



Ministry of National
Development Planning/Bappenas
Republic of Indonesia



ENERGY
TRANSITION
PARTNERSHIP

Powering Prosperity and Enabling Sustainability in South East Asia

SOLAR PV MAPPING AND DEVELOPMENT PLAN (INDONESIA)

Prepared by : Consortium lead by Trama TecnoAmbiental



OCTOBER 2025

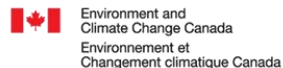


TABLE OF CONTENT

Introduction

Methodology

Key Insights

Solar PV Investment Roadmap

Major Challenges and Measures to Address Key Issues

Conclusion and Recommendation



INTRODUCTION

1.1. PROJECT OBJECTIVES

±1GW

Renewable Energy shared in 2024

443 GW

New additional RE installed capacity by 2060

~ 1T USD

Investment required

This project aims to increase the use of solar photovoltaic (PV) technology in Indonesia to reduce emissions and meet the country's goal of achieving net-zero emissions in the power sector by 2060.

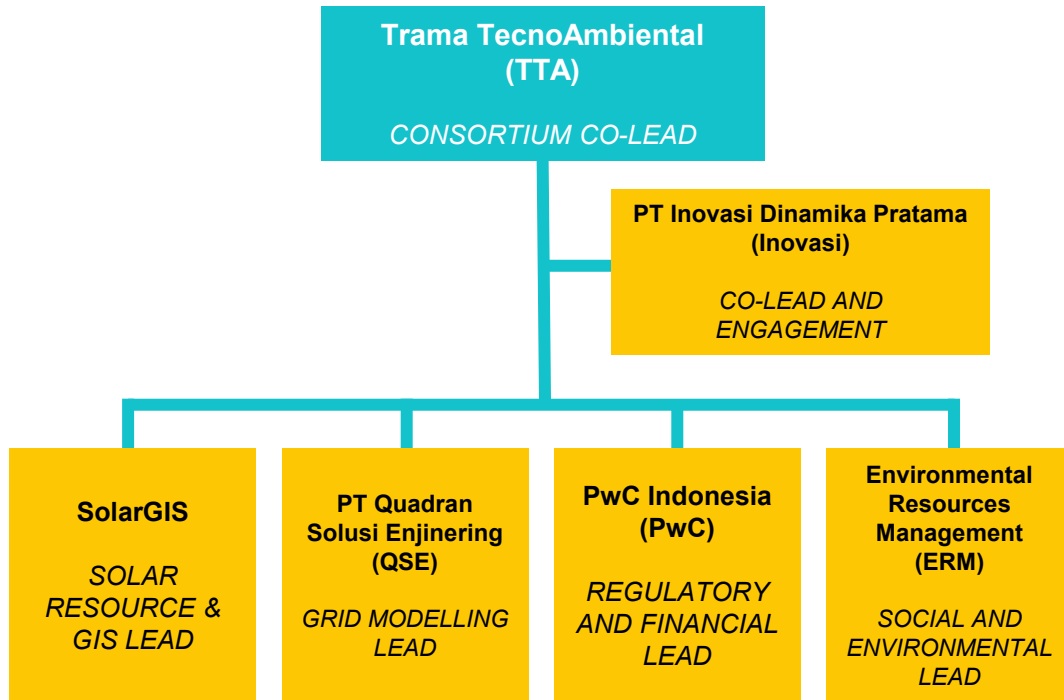
Key Project Outputs:

- Solar Irradiance Data Mapping and accessible database
- Grid assessment and Impact evaluation
- Environmental and Social Impact Assessment
- A solar PV development and investment plan for 1 GW of the JAMALI power grid
- Pre-feasibility document of the 1GW Solar PV mapping and development in JAMALI systems

Additional Outputs:

- Floating PV Potential in JAMALI

1.2 THE CONSULTANT TEAM



TTA is a global consulting and engineering company, providing specialised consulting services for regulating and implementing projects in distributed generation through renewable energies, energy management and efficiency, rural electrification, as well as integration of renewables in buildings.



INOVASI is an Indonesian social entrepreneurship specializing in technical, social, and economic innovations to drive rural economic development. INOVASI will provide support for project management, stakeholders engagement, as well as TWG events.



SOLARGIS a leading provider of solar irradiance data and software solutions, known for their rigorous validation process, resulting in the most accurate and reliable solar resource database in the market. SOLARGIS will provides consultation on solar irradiance and GIS.



QSE is a national consulting firm specializing in Electrical Power System Study, addressing challenges in the stability, availability, and reliability of power systems. QSE's expertise spans Grid Interconnection, Renewable Energy, Power System Planning, Operation, and Feasibility Study, demonstrated through their comprehensive competence in major and isolated power systems across Indonesia.



PwC Indonesia, a leading professional services provider in the resources sector for over 30 years. Serving as Knowledge Partner for Indonesia's G20 Presidency, PwC navigates the perspectives of government, state-owned enterprises, and the private sector, contributing to energy transition policy reforms and providing analytical support for projects such as the Affordable and Sustainable Energy Transition for the ADB.

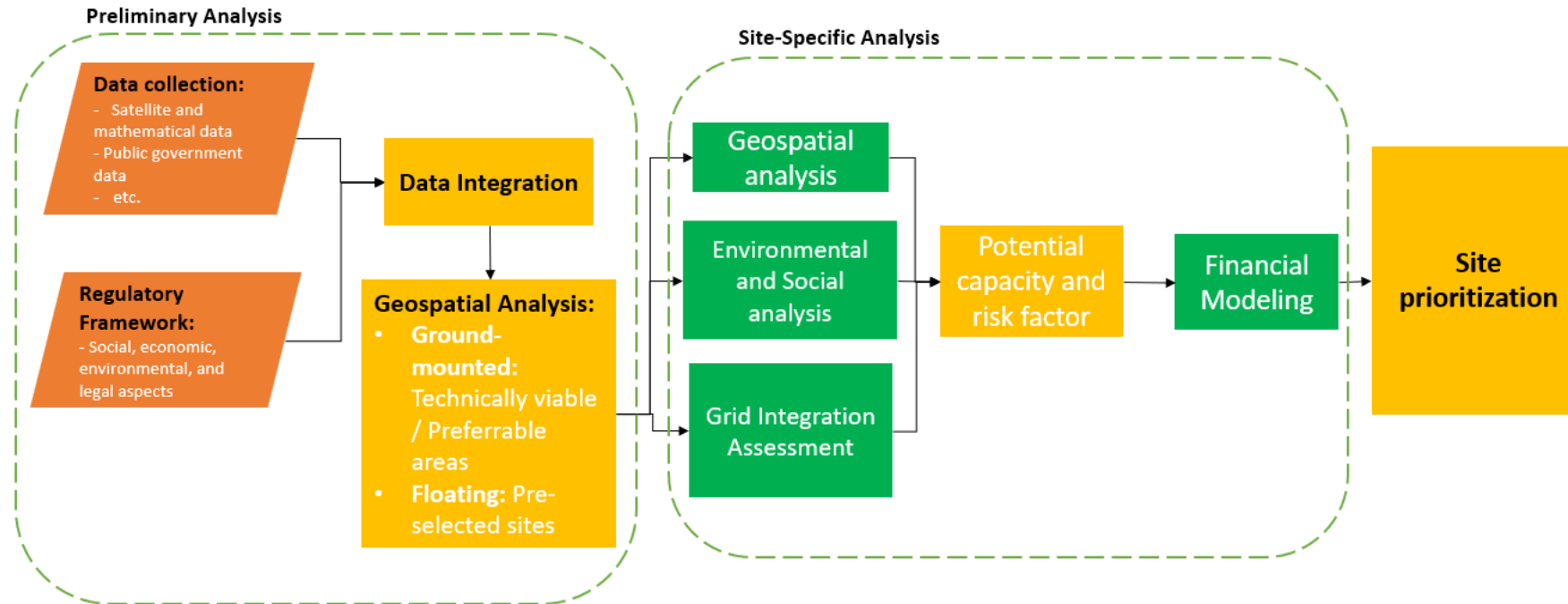


ERM, a global leader in environmental, health, safety, risk, and sustainability services, operates in over 40 countries with a team of 5,300 professionals and a distinguished history of collaborating with more than half of the Global Fortune 500 companies. In Indonesia,



METHODOLOGY

2. METHODOLOGY OF THE STUDY

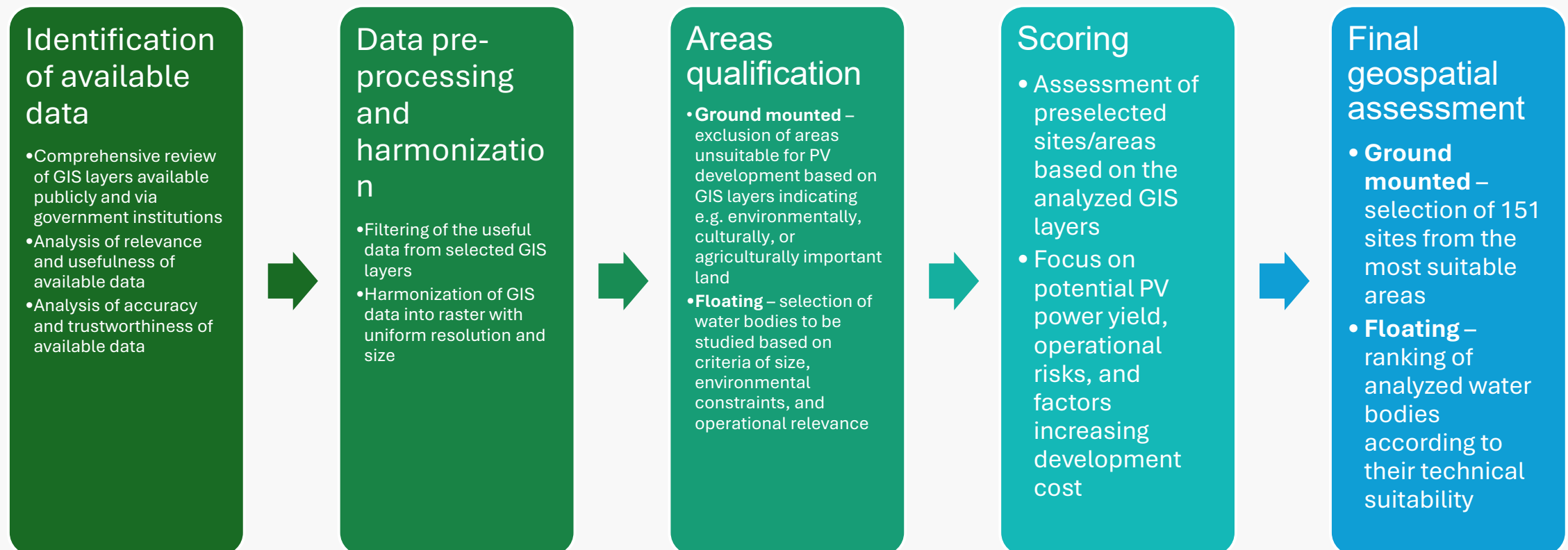


Key Methodology:

- **Geospatial analysis:** To identify technically feasible locations for floating PV deployment across the JAMALI region.
- **Environmental and social analysis:** To validate the technical findings and assess potential risks related to environmental, social, and regulatory factors.
- **Preliminary grid integration assessment:** To estimate the maximum hosting capacity of solar PV at the substation level for each shortlisted site.
- **Financial modelling:** To analyze the financial viability and bankability of each floating PV site.

2.2. GEOSPATIAL ANALYSIS

- The suitable placement of utility-scale PV power plants within the country is influenced by multiple factors, ranging from restrictive to unfavorable and favorable conditions.
- Using accessible spatial data from satellites, satellite-derived products, and thematic maps, potential areas for utility-scale PV deployment were assessed and preliminary locations identified

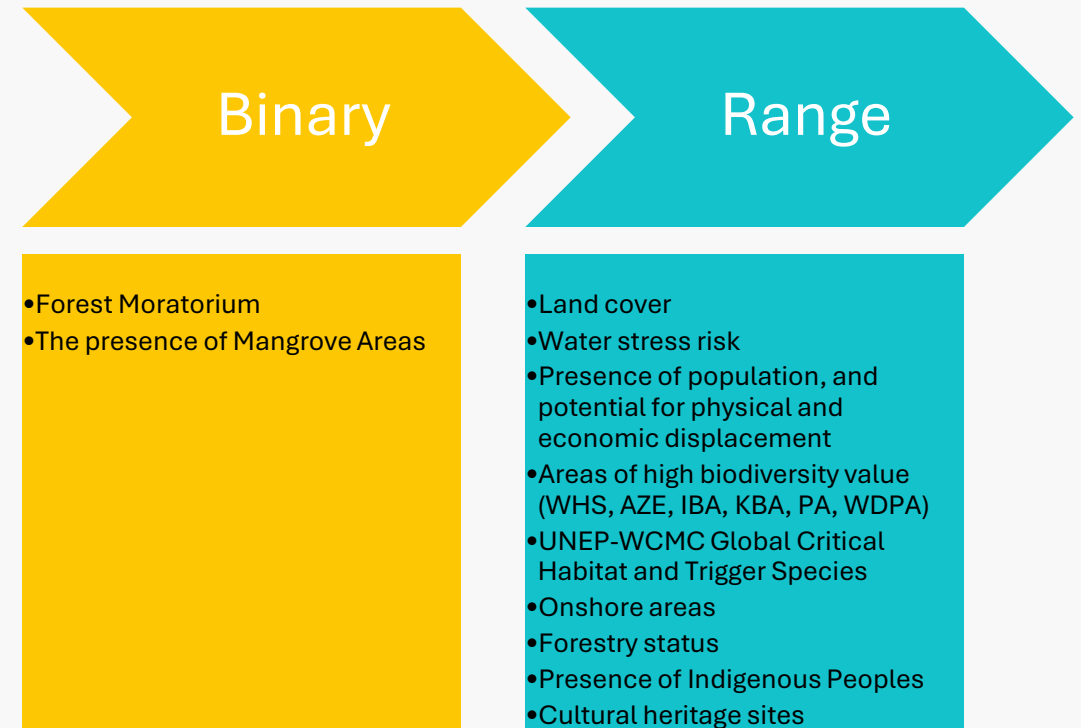


2.2. ENVIRONMENTAL AND SOCIAL ANALYSIS

- E&S Parameters and Criteria

Parameters	Criteria
Environment (Aligned With Ps5)	1. Land Cover 2. Water Stress Risk
Social (Aligned With Ps5)	3. Presence Of Population, And Potential For Physical And Economic Displacement
Parameters: Biodiversity (Aligned With Ps6)	4. Areas Of High Biodiversity Value (WHS, AZE, IBA, KBA, PA, WDPA) 5. UNEP-WCMC Global Critical Habitat And Trigger Species 6. Onshore Area 7. Forestry Status
Parameters: Indigenous People (Aligned With Ps7)	8. Presence Of Indigenous Peoples
Parameters: Cultural Heritage (Aligned With Ps8)	9. Cultural Heritage Sites

- Approach to E&S Analysis



2.3. GRID INTEGRATION ANALYSIS

Purpose: To evaluate the grid's capacity to handle additional renewable energy by considering factors such as peak load, existing power generation capacity, and planned renewable energy projects using **DigSILENT Power Factory**.

Substation Level Analysis

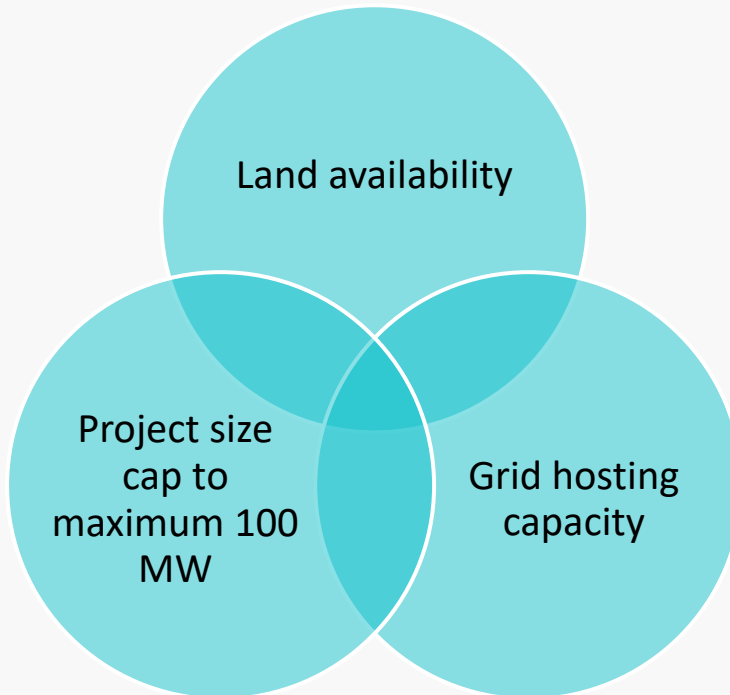
- This analysis focuses on evaluating the integration of photovoltaic (PV) systems at the substation level, aim to determine how much PV capacity can be connected to a substation before operational limits are reached.

System Level Analysis

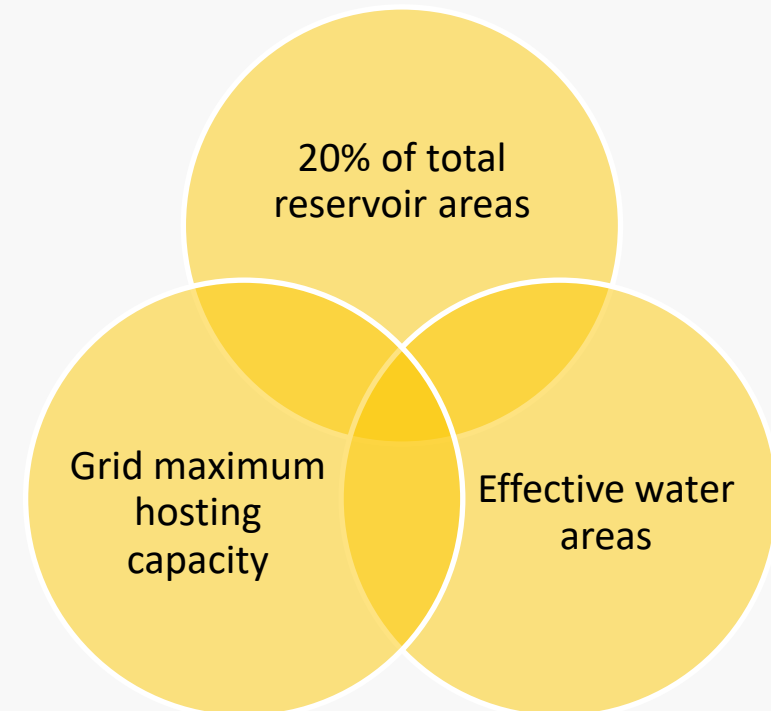
- At the system level, the hosting capacity analysis aims to determine the maximum amount of VRE specifically solar PV that the JAMALI grid can accommodate while maintaining overall system stability.

2.4. POTENTIAL CAPACITY

- **GROUND-MOUNTED PV**



- **FLOATING PV**



2.1. FINANCIAL ANALYSIS

KEY ASSUMPTION

- Inflation:**

	2025	2026	2027	2028+
Indonesia's Inflation Rate	2.80%	3.10%	3.10%	3.00%

- Currency exchange:**

1 USD = 16,209 (Middle rate data from the BI as of July 4th, 2025)

- Loan Interest rate:**

Interest Rate = 8%

- Ceiling price:**

Year 1-10: 6.95 cent USD/kWh

Year 11-30: 4.17 cent USD/kWh

- CAPEX:**

No	Capacity (MWp)	Price (USD/kWp)
1	Between 0 and 50	520
2	Between 50 and 75	510
3	Between 75 and 100	500
4	Between 100 and 250	485
5	Between 250 and 500	460
6	More than 500	450

- For the floating solar PV analysis, it assumed that the main power plant cost is 120% of ground mounted costs for the same capacity based on desktop research (NREL, 2021)

- OPEX:**

Fixed cost for OM: 12.36 USD/kWh/year

Variable cost for OM: 0.0005

USD/kWh/year

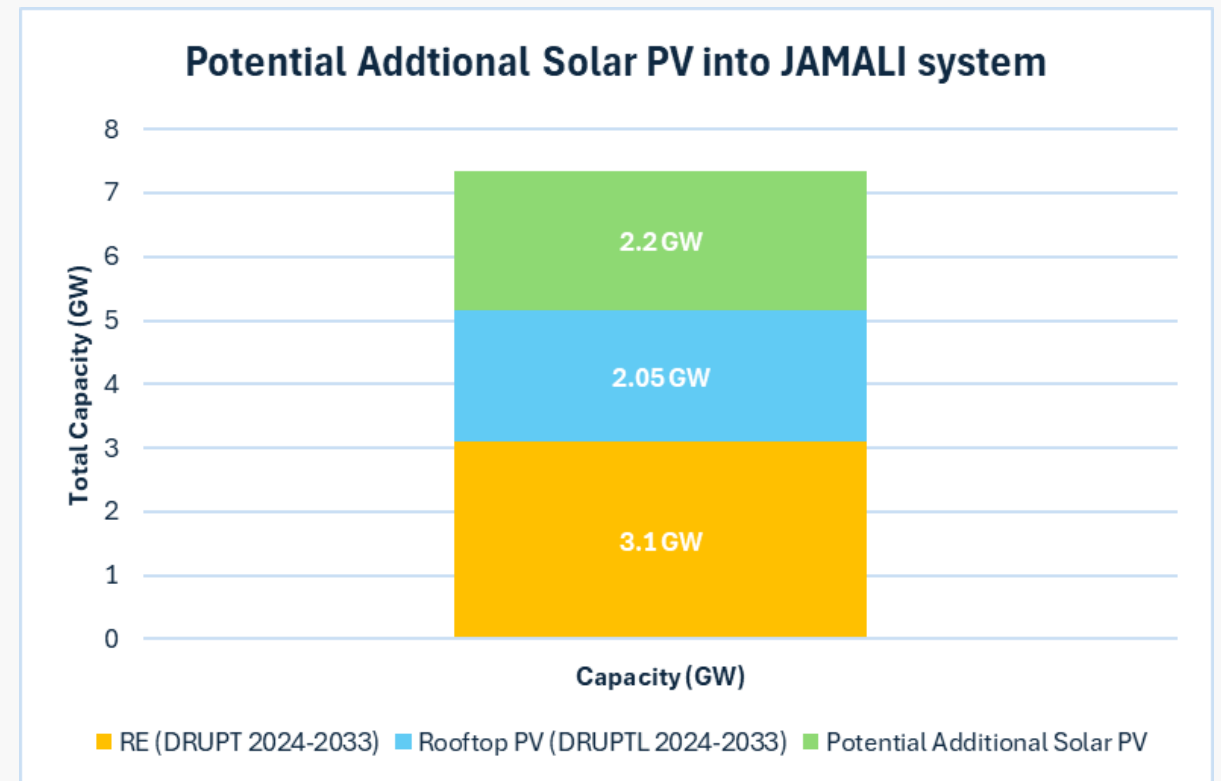


Key insights

3.1. GRID INTEGRATION ASSESSMENT FOR JAMALI GRID

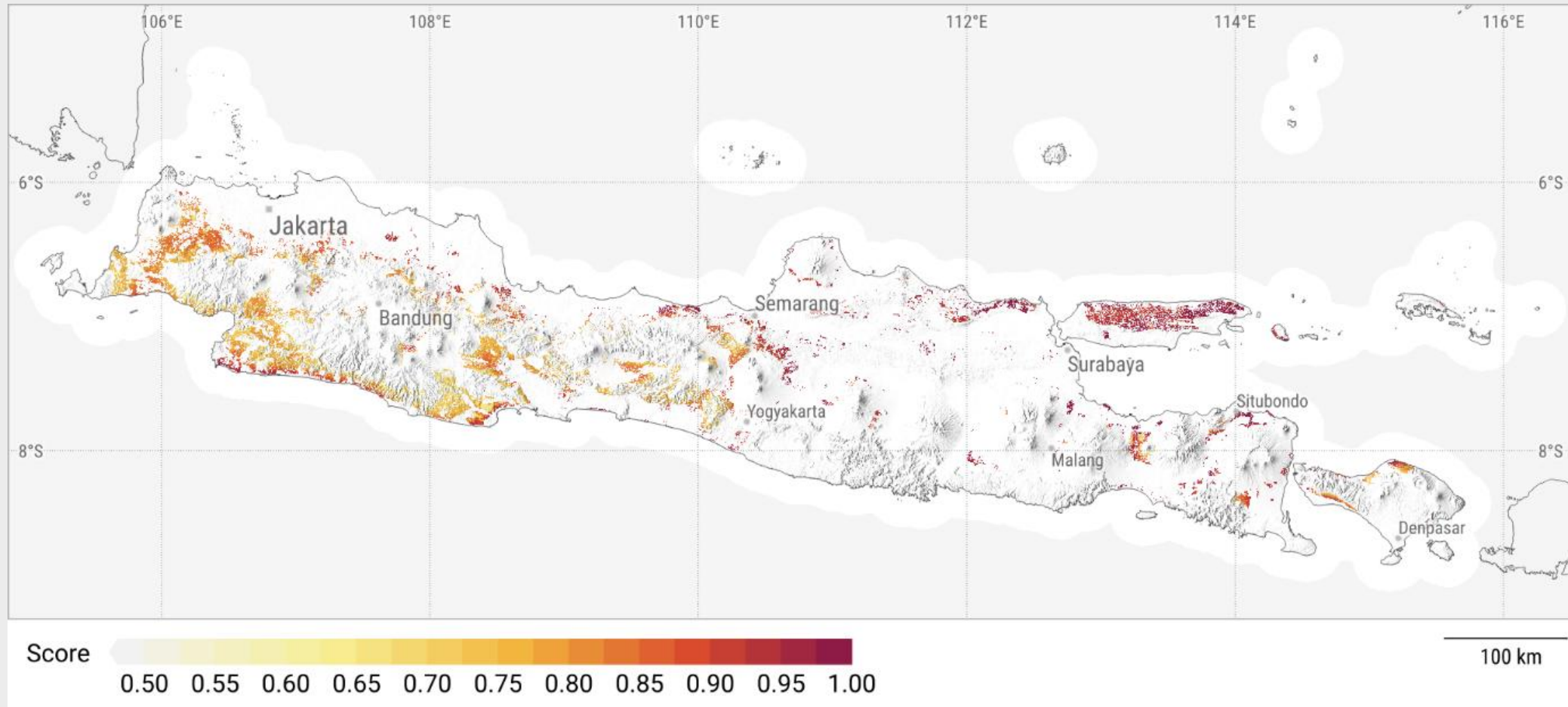
The key insights of the grid integration assessment are:

1. The JAMALI grid can absorb up to **2.2 GW** of Solar PV by 2030, on top of the **3.1 GW** Renewable Energy Plan in the PLN Electricity Plan (2024).
2. In the business-as-usual scenario, adding **2.2 GW of Solar PV increases the system's LCOE** due to the replacement of coal, the cheapest option when excluding social and environmental costs and carbon tax.
3. To further balance the cost increases associated with PV integration, implementing a carbon tax could be a strategic option to disincentivize fossil fuels or Carbon Credits or Renewable Energy Certificate to incentivize RE.
4. Optimal integration of **1.66 GW PV** can replace more expensive gas generation, helping **reduce overall system costs**. However, coal power production will not be replaced with Solar PV.
5. Aligning with the government's coal reduction plan, Solar PV will lower system costs by replacing gas, especially as coal is phased down.



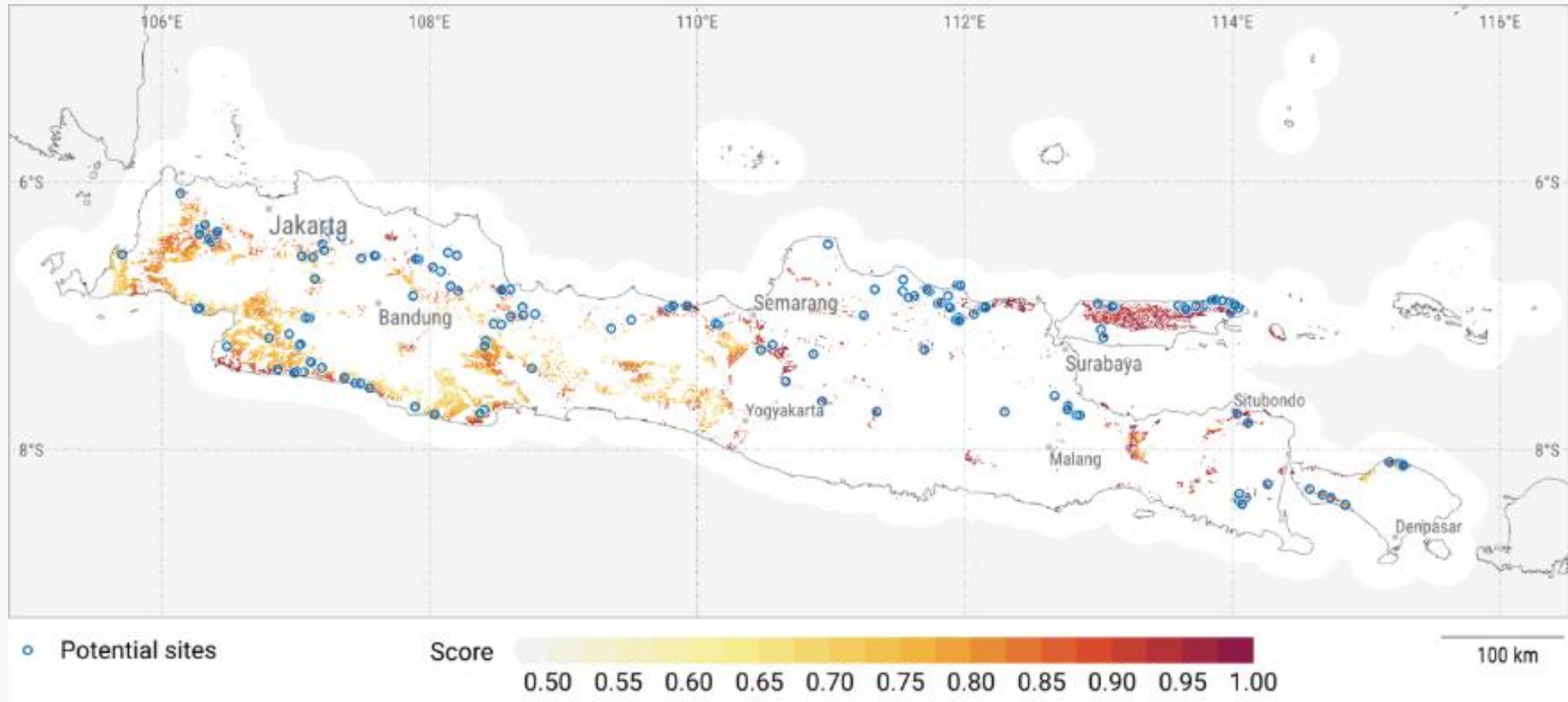
3.2. GROUND-MOUNTED PV ANALYSIS

Geospatial analysis result, the composite of binary and range layers



3.2. GROUND-MOUNTED PV ANALYSIS

151 Pre-selected Sites



Calculated score for the classified areas and 151 pre-selected potential locations for utility-scale PV development. Higher scores present more favorable areas

3.2. GROUND-MOUNTED PV ANALYSIS

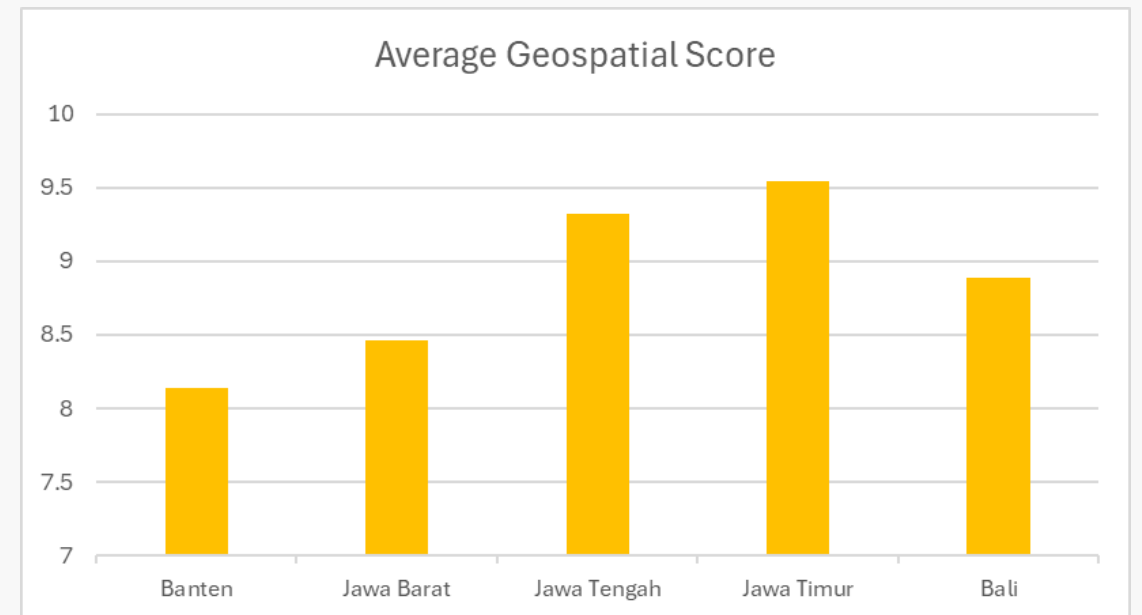
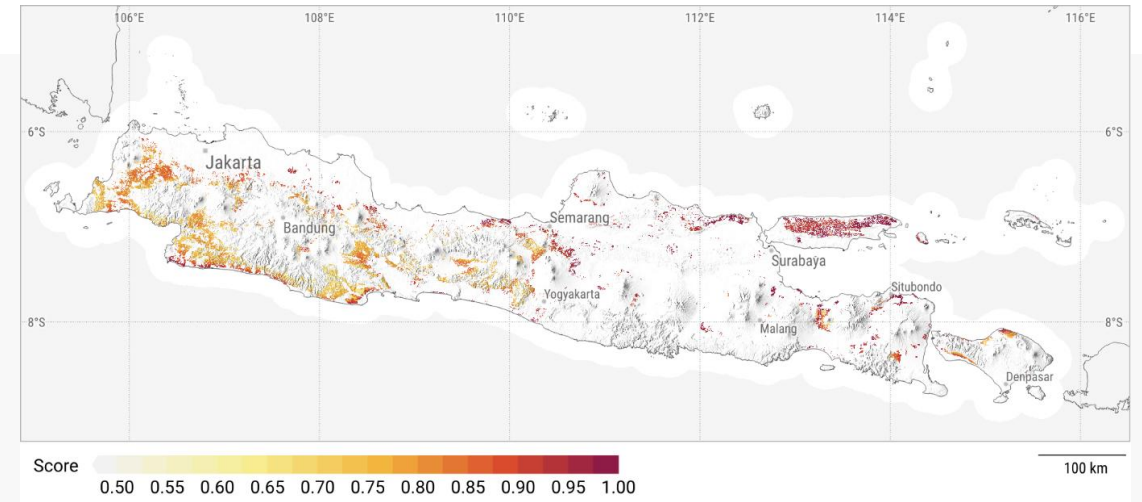
Ground-mounted Top Sites

Rank	S_id	ADM4	Assigned Capacity (MW)	ESIA Score	RISK	Geospatial Score	Project IRR	MCDM Score
1	118	Panji Kidul	100	9	Medium	0.983	8.84%	9.20
2	146	Wonokerso	100	8	Medium	0.98273	8.25%	9.16
3	150	Mendoyo Dauh Tukad	100	10	High	0.85118	7.97%	8.24
4	147	Delik	100	8	Medium	0.82301	7.33%	8.27
5	94	Dasuk Timur	100	10	High	0.986	6.68%	8.07
6	119	Bayeman	75	9	Medium	0.98	5.89%	7.74
8	56	Kenconorejo	100	8	Medium	0.941	7.68%	8.78
9	8	Citeureup	100	9	Medium	0.781	7.92%	8.18
10	148	Tulungrejo	100	10	High	0.92443	6.81%	7.94
11	81	Karangharjo	50	9	Medium	0.808	6.41%	7.33
12	67	Tengger	100	9	Medium	0.928	5.97%	7.75
13	117	Trantang	75	9	Medium	0.95	5.81%	7.62
14	100	Tambaagung Barat	75	9	Medium	0.965	5.17%	7.37
15	149	Maindu	100	8	Medium	0.94505	5.09%	7.63
16	84	Montongsekar	100	9	Medium	0.935	6.40%	7.96
17	144	Nanggela	100	9	Medium	0.90175	5.10%	7.28
18	20	Cipatujah	100	10	High	0.818	5.28%	6.93
19	80	Karangharjo	100	9	Medium	0.853	5.45%	7.29
22	142	Sindangmulya	100	10	High	0.84648	5.11%	6.94

3.2. GROUND-MOUNTED PV ANALYSIS

The key insights of the report are:

1. Geospatial analysis identified **around 9% of the JAMALI region's land area as technically suitable for utility-scale solar PV**. 151 sites were selected from the preferred areas.
2. Following E&S screening, several sites were excluded due to high environmental or social risks. Indeed, three sites were excluded because these sites are located within the PIPPIB and/or mangrove area. 100 sites have a high risk, 48 sites are considered medium risk,
3. **Insights for Specific Location:**
 - **West Java** offers substantial solar PV potential but faces high land-use conflict risks due to extensive agricultural areas, additionally.
 - **Madura** Island shows the highest potential in JAMALI, with strong solar resources and low social-environmental risks, making it well-suited for large-scale projects. However, the long distance evacuation line requirement making the costs higher.
 - **East Java and Central Java** in general also have high irradiance and scalable opportunities but requires careful E&S risk management.
 - **Banten** has relatively lower land prices, but higher environmental and social risks compared to other provinces. In contrast,
 - **Bali** has good irradiance but limited land, requiring innovative approaches to optimize available space for solar PV.



3.3. FLOATING PV ANALYSIS

21 Site selected



3.3. FLOATING PV ANALYSIS

The key insights of the Floating PV Potential in JAMALI are:

Based on the compiled dataset of water reservoirs in the JAMALI region, 51 distinct water bodies with a surface area exceeding 100 hectares were identified. 21 reservoirs were selected for further analysis.

1. Geospatial Analysis

- Technical scoring based on PVOUT, shading, wind, water level fluctuation, reservoir shape, infrastructure proximity, aquaculture/vegetation coverage.
- Scores <0.5 indicate higher technical challenges but not infeasibility; require advanced engineering/O&M.
- Site-specific feasibility studies essential to address bathymetry, anchoring, water level, and soil conditions.

2. Environmental & Social (E&S) Assessment

- No sites excluded; 11 medium-risk and 7 high-risk sites require ESIA & mitigation plans.
- Key challenge: high Floating Net Cage (FNC) aquaculture density causing environmental impacts & social tensions, high presence of cultural heritage in some locations.
- Apply international E&S standards to ensure sustainability & stakeholder acceptance.

3. Grid Integration

- Technical potential often exceeds grid hosting capacity for 2030.
- Grid upgrades & expansion essential to fully utilize FPV potential.

4. Financial Analysis

- Most sites deliver moderate returns under some condition; FPV not inherently unviable.
- Some sites show promising IRRs but below 12% equity IRR threshold without policy/tariff support.
- Excluding evacuation line costs improves viability; supportive mechanisms needed for bankability.

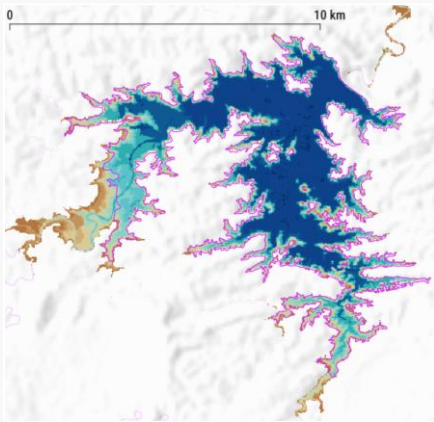
3.3. FLOATING PV ANALYSIS

Below is the result of site prioritization for the top ten sites.

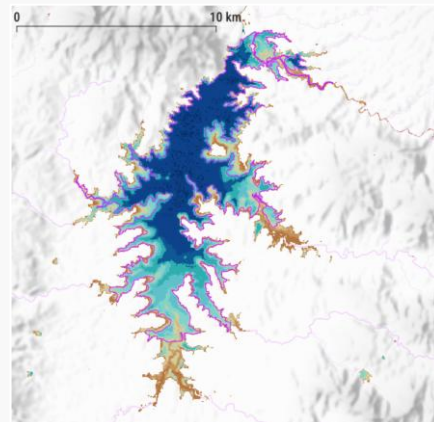
Rank	Reservoir name	Geospatial score	E&S score	Risk rating	Potential capacity (MWp)	Capex (USD/MWp)	Project IRR (Base Case)	Total score
1	Waduk Kedung Ombo	1.00	17	High	411	554,400	8.97%	8.628
2	Waduk Gajah Mungkur	0.89	14	Medium	340	580,815	8.19%	8.206
3	Waduk Karangates	0.78	14	Medium	257	554,741	8.69%	8.088
4	Waduk Jatigede	0.79	16	High	662	545,444	7.86%	7.708
5	Waduk Cirata	0.63	15	Medium	1146	542,713	7.85%	7.512
6	Waduk Jatiluhur	0.63	16	High	651	542,217	7.72%	7.153
7	Waduk Wadaslintang	0.64	14	Medium	261	555,693	6.34%	6.596
8	Waduk Mrica	0.76	14	Medium	97	623,81	5.10%	6.329
9	Waduk Cengklik	0.60	15	Medium	58	619,201	6.08%	6.152
10	Waduk Saguling	0.29	16	High	310	566,787	7.43%	5.844

3.3. FLOATING PV ANALYSIS

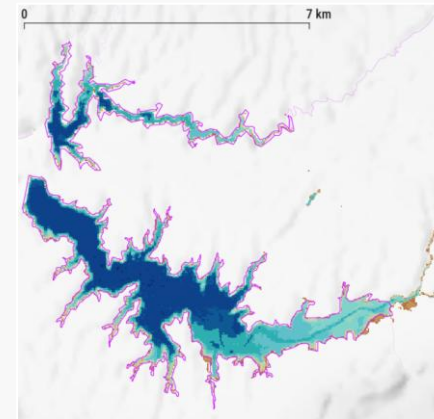
Effective Area



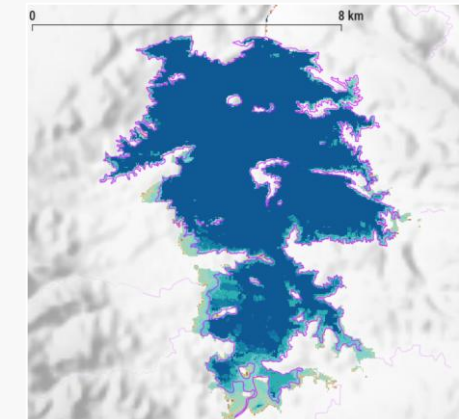
Kedung ombo



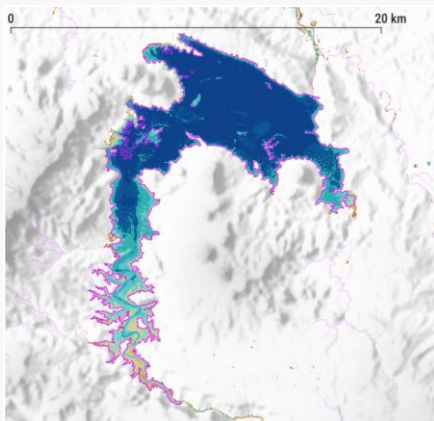
Gajah Mungkur



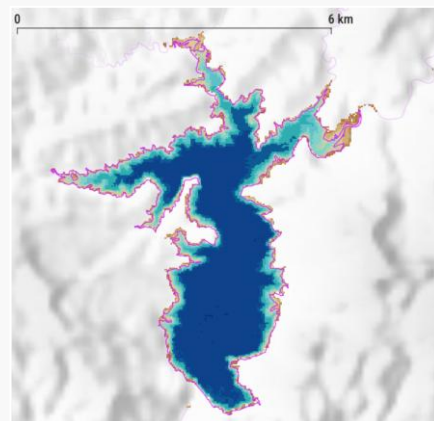
Karang Rates



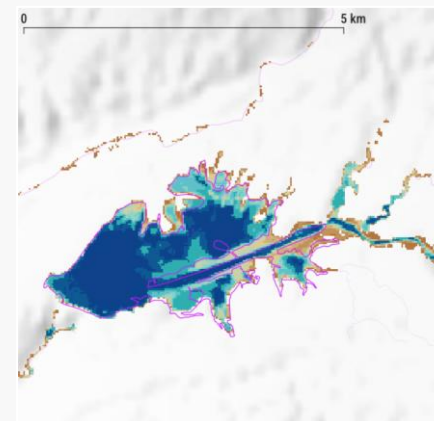
Jatigede



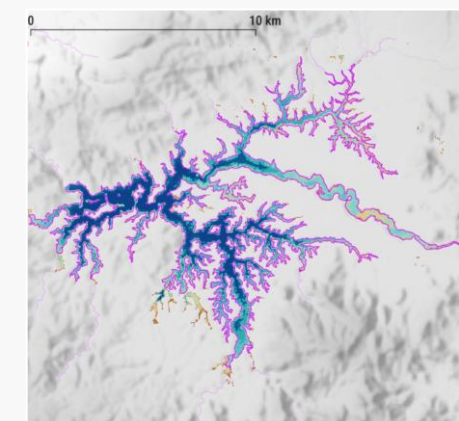
Jatiluhur



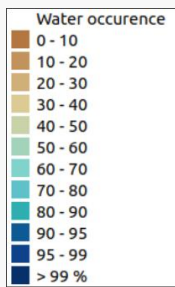
Wadaslintang



Mrica



Saguling





SITE PRIORITIZATION RESULT

3.4 Site Prioritization Result

Below is the result of site prioritization for the top sites

Id	Type	Name	Province	Hub Name	Geospatial Score	Risk Rating	Assigned Capacity (MWp)	Include Evacuation Line		Exclude Evacuation Line		MCDM Score
								Project IRR	Equity IRR	Project IRR	Equity IRR	
f_id 4	Floating PV	Waduk Kedung Ombo	Central Java	Kedungombo 150 kV	1.000	High	411	8.97%	9.78%	9.03%	9.90%	8.628
s_id 118	Ground-mounted PV	Panji Kidul	Jawa Timur	GI 150 kV Situbondo	0.983	Medium	100	8.84%	9.48%	9.38%	10.47%	9.205
f_id 7	Floating PV	Waduk Karangates	East Java	Sutami 150kV	0.784	Medium	257	8.69%	9.26%	8.76%	9.38%	8.088
s_id 146	Ground-mounted PV	Wonokerso	Central Java	GI 150 kV Batang	0.983	Medium	100	8.25%	8.44%	9.03%	9.84%	9.160
f_id 3	Floating PV	Waduk Gajah Mungkur	Central Java	Wonogiri 150kV	0.886	Medium	340	8.19%	8.34%	8.88%	9.61%	8.206
s_id 150	Ground-mounted PV	Mendoyo Dauh Tukad	Bali	GI 150 kV Negara GIS 150 kV PLTU	0.851	High	100	7.97%	7.95%	9.34%	10.43%	8.240
s_id 8	Ground-mounted PV	Citeureup	Banten	Labuan	0.781	Medium	100	7.92%	7.86%	8.12%	8.21%	8.183
f_id 6	Floating PV	Waduk Jatigede	West Java	Jatigede 150kV	0.794	High	662	7.86%	7.76%	7.99%	8.00%	7.708
f_id 2	Floating PV	Waduk Cirata	West Java	Cirata 150 kV	0.626	Medium	1146	7.85%	7.73%	7.91%	7.85%	7.512
f_id 1	Floating PV	Waduk Jatiluhur	West Java	Jatiluhur Baru 150 kV	0.631	High	651	7.72%	7.51%	7.77%	7.60%	7.153
s_id 56	Ground-mounted PV	Kenconorejo	Jawa Tengah	GI 150 kV Batang	0.941	Medium	100	7.68%	7.46%	9.28%	10.31%	8.779
f_id 5	Floating PV	Waduk Saguling	West Java	Rajamandala 150 kV	0.288	High	310	7.43%	7.00%	8.06%	8.12%	5.844
s_id 147	Ground-mounted PV	Delik	Central Java	GI 150 kV Jelok	0.823	Medium	100	7.33%	6.87%	7.57%	7.28%	8.266
s_id 151	Ground-mounted PV	Penyaringan	Bali	GI 150 kV Negara	0.871	High	100	7.14%	6.57%	9.40%	10.54%	7.926
s_id 148	Ground-mounted PV	Tulungrejo	East Java	GI 150 kV Genteng	0.924	High	100	6.81%	6.04%	8.85%	9.52%	7.940
s_id 94	Ground-mounted PV	Dasuk Timur	East Java	GI 150 kV Sumenep	0.986	High	100	6.68%	5.84%	10.09%	11.85%	8.065
s_id 81	Ground-mounted PV	Karangharjo	East Java	GI 150 kV Genteng	0.808	Medium	50	6.41%	5.40%	9.05%	9.88%	7.335
s_id 84	Ground-mounted PV	Montongsekar	East Java	GI 150 kV Kerek	0.935	Medium	100	6.40%	5.37%	8.53%	8.93%	7.961
f_id 8	Floating PV	Waduk Wadaslintang	Central Java	Wadaslintang 150 kV	0.638	Medium	261	6.34%	5.15%	6.42%	5.28%	6.596
s_id 143	Ground-mounted PV	Darmasari	Banten	GI 150 kV Bayah	0.747	High	100	6.18%	5.05%	6.45%	5.46%	7.749
f_id 21	Floating PV	Waduk Cengklik	Central Java	Banyudono 150kV GI 150 kV PLTU	0.598	Medium	51	6.08%	4.82%	8.15%	8.28%	6.152
s_id 65	Ground-mounted PV	Sambong	Central Java	Rembang	0.864	Medium	100	6.04%	4.84%	8.86%	9.52%	7.745

3.4 Site Prioritization Result

Top 10 sites



3.4 Site Prioritization Result

Top 10 sites

Type	Name	Province	Geospatial Score	Risk Rating	Assigned Capacity (MWp)	Project IRR	Equity IRR	CAPEX (Million USD)	OPEX (Million USD/ year)	MCDM Score
FPV	Waduk Kedung Ombo	Central Java	1.00	High	411	8.97%	9.78%	228	5.48	8.628
GM	Panji Kidul	East Java	0.983	Medium	100	8.84%	9.48%	63.31	1.11	9.205
FPV	Waduk Karangates	East Java	0.784	Medium	257	8.69%	9.26%	142.35	3.47	8.088
GM	Wonokerso	Central Java	0.983	Medium	100	8.25%	8.44%	59.59	1.11	9.16
FPV	Waduk Gajah Mungkur	Central Java	0.886	Medium	340	8.19%	8.34%	197.48	4.48	8.206
GM	Mendoyo Dauh Tukad	Bali	0.851	High	100	7.97%	7.95%	57.94	1.10	8.24
GM	Citeureup	Banten	0.781	Medium	100	7.92%	7.86%	54.3	1.10	8.183
FPV	Waduk Jatigede	West Java	0.794	High	662	7.86%	7.76%	361.02	9.00	7.708
FPV	Waduk Jatiluhur	West Java	0.631	High	651	7.72%	7.51%	353.12	15.20	7.153
GM	Delik	Central Java	0.823	Medium	100	7.33%	6.87%	62.1	8.55	8.266



Solar PV Investment Roadmap

4.1 Solar PV Investment Roadmap in JAMALI Region

This roadmap is based on MCDM Framework which select sites with strong technical potential, promising financial performance, and manageable environmental and social risks for both Ground Mounted and Floating Solar PV.

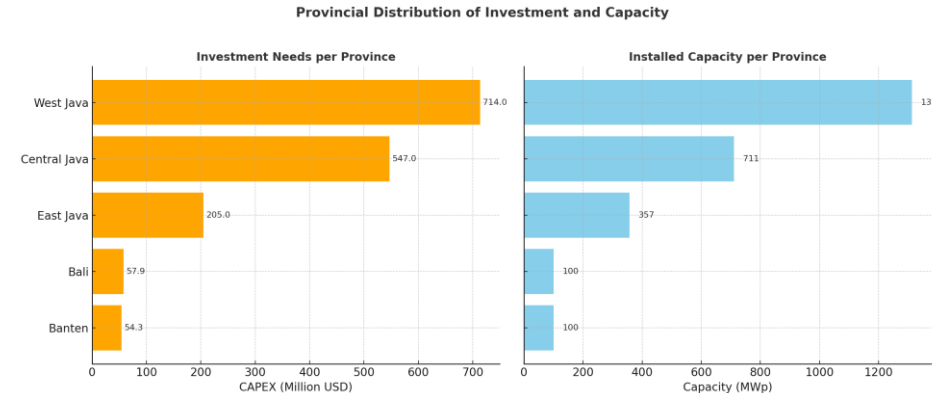
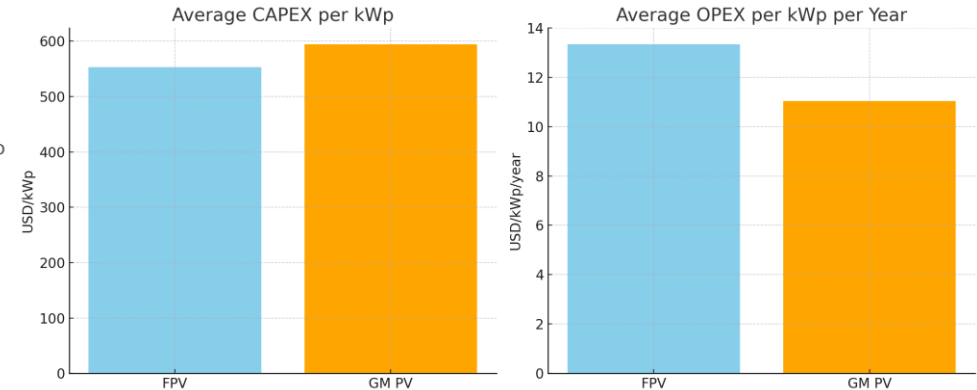
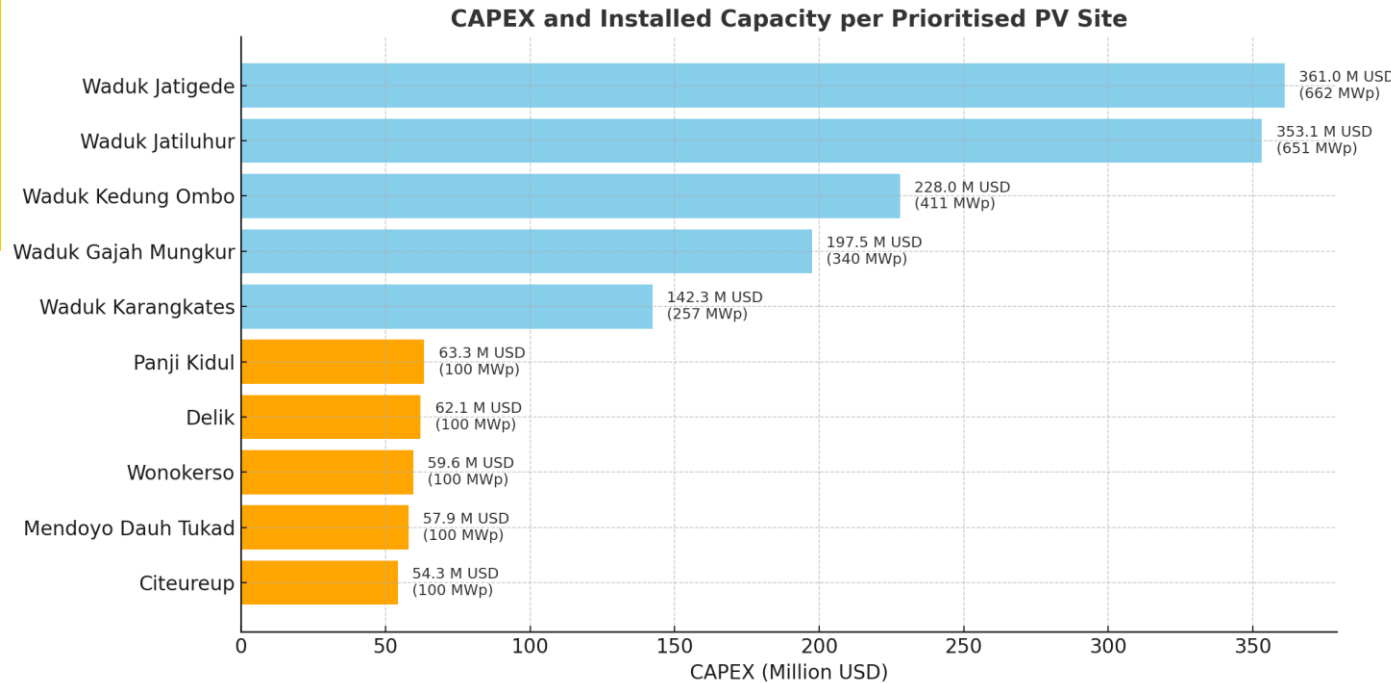
The selected sites are as follows:

No	Site Name	Hub Name	Capacity (MWp)	Project IRR (%)	Equity IRR (%)	Estimated CAPEX (Million USD)	Estimated OPEX (Million USD/year)	Suitable Investment and Financing Schemes
Ground-mounted solar PV								
1	s_id 118: Panji Kidul	GI 150 kV Situbondo	100	8.84%	9.48%	63.31	1.11	Investment Scheme 1,2 and 3
2	s_id 146: Wonokerso	GI 150 kV Batang	100	8.25%	8.44%	59.59	1.11	Investment Scheme 1,2 and 3
3	s_id 150: Mendoyo Dauh Tukad	GI 150 kV Negara	100	7.97%	7.95%	57.94	1.10	Investment Scheme 1,2 and 3
4	s_id 8: Citeureup	GI 150 kV PLTU Labuan	100	7.92%	7.86%	54.3	1.10	Investment Scheme 1,2 and 3
5	s_id 147: Delik	GI 150 kV Jelok	100	7.57%	7.28%	62.1	1.10	Investment Scheme 1,2 and 3
Floating solar PV								
1	f_id 4: Waduk Kedung Ombo	GI 150 kV Kedung Ombo	411	8.97%	9.79%	228	5.48	Investment Scheme 1,2 and 3
2	f_id 7: Waduk Karangates	GI 150 kV Sutami	257	8.69%	9.26%	142.35	3.47	Investment Scheme 1,2 and 3
3	f_id 3: Waduk Gajah Mungkur	GI 150 kV Wonogiri	340	8.19%	8.34%	197.48	4.48	Investment Scheme 1,2 and 3
4	f_id 6: Waduk Jatigede	GI 150 kV Jatigede	662	7.86%	7.76%	361.02	9.00	Investment Scheme 1,2 and 3
5	f_id 1: Waduk Jatiluhur	GI 150 kV Jatiluhur Baru	651	7.72%	7.51%	353.12	8.55	Investment Scheme 1,2 and 3

Notes:

- For the ground-mounted PV category, two sites, s_id 146 Wonokerso and s_id 147 Kencorejo, were both identified as high-performing candidates. As they are located within the same cluster, connected to the GI 150 kV Batang substation, and only about 3 km apart, the study considers them mutually exclusive from an investment planning perspective. To avoid redundancy and reflect realistic sequencing of projects, only s_id 146 Wonokerso has been retained in the final priority list to represent this cluster.
- For the floating PV category, the Cirata Floating PV project was also assessed as a technically and financially attractive site. However, as it is already operational, it has been excluded from this list, which is intended to focus on early-stage investment.
- Project IRR and Equity IRR is calculated in Base Scenario.

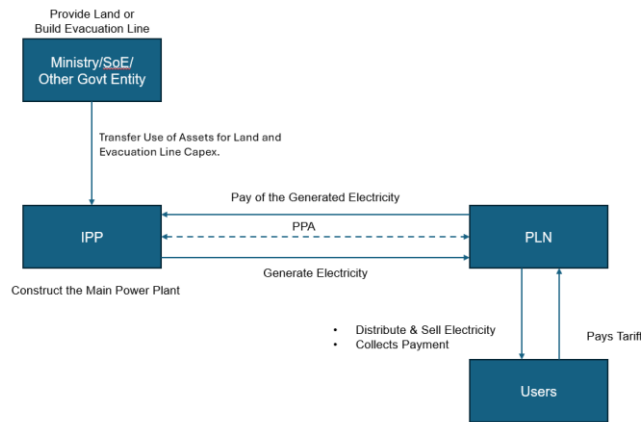
4.1 Solar PV Investment Roadmap in JAMALI Region



total capital investment requirements are estimated at approximately **USD 1.58 billion**, with individual site needs ranging from **USD 54.3 million to USD 361 million**

4.1 Solar PV Investment Roadmap in JAMALI Region

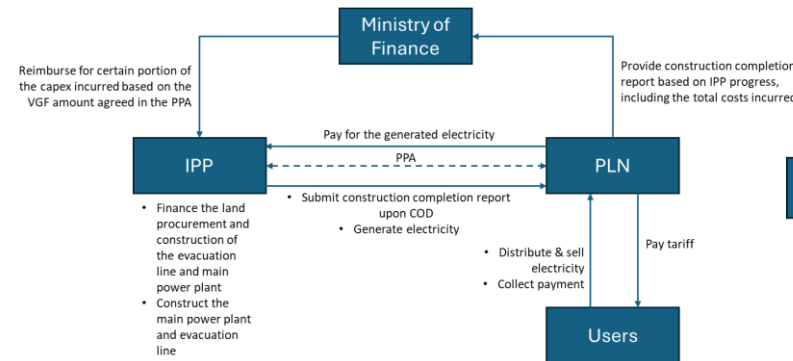
The investment and financing schemes that are suitable for each of the shortlisted sites are those which provides support to reduce or eliminate the capex for land and/or evacuation line purchase, namely Investment and Financing Scheme 1, 2 and 3.



Investment and Financing Scheme 1

Land or evacuation line to be provided by a ministry/government institution/SoE to be defined before the development of the main power plant.

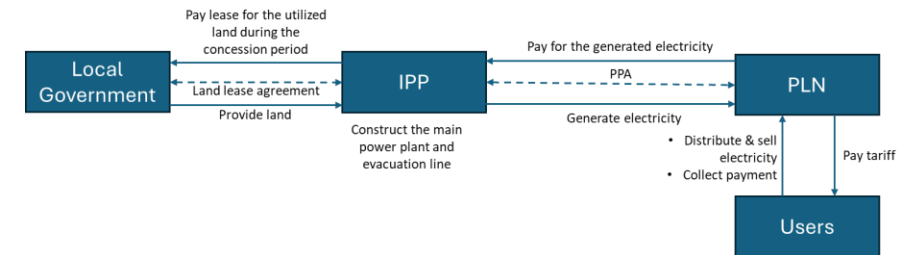
1. Certain ministry/government institution/SoE provides land or build the evacuation line prior to the construction, then transfer it to the IPP
2. IPP finances and builds the main power plant
3. IPP generates electricity upon the start of the commercial operation date (COD) during the concession period as agreed in the PPA
4. PLN pays IPP for the electricity generated by the IPP
5. PLN distributes and sells the electricity to the users then collect the payment based on the regulated tariff.
6. Users pay tariff to PLN based on their consumption



Investment and Financing Scheme 2

Portion of the CAPEX to be financed through a Viability Gap Fund (VGF) by the Ministry of Finance (MoF).

1. IPP procures the land and constructs the main power plant as well as the evacuation line using its own capital.
2. Upon COD, IPP will then need to submit construction completion report to PLN, who will submit it to the MoF as proof for the VGF payment to the IPP.
3. MoF pays VGF to the IPP
4. PLN pays IPP for the electricity generated by the IPP
5. PLN distributes and sells the electricity to the users then collect the payment based on the regulated tariff.
6. Users pay tariff to PLN based on their consumption



Investment and Financing Scheme 3

IPP and/or PLN to rent the land owned by the local government at a low or zero lease fee.

1. Local government provides the land
2. IPP constructs the main power plant and the evacuation line
3. IPP generates the electricity
4. PLN pays for the electricity generated by the IPP, then distribute and sell it to the users
5. The users pay tariff for the consumed electricity.

However, after the concession period ends and upon the asset transfer from the IPP to the PLN (on a Build-Transfer-Operate/BOT scheme), should the power plant continue to be operated by PLN, PLN will need to continue paying for the land lease to the local government.



Major Challenges and Measures to Address Key Issues

5.1. Procurement

Procurement Challenges for Solar PV Development in JAMALI

Procurement process

Despite the Presidential Regulation's 90-day direct appointment, the actual process may take more than the estimation. RUPTL's frequent updates provide uncertainty to the investors, while the RUPTL's unrealistic COD targets cause delays in project commencements. Delays can be caused by the lengthy IUPTLU permit process, requiring multiple approval phases.

Local Content Requirements

Most domestic products are more expensive than international alternatives, deterring investments in projects required to use local components. The limited availability of high-quality Tier-1 solar PV modules also lead to higher costs; currently, Indonesia needs to largely expand its production to reach cost competitiveness with imported panels.

Land Acquisition

Lengthy and complex land acquisition processes may stall the progress of solar projects and make international financiers invest in IPPs with already secured land permits and approvals. Besides, significant resistance from local communities persists due to cultural, and social factors, where adding community engagement strategies create more friction.

Shareholder Requirement

The shareholder loan requirement makes the strategic partner take on more debt than PLN, raising project costs and tax burdens. This shareholder requirement also impacts investment returns, making projects less attractive to investors. The requirement makes potential strategic partners face difficulties securing financing and maintaining competitive pricing.

5.1. Procurement

Measures to address key issues

Challenges	Potential Measures
Complex and lengthy procurement procedures	• Implement a robust system to regularly monitor the tender process • Implement bundled and capacity-based procurement models • Develop a comprehensive procurement timeline and project announcement schedule • Consider conducting pre-feasibility analysis on the potential sites before the tender process, utilising the output of this study during the planning of solar PV projects • Conduct market sounding or lenders briefing to gather inputs on the project's bankability
Local Content Requirements (LCR)	• Develop a long-term plan to balance the support for local industries and the project feasibility • Set clear milestones and timelines for LCR compliance • Provide fiscal incentives based on the LCR achieved • Provide non-fiscal support such as training and technical assistance to RE technology manufacturers, particularly for solar PV • Establish collaboration opportunities with leading solar PV manufacturers • Provide incentives for research and development of local solar PV modules at a national level
Lengthy and complex land acquisition processes	• Implement expedited land acquisition procedures for identified preferred zones • Implement Different Land Procurement Models (e.g., opening tenders for areas in which the land has been secured beforehand) • Collaborate with The Indonesia Land Bank Authority • Utilise government-owned land for solar PV projects
The requirement for PLN or its subsidiary to own a minimum of 51% share in the SPC	• Potential Measuresm shareholding required by PLN or its subsidiaries in project companies (SPC) • Explore available government support options (e.g., State Equity Participation, loans) • Explore support options from Danantara • Procure the projects without assigning PLN and/or its subsidiaries as mandatory strategic partner in the IPP • Restructure subsidy on the consumer's electricity tariff

5.2. Financial Feasibility

Procurement Challenges for Solar PV Development in JAMALI

Ceiling Price

Ceiling price as regulated in Perpres 112/2022 does not align with the market conditions. Furthermore, the tariff is set to be flat for the first 10 years then decreases and remains flat from Year 11 onwards. This structure does not align with operational realities, where O&M costs are likely to increase over time due to factors such as inflation.

High Loan Interest Rate

Indonesia's loan interest rate is the highest among other countries in ASEAN and significantly higher than China, due to limited competitions, with one of the reasons because of the limited number of foreign banks in Indonesia and a shallow foreign exchange market which means Indonesian banks cannot effectively hedge any foreign currency-based loans

Land Price & Evacuation Line Cost

High land capex is the result of high land price in Jamali Area especially in Industrial and Tourism Area while High evacuation line cost is the result of far distance to the existing substation. High Land and Evacuation Line Capex will increase the overall Capex thus reducing the overall feasibility of the project.

Investment schemes and financing mechanisms

Lack of attractive investment schemes and financing mechanisms poses a barrier to scaling solar PV development. Different investment schemes and financing schemes will be needed especially if the results of feasibility study yields small number of feasible sites for the project.

5.2. Financial Feasibility

Measures to address key issues

Challenges	Potential Measures
Ceiling Price	- Adjust the ceiling price to reflect the true cost of generation or by having a flat tariff for the whole concession period - Conduct discussions with developers on developing a pricing structure suitable for the market conditions
High Loan Interest Rate	- Liberalisation and deepening of the foreign exchange market to reduce the differential between USD and IDR interest rates - Macro-economic policy to have a controlled inflation forecast for 2025 and 2026 within the target range of 2.5±1% and the stable Rupiah exchange rate - Strengthening the interest rate structure of the Rupiah money market to maintain attractive yields and increase portfolio inflows to domestic financial assets - Strengthening the payment system infrastructure and expanding digital payment acceptance
Land Price & Evacuation Line Cost	- PLN to install substations close to some planned solar PV clusters prior to the solar PV development - Exclude costs of evacuation line from the ceiling price calculation - Consider utilising government-owned land or mandate ministries with unused land to make it available for solar PV development projects - Provide the developer with an in-principal agreement on the tariff that would be agreed in the PPA, so the developer could calculate the maximum land price that could be paid
Land Price & Evacuation Line Cost	- Earmark revenue from carbon tax for projects to achieve the NZE, including for solar PV development - Consider having a Viability Gap Fund (VGF) to finance some parts of the CAPEX (i.e., the land or the evacuation line costs) if the tariff reform is not possible. - Consider development of floating solar PV to minimise land use
Investment schemes and financing mechanisms	To consider alternative investment schemes and financing mechanisms for the project such as for some of the capex to be provided by the government, use of VGF to help finance some of the capex, land renting scheme from local government at a low or zero lease fee, use of blended finance, and use of guarantees.

5.3 Power Purchase Agreement (PPA)

Power Purchase Agreement (PPA) Challenges for Solar PV Development in JAMALI

Complex and long lead time for the PPA signing process

- Variability and lack of accessible templates lead to extensive back-and-forth communication between the parties involved in the PPA signing process, resulting in longer lead times and increased costs for project developers.
- The required BoD approval process for PLN and/or its subsidiaries for PPA signing
- Lender's due diligence process could prolong the PPA signing process

Risk allocation on land acquisition

When dealing with non-government land, IPPs must engage directly with landowners for buying and selling procedures. This requires them to navigate various legal requirements, address environmental concerns, negotiate with landowners, and manage community concerns, all of which can significantly delay project timelines if not properly managed.

Omission of Commercial Operation Date (COD) Acceleration Incentive

Omission of the COD acceleration incentive from the recently issued MEMR Regulation No. 5 of 2025 might be deemed unfavourable by the investors.

A case study example is a scheme implemented in Vietnam, where a specific COD deadline was established for solar PV power plants. Developers who successfully met this deadline became eligible for certain incentives (e.g., Feed-in-tariff). This approach led to a surge in solar PV development throughout the country.

5.3 Power Purchase Agreement (PPA)

Measures to address key issues

Challenges	Potential Measures
Complex and long lead time for the PPA signing process	• Conduct discussions or lenders' briefing prior to the procurement • Develop a standardised template PPA • Develop a SOP for BoD approval process • Consider having a KPI on PPA signing targeted timeline
Risk allocation on land acquisition	• PLN or government to assess land rights status and/or estimated land price prior to the procurement • PLN to secure a Memorandum of Understanding (MoU) or in-principal agreement with potential landowner prior to procurement process • Potential land acquisition risk sharing or differentiation of the risk allocation between PLN and Independent Power Producers (IPPs) in the PPAs (e.g., based on land ownership status)
Omission of Commercial Operation Date (COD) Acceleration Incentive	• Engage with developers and investors on the impact of omission of the COD acceleration incentive to the market's attractiveness • Consider reenacting the provision of incentive on COD acceleration

5.4 Environmental and Social Challenges

Environmental and Social Challenges for Solar PV Development in JAMALI

Land Ownership & Acquisition

Speculative land price inflation raises CAPEX unexpectedly. Unclear or disputed land titles make projects unbankable, while conflicts between legal and customary claims cause protests and delays. Squatter resettlement adds cost, time, and social risks.

Permits & Licensing

Projects require more than 15 permits with sequential steps (e.g., AMDAL before IUPTL), often taking 6–12 months. Inconsistent national vs. regional rules, corruption risks, and political changes further delay or revoke approvals.

Land Classification & Use

Solar PV is not a recognized zoning category, forcing case-by-case negotiations. Converting fertile land raises food security concerns, while large-scale land conversion risks biodiversity loss. The lack of carbon accounting may negate net climate benefits.

Social Inclusion & Acceptance

Unresolved customary land rights and lack of FPIC create community resistance. Large-scale projects may harm cultural sites, tourism landscapes, or archaeological areas. Limited local SME participation reduces community benefits and fuels social opposition.

5.4 Environmental and Social (E&S)

Measures to address key issues

Challenges	Potential Measures
Land ownership and acquisition	The acquisition strategy must include robust documentation and consent procedures, a specific plan for dense areas, clearly defined pricing and processes, and a framework for managing resettlement and compensation.
Permit and Licensing	- Establish a Provincial-Level One-Stop Service (OSS) - Create a Comprehensive Permit Handbook - Implement a Fast-Track Mechanism for Strategic Projects - Form a Dedicated Permitting Task Force
Land Classification and Use	- Integrate Renewable Energy Zones into Spatial Plans - Prioritize the Use of Non-Productive Land - Utilize State-Owned Assets and Collaborate with the Land Bank - Promote Dual-Purpose Land-Use Models - Develop Detailed GIS-Based Suitability Maps
Social Inclusion and Acceptance	- Secure a Social License to Operate through Ethical Practices - Promote Community Ownership and Investment - Establish a Multi-Stakeholder Forum for Dialogue - Implement a Transparent Benefit-Sharing Mechanism - Invest in Local Capacity and Employment - Empower and Integrate Local SMEs into the Supply Chain
Land ownership and acquisition	The acquisition strategy must include robust documentation and consent procedures, a specific plan for dense areas, clearly defined pricing and processes, and a framework for managing resettlement and compensation.



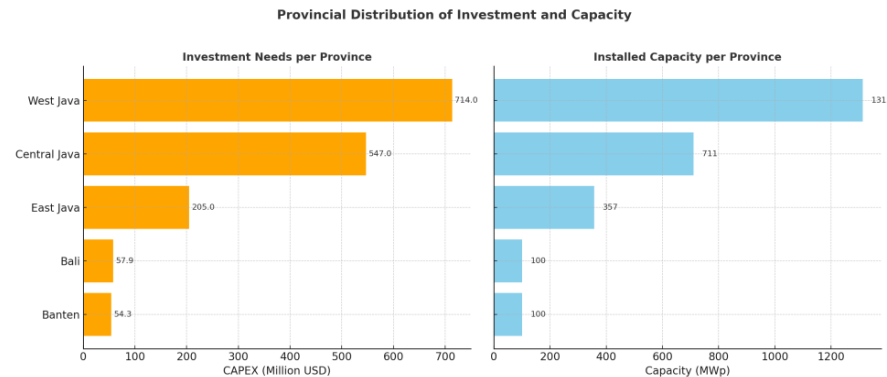
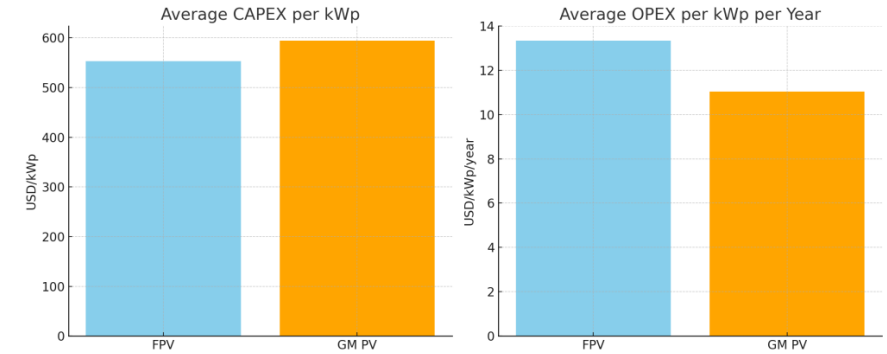
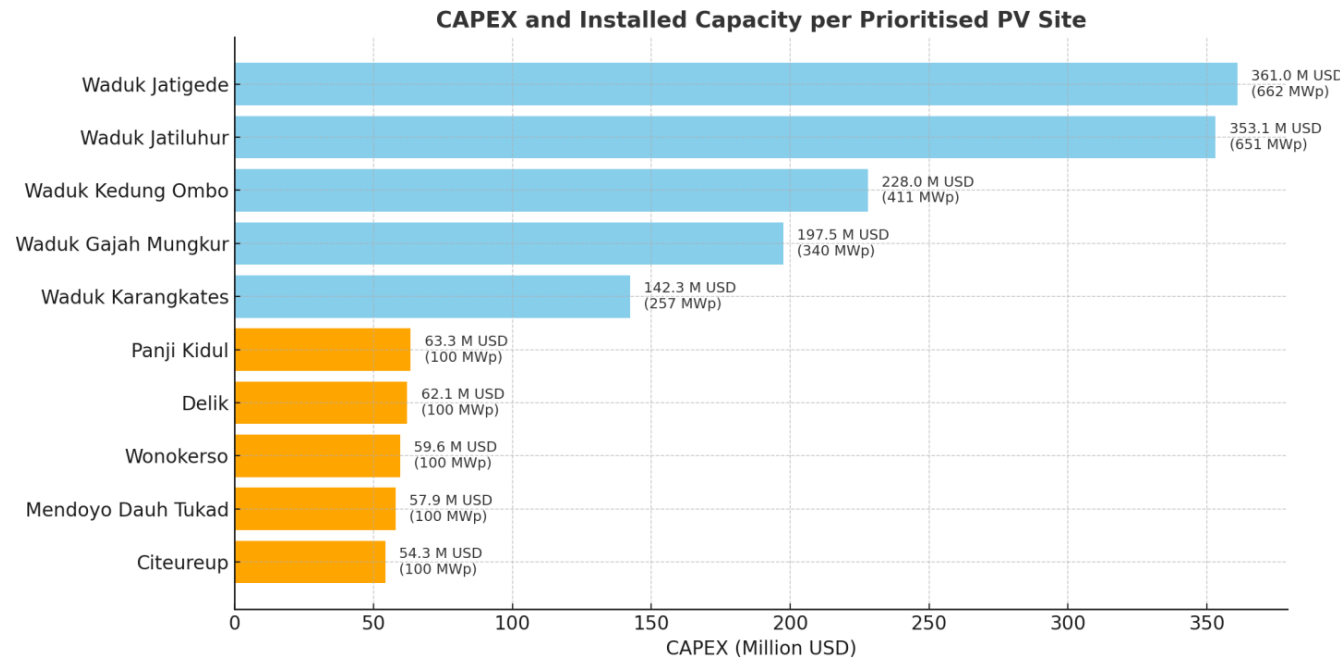
Conclusion and Key Recommendation

6.1 Conclusion and Recommendation

The conclusion of the report are:

1. **Grid analysis** confirmed that JAMALI can host **~2.2 GW of additional solar PV by 2030** beyond the DRUPTL 2024–2033. Although initial costs may raise the LCOE, long-term benefits are clear: **replacing 1.66 GW of gas generation with solar PV** could deliver immediate cost savings for PLN without compromising system stability.
2. **Ground-Mounted PV:** About 9% of the JAMALI region is technically suitable for solar PV. Using a multi-criteria decision-making approach, 151 sites were shortlisted considering solar resource quality, land cost, grid proximity, and E&S risks. Several high-priority sites demonstrated strong technical feasibility and promising financial performance under current tariff assumptions.
3. **Floating PV (FPV):** From 51 reservoirs screened (>100 ha), 21 were shortlisted for further analysis. Factors included water stability, wind/shading, grid access, and financial returns. Many sites are well-suited for large-scale FPV, offering minimal land-use conflicts, and several showed IRRs comparable to ground-mounted PV.
4. **Financial Viability & Investment Barriers**
 - Current financial performance of priority sites is **modest due to conservative assumptions**, but stronger returns are expected with **site-specific optimizations** (higher generation, lower costs).
 - **Government-owned land** can reduce acquisition risks and costs, improving project bankability.
 - Realizing potential requires addressing **systemic barriers**: fragmented procurement, non-bankable PPAs, lack of long-term financing and currency risk mitigation, and weak early-stage E&S screening.
 - Overcoming these barriers is **essential to unlock the pipeline** and mobilize large-scale private capital.

4.1 Solar PV Investment Roadmap in JAMALI Region



total capital investment requirements are estimated at approximately **USD 1.58 billion**, with individual site needs ranging from **USD 54.3 million to USD 361 million**

6.1 Conclusion and Recommendation

In the short term, it is recommended to establish:

Discuss with the Energy Transition and Green Economy Task Force (SATGAS TEH) The probability of establishing a specific sub-task force to simplify solar PV development processes, including site allocation, permitting, project planning, and procurement. The Ministry of Energy and Mineral Resources (MEMR) is proposed to lead this sub-task force.

PLN should standardize procurement and PPA frameworks (model RfPs and bankable PPAs) to reduce transaction costs.

The Ministry of Finance and the Ministry of State-Owned Enterprises will enhance PLN's creditworthiness and create blended finance facilities to attract private investment.

6.1 Conclusion and Recommendation

In the medium to long term

Institutionalise early-stage E&S screening through a central digital permitting portal, with the Ministry of Environment and Forestry and the Ministry of Agrarian Affairs and Spatial Planning (ATR/BPN), to accelerate approvals and reduce risk.

Scale up local content and workforce training to build domestic capacity.

Deliver targeted capacity building:

- Local governments: spatial planning, permitting, E&S compliance, basic grid planning
- Developers/PPPs: PPA structuring, financial modelling, International Finance Corporation (IFC) standards, land acquisition, and community engagement

Implement strategic grid reinforcements to expand hosting capacity near priority sites. For example, upgrading the grid near Waduk Kedung ombo, Jatiluhur, and Gajah Mungkur will improve the potential capacity of the sites.



BAPPENAS

Kementerian Perencanaan Pembangunan Nasional/
Badan Perencanaan Pembangunan Nasional

THANK you

