EWEA
WIND IS POWER

EWEA Working Group on Grid Code Requirements – Position Paper

European Grid Code Requirements for Wind Power Generation

Brussels, February 2008

Contents

Executive Summary

1. The way Grid Code requirements in Europe have been developed historically has resulted in gross inefficiencies for manufacturers and developers.
2. As the penetration of wind powered plants continues to grow across the eurozone there is an increasing need to develop a harmonised set of Grid Code requirements.
3. Harmonised technical requirements will maximise efficiencies for all parties and should be employed wherever possible and appropriate.
4. However, it must be noted that it is not practical to completely harmonise technical requirements straight away. In an extreme case this could lead to the implementation of the most stringent requirements from each Member State. This would not be desirable, economically sound, or efficient.
5. EWEA's Grid Code Working Group proposes a two step approach:
    a. A structural harmonisation exercise – with the aim of establishing a Grid Code template with common definitions, parameters, units and figures, as well as a common structure.
    b. A technical harmonisation exercise – with the aim of adapting existing Grid Code parameters to the new Grid Code template. This will be an important starting block for work in the years to come.
6. There is an urgent need to carry out a harmonisation exercise as wind penetration is forecast to increase significantly in the short to medium term.
7. This document makes a number of general and structural recommendations that will assist with the harmonisation process and form the basis for technical harmonisation.
8. When considered together, the proposed harmonising strategies should be of particular benefit to:
    a. manufacturers, who will now be required only to develop common hardware and software platforms;
    b. developers, who will benefit from the reduced costs;
    c. system operators, especially those who have yet to develop their own Grid Code requirements for wind powered plants.
9. The technical basis for the requirements should be further developed in work carried out jointly between TSOs and the wind power industry in studies at European and international level (EWIS, IEA, TP Wind, FP7).
10. It is believed that if the proposals can be introduced at European level, it will set a strong precedent for the rest of the world. As a next step, and in order to make this progress happen, the Working Group suggests that EWEA issue a 'Generic European Wind Grid Code' built on the above approach.

Foreword

As the penetration of wind power continues to grow across the eurozone there is an increasing need to develop a consistent and harmonised set of grid connection rules. Connection requirements are usually issued by system operators in the form of a 'Grid Code'[1]. Codes differ, often significantly, from country to country. Due to the rapid growth of wind generation, these have historically been developed on an ad hoc basis in response to immediate technical and regulatory issues. This has resulted in gross inefficiencies for manufacturers and developers as they struggle to:

- interpret the language and meaning of the various code documents; and
- develop hardware and software solutions to comply with different clauses from difference regions which have the same technical aim.

It is highly desirable that European grid connection regulations be developed in a more consistent and harmonised manner. Harmonised technical requirements will bring the maximum efficiency for all parties and should be employed wherever possible and appropriate, and while this applies for all generation technologies, there is a particular urgency in the case of wind power. As wind penetration is forecast to increase significantly in the short to medium term, it is essential that we begin the Grid Code harmonisation process immediately.

However, it must be noted that a complete European technical harmonisation is not practical in the short term. It could, in an extreme case, lead to the implementation of the most stringent requirements from each nation. This would not be desirable, efficient or economically beneficial.

On the other hand, there are a number of areas where harmonisation would improve the present situation. Currently, developers that operate in more than one country have to decipher and understand a number of Grid Codes with clauses that are formulated differently yet which perform essentially the same function. Manufacturers are often required to develop tailor-made software to achieve compliance in a particular region, whereas a common approach could deliver a technically equivalent solution.

There is an immediate need to harmonise approaches, terminology, formats and structure. The Working Group recommends that in the short term, a structural harmonisation of Grid Code requirements should be undertaken. A technical harmonisation of requirements should then be undertaken in a step by step process. Specific recommendations are given in Chapter 1.

The process should be implemented in a joint effort between TSOs, the wind power industry and regulatory bodies. The legal and institutional framework is to be put in place by EU and national governments.

[1] The term 'Grid Code' is commonly used to refer to the set of codes, rules and laws which define the technical requirements for parties connected to public electricity systems, i.e. consumers, generators and other network operators. In some countries, there may be separate documents for different classes of users, such as different generation technologies (e.g. wind). In some countries, there are different documents for transmission systems and for distribution systems. In this document, the term 'Grid Code' is used to cover all these documents.

1 Recommendations for the Harmonisation of Grid Code Requirements

1.1 Strategy for harmonisation

Setting the scene
Wind power is becoming a major generation source across the EU. A wind energy penetration level of 12% is expected in 2020. Power systems and market mechanisms have to adapt to facilitate the large-scale integration of renewables and improve the international transfer of electricity. Consequently, new practices and rules for connection and operation have to be developed and adopted. These should take the capabilities of wind power technology and network technology into account.

Concerns about Grid Codes
When it designs, builds and operates its products, the wind power industry has to consider a range of Grid Code requirements from a variety of countries. The wind power industry is aware that different systems may have different technical requirements. However, each country across the globe uses the same constant voltage and constant synchronous frequency system– it is only the physical parameters which are different. The set of Grid Code documents from the different EU countries is not at all homogeneous. Documents are often not available in English and are therefore rather inaccessible. These issues create extra costs and require additional efforts from the wind power industry.

Requirements introduced on the dimensioning, capabilities and behaviour of wind power plants are often not clear enough, and are not always technically justified nor economically sound from the point of view of the system.

In general the involvement of the wind power industry in the Grid Code development process should be improved, especially at European level, in order to compensate for the current lack of standardisation in requirements and approach.

Forward planning of Grid Code requirements
In the early days of the wind power industry, manufacturers had to solve multiple challenges regarding mechanical loads, power limitation and economical viability. Due to requirements at distribution level: this was followed by issues like flicker, power quality, limitation of inrush currents, power factor requirements and variable speed operation. In the late 1990s, large amounts of power started to be connected at transmission level. This created new requirements such as fault ride through, reactive fault current injection and fast active power recovery, which gave rise to new requirements such as voltage and frequency control.

Over several decades, manufacturers have continuously improved wind turbines in order to facilitate system operation in countries with varying degrees of penetration. The industry has gained an increasing understanding and acceptance of the need for these requirements. However, meeting new requirements at short notice is problematic. System Operators should leave a reasonable amount of development time by planning Grid Code requirements in advance. They can learn from the experiences of other System Operators.

In this new era of large-scale wind power there is considerable potential for improving the process of wind power integration by harmonising Grid Codes, and by doing so in an open-minded manner. Such a process will benefit all the stakeholders involved in the integration of wind power. The recommendations in this paper represent what is, in EWEA's view, an optimal systematic approach to setting the Grid Code harmonisation process in motion.

Two-step harmonisation of Grid Codes: structural and technical harmonisation
It is the opinion of the wind power industry that a two-step harmonisation strategy should be adopted. The strategy proposed by EWEA consists firstly of a structural harmonisation, and secondly a technical harmonisation. Together, the two forms of harmonisation should particularly benefit those system operators that have not yet developed their own customised Grid Code requirements for wind-powered plants.

The structural harmonisation consists of establishing a template Grid Code with a fixed and common structure (sequence and chapters), designations, definitions, parameterisation and units. The key aim of the structural harmonisation process is to establish a framework for an efficient Grid Code layout.

The technical harmonisation can be seen as a more long-term process. In general, it is recommended that a process be followed which works through the adaptation of existing Grid Code parameters to create the template of the aforementioned new Grid Code. This will be an important starting-point for the work of the coming years.

The process is to be implemented through co-operation between TSOs, the wind power industry and regulatory bodies. The enabling legal and institutional framework is to be set by EU and national governments.

In the following pages, the specific recommendations are described in more detail.

1.2 General recommendations

1. Grid Code requirements must be comprehensive and transparent in order to avoid misinterpretation.
2. Requirements should be as explicit as possible, and include clear, commonly shared definitions of the terms used for wind turbines, wind farms and other equipment.
3. The technical requirements should focus on the essential aspects of technical performance, leaving an opening for ancillary services.
4. Requirements should balance cost and benefits of technical performance, and generally be specified so that these can be met at minimum overall system cost.
5. Requirements for wind power plants should not be excessive or discriminatory.

1.3 Structural harmonisation - recommendations

The EWEA Working Group recommends the following as a minimum:
1. In all countries throughout the EU-27, requirements for the connection of wind power plants should be specified in a Wind Power Grid Code (WPGC).
2. WPGCs shall be easy to obtain and available in English from the issuing body (TSO or national authority) throughout the EU-27.
3. WPGCs shall all follow the same structure (division and sequence of chapters).

4. All WPGCs shall use the same format. This means uniformity in designation, parameterisation, definitions, units, diagrams, references to standards and where possible control methodologies.
5. All requirements in WPGCs should refer to the Point of Common Coupling (PCC)[2].
6. Revisions/changes should be made after consultation with the industry. This could be done through consultations coordinated by EWEA. This offers an advantage to TSOs and manufacturers as it uses a smaller group of experts than the standard panel of manufacturers.
7. A transition period should be applied for changes, revisions and new requirements. This should take due account of the development time needed to implement the modification. A typical expected time period is 18 months as a minimum, as this is considered to be the minimum period of time for performing the iteration in the design cycle after imposing a new WPGC.
8. New requirements shall not be applied to wind power plants that have already entered connection agreements. Changes or upgrades to meet new requirements shall be voluntary with additional incentives or payments.

1.4 Technical harmonisation – recommendations for the short term

As soon as the Grid Code template is ready, existing Grid Code parameters can be converted to the new template format. It obviously becomes visible when certain Grid Codes might be missing parameters and how different existing grid code parameters might relate to each other. This will also reveal where there might be potential for obvious technical harmonisation (bringing number values together) and where parameters have to stay fixed due to specific system requirements. This is a form of technical harmonisation, which also demonstrates the change in parameters and new requirements.
Over time, such a process will most likely bring down the number of grid codes and in doing so, reduce the need to revise new grid codes.

The Working Group is currently discussing several specific recommendations for technical harmonisation in the short term. These are related to:

- Wind power plant behaviour in normal network conditions
- Behaviour during and after network disturbances
- Frequency response / active power control
- Voltage control / reactive power
- Verification and testing
- Site-related aspects

Specific recommendations on these aspects will be given in future papers issued by the EWEA Working Group.

In addition, it is recommended that the technical basis for the requirements be further developed in a joint effort between TSOs and the wind power industry in studies at European and international level (EWIS, IEA, TP Wind, FP7).

[2] Point of common coupling (PCC) is the grid point at which the wind plant is connected to the network. Legally, it is the point where the competences of the network operator end and the competences of the wind turbine operator start. It is the point to which Grid Codes refer.

2 The European perspective on harmonised Wind Power Grid Code Requirements

2.1 Enabling the integration of renewable energy to meet the 2020 targets

Wind power has grown rapidly in the past five years in Europe, its high levels of new installed capacity second only to gas-powered generation. At the end of 2007, installed wind power capacity in Europe amounted to 56 GW. Based on current wind power market growth, and assuming that EU policy on renewable energy continues to be proactive, installed wind power will reach 110 GW in 2010, 150 GW in 2015, 180 GW in 2020 and 300 GW in 2030. Wind power will not only become a major electricity generator (more than 20% of gross electricity demand), but it will also provide grid security and a range of ancillary services.

The large-scale integration of wind power necessitates changed approaches in power system design and operation. Networks will also require upgrading and changes in management and operational procedures. Power transfer distances and capacities will increase. There is an especial need for an increase in cross-border transmission capacity, not only so that the liberalised market functions better and trading is improved, but also to enable an optimal utilisation of the continental characteristics of wind power. The significant future contribution of offshore wind (up to 25% of total wind power installed capacity in 2020) necessitates the construction of specific HV offshore grids.

Grid Code requirements must be seen in the light of these upgraded offshore grids. Additional specifications will probably have to be developed for the HVDC offshore networks. Future connection practice will also have to take into account future power wind power plant characteristics. Theoretically, wind power plants could be designed with similar performance and characteristics to conventional generation plants, providing reactive power on demand, spinning reserve, system inertia and so on. From an economic point of view however, the wind power industry would prefer a scenario with a strong split between active power production and ancillary service provision. The TSO pays for the ancillary services. The wind plants can provide more or less power at higher or lower extra costs. TSO allocates ancillary services (e.g. reactive power) where needed, which is not necessarily at the PPC of the wind plant. In such cases, the most economically sound solutions will be developed.

2.2 Improved codes in a better functioning Internal Electricity Market

According to current EU legislation, Grid Codes - including the requirements for connecting wind power – are a national responsibility. EU Directive 2003/54/EC (ref. □3) specifies that Member States have to ensure that the criteria are developed and made public, that these rules are objective and non-discriminatory, and that they ensure the interoperability of systems. As demonstrated above, this appears insufficient in the present situation.

In the developing European internal electricity market, national networks have to be interlinked in a more efficient way. They must be operated as part of an integrated European grid to enable the necessary cross border exchanges. This requires harmonised codes and technical standards, including grid connection requirements. However, the power systems in Europe today are so different that a full harmonisation cannot and should not be carried out straight away.

In its third liberalisation package, the European Commission made a number of legislative proposals to improve the functioning of the Internal Electricity Market. In a new regulation (ref.

☐4), the Commission proposes further ownership unbundling of TSOs and strengthened international cooperation between TSOs in a European Network for Transmission Operators (ENTSO). Technical codes for grid connection should be established under this ENTSO, with strengthened European regulatory supervision. The proposal asks for an open consultation with the relevant industry associations when establishing the codes. If adopted, the proposal will provide the legal framework for further developing harmonised Grid Code requirements through co-operation between TSOs and the wind power industry. At the same time, this creates the opportunity to strike a proper balance between requirements at wind plant and at network level, in order to ensure the most efficient and economically sound connection solutions.

3 References

1. Holttinen, Hannele e.a. Design and operation of power systems with large amounts of wind power. State-of-the-art report. ISBN 978-951-38-6633-4 (http://www.vtt.fi/publications/index.jsp), VTT 2007.
2. Van Hulle, F. e.a. Large scale integration of wind energy in the European power supply: analysis, issues and recommendations. http://www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report.pdf, EWEA 2005.
3. DIRECTIVE 2003/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC (Article 5)
4. 2007/0198 (COD). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL Amending Regulation (EC) No 1228/2003 on conditions for access to the network for cross-border exchanges in electricity.
5. IEC 61400-21 Ed.2.0 (FDIS circulated 2008)

The EWEA Working Group (WG GCR)

The wind industry needs to speak with one voice to influence the Grid Code requirement development process. To enable this, a Working Group has been launched within EWEA. Its objectives are:

- to produce a common position from the industry;
- to assist European and national institutions in setting proper regulations for the connection of wind power technology to the electricity grid;
- to facilitate the internationalisation of manufacturers and developers; and
- to make progress in the development of new standards, codes and verification procedures, interacting with the IEC working groups.

List of members: see Annex

WORKING GROUP ON GRID CONNECTION REQUIREMENTS FOR WIND POWER
WG convenor: Frans Van Hulle, EWEA

Wind turbine manufacturers

Name	**Company**	**Country**
Peter Wibaek Christensen Lise Backer	Vestas	Denmark
Peter-Heinrich Boysen	Nordex	Germany
Claus Kristensen	Suzlon	Denmark
Michael Frydensbjerg Stefan Wulff	Siemens	Denmark Germany
Carsten Junge	GE Energy	Germany
Dirk Ehlert Daniel Bagusche	Repower	Germany
Stephan Wachtel	Enercon	Germany
Oscar Moja	Gamesa	Spain
Ricardo Royo Oscar Alonso	Acciona Windpower	Spain
Marc Sala	Ecotecnia	Spain

Component manufacturers

Peter Sandeberg Slavomir Seman	ABB	Sweden Finland
Joris Peeters	Hansen	Belgium
Jan Declerq	Pauwels	Belgium
Jan Carstens Martin Bansemir	Converteam	Germany

Developers – Operators

Patrick O'Kane	Airtricity	Ireland
Iker Chocarro Aguirrebengoa Elisabeth Giraut	Acciona Energia	Spain
Grégoire Durand	EED	France
Juan Carlos Pérez Campión Carla Vico Rico	Iberdrola	Spain
Jesper Jerrild	Dong	Denmark
Richard Ford Joe Duddy	RES Group	UK

Consultants, service providers,

Jochen Möller	Windtest KWK	Germany
Karsten Burges Jens Bömer	Ecofys	Germany Germany
Tobias Gehlhaar	Germanischer Lloyd	Germany
Paul Gardner	Garrad Hassan	UK
Ana Morales	E2Q	Spain
Sigrid Bolik	Econnect	UK
Willem Schwardt	FGH	Germany
John Olav Tande	SINTEF	Norway
Poul Soerensen	DTU - Risø	Denmark

National associations, associations of manufacturers

Name	Company	Country
Graeme Cooper	BWEA	UK
Alberto Cena	AEE	Spain
Johannes Schiele	VDMA	Germany
Guillaume Duclos	FEE	France
Volker Schulz	FGW	Germany
Frans Van Hulle, WG convenor	EWEA	Belgium

For more information, please contact Frans Van Hulle at frans.vanhulle@ewea.org

The European Wind Energy Association (EWEA) is the voice of the wind industry, actively promoting the utilisation of wind power in Europe and worldwide.

It now has over 400 members from 45 countries. These include manufacturers with more than a 90% share of the global wind power market, component suppliers, research institutes, national wind and renewables associations, developers, contractors, electricity providers, finance and insurance companies and consultants. This combined strength makes EWEA the world's largest and most powerful wind energy network.

The EWEA Secretariat is located in Brussels at the Renewable Energy House. The Secretariat co-ordinates European policy, communications, research and analysis. It manages various European projects, hosts events and supports the needs of its members.

EWEA, rue d'Arlon 63-65
1040 Brussels
Tel: +32 2 546 1940 – Fax: +32 2 546 1944
Email: ewea@ewea.org – Website: www.ewea.org