

PV as an ancillary service provider

Laboratory and field experiences from different IEA PVPS countries

The PV penetration in many countries is continuously growing and PV is becoming a major energy source in the future electricity grid worldwide. Therefore, PV systems and PV hybrids need to take over more and more system responsibility by providing ancillary services. The specifications, types, needs, and procurement procedures of ancillary services can vary in different power systems and are changing with the progress of the energy transition in many countries. This report highlights the status and the potential of PV and PV hybrids as an ancillary service provider. The focus is set on mainly good practice examples, improvement and further development potential and needs for the application of PV as an ancillary service provider.

To meet CO₂ emission reduction targets and climate goals, PV deployment in the electric power system will increase rapidly in the upcoming years in many countries worldwide. The regulatory frameworks and grid codes therefore should not only cover current power system needs and demands but also anticipate the power system needs within the next (ten) years with increasing PV and other RES penetration levels. Therefore, regulatory frameworks and grid codes have to be continuously monitored and updated and should represent the state-of-the-art.

Besides, PV systems and PV hybrids can also provide several additional grid support functions and ancillary services beyond the current grid code and regulatory requirements. Field tests and field applications in this report show the proof of concept and technical capabilities of PV systems and PV hybrids. The regulatory frameworks in many countries should be further developed already based on existing functionalities in order to encourage the application of additional grid support functions and ancillary services by PV systems and PV hybrids by the grid operator, wherever meaningful. Therefore, selected report recommendations are:

- The characterization and development of standards of advanced grid support functions, such as synthetic inertia or grid forming capabilities of inverter-based generators.
- Development of common test procedures and quality criteria for advanced grid support functions that are best harmonized on an international level.
- Development of existing ancillary service procurement procedures enabling the participation of PV systems or PV hybrids, such as for frequency control service.
- Discussion and clarification on mandatory and optional grid support functionalities and ancillary services by the PV systems and other RES. This can require the development of new ancillary service products and new market-based procurement procedures for ancillary services by the grid operators.



Main outcomes of the presented case studies for already available and yet to develop ancillary services and future potentials are described in the report as follows:

- *PV frequency control* – In the future, PV systems can participate in frequency control reserve markets. However, prequalification procedures and product specifications might need to be adjusted to enable PV system participation.
- *PV power curtailment* – PV power curtailment can be an effective and economic measure to achieve a very high PV penetration level in electric power systems. Effective curtailment procedures need to be developed also for residential PV.
- *PV voltage support* – Besides local voltage support, such as volt-var control, distributed PV can compensate reactive power demands of consumers and can provide reactive power flexibility at the transmission-distribution interface.
- *PV hybrids in insular power systems* – Proof of concept of grid-forming inverters shown in field applications, but further requirement specifications needed for grid forming inverters.
- *PV plant power quality* – smart PV plant designs can reduce harmonic current emissions.
- *New services by PV systems* – PV inverter can provide additional services in hybrid DC/AC power systems.
- *Further development of regulatory frameworks and grid codes is required* for a wide application of ancillary services by PV systems and PV hybrids.