KfW Development Bank

Ex post evaluation
Development of geothermal resources, Indonesia

Title	Development of geothermal resources in Seulawah Agam		
Sector and CRS code	Energy generation, renewable sources / geothermal heat, 23260		
Project number	2008 66 871 / 2010 464 (training and advanced training measure)		
Commissioned by	BMZ		
Recipient/Project-executing agency	Republic of Indonesia represented by the Ministry of Finance / government of Aceh Province		
Project volume/ Financing instrument	EUR 7.0 million		
Project duration	37 months		
Year of report	2021	**Year of random sample**	2020

Objectives and project outline

The outcome-level objective according to the programme proposal was to demonstrate how private-sector partners can invest in the expansion of Indonesian geothermal resources and to develop the site of Seulawah Agam. By achieving these goals, the aim was to indirectly reduce climate-relevant emissions thanks to the potential construction of a power plant and encourage Indonesia to understand its key role in global climate action (impact-level objective).

To achieve this, the plan was to finance a transaction advisor to prepare and conclude a PPP agreement, exploratory drilling and a feasibility study for the construction of a power plant planned for a follow-up project. Furthermore, the project planned to implement training measures for the geothermal team (consisting of the government of Aceh Province and the province's own development company) in order to guarantee sustainable and efficient project implementation. The project was terminated in late 2017 due to low chances of successful implementation within an acceptable time frame.

Key findings

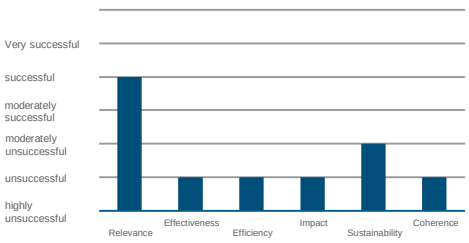
Since it was terminated, the project did not exhibit any development effectiveness. The project was therefore rated as unsuccessful.

– The FC project tackled a core developmental problem in the country – covering the demand surplus by using and developing fossil fuels. The concept and its underlying results chain were well thought out and suitable for helping to resolve the core problem.

– No exploratory drilling took place and no feasibility study was completed. During the ex post evaluation, it was not possible to identify any results from the consulting services provided up to the termination of the project that could be used later or for other purposes.

– Due to its termination, the project is evaluated as clearly insufficient with regard to the criteria coherence, effectiveness, efficiency, impact and sustainability, and thus as a whole.

Overall rating:
Unsuccessful



Conclusions

– The structure of the PPP model proved to be too complicated and costly given the highly politicised circumstances.

– Uncertainties relating to the regulatory framework and the power purchase agreements/ defined tariffs as well as prospecting risks are significant obstacles to private-sector investment.

1 = very successful, 2 = successful, 3 = moderately successful, 4 = moderately unsuccessful, 5 = unsuccessful, 6 = highly unsuccessful

Rating according to DAC criteria

Overall rating: 5

Ratings:

Relevance	2
Coherence	5
Effectiveness	5
Efficiency	5
Impact	5
Sustainability	4

Project description and general conditions

The subject of the FC project appraised in 2010 was the development of the deep geothermal volcanic resource Seulawah Agam in Aceh Province (Sumatra) as the foundation – assuming successful development – for the planned construction of a geothermal power plant of 40 to 55 MW for grid-connected energy production. The aim of the measure was to contribute to the direct coverage of demand in northern Sumatra and – as a pilot project for private sector participation – to structurally promoting the production of power from geothermal heat and to reducing carbon emissions in Indonesia.

The exploration and development of the site were envisaged to be bundled as part of a Public Private Partnership (PPP). The provision of FC grant funds for the exploration process was intended to assume some of the prospecting risk from the public partner (provincial government of Aceh) in order to reduce the entry threshold for private developers. The FC grant funds were to be used to (i) finance the tendering of the location as PPP (best practice model for the sector) and (ii) provide financial support for the exploration (trial drilling, feasibility study). In case of positive results of the exploration process, the plan was to co-finance the power plant as a follow-up project; this power plant was proposed to have a service life of around 30 years with a production capacity of around 300 GWh p.a. This could have avoided emissions of over 230,000 t of CO2 p.a. and a total of 7 million tons of CO2 over the power plant's service life.

The project was terminated in 2017 due to low chances of successful implementation within an acceptable time frame. The termination cannot be attributed to unsatisfactory exploration results, as this process had not even started by this point. No project-related activities had taken place since the second quarter of 2017, nor had any work taken place under the associated basic and advanced training measure.

Following the end of the disbursement period, the government and institutions involved were officially informed of the project's termination and reduced the funds accordingly (see breakdown of total costs).

Breakdown of total costs (only for 3 or more projects/phases)

		2008 66 871 (Planned)	2008 66 871 (Actual)	2010464 (Planned)	2010464 (Actual)
Investment costs	EUR million	18.7*	1.1	0.7	0.7
Counterpart contribution	EUR million	0.2	0.0**	0.0	0.0
Funding	EUR million	7.0	1.1	0.7	0.4
of which BMZ budget funds	EUR million	7.0	1.1	0.7	0.4

* EUR 11.5 million was to be provided by the private shareholder in the intended PPP.

** The public partner's investment in the PPP and any fees due prior to setup.

Relevance

At the time of the project appraisal (PA) in 2010, Indonesia generated almost 90% of its energy from fossil fuels. In 2019, Indonesia still generated around 84% of its energy from fossil fuels with corresponding

levels of carbon emissions. Coal-based power generation accounted for the largest share at almost 40%. Even at the time of the PA, plans were in place to massively expand coal-based power generation. The percentage of electricity generated from coal has risen considerably over the past decade and amounted to almost 60% in 2019[1].

At the same time, given its location on the Pacific Ring of Fire, Indonesia has an estimated geothermal potential of 28,000 (estimate from 2010)[2] or 24,000 MW (estimate from 2020)[2] and therefore is home to around 30–40% of the total global potential[3]. The project location Seulawah Agam is also regarded as a geothermal resource with a high level of potential. Some of the main advantages of producing power from geothermal heat when compared to fossil fuels include the lower greenhouse gas emissions, the base load capability, lower running costs, and isolation from the fluctuating prices on energy commodities markets. However, both at the time of the project appraisal and today, private investors involved in the development of geothermal heat for energy generation purposes are exposed to a number of obstacles and business risks. Most of these relate to the exploration phase, though some are also linked to the fact that, during the exploration phase, there is a lot of uncertainty surrounding the feed-in rate to be negotiated subsequently between the future power producer and the grid operator. The exploration phase requires a lot of investment, whereas future earnings are shrouded in uncertainty. When tendering the exploration and power plant construction as one package (as was the plan for this project), there are also considerable levels of uncertainty at the time of the tender surrounding the size and design of the power plant and, as a result, concerning the total costs too.

Beyond the issue of the environmentally harmful production of power from fossil fuels, there were also huge bottlenecks in the Indonesian power supply, even at the time of the PA. In the project region of northern Sumatra, the shortfall in capacity was estimated to be over 90 MW at the time of the PA, which coincided with a high dependence on unstable energy imports from more southerly regions. Due to the forecasted growth in demand, the situation was expected to become even more tense. According to current DC reporting, there continues to be high growth in demand in Indonesia.

From the perspective at the time of appraisal and also today, the project correctly addressed the expansion of geothermal energy as a climate-friendly way to produce electricity in light of both the coverage of increasing demand and the aforementioned high percentage of fossil fuels used to produce electricity with corresponding levels of carbon emissions. The project could have helped to resolve the core issues, which still exist today.

The project is based on the following results chain: Promotion of the invitation to tender as a PPP and provision of risk investment capital for exploration → Lowering of entry threshold for private developers → If the results of the exploration process were positive: Decision to develop the geothermal site as a PPP. Implementing the follow-up measure (construction and operation of the power plant under a PPP) continues the results chain as follows: Direct promotion of electricity production using geothermal energy, mainly as an alternative to coal-based energy production → If successful: Pioneering project for private-sector investment → More PPPs in the geothermal sector → Structural promotion of energy production → Indirect increase of the share of geothermal energy in Indonesia's energy mix → Reliable/secure energy supply with lower emissions → Reduction of (extra) carbon emissions, primarily in industry and administration, plus impetus for social-economic development → Promotion of Indonesia to understand its key role in global climate action. The results chain was largely based on the assumption that the exploration process would yield positive results and that this would lead to the construction of a power plant under a follow-up measure.

The project's concept addressed the aforementioned hurdles/uncertainties for private investors via its plans to pre-negotiate an energy off-take agreement (including provisions governing changes depending on the exploration results) and conclude a PPP agreement, as well as adopting a proportionate share of the prospecting risk[4]. Furthermore, investment by a private-sector partner aimed to ensure the time- and

[1] All information in this paragraph refers to the year 2019 and is taken from the International Energy Agency (IEA).

[2] Ministry of Energy and Mineral Resources: Handbook of Energy and Economic Statistics of Indonesia of the years 2008-20.

[3] World Bank Results Brief Geothermal (2017) estimates the potential to be 70,000-80,000 MW.

[4] Risk of developing a geothermal reservoir with drill holes in an insufficient quality or quantity.

cost-efficient completion of the project while investment by the public-sector partner[5] in the project company aimed to facilitate interaction between the project company, ministries and authorities. Due to the public-sector partner's lack of experience in the field of geothermal energy, the plan was to empower the partner through training under the basic and advanced training measure, though the public partner was to function mainly as a shareholder in the PPP project company to be set up. Responsibility for the project's technical implementation was due to lie mainly with the private partner given its expertise in geothermal energy, higher proportion of capital, and commercial interests.

The EPE considers the concept and results chain to be plausible. They were suited to helping resolve the core issue, even though in retrospect – according to the final review – the structure of the PPP model proved to be too complicated given the highly politicised circumstances in Aceh. The provision of the public-sector partner's (financial) counterpart contribution also proved problematic.

At the time of the PA (2010), the Indonesian government had declared the development of geothermal energy as one of its objectives, along with the expansion of production capacities in Aceh Province. In its general plans for energy policy in 2006, the government had set itself the ambitious goal of expanding the installed capacity from geothermal energy to a nationwide total of 9,500 MW by 2025. An additional 4,600 MW was to be created by 2016 as part of the 2nd Crash Programme and 70% of resources were to be developed by the private sector. By the end of 2020, the installed capacity was 2,131 MW.[6] This put Indonesia in second place in the global rankings in 2020.[7]

Furthermore, the project was in line with the goals of German-Indonesian cooperation. The DC programme objective at the time was "Industry and administration reduce climate-relevant emissions over the long term". The project was in line with both the Indonesian government's strategic development plan and with the goals of the German DC programme, and could have contributed to their target achievement. The project could have also contributed to Indonesia's NDC-codified climate objectives and to the NDC partnership between Germany and Indonesia, which was set up in 2016. Due to its high level of relevance for the protection of Global Public Goods and for the continuation of Indonesia's economic development, the energy sector was declared an independent focus area in bilateral DC in 2017.

Given the plausible results chain and coherent concept for resolving the correctly identified core problem, the project's relevance is regarded as good.

Relevance rating: 2

Coherence

At the time of the PA (2010), the project fit well into the commitments and objectives of German DC (see Relevance) and international donors, which was coordinated by the Indonesian Ministry for Development Planning. The activities were aimed at creating suitable framework conditions in the geothermal sector and promoting its expansion. Via the Studies and Consultancy Fund, a cross-regional study was financed at the time of the PA with a focus on Indonesia and the design of a geothermal prospecting risk fund. The results could have been incorporated into the structure of the PPP. The Asian Development Bank financed a consultant to support the structuring of PPPs (cross-sector). At the time of the PA, the World Bank also provided funds for the preparation of standard tender documents for geothermal locations. The FC project could therefore have benefited from the results of these measures on the one hand, but, as a pilot project, could also have served as a basis for the widescale reproduction of the PPP approach on the other.

Beyond this project, at the time of the PA, the German and Indonesian governments were discussing the financing of an open geothermal programme for at least EUR 100 million, which could have been used to finance the construction of the power plant in Seulawah Agam. The World Bank Clean Technology Fund was also planning investments of over USD 2 billion by the World Bank, ADB and IFC, the majority of which was to be used to develop geothermal locations. According to the PA, JICA was also planning

[5] The government of Aceh Province was due to be represented in the PPP by its own development company (PT.PDPA).

[6] Ministry of Energy and Mineral Resources - Indonesia: Handbook of Energy and Economic Statistics of Indonesia 2020

[7] ThinkGeoEnergy - Geothermal Energy News: Top 10 Geothermal Countries 2020 – installed power generation capacity (MWe)

investments of several USD 100 million, specifically in Aceh Province for the development of the transmission network.

According to DC reports in 2021, the promotion of renewable energy sources, including geothermal energy, remains an important component of cooperation with Indonesia for the majority of donor agencies. This applies to both financial cooperation via development banks (JICA, World Bank, ADB, AFD, KfW and the Asian Infrastructure Investment Bank [AIIB]) as well as to technical cooperation (along with GIZ and PTB, also organisations like Australia's DFAT, USAID, NZAid, SECO, etc.). JICA in particular has committed itself to the development of master plans in recent years. For grid-connected energy supplies using renewables, resources such as JICA-financed master plans continue to provide important frames of reference for the expansion of hydropower and geothermal energy.

According to DC reports from 2021, dialogue between donors tends to take place on an ad hoc basis. Donor contributions are generally coordinated by development banks because of co-financing measures for individual projects. Liaison also takes place between the remaining stakeholders in the geothermal sector. Beyond this, no structural donor coordination by the Indonesian government is visible to outsiders. Agreements concerning donor support continue to be bilateral. The Indonesian government's only transparent planning and coordination instrument for Financial Cooperation is the Indonesian Development Planning Ministry's Blue Book. It contains public projects open to foreign investors.

The project's concept as described above complemented the activities of German DC and other donors in principle, and it would have supported partner efforts. However, these potential synergy effects were not fulfilled due to the project's termination. Coherence is therefore rated inadequate.

Coherence rating: 5

Effectiveness

The outcome-level objective according to the PA was to demonstrate how private-sector partners can invest in the expansion of Indonesian geothermal resources and to develop the site of Seulawah Agam with the aim of meeting demand for electricity in northern Sumatra using power produced in an environmentally friendly manner. In as much as "Development of the site Seulawah Agam" referred to exploration and the feasibility study, the formulated targets are regarded as appropriate because the project as such was not supposed to be development in the sense of building a power plant, but development in the sense of creating a basis for the future construction of a power plant.

The target achievement at outcome level was due to be measured using the following indicators:

Indicator	Status PA / Target value PA	Status EPE
(1) Successful pre-negotiation of a power purchase agreement (PPA)	- / Pre-negotiated	Achieved.
(2) Submission of a sufficient number of qualified offers for the concession tender	- / Qualified offers	Achieved.
(3) Conclusion of a PPP agreement	- / Conclusion of a contract	Achieved.
(4) Presentation of a feasibility study regarding the exploration results	- / In place	Not achieved.
(5) Decision made by the project company regarding the construction of a geothermal power plant	- / Made	Not achieved.

In principle, the aforementioned indicators were suitable for measuring target achievement (development of the site of Seulawah Agam). Looking at the achievement of the indicator targets reveals a mixed picture:

A power purchase agreement was successfully negotiated (indicator 1) and was part of the tender documents for the concession. The public energy company and its geothermal subsidiary was awarded the contract for the investment in the planned PPP as part of an international competitive bidding process with several offers from qualified bidders in November 2013 (indicator 2). The PPP agreement (indicator 3) was concluded in 2015 following significant delays. However, the creation of the project company (PT.Geothermal Energy Seulawah – PT.GES) as a joint venture between the public partner's development company and the public energy company's geothermal subsidiary was delayed until 2017. Ultimately, the project company was never even registered. Approval from the provincial government for setting up the company but also the funds for fees and for the public partner's minimum share capital (provided as a counterpart contribution via the development company) were temporarily lacking. Furthermore, the provincial government gave unclear and contradictory political signals relating to the development of the geothermal site.

The project was terminated in late 2017 due to the low chances of successful implementation within an acceptable time frame. As a result, no exploratory drilling took place; thus, the feasibility study was not prepared (indicator 4) and no decision was taken regarding construction (indicator 5). The project was not pursued by the project company. The pre-negotiated power purchase agreement was not used following the project's termination either (end of 2017). The planned spill-over effects of a replicable example for the Indonesian geothermal sector were not achieved. There is no indication of any negative demonstration effects.

Due to the termination of the project, the objectives at outcome level could not be achieved and the results from indicators 1–3 were not used. Effectiveness is therefore rated inadequate.

Effectiveness rating: 5

Efficiency

The PPP's construct was also intended to support efficient implementation. The presence of the public partner was designed to facilitate interaction with authorities and ministries, while the private partner's role was designed to ensure the time- and cost-efficient completion of the project (see Relevance). As explained under Effectiveness, there were still massive delays, including delays in interaction with government agencies, right up to the project's termination. The intended effects relating to implementation efficiency were not achieved.

Since the project itself would not have created any production capacities or generated any income, the economic feasibility study of the project appraisal related to the project as a whole, including the plans to build and run a power plant as a follow-on from the project. The dynamic production costs were listed as 7.6 US cents per kWh in the PA. The maximum tariff published by the Ministry for Energy in December 2009 was 9.7 US cents. With this tariff, a micro-economic return of 12% could have been achieved according to the PA. When applying a feed-in tariff of 6 US cents per kWh for a geothermal power plant in northern Sumatra, set at the time of the PA, the microeconomic return would have been just 6%. This emphasises how important the feed-in tariff is for economic efficiency. According to the PA, the calculations at PA were subject to a high level of uncertainty as the yield from the geothermal reservoir and, as a result, the specific and absolute investment costs could only be roughly estimated, and the specified tariffs were very uncertain. The final review (2018) argued that the relatively low electricity tariff that could be achieved was at the edge of economic efficiency. The DC reports from 2021 also noted that, with the current tariff structure, the costs would not be covered in full. As such, the pre-negotiation of the tariff, including the change provisions, was of central importance (see Relevance and Effectiveness). The extent to which these measures would have contributed to a cost-covering tariff if the project were implemented remains unclear.

The macroeconomic assessment of power produced from geothermal resources in Indonesia in the PA related to coal-based power production as an alternative technology. The (additional) benefits of geothermal energy for the purpose of power production compared to the alternative of coal-based energy

production stemmed from the positive environmental effects and the export earnings from unneeded fuel. In the PA, the investment's economic return was estimated at 20%. Even the variation of the assumptions subject to high levels of uncertainty resulted in a clear positive value for the economic benefit at the time of the PA. However, from a global perspective, the inclusion of export earnings from unneeded fuel displaces the negative environmental effects.

Going beyond the aforementioned indirect evaluation of efficiency (follow-up project), direct efficiency assessments (decision to build the power plant) – in the sense of comparing alternatives – would have been worthwhile in the PA. The planned PPP agreement and the proportionate assumption of the prospecting risk had the potential to contribute to efficient target achievement at outcome level (decision to build the power plant) (allocation efficiency). It would not have been possible to make any statements regarding the specific costs for achieving the outputs given the lack of comparability with other projects (production efficiency).

The project was terminated due to the low chances of implementing the project in a (time) efficient manner. Furthermore, the activities completed up to the point of termination did not deliver any results that could be used elsewhere, nor did they deliver any positive individual or macroeconomic effects. In view of this situation, the efficiency is rated as unsatisfactory.

Efficiency rating: 5

Impact

According to the PA's logframe, the impact-level objective was to encourage Indonesia to understand its key role related to global climate action and adaptation to climate change. If the project were to be continued, refining the formulation in relation to the tangibility of the effects would have been expedient. Furthermore, the project's measures were designed to avoid emissions and not to adjust to climate change.

The sector-typical indicator at impact level "Annual carbon emissions avoided" was not used to measure target achievement at impact level as the project itself was not to create any production capacities.

Since the PPP project company was to construct and operate a power plant in a follow-up project, there would have been a significant gap in time between this project and the occurrence/initiation of any (if at all) direct effects (increase to production capacity and emissions savings) or structural effects in the geothermal sector (wide-scale spread of PPP approach and increase to low-emission geothermal energy production in the Indonesian energy mix). The same applies to the contribution to the DC programme objective (see Relevance). No conclusive statement can be made as to whether the project and its exemplary PPP approach would have been able to achieve any spill-over effects beyond Aceh Province and thus have a widescale impact. There is no indication of any negative effects arising from the project's termination (see Effectiveness).

Additional macroeconomic effects described in the PA also could only have arisen indirectly with the construction of the power plant as part of the planned follow-up project: among others, the contribution to reducing shortages in the electricity supply in Aceh Province and impetus for economic growth and socioeconomic development in the project region as a result of a more reliable supply of power from the grid.

Since the project was terminated, the aforementioned impacts could not be achieved. The impact is therefore assessed as unsatisfactory.

Impact rating: 5

Sustainability

Since the project's cancellation meant that the geothermal power plant was not built, no impacts were achieved, nor any other results that could be used elsewhere. The project was not pursued. As such, there can be no sustainability either.

The decision regarding the construction of the power plant and its sustainability would have been dependent on the results of the exploratory drilling. In the event of positive exploration results with the subsequent construction of the power plant, the power plant's sustainable operation would have had to be

ensured by the PPP project company. The negotiation of a cost-covering feed-in tariff would have been decisive for economically sustainable operation (see Efficiency).

Given the situation described above, there can be no sustainability.

Sustainability rating: 4

Notes on the methods used to evaluate project success (project rating)

Projects (and programmes) are evaluated on a six-point scale, the criteria being **relevance, effectiveness, efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's overall developmental efficacy. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): The developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall. (This is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability): The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a "successful" project while rating levels 4-6 denote an "unsuccessful" project. It should be noted that a project can generally be considered developmentally "successful" only if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") and the sustainability are rated at least "satisfactory" (level 3).