EU PVSEC 2025

PANEL DISCUSSION

Session CO.7:

Challenges and Opportunities of PV up to 2030

Key Take-aways

1. Introduction

The panel asked a direct question: **Can we integrate PV massively—and fast—by 2030?** Europe's target is 600–750 GW of cumulative PV by 2030, compared with ~338 GW installed by end 2024; globally, capacity must grow from ~2 TW to ~7 TW. The numbers imply doubling or tripling what exists in a single investment cycle. The panel's conclusion was measured but optimistic: **the technology is ready, yet the energy system—its grids, markets, digitalisation, and social adoption—must transform quickly.** PV is shifting from a promising technology to a critical infrastructure, which brings both new opportunities and new risks.

Reaching 2030 goals is feasible if **stakeholders act decisively on flexibility, secure digitalisation, market redesign, and public engagement**, with a clear stance on **energy sovereignty and a strong focus on reliability** for energy security.

2. Challenges

Grid integration and system readiness. High PV shares create voltage rise, congestion, and stability issues—especially in distribution networks—and today's planning and operating practices are not adequate for systems with millions of generators. Limited observability, insufficient real time measurements, and lack of distributed control prevent PV from acting as an active grid resource that can reduce reinforcement needs and provide services.

A risk-averse culture that brings a lack of innovation culture. Parts of the power sector remain risk averse, often following rather than leading technology shifts. Utilities are used to work with established providers, even as startups bring PV enabling solutions faster; this slows piloting and scaling of tools like smart inverters, hybrid PV storage, and EV smart charging/V2G.

Market conditions and price signals. Rising PV penetration contributes to negative prices and volatility. Current market rules rarely reward flexibility or locational value, constraining investment in storage and demand response, and feeding concerns about a declining PV market in parts of Europe. New ways to support distributed PV are needed so prosumers and communities can participate without eroding system reliability.

Not guaranteed public acceptance. Opposition—especially in rural areas—stems from land use, visual impact, and perceived inequities. Without planned engagement, fair burden sharing, and clear benefit sharing, permitting delays and social conflict can slow deployment. The conversation must shift from "renewables yes, but not like this" to "renewables yes—for example, like this," with citizens as protagonists through energy communities.

Digitalisation and cybersecurity. We are building a digital energy system. As PV becomes part of critical infrastructure, concerns grow about cyber vulnerabilities and common failure modes. Secure by design architectures, robust device identity, and incident response capabilities are essential to avoid cascading failures across millions of inverter-based assets.

AI-driven automation and workforce impacts. Generative AI and robotics could bring ~80% automation across the PV value chain by 2030, reducing workforce per MW installed. Automation is needed to meet build out speed, yet it raises social impacts that must be anticipated: reskilling, regional disparities, and redesigned education and training aligned with new industry and R&D needs.

Flexibility ceiling near 15%. Without substantial flexibility, PV systems struggle to move beyond ~15% of electricity supply due to curtailment and stability constraints. Unlocking the next tranche of growth requires storage, grid forming capabilities, demand response, EV smart charging, and electrolysers to absorb surplus generation reliably.

3. Opportunities

Smart and grid-forming inverters as grid assets. Modern smart inverters can deliver voltage support, frequency response, and other ancillary services at near zero marginal cost. With better observability, advanced monitoring, and distributed control, PV can become an active participant, lowering grid reinforcement needs and opening new revenue streams. Many of these capabilities are already embedded in devices but are underused due to regulatory barriers. Moreover, the step forward is brought by the grid-forming inverters, which are able to establish voltage and frequency reference during blackstart restoration, stability services (*e.g*. damp oscillations, stabilisation of weak grids) and provide synthetic inertia.

Storage providing multiple forms of flexibility. Battery storage enables energy shifting, ramp rate control, and peak shaving. Electric vehicles add mobile storage via smart charging and V2G/V2H. Pumped hydro can still be expanded where geography allows, and hydrogen via electrolysers offers long duration pathways for industrial and transport uses—though technology and cost improvements are needed. A key design question is where to place storage: centralised assets offer stronger state of charge (SoC) control and system services; local assets relieve the grid and enhance resilience. Determining the optimal size and mix across locations unlocks the highest system value.

Market redesign that values flexibility. Adapting market rules to new ways of commercialising PV electricity can stabilise project economics. Mechanisms such as local flexibility markets, non-price-based merit order adjustments, and tailored fiscal rules can better monetise speed and location, support distributed PV, and encourage load flexibility to absorb PV peaks.

AI and "smart monitoring." The main role of AI is not to replace people but to do what is not done today—from real time asset health and anomaly detection to forecasting and optimal dispatch across heterogeneous portfolios. Smart monitoring raises availability, improves safety, and shortens response times; it also accelerates project development (siting, grid studies), compressing time to build that is crucial for 2030.

Energy communities and social innovation. Empowering citizens through energy communities turns opposition into collaboration. Fair benefit sharing (co-ownership, local investment, targeted support for low-income households) can build trust, speed permitting, and increase project resilience.

Strategic grid investment and sovereignty choices. Meeting targets requires investment in new grid capacity, balancing centralised and decentralised infrastructures. Policymakers must decide how far to pursue energy sovereignty (domestic manufacturing, supply chain resilience) and assume the consequences—costs, standards, and industrial policy—without compromising reliability or energy security.

4. Main Takeaways and Recommendations

For policymakers:

- Require smart and grid-forming inverter functions and create remuneration mechanisms for grid services.
- Support storage, demand response, and EV integration; adapt rules to value flexibility.
- Accelerate grid upgrades and secure digital infrastructure with strong cybersecurity standards.
- Promote energy communities and fair benefit-sharing to secure social acceptance.
- Plan for workforce reskilling and clarify energy sovereignty goals.

For industry:

- Pilot advanced technologies like hybrid PV-storage and V2G to build confidence.
- Deploy AI-enabled monitoring and predictive maintenance at scale.
- Combine centralised and local storage for maximum impact.
- Engage communities early to reduce delays and improve project resilience.

For scientists and educators:

- Advance research on grid observability and control, stability, cybersecurity, and flexibility optimization.
- Develop tools for smart operations and human-centered AI.
- Update training programs to match an automated PV industry and address social impacts.

5. Conclusion

To meet 2030 targets—Europe 600–750 GW, global ~7 TW—**PV must become a smart, secure, and socially accepted** energy resource. **The tools exist:** smart inverters, storage, AI, and community engagement. What we need now is speed and coordination across policy, industry, and science. **If we act decisively, massive PV integration is not only feasible—it can be the backbone of a resilient, affordable, and low-carbon energy system.**

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