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EAAP Conference 2026

From Diagnosis to Design: Evaluating Mini-Grid Underperformance and Productive-Use Potential in Remote Indonesian Islands

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From Diagnosis to Design: Evaluating Mini-Grid Underperformance and Productive-Use Potential in Remote Indonesian Islands.

Presenters



Reiner Nathaniel Jabanto

Chairperson
Society of Renewable Energy (SRE)
reiner@sre.co.id



Roihans Muhammad Iqbal

Associate, Country Delivery Indonesia
Global Energy Alliance for People and Planet
roi hans.iqbal@energyalliance.org

Other Contributors



Anthea Previanti Amalia

Researcher
Society of Renewable Energy (SRE)
anthea.previanti@sre.co.id



Rizky Fauzianto

Country Director - Indonesia
Global Energy Alliance for People and Planet
rizky.fauzianto@energyalliance.org



Faraz Usmani

Director, Evaluation
Global Energy Alliance for People and Planet
faraz.usmani@energyalliance.org



Boaz Liesdek

Director, Monitoring & Operations
Global Energy Alliance for People and Planet
boaz.liesdek@energyalliance.org



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SRE

Reiner Nathaniel Jabanto

Chairperson, Society of Renewable Energy (SRE) Indonesia

Reiner Nathaniel Jabanto serves as Chairperson and Head of Research & Advisory of the Society of Renewable Energy (SRE) Indonesia, a youth-driven organization with more than 3,000 members across 19 provinces, a role he has held since May 2024. He previously served as Vice Chairperson from 2020 to 2024.

Across both terms, he has helped establish SRE as a national voice for youth in Indonesia's energy transition. He represented SRE in Indonesia's G20 Presidency through the Energy Transition Working Group (ETWG), bringing youth perspectives into national energy policy discussions. He also helped drive the installation of over 1 MWp of solar capacity across more than 100 locations and leads SRE's research and capacity-building initiatives, reaching over 40,000 participants. He has authored five sustainability publications in collaboration with ministries, intergovernmental organizations, and NGOs.

His expertise spans sustainability, strategy, and digitalization. He holds a Bachelor's degree in Electrical Power Engineering from ITB and represented Indonesia at UNFCCC COP27.



Roihans Muhammad Iqbal Associate - Country Delivery Indonesia, Global Energy Alliance for People and Planet

Roihans Muhammad Iqbal works at the intersection of energy transition, infrastructure, and sustainable finance in Indonesia, with a focus on turning clean energy ambitions into practical solutions and investment opportunities. As an Associate, Country Delivery at the Global Energy Alliance, he contributes to initiatives that strengthen Indonesia's power system while expanding the use of clean energy to support economic growth, productive activities, and essential services. His work covers project development, strategic analysis, sustainable financing, and engagement with government, development partners, and the private sector.

Prior to joining the Global Energy Alliance, Roihans worked with the Kemitraan Indonesia Australia untuk Infrastruktur (KIAT) and IIGF Institute, where he worked closely with national and subnational governments on infrastructure development and policy, public private partnerships, sustainable finance, and energy transition initiatives in Indonesia.





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Anthea Previanti Amalia

Researcher, Society of Renewable Energy (SRE) Indonesia

Anthea Amalia is a sustainability consultant with experience across renewable energy and sustainability strategy. She supports technical, socioeconomic, and institutional assessments for community-scale renewable energy projects, translating field findings and data into practical recommendations. She holds a B.Sc. in Geological Engineering from Institut Teknologi Bandung and an MS in Sustainability Management from Columbia University.

Before joining SRE in 2026, she worked as a sustainable finance analyst, a consultant at 17 Energy and Blue Yonder, and a mine plan engineer at Kalimantan Prima Persada. Her work also covers GHG emissions analysis, materiality assessment, ESG research, and sustainability reporting. She engages government agencies, development partners, and local communities through field assessments, interviews, and workshops.



Rizky Fauzianto

Country Director - Indonesia, Global Energy Alliance for People and Planet

Rizky Fauzianto is the Indonesia Country Lead at Global Energy Alliance. Rizky is based in Jakarta and assists the Global Energy Alliance in leading the development and implementation of ambitious strategies for energy transition in Indonesia.

Rizky has more than 15 years of experience in project management, business development, and stakeholder engagement. Previously, he worked at RMI for 4.5 years, building the RMI team and portfolio in Indonesia in 4 sectors (power, transport, industry, and built-environment) from 1 to 6 people. Before joining RMI, Rizky worked with GIZ GmbH for 8 years as the team leader for the ASEAN-German Energy Program, managing the implementation of EUR 7 million projects with 8 staff on various sustainable energy activities in the Southeast Asia region jointly with the ASEAN Center for Energy.

Rizky obtained his master's degree in Sustainable Resource Management from the Technical University of Munich, where he also worked part-time in Linde AG on European-scale procurement projects and Holzforschung München on palm oil bioenergy research. Before graduate school, he also worked for almost four years as Implementation Manager in Indonesia's largest state-owned bank (Bank Mandiri), where he managed the company's strategic project and corporate clients, including oil and gas companies (Chevron, ConocoPhillips, etc).

In 2022, he was awarded ASEAN Excellence in Energy Management by the Individual of ASEAN Energy Awards 2022 from the ASEAN Center for Energy for his long work and contribution to clean energy development in all ten ASEAN countries. Additionally, he was also selected as one of three RMI 2022 Emerging Leaders due to his growing work in Indonesia.





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Faraz Usmani

Director, Evaluation, Global Energy Alliance for People and Planet

Faraz Usmani is Director of Evaluation at the Global Energy Alliance for People and Planet. His work focuses on generating rigorous evidence on how energy access and climate programs affect employment, livelihoods, and environmental outcomes across Africa, India, Latin America, and Southeast Asia. He specializes in causal inference and quantitative impact evaluation and holds a PhD in Environmental Economics from Duke University.





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Boaz Liesdek

Director, Monitoring & Operations, Global Energy Alliance for People and Planet

Boaz Liesdek is the Director of Monitoring Evaluation & Learning (MEL) – Asia at the Global Energy Alliance for People and Planet. With extensive experience in impact measurement and data-driven decision-making, he ensures rigorous impact monitoring, evaluation, and strategic learning. Boaz leads the development of high-impact measurement frameworks, integrates MEL across global and regional portfolios, and equips program teams with advanced monitoring tools. He also spearheads impact modeling to assess renewable energy solutions. His evidence-based approach enhances organizational effectiveness, ensuring MEL drives progress and scalability at Global Energy Alliance.



Change Energy, Change Lives

Global Energy Alliance for People and Planet builds transformative partnerships to accelerate clean energy and economic opportunity in emerging economies.

We bring partners, capital and expertise together to turn clean energy into opportunity for people and communities.

Two mutually reinforcing pillars

Grids of the Future



Modern, digitally enabled electricity systems using AI, battery storage and distributed renewables.

Utilities serving 460M+ people

Powering Opportunity



Training, tools and markets that help communities turn clean power into businesses, jobs and growth.

Coalition across 8 countries

\$7.8B+

finance
unlocked

91M

people with
improved
energy access

300M

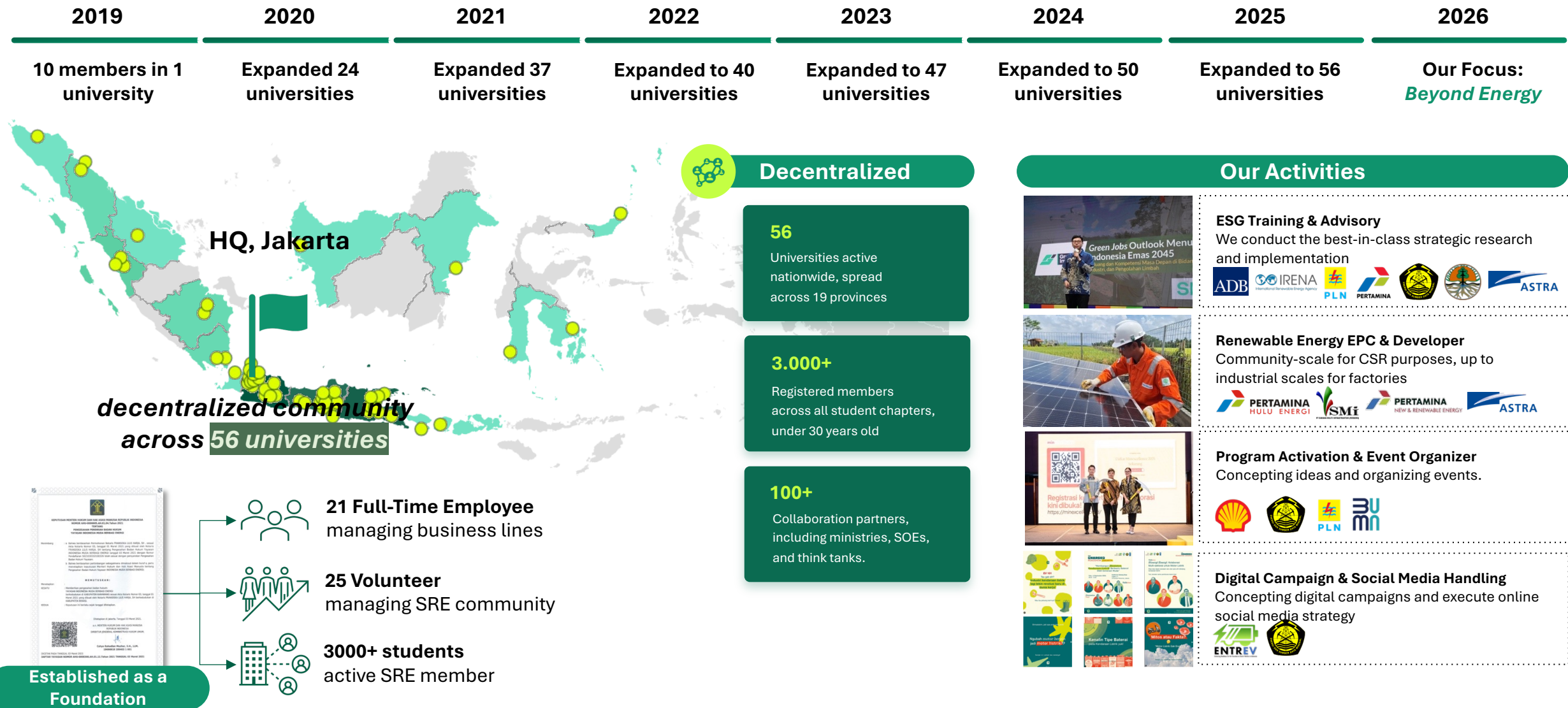
tCO₂ emissions
prevented

3.1M

jobs &
livelihoods
improved



SRE was established back in 2019, and now has grown into a community with 3000+ members, managed by a foundation with 21 FTE that conduct 4 main activities



The study analyzed the reason for underperformance of mini-grid infrastructure in NTB, and define potential solutions for future interventions

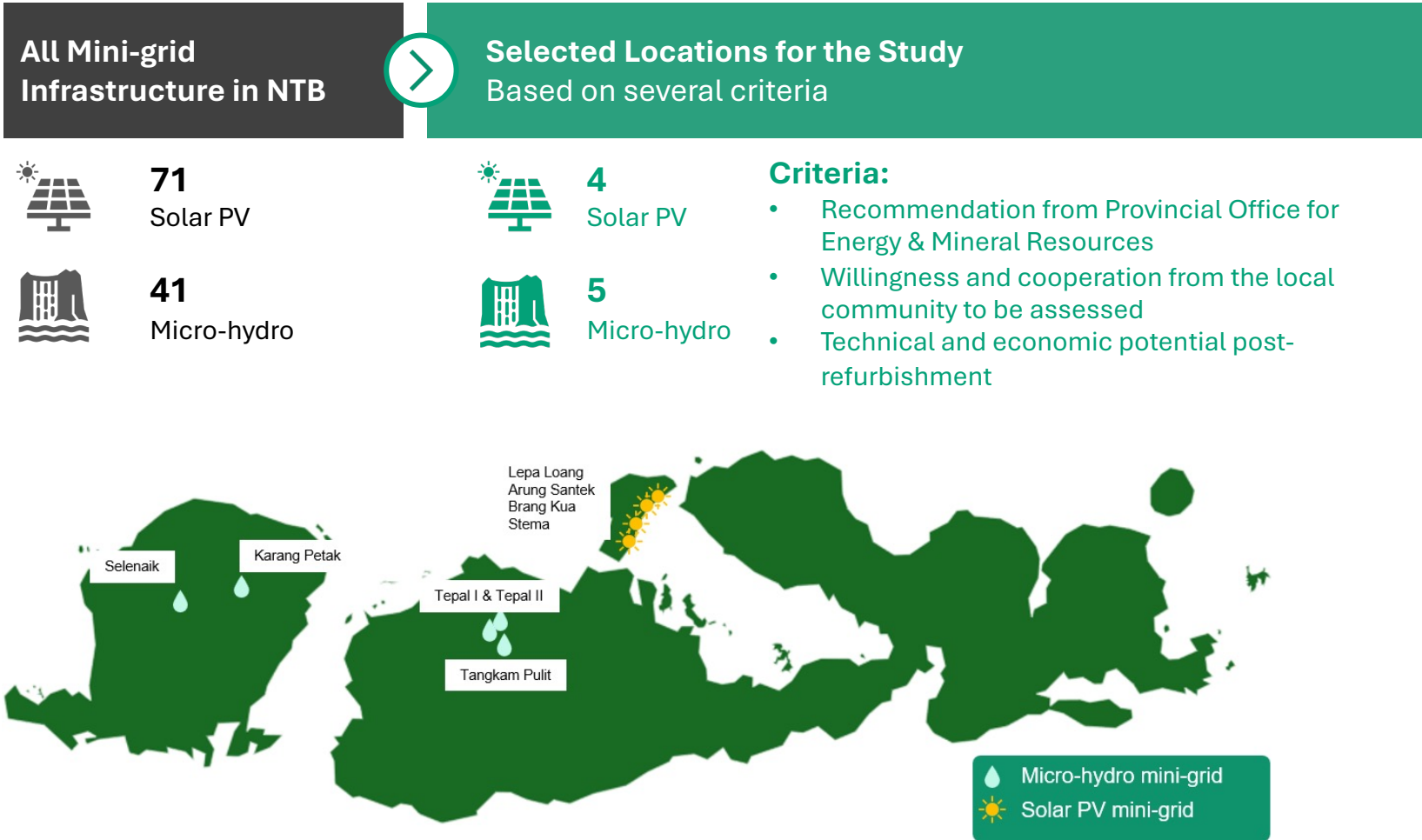
Background

Many of NTB’s government-built mini-grids **no longer operate or run below capacity**, because weak governance, no major-repair reserve fund and limited operator skills leave them unsustainable.

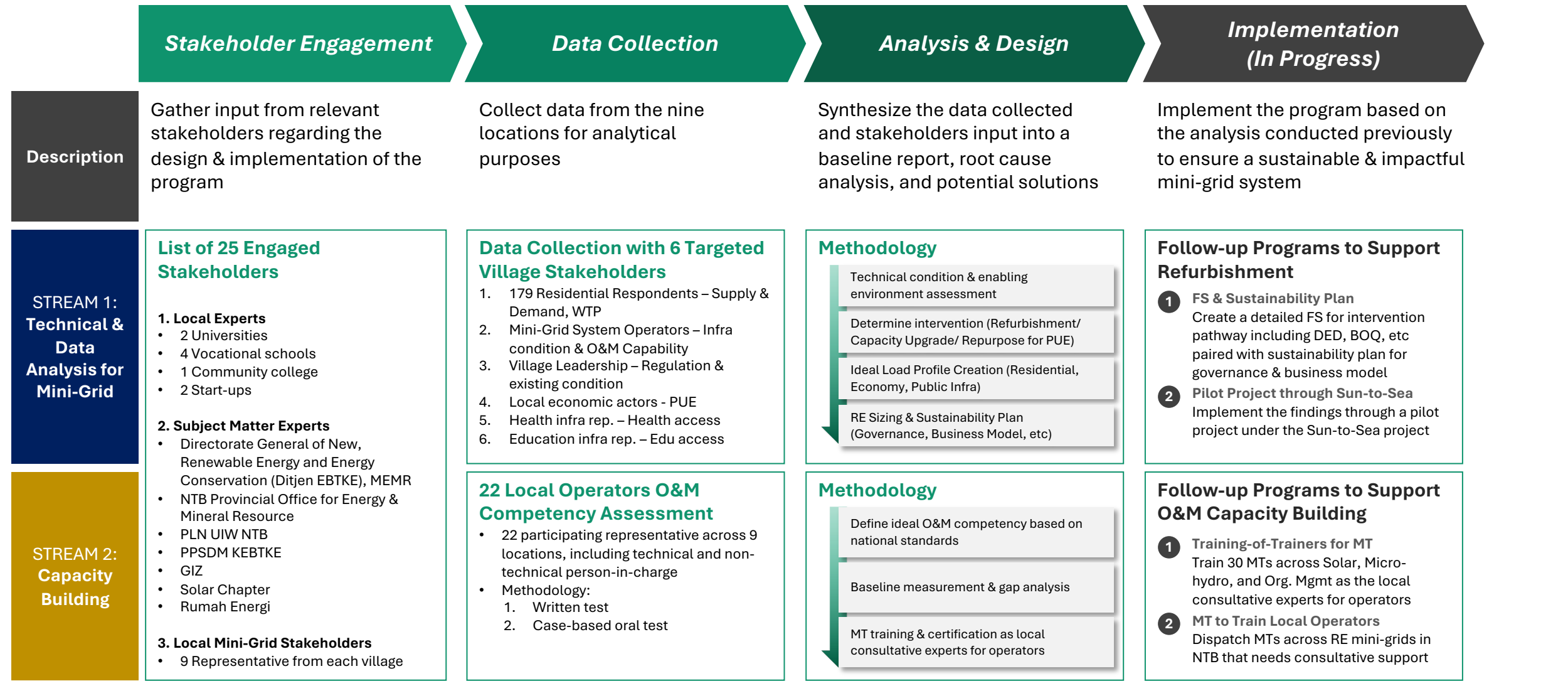
Study Objective

Assess refurbishment feasibility for the nine selected sites, **baseline local operators’ competency**, and recommend a **governance pathway and business model** for financial sustainability.

Location Selection



The paper is created in 4 steps involving 25 stakeholders' consultation, 179 respondents, and 22 local operators to prepare for the implementation phase



There are nine mini-grids included within this report with a potential for to uplift the local economy through productive use of energy

Site	Population	Main livelihood	Electricity access	Mini-grid	Current tariff	Productive use (PUE) potential
Selenaik West Lombok	201 households 1,250 people*	Vanilla, fruit	PLN since 2021 ~20% stay on both	Micro-hydro, 22 kW Not operating since 2025	IDR 20,000/month flat per household	Repurpose plant for PUE, since PLN now covers households
Karang Petak East Lombok	122 households 406 people	Chilli, vegetables	PLN available Mini-grid 24 h/day	Micro-hydro, 20 kW Operating	IDR 800/kWh flat rate	Repurpose for PUE, for example vanilla processing
Tepal I Sumbawa	478 households 1,797 people	Coffee	No PLN grid Two micro-hydros supply the village	Micro-hydro, 25 kW Not operating since 2023	IDR 50,000– 100,000/month tiered by usage	Active: coffee milling, cooperative equipment and coffee shops run on the mini-grid
Tepal II Sumbawa				Micro-hydro, 40 kW Operating, 6–7 outages/month		
Tangkam Pulit Sumbawa	493 households 1,543 people	Coffee	No PLN grid Night only	Micro-hydro, 2 × 150 kW Partly operating (1 unit)	IDR 30,000/month flat per household	None identified; coffee is the main crop
Lepa Loang Moyo, Sumbawa	76 households 256 people	Corn, sesame	No PLN grid 08:00–16:00 only	Solar PV, 10 kWp Partly operating (daytime)	IDR 15,000/month collection stopped	None yet; crops are sold raw to middlemen
Arung Santek Moyo, Sumbawa	151 households 447 people	Corn, sesame	No PLN grid Off since 2019	Solar PV, 15 kWp Not operating, assets sold	IDR 15,000/month stopped in 2019	None; no asset remains
Brang Kua Moyo, Sumbawa	121 households 406 people	Sesame, cashew	No PLN grid 07:00–19:00 only	Solar PV, 30 kWp Partly operating (daytime)	IDR 15,000/month collection stopped	None yet; add once household demand is met
Stema Moyo, Sumbawa	59 households 196 people	Sesame	No PLN grid 24 h/day supply	Solar PV, 15.9 kWp Operating, rare blackouts	IDR 15,000/month collection stopped	None today; sesame processing wanted once capacity is added

*Village-wide figure for Sedau. Tepal I and II share one village and one tariff.

Key findings show that mini-grid sustainability remains constrained by a combination of technical, governance, and O&M challenges

 Infrastructure Condition	 Governance & Business Model	 O&M Competency
17/9 sites Have unresolved technical damage that limits energy output and service. Of the 9 sites, 4 require high-priority repairs, 2 medium-priority, 2 low-priority, and 1 requires a new system.	17/9 sites Are managed by community-based organizations (Pokmas). Only Tepal I and II are managed by a cooperative. 23/9 sites Have active fee-collection mechanisms. All three are MHP sites. 3US\$ 3,72/month Avg Willingness-to-pay, provided electricity reliability & service improvements 4Insufficient Funds Despite fee collection mechanism, the current price still unable to replace major components	14/9 sites Conduct routine maintenance, but it does not yet cover electrical components. O&M remains reactive to failures rather than preventive. 21/9 sites Has an external contact for technical support when needed. The rest relies on uncertified experts 3Competency Scores Improvement Needed Average competency assessment scores: Solar PV – 42%; MHP – 56%; and Business Management – 37%.
Implication: Service restoration requires component repair or replacement	Implication: Operational sustainability requires stronger institutions and business model beyond monthly collections	Implication: Operators need structured O&M SOPs, upskilling, and support access for failures they can't solve independently

Technical rehabilitation alone is not enough to ensure sustainable electricity service.

Weak governance and revenue models, limited operator capacity, and insufficient preventive maintenance turn component-level problems into prolonged system disruptions.

Implementation readiness varies by location. Tepal has the highest readiness level.

Tepal MHP is managed by a structured organization and receives relatively stable tariff revenue, although it is still insufficient to fund major repairs.

MHP sites tend to have stronger governance and better payment compliance than solar PV sites.

The assessed MHP mini-grids generally still have functioning management and user-payment mechanisms.

Based on technical assessment, 4 systems out of 9 categorized as high repair necessity because of the condition and the damage implications

	Site	Infrastructure Condition	Damage Implications	Repair Necessity
Micro-hydro	Senaik Atas	Severe damage to the generator and part of the distribution system	The MHP system is not operational; however, the village already has access to the PLN grid	Low
	Karang Petak	Corrosion on several components; generator insulation resistance is below standard; part of the distribution network requires repair	The system remains operational 24 hours a day , but reliability and safety may deteriorate	Low
	Tepal I	Severe damage to the generator, protection system, and distribution network	The MHP system is not operational ; the load has been transferred to Tepal II	High
	Tepal II	Deterioration of the generator, civil infrastructure, and distribution network	Still operates 24 hours a day, but reliability may decline while also carrying Tepal I's load	Medium
	Tangkam Pulit	Failure of the ballast load ; Unit 2 is not operational; deterioration of the penstock and civil components	Limited operation and unable to provide 24-hour electricity ; only approximately 50% of installed capacity is usable	High
Solar	Lepa Loang	All batteries have failed ; the SCC and distribution network are damaged	Can operate only during daylight hours (08:00–16:00) , with frequent disruptions	High
	Arung Santek	The system has been non-operational since 2019; all major system components have been dismantled	System components are unavailable	New system required
	Brang Kua	Major damage to the batteries and inverter , as well as several supporting components	The system operates only from 07:00–19:00 and experiences recurring outages	High
	Stema	Some inverters, monitoring and protection systems, and physical structures are damaged	Still operates 24 hours a day , but system redundancy and reliability have been reduced	Medium

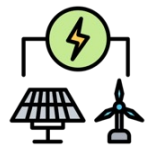
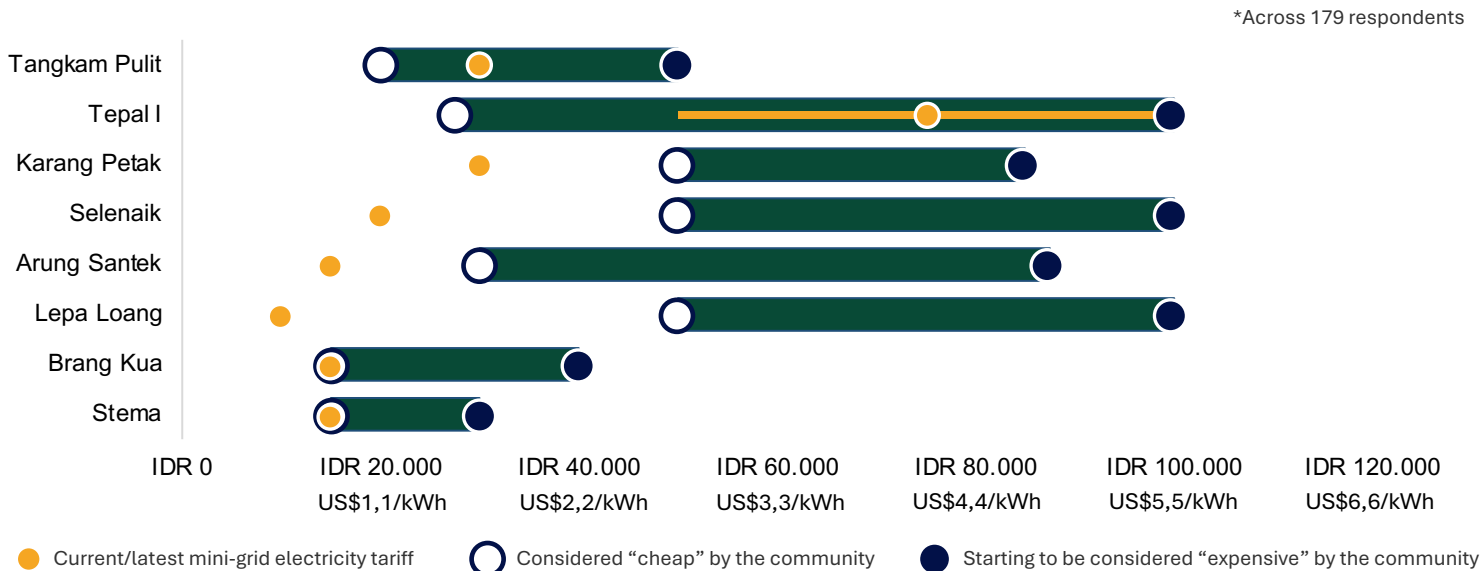
Besides technical check, supporting factors are also considered to ensure the sustainability of the system, with only 2 mini-grids qualified as “Strong”

	Site	Governance	Operator Capacity	Community Support	Overall
Micro-hydro	Selenaik Atas	Moderate ; management structure is still in place, but O&M financing is limited	Strong ; capable of basic operations, but still depends on external support for major repairs	Moderate ; the community and local government support the sustainability of the micro-hydro plant, but most users' WTP depends on the price difference	Moderate
	Karang Petak	Moderate ; management and tariffs are functioning, but heavily dependent on a few individuals	Strong ; capable of routine operations, basic maintenance, and simple troubleshooting independently	Moderate ; support for the micro-hydro plant exists, but most users' WTP depends on the price difference	Moderate
	Tepal I	Strong ; managed by an active cooperative with role allocation and a tariff mechanism that is still functioning	Strong ; experienced operators capable of O&M and basic maintenance	Strong ; the community and village government support the recovery and sustainability of the micro-hydro plant	Strong
	Tepal II	Strong — same active management system as Tepal I			
	Tangkam Pulit	Moderate ; organization and tariffs are in place, but financing for major repairs and preventive maintenance is not yet robust	Moderate ; capable of routine operations, but staff turnover and weak knowledge transfer limit advanced maintenance capacity	Strong ; the community and village government strongly support it; 78.9% of respondents are willing to pay more for more reliable service	Moderate
Solar	Lepa Loang	Weak ; management organization and tariffs are no longer active	Weak ; limited to basic operations, with low maintenance and troubleshooting capacity	Strong ; trust exists between the community and village government, along with support for the sustainability of the solar power plant	Weak
	Arung Santek	Weak ; there is no active manager and ownership of the assets is unclear	Weak ; operator capacity is no longer supported by an active system	Weak ; trust issues and conflict remain regarding fund management and distribution	Weak
	Brang Kua	Weak ; management organization and tariffs are no longer active	Weak ; capability comes mainly from routine operational experience, while troubleshooting, maintenance, and administration remain limited	Strong ; community acceptance of the mini-grid is high and WTP is positive; 56.5% are willing to pay more for more reliable service	Weak
	Stema	Weak ; management organization and tariffs are no longer active although the system is still operating	Moderate ; the TNA score is relatively higher than at other solar power plant sites, but maintenance and troubleshooting capacity remains low	Moderate ; electricity demand and WTP are positive, but trust issues remain regarding fund management	Moderate

The historical tariff is within the community’s WTP, and they are willing to pay more if quality improves



Willingness-to-Pay of Electricity, price is stated in kWh



US\$8,4 per operator per month

Historical incentive for solar power plant operators on Moyo Island



US\$5,6 – 83,6 per operator per month

Operator incentive for micro-hydro power plant sites



Key Insights

Willingness-to-pay tariff ranges vary by location, from an amount considered low at **IDR15,000** to high at **IDR100,000**

Particularly at solar power plant sites, **tariff collection stopped as service quality declined**; consequently, no regular funding is available for O&M and operator compensation

O&M funding, particularly for micro-hydro power plants, remains focused on **routine needs such as purchasing grease and gasoline**, and **is not yet able to finance major repairs / component replacement**

Micro-hydro power plant sites use tariff revenue to finance operations and maintenance, while solar power plants no longer have regular revenue sources; therefore, **repairs are funded through ad hoc community contributions**

Since monthly collection may not be sufficient, adding productive use to leverage the existing power plant might be a solution to ensure the financial sustainability of the system

Assessment results show that operator capabilities remain uneven across technical and mini-grid management areas and in need for an upskilling

Mini-grid Operator Profile

Predominantly male

All operator and manager respondents are male.

Relatively older workforce

13 of 22 respondents are over 35 years old.

Operator is not the primary occupation

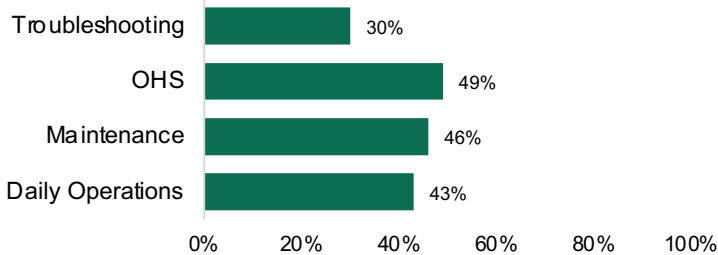
The operator role is generally a secondary job, with farming as the main livelihood.

Most operators have received training

15 of 22 respondents have attended technical training.

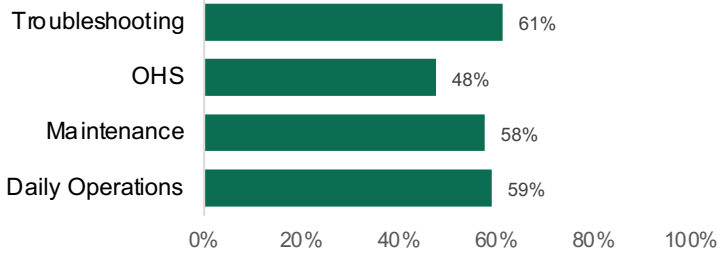
Assessment Results

Solar PV Technical Competency



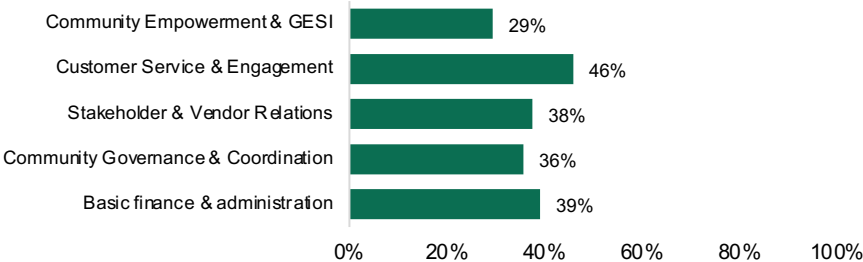
42%
Average Solar PV operator assessment score; with the largest gap in Troubleshooting

MHP Technical Competency



56%
Average MHP operator assessment score; with the largest gap in OHS (Occupational Health and Safety)

Business & Management Competency



37%
Average Business & Management competency score: with gaps across all competency areas

The findings on this paper will be used for the next steps that includes ToT for Master Trainers, Creation of FS, and Implementation of Sun-to-Sea Program

Key recommendations across the three reports

1. On Mini-Grid Infrastructure

- Refurbish **Tepal I, Tangkam Pulit, Brang Kua and Lepa Loang** first; Tepal I leads the pilot ranking
- Confirm scope and cost through **feasibility studies** for all nine sites,
- Fit each site’s plan to its path: **repurpose for productive use, asset refurbishment, or capacity upgrade**

2. On Ensuring O&M Capabilities

- Train **Master Trainers** in solar PV, micro-hydro and business
- Certify MTs at **SKTTK Level 3** collaborating with PPSDM and other experts
- Recruit **more women and youth**; deploy trainers to **Moyo Island** as a mobilized service

Master Trainer (MT): a certified trainer who coaches operators and helps diagnose faults, so support lasts beyond a one-off course.

PPSDM: the energy ministry’s training and certification body.

3. On Governance & Business Model

- Pair infrastructure repairs with **preventive maintenance and a reserve fund** for major repairs
- Choose the **most suitable governance structure**: BUMDes, cooperative or community group
- Secure **proper licensing** to sell electricity through **IUPTLS**

Next steps

1

Training of Trainers implementation

- Finalize the **three-track curriculum** (solar PV, micro-hydro, business) and certification with PPSDM
- Design the **trainer-skills assessment** and embed GESI into every module
- **MT to sign a commitment document** to consultative support on mini-grids and willing to be deployed to different areas in NTB

2

Feasibility Study of Mini-Grid and Sustainability Plan

- Run feasibility studies for all nine sites, **starting with the four refurbishment sites**, to confirm the pilot ranking and cost
- Set the **sustainability plan**: governance structure, proposed tariff to cover major maintenance, and PUE implementation
- Confirm each site’s **governance structure and IUPTLS licensing**, and track Perpres 112/2022

3

Implementation on Sun-to-Sea program

- Use the **site profiles and willingness-to-pay ranges** to set tariffs and service design
- Build training content around the **operator gaps** in business management and solar PV
- Partner with **mid-tier EPC firms** and document pilot lessons for replication



See the full report here



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