäudes aus (vorhandene Absicherung ist 3x _____ A)!

Ort/Datum
Stempel/Unterschrift der verantwortlichen Fachkraft

Angaben des Installateurs

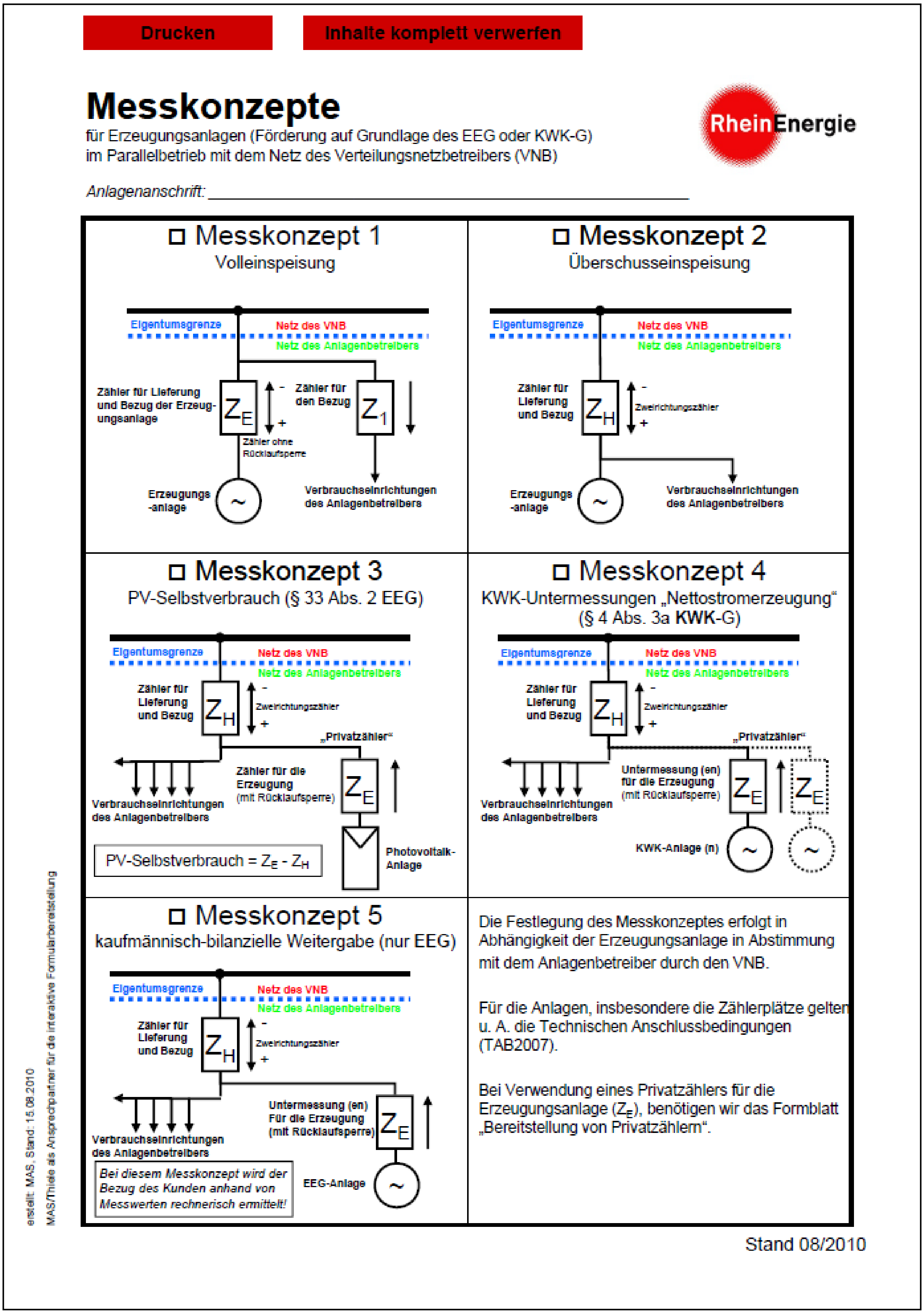
Die Inbetriebsetzung des Netzanschlusses und ggf die Zählerstellung erfolgt im Auftrag des Verteilungsnetzbetreibers (VNB)
Die **Rheinische NETZGesellschaft mbH** ist VNB u. a. für die Stadt Köln. Die **RWE Rhein-Ruhr Verteilnetz GmbH** ist VNB u. a. in den Städten/Gemeinden Pulheim, Frechen, Hürth, Wesseling, Bornheim, Alfter, Wachtberg, Königswinter, St. Augustin, Niederkassel, Lohmar, Rösrath und Langenfeld. Diese Netzbetreiber haben die RheinEnergie AG mit der Erbringung der mit dem Netzanschluss zusammenhängenden Dienstleistungen beauftragt.

Bitte beachten Sie auch die Hinweise auf der Rückseite

V009

RheinEnergie AG • Zählermontage • 50606 Köln • Telefon 0221 178-6654 • Telefax 0221 178-2218 • zaehlermontage@rheinenergie.com

Appendix B2: Measurement Concept Form



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Messkonzepte

für Erzeugungsanlagen (Förderung auf Grundlage des EEG oder KWK-G)
im Parallelbetrieb mit dem Netz des Verteilungsnetzbetreibers (VNB)

RheinEnergie

Anlagenanschrift: ______________________________

☐ Messkonzept 1
Volleinspeisung

☐ Messkonzept 2
Überschusseinspeisung

☐ Messkonzept 3
PV-Selbstverbrauch (§ 33 Abs. 2 EEG)

PV-Selbstverbrauch = Z_E - Z_H

☐ Messkonzept 4
KWK-Untermessungen „Nettostromerzeugung"
(§ 4 Abs. 3a **KWK-G**)

☐ Messkonzept 5
kaufmännisch-bilanzielle Weitergabe (nur EEG)

Bei diesem Messkonzept wird der Bezug des Kunden anhand von Messwerten rechnerisch ermittelt!

Die Festlegung des Messkonzeptes erfolgt in Abhängigkeit der Erzeugungsanlage in Abstimmung mit dem Anlagenbetreiber durch den VNB.

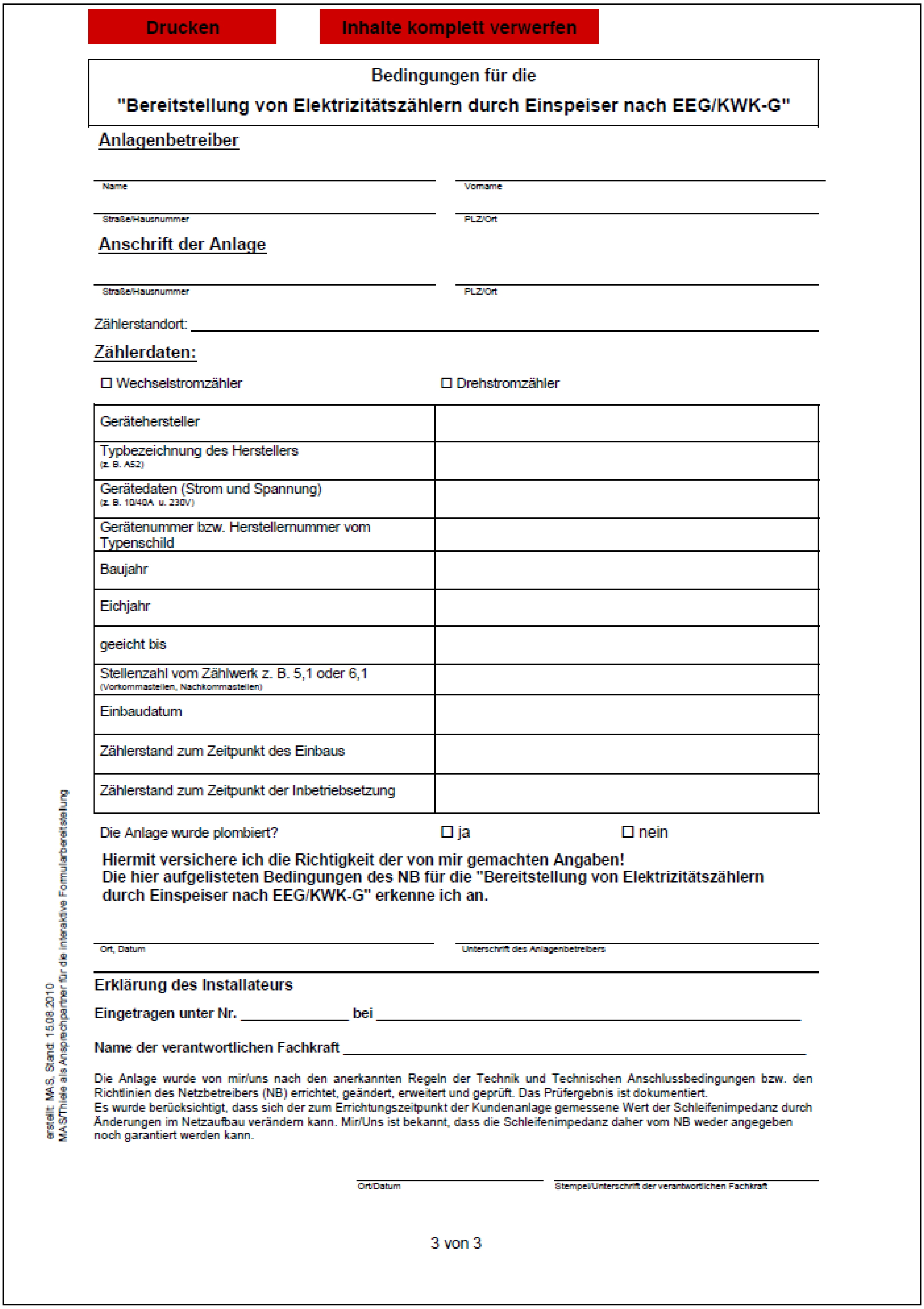
Für die Anlagen, insbesondere die Zählerplätze gelten u. A. die Technischen Anschlussbedingungen (TAB2007).

Bei Verwendung eines Privatzählers für die Erzeugungsanlage (Z_E), benötigen wir das Formblatt „Bereitstellung von Privatzählern".

Stand 08/2010

erstellt: MAS, Stand: 15.08.2010
MAS/Thiele als Ansprechpartner für die interaktive Formularbereitstellung

Appendix B3: Form when using a different meter than one of the grid operator



Drucken

Inhalte komplett verwerfen

Bedingungen für die

"Bereitstellung von Elektrizitätszählern durch Einspeiser nach EEG/KWK-G"

Anlagenbetreiber

Name
Vorname
Straße/Hausnummer
PLZ/Ort

Anschrift der Anlage

Straße/Hausnummer
PLZ/Ort

Zählerstandort: ______________________________

Zählerdaten:

☐ Wechselstromzähler ☐ Drehstromzähler

Gerätehersteller	
Typbezeichnung des Herstellers (z. B. A52)	
Gerätedaten (Strom und Spannung) (z. B. 10/40A u. 230V)	
Gerätenummer bzw. Herstellernummer vom Typenschild	
Baujahr	
Eichjahr	
geeicht bis	
Stellenzahl vom Zählwerk z. B. 5,1 oder 6,1 (Vorkommastellen, Nachkommastellen)	
Einbaudatum	
Zählerstand zum Zeitpunkt des Einbaus	
Zählerstand zum Zeitpunkt der Inbetriebsetzung	

Die Anlage wurde plombiert? ☐ ja ☐ nein

Hiermit versichere ich die Richtigkeit der von mir gemachten Angaben!
Die hier aufgelisteten Bedingungen des NB für die "Bereitstellung von Elektrizitätszählern durch Einspeiser nach EEG/KWK-G" erkenne ich an.

Ort, Datum
Unterschrift des Anlagenbetreibers

Erklärung des Installateurs

Eingetragen unter Nr. __________ **bei** ________________________

Name der verantwortlichen Fachkraft ________________________

Die Anlage wurde von mir/uns nach den anerkannten Regeln der Technik und Technischen Anschlussbedingungen bzw. den Richtlinien des Netzbetreibers (NB) errichtet, geändert, erweitert und geprüft. Das Prüfergebnis ist dokumentiert.
Es wurde berücksichtigt, dass sich der zum Errichtungszeitpunkt der Kundenanlage gemessene Wert der Schleifenimpedanz durch Änderungen im Netzaufbau verändern kann. Mir/Uns ist bekannt, dass die Schleifenimpedanz daher vom NB weder angegeben noch garantiert werden kann.

Ort/Datum
Stempel/Unterschrift der verantwortlichen Fachkraft

erstellt: MAS, Stand: 15.08.2010
MAS/Thiele als Ansprechpartner für die interaktive Formularbereitstellung

3 von 3

Appendix C: Net Metering Schemes in European Countries

Net Meteringe scheme in Italy

In Italy, the producers of electricity from renewable sources (Wind, Solar, Geothermal, Biogas, Biomass, Hydro)generated by systems whose production does not exceed 20 kW and systems whose production is 20 kW to 200 kW but which were commissioned after 31 December 2007 can make use of net-metering (scambio sul posto). This possibility may be used instead of the feed-in tariff.

“Scambio sul posto” differs from traditional net metering, as the system operator pays the supplier for the electricity consumed, while the GSE[7] gives credit for the electricity fed in. This procedure can lead to a surplus on behalf of the system operator. The balance is calculated once a year.

If more energy is fed in than is consumed, this positive balance can compensate for a possible negative balance in the following years. Generators who feed in more electricity than they consume do not receive any payment under the net metering scheme. If they feed in less than they consume, the difference is subject to a payment. System operators receive credit for electricity produced but not consumed. This credit will be available for an unlimited period of time.

Regardless of the technology used, all systems generating up to 20 kW are eligible. Furthermore, systems generating 20 kW to 200 kW are eligible if commissioned after 31 December 2007. Since 1 January 2009, “scambio sul posto” also applies to CHP stations with an output of up to 200 KW.

In order for “scambio sul posto” to apply, electricity must be supplied to and received from the grid at one and the same connection point. L 99/09 was introduced to enable municipalities with less than 20,000 inhabitants to make use of net metering without being obliged to use the same connection point to supply and receive electricity.

The obligated party is the grid operator GSE. He is also responsible for measuring the electricity fed into the grid.

A given system operator is contractually entitled to the net-metering against the grid operator. System operators must submit an application as defined by GSE. Applications are assessed by the directorate of the Regulatory Authority for Electricity and Gas (AEEG). GSE is obliged to pay a surcharge of 50 € for every kW of system capacity within 30 days starting after the end of the trimester in which the agreement was concluded. This surcharge is gradually compensated for by the payments claimed by the grid operator.

Operators of renewable energy generation systems are obliged to pay an annual fee of 30 € per connection point to cover the grid operator's administrative costs.

Net Meteringe scheme in Denmark

The Regulation on Net-metering for the Producers of Electricity for Own Needs is based on the Act on Electricity Supply and authorises the exemption of certain system operators from Public Service Obligation (PSO).

---

[7] GSE: The Gestore dei Servizi Elettrici (GSE) is an authority subject to the Italian Ministry of Economy and Finance. It plays a major role in the promotion of renewable energy. Among other things, it issues green certificates and certificates of origin, monitors the certificate system, purchases energy and re-sells it on the electricity market.

Every consumer is obliged to pay a surcharge, the so-called Public Service Obligation. It depends on each consumer's individual level of consumption. The PSO for the support of renewable energy is part of the PSO tariff. The surcharges are determined by Energinet.dk four times a year.

Electricity producers using all or part of the electricity produced for their own needs are exempt from paying Public Service Obligation on this electricity. The Public Service Obligation is a charge levied to support renewable energy.

Systems must be connected to a collective grid system, installed at the place of consumption and fully owned by the consumer.

All technologies except for geothermal energy are eligible for net-metering:

Wind	Eligible only if the system is connected to a private supply system
Solar	Eligible. Systems with a capacity of up to 50 kW must be connected to a supply system
Biogas	Eligible. The system capacity must not exceed 6 kW per household or per 100 m^2. Only systems in non-commercial buildings are eligible. Systems must be connected to a private supply system
Hydro	Eligible. The system capacity must not exceed 6 kW per household or per 100 m^2. Only systems in non-commercial buildings are eligible. Systems must be connected to a private supply system
Biomass	Eligible. The system capacity must not exceed 6 kW per household or per 100 m^2. Only systems in non-commercial buildings are eligible. Systems must be connected to a private supply system

The costs of the net-metering system are covered by the budget managed by Energinet.dk.