



Photovoltaic Power Systems TCP

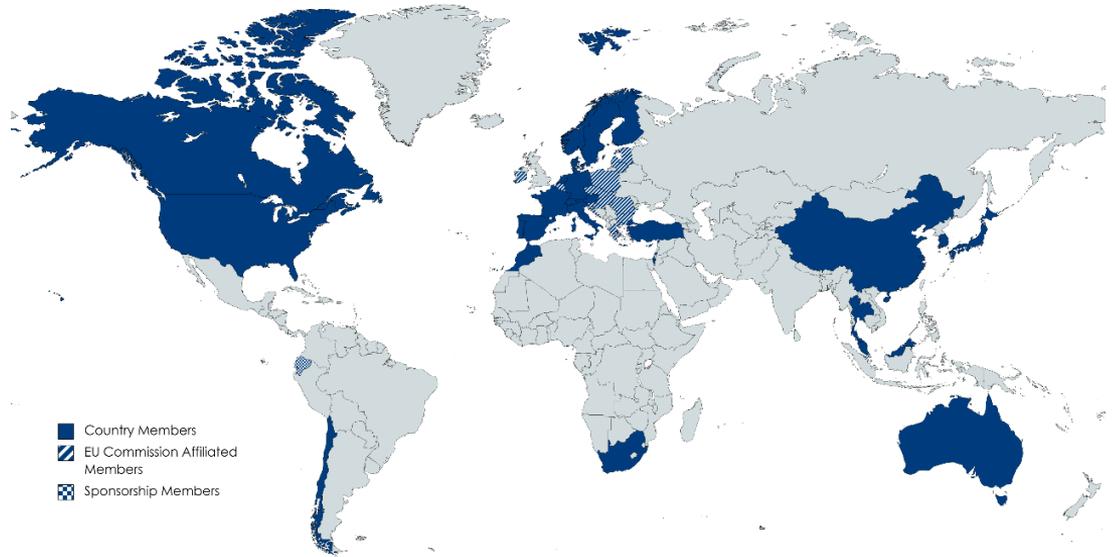
Daniel Mugnier, Chair

IEA Wind “Hydrogen in a 100% Renewable Energy System” Topical Expert Meeting #106

IEA PVPS Overview



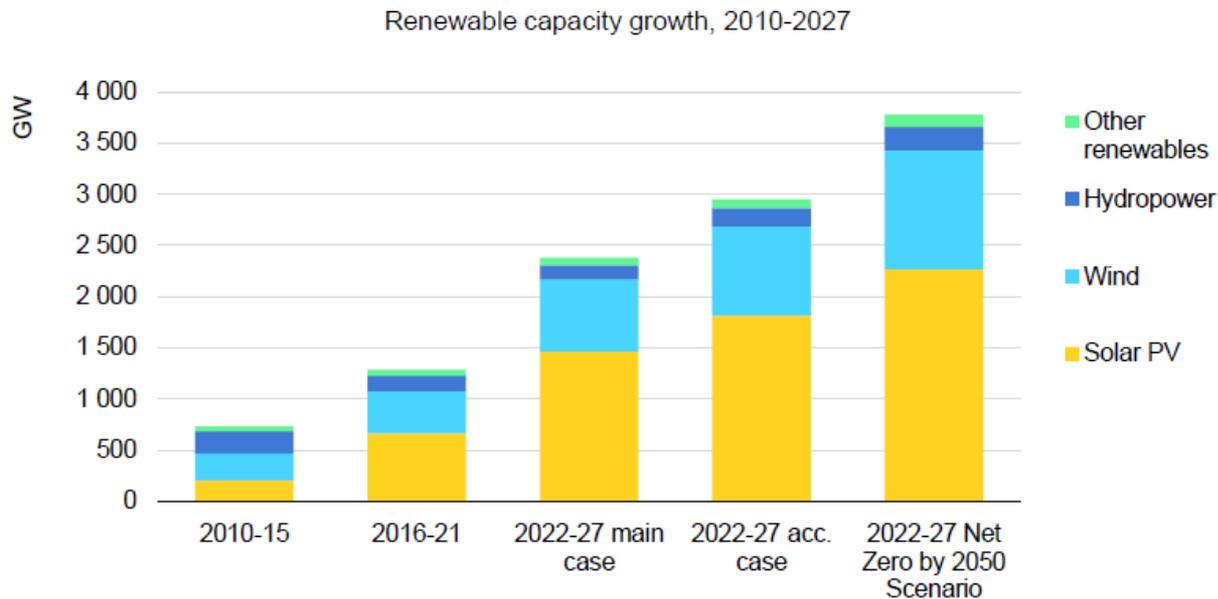
- 30 years of operation
- 31 members including 25 countries, plus EC and 5 sponsors
- 8 currently active Tasks
- 20 reports in past year 2022
- Working across topics of **PV technologies, applications, markets and policies.**



Solar PV is set to lead global markets



Improved policies can further narrow the gap with net zero by 2050



Faster permitting, addressing grid and system integration issues and enabling affordable financing in developing countries could unlock 25% additional capacity in the accelerated case narrowing the gap with net zero by 2050

PV Industry Status



- **Global PV markets expanding rapidly**, significantly over **230 GW** by end 2022
- **Decentralised market growing**, as well as new applications (AgriPV, floating PV)
- Climate change mitigation in 2022 = **3% of global emissions saved**
- Cost competitive → **removal of subsidies**, sale of “merchant PV”
- Initiatives to diversify global PV manufacturing **supply chain**
- Increasing **grid congestion**, need for flexible generation, demand side response
- Need to focus on **social acceptance** (land use concerns, circularity)
- **Complexity of policies** needed to frame PV will increase, especially with regard to grid costs and contribution to system stability.

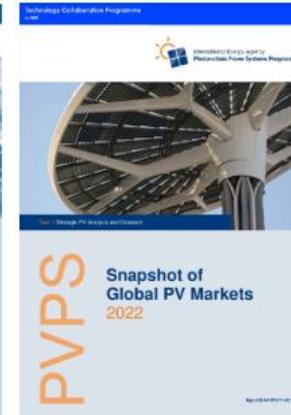
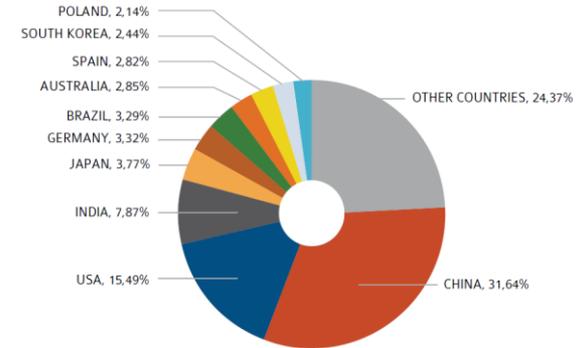


Task 1 - Strategic PV Analysis and Outreach



- Foundational never-ending Task
- Participation by **all PVPS Members**
- **Systematic analysis of PV market development, costs, industry trends, support policies & business models**
- Annual publication of:
 - **Trends in Photovoltaic Applications**
 - 27 years
 - Snapshot of Global PV Markets
 - National Survey Reports

FIGURE 2.5: GLOBAL PV MARKET IN 2021



Evolution of Top 10 PV Markets (from Trends report 2022)



| RANKING | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|-----------------------------------|-----------|-----------|-----------|--------------|-----------|-----------|-----------|-------------|-----------|-------------|-----------|
| 1 | ITALY | GERMANY | CHINA | CHINA | CHINA | CHINA | CHINA | CHINA | CHINA | CHINA | CHINA |
| 2 | GERMANY | ITALY | JAPAN | JAPAN | JAPAN | USA | INDIA | INDIA | USA | USA | USA |
| 3 | CHINA | CHINA | USA | USA | USA | JAPAN | USA | USA | INDIA | VIETNAM | INDIA |
| 4 | USA | USA | GERMANY | UK | UK | INDIA | JAPAN | JAPAN | JAPAN | JAPAN | JAPAN |
| 5 | FRANCE | JAPAN | ITALY | GERMANY | INDIA | UK | TURKEY | AUSTRALIA | VIETNAM | GERMANY | GERMANY |
| 6 | JAPAN | FRANCE | UK | SOUTH AFRICA | GERMANY | GERMANY | GERMANY | TURKEY | AUSTRALIA | AUSTRALIA | BRAZIL |
| 7 | BELGIUM | AUSTRALIA | ROMANIA | FRANCE | KOREA | THAILAND | KOREA | GERMANY | SPAIN | KOREA | AUSTRALIA |
| 8 | UK | INDIA | INDIA | KOREA | AUSTRALIA | KOREA | AUSTRALIA | MEXICO | GERMANY | INDIA | SPAIN |
| 9 | AUSTRALIA | GREECE | GREECE | AUSTRALIA | FRANCE | AUSTRALIA | BRAZIL | KOREA | UKRAINE | SPAIN | KOREA |
| 10 | GREECE | BULGARIA | AUSTRALIA | INDIA | CANADA | TURKEY | UK | NETHERLANDS | KOREA | NETHERLANDS | POLAND |
| RANKING EU | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 4 | 2 | 2 | 2 |
| MARKET LEVEL TO ACCESS THE TOP 10 | | | | | | | | | | | |
| | 426 MW | 843 MW | 792 MW | 779 MW | 675 MW | 818 MW | 944 MW | 1 621 MW | 3 130 MW | 3 492 MW | 3 710 MW |

Overview of currently active Tasks



| <u>Task:</u> | <u>Topic:</u> | <u>Running:</u> |
|--------------|--------------------------------|-----------------|
| • Task 1 | “PV market analysis” | 29 years |
| • Task 12 | “PV sustainability activities” | 15 years |
| • Task 13 | “PV Reliability & Performance” | 12 years |
| • Task 14 | “PV Grid Integration” | 12 years |
| • Task 15 | “Building-Integrated PV” | 7 years |
| • Task 16 | “Solar Resource Forecasts” | 45 years* |
| • Task 17 | “PV & Transport” | 4 years |
| • Task 18 | “Off-Grid & Edge-of-Grid PV” | 2.5 years |

PVPS

T1



Gaetan Masson



Izumi Kaizuka

T12



Garvin Heath



Jose Bilbao

T13



Ulrike Jahn

T14



Roland Bründlinger



Gerd Helscher

T15



Francesco Frontini



Helen Rose Wilson

T16



Jan Remund



Manajit Sengupta

T17



Keiichi Komoto



Manuela Sechilariu

T18



Christopher Martell

* Task 16 was part of SHC from 1977 until 2017, when it moved across to PVPS.

More information on Tasks



- Technical report highlights in PVPS Annual Report
- Task overview pages on PVPS Website
- Task publications available on PVPS Website



Publications Research tasks Events About us

Task 13 Reports



PVPS
Soiling Losses – Impact on the Performance of Photovoltaic Power Plants
2022



PVPS
Guidelines for Operation and Maintenance of Photovoltaic Power Plants in Different Climates
2022



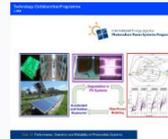
PVPS
Qualification of PV Power Plants using Mobile Test Equipment



PVPS
Quantification of Technical Risks in PV Power Systems
2021



PVPS
The Use of Advanced Algorithms in PV Failure Monitoring
2021



PVPS
Service Life Estimation for Photovoltaic Modules
2021

Soiling Losses – Impact on the Performance of Photovoltaic Power Plants

Guidelines for Operation and Maintenance of Photovoltaic Power Plants in Different Climates

Fact sheet: Qualification of PV Power Plants using Mobile Test Equipment

Quantification of Technical Risks in PV Power Systems

The Use of Advanced Algorithms in PV Failure Monitoring

Service Life Estimation for Photovoltaic Modules

22 | IEA PVPS ANNUAL REPORT 2024 TASK 14 HIGHLIGHT

ANCILLARY SERVICES FROM PV

TASK 14 HIGHLIGHT

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PV as an ancillary service provider
Task 14 Webpage



Fig. 17 – Hierarchical model for the definition of interrelations between various grid support functions of PV inverters

KEY MESSAGE

Laboratory and field experiences from IEA PVPS countries highlight the technical capabilities and the future potential of Solar PV systems to provide power system services.

OBJECTIVE

The report aims to highlight the status and the potential of PV and PV hybrids as ancillary service providers. The report provides a collection of laboratory and field experiences from different IEA PVPS countries and for different ancillary services and PV inverter functions.

METHODOLOGY

Field experiences and lessons learned for different ancillary services provided by PV systems and PV hybrids are presented in the report: Frequency control services, power curtailment, voltage support [1]. PV hybrids in insular power systems, Power quality support and new services from PV systems.[2]



Fig. 16 – PV penetration levels and identified challenges for the integration of Solar PV and VRE in the electrical power system



Fig. 18 – PV hybrid system on the island of St. Eustacius, Lutz, PV storage system view from above. Right: system setup

REFERENCES

These are relevant older reports from Task 14:

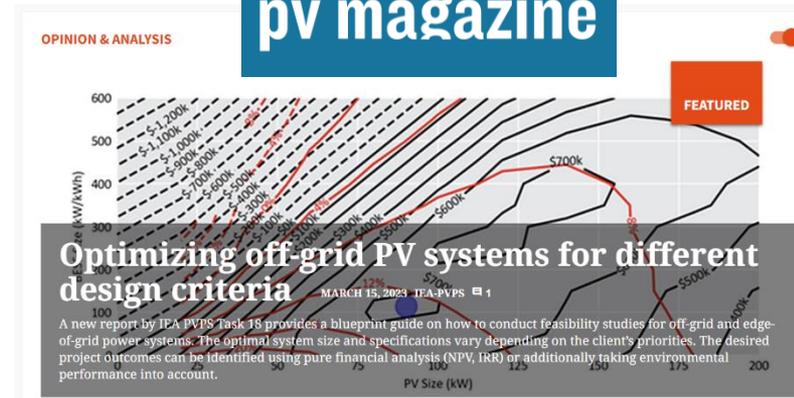
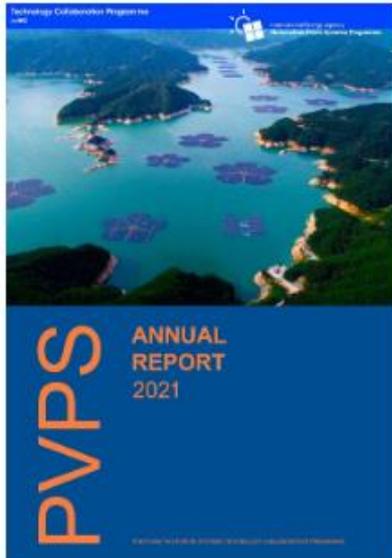
M. Krishna, A. Mikhal, I. Stea and M. Brown, 'On-Islands Local Voltage Support by Distributed Generation', A Management Summary Report IEA-PVPS 14-08-2017, 2017.

I. Stea, M. Ruking, I. Theophilus and et al., 'Transition from On-Island to Off-Island Distribution Grids: Management Summary of IEA Task 14 Subtask 2', Report IEA PVPS 14-03-2014, 2014.

Communications and Outreach



- Monthly featured articles in PV Magazine
- Workshops & Exhibitions
- Annual report, Newsletters, Social Media





- Green energy targets very high worldwide (100% RES-energy systems)
- Several possible answers for PV grid integration : curtailment but not only...
- Green H2 is a very promising solution
-but often adapted at commercial level for large green electricity production



- **Several challenges** of interest for PVPS :
 - Perspectives for small to medium size electrolyzers (TRL ?) adapted for PV
 - H2 electrolysis dynamics : how to conciliate variable PV production and Green H2 production in a commercial and cost competitive approach ? Complexity of integration ?
 - Seasonal management very interesting for Green H2 but difficulties to compete with battery storage at distribution grid level

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