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Pacific Centre for Renewable Energy and Energy Efficiency
SE4ALL Centre of Excellence to Promote Sustainable Energy Markets, Industries and Innovation

Development of regional quality infrastructure frameworks for solar photovoltaics products and services in the East African Community and the Pacific Community

Regional solar QI framework and management system for Pacific community (SPC)

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Contents

List of Abbreviations

ACCSQ	ASEAN Consultative Committee for Standards and Quality
CENELEC	European Committee for Electrotechnical Standardisation
EQAP	Boards Educational Quality and Assessment Programme
GN-SEC	Global Network of Sustainable Energy Centres
IEC	International Electrotechnical Commission
IRENA	International Renewable Energy Agency
ISA	International Solar Alliance
ISO	International Organisation for Standardisation
JASANZ	Joint Accreditation System of Australia and New Zealand
MEPS	Minimum Energy Performance Standard
NHTB	National Higher and Technical Education
PCREEE	Pacific Centre for Renewable Energy and Energy Efficiency
PPA	Pacific Power Association
PRIF	Pacific Regional Infrastructure Facility
PV	Photovoltaic
QA	Quality Assurance
QI	Quality Infrastructure
QIPR	Regional organization for quality infrastructure in the Pacific Region
RTC	Regional Technical Committees
SC	Steering Committee
SEIAPI	Sustainable Energy Industry Association of Pacific Islands
SHC	Solar Heating and cooling
SNZ	Standards New Zealand
SPC	Pacific Community
TNQAB	Tonga National Qualifications and Accreditation Board
UNIDO	United Nations Industrial Development Organisation
WELMEC	European Cooperation in Legal Metrology

1 Executive summary

Objective

The report outlines crucial insights and proposals aimed at enhancing the safety, quality, and sustainability of solar products and services within the Pacific Community (SPC). It presents an overview of the baseline assessment results and suggests establishing a Quality Infrastructure for the Pacific Region (QIPR). Additionally, it delineates the necessary resources and presents a roadmap involving key stakeholders for the implementation of the QIPR.

Results of the baseline assessment

The baseline assessment within the SPC highlights a shared acknowledgment of the importance of quality infrastructure (QI) for solar products and services. While there exists, a regional initiative led by The Sustainable Energy Industry Association of Pacific Islands (SEIAPI), aimed at establishing sustainable energy technical guidelines, training sessions, and workshops for solar photovoltaic (PV) systems, it is currently less inactive. This initiative encompasses guidelines for various types of PV systems, including grid-connected, off-grid, grid-connected with battery storage, and solar water pumping systems. Despite the presence of current guidelines and endeavours to align with international standards, obstacles remain in the broad acceptance and implementation. Concerns regarding safety, sustainability, and quality, coupled with challenges in market surveillance, emphasise the need for a regional QI framework.

Roadmap towards building a QI framework

Establishing a QI Framework is essential for ensuring the safety, quality, and sustainability of solar products and services within the SPC. Managed by the QIPR, this framework oversees the entire lifecycle of PV products and services, including design, installation, operation, maintenance, and disposal. Crucial components such as Standardisation, Metrology, Certification, Testing, Accreditation, and Conformity assessment are pivotal. The formulation of this framework involves collaboration among various stakeholders, including comprising stakeholders like PCREEE, SPC, SEIAPI, and others.

The QIPR framework comprises several key elements: establishing a Regional Technical Committee (RTC) to harmonize quality infrastructure directives, supporting international standards adoption, and offering training initiatives. Standardization focuses on PV system components and processes, ensuring quality management and certification across the value chain. Metrology and testing are crucial for accuracy, with efforts on lab establishment and collaboration. Certification and accreditation aim to streamline conformity assessment and promote mutual recognition among SPC states for trade facilitation and standard compliance.

The roadmap presents the deficiencies identified in the baseline assessment, the core objectives of the QIPR, and the short, medium, and long-term strategies for implementing quality infrastructure components. It also specifies the stakeholders engaged in the process and defines their respective roles and responsibilities.

2 Recommendations for QI Framework and Management systems in SPC

2.1 Justification of QI Framework and Management Systems

The baseline assessment indicates that within the Pacific Community (SPC) region, there is recognition of the significance of quality infrastructure (QI) for solar products and services. There is an existing but inactive regional initiative, spearheaded by The Sustainable Energy Industry Association of Pacific Islands (SEIAPI), aimed at creating sustainable energy technical guidelines, providing training sessions, and organizing workshops tailored to solar photovoltaic (PV) systems, specifically:

- Grid-Connected PV Systems - Design & Installation guidelines.
- Stand Alone Power Systems (off-grid) - Design & Installation guidelines.
- Grid-Connected PV Systems with Battery Storage - Design & installation guidelines.
- Solar water pumping systems - Design & installation guidelines

While photovoltaic (PV) systems are frequently perceived as easy deployable, it's vital to underscore the necessity of specialized knowledge throughout every stage of their value chain (refer to Figure 2-1 below).

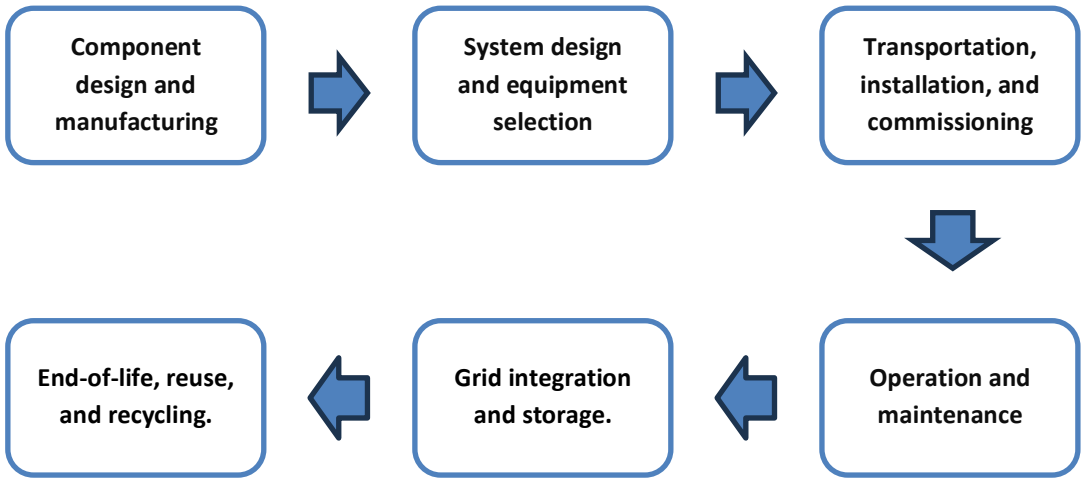

Figure 2-1: Value chain of PV systems.

This expertise is indispensable for guaranteeing the correct operation of systems and achieving sustained success in projects over the long term. Such proficiency is enhanced through experience, and in regions like the SPC, where the development of PV systems is still at the initial phase of the learning curve, issues regarding safety, quality, and sustainability are frequently inadequately tackled.

Fire risks

Both PV systems installed on buildings and off-grid systems carry a risk of fire, posing a potential danger to occupants and nearby individuals. This risk is predominantly attributed to installation errors, which are widespread in photovoltaic installations worldwide. Research conducted in 2015 by TÜV Rheinland in 100 global PV plants revealed that installation faults accounted for over 30% of serious issues in PV plants globally. Errors like improper wiring, inadequate grounding, loose connections, incorrectly installed components, use of poor quality components leading to short circuiting,

overhearing and premature failure, as well as a lack of ventilation in the installation site can significantly compromise the safety, efficiency, and financial viability of PV systems[1]. Based on the SPC baseline studies, regulatory frameworks and national standards are lacking, and even existing regulations are not effectively enforced, exacerbating safety concerns in the PV sector.

Health and Safety

Moreover, the health and safety issues concerning workers in the PV industry throughout production, installation, and end-of-life phases are becoming increasingly significant. There is a growing apprehension regarding workers' exposure to hazardous materials utilized in PV manufacturing. Throughout the life cycle of PV systems, there is potential for the release of toxic substances such as lead, arsenic, strong acids, or dioxins. Exposure can happen through inhalation of smoke, dust, or vapours, ingestion, or contact with the eyes[2]. Despite this, there remains a lack of comprehensive information regarding the chemical and physical hazards that pose risks to workers in the SPC region. A key obstacle to effective risk mitigation is the absence of coordinated efforts among stakeholders, including manufacturers, researchers, labour unions, and government bodies. Many SPC countries lack specific regulations addressing these concerns.

Sustainability

The region, as per SPC studies, faces sustainability challenges, including the lack of standardization for PV products throughout the region, which allows for the entry of counterfeit and substandard products to the market, harming the long-term performance of PV products, as well as harming the trust of the end users, along with the lack of funding for PV testing facilities, which limits their operation. Thus, it is important to develop strong infrastructure to support the sustainable growth of the PV industry. Quality infrastructure services can improve environmental impact, energy efficiency, and compliance with standards, thus helping local industries compete better and expand their markets, leading to sustainable economic development. Quality also attracts investments, lowers costs, and builds investor confidence, reducing risks. Ultimately, facilitating investments and project funding, lowering costs, and ensuring stable returns, potentially reducing electricity costs. Overall, quality infrastructure helps achieve sustainable development Goals (SDGs) and improves the environmental and social performance of PV power plants at every stage.

Quality

Ensuring sustainable market growth in the PV industry within the SPC requires a high standard of quality assurance. It is crucial for investors, policymakers, and consumers to create confidence in the performance of PV products and services. Quality assurance, following international standards and best practices, is essential across the entire lifecycle of a PV system, from design to end-of-life. This builds credibility and reduces risks for stakeholders, promoting the development and adoption of new technologies and fostering innovation within the industry.

Table 2-1 outlines the quality benchmarks for financing PV projects and presents a summary of the common issues found in PV installations.

[1] International Renewable Energy Agency (IRENA), "Boosting Solar PV Markets: The Role of Quality Infrastructure," IRENA, Abu Dhabi, 2017.
[2] Bakhiyi B, Labrèche F, Zayed J. The photovoltaic industry on the path to a sustainable future--environmental and occupational health issues. Environ Int. 2014 Dec; 73:224-34. doi: 10.1016/j.envint.2014.07.023. Epub 2014 Aug 27. PMID: 25168128/

Community trust[3]

- The lack of skilled labour and low-quality equipment has the potential to significantly harm the large-scale deployment of solar technology. Low quality products or incorrect installation practices can cause the systems to underperform or reduce their lifetime, thus disappointing end-users, making them prefer traditional energy sources.
- Furthermore. Considering that one of the main ways of promoting and scaling-up new technologies is via word of mouth, low quality products also discourage potential future users from deploying this technology. Therefore, national quality assurance and standards are a critical intervention towards the long-term adoption of solar PV products.

Table 2-1: Overview *of quality and safety problems and resulting risks in the PV value chain (adapted from*[4][5]*)*

Value Chain	Quality issues	Related risks	Examples of QI services that can reduce existing risks
Tendering and contracts	Lack of quality requirements in tenders and contracts.	Insufficient consideration of quality and risk of faults and issues leading to reduced performance.	Definition of clear quality criteria and reference to QI services (e.g. testing of PV plants).
Manufacturing and transport of components	Quality assurance of imported components.	Challenge to ensure imported components are of good quality due to large number of providers internationally.	Testing of components, e.g. module performance. as part of market surveillance. Internationally recognized accreditation of conformity assessment services, e.g. certification, module, and inverter testing. Recognition of certificates in country of origin.
	Limited industry and technology experience resulting in possible quality gaps of domestic products.	Varying quality and reliability of locally produced Components. Possible underestimation of durability risk-	Application of international standards for PV components. Application of accredited and internationally recognized certification schemes.
	Transportation and storage damage: micro cracks and resulting performance loss.	Possible performance loss and difficulty of assigning responsibility.	Reliable and locally available testing services. Adoption and implementation of existing international standards.
Planning	Lack of reliable irradiance data.	Uncertainty due to poor data as basis and resulting incorrect yield estimations.	Calibration of environmental testing equipment, e.g. pyranometers for solar irradiance measurements.

[3] Diallo, S: Diop, M: West Africa has great potential for solar energy. It's time to release it, blog post, UNDP, August 2023.
[4] Solar Bankability; Technical Risks in PV Project Development and PV Plant Operation, February 2017
[5]Telfser et al; Priorities for Quality Infrastructure Development for Photovoltaics in Indonesia, Physikalisch-Technische Bundesanstalt Braunschweig und Berlin, March 2019.

Value Chain	Quality issues	Related risks	Examples of QI services that can reduce existing risks
	Lack of experience and knowledge of the relevant service providers, including EPCs, owner's engineers and lender's technical advisors.	Possible mistakes in the project planning leading to reduced performance and false estimations.	Training and awareness raising on the consideration of quality criteria in the planning phase.
Installation and commissioning	Lack of experience of EPCs and installers resulting in installation or configuration errors.	Possible reduced performance, slower payback, reduced return on investment risk of fire, and increased maintenance costs. Mechanically broken modules	Training and certification of installers. Adoption and application of relevant international standards, e.g. for technical installation. Application of inspection and commissioning schemes according to international best practices. Installation by qualified/certified PV installers.
	Poor system documentation.	Higher Costs due to inefficiency and possible quality gaps.	Adoption and application of relevant international standards.
	Inappropriate commissioning procedures.	Uncertainty about the performance and safety of the plant from start of operation.	Definition and application of commissioning procedures according to international best practices.
Operations, maintenance, and monitoring	Lack of experience of O&M providers. Insufficient cleaning or cleaning instructions.	Reduced performance of the plant-	Creation of procedures and implementation of management systems according to international best practices.
	Lacking monitoring impeding the detection of underperformance and the collection of comprehensive performance data.	Persistent uncertainty about performance of PV systems.	Reliable testing of plant performance. Calibration of performance measurement devices, e.g. electricity meters.
Decommissioning	No product recycling procedure defined or implemented	Environmental damage, unproper/unsafe disposal of products. Risk of fire/explosion/accidents	Introduction of operational guidelines for the management and disposal of PV products aligned with international best practices
	Lack of capacity to recycle products	Environmental damage, unproper/unsafe disposal of products.	Training on procedures for PV system decommissioning aligned with best practices
	Damage on roof or land when decommissioning structure	Additional costs and delays, risk of accidents	Decommissioning by qualified/certified PV installers.

2.2 Formulation of QI Framework and Management Systems

To ensure the safety, quality, and sustainability of solar products and services within the SPC it is imperative to establish a regional entity solely dedicated to overseeing quality infrastructure. This entity, named the Quality Infrastructure for Pacific Region (QIPR), will serve as the framework necessary for introducing and deploying a comprehensive QI framework for PV products and services across their entire lifecycle within the region. This lifecycle encompasses crucial stages such as design, installation, operation, maintenance services, and end-of-life disposal. The successful implementation of this framework relies on the deployment of specific components outlined in Figure 2-2.

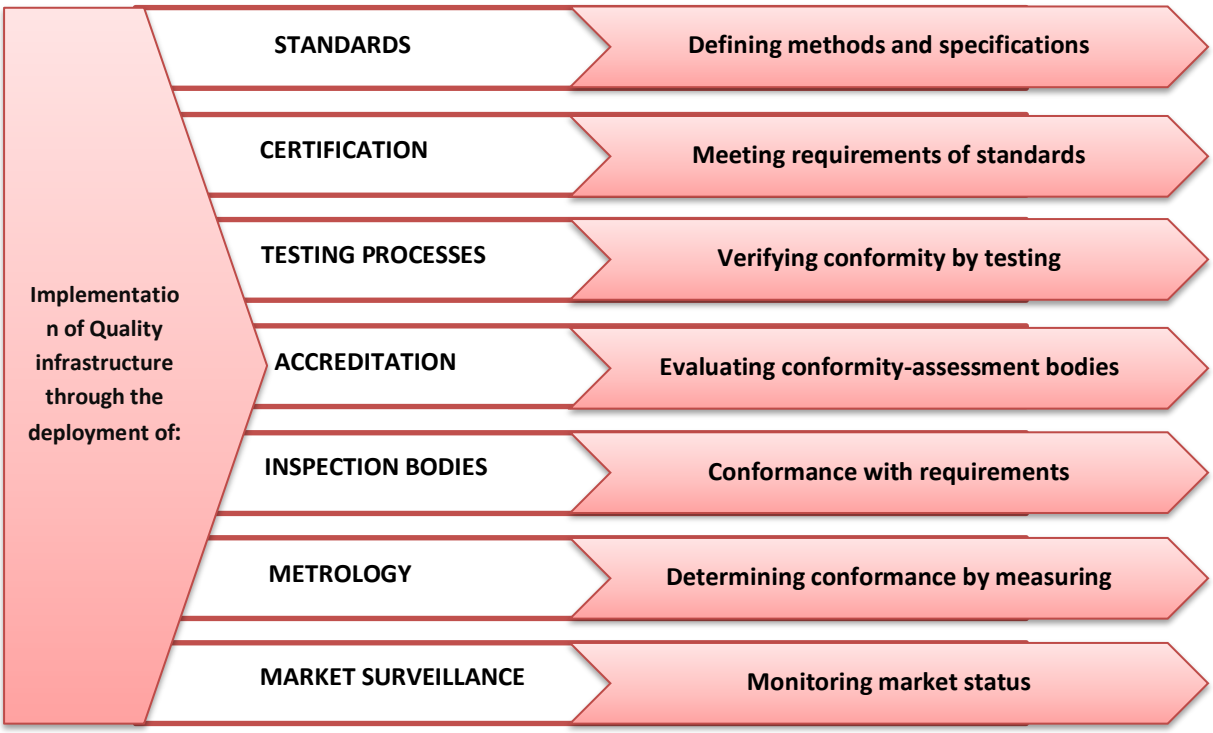

Figure 2-2: Elements of quality infrastructure (Source: adapted from[6])

Given the current absence of a unified regional quality infrastructure framework for solar products and services within the SPC, there exists an opportune moment to collectively develop a Regional Quality Infrastructure framework (as illustrated in Figure 2-3). By embracing a collaborative approach, stakeholders can effectively address the distinct challenges and opportunities present in individual SPC member countries. This ensures that the resulting framework is both comprehensive and adaptable enough to accommodate the diverse needs of the region.

[6] International Renewable Energy Agency (IRENA), "Boosting Solar PV Markets: The Role of Quality Infrastructure," IRENA, Abu Dhabi, 2017.

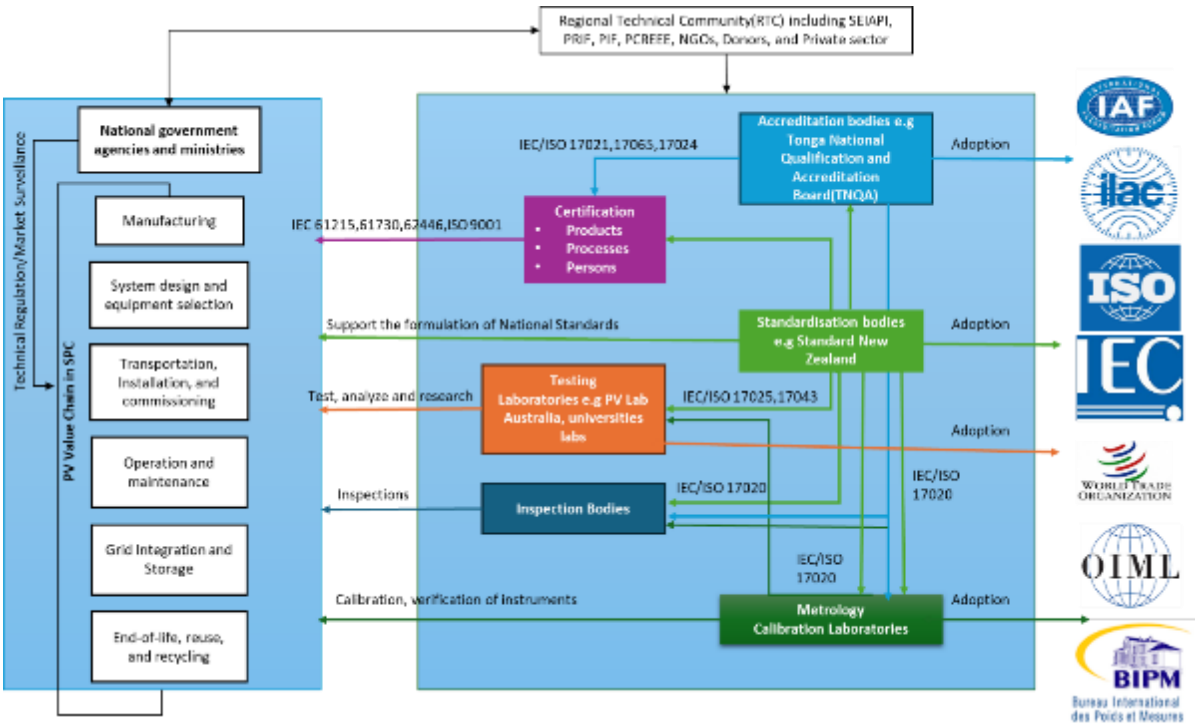

Figure 2-3: Quality infrastructure framework for the Pacific Community (Source: own representation)

The initial phase entails establishing a Regional Technical Committee (RTC), comprising members such as the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE), the Pacific Community (SPC), representatives from regional standardization bodies, and organizations with specialized knowledge in Quality Infrastructure (QI) such as the Pacific Power Association (PPA) and the Sustainable Energy Industry Association of the Pacific Islands (SEIAPI) and representatives from technical and vocational training institutions. Additionally, involvement from international organizations like the International Solar Alliance (ISA) and the United Nations Industrial Development Organization (UNIDO), as well as participation from the private sector and non-governmental organizations (NGOs), is crucial for comprehensive representation and expertise.

The Regional Quality Infrastructure Organization for the Pacific Region (QIPR), facilitated by the Regional Technical Committee (RTC) for quality infrastructure, will collaborate with national government agencies and ministries, such as the Ministry of Transport and Energy in Tokelau, National Energy Office in Marshall Islands, Ministry of Commerce, Industry and Labour in Samoa, Ministry of Public Works, Transport & Meteorological Services Fiji to supervise the implementation, enforcement, and monitoring of Quality Infrastructure (QI) standards in the SPC region.

This regional entity (RTC)responsibilities should include:

- Harmonize relevant definitions pertaining to Quality Infrastructure (QI) in solar photovoltaic (PV), particularly focusing on PV services.
- Development of regional directives for QI. These directives are aimed at local authorities, encompassing ministries and standardization agencies, and should serve as a repository for best practices concerning:
    - Testing of solar components
    - Execution of certification procedures for solar PV products and services
    - Identification of relevant international standards and compliant products and services

- Recognition of accredited conformity assessment bodies.

- Assisting in the adaptation of regional directives into national standards through activities like policy advocacy, dissemination of knowledge, and provision of technical support to stakeholders at the national level.
- Facilitating training and capacity-building initiatives for stakeholders from private, public, and civil society sectors involved in the implementation and enforcement of QI, accomplished through hosting training sessions, organizing knowledge dissemination events, and funding training programs.
- Supporting the establishment of connections between international standardization experts, organizations, and regional stakeholders through events, seminars, and networking sessions.

2.2.1 Standardisation (incl. List of suitable standards)

Standardization establishes criteria and specifications to guarantee the suitability of solar products, procedures, and services for their intended use. The national standardization bodies (e.g. Standard New Zealand) or representatives in the RTC assumes responsibility for recognizing international standards and developing regional/national standards, publishing them, raising awareness, and supplying relevant information. These standards should be applicable along the value chains in the SPC region:

Manufacturing

Quality and safety considerations for PV system components such as inverters should begin during the design phase, given their shorter lifespan compared to PV modules and their significant impact on service calls and operating costs. Ensuring durability and safety of all inverter components is crucial, especially considering harsh environmental conditions such as heat, humidity, ultraviolet (UV) rays, dust, or frost, which inverters may encounter depending on the PV plant's location. However, these stress factors are often overlooked during inverter manufacturing, leading to potential issues, including:

- Safety risks from modules with skipped or failed insulation tests
- Imperfections in cell soldering that can lead to corrosion
- Visually detectable hotspots where cells overheat and that lead to module degradation
- Failures on mechanical loads that make modules more prone to breaking
- Breakage of junction boxes or cells.
- Temperature derating of inverters, causing overheating, reducing the power or completely shutting down the inverters
- Low production quality or serial defects of the inverters, causing unexpected degradation or faults in the inverters, leading to loss in energy productions and safety risks.

Other components like cables and mounting structures play vital roles in PV system functionality, needing resistance to solar exposure and harsh environmental conditions throughout the system's lifespan. Local production of these components offers employment opportunities and value addition but failure to meet international standards has led to significant issues in PV power plants worldwide, including mounting structures failing under wind or corrosion and cable insulation breaking due to UV radiation, posing fire hazards.

During the PV manufacturing phase of the value chain in the SPC region, the Regional Technical Committee (RTC) for quality infrastructure should ensure the following:

- Facilitate the Implementation of a Quality Management System (QMS) in accordance with ISO 9001 standards, enabling PV component manufacturers to streamline processes and ensure product quality, potentially accessing new markets abroad or meeting local projects' quality demands.
- Support the adherence to specific guidance for PV module manufacturing outlined in IEC 62941: Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing, providing best practices for product design, manufacturing processes, and material selection and control.
- Facilitate the compliance with the following international standards for PV module design qualification and safety qualification:
    - IEC 61215: Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
    - IEC 61730: Photovoltaic (PV) module safety qualification
    - IEC 62093: Balance-of-system components for photovoltaic systems
    - IEC 62852: Safety requirements and tests for connectors in photovoltaic systems
    - IEC 62790: Standards for photovoltaic (PV) junction boxes
    - IEC 62109: General requirements for safety of power converters in photovoltaic power systems
    - IEC 62894: Requirements for photovoltaic inverters
    - IEC 62930: Standards for photovoltaic cable assemblies

System design and equipment selection

During the design stage of a PV project, numerous considerations such as shading must be considered to ensure the system is tailored appropriately for the specific requirements of a site. However, in the SPC region, the necessary expertise is often lacking. As a result, system design and component selection may not be optimal, leading to untapped potential for efficiency improvement. At this stage of the value chain, it is recommended that the RTC for quality infrastructure ensures the following:

- Support the strict adherence to the following international standards, which would serve as the foundation of quality assurance in PV systems, guaranteeing compliance with fundamental quality and safety criteria during component selection.
    - IEC 62548: Photovoltaic (PV) arrays - Design requirements, including DC array wiring, electrical protection devices, switching and earthing provisions.
    - IEC 61215-1-1: Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval. This standard establishes the requirements for the design qualification of terrestrial PV modules for suitable for long-term operation in open-air climates, including procedures for marking, documentation, pass, criteria reporting and testing flow and procedures.
    - IEC 61215-1-2: Providing special requirements for testing of thin film Cadmium Telluride based PV modules
    - IEC 61215-1-3: Providing special requirements for testing of thin film amorphous silicon-based PV modules

- IEC 62124: Photovoltaic (PV) stand-alone systems - Design verification, including requirements for testing methods, marking, testing, design specifications, user and technicians' manuals, major defects, testing protocols and reporting.
- IEC 60364-7-712: Electrical installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems

- Active involvement in initiatives aimed at adapting existing international standards to specific national context.

Transport, installation and commissioning.

The installation of PV systems demands specialized expertise, which is deficient in the SPC region since the PV sector is at its early stage of development. At this phase of the value chain, it is recommended that the RTC for quality infrastructure ensures the following:

- Facilitate the adoption of the following international standards which outline requirements for testing, documentation, and maintenance of grid-connected PV systems, specifying information preparation during installation and commissioning tests and inspections.
  - IEC 62446: Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance
  - IEC 62446-1: Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests, and inspection.
  - IEC 61724: Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis
  - IEC 60364-7-712: Low-voltage electrical installations - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems, including protective measures, selection and erection of critical equipment and inspection and testing procedures
  - IEC 62548: Terrestrial photovoltaic (PV) systems - Guidelines for the design and installation, including the configuration of PV arrays, safety considerations, the selection and erection of electrical equipment, operation and maintenance, and marking and documentation.
  - IEC 61829: Photovoltaic (PV) array - On-site measurement of current-voltage characteristics
- Facilitate the adoption of standards IEC 62759-1: Photovoltaic (PV) modules - Transportation testing - Part 1: Transportation and shipping of module package units for transportation testing of PV modules to ensure appropriate packaging, sampling and handling of products, along with measurements, transportation testing, environmental stress testing, environmental stress test, passing criteria and reporting procedures.
- Define commissioning procedures nationally, aligning with the following existing international standards, and consider specific national requirements and environmental conditions to ensure comprehensive quality assurance.
  - IEC 62446-1: Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection.
  - IEC 62446: Photovoltaic (PV) power plants - Commissioning, further explained below

Operation and maintenance

Maintenance tasks for PV systems typically involve cleaning solar panels based on local soiling conditions, ensuring proper functionality of monitoring equipment, trimming vegetation to prevent shading, and visually inspecting the system, its components, and monitoring data. Identifying and addressing defects promptly by repairing or replacing components is essential, underscoring the importance of having skilled personnel. However, many operators in the SPC region lack the necessary specialized PV knowledge, which is not limited to operation and maintenance of PV systems, but also extends to installation and the identification of international quality standards and compliant products. Furthermore, operation and maintenance procedures are often undefined for numerous power plants, and the applied guidelines frequently overlook critical aspects. It is recommended that the RTC for quality infrastructure ensures the following at this phase of the PV value chain:

- Support the adoption of international standards such as IEC 62446 is Photovoltaic (PV) Systems - Requirements for Testing, Documentation, and Maintenance. Particularly, part 2 for grid-connected systems maintenance and Part 3 for outdoor infrared thermography, a key maintenance field test. Basic requirements outlined in these standards include[7][8]:
    - Inspection of earth protective equipment and equipotential bonding conductor
    - Polarity inspection
    - Test for combiner box
    - Strings open circuit voltage and strings circuit current tests
    - Functional, insulation resistance and I-V curve tests
    - Infrared thermographic inspection
    - Additional tests (Voltage to ground resistive ground system, blocking diode, wet insulation and shade evaluation)
    - Basic maintenance of system components and connections
    - Measures for corrective maintenance and troubleshooting
    - Worker safety
- Additionally, utilize IEC 61829: Photovoltaic (PV) array for on-site measurement of current-voltage characteristics of PV arrays, including specifications on measurement procedures, analysis and test reports to conduct and translate to standard testing conditions:
    - Irradiance measurements in natural sunlight
    - Module temperature measurements
    - Electrical measurements
- Support the adaption of IEC 61724: Photovoltaic system performance - Monitoring for insights into PV system monitoring, including performance ratio measurement and calculation methods outlined in Parts 1, 2, and 3 of the standards. This standard presents the terminology, equipment and methods for performance monitoring and analysis of PV systems, including monitoring methods, documentation, data formatting, check of data quality and assessment of the following parameters: Global irradiation; Electric energy quantities; BOS component performance and System performance indices, along with provisions for sampling internals, data processing operation, recording intervals and monitoring period for the measurement of:
    - Irradiance

[7] Hioki - Maintenance of solar PV systems according to the IEC 62446-1 Standard
[8] IEC Webstore - IEC 62446-2:2020

- Ambient air temperature
- Wind speed
- Module temperature
- Voltage and current
- Electrical power

Grid integration, storage, and end-of life.

PV systems are commonly connected to either the grid or storage units. Excess electricity generated beyond immediate needs can be either fed into the grid or stored for later use. In the SPC region, grid codes are underdeveloped, and there's a lack of standards for inverters and efficient end-of-life management for PV components is lacking in the SPC region. At this stage of the PV value chain, the Regional Technical Committee (RTC) for quality infrastructure should ensure the following:

- Support the adoption of international standards Utilize the following, for requirements related to testing, documentation, and maintenance of grid-connected PV systems.
    - IEC 61727: Photovoltaic (PV) systems – Characteristics of the utility interface.
    - IEC 62446-1: Photovoltaic (PV) systems – Requirements for testing, documentation, and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests, and inspection, whose requirements have been previously described.
- Consider additional guidance provided by standards like the Institute of Electrical and Electronics Engineers (IEEE) standard 1547 for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces This standard provides[9]:
    - Interconnection technical specifications and performance requirements
    - Reactive power capability and voltage/power control requirements
    - Response to Area Emergency Power Supply (EPS) abnormal conditions, power quality, islanding
    - Requirements for operation, testing, safety and maintenance for interconnection
    - Test specifications and requirements for the design, production, installation, evaluation, decommissioning and periodic tests.
- Recognize the importance of national grid codes for effective grid integration, acknowledging that they may not always be sufficiently developed. Consult representatives of national quality infrastructure institutions during the development or revision of national grid codes to ensure alignment with relevant international standards.
- Establish minimum quality standards for recycled PV modules to guarantee the presence of secure and operational modules, particularly post-repair, while adhering to standardization initiatives
- Define minimum quality criteria for the reuse of PV modules to ensure the availability of safe and functional modules, especially after repair, possibly through standardization efforts. Currently there are no IEC standards on the reuse of PV components. However, the standard IEC TR 63525 ED1 for the reuse of PV modules and circular economy is under development.

[9] IEE Standards Association – IEEE 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interface

2.2.2 Metrology and Testing

Metrology and testing play a crucial role in ensuring the accuracy and reliability of measurements for solar-related instruments, serving vital functions in legal, industrial, and scientific domains. Regional and national metrology and testing institutes such as National Higher and Technical Education Boards (NHTB), Educational Quality and Assessment Programme (EQAP) provide essential services like traceability, calibrations, and investigations to laboratories (e.g. PV lab Australia) and industries in the SPC region, while calibration laboratories offer routine metrological services. To address the lack of testing facilities in the region, it is recommended to establish a technical working group on testing and metrology within the framework of the RTC and the QIPR. This group would comprise technical experts and researchers from the region, consolidating existing knowledge on metrology and testing of PV products and facilitating the development of local capacities through conferences, events, and collaboration with international experts.

Within the RTC quality infrastructure along the PV value chain in the SPC region, it is recommended that the technical working group on testing and metrology should ensures the following:

- The regional or national testing and metrology laboratories adhere to the following international standards, ensuring their competence and proficiency in testing and calibration:
    - ISO/IEC 17025: Specifies general requirements for the competence of testing and calibration laboratories, including provisions on general requirements, including impartiality and confidentiality, structural and resource requirements, and requirements for processes and management systems.
    - ISO/IEC 17043: Establishes general requirements for proficiency testing in conformity assessment, including provisions on general requirements, including impartiality and confidentiality, structural and resource requirements, and requirements for processes and management systems.
- Focus on the development of national testing laboratories on the commissioning phase and system inspection, ensuring adherence to both national existing guidelines and the following international standards and best practices:
    - IEC 62446: Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests, and inspection for commissioning tests and inspections, whose requirements have been presented in section 2.2.1 above.
    - IEC 61829: Photovoltaic (PV) array - On-site measurement of current-voltage characteristics for on-site measurement of I-V characteristics for c-Si modules, whose requirements have been presented in section 2.2.1 above.
- While testing procedures should align with prevailing standards, it is permissible to involve the services of unaccredited testing entities, although accreditation is preferred for quality assurance purposes.
- Facilitate and emphasize through awareness creation the importance of integrating simple devices like multi-meters and thermal cameras into testing processes to enhance efficiency and accuracy.

2.2.3 Certification and Accreditation

Certification usually entails testing and audits to confirm that a product or procedure meets a particular standard or specification, providing assurance of adherence. Accreditation, issued by the

competent accreditation body such as the Tonga National Qualifications and Accreditation Board (TNQA) (the one identified in the region), formally recognizes an organization's proficiency in carrying out specific conformity assessment activities. Testing and calibration laboratories, as well as certification and inspection bodies, should pursue accreditation as proof of their ability to provide reliable services.

To enhance the capacity of the SPC in certification and conformity assessment, it is recommended for RTC quality infrastructure to ensure the following:

- The regional/national certification and conformity assessment bodies adhere to the following international standards, ensuring their competence and proficiency in certification and accreditation:
    - ISO/IEC 17020: Conformity assessment – Requirements of the operation of various types of bodies performing inspection, covering the activities of inspection bodies, including examination of materials, products, installations, plants, processes, work procedures or services, these requirements are divided in:
        - General requirements
        - Structural requirements
        - Resource requirements
        - Process requirements
        - Management system requirements
    - ISO/IEC 17021: Conformity assessment - Requirements for bodies providing audit and certification of management systems, the requirements presented by this standard include:
        - Leading principles
        - General requirements (legal, management of impartiality and of liability and financing)
        - Structural requirements
        - Resource requirements (personnel)
        - Information requirements
        - Process requirements (including pre-certification, auditing, appeals and client records, among others)
        - Management system requirements
    - ISO/IEC 17023: Conformity assessment -Guidelines for determining the duration of management system certification audits.
    - ISO/IEC 17065: Conformity assessment - General requirements for bodies certifying products, processes and services, the requirements of this standards are written to be considered as general criteria for certification bodies, operating certification schemes of products, processes or services covering, among others:
        - General requirements
        - Structural requirements, such as organisational structure and mechanisms to safeguard impartiality
        - Resource requirements
        - Process requirements

      Management system requirements

- Support the Integration of local conformity assessment bodies into the RTC and the QIPR, starting with an assessment of current certification processes and providing technical assistance for establishment where needed.
- Develop regional guidelines for certifying PV products and services, providing insights and best practices for both certification processes and product identification. Initial steps for these guidelines could include leveraging existing frameworks like the certificate of compliance (CoC) for completed solar installations and implementing standards such as:
    - IEC 61215: Terrestrial photovoltaic (PV) modules - Design qualification and type approval, whose requirements are described in section 2.2.1, under design and equipment selection.
    - IEC 61730: Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction, describing the fundamental construction requirements for PV modules to provide a safe operation, including the assessment of the prevention of electrical shocks, fire hazards and personal injuries.
    - IEC 62446: Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance, described in section 2.2.1, under operation and management
    - ISO 9001: Quality management systems - Requirements.

2.3 Improvement of capacities and processes

- Capacity building programs should be implemented to train local technicians and professionals in testing procedures and standards compliance and integrate these training programs with personnel certification schemes.
- Allocate the necessary resources towards the development of infrastructure necessary for solar PV testing, calibration, and certification. This should include establishing well-equipped testing laboratories and facilities to ensure accurate and reliable assessment of PV products and services within the SPC region.
- Establish a robust quality management system (QMS) to ensure consistent adherence to quality standards throughout the solar PV value chain. This should involves implementing quality control measures, conducting regular audits, and fostering a culture of continuous improvement.
- Create directives and support national government agencies and ministries to adapt, implement and enforce compliance with quality standards and regulations. This should involve updating existing regulations, establishing quality assurance mechanisms, and enforcing penalties for non-compliance.
- Facilitate collaboration and knowledge sharing among stakeholders along the PV value chain. Encourage the exchange of best practices, lessons learned, and technical expertise to accelerate capacity building and process improvement efforts.
- Integrate considerations for gender inclusivity, digitalization, and climate change resilience into all aspects of the PV sector's development and operations. This should include ensuring equitable access to opportunities for women and marginalized groups, leveraging digital technologies for efficiency and transparency, and implementing measures to mitigate and adapt to climate change impacts on PV infrastructure and operations.

2.4 Roadmap for regional solar QI implementation

2.4.1 Phase 1 – Year 1 of implementation

2.4.1.1 Standardisation

- Within the first year of intervention, a Regional Technical Committee (RTC) for QI in the Pacific Region should be established, in close collaboration with PCREEE, ISA and UNIDO. Within the RTC, a working group in standardisation and a working group in policy advocacy should be established. The working group in standardisation should be further divided into two sub-groups, due the gap in standards adoption identified among countries:
    - One of the working groups should cover advanced standardization: with members with countries such as New Zealand with the more advanced QI frameworks, focused on enforcement and harmonization initiatives
    - The other group should focus on initiatives towards entry-level standardization: with members of those countries such as other Pacific countries with QI frameworks under development, with a focus on the adoption and adaptation of existing standards.
- The regional policy advocacy working group should establish, within the first year, a database of key members in collaboration with PCREEE and SPC and organise an awareness raising workshop on regional quality infrastructure in the pacific, including the strategy for its long-term adoption in the region.
- The RTC should advocate for the introduction of technical assistance, with support from ISA and UNIDO, that allows for the development **of a regional repository of international standards for solar PV products and services**, in close collaboration with SEIAPI (which has already developed guidelines on PV products and services) encompassing the most relevant IEC/ISO standards for PV, products and services, but also the most relevant standards that support the establishment of testing facilities, certification and conformity assessment schemes.
- The RTC, with support from international organizations and development cooperation organisations should advocate for cooperation with international standardisation bodies to **support knowledge transfer and technical assistance for the region**, these initiatives should leverage on events organised by the SPC.

2.4.1.2 Certification and conformity assessments

- The first year of implementation of the roadmap requires the **establishment of a technical working group on certification and conformity assessments**, within the RTC.
- The first task of this working group, in collaboration with PCREEE is the **development and distribution of awareness raising material and educational resources** for public authorities and regulatory bodies to facilitate the conduction of conformity assessments and certification of PV products and services.

2.4.1.3 Metrology and testing

- The RTC should establish a technical working group on testing facilities to support the exchange of knowledge among national stakeholders, as well as the delivery of trainings.
- The RTC, with support from ISA, SPC and PCREEE, should support the organisation of a workshop or conference on testing facilities ensuring the participation of bodies and

representatives of international testing facilities to promote the creation of networks of knowledge exchange, along with the formalisation of partnerships with selected metrology and testing laboratories, establishing agreements for mutual support and knowledge exchange.

- The working group of the RTC, with support from ISA, UNIDO and PCREEE should provide technical assistance for the development of guidelines for the testing of solar PV products, in line with the ISO standards for testing laboratories. The scope of this technical assistance should also include the mapping and identification of possible regional testing facilities and the mobilisation of funding for its modernisation.
- The RTC, in cooperation with ISA and PCREEE, should design a training programme for the conduction of solar PV testing, this programme should include basic educational materials on calibration and testing procedures for key personnel involved in testing and metrology within the region.

2.4.1.4 Accreditation

- Provision of technical assistance and capacity-building support to national accreditation bodies in aligning their practices with regional and international standards
- In the first year of implementation, the RTC should establish a working group for the accreditation of conformity assessment bodies and testing facilities. This group should map the existing facilities in the region and select possible candidates to receive technical assistance aimed at achieving its accreditation.
- To build regional knowledge on the topic of accreditation, one regional conference on this topic, with the participation of national, regional and international experts in accreditation, should be organised by the RTC, with support from UNIDO, ISA, SPC and PCREEE.

2.4.2 Phase 2 – Years 1 to 3 of implementation

2.4.2.1 Standardisation

- The RTC should support the mobilisation of technical assistance to the SPC member countries, so they all **achieve IEC membership**.
- The RTC, with support from international development cooperation organisations should organise **one regional conference on standardisation**, with expert support from PCREEE, and leveraging on the network and expertise of the SPC in the organisation and coordination of regional events.
- Phase 2 aims at the harmonisation of national standards and gird-compliance codes across the EAC with the regional set of standards.
- **Publication of a set of regional standards**, collecting the most relevant IEC/ISO standards for PV products and services, including a regional code of practice for the installation of PV systems, along with the existing national standards on solar PV products and services.
- The RTC, with support from ISA and PCREEE, should facilitate the provision of training for the staff of national standards bodies and other key stakeholders on the international and regional standards for solar PV products and services. These trainings can be delivered via technical assistance and its content validated by organisations with experience in the sector (SEIAPI).

- The RTC should facilitate cooperation among national authorities and standard bodies that leads to all the SPC countries developing a set of national standards for PV products and services, based on the regional repository of IEC/ISO standards.

2.4.2.2 Certification and conformity assessments

- Through technical assistance, the RTC should support, along with ISA, UNIDO and PCREEE, the provision of technical assistance for the development of regional guidelines for the conduction of conformity assessments for PV products, based on international IEC/ISO standards on requirements for conformity assessments.
- The scope of the technical assistance should also contemplate the design of a certification framework for solar PV, along with a label or digital label or credential that allows the identification of certified products and certified installers of PV products.
- The RTC, along with SPC and PCREEE should organise a conference or workshop of solar PV product certification with local standards agencies, key public sector stakeholders and international standardization bodies to promote knowledge exchange and transfer.

2.4.2.3 Metrology and testing

- In the mid-term, the technical assistance mobilised by the RTC, with support from ISA and UNIDO should ensure that one regional testing facility is accredited and can perform testing of solar home systems and off-grid products under IEC/ISO standard.
- Furthermore, local technicians and engineers from the region should be trained on the conduction of testing of SHS and off-grid solar products under IEC/ISO standards, with at least 40% of the trained staff being women.
- The training of local technicians and engineers should be accompanied by a pilot phase of online training modules, focusing on fundamental concepts of calibration and testing

2.4.2.4 Accreditation

- The RTC, in close cooperation with UNIDO, ISA and PCREEE should support the mobilisation of funding and the provision of technical assistance towards the accreditation of at least one national conformity assessment body and one testing laboratory.
- The RTC with support from PCREEE and the SPC should support national authorities in the alignment of accreditation procedures across national accreditation bodies in the region.

2.4.3 Phase 3 – Years 3 to 5 of implementation

2.4.3.1 Standardisation

- On the long term, the RTC, along with the SPC and PCREEE should continue to provide knowledge exchange and cooperation among national governments and standards authorities through the conduction of **at least two annual regional conferences on standardisation**.
- The RTC, along with PCREEE and national authorities should pursue the **training and technical assistance to national authorities and customs officials** through the region in the verification of standard compliant products and the enforcement of national standards.

- The regional standardisation efforts for the SPC region should aim in the long term, and supported by the SPC, ISA and PCREEE, to the harmonisation of the regional SPC standards framework with the Australian standards protocol.

2.4.3.2 Certification and conformity assessments

- In the long term, the efforts for achieving a regional framework for certification and conformity assessments should lead to the establishment of a regional online platform that allows end-users, developers and national authorities to verify the authenticity of the certifications for PV products.
- Through the provision of technical assistance, the RTC, along with PCREEE should train national enforcement agencies on the regional guidelines for conformity assessments for PV products, the content of these trainings should be validated by organisations with experience in the sector such as SEIAPI, and it should be ensured that at least 40% of the trained staff are women.
- The RTC, along with PCREEE, ISA and UNIDO should support the mobilisation of funding towards the establishment of a digital label for certified PV products that is valid across the region and allows to identify certified products.

2.4.3.3 Metrology and testing

- In the long term, the mobilisation of funding and technical assistance should lead to at least one testing facility in the region that receives accreditation and can perform the testing of solar components under international IEC/ISO standards.
- Training of technicians/engineers for the conduction of testing of solar PV components under IEC/ISO standards, with at least 40% of the trained staff being women, accompanied by training workshops, seminars and online training modules on metrology and testing.
- The RTC, with support from ISA and the SPC should support the establishment of regional testing networks, facilitating that regional testing facilities can serve the entire region.
- The capacity building efforts on testing of PV products require the organisation of at least three workshops on PV testing facilities with international accreditation bodies and representatives of international testing facilities to promote the creation of networks of knowledge exchange.

2.4.3.4 Accreditation

- The long-term effort towards a regional framework for accreditation of facilities requires the organisation of at least two regional conferences in the topic of accreditation with participation of national, regional and international experts in accreditation, to consolidate regional and local knowledge on this topic.
- The RTC, ISA and PCREEE should mobilise technical assistance to support the recognition of the regional accreditation body with the ILAC via a multilateral recognition agreement (MRA).

2.4.4 Expected outcomes

2.4.4.1 Standardisation

- Development of a repository of IEC/ISO standards for solar PV products and services that is, in the long term, adapted to national standards across the SPC countries.
- Cooperation among national and regional stakeholders for the mutual recognition and validation of products certified under The New Zealand and Australian standards that are compliant to the regional standards framework.
- Establishment of a regional standards database and sharing of knowledge on QI and standards via regional conferences.
- Policy advocacy at the regional level that supports the enforcement of national standards and market-based mechanisms that promote the uptake of certified products.
- Alignment with *Outcome 3 of the STAR C project: Increased impact of solar networks and knowledge management systems* via regional cooperation on the alignment of national standard towards a regional framework and its further integration to regional standardization efforts.

2.4.4.2 Certification and conformity assessments

- Regional adoption of a quality management system according to international standards such as ISO 9001 which ensures the required levels of product quality.
- Development of regional and national capacity for the regional certification of solar PV products.
- Development of a regional certification scheme that allows end-users to identify those PV products that are compliant to IEC/ISO based regional and national standards.
- Development of a regional certification for solar PV installers
- Promotion of policy advisory and training for national customs agents and standards enforcement agencies can identify non-certified products.
- Awareness raising on the regional certification scheme, so project developers and end-users can identify compliant products and are aware of their benefits.
- Alignment with *Outcome 2 of the STAR C project: Enhanced capacities of institutions to offer certified quality solar curricula and training* via the delivery of trainings on certification frameworks and the conduction of conformity assessments.

2.4.4.3 Metrology and testing

- Building a regional testing infrastructure, along with capacity for the conduction of test of PV products under international standards.
- Mobilisation of funding to improve testing capacities of existing testing centres.
- Training of staff specialized in the testing of solar PV products ensuring that personnel involved in testing and metrology acquire the necessary knowledge and skills to proficiently conduct testing and metrological activities.
- Strengthening regional cooperation for the establishment of regional testing centres that test products across the SPC countries.
- Establishing a robust system to ensure calibration and traceability for all equipment and devices utilized in testing and monitoring meteorological parameters.

- Increase in the dissemination of quality-tested solar products and services in the Pacific region by providing the necessary required resources and infrastructure.
- Alignment with *Outcome 2 of the STAR C project: Enhanced capacities of institutions to offer certified quality solar curricula and training* via the delivery of trainings on testing procedures for solar PV products in regional testing laboratories.

2.4.4.4 Accreditation

- Accreditation of at least one regional laboratory for testing solar PV products.
- Policy advocacy on the need for accredited national certification and conformity assessment bodies, as well as testing laboratories.
- Attracting investments in the solar sector in the region by providing a transparent and reliable accreditation framework that instils confidence in investors and financiers.
- Harmonizing accreditation processes and standards across the region to reduce trade barriers, encourage cross-border trade, and promote regional economic integration.
- Alignment with *Outcome 4 of the STAR C project: Effective STAR-C management and governance structure established and sustained* through the establishment of regional institutions for certification, conformity assessment and testing internationally accredited and able to provide QI services to the entire region under frameworks that fulfil international best practices.

2.4.5 Roadmap overview

The roadmap was designed by grouping the gaps identified as part of the baseline assessment in three major groups:
Knowledge-to-action gaps; technical-to-action gaps and policy-to-action gaps, for each gap category, the roadmap includes:

1. Status quo as per the results of the 2024 baseline assessment.
2. Overall intervention goals
3. The list of recommended interventions
4. Short term targets
5. Mid-term targets
6. Long term targets
7. Responsible stakeholders, along with their role in supporting the interventions

Table 2-2: Roadmap for the implementation of a QI framework for the Pacific Community

Intervention area	Status quo	Overall Goal	Interventions	Targets			Responsible stakeholders
				Short term (0 - 1 year)	Mid-term (1 - 3 years)	Long term (3 - 5 years)	
Standardization	Existence of regional guidelines for standardization based on SEIAPI's PV system design and installation guidelines, and standards from Australia and New Zealand. However, these guidelines are not implemented. Lack of political awareness and willingness the enforce the technical guidelines developed by SEIAPI.	1. Development of regional standards framework for solar PV products/services based on the IEC/ISO frameworks that is adapted to the country level 2. Mutual recognition and validation of products certified under New Zealand and Australian standards that are compliant with the regional standards framework 3. Building of a regional standards database and dissemination of available knowledge on international and regional standards for PV products and services 4. Policy and regulation advocacy to support the enforcement of technical guidelines and market-based mechanisms that promote the uptake of solar products and services	1. Technical assistance to build a regional repository of standards, gathering the most relevant IEC/ISO standards for solar PV products and services 2. Provision of technical assistance to national representatives in the Regional Technical Committee (RTC) to adapt relevant IEC/ISO standards to their national frameworks. 3. Organisation of regional conferences and technical working groups in standardisation and policy advocacy. 4. Creation of a standardized framework applicable across the region, facilitating the recognition of product compliance with national standards based on IEC/ISO criteria. This enables neighbouring countries' authorities to identify such products as meeting quality standards. 5. Establishment of a digital label for products showing their entry point and standards compliance, to allow for the easy identification of compliant products	1. Establishment of the Regional Technical Committee (RTC) for the Pacific Region, along with working groups on standardisation and policy advocacy. The working group on standardization can be further subdivided into two groups: - Advanced standardization: with members with countries such as New Zealand with the more advanced QI frameworks, focused on enforcement and harmonization initiatives. - Entry-level standardization: with members of those countries such as other Pacific countries with QI frameworks under development, with a focus on the adoption and adaptation of existing standards. 2. Engagement and cooperation with international standardisation bodies to support knowledge transfer and technical assistance for the region. 3. Establishment of a regional repository of standards that gathers the most relevant IEC/ISO standards required to set up QI frameworks in SPC, along with the existing guidelines developed by SEIAPI on solar PV products and services and groups them, thus facilitating the elaboration of regional	1. Technical assistance to support the achieving of IEC membership for all interested countries in the region. 2. Organistation of one regional conference on standardization. 3. Support the harmonisation of grid compliance codes among the SPC countries. 4. Provision of training to national representatives in the Regional Technical Committees (RTCs) and other pertinent stakeholders on international and regional standards for solar PV products and services. This training, facilitated through technical assistance, ensures its content validity, verified by experienced organizations in the sector such as SEIAPI.	1. Organisation of two annual regional conferences on standardisation 2. Support national authorities and customs officers across the SPC region in standard verification and enforcement. 3. Harmonization of SPC regional standards framework with Australian standards protocol 4. Scaling up efforts to reach broader audiences and stakeholders beyond the initial target groups, thereby maximizing the impact of capacity-building initiatives and advocacy efforts.	1. UNIDO-ISA: Overseeing the establishment of the regional technical committees, support mobilisation of funding, and provision of technical assistance to achieve the goals set in the roadmap. 2. PCREEE: Support the coordination among international, regional, and national stakeholders. 3. SPC: Support policy advocacy measures and support awareness raising and capacity building among decision-makers and national public sector stakeholders. 4. SEIAPI: Technical advisory supporting the development of regional standards, its adaptation into national frameworks, and its integration with the Pacific frameworks. 5. Standard New Zealand: Support the development of regional standards and the harmonization of national standard frameworks. 6. Standard Australia: Support the development of regional standards and the harmonization of national standard frameworks. 7. PASC: Technical advisory supporting the development of regional standards, its adaptation into national frameworks.

Intervention area	Status quo	Overall Goal	Interventions	Targets			Responsible stakeholders
				Short term (0 - 1 year)	Mid-term (1 - 3 years)	Long term (3 - 5 years)	
			6. Establishment of a regional policy advocacy working group that supports capacity building among decision-makers and public sector stakeholders on the importance of quality infrastructure and supports national governments on the development and enforcement of market-based mechanisms to promote the uptake of standard-compliant PV products and services	standards and avoiding the duplication of efforts in the national development of standards. 4. Set up the regional policy advocacy working group, including identifying key members and establishing communication channels such as organising awareness workshops and training sessions for decision-makers and public sector stakeholders to understand the significance of quality infrastructure.	5. Support the development of national standard frameworks for solar PV products and services in all the SPC countries based on the regional repository of regional and international standards. 6. Strengthening the operations of the regional policy advocacy working group, including expanding its membership and refining its strategies.		
Certification and conformity assessment	Lack of local capacity to conduct conformity assessments due to a lack of trained staff and institutions with the necessary accreditation. There is a lack of in-country product certification There is a deficiency in policies governing the entry and cross-border movement of non-certified products into the market. This occurs through unmonitored or inadequately regulated entry points where quality infrastructure is not	1. Setting up a quality management system according to international standards such as ISO 9001 which ensures the required levels of product quality. 2. Develop local capacity for the regional certification of solar PV products. 3. Develop a regional certification scheme that allows end-users to identify those PV products that are compliant with IEC/ISO-based regional and national standards.	1. Technical assistance in developing regional guidelines for certification of solar PV products and services. 2. Capacity building and training of enforcement agencies to conduct conformity assessments of solar products and services. 3. Establishment of a unified Pacific certification for both solar products and installers, regionally recognized across all countries. 4. Creation of a Pacific regional working group on certification of solar products and services. 5. Development of an online platform to verify the authenticity of regional certifications.	1. Creation of a technical working group on certification and conformity assessments within the RTC. 2. Creation and distribution of educational resources and awareness materials for regulatory bodies to facilitate the certification and conformity assessment of solar products and services.	1. Development of regional guidelines for conducting conformity assessments for PV products and services. 2. Develop a certification program for solar products in the Pacific region through technical support, accompanied by a label or digital credential for easy identification of certified products.	1. Launch a regional online platform for consumers to verify the authenticity of certifications for products 2. Train national enforcement agencies on regional guidelines for PV product conformity assessments. Deliver this training through technical support and validate its content with experienced organizations in the sector, such as SEIAPI. 3. Establishment of a digital label for certified solar products that is valid across the entire region.	1. UNIDO-ISA: Overseeing the establishment of the regional technical committees, promoting cooperation among national stakeholders, supporting the mobilisation of funding, and provision of technical assistance for the development of a regional certification scheme. 2. PCREEE: Support the coordination among international, regional, and national stakeholders . 3. SPC: Support policy advocacy measures and support awareness raising and capacity building among decision-makers and national public sector stakeholders. 4. TNQAB: Technical and capacity building advisor on the development of training material on conformity assessment guidelines.

Intervention area	Status quo	Overall Goal	Interventions	Targets			Responsible stakeholders
				Short term (0 - 1 year)	Mid-term (1 - 3 years)	Long term (3 - 5 years)	
	enforced, or border protection is weak.	4. Develop a regional certification for solar PV installers 5. Promote policy advisory and training so customs agents and national standards enforcement agencies can identify non-certify products. 6. Awareness raising on the regional certification scheme, so project developers and end-users can identify compliant products and are aware of their benefits.			3. Organize a conference or workshop on solar PV product certification involving local standards agencies, key public sector stakeholders, and international standardization bodies to facilitate knowledge sharing and transfer.		5. SEIAPI: Support the development of a regional code of practice for PV installers and a platform for verifying certifications of PV products and services. Support awareness raising on certifications among installers and developers. 6. Standard New Zealand: Technical and capacity building advisor on the development of training material on certification and conformity assessment guidelines. 7. Standard Australia: Technical and capacity building advisor on the development of training material on certification and conformity assessment guidelines. 8. EQAP: Support the development of training material on certification and conformity assessment guidelines.
Metrology and Testing	There is a notable absence of clearly defined and standardized regional procedures for conducting testing. However, one exists in New Zealand The local infrastructure or resources necessary to conduct testing and metrology are lacking or insufficient, hindering the ability to perform thorough and accurate assessments. Personnel involved in testing and metrology lack sufficient knowledge required to effectively carry out	1. Establish a robust system to ensure calibration and traceability for all equipment and devices utilized in testing and monitoring meteorological parameters. 2. Increase the dissemination of quality-tested solar products and services in the Pacific region by providing the necessary required resources and infrastructure 3. Implement	1. Implement a centralized database or information system to track calibration records and ensure traceability of equipment used in testing. 2. Upgrade existing and establish new testing and metrology facilities to ensure they meet international standards for accuracy and precision. 3. Establish partnerships with accredited metrology and testing laboratories or institutions such as PV Lab Australia to facilitate knowledge exchange and provide access to specialized training and expertise. 4. Develop and distribute educational materials and manuals on calibration and	1. Conduct an assessment of existing testing and metrology facilities to pinpoint immediate areas for enhancement or modernization. 2. Creation of a technical working group on testing facilities to support the exchange of knowledge across local stakeholders. 3. Develop and distribute basic educational materials on calibration and testing procedures to key personnel involved in testing and metrology within the region. 4. Formalize partnerships with selected metrology and testing laboratories,	1. upgrade of current testing and metrology facilities, adhering to international standards for accuracy and precision. 2. Launch a pilot phase of online training modules, focusing on fundamental concepts of calibration and testing	1. Establish testing and metrology facilities, prioritizing countries with significant demand for solar products and services. 2. Integrate training workshops and seminars into existing online training modules, inviting local experts to provide hands-on training and guidance to participants. 3. Training of technicians/engineers for the conduction of testing of solar PV components under IEC/ISO standards, with at least 40% of the trained staff being women	1. UNIDO-ISA: Overseeing the establishment of the regional technical committees, promoting cooperation among national stakeholders, supporting the mobilisation of funding, and provision of technical assistance for the development of regional metrology. 2. PCREEE: Support the coordination among international, regional, and national stakeholders. 3. SPC: Support policy advocacy measures and support awareness raising and capacity building among decision-makers and national public sector stakeholders . 4. EQAP: Technical and capacity-building advisor on the development of training material on testing and metrology

Intervention area	Status quo	Overall Goal	Interventions	Targets			Responsible stakeholders
				Short term (0 - 1 year)	Mid-term (1 - 3 years)	Long term (3 - 5 years)	
	testing and metrological activities There is a shortage or inadequacy of personnel who have received proper training and education in conducting testing and metrology, resulting in suboptimal performance and potential errors There is a challenge in verifying the accuracy and reliability of testing and metrological equipment	comprehensive training programs to ensure that personnel involved in testing and metrology acquire the necessary knowledge and skills to proficiently conduct testing and metrological activities, thereby enhancing performance and reducing the occurrence of errors.	testing procedures to personnel involved in testing and metrology activities. 5. Develop local capacity through workshops, conferences, and seminars to train personnel on best practices for calibration and traceability, emphasizing the importance of accuracy and reliability in testing and metrology. 6. Establish online training modules or courses that personnel can access at their convenience to deepen their understanding of testing and metrology principles.	establishing agreements for mutual support and knowledge exchange.		4. Organise at least one workshop on PV testing facilities with international accreditation bodies and representatives of international testing facilities to promote the creation of networks of knowledge exchange. 5. Reach one regional testing facility that is accredited and can perform testing of solar components under IEC/ISO standards (IEC 17025 compliance).	5. SEIAPI: Support the development of a regional code of practice for PV installers and support awareness raising on testing and metrology among installers and developers. 6. Standard New Zealand: Technical and capacity-building advisor on the development of training material on testing and metrology guidelines 7. Standard Australia: Technical and capacity building advisor on the development of training material on Testing and metrology guidelines.
Accreditation	There is a lack of capacity development programs for accreditation assessors and technical experts in the region Accreditation process for conformity assessment is still in the developmental phase.	1. Ensure accurate execution of inspections and empower the responsible individual to recognize and address any instances of non-compliance 2. Attracting investments in the solar sector in the region by providing a transparent and reliable accreditation framework that instils confidence in investors and financiers. 3. Harmonizing accreditation processes and standards across the region to reduce	1. Collaborating with national and international accreditation bodies to develop and implement a standardized accreditation framework that meets global best practices. 2. Developing mutual recognition agreements (MRAs) between accreditation bodies to streamline the accreditation process for solar products and services across the region. 3. Establish regional training programs for inspectors to enhance their skills in accurately identifying non-compliance issues.	1. Providing technical assistance and capacity-building support to accreditation bodies such as the Tonga National Qualification and Accreditation Board (TNQAB) in aligning their practices with regional and international standards. 2. Engage in outreach and promotional activities to raise awareness among investors and financiers about the benefits of investing in the region's accredited solar sector. 3. Establishment of a regional working group for accreditation of conformity assessment bodies and testing facilities.	1. Develop and launch pilot programs for the accreditation process within the region	1. Expand and enhance capacity development programs to cover a wider range of topics and ensure continuous learning and skill improvement for accreditation assessors and technical experts. 2. Organisation of at least one regional conference in the topic of accreditation with participation of national, regional and international experts in accreditation. 3. Achieving an MRA for at least one national or accreditation body.	UNIDO-ISA: Overseeing the establishment of the regional technical committees, support mobilisation of funding, and provision of technical assistance to achieve the goals set in the roadmap. 2. PCREEE: Support the coordination among international, regional, and national stakeholders. 3. SPC: Support policy advocacy measures and support awareness raising and capacity building among decision-makers and national public sector stakeholders. 4. TNQAB: Provide information and guidance to individuals, institutions, and employers on matters related to qualifications, accreditation, and quality assurance for solar products and services in the region

Intervention area	Status quo	Overall Goal	Interventions	Targets			Responsible stakeholders
				Short term (0 - 1 year)	Mid-term (1 - 3 years)	Long term (3 - 5 years)	
		trade barriers, encourage cross-border trade, and promote regional economic integration.					

2.5 Resources required for regional QI framework.

Table 2-3: Resource requirements for QI roadmap implementation in SPC

Area	Resource requirements	Estimated costs (EUR)
Establishment of Regional Technical Committee	Organisation of two webinars and three hybrid regional conferences on Quality Infrastructure for PV products and services.	69,000.00 €
	Operational expenses across the first five years of the RTC	5,000.00 €
Standardization	Technical assistance for the harmonisation of solar PV standards across the SPC region	20,000.00 €
	Development of a regional repository of technical standards for solar PV products, including online platform and purchasing IEC/ISO standards	10,000.00 €
	Establishment of a regional digital certification label for PV products	20,000.00 €
Certification and conformity assessment	Technical assistance for the development of regional guidelines for certification of solar PV products and services and a common certification framework.	63,000.00 €
	Training of national enforcing agencies to conduct conformity assessments of PV products and services.	33,000.00 €
Testing facilities	Support the accreditation of at least one national testing facility for PV products	50,000.00 €
	Training of local technicians and engineers on the testing of solar PV products	20,000.00 €
Accreditation	Technical assistance for achieving a Multilateral Recognition Agreement between a national accreditation body and the International Accreditation Forum (IAF)	20,000.00 €
Total		**310,000.00 €**

3 Annex - Outline and procedures for the regional technical committees (RTCs) for QI implementation support in SPC.

Working guidelines

Regional Technical Committee (RTC):

Development of a regional quality infrastructure (QI) framework for solar photovoltaics products and services in the Pacific Community

3.1 Introduction

The STAR C project - *Structuring of an International Network of Solar Technology and Application Resource Centres* aims at creating a strong network of institutional capacities within the member states of the International Solar Alliance (ISA) to enhance quality infrastructure for the uptake of solar energy product and service market.

The regional approach of the STAR C project intends to create a cross-border harmonisation of solar product, service and qualification standards, shared resources and joint implementation in the national level.

The assignment tilted "Development of regional quality infrastructure frameworks for solar photovoltaics products and services in the East African Community and the Pacific Community "is a technical assistance provided on behalf of the United Nations Industrial Development Organization (UNIDO) and the International Solar Alliance (ISA) for the East African Community (EAC) and the Pacific Community (SPC) under the scope of the STAR C project.

This assignment aims to further enhance and establish equivalent and trusted Quality infrastructure (QI) capabilities in these regions. This effort is intended to create a level playing field for solar energy businesses in the regions, fostering competitiveness. As part of this assignment– *the development of solar QI framework and management systems for EAC and SPC* – requires the establishment of a regional technical committee (RTC), whose main responsibility will be the long-term implementation of the quality infrastructure framework for the Pacific Community, thus ensuring the sustainability of this assignment and the accomplishment of the objectives of the STAR C project.

3.2 Main responsibilities of the RTC

The main responsibilities of the RTC include:

- Oversee the further implementation and enforcement of the QI frameworks and standards at the regional and national levels.
- Become a regional knowledge hub for standards, conformity assessment and testing procedures.
- Facilitate the training of regional and national authorities and key stakeholders on the different aspects of Quality Infrastructure (QI) and how to monitor and evaluate compliance to them.
- Organisation of technical conferences and knowledge dissemination events in the topic of Quality Infrastructure.
- Conduct policy advocacy and awareness raising on the importance of compliance to QI frameworks within the regional PV sector.
- Coordinate efforts in the harmonisation of standards, certifications and testing of PV products for the SPC countries.

- Cooperation and knowledge exchange with international organisations expert in Quality Infrastructure.

3.3 Members and responsibilities

The following are the proposed members of the Regional Technical Committee:

- The United Nations Industrial Development Organization (UNIDO): UNIDO will oversee the establishment of the RTC and the technical working groups. Furthermore, UNIDO will guide the development of Terms of Reference for the provision of technical assistance to achieve the goals established in the roadmap, as well as support the RTC in the raising of funds to cover the costs associated with the implementation of the roadmap.
- The International Solar Alliance (ISA): ISA will support knowledge dissemination and sharing among local, regional and international stakeholders for the development and implementation of the QI framework, in alignment with the objectives of the STAR C project and leveraging on its vast international presence and contacts along the value chain of solar PV.
- The Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE): PCREEE will assume the technical advisory and leadership of the implementation of the roadmap towards QI framework, providing technical expertise in the different areas of QI frameworks and overseeing that the goals established in the roadmap are fulfilled. Furthermore, PCREEE will support coordination and joint efforts among local and regional stakeholders.
- The Pacific Community (SPC) and the Pacific Islands Forum (PIF): The SPC will support the local implementation of the regional QI framework dispositions through the support of policy advocacy measures and support awareness raising and capacity building among decision-makers and national public sector stakeholders.
- Representatives from national standard bodies and other key stakeholders: Which will fulfil several roles in the implementation of the roadmap, including:
    - Participation in knowledge dissemination events
    - Facilitating the development of a regional framework for QI the harmonisation of national frameworks with the newly developed regional frameworks.
    - Support the development of training materials and the delivery of trainings for their key personnel.
    - Supporting awareness raising on the regional QI frameworks
- The Sustainable Energy Industry Association of Pacific Islands (SEIAPI): Technical advisory supporting the development of regional frameworks for quality infrastructure, its adaptation into national frameworks, and its integration and alignment with the current efforts in the areas of standardization and quality infrastructure in the Pacific region.
- Pacific Area Standards Congress (PASC): Providing Technical advisory supporting the development of regional standards, its adaptation into national frameworks.

3.4 Procedures and organisation

- The RTC will meet online and periodically in person (when required) once a month. The duration of the RTC meetings is recommended to be of one hour, with a recommended hybrid launch session of four hours.
- The RTC will be directed by a head organisation. During the first six months of implementation, this position will be held by representatives of PCREEE, afterwards this organisation will rotate every six months among the organisations from the participating countries.

It is recommended to streamline the work of the RTC among technical working groups focused on:

1. Events and knowledge dissemination
2. Policy advocacy
3. Standardisation
4. Certification frameworks and conformity assessment
5. Testing facilities
6. Accreditation

3.5 Timeline and milestones

3.5.1 Phase 1 - Year 1 of implementation

After the first year of establishment the RTC should have achieved the following milestones (M):

- M1.1 – Launch meeting with all the participants.
- M1.2 – Establishment of six technical working groups.
- M1.3 – Establishment of international cooperation partnerships and development of terms of reference for the provision of technical assistance for the implementation of Phase 1 activities.
- M1.4 – Development of a regional repository of standards for solar PV products and services based on IEC/ISO standards and the available national standards and aligned with the existing guidelines developed by SEIAPI on PV products and services.
- M1.5 – Conduction of an assessment of the existing testing and metrology facilities and Identification of suitable regional testing facilities for modernisation and mobilisation of funding.
- M1.6 – Set of awareness raising materials, training materials and a regional training strategy on the areas of:
    - Certification, frameworks and conformity assessments
    - Calibration and testing of PV products.
- M1.7 – Provision of technical assistance to national accreditation bodies to align their practices with international best practice.

3.5.2 Phase 2 – Years 1 to 3 of implementation

At the end of year 3 of the RTC, the following milestones should have been achieved

- M2.1 Establishment of international cooperation partnerships and development of terms of reference for the provision of technical assistance for the implementation of Phase 2 activities.
- M2.2 –Support IEC membership of SPC countries.
- M2.3 - Conduction of a regional conference on quality infrastructure, covering two major topics:
    - Standardization of solar products
    - Solar PV product certification
- M2.4 – Protocol for the regional harmonisation of grid-compliance codes and the harmonisation of standards for PV products and services among SPC countries.
- M2.5 Support the development of national standard frameworks based on the harmonisation of standards for the region.
- M2.6 – Development of training materials and provision of trainings in the areas of:
    - International and regional standards framework for PV products and services.
    - Enforcement of quality standards for solar PV components
    - Fundamentals of calibration and testing
- M2.7 - Development of regional guidelines for the conduction of conformity assessments for PV products.

- M2.8 – Design of a certification framework for solar products within the SPC region, including:
- M2.9 – Achieving the international accreditation of:
    - At least one regional testing facility.
    - At least one national conformity assessment body

3.5.3 Phase 3 – Years 3 to 5 of implementation

At the end of year 5 of the RTC, the following milestones should have been achieved

- M3.1 - Establishment of international cooperation partnerships and development of terms of reference for the provision of technical assistance for the implementation of Phase 3 activities.
- M3.2 – Organising one yearly conference on Quality Infrastructure, covering the following topics
    - PV testing facilities and procedures
    - Accreditation of testing facilities and conformity assessment bodies
- M3.3 – Design of training materials and support for the provision of trainings in the areas of:
    - Standard verification and enforcement for national authorities and customs officers across the SPC.
    - Conduction of conformity assessments for PV products.
    - The conduction of testing of solar PV components under IEC/ISO standards
- M3.4 – Adjustment of protocol on regional harmonisation of standards with the Australian standards protocol.
- M3.5 - Design and launch of a digital label and a regional online platform for consumers to verify the authenticity of certifications for PV products.
- M3.6 – Ensure the accreditation of one regional testing facility able to perform testing of solar components.
- M3.7 Recognition of at least one national accreditation body with the ILAC via a Multilateral Recognition Agreement.