

# External evaluation

Lead assessor: Bernward Causemann

Technical assessor: Andhika Prastawa

Strengthening Quality Infrastructure for the Photovoltaic Sector in  
Indonesia

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PTB | Section: PTB Group 9.3

PTB | Project Coordinator: Cora Buchenberger

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This evaluation is an independent assessment. Its contents reflect the assessor's opinion which is not necessarily equivalent to PTB's view.

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**List of abbreviations**

<b>AESI</b>	Indonesia Solar Energy Association
<b>APAMSI</b>	Association of Solar Module Manufacturers
<b>ASRS</b>	Automatic Solar Radiation System
<b>B2TKE- BPPT</b>	Center for Energy Conversion Technology of BPPT
<b>BAPPENAS</b>	National Development Planning Agency of Indonesia
<b>BGR</b>	Bundesanstalt für Geowissenschaften und Rohstoffe
<b>BMKG</b>	Indonesian Agency for Meteorology, Climatology and Geophysics
<b>BMZ</b>	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
<b>BPPT</b>	Agency for the Assessment and Application of Technology
<b>BRIN</b>	Agency for Research and Innovation
<b>BSN</b>	Badan Standardisasi Nasional Agency for Research and Innovation (National Standardization Agency)
<b>BSN SNSU</b>	Indonesian National Metrology Institute
<b>CW</b>	Capacity WORKS
<b>DC</b>	Development Cooperation
<b>EBTKE</b>	Directorate General of Renewable Energy and Energy Conservation
<b>EPC</b>	Engineering, Procurement, Construction
<b>ESDM</b>	Ministry of Energy and Mineral Resources
<b>GIZ</b>	Gesellschaft für internationale Zusammenarbeit
<b>GWp</b>	Giga Watt peak

<b>IEC</b>	International Electrotechnical Commission
<b>KAN</b>	Komite Akreditasi Nasional (National Accreditation Body of Indonesia)
<b>KfW</b>	Kreditanstalt für Wiederaufbau
<b>LCR</b>	Local Content Requirement
<b>Mol</b>	Ministry of Industry
<b>OECD-DAC</b>	Organisation for Economic Cooperation and Development – Development Assistance Committee
<b>P4SI</b>	Center for Formulation, Implementation and Enforcement of Industrial Standardization at Mol
<b>PCC</b>	Project Coordination Committee
<b>PID</b>	Potential Induce Degradation
<b>PR</b>	Performance Ratio
<b>PT. PLN</b>	Perusahaan Listrik Negara (state-owned electricity company)
<b>PRKKE</b>	Research Center for Energy Conversion and Conservation
<b>PTB</b>	Physikalisch-Technische Bundesanstalt
<b>PV</b>	Photovoltaic
<b>RUPTL</b>	General Planning of Electricity System Expansion
<b>QI</b>	Quality Infrastructure
<b>REEP</b>	Renewable Energy for Electrification Programme
<b>RESD</b>	Renewable Energy Skills Development Project of SECO
<b>SDG</b>	Sustainable Development Goal(s)

<b>SECO</b>	Swiss State Secretariat for Economic Affairs
<b>SME</b>	Small and Medium Enterprise
<b>SNI</b>	Indonesian National Standards
<b>TC 27-03</b>	Technical Committee on Renewable Energy
<b>TC 27-08</b>	Technical Committee on Solar Energy

## 1. Summary

Evaluation subject is the project “Strengthening Quality Infrastructure for the Photovoltaic Sector in Indonesia”, running from November 2020 to May 2025 with a planned volume of 2 Mill. Euro. The project objective is to improve quality assurance in the PV sector for new and existing PV systems in Indonesia in line with international good practice. The evaluation was conducted on-site, with an online inception phase and after the evaluation mission an online survey of the photovoltaic industry in Indonesia.

The government of Indonesia plans to substantially increase the share of renewable energies in the national energy mix. Solar energy is one of the renewable energies promoted, although the implementation currently is not sufficient to achieve grand plans. But the solar power contribution to general power production in Indonesia is increasing, there are solar module manufacturing companies in Indonesia and a growing industry of photovoltaic services providers. Large deployment of solar PV generation requires, amongst other conditions, the development of technical competence to overcome existing quality problems in PV installations and prevent further negative experiences with PV.

The core problem that the project addresses is that currently in Indonesia, the QI ecosystem is not fully established, and hence quality aspects are not sufficiently included in PV processes. Furthermore, necessary services for quality assurance are not sufficiently available and used, to ensure the quality, security and longevity of PV installations. One of the problems is that on small islands, where there is a massive need for electricity, quality services are difficult to establish. An opportunity for developing solar energy industry has arisen in the growing industry on islands outside of Java. Particularly on Batam a new contract has been agreed on to supply renewable energy to Singapore.

The project works with three pillars or fields of activity. The first field is the work with institutions providing quality assurance services for the PV sector. The project interventions aim to strengthen the capacity of these providers and assist in expanding their services. The second field is the work with decision makers in key institutions for the PV sector. Interventions aim to better inform these decision makers and to have a better understanding of QI services for PV. The third field of activity is the work with PV practitioners. Interventions are to increase the awareness about quality and about quality assurance services amongst PV practitioners. The main project hypothesis is that these outputs lead to an overall improvement of quality assurance in the PV sector for new and existing PV systems in Indonesia in line with international good practice. The project has a very flexible way of working with multiple partners on many relevant issues as part of a very agile strategic approach.

### Assessment according to the OECD DAC criteria

The six evaluation criteria are assessed as follow.

Criterion	Evaluation of the criterion
1. Relevance	1.3
2. Coherence	1.5
3. Effectiveness	1.5
4. Efficiency	2.0
5. Impact	2.0

6. Sustainability 1.3

**Global assessment 1.6**

- Since effectiveness, impact or sustainability were rated "4" or worse, the global assessment is downgraded to "4" although the mean would actually be better than "4".
- No downgrading of the global assessment.

Relevance	<p>The project's relevance is overall assessed as very successful (1.3), based on its design promoting solar energy and quality infrastructure which Indonesia prioritises. It is adjusted to the complexity of the sector, involving many actors who are all addressed. It was well suited to increase their capacities. The design allows for much agility, responding to partner needs, and the project has shown great flexibility in adjusting to changing circumstances particularly during the Covid crisis.</p> <p>Mark: 1.3</p>
Coherence	<p>The project's coherence is overall assessed as successful (1.5), based on its contribution to a German development cooperation programme on renewable energy in Indonesia where it covers the niche on quality. It is considered very successful regarding external coherence, that is successfully complementing the efforts of many local partners who invested massively in the project. It also contributed substantially to the efforts of a Swiss organisation promoting capacity building of polytechnics on renewable energy.</p> <p>Mark: 1.5</p>
Effectiveness	<p>The project's effectiveness is overall assessed as successful (1.5), based on a successful achievement of objectives and prevention of negative effects. Main achievements are that two photovoltaic module testing facilities were established by partners, a solar module regulation was introduced that requires certification of all modules. Solar simulator classification is about to be accredited. The project is assessed very successful for its contribution to the results and a very good implementation. Many of the changes achieved cannot be explained without the project input.</p> <p>Mark: 1.5</p>
Efficiency	<p>The project's efficiency is overall assessed as successful (2), based on an assessment of successful efficiency on output and outcome level. The budget is considered as having been used as efficiently as possible because no ways to further increase efficiency could be identified.</p> <p>Mark: 2.0</p>
Impact	<p>The project's higher-level effects are overall assessed as successful (2.0), based on a high potential but limited realised higher-level results. Local manufacturers are now forced to improve their quality management, a process of steady quality improvement in ongoing in many institutions and the</p>

	<p>Ministries of Industry and Energy now have potential to cooperate on solar quality infrastructure. Its impact would be higher if the Indonesian solar electricity sector grew faster. The project shows a strong contribution to these results and a very good prevention of negative effects.</p> <p>Mark: 2</p>
Sustainability	<p>The project results' sustainability is overall assessed as very successful (1.3), because the capacities of partners are strong. They can sustain the results and are likely to overcome many problems on their own. The project has also made a very successful contribution to the partner capacities. A long duration of many of the achieved outcomes is expected.</p> <p>Mark: 1.3</p>

## 2. Introduction

Project title	Strengthening Quality Infrastructure for the Photovoltaic Sector in Indonesia
Programme	Energy in Indonesia
Project objective	Quality assurance in the photovoltaic (PV) sector to support new and existing PV systems has been improved in line with international best practice.
Term	November 2020 to May 2025 (incl. one year extension)
Volume	EUR 2,000,000 (plus EUR 250,000 residual funds from previous projects)
Evaluation period	January to June 2024

The evaluation was conducted on-site, with an online inception phase. After the evaluation mission an online survey of the photovoltaic industry in Indonesia was conducted. The evaluators bring different competencies to the team. The lead evaluator brings in extensive evaluation experience and some Physikalisch-Technische Bundesanstalt (PTB), Indonesia and limited renewable energy experience. The national, technical evaluator brings in extensive audit and photovoltaics (PV) experience and context knowledge.

Evaluations are an important quality assurance tool for PTB. They are conducted to provide accountability to the German Ministry for Economic Cooperation and Development (BMZ), to support internal learning processes and to improve the quality of the project in terms of the Organization for Economic Cooperation and Development Assistance Committee's (OECD-DAC) evaluation criteria relevance, efficiency, effectiveness, development policy effectiveness (impact) and sustainability. The evaluation results serve as an input to the appraisal mission of the follow-up project.

Specific evaluation questions of PTB are:

- Did the project reach (out to) the industry? Does or could the project reach / benefit the local industry?
- Does the top management level (of different institutions) understand the quality issues? In other words: Do the highest levels of leadership have a sufficient (technical, possibly also organisational) understanding of what quality issues are about, how relevant they are and what do they require in terms of resources, structures and leadership support? These specific questions will be addressed under the effectiveness and impact criteria.

## 3. Context and strategic approach of the project

### 3.1. Context

The government of Indonesia plans to substantially increase the share of renewable energies in the national energy mix. This is not only to reduce the dependency of fossil fuels, but also to achieve the climate change commitment to reduce greenhouse gas emissions. The Ministry of Energy and Mineral Resources has announced that Indonesia will pursue a target of Net Zero Emission in 2060. Reflecting this policy, the National Electricity Company - Perusahaan Listrik Negara (PT. PLN) published the 2021-2030 General Planning of Electricity System Expansion (RUPTL) which indicates that renewable energy-based electricity would dominate the additional capacity generation by more than 50% or

about 20.9 Giga Watt (GW). This includes hydro, geothermal, wind, solar energy, waste to energy and biomass.

Solar energy has great potential in Indonesia, and therefore the National Electricity Company PT. PLN plans to expand electricity generation from PV significantly, to achieve 4.7 Giga Watt peak (GWp) installed capacity in 2030. To achieve the national target of renewable energy share in the energy mix, extensive solar PV development is planned. Solar PV generation is a convenient electrical generation type both for on-grid application and off-grid for the electrification of remote areas.

According to the project proposal and progress reports to BMZ, renewable energy can contribute to local economic development. The government intends to achieve that and create jobs partly through the preferential installation of locally produced PV components (an element of the Green Economy). During the project period, the government confirmed and further specified its intentions in this regard and created new initiatives and projects. The government through the Ministry of Industry encourages the private sector to invest in the developing solar PV industrial supply chain. The government imposed a Local Content Requirement (LCR) to promote local manufacturers, e.g. of PV modules. LCR means that a certain percentage of the product value needs to have been produced in Indonesia. In this context, quality aspects are an important issue to assure that the locally manufactured products meet the required quality standard, hence providing a well proven performance that promotes the trust and consumer satisfaction to the solar PV product. The survey of practitioners shows that this effort bears fruit. 15 of 21 respondents confirmed that their company has a quality management system in place (12: ISO 9001, question 5).

Currently there are around 22 solar PV manufacturing companies. These companies have an annual production capacity for solar PV modules with at least 1,800 MW. Twelve of the manufacturing companies are members of the Indonesian Solar PV Module Manufacturing Association or APAMSI, who are considered as the pioneers in establishing solar PV module manufacturing in Indonesia for more than 15 years. The rest are relatively new manufacturing facilities, with larger production capacity and more up to date technology. Two manufacturing facilities, located in Batam, Riau, and Demak, Central Java have the large production of respectively 500 MW and 800 MW annually, which accounts as the largest in Indonesia.

The Local Content Requirement for Solar PV module calculation is stipulated in the Ministry of Industry Regulation No 4 – 2017, and the Level of LCR is stated in the Ministry of Industry Regulation No 5 – 2017. The existing local manufacturing is only module manufacturing. As a result, currently the common LCR level is around 40 to 45%, still below the expected value of 60% as stated in the Regulation of Ministry of Industry No 5 – 2017. This provides an opportunity to establish the solar module supply chain in the upstream industry, including solar cells, tempered glass etc. As the industry is growing, the needs of Quality Infrastructure (QI) for solar PV becomes more important. Not only that this will help the industry to produce certified quality products that are trusted by the domestic market, but also to open opportunities for the regional and global market.

Large deployment of solar PV generation requires, amongst other conditions, the development of technical competence to overcome existing quality problems in PV installations and prevent further negative experiences with PV. This leads to the core problem of lack of quality (see below). Quality problems are mostly related to a lack of quality awareness and know-how amongst decision makers in central functions (Ministries, the central energy provider), and amongst actors in the PV sector, like experts and skilled workers in companies. Another reason for quality problems is that there are no or insufficient quality requirements for PV installations and that quality aspects are not sufficiently considered when implementing PV projects. Quality assurance of PV installations and their

components, awareness and competence about quality of actors in the PV sector are important to ensure that the perception and trust of potential PV technology users into its quality are secured.

The project's core problem has been defined as such: Currently in Indonesia, the QI ecosystem is not fully established, hence, quality aspects are not sufficiently included in PV processes and necessary services for quality assurance are not sufficiently available and used, to ensure quality, security and longevity of PV installations.

During our interviews, we received varying responses on the prospects on growth of PV electricity generation in Indonesia. Quite some are sceptical. The rooftop PV is considered as a suitable strategy to increase the private sector PV market. The issuance of the new regulation of rooftop PV, among others, alleviates the net-metering principle, and implements a capacity quota of new rooftop PV connections. This would have effects on rooftop installations particularly for households. Regarding the upcoming large PV installations, there are concerns whether private sector providers will get an equal and fair chance to get rooftop customers, considering the competition with the subsidiary PT. PLN that also provides services to install rooftop solar PV, and that PLN might ensure its quasi monopoly. Another issue that hinders a massive growth of rooftop PV is the electricity oversupply in large parts of Java and Bali, and parts of Sumatra. In survey responses, the need to provide better opportunities and reduce regulation for PV installation was also raised (question 20).

From the information that were gathered, there is a massive need for electricity on remote islands, particularly to replace small remote and isolated diesel generator ("gen-set") system. Although these would be the field where quality assurance would be required, it seems difficult to establish QI there. Even the transport of PV modules to the island is challenging. As a result, there are severe maintenance problems with rural or small-town PV installations, which are frequently replaced with generators after some time.

Another issue is important regarding PV on smaller islands. Since 2020, it is prohibited to export unprocessed minerals like nickel. Indonesia is now the world's largest nickel producer, and with the growth in battery production, its export is expected to rise, with many mines on Sulawesi and North Maluku. Nickel processing is highly energy intensive, so that according to conservative estimates, by 2030 a total of 31.4 GW will be required. Currently, this energy requirement could be provided sufficiently, reliably, and rapidly, only by fossil-based power generation. It seems a huge challenge, to provide these with renewable energy.

An opportunity for developing solar energy industry has arisen in the growing industry on islands outside Java, and particularly on Batam with a contract to supply renewable energy to Singapore.

Regardless the challenge and opportunities that are faced by the PV industry in Indonesia, there is a common agreement found during the interviews, that Indonesia needs good QI with all QI instruments to ensure a well-accepted quality PV industry for the benefit of consumers and industry itself.

### 3.2. Strategic approach of the intervention

The project works with three pillars or fields of activity (see the results model in Annex 2). The **first field** is the work with institutions providing quality assurance services for the PV sector. The hypothesis is that targeted interventions help to strengthen the capacity of these providers and that the providers expand their services.

The **second field** is the work with decision makers in key institutions for the PV sector. The hypothesis is that through targeted interventions these decision makers are better informed and have a better understanding of QI services for PV.

The **third field** of activity is the work with PV practitioners. The hypothesis is that targeted interventions increase the awareness about quality and about quality assurance services amongst PV practitioners like manufacturers, importers, developers and those maintaining PV systems.

All three fields have defined outputs (see section 5.1.3). The main hypothesis is that these outputs lead overall to an improved quality assurance in the PV sector for new and existing PV systems in Indonesia in line with international good practice (module objective).

Initially, the kind and character of interventions was not pre-defined from the beginning, but left room for continuous adjustment. It was to be decided during the running of the project in close collaboration with the political partner and implementing partners, and changed depending on demand and opportunities during the project. The evaluators consider this very flexible way of working with multiple partners on many relevant issues as part of a very agile strategic approach.

## 4. Evaluation methodology

### 4.1. Evaluation design

The evaluation approach comprises the analysis of documents and data available at PTB and partners, interviews and group discussions with all implementing partners, some participants and a few stakeholders that are not so closely involved, a visit to a rooftop PV installation on a commercial building, and a visit to a PV industry fair. Part of the interviews were conducted on-site, while others were online. Interviews were clustered so that more than one person per organisation could be interviewed on one morning or afternoon. The technical expert participated in a training course on PV module handling and storage. After the field visit, an online survey has been conducted. The survey's goal was to inquire the needs of the PV industry and their perception of the project, in cooperation with PV associations, and building on questions that interview partners suggested for the survey. The survey language was English, but Bahasa responses were invited. Detailed survey results are presented in annex 9.6.2. All implementing partners were invited to the kick-off and closing workshop. The kick-off workshop received good response. The closing workshop took place during Ramadan and only a small subset of the partners could attend. However, all partners were invited to comment on the inception report and on the main evaluation report.

The methodology allowed to gather within a limited timeframe a wide variety of different perspectives from stakeholders closely and less closely involved. There was a triangulation of interviews and observations of installations (comparing what is said with what can be observed), and through the online survey, a perspective of industry and universities was included to ensure an additional perspective on the subject. A weakness is that information about wider sections of society that should benefit from the intervention in the long run could not be included.

The methodology was chosen because within limited time, core information can be gathered that should allow drawing relevant conclusions and recommendations.

## 4.2. Data sources; data quality

As described in section 4.1, data sources are project documents (from core documents of the predecessor project through the initial plans to reports and all publications and products) and general publications on the sector. The documents provided were comprehensive and fully satisfactory for the purpose of the evaluation. The evaluators have not requested to get complete statistical data on participants and their feedback on training courses. This seems not relevant enough to justify the effort of compiling such data which the project team would have had to do.

Further data sources are the interviews and observations conducted. They give us fully satisfactory information about most evaluation questions. Financial data are from November 2023, which does not permit a valid assessment of financial expenses. The survey had a very slow start. It was developed after the field visit, building on information received, to make it most relevant for the PV sector in Indonesia. Ramadan began at the end of the evaluation mission, and hardly any responses were received during Ramadan. Therefore, the deadline was extended beyond the deadline for this draft report. The online survey was to give more information on the project's impact, but also on other evaluation criteria. With only 39 responses, and only 17 fully completing the survey, and only 11 participants in PTB courses, the data generated by this survey is limited. Of 39 respondents, 20 were from the group of engineering/procurement/construction (EPC) / installer. Overall, the evaluators have good data from interviews, and some statistics.

## 5. Evaluation results

### 5.1 Status of the transformation process (OECD/DAC)

The status of the transformation process is assessed following the OECD/DAC criteria. Marks per criterion are given following the scale as in the table.

#### Marking scale for the evaluation of the OECD/DAC criteria

Evaluation	Grade	Description
very successful	1	very good result, far above expectations
Successful	2	good result, entirely meets expectations
successful to a limited extent	3	satisfactory; results are below expectations, but mainly positive
rather unsuccessful	4	unsatisfactory result; below expectations; negative results prevail despite several positive results
mainly unsuccessful	5	negative results clearly prevail despite several positive partial results
entirely unsuccessful	6	the project has failed completely; situation has rather deteriorated

#### 5.1.1 Relevance

The relevance criterion focuses on the intervention's design in several dimensions (in bold).

**The intervention's design is geared to country-specific, regional, and global policies and priorities of the partners and the BMZ.**

The project's objectives are fully geared to the partners' policies and priorities, and particularly to the political partner, the Directorate General of Renewable Energy and Energy Conservation (EBTKE), a department within the Ministry of Mines and Energy (ESDM). The government of Indonesia has a number of older and recent policies to promote renewable energy including solar power, and to improve its QI as a means to promote its transition to a post-extractive economy (see chapter 3.1). The project fully fits into these policies and is designed to contribute to the development both in the PV and the QI sector.

The relevant political and institutional conditions in the context are considered in the project design. It considers the weaknesses in the QI, where important services in Indonesia are not available and the expected growth of the PV market at the time of project planning (although that growth then did not materialise as expected). The excess of electricity supply on Java, that could mean that needs are higher on other islands, was not considered in the design, but that becomes more relevant now that initial services have been developed. The fact that the Ministry of Industry (Mol), neither through the Directorate of Machinery and Agricultural Equipment nor through the Center for Formulation, Implementation and Enforcement of Industrial Standardization (P4SI), were included in project plans could be considered a limitation, but its relevance increases only now that services are available. It also considers a general lack of awareness in the country on the importance of quality and QI amongst decision-makers and practitioners.

The project design is fully geared to the German DC programme Energy in Indonesia which also includes various Kreditanstalt für Wiederaufbau (KfW) and Gesellschaft für Internationale Zusammenarbeit (GIZ) projects, providing an important element to other interventions of the programme. The potential for cooperation is nevertheless limited because during the running of the project, planned PV interventions of other German institutions were changed or not implemented. It fits fully into the BMZ country strategy that emphasises renewable energy and in the BMZ sectoral concepts on renewable energy and quality infrastructure.

In terms of the evaluation dimension on policy and conditions, the project is considered successful (2). It is slightly above expectations in its response to policies, but not far above.

**The intervention's design is geared to the needs and capacities of the target groups.**

The project objectives are aligned with the development needs and the capacities of beneficiaries and stakeholders. There are specific needs in the PV sector for QI services and capacity building, and these are addressed by the project design, specifically per partner organisation and with the ultimate objective of improving the PV QI infrastructure overall. Its design also addresses a lack of capacity in terms of skills and awareness. Respondents to the online survey generally confirm the need for improved quality in the PV sector (question 3) and the justifications given show an understanding of the issue (question 3.a).

The evaluation team defines small companies as the particularly disadvantaged and vulnerable beneficiaries and stakeholders within the project context and its target groups are small local enterprises, as the project works with institutions mostly on meso level and with Small and Medium Enterprises (SMEs), not with particularly disadvantaged sections of the population. The project objectives are to a reasonable extent aligned with the development needs and the capacities of SMEs. The project has not addressed that some stakeholders, particularly SMEs, are not strong regarding

the costs of QI, but it nevertheless helps to strengthen them by providing free-of charge training. It cannot be assessed whether all SMEs have the necessary resources for QI, but not all have fully established quality management yet.

In terms of the evaluation dimension on needs and capacities of target groups, the project is considered very successful (1). It is far above expectations in addressing needs, particularly through its broad and flexible design.

**The intervention's design is appropriately, realistically and plausibly geared towards achieving the intervention's objective.**

The project design is considered very appropriate and realistic in the sense that its design allows for an improvement of technical capacity, political support and practitioner response, so that achievements in one of the three fields can get response and further support in the other fields. Organisationally, the EBTKE is well placed as political partner, for example as the responsible institution for the relevant Technical Committee. At the same time, working with many implementing partners makes sense for this field and this approach. The intervention's design is financially realistic, its objectives can be achieved with the financial means given. There is a caveat as an external factor in that the Covid crisis made implementation difficult, which is why the project extended the implementation.

The project design is sufficiently precise and plausible, and particularly also flexible. The indicators are efficient in that they are based on outputs that the project would have to produce anyway in the process, like conformity assessment services. That means that no extra costs are generated to produce information for indicators. The indicators are sufficiently suited to indicate project progress at the relevant level, although a bit slow in responding to developments. The planned activities and outputs are suited to achieve the intervention's objective. They are closely linked to what the project wants to achieve. The underlying results hypotheses are plausible. These planned activities can achieve the outputs if no external factors obstruct, and if the outputs are achieved, the objective/outcome can be achieved.

The project design is based on a holistic approach to sustainable development. Concerning the social dimension, it involves a wide range of stakeholders that become interconnected. The economic dimension is covered through the strengthening of a future oriented industry that could generate employment and tax income. It covers areas from the upstream of the industry, that is the procurement and production of equipment, to inspection and the performance ratio. The project is also very relevant for the environmental dimension in that it is geared to create conditions for climate change mitigation.

In terms of the evaluation dimension on appropriateness, the project is considered very successful (1). The project design is complex and flexible and well-adjusted to this complex sector. As such it is considered challenging but realistic, and beyond expectations for such a project.

**The intervention's design has responded to changes in the environment and adapted to the needs.**

The project design has responded appropriately to changes in the environment during implementation. The greatest challenge was the Covid crisis. The project responded especially well by switching to online training and by extending for a year, a no-cost extension approved by BMZ. In its

implementation, it also has responded to emerging needs of old and new partners. For example, the Agency for the Assessment and Application of Technology (BPPT), with its Center for Energy Conversion Technology (B2TKE) that has the first solar module testing lab, was merged into the new Agency for Research and Innovation (BRIN). The change of organisation and new priorities of the BRIN leadership were addressed. It also responded largely well to the frequent change of personnel in organisations, but there could have been more communication with new staff, and with the top leadership. The change of regulations regarding PV, like solar rooftop regulations of 2021, replaced in 2024, did not affect QI so much as the need for QI remains. The mandatory Indonesian National Standard (SNI) for PV module testing helped to achieve the project objective and the project responded by supporting a second, private testing facility for PV modules. The reduction in electricity demand on national level during the Covid crisis also did not need a response from the project.

In terms of the evaluation dimension on response to changes in the environment, the project is considered very successful (1). It responded very well and considerate to quite a number of changes, continuously adapting the implementation approach.

### Summarized evaluation

The relevance of the project is overall assessed as very successful (1.3), based on its design adjusted to the complexity of the sector, the agility that it allows, and the agility the project has shown in adjusting to changing circumstances.

Criterion	Evaluation dimension	Weighting	Appraisal
<b>Relevance</b>	The intervention's design is geared to country-specific, regional and global policies and priorities of the partners and the BMZ.	25 %	2
	The intervention's design is geared towards the needs and capacities of the target groups	25 %	1
	The intervention's design is realistically and plausibly geared towards achieving the intervention's objective	25 %	1
	The intervention's design has responded to changes in the environment and adapted to the needs.	25 %	1
Global assessment of the relevance			1.3

### 5.1.2 Coherence

The coherence criterion focuses on the project's compatibility with other development interventions in several dimensions (in bold).

**Internal coherence: Within German development cooperation, the intervention was designed and implemented in a complementary manner, based on the division of tasks.**

The project is essentially designed in a complementary manner within German development cooperation, as part of the DC programme *Energy in Indonesia*. This programme includes projects of GIZ, KfW, Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) and PTB on various aspects of renewable energy, i.a. geothermal, hydropower, rural electrification and electricity infrastructure. Within this programme, PTB concentrates on QI as an essential service for PV. There is potential for synergy and cooperation and willingness to apply it, but little opportunity. PTB is not fully involved in German coordination in Indonesia, partly because of language barriers for local staff, but not entirely. The reasons could not be discerned. Within the limited time available for the evaluation, the complex field of all GIZ projects could not be explored, so that the potential for cooperation could not be fully discerned.

Synergies have been leveraged to a small extent, but have helped to increase the efficiency of the programme. KfW's work in Indonesia did not include much of PV, partly because of local content requirements that were not accepted by German cooperation. GIZ made use of PTB expertise for training PLN staff in its own project with PLN, but there seems to be limited potential for cooperation.

The project is fully consistent with German commitments like the Paris Declaration on Climate Change and follow-on commitments around climate change and renewable energies. It is also fully consistent with international agreements on QI and with German commitments to economic development.

In terms of the evaluation dimension on internal coherence, the project is considered successful (2) because it is consistent with German cooperation commitments and integrated into a programme and cooperates, but not much potential seems to have existed for cooperation.

**External coherence: The intervention's design and implementation complement the partner's own efforts and are coordinated with other donors' activities.**

The project strongly complements partner efforts. Political partner of the project is EBTKE.

Implementing partners with respective activities are

- AESI, the Indonesia Solar Energy Association,
- APAMSI, the Association of Solar Module Manufacturers, both cooperating on capacity and awareness building in the industry,
- BAPPENAS, National Development Planning Agency of Indonesia,
- BMKG, the Indonesian Agency for Meteorology, Climatology and Geophysics, cooperating on calibration of pyranometers,
- BRIN, the national Agency for Research and Innovation, cooperating with its PRKKE, the Research Center for Energy Conversion and Conservation, on the first testing lab for PV modules,
- BSN, the National Standardization Agency, cooperating on the development and implementation of standards, as well as accreditation,
- BSN SNSU, the Indonesian National Metrology Institute, cooperating on photometry and radiometry and on the classification of solar simulators,
- PT. PLN Pusertif, the national electricity company, cooperating on the improvement of PV inspection, PV commissioning standards, and general improvement of quality and quality awareness, and
- PT Qualis, a private company, cooperating on the second testing lab on PV modules.

There are substantial capital investments, own contribution of time and ideas by partners. The control of the process lies with EBTKE, in the Technical Committee on PV (TC 27-08) and to some extent the Project Coordination Committee (PCC), and in close coordination with partners. Sometimes, when cooperation was agreed, and contract with experts made, partners have responded slowly and PTB implemented activities with less partner consultation than originally aimed for. However, the partners deemed this consultation as sufficient.

There were clear efforts in the project design and implementation to coordinate with other donors that also led to results in the cooperation with the Renewable Energy Skills Development Project (RESO) of the Swiss State Secretariat for Economic Affairs (SECO) that builds capacity of polytechnics to start one-year post-bachelor courses on photovoltaic. Within this, the evaluated project provided expertise and trainers for RESO's training of trainers for lecturers. No other opportunities for coordination were identified which seems a reasonable result. Even though, theoretically, cooperation with development banks e.g. on commissioning of PV would have been an option, it would have required much effort to probably little effect given that government regulations can achieve the same on a larger scale.

The project design has been strongly geared to use existing systems and structures. For all activities, partner structures are used, be it metrology institutions, existing laboratories, and industry associations. The project has made strong efforts to work with these structures. The TC 27-08 plays a crucial role in the further development of QI on the PV sector. The evaluators have identified no other systems and structures that could be used.

For monitoring and evaluation, learning and accountability, the TC 27-08 and the Project Coordination Committee (PCC) are used. From the evaluators' view, the PCC maybe could have met more often and be involved more strongly, judging from the feedback and the understanding discovered in some interviews. As the cooperation on many of the activities concerns only one of the partners, it is adequate that much of the practical coordination is bilateral with national institutions of the QI and EBTKE. Nevertheless, this is considered an exceptional level of integration of learning and reflection in national structures.

In terms of the evaluation dimension on external coherence, the project is considered very successful (1). It works very closely with partners and moves forward many processes in parallel through national structures and institutions.

### Summarized evaluation

The coherence of the project is overall assessed successful (1.5), based on its successful internal and very successful external coherence.

Criterion	Evaluation dimension	Weighting	Appraisal
<b>Coherence</b>	Internal coherence: Within German development cooperation, the intervention was designed and implemented in a complementary manner, based on the division of tasks.	50 %	2

	External coherence: The intervention's design and implementation complement the partner's own efforts and are coordinated with other donors' activities.	50 %	1
Global assessment of the coherence			1.5

### 5.1.3 Effectiveness

The effectiveness criterion focuses on the extent to which the project is expected to achieve its objective by the end of its term in a number of dimensions (in bold).

**The intervention has achieved its objective (at outcome level) according to the indicators agreed upon.**

The project is expected to achieve its objective of an improved quality assurance in the PV sector for new and existing PV systems in Indonesia in line with international good practice successfully, as shown in the following table on outcome indicators. Degree of fulfilment is given at the time of progress report to BMZ, August 2023, and as expected by project end (May 2025).

Outcome indicator	Degree of fulfilment (in %)	Appraisal (A-C)*	Justification
1. Three (3) new conformity assessment services based on national or international standards that are relevant to the PV sector are offered. (base value: 28; target value: 31)	2023: 67% 2024: 100%	B	Indicator rated B because it was adjusted from base value 31 to 28 services.  1: Product certification for PV modules according to SNI IEC 61215 through test laboratory BRIN. 2: Testing for Potential Induced Degradation (PID) as a new testing service at PT Qualis laboratory  The third service is currently under discussion. It could be Salt Mist Corrosion test or testing of bifacial PV modules and is safe to be achieved.
2. Three (3) documents on the development of the PV sector (e.g. tender documents, technical regulations) recommend the use of quality assurance services. (Base value: 0; target value: 3)	2023: 33% 2024: 100%	A	Document 1, achieved: Technical regulation SNI IEC 61215. 2/3: expected, two of the following are safe to be achieved: tender document EBTKE / Pusertif checklist renewal / circular note on

			PR / technical regulation on IEC 61730
3. Two (2) case studies document the use of quality infrastructure services in the PV sector. (Base value: 0; target value: 2)	2023: 50% 2024: 75%	A	Case study 1: scientific publication at the European Photovoltaic Solar Energy Conference (EU PVSEC) conference in Lisbon on QI for PV in Indonesia. Case study 2: planned, multiple options. One of them is a study on performance ratio (PR) measurement which is under preparation. As they are not safe to be achieved by project end, but potentially after project end, this indicator is rated only 75%.

\*: Appraisal: A = adequate indicator; B = slight objections; C = poor indicator, to be revised if applicable

There are also quite a number of not completed achievements that are not counted in the indicators but provide a good base to achieve more in a follow-on phase. For example, in cooperation with BMKG, that currently does indoor calibration of pyranometers as part of Indonesia's metrological system, competence to conduct outdoor calibration has been built, but BMKG lacks the sun tracker to apply this competence. Perspectives to purchase this equipment from national resources are rather for 2026 than for 2025. A formal commitment that BMKG would provide the outdoor calibration service also to industry was not yet made in early March 2024, so that PTB could also not provide the equipment. With BSN SNSU, work on solar simulator classification is almost completed. One of the achievements counted is the establishment of PV module testing labs. PV modules have increased in size and in the maximum Watt peak. Testing laboratories are at a point where they cannot test the largest modules anymore. Ideas for a best practice case study on the promotion of standards are already developed.

In terms of the evaluation dimension on achievement of objectives, the project is considered successful (2) as it is about to achieve most of its outcome indicators, but not exceeding them.

**The intervention's activities, inputs and outputs have considerably contributed to achieving the intervention's objective (at outcome level).**

The defined inputs have been largely delivered and outputs have been achieved, and many have been over-achieved particularly regarding decision-makers and practitioners. Overall, the beneficiaries have used the benefits and results in their work. This is the case for all three fields of work. Regarding quality assurance services, apart from the services described in the indicator, much capacity building took place. Interview partners and survey respondents (question 2.a) confirm that the capacity building had effects on the work in the PV sector. In the dialogue with decision-makers, in a couple of cases, QI work in several institutions was facilitated. Concerning awareness building, not only training, but also e.g. translation of IEC standards made increased awareness possible. Responses to interviews show that this has contributed to achieving the project objective of a strengthened QI system. That observation was made across all activities with partners. The online survey supports this assessment. 16 or 17 respondents to the online survey confirm that they use SNI in their work (question 6).

The assumptions and risks mentioned during plans were considered during the project implementation. Covid 19 had a strong effect. Activities were adjusted and the project period was extended to address those restrictions. Demand for PV installations was smaller than expected, but demand for PV QI was still strong enough to justify the project activities, so that the project did not specifically address these influences.

In terms of the evaluation dimension on inputs and outputs, the project is considered very successful (1) because it produced far more outputs than planned and dealt very well with the Covid 19 crisis.

**The quality of the intervention's implementation has considerably contributed to achieving the intervention's objective (at outcome level).**

The implementation quality is assessed according to the five Capacity WORKS (CW) success factors, as elaborated below. The project team has used the mandatory Capacity WORKS tools and the project benefited from this process.

**CW – Strategy factor**

The project strategy has been developed and continuously refined with the political partner and the implementing partners throughout the project period. There is a common understanding of the project objectives with partners, although in varying detail. The project invests much and systematically in capacity building with partners on all levels, but not by using the written capacity development strategy. The very agile strategic approach of the project – working in parallel on many relevant issues within the PV QI with many actors – is successful and convinces us, but not all actors understand it. The strategy in its diversity is implemented jointly with the respective partners, and with much responsibility and investment on partner side.

**CW – Cooperation factor**

The project builds on the cooperation of partners. Most partners cooperate intensively, although sometimes slowly. Activities in which partners did not cooperate, were slowed down or stalled. PTB did not unilaterally take control over the project or project activities, but moved together with the respective partner, except for specific activities where contracts were made already, and where partners responded slowly during the preparation. But during implementation, partners were fully involved again. Regarding their role in the project, partners can work toward their own goals and at the same time contribute to the project. They know what kind of support they can receive from the project, although not all know how their part fits in the overall picture. Some partners have more actively adapted to contribute to the project objective, like BSN SNSU working on solar simulator classification. The project has successfully shaped the communication and cooperation relationships between PTB, partners and relevant actors by establishing a network among partner institutions. Partners mentioned as a downside that reimbursement of international travel costs by PTB is rather slow. In a few cases, effectiveness might have been hindered through small hitches that partners brought up: Not in all cases did partners receive reports after expert visits. Partners received in most cases fully satisfactory reports of training courses. Only one partner requested to add a summary of newly raised issues that were not covered in the training material. Partners did not get in all cases an offer to contact experts after visit and draw on her or his experience extensively where it would have made sense. One association raised the concern that they invited their members to project training courses but had not been involved in conceptualising the courses.

**CW - Steering structure factor**

The PCC membership reflects the relevant actors and interests. It meets once a year with (almost) all relevant institutions. All are actively involved in the discussions, but interviews showed that they did not all understand the project's complexity. Secondly, bilateral partner meetings are crucial in the project implementation and are considered part of the steering structure.

#### **CW – Processes factor**

Processes that occur independently of the project in its sector have been analysed. For that purpose, a mapping of QI services and possible intervention points was prepared and discussed with partners. The annual progress reports are organised that way. The project can adequately address new information and fit it in to what is done already. The evaluators see that appropriate processes are established and that cooperation partners contribute to interfaces between relevant processes and stakeholders to increase the overall performance. The project in its self-assessment says that in terms of learning processes, internal knowledge management should be structured better, although much has happened already. Cooperation partners have made adjustments to make the project succeed, but in large organisations, the persons responsible find it sometimes difficult to reach the highest leadership and get their support which results in a delay in decisions. PTB is not in all cases engaging these leaders sufficiently.

#### **CW – Learning and Innovation Factor**

The project focuses on promoting technical innovations within the partner system that clearly increase the system's capacity. Institutional innovations are promoted in some cases, especially in improving processes, systematic cooperation and extension of services, like the expansion of the focus of TC 27-08 to also address socialisation and implementation of standards. The project aims at learning in the partner system, but this is not always done in explicit agreement with the leadership, as this is not always necessary. In some cases, leadership was involved, in single cases, leadership support is lacking. Learning experiences were discussed with the relevant stakeholders in debriefing sessions after visits. Reports and documented training were shared in most cases, but not always passed on to all stakeholders within an organisation.

In terms of the evaluation dimension on the quality of implementation, the project is considered very successful (1) because of its strong, flexible strategy, strong cooperation, good steering and processes, good learning and very good innovation.

#### **The intervention has leveraged potentials of unintended positive results and reacted to risks and/or the occurrence of (unintended) negative results.**

The project's intended effects are very broad, and positive effects like a strong demand for testing services were then integrated into project activities, supporting a private company to open up a second lab for PV module testing. No further unintended positive effects were identified.

The only unintended negative result that could be identified results from the regulation in SNI IEC 61215 that all imported PV modules need to undergo testing and certification in Indonesia. As a consequence of this regulation, the labs are so occupied now that there is a testing backlog of almost a year. That delays the import of PV modules for some importers and limits competition. It also increases costs for PV modules. This could probably be avoided if certificates or tests from abroad were accepted in Indonesia as long as they fall under the same accreditation system as Indonesia. The concept of "One Test Accepted Everywhere" through Mutual Recognition Agreements would have to be implemented. To implement such a system, targeted cooperation with the National Accreditation Body of Indonesia (KAN) would be required. For some local PV module manufacturers, the new

requirements introduced by the same SNI brought additional stress, but the evaluators do not consider this as a negative result because such stress was required to achieve the implementation of the SNI.

The project has monitored and promoted direct results intensively. Its staff are in close, good contact with partners and engage on project results. It has responded very well to risks, like the Covid pandemic, as described above. It has, to our knowledge, not yet reacted to the negative result described in this section, but this is a relatively new development, and one company is already planning to expand its facilities independently of the project.

In terms of the evaluation dimension on unintended results, the project is considered successful (2). It has largely avoided negative results, and it has monitored the context such that it could identify new opportunities and include them in the project so that intended results came about.

### Summarized evaluation

The effectiveness of the project is overall assessed successful (1.5), based on a successful achievement of objectives and prevention of negative effects, and a very successful contribution to the results and a very good implementation.

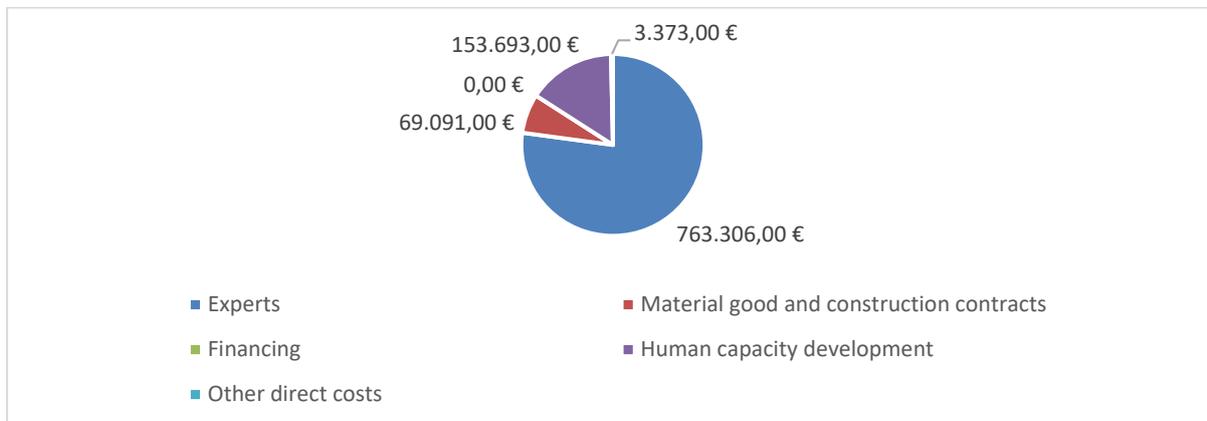
Criterion	Evaluation dimension	Weighting	Appraisal
<b>Effectiveness</b>	The intervention has achieved its objective (at outcome level) according to the indicators agreed upon.	25 %	2
	The intervention's activities, inputs and outputs have considerably contributed to achieving the project's objective (at outcome level).	25 %	1
	The quality of the intervention's implementation has considerably contributed to achieving the intervention's objective (at outcome level).	25 %	1
	The intervention has leveraged potentials of unintended positive results and reacted to risks and/or the occurrence of (unintended) negative results.	25 %	2
Global assessment of the effectiveness			1.5

#### 5.1.4 Efficiency

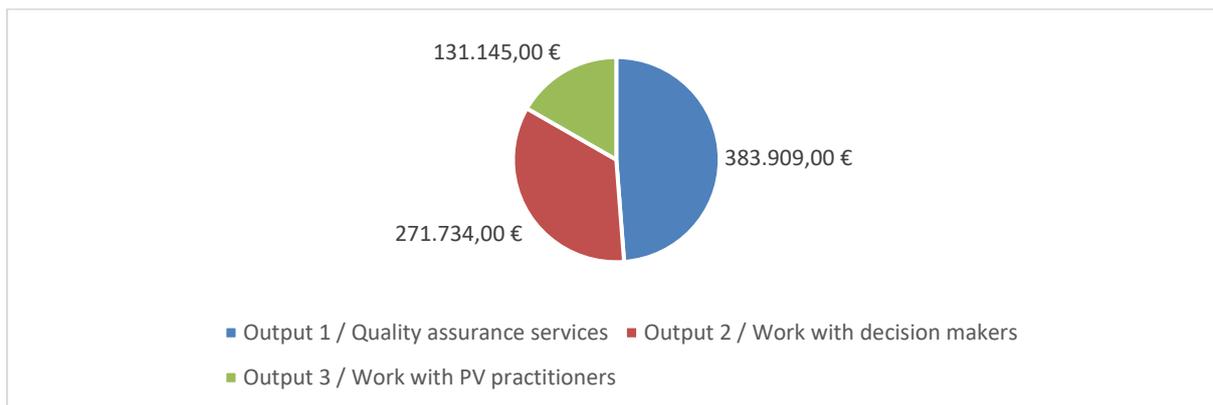
The efficiency criterion focuses on the economical use of resources in a number of dimensions.

##### *Description of inputs*

The project had a budget of 2.25 Mio. Euro. Actual expenditures as of November 2023 were 989.463 Euro. The project had until then spent about 40% of its budget. The division of costs is as in the chart.



Of the costs, 786.788 Euro (79.5%) can be attributed to outputs. The division of costs by output is as in the following chart.



**The use of resources by the intervention is deemed reasonable with regard to the outputs achieved (production efficiency).**

The evaluation dimension “production efficiency” refers to the appropriateness of the relationship between inputs and outputs. The evaluators could not identify ways how outputs could have been achieved at lower costs, on any budget item. The evaluators could also not identify how the results could have been increased with a different use of finances. The expenses all appeared reasonable.

Some of the outputs, particularly the services provided, were delayed, partly because of the Covid pandemic, partly because of delays on partner side that were not within project responsibility. These delays were managed well and could be compensated through a no-cost project extension.

In terms of the evaluation dimension on production efficiency, the project is considered successful (2). It appears to have a reasonable relation between finances and outputs, but with no exceptional savings that would justify a rating as “very successful”. The delays were managed well and do not lead to a lower rating.

**The use of resources by the intervention is deemed reasonable regarding the achievement of the intervention’s objective/outcome (allocation efficiency).**

The evaluation dimension “allocation efficiency” refers to the appropriateness of the relationship between the inputs and the results achieved by the intervention.

The evaluators could not identify results at outcome level that could have been delivered using less finance. The evaluators could also not identify results that could have been maximised using the same financial amount. In terms of outcomes, the expenses all appeared reasonable.

In terms of the evaluation dimension on allocation efficiency, the project is considered successful (2). It appears to have a reasonable relation between finances and outcomes, but with no exceptional savings that would justify a rating as “very successful”.

### Summarized evaluation

The efficiency of the project is overall assessed successful (2), based on an assessment of successful efficiency on output and outcome level.

Criterion	Evaluation dimension	Weighting	Appraisal
Efficiency	The use of resources by the intervention is deemed reasonable with regard to the outputs achieved (production efficiency).	50 %	2
	The use of resources by the intervention is deemed reasonable with regard to the achievement of the objective/outcome (allocation efficiency).	50 %	2
Global assessment of the efficiency			2

### 5.1.5 Higher-level development results

The higher-level development results criterion focuses on relevant development changes outside the project’s direct sphere of responsibility in a number of dimensions (in bold).

**The intended higher-level development changes have taken place or are expected to take place in the near future.**

The project has defined outcomes at a rather high level: QI systems are strengthened, awareness of decision-makers and practitioners has increased, even though feedback from interviews indicates that there are still limitations of quality awareness. That was particularly amongst practitioners, limitations of awareness amongst decision-makers cannot be assessed, see remarks on leadership in other parts of the report. All that has been achieved in multiple ways. Changes that are on a higher level than this are actually difficult to discern. One such change is that those PV module manufacturers that started about 10 years ago with little QI support, are now challenged to meet the requirements of SNI IEC 61215 on module quality. Some are certified, others not, but all have engaged in improving their quality. Another change might be that modules of poor quality are not imported anymore, but there are no reports to this effect. Some metrology services have become cheaper and more easily available because they are provided in Indonesia now. There are efforts to also improve the quality of installation, maintenance and inspection, but when interview partners spoke about problems in quality, they referred mostly to islands other than Java. Half of the survey respondents (12 of 24) confirm that

they have experienced quality problems in the PV sector (question 4), and the description show a good understanding of such problems (question 4.a, 4.b). Graduates of polytechnic courses on renewable energy to a large percentage have found employment and are working in the industry now. Only very few PV module manufacturers have switched to larger modules and new investments are planned for large PV installations. The potential for growth of the PV sector has increased. One higher-level result is that beyond single results there is a process of steady improvement of QI, and potential for MoI and ESDM to cooperate on QI for the PV sector has evolved.

The higher-level changes expected at the level of beneficiaries, defined as inhabitants of Indonesia, would occur when PV is expanded massively. That would lead to less pollution, less greenhouse gas emissions, more employment and access to electricity in areas not connected to the grid. Increased employment is happening to a small extent, expansion of PV to remote areas is also happening to a small extent. The other effects appear to be minimal at this stage.

In terms of social, economic and environmental changes, at the moment these relate little to each other yet. Only if PV grows massively and replaces fossil fuels, or if a good maintenance system ensures that insular PV installations in rural areas remain running for longer, can such effects be expected. At this stage, particularly disadvantaged groups will not yet benefit. That could be expected in the long run if the PV sector grows strongly and replaces coal and gas fired power on a large scale.

In terms of the evaluation dimension on actual higher-level results, the project is considered successful (2) because it is assessed at a rather high level, and the potential for much higher-level change has been developed.

**The results achieved by the intervention (at outcome level) have contributed to the intended or implemented higher-level changes.**

The fact that some of the Indonesian PV module manufacturers are not certified and have improved the production quality, and others are on the way, can clearly be linked to the project outcomes, amongst them the SNI IEC 61215 and the increased quality awareness and improved capacity. There are also other reports on improved quality, like efforts by PLN to improve quality in their off-grid installations, that were clearly linked to project outcomes. The evolved potential for MoI and ESDM to cooperate on QI for the PV sector can also be considered a project effect. For other higher-level changes, a link to the project is possible but could not be identified. The employment of polytechnic graduates cannot be attributed to the project, but it can be expected that they apply knowledge on quality infrastructure, a knowledge that was provided by the project through training polytechnic lecturers and others. An expectation was that an improved QI would lead to better quality and therefore to a more sustainable growth of PV installations and potentially also PV module manufacturing. The increased potential for growth of the PV sector is largely because of external factors, and is not fully developed currently because of external factors, but the improved quality infrastructure and quality awareness are project outcomes that contribute to the growth potential. Overall, the beneficiaries, institutions and companies have used the project outcomes in their work. This is the case for all three fields of work of the project.

No broad-based impact can be discerned currently, but core systems of QI have been strengthened which appears to be as crucial. Institutions have gained more capacity and provide that to the entire industry.

In terms of the evaluation dimension on the contribution to higher-level results, the project is considered successful (2) because it contributed much to the described changes and particularly to the much larger potential for change, but did not contribute to the expected market growth.

**The intervention has contributed to positive and not to negative unintended higher-level development changes.**

The changes described to which the project contributed or has developed the potential for are all considered positive. It has largely avoided causing negative effects.

The only negative unintended effect identified, the delay in imports described in section 5.1.3, can be addressed in the next project phase. Currently government and PLN, the country's electricity provider, seem to trade off the need to replace greenhouse gases, the costs involved in replacing fossil fuel plants, the higher costs of renewable energies, and the stability of the grid. The results are regulations that seem to provide limited potential for PV growth, although assessments differ. The project has little leverage in this field, except that it could coordinate better with GIZ and KfW, and that it could identify areas that are not affected from PLN's trade-off, like areas that have less power supply from coal and an immediate requirement for more electricity production.

In terms of the evaluation dimension on unintended higher-level results, the project is considered successful (2) because the project had hardly any negative effects and mitigated risks for negative effects very well.

**Summarized evaluation**

The higher-level effects of the project are overall assessed successful (1.8), based on a high potential but limited realised higher-level results, a strong contribution to these results and a very good prevention of negative effects.

Criterion	Evaluation dimension	Weighting	Appraisal
<b>Higher-level development results</b>	The intended higher-level development results have taken place or are expected to take place.	25 %	2
	The results achieved by the intervention (at outcome level) have contributed to the intended or implemented higher-level results.	50 %	2
	The intervention has contributed to positive and not to negative unintended higher-level development changes.	25 %	2
Total assessment of the higher-level development results			2

### 5.1.6 Sustainability

The sustainability criterion focuses on the question whether the achieved changes will last in the long term, in a number of dimensions (in bold).

**The partners, target groups and organizations involved have the capacities required to ensure that positive results are continued.**

It is difficult to assess to what extent the partners have the resources and willingness to sustain the positive changes over time. Overall, a strong capacity seems to have developed. Institutions that have developed new capacities, like new testing services, are likely to sustain these services as long as the equipment remains intact. The strong commitment of Indonesia to improve its QI makes it likely that equipment will also be replaced after some time. With the change from B2TKE-BPPT into PRKKE-BRIN, the overall policy has become one of research. Whether the solar module testing lab at PRKKE will continue to provide dedicated services within the PV sector, and not be made available for any research, needs to be clarified. The regulations, especially SNI IEC 61215, are likely to remain valid, and there is a committed group of organisations that would likely want to develop it further over time. As Indonesia has implemented such changes before without the project, there is a high likelihood that this will happen in future, too. Given the political will to promote quality and economic development, it is likely that some of the quality awareness among decision-makers will play out in the future. Whether that can be transferred to new personnel remains to be seen. Quality awareness amongst practitioners trained should remain, particularly if they make positive experiences. Whether they can apply this awareness in practice depends on work structures. More specifically, in manufacturing it depends on the continued provision of testing, and in installation it depends on functioning maintenance and inspection services as well as the provision of equipment to ensure that installed PV can continue to operate. The fact that QI is now part of the curriculum of a number of polytechnics is a positive factor in this regard. For quality in installation and maintenance, structures still need to be developed.

The partners are capable to counteract risks to the successful continuation of the achieved results in terms of mandate. They have power and influence if they get support from their leadership. They have access to information in Indonesia, but are not strongly connected in the international QI network (like IEC) to easily draw on the knowledge available there. If PTB continued its engagement in the QI sector beyond the follow-on project in other fields, but with a mandate to also involve these partners in international exchange, that could be an important resource. Whether they will get the required financial and material resources to confront risks will depend on the needs of the specific situation and on government decisions to support such exchange and QI development. The potential will be there.

In terms of the evaluation dimension on available local capacities, the project is considered successful (2), because partners seem to have a good level of resources and willingness to continue the positive changes.

**The intervention has considerably contributed to the capacity of partners, target groups and other organizations involved to continue the positive results.**

The project has contributed much to the resources and willingness to sustain positive changes. There has been an initial intent in Indonesia, but through the project, this was substantiated and expanded to more actors. The project achieved that through its capacity building activities and its close engagement of partners, building on their priorities and a joint assessment of context. It also

contributed through its investment in awareness raising amongst decision-makers and practitioners. The project has so far not addressed the one identified negative result of a delay in imports.

The resilience of partners to counteract risks has clearly been strengthened through capacity building and the way the project was conducted (close engagement, see above), and also through the strengthening of the PV QI network. The project had a crucial role in strengthening this resilience. Interviews showed that the close cooperation facilitated a stronger focus on PV QI. On the other hand, a change in personnel with the consequence of different priorities might jeopardize this achievement. A stronger involvement of leadership in the organisations might have been helpful. SMEs are considered particularly disadvantaged groups in the context of this project. Their resilience has been strengthened together with that of many other practitioners through capacity building and through the introduction of quality tests that force SMEs to become competitive in terms of quality. Because of that, they become more competitive on the PV market.

In terms of the evaluation dimension on capacity building, the project is considered very successful (1) because the project has contributed much to sustainability and resilience and was a core influence in this process.

#### **The results of the intervention are durable.**

Most project results are likely to be durable given that with the growth of the PV industry in Indonesia needs for QI services for PV are likely to increase, and because the results are well established in stable institutions in Indonesia. As described above, change of personnel, change of focus of institutions, non-replacement of non-functioning equipment and other issues might compromise this in some instances, but for example for PV module testing services, other companies could step in. This knowledge is now available in the country and it has been proven that it can work in Indonesia. The awareness on quality amongst leaders and practitioners is also likely to last on a personal level, but if the environment changes such that it becomes difficult to assure quality, the quality awareness might get less priority. Through change of personnel, this awareness might get lost for institutions. On the other hand, where quality is implemented, this awareness will further grow further. At least parts of the PV module manufacturers seem to be stable and growing. We cannot speak about the others that work at very low capacity currently.

The growth of the PV sector would be a potential for securing the project benefits in the long term while a stagnant sector could put benefits at risk. A growth is likely, the extent of this growth depends on political and economic decisions outside the project scope. The established Indonesian QI infrastructure as a whole is a potential in itself because the QI for PV is just one sector amongst many sectors with QI, so that a joint understanding of QI exists across sectors. This will help to sustain benefits, also outside the project scope. The interest of partners to improve the PV QI represents a big opportunity, and the project has seized it. The international QI network, including the regional networks, and particularly in metrology, is an important potential. It exists independent of the PTB project. The project has facilitated access to such structures, but Indonesian engagement is limited which will limit the opportunities to benefit from it without PTB. It is likely that mostly those who engage intensively will also access these benefits in case they need support. A risk is the frequent change of personnel (see above). The project addressed this well through institutionalising regulations and through extensive capacity building especially for import and manufacturing of PV modules. Another risk is in the area of installation and maintenance where severe quality issues are reported. That has not yet been a project focus, given the limited project resources.

In terms of the evaluation dimension on durable results, the project is considered very successful (1) because a high durability and high potentials to ensure the long-term duration of benefits have been identified.

### Summarized evaluation

The sustainability of the project is overall assessed very successful (1.3), based on good capacities of partners, a very successful contribution of the project to the partner capacities and a long duration expected.

Criterion	Evaluation dimension	Weighting	Appraisal
<b>Sustainability</b>	The partners, target groups and organizations involved have the capacities required to ensure that positive results are continued.	33.33 %	2
	The intervention has considerably contributed to the capacity of partners, target groups and other organizations involved to continue the positive results.	33.33 %	1
	The results of the intervention are durable.	33.33 %	1
Total assessment of the sustainability			1.3

### 5.1.7 Summary of the intervention's contributions to the 2030 Agenda for Sustainable Development

This section describes the project's contribution to implementing the goals and principles of the 2030 Agenda for Sustainable Development.

#### Universality, shared responsibility and accountability

In terms of Sustainable Development Goals (SDGs), the module proposal expects a direct contribution to goal seven (ensuring access to affordable, reliable, sustainable and modern energy for all) and indirect contributions to goal 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all), goal 13 (Take urgent action to combat climate change and its effects) and by increasing the use of electricity from PV systems by industry to Goal 12 (Ensure sustainable consumption and production patterns). It can be confirmed that all these are potential effects of the project that will come to play when the improved QI leads to an increase in PV installations and use of renewable energy. Currently, this effect cannot be ascertained, or only to a small extent, given the slow growth of the PV industry and the loose connection between QI und PV installations, but the project is highly relevant for such a development. The project has contributed directly to goal 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation) in strengthening the QI and in fostering quality amongst Indonesian manufacturers and potentially also amongst importers.

The intervention almost exclusively cooperates with existing structures and systems of Indonesian partners and only to a much lesser extent with other donors for its implementation. It was designed as such. The own project activities are almost all closely interlinked with partners. The principle of shared responsibility is strongly regarded.

The project has a division of labour with some international donors, although only to a small extent as other donors do not work in the same field. But this cooperation works well and PTB can make an important difference in those projects where it cooperates. The project has no cooperation with international non-state development partners.

The project's joint systems for monitoring, learning and accountability can be divided into three parts: The TC 27-08, the PCC and frequent bilateral meetings with the political partners and with implementing partners. They are all used intensively and are adequately designed, except for PCC meetings that should take place more than once a year. Overall, there is a high level of joint learning.

### **Interplay of economic, environmental and social development**

The project addresses a core infrastructure system that as such addresses the three dimensions of sustainable development. It lays the base to address social, environmental and economic aspects of development.

Interactions between social, economic and environmental results ensue from the very concept of the PV industry. At the moment these relate little to each other yet but with a strong PV growth, mutual benefits of the three dimensions are to be expected.

The intervention through its concept is likely to contribute to future mutual benefits of social, economic and environmental results.

### **Inclusiveness/Leave no one behind**

In its implementation, outputs and outcomes, the project is not designed to promote the participation of particularly disadvantaged groups. That would hardly be possible as the project works on a meso level. It could hardly promote the promotion of such groups on this level.

PV module manufacturing SMEs, considered for this project as particularly disadvantaged groups, are more challenged to meet the new quality standards, but those that succeed, have a better chance to survive and benefit from a potential growth of the industry.

The project has contributed strongly to the project results that in the long term have the potential to, indirectly, particularly benefit vulnerable and disadvantaged groups – especially those groups that find it especially difficult to adapt to climate change.

The project through its general activities has contributed to building resilience of PV module manufacturing SMEs through capacity building and the enforcement of standards that are designed to make them more competitive.

## **6. Assessment of specific evaluation questions**

Specific evaluation questions of PTB towards this project are:

- Did the project reach (out to) the industry? Does or could the project reach / benefit the local industry?

- Does the top management level (of different institutions) understand the quality issues? In other words: Do the highest levels of leadership have a sufficient (technical, possibly also organisational) understanding of what quality issues are about, how relevant they are and what do they require in terms of resources, structures and leadership support?

These have been answered in the relevant sections of the report. The first question is addressed in section 5.1.1 (relevance) in the appropriateness section and in 5.1.3 (higher-level development results) under the changes and contribution dimensions. The project reached out to industry which benefited from it, initially more the manufacturing and importing industry but also the installation and maintenance industry.

The second question is addressed in section 5.1.1 (relevance) under the adaptation dimension, in 5.1.3 (effectiveness) in the quality dimension and in 5.1.6 (sustainability). Top management understands quality issues better than before, but needs more engagement, particularly in some institutions. Change of leadership needs to be addressed.

## 7. Learning processes and experiences

The project had many systematic and planned processes of learning, “learning processes” and also many unplanned insights, “experiences” in PTB terminology. On **project level**, planned learning was the development of the steering structure that is now well established, and adjustments within it. The establishment of more cooperation with new partners as opportunities and needs arose, like the QI training for PLN within a GIZ project, the training for polytechnic lecturers on QI in cooperation with RESD, and finally the development of issues for training over the years, with the last two on storage and handling of PV modules.

Unplanned insights were the realisation that installation and maintenance need to be addressed to improve the usefulness of the QI project for the sector. The TC 27-08 included it in its frame of work. The larger than planned demand for testing PV modules was a realisation that came during the process after testing became mandatory, and the support to a second, private testing lab was a consequence. Another insight was that there was potential and demand to expand work on awareness to more islands than initially planned.

Regarding the **cooperation with partners**, planned learning were the same as for the project itself, they are very closely connected.

Unplanned insights were the need for stronger support from leadership at least in some of the partner institutions, that was partly addressed, and the tendency in the new agency BRIN to focus on research, which was addressed but may have to be addressed again.

On **content and thematic level**, planned learning was through all the training courses and expert visits. Participants reported that they had learned much, and that the trainings were useful. There is not the space to detail all this, but there was extensive learning amongst participants and institutions in large numbers.

Unplanned learning is the realisation of partners, expressed in interviews with the evaluators, that there will be a need to develop silicon economy circular streams in which PV modules and other silicon waste, like electronic gadgets, are reused and recycled. Another such realisation was that there will be a need for lithium and lead acid batteries reuse and recycling, and that these also provide economic opportunities for Indonesia, and a need to develop a respective QI. During a meeting of the evaluators with BMKG, BMKG staff and an AESI member realised that AESI has 54 pyranometers,

presented to the public in a database (<https://indonesiasolarmap.com/>), while BMKG has 34 Automatic Solar Radiation Systems (ASRS), and that they partly measure comparable data. The question arose if the ASRS data could also be presented in the AESI data base.

## 8. Recommendations

The recommendations are based on the findings described above. They are divided into different groups to be addressed. Overall, the evaluators find the project is successful, while important issues and new aspects are worth to continue to work on. We therefore recommend that the project be followed up, as planned, with another project. Many of the following recommendations raise points and issues that should be addressed in the follow-on project. Priority 1= high, 2= middle, 3= low.

### Recommendations to partners

1. Recommendation to core partners: Engage more in IEC meetings, beyond participation, to establish closer working relationships with IEC members from other countries.  
Justification: A close connection with other IEC structures, or other PV QI structures, like in sub-committees, can be established through intensive engagement. This can pay off in the long run because there is much knowledge represented in these structures. For the sustainability of the PV QI, it should be helpful to be able to tap into this knowledge.  
Reference: Section 5.1.6, Priority: 1, Time-frame: Follow-on project
2. Recommendation to EBTKE: Consider the certification of imported modules if they have been certified by other accredited institutions according to IEC standards, or reduce the requirement to a confirmation testing (a shorter test) or confirmation certification (certifying the validity of the external certificate and test). For this, find a way with KAN to accept certificates or tests by accredited certifiers.  
Justification: Accepting the certification by accredited certifiers from other countries is considered good international practice. It will make the import of PV modules faster and cheaper and reduce the burden on the Indonesian economy. It might also reduce the need to open further test laboratories.  
Reference: Section 5.1.3, Priority: 1, Time-frame: Follow-on project
3. Recommendation to KAN: Within the QI institutions, explain the concept of “One Test Accepted Everywhere” through the Mutual Recognition Agreements in the context of recertification/ retesting.  
Justification: As in the case of the testing and certification of imported PV modules, interviews indicate that many in the PV sector are not aware, that there is a universal system of accreditation within which equal certificates are mutually recognised. That would be an important realisation for the future development of the QI sector as a whole, and also for the future development of PV regulation.  
Reference: Section 5.1.3, Priority: 2, Time-frame: Follow-on project
4. Recommendation to EBTKE and others: Develop a region outside areas of electricity over-supply where QI outreach services for PV could be established locally; possibly on an island where there is a polytechnic that conducts the RESD supported PV/hydro power specialisation training for engineers. An institution like such a polytechnic could become the change agent for human capacity development, testing, inspection, and services dedicated to maintenance, like spare part provision. Considering the expected high demand of electricity for nickel processing around the mines on Sulawesi and North Maluku, these islands might be most suitable for this approach.

Justification: Given the current electricity over-supply on Java and regulations that limit the growth of PV, a region that has a greater need for increased electricity supply could be selected to roll out QI along the process that has not been addressed so much, from installation to maintenance.

Reference: Section 3.1, Priority: 1, Time-frame: Follow-on project

5. Recommendation to EBTKE: Consider inviting the Mol, Directorate of Machinery and Agricultural Equipment, in the TC 27-08, and involve the Mol in monitoring and promotion of the standard application.

Justification: The directorate of Machinery and Agricultural Equipment is directly involved with the PV manufacturing industry and supports their development. Quality issues should be an important aspect of this.

Reference: Section 5.1.3, Priority: 1, Time-frame: Follow-on project.

6. Recommendation to Mol: Focus more on quality production in local manufacturers, and make QI and the need for quality better accepted amongst local manufacturers. For this, it could possibly involve Mol's Directorate of Machinery and Agricultural Equipment and the P4SI in the supervision of the PV standards. And, Mol should involve associations as strategic partners in order to effectively reach local manufacturers.

Justification: Quality is a core element for the success of companies and the growth of industry. This should be promoted by all Ministries involved with the PV industry.

Reference: Section 5.1.3, Priority: 1, Time-frame: Follow-on project

7. Recommendation to EBTKE: If there is a need for more PV module testing labs, facilitate testing labs outside Java.

Justification: The industry currently seems to develop also outside Java. A lab on Sulawesi or Sumatra could reduce shipment costs. An alternative could be a testing lab close to the industry near the port by the Free Trade Zone on Batam as there are several initiatives to build PV module factories on Batam.

Reference: Section 3.1.1, Priority: 2, Time-frame: Follow-on project

8. Recommendation to EBTKE and BSN: Develop concepts and standards for the silicon economy circular streams with reuse and recycling PV modules and other silicon waste, like electronic gadgets.

Justification: With an increase in PV and a delay of some years, the amount of silicon waste is expected to increase. This creates a need to manage that waste, economic opportunities and a need for the respective QI.

Reference: Section 7, Priority: 3, Time-frame: Follow-on project

9. Recommendation to EBTKE and BSN: Develop concepts and standards for lithium and lead acid batteries reuse and recycling.

Justification: With an increase in PV and a delay of some years, the amount of lithium waste is expected to increase. There is already a huge number of lead battery waste from cars. As lead batteries are also used for some PV systems, the amount of lead battery waste can increase further. This creates a need to manage that waste, opens economic opportunities and initiates a need for the respective QI.

Reference: Section 7, Priority: 3, Time-frame: Follow-on project

10. Recommendation to BRIN: Evaluate the BRIN policy for dedicating the PV Module Testing Laboratory for research purpose, and consider to return the initial function of testing laboratory to serve the demand of PV module industrial sector.

Justification: There is a high growing need of PV module tests, while there are only two accredited PV testing laboratories in Indonesia. This results in a long backlog of the waiting list which may induce discouragement in the PV industry sector. Hence a full functional BRIN PV

- Module Testing Laboratory for industrial product testing is required.  
Reference: Section 5.1.6, Priority: 1, Time-frame: Follow-on project
11. Recommendation to PV module testing laboratories: Develop the capacity to test modules that are larger in size and Watt peak.  
Justification: Indonesia needs the possibility to make use of the most efficient PV modules. As long as these are imported and need to be tested in Indonesia, and if modern production facilities are to be developed, these testing facilities are required.  
Reference: Section 3.1 and 5.1.3, Priority: 1, Time-frame: Follow-on project
12. Recommendation to AESI and APAMSI: Promote more QI awareness of members.  
Justification: The reports about quality problems received during interviews confirm the impression that there is a need to improve QI awareness in the industry. The associations should be well placed to engage the industry.  
Reference: Section 5.1.5, Priority: 2, Time-frame: Follow-on project
13. Recommendation to AESI and BMKG: Explore if BMKG's ASRS data can be included in the AESI solar radiation map.  
Justification: If the BMKG ASRS data could be integrated in AESI's data base, the data available would not only be more comprehensive, it would also cover a much larger part of Indonesia. It needs to be clarified if the ASRS data is comparable to the AESI data base and if the integration is administratively possible.  
Reference: Section 7, Priority: 3, Time-frame: Follow-on project
14. Recommendation to ESDM and PLN: Review regulations and their implementation so that PV rooftop investments become more attractive after some experience with the new regulation.  
Justification: In March 2024, government changed the regulation for, amongst other things, the connection of rooftop PV installations into the public grid and other renewable energy input into the grid. Experts fear that this might discourage investment in PV. If that happens, it would compromise Indonesia's commitment to move into renewable energy. From evaluation perspective, a close observation if that risk becomes reality seems necessary, as a decline of new PV installations would also affect the relevance of this project.  
Reference: Section 3.1, Priority: 3, No Time-frame
15. Recommendation to BMKG: Invest in a sun tracker, the required equipment for outdoor pyranometer calibration, and make a commitment to provide calibration services also to the PV industry.  
Justification: Outdoor calibration gives the PV sector much more flexibility than the indoor calibration that BMKG currently implements. On the other side, it would also help to improve the meteorological data collection in Indonesia.  
Reference: Section 5.1.3, Priority: 3, Time-frame: Follow-on project

#### **Recommendations to the project team**

16. Recommendation: Engage top management in government institutions, e.g. through short information meetings about the essence of capacity building programmes conducted for their respective organisation.  
Justification: In some cases, the technical departments of implementing partners were cooperating with the project, but were delayed by leadership that, in their view, did not give the necessary support. This seems to be a systematic problem. Working on two levels of the hierarchy, giving more attention to top management (director level and above) than currently, could help to overcome this constraint.  
Reference: Section 5.1.3, Priority: 1, Time-frame: Throughout follow-on project

17. Recommendation: Find ways of communicating, also in the PCC, where the activities with partners are in the context of the overall PTB programme. Explain the whole context of the project and its overall, very agile, strategy to more partners.  
Justification: Not all partners understood the project's set-up, even some of those staff members that had attended PCC meetings, and more so other staff members. From minutes it can be seen that the set-up was explained during meetings. It was not so clear if this set-up was not understood, or if partners expected a more traditional project management. It might be important to explain the agile approach that the project applies.  
Reference: Section 5.1.3, Priority: 1, Time-frame: Throughout follow-on project
18. Recommendation: Facilitate more regular exchange with other German development organisations involved in PV promotion and with the German Embassy.  
Justification: German development cooperation is strongly involved in promoting various aspects in renewable energy. Through this, it has strong links into Indonesian institutions, and the German Embassy has opportunities to address political questions. PTB could contribute to this and benefit from it, if it was fully involved, and not only partially.  
Reference: 5.1.2, Priority: 1, Time-frame: Throughout follow-on project
19. Recommendation: Work with the Mol for strengthening QI in local manufacturers. Associations could be strategic partners for PTB in reaching local manufacturers alongside Mol.  
Justification: As stated in the recommendations to partners, Mol could play a role in promoting QI amongst local manufacturers. This should justify also an engagement of the PTB project with the Mol.  
Reference: Section 5.1.3, Priority: 2, Time-frame: Follow-on project
20. Recommendation: Ensure that after expert visits, a report of findings and recommendations goes to the partner, and that both the trained department and the department that is responsible for this training receives the report.  
Justification: Not in all cases did partners receive such reports, for various reasons. Ensuring means that the project gets confirmation that all affected have actually received the report, or that reports containing confidential information is edited so that one version can go to the partner.  
Reference: Section 5.1.3, Priority: 2, Time-frame: Throughout follow-on project
21. Recommendation: Provide short summaries after training courses of new issues raised that are not covered in the training material.  
Justification: Trainers provide good quality training material. But more information is given verbally, e.g. when answering questions. If the points are later written up, participants would then not only need to depend on their own notes.  
Reference: Section 5.1.3, Priority: 2, Time-frame: Throughout follow-on project
22. Recommendation: Develop letters of intent with some strategic partners and PCC members, that were so far involved in distributing information and would like to be more involved in the development.  
Justification: This refers mainly to associations that could provide more input on their members' needs if they were involved in conceptualising training courses, not only informing their members. Discussions at the annual PCC meetings seem not to be sufficient for this purpose.  
Reference: Section 5.1.3, Priority: 2, Time-frame: Follow-on project
23. Recommendation: In all cases, clarify if partner visited by an expert wishes a follow-on opportunity.  
Justification: This is good common practice in the project and can facilitate that what was

learned is also implemented, but was not done in at least one case.

Reference: Section 5.1.3, Priority: 3, Time-frame: Throughout follow-on project

24. Recommendation: Discuss with partners in the appraisal mission the following options to be taken up in phase 3 of the project:

Justification: There are ideas for a follow-on project that evolve organically from what was achieved so far. We have not listed these plans and opportunities. Instead, here we suggest alternative opportunities to promote PV QI over the next years that come from our findings and analysis. Not all can be implemented. Priorities need to be set with partners, as was done throughout this project.

Reference: see below, Priority: 2, Time-frame: Follow-on project

- a. Provide more support to the industry and particularly to associations and partners working with the industry in dissemination of and capacity building on standards  
Justification: While more awareness of quality has been created, much more awareness is required. BSN, for example, could do a test case on promoting a new standard. This would mean to increase the investment in what is now output 3.  
Reference: Section 5.1.5
- b. Cooperate with RESD on 5 more polytechnics in 2026.  
Justification: RESD intends to replicate its current training programme for polytechnics that establish courses on renewable energy. This is planned for five more polytechnics, to start in 2026. This is an good opportunity to reach a large number of future practitioners.  
Reference: Section 5.1.2 and 7.
- c. Adopt and adapt the existing international standards for installation and for operation, monitoring and maintenance. Then train on these standards.  
Justification: The success of PV is not only in the quality of modules, but also in the quality of the follow-on processes, that according to interview partners often fail in remote locations. A refocus to this might be of great benefit.  
Reference: Section 5.1.1 and 5.1.5
- d. In standards for installation, consider the transport costs and methods so that modules can be transported safely and cost-effectively to remote islands. Possible develop guideline for transport to remote islands, including module size.  
Justification: The travel to remote locations is often very challenging, and large modules often cannot be transported safely. Standards, guidelines and then training need to consider this.  
Reference: Section 3.1
- e. Promote outdoor pyranometer calibration.  
Justification: The project has already invested in building competence at BMKG for outdoor pyranometer calibration. But to implement it, it needs a sun tracker. It might require engagement with the BMKG leadership to explore how and when this service can be provided to the industry. It might also need further clarification how important this specific service is.  
Reference: Section 5.1.3
- f. With BSN Standard Implementation Division, assist SMEs to apply the SNI IEC 61215 standard. Do a case study or best practice publication about the way the promotion of a standard was done.  
Justification: SMEs require assistance to apply standards. In a PTB supported process,

BSN SNSU could learn how this assistance can work best and efficiently. A case study on the promotion of the standard could be used to document learning for further standards and to have arguments for the further promotion of such standards.

Reference: Section 5.1.3

**Recommendations to the International Cooperation Department (Group 9.3)**

(none)

**Recommendations to the evaluation unit of Working Group 9.01.**

25. Recommendation: Facilitate faster travel cost reimbursement to partners.  
Justification: Partners mentioned that PTB is slow in reimbursing international travel costs. Particularly these costs are often hard to carry for persons or institutions.  
Reference: Section 5.1.3, Priority: 3, Time-frame: Follow-on project

## 9. Annexes to the evaluation report

### 9.1 Intervention logic (from the module proposal)

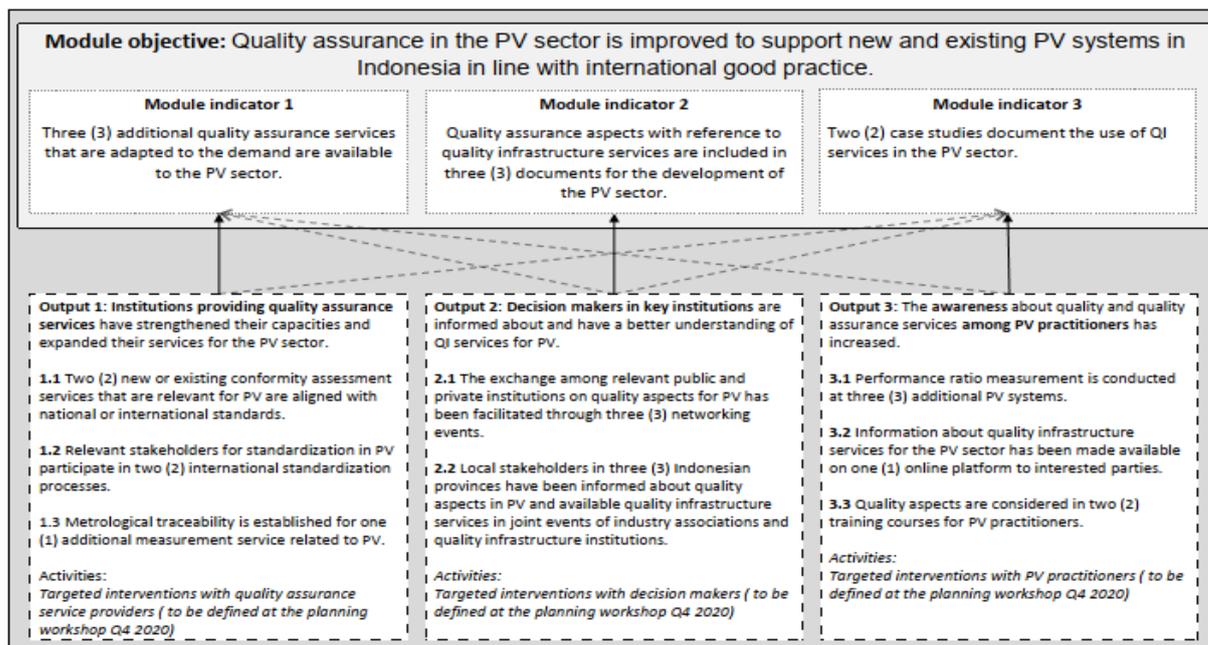
The original intervention logic (“Wirkungsmatrix”) is as follows. Indicators have been modified since. Current indicators can be found in the text.

Objectives	Indicators	Source of verification
<b>Output 1</b> Institutions providing <b>quality assurance services</b> have strengthened their capacities and expanded their service scope for the PV sector.	<b>1.1</b> Two (2) new or existing conformity assessment services that are relevant for PV are aligned with national or international standards. Baseline : X Target: X+2	Information by quality assurance service providers, expert reports, publicly available information about services
	<b>1.2</b> Relevant stakeholders for standardization in PV participate in two (2) international standardization processes. Baseline: 0 Target: 2	Documentation of participation by TC members
	<b>1.3</b> Metrological traceability is established for one (1) additional measurement service related to PV. Baseline: X Target: X+1	Information by SNSU, expert reports
<b>Output 2</b> <b>Decision makers</b> in key institutions are informed about and have a better understanding of QI services for PV.	<b>2.1</b> The exchange among relevant public and private institutions on quality aspects for PV has been facilitated through three (3) networking events. Baseline: 4 (FGDs for RPJMN and standard seminar) Target: 7	Event documentation
	<b>2.2</b> Local stakeholders in three (3) Indonesian provinces have been informed about quality aspects in PV and available quality infrastructure services in joint events of industry associations and quality infrastructure institutions. Baseline: 2 (Jakarta & East Java) Target: 5	Event documentation
<b>Output 3</b> The awareness about quality and quality assurance services among <b>PV practitioners</b> has increased.	<b>3.1</b> Performance ratio monitoring is conducted at three (3) additional PV systems and the results are discussed and evaluated. Baseline : X Target: X+3	Documentation of performance ratio measurement
	<b>3.2</b> Information about quality infrastructure services for the PV sector has been made available on one (1) online platform to interested parties. Baseline: 0 Target: 1	Online platform
	<b>3.3</b> Two (2) training courses for PV practitioners are designed and implemented to address quality aspects. Baseline: 0 Target: 2	Outline of training course content, documentation of trainings

## 9.2 “Results logic” Capacity WORKS tool 7

### Results logic

Strengthening Quality Infrastructure for the Photovoltaic Sector in Indonesia  
11/2020 – 10/2023



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### 9.3 Technical report (not applicable)

### 9.4 Evaluation schedule

28.2.2024	Training Module Handling & Storage (PI Berlin)
1.3.2024	International evaluator leaves Germany
3.3.2024	Evaluator team meeting in Jakarta
4.-12.3.2024	Interview field phase, partly online interviews
4.3.2024	Briefing of staff and partners
11./12.3.2024	Report writing, preparation of online survey
12.3.2024	Departure of international evaluator
14.3.2024	Debriefing of staff and partners
15.-19.3.2024	Online interviews
15.4.-3.5.2024	Online survey
5.5.2024	Delivery of first draft of evaluation report

## 9.5 Schedule of the field phase/data acquisition, and list of contact persons

4.3.2024	Staff members, EBTKE PTB Local Project Coordinator Online workshop with staff and partners PTB Project Coordinator
5.3.2024	Staff members, BMKG Staff members, BAPPENAS Oksi Sigit (certification), Ariandiky (testing), Buda (assistant manager for generation system testing management), PLN Pusat Sertifikasi
6.3.2024	Visit to Solar Indonesia 2024 exhibition Staff members, PT Qualis at the exhibition Seraphim Sale Manager Indonesia at the exhibition Staff members, PRKKE-BRIN Staff members, BSN SNSU Staff members, BSN KAN
7.3.2024	Staff members, BSN standard development Staff members, BSN international cooperation for electronics Staff members, BSN training directorate PTB National Administrative Assistant PTB, expert
8.3.2024	Staff members, Ministry of Industry, Directorate of Machinery and Agricultural Equipment Fabby Tumawa, president, AESI Members, APAMSI Staff members, SECO/RESD
11.3.2024	Staff members and cooperation partners, BPH Migas, visit of PV rooftop installation, Pa Koko (the developer), and further staff Staff member, BRIN PTB accompanying international short-term expert
12.3.2024	Debriefing PTB local staff Staff member, GIZ REEP
14.3.2024	Debriefing workshop
15.3.2024	PTB, head of Asia section Staff member, BSN SNSU
19.3.2024	Staff members, coordinator energy sector Indonesia, KfW

## 9.6 Questionnaires and/or interview guidelines

### 9.6.1 Interview Guideline

Initial information: Interviews will be kept confidential. We will not quote and not inform PTB about what individual interview partners said. If applicable: There will be a debriefing workshop on which we will present preliminary results. For all information on the evaluation results and steps taken after the debriefing workshop, PTB will be responsible. Questions, to be adapted to the respective interviewee. Evaluators will list specific questions, potential suggestions and preliminary conclusions that the

interviewee should be asked about). Each question below can be followed up by more specific questions. The order of questions is tentative.

- What are you doing now? Project activities. In terms of PTB project / PV quality.
- What has changed since 2020 in the project, in the work? Or since you got involved?
- What are highlights?
- What are particular challenges?
- What do you achieve (outputs)?
- What do people do with it? What changes on the ground? (utilisation of outputs)
- What are risks? And how do you manage them?
- What would be possible in the PV quality sector in Indonesia now? What are new opportunities? And limitations? Does PTB address what is needed, or should it address something else?
- And at the end, check all the evaluators' specific questions or initial ideas (potential suggestions, conclusions): ask what interview partners think about them.

### 9.6.2 Online survey

Welcome to this survey on the Indonesian Photovoltaic Industry.

#### Opening message:

Dear colleagues,

PTB, the German National Metrology Institute, has commissioned us with an independent, external evaluation of its project on Quality Infrastructure for the Photovoltaic (PV) sector in Indonesia, which it conducts in cooperation with EBTKE, the Indonesian Directorate General of New Renewable Energy and Energy Conservation and many other institutions in Indonesia. We would like to hear the views and needs of the Photovoltaic Industry. We send this survey through cooperating institutions.

Please fill in the survey until Monday, 15 April 2024.

You are welcome to respond in Bahasa Indonesia

At the end, you will be invited to download your answers. PTB will share survey results in the further course of the project.

Your responses are entirely confidential. We cannot trace back your answers to you.

If you have any questions, please write to [bc@causemann.org](mailto:bc@causemann.org)

Thank you very much for your support.

Andhika Prastawa, Bernward Causemann

1. The PV industry in Indonesia can be divided into different groups. Which group do you belong to (please choose the one that fits most)

- Manufacturer of PV modules or other PV equipment
- Engineering/Procurement/Construction (EPC) / installer
- Developer of PV installations
- Importer of PV modules or other PV equipment
- Energy producer (PLN or private)
- Other. Please specify (open field)

#### Questions to all:

##### **Training courses**

2. Did you ever participate in a PTB supported training course or event?

- Yes/No

2.a If yes: Have there been any improvements in the ways your business works because of ideas and knowledge you gathered during the PTB supported training course or event? Please answer on a scale from 1 = "Not at all" to 5 = "To a very high extent"

	<b>1=Not at all</b>	<b>2=To little extent</b>	<b>3=To some extent</b>	<b>4=To a large extent</b>	<b>5=To a very large extent</b>
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**Quality issues**

3. How important is quality for you when it comes to solar PV? Please answer on a scale from 1 = "Not at all" to 5 = "To a very high extent"

	<b>1=Not at all</b>	<b>2=To little extent</b>	<b>3=To some extent</b>	<b>4=To a large extent</b>	<b>5=To a very large extent</b>
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3.a Please explain your answer (open question)

4. Have you experienced problems with quality in PV?

- Yes/No

4.a If yes: Please describe the problems you experienced (open question)

4.b Which of these issues could be addressed in some way by the PTB project, by the government or by the associations? (open question)

5. Do you have a quality management system in place?

- Answers: yes - ISO 9001, yes - other, no, don't know

6. Do you use Standar Nasional Indonesia (SNI) in your work? yes / no

7. Which of the following SNIs are you familiar with?

- SNI IEC 62446 (commissioning)
- SNI IEC 62548 (design)
- SNI IEC 61724 (part 1 of Performance Ratio Measurement)
- SNI IEC 61730 (module safety)

Answers: - Not familiar at all / - Have heard about it / - I know the content of this SNI / - We use this SNI

7.a If not "not familiar at all" in all cases: How did you learn about the standards? (open question)

8. What would enable you to use SNI (more) in your work? (open question)

9. Do you use IEC (International Electrotechnical Committee) standards in your work?

- yes / no

9.a If yes: How many SNI or IEC standards do you use in your daily work?

- 1
- 2-5
- more than 5.

9.b If >1, Are these

- Rather national standards (SNI),
- Rather international standards (IEC and ISO),
- Both?

10. Did you know that SNI are often full adoptions of IEC / ISO standards?

- yes / no

Questions to manufacturers only:

11. Do you plan to financially invest further in your production facilities? Please indicate which of the following statements apply to your company:

I/we/my company intend/s to...

- 11.a increase the number of units we can produce
- 11.b introduce new production technology
- 11.c introduce new PV module sizes
- 11.d introduce new PV cells
- 11.e increase the range of products for PV that we produce
- 11.f produce inverters and other PV components

- Answers: Yes, we intend to do this / Yes, we have concrete plans to do this / No, we have no such plans / I do not know / Questions does not apply to us

12. Please explain your plans for investment (open question)

13. How can this investment be facilitated by the Mol or other governmental institutions? (open question)

14. Do you use solar simulators?

- Yes/no

14.a If yes: How many solar simulators do you have? (1, 2-4, more than 5)

14.b If yes: do you have golden modules? Yes/no

14.c If yes: How often do you need solar simulator classification (I don't know, every year, every 2-4 years, more than 5 years) If you have different solar simulators, please answer for the type that you use most.

14.d If yes: What is the maximum measurement uncertainty of your solar simulator you can tolerate? Where do you see potential to lower the measurement uncertainty of your instruments, standards and sensors? What measurement uncertainty of your solar simulator would you like to achieve? How can SNSU-BSN assist in lowering the measurement uncertainty of your measurements?

If you have different solar simulators, please answer for the type that you use most.

To importers and manufacturers only

15. Regarding tests of solar modules, the technical committee 27-08 intends to revise standard SNI IEC 61730 on module safety. Do you consider it important for modules to comply with SNI IEC 61730? Yes – No – Don't know

15.a Please explain your answer on SNI IEC 61730 on module safety (open question)

15.b Please explain if or why you find it important to comply with SNI IEC standards 61215 on module quality (open question)

For developers and electricity producers

16. Which type of PV installation do you have, or have you installed?

- 11.a PV system for rooftops
- 11.b Utility scale PV system

17. What is the biggest PV module you have installed?

- Up to 300 Watt peak / - Up to 400 Watt peak / - Up to 500 Watt peak / - Up to 600 Watt peak / - Above 600 Watt peak

18. Some of the regulations do not differentiate between PV systems for rooftops and utility scale systems. Should there be different regulations?

- Yes/no

18.a If yes: What should be regulated differently? (open question)

19. Which incentives do you need from government for producing and installing PV? (open question)

**Support**

20. For the Indonesian PV sector to grow, what support do you wish for from government, from the associations or from the PTB project? (open question)

Questions to all:

21. On which island(s) are you active in the PV sector? (multiple answers allowed)

Java / Sumatra / Bali and Lombok / Sulawesi / Other

Closing remarks

Thank you for your support!

You are welcome to download your answers.

**9.7 Online survey results**

1. Introduction, methodology

In the context of the project evaluation “Strengthening Quality Infrastructure for the Photovoltaic Sector in Indonesia” for PTB, and after the field visit, an online survey of the industry was conducted. PTB invited its contacts in the industry to participate and asked networks (AESI, APAMSI, SECO/RESO) to invite their members and participants to fill in this survey. The survey was online from 28.3.2024 to 3.5.2024. Initially, there was hardly any response as the survey was started during a holiday during and after Ramadan. PTB and networks reminded potential respondents end of April after the holiday. It was then that respondents came in, the last one on 30.4.2024.

Questions for the survey were developed by the evaluators based on questions during the field phase to organisations involved in PV QI, including PTB, on what they would want to know from the industry, and based on interests evolving from the evaluation itself. PTB commented on draft versions of the survey and tested it. The survey was implemented in Limesurvey in English only, with the offer to respond in Bahasa Indonesia. All text responses are documented here. No anonymisation was necessary. The Bahasa responses are presented here in the original and with translation.

**2. General results**

The survey generated 64 views. Of these, 25 were merely views in which respondents did not answer a single question. 39 respondents answered at least one question. It is possible, but there are no indications that one respondent answered more than once. Because of the way the survey was distributed, it is not possible to give a number of persons invited, and therefore also no response rate can be given. Nevertheless, this seems to be a weak response. The fact that the survey was in English might partly explain the limited number of responses. To what extent the survey is representative, cannot be said as the total of potential respondents cannot be defined. Only two persons responded in Bahasa. No questions were sent to the evaluators about the survey.

Not all 39 responded to all questions. Here, only responses are listed, so that the total per question is often less than 39. The survey had seven sections. 17 continued the survey until the last page.

Answered up to section	Number
-1	1
0	1
1	11
2	8
6	1
7	17
<b>Total</b>	<b>39</b>

The following questions have been addressed to all respondents.

1. The PV industry in Indonesia can be divided into different groups. Which group do you belong to? (please choose the one that fits most)

Engineering/Procurement/Construction (EPC) / installer	20
Developer of PV installations	8
Energy producer (PLN or private)	6
Manufacturer of PV modules or other PV equipment	4
Other. Please specify (open field)	4
Importer of PV modules or other PV equipment	2
<b>Total / of 39, double entries were possible</b>	<b>44</b>

The other are: "Consultant, Engineer in hospitality company, TVET Center for Solar PV"

### 3. Training courses

2. Did you ever participate in a PTB supported training course or event?

No	21
Yes	11
<b>Total</b>	<b>32</b>

2.a If yes: Have there been any improvements in the ways your business works because of ideas and knowledge you gathered during the PTB supported training course or event? Please answer on a scale from 1 = "Not at all" to 5 = "To a very high extent"

3=To some extent	4
4=To a large extent	6
5=To a very large extent	1
<b>Total</b>	<b>11</b>

### 4. Quality issues

3. How important is quality for you when it comes to solar PV? Please answer on a scale from 1 = "Not at all" to 5 = "To a very high extent"

3=To some extent	2
4=To a large extent	8
5=To a very large extent	15
<b>Total</b>	<b>25</b>

3.a Please explain your answer (open question)

EPC/installer		Quality of PV is important but the cost is also important, especially for retail customer.
TVET Center for Solar PV		Quality will determine all the aspects of the Powerplant, especially the future performance-how frequent the downtime due to repairs, the longevity of the power plant, quality of the preventive maintenance is also a a major factor.
EPC/installer	developer	Along with the development of technology and technical methodologies in the solar power generation industry, it must be supported by human resources who are competent and experts in this field.

EPC/installer		Good Quality, makes more lifetime to use
EPC/installer		because quality determines the lifespan of the system.
Engineer in hospitality company		To get green energy
EPC/installer		because the quality of solar PV will affect the efficiency of the electrical power it is able to supply.
EPC/installer / manufacturer	importer	PV quality determines the sustainability of the system over a long period of time
Consultant		The quality solar PV is important because of its sustainability
Manufacturer		Actually when the event already coming, it's not just added value for the participant only, but also for trainer, because we share our experience maybe that we never had before
EPC/installer	electricity producer	Quality greatly influences the effectiveness and efficiency of a solar power plant
developer		PV module quality will greatly affect our project reliability, generation, and thus revenue.
EPC/installer		Solar PV has benefits in people's lives because it uses renewable energy sources as an energy source so that in the industrial world there is a huge opportunity for us to continue to develop while reducing damage and protecting nature.
EPC/installer		PV is the important material
EPC/installer		PV is expensive, thus it shall come in good quality to last long.
EPC/installer		kualitas sangat berpengaruh karna setiap kondisi cuaca dan iklim di indonesia bisa berubah dengan sangat signifikan jdi kalau kualitas pv tidak bagus pasti akan berpengaruh terhadap output yg di berikan / Quality is very influential because every weather and climate conditions in Indonesia can change very significantly so if the quality of pv is not good, it will definitely affect the output provided.
electricity producer		High-quality components ensure better performance, longer lifespan, and increased efficiency of the system, leading to better energy production, and cost savings in the long run.

4. Have you experienced problems with quality in PV?

No	12
Yes	12
<b>Total</b>	<b>24</b>

4.a If yes: Please describe the problems you experienced (open question)

4.b Which of these issues could be addressed in some way by the PTB project, by the government or by the associations? (open question)

		4.a problems	4.b address
EPC/installer / manufacturer	importer	There are some PV that are stored for a long time in boxes where the glass fogs up. After removing it from the box and exposing it to the sun for a few hours, it returned to normal. what caused that to happen?	both of them

EPC/installer	No	PV get burn	Government
Consultant		Non-standard of installation of some instruments/pieces of equipment	The EPC should be install/implement of government regulation related to standard of installation for solar PV to guarantee the quality
developer		Lack of quality of workmanship in installation caused several outages in our PV plants, especially during the first few years of operation.	
EPC/installer		especially for pv manufacturer in indonesia, the quality is still below Chinese manufacturers. and i have some case the PV module burn when operating	
TVET Center for Solar PV		After less than a year, there were numerous downtimes until several months became a white elephant.	PTB Project carried out courses in Indonesia for trouble shooting, for hands-on discussion, demonstrating using real equipment/measuring instruments, etc...
Manufacturer		Actually in Indonesia we not have some proper standard to crosscheck testing, especially for material of the PV System, so maybe when it comes, some of PV already have microcrack, either, the quality of the installer maybe must be improved, to make sure the installation already on point, some the system work already properly	Both of
EPC/installer		- pv module is easily broken due to poor glass quality - inverters that are easily damaged. - etc.	cultivate awareness of the operation pattern, usage method, correct installation and appropriate maintenance.

5. Do you have a quality management system in place?

No	3
I do not know	3
Yes, ISO 9001	12
Yes, other	3
<b>Total</b>	<b>21</b>

## 5. Standards

6. Do you use Standar Nasional Indonesia (SNI) in your work? yes / no

No	1
Yes	16
<b>Total</b>	<b>17</b>

7. Which of the following SNIs are you familiar with?

SNI IEC 62446 (commissioning)	SNI IEC 62548 (design)	SNI IEC 61724 (part 1 of	SNI IEC 61730 (module safety)
----------------------------------	---------------------------	-----------------------------	----------------------------------

			Performance Ratio Meas- urement)	
Not familiar at all	4	3	2	2
Have heard about it	2	3	5	4
I know the content of this SNI	3	3	1	5
We use this SNI	5	6	5	3
<b>Total</b>	<b>14</b>	<b>15</b>	<b>13</b>	<b>14</b>

7.a If not "not familiar at all" in all cases: How did you learn about the standards? (open question)

8. What would enable you to use SNI (more) in your work? (open question)

		7.a learn about standards	8. enable to use SNI
EPC/installer		this standard is the requirement for permit to operate such as SLO (sertifikat laik operasi), etc	Mandatory when we want to proceed the permit
TVET Center for Solar PV		study and courses	more simplified pictorial or video short explanations/digital posters/picture (infographics) ... because sometimes we do not remember all of the details, or get confused with an older version of the standards.
EPC/installer	developer	Standards in the operation of solar power plants are the most important thing to be able to run a work mechanism in accordance with existing rules.	in terms of conducting solar power plant feasibility studies and project planning
EPC/installer		standard operation and installation PV module	using SNI for determine the color of the cable and cable bending (PUIL)
EPC/installer		seminars, discussions, and self-study	
Engineer in hospitality company		Safety to use	
EPC/installer	importer	reading the standards	Keep the quality and update the technology
EPC/installer	Manufacturer	reading the standards	to ensure that the system is working properly in accordance with applicable standards
Consultant		Just read the SNIs	
Manufacturer		It's actually preference standard we used on our company	Mostly of SNI already adopted from IEC standard that relevant with the Indonesia Condition and require at the time.
EPC/installer	electricity producer	from the training or training modules that I attended	The quality of equipment will affect its function and safety, both in terms of equipment and labor
developer		From searching in online resources	That the SNI will be the reference for certification or license or permit.
EPC/installer		belajar melalui internet atau sumber lain / Learning through the internet or other sources	membuat kerangka pv serta saat merangkai rangkaian pv / Making the PV framework and assembling the PV array

EPC/installer		1. Standar produk sudah kita kaji sebelumnya terkait datasheet dan beberapa sertifikat dll, 2. Standar pekerjaan kita membentuk SOP agar lebih mudah dalam penerapan 3. Standar hasil kita proses melalui tes dan quality control / 1. The product standard has been reviewed before regarding the datasheet and some certificates, etc. 2. Our work standards form an SOP to make it easier to implement 3. Standardised results, we process through tests and quality control.	1. Regulasi 2. Kualitas material 3. kepercayaan pelanggan / 1. Regulation 2. Material quality 3. Customer trust
EPC/installer			More socialization on its importance
electricity producer			Access to comprehensive database or resource containing the latest standards and guidelines set by SNI. Continuous updates and notifications regarding any changes or revisions to the standards. Training / dissemination regarding what these standards are all about and the benefits they offer. Incentives of using SNIs.

9. Do you use IEC (International Electrotechnical Committee) standards in your work?

No	2
Yes	11
<b>Total</b>	<b>13</b>

9.a If yes: How many SNI or IEC standards do you use in your daily work?

1	1
2-5	5
More than 5	2
<b>Total</b>	<b>8</b>

9.b If >1, Are these

Rather international standards (IEC and ISO)	4
Rather national standards (SNI)	3
Both	4
<b>Total</b>	<b>11</b>

10. Did you know that SNI are often full adoptions of IEC / ISO standards?

No	3
Yes	10
<b>Total</b>	<b>13</b>

## 6. Manufacturers: investments

The following questions have been addressed to manufacturers only:

11. Do you plan to financially invest further in your production facilities? Please indicate which of the following statements apply to your company. Answers: Yes, we intend to do this / Yes, we have concrete plans to do this / No, we have no such plans / I do not know / Questions does not apply to us

	Yes, intentions	Yes, concrete plans
11.a increase the number of units we can produce	1	0
11.b introduce new production technology	1	0
11.c introduce new PV module sizes	0	1
11.d introduce new PV cells	0	0
11.e increase the range of products for PV that we produce	1	0
11.f produce inverters and other PV components	0	0

12. Please explain your plans for investment (open question)

1. Stringer up to 210mm
2. Auto layup machine
3. Final Test Equipment

(All answers to 11 and 12 came from the same respondent.)

13. How can this investment be facilitated by the Mol or other governmental institutions? (open question)

(no response)

## 7. Manufacturers: solar simulators

14. Do you use solar simulators?

1 respondent answered with yes. The following answers are all from that respondent

14.a If yes: How many solar simulators do you have? (1, 2-4, more than 5)

2-4

14.b If yes: do you have golden modules?

Yes

14.c If yes: How often do you need solar simulator classification

Every 2-4 years

14.d If yes: What is the maximum measurement uncertainty of your solar simulator you can tolerate? Where do you see potential to lower the measurement uncertainty of your instruments, standards and sensors? What measurement uncertainty of your solar simulator would you like to achieve? How can SNSU-BSN assist in lowering the measurement uncertainty of your measurements? If you have different solar simulators, please answer for the type that you use most.

6% for spectrometer. Potential to lower is spectrometer

### 8. Importers and manufacturers: solar module tests

The following questions have been addressed to importers and manufacturers only:

15. Regarding tests of solar modules, the technical committee 27-08 intends to revise standard SNI IEC 61730 on module safety. Do you consider it important for modules to comply with SNI IEC 61730? Yes – No – Don't know

Yes: 2, No: 0, Don't know: 0

15.a Please explain your answer on SNI IEC 61730 on module safety (open question)

1 response: It's very helpfull absolutely, to have a guidance for safety and testing

15.b Please explain if or why you find it important to comply with SNI IEC standards 61215 on module quality (open question)

1 response: Ensure that PV, especially for PV with local content already have a benchmark, to create that product already safety and fulfill testing requirement, so the local content PV could be competitive with another PV, from price and perform

### 9. Developers and electricity producers: type of PV installation

The following questions have been addressed to developers and electricity producers only:

16. Which type of PV installation do you have, or have you installed?

	Yes	No
11.a PV system for rooftops	1	3
11.b Utility scale PV system	4	0
11.c Other	0	4

17. What is the biggest PV module you have installed? (Up to 300 Watt peak / Up to 400 Watt peak / Up to 500 Watt peak / Up to 600 Watt peak / Above 600 Watt peak)

More than 600 Watt peak	1
Up to 400 Watt peak	2
<b>Total</b>	<b>3</b>

### 10. Developers and electricity producers: regulations

18. Some of the regulations do not differentiate between PV systems for rooftops and utility scale systems. Should there be different regulations?

No	2
Yes	2
<b>Total</b>	<b>4</b>

18.a If yes: What should be regulated differently? (open question)

19. Which incentives do you need from government for producing and installing PV? (open question)

	18	18.a different regulation	19. incentives from government
Developer	Yes	Safety requirements, irradiation monitoring and forecasting, power quality, interconnection requirement, mandatory certifications	Ease of licenses and permits

electricity producer		Yes	Installation requirements and safety measures or considerations.	Provide cash rebates or grants, guarantee feed-in tariffs (fixed payment) for every kWh generated, financing programs, reduce regulatory barriers, implement renewable energy regulatory incentives.
EPC/ installer	develo- per	No		Regulatory incentives for relatively more massive installation of solar power plants, and allowing the commercial and industrial sectors to participate in the installation of solar power plants.
EPC/ installer	electricity pro- ducer	No		Legal certainty in the form of regulations to encourage the development of new energy is increasingly popular and in demand

## 11. Support

The following question has been addressed to all respondents

20. For the Indonesian PV sector to grow, what support do you wish for from government, from the associations or from the PTB project? (open question)

Engineer in hospitality company			To get more land for place pv module
Consultant			The government should make regulations that benefit the consumer, developer, and industries positively.
EPC/installer			supporting in regulation, especially synchronizing all ministry n stakeholder
EPC/installer	Develo- per		support such as training for operators and supervisors or higher levels to be able to increase competence in the field of renewable energy, especially solar power plants.
EPC/installer			lebih banyak pelatihan serta praktek langsung dalam hal penerapan ilmu yg di dapat / Provide more training and direct practice in terms of applying the knowledge gained
EPC/installer			I think it would be better if the government can review the regulations that limit the utilisation of PLTS functions, especially in the residential sector.
EPC/installer			I hope the government can be open and provide definite regulations regarding the installation of solar power plants, because in my opinion the installation of solar power plants is too limited and too biased towards the strongest factors in the energy industry in Indonesia
TVET Center for Solar PV			help out/update/visit the TVET Centers that produce the field technicians and the universities that produce the design engineers in the PV industry.
electricity producer			Government: support through policies that includes incentives, permitting processes (reduce bureaucratic hurdles), clear renewable energy targets. Associations or PTB: facilitate knowledge sharing on best practices, provide training and capacity building initiatives, help create or develop new market opportunities.
EPC/installer	electricity pro- ducer		From government support from regulations and legal certainty, PTB continues to carry out training and training to prepare reliable personnel in the fields of technology and human resources.
developer			For utility scale project, clear timeline of the project tendering. Commitment to carry out the energy transition plan, so that developers can allocate appropriate resources for project development.

EPC/installer			Ease licensing, increase training and cooperation between sectors (PLN, ESDM, BLK, etc.)
Manufacturer	EPC/installer	importer	development of materials and recycling industries
Manufacturer			At this moment we need long certainty for the Solar System Power Plant installation quota for each grid, because the regulation already change in short time.
EPC/installer			<ol style="list-style-type: none"> <li>1. Mudah dalam proses regulasi/perizinan pemasangan dll</li> <li>2. Harga produk diharapkan lebih terjangkau agar masyarakat menengah kebawah dapat menikmati dan ikut serta dalam membangun energi ramah lingkungan /</li> </ol> <ol style="list-style-type: none"> <li>1. Easy to process regulations/installation permits, etc.</li> <li>2. Product prices are expected to be more affordable so that the middle to lower class people can benefit and participate in building environmentally friendly energy.</li> </ol>

### 9.8 Interview Guideline

Initial information: Interviews will be kept confidential. We will not quote and not inform PTB about what individual interview partners said.

If applicable: There will be a debriefing workshop on 14.3.2024 on which we will present preliminary results. For all information on the evaluation results and steps taken after the debriefing workshop, PTB will be responsible.

Questions, to be adapted to the respective interviewee. Evaluators will list specific questions, potential suggestions and preliminary conclusions that the interviewee should be asked about). Each question below can be followed up by more specific questions. The order of questions is tentative.

- a) What are you doing now? Project activities. In terms of PTB project / PV quality.
- b) What has changed since 2020 in the project, in the work? Or since you got involved?
- c) What are highlights?
- d) What are particular challenges?
- e) What do you achieve (outputs)?
- f) What do people do with it? What changes on the ground? (Utilisation of outputs)
- g) What are risks? And how do you manage them?
- h) What would be possible in the PV quality sector in Indonesia now? What are new opportunities? And limitations? Does PTB address what is needed, or should it address something else?
- i) And at the end, check all the evaluators' specific questions or initial ideas (potential suggestions, conclusions): ask what interview partners think about them.