Energising Development Indonesia
(EnDev Indonesia)

# Executive Overview

# Indonesia Solar Mini-grid Programme (PVVP/PLTS Terpusat)

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Compiled by:
Robert Schultz, Amalia Suryani and Atiek Fadhilah Puspa

kerja sama jerman
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ENERGI DAN SUMBER DAYA MINERAL

# EXECUTIVE OVERVIEW

## Indonesia Solar Mini-grid Programme (PVVP/PLTS Terpusat)

## 1 Introduction

In 2012 the Directorate General for New and Renewable Energy and Energy Conservation (EBTKE) launched an ambitious rural electrification programme: the annual electrification of over 100 rural communities across Indonesia using 15kW to 150kW solar mini-grid systems (PLTS Terpusat). GIZ EnDev uses the terminology "photovoltaic village power" (**PVVP**).

This Executive Overview describes the key experiences made by EBTKE and GIZ in rolling-out the national PVVP Programme in the years inspection years 2013 and 2014 and takes a closer look at:



The PVVP Programme is a collaboration between EBTKE and GIZ. EBTKE annually installs more than 100 PVVPs, through local contractors, while GIZ conducts the technical inspections and community preparations. This two-year partnership has yielded some strikingly positive results. Not only has it lead to the development of an effective quality improvement instrument, but also strengthened one of the world's largest rural electrification programmes using renewable energy-based mini-grid systems.

**EBTKE's rural electrification programme commissions over 100 PVVP installations annually.**

# 2 Background

EBTKE's rural electrification programme using PVVP systems was launched in 2012 with an annual budget of over €20million. Tenders and contracting was done in the budget years 2012 and 2013, while GIZ EnDev inspections of PVVP installations were done in the years 2013 and 2014 respectively. Therefore these inspections and findings are referred to *PVVP2013* and *PVVP2014* in this Executive Overview report.

**A PVVP installation comprises solar PV modules, a power house for batteries and electronic equipment and a distribution network of cables, connecting all houses.**

EBTKE, as implementing agency, was only established in mid-2010, after a ministerial restructuring process. Within less than 2 years, this directorate put all its internal structures in place and launched a €20-25million per annum rural electrification roll-out programme. Within the context of international rural electrification ambitions this is a remarkable and determined commitment in both speed and resources shown by the Indonesian government.

EBTKE's programme was not cozily restricted to a few confined and manageable regions, but encompassed 28 provinces and 87 districts in 2013 and 25 provinces and 83 districts in 2014. In an archipelago of 6,000 inhabited islands, characterized by dense jungles, extremely mountainous terrain and only poor and sporadic access to transport and communication infrastructure, the logistical challenge alone is daunting. Nonetheless, by mid 2014 EBTKE managed to deploy 236 PVVP installations, providing electricity to over 21,000 rural households and over 900 social institutions.

**PVVPs are typically installed in remote, poorly accessible communities.**

GIZ has been active in Indonesia's renewable energy sector (primarily micro hydro power) since the 1990s. The current support initiative, GIZ EnDev Indonesia, was launched in 2009, but until 2012 focused exclusively on micro-hydro power (MHP) support to Ministry of Home Affairs' rural development fund (Green PNPM). The newly-established EBTKE, as national custodian for rural electrification and renewable energy, summoned GIZ EnDev in mid-2012 to jointly discuss how the ambitious PVVP Programme can be strengthened.

EBTKE was keenly aware of the key challenges and thus their briefing of GIZ EnDev was straightforward:

**Design and implement a support initiative that can objectively inspect the technical quality of the PVVP installations, build necessary operational skills in the community and provide concise feed-back to EBTKE before the contractor warranty period expires**.

In fine print this implied: The inspection results must stand up to the scrutiny of any contractor feeling unjustly appraised, all inspection information must be handled in the strictest confidentiality, the inspection must include capacity development of the community and the establishment of monitoring support, and there will be no extension of the dead line.

# 3 Key Experiences and Lessons Learned

With two years of jointly collaborating in the roll-out of Indonesia's rural electrification PVVP Programme, EBTKE and GIZ EnDev can look back on several achievements and valuable experiences. This Executive Overview considers major experiences only, while it is of course understood that innumerable smaller lessons learnt abound. Also not all outcomes were planned for, nor expected, and it is therefore appropriate to take stock and reflect on lesson learnt.

GIZ EnDev submits Executive Reports on the findings of the technical evaluations, in order to record lessons learnt and make recommendations for improvements.


**Confidential final reports on the technical performance of PVVP installations and contractors to EBTKE.**

## 3.1 GIZ Mini-grid Service Package (MSP)

It should be emphasized that the experiences and lessons described in this Executive Overview would not have been available in such a detailed and concise form, if it were not for the GIZ EnDev-developed "mini-grid service package" (MSP). The MSP was GIZ EnDev's answer to the challenge posed by EBTKE. It was the direct response to EBTKE's request for active involvement and support. The MSP proved to be an exceptionally robust, cost-effective and time-efficient instrument, with great potential for replication nationally and internationally.

Initially, in defining and structuring its support, GIZ EnDev considered a number of criteria:

- Specialist solar PV engineering expertise is costly and scarce, thus field inspections should be done by technicians familiar with rural electricity installations. In fact technicians are preferred because of their familiarity with working under difficult conditions, their better understanding of language and cultural aspects, and a more holistic understanding of a rural installation.
- Distances and access are a major logistical concern and thus the inspection teams must be as small as possible, and all inspection and training equipment easily portable to ensure unencumbered mobility. In addition, time spent at site cannot exceed two (2) full days, in order to remain both cost-effective and on schedule.
- A standard inspection template, as quantitative as possible, with verifiable evidence and strict inspection regime, must be devised to avoid variations and accidental bias. A re-visit of remote installations because of inadequate data capture or corrupted data is not possible, and conflict with contractors based on unjust criticism avoided entirely.

- The inspections must equally consider all technical and construction aspects of a mini-grid installation, from electrical to civil construction. Thus the inspection must be technically holistic, with emphasis on safety aspects.

GIZ EnDev devised a series of concise technical checklists, built community training and facilitation skills, trained photography skills for evidence capture, devised a socio-economic questionnaire for baseline data on each community, and developed data analysis and reporting systems. The various instruments were designed to intertwine and complement each other and are collectively referred to as the "mini-grid service package" (MSP). **Annex A** provides an overview of the different instruments consolidated under the MSP.

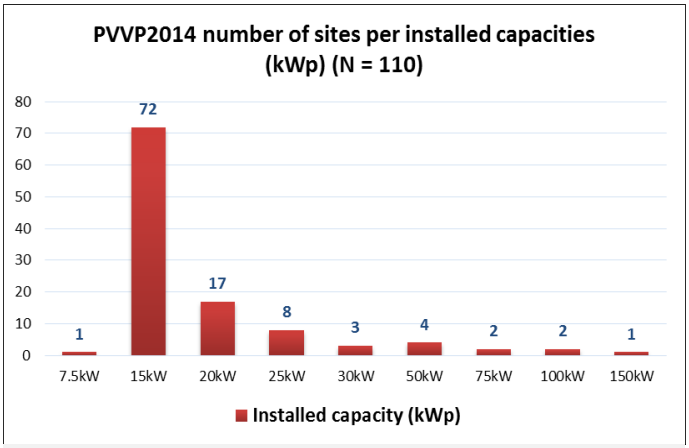
**Guided, group-based evaluation of the data obtained from the field is a key element to rapid evaluation and evaluation quality assurance in the MSP.**

GIZ EnDev first deployed the MSP for 112 PVVP installations in March 2013. Field inspections by eight 2-person teams were concluded within 4 months after an estimated 80,000 km travelled across Indonesia using all modes of transport. Detailed individualized performance feed-back, with evidence, and recommendations for each PVVP installation were submitted, via EBTKE, to contractors by the deadline end September 2013, with all final evaluations submitted to EBTKE in October 2013.

With similar human resources, the same stringent schedule was adhered to for further 110 PVVP installations in 2014, and the original MSP checklists proved robust and versatile enough to only require minor adjustments. This allows for a direct comparison between two successive years of EBTKE's PVVP Programme.

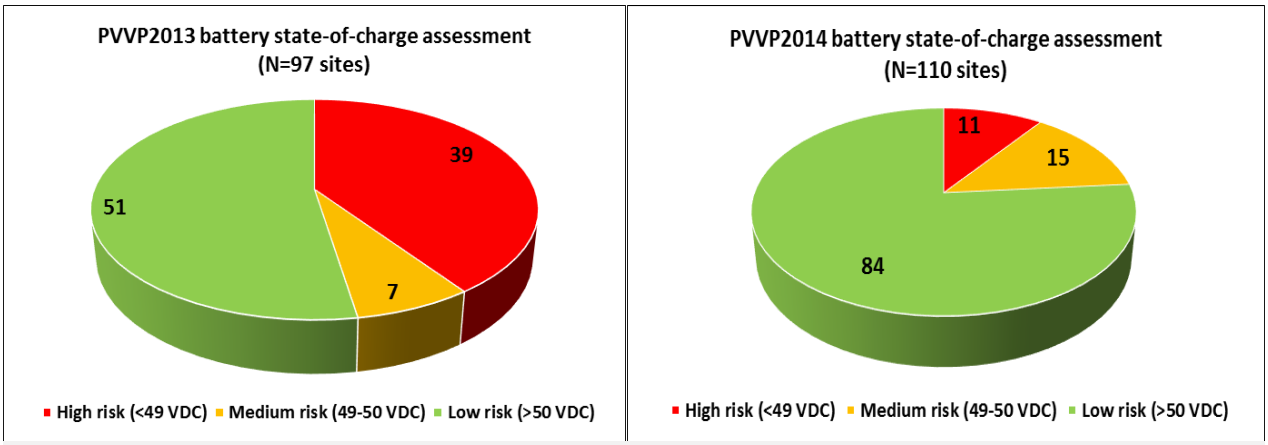
## 3.2 Turn-key PVVP specifications

EBTKE opted for a turn-key approach and standardized the installation specifications and performances. This improves tender procedural efficiencies and is sensible for a roll-out type programme of this magnitude. Specialist engineering inputs for system design can be kept to a minimum, since each tender document does not require a detailed engineering drawing (DED) or Bill of Quantities (BoQ). Although the EBTKE tender document does not include a detailed DED or BoQ, these documents are submitted by the bidding contractors, forming part of their costing proposal and leading to a clear evaluation process by EBTKE. The risk of course is whether a standard-size system is robust enough to cater for the on-site reality. In other words: Can one size fit all? In *PVVP2013* all 117 PVVP systems had a 15kWp capacity, regardless of number of households connected. In *PVVP2014* the PVVP systems were no longer as




**In PVVP2014 installed capacities were more varied, catering better for larger communities.**

standardized and more aligned to village size. This contributed toward a better balance between generation (supply) and load (demand), which can be observed from the battery state-of-charge recordings.

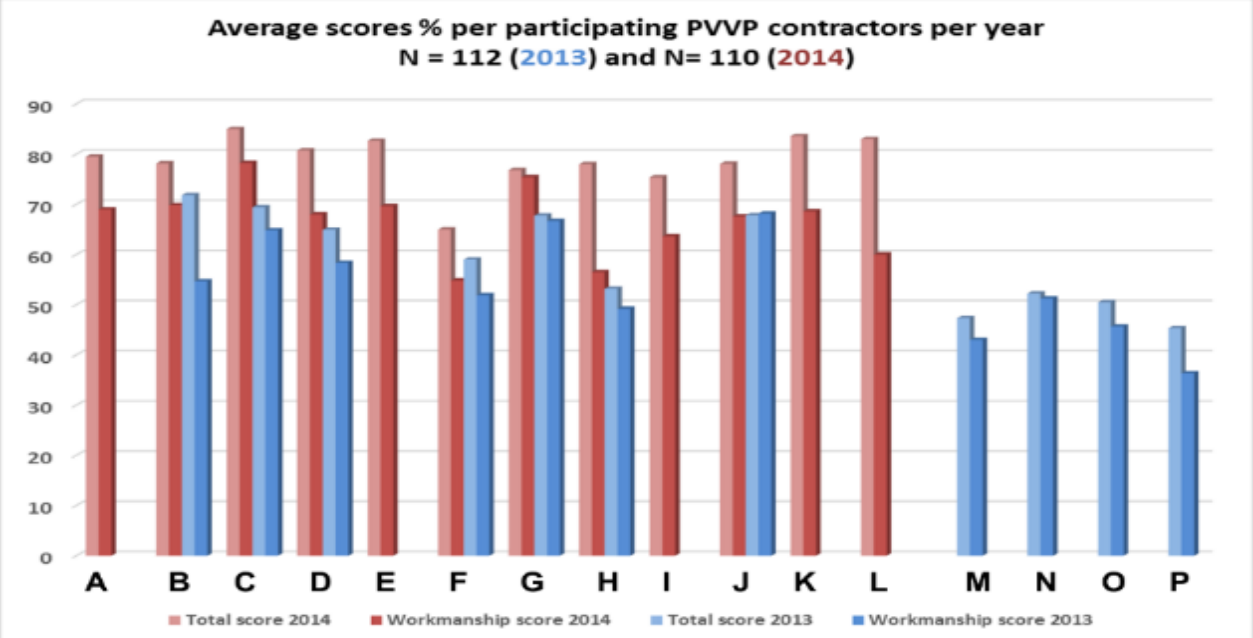



**PVVP battery bank state of charge (VoltDC) has improved, leading to better life expectancy of the batteries.**

## 3.3 Contractor accountability

EBTKE has a limited number of technical personnel. While they are proficient in drafting turn-key tender proposals, and ensure transparent tender selection, the small team is not able to inspect each of the PVVP installations as per their technical performance. How can quality supply and installation from contractors be ensured, if the sites cannot be technically reviewed? Particularly, if there is only a 6-month window of opportunity between commissioning and end of the contractor warrant period? What prevents contractors from making compromises on the contract obligations and installation quality?

The conceptualization of the MSP was at the heart of resolving this risk. With 2-persons inspection teams, suitable trained and equipped, spending two full days at each PVVP site, over 90% of PVVP installations could be reviewed within 3 months (both in 2013 and 2014). Over 2,000 pages of checklists were completed




**PVVP contractor level of quality improved substantially within only 1 year, due to the EBTKE's feed-back.**

and about 100,000 photographs taken each year. In a strenuous group effort, the evidence from the field was evaluated, summarized and submitted to the contractors. This targeted feed-back, coupled with accountability to EBTKE, was hesitantly accepted by the contractors initially.

In December 2013, EBTKE invited all contractors to a conference to share the 2013 results. Care was taken to anonymize the data, in order to avoid contractors reacting negatively to exposure, but given Indonesia's small solar sector, there was nonetheless a high degree of recognition of which contractors performed well (and which poorly). The resulting subtle peer pressures were too much for some contractors, and indeed the poorest performing contractors in 2013 opted not to bid for the next EBTKE tenders (PVVP2014). Contractors who remained active, improved their performance, while new contractors in turn were already aware that EBTKE will not blindly accept installation quality and that an inspection will be done.

The open, yet discreet, presentation of the PVVP inspection results since 2013, at several occasions has markedly facilitated discussion and exchange of thoughts amongst stakeholders.



**EBTKE's PVVP events demonstrated how targeted, transparent feed-back is a major stimulus to change.**

## 3.4 Site accessibility and conditions

Indonesia has only a tiny solar industry, relative to the economy and size of population. Will these contractors be willing to accept the risk of bidding for a supply and installation tender for remote sites which they were unable to visit prior to tendering? How will an estimated 15 tons of equipment for a typical 15kWp installation be transported to a poorly accessible site? Any forgotten materials or equipment cannot be easily procured from any nearby source, and thus the materials list would need to be comprehensively checked and re-checked before shipment. It is indeed admirable, that Indonesian contractors accepted the uncertainties and managed to install relatively complex technology under severe logistical constraints. Through the MSP an appreciation of the remoteness of sites could be gained and photographically documented.

**Remote islands, reachable only by small motorised boats for transportation, are included in the PVVP Programme.**

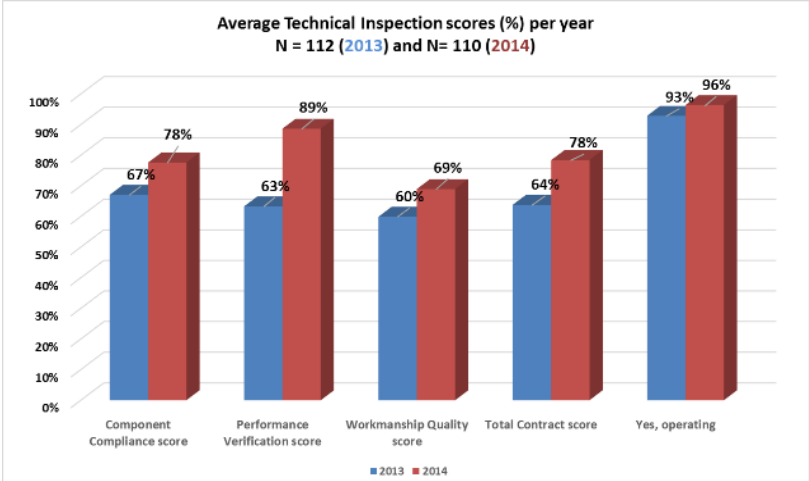
What is of concern though, is that the exact installation site is not determined by the contractor. A village would typically select a site that is barren and of no community use. Several PVVP sites inspected in both 2013 and 2014 are located in flood zones or on erosion-exposed slopes. In 2013, contractors simply installed the PVVP system as planned, and the resulting feed-back sessions clearly showed how vulnerable the installations are. As a consequence, the contractors in 2014 took active counter-measures, such as placing entire installations on stilts or raised platforms. According to contractor feed-back this was seldom anticipated and also not budgeted for in the tender bid.

**Several PVVP installations are placed in unsuitable sites, which increases risks to technology performance and operator safety.**

It thus appears, that the majority of Indonesian contractors are willing to accept the unknown logistical risks associated with the EBTKE tender, while also acting beyond contract requirements to ensure that the installations are not damaged by adverse site conditions. This is commendable.

## 3.5 PVVP quality and performance improvement

Without exception, the compliance, performance and quality of all technical aspects of the *PVVP2014* installations showed significant improvement. While minor refinement of the tender technical specifications can account for a small proportion of these improvements, the single most dominating change agent was greater contractor accountability. A dual approach is the foundation of this success: on the one hand feed-back provided by EBTKE to the contractors, placed pressure on contractors to comply or face consequences; on the other hand, the sharing of the MSP checklists with the contractors, provided guidance on how technical quality can be easily improved. Certainly there are still examples of poor workmanship, technical inexperience and lack of consistency, but these are becoming increasingly isolated.




**EBTKE's PVVP installations, as reviewed using the GIZ MSP instruments, improved on all levels within only one year.**

## 3.6 Number of connected households

EBTKE's PVVP Programme over two years has connected a total of about 21,500 households to an off-grid electricity mini grid. However, the planned connections for these two years was 27,700 households. This over 20% shortfall is primarily due to incorrect information received by EBTKE. Generally there were fewer households in the beneficiary communities than initially reported. This emphasizes the need for a more accurate pre-tender site evaluation, preferably conducted by the provincial government or local authority. Such an evaluation would determine the exact number of required electrical connections (households and social institutions) and can also determine exact installation location (see *3.4 Site accessibility and conditions*).

**Household installation are still inadequate, often without weather protection, cable conduits and grounding.**

Far more seriously though is the fact that household installations are still poorly installed. The low safety standards at household-level are in stark contrast to the good quality workmanship often found at the PVVP installation.

## 3.7 Remote monitoring

EBTKE included the supply and installation of remote monitoring systems and irradiation recording (introduced in 2014) into its technical tender specifications. This is a very pro-active step towards being able to monitor the energy performance of the sites. However, 45% of the 222 sites inspected do not have access to a mobile GSM network nor is there as yet an operational centralized monitoring centre at EBTKE. This means the intention of remote diagnostics is not yet satisfied. Furthermore, the data reliability from the various monitoring devices attached to different inverter types is very poor. During *PVVP2013*, no reliable data could be obtained from the field, while in *PVVP2014* reliable data for only 10% of sites could be extracted.

**Monitoring hardware (computers) are generally installed, but incorrect configurations provide unreliable data.**

Aware of the need to support rural communities with remote troubleshooting guidance, GIZ EnDev established a Short Message Service (SMS)-platform to act as a hotline for rural operators. Launched under the name BREIDGE in early 2013, this SMS service has now reached maturity and is referred to as Energi Desa. Energi Desa is now implemented in close cooperation with an agriculture-support organization. Over 1,000 SMS have been processed to date and for most communities this is the only means of obtaining technical advice and troubleshooting guidance on their PVVP system.

## 3.8 Community preparation

Day-to-day operation of the PVVP system is the responsibility of the community, but the installation assets are handed over to the provincial governments, to support development programmes in their province. This asset transfer from EBTKE to provincial government is a lengthy process and for a long period of time the community does not have the necessary support should key technical components fail. Given the prevailing low skill levels (relevant to electricity generation using photo-voltaic technology) in rural communities, how can the community best be capacitated to rise to the operational and managerial challenges of their own electricity generation?

The MSP integrates training of a village management team (VMT), which generally comprises a chairperson, secretary, treasurer and operator. The VMT has accepted the responsibility of technical operation, sanctions if connections are tampered with, and to collect revenue for remunerating the VMT members. The latter is a critical aspect, since it ensures that the VMT remains active. EBTKE views the collection of a basic electricity tariff with doubt, since it raises issues around fairness towards the community, generating income from government resources, and undermining the objective that this is a "free" social investment.

Since an active VMT is essential to maintaining the PVVP installation, a formalized recognition of the VMT should be considered. Establishment of energy cooperatives, or long-term operating and service agreements with contractors, or incentivizing the privatization of rural electrification or a provincial government-administered maintenance fund, are some models worth investigating further.



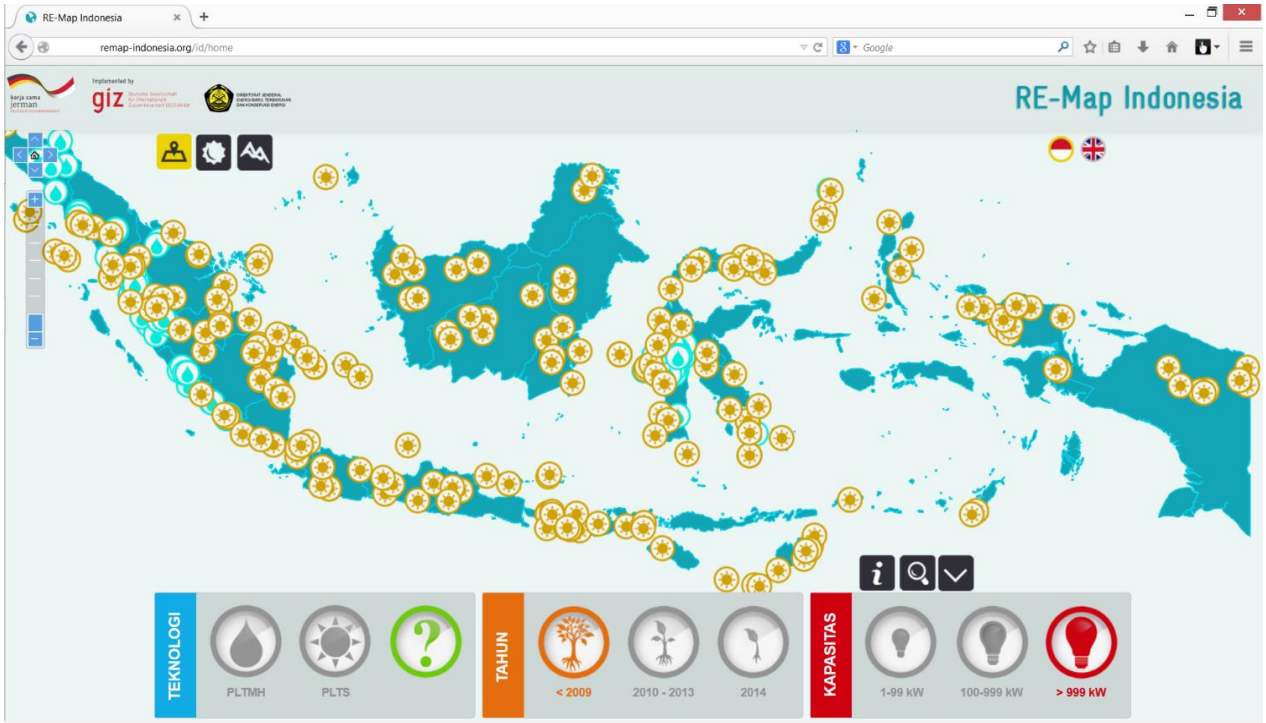
**GIZ EnDev has comprehensive materials and mechanisms to ensure participatory community preparation.**

# 4 Conclusions

This Executive Overview crystalizes the most important lessons learnt over the last two and half years of EBTKE's PVVP Programme, through which over 100,000 rural people have benefitted with access to electricity. GIZ EnDev, being privileged to accompany EBTKE on this development path, can summarise some key conclusions as follows:

- EBTKE has found effective ways of streamlining its PVVP technical specifications and no major adjustments are required. From a technical perspective there is little need for improvement. Fine tuning is however required in terms of final commissioning procedures, which should include contractors completing the MSP checklists, taking photographs and extracting monitoring data, and submitting all to EBTKE for final evaluation.
- EBTKE's feed-back mechanism to contractors, via GIZ EnDev's MSP instrument, is bold and very effective at improving PVVP performance and quality. This transparency is far more conducive towards immediate advances for PVVP sustainability, than general standards or training programmes (although these might be useful long-term measures).

- Community preparation is currently undertaken by GIZ EnDev, but this is only a once-off measure (Contractors are required to conduct training for the PVVP operator, but this training is strictly technical and does not consider any managerial or administrative aspects). Far more efforts are required to mainstream community preparation and long-term support. As this should not be EBTKE's core activity, suitable partners must be solicited. This may include other government ministries, but most notably should involve provincial governments, as they are far more accessible to the community.
- Indonesia's solar energy contractors are a vital partner in EBTKE's rural electrification effort, and several of them have proven their commitment to technical quality by accepting significant risks and undertaking voluntary and costly on-site improvements. Measures to reinforce this public-private relationship can be strengthened, for instance by providing more site-specific information in tender documents, and making the contractors responsible for long-term PVVP operation and performance.
- It is not easy for a VMT to access technical support or purchase spare parts, with contractors concentrated in only a few urban areas. As the market for solar energy technologies in Indonesia increases, contractors will see merit in establishing rural agents. This process should be expedited though, by providing contractors with incentives. A concession area-based maintenance contract, possibly coupled with an energy-related payment per delivered kWh, is one model to consider.
- EBTKE's PVVP Programme's ultimate success rests with how the good performance of the PVVP installations is ensured. The first step towards this is to maintain and share exact data on locations. For this purpose, EBTKE is establishing an Information Clearing House on renewable energy in Indonesia. GIZ EnDev has thus provided EBTKE with a geo-location database with graphic platform, called RE-Map. Over time, this database should accommodate all renewable energy installations in Indonesia as a prerequisite for informed decision-making.




**RE-Map Indonesia (http://remap-indonesia.org/en/home) currently lists 222 PVVP sites and 295 micro-hydro power (MHP) sites with a total installed capacity of 9.4MW. These are all off-grid sites.**

# 5 Annex A: Overview of MSP instruments

| Mini-grid Service Package (MSP) instruments | |
|---|---|
| **Data capture** | |
|  | **Component compliance check**: after prior contract reviews, all electrical, electronic, mechanical and civil components installed, are verified with required contract specifications |
|  | **Performance verification**: through targeted spot measurements over a 2-day period, the key technical performance parameters are measured and recorded. Installation defects, leading to system underperformance and eventual failure can be detected. Furthermore records from installed monitoring data loggers are extracted. |
|  | **Workmanship quality**: a visual inspection of the entire system's workmanship quality. Regardless of component quality, workmanship quality ultimately influences long-term system performance to deliver reliable electricity. |
|  | **Photographs**: each site inspection comprises the collection of about 1,000 high quality photographs, including macro views, area overviews, community interactions and scenery. These are not only referred to as evidence for the technical assessment, but also provide geographic and cultural context (e.g. site accessibility, community scenes). |
|  | **Baseline survey**: rural electrification is beyond simply installing technology. Understanding the current socio, economic and environmental conditions in the village is invaluable for assessing the impact of electrification. For this reason a baseline survey is conducted for future comparisons and analyses. |
| **Training** | |
|  | **Inspector training:** 5-day training on methodology on completing checklists, photography skills, basics on community interactions and complete training programme on how to train Village Management Teams (VMT). Training available manuals: *Village Management Team Training Manual (GIZ, 2014)*, *PVVP Inspection Guide (GIZ, 2013)* |
|  | **VMT training**: a Village Management Team, elected by the community, receives hands-on training on technical, managerial and financial aspects, along with necessary materials and tools. A comprehensive training manual has been compiled and includes important issues like productive use of energy, financial record-keeping and transparent decision-making. |
| **Documentation** | |
|  | **Technical Site Summary**: technical expert team evaluates all data and photographs collected from the field. Technical findings are summarised, with recommendations, scorings and photographic evidence. Summaries are submitted to respective contractors to address technical problems. |

**Executive Report**: a *Final Executive Report on Technical Review of PVVP* is submitted as concluding deliverable. This report presents the status and progress of the electrification programme, vis-à-vis its technical standing, overall performance of each contractors and good and bad examples.

**This MSP element concludes with anonymized collective feed-back at conferences with contractors.**

**Database**: a wealth of data is collected from the field. Technical evaluation scorings and baseline data are collected Excel®-format files for export into other databases or for further analysis. Site geo-location data is added to an on-line geographic information platform (http://remap-indonesia.org/en/home).

EnDev Indonesia is a proud project under

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giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Energising Development (EnDev) Indonesia
Jl. Tebet Barat VIII No. 52
Jakarta 12810 – Indonesia
T +62 21 830 9438
F +62 21 830 9032
I www.giz.de; www.endev-indonesia.org

NL Agency
Ministry of Foreign Affairs