ENERGY TRANSITION PARTNERSHIP

PHASE 1 REPORT

1 GW SOLAR MAPPING AND DEVELOPMENT PLAN : SOLAR IRRADIANCE MAPPING

JULY 2024

Prepared by : Trama TecnoAmbiental and The Consortiums

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1 GW SOLAR MAPPING AND DEVELOPMENT PLAN (INDONESIA)

Phase 1 Report: Solar irradiance mapping

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Glossary

Acronym	Explanation
AZE	Alliance for Zero Extinction sites
BAPPENAS	Ministry of National Development Planning
B2B	Business to Business
BNPB	National Disaster Management Agency
CFPPs	Coal-Fired Power Plants
CH	Critical Habitat
C&I	Commercial and Industrial
E&S	Environmental and Social
ESMS	Environmental and Social Management Systems
ETP	Southeast Asia Energy Transition Partnership
FPIC	Free, Prior, and Informed Consent
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GIS	Geographical Information System
GSW	Global Surface Water
GW	Gigawatt
HCV	High Conservation Value
IBA	Important Bird and Biodiversity Areas
IFC	International Financial Corporation
IPSDA	*Izin Pemanfaatan Sumber Daya* - Water resources utilization permit
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
KBA	Key Biodiversity Area
kWh	Kilowatt-hour
kWp	Kilowatt-peak (installed power)
JAMALI	Java, Madura, Bali
MCDM	Multi-Criteria Decision Matrix
MEMR	Ministry of Energy and Mineral Resource
MoEF	Ministry of Environment and Forestry
MW	Megawatt
NTFP	Non-Timber Forest Products
ODCB	*Objek Diduga Cagar Budaya* - Object of Alleged Cultural Heritage
PA	Protected Area
PBPH	*Perizinan Berusaha Pemanfaatan Hutan* - Business Licensing for Forest Utilization
PLN	National Electricity Company
PPA	Power Purchase Agreements

PSs	Performance Standards
PV	Photovoltaic
PVOUT	PV power production (Output)
RE	Renewable Energy
RUKN	National Electricity General Plan
RUPTL	The National Electricity Supply Business Plan
SDGs	Sustainable Development Goals
TWG	Technical Working Group
UNEP-WCMC	The UN Environment Programme World Conservation Monitoring Centre
VEI	Volcanic Eruption Index
VRE	Variable Renewable Energy
WHS	World Heritage Site
WDPA	World Database of Protected Areas
WRI	World Resources Institute

Executive Summary

The Southeast Asia Energy Transition Partnership (ETP) works with the Ministry of National Development Planning (BAPPENAS) to promote solar photovoltaic (PV) technology, aiming to accelerate solar PV project implementation and help Indonesia achieve net-zero emissions in the power sector by 2050. Indonesia targets generating 23% of its energy from renewable sources by 2025 and 52% of new capacity by 2030, requiring an additional 8.8 GW of renewable energy capacity and $8 billion in annual investment.

Despite the country's potential to generate 208 GW of solar power, as of 2022, only 271.6 MW peak of solar PV has been installed, falling short of the 893.3 MWp target. The development of solar PV in Indonesia faces significant challenges, necessitating the implementation of risk-reducing measures to overcome these obstacles and advance renewable energy development.

This study's primary objective is to comprehensively analyze potential site locations for solar PV development in the JAMALI region. This involves identifying technically viable areas for solar PV installation through detailed geospatial analysis, assessing environmental and social risks associated with each potential site to ensure sustainable and responsible development, evaluating the preliminary grid impact to determine the hosting capacity of the identified sites, and providing a ranked list of prioritized sites to guide stakeholders in planning utility-scale solar PV projects. The goal is to facilitate the sustainable growth of solar energy in the region, supporting Indonesia's commitment to increasing its renewable energy share.

The methodology for this study integrates several advanced analytical approaches. Geospatial analysis identified preferred areas within the JAMALI region and scored them based on technical viability for solar PV development. The analysis revealed that approximately 9% of the JAMALI region's land area is technically viable for solar PV development. Environmental and Social (E&S) analyses were conducted to evaluate the potential environmental and social aspects of solar PV development in specific sites. Sites were scored based on risk levels, and three sites were excluded due to high risks. Preliminary grid impact studies assessed the maximum hosting capacity of each site and determined the potential capacity based on land availability and maximum hosting capacity. Finally, a Multi-Criteria Decision Making (MCDM) approach integrated the results of the geospatial analysis, E&S sreening, and potential capacity, resulting in a prioritized list of sites. In total, 137 sites were validated and ranked across JAMALI regions based on the MCDM.

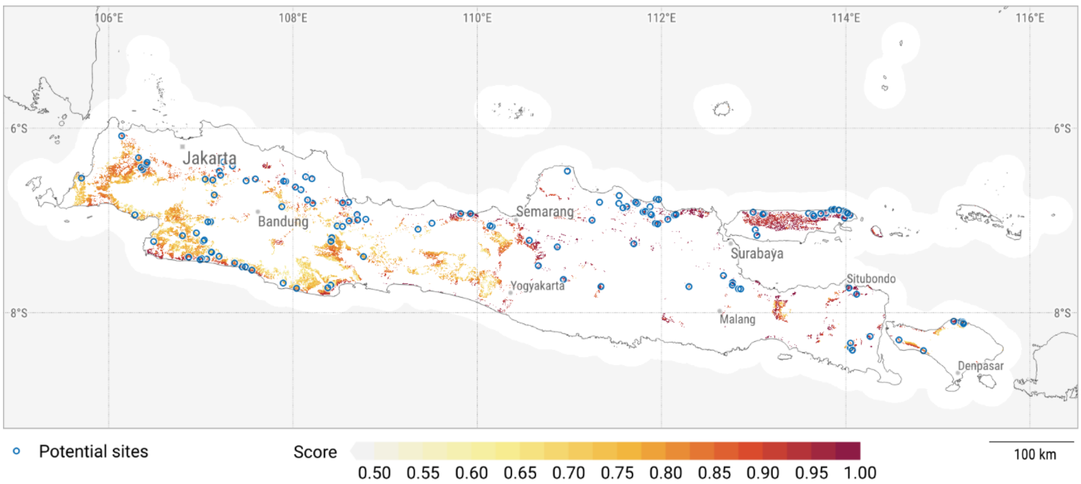

Figure 1 - Results: Sites validated in JAMALI region

The comprehensive analysis yielded several essential insights. While West Java shows significant potential areas for solar PV development, the presence of extensive agricultural land presents higher risks and potential land use conflicts, necessitating careful consideration and balancing of development needs with agricultural preservation. Madura Island demonstrates the highest potential among the JAMALI areas, primarily due to superior solar irradiance and lower social and environmental risks, making it an ideal candidate for large-scale solar PV projects. East Java, exhibiting high solar irradiance potential, offers scalable development opportunities, though varying levels of environmental and social risks must be managed effectively. Despite having good solar irradiance, Bali's limited availability of land restricts large-scale development compared to Java, requiring innovative approaches to maximize the use of available land for solar PV installations.

The JAMALI region, particularly Java, boasts extensive commercial and industrial rooftops suitable for large rooftop PV power plants, with over 375 km^2 of rooftop areas in total. Further study is needed. Floating PV systems present another innovative solution, particularly for areas with dam reservoirs. The potential for floating PV systems exceeds 11,000 MW across 28 hydropower locations, including approximately 1,800 MW in the JAMALI region. Further studies and stakeholder engagement are necessary to address these challenges and realize the full potential of these innovative solar PV solutions.

The next steps involve a detailed grid impact assessment, economic and regulatory analysis, and stakeholder engagement. The grid impact assessment will cover production cost analysis, load flow analysis, short circuit analysis, dynamic stability analysis, and quasi-dynamic analysis. Economic analysis will identify the most feasible locations for solar PV development, considering comprehensive cost, and the revenue from electricity sales. It will also explore potential financing and investment mechanisms. Regulatory analysis will identify factors impeding solar PV development, such as energy prices and transparency of Power Purchase Agreements (PPAs). Stakeholder engagement will ensure the inclusion of relevant stakeholders in the planning and implementation process.

By integrating these analyses, the project aims to provide a comprehensive analysis of potential solar PV development in the JAMALI regions, supporting Indonesia's transition to a sustainable energy future.

1. Introduction

1.1. Project Background

The Southeast Asia Energy Transition Partnership (ETP) brings together governments and philanthropies to work with partner countries in the region. ETP supports the transition towards modern energy systems that simultaneously ensure economic growth, energy security, and environmental sustainability. To contribute to achieving the UN's Sustainable Development Goals (SDGs) and the Paris Climate Agreement objectives, ETP works in Southeast Asia, focusing on three priority countries, namely Indonesia, the Philippines, and Vietnam.

ETP's strategy is built around four interrelated pillars of strategic engagement that are squarely aligned to address the barriers to energy transition. These are (i) policy alignment with climate commitments, (ii) de-risking energy efficiency and renewable energy investments, (iii) extending smart grids, and (iv) expanding knowledge and awareness building.

ETP is working with the Ministry of National Development Planning (BAPPENAS) for this project to support Indonesia's renewable energy transition planning. This project aims to increase solar photovoltaic (PV) technology use in Indonesia. This project will become the catalyst for Indonesia's stakeholders to accelerate further solar PV project implementation, resulting in reduced emissions and meeting the country's goal of achieving net-zero emissions in the power sector by 2050.

Indonesia has set a target of generating 23%[1]. of its energy from renewable sources by 2025 or 52% of new additional installed capacity by 2030[2], up from the current 14.11%. An additional 8.8 GW of renewable energy capacity will be required to reach this target, representing an investment of approximately $8 billion in annual investment in RE, four times the current yearly investment target.

Of this new capacity, 3.6 GW[3] and 6.4 GW[4] are expected to come from rooftop and large-scale solar PV, respectively. However, as of 2022, only 271.6 MW peak (MWp) of solar PV has been installed, far short of the 893.3 MWp target for that year. The National Energy Plan (RUEN) drafted by the Ministry of Energy and Mineral Resources (MEMR) and enacted by the National Energy Council (DEN) in 2017 indicates that Indonesia has the potential to generate 208 GW of solar power.

Despite this potential and the ambitious goals set by the government, the development of solar PV power plants in Indonesia faces many challenges. It is crucial to implement risk-reducing and mitigation measures to address these obstacles and enable renewable energy development,

1.2. About the project

This project will provide technical knowledge to key stakeholders, including the Ministry of National Development Planning (BAPPENAS), MEMR, and the state-owned electricity company (PLN) to support decision-making on investments in large-scale solar PV development in the JAMALI grid and lessons learned for other grids in Indonesia. It links to and acts as a follow-up of ETP's previous project,

[1] The Indonesian National Energy Policy (Presidential Regulation No. 79/2014 on the National Energy Policy (Kebijakan Energi Nasional, KEN))

[2] Indonesian Ministry of Energy and Mineral Resources website: https://www.esdm.go.id/id/media-center/arsip-berita/dirjen-ebtke-kapasitas-terpasang-pembangkit-ebt-2022-lebihi-target

[3] Indonesian Ministry of Energy and Mineral Resources website: https://ebtke.esdm.go.id/post/2021/08/26/2945/bidik.kapasitas.terpasang.36.gw.ini.sederet.keuntungan.pengembangan.plts.atap

[4] Draft National Electricity General Plan (RUKN) 2015-2034

Upgrading PLN JAMALI Load Dispatch Centre, by utilizing the newly designed system capability to integrate more Variable Renewable Energy (VRE) into the grid.

The project will produce a comprehensive study and assessment, including technical and non-technical aspects, to inform investment decisions for developing 1 GW solar energy infrastructure in the JAMALI grid. The project also advises on the mechanisms for engaging with financiers and investors, with an emphasis on private-sector investors and developers. This work will serve as a key reference for PLN and the Government of Indonesia (MEMR and BAPPENAS) as they strive to increase the share of renewable energy in the country's energy mix and accelerate the transition to clean energy.

1.3. About the Report

Land availability often becomes a significant challenge in developing solar PV projects, especially in high-density population areas such as the Java, Madura, and Bali (JAMALI) regions. Competing land uses for agriculture, housing, and industry significantly limit the areas available for large-scale solar installations in this region. With the current target of government and PLN to integrate Solar PV in the region, the identification of potential sites for solar PV development is essential to support its acceleration.

This report aims to analyze the potential areas for utility-scale solar PV development in the JAMALI region by conducting a Geographic Information System (GIS) analysis of the technical aspects of solar PV development, an Environmental and Social Impact Assessment (ESIA), and a grid analysis. The objective is to reduce risks and support stakeholders' decision-making processes for solar PV investment.

This deliverable constitutes Phase 1 of the project, and the object is to be completed thanks to collaborative work between the consultants to enhance their expertise. By harnessing a holistic dataset, the consultants aim to improve the accuracy of existing mathematical models provided by Solargis. Additional factors such as zoning maps, elevation data, soil type, and others are used to eliminate further locations that are physically, legally, or otherwise not viable for implementing solar PV projects. Once the data is integrated into a GIS tool, the goal is to select and prioritize a sufficient number of sites (100++) through the GIS and non-GIS Multi-Criteria Decision Matrix (MCDM) developed as part of this deliverable.

GIS analysis prioritizes locations with high irradiation levels across the JAMALI region, integrating additional factors like zoning, elevation, soil type, forest moratorium sites, conservation forests, key biodiversity areas (KBA), and Protected Areas (PA) to filter out unsuitable sites. Additionally, the solar installation potential is reviewed to ensure it aligns with PLN's strategic plans. In addition to the GIS analysis, a high-level environmental and social screening was conducted to evaluate the feasibility of solar PV development within the selected sites.

Lastly, part of the analysis is a pre-grid impact study that provides additional criteria for site selection and prioritization. The site prioritized as a result of this report includes areas near an interconnection point/substation to the JAMALI transmission grid. This additional study aims to identify the JAMALI grid's hosting capacity for distributed solar PV installations. This study constitutes a pre-grid assessment that is essential to support this project further, especially the following deliverable about grid assessment. This report initiates a first-step analysis to reach the general goal of the project and prove that 1 GW (or more) of distributed solar PV can be well within the JAMALI grid hosting capacity without any impact on grid stability.

Overall, this deliverable is the first step of the project, which will provide technical knowledge to key stakeholders, including the Ministry of National Development Planning (BAPPENAS), MEMR, and the state-owned electricity company (PLN), to support decision-making on investments in large-scale solar PV development in the JAMALI grid and lessons learned for other grids in Indonesia.

1.3.1. Objectives of Report

Deliverable 2 entails a comprehensive assessment of solar irradiance data and site suitability within the JAMALI regions. The deliverable provides answers to the following:

- ❖ Define the optimal placements for solar PV installations in JAMALI, Indonesia, to reach 1 GW installed capacity of solar PV.
- ❖ Provide solar irradiance data mapping, which will serve as the starting point of the analysis and then can be used as reference to strengthen the MEMR database, and make it accessible to the public.
- ❖ Develop an MCDM, including GIS and non-GIS data layers, to prioritize sites according to environmental and social criteria, land availability and regulations.

1.3.2. Outputs of the Report

The outputs of this report are as follows:

1. Map of Solar Irradiance and potential Solar PV development areas in the JAMALI region
2. Regulatory, social, and environmental suitability analysis
3. Multi-Criteria Decision Matrix for the selection of the most suitable distributed solar PV installation
4. Optimal sites for distributed Solar PV installation across the JAMALI region

The report includes the methodology of the selection, the types of data utilized for the output, and the final visual map of the potential sites for distributed solar PV installations across the JAMALI region.

The final location selection is available, and the GIS data provided in this analysis are expected to be added to Indonesia's MEMR One Map (geoportal.esdm.go.id). The Indonesian government counterpart can use this as the basis to develop a 1 GW solar PV roadmap and procurement strategy for private sector project developers.

2. Methodology

Figure 1 outlines the overall methodology of the project, which is composed of subsequent phases to be completed. This report focuses on Phase 1 to effectively identify and prioritize optimal sites for solar PV development in the JAMALI regions. The consultants employed a comprehensive and systematic methodology that encompasses geospatial analysis, environmental, social, and regulatory analysis, and preliminary grid assessments.

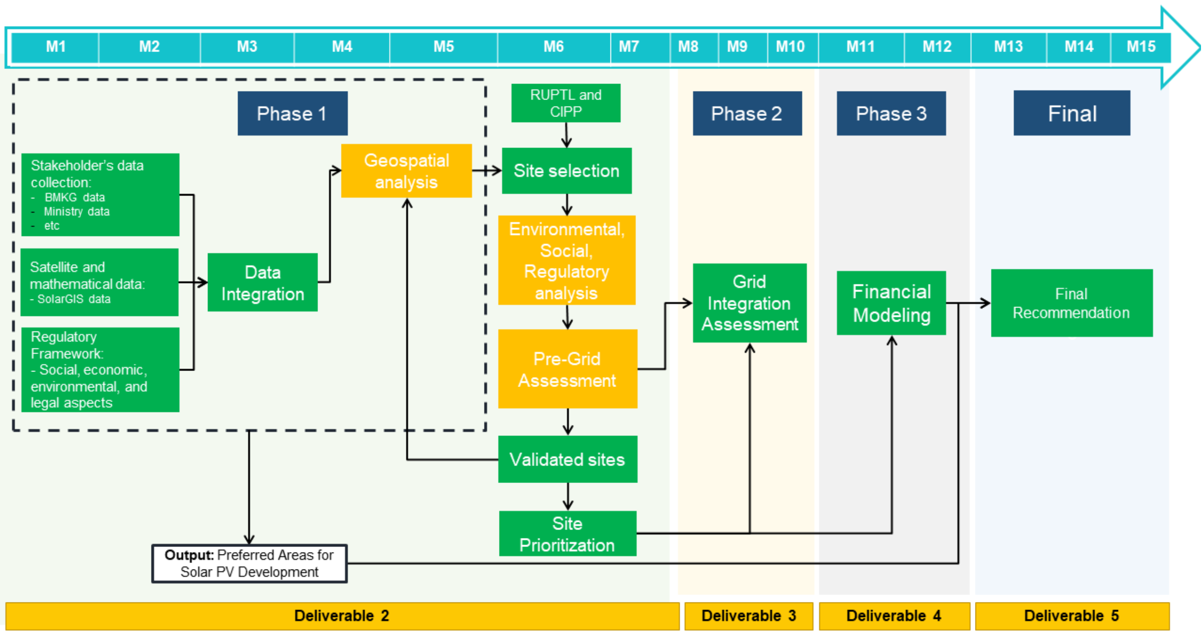

Figure 2 - Project's methodology

A Multi-Criteria Decision Matrix (MCDM) assessment was built collaboratively to identify the preferred locations for PV development in JAMALI. This matrix incorporated both GIS and non-GIS data layers, assessing sites against criteria such as land availability, environmental and social risks, and regulatory considerations. The process consisted of three main activities highlighted in yellow in Figure 2:

1. Geospatial analysis to identify technically viable areas for PV development, including the solar irradiance across JAMALI
2. Study of environmental, social, and regulatory aspects to confirm the outcomes of the technical study
3. A preliminary grid integration analysis to assess the impact of connecting 1 GW of intermittent solar PV to the JAMALI grid and the maximum hosting capacity of solar PV per substation.

The three steps were applied in the sequential order above, and importantly, frequent feedback between the layers of analysis (the three steps) was maintained throughout the process to ensure the results were consistent and fulfilled all the selection criteria.

The methodology of the three steps is elaborated in the sections Geospatial analysis, Environmental and Social Analysis, and Pre-Grid impact assessment.

2.1. Geospatial analysis

The geospatial analysis aims to identify the preferred areas for utility-scale PV development in the JAMALI region from the point of technical and social constraints, which can be analyzed in a geospatial context using GIS-based methods. The MCDM is an established method for geospatial analysis of renewable energy potential and has been used in studies with similar objectives[5] [6,7]
A custom-tailored Python program, utilizing geospatial libraries such as NumPy, Rasterio, and GDAL was developed to perform the geospatial analysis. The Python code is customizable and can be run with different criteria, directly influencing the MCDM results. The resultant maps were subsequently refined using QGIS software. The method of geospatial analysis applied in this study consists of the following steps:

1. Identification of the accessible spatial data (GIS layers) relevant to PV development

The selection of input data and its quality directly influence the outcomes of MCDM. Thorough attention was given to the data selection process to ensure optimal results. In the geospatial analyses, the consultants addressed various natural, technical, and social phenomena of the JAMALI region:

- Photovoltaic power potential (area qualification factor)
- Intermittency of the solar resource (area qualification factor)
- Terrain complexity
- Occurrence of surface water and permanent water bodies (as a limitation factor for ground-mounted PV)
- Landcover (evaluation of forest areas, agricultural land, open areas, etc.)
- Built-up areas (urbanized surfaces, cities, settlements as a limitation factor)
- Forestry status (additional data on forest areas)
- Soil types (for more detailed qualification of the agricultural land)
- Localization of the protected areas and key biodiversity areas (limitation factor)
- Localization of the cultural heritage sites and the Indigenous people's lands (limitation factor)
- Recent volcanic and seismic activity (risk factor)
- Road network (accessibility of the land plots)

Chapter 4.1 presents and explains all the data layers used in detail, and Chapter 3 addresses the data sources.

To enhance the outcomes, future iterations of this MCDM approach may incorporate additional data layers, including information on the spatial distribution of the electricity grid objects, land availability, land prices, etc. Such layers were unavailable when this segment of the study was finalized.

2. Data pre-processing and harmonization

The input data are typically provided in different data formats and data structures. Some layers require pre-processing of the data they contain to be useful for geospatial analysis. It includes

[5] J. Langer et al., "Geospatial analysis of Indonesia's bankable utility-scale solar PV potential using elements of project finance," Energy, vol. 283, p. 128555, Nov. 2023, doi: 10.1016/j.energy.2023.128555.

[6] UC Santa Barbara, "MapRE," Multi-criteria Analysis for Planning Renewable Energy. Accessed: May 01, 2024. [Online]. Available: https://mapre.es.ucsb.edu/

[7] ESMAP. 2020. Global Photovoltaic Power Potential by Country. Washington, DC: World Bank.

selecting the usable part of the information from the layer and various GIS techniques, such as reclassification, data transformation, etc.

All input layers were harmonized into categorical raster files with uniform resolution and size. Thus, smooth integration into the raster calculation process was ensured. Output raster resolution (pixel size) was defined as 9 arcseconds (in the JAMALI region, approximately 275x275 m). Thus, each pixel represents approximately an area of 7.5 hectares, which may typically facilitate a 4 to 8 MWp PV power plant (depending on the technical configuration).

3. Identification of exclusion and qualified areas

In this step, unsuitable areas for utility-scale PV development were identified. The result of this geospatial analysis is a binary layer, where each pixel of the array is assigned a True or False value. True pixels represent the qualified areas, and False pixels represent the excluded areas. The selection of data inputs and the criteria are explained in detail in chapter 4.1.1.

4. Scoring of the qualified areas

A higher score in the qualified areas indicates a higher suitability for PV power development. Scoring comprises the evaluation of PV power potential, closeness to relevant infrastructure, or terrain features. The parameters in these range layers are expressed on a scale (e.g. terrain slope from 0° to 15°), and the scale is converted into a "score" normalized into a scale from 0 to 1. In the analysis, more suitable areas are scored higher than less suitable ones. Each range layer is additionally assigned its weight to account for the relative difference in the importance of these parameters for PV power development.

5. Combination of the layers to generate the output

Once each layer has been prepared as described above, they are combined to produce the final output. First, binary layers are applied to exclude unsuitable land from further consideration. Then, the range layers are combined to produce the final scoring of the land areas of JAMALI for PV power development. The final output is a GIS raster (map) scoring the available areas on a scale from the most suitable to the least suitable for PV development.

6. Site selection

Based on the output of the geospatial analysis, 100++ sites with minimum potential PV power installed capacity of around 10 MWp were identified in the qualified areas. In this step, aerial and satellite imagery were investigated, and selection criteria prioritized the locations:

- Shrubland, grassland
- Abandoned or semi-abandoned agricultural land
- Extensively cultivated (less productive) agricultural land
- Open areas or shrubland, typically in proximity to industrial or mining areas
- Other specific, such as large, terraced groundworks along the transport corridors

The sites were identified on the JAMALI islands. The small islands in the area were disregarded due to a lack of interconnectivity in the JAMALI electricity grid. These areas were then further analyzed in the next two steps of the analysis.

7. Land Analysis

The available land for each site is analyzed as a key criterion for defining the maximum potential PV capacity for each location, along with the maximum hosting capacity, which will be detailed in Section

2.3. The available land areas are assessed using urban planning zoning data through bhumi.atr.bpn to delineate the boundaries of each site.

8. Notes on the sites selected

Based on the geospatial analysis, it should be noted that the sites do not cover all the highest-ranked areas in JAMALI. The sites selected are among the best sites with the data layers available, on which a methodology of selection was applied by the consultants. This means the technical potential for developing PV power in the JAMALI region can be much higher than 1 GW. However, since the purpose of this project is the pre-feasibility study for 1 GW of solar PV development, the analysis was narrowed down to this scope. The results of the geospatial analysis are then to be assessed thanks to pre-feasibility analysis (using the further steps of the study described in chapters 2.2 and 2.3) Then, the total technical potential for PV power development is quantified in chapter 4.1.

It is essential to highlight that the geospatial analysis output necessarily reflects the input data quality. The data collection phase attempted to obtain high-quality, verified, and up-to-date GIS layers for the geospatial analysis. However, this was not possible in few instances. Hence, layers with inferior quality (e.g. poorer spatial resolution) or unverified status (e.g. coming from public open sources rather than official Indonesian government sources) had to be used. In some cases, the data obtained for a desired layer was completely unsatisfactory or unusable (e.g. due to extremely poor quality, or unusable format); consequently, the factor could not be considered in the geospatial analysis. These facts may result in inaccuracies in the final output of the geospatial analysis, which should be considered when interpreting the results. For instance, the land cover layer used in the analysis may indicate agricultural land, but in practice, the plot of land has not been used for agriculture in the past 10 years. Therefore, solely reliable and trustworthy sources were used. Overall, the geospatial analysis should not contain any coarse errors, and the results should be consistent. The result should only be considered as pre-feasibility type output, and a detailed local study should be performed before any investment decisions are taken.

2.2. Environmental and Social Analysis

The environmental and social (E&S) analysis aims to analyze layers that could not be integrated into the geospatial analysis. This assessment is conducted as a confirmatory step to the relevant spatial plan regulations related to protected areas that need to be reviewed after the sites are selected due to the limited database provided by Indonesia's government. The purpose of E&S analysis is ultimately to rank the pre-selected sites and exclude unsuitable sites,

Overall, the E&S screening fulfils the following objectives:

- Describe the E&S framework and International Financial Corporation (IFC) Performance Standards (PSs) requirements.
- Describe the Indonesian environmental and social requirements concerning solar projects solar projects and batteries of the proposed scale, including relevant regulations for land acquisition.
- Provide a desktop socio-environmental assessment of the proposed project locations based on a land-use map, indicating high-level risk assessment and mitigation measures.
- Prepare a high-level review demonstrating an understanding of the process for purchasing land and securing the required land access rights at different geographical locations in Indonesia.

The method of E&S analysis applied in this study consists of the following steps:

1. Preparation of the environmental and social screening

The step identifies social, economic, environmental, and regulatory aspects that could not be integrated into the GIS analysis. This high-level screening clarifies the E&S considerations required across the selected sites. The screening exercise aims to identify potential significant effects on E&S receptors/resources due to solar PV development. It also seeks to anticipate the risks in the selected areas based on the consultants' experience with local context, compliances and regulations.

a. Environmental screening

Based on experiences in similar power generation projects in the region, understanding potential environmental impacts—especially concerning biodiversity and climate change—early in the project lifecycle is critical for managing and mitigating risks. The environmental data collection and screening process includes several key components:

- **Biophysical and Socio-economic Characteristics**. A comprehensive description of the area's biophysical and socio-economic characteristics, including preliminary identification of ecosystem services and vulnerability to climate change.
- **Land Use Patterns**. Analysis of land use patterns in areas influenced directly and indirectly by the project. This includes providing a land use and cover map, demarcating various land uses and identifying general habitat types.
- **Land Categories and Ownership**. Initial checks of land categories and ownership status for all potential sites, providing crucial information for the land acquisition process. This can be done through platforms such as ATR/BPN's Gistaru and BAPPENAS's WebGIS SIMRENAS, with land ownership status available at ATR/BPN's Bhumi.
- **Supporting Infrastructure**. Evaluation of potential sources and availability of water and other supporting infrastructure necessary for construction.
- **Biodiversity Data** Utilizing public available databases from Ministry of Environment and Forestry and Nature Conservation Agency (from protected areas recognized as conservation forest or national parks, nature and wildlife reserve) as well as globally recognized high biodiversity value areas to gather biodiversity data, including identified protected areas, species, and habitats of concern. This involves forming a preliminary opinion on whether these factors are likely to trigger Critical Habitats or Priority Biodiversity Features (PBFs) and assessing the extent to which they could impact the project.
- **Natural Hazard Parameters**. Identification and assessment of risks associated with natural hazards such as floods, earthquakes, and landslides. This involves using GIS layers to overlay potential solar PV sites with hazard maps from the National Disaster Management Agency (BNPB) portal and analyzing historical data on flood events, earthquakes, and landslides in recent years.
- **Key Biodiversity Data**. Assessment of the potential impact on local flora and fauna, particularly endangered species or protected habitats, to minimize habitat loss and disruption during the integration with the JAMALI grid.
- **Soil Data**. Evaluation of soil types and their potential impacts on agricultural land or sensitive ecosystems.

b. Social screening

Solar PV development's footprint, construction, and operation activities can impact the local community on the selected sites and surrounding areas. The social data collection screening includes:

- Cultural Heritage—Identify potential cultural heritage sites within the vicinity of the project site, such as archaeological value, national heritage, or historic buildings (if any).
- Identify Indigenous groups' territory. The registered indigenous territories map is available on BRWA (*Badan Registrasi Wilayah Adat*) and will be overlaid with the MCDM to avoid conflicts with indigenous land rights.
- Livelihood sources, including informal economic activities and reliance on common resources for all affected households.
- General overview of formal and informal tenure conditions for residential, agricultural, and commercial land use.
- Identify potential opportunities for livelihood improvements and economic development.
- Utilize the *Zona Nilai Tanah* (ZNT) data issued by the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency for initial land price identification facilitates additional information and estimates cost-effective approach to land acquisition, ensuring fair compensation for landowners while aligning with project developer budgets.
- Identification of potential impacts relevant to the activity, including environmental impact and climate change-related, if applicable.
- Delineation of the areas on which the project has direct and indirect influence.

c. Regulatory screening

The regulatory screening is covered in the chapter Regulatory Analysis and the results are available in the chapter List of Relevant Regulations **.**

2. Definition of the environmental and social parameters

The first examination ensures high-level suitability and compliance with the applicable E&S regulations, as well as international E&S safeguards such as IFC performance standards. These E&S parameters, derived from relevant regulations, were used to screen suitable potential sites.

The E&S adheres to IFC Performance Standards, which provide a robust framework for managing E&S risks. Globally recognized as a benchmark for best practices in project financing, these standards ensure that projects maintain high levels of sustainability and social responsibility. Adhering to IFC PSs enables projects to attract investment from reputable financial institutions, mitigate environmental and social risks, and build positive relationships with local communities and stakeholders. Furthermore, promoting private sector participation necessitates using IFC standards as a reference, given their global acceptance and credibility. IFC requires projects to adopt and implement eight environmental and social performance standards points. Key requirements of each performance standard are provided in Table 1 - IFC Performance Standards.

Table 1 - IFC Performance Standards

Performance standards (PS)	Key Requirements
PS 1: Assessment and Management of Environmental and Social Risk and Impacts	IFC PS1 requires identifying and assessing any project's environmental and social risks and impacts. It shall cover all relevant environmental and social risks and potential effects outlined in PS 2 through 8. The Project must adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not

	possible, minimize, and where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment. IFC PS1 promotes improved E&S performance of clients through the effective use of Environmental and Social Management Systems (ESMS). In addition to meeting the IFC PS 1 requirements, the Project must comply with applicable national law, including those laws implementing host country obligations under international law.
PS 2: Labour and Working Conditions	The key elements for compliance with IFC PS2 include human resources policy and its management; direct and contractual worker management; working conditions and terms of employment; retrenchment; freedom to form and join workers' organizations; internal grievance mechanism; protection of workforce to avoid child labour and forced labour; non-discrimination and equal opportunity considerations (including local hiring preferences); occupational health and safety procedures and mechanisms; and procedure for managing contractors and suppliers.
PS 3: Resource Efficiency and Pollution Prevention	IFC PS 3 outlines a Project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices. Critical compliance elements in IFC PS3 include greenhouse gas emissions, water consumption, air and water emissions, noise, ambient air quality, waste management, hazardous materials management, and pesticide use and management.
PS 4: Community Health, Safety, and Security	The two key aspects of IFC PS4 concern community health and safety and security personnel requirements. IFC PS4 requires the Project to evaluate the potential for community impacts associated with the Project and avoid or minimize risks/effects on community health and safety, particularly with regards to infrastructure, equipment, hazardous materials safety, natural resource issues related to the ecosystem services utilization, and exposure to disease. The performance standard also requires the assessment of risks posed by its security arrangements to those within and outside the project site.
PS 5: Land Acquisition and Involuntary Resettlement	Essential requirements of the IFC PS 5 include Compensation and Benefits for Displaced Persons, Community Engagement, resettlement and Livelihood Restoration Planning and Implementation, and a Grievance Mechanism for Physical and economic displacement.
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	To ensure that biodiversity is protected and conserved, and that sustainable management and use of natural resources is used wherever feasible throughout the Project lifecycle. The key concerns required by the IFC PS6 include the protection and conservation of biodiversity through assessment and management of modified and natural habitats, critical habitat, legally protected and internationally recognized areas and invasive alien species; management of ecosystem services;

	management, living natural resources, and supply chain management.
PS 7: Indigenous People	Require the Project to anticipate and avoid adverse impacts on the Indigenous People, including People screening and impact assessment, maintain relationships based on Informed Consultation and participation (ICP), obtain FPIC if the Project significantly affects the Indigenous People, and promote sustainable development benefits and opportunities.
PS 8: Cultural Heritage	IFC PS8 requires sites to make efforts to protect cultural heritage from any adverse impacts of Project activities and to support its preservation. In this case, the implications of IPs are being assessed.

3. Identification of exclusion and qualified areas

Binary layers are the first parameters defined to qualify or exclude areas that are unsuitable, thanks to the E&S screening and the regulatory analysis. In this step, unsuitable areas for utility-scale PV development are excluded from the rest of the analysis. **The output of this first evaluation is to provide a list of the qualified areas among the selection of sites.** The results of the sites excluded and the list of binary criteria are detailed in the chapter Environmental and social assessment.

4. Scoring of the qualified areas

After the sites are excluded, the qualified areas are assigned a score of 1-3, with 1 indicating lower risk and 3 indicating higher risk, for six parameters (as detailed in Section **Error! Reference source not found.**). The total score from the parameters in these range layers results on a score from 8 to 15. A lower score in the qualified areas indicates fewer E&S risks and, therefore, higher suitability for PV power development.

At this stage of the report, the reference for the table of E&S risks is shown in Table 2 however an updated table of risks used for the scoring is developed in the section Environmental and social assessment.

Table 2 - Risk categories from inception report

Risk Category	Description	Action point
Excluded	Significant E&S Risk, ineligible for financing or investment due to their important, irreversible, or unacceptable environmental and social risks and impacts. Exclusion zones includes forest moratorium (PIPPIB) area, Mangroves area, and high biodiversity value area.	No Go site
Category A	**Critical high risk** Site with potentially significant adverse environmental and social risks and impacts, which are diverse, irreversible, or unprecedented	Requires Due Diligence and development of Mitigation action (ESMP)

Category B+	**High Risk** Site with potentially adverse social or environmental impacts that are generally beyond the site boundaries, largely reversible, and can be addressed through relevant mitigation measures	Requires Due Diligence and development of Mitigation action (ESMP)
Category B	**Moderate Risk** Site with moderate environmental and social risks and impacts, largely reversible and readily addressed through mitigation measures	Requires Due Diligence and development of Environmental and Social Management Plan (ESMP)
Category C	**Low Risk** projects have minimal or no adverse environmental or social risks and impacts.	Require compliance with applicable laws

5. **Site qualification and ranking**

Once each parameter has been prepared as described above, it is combined to produce the final output. In summary, binary layers are applied first to exclude unsuitable land from further consideration. Then, the range layers are combined to generate the final scoring of the sites selected in the JAMALI region. The categories in Table 2 above were included in the inception to define the classification of the qualified sites. Theoretically, the objective is to rank the site from the lowest risk to the highest. The assumption is to prioritize low-risk locations. The final output ranks the qualified areas on a scale from the less risky to the riskier for E&S analysis for PV development.
The scoring table as well as the final ranking, is available in the section MCDM parameters

2.3. Pre-Grid integration assessment

The grid impact assessment's objectives are to analyze the feasibility of developing around 1 GW of solar PV development for the JAMALI system and then to identify its impact and risks that may be involved. The social, environmental, and regulatory review provides pre-selected rank sites. These 140 sites were inputted into the system to conduct several studies and measure the impact on the existing grids.

Data collection and power system modelling focus on several critical components of grid infrastructure along with its parameters, such as power plants (location, type and capacity), transmission system (route, length, and capacity/ rating), and loads (substations, demand profile and growth); these components are modelled for both the existing ones and the ones that are included in the expansion planning. The primary reference to model JAMALI power system is the RUPTL 2021-2030, combined with previously owned data.

Once the complete system is modelled, multiple analyses are conducted to observe the impact. Economic analysis uses the software PLEXOS, and technical analysis uses DIgSILENT PowerFactory.

2.3.1. Preliminary grid analysis

This study focuses on the preliminary grid assessment to evaluate the system's capacity to absorb 1 GW of solar PV into the JAMALI Grid. It also aims to evaluate the potential capacity of each site by analyzing the maximum hosting capacity at each substation. The following analysis is conducted within this study:

1. Preliminary Grid Systems analysis

The preliminary grid study confirms that the JAMALI grid system can absorb 1 GW of Solar PV that is spread across the system (which will be explained further in Chapter 4.3). A high-level grid assessment of 10 x 100 MW is performed in a spread substation within the JAMALI system.

2. Distance to the nearest substation

One important process before conducting both economic and technical analysis, given that potential site selections have been previously made, is site prioritization. A part of site analysis will be done based on the proximity of the sites to the nearest 150 kV substation, with the assumptions that around 200 kUSD/km will be applied as the cost to connect those PV sites. Another important aspect related to this is clusterization: several adjacent sites can be clustered and connected to one 150 kV substation, which is also based on the proximity of the PV sites to the nearest 150 kV substation.

3. Maximum hosting capacity

The first step to determine the maximum PV that can be developed in an area is to conduct a maximum hosting capacity of a substation, which is the maximum amount of PV that can be injected into a substation, either from a single PV site or a cluster of PV sites. The hosting capacity of a substation is based on two limitations: voltage level component’s loading (in N-1 contingency condition). Basically, the amount of PV connected to a substation gradually increases until one of those constraints is exceeded. Then, the numbers is compared with the potential of the site or cluster that is connected to that particular substation.

2.4. Regulatory Analysis

Reviewing the relevant regulations establishes the context and landscape of the 1GW solar PV development. Analysis of relevant regulations was performed to provide suggestions on how they affect location selection. The regulations are split into two categories:

- Regulations that are directly relevant to the MCDM and
- Other regulations that do not directly affect the MCDM but are relevant to the broader project analysis, such as available government support and permit requirements for floating solar PV development, have also been identified.

The regulatory review process involves three primary steps, as described in the following diagram in Figure 3.

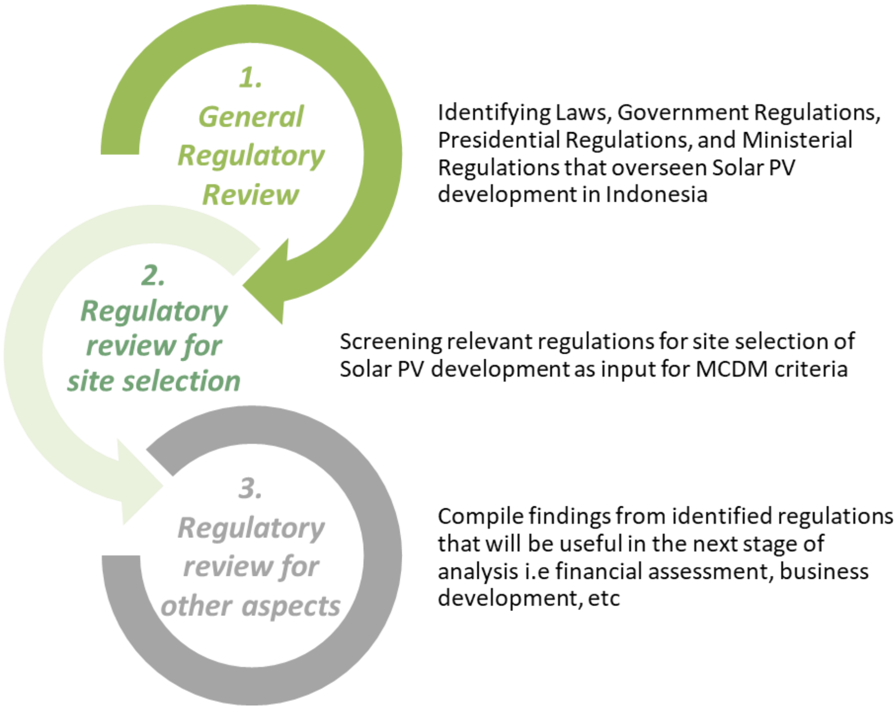

Figure 3 - Regulatory review methodology

Firstly, all regulations related to Solar PV development in Indonesia are identified, including laws, government regulations, presidential regulations, and ministerial regulations. The identified regulations are limited to nationwide regulations as the detailed implementation on the regional level usually differs based on applicable local procedures[8].

The list of relevant regulations summarizes regulations and suggestions for MCDM criteria development and E&S screening. Regulations that will be considered for the next stage are provided in Annex A. It is also important to note that a more detailed legal assessment will be required to complement the regulatory reviews before any decisions are made regarding solar PV development.

The regulatory data collection and screening include reviewing of the following:

- Compliance with National Spatial Planning: analyse whether the site complies with National Spatial Planning regulations. It involves examining whether the site is located within a Protected Rice Field, as stipulated by the Decree of the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Number: 1589/SK-HK.02.01/XII/2021, which outlines the Protected Rice Fields Map in Regencies/Cities in several provinces. This regulation aims to control the conversion of rice fields into non-agricultural functions, which poses a risk to site prioritization in this project. It is recommended that data be generated from https://bhumi.atrbpn.go.id/.
- Compliance with Regional Spatial Planning: provide mapping and an analysis of whether the site complies with regional spatial planning regulations.
- Compliance with Forest Land Tenure: analyse whether the site complies with forest land tenure regulations. It is necessary to determine whether the area falls within non-forest areas, also known as areas for other land uses/ *Area Penggunaan Lain* (APL). The areas under APL

[8] Local regulatory review will be done after the potential sites have been decided

are formally designated as privately owned land. It is recommended to generate data from https://sigap.menlhk.go.id/sigap/peta-interaktif

- Regulatory review of Indonesia's requirements and international safeguards, such as those of the IFC (International Finance Corporation) and ADB (Asian Development Bank).
- Applicable environmental and land use laws concerning the requirements of the Ministry of Environment and Forestry of Indonesia in specific areas, forests, waste management regulations, and potential environmental permits. As stated in the Ministry of Environment and Forestry, the Regulation No. 07 of 2021 about Forestry Planning, Changes of Designation in Forest Areas and Changes of Function in Forest Areas, and Forest Utilization and Government Regulation No. 23 of 2021 about Forestry Administration and Management is essential to analyse.
- Compliance with the cultural heritage map and its regulations as stated in Government Regulation No. 1 concerning the National Registry and Conservation of Cultural Heritage and Law No.11 of 2010 about Cultural Heritage.
- Legal procedures for land acquisition regulations, including compensation requirements, land titling processes, and potential challenges as stipulated in Presidential Regulation No.39 of 2023 about the Implementation of Land Procurement for Development for the Public Interest.
- Identification of available government incentives or support for solar PV development as stipulated in Presidential Regulation No. 112 of 2022 concerning Accelerating the Development of Renewable Energy for Providing Electric Power.
- Compliance with PLN grid connection procedures and the grid codes mentioned in Minister of Energy and Mineral Resources Regulation No. 20 of 2020 about Codes of Electricity Power System Network (Grid Code) to analyze connection procedures, technical requirements, and the permitting process for connecting solar PV plants to the JAMALI region.

2.5. Site Prioritization Methodology

This section elaborates on the methodology for obtaining the final site prioritization among suitable sites based on the selection stages. The criteria to proceed to site prioritization are composed of:

- Technical scoring and solar resource
- Environmental and social risks
- Scalability of the site

The geospatial analysis, the E&S analysis, and the pre-grid integration assessment confirm the site's suitability. A site considered unsuitable in one of these three aspects is excluded from the site prioritization. The MCDM for site prioritization is based on three scoring: geospatial analysis, E&S, and potential solar PV capacity.

3. Preliminary desk study and data collection

3.1. Literature Review

Another step in effectively choosing locations for solar PV development is understanding the strengths and weaknesses of potential sites through desk study and primary and/or secondary data collection. This literature review examines how Multi-Criteria Decision Matrix (MCDM) methods are utilized to assess various factors through GIS and non-GIS collected data that influence solar PV suitability. By incorporating research from both domestic (Indonesia) and international sources, this review sheds light on the key considerations for solar PV mapping and development. This enhanced knowledge will be important to add more points of view in selecting the most optimistic areas for solar PV projects within this report. Table 3 is the following literature review:

Table 3 - Literature Review

Source	Notes
Geospatial analysis of Indonesia's bankable utility-scale solar PV potential using elements of project finance[9]	• Under current land use, 92.1% of Indonesia's land is unavailable for utility-scale PV. Especially Java, where only 0.6% of land remains. • Economic potentials are mainly in East Indonesia and absent on Java due to tariffs and land availability
Beyond 207 Gigawatts: Unleashing Indonesia's Solar Potential - Nationwide solar potential assessment based on Geographic Information System (GIS) mapping[10]	• Scenario 1 (S1): Base exclusions (protected areas, forested areas, water bodies, wetland areas, airports and seaports) + slope exclusion (>10°): Suitable area 484,455 km² (24.43%), Capacity 19,835 GWp • Scenario 2: S1 + agricultural lands (both pure and shrub-mixed) and plantation forest areas exclusions: Suitable area 187,806 km² (9.85%), Capacity Potential 7,700 GWp • Scenario 3 (S3): S2 + transmigration and settlements areas exclusions: Suitable area 153,915 km² (8.07%), Capacity Potential 6,310 GWp • Scenario 4 (S4): S2 + dry shrub exclusion: Suitable area 82,847 km² (4.34%), Capacity Potential 3,397 GWp

[9] Jannis Langer, Zenlin Kwee, Yilong Zhou, Olindo Isabella, Ziad Ashqar, Jaco Quist, Aaron Praktikno, Kornelis Blok, "Geospatial analysis of Indonesia's bankable utility-scale solar PV potential using elements of project finance", Elvesier LTD, Vol. 283 (July 2023). https://doi.org/10.1016/j.energy.2023.128555

[10] Agus Tampubolon, Daniel Kurniawan, Deon Arinaldo, Handriyanti Diah Puspitasari, Hapsari Damayanti, Idaon Marciano, "Nationwide (Indonesia) solar potential assessment based on geographic information system (GIS) mapping, IESR. March 2021. https://iesr.or.id/wp-content/uploads/2021/03/Daniel-Kurniawan.pdf

Statistik Pertanian (Agricultural Statistics) 2023 – Center for Agricultureal Data and Information System – Ministry of Agriculture Republic of Indonesia[11]	• There was a decrease in the area of wetland in Indonesia from 2015 to 2019 amounting to 628,959 hectares • There was an increase the area of wetland in West Java from 2015 to 2019 amounting to 15,424 hectares • There was an increase the area of wetland in Central Java from 2015 to 2019 amounting to 84,400 hectares • There was an increase the area of wetland in Yogyakarta from 2015 to 2019 amounting to 22,720 hectares • There was an increase the area of wetland in East Java from 2015 to 2019 amounting to 123,157 hectares • There was an increase the area of wetland in Banten from 2015 to 2019 amounting to 4,843 hectares • There was a decrease in the area of wetland in Bali from 2015 to 2019 amounting to 4,926 hectares
Peta Potensi Energi Surya Indonesia, P3TKEBTKE, Ministry of Energy and Mineral Resource of Indonesia	• ESDM (Ministry of Energy and Mineral Resource) estimates a theoretical solar PV potential of 3,551 GWp with forest areas and 1,360 GWp without forest areas.
Suitability of Selecting Locations for Solar Power Plants (PLTS) in Bali Province Using Spatial Methods - Multi Criteria Decision Making (Spatial-MCDM)[12]	• Percentage of potential land for solar PV development in Bali Province have a less recommended area of 3,251.98 km^2 (57.7%), a quite recommended area of 558.53 km^2 (9.9%) and a highly recommended area of 1,825.5 km2 (32.39%)

3.2. Stakeholders' data collection

3.2.1. Data collection process

A multidimensional procedure of data collection is necessary for a thorough analysis of the MCDM. Engaging stakeholders through interviews yields qualitative information about the issues and priorities of the project. Furthermore, Solargis data offers useful quantitative data on solar radiation, which is essential for projects involving renewable energy sources. Open-source data, easily accessible on the internet, can add pertinent environmental or socioeconomic context to this information. Ultimately, targeted data purchases can fill specific knowledge gaps to ensure a robust MCDM analysis. This combined approach incorporates diverse perspectives and ensures data-driven decision-making.

[11] Statistik Pertanian (Agricultural Statistics) 2023 – Center for Agricultural Data and Information System – Ministry of Agriculture Republic of Indonesia

[12] Dhipaatmaja, Ketut Sura (2024) Kesesuaian Pemilihan Lokasi Pembangkit Listrik Tenaga Surya (PLTS) Di Provinsi Bali Menggunakan Metode Spasial – Multi Criteria Decision Making (Spasial-MCDM). Masters thesis, Institut Teknologi Sepuluh Nopember.

Data were collected based on interviews with the stakeholders to proceed with data integration in the GIS tool and then elaborate the MCDM. Due to some limitations in the engagement of the key stakeholders for the project, the consultants still managed to meet key stakeholders, but most of the data layers came from the Solargis source.

3.2.2. Spatial data layers

The consultants collected spatial data to consolidate the geospatial analysis. The following data layers were collected from available sources, as shown in Table 4.

Table 4 - Spatial data layers

Data layer	Details	Source
PV power production (PVOUT) potential	Calculated using Solargis in-house methods, from Solargis solar resource and meteorological data	Solargis
Land cover classes	Landcover definition according to Regulation of the Director General of Forestry Planning No P.1/VII-IPSDH/2015	Director General of Forestry Planning
Forestry Status KLHK	Forests classifications, and their management, defined by the *Forestry Law* (Undang-Undang Kehutanan No. 41 Tahun 1999). It divides forests into several categories, distinguishing production, protection and conservation forests.	Ministry of Environment and Forestry (MoEF) Indonesia[13]
Short-term variability of solar resource	Calculated using Solargis in-house methods, based on Solargis 10-minute time-series of Global Horizontal Irradiance (GHI) data	Solargis
Terrain	Terrain slope and terrain complexity (calculated as a combination of standard deviation and range of elevation in approx. 10 km radius)	Solargis, based on terrain data from SRTMv4.1[14], GEBCO_2014[15]

[13] Ministry of Environment and Forestry (MoEF) Indonesia, "Peta Interaktif." Accessed: Jun. 05, 2024. [Online]. Available: https://geoportal.menlhk.go.id/Interaktif2/

[14] Jarvis, A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org).

[15] General Bathymetric Chart of the Oceans, "GEBCO_2014 Grid version 20150318" Accessed: Jun. 05, 2024. [Online]. Available: https://www.gebco.net/data_and_products/gridded_bathymetry_data/version_20141103/

Data layer	Details	Source
Surface water occurrence	Flooding risk - at least 2 documented occurrences of surface water in the recent approx. 30 years. Based on analysis of Landsat satellite data.	Global Surface Water (GSW), JRC, EU[16]
Built-up areas	Built-up surface grid, derived from Sentinel2 composite and Landsat satellite data	GHS-BUILT-S, year 2020, JRC, EU[17]
Protected areas	Based on IUCN categorization	World Database on Protected Areas (WDPA)[18]
Key Biodiversity Areas	Sites contributing significantly to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems.	World Database on Key Biodiversity Areas (WDKBA)[19]
Road network	Accessibility to land plots	OpenStreetMap Contributors
Recent volcanic activity	Based on VEI (Volcanic Eruption Index) in the recent 100 years history	Global Volcanism Program, 2024[20]
Recent seismic activity	Earthquake epicenters with magnitude 3 and higher in the recent 30 years	USGS Earthquake Hazards Program[21]

[16] Pekel, Jean-François; Cottam, Andrew; Gorelick, Noel; Belward, Alan (2017): Global Surface Water Explorer dataset. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-gswe-global-surface-water-explorer-v1

[17] Pesaresi M., Politis P. (2023): GHS-BUILT-S R2023A - GHS built-up surface grid, derived from Sentinel2 composite and Landsat, multitemporal (1975-2030) European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/9f06f36f-4b11-47ec-abb0-4f8b7b1d72ea, doi:10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA

[18] UNEP-WCMC and IUCN (2024), Protected Planet: [The World Database on Protected Areas (WDPA)] [Online], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

[19] BirdLife International (2024). The World Database of Key Biodiversity Areas. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. Available at www.keybiodiversityareas.org. [Accessed 4/6/2024].

[20] Global Volcanism Program, 2024. [Database] Volcanoes of the World (v. 5.1.7; 26 Apr 2024). Distributed by Smithsonian Institution, compiled by Venzke, E. https://doi.org/10.5479/si.GVP.VOTW5-2023.5.1

[21] U.S. Geological Survey, “Earthquake Hazards Program | U.S. Geological Survey.” 2024. Accessed: Jun. 05, 2024. [Online]. Available: https://www.usgs.gov/programs/earthquake-hazards

Data layer	Details	Source
Open Buildings	Large-scale open dataset containing the outlines of buildings derived from high-resolution satellite imagery	W. Sirko, S. Kashubin, M. Ritter, A. Annkah, Y.S.E. Bouchareb, Y. Dauphin, D. Keysers, M. Neumann, M. Cisse, J.A. Quinn. Continental-scale building detection from high resolution satellite imagery. arXiv:2107.12283, 2021.
Distribution of Cultural Heritage	Points of cultural heritage distribution including historical landmarks, archaeological sites, and heritage zones	Geospatial Information Agency[22]
Indigenous People Territory Distribution	Registered indigenous territory on Java Island	BRWA – Customary Area Registration Agency[23]
Type of Soil	Types of soil categorization in Java and Bali with exploration scale 1:1,000,000	Center for Agricultural Land Resources Research and Development, Ministry of Agriculture – 2016[24]

22 Kemendikbudristek, "Cagar Budaya." Accessed: Jun. 05, 2024. [Online]. Available: https://referensi.data.kemdikbud.go.id/kebudayaan/cagarbudaya

23 Badan Registrasi Wilayah Adat, "GIS - BRWA." Accessed: Jun. 05, 2024. [Online]. Available: https://brwa.or.id/sig/

24 Lapak GIS, "Shapefile (SHP) Jenis Tanah Provinsi Pulau Jawa dan Bali.'' April. 22, 2024

3.3. List of Relevant Regulations

As explained in the Regulatory Analysis, the consultants considered several relevant regulations and provided suggestions on how the regulations affect the location selection in developing the MCDM. The regulations were also key to proceeding with E&S screening and the legal assessment. Table 5 summarizes regulations and recommendations on E&S screening and MCDM development.

Table 5 – Summary of relevant regulations and recommendations on E&S screening and MCDM development

No	Policies / Regulations	Key Summary	Recommendations on E&S Screening and MCDM development
1	**Law No 1 Year 2014 Concerning Amendment to Law No 27 Year 2007 concerning Management of Coastal Zone and Small Islands**	This regulation provides guidelines for utilizing coastal zones by owning a Location Permit (now Suitability of Space Utilization Activity Permit or KKPR) in Article 16 Paragraph 1. In Article 35, it is explained that in the utilization of coastal areas and small islands, everyone is directly or indirectly prohibited from using tools, methods and other methods that damage the ecosystems of coral reefs, mangroves and seagrass beds that are not in accordance with the characteristics of the area; carry out conversion of mangrove ecosystems in cultivation areas or zones; carry out physical development that causes environmental damage and/or harms the surrounding community.	This regulation is taken into consideration when conducting E&S Screening to exclude sites located in mangrove areas.
2	**Presidential Regulation No. 120 Year 2020 concerning Peatland and Mangrove Restoration Body**	The regulation stipulates the peatland and mangrove restoration Body as the body to facilitate the acceleration of peatland restoration in 7 provinces and implement the acceleration of mangrove rehabilitation in 9 provinces.	This regulation is taken into consideration when conducting E&S Screening to exclude sites located in mangrove areas

	(Badan Restorasi Gambut dan Mangrove or BRGM)		
3	**Presidential Regulation No. 121 Year 2012 concerning Rehabilitation of Coastal Zone and Small Islands**	This regulation regulates the rehabilitation of coastal and small island ecosystems which are considered to have exceeded the criteria for ecosystem and population damage due to the utilisation of coastal areas and small islands. One of these rehabilitations was also carried out on mangroves. This regulation describes the criteria for damage to the ecosystem or population in question which require rehabilitation, rehabilitation stages, monitoring and evaluation, participation, and financing.	This regulation is taken into consideration when conducting E&S Screening to exclude sites located in mangrove areas
4	**Government Regulation No. 23 of 2021 concerning Forestry Management**	1. Forest protection: To comply with forest protection according to Chapter VII, the regulation describes the holders of forest utilization approvals. Forest Protection should be carried out by the business (or permit holders) in their working areas. The scope of protection includes landscapes, vulnerability of endemic flora and fauna, protection of HCV, fragmentation of fauna corridors, and mangrove or peatland. 2. Social Forestry - Indicative Map and Utilization Permit Social Forestry is a system of sustainable Forest management implemented within the State Forest or Private Forest/Customary Forest Area implemented by the local community or Customary Law Community as the main actor to improve their welfare, the environmental balance and socio-cultural dynamics in the	This regulation is a reference in carrying out E&S screening to assess the risk of potential sites according to the type of forestry category they are situated in.

		form of village forest, community forest, community crop forest, customary forest, and forestry partnerships. Social forestry indicative map is established from protection forest and production forest that is not managed by local forestry agencies, locally known as Peta Indikatif Areal Perhutanan Sosial or PIAPS. A social forestry utilization permit is obtained through MoEF approval, managed by the local forestry management unit, and utilized by the village-based forest farmer community. 3. <u>Forest utilization permit for forestry and non-forestry uses</u> Forest utilization approval (*Persetujuan Pinjam Pakai Kawasan Hutan or* PPKH) is an approval for the use of part of a forest area for development purposes outside of forestry activities without changing the function and designation of the forest Area. Business Licensing for Forest Utilization (Perizinan Berusaha Pemanfaatan Hutan or PBPH) is the business licensing granted to Business Actors to start and operate forest utilization businesses and/or activities. PBPH and PPKH holders cannot share their forest utiilization permit to other parties without MoEF approval."	

5	**Ministry of Environment and Forestry Regulation No. 7 of 2021 concerning Forestry Planning, Changes of Designation in Forest Area, and Changes of Function in Forest Area, and Forest Utilization**	The regulation stipulates the definition of forest based on status, area, functions, and guidelines for forest inventory as the basis of forestry planning and designation. The regulation provides guidelines to change and utilize forest area outside forestry activities including guidelines to obtain forest utilization approval (PPKH). The use of Forest Area with the mechanism of Forest Area Utilization Approval by the decision of the Minister includes: electricity supply, including power generation installations, transmission, electricity distribution, substations, as well as new and renewable energy technologies"	This regulation is a reference in carrying out E&S Screening to assess the risk of potential sites according to the type of forestry category the sites are situated in.
6	**Ministerial Decree of Environment and Forestry SK. 3554/MENLHK-PKTL/IPSDH/PLA.1 3/2023 of 2023 concerning Determination of an Indicative Map for Cessation of Granting Business Permits, Approvals for Use of Forest Areas, or New Forest Area Allocation Requirements for Primary Natural Forest and Peatland in 2023 Period I**	The ministerial decree explains about indicative areas of termination to grant business permits, approval for use of forest areas or changes to the designation of new forest areas including business permits for the utilization of protected forests. The permitted location could be proposed as a revision to the PIPPIB Map. Report to MoEF should be done bi-annually by the permitting agency (3rd decree and 12th decree).	This regulation is a reference in carrying out E&S Screening to assess the risk of potential sites according to the type of forestry category the sites are situated in.
7	**Law No. 11 of 2010 concerning Cultural Heritage**	The law stipulates criteria for cultural heritage and the conservation of cultural heritage in general.	This regulation is a reference to provide recommendations for

		Cultural heritage shall be conserved and protected, and it is prohibited to prevent and obstruct efforts to preserve cultural heritage intentionally.	potential sites not located in cultural heritage zones. Geospatial analysis is carried out in the MCDM process by following this recommendation.
8	**Government Regulation No. 1 of 2022 concerning National Registry and Conservation of Cultural Heritage**	The regulation acts as an implementation of Law No. 11 of 2010 concerning Cultural Heritage. GR 1/2022 gives authority to the government and community participation in managing cultural heritage so that a good managerial system of planning, implementation and evaluation can be achieved regarding the protection, development and utilization of cultural heritage as a cultural resource for broad interests. Various aspects of cultural heritage conservation, i.e., registration, preservation, area management, incentives and compensation, supervision to funding are stipulated in this regulation. It is stated that every person who owns or controls an Object of Alleged Cultural Heritage (Objek Diduga Cagar Budaya or ODCB) is required to register with the regent/mayor free of charge. Anyone who finds an ODCB is also obliged to report their findings to the competent authority in the field of culture, the Indonesian National Police, and/or related agencies in the area where the object was found.	This regulation is a reference to provide recommendations for potential sites not located in cultural heritage zones. Geospatial analysis is carried out in the MCDM process by following this recommendation.
9	**Ministry of Education, Culture, Research, and Technology concerning Cultural Heritage Database**	The database provides information such as coordinates, administrative locations, name and shape of the cultural heritage nationwide. However, it does not provide the map of cultural	These regulations are references to provide recommendations for potential sites not located in cultural heritage zones.

		heritage distribution, and there is some missing information in some of the data list.	Geospatial analysis is carried out in the MCDM process by following this recommendation.
10	**Registration Body of Indigenous Area (Badan Registrasi Wilayah Adat) concerning Indigenous territory map**	The database is from national NGO covering Indigenous area and people. Each indigenous area has different status, i.e., registered, verified, and certified. No information available regarding the details of each status, however, some policies and regulations were added to some of the indigenous area as additional information.	
11	**Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) Regulation No. 1589 of 2021 concerning Map of the designation of protected rice fields**	"Protected rice fields area are designated to fulfill national staple needs of rice, and accelerate the determination of sustainable agricultural land. According to the regulation, protected rice fields are distributed in several provinces, relevant areas to the project area of interest are Banten, West Java, Central Java, DI Yogyakarta, East Java, and Bali. The regulation stipulates that initiative of industrial area and strategic national policy situated within the protected rice fields can be omitted from the protected rice fields area. Land use change recommendation is needed from the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency if the project wants to utilize protected rice fields area."	This regulation is a basis for the recommendation to exclude potential sites in rice fields.
12	**Presidential Instruction No. 5 of 2019 concerning Termination of Granting New License and Governance Improvement for Primary Forest and Peatlands**	This regulation focuses on the moratorium on new licenses for primary natural forest and peatland conversion. It's relevant to peatland and mangroves as they fall within the scope of primary natural forests. It is also relevant to area with forestry status (conservation, protection, and production forest).	This regulation is a reference in conducting E&S Screening to exclude potential sites located on moratorium land.

13	**Regional Regulation of Banten Province No. 1 of 2023 concerning Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of Banten Province in 2023-2043**	"The scope and content of the Provincial RTRW include objectives, policies, and strategies for spatial arrangement, plans for the structure of the spatial area, plans for the spatial pattern, designation of strategic areas, directions for spatial utilization, guidelines for spatial utilization control, rights, obligations, roles of the community, and spatial planning institutions, as well as provisions for investigation, criminal provisions, other provisions, transitional provisions, and closing provisions. This regulation provides a comprehensive framework for the spatial planning of the entire province, encompassing both land and sea areas. It outlines various aspects including objectives, policies, and strategies for spatial arrangement, as well as specific plans for the structure and pattern of the spatial area. Additionally, it addresses important matters such as the designation of strategic areas, guidelines for spatial utilization, and control measures. The regulation also covers aspects related to community roles, institutions for spatial planning, legal provisions for investigation and penalties, and other miscellaneous provisions, ensuring a well-rounded approach to regional spatial planning."	These regulations are references to determine the type of spatial plan category potential site is located in the E&S Screening process, this determines the type of risk the potential site has in the context of solar panel infrastructure development. It refers to regional regulation of regency level of the respective provinces.
14	**Regional Regulation of DKI Jakarta Province No. 1 of 2012 concerning Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of DKI Jakarta Province in 2030**		
15	**Regional Regulation of West Java Province No. 9 of 2022 concerning Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of West Java Province in 2022-2042**		
16	**Regional Regulation of Central Java Province No. 16 of 2019 concerning Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of Central Java Province in 2009-2029**		
17	**Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of DI Yogyakarta Province in 2023-2043**		
18	**Regional Regulation of East Java Province (approved by the legislative agency but not yet published) concerning Spatial plan (Rencana Tata Ruang**		

	Wilayah or RTRW) of East Java Province in 2023-2043		
19	**Regional Regulation of Bali Province No. 2 of 2023 concerning Spatial plan (Rencana Tata Ruang Wilayah or RTRW) of Bali Province in 2023-2043**		
20	**Key Biodiversity Area concerning Key Biodiversity Area**	Key biodiversity area is one of high biodiversity value areas which is recognized by international standards, i.e., IFC PS 6 and ADB Environmental Safeguards.	This regulation is a reference to exclude potential sites located in high biodiversity areas.
21	**Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Power Supply**	To increase the proportion of renewable energy in the electrical energy mix, PT PLN (Persero) is mandated to accelerate the termination of Coal-Fired Power Plants ("CFPP") that satisfy the following criteria: a. CFPPs owned and operated by PT PLN; and/or b. CFPPs developed by Independent Power Producer ("IPP") that already have signed Power Purchase Agreements ("PPA"), with consideration given to the conditions of supply and demand for electricity. It is also noted that if replacement of electricity resources is required during the termination of the CFPP, the CFPP can be replaced with renewable energy power plants in consideration of the electricity supply and demand.	CFPPs owned by PT PLN as informed in the RUPTL can be identified as one of the considerations as potential sites in developing MCDM. However, as of the writing of this report, no specific dates have been provided for any of the CFPPs retirement plan. Currently, there are only two CFFPs estimated for phase-out, namely CFFP Pelabuhan Ratu (1050 MW) and Cirebon-1 (660 MW), which are planned for early retirement in 2037 and 2035, respectively.[25]

[25] JETP. *Comprehensive Investment and Policy Plan*. 2023

22	**Minister of Public Works and Housing Regulation Number 27/PRT/M/2015 concerning dam as amended through Minister of Public Works and Housing Regulation Number 7 of 2023**	The regulation allows the utilization of reservoir inundation areas for energy generation purposes, including deployment of floating solar power plant facilities. The use of space in a reservoir inundation area for floating solar power plants must be based on a technical study conducted by the applicant. The technical study should at least analyze the effect of floating solar power plants on: a. The sustainability of the reservoir's function as a provider of irrigation water and raw water, flood control, energy generation, and water resource conservation. b. Dam safety and reservoir operation and maintenance; and Reservoir environmental sustainability in the form of environmental carrying capacity, reservoir water quality, and social, economic and cultural conditions.	The contents of technical study can be considered in the MCDM in relation to the impact of floating solar PV on the surrounding environment.
23	**Electricity Supply Business Plan 2021–2030 (RUPTL 2021–2030)**	In relation to solar PV deployment and land allocation, several related strategic initiatives include: a. Development of solar power plants on inactive mining sites in collaboration with local governments to optimize land utilization. b. Utilization of reservoirs across Indonesia as floating solar power plant installations to minimize land acquisition expenses while also considering operational and maintenance factors. c. Development of solar PV at PLN's existing power plants for PLN's own consumption. To illustrate, the policy document also provides the estimated capacity of repurposed ex-mining land, which is projected to yield 435.5 MW of solar power across regions such as South Sumatra	According to RUPTL, ex-mining land and reservoirs can be explored as potential sites for solar PV development and therefore can be considered as potential location in MCDM

<table>
<tr>
<td></td>
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<td>(27 MW), West Sumatra (50 MW), South Kalimantan (12.5 MW), and East Kalimantan (346 MW). Similarly, developing solar PV at PLN’s existing power plants is estimated to generate 112.5 MW, consisting of 87.5 MW in Java and 25 MW outside Java. Moreover, the proposed utilization of reservoirs for floating solar PV is estimated to reach a capacity of 612 MW as detailed in the table below.
<table>
<tr><th rowspan="2">Name</th><th rowspan="2">Location</th><th colspan="2">Coordinates</th><th rowspan="2">Est Capacity (MW)</th></tr>
<tr><th>Latitude</th><th>Longitude</th></tr>
<tr><td>Wonogiri Reservoir</td><td>Central Java</td><td>-7.886835653</td><td>110.9022503</td><td>100</td></tr>
<tr><td>Sutami Reservoir</td><td>Karangkates, East Java</td><td>-8.172660594</td><td>112.461194</td><td>122</td></tr>
<tr><td>Jatiluhur Reservoir</td><td>West Java</td><td>-6.519235185</td><td>107.3483012</td><td>100</td></tr>
<tr><td>Mrica Reservoir</td><td>Banjarnegara, Central Java</td><td>-7.384789264</td><td>109.6228277</td><td>60</td></tr>
<tr><td>Saguling Reservoir</td><td>West Java</td><td>-6.917686</td><td>107.406212</td><td>60</td></tr>
<tr><td>Wonorejo Reservoir</td><td>Tulung Agung, East Java</td><td>-8.017921723</td><td>111.7962749</td><td>122</td></tr>
<tr><td>Singkarak Lake</td><td>West Sumatra</td><td>-0.61636973</td><td>100.5413161</td><td>48</td></tr>
<tr><td colspan="4">Total</td><td>612</td></tr>
</table>
Source: RUPTL PLN 2021-2030</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Minister of Energy and Mineral Resources Regulation No. 2 of 2024 about Rooftop Solar Power Plant Connected to IUPTL Holder's</td>
<td>The IUPTLU owner (such as PLN) is required to establish a certain quota plan for rooftop solar PV systems. This plan is crucial in determining the capacity permitted for the installation of new solar PV systems.</td>
<td>Not entirely related to the MCDM process, but the quota plan based on RUPTL can be identified to determine rooftop solar PV capacity and area</td>
</tr>
</table>

	Electric Power Network for Public Interest	Essentially, the installed capacity of a new rooftop solar system relies on the availability of a clustered quota, which is determined by the Director General of Electricity ("DGE") based on the IUPTLU owner's proposal. The development quota is established for every five-year period and includes specific monthly allocations. Should there be any unused quota each year, it can be carried over to the subsequent year, thereby augmenting the quota for that year. However, once the quota is depleted, consumers will be prohibited from installing rooftop solar systems.	coverage as points for consideration in the MCDM.

4. Data Integration and Site Selection Result

4.1. GIS and spatial analysis

In the following chapter, the methodology described in Chapter 2.1 is applied to the data described in Chapters 3.2 and 3.3. The spatial analysis is performed in two steps: first, the limiting factors are investigated as binary layers. Through this process, the area of the JAMALI region is split into excluded areas and areas qualified for further analysis. Afterwards, the JAMALI region is quantitatively assessed using the range layers to identify relatively more and less suitable areas for PV development.

4.1.1. Binary layers

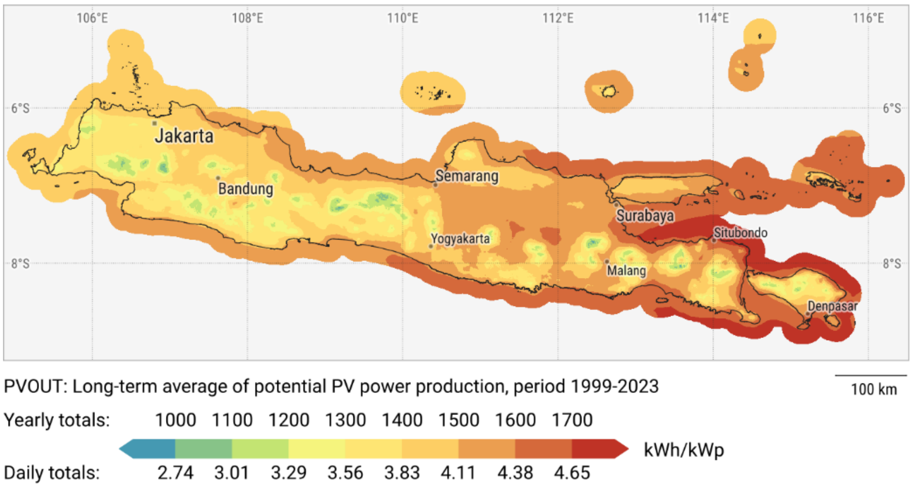
In this part of the spatial analysis, the distribution and interaction of various phenomena limiting the development of PV power across different geographical areas are studied. Regions that do not meet the specific criteria are excluded from further analysis. Regions that fit the postulated criteria are qualified for further analyses. In this chapter, the selective approach is summarized and provides detailed information for a clearer understanding of spatial patterns and relationships.

4.1.1.1. PV power production potential

The PV power production potential was calculated using the Solargis PV software, solar resources and air temperature data. The PV power plant configuration was set for a typical utility-scale plant with fixed-mounted crystalline-silicon (cSi) modules inclined at optimum tilt towards the Equator. Proprietary Solargis PV simulation algorithms were used to calculate PV power production. In the simulation, the conversion losses due to angular reflectivity and distribution of irradiance and temperature are considered. The cumulative effect of other conversion losses (dirt, inverters, cables and transformer) is assumed to be 7.8%. PV power production potential (PVOUT) was calculated for the period of 2007-2023 in 15-minute time granularity for the entire JAMALI region with a spatial resolution of 30 arcsec (approximately 1 km).

Based on Solargis PV software and data, the calculated PVOUT yearly totals in the JAMALI region range approximately from 1,000 to 1,800 kWh/kWp (Figure 4). The lowest PVOUT is documented mostly in the mountainous areas, and the highest is in the coastal areas, specifically in the southeast part of the region.

The areas with the lowest PVOUT (lowest 20% of the pixels) were excluded from further evaluation. This corresponds to PV power production of approx. < 1,300 kWh/kWp/year. The output of the calculation is shown below – the areas in green are considered qualified, and areas in red are excluded.



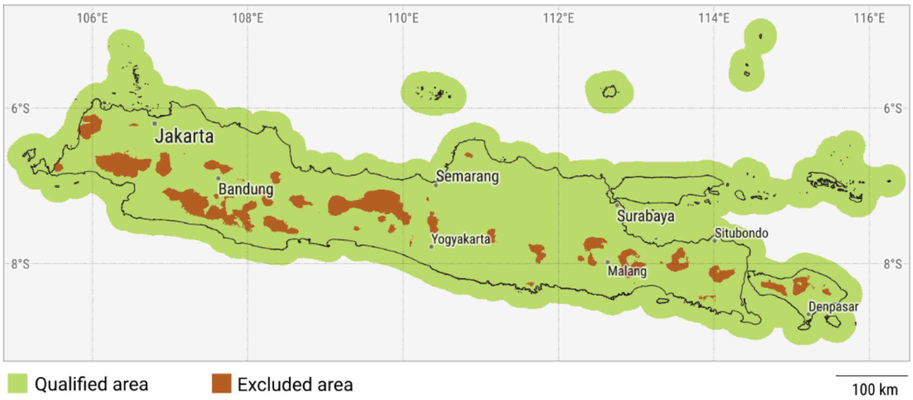


Figure 4 - Photovoltaic power potential (PVOUT), calculated by Solargis model (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.2. Water bodies

In the next step, all areas that are either permanent water bodies or areas liable to flooding were excluded. Both are unsuitable for utility-scale PV development. The layer was calculated using the GSW water occurrence dataset[26]. Based on the Landsat satellite data, the long-term monitoring of the water surface and flooding has been evaluated in more than 30 recent years. Areas where there were at least 2 documented occurrences of surface water in this period were subsequently excluded.

Please note that floating PV technologies have different deployment criteria and were not considered in this report. However, due to the relevant potential for developing floating PV in the JAMALI region, this option is briefly discussed separately in Chapter 4.1.3.

The results are shown below. The first map as shown in Figure 5presents the GSW water occurrence dataset. In the second map, the areas in green are considered further, and areas in red are excluded.

As the data is satellite-based and processed statistically (occurrence of water in the satellite image samples), the resultant exclusion zones have a high degree of accuracy. However, as the analysis is based on historical flooding data, zones not identified in the exclusion layer may experience flooding

[26] Pekel, J.-F & Cottam, Andrew & Gorelick, Noel & Belward, Alan. (2016). High-resolution mapping of global surface water and its long-term changes. Nature. 540. 10.1038/nature20584. https://www.nature.com/articles/nature20584.epdf

in the future. The impacts of climate change and human changes to the land (e.g. deforestation, building of dams and canals) can change the probability of future flooding in any area.

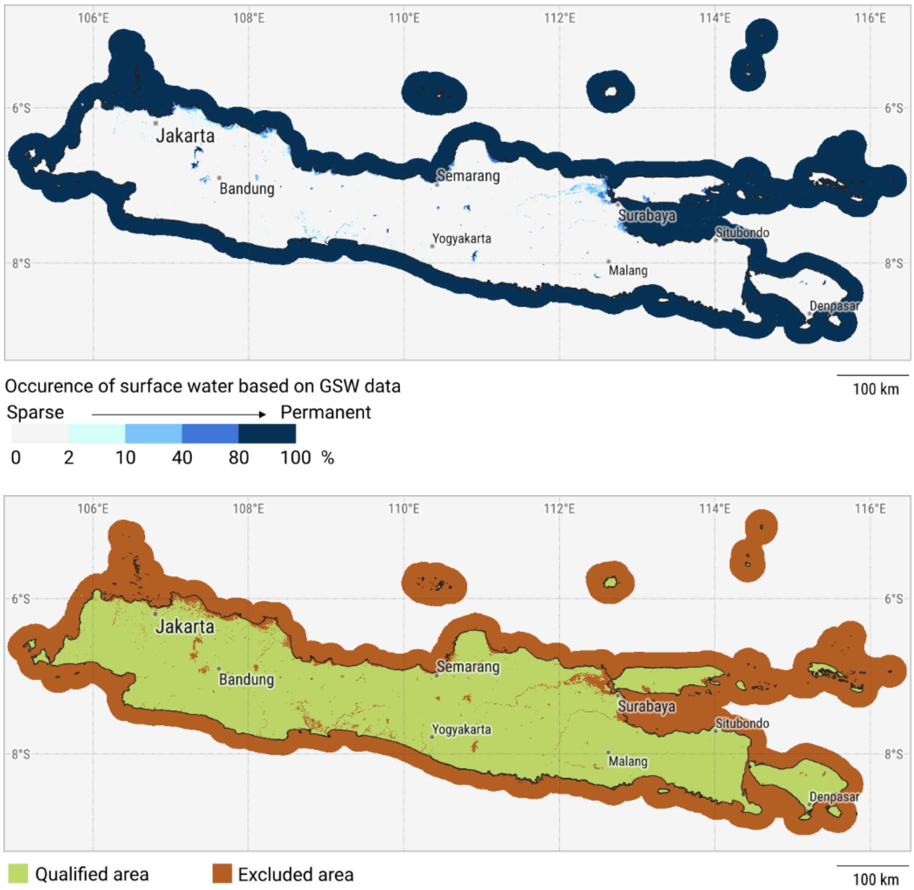


Figure 5 - Occurrence of surface water based on GSW (global surface water) dataset (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.3. Land cover classes

The land cover data layer shows the type of objects on the surface of the land, classified into standard categories. The land cover classes often indicate probable land use. Here, the aim was to exclude those areas in which utility-scale PV development may have a negative impact from an environmental or social point of view.

The quality of the input data is important for the whole MCDM. The land cover dataset was prepared for the reference scale 1:250 000 and reflects the status for the year 2022. A sample verification based on aerial imagery shows, in general, a reasonably good match with sparse inconsistencies. However, the classification is relatively coarse, and some classes deserve finer classification and identification for the purposes of this analysis (e.g., a class Settlement/Developed Area or better specification of agricultural land). Therefore, to achieve finer results, the key classes (urban areas, agricultural land, forest areas, and water bodies) are additionally addressed in more detail in further steps of the geospatial analysis. Table 6 presents the land cover classes and their relation to MCDM for geospatial analysis.

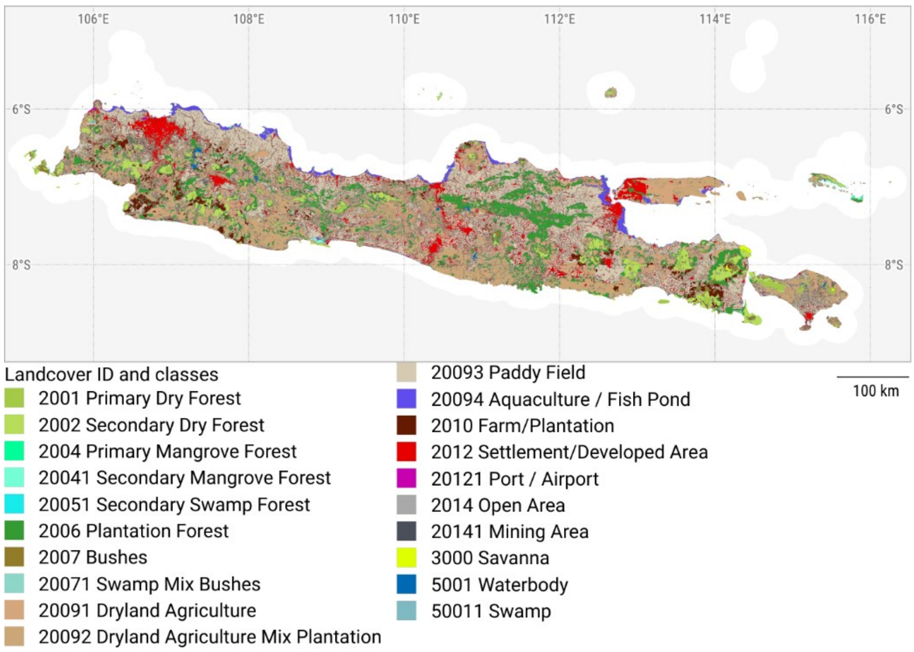
Table 6 - Land cover classes and their relation to MCDM for geospatial analysis

Exclusion	Description	Justification for exclusion/qualification
Excluded	Primary Dry Forest	PV power development must not encourage deforestation, forests are protected under Indonesian government regulations
Excluded	Secondary Dry Forest	PV power development must not encourage deforestation, forests are protected under Indonesian government regulations
Excluded	Primary Mangrove Forest	Mangroves are protected under various Indonesian national regulations
Excluded	Secondary Mangrove Forest	Mangroves are protected under various Indonesian national regulations
Excluded	Secondary Swamp Forest	PV power development must not encourage deforestation, forests are protected under Indonesian government regulations
Excluded	Plantation Forest	PV power development must not encourage deforestation, forests are protected under Indonesian government regulations
Qualified	Bushes	Often indicates abandoned agriculture land, pastures, or waste land.
Excluded	Swamp Mix Bushes	Unsuitable for PV power development due to swampy terrain
Qualified	Dryland Agriculture	Only areas with soil types with low agricultural value are considered (the filtering based on soil type is performed in the next step).
Qualified	Dryland Agriculture Mix Plantation	Only areas with soil types with low agricultural value are considered (the filtering based on soil type is performed in the next step).
Excluded	Paddy Field	Unsuitable for PV power development by administrative regulations
Excluded	Aquaculture / Fishpond	Unsuitable for PV power development
Qualified	Farm/Plantation	Only areas with soil types with low agricultural value are considered (the

Exclusion	Description	Justification for exclusion/qualification
		filtering based on soil type is performed in the next step).
Excluded	Settlement/Developed Area	This land areas are better treated in the GHS Built-up dataset, described in the next steps. Therefore areas with this class were excluded.
Excluded	Port / Airport	Unsuitable for PV power development
Excluded	Open Area	In JAMALI region, areas are localized only in high altitudes, unsuitable for PV power development
Excluded	Mining Area	Unsuitable for PV power development due to industrial activity and air pollution
Excluded	Savanna	In JAMALI region, areas are localized only in high altitudes, unsuitable for PV power development
Excluded	Waterbody	Unsuitable for PV power development
Excluded	Swamp	Unsuitable for PV power development

The results are shown in Figure 6– the areas in green are considered further, and the areas in red are excluded.

The land cover layer is limited in the fact that it does not necessarily reflect the current use of the land, as discussed above. However, the data has been obtained from the Indonesian authorities and hence can be considered up to date. Therefore, the layer is fully suitable for the pre-feasibility assessment undertaken within this project.



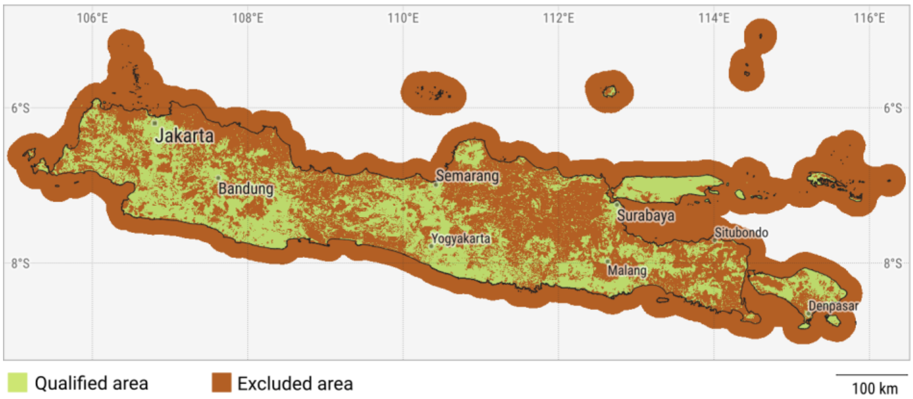


Figure 6 - Land cover classes, based on PL dataset (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.4. Built-up areas

This layer is aimed at exclusion of settlements and urban areas. The analysis is based on the GHSL[27, 28], GHS-BUILT-S dataset. The spatial raster dataset depicts the distribution of built-up surfaces, expressed as number of built-up square meters in a raster cell (here considered as dataset with 3 arcsec i.e. approx. 90m resolution). In this case, the usual value for urban space in the cities exceeds 2000, in built-up rural areas 1000. Value 500 often represents scattered settlements, with reasonable space between the built objects. Values below 100 represents areas with sparsely built-up objects.

The areas with the value 400 and above were excluded from further evaluation. This ensures exclusion of land which is undeveloped but serves a function within the settlements – e.g. city parks or village common greens.

The source dataset and the results are shown in the Figure 7 maps the areas in green are considered further, and areas in red excluded.

The data in this layer refers to the year 2020, and therefore it is likely that it may contain outdated information in some locations. A layer of built-up areas based on cadaster records, or similar source would likely provide higher accuracy, however, it was not possible to obtain such layer within the scope of the project.

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[27] European Commission, GHSL Data Package 2023, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-68-02341-9, doi:10.2760/098587, JRC133256

[28] Pesaresi M., Politis P. (2023): GHS-BUILT-S R2023A - GHS built-up surface grid, derived from Sentinel2 composite and Landsat, multitemporal (1975-2030)European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/9f06f36f-4b11-47ec-abb0-4f8b7b1d72ea, doi:10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA

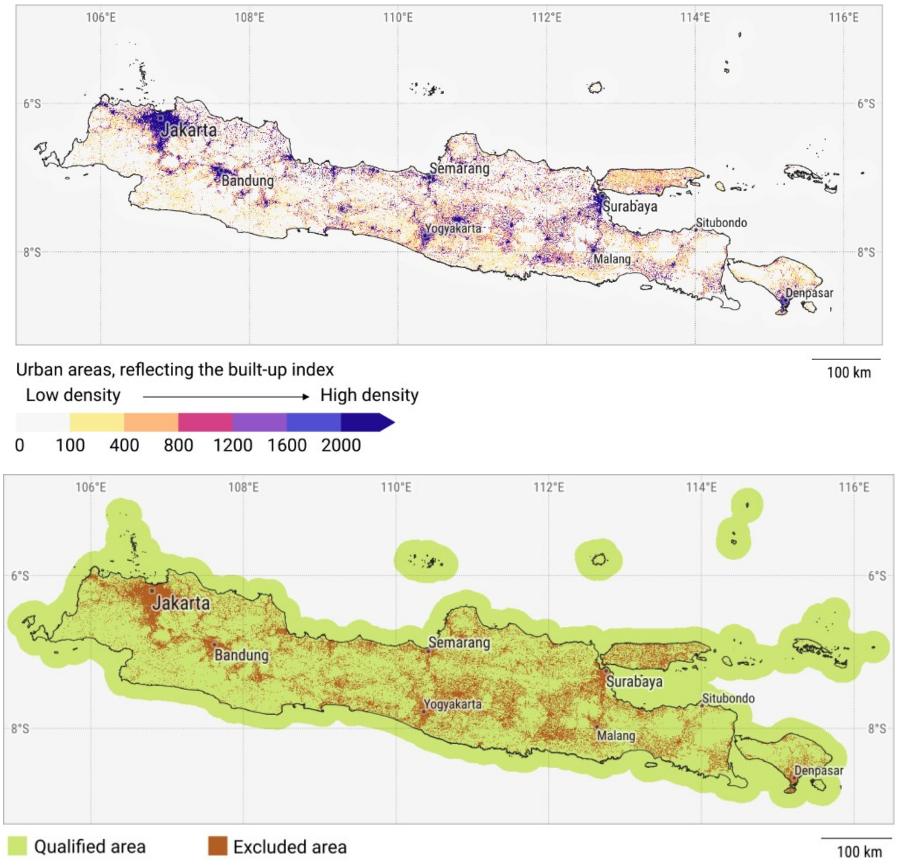


Figure 7 - Localization of the urban areas based on quantification of built-up index, derived from GHS dataset (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.5. Additional forestry data

Slight disagreements were found during the detailed comparison of the implemented land cover data with forestry status data provided by the Ministry of Environment and Forestry of the Republic of Indonesia. The forests are classified in several categories, from natural parks, conservation areas, natural forests, and production forests. IAll forest areas (including the production forest) were excluded from further analysis in this step The results are shown in Figure 8 below.

This approach ensures higher fidelity of the analysis, as this layer can be considered of higher accuracy than the general land cover layer analyzed in a previous chapter.

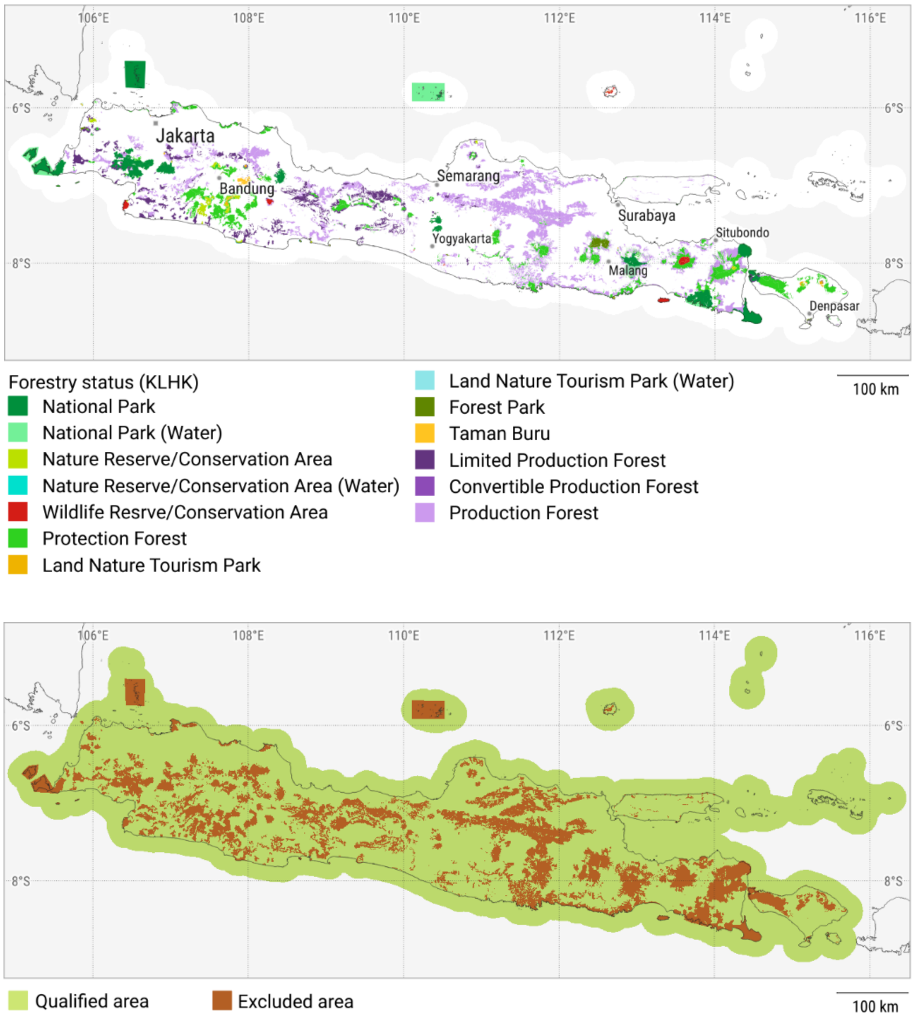


Figure 8 - Forestry status and areas (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.6. Soil types and the agricultural value

Soil types were analyzed to improve the analysis based on land cover types further and ensure that PV power development does not significantly affect agricultural production in the JAMALI region. The aim was to exclude high-quality soils and only allow PV power development on soils with lower agricultural value. This is an approach often seen in practice globally and leads to the maximum utilization of the available land. As the specific use of the land at each location selected by the MCDM is analyzed in detail in Chapters 4.2 and 4.3, the possibility of identifying productive agricultural land as suitable for PV power development is minimized.

In the analysis, the soil data and classification from the Center for Agricultural Land Resources Research and Development, Ministry of Agriculture, was used. In the JAMALI region, the soil typology involves 10 soil types with major extent, which for the purpose of MCDM were classified as follows:

- Excluded from further consideration: Molisols, Grumosol, Gleisol, Oksisol, Aluvial, Mediterranean, Andosol
- Qualified for further consideration: Kambisol, Podzolik, Regosol

The soil type layer was obtained at a rough scale (1:1,000,000) and hence cannot be considered very accurate. However, this is plausible for the pre-feasibility stage assessment within the scope of this project.

The maps shown in Figure 9 below illustrate the spatial distribution of the soil types and resulting masks. Areas in green are considered further, and areas in red are excluded.

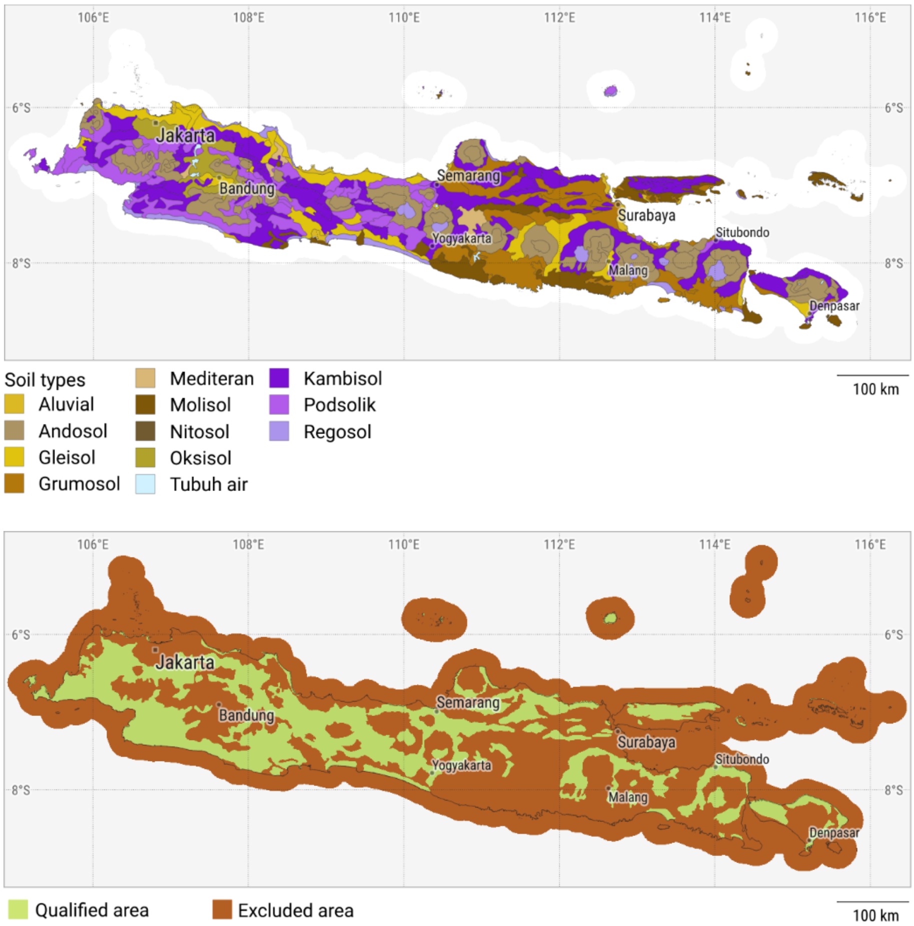


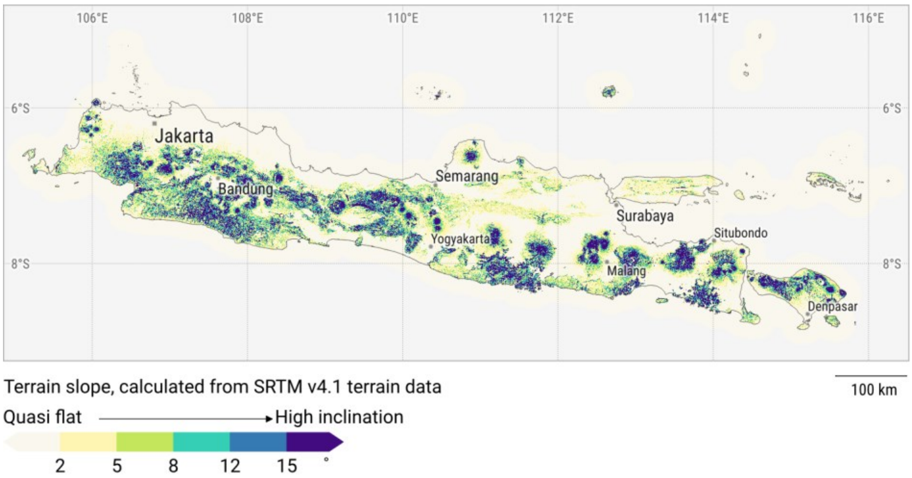
Figure 9 - Soil types, based on data provided by Ministry of Agriculture (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.7. Terrain slope

In tropical climates with high precipitation, areas with steep terrain are liable to soil erosion. Clearing large areas for PV power development on inclined terrain significantly increases the risk of such phenomena. Hence, terrain with a slope over 15° was excluded from further consideration.

The terrain data originates from SRTMv4.1 and was further post-processed by Solargis. Slope data were calculated at a resolution of 3 arcsec (nominally 90 m). The accuracy of the dataset is sufficient, and this layer is suitable for pre-feasibility assessment and analyses in the later project stages of PV power development.

The terrain slope data and the results are shown in Figure 10 below – the areas in green are considered further, and areas in red are excluded.



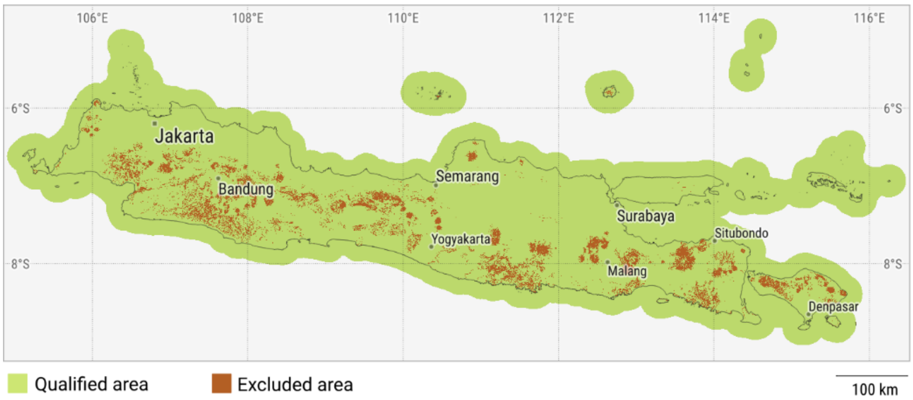
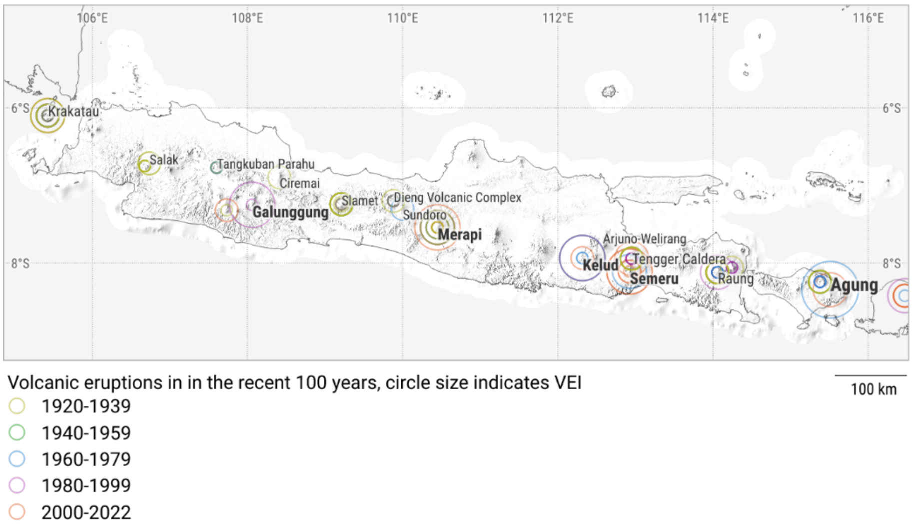


Figure 10 - Terrain slope, calculated from SRTM v4.1 terrain data (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.8. Volcanic activity

The islands of Java and Bali have active or dormant volcanoes, which naturally pose a significant risk to PV power. For this reason, the volcanic activity was analyzed, and the impacted areas were excluded. The analysis is based on data from the Global Volcanism Program. All recorded events in the recent 100 years in the JAMALI region are transformed into a point database. Based on the VEI (Volcanic Eruption Index) attribute, the exclusion zones were estimated in proximity to active volcanoes. The results are shown in Figure 11.

The exclusion zones in this layer are based on past data and, hence, do not necessarily cover all future zones impacted by volcanic activity. However, as the analyzed dataset spans 100 years, documented data offers a good indication of the spatial distribution and magnitude of the volcanic activity in the area. The dataset is suitable for the pre-feasibility analysis. Localization of a larger PV power project in proximity to a potentially active volcano always deserves a separate study, reflecting the state-of-the-art state of the tectonic processes.



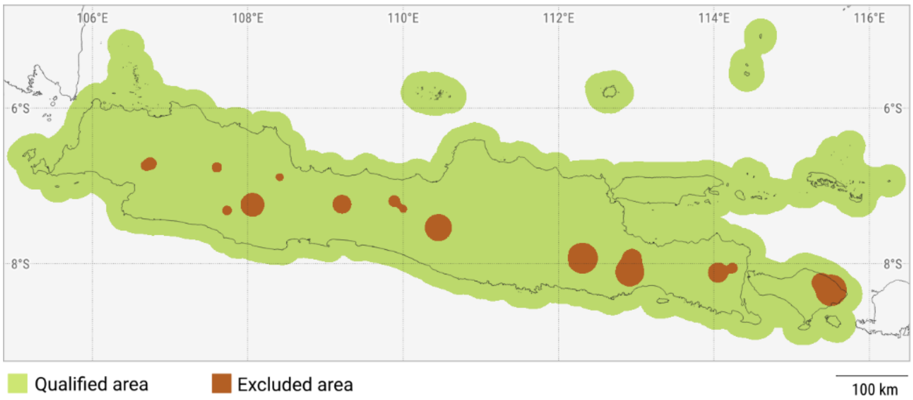


Figure 11 - Volcanic activity in the recent 100 years, based on Global Volcanism Program (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.9. Natural reserves, protected areas, and key biodiversity areas

Natural reservations and other protected areas are naturally unsuitable for PV power development. Two principal data sources were used for the identification of such areas:

- WDPA: The World Database on Protected Areas[29] with any IUCN status
- Key biodiversity areas[30]

All areas with any level of protection were used to map exclusion zones, and an additional buffer of 0.5 km along the boundary of each area was added to the exclusion zone. The outline of the areas and the partial result for MCDM are shown in Figure 12 below.

[29] UNEP-WCMC and IUCN (2024) Protected Planet: The World Database on Protected Areas (WDPA), 03/2024, Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

[30] BirdLife International (2024). The World Database of Key Biodiversity Areas. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. Available at www.keybiodiversityareas.org. [Accessed 4/6/2024].

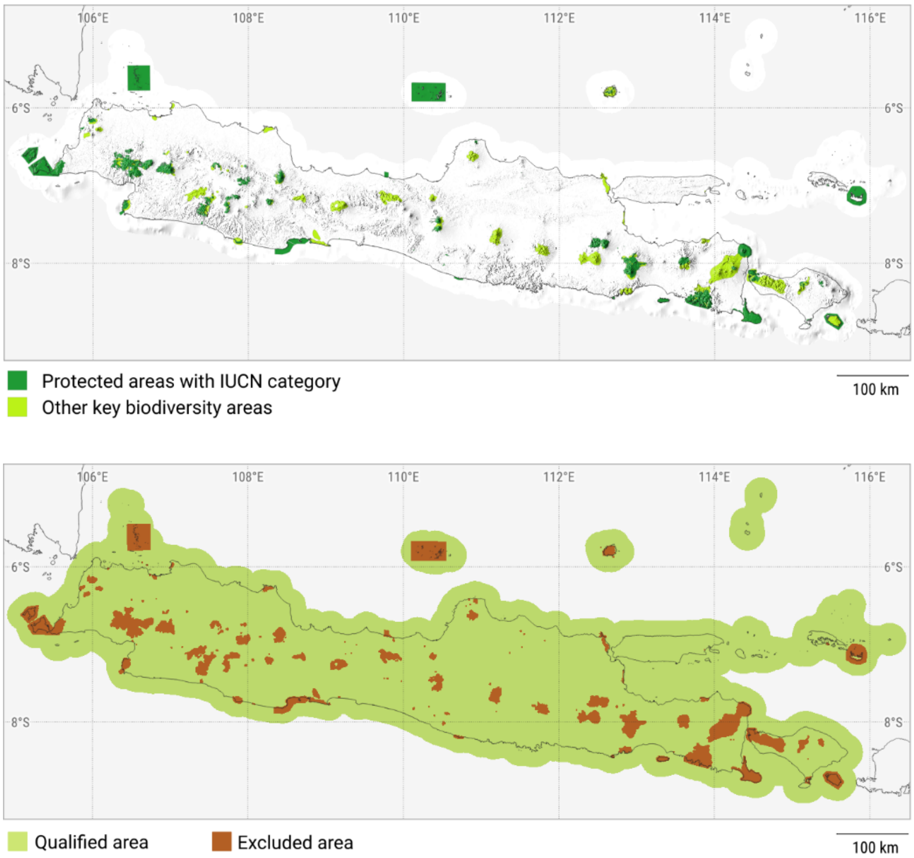


Figure 12 - Protected areas and key biodiversity areas (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.10. Indigenous peoples' territories

Indonesia protects the territories of indigenous peoples, making them unsuitable for PV power development. To address this, an additional buffer of 0.5 km was extended along the boundaries of all areas in the source dataset. The results are shown below—the areas in green are considered further, and the areas in red are excluded.

The dataset was obtained from BRWA—Customary Area Registration Agency (an official Indonesian source). Therefore, it can be considered high-accuracy and suitable for analysis in all lifecycle stages of a PV project.

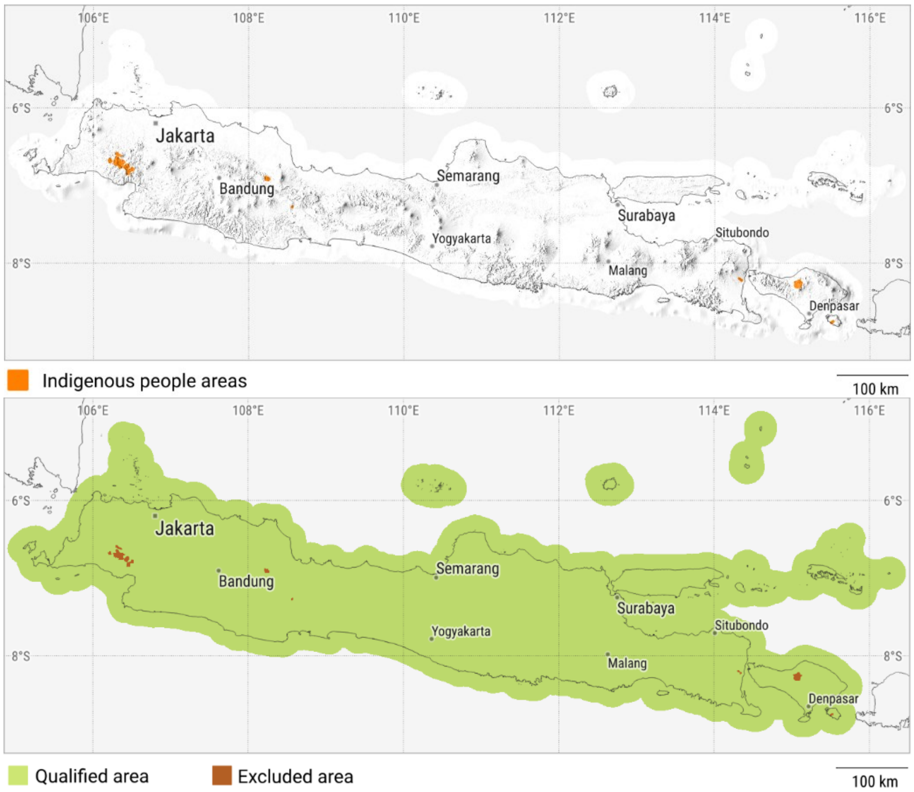


Figure 13 -Location of indigenous people areas (top); Qualified and excluded areas based on the specified criteria (bottom)

4.1.1.11. Cultural heritage sites

Indonesia has a list of cultural heritage sites that are protected by law. Any PV development in their vicinity or directly impacting them must be avoided. All areas in the source dataset were extended by an additional buffer of 0.5 km along their boundaries. The results are shown Figure 14—the areas in green are considered further, and areas in red are excluded.

The dataset was obtained from the Geospatial Information Agency, an official Indonesian source. Therefore, it can be considered high-accuracy and suitable for analysis in all lifecycle stages of a PV project.

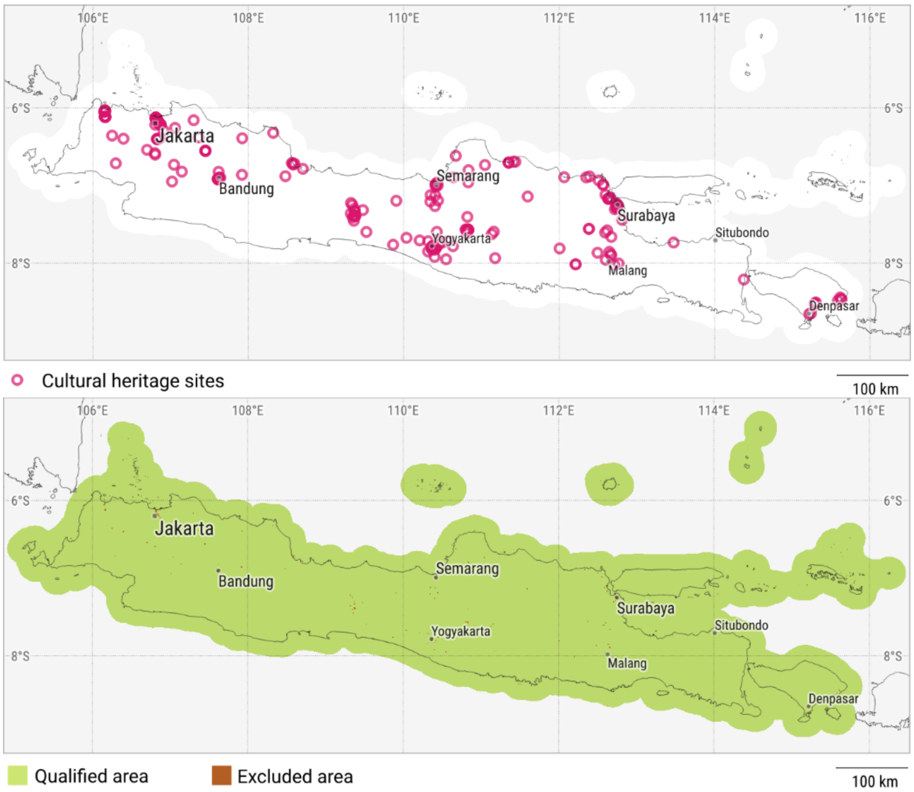


Figure 14 - Location of cultural heritage sites (top); Qualified and excluded areas based on specified criteria based on the specified criteria (bottom)

4.1.1.12. Binary layers composite

Finally, all binary layers described in the preceding sections are integrated. Only areas that meet the criteria in all previously analyzed aspects are deemed qualified. Conversely, if an area fails to meet any single exclusion criterion, it is considered unsuitable for utility-scale PV development and excluded.

The extent of the qualified areas is approximately 9% of the land area of the JAMALI region. The final result is shown in the map below Figure 15- the areas in green are considered further in the analysis using the range layers (score), and areas in red are excluded.

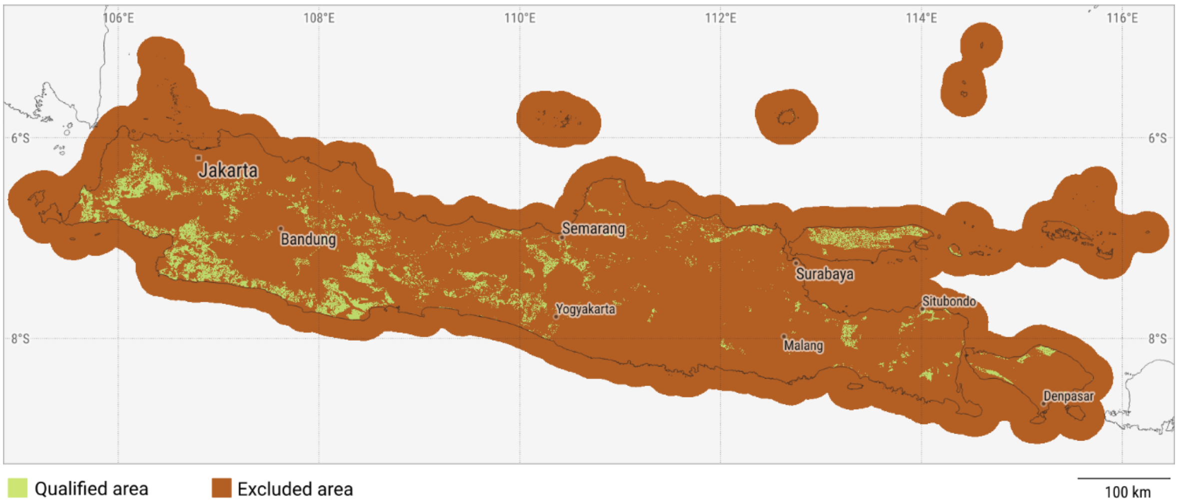


Figure 15 - Composite layer, showing qualified and excluded areas based on all specified criteria

4.1.2. Range layers

After applying the exclusion zones of the binary layers, the suitability of PV power development was investigated through a number of parameters affecting the expected productivity, the costs of construction and operation of the PV power plants, and specific risks to the power plants. Each range layer scores the whole area of JAMALI, recalculated by the normalization formula for custom ranges to the range of 0 – 1, and the individual results are presented in the following sections.

4.1.2.1. PV power production potential

The PV power potential (PVOUT) is the most important indicator affecting the suitability of any area for PV development. For scoring, the same PVOUT data were used as described in Chapter 4.1.1.1, calculated by Solargis PV simulation algorithms, using Solargis solar resource and meteorological data. The simulation assumed a standard utility-scale PV power plant configuration with fixed-tilt PV module mounting. The mounting angle is set such that the yearly tilted irradiation on the PV module is maximized. Although this configuration may not reflect the configuration of the PV power plants that will be built in the JAMALI region, it allows for a comparison of the sites across the region while keeping the computational complexity and time reasonably low. A detailed PV yield assessment will be needed for any PV project being developed at a later stage.

Based on the PV calculation results, we found that the PVOUT in the JAMALI region ranges approximately from 1,000 to 1,800 kWh/kWp. By applying the normalization formula for custom ranges to the range 0 – 1, we calculated the final score for the layer. The results are shown in the map below Figure 16 - the dark red areas have the highest scoring, while the white areas have the lowest.

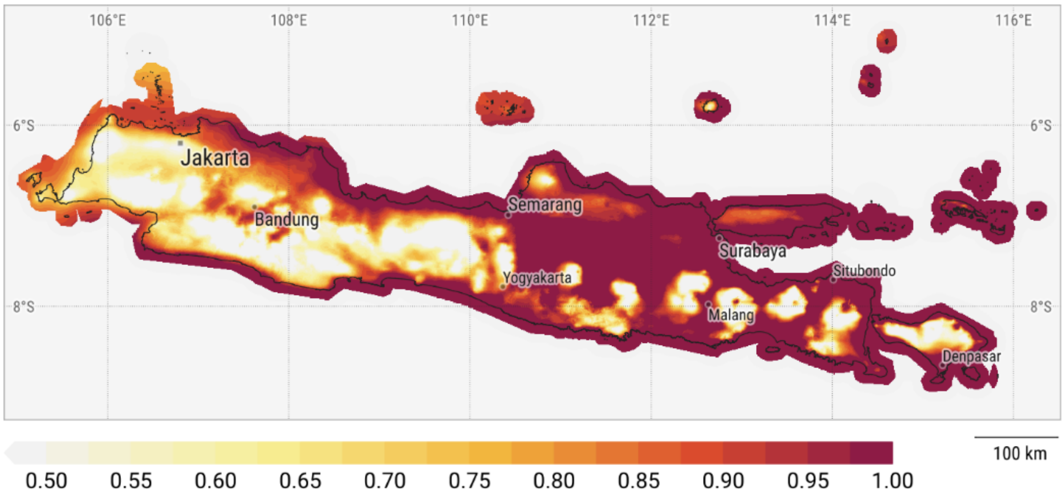


Figure 16 - Scoring of the areas based on PVOUT

4.1.2.2. Short-term variability of solar resource

Solar resource intermittency is a perceived problem in tropical regions, including JAMALI. If PV power production is intermittent, the integration of the power plants into the grid is more complex and consequently costly. Therefore, it is advantageous to locate the PV project in areas with lower variability of solar resources. Alternatively, in regions with high intermittency, it is recommended that PV projects be distributed spatially, supported by a sensitivity analysis.

Here, the magnitude of short-term variability of solar resources is evaluated based on the occurrence of solar ramps[31]. Solargis Time Series of Global Horizontal Irradiance (GHI) values with 10-minute time resolution for the recent four years are used to count the number of solar ramps exceeding 400 W/m^2 within 10-minute intervals. The calculated annual average value serves as an index of intermittency – how often will the PV power plant see irradiance ramps of the order of 400 W/m^2. The areas with the lowest count of these irradiance ramps are then considered to have lower variability and are hence preferred.

The layer results are shown in the map below Figure 17 – the dark red areas have the highest scoring, while the white areas have the lowest.

The main limitation of the data layer is that it is constructed based on 10-minute source data. The real intermittency experienced at any site can be larger, as solar resource intermittency is driven by high-frequency phenomena at the scale of minutes or even tens of seconds. However, as the layer is used only for comparing different areas in the JAMALI region, it is used as an indicator, and it is sufficient for the pre-feasibility study.

[31] Juraj Betak, Martin Opatovsky, Konstantin Rosina, Marcel Suri, 2024: Global Patterns of Solar Resource Short-Term Variability Based on Solargis Time Series Data. EUPVSEC 2024 Proceedings. In press.

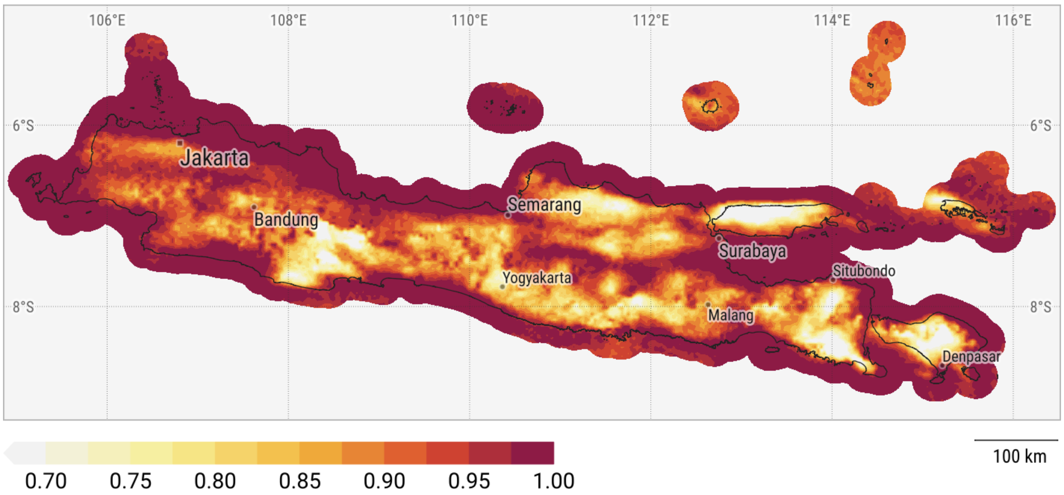


Figure 17 - Scoring of the areas based on the evaluation of the intermittency of the solar resource (10-minute variability of the global horizontal irradiance)

4.1.2.3. *Terrain slope*

High terrain slopes pose difficulties for PV power plant construction and maintenance due to problems with physical access. In the previous steps (Chapter 4.1.1.7), areas with terrain slopes above 15° were already excluded. In this step, lower-lope areas are further prioritized for utility-scale PV development.

The layer results are shown in the map below Figure 18 - the dark red areas have the highest scoring, while the white areas have the lowest.

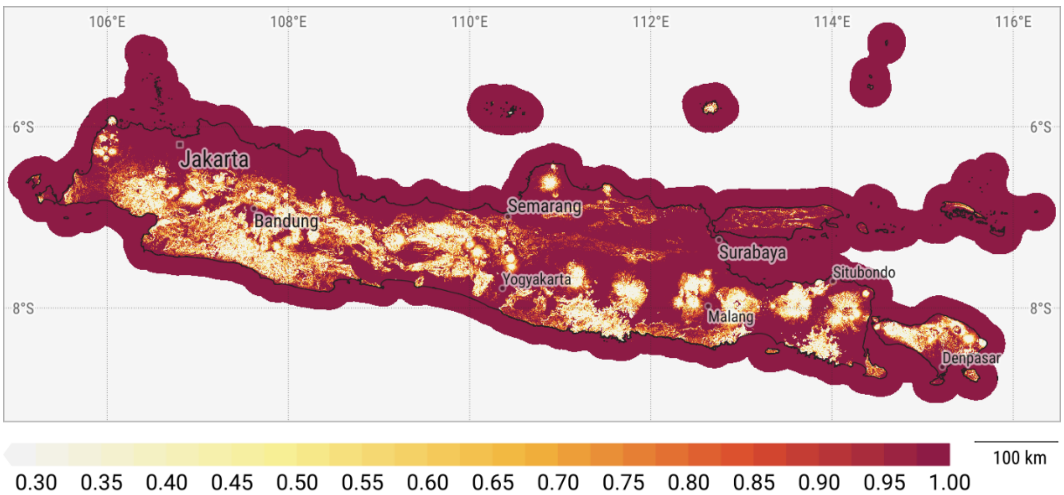


Figure 18 - Scoring of the areas based on the evaluation terrain slope

4.1.2.4. *Terrain complexity*

In addition to the terrain slope, heterogeneous terrain (e.g. fine structure of valleys and hills) poses technical challenges for utility-scale PV deployment. This specifically involves complex spacing of the PV modules, backtracking issues, but often also accessibility of the constructions and more demanding maintenance. Therefore, PV developers prefer more homogeneous terrain areas.

The terrain complexity index is calculated using a geostatistical approach involving moving window statistics. It is based on terrain data derived from the SRTM v4.1 dataset, with a resolution of 3 arcsec (nominally 90 m), and performed by Solargis. Figure 19 indicates that the central and southern parts of the region predominantly feature more heterogeneous terrain, whereas the northern parts contain more areas with quasi-homogeneous terrain.

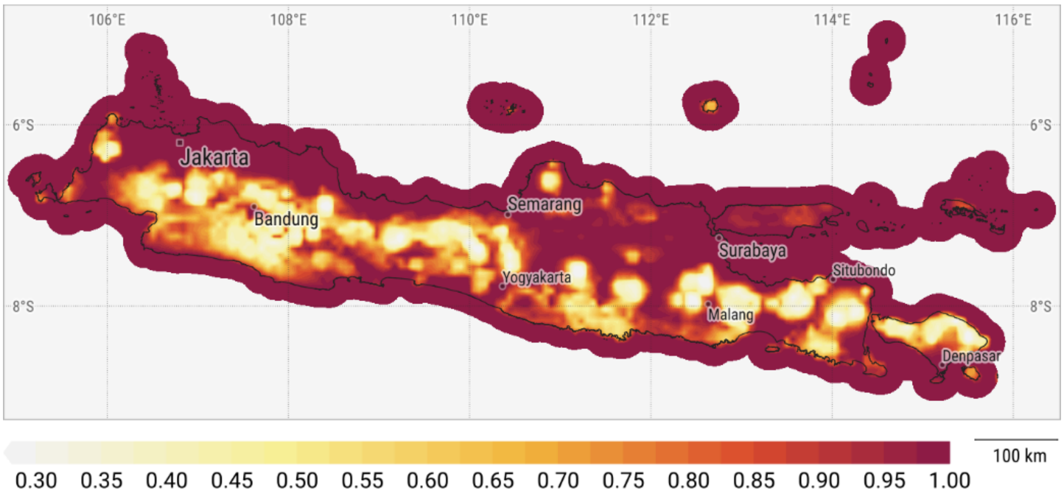


Figure 19 - Scoring of the areas based on the evaluation terrain complexity

4.1.2.5. Accessibility by road

Accessibility of land by road is key during PV power plant construction and operation, as it drives the costs of transport of material and personnel. In this analysis, the distance to the roads was evaluated. The roads data layer is derived from OpenStreetMap dataset. Highways, primary, secondary, and tertiary roads (paved roads) are prioritized in the scoring. Other unclassified roads (involving mostly unpaved roads) are also considered but with a lower score.

The layer results are shown in the map below Figure 20 - the dark red areas have the highest scoring, while the white areas have the lowest. Essentially, the JAMALI region features a high-density road network, and only some areas have limited transport access.

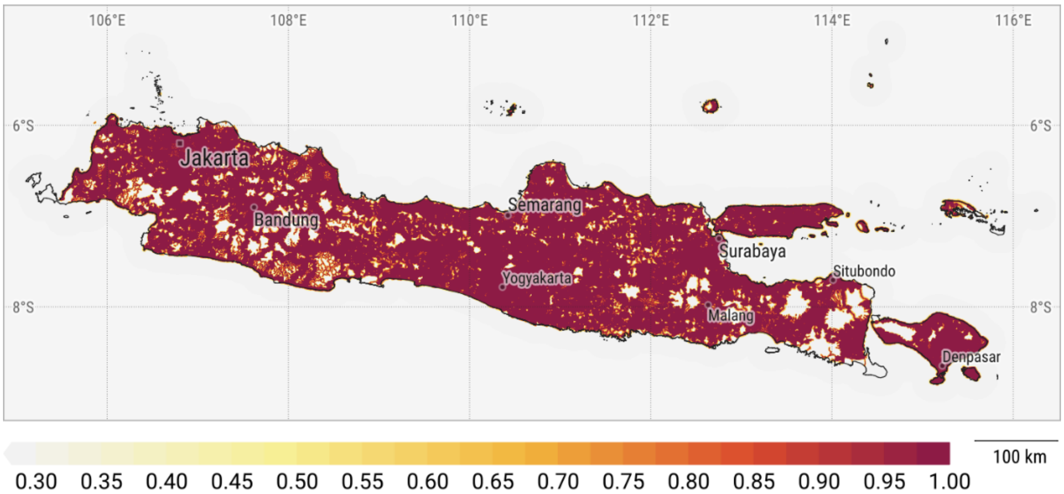


Figure 20 -Scoring of the areas based on the accessibility to roads

4.1.2.6. Seismic and volcanic activity

Seismic and volcanic activity are risk factors for PV power plants, as they can damage the installed technology. Structures and PV modules situated near earthquake epicenters are more likely to experience damage than those located in seismically stable areas.

For the evaluation of this data layer, the data from the USGS Earthquake Hazards Program was pre-processed. We considered epicenters of earthquakes with a magnitude of 3 or higher that have occurred in the past 30 years and combined this information with active volcano point data, as described in Chapter 4.1.1.8.

Based on the magnitude of the earthquake and the Volcanic Eruption Index (VEI), the point data were transformed into a score array with the kernel density estimation method. The resulting as shown in Figure 21 that the most stressed areas occur in the southwest part of the JAMALI region. In general, most of the southern coast experiences higher tectonic stress than the northern part.

This layer is based on past data and, hence, does not involve all future events induced by tectonic activity. The dataset is suitable for the pre-feasibility analysis. Localization of a larger PV power project in proximity to a potentially tectonically active area always deserves a separate study, reflecting the state-of-the-art knowledge of the tectonic processes.

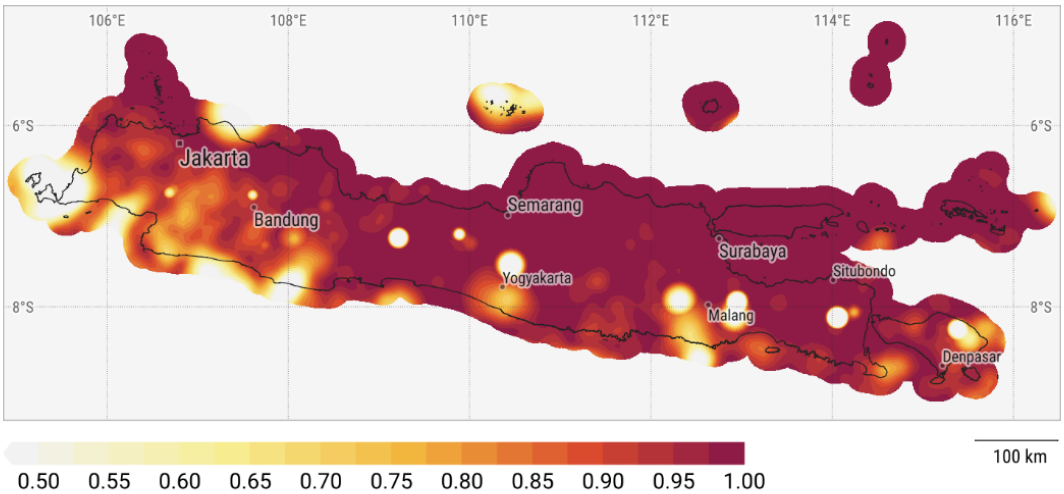


Figure 21 - Scoring of the areas based on the evaluation seismic and volcanic activity

4.1.2.7. Range layers composite

The analyzed range layers, as described in the sections above, were combined to produce an overall map of preferred areas for PV development in the JAMALI region. The combination was performed as a weighted average of the layers. The weights (shown in Table 7) were assigned based on the relative importance of the parameter to the efficiency of PV power production and the cost of development, operations, and maintenance of a plant. The weights were assigned based on expert know-how and experience with similar projects, assessing the impact of each parameter on the feasibility of PV power development.

Table 7 - Range layer weight

Layer	Weight
PV power production potential	1.0
Short-term variability of solar resource	0.8
Terrain slope	0.5
Terrain complexity	0.5
Accessibility by road	0.8
Tectonic activity (seismic and volcanic)	1.0

The overall score is illustrated in the map Figure 22. Dark red areas represent the highest scores, while white areas indicate the lowest scores. The highest-scoring areas are predominantly located along the northern coast and the north-central part of the region, from Semarang to Surabaya, including Madura Island.

Lower scores are typical for mountainous regions, which are often characterized by lower PVOUT yields and complex terrain features.

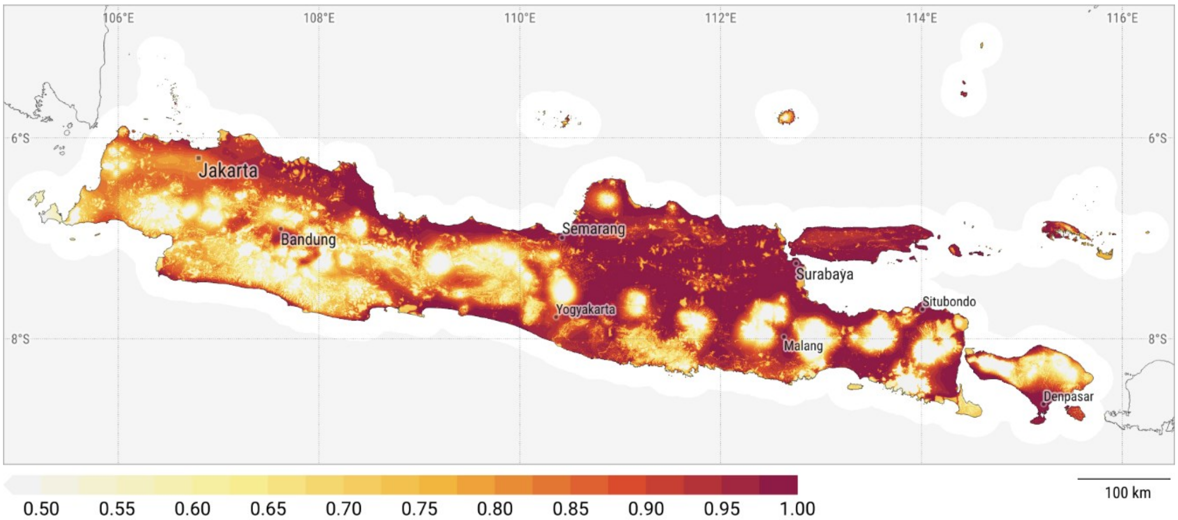


Figure 22 - Calculated score for utility-scale PV development. Higher scores present more favorable areas

4.1.3. Results of the spatial analysis and the pre-selection potential sites

After performing the separate analyses of binary and range layers, the two results are combined to obtain the final map of the preferred areas for utility-scale PV development as shown in Figure 23.

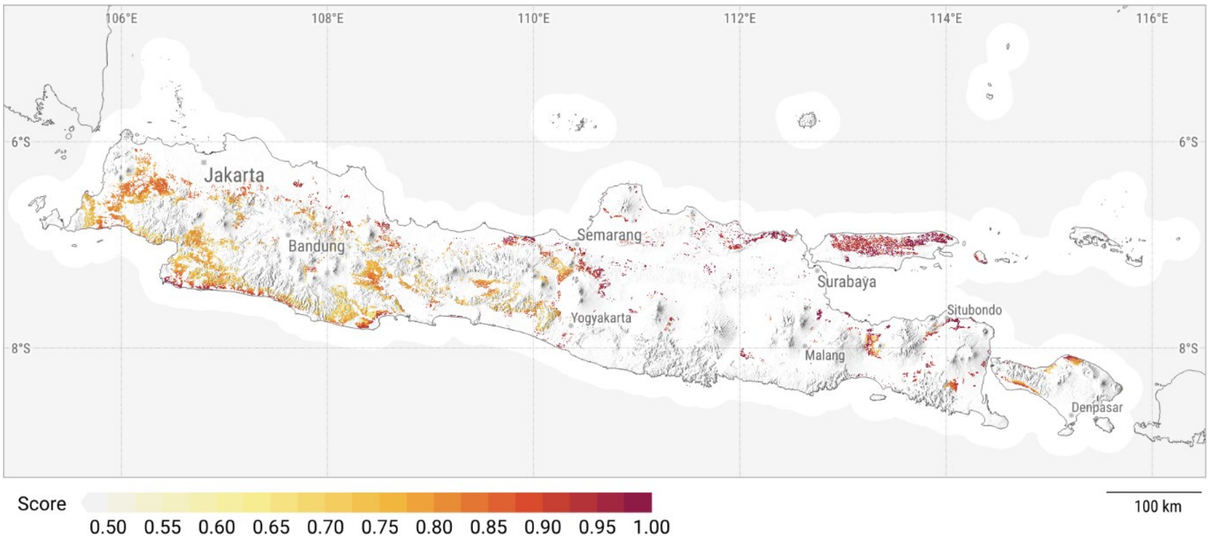


Figure 23 - Geospatial analysis result

Within these areas, 140 potential sites were identified. This selection of sites aims to facilitate at least a total of 1 GWp of PV installed capacity (a minimum of 10 MWp per site). The potential sites were selected considering the final score in the qualified areas. The second important criterion was the dispersion of the potential sites across the JAMALI region to reduce the burden on the infrastructure. The locations were identified based on analysis of aerial imagery and (if necessary) the inspection of the more detailed terrain data. The suitability of these potential locations for PV development is further analyzed in Chapter 4.2, with the aim of validating their suitability with respect to social, economic, environmental, and legal aspects. Figure 24 illustrates the map of 140 pre-selected sites.

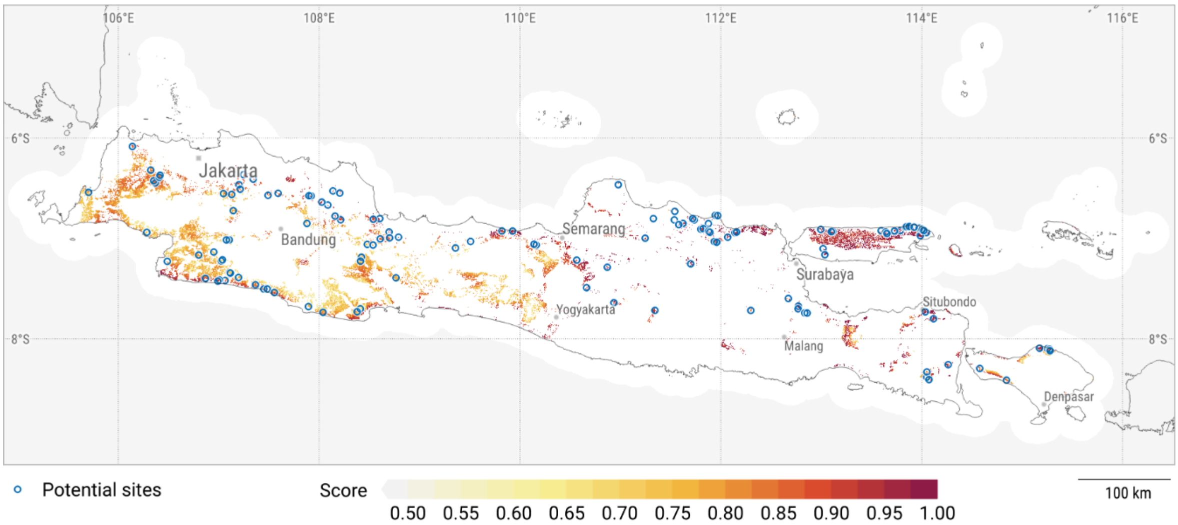


Figure 24 - Calculated score for the classified areas and 140 pre-selected potential locations for utility-scale PV development. Higher scores present more favorable areas

Additionally, a detailed land analysis was conducted for each site by defining its boundaries. Figure 25 illustrates an example of this analysis, with boundaries established using urban planning data as references. For utility-scale solar PV development, the assumption is that 1 hectare can accommodate

1 MW of solar PV. However, the actual capacity may vary based on specific environmental and technical considerations.

Figure 25 - Land border analysis example

4.1.4. Note on large rooftop PV power

Through the analysis of the data, it was found that there is a large area of commercial and industrial (C&I) rooftops available in the JAMALI region, particularly in Java. These large rooftops are extremely suitable for the development of PV power plants. Large buildings are usually close to the power demand and, hence, do not require significant infrastructure to support the power flows. Also, large buildings (specifically newer buildings) often have electricity grid capacities in their proximity.

The primary advantage of rooftop PV systems is that the land has already been developed during the construction of buildings. Consequently, there is no need for additional land transformation, preserving natural landscapes and agricultural areas that would otherwise be required for open-space PV installations. This minimizes environmental impact and optimizes the use of existing infrastructure for sustainable energy production.

Although the C&I rooftop potential of the JAMALI region deserves a separate study, we outline here some preliminary findings:

- Based on Open Buildings database[32], we filtered large buildings (exceeding 1000 m^2 of rooftop area) and identified an extensive rooftop area exceeding 375 km^2 in JAMALI region. The average confidence of the filtered buildings data exceeds 0.9 value, which is quite a satisfactory value (the confidence score indicates the certainty that the identified object is a building; the score takes values from 0 to 1, with 1 being the highest). Still, it is essential to note that this figure may be incomplete due to the absence of all large roofs, particularly those belonging to newer buildings.
- As identified on aerial imagery, the predominant type of structure is industrial buildings characterized by relatively simple and clean geometry, typically devoid of significant obstacles. This architectural profile presents favorable conditions for the deployment of PV modules.

[32] Sirko, W., Kashubin, S., Ritter, M., Annkah, A., Bouchareb, Y.S.E., Dauphin, Y., Keysers, D., Neumann, M., Cisse, M. and Quinn, J., 2021. Continental-scale building detection from high resolution satellite imagery. arXiv preprint arXiv:2107.12283.

Furthermore, relevant electrical grid capacities and infrastructure are presumed to already be present within the industrial zones.

A conservative estimate of the technical PV power potential for the assessed 375 km² of C&I rooftop area, which is about 57% Jakarta's total area, suggests a capacity exceeding 37.5 MW. This figure represents the theoretical PV capacity. However, not all buildings and rooftop areas can be fully utilized due to various technical constraints and obstacles. Consequently, the practical PV potential would be lower, yet it would still significantly surpass the 1 GW target of the PV installed capacity in this study. According to NREL, for commercial buildings, about 60% of the rooftop area can be utilized for PV systems, and for Industrial buildings, around 70-80%, according to the type of rooftop and the utilization[33]. Assuming 60% of the rooftop is utilized as suggested, the potential capacity will exceed 22.5 MW. Further studies are necessary.

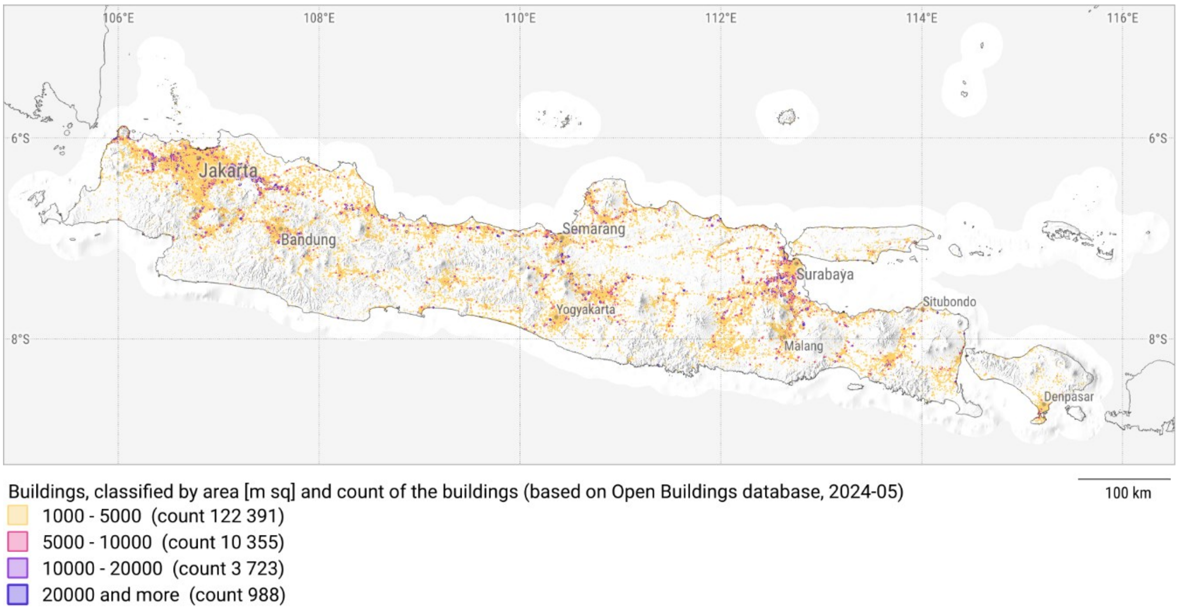


Figure 26 - Distribution of the large roofs with the area larger than 1000 m2 across the JAMALI region, processed from Open Buildings database

4.1.5. Note on floating PV power

Floating Solar PV systems on water bodies in dam reservoirs are an opportunity to increase renewable energy. This opportunity is needed to overcome land limitations because the lack of land can be a barrier to the development of solar PV installations. In addition, public opposition to the land acquisition process is a significant obstacle to the economic scalability of solar PV installed capacity.

Based on data from the Directorate of New and Renewable Energy, the Ministry of Energy and Mineral Resources has identified a potential for Floating Solar PV of 11,913 MW in 28 hydropower locations in reservoirs and lakes, of which 1,783.4 MW is in the JAMALI region. The analysis of the National Electricity Supply Business Plan (RUPTL) 2021-2030 and Comprehensive Investment and Policy Plan

[33] P. Gagnon, R. Margolis, J. Melius, C. Phillips, and R. Elmore, "Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment," National Renewable Energy Laboratory, Tech. Rep. NREL/TP-6A20-65298, Jan. 2016. Available: https://www.nrel.gov/docs/fy16osti/65298.pdf.

(CIPP) document highlights that solar PV floating the most for clean energy technologies development planning. Data from the Central Java Energy and Mineral Resources Agency states that of the 42 reservoirs spread across Central Java, there is technical potential for Floating PLTS with a capacity of 723.07 MWp. Two reservoirs out of 10 reservoirs with the highest technical potential have been included in the floating solar PV proposed location at RUPTL 2021 - 2030, namely Wonogiri Reservoir (100 MW) and Mrica Reservoir (60 MW).

Table 8 - Reservoirs locations and capacity

Name	Location	Coordinates		Est Capacity (MW)	Area Coverage (ha)	Source
		Latitude	Longitude			
Wonogiri Reservoir	Central Java	-7.88683565	110.9022503	100	7,360	RUPTL PLN 2021-2030
Sutami Reservoir	Karangkates, East Java	-8.17266059	112.461194	122	7,900	RUPTL PLN 2021-2030
Jatiluhur Reservoir	West Java	-6.51923518	107.3483012	100	7,780	RUPTL PLN 2021-2030
Mrica Reservoir	Banjarnegara, Central Java	-7.38478926	109.6228277	60	1,250	RUPTL PLN 2021-2030
Saguling Reservoir	West Java	-6.917686	107.406212	60	5,606	RUPTL PLN 2021-2030
Wonorejo Reservoir	Tulung Agung, East Java	-8.01792172	111.7962749	122	3,850	RUPTL PLN 2021-2030
Total Capacity and Coverage Area				**564**	**33,746**	
Malahayu Reservoir	Central Java	-7.03560000	108.8084277	4,08	7,000	ESDM Central Java
Wadaslintang Reservoir	Central Java	-7.58488889	109.7859555	76,89	1,320	ESDM Central Java
Klego Reservoir	Central Java	-7.36082222	110.7014083	3,97	68	ESDM Central Java
Kedung Ombo Reservoir	Central Java	-7.27277778	110.8200000	267,95	4,800	ESDM Central Java
Butak Reservoir	Central Java	-7.17694444	111.1180555	0,47	45	ESDM Central Java
Simo Reservoir	Central Java	-7.20157778	111.0981694	0,37	60	ESDM Central Java
Logung Reservoir	Central Java	-6.75842222	110.9225194	5,15	88	ESDM Central Java
Songputri Reservoir	Central Java	-7.99138889	110.82861111	0,47	8	ESDM Central Java
Total Capacity and Coverage Area				**359,35**	**13,389**	

Regulation from Ministry of Public Works and Housing 2/2024 states that up to 20% of the reservoir surface can be used for solar PV applications with reasonable studies and permits conducted. And, according to the Minister of Public Works and Housing Regulation No.7 of 2023, if the proposed floating solar PV is more than 20% use of the reservoir surface, it will require additional approvals from Dam Safety Commission. There are five main permits of several permit categories that require more attention when planning, as shown in Figure 27 below. These five permits can be processed separately, but the environmental permit needs to be processed first as a basis for processing other permits.

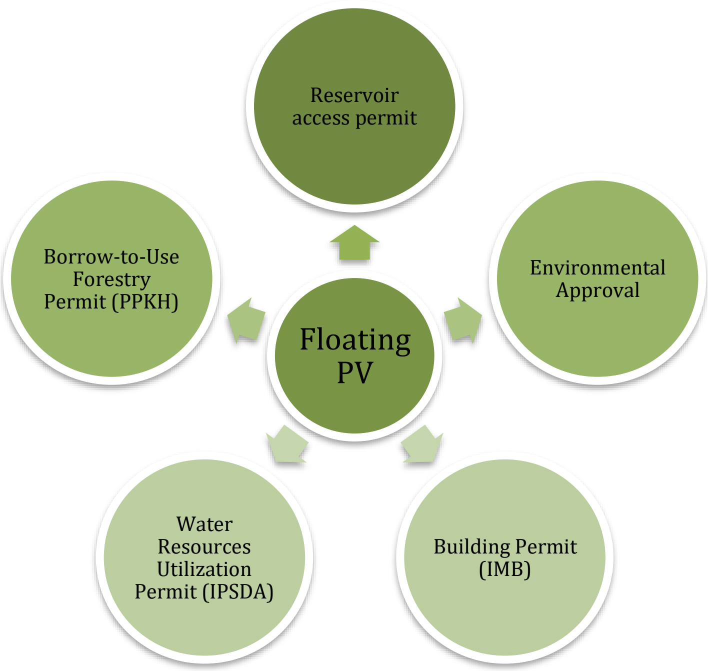


Figure 27 - Permits required for floating PV

With a minor extension, the 1 GWp target of this study could be accomplished wholly by using floating PV power. However, as this requires additional permits or even legal changes, it is not covered by this study. A separate study focusing only on floating PV power should be undertaken in the future.

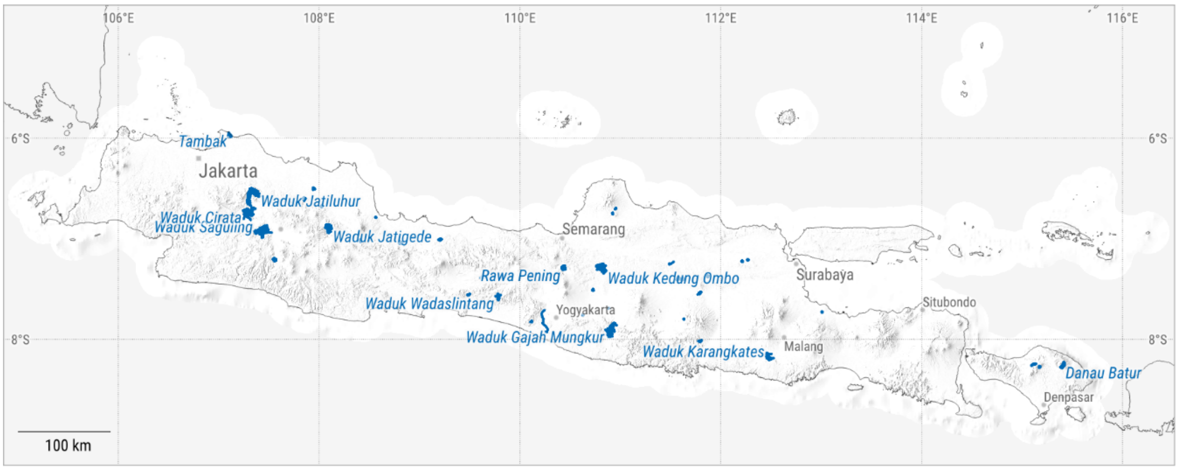


Figure 28 - Water reservoirs in the JAMALI region

Deploying large-scale floating solar PV systems on reservoirs used by local communities for fishing or recreation could lead to conflicts over resource use. Besides that, a significant portion of Java's suitable freshwater bodies are used for drinking water, irrigation, and aquaculture. Deploying large-scale floating solar PV systems on these reservoirs could compete for this vital resource and potentially impact water quality. Consequently, engaging with stakeholders and ensuring equitable benefits from these projects is important for social acceptance.

Limitations also come from an environmental perspective. Floating solar PV systems can change water temperature, light penetration, and oxygen levels in reservoirs, thereby potentially impacting aquatic ecosystems. Studies are needed to assess long-term ecological impacts and develop mitigation strategies.

For the same capacity value, floating solar PV has a greater initial investment value than ground-mounted solar PV. The cost of constructing floating platforms, anchoring systems, and specialized inverters for waterborne installations is significantly higher than that of ground-mounted systems. This can be a barrier to initial project development, especially for smaller-scale deployments.

4.2. Environmental and social assessment

This section presents the results of the E&S assessment. Thanks to a non-GIS analysis approach, the purpose of this E&S assessment is ultimately to rank the pre-selected sites and exclude unsuitable sites thanks to environmental, social and legal screening and defined scoring parameters.

4.2.1. Scoring parameters

1. Environmental, social and legal screening

The step identified social, economic, environmental, and regulatory aspects that could not be integrated into the GIS analysis. This high-level screening clarified the E&S considerations required across the selected sites that have been checked as per Environmental and Social Analysis and the regulatory analysis can be found in List of Relevant Regulations
The analysis focuses particularly on all the regulations in place to prevent E&S risks that can have consequences on mangrove areas, forestry, cultural heritage zones, rice fields, key biodiversity areas, and Indigenous territories. The screening results are divided into parameters described in the section below.

2. Environmental and social parameters

First of all, only relevant IFC performance standards (PSs), i.e., IFC PS 5 to IFC PS 8, are used for the sites' E&S assessment. Indeed, those PSs are mostly applicable at the early stage of a project to determine the risk category, whereas PSs 1 to 4 do not apply to the E&S study at this stage; they pertain to ongoing projects. Table 9 provides the key requirements of each IFC performance standard that have been selected for this preliminary study.

In the assumptions and limitations of the application of the IFC standards, it is essential to note that PS 5 recognizes that project-related land acquisition and restrictions on land use can adversely impact communities and persons who use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) that can happen as a result of project-related land acquisition and/or due to restrictions on land use. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement. This occurs in cases of (i) lawful expropriation or temporary or permanent restrictions on land use and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.

Lastly, due to the high-level approach in terms of the E&S approach for the site selection and limited information on the details of current land condition and land acquisition process, it is to the consultants' assumption that the assessment will not go further into detail on the information of any specific land acquisition and resettlement action plan and prior land acquisition process.

Considering 56.1% (according to 2020 Census by *Badan Pusat Statistik* (BPS) Indonesia) of Indonesia's population lives in the JAMALI region and the limited ground information available, the consultants took the assumption that economic activity exists in all type of land cover (agriculture, grazing land, Non-Timber Forest Products (NTFP), etc) hence, the focus on PS5 assessment was solely on physical structure in sites and the lowest category is medium. The absence of physical structures does not necessarily indicate there is no land ownership, land utilization, and future land use plans as outlined in the Regional Spatial Planning (RTRW). As such, the consultant provides high-level information on the potential physical displacement based on land cover, regional spatial planning, and desktop review of land issues.

Table 9 - IFC Performance Standards applicable for E&S analysis

Performance standards (PS)	Key Requirements
PS 5: Land Acquisition and Involuntary Resettlement	Essential requirements of the IFC PS 5 include Compensation and Benefits for Displaced Persons, Community Engagement, resettlement and Livelihood Restoration Planning and Implementation, and a Grievance Mechanism for Physical and economic displacement.
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	To ensure that biodiversity is protected and conserved, and that sustainable management and use of natural resources is used wherever feasible throughout the Project lifecycle. The key concerns required by the IFC PS6 include the protection and conservation of biodiversity through assessment and management of modified and natural habitats, critical habitat, legally protected and internationally recognized areas and invasive alien species; management of ecosystem services; management, living natural resources, and supply chain management.
PS 7: Indigenous People	Require the Project to anticipate and avoid adverse impacts on the Indigenous People, including People screening and impact assessment, maintain relationships based on Informed Consultation and participation (ICP), obtain FPIC if the Project significantly affects the Indigenous People, and promote sustainable development benefits and opportunities.
PS 8: Cultural Heritage	IFC PS8 requires sites to make efforts to protect cultural heritage from any adverse impacts of Project activities and to support its preservation. In this case, the implications of IPs are being assessed.

3. Identification of exclusion and qualified areas

The E&S screening and regulatory assessment enabled the listing of binary layers to consider in order to exclude unsuitable sites. A site in the following situation in Table 10 is to be excluded.

Table 10 - Table of binary criteria for E&S analysis

Binary criteria	Definition of the site exclusion
Forest moratorium	According to Indicative Map of Business Permit Granting Termination (Peta Indikatif Penghentian Pemberian Izin Berusaha or PIPPIB): a site located in the PIPPIB area is prohibited for any development.

	The Ministry of Environment and Forestry issue regular update on PIPPIB areas usually every six months. The reference for this screening is the latest version of PIPPIB which is 2023 period II PIPPIB based on the Minister of Environment and Forestry Decree No. SK.12764/MENLHK-PKTL/IPSDH/ PLA. 1/ 11/2023 dated 22 November 2023.
The presence of mangrove areas	Mangrove areas along with peatland is the focused of the Government of Indonesia's Forestry and Other Land Use (FOLU) Net sink 2030 in order to reduce GHG emission from foresty and land sector to increase carbon absorption. Reducing deforestation rate of mangrove area and forest are one of among 15 mitigation action plans in Indonesia's FOLU Net Sink 2030. Hence, preserving current mangrove areas will be priority to increase carbon sink.
Forestry status	the Government of Indonesia has determined Protection area in the Government Regulation no 22 of 2021 (Appendix I) where it also covers conservation forest such as wildlife and nature reserve, and national park. Those forest has main functions as preservation area on the diversity of flora and fauna and their ecosystems where activities allowed to be done is limited to those that will not disturb the purpose of the conservation ie research and development, education, and other activities supporting cultivation. Changes to the integrity of the natural reserve area includes reducing, eliminating function and width of the protection area is prohibited.
Regional spatial planning category	Each regency in Indonesia must develop a spatial planning for their area with 20 years period since the issuance of the Regional Regulation where it can be reviewed every five (5) years for update if necessary. The spatial planning serves as guidance for the regional government in regency level for the development of their area by determining area that can be developed and those that can't be developed for example to protect environment quality, or prone to natural disaster based on risk assessment. The area that is classified as prone to ground movement (protected designation area) will be unsuitable for Solar PV development hence excluded.

The E&S screening and regulatory assessment generates a list of range layers to attribute a score according to exposure to the E&S risks. The following range criteria enable scoring the qualified areas. The sites are assessed from medium to critical high-risk.

Table 11 - Table of range criteria for E&S analysis

Range criteria	Definition
Water risk	It refers to the WRI Aqueduct Water Risk Atlas, JAMALI region is classified as extremely high-water risk except in Surabaya (East Java) for overall water risk. The overall water risk measures all water related risks, by aggregating all selected indicators from physical quantity, quality and regulatory and reputational risk categories.
Presence of social forests	The Government of Indonesia issued Government Regulation no 23 of 2021 on Forestry Guidance where it also covers Social Forest. The definition of social forest is sustainable forest management system being implemented within State's forest area or Customary forest by the local community

	or indigenous people as the main actor to increase their improve welfare, environmental balance and socio-cultural dynamics in form of village forests, community forests, community plantation Forests, customary forests, and forestry Partnerships. The indicative map of social forest is updated every six months by the Minister of Environment and Forestry. The reference used is the latest indicative map through Minister of Environment and Forestry Decree no SK.8/MENLHK – PKTL/PLA.0/1/2023 dated 3 January 2023;
Population density, and potential for physical and economic displacement	IFC PS 5 stated that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Population density in Java Island is 1,317 people/sq kilometer; and
Regional spatial planning category	Area of high biodiversity value are evaluated according to World Heritage Sites (WHS), Alliance for Zero Extinction sites (AZE), Important Bird and Biodiversity Areas (IBA), Key Biodiversity Areas (KBA), Protected Areas (PA), and World Database on Protected Areas (WDPA), as well as the presence of critical habitats based on United Nations Environment Programme World Conservation Monitoring Centre (UNEP WCMC): project or activities that might be located less than 5 km and within 10 km from high biodiversity values area need to carry out further study to identify any potential impact to those areas such as in form of critical habitat assessment, biodiversity management plan, ecosystem services assessment.

4. Scoring of the qualified areas

Once each layer has been prepared as described above, it is combined to generate the final scoring and prepare the final output. Binary layers are first applied to exclude unsuitable land from further consideration. Then, the range layers are combined to produce the final scoring of the land areas of JAMALI for PV power development. Forest moratorium, presence of mangrove areas, conservation forest that is high biodiversity value areas, and areas prone to ground movement (protected designation areas) in regional spatial plan regulations are binary criteria and result in site exclusion, while water risk level, presence of social forest, parameters aligned with IFC PS 5 and presence of critical habitat (aligned with PS 6) are ranged criteria.

The cumulative total score of each site was then ranked and divided into three risk categories: Medium, High, and Critically High. The risk starts with medium and not low based on the consultants' considerations that the JAMALI region is a highly populated area (Jawa: 1,371 people/sq kilometres, Bali: 747 people/sq kilometers, and Madura: 955 people/sq kilometres) as shown in Figure 29, which leads to significant E&S risk from the project life cycle, i.e., pre-construction (land acquisition, permitting process), construction, and operation. The remaining potential sites were then analyzed and scored according to the parameters, criteria, and associated risks described in Table 12.The final output scores the qualified areas on a scale from the least risky to the riskiest for E&S analysis for PV development.

The parameters and considerations are summarized in the scoring parameters presented in Table 12.

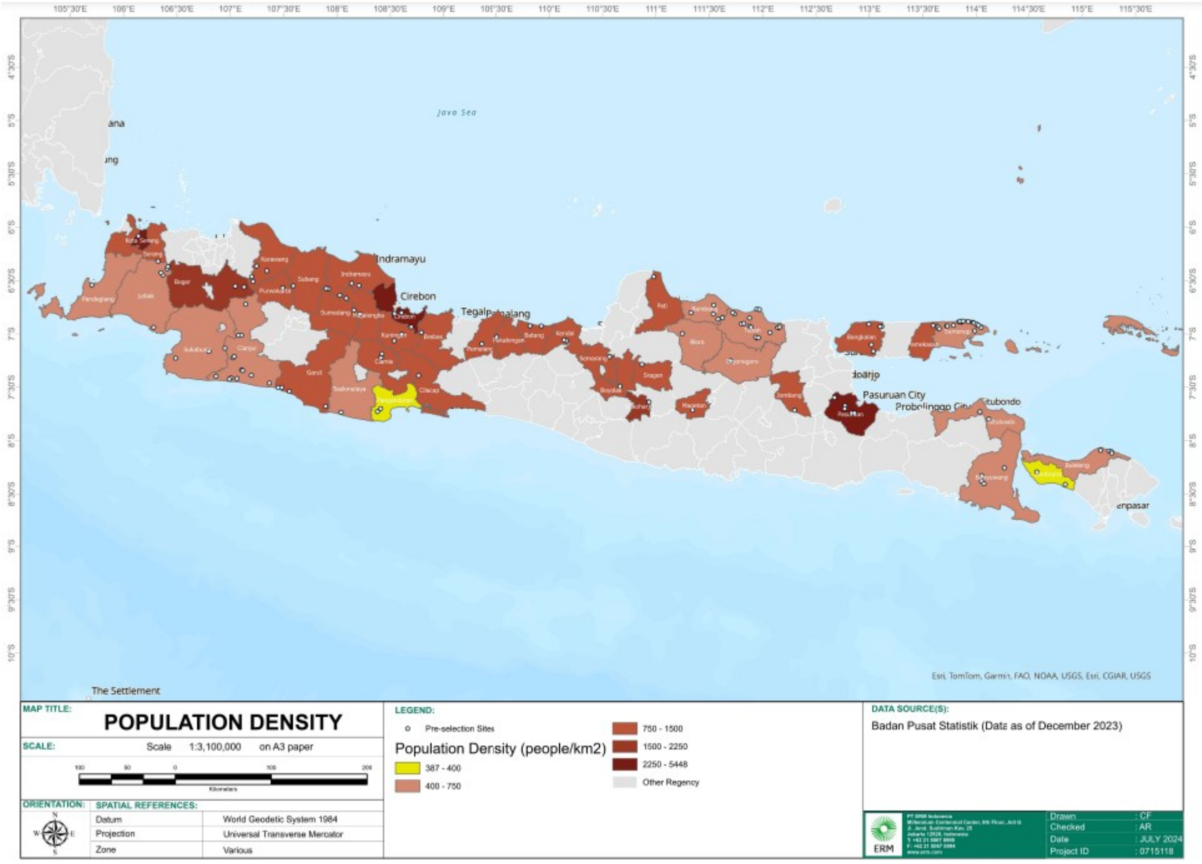


Figure 29 - JAMALI population density

Table 12 - Scoring parameters table

Risk rating					
Parameters	**Criteria**	**Medium Risk**	**High Risk**	**Critical High Risk**	**Exclusion**
Regulatory review	**Regional Spatial Plan Category**	Industrial Area, Other Use	Holticulture, Farm/Moor, Food Crops, Dryland Agriculture, Community Plantation, Tourism, Mining, River Border Area, Wetland Agriculture	Residential Area, Riverbank, Green Open Space, Water Catchment Area, School Area, Rice Field, Farm Forestry, Agricultural Area	Prone to Ground Movement Area (Protected Designation Area)
	Forestry Status	Other use	Limited production Forest, Production Forest	Protection Forest	Conservation Forest
Environmental Screening	**Water Risk**	Low to Low-Medium water risk in WRI Water Atlas	Medium-high water risk in WRI Water Atlas	High to extremely high-water risk in WRI Water Atlas	-

	Social forest surrounding project area	Located outside indicative map of social forestry	Located adjacent to permitted social forestry area	Have permitted for social forestry utilization	-
Performance Standard 5	**Presence of Physical Structures and Public Facilities**	Available maps shows no physical structure	Available maps shows physical structure	Available maps shows physical structure and located near public facilities	-
Performance Standard 6	**UNEP WCMC Global Critical Habitat, trigger critical habitat**	Unclassified	Likely	Potential	-

4.2.2. E&S Results

Based on the final scoring, the potential sites are classified as 96 sites with medium risk, 41 with high risk, and 3 sites excluded. None obtained a score to be considered critical high risk.

Before providing explanations per category of sites, it is critical to notice that, overall, as the JAMALI region is a densely populated land, it raised concerns about livelihood and physical and economic displacement, resulting in the complexity of the land-acquisition process. Additionally, a factor that increased the scoring of risk exposure of the site is the WRI Aqueduct Water Risk Atlas. Indeed, the JAMALI region has a high to extremely high overall water risk. The physical risks include water stress, water depletion, interannual variability, seasonal variability, groundwater table decline, riverine flood risk, coastal flood risk, and drought risk. The physical risks quality includes untreated connected wastewater and coastal eutrophication potential.

The results are available in Annex D

4.2.2.1. Excluded sites

Out of 140 potential sites screened using geospatial analysis, 3 sites were excluded due to their location in protected areas prone to ground movement as identified in the regional spatial plan (RTRW). This exclusion is identifiable and determined using data that could not be integrated into the previous geospatial analysis.

4.2.2.2. Medium risk sites

Out of the remaining 137 potential sites that were not excluded, 96 sites were categorized as medium risk, with scores between 8 and 9. In addition to being located in high-water risk areas in the JAMALI region, these potential sites fall under medium-risk spatial plan categories such as horticulture, food/crop/agriculture areas, estates, farmland, tourism areas, business areas (rock mining, oil and gas), plantations, and production forests as stipulated in the regional regulations for the respective areas.

4.2.2.3. High risk sites

Out of the remaining 137 potential sites, 41 were categorized as high risk with scores ranging from 10 to 12. In addition to being located in high water risk areas in the JAMALI region, the potential site falls under this category is located in high-risk spatial plan category, such as water catchment areas, land and security areas, residential areas, and relatively higher population area which pose more complex risk on land acquisition. The potential sites are also located in areas that have been identified as potential global critical habitat areas or may trigger critical habitat, according to UNEP-WCMC. This results in requirements for ground truthing and extensive Critical Habitat Assessment in the area, according to the requirement of international standards (i.e., IFC PS 6 2012) for permitting requirements and compliance with lender requirements, respectively.

4.2.2.4. Mitigation actions of E&S risks

The results of the E&S analysis indicated that among the qualified 137 sites, 96 sites are exposed to medium-risk and 41 to high-risk. For future considerations of the site for solar PV development, the consultants elaborated a initial high-level list of actions point to mitigate the risks. The summary of the analysis together with the mitigations actions can be found in Table 13

Table 13 - Summary of E&S results

Risk Category	Description	Results	Action point
Excluded	Significant E&S Risk, ineligible for financing or investment due to their significant, irreversible, or unacceptable environmental and social risks and impacts Considerations for exclusion are as follows: - Moratorium of permit issuance (PIPPIB) - Mangroves Area - Key Biodiversity Area - Protected Area in Spatial Plan	**3 sites**	No Go site
Critical High Risk	**Critical High Risk** Sites with potentially significant gaps with relevant international standards of IFC PS 6 and IFC PS need further detailed studies on biodiversity, pro prolonged thorough studies, and complex land acquisition processes, respectively. **In addition, the site may pose a higher social conflict with the surrounding community. Sites may pose adverse environmental and social risks and diverse, irreversible, or unprecedented impacts.**	**0 site**	Requires initial environmental and social risk screening for site selection. Requires Due Diligence, including Site visits and development of Mitigation action (ESMP) should the site be selected.

High Risk	**High Risk** Sites with potential significant gaps with relevant international standards of IFC PS 6 and IFC PS5 might need further detailed studies on biodiversity and prolonged, thorough studies and complex land acquisition processes, respectively. **The site may pose limited adverse social or environmental impacts that are generally beyond the site boundaries, largely reversible, and can be addressed through relevant mitigation measures.**	**41 sites**	Requires Due Diligence, including Site Visit and development of Mitigation action (ESMP)
Medium	**Medium Risk** Sites with potentially significant gaps to IFC PS5 might need prolonged, detailed studies and complex land acquisition processes. **Site may pose moderate environmental and social risks and impacts, largely reversible, and readily addressed through mitigation measures.**	**96 sites**	Requires Due Diligence with potential site visit and development of Mitigation action (ESMP)

4.3. Grid integration assessment

Grid integration assessment is conducted to ensure that the system does not compromise grid stability. Fortunately, for the JAMALI case, electrical grid conditions will not be a significant constraint in selecting the site for 1 GW PV development. Integrating 1 GW PV into a 30 GW+ system in the JAMALI region, which is only around 3% of its size, will not cause any significant impact. Furthermore, since this 1 GW PV will be distributed across more than 100 sites, each site will have a minimum capacity of 10 MW. Typically, these sites will be connected via a 20 kV line to a high-voltage (HV) substation using a 20/150 kV step-up transformer, or if they exceed 10 MW, they will be connected directly to the substation. The distributed locations of these plants will also not cause any significant impact since one HV substation has a capacity of around 250 MVA, and there are more than 400 substations in the JAMALI system. Therefore, from the electrical system perspective, only proximity to PLN substations is considered in this part. A detailed grid impact assessment to analyze the integration of 1 GW PV into the JAMALI system will be conducted in the next deliverable.

4.3.1. Preliminary Grid Integration Assessment

A preliminary grid assessment is conducted as follows to confirm that the JAMALI system can absorb 1 GW of PV in 2030 before proceeding to the next steps. This simulation assumes the demand in 2030.

For this preliminary grid impact assessment purpose, a solar irradiation profile is obtained from the Solargis. This source provides solar irradiation data with 10 10-minute time steps in 10 points in JAMALI as shown in Figure 30.

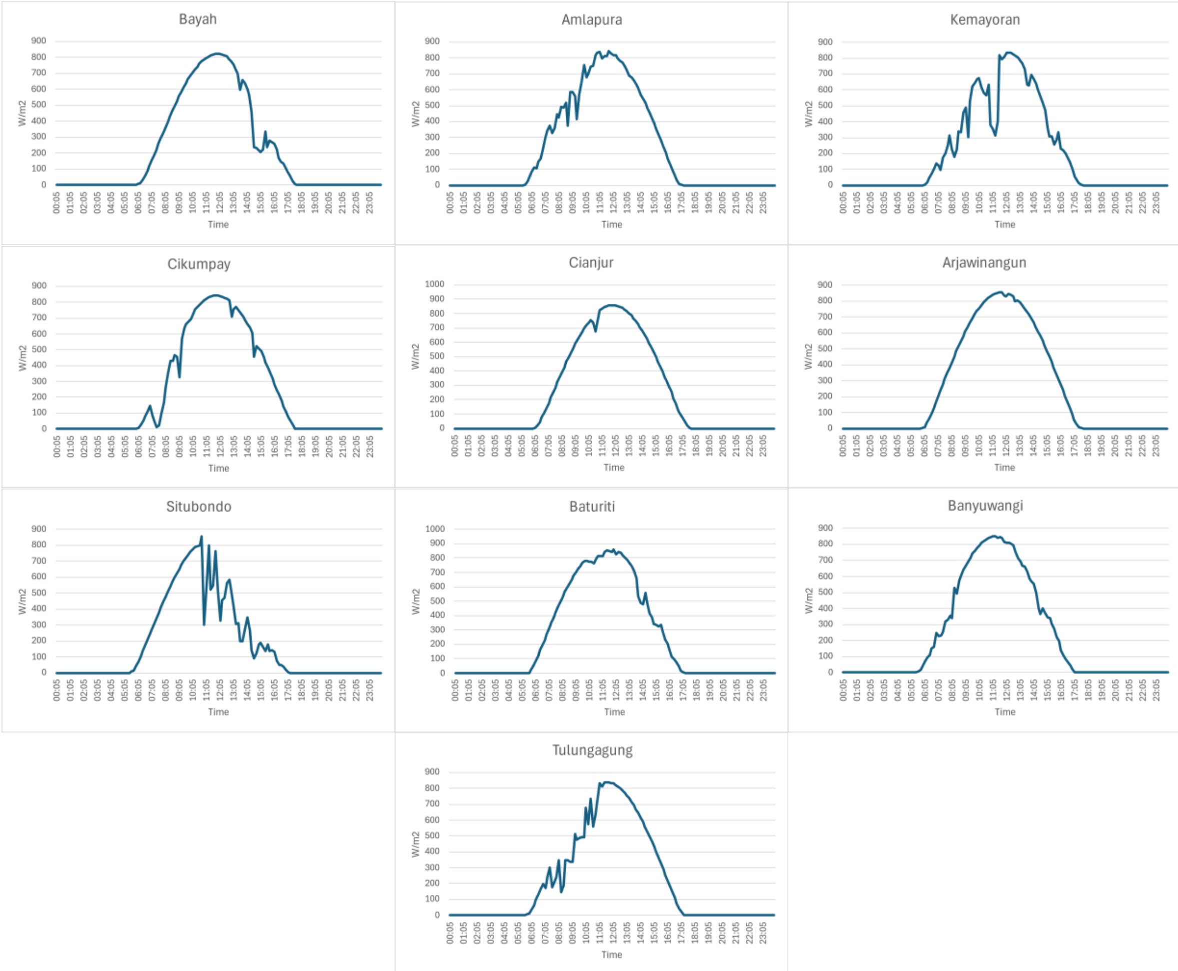
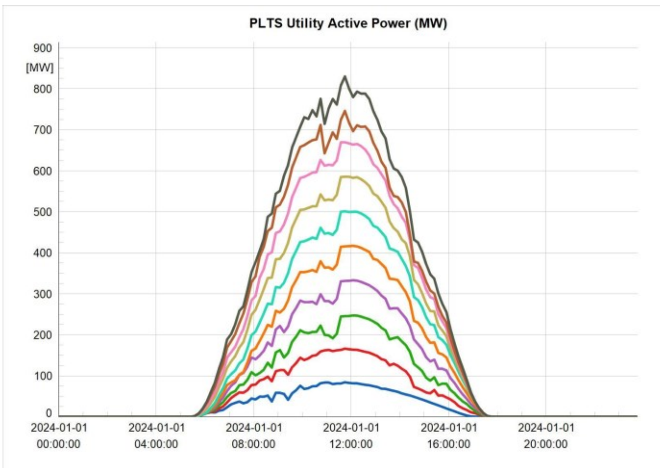


Figure 30 -Solar Irradiance in 10 selected locations

The simulation will utilize the measurement data in a day. For simplicity purposes, 1 PV plant size is assumed to be 100 MW, hence there will be 10 sites. Since 10 sites of 100 MW PV will have a bigger impact compared to 100 sites of 10 MW, this simulation can be considered as representing a worse condition than the actual.



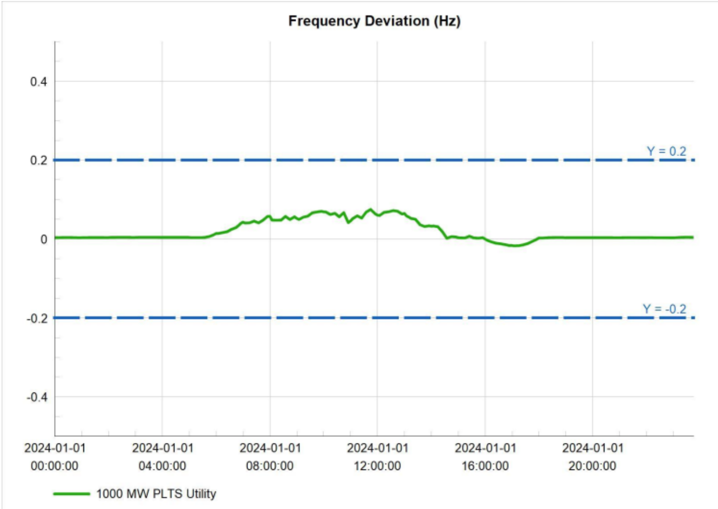


Figure 31 -Utility active power and frequency deviation of 10 PV sites

The graph in Figure 31 above show a stacked solar irradiation profile of 10 PV sites and the frequency response when those 10 PV sites of 100 MW are fluctuation simultaneously. The frequency result shows that its deviation is still within the allowable and safe operation range stated in the grid code, which is ±0.2 Hz.

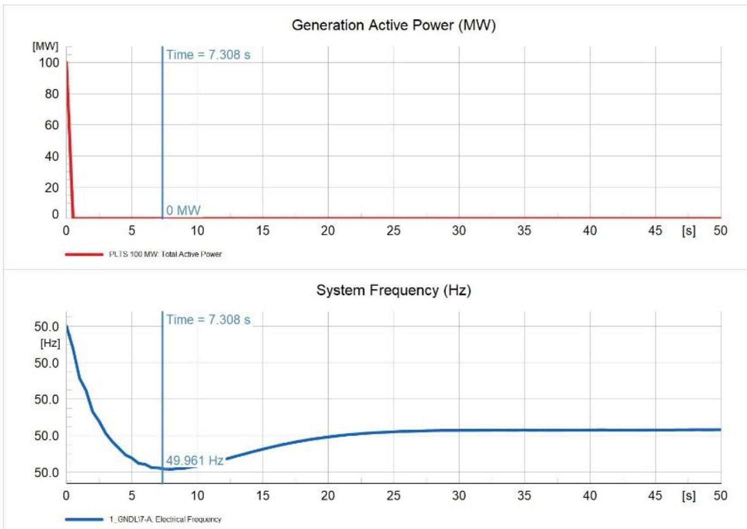


Figure 32 - System frequency simulation

The graph in Figure 32 above shows system frequency when 1 PV site of 100 MW suddenly trips. This represents the worst case that may happen to a single PV site. The result shows that the frequency drops to 49.961 Hz, which is still above the allowable frequency range stated in the grid code, Grid Code chapter OC 3.1, which is ±0.5 Hz.

The results show that injecting 1 GW PV with the composition of 10 sites of 100 MW into the Jamali system will not cause the system to violate any limitation stated in the grid code. Therefore, it can be concluded that the Jamali system is able to absorb (more than) 1 GW of PV since the result is still far within the allowable limit.

4.3.2. Maximum Hosting Capacity

While land availability is a crucial factor in determining potential solar PV capacity, another critical consideration is grid stability. Once a site is selected and an E&S analysis is performed, it is imperative to analyze it from a grid stability perspective. This ensures that the injected solar PV does not compromise grid stability, necessitating an understanding of the maximum hosting capacity. Therefore, land availability and the maximum hosting capacity per substation are the two primary constraints in determining potential solar PV capacity. The maximum solar PV hosting capacity refers to the maximum amount of solar PV that can be injected into a specific substation without disrupting grid stability.

Additionally, although the selected sites are distributed throughout the JAMALI region, some sites are connected to the same substation. This requires a clustered site analysis based on their respective substations. Even if individual sites do not exceed the maximum hosting capacity when considered in isolation, the aggregated capacity of sites connected to the same substation may be limited by the substation's maximum hosting capacity.

This report presents the maximum hosting capacity for the nearest substation to each selected site, encompassing 67 substations assessed. The Table 14 below details the maximum hosting capacity of these 67 substations.

Table 14 - Maximum hosting capacity for Solar PV Development

No	HubName	Maximum Hosting Capacity (MW)
1	GI 150 kV Bayah	160
2	GI 150 kV Rangkasbitung	260
3	GI 150 kV Tigaraksa	560
4	GI 70 kV Serang	145
5	GIS 150 kV PLTU Labuan	480
6	GI 150 kV Ciamis	950
7	GI 150 kV Cianjur	245
8	GI 150 kV Haurgeulis	140
9	GI 150 kV Jatibarang	270
10	GI 150 kV Juishin	420
11	GI 150 kV Karangnunggal	650
12	GI 150 kV Kutamekar	425
13	GI 150 kV Mandirancan	330
14	GI 150 kV Mekarsari	730
15	GI 150 kV Pabuaran	460
16	GI 150 kV Patuha	290
17	GI 150 kV PLTU Cirebon	380
18	GI 150 kV Purwakarta	500
19	GI 150 kV Semen Baru	510
20	GI 150 kV Semen Jawa	70
21	GI 70 kV Babakan	80
22	GI 70 kV Cianjur	245
23	GI 70 kV Kadipaten	65

24	GI 70 kV Kuningan	80
25	GI 70 kV Lembursitu	35
26	GI 70 kV Pameungpeuk	85
27	GI 70 kV Pangandaran	80
28	GI 70 kV Parakan	70
29	GI 70 kV Sumadra	100
30	GIS 150 kV PLTU Pelabuhan Ratu	60
31	GI 70 kV Sumedang	100
32	GI 150 kV Batang	1050
33	GI 150 kV Blora	50
34	GI 150 kV Jelok	180
35	GI 150 kV Kedungombo	170
36	GI 150 kV Majenang	200
37	GI 150 kV Mojosongo	1050
38	GI 150 kV Palur	970
39	GI 150 kV Pemalang	390
40	GI 150 kV PLTU Rembang	240
41	GI 150 kV Rembang	240
42	GI 150 kV Semen Indonesia	760
43	GI 150 kV Weleri	650
44	GITET 500 kV Tanjung Jati	650
45	GI 150 kV Bangkalan	230
46	GI 150 kV Banyuwangi	520
47	GI 150 kV Bojonegoro	255
48	GI 150 kV Cepu	190
49	GI 150 kV Genteng	280
50	GI 150 kV Gondangwetan	870
51	GI 150 kV Kerek	360
52	GI 150 kV Mliwang	1350
53	GI 150 kV Pier	1080
54	GI 150 kV Purwosari	850
55	GI 150 kV Sampang	680
56	GI 150 kV Sementuban	240
57	GI 150 kV Situbondo	560
58	GI 150 kV Sumenep	310
59	GI 150 kV Tanjung Awar Awar	250
60	GI 150 kV Tuban	1100
61	GI 70 kV Magetan	75
62	GI 70 kV Pandaan	90
63	GI 70 kV Siman	65
64	GI 70 kV Sukorejo	50
65	GI 150 kV Baturiti	240
66	GI 150 kV Negara	350
67	GI 150 kV Pemaron	210

4.4. Site Prioritization

The technical scoring and solar resource evaluation for site prioritization are grounded in the geospatial analysis. As detailed in the previous section, the geospatial analysis identifies preferred areas within the JAMALI region suitable for solar PV development, encompassing approximately 9% of the total area. The geospatial analysis results in a scoring system within the preferred areas, including the 140 sites. 140 sites were selected and given a geospatial analysis score between 0 and 1.

The E&S analysis determines the environmental and social risks. The E&S analysis attributes scores to these sites to identify risks, excluding three sites deemed socially and environmentally unsuitable.

Each validated site is further analyzed for land availability to determine the maximum solar PV capacity, which should be a minimum of 10 MW. Subsequently, these validated sites undergo pre-grid assessment to analyze maximum hosting capacity. The final potential capacity is constrained by land availability and hosting capacity. This part ultimately assesses the site's potential scalability. It shows that one site (S20) has a potential solar PV capacity of less than 10 MW. However, it will be included in the list of sites since if we bundle that specific site into its clustered (GI 150 kV Tuban) the capacity will exceed 244 MW.

Finally, the final score is a computation of the scores obtained in geospatial analysis, E&S analysis and pre-grid assessment and is weighted as follows:

Table 15 - Site prioritization scoring weight

	Geospatial analysis	E&S	Pre-grid assessment
Parameter	Geospatial score	E&S score	Solar PV Potential Capacity
Score	40%	30%	30%

The higher weighting assigned to the geospatial analysis (40%) compared to the Environmental and Social assessessment and the potential capacity (both at 30%) reflects the critical importance of technical feasibility and spatial suitability in the early stages of solar PV development. Here are the key reasons for this prioritization:

1. **Geospatial Analysis (40%):**
    a. **Technical Viability and Site Suitability:** Geospatial analysis rigorously evaluates the technical aspects of potential sites, including solar irradiance, topography, land use, and proximity to existing infrastructure. These factors are fundamental in determining whether a site can feasibly support a solar PV installation. By identifying areas with high solar irradiance, minimal shading, and suitable topographical conditions, geospatial analysis ensures that only the most technically viable sites are selected, reducing the risk of underperforming solar PV systems.
    b. **Comprehensive Spatial Assessment**: The geospatial analysis provides a holistic view of the entire JAMALI region, identifying the most promising areas for solar PV development. This broad spatial perspective is essential for strategic planning and optimizing the distribution of solar PV projects across the region. The ability to analyze large geographic areas and integrate multiple layers of spatial data (e.g., land use, environmental constraints, and infrastructure) makes geospatial analysis a powerful tool for site selection.
    c. **Foundation for Further Assessments**: Geospatial analysis serves as the foundation for subsequent evaluations, including ESIA and potential capacity assessments. By first

ensuring technical feasibility, the analysis streamlines the overall site selection process and enhances the reliability of further assessments. Without robust geospatial analysis, ESIA and potential capacity assessments may be conducted on sites that are technically unsuitable, leading to wasted resources and time.

2. **Environmental and Social Impact Assessment (30%):**
   While environmental and social impacts are crucial for sustainable development, these factors are often site-specific and can be mitigated through careful planning and management. The ESIA ensures that these considerations are thoroughly evaluated and addressed but follows the technical feasibility established by geospatial analysis. The ESIA provides valuable insights into the potential environmental and social risks, enabling developers to implement appropriate mitigation measures and engage with stakeholders effectively.

3. **Scalability and Potential Capacity (30%):**
   The potential capacity assessment evaluates the maximum solar PV capacity that can be installed at each site, considering land availability and grid hosting capacity. This assessment is vital for determining the scalability and economic viability of each project. By weighting this aspect at 30%, the methodology ensures that selected sites can support substantial solar PV installations, contributing significantly to Indonesia's renewable energy targets.

In summary, the higher weighting for geospatial analysis reflects its critical role in ensuring the technical feasibility and strategic suitability of potential solar PV sites. By establishing a solid foundation through geospatial analysis, the subsequent ESIA and potential capacity assessments can be conducted more effectively, ensuring that selected sites are not only technically viable but also environmentally and socially responsible and capable of supporting large-scale solar PV installations..

Each site is scored individually based on a comprehensive set of criteria, resulting in a prioritization. The final prioritization results, which are elaborated in the next chapter, "Result Analysis," provide a an overview of the potential sites for solar PV development in JAMALI. This chapter includes essential information such as:

- Cost of land
- Type of land: authorization to build / ownership situation
- Cost per connection – distance to the substation
- Advantages in terms of regulation

It is important to note that some sites will be connected to the same substation; the clustered sites are also analyzed to indicate the constraint of maximum hosting capacity per substation, and recommendations can be provided according to the site's cluster.

5. Results Analysis

This section highlights the results of three major analyses in this report: geospatial analysis, environmental and social regulatory assessment, and preliminary grid integration assessment. Following these, the output of GIS and Non-GIS MCDM, as well as site prioritization, are presented.

1. Geospatial analysis

The purpose of the geospatial analysis is to identify technically viable areas for PV development, including assessing solar irradiance across JAMALI. The output is a map highlighting preferred areas for solar PV development, showcasing technically viable locations within the JAMALI region. This map is a valuable tool for identifying potential solar PV development sites at a pre-feasibility level, with the geospatial analysis scores providing guidance on the most promising sites for development.

The study reveals that approximately 9% of the JAMALI region's land area, equating to 12,518.6 km², is ideal for solar PV development, indicating significant opportunities. The analysis also shows that the western part of Java and Madura Island has higher percentages of preferential land for solar PV development. However, further environmental and social analysis is necessary due to the limitations of the available geospatial data.

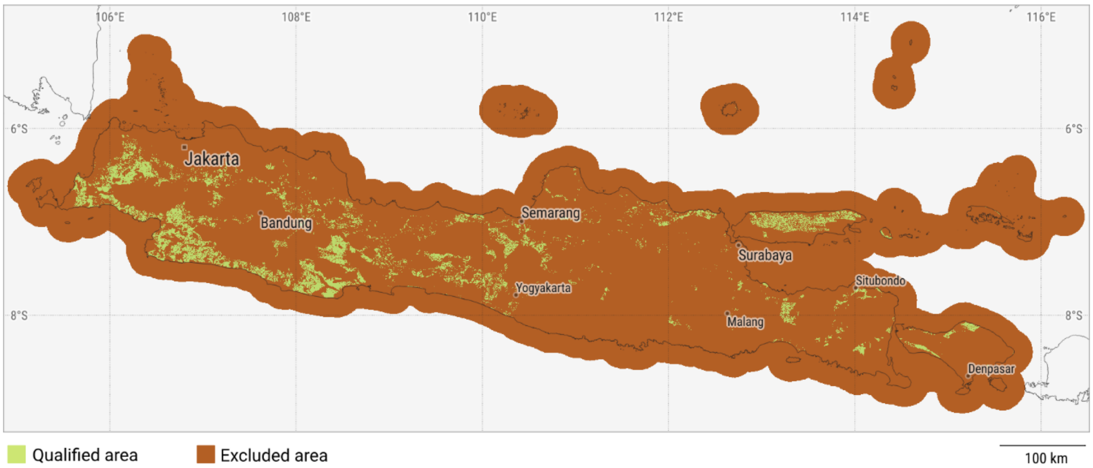


Figure 33 - Composite layer, showing qualified and excluded areas based on all specified criteria

From the preferred areas map, 140 sites have been selected, distributed across the JAMALI region. These potential sites were chosen based on their final scores in qualified areas, emphasizing geographical dispersion to lessen infrastructure strain and enhance social acceptance. Locations were identified through aerial imagery analysis and, when necessary, detailed terrain data inspection, ensuring that the sites were evenly distributed geographically to promote better integration and community acceptance (i.e. avoid the concentration of developments in just a few areas within the region). Furthermore, a land analysis was conducted to define boundaries and identify potential land availability. The results show that available areas vary from 6.99 ha to 931 ha. The result of the geospatial score for those 140 sites is shown in Annex C.

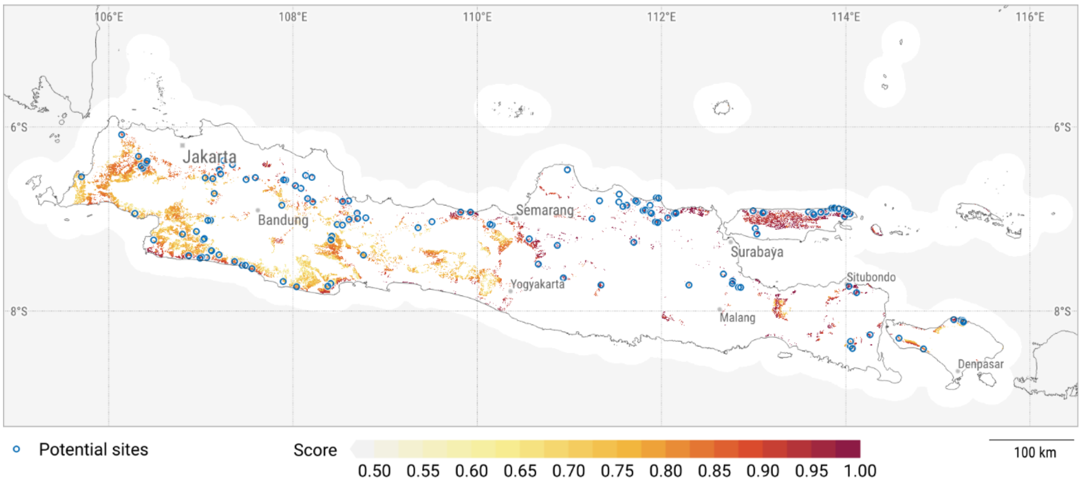


Figure 34 -Calculated score for the classified areas and 140 pre-selected potential locations for utility-scale PV development. Higher scores present more favorable areas

Figure 35 presents the average geospatial score of the selected sites per province, indicating the technical viability of these sites for solar PV development. The data shows that Central Java and East Java have higher average scores compared to other provinces. This implies that the sites in both Central Java and East Java exhibit superior technical conditions, such as optimal solar irradiance, suitable topography, and minimal shading obstacles, making them more favorable for solar PV installations.

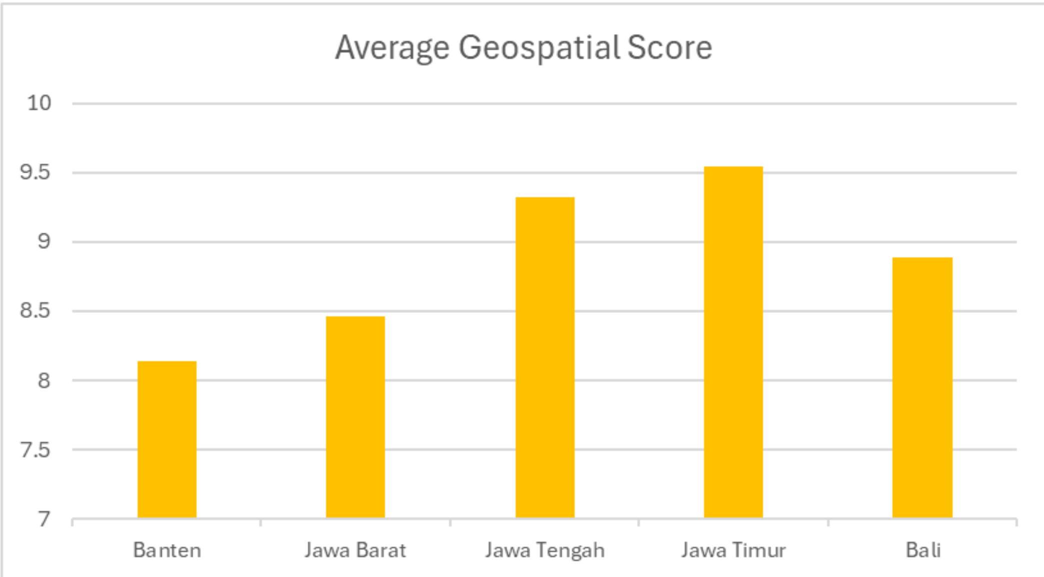


Figure 35 -Average geospatial score from selected sites per province

2. Study of environmental, social, and regulatory assessment

Out of the initial 140 potential sites identified for solar PV development, 137 sites remained after excluding three due to environmental and social concerns, specifically according to their land category based on the zoning. These remaining sites were categorized based on socio-environmental risk levels, with 96 classified as medium risk and 41 as high risk. As mentioned in Section 4.2, it is important to note the complexities associated with the Java, Madura, and Bali regions, which are densely populated and face challenges such as livelihood, physical, and economic displacement. Additionally, these areas exhibit high to extremely high overall water risk according to the WRI Aqueduct Water Risk Atlas. Therefore, no area within the JAMALI region is considered low risk for solar PV development.

The exclusion of three sites out of 140 demonstrates that the results from the geospatial analysis are robust enough as a prefeasibility study for identifying potential utility-scale solar PV development in the JAMALI regions. However, it also underscores the necessity for thorough environmental and social analysis scrutiny following site identification. Environmental and social screening for these 140 sites is presented in the Annex D.

The environmental and social analysis of the selected sites reveals that installing solar PV in Banten carries a higher risk compared to other provinces. This elevated risk is primarily due to water-related issues and the potential presence of habitats for threatened species or proximity to the geographic range of these species. Additionally, West Java exhibits slightly higher risks than the three remaining provinces. This is mainly attributable to its Regional Spatial Plan Category, where many sites fall under agriculture and plantation categories. Consequently, land use conflicts and challenges related to land transformation are more pronounced in West Java. These factors underscore the need for careful consideration and mitigation strategies in these regions to ensure sustainable and responsible solar PV development.

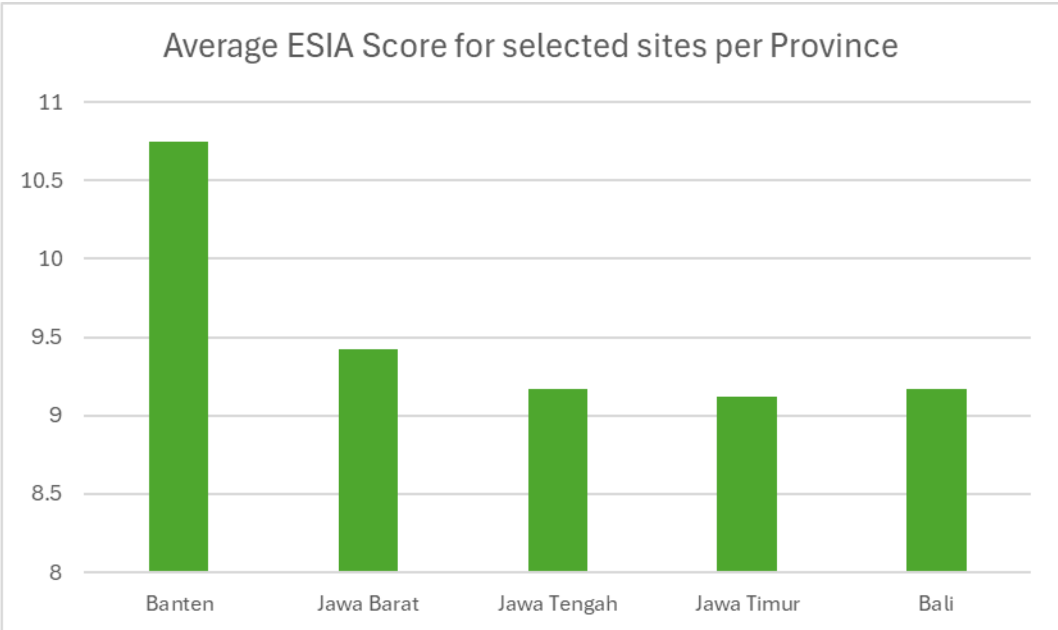


Figure 36 - Average E&S score of selected sites per province

3. Preliminary grid integration analysis

A preliminary grid integration analysis was conducted to assess the effects of integrating 1 GW of intermittent PV power into the JAMALI grid. The analysis demonstrates that the integration of 1 GW of solar PV does not compromise grid stability. The maximum solar PV capacity that can be injected into the grid will be detailed in the next deliverable.

Additionally, an assessment of the 140 selected sites revealed their distribution across 67 nearby substations. Clustering analysis was performed to identify constraints on potential solar PV capacity at each site. Capacities ranged from 10 MW up to their maximum potential, which is determined by two main constraints: land availability and grid hosting capacity. This variability not only reflects site suitability but also supports project scalability, ensuring that solar PV installations can be expanded based on available resources and grid stability requirements. Each cluster of sites indicates the same substation to be connected, suggesting that the potential capacity of each site might be limited by the other sites within the same cluster. After the analysis, there is one site that has potential capacity of less than 10 MW. However, that specific site is still included in the site prioritization since the cluster analysis shows that if that site is combined with its cluster, it will exceed 244 MW.

The final decision on this will be made after analyzing the procurement strategy for utility-scale solar PV development. The result also shows that the maximum hosting capacity for solar PV in 70 kV substations is lower than in 150 kV substations, suggesting that solar PV development in those areas is likely capped by hosting capacity constraints. The preliminary grid assessment and potential capacity for each site are presented in Annex E.

4. Site Prioritization

West Java dominates the areas with relatively higher potential for solar PV development despite having slightly lower solar irradiance compared to the eastern part of Java. However, some locations in West Java indicate higher risks primarily due to the extensive presence of agricultural land, which competes for land use and poses challenges for solar PV projects.

In contrast, Madura Island shows a higher overall potential for solar PV development compared to other regions within JAMALI. This advantage is due to Madura's higher solar irradiance and relatively lower social and environmental risks. Other areas in East Java also demonstrate high solar irradiance potential, with varying levels of environmental and social risks and capacity scalability. Meanwhile, certain areas in Bali exhibit good potential for solar irradiance, but the availability of land for development is limited compared to Java.

The potential capacity varies between each location. However, the majority of them have a capacity of less than 107 MW, as shown in Figure 37.

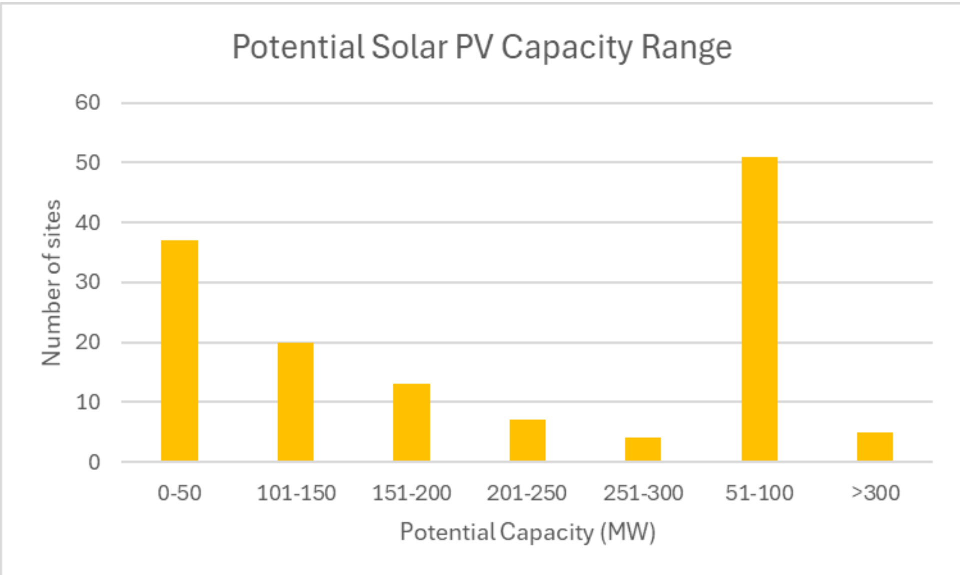


Figure 37 - Potential Solar PV Capacity Range

Figure 38 shows the top 20 sites based on their rank of site prioritization. It shows that when the geospatial score indicates an almost similar score, scalability plays an important role.

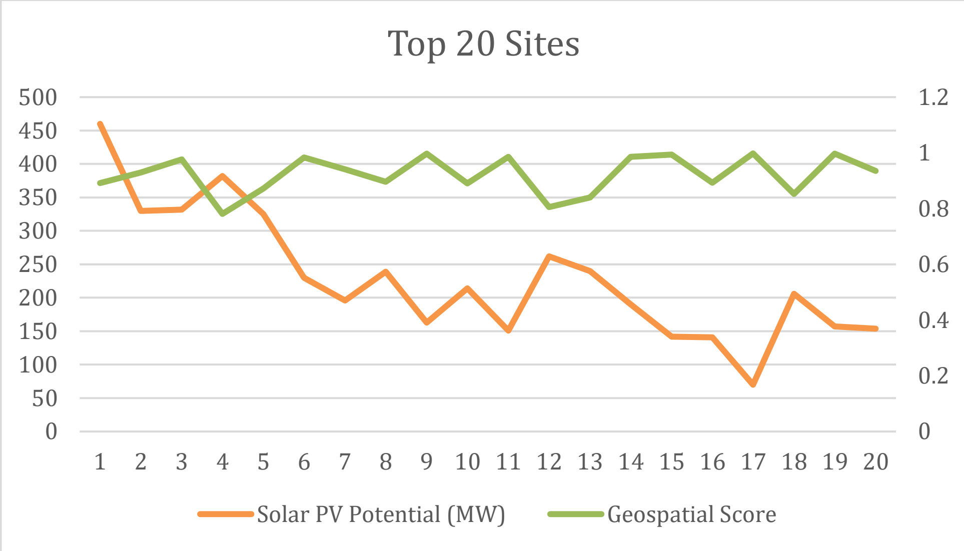


Figure 38 – Solar PV potential and geospatial score for the top 20 sites after prioritization

These prioritized sites offer valuable guidance for stakeholders in planning utility-scale solar PV development in the JAMALI region. They provide a strategic starting point for site selection, balancing technical viability, social acceptance, and environmental sustainability. The complete site prioritization is presented in Annex A.

5. Additional Notes

Solution for small islands. The geospatial analysis, which encompasses the entire JAMALI region, including the islands, indicates that small islands also hold potential for development through microgrid solutions. Nonetheless, additional studies are required to explore this potential further.

Large rooftop PV power. The JAMALI region, particularly Java, has extensive commercial and industrial rooftops suitable for PV power plants, offering over 375 km² of rooftop area, using NREL[34] reference of 60% utilization of the rooftop, it can generate over 22.5 GW. Rooftop PV systems minimize environmental impact by utilizing existing infrastructure without additional land transformation. Further studies are needed.

Floating PV power. Floating Solar PV systems on dam reservoirs offer a solution to land limitations and public opposition to land transformation for solar PV installations, with a potential over 11,000 MW identified in 28 hydropower locations, including around 1,800 MW in the JAMALI region. However, deploying these systems might lead to conflicts over resource use, impact water quality and aquatic ecosystems, and incur higher initial investment costs compared to ground-mounted systems, necessitating further studies and stakeholder engagement.

[34] P. Gagnon, R. Margolis, J. Melius, C. Phillips, and R. Elmore, "Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment," National Renewable Energy Laboratory, Tech. Rep. NREL/TP-6A20-65298, Jan. 2016. Available: https://www.nrel.gov/docs/fy16osti/65298.pdf.

6. Next steps

6.1. Grid Integration Assessment

Although the detailed grid impact assessment study will be presented in the next report, the main aspects to be covered in the grid impact assessment are presented below:

1. Production cost analysis

Injecting 1 GW PV can change the generator dispatching mechanism in the JAMALI system since PV is considered an RE source that the system must absorb. This part analyses the changes in energy production after 1 GW PV enters the system. Key parameters that will be analyzed are generation cost, renewable energy mix, and generators' Capacity Factor.

2. Load flow analysis

Load flow analysis is used to observe bus voltage and line loading around PV sites before and after 1 GW PV is fed into the JAMALI system and to check for violations of those two parameters.

3. Short circuit analysis

A short circuit analysis is conducted to assess the increase in the short-circuit current level provoked by the solar plant's interconnection. The short-circuit level results are compared to the breaker ratings (if available) to check if any limit is exceeded.

4. Dynamic stability analysis

Transient/ dynamic stability analysis observes system behaviour during and after disturbances to check whether the JAMALI system can return to a new stable condition. Since injecting 1 GW PV into the JAMALI system may change system dispatch and performance, several test cases will be done to analyse system performance in terms of stability before and after solar plant injection.

5. Quasi-dynamic analysis

One of the main concerns in penetrating solar power plants is their intermittency, which may cause fluctuation in system frequency. The quasi-dynamic analysis basically simulates the condition where all PV sites are fluctuating simultaneously based on the solar irradiation profile obtained from the previous analysis. System frequency response is observed.

6 Mitigation and Recommendation

If any problem occurs due to solar power plant development, suitable mitigation is included in the recommendations.

6.2. Economic and Regulatory Analysis

The economic analysis will be performed in the next deliverable to identify the most economically feasible locations for solar PV development by estimating the incurred costs of the solar PV development and potential incentives or facilities based on prevailing regulations. The economic analysis will consider the following:

- Land Acquisition Costs

- Social and Environmental Costs, including potential social and environmental costs in the analysis (e.g., costs required to mitigate any environmental and/or social risks, such as resettlement costs).
- Capital expenditures (CAPEX), covering costs of installing the solar PV and transmission line infrastructure as well grid integration costs (if any)
- Operational expenditure (OPEX), costs required to operate and maintain the system, including both the regular and incidental maintenance
- Contingency costs, covering estimated costs required to mitigate potential risks, such as estimated resettlement costs, costs to cover potential delay in the construction
- Revenue from electricity sales, by considering the estimated total demand per system, tariff based on the prevailing regulations, estimated generated electricity, and length of concession period.
- Financial feasibility parameters, such as Project Internal Rate of Return ("IRR") and payback period

In addition to the parameters above, available facilities or incentives relevant to solar PV development will also be assessed. The available facilities will be assessed based on applicable regulations at the national or regional levels, such as Special Allocation Budget/*Dana Alokasi Khusus*/"DAK". However, since facilities and/or incentives will not be certainly obtained, the analysis will only be done on a high-level basis. Further discussions with relevant stakeholders will be required if any of the facilities/incentives are applied to any of the developments.

To complement the economic analysis, further analysis of potential financing and investment mechanisms will also be done by considering potential suitable business models for the selected solar PV development. The business model development will consider the following aspects:

- Stakeholders involved in the solar PV development and their respective roles and responsibilities
- Procurement mechanism for public infrastructure
- Project scheme (e.g. Build-Operate-Transfer/BOT, Build-Operate-Own/BOO)
- Available relevant facilities and/or incentives for respective procurement method
- Contractual arrangement among the stakeholders
- Foreign ownership limitation
- Local content requirement

In addition to the economic analysis, a more in-depth regulatory analysis will also be performed in the next deliverable. The regulatory analysis will identify the regulatory factors and that might impede the development of solar PV in Indonesia, e.g., solar energy electricity price, transparency of the Power Purchase Agreement (PPA), local requirements, and other aspects. Some of the relevant regulations that will need to be analyzed are as follows:

- Presidential Regulation No. 112 of 2022
- MEMR Regulation No. 20/2020
- MEMR Regulation No. 26 of 2021
- MoI Regulation No. 04/2017, No. 5/2017
- MEMR Regulation No. 4/2020 (amendment to MEMR Regulation No. 53/2018 and No. 50/2017)

Other relevant local regulations (depend on the shortlisted potential sites)

6.3. Stakeholders Engagement

Table 16 - Next steps on stakeholders engagement

Topic	Next Steps	Relevant Stakeholders	Relevant Deliverable	Note
MCDM analysis	To discuss the results with the TWG and update the results based on inputs obtained from the TWG	TWG		
Selection of potential sites	Evaluate the prioritized sites and assess the grid impact of each site	Consultant		
	To do relevant regional regulations analysis after the potential sites have been determined	Consultant		
	To assess the financial feasibility and develop potential business models of the selected sites	Consultant	Deliverable 4: Review and Recommended Solutions of the Impediments of Solar PV Development	Please refer to Section 2.5 for details on the financial analysis and business models development
Publication of potential solar PV development map	To coordinate and consult with MEMR for the map publication through MEMR Geoportal	MEMR	Deliverable 3: Grid Integration Assessment	The map will showcase solar potential within the JAMALI regions
	To compile and prepare a comprehensive dataset for integration into the MEMR Geoportal	• Consultant • MEMR		The compilation will be done using ESRI's ArcGIS, ensuring seamless compatibility with MEMR's existing infrastructure.

1. Annex A: Site Prioritization Results

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
1	S25	-6.549476	107.5913	Jawa Barat	Subang	Kalijati	Jalupang	GI 150 kV Pabuaran	460	9	0.892	9.2347
2	S23	-6.80754	108.538932	Jawa Barat	Cirebon	Greged	Jatipancur	GI 150 kV Mandirancan	330	8	0.929	8.8682
3	S62	-7.638159	110.934651	Jawa Tengah	Sukoharjo	Polokarto	Genengsari	GI 150 kV Palur	332	10	0.977	8.4731
4	S8	-6.540033	105.703628	Banten	Pandeglang	Panimbang	Citeureup	GIS 150 kV PLTU Labuan	382	9	0.781	8.2819
5	S135	-8.409523	114.84328	Bali	Jembrana	Pekutatan	Pekutatan	GI 150 kV Negara	325	9	0.872	8.2742
6	S118	-7.729317	114.03488	Jawa Timur	Situbondo	Panji	Panji Kidul	GI 150 kV Sumenep	230	9	0.983	8.0987
7	S56	-6.923886	109.819915	Jawa Tengah	Batang	Tulis	Kenconorejo	GI 150 kV Batang	196	8	0.941	8.0423
8	S64	-7.028522	109.507938	Jawa Tengah	Pekalongan	Kesesi	Kesesi	GI 150 kV Pemalang	239	9	0.896	7.8095
9	S59	-7.285359	110.868949	Jawa Tengah	Sragen	Sumberlawang	Ngargosari	GI 150 kV Kedungombo	163	9	0.997	7.7176
10	S132	-8.116732	115.27702	Bali	Buleleng	Tejakula	Sembiran	GI 150 kV Baturiti	214	9	0.891	7.6263
11	S74	-7.100333	113.017469	Jawa Timur	Bangkalan	Blega	Kajan	GITET 500 kV Tanjung Jati	151	9	0.986	7.5956
12	S63	-7.093456	109.357606	Jawa Tengah	Pemalang	Randudongkal	Semaya	GI 150 kV Pemalang	262	9	0.805	7.5955
13	S115	-6.851106	111.875362	Jawa Timur	Tuban	Kerek	Kedungrejo	GI 150 kV Sumenep	240	9	0.84	7.5918
14	S94	-6.888254	113.858622	Jawa Timur	Sumenep	Dasuk	Dasuk Timur	GI 150 kV Sementuban	190	10	0.986	7.583
15	S86	-6.813834	111.734607	Jawa Timur	Tuban	Bancar	Siding	GI 150 kV Kerek	142	9	0.994	7.5688
16	S24	-6.363727	107.246842	Jawa Barat	Karawang	Telukjambe Barat	Wanasari	GI 150 kV Mekarsari	141	8	0.893	7.4915
17	S92	-7.160636	113.035305	Jawa Timur	Bangkalan	Blega	Ko'olan	GI 150 kV Sampang	70	8	0.998	7.4486
18	S80	-8.379733	114.049428	Jawa Timur	Banyuwangi	Glenmore	Karangharjo	GI 150 kV Cepu	206	9	0.853	7.4221
19	S79	-7.251292	111.699117	Jawa Timur	Bojonegoro	Tambakrejo	Dolokgede	GI 150 kV Bojonegoro	157	10	0.997	7.4119
20	S84	-6.936615	111.889799	Jawa Timur	Tuban	Montong	Montongsekar	GI 150 kV Gondangwetan	154	9	0.935	7.4111
21	S95	-6.940136	114.045873	Jawa Timur	Sumenep	Batang Batang	Bilangan	GI 150 kV Sementuban	105	9	1	7.3516
22	S93	-6.848907	111.621764	Jawa Timur	Tuban	Jatirogo	Wangi	GI 150 kV Sampang	127	9	0.964	7.351
23	S87	-6.800867	111.719162	Jawa Timur	Tuban	Bancar	Siding	GI 150 kV Mliwang	103	9	0.999	7.3344

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
24	S31	-6.801179	108.603961	Jawa Barat	Cirebon	Astanajapura	Buntet	GI 150 kV PLTU Cirebon	106	9	0.994	7.3339
25	S120	-6.768347	111.943708	Jawa Timur	Tuban	Jenu	Tasikharjo	GI 150 kV Tanjung Awar Awar	47	8	1	7.3066
26	S42	-6.66601	108.086401	Jawa Barat	Majalengka	Kertajati	Mekarjaya	GI 70 kV Kadipaten	65	8	0.962	7.2719
27	S85	-6.926187	111.876359	Jawa Timur	Tuban	Kerek	Hargoretno	GI 150 kV Kerek	121	9	0.95	7.2557
28	S21	-7.727922	108.378377	Jawa Barat	Ciamis	Cimerak	Sindangsari	GI 150 kV Karangnunggal	186	9	0.843	7.2516
29	S60	-7.390214	108.764788	Jawa Tengah	Cilacap	Cipari	Pegadingan	GI 150 kV Majenang	200	9	0.82	7.2511
30	S90	-6.931467	113.099427	Jawa Timur	Bangkalan	Tanjungbumi	Larangan Timur	GI 150 kV Purwosari	119	9	0.951	7.2468
31	S71	-6.924883	109.92602	Jawa Tengah	Batang	Banyuputih	Kedawung	GI 150 kV Weleri	42	8	0.99	7.2339
32	S98	-6.949569	113.653144	Jawa Timur	Sumenep	Pasongsongan	Lebeng Barat	GI 150 kV Situbondo	95	9	0.985	7.2262
33	S121	-6.770969	111.968529	Jawa Timur	Tuban	Jenu	Remen	GI 150 kV Tanjung Awar Awar	34	8	0.999	7.2177
34	S91	-6.929501	113.114488	Jawa Timur	Bangkalan	Tanjungbumi	Tambak Pocok	GI 150 kV Sampang	117	9	0.946	7.2136
35	S41	-6.776488	108.158431	Jawa Barat	Sumedang	Tomo	Marongge	GI 70 kV Kadipaten	65	8	0.944	7.1999
36	S16	-6.546382	108.205422	Jawa Barat	Indramayu	Cikedung	Jatisura	GI 150 kV Jatibarang	184	10	0.894	7.176
37	S67	-6.81405	111.536483	Jawa Tengah	Rembang	Sale	Tengger	GI 150 kV Semen Indonesia	121	9	0.928	7.1677
38	S5	-6.369875	106.415828	Banten	Lebak	Maja	Tanjung Sari	GI 150 kV Tigaraksa	270	12	0.848	7.1531
39	S77	-7.029902	111.934325	Jawa Timur	Tuban	Grabagan	Ngarum	GI 150 kV Banyuwangi	147	9	0.877	7.1335
40	S17	-6.560381	107.129157	Jawa Barat	Bogor	Cariu	Bantar Kuning	GI 150 kV Juishin	247	10	0.78	7.131
41	S103	-6.908124	114.004647	Jawa Timur	Sumenep	Batuputih	Juruan Daya	GI 150 kV Sumenep	76	9	0.991	7.1263
42	S102	-6.95054	113.650841	Jawa Timur	Sumenep	Pasongsongan	Lebeng Barat	GI 150 kV Sumenep	79	9	0.986	7.1258
43	S119	-7.79798	114.117181	Jawa Timur	Situbondo	Arjasa	Bayeman	GI 150 kV Sumenep	82	9	0.98	7.1216
44	S122	-6.986106	112.068169	Jawa Timur	Tuban	Semanding	Ngino	GI 150 kV Tuban	78	9	0.986	7.1195
45	S61	-7.488894	110.66251	Jawa Tengah	Boyolali	Sambi	Catur	GI 150 kV Mojosongo	77	9	0.987	7.1169
46	S20	-7.733974	108.038529	Jawa Barat	Tasikmalaya	Cipatujah	Cipatujah	GI 150 kV Karangnunggal	219	10	0.818	7.1003
47	S100	-6.924807	113.728822	Jawa Timur	Sumenep	Ambunten	Tambaagung Barat	GI 150 kV Sumenep	87	9	0.965	7.094
48	S68	-6.861324	111.581306	Jawa Tengah	Rembang	Sale	Joho	GI 150 kV Semen Indonesia	91	9	0.956	7.0841
49	S3	-6.425143	106.352366	Banten	Lebak	Sajira	Mekarsari	GI 150 kV Rangkasbitung	260	12	0.842	7.0637

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
50	S89	-7.740245	112.834374	Jawa Timur	Pasuruan	Kejayan	Oro Oro Pule	GI 150 kV Pier	78	9	0.971	7.0595
51	S58	-7.214495	110.564115	Jawa Tengah	Semarang	Bringin	Gogodalem	GI 150 kV Jelok	124	10	0.962	7.0568
52	S104	-6.88439	113.86962	Jawa Timur	Sumenep	Batuputih	Sergang	GI 150 kV Sumenep	74	9	0.976	7.0534
53	S72	-6.985719	108.790202	Jawa Tengah	Brebes	Banjarharjo	Cikakak	GI 150 kV Weleri	80	9	0.961	7.0324
54	S66	-6.801009	111.327478	Jawa Tengah	Rembang	Sulang	Sudo	GI 150 kV Rembang	82	9	0.954	7.0176
55	S117	-6.901331	111.823752	Jawa Timur	Tuban	Kerek	Trantang	GI 150 kV Sumenep	84	9	0.95	7.0145
56	S73	-6.463676	110.978186	Jawa Tengah	Pati	Dukuhseti	Wedusan	GI 70 kV Babakan	110	10	0.973	7.0093
57	S88	-7.672422	112.770756	Jawa Timur	Pasuruan	Rembang	Kalisat	GI 150 kV Mliwang	49	9	0.992	6.9542
58	S13	-6.525476	108.137335	Jawa Barat	Indramayu	Cikedung	Loyang	GI 150 kV Haurgeulis	106	10	0.965	6.9512
59	S99	-6.92464	113.723392	Jawa Timur	Sumenep	Ambunten	Tambaagung Barat	GI 150 kV Sumenep	90	9	0.923	6.9458
60	S105	-6.88157	113.864133	Jawa Timur	Sumenep	Dasuk	Dasuk Timur	GI 150 kV Sumenep	58	9	0.975	6.945
61	S116	-6.906619	111.79984	Jawa Timur	Tuban	Kerek	Gemulung	GI 150 kV Sumenep	151	10	0.89	6.9449
62	S131	-7.699438	112.767905	Jawa Timur	Pasuruan	Wonorejo	Rebono	GI 70 kV Sukorejo	50	9	0.988	6.9448
63	S128	-7.715003	111.34321	Jawa Timur	Magetan	Parang	Joketro	GI 70 kV Magetan	75	9	0.942	6.9237
64	S39	-6.934184	108.695733	Jawa Barat	Cirebon	Waled	Waled Asem	GI 70 kV Babakan	80	9	0.927	6.8964
65	S2	-6.446755	106.368132	Banten	Lebak	Curugbitung	Sekarwangi	GI 150 kV Rangkasbitung	260	11	0.752	6.8855
66	S129	-7.596396	112.67149	Jawa Timur	Pasuruan	Gempol	Jeruk Purut	GI 70 kV Pandaan	90	9	0.907	6.8818
67	S69	-7.056141	110.13914	Jawa Tengah	Kendal	Patean	Sidodadi	GI 150 kV Semen Indonesia	111	10	0.935	6.8639
68	S12	-6.573166	107.898683	Jawa Barat	Indramayu	Gantar	Bantarwaru	GI 150 kV Haurgeulis	110	10	0.933	6.8493
69	S110	-6.919903	114.020474	Jawa Timur	Sumenep	Batang Batang	Legung Barat	GI 150 kV Sumenep	30	9	0.996	6.8463
70	S35	-7.423571	106.991565	Jawa Barat	Cianjur	Agrabinta	Wanasari	GI 150 kV Semen Jawa	70	9	0.928	6.8353
71	S75	-6.909194	112.994416	Jawa Timur	Bangkalan	Sepulu	Tanagura Timur	GI 150 kV Bangkalan	71	10	0.988	6.8149
72	S112	-6.881294	113.848313	Jawa Timur	Sumenep	Dasuk	Dasuk Timur	GI 150 kV Sumenep	25	9	0.994	6.8056
73	S109	-6.879662	113.875716	Jawa Timur	Sumenep	Batuputih	Sergang	GI 150 kV Sumenep	33	9	0.979	6.7978
74	S123	-7.035883	111.95829	Jawa Timur	Tuban	Grabagan	Banyubang	GI 150 kV Tuban	64	9	0.925	6.784
75	S65	-6.728982	111.541064	Jawa Tengah	Rembang	Sedan	Sambong	GI 150 kV PLTU Rembang	101	9	0.864	6.7815
76	S101	-6.919549	113.786772	Jawa Timur	Sumenep	Dasuk	Semaan	GI 150 kV Sumenep	86	10	0.954	6.777

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
77	S15	-6.575333	107.920984	Jawa Barat	Indramayu	Gantar	Bantarwaru	GI 150 kV Haurgeulis	97	10	0.936	6.7767
78	S136	-8.293214	114.577632	Bali	Jembrana	Melaya	Manistutu	GI 150 kV Negara	96	9	0.869	6.7688
79	S107	-6.891748	113.968872	Jawa Timur	Sumenep	Batuputih	Badur	GI 150 kV Sumenep	50	9	0.943	6.7648
80	S18	-6.46369	107.20107	Jawa Barat	Karawang	Pangkalan	Mulangsari	GI 150 kV Juishin	86	9	0.882	6.7557
81	S113	-6.921716	113.595546	Jawa Timur	Pamekasan	Pasean	Dempo Barat	GI 150 kV Sumenep	23	9	0.984	6.7527
82	S14	-6.574419	107.915029	Jawa Barat	Indramayu	Gantar	Bantarwaru	GI 150 kV Haurgeulis	97	10	0.929	6.7487
83	S114	-6.934192	113.641757	Jawa Timur	Sumenep	Pasongsongan	Lebeng Barat	GI 150 kV Sumenep	23	9	0.983	6.7487
84	S27	-7.416727	107.063116	Jawa Barat	Cianjur	Sindangbarang	Kertasari	GI 150 kV Patuha	76	9	0.895	6.7423
85	S78	-7.037614	111.946113	Jawa Timur	Tuban	Grabagan	Ngrejeng	GI 150 kV Bojonegoro	42	9	0.95	6.7406
86	S83	-7.741457	112.859112	Jawa Timur	Pasuruan	Kejayan	Kepuh	GI 150 kV Genteng	29	9	0.97	6.7357
87	S32	-6.569329	107.491233	Jawa Barat	Purwakarta	Pasawahan	Margasari	GI 150 kV Purwakarta	158	9	0.754	6.7132
88	S43	-6.812715	108.214043	Jawa Barat	Majalengka	Majalengka	Cikasarung	GI 70 kV Kadipaten	65	9	0.903	6.7026
89	S37	-7.396133	106.867631	Jawa Barat	Cianjur	Agrabinta	Mekarsari	GI 150 kV Semen Jawa	57	9	0.914	6.6944
90	S108	-6.886059	113.838383	Jawa Timur	Sumenep	Dasuk	Dasuk Timur	GI 150 kV Sumenep	47	10	0.995	6.6866
91	S126	-6.935325	112.156381	Jawa Timur	Tuban	Palang	Leran Wetan	GI 150 kV Tuban	18	9	0.975	6.684
92	S127	-6.936296	112.148195	Jawa Timur	Tuban	Palang	Leran Wetan	GI 150 kV Tuban	7	9	0.982	6.6403
93	S1	-6.93775	106.283811	Banten	Lebak	Bayah	Darmasari	GI 150 kV Bayah	160	9	0.732	6.6381
94	S96	-6.971228	113.985799	Jawa Timur	Sumenep	Batang Batang	Batangbatang Laok	GI 150 kV Sementuban	38	10	0.995	6.6278
95	S124	-6.940865	112.139568	Jawa Timur	Tuban	Palang	Pucangan	GI 150 kV Tuban	51	9	0.906	6.6234
96	S57	-6.996164	111.246076	Jawa Tengah	Blora	Kunduran	Balong	GI 150 kV Blora	50	9	0.906	6.6168
97	S44	-7.00293	108.608177	Jawa Barat	Kuningan	Ciawigebang	Keramatmulya	GI 70 kV Kuningan	80	10	0.922	6.6097
98	S53	-6.636831	108.026444	Jawa Barat	Indramayu	Terisi	Cikawung	GI 70 kV Parakan	70	10	0.935	6.5966
99	S125	-6.942557	112.146967	Jawa Timur	Tuban	Palang	Leran Kulon	GI 150 kV Tuban	26	9	0.94	6.5962
100	S34	-7.412025	107.007522	Jawa Barat	Cianjur	Sindangbarang	Jatisari	GI 150 kV Semen Jawa	70	9	0.864	6.5793
101	S97	-6.918821	114.012356	Jawa Timur	Sumenep	Batang Batang	Jangkong	GI 150 kV Situbondo	35	10	0.979	6.5443
102	S26	-7.387065	107.197134	Jawa Barat	Cianjur	Cikadu	Padaluyu	GI 150 kV Patuha	174	10	0.75	6.5349
103	S54	-7.501991	107.482838	Jawa Barat	Garut	Caringin	Indralayang	GI 70 kV Sumadra	62	9	0.862	6.5191
104	S76	-8.255255	114.263197	Jawa Timur	Banyuwangi	Songgon	Bangunsari	GI 150 kV Bangkalan	20	9	0.93	6.5172

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
105	S106	-6.885831	113.924179	Jawa Timur	Sumenep	Batuputih	Batuputih Daya	GI 150 kV Sumenep	54	10	0.939	6.5082
106	S29	-7.460115	107.366101	Jawa Barat	Cianjur	Cidaun	Kertajadi	GI 150 kV Patuha	58	9	0.865	6.505
107	S9	-7.224362	108.411471	Jawa Barat	Ciamis	Jatinagara	Cintanagara	GI 150 kV Ciamis	105	9	0.787	6.4996
108	S70	-7.063862	110.161113	Jawa Tengah	Kendal	Patean	Sidodadi	GI 150 kV Weleri	62	10	0.922	6.4924
109	S133	-8.102311	115.273379	Bali	Buleleng	Tejakula	Pacung	GI 150 kV Baturiti	52	9	0.868	6.4777
110	S49	-7.677255	107.893422	Jawa Barat	Garut	Cibalong	Sancang	GI 70 kV Pameungpeuk	85	9	0.813	6.4731
111	S50	-7.536841	107.553677	Jawa Barat	Garut	Mekarmukti	Cijayana	GI 70 kV Pameungpeuk	85	9	0.813	6.4731
112	S134	-8.096548	115.250903	Bali	Buleleng	Kubutambahan	Bukti	GI 150 kV Baturiti	45	9	0.867	6.4281
113	S111	-6.897391	113.97715	Jawa Timur	Sumenep	Batuputih	Juruan Daya	GI 150 kV Sumenep	30	10	0.948	6.3876
114	S137	-8.091324	115.172601	Bali	Buleleng	Kubutambahan	Bengkala	GI 150 kV Pemaron	19	10	0.965	6.3839
115	S33	-6.55169	107.046818	Jawa Barat	Bogor	Sukamakmur	Sukadamai	GI 150 kV Semen Baru	101	10	0.822	6.3468
116	S7	-6.082806	106.140263	Banten	Kota Serang	Taktakan	Tamanbaru	GI 70 kV Serang	72	10	0.869	6.3455
117	S81	-8.403846	114.072117	Jawa Timur	Banyuwangi	Glenmore	Karangharjo	GI 150 kV Genteng	63	9	0.808	6.3097
118	S22	-6.407955	107.34291	Jawa Barat	Karawang	Ciampel	Kutanegara	GI 150 kV Kutamekar	39	10	0.911	6.2984
119	S82	-8.327976	114.051084	Jawa Timur	Banyuwangi	Glenmore	Karangharjo	GI 150 kV Genteng	31	9	0.855	6.2889
120	S51	-7.501746	107.448508	Jawa Barat	Garut	Caringin	Cimahi	GI 70 kV Pameungpeuk	46	10	0.896	6.284
121	S130	-7.715605	112.297694	Jawa Timur	Jombang	Bareng	Mundusewu	GI 70 kV Siman	65	9	0.79	6.2506
122	S19	-6.508367	107.213365	Jawa Barat	Karawang	Pangkalan	Kertasari	GI 150 kV Juishin	22	9	0.856	6.2341
123	S45	-7.064115	108.536559	Jawa Barat	Kuningan	Ciniru	Cipedes	GI 70 kV Kuningan	80	10	0.814	6.1777
124	S36	-7.164091	106.800571	Jawa Barat	Sukabumi	Pabuaran	Sirnasari	GI 150 kV Semen Jawa	70	10	0.813	6.1086
125	S6	-6.38938	106.407981	Banten	Lebak	Maja	Pasir Kecapi	GI 150 kV Tigaraksa	104	12	0.855	6.0984
126	S28	-7.343449	107.115982	Jawa Barat	Cianjur	Cibinong	Girijaya	GI 150 kV Patuha	61	9	0.746	6.0485
127	S11	-6.721517	107.144888	Jawa Barat	Cianjur	Sukaresmi	Cikancana	GI 150 kV Cianjur	21	9	0.796	5.9878
128	S55	-7.226885	106.487818	Jawa Barat	Sukabumi	Ciemas	Mekarsakti	GIS 150 kV PLTU Pelabuhan Ratu	25	10	0.843	5.9349
129	S10	-7.185267	108.421359	Jawa Barat	Ciamis	Jatinagara	Bayasari	GI 150 kV Ciamis	11	9	0.79	5.8984
130	S30	-7.336353	107.108033	Jawa Barat	Cianjur	Cibinong	Girijaya	GI 150 kV Patuha	14	9	0.769	5.8339
131	S40	-7.012972	107.104993	Jawa Barat	Cianjur	Campaka	Sukadana	GI 70 kV Cianjur	94	12	0.779	5.729
132	S52	-7.699123	108.409613	Jawa Barat	Ciamis	Cijulang	Cibanten	GI 70 kV Pangandaran	80	9	0.629	5.7044

MCDM Rank	S_id	Latitude	Longitude	ADM1	ADM2	ADM3	ADM4	HubName	Solar PV Potential (MW)	ESIA Score	Geospatial Score	MCDM Score
133	S48	-7.223319	107.025116	Jawa Barat	Cianjur	Kadupandak	Bojongkasih	GI 70 kV Lembursitu	20	9	0.717	5.6652
134	S4	-6.318448	106.323406	Banten	Serang	Jawilan	Pagintungan	GI 150 kV Rangkasbitung	20	11	0.833	5.6444
135	S46	-7.211387	107.03726	Jawa Barat	Cianjur	Kadupandak	Sukasari	GI 70 kV Lembursitu	35	9	0.629	5.411
136	S47	-7.013509	107.076605	Jawa Barat	Cianjur	Campaka	Karyamukti	GI 70 kV Lembursitu	32	11	0.735	5.3307
137	S38	-7.133943	106.950902	Jawa Barat	Sukabumi	Purabaya	Cicukang	GI 150 kV Semen Jawa	37	12	0.723	5.1333

2. Annex B: Site's Basic Information

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S1	93	-6.93775	106.283811	Banten	GI 150 kV Bayah	160	876.70	160	Medium	0.732	< 100.000	34	Agricultural Area	Right to Cultivate (HGU)
S2	65	-6.446755	106.368132	Banten	GI 150 kV Rangkasbitung	260	931.05	260	High	0.752	< 100.000	14	Community Plantation Area	Right of Ownership (HM)
S3	49	-6.425143	106.352366	Banten	GI 150 kV Rangkasbitung	260	531.82	260	High	0.842	100.000 - 200.000	11	Land and Security Area	Right to Use
S4	134	-6.318448	106.323406	Banten	GI 150 kV Rangkasbitung	260	20.24	20	High	0.833	< 100.000	78	Plantation Area	Right of Ownership (HM)
S5	38	-6.38938	106.407981	Banten	GI 150 kV Tigaraksa	560	104.41	104	High	0.855	< 100.000	15	Settlement Area	Right to Build (HGB)
S6	125	-6.369875	106.415828	Banten	GI 150 kV Tigaraksa	560	269.79	270	High	0.848	< 100.000	12	Settlement Area	SPPFBT, Right of Ownership (HM), Right to Build (HGB)
S7	116	-6.082806	106.140263	Banten	GI 70 kV Serang	145	71.62	72	High	0.869	200.000 - 500.000	47	Residential Area	Right of Ownership (HM)
S8	4	-6.540033	105.703628	Banten	GIS 150 kV PLTU Labuan	480	381.93	382	Medium	0.781	< 100.000	2	Horticulture Area	Right to Build (HGB)
S9	107	-7.185267	108.421359	Jawa Barat	GI 150 kV Ciamis	950	10.57	11	Medium	0.79	< 100.000	18	Plantation Area	N/A, Right of Ownership (HM)
S10	129	-7.224362	108.411471	Jawa Barat	GI 150 kV Ciamis	950	105.04	105	Medium	0.787	< 100.000	13	Food Crops Area	N/A, Right of Ownership (HM)
S11	127	-6.721517	107.144888	Jawa Barat	GI 150 kV Cianjur	245	21.27	21	Medium	0.796	< 100.000	95	Plantations/Annual Crops	N/A, Right of Ownership (HM)
S12	68	-6.525476	108.137335	Jawa Barat	GI 150 kV Haurgeulis	140	106.28	106	High	0.965	< 100.000	23	Production Forest (Enclave)	SPPFBT, Right of Ownership (HM)
S13	58	-6.574419	107.915029	Jawa Barat	GI 150 kV Haurgeulis	140	97.14	97	High	0.929	< 100.000	15	Farm Forestry/Hutan Rakyat	Right of Ownership (HM)
S14	82	-6.575333	107.920984	Jawa Barat	GI 150 kV Haurgeulis	140	97.14	97	High	0.936	< 100.000	15	Production Forest (Enclave)	SPPFBT, Right of Ownership (HM)
S15	77	-6.573166	107.898683	Jawa Barat	GI 150 kV Haurgeulis	140	110.49	110	High	0.933	200.000 - 500.000	16	Production Forest (Enclave)	N/A

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S16	36	-6.546382	108.205422	Jawa Barat	GI 150 kV Jatibarang	270	184.03	184	High	0.894	100.000 - 200.000	17	Farm Forestry/Hutan Rakyat	SPPFBT, Right of Ownership (HM)
S17	40	-6.46369	107.20107	Jawa Barat	GI 150 kV Juishin	420	86.31	86	Medium	0.882	100.000 - 200.000	1	Medium Density Urban Settlements	N/A, Right of Ownership (HM)
S18	80	-6.508367	107.213365	Jawa Barat	GI 150 kV Juishin	420	22.34	22	Medium	0.856	100.000 - 200.000	61	Food Crops Area	SPPFBT, Right of Ownership (HM)
S19	122	-6.560381	107.129157	Jawa Barat	GI 150 kV Juishin	420	246.75	247	High	0.78	100.000 - 200.000	15	Food Crops Area	N/A, Right of Ownership (HM)
S20	46	-7.727922	108.378377	Jawa Barat	GI 150 kV Karangnunggal	650	185.51	186	Medium	0.843	200.000 - 500.000	30	Prone to Low Land Movement Area	N/A
S21	28	-7.733974	108.038529	Jawa Barat	GI 150 kV Karangnunggal	650	218.58	219	High	0.818	< 100.000	15	Wetland Agricultural Area	SPPFBT, Right of Ownership (HM)
S22	118	-6.407955	107.34291	Jawa Barat	GI 150 kV Kutamekar	425	39.07	39	High	0.911	500.000 - 1.000.000	23	Industrial Estate	Right to Build (HGB)
S23	2	-6.80754	108.538932	Jawa Barat	GI 150 kV Mandirancan	330	360.02	330	Medium	0.929	200.000 - 500.000	60	Industrial Designation Area	SPPFBT, Right of Ownership (HM)
S24	16	-6.363727	107.246842	Jawa Barat	GI 150 kV Mekarsari	730	141.32	141	Medium	0.893	100.000 - 200.000	0	Industrial Estate	Right to Build (HGB)
S25	1	-6.549476	107.5913	Jawa Barat	GI 150 kV Pabuaran	460	766.58	460	Medium	0.892	200.000 - 500.000	11	Plantation Area	SPPFBT
S26	102	-7.336353	107.108033	Jawa Barat	GI 150 kV Patuha	290	13.85	14	Medium	0.769	< 100.000	39	Plantations/Annual Crops	Right to Cultivate (HGU)
S27	84	-7.343449	107.115982	Jawa Barat	GI 150 kV Patuha	290	61.46	61	Medium	0.746	< 100.000	38	Horticulture	N/A, Right of Ownership (HM)
S28	126	-7.416727	107.063116	Jawa Barat	GI 150 kV Patuha	290	76.34	76	Medium	0.895	< 100.000	5	Plantations/Annual Crops	Right to Cultivate (HGU)
S29	106	-7.387065	107.197134	Jawa Barat	GI 150 kV Patuha	290	174.33	174	High	0.75	< 100.000	34	Horticulture	N/A, Right of Ownership (HM)
S30	130	-7.460115	107.366101	Jawa Barat	GI 150 kV Patuha	290	58.35	58	Medium	0.865	200.000 - 500.000	3	Plantations/Annual Crops	N/A, Right of Ownership (HM)
S31	24	-6.801179	108.603961	Jawa Barat	GI 150 kV PLTU Cirebon	380	106.19	106	Medium	0.994	200.000 - 500.000	36	Agricultural Designation Area	N/A, SPPFBT, Right of Ownership (HM)

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S32	87	-6.569329	107.49123 3	Jawa Barat	GI 150 kV Purwakarta	500	157.96	158	Medium	0.754	100.000 - 200.000	40	Food Crops Cultivation Area	SPPFBT, Right of Ownership (HM)
S33	115	-6.55169	107.04681 8	Jawa Barat	GI 150 kV Semen Baru	510	101.20	101	High	0.822	< 100.000	16	Low Density Urban Settlements	Right to Build (HGB)
S34	100	-7.412025	107.00752 2	Jawa Barat	GI 150 kV Semen Jawa	70	374.44	70	Medium	0.864	< 100.000	51	Plantations/Annual Crops	Right to Cultivate (HGU)
S35	70	-7.423571	106.99156 5	Jawa Barat	GI 150 kV Semen Jawa	70	241.52	70	Medium	0.928	< 100.000	52	Plantations/Annual Crops	Right to Cultivate (HGU)
S36	124	-7.396133	106.86763 1	Jawa Barat	GI 150 kV Semen Jawa	70	56.87	57	Medium	0.914	< 100.000	47	Plantation Designation Area	N/A
S37	89	-7.164091	106.80057 1	Jawa Barat	GI 150 kV Semen Jawa	70	220.12	70	High	0.813	100.000 - 200.000	22	Plantations/Annual Crops	N/A, Right of Ownership (HM)
S38	137	-7.133943	106.95090 2	Jawa Barat	GI 150 kV Semen Jawa	70	37.00	37	High	0.723	< 100.000	20	Plantation Designation Area	Right to Cultivate (HGU)
S39	64	-6.934184	108.69573 3	Jawa Barat	GI 70 kV Babakan	80	147.01	80	Medium	0.927	< 100.000	58	Production Forest Area	SPPFBT, Right of Ownership (HM)
S40	131	-7.012972	107.10499 3	Jawa Barat	GI 70 kV Cianjur	245	94.15	94	High	0.779	< 100.000	23	Plantations/Annual Crops	N/A
S41	35	-6.812715	108.21404 3	Jawa Barat	GI 70 kV Kadipaten	65	126.10	65	Medium	0.903	500.000 - 1.000.000	49	Industrial Area	SPPFBT, Right of Ownership (HM)
S42	26	-6.776488	108.15843 1	Jawa Barat	GI 70 kV Kadipaten	65	340.68	65	Medium	0.944	200.000 - 500.000	25	Other Designated Area	SPPFBT, Right of Ownership (HM)
S43	88	-6.66601	108.08640 1	Jawa Barat	GI 70 kV Kadipaten	65	162.49	65	Medium	0.962	N/A	17	Other Designated Areas	SPPFBT, Right of Ownership (HM)
S44	97	-7.064115	108.53655 9	Jawa Barat	GI 70 kV Kuningan	80	138.55	80	High	0.814	< 100.000	11	Rural Residential Area	SPPFBT, Right of Ownership (HM)
S45	123	-7.00293	108.60817 7	Jawa Barat	GI 70 kV Kuningan	80	160.99	80	High	0.922	200.000 - 500.000	13	Wetland Food Agricultural Area	N/A
S46	135	-7.013509	107.07660 5	Jawa Barat	GI 70 kV Lembursitu	35	32.11	32	High	0.735	< 100.000	21	Plantations/Annual Crops	N/A
S47	136	-7.223319	107.02511 6	Jawa Barat	GI 70 kV Lembursitu	35	19.94	20	Medium	0.717	< 100.000	33	Plantations/Annual Crops	Right to Cultivate (HGU)

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S48	133	-7.211387	107.03726	Jawa Barat	GI 70 kV Lembursitu	35	84.84	35	Medium	0.629	< 100.000	32	Plantations/Annual Crops	N/A
S49	110	-7.501746	107.448508	Jawa Barat	GI 70 kV Pameungpeuk	85	45.87	46	High	0.896	< 100.000	33	Plantation Area	Right to Cultivate (HGU)
S50	111	-7.536841	107.553677	Jawa Barat	GI 70 kV Pameungpeuk	85	167.67	85	Medium	0.813	< 100.000	21	Dryland Agricultural Area	SPPFBT
S51	120	-7.677255	107.893422	Jawa Barat	GI 70 kV Pameungpeuk	85	292.44	85	Medium	0.813	< 100.000	21	Urban Residential Area	Right to Build (HGB), SPPFBT, Right of Ownership (HM)
S52	132	-7.699123	108.409613	Jawa Barat	GI 70 kV Pangandaran	80	118.45	80	Medium	0.629	200.000 - 500.000	31	Wetland Agricultural Area	SPPFBT, Right of Ownership (HM)
S53	98	-6.636831	108.026444	Jawa Barat	GI 70 kV Parakan	70	210.10	70	High	0.935	< 100.000	2	Farm Forestry/Hutan Rakyat	N/A, Right of Ownership (HM)
S54	103	-7.501991	107.482838	Jawa Barat	GI 70 kV Sumadra	100	61.55	62	Medium	0.862	< 100.000	30	Dryland Agricultural Area	N/A, Right of Ownership (HM)
S55	128	-7.226885	106.487818	Jawa Barat	GIS 150 kV PLTU Pelabuhan Ratu	60	25.10	25	High	0.843	< 100.000	24	Plantation Designation Area	N/A, Right of Ownership (HM)
S56	7	-6.923886	109.819915	Jawa Tengah	GI 150 kV Batang	1050	196.38	196	Medium	0.941	100.000 - 200.000	6	Industrial Designation Area	SPPFBT, Right of Ownership (HM)
S57	96	-6.996164	111.246076	Jawa Tengah	GI 150 kV Blora	50	266.01	50	Medium	0.906	< 100.000	17	Food Crops Area	N/A, Right of Ownership (HM)
S58	51	-7.214495	110.564115	Jawa Tengah	GI 150 kV Jelok	180	123.78	124	High	0.962	< 100.000	97	Food Crop Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S59	9	-7.285359	110.868949	Jawa Tengah	GI 150 kV Kedungombo	170	163.35	163	Medium	0.997	200.000 - 500.000	45	Horticulture	SPPFBT, Right of Ownership (HM)
S60	29	-7.390214	108.764788	Jawa Tengah	GI 150 kV Majenang	200	474.72	200	Medium	0.82	< 100.000	91	Plantation Area	SPPFBT
S61	45	-7.488894	110.66251	Jawa Tengah	GI 150 kV Mojosongo	1050	76.74	77	Medium	0.987	100.000 - 200.000	72	Wetland Agricultural Area	N/A, Right of Ownership (HM)

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S62	3	-7.638159	110.934651	Jawa Tengah	GI 150 kV Palur	970	331.64	332	High	0.977	< 100.000	10	Plantation Designation Area	Right of Ownership (HM), Right to Use (HP), Right to Cultivate (HGU)
S63	12	-7.028522	109.507938	Jawa Tengah	GI 150 kV Pemalang	390	239.00	239	Medium	0.896	100.000 - 200.000	19	Dryland Agricultural Area	SPPFBT
S64	8	-7.093456	109.357606	Jawa Tengah	GI 150 kV Pemalang	390	262.3407	262	Medium	0.805	< 100.000	20	Food Crops Area	SPPFBT, Right of Ownership (HM)
S65	75	-6.728982	111.541064	Jawa Tengah	GI 150 kV PLTU Rembang	240	101.27	101	Medium	0.864	< 100.000	12	Mineral and Coal Mining	SPPFBT, Right of Ownership (HM)
S66	54	-6.801009	111.327478	Jawa Tengah	GI 150 kV Rembang	240	82.23	82	Medium	0.954	< 100.000	90	Dryland Agricultural Area	SPPFBT, Right of Ownership (HM)
S67	37	-6.81405	111.536483	Jawa Tengah	GI 150 kV Semen Indonesia	760	121.24	121	Medium	0.928	< 100.000	10	River Border Area	SPPFBT, Right of Ownership (HM)
S68	48	-6.861324	111.581306	Jawa Tengah	GI 150 kV Semen Indonesia	760	91.22	91	Medium	0.956	< 100.000	13	Dryland Agricultural Area	SPPFBT, Right of Ownership (HM)
S69	67	-6.848907	111.621764	Jawa Timur	GI 150 kV Semen Indonesia	760	127.15	127	Medium	0.964	200.000 - 500.000	18	Food Crops Area	N/A, Right of Ownership (HM)
S70	108	-6.924883	109.92602	Jawa Tengah	GI 150 kV Weleri	650	42.42	42	Medium	0.99	100.000 - 200.000	17	Food Crops Area	Right of Ownership (HM)
S71	31	-7.063862	110.161113	Jawa Tengah	GI 150 kV Weleri	650	61.60	62	High	0.922	< 100.000	14	Industrial Designation Area	Right to Manage (HPL)
S72	53	-7.056141	110.13914	Jawa Tengah	GI 150 kV Weleri	650	110.97	111	High	0.935	< 100.000	11	Food Crops Area	SPPFBT
S73	56	-6.985719	108.790202	Jawa Tengah	GI 70 kV Babakan	80	499.05	80	Medium	0.961	< 100.000	13	Agricultural Area	SPPFBT, Right of Ownership (HM)
S74	11	-6.463676	110.978186	Jawa Tengah	GITET 500 kV Tanjung Jati	650	110.45	110	High	0.973	< 100.000	3	Farm/Moor	SPPFBT, Right of Ownership (HM)
S75	71	-7.100333	113.017469	Jawa Timur	GI 150 kV Bangkalan	230	150.66	151	Medium	0.986	500.000 - 1.000.000	25	Rural Residential Area	N/A, SPPFBT, Right of Ownership (HM)
S76	104	-6.909194	112.994416	Jawa Timur	GI 150 kV Bangkalan	230	70.71	71	High	0.988	500.000 - 1.000.000	28	Plantation Area	N/A

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S77	39	-8.255255	114.263197	Jawa Timur	GI 150 kV Banyuwangi	520	19.59	20	Medium	0.93	100.000 - 200.000	12	Food Crops Estate	N/A
S78	85	-7.037614	111.946113	Jawa Timur	GI 150 kV Bojonegoro	255	41.85	42	Medium	0.95	100.000 - 200.000	18	Food Crops Estate	N/A
S79	19	-7.029902	111.934325	Jawa Timur	GI 150 kV Bojonegoro	255	146.61	147	Medium	0.877	< 100.000	18	Oil and Gas Mining Area	Right of Ownership (HM)
S80	18	-7.251292	111.699117	Jawa Timur	GI 150 kV Cepu	190	157.13	157	High	0.997	< 100.000	18	Plantation Area	N/A
S81	117	-8.379733	114.049428	Jawa Timur	GI 150 kV Genteng	280	206.47	206	Medium	0.853	< 100.000	13	Plantation Area	N/A
S82	119	-8.327976	114.051084	Jawa Timur	GI 150 kV Genteng	280	30.60	31	Medium	0.855	< 100.000	14	Plantation Area	Right to Cultivate (HGU)
S83	86	-8.403846	114.072117	Jawa Timur	GI 150 kV Genteng	280	63.40	63	Medium	0.808	< 100.000	10	Dryland Agricultural Designation Area	N/A, Right of Ownership (HM)
S84	20	-7.741457	112.859112	Jawa Timur	GI 150 kV Gondangwetan	870	28.75	29	Medium	0.97	200.000 - 500.000	72	Food Crops Estate	N/A, SPPFBT, Right of Ownership (HM)
S85	27	-6.926187	111.876359	Jawa Timur	GI 150 kV Kerek	360	120.99	121	Medium	0.95	< 100.000	80	Food Crops Estate	SPPFBT, Right of Ownership (HM)
S86	15	-6.936615	111.889799	Jawa Timur	GI 150 kV Kerek	360	154.16	154	Medium	0.935	< 100.000	83	Food Crops Estate	N/A, Right of Ownership (HM)
S87	23	-6.813834	111.734607	Jawa Timur	GI 150 kV Mliwang	1350	141.71	142	Medium	0.994	200.000 - 500.000	17	Food Crops Estate	SPPFBT, Right of Ownership (HM)
S88	57	-6.800867	111.719162	Jawa Timur	GI 150 kV Mliwang	1350	103.33	103	Medium	0.999	< 100.000	19	Dryland Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S89	50	-7.672422	112.770756	Jawa Timur	GI 150 kV Pier	1080	49.15	49	Medium	0.992	< 100.000	68	Dryland Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S90	30	-7.740245	112.834374	Jawa Timur	GI 150 kV Purwosari	850	77.59	78	Medium	0.971	200.000 - 500.000	88	Farm/Moor	N/A
S91	34	-7.160636	113.035305	Jawa Timur	GI 150 kV Sampang	680	69.64	70	Medium	0.998	200.000 - 500.000	22	Farm/Moor	N/A, Right of Ownership (HM)
S92	17	-6.931467	113.099427	Jawa Timur	GI 150 kV Sampang	680	119.23	119	Medium	0.951	100.000 - 200.000	31	Rainfed Rice Fields	N/A, Right of Ownership (HM)

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S93	22	-6.929501	113.114488	Jawa Timur	GI 150 kV Sampang	680	116.68	117	Medium	0.946	100.000 - 200.000	3	Plantation Area	N/A, Right of Ownership (HM)
S94	14	-6.851106	111.875362	Jawa Timur	GI 150 kV Sementuban	240	422.42	240	Medium	0.84	< 100.000	38	Water Catchment Areas	N/A
S95	21	-6.906619	111.79984	Jawa Timur	GI 150 kV Sementuban	240	150.98	151	High	0.89	< 100.000	13	Horticulture	SPPFBT, Right of Ownership (HM)
S96	94	-6.901331	111.823752	Jawa Timur	GI 150 kV Sementuban	240	83.66	84	Medium	0.95	< 100.000	10	Water Catchment Areas	N/A, Right of Ownership (HM)
S97	101	-7.79798	114.117181	Jawa Timur	GI 150 kV Situbondo	560	82.16	82	Medium	0.98	< 100.000	14	Water Catchment Areas	N/A
S98	32	-7.729317	114.03488	Jawa Timur	GI 150 kV Situbondo	560	230.19	230	Medium	0.983	< 100.000	23	Holticulture	N/A
S99	59	-6.888254	113.858622	Jawa Timur	GI 150 kV Sumenep	310	190.13	190	High	0.986	< 100.000	13	Holticulture	N/A
S100	47	-6.918821	114.012356	Jawa Timur	GI 150 kV Sumenep	310	34.81	35	High	0.979	< 100.000	22	Holticulture	N/A
S101	76	-6.940136	114.045873	Jawa Timur	GI 150 kV Sumenep	310	105.07	105	Medium	1	< 100.000	24	Water Catchment Areas	N/A, Right of Ownership (HM)
S102	42	-6.971228	113.985799	Jawa Timur	GI 150 kV Sumenep	310	38.25	38	High	0.995	< 100.000	17	Holticulture	N/A
S103	41	-6.921716	113.595546	Jawa Timur	GI 150 kV Sumenep	310	23.42	23	Medium	0.984	100.000 - 200.000	28	Holticulture	N/A, Right of Ownership (HM)
S104	52	-6.95054	113.650841	Jawa Timur	GI 150 kV Sumenep	310	79.49	79	Medium	0.986	< 100.000	21	Production Forest	N/A, SPPFBT
S105	60	-6.934192	113.641757	Jawa Timur	GI 150 kV Sumenep	310	22.65	23	Medium	0.983	< 100.000	23	Production Forest	N/A
S106	105	-6.92464	113.723392	Jawa Timur	GI 150 kV Sumenep	310	89.98	90	Medium	0.923	< 100.000	15	Water Catchment Areas	N/A
S107	79	-6.88439	113.86962	Jawa Timur	GI 150 kV Sumenep	310	73.70	74	Medium	0.976	N/A	14	Holticulture	SPPFBT, Right of Ownership (HM)
S108	90	-6.88157	113.864133	Jawa Timur	GI 150 kV Sumenep	310	58.24	58	Medium	0.975	< 100.000	14	Water Catchment Areas	N/A, Right of Ownership (HM)
S109	73	-6.891748	113.968872	Jawa Timur	GI 150 kV Sumenep	310	49.92	50	Medium	0.943	< 100.000	19	Holticulture	N/A

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S110	69	-6.897391	113.97715	Jawa Timur	GI 150 kV Sumenep	310	29.52	30	High	0.948	< 100.000	20	Food Crops Agricultural	SPPFBT, Right of Ownership (HM)
S111	113	-6.908124	114.004647	Jawa Timur	GI 150 kV Sumenep	310	76.26	76	Medium	0.991	< 100.000	21	Water Catchment Areas	SPPFBT, Right of Ownership (HM)
S112	72	-6.919903	114.020474	Jawa Timur	GI 150 kV Sumenep	310	30.43	30	Medium	0.996	< 100.000	22	Holticulture	N/A, Right of Ownership (HM)
S113	81	-6.919549	113.786772	Jawa Timur	GI 150 kV Sumenep	310	85.73	86	High	0.954	< 100.000	11	Holticulture	SPPFBT, Right of Ownership (HM)
S114	83	-6.924807	113.728822	Jawa Timur	GI 150 kV Sumenep	310	86.76	87	Medium	0.965	< 100.000	15	Holticulture	N/A
S115	13	-6.949569	113.653144	Jawa Timur	GI 150 kV Sumenep	310	94.76	95	Medium	0.985	< 100.000	21	Rock Mining Area	N/A, SPPFBT
S116	61	-6.886059	113.838383	Jawa Timur	GI 150 kV Sumenep	310	47.09	47	High	0.995	< 100.000	13	Food Crops Estate	N/A, Right of Ownership (HM)
S117	55	-6.881294	113.848313	Jawa Timur	GI 150 kV Sumenep	310	24.58	25	Medium	0.994	< 100.000	14	Food Crops Estate	SPPFBT, Right of Ownership (HM)
S118	6	-6.879662	113.875716	Jawa Timur	GI 150 kV Sumenep	310	33.20	33	Medium	0.979	< 100.000	15	Dryland Agricultural Area	N/A, SPPFBT, Right of Ownership (HM)
S119	43	-6.885831	113.924179	Jawa Timur	GI 150 kV Sumenep	310	54.35	54	High	0.939	N/A	16	Dryland Agricultural Area	SPPFBT, Right of Ownership (HM)
S120	25	-6.768347	111.943708	Jawa Timur	GI 150 kV Tanjung Awar Awar	250	46.60	47	Medium	1	500.000 - 1.000.000	74	Industrial Designation Area	N/A
S121	33	-6.770969	111.968529	Jawa Timur	GI 150 kV Tanjung Awar Awar	250	33.53	34	Medium	0.999	200.000 - 500.000	54	Industrial Designation Area	N/A
S122	44	-6.936296	112.148195	Jawa Timur	GI 150 kV Tuban	1100	6.99	7	Medium	0.982	200.000 - 500.000	1	Food Crops Estate	N/A, Right of Ownership (HM)
S123	74	-6.942557	112.146967	Jawa Timur	GI 150 kV Tuban	1100	26.10	26	Medium	0.94	200.000 - 500.000	14	Food Crops Estate	N/A
S124	95	-6.940865	112.139568	Jawa Timur	GI 150 kV Tuban	1100	51.44	51	Medium	0.906	200.000 - 500.000	13	Food Crops Estate	Right of Ownership (HM)
S125	99	-6.935325	112.156381	Jawa Timur	GI 150 kV Tuban	1100	18.34	18	Medium	0.975	200.000 - 500.000	14	Food Crops Estate	N/A, Right of Ownership (HM)
S126	91	-7.035883	111.95829	Jawa Timur	GI 150 kV Tuban	1100	64.34	64	Medium	0.925	100.000 - 200.000	2	Food Crops Estate	N/A, Right of Ownership (HM)

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S127	92	-6.986106	112.068169	Jawa Timur	GI 150 kV Tuban	1100	78.39	78	Medium	0.986	100.000 - 200.000	11	Food Crops Estate	N/A, Right of Ownership (HM)
S128	63	-7.715003	111.34321	Jawa Timur	GI 70 kV Magetan	75	199.71	75	Medium	0.942	< 100.000	80	Food Crops Agricultural	Right of Ownership (HM)
S129	66	-7.596396	112.67149	Jawa Timur	GI 70 kV Pandaan	90	102.17	90	Medium	0.907	< 100.000	58	Dryland Agricultural Designation Area	Right of Ownership (HM)
S130	121	-7.715605	112.297694	Jawa Timur	GI 70 kV Siman	65	217.87	65	Medium	0.79	100.000 - 200.000	13	Plantation Area	Right of Ownership (HM)
S131	62	-7.699438	112.767905	Jawa Timur	GI 70 kV Sukorejo	50	63.04	50	Medium	0.988	< 100.000	63	Dryland Agricultural Designation Area	N/A
S132	10	-8.096548	115.250903	Bali	GI 150 kV Baturiti	240	45.26	45	Medium	0.867	< 100.000	20	Tourism Designation Area	Right of Ownership (HM)
S133	109	-8.102311	115.273379	Bali	GI 150 kV Baturiti	240	51.84	52	Medium	0.868	500.000 - 1.000.000	21	Plantation and Holticulture Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S134	112	-8.116732	115.27702	Bali	GI 150 kV Baturiti	240	213.90	214	Medium	0.891	100.000 - 200.000	20	Plantation and Holticulture Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S135	5	-8.409523	114.84328	Bali	GI 150 kV Negara	350	324.77	325	Medium	0.872	200.000 - 500.000	21	Tourism Area	N/A, Right to Use
S136	78	-8.293214	114.577632	Bali	GI 150 kV Negara	350	96.18	96	Medium	0.869	100.000 - 200.000	12	Plantation Area	SPPFBT, Right of Ownership (HM)
S137	114	-8.091324	115.172601	Bali	GI 150 kV Pemaron	210	19.36	19	High	0.965	1.000.000 - 2.000.000	13	Food Crop Agricultural Designation Area	SPPFBT, Right of Ownership (HM)
S138	138	-6.993032	108.701195	Jawa Barat	GI 70 kV Babakan	80	133.16	80	EXCLUDED	0.912	100.000 - 200.000	12	Prone to Ground Movement Area	N/A

S_id	MCDM Rank	Latitude	Longitude	ADM1	HubName	Maximum Hosting Capacity (MW)	Estimated Available Land Coverage Area (ha)	Solar PV Potential (MW) - Individual	RISK	Geospatial Score	Land Value Zone/ZNT (Rp/m2)	Hub Distance (kmr)	Land Category at Regency Level	Type of Right of Land
S139	139	-7.057922	108.479136	Jawa Barat	GI 70 kV Kuningan	80	215.76	80	EXCLUDED	0.747	< 100.000	10	Prone to Ground Movement Area	N/A
S140	140	-6.849257	107.87823	Jawa Barat	GI 70 kV Sumedang	100	40.91	41	EXCLUDED	0.784	1.000.000 - 2.000.000	36	Ground Movement (Protected Designation Area)	N/A, Right of Ownership (HM)

3. Annex C: Geospatial MCDM Result

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S1	-6.93775	106.283811	Banten	0.732	227	1773.6	1418.5	0.796	1	1	0.809	0.707	0.635	1	876.70
S2	-6.446755	106.368132	Banten	0.752	79	1721.6	1371.3	0.675	0.958	0.949	0.998	0.66	0.92	1	931.05
S3	-6.425143	106.352366	Banten	0.842	60	1715.1	1366.3	0.662	0.968	0.911	1	1	0.92	1	531.82
S4	-6.318448	106.323406	Banten	0.833	41	1688.4	1343.5	0.608	0.908	1	1	1	0.891	1	20.24
S5	-6.369875	106.415828	Banten	0.848	59	1708.7	1361.4	0.648	0.92	1	1	1	0.891	1	104.41
S6	-6.38938	106.407981	Banten	0.855	74	1713.2	1365.2	0.662	0.936	1	1	1	0.898	1	269.79
S7	-6.082806	106.140263	Banten	0.869	20	1724.6	1374	0.673	0.981	1	0.996	1	0.959	1	71.62
S8	-6.540033	105.703628	Banten	0.781	25	1707.4	1363.9	0.65	0.983	1	0.962	1	0.566	1	381.93
S9	-7.224362	108.411471	Jawa Barat	0.787	321	1659.1	1322.6	0.562	0.7	0.987	0.798	1	0.955	1	10.57
S10	-7.185267	108.421359	Jawa Barat	0.79	430	1648.7	1321.1	0.551	0.7	0.98	0.841	1	0.957	1	105.04
S11	-6.721517	107.144888	Jawa Barat	0.796	667	1791.3	1437.2	0.832	0.977	0.799	0.615	1	0.829	1	21.27
S12	-6.573166	107.898683	Jawa Barat	0.933	51	1819.4	1442.3	0.848	0.961	1	0.978	1	0.966	1	106.28
S13	-6.525476	108.137335	Jawa Barat	0.965	26	1852.9	1466.6	0.91	1	1	1	1	0.991	1	97.14
S14	-6.574419	107.915029	Jawa Barat	0.929	46	1821.3	1443.2	0.851	0.956	1	0.989	0.977	0.966	1	97.14
S15	-6.575333	107.920984	Jawa Barat	0.936	52	1820.3	1442.5	0.851	0.955	1	0.988	1	0.965	1	110.49
S16	-6.546382	108.205422	Jawa Barat	0.894	28	1867.6	1478.5	0.94	1	1	1	0.724	0.993	1	184.03
S17	-6.560381	107.129157	Jawa Barat	0.78	177	1769.8	1407.4	0.765	0.96	0.76	0.66	1	0.874	1	86.31
S18	-6.46369	107.20107	Jawa Barat	0.882	37	1768.8	1401.4	0.752	0.937	1	0.95	1	0.912	1	22.34
S19	-6.508367	107.213365	Jawa Barat	0.856	89	1770.8	1408.3	0.768	0.974	1	0.8	1	0.896	1	246.75
S20	-7.733974	108.038529	Jawa Barat	0.818	42	1786.6	1427.3	0.794	0.785	1	0.94	1	0.5	1	185.51
S21	-7.727922	108.378377	Jawa Barat	0.843	119	1725.9	1387.3	0.714	0.942	1	0.978	0.862	0.974	1	218.58
S22	-6.407955	107.34291	Jawa Barat	0.911	30	1782.8	1417.7	0.785	0.953	1	0.992	1	0.959	1	39.07
S23	-6.80754	108.538932	Jawa Barat	0.929	150	1853	1481.3	0.939	0.974	0.9	0.846	1	0.998	1	360.02
S24	-6.363727	107.246842	Jawa Barat	0.893	57	1757	1399.3	0.742	0.973	0.99	1	1	0.956	1	141.32

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S25	-6.549476	107.5913	Jawa Barat	0.892	187	1769.3	1408.3	0.766	0.964	0.966	0.954	1	0.97	1	766.58
S26	-7.387065	107.197134	Jawa Barat	0.75	304	1702	1363.5	0.651	1	1	0.743	0.862	0.839	1	13.85
S27	-7.416727	107.063116	Jawa Barat	0.895	82	1846.3	1476.1	0.91	1	0.998	0.928	1	0.694	1	61.46
S28	-7.343449	107.115982	Jawa Barat	0.746	397	1678.7	1347.7	0.605	0.987	0.866	0.733	1	0.831	1	76.34
S29	-7.460115	107.366101	Jawa Barat	0.865	136	1811.6	1444.4	0.842	1	0.955	0.806	1	0.831	1	174.33
S30	-7.336353	107.108033	Jawa Barat	0.769	440	1673.1	1342.3	0.596	0.982	1	0.74	1	0.834	1	58.35
S31	-6.801179	108.603961	Jawa Barat	0.994	14	1896	1513	1	0.995	1	0.972	1	0.996	1	106.19
S32	-6.569329	107.491233	Jawa Barat	0.754	98	1771.2	1406	0.759	0.991	0.966	0.93	0.574	0.954	1	157.96
S33	-6.55169	107.046818	Jawa Barat	0.822	474	1750	1403.9	0.759	0.978	0.934	0.682	1	0.914	1	101.20
S34	-7.412025	107.007522	Jawa Barat	0.864	84	1851.4	1480.2	0.935	0.995	1	0.947	0.846	0.701	1	374.44
S35	-7.423571	106.991565	Jawa Barat	0.928	42	1866.8	1492.5	0.97	0.992	1	0.973	1	0.7	1	241.52
S36	-7.164091	106.800571	Jawa Barat	0.813	497	1700.9	1369.2	0.672	0.876	0.95	0.862	1	0.845	1	56.87
S37	-7.396133	106.867631	Jawa Barat	0.914	77	1830	1464.5	0.904	1	0.986	0.95	1	0.798	1	220.12
S38	-7.133943	106.950902	Jawa Barat	0.723	691	1621.3	1304.3	0.506	0.889	0.881	0.774	1	0.854	1	37.00
S39	-6.934184	108.695733	Jawa Barat	0.927	29	1832.3	1456.8	0.89	0.964	0.891	0.955	1	0.983	1	147.01
S40	-7.012972	107.104993	Jawa Barat	0.779	1025	1672.9	1359.2	0.639	0.882	0.979	0.671	1	0.891	1	94.15
S41	-6.776488	108.158431	Jawa Barat	0.944	53	1825.3	1445.9	0.864	0.926	1	0.976	1	0.997	1	126.10
S42	-6.66601	108.086401	Jawa Barat	0.962	51	1855.4	1470.7	0.918	0.975	1	0.986	1	0.975	1	340.68
S43	-6.812715	108.214043	Jawa Barat	0.903	105	1795.8	1425.2	0.805	0.908	1	0.882	1	0.992	1	162.49
S44	-7.00293	108.608177	Jawa Barat	0.922	156	1826.7	1454.7	0.877	0.941	1	0.841	1	0.986	1	138.55
S45	-7.064115	108.536559	Jawa Barat	0.814	273	1793	1428.3	0.812	0.939	1	0.644	0.862	0.959	1	160.99
S46	-7.211387	107.03726	Jawa Barat	0.629	428	1635.8	1305.7	0.51	0.928	0.835	0.725	0.724	0.877	1	32.11
S47	-7.013509	107.076605	Jawa Barat	0.735	994	1659.4	1347.1	0.608	0.902	0.8	0.688	1	0.881	1	19.94
S48	-7.223319	107.025116	Jawa Barat	0.717	359	1650	1315.1	0.548	0.931	1	0.735	0.862	0.878	1	84.84
S49	-7.677255	107.893422	Jawa Barat	0.813	282	1778	1430.8	0.818	0.837	0.925	0.79	1	0.648	1	45.87
S50	-7.536841	107.553677	Jawa Barat	0.813	112	1825.3	1454.7	0.874	1	0.51	0.815	1	0.927	1	167.67

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S51	-7.501746	107.448508	Jawa Barat	0.896	54	1833.7	1462.1	0.89	1	0.963	0.824	1	0.876	1	292.44
S52	-7.699123	108.409613	Jawa Barat	0.629	105	1735.5	1392.4	0.724	0.963	0.903	0.969	0.2	0.977	1	118.45
S53	-6.636831	108.026444	Jawa Barat	0.935	75	1837.8	1456.9	0.884	0.962	1	0.919	1	0.965	1	210.10
S54	-7.501991	107.482838	Jawa Barat	0.862	179	1817.8	1453.7	0.857	1	0.866	0.774	1	0.908	1	61.55
S55	-7.226885	106.487818	Jawa Barat	0.843	28	1778.5	1425.9	0.806	0.969	0.964	0.766	1	0.818	1	25.10
S56	-6.923886	109.819915	Jawa Tengah	0.941	60	1918.5	1535.6	1	1	0.769	0.929	1	0.983	1	196.38
S57	-6.996164	111.246076	Jawa Tengah	0.906	101	1872.6	1484.6	0.953	0.834	1	0.996	0.746	1	1	266.01
S58	-7.214495	110.564115	Jawa Tengah	0.962	121	1907.9	1516.5	1	0.93	0.916	0.881	1	1	1	123.78
S59	-7.285359	110.868949	Jawa Tengah	0.997	119	1935.1	1537.5	1	0.933	1	1	1	0.982	1	163.35
S60	-7.390214	108.764788	Jawa Tengah	0.82	218	1687.3	1353.5	0.624	0.787	0.889	0.902	1	1	1	474.72
S61	-7.488894	110.66251	Jawa Tengah	0.987	265	1956.8	1564.5	1	0.964	1	0.93	1	1	0.999	76.74
S62	-7.638159	110.934651	Jawa Tengah	0.977	159	1863.9	1482.9	0.949	0.838	1	0.98	1	0.999	1	331.64
S63	-7.093456	109.357606	Jawa Tengah	0.805	206	1726.4	1379	0.686	0.915	0.91	0.685	1	0.993	1	239.00
S64	-7.028522	109.507938	Jawa Tengah	0.896	29	1761.1	1404.5	0.758	0.949	1	0.928	1	1	1	262.3407
S65	-6.728982	111.541064	Jawa Tengah	0.864	135	1901.8	1526.4	1	0.958	0.782	0.712	0.862	0.997	1	101.27
S66	-6.801009	111.327478	Jawa Tengah	0.954	71	1830.7	1461.4	0.896	0.721	1	0.974	1	0.987	1	82.23
S67	-6.81405	111.536483	Jawa Tengah	0.928	138	1836.5	1468.8	0.914	0.762	1	0.786	1	0.998	1	121.24
S68	-6.861324	111.581306	Jawa Tengah	0.956	115	1847.6	1473.1	0.925	0.71	1	0.913	1	0.999	1	91.22
S69	-7.056141	110.13914	Jawa Tengah	0.935	114	1836.5	1472.3	0.921	0.899	1	0.815	1	0.993	1	127.15
S70	-7.063862	110.161113	Jawa Tengah	0.922	72	1827.5	1460.9	0.897	0.897	0.961	0.838	1	0.99	1	42.42
S71	-6.924883	109.92602	Jawa Tengah	0.99	67	1941.3	1558.4	1	1	1	0.947	1	0.998	1	61.60
S72	-6.985719	108.790202	Jawa Tengah	0.961	44	1850.2	1473.9	0.925	0.953	1	0.961	1	0.98	1	110.97
S73	-6.463676	110.978186	Jawa Tengah	0.973	58	1893.5	1521.8	1	1	1	0.857	1	0.999	1	499.05
S74	-7.100333	113.017469	Jawa Timur	0.986	41	1886.7	1506.7	0.997	0.838	1	0.932	1	0.998	1	110.45
S75	-6.909194	112.994416	Jawa Timur	0.988	32	1859.6	1492	0.988	0.7	1	0.967	1	0.994	1	150.66
S76	-8.255255	114.263197	Jawa Timur	0.93	217	1857.2	1479.4	0.947	0.889	0.868	0.864	1	1	1	70.71

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S77	-7.029902	111.934325	Jawa Timur	0.877	435	1898.9	1527.7	1	0.895	0.563	0.795	1	0.986	1	19.59
S78	-7.037614	111.946113	Jawa Timur	0.95	374	1913.4	1535.2	1	0.901	0.955	0.792	1	0.984	1	41.85
S79	-7.251292	111.699117	Jawa Timur	0.997	57	1920.4	1522.1	1	0.846	1	1	1	0.983	1	146.61
S80	-8.379733	114.049428	Jawa Timur	0.853	181	1747.3	1395.5	0.748	0.7	1	0.725	1	0.991	1	157.13
S81	-8.403846	114.072117	Jawa Timur	0.808	145	1764.2	1407.5	0.766	0.7	1	0.774	0.797	0.996	1	206.47
S82	-8.327976	114.051084	Jawa Timur	0.855	258	1762.5	1403.8	0.747	0.7	1	0.754	1	0.979	1	30.60
S83	-7.741457	112.859112	Jawa Timur	0.97	63	1992	1588.4	1	0.981	1	0.87	1	0.971	1	63.40
S84	-6.936615	111.889799	Jawa Timur	0.935	258	1850.1	1481.3	0.947	0.822	0.829	0.933	1	0.996	1	28.75
S85	-6.926187	111.876359	Jawa Timur	0.95	183	1848	1481.3	0.942	0.813	0.933	0.918	1	0.997	1	120.99
S86	-6.813834	111.734607	Jawa Timur	0.994	48	1929	1536.3	1	0.843	0.974	1	1	0.994	1	154.16
S87	-6.800867	111.719162	Jawa Timur	0.999	46	1935.5	1543.1	1	0.884	1	1	1	0.993	1	141.71
S88	-7.672422	112.770756	Jawa Timur	0.992	84	2002.8	1594.3	1	1	1	0.967	1	0.991	1	103.33
S89	-7.740245	112.834374	Jawa Timur	0.971	68	1988.5	1584.6	1	0.981	1	0.87	1	0.977	1	49.15
S90	-6.931467	113.099427	Jawa Timur	0.951	130	1836.7	1477.8	0.928	0.7	0.92	0.963	1	1	1	77.59
S91	-6.929501	113.114488	Jawa Timur	0.946	133	1841.3	1481.1	0.946	0.7	0.854	0.964	1	1	1	69.64
S92	-7.160636	113.035305	Jawa Timur	0.998	20	1938	1548.8	1	0.915	1	0.991	1	1	1	119.23
S93	-6.848907	111.621764	Jawa Timur	0.964	108	1857.7	1481.8	0.943	0.7	1	0.96	0.979	0.996	1	116.68
S94	-6.888254	113.858622	Jawa Timur	0.986	97	1905	1526.8	1	0.803	0.978	0.957	1	0.991	1	422.42
S95	-6.940136	114.045873	Jawa Timur	1	51	1960.7	1570.7	1	0.953	1	1	1	0.998	1	150.98
S96	-6.971228	113.985799	Jawa Timur	0.995	63	1924.4	1538.6	1	0.927	1	0.985	1	0.989	1	83.66
S97	-6.918821	114.012356	Jawa Timur	0.979	59	1915.7	1529.9	1	0.925	0.92	0.97	1	0.996	1	82.16
S98	-6.949569	113.653144	Jawa Timur	0.985	150	1871.3	1504	1	0.719	1	0.92	1	1	1	230.19
S99	-6.92464	113.723392	Jawa Timur	0.923	126	1884.5	1515.1	1	0.762	1	0.901	0.806	0.999	1	190.13
S100	-6.924807	113.728822	Jawa Timur	0.965	113	1885.7	1514.6	1	0.759	1	0.908	0.942	0.999	1	34.81
S101	-6.919549	113.786772	Jawa Timur	0.954	142	1887.8	1516.2	1	0.755	0.804	0.957	1	0.993	1	105.07
S102	-6.95054	113.650841	Jawa Timur	0.986	151	1870.4	1506.4	1	0.716	1	0.923	1	1	1	38.25

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S103	-6.908124	114.004647	Jawa Timur	0.991	75	1938.6	1550.2	1	0.935	1	0.954	1	0.996	1	23.42
S104	-6.88439	113.86962	Jawa Timur	0.976	79	1903.6	1525.5	1	0.824	0.922	0.956	1	0.992	1	79.49
S105	-6.88157	113.864133	Jawa Timur	0.975	63	1913	1530.8	1	0.824	0.911	0.965	1	0.992	1	22.65
S106	-6.885831	113.924179	Jawa Timur	0.939	212	1898.4	1531.7	1	0.874	0.758	0.923	1	0.992	1	89.98
S107	-6.891748	113.968872	Jawa Timur	0.943	131	1927.1	1544.1	1	0.907	0.796	0.906	1	0.994	1	73.70
S108	-6.886059	113.838383	Jawa Timur	0.995	30	1907.7	1527.1	1	0.798	1	0.978	1	0.992	1	58.24
S109	-6.879662	113.875716	Jawa Timur	0.979	72	1911.8	1531.7	1	0.853	0.938	0.959	1	0.992	1	49.92
S110	-6.919903	114.020474	Jawa Timur	0.996	35	1926.1	1539.8	1	0.929	1	0.984	1	0.997	1	29.52
S111	-6.897391	113.97715	Jawa Timur	0.948	114	1934.6	1548.9	1	0.917	0.824	0.905	1	0.994	1	76.26
S112	-6.881294	113.848313	Jawa Timur	0.994	27	1914.5	1530.9	1	0.801	1	0.977	1	0.993	1	30.43
S113	-6.921716	113.595546	Jawa Timur	0.984	154	1871.8	1511.8	1	0.718	0.997	0.92	1	1	1	85.73
S114	-6.934192	113.641757	Jawa Timur	0.983	108	1870.2	1507	1	0.734	0.989	0.922	1	1	1	86.76
S115	-6.851106	111.875362	Jawa Timur	0.84	99	1918.9	1533.9	1	0.95	0.953	0.963	0.516	1	1	94.76
S116	-6.906619	111.79984	Jawa Timur	0.89	170	1829.9	1461.1	0.898	0.778	0.882	0.904	0.893	1	1	47.09
S117	-6.901331	111.823752	Jawa Timur	0.95	214	1835.6	1467.8	0.918	0.785	1	0.895	1	1	1	24.58
S118	-7.729317	114.03488	Jawa Timur	0.983	112	2081.9	1657.8	1	0.931	0.913	1	1	0.997	1	33.20
S119	-7.79798	114.117181	Jawa Timur	0.98	139	2013.4	1608.3	1	0.849	0.985	0.908	1	0.999	1	54.35
S120	-6.768347	111.943708	Jawa Timur	1	8	2039.7	1632.2	1	1	1	1	1	0.999	1	46.60
S121	-6.770969	111.968529	Jawa Timur	0.999	12	2038.6	1631.7	1	1	1	1	1	0.997	1	33.53
S122	-6.986106	112.068169	Jawa Timur	0.986	50	1906.1	1521.6	1	0.88	1	0.927	1	1	1	6.99
S123	-7.035883	111.95829	Jawa Timur	0.925	324	1915.4	1533.8	1	0.897	0.839	0.773	1	0.986	1	26.10
S124	-6.940865	112.139568	Jawa Timur	0.906	77	1909.3	1527.5	1	0.861	0.518	0.978	1	1	1	51.44
S125	-6.942557	112.146967	Jawa Timur	0.94	84	1904.1	1520.2	1	0.862	0.703	0.976	1	1	1	18.34
S126	-6.935325	112.156381	Jawa Timur	0.975	77	1912	1531.1	1	0.869	0.889	0.979	1	1	1	64.34
S127	-6.936296	112.148195	Jawa Timur	0.982	93	1912.3	1532.9	1	0.861	0.925	0.98	1	1	1	78.39
S128	-7.715003	111.34321	Jawa Timur	0.942	300	1967.4	1571.1	1	0.934	0.956	0.807	1	0.928	1	199.71

S_id	latitude	longitude	admin1	Geospatial Score	Elevation	GHI	PVOUT	PVout Score	Intermittency Score	Terrain Slope Score	Terrain Complexity Score	Road Access Score	Earthquakes Score	Volcanic activity	Estimated Available Land Coverage Area (ha)
S129	-7.596396	112.67149	Jawa Timur	0.907	111	1962.6	1561.4	1	1	0.859	0.655	1	0.986	1	102.17
S130	-7.715605	112.297694	Jawa Timur	0.79	140	1758.8	1403.3	0.729	0.81	0.944	0.866	0.793	0.985	0.975	217.87
S131	-7.699438	112.767905	Jawa Timur	0.988	105	1991.7	1585.8	1	0.991	1	0.946	1	0.991	1	63.04
S132	-8.116732	115.27702	Bali	0.891	285	1915.5	1555.3	1	1	0.924	0.516	1	0.975	1	45.26
S133	-8.102311	115.273379	Bali	0.868	91	1978.8	1600.5	1	1	0.711	0.608	1	0.977	1	51.84
S134	-8.096548	115.250903	Bali	0.867	156	2009.1	1624.1	1	1	0.697	0.613	1	0.977	1	213.90
S135	-8.409523	114.84328	Bali	0.872	105	1807.4	1442.3	0.825	0.827	0.93	0.747	1	0.988	1	324.77
S136	-8.293214	114.577632	Bali	0.869	76	1794.5	1436.8	0.829	0.817	0.947	0.727	1	0.968	1	96.18
S137	-8.091324	115.172601	Bali	0.965	82	2040.7	1646	1	0.949	0.955	0.873	1	0.984	1	19.36
S138	-6.993032	108.701195	Jawa Barat	0.912	74	1818.6	1443.3	0.849	0.967	0.929	0.912	1	0.992	1	133.16
S139	-7.057922	108.479136	Jawa Barat	0.747	354	1789	1423.9	0.769	0.947	0.763	0.614	0.862	0.951	1	215.76
S140	-6.849257	107.87823	Jawa Barat	0.784	710	1786.7	1434.2	0.831	0.927	0.655	0.56	1	0.969	1	40.91

4. Annex D: Environmental and Social Analysis Result

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
1	-6.93775	106.283811	Banten	1	1	1	2	3	1	1	1	1	**9**	Medium
2	-6.446755	106.368132	Banten	1	1	1	2	3	1	1	1	3	**11**	High
3	-6.425143	106.352366	Banten	1	1	1	3	3	1	1	1	3	**12**	High
4	-6.318448	106.323406	Banten	1	1	1	2	3	1	1	1	3	**11**	High
5	-6.369875	106.415828	Banten	1	1	1	3	3	1	1	1	3	**12**	High
6	-6.38938	106.407981	Banten	1	1	1	3	3	1	1	1	3	**12**	High
7	-6.082806	106.140263	Banten	1	1	1	3	3	1	1	1	1	**10**	High
8	-6.540033	105.703628	Banten	1	1	1	2	3	1	1	1	1	**9**	Medium
9	-7.224362	108.411471	Jawa Barat	1	1	1	2	3	1	1	1	1	**9**	Medium
10	-7.185267	108.421359	Jawa Barat	1	1	1	2	3	1	1	1	1	**9**	Medium
11	-6.721517	107.144888	Jawa Barat	1	1	1	2	3	1	1	1	1	**9**	Medium
12	-6.573166	107.898683	Jawa Barat	1	1	1	2	3	2	1	1	1	**10**	High
13	-6.525476	108.137335	Jawa Barat	1	1	1	3	3	1	1	1	1	**10**	High
14	-6.574419	107.915029	Jawa Barat	1	1	1	2	3	2	1	1	1	**10**	High
15	-6.575333	107.920984	Jawa Barat	1	1	1	2	3	2	1	1	1	**10**	High
16	-6.546382	108.205422	Jawa Barat	1	1	1	3	3	1	1	1	1	**10**	High
17	-6.560381	107.129157	Jawa Barat	1	1	1	3	3	1	1	1	1	**10**	High
18	-6.46369	107.20107	Jawa Barat	1	1	1	2	3	1	1	1	1	**9**	Medium
19	-6.508367	107.213365	Jawa Barat	1	1	1	2	3	1	1	1	1	**9**	Medium

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
20	-7.733974	108.038529	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
21	-7.727922	108.378377	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
22	-6.407955	107.34291	Jawa Barat	1	1	1	1	3	1	3	1	1	10	High
23	-6.80754	108.538932	Jawa Barat	1	1	1	1	3	1	1	1	1	8	Medium
24	-6.363727	107.246842	Jawa Barat	1	1	1	1	3	1	1	1	1	8	Medium
25	-6.549476	107.5913	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
26	-7.387065	107.197134	Jawa Barat	1	1	1	2	3	1	2	1	1	10	High
27	-7.416727	107.063116	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
28	-7.343449	107.115982	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
29	-7.460115	107.366101	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
30	-7.336353	107.108033	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
31	-6.801179	108.603961	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
32	-6.569329	107.491233	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
33	-6.55169	107.046818	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
34	-7.412025	107.007522	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
35	-7.423571	106.991565	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
36	-7.164091	106.800571	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
37	-7.396133	106.867631	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
38	-7.133943	106.950902	Jawa Barat	1	1	1	3	3	1	1	1	3	12	High
39	-6.934184	108.695733	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
40	-7.012972	107.104993	Jawa Barat	1	1	1	2	3	2	1	1	3	12	High

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
41	-6.776488	108.158431	Jawa Barat	1	1	1	1	3	1	1	1	1	8	Medium
42	-6.66601	108.086401	Jawa Barat	1	1	1	1	3	1	1	1	1	8	Medium
43	-6.812715	108.214043	Jawa Barat	1	1	1	1	3	1	2	1	1	9	Medium
44	-7.00293	108.608177	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
45	-7.064115	108.536559	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
46	-7.211387	107.03726	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
47	-7.013509	107.076605	Jawa Barat	1	1	1	2	3	1	1	1	3	11	High
48	-7.223319	107.025116	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
49	-7.677255	107.893422	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
50	-7.536841	107.553677	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
51	-7.501746	107.448508	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
52	-7.699123	108.409613	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
53	-6.636831	108.026444	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
54	-7.501991	107.482838	Jawa Barat	1	1	1	2	3	1	1	1	1	9	Medium
55	-7.226885	106.487818	Jawa Barat	1	1	1	3	3	1	1	1	1	10	High
56	-6.923886	109.819915	Jawa Tengah	1	1	1	1	3	1	1	1	1	8	Medium
57	-6.996164	111.246076	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
58	-7.214495	110.564115	Jawa Tengah	1	1	1	2	3	1	2	1	1	10	High
59	-7.285359	110.868949	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
60	-7.390214	108.764788	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
61	-7.488894	110.66251	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
62	-7.638159	110.934651	Jawa Tengah	1	1	1	3	3	1	1	1	1	10	High
63	-7.093456	109.357606	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
64	-7.028522	109.507938	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
65	-6.728982	111.541064	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
66	-6.801009	111.327478	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
67	-6.81405	111.536483	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
68	-6.861324	111.581306	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
69	-7.056141	110.13914	Jawa Tengah	1	1	1	2	3	2	1	1	1	10	High
70	-7.063862	110.161113	Jawa Tengah	1	1	1	2	3	2	1	1	1	10	High
71	-6.924883	109.92602	Jawa Tengah	1	1	1	1	3	1	1	1	1	8	Medium
72	-6.985719	108.790202	Jawa Tengah	1	1	1	2	3	1	1	1	1	9	Medium
73	-6.463676	110.978186	Jawa Tengah	1	1	1	2	3	2	1	1	1	10	High
74	-7.100333	113.017469	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
75	-6.909194	112.994416	Jawa Timur	1	1	1	3	3	1	1	1	1	10	High
76	-8.255255	114.263197	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
77	-7.029902	111.934325	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
78	-7.037614	111.946113	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
79	-7.251292	111.699117	Jawa Timur	1	1	1	2	3	2	1	1	1	**10**	High
80	-8.379733	114.049428	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
81	-8.403846	114.072117	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
82	-8.327976	114.051084	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
83	-7.741457	112.859112	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
84	-6.936615	111.889799	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
85	-6.926187	111.876359	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
86	-6.813834	111.734607	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
87	-6.800867	111.719162	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
88	-7.672422	112.770756	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
89	-7.740245	112.834374	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
90	-6.931467	113.099427	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
91	-6.929501	113.114488	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
92	-7.160636	113.035305	Jawa Timur	1	1	1	1	3	1	1	1	1	**8**	Medium
93	-6.848907	111.621764	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
94	-6.888254	113.858622	Jawa Timur	1	1	1	3	3	1	1	1	1	**10**	High
95	-6.940136	114.045873	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium
96	-6.971228	113.985799	Jawa Timur	1	1	1	3	3	1	1	1	1	**10**	High
97	-6.918821	114.012356	Jawa Timur	1	1	1	3	3	1	1	1	1	**10**	High
98	-6.949569	113.653144	Jawa Timur	1	1	1	2	3	1	1	1	1	**9**	Medium

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
99	-6.92464	113.723392	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
100	-6.924807	113.728822	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
101	-6.919549	113.786772	Jawa Timur	1	1	1	3	3	1	1	1	1	10	High
102	-6.95054	113.650841	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
103	-6.908124	114.004647	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
104	-6.88439	113.86962	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
105	-6.88157	113.864133	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
106	-6.885831	113.924179	Jawa Timur	1	1	1	3	3	1	1	1	1	10	High
107	-6.891748	113.968872	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
108	-6.886059	113.838383	Jawa Timur	1	1	1	3	3	1	1	1	1	10	High
109	-6.879662	113.875716	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
110	-6.919903	114.020474	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
111	-6.897391	113.97715	Jawa Timur	1	1	1	3	3	1	1	1	1	10	High
112	-6.881294	113.848313	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
113	-6.921716	113.595546	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
114	-6.934192	113.641757	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
115	-6.851106	111.875362	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
116	-6.906619	111.79984	Jawa Timur	1	1	1	2	3	2	1	1	1	10	High
117	-6.901331	111.823752	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
118	-7.729317	114.03488	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
119	-7.79798	114.117181	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium

S_id	Latitude	Longitude	ADM1	Scoring Summary									Total Score	Site rating
				Regulatory Review				Environmental Screening		PS 5	PS 6			
				PIPPIB Status	Mangroves Area	Forestry Status	Regional Spatial Plan Category	Water Risk	Social forest surrounding project area	Presence of Population, physical and economical displace	High biodiversity value area (WHS, AZE, IBA, KBA, PA, WDPA)	UNEP WCMC Global Critical Habitat, trigger critical habitat		
120	-6.768347	111.943708	Jawa Timur	1	1	1	1	3	1	1	1	1	8	Medium
121	-6.770969	111.968529	Jawa Timur	1	1	1	1	3	1	1	1	1	8	Medium
122	-6.986106	112.068169	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
123	-7.035883	111.95829	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
124	-6.940865	112.139568	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
125	-6.942557	112.146967	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
126	-6.935325	112.156381	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
127	-6.936296	112.148195	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
128	-7.715003	111.34321	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
129	-7.596396	112.67149	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
130	-7.715605	112.297694	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
131	-7.699438	112.767905	Jawa Timur	1	1	1	2	3	1	1	1	1	9	Medium
132	-8.116732	115.27702	Bali	1	1	1	2	3	1	1	1	1	9	Medium
133	-8.102311	115.273379	Bali	1	1	1	2	3	1	1	1	1	9	Medium
134	-8.096548	115.250903	Bali	1	1	1	2	3	1	1	1	1	9	Medium
135	-8.409523	114.84328	Bali	1	1	1	2	3	1	1	1	1	9	Medium
136	-8.293214	114.577632	Bali	1	1	1	2	3	1	1	1	1	9	Medium
137	-8.091324	115.172601	Bali	1	1	1	2	3	1	2	1	1	10	High
138	-6.993032	108.701195	Jawa Barat	EXCLUDED										EXCLUDED
139	-7.057922	108.479136	Jawa Barat	EXCLUDED										EXCLUDED
140	-6.849257	107.87823	Jawa Barat	EXCLUDED										EXCLUDED

5. Annex E: Preliminary Grid Integration Analysis

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S1	-6.93775	106.283811	876.70	877	GI 150 kV Bayah	160	160	160	34
S2	-6.446755	106.368132	931.05	931	GI 150 kV Rangkasbitung	260	260	260	14
S3	-6.425143	106.352366	531.82	532	GI 150 kV Rangkasbitung	260	260		11
S4	-6.318448	106.323406	20.24	20	GI 150 kV Rangkasbitung	260	20		78
S5	-6.38938	106.407981	104.41	104	GI 150 kV Tigaraksa	560	104	104	15
S6	-6.369875	106.415828	269.79	270	GI 150 kV Tigaraksa	560	270	270	12
S7	-6.082806	106.140263	71.62	72	GI 70 kV Serang	145	72	72	47
S8	-6.540033	105.703628	381.93	382	GIS 150 kV PLTU Labuan	480	382	382	2
S9	-7.185267	108.421359	10.57	11	GI 150 kV Ciamis	950	11	11	18
S10	-7.224362	108.411471	105.04	105	GI 150 kV Ciamis	950	105	105	13
S11	-6.721517	107.144888	21.27	21	GI 150 kV Cianjur	245	21	21	95
S12	-6.525476	108.137335	106.28	106	GI 150 kV Haurgeulis	140	106	140	23
S13	-6.574419	107.915029	97.14	97	GI 150 kV Haurgeulis	140	97		15
S14	-6.575333	107.920984	97.14	97	GI 150 kV Haurgeulis	140	97		15
S15	-6.573166	107.898683	110.49	110	GI 150 kV Haurgeulis	140	110		16
S16	-6.546382	108.205422	184.03	184	GI 150 kV Jatibarang	270	184	184	17
S17	-6.46369	107.20107	86.31	86	GI 150 kV Juishin	420	86	355	1
S18	-6.508367	107.213365	22.34	22	GI 150 kV Juishin	420	22		61
S19	-6.560381	107.129157	246.75	247	GI 150 kV Juishin	420	247		15
S20	-7.727922	108.378377	185.51	186	GI 150 kV Karangnunggal	650	186	405	30
S21	-7.733974	108.038529	218.58	219	GI 150 kV Karangnunggal	650	219		15
S22	-6.407955	107.34291	39.07	39	GI 150 kV Kutamekar	425	39	39	23
S23	-6.80754	108.538932	360.02	360	GI 150 kV Mandirancan	330	330	330	60
S24	-6.363727	107.246842	141.32	141	GI 150 kV Mekarsari	730	141	141	0

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S25	-6.549476	107.5913	766.58	767	GI 150 kV Pabuaran	460	460	460	11
S26	-7.336353	107.108033	13.85	14	GI 150 kV Patuha	290	14	290	39
S27	-7.343449	107.115982	61.46	61	GI 150 kV Patuha	290	61		38
S28	-7.416727	107.063116	76.34	76	GI 150 kV Patuha	290	76		5
S29	-7.387065	107.197134	174.33	174	GI 150 kV Patuha	290	174		34
S30	-7.460115	107.366101	58.35	58	GI 150 kV Patuha	290	58		3
S31	-6.801179	108.603961	106.19	106	GI 150 kV PLTU Cirebon	380	106	106	36
S32	-6.569329	107.491233	157.96	158	GI 150 kV Purwakarta	500	158	158	40
S33	-6.55169	107.046818	101.20	101	GI 150 kV Semen Baru	510	101	101	16
S34	-7.412025	107.007522	374.44	374	GI 150 kV Semen Jawa	70	70	70	51
S35	-7.423571	106.991565	241.52	242	GI 150 kV Semen Jawa	70	70		52
S36	-7.396133	106.867631	56.87	57	GI 150 kV Semen Jawa	70	57		47
S37	-7.164091	106.800571	220.12	220	GI 150 kV Semen Jawa	70	70		22
S38	-7.133943	106.950902	37.00	37	GI 150 kV Semen Jawa	70	37		20
S39	-6.934184	108.695733	147.01	147	GI 70 kV Babakan	80	80	80	58
S40	-7.012972	107.104993	94.15	94	GI 70 kV Cianjur	245	94	94	23
S41	-6.812715	108.214043	126.10	126	GI 70 kV Kadipaten	65	65	65	49
S42	-6.776488	108.158431	340.68	341	GI 70 kV Kadipaten	65	65		25
S43	-6.66601	108.086401	162.49	162	GI 70 kV Kadipaten	65	65		17
S44	-7.064115	108.536559	138.55	139	GI 70 kV Kuningan	80	80	80	11
S45	-7.00293	108.608177	160.99	161	GI 70 kV Kuningan	80	80		13
S46	-7.013509	107.076605	32.11	32	GI 70 kV Lembursitu	35	32	35	21
S47	-7.223319	107.025116	19.94	20	GI 70 kV Lembursitu	35	20		33
S48	-7.211387	107.03726	84.84	85	GI 70 kV Lembursitu	35	35		32
S49	-7.501746	107.448508	45.87	46	GI 70 kV Pameungpeuk	85	46	85	33
S50	-7.536841	107.553677	167.67	168	GI 70 kV Pameungpeuk	85	85		21
S51	-7.677255	107.893422	292.44	292	GI 70 kV Pameungpeuk	85	85		21

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S52	-7.699123	108.409613	118.45	118	GI 70 kV Pangandaran	80	80	80	31
S53	-6.636831	108.026444	210.10	210	GI 70 kV Parakan	70	70	70	2
S54	-7.501991	107.482838	61.55	62	GI 70 kV Sumadra	100	62	62	30
S55	-7.226885	106.487818	25.10	25	GIS 150 kV PLTU Pelabuhan Ratu	60	25	25	24
S56	-6.923886	109.819915	196.38	196	GI 150 kV Batang	1050	196	196	6
S57	-6.996164	111.246076	266.01	266	GI 150 kV Blora	50	50	50	17
S58	-7.214495	110.564115	123.78	124	GI 150 kV Jelok	180	124	124	97
S59	-7.285359	110.868949	163.35	163	GI 150 kV Kedungombo	170	163	163	45
S60	-7.390214	108.764788	474.72	475	GI 150 kV Majenang	200	200	200	91
S61	-7.488894	110.66251	76.74	77	GI 150 kV Mojosongo	1050	77	77	72
S62	-7.638159	110.934651	331.64	332	GI 150 kV Palur	970	332	332	10
S63	-7.028522	109.507938	239.00	239	GI 150 kV Pemalang	390	239	390	19
S64	-7.093456	109.357606	262.3407	262	GI 150 kV Pemalang	390	262		20
S65	-6.728982	111.541064	101.27	101	GI 150 kV PLTU Rembang	240	101	101	12
S66	-6.801009	111.327478	82.23	82	GI 150 kV Rembang	240	82	82	90
S67	-6.81405	111.536483	121.24	121	GI 150 kV Semen Indonesia	760	121	339	10
S68	-6.861324	111.581306	91.22	91	GI 150 kV Semen Indonesia	760	91		13
S69	-6.848907	111.621764	127.15	127	GI 150 kV Semen Indonesia	760	127		18
S70	-6.924883	109.92602	42.42	42	GI 150 kV Weleri	650	42	215	17
S71	-7.063862	110.161113	61.60	62	GI 150 kV Weleri	650	62		14
S72	-7.056141	110.13914	110.97	111	GI 150 kV Weleri	650	111		11
S73	-6.985719	108.790202	499.05	499	GI 70 kV Babakan	80	80	80	13
S74	-6.463676	110.978186	110.45	110	GITET 500 kV Tanjung Jati	650	110	110	3
S75	-7.100333	113.017469	150.66	151	GI 150 kV Bangkalan	230	151	222	25
S76	-6.909194	112.994416	70.71	71	GI 150 kV Bangkalan	230	71		28
S77	-8.255255	114.263197	19.59	20	GI 150 kV Banyuwangi	520	20	20	12
S78	-7.037614	111.946113	41.85	42	GI 150 kV Bojonegoro	255	42		18

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S79	-7.029902	111.934325	146.61	147	GI 150 kV Bojonegoro	255	147	189	18
S80	-7.251292	111.699117	157.13	157	GI 150 kV Cepu	190	157	157	18
S81	-8.379733	114.049428	206.47	206	GI 150 kV Genteng	280	206	280	13
S82	-8.327976	114.051084	30.60	31	GI 150 kV Genteng	280	31		14
S83	-8.403846	114.072117	63.40	63	GI 150 kV Genteng	280	63		10
S84	-7.741457	112.859112	28.75	29	GI 150 kV Gondangwetan	870	29	29	72
S85	-6.926187	111.876359	120.99	121	GI 150 kV Kerek	360	121	275	80
S86	-6.936615	111.889799	154.16	154	GI 150 kV Kerek	360	154		83
S87	-6.813834	111.734607	141.71	142	GI 150 kV Mliwang	1350	142	245	17
S88	-6.800867	111.719162	103.33	103	GI 150 kV Mliwang	1350	103		19
S89	-7.672422	112.770756	49.15	49	GI 150 kV Pier	1080	49	49	68
S90	-7.740245	112.834374	77.59	78	GI 150 kV Purwosari	850	78	78	88
S91	-7.160636	113.035305	69.64	70	GI 150 kV Sampang	680	70	306	22
S92	-6.931467	113.099427	119.23	119	GI 150 kV Sampang	680	119		31
S93	-6.929501	113.114488	116.68	117	GI 150 kV Sampang	680	117		3
S94	-6.851106	111.875362	422.42	422	GI 150 kV Sementuban	240	240	240	38
S95	-6.906619	111.79984	150.98	151	GI 150 kV Sementuban	240	151		13
S96	-6.901331	111.823752	83.66	84	GI 150 kV Sementuban	240	84		10
S97	-7.79798	114.117181	82.16	82	GI 150 kV Situbondo	560	82	312	14
S98	-7.729317	114.03488	230.19	230	GI 150 kV Situbondo	560	230		23
S99	-6.888254	113.858622	190.13	190	GI 150 kV Sumenep	310	190	310	13
S100	-6.918821	114.012356	34.81	35	GI 150 kV Sumenep	310	35		22
S101	-6.940136	114.045873	105.07	105	GI 150 kV Sumenep	310	105		24
S102	-6.971228	113.985799	38.25	38	GI 150 kV Sumenep	310	38		17
S103	-6.921716	113.595546	23.42	23	GI 150 kV Sumenep	310	23		28

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S104	-6.95054	113.650841	79.49	79	GI 150 kV Sumenep	310	79		21
S105	-6.934192	113.641757	22.65	23	GI 150 kV Sumenep	310	23		23
S106	-6.92464	113.723392	89.98	90	GI 150 kV Sumenep	310	90		15
S107	-6.88439	113.86962	73.70	74	GI 150 kV Sumenep	310	74		14
S108	-6.88157	113.864133	58.24	58	GI 150 kV Sumenep	310	58		14
S109	-6.891748	113.968872	49.92	50	GI 150 kV Sumenep	310	50		19
S110	-6.897391	113.97715	29.52	30	GI 150 kV Sumenep	310	30		20
S111	-6.908124	114.004647	76.26	76	GI 150 kV Sumenep	310	76		21
S112	-6.919903	114.020474	30.43	30	GI 150 kV Sumenep	310	30		22
S113	-6.919549	113.786772	85.73	86	GI 150 kV Sumenep	310	86		11
S114	-6.924807	113.728822	86.76	87	GI 150 kV Sumenep	310	87		15
S115	-6.949569	113.653144	94.76	95	GI 150 kV Sumenep	310	95		21
S116	-6.886059	113.838383	47.09	47	GI 150 kV Sumenep	310	47		13
S117	-6.881294	113.848313	24.58	25	GI 150 kV Sumenep	310	25		14
S118	-6.879662	113.875716	33.20	33	GI 150 kV Sumenep	310	33		15
S119	-6.885831	113.924179	54.35	54	GI 150 kV Sumenep	310	54		16
S120	-6.768347	111.943708	46.60	47	GI 150 kV Tanjung Awar Awar	250	47	81	74
S121	-6.770969	111.968529	33.53	34	GI 150 kV Tanjung Awar Awar	250	34		54

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S122	-6.936296	112.148195	6.99	7	GI 150 kV Tuban	1100	7	244	1
S123	-6.942557	112.146967	26.10	26	GI 150 kV Tuban	1100	26		14
S124	-6.940865	112.139568	51.44	51	GI 150 kV Tuban	1100	51		13
S125	-6.935325	112.156381	18.34	18	GI 150 kV Tuban	1100	18		14
S126	-7.035883	111.95829	64.34	64	GI 150 kV Tuban	1100	64		2
S127	-6.986106	112.068169	78.39	78	GI 150 kV Tuban	1100	78		11
S128	-7.715003	111.34321	199.71	200	GI 70 kV Magetan	75	75	75	80
S129	-7.596396	112.67149	102.17	102	GI 70 kV Pandaan	90	90	90	58
S130	-7.715605	112.297694	217.87	218	GI 70 kV Siman	65	65	65	13
S131	-7.699438	112.767905	63.04	63	GI 70 kV Sukorejo	50	50	50	63
S132	-8.096548	115.250903	45.26	45	GI 150 kV Baturiti	240	45	240	20
S133	-8.102311	115.273379	51.84	52	GI 150 kV Baturiti	240	52		21
S134	-8.116732	115.27702	213.90	214	GI 150 kV Baturiti	240	214		20
S135	-8.409523	114.84328	324.77	325	GI 150 kV Negara	350	325	350	21
S136	-8.293214	114.577632	96.18	96	GI 150 kV Negara	350	96		12
S137	-8.091324	115.172601	19.36	19	GI 150 kV Pemaron	210	19	19	13
S138	-6.993032	108.701195	133.16	133	GI 70 kV Babakan	80	80	80	12
S139	-7.057922	108.479136	215.76	216	GI 70 kV Kuningan	80	80	80	10

S_id	Latitude	Longitude	Available Land Coverage Area (ha)	Solar PV Potential by Land (MW)	HubName	Maximum Hosting Capacity (MW)	Solar PV Potential (MW) Individual	Solar PV Potential (MW) Clustered	Hub Distance (kmr)
S140	-6.849257	107.87823	40.91	41	GI 70 kV Sumedang	100	41	41	36

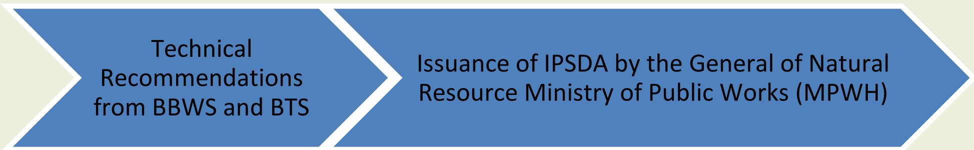
6. Annex F: Detailed List of Relevant Regulations

In addition to the regulations that directly related as input for developing MCDM criteria, as outlined in Chapter 3.3, regulations that do not affect the MCDM processes directly but are relevant for the other aspects of this Project, were also assessed, such as potential financing sources, required permits for floating solar PV development, and available government supports for solar PV development. The detailed list is provided below.

No.	Regulation	Key Summary	Recommendations on MCDM Development
1	**Presidential Regulation No. 112 of 2022 about Accelerating the Development of Renewable Energy for Providing Electric Power**	Government support for power plants that utilize renewable energy sources includes rewards for business entities in the form of fiscal and non-fiscal incentives. Fiscal incentives can be given in the following forms: ● Income tax facilities; ● Import facilities in the form of exemption from import duties and/or taxes in the context of imports; ● Land and building tax facilities; ● Support for geothermal development; ● Support for financing and/or guarantee facilities through state-owned enterprises assigned by the government. Whereas non-fiscal incentives can be provided further by central government and/or local government.	Not directly relevant to the MCDM, but will be considered for the financial analysis and government support for potential financing sources
		● Ministers, related ministers, heads of institutions, or regional governments are obliged to provide the necessary support in developing power plants that utilize renewable energy sources in accordance with their authority. ● Some of the most relevant support is provided by the Ministry of Environment and Forestry ("MoEF"); it facilitates the licensing processes in forest areas and can reduce associated permit costs to promote renewable energy development. Simplification of land permits is also reinforced at the local government level, where local authorities are obligated to streamline licensing procedures, offer incentives, and ensure land availability as designated for renewable energy power plant development.	The provision can be considered as a regulatory/administrative difficulty criterion for MCDM. Other than that, the provision is beneficial for later stages, especially to identify potential required support from each entity for the solar PV development.

No.	Regulation	Key Summary	Recommendations on MCDM Development
2	**Minister of Public Works and Housing Regulation Number 27/PRT/M/2015 concerning DAM as amended through Minister of Public Works and Housing Regulation Number 7 of 2023**	It is recommended that any floating solar power plant proposal within the reservoir area undergo a thorough technical study to assess its impact on the reservoir's functions, dam safety, and environmental sustainability. For instance, if the proposed solar plant exceeds 20% of the reservoir's surface area, it must obtain a recommendation from the Dam Safety Commission. Additionally, compliance with statutory regulations regarding business licensing and water resource use approval procedures is essential for utilizing reservoir space.	Not directly related to the MCDM but needs to be considered when assessing the necessary permits for floating PV deployment.
3	**Ministry of Energy and Mineral Resource ("MEMR") Planning Guideline for Floating Solar Power Plants[35]**	The regulation outlines the list of required licensing for the deployment of floating solar PV. In general, the required permits consist of: 1. Reservoir access permit a. Privately owned dams must undergo a relatively simple licensing process, through a Business to Business ("B2B") scheme between the prospective floating solar PV developer and the owner of the reservoir or water body. b. Government-owned dams require a more complex permit, given the context of other national-level regulations and possibilities of leasing state assets. 2. Environmental permit based on the scale of the floating solar PV deployed, the intended capacity, and the area coverage. If the designated land is located within the local government area, the permit process should be proposed to the local government. However, for dam areas located in more than one city or regency, the	Not directly related to the MCDM but needs to be considered when assessing the necessary permits for floating PV deployment, as follows: ● Reservoir access permit; ● Applicable environmental permit; ● *Izin Pemanfaatan Sumber Daya Air* ("IPSDA"); ● Building permit ("IMB"); and ● *Persetujuan Pinjam Pakai Kawasan Hutan* ("PPKH"). Additionally, considerations to respective regulation as stated in environmental

[35] MEMR. "Planning Guideline for Floating Solar Power Plants". https://ebtke.esdm.go.id/post/2021/12/14/3036/panduan.perencanaan.pembangkit.listrik.tenaga.surya.plts.terapung (accessed March, 2024)

No.	Regulation	Key Summary	Recommendations on MCDM Development
		license is submitted to the agency responsible for the environment at the provincial level. The required environmental permit is as follows:[36] ● SPPL for capacity < 1 MW ● UKL-UPL for capacity 1–50 MW ● AMDAL for capacity ≥ 50 MW 3. Water resources utilization permit (*Izin Pemanfaatan Sumber Daya Air* or "IPSDA"). This type of permit is similar to a building permit (*Izin Mendirikan Bangunan* or "IMB") for water areas. The IPSDA permit is essential for securing a financing date with PT PLN (Persero) and disbursement from lenders. The IPSDA permit is acquired in line with the process illustrated below.[37]  4. A building permit (IMB) is typically not required if an IPSDA permit is already considered sufficient by the assessors. However, if deemed necessary, it is usually processed for components and supporting infrastructure located at the perimeter of the water body. Licensing procedures can be completed through the One Stop Integrated Service provided by the District Office in each respective location.[38] 5. Approval for the Utilization of Forest Area (*Persetujuan Pinjam Pakai Kawasan Hutan* or "PPKH") is necessary if the water body selected for the floating solar PV is located within a forested area. PPKH applications are forwarded to the MoEF	permit can also be an input in determining site location for MCDM If applicable, adherence to regulations on dam utilization will be necessary, as will obtaining electricity-related licenses such as IUPTLU. [39]

[36] SPPL: *Surat Pernyataan Kesanggupan Pengelolaan dan Pemantauan Lingkungan Hidup* or Letter of Undertaking for Environmental Management and Monitoring; UKL-UPL: *Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup* or Environmental Management Efforts and Environmental Monitoring Efforts; and AMDAL: *Analisis Dampak Lingkungan* or Environmental Impact Assessment.

[37] BBWS: *Balai Besar Wilayah Sungai* or River Basin Center, BTS: *Balai Teknik Bendungan* or Dam Engineering Center.

[38] One Stop Integrated Service is processed by the Investment and One-Stop Integrated Service Office or *Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu* ("DPMPTSP")

[39] IUPTLU: *Izin Usaha Penyediaan Tenaga Listrik untuk Kepentingan Umum* or Electricity Supply Business License for General Purposes

No.	Regulation	Key Summary	Recommendations on MCDM Development
		following endorsements from the local Governor and *Perum Kehutanan Negara Indonesia* ("Perhutani"). 6. Licensing procedures for electricity-related activities involve the application of Electricity Supply Business License (*Izin Usaha Penyediaan Tenaga Listrik* or "IUPTL") based on Government Regulation no. 5/2021 regarding the Implementation of Risk-Based Business Licensing for Electricity Supply Businesses Serving Public Interests. Application requirements include a feasibility study and PPA consisting of: a. Financial assessment; b. Operational assessment; c. Network interconnection evaluation; d. Site selection; e. One line diagram preparation; f. Determination of business type and capacity; g. Construction timeline; and h. Operation schedule conducted by certified business entities.	