Recommendations for unified technical regulations for grid-connected PV systems

2009

SUNRISE project

Strengthening the European Photovoltaic Sector by Cooperation with important Stakeholders

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Authors:

This study has been carried out by the Consortium of the Sunrise Project formed by EPIA (European Photovoltaic Industry Association), WIP, FIEC (the European Construction Industry Federation), AIE (the European Association of Electrical Contractors), UIA-ARES (International Union of Architects).

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Contact:

Daniel Fraile Montoro
European Photovoltaic Industry Association

Telephone: +32 2 465 38 84
Email: d.fraile@epia.org
Web: www.epia.org

Web : www.pvsunrise.eu

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1. Introduction

SUNRISE is a Co-ordination Action type project financed within the 6^{th} Framework Programme. The main aim of the SUNRISE project is to support the key objective to reduce costs of PV systems by achieving further growth to compete in the liberalised energy market of the future. The co-operation with important stakeholders and networking with the European PV industry needs will lead to cost reduction as a direct result of stimulating market demand. With the anticipated reduced levels of subsidies, the manufacture of PV systems needs to be more cost-effective if the PV industry wants to be competitive with conventional energy production. Therefore, the SUNRISE project delivers the basis for ensuring a cost-effective supply of PV products by improving interaction and production processes within the European PV industry and through involving all relevant stakeholders, in particular those in the construction sector, utilities, planners and architects.

Work Package 2 "PV Network Integration" aims to start a dialogue between the PV industry and utilities. Under discussion will be the integration of PV in the network and to find a balance between centralised and decentralised generation, keeping in mind grid stability and system control. So far utilities often took a very critical attitude towards renewable energy sources in general and therefore as well towards PV. Therefore it will be essential not to take the road of conflict but to start a constructive dialogue how the integration of PV into the European electricity supply can be managed in a win-win-situation for all parties. Within this work package especially the contribution of solar electricity to the peak power supply, the role of solar electricity in marketing campaigns and technical regulations for PV grid-connection will be analysed.

The Work Package includes the organisation of workshops on the PV network integration involving the stakeholders potentially interested in introducing PV systems into the electrical grids, such as the representatives of utilities and grid operations, in order to ensure that they become increasingly aware of the added value and advantages offered by PV network integration and to encourage them to integrate more PV systems into the network.

The aim of this report is to inform about the current situation of PV network integration to the electricity network in EU and point out the major activities taking place in order to facilitate the removal of technical barriers, including the PV industry point's view.

Firstly, it presents which the administrative and technical bottlenecks exist in Europe regarding integration of renewable and in particular PV (section 2). Furthermore, an overview of the current regulation (grid code) for selected countries is given (section 2). Secondly, it presents briefly which are the constrains of having such wide regulations and specification and its negative impact to the deployment of PV. As an example, the behavior under fault conditions defined by each country is shown (section 3).

In section 4, the major activities working on the definition and implementation of a harmonized European standard for PV grid connection are shown, including activities within standardization bodies like CENELEC and those carried out by European funded projects like DER-Lab.

Finally, it presents some industry recommendations on how such harmonized standards shall look like in the future, in order to facilitate the development of equipment, to provide the maximum added value to the electricity grid and to allow a large deployment of photovoltaics in Europe.

2. Current situation of PV network integration to the electricity network in EU

The electricity grid is a highly capital intensive natural monopoly. In most Member States it has been developed under public ownership over decades, for the conventional energy sector. It is therefore not surprising that access to the grid for new, private sector renewable energy producers is problematic. Whereas “Directive 2001/77/EC of the European Parliament and of the council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market” requires objective, transparent and non-discriminatory criteria for grid access for renewable energy sources (RES) it appears that the connection of small decentralised RES in many EU countries is still frequently blocked by local authorities and/or utilities. Some exceptions can be found in countries like Germany, Spain and Denmark which count with large amount of Wind and/or Photovoltaic power and priority access to the grid is always given to Renewable energy sources. This situation shows clearly that the Directive 2001/77/EC has not been uniformly implemented in the regulatory frameworks of the EU member states.

Besides the administrative barriers and bottlenecks, there a number of technical barriers that project developers and product manufacturers continuously face; these are for instance the lack of standardisation and testing procedures. Requirements, that often vary from utility to utility, are usually not transparent enough, and not uniformly applied, which results in additional costs for manufacturers and project developers to comply with the requirements. Under this framework, economies of scale are limited since manufacturers cannot offer unique pieces of equipment for the European market but have to design, build, certify and sell different pieces of equipment for each national market. Various studies already pointed out the missing economies of scale. For example, the data for photovoltaic generation presented in [1] show that the learning rates calculated for inverters (not only playing the role of DC to AC converter but also interconnecting the generator to the grid) are about half those calculated for photovoltaic modules.

The large diversity of requirements and norms presents one of the major obstacles toward the deployment of distributed energy renewable sources like PV, as it slow the harmonisation process which leads as previously explained to economies of scale.

A series of activities are currently happening in EU in order to develop harmonized interconnection requirement and Standards for Distributed energy source; this is the case of CENELEC, through the technical committee TC8X (CLC/TC8X). EU projects like European Network of Excellence of DER laboratories and Pre-Standardisation (DER-Lab) work also on the development of recommendations for the work carried out in the CLC/TC8X working group. More information is presented in section 4.

2.1 Administrative Barriers

A frequently encountered problem for the implementation of PV is the regulation concerning grid access. Whereas "Directive 2001/77/EC of the European Parliament and of the council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market" requires objective, transparent and non discriminatory criteria for grid access for renewable energy sources (RES), it appears that the connection of small decentralised RES is still frequently blocked by local authorities or utilities. This appears to be caused by a lack of knowledge of the European and national regulatory frameworks and a lack of understanding of renewable energy technologies. In several cases, take-off is blocked by complex licensing procedures, poor integration of electricity from RES in regional and local planning and opaque grid-connection procedures.

During the last years, the EC has noted [2] than grid connections and extensions needed to be simplified and stated that the Commission would "continue to co-operate closely with grid authorities, European electricity regulators and the renewable industry to enable a better integration of renewable energy sources into the power grid. In 2008, another EU communication [3] noted that despite the requirements of Directive 2001/77/EC, project developers still faced different grid-related barriers, which were mainly related to insufficient grid capacity, non-transparent procedures for grid connection, high connection costs and long lead times to obtain authorization for grid connection. The Communication noted that high priority should be given to removing administrative barriers and improving grid connection for renewable energy producers.

In general, **average lead times for grid connection** are very high representing a significant bottleneck. Within the framework of the *Progress project* [4], a study carried out by Ecofys shows that the technology which presents the highest authorisation procedure lead times is offshore wind. For the case of PV, the lead time for grid connection represent almost half of the overall procedure time (see figure 1)

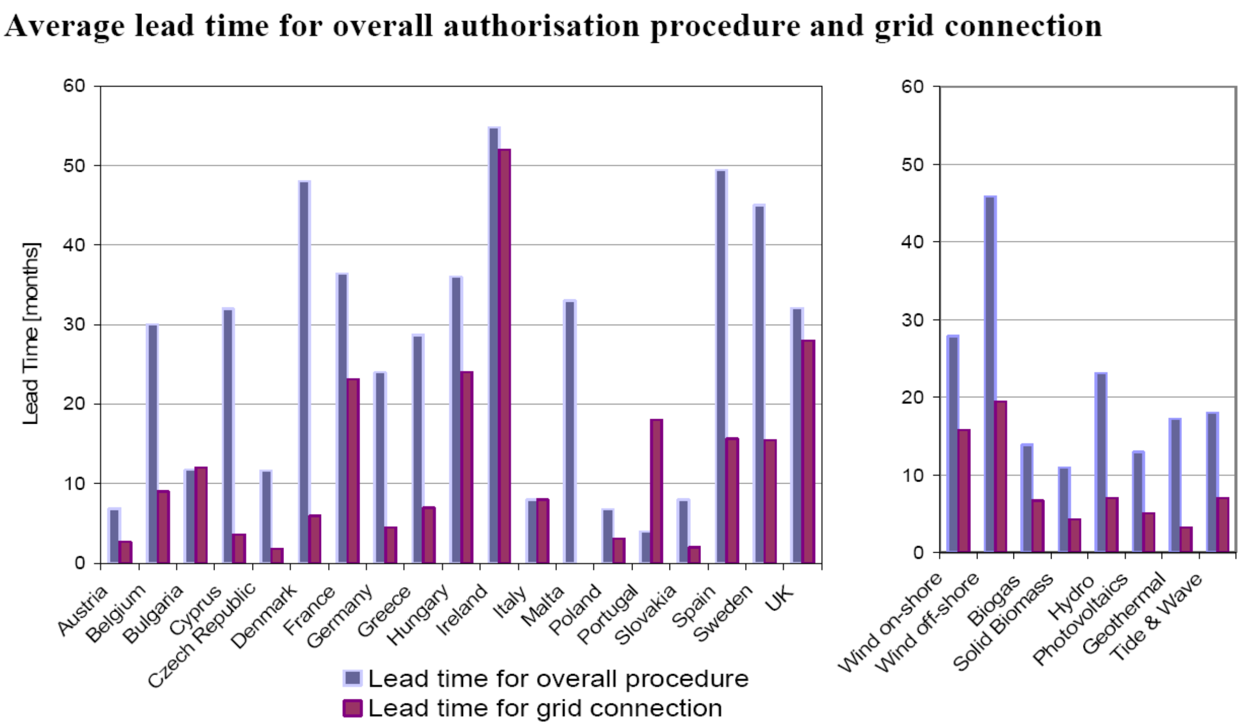

Figure 1. Average lead time for overall authorization procedure and grid connection.
Source: "Promotion and growth of renewable energy sources and systems" Progress project, [4]

The uncertainty of the procedure and the time it takes to complete the process compound the uncertainty of the overall acceptance or rejection of an application. On this point to there is wide variation across Member States but less variation according to technology. Photovoltaics, in this sense present one of the lower permit rejection time.

The average rate of permit rejections.

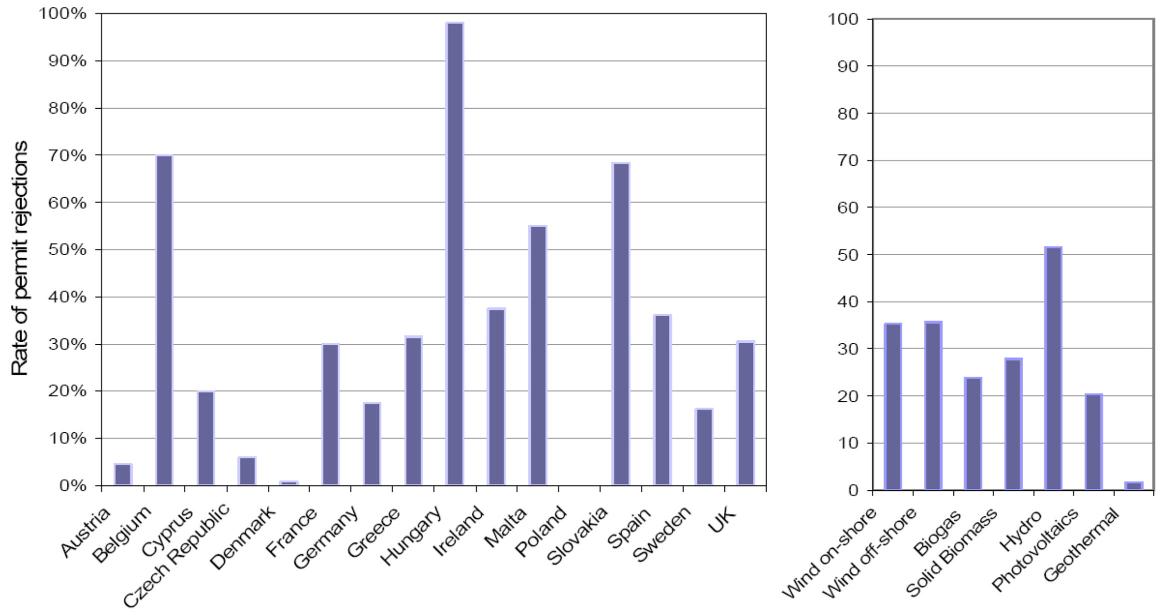

Figure 2. Average lead time for overall authorization procedure and grid connection
Source: "Promotion and growth of renewable energy sources and systems" Progress project, [4]

The average rate of permit rejection is 30% but in some cases (reflecting ad hoc moratoriums on certain technologies in certain regions or countries) the rate is much higher. In this sense, Photovoltaics present a better position than other Renewable energy sources with a rate of permit rejection of 20%.

In many cases, a lack of grid capacity represents a crucial factor for rejection. This and other reasons (such as an excess of applications) suggest that better structured administrative procedures, further administrative resources and coordination with grid planning is necessary. For instance, in countries with a high rate of successful planning appeals, an increase in resources for initial applications could speed up the treatment of applications, increase the rate of initial approvals and reduce the administrative costs associated with appeals.
Analysis of the planning process reveals that problems relating to grid connection and capacity are a major obstacle which is more often generated by limits on administrative and other resources than technological constraints.

Perceptions of insufficient grid capacity.

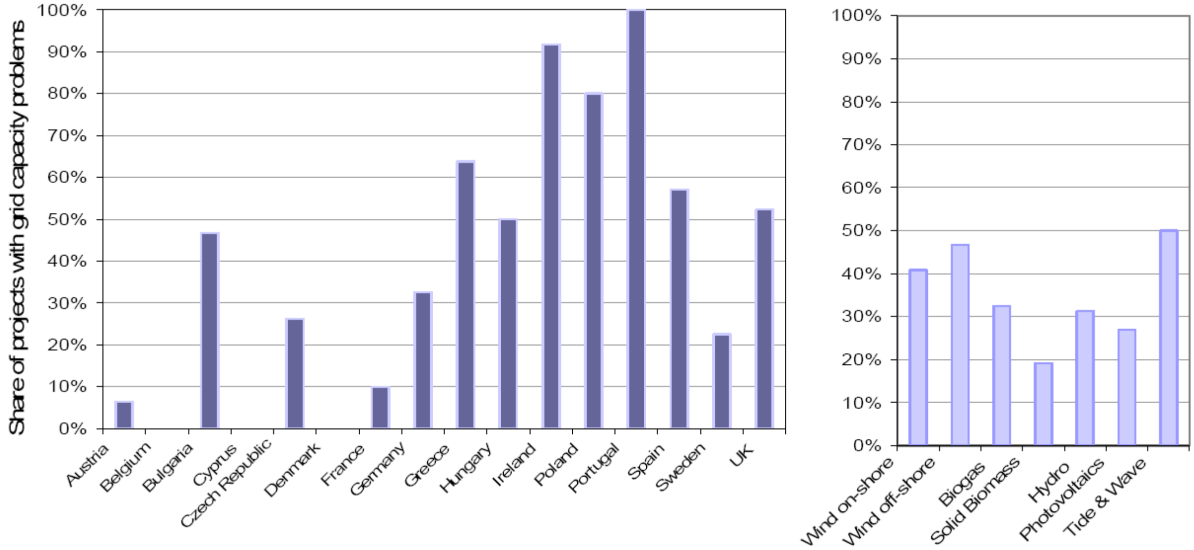

Figure 3. Perception of insufficient grid capacity
Source: "Promotion and growth of renewable energy sources and systems" Progress project, [4]

One important element for ensuring that there is sufficient grid capacity is grid expansion financing. One crucial problem is a lack of clarity regarding cost breakdowns and in some Member States there appears to be no transparency. Also in some Member States grid connection and expansion costs and the charging regimes of some transmission system operators and distribution system operators still favour incumbent producers and discriminate against new often decentralised smaller renewable electricity producers. This hampers job creation and growth at local and regional level.

2.2 Technical Barriers

The major technical barrier for the PV industry regarding network integration is the wide variety of requirements and norms which vary from country to country and in many cases even from utility to utility (some examples are presented in section 2.3). Besides the large range of requirements, those are usually not transparent enough, and not uniformly applied, which results in additional costs for manufacturers and project developers to comply with the requirements. Under this framework, economies of scale are limited since manufacturers cannot offer unique pieces of equipment for the European market but have to design, build, certify and sell different pieces of equipment for each national market.
In sectors like the photovoltaic, in which the technology is still not competitive with conventional energy sources, cost reduction is the main priority for the whole industry. Cost reduction is only possible through continuous R&D and economies of scale; Hence, the importance of harmonized grid connection requirements.

Many European wide activities (e.g. EC projects) have underlined the urgent need for a novel, consistent and pan-European approach to Decentralised Generation (DG) interconnection issues. An overview of those projects and activities is given in section 4

Before presenting the technical requirements for the interconnection of distributed generation (Photovoltaics) to the public distribution network in different EU member states, it is important to identify which type of documents can be found and who is responsible of preparing such documents.

Type of documents:

- national standards (NS)
- grid codes or assimilated (disregarding if the grid code is approved by the regulator or proposed by DNOs…) (GC)
- company regulations or guide (in some cases such as the absence of detailed and applicable requirements, company regulations may be considered) (CR)

These documents, in some cases will be specific to one energy source (e. g. Photovoltaics) or to a particular generating technology (e.g. inverter-connected generation) although they are normally developed for any decentralized energy technology. In many cases, a regulation will apply to one or other technology depending on the size (voltage and current) of the system, and if it directly connected to the low, medium or high voltage network.

Besides the large variety of documents, the **type of organizations** involved in the development of such requirements is very diverse:

- National parliaments
- Ministry covering energy issues (e.g. Energy Ministry of Industry Ministry)
- Regulators
- National standardisation bodies
- DNO associations
- DNOs

This diversity is also probably one of the major causes for the slowness of the harmonisation process.

2.3 Overview of Grid codes for PV in certain European countries

This chapter briefly presents the interconnection requirements which affect grid-connected PV systems in certain European countries. This information is based on DEDIS (Data Base of European DER Interconnection Specifications of the European project DER-Lab) [5]

Austria:

There are two main documents which affect the interconnection of PV systems in Austria:

- TOR: Technical and organisational rules for operators and users of transmission and distribution networks
- ÖVE ÖNORM E2750: Photovoltaic power-systems – Erection and safety require-ments

The general technical framework is defined in the “Technical and organisational rules for operators and users of transmission and distribution networks (TOR)”. The TOR represent the national grid code and are also part of the so called “Market rules” for the liberalised electricity market, which have a special legal status, similar to a law. The ÖVE ÖNORM E2750, “Photovoltaic power-systems – Erection and safety requirements” is a specific national standard which covers PV installations including their interconnection to the grid.
Besides the grid code, there is also a specific national standard that covers PV-installations including their connection to the grid, the ÖVE ÖNORM E2750, “Photovoltaic power-systems – Erection and safety requirements”.

Germany:
The technical framework defining the rules for interconnecting DER to the public distribution network is mainly set through three documents:

- VDEW Guideline for the connection of DG to the LV grid
- VDEW Guideline for the connection of DG to the MV grid
- VDE 0126-1-1, Automatic disconnection device between a generator and the public low-voltage grid

The first two documents are guideline issued by the association of DNOs while the third one is a national standard. All these three documents are therefore DER specific: they deal only with issues related to the connection of DER to the public distribution network. The two guidelines from the DNO association can be classified as the known Grid-Codes.

Spain:
The most important technical requirements for the connection of PV to the public distribution network are specified through a royal decree brought to force in 2000:

- RD 1663/2000: interconnection of PV installations to the low voltage grid

This document is dedicated to the connection of PV systems up to 100 kW. Testing requirements are not included in this decree, and no examples are provided. This decree also contains procedural details.

France

In France, the most important technical requirements for the connection of DER to the public distribution network are specified through a ministerial order, a royal decree and a company guide (3 documents):

- Ministerial decree n° 2008-386 of 23 april 2008 on the general technical requirements regarding design and operation which installations must fulfill for connection to the public networks
- Ministerial order of 23 April 2008 on the technical requirements regarding design and operation which production installations must fulfill for connection to the public distribution network
- Distribution Technical Guide (published by EDF)

While the first decree covers transport as well as distribution networks, the ministerial order is dedicated to distributed generators connected to the distribution networks: it is the most important. The users of the public electricity distribution network operated by EDF can access to all documents constituting the Technical Guide on Internet.

Italy

The technical requirements for connecting DER to the public distribution network in Italy are mainly defined in the following two documents:

- CEI 11-20: Requirements for energy generation installations of power higher than 1 kW connected to the LV and MV grids
- DK 5940: Company requirement (ENEL Distribuzione): Connection requirements to the LV grid for PV installations (powers between 1 and 20 kW)

The first document is a national standard issued by CEI, the national standardisation institute, and the second one is a company regulation (ENEL). Both documents are DER- specific: they only address the connection of DER to the grid. While the national standard is energy resource neutral, the second document (the company regulation), is dedicated to the connection of photovoltaic generators to the grid. The national standard also specifies the requirements for different technologies through different sub-chapters (e.g. protection requirements for converters or rotating machines).

The Netherlands

The technical framework defining the rules for interconnecting DER to the public electricity grid is mainly set through these two documents:

- Netcode, April 1, 2006

The Netcode is the Dutch Grid code It establishes the rules between grid operators and users connected to the public electricity network and is not DER specific. The Netcode distinguishes first between (consumer) connections and production units, and subsequently between low and high voltage. Besides some general conditions that apply to all connections, the technical issues are addressed per mentioned category. The operating conditions are specified separately for producers and consumer/producers, where producers are divided between smaller and larger than 60MW.

Greece

The main document describing the technical requirements and assessment methodologies for the interconnection of RES to the distribution network is the following technical directives of the distribution utility PPC S.A.:

- Technical requirements for the connection of independent generation to the grid
- Guide for the connection of PV installations to the LV network

Additional provisions are included in the distribution network and transmission system Codes, as well as in the ministerial decree for the standardized grid connection agreement of DG stations.

The first directive comprises the technical evaluation framework and the limits set for DG installations to be connected to the public LV or MV distribution network. Therefore, they are DER specific documents. While the first one is applicable for any DG station, it still comprises specific provisions for wind power stations. The second document concerns specifically PV installations with installed capacities up to 100 kW.

3. Need for harmonized grid codes

As introduced in section 2, when it designs and builds its products, the PV industry has to consider a range of Grid Code requirements from a variety of countries. The PV 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.

Requirements introduced on the dimensioning, capabilities and behaviour of PV 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 PV 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.

All country specifications comply with the European standards:

- EN 50160 *Voltage characteristics of electricity supplied by public distribution systems*
- EN 50438 *Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks*

While these standards give general limits for public supply networks, various European countries have additional rules governing supply conditions (see section 2.3). Many of these national regulations cover areas not included in the above mentioned standards, such as the maximum permissible harmonic load to be connected to the PCC (point of common coupling) or the **low voltage fault-ride -through behaviour** among others.

As just one example, detailed below are the different schemes for fault-ride-through in different European countries:

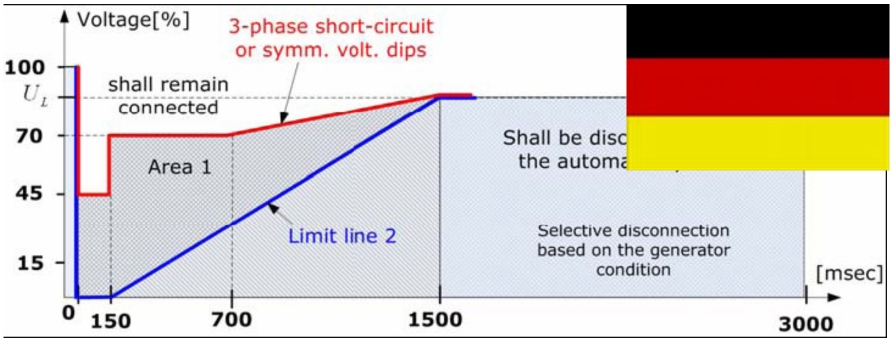

Figure 4. Fault-through-ride behaviour in Germany [6]

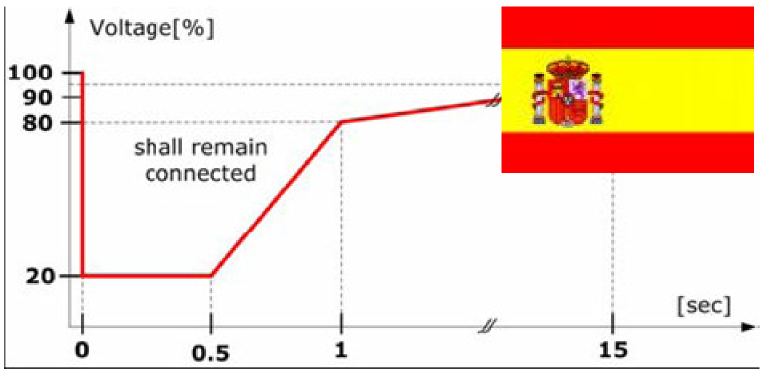

Figure 5. Fault-through-ride behaviour in Spain [6]

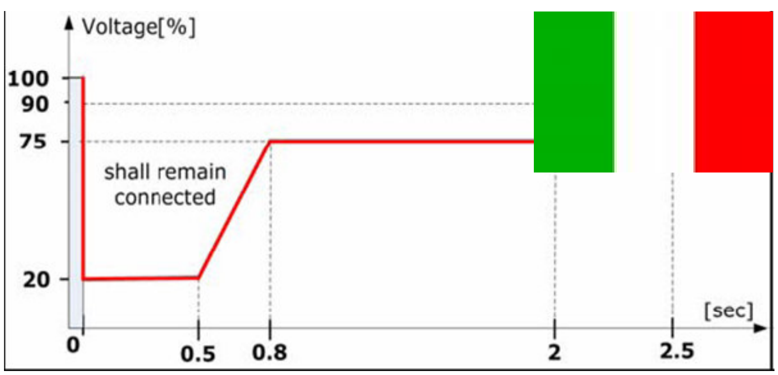

Figure 6. Fault-through-ride behaviour in Italy [6]

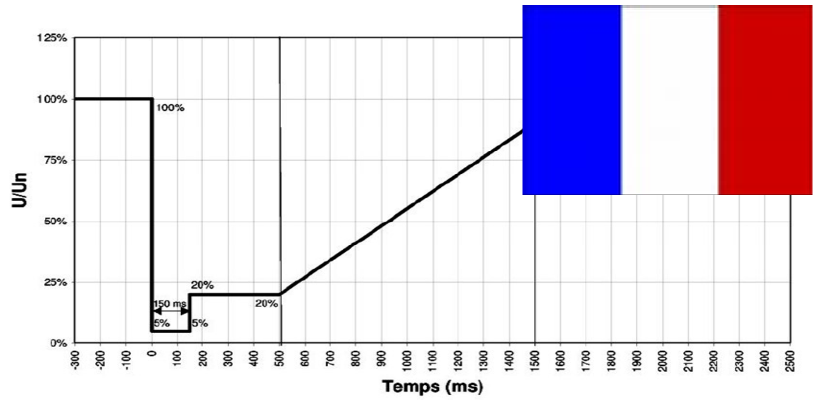

Figure 7. Fault-through-ride behaviour in France [6]

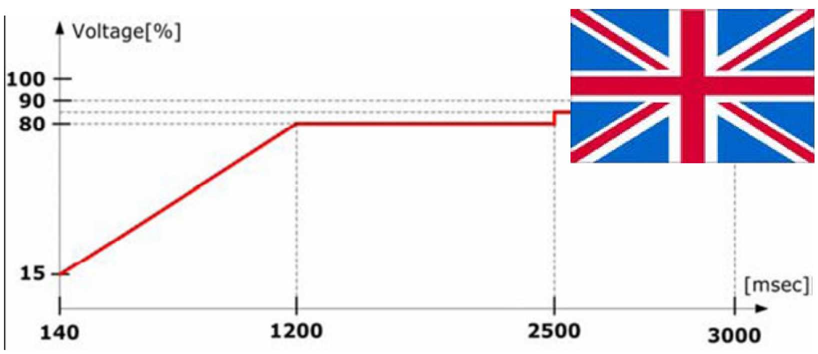

Figure 8. Fault-through-ride behaviour in United Kingdom [6]

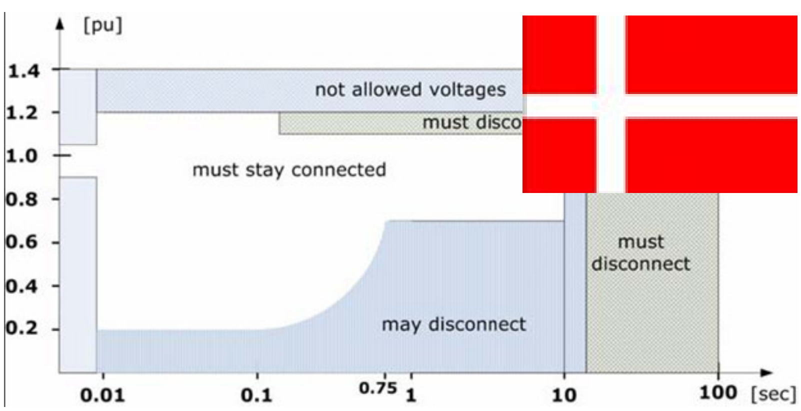

Figure 9. Fault-through-ride behaviour in Denmark [6]

It can be clearly observed that the behaviour that connected generators need to maintain under fault situations is very different from country to country which, as explained in section 2.2, makes difficult and costly the deployment of photovoltaics.

Some solutions for harmonized specifications across Europe are being prepared and are presented in section 4.

For instance, the “International White Book on the Grid Integration of Static Converters” being prepared under the Network of Excellence of DER laboratories and Pre-Standardisation (DER-Lab) [5] (see section 4.2 and 4.3) works on a common definition for the behaviour under fault condition as presented in Figure 10.

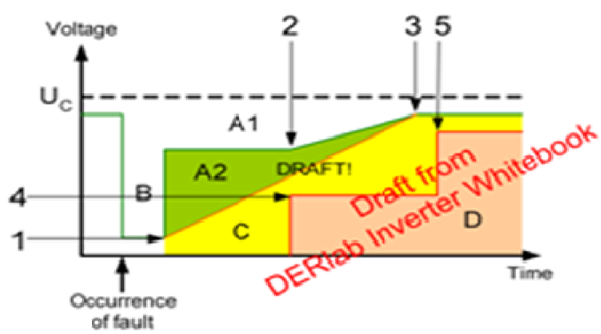

Figure 10. Draft scheme for Fault-through-ride under “International White Book on the Grid Integration of Static Converters” [6]

4. Activities at EU level on Grid codes

The large diversity of requirements and norms presents one of the major obstacles toward the deployment of distributed energy renewable sources like PV, as it slows the harmonisation process which leads to economies of scale (as previously explained in section 2).

In order to diminish the impact of the many diverse interconnection requirements and Standards, a series of activities are currently taking place at EU level. A non exhaustive list of those is presented below:

4.1 European Committee for Electrotechnical Standardization (CENELEC)

CENELEC, through its technical committee TC8X (CLC/TC8X), under the Working Group 3, it is preparing a technical specification so called ***"Requirements for the connection of generators above 16A per phase to the low voltage distribution system or to the medium voltage distribution".***

This standard aims at harmonizing at European level the technical requirements for the connection of distributed energy resource (DER) to the LV and MV networks.

The leading research laboratories in the field, together with distribution system operators, (DSO), regulators and manufacturers are part of this working group.

The working group 3 initiated its activities in 2006 and expects to publish the first version of the standard by 2010

4.2 Network of Excellence of DER laboratories and Pre-Standardisation (DER-Lab)

DER-Lab [5] is an EU funded project formed by 11 Laboratories across Europe (see figure 11). Coordinated by ISET, DER-lab's mission is to provide support for the sustainable integration of renewable energy sources (RES) and distributed generation (DG) in the electricity supply by describing common requirements, developing quality criteria, and supporting international pre-standardisation activities. The network will propose test and certification procedures concerning connection, safety, operation and communication of DG components and systems.

The partners of DER-lab are shown in Figure 11.

DER Laboratories	Country	independent	accreditation 17025	longtime DG experience	active in standardisation committees
Arsenal	Austria	✓	✓	✓	✓
ICCS-NTUA	Greece			✓	✓
ISET	Germany	✓	✓	✓	✓
CEA	France	✓		✓	✓
CESI RICERCA	Italy		✓	✓	✓
CRES	Greece	✓		✓	✓
KEMA	Netherlands	✓	✓		✓
Labein	Spain	✓	✓	✓	✓
TU Lodz	Poland	✓	✓		
TU Sofia	Bulgaria	✓		✓	✓
UKDG	UK	✓		✓	✓

Figure 11. Partners of DER-Lab

One of the main objectives of Der-Lab is to provide recommendations to CLC/TC8X WG3 on how to set harmonized European requirements for the connection of generators to LV and MV distribution system. So far, a deliverable so called "*key needs, priorities and framework for the development of a common European pre-standard on DER interconnection*" *[7]* has been proposed. It presents how the future standard should be structure so that it is easier accessible and understandable for all type of users.

They work also on the development of recommendations for the work carried out in the CLC/TC8X working group.

4.3 International White Book on the Grid Integration of Static Converters

"DERlab" [5] has started to prepare the "International White Book on the Grid Integration of Static Converters". It aims at describing medium to long-term harmonisation needs for the behaviour and technical interfaces of grid connected static converters. It should support the preparation of international standards that describe controllable power units for:

- grid operators to assure grid compatibility of power devices that might contribute with ancillary grid services
- manufacturers to produce products that are applicable in different countries
- operators to have devices available that are of well defined quality/compatibility and that can be used efficiently.

For developing and discussing the draft DERlab has held a series of workshops for international DER experts to discuss these new requirements and find a common vision for the grid inverters of the future. The outcome of these workshops will be documented in the white book which is expected to be published in 2010.
The main results are presented in three chapters: "Ancillary services", "Behaviour under fault conditions", and "Control and Communication for operation of inverters in future power systems".

More details on the white book and the workshops can be found at www.der-lab.net/workshops .

4.4 Guidelines for Good Practice (GGP) on Grid Connection and Access

European Energy Regulators have undertaken in their 2008 Work Programme to analyse the needs and draft key concepts for common grid access and connection approaches throughout the EU electricity grids. This includes the drafting of ***Guidelines for Good Practice (GGP) on Grid Connection and Access*** which seeks to initiate discussion on ERGEG's (European Regulators' Group for Electricity and Gas) input to the draft Framework Guidelines.
The Guidelines, in its final version, may be used as an input to the Framework Guidelines to be developed by the *Agency for the Cooperation of Energy Regulators* [8], 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 the guidelines 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 ***draft Guidelines for Good Practice (GGP) on Grid Connection and Access*** [9] guidelines were submitted to public consultation (March 2009- June 2009) among the different stakeholder to gather all the points of views and improve the preliminary work.
The results of all stakeholder position to the document can be found in [10]
The results of integrating of comments are expected to be published in 2010.

All stake holders have welcomed the ERGEG Consultation (and its related dedicated workshops) as a step forward towards the development of Framework Guidelines on Electricity Grid Connection and Access.
However, many issues presented in the draft still need to be addressed. Some of those issues deal with:

- priority access the grid for renewable energy sources
- Who should be responsible body/ies for the design of the technical solutions for connection.
- Lack of minimum European requirement specification
- Better specification/ differentiation among different generation technologies
- Resposible for the definition of the of point of interconnections
- Etc.

All these aspects can be found in the reply of EPIA to ERGEG's public consultation [11].

4.5 European projects dealing with interconnection of Distributed Energy resources to the electricity grid.

Beside the major European initiatives described in sections from 4.1 to 4.4, there are a series of European Commission funded projects which aim at improving the situation of the interconnection of distributed energy resources, including PV.

The following is a non-exhaustive list of those projects:

- DISPOWER: *Distributed Generation with High Penetration of Renewable Energy Sources*
- DG-FER: *Distributed Generation- Future Energy resources*

- IRED: *"Integration of Renewable Energy Sources and Distributed Generation into the European Electricity Grid"*
- ELEP: *European Local Electricity Production*
- Soli-DER: *Coordination Action to Consolidate RTD Activities for Large-Scale Integration of DER into the European Electricity Market*
- PV-Upscale: *Photovoltaic in Urban Policies- Strategic and Comprehensive Approach for Long-term Expansion*
- EU-DEEP: *The birth of a European Distributed EnErgy partnership*
- ADDRESS project: *Active Distribution network with full integration of Demand and distributed energy RESourceS*

4.5.1 DISPOWER: Distributed Generation with High Penetration of Renewable Energy Sources (January 2001 to December 2005)

Supported by the European Commission under the 5th Framework Programme, the project DISPOWER has significantly contributed to the further development of technology as well as to the European exchange of experience in the field of integrating small and distributed generators into the electricity distribution grid. The central question was as follows: how does the technology has to be developed so that the growing number of decentralized energy resources can be further integrated into the European electricity grids in the future, without losing reliability, safety and quality?

The project, coordinated by ISET, consisted of 38 different partners from utilities, power industry, service companies, research centres and universities from 11 European countries.
The broad European basis of the consortium facilitated an intensive exchange and dissemination of national knowhow and experience.

More information at: www.iset.uni-kassel.de/dispower_static/welcomeg.html

4.5.2 DG-FER: Distributed Generation- Future Energy resources

(January 2003 to March 2004)

Supported by the EU's ALTENER Programme, The DG-FER project developed a roadmap ***(Roadmapping of the paths for the introduction of distributed generation in Europe)*** for distributed energy in Europe, bringing together the various elements that comprise all the technologies that make up distributed generation (DG) in order to provide an understanding of the links between RES, CHP, distributed electricity-only projects and changes in the operation of the electricity network and the needs for network reinforcement.

More information at: www.dgfer.org

4.5.3 IRED: "Integration of Renewable Energy Sources and Distributed Generation into the European Electricity Grid"

(2004-2008)

IRED is a large European Cluster of RTD projects funded by the European Commission and coordinated by ISET, Germany.

The activities of the European research cluster on the integration of renewable energies and distributed generation into the European electricity grid started in 2002 under the initiative and guidance of the European Commission – DG Research with the aim of coordinating the European projects in the fields of RES and DG in a high level steering group. Since 2004 the EC has funded the cluster in the frame of the IRED Coordinated Action for four years. During this time the cluster membership has been expanded by including representatives of new European projects in the area.

The project aims at:

- Increase stakeholders' awareness of the growing importance of RES and DG.
- Contribute to remove technical, economical and regulatory barriers for the grid connection of RES and DG.
- Create a favourable environment for socio-economic acceptance of intermittent RES and DG without risks to quality or safety.
- Create a knowledge infrastructure for design, realisation and operation of the future European smart electricity grid.

Most Important Initiatives:

- International exchange and conferences in 2004, 2006 and 2008.

- Set-up of the European Technology Platform "Smart Grids" for the electricity networks of the future.

More information at: http://www.ired-cluster.org/

4.5.4 ELEP: European Local Electricity Production

(February 2005-September 2007)

ELEPs- European Local Electricity Production- mission is to support to use of Distributed Power Generation (DG) in Europe by working towards removal of policy, commercial and regulatory barriers currently restricting the use of DG in Europe. It is a project partly funded by EU as part of Intelligent Energy for Europe.

The work is based upon the findings in the DG-FER project where the most important obstacles to a wide spread use of DG were identified. These had to do with:

- Interconnection standardisation
- Commercial and policy issues
- Building Directive issues
- Certification and Authorisation

More information at: www.elep.net

4.5.5 Soli-DER: Coordination Action to Consolidate RTD Activities for Large-Scale Integration of DER into the European Electricity Market

(November 2005 to October 2008)

The project SOLID-DER, a Coordination Action funded by the EC under the 6th Framework Programme and within “Sustainable Energy Systems” has focused on:

1. Unite Research& development forces to tackle key issues of DER integration by:
   - Identify, evaluate and assess the critical developments, innovations and findings in EU R&D on large-scale integration of DER.,

- synchronising and distributing efforts, and
- explaining the process to market players, technical and regulatory decision-makers

2. Establish an EU wide DER integration R&D community by including the NMS stakeholders into the existing ERA (European Research Area).

More information at: www.solid-der.org

4.5.6 PV-Upscale: Photovoltaic in Urban Policies- Strategic and Comprehensive Approach for Long-term Expansion

(January 2006- June 2008)

PV UP-SCALE is a European founded project (under Intelligent Energy Europe) related to the large-scale implementation of photovoltaics (PV) in European cities.

Its objective is to bring the stakeholders in the urban planning process to attention the economical drivers, bottlenecks like grid issues, the do and don'ts within the PV-urban planning process.

The project suits the activities that are executed in the IEA PVPS implementing agreement, in particular IEA PVPS Task 10. It takes information from Task 7 (building integrated PV), which ended in 2001 and Task 5 (grid issues), ended in 2003.

The project offers a large database www.pvdatabase.org in which many BIPV projects are analyzed. It also offers a large number of real cases studies in which the interaction with the electricity network is studied.

Some of the published reports which are directly related to the development of PV interconnection requirements are:

- Report on effects of urban scale PV on the LV network based on measured voltage and load characteristics at PV system interconnection nodes
- Recommendations for utilities on PV system interconnection issues

- Draft standard / guideline for grid connection of larger-scale or dense urban PV systems

More information at: www.pvupscale.org

4.5.7 EU-DEEP: The birth of a European Distributed EnErgy partnership

Funded by the EC 6th Framework Programme, the overarching goal of EU-DEEP was to:

Design, develop and validate an innovative methodology, based on future energy market requirements, and able to produce innovative business solutions for enhanced DER deployment in Europe by 2010.

The project objectives were therefore to address the removal of the above barriers by providing solutions based on a demand-pull approach:

- Innovative business options to favour DER integration
- Equipment and electric system specifications to connect safely more DER units to existing grids
- An in-depth understanding of the effect of large penetration of DER on the performances of the electrical system and on the electricity market
- Market rules recommendations to regulators and policy makers that will support the three studied aggregation routes
- A comprehensive set of dissemination actions targeting all stakeholders of DER in Europe

After 5 years of research involving 42 partners from 16 countries, the EU-DEEP consortium is now in a position to detail the conditions under which all players will be able to cope with the growing demand for DER units. Firstly, the project has identified the current “hosting capacity” of the electrical power system and the conditions that will enable this to be increased at an acceptable cost. Following this, an in-depth economic analysis of DER reveals that they can provide significant added value for the electrical system when they comply with network design constraints and contribute, in a reliable way, to better management of peak consumption. Using three aggregation business models extensively tested in the field, the project highlights the most promising directions to take from now on, to ensure efficient and sustainable integration of DER in the current electrical power system.

4.5.8 Address project: Active Distribution network with full integration of Demand and distributed energy RESourceS

(June 2008 - June 2012)

ADDRESS, formed by 25 partners from 11 EU countries, is a large-scale Integrated Project co-founded by the European Commission under the 7th Framework Programme.
ADDRESS targets to enable the Active Demand in the context of the smart grids of the future, or in other words, the active participation of small and commercial consumers in power system markets and provision of services to the different power system participants.

ADDRESS is framed in the Smart Grids European Technology Platform, whose vision for the electricity networks of the future may be expressed in just 4 words: flexibility, accessibility, reliability, economy.

One of the project main objectives is to propose solutions to remove commercial and regulation barriers against active demand and the full integration of DG (Distributed Generation) and RES (Renewable Energy Resources)

More information at: www.addressfp7.org

5. Recommendation from the PV industry

There is a clear need to strengthen cooperation between Distributed System Operators/ Transport System Operators (DSO/TSOs), the photovoltaic sector and energy regulators when drafting grid codes and other technical requirements. This is crucial in order to ensure a full transparency of the drafting processes on the basis of fruitful exchange of views between all relevant stakeholders. In this perspective, the photovoltaic industry is definitely keen to provide any expertise needed.

As **general recommendations**, PV industry and the Sunrise consortium identifies the followings aspects:

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 PV inverters, PV power plants and other equipment.
3. Requirements shall be easy to obtain and available in English from the issuing body (DSO, TSO or national authority).
4. The technical requirements should focus on the essential aspects of technical performance, leaving an opening for ancillary services.
5. Requirements should balance cost and benefits of technical performance, and generally be specified so that these can be met at minimum overall system cost.
6. Requirements for PV power plants should not be excessive or discriminatory (for instance, no requirements for residential PV plants with less than 30 kWp until major share of PV (> 20 %) is reached)
7. All requirements should refer to the Point of Common Coupling (PCC) which shall be defined in cooperation between TSO/DSO and the owner of the generation/consumption unit.
8. Requirement should be drafted as a result of a mandatory cooperation involving all related parties: DSO, TSO, Regulators, equipment manufacturers (inverters) and system integrators.
9. Revisions/changes should be made only after consultation with the industry
10. 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.

Harmonisation of Grid Codes should be done at two levels or steps: first a structural harmonization and second, a technical harmonization.

- **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. 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.

At both levels (structural and technical), the PV industry fully support the on-going activities of DER-Lab (see 4.2 and 4.3) and their preliminary recommendations for an European standard of DER interconnection, which are presented in the document "*key needs, priorities and framework for the development of a common European pre-standard on DER interconnection" [7]*.

An overview of the structure of a possible EU standard is presented in the Figure 12

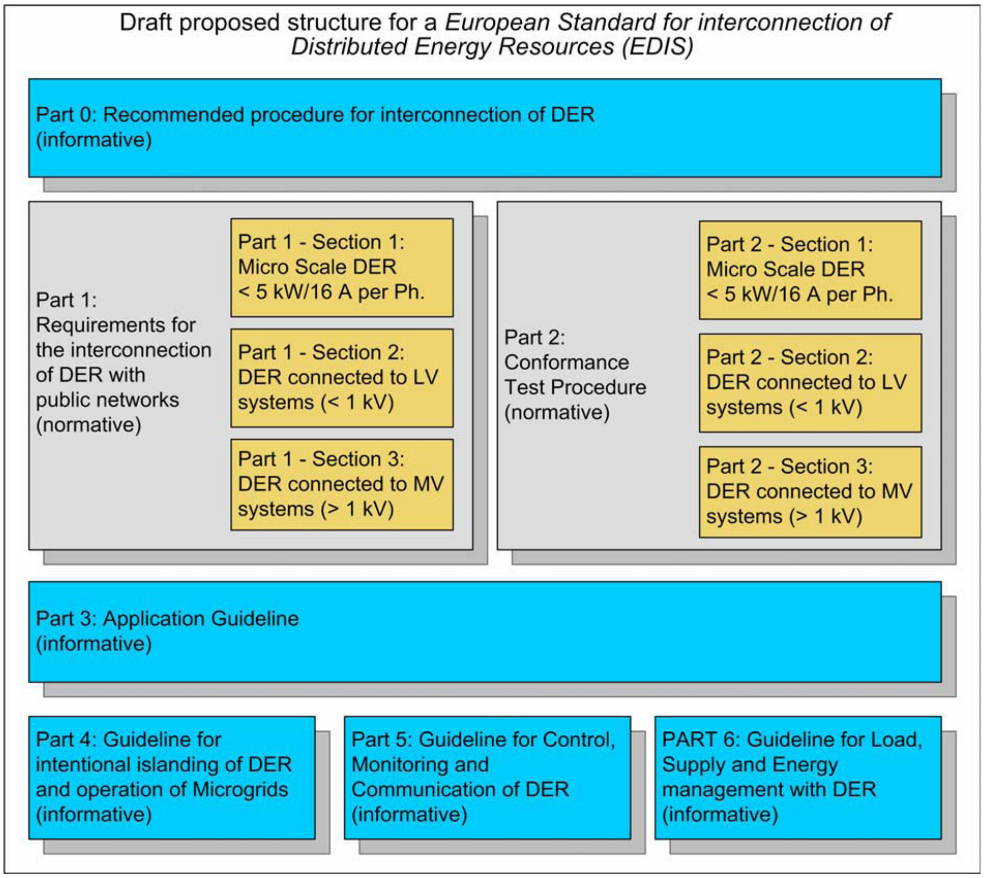

Figure 12. Proposed structure for the EDIS *[7]*

6. Conclusions

As highlighted by the recently published European Commission Renewable Energy Progress Report [12], *“the problems of gaining connection to the electricity grid often result from a lack of adequate rules on grid connection and from a failure to dedicate sufficient administrative resources to process applications. Technical problems are also disruptive, with limited capacity of the grid to incorporate more variable renewable electricity and a general lack of strategy to address the problem. There are also financial constraints, with different and often opaque connection charging rules and risk of discrimination against smaller distributed power generators compared to large incumbent conventional energy producers”.*

Therefore, it is clear that administrative bottlenecks could be easily solved if more capabilities are dedicated to the integration of photovoltaics.

In the case of technical barriers regarding the interconnection of PV system, an increase of the cooperation in **developing jointly grid codes**:

- will provide an **undisputed benefit** to DSOs, system integrators and manufacturers and
- is mandatory to **significantly increase** the share of PV in European utility grids and thus make a reality the EU target on a 20% of renewable share for 2020

7. References

[1] A Review of PV Inverter Technology Costs and Performance Projections, NREL report, January 2006, www.nrel.gov

[2] COM(2006)84810

[3] SEC(2008)5711

[4] Promotion and growth of renewable energy sources and systems, Progress project,

[5] DEDIS - Data Base of European DER Interconnection Specifications http://www.der-lab.net/

[6] Presentation of Volker Wachenfeld, SMA; *Towards a Harmonized European Grid Code* during Sunrise project event*: PV network integration: challenges and opportunities,* 13th February 2009.

[7] *Key needs, priorities and framework for the development of a common European pre-standard on DER interconnection, DER-lab,* http://www.der-lab.net/

[8] *Agency for the Cooperation of Energy Regulators*: http://euroalert.net/en/news.aspx?idn=9034

[9] *Draft Guidelines for Good Practice (GGP) on Grid Connection and Access* http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/GGP%20Electricity%20Grid%20connection%20%20Access/CD

[10] European Energy Regulators - CEER & ERGEG www.energy-regulators.eu

[11] EPIA's reply to ERGEG's public consultation http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/GGP%20Electricity%20Grid%20connection%20%20Access/RR

[12], COM(2009) 192 final, April 2009

Other sources of information:

- *Large scale integration of wind energy in the European power supply: analysis, issues and recommendations, EWEA www.ewea.org*
- *European Commission CORDIS http://cordis.europa.eu/home_en.html*
- *European Photovoltaic Industry association EPIA www.epia.org*