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# Fact sheet for geothermal development to promote Public Private Partnerships in East Africa

# Potential risks and mitigation measures associated with geothermal development

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## Potential risks and mitigation measures associated with geothermal development

As the level of risk of each phase in geothermal development was introduced in the previous section, understanding the risks and their mitigation measures is essential for private sector when decide to participate in geothermal project. Thus, this section aims at identifying the potential risks and the mitigation measures for geothermal development with the applications. PPP model which distributes risks to public and private sector is probably an effective model to address all the risks and to implement the mitigation measures for geothermal development.

## Risks in geothermal development

Development of a geothermal project takes several stages from initial reconnaissance phase to detailed surface studies phase which then leads to exploration drilling phase. After successful feasibility studies then the project moves to production drilling and power plant construction and commissioning (Figure 1).

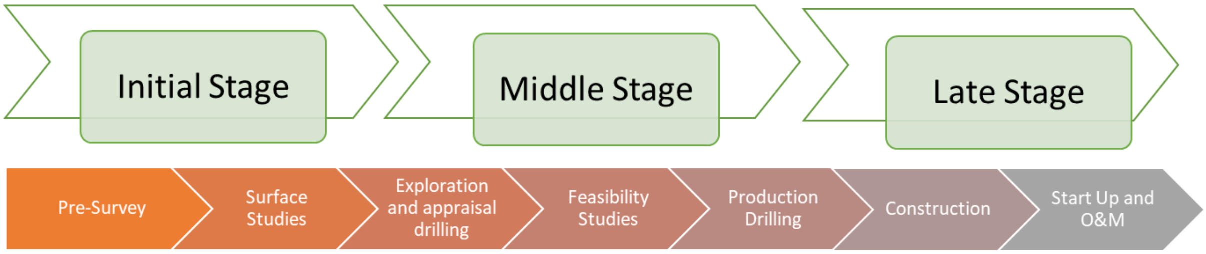


**Figure 1: Development stages of a geothermal project**

There are various risks to take into account when developing geothermal power development project in general as described in Table 1. Some of risks are described in detail in the subsequent sections.

**Table 1: Risks for each phase in geothermal development**

| Level of Risk | High | Moderate | Low |
|---|---|---|---|
| Main Specific Risks | • No access road<br>• Resource Risk<br>• Technical Risk<br>• Permitting Risk, etc | • Resource Risk<br>• Technical Risk<br>• Completion Delay Risk<br>• Operational Risk, etc. | • Credit Risk of Off-taker/Steam Provider<br>• Price Risk<br>• Completion Delay Risk, etc. |
| Common Risks | • Political Risk<br>• Organizational Risks<br>• Financial Risk<br>• Social and Environmental Risk<br>• Force Majeure | | |

### Resource Risk

Resource is the uncertainty of the existence of a resource reservoir, reservoir potential size, and reservoir suitability, including, among others, its temperature, permeability, and scaling characteristics of the resource. It is also called as exploration and reservoir risk. While the up-front costs for exploration are not low, risk of negative outcome is high which could steer clear of the investors. As part of the resource risk, the risk of oversizing the power plant needs to be considered as well. It is because the results would be suboptimal when a geothermal power plant is either too large or too small in relation to the geothermal reservoir. Excessive plant capacity can cause unsustainable extraction rates and result in pressure drops or reservoir depletion (ESMAP, 2012).

### Technical Risk

Technical risks associated with geothermal development refer to the possibility of project failure and/or extra costing due to geographical factors. Technical risks include geological risk and casing and cementing risk. Geological risk includes risk of unsuccessful drillings due to geological conditions, such as hard rocks, fracture, and permeability. Casing and cementing risk are the risk of additional cost for extra cementing to fix cementing failures (ESMAP, 2012).

### Organizational Risk

Organizational risks refer to the lack of preparedness and ability of the local executing agencies, usually the national power generation company, for implementing a geothermal project. The credit risk of steam provider/off-taker and public institution capacity constraints risk is considered to be organizational risks. The credit risk of steam provider/off-taker is the risk particular to power development projects while the public institution capacity constraints risk is common risk for any kind of investment projects. The credit risk is the termination of steam supply/payment of generated electricity by the steam provider/off-taker due to bankruptcy and/or non-performance of the counterpart (IRENA, 2022). Although IPP in both the models is exposed to the credit risk of off-takers, the credit risk of steam provider will be only for the IPP in the separated model. Public institution capacity constraints risk is the risk of affecting the viability of the project due to insufficient capacity of public institutions, including the lack of experience to undertake their roles; the financial capacity to undertake the projects and to endure financial shock that may arise during the project implementation; and the human resource capacity to undertake, manage, and operate the projects.

### Commercial Risk

Commercial risk is the uncertainty of obtaining a potential reward from investments on the commercial opportunity represented by a geothermal project. Commercial risk includes completion delay risk, operational risk, overexploitation risk, and price risk. Completion delay risk is a risk that could result in a reduced value of the project’s revenues due to delays or disruptions in the completion. For geothermal projects, it is difficult to estimate the time needed to finish the drilling for both production and reinjection wells. Since this risk affects the entire project, all stakeholders would be exposed to. Operational risk refers to troubles mainly from steam field O&M leading to high cost in O&M phase. Some wells need to be worked over repeatedly, and many make-up wells must be drilled due to heavy scaling from silica saturation or corrosion. These activities could affect the O&M cost and overall power generation costs.

Overexploitation risk is a risk of causing pressure drops or even depletion mainly due to unsustainable extraction rate in relation to resource reservoir. It would not only deprive the income for the IPP and steam provider but also result in land degradation of the country. For operational risk and overexploitation risk, the risk-taker is steam provider for the separated model and IPP for the integrated model. Price risk is less than expected revenue resulting from lower than expected off-take prices mainly due to unfixed market price. Since price does not only stand for electricity price but also the steam price, this risk is not only for the IPP but also the steam provider.

### Financial Risk

Financial risk most referred is the possibility of losing money and ripped off. The major ones are interest rate risk, foreign exchange risk, and currency inconvertibility and transfer restrictions risk. Unexpected fluctuation of interest and/or exchange rate would affect the payback plan, and currency convertibility could force to cancel the financial transaction in the worst case. Currency convertibility needs to be considered for energy projects since most of the capital expenditure and the loans used for projects are usually denominated in international currency or donor's currency, while the users of electricity will pay in local currency. The financial risks emerging from the insecurity of public sector would be "unfair calling of bonds risk" and "non-honoring of sovereign obligation risk." The former is losses of expected profit from interest due to early and/or unexpected redemption by the bond (bid bond, performance bond, etc.) issuer, and the latter refers to losses due to breach of contract, such as a financial obligation (e.g., non-repayment of a loan, non-respect of a tax exemption) or a performance obligation (e.g., construction of a road or transmission line that connects the power plant), by the government. Since it is public oriented, the risk-takers are usually the counterparts of the public sectors.

### Social and Environmental Risks

Social and environmental risks refer to the possibility that a viable project would be rejected for approval and denied financing and disbursement of funds for very sensitive environment and social economic issues. It is one area that many governments control and regulate through legislation and have governmental bodies monitoring on a continuous basis. Major example is "local communities opposition risk" which is likely to happen where there is a large impact on the land and inhabitants. If they oppose to the implementation of the project, that could result in delay or forced cancellation of the project, which would negatively impact all stakeholders.

### Regulatory Risk

Regulatory risks refer to the possibility to affect the viability of the project and/or commercial success of project developer due to discretionary power of the government. It includes absence of policies and regulations related to pricing and taxation, natural resource use, procurement procedures, and land usage. For example, if the government does not have supportive policies for promoting renewable energy development, such as feed-in tariffs (FITs) or renewable portfolio standards (RPS), it could be less attractive for private investors. Unclear definitions and regulations regarding topics such as the ownership of resources, the types of licenses, the licenser, the licensee, and the setting of licensed area, could be another driver as its clarity and consistency are important to geothermal developers. Since geothermal energy laws and regulations form the basis of geothermal resource development (GRD) and stipulating the rights and duties of geothermal resource developers, regulatory risks are exposed to all stakeholders.

### Political Risk

Political risk is the possibility that the business could suffer because of instability or political changes in a country: conflicts and unrest, changes in regime or government, and changes in international policies or relations between countries. For instance, license cancellation risk emerges when the stakeholders cannot meet the terms of the contract and/or failure of project due to cancellation or unrenewed license issued by the government and/or IPP. The one who has the ownership of the resource would be the risk-taker. Country risk covers widely but could be narrowed down to two kinds: 1. material loss due to one of the events, such as war, social unrest, political violence, and sabotage and 2. financial damage due to loss of property resulting from government nationalization of the property or deprivation of the insured property or restricting its operations.

### Force Majeure Risk

Force majeure risk is termination of project and/or losses due to unexpected events, including human-made events, like wars, and natural disasters, such as flood, landslide, and earthquake. For geothermal projects, earthquakes are the most obvious risk. Induced micro-seismicity may occur, but the magnitudes are often relatively low in the rifts. The responsibility for losses due to natural catastrophe is most likely to be decided in the contracts.

Regarding the risks identified above, countermeasures are diverse. This section will describe the relatively common and effective approaches with their application to mitigate geothermal risks. In this study, mitigation measures were divided into two categories, namely risk mitigation measures taken by the public sector, and both public and private sector. The relationship between risk and risk mitigation measure is summarized Table 22 and 3. As summary, geothermal development with PPP scheme whose risks are allocated to both public and private sector, is potential method to mitigate some of these geothermal risks.

## Risk mitigation measures

### Government-led exploration drilling

Government agencies carry out publicly funded surface reconnaissance and exploration drilling to reduce resource risk. This approach has implemented in Kenya, Mexico, New Zealand, the Philippines, and Costa Rica (World Bank, 2016). As example, GDC was formed by Kenya Government to undertake and lead geothermal exploration and drilling in Kenya and has successfully developed Menengai geothermal site. GDC is also developing other geothermal sites such as Paka, Korosi and Silali geothermal sites in Kenya.

As an innovative approach, the government can cover the cost of exploration by the private sector (developer) if it failed in finding the resource by holding a call option of financial instruments (FIs) issued by the private sector. Call option is the right to buy the object (i.e., project itself, shares, electricity) at premium and/or fixed fee in the future. This measure has not been taken in any potential projects, but Indonesia Ministry of Finance (MoF) implemented it under Indonesia Geothermal Resource Risk Mitigation Project (GREM) in 2019. MoF assigned “PT Sarana Multi Infrastruktur (PT SMI)”, a national infrastructure finance company formed by the MoF, as an implementation agency to develop resource risk mitigation facility (the “Facility”), with the grants and loans from the World Bank, International Bank for Reconstruction and Development (IBRD), GCF, and CTF, which detailed flow of funds as demonstrated in Figure 2. PT SMI was appointed to procure the developer, either public or private sector, including Special Purpose Vehicle. For the conditions offered by PT SMI to the private developers.

- Provide sub-loan from IBRD and CTF with the guarantee of sponsor for exploration and test drilling
- Purchase the FIs, such as bonds or shares issued by the private developer (funded by GCF or CTF) under the condition of call/put option where the successful exploration will lead to full repayment of the FI with a premium while unsuccessful exploration would make the FI’s value into zero.

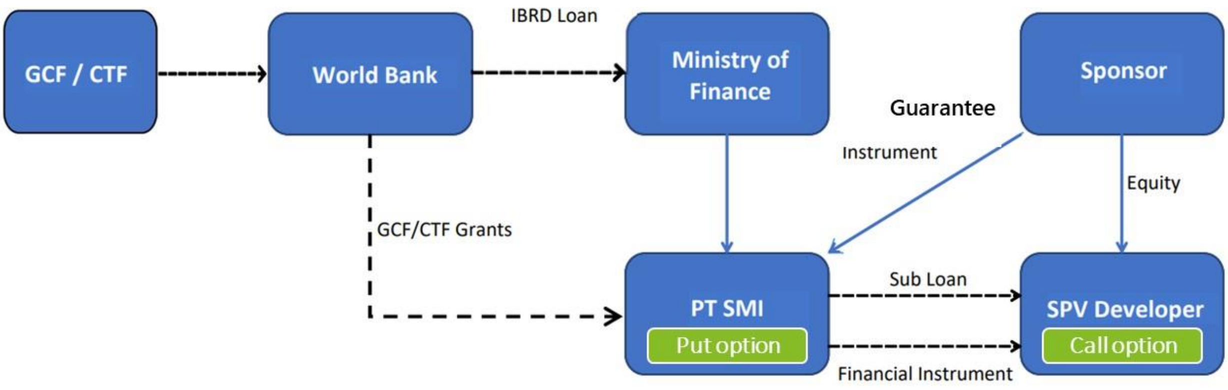


**Figure 2: Flow of the funds for GREM**

## Cost-shared exploration and appraisal drilling

Cost-shared drilling is one of the mitigation measures for resource risk in vertical integration model. It has successfully reduced resource risk in several countries and has helped mobilize risk capital toward geothermal exploration/resource confirmation. It can be particularly suitable where governments seek to engage the private sector in geothermal development. Cost-shared drilling was implemented successfully in Japan. During a number of periods over the past several decades, Japanese private developers benefitted immensely from a cost sharing scheme that included a cost share of up to 40% for exploration wells and 20% cost share on production and injection wells. This cost sharing hastened the installation of most of geothermal power in Japan. In the United States, developers were able to confirm productive conditions at several fields that were later developed for a total of about 150 MW. In both countries, the national geological survey initially identified the most promising fields that would be eligible for cost-shared drilling, but the drilling and development were conducted by the private sector.

Another example of cost-shared drilling available in the targeted country is GRMF. The facility provides qualified public and private developers with (i) grants for surface studies and (ii) cost sharing for exploration drilling. For latter, qualified developers can receive up to 40% of the cost of up to two exploration wells plus 20% of the cost of related infrastructure. In the case of a successful exploration and subsequent field development, project developers can receive an additional 30% of the predetermined cost of exploration wells as a “premium.” Developers can apply once per year for grant funding from the GRMF.

## Initial-stage fiscal incentives

The government provides incentives, such as exemption from duties, tax credits, and so on, for those implementing the exploration drilling. Examples can be seen in the United States, such as Investment Tax Credit (ITC) and Production Tax Credit (PTC). The ITC provides a tax credit of 10 to 30 percent of the capital investment costs in a geothermal project and is paid out once at the completion of power plant construction. On the other hand, the PTC provides benefit to companies with limited tax liabilities once a project becomes operational and is paid throughout the production lifetime of an operating project, at the rate of $0.02/kWh (World Bank, 2016). Another example is fiscal incentives provided by Government of Kenya. The incentives include tax and duty exemption for imported equipment, ten years tax holiday for geothermal plants of at least 50MW, exemption from stamp duty, the issuance of letter of support or government guarantee (for Olkaria I, II, III, IV project), etc.

### Structural improvement

The government strengthens the institutional capacity of geothermal development by establishing a clear legal and regulatory framework; well-defined institutional responsibilities; and transparent, competitive, and non-discriminatory procedures, including adequate measures for controlling speculative practices. Examples are below:

- Setting clear definition and simplifying the authorization and administrative/licensing procedures (e.g., setting up a unique geothermal licensing authority).
- Building capacity for utilizing international competitive tender (ICT) to elect experienced/skilled institutions and human resources, and forming supportive policies for renewable energy development, such as FITs and RPS.
- Although the government of potential projects is making effort to progress, there is more to be done.

### Portfolio exploration

The government explores and evaluates multiple geothermal fields to increase the probability of finding at least one viable site and reducing the chance of overlooking significant development opportunities at the viable site and to reduce time and costs (ESMAP, 2012).

### Resource viability research/exploration

The government/developer conducts research on geothermal resources to certify the existence of sufficiently accurate reservoir and prove the viability of the project. Due to the high uncertainty level of financial return, the funding is usually procured in the form of grants by the government. This approach has been implemented in Kenya where Government provides fund through GDC and KenGen to conduct research on geothermal resources.

### Incremental/Stepwise approach

The government/developer proceeds the project in cautiously sized steps (not large size at one site) determined by reservoir data. As a rule of thumb, a pilot power plant (e.g. well head generator with 2 to 10 MW capacity) should be installed to gain solid geophysical data about the reservoir over a period of 2 years. Thereafter and based on this information, a utility scale power plant can be built in incremental steps of e.g. 25 or 50 MW, depending on field potential and pressure drop estimated. This approach was implemented in Menengai project in Kenya.

### Guarantee/Insurance

Guarantee and insurance can be provided by either public or private sectors which compensate against unexpected results, including lower-than-expected drilling results (i.e., well productivity, temperature, flow rate, fluid chemistry), breach of contract, default/bankruptcy of stakeholders, and so on. Guarantee provided by government is sovereign guarantees. Sovereign guarantees usually relate to payment defaults, but they can cover all kinds of obligations and commitments. sovereign guarantees are mostly used to attract investments in generation by IPPs, in countries that suffer from a negative risk perception. They can cover non-payment by the off-taker or/and steam provider (state-owned company), any other obligation of the utility as stated in the PPA, unilateral changes in the tax treatment, the termination clauses, currency inconvertibility and currency transfer restrictions. Sovereign guarantee can be replaced by letters of support, but does not have the same strength as a sovereign guarantee (World Bank, 2019).

Not many precedents in Africa, but other countries, such as Iceland, Germany, France, the Netherlands, and Switzerland, have public insurance scheme for exploration and drilling. Furthermore, there are some private sectors in Germany, namely Munich Re, that provide insurance for geothermal development. As an example, Munich Re provided insurance to Akiira geothermal project in Kenya. Some programs are provided by the DFIs, including GeoFund program under GEF and Geothermal Well Productivity Insurance under World Bank in Turkey (World Bank, 2016).

### Creditworthiness Analysis

Creditworthiness of off-takers, steam provider (if different entity with IPP), and developer are essential to be analyzed for investor when deciding to invest in geothermal project. Creditworthiness is determined by a number of factors. For companies, this includes issues such as solvency – for example, how big is the company's debt compared to its equity? What is its liquidity like? Is there sufficient cash flow to meet current and future obligations? Does the company have a history of prompt payment? What is its projected sales trajectory? How is the wider sector or industry faring? How many customers does it have? This is because companies with many customers are considered more creditworthy than firms that depend on a small pool of clients (and so are exposed to greater risk).

Creditworthiness is based on extensive financial data (e.g. financial statement data) which is combined to create a credit score ranging from A to D. An 'AAA' score means the company is extremely creditworthy. D-score means the customer has no credit standing. Another measure to analyse the creditworthiness, particularly for off-taker is ERI score published by AfDB. ERI score measures the level of development and implementation of a country's regulation of the electricity sector aligned with its impact on stakeholders. ERI score can be divided into three indicators below (AfDB, 2022).

- Regulatory Governance Index assesses the institutional and legal design aspect of regulations.
- Regulatory Substance Index assesses to what extent regulations are implemented.
- Regulatory Outcome Index assesses the effect on beneficiaries of the regulations.

Since poor financial condition of off-takers and sector indebtedness are seen as the main contributors to lower the score of ERI, they can be one of the indirect indicators to assess creditworthiness of off-takers as well as the business risk in the country. Addition to the ERI score, UPBEAT proposed by the World Bank can also be an indicator of creditworthiness of off-taker. UPBEAT is a publicly available data platform to understand, diagnose, and benchmark the performance of 76 utilities in 45 countries in Sub-Saharan Africa. It consists of 60 indicators of financial and operational performance and of transparency and accountability. The reason why UPBEAT could be an indirect indicator of creditworthiness is because it could create a virtuous cycle shown in Figure 3. Starting from better financial performance indicated by cost recovery, liquidity, profitability, and capital structure make off-takers available for essential investments and maintaining the assets. It will lead to high reliability and efficiency of off-takers improving willingness to pay and ability to charge by providing good service quality. Then it will result in stronger governance, in other words transparency and accountability, which makes it easier to reach external funding by promoting active communication with stakeholders (World Bank, 2021).

### Capacity Building

Capacity building is important to solve problem of lack of human resources not only for geothermal developers, but also for government officials to create and implement investor-friendly policy and regulations, accelerating geothermal development in the country. It can enhance capacity level of geothermal developer and government officials, so that it can mitigate organizational risk and regulatory risk. The African countries have set up African Geothermal Centre of Excellence (AGCE) to help address the issues of capacity gaps for technical skills. The setup of the centre was facilitated by UNEP and is hosted in Kenya.

### Deployment of Climate Finance

Climate finance has a great potential to de-risk the geothermal development project, particularly during the initial and middle stages of geothermal development. As an example, climate finance has been used to mitigate resource/exploration risk for project developer in many geothermal projects, such as Ngozi project through Scaling Up Renewable Energy Program in Low Income Countries (SREP) and Menengai project through the Climate Investment Funds (CIF). Another type of climate finance, such as SEFA grant provided by AfDB, is also being used to support drilling program in Menengai project. Climate finance has also been used to finance the later stage of geothermal development, particularly construction phase, to mitigate the financial risk for IPPs with affordable loan. As an example, loan from CTF was provided to two IPPs in Menengai project (AfDB, 2022).

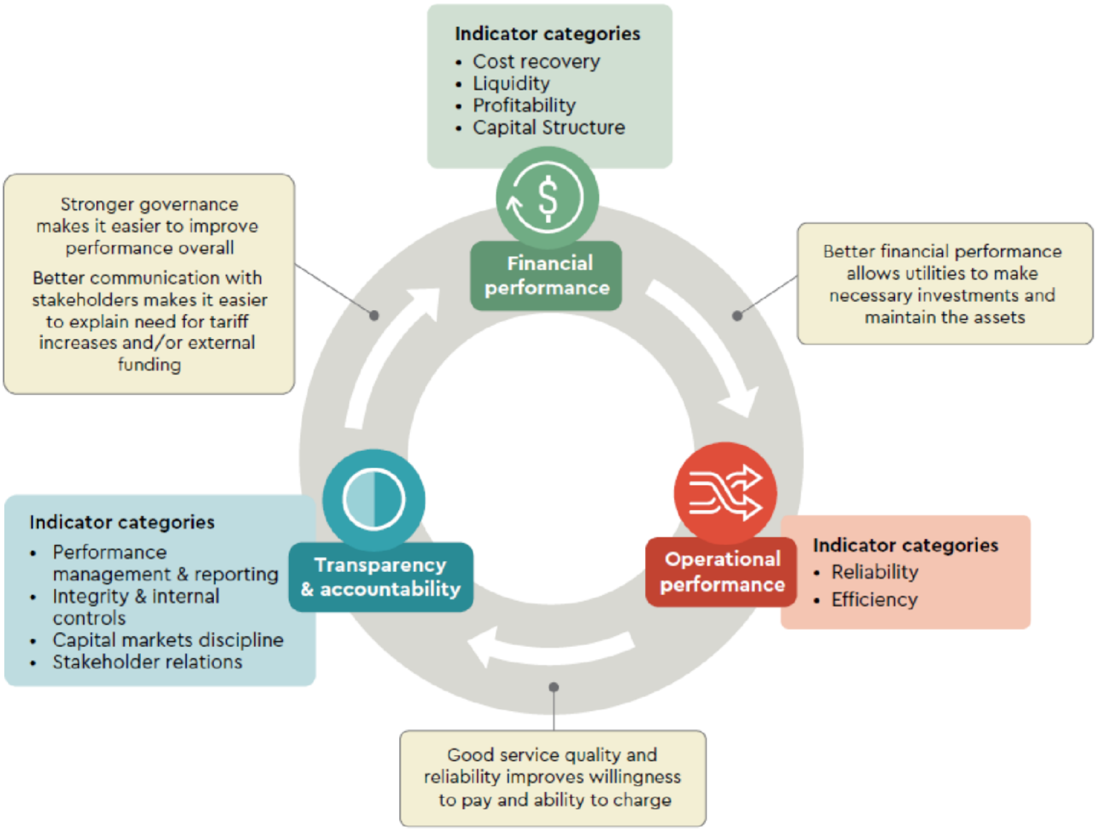


**Figure 3: Virtuous cycle created by UPBEAT**

Climate finance can be utilized as risk mitigation measures of “cost-shared drilling” for Resource risk and Financial risk. However, regulatory risk and organizational risks can be mitigated through structural improvement”.

Table 2: Risks particular for energy development project and corresponding mitigation measures with potential projects

| Mitigation measures | Resource risk | Technical risk | Organizational risk | Commercial risk | |
|---|---|---|---|---|---|
| | Exploration risk | Geological/Drilling/ C&C[*1] risk | Credit risk | Operational risk | Overexploitation risk |
| Government-led drilling | o | | | | |
| Cost-shared drilling | o | | | | |
| Initial-stage fiscal incentives | o | | | | |
| Resource viability research | o | o | | | |
| Portfolio exploration | o | | | | |
| Incremental/Stepwise approach | o | o | | | |
| Guarantee/Insurance | o | o | o | o | o |
| Structural improvement | o | | o | | |
| Creditworthiness analysis | | | o | | |
| Deployment of climate finance | o | | o | o | |
| Capacity Building | o | o | o | o | o |
| Others | | Consulting support | | PM[*2], ICT[*3], Consulting support | PM, ICT, SG[*4] Consulting support |

*1: C&C = Casing and cementing *2: PM = Periodical maintenance *3: ICT = International competitive tender *4: SG = Safeguards

Table 3: Risks for investment project in general and corresponding mitigation measures with potential projects

| Mitigation measures | Financial risk | | | Commercial risk | | Social and environmental risks | Organizational risk | Regulatory risk | Political risk | Force majeure |
|---|---|---|---|---|---|---|---|---|---|---|
| | Interest rate/ Foreign exchange risk | Currency inconvertibility/ Transfer restrictions | Unfair calling of bonds/ Non-honouring of sovereign obligation | Completion delay risk | Price risk | Local communities' opposition/ Equipment and personnel safety | Public institution capacity risk | Unsupportive policy/Land usage permission | License cancellation /Country risk | |
| Government-led drilling | | | | | | | | | | |
| Cost-shared drilling | | | | | | | | | | |
| Initial-stage fiscal incentives | | | | | | | | | | |
| Resource viability research | | | | ○ | | ○ | | | | |
| Portfolio exploration | | | | | | ○ | | | | |

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| Incremental/Stepwise approach | | | | ○ | | ○ | | | | |
| Guarantee/ Insurance | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Structural improvement | | | ○ | ○ | ○ | | ○ | ○ | ○ | |
| Creditworthiness analysis | | | ○ | | | | ○ | ○ | ○ | |
| Deployment of climate finance | | | | | ○ | | ○ | ○ | | |
| Capacity building | | | | ○ | | | ○ | ○ | | |

| Mitigation measures | Financial risk | | | Commercial risk | | Social and environmental risks | Organizational risk | Regulatory risk | Political risk | Force majeure |
|---|---|---|---|---|---|---|---|---|---|---|
| | Interest rate/ Foreign exchange risk | Currency inconvertibility/ Transfer restrictions | Unfair calling of bonds/ Non-honoring of sovereign obligation | Completion delay risk | Price risk | Local communities' opposition/ Equipment and personnel safety | Public institution capacity risk | Unsupportive policy/Land usage permission | License cancellation /Country risk | |
| Others | Concessional loans, Usage of donor banks and specialized institutions, Financial swaps | | | Well-developed plan | | Well-developed plan, SG, Consulting support | | | | Well developed plan |