



EnDev Indonesia

Report

The First International Mini-grid Practitioners Workshop

Makassar, 26 - 29 August 2019



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EnDev Indonesia

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The First International Mini-grid

Practitioners Workshop

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Imprint

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Executive Summary

Over the past 10 years, Indonesia has succeeded in establishing more than 1,000 renewable energy (RE) mini-grids from micro-hydro power and solar PV-battery hybrid systems. Rolling out mini-grids at a speed of 100 to 200 grids per year, by today, more than 100,000 households and 3,000 businesses have access to clean and affordable electricity. To share this rich experience with other countries and identify opportunities for further cooperation, an International PV Mini-grid Practitioners Workshop was held in Makassar, Indonesia, 26-29 August 2019. In the spirit of Asia-Africa Conference in 1955, the workshop provided an excellent opportunity to facilitate triangular cooperation among Indonesia, other Asian and African countries and the countries of the EnDev Partnership for sharing insights on RE mini-grids. The workshop hosted 49 participants from 7 countries namely from South Africa, Kenya, Ethiopia, Nepal, Myanmar, Germany and Indonesia. In total there were 25 different presentations, representing 8 different topics from planning to sustainability of mini-grids.

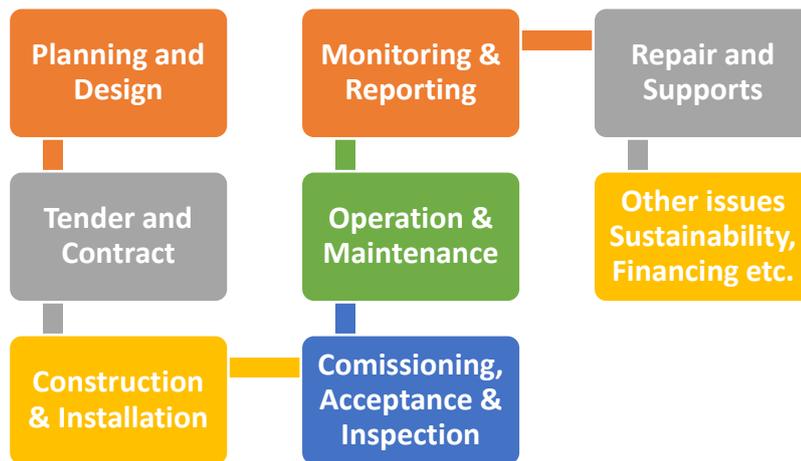
The objectives of this workshop were:

1. Catalysing knowledge exchange among renewable mini-grid practitioners, especially for GIZ advisors and counterparts, fostering South-South-North Cooperation
2. Generating new and applicable ideas to improve sustainability of PV mini-grids.
3. Foster stronger south-south cooperation across GIZ mini-grid practitioners to improve the sustainability of mini-grids
4. Agreeing on next steps to establish a platform for knowledge exchange.

Starting with the identification of key factors affecting sustainability of mini-grids, the participants identified three issues that commonly hinder or improve sustainability of a mini-grid. Those common issues are existing in different stages of mini-grid development.

- Capacity building (competence issues) – Lack of local capacities in conducting various processes in mini-grid development. This includes financing institutions, consultant, developers, government officials, communities etc. for different kind of topics. Without adequate competence, sustainability of mini-grids will likely to be lower due to sub-par work quality.
- Standardized approach or tools – There is strong need to have different standardized approaches for different phases of mini-grid development, for example for contracting, planning approach, implementing, commissioning. Standardized approaches or tools may help improve sustainability of mini-grids by ensuring standard approaches are implemented, hereby maintaining high quality of work.
- Collaboration or coordination – In different phases of mini-grid development, coordination and collaboration from different stakeholders is needed. Collaboration means different stakeholders can best function in their roles and contribute to better mini-grid sustainability.

Each of these topics were then included in the following discussions along the segments along the mini-grids value chain: planning, tendering, contracting, installation/implementation, commissioning, operation, maintenance and other sustainability aspects.



Following a series of presentations from 5 countries for the segment “**planning, design, tender and contracting**” some important conclusions emerged from the discussion with the audience:

- The existence of a clear electrification plan from the government is crucial to allow for RE mini-grids planning in any country. Clear directions from the government are needed so that mini-grid projects can be planned accordingly, e.g. through the preparation of the grid connection of mini-grids.
- Skilled labour and appropriate competences in planning/design/tender/contracting are required in order to develop accurate feasibility studies.
- Mini-grid performance indicators are required to be included in the contract of mini-grid development. This requirement will need accurate planning, and shows the importance of data, e.g. for solar irradiation.
- Close collaboration and coordination in planning with different stakeholders, especially with the target group community, will allow the different stakeholders to play their specific role in relation to the mini-grid project and to maximally contribute to the sustainability of a mini-grid project.
- For tendering purposes, the technology standard should be chosen carefully. Applying too high standards means increasing the cost of implementation and reducing the efficiency of the project.
- It is strongly suggested to include the O&M contract already in the planning, to allow – in particular – for budgeting purposes for O&M. Technical support is usually required especially in remote areas where the competence of local operators might not even be sufficient to conduct minor repairs.
- The quality infrastructure (or system for quality assurance), for example in the form of a certification body, testing labs etc., is an important system to be considered. This quality assurance system will protect the quality of installation, if done properly. This system may include capacity development component.

During the segment “**construction, installation, commissioning, acceptance and inspection**, country presentations from 5 countries provided insights into the challenges and solutions for aspects related to construction until inspection. A range of conclusions can be drawn from the discussions:

- Straightforward and concise development procedures and regulations should be applied to keep implementation costs down and avoid lengthy development processes.

- Generally, the quality and accuracy of planning determines the quality of the implementation. This statement strongly supports the finding in the planning session, i.e. the need for accurate planning.
- Performance guarantees can be included in the construction contract and can then be checked during the commissioning process.
- Examples of good and bad PV mini-grids implementation are available to be shared. There are lessons learnt from different GIZ projects around the world which can be shared as global lessons learnt.
- Project financing models vary across countries, but a range of practical examples are already available, e.g. government funded project from Indonesia and RBF (Result Based Financing) financing model from Kenya.
- It is further crucial to have a valid certification process for skilled labour working on the implementation of mini-grid projects in place. This statement strongly supports the capacity building need in different stages of mini-grid.

With regards to the segment “**operation, maintenance, reporting and monitoring**”, representatives from 4 countries shared insights from their national perspectives. The discussions led to the following conclusions:

- Battery replacement will eventually come up during operation stage (possible after 6 to 10 years of operation). For better operation planning (especially financial), PV battery system replacement must be considered early on during planning phase. In a broader point of view, the infrastructure for battery recycling, battery collection, roles and responsibilities and other safety precautions must be considered and prepared. This one strongly related to clarity of electrification plan from the government especially if the area will not be served by main grid soon.
- The realization of an operation & maintenance (O&M) contract is crucial especially for areas where mini-grid operators have less than adequate competence to make minor repairs. This concept may help remote locations with limited operator competence to get proper support, thus increasing the sustainability of mini-grid.
- The formation of a cooperative can be a successful mini-grid management model. However, there are certain aspects to be carefully considered: there must be strong capacity building actions to the management committees; there must be an economical anchor load that can cross subsidize the mini-grid operation; O&M service provider should be employed to provide technical supports to the cooperative.
- There are ready to use monitoring tools and platforms such as the universal remote monitoring system of EnDev Indonesia, an off-the-shelf monitoring tool used by a Nepal GIZ energy project and KOBO tool box for survey (<https://www.kobotoolbox.org/>).
- Mobilizing local champions for monitoring may increase the rate of successful monitoring efforts to mini-grids performance as they have more easiness in communication with the local people.
- Key findings from O&M monitoring in Nepal demonstrate that inaccurate planning leads to low quality project implementation. The other key finding is lack of managerial capacity to handle mini-grid operation. These findings are concurrent with the overall findings that there should be strong capacity building actions for different actors at different stages of mini-grid development.

As final segment of the mini-grids value chain, “**sustainability and other topics**” were explored in more depth by the participants. Country presentations from 5 countries supported a vivid discussion among

the audience, which led to the following session conclusions to make the overall mini-grid profitable, its management should be formed as an enterprise which includes anchor load (or productive end use) as one of its businesses. It is crucial to have other businesses, such as for the productive use of energy, that are related to the energy business e.g. and that can provide cross subsidies for the financing of the O&M of the mini-grid.

- Proper and accurate planning is a prerequisite for mini-grid sustainability. This planning is not just covering technical aspects but also social aspects.
- The setting of a tariff can be a decisive aspect for mini-grid sustainability. the tariff must be able to cover O&M costs, i.e. be cost reflective. There should be options for tariff payments i.e. not just in monetary form but also in kind, through payment by goods, products or services.
- Smart meters can have two functions as protection system for the mini-grid from over-use and as tool to improve the tariff payment rate.
- Women empowerment and productive use of energy (PUE) business models are strongly related and they form crucial aspects for the mini-grid sustainability. PUE will empower women, therefore proper planning and capacity development should be applied to foster these empowering potentials of PUE. As a result, PUE is a determining factor for long term sustainability of mini-grid.
- Demand side management (DSM) can be an option to prolong the operation of mini-grids, thus increasing the sustainability of a system. DSM can use different solutions and there are ready made solutions available in the market.
- A mini-grid must be prepared early on for the interconnection with the main grid. When the main grid arrives, mini-grid must not stop operating but should rather be interconnected with the main grid for longer period and provide sustainable income to the community or to the grid management.

Reviewing the discussions of the various segments, participants agreed on three critical areas that can be commonly identified as the key takeaways across the various segments:

- Proper planning is key and an absolute must to develop a successfully sustainable mini-grid project. The planning aspect emerged in almost all discussions from planning to sustainability. It highlights the importance of accurate, detailed planning of a mini-grid, stretching from technical aspects to social aspects such as productive use of energy and women empowerment.
- Capacity building at the various steps along the value chain of mini-grid development is strongly needed, adapted to the different target groups.
- The linkage to the planning aspect is clear, as without competent people, no proper planning can be applied.
- Adding to the first two points, the importance of collaboration in planning, project implementation, operation & maintenance and monitoring & evaluation is crucial. Only with close cooperation across all stakeholder groups can a RE mini-grid project become sustainable.

At the end of workshop, the participants agreed on some priority topics to be included in further workshops and through South-South-North cooperation approaches:

- **Tariff:** Cost reflective tariff setting, calculation approach, tariff calculation tools, etc.
- **Accurate demand assessment and community sensitization process in the mini-grid planning:** Consider social preparation and inclusion of mini-grid development.
- **Mini-grid market development and business models:** Which includes financing of mini-grids, ownership models, and mini-grid management models.

- **Income generating activities or anchor load:** including a discussion about how to develop income generating activities, how to integrate this approach with mini-grid management, etc.

Participants agreed that the discussions should continue in an open fashion, open to not only participants of the workshop, but also wider stakeholder groups from different parts of the world. This Stakeholder exchange forum under the global EnDev **RE Mini-Grids Knowledge Hub** is expected to be global and engage with other networks. It will be driven by EnDev global and supported by the Energy Programme Indonesia. Participants also agreed that there the RE Mini-grids Knowledge Hub should further facilitate knowledge sharing (e.g. the various tools presented at the workshop), and possibly develop a library of practical products. The format of this exchange could be in various forms, either through webinars, expert exchange, or online platforms.

Participants further agreed that there should be another similar workshop in 2020, most probably it will be held in Africa.

The workshop has revealed that there are lots of potentials for cooperation between projects within GIZ framework. It also showed that south-south-north triangular cooperation is possible and can be the future of cooperation. There are lots of experiences from different GIZ projects and those are very useful for other projects.

1. Background and Objective

1.1. Background



Figure 1 Participants of PV Mini-grid Practitioners Workshop.

Renewable mini-grids thrive to gain momentum to become the energy solutions in areas where access to modern energy is lacking, enabling industry in isolated area, and providing back-up to the main grid when it fails. It offers higher levels of service that can foster productive use of energy applications compare to basic lighting from solar home systems. In the meantime, when main grid arrives, mini-grids can connect to main grid which in turn can improve it to be more resilient. Renewable mini-grid technology has been improving in its reliability, provision of alternatives for local control of energy used, cost efficiency, while reducing environmental impact.

Growing market of renewable mini-grids is potentially worth more than USD 200 billion per year¹. In Indonesia, renewable mini-grids have been very popular in the form of micro-hydro power and PV mini-grids to electrify isolated communities and industries such as plantations, and mining. In the past eight years, the Government of Indonesia (GoI) has installed more than 700 PV mini-grids in isolated rural communities. Moreover, communities, donors, and private sectors are installing PV mini-grids with various mechanisms. Through policies, the government encourages many actors to implement renewable mini-grids and operate it sustainably. The trend is also vividly apparent in many Asian and African countries with their energy access initiatives.

Leveraging experiences that Asian-African countries already have, Indonesia aims to catalyse the knowledge exchange and foster South-South-North cooperation network among GIZ advisors and counterparts about sustaining PV mini-grids. The workshop will cover end-to-end aspects of PV mini-grid development and sustainable measures for energy access which comprise of technology, socio-economic, policies, and business.

¹ IRENA Innovation Outlook Mini-grids (2016)

1.2. Objective

Objectives of this workshop were:

1. Catalyse knowledge exchange among renewable mini-grid practitioners, especially for EnDev and GIZ advisors as well as partners/counterparts, fostering South-South-North Cooperation
2. Generating new and applicable ideas to improve sustainability of PV mini-grids.
3. Foster stronger south-south cooperation across GIZ mini-grid practitioners to improve the sustainability of mini-grids.
4. Agreeing on next steps to establish a platform for knowledge exchange.

2. Workshop Concept and Plan

2.1. Participants of the Workshop



Figure 2 The invitees to this workshop were mainly from GIZ projects all over the world, especially from Asia and Africa. And from Indonesia, coming from different ministries such as from Ministry of Energy and Mineral Resources, Ministry of Cooperative and Small Medium Enterprises, and Ministry of Villages, Development of Underdeveloped Regions and Transmigration. National electricity utility (PLN) and local energy office of South Sulawesi Province.

The invitations were sent to potential participants from Asia, Africa, Europe and Central/South America through different channels including direct invitation to individuals. The invitation was also circulated via GIZ TUEWAS (transport, umwelt, & wasser) network in Asia.

Participants were coming from the following countries:

- South Africa, 1 representative;
- Kenya, 2 representatives from EnDev (GIZ) and 3 from government partners;
- Ethiopia, 3 representatives from EnDev (GIZ) and 3 from government partners;
- Nepal, 3 representatives from GIZ;
- Myanmar, 2 representatives from GIZ;
- Germany, 1 representative from EnDev Global (GIZ) and
- Indonesia and EnDev (GIZ).

In total there were 50 participants attending the workshop.

2.2. Workshop Content and Format

The workshop was designed to look at different stages of PV or renewable based mini-grid developments. This allowed the participants to share their experiences in different phases of mini-grid development and at the same time to benefit from some insights from other one's experiences. After each session of specific topic, there were conclusions of the discussion and possible follow ups.

The topics of discussion followed the following phase of PV mini-grid development.



Figure 3 PV Mini-grid Development Phases

The workshop was planned for four days that consist of three days seminar and one day for field trip to Sabangko Island. Sabangko is an island where EnDev Indonesia has implemented some pilot activities such as community empowerment, smart payment system and electric boat for fishers.

The workshop was opened by representative from Ministry of Energy and Mineral Resources, Directorate New and Renewable Energy and Energy Conservation. Reception dinner was made in the evening of 26 August, inviting all participants.

The final workshop agenda you can find in the annex.

3. Workshop Segments, Content and Conclusions

3.1. Opening Segment

Dr. Rudolf Rauch, Director of Energy Programme Indonesia/ASEAN (GIZ) delivered his welcoming remarks. He welcomed all participants especially from abroad to Indonesia. He appreciated their participation in the workshop and pointed out that renewable energy can play important role in increasing electrification rate in different countries and give positive impact to economy of local community. He expressed his wish for successful workshop and hope the participants enjoy Makassar and the workshop.

Mrs. Ani Wiyanti represented Ministry of Energy and Mineral Resources to open the workshop. In her remarks, she pointed out that renewable energy is the answer for climate change especially in the power sector. It provides economical solution for energy access both on grid and off grid. Especially for rural renewable energy projects, the government of Indonesia supports the collaboration between government sector, private sector and local people.

3.1.1 Opening Plenary Session

The plenary session had two key intensions:

1. Understanding the expectations and needs from the participants
2. Understanding the key determining aspects for sustainable mini-grid development.

The first part of plenary session was about sharing the **expectations and needs**:

- **Knowledge sharing:** It is expected that the workshop will enable a knowledge sharing platform, which will accommodate learning from others who have experiences or share experiences to others.
- **Learning from others:** It is closely linked to the first expectation. Learning from the success of others or from the failures of others.
- **Collaborate with others:** It is expected that this workshop can link different projects for collaboration in mini-grid topic. One specific expectation was mentioning about south-south cooperation.
- **Window shopping for innovative solutions:** There are some ready to use solutions that can be used for mini-grid implementation. This can be in the form of tools, hardware, or other innovative solutions. Participants expected that they can have such opportunity.



Figure 4 The first part of plenary session, sharing the expectations and needs from the workshop.

Those expectations are very much aligned with objective of the workshop which means the workshop is well targeted. Overall, there is strong need for more intense communication or exchange between GIZ mini-grid practitioners improving the sustainability of mini-grids that enable and foster stronger south-south cooperation in mini-grid.

In the second part of plenary session was about identifying **key determining aspects** for sustainable mini-grid, and resulted in the following insights:

PLANNING and DESIGN

- Proper planning is essential for optimal use of mini-grid. This is broad issue and can cover technical and non-technical aspects. The quality of planning is very important determinant for mini-grid sustainability.
- Strong commitment from the government is needed to secure electrification plan and possibly funding. In Indonesia case and in other cases, it is about the regulatory framework for proper planning of mini-grid, clear electrification plan and funding.
- Growing demand must be properly accounted in the planning. This mean demand assessment must be properly and accurately done.
- Mini-grid should reach the unreached. The plan should consider remote areas and underprivileged groups of community to get access to energy.
- Renewable energy or electrification regulator is needed to do proper planning and oversee the electrification efforts. In Myanmar case, there is no electricity regulator to conduct proper planning.
- Collaboration and coordination in planning between different stakeholders is crucial in planning. This will allow different stakeholders to put resources in the implementation of mini-grid. This should not just about technical aspect of mini-grid but also about the community and social aspects. Comprehensive planning is very much needed.

- During planning, it is important to have discussion with target group or the locals. As part of planning, it is necessary to ensure that local people or target groups are aware of the project and ready to welcome it.
- It is important to strike the balance between ideal project implementation and cost-effective project implementation. Considering the cost of investment in the planning is crucial i.e. not too high and just enough. It is very possible that remote rural people may not be able to pay the cost reflective tariff if the implementation cost is too high.
- Standard design and financial model are needed for proper planning. This standard form for design and financial model is important for standardized approach that can be easily compared and verified.
- Mini-grid plan must consider ownership issue, management issue and O&M issue. This means the potential form of ownership, structure of management, and standard O&M issues must already be considered since planning. This means to talk to local people is strongly suggested.
- Accurate and update main grid planning is important prerequisite for mini-grid plan. Mini-grid should not be developed in areas where main grid is soon to come. In the future, when the main grid does come, the mini-grid must be integrated to the main grid.

TENDER and CONTRACT

- Standard tender and contract document are needed. Similar to planning, standard tender process and documents (and contract) may help to speed up the tending and contracting process.
- Contract must include quality criteria and performance criteria. By including quality and performance criteria, contractor will try as hard as possible to meet and thus provide benefits to the community.
- Contract should include capacity building for operators of the system with clear training expectations. EPC contractor must be responsible to train the operators to ensure they can operate the system well and do basic troubleshooting and maintenance.
- High competence manpower is needed for better tender and contracting system. There is a need that people handling tender and contract must know well about the system to be tendered. This means contracting team must have all technical capacities to assess proposals
- Land acquisition can be a problem in some cases, and it may need government's intervention e.g. by regulation.

CONSTRUCTION and INSTALLATION

- Local content will improve the renewable industry and may reduce the overall cost of implementation. However, there must be a strong roadmap for local content improvement for RE industry. This is where the government will play important role. The process may take long time.
- Past experiences from other countries are important lessons learnt for other countries. It is important to repeat what's good and avoid what's bad.
- Local companies with local capacities should make the cost of implementation more sensible. However, this needs quite strong efforts to attract private sectors to enter the RE business by providing complete regulatory framework for private sector to enter and incentives are available.
- Competence of local manpower for project implementation is important for maintaining high quality results. There should be competence development process and possibly certification of competence.

- Containerized solution is an interesting solution for modularity and flexibility. Containerized solution provides possibility of system expansion if the demand is higher.

COMMISSIONING, ACCEPTANCE and INSPECTION

- Competence of local manpower for hardware inspection is crucial in ensuring work quality of EPC contractor. Quality assurance process will need people who can differentiate bad work quality from the good ones. There should be competence development process and possibly certification of competence.
- Standard for commissioning, acceptance and inspection for PV mini-grid is hugely needed to ensure the quality assurance process can be done properly. Indonesia is currently developing such system and can be shared when it is completed.
- The standard for commissioning, acceptance and inspection process must be harmonized with the globally accepted standards or norms to have world quality standard anywhere in the world.
- Certification process for manpower competence to conduct inspection of PV mini-grid is important part of quality infrastructure. Broader more complete quality infrastructure for PV system or other mini-grid technology might be needed which then needs different responsible institutions to conduct different processes e.g. labs for testing, certification body, competence standard issuance body etc.

OPERATION and MAINTENANCE

- Ownership model for PV mini-grid must be aligned with local needs and competence for better O&M practices. There are different ownership models and not all will fit to local needs. This ownership model must already be identified in the planning stage.
- It is crucial to increase the awareness and capacity of mini-grid operators and receiving community. Proper capacity building is needed for mini-grid operators, mini-grid management, and the customers and this can be a collaboration effort between different stakeholders having different strong competences.
- Adequate O&M fund is important for mini-grid management team to operate and maintain the mini properly. This relates back to the ownership model which allow adequate fund to be collected for proper O&M. Tariff structure will affect this aspect, too.
- Tariff structure that reflects the cost of O&M is instrumental for sustainability of a mini-grid. Cost reflective tariff, although hard to achieve, will ensure proper maintenance and replacements or repairs of mini-grid which in the end increasing the operation of mini-grid.
- Low per capita consumption leads to low availability of O&M funds which then affect the sustainability of mini-grid. Anchor load is needed to ensure mini-grid management gets enough fund to finance O&M, local economic development can lead to better/more consumption per capita and thus availability of O&M fund.

MONITORING and REPORTING

- Common monitoring system for different PV mini-grid systems is needed. Monitoring of mini-grid performance can benefit the operator and financier in different aspects e.g. technical (e.g. for problems) or non-technical (e.g. financial performance of mini-grid).
- It is important to define clear data set to be collected, by whom, and for what in the effort to monitor mini-grids. Clear definition will make it easier for selection of monitoring technology and expected output of monitoring e.g. policy change, financial analysis of MG, decisions to make repair or changes etc.
- Spreading the good practice from well managed mini-grids is important for mini-grid community. Peer learning is a good method to share knowledge between mini-grid

practitioners. A system to enable sharing between operators or mini-grid management is needed.

SUSTAINABILITY AND OTHERS

- Ownership (senses of belonging) and taking full responsibility of mini-grid operation by the community or individuals is most important aspect of mini-grid sustainability. Without strong ownership, the mini-grid will not be operated and maintained in a good way.
- Promotion of anchor load or productive use of energy must be done since the beginning of mini-grid development. PUE awareness building to the community and its implementation will improve the energy consumption, possible will increase the amount of O&M fund and in the long-term improving sustainability of system.
- Change of leadership in government level may impact the policy of mini-grid implementation plan. It is quite common that change of leadership will be followed with change of policy. It is expected that policy will stay the same with even a change in the leadership (especially for mini-grid).
- There is a huge need to improve O&M strategy, directives for sustainability, knowledge about LCOE (levelized cost of energy / cost of energy supply), and experience in improving the sustainability of a mini grid.
- Tariff scheme must be representing the cost of O&M
- There must be clear role division for the mini-grid development program. It is important to have better collaboration and coordination.
- In some cases, too much subsidy from the government will influence the willingness to pay. Heavy subsidies may reduce the willingness to pay of the receiving community. This leads to low O&M fund availability and low ownership/responsibility.
- There is a strong need to increase private sector participation in mini-grid development because private sector ownership may increase the sustainability of PV mini-grid.
- There is a need to improve the accuracy of mini-grid planning to avoid lower capacity installed. Low capacity may influence the habit of energy usage that leads to abuse of the system e.g. by theft etc.

There were lots of information collected from the participants. We can name few aspects that prominently appearing in different phases of mini-grid development:

1. **Capacity building (competence issues)**: there are needs to improve the capacities of local partners in conducting various processes in mini-grid development.
2. **Standardized approach or tools**: There is strong need to have different standardized approaches for different phases of mini-grid development.
3. **Collaboration or coordination**: There is a strong need to have a more coordinated and collaborative implementation of mini-grid development.

3.2 Session I “PLANNING & DESIGN AND TENDER & CONTRACTING

3.2.1 Presentations



Figure 5 Joseph Hermann from EnDev Ethiopia, sharing about EPC contract approach in Ethiopia.

This first presentation session is focusing on Planning & Design and Tender & Contracting. The afternoon session started with presentations from:

1. Josef Hermann, from EnDev Ethiopia – he talked about EPC contract approach in Ethiopia especially about the procedures implemented, results of the bidding process and most important the lessons learnt from the tendering process.
2. Kevin Kerigu Mwangi, from EnDev Kenya – he talked about lessons learnt from planning, tendering and contracting in Kenya particularly about the RBF setup in Kenya, its objective, the progress and lessons learnt from RBF scheme tendering process.
3. Sander Maebe, from SAGEN, South Africa – he talked about social facilitation and licensing contracting experiences. He explained about South African context and emphasized the importance of social facilitation.
4. Nanik Rahmawati, from ELREN, Indonesia – she talked about multi stakeholder collaboration SOLID. She emphasized the importance of coordination between key actors in mini-grid development process.
5. Sandra Imelda, from PTB, Indonesia – she talked about PV industry quality infrastructure in Indonesia. She shared about PV quality infrastructure development process, how complex it is and the benefits of having quality infrastructure established.
6. I Gede Yudistira, from Ministry of Energy and Mineral Resources – he talked about the practice of planning, tendering and contracting of small PV mini-grids in Indonesia. Key points from his presentation are:
 - a. Current energy situation in Indonesia,

- b. Energy policy and strategy to accelerate RE implementation,
- c. Government's budget priority and
- d. The procurement process conducted by the government.

3.2.2 Conclusions

The conclusions from the presentations are:

1. Economic scale of a project is important for an EPC contract. Bigger capacity will make cost per unit lower.
2. Monopoly market leads to unfair pricing for an EPC contract. There must be internal capacity building for the industry to reduce monopoly.
3. For certain cases, access to foreign currency is important aspect for contracting. It also can become a high risk for EPC contractor.
4. Clear electrification plan is important, especially for site allocation where mini-grids will be built. Harmonization of information between key actors is key for accurate planning and project preparation.
5. Low technical capacity from both financial institution (who manage the result-based financing) and local developers are key hindrance for successful tendering and contracting.
6. Social facilitation is important in the project planning. This is to ensure that local community understands and aware about the coming project and all the consequences.
7. Performance of mini-grid should be included in the contract to the developer.
8. Multi stakeholder forum on planning and implementation of mini-grid is an important model for better coordination between line ministries working in mini-grid development.
9. Quality infrastructure is important in securing quality standard for the planning, tendering and contracting of renewable mini-grid especially PV battery mini-grids.

The conclusions from the Q&A session are:

1. Land acquisition is an important part of planning of mini-grid (especially PV mini-grid). Social issue might arise if land acquisition is not done properly.
2. Contribution of mini-grid in universal electricity access in different countries is significant and will increase especially in Africa region. Thus, further cooperation with more experienced countries will be needed.
3. Complexity of tendering process might slow down the contracting process and eventually slow down and delay the implementation stage. Different contract setups are applied by different countries. It is possible to combine EPC contract with O&M contract.
4. To accommodate the risks in the contract, accurate planning is very important. However, striking the right balance between hedging risks (which usually means higher cost) and cost efficiency is also important.
5. Scale of project will impact the effectiveness of contract. Smaller projects will usually cost more than bigger one. It is possible to bundle projects to bring the unit cost down and make the contract more feasible.
6. Multi-stakeholder participation in the mini-grid planning is important, and the government should take the ownership of the process. This process is important because different actors will.
7. Warranty of system should be included in the contract. Education of mini-grid operator is important to make sure that the warranty is not void.

- Battery recycling scheme must be considered in the planning of mini-grid in general. End of life planning for especially batteries must be done properly identifying who must do what and when.

3.3 Session II “CONSTRUCTION, INSTALLATION, COMMISSIONING, ACCEPTANCE and INSPECTION”

3.3.1 Presentations

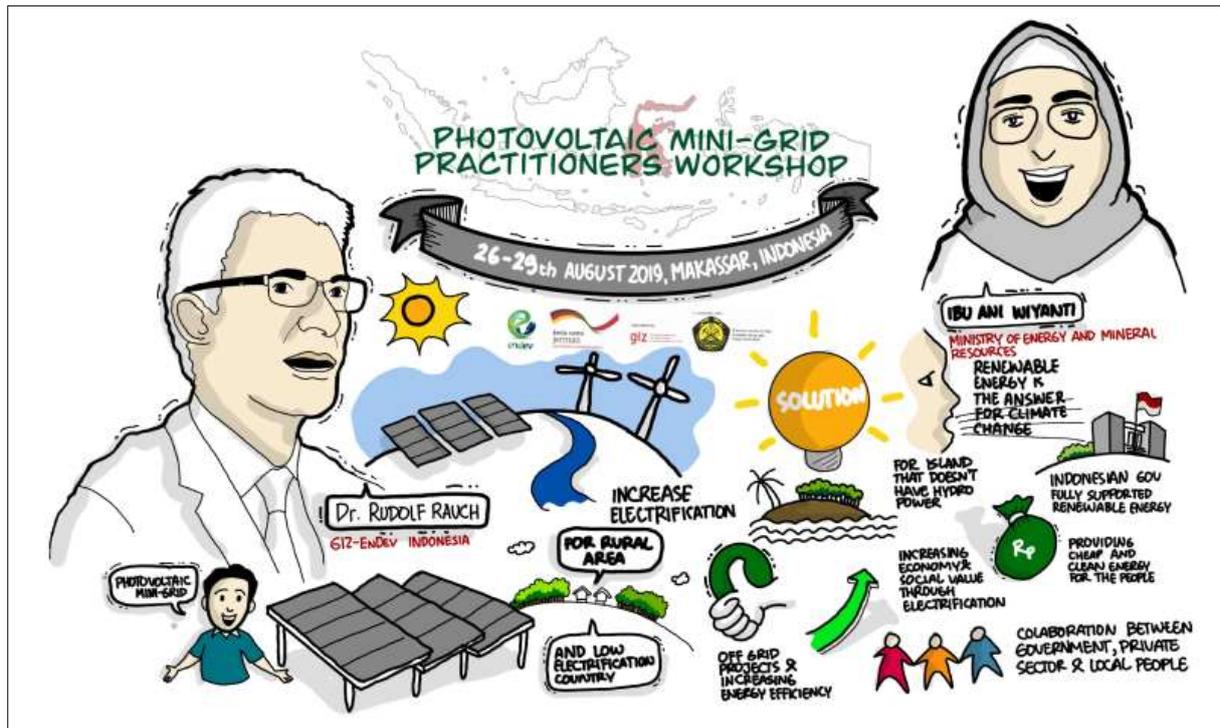


Figure 6 Example of the graphic record. Before the presentation started, workshop committee played the graphic recording videos from the first day. The full video showed the process of the workshop since morning until afternoon session.

Morning session presentations were about Construction, Installation, Commissioning, Acceptance and Inspection. Presentations were made by:

- Edwin Ongeri, from EnDev Kenya – talked about Experiences and Lessons Learnt in the implementation of off-grid mini-grid in Kenya. In his presentation Edwin showed that Kenya has universal electrification target by 2020 and they have issues achieving the target. Other issues are operation/management, part availability and remote monitoring of the remote sites.
- Sander Maebe, from South Africa – talked about Experiences and lessons learnt in construction, installation, commissioning and inspection of mini-grid. He emphasized the importance of clear terms or reference for construction/installation. He also saw that performance guarantee must be part of contract. He concluded that accurate and clear plan for construction/installation will get everyone on board.
- Bagus Ramadhani, from EnDev Indonesia – talked about the Do’s and Don’ts of PV Mini-grid. The explained that the book is a compilation of knowledge gained in the surveys. It compares the good and the bad practices of installation. It contains lots of information from the field. The book provides good impact to installation practice in Indonesia which is better now.

Imam Askolasi, from ELREN Indonesia – talked about the PV mini-grid commissioning guideline which currently is still in development. This guideline is aimed for inspector. The guideline consists of documentation, visual inspection, performance test and system test. A checklist will also be included. When ready the guideline will be shared.

4. Selamawit B., from EnDev Ethiopia – talked about mini-grid opportunities, experiences and challenges in Ethiopia. She informed that population are scattered in rural areas and electrification rate is around 44% now. There are some challenges to achieve universal electrification such as limited experience, security issues, the need to better directives and financial issues. She emphasized that cooperation between actors is important.

3.3.2 Conclusions

Conclusions from the presentations are:

1. Remoteness of sites are often becoming a problem in construction and subsequent activities.
2. Lengthy development process which lead to higher cost for implementation should be avoided.
3. Quality of FS (feasibility study) determines quality of implementation. There is a strong challenge in increasing the capacity of manpower who develop FS.
4. Complete and detailed TOR can improve the clarity of project activities especially during construction until commissioning.
5. Performance guarantee must be a part of construction process that can be proven during commissioning/acceptance test.
6. There are lots of examples from Indonesia collected from the Mini-grid Service Package activity. It has been collected into book which will be useful for practitioners.
7. Commissioning guideline can be an important tool to properly commission a mini-grid especially PV battery mini-grid.
8. Cooperation and coordination between key actors in mini-grid development are important.

The conclusions from the Q&A session are:

1. PV mini-grid are often installed at remote sites, to motivate private sector to enter remote mini-grid business, government subsidy must be applied.
2. Revenue projection must be done as accurate as possible. This is important to accurately calculate the profitability of mini-grid construction.
3. Result Based Financing is one of the possible financing schemes for private sector participations in mini-grid development. Different subsidy schemes in the RBF can be applied.
4. Service and maintenance contract can be included in the construction contract.
5. Quality of construction will determine the sustainability of a mini-grid in a major way. Certification of technicians is one of solutions for quality improvement.
6. EPC contracting should include social team. Social team will help to prepare the community for the new infrastructure to come which will increase the chance of more sustainable operation.

3.4. Session III “OPERATION, MONITORING and REPORTING”



Figure 7 Ashish Dhankar, from Myanmar Energy Program – talked about Battery Management Practices in PV mini-grids in Myanmar.

3.4.1 Presentations

The session was focusing on Operation, Monitoring and Reporting. Presentations were given by seven presenters. Below is the summary of presentations:

1. Ashish Dhankar, from Myanmar Energy Program – talked about Battery Management Practices in PV mini-grids in Myanmar. Mini-grid plays important role in national electrification plan. Since battery is a big part of investment cost, battery replacement should be properly planned. End of life processes must be prepared and should include private sector.
2. Sander Maebe, from South Africa – talked about the approach to operation and maintenance of mini-grid in South Africa. He emphasized the importance of fail-safe measures which can take form as hardware installation. Such measure can protect the system from abuse which will prolong mini-grid operation. He also emphasized the importance of maintenance contract for service providers to support local operators maintaining the mini-grid.
3. Addisu Amare, from EnDev Ethiopia – talked about the cooperative ownership model in Ethiopia. He mentioned that cooperative is one of the ownership models implemented in Ethiopia and it works with some remarks. Key considerations for implementing cooperative: anchor load, trouble shooting skills, and cost reflective tariff. Area wide cooperative might work to improve efficiency for OM.
4. Christian Liedtke, from RERA Nepal – talked about the result of 350 MHP survey in 2 provinces in Nepal. He explained that for the survey, they’ve used KOBO toolbox and deployed consultants to conduct the survey. There are 11 parameters in the survey to measure the

sustainability of the MHP schemes. Only 2% are in good condition while around 79% of sites are not. Key issues are low workmanship, inaccurate plan, missing post installation support and tariff that can be higher.

5. Bagus Ramadhani from EnDev Indonesia – he presented about the Universal Remote Monitoring System developed by EnDev Indonesia. He explained that current monitoring systems are not always working. The universal monitoring system provides flexibility. It will take raw data and convert to useful information such as performance information.
6. Vikash from RERA Nepal – he presented about monitoring and reporting conducted by RERA. He presented about the off the shelf monitoring system for MHP sites in Nepal. The system can be easily bought and installed. Challenges are locations; GSM coverage and electrical safety.
7. Aris Sudarto from Ministry of Energy and Mineral Resources Indonesia – he presented about the monitoring system employed by the ministry. He presented about the monitoring system implemented by ministry of energy since 2015. The challenge he faces is GSM coverage and cost of maintenance.
8. Jacob Chepkwony from Kenya – he presented about Kenya Off Grid Solar Access Project (KOSAP). He explained that KOSAP has supported Kenyan government to electrify more than 1,3 million people. Mini/micro grid is one of the components. Kenya has potential of 151 mini/micro grid for remote rural areas.

3.4.2 Conclusions

From this session, it can be concluded that:

1. There should be clear plan for battery replacement. This includes initial planning for replacement and preparation of appropriate method of used battery handling. Selection of battery technology must also be aligned with available supports.
2. For operation and maintenance, it is strongly suggested that there is an O&M contract for operation and maintenance of a mini-grid. The contract should at least include operational availability; performance; and limited repairs.
3. Cooperative is a viable ownership model but there should be additional effort to:
 - a. Increase the capacity of the management,
 - b. Set cost reflective tariff and
 - c. Integration of productive use load.
4. Cooperative ownership model can be a regional approach combining different cooperatives and become small utility. However, it must have legal entity and would be better to link with private sector to increase the business viability of this cooperative.
5. Monitoring of the operation of mini-grid is important and KOBO toolbox can be a simple tool to help administering the data.
6. Findings from Nepal, the operation of MHP schemes are not as good as planned. Conclusion from the survey:
 - a. Strong need for accurate planning
 - b. Strong need for better workmanship and supervision
 - c. Strong need for capacity building about management and operational skills
 - d. Adequate OM fund for repairs and replacement
7. Monitoring the performance of micro grid or mini-grid is important and there are different ways to do that.
8. The solution offered by EnDev Indonesia is free from proprietary technology, providing universal tool for remote monitoring.

9. Commercial solutions or off the shelf solutions are also available to meet the needs for monitoring.
10. The data connection or GSM coverage is usually the key issues challenging the implementation of remote monitoring system.
11. Kenya is currently in the process of developing micro grids to achieve 2022 universal electrification target.

The conclusions from the Q&A session are:

1. Service providers network is one of the solutions to provide technical backup for mini-grids, especially for more complex problems.
2. Components, especially batteries, replacement of a PV mini-grid, must be considered in the planning and there must be enough OM fund to replace batteries. Battery recycling network must be available.
3. Protection system, from overload, can be installed to prolong system lifetime with some trade-offs e.g. limited productive use.
4. Locally available spare parts are important to reduce lead time of repairs and possibly bring the repair cost down.
5. Expansion of the current system provided that the fund is available which is depending on the financing scheme of the PV mini-grid.
6. Experience sharing from different projects is important. Key findings from Nepal survey are lack of OM fund, lack of interest from community, general MHP managerial issues.
7. Community based projects must be carefully supervised. Limited construction fund usually affects the quality of work.
8. The universal remote monitoring system is a cost-effective solution. The cost depends on the size of the PV mini-grid system, the bigger the more the cost.
9. Proprietary technology from different manufacturers requires lots of hard work to accumulate the data because there might be different algorithms in each system.
10. Access to monitoring data should be given to different levels of responsible actors and must include the operator.
11. Ready-made solutions operated by private company are available.

3.5. Session IV “SUSTAINABILITY”

3.5.1 Presentations

The last day of the workshop was focusing on sustainability and other topics. There were two big sub-sessions in the morning and in the afternoon.



Figure 8 Mrs. Maritje Hutapea former Director of Various New and Renewable Energy, DG NREEC, presented about mini-grid implementation framework in Indonesia.

Presentations in the morning and afternoon sessions were from:

1. Josef Hermann from EnDev Ethiopia – he presented about the productive use and energy justice. He explained that energy access gave positive impacts to community especially underprivileged groups (e.g. women, children, poor). However, the getting most impact is still high to medium income households. PUE is expected to grow after energy is introduced and this anchor load must be part of the cooperative.
2. Mrs. Maritje Hutapea former Director of Various New and Renewable Energy Directorate, Ministry of Energy – she presented about mini-grid implementation framework in Indonesia. She explained that as archipelago, mini-grid is one of key solutions. Government has supported the transition from diesel mini-grid to renewable mini-grid. She emphasized to have accurate plan, standardized procurement and contract, and higher quality standard. She expects to have more private sector involvement in the future.
3. Binor Prasad from RERA Nepal – he presented about the approaches to ensure sustainability of mini-grid. His presentation highlighted that surveys found only few MHP are in good condition. Key issues affecting are poor infrastructure, lack of proper management and governance, lack of cost reflective tariff, low load factors, OM issues and uncertainty of grid extension. He recommended that MHP must be operated as enterprise.

4. Husni Mubarak from Ende Indonesia – he presented the smart payment system solution that is piloted in Sabangko Island. He explained that reasons for SPS are small savings, no energy consumption records, and low energy utilization. The SPS uses LORA network, utilize local server and can record energy consumptions, provides early warning for problems, and excess energy information. SPS is expected to improve the sustainability of PV mini-grid.
5. Mr. Yohanes Bambang Sumaryo, head of Solar PV User Association – he presented about Indonesia’s feed in tariff and the journey of renewable interconnection in Indonesia. In his presentation, he pointed out that FIT did not work in Indonesia. The reasons were budget limitation, no subsidy paid, corruption indication and intermittency of renewable energy source. However, renewable energy integration to the grid is still possible at the right economic scale.
6. Sander Maebe of South Africa – he presented about sustainability approach in South Africa. He pointed out that renewable energy project must be measured by different measures such as technical, financial, social and environmental. The process should include different parties who can focus on different aspects of monitoring.

3.5.2 Conclusions

Conclusions from Presentations and Q&A sessions

From the morning session, it can be concluded that:

1. For energy justice, special approach might be needed to underprivileged group of the community so that they can benefit from the new energy access.
2. Energy justice may bring more positive impacts to the system and to the community such as better health and sanitary condition, more time for studying and less time for cooking and opportunities to do business.
3. Multistep approach involving different stakeholders in productive use of energy is important. It should be done carefully especially in identifying local potential and market for the products.
4. In a cooperative setup or other operation model, the anchor load should be part of the management, as part of the business and not just relying only on electricity business.
5. From Indonesia it is important to consider proper planning in the beginning, standard procurement model, application of national or international standard in the installation, involvement of other stakeholders to improve the operation of mini-grids.
6. Aligned with the result of pilot in Ethiopia, in Nepal it was found that sustainability of mini-grid can be improved if the MHP management combines other businesses into its electricity business or the MHP management act as an enterprise rather than just a utility.
7. There are technical solutions to improve the sustainability of a mini-grid. The smart payment system will not only cover tariff or revenue issues but also at the same time protect the system from over used or tempering.
8. When the grid comes, feeding the renewable energy to the grid is one of the solutions. This solution will not only improve the financial performance of a system but also keeping the scheme from not working.
9. Monitoring of mini-grids is an important step to ensure sustainability of systems. There are different aspects to be monitored such as technical, operational, and social. Different parameters for each aspect can be applied.
10. For monitoring, involving local champion is highly recommended and too collaboration/coordination with different partners.

The conclusions from the Q&A session are:

1. There are different models of ownership and they can be fitted to community's need and capacity. Most important is that the management of mini-grid can perform well to operate and maintain the mini-grid.
2. Tariff system should reflect energy use. Metered consumption with different tariff schemes for different kind of loads can be applied.
3. Tariff of a mini-grid should consider the income of local people and to previous energy use payment (if any e.g. diesel generators or kerosene lamps).
4. There are different kind of tariff payment methods. It is important to investigate the spending pattern of target community e.g. farmers usually have more money after the harvest.
5. Tariff collection by mini-grid operator may use products or goods instead of hard cash. This can then be integrated to the concept that mini-grid management should not only rely on electricity business but also to productive use (maximizing the local products) e.g. become distributor of agriculture products from the area.
6. Commercial off grid mini-grid depends on the attractiveness of financial incentives and size of the project.
7. Productive use of energy can be the driver for sustainable mini-grid, and it should be integrated to mini-grid management. Multistep approach to identify productive use of energy.
8. Ownership of mini-grid must be clear from the beginning especially if the mini-grids are government or donor projects.
9. Mini-grid should be ready for the main grid to come. The system should be ready for grid integration in the future
10. There are different schemes for grid interconnection promotion such as feed in tariff or preferred interconnection tariff for small renewable energy units. Each country has its preference and it is quite common to introduce feed in tariff in the beginning.

3.6 Closing Segment



Expectations and key takeaways

Participants were mainly satisfied with the implementation of the workshop both for the arrangements and also the content. They particularly liked the practicality of the topics and discussions. They were able to bring home key lessons or key takeaways and are willing to work more closely in a collaborative and active manners.

The participants also agreed that the workshop was the first of a kind where it combined the experiences from Africa and Asia.

As for the key takeaways during the workshop, participants have gained many and below are their comments:

1. Nepal delegate expressed that they have taken some important lessons such as:
 - a. The checklist for sustainability
 - b. Guidelines for commissioning
 - c. Do's and Don'ts of PV mini-grid
 - d. The mini-grids PPP (public private partnership) from Kenya and Myanmar
2. Kenya delegate also have got many to bring home such as:
 - a. The universal remote monitoring system that will be useful for their projects in Kenya
 - b. The OM Do's and Don'ts
 - c. The battery recycling and replacement concept and
 - d. Involvement of different stakeholders in productive use of energy development efforts
3. Myanmar delegate brought home some take away:
 - a. The PV mini-grid Do's and Don'ts
 - b. Different remote monitoring platforms, especially the universal remote monitoring system
 - c. Challenges and learnings for community owned mini-grid
4. South Africa delegate mentioned about the following takeaways:
 - a. GIZ in house knowledge especially about digital monitoring platform, the PV mini-grid Do's and Don'ts, the commissioning guideline
 - b. The broader knowledge about mini-grid and things to consider for future implementation
 - c. Tariff information, household income, willingness to pay and the relation between them
5. Ethiopia delegate has learnt that:
 - a. Good will from the government towards off grid energy solution is very important
 - b. That there is impressive will to improve own processes
 - c. Off grid subsidies and cross finances are possible and viable solutions
6. From Indonesia, they learned that community project needs strong steering committee.

Summary of key take-aways:

- Lessons and knowledge from different projects are useful and applicable e.g. the sustainability checklist, the book Do's and Don'ts of PV Mini-grid, different ownership models, different financing models
- Countries and GIZ project are ready to share tools that are applicable for different projects such as the universal remote monitoring system, the KOBO Box tool, the tariff calculation tool etc.

- It is important to consider involving different stakeholders in planning and implementing mini-grid project (even up to monitoring)
- Sustainability of mini-grid is depending on many aspects from planning to operation.

Topics to be further discussed

There were some topics that would be further discussed and exchanged in different platforms. Tariff and approaches to ensure sustainability are two topics closely related to mini-grid operation. Those two topics are considered important to especially targeting better operation of mini-grid.

At higher level, subsidy schemes, off grid business model and strategies to improve mini-grid business are other issues to be further discussed.

Other specific topic that were not deeply discussed during workshop and participants agreed to discuss further are:

1. Business model, market development, scalability and contractual arrangement especially for Operation and Maintenance
2. Income generating activities or productive use of energy or anchor load
3. Tariff issues which covers at least the following sub-issues: cost reflective tariff, different payment methods, new innovations in tariff collections etc.
4. Demand assessment methodology, ownership, willingness to pay, sustainability (based on revenue stream) and community/end-user sensitization
5. Warranty and quality assurance
6. Battery replacement and recycling or end of life support system for batteries of PV mini-grids.

The prioritization of topic discussion finally decided that the following topics have higher priority to be discussed:

1. **Tariff** – the lead for this discussion will be Sander from South Africa with Myanmar, Kenya and Indonesia as the key members
2. **Demand assessment and community sensitization (includes willingness to pay and ownership)** – the lead will be Indonesia with active members from Ethiopia, Myanmar and Nepal
3. **Market development, business model, scalability and contractual arrangement** – the lead will be Nepal and or Ethiopia with active member from Indonesia
4. **Income generating activities** – the group will have Indonesia and Ethiopia as active members
5. **Warranty and quality assurance** – the group will have active discussion between Myanmar, Indonesia and Nepal
6. **Battery replacement** – the discussion will involve Ethiopia, Kenya, Indonesia.

Although there are specific members in each discussion group, other countries can certainly join the discussion and will receive updates about it.

Tools to be shared

There are some products from different projects and those products are in house GIZ products that are ready for sharing. The list below are some tools or documents for sharing:

1. The book Do's and Don'ts of PV Mini-grid – currently still in Indonesian and is in the plan for translation to English
2. The Commissioning Guideline of PV Mini-grid – currently still in finalization and will still be in Indonesian. The plan for translation is for December 2019
3. The Operation and Maintenance Guideline – currently still in Indonesian and is planned to be translated soon in December 2019

4. Universal Remote Monitoring System – this monitoring tool and software are ready and currently in replication
5. Survey tool with KOBO toolbox – Nepal team has used this
6. Remote monitoring tool (off the shelf) for MHP – Nepal team has implemented this
7. Load shedding tool – a hardware that is used in South Africa
8. Tariff calculation tool – Kenya team has supported the Kenyan Electricity Regulator to develop this tool. It needs the approval from the regulatory body before sharing it with others.

The tools are ready, and the knowledge are available. It is time to share and collaborate.

Dr. Rudolf Rauch, Director of Energy Programme Indonesia and ASEAN, closed the event. In his closing statement he pointed out that the workshop will not be the last. There will be continuation of this workshop in different forms. He observed that there are lots of in-house knowledge and experience worth sharing and it means exchange and collaboration is very crucial. He emphasized that South-South-North triangular cooperation is the strategy for increasing exchange and knowledge sharing. He also thanked all participants for active participations in the discussions and wished them safe journey back home.

Dr. Rudolf's speech officially marked the end of the workshop.

4. Next Steps

The workshop will not be the first and the last. It is a trigger for more exchanges and knowledge sharing between projects from Asia and Africa. It is expected to reactivate the mini-grid discussion group within GIZ network. To keep the process active, the following are expected to happen:

The Way Forward and How to Keep the Network Alive

the way forward to follow up this workshop are:

1. Tool sharing – tool list above to be shared or new tools to be shared
2. Knowledge management and sharing – collect and share what's relevant for others
3. Keep practical – focus on practical aspects of mini-grid sharing
4. Keep global – not regional focus but share the knowledge globally
5. Position this forum to be open – welcome new members and encourage sharing
6. More open to different projects – not just focusing on GIZ projects or EnDev but also other projects on mini-grid.

Those above were just the list of activities identified during the workshop. There will be more activities to follow up the workshop and it will depend on how active the members are.

There are some options on how to keep the network alive for example:

1. **Webinars** – this will be arranged per topic and support from Indonesia team for arranging can be expected
2. **IDA Platform** – this IDA Platform is the mainstream with GIZ staffs but not accessible by other partners which are not GIZ employee
3. **Person to person sharing** – this can be done individually and reported to the group
4. **Expert exchange or staff exchange** – this is usually done by EnDev or other projects. This can be done if it follows GIZ rules and there is matching supply and demand
5. **Library of practical product** – this one is a must for broader audiences. This can be hosted at GIZ server accessible by more global audiences.

To follow up the results of the workshop, the following actions will be done mainly by GIZ Indonesia team and supported by other GIZ projects:

1. Setup communication forum in the most suitable platform. Possible platforms are IDA community platform and Energypedia. The forum will be used to connect with workshop participants and continue the discussions of specific topics. For this activity, EnDev Indonesia will be supported by EnDev Global team.
2. Start the discussion in whatever form available. It can start in the form of email communication, webinar, WhatsApp™ group or any mode of communication. Schedule agreed by all can be used for better coordination and communication. This will be part of the forum activities once the platform is ready.
3. Make the tools or guidelines available for public. This will take sometimes especially for the documents because they are in local languages. Ready to use tools can be then shared with others.
4. Continue the regular sharing in a monthly or bi-monthly frequency and
5. Plan for the next PV Mini-grid Practitioners Workshop.
6. Individual connection with different projects for collaboration and cooperation.

5. Field Visit Solar PV Mini-grid at Sabangko Island



Figure 9 Site visit to Sabangko Island. Participants tried the e-mobility solution renewable energy boat. The boat is powered by electrical outboard motors with battery charged by the PV system.

A Site visit was made to Sabangko Island where EnDev Indonesia has put some innovations. The workshop participants especially the foreign participants were transferred by bus to Maccini Baji port where they boarded some boats to take them to the island.

Reaching the island, the site visit participants were greeted by the local people. There was traditional dance, speeches from village leaders and song by students. The participants were grouped into two, both are visiting the same show points at different time. The show points were:

1. Productive use of energy by women groups of Sabangko Island
2. Universal Remote Monitoring system applied at Sabangko Island
3. Smart Payment System applied at Sabangko Island and
4. E-Mobility, renewable energy boat applied at Sabangko Island including the charging station.



Figure 10 Women groups in Sabangko Island, used the energy from solar PV to pre-process the material and packaging of their products.

Productive use of energy by women groups were showing the local products based on the resources available at location which are mainly seaweeds and crabs. The women groups made different products out of the basic materials. The energy is used mainly for pre-processing the material and for packaging.

Key characteristics about this productive use of energy are:

1. Using local material. In Sabangko case they are using locally harvested seaweeds and crab meats.
2. Women group plays important role. The activities are mainly run by women groups. This shows that, in this particular case, women directly benefit from the local businesses.
3. Peer to peer learning is eye opening and encouraging. In the process of developing the activities, the women groups were taken to Jogjakarta to directly meet their peers, learn from them and share experience with them. This has proved to be an effective way to transfer knowledge compared to class room setup.
4. Social media marketing. The women groups are using social media to market their products. It was in the infancy stage, but it is believed that the result is good in term of sales.
5. However, energy utilization in the production process is not significant. This is due to the limitation of PV mini-grid capacity. Electricity from solar power is mainly used for packaging purpose only.

Universal remote monitoring system was drawing a lot of interests from the participants. They looked mainly at the sensors, the configuration of the system and the human machine interface of the remote monitoring system. They witnessed directly the performance of the Sabangko Island PV battery system. Colleagues from Africa were particularly interested to replicate the system for their needs.

This universal remote monitoring system has some characteristics:

1. It can be used for different PV systems both off-grid and on-grid.
2. It relies on GSM network to transfer data to server.
3. The software automatically calculates the performance of PV system.
4. It will give warning if something wrong happening to the system.
5. It is relatively cheap and easy to reproduce compared to preoperatory technologies from inverter manufacturers.

Smart Payment System (SPS) was also drawing lots of attention. Participants were first brought to one of the houses where they can see the actual physical form of the SPS. Afterwards, they were taken to the power house where the server for the SPS is located and the communication centre is located. The SPS developer, Jason, presented his innovation together with Husni of EnDev Indonesia. People were particularly interested in knowing how the system works and what benefits it can give to overall mini-grid management. This smart payment system is relatively new and GIZ energy programme Indonesia is still collecting information for further studies. Specific characteristics of this SPS are:

1. There is no need for cloud-based server. Server is local.
2. It is using LORA (long range) communication protocol which has low bandwidth requirement and low energy consumption.
3. It can manage different tariff schemes, provide warning if the credit is almost used up, can be charged remotely and wirelessly, records the energy consumption pattern of the customer an.
4. It is locally made with some imported materials.

After lunch, participants tried the e-mobility solution renewable energy boat. The boat is powered by electrical outboard motors with battery charged by the PV system. Charging station is located at power house and this becomes an alternative of productive use of energy maximizing the solar power after the PV battery is fully charged.

Combining the data input from universal remote monitoring system, the charging station will maximize the utilization of direct solar energy after the battery is fully charged. This activity will increase the solar energy utilization. It is roughly calculated that for a seaweed farmer, using the e-boat, will save him approximately IDR 50,000 per trip. This saving comes from fuel cost avoidance.

The group left the island at around 2 p.m. and back to Makassar. One of the delegates, Ethiopian, left directly to Jakarta to continue meeting other renewable energy stakeholders in Bandung and Jakarta.

Annexes

Annex 1: Workshop Program

MONDAY, 26 AUGUST 2019

08.00 – 09.00	Registration
09.00 – 09.30	<p>Welcoming Remarks, Rudolf Rauch (Director of GIZ Energy Programme Indonesia)</p> <p>Opening Remarks & Keynote, Challenges and Opportunities in Implementing PV Mini-grid in Indonesia – Experiences and Lessons Learned, Mrs. Ani Wiyanti (Representing, Director of Various Energy, Ministry of Energy and Mineral Resources)</p>
09.30 – 10.00	Coffee Break
10.00 – 12.30 Factors affecting successful implementation of PV mini-grids – from planning to operation	
Facilitator: Atiek Puspa Fadhilah (EnDev Indonesia)	
<p>In a plenary setup, all participants are expected to share their experiences and lessons learned to successfully implement PV mini-grid projects following the project cycle of a PV mini-grid implementation. Meta Plan method will be used to capture key issues which leads to key lessons learned to share.</p> <pre> graph LR A[Planning and Design] --> B[Tender and Contract] B --> C[Construction & Installation] C --> D[Comissioning, Acceptance & Inspection] D --> E[Operation & Maintenance] E --> F[Monitoring & Reporting] F --> G[Repair and Supports] G --> H[Other issues Sustainability, Financing etc.] </pre>	

12.30 – 14.00 Lunch Break

14.00 – 17.00 Planning & Design and Tender & Contracting

Moderator: Catoer Wibowo (EnDev Indonesia)

Presentation (15 minutes each)

- Endev Ethiopia – Engineering Procurement and Construction (EPC) contract approach in Ethiopia
- Endev Kenya – Experiences and lessons learnt on Planning, Tender, and Contracting
- South African German Energy Programme (SAGEN) – Social facilitation and licensing contracting experiences

- GIZ ELREN - Multi-stakeholder planning for Rural RE Based Electrification – A new planning paradigm for better PV Mini-grid implementation
- PTB – Strengthening Quality Infrastructure for the Energy Sector in Indonesia Project (focus on PV)
- Ministry of Energy – MEMR - Planning, Tender and Contracting of Small Solar PV Construction in Remote Areas

Discussion: 15-20 minutes after each presentation

Key Takeaways and Follow Up actions by Moderator

15.30 – 16.00 Coffee Break

TUESDAY, 27 AUGUST 2019

08.30 – 12.00 Construction, Installation, Commissioning, Acceptance and Inspection

Moderator: Gregor Josef Broemling (EnDev Head Quarter, Germany)

Presentation (15 minutes each)

- Endev Kenya – Experiences and lessons learnt in the implementation of off-grid mini-grid
- South African German Energy Programme (SAGEN) – Experiences and lessons learnt in construction, installation, commissioning and Inspection
- Endev Indonesia – Do’s and Don’ts of PV mini-grid - Collection of experiences from 300 PV mini-grids
- GIZ ELREN – PV mini-grid commissioning guideline
- Endev Ethiopia - Mini-grid opportunities, experiences and challenges in the Ethiopian context

Discussion: 15-20 minutes after each presentation

Key Takeaways and Follow Up actions by Moderator

10.00 – 10.30 Coffee Break

12.00 – 13.30 Lunch Break

13.30 – 17.00 Operation, Maintenance, Monitoring, and Reporting

Moderator: Imam Askolani (ELREN Indonesia)

Presentation (15 minutes each)

- RELEC Myanmar – Overview and Analysis of Battery Management Practices in PV Mini-Grids in Myanmar
- South African German Energy Programme (SAGEN) – Approaches to guarantee proper operation, maintenance and monitoring
- Endev Ethiopia – Endev Ethiopian cooperative model approach, a mini-grid operation model
- RERA Nepal - Preliminary outcomes and their analysis of a study on the status of 350 micro-hydro projects in Province 1 and Sudoorpaschim Province in Nepal
- Endev Indonesia – Universal remote monitoring system for PV mini-grid performance monitoring

- RERA Nepal – Digital approaches for assessing and monitoring mini-grid projects
- Deputy Director of Technical and Environmental for Various New Renewable Energy, MoEMR – Monitoring and Reporting of Small Solar PV Performance in Remote Areas

Discussion: 15-20 minutes after each presentation

Key Takeaways and Follow Up actions by Moderator

WEDNESDAY, 28 AUGUST 2019

08.30 – 16.00 Sustainability and Other Aspects of PV Mini-grid Implementation

Moderator: Nanik Rahmawati (ELREN Indonesia)

Presentation (15 minutes each)

- Endev Ethiopia – Productive Use of Energy, Gender and Justice
- Mrs. Maritje Hutapea (ex. Director of Various Energy, MEMR) – Mini-grid implementation framework in Indonesia
- RERA Nepal – Approached to Ensure Sustainability of the Mini-grids
- Endev Indonesia – Smart metering system for PV mini-grid system
- Mr. Bambang Sumaryo (Indonesia Solar Rooftop Association) – Interconnection tariff scheme in Indonesia, a lesson learned
- South African German Energy Programme (SAGEN) – Approach to Sustainability in South Africa

Discussion: 15-20 minutes after each presentation

Key Takeaways and Follow Up actions by Moderator

THURSDAY, 29 AUGUST 2019

08.00 – 17.00 Site Visit to Sabangko Island in South Sulawesi

- **Small island PV mini-grid with community-based management approach**
- **Productive use activities utilizing excess energy from PV system**
- **Smart payment system implementation for smart fee collection and energy management system of PV Mini-grid**
- **Remote monitoring system for performance monitoring tool**
- **RE Boat implementation for small artisanal fisheries**

- Transport to Maccini Baji port (07.00 – 08.30)
- To Sabangko (09.00 – 09.30)
- At Sabangko (09.30 – 15.00)
- To Maccini Baji port (15.00 – 15.45)
- To Makassar (16.00 – 17.30)
- Dinner (19.00 – 21.00)

Annex 2: Workshop Topic Guideline

PLANNING AND DESIGN

Planning of PV mini-grid can cover issues about planning policy of PV mini-grid deployment (for government), site selection, resource assessment, demand calculation, spatial plan for PV mini-grid planning, new technology to support planning, multi-stakeholder engagement in planning, community-based planning and other issues related to plan for a new PV mini-grid.

Design is specifically looking at how specific PV mini-grid design is selected. It covers issues about sizing, configuration selection, future considerations of demand, future considerations of grid connection, design of distribution system, metering and other issues related to PV mini-grid design phase.

TENDER AND CONTRACT

Tender and contract phase is defined as the phase to release the information about the project to EPC company to get the best offer to construct the PV mini-grid. Contracting is the following step after a winning EPC company is selected.

This topic will cover issues about key aspects in tender document (e.g. technical specification, site information etc.), ways to ensure that contractor delivers, and other issues related to tendering and contracting process.

CONSTRUCTION AND INSTALLATION

Construction and installation phase are very clear in definition. It is the phase when the actual PV mini-grid is erected. This topic can cover issues about best practices in construction of PV mini-grid, materials, handling of fragile PV mini-grid equipment, standards or guidelines to follow, capacity building for PV mini-grid builders and installers and other issues related to construction and installation of PV mini-grid.

COMMISSIONING, ACCEPTANCE AND INSPECTION

Commissioning phase is way to formalize quality control of installed PV systems. The process ensures that systems are safe and high performing. It is very important for the safe operation of PV mini-grid. This phase determines the long-term operation of PV mini-grid. This topic can cover issues about standard or guideline applied for commissioning, who conduct commissioning, specific checklist used, best practice of commissioning, performance rating, tools and equipment for commissioning, safety measures, reporting, capacity building, re-commissioning and other issues about commissioning.

Acceptance is the process to accept the performance of the system. Commissioning is usually a requirement in the acceptance test. This topic can cover issue about acceptance test requirements, who conduct acceptance test, best practice in conducting acceptance test and other issues related to acceptance process.

Inspection is the process to inspect the PV mini-grid. This topic can cover issues about best practice in inspection, inspection check list, who conduct the inspection and other issues related to inspection.

OPERATION AND MAINTENANCE

After the PV mini-grid is erected, they will be operated to provide service. Operation and maintenance topic can cover issues about capacity building for operators or technicians, key aspects in operation and maintenance for sustainable mini-grid, institutional setup (community based, utility like, pure private etc.), OPEX cost, maintenance cost, tariff system, performance contracting, and other issues related to operation and maintenance.

MONITORING AND REPORTING

Monitoring of PV mini-grid performance is important to assess the sustainability and potential technical issues of the system. This topic can cover issues about monitoring system implemented, how the information is used, the trends, follow up actions after monitoring, reporting mechanism, who do the monitoring and reporting, and other issues related to monitoring and reporting.

REPAIR AND SUPPORTS

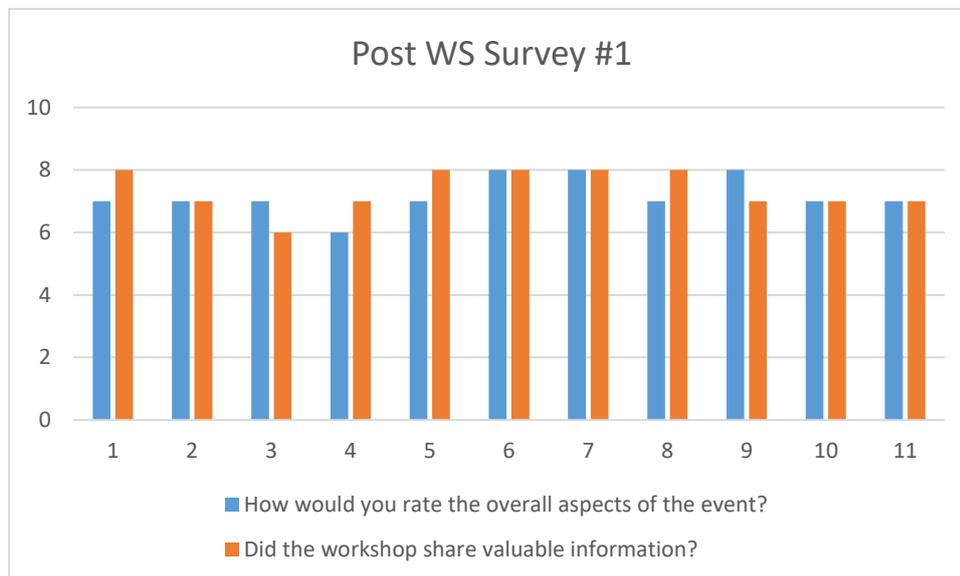
In different levels, internal capacity can do repairs of the PV mini-grid. There are cases when internal capacity can only do the basic maintenance, therefore repairs and other supports are conducted by specific technicians. This topic can cover issues about warranty system implemented, repairs beyond warranty period, performance contracting, issues in warranty claim, new ideas for tackling repair and support issues, capacity building, and other aspects relate to repair and supports.

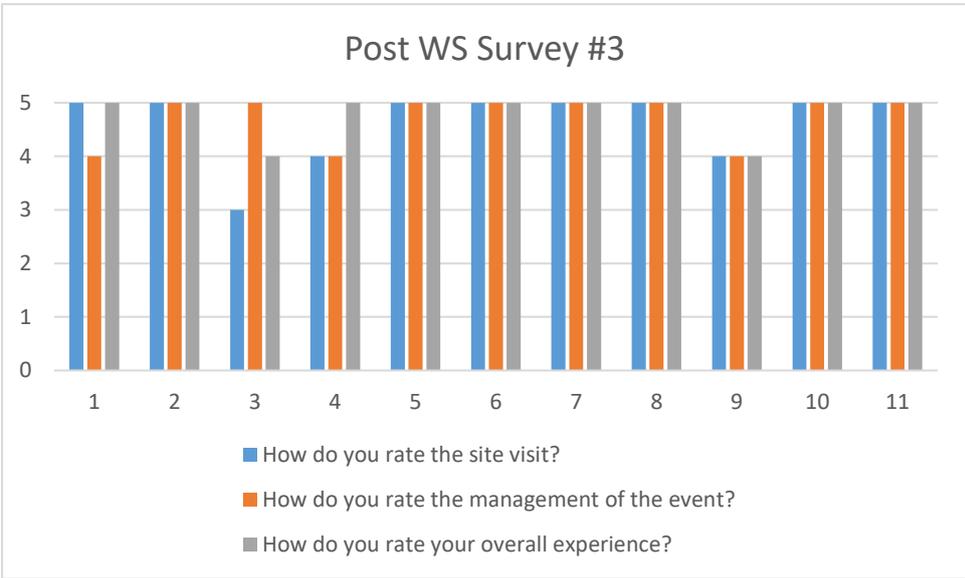
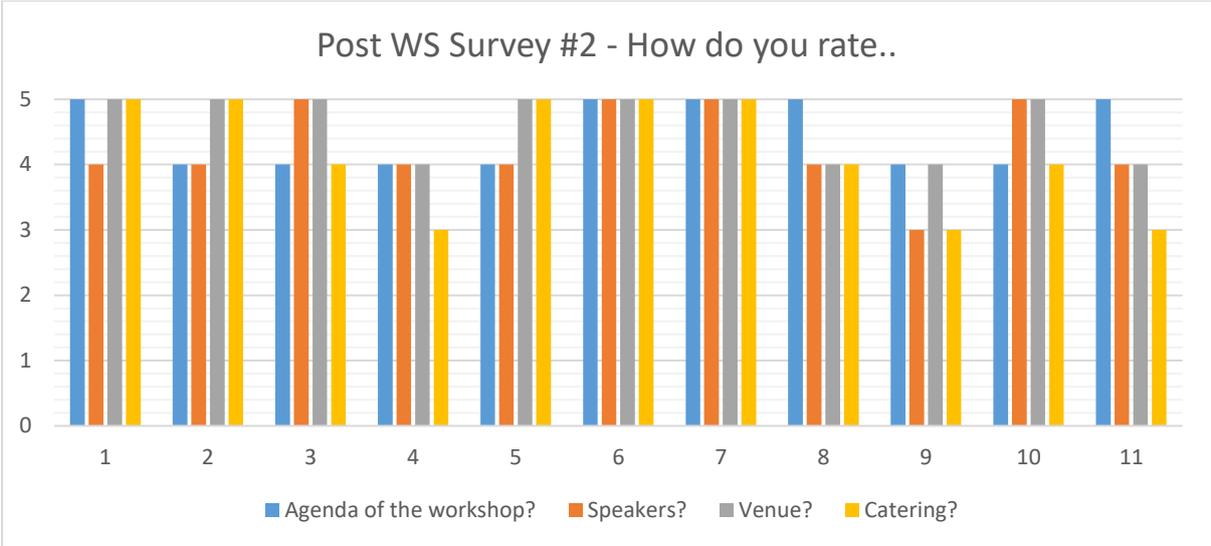
OTHER ISSUES: SUSTAINABILITY, FINANCING ETC.

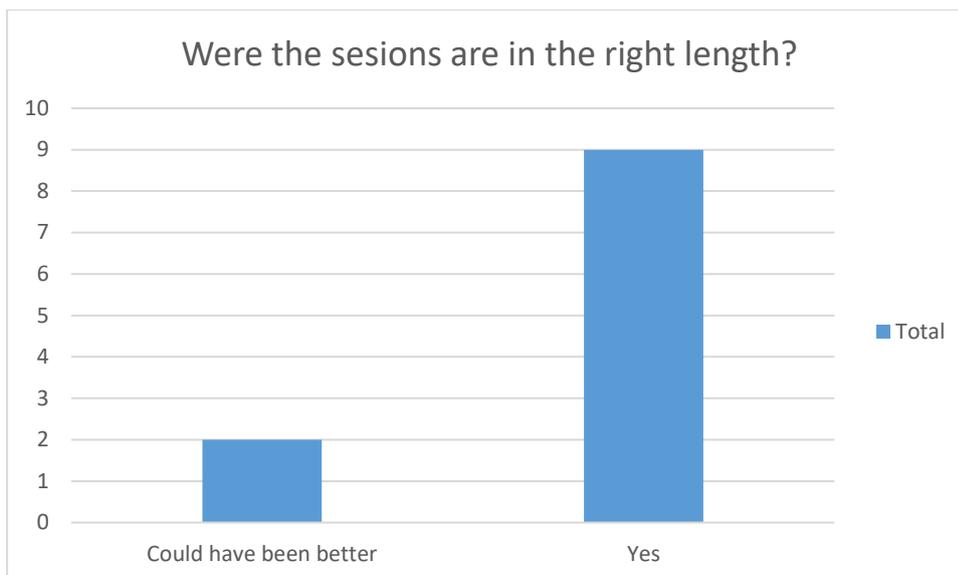
Other issues related to sustainability of PV mini-grid is widest topic. It can cover issues about productive use of energy, community aspect of PV mini-grid, financing of PV mini-grid, new innovations to improve sustainability of PV mini-grid, capacity building, and other issues related to improvement of PV mini-grid sustainability. Any other issues related to PV mini-grid that are not covered in other sections can be included here.

Annex 3: Post Workshop Survey Results

An online survey was conducted after the workshop. The target group is mainly the foreign participants. There are 11 responses. Here are the results.







No	Would you like to put other comments or feedback?
1	The event was organized very well. Countries with proven experience on the subject matter were also participated. A lot of new information and lesson learned! Many takeaways!! Was incredible!!Thank you EnDev Indonesia!!
2	No
3	Well prepared, very well executed
4	More interactive sessions would have been good to keep everyone on board, especially after the lunch brakes.
5	Missed more of the topic how to support or even create the market for Mini-grids (climate funding, other alternative supports, ...)
6	Great job on the facilitation and time management, this made the event very successful. Good energy from GIZ Indonesia colleagues. I really enjoyed the cartoon movies at the end of the presentations, and the awards in the end, which makes the atmosphere very light but still dynamic and interactive. As a small comment, an energizer exercise when the afternoon session would start could benefit the attention and avoid sleepy eyes after lunch.
7	Apparat from the knowledge exchange the event organization and all the hospitality Great! thanks Again. And glad to see the group in active communication!
8	None
9	
10	None
11	No comment

No	What was your least favourite part of this event?
1	Difficult to choose
2	None
3	N/a

4	The missing good-bye dinner.
5	Not enough time, more commitment by government partners.
6	None
7	Everything was interesting for me even though it is not possible to share and harness everything with a single workshop but with the planned platform it will be a support network for the sector.
8	None
9	Discussion part
10	None
11	N/A

No	Were there any parts of the conference that you found especially useful? Please elaborate the reason
1	Yes, there are. For example; the monitoring system by EnDev Indonesia, management model/Operation and maintenance.
2	The Remote Monitoring System being developed by GIZ Indonesia.
3	Knowledge sharing between audience, new method/technology on monitoring and management of mini-grid/off-grid.
4	Discussion were on a very high level - focus on practicality.
5	Practical experience of the members - knowledge exchange between these practitioners.
6	Very well facilitated and time managed, so lots of different subjects could be addressed which was very helpful in general. Q&A sessions were all relevant and useful to dive deeper in certain subjects. In general, all topics were useful, but personally most useful topic was the discussion about tariffs and smart metering system from GIZ Indonesia.
7	The role of Indonesian Government on giving focus on mini-grid technologies. synergy among different organization for the implementation of mini-grids, rebuts technical skill of Endevo, private sector and government officials, running businesses in rural community etc. other countries experience, also no matter how advance with some technology always there is a challenge which helps to advance technical and management skills.
8	Yes. Monitoring and Reporting of Solar PV mini-grids plants in remote areas; Productive use of Energy and Energy Justice; approaches to ensure sustainability of mini-grids projects.
9	-
10	Discussion on the evolution of the legal framework for RE in Indonesia.
11	Different Examples from participants delegates.

No	How beneficial was the information presented at this event will positively impact execution of your job?
1	It was very informative and good inputs already for my job. for example, the ownership model what we are currently tackling. The Operation, maintenance and management issues are very critical activities in mini-grid implementation. We had a lot of changes on that. Discussion on ULAB was very constructive which we are looking to have some support in the area.
2	With the coming on line of more than 160 solar PV mini-grids in Kenya a way to help remote monitor them will be much helpful.
3	Helping to open new opportunities and possibilities.
4	Good practise is shared and gives an overview on "how is working on what and on which level".
5	Yes, very motivating, hope to keep contact to further exchange knowledge.
6	Very beneficial, especially the tariffs, smart metering, and knowing the challenges that other colleagues are facing are almost the same everywhere.
7	Defiantly!
8	It was quite useful because we are rolling out a programme of implementing 151 mini-grids in underserved counties in our country
9	Mostly impactful
10	Very beneficial as we are in the process of drafting regulations on mini-grid and net metering.
11	Yes

No	How likely are you to attend another mini-grid practitioner workshop?
1	Very much !!
2	Very likely when the opportunity is presented
3	Very much interested, especially if organised in the region/area
4	100%
5	Very likely!!!
6	Very likely
7	Very much interested based on our program implementation approach and availability of budget
8	Given an opportunity I will attend such an informative workshop
9	Interested
10	Very likely
11	Yes

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