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Preparing Technical and Commercial Documents for Geothermal Exploration Project Financing in Indonesia

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ABSTRACT

In recent years, public awareness of using clean and renewable energy, such as geothermal, in a more significant portion is starting to increase. Indonesia is one of the countries that have the most considerable geothermal energy potential, but it has yet to be utilized optimally. The Government of Indonesia aims to achieve 5,486 MWe geothermal energy utilization by 2030. Therefore, Indonesia is expected to see many geothermal development projects in the next eight years, with more attention to exploration projects.

With the increasing number of geothermal projects in Indonesia, the government and the geothermal developer companies will need more funds to finance project expenditures in the exploration and development stages. However, lenders generally prefer to fund the development phase of a project rather than the exploration phase because the risks associated with the project are acceptable, and the potential return on investment is more certain in the development phase. This preference is comprehendible since the project's success in the exploration phase is uncertain, and the potential rewards are largely speculative. The exploration phase also involves greater uncertainty and risk, as the geology and potential resources still need to be fully understood.

The funding can come from various financial institutions, either Indonesia or International institutions, where they will require prospective borrowers to submit multiple documents as part of the assessment process. This practice will be straightforward for geothermal development companies familiar with the due diligence process in accessing funding facilities, but preparing these documents will be a challenge for companies that are not used to it. Integrating indirect and limited data of exploration projects to justify the relatively high drilling costs will require much effort.

This paper discusses the process that is generally gone through by geothermal development companies seeking to obtain funding from financial institutions for their geothermal exploration project. To provide background, the authors will first discuss a geothermal exploration project's cost estimate and challenges. Then, it will focus on the proposal submission and evaluation process and the critical information that is expected to be included in the submitted document. The discussion in this paper is based on the results of a literature study and interviews with various financial institution personnel who have experience financing geothermal project activities in Indonesia.

1. INTRODUCTION

1.1 Challenges in Developing Geothermal Energy in Indonesia

The history of geothermal energy in Indonesia can be traced back to the early 20th century when the Dutch colonial government began exploring geothermal energy potential on Java Island. However, it was in the 1970s that the Indonesian government started actively pursuing the development of geothermal energy as a source of electricity.

1. Exploration: In the 1970s, the Indonesian government began to explore the potential for geothermal energy in several areas of the country, including the Kamojang area in West Java. This involved drilling test wells and conducting geophysical surveys to assess the size and quality of the geothermal resources in the area.
2. Early development: The first geothermal power plant in Indonesia, the Kamojang Geothermal Power Plant, was built in the Kamojang area in the 1980s. It was one of the first geothermal power plants in the world and had an installed capacity of 55MW.
3. Expansion and growth: In the following decades, the Indonesian government continued to invest in geothermal energy development. Indonesia's Kamojang power plant expanded several times, and in parallel, they gradually built new geothermal power plants in other areas. By 2023, Indonesia had become one of the world's largest geothermal energy producers, with an installed capacity of over 2,356 MW (Direktorat Panas Bumi, 2022; ThinkGeoEnergy, 2023).

In recent years, the Indonesian government has set ambitious targets for developing geothermal energy by having 5,486 MWe installed capacity by 2030 (Direktorat Panas Bumi, 2022) to align with the country's effort to mitigate climate change. However, from the time Kamojang commercial power plant was commissioned for the first time in 1983 until the end of 2022, the development of geothermal energy in Indonesia has only reached 2,356 MW installed capacity (ThinkGeoEnergy, 2023). This additional rate is equivalent to a 54

MW per year development rate to the installed capacity of geothermal power plants, which is still below the expected 375 MW per year to reach the national geothermal target in 2030.

From the world's perspective, Indonesia is the country with the second largest installed geothermal power plant (PLTP) after the United States (ThinkGeoEnergy, 2023). However, compared to the total reserves of geothermal energy owned, Indonesia only uses ±11%. In comparison, New Zealand has used 38% of its total potential, while the United States has used 21% of its total potential (Asokawaty et al., 2020). Similar to other countries worldwide, Indonesia faces many challenges in developing its geothermal energy, including (Ibrahim et al., 2005; IGA, 2014; Poernomo, 2015; Darma, 2016; Purba, 2018; Umam et al., 2018; Purba et al., 2019; Purba et al, 2020; Utami, 2010):

1. High exploration and development costs: Geothermal projects can be expensive to explore and develop, especially in the early stages. Drilling test wells and conducting geophysical surveys can be costly, and there is always the risk that a project will not yield a viable resource.
2. Complex and uncertain regulatory environment: Geothermal projects are subject to various national, regional, and local regulations. This uncertainty can make it difficult for developers to navigate the regulatory environment and can increase the risk of project delays or cancellations.
3. Lack of infrastructure: Many geothermal resources in Indonesia are located in remote areas, making them difficult and expensive to access. These infrastructures can include building roads, power lines, and other infrastructure to support a geothermal project.
4. Environmental impacts: Geothermal projects can have various environmental impacts, such as deforestation and the potential for groundwater contamination. Mitigating these impacts can be costly and time-consuming.
5. Social and community impact: Geothermal projects can also have social and community impacts, such as displacement of local communities and land-use conflicts. Developers need to address these impacts and engage with local communities to ensure their support and minimize the risk of project delays or cancellations.
6. Technical challenges: Building geothermal power plants and drilling geothermal wells require a high level of technical expertise and knowledge, which can be challenging. Additionally, geothermal wells can be more prone to clogging and scaling than oil or gas wells, leading to production issues and increased maintenance costs.
7. Electricity single-buyer regulation: The Indonesian government regulates the electricity sector, including setting tariffs and determining the energy mix. This policy limits PLN's flexibility in responding to market conditions and changing customer demands.

The Ministry of Energy and Mineral Resources (Direktorat Panas Bumi, 2022) reported that the government had issued 63 geothermal concessions with an estimated capacity of 13,517.5 MW. The data indicates that 22 locations are still under the exploration stage, with an estimated capacity of 4,011 MW (Table 1).

Table 1: List of Indonesia's Geothermal Prospect Areas/ Concession Areas in the Exploration Stage (Direktorat Panas Bumi, 2022)

No	Name of the Prospect Area / Concession Area	Location	Estimated Capacity (MWe)	Developer
1.	Tulehu	Maluku	31	PT PLN (Persero)
2.	Gn. Ungaran	Central Java	150	PT PLN (Persero)
3.	Atadei	East Nusa Tenggara	40	PT PLN (Persero)
4.	Songa Wayaua	North Maluku	42	PT PLN (Persero)
5.	Danau Ranau	South Sumatera	210	PT PLN (Persero)
6.	Oka Ile Ange	East Nusa Tenggara	50	PT PLN (Persero)
7.	Kepahiang	Bengkulu	254	PT PLN (Persero)
8.	Gn. Sirung	East Nusa Tenggara	152	PT PLN (Persero)
9.	Tangkuban Perahu	West Java	375	PT PLN (Persero)
10.	North Patuha (WKP Patuha)	West Java	55	PT Geo Dipa Energi
11.	Candradimuka (WKP Dieng)	Central Java	50	PT Geo Dipa Energi
12.	Candi Umbul Telomoyo	Central Java	92	PT Geo Dipa Energi
13.	Gn. Arjuno Welirang	East Java	302	PT Geo Dipa Energi
14.	Gn. Rajabasa	Lampung	283	PT Supreme Energy Rajabasa
15.	Rawa Dano	Banten	385	PT Sintesa Banten Geothermal
16.	Baturaden	Central Java	258	PT Sejahtera Alam Energy
17.	Telaga Ngebel	East Java	120	PT Bakrie Darmakarya Energi
18.	Seulawah Agam	Aceh	223	PT Geothermal Energi Seulawah
19.	Gn. Lawu	Central Java & East Java	332	PT Pertamina Geothermal Energy
20.	Kotamobagu	North Sulawesi	410	PT Pertamina Geothermal Energy
21.	Jaboi	Aceh	107	PT Sabang Geothermal Energy
22.	Gn. Talang – Bukit Kili	West Sumatera	90	PT Hitay Daya Energy
TOTAL			**4,011**	

Table 1 shows the list of the 22 geothermal prospect areas or concession areas still in the exploration stage and is expected to contribute in achieving the aforementioned national geothermal target. Despite the compelling opportunity presented by the untapped geothermal resources, the effort to translate this opportunity into actual megawatt is quite challenging given the high uncertainty and substantial upfront capital expenditure required to drill deep geothermal exploration wells. To achieve its national target of 5,486 MW in 2030, around eight years from now, Indonesia must address these exploration project challenges, which require technical expertise, careful planning, and engagement with local communities and stakeholders.

1.2 Risks in the Exploration Stage

Geothermal exploration can be challenging, as it involves identifying and assessing the potential for geothermal resources in a specific area. The fundamental objective of a geothermal exploration program is to identify and characterize a geothermal resource that can be economically developed by applying an optimized design based on the exploration results.

Therefore, it is common for geothermal developers or investors to face dilemmas with making investment decisions in the exploration stage. The difficulty is created by the requirement to spend high upfront capital but relying on information that is still very minimal and has a very high level of uncertainty. Additionally, the most significant cost component of an exploration project comes from the drilling activities and the construction cost of supporting infrastructures such as access roads, well pads, and other supporting facilities. This portion could significantly impact the total project costs if not planned and managed correctly.

The main challenges of geothermal exploration in Indonesia are summarized as follows (IGA, 2014; Poernomo, 2015; Darma, 2016; Purba, 2018; Umam et al., 2018; Purba et al., 2019; Adityatama, 2020; Purba et al., 2020):

1. Difficulty in locating the "hottest area": Geothermal resources are not always visible at the surface and can be challenging to locate without conducting detailed geological, geochemical, and geophysical (3G) surveys and drilling test wells. The unclear indications or thermal manifestations from surface studies can make it challenging to identify the most promising areas for exploration and increase the risk of drilling dry wells.
2. High exploration costs: Conducting 3G surveys, developing a reliable conceptual model, and drilling test wells can be expensive, and there is always the risk that a project will not yield a viable resource. The high upfront capital and resource uncertainties can make it difficult for developers to secure funding for exploration activities.
3. Complex geology: Geothermal resources in Indonesia are mainly located in a volcanic area with complex geological environments, making it difficult to understand the subsurface conditions and identify the most promising areas for exploration.
4. Lack of direct and reliable data: In some cases, there may be a need for more data on the geology and geochemistry of an area, making it challenging to identify potential resources and plan the exploration activities.
5. Environmental impacts: Exploration activities can have various environmental impacts, such as air and surface water pollution, soil degradation, hazardous noise, release of hazardous gases, landslides, deforestation, and the potential for groundwater contamination. Mitigating these impacts can be costly and time-consuming.
6. Social and community impacts: Exploration activities can also have social and community impacts, such as displacement of local communities and land-use conflicts. Developers need to address these impacts and engage with local communities to ensure their support and minimize the risk of project delays or cancellations.
7. Uncertain regulations: Geothermal exploration is subject to various national, regional, and local regulations. The uncertainty can make it difficult for developers to navigate the regulatory environment and can increase the risk of project delays or cancellations.

Given the high uncertainty and risks involved in the exploration stage, most commercial lenders are still reluctant to provide financing facilities for this purpose. Even international financial institutions (IFI) are reluctant to fund up-front exploration and typically will provide financing only once 50% or more of the steam resource is proven (Asian Development Bank and The World Bank, 2015). With this consideration, exploration drilling generally requires the sponsor's equity, which may only be recovered if the drilling reveals that the resource is technically sufficient and economically viable for exploitation. Meanwhile, from the developers' point of view, to mobilize the up-front equity needed for exploration, they will also consider the adequacy of the tariff, which adds to the challenges faced by the developers given the single buyer model applied in Indonesia.

One way that GoI has taken to tackle the challenges in the exploration stage is by launching the Infrastructure Financing for Geothermal Sector fund / Pembiayaan Infrastruktur Sektor Panas Bumi ("PISP Fund") through PT Sarana Multi Infrastruktur (Persero), as stipulated in the Minister of Finance Regulation No. 80 in 2022. This solution can be an alternative funding scheme that the developers may consider financing their exploration program, of which the typical funding application process will be described in the latter section.

1.3 Research Questions and Method

This paper begins by providing an overview of the typical activities carried out by developers in the exploration stage, along with estimated costs and duration of these various activities. After that, this paper briefly discusses various funding options for geothermal exploration projects.

While as the central part, this paper will discuss in more detail the process of submitting proposals and the completeness of documents that must be prepared by developers who plan to access funding facilities from financial institutions to finance geothermal exploration projects that will be carried out, particularly from the technical and commercial aspects. Most of the information described in this paper will use the exploration financing facility that will be channeled through PT Sarana Multi Infrastruktur (Persero) under the PISP Fund facility provided by the government as a reference. Although each financial institution may have a mechanism that may differ from one

another in processing funding proposals, the authors of this study believe that there are fundamental similarities in the aspects assessed from the proposals submitted.

This study was conducted using the literature study method combined with interviews with several experts who have knowledge and experience relevant to this study. The objective of this paper is to provide general guidelines for investors or geothermal development companies who wish to access funding from financial institutions to finance geothermal exploration projects in Indonesia.

The research questions that will be explored in this paper are as follows:

1. What is the estimated cost of geothermal exploration in Indonesia currently?
2. What options are available to finance geothermal exploration projects in Indonesia?
3. What are the pros and cons of each funding option?
4. How long does it take to process a funding proposal?
5. What is the critical information that required in a funding proposal?

2. EXPLORATION PROJECT COST ESTIMATE IN INDONESIA

2.1 Geothermal Regulation in Indonesia

Geothermal business in Indonesia is regulated in Law (Undang-undang / UU) No. 21 / 2014 and Government Regulation (Peraturan Pemerintah / PP) No. 7 / 2017, with some relevant detail shown in Table 2. Understanding the definition of exploration is very important because one of the criteria for the success of an exploration project is when the project complies with regulations related to geothermal exploration in Indonesia.

Table 2: The Detail of UU 21/2014 Explaining Exploration and Exploitation Definition (GGGI, 2023)

No.	Regulation	Article and Section	Description
1	UU No 21 / 2014	Article 1, section 7	Definition of "Exploration".
2	UU No 21 / 2014	Article 1, section 9	Definition of "Exploitation".
3	UU No 21 / 2014	Article 1, section 11	Definition of "Geothermal Indirect Utilisation".
4	UU No 21 / 2014	Article 20	Description on the geothermal indirect utilisation business and developers' obligation.
5	UU No 21 / 2014	Article 31	Duration of "Exploration"
6	UU No 21 / 2014	Article 32, section 1	Duration and when "Exploitation" and "Utilisation" starts.
7	UU No 21 / 2014	Article 32, section 2	Description of the developers' obligation to submit Feasibility Study Report to get approval from Minister of Energy and Mineral Resources.

2.2 Stages in Developing Geothermal Energy in Indonesia

Like other countries, geothermal development projects in Indonesia typically involve several stages (Figure 1), including (IGA, 2014, Direktorat Panas Bumi, 2022):

1. Preliminary survey and exploration: These are the first stage of a geothermal development project and involves identifying areas with potential geothermal resources and conducting surveys to gather information on the geology and geochemistry of the area. The main activities include 3G (geology, geochemical, geophysical) surveys, hydrology study, topographic mapping, construction of conceptual model, drilling test wells.
2. Feasibility study / resource assessment: Once a viable resource has been identified, the resource assessment phase begins, which includes determining the size of the resource and the potential for energy production. Engineers will also conduct various studies such as environmental impact assessment, social impact assessment, and feasibility study.
3. Exploitation (field development and construction): After the resource assessment is done, the next step is the development and construction of a geothermal power plant. Activities may include drilling production wells, building power plants and transmission infrastructure, and connecting the plant to the grid. This phase also includes the installation of power generation equipment, such as turbines and generators.
4. Operation and maintenance: After the construction of the steamfield and power plant are finished, the operators will operate and monitor the power plant's performance, make repairs and improvements as necessary, and ensure that it complies with relevant regulations.
5. Decommissioning: At the end of the life of the power plant, decommissioning phase will take place, which includes disposal of hazardous waste and the management of contaminated sites with the goal is to ensure that the power plant site is safe and suitable for future use, and that the environment is protected from any negative impacts.

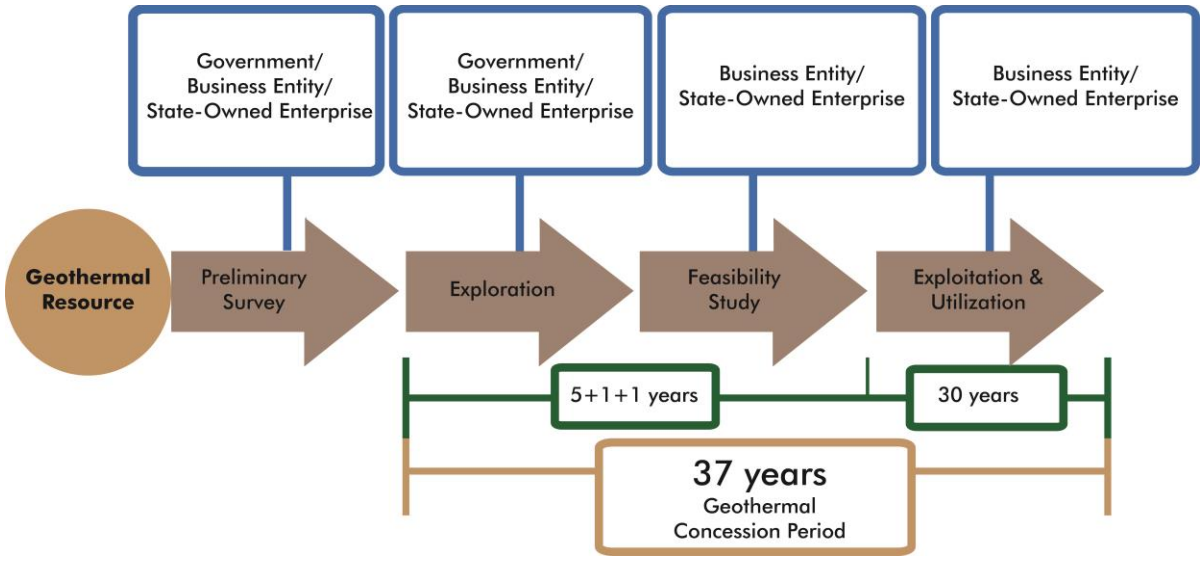

Figure 1: Geothermal development stages in Indonesia (modified from Purba, 2018; Adityatama, 2020; Purba et al., 2021; Direktorat Panas Bumi, 2022)

As the information obtained increases, the level of risk should decrease at each stage of the project, assuming that the information obtained is accurate and reliable. Table 3 summarizes the activities at each stage of the geothermal development project, along with the level of risk and potential funding sources. The table shows that project funding schemes through commercial loans can generally only be accessed when the project risk level has reached moderate to low, typically achieved after exploratory drilling has been completed.

Table 3: Geothermal energy development project activities, risk levels, and potential funding sources (modified from Direktorat Panas Bumi, 2022; Purba, 2018; Purba et al., 2019; Adityatama, 2020; Purba et al., 2021; IGA, 2014)

Stages	Key Activities	Level of project risk	Possible funding source(s)
Preliminary Study / Reconnaissance study	Electricity demand analysis, infrastructure assessment, study on regulation, political, environmental, and social issues, study on available geoscientific and drilling data, remote sensing survey, preliminary site visit/geoscience study, go/no-go decision-making on proceeding to the preliminary survey.	Very High risk	Government, grant, sponsor's equity
Preliminary Survey and Exploration (PSAE)	Detailed geoscientific surveys (geology, geochemistry, geophysics), geotechnical study, environmental and social study, temperature gradient well or deep slimhole drilling (at least one exploration well), conceptual model, resource estimation and Pre-feasibility study, go/no-go decision-making on proceeding to the exploration drilling.	High risk	Government, grant, sponsor's equity
Exploration drilling	Exploration drilling infrastructures construction, exploration drilling (2-5 wells), downhole data acquisition (mud logging, wireline logging, cutting sampling, coring), well testing, conceptual model updating, preliminary field development concept, preliminary reservoir numerical model.	High to moderate risk	Government, sponsor's equity, GREM, GEUDP
Feasibility Study	Resource assessment and confirmation, feasible development size, justification to proceed to the development stage, forecast of reservoir performance, field development strategy, delineation and development drilling plan, steamfield and power plant design, project budge and revenue projection, economic analysis, environmental and social study, go/no-go decision-making on proceeding to the field development stage.	Moderate risk	Sponsor's equity
Exploitation: Field development and power plant construction	Drilling infrastructure construction, development drilling (production and injection wells), conceptual model update, reservoir numerical model update, engineering design, procurement, steamfield and power plant construction, commissioning.	Moderate to low risk	Sponsor's equity, commercial loan
Utilization: Operation & maintenance	Operation and maintenance, well intervention, well service, workover, make up well drilling, annual inspection, major overhaul	Low risk	Sponsor's equity, commercial loan

2.3 Geothermal Exploration Project Cost Estimate

Cost estimates help identify potential risks and ensure adequate funds are available to complete the project successfully. Additionally, cost estimates serve as a baseline for monitoring and controlling project costs and can help to ensure that projects are completed within budget.

Each geothermal company trying to access funding for an exploration project may have different cost estimates, which is acceptable if the prospective borrower can show a reasonable estimation basis. However, geothermal developers must ensure the accuracy of the cost estimate for exploration costs submitted because it will significantly affect the proposal evaluation process and the project's success later. Some of the factors that may cause inaccuracy in the cost estimate are as follows:

1. The cost estimate based on complete and accurate information about the scope of work, resources required, or market rates can lead to incorrect cost estimates. A half-baked plan with plenty of possibilities for changes often causes incomplete information and many assumptions.
2. Assign the task to cost estimators with limited experience or personal biases that lead to incorrect assumptions or estimates.
3. Fail to consider all costs. The cost estimates focusing on direct costs, such as labour and materials, may not account for indirect costs, such as overhead and profit. The cost estimators often need to remember to include contingencies for risks or uncertainties.
4. The cost estimator needs to consider the experience from the industry, including actual project data, best practices, lessons learned, market fluctuation, annual inflation, material shortage, and equipment availability.
5. The cost estimate is not based on the latest or up-to-date market survey.
6. The cost estimate is based on underestimated task/work duration, which needs to reflect the sufficient time/duration required to complete a task.

Table 4 shows the rough cost estimate of each critical activity in a geothermal exploration project. The table shows that drilling activities require the most funds and take the longest to implement than surface survey (geology, geochemistry, geophysical) activities.

Table 4: Exploration work cost and duration estimates (modified from IGA, 2014; GeothermEx, 2010; Kristianto, 2018; Purwanto et al., 2018; Purba et al, 2019; Purba et al., 2020; Adityatama, 2020; Purba et al., 2021)

Activity	Cost estimate (US$)	Estimate work duration	Activities and Assumptions	Considerations
Geology survey	300,000 – 700,000	4-8 months	The assumption is geological mapping on an area of 400 km2—the work package includes pre-field-work study, rock sampling and identification, structural mapping, QA/QC, and reporting.	The accuracy might be affected by terrain, weather, and field personnel experiences. The wider the area and the more detailed the survey is, the cost and duration will increase.
Geochemistry survey	200,000 – 500,000	4-8 months	The work package is assumed to include a pre-field-work study, liquid and gas sampling from 30 locations, QA/QC, laboratory analysis, and reporting.	The sampling method (minimizing contamination) and laboratory competencies might affect the accuracy. The more the thermal manifestation sample is investigated, the higher the cost and duration.
Geophysical survey	1,000,000 – 2,000,000	4-8 months	The work package is assumed to include a pre-field-work study, 100 MT stations, 150 Gravity stations, QA/QC, interpretations, and reporting.	The accuracy might be affected by noise during data acquisition and data processing methods, including personnel interpretation. The more stations deployed, the higher cost and duration will be.
Initial conceptual integration and well targeting	100,000 – 300,000	3-6 months	The activities include integrating all data and report from 3G surveys to create several scenarios of conceptual models, including peer review. The more reliable the data used, the more reliable the conceptual model constructed, which is very important for the basis of later decision-making in the drilling phase.	The accuracy might be affected by 3G data accuracy and personnel experiences and interpretation. The more data analyzed and integrated, the higher the cost and duration.
Exploration drilling	15,000,000 – 45,000,000	24 - 36 months	It is assumed to use 3 (three) standard/big hole type or 5 (five) slimhole type. The cost estimate includes infrastructure construction costs to support the drilling operation. The duration estimate includes procurement, preparation, equipment mobilization, drilling, well testing, and demobilization.	Drilling deep wells allow personnel to acquire downhole data directly from the reservoir, which is valuable for more accurate resource assessment but requires higher cost and time than the 3G survey. The total drilling cost will be impacted by the well type chosen, the number of wells, the rig used, and the difficulties of the drilling infrastructure construction.

3. FUNDING OPTIONS FOR GEOTHERMAL EXPLORATION PROJECT IN INDONESIA

As mentioned earlier, financing the geothermal exploration project is still considered a high-risk business for lenders as the resource uncertainty is still high. This section will further discuss the funding options for the geothermal exploration project that is currently available in Indonesia.

3.1 Own Equity

Most developers use their equity as the financing source for the geothermal exploration project. The cost estimate of a geothermal exploration project in Indonesia is around USD 15-50 million (Table 4), which depends mainly on the drilling strategy and little dependency on the size of the development project. Typically, the developers raise the equity from parent company loans and shareholder loans. The other options are issuing bonds and shares, but they can only do this after the resource is confirmed.

The primary consideration in using own equity is the risk borne solely by the developers. With such a considerable capital cost, there is still high possibility that the exploration found no economic geothermal resource. Or in some cases, the resource characteristic needs to be more attractive to be developed, which requires the developers to spend more capital to drill more exploration wells. In this stage, the developer has a high risk of losing all the equity spent on exploration activities.

3.2 Infrastructure Financing for Geothermal Sector (Pembiayaan Infrastruktur Sektor Panas Bumi, or PISP) Fund

The government of Indonesia has allocated around IDR 3.1 trillion (equivalent to approximately USD 200 million) from the government budget to support geothermal development in Indonesia. This fund will be leveraged with another funding source from international financial institutions, donors, and other stakeholders to collaborate in the de-risking funding scheme of geothermal exploration. This fiscal incentive is regulated by Ministry of Finance Regulation No.80/PMK.08/2022 Regarding Geothermal Development Support through the Use of Pembiayaan Infrastruktur Sektor Panas Bumi (PISP) Fund at PT Sarana Multi Infrastruktur ("PT SMI").

PT SMI is a state-owned enterprise (SOE) under the Ministry of Finance (MoF) assigned to manage the PISP fund. Ministry of Energy and Mineral Resources (MEMR) will use this fund to support a geothermal exploration program called Government Drilling. Other than that, the fund will be used as a financing facility for SOE and private developers with the de-risking feature for SOE developers. This feature allows the developer to not fully bear the risks and costs of exploration in the event of an exploration failure.

The overview of geothermal exploration de-risking facilities available in Indonesia that just discussed is illustrated in Figure 2.

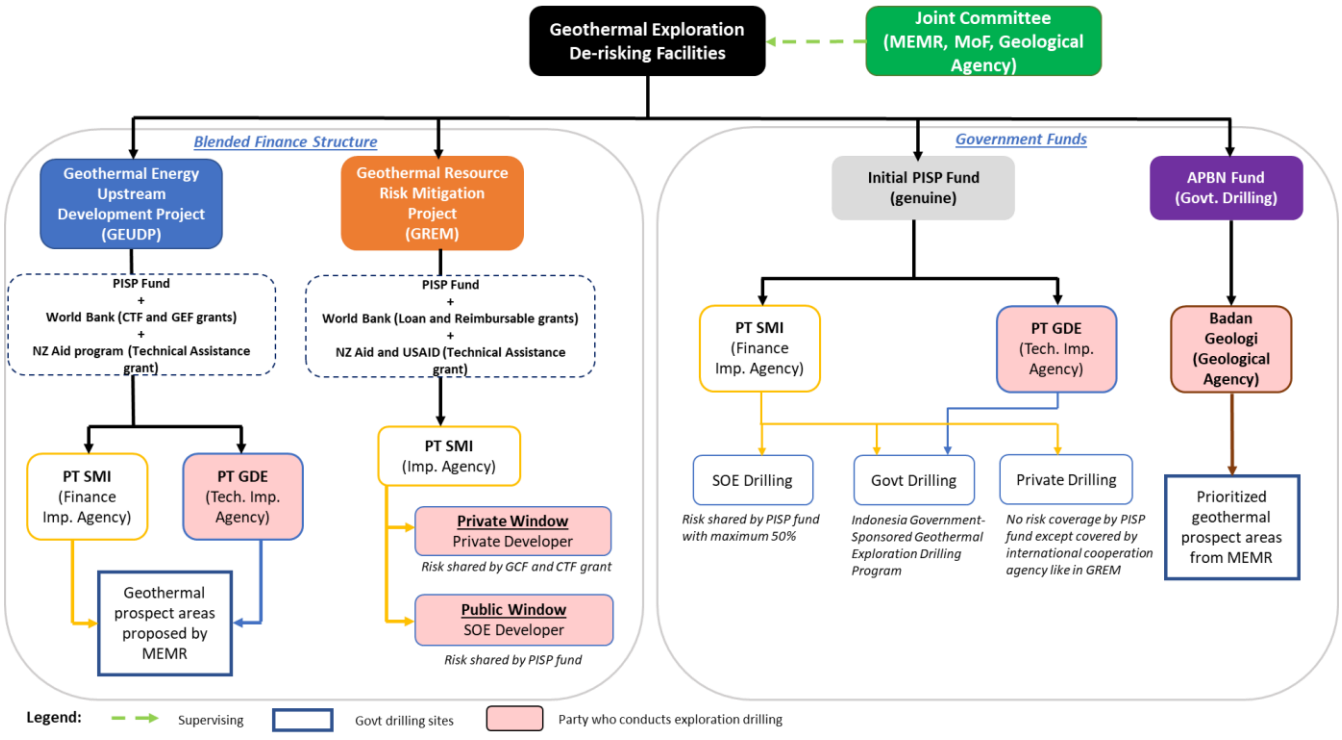

Figure 2: Overview of Geothermal Exploration De-Risking Facilities in Indonesia (PT SMI, 2022a)

3.2.1 Geothermal Energy Upstream Development Project (GEUDP) or Government Drilling

Geothermal Energy Upstream Development Project (GEUDP) is a government-sponsored exploration drilling collaboration program between the Government of Indonesia and the World Bank. The program aims to develop greenfield geothermal areas that have yet to be

tendered, especially in eastern Indonesia, where the area's electrification ratio is low compared to the other parts of Indonesia (Aprianiet al., 2018). The source of funds for the GEUDP program comes from the PISP Fund of USD 49 million, with matching grants from the Clean Technology Fund (CTF) of USD 49 million and the Global Environment Facility of USD 6.25 million. The program also received grants from the New Zealand Ministry of Foreign Affairs and Trade (NZ MFAT) in the form of technical assistance that equals the amount of NZD 2.13 million.

MEMR, as the beneficiary of this program, will propose a geothermal prospect area to MoF to seek exploration support under the GEUDP program. Then, as the technical implementing agency, PT Geo Dipa Energi ("GDE") will conduct a preliminary assessment to see whether the proposed area is feasible to continue exploration drilling. Suppose the result shows that the proposed prospect area is viable; MoF will issue an assignment letter to GDE as the technical implementing agency and PT SMI as the financial manager to conduct the exploration drilling activities, which is supported under the GEUDP scheme.

The data acquired in the exploration drilling will be assessed by an independent party and discussed in the Joint Committee meeting to decide if the geothermal resource in the prospect area is proven and sufficient to be tendered by MEMR. Assuming that resource is now de-risked, then MEMR will proceed with the tender process of WKP. In this stage, the participation of both public and private sector geothermal developers in the tender process is expected to increase as the geothermal resource risk has significantly reduced. Suppose the drilling exploration result shows that the resource is not economically attractive enough to be further developed; the government funds and donor funds will cover the exploration cost. Figure 3 shows the business model of GEUDP.

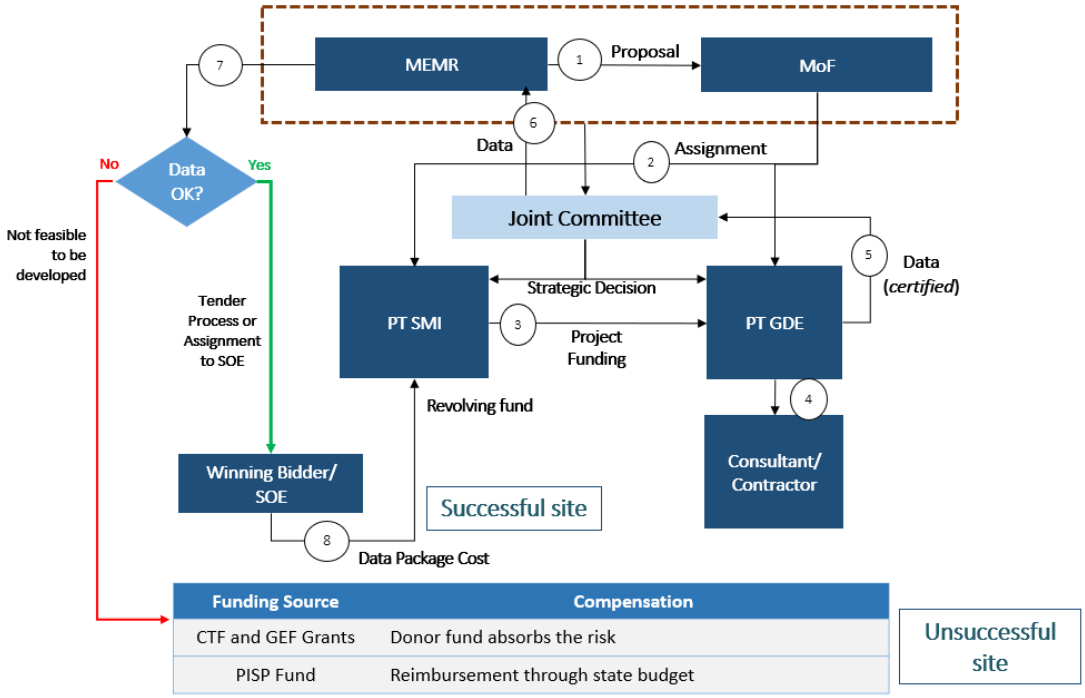

Figure 3: GEUDP Business Model (modified from PT SMI, 2022b)

However, since most of the geothermal prospect area under GEUDP has yet to be tendered and awarded to the geothermal developers, the beneficiary of this facility is MEMR. MEMR will use the fund to undertake the exploration drilling to improve the quality of information available at the time of tender. The winning geothermal developer will reimburse the exploration costs at the time of the concession award. In other words, GEUDP is designated for something other than a geothermal developer who already holds a geothermal working area license or concession.

Aside from GEUDP, the Geological Agency of Indonesia, under MEMR, also conducted exploration drilling in several geothermal prospect areas in Indonesia, namely Nage, Bittuang, and Cisolok-Cisukarame. The activities include preliminary survey, land acquisition, permits, infrastructure construction work, drilling, well testing, and pre-FS document updating. The source of funds to support these activities comes from the state budget (APBN), and the risks are covered 100% by the government.

3.2.2 Geothermal Resource Risk Mitigation Project (GREM)

The government of Indonesia, through PT SMI and the World Bank, has developed a geothermal exploration financing facility called Geothermal Resource Risk Mitigation Project (GREM). In contrast to GEUDP, GREM is designated to support the exploration drilling undertaken by geothermal developers who already hold the license or concession of geothermal working areas. One of the prerequisites for the geothermal developers to access this facility is that they already have the preliminary data of the prospect area/WKP. The data and information could be obtained from Preliminary Surveys, such as 3G surveys and other related studies. This information should assist the geothermal developers in concluding the feasibility of the geothermal area to proceed to the development stage so that further exploration

drilling is deemed required. The unique feature of GREM is the availability of a de-risking facility or a risk-sharing scheme at which, in the event of an exploration failure, the developer does not fully bear the risks and costs of exploration. GREM facility is intended for SOE developers/subsidiaries of SOEs ("GREM Public Window") and private developers ("GREM Private Window").

The total commitment of GREM funding is USD 651.25 million. The pledge comes from a combination of multilateral funds, namely the International Bank for Reconstruction and Development (IBRD), Green Climate Fund (GCF), Clean Technology Fund (CTF), Global Infrastructure Facility (GIF), and PISP funds. The overview of the institutional arrangement and flow of funds of the GREM facility is shown in Figure 4.

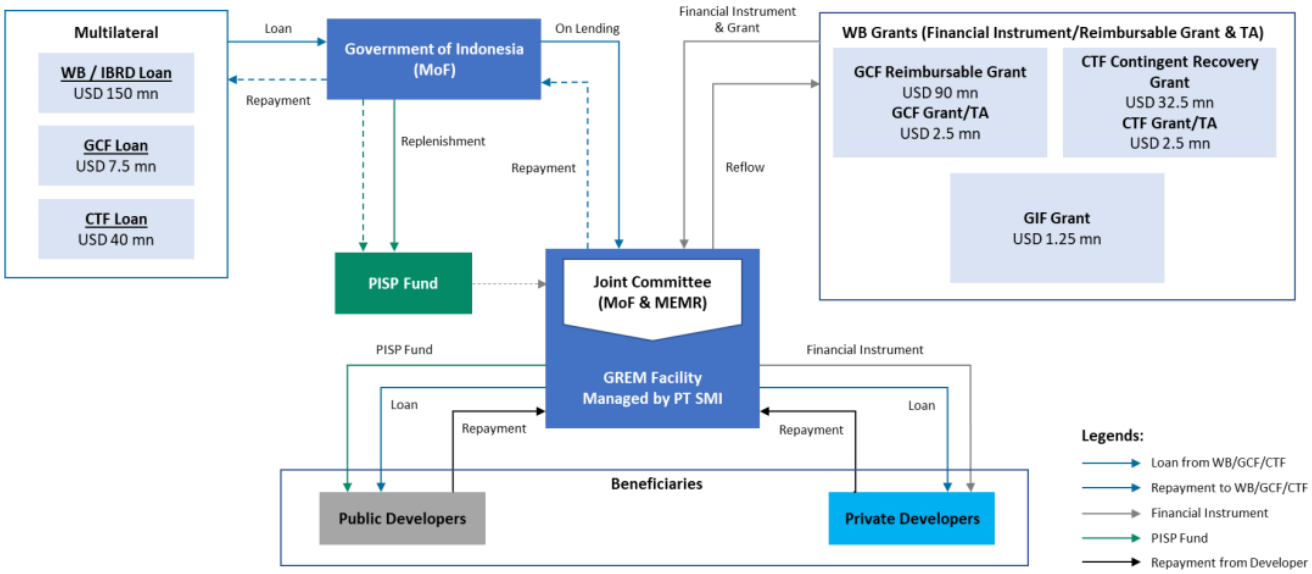

Figure 4: Overview of Institutional Arrangement and Flow of Funds of GREM Facility (PT SMI, 2022a)

GREM Public Window facility will support geothermal exploration activities to public developers (SOE/subsidiaries of SOE) by providing loan and de-risking facilities with a maximum total limit of USD 30 million. Half of the facility is a blended loan from IBRD/GCF/CTF, while the other half is de-risking from the PISP fund. The risk coverage is provided when exploration and political risks occur, with the maximum risk coverage being 50% of the total loan (Figure 5). The forgiveness calculation of the facility will be assessed in the projected project value (PPV) financial model and further decided by Joint Committee.

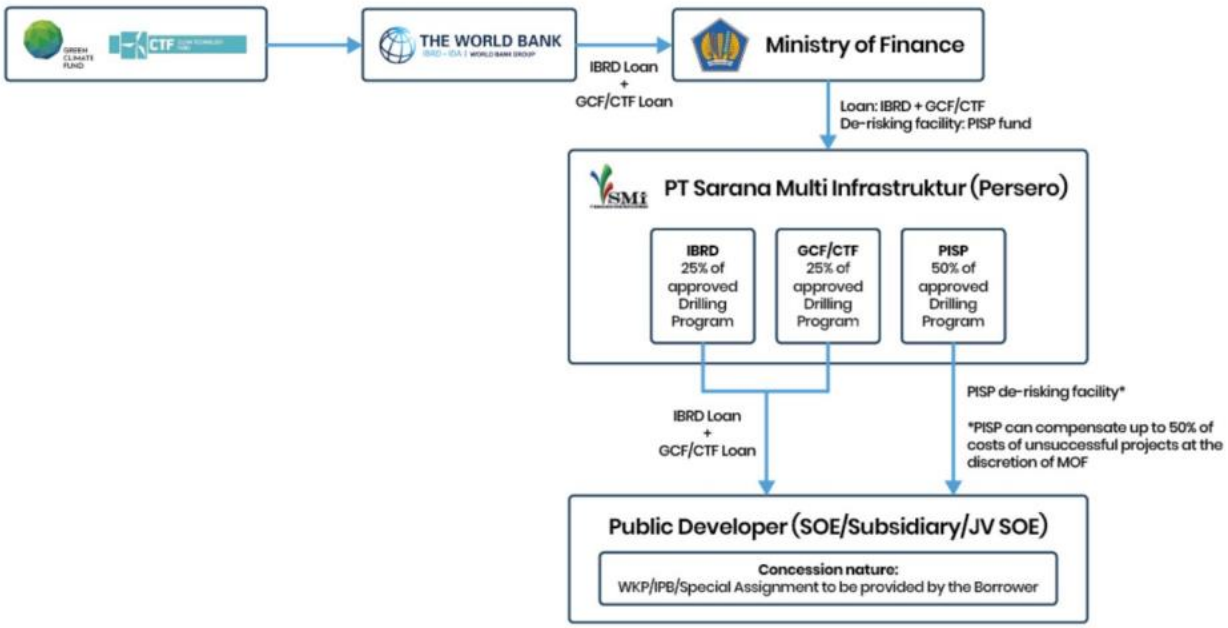

Figure 5: GREM Public Window Facility Scheme (PT SMI, 2022a; PT SMI 2022b)

To access the GREM Public Window facility, public developers shall have a valid geothermal exploration license or Izin Panas Bumi (IPB), a minimum proven track record of 3 (three) years, and a minimum equity portion of 25% of the total project cost. They must also possess geothermal data from a preliminary survey that still needs to be proven by exploration drilling to conclude the resource feasibility. Additionally, all or most of the land for exploration purposes in the working area must be legally controlled or licensed and is not currently the object of a case/dispute in any court. Finally, the implementation of the exploration project must comply with the World Bank ESS (Environmental Social Safeguards) and Procurement Standards.

GREM Private Window facility will support geothermal exploration activities to private developers by providing loan and de-risking facilities through the purchase of financial instruments (FI) that developers issue, with a maximum total limit of USD 30 million. The facility is divided into two categories: Facility A, a blended loan from IBRD, and Facility B, FI de-risking from GCF/CTF reimbursable grants (Figure 6).

The Private developers that are eligible to access the GREM Private Window facility shall have a valid geothermal exploration license or Izin Panas Bumi (IPB), a minimum proven track record of 3 (three) years, and a minimum equity portion of 25% of the total project cost. They must also possess geothermal data from a preliminary survey that still needs to be proven by exploration drilling to conclude the resource feasibility. Additionally, all or most of the land for exploration purposes in the working area must be legally controlled or licensed and is not currently the object of a case/dispute in any court. Finally, the implementation of the exploration project must comply with the World Bank ESS (Environmental Social Safeguards).

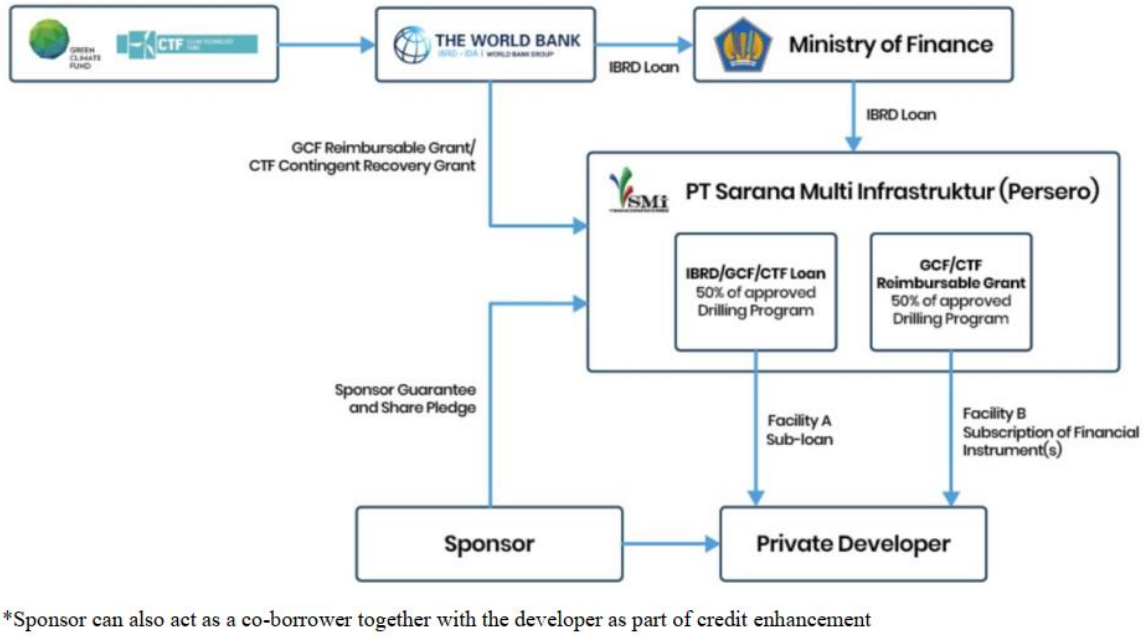

Figure 6: GREM Private Window Facility Scheme (PT SMI, 2022a; PT SMI 2022b)

3.3 Assessment on the Funding Options for Geothermal Exploration Project in Indonesia

This section aims to give insights to the developer and its sponsor in deciding which financing scheme is suitable for their geothermal exploration project by assessing the pros and cons of available funding options in Indonesia. The assessment summary is provided in Table 5.

Table 5. Assessment Summary of Geothermal Exploration Project Funding Options

Funding Options	Pros	Cons
Own Equity	1. Geothermal developers do not have to prepare application proposals to get funding which usually takes time and effort.	1. Developers bear the entire risk of unsuccessful geothermal exploration projects. 2. The risks of losing capital are relatively high if geothermal resources are not found or the size of the resources found is considered insufficient to be developed commercially. 3. There is no third party that can help to assess, monitor, and evaluate the project implementation.

Government Funds + IFI Funds: GEUDP (Government-led Exploration Drilling)	1. Geothermal developers do not have to take the entire risk of unsuccessful geothermal exploration projects as the risk is shifted to the government. 2. Developers do not have to prepare equity or cost of capital in the early stage of geothermal exploration as the government will bear the cost of exploration drilling and its risks. The cost of capital only needs to be prepared when the developers join the tender process of the geothermal exploration data package of WKP, at which the resource has been confirmed and sufficient to be developed commercially. 3. Once resource risks are significantly reduced, developers can access debt financing more easily for geothermal exploitation projects.	1. Developers might have to pay higher for the geothermal exploration data package to cover the cost incurred during the exploration project and the risk premium that was borne by the government previously. 2. Developers must carefully check the adequacy of the data package being tendered and ensure that the resource is economically attractive to be developed and meet the return of investment needed by the developer and sponsor.
Government Funds + IFI Funds: GREM (Exploration Financing Facility to Public and Private Developers)	1. Geothermal exploration risks are being shared between the developer and lenders. If the exploration drilling fails to reach the success criteria, the developer is eligible to get forgiveness which the value is agreed upon between developers and the lender. 2. Implementing a cost-efficient risk-sharing mechanism would bring substantial leverage of developers' equity, public funds from PISP, IBRD, and climate finance. 3. Developers can have third-party reviewers assist in monitoring and evaluating the project implementation. 4. When the exploration financing scheme applies and significantly reduces the resource risk, the developer can easily access debt financing to finance the next stage of geothermal development.	1. Geothermal developers must prepare a good application proposal to get funding which usually takes time and effort. 2. GREM facility, developed by the World Bank and the Government of Indonesia, has relatively higher standards to comply especially in the environmental, social, and safeguards standards compared to the national standard/regulation.

4. TYPICAL FUNDING APPLICATION PROCESS

It is expected that when geothermal developers, both public and private, want to access the exploration financing facility, the application proposal shall cover a comprehensive detail of the exploration drilling plan that covers the technical, environmental, social, legal, and financial aspects of the project. A good application proposal from developers will give confidence to lenders to fund the exploration drilling project as the project is considered a risky investment. This section will explain in detail the typical application process and the critical information required in the funding application proposal of the geothermal exploration project.

4.1 Typical application process

Several geothermal exploration financing facilities are currently available worldwide. GREM, as one of the financing facilities for exploration projects in Indonesia, has the typical application process that follows the provisions stated in the Minister of Finance Regulation / Peraturan Menteri Keuangan (PMK) No. 80 the Year 2022 and then elaborate more in GREM Developers Manual (PT SMI, 2022a).

While in Turkey, a similar scheme is available, called Risk Sharing Mechanism for Resource Validation (RSM). It has the application process divided into two stages. The first stage calls for Expressions of Interest (EoI), and the applicants will be shortlisted and invited to prepare a full proposal (TKYB & The World Bank, 2021). In summary, the typical application process to access the geothermal exploration financing facility is as follows (Table 6):

Table 6: Summary of Funding Application Process (modified from PT SMI, 2022a)

Application Stage	Activities Description	Estimated Duration
Preliminary Assessment and Discussion	Prior to submitting the formal proposal, the developer or sub-borrower shall submit a request to lenders to discuss the plan for proposal submission. In this stage, the developer is also expected to check the conditions and criteria needed to access the financing facility. In some cases, sharing documents about the project between the developer and lender also occurred to conduct a preliminary assessment. A preliminary assessment by the lender will provide early feedback to the developer on the readiness of the proposal, give sufficient time for the developer to meet the level of details expected, and identify if there is any fatal flaw/red flag of the project.	3 months – 1 year (subject to developer's readiness)
Proposal Submission	The timeline of proposal submission may vary for each lender. Some lenders may set the proposal submission at a specific period, while others open for submission at any time. In this stage, the developer is expected to submit the required information in the proposal that includes a comprehensive and detailed plan of the geothermal exploration project.	1 – 3 months (subject to the completeness of proposal)

Proposal Due Diligence	In the due diligence process, lenders will check thoroughly on the geothermal exploration project plan to assess the detail of the exploration project. It includes the geothermal resource assessment, the detailed drilling plan, technical and financial viability of the project, compliance with environmental and social safeguards, appraisal of legal and compliance aspects, and assessment of whether the developer has demonstrated capability to conduct the project. This process is mainly conducted by independent consultant firms/experts of the lenders to ensure a detailed and thorough assessment has been carried out. Aside from the detailed assessment, the process may include a site visit to verify on-site technical, environmental, and social aspects and discussion with related stakeholders such as Ministries if the fund source also comes from government funds.	6 months (may vary depends on the actual condition)
Signing Loan Agreement	Following a positive result of the due diligence process and all the requirements or conditions precedent required has been met by the developer, the loan agreement's signing process can then proceed. The loan agreement will stipulate the financing terms and loan covenants to ensure proper implementation of the project.	-
Implementation and Monitoring	During the financing facility execution, lenders will monitor the implementation of the project and ensure that disbursement has been made for eligible activities. The developer is also obliged to make reporting to the lender during the financing facility period as stipulated in the loan agreement. An independent consultant firm usually assists the project monitoring in verifying that the arrangement in the loan agreement is maintained.	2 – 4 years (may vary depends on the actual condition)

4.2 Key Information Required in the Proposal

Due diligence is a critical step in any business transaction, as it helps to identify potential risks and opportunities before making any decision. This process involves thoroughly researching and analyzing a company, a project, or an investment opportunity, including reviewing technical documents, financial statements, legal documents, and other relevant information. By conducting due diligence, lenders, investors, and business owners can make more informed decisions and minimize the potential for financial losses or legal issues. Overall, due diligence is an essential tool for protecting one's assets and ensuring the success of any business venture.

Technical assessment during due diligence is a crucial step for geothermal exploration financing facilities as the project risk is highly allocated in the technical aspect. Thus, the developer must prepare detailed information on the technical part so the lender can assess whether the project is feasible and whether the risks associated with the project have been addressed in the mitigation plan.

As discussed earlier, after the required documents from the initial screening are considered complete, the lender's team will start the financing feasibility analysis, which several independent consultant firms or experts will most likely support. The technical consultant firm typically consists of experts such as geoscientists, reservoir engineers, drilling engineers, civil engineers, environmental engineers, social specialists, and project managers.

Table 7 shows a framework used by lenders in evaluating technical proposals submitted by prospective borrowers. An evaluation framework is important because it provides a structured approach for assessing the effectiveness and impact of programs, projects, or initiatives. It helps ensure that evaluations are comprehensive, rigorous, and consistent and provide useful information for decision-making. Organizations can use a framework to ensure that they are addressing key evaluation questions, gathering relevant data, and using appropriate methods to analyze and interpret the data.

Table 7: Evaluation Framework for Technical Due Diligence Process of a Geothermal Exploration Project Funding Proposal (modified from Jacobs & PT SMI, 2022)

Main Category	Sub-category	Required Key Information	Potential Red Flags
The Project: A high-level overview of the overall project scope & objectives, including developer, physical setting, project history	Project Status	Concession status, ownership, history of exploration	1. Ownership status is unclear, 2. Fail to provide evidence of project/concession ownership
	Geothermal Resource	Exploration summary (3G), drilling summary, resource conceptual model, data gaps, resource uncertainties and POD (probability of discovery), energy potential, key areas to test by drilling, expected well productivity, expected production enthalpy	1. Fail to provide explanation on previous negative results from drilling (if any), 2. No resource conceptual model is presented, or resource conceptual model presented is inconsistent with data, 3. There are fundamental data gaps (e.g. key resource data is missing or is of poor quality), 4. No resource-related uncertainties are presented, or resource-related uncertainties poorly understood, or the POD is very low < 25%, 5. Energy potential is not estimated, or the resource assessment method used was inappropriate, or energy not technically feasible for development,

			6. Areas to test not identified; no justification indicated for the drilling areas presented, 7. No data presented to indicate expected production enthalpy; expected enthalpy unsupported by data, 8. No well productivity indicated; well productivity indicated is not justified.
	Development Plan	Development size (MW), concept layout, power plant concept, transmission connection, project implementation, schedule/phasing	1. No development description presented; development description presented incompatible with resource conceptual model/information, 2. No development size indicated, development size inconsistent with development description and resource potential, 3. No concept layout/power plant concept/transmission connection plan/project implementation plan/development plan is presented, or the layout/plan are inconsistent with the resource and development description.
	Economic/ Financial	Project capital cost, project financial model, macro status of the market, PPA/HoA status with PLN, financing plan	1. Summary cost estimates presented were incomplete or had unclear basis for cost assumptions, 2. Inputs and outputs of the financial model are not described, and project viability not presented, 3. No market opening for project (flat or declining power demand forecast), 4. No financing plan presented; financing plan presented is incompatible with project.
	Environmental/ Social	Land ownership/use, social acceptance, environmental, direct heat/direct use project (if any), social engagement plan	1. Unclear land use/access or ownership terms, 2. Significant community issues with no community engagement plan presented, 3. No environmental studies/status summary presented; project environmental context is incompatible with development.
Drilling Proposal: This will include the strategy to achieve the objectives of the sub-project with detail on targets, number of wells, infrastructure requirements, permits, cost estimates and schedules. Information regarding the drilling contract (turnkey, day-rate, combination), including service companies	Drilling Plan	Drilling strategy, well objectives, well target, drilling sequence, decision tree, well type, well design, drilling rig specification, supervision plan, data acquisition/collection plan, well testing plan, drilling procurement plan, DWOP (drill-well-on-paper) plan, stuck pipe prevention plan, well control plan, risk assessment and mitigation plan, well plug & abandoned (P&A) plan	1. The targets are not based on concept model, or have no reasoning provided. Objectives are not stated, 2. Decision sequence is illogical or shows a weakness in the drilling plan that could be fixed with more thought, 3. Well depths are inadequate to meet objective, or designs are unsafe, 4. Rig specification is not suitable for planned well design or has high risk of failure to complete wells, 5. Inadequate or limited supervision is planned, 6. Data collection plans not developed, or no thought given to data, 7. Inadequate identification of tests or how they will be conducted, 8. Major risks, such as well control, stuck pipe, and H_2S release are not addressed properly in the document.
	Infrastructure	Transportation/mobilization plan, existing infrastructure, access road and wellpad plan, water supply system, well testing and disposal, basecamp/laydown area, explosive bunker, site office, evacuation plan, remediation	1. Transportation plan incomplete or indicates major flaws for access to the project, 2. Missing or incorrect information, 3. No access road & pad plans presented; plans presented are incompatible with terrain, environmental and social constraints, 4. No water supply plant/well testing/disposal/site remediation is presented; water supply plan is not viable or compatible with the project
	E&S and Permits	Permitting plan, enviro permits (UKL-UPL), social engagement, land ownership, compensation	1. Information is inadequate or inconsistent, 2. The company has no HSE policy, 3. Major risks related to environmental and social are not presented.
	Implementation	Procurement plan, project team structure, schedule, health and safety plan	1. There is no plan or statement of how major contracts are to be tendered,

			2. Project team is substantially inadequate for the project, 3. Inadequate information on project schedule, HSE plan and target/KPI.
	Cost / Budget	Infrastructure cost, drilling cost, well testing cost, remediation cost, contingency cost	1. Costing missing major elements, flawed, or show the project is not viable, 2. No information on how the project cost was estimated (basis of cost assumptions).
Capability: Showing the technical and financial capabilities of the developer and key stakeholders, relevant to the current phase of project development, must be demonstrated. Basic information on the project's organization and relevant characteristics (joint venture, project funding, etc.) should be included.	Company	SPV/JV proposed, owners, geothermal track record, technical resources, health, and safety (H&S)	1. No description of the JV/SPV proposed, project company unclear, 2. No description of owners and capability available to the project, 3. Geothermal track record is negative, 4. No available technical resources identified, 5. Negative H&S track record; H&S policy is insufficient, and capability is lacking.
	Personnel	Key personnel assigned, support personnel, responsibilities	1. No indicated personnel or organizational chart presented, 2. No responsibility assignment matrix (RACI chart) and key responsibilities document presented.
	Contractors	List and requirements of consultants and contractors, peer reviewers, scope of work/deliverables	1. No information provided on consultants; information provided indicate incompatible consultants to the project, 2. Peer reviewers identified are incompatible with the project/industry.
	Financial	Financial history, credit rating, funding source for drilling,	Found no audited financial statement of the developer and sponsor (in the case that the borrower is a Special Purpose Vehicle, which is required to assess the capacity to fulfill the required equity contribution and loan repayment obligation. Generally, audited financial statements for the last two years are required.

An evaluation framework also provides a means of tracking progress and measuring outcomes over time, essential for continuous improvement and accountability. Ultimately, an evaluation framework helps organizations make informed decisions about allocating resources and improving their operations for maximum impact.

Furthermore, apart from the potential red flags that have been presented in the far-right column in Table 8, several things that must be considered by prospective borrowers when preparing technical and commercial proposal documents for funding geothermal exploration projects in Indonesia are:

1. Get a clear understanding of the lender's needs and requirements. It is important to fully understand the lender's needs, expectations, and requirements to ensure that the proposal meets their specific needs, which will save a lot of due diligence process time.
2. Communicate the major risks, uncertainties, and opportunities of the project, supported by clear evidence in a written format such as study/survey reports, basis of design (BoD), detailed design, engineering calculation, model, analysis, peer-review reports, and raw data as necessary.
3. Present the availability, quality, and limitations of data used for the basis of exploration drilling planning. Provide clarity of plan if any additional data is required to enhance the success of the proposed exploration drilling project.
4. In presenting technical and commercial proposals, provide a high-level overview of the project by linking it to other important social, environmental, and legal aspects. Integrating all aspects helps to identify potential risks and plans for risk management strategies, reducing the likelihood of project delays or failures.

5. DISCUSSION

To achieve the national geothermal target, Indonesia must focus on various prospect areas or WKP currently in the exploration stage. The importance of exploration projects can be seen from the target of adding an installed capacity of approximately 3,300 MW in 2030; more than 60% is expected to come from geothermal areas or WKPs, which are still in the exploration stage. With this understanding, all geothermal stakeholders in Indonesia need to work together to overcome the obstacles and complete all ongoing and future geothermal exploration projects.

This paper has discussed that one of the major challenges for geothermal exploration projects is the high upfront capital that must be allocated where the level of uncertainty on the economic geothermal resource's availability is still very high. The results of literature studies and interviews with various geothermal experts concluded that the funds that must be prepared for a geothermal exploration project in Indonesia range from USD 15-50 million, with deep well drilling activities being the largest cost component. Accurate project cost

estimates required to achieve the agreed project objectives are crucial for the success of a project. They help communicate project expectations to stakeholders and ensure everyone is on the same page regarding budget constraints, project goals, and project outcomes.

Not all geothermal companies in Indonesia have or are willing to allocate their equity to finance geothermal exploration projects due to the high risk of losing all that equity if it turns out that the results of exploration are uneconomical. Therefore, it is important to have other funding options available for geothermal exploration activities besides using company equity.

This paper has discussed 3 (three) funding options currently available for geothermal exploration projects in Indonesia: own equity, government funds (PISP fund and APBN fund), and blended finance structure (combination of government funds and IFI funds, GEUDP and GREM). Although for GEUDP, the facility is not applicable for geothermal developers who already hold IPB licenses. This paper has also compared the pros and cons of the funding options. Of course, no option ultimately eliminates the risk of geothermal exploration. However, with the availability of several funding options, it is hoped that geothermal exploration projects in Indonesia can run at a higher pace. Therefore, geothermal developers need to understand the scheme, features, eligibility, requirements, application process, payment terms, funding amount, flexibility, cost, and timeframe of each available funding option for geothermal exploration projects in Indonesia to see suitability.

Understanding how to prepare technical documents properly becomes crucial for geothermal companies in Indonesia who wish to access funding facilities such as GREM. Considering that the application evaluation process will take 6-12 months, prospective borrowers need to understand the various information/documents required by the lender. This paper has provided complete information on what must be available in the proposal documents submitted to lenders, including potential red flags, which will be the focus of the lenders' assessment team.

In addition, providing critical information in a funding proposal is crucial as it helps lenders assess a project's viability and potential success. Accurate and comprehensive information helps to build trust and confidence with the lender and increases the chances of obtaining funding. Critical information includes, but is not limited to, the project's goals and objectives, technical details, expected outcomes, budget and cost estimates, project timeline, and risk assessment. Information about the project's management team and their relevant experience, as well as the market demand and competition, are also important to provide. Providing all relevant information in a funding proposal can demonstrate the project's ability to deliver on its promises and repay the loan. It also helps to identify potential issues and address them proactively, which can improve the project's overall success.

In conclusion, providing critical information in a funding proposal is essential to securing the required funding and ensuring the project's success. Hopefully, this paper can provide essential guidance for stakeholders working on geothermal exploration projects in Indonesia. Of course, this paper has not touched on many aspects of submitting funding for geothermal exploration projects. Therefore, the authors plan to cover several additional aspects with a more focused discussion on the detail of various funding schemes to de-risk resource risk in the exploration stage in a separate publication.

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