Netzanschlussregeln und Verbindungsstandards – eine wichtige Voraussetzung für hohe Photovoltaikdurchdringung
Zusammenfassung der Ergebnisse des IEA-PVPS Task 14

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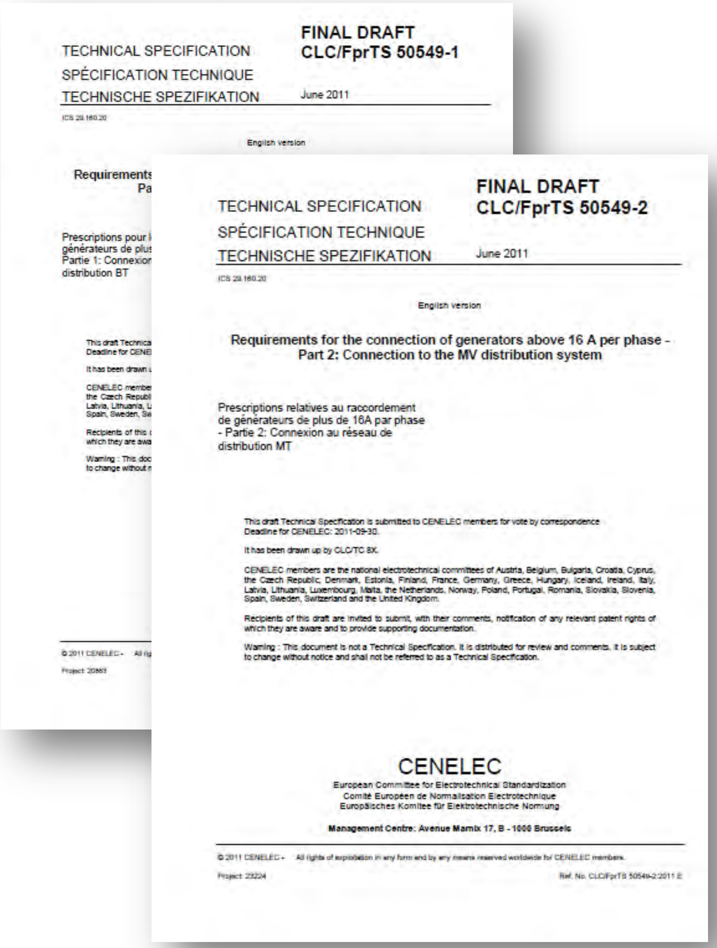
FINAL DRAFT
CLC/FprTS 50549-1

TECHNICAL SPECIFICATION
SPÉCIFICATION TECHNIQUE
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June 2011

English version

FINAL DRAFT
CLC/FprTS 50549-2

TECHNICAL SPECIFICATION
SPÉCIFICATION TECHNIQUE
TECHNISCHE SPEZIFIKATION

June 2011

ICS 29.160.20

English version

Requirements for the connection of generators above 16 A per phase - Part 2: Connection to the MV distribution system

Prescriptions relatives au raccordement de générateurs de plus de 16A par phase - Partie 2: Connexion au réseau de distribution MT

This draft Technical Specification is submitted to CENELEC members for vote by correspondence
Deadline for CENELEC: 2011-09-30.

It has been drawn up by CLC/TC 8X.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the 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 and the United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a Technical Specification. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a Technical Specification.

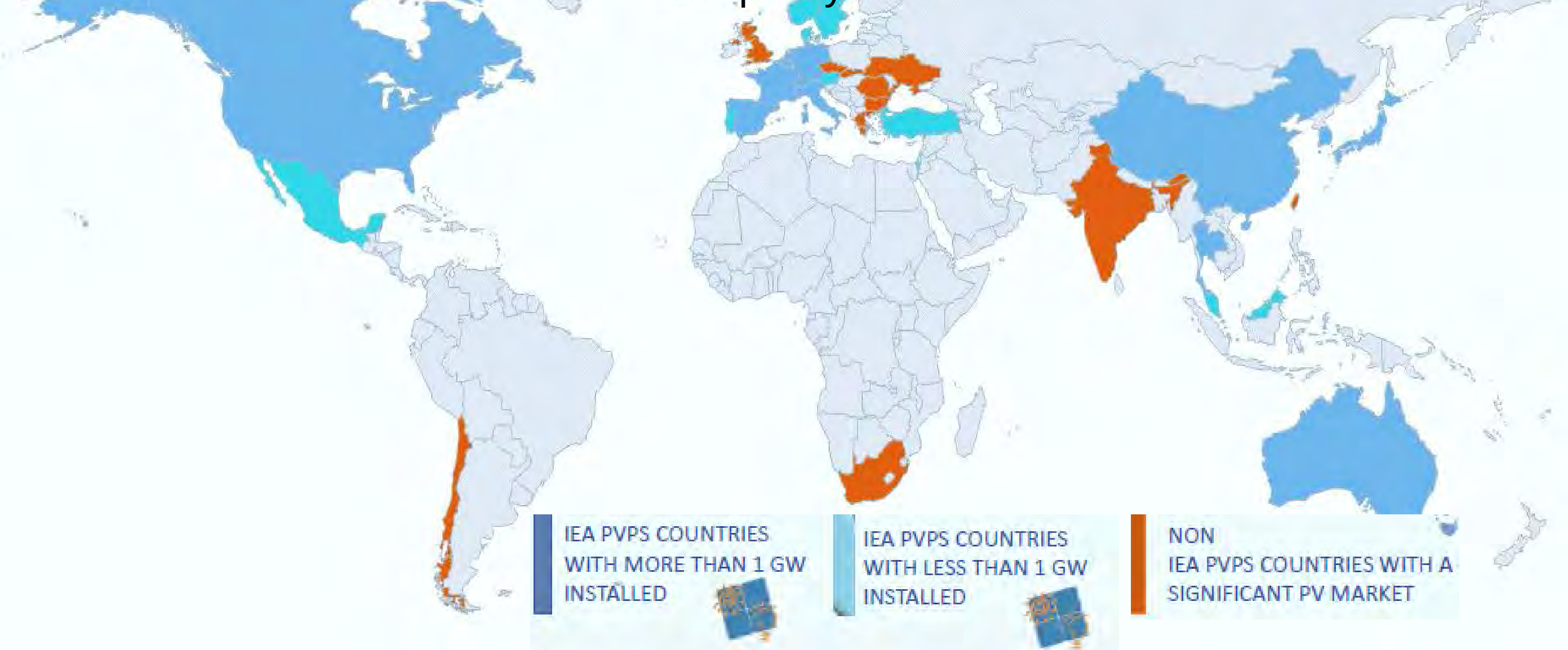
CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Project 23224 Ref. No. CLC/FprTS 50549-2:2011 E

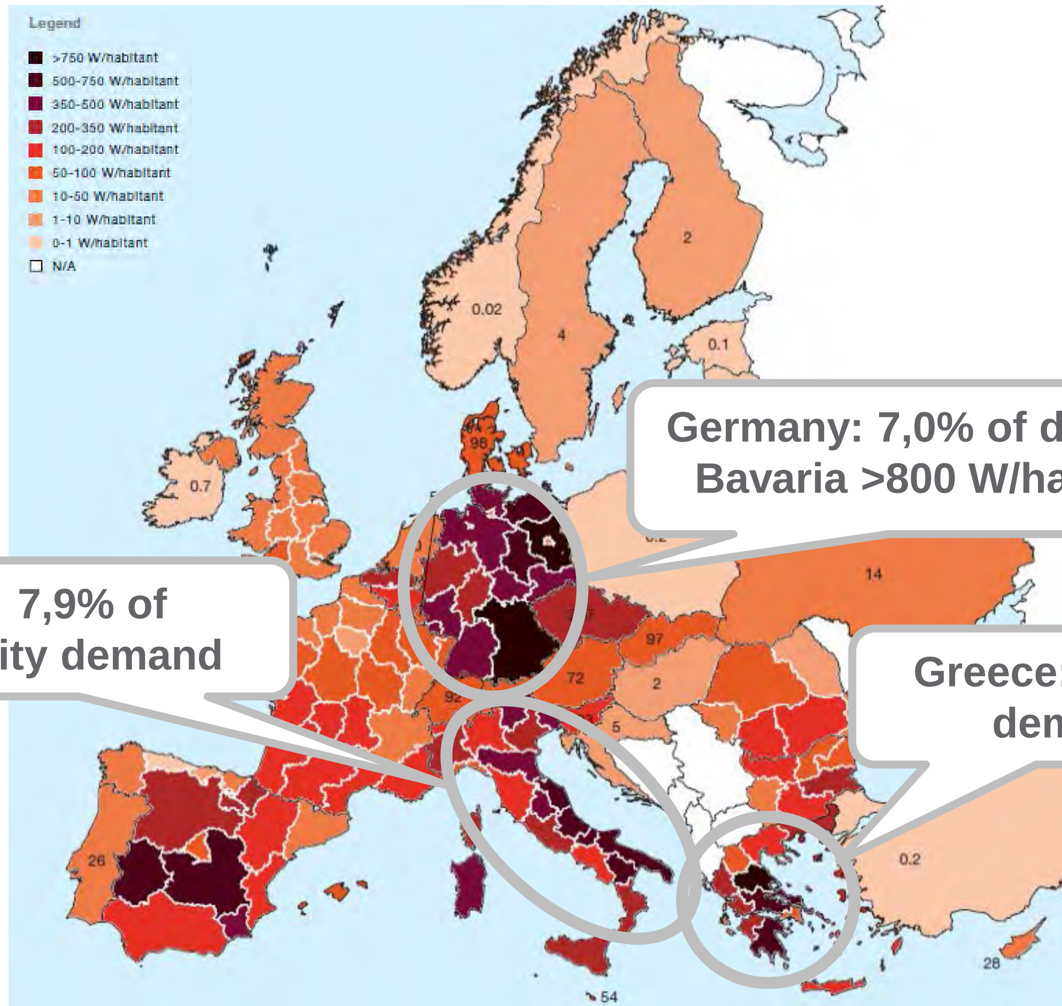
High Penetration of PV in Electricity Grids
A global trend

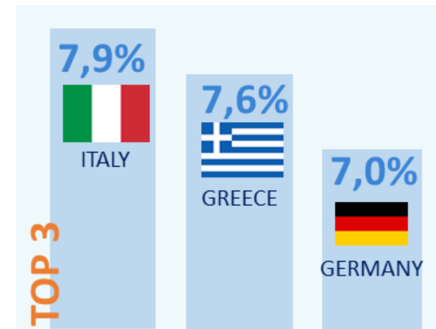
- 177 GW installed worldwide at the end of 2014
- PV penetration levels growing worldwide (+38.7 GW in 2014)
- 20 countries with installed PV capacity of more than 1 GW



(source IEA-PVPS snapshot of global PV markets)

Europe leading integration of High Penetration of PV in the electricity system





Germany: 7,0% of demand, Bavaria >800 W/habitant

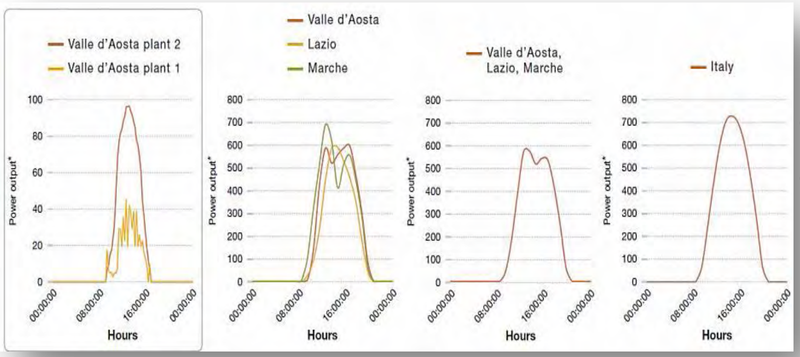
Italy: 7,9% of electricity demand

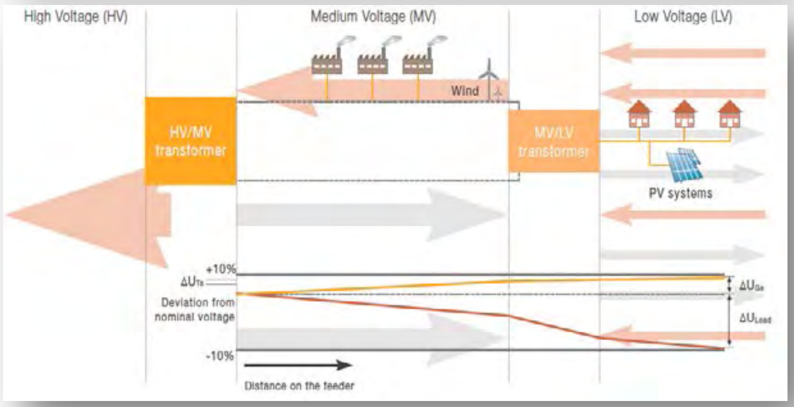
Greece: 7,6% of demand

(Source: EPIA-Global Market Outlook 2014-2018)

High Penetration PV in electricity grids
Key Integration Challenges

- PV integration challenges in the <u>overall power system</u>
  - Managing variability
  - Ensuring security of supply
  - Matching supply and demand
  - Ensuring frequency stability
- PV integration challenges on the <u>local distribution level</u>
  - Managing voltage profiles
  - Avoiding overloading of components
  - Transforming passive to active grids
  - Integrating PV in Smart Grids





Source: EPIA, "Connecting the sun"

Task 14: Overall objectives of this international collaboration

- *Promote the use of grid connected PV* as an important source in electric power systems also on a high penetration level where additional efforts may be necessary to integrate the dispersed generators in an optimum manner.
- *Develop and verify mainly technical requirements for PV* and electric power systems to allow for high penetrations of PV systems interconnected with the grid
- Discuss the *active role of PV systems* related to energy management and system control of electricity grids
- *Reduce the technical barriers* to achieve high penetration levels of distributed renewable energy systems on the electric power system

Task 14: Overall objectives of this international collaboration

- *Discuss the market implications of technical solutions* for the integration of PV at high penetration levels
- *Discuss and develop new solutions for operation and grid planning* for High PV Penetration scenarios
- *Re-think existing rules-of-thumb and practices* with respect to their validity with high-penetration PV
- *Discuss the opportunities for PV to provide advanced grid support services* for local as well as system wide use.
- Discuss the possible *role of PV in a future Smart Grid*

IEA PVPS Task 14:
A global network, led by Austria

16 Countries

Broad expertise

Participants from

- Utilities, DNOs
- Industry, manufacturers, consultancies
- Applied research
- Universities
- Agencies

- List of contacts: Link

Industry association

European commission

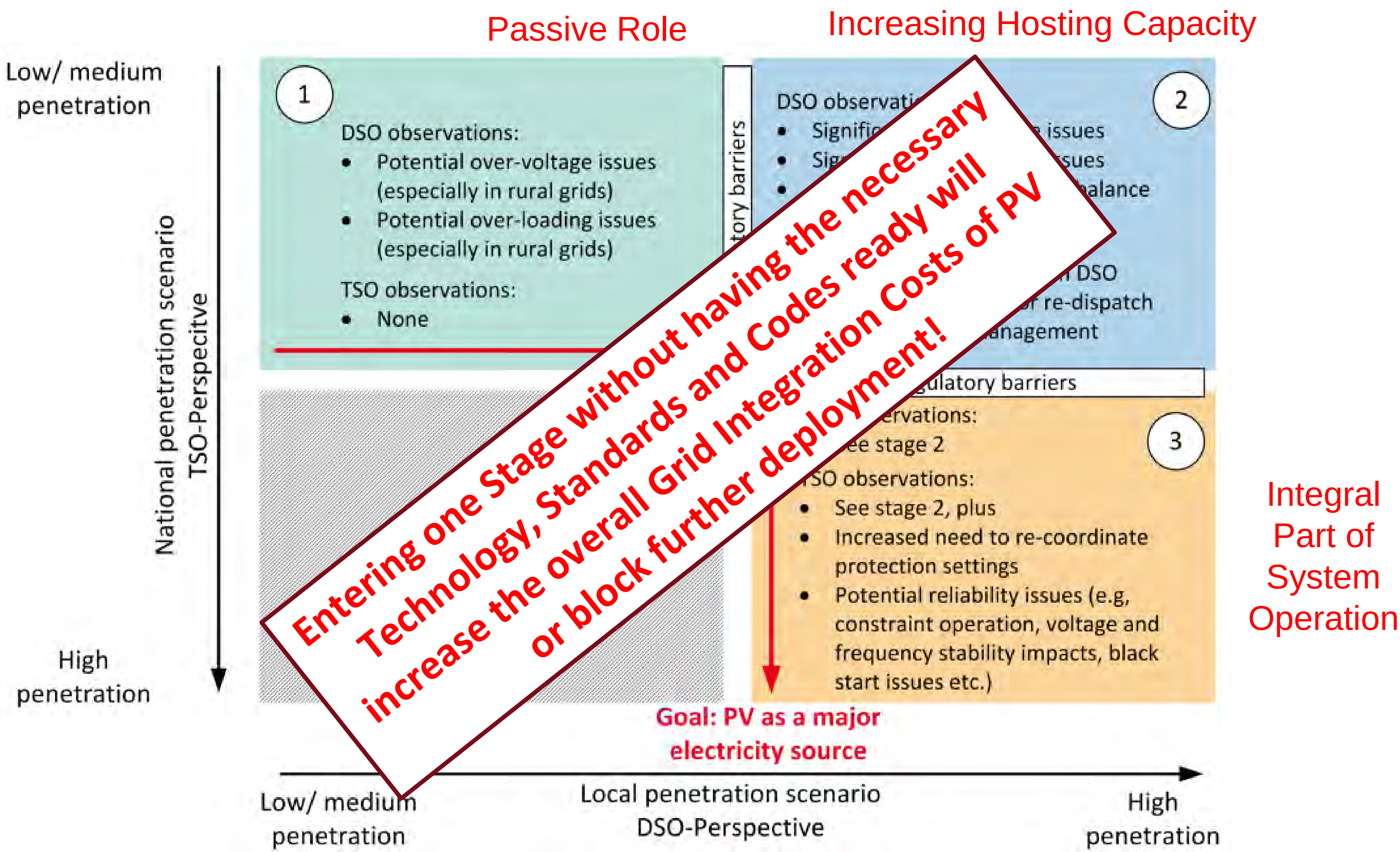
Candidate countries

IEA PVPS Task 14
Organization and structure

IEA PVPS Task 14:
Outcomes

- Support PV integration on high penetration levels by
  - access to more transparent technical analyses
  - guidelines and best practices for industry, network operators, energy planners as well as authorities in the energy business
  - comprehensive international studies for high penetration PV
- Develop key methodologies for large scale PV integration
  - PV Power Forecast
  - Active management and control of grid integrated PV
  - Grid interconnection studies and planning
  - **Technical standards and interconnection requirements**
- Active dissemination of objective and neutral high-quality information
  - Task 14 Reports & Workshops
  - National information networks of Task 14 members

High Penetration Integration Model developed in PVPS Task 14



IEA PVPS Task 14 ST2

Negative example: 50,2 Hz issue in Germany

- In the early 2000s, PV growth potential was not taken seriously by the responsible TSOs and DSOs in Germany
  - Philosophy: Small scale PV systems should behave passively and disconnect from grid at first sign of trouble
  - Standard requirement to set over-frequency protection of LV connected PV to 50.2 Hz
- The problem: In 2012, already 12.700 MW installed PV capacity (with 50.2 Hz setting) had been installed. However, the primary frequency reserve of whole continental Europe is only 3.000 MW
  - In a case of over-frequency event (f>50.2 Hz) up to 12.700 MW PV power could be lost, due to the fixed threshold value of 50.2 Hz → Danger for system stability
  - Retrofitting of about 9.000 MW installed PV capacity within three years (2012 – 2015) - In total about 300.000 individual PV systems

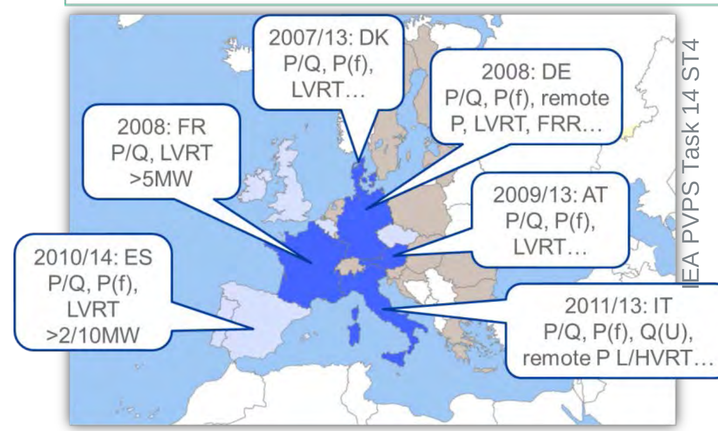
Task 14 work on Technical standards, grid codes and interconnection requirements

- Research and Investigations
  - What are the specific requirements for grid support by PV in certain countries?
  - Are these compatible with requirements with High-Pen PV?
  - How to they need to be adapted to accommodate High Pen PV
- Share experiences with local stakeholders
  - Inform them on necessary adaptations of local standards and codes Provide local Task 14 members working in grid code development with best practice examples from Task 14 member countries

➔ Support local grid code development process by dissemination and awareness raising activities

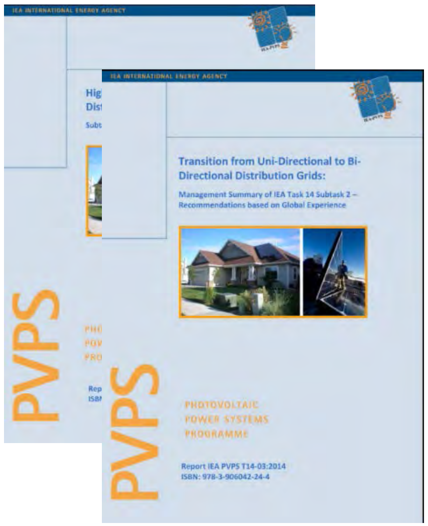
Country	Europe (≤16 A)	Germany	Italy	Austria	France	Spain	Europe (≤16 A)	Europe (>16 A)
Function	2007	2011	2012	2013	2013	11/14	2013	2014

Country	Germany	Italy	Austria	France	Spain	Europe	ENTSO-E
Function	2008	2012	2013	2013	2010	2014	2013
P at low f	yes	yes	yes	>5MW	No	yes	Yes ABCD
P(f)	yes	yes	yes	No	>2/10MW	yes	Yes ABCD
Q/cosφ	yes	yes	yes	Yes	>2/10MW	yes	Yes BCD
Q(U)	optional	yes	optional	No	No	yes	yes BCD
Remote P	>100kW	yes	>100kW	No	>2/10MW	yes	yes BCD
Rem. trip	optional	yes	No	No	No	yes	yes ABCD
LVRT	Yes	yes	Yes	>5MW	>2MW	yes	yes BCD
HVRT	No	yes	No	No	No	yes	No
	BDEW MV Guideline (2008)	CEI 0-16:2012	TOR D4:2013	Arrêté du 23 avril 2008	P.O.12.3:2006 P.O.12.2: RD1565:2010 UNE 206007-2 IN:2014	FprTS 50549-2	Final Version RfG 2013



Task 14 work on Technical standards, grid codes and interconnection requirements

- Reports:
  - Recommendations for managing the transition from One-Directional to Bi-Directional Distribution Grids
  - State-of-the-Art and advanced solutions for the transition of local distribution grids
- Task 14 utility workshops – >500 participants
  - 12 workshops since 2010
  - Joint workshops with other IEA IAs
- Keynote and invited talks by Task 14 experts
  - International conferences
  - European events
  - >15 presentations in 2014-2015 alone
- Active support to Austrian national standardization (e-Control, OVE)



Source: IEA PVPS Task 14

Standards and grid codes – a key requirements for the successful integration of high pen PV

- With PV and other RES changing from a marginal technology to a visible player in the electricity market, appropriate standards and codes are urgently needed
- Numerous countries already implemented advanced functionalities of DER in their national grid codes and require DER to provide
  - Steady state and dynamic voltage support
  - Frequency control capabilities
  - On-demand response via remote control and communication
- Coordinated requirements needed for safe and reliable grid integration
- IEA-PVPS Task 14, led by AIT, Austria supports this development by
  - International collaboration
  - Research
  - Dissemination and awareness raising

Thank you for your attention

Task 14 Publications: http://www.iea-pvps.org/index.php?id=58
Task 14 Workshops: http://www.iea-pvps.org/index.php?id=323

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Selected European Country Requirements LV Connection

Country	Europe (≤16 A)	Germany	Italy	Austria	France	Spain	Europe (≤16 A)	Europe (>16 A)
Function	2007	2011	2012	2013	2013	11/14	2013	2014
P at low f	No	Yes (all)	Yes (all)	Yes	No	No	Yes	Yes
P(f)	No	Yes (all)	Yes (all)	Yes	Yes*	No	Yes	Yes
Q/cosφ	No	**>3.68kVA**	>3 kVA	**>3.68kVA**	No	No	Yes	Yes
Q(U)	No	No	>6 kVA	Yes*	No	No	Yes	Yes
P(U)	No	No	Optional	Yes*	No	No	No	Optional
Remote P	No	>100kW	>3 kVA	>100kW	No	No	No	Yes
Rem. trip	No	No	Yes	No	No	No	No	Yes
LVRT	No	No	>6 kVA	No	No	No	No	Yes
HVRT	No	N/A	No	No	No	No	No	Yes
Reference	EN 50438 2007	VDE AR N 4105: 2011	CEI 0-21:2014	*TOR D4:2015 (not yet published)	* ERDF-NOI-RES_13E Version 5 - 30/06/2013	RD 1699/2011 206007-1 IN:2013	EN 50438 2013	FprTS 50549-1:2014

Selected European Country Requirements MV Connection

Country	Germany	Italy	Austria	France	Spain	Europe	ENTSO-E
Function	2008	2012	2013	2013	2010	2014	2013
P at low f	yes	yes	yes	>5MW	No	yes	Yes ABCD
P(f)	yes	yes	yes	No	>2/10MW	yes	Yes ABCD
Q/cosφ	yes	yes	yes	Yes	>2/10MW	yes	Yes BCD
Q(U)	optional	yes	yes*	No	No	yes	yes BCD
Remote P	>100kW	yes	>100kW	No	>2/10MW	yes	yes BCD
P(U)	No	Optional	yes*	No	No	Optional	No
Rem. trip	optional	yes	No	No	No	yes	yes ABCD
LVRT	Yes	yes	Yes	>5MW	>2MW	yes	yes BCD
HVRT	No	yes	No	No	No	yes	No
	BDEW MV Guideline (2008)	CEI 0-16:2014	*TOR D4:2015 (not yet published)	Arrêté du 23 avril 2008	P.O.12.3:2006; P.O.12.2: RD1565:2010; UNE 206007-2 IN:2014	FprTS 50549-2	Final Version RfG 2013