

Building Quality Infrastructure for Photovoltaic Systems

Let the sunshine in / Пусть всегда будет солнце

Ensuring safety, quality and sustainability of regenerative energy sources
in Eastern Partnership Countries

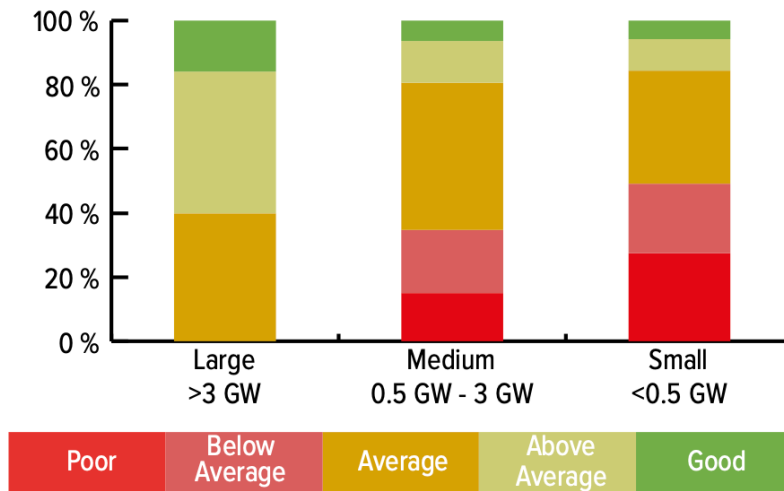
Key messages

- Photovoltaic Systems (PV) increase the reliability of power supply and support the achievement of the Sustainable Development Goals (SDGs), given that safety, quality and sustainability challenges are met by appropriate quality assurance measures in the entire lifecycle of a PV system.
- The application of standards – via Quality Infrastructure (QI) – as well as the systematic use of testing and certification services during the production phase can increase the efficiency of production, the overall quality of the end-product, and the competitiveness of national PV manufacturers.
- Public policies and programmes should include objectives and criteria related to quality in the PV sector and make reference to quality infrastructure services.
- Armenia has laws and strategies on energy efficiency and renewable energy, but it lacks a national policy which defines and regulates mandatory requirements for QI for PV.

What's the issue?

Reliable energy is a cornerstone of economic and social development. A reliance on non-renewable energy sources (i.e. fossil fuels) has negative impacts that go beyond the obvious – and significant – environmental impact of their use. These impacts include dependency on petroleum imports and the social cost of pollution. PV technologies can reduce these negative impacts while increasing the reliability of power supply and supporting the achievement of the SDGs. PV systems include off-grid applications without connection to the electricity grid (e.g. in rural areas), distributed generation involving multiple grid-connected generators (e.g. rooftop PV) as well as utility-scale PV systems that usually deliver the entirely energy produced to the grid.

Safety, quality and sustainability challenges constitute barriers to the development of PV energy. Experience has shown that countries tend to undergo a learning curve: after a boom in the PV sector, awareness for the importance of quality assurance usually increases – as cases of underperformance of installed power plants emerge. If Quality Infrastructure is included early on, quality deficiencies and the risk of damaging the reputation of PV technology can be reduced. A White Paper of PI Berlin that analyzed trends in PV module quality from over 250 independent factory audits shows that smaller production sites are especially exposed to quality risks – whereas countries with mass production sites that managed to create a complete supply chain ecosystem designed to support production show a better performance.



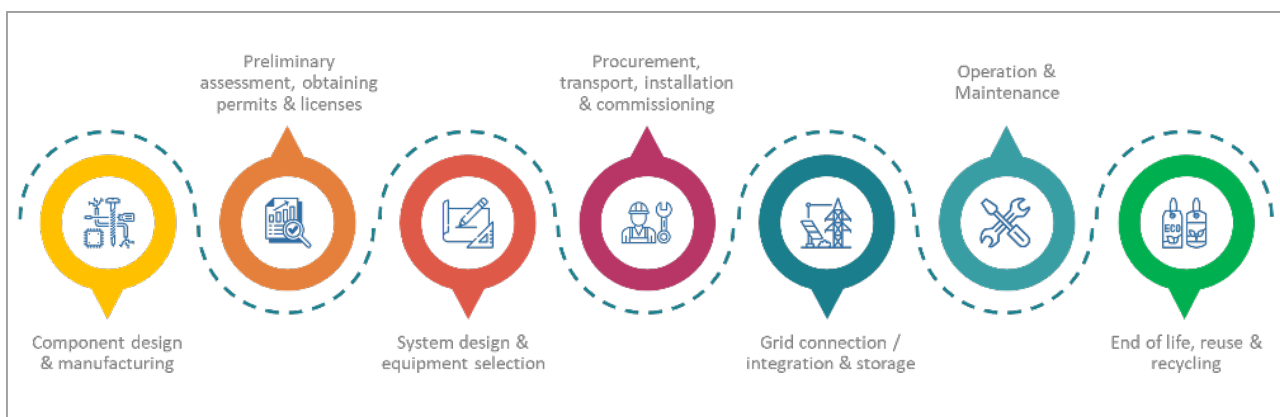
Quality ratings compared to factory size (based on 2017 industry-wide audit results). Source: PI Berlin (2018) White Paper. Industry Trends in PV Module Quality from over 250 Factory Audits.

Why is this important?

Although PV is often perceived as easily deployable, special expertise is required throughout all phases of a PV project. Incorrect installation can have devastating effects on plant safety (e.g. risk of fire), performance and financial returns. If weaker control mechanisms for imported PV parts exist compared to neighboring markets, there is a risk that low-quality parts will be imported unnoticed, weakening the PV systems in the country. A well-developed and commissioned solar PV system might underperform due to inefficient exploitation and maintenance as well as replacement of parts. Declining acceptance of PV due to quality deficits could undermine national plans to develop renewable energies.

Health and safety problems among workers in the PV industry during the production, installation and end-of-life stages represent an additional challenge of growing importance. During the life cycle of PV systems, there is a risk of potentially toxic materials being released – such as lead, arsenic, strong acids, or dioxins.

As more and more systems will be reaching their end-of-life stage in the foreseeable future, the topics of circularity and recyclability are also becoming increasingly important. PV panels are made from rare or valuable substances, including silver, indium, or tellurium, that is why their recycling could prevent the loss of such substances as well as reduce the environmental impacts associated with their extraction.



The value chain of photovoltaic projects (source: Andreas, N. (2024) QI for PV in Armenia - Gap Analysis Report)

The role of Quality Infrastructure (QI) ¹

A QI that is aligned with international (and European) standards as well as the best practices can play a crucial role throughout the lifecycle of a PV system from the design phase to the end-of-life phase.

The application of existing quality standards as well as the systematic use of testing and certification services during production can increase the efficiency of production, the overall quality of the end-product and the competitiveness of national PV manufacturers. For planning and site selection, the availability of reliable solar irradiation data is of utmost importance as it is the basis for determining plant performance.

According to the worldwide study of TÜV Rheinland from 2015, approximately 30% of PV installations have serious defects, mainly caused by installation errors. Certification and inspection ensure compliance with safety criteria, which is essential to protect the safety of workers, nearby communities, and, in the case of roof-top power plants, buildings, by reducing the risk of electric shock and fire, for example. It is recommended that PV modules are tested upon arrival at the construction site to identify any transport-related damages, such as visible cracks on PV modules, or microcracks that remain invisible by using electroluminescence testing (EL) imaging. During operation and maintenance, the application of appropriate measurements and procedures is essential to evaluate how the PV plants perform in practice, on underperformance, and on system damage. This makes PV systems a safer investment.

QI has a key impact on the end-of-life, reuse and recycling of PV power plant components. The use of QI services such as testing can help improve the environmental impacts of materials and products as well as their energy efficiency.

What should policy makers do?

The development of the PV sector requires a systematic consideration of QI – meaning a coordination of standardization, metrology, testing, certification, inspection and accreditation. These components and a national regulatory framework complement each other. Consequently, they need to be developed together in order to be coherent and functional.

The national QI should not be developed in an isolated way but rather linked to the international (and European) system by establishing the respective relations: to ISO and IEC for standardization (e.g. IEC Technical Committee 82 for Solar PV energy systems); to BIPM and OIML for metrology and legal metrology; to IAF and ILAC for accreditation; and to the various regional organizations.

The national policy and regulatory frameworks influence both the supply of and demand for QI services. Public policies and programmes should include objectives and criteria related to quality in the PV sector and reference QI services. Furthermore, quality criteria and relevant standards should be specified in public tenders, contracts and government programmes.

At the same time, an inclusion of too detailed quality criteria in technical regulations should be avoided. Such mandatory requirements that go beyond safeguarding human health and safety or the environment are not aligned with international best practice and WTO TBT agreements. Experience shows that mandatory requirements that are too detailed often fail to be implemented due to a lack of enforcement.

It is important however to implement effective measures to raise awareness and to inform relevant stakeholders about the benefits of the systematic consideration of quality, safety and sustainability aspects in the PV sector. Relevant studies

¹ Quality Infrastructure (QI) is the system put in place to ensure products and services are safe and of high quality. It covers everything from standardization and conformity assessment (testing, inspection and certification) to accreditation, metrology and market surveillance.

on the benefits of standards and standardization for PV are, for instance, collected by the International PV Quality Assurance Task Force (<https://www.pvqat.org/>).

Local example from Armenia

Armenia has a very dynamic PV market, and the Government set the ambitious target of 1000 Megawatt PV capacity in its Energy Sector Development Strategic Program to 2040. The Global Horizontal Irradiance (GHI) varies between 1200 to 1700 kWh/m²/year – which is above the European average of 1000 kWh/m²/year. To exploit this potential, the country faces the challenge to develop support mechanisms such as the establishment of QI services or capacity building of PV stakeholders as well as the parallel need to develop a more comprehensive policy framework for PV.

So far, Armenia has a Law on Energy Efficiency and Renewable Energy, an Energy Sector Development Strategy until 2040 and a National Energy Efficiency and Renewable Energy Program – but no national policy which defines and regulates mandatory requirements for QI for solar PV. There is an exhaustive list of technical requirements (e.g. national or Eurasian Economic Union) but neither is solar PV-specific, and PV is not on the unified list for technical regulations approved by the Eurasian Economic Commission. The minimum technical requirements are set by donor organizations that finance PV projects, or by own efforts of local project developers and individual technical experts in enhancing their competences in planning, operation and maintenance of PV plants.

Currently, PV developers cannot rely on comprehensive QI services for the enhancement of standards and technical requirements. For certification, there are several global players active in Armenia. But there are no testing laboratories that can perform the tests required in the main PV related standards, and there are limited resources of technical inspectors, quality controllers and third-party verifiers. Calibration and traceability are not ensured for testing equipment used for PV components (e.g., power analyzers, multimeters, insulation testers, resistance testers, electrical meters, PPE, etc.), for recording solar resource and weather data or for equipment, devices and reference (golden and silver) cells used in PV modules manufacturing and testing processes.

The Armenian public authorities should include the most relevant PV standards (see Andreas, N. (2024) Quality Infrastructure for Photovoltaic Systems in Armenia - Gap Analysis Report) in its annual program for development of national standards, and they should establish a sub-committee to the Technical Committee for Energy or a national workgroup dedicated to solar PV. Possibilities for establishing requirements for development, implementation and maintenance of QI for the PV market should be explored in the development process of the new Law on Renewable Energy and Energy Efficiency and/or the National Energy Saving and Renewable Energy Program.

References

Ferdinand, N., Telfser, K., Heider, C., Balbin, N. (2023) Quality infrastructure for Photovoltaic Systems, https://www.ptb.de/cms/fileadmin/internet/fachabteilungen/abteilung_9/9.3_internationale_zusammenarbeit/publikationen/Studies/PTB_Study_QI_for_PV_EN.pdf

Wallerath, S., Lange, S. (2024) QI4GT project on PV Standards in Armenia, https://www.eastern-partnership.ptb.de/fileadmin/documents/eastern-partnership/documents/Green_Transformation_Fund/PTB_QI4GT_Project_Overview_ARM.pdf

Andreas, N. (2024) Quality Infrastructure for Photovoltaic Systems in Armenia - Gap Analysis Report, <https://exergy.am>

PI Berlin (2018) White Paper. Industry Trends in PV Module Quality from over 250 Factory Audits, <https://now.solar/wp-content/uploads/2019/01/white-paper-industry-trends-in-pv-module-quality.pdf>

International PV Quality Assurance Task Force: <https://www.pvqat.org/>