



RESTRUCTURING PAPER
ON A
PROPOSED PROJECT RESTRUCTURING
OF
ID-GEOTHERMAL ENERGY UPSTREAM DEVELOPMENT
APPROVED ON FEBRUARY 9, 2017
TO
PT SARANA MULTI INFRASTRUKTUR (PERSERO)

ENERGY & EXTRACTIVES

EAST ASIA AND PACIFIC

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ABBREVIATIONS AND ACRONYMS

AM	Aide Memoire
BCS	Broad Community Support
CTF	Clean Technology Fund
DED	Detail Engineering Design
EIRR	Economic Internal Rate of Return
EMC	Exploration Management Consultant
ENPV	Economic Net Present Value
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESSC	Environment & Social Management Consultant
FA	Financial Analysis
FIRR	Financial Internal Rate of Return
GEF	Global Environmental Facility
GEUDP	Geothermal Energy Upstream Development Project
GHG	Greenhouse gas
GoI	Government of Indonesia
GREM	Geothermal Resource Risk Mitigation
GRS	Grievance Redress System
IOC	Incremental Operating Cost
IPP	Indigenous People Plan
JC	Joint Committee
LARAP	Land Acquisition and Resettlement Action Plan
MEMR	Ministry of Energy and Mineral Resources
MoF	Ministry of Finance
MTR	Mid-Term Review
MW	Megawatt
NoA	Notification of Award
PDO	Project Development Objective
PIM	Project Implementation Manual
PLN	Perusahaan Listrik Negara
PMU	Project Management Unit
PISP	<i>Pembiayaan Infrastruktur Sektor Panas Bumi (Infrastructure Financing for Geothermal Sector)</i>
PT GDE	PT Geo Dipa Energi
PT SMI	PT Sarana Multi Infrastruktur
RF	Results Framework
SOE	State-Owned Enterprise
SORT	Systematic Operations Risk-rating Tool
TA	Technical Assistance
WB	World Bank



BASIC DATA

Product Information

Project ID P155047	Financing Instrument Investment Project Financing
Original EA Category Full Assessment (A)	Current EA Category Full Assessment (A)
Approval Date 09-Feb-2017	Current Closing Date 31-Dec-2025

Organizations

Borrower PT Sarana Multi Infrastruktur (Persero)	Responsible Agency
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Project Development Objective (PDO)

Original PDO

The PDO is to facilitate investment in geothermal power generation and reduce greenhouse gas emissions.

Summary Status of Financing (US\$, Millions)

Ln/Cr/Tf	Approval	Signing	Effectiveness	Closing	Net Commitment	Disbursed	Undisbursed
TF-A4086	09-Feb-2017	07-Mar-2017	04-Aug-2017	31-Dec-2025	6.25	6.02	.23
TF-A4089	09-Feb-2017	07-Mar-2017	04-Aug-2017	31-Dec-2025	49.00	8.24	40.76

Policy Waiver(s)

Does this restructuring trigger the need for any policy waiver(s)?

No



I. PROJECT STATUS AND RATIONALE FOR RESTRUCTURING

A. PROJECT STATUS

1. **The Project.** The Indonesia Geothermal Energy Upstream Development Project (GEUDP) was approved on February 9, 2017, and became effective on August 4, 2017. The Project Development Objective (PDO) is to facilitate investment in geothermal power generation and reduce greenhouse gas emissions. The Project finances geothermal exploration drilling to confirm the sufficient generating capacity-equivalent of steam yields from wells drilled to enable the development of geothermal power generation capacity. The GEUDP is financed by US\$49 million of Clean Technology Fund (CTF) grant and US\$6.25 million of Global Environment Facility (GEF) grant.

2. **Components and implementation arrangements.** The Project has two components: Component 1 – Risk Mitigation for Geothermal Exploration Drilling (US\$49 million), and Component 2 – Capacity Building on Geothermal Exploration and Environmental and Social Safeguards Management (US\$6.25 million). The Project is being jointly implemented by PT Sarana Multi Infrastruktur (PT SMI), a non-banking financial institution and PT Geo Dipa Energi (PT GDE)¹, a public geothermal developer. Both institutions are fully owned by the Ministry of Finance (MoF). Together with the Ministry of Energy and Mineral Resources (MEMR), MoF constitutes the Joint Committee (JC), established to provide sound guidance and oversight to the Project governance and decision-making on exploration drilling. MoF is also responsible for overseeing the Government’s Infrastructure Financing for Geothermal Sector (*Pembiayaan Infrastruktur Sektor Panas Bumi*, or PISP) which is managed by PT SMI, of about US\$49 million used to co-finance the Project. PISP fund also provides US\$75 million co-financing to finance geothermal drilling exploration carried out by public and private developers beyond the Project, through the Geothermal Resource Risk Mitigation (GREM) Project. PT Sarana Multi Infrastruktur (PT SMI), an infrastructure company fully-owned by MoF, is the entity officially designated to manage the totality of the PISP funds.

3. **Former restructurings.** Since Project approval, the Project underwent two restructurings in 2020 and 2021. The Project restructuring extended the CTF and the GEF Grants closing dates from December 31, 2022, to December 31, 2025, as these was considered necessary to complete the exploration of subprojects and achieve the PDO. The other changes in the earlier Project restructurings included: (i) introducing PT GDE² as the second Implementing Agency, (ii) downscaling the number of exploration drilling subproject from five-six estimated at Project approval to a new target of four, (iii) updating the targets and timelines of PDO and intermediate indicators according to these changes, and (iv) reflecting changes in the drilling strategy³ in the intermediate indicators.

4. **Ratings and performance.** Following the Mid-Term Review (MTR) Implementation Support Mission in January 2020, the achievement of the Project Development Objective (PDO) and the overall Implementation Progress ratings were downgraded to Moderately Unsatisfactory due to prolonged social issue regarding community concerns in the first GEUDP prospective site under consideration in Waesano village. These issues had resulted in accumulated implementation delays. Since then, these ratings have been maintained as the delays were aggravated by not reaching Broad Community Support (BCS) for the exploration in Waesano site despite the numerous efforts by PT GDE to discuss and address community concerns. In consequence, the Indigenous People Plan (IPP) for the site could not be finalized and civil/drilling works have not started. The Procurement rating was also downgraded to Moderately Unsatisfactory in

¹ It must be noted that, at Project approval, the Project was approved with PT Sarana Multi Infrastruktur (PT SMI) as implementing agency. PT SMI is an infrastructure financing company fully-owned by MoF. The Project’s restructuring in 2021 introduced PT GDE, as the second implementing agency.

² PT GDE was added as an additional Implementing Agency to strengthen the institutional capacity to implement the Project. PT GDE is responsible for all technical, procurement and safeguards aspects. PT SMI, as the Grant Recipient, retains the overall Project and oversight, including the financial management.

³ According to the Project Restructuring Paper, in order to reduce costs, GEUDP will execute one of two drilling strategies: (i) standard-sized (as originally assumed) or (ii) slim hole drilling based on economic viability on a case-by-case basis.



June 2021 due to the pervasive delays and limited progress experienced in procurement, particularly of the technical and safeguards consultants for Jailolo site, another subproject in the GEUDP Technical Assistance (TA) pipeline. While these issues have improved, this rating remains Moderately Unsatisfactory due to previous limited progress on GEUDP procurement packages as impacts on Waesano site of not reaching BCS.

5. **Disbursement.** As of December 2023, the Project has disbursed US\$13.97 million out of US\$55.25 million (25.3 percent), including US\$8.24 million of the US\$49 million CTF Grant (16.8 percent) under Component 1 and US\$5.73 million of the US\$6.25 million GEF Grant (91.6 percent) under Component 2. Table 1 provides a breakdown of these disbursements by component and Project locations. The Project documents⁴ refer to four expected subprojects to receive support from the Project. Two of these locations, Bittuang and Nage sites, have not received the Project financing and are no longer considered as candidates to GEUDP pipeline as per MEMR decision to move forward on these projects through other financing sources.

Table 1. Breakdown of Project Actual Expenses as of December 2023⁵

	CTF (US\$ million)	GEF (US\$ million)	PISP (US\$ million)
Component 1. Risk Mitigation for Geothermal Exploration Drilling			
Waesano site	1.06	0.00	0.00
Jailolo site	0.00	0.00	0.00
Sub Total	1.06	0.00	0.00
Component 2. Capacity Building on Geothermal Exploration and Environmental and Social Safeguards Management			
Waesano site	0.00	4.20	0.00
Jailolo site	0.00	1.67	0.00
Sub Total	0.00	5.87	0.00
Total	1.06	5.87	0.00

Note: As of December 2023, PT SMI has withdrawn US\$8.24 million of the CTF Grant (Component 1) and US\$6.02 million of the GEF Grant (Component 2) through advance disbursements. PT GDE is processing invoices with the amount of US\$200,803 for the actual survey works and claim submitted by Waesano Civil Works contractors. In addition to support the preparation activities for specific sites, the Component 2 is also financing broader TA and capacity building. The difference between these amounts and the expenses reflected in Table 1 is kept at PT SMI's bank account.

6. **Implementation challenges on social matters.** Since July 2019, local government and the Government of Indonesia (GoI) have received letters and statements from part of the village community opposing Waesano exploration activities. Since then, PT GDE has reported to have intensified community engagement efforts to record key concerns of the community and discuss appropriate mitigation measures based on it. As part of these efforts, adjustments to the technical design of the Waesano exploration program were proposed to address the concerns of the local community. The World Bank (WB) Grievance Redress System (GRS) registered a case associated to the Waesano site when the first letter opposing the Waesano exploration was received by the WB in March 2020. Finally, the GRS closed this case without a satisfactory resolution on the grounds that all reasonable efforts to engage and reach an agreement with the remaining group of complainants have been exhausted, as per GRS confirmation via email on February 18, 2022.

⁴ Specifically, the Project Restructuring Papers of 2020 and 2021, Environmental and Social Management Framework (ESMF) 2021 version, and Project Implementation Manual (PIM) 2021 version.

⁵ Refer to the Project's Interim Financial Report (IFR) for the period Q4 – 2023.



7. Due to COVID19 travel restrictions, the WB had not been able to visit the subproject site in response to the opponents' March 2020 letter. The WB team visited Waesano village in May 2022 and in December 2022 to meet community members and broader stakeholders, including the local government. Overall, the team did not find significant progress in the scale and depth of community support to the Waesano exploration and did not find sufficient evidence that BCS had been reached. It is important to note that the subproject triggers OP 4.10 and the IPP was prepared in February 2022. The clearance of IPP by the WB is pending subject to the BCS achievement.

8. **Request to exclude Waesano.** PT SMI awarded a contract for Civil Works in Waesano site in December 2019 and after the Project restructuring, in October 2021, the contract was taken over by PT GDE. However, with BCS not being achieved, the Waesano site has not received the WB approval to commence civil/drilling works activities on the ground. For 36 months, works could not be initiated under the WB financing. In view of the delays, the MoF and PT SMI have requested to remove Waesano site from the GEUDP subproject pipeline. Once subprojects are removed from the GEUDP-financed pipeline, the JC may decide to develop subprojects using its own sources of financing and applying its own national safeguards regulations.

9. Subsequent to the JC's decision, on November 9, 2023, PT GDE organized two community consultations in the Waesano Village area which were attended by local government, JC and the WB team as observers. At that time, the local government conveyed that the WB will no longer be involved in the Waesano exploration activity, and the JC will continue with the exploration activities utilizing its own funds and applying its own legislative framework. Community members both who support and reject the project were both present and expressed their opinions in the forum. The supporters expect the Government to commence the project while those who oppose mentioned that they would continue to voice their rejection regardless the source of funding. The JC representatives noted that more consultations will be held before commencing the activities to provide further opportunity for members of the community to raise their concerns. These consultations should be a platform for meaningful conversations between the JC, local government, PT GDE, and community members.

10. **Procurement discussions.** Following the JC's decision to exclude Waesano site from the subproject pipeline, the WB conducted a discussion of ongoing procurement activities and contracts related to the site during the supervision mission of November 2023. For seven procurement packages, Notification of Awards (NoA) were issued to firms⁶. PT GDE informed the WB that the NoA are being canceled due to the Project's restructuring. The firm notified of contract award for Detail Engineering Design (DED) consulting services has requested a payment of the amount corresponding to the cost of site surveys for civil work design initiated at the request of PT GDE as the employer. With the contract yet to be signed, the payment for the claim may be covered under Incremental Operating Costs (IOC), provided that the expenses are according to the definition of IOC in the Grant Agreement. PT GDE has agreed to ensure that this payment is made on an actual cost and will make sure that all payments will be made as per definition of IOC in the Grant Agreement and to provide evidence of the expenses. The eighth procurement package, for the Waesano Civil Works contract, had been signed and was on hold given the issues related to non-achievement of BCS. PT GDE informed the WB that the contract is being canceled as well, due to the Project's restructuring. The contractor has requested payments due to site survey conducted, overhead cost since the contract was signed, and loss of business opportunities due to contract cancellation. PT GDE has agreed to pay the contractor based on the terms and conditions of the signed contract. After the payment is made and the contract is terminated, the WB will conduct the post review of this activity.

⁶ These packages are 1) Land Appraisal for Waesano, 2) Legal Consultant for Land Leasing for Waesano, 3) Waesano Site Services for subproject implementation support, 4) Update Detail Engineering Design for Civil and Infrastructure Waesano, 5) Supply of Wellheads and Subsurface Equipment for Waesano, 6) Site Manager for Waesano, and 7) Exploration Management Consultant for Waesano.



B. RATIONALE FOR RESTRUCTURING

11. **The Waesano exclusion and pipeline downscaling is justified.** Based on this Project background, the WB has agreed with the JC and the Implementing Agencies to restructure the GEUDP Project to remove the Waesano site from the subproject pipeline to be financed by the GEUDP, given that (i) the exploration activities in the site have not progressed over the past 36 months pending the achievement of BCS and, subsequently, the WB IPP clearance and (ii) the JC and PT GDE have expressed their preference to move forward with this site outside of the GEUDP. The relevant Project documents⁷ are therefore being revised to exclude Waesano site. With one subproject dropped and limited time left for implementation, the Project targets need to be downscaled under Component 1 and the respective indicators need to be revised. The GEUDP current targets were estimated based on the assumption that four subprojects would progress from the TA pipeline under Component 2 to the investment pipeline under Component 1. As the Project is approaching the closing date on December 31, 2025, the targets set by Project closing have become unrealistic since only one subproject is currently assigned to the GEUDP TA pipeline (Project Component 2) by PT SMI, PT GDE, and the JC.

12. **An additional extension of the project closing date is not justified.** The JC has formally requested a Project restructuring through MoF and PT SMI letters dated July 2023 and August 2023, respectively. In addition, the JC requested an extension of the grant closing date from December 31, 2025, to December 31, 2027, and a downscaled pipeline of two subprojects⁸. Due to the various restructurings conducted for this Project, the significant downsizing experienced since its approval, and the limited progress made despite these efforts with no drilling initiated yet in any site, an additional extension for the Project closing date as requested by the Client is not justified⁹. As a result, the Project closing date will remain on December 31, 2025, and all works financed under the Project will need to be completed by then. Considering that, as of today, the WB has not received the nomination of another subproject to be financed under GEUDP TA and Investment pipelines, it will be technically unfeasible to prepare and implement another subproject under GEUDP for completion by December 31, 2025. As a result, the GEUDP restructuring would need to scale down the pipeline to one subproject. The revised Project's budget is under discussion with the Implementing Agencies and the JC reflecting only one subproject in the GEUDP pipeline. By scaling down the intended Project pipeline of subproject, it is anticipated that a partial cancellation for the CTF Grant will be needed for approximately US\$31.5 million. This has been communicated to the JC who is considering a formal request to the WB to initiate the cancellation process. Once the request for cancellation is received, the WB will process an additional restructuring to reduce the size of the Project financing.

13. **Reconfirmed PDO relevance and rationale for the WB's involvement.** The PDO is still highly relevant and achievable provided that the proposed changes are implemented and continue to have strong rationale for the Bank's involvement. The Project has been continuously complying with the legal covenants and Safeguards Policy, with Moderately Satisfactory rating on Safeguards and Financial Management ratings from the Implementation Status and Result Report in October 2023. The performance of the Implementing Agency is Moderately Unsatisfactory as refer to the Project Management rating in the ISR and that revised implementation plan is being prepared based on the proposed changes in this restructuring.

II. DESCRIPTION OF PROPOSED CHANGES

⁷ The Project Implementation Manual (PIM) and the Environmental and Social Management Framework (ESMF)

⁸ Specifically, the following restructuring objectives were requested: (i) exclude the Waesano exploration activities from the GEUDP pipeline, (ii) scale-down the GEUDP pipeline into two proposed subprojects, (iii) extend the grants' closing dates from December 31, 2025, to December 31, 2027, and (iv) update the Project's results framework.

⁹ The Bank has responded to the Clients request with letters dated August 30, 2023, and December 1, 2023.



14. The Project changes proposed are described as follows:

15. **First change.** The subproject in the Waesano site will no longer be eligible under GEUDP for either TA or investment pipelines. This triggers the following changes:

- (a) Amendment of the following Project documents to reflect that the Waesano site is no longer eligible under GEUDP. In addition, following best practices in the preparation of framework projects, specific references to other subprojects will also be removed from Project documents as follows:
 - (i) Waesano, Jailolo, Nage, Bittuang: Environmental and Social Management Framework (ESMF)
 - (ii) Waesano, Jailolo, Nage, Bittuang: Project Implementation Manual (PIM)
- (b) The PIM and the ESMF are being revised to clarify the selection process for the inclusion of a candidate site for the TA pipeline (Component 2) and investment pipeline (Component 1) and the requirements required to qualify each pipeline.
- (c) The revised ESMF will clarify that the JC may decide to proceed with the exploratory drilling of subprojects that are not being financed by the GEUDP, while adhering to its national E&S standards and financing such activities with the PISP fund or state budget.

16. **Second change.** The number of subprojects targeted under the Project will be scaled down along with the Project budget. The Investment Phase will finance only one subproject¹⁰, instead of four currently considered. The current budget for the Investment Phase (Component 1 – Risk Mitigation for Geothermal Exploration Drilling) is US\$98 million with US\$49 million contribution from CTF Grant and US\$49 million co-financing from PISP fund. It is important to note that, under the Component 1 of the Project for the Investment Phase, the CTF committee requires the equal co-financing ratio between CTF and PISP as agreed in the original GEUDP Grant Agreements. The partial cancellation of the CTF Grant from \$49 million to \$17.5 million will be processed separately once a letter from the recipient requesting cancellation is received.

17. **Third change.** the Results Framework must be adjusted to reflect the first and second changes. Table 2 reflects the adjusted Results Framework to accommodate the changes in the pipeline.

Table 2. Changes proposed in the Results Framework

No	Indicators	Previous Target	Revised Target	Reasons for Changes
A	PDO Indicators			
1	Electric power generation capacity enabled through the issuance of geothermal development licenses	65 MW (to be achieved in 2025)	10 MW (to be achieved in 2025)	- Scale down subproject numbers from four to one, with an assumption that the site will have successful exploration drilling to prove the existence of at least 10 MW geothermal resource for power development.
2	Commercial capital mobilized for investment in geothermal power generation	US\$195 million	US\$40 million	- Scale down the target of generation capacity enabled by the Project from 65 MW to 10 MW, with an assumption of US\$4

¹⁰ Jailolo site is currently under the TA pipeline. TA activities on the technical design and safeguards instruments preparation for the Jailolo site are ongoing and aiming for completion by December 2023. The preparation of safeguards instruments has been commenced by the Environmental and Social Safeguards Consultant (ESSC) and aiming for completion by January 2024.



No	Indicators	Previous Target	Revised Target	Reasons for Changes
		(to be achieved in 2025)	(to be achieved in 2025)	million per MW (reflecting an increase of geothermal development cost) will be required to develop a full geothermal subproject. The previous assumption at the Project design was US\$3 million per MW.
3	Estimated GHG emission reduction compared to a business-as-usual baseline	330,000 Metric ton (to be achieved in 2025)	50,770 Metric ton (to be achieved in 2025)	<ul style="list-style-type: none"> - Scale down the target of generation capacity enabled by the Projects from 65 MW to 10 MW, with an assumption of 1 MW of capacity will reduce GHG emissions by 5,077 metric tons of CO2 equivalent per year.
B	Intermediate Results Indicators			
1	Total generating capacity-equivalent of steam yield from all wells drilled when converted to equivalent full size diameter well production	48 MW (to be achieved in 2025)	3 MW (to be achieved in 2022)	<ul style="list-style-type: none"> - Scale down subproject numbers from four to one, two wells will be drilled for the subproject. It is assumed that GEUDP will get 1 successful well with steam yield of 3 MW/well. - Current indicative prospects in the pipeline are classified as medium to high enthalphy, with expected lower productivity per well. - The equivalent conversion is changed from standard size to full size well because the production industry practice uses the full size well.
2	Average generating capacity-equivalent of steam yield per well drilled when converted to equivalent full size diameter well production	6 MW (to be achieved in 2025)	3 MW (to be achieved in 2025)	<ul style="list-style-type: none"> - Current indicative prospects in the pipeline are classified as medium to high enthalphy, with expected lower productivity per well. - The equivalent conversion is changed from standard size to full size well because the production industry practice uses the full size well. - 3 MW / well refer to IFC report "Success of Geothermal Wells: A Global Study" (2013).



No	Indicators	Previous Target	Revised Target	Reasons for Changes
3	Issuance of geothermal development licenses	3 licenses (to be achieved in 2025)	0 license (to be achieved in 2025)	- Revising the target to zero since the concession tender will be carried out beyond the Project closing date.
4	Estimated increase in the number of connected households for the associated local electricity networks	116,411 households (to be achieved in 2025)	17,900 households (to be achieved in 2025)	- Scale down the target of generation capacity enabled by the Projects from 65 MW to 10 MW, with assumption of 1 MW plant capacity, with 92 percent capacity factor, produces 8,059 MWh/year, 20 percent of which serving electrification needs, with an average consumption level of 900 kWh/y/residential consumer (intended as household).
5	Estimated Direct Project beneficiaries (Number)	582,055 people (to be achieved in 2025)	71,600 people (to be achieved in 2025)	- Scale down the target connected households, with assumption of 4 family members per household.
6	Estimated Female beneficiaries (Percentage)	50 percent (to be achieved in 2025)	50 percent (to be achieved in 2025)	- No change of the target.
7	Delivery of Inferred Resource Capacity Reports by Exploration Management Team	4 reports (to be achieved in 2025)	1 report (to be achieved in 2025)	- Scale down subproject numbers from four to one.
8	Villages located next to exploration sites with at least one public consultation held	100 percent	100 percent	- No change of the target.
9	Share of public consultations segregated by gender (Percentage)	50 percent	50 percent	- No change of the target.
10	Practice guides for safeguards implementation	2 reports (to be achieved in 2025)	2 reports (to be achieved in 2025)	- No change of the target.

18. **Updates to the economic and financial analysis.** An update on the economic and financial analysis has been made to reflect the increased drilling cost, the new geothermal tariff setting which was introduced through the Presidential



Regulation No 112/2022¹¹, and the recent WB's Guidance Note on Social Value of Carbon (2017)¹². Simulations were carried out for an assumed high capacity of 55 MW and a lower capacity of 10 MW. At a discount rate of six percent and a social cost of carbon following the recent WB's Guidance, the big geothermal development scenario (55 MW) yields an economic net present value (ENPV) of US\$764 million with an economic internal rate of return (EIRR) of 32.1 percent; and the small geothermal development scenario (10 MW) yields an ENPV of US\$138 million with an EIRR of 23.5 percent. Therefore, both developments are economically viable. An updated financial analysis for both small and big development scenarios has been made referring to the new geothermal tariff for eastern of Indonesia, where the current subproject in GEUDP TA pipeline is located. The new tariff set in the Presidential Regulation, which is lower compared to the previous tariff applicable at the Project appraisal, has deteriorated the financial analysis. With and without Project intervention, the geothermal development will yield negative financial internal rate of return (FIRR). This financial analysis indicates that the subproject would move ahead only as the MEMR's geothermal development assignment to public developers.

19. **Risk rating.** The overall Project risk rating is considered to remain Substantial. Most risk categories are perceived to remain on the same ratings held for the last implementation year with exception of the risks associated to Stakeholders, which have been increased to High risk rating. A comprehensive assessment of risk during the remainder of the Project implementation period is included in Box 1 below.

Box 1: Risk assessment based on SORT (Systematic Operations Risk-rating Tool)

The *Political and Governance* risk is considered **Moderate**. The presidential election will be carried out in 2024 and a transition to the new government is expected not to affect the Project.

The *Macroeconomic* risk is perceived to be **Moderate** since there is no risk to Counterpart Funding.

The *Sector Strategies and Policies* risk remains **Substantial**. The Ministry of Finance Regulation No 80/2022 provides guidance on the management of PISP fund by PT SMI which contributes to the Government's co-financing to the Project. The Presidential Regulation No 112/2022 sets renewable energy tariffs, including geothermal. While the new tariffs setting provides higher tariff in Java and Sumatra, but the tariff in Eastern Indonesia is lower than the previous tariff. The lower tariff setting for Eastern Indonesia will impact to the financial feasibility of the subproject.

The *Technical Design of Project and Program* risk is **Moderate**, as the JC and PT SMI / PT GDE fully understand the Project's technical design and PT GDE has a good understanding of Project implementation. However, with various strategies implemented by MEMR to accelerate geothermal exploration drilling, there has been competition for each strategy to have geothermal site candidates for its pipeline, including for the GEUDP.

The *Institutional Capacity for Implementation and Sustainability* risk remains **Substantial**. PT GDE has adequate capacity to plan and implement exploration drilling, supported by the technical consultant and additional staffing from manpower supply. However, continues support in safeguards and communication capacity building will be required for PT GDE, particularly in the capacity to conduct social engagement with the community affected by the subproject.

The *Fiduciary* risk is considered **Moderate**, in light of the close coordination between PT SMI / PT GDE and the WB team to date and the steadily increasing proficiency with which PT GDE has handled procurement management tasks and procurement / contractual issues.

¹¹ The Presidential Regulation No 112/2022 on Acceleration of Renewable Energy Development for Electricity Provision, commonly referred to as Perpres, provides tariff setting for various renewable energy technologies, including geothermal.

¹² <https://documentsinternal.worldbank.org/search/27977750>



The *Environmental and Social* risk was increased to **High** in June 2022 following the prolonged social issues at Waesano site. Although an improvement of PT GDE’s capacity for handling can be observed, the social risk rating remains high since similar challenges experienced in Waesano in Project communications within the community and with Non-Government Organizations and the developer could arise in other subprojects of the pipeline.

The *Stakeholders* risk is increased to **High**, from the previous Substantial rating. Obtaining community acceptance to geothermal exploration drilling in the other pipeline may pose significant risks of implementation delays to the Project. For GEUDP pipeline, the Stakeholder Engagement Plan (SEP) for each subproject will be strengthened to cover broader stakeholders, including Non-Government Organizations and other relevant institutions.

The rating of SORT subcategories will be evaluated regularly as part of the implementation support and reporting (ISR) process.

The *Overall* risk is expected to be **Substantial**, based on the risk ratings of the various categories described above.

20. **Other changes.** The PIM and the ESMF will also be revised to clarify the decision-making process for inclusion or exclusion of candidate subproject in the TA and the Investment pipeline of the GEUDP.

III. SUMMARY OF CHANGES

	Changed	Not Changed
Results Framework	✓	
Disbursement Estimates	✓	
Overall Risk Rating	✓	
Implementation Schedule	✓	
Economic and Financial Analysis	✓	
Implementing Agency		✓
DDO Status		✓
Project's Development Objectives		✓
PBCs		✓
Components and Cost		✓
Loan Closing Date(s)		✓
Cancellations Proposed		✓
Reallocation between Disbursement Categories		✓
Disbursements Arrangements		✓



Safeguard Policies Triggered		✓
EA category		✓
Legal Covenants		✓
Institutional Arrangements		✓
Financial Management		✓
Procurement		✓
Other Change(s)		✓
Technical Analysis		✓
Social Analysis		✓
Environmental Analysis		✓

IV. DETAILED CHANGE(S)

DISBURSEMENT ESTIMATES

Change in Disbursement Estimates

Yes

Year	Current	Proposed
2017	0.00	0.00
2018	0.00	0.00
2019	2,100,000.00	2,100,000.00
2020	8,000,000.00	0.00
2021	8,000,000.00	6,139,881.00
2022	10,000,000.00	0.00
2023	12,000,000.00	0.00
2024	12,000,000.00	1,500,000.00
2025	8,000,000.00	6,000,000.00
2026	3,400,000.00	33,260,119.00



SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Rating at Approval	Current Rating
Political and Governance	● Substantial	● Moderate
Macroeconomic	● Moderate	● Moderate
Sector Strategies and Policies	● Substantial	● Substantial
Technical Design of Project or Program	● Moderate	● Moderate
Institutional Capacity for Implementation and Sustainability	● Substantial	● Substantial
Fiduciary	● Substantial	● Moderate
Environment and Social	● Substantial	● High
Stakeholders	● Substantial	● High
Other		
Overall	● Substantial	● Substantial



Indicator Name	PBC	Baseline	Intermediate Targets									End Target
			1	2	3	4	5	6	7	8	9	
Action: This indicator has been Revised	Rationale: The revision is made to the value of the intermediate target.											
Delivery of Inferred Resource Capacity Reports by Exploration Management Team (Number)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Action: This indicator has been Revised	Rationale: Scale down subproject numbers from four to one.											
Villages located next to exploration sites with at least one public consultation held (Percentage)	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Share of public consultations segregated by gender (Percentage)	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Capacity Building on Geothermal Exploration and Environmental and Social Safeguards Management												
Practice guides for safeguards implementation (Number)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	2.00	2.00	2.00	2.00



The World Bank

ID-Geothermal Energy Upstream Development (P155047)



Annex 1

Environmental and Social Risks Screening

Proposed subproject Name: Jailolo

Location: West Halmahera Regency, North Maluku Province

Current status: Technical Assistance Pipeline

Description of Proposed Activities:

1) Geoscience Surveys

The purpose of geoscience surveys activity is to collect geoscientific data related to estimates of key reservoir parameters such as temperature, depth, extent, etc., prior to the exploration drilling. The surveys typically begin by gathering samples and data from existing surface manifestations, and then proceeds to surface and sub-surface surveying using geological, geochemical, and geophysical methods. There are no environmental and social impacts resulting from this activity, apart from hiring a few local laborers and guides.

2) Infrastructure and Well Pad Development

Well pad locations need to be identified in such way to allow the drilling to reach the expected geothermal reservoir. The locations could be within several hundred meters from existing roads and therefore construction of new access roads will be required. A dedicated well pad will be prepared for each well. Generally, the well pad size will be 60 m × 110 m large excluded 2000 m³ water pond. The estimated land procurement for each well pad is 1.5 – 2 hectares.

Other supporting facilities also need to be prepared such as laydown area, drilling basecamp, reserved area for civil basecamp, disposal area and pump stations. The required area for these facilities will be studied further in civil Front-End Engineering Design (FEED) stage.

The construction of new access road and the road improvement or widening, as well as strengthening of any bridges will be necessary for the mobilization of drilling rigs and supporting equipment, construction equipment, personnel, and related construction and drilling materials to each site. Existing access roads to site are sealed, typically wide enough for exploration vehicle traffic and generally, in good condition. Existing bridges are Class B or better and likely to be suitable for mobilization of exploration drilling equipment. The exception is a 2 km section of road leading to Idamdehe. There are a number of curves that will require widening works and some sections are 20% grade – meaning helper vehicles will likely be required for significant loads. A number of overhead power line crossings will need to be raised; however, this is considered relatively minor.

Some new road within the project site needs to be constructed to access the well pad and other surface facilities. The minimum width of new roads shall be 4 m (excluding 2 x 0.5m paved shoulders). The minimum width of road formation shall consider the appropriate room required for pipe corridor; (these criteria shall also apply for the existing road within the project site).

To support the drilling activity, a water supply of 900 – 1100 gallon per minute (GPM) will be required. A feasible water source is located around 7.5 km away from project area. At this location there is a large river and locals reported abundant flow year-round. The long transmission distance of the water pipeline means that additional piping and equipment may be required to pump the water to the site. Further detail study for new road and water supply requirement will be conducted during FEED stage.

3) Exploration Drilling



There are two types of drilling techniques that may be implemented in the Jailolo prospect area, namely 'mud/water drilling' and 'aerated drilling'. The depth of the planned exploration well is planned to be around 2000 m - 2500 m for each well. A significant activity in the drilling is the management of the drilling mud. Drilling mud serves as a lubricant that reduces the friction at the cutting bit and prevents fouling of the drilling shaft in the shallower parts of the well. The mud is actually a slurry of bentonite clay and theoretically recyclable, although some of it flows into subsurface cracks in the rock matrix. There is constant production of the bentonite slurry. Settling ponds are constructed to contain the mud. The deeper parts of the well are usually drilled with plain water. There will be continued heavy traffic to the site, bringing fuel and other consumables, throughout this period.

4) Well Testing

Various formation evaluation and well tests will be undertaken during drilling, on completion or shortly afterwards. The completion tests involve injection of fluid into the well to identify loss zones and well injectivity. The well will progressively heat up then, and temperature and pressure measurements will be taken during this period. The most noticeable test will be discharge testing of the wells. This clears the well of drilling cuttings and mud and provides a direct measurement of well output. The first well will be tested when the second well has been completely drilled so that it can be used as reinjection well. Before the well is opened, the Non-Condensable Gas (NCG), especially Hydrogen Sulfide (H₂S) gas, will be dissolved into a tank containing sodium hydroxide solution to reduce its concentration.

The discharge test will be carried-out for at least 7 days for each well. If the well is not able to self-discharge, it will be stimulated using air compression method by utilize the aerated drilling equipment. A significant amount of geothermal fluid will be extracted to the surface during the well discharge testing. Parallely, some Pressure – Temperature – Spinner (PTS) surveys, Chemical Sampling and Tracer Flow Test (TFT) will be conducted. The extracted liquids, or 'brine', will be disposed of to a drilling pond before injected into the reinjection well. The steam will be discharged to air which can contain high concentrations of sodium chloride, and some boron. The remain non-condensable gas discharges include carbon dioxide and hydrogen sulfide.

In order to facilitate reinjection, it will be necessary to run a hot pipe from the test well to a reinjection well, if both of well located in separated well pad. The hot pipe will run from the first test well to a second well, and these roles can be reversed when the second well is tested. This temporary pipeline could be several kilometers long and will require easements along its alignment for the duration of the project.

5) Site Rehabilitation

Once the testing is completed the well may be capped for future use (if the resource is promising for exploitation for electricity generation) or may be decommissioned (if the resource is not good enough). In either case the well pad site, including the ponds, will be made safe and restored to a condition agreed with the land owner.



Safeguard Screening, Policy Triggering and Safeguard Instrument Checklist

Question	Answer	Policy triggered/
	YES (Significant, Moderate, Minor) OR NO	Category and Safeguard Instrument
Are the subproject impacts likely to have significant adverse environmental impacts that are sensitive, ¹³ diverse or unprecedented? ¹⁴ Provide brief description:	<p>Yes. Moderate</p> <ol style="list-style-type: none"> 1. Decreasing air quality due to increased levels of emissions (CO and HC) and dust in the air. 2. Increased noise due to vehicle engine noise, heavy equipment operation, etc. 3. Decreasing water quality due to increased turbidity from overflow of top soil when rain occurs, increased concentrations of heavy metals, etc. 4. The occurrence of disturbance to aquatic biota 5. Occupational health and safety 6. Possible presence of poisonous gases from wild bursts 	<p>OP 4.01 Environmental Assessment</p> <p>Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL</p>
Are the subproject impacts likely to have significant adverse social impacts that are sensitive, diverse or unprecedented? ¹⁵ Provide brief description.	<ul style="list-style-type: none"> - Land Acquisition (Significant) - Mobilization and demobilization of equipment and materials can have an impact: (Moderate): - Noise and vibration interference. - Decreasing air quality (dust). - Decreasing water quality due to increased turbidity from overflow of top soil when rain occurs, increased concentrations of heavy metals, etc. (Moderate) 	<p>OP 4.01 Environmental Assessment</p> <p>Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL</p>

¹³ Sensitive (i.e., a potential impact is considered sensitive if it may be irreversible, e.g., permanently affect significant landscape features.

¹⁴ Large scale induced slash and burn agricultural development into forested areas.



Question	Answer	Policy triggered/ Category and Safeguard Instrument
	YES (Significant, Moderate, Minor) OR NO	
Do the impacts affect an area broader than the sites or facilities subject to physical works and are the significant adverse environmental impacts irreversible? Provide brief description:	No.	OP 4.01 Environmental Assessment Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL
Will the subprojects have positive environmental or social benefits? Provide brief description:	Yes. Moderate <ul style="list-style-type: none"> - Better access road - New job opportunity - Diverse job opportunity - Additional income - Facilities and infrastructure improvement 	OP 4.01 Environmental Assessment Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL
Will the subprojects adversely impact physical cultural resources? ¹⁶ Please provide brief justification.	No. Physical Cultural Resources that have been identified as a sacred tomb, namely the Iki Malaha Tomb, are far outside the location of the Jailolo WKP plan. This sacred tomb is located in Bukit Jere, Idamdehe Gamsungi Village.	OP 4.01 Environmental Assessment OP 4.11 Physical Cultural Resources Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL
Will the subprojects involve the conversion or degradation of non-critical natural habitats? Please provide brief justification.	Yes. Minor Construction of a water supply line for drilling activity (pipeline from the source on the Gamtala Akediri River to the drilling pond at the drilling location following the existing road. At the Akediri River location, a temporary dam and a pump site will be built to pump water from the river to the drilling location. Water capacity the maximum to be taken from the river is 90 ltr / second.	OP 4.01 Environmental Assessment OP 4.04 Natural Habitats Cat A/B (to be confirmed): ESIA & ESMP; UKL/UPL

¹⁶ Examples of physical cultural resources are archaeological or historical sites, religious or spiritual sites, particularly sites recognized by the government.



Question	Answer	Policy triggered/
	YES (Significant, Moderate, Minor) OR NO	Category and Safeguard Instrument
Will the subprojects involve the conversion or degradation of critical natural habitats? ¹⁷	No. There is no document that indicate that this project will be related to activities that involve the conversion or degradation of critical natural habitats. This is to be confirmed in the ESIA.	OP 4.04 Natural Habitats
Do the subprojects involve involuntary land acquisition? Significant >200 people displaced, or 10% households' assets affected. Moderate <200 people or 10% of households' assets affected.	Yes. Moderate. Based on the results of discussions and field surveys, the average land currently being cultivated is various types of agricultural commodities (field rice, secondary crops, and horticulture) and plantations (nutmeg, cloves, and coconut). But there is no information yet about how many people or households will be affected by the project.	OP 4.12 Involuntary Resettlement (Abbreviated) LARAP
Do the subprojects involve loss of assets or access to assets, or loss of income sources or means of livelihood as a result of involuntary land acquisition? Please provide brief justification	Yes. Moderate Based on the results of discussions and field surveys, the average land currently being cultivated is various types of agricultural commodities (field rice, secondary crops, and horticulture) and plantations (nutmeg, cloves, and coconut).	OP 4.12 Involuntary Resettlement (Abbreviated) LARAP
Do the subprojects involve loss of assets but not as a result of involuntary land acquisition?	No. All lost assets mentioned in the document are assets related to land ownership.	OP4.01 Environmental Assessment Manage compensation at replacement value under ESMP.

¹⁷Sub-projects that significantly convert or degrade critical natural habitats such as legally protected, officially proposed for protection, identified by authoritative sources for their high conservation value, or recognized as protected by traditional local communities, are ineligible for Bank financing.



Question	Answer	Policy triggered/
	YES (Significant, Moderate, Minor) OR NO	Category and Safeguard Instrument
<p>Are there Indigenous People present in the subprojects' areas?</p> <p>Self-identify as part of a distinct social and cultural group, and</p> <p>Maintain cultural, economic, social and political intuitions distinct from the dominant society and culture?, and</p> <p>Speak a distinct language or dialect?, and</p> <p>Been historically, socially and/or economically marginalized, disempowered, excluded and/or discriminated against?</p>	<p>Yes; significance to be further confirmed</p> <p>Culturally, the villages of Idamdehe and Idamdehe Gamsungi were under the Jailolo sultanate.</p> <p>The customary law of the Sahu tribe is led by the customary leader in each village. Customary law only applies to wedding ceremonies and big harvest celebrations.</p> <p>In the villages of Idamdehe and Idamdehe Gamsungi there are still several areas of land which are village treasury lands, the land is managed by the village head who is elected as the income / salary of the village head. The village treasury land is currently being used for clove and nutmeg plantation areas and the result is the right of the incumbent village head. The process of land ownership and transfer of land rights is carried out as follows</p>	<p>OP4.10 Indigenous Peoples</p> <p>Indigenous Peoples Plan (IPP)</p>

Environmental and Social Instruments Status

Instrument	Status	Remarks
Environmental and Social Impact Assessment (ESIA)	Under preparation	
Environmental and Social Management Plan (ESMP)	Under preparation	
Land Acquisition and Resettlement Action Plan	Under preparation	
Indigenous Peoples Planning	Under Preparation	
Stakeholder Engagement Plan	Under Preparation	
UKL/UPL (Environmental Assessment as per Gol regulations)	Under preparation	

Environmental and Social Instruments for the GEUDP Restructuring

Instrument	Status	Remarks
Environmental and Social Management Framework (ESMF) V5	Cleared by the Bank	



Annex 2

Updated Economic – Financial Analysis

1. This Annex comprises two parts, an economic analysis to assess the economic viability of a given geothermal site; and a financial analysis to demonstrate how a government-sponsored exploration drilling scheme helps reduce the barrier-to-entry to the geothermal sector in Indonesia.

Economic Analysis

2. The exact capacity of the geothermal plants that will be developed following the exploration drilling is not yet known. For the sake of this analysis, two hypothetical sites in Eastern Indonesia were analyzed: (i) a relatively large site with a resource potential of 55 MW; and (ii) a relatively small site with a resource potential of 10 MW. The varied size of the hypothetical plants will help assess the impact of site scale on the economic and financial viability of geothermal development and the government-sponsored exploration drilling scheme. The large site is assumed to be on a bigger island with a considerable existing load and relatively high connection rate of consumers. The small site is assumed to be on one of the many small-to-medium sized islands in Eastern Indonesia with a moderate existing load and low connection rate.
3. A benefit-cost analysis was carried out, on a site-by-site basis, to assess the economic viability of each geothermal development selected for government-sponsored exploration drilling under the Project scheme, taking into account the global environmental benefit of avoided greenhouse gas (GHG) emissions from geothermal-based generation vis-à-vis a comparable thermal power development. The analysis was carried out over a 30-year lifetime of a geothermal development, exclusive of the construction period, at an economic opportunity cost of 6.0 percent.¹⁸ The social cost of carbon is assumed to follow a curve proposed by The Guidance Note on Social Value of Carbon (2017)¹⁹ increasing from US\$37 per ton of CO₂ in 2017 to US\$83 ton of CO₂ in 2052 at the social discount rate of 6.0 percent.

Cost-benefit analysis²⁰

4. The economic cost estimates were derived based on known or inferred relationships between costs and technical characteristics of geothermal projects, excluding taxes and duties. Investment costs of geothermal development are determined by the following factors: (i) size of the development (MW) determined by both resources availability and demand; (ii) the enthalpy and depth of the resources; (iii) difficulty of access to the concession area; and (iv) cost and efficiency of project management.
5. In terms of composition, geothermal development comprises four types of costs: (i) drilling costs, a function of the number wells and the cost of each well; (ii) infrastructure costs for construction roads, well pads and other infrastructure facilities; (iii) equipment costs, including power plant and steam field above ground systems (SAGS); and (iv) project management costs.
6. Drilling cost is a function of the following factors: (i) well productivity; (ii) success rate of drilling; (iii) well depth, and (iv) prevailing services and material cost. Well productivity, in turn, depends largely on the enthalpy of the resources and well permeability (i.e. the ease with which fluids flow into the well).
7. Three enthalpy scenarios were assumed in the analysis: (i) low enthalpy, i.e., low temperature between 180°C and 230°C;

¹⁸ Source: Discounting Costs and Benefits in Economic Analysis of World Bank Projects, OPSPQ, 2016

¹⁹ Source: *The Guidance Note on Social Value of Carbon* (2017) <https://thedocs.worldbank.org/en/doc/911381516303509498-0020022018/original/2017ShadowPriceofCarbonGuidanceNoteFINALCLEARED.pdf>

²⁰ Data from this section are from the team's own estimates



(ii) medium enthalpy with temperature above 230°C but relatively low pressure²¹; and (iii) high enthalpy with both high temperature and high pressure. Resource enthalpy is also a key determinant of the reinjection-to-production well ratio. Lower enthalpy resources generally require a higher reinjection-to-production well ratio. Estimates of resource temperature and other parameters were made based on interpretations of previous geothermal developments in Indonesia. Below is a summary of the well productivity and reinjection-to-production well ratio assumptions under each enthalpy scenario.

Table 1 - Well Assumptions

Enthalpy	Well Productivity (MW/well)	Reinjection-to-Production Well Ratio
High	10.0	15 percent
Medium	7.0	33 percent
Low	5.0	90 percent

8. Drilling cost per well was assumed at US\$6.0 million for a 7" x 2,500 meter deep production well, US\$8.25 million for a 9-5/8" x 2,500 production well, and US\$5.5 million for a 7" x 2,000 meter reinjection well. Success rate²² of drilling improves along the phases of the geothermal development from around 60 percent in the exploration phase to 75 percent for delineation and production drilling.
9. The base case scenario assumes medium enthalpy for both fields. It was further assumed three wells will be drilled at the exploration phase. Thus, the total number of wells to be drilled based on the above assumptions are estimated and summarized below.

Table 2 – Number of Wells to be Drilled

	Development 1 - 55 MW			Development 2 - 10 MW		
	<i>Low</i>	<i>Base case Medium</i>	<i>High</i>	<i>Low</i>	<i>Base case Medium</i>	<i>High</i>
Enthalpy						
Productivity (MW per well)	5.0	7.0	10.0	5.0	7.0	10.0
Number of wells						
Exploration wells	3	3	3	3	3	3
Delineation and production	9	7	5	1	-	-
Reinjection	9	3	1	1	-	-
Total	21	13	9	5	3	3

10. Infrastructure Costs are driven primarily by the difficulty in site access. The analysis laid out three scenarios: (i) easy access with initial access road length ranging between 0 and 7.5 km from existing public access road; (ii) medium with initial access road between 7.5 km and 20 km; and (iii) difficult with initial access road longer than 20 km. All well pads are assumed to require 2 km additional road. Initial access road cost was assumed at US\$0.5 million per km for easy and medium access scenarios, US\$0.75 million per km for difficult access scenario. It is further assumed an average length of 0.75 km of access road to additional well pads. The additional access road was assumed to cost US\$0.38 million per km for easy and medium access scenarios, and US\$0.56 million for difficult access scenario. The base case scenario assumes easy access for both fields.

11. Power Plant Costs assumed at US\$1,500 per kW for a standard single-unit 55 MW plant, and US\$2,000 per kW for the 10

²¹ Defined as less than 10 percent excess enthalpy compared to reservoir temperature when measured in a discharging well with at least 5 barg WHP, a definition agreed with MEMR albeit minor inconsistencies with the international conventions.

²² Defined as the likelihood the well productivity exceeds a preset threshold



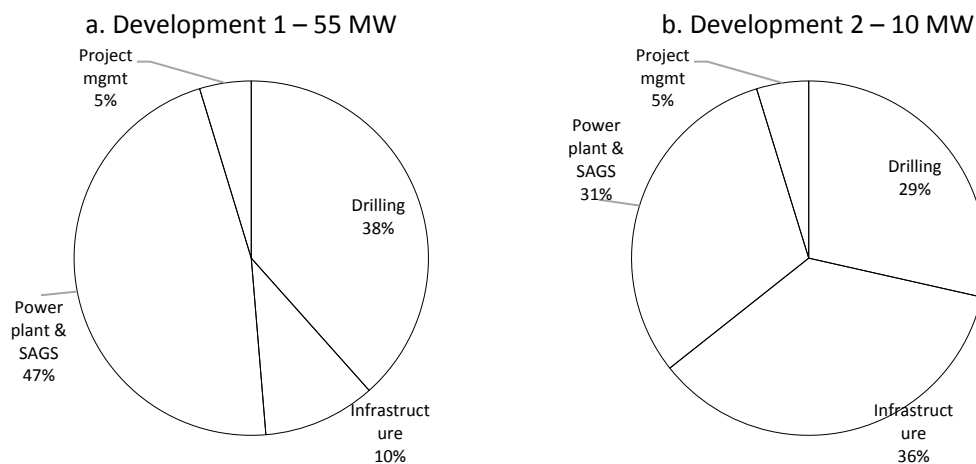
MW plant. For any other sizes, the plant costs were estimated using an experiential formula derived from actual plant cost data.²³

12. Assuming medium enthalpy and difficult access, the total cost of geothermal development under the base case scenario was thus estimated at US\$211.5 million for the 55 MW site, and US\$54.1 million for the 10 MW site.

Table 3 – Total Investment Cost

	Development 1 (US\$ million)	Development 2 (US\$ million)
Drilling	92.3	26.5
Infrastructure	7.1	3.5
Power plant and SAGS	101.8	21.5
Project management	10.3	2.3
<i>total</i>	211.5	54.1
(new cost table)		
	Development 1 (US\$ million)	Development 2 (US\$ million)
Drilling	90.5	18.0
Infrastructure	24.2	22.6
Power plant and SAGS	109.8	19.5
Project management	11.1	3.0
<i>total</i>	231.9	63.3

Figure 1 – Investment Cost Breakdown



13. O&M costs include (i) on-going expenses assumed at US\$0.02 per kWh and US\$0.023 per kWh for the 55MW and 10 MW unit respectively, (ii) occasional costs for plant shutdown and overhaul assumed to occur every 5 years, at a cost of US\$500,000 per event, and (iii) costs of make-up wells assuming a 3 percent linear reservoir drawdown, with 3 production size wells being drilled at each make-up well drilling campaign for the 55 MW site; and 1 at the 10 MW site.

²³ Single unit plant cost = 1.6051 * (MW)^{-0.316}



Benefits

14. The economic benefits of each development comprise two parts: (i) the economic value of the power supply from the plant; and (ii) the avoided cost in CO₂ emissions vis-à-vis thermal powered generation.
15. Plant Factor. A plant factor of 92 percent was assumed based on experience from operations of existing geothermal power plants in Indonesia.
16. Power supply. The annual power output amounts to 443.3 GWh from the 55 MW plant, and 80.6 GWh from the 10 MW plant.
17. The economic value of the power supply from each geothermal development is estimated as the weighted average of the cost of diesel-based power supply it substitutes and the willingness-to-pay for the additional power supply it enabled to provide access to un-electrified households.
18. The substituted cost of supply. In Eastern Indonesia where indigenous coal resources are generally rare, and low quality coal is costly to transport, the least-financial-cost power supply usually comes from diesel generators burning expensive fuel transported from afar. The supply substituted by the geothermal development is thus assumed at marginal cost of diesel-based generation at a diesel cost of US\$0.70 per liter.²⁴ At a thermal efficiency of 34 percent for a larger more efficient unit and 30 percent for a smaller unit, the marginal cost of diesel generation is estimated at US\$0.20 per kWh for the larger plant and US\$0.21 per kWh for the smaller plant.
19. Expanded supply to increase access to electricity. In Eastern Indonesia, access to electricity is far from being universal, in part, due to shortage of power supply. The need for electrification is assumed to be bigger on the smaller islands. Thus, for the 55 MW plant it is assumed that 80 percent of the geothermal-based generation will be substituting diesel-based supply while 20 percent will be serving the need for electrification, whereas for the 10 MW plant 60 percent diesel substitution and 40 percent electrification is assumed. The WTP for power supply made available through electrification is conservatively assumed at US\$0.40 per kWh.²⁵ Assuming total system losses at around 30 percent, the WTP for power generation for electrification was thus estimated at US\$0.28 per kWh.
20. Willingness to pay (WTP) based on the above-mentioned assumptions, is thus estimated at around US\$0.22 per kWh for power generated from the large site and US\$0.25 per kWh for that from the small site.
21. Avoided cost vis-a-via thermal power. Modern closed-loop geothermal power plants emit no greenhouse gasses; lifecycle GHG emissions are around 122 gCO₂/kWh.²⁶ With an efficiency of 34 percent and 30 percent, the emission factor of diesel generation is estimated at 784 gCO₂/kWh and 889 gCO₂/kWh, respectively. Assuming the global social cost of CO₂ following the curve proposed by the Guidance Note on Social Value of Carbon (2017) with a weighted average of US\$49.64 per tCO₂ for the period 2017-52, geothermal generation will thus avoid an estimated US\$0.032 per kWh in CO₂ emissions from the 55 MW plant, and an estimated US\$0.037 per kWh from the 10 MW plant.

Table 4 – Avoided Cost of CO₂ Emission

²⁴ The Government of Indonesia provides subsidies on automotive diesel to keep its retail price around IDR 5,500 (US\$0.42) per liter. However, the subsidy is not available for diesel used in electricity generation. Table 68, PLN Statistics 2014 indicated the cost of generation of PLN's diesel fleet averaged from US\$ 0.23 to US\$0.25 per kWh in the period of 2012-14, translating to a marginal cost of diesel generation between US\$0.21 to US\$0.24 per kWh, or a cost of fuel between \$0.70-0.85 per liter, assuming 34 percent efficiency. Here, to be conservative cost of US\$0.70 per liter is assumed. IEA Statistics, July 2016 <https://www.iea.org/media/statistics/surveys/prices/mps.pdf> recorded an automotive diesel price range of US\$0.686 – US\$1.369 per liter in OECD countries in the month of July, 2016.

²⁵ The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits and IEG Impact Evaluation (2008) indicated the estimated WTP for lighting at US\$0.71 per kWh in Indonesia.

²⁶ Source: [Thráinn Fridriksson, Gases in Geothermal Fluids and Gas Emissions from Geothermal Power Plants, April 2016, ESMAP](#)



	Development 1 (55 MW)	Development 2 (10 MW)
Substituted technology	Large diesel	Medium diesel
Substituted diesel efficiency	34 percent	30 percent
CO ₂ conversion factor of diesel (Kg/GJ)	74.1	
Heat content of diesel used for generation (kJ/kWh)	10,588	12,857
Diesel generation emissions (kg/kWh)	0.784	0.889
Geothermal generation emissions (kg/kWh)	0.122	0.122
Avoided CO ₂ emission (kgCO ₂ /kWh)	0.663	0.767
Avoided cost of CO ₂ emission (US\$/kWh)	0.033	0.038

22. The total economic value of the geothermal development is thus estimated at US\$0.25 per kWh from the 55 MW development, and US\$0.29 per kWh from the 10 MW development. The table below provides a summary of the economic benefits from each geothermal development.

Table 5 - Summary of Economic Benefits

	Development 1	Development 2
Power supply		
Capacity (MW)	55.0	10.0
Capacity factor	92 percent	92 percent
Annual output (GWh)	443.3	80.6
Substituted power generation		
Type	Large diesel	Small diesel
Cost of fuel (US\$/liter)	0.70	0.70
Efficiency	34 percent	30 percent
Economic value of the power generated		
Substituted existing supply	80 percent	60 percent
Marginal cost of substituted diesel generation (\$/kWh)	0.20	0.23
Electrification	20 percent	40 percent
WTP for electrification (\$/kWh)	0.40	0.40
Average WTP (US\$/kWh)	0.22	0.25
Avoided cost of CO₂ emissions vis-a-vis thermal (US\$ kWh)	0.03	0.04
Total economic value of geothermal power supply (US\$ kWh)	0.26	0.29

23. Global environmental benefit. Based on the above-mentioned assumptions, an estimated 0.294 million-tCO₂ and 0.062 million-tCO₂ emissions will be avoided through the 55 MW and 10 MW geothermal development respectively. With a global social cost of CO₂ following the curve proposed by The Guidance Note on Social Value of Carbon (2017) with a weighted average of US\$49.64 per tCO₂ for the period 2017-52, an estimated US\$14.58 million and US\$3.07 million worth of CO₂ emissions will be avoided annually from the 55 MW and 10 MW geothermal development respectively.

24. Outcome of the economic analysis. At a discount rate of 6 percent and a social cost of carbon following the curve proposed by The Guidance Note on Social Value of Carbon (2017) with a weighted average of US\$49.46 per tCO₂ for the period 2017-52, the 55 MW geothermal development yields an economic net present value (ENPV) of US\$764 million with an economic internal rate of return (EIRR) of 32.1 percent; and the 10 MW development yields an ENPV of US\$138 million with an EIRR of 23.5 percent. Therefore, both developments are economically viable.



Table 6 – Economics Analysis, ENPV and EIRR Results

	Development 1 55 MW	Development 2 10 MW
ENPV @ 6 percent discount rate	US\$764 million	US\$138 million
EIRR	32.1 percent	23.5 percent

25. A sensitivity analysis examines the impact of global externality, i.e., the value of the avoided CO2 emissions, on the EIRR. The results are summarized in the table below.

Table 7 – Sensitivity of Global Externalities

	55 MW	10 MW
EIRR – including global externality	32.1 percent	23.5 percent
EIRR – excluding global externality	27.7 percent	20.4 percent

Financial Analysis

26. The Financial Analysis (FA) was carried out from two different perspectives: (i) one from a developer’s perspective, assessing the financial viability of a given geothermal site on a with- and without project basis; (ii) the other from the implementing agency’s perspective, assessing its cash in- and out-flows related to the investments in geothermal exploration drilling over a period of 18 years.

From a Developer’s Perspective

27. The financial analysis assesses the financial viability of each geothermal development, using the geothermal ceiling tariff schedule set by the Presidential Regulation No. 112/2022 concerning Acceleration of Renewable Energy Development for Electricity Provision. Based on Presidential Regulation, the ceiling tariff are as follows:

- For projects with capacity up to 10 MW, the ceiling tariff will be US\$0.0976 per kWh from Year 1 to Year 10, and US\$0.083 thereafter.
- For projects with capacity greater between 10 MW and 50 MW, ceiling tariff will be US\$0.0941 per kWh from Year 1 to 10, and US\$0.08 thereafter.
- For project with capacity between 50 MW and 100 MW, the ceiling tariff will be US\$0.0864 from Year 1 to Year 10, and US\$0.0735 thereafter.

Moreover, a geographical factor of 1.25 will be applied to projects in Eastern Indonesia.

28. All project related costs are calculated on nominal basis, assuming a 3 percent price escalation annually, inclusive of taxes, duties and financial charges. In the with-Project scenario, it has been assumed the winning developer will pay the equivalent of a 25 percent premium on top of the cost of exploration in order to acquire a license.

29. Financing mix. In Indonesia, the costs of geothermal exploration have been borne by the developer through full equity financing because debt financing is usually not available at this stage of the development due to the high levels of resource uncertainties. Once resources risks are greatly reduced, developers can access debt financing more easily. Thus, in the without-Project scenario the financing mix is assumed to vary from full equity financing at the exploration stage, to a 70/30 debt-to-equity thereafter.

30. Financing cost. Each stage of geothermal development is associated with a certain number of risks and capital requirements. Although the capital requirements are higher in later stages, the resource risks at early exploration stages are often deemed



insurmountable from a financial perspective, stalling the sector’s development. Developers would demand a considerable risk premium commensurate with the high resource uncertainty associated with the exploration stage of the geothermal development. For the later stages of the development, developers required risk premium is much lower due to the much-reduced resources risks. The table below provides a summary of the required risk premiums of IPP and SOE (with lower hurdle rates) developers and their corresponding weighted average cost of capital (WACC).

Table 1 - Risk premium

	Exploration	Post-Exploration
IPP	25 percent	14 percent
SOE	16 percent	11 percent

31. Weighted average cost of capital. With the cost of debt at 8 percent and corporate tax at 25 percent, the WACC with- and without- the Project intervention, under high, medium and low enthalpy scenarios are summarized in the table below.

Table 2 - Project WACC

	Without Project (Greenfield)						With Project (Brownfield)	
	Development 1			Development 2			Development 1	Development 2
Enthalpy	high	medium	low	high	medium	Low		
IPP	10.4 percent	10.1 percent	9.7 percent	16.4 percent	16.4 percent	14.3 percent	10.2 percent	10.2 percent
SOE	8.5 percent	8.4 percent	8.2 percent	11.6 percent	11.6 percent	10.5 percent	8.4 percent	11.6 percent

32. Outcome of the financial analysis. At the recommended ceiling tariff per Presidential Regulation No. 112/2022:

- Without the Project intervention, the 55 MW geothermal development will yield a negative FIRR in the low, medium and high enthalpy scenarios, which means that it fails to meet the WACC requirement of both IPP and SOE developers.
- Without the Project intervention, the 10 MW geothermal development will yield a negative FIRR in the low, medium and high enthalpy scenarios, which means that it fails to meet the WACC requirement of both IPP and SOE developers.
- The main reason is that the Presidential Decree sets a lower ceiling price for geothermal development in eastern Indonesia than the previous rule, which related the geothermal price to the average cost of generation in the grid. The indication is that these projects would move ahead only as public sector assignments to SOEs justified by the high economic rate of return.



Annex 3
Project Schedule

