Performance of geothermal power generation for the past five years in Indonesia to achieve renewable generation target 2025: a critical review

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Abstract. The geothermal power generation (GPG) development has strategic importance in achieving renewable-based energy security, climate mitigation, and sustainable development. As a country with abundant geothermal resources, Indonesia has taken breakthrough policies in developing GPG to improve the renewable energy mix in 2025 and beyond. The government's breakthrough policies to promote generation development have significantly contributed to the progress already made in this field. Nevertheless, it is still insufficient to meet the target set by 2025. This article critically reviews crucial issues the breakthrough policies for the GPG development and their impact on achieving the target of the renewable energy mix in Indonesia, such as problems with policy framework instrument, institutional aspect, fiscal policy, or better social opposition management GPG projects. In addition to identifying the consequent disadvantages, this review also presents improvement recommendations.

1. Introduction
Enactment of Law No. 21/2014 replacing Law No. 27/2003 on Geothermal has strategic importance and reflects the strong political will in developing renewable energy (RE) sources. The strategic significance and strong political will reflect at least for the following reasons. First, Indonesia has enormous geothermal potential (28,617 MW) or 40% of the world's geothermal reserves [1]. The government of Indonesia (GoI) had set a target of developing the GPG to 6,000 MW in 2020. Through the new policy, the target even reached 7,000 MW in 2025 [2]. Second, to encourage economic growth and energy security goals, the government has also launched a program to accelerate the development of 35,000 MW power plants in 2019, mostly sourced from RE. Third, geothermal exploitation is no longer part of mining activities. One of the crucial issues in geothermal development relates to licensing in forest areas based on Law No. 41/1999 on Forestry and Law No. 5/1990 on Biodiversity and its Ecosystems. Both laws stipulate that GPG developers can only carry out the use of production and protection forests. Thus, they can not exploit geothermal potential in conservation forest areas, which account for 21% of the forest coverage [3].

Using forest areas for GPG development certainly relates to deforestation and forest degradation, illegal logging, and tenurial conflicts [4]. In 2016-2017, for example, deforestation rates both inside and outside the forest areas are still relatively high, reaching 480,000 hectares/year. Deforestation rates in forest areas reached 297,183.2 hectares per year, and 182,827.5 hectares in non-forest areas per year [5]. Also, serious challenges include the issue of forest fires. The 2015 forest and land fires and the establishment of the Peat Restoration Agency reflect the government's severe response to address the
issue [6]. At the UNFCCC Conference of Parties (COP21) in Paris, Indonesia embarked on reducing national emissions independently to 29% or 41% with international support in 2030. However, in the context of GPG development as climate mitigation efforts, the breakthrough measures in the above-mentioned legal framework have not yet encouraged optimal GPG development. Until 2019, the GPGs development only reached 1,900 MW or 4.6% of its potential. This performance is certainly far below the target set. Based on the National Energy General Plan (RUEN) policy, the national GPP development target reached 3,195 MW in 2019. Under a business-as-usual scenario, the target of 7,200 MW of the GPG will undoubtedly be challenging to achieve in 2025. With economically more expensive and declining fossil energy sources, breakthrough policies in the GPG development will become the right choice for energy security, climate change mitigation, and sustainable development in the future.

The political breakthrough for GPG development reflects the political will to make geothermal energy sources a viable option for renewable electricity generation, climate mitigation, and sustainable development. However, the non-optimal performance of GPG development in the past five years indicates that breakthrough policies have not contributed to the development of renewable generation. This paper will review the breakthrough policies' performance from the perspective of the state's political role. This study aims to look at GPG development's performance in 2015-2019 and what factors have affected this performance.

2. Method
This article critically reviews crucial issues the breakthrough policies for the GPG development for the past five years in 2015-2019 time span, and their impact on achieving the target of the renewable energy mix in Indonesia, such as problems with policy framework instrument, institutional aspect, fiscal policy, or better social opposition management GPG projects. In addition to identifying the consequent disadvantages for achieving the target of GPG development and the renewable energy mix the government has to pursue in 2025 and beyond.

3. Results and Discussions
3.1. General framework of Indonesia's geothermal energy law and policy
The government has retrospectively issued a specific legal framework for geothermal development issued through Law No. 27/2003 on Geothermal Energy. To strengthen the GPG development, the government issued a National Energy Policy (NEP) and later strengthened its legality basis through Government Regulation No. 79/2014. Under NEP, the government sets RE's contribution to the national energy mix at 23% in 2025 or 31% in 2050. To implement this NEP, through Presidential Decree No. 22/2017 on RUEN, the government sets RUEN and the Regional Energy General Plan (RUED). Under this policy, from the national RE mix's target, the contribution of GPG is 7.2 GW or 15.93% of the electricity generation target of 45.2 GW or 25.26% of the national geothermal potential in 2025. This target has been adopted in the General Plan on National Electricity (RUKN) and the Electricity Supply Business Plan (RUPTL), most recently with RUKN 2018-2037 and RUPTL 2019-2028.

Based on Law No. 27/2003, geothermal development politics is still a part of the mining regime. Thus, following the forestry law provisions, investors can not carry out GPG development in conservation forests. Besides, geothermal development licensing adheres to decentralization, so licensing is carried out at the district/city level. The enactment of Law No. 21/2014 replacing Law 27/2003 can be a breakthrough at least for the following reasons: (1) geothermal exploitation is no longer part of the mining regime, and therefore exploitation can be carried out in conservation forests; (2) the centralization of geothermal business licensing; and (3) business-friendly geothermal economic pricing.

Three breakthrough legal frameworks are directly related to the development of GPG. First, Law No. 30/2007 on Energy. Through this law, several essential institutions become the basis for the GPG development legally and politically, namely National Energy Council (NEC), NEP, energy conversion policies, and the direction of developing GPG, and RE in general, namely RUEN/RUED. Those breakthrough legal frameworks reflect several affirmations, namely the priority of providing energy by the government and regional governments for underdeveloped areas, remote areas, and rural areas with
local energy sources, particularly renewable energy sources (Art. 20 paragraph (2)). The second affirmation is related to the government's obligation to increase renewable energy (Art. 20 section (4)). Finally, the energy provision from renewable energy sources by business entities, permanent establishments, and individuals can obtain facilities and incentives from the government for a while the economic value is achieved (Article 20 paragraph (5)). Facilities here can refer to simplify licensing procedures and concession requirements, while incentives can be in the form of capital, tax, and fiscal assistance (Expl. of Art. 20 (5)). The same in terms of energy utilization. The first affirmation is related to the political commitment to the principle of energy utilization to consider the balance of technological, socio-economic, and environmental conservation aspects (Art. 21 (1) letter b). Second, the affirmation regarding the government's obligation to increase RE's use (Article 21 (2)). Third, room for convenience and incentives for business entities to utilize energy from RE sources for a particular time until their economic value is achieved (Article 21 (3)). Based on the Energy Law regime, the implementation of new and RE physical activities is also strengthened through a technical ministerial decree. All these legal frameworks must, of course, enhance the environment protection law (Law No. 32/2009), the Paris Agreement ratification (Law No. 16/2016), and forestry (Law No. 41/1999).

Second, electricity law provides an adequate basis for geothermal development. Several operational policies for the generation that facilitate the GPG development are namely KUPTL [7], acceleration of national strategic projects [8], and acceleration of electricity infrastructure [9]. Through several laws and operational policies related to the institutional existence of RUPTL, RUKN, and the main points in the power purchase agreement [10], and RE resources for the electricity supply [11].

Another legal framework that is macro is the Geothermal Law. Geothermal Law No. 21/2014 is the turning point in the development of geothermal. Some arrangements have provided a relatively comprehensive basis. One of the breakthroughs in GPG development is no longer the mining regime. Consequently, GPG development can be done in conservation forests. Other breakthroughs relate to the establishment of the Geothermal Fund Facility [12], strengthening the geothermal assignment mechanism [13], and strengthening the geothermal data and information [14]. The provision of space for the utilization of geothermal potential in conservation forest areas is a breakthrough value because 18% of the geothermal potential is in the conservation forest area. In its development, based on this rule, another breakthrough concerns the arrangement of government funding space for exploration and a risk-sharing regime if exploration activities by a developer fail to meet its economic value. This breakthrough is significant because the exploration stage is the critical stage in developing GPG, which is non-quick yielding in nature, and there is no cost-recovery mechanism. Of course, laws must comply with and mutually reinforce regulations regarding environment protection, Paris Agreement, and forestry.

So far, the legal and policy framework regarding geothermal development is sufficient. The political will of the government to manage and oversee its implementation is essential. What are the things that the government needs to do to measure its political-will? First, ensure that the government meets or refines the legal and regulatory framework. Second, the government is overseeing the implementation of GPG development policies and RE generation in general. Third, ensure breakthrough support institutions. For example, the Renewable Portfolio Standard (RPS), risk-sharing mechanisms in the exploration stage, and government financing support are some of the issues. The data show that the increase in more than half of RE generation in the United States is due to the RPS policy. To strengthen the government's political will, several laws and regulations related to geothermal development, such as the Law on Environment, Forestry, and the Paris Agreement's ratification, also need to be strengthened. Indonesia has developed a series of five-year, medium, and long-term plans that set out guidelines and objectives for promoting geothermal development. These national plans enjoy particular positions in geothermal energy development and policy and sometimes even produce more efficient implementation effects than the laws. Thus far, Indonesia has formed a comprehensive renewable energy legal system based on the Geothermal Law and supplemented by other related laws and policies (Figure 1).
3.2. Indonesia’s GPG development

Several factors have contributed to the weak performance of the GPG development ranging from the legal framework, government little investment incentives to low private investment issues. The amendment to Law No. 27/2003 was considered essential breakthrough in GPG development [15]. Besides, the amendment was also conducive to enhancing the 10,000 MW I and II electricity generation crash program. Besides achieving this goal, through the RUEN policy the government revised its GPG development target from 9,500 MW to 7,241.5 MW [16]. Of course, these efforts support the implementation of the Paris Agreement, ratified through Law No. 16/2016. Under this ratification, Indonesia reiterates its global commitment to climate mitigation through RE development [17].

Some points of policy breakthroughs based on the Law No. 21/2014 replacing the Law No. 27/2003 are as follows. Firstly, geothermal sources’ centralization for electricity (Art. 5 (1) point b). This centralization is intended to ensure that the utilization of geothermal sources can run optimally due to the nature of its development, which is very risky, high cost, and with a slow return on capital (non-quick yielding). Through this centralization, the government can resolve debottlenecking issues in GPG.
development in several aspects of financing, licensing, incentives, land provision, and any other issues. For instance, as a type of business that is high risk and with unfavorable geographical conditions, the GPG development in remote areas barely needs significant state investments. Efforts to provide electricity in the remote islands and outermost areas are increasingly demanding. The new legal framework reinforces the government's role in the exploration stage. This is directed to encourage private investors and state-owned enterprises to exploit geothermal sources in areas that are not in demand by private sectors. Secondly, the change in the geothermal utilization regime is no longer part of the mining activities. Based on the provision of the Law No. 41/1999 on Forestry, mining activities can only be done in production and protected forests (Art. 38). In GPG development, this provision becomes an obstacle in the GPG development in conservation forests. Of 28.6 GW of the Indonesian geothermal potential, 13% of it is in the production forests, 23% in the protected forests, and 21% in conservation forests [18]. Thirdly, the determination of geothermal prices according to economic prices. The low incentive for geothermal developers in the form of the selling price of steam and electricity generated from geothermal was one of the GPG development problems. Through a feed-in tariff policy, the economy's price level closing is considered useful to encourage private investment in GPP development.

Table 1 Installed Capacity of GPG 2015-2019 (MEMR, 2019)

| No. | GPP         | Installed Capacity (MW) |
|-----|-------------|-------------------------|
|     |             | 2015 | 2016 | 2017 | 2018 | 2019 |
| 1.  | Kamojang    | 235  | 235  | 235  | 235  | 235  |
| 2.  | Lahendong   | 80   | 120  | 120  | 120  | 120  |
| 3.  | Sibayak     | 12   | 12   | 12   | 12   | 12   |
| 4.  | Gn. Salak   | 377  | 377  | 377  | 377  | 377  |
| 5.  | Darajat     | 270  | 270  | 270  | 270  | 270  |
| 6.  | Wayang Windu| 227  | 227  | 227  | 227  | 227  |
| 7.  | Dieng       | 60   | 60   | 60   | 60   | 60   |
| 8.  | Ulubelu     | 110  | 165  | 220  | 220  | 220  |
| 9.  | Ulumbu      | 10   | 10   | 10   | 10   | 10   |
| 10. | Mataloko    | 2.5  | 2.5  | 2.5  | 2.5  | 2.5  |
| 11. | Patuha      | 55   | 55   | 55   | 55   | 55   |
| 12. | Sarulla     | -    | 110  | 220  | 330  | 330  |
| 13. | Karaha      | -    | -    | -    | 30   | 30   |
| 14. | Sorik Marapi| -    | -    | -    | -    | 50*  |
| 15. | Lumut Balai I| -  | -    | -    | -    | 55*  |
| 16. | Sokoria     | -    | -    | -    | -    | 5*   |
|     | Total       | 1,438.5 | 1,643.5 | 1,808.5 | 1,948.5 | 2,058.5 |

*Postponed COD due to grid construction delay in the 2nd Sem. of 2018

Nevertheless, the policy breakthrough above has not been able to encourage the development of GPG under the targets set. Data indicated that up to the first semester of 2019, the installed capacity of GPG has only reached 2,058.5 MW or 7.2% of geothermal potential. Calculated from the annual average performance in the 2006-2014 period, it has reached 200% for the past five years (2015-2019). However,
this performance is still far from the target, which was targeted at 3,195 MW in 2019 [19]. In other words, GPP development's performance in 2014-2019 only reached 655 MW, or until the first semester of 2019, the average increase in GPP development was only 131 MW per year (Table 2).

Under the business-as-usual condition and unless there is an extraordinary approach in the institutional, legal framework and policies, and funding aspects of the GPG development, even in an optimistic scenario, the addition of GPG generation will only reach around 800 MW until 2025 or 2,900 MW in total. This scenario implies at least three important things, namely (1) until 2025, the target of GPP development under the RUEN policy will certainly not be achieved so that the power generation target of the renewable source in 2025 will be disrupted (45 GW); (2) the need for an extraordinary approach to encourage the performance of GPP development; and (3) the government needs to revise the GPP development target or RE source contribution in general in the national energy mix as a politically face-saving strategy. Analytically, this view is in line with the view of bounded rationality [20].

The following analysis will offer several alternatives to encourage improvement in GPP development performance either through legal and policy framework instrument, institutional aspect, fiscal policy, or better social opposition management GPG projects. Through the legal and policy framework, normatively from a political perspective, the issue of weak development of GPP must be overcome by the more stringent government political will to set transformative and decisive policies. For example, in this context, completing a legal umbrella, which specifically regulates the development of renewable source, and any other improvement measures towards the existing legal and policy frameworks are needed. Of course, the improvement and completion of the legal and policy framework must be able to bring a breakthrough and affirmative efforts, especially regarding the affirmation of the state's 'responsibility' as a single buyer of the RE output and the RE market provider.

Besides, the determination of the more potent political will is also needed to thoroughly implement Indonesia's global emission reduction commitment based on the Paris Agreement. To be seen from the perspective of co-evolutive systems of the national energy transition, political initiatives to take a breakthrough policy in the GPG development can also taken by policy isomorphism [21]. Indonesia's global commitment to reduce its national emissions reflects this aspect. Under this commitment, Indonesia is committed to developing 19.6% of renewable power plants equivalent to 7.4 GW under the RUPTL 2019-2028. Thus, with the enormous potential of geothermal potential, Indonesia takes the stake to enable GPP development to reduce emissions reduction in the energy sector. Therefore, encouragement of or strengthening the political will to develop GPG is a necessity. For instance, to strengthen policy isomorphism, Indonesia needs to follow the 19 countries' measures that expressly affirmed their commitment to making the GPG as a climate mitigation tool based on the Paris Agreement to potentially quintuple the installed GPP capacity from 13.3 GW by 2015 to 63 GW by 2030 [22].

Other institutional aspects relate to the need to focus more on RE sources' management by establishing a public office directly and specifically responsible for renewable energy development. For instance, referring to the provisions of the Law No. 39/2008 on the State Ministry, if there is a workload that requires special handling, the government may appoint a deputy minister (Art. 10). By strengthening this institutional aspect, it can also encourage establishing a national energy security fund, which will be allocated for the RE development. Under the 'discursive institutionalism', institutions play a role both as a constraining structure and driving change factor [23]. Based on this perspective, the proposed establishment of a deputy minister specifically dealing with RE development and manages RE security fund, in the end, the government can also continue to impose a policy paradigm (a pattern for framing policy problems and achieving alternative solutions). Through this new institutional alternative, a 'fast' change can be possible because changes become a necessity. In contrast, in the perspective of new institutionalism, an institution can only explain aspects of continuity. In other words, under this new institutionalism analysis, an institution is more positioned as a barrier [24].

This institution also comparatively received empirical support. In India, for instance, the Ministry of New and Renewable Energy, established in 2006, was formed with a strong foundation as an effort to overcome the problem of national energy security after the twin oil shock crisis in the 1970s. For
instance, in the context of public funding, this ministry also eventually led to the establishment of the Indian Renewable Energy Development Agency, a non-bank financial institution under the ministry's administrative oversight to provide loans for RE and energy efficiency projects [25]. In the Indonesian context, the existence of state-owned company ‘PT Sarana Multi Infrastruktur’ (PT SMI) and now the Fasilitas Dana Panas Bumi scheme, a state-owned company holding state's participating interest, actually reflects the government's strong willingness to facilitate infrastructure financing, including financing for GPG development. This institutional urgency, relates to the financial costs that must be born particularly at the exploratory stage of the GPG development [26].

The case of the slow development of the Bukit Kili GPG project indicated that although the government financing has been at hand, the social opposition issue is also essential in GPG development. This case reinforces the several studies that as a source of RE, GPG development has confronted technical, socio-economic, and environmental feasibility in the long term [27]. However, especially at the beginning of its development, social opposition's issue becomes a significant obstacle. As a result, GPG development is relatively slow compared to other RE source projects globally [28]. For instance, the GPG development project in Bedugul, Tabanan, Bali Province, which had been planned since 2008 until now, has not yet been completed due to the strong social opposition. In its development, even such an opposition was taken by the regional government [29]. Therefore, strengthening political will in managing social issues is one factor that also determines GPG development's success. Strengthening the legal and policy framework, special institutions, and financial or fiscal support becomes a critical modality to ensure that social opposition can be adequately managed [30].

3.3. Problems arising from legal framework

One analysis of RE generation so far shows that the three aspects above are suspected contributing to the renewable energy generation problem so far [31]. Another perspective, efforts to accelerate the generation of RE must target three strategic aspects, reducing investment costs on the upstream side, the mandatory diversification of generation, and institutional breakthroughs or business processes. These three strategic aspects are described in several programs/policies, which require political will in their implementation. This political will include a restructuring of the legal and policy framework. Based on data and following the understanding of energy transitions, a political perspective is an essential analytical tool to unravel renewable energy generation. In other words, the acceleration program of RE generation as part of the energy transition process is more due to political factors, namely how the legal and policy framework can work well. Therefore, the government must strengthen its political will. The formal agenda for discussing the draft RE bill as the 2020 national legislation priority is a pioneer towards this political will. Of course, it does not stop at this agenda-setting political will. The arrangement's design also plays an important role [32].

3.4. Factors influencing the 2015-2019 GPG project performance

Some factors have influenced GPG generation so far, leading to the political issue of renewable energy generation. The RUKN has set an ambitious target for the generation of GPG to reach 7,000 MW by 2025. Steps to determine the politics of GPG have also been emphasized internationally, for example, the Paris Agreement. The follow-up document on the Paris Agreement results describes steps and a roadmap for reducing emissions in the energy sector through RE generation. In the 2015-2019 period, the GPG generation program per year practically only experienced an average increase of 9.43% or 155 MW per year. Overall, the average GPG generation performance is 18.94%/year from the national RE generation performance. This performance is still far below the optimal performance, which requires a minimum generation performance of 1000 MW/year within the period 2020-2025. This performance target is undoubtedly challenging to achieve, primarily since the new RE generation program's acceleration will be targetted after completing the 35 GW generation program [33].
In the energy transition perspective, the political (energy) aspect is also the root cause of the low GPG. In this perspective, the problem lies in the lack of policy monitoring. This aspect indeed becomes important when the achievement of RE generation, in general, is still far from being determined. In this perspective, there is no breakthrough way to take to increase the role of GPG. With the generation performance that has only reached 2 GW or 7.14% until 2019, the generation mix is of minimal value. With the generation achievement rate of only 155 MW per year since 2015, it is therefore this mix target needs to be reviewed. The need for this review is certainly not excessive. Three policies for accelerating generation programs that have breakthrough values, namely the 10,000 MW Phase I and II Fast-Track Program and the 35 GW generation program, which are mostly supported by GPG, have not been completed far from the set time target. From the political (energy) aspect, several derivative problems that also affect GPG generation's performance include public budget support, incentive schemes (fiscal and non-fiscal), and the purchase price of electricity by the government. The government has revised the necessary legal framework for GPG development. However, as long as the framework can not still provide room for incentives, the market's role remains not optimal.

When the price policy is still considered not meeting economic value, the nature of RE generation is still high cost, risky, and with a long rate of return [34]. For example, the Sarulla GPG, with a capacity of 330 MW, has the total project cost of up to $1.7 billion or $5.15 million per MW. Social costs also have an impact on cost pressures. Therefore, this GPG needs political 'coercion' [35]. Another derivative problem concerns the issue of incentives for developers. In this context, institutional strengthening of energy security funds can reduce investment burdens, risk sharing, especially in the exploration stage, and consider the use of a cost of recovery scheme in the exploration stage. Other incentives aspects relate to economical price issues, including compensation for PT PLN if the price is lower than the essential cost of supply [36].

Another factor concerns the policy narrative of the affirmative generation of RE. It can be voluntary or mandatory. The institutional scheme is, for example, the RPS. In Asia, several countries have implemented this policy, such as Australia, China, and Japan. At the ASEAN level, two countries have implemented or at least adapted this policy, namely the Philippines and Thailand. Of course, this policy targets generation and utility companies or even consumers to provide or use the RE minimum target from installed capacity, or electricity produced/sold. Sanction schemes can be applied for those who meet and do not meet [37]. As a reference for best practices, this scheme policy in the US has proven to have increased more than half of RE generation since the 2000s [38].

### 3.5. Efforts to optimize GPG

Efforts to optimize the performance of GPG to achieve the KEN target certainly require an extraordinary approach. Three aspects need to be given weight to political will to address weak GPG performance. First, financial support, both public and private. A breakthrough regulatory framework is needed, for example, to strengthen financing sources, fiscal and non-fiscal incentives, and specific institutions. Thus, government financing schemes such as the Geothermal Fund Facility and PT SMI schemes can

### Table 2 Indonesia’s GPG and RE Power Generation Development

| Year | GPG Installed Capacity (MW) | National RE Installed Capacity (MW) | RE Installed Capacity (%) |
|------|-----------------------------|------------------------------------|--------------------------|
| 2015 | 1,438.50                    | 8,495.81                           | 16.93                    |
| 2016 | 1,643.50                    | 8,985.42                           | 18.29                    |
| 2017 | 1,808.50                    | 9,378.95                           | 19.28                    |
| 2018 | 1,948.50                    | 9,780.53                           | 19.92                    |
| 2019 | 2,058.5                     | 10,157.00                          | 20.27                    |
be raised in budget coverage and scale. Second, the aspect of preparing an incentive regulation scheme with an increasingly competitive level and scale. The scheme also applies to government developers, for example, PT PLN and PT Pertamina. In recent years the government has prepared an incentive regulatory framework to strengthen the GPG. However, to strengthen the regulatory framework's impact, the emphasis on the incentive space needs to be raised to ensure a generation's real impact. Therefore, several aspects concerning price determination, business processes, electricity purchase and sale agreements, institutional energy security funds, and other incentives need to be continuously increased. Third, the scheme for implementing affirmative policies for RE generation, for example, the RPS scheme, both mandatory and voluntary. Several countries have made this scheme an instrument to increase the RE mix nationally and reduce the burden of energy imports, which has continued to increase starting 1999 [39]. This policy is increasingly relevant if the target is massive in the medium and long term. The mandatory use of biodiesel (Policy B-20) of 6.26 million kiloliters can save foreign exchange of around US$ 3.35 billion or IDR48.19 trillion in 2019. This reduction in imports and savings in foreign exchange will undoubtedly increase by more than half of this amount if the B-30 policy plan will be implemented immediately [40]. This mandatory policy undoubtedly had also a significant impact not only at economical but also social and environmental [41]. Of course, this does not mean that efforts can be more focused not only on the context of the legal, institutional and economic framework but also technical constraints and other social issues [42]. At technical constraints for instance, include the need to mainstream the rising role of engineering in achieving sustainability in the GPG developments. For this reason, engineering education should refocus its efforts on training engineers to be active agents of sustainability [43].

3.6. The synergy of legal framework and policy

Indonesia has made significant progress in terms of the legal system in exploiting geothermal sources as specific parts to improve its renewable energy legal system. The draft RE bill, which is in the agenda-setting process at the parliament, should specifically regulate the issues of renewable energy development to ensure it can reinforce and meet the practical needs of the geothermal deployment. A main law in the field of energy, the Energy Law, can precisely facilitate the development of geothermal deployment. As the GPG development provisions still overlap with any other different laws, ministerial regulations, local government regulations, and any other geothermal implementing regulations, they can be synergically implemented. The continuity and consistency of related laws and policies. GPG deployment is now at a stage of rapid development. Therefore, it is necessary to timely track the implementation of geothermal laws and their implementing regulations and make requisite revisions accordingly.

3.7. Financial support

The rapid deployment of GPG is inseparable from adequate funding. Geothermal energy has a relatively high cost due to its vast capital needs, high technical requirements, and non-quick yielding. It thus cannot compete with traditional energy in the early phases. As a result, its deployment needs various financial supports such as government subsidies, tax relief, mandatory/voluntary market quotas, guaranteed purchases, and other supportive measures. The subsidy issue for GPG is still challenging. An effective method would be to reinforce a national energy security fund or specifically the Geothermal Fund Facility to fill the gap. It needs to be noted that financial supports must be subject to national conditions and the market environment. Inappropriate subsidies might lead to excessive market distortion. The purpose of subsidies is not just to assist geothermal industries to survive and make profits but also the ultimate aim is to improve their market competitiveness to get rid of subsidies [44].

4. Conclusion

The use of geothermal energy for GPG development has a strategic mission to achieve national energy security from RE sources. The national GPG development target is still not optimal, so that the GPG development target set by the RUEN policy will be certainly difficult to achieve. Positioning the GPG
development policy as a national energy transition effort that is determined by the process of the co-evolutive system of energy flows and markets, technologies, and energy-related policies, the role of state becomes an important variable. The government can take more roles to provide legal and policy framework, institution, fiscal, and social opposition management. The government shall complete a more affirmative and decisive legal framework to encourage GPGP development’s performance by completing the legal framework addressing the development of the RE. The fulfillment of derivative regulations needed to ensure the government is a factor of production and market creators. To ensure the implementation of the legal framework and several related policies, the institutional aspect of managing GPG development is also essential. Thus, efforts to mobilize financial support and the issue of social opposition become easier to manage.

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