European Regulators Group for Electricity & Gas

Draft Guidelines for Good Practice on Electricity Grid Connection and Access

An ERGEG Public Consultation Paper

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European Regulators' Group for Electricity and Gas
Contact: Council of European Energy Regulators ASBL
28 rue le Titien, 1000 Bruxelles
Arrondissement judiciaire de Bruxelles
RPM 0861.035.445

INFORMATION PAGE

Abstract

This document E08-ENM-09-03 is an ERGEG public consultation on proposed Guidelines for Good Practice on Electricity Grid Connection and Access.

This document seeks to initiate discussion on ERGEG's input to the draft Framework Guidelines. It is intended to serve as a background paper in drafting the input to the Framework Guidelines, which may be utilised in the development of the Framework Guidelines for the network codes by the Agency.

Target Audience

Energy suppliers, traders, electricity customers, electricity industry, consumer representative groups, network operators, academics and other interested parties.

How to respond to this consultation

Deadline: **2 June 2009**

Comments should be sent by e-mail to **grid@ergeg.org**

If you have any queries relating to this consultation paper please contact:
Mrs. Fay Geitona
Tel. +32 (0) 2788 73 32
Email: fay.geitona@ceer.eu

All responses (except "confidential material") will be published on the website www.energy-regulators.eu.

Treatment of Confidential Responses

In the interest of transparency, ERGEG:

i) will list the names of all respondents (whether confidential or not) or, alternatively, make public the number (but not the names) of confidential responses received;
ii) requests that any respondent requesting confidentiality submit those confidential aspects of their response in a "confidential appendix". ERGEG will publish all parts of responses that are not marked confidential.

For further information on ERGEG's rules, see ERGEG Guidelines on Consultation Practices.

Related Documents

CEER/ERGEG documents

- "Guidelines for Good Practice for Operational Security in Electricity ", ERGEG, November 2008, Ref. E08-ENM-02-04, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/GGP%20Operational%20Security/CD/E08-ENM-02-04_GGP-OpS_2008-11-28.pdf
- "ERGEG Guidelines on Consultation Practices ", ERGEG, July 2007, Ref. E07-EP-16-03, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/E07-EP-16-03_PC-Guidelines_v2.pdf
- "ERGEG Final report, The lessons to be learned from the large disturbance in the European power system on the 4th of November 2006", ERGEG, February 2007, Ref. E06-BAG-01-06, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_ERGEG_PAPERS/Electricity/2007/E06-BAG-01-06_Blackout-FinalReport_2007-02-06.pdf

External documents

- "Study on the Technical Security Rules of the EU Electricity Networks", PB Power for the European Commission, February 2006, Ref. 62236A/001 REV 2, http://www.docstoc.com/docs/961385/ Study-on-the-Technical-Security-Rules-of-the-European-Electricity-Network

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EXECUTIVE SUMMARY

Background

Experiences from critical situations and large disturbances in the European electric power systems in the past indicate a number of drawbacks and problems which originate from insufficiently standardised procedures for grid connection and access. The lack of standardised procedures has resulted in there being no uniform approach for grid connection and access for European grid users, with technical and organisational provisions being diverse. This situation is exacerbated by the growing maturity of the EU electricity market and with the massive deployment of existing and new concepts, including among others:

- Distributed generation;
- Intermittent generation; and
- Participation of demand response in network and market operations.

Common rules for operational security – addressing the interworking of the transmission networks across control areas – have existed in the European synchronous areas (e.g. UCTE, Nordel) for many decades. These are presently undergoing a process of adjustments to meet the needs of changed conditions in the electricity market. In contrast, the common issues of grid connection and access have not been addressed in a common way. This is understandable bearing in mind that grid connection and access were not a critical issue for the vertically integrated utilities, as is the case today for the unbundled grid and market operations. Transmission System Operators (TSOs) and Distribution System Operators (DSOs) are migrating from having a role as infrastructure undertakings towards being grid-user-oriented service providers employing a plethora of new concepts, and interacting with different actors and a variety of independent grid users.

The European Regulatory Group for Electricity and Gas (ERGEG) has committed to work diligently during the interim period between the adoption of the 3rd Legislative Package (3rd Package) and the date when the Agency for the Cooperation of Energy Regulators (Agency) is able to fully exercise its powers.

As stated in the report on the November 2006 disturbance[1] and in its 2008 and 2009 Work Programmes, ERGEG has undertaken to analyse the needs of, and draft the key concepts for, common grid connection and access approaches throughout the EU electricity grids. This includes designing and consulting upon Guidelines for Good Practice (GGP) on Grid Connection and Access.

This document seeks further to initiate discussion on ERGEG input to the draft Framework Guidelines for grid connection and access, to be utilised in the

[1] "ERGEG Final report, The lessons to be learned from the large disturbance in the European power system on the 4th of November 2006", ERGEG, February 2007, Ref. E06-BAG-01-06, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_ERGEG_PAPERS/Electricity/2007/E06-BAG-01-06_Blackout-FinalReport_2007-02-06.pdf

development of the Framework Guidelines for the network codes by the Agency.

In the preparatory work, the results of previous analyses and studies have been used, notably "Comparison of the European Grid Codes"[2] and "Study on the Technical Security Rules of the EU Electricity Networks"[3].

Moreover, the first draft of this document has been discussed with different stakeholders[4] at a common workshop on 6 October 2008, with the discussion results integrated into the document accordingly.

Objectives and Contents of the Document

The document in its final version may be used as an input to the Framework Guidelines to be developed by the Agency, which will in turn provide guidance to the European Network of Transmission System Operators - Electricity (ENTSO-E) to develop the necessary network codes.

Beyond that, the specific issues addressed in this document include:

- EU-wide common connection principles for generation units (including distributed generation), for consumption units and for DSOs;
- Principles for provisions for the voltage and frequency quality;
- Provisions for sufficient transparency and information; and
- EU-wide non-discriminatory and fair treatment of all grid users.

The content of the document is as follows:

- General provisions and objectives;
- Roles and responsibilities of different stakeholders and market players;
- General provisions on grid connection and access;
- Technical framework for grid connection and access referring to
    - general aspects;
    - generation;
    - consumption;
    - DSOs;
    - a special consideration for the exemptions under Article 7 of Regulation (EC) 1228/2003 on merchant lines;
- Glossary of Terms.

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[2] ERGEG internal work from 2003/2004.

[3] "Study on the Technical Security Rules of the EU Electricity Networks", PB Power for the European Commission, February 2006, Ref. 62236A/001 REV 2, http://www.docstoc.com/docs/961385/ Study-on-the-Technical-Security-Rules-of-the-European-Electricity-Network

[4] Stakeholders attending the workshop included COGEN Europe, UCTE, NORDEL, ETSO, IFIEC, GEODE, EURELECTRIC, EWEA, ETSO and EPIA.

Public Consultation and Next Steps

The document fulfils the role of the public consultation on these Guidelines for Good Practice, in line with the ERGEG rules for conducting public consultations. The results of this public consultation will be duly evaluated and where applicable integrated into the final version.

The final version is intended to initiate discussion on the basis of, and input for, future Framework Guidelines on grid connection and access, to be prepared by the Agency according to the 3rd Package. The future Framework Guidelines are delivering principles upon which respective codes for grid connection and access will be developed by TSOs.

1 Introduction

1.1 Problem identification

Recent experiences during large disturbances in European power systems have indicated that the security of the power system has been in danger when generation and consumption units have tripped from the system in an uncoordinated and uncontrolled manner due to different national requirements on tolerating voltage and frequency variations. These different frequency and voltage requirements within national grid connection and access rules increase the probability of more severe disturbances when national power systems become more interlinked through market integration. Emerging disturbances are therefore more likely to spread across several countries. Thus, some minimum requirements should be set for the voltage and frequency variations of generation and consumption units to be connected within a synchronous area.

The recent large disturbances have shown that uncoordinated reconnection of generation units, especially distributed generation, when the system is in a disturbed state has endangered the rapid restoration of the power system to normal operating state. This has partly been due to the lack of real time information of the status of this generation. The secure operation of the power system requires information exchange between TSO and distributed generation connected to the DSO network.

The problems identified above will be amplified even more with the growing maturity of the EU electricity market and with the massive deployment of existing and new concepts including, among others, distributed and intermittent generation, demand response and smart grids.

The problems addressed here can be solved by harmonising, to a certain extent, the rules for grid connection and access set by the TSOs for DSOs and generation and consumption units. This harmonisation ensures that rules for connection and access which have the greatest effect on the security of power system are consistent across all Member States.

ERGEG has undertaken in its 2008 Work Programme to analyse the needs of, and draft key concepts for, common grid connection and access approaches throughout the EU electricity grids. This document seeks to initiate discussion on input to the draft Framework Guidelines. It is intended to serve as a background paper in drafting the input to the Framework Guidelines, which may be utilised in the development of the Framework Guidelines for the network codes by the Agency.

1.2 Questions for Public Consultation

In addition to inviting relevant stakeholders and market participants to respond generally to this consultation and participate in the discussions and the hearing on this document, ERGEG seeks the opinion of the respondents on a number of specific issues related to the scope and applicability of the document.

The respondents are therefore invited to reply and provide comments on the following questions:

- Do you agree with the problems these GGP are trying to solve – are there other problems that should be addressed within grid connection and access not yet included in these guidelines?

- Do these guidelines address the problem - will they lead to more transparent, effective and non-discriminatory grid connection and access?

- Please outline your views on the description of the roles and responsibilities set out in Section 3.

- Are the technical framework and general provisions for generation, consumption and DSOs relevant and practical? Is there anything else that should be included / excluded? (Sections 4&5).

- How would the implementation of these GGP affect your business / market – what would the impacts be?

- We note that respondents to the consultation on the Implementation of the 3rd Package asked for certain areas, such as priority access for renewables, to be dealt with by ERGEG GGP. Priority access has not been covered by these particular guidelines, however, regulators welcome further input on this and other relevant issues.

2 General Provisions and Objectives

The grid connection and access conditions that should apply to all the grid users of transmission and distribution grids (including here generation units, consumption units, interconnections and also the DSOs in their position of the TSOs' "grid users") throughout the EU are specified in this document. Within that scope, it must be ensured that the TSOs, each being responsible for their control area, also have the responsibility for the definition and implementation of specific provisions which must be met by the grid users at the transmission level and which must also be duly followed by all other grid users.

Moreover, issues of coordinated planning and operation of the EU transmission grids are addressed in a separate document: the ERGEG GGP on Operational Security[5].

It is envisaged that the future Framework Guidelines will provide a framework for EU codes. However, those EU codes will not replace the national grid codes (or equivalents), but instead need to be specific enough to ensure EU-wide equal, non-discriminatory and balanced treatment of all grid users and grids.

This document takes into account the results of the ERGEG reports on large disturbances and blackouts in the EU in the past.

The authorisation and construction permission procedures are presently not within the scope of this document.

[5] "Guidelines for Good Practice for Operational Security in Electricity ", ERGEG, November 2008, Ref. E08-ENM-02-04, http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/GGP%20Operational%20Security/CD/E08-ENM-02-04_GGP-OpS_2008-11-28.pdf

3 Roles and Responsibilities of Different Stakeholders and Market Players

3.1 Member States

3.1.1 While complying with all the EU legal provisions for the electricity market in the related Directives and Regulation, the Member States shall pay particular attention to ensuring objective, transparent and non-discriminatory implementation of a system of regulated Third Party Access (rTPA).

3.2 Regulators

3.2.1 The regulators shall be responsible for fixing or approving, prior to their entry into force, at least the methodologies used to calculate or establish the terms and conditions for connection and access to the electricity grids.

3.2.2 The regulators shall monitor the effects of the terms and conditions for grid connection and access.

3.2.3 The regulators shall have the authority to require Transmission and Distribution System Operators, if necessary (e.g. if some discriminatory practices are identified, or if other change procedures have failed), to modify the terms and conditions for grid connection and access.

3.2.4 The regulators shall have the power to settle disputes related to connection and access to the grid.

3.3 Transmission System Operators (TSOs)

3.3.1 The TSOs shall set the terms and conditions for grid connection and access to their networks, for ex-ante approval by the national regulators. When submitting these terms and conditions to the national regulators, the TSOs shall enclose, where appropriate, the results of the consultation of the stakeholders.

3.3.2 The TSOs shall provide the system users with the information they need for efficient access to the system and provide all necessary data and information needed to evaluate the connection and access conditions. The TSOs shall have agreement models publicly available for those requesting grid connection and access.

3.3.3 The TSOs shall deliver a proposition to any grid user requesting connection to the grid. This proposition shall expose the technical, organisational (e.g. timeline and time limits) and financial aspects of the adopted solution. The proposition shall contain all relevant justifications.

3.3.4 The TSOs shall oversee that all users connected to their grid meet the requirements set in the approved terms and conditions for grid connection and access.

3.4 Distribution System Operators (DSOs)

3.4.1 The DSOs shall set the terms and conditions for grid connection and access to their networks for ex-ante approval by the national regulators. When submitting these terms and conditions to the national regulators, the DSOs shall enclose, where appropriate, the results of the consultation of the stakeholders.

3.4.2 The DSOs shall provide system users with the information they need for efficient access to the system and provide all necessary data and information needed to evaluate the connection and access conditions. DSOs shall have agreement models publicly available for those requesting grid connection and access.

3.4.3 The DSOs shall deliver a proposition to any grid user requesting a connection to the grid. This proposition shall expose the technical, organisational (e.g. timeline and time limits) and financial aspects of the adopted solution. The proposition shall contain all relevant justifications.

When appropriate, TSOs and DSOs shall coordinate to establish such a proposition without undue delay.

3.4.4 The DSOs shall oversee that all users connected to their grid meet the requirements set in the approved terms and conditions for grid connection and access.

3.4.5 The DSOs shall meet the requirements set in the terms and conditions agreed with TSO.

3.5 Generation Units

3.5.1 The generation units shall meet the requirements set in the terms and conditions defined by the TSO and/or DSO and contractually agreed upon.

3.5.2 The generation units shall provide all necessary data and information needed by the TSO/DSO to evaluate the connection and access conditions.

3.5.3 The generation units shall provide the system operator (TSO and/or DSO) with the data (e.g. feed-in power, state of operation) that are required to ensure secure real-time operation of the system.

3.5.4 The generation units shall ensure the proper functioning of all services to the extent they have committed to, so that the TSO/DSO can use those services whenever needed.

3.6 Consumption units

3.6.1 The consumption units shall meet the requirements set in the terms and conditions defined by the TSO and/or DSO and contractually agreed

upon.

3.6.2 The consumption units shall provide all necessary data and information needed by the TSO/DSO to evaluate the connection and access conditions.

3.6.3 The consumption units shall provide the system operator (TSO and/or DSO) with the data that is required to ensure secure real-time operation of the system.

3.6.4 The consumption units shall ensure the proper functioning of all services to the extent they have committed (e.g. load shedding and demand response).

4 General Provisions

4.1 Connection Procedures

4.1.1. The connection procedures shall be elaborated and / or approved by the regulators as part of the terms and conditions for connection and access to the grid. These terms and conditions shall enter into force only after proper consultation with stakeholders.

4.1.2. The grid connection procedures shall comply with the principles of regulated Third Party Access, be transparent and non-discriminatory.

4.1.3 As part of the grid connection procedures, connection agreement / contract models (i.e. standard agreements) shall be prepared and published. These models shall be drafted in consultation with stakeholders – most notably, grid users and grid operators - and shall be approved by the regulators as a part of the terms and conditions.

4.1.4 Connection procedures shall not lead to undue connection delays. The TSO and / or DSO have to be transparent about the connection time schedules to those requesting the connection. Any delay and reasons for it have to be transparently communicated to those requesting the grid connection. The solutions to overcome the delays in grid connection access shall be jointly agreed between the TSO and / or DSO and the grid user.

4.1.5 Connection procedures shall define the information and data (including technical data) that the applicant for grid connection has to provide to the TSO and / or DSO. Connection procedures shall also describe the measures to be taken in the case of modifications to the System Operator's and grid users' installations. Furthermore, all the connection procedures and required information for grid connection and access have to be publicly available.

4.2 Connection Requirements

4.2.1. The connection and access requirements apply to new installations and to the modification of the existing installations (without changing contractual arrangements). Existing installations shall retain the technical features they had when they were connected to the grid. This needs to be ensured by regular tests where appropriate. This applies for generation and for consumption units and the TSOs and / or DSOs shall follow this provision acting swiftly and without delay.

4.2.2 The system operators (TSOs and / or DSOs) shall design the technical solution for connection under transparent and non-discriminatory conditions.

4.2.3 Compliance with connection requirements shall be checked under transparent and non-discriminatory conditions. This should be carried out by the system operator, who operates the grid to which the given user (unit) wants to connect. If there are diverging positions on the possibility to connect between the system operator and the grid user, an independent expert may be utilised and / or the dispute may be submitted to the regulators for settlement.

4.3 Information Exchange

4.3.1 The TSO and DSO shall provide the information on technical requirements for the grid connection point, including among others:

(1) Short circuit capacity levels indicating max and min short circuit capacity;
(2) Protection concept with time frames for fault recognition and relay tripping;
(3) Insulation co-ordination;
(4) Grounding;
(5) Requirements for parallel operation with the power system;
(6) Maximum permitted harmonics emissions;
(7) Highest and lowest operating voltage in normal and disturbed operating states;
(8) Highest and lowest operating frequency in normal and disturbed operating states; and
(9) Devices required for metering and information exchange.

4.3.2 Every significant generation and consumption unit shall provide the system operator of the grid where it is connected with all available information, including real-time information, where applicable, which is necessary to ensure the operational security of the system.

4.3.3 Every significant generation and consumption unit shall be able to receive and to execute the instructions sent by the system operator (TSO and / or DSO).

4.3.4 TSOs shall inform each other about the commissioning of significant

generation and consumption units. This implies that adjacent TSOs shall agree on the criteria (e.g. a power threshold) defining which units are considered to be significant. With the growing importance of distributed generation, this provision applies also to the DSOs with significant installed distributed generation capacity; for that matter, the affected DSOs and TSO shall coordinate and inform each other in a coherent way.

4.4 Access Limitations

4.4.1 The system operator shall put rules in place to handle the access limitation situations where the reasons for such curtailments and their effect on grid users shall be described in detail. These rules shall be communicated transparently to the grid users and market participants and approved by the regulators.

4.4.2 Access limitations shall be considered only if operational security is at stake and no other solution is available.

5 Technical Framework for Grid Connection and Access

5.1 General Requirements

5.1.1 Operating Frequency

5.1.1.1 The TSOs interconnected within a synchronous area shall jointly specify the normal operating frequency range.

5.1.1.2 The TSOs within a synchronous area shall jointly also set predefined frequency deviations levels that the grid users shall be able to sustain (at least for a predefined time period). Particularly, these levels define the ranges of frequency within which the significant generation units shall be able to remain connected and support the grid in disturbed operating conditions.

5.1.1.3 When setting these ranges and levels, grid users shall be informed, the defined thresholds and requirements discussed and – where applicable and justified – any necessary adjustments conducted in line with the operational security requirements and with specific provision for non-discrimination in Third Party Access.

5.1.1.4 Where applicable, a TSO may apply a wider range of frequency deviations. Justification for this shall be transparently communicated to the grid users and those requesting connection.

5.1.2 Operating Voltage

5.1.2.1 The system operator shall define the nominal operating voltage for each voltage level applied in the network. TSOs across interconnections and TSO and DSOs within the control area shall co-ordinate and co-operate when defining voltage levels and nominal operating voltage.

5.1.2.2 The system operators shall specify the range for normal operating voltage for steady state conditions. The equipment connected to the grid shall remain connected to the grid during the voltage deviations within the defined normal operating voltage range, as far as no damage to the equipment is foreseen.

When setting levels of voltage deviations, grid users shall be consulted.

TSOs and DSOs are allowed to use a wider voltage range if it is necessary to ensure operational security of the respective control area. Reasons for this requirement have to be transparently communicated to the grid users and those requesting connection.

5.1.2.3 Within the terms and conditions for connection and access, TSOs and DSOs shall define for the equipment to be connected, the allowed:

(1) Highest operating voltage;
(2) Lowest operating voltage;
(3) Withstand voltage for lightning and switching surges; and
(4) Withstand voltage for specified time period under given frequency (according to the applicable standard).

5.1.2.4 Within the terms and conditions for connection and access, TSOs and DSOs shall define for the equipment to be connected, the allowed range and duration of:

(1) Fast voltage variations and voltage dips;
(2) Overvoltages; and
(3) Voltage imbalances and harmonics;

The ranges and durations shall comply as far as possible with the existing technical standards in this field.

Specific requirements may be applied to different equipment (e.g. generation units, consumption units)

5.1.3 Protection Scheme

5.1.3.1 Generation units, consumption units and distribution grids shall be equipped with protection devices, which shall disconnect the units (respectively grids) from the network in case of unacceptable operational states, i.e. in case of failures in the units (respectively grids) or when frequency and voltage of the power system is outside the defined permitted range.

5.1.3.2 Settings of protection devices of the units (or possibly distribution grids) shall be coordinated with protection systems of the system operator (TSO and / or DSO) to prevent non-selective activation. Protection settings have to be set after consultation with the system operator to ensure the secure operation of the system as well as protecting the

connected units from damages. The unit owner shall provide the system operator with the actual settings, where appropriate.

5.1.3.3 Protection systems of the generation and consumption units shall be equipped with back-up devices. These back-up devices can be either within the unit or protection systems of the network may be used for back-up, if agreed, between the system operator and the grid user (respectively distribution grids).

5.2 Generation Units

5.2.1 Characteristics of Generation Unit

5.2.1.1 The TSO and / or DSO shall be able to define in a transparent way, those generation units which shall be equipped with (depending on the technology and the size):

(1) Main circuit breaker;
(2) Synchronisation facilities;
(3) Voltage control equipment;
(4) Frequency control equipment;
(5) Power control equipment, where appropriate;
(6) Protection equipment; and
(7) Devices for metering and information exchange.

5.2.1.2 The generator reactance shall be as low as technically and economically possible in order to ensure stability of the generation units and stable power system operation.

5.2.1.3 The TSO shall define in a transparent way the generation units for which the requirements affecting the technical characteristics of the synchronous generators, especially in relation to the P/Q diagram apply. Each such generator shall be capable of operating continuously at the rated active power within the power factor range defined by the TSO or DSO. This range shall be defined in a transparent way.

5.2.1.4 The system operator shall define requirements for step-up transformers affecting the design and the operation.

5.2.1.5 All significant generation units shall be equipped with a device (Power System Stabilizer, PSS) that improves damping of the oscillations of the generation unit and the power system. This device should allow for damping of inter-area oscillations and damping of oscillations between the generation unit and the power system. The settings for this device shall be agreed between the generation unit and the TSO.

5.2.1.6 Beyond the frequency and voltage deviations defined according to 5.1.1 and 5.1.2, generation units shall remain connected to the network as long as possible to sustain the grid. Reconnection after tripping shall be coordinated with the TSO and (if applicable) DSO.

5.2.1.7 The generation unit and its control system shall be designed so that the unit will not be tripped due to the transient frequency or voltage gradient occurring in the case of a short-circuit in the network to which the unit is connected. The extent of these gradients shall be defined by the TSO.

5.2.1.8 The generation unit shall be designed to withstand the mechanical stresses associated with any kind of faults occurring in the transmission or distribution network.

5.2.1.9 The generation unit shall remain connected to the network after a nearby network fault, as far as it is possible according to the configuration of the remaining network after the fault. The TSOs within a synchronous area shall define the maximum clearing time for network faults to be applied in designing the generation units.

5.2.1.10 Requirements for the reactive power generation / absorption capability at normal voltage levels and reactive power output capability in under-voltage conditions shall be defined by the TSO (or DSO if applicable). Each TSO shall determine the reactive power generation / absorption capabilities of generation units, taking into account the specific system characteristics including specifications and control schemes for step-up transformers and for generators. Those requirements shall ensure that sufficient reactive power generation capabilities are available on TSOs request to prevent system collapse during disturbances.

5.2.1.11 All the technical and design data necessary for power system stability studies shall be provided to the TSO and / or DSOs by the generation units. The specifications for data shall be transparently communicated by the TSO and / or DSO to all generation units requesting connection.

5.2.2 Requirements for Voltage Control and Reactive Power Management

5.2.2.1 The system operators shall clearly and transparently define the technical requirements related to the contribution to voltage control and reactive power management that should be met by the generation units. The technical requirements may vary according to generation technology and size as far as it is technically justified and it does not create undue discrimination.

5.2.2.2 Each generation unit shall contribute to voltage control either at the generator voltage level or at the voltage level of the network connection point within the design parameters of the generation unit. Normal operating mode should be the automatic control of voltage to ensure secure power system operation during disturbances. Other control types, like control according to power factor or reactive power output, when applied, shall have a lower priority than the control of voltage. Automatic change from other control types to voltage control shall occur when there is a predefined voltage change.

5.2.2.3 The provisions regarding the actual contribution of a generation unit to

voltage control and reactive power management shall be agreed with the TSO and / or DSO concerned. These provisions shall be clearly and transparently set by the system operator. This includes the dynamic and static behaviour of the voltage control equipment and how this is verified.

5.2.3 Requirements for Frequency and Active Power Control

5.2.3.1 Generation units that contribute to balancing services and automatically activated reserves have to fulfil the related technical and organisational requirements and follow the instructions given by the control area manager (i.e. TSO).

5.2.3.2 The input to the automatic frequency control unit of the generator is the frequency at the connection point if not agreed otherwise with the TSO.

5.2.3.3 The TSOs shall clearly and transparently define the technical requirements related to the contribution to frequency and active power control. These requirements shall be in line with the technical rules set at the synchronous system level for operational security. Technical requirements may vary according to generation technology and size as far as it is technically justified and if it does not create discrimination. When setting technical requirements, the following issues need to be considered:

(1) Operational characteristics, including e.g. minimum output, overload capacity, and starting time;
(2) Power control equipment characteristics, including e.g. operational modes, limiter for power step change and power control during normal operation and disturbances;
(3) Power response capability during normal operation of the power system, including e.g. load following and power response rate and range for different generation technologies; and
(4) Power response capability during power system disturbances, including e.g. instantaneous power response, power step change for different generation technologies and subsequent power response rate after power step change for different generation technologies.

5.2.3.4 Generation units shall be able to execute their control activities in normal and in alert (disturbed) operational states, whereas specific parameters for operation outside these operational states have to be agreed separately between generation units and TSOs.

5.2.4 House Load Operation

5.2.4.1 All significant generation units shall be able to change from parallel operation with the network to house load operation, in the operating conditions specified by frequency and voltage requirements set in the terms and conditions for connection and access. Exceptionally, if tripping into house load operation is not possible, the generation unit shall be capable of reconnecting to the system on request by the TSO (and in

coordination with the DSO if applicable) within a determined timeframe.

5.2.4.2 The generation unit and its auxiliary system shall be designed so that a safe changeover to house load operation can take place after disconnection from the network.

5.2.4.3 Requirements for house load operation including the minimum duration of house load operation set by the system operator shall be clear and transparent.

5.2.5 Black Start Capability and Island Grid Operation

5.2.5.1 Generation units having the black start capability are able to provide voltage to the network without any support (most notably with no external voltage and frequency supplied) from the network. The TSO shall ensure through contracts that the necessary number and capacity of generators required to ensure black start capability within its control area are available.

5.2.5.2 Every black start generation unit shall have the ability to control voltage and frequency during isolated operation. This enables generation units to serve the system operator with the black start capability.

5.2.5.3 The system operator may have contracts with generation units for island grid operation if the security of the system and fast restoration after disturbances require the island grid operation.

5.2.5.4 Control systems of generation units that have been contracted for island grid operation have to be set in a way that allows load following above minimum power.

5.2.5.5 All generation units capable of island operation shall be able to keep up the operation of an incidental island as long as no unacceptable operational state appears.

5.2.5.6 Requirements set for black start and island grid operation by the system operator have to be unambiguous and transparent.

5.2.6 Verification

5.2.6.1 The specifications shall be to the largest possible extent verified by full-scale tests. These tests should be made by the owner of the generation unit during commissioning upon request from the system operator. Measurements from actual operation should be reviewed regularly in order to prove compliance with the specifications set for the generation unit.

5.2.6.2 The contents of the tests shall be clearly and transparently defined by the system operator.

5.3 Consumption Units

5.3.1 General

5.3.1.1 The consumption unit shall be equipped with:

(1) Main circuit breaker;
(2) Protection equipment; and
(3) Devices for metering and information exchange.

5.3.1.2 The consumption unit is responsible for its equipment compliance with the requirements set by the system operator.

5.3.2 Requirements for Reactive Power

5.3.2.1 Consumption units shall compensate as far as possible their consumption of reactive power.

5.3.2.2 Reactive power generation and/or absorption by consumption units outside the limits set by the system operators shall be accounted for by the consumption unit and may imply economical sanctions to the consumption unit if recurrent. The limits for production and consumption of the reactive power shall be transparently communicated to grid users including the economic sanctions.

5.3.2.3 The system operator shall establish mechanisms that enable the participation of consumption units in voltage control (i.e. producing and consuming reactive power for the needs of the network).

5.3.3 Interference and Electromagnetic Perturbations / Emissions

5.3.3.1 No interference resulting in electromagnetic perturbations with other consumption units or other equipment should be allowed from a consumption unit in the power system. The TSO and / or DSO is responsible for taking measures regarding this issue and shall ensure that all connected consumption units and equipment have no interference with other consumption units or equipment.

5.3.3.2 The TSO and / or DSO is responsible for ensuring that there are publicly available methodologies for the establishment and assessment of the emission limits for both distorting (resulting in harmonics and/or interharmonics) and fluctuating (resulting in flicker) loads directly connected to the networks. The corresponding thresholds shall be defined and published accordingly.

5.3.3.3 The purpose of the methodologies is to set limits for the disturbances injected into the networks by distorting and fluctuating installations in order to respect the established networks reference levels for voltage quality. When the system operator is setting the emission limits, the propagation of these disturbances between the different voltage levels must be considered.

5.3.3.4 When assessing and controlling the disturbance levels, the system operator shall separate and quantify the contribution from each installation. In cases where this is not possible, the evaluation shall be made, as a last resource, by successively monitoring the network area, having each one of the polluting installations connected and disconnected. The time period during which each installation is to be disconnected shall be agreed between system operators and installation owners.

5.3.3.5 The established emission limits are applied to all the installations and shall be respected from the moment the installation is connected to the network.

5.3.3.6 The system operator may disconnect an installation every time it does not respect the established emission limits, particularly in situations of menace concerning the security of equipment belonging to other installations or networks. The reconnection of the installations in these cases shall be conditioned to the proof that the identified problem has been solved.

5.3.4 Demand Response

5.3.4.1 The TSO and DSO shall involve consumption units as much as possible when designing and contracting ancillary services. In that context, consumption units may also contribute by decreasing consumption during peak load or during the restoration phase after a disturbance.

5.3.5 Load Shedding

5.3.5.1 The system operator may agree with consumption units to perform actions during critical operation states, requested by the system operator to restore system to normal operating state such as:

(1) Adapt or curtail the load; and
(2) Modify the power factor if technically possible (not every consumption unit is able or needs to be able to modify the power factor).

5.3.5.2 The consumption unit connected to the transmission network shall be equipped with a load shedding device. This applies to consumption units connected to the distribution network, where appropriate. Application of load shedding shall be clearly and transparently communicated to the grid users in transmission and distribution networks. Load shedding shall be applied in a non-discriminatory way.

5.3.5.3 Besides automatically activated load shedding, there must be a possibility for the TSO to perform manual load shedding if operational security is endangered.

5.3.6 Verification

5.3.6.1 Consumption units are responsible for testing that requirements set for the connecting installation, including electrical safety, are met.

5.3.6.2 The TSOs individually or in cooperation with the DSOs are responsible that the verification of all the requirements set in the terms and conditions for grid connection and access is accomplished before the connection of consumption unit to the network is allowed.

5.4 Distribution System Operators (DSOs)

5.4.1 General

5.4.1.1 The connection point between networks of transmission and distribution system shall be equipped with:

(1) Main circuit breaker;
(2) Protection equipment; and
(3) Devices for metering and information exchange.

5.4.1.2 The DSO has the responsibility for transposing the requirements set by the TSO (or DSO) and to ensure that generation and consumption units (and also other distribution networks connected) within the distribution network meet these requirements.

5.4.1.3 The DSO shall be able to execute (manually or automatically, depending on the purpose) the instructions given by the TSO. The TSO and the DSO shall agree how these instructions are delivered in practice. This applies also for those DSOs connected to another DSO network.

5.4.2 Requirements for Reactive Power

5.4.2.1 Voltage control and reactive power management are critical for the security of grid operation. Voltage range requirements at the interface between TSOs and DSOs shall be defined to maintain the voltage in acceptable ranges in the grid and to prevent voltage collapse.

5.4.2.2 Reactive power flow between TSO and DSO networks shall be avoided.

5.4.3 Load Shedding

5.4.3.1 Load shedding systems are crucial in preventing system collapse when frequency declines below allowed operating levels during emergency operating state. Load shedding may be activated either manually or automatically. The DSOs shall install either dedicated relays or devices allowing for automatic and / or manual load shedding.

5.4.3.2 The DSOs shall design load shedding systems according to the requirements set by the TSOs. This includes load shedding stages, amount of shed load and settings for load shedding relays. The load

shedding system shall be non-discriminatory as far as possible.

5.4.3.3 The TSOs may ask the DSOs to perform selective manual load shedding. For that purpose, the TSOs together with the DSOs shall establish plans and agreements in order to minimise the impact on the consumption units. These plans, which shall be revised periodically and integrated under existing operating protocols between the TSOs and the DSOs, shall at least specify the involved substations, the affected switchgears and the estimated load to be interrupted. Selective manual load shedding may be applied only if automatic load shedding is not feasible.

5.4.3.4 Load shedding systems should be designed to allow distributed generation to support the system as far as possible.

5.4.3.5 The DSOs shall design and execute the reconnection of loads after load shedding after instructions by the TSOs and ensure fast recovery of normal operating state.

5.4.4 Specific Requirements for Distributed Generation

5.4.4.1 The TSOs of a synchronous area among themselves and with the DSOs shall exchange all necessary information and data, especially relating to distributed generation. The TSO shall define clearly and transparently the necessary information, including real-time data, and agree with the DSOs (and distributed generation) how this information will be exchanged. When appropriate, the DSOs shall ensure that the significant distribution generation units receive and execute the instructions sent by the TSOs.

5.4.4.2 The DSOs shall take all necessary measures to avoid that a fault on the transmission grid or disturbed operation conditions lead to a sudden load variation generated by simultaneous tripping of distributed generation units.

5.4.4.3 Coordinated protection schemes and settings are crucial for secure network operation. In particular, protection schemes shall prevent any fault on distribution networks from affecting the transmission network and allow distributed generation to support the system.

5.4.4.4 If islanded operation is considered, the situations when it can occur and the role of distributed generation shall be defined and formally agreed.

5.5 Exemptions under Article 7 of the Regulation (EC) 1228/2003 (“merchant lines”)

5.5.1 When connecting to the transmission grid, merchant lines shall follow the connection requirements set by the TSOs of that grid. These requirements shall be clearly and transparently communicated to those requesting connection. They shall be non-discriminatory.

6 Glossary of Terms

The descriptions of terms provided here serve mainly for the purpose of common understanding of different subjects and apply in the first instance to the issues addressed in this document. Beyond that, for any other issue of general importance or of common understanding, the definitions in the existing legal framework, including Directive 2003/54/EC and Regulation (EC) 1228/2003 apply.

Therefore, some differences to the already existing definitions in use in other situations and / or specifications are possible.

The → symbol indicates definition of the term in italics elsewhere in the glossary.

Alert (disturbed) state ..... an operating state which entails that all consumption is met and that the frequency, voltage and transmission are within the predefined acceptable limits / thresholds. In alert state, the reserve (margins) requirements are not fulfilled and faults in network elements or in generation (i.e. unforeseen disturbances / outages) will lead to further deterioration of system state.

In alert state, the power system is stable and all operational reserves (for transmission and generation balance) have to be mobilised. It is not clear if (or in which time frame) it will be possible to fully return to security limits (it depends on the gravity of the alert and the possible risk of cascading events). The system is viable and operated within the acceptable operating constraints, however, in this case the system parameters are very close (still within or just beyond) to the security limits. The dispatchers have difficulties returning to a normal state due to existing network or load/generation margin constraints, and the situation is potentially dangerous.

Connection point ..... point in the network, to which the installation is to be connected; this point is defined by the system operator.

Critical state ..... an operating state entailing that compulsory load shedding has been applied and that further production shedding and network divisions may occur.

In the critical system state, the system is not stable and its ”natural” evolution (phenomena such as tripping in cascade, frequency drop, loss of synchronism, power cuts, islanding may occur) tends to bring it to an insecure and uncontrollable situation. Global security of the whole interconnected power system is endangered. Exceptional actions such as load shedding may be further necessary to limit the spreading of the dangerous phenomena and prevent the collapse of part or of the whole power system. In this state, the system goes rapidly towards highly endangering conditions of operation with system parameters out of the limits fixed for operational security.

Frequency control ..... capability of a generation unit to control frequency and maintain stable operation within an isolated grid.

House load operation operation of a generation unit with its own auxiliary system as its only load, when the unit is disconnected from the external power system.

Interconnection a line (circuit) / or a set of lines (circuits) between two control areas or between two synchronous areas; an interconnection between the two control areas can be an AC or a DC one, whereas in the latter case always an AC/DC & DC/AC conversion is necessary at both ends of the line; an interconnection between the two synchronous areas is assumed to be a DC one.

Isolated grid operation independent operation of a part of the power system that is isolated after its disconnection from the interconnected system, having at least one generation unit in operation with ability to frequency control.

Load shedding the disconnection of load from the synchronous power system, usually performed automatically, to control the system frequency in emergency situations.

Network collapse after network collapse, all loads in one or more parts of the control area are shed and further production shedding and network divisions can occur.

Normal state an operating state entailing that all consumption and production is in balance and requirements on ancillary services and framework conditions are met, frequency, voltage and electric power flows are within their predefined and allowed limits (thresholds) and reserve (margins) are sufficient. In normal state, the electric power system can withstand disturbances like unplanned outages without losing its functionality and without supply interruptions.

Operating states are → *normal state*, → *alert (disturbed) state*, and → *critical state*; when the electric power system function and synchronous operation are interrupted, it is the state of → *network collapse*; an improvement of system operating states towards the normal one is achieved by → *restoration*.

Restoration a transition between the → *operating states* characterised by the network being restored, production being regulated, and frequency, voltage and / or transmission being restored to within predefined and allowed thresholds. During restoration, consumption is connected at a pace which the restored network and generation resources can accommodate.

7 Conclusions

The purpose of this document is to present the draft Guidelines for Good Practice on Grid Connection and Access to interested parties. ERGEG hopes to receive input from stakeholders through this consultation in order to develop the final GGP. To this end, a list of questions is included in the introduction section which we would particularly like responses to.

In addition, it is hoped that this document, through the development of the GGP, will provide the basis for discussion on the inputs for the Framework Guidelines.

Annex 1 – ERGEG

The European Regulators for Electricity and Gas (ERGEG) was set up by the European Commission in 2003 as its advisory group on internal energy market issues. Its members are the energy regulatory authorities of Europe. The work of the CEER and ERGEG is structured according to a number of working groups, composed of staff members of the national energy regulatory authorities. These working groups deal with different topics, according to their members' fields of expertise.

This report was prepared by the Electricity Network and Market Task Force of the Electricity Working Group.

Annex 2 – List of abbreviations

Term	Definition
3rd Package	3rd Legislative Package
CEER	Council of European Energy Regulators
DSO	Distribution System Operator
ENTSO-E	European Network of Transmission System Operators for Electricity
ERGEG	European Regulators Group for Electricity and Gas
GGP	Guidelines for Good Practice
PSS	Power System Stabilizer
rTPA	regulated Third Party Access
TSO	Transmission System Operator