EnDev Indonesia

Annual Report 2017

February 2018

energising development

Funded by:

Ministry of Foreign Affairs of the Netherlands

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

In cooperation with:

Directorate General of New, Renewable Energy and Energy Conservation (DG NREEC)

Coordinated and implemented by:

Netherlands Enterprise Agency

EnDev Indonesia

Annual Report 2017

February 2018

energising development

This Annual Report provides a summary of achievements and lessons learned as annual reviews. Further information can be obtained from GIZ.

In collaboration with:
Directorate General of New, Renewable Energy and Energy Conservation (DG NREEC)
under Ministry of Energy and Mineral Resources (MEMR)

Published by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Energising Development (EnDev) Indonesia
Gedung De RITZ Lantai 3
Jl. HOS. Cokroaminoto No. 91
Menteng, Jakarta Pusat 10310
Indonesia
Tel: +62 21 391 5885
Fax: +62 21 391 5859
Website: www.endev-indonesia.info

GIZ team for EnDev Indonesia:
Rudolf Rauch | *Principal Advisor*
Amalia Suryani | *Project Manager*
Erwina Darmajanti | *Senior Advisor*
Atiek Puspa Fadhilah | *Advisor*
Bagus Fajar Ramadhani | *Advisor*
Nurul Indariah | *Office Manager*
Syifa Astarini Iskandar | *Communication Advisor*
Masri J. Vani | *Multimedia Professional*
Ateng Kurniawan | *Office Assistant*

Title of cover picture: Officials of the Work Acceptance Committee (PPHP) are taking part in the field training on technical inspection of PV mini-grid to further understand the function, performance, and safety aspect of PV mini-grid system (location: PV mini-grid in Sampang, Sidomulyo, DI Yogyakarta, 15 kWp capacity, connected to 52 houses).

Printed and distributed by GIZ
Jakarta, 2018

Table of Content

Table of Content ii

List of Tables and Figures iii

Abbreviations v

Introduction 1

1. Model of PV Mini-grid Management 7
2. Model of Local Technical Service Provider for PV Mini-grid 11
3. Technical Quality Support 18
   - 3.1. Development of PV Mini-grid Commissioning Protocol 18
   - 3.2. Facilitation for Inspection of PV Mini-grid and MHP 20
   - 3.3. Knowledge Transfer on Methodology of PV Mini-grid Technical Performance Analysis 23
   - 3.4. Support for the PV mini-grid/MHP revitalisation programme 23
   - 3.5. Guideline for Local Government on Warranty of PV Mini-grid Components and Installation 25
4. Support on Monitoring and Evaluation 27
   - 4.1. Support in Development of Electronic/Online Platform 27
   - 4.2. Facilitating the Feasibility Study Evaluation 33
   - 4.3. Development of Detailed Reporting Forms 34
5. Knowledge Management 37
   - 5.1. Book of Good and Bad of PV Mini-grid 37
   - 5.2. Checklist for PV Mini-grid Maintenance 40
   - 5.3. Training Module on Operation and Maintenance of PV Mini-grid 41
   - 5.4. Guide Poster on Maintenance and Troubleshooting of PV Mini-grid 41
   - 5.5. IRENA: MSP Instrument for Quality Assurance of PV Mini-grid 42
   - 5.6. Roadshow: Socialisation of PV Mini-grid for Students 43
6. Support for Bioenergy-based Rural Electrification 45
7. Gender Equality Mainstreaming 46

Collaboration with Other GIZ Projects 50

Participation in External Activities 55

Implementation Plan 2018 60

Annex A: List of Training 62

Annex B: List of Publications 65

List of Tables and Figures

Table 1 Overview of EnDev Indonesia Work Plan 2017-2018 2
Table 2 Structure of Annual Report 2017 5
Table 3 Location of RUMI pilot 7
Table 4 SWOT analysis table for local technical service 12
Table 5 Selection criteria for National Partner and Local Partner 13
Table 6 Technical training materials for potential Local Partners 15
Table 7 Criteria of trainees in Local Technical Service Provider pilot 15
Table 8 Advantages and disadvantages of Software as a Service (SaaS) scheme 32
Table 9 Advantages and disadvantages of PPP scheme 33
Table 10 List of activities implementation and participation 58

Figure 1 DG NREEC and GIZ together developing the Work Plan of EnDev Indonesia 2017-2018 4
Figure 2 PV mini-grid 30 kWp in Pegadungan, Lombok Utara 7
Figure 3 The scope of the RUMI pilot 8
Figure 4 Facilitation process in relation to the establishment of a formal institution 8
Figure 5 Four activity components in implementation of RUMI 9
Figure 6 Inauguration of cooperative management by the local agency 10
Figure 7 PV technicians and operators training in the field 11
Figure 8 Alumnis of vocational school is the prospective reliable technician partner 12
Figure 9 Partnership scheme for local PV mini-grid technical services 13
Figure 10 Female participants are highly recommended in the training 14
Figure 11 Composition of technical training participants 16
Figure 12 Training session “Good and Bad of PV Mini-grid Installation” 16
Figure 13 Content of PV mini-grid commissioning procedure 19
Figure 14 Technical staff of DC NREEC are conducting KPI survey with the Village Chief 21
Figure 15 Current measurement on cables detected by infrared camera (thermal imaging) 21
Figure 16 Presentation on basic theory of PV mini-grid 22
Figure 17 On-the-job inspection training at PV mini-grid 22
Figure 18 DG NREEC staff are conducting measurement at combiner box 24
Figure 19 SINERGI DESA display 28
Figure 20 SINERGI DESA Team presentation, SINOVIK 2017 29
Figure 21 Awarding of Top 99 Public Innovation 29
Figure 22 Map of Rural Power Plants www.remap-indonesia.org 30
Figure 23 Development of the communication platform until it became Energi Desa 31
Figure 24 Development of Energi Desa users 31
Figure 25 Aspects to be evaluated in feasibility study 34
Figure 26 Content and structure of the book of Good and Bad of PV Mini-grid 38
Figure 27 Preview Book of Good and Bad PV Mini-grid 39
Figure 28 Explanation on example of Good and Bad Installation of PV power plant 39
Figure 29 Matrix of periodic maintenance of PV mini-grid 40
Figure 30 Explanation by the trainer regarding the maintenance checklist 41
Figure 31 Newest Version of Maintenance and Troubleshooting Guide for PV Mini-grid Poster 42
Figure 32 Question and answer session with full enthutiasm regarding PV system 43
Figure 33 Workshop on student empowerment for the implementation and utilisation of RE in rural areas 44
Figure 34 Work division plan on off-grid PLTBiogas management pilot 45
Figure 35 Series of poster in promoting gender equality 46
Figure 36 Women participants during the Training of PV Mini-grid Management at Pegadungan Hamlet 47
Figure 37 Women and men have equal chance in the activities 48

Figure 38 Pilot project location of solar-powered ice maker in Papagarang Island 50
Gambar 39 The concept of solar-powered ice block maker development 51
Figure 40 Pilot site criteria for solar-powered ice block maker 51
Figure 41 Schedule of pilot implementation 52
Figure 42 PV mini-grid at Tungkup Hamlet, Belitung Timur District 53
Figure 43 Participants of study tour who are the stakeholders from DG NREEC, DJK, and PLN 55
Figure 44 Introduction of ELREN project at EBTKE Conex 2017 56
Figure 45 Contingent of Vice Minister EMR in PV mini-grid Tungkup, Belitung Timur 58

Abbreviations

AKLI	Indonesian Electrical and Mechanical Contractors Association
APBN	National Budget
Bappeda	Regional Development Planning Agency
Bappenas	National Development Planning Agency
BMWi	German Federal Ministry of Economics and Energy
BMZ	German Federal Ministry of Economic Cooperation and Development
BPS	Statistics Center Agency
BUMDes	Village Owned Enterprise
CEFE	Competency based Economies through Formation of Entreprise
DAE	Directorate of Various New and Renewable Energy
DAK	Special Allocated Budget
DFW	Destructive Fishing Watch
DG NREEC	Directorate General of New, Renewable Energy and Energy Conservation
Dit.	Directorate
DJK	Directorate General of Electricity
EBT	New Renewable Energy
ELREN	Electrification through Renewable Energy
EnDev	Energising Development
EPC	Engineering, Procurement, Construction
ESDM	Energy and Mineral Resources
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
HH	Household
ID/IDR	Indonesia/Indonesian Rupiah
IESR	Institute for Essential Services Reform
IRENA	International Renewable Energy Agency
IT	Information Technology
IUPTL	Licence for Electricity Supply Business
Kemendesa	Indonesian Ministry of Villages, Disadvantaged Regions, and Transmigration
KfW	German Development Bank
KKP	Ministry of Marine Affairs and Fishery
Koperindag	Cooperative, Industry and Trade
KPI	Key Performance Indicator
KPS	Public and Private Partnership
KSU	Multi-Purpose Cooperative
KUKM	Indonesian Ministry of Cooperatives and Small and Medium Enterprises
kW	kilo Watt
kWh	kilo Watt-hour
kWp	kilo Watt-peak
LCORE-INDO	Promotion of Least Cost Renewables in Indonesia
LSM	Non-Governmental Organisation
MCA-Indonesia	Millennium Challenge Account Indonesia
MCB	Miniature Circuit Breaker
MEMR	Ministry of Energy and Mineral Resources
MHP	Micro Hydro Power
MSP	Mini-grid Service Package
MW	Mega Watt

MWp	Mega Watt-peak
NTB	Nusa Tenggara Barat
NTT	Nusa Tenggara Timur
Permen	Ministerial Regulation
PJBL	Power Purchase Agreement
PLN	PT Perusahaan Listrik Negara (Indonesia National Electricity Company)
PLTBiogas	Biogas power plant
PLTS	Centralised PV power plant (= PV mini-grid)
PNPM LMP	National Programme for Community Empowerment – Independent Rural Areas Environment
PNPM MP	National Programme for Community Empowerment – Independent Rural Areas
POME	Palm Oil Mill Effluent
PPA	Power Purchase Agreement
PPHP	*Panitia Penerima Hasil Pekerjaan* (the Work Acceptance Committee)
PPP	Public Private Partnership
PUE	Productive Use of Energy/Electricity
PV	Photovoltaic
RAB	Budget Plan
RE	Renewable energy
REEP	1000-Islands Renewable Energy for Electrification Programme
RUMI	Rural Mini-grid Management
SDG	Sustainable Development Goals
SMKN	Public Vocational Secondary School
SMS	Short Message Service
SNI	Indonesian National Standard
SWOT	Strengths, Weaknesses, Opportunities, Threats
TOT	Training of Trainers
TSU	Technical Support Unit
UN	United Nation
VMT	Village Management Team
WWF	World Wildlife Fund

Until 2017,

EnDev Indonesia has supported rural electrification programme for more than

190,000 people

1,500 public facilities

2,700 rural businesses

from

617 power plants,

built across the archipelago by various government and non-government initiatives.

Introduction

Energising Development (EnDev) Indonesia has a mission to support the availability of access to modern energy for 172,000 people in rural areas, 900 public facilities such as schools and community health centres, and 1,000 rural businesses through the use of renewable energy technologies. Based on the Implementing Agreement on November 1, 2014 between the Directorate General of New, Renewable Energy and Conservation (DG NREEC) and GIZ, EnDev Indonesia project focuses its support on micro-hydro, photovoltaic, and biomass-based rural electricity infrastructure. This cooperation also aims to improve the sustainability of rural electricity infrastructure as well as to institutionalise knowledge and experience to the local actors.

Until 2017, EnDev has worked for almost eight (8) years to support the implementation of rural electrification programme using renewable energy initiated by various initiatives in Indonesia. The support includes five (5) main approaches such as:

1. technical quality assurance measures
2. monitoring and evaluation
3. capacity development
4. technical support and/or pilot projects
5. information dissemination.

EnDev Indonesia period 2014-2018	
Official partner:	Ministry of Energy and Mineral Resources cq. DG NREEC
Implementation partner:	KKP, KUKM, Local government (especially Nusa Tenggara Barat Province), UGM, and several other non-governmental organisations, both private and public
Period:	November 2014 until Juli 2018
Contribution:	EUR 2,960,000
Funder:	Multi-donor EnDev (Germany, Netherlands, Norway, UK, Switzerland, Sweden)

By the end of 2017, EnDev Indonesia has supported and facilitated the programme of providing access to energy in 617 locations consisting of 309 micro hydro power plants (MHP) and 308 PV mini-grid (PLTS). The plants have capacity ranging from 5 kW to 600 kW which is operated and managed by the community. The fund for infrastructure development comes from various programmes, among others by the Ministry of Energy and Mineral Resources, Ministry of Cooperatives and local government through the Special Allocation Fund (DAK). The achievement is an accumulation of the supported locations since 2009 where the sustainability monitoring efforts of the systems is continuously being conducted.

EnDev is a global programme to support the provision of energy access. In Indonesia, EnDev is implemented together by the Directorate General of New, Renewable Energy and Energy Conservation (DG NREEC) and GIZ. EnDev Indonesia specifically supports rural electrification programmes through mini-grids from renewable energy, where the operation, maintenance and management are carried out directly by the community. The mini-grid infrastructure is generally funded by the Government of the Republic of Indonesia through various ministerial or local government programmes.

From the 617 installed power plants constructed all over Indonesia, as many as 191,434 people[1], 1,546 public facilities (such as schools, health centres, and religious buildings), and 2,741 rural businesses have benefited electricity both for lighting and productive activities.

WORK PLAN 2017-2018

In early 2017, DG NREEC and GIZ jointly drafted the EnDev Indonesia work plan for the period 2017 until the end of the project period in July 2018. A series of activities were agreed to be implemented together as shown in Table 1.

Table 1 Overview of EnDev Indonesia Work Plan 2017-2018

ACTIVITY	NAME OF ACTIVITY	DESCRIPTION	IMPLEMENTING PARTNER
1	**Pilot: development of local technical support service model**	Cooperation with private parties to provide maintenance and repair services of PV mini-grid at the provincial level. The private parties involved are national and local companies. The activity includes training for local technicians and establishment of business partnership between companies for the provision of technical services for PV mini-grid.	DAE
2	**Support for bioenergy-based rural electrification**	▪ It is an effort to develop a model for the management of commercial Biogas Power Plant capable of operating sustainably. ▪ Support will be in the form of coordination among stakeholders as well as case studies on Biogas Power Plant management. ▪ Implementation of this activity is planned to begin in the first semester of 2018, in collaboration with LCORE-INDO project.	Dit. Bioenergy
3	**Documentation of all the best practices of EnDev Indonesia project**	▪ It is a step to institutionalise the learning from each activity within EnDev Indonesia project to be applied in the future programmes, both within and outside DG NREEC. ▪ Documentation such as in the form of guidelines, reports, videos, or posters.	DAE
4	**Pilot: PV mini-grid management model in NTB Province (RUMI - Rural**	RUMI is a pilot project to improve the sustainability of rural electrification programme through the development of a cooperative-based PV mini-grid	DAE

[1] Then figure does not consider the correction factors applied in the calculation method by EnDev Global, which cover: sustainability adjustment factor, windfall gain factor, and double energy factor. Explanation about the correction factor can be accessed at https://endev.info/content/Monitoring.

	Mini-grid Management Model)	management model, strengthening the capacity of stakeholders and pioneering the availability of local technical services for PV mini-grid.	
5	**Support for proposal development, monitoring and dissemination of knowledge electronically/online**	Support for the online platform development initiative and adoption of the rural power generation map (RE-Map Indonesia), as well as recommendation on the concept of platform management for disseminating rural knowledge (*Energi Desa* application).	DAE
6	**Development of PV mini-grid commissioning protocol**	Commissioning is a method to control the quality of PV mini-grid that has been built. Due to the unavailability of standardised commissioning procedures for PV mini-grid, this activity aims at developing the concept of commissioning protocol based on EnDev Indonesia's experience in carrying out technical inspection during the previous three (3) years.	DAE
7	**Inspection facilitation for PV mini-grid and MHP**	Consists of several sub-activities: ▪ PPHP training on PV mini-grid systems and technical inspection methods. ▪ PPHP facilitation during field work. ▪ Recommendation on MHP experts for facilitating the PPHP for MHP.	DAE, Dit. Infrastructure
8	**Knowledge transfer on the methodology of technical performance analysis of PV mini-grid**	This is a follow-up activity of the technical performance analysis of two (2) PV mini-grids implemented at the end of 2016 which aims to train DG NREEC staff in conducting research and comparison of technical performance among PV mini-grids that have been built.	DAE
9	**Facilitate the evaluation of PV mini-grid feasibility study for the staff of DAE and Dit. Infrastructure**	Feasibility study is an important step in PV mini-grid construction. EnDev Indonesia supports DG NREEC in developing evaluation method of feasibility study for PV mini-grid either in the form of mentoring or training.	DAE, Dit. Infrastructure
10	**Support for the PV mini-grid/MHP revitalisation programme**	Support for revitalisation initiative of PV mini-grid infrastructures that require repair. That is in the form of technical guidance for PPHP in charge in checking the condition of the power plants in the field. This technical guidance include the introduction and	Dit. Infrastructure

		direction to use of the PV mini-grid technical inspection instrument.	
11	**Guideline for local government on warranty of PV mini-grid installation and components**	This guide aims to demonstrate how to apply for the warranty claim of PV mini-grid system and components, both within the warranty period and after.	DAE
12	**Development of detailed reporting forms and socialisation for local agencies**	It is planned to be part of the PV mini-grid Operation and Maintenance Guideline being prepared by DG NREEC. Support in the form of recommendation on reporting component by the local agencies.	DAE
13	**Gender mainstreaming in the management and electricity utilisation**	Promoting women participation in every aspect of rural development, including to increase women participation in PV mini-grid management through introduction of the basic concept of gender equality.	DAE

Figure 1 DG NREEC and GIZ together developing the Work Plan of EnDev Indonesia 2017-2018

STRUCTURE OF ANNUAL REPORT 2017

This report is prepared based on the topic of activity as well as the intensity of EnDev Indonesia's support with the structure according to the following table:

Table 2 Structure of Annual Report 2017

Chapter	Topic	Scope of Activities/Reference to the Work Plan
	Introduction	Achievement of main indicators
1	Model of PV Mini-grid Management	**(4)** Pilot: PV mini-grid management model in NTB Province (RUMI - Rural Mini-grid Management Model)
2	Model of Local Technical Service Provider for PV Mini-grid	**(1)** Pilot: development of local technical support service model
3	Technical Quality Support	**(6)** Development of PV mini-grid commissioning protocol **(7)** Inspection facilitation for PV mini-grid and MHP **(8)** Knowledge transfer regarding methodology on technical performance analysis of PV mini-grid **(10)** Support for the PV mini-grid/MHP revitalisation programme **(11)** Guideline for local government on warranty of PV mini-grid installation and components
4	Support on Monitoring and Evaluation	**(5)** Support for proposal development, monitoring and dissemination of knowledge electronically/online **(9)** Facilitate the evaluation of PV mini-grid feasibility study for the staff of DAE and Dit. Infrastructure **(12)** Development of detailed reporting forms and socialisation for local agencies
5	Knowledge Management	**(3)** Documentation of all the best practices of EnDev Indonesia project
6	Support for Bioenergy-based Rural Electrification	**(2)** Support for bioenergy-based rural electrification
7	Gender Equality Mainstreaming	**(13)** Gender mainstreaming in the management and electricity utilisation
	Collaboration with Other GIZ Projects	
	Participation of External Activities	
	Implementation Plan 2018	
	Annexes	

Note: **(##)** is the sequence number of activities based on the Work Plan 2017-2018 as a reference.

"Through the entrepreneurship training, we can improve our knowledge and insight about good business ideas and in the future we can use to develop our own business,"

Syamsuddin, participant of Entrepreneurship Training in Moyo Island, Sumbawa District, NTB.

1. Model of PV Mini-grid Management

In May 2017, EnDev Indonesia initiated a pilot project called Rural Mini-grid Management Model (RUMI) which is part of the efforts in improving the sustainability of renewable energy-based rural electrification programme by 1) strengthening and transforming the institutional management of PV mini-grid into a formal legal organisation, 2) strengthening the capacity of local actors, including the development of local service provider and technician for PV mini-grid.

RUMI began with a workshop titled “Mapping of Stakeholders’ Role and Support for Sustainability of PV mini-grid Management" on 17 May 2017 in Mataram, attended by 28 participants from various government and non-governmental elements. This pilot was conducted in four hamlets in Nusa Tenggara Barat Province (NTB), as follow:

Table 3 Location of RUMI pilot

Location code	Hamlet	Village	Sub-District	District	Capacity (kWp)	HH	Funding
NTBS15	Pegadungan	Sambik Elen	Bayan	Lombok Utara	30	79	APBD (DAK)
NTBS13	Arung Santek	Labuan Aji (Pulau Moyo)	Labuan Badas	Sumbawa	15	104	APBN
NTBS16	Brang Kua				30	105	APBD (DAK)
NTBS17	Lepa Loang				10	59	Kemendesa

Figure 2 PV mini-grid 30 kWp in Pegadungan, Lombok Utara

In RUMI, the developed model is not only limited to the management and performance aspects of the plant, but also on the community income aspect, since these two aspects are closely intertwined in building a sustainable PV mini-grid management. To achieve such sustainable management system, the support of all relevant stakeholders is required. For that reason RUMI works in the scope as shown in Figure 3.

In the implementation of activities, GIZ is assisted by TRANSFORM Foundation who serves as a communication bridge with the local stakeholders as well as field facilitator. The implementation of RUMI pilot was divided into three (3) stages: (a) the preparation stage, (b) the implementation stage, and (c) the forward strategy formulation stage.

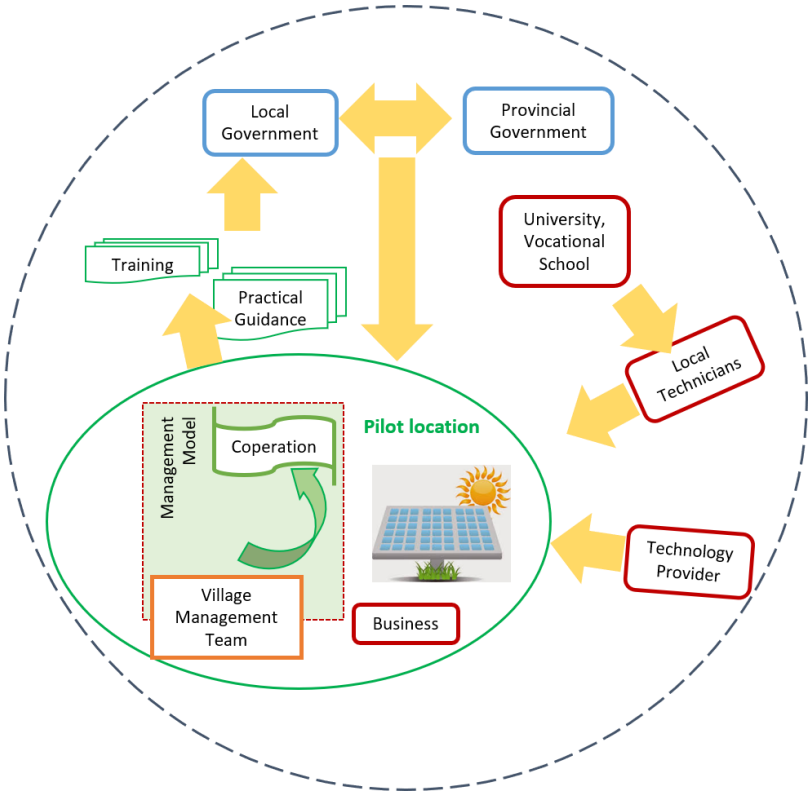


Figure 3 The scope of the RUMI pilot

A. PREPARATION STAGE

This stage began with a series of discussions with stakeholders, including the ESDM agencies at provincial and district levels, Bappeda NTB, provincial and district KUKM agencies, NTB branch of Indonesian Electrical and Mechanical Contractors Association (AKLI), NTB Regional Development Bank, and PEKA Sinergi. The objective of this stage is to acquire support from the key stakeholders in NTB Province. This process resulted in an agreement through the issuance of a Joint Agreement between the Government of NTB and GIZ on 16 May 2017 to conduct RUMI pilot.

Figure 4 Facilitation process in relation to the establishment of a formal institution

B. IMPLEMENTATION STAGE

There are four (4) components of the activities undertaken at this stage which are: (a) improving the performance of PV mini-grid, (b) improving the institutional and management quality of the PV mini-grid, (c) increasing the community's ability to pay, and (d) improving coordination and cooperation among stakeholders. The activities of each component are shown out in Figure 5.

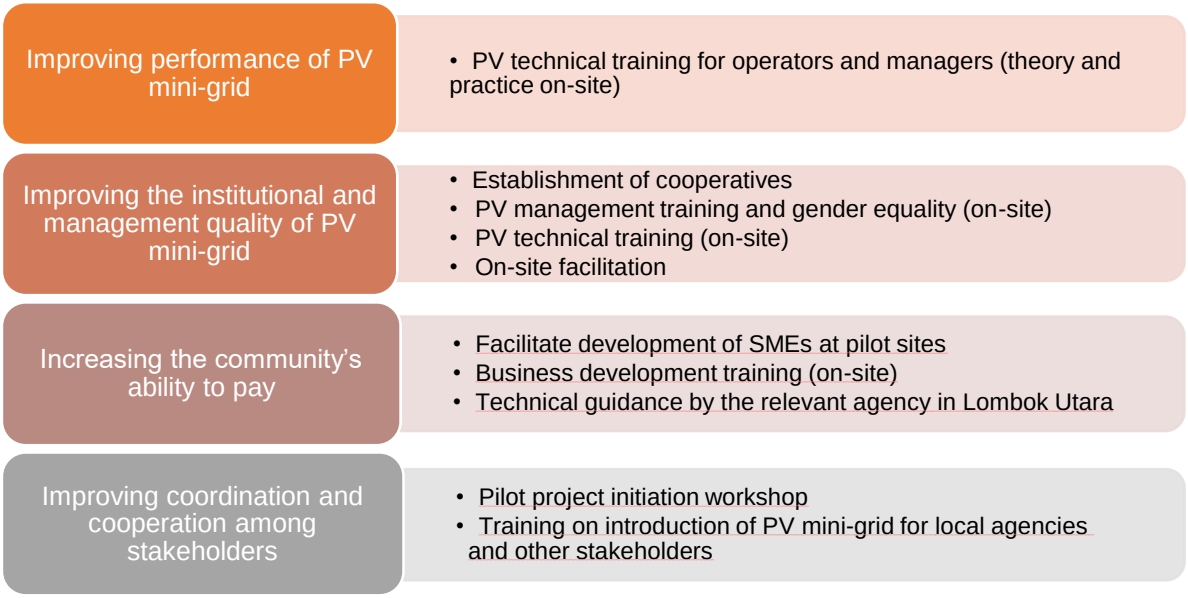


Figure 5 Four activity components in implementation of RUMI

Until end of December 2017, the results achieved by RUMI are as follow:

[1] Stronger communication and cooperation among stakeholders related to electricity and rural economy development. One of the tangible cooperation on-site is technical guidance with the tittle "Local Food Processing" by the Local Agency of Cooperative, Industry, Trade and SME (*Dinas Koperindag dan UKM*) of Lombok Utara District for entrepreneurs in Pegadungan Hamlet.

[2] Inauguration of the establishment of Multipurpose Cooperative (KSU) "Cahaya Surya Pegadungan" on November 15, 2017.

[3] The establishment of three (3) pre-cooperatives in Moyo Island, i.e. KSU "Arung Pulau Moyo" in Hamlet of Arung Santek, KSU "Karya Mitra Brang Kua Mandiri" in Hamlet of Brang Kua, and KSU "Karya Moyo Utama" in Hamlet of Lepa Loang. All of these three pre-cooperatives are processing their licences to the relevant office. For the record, cooperative is a formal institution selected by the community to manage the village electricity. The process of establishing the cooperatives was guided by the local government.

	[4] Inside the (pre-) cooperatives there is a unit responsible for the operation and maintenance of PV mini-grid. This unit, called the Electricity Service Unit, has started running a good administration system such as recording the financial condition and using logbook to record the technical performance of PV mini-grid. In addition, operators now understand better how to operate and maintain the PV mini-grid.
	[5] Through an intensive facilitation process in raising public awareness on gender equality issues, RUMI monitored the increased involvement and participation of women in activities related to the management and utilisation of PV mini-grid reaching 3% to 30%.

C. FORWARD STRATEGY FORMULATION STAGE

As the closing of RUMI pilot project, a workshop will be held in March 2018 to discuss the support strategy of the stakeholder in the future. Discussion topic will focus on the efforts to improve the community welfare in achieving the sustainability of PV mini-grid post RUMI. Workshop participants will include all stakeholders from the government side, private sector, banking, non-governmental organisation, university as well as PV mini-grid beneficiary in NTB Province.

The mapping design of the follow-up synergies in the rural economic development based on PV mini-grid will be presented in the following structure:

- ideal sustainability condition in rural economic development based on PV mini-grid,
- condition before RUMI was implemented,
- results achieved until the end of RUMI implementation,
- programmes and support needed by the PV mini-grid beneficiary community post RUMI.

The workshop is expected to bring in an agreement on strategies to improve the community welfare in four RUMI locations to achieve sustainability of PV mini-grid.

Figure 6 Inauguration of cooperative management by the local agency

2. Model of Local Technical Service Provider for PV Mini-grid

A. RATIONALE

Currently, the adoption of renewable energy technologies in rural areas has not been supported by the availability of reliable maintenance and repair services. As a result, some power generation systems struggle to survive in order to operate within their intended use and lifespan. It is even worse for sophisticated technology, such as PV mini-grid, where the expertise and skill in handling are still concentrated on a small number of technicians in Jawa Island. In addition, the quality of local technician and the technical support mechanism need to be set to sustain the quality of maintenance and repair required.

Building the expertise and skill on RE technology requires time and encouragement from the support structures such as government, academia and other RE industry sectors. The development of MHP technology in rural areas can be an example in building a network of expertise and skill in the technology. Technicians and spare parts are easily accessible, thus enable people to conduct repair when needed. For PV mini-grid users, such service is still very limited and constrained by the distance and cost because the service providers are generally located in the island of Jawa and Bali.

EnDev Indonesia initiated a pilot project related to the availability of affordable and qualified technical services for PV mini-grid. The pilot is implemented in the NTB Province, which is situated in the central part of Indonesia, so it can be accessed both from the western and eastern regions. This pilot involves experienced national-scale private companies with an interest in the providing the technical services for PV mini-grid and build a wider network of PV mini-grid technicians. The private company will partner with a local electrical contractor to run a technical service business covering maintenance and repair for PV mini-grid. Therefore, skilled technicians are needed to handle the PV mini-grid.

Figure 7 PV technicians and operators training in the field

The pilot **Local Technical Service Provider** aims to realise the availability of technical support for RE power generation plants that are easily accessible by the local community. This activity is not limited to physical construction such as renewable energy “workshop”, but instead in the form of capacity development of local technicians to be more skilful in handling RE technology and partnership with experienced companies.

B. CONCEPT OF LOCAL TECHNICAL SERVICE PROVIDER

The technical service model developed in this pilot is a partnership model between a national-scale PV company (National Partner) and local contractor/local electrical technician (Local Partner) who have at least work experience at the provincial level. Simply put, this partnership is a service extension of the National Partner to be able to reach PV mini-grid users who need maintenance and repair services for their PV mini-grid.

Before reaching the decision to establish this partnership model, a SWOT analysis was conducted to map out the condition of technical service unit. The analysis can be seen in Table 4.

Table 4 SWOT analysis table for local technical service

Strength	**Opportunity**
▪ Closer to customers both geographically and socially ▪ Faster response ▪ Better market understanding ▪ More efficient travel and logistics costs ▪ Presence at the local level demonstrates the credibility and reliability of the service	▪ Increased number of private sector and communities using PV mini-grid ▪ Government policy to involve private sector to manage PV mini-grid in rural areas ▪ Manufacturers of battery and solar panel available in Indonesia ▪ Availability of vocational high school (SMK) students and electrical engineering students in every provinces in Indonesia
Weakness	**Threat**
▪ Additional cost to train local technicians ▪ Additional expenses for National Partner companies ▪ Various quality of work	▪ Stagnant customer growth ▪ Price increase on RE/PV mini-grid system components ▪ Parts are not available from the manufacturers ▪ Disturbance on logistics system ▪ Competition with other companies ▪ Government policies that do not support RE

C. PARTNERSHIP SCHEME

Based on the SWOT analysis, a number of criteria for selecting National Partner and Local Partner is prepared. After going through approach and discussion process with several national-scale EPC[2] companies, the idea of local technical services was welcomed by one EPC company i.e. TMLEnergy. The cooperation was then formalised in a Memorandum of Understanding. Furthermore, together with selected National Partner, criteria for the Local Partner were developed. This approach is important to ensure that the desired definition of quality can be achieved and long-term cooperation can take place.

Figure 8 Alumnis of vocational school is the prospective reliable technician partner

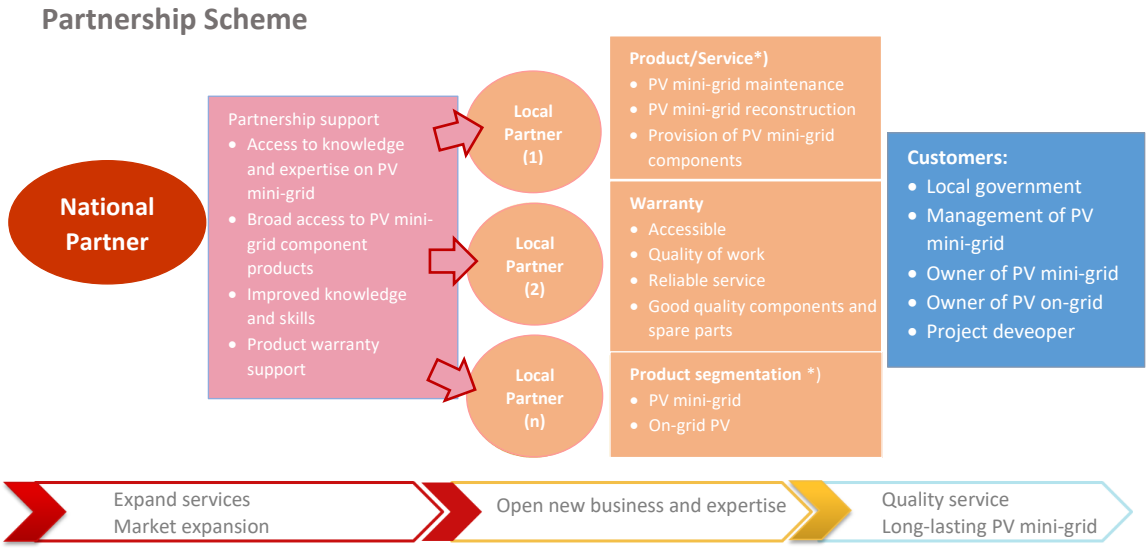
In general, the added value of this partnership for the Local Partner can be in the form of product and/or services diversity provided as well as guarantee on quality and availability. Quality assurance is achieved through transfer of knowledge and expertise from National Partner to Local Partner through training and guidance in carrying out the work. Thus the Local Partner can provide excellent service on the maintenance and repair of PV mini-grid.

[2] Engineering, Procurement, Construction

Table 5 Selection criteria for National Partner and Local Partner

National Partner	Local Partner
National-scale PV company	**Local contractor/electrical technician**
Company with legal status	Company with legal status
Work portfolio is spread in various regions in Indonesia	Has certification (at least) for electrical installation and distribution
A wide range of business services, including: feasibility study, construction, testing and commissioning, maintenance, and distributor	Has at least one (1) permanent technician and managerial employees
Experienced in handling PV mini-grid maintenance and repair	Have qualified technicians to work on projects related to PV mini-grid
Diverse variations of PV technology	

Within the framework of cooperation between National Partner and Local Partner, a partnership scheme that captures opportunities and minimises the expected weaknesses and threats was formulated. The form of cooperation between National Partner and Local Partner is described in Figure 9. National Partner would provide added value in the form of technical support that can help the Local Partner to provide better services.



**) May develop at any time according to market condition and interaction of cooperation between partners involved*

Figure 9 Partnership scheme for local PV mini-grid technical services

Together with the National Partner, a number of technical service packages for PV mini-grid has been developed in this pilot of which the Local Partner can use the packages to offer services/products to the intended customers. These service packages are discussed with the local government to test the accuracy of the service with the needs of potential customers. This process uses a simple co-creation strategy, by engaging the customer actively in preparing the product/service to match the needs and service experience desired by the customer. This partnership model is only one form of technical service that can be applied. Therefore, other pilots are needed to adapt with different regional contexts.

D. CAPACITY DEVELOPMENT THROUGH TRAINING

To solve the problem of lack of capacity of local technicians related to PV mini-grid technology, a training programme was designed and implemented as part of this pilot. The training is divided into two (2) main topics, which are (a) service business opportunity in RE field, and (b) technical training on maintenance and repair services of PV mini-grid. The topic of business opportunity was discussed in a discussion forum between the National Partner and potential Local Partners, both company and individual participants. As for the technical topic, the participants were trained on the maintenance and repair of PV mini-grid.

Figure 10 Female participants are highly recommended in the training

In this training, each local electrical contractor could assign up to three (3) employees consisting of management and engineering (preferably field technicians), with a maximum quota of two (2) technicians from one company.

Expected results

1. Develop the skills on PV mini-grid for the local technicians.
2. Initiate the network of PV mini-grid technicians both local and national scale.
3. Develop a unit capable of serving maintenance and repair services for PV mini-grid.
4. Encourage the adoption of renewable energy at provincial level and beyond.

Output

1. Training module on troubleshooting, maintenance and repair of PV mini-grid.
2. Training alumni book containing biodata information of the trainees (name, address/telephone to be contacted, expertise) with the purpose to facilitate a network among technicians and students who join the training.
3. Skilled technicians in the basics of troubleshooting and maintenance of PV mini-grid. The results of the training were measured through tests before and after the training.

Training method

Training materials were prepared and presented by the GIZ technical team and TMLEnergy (as National Partner), which includes explanation of the training materials as well as the test materials to measure the participants' skill before (pre-test) and after (post-test) the training. Detailed assessment criteria were also prepared for the trainees to accommodate the selection of Local Partners.

Table 6 Technical training materials for potential Local Partners

PV mini-grid theory	Service business opportunity	Field practice
1. The basics of PV mini-grid system 2. PV mini-grid components and the function 3. Construction of PV mini-grid 4. Operation and maintenance of PV mini-grid 5. Troubleshooting of PV mini-grid 6. Good and bad installation of PV mini-grid	Partnership schemes and business discussions of RE services, particularly PV mini-grid	Field practice (only for selected participants)

Selection for potential Local Partners and trainees

The pilot on development of technical service unit is a combination of partner selection and technical training. The trainees must meet the requirements set by GIZ and TMLEnergy based on documents reflecting their expertise and experience.

Table 7 Criteria of trainees in Local Technical Service Provider pilot

Criteria for local electrical contractors	Criteria for individual participants (technicians and vocational school students/university students)
1. Company with legal status (e.g. PT, CV). 2. Has certification (at least) for electrical installation and distribution. 3. Have at least one (1) year experience in electrical construction project. 4. Have at least one (1) permanent technician and managerial employees. 5. Have qualified technicians to work on projects related to PV mini-grid.	1. Understand the basic principles of electricity. 2. Capable of performing basic electrical measurements. 3. Reside in the province where the pilot is located. 4. Undergoing final year of vocational education in the field electrical/electronic or final year student (7^{th} or 8^{th} semester). 5. Female participants are strongly encouraged to participate in this training.

Training implementation

During two (2) weeks of registration period, seven (7) companies, 32 individual applicants, and eight (8) students of vocational school registered for the training. Only 13% of all prospective participants are female.

Of the total individual applicants, only 13% have certificates of competence in the electrical field, since most applicants are students. Prospective participants who pass the requirement were obliged to confirm within the period of 21-27 November 2017. Confirmation was made by six (6) companies with total representation of 14 participants from companies, and 36 individual participants. Of the registered participants, 45 people were present including personnel from three (3) local contractor companies who followed the training programme fully.

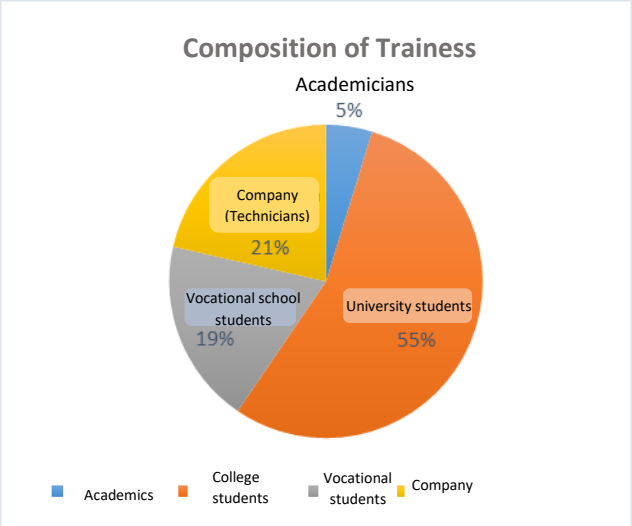


Figure 11 Composition of technical training participants

The electrical contractor companies participating in the training are members of the Indonesian Electrical and Mechanical Contractors Association (AKLI) of NTB region. The academicians involved are from Mataram University, Sumbawa University of Technology, and SMKN 3 Mataram.

Figure 12 Training session "Good and Bad of PV Mini-grid Installation"

Training evaluation

Each participant took a test before and after the training session. The results of this evaluation provide an interesting picture of the potential local technicians in the field of PV mini-grid, among others:

- Prospective technicians from vocational school have sufficient skills but require knowledge of the concept and design of PV mini-grid technology.
- Prospective technicians from universities have sufficient understanding of the concept and design, but require practical skills and knowledge of PV mini-grid system and technology.
- Prospective PV mini-grid technicians from companies absorb knowledge better when conducting case study discussion in the classroom and field practice.
- In general, company and individual technicians have improved understanding, especially on the topic of maintenance and repair of PV mini-grid where the teaching methods were focused on case study discussion and by seeing examples of work results and on-site condition.

3. Technical Quality Support

Since 2012 until now, DG NREEC has built more than 600 renewable energy-based power infrastructures. Various efforts to maintain the sustainability have been done through the EnDev Indonesia project, for example by the implementation of technical inspection for PV mini-grid in 2013-2015 and for MHP in 2014-2015, on-site training for the village electricity management team in the same years, technical performance analysis of two (2) PV mini-grid in 2016, pilot of PV mini-grid management model in NTB Province and compiling the book of Good and Bad PV Mini-grid in 2017. GIZ is also committed to provide continuous technical support through policy advice to maintain the technical quality of constructed PV mini-grid and MHP systems.

These series of technical support aims to ensure that the rural renewable energy-based electrification programmes will be better over time. In 2017, EnDev Indonesia has five (5) activities in the scope of technical support covering:

1. Development of PV mini-grid commissioning protocol,
2. Facilitation of PV mini-grid and MHP technical inspection together with DG NREEC staff,
3. Knowledge transfer on the methodology of technical performance analysis of PV mini-grid,
4. Support for revitalisation programme of PV mini-grid,
5. Guidelines for the local government on warranty of PV mini-grid components and installations.

Each of the above activities is described in Chapter 3.1. up to 3.5.

3.1. Development of PV Mini-grid Commissioning Protocol

The commissioning process is one of the crucial processes to ensure the quality of PV mini-grid systems. Commissioning aims to ensure that the system as well as sub-system have been installed, functioning and producing output according to the expected performance and meeting the safety standard. PV mini-grid commissioning process involves visual observation as well as test and measurement up to verification of safe operation of the system. A thorough process can improve the quality and safety of PV mini-grid system in accordance with the design and existing standard.

However, there is currently no standardised commissioning protocol available to ensure the quality of PV mini-grid installations in Indonesia. Each contractor uses their own protocol which is based on the verification requirement of each contractor. This results in varied performance quality from 600 locations of PV mini-grid. There is even quite a number of PV mini-grid systems which were not thoroughly evaluated which affecting the safety aspect of the system and poor system performance. To avoid this, a commissioning protocol for PV mini-grid is compiled and packed in a form of procedure to be used as reference in commissioning activities. The results of the commissioning report can also be an initial estimation of energy production from the system to consider the future maintenance needs.

This commissioning protocol contains recommendations on measurement method, data collection and checklists that can be used to maintain the quality uniformity of the performance verification methodology. Different from the grid-connected PV, there is no standard can be used as reference for PV mini-grid yet. However in the process of drafting, the protocol adopted IEC 62446 combined with some of the best practices in the commissioning process. The content of the commissioning procedure are as follow:

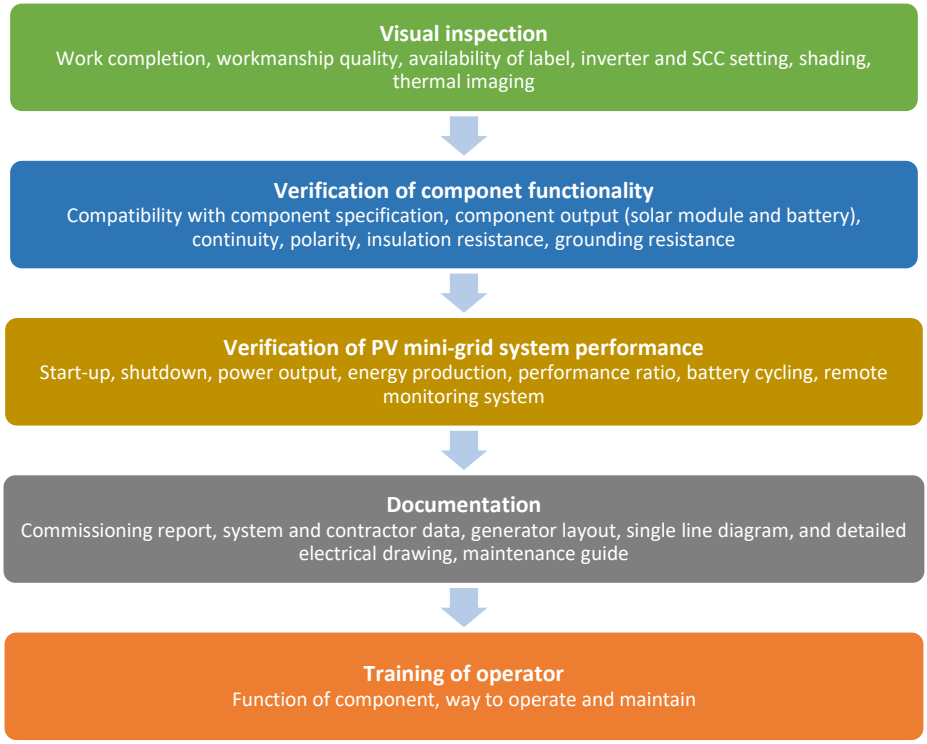


Figure 13 Content of PV mini-grid commissioning procedure

The commissioning method should be appropriate and the documentation of commissioning result should be attached to the report. Below are the information contained in the commissioning report:

- Information on the responsible person, witness, and commissioning date
- Information and specification of PV mini-grid system
- Visual inspection result completed with photographs as support
- Measurement and test results conducted in commissioning process
- Summary of commissioning results with additional corrective action if repair is required
- Identification of special maintenance needs or periodic actions.

Currently the draft of commissioning protocol has been prepared. The draft will be socialised to DG NREEC and contractors as the implementers of commissioning activity to get input and suggestion. To ensure product quality, the protocol will be tested in several sites to get feedback from users. A commissioning guide containing the protocol is expected to be published by the end of the second quarter of 2018 under ELREN project activity.

3.2. Facilitation for Inspection of PV Mini-grid and MHP

There are two main activities carried out with regards to technical inspection facilitation activities for PV mini-grid and MHP. First, in the form of facilitation for technical staff of Directorate of Various New Renewable Energy (DAE) through PV mini-grid supervision activity. The second activity is series of training on technical inspection of PV mini-grid for PPHP initiated by Directorate of Infrastructure.

A. Facilitation of technical staff of DG NREEC

In the supervision framework of PV mini-grid that has exceeded its warranty period, DG NREEC through the Sub-Directorate Engineering and Environment DAE regularly conduct inspection in several sites to understand the operational status of the PV mini-grid. To maximise the supervision activities, technical expertise in conducting inspection is indispensable for DG NREEC technical staff. This includes the skills to identify anomalies on the system and conduct evaluation for handling recommendation that can be incorporated into the technical specification for future PV mini-grid.

In order to support the inspection activity, GIZ and the Sub-Directorate Engineering and Environment DAE took the initiative to conduct knowledge transfer activity in the form of peer mentoring in conducting inspection at PV mini-grid site. The purposes of this activity are as follow:

1. Strengthen the capability of DG NREEC staff on PV mini-grid system.
2. Transfer the knowledge through learning by conducting inspection at the plant site.
3. Introduce DG NREEC staff with the methodology used for technical inspection and KPI survey.

The mentoring activities were conducted in three sessions: (1) briefing on technical inspection activity and equipment needed on site, (2) direct assistance at the power plant site, and (3) feedback session from the inspection result by DG NREEC technical staff.

PV mini-grid supervision activity was conducted in April 2017 in Konawe District, Sulawesi Tenggara Province. Staff of seven people were divided into two groups to visit two different PV mini-grid sites. Only one group was accompanied to the PV mini-grid in Lalimbue Jaya Village with a plant capacity of 20 kWp built in 2015.

Unlike in the classroom, in this capacity development process the participants became more active and are given the opportunity to conduct inspection using the GIZ technical inspection methodology as well as the required measuring devices. At the time of mentoring process it was apparent that the technical staff who in fact have technical background were proficient in using the measuring tool and require only more practice in conducting technical inspection so they are more critical in assessing the installation quality.

Figure 14 Technical staff of DC NREEC are conducting KPI survey with the Village Chief

Figure 15 Current measurement on cables detected by infrared camera (thermal imaging)

Beside technical inspection, the participants also conducted a socio-economic survey or KPI survey with the Village Chief as resource person. The mentoring activities are followed with an overall assessment on the quality and performance of the PV mini-grid. Subsequently, the supervision results were presented in a sharing session with better inspection understanding by DG NREEC technical staff.

In a sharing session attended by the staff of DAE and Directorate of Infrastructure, there are several conclusions that should be followed up:

1. There are cables that do not fit the design size which caused the cables to overheat. One solar charge controller is recommended to shut-off during activity. This lead to lack of energy supply from solar modules to batteries thereby reducing power supplies to the community. To anticipate the non-conformity of cable size, DG NREEC shall conduct technical design evaluation. Calculating the cable size and protection system automatically using an application or simple spreadsheet may help with the evaluation process.
2. Performance verification process during commissioning was less detailed. Discrepancies in cables which might be fatal if overheated, should be found during commissioning.
3. The community did not realise that shading from trees can significantly reduce energy production. As a result, they can only enjoy electricity for two hours because almost 50% of solar modules were covered by tree shadow. Therefore, the operator and the village electricity management team should be briefed on the operation and maintenance of PV mini-grid. A guide on operation and maintenance of PV mini-grid at the site is believed to be highly useful in helping the operators in performing their duties.

B. Training of PPHP for PV mini-grid and MHP

Learning from PPHP training activity in 2016, PPHP training in 2017 initiated by the Directorate of Infrastructure was conducted with a longer session aiming that the participants can better understand PV mini-grid both in theory and practice. Similar to previous year's activity, this training aims to develop the capacity of inspectors to be able to perform the work acceptance not only based on compliance of number and type of components on site, but also to consider the system performance and the installation quality for sustainability of the PV mini-grid system.

In 2017, EnDev Indonesia provided direct support for PPHP training on PV mini-grid systems and connect DG NREEC with MHP experts for MHP inspection training held on 14-16 September 2017.

The training module for PV mini-grid technical inspection was prepared to provide learning about PV mini-grid for beginners due to the diverse educational background and profession of PPHP personnel. The training was conducted with the following methodology:

1. Presentation of PV mini-grid theory by the resource person.
2. Case study of inspection in group using inspection forms prepared by GIZ.
3. Inspection practice at PV mini-grid site using inspection forms and measuring devices required during inspection.

This training activity is a series of PV mini-grid technical inspection training for PPHP which was divided into (5) five sessions with a total duration of 13 hours. Training was held on 14-16 August 2017 and field training on 18 August 2017 with the following materials:

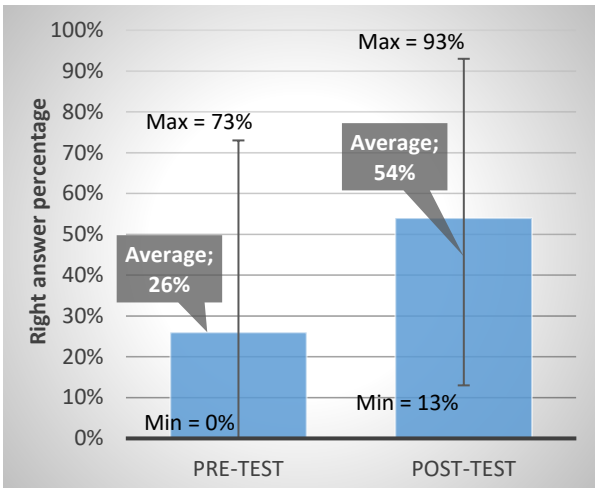
Session 1 – Basics of PV mini-grid (3 hours) • Basic physics (basic electricity and solar energy) • Type of PV mini-grid system
Session 2 – PV mini-grid (3 hours) • Configuration and how to work • Components in PV mini-grid system • Installation quality of PV mini-grid (good and bad examples)
Session 3 – Inspection guideline (3 hours) • Inspection preparation • Component compliance • Performance verification • Workmanship quality
Session 4 – Operation and maintenance of PV mini-grid (1 hour) • Operation • Regular maintenance • Repair maintenance
Session 5 – On site practical inspection (3 hours)

Figure 16 Presentation on basic theory of PV mini-grid

Figure 17 On-the-job inspection training at PV mini-grid

From a total of 24 people, some participants showed curiosity and enthusiasm to understand the PV mini-grid systems both in theory and practice. This is indicated by a significant increase in the average results of tests both before and after training.

Although the evaluation result showed a two-fold improvement, the average score does not exceed 60%. This indicates that many participants still do not understand the function of components, safety, and installation quality of PV mini-grid. The graph on the side also shows an imbalance of scores caused by educational background and profession.



Based on the assessment of liveliness in the classroom and during inspection practice, it showed that PPHP personnel with technical background are more active in the training activities and more critical in assessing the workmanship quality. Thus it would be better if the selected inspectors or PPHP are the staff with technical background and skills needed for an inspector, in order to ensure the quality of PV mini-grid system.

3.3. Knowledge Transfer on Methodology of PV Mini-grid Technical Performance Analysis

EnDev Indonesia has conducted a study on technical performance analysis of PV mini-grid built by DG NREEC using two sample locations in Maluku and Jawa Tengah. The methodology developed from the study is useful for DG NREEC in analysing the performance of the PV mini-grid. The training was held on 10 May 2017 and was attended by six (6) DG NREEC staff from the Sub-Directorate Engineering and Environment DAE.

This knowledge transfer was intended to introduce DG NREEC staff with the methodology used in evaluating the technical performance of PV mini-grid to ease DG NREEC staff, particularly those authorised to analyse the technical aspects of the plant, to conduct research and comparison of technical performance among the constructed PV mini-grids. The aspects reviewed include: (a) solar module performance, (b) overall PV mini-grid performance, (c) battery performance, and (d) electrical load pattern.

This knowledge transfer method is a direct practice of analysis on PV mini-grid performance data taken from several PV mini-grid sites using tested methods and formulas for locations of Maluku and Jawa Tengah. Presentation on technical performance analysis of the two (2) PV mini-grid sites can be downloaded at http://endev-indonesia.info/libraries/2.

3.4. Support for the PV mini-grid/MHP revitalisation programme

After obtaining a report on the operation of the power plants, DG NREEC initiated a revitalisation programme on PV mini-grid and MHP systems that are not operating properly due to technical and non-technical problems. The revitalisation process began with identification of damages followed by preparation of Budget Plan (RAB) until component replacement. Identification of damages is a crucial step in order to repair the system accurately. Reports of the damages identification will be used as reference in designing RAB before proceeding to the tender process.

GIZ with its three years' experience of inspection, supported the revitalisation programme by providing direction to the inspector prior to their departure to the sites. A briefing is conducted so that the inspectors, consisting of DG NREEC staff and experts, will be able to conduct inspection and deliver inspection results with a good and standardised methodology. The briefing to the inspectors includes:

- Introduction to inspection method and guide has been done by GIZ. Experts are advised to use the inspection guide prepared by GIZ as a guideline where the forms in it becomes the minimum parameter to be observed, measured, and documented.
- The inspectors are advised to use the troubleshooting analysis guide form so that the system and damage condition can be verified and recorded properly.
- Inspection must be done by more than one person and have technical background in order to assess the damage condition more objectively and in detail.

Figure 18 DG NREEC staff are conducting measurement at combiner box

3.5. Guideline for Local Government on Warranty of PV Mini-grid Components and Installation

PV mini-grid consists of several components of which the replacement or repair costs are high. In order to avoid system damage that exceeds what was estimated, the installation design and installed components must provide warranty, both for installation and product. This is to anticipate the asset owner to replace any components at the beginning of the operation.

As anticipation, DG NREEC required providers of products and services to provide a minimum one year warranty to the PV mini-grid system. Therefore, the contractor is responsible for the PV mini-grid system and ensures the operational condition of the PV mini-grid. However, there are many asset owners or even operators who do not know how to file a warranty claim especially for the damage of main component which involve the manufacturer. There are many providers of products and services who do not leave an address or contact that can be accessed by the operator or official as the asset owner. As a result, many damaged components cannot be tackled.

From these findings it can be concluded that the warranty does not guarantee that the damage will be handled immediately even within the maintenance warranty period. Thus, a guide for the operator or local government as the asset owner on how to make a warranty claim from small components such as fuse, Miniature Circuit Breaker (MCB) to core components such as solar charge controller, inverter, battery, and solar module is required.

The guideline will provide information on the flow of how local government or PV mini-grid asset owner filing a warranty claim on damaged component within the warranty period as well as the procedure to perform corrective/repair maintenance after the warranty period.

The development of this guide is currently on the stage of collecting the results of survey conducted to the providers of products and services on best practices for the submission of warranty claims for both consumables and core components involving the manufacturer. This activity also aims to provide input on the constraints often faced during the claim process. After the information collection, a pocket book will be compiled and socialised to the stakeholders.


To ensure the sustainability of electricity facilities for communities in remote villages, on-the-job training on the operation and maintenance of PV mini-grid is one of the things that needs to be done continuously and accompanied by competent experts.

4. Support on Monitoring and Evaluation

EnDev sets a fairly high standard regarding monitoring and evaluation as outlined in the regular monitoring steps on operational status of supported PV mini-grid and MHP systems. EnDev also continuously supports DG NREEC's efforts to institutionalise monitoring and evaluation methods electronically into the online platform. These platforms include the process of collecting proposals, monitoring of documents, evaluation of technical feasibility studies, and later expected to be a mode for information dissemination related to renewable energy-based rural electrification.

In addition, EnDev Indonesia also supports the monitoring efforts through preparation of a detailed reporting form to be used by local government in conveying operational condition of RE infrastructures in its territory.

4.1. Support in Development of Electronic/Online Platform

DG NREEC has hundreds of PV mini-grid and MHP throughout Indonesia of which the operation needs to be monitored, thus the role of monitoring and evaluation becomes very important for sustainability of the constructed power plants. Therefore, a technology that is able to accommodate the monitoring and evaluation of more than 600 sites of PV mini-grid and MHP is necessary. The utilisation of digital technology has been started by DG NREEC and GIZ to ease up the process within the organisation.

The activity of **Proposal Development, Monitoring, and Knowledge Dissemination Electronically/Online** is the support for digital development initiative for rural electrification, as well as adoption of digital application that has been developed together by EnDev Indonesia within DG NREEC. The involved parties in the activity among others: application or software developer, renewable energy experts and/or general public, local government, and operators of the rural power plant.

The support includes concept development and evaluation of the existing digital platform being developed. Process digitalisation in the rural electrification covers:

▪ **E-proposal**	process of proposing rural power plant through both Special Allocation Fund (DAK) and National Budget (APBN)
▪ **Data Acquisition**	remote monitoring of PV mini-grid performance
▪ **Energi Desa**	application of knowledge dissemination via SMS and mobile application (Energi Desa)
▪ **REMAP**	location mapping of PV mini-grid and MHP built by DG NREEC
▪ **DREID**	database of rural power plant
▪ **Review**	review of feasibility of proposed power plant in rural areas

Digital development is a process which is done for years and needs upgrade for the functionality, features, mechanism as well as the platform used. Changes in the process within the organisation is an important factor in determining the implementation strategy of digital development. In an ideal condition, an integrated platform of data storage within the ministry or at least within the same directorate is needed to maintain the consistency and accuracy of the data.

The challenge in digital development is on the compatibility of application with the management design of information system within DG NREEC and MEMR. This relates to the platform used, the readiness of the software, hardware as well as the experts needed for the information management.

A. SINERGI DESA

SINERGI DESA is a platform developed by DG NREEC for the management of proposal, monitoring, until the knowledge dissemination knowledge in the society. The development of SINERGI DESA has been done since 2015 and keep being developed until 2017. EnDev Indonesia supported the initiative by working together in (1) mapping of business process that needs to be accommodated within the platform, (2) development of the features and functionality within the application, and (3) socialisation of SINERGI DESA by DG NREEC to local government.

SINERGI DESA is an integrated platform where the users can access four applications of DG NREEC since the proposal, monitoring, until the knowledge support for operation of PV mini-grid and MHP in the village, as seen in Figure 19. This platform is Internet base thus can easily be accessed by all stakeholders. The four applications currently integrated in SINERGI DESA are: *e-Proposal*, Monitoring and Evaluation of DAK, Data Acquisition, and Energi Desa.

Figure 19 SINERGI DESA display

In 2017, SINERGI DESA had the opportunity to compete in *Sistem Informasi Inovasi Pelayanan Publik* (SINOVIK[3]) held by the Ministry of State Apparatus Empowerment and Bureaucratic Reform. SINERGI DESA reached the 99 best innovation stage and was entitled to present the idea in front of the judges on 21 April 2017. For the presentation, the team prepared a video[4] to introduce SINERGI DESA concept. On 18-20 May 2017 in Surabaya, DG NREEC received the award as one of the Top 99 Public Innovation.

The development and implementation of SINERGI DESA platform is currently led by DG NREEC, especially with regards to the further improvement of the application, integration with the system within the MEMR, as well as the strategy of platform utilisation by local government and other stakeholders. EnDev support lies on the

[3] http://sinovik.menpan.go.id/
[4] https://www.youtube.com/watch?v=o7laxc5FC9g

definition and alignment of the process flow needed by the system. SINERGI DESA has been used by local government to propose new MHP and PV mini-grid for the budget year of 2017. However, there are several things need to be fixed especially with regards to the validity of documents uploaded by the users, and skill improvement of the users in using computer.

Figure 20 SINERGI DESA Team presentation, SINOVIK 2017

Figure 21 Awarding of Top 99 Public Innovation

B. RE-MAP INDONESIA

The Rural Electrification Map known as RE-Map Indonesia is an example of a consolidation of geolocation information developed by EnDev Indonesia. This map covers the locations of MHP and PV mini-grid built by at least three (3) ministries as well as a small number of sites built from other initiatives..

RE-Map Indonesia was created to help collecting, storing and later sharing information on rural electrification projects in Indonesia. This map can serve as a tool to facilitate coordination and planning. The expected impact of RE-Map initiative is that the rural electrification and renewable energy stakeholders have enough information to design, implement and make the right decisions.

The first version of RE-Map Indonesia was created in 2014 and then continually being updated. The first version used static map basis so it can be accessed both with and without Internet network. If Internet network is unavailable, the user can install RE-Map application in their computer. On the other hand, if using an online map basis, the map will only be accessible via the Internet but with slower page loading time.

According to the change of needs of the users and current system, the update of RE-Map Indonesia in 2017 can be seen on:

a. use of online map from Google Maps© as the basis to speed up loading time and for easier access,
b. simplification of user interface design,
c. reorganising the features displayed on the RE-Map page,
d. reorganising on settings page for administrator (backend).

There are currently more than 600 sites recorded in this map, covering the GPS coordinate information, location name, capacity of power plant, beneficiaries, and the funder.

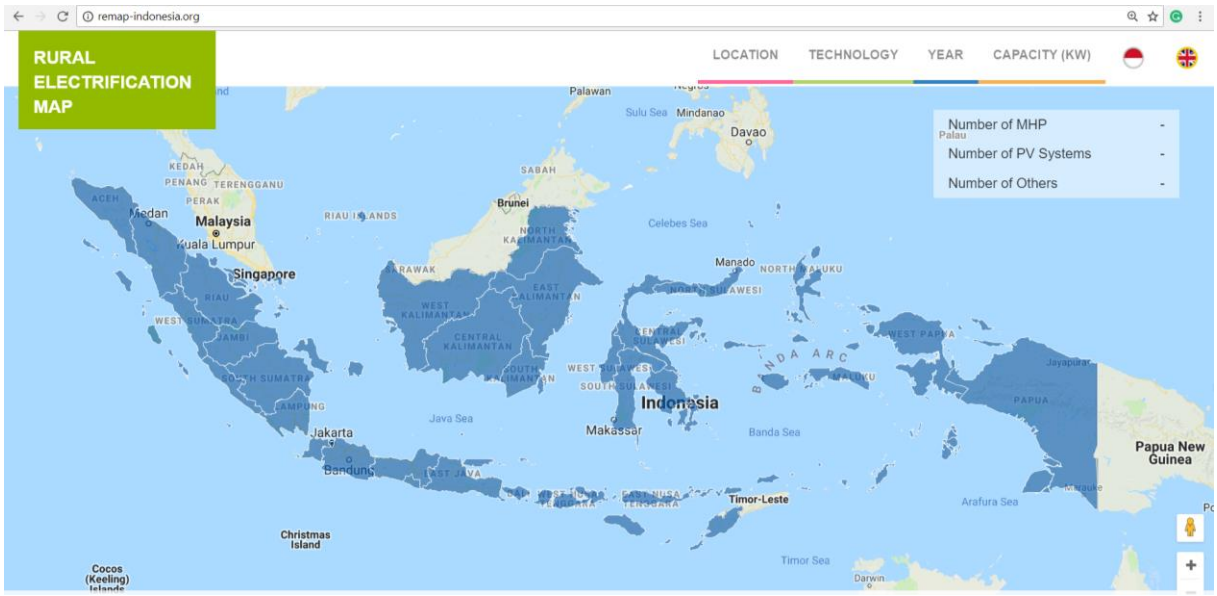


Figure 22 Map of Rural Power Plants www.remap-indonesia.org

C. ENERGI DESA

Energi Desa is a knowledge dissemination platform of RE-based rural electrification developed since 2014. The targeted users among others MHP and PV mini-grid operators, local government, academicians, and RE practitioners. By subscribing to Energi Desa service, the users receive tips on maintaining the RE power plant as well as basic understanding of the technology.

Energi Desa uses SMS and smartphone application as the way of communication. Users can ask and answer questions in the forum for free, both using SMS and mobile application. Both access methods are used because many of the rural power plant operators still use SMS as the main way of communicating, also the accessibility to 3G network (data) is still low.

Energi Desa development is implemented gradually, starting from the use of centralised SMS communication, the development of communication and monitoring applications using SMS called BReIDGE, then using a rural community-specific communication platform developed by an information technology company (see Figure 23).

- Custom made software, initiate from concept to implementation
- Web-based applications, software and modem are installed in server
- General phone number, prone to ads via SMS
- Software has data processing feature inside
- Report and data analyses are possible

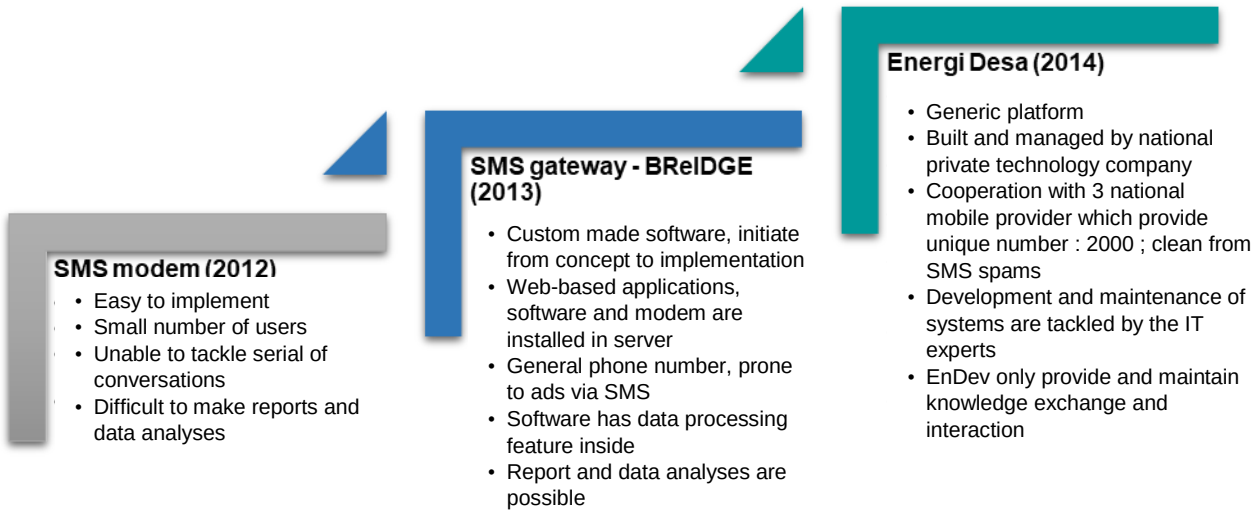
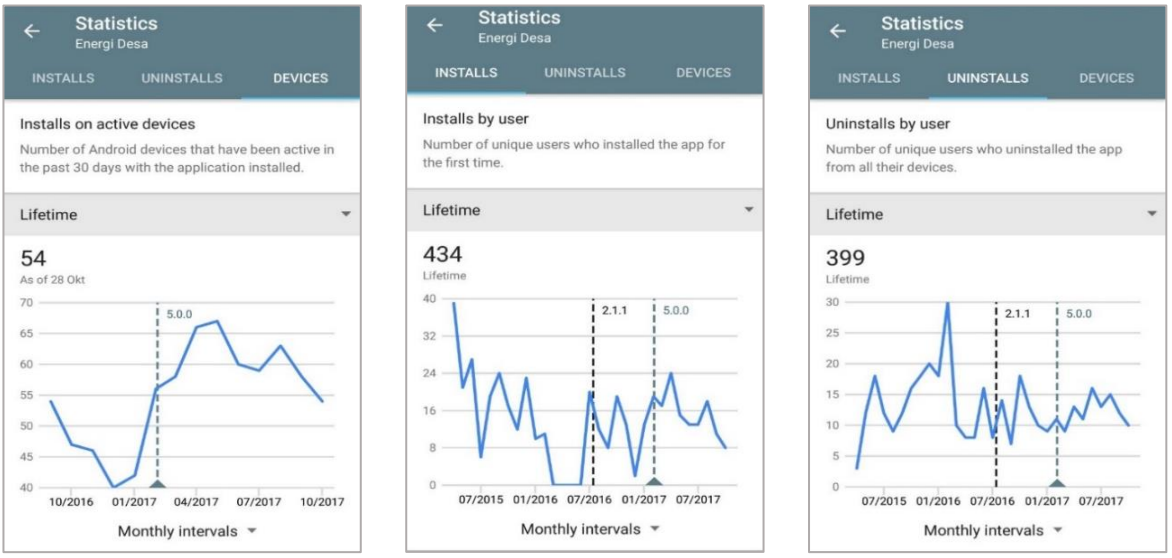


Figure 23 Development of the communication platform until it became Energi Desa

The challenge faced in managing a communication platform and knowledge dissemination in rural electrification is the willingness of experts, practitioners, and local government to engage in communication with rural power plant operators. Energi Desa sends tips and knowledge regularly to the users, especially operators. Moreover, some questions have also been asked by operators but the question-and-answer process has not been going smoothly due to the constraints on participation scheme and language. The communication pattern between actors has not been aligned either, making the interaction in cyberspace is difficult.



Data on number of active devices on user's phone

Number of installed application over time

Number of un-installed application over time

Figure 24 Development of Energi Desa users

SUSTAINABLE STRATEGY OF ENERGI DESA

Energi Desa is a useful communication platform, especially for the operators away from the centre of knowledge and the experts who need experience from the RE power plant. The interaction from both sides is fertile soil for innovation, especially in RE. To achieve it we need an institution that eagers to activate the interaction in rural electrification topic, has technical and social capability in RE sector, as well as management budget. DG NREEC is one of the potential institutions to adopt the mechanism in Energi Desa. Moreover, universities and research institutions are also alternative institutions to take over the operation of Energi Desa.

This platform will be better if it can be merged with the system or data related to the application media or website. The benefit is the data can be used jointly among related institutions to avoid data repetition in order to make the system more efficient.

In 2016 to 2017, the Energi Desa platform is operated and managed by EnDev Indonesia. At the end of its operational phase, a number of scenarios for continuing Energi Desa are explored and analysed. The proposed management schemes for Energi Desa management are:

1. **Software as a service (SaaS)**

In SaaS service, the data management and system maintenance are managed by a service provider to make it easier for the users to run the software application. The client pays the service provider for software application cost within certain period of time and do not possess the right of ownership to the software. The SaaS service has been commonly used and the implementation can be seen in *Google Apps*, *Microsoft Office 365*, *Wordpress.com* and many other examples of application.

SaaS scheme is used by EnDev Indonesia in the past two years. Division of roles performed includes: (a) service provider conducts system maintenance and development of application features; (b) manager (admin, in this case EnDev Indonesia) designs some adjustments to meet the user's needs, manage the application and knowledge materials used; (c) user is the beneficiary of the service who has registered on the system.

This scheme has been run by EnDev Indonesia for two years and ended in December 2017. When there is institution that is willing to fully manage its operation, the service of Energi Desa can be resumed quickly.

Table 8 Advantages and disadvantages of Software as a Service (SaaS) scheme

Advantages	Disadvantages
• Efficiency in developing application and managing the system. • Service can directly be used without the process of developing an application from scratch. • Programme can be stopped and reactivated quickly.	• Manager has no full control over the leased application. • Manager cannot modify the features provided by the service provider because the application is used by other service managers.

2. **Rebuild and owned**

The rebuild and owned scheme is significantly different from SaaS. In this scheme the manager shall design, build, maintain, and develop the whole software application. This option requires a lot of resources and mature concept which includes the system design, workforce, choice of technology used, and specification of the device used to meet the principles of a good system.

The most challenging part is the system maintenance and development since it is performed continuously and requires adequate resources. The required resources such as human resources, system infrastructures (hardware), and system maintenance. The scope of maintenance activity covers the regular and periodic test of the system, bug-fixes on the devices, test and adjustment with the new operating system according to the updates from Google, innovation and further development.

3. Public-private partnership

Public Private Partnership (PPP) is a collaboration between public and private parties in terms of expertise and asset to provide services to the public. This scheme allows sharing of risks and benefits in serving the public among the public and private sectors. In running this scheme, the private sector needs to have a programme which is in line with the government in community economic development, also to have a platform that has been implemented effectively.

Table 9 Advantages and disadvantages of PPP scheme

Advantages	Disadvantages
• Cooperation with government can accelerate and increase the number of application users. • Mentoring assistance in the form of field access or socialisation facility.	• Schedule and time of socialisation depends on the government schedule. • Programme timeframe is limited that it prevent long term sustainability and maintenance.

4.2. Facilitating the Feasibility Study Evaluation

During the proposal process, local government is requested to prepare a proposal equipped with a feasibility study to determine whether a power plant is feasible to build. Thus the feasibility study results shall cover both technical and non-technical aspects in detail such as: economy, social, and environment from the proposed power plant area. The feasibility study results will then be assessed by the evaluation team in DG NREEC to determine whether the proposed project is feasible or not.

However, in practice the quality of feasibility study proposed varies and still in the form of hardcopy which makes the evaluation process become subjective and dependent on the evaluator. To reduce the variation in the report and quality of the feasibility study, DG NREEC through Sub-Directorate Engineering and Environment DAE has started an activity to develop an evaluation form for feasibility study in beginning of 2017 and followed by developing an online platform which adopts the form developed before.

The development of this platform aims not only to digitalise the feasibility study results, but also to computerise the calculation of an ideal system size as a criteria reference and as a comparison from the manual calculation in the feasibility study. The purpose is to get uniformity in the assessment by evaluators especially with regards to the power plant capacity. Here EnDev Indonesia supported the content preparation of the review aspects, calculation of the system size, features development in the application, and evaluation criteria.

This online evaluation system was developed according to the Indonesian National Standard (SNI) Guide for Feasibility Study of PV Mini-grid Construction (SNI 8395:2017) combined with the best practices for feasibility study. In total there are nine (9) aspects reviewed to give recommendation for PV mini-grid construction.

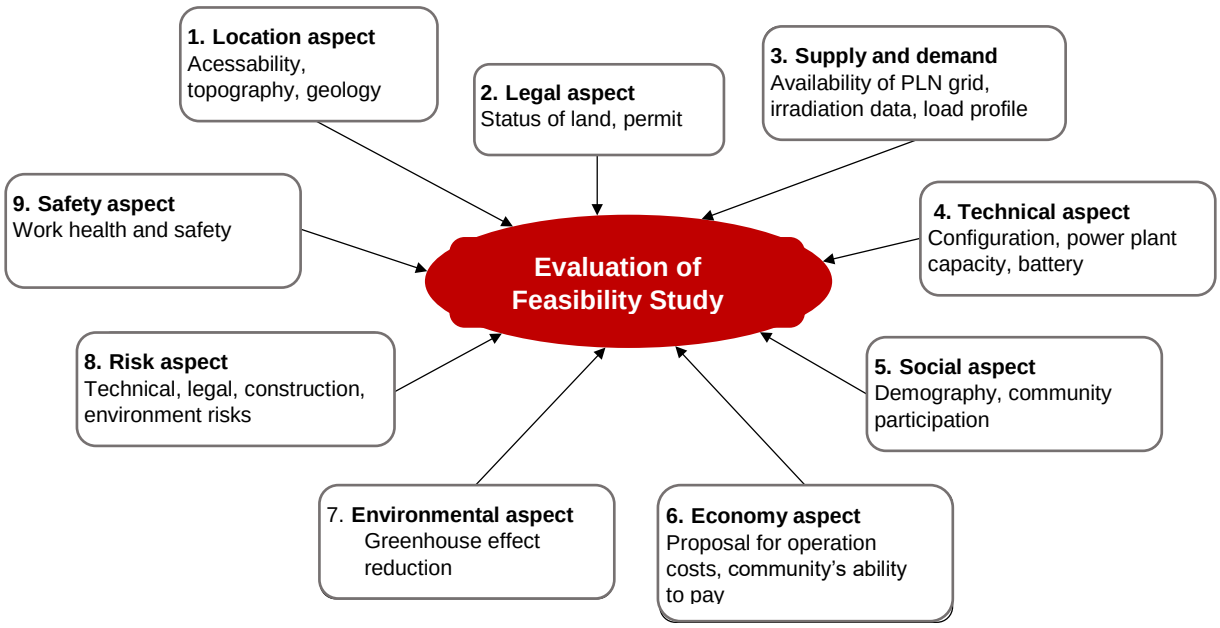


Figure 25 Aspects to be evaluated in feasibility study

Currently the application is being developed by the experts and planned to be socialised to the local government. The trial for filling out the application will be done by a couple of users when the beta version of the application is ready. It is expected that through the feasibility study evaluation platform the quality and evaluation process of feasibility study will get better. Training measures for the evaluation team of feasibility study is necessary to assess the aspects that are tend to be subjective, so that the assessment system is standardised.

4.3. Development of Detailed Reporting Forms

Ministerial Regulation of Minister of EMR No. 39 Year 2017 stated that:

- Manager of the result of NREEC Utilisation Infrastructure shall submit periodic reports every six (6) months after the operation acceptance test is carried out to the proposer of NREEC Utilisation Infrastructure.
- Proposer of NREEC Utilisation Infrastructure shall submit periodic reports every six (6) months regarding the management of NREEC Utilisation Infrastructure to the Minister through the Director General.

However, monitoring and evaluation activities by local government (as the proposer of infrastructure) are still not optimal. Only a small percentage of sites can easily be monitored on their actual operational condition due to uneven monitoring mechanism. As a result, the support that should be provided to the community is hampered by undelivered information between the two parties.

EnDev Indonesia has initiated monitoring and evaluation activities for rural electrification, particularly MHP and PV mini-grid. The most important thing in monitoring is the mechanism to identify the plant location. A codification system for RE power plant site is a basic step applied to every sites supported by EnDev Indonesia. This codification is unique and is bound to the GPS coordinates of the site, rather than relying on the hamlet or village name, therefore the risk of record duplication is almost none. Example of code used:

Type of power plant	**MHP**	**PV mini-grid**
Location code	SulBar004	MalS03
GPS coordinate (*latitude*)	2.946639	-8.33359
GPS coordinate (*longitude*)	119.360806	130.77985
Village	Osango	Eliasa
Sub-District	Mamasa	Selaru
District	Mamasa	Maluku Tenggara Barat
Province	Sulawesi Barat	Maluku
Year of construction	2012	2013

On 16 November 2017, DG NREEC held a workshop on "Discussion on the Mechanism of Monitoring and Evaluation of Various New and Renewable Energy Power Plant by the Local Government". The forum was attended by DG NREEC staff, representatives of several local government, and GIZ discussing the necessary monitoring and evaluation mechanism.

EnDev Indonesia has initiated the concept of RE power plant reporting which can be adopted by the local government to report the RE power plants inventory in their region as well as the operational condition. Up until this report being compiled, the reporting concept and the draft of reporting form are still under internal discussion within DG NREEC.

Under RUMI Pilot,

the community is introduced to the concept of entrepreneurship through training that addresses entrepreneurial tips, production processes, marketing, finance, and how to create a Business Model Canvas.

5. Knowledge Management

Throughout the implementation of technical cooperation support through the EnDev Indonesia project, a lot of learnings and best practices are documented into various knowledge products, such as reports, guidelines, forms, posters, photographs and videos. For the dissemination, these publications are available in printed version distributed in various meeting forums as well as online at the http://endev-indonesia.info/ and https://energypedia.info/ website pages. In 2017, EnDev Indonesia has been working to produce the following knowledge products:

1. Book of Good and Bad of PV Mini-grid
2. Checklist on Maintenance of PV Mini-grid
3. Training Module for Operation and Maintenance of PV Mini-grid
4. Poster of PV mini-grid Troubleshooting Guide (latest version)
5. IRENA: Instrument of Mini-grid Service Package (MSP) for PV Mini-grid High Quality Guarantee.

5.1. Book of Good and Bad of PV Mini-grid

In recent years, PV mini-grid took an important role in increasing the electrification ratio in rural areas of Indonesia. Over a period of seven years, several institutions from the private and government sectors, notably DG NREEC have made efforts to improve the quality and reliability of systems' installation built using APBN and DAK funds. Based on the results of technical inspections conducted by GIZ in 2013 to 2015, the systems built by DG NREEC have shown significant quality improvement from year to year. After conducting technical inspection activities, DG NREEC and GIZ have received valuable information and experiences on the performance and quality of work on the constructed sites as evaluation material for the new plant.

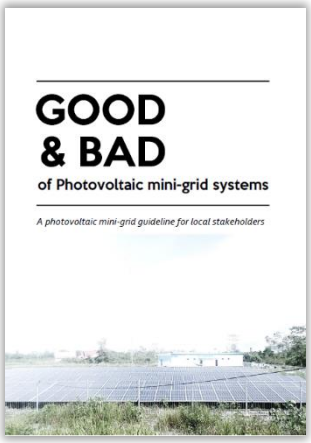
To improve and generalise the quality of PV mini-grid, lessons learned from the three years of inspection are important to be spread to stakeholders such as DG NREEC, inspectors, contractors, technicians, operators, and local governments. Therefore, the book of **Good and Bad of PV mini-grid** was written as a recommendation of best practices for installation of PV mini-grid in rural areas in Indonesia. The book will also support the capacity development of related stakeholders in the process of design, installation, verification, as well as operation and maintenance of PV mini-grid systems.

The writing process including the photo selection of good and bad installations from about 300 locations has been started by GIZ since the fourth quarter of 2016. Currently the book is in the process of technical review and translation. The book that is written in Indonesian and English will be published at the second quarter of 2018.

The book of Good and Bad of PV Mini-grid is divided into 14 chapters of which the topics are based on the core components of PV mini-grid. In general, this book will present over 500 photos of good and bad practices of PV mini-grid systems built in the period 2012-2014 as well as from some newer PV mini-grid. Each photo will be assessed as a good or bad example and supported with a brief explanation of the reasons behind the assessment. Each pair of good and bad photos will be followed by recommendation and a brief theoretical foundation of the finding in the photo. The book is intended to be a reference for stakeholders according to their needs, which will cover:

1. The basic principles of PV mini-grid system and its components
2. The principle of design and installation in general
3. Tips to repair a bad installation and to avoid safety hazard
4. Recommendation for PV mini-grid performance verification process
5. Measurement techniques for operator and technician
6. Simple maintenance and troubleshooting guideline for local operator and technician.

With the example of good and bad installation, the repetition of same errors can be avoided and can refer to the example of good installation to ensure the safety of the system and the users. With a good system installation, PV mini-grid can be more reliable, its components' lifetime improves, operates efficiently and the risk of damage will be really small.



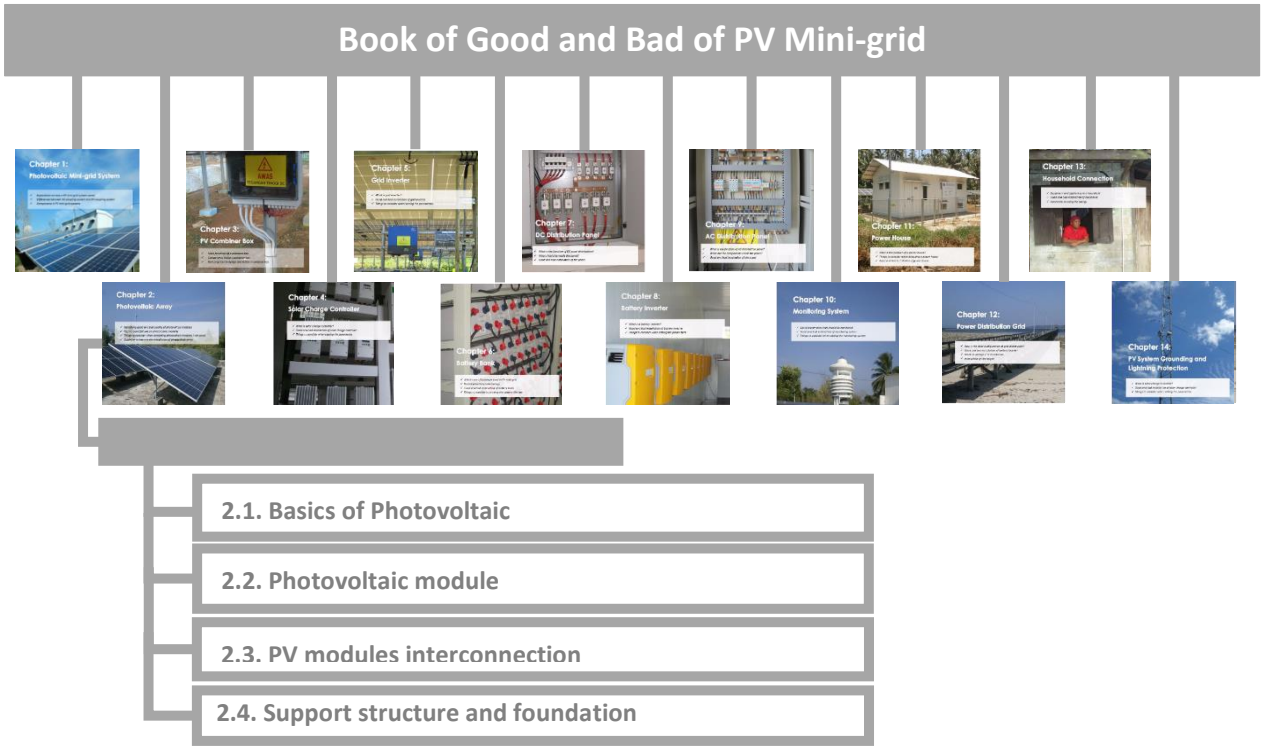


Figure 26 Content and structure of the book of Good and Bad of PV Mini-grid

A good photo will show an example of secure and precise installation of components, both for hardware and software. On the other hand, a bad example does not mean that the installed system is now mostly poor quality, but it can be used as a valuable lesson to be avoided on the system to be built. Repetition of similar errors can lead to unsustainable system as well as risking the entire PV mini-grid programme.

Figure 27 Preview Book of Good and Bad PV Mini-grid

Good design and good quality workmanship is the first effort to present a reliable system from the beginning of construction. Routine maintenance plan is important to undertake at least by the plant operator to maintain the PV mini-grid sustainability. Therefore, operator and technician should be provided with adequate knowledge on the basis of PV mini-grid and its components, simple troubleshooting, and measurement techniques. As a complement to the training, this book is also used as a handbook or manual for operator and technician.

Figure 28 Explanation on example of Good and Bad Installation of PV power plant

Initial introduction to the content of Good and Bad PV of Mini-grid book was conducted during the training of local technician for PV mini-grid in Mataram, NTB. The introduction was done using quiz method to determine whether an installation is good or bad through photos. It is expected that by using this book, the technician, operator, inspector or other users can have the same perception to safeguard the quality of the system.

5.2. Checklist for PV Mini-grid Maintenance

Since 2013 until now, GIZ has continuously been supporting the PV mini-grid maintenance measures by conducting training to the village electricity management team, particularly the operator. Through training activities, the operator will be able to perform regular maintenance to sustain the operation of PV mini-grid system. In fact, many operators ignore some maintenance activities which may cause risks of lacking of energy supply, system malfunction, even endanger the operator. This is allegedly due to the absence of a written checklist and training that is only done verbally, so that operator forget what activities to be done and how to perform an examination.

To anticipate it, a maintenance checklist of PV mini-grid was developed based on the training materials developed by GIZ. With the checklist available on site, the operator can conduct regular inspection uniformly that it can be used as a report to the asset owner. Since the target of the checklist is operator, the design of periodic maintenance was adjusted according to the expertise of operator.

Ideally, the maintenance checklist shall be printed on A3 size and stored in the power house to be filled by the operator every day. The frequency of maintenance activity itself is divided into daily, weekly, monthly, up to six (6) monthly depending on condition and difficulty level of the activity. The components included in the periodic maintenance are solar module, combiner box, battery, distribution panel, power house, and distribution grid. Maintenance includes daily data retrieval, visual inspection, and minor repair activity that the operator is able to perform.

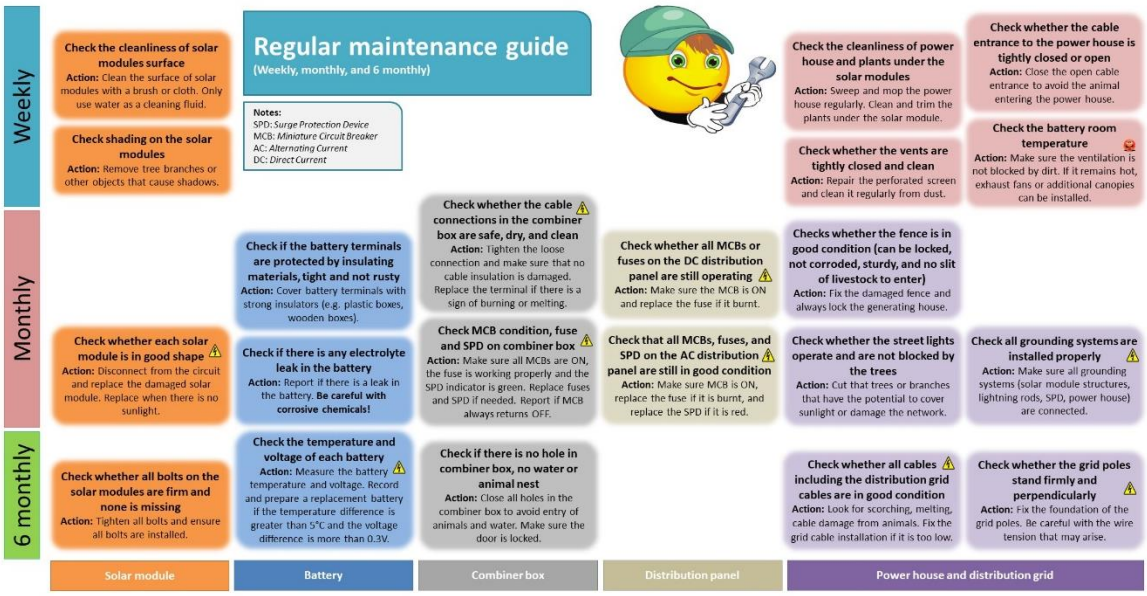


Figure 29 Matrix of periodic maintenance of PV mini-grid

In addition to the periodic maintenance checklist, EnDev Indonesia also supported the Sub Directorate of Technical and Environment DAE DG NREEC in the preparation of the PV Mini-grid Operation and Maintenance Manual Book which will be disseminated to operators at the PV mini-grid sites. The checklist that have been prepared are adopted in this manual book. In general, this manual book will explain in more detail on how to conduct inspection and the potential hazard to be observed from maintenance activities.

Figure 30 Explanation by the trainer regarding the maintenance checklist

A trial on the checklist design was carried out at one of PV mini-grid sites in Pegadungan Hamlet to ensure that the operators understand the contents of the checklist. The trial was conducted simultaneously with the Training of PV mini-grid Operators and Management. This trial was conducted by explaining every necessary activity to do and then the operator practiced the examination activity.

It can be seen from the trial results that the operators can understand how to conduct an examination after getting some directions for a few times. It can be concluded that maintenance activities will be more effective if operators receive training on the operation and maintenance of PV mini-grid intensively. In addition, the manual book will also be very helpful in assisting the operator to conduct examination.

5.3. Training Module on Operation and Maintenance of PV Mini-grid

In line with the technical capacity development activities, there have also been several training programmes related to the operation and maintenance of PV mini-grid, i.e.:

1. Training of official staff in NTB Province, as part of RUMI Model pilot project
2. Training of DG NREEC staff, as part of support for PPHP
3. Roadshow for socialisation of PV mini-grid in three (3) universities
4. Training of PV mini-grid operator at the RUMI pilot project site in NTB Province
5. Training of local contractor and technician, related to the Local Technical Service Provider pilot project.

For the capacity development programmes, a training module on Operation and Maintenance of PV Mini-grid was prepared, which covers a) component of PV mini-grid, b) steps of operation and maintenance, c) simple troubleshooting, as well as d) examples of good and bad installation of PV mini-grid.

This training module is available for public and can be used and/or adopted for the training programme conducted by other institutions. This module has also enriched the book of Guide on Operation and Maintenance of PV Mini-grid published by DG NREEC at the end of 2017. The training module document can be downloaded at: http://endev-indonesia.info/libraries/3.

5.4. Guide Poster on Maintenance and Troubleshooting of PV Mini-grid

Technical support for PV mini-grid built by DG NREEEC started in 2013, where one of the activities was through the training of operators on site. To help the operators performing their tasks, a poster on the guide of maintenance and troubleshooting for PV mini-grid was developed. Until now, the poster has been distributed to more than 300 sites of PV mini-grid visited between 2013 and 2015.

After receiving feedback from various parties, including PV mini-grid operators and academicians, in 2017 EnDev Indonesia has revised the poster of Troubleshooting and Maintenance Guide for PV Mini-grid to make it easier

for the users. The revised poster includes a more elaborated explanation of necessary regular maintenance steps by operator. This poster can be downloaded at the page http://endev-indonesia.info/libraries/5.

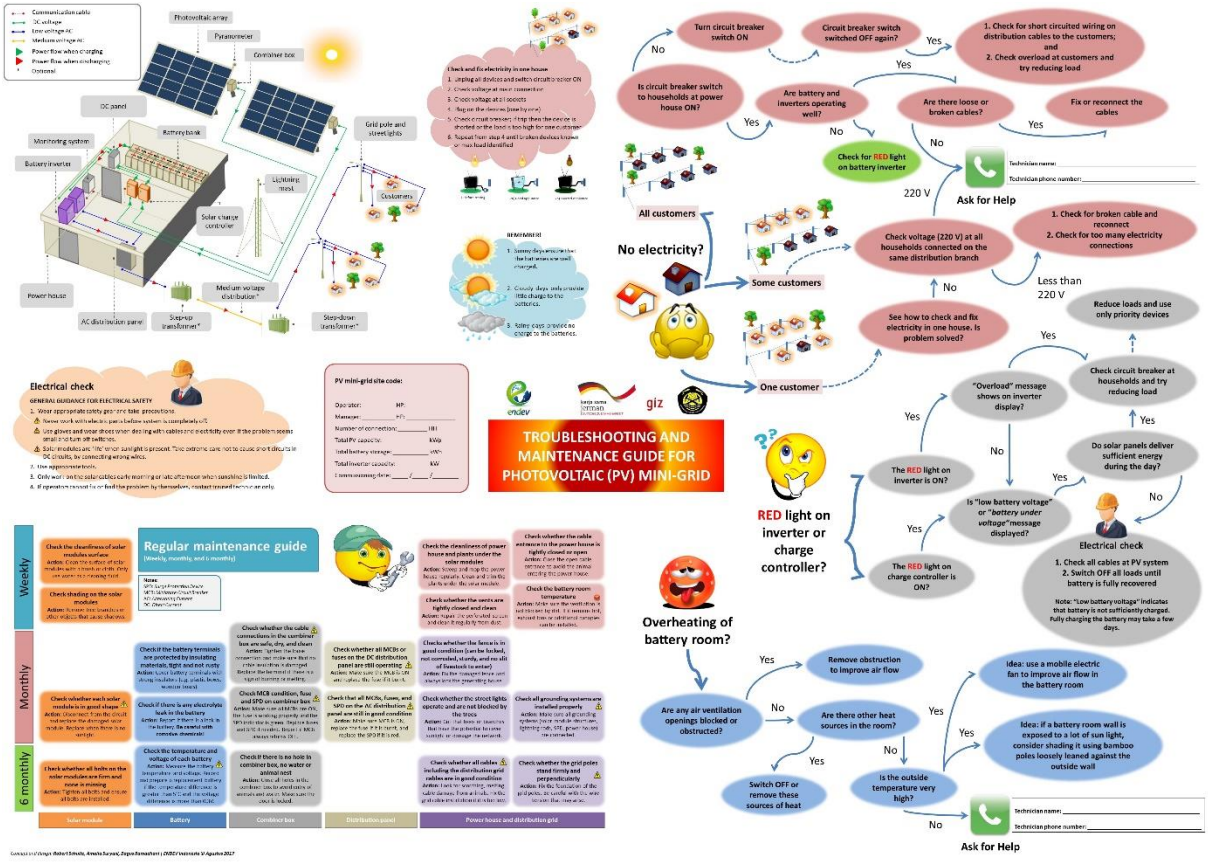


Figure 31 Newest Version of Maintenance and Troubleshooting Guide for PV Mini-grid Poster

5.5. IRENA: MSP Instrument for Quality Assurance of PV Mini-grid

Technical inspection programme of PV mini-grid, which was conducted by EnDev Indonesia in 2013-2015 towards 305 PV mini-grids constructed by the Indonesian government, has attracted both local and international actors of PV mini-grid. Through the technical inspection in three consecutive years, an instrument to safeguard the installation quality was developed which is called Mini-grid Service Package (MSP).

IRENA (International Renewable Energy Agency) assessed that this instrument may enrich learnings and best practices in safeguarding the quality of renewable energy technology infrastructure. Therefore in 2017, the MSP instrument was covered and summarised in a collection of case studies related to quality assurance. The IRENA article on MSP instrument can be downloaded at the following link:

http://inspire.irena.org/Pages/qualityassurance/Casestudies.aspx

The MSP instrument consists of five (5) main steps, which are:

1. Inspection of **component compliance** in a form of checklist to see if the components are installed in accordance with the specifications in the contract.
2. **Technical performance verification** which is a form concerning the things need to be done during on-site measurement or recording from the display screen of the core components of PV mini-grid.

3. **Workmanship quality** in a form of checklist to see if the installation complies with technical standards, safety rules and/or best practices.
4. Socio-economic survey by using the KPI (Key Performance Indicator) questionnaire.
5. Training of operator and manager of PV Mini-grid.

5.6. Roadshow: Socialisation of PV Mini-grid for Students

In order to disseminate information and improve the students' understanding on renewable energy, DG NREEC took an initiative to organise a socialisation in a form of workshop regarding renewable energy. In addition to introduction of renewable energy for students, the socialisation also aims to improve the role of students and universities to contribute in renewable energy programmes in rural areas.

Figure 32 Question and answer session with full enthutiasm regarding PV system

The workshop, titled "Student Empowerment to Support the RE Programme in Rural Areas", was held in several state universities in Indonesia, such as: University of Riau, University of Andalas, Syiah Kuala University, Ambon State Polytechnic, and University of Sam Ratulangi. Universities are considered as a centre of knowledge where the science and human resources are critical and competent in the development of renewable energy.

During each of the two-day activities, GIZ had an opportunity to present on PV mini-grid both theoretically and the situation that often faced in the field. The materials presented such as:

(1) basic of PV mini-grid,
(2) PV mini-grid: components and their function,
(3) operation and maintenance.

GIZ advisor acted as the resource person to share knowledge to the students in University of Riau, University of Andalas, and Syiah Kuala University. Through debriefing regarding PV mini-grid, it is expected that the students are able to share knowledge to the society in rural areas either the technical part of the system, the management, as well as the energy utilisation.

From the three visits, the students seemed very enthusiastic, which was shown by the many questions asked. Not only in the classroom, were students also given the opportunity to ask questions about research or final assignment related to renewable energy.

On the same occasion, DG NREEC through the Sub-Directorate Investment and Cooperation presented an overview on "Policy and Development Programme of RE" and the local universities also shared about "The Role of Universities in RE Development ". Not only PV mini-grid, the students obtained some knowledge about MHP as well on the second day session. From these two-day workshops, the students are expected to get a full picture on the status of RE in Indonesia and are willing to take role in its development to achieve the electrification target and energy justice.

Figure 33 Workshop on student empowerment for the implementation and utilisation of RE in rural areas

6. Support for Bioenergy-based Rural Electrification

The form of support for bioenergy-based rural electrification has changed two times. During the planning meeting with Directorate of Bioenergy, it was agreed that GIZ will assist the development of guideline (for local government) regarding the identification of bioenergy potential for electrification. However, considering the low potential of constructing off-grid bioenergy-based electricity power plant funded by the Government, the guideline preparation was then considered irrelevant.

Thereafter the support was agreed to be replaced by a study on potential utilisation of PLTBiogas for off-grid electrification, but this could not be implemented either given that the Directorate of Bioenergy needs more GIZ support in developing a management model for PLTBiogas (with POME as raw material) in the form of a pilot project.

The pilot project of management model for sustainable POME-based PLTBiogas will be jointly implemented by EnDev Indonesia and LCORE-INDO projects. The site selection for the pilot is to be discussed further with Directorate of Bioenergy.

The plan for pilot project development is a follow up of the Study on Management Set-Up of Bioenergy Power Plants conducted by LCORE-INDO in 2017. Based on the study results, there are four (4) key issues need to be addressed to achieve sustainability of an off-grid PLTBiogas, which are:

- Organisational arrangement (management of PLTBiogas to handover to BUMD).
- Operation and management arrangement; including if there is a plan to sell the electricity to PLN, where there are two sales options to be assessed, based on the MEMR Ministerial Regulation No. 39/2016 or based on the sale of excess power.
- Financial schemes.
- The management team's capacity, mainly related to management and financial aspects.

The work division plan between EnDev Indonesia and LCORE-INDO can be seen in the following diagram:

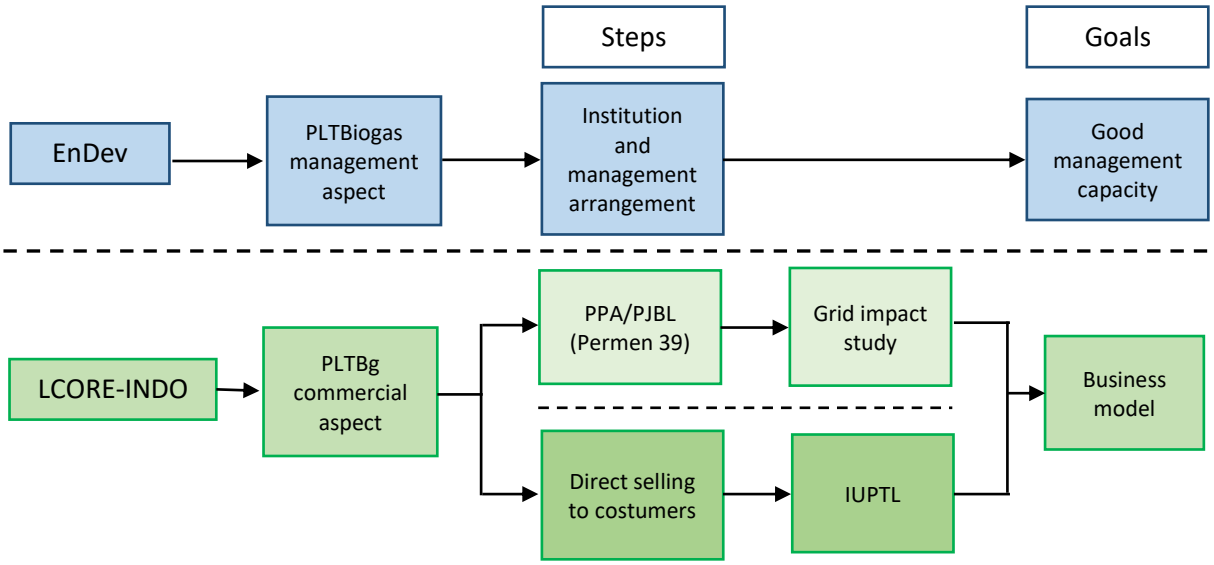


Figure 34 Work division plan on off-grid PLTBiogas management pilot

7. Gender Equality Mainstreaming

Equal participation of women and men in PV mini-grid management will create a conducive working environment and better working result. This is because women and men have different perspective, attention, and needs that will enrich the style of PV mini-grid management and operation.

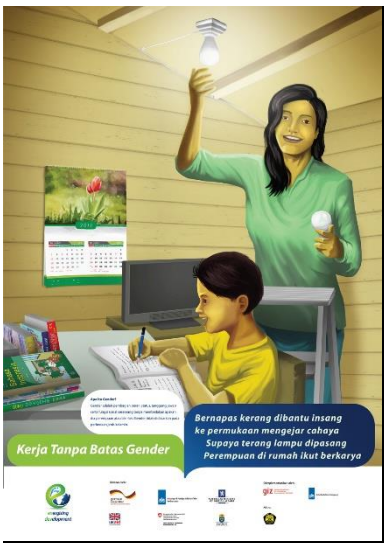
The capabilities of women and men are essentially the same, but generally women in rural areas do not have equal opportunities on access to education, information and employment. Within this framework, EnDev Indonesia introduced the concept of gender equality as one of the strategies to improve the sustainability of PV mini-grid operation initiated by the Government of Indonesia.

There are two big activities conducted in promoting the gender equality which are (1) production of series poster on gender equality, and (2) increasing women participation in the management and entrepreneurship opportunities in PV mini-grid.

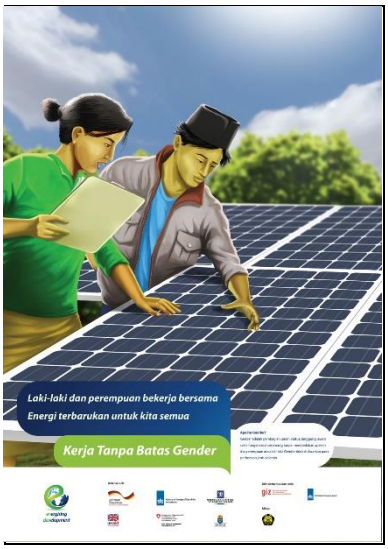
A. Production of Gender Equality Poster

In promoting gender equality to increase the number of women participating in PV mini-grid management and in every aspect of village development, EnDev Indonesia attempted to introduce gender equality using a popular way which is through poster.

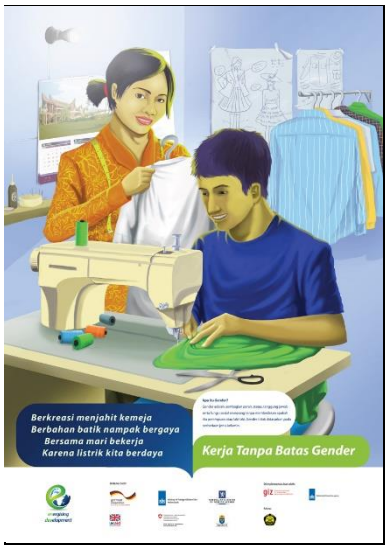
Posters, using illustration and *pantun* (traditional poem), are selected as media to communicate the concept of gender equality. Poster is an effective communication tool for villagers. There are three posters themed "Work without Gender Boundary" were produced. This poster aims to increase the understanding on the importance of balancing the participation of women and men in the management of PV mini-grid and to gain recognition of women role in rural electrification programmes. It is expected that this gender equality campaign can increase the number of women active in the management of PV mini-grid and also more productive utilisation of electricity. This poster can be duplicated and distributed for public purposes.



Poster 1: Women's role in electricity utilisation at home



Poster 2: Equal roles between women and men in PV mini-grid management



Poster 3: Importance of electricity utilisation for productive activities

Figure 35 Series of poster in promoting gender equality

B. Increasing women participation in PV mini-grid management and entrepreneurship

Women empowerment activity is part of RUMI pilot which aims to support the PV mini-grid management in the long term. Gender aspect is inserted into the every activities conducted in RUMI pilot.

The purposes of this activity are (a) the target groups recognise and understand the importance of equal involvement of women and men in PV mini-grid management; (b) the target groups are aware that women also play an important role in rural electrification programme and provide women with opportunities to participate; and (c) women's skills and knowledge improved in the field of PV mini-grid management and entrepreneurship.

Activities in increasing women participation consist of six (6) stages which are:

1. Collection of preliminary and final data through questionnaires
2. Socialisation through posters with the theme "Work without Gender Boundary”
3. Field facilitation
4. Training on introduction of gender equality
5. Training on technical aspect and management of PV mini-grid
6. Training on entrepreneurship development.

C. Achievement in RUMI pilot

In the structure of electricity management cooperative in the four pilot hamlets, women take part in the management of the cooperatives. Women's participation was also observed in village meetings where there was an increase in participation as high as 3% to 30%. In the field of business development, women are strongly encouraged to attend training where about 50% of the trainees were women. Participation in training activity has helped women to open new businesses or increase income from existing businesses.

Figure 36 Women participants during the Training of PV Mini-grid Management at Pegadungan Hamlet

D. Lessons learned from RUMI

A number of lessons learned from the gender mainstreaming activities in RUMI pilot are:

a) In the implementation of gender equality activities and increasing the participation of women, not only the women group being approached but also the men group. This is to avoid exclusivity of women in the community groups and to achieve positive gender equality. This approach turned out to be effective because the women and men groups could learn together and jointly identify problems that occur, so that after finishing the activities the men group may openly accept women to work together in the management of PV mini-grid.

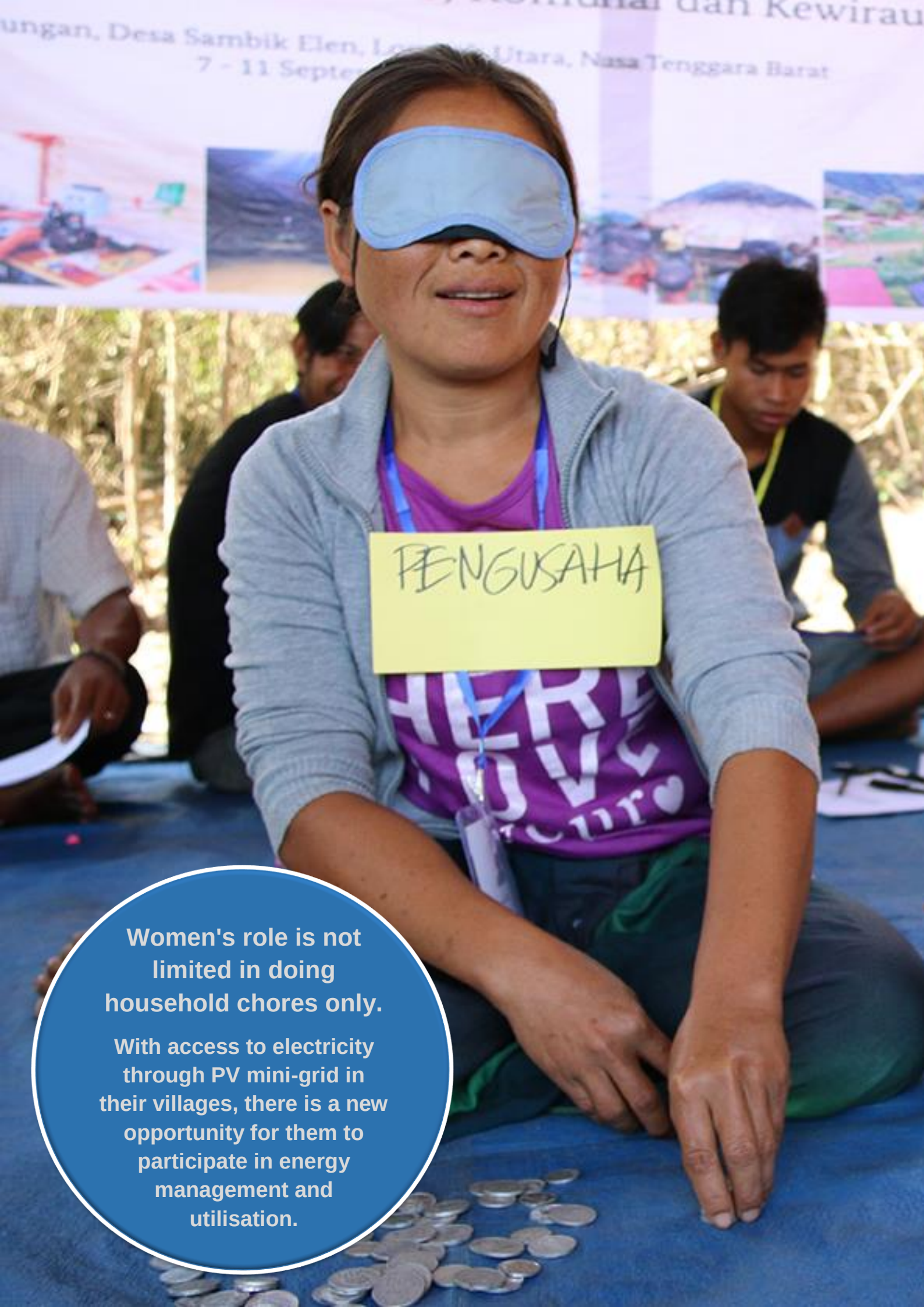
Figure 37 Women and men have equal chance in the activities

b) Quota setting on the number of women in each training, which has become GIZ's strategy to encourage and increase women's participation, has provided women with opportunities to practice.

c) Generally women are interested in becoming PV mini-grid management, including as operator. But due to the lack of capabilities, there is a need for further efforts to train their technical skills in a simple way.

d) In the four targeted hamlets, men's acceptance on the role of women in PV mini-grid management and entrepreneurship is very positive, given that many women have been active in the efforts to increase family income.

e) The role of facilitators in the socialisation of gender equality idea has helped preparing the community to accept the relatively new idea for them.



Women's role is not limited in doing household chores only.

With access to electricity through PV mini-grid in their villages, there is a new opportunity for them to participate in energy management and utilisation.

Collaboration with Other GIZ Projects

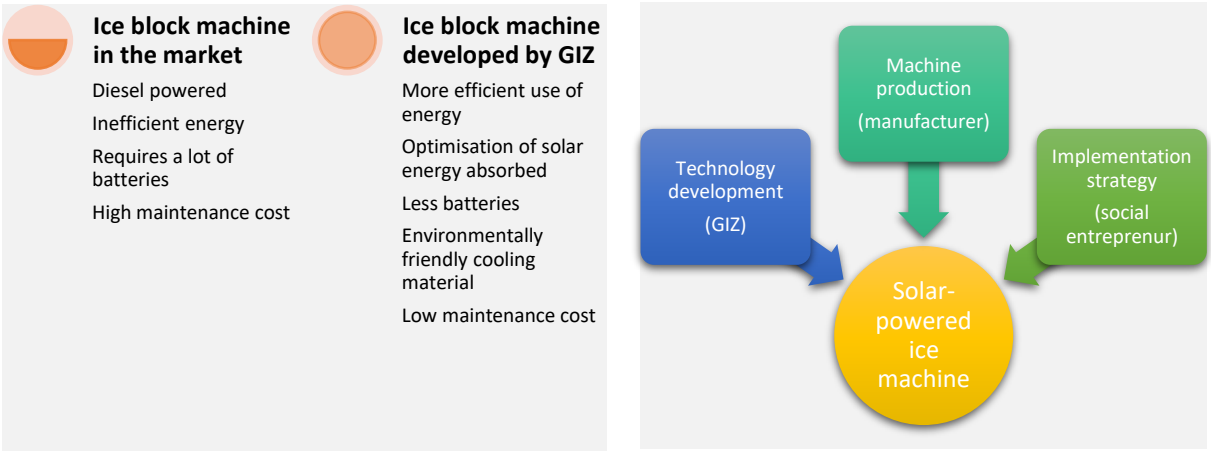
Pilot Project: Solar-powered Ice Block Maker

Other GIZ projects involved: LCORE-INDO, Green Chillers

GIZ continuously provides technical support in the development of NREEC from various lines, such as (a) promoting low cost RE in Indonesia through LCORE-INDO project, (b) the use of environmentally friendly hydrocarbon cooling through Green Chillers project, and (c) support towards supply and utilisation of electricity access through EnDev Indonesia. Accumulation of knowledge and experience from various aspects has encouraged GIZ to innovate in stimulating RE electricity utilisation for economic development of a region. One of innovations being currently developed is a solar-powered ice block maker.

Figure 38 Pilot project location of solar-powered ice maker in Papagarang Island

The concept of solar-powered ice block maker technology developed by GIZ is different from the ice block machine on the market in terms of the solar energy utilisation. The machine being developed requires much less batteries by utilising the overall time of sunlight during the day. The amount of ice produced will adjust to the amount of solar energy that can be absorbed by the plant. This is different from today's technology which can only utilise 4-5 hours of peak-time irradiation per day, so it requires batteries to store and dispense energy at times when the irradiation is low. The key characteristics of this machine are in its ability to optimise the utilisation of solar energy and the environmentally friendly cooling technology. These characteristics make it very suitable to be applied in Indonesia, especially for the fishing communities in small islands with limited electricity supply.



Gambar 39 The concept of solar-powered ice block maker development

GIZ realised that the technology development is not enough without the readiness of local actors in adopting the new technology. Therefore, the pilot activity is designed within the private and public partnership (PPP) scheme among GIZ, manufacturing company (AIREF Indonesia), and a social entrepreneur operating at pilot location (PT Tinamitra Mandiri). Each partner in PPP contributes according to their role in this pilot project.

The output target of this pilot activity is the application of solar-powered ice block maker for fishing communities in Indonesian waters. The design of the machine and its support system is based on general needs of fishers. Implementation at the pilot site will test the assumptions used at the design phase and will try out one management model using the concept of social entrepreneurship. In conducting its business, the social entrepreneur is not focusing only on material benefits, but also targeting social impact as one of the benefits of their business.

The current pilot site is Papagarang Island located in Komodo Archipelago, Nusa Tenggara Timur Province. This island meets the criteria of pilot site as shown in the diagram below.

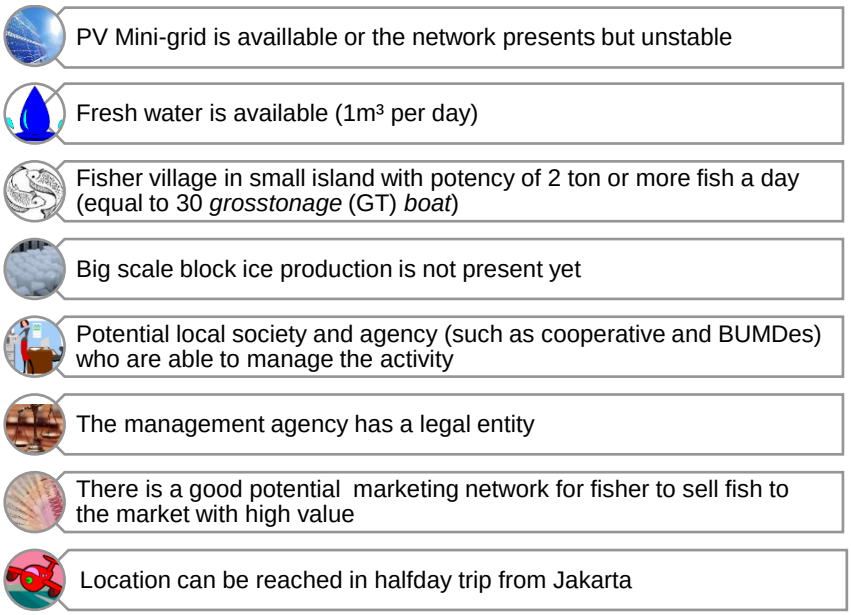


Figure 40 Pilot site criteria for solar-powered ice block maker

The development activities of this solar-powered ice block maker has been ongoing since 2016, since the idea formulation process until the establishment of partnership with cooling technology manufacturing company in Indonesia. In 2016, the activities focused on nurturing technology ideas with experts from the research institute ILK Dresden initiated in the LCORE-INDO and Green Chillers projects. In 2017, the activities begin to be directed to the implementation process of the technology with the stages as indicated in Figure 41.

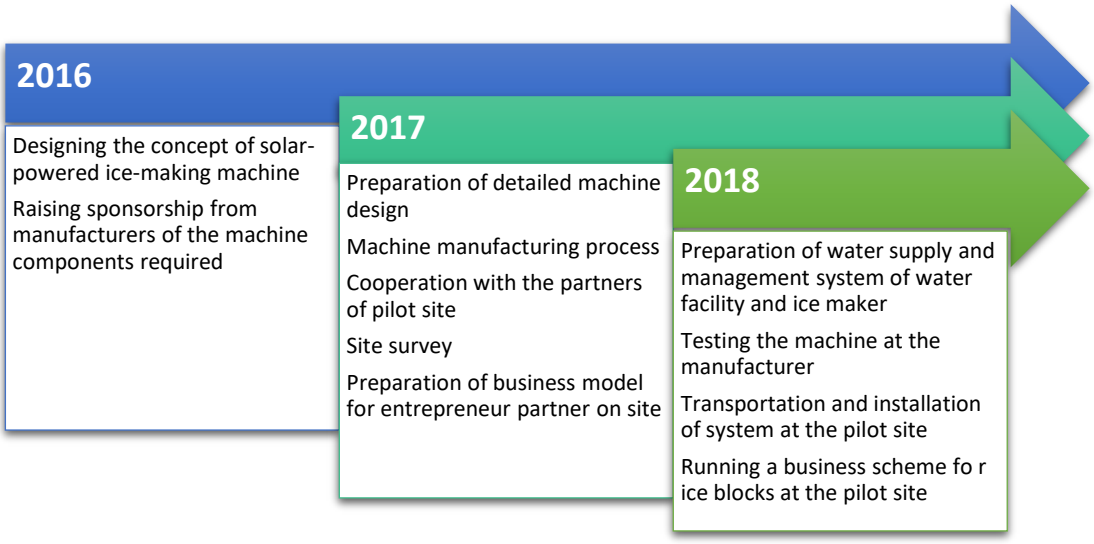


Figure 41 Schedule of pilot implementation

Various cooperation opportunities with private partners and funding are being explored, both by GIZ and partners in the PPP. Some challenges in this pilot activity are: (a) technology transfer from machine design to manufacturing process at a manufacturer's production facility; (b) funding for social entrepreneur partners who generally do not have sufficient capital; (c) untested business model.

Pilot Project: Interconnection PV Mini-grid to PLN in Belitung

Other GIZ project involved: REEP

By the end of 2017 more than 600 PV mini-grids with a total capacity of 25 MW have been built by DG NREEC. However, at the same time PLN grid continues to electrify areas which previously had installed PV mini-grid, where one of them is Tungkup Hamlet, Nyuruk Village, Belitung Timur District.

PV mini-grid in Tungkup Hamlet is located in the area of palm oil plantation in Belitung Timur. The PV mini-grid was built by DG NREEC in the 2012 fiscal year and started to operate in 2013. The electricity generated by PV mini-grid Tungkup is connected to 80 HH and 4 public facilities in the form of mosques, schools, village halls and community health centres. There are 6 stalls and 60 streetlights in Nyuruk Hamlet that also utilise electricity from the PV mini-grid. PV mini-grid costumers pay a fee of IDR 30,000 per month per HH to enjoy 370 Wh per day of electricity. The fee is used to cover the operational costs.

The PV mini-grid asset had been handed-over to the District Government of Belitung Timur since 30 November 2015, which currently being managed by the local community. The facts show that after PLN grid entered in 2015, the majority of communities who previously were beneficiaries of PV mini-grid turned to become PLN customers to get more reliable electricity service.

On the other hand, the PV mini-grid becomes not optimally utilised. Currently only 14 HH are still using electricity from the PV mini-grid, of which they pay a fee of IDR 10,000 per month. Meanwhile, according to PLN customers, the electricity bill they pay every month ranges from IDR 100,000 to IDR 300,000 per month.

Figure 42 PV mini-grid at Tungkup Hamlet, Belitung Timur District

Starting with the idea of keeping the government-built PV mini-grid to still be able to give benefit even though the PLN grid is entering the PV mini-grid site, EnDev Indonesia in collaboration with REEP project intend to develop a pilot of PV mini-grid interconnection project to PLN grid in Tungkup Hamlet.

The interconnection of PV mini-grid to the PLN grid has benefits among others: (a) to contribute to the achievement of 23% RE target in the national energy mix; (b) utilisation and optimisation of APBN-funded renewable energy assets; (c) to create a social and economic added value for beneficiary communities, such as additional income and productive activities; (d) to provide an economical RE electricity to PLN.

In addition, interconnection of PV mini-grid to PLN grid has been made possible and regulated in the MEMR Ministerial Decree No. 39/2017 on the Implementation of NREEC Infrastructure Utilisation which determines the purchase price of PV mini-grid electricity is IDR 750/kWh. PV mini-grid Tungkup is considered potential to serve as an example of interconnection to PLN grid due to its situation that is commonly experienced by a number of RE plants built by the government.

There are four aspects to be reviewed in this pilot, which are:

1. Technical aspect of interconnection configuration
2. Aspect of interconnection financing
3. Aspect electricity selling pattern to PLN
4. Aspect of institutional management.

The successful interconnection of PV mini-grid Tungkup to PLN grid will have a big impact because it can be used as a pilot project for other off-grid PV mini-grids where PLN grid comes. Thus, PV mini-grid can still be utilised even though PLN grid is available.

Participation in External Activities

In implementing the Work Plan of 2017-2018, EnDev Indonesia is working actively in coordination and synergy with various renewable energy-based electrification initiatives, particularly those that intersect with rural electrification topics. Here are some significant activities on the implementation of EnDev Indonesia activities:

A. Study tour to Germany with REEP

The study tour themed "Renewable Energy Electrification and Grid Integration" was held on 27 May - 4 June 2017 in Munich, Germany, was a collaboration of REEP and EnDev Indonesia projects. The tour invited various renewable energy stakeholders in Indonesia such as MEMR from DG NREEC and Directorate General of Electricity (DJK) and PLN.

The main purpose of the tour was to provide insights for the delegates and to learn from Germany's experiences who successfully transitioned fossil energy to renewable energy, including the opportunities and challenges during the transition. The tour had three main activities: visiting the Wildpoldsried Renewable Energy Village, attending InterSolar Conference and Exhibition, as well as engaging in policy dialogue with the German Federal Ministry of Economy and Energy (BMWi).

Figure 43 Participants of study tour who are the stakeholders from DG NREEC, DJK, and PLN

B. Workshop on Rural Electrification by ELREN in Indo EBTKE Conex 2017

In 2017, DG NREEC started cooperation with the German government in a project called Electrification through Renewable Energies (ELREN) which has the main objective to institutionalise knowledge on rural electrification programmes through the utilisation of renewable energy. In the first phase, ELREN will focus on PV mini-grid infrastructure funded and built by the Indonesia Government.

The workshop which is part of Indo EBTKE Conex 2017 was held on 15 September 2017, aims to provide an understanding of various challenges in the rural electrification programme and to discuss potential solutions

with the stakeholders. In this workshop ELREN presented various stages of electrification process in rural areas, whereas participants were actively involved to share their experience and knowledge.

Figure 44 Introduction of ELREN project at EBTKE Conex 2017

ELREN works on several fields and provides input for DG NREEC's capacity development in order to:

a. Integrate quality standards and the performance scopes into off-grid electrification programmes.
b. Monitoring and evaluation of existing system and database arrangements for off-grid RE facilities.
c. Support DG NREEC in stimulating coordination platform among ministries/agencies.
d. Strengthen the private sector in providing functional and environmentally friendly services as well as its maintenance structures.

Indo EBTKE Conex has been conducted since 2012 and aims to promote the implementation of new and renewable energy and energy conservation in Indonesia. The event participants are representatives of various renewable energy stakeholders ranging from government, consultants, EPC companies, suppliers, universities and donor agencies.

C. Coordination Meeting on Rural Electrification by Bappenas

During 2017, Bappenas has initiated two (2) "Coordination of Rural Electrification Programme and Activity" meetings, attended by the government components and international cooperation organisations such as GIZ and MCA-Indonesia. The first meeting was held on 5 October 2017 with an agenda of learning exposure from technical cooperation related to rural renewable energy-based electricity implemented by GIZ and infrastructure development projects by MCA-Indonesia. The second meeting was held on 17 November 2017 with the agenda of elaborating the off-grid renewable energy project scheme implemented by MCA-Indonesia, continued by discussions with various related institutions especially in the Ministry of Energy and Mineral Resources.

D. Interactive discussion regarding SDG by WWF-Indonesia

The seriousness of the Indonesian government in achieving Sustainable Development Goals (SDG) is shown by the issuance of Presidential Regulation No. 59/2017 on the Implementation of SDGs Achievement, which aligns the national target of RPJMN 2015-2019 with the global goals and targets of SDGs. Achievement of SDGs inclusively requires the role and contribution of various parties. For that, WWF-Indonesia together with Hivos, and IESR held an interactive discussion on "Implementation of Inclusive Sustainable Development Goals in Achievement of National Energy Security."

The theme is in line with the 7th goal of SDGs that is to guarantee an accessible, reliable, sustainable and modern energy for all. This target is in line with the global initiative of Sustainable Energy for All (SE4ALL) initiated in 2012 in which Indonesia through the MEMR acts as a focal point to support its implementation in Indonesia.

The discussion held on 1 November 2017 was attended by representatives from government, civil society organisations, business actors, academicians and other stakeholders. The discussion aimed to 1) increase the understanding and role of stakeholders on the 7th SDG implementation plan related to energy sector, 2) to identify the transformation of Indonesia's energy sector towards achieving the 7th SDG, and 3) to facilitate a healthy discussion space among government and other stakeholders for the formulation of action and implementation plan of the 7th SDG.

E. Coordination Meeting of Ministry of Villages, Disadvantaged Regions, and Transmigration (Kemendesa)

Under the RPJMN 2015-2019, poverty alleviation is targeted in 80 of the total 122 disadvantaged districts. According to the Village Potential 2014 data published by BPS, the electrification rate in the disadvantaged areas is 81.54%, lower than the national average of 96.08%. To encourage electrification improvement for 1.44 million HH in disadvantaged areas, the Ministry of Villages, Disadvantaged Regions, and Transmigration conducts a coordination meeting on electrification needs.

The meeting was held to obtain information on programmes and lessons learned from stakeholders, as substance to synergise various programmes which can encourage the increasing percentage of electrification in disadvantaged areas sustainably. This coordination meeting was also attended by representatives from DG NREEC and other ranks of Kemendesa.

E. Visit of Vice Minister of Energy and Mineral Resources to Belitung

On 15 December 2017, EnDev Indonesia took part in supporting the visit activity of Vice Minister of Energy and Mineral Resources, Arcandra Tahar, to Belitung especially to PV mini-grid Tungkup. The visit aimed to see the potential of renewable energy power plant interconnection to PLN grid coming in 2015.

Since 2011 to the end of 2016, DG NREEC has built more than 600 PV mini-grids with a total capacity of 25 MW. PLN currently keeps expanding to provide electricity access to villages in Indonesia, so the interconnection of PV mini-grid becomes essential for the sustainability of utilisation of PV mini-grids built from APBN fund for community welfare.

PV mini-grid Tungkup is considered potential to be an example of interconnection to PLN grid due to its relatively good and well maintained physical condition. This interconnection of PV mini-grid Tungkup to PLN grid may give a big impact because it can be used as a pilot for other PV mini-grid where PLN grid is available.

Figure 45 Contingent of Vice Minister EMR in PV mini-grid Tungkup, Belitung Timur

List of all activities implemented and/or actively participated by EnDev Indonesia, is summarised in Table 10.

Table 10 List of activities implementation and participation

No	Date	Location	Name of Activity	Type of Activity	Implementing Partner
1	6 Feb	Bekasi	Development of EnDev Indonesia Work Plan 2017-2018	Meeting	Dit. Various RE (DAE), Bioenergy, Infrastructure
2	7 April	Yogyakarta	Proposal submission for RE infrastructure using SINERGI DESA application	Meeting	DAE (Programme)
3	21 April	Konawe	On-site training on technical inspection of PV mini-grid	Facilitation	DAE (Technical)
4	10 May	Jakarta	Transfer session on technical performance analysis methodology of PV mini-grid	Facilitation	DAE (Technical)
5	7 July	Jakarta	Development of Evaluation and Feasibility System for PV mini-grid	Meeting	DAE (Technical)
6	9 July	Jakarta	Development of Evaluation and Feasibility System for PV mini-grid	Meeting	DAE (Technical)
7	11 July	Jakarta	Discussion on Environmental Guide for MHP	Meeting	DAE (Technical)
8	11 July	Bogor	Training for PPHP on basics of PV mini-grid	Training	Dit. Infrastructure
9	21 July	Lombok Utara	Site visit from BMZ, GIZ, KfW	Site visit	Local Government of NTB
10	27 July	Jakarta	Development of Operation and Maintenance Guide of PV mini-grid	Meeting	DAE (Technical)

11	3 Aug	Jakarta	Development of Evaluation and Feasibility System for PV mini-grid	Meeting	DAE (Technical)
12	9 Aug	Jakarta	Briefing on technical inspection of PV mini-grid for revitalisation	Facilitation	Dit. Infrastructure
13	11 Aug	Jakarta	Technical Consultation on Women Access towards Economy and Financial Sources in Energy Sector in Indonesia	Workshop	UN Women
14	14-16 Aug	Jakarta	PPHP training on PV mini-grid	Training	Dit. Infrastructure
15	18 Aug	Yogyakarta	PPHP training on PV mini-grid site	Facilitation	Dit. Infrastructure
16	7-11 Sep	Lombok Utara	▪ Training of operators & management of PV mini-grid ▪ Entrepreneurship training ▪ Technical inspection of PV mini-grid Pegadungan in Lombok Utara	On-site training	Local Government of NTB
17	7-8 Sep	Riau	*Roadshow*: Socialisation on PV mini-grid for students (UNRI)	Socialisation	DAE (Cooperation & Investment)
18	15 Sep	Jakarta	Institutionalise the Learnings on Renewable Energy Based Rural Electrification	Workshop	ELREN
19	25-29 Sep	Moyo Island, Sumbawa	▪ Training of operators & management of PV mini-grid ▪ Entrepreneurship training ▪ Technical inspection of PV mini-grid Arung Santek, Brang Kua, and Lepaloang in Moyo Island, Sumbawa	On-site training, technical inspection	Local Government of NTB
20	26 Sep	Jakarta	Discussion on Environment Management Guide for MHP	Meeting	DAE (Technical)
21	5 Oct	Jakarta	Coordination of Programme and Activity of Rural Electrification	Meeting	Bappenas
22	20 Oct	Jakarta	Discussion "2 Years of SDGs: Role of Business in Gender Equality and Women Empowerment"	Interactive discussion	IBCWE (*Indonesia Business Coalition for Women Empowerment*)
23	1 Nov	Jakarta	Implementation of Inclusive SDGs in the Achievement of National Energy Security	Interactive discussion	WWF-Indonesia, HIVOS, IESR
24	17 Nov	Jakarta	Coordination of Programme and Activity of Rural Electrification	Meeting	Bappenas
25	28 Nov	Jakarta	Coordination of Fulfilment of Electrification Needs in Disadvantaged Areas	Meeting	Kemendesa
26	4-6 Dec	Mataram	Training on PV Mini-grid Operation, Maintenance and *Troubleshooting* for electrical technicians	Training	ESDM local agency, TMLEnergy

Implementation Plan 2018

Some of the main activities to be conducted in 2018 are:

Support on revitalisation initiative of PV mini-grid

In 2018, EnDev Indonesia will focus on technical support for revitalisation initiative of PV mini-grid built by DG NREEC during period 2012-2016. A total of 52 PV mini-grids were proposed to be rehabilitated before being handed over to the local government, since there are disruptions on their physical and operational conditions.

GIZ through the EnDev Indonesia and ELREN projects will support DG NREEC in the technical evaluation process of these 52 PV mini-grids in the form of: 1) facilitation on evaluating the documentation of revitalisation proposal on the technical side, and 2) recommendation of revitalisation mechanism of PV mini-grid that can support the sustainability of PV mini-grid system after rehabilitation.

Map data update of RE-Map Indonesia

EnDev Indonesia intends to enrich and update the data and information in RE-Map Indonesia, by including PV mini-grid and MHP sites built by DG NREEC (but not directly supported on site by EnDev Indonesia) as well as the sites built by other ministries or institutions.

Support on POME-based PLTBiogas management

EnDev Indonesia also intends to continue the initiative to support bioenergy programme, especially POME-based biogas power plant for rural electricity.

Implementation of technical service unit pilot in NTB

With the end of the RUMI pilot project in NTB Province, EnDev Indonesia intends to encourage local stakeholders to continue the RUMI mission in the sustainable PV mini-grid management by optimising the function of power plants in supporting the local economy.

EnDev Indonesia will also continue the pilot initiative of Local Technical Service Providers in NTB Province with local partners. The targets to be achieved in this activity is the presence and readiness of a technical unit in NTB to provide technical services for PV mini-grid in NTB region. The technical unit will be designed in a form of partnership between a national EPC company with a local contractor and/or technician.

Pilot implementation of solar-powered ice block machine

It is expected that by mid to late 2018, EnDev Indonesia along with other GIZ projects and private partners collaborating in this initiative will be able to begin installing and operating a solar-powered ice block machine using environmentally friendly cooling technology in Papagarang Island, NTT Province.


Their smile
is our reason to keep developing
renewable energy
for a bright future

Annex A: List of Training

EnDev Indonesia conducts capacity building activities through a wide scope of training. Training modules formulated for training activities are available for general use. The training list that has been conducted until the end of 2017 is as follows.

No	Period	Number of Participants	Participants	Location	Technology
FIELD TRAINING OF VILLAGE MANAGEMENT TEAM (VMT) AND OPERATOR					
1	7-9 Sep 2017	Women: 4 Men:16	VMT, operator, community	Pegadungan, NTB	PV mini-grid
2	25-26 Sep 2017	Women: 13 Men: 16	VMT, operator, community	Moyo Island, NTB	PV mini-grid
3	For 4 months in 2015		Village review on Inspection of PV mini-grid 2015	83 villages	PV mini-grid
4	For 4 months in 2015		Village review on Inspection of MHP 2015	23 villages	MHP
5	For 4 months in 2014		Village review on Inspection of PV mini-grid 2014	110 villages	PV mini-grid
6	For 4 months in 2014		Village review on Inspection of MHP 2014	19 villages	MHP
7	For 4 months in 2013		Village review on Inspection of PV mini-grid 2013	112 villages	PV mini-grid
				349 villages	
TRAINING ON OPERATING AND MAINTENANCE OF PV mini-grid FOR TECHNICIANS					
1	6-8 Dec 2017	45	Local electricity contractor, technicians, vocational school & university students	Mataram, Lombok Utara	PV mini-grid
		45	**People**		
TRAINING ON VMT WORK MECHANISM					
1	28 Mar-2 Apr 2016	18	KKP facilitator	Jakarta	PV mini-grid
2	19-25 April 2015	35	KKP facilitator, staff DG NREEC and KKP	Jakarta	PV mini-grid
3	2-6 June 2013	36	Member of VMT Luwu Utara	Luwu Utara	MHP
4	13-16 May 2013	40	Member of VMT Luwu Utara	Luwu Utara	MHP
5	14-18 April 2013	40	Member of VMT Tana Toraja and Minahasa	Tana Toraja	MHP
6	13-17 March 2013	36	Member of VMT and Officials of ESDM Luwu Utara	Luwu Utara	MHP
7	17-21 Feb 2013	28	Member of VMT Majene	Mamuju	MHP
8	11-14 Feb 2013	40	Member of VMT and Officials of ESDM Enrekang	Enrekang	MHP

9	10-13 Jan 2013	15	Member of VMT Sangihe Utara and Buton	Makassar	MHP
10	17-20 Dec 2012	24	Member of VMT Toraja Utara	Rantepao, Toraja Utara	MHP
11	11-15 Dec 2012	40	Member of VMT Phakphak Barat, Tapanuli Selatan, and Madina	Bukittinggi	MHP
12	10-13 Dec 2012	28	Member of VMT Luwu Utara	Masamba, Luwu Utara	MHP
13	4-8 Des 2012	32	Member of VMT Lebong, Bengkulu Utara, Bengkulu Selatan and Kaur	Bengkulu	MHP
14	8-10 October 2012	20	Member of VMT Mamasa	Mamasa	MHP
		432	**People**		
TRAINING OF TRAINER (ToT) ON CONCEPT OF VMT AND WORKING PROCEDURES					
1	1-4 Oktober 2012	15	Staff of NGO from Sulawesi and Sumatra	Makassar	MHP
		15	**People**		
TRAINING ON COMISSIONING AND TECHNICAL INSPECTION					
1	18-19 August 2016	23	PPHP of DG NREEC	Bogor	PV mini-grid
2	4-5 August 2016	22	PPHP of DG NREEC	Bekasi	PV mini-grid
3	28-29 July 2016	27	PPHP of DG NREEC	Bandung	MHP
4	15 May 2013	18	Observer of PV mini-grid	Jakarta	PV mini-grid
5	12-14 Dec 2013	11	Officials of ESDM Banjarnegara, Banyumas, Blora, Jombang, Gunung Kidul, Sumenep, and PV mini-grid contractor	Jakarta	PV mini-grid
6	1-2 May 2012	18	Local manufactures, university, vocational school students, NGOs, and facilitators of PNPM LMP	Bandung	MHP
		119	**People**		
TRAINING ON BUSINESS DEVELOPMENT					
1	9-11 Sep 2017	Women: 13 Men: 16	Prospective member of cooperative	Pegadungan, NTB	PV mini-grid
2	27-29 Sep 2017	Women: 4 Men:16	Prospective member of cooperative	Moyo Island, NTB	PV mini-grid
3	27-29 May 2016	16	Member of cooperative	Komba, Manggarai Utara	MHP
4	27-29 May 2016	19	Member of cooperative	Batulanteh, Sumbawa	MHP
5	27-29 May 2016	14	Member of cooperative	Kolaka Timur	MHP
6	27-29 May 2016	13	Member of cooperative	Uesi, Kolaka	MHP

7	18-20 May 2016	12	Member of cooperative	Kamosope, Pasir Puti	MHP
8	18-20 May 2016	19	Member of cooperative	Cantung Kanan	MHP
9	15-17 Dec 2015	22	Member of cooperative	Sekadau Hulu, Sekadau	MHP
10	10-12 Nov 2015	18	Member of cooperative	Gunung Komba, Manggarai Timur	MHP
11	10-12 Nov 2015	14	Member of cooperative	Borong, Manggarai Timur	MHP
12	1-5 October 2015	15	KKP facilitator	Denpasar	MHP
13	19-21 August 2014	11	Member of cooperative	Tepal, Sumbawa	MHP
14	12-14 August 2014	15	Member of cooperative	Sintang	MHP
15	29 July-4 August 2015	13	KKP facilitator	Makassar	PV mini-grid
16	16-18 June 2014	11	Member of cooperative	Parsoburan, Toba Samosir	MHP
17	16-18 June 2014	15	Member of cooperative	Humbang Hasundutan	MHP
18	10-12 June 2014	13	Member of cooperative	Solok Selatan	MHP
19	21-23 May 2014	24	Member of cooperative	Mambi	MHP
20	21-23 May 2016	11	Member of cooperative	Enrekang	MHP
21	14-16 May 2014	11	Member of cooperative	Pidie	MHP
22	7-9 May 2014	8	Member of cooperative	Alor	MHP
23	7-9 May 2014	27	Member of cooperative	Manggarai Timur	MHP
		370	**People**		

Annex B: List of Publications

Guideline/Manual

- Technical Inspection Guide of PV mini-grid (latest version) (GIZ, 2015)
- TPD Training Manual: A Guide for Trainers and Rural Electrification Facilitators (GIZ, 2014)
- Multimedia DVD Version 3: All About MHP (bilingual) (GIZ, 2013)
- KPI User Manual for PVVP (GIZ, 2013)
- KPI User Manual for MHP (GIZ, 2012)
- Manual on Productive Use of Energy (English) (GIZ, 2011)
- Best Practice Guidelines for Electricity in Rural Areas (GIZ, 2011)
- Short Guide to MHP (GIZ, 2011)
- Short Guide - Knowing the MHP Environment (Entec, 2010)
- Technical Specification Guide (TSU, PNPM, 2010)
- Technical Guide on MHP Construction (TSU, PNPM, 2010)
- Good & Bad from Mini Hydro Vol 1 (ACE, 2009)
- Good & Bad from Mini Hydro Vol 2 (ACE, 2009)
- Good & Bad of Mini Hydro Power Vol 1 (ACE, 2009)
- Good & Bad of Mini Hydro Power Vol 2 (ACE, 2009)
- Hydro Scout Guide (GTZ, 2009)

Posters

- Poster Series themed "Work Without Gender Boundary " (GIZ, 2017)
- Operation and Troubleshooting Guide for Centralized PV mini-grid (latest version, GIZ, 2017)
- Socialisation of Energi Desa (Indonesian) (GIZ, 2015)
- Operation and Troubleshooting Guide of MHP (bilingual) (GIZ, 2013)
- Poster on Troubleshooting Guide for PVVP Problems (English) (GIZ, 2013)
- Basin Management Guide (bilingual) (GIZ, 2013)
- Village Electricity Management Team Guide (bilingual) (GIZ, 2013)

Reports

- EnDev Indonesia Progress Report for the Period of January to September 2017 (GIZ, 2017)
- Final Report of Energi Desa (GIZ, 2017)
- RUMI Model Pilot Interim Report (GIZ, 2017)
- Master Thesis: Evaluation of Energy Access at RE Powered Mini-grid in Indonesia “A Multi-Tier Framework Approach” (Hasan, Europa-Universität Flensburg, 2017)
- Report on Operational Status of Micro-grid 2016 (GIZ, 2017)
- Review on Design and Specification of PV Micro-Grid System (GIZ/Fraunhofer ISE, 2016)
- Report on Technical Performance Analysis of two PV Mini-grids (GIZ, 2016)
- Concept Notes of Pilot Project: RUMI Model (GIZ, 2016)
- Portrait of Activity and Learning of PV mini-grid Management Facilitation Programme in Small and Outermost Inhabited Small Islands (GIZ, 2016)
- Thesis: Analysis of PV mini-grid System Performance in Five Villages Spread in Kalimantan Selatan, Kalimantan Timur and Sulawesi Tengah to Rural Electricity Demand in 2015 (UGM, 2016)

- Thesis: Performance Analysis of PV mini-grid System in meeting the Electricity Demand of 5 villages location of Papua Barat, Papua and Maluku Utara Province in 2015 (UGM, 2016)
- PPHP Training Implementation Report Regarding the Technical Inspection of MHP and PVVP (GIZ, 2016)
- Training Report on Capacity Building for Business Actors of MHP Management Cooperative (GIZ, 2016)
- Reports on Cooperation among GIZ, KKP and DFW for Programmes on the Small Outermost Islands (GIZ, 2016)
- Report on Operational Status of Micro-grid 2015 (GIZ, 2016)
- Final Executive Report on Technical Review of PVVP 2015 (GIZ, 2016) (confidential)
- Final Report MHP Technical Review for KUKM 2014 (GIZ, 2015) (confidential)
- Final Report MHP Technical Review for DG NREEC 2014 (GIZ, 2015) (confidential)
- Report Rural PNPM Institutional Strengthening for Renewable Energy (GIZ, 2015) (confidential)
- Documentation on MHP Based Productive Economic Development (GIZ, 2015)
- Training Report on Capacity Development for Business Actors of MHP Management Cooperative (GIZ, 2014)
- Report on Business Capacity Development Training for Cooperatives in MHP Community (GIZ, 2014)
- Final Executive Report on Technical Review of PVVP 2014 (GIZ, 2014) (confidential)
- Final Executive Report on Technical Review of PVVP 2013 (GIZ, 2013) (confidential)
- EnDev2 Impact on Sustainability - A Comparative Study (GIZ, 2013)
- Productive Use of Energy - Findings of Pilot Project (GIZ, 2013)
- Survey on Key Performance Indicators for Indonesian Micro-hydro Power Sites (GIZ, 2012)
- Benefit & Cost Study: Retrofitting the Standalone MHP into Grid-connected System (GIZ, 2012)
- Grid in-feeding Screening Tool User Manual (GIZ, 2012)
- Indonesia PUE Database Introductory Manual (GIZ, 2012)
- Report: Indonesia - Sustainable PV Diffusion Alternatives (GIZ, 2012)
- Survey Productive Use Potential (GIZ, 2011)

Templates and *Tools*

- Forms: Operational reports of PV mini-grid and MHP (draft) (GIZ, 2017)
- Forms: Commissioning of PV mini-grid (draft) (GIZ, 2017)
- Questionnaire: Understanding the concept of gender equality (GIZ, 2017)
- Templates: Checklist for operation and maintenance of PV mini-grid (GIZ, 2017)
- Templates: PV mini-grid checklist (revision, bilingual) (GIZ, 2015)
- Template: Technical Summary of PV mini-grid and MHP (revised, bilingual) (GIZ, 2015)
- PV mini-grid KPI Questionnaire (revised) (GIZ, 2013)
- KPI Questionnaire of MHP (revision) (GIZ, 2013)
- Spread sheet: Grid in-feeding screening tool (version 2) (GIZ, 2012)
- Template: MHP commissioning checklist and manual (GIZ, 2012)
- Template: MHP commissioning report (GIZ, 2012)
- Templates: Pre-commissioning and manual checklist of MHP (GIZ, 2012)
- Forms: Screening of potential PUE/rural business (GIZ, 2012)
- Tool: Cash book for MHP and PV mini-grid (GIZ, 2012)
- Tool: Operator logbook for MHP and PV mini-grid (GIZ, 2012)
- Tool: Customer book for MHP and PV mini-grid (GIZ, 2012)
- Tool: Activity book for MHP and PV mini-grid (GIZ, 2012)
- Tool: Tariff card for MHP and PV mini-grid (GIZ, 2012)

Training Modules

- Training Modules: Operation and Maintenance of PV Mini-grid (GIZ, 2017)
- Training Modules: Good and Bad Installation of PV Mini-grid (GIZ, 2017)
- Training Module: Technical Inspection of MHP (GIZ, 2016)
- Training Module: Technical Inspection of PV Mini-grid (GIZ, 2016)
- Training Modules: Mini-grid Service Package for MHP and PV Mini-grid (GIZ, 2015)
- Training Module: TOT for Facilitation and Village Electricity Management Team (bilingual) (GIZ, 2015)
- Training Module: TOT for Business Capacity Development (GIZ, 2015)
- Training Module: Rural Business Capacity Development (GIZ, 2014)
- Training Module: Institutional Model of Village Electricity Management Team for PV Mini-grid (GIZ, 2013)
- Training Module: Institutional Model of Village Electricity Management Team for MHP (GIZ, 2012)

Videos

No	Tittle	Material	Year	Language
01.	**Development Programme of Solar Power Plant Rural Mini-grid Management Model (RUMI Model)**	RUMI is a pilot project in four PV mini-grid sites located in NTB Province. The goal of the programme is to develop a PV mini-grid management model and strengthen the capacity of local stakeholders to work together in supporting the sustainable PV mini-grid maintenance.	Feb 2018	Indonesian + English Text
02.	**Lessons Learned from Facilitators Mentoring Programme for Community in Three Outermost Small Islands**	Lessons Learned from Facilitators Mentoring Programme for Community is a collaboration programme between the MEMR with and Ministry of Marine Affairs and Fisheries to implement the programme of providing energy through PV mini-grid in the outermost islands of Indonesia.	Feb 2017	Indonesian + English Text
03.	**Launch of Renewable Energy Guides Cooperation of Indonesia Germany**	During the gala dinner at conference and exhibition of Indonesia NREEC 2015 held on 19 August 2015, Director General of NREEC launched two guideline “Guide on Renewable Energy for Electricity Power from Biomass/Biogas in Indonesia” and “Guide on Training of Village Electricity Management team and Facilitators”	Dec 2015	Indonesian + English
04.	**Training:** **Capacity Development of Business Actors of MHP Management Cooperative**	Capacity Development of Cooperative Business and MHP Management was conducted based on cooperation between GIZ and KUKM in 9 locations, one of which is in Sintang, Kalimantan Barat. Topics consist of four aspects of	August 2015	Indonesian + English

	in Sintang, Kalimantan Barat	business management such as marketing, production, human resource and organisation, and finance) using Competency based Economies through Formation of Enterprise (CEFE) method.		
05.	**People of Napajoring Village received access to Electricity**	Napajoring MHP is a power plant construction for development of productive economy through the funding from Ministry of Cooperatives and Small and Medium Enterprises and supported by Government of Toba Samosir District, Sumatera Utara.	Dec 2014	Indonesian + English
06.	**Capacity Development for Management of MHP**	The goal this training is to improve the capability of villages business actors related to MHP programme. It is expected that the utilisation of energy for productive activity can encourage the sustainable operational of MHP.	Dec 2014	Indonesian + English
07.	**Technical Aspects of PV mini-grid**	Maintenance of PV mini-grid is very important to ensure that all components are functioning properly. Routine maintenance is one of the factors that determine the sustainability of PV mini-grid.	Sep 2014	Indonesian + English Text
08.	**Management of the Water Basin**	Natural forests provide many benefits to people. Maintaining the availability and stability of water volumes in the river is important in building MHP and also in maintaining forest sustainability.	Jun 2013	Indonesian + English
09.	**Global Hydro Workshop 2013**	The fifth GIZ Global Hydro Workshop was held in Indonesia from 15 to 22 April 2013, with the support of the GIZ Sectoral and Empowerment Development Network in Sub-Saharan**.**	Apr 2013	English
10.	**Productive Energy Utilisation**	Rural electrification has the goal to improve the living standards of rural communities in a sustainable manner by giving a large positive impact on the economy, social and environment.	Nov 2012	English + Indonesian
11.	**Sustainable Centralized PV mini-grid**	PV mini-grid is an alternative for many remote villages. Unlike the installation of solar panels in homes, this PV mini-grid can meet	Jun 2013	English + Indonesian

		more electrical appliances and encourage productive use of energy.		
12.	**Centralized PV mini-grid provide electricity to people**	Maintenance and sustainability of PV mini-grid.	Jun 2013	Indonesian
13.	**Centralized PV mini-grid in Solok District**	PV mini-grid and implementation of monthly tariff system for sustainability of PV mini-grid.	Apr 2013	Indonesian
14.	**Micro Hydro Power Plant System**	Electricity is a very efficient energy to reduce workload, facilitate work and provide access to education and entertainment.	Jan 2013	English
15.	**Administration of MHP**	Administration is an activity related to recording or bookkeeping which is an important part of MHP management.	Jan 2013	English
16.	**Financial management of MHP**	Financial management, conducted by the treasurer that regulates and controls all the financial aspects of MHP, including bookkeeping and reporting the flow of funds.	Jan 2013	English
17.	**Maintenance of MHP**	Maintenance of the MHP is important to ensure that all components are functioning properly, avoiding damage and keeping the stable electricity supply. Regular maintenance is a key factor for sustainability.	Jan 2013	English
18.	**Electricity utilisation**	Proper utilisation of electricity can improve the quality of life of rural people, by doing more useful or entertaining activities.	Jan 2013	English
19.	**Commissioning of MHP**	Commissioning is a thorough process of testing the function of MHP. This consists of construction verification in accordance with the design and testing of the equipment.	Jun 2012	Indonesian + English Text
20.	**Construction of MHP Mesakada**	The progress of MHP development in Mesakada, April 2010. Construction of the dam, rapid pipe and power plant and also planting pine trees.	Jun 2013	Indonesian + English Text
21.	**Utilisation of MHP in the Lisuan Ada Village**	With the right facilities and technology for the utilisation of rural energy resources, it is expected that small-scale industrial and productive activities will boost the village economy.	Jun 2013	Indonesian + English Text

22.	**Current Meter**	Manual on measurement of debit flow using current meter method. Current meter is a measuring device used to measure the flow of river water.	Feb 2013	Indonesian + English Text
23.	**Easy-flow**	Manual on the use of debit measuring device Easy-flow. Easy-flow is a measuring device used for measuring river's water debit.	Feb 2013	Indonesian + English Text
24.	**Measurement of Water Debit using Buoyancy Method**	The buoyancy Method for measuring the water debit. This method is an indirect method of measuring water debit, since it only measures the velocity of the water flow by measuring the time it takes for the floating object to pass the distance specified in a stream.	Feb 2013	Indonesian + English Text
25.	**Measurement of Head using Plastic hose Method**	Measurement of head using the water filled plastic hose. This method should be used only if other levelling equipment are not available. Despite being quite accurate, this method is quite time-consuming to study and design the MHP.	Feb 2013	Indonesian + English Text
26.	**Construction implementation method of MHP**	The construction method is the work implementation stage of MHP development process. Implementation of MHP construction work begins with the preparation of materials, the setting of quality standards of work and methods of implementation of work.	Jan 2013	Indonesian + English Text
27.	**Productive Utilisation of Energy**	Besides being used for households such as lighting, TV, etc. electricity can also be used for productive purposes such as for welding machines, milling and others.	Feb 2013	Indonesian + English Text
28.	**Operating the MHP**	Prior to operating the MHP, the intake, channel, tranquilizer basin, rapid pipe, and turbine components should be initially, so MHP can run well.	Feb 2013	Indonesian + English Text
29.	**Institutional Management of MHP**	The energy supply from MHP can provide various benefits. Communities can enjoy better lighting at night, receive information from television or use the energy of the MHP for productive business.	Feb 2013	Indonesian + English Text

30.	**Preparation of Village's Regulation and Monitoring System**	People must determine clear and transparent tariff system to be followd by the electricity users. The ones who violate it must be subjected to fine.	Feb 2013	Indonesian + English Text
31.	**Financial management of MHP**	The management organisation is established to ensure the well operation of the MHP equipment, which is also based on good financial management.	Feb 2013	Indonesian + English Text
32.	**Measurement of Head using *Pressure Gauge* method**	*Pressure gauge* or manometer is a method for measuring head (height difference) using he water hose installed to the water pressure gauge.	Feb 2013	Indonesian + English Text
33.	**Institutional Socialisation of MHP**	MHP institutional socialisation on institutional establishment and strengthening at the village level. In the LMP PNPM programme, socialisation is done when the development is still ongoing.	Jan 2013	Indonesian + English Text
34.	***Stakeout* to determine the elevation of water surface**	Stakeout is a measurement of elevation and installation of elevation stakes that will be used as a reference in the construction implementation. This activity is very important because it aims to determine the elevation of water surface, as a reference to the construction work of civil components of MHP	Jun 2012	Indonesian + English Text
35.	**Construction Supervision and Monitoring of MHP**	Technical Support Unit (TSU) as a technical team at PNPM LMP (MHP), conducts periodic supervision and monitoring of the development process to direct or facilitate the community in construction works.	Jan 2013	Indonesian + English Text
36.	**Tender Process**	Tender is one of the activities to be performed in the implementation procedure of the LMP PNPM project. Implementation procedure of tender has been regulated through PNPM MP mechanism which is then adopted for PNPM LMP project.	Jan 2013	Indonesian + English Text
37.	**Role of TSU in PNPM LMP**	As an integral component of the PNPM Programme, the TSU is working with the Directorate General of Rural Community Empowerment and the Ministry of Home Affairs as the project implementing agency.	Jan 2013	Indonesian + English Text

38.	**Verification and Potential Survey of MHP**	Proposal verification is an activity stage that aims to examine and assess the feasibility of activity proposals from each village to be funded in PNPM LMP.	Jan 2013	Indonesian + English Text

Energising Development

EnDev Indonesia
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
De RITZ Building, 3 Floor
Jalan H.O.S. Cokroaminoto No. 91
Menteng - Jakarta 10310
INDONESIA
Tel: +62 21 391 4765
Fax: +62 21 391 5859
Website: www.endev-indonesia.info