IEA PVPS Task 13 – Meet the Experts

Ulrike Jahn, David Moser, Atse Louwen

Intersolar Exhibition 2026, Hall A2. Booth A.216, 24 June 2026, 2.00 – 3.00 PM

Overview

- What is IEA PVPS?
- Models and Tools for Digital Design and O&M
- Long-term Yield trends of PV power plants across climates
- Performance and Durability of Emerging PV Applications
- Task 13 - Meet the Experts

What is IEA PVPS?

IEA PVPS in a nutshell

- One of 38 currently active Technology Collaboration Programmes within the IEA
- 33 years old – established in 1993
- 28 countries plus the European Commission and 2 Sponsors
- 9 active Tasks and 1 Action Group
- 27 reports published and 20 events organized in the past year
- ~400 participants across ExCo and all Tasks

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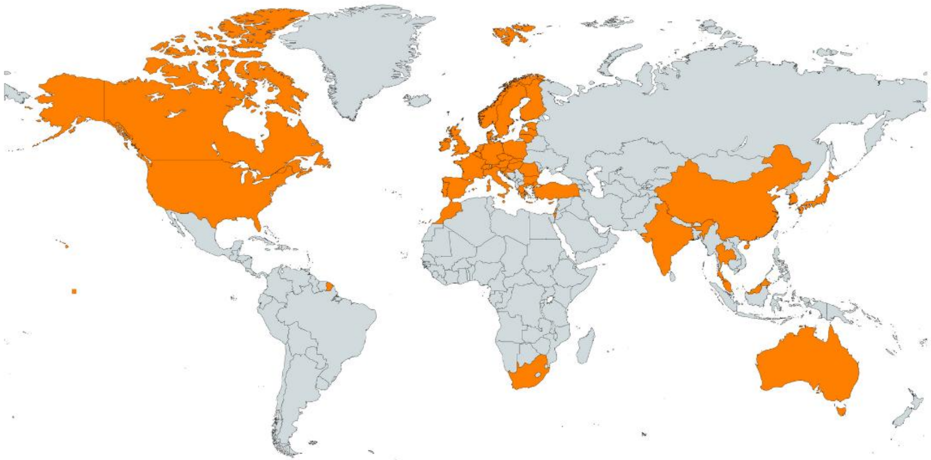
Our members



- Australia
- Austria
- Belgium
- Canada
- China
- Denmark
- European Union
- Finland
- France
- Germany
- India
- Israel
- Italy
- Japan
- Korea
- Lithuania
- Malaysia
- Morocco
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- Portugal
- SERIS
- SolarPower Europe
- South Africa
- Spain
- Sweden
- Switzerland
- Thailand
- The Netherlands
- Türkiye
- United Kingdom
- United States of America

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IEA PVPS Task 13

Reliability and Performance of PV Systems

Task 13 Collaboration - History and Presence

Task 13: Reliability and Performance of Photovoltaic Systems

Task 13: 2010-2014

+ Performance and reliability of components
+ Testing and standards

Task 13: 2014-2017

+ Economical aspects and business models
+ Yield prediction & uncertainties
+ Failure detection and statistics

Task 13: 2018-2021

+ New module and system designs
+ Field testing
+ O&M practice
+ Risk assessment & mitigation

Task 13: 2022-2025

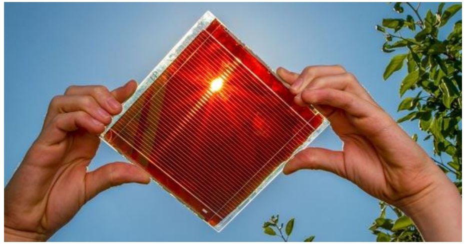
+ New materials & applications (IPV)
+ Digitalization
+ Climate/environment specific design/testing
+ Techno-Economic key performance indicators
+ Second Life PV
+ PV & storage

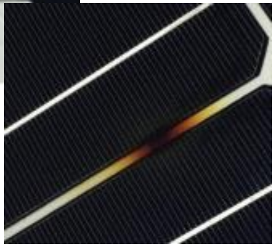
Task 13: 2026-2029

- PV module structures
- Digitalization and AI
- PV Applications
- PV Enabler

Boosting PV Performance & Reliability

- **Reliability** is a key factor in a Rapidly Evolving Technological Landscape, specifically in the **context of future energy markets.**
- **PV technology is evolving rapidly;** new materials and designs impact performance and lifetime. Understanding new degradation effects is key for **decisions by stakeholders**.
- Reliability and performance need to be further investigated **to ensure that PV continues to be a good investment!!**
- Cost reduction measures, climate-specific designs, and digitalization are emerging as **key enablers for enhancing reliability** and **enabling data-driven performance assessment**.





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Automation, AI, and New Applications

- **Digitalisation and automation** are key to reducing O&M costs, especially for operators managing large, gigawatt-scale PV portfolios.
- **Task 13** focuses on PV system reliability topic through digital O&M tools: data standardisation, ontologies, fault detection, and automated maintenance. The use of **Generative AI and robotics** solutions will be explored to optimise plant design and operation.
- Task 13 continues to provide a unique and fundamental analysis of **PV components and systems**, including new PV applications such as Floating PV and Integrated PV, focusing the **reliability and performance aspects over their lifetime**.

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Bridging Research and Industry for PV

- With strong technical focus and global expert input, Task 13 delivers relevant outcomes to both research and industry, supporting technology development, risk reduction, and standardization.

- Its high-quality results rely on **active expert collaboration** and **long-term data efforts**. Maintaining this dynamic is key to keeping pace with the fast-evolving PV market.

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Models and Tools for Digital Design and O&M

David Moser, Managing Director Becquerel Institute Italia

Key points for generative AI

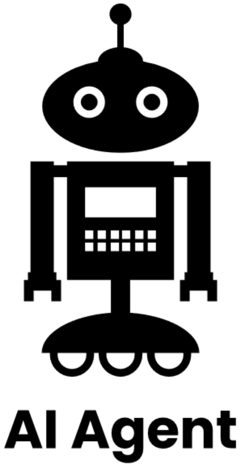
Create novel solutions optimized for specific contexts rather than applying standardized approaches

Adapt to changing conditions by generating new strategies rather than following fixed procedures

Provide comprehensive explanations that enhance human understanding and decision-making

Bridge knowledge gaps between specialized domains, facilitating integration across the value chain

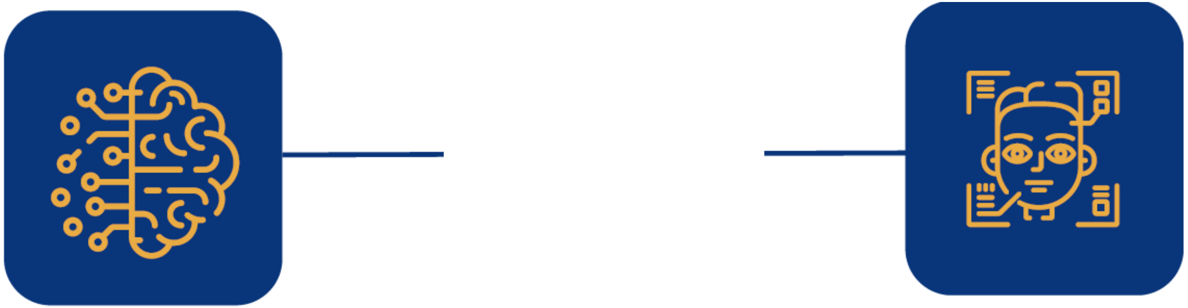
AI agent



An artificial intelligence (AI) agent refers to a system or program that is capable of autonomously performing tasks on behalf of a user or another system by designing its workflow and utilizing available tools.

Agentic user interface

Any step of the PV value chain



Insights
Engine

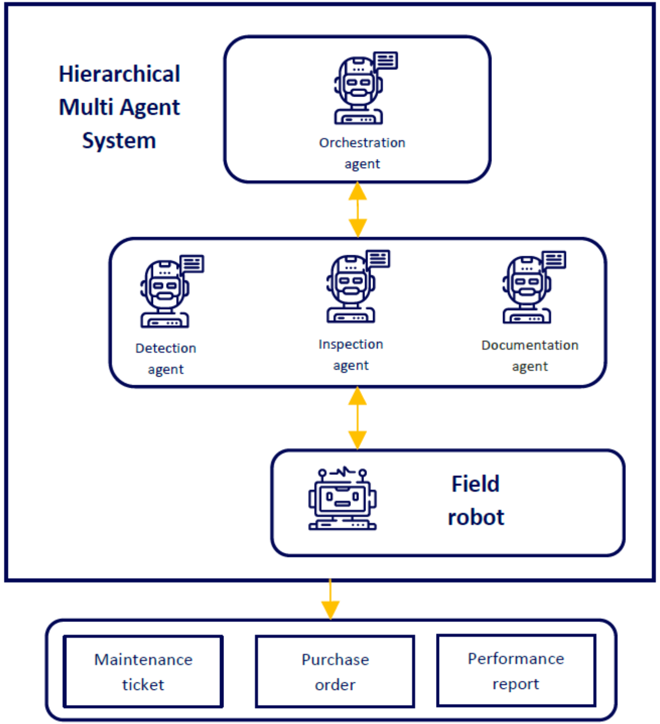
Agentic User
Interface

User

meets

Multi-AI agent systems

Multi-AI Agent Systems are composed of multiple specialized AI agents that collaborate to complete defined tasks by performing different actions within a shared workflow. Unlike single-agent systems, which may struggle with complex or multi-step processes, multi-agent architectures distribute responsibilities across agents with distinct specialties.



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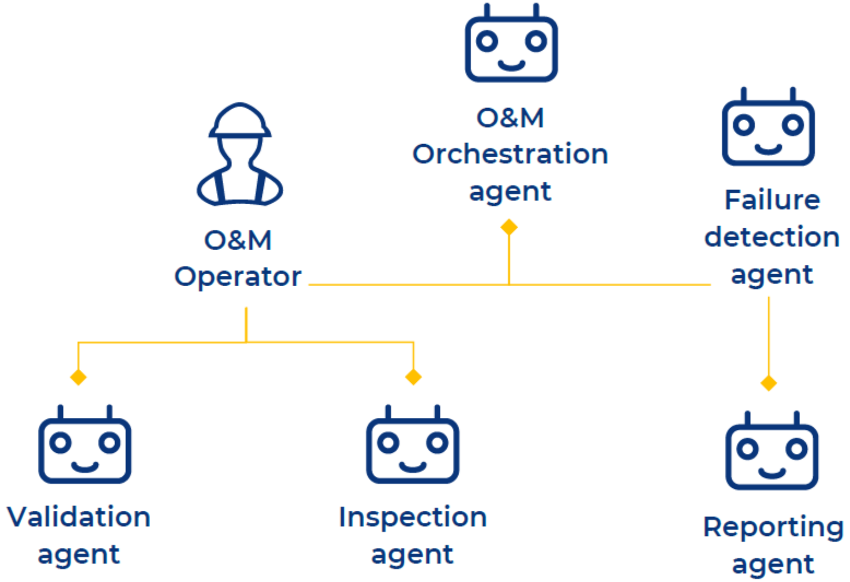
A future of hybrid teams?

AI-Human Hybrid Teams are collaborative work arrangements where artificial intelligence systems and human workers operate together as integrated units, combining their complementary strengths to accomplish tasks.

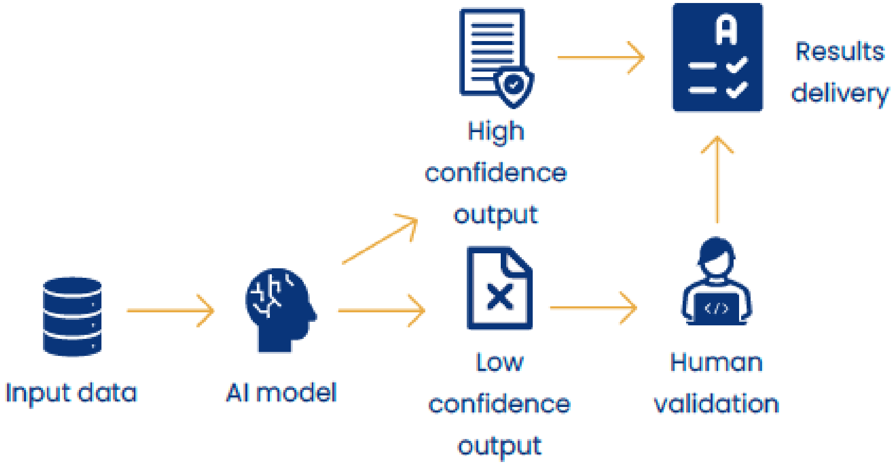


Aspects to be further analyse:

- Psychological impact
- Work organization
- Workforce management

A future of hybrid teams?

Human-in-the-Loop refers to a design approach where humans remain actively involved in AI system operations, particularly in critical decision points. Rather than fully automated processes, human-in-the-loop systems require human oversight, validation, or intervention at key stages. This ensures human judgment guides important outcomes while benefiting from AI's analytical capabilities.



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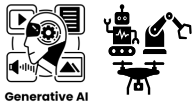
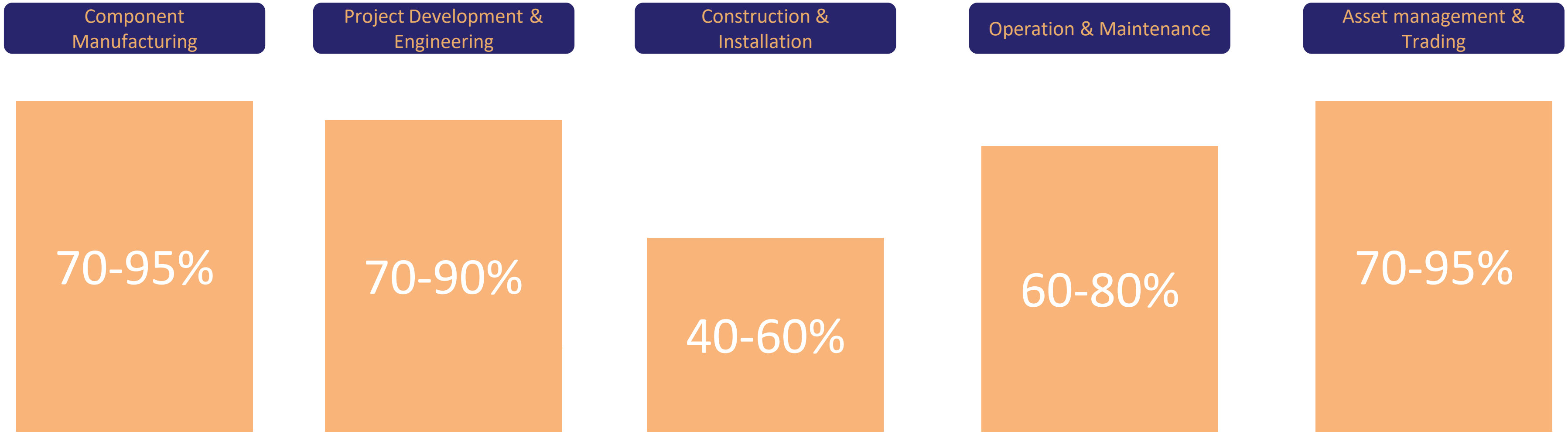
Automation along the value chain





Source: Transforming the PV Sector: The AI & Robotics Revolution Becquerel Institute

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From manual design to AI-driven optimisation

Project Development and Engineering | Construction & Installation | Operation & Maintenance | Asset management & Trading

Top 5 Most Impacted Development Tasks

1 Site Assessment & Layout Optimization — 80%

AI generates thousands of layout iterations optimizing yield and cost beyond human design capabilities...

2 Energy Yield Assessment — 90%

Advanced predictive models integrate weather data and degradation patterns for superior accuracy...

3 Electrical Design & BOM Generation — 70%

Automated cable routing, component selection, and cost-optimized system configurations...

4 Structural Engineering Calculations — 80-85%

Site-specific load analysis and foundation optimization through AI-driven engineering...

5 Permit Package Documentation — 70%

Jurisdiction-specific document generation with automated compliance verification...

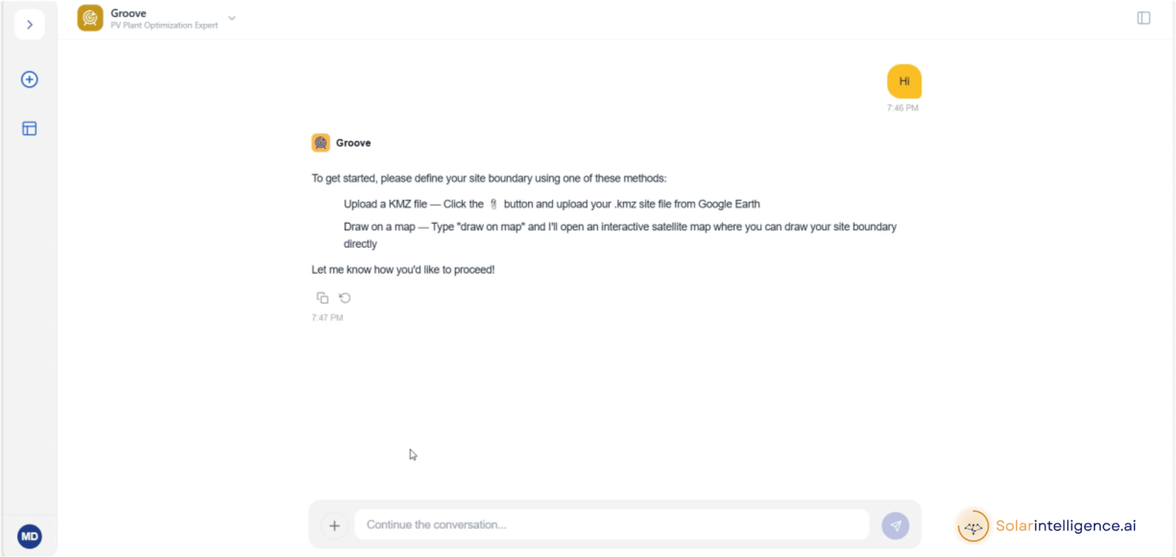
From manual design to AI-driven optimisation

Project Development and Engineering

Construction & Installation

Operation & Maintenance

Asset management & Trading



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From manual design to AI-driven optimisation

Project Development and Engineering

Construction & Installation

Operation & Maintenance

Asset management & Trading

DIGITAL TWIN:
DATA FUSION
(real example)

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The automation sweet spot

Project Development and Engineering | Construction & Installation | Operation & Maintenance | Asset management & Trading

Top 5 Most Impacted O&M Tasks

1 Performance Monitoring & Anomaly Detection — 95%

AI systems continuously monitor with minimal human oversight, detecting performance issues before humans can identify them...

2 PV Module Cleaning — 70%

Autonomous cleaning robots optimized for different mounting systems achieve efficiency equal to manual methods...

3 Vegetation Management — 50%

Autonomous robots handle mowing and targeted vegetation control with computer vision differentiation...

4 Visual and Image-based Inspection — 70%

Ground robots and drone-based inspections with automated analysis detect faults more accurately than manual inspection...

5 Inverter & Electrical Maintenance — 35%

Predictive maintenance systems identify failures before they occur with automated diagnostic guidance...

Autonomous AI O&M pipeline for PV field diagnostic

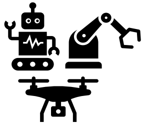
When

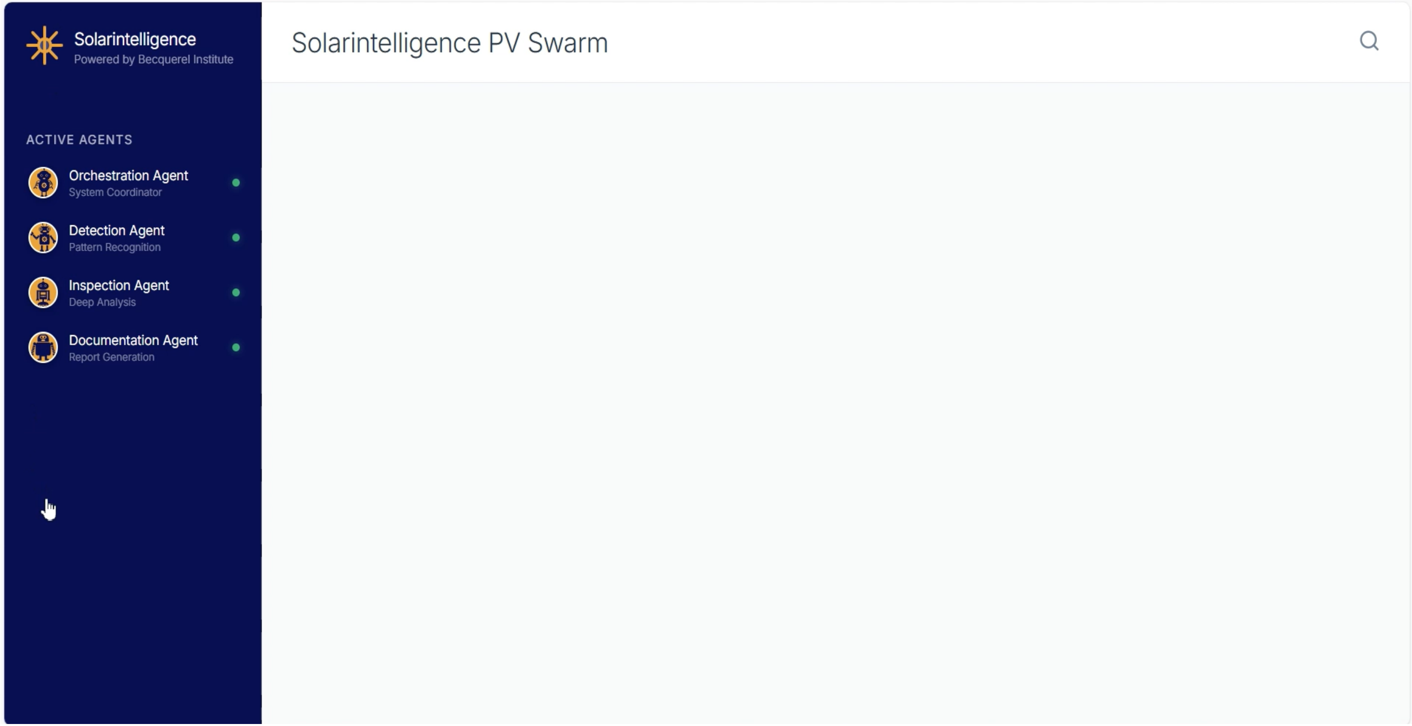
Predictive AI

meets

Generative AI

deploying





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Autonomous AI O&M pipeline for PV field diagnostic

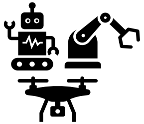
Project Development and Engineering | Construction & Installation | Operation & Maintenance | Asset management & Trading

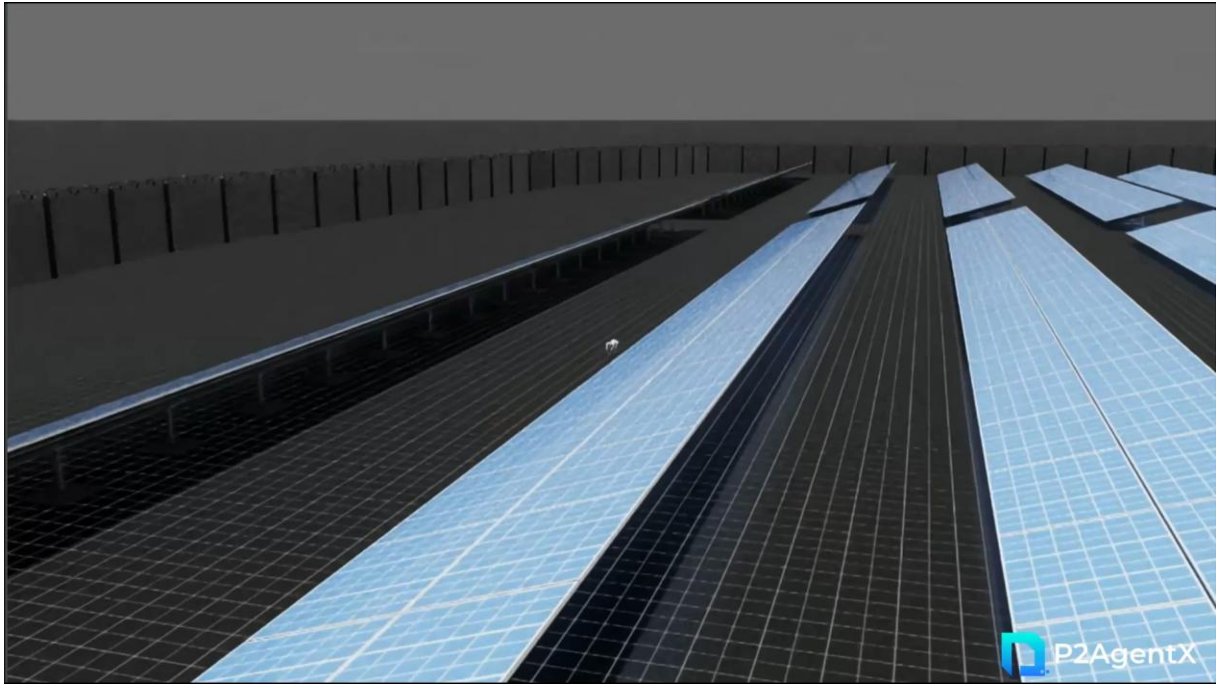
When 

Predictive AI

meets 

Generative AI

deploying 



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2030 Autonomous PV

Lesson	Autonomous Driving Parallel	PV Sector Application
1. Phased Progression	Shift from manual driving to ADAS to full autonomy	From manual O&M, to centralized control, to self-optimizing ("autonomous PV")
2. Real-Time Edge Decisions	Instant onboard processing for navigation and safety	Local processing for rapid fault response and performance optimization
3. Incremental Trust	Human oversight during early deployments, full autonomy as confidence grows	AI starts as decision-support, transitions to autonomous plant management
4. Self-Healing Systems	Vehicles detect/correct anomalies and learn from events	PV plants autonomously correct faults, adapt, and share learnings fleet-wide
5. Integration & Interoperability	Vehicles interact with traffic/infrastructure in real time	PV plants integrate with grids/markets for dynamic, system-level optimization

Solarintelligence.ai

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Disruptions / opportunities

READY4
Generative AI

Disruptive Shift	Key Risk	Primary Stakeholders Affected
Internalization of digital platforms	Reduced demand for service providers	Service providers, consultancies
Data ownership becomes central	Competitive imbalance, dependency	Small operators, manufacturers
Workforce reduction/role shift	Redundant jobs, reskilling needs	Lower-skill employees, HR teams
Scale & capital drive consolidation	Exit of small/mid-size players	Small/mid-size firms, regional EPCs
Regulatory/standardization barriers	Fragmentation, compliance headaches	Tech adopters, legal, insurers
Cybersecurity/digital risk	Operational and reputational threats	Owners, operators, IT/security teams
Legacy asset lock-in	Underperforming portfolios	Operators with old assets, O&M providers

PV reliability across climates: Lessons from cold and snowy latitudes

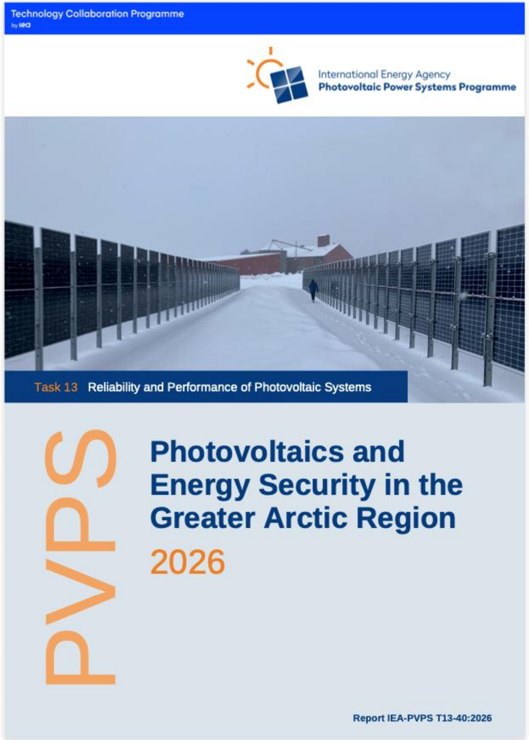
Atse Louwen, Senior Researcher at RISE, Sweden

PV in the arctic, why even bother?

- Arctic region largely overlooked for PV deployment
- Low population, low irradiance, challenging conditions

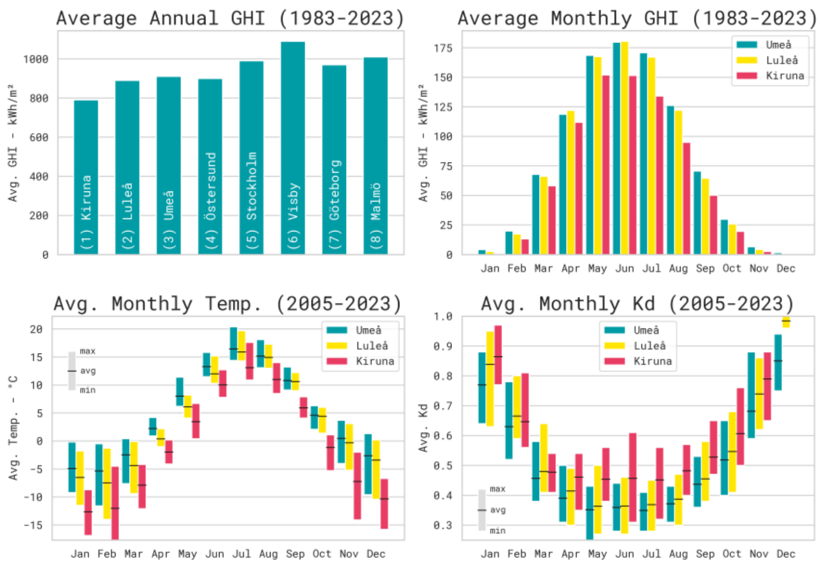
- But:
  - High availability of land
  - High electricity prices and dependency on fossil fuels
  - PV can contribute to energy security in the region

- Substantial challenges remain!



Arctic or subarctic conditions, what are they?

- Examples from Sweden:
  - Low irradiance (900 kWh/m^2) + Very high seasonal difference
  - Cold (average around 0°C) + 4-5 months of freezing
  - Highly diffuse irradiance + low solar elevation



- **So, ideal conditions for low degradation (??)**

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Models and some data show low degradation

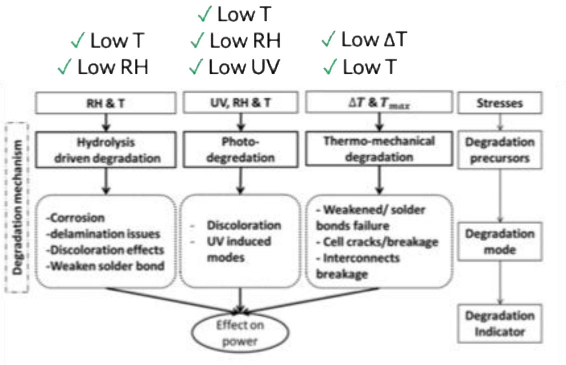
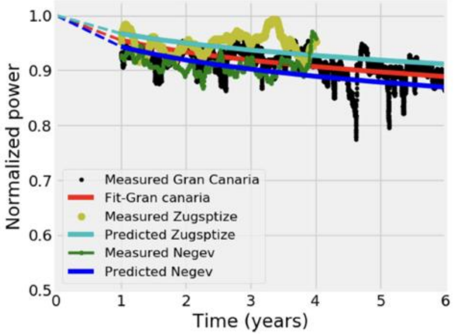


Fig. 1. Schematic diagram of the modeling hypotheses.

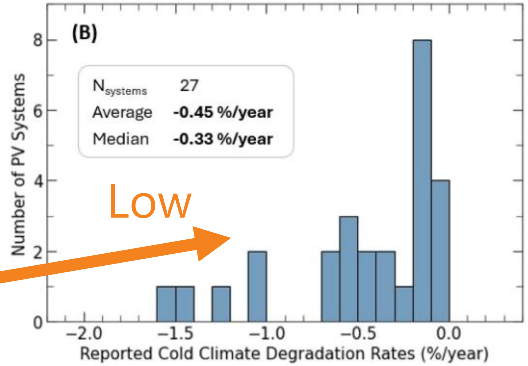


Low

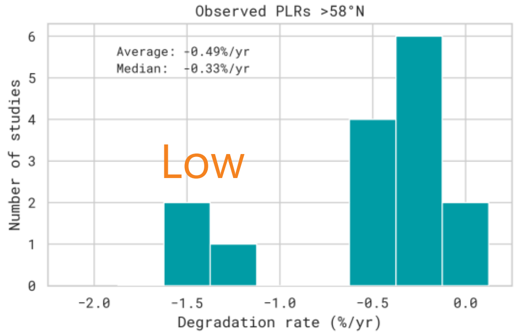
Fig. 13. Combined model (7) calibration and validation with hourly resolution.

Kayaa et al, 2019. 10.1109/JPHOTOV.2019.2916197

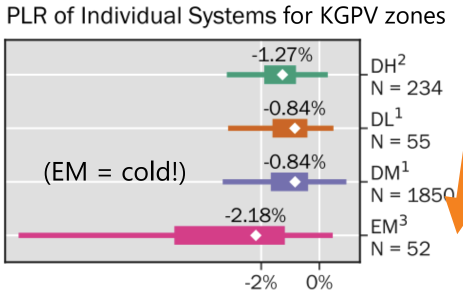
- Modelling of key degradation pathways predicts **low degradation**
- Very **limited** field data on systems tell **contrasting stories**



Low



Low



HIGH!

Louwen et al, 2024. Climate- and technology dependent Performance Loss Rates in a Large Commercial Photovoltaic Monitoring Dataset. 10.1002/solr.202300653

Long-Term Photovoltaic System Performance in Cold, Snowy Climates

Erin M. Tonita[1] | Dirk C. Jordan[2] | Silvana Ovaitt[2] | Henry Toal[3] | Karin Hinzer[1] | Christopher Pike[3] | Chris Deline[2]

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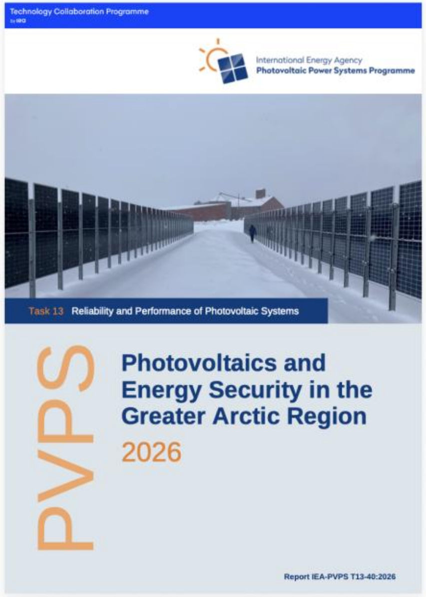
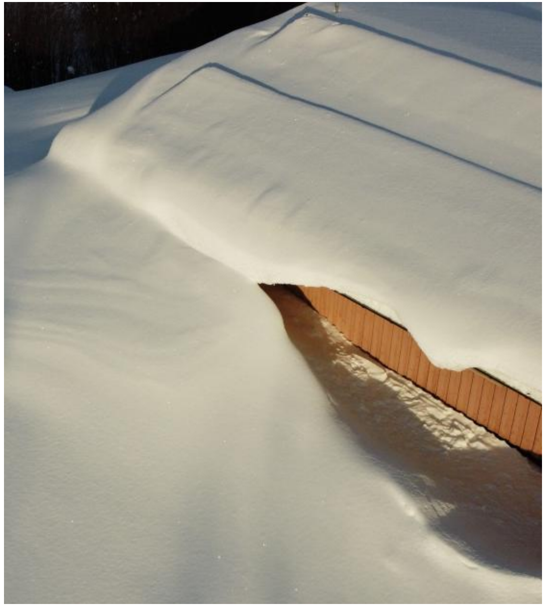
What are the main system level challenges?

- Recently published Task 13 report
- Low UV, temperature stresses in arctic climates
- Main drivers of performance loss are instead:
  - Snow loads
  - Frost heave
  - Freeze-thaw cycles
  - Extremely low temperatures (below -40 °C)



Stein et al, 2026. Photovoltaics and Energy Security in the Greater Arctic Region. 10.69766/JXHM9635

A major challenge: snow



Snow covered rooftop PV
(Piteå, SE)

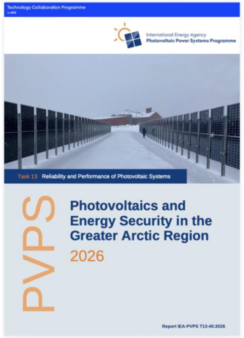
Rooftop PV
(Piteå, SE)

Lindbäcks Bygg
(Haraholmen, SE)

Snow covered array [Alaska, USA]

Images courtesy of:
Mattias Lindh (RISE),
Alexander Granlund (RISE),
Stein et al, 2026 (10.69766/JXHM9635)

Snow related performance losses

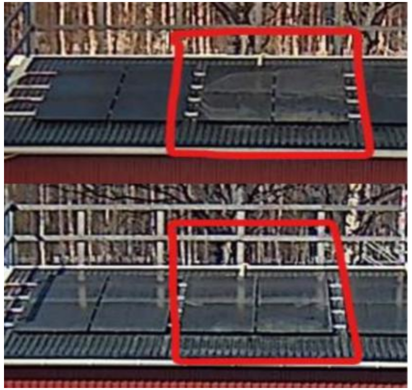


Stein et al, 2026. Photovoltaics and Energy Security in the Greater Arctic Region. 10.69766/JXHM9635

- **Shading**: snow shading causes up to 30% losses on annual basis
- **Damage**: high loads, snow clearing
- **Moisture ingress**: snow melts over long periods of time
- **Soiling**:
  - Airborne dust and caught by snow and accumulates over time
  - With gradual snow melt substantial amount of soiling remains
- Most problems exacerbated if snow cannot properly shed!

PV installation where snow cannot shed [Östersund, SE]. Image courtesy of Alexander Granlund (RISE)

Damage due to snow loads and improper clearing. Images courtesy of Mattias Lindh, Alexander Granlund (RISE)



PV installation where soiling occurs after snow could not properly shed [Piteå, SE]

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Other cold climate PV losses and stresses

Frost heave:
- Ground expanding due to freezing ground water
- Consequences: movement in mounting structures causing uneven racking, tension in frames, screws and module clamps coming loose





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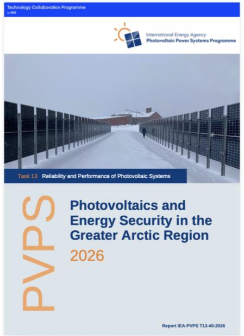
Other challenges for (sub)arctic PV

- Extreme cold and freeze-thaw give specific stresses to materials and system components (e.g. inverter temperature range)!
- Snow affects sensors as well as modules 😅
- Snow cover causes drastic change in albedo
- Data is scarce and satellite data is generally inaccurate at high latitude

Figure 14: Photo of sensors with snow buildup and without snow buildup (built-in heating option). Photo credit Sven Ruin, TEROC AB.

- Implications for **modelling** (yield assessment, business case, bankability) **and monitoring** (quality assurance) are substantial!

Stein et al, 2026. Photovoltaics and Energy Security in the Greater Arctic Region. 10.69766/JXHM9635



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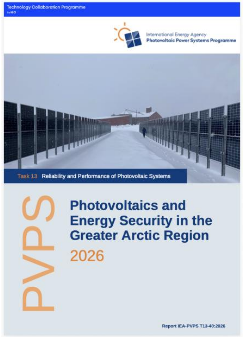
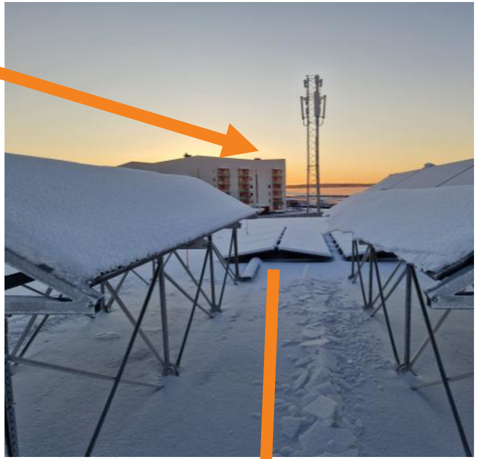
Mitigation



Stein et al, 2026. Photovoltaics and Energy Security in the Greater Arctic Region. 10.69766/JXHM9635

- **Snow loads** can be dealt with by optimising mounting design
- To prevent **frost-heave**, cold-climate frame piling is necessary
- Proper PV module design and material use limits effects of extreme cold and freeze thaw cycles
- Array design, mounting and using bifacial modules can partly offset losses of low irradiance and low solar elevation.
- Heated sensors help ensure proper monitoring year round

Snow first covers both 10 and 30 degree modules



- Higher tilt: snow clears more easily
- Higher frames: room for snow to accumulate away from modules

Wrap up

- Cold climates are potentially low stress locations for PV modules
- Specific characteristics can strongly affect overall system performance
  - Snow: shading, mechanical damage, moisture, soiling
  - Frost heave
  - Freeze-thaw and extreme cold
- While typical model suggest low PLR, and empirical data seems to confirm, current literature data is very limited in terms of numbers of systems
- **High latitude, cold and snowy PV has specific needs in terms of PV system design, monitoring and modelling**

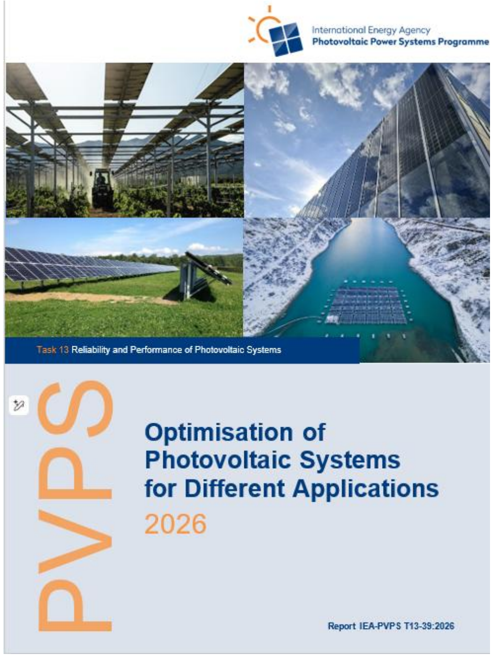
Performance and Durability of Emerging PV Applications

Ulrike Jahn, Senior Researcher, Fraunhofer CSP, Germany

Optimisation of Photovoltaic Systems for Different Applications

Introduction

- Photovoltaic deployment is entering a new phase of diversification. Ground-mounted systems have driven the rapid global expansion of solar power, but future growth will increasingly rely also on integrated PV solutions such as **BIPV, FPV and APV**.
- As PV applications diversify, understanding application-specific stressors becomes essential. Integrated PV systems must move beyond energy yield and cost optimisation, considering also reliability, lifetime, environmental compatibility, and social acceptance.
- This report aims to provide comprehensive guidance and a structured overview of current strategies for optimising PV module and system design across three key PV integration examples: BIPV, FPV, and APV.



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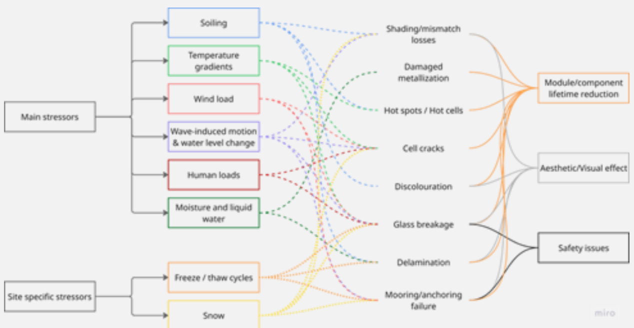
Report IEA-PVPS T13-39:2026, June 2026

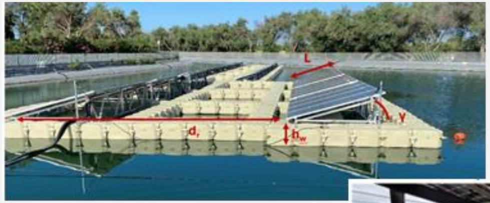
This report addresses application-specific optimisation of PV systems, focusing on the main technical challenges and design strategies for BIPV, FPV, and APV.

Optimisation of Photovoltaic Systems for Different Applications

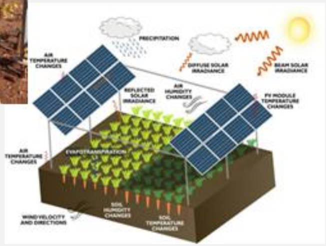
Stress factors and stress combinations acting on BIPV systems



Stressors, induced degradation mechanisms and failure modes in FPV modules.

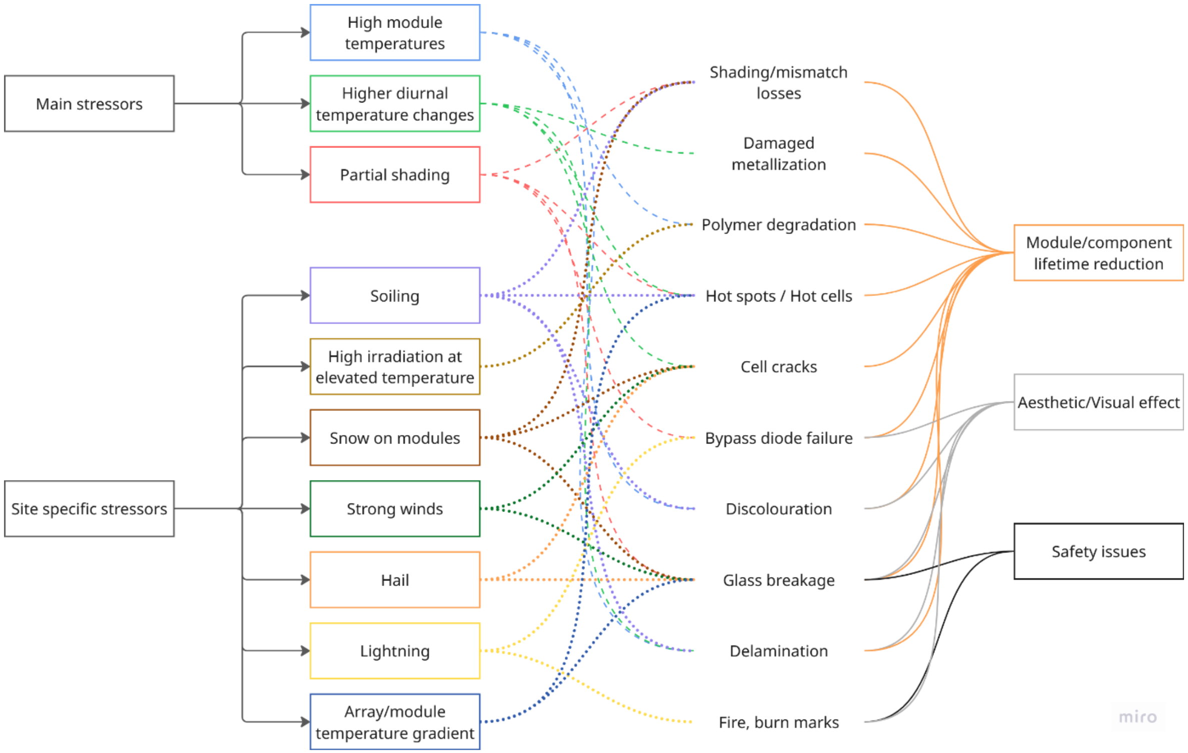


Stress factors acting on APV systems



Optimisation of Photovoltaic Systems for Different Applications

The Report identifies **key stressors** in three different applications and provides **recommendations** to address them.



Stress factors and stress combinations acting on BIPV systems

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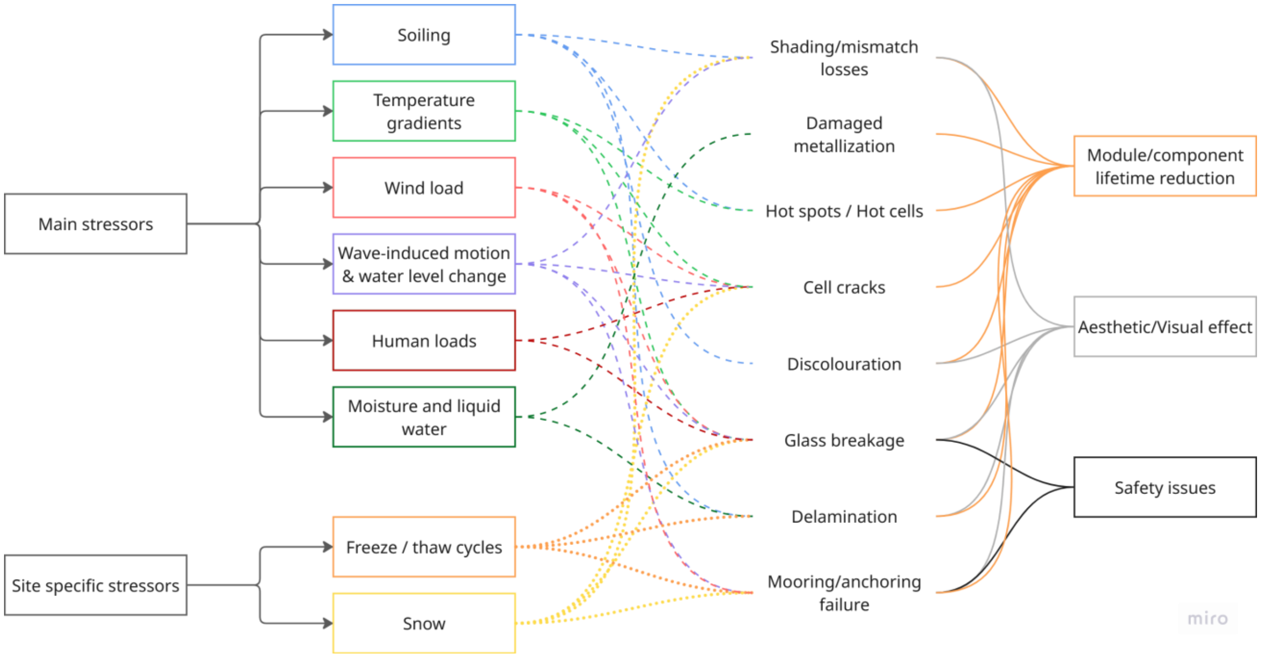
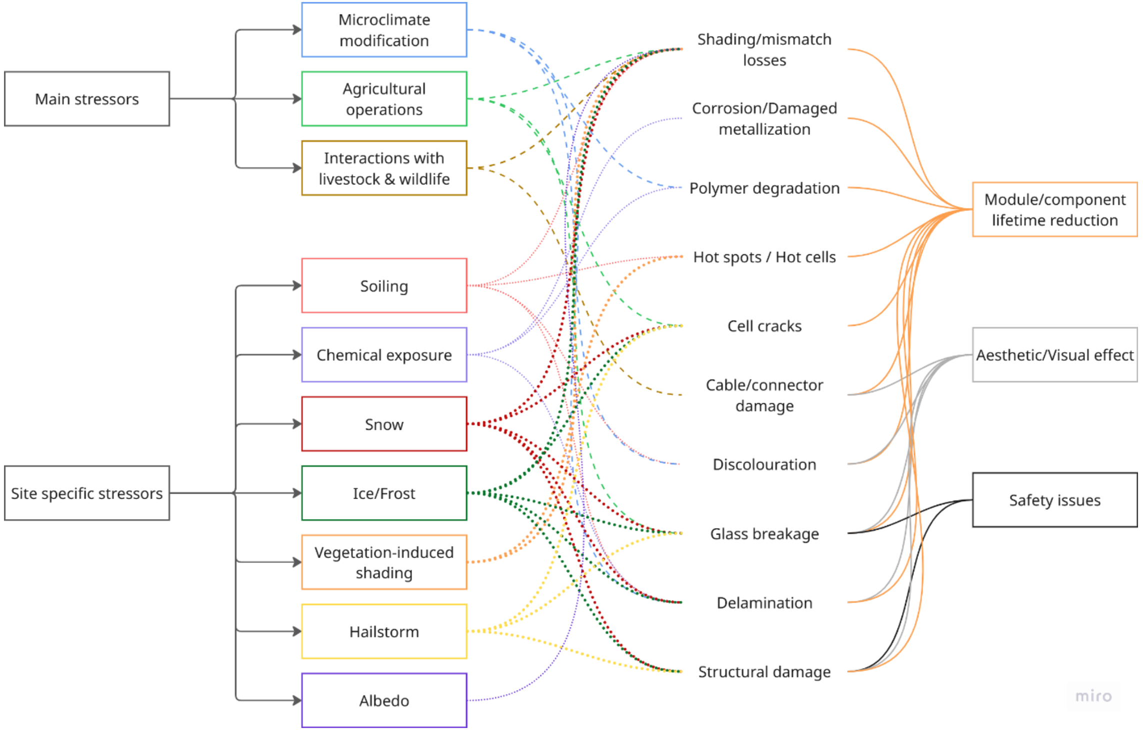


Stress factors, induced degradation mechanisms and failure modes affecting FPV systems

Optimisation of Photovoltaic Systems for Different Applications

The Report identifies **key stressors** in three different applications and provides **recommendations** to address them.



Stress factors and stress combinations acting on APV systems

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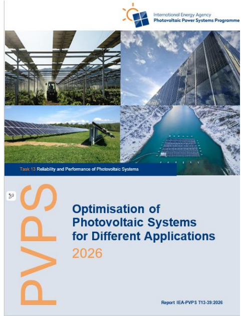
Key Takeaways

- Integrated PV applications like BIPV, FPV, and AV are driving future PV growth and addressing land-use and sustainability issues.
- Optimisation must now consider reliability, durability, environmental impact, and social acceptance, not just energy yield and cost.
- New stressors in integrated PV systems (e.g., shading, humidity, corrosion) mean standard approaches for ground-mounted PV are insufficient.
- Tailored design, materials, standards, and operational strategies are crucial for long-term performance and reliability of BIPV, FPV, and APV.



Report IEA-PVPS T13-39:2026, June 2026

Questions to the Experts

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IEA PVPS - Mission

IEA PVPS aims to:

- serve as a **global reference on PV** for policy and industry decision makers;
- provide a **global network for expertise**
- provide meaningful **guidelines and recommended practices** for state-of-the-art PV applications;
- contribute to advancing the understanding and solutions for **integration of PV power systems** in utility distribution grids;
- provide an **overview of successful business models** in various markets segments;
- to support the **definition of regulatory and policy parameters** for effective PV markets to operate.

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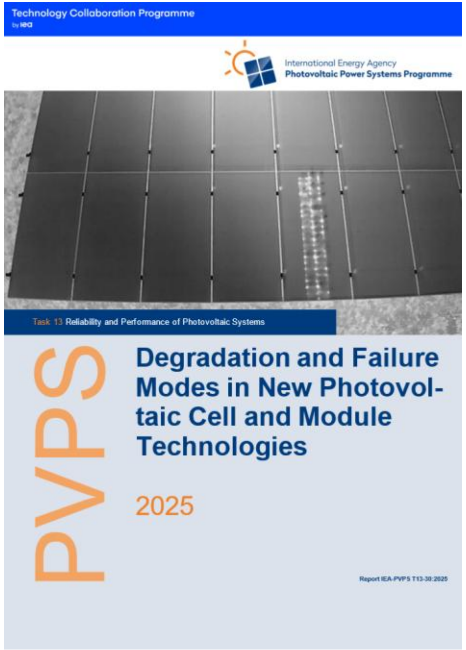
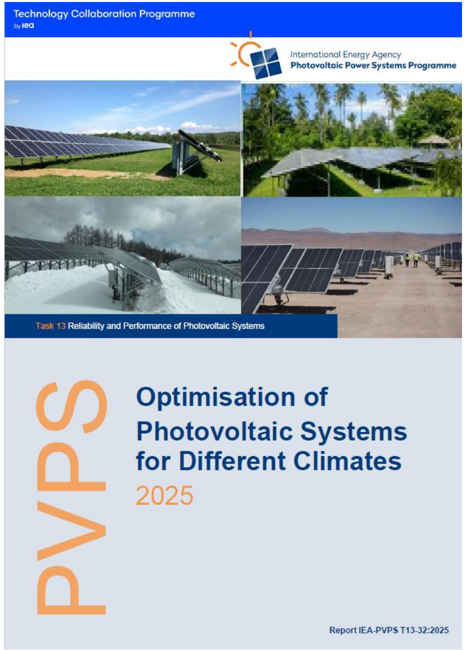


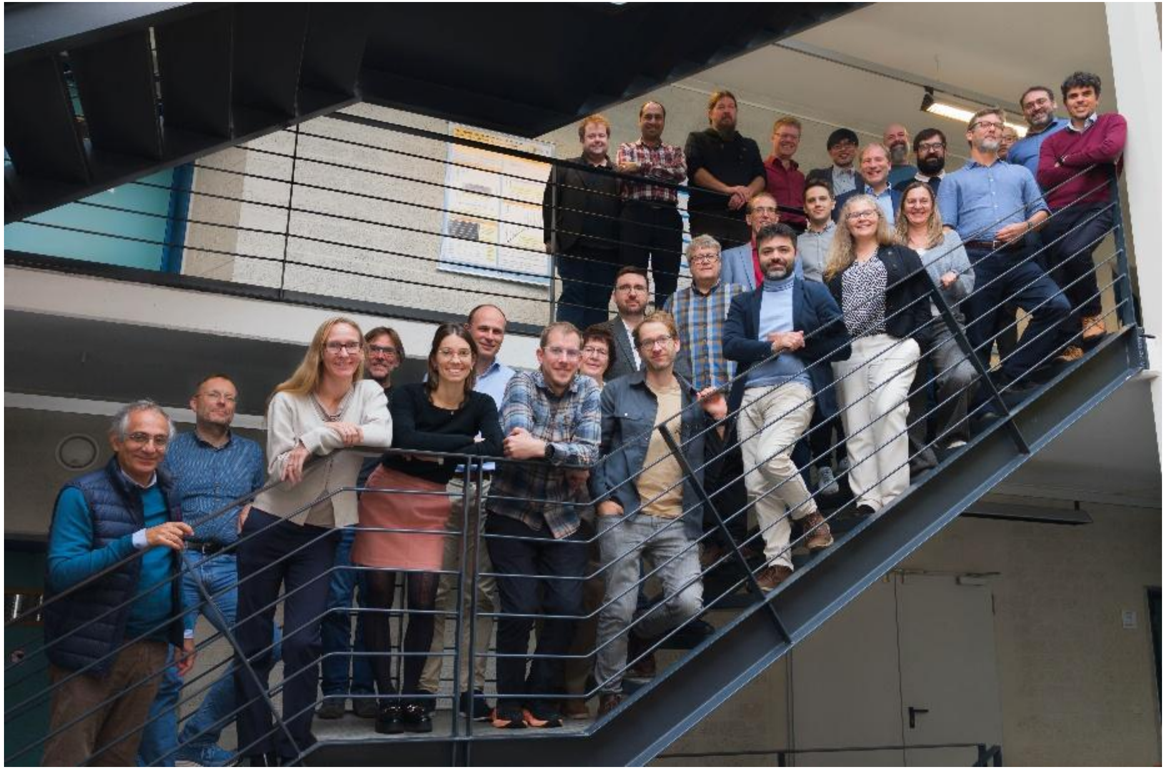


This report overviews currently known degradation modes and failures of PV module technologies and their mitigations.

The report explores strategies for enhancing the performance of PV systems in different climates.

Thank You!

IEA PVPS



PVPS Task 13 Collaboration: 125 experts from 25 countries