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Indonesia Geothermal Development Target and Relevant Measures

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ABSTRACT

The geothermal development in Indonesia is again, falling behind the yearly national target in the period of 2021 – 2023 referring to the general plan of electricity supply of 2021 – 2030 (RUPTL). A number of measures have been applied, one of them is the geothermal government drilling. The geothermal government drilling is aimed at leveraging the appetite of the remaining undeveloped geothermal prospects by taking care of the early exploration risk. This program is also aimed to reduce resource uncertainty and bear some portion of the exploration cost. In return, the government of Indonesia intends to reduce the ceiling price of geothermal electricity price which is considered still not competitive among the other renewable energies. As of early 2024, two Indonesia geothermal government drillings have been finished. The results of these drills will be discussed in this paper, as well as how this program fulfilled its purpose. The geothermal market in Indonesia is undoubtedly growing as the number of geothermal-generated electricity consistently rises each year. This boundless opportunity requires the attention of the Indonesian government since 2024 is a political year for Indonesia, as the newly elected president will take charge, and policy changes have the chance to benefit the Indonesia geothermal industry even more. The government should put their concern of how to clear the passages for geothermal developers, both public and private sectors that could be done in many relevant ways.

1. INTRODUCTION

By the end of 2023, the total installed capacity of geothermal power plants in Indonesia reached 2597.51 MW (MEMR, 2023; Figure 1). By 2030, the geothermal installed capacity is aimed to achieve 5799 MW as the result of the projected 3355 MW additional installed capacity between 2021 and 2030 (RUPTL 2021 – 2030) (PLN, 2021). Catching up the 3381 MW gap in the next 6 years requires a robust acceleration and relevant measures to cope with current existing geothermal exploration deacceleration factors. Indonesian Government regards the uninteresting investment atmosphere plays a major role in deaccelerating both the size and duration of geothermal power plant development. On the other hand, geothermal associations that represent industrial practitioners in Indonesia did not quite agree with the government drilling program as a solution with its current way of execution to accelerate the size and duration of explorable geothermal resources in Indonesia (Think Geoenergy, 2021).

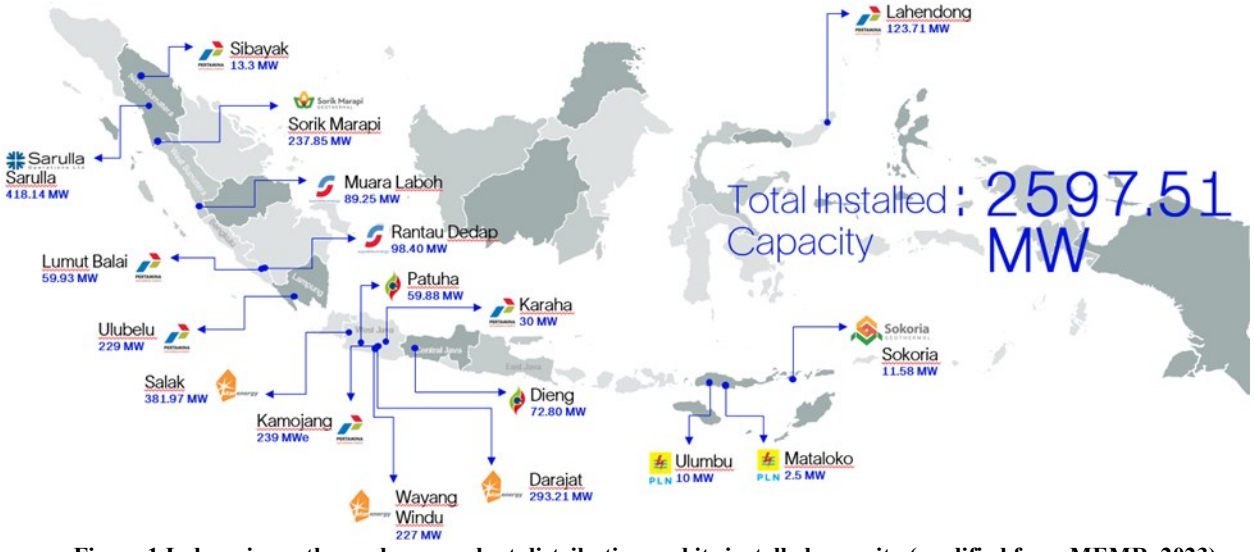

Figure 1 Indonesia geothermal power plant distribution and its installed capacity (modified from MEMR, 2023).

Previous studies (Darma, 2016; Purba et al., 2019) are in general agreement with several key limiting factors of geothermal development in Indonesia. Several issues such as (1) high upfront investment cost against unfavorable energy pricing policy (causing uncompetitive geothermal electricity price) and (2) legal aspects and uncertainties related to government guarantee of the power purchase agreement between geothermal developer and Indonesia electricity buyer are not things that could be resolved in less than 6

years. Facing these two crucial issues, the 3381 MW additional installed capacity would be very challenging to achieve in a matter of time. Developing newly explored prospects would be much more challenging since at some point it will encounter the huge resource risk and uncertainties as well as the typical tough power purchase agreements (PPA) negotiations.

Up until recently, the government of Indonesia, through the Ministry of Energy and Mineral Resources (MEMR) has been committed to contribute to accelerate the geothermal industry development. Up until recently, geothermal exploration de-risking schemes have been available (Siahaan et al., 2023), including:

Table 1 List of geothermal exploration de-risking facilities in Indonesia (Siahaan et al., 2023).

Risk Reduction Scheme	Program
Government-led exploration	1. Geothermal Energy Upstream Development Project (GEUDP) 2. Government Drilling Through Geological Agency
Loan and risk sharing	1. Geothermal Resource Risk Mitigation Project (GREM) 2. State Owned Enterprise (SOE) Drilling

Siahaan et al. (2023) described each program concisely and comprehensively and showed that all of these schemes are aimed at funding the exploration stages. Timely speaking, these schemes are long-term investments since geothermal exploration up to feasibility study is regulated to spend a maximum of 5 years + 1 year + 1 year (Figure 2). Hence, it is important to consider other relevant ways to accelerate geothermal development progress in a relatively short time to allow the Indonesian government to catch up with its target.

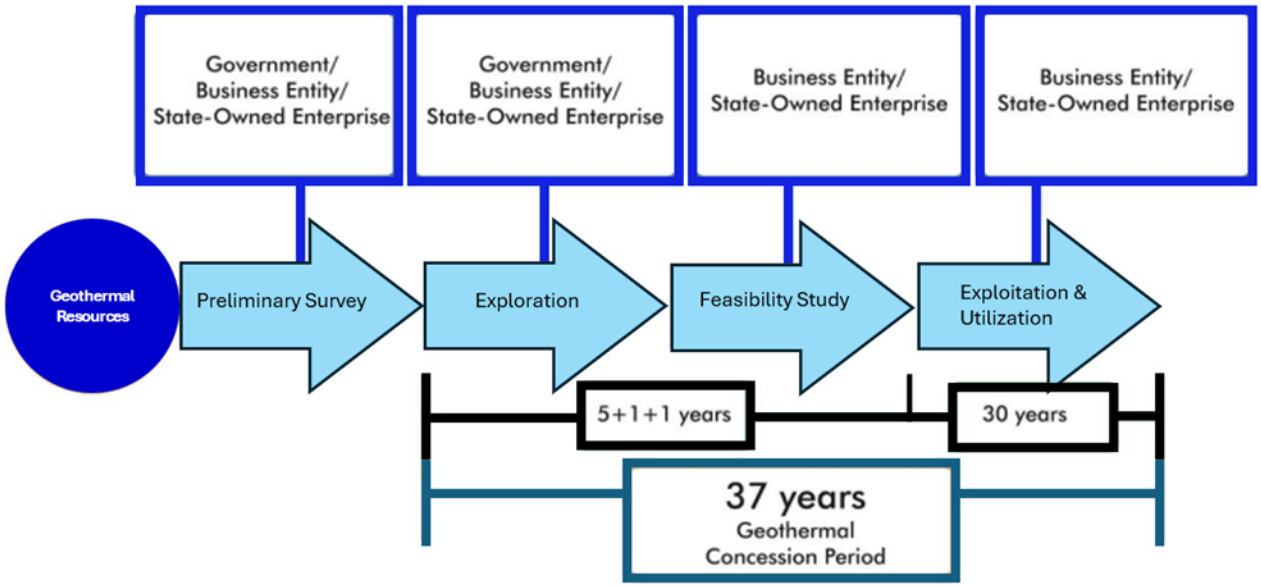

Figure 2 Geothermal development stages in Indonesia (cited from Siahaan et al., 2023).

2. GOVERNMENT DRILLING THROUGH GEOLOGICAL AGENCY

The competitiveness of the geothermal investment atmosphere today and in the future has raised Indonesia's government alarm. This is reflected in the measures taken by the government to conduct the government drilling program. Geothermal Government Drilling has become a hot topic, regarded as one of the troubleshoots to leverage the geothermal investment appetite in Indonesia. Two slim holes and possibly one extra standard hole in each designated geothermal working area (GWA or so-called WKP) are expected to reduce the exploration risk and the usual capital expenditure of a geothermal development project (Harris in Think Geoenergy, 2021). This prior knowledge obtained before the GWA bidding is expected to increase the certainty of the resource existence, reduce further investment costs as well as lead to chances of reasonable electricity tariff reduction.

In 2020, it was announced that early exploration attempts would be conducted at 20 geothermal areas and are expected to be done in 2024 (Think Geoenergy, 2020). The 20 fields were expected to contain additional 683 MW potential (Finahari Ida in Think Geoenergy, 2020). In mid-2021, two government geothermal exploration drilling were started at Cisolok and Nage GWA. In the meantime, 6 other

government proposed GWA (Bittuang, Gunung Endut, Marana, Ciremai, Tampomas, and Sembalun) were exoplored but not drilled yet. In total, by 2021, 8 out of 20 fields were explored and informed publicly (PSDMBP, 2022).

The slim hole drilling result in Cisolok and Nage GWA, however, did not meet satisfactory (PSDMBP, 2022). PSDMBP (2022) elaborated that the drilling in Cisolok (CKK-01A) which initially targeted 2000 mD can only reach down to 820 m TD due to unsuccessful fishing attempts. Furthermore, another well in Cisolok (CKK-02) was not drilled due to land acquisition problem at the designated well pad area. On the other hand, one well in Nage (NGE-01A) successfully accomplished its targeted depth, down to 1500 m TD and fulfilled its purpose as exploratory well by providing subsurface lithology, pressure, and temperature. Another well in Nage (NGE-02) was decided to be terminated at 600 m MD due to limited budget that has been overused during the drilling of NGE-01 (plugged and abandoned) and the challenging drilling of NGE-01A. Event though, both fields were concluded ready to be tendered. Later in early 2024, Nage and Cisolok GWA were officially tendered to public (EBTKE, 2024a; EBTKE, 2024b). It took a total of four years for both fields to be tendered, and possibly take another year for the tender process.

This program must have been taking the risk into account, should the government drilling don't find any satisfying result. Any expected tariff reduction should be equal to the portion of what the government drilling has taken care of both from a risk and financial point of view, and vice versa. Since everything is countable, this intention to (in the end) reduce the electricity tariff, which would lead to a revenue reduction of a geothermal development project should be adjusted to reciprocate with what the government is willing to spend at the exploration stage.

3. GEOTHERMAL ENERGY UPSTREAM DEVELOPMENT PROJECT (GEUDP)

Geothermal Energy Upstream Development Project (GEUDP) is very similar with the government drilling with differences in the fund source and the project executor. It is elaborated by Siahaan et al. (2023) as a government-sponsored exploration drilling collaboration program between the Government of Indonesia and the World Bank. This program intended for the development of greenfield geothermal areas prior to be tendered, with prioritized field at eastern Indonesia. **Error! Reference source not found.** summarizes the differences between Government Drilling Trough Geological Agency and GEUDP.

Table 2 Comparison between Geovernment Drilling Through Geological Agency and GEUDP.

Program	Executor	Source of Funds
Geovernment Drilling Through Geological Agency	PSDMBP (Indonesia Geological Agency)	Indonesia National Budget (APBN)
GEUDP	PT Geo Dipa Energi	PISP Fund: – USD 49 million from CTF – USD 6.25 million from GEF – USD 2.13 million from NZ MFAT

PT Geo Dipa Energi ("GDE"), a state-owned enterprise geothermal developer act as a technical implementing agency responsible to conduct a pre-feasibility study of the proposed prospective area from the MEMR. Upon the feasibility of the prospective resource, the program will be furtherly proceeded with exploration drilling. Currently, two GWA are in the program, Jailolo (Halmahera Regency, North Maluku) and Wae Sano (West Manggarai Regency, East Nusa Tenggara) GWA. Both GWAs have not been publicly reported to be drilled, especially Wae Sano which is facing local community resistance (GeoDipa, 2021; Fadhillah et al., 2023; Floresa, 2023). On the other hand, the activity in Jailolo has not been updated publicly.

4. GOVERNMENT REGULATION

Up above the other de-risking schemes to accelerate the geothermal development, government regulations shall be considered as most impactful instrument to current and future geothermal development acceleration. Peraturan Presiden 15/2002 which revoked the Peraturan Presiden 5/1998 played an important role in the beginning of Indonesia geothermal industry advancement by enabling a lot of suspended geothermal project to be back in progress. The Undang-Undang Republik Indonesia 27/2003 also placed geothermal energy in the spotlight (GeothermEx, 2010). This led to series of favorable government effort and better investment atmosphere for geothermal industry in Indonesia. From year 2006 to year 2023, these regulations have allowed impressive progresses in terms of installed capacity as visualized through Figure 3. The electricity tariff in Indonesia has also been through changes time to time, regulated by the following:

- Peraturan Menteri ESDM Nomor 2 Tahun 201;
- Peraturan Menteri ESDM 17 Tahun 2014;
- Peraturan Menteri ESDM Nomor 12 Tahun 2017;

- Keputusan Menteri Nomor 1404 K/20/MEM/2017;
- Keputusan Menteri Nomor 169.K/HK.02/MEM.M/2021;
- Peraturan Presden Nomor 112 Tahun 2022.

The most recently released regulation was the Number 112/2022 Presidential Regulation in a bid to attract more investors by allowing better prices for geothermal. Think Geoenergy (2022) summarizes the regulated tariff, reflected by Figure 4 Summary of regulated geothermal electricity price based on number 112/2022 Presidential Regulation.

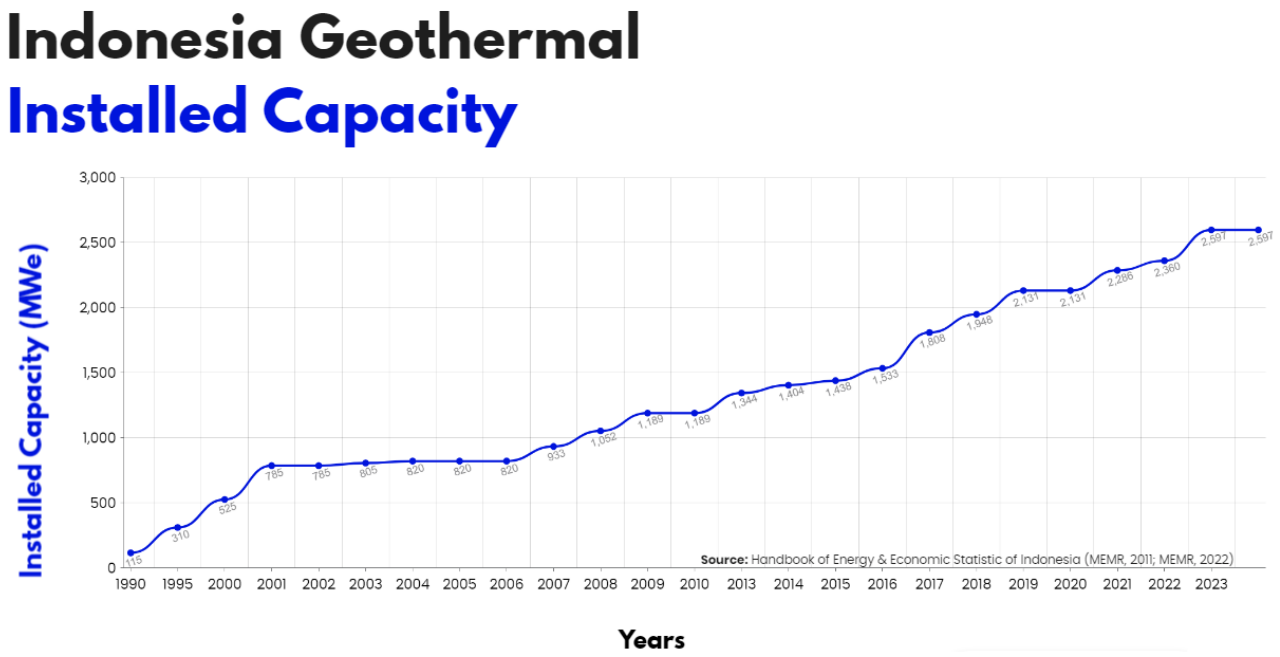

Figure 3 Indonesia historical geothermal power plant installed capacity (IGA, 2024; MEMR, 2011; MEMR, 2023).

	10 MW	10 – 50 MW	50 – 100 MW	>100 MW
	Cents/kWh			
Year 0 - 10	9.76 x F*	9.41 x F*	8.64 x F*	7.65 x F*
Year 11 - 30	8.30	8.00	7.35	6.50

Figure 4 Summary of regulated geothermal electricity price based on number 112/2022 Presidential Regulation.

It has been 14 years since GeothermEx (2010) elaborated on geothermal project risks in Indonesia extensively. By comparing with other countries, several options for mitigating geothermal risk in Indonesia, which are most crucial such as:

1. Government carries out resource discovery and confirmation drilling;

2. Cost-shared drilling with a direct subsidy to the developer;

3. Contingent support to the developer through an insurance scheme; and

4. Price Incentive.

The Government of Indonesia has managed to come up with several aforementioned programs (Table 1) that practically cover the above options number 1, 2, and 3 as visualized through the scheme in Figure 4. However, option number 4, which is considered simpler and more efficient to administer and could scale up development faster does not align with any recently issued government regulation. The number 112/2022 Presidential Regulation indeed offers better geothermal electricity prices for some areas in Indonesia, but the impact of leveraging the feasibility of geothermal projects is still questionable (Think Geoenergy, 2022).

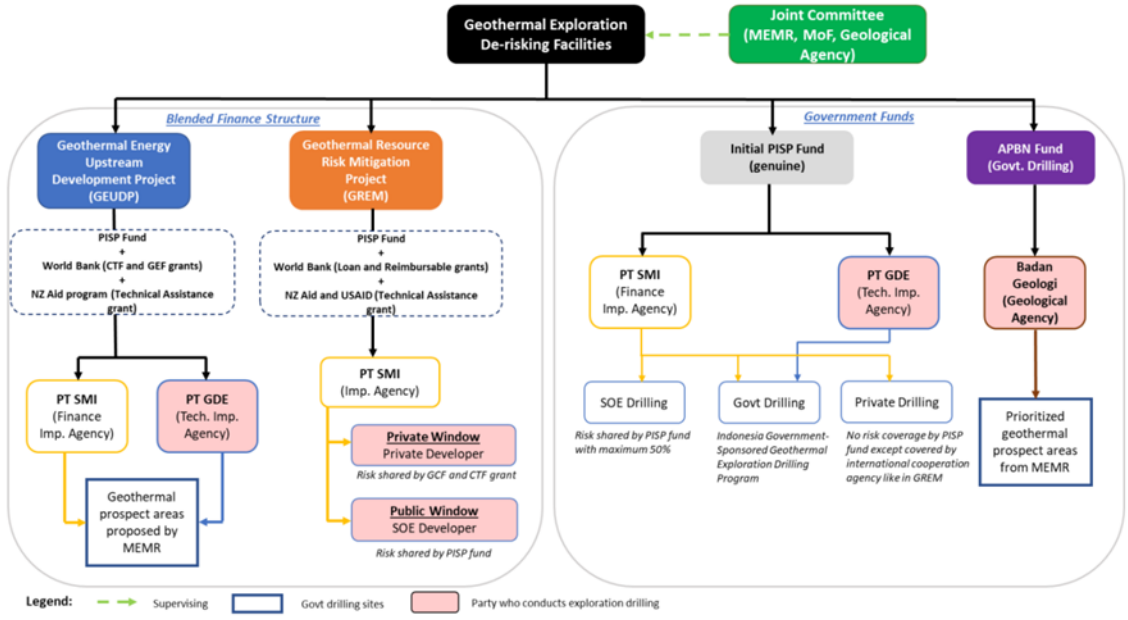

Figure 5 Overview of Geothermal Exploration De-Risking Facilities in Indonesia (PT SMI, 2022 cited from Siahaan et al., 2023).

5. DISCUSSION

It could be clearly seen that all the Indonesian government attempts to accelerate the achieved number of geothermal installed capacity are focusing on the exploration phase. This would likely provide long-term progress, realizing several factors, including:

1. The maximum duration of exploration phase in Indonesia is 5+1+1 years (Figure 2);

2. The highest risk of not meeting the drilling success criteria;

3. The long, tough, power purchase agreement (PPA) negotiation;

4. More stages after the exploration drilling have been finished (such as feasibility study, development drilling, power plant and other facilities construction, etc) which also involve a lot of external factors (at least) including measures to reach financial closure and social responses from the land acquisition process.

These seem pessimistic, but those are the real challenges between the attempt and additional installed capacity that the Indonesian government is trying to achieve.

On the other hand, Indonesia has 18 producing fields and several other (explored) fields that already passed the PPA negotiation stage. Some of them do not yet meet the final target of the PPA which means they are still developing and will have additional installed capacity in their further development plan. These are very much possible for the Indonesian government to keep an eye on. Focusing on the "expanding" producing fields might as well benefit the geothermal developer and speed up Indonesia's government target for several reasons:

1. The producing fields have a better drilling success ratio, with a well-developed historical drilling portfolio in each particular field;

2. The risk of resource as well as investment is rather adaptable and measurable;

3. The typical planning and execution duration of expanding the production to additional installed capacity in Indonesia is 3 years;

4. The overall financial parameters of the business expansion feasibility are relatively more achievable since the electricity tariff of the project has been acknowledged.

Each producing geothermal field in general is unique and has its potential upsides and downsides. However, there are (at least) three aspects in common where the government can get involved in facilitating and supporting the geothermal developer to advance with their further development plan:

1. Providing/Regulating the use of advanced drilling bits, would likely improve drilling performance since any expanding geothermal-producing field will inevitably need to drill a lot of wells.

2. Providing an electrical submersible pump (ESP) to optimize the resource extraction towards the outflow of a high-temperature geothermal system (and/or to be installed in the reinjection wells), would likely enable steam production in the "step out" area from the sweet spot and/or to accommodate more sustainable brine injection rate as well as pressure. This would be very beneficial to counterfeit the inevitable reservoir decline rate in conventional geothermal systems.

3. Providing an integrated real-time geothermal production process system, would likely enable the geothermal developer to keep their historical geothermal production record "tidy" for so many advantages both in technical and financial perspectives. This could ensure that a geothermal developer would have an excellent basis of how to maintain the performance of their resource by making the best decisions based on well-integrated data records as well as the utilization of artificial intelligence as a "second opinion". A well-integrated monitoring data set would also be likely to provide better insight into any Due Diligence activity that will yield clarity of a resource condition. This is very important for project financing to assess current and future investment risk since any clear resource assessment result will always make a better use than an inconclusive one.

These technologies are very much accessible, well-researched, and proven to be performing in the industry (Ford et al., 2023; Rasyid et al., 2021; Mardiana and Pasaribu, 2022; Aydin et al., 2021; Lovekin et al., 2021; Fastovets et al., 2023; Radov et al., 2023). Many other technologies are advancing these days and are ready to be applied in the industry. Along with the steady progress of the grant fund utilization in the exploration sector that have become government programs (Table 1), it would be very advantageous to consider and include the utilization of these aforementioned "tools" in the Indonesia Government's program to accelerate Indonesia's installed capacity target in the next 6 years (until 2030). In addition, government regulation will also play an important role in the geothermal industry development acceleration.

Per current condition of Indonesia's geothermal development has not changed since 2010 when GeothermEx conducted a geothermal resource risk assessment in Indonesia, two important regulations that considered as most influential to the geothermal investment atmosphere are:

1. For the Indonesia government to allow higher geothermal electricity tariff, or might as well redirect subsidies from fossil fuel to renewable energy;

2. For the Indonesian government to allow an open and competitive market for electricity.

With the newly elected president of Indonesia coming up with a mission to "revise the regulation to facilitate new investments in renewables" (cited from Rystad Energy, 2024), there is still a chance to have regulations that are in favor of Indonesia's geothermal investment climate. This would also be very much beneficial to keep the geothermal investment atmosphere in good shape since the demand will constantly grow (**Error! Reference source not found.**).

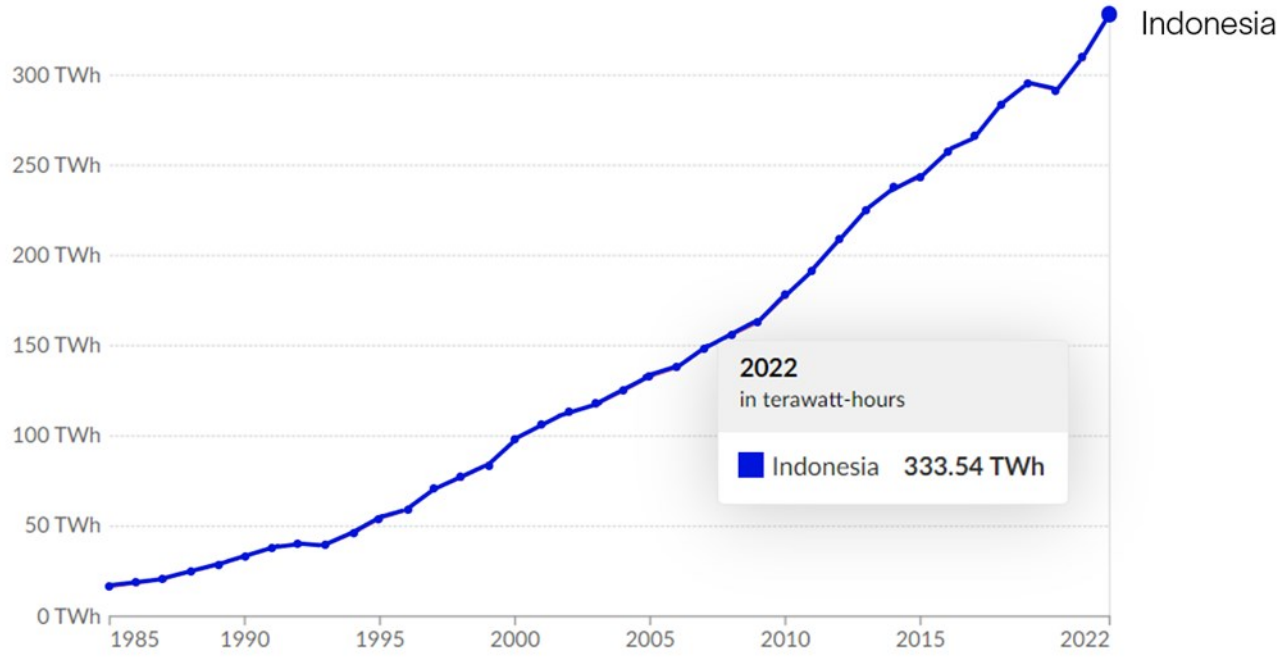

Figure 6 Indonesia's electricity consumption (modified from Ourworldindata, 2024).

CONCLUSION

The ongoing government drilling by geological agency were planned to be conducted in 20 geothermal areas from 2021 to 2024. From the 20 geothermal areas, eight GWAs have been surveyed, and two have been drilled. The program itself took a total of four years to accommodate two GWAs to be tendered, with possible upcoming efforts that also time consuming. Similarly, the GEUDP program has not been reported moving forward with any progress. The current government effort might be relevant to reduce the electricity tariff (depend on the exploration drilling result), but these programs are still not aligned with the geothermal development acceleration target.

An optimistic target requires every available resource to thrive, developing the geothermal concept, human resources, and technology, as well as supported by government regulation. The government of Indonesia should expand its program to accommodate every geothermal developer that has been and will contribute more to geothermal power generation, not only allocating the grants and loans to exploration activities but also to the currently producing geothermal fields. As important, regulating geothermal electricity tariffs and enabling an open competitive electricity market would enable chances of a better geothermal investment atmosphere in Indonesia.

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