



International Energy Agency
Photovoltaic Power Systems Programme



PVPS

INSIGHTS

2025

PHOTOVOLTAIC POWER SYSTEMS TECHNOLOGY COLLABORATION PROGRAMME

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Insights 2025

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COVER PICTURE

PV system in China before sunset. Credit: huangyifei via istock.

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PHOTOVOLTAIC POWER SYSTEMS PROGRAMME



Figure 1: The Members of the Executive Committee and Task Managers at their meeting in Pamplona in October 2025.

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Cooperation and Development (OECD), which carries out a comprehensive programme of energy cooperation among its member countries. The European Union also participates in the IEA's work. Collaboration in research, development and demonstration (RD&D) of energy technologies has been an important part of the IEA's Programme.

The IEA RD&D activities are headed by the Committee on Research and Technology (CERT), supported by the IEA secretariat staff, with headquarters in Paris. In addition, five Working Parties on Industrial Decarbonization, Building and Transport, Fossil Energy and Carbon Management, Renewable Energy Technologies and Fusion Power, are charged with monitoring the various collaborative energy agreements, identifying new areas of cooperation and advising the CERT on policy matters.

The Renewable Energy Technologies Working Party (REWTP) oversees the work of twelve renewable energy agreements and is supported by the Renewable Energy Division, Directorate of Energy Market and Security at the IEA Secretariat in Paris, France.

IEA PVPS

The IEA Photovoltaic Power Systems Programme (PVPS) is one of the Technology Collaboration Programmes (TCP) established within the IEA, and since its establishment in 1993, the PVPS participants have been conducting a variety of joint projects in the application of photovoltaic conversion of solar energy into electricity.

The overall programme is headed by an Executive Committee composed of representatives from each participating country and organisation, while the management of individual research projects (Tasks) is the responsibility of Task Managers.

By the beginning of 2026, twenty Tasks were established within the PVPS programme, of which nine are currently operational. The thirty-one PVPS members include twenty-eight countries: Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, Korea, Lithuania, Malaysia, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom, and the United States of America; as well as the European Commission, Solar Power Europe and the Solar Energy Research Institute of Singapore.



MISSION AND OBJECTIVES

The mission of the IEA PVPS programme is:

Enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems.

The IEA PVPS programme aims to realise its mission through the following objectives related to reliable PV power system applications, contributing to sustainability in the energy system and a growing contribution to CO₂ mitigation:

- PV technology development
- Competitive PV markets
- An environmentally and economically sustainable PV industry
- Policy recommendations and strategies
- Impartial and reliable information.

CURRENT TERM 2023-2028

In its 7th term from 2023 to 2028 IEA PVPS continues its commitment to advancing international cooperation in the field of photovoltaic technology. With 31 member countries contributing to its success over the past 33 years, PVPS outlines a strategic orientation aimed at supporting the overarching goals of IEA in terms of energy security, climate change mitigation, and economic competitiveness. The focus of this strategic plan is to empower photovoltaic technology to not only meet but surpass the targets outlined in the IEA's "Net Zero 2050 Scenario."

The significance of photovoltaic technology has been steadily rising, with its emergence as one of the most cost-effective means of electricity production. Its attributes, including rapid deployability, ease of installation, and minimal maintenance costs, have positioned it as a key player in the global transition towards clean energy systems. Moreover, PV's impact extends beyond the energy sector, infiltrating various domains such as buildings, transportation, agriculture, and industrial processes.

IEA PVPS participants are undertaking collaborative efforts encompassing research, development, demonstration, analysis, and information exchange related to photovoltaic power systems. Emphasizing both technical and non-technical aspects, the aim is to facilitate the large-scale and sustainable deployment and operation of PV. This includes integration into energy systems and infrastructure while embracing the emerging concept of circularity.

Looking beyond 2030, the strategic plan anticipates addressing forthcoming challenges such as physical, technical, and economic integration, alongside policy, regulatory, and social acceptance considerations. Collaboration with stakeholders from diverse energy sectors, networks, storage, and digitalisation arenas will be intensified to foster innovation and address evolving needs effectively.



RESEARCH HIGHLIGHTS 2025

In 2025 there were over 350 Experts from 29 countries participating in the global collaborative research activities of IEA PVPS. In total, they published 30 reports and 7 Fact Sheets during 2025. What follows is an overview of the key messages from the published work of the IEA PVPS activities in 2025.

GLOBAL PV MARKET AND INDUSTRY ANALYSIS

2024 was another record year for solar PV, with between 553 GW and 601 GW newly installed worldwide. This volume is a 29% increase compared to 2023, which was almost double that of 2022, itself well above 2021 volumes – resulting from a combination of increased action on climate imperatives, plummeting module costs and actions in China to absorb manufacturing capacity.

China remained the dominant market, installing between 309 GW and 357 GW and accounting for nearly 60% of all new installations. The European Union followed with 66 GW, led by Germany (17.2 GW), Spain (8.7 GW), Italy (6.7 GW), France (6 GW), and Poland (4.2 GW). The United States installed 47 GW, a 40% increase compared to 2023, while India added 32 GW. In total, close to 35 countries now operate GW-scale annual markets, and over 40 countries have more than 4 GW cumulative capacity.

The [Trends in PV Applications 2025](#) report (also available as a [Fact Sheet](#)) highlighted several technological and market factors:

- Module efficiencies continue to improve, with n-type technologies now representing 70% of global production.
- Bifacial modules dominate the market, making up over 75% of production.
- Utility-scale systems accounted for about 62% of new installations, while distributed and prosumer markets continue to expand, driven by self-consumption and new business models.
- Dual-use applications such as agrivoltaics, floating PV, and infrastructure-integrated PV are becoming increasingly relevant, helping balance land use, food production, and renewable energy generation.

Deep-dive market analyses of individual countries can be found in the National Survey Reports published by IEA PVPS Experts from [Australia](#), [Austria](#), [Belgium](#), [Canada](#), [China](#), [France](#), [Italy](#), [Sweden](#) and [Switzerland](#). For an updated analysis based on the early market figures from 2025, look out for IEA PVPS [Snapshot of Global PV Markets](#) report, which is published every April.

➔ See more PVPS [market reports](#).

YEARLY PV INSTALLATION, MODULE PV PRODUCTION AND MODULE PRODUCTION CAPACITY 2014-2024 (GW)

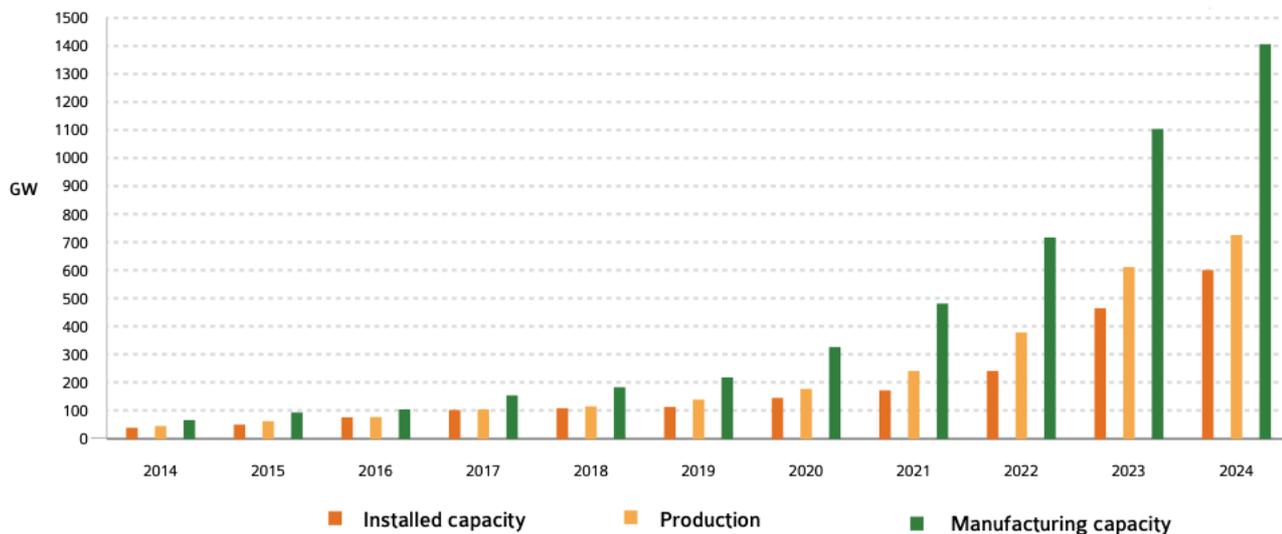


Figure 3: Yearly PV Installation, Module PV Production and Module Production Capacity 2014-2024 (GW) Source: IEA PVPS Trends in PV Applications Report, 2025.



IMPLEMENTING PV SYSTEMS IN DIFFERENT ENVIRONMENTS AND CLIMATES

PV plant design and operation vary according to the installation type and location. PVPS activities have assessed floating PV plants and agrivoltaic systems, as well as analysing PV systems in different climate zones and how PV systems fare are affected by extreme weather events.

AGRIVOLTAIC SYSTEMS



Figure 4: Sheep grazing next to Photovoltaic Panels. Credit: Lindsay France/ Cornell University.

As the energy transition accelerates and climate challenges intensify, agrivoltaics offers a promising solution for optimising land use by combining agriculture with solar power generation. There is a growing

need for harmonised definitions, reliable performance modelling, and supportive policy frameworks to enable the successful deployment of agrivoltaic systems globally. Modelling and simulation of agrivoltaic systems represent a pivotal task in reliably predicting agricultural and electrical performances and optimizing systems design.

Creating a common understanding of agrivoltaics seems key at this early stage of the market uptake. The diversity of agricultural applications represents a challenge for the definition of agrivoltaics, which varies globally, influenced by legislative, historical, and societal factors. More narrow definitions typically focus on productive agriculture (e.g., food, fibre, dairy), while wider definitions also include nonproductive agriculture (e.g., ecosystem services).

Unlike traditional agriculture or PV systems, monitoring of agrivoltaic systems requires the assessment of a much broader range of parameters. This task is especially complex due to the interactions between agricultural and PV-related factors. Regarding operation and maintenance, common challenges include the soiling and increased damages or corrosivity of PV components due to farming activities and plant protection agents.

Best practice examples of legal and socio-economic frameworks show that key factors for the successful implementation of agrivoltaic projects are early stakeholder involvement, a supportive policy environment and incentive programs, and transparent performance standards.

Read more in the report ‘[Dual Land Use for Agriculture and Solar Power Production: Overview and Performance of Agrivoltaic Systems](#)’ (also available as a [Fact Sheet](#)).

➔ See more PVPS publications about PV [performance](#) and [modelling](#).

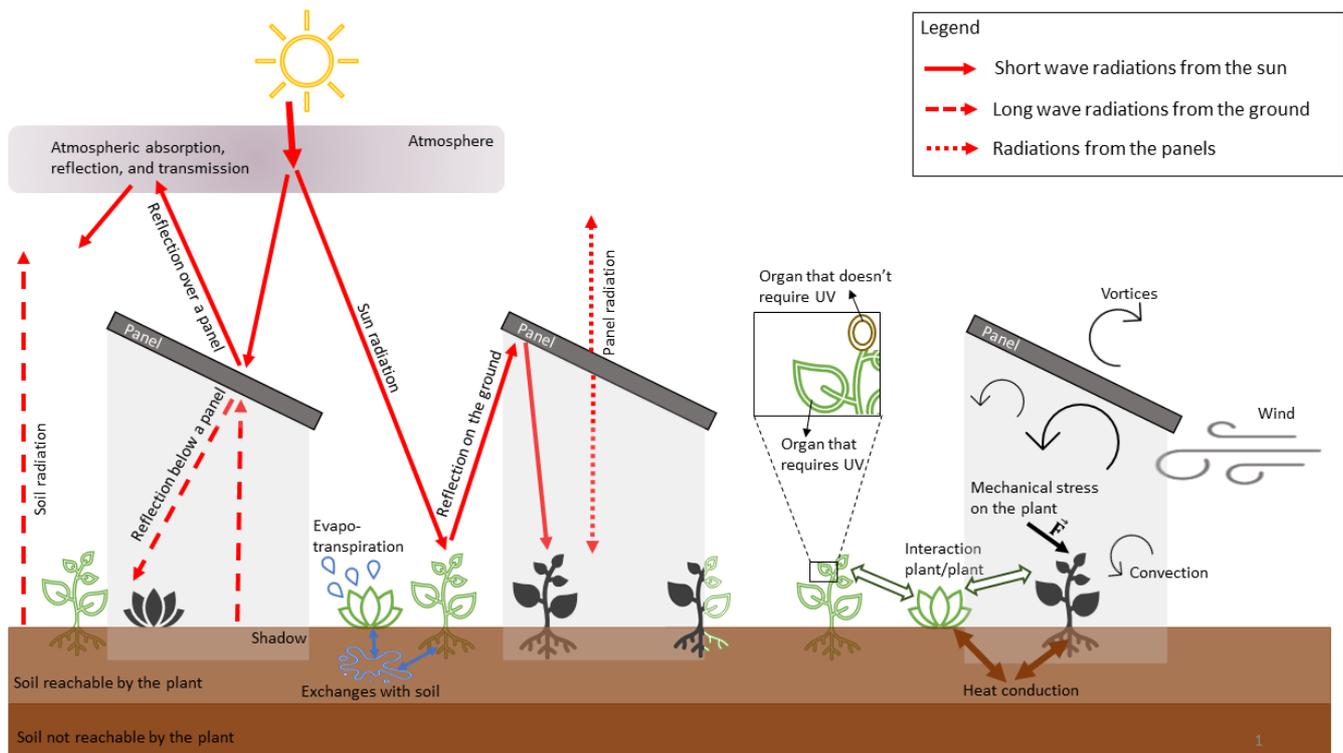


Figure 5: Diagram of the main physical phenomena within an agrivoltaic system and how they interact. Colour code: red (irradiance); blue (evapotranspiration); black (displacement of air, sensible heat); brown (heat conduction in the soil). Note that relevant weather phenomena, like rain, or energy removal by electric cables, are not shown here (Vernier, 2023).



FLOATING PV SYSTEMS



Figure 6: FPV power plant with ZIM Float technology installed in 2021 with a capacity of 13.7 MW at Lippe Gabriëlsplas in the Netherlands. Photo Credit: BayWa r.e.

Floating PV represents a promising approach to increasing solar energy capacity in land-constrained regions, enabling dual use of water surfaces. However, uncertainties remain regarding yield modelling, degradation mechanisms, and the development of cost-efficient O&M strategies.

The potential of FPV to expand solar capacity without land constraints is very promising. In order to accelerate the adoption of FPV, more work is needed to assess environmental impacts, address complex or missing regulatory frameworks, and reduce cost barriers.

Further improvements are needed in the accuracy of engineering judgements of FPV specific losses in energy yield assessments (EYA), for example by closing gaps in meteorological data and gaining more quantitative knowledge on loss mechanisms and degradation. Improvements and automation of monitoring and O&M practices, combined with more open sharing of data, can reduce costs during operation and support assessment of FPV specific stressors and reliability, ultimately leading to faster scalability.

Read more in the report ‘[Floating Photovoltaic Power Plants: A Review of Energy Yield, Reliability, and Maintenance](#)’.

➔ See more PVPS publications about [floating PV](#), [performance](#), [reliability](#) and [modelling](#).

PV IN DIFFERENT CLIMATES

As global PV deployment accelerates – driven by falling costs, advances in technology, and urgent climate goals – installations are increasingly located in challenging environments such as deserts, tropical regions, areas prone to hail damages, and cold, snowy areas. These regions often provide excellent solar resources but also introduce unique risks to PV system durability and performance, making tailored design and climate specific approaches essential.

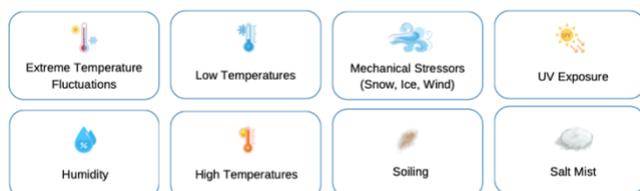


Figure 7: Climate-specific stressors to PV Systems.

In cases of limited knowledge about site-specific requirements and/or unavailability of climate-specific PV modules, standard products are

often deployed. Failure rates in harsh environments are increasing nowadays due to the push for cheaper modules, which has driven the trend toward larger PV modules with thinner glass, cheaper encapsulants and backsheets, and reduced frame thickness.

Durability in harsh conditions can be enhanced with reinforced front glass, improved frame geometries, micro-crack-resistant interconnections, and advanced encapsulants like POE or silicone. Special coatings for soiling, heat, snow, or corrosion are being explored, but further studies are needed to confirm their longevity and cost-effectiveness.

Very often, mitigation measures aimed at addressing one issue can inadvertently exacerbate another, making it essential to conduct thorough testing or gain a deeper understanding of actual load conditions to identify the most effective solution. Experience with climate-optimised PV modules is still limited, requiring more field data and lessons learned to be exchanged within the PV community.

Read more in the report ‘[Optimisation of Photovoltaic Systems for Different Climates](#)’ or in the related [Fact Sheet](#)

➔ See more PVPS publications about [PV in different climates](#) and [performance](#).

PV AND EXTREME WEATHER EVENTS

As extreme weather events become more frequent and severe, and global PV capacity continues to grow rapidly, understanding and addressing weather-related risks is increasingly important. The most relevant extreme weather events for PV systems include tropical cyclones, convective storms and hail, snowfalls, dust and sandstorms, heatwaves, floods and wildfires. The events cause both catastrophic damage, such as the destruction of modules or mounting structures, and sub-catastrophic damage that may not be immediately visible but can lead to accelerated performance degradation over time.



Figure 8: Damaged PV systems due to extreme weather events. Images: Laurie Burnham, Sandia National Laboratories.

Most PV plants can survive most extreme weather events, if appropriately sited, designed and maintained. Some weather events have short-term impacts and occur sporadically, e.g., tropical cyclones, convective storms (including hail), while others have longer-term impacts and tend to be repetitive, e.g., snow, dust storms, heatwaves, and wildfires. From an impact perspective, the damage that occurs to PV systems can be classified as acute or chronic.



From a resilience and mitigation standpoint, site planning is essential. Risk assessment based on a review of historical weather data and the probability of future extreme weather events for each location is crucial and must be addressed in the design phase. Once the threat landscape has been properly assessed, project developers, and owners must make informed design and procurement choices. All materials and structural components must be code-compliant; module architecture also matters, as in, modules specifically designed for hail resilience. In addition, review of the racking/tracking design, including hardware, by an independent engineer is strongly encouraged, and architects should pay close attention to the terrain and geological conditions at the proposed site. For example, when installing a PV system on sloped ground, the foundation should include features to prevent landslides triggered by tropical cyclones or flooding.

Site owners and operators should keep relevant commissioning documents, particularly those related to energy production in order to have a baseline against which future performance can be compared. Similarly, any electroluminescent (EL) and infrared (IR) images, along with records of visual inspections and I-V measurements, should be preserved. Electrical performance data combined with time-series weather data can help detect weather-related damage. Site owners and maintenance teams must be aware of the need to collect and preserve these data.

Robust operation and maintenance protocols are essential. Defects left unresolved after storm exposure may worsen over time when exposed to additional environmental stressors like heat, wind, and moisture. Proactive preventative maintenance is equally important and should be tailored to the probability of risk. Before a tropical cyclone, for example, the tightness of fasteners should be checked and any debris that could become airborne should be cleared from the site.

If damage from extreme weather does occur, immediate steps include 1) ensuring the safety of the site by disconnecting it from the grid and opening all breakers; and 2) conducting electrical and mechanical inspections of the affected PV system. Damaged equipment should be left in situ, pending insurance or other claim-related inspections but all damaged PV modules and electrical components must be replaced prior to re-energization.

Read more in the report ‘[Operational and Economic Impacts of Extreme Weather on PV Power Plants](#)’.

➔ See more PVPS publications about [PV in different climates, performance](#) and [reliability](#).

OFF-GRID PV SYSTEMS

Today, around 770 million people worldwide still live without electricity, with off-grid and edge-of-grid PV systems emerging as key solutions for affordable and reliable electrification. PVPS Experts have assessed the suitability of Li-ion battery technology for off-grid systems, and have compiled a catalogue of over 60 digital tools that can support planning and operation of off-grid systems.

LI-ION BATTERIES

Lithium-ion (Li-ion) batteries are reshaping off-grid PV systems and improving access to reliable, sustainable energy in remote regions. The PVPS activity has analysed technical performance, system classification, simulation studies and operational recommendations.



Figure 9: Lithium Ion battery storage system supplying a hospital in Haiti with 24/7 reliable power supply. PV is the main source of electricity, supported by two Diesel generators.

Li-ion batteries are now economically viable for large off-grid PV systems in the megawatt range, offering higher efficiency, longer lifetimes, and lower total costs than lead-acid batteries. System size determines the best technology: Li-ion performs best in very small and very large systems, while lead-acid can still be more economical in mid-sized applications.

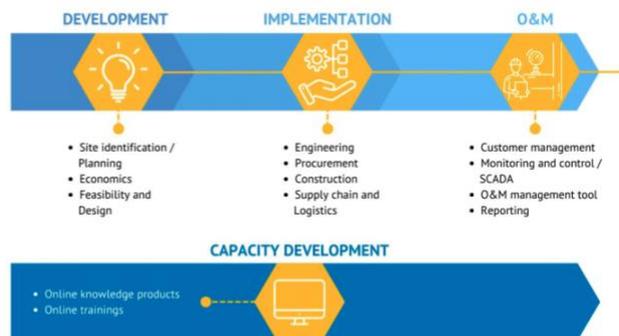
Long-term success depends on proper design, monitoring, and maintenance, including trained local operators, remote system supervision, and lifetime service contracts. Practitioners and project developers need practical tools to design, operate, and maintain systems that deliver long-term performance and resilience.

Read more in the report ‘[Li-Ion Battery Systems in Off-Grid Applications](#)’.

➔ See more PVPS publications about [energy storage](#) and [off-grid systems](#).

DIGITAL TOOLS

Digital tools can be strategically deployed throughout the entire off-grid project value chain – from development and implementation to operation and capacity building. Digitalization is not just a support tool; it’s a catalyst for transforming off-grid energy access into a smarter, scalable, and sustainable reality.



Graphic by Asantys Systems GmbH

Figure 10: Areas and categories of the project value chain.



Digital technologies are essential to improving the planning, performance, and sustainability of off-grid PV systems. Tools such as GIS-based site assessment, IoT-enabled monitoring, and remote troubleshooting are already improving system design and long-term viability.

PVPS Experts have created an open-access catalogue of over 60 digital tools, structured according to a four-phase framework: Development, Implementation, Operation & Maintenance, and Capacity Development. It is aimed at supporting developers, implementers, and policymakers to make informed choices to accelerate clean energy access.

Read more in the report '[Digitalization in Off-Grid Systems](#)'.

➔ See more PVPS publications about [digitalisation](#) and [off-grid systems](#).

SOLAR RESOURCE AND FORECASTING

Solar resources are introducing the highest share of uncertainty in yield assessments. Enhancing the quality of forecasts and resources assessments for PV can lower planning and investment costs, thereby reducing barriers to the grid integration of PV.

SOLAR IRRADIANCE MONITORING STATIONS

Ground-based measurements remain the most accurate method for determining solar surface irradiance despite continuous improvements in satellite-derived and reanalysis models. However, identifying and accessing high-quality irradiance measurements is challenging, largely due to incomplete information on available stations. Consequently, many studies use low-quality data or have poor geographical coverage, reducing the scientific outcomes.

To address this issue, a global catalog of multi-component solar irradiance monitoring stations has been created, streamlining the identification of relevant stations.

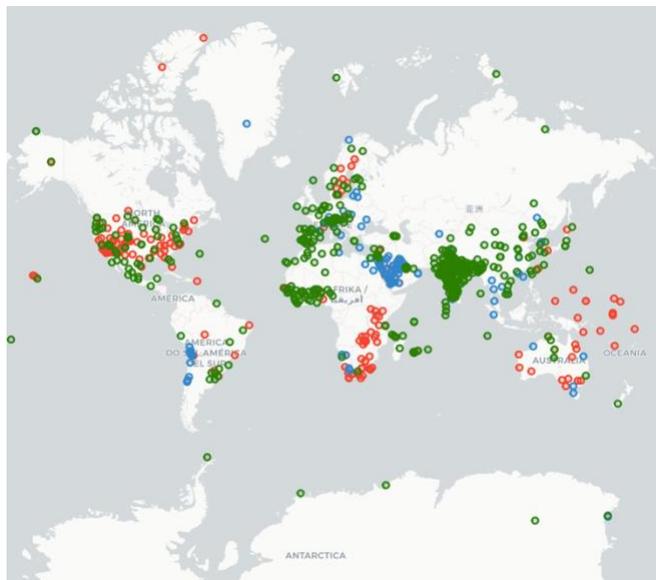


Figure 11: Solarstations.org, an overview of multi-component solar irradiance stations worldwide and supporting metadata.

Each station entry includes the following metadata: station name, location, elevation, owner, network, period of operation, data availability, instrumentation, and climate zone. The station catalog and an interactive map are available for free at www.SolarStations.org. As of April 2025, the catalog contained information on 808 stations, of which 440 were currently active. Only half of the active stations share data freely, highlighting a widespread issue of data availability. The catalog and website are developed openly on GitHub and welcome community contributions.

Read more in the article '[SolarStations.org—A global catalog of solar irradiance monitoring stations](#)'.

➔ See more PVPS publications about [solar resource](#), [forecasting](#) and [performance](#).

PROBABILISTIC FORECASTING

A probabilistic forecast provides a range of possible future outcomes with associated probabilities, rather than a single "point" prediction, helping decision-makers understand the uncertainty. In recent years, the prominence of probabilistic forecasting has risen among numerous research fields (finance, meteorology, banking, etc.). Best practices on using such forecasts are, however, neither well explained nor well understood.

A sound methodology already exists to evaluate the value of probabilistic forecasts of binary events. A methodology has now been developed for assessing the value of probabilistic forecasts of continuous variables, which is valid for a specific class of problems where the cost functions are piecewise linear. The proposed methodology is based on a set of visual diagnostic tools.

In particular, a new diagram called EVC ("Effective economic Value of a forecast of Continuous variable") provides the effective value of a forecast.

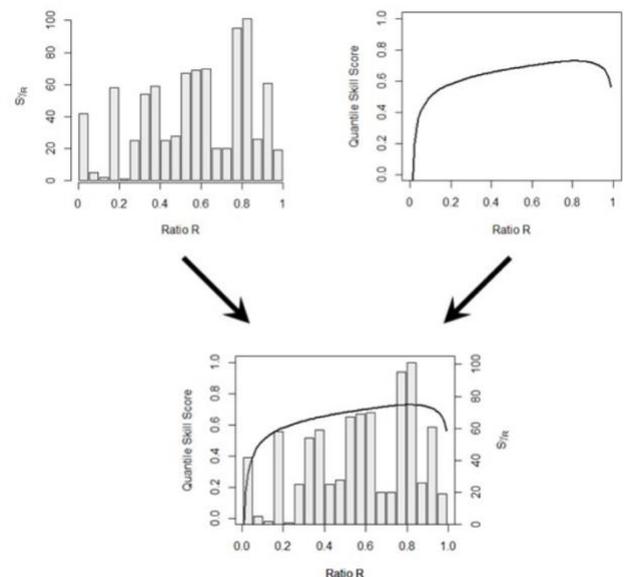


Figure 12: Construction of an EVC diagram.

Simple case studies show that the value of probabilistic forecasts of continuous variables is strongly dependent on a key variable called the risk ratio. It leads to a quantitative metric of a value called the OEV



(“Overall Effective Value”). The preliminary results suggest that typical OEVs demonstrate the benefits of probabilistic forecasting over a deterministic approach.

Read more in the article ‘[A Set of New Tools to Measure the Effective Value of Probabilistic Forecasts of Continuous Variables](#)’.

➔ See more PVPS publications about [forecasting](#).

EVALUATING THE QUALITY OF PROBABILISTIC FORECASTING

Probabilistic forecasting is increasingly recognized in academia and industry for its potential to further enhance the integration of variable photovoltaic power generation into electrical power grids. Hence, PVPS Experts have established a benchmarking exercise to evaluate the quality of intra-hour and intra-day probabilistic irradiance forecasts.

The exercise highlights different forecast quality depending on the method used, and more importantly, on the input data fed into the models. In particular, the benchmarking procedure reveals that the association of a point forecast that blends ground, satellite and NWP data with a statistical technique generates high-quality probabilistic forecasts. Therefore, in a subsequent step, an additional investigation was conducted to assess the added value of such a blended point forecast on forecast quality.

These results suggest that there are two important aspects to ensure consistent generation of high-quality intra-hour or intra-day probabilistic forecasts. The first aspect is to use blended point forecasts that optimally combine different sources of input data. The second point is to employ a post-processing with a statistical method to produce the quantile forecasts.

Read more in the article ‘[The added value of combining solar irradiance data and forecasts: A probabilistic benchmarking exercise](#)’.

➔ See more PVPS publications about [forecasting](#).

DEGRADATION AND LOSSES IN PV MODULES

PV technologies are changing rapidly as new materials and designs are entering the market. These changes affect the performance, reliability, and lifetime characteristics of modules and systems. Similarly, operation and maintenance aspects play a significant role, including the management of soiling.

DEGRADATION AND FAILURE MODES

The reliability and performance of photovoltaic modules varies with the module type. There are some challenges introduced by innovative technologies, including perovskite-based technologies, and there are also potential mitigation strategies.

Cell cracking issues are mitigated by multi-wire technology. Light and temperature-induced degradation is addressed by using gallium-doped wafers and improved manufacturing processes. Potential-induced degradation mechanisms can be reduced through targeted tests and adjustments at cell, module, and system levels. For example, UV irradiation during testing shows promise in minimizing degradation in

specific cell types like TOPCon. UV-Induced Degradation occurs in some PV modules but is manageable by using UV-stable designs and encapsulation materials. Degradation in polymer encapsulation materials remains a major issue, requiring new testing standards that combine stresses like UV radiation, humidity, and temperature. Thin glass in modern modules has shown higher breakage rates, necessitating multiple-module testing under real installation conditions. Faulty bypass diode connections in junction boxes pose safety and performance risks, hence 100% testing during production is recommended. Regarding perovskite-based PV module technologies, there are still plenty of reliability issues and many possible solutions, but they have not yet been evaluated in literature when combined in a single process solving all challenges at once.

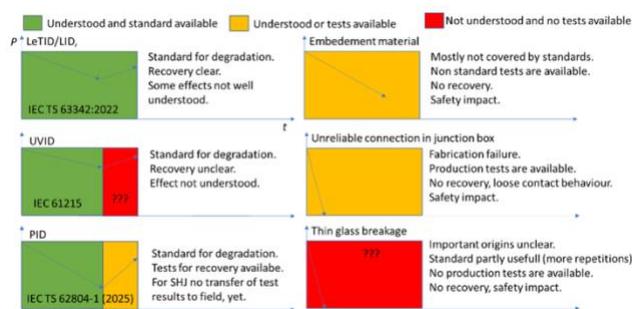


Figure 13: Overview of test availability and impact of currently relevant degradation modes of TOPCon and SHJ module designs.

Read more in the report ‘[Degradation and Failure Modes in New Photovoltaic Cell and Module Technologies](#)’ as well as in the annex ‘[Photovoltaic Failure Fact Sheets 2025](#)’, which is aimed at PV planners, installers, investors, independent experts and insurance companies.

➔ See more PVPS publications about [performance](#), [reliability](#) and [quality assurance](#).

SOILING LOSSES: MONITORING, MODELLING AND MITIGATION

PV technologies are changing rapidly as new materials and designs are entering the market. These changes affect the performance, reliability, and lifetime characteristics of modules and systems. Similarly, operation and maintenance aspects play a significant role, including the management of soiling.



Figure 14: Different types of soiling. Credit: (1) Kim Verduyck; (2) Kim Verduyck; (3) National Renewable Energy Laboratory; (4) Tihomir Betti, FESB, University of Split



Soiling, caused by dust, pollution, and biological debris, is a leading cause of PV underperformance, considered responsible for an average of 4% to 7% global energy loss and causes a multi-billion-euro loss every year worldwide. Soiling reduces the energy yield, raises O&M costs, accelerates degradation, and increases the uncertainty in PV production forecasts. Climate change will impact PV system operation and soiling might become a more severe challenge due to amplification of droughts and dust storms.

Soiling data should be included in the yield assessment to allow for the selection of adequate mitigation measures. Soiling measurements are often not available for the project's site of interest, but soiling can be modelled based on available meteorological data if the uncertainty is managed.

Soiling can be monitored using a comparison of power on a pair of devices, scattering-based non-imaging methods, microscope-based methods, lamp-based methods and module image-based methods (e.g. using drones). Soiling can be forecasted using climatologies, multi-year re-analysis data, persistence forecasts based on the most recent measurements of the soiling rate, statistical methods, machine learning approaches, or forecasts of meteorological data as input for soiling models.

Mitigation strategies must be tailored to local conditions and system/site characteristics. Cleaning is the most common solution, but optimal strategies should be put in place during the site assessment, component selection, and system design phases. Cleaning technologies should be selected based on site-specific factors such as water availability, system layout, and budget. Cleaning schedules must be optimized to balance the revenues from the recovered energy and the operational costs. As market conditions change, PV system designs and operational strategies evolve, and extreme weather intensifies, soiling losses and mitigation approaches become more complex and important.

Read more in the Fact Sheet '[Understanding, Measuring, and Mitigating Soiling Losses in PV Power Systems](#)'.

➔ See more PVPS publications about [performance](#) and [reliability](#).

PHOTOVOLTAICS FOR TRANSPORT

PV technology embedded in vehicles can significantly boost the sustainability of electric transport. PVPS Experts have recently analysed what it will take for VIPV to move from a niche applications into the broader transport market and tested the impacts of curved roof shapes on power generation uniformity. The work on PV-powered charging stations continues with further analysis of technical, economic, environmental, and social dimensions.



Figure 15: Lightyear PV car manufacturing in the Netherlands.

VEHICLE-INTEGRATED PV (VIPV)

VIPV reduces reliance on grid charging by generating clean electricity onboard, cutting CO₂ emissions and enhancing vehicle autonomy. Efficient solar EVs may achieve consumption as low as 9 kWh/100 km, and models like Lightyear 0 can travel up to 4,500 km annually on solar power alone. Cost reductions are driving adoption, with VIPV panel costs projected to fall below \$1/Wp, making onboard solar economically competitive.

Applications in trucks and buses already show promising returns, and technical advances, including tandem cell efficiencies and flexible panel integration, are paving the way for broader market uptake. VIPV has a key role in reducing infrastructure needs, with potential across transport modes, to be enhanced by ongoing efforts to optimize system efficiency.

Read more in the Fact Sheet '[PV Powered Vehicles VIPV](#)'.

➔ See more PVPS publications about [vehicles](#).

MARKET ENTRY OF VIPV

Over the past decades, VIPV has fascinated engineers and pioneers, yet bringing VIPV successfully into the mass market remains complex. For VIPV to succeed, clear advantages over competing technologies must be demonstrated, whether in cost, convenience, or unique value.

Past attempts to cross into the mass market often failed to move beyond the innovator and early adopter stages due to high costs, technical challenges, and insufficient customer advantages. Niche markets, such as trucks, buses, recreational vehicles and boats offer opportunities and may provide profitable early markets for VIPV.



Figure 16: Modern busses can use solar cells to replace Diesel. Credit: coop.ch.

High-efficiency PV cells may act as a driver because VIPV can be an outlet for cutting-edge solar cells exceeding 30% efficiency, where customers may accept a premium. Furthermore, bi-directional EVs, solar carports and household PV installations create synergies that can strengthen the case for VIPV.

Read more in the report '[Challenges Associated With the Market Entry of Vehicle Integrated PV](#)'.

➔ See more PVPS publications about [market](#) and [vehicles](#).

EFFECT OF CURVED VEHICLE ROOFS ON SOLAR PERFORMANCE

Curved PV roofs can affect the uniformity of solar irradiance and temperature, thereby impacting energy collection on vehicle-integrated photovoltaic systems (VIPV). Using a matrix approach, it was possible to monitor irradiance and temperature on curved PV surfaces, providing a precise and detailed analysis of energy collection dynamics.

Curved PV roofs for VIPV trigger irradiance and temperature non-uniformity, resulting in energy losses of 17% on sunny days and 6% on rainy days compared to a flat PV surface. To mitigate the effects of curvature-induced losses, the number of Maximum Power Point Tracking (MPPT) channels on curved PV surfaces can be increased, but this may increase costs. Alternatively, flatter PV surfaces could be used but this will affect vehicle aesthetics.

Read more in the report '[Irradiance and Temperature Uniformity on Vehicle Roof VIPV](#)'.

➔ See more PVPS publications about [vehicles](#).

PV FOR ELECTRIC CHARGING STATIONS

The technical, economic, environmental, and social dimensions of electric vehicle (EV) charging infrastructure are all important. Microgrid-based stations can integrate photovoltaic sources and smart energy management can be achieved through intelligent charging systems. However, user acceptance and the social acceptability of EV charging

infrastructure impact the successful implementation of electromobility solutions.

Using PV sources during daytime EV charging can reduce stress and energy allocation from the power grid. However, smart charging is essential and must go beyond the usual reduction of power available at charging terminals. Based on users' forecasted departure times, real-time control is able to fully recharge EV batteries while maximizing the use of PV energy during recharging. Depending on departure times, most EVs can be charged with more than 80% PV energy. Compared to traditional charging stations powered by grid electricity, the PVCS carbon impact is between 1.5 and 10 times smaller, depending on the energy mix implemented in the electricity grid.

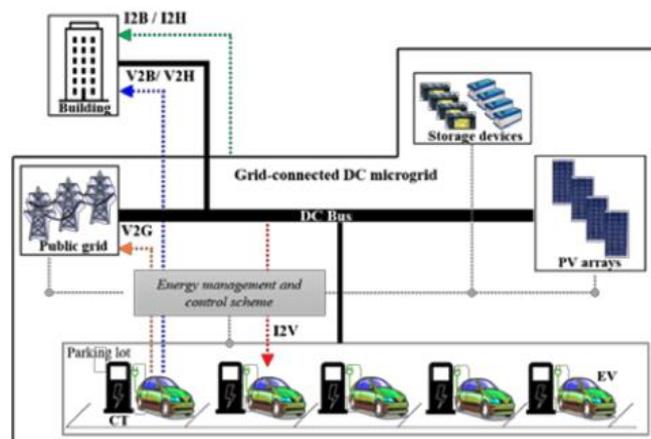


Figure 17: Example of an Intelligent Infrastructure for Recharging EVs.

Significant opportunities but also challenges exist with the integration of PV and EV charging. Applying consistent standards is essential to ensuring system reliability and public confidence.

Read more in the report '[PV-Powered Electric Vehicle Charging Stations: Requirements, barriers, solutions and social acceptance VIPV](#)'

➔ See more PVPS publications about [vehicles](#) and [infrastructure](#).

BUILDING-INTEGRATED PV

Building-Integrated Photovoltaics (BIPV) represents a paradigm shift in architecture and energy, transforming buildings into renewable energy generators by seamlessly integrating solar technology into roofs, façades, and external structures.

BIPV represents a promising approach to integrating solar power generation into buildings, yet in most countries, it remains a niche market. It is important to identify the key challenges, strengths, and opportunities for advancing BIPV towards broader commercial adoption.



TECHNICAL GUIDEBOOK FOR ARCHITECTS, ENGINEERS, BUILDING OWNERS AND POLICY MAKERS

With rising global energy demands and decarbonisation goals, BIPV offers a dual solution: advancing clean energy production while maintaining high architectural and design standards. However, widespread adoption of BIPV has been hindered by a lack of technical guidance and standardisation. A comprehensive step-by-step guidebook was needed to provide best practices and empowering decision-makers with practical tools to successfully implement BIPV systems.



Figure 18: Semi-transparent BIPV Skylight using c-Si solar cells at a school, in Courbevoie, France. Credits: MTECH & CSTB.

Technical drawings provide detail on BIPV integration in roofs, façades, shading systems, and infrastructure. Many real-world case studies showcase BIPV solutions in diverse climates and architectural settings. Best practices assist decision-making, from site assessment to energy modelling, business models, and sustainability analysis. An in-depth analysis of BIPV system performance covers electricity generation, thermal behaviour, daylighting, acoustic insulation, and safety aspects. Guidance is given on long-term operation & maintenance strategies to ensure system durability and efficiency.

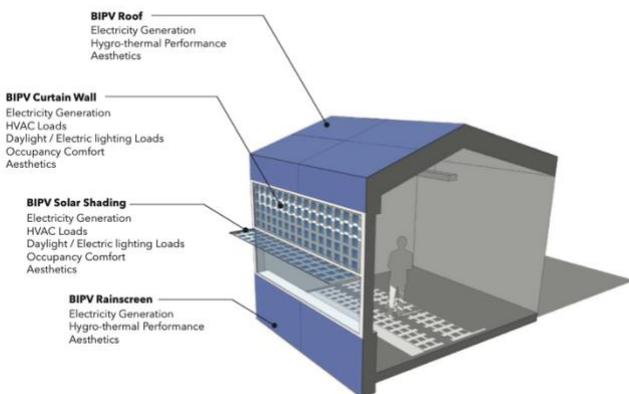


Figure 19: Major interactions between BIPV application, building systems, and occupants should be assessed and optimised using building performance simulations. Adapted by NRCan.

Read more in the book '[Building-Integrated Photovoltaics: A Technical Guidebook](#)'.

➔ See more PVPS publications about [product innovation](#) and [building integration](#).

COMPARING BIPV INNOVATION ECOSYSTEMS IN SEVEN COUNTRIES

The markets for BIPV in Austria, Australia, Finland, Italy, the Netherlands, Spain, and Sweden remain niche, with integrated roof systems using regular-sized PV modules as a leading application in all countries except Spain. Spain and Austria lead in PV glazing façade applications.

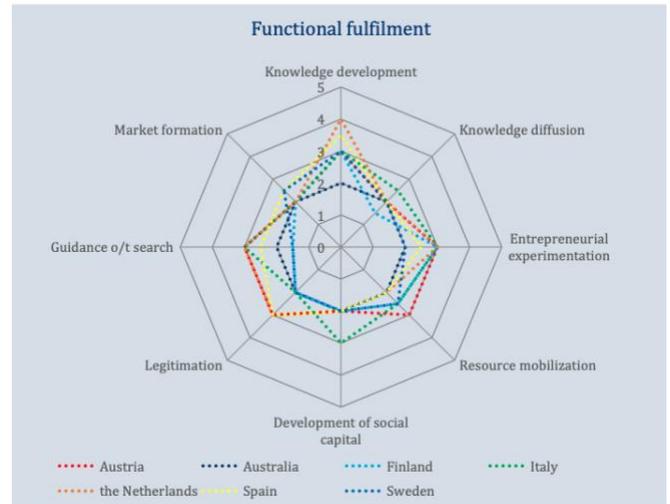


Figure 20: Results of the fulfilment assessment of the TIS-functions. Numbers indicate the degree of fulfilment: 1 – absent; 2 – weak; 3 – moderate; 4 – strong; 5 – excellent.

Common barriers across these countries include weak collaboration between the PV and construction industries, limited institutional support (economically, technically, or culturally), and the perception that BIPV lacks legitimacy as a standard construction product.

To overcome these challenges, it is recommended to engage new actors in BIPV to create a more diverse and robust innovation ecosystem. Collaboration across the value chain must be enhanced through joint actions such as roadmaps, market development strategies, and knowledge-sharing initiatives. The cultural and operational divide between the solar and construction sectors must be bridged, for example, by requiring cross-sector collaboration in tenders and funding calls.

Countries should support innovation and technological advancements, and improve regulations, standardisation, and technical guidance to ensure BIPV products are recognised as legitimate construction materials. Targeted incentives and regulatory measures should be created to stimulate market demand for BIPV solutions. More education, training, and knowledge transfer is needed to equip industry stakeholders with the necessary expertise to integrate BIPV effectively.

Read more in the report '[Analysis of Technological Innovation Systems for BIPV in Different IEA Countries](#)'.

➔ See more PVPS publications about [policies](#), [countries](#), [product innovation](#) and [building integration](#).



REDUCING COOLING DEMAND IN INTEGRATED PHOTOVOLTAICS

The solar heat-gain coefficient (SHGC) is a key indicator of how much solar radiation is transmitted through transparent building envelope components (such as windows or curtain-wall) and converted into heat. A potential benefit of BIPV modules is the reduced amount of received solar energy that is transferred into indoor spaces, reducing therefore cooling demand. Methodologies are needed to assess the SHGC of BIPV modules used as architectural glazing, considering also that part of the absorbed solar energy is converted into electricity, and should be included in international standards.

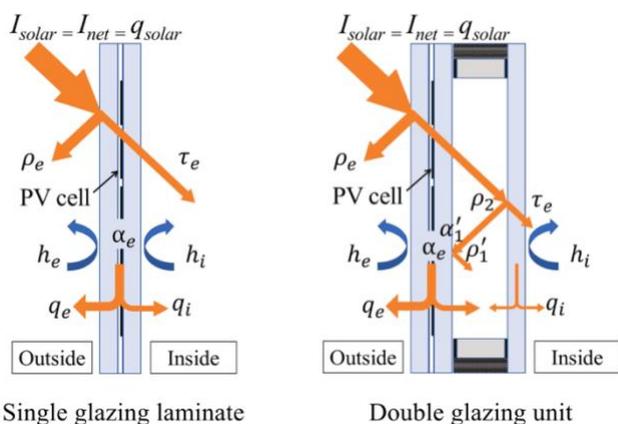


Figure 21: Glazing configurations of single-glazed and double-glazed BIPV modules in the open-circuit (OC) state.

Two existing approaches were successfully modified and proposed by Task 15 experts, for application to BIPV modules: calorimetric measurements and component-based calculation methods. It was confirmed that the SHGC decreases when electricity is generated and extracted, with the reduction depending on the PV cell coverage ratio and the thermal properties of the glazing. Existing international standards for conventional glazing were adapted to account for typical characteristics of BIPV, allowing improved comparability and accuracy in SHGC assessment of BIPV glazing units (currently in the public enquiry phase).

Read more in the article ‘[Solar Heat Gain Coefficient of BIPV modules for electricity-generating facades](#)’.

➔ See more PVPS publications about [building integration](#) and [standardisation](#).

RECYCLING OF PV

As global PV deployment grows rapidly, the management of modules at the end of their lifetime is becoming increasingly important. Although PV systems are designed for long service lives, significant volumes of end-of-life (EOL) modules are expected in the coming decades.

Recycling plays a central role in ensuring the sustainability of PV by recovering valuable materials and reducing environmental impacts. However, scaling up recycling capacity and improving economic viability remain key challenges.

IEA PVPS experts have assessed regulatory frameworks, technological developments, and market conditions to support the expansion of effective PV recycling systems.

STATUS OF PV MODULE RECYCLING IN VARIOUS COUNTRIES

PVPS Experts examined the current state of PV module recycling, regulatory developments, and emerging technology trends in countries across the globe. The goal was to provide the evidence base and practical knowledge needed to scale up recycling capacity, improve economic viability, and ensure recovered materials feed back into the PV supply chain. As the volume of end-of-life (EOL) modules grows in the coming decades, effective recycling will be critical to ensuring that PV remains a sustainable cornerstone of the global energy transition.

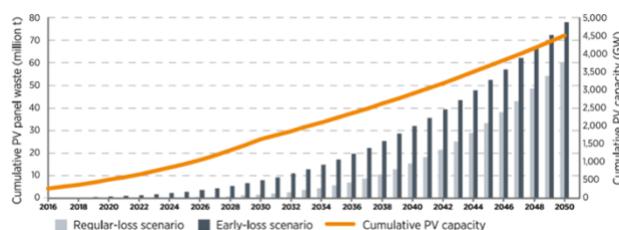


Figure 22: Estimated cumulative global volumes of EOL PV modules by IRENA/Task 12 in 2016

Regulatory frameworks are evolving worldwide. The EU has adopted the WEEE Directive for PV waste. In other parts of the world, legislative and regulatory frameworks for PV module waste are installed or in preparation. Regardless of whether there are PV-specific waste regulations, many companies are treating PV module waste for proper EOL management and recycling, and the number has increased since it was surveyed three years ago.

The current low volumes, limited recycling technologies, logistics challenges, and underdeveloped markets for recovered materials result in a high-cost, low-revenue scenario for PV module recycling today. Further improvement in the PV recycling capacity and technology is needed and the values of recovered materials such as critical minerals must be considered.

Technology development is broadening the scope of recycling. PV module recycling technology is expanding from delamination to metal recovery as well as exploring more valuable markets for recovered materials. Enabling the use of recovered materials in new PV cells/modules and other high-value markets are ultimate targets, whereas impurities and additives remain issues to be solved. Recycled materials from PV module waste could play a significant role in material supply for PV module production and other industries.

Read more in the report ‘[Status of PV Module Recycling in IEA PVPS Task 12 Countries](#)’.

➔ See more PVPS publications about [recycling](#), [circular economy](#), [sustainability](#) and [countries](#).



STANDARDISATION

For any industry growing and developing as rapidly as the photovoltaic sector, it is difficult, and yet critical, for the development of the necessary standards to keep pace. PVPS Experts frequently focus on various aspects of the standardization procedures, including most recently analyses of relevant sustainability standards as well as BIPV standards.

SUSTAINABILITY STANDARDS

Sustainability standards for PV are evolving rapidly, but significant gaps and opportunities remain – particularly in end-of-life management and the inclusion of robust social criteria. PVPS Experts have mapped the current landscape of regulatory and voluntary frameworks that influence the industry's environmental and social performance. A wide disparity in maturity is noted, from long-standing EU regulations to emerging ecolabels with limited uptake.

Streamlining and harmonising standards could reduce reporting burdens and accelerate sustainability progress across the PV value chain. Standards can be classified into three categories — sectoral reporting, product-related standards, and regulatory frameworks. Policymakers, industry stakeholders, and researchers must collaborate to align PV practices with the United Nations Sustainable Development Goals.

Read more in the report '[Review of PV Sustainability Standards 2025](#)'.

→ See more PVPS publications about [standardisation](#), [policies](#), [countries](#), [circular economy](#) and [sustainability](#).

BIPV STANDARDS

The development of the Building-Integrated Photovoltaics (BIPV) sector faces several key challenges, some of which could be reduced with the improvement of standardization for BIPV. The testing procedures for BIPV products could be in certain cases very complex, with some redundant testing and certifications. Unclear procedures, along with higher costs and long timelines, hinder the adoption of BIPV in certain markets. There are regulatory gaps because existing standards mainly focus either on PV or on buildings, but not on the specific requirements for BIPV.

A unified performance-based testing tailored to façade or roof conditions (thermal, impact, water) can better support the adoption and implementation of BIPV in the construction sector. Unified processes and integrated retesting frameworks would reduce unnecessary duplication and simplify compliance pathways.

Harmonising the standards for BIPV could ensure safety, reliability, and performance consistency across global markets. Market access for manufacturers would be simplified, which would foster international collaboration. BIPV adoption could be promoted to meet renewable energy and building efficiency goals.

Read more in the Fact Sheet '[Advancing BIPV Standardization - Addressing Regulatory Gaps and Performance Challenges](#)'.

→ See more PVPS publications about [policies](#), [standardisation](#) and [building integration](#).

UPDATES FROM OUR TASKS





TASK 1

STRATEGIC ANALYSIS AND OUTREACH

Task Managers: Melodie de l'Epine, Becquerel Institute, France
Izumi Kaizuka, RTS Corporation, Japan



Figure 23: Task 1 members at their meeting in Berlin 2025.

INTRODUCTION

Task 1 continuously researches the drivers and status of PV development both in IEA PVPS countries and globally. It provides at least two reports or special events annually, highlighting the key developments in the PV sector.

CURRENT FOCUS TOPICS

In 2025 Task 1 focused on supporting robust PV market and industry intelligence reporting while addressing the emerging economic and operational constraints in high PV penetration regions. System integration in countries with mature deployment and increasingly high penetrations was a focal point, notably grid capacity, flexibility needs, curtailment drivers, negative price episodes, and the role of decentralised and utility scale storage and demand side measures as enabling tools rather than standalone objectives. Exchanges on the increasing politicisation of PV deployment, supply chain and

manufacturing positioning, and the need for communication, repositories, and stakeholder targeted outputs that translate technical evidence into actionable policy and regulatory insight were also important.

2025 KEY ACCOMPLISHMENTS

A Snapshot of Global PV Report

The Snapshot of Global PV report is compiled from the preliminary market development information provided annually by all countries participating in the IEA PVPS Programme. Published in April, the Snapshot report provides a first sound estimate of the prior year's PV market. Task 1 members collect and share data in the report, supplying an early look at the previous year's market developments and policy drivers. The 2025 report highlighted the increasing impact of grid congestion and oversupply at specific moments leading to curtailment, as well as the continued over-capacity in manufacturing.



Trends in Photovoltaic Applications Report

Compiled from data collected for the annual National Survey Reports (NSR; below) and information supplied by a worldwide network of market and industry experts, the Trends in Photovoltaic Applications report presents a broad view of the current status and trends relating to the development of PV globally. It provides accurate information on the evolution of the PV market and the industry value chain, with a clear focus on support policies and the business environment, whilst also bringing an in-depth analysis of the drivers and factors behind PV market development and an analysis of the global PV market and industry.

Funded by the IEA PVPS Programme, it is prepared by a small editorial group within Task 1 and is communicated by Task 1 participants to their identified national target audiences, at selected conferences and meetings and can be downloaded from the IEA-PVPS website with all previous editions. A summary is published in PV Magazine, and its results are disseminated widely in industry media.

National Survey Reports

A key component of the collaborative work carried out within the PVPS Programme, the National Survey Reports (NSR) provide a detailed look into what has happened in the specific country over the year. Written (and funded) by the country teams, the reports build on Task 1 discussions on effective data collection across the range of subjects addressed, from national market frameworks, public budgets, the industry value chain, prices, economic benefits, new initiatives including financing and electricity utility interests. Nine reports covering 2024 were published on the www.iea-pvps.org website over the 2nd semester, with the first becoming available from July.

Meetings in Canada & Berlin

Task 1 meetings were held in June (Montreal) and October (Berlin). At each of these meetings, members shared the current market status and exchanged on the impact of increasing penetration in member countries and wider. Fruitful discussions with local stakeholders in each city highlighted transferable learnings. In particular, discussion with T15 members in Montreal centered on the different ways BIPV and other PV markets evolve, and the resulting impacts on building envelope, safety, reliability and insurance expectations. Local stakeholders discovered the similarities in climatic and energy mixes/grid architectures in Canada and Nordic countries, with interest in follow up exchanges to build on lessons learnt. In Berlin, focal subjects included the growing PV/storage nexus and evolving data harmonisation. Core technical themes in the local stakeholders workshop included curtailment dynamics, negative prices, grid capacity constraints, ramping and market time step effects, controllability requirements for distributed PV, and emerging ancillary service and inertia market arrangements; a follow-up meeting with a member of parliament extended discussion to wider social acceptability issues.

Dissemination Events

A webinar to present the Snapshot findings was held in April 2025, and results were presented at IEEE PVSEC-53 in Canada in June. The main findings of the Trends in PV Applications were presented at EUPVSEC in September (Spain), followed by a webinar in October 2025. A parallel event was held at EUPVSEC to bring together industry and research perspectives on the impact of grid congestion, curtailment and negative prices on the current and future development of PV.

→ [Learn more about Task 1](#)



TASK 12

PV SUSTAINABILITY ACTIVITIES

Task Managers: Garvin Heath, NLR, USA
Etienne Drahi, Total Energies, France



Figure 24: Task 12 experts at their meeting in Freiburg, Germany in 2025.

INTRODUCTION

Within the framework of PVPS, Task 12 endeavors to promote international collaboration, facilitate information exchange, and drive knowledge creation in the realm of PV sustainability, encompassing both environmental and social dimensions. It generates, compiles, and disseminates both primary and secondary information to technical experts, the public, and policymakers alike.

Accurate information regarding the environmental and social sustainability of photovoltaic technology is essential for various purposes, be it conducting due diligence to navigate risks and opportunities associated with PV systems or educating consumers and policymakers about their impacts and benefits. By enhancing consumer

confidence and garnering support from policymakers, this information contributes to the broader adoption of PV energy systems, thereby advancing the global energy transition.

CURRENT FOCUS TOPICS

Within subtask 1, Task 12 is currently trying to develop non-recycling activities within a circular economy. For example, the experts are preparing a report on repair of PV modules to extend the lifetime and use of degraded equipment, also a report on critical material demand scenarios for PV in terawatt era is being finalized leading to a better understanding of potential bottlenecks in material supply chain due to strong growth of PV deployments. Also, a series of status and trends of PV recycling in several countries is under work.

Regarding Life Cycle Analysis, a major update of our Life Cycle Inventory will be published around mid-2026. This LCI will contain new data from state-of-the-art cells and modules as well as new Balanced of System data based on new sources. The team is changing the way to generate new LCI data to provide much quicker state of the art LCI while not reducing the quality. Several Life Cycle Assessments are also ongoing (PV recycling pathways in France, PV recycling pilots and plants...).

On the Ecosystem integrated PV (EcoPV) topic, strong involvement of our team in the Agrivoltaics Action Group needs to be mentioned and a report on Field research methods for Agrivoltaics applications is being finalized. A study on the environmental impacts of Floating PV on coral reef is ongoing in French Polynesia with already 2 years of data acquisition and treatment. The project is continuing.

Finally on the broader sustainability topic, we are willing to extend our workplan on the public acceptance area while a journal article on a comparative analysis between Spain and Australia of acceptance of residential PV should be published this year.

Task 12 is always eager to welcome new experts who can support and complement our existing workplan.

2025 KEY ACCOMPLISHMENTS

In 2025 Task 12 published 3 reports, also welcomed 5 new experts, added 1 new country, bringing our global numbers to 35 experts (29 academic and 6 industrial researchers), 10 alternates, from 14 countries.



Our Task 12 experts met twice in 2025, in Denver, Colorado, USA in March and in Freiburg, Germany in December. Both meetings were the opportunity to engage more globally with the community. In Denver we organized a hands-on training on the topic “field inspection for Solar PV reuse” by Rich Stromberg, while in Freiburg Task 12 experts contributed to Solaris project ([SOLARIS – Supporting optimisation of photovoltaic resource efficiency and sustainability](#)) Workshop.

Additionally, to our meetings Task 12 organized a Parallel event at EUPVSEC 2025 in Bilbao on the topic “Latest Work on Sustainability and Circularity of PV”. This event attracted ~50 people interested in exchanging on PV circular Economy, Life Cycle Inventory of PV Recycling Processes and Facilities, as well as PV Sustainability Standards.

→ [Learn more about Task 12](#)



TASK 13

RELIABILITY AND PERFORMANCE OF PV SYSTEMS

Task Managers: Ulrike Jahn, Fraunhofer CSP, Germany
 Giosuè Maugeri, RSE, Italy
 Laura Bruckman, Case Western Reserve University, USA



Figure 25: Task 13 experts at their meeting in Hameln, Germany in 2025.

INTRODUCTION

Within the framework of PVPS, Task 13 aims at supporting market actors to improve the operation, the reliability, and the quality of PV components and systems. Operational data of PV systems in different climate zones compiled within the project will allow conclusions on the reliability and yield estimations. Furthermore, the qualification and lifetime characteristics of PV components and systems shall be analysed, and technological trends identified. Task 13 will continue to provide a unique and fundamental analysis of PV components and systems, including new applications such as floating PV, performance and reliability of PV systems in greater arctic and alpine regions, and the impact of soiling on PV power plants that affect the reliability and performance of PV systems in different environments during their lifetime.

CURRENT FOCUS TOPICS

In its fourth phase (2026–2029), IEA PVPS Task 13 focuses on PV technologies evolution driven by the introduction of new materials and innovative design to the market. For many of these emerging technologies, long-term field data remain limited, and their real-world performance under diverse climatic and operational conditions is not yet fully understood. Furthermore, the interaction between new materials, cell architectures, and module designs may lead to the emergence of previously unobserved degradation mechanisms and new types of failure modes. Such information on new technology - and how these new technologies interact with each other - is of great importance to investors, manufacturers, plant owners, EPCs and plant operators. These stakeholders are keenly interested in gaining more information about such technological innovations.



The digitalisation and robotisation of inspection activities in PV plants are becoming fundamental tools to ensure high system performance while maintaining O&M costs at competitive levels. This is particularly relevant for PV operators managing an ever-growing portfolio of plants, often reaching gigawatt scale. While modern monitoring systems are already capable of collecting high quality operational data, current analytical tools need to be further developed to effectively support O&M decision-making leveraging advanced data analytics and generative AI approaches. These advanced tools can support automated reporting, anomaly interpretation, predictive scenario analysis, decision-support systems, and the creation of digital twins, thereby enhancing fault diagnosis and accelerating corrective actions. Task 13 will focus on strengthening the reliability of photovoltaic systems through advanced digital O&M solutions. Key areas of work include data standardisation, ontology development, fast localization of faults and maintenance automation. This also includes studying advanced diagnostics combined with robotic solutions for continuous monitoring and targeted interventions. Furthermore, the development of automated O&M pipelines — combining structured data frameworks, machine learning, and generative AI — will be pursued to optimise the design, operation, and long-term management of PV plants.

The performance and durability of emerging PV applications are another current focus of Task 13. This includes delivering nearshore and offshore floating PV (F-PV) systems with accurate energy yield analysis, investigating the impact of F-PV on specific environmental parameters and looking for the optimised design for accelerated ageing tests for PV modules installed in F-PV applications. For PV systems in Greater Arctic and Alpine regions, recommendations will be made to increase reliability and performance by collecting research results, real-world experiences and case studies of PV systems in greater arctic regions and at high altitudes. The aim is to minimise the risks of expanding PV in greater arctic and Alpine regions and to enable accurate performance forecasts. Additionally, Task 13 will quantify the impact of soiling on PV energy yield today and in future scenarios. The overall aim is to review and compare current monitoring technologies and models, identifying strengths, limitations and gaps between theory and application.

As PV systems mature and increasingly integrate with energy storage, the need for robust lifetime management and asset optimization strategies becomes critical. Operators are increasingly faced with decisions on how to maintain, upgrade, or repower aging systems while ensuring safety, reliability, and long-term economic viability. Task 13's current work focuses on the system-level enablers that influence long-term PV performance, including battery energy storage systems (BESS) and repowering strategies. The Task 13 examines degradation mechanisms, operational challenges, and techno-economic trade-offs associated with these components, providing actionable insights to support data-driven asset management and investment decisions.

2025 KEY ACCOMPLISHMENTS

In 2025, Task 13 published 5 technical reports, and prepared & published 4 Fact Sheets, which can be downloaded from the PVPS website.

Task 13 organised 5 dedicated workshops & webinars on various topics with relevant stakeholders in 2025:

- Task 13 Workshop: **Bifacial Tracking Systems**, Rome, Italy, 27 February 2025
- Task 13 Workshop: **Strategies for Addressing Important Degradation and Failure Causes of Current Module Types**, Copenhagen, Denmark, 29 April 2025
- Task 13 Workshop: **Impacts of Extreme Weather on Photovoltaic Power Plants**, Munich, Germany, 7 May 2025
- Task 13 Workshop: **Reliability and Qualification of Second Life Photovoltaics**, Bilbao, Spain, 25 September 2025
- Task 13 Workshop: **Characterisation of PV Systems**, Hamelin, Germany, 23 October 2025.

In addition to the workshops organized during Task meetings and events, Task 13 was represented in Conferences & Events with Task 13 focus contributions in 2025:

- ELMIA Solar, Jönköping, Sweden, 5 February 2025
- SOLAR QUALITY SUMMIT, Barcelona, Spain, 18-19 February 2025
- NREL PV Reliability Workshop, PVRW, Golden, CO, USA, 4-6 March 2025
- SiliconPV 2025 / nPV Workshop, Oxford, UK, 08-11 April 2025
- SOPHIA Reliability Workshop 2025, DTU, Copenhagen, Denmark, 28-30 April 2025
- Intersolar Europe Conference, Munich, Germany, 6-7 May 2025
- PVPMC Workshop, Albuquerque, NM, USA, 13-15 May 2025
- 53rd IEEE PV Specialists Conference, Montreal, Canada, 9-13 June 2025
- RE+, Industry Event, Las Vegas, NV, USA, 08-11 September 2025
- 42nd EU PVSEC, Bilbao, Spain, 22-26 September 2025
- European PVPMC Workshop, Ayia Napa, Cyprus, 29-30 October 2025
- 36th International PVSEC-36, Bangkok, Thailand, 16-21 November 2025.

The current work programme (2026-2029) comprises 12 activities. A total of 66 Task 13 experts and 54 contributors from 55 organisations in 23 countries are participating in Task 13.

→ [Learn more about Task 13](#)



TASK 15

ENABLING FRAMEWORK FOR THE DEVELOPMENT OF BIPV

Task Managers: Francesco Frontini, SUPSI, Switzerland
Jose Maria Vega de Seoane, Becquerel Institute, Spain

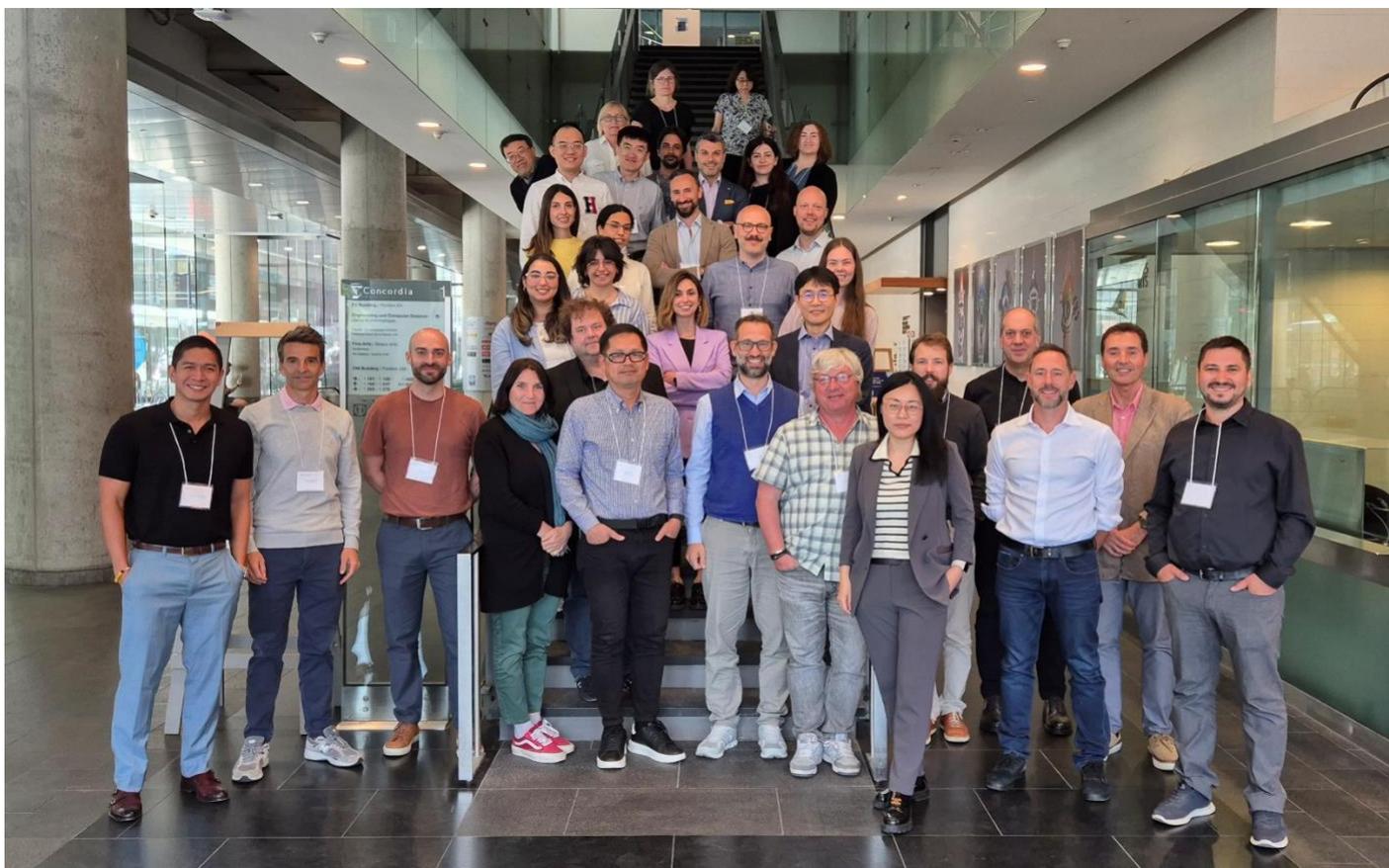


Figure 26: Task 15 experts at their meeting in 2025.

INTRODUCTION

Building-Integrated Photovoltaics (BIPV) refers to the integration of solar photovoltaic panels directly into building elements or components, such as windows, roof tiles, or façade cladding systems. This integration allows buildings to generate electricity from the sun while serving their primary function as constructions. Several studies in previous phases of Task 15 revealed the large technical and economic potential of building skins for photovoltaic energy conversion, but some further steps should be taken to speed up the implementation of this technology in our constructions. In particular, new approaches and procedures should be developed to better assess the module performance under different environmental conditions (shading, fire, high temperature, etc.) and guarantee the necessary durability of the

system. New digital solutions and approaches need to be further explored to make the design process easier and enable the coordination of different aspects of the BIPV value chain involving architects, engineers, and materials scientists. In addition, new training models and collaboration opportunities are also needed.

CURRENT FOCUS TOPICS

In its third phase (2024–2027), IEA PVPS Task 15 focuses on creating the conditions for the mainstream adoption of Building Integrated Photovoltaics (BIPV) by addressing the remaining key technical, social, economical and safety barriers that limit market uptake. The work builds



on previous phases and adopts a holistic approach, recognising BIPV as both an energy technology and a multifunctional building envelope component.

Task 15 is developing harmonised approaches to market data collection, responding to the lack of consistent statistics following the phase-out of many national support schemes. In parallel, the task is refining methodologies to assess BIPV market potential by linking technical potential with economic, regulatory, and social drivers. Attention is also given to the integration of BIPV into energy and environmental labelling schemes and international building certification systems, with the aim of better reflecting BIPV's multifunctional value. Collaboration with other IEA TCPs have been put in place in particular with EBC. Social acceptance is addressed through structured case studies that analyse user perception, stakeholder interaction, and architectural integration.

From a technical perspective, Task 15 continues to address pre-normative research gaps where existing standards and regulations are not fully adapted to BIPV. Fire safety remains a major focus, with work highlighting the specific risks of integrated PV systems and the need for dedicated testing approaches and clearer regulatory guidance. Another important topic is glare from BIPV installations, where current regulations often require assessments but lack clear metrics or thresholds. A first report has been finalized and will be soon published presenting the landscape of glare regulatory frameworks in different countries. Additional activities address solar heat gain characterisation, the performance and durability of coloured BIPV modules, and the impact of complex shading conditions on energy yield and system design.

Digitalisation represents another strategic focus. Task 15 is working to embed BIPV into digital building design workflows, particularly through the definition of BIM-compatible BIPV property sets that cover electrical, architectural, mechanical, visual, and economic aspects. Collaboration with the open BIM ecosystem aims to ensure interoperability and consistent data exchange across design tools.

In parallel, Task 15 maintains a strong link to real products and projects, collecting information on innovative BIPV solutions and monitoring long-term behaviour, especially for coloured BIPV systems where aesthetic stability is critical. Finally, the task places increasing emphasis on training, dissemination, and stakeholder collaboration, recognising that skills development and cross-sector understanding are essential for widespread adoption.

2025 KEY ACCOMPLISHMENTS

Overall, the achievements of 2025 demonstrate that Task 15 is steadily advancing toward its objective of establishing a coherent enabling framework that combines technical robustness, regulatory clarity, digital integration, and professional competence—key prerequisites for BIPV to become a mainstream solution in the built environment

Four publications were published in 2025 (see Research Highlights) - two within Task 15 and one in collaboration with Task 1 (Trend in photovoltaic application), a fact-sheet was also produced on advancing standardization.

Additionally, 4 scientific papers have been published in 2025:

- Martín-Chivelet, N.; van Noord, M.; Tilli, F.; Yang, R.J.; Weerasinghe, N.; Daun, E.; Baggini, A. BIPV Market Development: International Technological Innovation System

Analysis. Buildings 2025, 15, 3011. <https://doi.org/10.3390/buildings15173011>

- M. Babin, G. Eder, How to Perform Accurate Colour Measurements for BIPV Module Glass Covers: an IEA PVPS Task 15 Round-Robin Measurement Campaign, EUPVSEC 2025, Bilbao
- M. Tobakovic, S. Thorsteinsson, M. Trampert, The utilization of BIPV I the context of Environmental labelling, EUPVSEC 2025, Bilbao
- Aurrekoetxea-Arratibel, O.; Otano-Aramendi, N.; Valencia-Caballero, D.; Vidaurrazaga, I.; Oregi, X.; Olano-Azkune, X. Flame Spread on an Active Photovoltaic-Roof System. Fire 2025, 8, 105. <https://doi.org/10.3390/fire8030105>

Task 15 was also cited in the recent publication in Nature Reviews: Faes, A., Virtuani, A., Quest, H., Frontini, F. et al. Building-integrated photovoltaics. Nature Review Clean Technologies 1, 333–350 (2025). <https://doi.org/10.1038/s44359-025-00059-9>

In addition to the workshops organized with relevant stakeholder during plenary meetings, Task 15 was represented in several conferences with different contributions:

- 53rd IEEE PVSC, Montreal, 8-13th June
- Symposium Solares Bauen, Regensdorf, Switzerland, 9 September 2025
- 42nd EU PVSEC, Bilbao, Spain, 22-26 September 2025
- IPV Conference, Florence, 25-26 November 2025
- Advance Building Skins conference, Bern, Switzerland, 3-4 November 2025.

→ [Learn more about Task 15](#)



TASK 16

SOLAR RESOURCE FOR HIGH PENETRATION AND LARGE SCALE APPLICATIONS

Task Managers: Jan Remund, Meteotest, Switzerland
Manajit Sengupta, NLR, USA



Figure 27: Task 16 experts at their meeting in 2025.

INTRODUCTION

Task 16 provides access to comprehensive international studies and experiences with solar resources and forecasts. It supports different stakeholders from research, instrument manufacturers as well as private data providers and utilities.

Task 16 is a joint Task with the TCP SolarPACES (Task V). It collaborates also with the Solar Heating and Cooling (SHC) and with Wind Task 51.

CURRENT FOCUS TOPICS

As in the first two phases, the main result of the third phase of Task 16 is the update of the Solar Resource Handbook. This last version (4th edition) has been published in October 2024. It includes the major results of the collaboration during the years 2020 - 2024 (Sengupta et al., 2024a and Sengupta et al., 2024b).

The team works on the following topics:

1. Scientific Paper on comparison of simple diffuse or direct radiation measurement options. The paper is in 2nd review and should be published in spring 2026.
2. Scientific Paper of results of climate models regarding changes of radiation parameters (state: draft).
3. Three benchmarks of solar forecasts based on all sky imagers, satellite data and day ahead forecasts are ongoing. The benchmarks will be published in 2027 in the form of papers and reports.
4. Update of first Firm power generation report (Firm Power Generation 2026). The report has been published in February 2026.



2025 KEY ACCOMPLISHMENTS

Four publications were published in 2025 - three within Task 16 and one in collaboration with Task 13 (a Fact Sheet on soiling).

Additionally, six further scientific papers have been published in 2025:

- Blum, Niklas, et al., 2025: "Geometric calibration of all-sky cameras using sun and moon positions: A comprehensive analysis." *Solar Energy* 295 (2025): 113476. <https://doi.org/10.1016/j.solener.2025.113476>
- Bonanno, R. and E. Collino, 2025: Assessing the impact of climate change on solar energy production in Italy, *Reg. Environ. Change*, vol. 25, fasc. 3, p. 78, July 2025, [doi: 10.1007/s10113-025-02417-6](https://doi.org/10.1007/s10113-025-02417-6).
- Honningdalsnes, Erlend Hustad, Erik Stensrud Marstein, Dag Lindholm, Helge Bonesmo, Heine Nygard Riise, 2025: Wind sheltering in vertical agrivoltaics can increase crop yields: A modeling study for Northern Europe, *Energy Nexus*, Volume 19, 2025, 100516, ISSN 2772-4271, <https://doi.org/10.1016/j.nexus.2025.100516>
- Meddahi, A., Tuomiranta, A., & Guillon, S., 2025: Skill-Driven Data Sampling and Deep Learning Framework for Minute-Scale Solar Forecasting with Sky Images. *Solar RRL*, 9, 2400664. <https://doi.org/10.1002/solr.202400664>
- van Eldik, Ruben and Wilfried van Sark, 2025: Firm wind and solar photovoltaic power with proactive curtailment: A European analysis, *Energy Conversion and Management*, Volume 347, 2026,120399, ISSN 0196-8904, <https://doi.org/10.1016/j.enconman.2025.120399>
- Sohani, Ali, Marco Pierro, David Moser, and Cristina Cornaro, 2025: Comparison of Physical Models for Bifacial PV Power Estimation. *Journal Energy Conversion and Management* Volume 327, 2025, 119515, ISSN 0196-8904, <https://doi.org/10.1016/j.enconman.2025.119515>.

Two workshops were held as side events for the Task workshops in spring and autumn:

- A public workshop organized by LMD, Univ. Palaiseau, was held in the conjunction with the Task meeting. Topic: "Journée De meilleures données solaires pour booster le photovoltaïque" (Palaiseau, Paris, April 4th 2025)
- A workshop on invitation about "VRE remuneration models adequate for firm power" was held in Neuchatel, Switzerland, in collaboration with IEA PVPS Task 19 (JRA-40) (October 17th, 2025).

At two internal workshops, the new work plan for the period of July 2026 – June 2029 has been developed. Task 16 members started also the activity to update and enhance Wikipedia entries regarding solar irradiance. Some updates were successful for:

- https://en.wikipedia.org/wiki/Solar_irradiance and
- https://en.wikipedia.org/wiki/Direct_solar_irradiance

→ [Learn more about Task 16](#)



TASK 17

PV & TRANSPORT

Task Managers: Keiichi Komoto, , Japan

Berk Celik, Université de Technologie de Compiègne, France



Figure 28: Task 17 experts at their meeting in 2024.

INTRODUCTION

Task 17 enables collaboration among research institutions, industry stakeholders, and policymakers by providing access to comprehensive studies and practical experience in the field of “PV and transport.” In the transport sector—particularly in passenger vehicles—electric vehicles (EVs) are being widely adopted as key solutions for reducing CO₂ emissions. In alignment with this trend, numerous countries and regulatory bodies have introduced and implemented vehicle emission targets and policy measures to accelerate the deployment and use of electric vehicles (EVs). In contrast, the electrification of heavy-duty vehicles, such as trucks, buses and trailers, presents comparatively greater technical and economic challenges than that of passenger cars and light commercial vehicles.

As transportation becomes increasingly electrified and electricity demand for vehicle charging grows, photovoltaic (PV) will play a critical role in ensuring that EV adoption translates into substantial CO₂ emission reductions. The distributed nature of PV generation creates new opportunities for charging battery electric vehicles. Low-carbon charging solutions include the use of grid-connected electricity supplied by PV or other renewable sources, dedicated charging

infrastructure with on-site PV generation, and direct on-board PV systems integrated into vehicles (PV-powered vehicles). The characteristics, technical requirements, and suitability of each approach vary depending on the specific vehicle category and use case.

To contribute to the decarbonization of the transport sector while supporting PV market expansion, Task 17 seeks to assess and clarify the potential of PV integration in transport applications and to develop strategic pathways for practical implementation. The scope of Task 17 encompasses a broad range of PV-powered vehicle categories—including passenger cars, light commercial vehicles, heavy-duty vehicles, and other specialized vehicles—as well as PV applications within electric mobility systems and infrastructure, such as PV-powered charging facilities, battery integration, and advanced energy management systems.



CURRENT FOCUS TOPICS

The main goal of Task 17 is to accelerate and structure the deployment of PV in the transport sector, thereby reducing CO₂ emissions while fostering sustainable PV market expansion.

- **Optimization of Vehicle-Integrated Photovoltaics (VIPV)** addresses the technical optimization and performance enhancement of VIPV systems integrated into passenger cars, trucks, buses, and other vehicle categories
- **Market Introduction and Scaling of VIPV** aims to enable large-scale commercialization of VIPV solutions through evidence-based and economically viable pathways
- **Performance Metrics and Intelligent Operation of PV Charging Stations (PVCS)** defines technical, operational, and user-oriented performance criteria for PV-powered charging infrastructure
- **Environmental and Economic Assessment of PVCS** evaluates trade-offs and system-level impacts associated with PV-powered charging infrastructure
- **Grid Impact and System Integration** examines interactions between PVCS and the electricity grid to ensure stability and optimized power distribution
- **PVCS for Heavy-Duty Transport (Trucks and Buses)** gives the strategic importance of electrifying heavy-duty transport
- **Policy Support and System-Level Impact Assessment** aims to provide robust evidence to policymakers and public authorities

2025 KEY ACCOMPLISHMENTS

In addition to the reports highlighted under Research highlights, two journal articles were published in 2025:

- Celik, B., Kassab, F. A., Locment, F., Sechilariu, M., & Hansen, T. M. (2025). Regional insights in microgrid planning: Combined optimal energy management and sizing across French cities. *Mathematics and Computers in Simulation*. <https://doi.org/10.1016/j.matcom.2025.08.028>
- Kassab, F. A., Celik, B., Locment, F., Sechilariu, M., Liaquat, S., & Hansen, T. M. (2025). Microgrid sizing with EV flexibility: Cascaded MILP and embedded APSO-MILP approaches. *Applied Energy*, 396, 126273. <https://doi.org/10.1016/j.apenergy.2025.126273>

➔ [Learn more about Task 17](#)



TASK 18

OFF-GRID AND EDGE-OF-GRID PV SYSTEMS

Task Manager: Michael Müller, OFRES, Germany



Figure 29: Task 18 experts at their meeting in 2025.

INTRODUCTION

The objective of Task 18 is to identify the innovations that drive PV off-grid technology and impact the market. The scope covers the whole supply- and value chain including planning, financing, design, construction, operations, and maintenance of off-grid and edge-of-grid systems. The most important areas of innovation are addressed, including the technology change coming from lithium-ion battery systems, LED lighting, price reduction of solar modules and the whole area of digitalisation. The Task focuses especially on challenges that are common across nations, markets, and system scales. It aims to provide solutions, tools, guidelines, and technical reports for free dissemination to those who might benefit from them.

CURRENT FOCUS TOPICS

Task 18 is currently focused on its second Work Plan, which is scheduled for completion in mid-2026. There are several key activities that dominate the collaboration work of the Task 18 Expert group in this period.

Innovations in Li-Ion battery based PV off-grid systems are an important topic, with key attention being given to collecting best practise case studies among the member countries. Special focus is given to systems that are not only equipped with professional monitoring systems but also a connection to the operators who can provide real life annual monitoring data to Task 18. Such systems have been identified in Australia, Malaysia, Morocco, Canada, Madagascar and Haiti. All systems have been analysed and categorized according to their suitability to the Task 18 scope in terms of size, application focus and solar fraction. The performance indicators and overall system round-trip efficiencies can be calculated and compared among the systems. Specifically the systems from Australia and Malaysia have been selected for further investigations as best practice systems.

Thirteen islands around the globe have been identified that are already powered by 100% renewable PV off-grid electricity systems. Contacts to those islands have been established and key success factors are being analysed. The focus of work is to identify political and framework conditions that enable and support the successful and sustainable operation of these systems incorporating distributed generation, storage and consumption.



With a special focus on Africa, innovative mobility solutions are being analysed by Task 18. Small electrical mobility solutions like scooters, small motor bikes, e-bikes and many other applications allow people in remote areas to offer all kinds of mobility and postal services. Such appliances can be recharged by PV off-grid systems or during hub operation in the city.

In particular, we are focusing on examples from Tanzania, where a lot of small PV off-grid systems have been installed in the last decades. In order to operate these systems sustainably and reliably, several organisations have established training frameworks and courses for people living in remote PV off-grid driven areas, to enable them to perform the first-level maintenance of the system. The training frameworks are being analysed to identify and evaluate the key success factors.

2025 KEY ACCOMPLISHMENTS

During 2025, Task 18 made significant progress on the work plan, not only related to the technical topics, but especially in analysing and understanding boundary conditions that lead to successful operation of

systems. Innovations such as lithium-ion battery systems and small electrical mobility solutions play a key role in this context.

The Task 18 working group was led by teams of Experts from Germany, Australia and the Netherlands and strengthened by additional valuable support from Canada, Morocco and Malaysia which reflect the world-wide application range of PV off-grid systems Task 18 is dealing with.

Two new reports were published by IEA PVPS Task 18 in 2025:

- [Li-Ion battery systems in PV off-grid applications](#)
- [Digitalization in PV off-grid Systems](#)

In June 2025 an international Task 18 physical meeting was realized in conjunction with the Intersolar and Smarter-E exhibition in Munich in Germany.

➔ [Learn more about Task 18](#)



TASK 19

PHOTOVOLTAIC INTEGRATION IN ELECTRICITY NETWORKS AND MARKETS

Task Managers: Ricardo Aguiar, DGE, Portugal
Gerd Heilscher, THU, Germany



Figure 30: Task 19 experts at their meeting in Tenerife in 2025.

INTRODUCTION

Task 19's main objectives are to advocate for grid-connected solar PV as a major power source and to support stakeholders by providing international studies and technical knowledge. Moreover, we will offer expertise on PV integration for grid stability, digitalization and energy systems management, while promoting cooperation among renewable energy sources. The initiative aims to establish technical, economic, and regulatory foundations for PV as a major supply component in future 100% renewable-based power systems.

CURRENT FOCUS TOPICS

Through nine subtasks and Joint Research Activities (JRAs), Task 19 addresses critical challenges including hosting capacity, prosumer rights and obligations, smart grid integration, commissioning processes, curtailment strategies, inverter capabilities, aggregator models, local energy management, and market design.

Task 19 was launched in January 2025 to focus specifically on integrating PV into electricity networks and markets within the context of high or complete renewable penetration.

This initiative involves experts from more than eighteen countries and the European Union, emphasising cross-border collaboration and best practice exchange to address the multifaceted challenges of PV integration.

Task 19 implements its research agenda through Joint Research Activities (JRAs), representing self-organised teamwork amongst expert groups focusing on specific technical challenges. These time-limited activities with quantified outcomes enable flexible response to emerging issues whilst maintaining rigorous research standards. Each JRA requires a designated lead, minimum participation from five experts across at least two continents, and clearly defined objectives aligned with Task 19 topics.



2025 KEY ACCOMPLISHMENTS

During 2025 Task 19 Experts started the following five JRAs

- Within subtask one on “national targets versus grid capacity” an international comparison of grid hosting capacity rules and methodologies has been started.
 - Subtask three “PV in smart grids” started with addressing cybersecurity issues
 - Subtask five “active power management” started comparing international approaches to managing very high PV penetration.
 - The “aggregator and energy community” subtask is examining PV’s role in microgrid resilience strategies.
 - “Integrating PV systems in the energy market” within subtask nine started to analyse PV integration in energy, capacity and balancing markets.
-

➔ [Learn more about Task 19](#)



TASK 20

ENERGY HUBS AND GREEN HYDROGEN

Task Manager: Veronika Vancheri, Stedin, the Netherlands



Figure 31: Task 20 is a joint activity between the IEA TCPs Wind, Hydrogen and PVPS. (Photo courtesy of TNO)

INTRODUCTION

As a joint activity by the IEA TCPs Wind, Hydrogen and PVPS, Task 20 was developed in 2025 with the goal of managing data and design information for hybrid wind-solar-hydrogen plants and to recommend the best practices for global integration taking into account location-specific factors. Moreover, it aims to identify local legal and societal challenges as well as to develop the tools to address a variety of potential concerns, thereby improving project viability.

CURRENT FOCUS TOPICS

The main focus of Task 20 is the systematic comparison of selected countries' energy strategies, climate targets, and policy frameworks. We examine how national approaches differ in terms of ambition,

implementation mechanisms, and alignment with long-term decarbonisation goals. Our analysis covers renewable energy deployment trends, energy demand patterns, electricity generation mixes, and the development of grid infrastructure.

A central objective is to evaluate how hydrogen can be produced from renewable electricity and effectively integrated into existing energy systems. We assess the technical feasibility of different production routes, as well as the interaction between hydrogen production and power system operation. In addition, we analyse how regulatory frameworks, market design, economic conditions, and societal acceptance influence market development, investment decisions, and overall project feasibility.

The second part of the work provides a detailed assessment of hydrogen's role in long-term energy scenarios for the period 2030–2050. Particular attention is given to sector-specific demand in industry, ammonia production, transport applications, and energy storage. We



investigate how hydrogen could contribute to decarbonising hard-to-abate sectors and balancing renewable-based power systems.

Furthermore, we explore production pathways, infrastructure requirements, storage and transport options, cost development trajectories, technology maturity levels, and examples of real-world deployment projects.

Taken together, the reports will demonstrate how policy design, infrastructure investment, and technological progress interact to shape the transition from fossil-based hydrogen production to sustainable, low-carbon hydrogen systems.

2025 KEY ACCOMPLISHMENTS

In March 2025, the first Task meeting was held in Rotterdam as a hybrid event and was attended by five members of our team. In September 2025, the second Task meeting took place in Pamplona, also in a hybrid format, with six members of our team participating.

→ [Learn more about Task 20](#)



ACTION GROUP

AGRIVOLTAICS

Managers: Alessandra Sognamiglio, ENEA, Italy
Jordan Macknick, NLR, USA



Figure 32: Select members of the Agrivoltaics Action Group Coordination Board at the 2025 Agrivoltaics World Conference in Freiburg, Germany.

INTRODUCTION

The Agrivoltaics Action Group focuses on a collaborative effort to explore the synergies between agriculture and solar energy generation. Through international cooperation and interdisciplinary engagement, the group aims to enhance the potential of agrivoltaics by optimizing land use, improving agricultural resilience to climate change, and encouraging broad-based support for solar energy initiatives.

CURRENT FOCUS TOPICS

The Action Group is divided into three phases of activity:

Phase 1: Action Group Formation. Key activities and outcomes in Phase 1 include: Expert identification and commitments, Board formation, clarification and definition of roles and responsibilities, and a finalization of the workplan and timeline.

Phase 2: Stakeholder Workshops. Key activities and outcomes in Phase 2 include: workshop host identification, establishing workshop schedule, conducting workshops, and summary reports.

Phase 3: Synthesis Reports: Key activities and outcomes of Phase 3 include the development of public documents on high priority research



needs of agrivoltaics and an internal IEA PVPS document on the recommendations for IEA PVPS next steps on agrivoltaics.

The objectives of the workshops are to develop a common understanding of agrivoltaics in the IEA PVPS context, have a standard and consistent set of metrics and methods across IEA PVPS Tasks, and foster a community with IEA PVPS that can lead to improved research outcomes. The workshops will also serve as an opportunity to engage and include outside subject matter expertise, specifically related to agricultural and social science expertise. Researchers and practitioners from these disciplines have traditionally not been a part of IEA PVPS, but their contributions are essential to agrivoltaics research. Engagement in the Action Group workshops will provide an entry point for these outside experts to more substantially contribute to IEA PVPS activities.

The results of the workshops have indicated a desire from IEA PVPS experts and other global agrivoltaics researchers for targeted publications and resources on certain crosscutting topics that could benefit all agrivoltaics researchers. These resources would also leverage the unique position of IEA PVPS in its ability to enable international collaboration and consensus on fundamental research topics. Therefore, we are proceeding with the following public-facing deliverables, which were ranked among the highest priority topics for IEA PVPS to pursue during our stakeholder workshops:

- Online visual glossary and accompanying report defining key agrivoltaic terms and research concepts that were identified and prioritized during the stakeholder workshops
- Dynamic database listing and providing key information about existing agrivoltaic modeling tools and associated datasets
- Global geospatial platform enabling networking and connections across agrivoltaics researchers, which could serve as a foundation for a larger global geospatial tool.

2025 KEY ACCOMPLISHMENTS

The Action Group made significant progress in conducting stakeholder workshops and in scoping public-facing deliverables in 2025. Highlights include:

- March 2025: IEA PVPS Action Group virtual workshop held. 152 participants from 35 countries. Interactive workshop involved Mural Boards and participant contributions related to 3 topics: 1) Standardized terms and definitions for agrivoltaics research; 2) International collaboration and coordination opportunities; and 3) Future IEA PVPS Agrivoltaics priorities.
- May 2025: The IEA PVPS Action Group Coordination Board selected public-facing research publications for the Action Group to pursue based on stakeholder workshop input in 2024 and 2025.
- July 2025: The IEA PVPS Action Group Coordination Board convened and was represented at the 2025 Agrivoltaics World Conference in Freiburg, Germany.
- September 2025: The IEA PVPS Action Group Coordination Board hosted a panel session on agrivoltaics at EUPVSEC 2025 in Bilbao, Spain.

➔ [Learn more about the Action Group Agrivoltaics](#)

PARTICIPATION MATRIX



Please note:

- The information presented in the Participation Matrix reflects the participation status as of February 2026.
- The numbers in the table refer to IEA PVPS Tasks.
- The 'TM' squares indicate that an Expert from the listed entity is a Task Manager.
- ExCo is the abbreviation for the Executive Committee delegate.

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
Australia	Australian PV Institute (APVI)	ExCo	1									
	Ekistica								18			
	Global Sustainable Energy Solutions (GSES)								18			
	IT Power Australia							17				
	RINA Consulting				13							
	Sustainable Energy for All	ExCo										
	University of Adelaide										20	
	University of Melbourne					15						
	University of New South Wales (UNSW)	ExCo	1	12	13		16	17				
	University of South Australia (UniSA)						16					
Austria	Austrian Institute of Technology GmbH (AIT)				13	15				19		
	Austrian PV Technology Platform (TPPV)	ExCo	1									
	Austrian Research Institute for Chemistry and Technology (OFI)			12	13	15						
	Federal Ministry of Innovation, Mobility and Infrastructure	ExCo										
	Fronius International									19		
	Polymer Competence Center Leoben GmbH (PCCL)			12	13							
	University of Applied Sciences Technikum Vienna					15						
	University of Applied Sciences Upper Austria (FH-OÖ)						16					
	Vienna University of Technology (TU Wien)					15						
Belgium	Becquerel Institute		1			15						
	Energyville - IMEC				13			17				
	Energyville - KU Leuven	ExCo	1							19		
	Energyville – UHasselt	ExCo			13	15						
	Energyville – VITO			12								
	Lucisun				13	15						
	PV Cycle Association			12								
	Royal Meteorological Institute of Belgium (RMIB)						16					
Canada	Canadian Renewable Energy Association (CanREA)	ExCo	1									
	Concordia University					15						
	McGill University			12								
	National Research Council Canada					15						
	Natural Resources Canada - CanmetENERGY	ExCo	1		13	15	16					
	University of Waterloo					15						
	Yukon University Research Centre								18			
China	China Electric Power Research Institute									19		
	China Epower Solutions Corp. Ltd.								18			
	Energy Internet Research Institute, Tshinghua University							17				
	GoodWe					15						
	Institute of Electrical Engineering, Chinese Academy of Sciences (CAS)	ExCo		12	13				18	19	20	
	LONGI Green Energy Technology Co., Ltd.		1			15						
	Public Meteorological Service Center (CMA)						16					
	PV Committee of China Green Supply Chain Alliance (ECOPV)	ExCo	1	12								
	Siemens Energy Co., Ltd.									19		
	Sungrow Renewables Development Co., Ltd.									19	20	
	Trinasolar Co. Ltd.					15						
	Xi'an LONGI Hydrogen Energy Technology Co.										20	

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
	Zhejiang Jinko Solar Co. Ltd.			12								
Denmark	Danish Institute of Fire and Security Technology (DBI)					15						
	Danish Meteorological Institute (DMI)						16					
	EMD International									19		
	FKSol ApS	ExCo										
	Kenergy	ExCo	1									
	SiCon				13							
	Solar City Denmark					15						
	Technical University of Denmark (DTU)				13	15	16					
European Union	European Commission Directorate-General for Research & Innovation	ExCo										
	Joint Research Centre - European Commission		1				16			19		AG
Finland	Aalto University School of Science					15						
	Fortum Renewables Oy				13							
	Innovation Funding Agency Business Finland	ExCo										
	Lappeenranta-Lahti University of Technology LUT		1									
	Turku University of Applied Sciences				13					19		
	University of Turku									19		
	VTT Technical Research Centre of Finland	ExCo										
France	ADEME (The French Agency for Ecological Transition)	ExCo						17				
	Becquerel Institute France		TM									
	Department of Solar Technologies (CEA-LITEN)			12								
	Ecole Polytechnique à Palaiseau						16					
	Electricité de France (EDF R&D)						16					
	EnerBIM					15						
	European Space Agency						16					
	French Alternative Energies and Atomic Energy Commission							17				
	HESPUL									19		
	Institut National de l'Energie Solaire (INES) Laboratoire des systèmes Solaires (L2S)				13							
	Laboratoire PIMENT University of Reunion						16					
	Lorraine University									19		
	Mines ParisTech			12			16					
	Planair France SAS	Chair	1					17				
	Réseau de Transport d'Électricité (RTE)						16					
	SAP Labs France							17				
	Scientific and Technical Centre for Building (CSTB)					15						
	SOREN (PV Cycle France)			12								
	TotalEnergies			TM	13		16					
Université de Technologie de Compiègne							TM					
UPEC										19		
Germany	Africa GreenTec								18			
	Asantys								18			
	CSP Services						16					
	Ecolog Institute								18			
	Energynautics GmbH									19		
	Forschungszentrum Jülich GmbH							17				

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
	Projektträger Jülich (PTJ)	ExCo	1									
	Fraunhofer Center for Silicon Photovoltaics CSP				TM							
	Fraunhofer IEE									19		AG
	Fraunhofer Institute for Solar Energy Systems (ISE)			12	13		16		18			
	German Aerospace Center (DLR)						16					
	Institute for Solar Energy Research GmbH (ISFH)				13							
	OFRES								TM			
	Reiner Lemoine Institute								18			
	Rolls Royce Solutions								18			
	Technische Hochschule Ulm (THU)									TM		
	TÜV Rheinland Solar GmbH					13						
Univers GmbH					13							
India	Himachal Pradesh University				13							
	National Institute of Solar Energy (NISE)	ExCo					16					
	School of Planning and Architecture New Delhi					15						
Israel	Ministry of Energy & Infrastructure	ExCo	1									
Italy	Becquerel Institute Italia (BII)				13							
	European Academy Bozen/Bolzano (EURAC)				13	15	16					
	Gestore dei Servizi Energetici (GSE S.p.A.)		1		13	15						
	GreenHorse Legal Advisory		1									
	i-em						16					
	National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)	ExCo	1	12			16			19		TM
	Politecnico Milano						15					
	Ricerca Sistema Energetico (RSE S.p.A.)	ExCo	1	12	TM		16					
	Sapienza University of Rome				13							
	Tor Vergata University of Rome											AG
	University of Catania				13							
	University of Naples Federico II						15					
University of Rome II - Tor Vergata							16					
Japan	Lixil						15					
	National Institute of Advanced Industrial Science and Technology (AIST)				13	15						
	New Energy and Industrial Technology Development Organization (NEDO)	ExCo		12						19		
	Photovoltaic Power Generation Technology Research Association (PVTEC)						15					
	RTS Corporation		TM									AG
	Tokyo University of Science									19		
	University of Miyazaki			12					TM			
Korea	KENTECH		T1									
	Kongju National University					15						
	Korean Energy Agency (KEA)	ExCo										
	Korean Institute for Energy Research (KIER)	ExCo										
Lithuania	Protech	ExCo	1			15						
Malaysia	Sarawak Energy Berhad								18			
	Sustainable Energy Development Authority (SEDA)	ExCo	1									
	Tenaga Nasional Berhad									19		

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
Morocco	Green Energy Park	ExCo			13					19		
	IRESEN	ExCo	1						18			
Norway	Institute for Energy Technology (IFE)				13	15	16			19		
	Norwegian Meteorological Institute						16					
	Norwegian University of Science and Technology (NTNU)				13	15						
	Norwegian Water Resources and Energy Directorate (NVE)	ExCo	1									
	Research Council of Norway	ExCo										
	RISE Fire Research AS					15						
Portugal	Directorate-General for Energy and Geology (DGEG)	ExCo	1							TM		
	Finerge									19		
	Portuguese Renewable Energy Association (APREN)	ExCo								19		
	University of Lisbon						16	17				
Sponsor members	Solar Energy Research Institute of Singapore (SERIS)	ExCo			13	15						
	Solar Power Europe	ExCo	1									AG
South Africa	South African National Energy Development Institute (SANEDI)	ExCo	1									
Spain	Becquerel Institute Spain					TM						
	Centre for Research on Energy, Environment and Technology (CIEMAT)			12		15	16					
	Mactech						16					
	National Hydrogen Centre (CNH2)										20	
	National Renewable Energy Centre of Spain (CENER)	ExCo			13		16					
	Public University of Navarra (UPNA)						16					
	Polytechnic University of Madrid							17				
	Tecnalia					15		17				
	Trama Tecno Ambiental								18			
	Union Española Fotovoltaica (UNEF)		1									
	University of Alcala								18			
	University of Almeria						16					
	University of Castilla La Mancha									19		
	University of Jaen						16					
	University of La Laguna									19		
	University of Las Palmas de Gran Canaria						16					
University of Malaga						16						
University of Murcia			12									
University of Sevilla						16						
Sweden	Becquerel Sweden AB		1									
	Chalmers University of Technology			12								
	CheckWatt AB				13							
	Dalarna University			12						19		
	IVL Swedish Environmental Research Institute			12								
	Mälardalen University (MDU)				13							AG
	Research Institutes of Sweden (RI.SE)			12	13							
	Swedish Energy Agency	ExCo										
	Swedish Meteorological and Hydrological Institute (SMHI)						16					
	University Uppsala						16					
Switzerland	Bern University of Applied Sciences				13							

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
	CSEM PV-Center EPFL Photovoltaics Laboratory				13							
	Dr. Schüpbach & Muntwyler GmbH							17				
	Eastern Switzerland University of Applied Sciences (OST); Institute SPF						16					
	HES-SO Geneva (HEPIA)					15						
	Megasol					15						
	Meteotest						TM			19		
	NET - Ltd	ExCo										
	Planair SA		1									
	Swiss Center for Electronics and Microtechnology (CSEM)								17			
	Swiss Federal Office of Energy	ExCo										
	Treeze Ltd.			12								
	University of Applied Sciences and Arts of Southern Switzerland (SUPSI)					13	TM					
	Viridén + Partner						15					
	Zurich University of Applied Sciences (ZHAW)				12							
Thailand	Department of Alternative Energy Development and Efficiency	ExCo	1									
	King Mongkut University of Technology Thonburi, CES Solar Cells Testing Center (CSSC)				13							
The Netherlands	bear-ID					15						
	Delft University of Technology			12					18		20	
	Eindhoven University of Technology									19		
	Netherlands Enterprise Agency RVO	ExCo	1						18	19	TM	
	Netherlands Organisation for Applied Scientific Research (TNO)			12		15		17				
	SmartGreenScans			12								
	University of Twente									19		
	Utrecht University					13		16				
ZUYD						15						
Turkiye	Middle East Technical University								18			
	Turkish Energy Nuclear and Mineral Research Agency (TENMAK)	ExCo	1									
United Kingdom	Department for Energy Security and Net Zero (DESNZ)	ExCo										
	Northumbria University			12								
	Oxford Brookes University			12								
	Peak Designs Ltd						16					
	UK Power Networks									19		
USA	Case Western Reserve University (SDLE)					TM						
	Clean Power Research (CPR)						16					
	David Renne Renewables						16					
	Electric Power Research Institute (EPRI)			12								
	First Solar			12								
	National Aeronautics and Space Administration (NASA)						16					
	National Laboratory of the Rockies (NLR)				TM	13	TM		18			TM
	Sandia National Laboratory (SNL)					13						
	Solar Consulting Services						16					
	State University of New York (SUNY Albany)						16			19		
	Univers Inc.					13						
	University of Central Florida					13						

Country	Entities	ExCo	1	12	13	15	16	17	18	19	20	AG
	University of Oregon						16					
	University of Washington			12								
	US Department of Energy	ExCo	1									

