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Policy Brief

Accelerating Sustainable Energy Access Through *Koperasi Desa Merah Putih's* 100 GW Solar PV Program

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Key Messages

Indonesia’s 100 GW PLTS initiative through 80,000 Koperasi Desa Merah Putih presents a once-in-a-generation opportunity to accelerate decarbonization, promote inclusive local economic growth, and increase rural energy access.

High risk of repeating past failures: In the absence of governance and subsidy reform, the program runs the risk of repeating previous mini-grid failures, in which systems degraded within three to five years due to weak operations, uncertain legal status, and poor institutional coordination.

Productive use is the sustainability anchor: Compared to household-only electrification, village solar systems connected to revenue-generating industries (agro-processing, fisheries cold chains, irrigation, and digital services) demonstrate higher utilization, stronger cost recovery, and improved long-term viability.

The main bottleneck is policy misalignment: The cooperative-based delivery model is weakened by current power regulations, capital-only subsidy schemes, fragmented ministerial mandates, and a lack of technical and competency standards in cooperative-based delivery model.

Success is determined by institutional reform: To safeguard public investment and guarantee long-term effects, it is crucial to clarify the legal status of community energy systems, reform subsidies to cover operations and capacity building, strengthen inter-ministerial coordination, integrate rural finance, and embed gender and social inclusion.

Introduction

Mid last year, President Prabowo launched an ambitious plan of a 100 Gigawatt (GW) Solar Photovoltaic (PLTS or *Pembangkit Listrik Tenaga Surya*) program, of which 80 GW will be executed through the 80,000 *Koperasi Desa Merah Putih* (KDMP) or Red White Village Cooperative management model. This signals Indonesia's most significant leap toward both universal energy access and decarbonization by simultaneously achieving three critical objectives: closing the energy access gap for rural communities, stimulating rural economic growth, and contributing 84% of Indonesia's 2060 net-zero target [1][2]. The vision is strategic, but its implementation also faces a critical problem and doubt due to gaps in policy integration, subsidy misalignment, and constraints in the governance capacity of the community.

The program risks repeating the shortcomings of past rural electrification efforts. This brief looks at the policy barriers and outlines the necessary reforms that need to be made for it to work for successful implementation. This brief is built based on more than 10 years of Humanis experience in developing rural electrification through renewable energy using various management model including cooperative.

The Opportunities

With an estimated 3,294 GWp potential, Indonesia ranks among the highest solar potential globally [3]. By end of 2024, only 912 MW of this potential has been harnessed, this is only a mere 0.03% of penetration rate [3]. The KDMP-100GW PLTS initiative provides a transformative potential. Compared to past infrastructure-centric programs, the Koperasi Desa Merah Putih model combines village economic development, community ownership, and productive energy use (PUE) at its core [4]. Each cooperative is established to offer more than just electricity; it serves as a platform for livelihood development, such as cold storage facilities for fishermen, value-added products for farmers, charging terminals for electric vehicles, access to productive equipment, and strengthening financial services through village-based cooperatives [5].

Designing the PV-technology for the energy access program with the KDMP model offers advantages compared to past infrastructure-centric traditional approaches:

1. **Community ownership and management.** The cooperative model reflects Indonesia's strong cultural emphasis on *gotong royong* and consensus-based decision-making. This model will reduce conflict as each member has one vote, and any infrastructure/ project is seen as a shared asset. In remote areas, many microgrid PLTS systems built in the past are run by communities, but engagement typically starts after installation is completed and is limited to short-term operator training, which rarely builds real ownership and deeper technical skill transfers. In contrast, community-based cooperatives operationalize *gotong royong* by involving members at every stage of the project, thereby strengthening accountability and ownership. Evidence from Mataredi (East Nusa Tenggara), Berau (East Kalimantan), and Cilamaya (West Java) that inclusive participation, particularly the early involvement of women alongside men in community-based renewable improves system sustainability and financial viability [6][7].
2. **Economic multiplier effect.** KDMP is being designed and functioning as a multi-purpose economic engine offering services, financial inclusion and energy access in an integrated model. This economic-based approach hooks energy from a consumption good into a productive asset while anchoring capital locally. Compared to other management models, Cooperative has compulsory and voluntary contributions, which together form the cooperative's initial and ongoing capital base.
3. **Alignment with energy transition goals.** With up to 1 MW + BESS target of PLTS installation per village, the program creates localized mini grids capable of supporting both approximately up to 1,500 households' needs and industrial productive uses (depending different contexts), addressing the past energy poverty legacy problem where communities have electricity but lack

income-generating capability due to the limited size of energy capacity [8]. Although this size is considered too big for Community Co-op to manage, with proper external partnership, the risks can be mitigated.

4. Private sector participation. In mini-grid and community-owned systems, private sector partnerships play a critical role beyond technology supply and installation. Operation & Maintenance (O&M) partnerships with experienced developers and manufacturers help ensure system reliability by providing preventive and corrective maintenance, and troubleshooting and repair, which community operators often cannot manage alone. These partnerships support hands-on skills transfer to local technicians, establish service and spare-parts networks, reduce downtime, and lower lifecycle costs.

The Mismatch in Policy Implementation

Despite of the above advantages, the PLTS 100 GW program faces significant challenge on its long-term impact. The existing policy framework is still fragmented and misaligned with the program's operational needs and vision. This is not a problem with resources or technology, it is a governance problem.

Problem 1: Regulatory framework designed for conventional utility models

Indonesia's current power regulatory framework was made for utility-scale projects with PT Perusahaan Listrik Negara (PLN) as the primary operator. This concept is fundamentally conflicting with the *Koperasi Desa Merah Putih*'s community-ownership model [9].

Specific barriers:

- Mandatory PLN partnership requirements. Current regulations only acknowledge PLN as the single ownership and control in all renewable energy projects in Indonesia, including the small village-scale installations. As the sole utility, it controls and owns the entire national territory. PLN acts as the single buyer, manages the grid, dominates Power Purchase Agreement (PPA) and holds authority over licensing and interconnection. This takes away meaningful ownership from local cooperatives and limits revenue retention within communities [9][10].
- Uncertainty over grid connection and net-metering. There is a loophole in regulation for village-scale systems that are connected to or run independently of PLN's distribution. The Ministerial Regulation of the Ministry of Energy and Mineral Resources (ESDM) Permen ESDM No. 2/2024 on rooftop solar provides a regulatory model for grid-connected rooftop systems but is limited in scope to individual customers and quota mechanisms. There is a need for regulations that provide more clarity and comprehensively recognize communal settings, including community-based renewable energy [11].
- Absence of a community energy service agreement mechanism. Under ESDM Regulation No. 5/2025, the Power Purchase Agreement (PPA) applies to utility-scale renewable plants selling to PLN, and does not extend to community-owned, village-scale mini-grids or mechanisms for the community to PLN or between cooperative-to-consumer contracts. As a result, village-based project lacks a clear legal basis for long-term service agreements and tariff structures. Existing village-based projects rely on ad hoc local practices that vary from case to case, creating legal uncertainty, bankability and limiting scalability.

Implication: Village cooperatives are not able to legally set themselves up as energy producers and sellers without going through PLN or the appointed IPP (Independent Power Producer) or ESCOs (Energy Service Companies). It takes away the governance and financial independence that make the cooperative model work.

Problem 2: The subsidy mechanism excludes capacity development and operations

One of the main causes of failed mini-grid models in rural areas is that Indonesia's current subsidy scheme which only allocates capital funds for hardware and system installation but not subsidy for operation, maintenance, capacity building, or O&M support that are critical in village-based settings [6] [12].

Specific barriers:

- Subsidy targeting mismatch. At the moment, capital subsidy for village-renewable focus on upfront hardware costs (capex), particularly for 450 VA consumers in 3T (*Terdepan, Terluar, Tertinggal* or frontier, outermost, and underdeveloped) regions. The subsidy mechanism is largely neglecting essential operational support such as operator training and certification, battery replacement, and management systems. A 2024 MENTARI study identified 800 existing mini-grid systems built between 2015 and 2023 had major sustainability issues 2-3 years after installation due to inadequate operational support [6]. Without addressing this, the PLTS 100 GW program could be exposed to the same failure risk.
- No demand aggregation mechanism. The World Bank's energy access framework emphasizes that tariff affordability depends on demand density. Village energy systems need different ways to spread O&M expenses, yet current subsidies only provide for household-level, which does not create sufficient economies of scale for sustainability [8].
- Fossil fuel subsidy lock-in. Indonesia's current fuel subsidies are estimated at Rp 300+ trillion per year, which largely went to diesel generators and coal-fired backup power; this indirectly makes solar systems or any renewables seem more expensive [12]. There is no compensatory mechanism that redirects fossil fuel savings toward renewable energy adoption.

> Implication: Village cooperatives will likely collapse after 3 to 5 years of operation, when they need to replace inverters or batteries, and local fee collection proves insufficient. This is the pattern observed in previous initiatives; lack of accessible long-term funding mechanisms.

Problem 3: Institutional fragmentation and silo coordination

The PLTS 100 GW program spans four distinct ministerial jurisdictions (ESDM, Cooperatives, Villages Development, and Manpower), and coordination mechanisms remain a fundamental issue [13].

Specific barriers:

- Fragmented planning and monitoring. There is no integrated planning or shared-KPI (Key Performance Indicators) that connects renewable energy targets link with village development priorities (under Ministry of Village) or cooperative governance or economic indicators (under Ministry of Cooperatives), including workforce development strategy to fulfil energy transition pathway (under Ministry of Manpower). Current projects operate ad-hoc without synchronized shared-KPIs [14].
- Conflicting regulatory authority and capacity. The Ministry of Cooperatives has provided commitment to support *Koperasi Desa Merah Putih* as PLTS operators, but lacks energy sector expertise and does not understand with the current power sector dynamics or have exposures to past lessons. Issues around reconciliation, especially when the grid arrives, requires formal MOU, complicated licensing and regulatory alignment, and further support that is not yet clear [15].
- No standardized technical standards. For village-based renewable installations, including PLTS, there are no unified specifications such as optimal capacity, battery sizing, inverter standards, voltage regulation, and meter systems. This means each project innovates independently, limiting economies of scale and complicating future replication [16].

> Implication**:** Programs move forward in parallel instead of coordination, which leads to duplicating efforts and leaving regulatory gaps that block scale-up.

Problem 4: Limitation of governance and technical capacity

Historically, village cooperatives have mostly focused on agricultural inputs and retail, and lacking technical or financial management skills needed to run energy systems. The assumption that a few days to a week of operator training can transform cooperatives into energy utility operators is contradicted by evidence [6][17].

Specific barriers:

- Insufficient operator certification. Indonesia does not yet have a fully operational and widely applied national competency framework for village-level energy operators. While competency standards have been proposed under existing national certification systems such as SKKNI (*Standar Kompetensi Kerja Nasional Indonesia*), they have not been systematically implemented, and funding for training and certification remains very limited. As a result, operator capacity varies widely across projects, increasing system downtime, safety risks, and high dependence on external supports, this undermining the village mini-grid sustainability [6].
- Fee collection and tariff governance weakness. For many years, rural cooperatives have struggled with fee collection even for agricultural services. Energy systems need at least 95%+ collection rates to be able to sustain O&M costs, in addition to technical capacity issue; this is mostly a significant bottleneck problem in village mini-grids. No proven model for community-based tariff setting exists that balances affordability with full cost recovery without the additional financial support [17][18].
- Gender and social inclusion gaps. While existing projects such as Mataredi and Berau demonstrate that female cooperative leaders improve system management, no systematic design or mechanism that ensures gender participation across 80,000 newly established village-cooperatives. This risks replicating past projects where women were excluded from governance [6].
- Limited financing and business plan capacity. Village cooperatives lack experience with energy service models. Current models assume simple cost-recovery tariffs, but advanced models that will be needed to support its financial sustainability, such as energy-as-a-service, tiered tariffs for different users, and cross-subsidy schemes, require advanced financial literacy [4].

Implication: Without in-depth intervention on the required institutional capacity strengthening support, technical management failures and fee collection collapse will emerge 2-3 years after installation, regardless of equipment quality.

Problem 5: Demand creation and local economic integration are absent from policy

Previous rural electrification initiatives prioritized "access" (connection) over "use" (productive consumption), with this in fact being set as the program's success indicator. The same risk threatens PLTS 100 GW's household-centric pathway; villages may receive solar systems, but lack integration with local economic development strategies, leaving energy as an input without complementary productive assets [8]. However, this problem is fundamentally solvable through the PUE-centric alternative design, which embeds productive equipment strategy and local economic integration from project inception [21][22][23].

For the household-centric pathway specifically, the barriers remain:

- No integrated PUE equipment strategy. The *Koperasi Desa Merah Putih* promises support for fishing cold storage, irrigation, rice mills, and other productive uses, but lacks policy-coordinated funding and operational mechanisms. Productive equipment requires both energy availability and equipment financing, and skills to operate it. Villages with PLTS but no credit line for fishing equipment or irrigation pumps cannot convert energy access into livelihood improvement [18]. Separate policy streams, including financing, can create implementation gaps.

- Absence of demand forecasting mechanisms. Feasibility studies for village installations typically estimate household consumption based on generic models rather than local economic opportunity assessment. This produces undersized systems that satisfy household (current) demand but cannot serve (future) productive uses to enable economic change. This is a critical limitation for the household-only approach [8][22][36].

Implication: The program achieves electrification without economic transformation, failing its central promise of livelihood enhancement as the core mandate of Cooperative establishment, and leaving communities dependent on government support rather than self-sufficient.

Alternative pathway through Productive Use of Energy (PUE)-centric design

While the household electrification/transmission pathway remains valid, there is another emerging alternative of PUE centric design which offers more sustainable impact, particularly for 3T regions [21][22][36].

Instead of sizing village PLTS systems on household demand (typically 0.2-0.5 kW per household per day, or 50-150 kW village-level), a PUE-centric model uses productive loads as the system anchor, with household electrification as an added benefit:

- Primary load: productive businesses that need power during the day include fishing/vegetable cold storage/cold room, rice/maize milling, irrigation systems, ice-making, agro-processing, and digital hubs. These businesses usually need 50-150 kW of power throughout the day.
- Secondary load: the power used by the household for lighting, phone charging, basic appliances, usually 30-50 kW in the evening.
- System design: taking the original plan of up to 1.5 MW solar + 1.5 MWh battery storage, with a capacity factor of 45-60% (compared to 20-30% for systems that only serve households). This makes tariffs and cost recovery possible [21][24][25].

For example, EnDev Indonesia's ten years of experience with community-based mini-grids shows that systems that combine productive use equipment with household electrification have a sustainability rate of 85-90% over 10 years, while systems that just provide electricity to homes have failure rates of 30-40% [24]. A World Bank study of rural electrification in Indonesia in the 1990s found that using productive machines increased revenue by 40-60%, which directly lowered the cost of tariffs burden on poor households [23].

Design aspects of a PUE-centric PLTS with a cooperative model

1. Anchor business model

Village PLTS systems are designed around identified productive opportunities specific to the local context:

Fishing Communities	Agricultural Communities	Agro-processing Communities	Digital Service Hubs
• Cold storage and ice-making enable 24-hour fish preservation and access to regional markets. • Cooperative-based fee systems generate Rp 5 to 10 million per month, sufficient to cover basic regular O&M costs. • Strengthens fisheries value chains and reduces post-harvest losses [5][22]	• Milling and irrigation systems support dry-season farming, mix agro forestry and mechanized processing. • Ability to process 2 to 3 cropping cycles per year, compared to max 2 under rain-fed systems. • Agro-mill services such as rice and corn peel from nearby villages. • Seasonal revenues during harvest periods improve farm incomes and energy utilization [25]	• Processing of copra, cocoa, coffee, and spices adds up to 40% raw products value. • Generates Rp 8 to15 million per month during processing seasons. • Anchors local economic activity and provide a stable demand base for mini-grid operations which maximizing system utilization and financial viability.	• Power for internet access/ telecommunication tower, phone charging, printing, and e-commerce services in last-mile areas. • Generates Rp 2 to 5 million per month with high profit margins. • Supports digital inclusion and youth employment with low energy demand [22]

Why do anchor models work better?

Productive equipment provides daytime baseload, which is important for solar systems because they make the most power in the midday. A single rice mill operating for 8 hours a day can require 240 kWh, which is the same as 600-800 homes with solely night-time lights. This concentration of demand raises the system load factor and makes it possible to charge cost-recovery tarrifs [21].

2. Cooperative as energy-enterprise developer

Under a PUE-centric approach, *Koperasi Desa Merah Putih* can transition from a passive energy distributor or operator into a local energy–enterprise developer. It manages energy assets to support income-generating activities and local value changes rather than just electricity provision.

As an asset owner, Cooperative also retains revenues from the services it provides and reinvests them to ensure system sustainability, community benefits and member returns. Cooperatives may operate productive use equipment directly or lease it to members or small businesses through transparent fee-based arrangements. Evidence from Mataredi (NTT) shows that inclusive management, particularly with women in leadership roles, significantly improves revenue collection and tarrif transparency [6][22]. Experience from Kamanggih cooperative microhydro (NTT) shows that when a community has strong technical and management know-how as a small-scale utility, it can confidently manage multiple renewable technologies, including solar, small-scale wind and domestic biogas while also creating additional economic opportunities for its members.

Beyond energy services, cooperatives can play a catalytic role by linking productive users to markets, finance, and basic business support. Energy services assist in building local economic multipliers when they are added to other cooperative services like retail, savings and loans. In parallel, it strengthens rural businesses and sustaining energy system over time.

3. Demand aggregation and tariff sustainability

A PUE model significantly improves the financial sustainability of community mini-grids by bringing together demand from homes and income-generating users. It allows for differentiated rates based on consumption, unlike households distribution network, which often employs flat rates. Users who use energy for productive activities such as agro-processing, cold storage, and irrigation, use the power throughout the day and generate income from its use, thus able to pay higher tariffs. This creates a steady revenue base that enables cross-subsidy for poor households, protecting affordability for vulnerable groups while maintaining cost recovery for the system operations

When it's well-executed, evidence shows that mini-grids with productive demand achieve full O&M cost recovery and surplus generation, allowing the accumulation of maintenance reserves and system expansion. In contrast, mini-grids that only serve households mostly fail to cover their running costs, leading to system degradation and early system failure. This shows that tariff sustainability is not just a matter of pricing issues, but also of how demand is structured. Therefore, to ensure rural electrification programs that are financially sustainable and socially fair, it is important to include productive users from the start [21][24].

4. Gender and social inclusion in PUE operations

International and national evidence shows that gender and socially inclusive management of productive-use activities improves the sustainability, credibility of energy systems, and community's trust [6][7][22]. In projects in Mataredi (East Nusa Tenggara) and Berau (East Kalimantan), for example, the involvement of women in the leadership and management of productive equipment, including energy system operation, has been associated with stronger revenue collection, better maintenance practices, and higher levels of community trust in tariff setting and financial transparency. These outcomes contribute directly to system longevity and more equitable benefit sharing at the household level.

Apart from that, PUE-centric mini-grids also create new employment opportunities for trained rural youth, particularly in equipment operation, technician maintenance, digital services operators, and value-chain logistics. It is estimated that one PLTS with productive equipment can create 3-5 direct jobs and 5-10 indirect jobs in value chain services [19][25].

5. Integrated financing for productive rural energy

Rural mini-grid investments are most effective when energy infrastructure financing is integrated with financing for productive equipment. Current sectoral silos, where energy subsidies and productive asset financing are managed separately, have led to underutilized systems and repeated fiscal top-ups. International and domestic experiences show that combining public subsidies for energy infrastructure with concessional finance and cooperative contributions for productive uses improves energy utilization, strengthens cost recovery, and reduces long-term budget exposure. For the government, this integrated financing increases the return on public spending, lowers the risk of stranded assets, and improves the sustainability of rural electrification investments [22][23].

Policy Recommendations

To realize the *Koperasi Desa Merah Putih's* potential and close the policy-implementation gap to mitigate the risk of repeating the past rural electrification shortcomings, the following urgent policy reforms are needed:

Recommendation 1: Clarify the legal status of community-based RE systems for household electrification/transmission pathway

While Law No. 30/2009 on Electricity allows electricity services run by cooperatives and other non-PLN entities, existing implementing regulations, including Ministerial Regulation ESDM No. 36/2018, remain oriented toward utility-scale and PLN-centric models. The most immediate impact, village-scale, community-based energy systems are unable to compete in meeting the many technical, administrative, and commercial requirements to partner with PLN. As a result, these systems operate without a clear legal status over operations, retail authority, tariff setting, and excluding them from government subsidy support.

The government needs to issue supplementary or implementing regulations pursuant to Law No. 30/2009 and Permen ESDM No. 36/2018 that accommodate community-based systems according to their scale and capacity (up to 1 MW). Key regulatory clarifications:

- To formally recognise community cooperatives as eligible entities to own and operate village-scale renewable energy systems. Provide help on licensing processes and governance.
- To clarify the authority of cooperatives to supply electricity directly to their members in off-grid or isolated systems.
- To establish a standard contractual framework for the sale of excess electricity to PLN where grid interconnection exists.
- To confirm eligibility of community-based systems for existing government subsidy and other non-financial support schemes.

Regulatory clarification would reduce legal uncertainty, enable standardisation, and support the scale-up of village renewable energy systems while remaining fully consistent with the existing Electricity Law framework. This approach strengthens asset sustainability, improves public investment efficiency, and supports rural energy access without altering PLN's mandate. Village systems require different governance. International evidence from Costa Rica, Kenya, and Bangladesh demonstrates that community ownership improves system sustainability and socio-economic outcomes [26][30].

Recommendation 2: Reform energy subsidy architecture for operational support

Instead of providing 100% to hardware capital subsidy, restructure energy subsidies to allocate 30-40% of the subsidy budget to operational support, such as O&M, training, battery replacement reserve funds over a 10-year period.

- Set up a **Renewable Energy Operations Fund** with an annual budget of Rp 2-3 trillion, to fund:
  - A national O&M reserve fund (including insurance) for village systems that are about to need new batteries
  - Training and certification for operators through local vocational centers
  - Building the capacity of cooperative's governance and management skills

A method for adjusting tarrifs to support affordability for the poorest consumers, and

Gender-responsive governance to support women in leadership roles and local businesses.

- Disbursements should be based on performance, with villages demonstrating 70% of their fees and having female-balanced governance receiving enhanced subsidies.

Evidence from 800 existing mini-grids demonstrates that capital-only subsidies create systems communities cannot maintain. Operational subsidies are standard practice globally for extending services to lowest-income populations [6][12]. Redirect savings from fossil fuel subsidy phase-out (estimated Rp 50+ trillion potential if implemented fully) or allocate 20% from the carbon tax revenue.

Recommendation 3: Establish inter-ministerial coordination framework

With the complex implementation trajectory, there is a need to set up the PLTS 100 GW Task Force with executive authority. This task force can be led by the Coordinating Ministry for Economic Affairs with teamwork representation from ESDM, Cooperatives, Villages, Manpower, Finance, and Women Empowerment ministries. Establish shared-KPIs and quarterly review mechanisms as well.

Implementation should be driven by cross-ministerial alignment, with a single implementation roadmap that must harmonise ESDM's national electricity plan (RUKN or *Rencana Umum Kelistrikan Nasional*), cooperative development strategies, village development frameworks, and workforce plans. Delivery should be supported by a unified monitoring platform (SIMREG or *Sistem Informasi Manajemen Regulasi*) to track technical performance, financial sustainability, gender leadership, and productive-use integration at village level. To mitigate potential risk of inter-ministerial roadblocks, there should be dedicated resources budgeted to support the task force in resolving coordination challenges swiftly. Intensive monthly coordination during the first two years is essential to stabilise implementation, reflect and pivot, followed by quarterly reviews once systems mature.

Recommendation 4: Set standard technical specification and operator competency

Set a single technical standard for village-based PLTS systems and make it mandatory for operators to obtain a national competency standard certification. The government should provide the financing for the training for a minimum of O&M, health and safety, and power generation management skills.

ESDM should develop a technical rule that set minimum standard for safety, performance and monitoring for village-scale PLTS. These standards should include requirements for system dependability, grid stability, redundancy, and data reporting including battery (waste) management. Standards should be able to adapt to local conditions while ensuring interoperability, environmental compliance, asset protection and that there is sufficient energy capacity to support local economic growth.

In parallel, ESDM should collaborate with the Ministry of Manpower to operationalise national competency standards for village energy system operators and cooperative energy managers. Certification should be delivered through existing vocational training centres and linked directly to system eligibility for public subsidies and support. The more these local facilities are closer to the 80,000 villages the better they provide long-term services in providing technical talents ready for energy transition.

The absence of technical standards and mandatory certified operators in the past has resulted in variety of system quality, higher downtime, and accelerated asset degradation. Linking technical benchmarks and operator certification to subsidy eligibility would improve system reliability, reduce fiscal leakage from repeated repairs or replacements, and professionalize village energy management.

Standardization also makes it possible to buy in bulk (which lowers equipment costs by 10–15%), makes it easier to copy, and makes systems better and more reliable. India's MNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) green jobs certification program and Rwanda's solar technician training show that standardized certification makes it easier for people in rural areas to use new technologies [31][32].

Recommendation 5: Integrate productive use equipment and agricultural financing

Establish a coordinated Energy and Productive Assets financing facility, jointly managed by the Ministry Cooperative and the Ministry of Agriculture or the Ministry of Fisheries, to link village PLTS investment with concessional financing for income-generating equipment. For example, offer 80% equipment subsidy with 20% cooperative co-financing for cold storage, irrigation pump systems, agricultural processing or charging stations for farm equipment.

Energy access alone does not guarantee income generation or ensure system sustainability. International and Indonesia evidence shows that coupling renewable energy with productive equipment significantly increases rural incomes 15-25% and improves mini-grid utilization [20][33]. Connecting equipment financing as part of PLTS systems and basic cooperative readiness helps create steady demand, improve cost recovery and increases the return on public energy investments. This integrated approach reduces the risk of underutilized systems and accelerates rural economic growth, particularly in agriculture and fisheries.

Recommendation 6: Embed GESI performance criteria

Mandate gender and social inclusion (GESI) criteria for all government-supported village project funding, include a performance-based incentive for projects that exceed minimum requirements as part of monitoring system. For an example minimum 50% female cooperative board representation, inclusive decision making, targeted training for women entrepreneurs and tariff setting including the poorest household.

Evidence from Mataredi and Berau demonstrates that gender-inclusive governance significantly improves system sustainability, fee collection, and livelihood outcomes [6]. International experience (India's NRLM or National Rural Livelihood Mission, Rwanda's VSLAs or Village Savings and Loan Associations) confirms that gender-targeted support accelerates poverty reduction and behavioral change [34][35]. Includes GESI requirements as part of both project eligibility and performance monitoring will improve relevant actors view inclusion as an operational and risk-management tool, not a social add-on. For the government, this approach improves system sustainability, protects public assets, and enhances poverty-reduction outcomes, while remaining compatible with existing delivery mechanisms.

What is at stake

The success of PLTS 100 GW *Koperasi Desa Merah Putih* program will depend not on technology, but on political and institutional choices. Indonesia has the resources, the market interest and the demand. What remains is whether existing sectoral mandates and power structures can adapt to a community-centered model.

The cost of neglecting these reflections will be another replication of failed mini-grid initiatives, billions in wasted public investment, and locking underdevelopment for rural villages. Reform will open new coalitions, cooperatives, local governments, private suppliers, and financiers, around shared incentives and measurable outcomes. The program will test the government's ability to move beyond sectoral silos toward integrated development delivery, beyond jargon or rhetoric vision.

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