INTERNATIONAL COOPERATION

EXTERNAL EVALUATION – SHORT REPORT

Key evaluator: Annette Schmidt
Technical evaluator: Dr. Timothy Walsh
PTB co-evaluator: Laura Blomenkemper

Strengthening Quality Infrastructure for the Solar Industry in India

Country | Region:	India
Project No.:	2013.2117.3
Period:	03/2014 – 02/2019
Executing Agency:	PTB
Implementing Partner:	National institute for Solar Energy (NISE)
PTB | Working Group:	9.32
PTB | Project Coordinator:	Dr. Michael Brinkschröder
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List of abbreviations

BIS	Bureau of Indian Standards
BMWi	German Ministry of Economic Affairs and Energy
BMZ	German Ministry for Economic Cooperation and Development
CII	Confederation of Indian Industry
DAC	Development Assistant Committee of the OECD
DC	Development Cooperation
EL	Electroluminescence
Fraunhofer ISE	Fraunhofer Institute for Solar Energysystems
Fraunhofer IWES	Fraunhofer Institute for Wind Energy Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit German Agency for International Cooperation
GW	Gigawatts
IACS	Indian Association for the Cultivation of Science - Kolkata
IEC	International Electrotechnical Commission
IGEF	Indo-German Energy Forum
IIT-Bombay	Indian Institute of Technology
INDC	Intended Nationally Determined Contribution = Indian New Climate Plan
IREDA	Indian Renewable Energy Development Agency
ISA	International Solar Alliance
KfW	Kreditanstalt für Wiederaufbau

MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
NABCB	National Accreditation Board for Certification Bodies
NAPCC	National Action Plan on Climate Change
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCPRE	National Centre for Photovoltaic Research and Education Mumbai
NISE	National Institute of Solar Energy
NITI	The National Institution for Transforming India (NITI) Aayog
NPL	National Physical Laboratory
OECD	Organization for Economic Cooperation and Development
PI	Photovoltaic-Institute Berlin AG
PID	Potential-Induced Degradation
PV	Photovoltaics
QI	Quality Infrastructure
REC	Rural Electrificaction Corporation Ltd.
SDG	Sustainable Development Goals
SEC	Solar Energy Centre (today NISE)
SECI	Solar Energy Cooperation of India Ltd.
SERIS	Solar Energy Research Institute of Singapore
SR	Spectral Responsivity

TERI	The Energy and Resources Institute
UNFCCC	United Nations Framework Convention on Climate Change

1. Project Description

The National Institute of Solar Energy (NISE) and the Physikalisch-Technische Bundesanstalt (PTB), are, on behalf of the German Ministry for Economic Cooperation and Development (BMZ), jointly implementing the project: “Strengthening Quality Infrastructure for the Solar Industry in India”, which will be referred to in the following as “PV Project”. The stated objective of this project is as follows:

“The scope of Quality Infrastructure (QI) services needed for assuring the quality and reliability of solar energy systems has been improved by taking into account international good practices, and is increasingly used”.

To achieve this objective, four outputs were developed:

Output A: The relevant capacities for the solar sector of the Indian metrology system have been strengthened.

Output B: Conformity assessment bodies use and set up quality assurance procedures in the field of solar energy collectors.

Output C: Standardization institutions and regulatory institutions are informed about international requirements and good practices for quality assurance in the solar sector.

Output D: Companies from the private and state-owned solar sector have been qualified for and made aware of quality aspects in the sector.

Besides the NISE, the National Physical Laboratory (NPL), the Indian Institute of Technology (IIT-Bombay), the Bureau of Indian Standards (BIS), the National Accreditation Board for Testing and Calibration Laboratories (NABL), the Solar Energy Corporation of India (SECI), the Indian Renewable Energy Development Agency, Limited (IREDA) and The Energy Resources Institute (TERI) are further implementing partners. The political partner is the Ministry of New and Renewable Energy (MNRE). The project has a life span of 5 years (03/2014 – 02/2019) and a budget of 1.8 Million Euro. The evaluation was carried out in April 2018 by Annette Schmidt (key evaluator), Dr. Timothy Walsh (technical evaluator) and Laura Blomenkemper (PTB).

2. Assessment of the project

2.1 Status of the change process

Relevance

The project is in line with the Indian governmental environmental policies and strategies, and with the guiding principles for reducing CO_2 emissions, such as the Paris Agreement on Climate Change - the agreement of the United Nations Framework Convention on Climate Change (UNFCCC) – signed in 2015 and ratified in October 2016 by India. India has a National Action Plan on Climate Change (NAPCC), and its national development policy has clear links to the Agenda 2030. The Indian government has committed itself to increasing the share of renewable energies to 40% by 2030. Through the Jawaharlal Nehru National Solar

Mission, an ambitious target was formulated regarding photovoltaics: the current 8 GW of installed photovoltaics (PV) capacity will be expanded to 100 GW by 2022.

India is a global development partner of high strategic importance for the German development cooper-ation. For example, India is indispensable in the implementation of the Paris Agreement on Climate Change. Both countries have signed strategic partnerships on "Green Energy Corridors" (expan-sion of grid integration of renewable energies) and on solar energy. In October 2015, the Indian Prime Minister Narendra Modi and the German Chancellor Angela Merkel signed a solar partnership, where the German side committed itself to make 1 Billion Euro available for solar energy in India within five years.

During the evaluation, the evaluation team had the possibility to talk with various representatives from the partner institutes about the relevance of the project. They unanimously agreed that the PV Project and its different components such as secondary cell calibration, module testing, standards etc, are of high relevance for India in general but also for their specific institutions.

There was a systematic examination of the target groups' core problem which stated that their highest interest was expressed towards the end of the value chain of PV systems such as installation and monitoring. That is why during the evaluation, a discussion among the experts has evolved as to whether the strong orientation on secondary cell calibration of the project (low to medium priority according to the systematic examination) instead of on the monitoring of the performance of the PV plants (medium to high priority according to the systematic examination) is the right approach to address the most relevant needs of the sector. Quite a few interview partners agreed that monitoring would have been more relevant to the sector in general, whereas a few insisted on the higher relevance of the chosen approach. A clear statement as to whether the most relevant work packages have really been developed or not cannot be made here, because there are other aspects to consider in addition to the wishes of the target group, such as the comparative advantages to each institution and in which areas other donors are already active.

The DAC-criterion relevance is rated “good” (2).

Effectiveness

Activity Area A: Metrology

Indicator: The Indian metrology system (especially the NPLI and the NISE) ensures the traceability of an additional measurand – which is relevant to the solar sector – to the international system of units.

Findings: The main activity undertaken in this area has been secondary solar cell calibration. The laboratory personnel of NPL, NISE and IIT-Bombay received expert visits and participated in workshops, a round-robin testing was arranged and conducted between these three institutes and Fraunhofer ISE in Germany. All the feedback received by the evaluation team about these activities was excellent. Obviously, these interventions have helped to build the technical capacity of the laboratories involved. However, the evaluation team does encounter some criticism and a gap in the project in terms of its effectiveness towards the overall objective. That is, that none of the three laboratories involved in this project activity are able to provide secondary solar cell calibration as a service to external clients, although it was stated in one of the planning documents that "NISE provides calibration and module testing services (e.g. secondary PV cells; SECI field lab instruments)". Two main reasons are responsible for this shortcoming, one is the lack of equipment and the other is that none of laboratories has the required accreditation. Overall the evaluation team realized a lack of strategic orientation in the labs. For example, it is unclear whether the future of the labs at IIT Bombay is seen as a purely educational or scientific institution or as a service provider. More strategic planning for all the partner labs is needed in the future.

Achievement of the indicator: 70%

Activity Area B: Conformity Assessment

Indicator: Selected conformity assessment bodies (especially the NISE) offer at least 3 new or improved quality or performance tests in accordance with international standards.

Findings: The main focus of this activity area was on enhancing the capabilities of the testing laboratories at NISE. There are three areas of testing which were worked on – PV module testing, PV inverter testing, and solar water pump testing. In the field of PV module testing, short-term experts worked together with staff at NISE to introduce two new tests and to improve one, all of them are extremely relevant and important to the PV industry. Unfortunately a tender to purchase a new solar simulator for PV modules was not successful and thus a follow-up visit by the expert from Fraunhofer had to be cancelled. In the field of PV inverter testing an expert from Germany was sent to assess and provide advice to the inverter testing lab at NISE. A round-robin test between the inverter lab at NISE and Fraunhofer IWES was added to the project later, and is currently still ongoing. In the field of solar water pump testing, an expert was sent from Fraunhofer ISE to assess the situation in India. What he found is that the capabilities and testing procedures already in place in Indian labs are ahead of those in German labs, and thus there was little or no assistance which could be provided in terms of PV water pump testing. In lieu of this, the expert gave input and advice to the development of an Indian national standard for solar water pump testing.

Achievement of the indicator: 100%

Activity Area C: Standardization

Indicator: (In cooperation with BIS), at least 3 new standards, guidelines or other normative or technical documents have been developed on quality aspects in the solar sector in accordance with international good practices and have been implemented as a pilot approach.

Findings: In the area of standardization, the most important project activity was to send a German expert on PV standardization to work with the Indian Technical Committee for PV standards. The main outcome of this activity was a prioritization of around 20 standards from the more than 100 published International Electrotechnical Commission (IEC) standards and technical specifications (and more than 70 working documents) relating to photovoltaics. On the basis of this advice, the Indian Technical Committee for PV was able to prioritize four IEC standards which are in the process of being adopted as national standards.

Achievement of the indicator: 100%

Activity Area D: Awareness Raising

Indicator: At least 2 QI institutions funded by the project (NPLI and NISE) furnish evidence of the fact that the services they provide for customers of the solar sector have increased.

Findings: This fourth activity area includes a bankability workshop lead by a short-term expert from PI Berlin. Everybody the evaluation team spoke to who attended these workshops spoke very highly of them. The other main activity in this area is the “Pilot Study on Quality Aspects of PV Power Plants in India” on the performance of selected PV systems around India.

There is a disconnect between the indicator and the awareness raising activities, as the indicator does not directly measure awareness raising. Additionally data supplied by the project team regarding increased services was not complete, the needed baseline was not conducted. This requires improvement in the follow-up project.

Achievement of the indicator: 50%

DAC-criterion effectiveness is rated “good” (2).

Impact

Throughout the various project documents seven different impacts were formulated. The design of the project, the underlying hypotheses and the methodology chosen and applied proved that the potential to achieve these impacts is considerable. Even though progress will be difficult to assess, and attribution of changes to the project activities cannot be measured concretely, plausibility can be established. For example without a doubt *the awareness of the importance of quality assurance in the sector* is an issue that a lot of the evaluation teams’ interview partners have clearly internalized. As the aim of the project is to improve those QI services required to secure the quality and reliability of the solar energy systems and thus their performance rate, the impact formulated as *contribute to sustainable energy supply* and *reduced emissions and environmental damages* will plausibly be achieved. The *limitation of an increase of greenhouse gas emissions* can be achieved through better performing PV systems. The four project components with their strong emphasis on training meant to strengthen *the recognition of the participating QI organizations as relevant stakeholders in the* *solar sector.* Unfortunately, because the service provisions initially planned – for example the provision of calibration services – could not fully be achieved, this impact falls short of its potential.

DAC-criterion impact is rated “good” (2).

Efficiency

It is hard to judge whether the use of the project resources is appropriate in terms of the ratio between cost and output and cost and outcome, due to two limitations: (i) data are only available about spending until December 2017, where less than half of the 1.8 Million Euro were recorded and (ii) due to PTB data protection policy the evaluation team can only assess a set of accumulated data. On the basis of this data the conclusion can be drawn that the mentioned ratio is appropriate. However, it also became clear that the project did not manage to spend the money within the planned time frame. There are several reasons. One is that it took almost one year until the partner signed the implementation agreement, another is that activities were delayed or could not be carried out, because the partner – due to various difficulties such as problems with purchasing the necessary equipment - was not prepared.

PTB has its own mode of delivery, which means that projects are implemented without the participation of a long-term expert. Instead, a project coordinator visits the project several times a year to supervise and orient the project’s work content and is also in charge of managerial aspects. Complementary to the project coordinator, an intermittent short-term expert accompanies the project mainly to give advice about strategic questions. In addition, a national project coordinator with a part-time job measures project progress, organizes the training and solves all questions or problems that arise. This lightweight project structure makes efficient use of financial resources.

Local logistical and financial resources from the partners, such as the provision of staff, laboratories, equipment, meeting venues, lunch during events, transport etc., were well integrated into the project and reduced costs on the PTB side.

The DAC-criterion efficiency is rated “good” (2).

Sustainability

According to the evaluation team’s assessment, and also according to interviewees, the selection of the partners was adequate, because laboratories participated in the project activities that were from the side of the government entrusted to develop the QI needed for PV. There are quite a lot positive results achieved so far, such as capacity development through training for key laboratory personnel, knowledge and know-how transfer, equipment improvements and completion etc. Whether these positive results stay within the institution and will be spread to further employees is not certain, as no dissemination strategy or hand-over to other colleagues has been developed by the institutions so far. In some institutions the newly acquired knowledge, for example, about round-robin tests for cell calibration, or about inverters were mainstreamed into the partner system, and could become part of the daily routine in the labs. But whether the partners are really interested and able to provide the services based on this newly acquired knowledge to the industry is not yet clear for all the participating laboratories. This depends on decisions taken by the MNRE about the future role of these labs, which are still pending – this was at least the message the evaluation team got, for example, from IIT-Bombay. On the other hand, some laboratories understand themselves as scientific institutions rather than as service providers to customers which makes the development of demand-driven offers difficult. These unclear situations are a clear risk for the sustainability of the positive results achieved.

The DAC-criterion sustainability is rated “satisfactory” (3).

2.2 Success factors for the observed results and change processes

Strategy

The strategic orientation of the project expressed in the four components (metrology, testing, standardization, and awareness raising) seems to be logical and coherent and the right approach to push forward quality in the PV sector in India. It addresses some of the main issues relevant for improving quality and thus contributes to better performance of PV systems. This is of major concern in India, because of the very ambitious PV targets which have been formulated. The project is not a self-contained construction, instead it broadly supplements the strategies and plans of the partners and gives them the opportunity to apply and expand their already existing knowledge. The work packages on the operational level are also logical and coherent. They were developed according to components 1 - 4 and are in line with the initial idea of the project as well as with the national policies and strategies for renewable energy. Project activities were harmonized with those of other implementing agencies, good cooperation with GIZ and KfW could be achieved. The interviewees highly appreciated PTB’s work and their excellent knowledge of quality aspects. What’s more, PTB is present in one of the working groups of the Indo-German Energy Forum (IGEF), a high-level policy forum, where PTB’s knowledge can be highly relevant for the working group, and where their presence can be used for networking with all the important players in the sector.

Cooperation

The project was the result of a two-year long orientation phase where initial activities with the relevant quality infrastructure stakeholders of the Indian solar sector were conducted. In addition to the exchange with important stakeholders that had taken place on project activities during those two years, the concrete work packages in which the activities for the four different project components were defined and discussed with the partners during the first steering committee meeting. As no stakeholder mapping was conducted at the beginning of the project, the choice of the steering committee members was based upon discussions with the main project partner NISE and MNRE. During the term of the project, new activities for these work packages have been continuously included.

Throughout the project the contact persons for the project changed frequently in several key partner institutions. This constituted a major challenge especially with respect to cooperation with the implementation partner NISE and the political partner MNRE. Furthermore, MNRE and other stakeholders did not use the opportunity to regularly take part in the steering committee meetings, which hampered strengthening relations among the stakeholders and knowledge transfer about project related activities. Some of the interview partners stated that they were not informed about the project activities and felt that there was not enough opportunity to bring in their ideas. This assumption might have been caused by the frequent changes of contact partners and limited knowledge transfer within the institutions.

Steering structure

A steering committee that includes all major stakeholders of the quality infrastructure relevant for solar energy is in place and meets regularly twice a year. Invitations with the objectives and tasks of the meeting were send to all members. During the steering committee meetings updates on the current activities and the overall operational plan were given, the project strategy was discussed and propositions for future activities could be voiced. The way decisions were made for the different working packages of the project was transparent, and agreements were made jointly. After the steering committee meetings, a report on the most important results was distributed to all members to assure broad dissemination of information. The partners had been informed about the current state of the indicators. Nevertheless there was no joint development of milestones and a common understanding on how the different intervention areas are linked to each other and are aiding to reach the objective seemed to be lacking. A more participatory approach could have strengthened the sense of ownership of the members and their commitment towards reaching the targets.

Processes

To achieve the intended changes within the partner system, the necessary core processes as well as steering and support processes have to be defined and facilitated by the project. Without designating the processes as such or formulating a process map, the appropriate technical core processes to achieve the project objective were identified and clearly defined in the form of work packages. The partners had the opportunity to influence these work packages, which they also made extensive use of. However, not all wishes could be taken into account, which led for some partners to the assessment that everything had already been tied down before they were allowed to participate. Necessary steering processes for activities were addressed by the steering committee. Although a results-based monitoring was established, its potential for strategic steering together with the partners could not be fully exploited, because the system was too complex, and the partners were not involved in the monitoring. Support processes such as the organization and implementation of training sessions and the organization of expert missions went very smoothly and were very well received. Quite a lot of interview partners mentioned this aspect without being asked directly.

Learning and innovation

Successful cooperation management has to make sure that learning capacities are strengthened on the four different levels of capacity development, the individual, the organizational, the network and the societal levels.. The main focus of the project was capacity building on the individual level. Technical knowledge was acquired by the staff of all partner organizations. Even where progress was slower, a general understanding of metrology and uncertainty of measurement was acquired that will positively impact the individual approach towards analytical tasks and research in the future. As in most technical cooperation projects, however, this strong focus on individual learning proved to have its limitations. Acquired knowledge is about to be lost due to trained personnel leaving their institutions (retirement, expired contracts). Whether the individually acquired knowledge led to structural adaptations on the organizational level is hard to judge. Some of the newly acquired knowledge on the individual level may have been mainstreamed into the organizations' structure, resulting in process innovations, but certainly not throughout all organizations. On the cooperation/ network level, the project showed mixed results. As there was no guarantee that always the same people would participate in the steering committee meetings, networking and the improvement of the relationships among the institutes was hampered. Interview partners interestingly stated that the relevance of networking, e.g. among technicians and scientists in the different laboratories, is not a strength of Indian organizations, but at least some of them are willing to overcome this unfortunate behavior. On the societal level, learning and innovation opportunities were well exploited to enhance the awareness for the quality of PV plants among groups such as banks and financiers that were not ordinarily involved in these topics on a daily basis.

3. Learning processes and learning experience

From the point of view of the evaluation team but also of some of the interview partners who have an overview of the majority of the project activities, the bankability workshop and the "Pilot Study on Quality Aspects of PV Power Plants in India" were among the most successful activities of the project. Both were carried out by Mr. Asier Ukar from the Photovoltaic Institute Berlin AG (PI-Berlin). The objective of the 2-day bankability workshop was to demonstrate to the 75 participants from 20 different banks – managers, decision makers, and a few technicians - what investment risks exist with regard to PV plants, and how these risks could affect refinancing processes. Based on the great interest expressed in this issue, a pilot study was designed to examine the performance of Indian PV plants. Six Indian PV plants were selected and inspected. The selection of the plants took environmental stress factors specific to India into consideration. Seven main topics were assessed, such as the installation and the quality of the modules, the system performance, operation and maintenance etc. Failure, risks and mitigation points that can help to increase awareness among solar project developers and financing institutions in regard to quality assurance of PV projects were identified. According to the study, the results of the survey showed that four key aspects need to be addressed: (i) strict technical requirements in regard to accurate component selection, (ii) failure free installation, (iii) commissioning aligned with international norms, and (iv) a comprehensive operation and maintenance program. Most of the investment risks are clearly linked to the poor quality of the modules and installation failures. PTB is addressing both of these aspects with its projects. The study helps to counteract and to prevent the negative effects of poor quality. More generally, it also raises the awareness among important stakeholders about quality issues. On several occasions the study was presented to the public and discussed.

These two activities were not foreseen from the beginning of the project, but in coordination with KfW PTB carried them out, as access to the PV plants to assess their quality was crucial for the study. PTB – as broker for quality – was thus able to make this possible. Also, publishing failures and insufficiencies of the plants as a challenge to the Indian environment was made possible due to PTB's impartial striving for the highest quality. So, on the one hand, the study itself is a learning process which helps the dissemination of the topic of quality in a very lively way. The study helped to take the topic of quality beyond the narrow scope of the institutions of quality infrastructure into a broader area of other interested parties. On the other hand, the project team has recognized that the study is a good opportunity to anchor quality aspects in the sector and has responded flexibly to this request.

4. Recommendations

Recommendations for the project team

One of the most relevant recommendations is to integrate into project quality assurance activities which are targeted towards the downstream end of the PV value chain (i.e. systems, monitoring), rather than just focusing on cell and module calibration and testing. The idea of supporting capacity development for mobile testing labs should be further explored in this context.

As the dissemination of traceability is crucial, practical training, peer evaluations and consultancies for laboratory assessors on the specific aspects relating to secondary cell calibration should be offered to make them available for accreditation.

Quality aspects should be brought into tendering processes for PV power plants, so far, the requirements in the tendering process are very limited and even so, they are not respected or can't be measured (e.g. performance ratio). An expert could be engaged to conduct a workshop on best practices for tendering of PV power plants – including minimum performance ratio guarantees.

As the future of some of the testing labs, in terms of whether they will provide services or not, seems not entirely clear, support with strategic development and marketing (i.e. business plans) is advised.

It is highly recommended to further broaden the participation in the project by relevant stakeholders to include additional state-owned and private labs involved in metrology and conformity assessment activities, so that in case not all selected labs stick to the project, the achievement of the objectives can nevertheless be assured, and sustainability can be enhanced and secured.

In the future project, the idea of a network should also be reflected in its structure. Thus, a multiple-partner structure would be the preferred choice. Partners should be motivated, oriented toward and supported in pursuing a systemic approach. This means that representatives of the entire value chain, thus not only the classical partners of QI, such as metrology, accreditation, testing laboratories, standardization and regulation, but also the producers, importers, developers and the consumer protection, etc. should be involved in the project and its activities. The aim is to raise awareness of the demand for quality in all of the different aspects involved. Stakeholder forums where all the stakeholders mentioned above should be invited could be one format that provides opportunity for exchange on the relevant quality control procedure in the respective sector.

To improve project monitoring, a better understanding of what the indicators really imply and what data thus has to be collected is needed. For example the indicator that reads as follows: "At least 2 QI institutions furnish evidence of the fact that the services they provide for customers of the solar sector have increased" implies a baseline and serious counting of the increase of the service.

The evaluation team additionally recommends that a more participatory approach should be taken in future steering events. This approach should involve group work, including moderation with cards, etc.

<u>Recommendations for the partner</u>

Communication, networking and exchange among laboratories to learn about the details of measurement and testing should be strengthened to improve knowledge transfer among the labs and to come to future agreements on division of labor in the PV sector.

This could perhaps be carried out by the relevant laboratory personnel accompanying the solar cells to the various labs involved in the round-robin tests of solar cells during the learning phase. In this way they can participate in, and discuss details of the tests with their counterparts. This would also improve networking between the institutes.

The evaluation team would recommend the continuation of the round-robin tests between the labs. This can continue between the Indian labs on their own, without the support of the Fraunhofer Institute. This could strengthen the networking efforts and the sustainability.

<u>Recommendations for the PTB department of international cooperation</u>

The procedure of conducting the evaluation at the same time as the mission, from which the module proposal will then emerge, should be reconsidered. As the short brief statement has already been finalised, when the evaluation is carried out, and BMZ has already taken a decision for one of the provided options, the chance of responding to the recommendations from the evaluation in the project proposal is limited. On the other hand, this means that the evaluation has to be carried out quite early when project results may not have been achieved in their entirety, which is also not ideal.

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evaluierung-9.3@ptb.de
www.evaluierung.ptb.de