



International R&D Project Collection – Advanced Cooperation between Distribution and Transmission Network Operation

Outlook IEA PVPS Task 14 Activity 2.7 Report
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PVPS

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Motivation

- Increasing share of distributed energy resources (DER) in the generation portfolio
- PV (partly also Wind) mainly connected to the distribution level in many countries
- Growing need that DER support the bulk power system operation by providing ancillary services and/ or market flexibilities

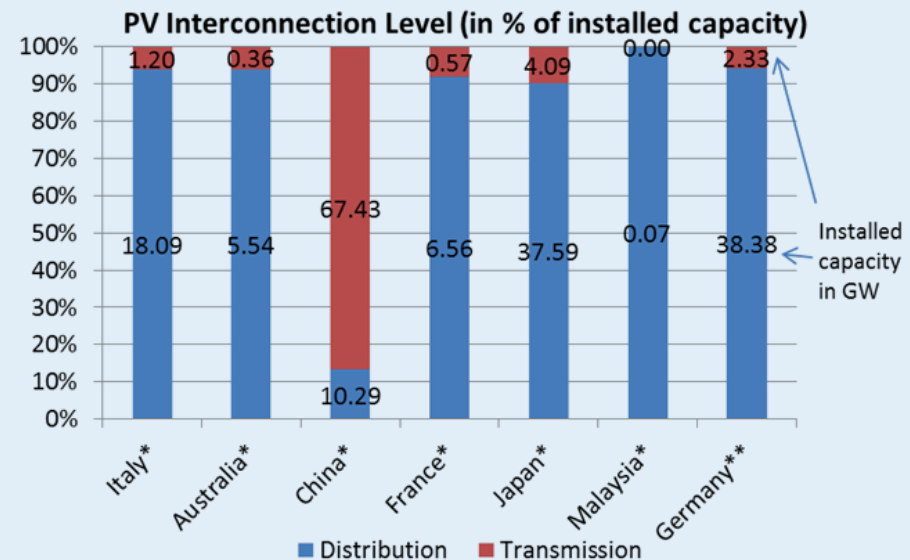


Fig.: Installed PV capacity in the distribution and transmission level for selected countries. (Data source: * National Survey Reports 2016 IEA PVPS, ** Bundesnetzagentur, EEG in Zahlen 2016)

“It is essential to take advantage of the opportunity to harness the valuable and increasing amount of resources at the distribution level (solar panels, wind power, DSR, storage, etc.) for providing services for the overall benefit of the power system.”

European Network of Transmission Systems Operators for Electricity (ENTSO-E: Towards smarter grids: Developing TSO and DSO roles and interactions for the benefit of consumers)

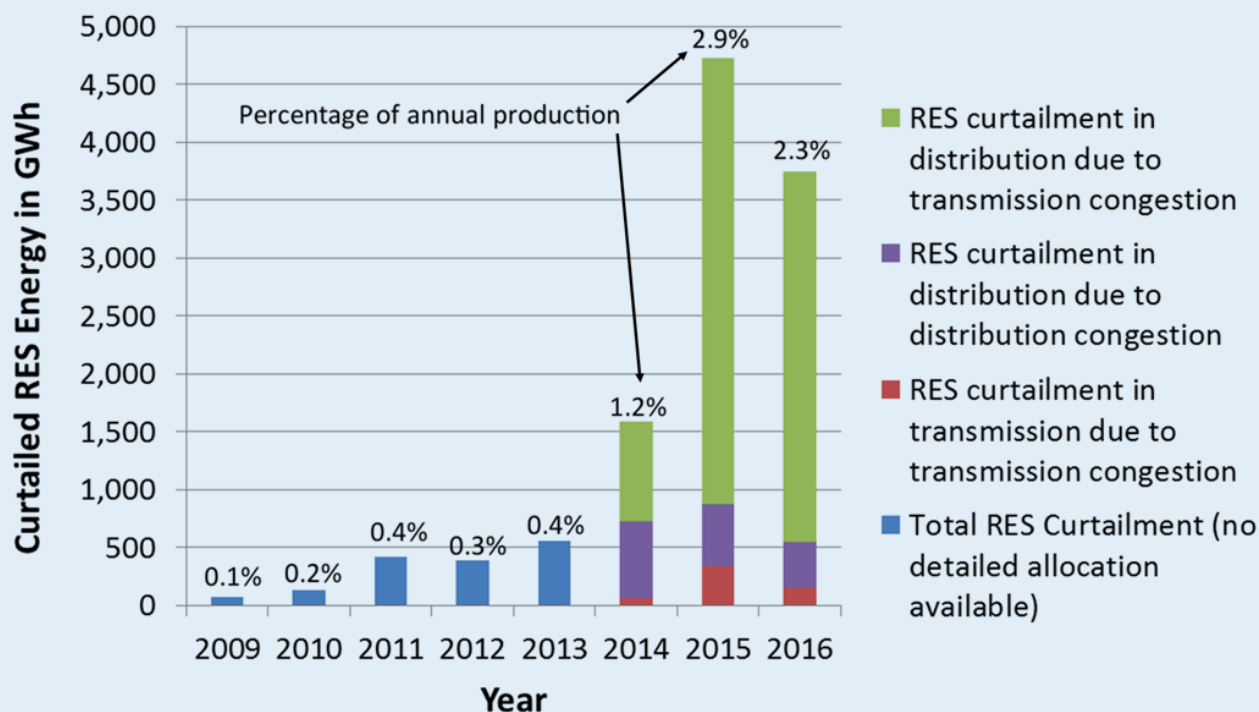




Motivation

Example: Curtailed RES energy from feed-in management in Germany

own diagram, data source: Bundesnetzagentur, EEG in Zahlen 2016



→ Strong TSO/DSO cooperation already required in regions with high DER penetration






Objective Report

- Collection of 19 international R&D projects from the U.S., Europe and Japan with a focus on advanced TSO/DSO cooperation
- Overview on scope, objectives, key findings and recommendations of the identified R&D projects
- Collection of experiences and discussion on the technology readiness level for the provision of ancillary services by PV

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**International R&D Project Collection –
Advanced Cooperation between Distribution
and Transmission Network Operation**

Summary Report of IEA PVPS Task 14 Activity 2.7 on
DSO – TSO cooperation



PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

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TSO/DSO cooperation challenges

TSO/DSO grid operation challenges (see also [3]):

- Congestion management
- Balancing challenge
- TSO/DSO voltage support
- (Anti-) Islanding, re-synchronisation & black-start
- Coordinated protection

Further TSO/DSO cooperation challenges

- Market design & regulatory framework
- ICT infrastructure & protocols
- System modeling and planning aspects

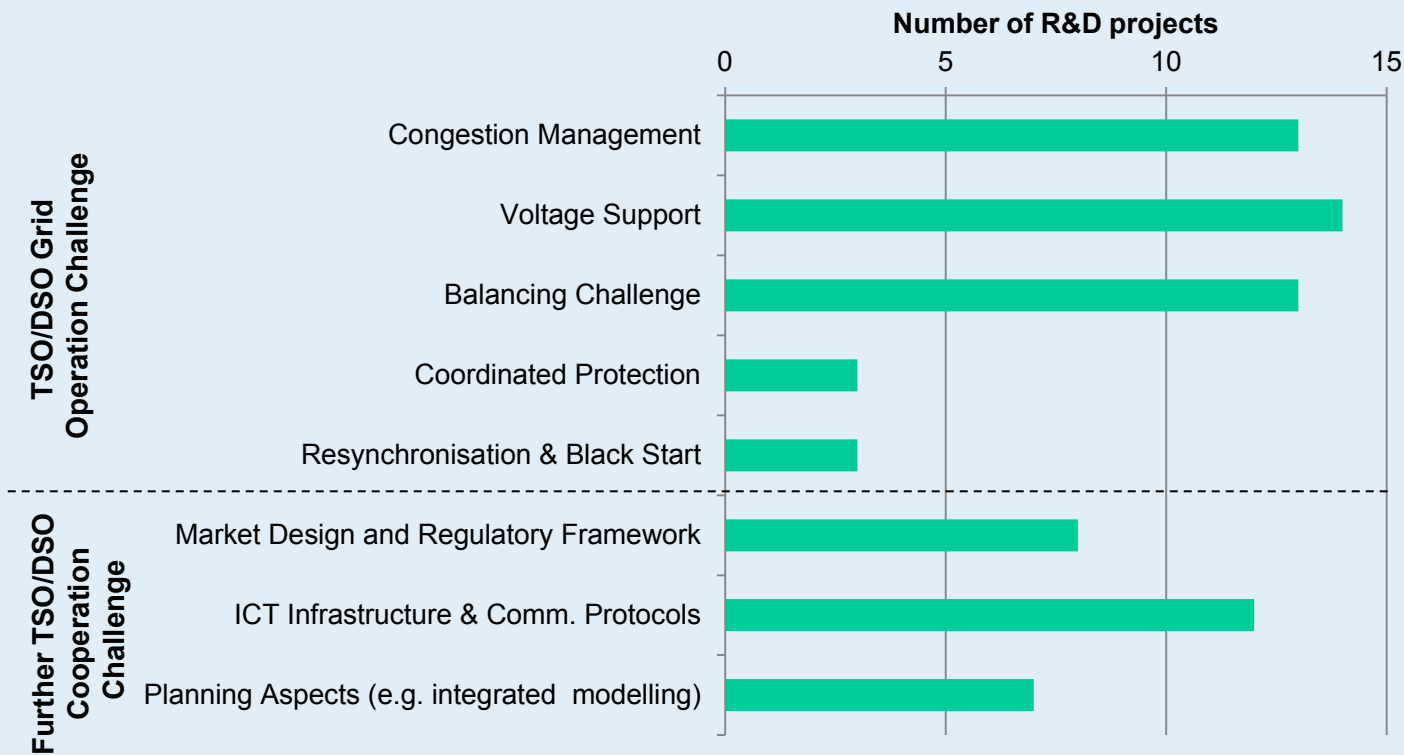
[3] A. Zegers, H. Brunner: TSO-DSO interaction: An Overview of current interaction between transmission and distribution system operators and an assessment of their cooperation in Smart Grids, ISGAN, Sept.2014





TSO/DSO cooperation challenges

Scope of identified 19 R&D projects on advanced TSO/DSO cooperation (multiple scopes per R&D projects possible) (preliminary)





Selected highlights and trends

R&D Status: Bulk system support by DER

- **Congestion management (TSO/DSO):**
 - Partly applied in practice in several countries (see example Germany)
 - Research focus: especially forecasting and optimization of congestion procedures and implementation of congestion procedures in market services
 - *Identified relevant projects: i.e. New 4.0, SmartNet, evolvDSO and SysDL2.0*
- **Voltage support (TSO/DSO):**
 - Overall a relevant DER voltage support potential at the TSO/DSO interface is identified in the investigated projects.
 - In a field test application (Project SysDL 2.0) Wind-DER and PV-DER are actively used to control the Q-exchange at the TSO/DSO interface and to support the voltage control in the transmission level.
 - *Identified relevant projects: i.e. SysDL2.0, Q-Study and VOLATILE.*





Selected highlights and trends

R&D Status: Bulk system support by PV and other DER

- **Balancing challenge:**
 - Economic dispatch of utility-scale PV partly already applied in practice. The provision of frequency control reserves by PV is addressed within R&D projects (i.e. PV-Regel).
 - Research focus: demonstrate controllability and provision of different flexibility services with DER, increasingly also small scale DER (i.e. residential PV) considered
 - *Identified relevant projects: e.g. PV-Regel, SmartNet, PVPT, FutureFlow, CALLIA, Real-time optimization and control of next-generation distribution infrastructure*
- **Grid Restoration:**
 - A rather low technology readiness level is determined for an active support of DER within a grid restoration process
 - R&D project (NETZ:KRAFT) demonstrate, that controllable DER can be used to balance the uncontrolled feed-in of small scale DER and loads and actively support the grid restoration process
 - *Identified relevant projects: e.g. NETZ:KRAFT, IDE4L*





Selected highlights and trends

Automation in the distribution level

- Advanced automation within the distribution level is a key enabler for an advanced TSO/DSO cooperation
- In identified R&D projects focus is set especially on the improvement of system controllability and situational awareness
- Increased focus on reliability aspects in future (system-wide) high DER penetration scenarios expected
- **Relevant Projects:**
 - Identified R&D projects, e.g. SmartNet, evolveDSO, SysDL2.0, Q-Study, TDxAssist, PVPT, Netzkraft, VOLATILE, PV-Regel, TDI 2.0, IDE4L, FutureFlow, Next-Generation SCADA

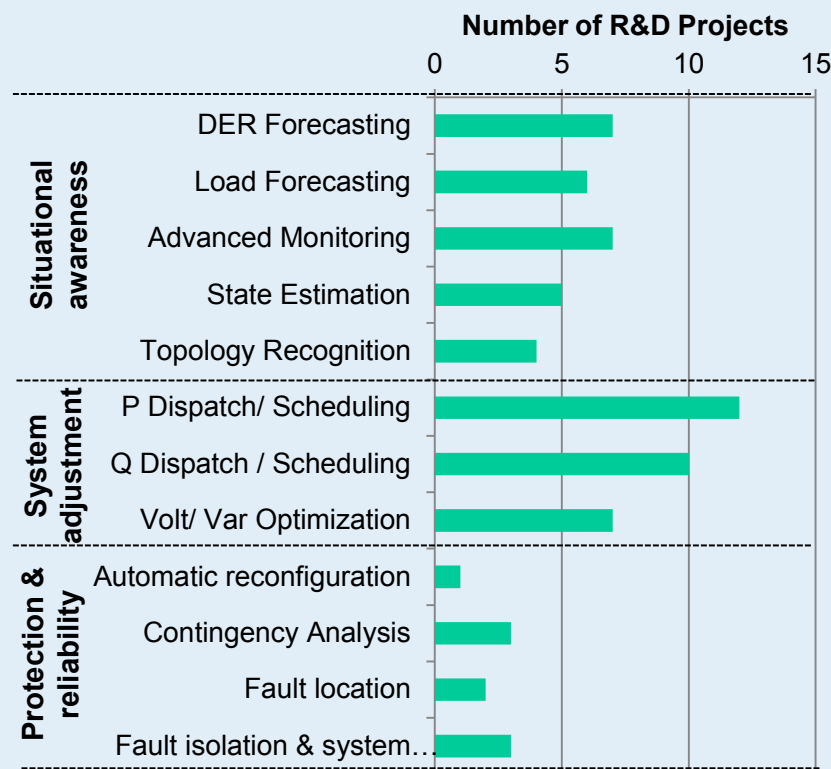


Fig: Addressed functionalities for network automation in the identified 19 R&D projects (multiple scopes per R&D projects possible, preliminary outcome)

For detailed information on emerging TSO/DSO functionalities, see:

[4] F. Pilo, G. Mauri, B. B.-Jensen, E. Kämpf, J. Taylor, F. Silvestro: „ Control and Automation Functions at the TSO and DSO Interface – Impact on Network Planning, 24th Int. Conference on Electricity Distribution, Glasgow, June 2017





Selected highlights and trends

Market design and regulatory framework

- Optimal TSO/DSO coordination schemes can differ for different regulatory structures, DER penetration level and growth, overarching policy objectives and other factors.
- Most promising schemes consider an increased responsibility and a crucial role of DSOs, for the coordination and provision of ancillary system services by DER.
- Regional markets can be a solution to provide location-dependent services by DER for the transmission or distribution level (i.e. for balancing challenge, congestion management and voltage support).
- **Relevant Projects:**
 - TSO/DSO coordination schemes: e.g. SmartNet, activities by Kristov & De Martini, evolveDSO
 - Regional markets: e.g. SmartNet, New 4.0, VOLATILE, CALLIA

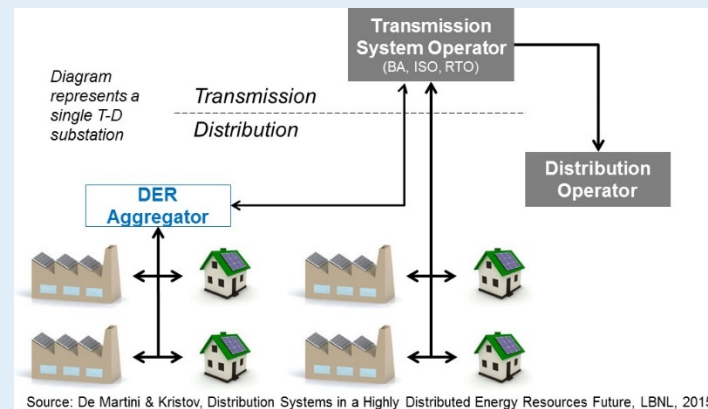


Fig. Minimal DSO Model (Source: De Martini & Kristov)

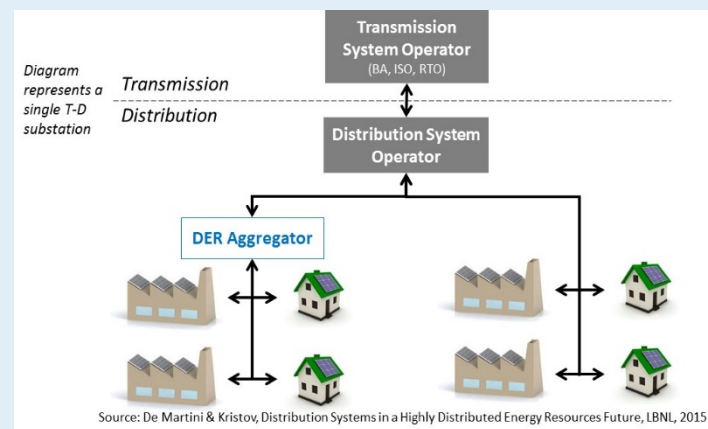


Fig. Total DSO Model (Source: De Martini & Kristov)





Selected highlights and trends

ICT infrastructure and data exchange

- A widely applied model for data exchange in European R&D projects is the Common Information Model (CIM), e.g. Common Grid Model Exchange Specifications (CGMES).
- In European projects, a strong focus is set especially on the standardization of communication interfaces between different stakeholders and their management systems.
- In a Japanese R&D project an integrated SCADA system for the transmission and distribution level is developed, where it is possible to set flexible authority for persons in charge of multiple internal organizations, including future task sharing.

Relevant Projects:

- CIM interface: e.g. IDE4L, SysDL2.0, TDX-ASSIST, EU-SysFlex
- Integrated SCADA:
Next-Generation SCADA

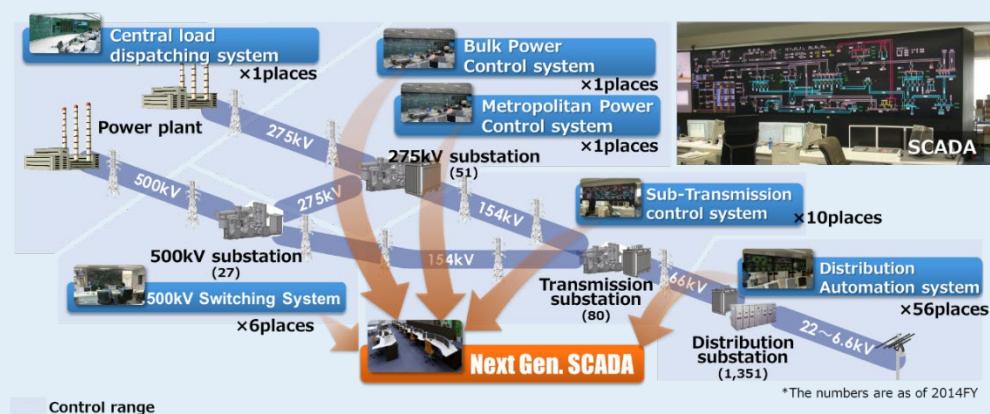


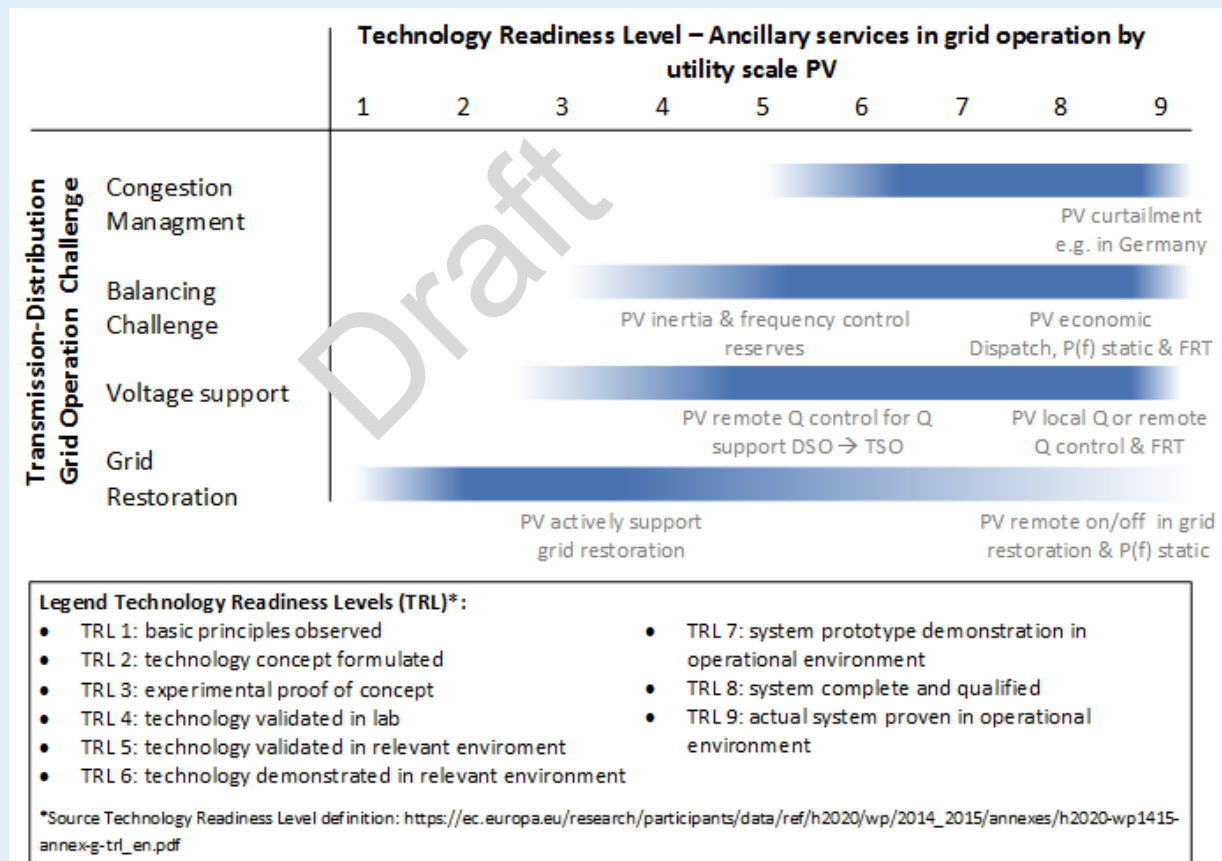
Fig: Integrated SCADA system for transmission and distribution level (Project: Next-Generation SCADA, Source: TEPCO)



Overview

Technology readiness level - Provision of ancillary services by utility-scale PV ($P_N > 2$ MW, preliminary)

- Readiness level considers capability of PV plant, ICT infrastructure and management system in the transmission and distribution level
- Readiness level for residential PV and commercial PV is usually ranked behind utility-scale PV





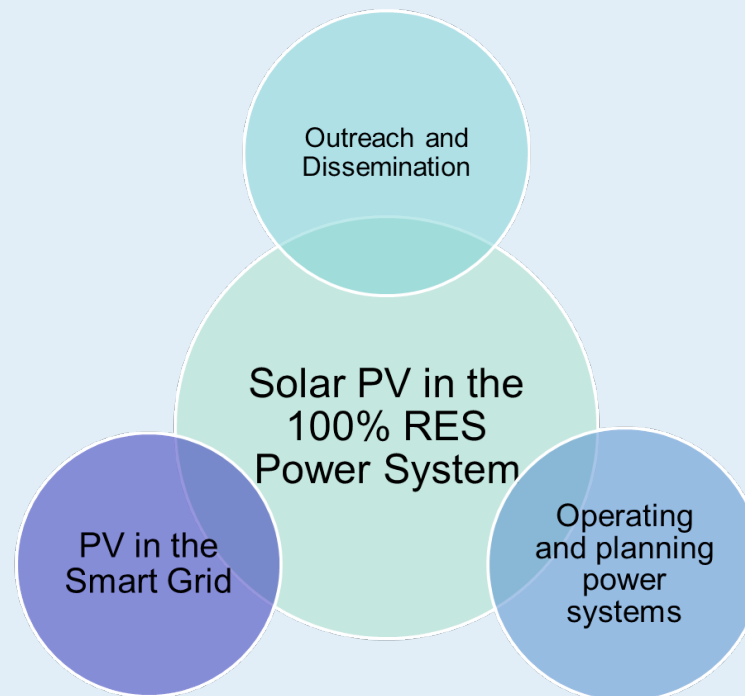
Thank you for attention.

IEA-PVPS Task 14 Phase 3

„Solar PV in the 100%
RES Power System“

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