STARGRID Workshop
"Distributed Energy Resources Integration Recommendations"

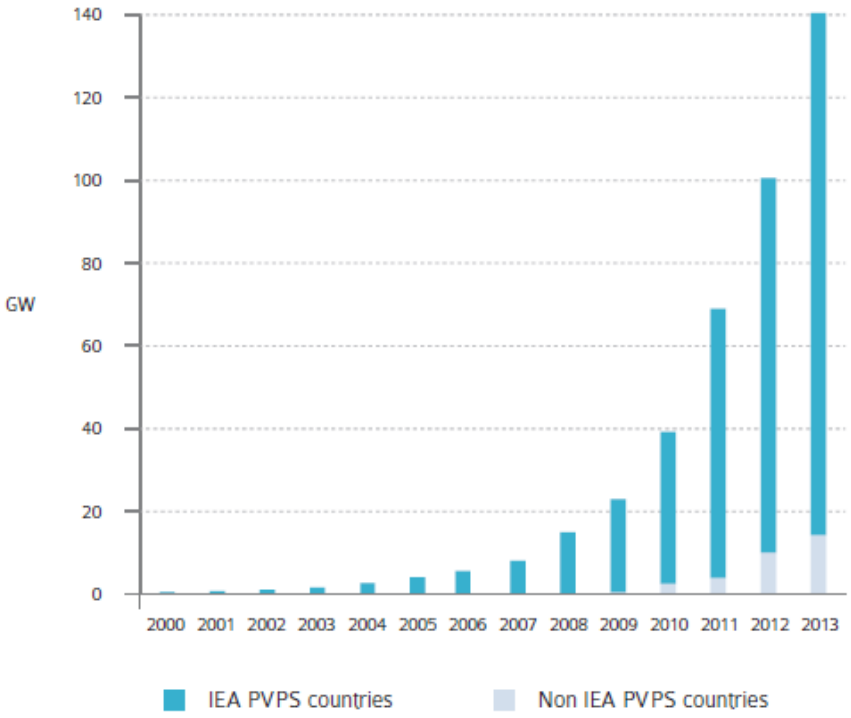
Giorgio Franchioni (RSE)

Brussels, January, 23rd 2015

Contents

- DER Integration and the electric system: problems and opportunities
- The need of regulations – standards –procedures
- Discrepancies at EU level
- Position and concerns by stakeholders
- STARGRID Recommendations
- Expected Impact
- Conclusions

DER Integration: the dimensions of a phenomenon



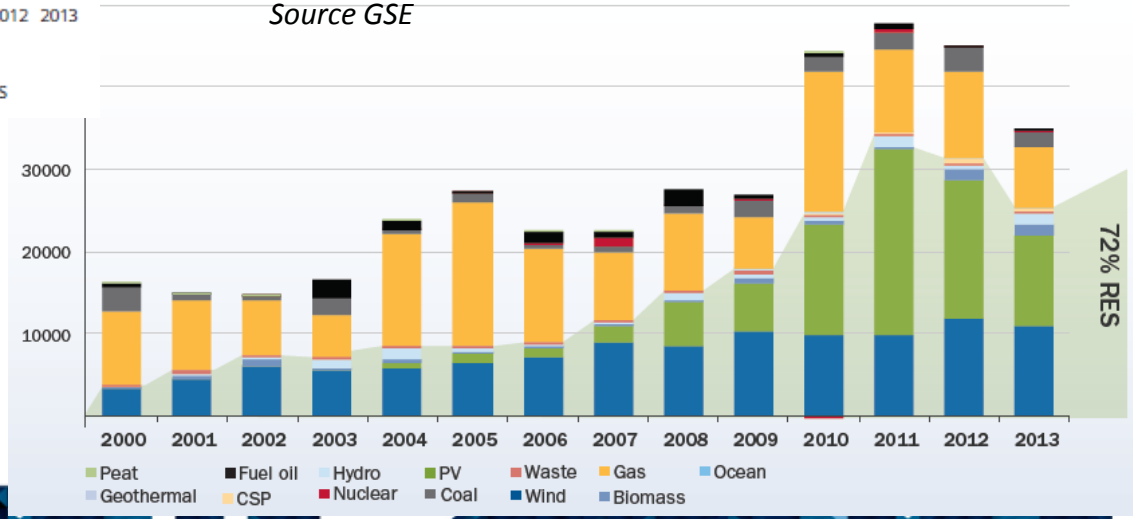
Classi di potenza (kW)	2013 n°	2013 MW
1<=P<=3	192.252	531,3
3<P<=20	341.640	2.691,7
20<P<=200	45.694	3.599,9
200<P<=1.000	10.326	7.142,0
1.000<P<=5.000	935	2.297,3
P>5.000	182	1.790,8
Totale	591.029	18.053,0

PV installations in Italy

Source GSE

Evolution of PV installations in EU

Source IEA



Evolution of the energy Mix in EU

Source EWEA

Impact of massive DER integration

Energy Revolution Hiccups: Grid Instability Has Industry Scrambling for Solutions

By Catalina Schröder

Sudden fluctuations in Germany's power grid are causing major damage to a number of industrial companies. While many of them have responded by getting their own power generators and regulators to help minimize the risks, they warn that companies might be forced to leave if the government doesn't deal with the issues fast.

August 16, 2012 – 06:00 PM

Print | Send | Feedback

+1

FROM DER SPIEGEL

DPA

Even a millisecond in voltage fluctuation can cause major damage at large industrial firms.

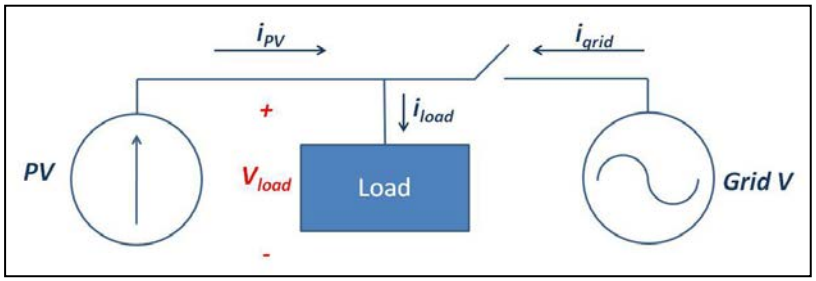
Dramatic increase of risk for:

- Short interruptions of supply
- Service failures
- Production stoppages
- Economic losses

Main problems with operation of distribution grid:

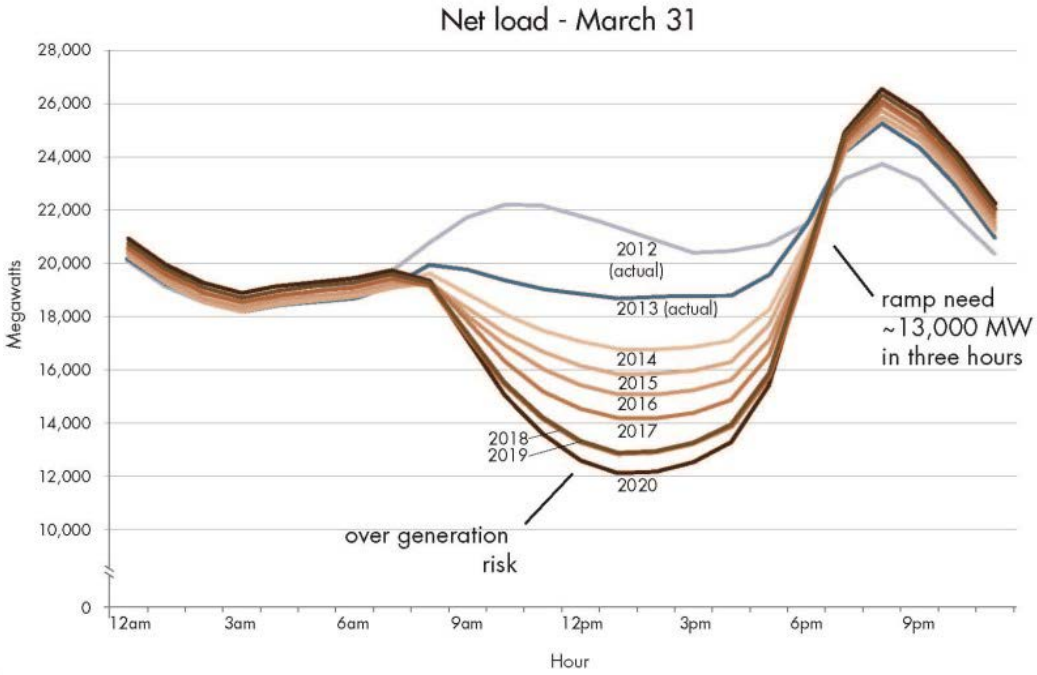
- Voltage variations (fluctuations, harmonics, flickers) -> poor quality, overcoming of limits
- Congestions and Exceeding hosting capacity –> Losses increase, interruptions, curtailments
- Repercussion on transmission grid -> Frequency/Voltage instability
- Problematic management of reserve

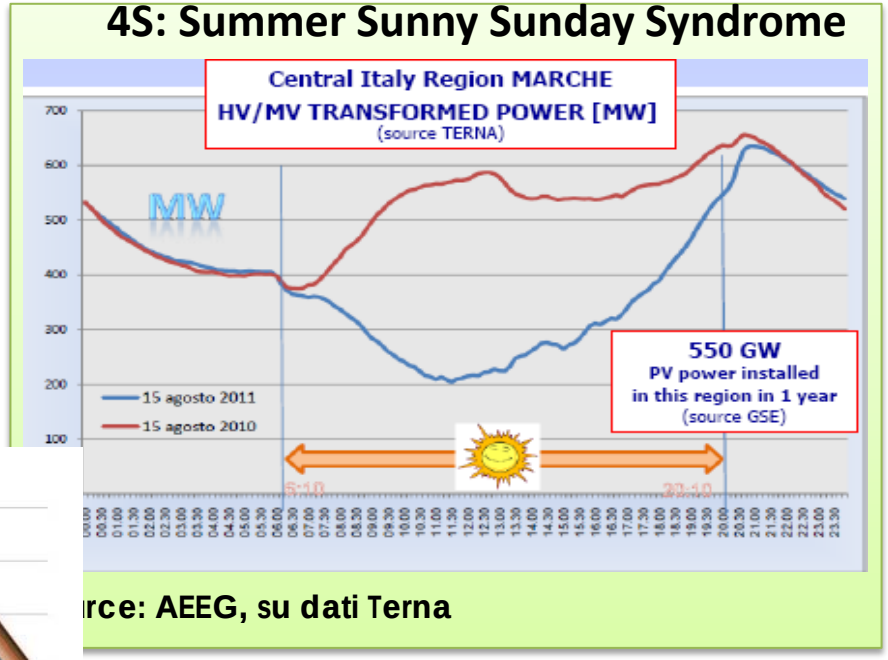
A number of related issues



Unintentional islanding

Source: EPRI





In Italy…

In USA…

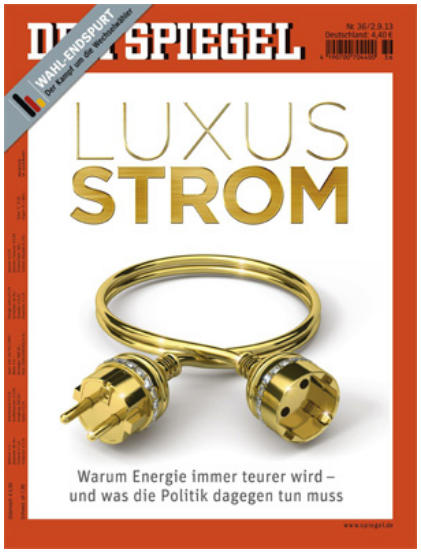
The “duck curve”: The Changing Net Load Pattern

Source Olivine for California

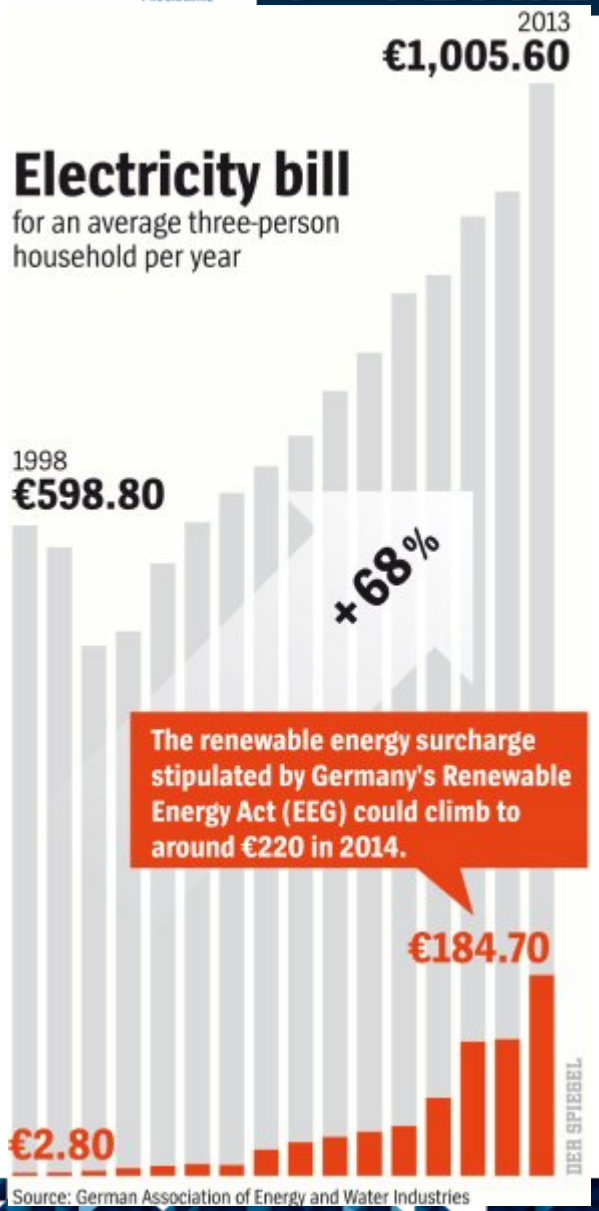
…not only in Italy

SPIEGEL ONLINE

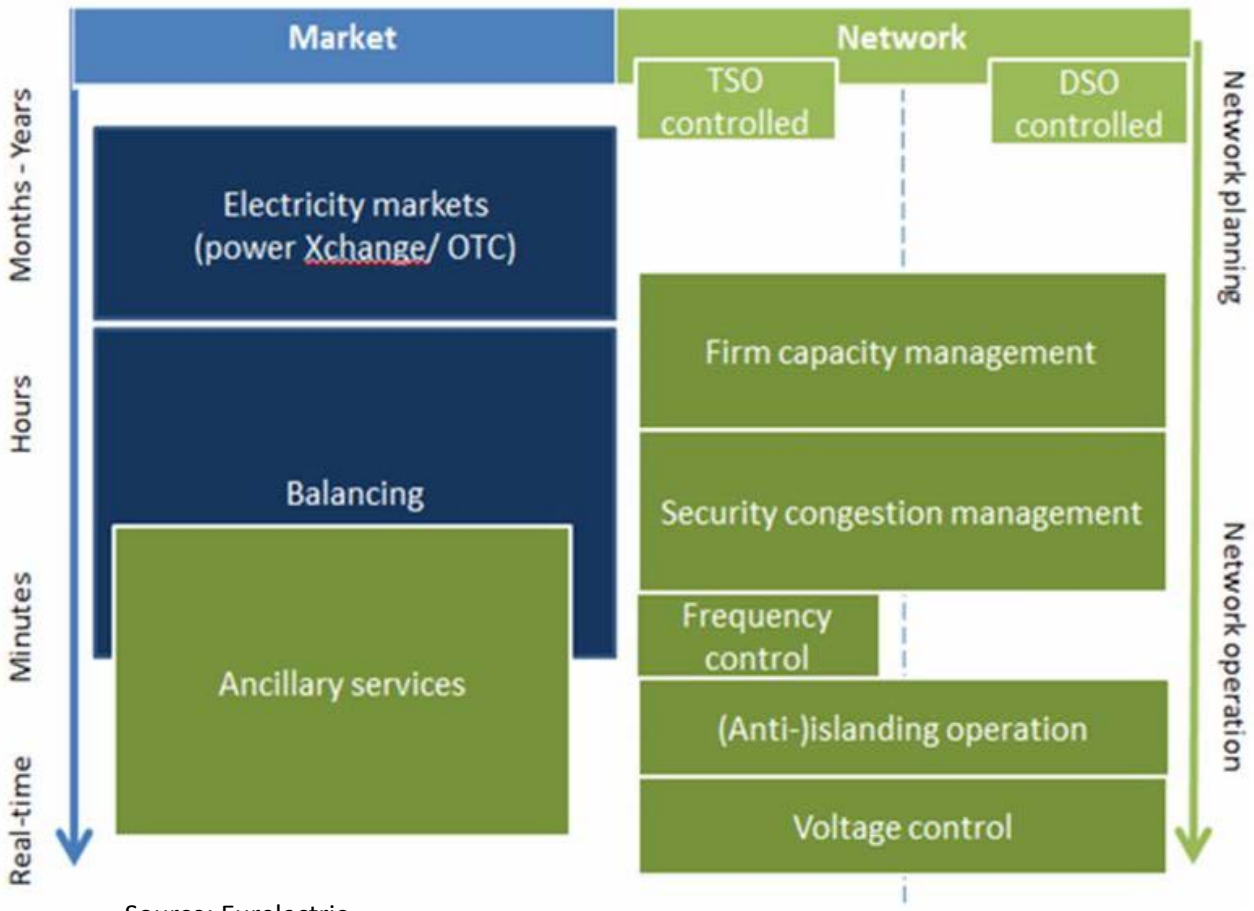
"This is one of the most curious developments in the story of German energy reform. The country's most heavily polluting plants are now also its most profitable: old and irrelevant brown coal power stations. Many of the plants are now running at full capacity.



This leaves a dirty stain on Germany's environmental statistics. While the amount of electricity from renewable energy rose by 10.2 percent in 2012, the first year of the new energy policy, the amount of electricity generated in hard coal and brown coal plants also increased by 5 percent each. As a result, German CO2 emissions actually increased by 2 percent in 2012."



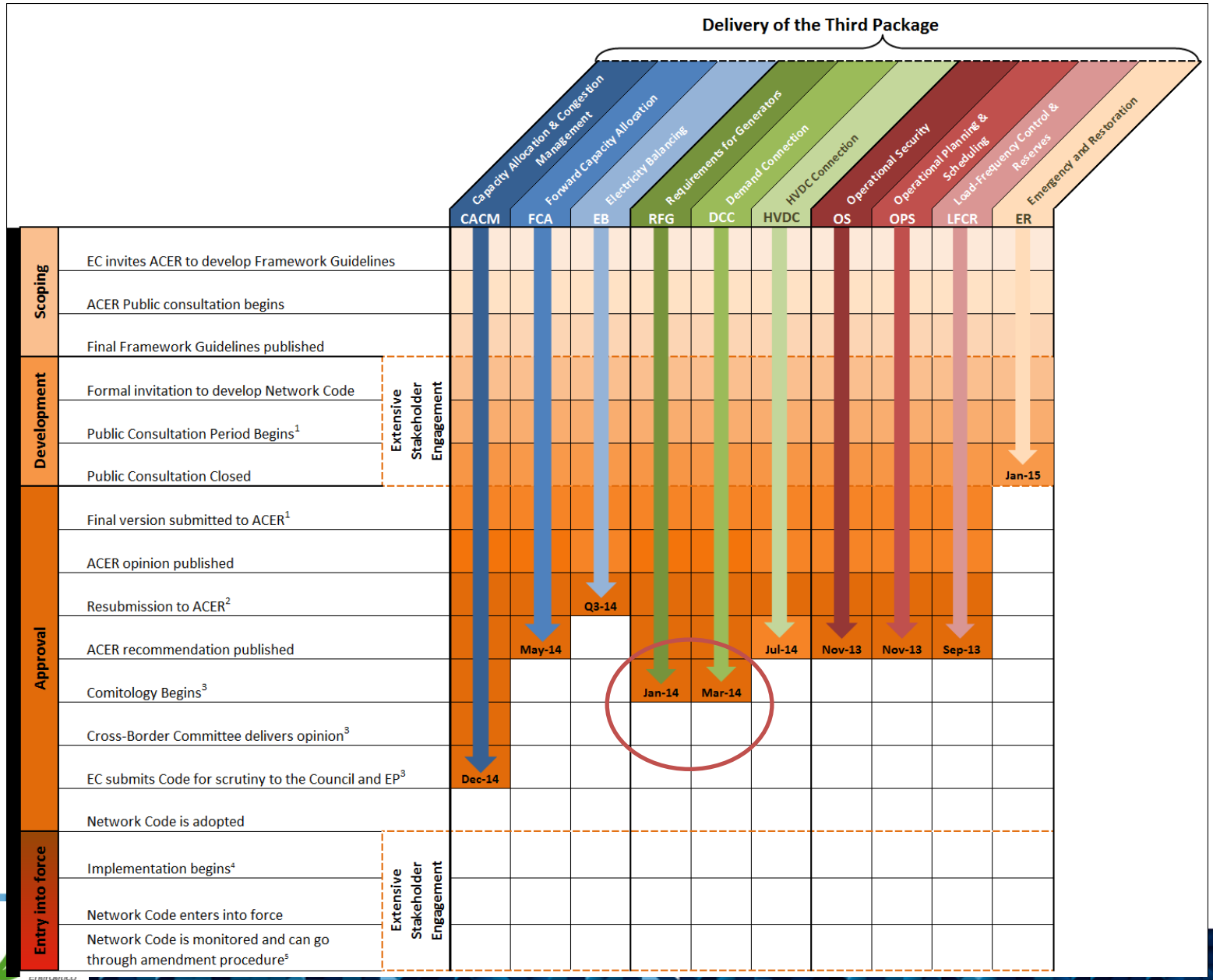
But also opportunities



Source: Eurelectric

- ***Contribution of DERs in the management and control operations***

Need of Regulation: the Network Codes



The RfG Network Code and Guidelines

entsoe
Reliable Sustainable Connected

ENTSO-E Network Code for

Requirements for Grid Connection Applicable to all Generators

8 March 2013

European Network of Transmission System Operators for Electricity
entsoe

IMPLEMENTATION GUIDELINE FOR NETWORK CODE "Requirements for Grid Connection Applicable to all Generators"

16 October 2013

Requirement	type	Type A	Type B	Type C	Type D
FREQUENCY RANGES	Frequency stability	X	X	X	X
LIMITED FREQUENCY SENSITIVE MODE (OVERFREQUENCY)	Frequency stability	X	X	X	X
RATE OF CHANGE OF FREQUENCY WITHSTAND CAPABILITY	Frequency stability	X	X	X	X
CONSTANT OUTPUT AT TARGET ACTIVE POWER	Frequency stability	X	X	X	X
MAXIMUM Active POWER REDUCTION AT UNDERFREQUENCY	Frequency stability	X	X	X	X
AUTOMATIC CONNECTION	Frequency stability	X	X	X	X
REMOTE SWITCH ON/OFF	Frequency stability	X	X		
ACTIVE POWER REDUCTION	Frequency stability		X		
ACTIVE POWER CONTROLLABILITY AND CONTROL RANGE	Frequency stability			X	X
DISCONNECTION OF LOAD DUE TO UNDERFREQUENCY	Frequency stability			X	X
FREQUENCY RESTORATION CONTROL	Frequency stability			X	X
FREQUENCY SENSITIVE MODE	Frequency stability			X	X
LIMITED FREQUENCY SENSITIVE MODE (UNDERFREQUENCY)	Frequency stability			X	X
MONITORING OF FREQUENCY RESPONSE	Frequency stability			X	X
FAULT RIDE THROUGH CAPABILITY OF GENERATORS CONNECTED BELOW 110 kV	Robustness of Generating Units		X	X	
CONTROL SCHEMES AND SETTINGS	General system management		X	X	X
INFORMATION EXCHANGE	General system management		X	X	X
PRIORITY RANKING OF PROTECTION AND CONTROL	General system management		X	X	X
TRANSFORMER NEUTRL-POINT TREATMENT	General system management			X	X
CHANGES TO/MODERNISATION OR REPLACEMENT OF EQUIPMENT OF GENERATING UNITS	General system management			X	X
ELECTRICAL PROTECTION SCHEMES AND SETTINGS	General system management		X	X	X
INSTALLATION OF DEVICES FOR SYSTEM OPERATION AND/ OR SECURITY	General system management			X	X
INSTRUMENTATION FOR FAULT AND DYNAMIC BEHAVIOUR RECORDING	General system management			X	X
LOSS OF STABILITY	General system management			X	X
RATE OF CHANGE OF ACTIVE POWER	General system management			X	X
SIMULATION MODELS	General system management			X	X
SYNCHRONISATION	General system management				X
AUTO RECLOSURES	Robustness of Generating Units			X	X
STEADY-STATE STABILITY	Robustness of Generating Units			X	X
RECONNECTION AFTER AN INCIDENTAL DISCONNECTION DUE TO A NETWORK DISTURBANCE	System restoration		X	X	X
BLACK START	System restoration			X	X
CAPABILITY TO TAKE PART IN ISOLATED NETWORK OPERATION	System restoration			X	X
QUICK RE-SYNCHRONISATION	System restoration			X	X
HIGH/LOW VOLTAGE DISCONNECTION	Voltage stability			X	
FAULT RIDE THROUGH CAPABILITY OF GENERATORS CONNECTED AT 110 kV OR ABOVE	Robustness of Generating Units				X
VOLTAGE RANGES	Voltage stability				X

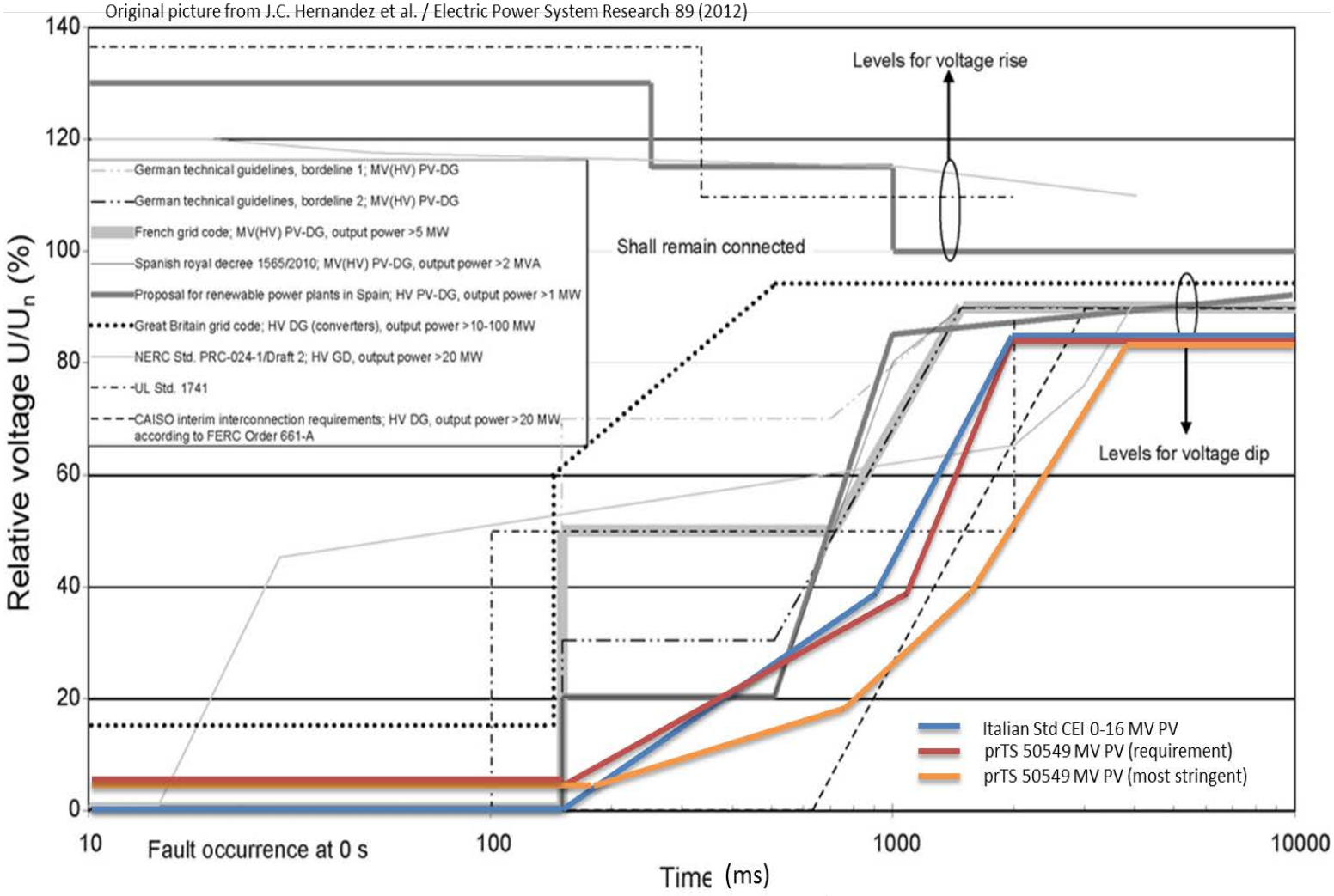
Table 1 - Requirements applicable to all Power Generating Modules

Interconnection standards

	EU Level	National Level	
Energy Authority	ACER	National Authority	...
Network Operator	EU Network Codes for Electricity	Relevant TSO	...
Standardization Organization	EN 50438 TS 50549-1/2	Interconnection Standards	...

Fault-Ride-Through specifications

Original picture from J.C. Hernandez et al. / Electric Power System Research 89 (2012)



Other discrepancies

e.g.

- Categorization of generators and participation in the system
- Protection systems: Settings, Modality of intervention and protocols
- Communication modality
- Considered Operations: e.g. Teledistacco (remote tripping for system balance)

…….

Critical issues from the STARGRID survey

- New requirements impact on design, sizing and life time of products; generate higher costs associated with their implementation and possibly the retrofitting of the current products; weaken the competitiveness.
- Country-by-country discrepancies increase the difficulty
- EU harmonized compliance procedures needed
- Standards for auxiliary power systems are missing

GAPS & Required Actions	OVERALL
Full automation of the distribution grid, to ensure higher efficiency of operation, security, control and quality. Faults detectors will enhance operation and reduce shutdown times	4,26
Electrical connections and operation rules of DERs should be harmonized within Europe.	3,93
Communication protocols as well as information data models for control center <-> DER communication have to be harmonized	3,82
Installation rules of DER should be adapted to allow for new ways of operating grids, such as islanding. E.g. safety issues have to be covered for all kind of operation and plant technology	3,76
A single communication protocol for the remote control of DERs should be imposed in interconnection rules, to ensure interoperability.	3,62

- Interoperability related issues still open
- A transparent approach is necessary, to guarantee open access to the energy market
- Security, privacy and data access and protection are issues to be solved

STARGRID MAIN RECOMMENDATION

To Standardization Organizations and Regulation authorities

R6: Foster the coherent harmonization of the regulations/standards framework ensuring effective, transparent and economically fair integration of DER in Smart Grids

- Use European standards to provide guidance for a progressive alignment of the national legal frameworks avoiding product variance and facilitating further deployment of DER.
- The standardization New Approach is suitable to the scope. The opportunity of elaborating EN 50438 and coming TS 50549 1-2 so as to be part of a set of Harmonized standards could be explored.
- For requirements and specifications refer to existing or upcoming European and international standards (IEC, IEEE)

Ancillary recommendations - 1

To Regulation authorities and Standardization organisms mainly

- Take care of prosumers equipped with small and low cost equipment when elaborating regulation and standards, to foster their integration, compatibly with the system operation needs.
- Use cost-effectiveness criteria related to the typology of equipment, consider possible retrofitting needs in relation to the life cycle of the equipment.

- Take advantage of EU funded projects to develop “system studies” on DER integration and relevant service capacity.

Ancillary recommendations - 2

To Standardization Organization mainly

- Complete pro-actively the standards framework, including new needs coming from the extended integration of DERs at LV grid level, e.g. concerned with the monitoring.

- Upgrade the standardization process, so as to foster a more active, skill and conscious participation of stakeholders and to allow a more deep and extended consultation (see R5).

- Foster a closed collaboration of TSO and DSO in standardization to optimize the development of products and reduce their costs.

- Foster a mutual acknowledgment system, based on EU standards, for conformance testing related to Smart Grid and DER integration to promote competitiveness of industry and enhance the quality of products

Expected impact

- Harmonization of regulation and standardization frameworks.
- A more complete and coherent standard framework (e.g. including requirements and provisions for the LV grid)
- Progressive alignment of country connection requirements, based on agreed EU standards (however accounting of country-specific restraints). Filling the lack of missing standards in some countries.
- More closed cooperation of actors, with main focus on agreements about DER integration needs (monitoring, compliance, access to data, services related to DER categorization and typology, communication protocols etc.)
- Improved quality of products and containment of costs as an effect of a more closed cooperation of actors for standardization
- Better matching of compliance/conformance test requirements with laboratories capacity.
- Mutual acknowledgement for compliance/conformance by test laboratories will impact on competitiveness of products and producers.

Considering the timing of the evolution of the Smart Grid system, including standardization, full harmonization of regulation and standards is deemed a medium-term objective (2020). However some steps, e.g. conditions for closer cooperation of actors, could be completed in shorter timing (2016)

Conclusions

- DER integration is a very actual and crucial problem of the energy system
- It is also the pre-requisite for the evolution of the system towards the Smart Grid and an opportunity
- STARGRID Survey showed that discrepancies and lacks in standardization have to be urgently solved as they are creating concerns among the stakeholders for impact on costs, design of products, conformance tests and access to the energy market

Main Recommendation from STARGRID:

R6: Foster the coherent harmonization of the regulations/standards framework ensuring effective, transparent and economically fair integration of DER in Smart Grids

Thank you
of your attention

STARGRID.EU

RSE Ricerca Sistema Energetico

Giorgio Franchioni
RSE SpA
Milan
Tel: 0039 02 3992 4541
Giorgio.franchioni@rse-web.it