Power Quality & Utilisation Guide
Section 8: Distributed Generation
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Standards

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1 Introduction

The focus of this paper will be on standards related to the hardware, integration and performance of renewable energy systems (as discussed in the other application notes to Chapter 8: Cogen, wind, BIPV and integration & interconnection).

The purpose will be to give the reader a first introduction in related standards regarding renewable energy generation by wind, photovoltaic or cogeneration. The aim is to inform the reader (for example a potential buyer or investor) about the standards applicable to renewable energy generation.

The need to standardize a material, product or system can present itself for a number of reasons: the manufacturer's desire to have interchangeable products, public concerns about quality and compatibility, or consumer protection measures enacted by the government. A standard is a document that interested parties have agreed upon, whether it refers to the width of a railway track, or the way a solar PV installation should perform. Standards are needed so that a product can be defined technically, in terms of its various characteristics and measures of its performance. Standards also define how this should be measured and tested, and what criteria apply for passing or failing these tests.

2 The organizations involved in standards

A standards organization, also referred to as a standards development organization, is a company or institute whose primary activities are developing, coordinating, revising, interpreting, or otherwise maintaining standards that address the interests of users. Most standards organizations are established exclusively for the purposes outlined above. There are, however, a few examples of organizations that acquired a status as the standards setter (like DIBt).

2.1 ISO standards

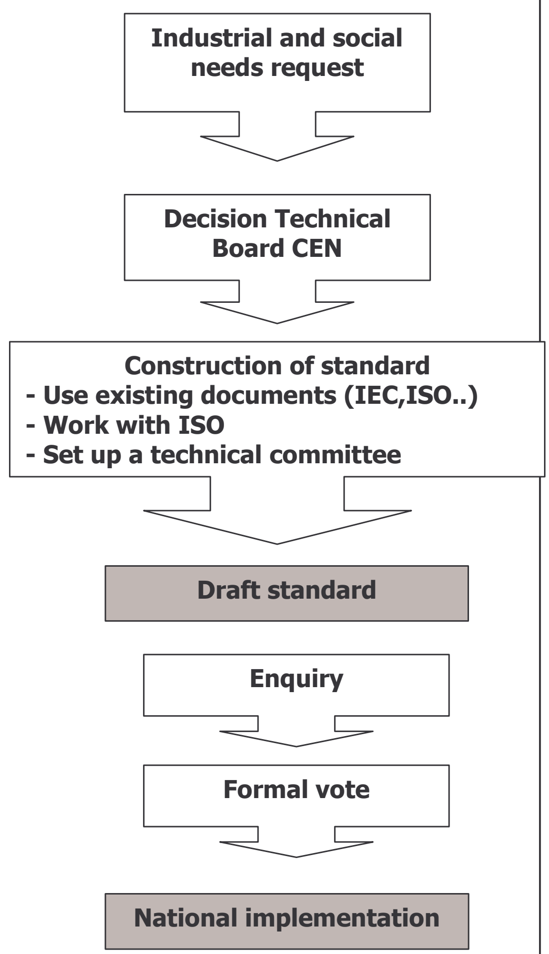
ISO (International Organization for Standardization) is a global network that identifies what International Standards are required by business, government and society. Standards are developed in partnership with the sector concerned. The derived codes, rules and guidelines are the result of consensus from input by numerous national working groups. ISO is responsible for worldwide implementation of standards.

2.2 IEC standards

The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work (website IEC). International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO).

2.3 European committee

The most important European Governmental organization involved in standards is CEN, the European Committee for Standardization (Comité Européen de Normalisation). This Committee is an organization providing an infrastructure to interested parties for the development, maintenance and distribution of coherent sets of standards and specifications. CEN works closely with the European Committee for Electrotechnical Standardization (CENELEC), the European Telecommunications Standards Institute (ETSI), and the International Organization for Standardization (ISO). CENELEC (European Committee for Electrotechnical Standardisation) deals with the creation of standards in the electrotechnical field.



The figure on the right displays the rough procedure which is undertaken by CEN when new standards are required. The national standards bodies of the Union, EFTA and some Eastern and Central European countries are the National Members of CEN. They make up the delegations to the technical committees by finding expertise in each country and vote for and implement European Standards as national standards.

National implementation is done by national standard bodies (see next paragraph). In the case of European Standards (designated 'EN'), the Members must transpose the final text ratified by vote into national standards, translating them if desired, but without deviation or alteration, and retain the prefix EN in the national designation: e.g. BS EN 1234, NF EN 1234, DIN EN 1234. Thus the number and reference of the standard are exactly the same throughout Europe. In most countries the technical content is completed with requirements of explicit national validity and is often based on long-term practice.

The standardization bodies of the twenty-nine national members represent the twenty-five member states of the European Union, three countries of the European Free Trade Association (EFTA) and Turkey, which is likely to join the EU or EFTA in the future. The current CEN Members are: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom. Affiliates: Albania, Bulgaria, Croatia, Macedonia, Turkey. Partner standardization bodies: Australia, Bosnia and Herzegovina, Egypt, Russian Federation, Serbia, Tunisia, Ukraine.

2.4 CE-mark

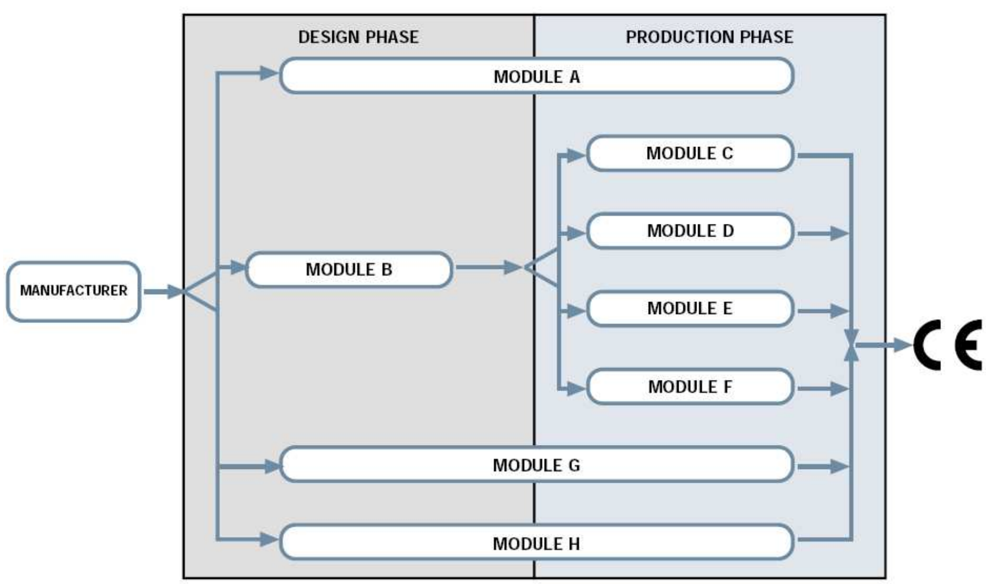
The CE mark (officially CE marking) is a mandatory marking on products, which is required if they are placed on the market in the European Economic Area (EEA). By affixing the CE marking, the manufacturer, or his representative (e.g. an importer) assures that the item meets all the essential requirements of all applicable EU directives. Examples of European Directives requiring CE marking include toy safety, machinery, low-voltage equipment, R&TTE, and EM compatibility. There are about 25 Directives requiring CE marking (the full list of Directives is added in Appendix I).

To permit the use of a CE mark on a product, proof must be documented that the item meets the relevant requirements. Sometimes this is achieved using an external test house, recognized by the EC as notified body, which evaluates the product and its documentation. Often it is achieved by an in-house certification process.

The responsible organization (manufacturer, representative) has to issue:

- An EC-Declaration of Conformity (EC-DoC) indicating its identity (location, etc.)
- The list of European Directives it declares compliance with
- A list of standards the product complies with
- And a legally binding signature on behalf of the organization

The figure below gives a simplified projection of how a conformity assessment procedure for a CE mark has to be conducted. Appendix II shows a detailed example for the conformity assessment procedure of Directive 97/23/EC; Pressure equipment. (European Commission, 2000)



The EC-DoC is the sole responsibility of the manufacturer. The CE marking could be licensed from a 3rd party test institute or certification body. In that case the CE symbol also includes a number that identifies the 3rd party body.

Directives providing the requirements for the CE mark are created by the European Union, but the markings are required throughout the European Economic Area (EEA), which also includes the European Free Trade Association (EFTA) members Norway, Iceland, Liechtenstein and Turkey, which is not a part of the EU or the EFTA.

The following European Directives apply to Wind, PV and cogeneration as machinery in general (for the full list of Directives, see Appendix I):

Directive reference	Subject of directive
89/336/EEC	Electromagnetic compatibility
73/23/EEC	Low voltage equipment
98/37/EC	Machinery safety
97/23/EC	Pressure equipment

3 Wind energy

The industry trend seems to be a move towards international standardization for wind energy laid down in the new international scheme called IEC WT 01 Type Certification System. Based on the IEC and ISO standards most modules are more or less equivalent in content to the Danish and German Certification systems. It is important for manufacturers, banks and underwriters of wind turbines and their components to know the different certification processes as well as technical guidelines.

The procedures to obtain certificates on a national level, such as the Danish and German Type Approval schemes, have a long history. They are also recognized outside Denmark and Germany. But as they are based on national codes, practice and environmental conditions, comparison of the two is difficult and transference without adaptations to other external conditions may even be dangerous.

3.1 Wind and CE

The following directives apply to wind for which a CE-mark has to be gained in order to operate on the European market (see Section 2.1):

Directive reference	Subject of directive
89/336/EEC	Electromagnetic compatibility
73/23/EEC	Low voltage equipment
98/37/EC	Machinery safety

3.2 Wind and ISO

ISO has published one standard related to wind energy: ISO 81400-4:2005 Wind turbines -- Part 4: Design and specification of gearboxes. It establishes the design and specification of gearboxes for wind turbines with power capacities up to 2MW. The content is based on field experience with wind turbines having the above power capacities and configurations. This standard can be applied to higher capacity wind turbines provided the specifications are appropriately modified to accommodate the characteristics of higher capacity wind turbines. Life requirements apply to wind turbines with a minimum design lifetime of 20 years.

3.3 Wind and IEC

The International IEC standards for wind energy are developed by the working groups of Technical Committee-88 (TC-88). The content of national standards for wind energy -- not every European country has one -- are nearly always derived from or an exact copy, of these standards. Even for countries with no national standards, this standard can be seen as one to take into account. Insurance companies or banks for example tend not to cooperate if a certain installation does not fulfil this standard. The main standard TC88 has published is the IEC – 61400 series.

In general IEC – 61400 deals with safety philosophy, quality assurance and engineering integrity, and specifies requirements for the safety of Wind Turbine Generator Systems (WTGS), including design, installation, maintenance, and operation under specified environmental conditions (IEC, 61400).

The more important hardware related parts of the IEC – 61400 are the subject of working groups (WG) 1, 2, 3 and 7 and focus mainly on safety issues. The purpose of these WG's is to provide the appropriate level of protection against damage from all hazards from these systems during their planned lifetime. This standard is concerned with all subsystems of WTGS such as control and protection mechanisms, internal electrical systems, mechanical systems, support structures, foundations and the electrical interconnection equipment.

IEC certificate

Type approval, i.e. assessment of structural integrity, safety philosophy and quality assurance etc., resulting in a type certificate, has to be performed by a recognized institute. In Europe DNV from Denmark and Germanischer Lloyd from Germany are the sole institutes to issue wind turbine type certificates. Measurements and tests, part of the type approval process, are to be carried out by members of the MEASNET group. Amongst others, in the USA Underwriters Laboratories is recognized for testing and type certification of wind turbines.

The IEC WT 01 Type Certification System is the international scheme for type certification of wind turbines. The system creates significant benefit to the manufacturer by reducing the number of steps necessary to obtain certification or approval at the national level. IEC WT 01: IEC System for Conformity Testing and Certification of Wind Turbines, Rules and Procedures, 2001-04

The system is based on standards by IEC (International Electrotechnical Commission) and ISO (International Standardization Organization). The design evaluation is based on the safety requirements given in IEC 61400-1.

National standards + type certificate

Three European countries have their own national standards for wind energy applications. These are: Denmark, Germany and the Netherlands. These three countries were the first to introduce wind energy on a large scale. The installation of wind turbines is generally based on a Type Certification involving design assessment, prototype testing and quality management.

Country	Standard	Regulatory body	More information
Denmark	Technical Criteria for the Danish Approval Scheme for Wind Turbines	Danish Wind Turbine Certification Scheme	http://www.wt-certification.dk
Germany (Turbine)	GL Wind Guideline	Germanischer Lloyd AG	http://www.gl-group.com
Germany (Tower)	German Building Institute (DIBt) Guideline	Deutsches Institut für Bautechnik (DIBt)	http://www.dibt.de
The Netherlands	Wind turbines - Part 0: Criteria for type-certification	NEN	http://www2.nen.nl

In Germany two approvals have to be acquired. One for the machinery (i.e. turbine) by GL and the other for the building part, i.e. foundation and tower according to DIBt regulations. The GL Wind Guideline is based on the requirements laid down in the European standard EN 61400-1 and the German Building Institute (DIBt) Guideline. Besides applying the new terminology laid down in the IEC standards, the Guideline also includes a prototype design assessment, prototype test requirements and new requirements for gearbox design (GL, 2003).

MEASNET

The measurement and test institute should be a member of MEASNET. The international Measuring Network of Wind Energy Institutes (MEASNET) is a co-operation of institutes which are engaged in the field of wind energy and want to ensure high quality measurements. Clients can choose one of the member institutes for the desired measurements, which will then be performed under the quality rules and requirements of the network. The acknowledged members of Measnet are:

- CENER - Centro Nacional de Energias Renovables, Spain
- CRES - Centre for Renewable Energy Sources, Greece
- DEWI - Deutsches Windenergie-Institut GmbH, Germany
- ECN - Energieonderzoek Centrum Nederland, The Netherlands
- RISØ - National Laboratory, Denmark
- TRIPOD - TRIPOD Wind Energy ApS, Denmark
- WINDTEST- Kaiser-Wilhelm-Koog GmbH, Germany
- WINDTEST - Grevenbroich GmbH, Germany
- Barlovento - Barlovento Recursos Naturales S.L., Spain
- NREL - National Renewable Energy Laboratory, USA

3.4 Wind Energy and power quality, earthing and EMC

The following issues can be seen as important when generating electricity, thus also electricity from a renewable source.

- Electromagnetic compatibility (EMC)
- Power Quality
- Earthing

EMC applies to all electronic equipment and will be explained in more detail (see Appendix III).

Wind energy and power quality

For Power Quality the main standard is the IEC standard 61400-21: "Measurement and assessment of power quality characteristics of grid connected wind turbines".

This part of IEC 61400 includes:

- Definition and specification of the quantities to be determined for characterizing the power quality of a grid connected wind turbine;
- Measurement procedures for quantifying the characteristics;
  Procedures for assessing compliance with power quality requirements, including estimation of the power quality expected from the wind turbine type when deployed at a specific site, possibly in groups.

The purpose of this part of IEC 61400 is to provide a uniform methodology that will ensure consistency and accuracy in the measurement and assessment of power quality characteristics of grid connected wind turbines. In this respect the term power quality includes those electric characteristics of the wind turbine that influence the voltage quality of the grid to which the wind turbine is connected. The standard has been prepared with the intention for it to be applied by:

- Manufacturers striving to meet well-defined power quality characteristics;
- Purchasers or operators in specifying power quality characteristics;
- Network operators who must be able to accurately and fairly determine the impact on the voltage quality
- Certification authorities or component testing organizations

Wind energy and earthing

For Earthing the leading European standard is the IEC standard 61400-24: "Lightning protection".

The increasing number and height of installed turbines have resulted in a frequency of occurrence of lightning strokes greater than anticipated with repair costs beyond acceptable levels. Unlike other electrical installations, such as overhead conductor lines, substations and power plants, where protective measures can be arranged around or above the installation, wind turbines pose a different lightning protection problem due to their physical size and nature. The lightning protection system has to be fully integrated into the different parts of the wind turbine to ensure that all parts likely to be hit by lightning are able to withstand the stroke and that subsequently the lightning current is conducted safely to the ground without unacceptable damage or disturbances. To that end this standard was developed to inform designers, purchasers, operators, certification agencies and installers of wind turbines on the state-of-the-art of lightning protection of wind turbines.

Wind energy and EMC

For protection against lightning electromagnetic impulse, the over-voltage protection has to be designed in accordance with the requirements of IEC 61312. The limits of the protection shall be so designed that any lightning electromagnetic impulse transferred to the electrical equipment will not exceed the limits governed by the equipment insulation levels.

For emissions of radiated disturbances the standard which requirements have to be applied to, is IEC 61000-6-4. Immunity to radiated disturbances shall meet the requirements of IEC 61000-6-1 or IEC 61000-6-2. The turbine manufacturer shall state which of these two standards applies to the wind turbine design.

4 Photovoltaic

In a report of 2005 the European Commission reports that the quality assurance and standardization of photovoltaic technologies have been largely neglected, which is causing a threat to the rapid development of PV (European Commission 2005). At present, few PV product specifications, and no system specifications, exist. (website PV GAP)

4.1 PV and CE certificate

The following EU directives apply to PV systems for which a CE certificate is obligatory.

Directive reference	Subject of directive
89/336/EEC	Electromagnetic compatibility
73/23/EEC	Low voltage equipment

For PV modules the inverters are most important to fulfill these directives and have to obtain a CE mark. Tests for these are performed by the procedures as mentioned in Section 4.2.

4.2 PV and IEC

The IEC technical committee on photovoltaics, TC 82, is responsible for constructing PV-related standards. The main IEC standards for PV are:

IEC standard	Title of standard
IEC 61730	Photovoltaic Module Safety
IEC 61215	Terrestrial Photovoltaic (PV) Modules with Crystalline Solar Cells – Design qualification and Type Approval
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval

IEC 61730 Parts 1 and 2 describe the fundamental construction requirements for photovoltaic modules in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are mentioned to assess the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses. This standard mainly focuses on the particular requirements for construction and is to be used in connection with IEC 61215 or IEC 61646.

IEC certificate

The product certification of crystalline PV modules is based on international standards from the IEC, viz.: IEC 61215, IEC 61646, IEC 61215 and IEC 61646, respectively, deal with the reliability of crystalline silicon PV modules and Thin-Film Terrestrial PV Modules and specify the test protocol needed to establish product performance.

Certificates are issued by test institutes, like TÜV Rheinland Group. A test institute tests the product according to the appropriate standards and can issue a type certificate. For PV, TÜV can test both with regard to the IEC 61646 and IEC 61215 for issues like performance measurements on PV modules and characterization of solar cells (website TÜV).

4.3 ISO 27.160

The ISO has published different standards under ISO number 27.160: Solar energy engineering. The content of this is however mostly related to (heat related) solar energy systems, rather than to photovoltaic systems. We refer to the general statements made in the introduction to this chapter, that at present few standards exist. This is certainly also the case with ISO and PV; therefore, we refer to the other standards (IEC, CE and PV GAP) mentioned in this chapter.

4.4 PV GAP

The Global Approval Program for Photovoltaics (PV GAP) is a non-profit organization that emphasizes the standardization of PV on a global scale. At present, few PV product specifications, and no system specifications, exist. PV GAP tries to establish a "Quality Mark and Seal" for PV components and systems. The certification assessment is mainly based on IEC standards (as mentioned above).

First, an IECEE certification body certifies the manufacturer's PV product(s), and the second step is that PV GAP issues a license to the manufacturer to utilize the PV Quality Mark for components and/or PV Quality Seal for systems. The IECEE (International Electrotechnical Commission System for Conformity Testing and Certification of Electrical Equipment) is the organization that is currently carrying out the certification program for PV GAP and is part of the IEC.

4.5 PV and power quality, earthing and EMC

In general, there is a lack of international standards for grid-connected PV systems. For power quality there are no leading standards.

PV and earthing

For earthing the leading European standard is the IEC standard 61173-24: “Over voltage protection for photovoltaic (PV) power generating systems”.

This standard gives guidelines for over voltage protection issues for both stand-alone and grid connected photovoltaic power generation systems. It is intended to identify sources of over voltage hazards (including lighting) and to define the types of protection, such as grounding, shielding, stroke interception and protective devices.

PV and EMC

For EMC the IEC standards as mentioned in appendix III apply, but also the CE directive 89/336/EEC.

4.6 Islanding

For decentralized energy generation there is a risk that islanding may occur.

Islanding may occur under circumstances when the local network including the connected decentralized power source(s), i.e. PV system(s), is disconnected from the public grid network. Islanding is meant to refer to the condition that in the absence of the public grid the decentralized power sources are maintaining the local grid including the supply of sufficient power to the local users. The proper conditions for islanding may occur when a residential house including PV system is disconnected from the public grid. Another example is that a complete residential area is disconnected from the public grid and the local decentralized power sources are able to maintain all relevant grid properties and power supply.

For safety reasons it is obvious that islanding is an undesired and unacceptable situation which has to be avoided by all means. The network is not designed for safe and reliable operations under such unforeseen conditions. (Dispower, 2006).

Germany is the biggest market for PV systems. The German standard for grid interconnection applying for PV systems is the most important in this field. This standard, VDE 0126:1999, defines a standardized interconnection system which has to use impedance monitoring as a third criterion in addition to voltage and frequency monitoring in order to safely detect an unintentional island. For this purpose the standard defines a test procedure.

5 Cogeneration

For cogeneration there is no clear European standard. Cogeneration can be applied on different scales, using different technologies and in different fields of application. In the context of cogeneration, a distinction is often made between large-scale and small-scale cogeneration. Because cogeneration can be based on different technologies in different configurations, there is no applicable overall standard.

For example, there are several standards for generating power with gas turbines (e.g. ISO 3977-1:1997 or IEC 60034-1). There are different laws or directives which apply to combined heat and power (CHP) generation. The EU Legislation mentioned hereafter is of relevance to CHP. (COGEN Europe, 2002)

5.1 Cogeneration and CE

The following directives apply to cogeneration:

Directive reference	Subject of directive
89/336/EEC	Electromagnetic compatibility
98/37/EC	Machinery safety
97/23/EC	Pressure equipment

5.2 European directive promotion CHP

The European Parliament and Council composed a directive in order to promote CHP on a European scale. Directive 92/42/EEC: 'on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending.' The purpose of this Directive is to increase energy efficiency and improve security of supply by creating a framework for promotion and development of high efficiency cogeneration of heat and power based on useful heat demand and primary energy savings in the internal energy market, taking into account the specific national circumstances especially concerning climatic and economic conditions. (European Commission, 2004).

This directive is meant to be implemented on a national level. The directive formulates guidelines and procedures on how legislation can be implemented on a national level in order to stimulate CHP. The directive proposes some standards to harmonize definitions like: CHP, efficiency, useful heat etc.. As mentioned in the directive the European Union must establish harmonized efficiency reference values for several electricity production heat and power sources. This task has yet to be completed.

It's not known exactly how this directive will impact on standards related to CHP. When the harmonized efficiency reference values are defined and the directives are implemented on a national level, it is anticipated that these reference values have to be reported for each installed CHP plant.

5.3 Pollution control and BREF

The IPPC Directive (Directive 96/61/EC concerning integrated pollution prevention and control) sets out common rules on permits for industrial installations. All installations covered by the Directive must obtain a permit from the authorities to allow operation. Permits have to be based on the concept of "Best Available Techniques (BAT)". CHP is likely to be defined based on the BAT for large combustion plants. The BREF (BAT reference document) requires that a new CHP plant is built according to the best available technologies. When a permit for a newly to be built plant is applied for, fulfilling the BREF can be one of the criteria set by the authorities.

Large combustion plant directive

The Large Combustion Plant Directive (Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants) applies to installations for production of energy with a rated thermal input > 50 MW and despite numerous exceptions it defines emission threshold values and the measures necessary to achieve these. Among other things, the directive may give extra emission rights to CHP plants; however, it also requires that the technical and economic feasibility of CHP is examined for new plants.

For large combustion plants >50 MW the following BREF document is leading: 'Reference Document on Best Available Techniques for Large Combustion Plants' (European Commission, 2006). This document is published by the European Commission and gives the most recent overview of technologies, which can be regarded as BAT.

5.4 Pressure Equipment

For equipment dealing with pressurized systems at 0.5 bar or higher the Pressure Equipment directive applies. The directive provides a flexible regulatory environment that does not impose any detailed technical solution. The Pressure Equipment Directive concerns pressurised systems and components such as vessels, pressurised storage containers, heat exchangers, steam generators, boilers, industrial piping, safety devices and pressure accessories.

The Pressure Equipment Directive (97/23/EC) was adopted by the European Parliament and the European Council in May 1997. From 2002 on, the pressure equipment directive has been obligatory throughout the European Union.
Together with the directives related to simple pressure vessels (87/404/EC), transportable pressure equipment (99/36/EC) and Aerosol Dispensers (75/324/EEC), this directive provides for an adequate legislative framework on a European level for equipment subject to a pressure hazard. (website eur-lex)

6 Integration of standards

Although all European high voltage grids are mutually connected, the underlying legislation is still based on national laws and rules. Furthermore, each country has one or more network coordinators who have their own specific demands on how renewable generation should be integrated and connected to the grid. These coordinators can be organized in network coordination groups such as UCTE and Nordel, which are responsible for setting network security criteria and ensuring secure day-to-day operation of Europe's power transmission networks. The Union for the Co-ordination of Transmission of Electricity (UCTE) coordinates the interests of transmission system operators in 23 European countries (website UCTE). Their common objective is to guarantee the security of operation of the interconnected power system. Close co-operation of member companies is essential to make the best possible use of benefits offered by interconnected operation. For this reason, the UCTE has developed a number of rules and recommendations that constitute the basis for the undisturbed operation of the power system. Only the consistent maintenance of high quality demands will permit future standardisation in terms of security and reliability as in the past.

6.1 National codes for integration

To enhance the security of supply, it is important for all transmission grids to be uniformly managed and centrally organised and controlled. This is an opportunity to increase efficiency, because the development, administration and control of grids will no longer be the subject of regional operators, but will be raised to national and European levels. Any potential operator of renewable energy generation systems should be aware of this, and make sure the national code for integration is well known and can be applied to.

Supply of and demand for electricity is balanced via the electricity grid. Independent grid administrators look after the transmission of electricity. For example, in the Netherlands there are currently 22 grid administrators, including TenneT, the Transmission System Operator (TSO). A Grid Code is constructed by the Office of Energy Regulation (DTe) based on the 1998 Dutch Electricity Act (Grid Code, 2006). This Grid Code contains a set of criteria for electricity generation units when connected to the grid. TenneT operates the grid and with that purpose monitors that all suppliers meet the Grid Code. When operating renewable electricity generation systems, national grid codes will apply. These differ from country to country.

7 Conclusion/summary

As a conclusion we present a table which gives an summary of all discussed directives or standards and should in one glance give a good overview.

	standard	description
Wind	89/336/EEC	Electromagnetic compatibility
	73/23/EEC	Low voltage equipment
	98/37/EC	Machinery safety
	ISO 81400-4:2005	Wind turbines -- Part 4: Design and specification of gearboxes.
	IEC standard 61400	Wind turbines
	IEC WT 01	IEC System for Conformity Testing and Certification of Wind Turbines – Rules and procedures
	National standard, Denmark	Technical Criteria for the Danish Approval Scheme for Wind Turbines
	National standard, Germany (Turbine)	GL Wind Guideline
	National standard, Germany (Tower)	German Building Institute (DIBt) Guideline
	National standard, the Netherlands	Wind turbines - Part 0: Criteria for type-certification
	IEC 61312	Protection against lightning electromagnetic impulse
PV	89/336/EEC	Electromagnetic compatibility
	73/23/EEC	Low voltage equipment
	PV GAP	Quality Mark and Seal
	IEC 61730	Photovoltaic Module Safety
	IEC 61215	Terrestrial Photovoltaic (PV) Modules with Crystalline Solar Cells – Design qualification and Type Approval
	IEC 61646	Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval
	ISO number 27.160	Solar energy engineering
	PV GAP	Quality Mark and Seal
	61173-24	Over voltage protection for photovoltaic (PV) power generating systems
	VDE 0126:1999	German standard for grid interconnection

Cogeneration	89/336/EEC	Electromagnetic compatibility
	98/37/EC	Machinery safety
	Directive 97/23/EC	Pressure Equipment Directive
	Directive 92/42/EEC	on the promotion of cogeneration
	Directive 96/61/EC	Integrated pollution prevention and control (IPPC)
	BAT/BREF	Best Available Techniques (Reference document)
	Directive 2001/80/EC	Large Combustion Plant Directive

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International standard, IEC 61400-1, 13 June 2003.

A. LIST OF CE DIRECTIVES

List of CE - directives

Directive reference	Subject of directive
90/396/EEC	Appliances burning gaseous fuels
00/9/EC	Cableway installations designed to carry persons
89/106/EEC	Construction products
89/336/EEC	Electromagnetic compatibility
94/9/EC	Equipment and protective systems in potentially explosive atmospheres
93/15/EEC	Explosives for civil uses
95/16/EC	Lifts
73/23/EEC	Low voltage equipment
98/37/EC	Machinery safety
2004/22/EEC	Measuring instruments
90/385/EEC	Medical devices: Active implantable
93/42/EEC	Medical devices: General
98/79/EC	Medical devices: In vitro diagnostic
92/42/EEC	New hot-water boilers fired with liquid or gaseous fluids (efficiency requirements)
90/384/EEC	Non-automatic weighing instruments
94/62/EC	Packaging and packaging waste
89/686/EEC	Personal protective equipment
97/23/EC	Pressure equipment
99/5/EC	Radio and telecommunications terminal equipment
94/25/EC	Recreational craft
87/404/EEC	Simple pressure vessels
88/378/EEC	Toys safety

B. DETAILED CE PROCEDURE FOR PRESSURISED EQUIPMENT

Type of equipment	Vessels Pressure accessories (1)				Fired or otherwise heated equipment	Piping Pressure accessories (2)			
Fluid to be contained (Art. 9)	gaseous		liquid		Steam or superheated water	gaseous		liquid	
	d (3)	n-d (4)	d	n-d		d	n-d	d	n-d
Annex II: **Tables specific categories as a function of PS, V or DN**	1	2	3	4	5	6	7	8	9

Category	Applicable procedures (For categories I to IV, the manufacturer must apply one of the modules or one of the module combinations set out in the relevant category)	CE marking
SEP (Sound engineering practice)	See Article 3.3	No
I	A; A1; D1; E1; B1+D; B1+F; B+E; B+C1; H; B+D; B+F; G; H1	Yes
II	A1; D1; E1; B1+D; B1+F; B+E; B+C1; H; B+D; B+F; G; H1	
III	B1+D; B1+F; B+E; B+C1; H; B+D; B+F; G; H1	
IV	B+D; B+F; G; H1	

Safety accessories
(Annex II, point 2)

In general:
Category IV

For specific equipment:
Category of equipment to be protected

Assemblies
'Global procedure'
(Art. 10.2)

(a) Each item making up the assembly:
according to its category;

(b) Integration of items:
according to the highest category of equipment not considering safety accessories;

(c) Protection of assembly:
highest category of equipment to be protected.

CE marking (5)

(1) If classified on the basis of PS and V. See Annex II, point 3.
(2) If classified on the basis of PS and DN. See Annex II, point 3.
(3) 'd' means dangerous fluid. See Article 9.2.1.
(4) 'n-d' means non-dangerous fluid. See Article 9.2.2.
(5) Within an assembly, CE marking need not be affixed to each individual item of pressure equipment.

C. ELECTROMAGNETIC COMPATIBILITY

EM emissions are potential disturbances to any other susceptible device in the environment. They may either put it out of action or cause it to malfunction, which in many cases is even worse. For many reasons, an electrostatic discharge may take place even when a device or system is operating normally. EMC may appear in two ways:

- Source equipment whose emissions must be limited; and
- Equipment that needs to have adequate immunity to EM disturbances in the environment.

The aim of electromagnetic compatibility (EMC) is to ensure the reliability and safety of all types of systems wherever they generate or are exposed to electromagnetic disturbances. So, EMC is closely linked with that of the whole field of electrical and electronic engineering. EMC requirements must be specified for each item and the suppliers subsequently have to indicate the installation conditions for their products (such as earthing or wiring) to ensure that the whole installation can function properly.

The main IEC standard for EMC is IEC 61400. For wind turbines a specific EMC standard is constructed based on more general EMC guidelines. The parts of the general EMC standards which apply most to all renewable generation systems are:

- IEC 61000-4-7, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 7: General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected
- IEC 61000-4-15, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications
- IEC 61800-3, Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods

In developing or operating electronic equipment it is important to know that the installation can either be influenced by, or influence other electromagnetic equipment by electromagnetic emissions. The standards serve as guidelines to indicate how the equipment may be protected against these phenomena.