

## Geothermal Role as a Renewable Energy in Energy Mix Indonesia During and Post COVID-19 Pandemic

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### ABSTRACT

The energy consumption in the world, especially in Indonesia was increasing year by year. The energy consumption of electricity has a similar trend with the general energy consumption trend. Final electricity consumption from 2018 to 2019 increase 1.35% with a 16.82% share of final energy consumption by types. In Indonesia, coal and oil energy dominated the electricity sector in Indoensia which will create CO2 emission and have a direct impact on the environment. Renewable energy is a solution to this problem, with the decrease of ratio fossil fuel in the energy mix Indonesia is expected to reduce CO2 emission in Indonesia. The rationale of each sector energy in energy mix Indonesia divided into several percentages, there are at least 23% for renewables energy, 25% for oil energy (petroleum energy), and the largest portion in this energy mix is coal in 30% with natural gas energy in 22% of primary energy.

2020 is a tough year for a developed country to achieve the target of national capacity for energy management and integrated energy for every sector and the nation's energy independence. When pandemic COVID-19 spread in all countries in this world, many sectors are hampered, one of them is the energy sector. Covid-19 can attack and disrupt the energy needs in the world by directly affected on the production and demand of energy. The geothermal industry is also affected by this pandemic, the relation between the economic sector with the weakness of the rupiah case supported the challenge of geothermal development in Indonesia. The implementation of a large-scale social restriction or PSBB in Indonesia definitely affects the economic activity. This hampered the mobilization process of a supply chain in field projects and the health protocol rules that must be applied in every area lead the labor productivity of the project decreases.

This Pandemic COVID-19 adds to the challenges that must be faced by the Government of Indonesia (GOI), Investor and Developer. The target of 23% of renewable energy in energy mix Indonesia must be accomplished in 2025, and as a part of renewable energy, the geothermal industry is expected to be able to help achieve these targets with an installed capacity of 7.2 GW but at the end of 2019, the installed capacity of a geothermal power plant is 2.13 GW, this data shows that the amount of installed capacity in 2019 still far from the expected target. By study literature and the author's insight into the condition in a geothermal industry with a pandemic COVID-19 situation right now, this paper will explain the impact of the pandemic on the geothermal industry, as well as recommendations that are expected to be implemented after this pandemic end to continue to achieve the target of Indonesia's energy mix

### 1. INTRODUCTION

#### 1.1 Background of Energy Mix in Indonesia

Energy is the one important sector that supports the economic growth of the country due to its role as a production input in various sectors. Indonesia has significant energy resources, with 23.9 GW geothermal energy potential in Indonesia. According to *The Handbook of Energy Economics Statistic (2019)*, energy consumption in each sector was increasing year by year, especially in the electricity sector. Final electricity consumption from 2018 to 2019 increase 1.35% with a 16.82% share of final energy consumption by types.

Girianna (2013) states that the government was confronted with two policies: 1) least-cost policy (choosing the cheapest energy), and 2) environmental mitigation policy. The least-cost policy was eventually chosen to reduce electricity production costs by using coal. Coal and oil energy dominated Indonesia's electricity sector which has a direct impact on the environmental aspect. Coal and energy produced CO2 emissions that will be affected by climate change in the world. The emission of CO2 that was produced by Indonesia's power plant 2020 not yet available, however, based on (Aissa N, Hartono D. 2016) CO2 emission in the electricity sector increased significantly since 1971 and reached 149.62 million tons in 2010. So far, the main CO2 emitters such as power generation, traffic operations, and industry mainly by burning fossil fuel. Any change to low emission technologies in these sectors can thus counteract global warming. Increasing CO2 can be mitigating by replacing fossil fuels (coal & oil energy) with renewable energy, such as geothermal energy.

#### 1.2 Energy Mix Condition in Indonesia

Based on government law No 30, 2007 which discussed energy that the management of energy must consider several things such as meet the Indonesian society needs, the access of energy equal in all areas, achieve optimal economic value, ensure the availability of energy for the future, and achieve the national capacity in energy management and integrated energy management for every sector.

Indonesia has a large potential for renewable energy, but not all of the potential was utilized to support sustainable energy in Indonesia. Currently, the role of fossil energy is still quite large compare with coal, gas, and renewable energy. In January 2019, Minister of Energy

and Mineral Resources Ignasius Jonan reiterated that the government remains committed to increasing the use of renewable energy in the national energy mix, in line with their commitment during the 21st Conference of the Parties to reduce GHG emissions (the Republic of Indonesia, 2016)

The target of primary energy supply and utilization in 2025 is 400 MTOE and in 2050 is 1,000 MTOE, while the energy mix for each sector energy is at least 23% for renewables energy, 25% for oil energy (petroleum energy), and the largest portion in this energy mix is coal in 30% with natural gas energy in 22% of primary energy.

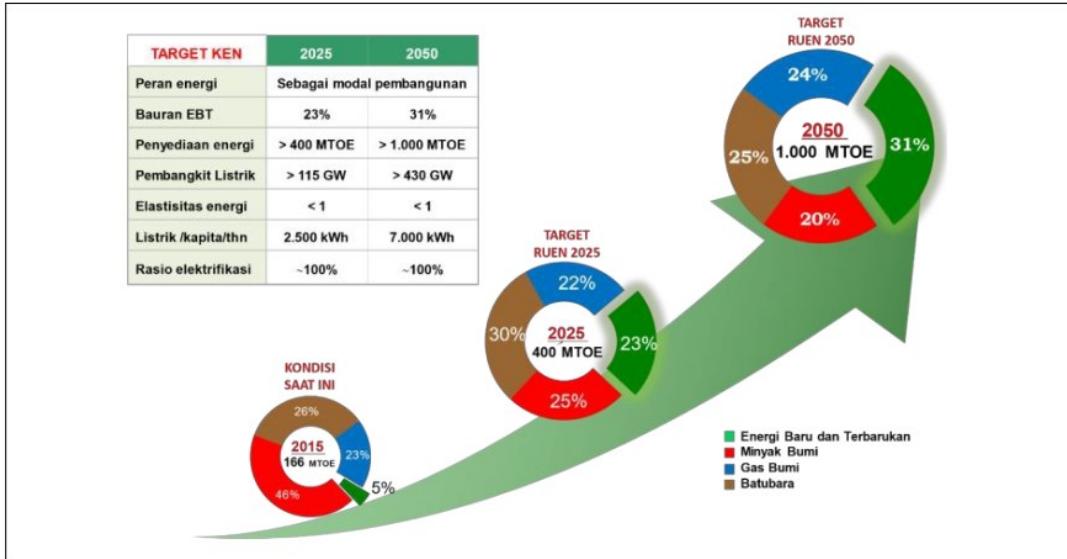


Figure 1. The Target of Energy Mix in Indonesia based on KEN (2014)

The composition of 23% renewable energy is 10% for bioenergy, 7% for geothermal, 3% for hydropower, and 3% for other renewable energy. In 2020, there is a challenge to government Indonesia for achieving the goal of Energy Mix in 2025 becomes complicated because of the covid-19 pandemic, and before pandemic hitting Indonesia, the lack of transparency and availability of good quality data to ensure robust planning and monitoring are even greater challenges to overcome. The fundamental political challenge for the deal with renewable energy development was need to meet the 3 objectives the need to keep traffic lows, the need to keep subsidy costs lows, the need to meet the renewable energy targets (IISD, 2019). The pandemic situations that damage and disrupt the country's economy, the three objectives above are increasingly difficult to achieve by the government.

## 2. GEOTHERMAL ENERGY IN RENEWABLE ENERGY PORTION OF ENERGY MIX INDONESIA

Indonesia is a country that is endowed with abundant geothermal resources. Indonesia is geologically located in three majors of tectonic plates, the Eurasian plates, and the indo-australian pacific, so is known as the ring of fire (Suharmanto, et al. (2015)). Indonesia has the largest geothermal potential in the world, reaching up to 40% of world reserves or about 27,000 MW to 29,000 MW. However, Setiawan, Hadi (2014) states the development of geothermal currently is only about 4.2% (1,226 MW) of the existing reserves. Based on DITJEN EBTKE, the capacity geothermal energy that was installed in 2019 is 2.1 GW from potential sources at 23.9 GW.

Geothermal energy is a part of “greenhouse energy” because the environmental impacts of geothermal energy depend on how geothermal energy is used for, or how it is converted to useful energy. Direct use applications and geothermal heat pumps have almost no negative effects on the environment. They can have a positive effect by reducing the use of energy sources that may have negative effects on the environment. Geothermal power plants use their steam from a reservoir of hot water in the subsurface to produce electricity, which means geothermal activity does not burn fuel to generate electricity, but it may release small amounts of sulfur dioxide and carbon dioxide. Geothermal power plants emit 97% less acid rain-causing sulfur compounds and about 99% less carbon dioxide than fossil fuel power plants of similar size (EIA, 2020). Most of the geothermal power plants re-inject the geothermal brine or water that they use back into the earth. This recycling process is called renewable energy, because ideally the fluids that were re-injected to reservoirs will charge the loss of fluid in the reservoir production, and its process can reduce emissions from the geothermal power plants.

Based on resources of geothermal energy in Indonesia and demand for electricity especially for remote areas in Indonesia, this is expected to play an important sector in reducing gas emission problems to become Indonesia's Greenhouse Gas Emission. As a clean and renewable energy source that provides power continuously, geothermal can reduce the country's dependence on coal-fired power and other fossil fuels. If geothermal resources can be accessed easily, costs are competitive with coal and natural gas (World Bank, 2019). Geothermal energy in Indonesia has the rational reasons to maximally developed, Ditjen EBTKE report states several things that can be convincing the investor in developing geothermal project in Indonesia, such as:

## A Huge Geothermal Resource in Indonesia

23.9 GW potential resources (Badan Geologi, 2019) and the installed capacity approximately at 2.1 GW. The utilization of geothermal energy can improve the electricity needs of the local area because it can't be distributed to another area

### More Reliable than Fossil Fuel

The time operation of PLTP can be more than 30 years, the categorized as renewable energy, doesn't need fossil fuel to produce the electricity, high availability factor (90-95%)

### Indonesian Greenhouse Emissions

Has a minimal impact on the environment, CO2 emission approximately on 75 gram/kWh (used Indonesian Field Reference), and much lower than the emissions from fossil fuel, natural gas, or coal.

## **3. GEOTHERMAL INDUSTRY CONDITION IN ENERGY MIX INDONESIA**

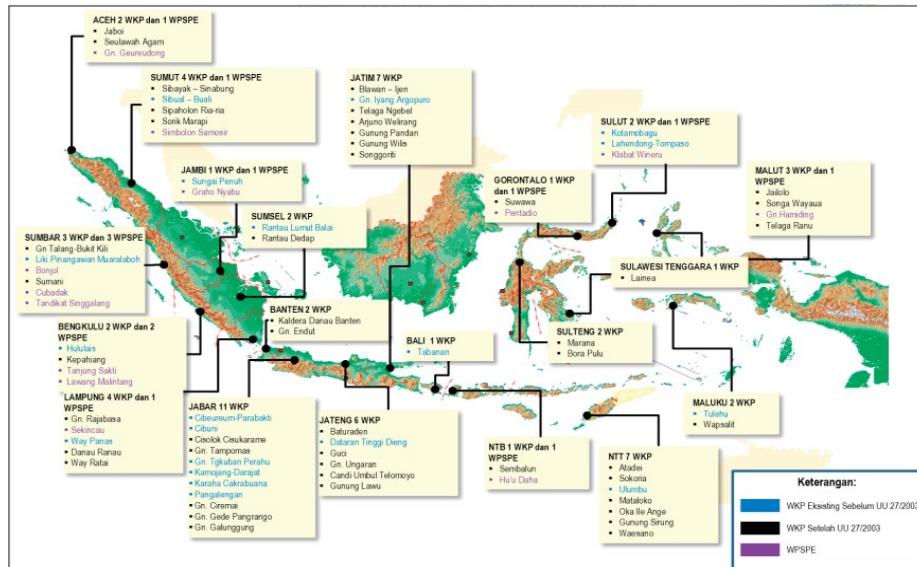
### **3.1 Target and Facts of Geothermal Industry in Energy Mix Indonesia**

Based on the Book of Energy Mix Indonesia 2020, the government targeting the renewables energy portion in energy mix scheme 2025 in 23% with geothermal development for electric power is projected at 7.2 GW in 2025, and 17.6 GW in 2050, or 59% of the geothermal potential on 29.5 GW to support the electricity needs. The potential of geothermal in Indonesia can increase along with the project of exploration preliminary study and discovery of new resources. From (RUEN, 2017), the plan for developing renewable energy projects for each sector was projected and consists of a committed project and potential project. The committed project is the power plant construction from renewable energy that was planned by the government until 2025. However, this planned was not meet the target capacity in 2025 of 45.2 GW and 2050 of 167.7 GW. To achieve this target, an additional renewable energy development project will be created accordingly to prospect the future renewable energy development opportunities.

**Table 1. The Plan for Distribution of Renewable Energy Powerplant (Geothermal) in 2025 – 2050:**

Energy	Committed Project (MW)			Potential Project (MW)		
	2015	2025	2050	2015	2025	2050
<b>Geothermal</b>	1,438.5	7,241.5	7,238.5	1,438.5	7,241.5	17,546

Geothermal energy is one of the most important sectors to support renewable energy portion in energy mix Indonesia. At the end of 2019, the installed capacity of a geothermal power plant is 2.13 GW, this data shows that the amount of installed capacity in 2019 still far from the expected target to reach 7.2 GW at 2025, the investment still needed for additional electricity from PLTP of approximately at 5.1 GW. The development of the geothermal project has contributed to generating electricity up to 13.979 GWh in 2019 or equivalent to 100.16 million tons of steam production.



**Figure 2. The Map of Geothermal Working Areas in Indonesia**

The distribution of geothermal working area in Indonesia in 2014-2019 shown in the figure above, beside the distribution of geothermal working areas, in 2014 – 2019, the details of PLTP Commercial Operation Date (COD) with a total 605 MW consist of:

The total is 60 MW in 2014

PLTP Patuhan Unit 1 (55 MW) by PT. Geo Dipa Energy & PLTP Ulumbu Unit 3 & 4 (5 MW) by PT. PLN (Persero)

The total in 2015 is 35 MW

PLTP Kamojang Unit 5 (35 MW) by Pertamina Geothermal Energy

The total in 2016 is 205 MW

PLTP Sarulla Unit 1 (110 MW) by Sarulla Operation Limited, PLTP Lahendong Unit 5 & 6 (40 MW) by PT. Pertamina Geothermal Energy, & PLTP Ulubelu Unit 3 (55 MW) by PT. Pertamina Geothermal Energy

Total in 2017 is 165 MW

PLTP Ulubelu Unit 4 (55 MW) by PT. Pertamina Geothermal Energy & PLTP Sarulla Unit 2 (110 MW) by Sarulla Operation Limited

Total in 2018 is 140 MW

PLTP Sarulla Unit 2 (110 MW) by Sarulla Operation Limited & PLTP Karaha Unit 1 (30 MW) by PT. Pertamina Geothermal Energy

Total in 2019 is 182.4 MW

PLTP Lumut Balai 1 (55 MW) by PT. Pertamina Geothermal Energy, PLTP Sorik Marapi Unit 1 (42.4 MW) by PT. Sorik Marapi Geothermal Power, & PLTP Muara Laboh Unit 1 (85 MW) by PT. Supreme Energy Muara Laboh

The target that was planned by Indonesian Government for generating capacity in geothermal sector actually almost impossible to achieve the target in 2025. Based on *Energy Mix Indonesia Books, 2020* this year, the installed capacity of geothermal energy must be reach 3,1 GW by 2020. However, the data 2020 is not available yet at ESDM Journal but based on the ESDM website in 2020 the installed capacity still at 2,1 GW. There is no additional capacity of geothermal in 2020, because the project is delayed until 3 months so that this project will be shifted to 2021.

**Table 2. Target and Realization of Geothermal Industry 2015 – 2019**

No	Work Indicator		2015	2016	2017	2018	2019
<b>Strategic Target: Increase the investment of renewable energy and conservation energy subsector</b>							
1	Geothermal working areas	Target	5	8	8	5	5
		Realization	5	8	10	5	6
		% achievement	100	100	125	100	120
2	Investation (Miliar US\$)	Target	0.94	0.96	1.104	1.21	1.23
		Realization	0.876	1.13	1.152	1.21	0.83
		% achievement	93.24	117	104.34	100	67.48
<b>Strategi Target: Increasing of energy supply capability</b>							
3	Geothermal Steam (billion ton)	Target	71.46	73.8	86.73	97.84	103.8
		Realization	74.26	79.7	92.11	101.47	100.16
		% achievement	104	108	106.21	103.7	96.49
4	Total Installed Capacity (MW)	Target	1,438.5	1,657.5	1,858.5	2,058.5	2,128.5
		Realization	1,438.5	1,643.5	1,808.5	1,948.5	2,130.7
		% achievement	100	99,15	97,31	95	100,1%

Based on data from ***The Strategic Planning Books EBTKE 2020-2024 (2020)***, the geothermal targets and the achievement will be listed in the table above (only for geothermal energy). The data from 2015-2019, in 2020 it can be sure that there is no additional installed capacity, and it will be shifted on 2021.

### **3.2 The Differences in Target and Facts until 2020**

In 2020, the government, investor, and developer of geothermal projects faced a huge challenge because of this pandemic COVID-19. Based on information from ESDM website, Mrs. Ida as Director of EBTKE ESDM Indonesia states that in COVID-19 condition give challenges which were different with the challenges usually, this will be discussed in the next chapter. Before pandemic COVID-19 hit the world, there were any challenges in Indonesia's geothermal project, one of them is about the feasibility of the project economic and electricity tariff for Indonesian society. In order to achieve the 3 objectives of geothermal energy development, the tariff of geothermal electricity must be equal or quite different with electricity from coal.

Based on ***The Strategic Planning Books EBTKE 2020-2024 (2020)***, there are several challenges in developing PLTP in Indonesia, such as:

#### The Prospect Area is in a Conservation Forest

Some of identified geothermal area prospects in the zone of conservation forest that cannot be developed, in 2019 ESDM ministry and LHK ministry discussing zoning arrangements in order to the geothermal prospect in area conservation forest can be utilized optimally.

Besides the zoning issues, the conservation forest in Sumatra has been appointed as World Heritage by UNESCO known as Tropical Rainforest Heritage of Sumatera (TRHS), so the government still discuss geothermal development project in TRHS area which can still be carried out of the UNESCO parameter to maintain the Outstanding Universal Values for this area (natural beauty, habitat sustainability & flora fauna conservation)

#### The Risk of Geothermal Exploration & Development

Geothermal energy development has several risks at each development phase, the higher the development phase the lower its risk. In the early exploration of geothermal energy, the subsurface uncertainty has a high risk, however, at the same time, the investor and developer must be paid a high cost for exploration drilling

#### Cost efficiency

The magnitude of the risk of developing a geothermal energy project can affect the cost of generating electricity for a PLTP project. The certainty of funding and an electric buyer from PLN can reduce the risk of geothermal development project so that the return/income can afford the economic feasibility of the project. In general, a business entity expects the IRR value of 16% but with the certainty of project funding and buyer, the IRR can be reduced to 10-12 %. Also, the availability of high qualities data will reduce the uncertainty of the reserve.

#### Social Issues

The social issues that might be faced in geothermal development are society's refusal to geothermal development. Those society's refusal stems from several reasons, first is society's refusal due to environmental issues, the society worried the water availability and the environment would be disrupted caused by the geothermal development. The second society's refusal is ancestral or ulayat land, the local communities thought that the geothermal development in their land would stain their land. Another society's refusal is customs issues, the society thought that geothermal development would interfere with their customs and culture.

#### Geothermal Project Funding

The challenge in the exploration phase, in general, is caused by its type of funding, the equity funding generally applied for geothermal exploration project, that is resulting in termination of funding capability to fund the exploration project especially in drilling project that requires high cost. The development phase of geothermal energy is divided into three main phases, they are explorations, exploitation and operations. The risk of geothermal development in exploration phase is quite high that terminates the financial institutions both local and international to fund the project. The geothermal development project must use the owner's equity to execute the project phase development.

The challenges above based on Strategy Plan EBTKE 2020 which means that geothermal targets are not achieved is an impact from pandemic COVID-19, and from the downstream and upstream sector.

#### **4. COVID-19 PANDEMIC ON GEOTHERMAL ENERGY IN THE PORTION OF ENERGY MIX INDONESIA**

Pandemic covid-19 is a new situation in all country including Indonesia. The crisis of global economy is inevitable as the covid-19 virus outbreak has forced many strategic sectors to their lowest level. Covid-19 can attack and disrupt the energy needs in the world by directly affected on the production and demand of energy. This situation encourages all the industry to plan the strategy for energy sustainability. Generally, Covid-19 is affected for all development of renewable energy in Indonesia. The biggest challenge is reviving the economic sector with the weakness of the rupiah case was support the challenge in Indonesia, so that there was any impact to the investor-investment process and project development of renewable energy especially in geothermal industry sector.

The weakness of rupiah is also affected to PT. Perusahaan Listrik Negara (PLN) which PLN pays the developer or PLTP in dollars and then selling the electricity product in rupiah, which means if the value of rupiah to the dollar was decreasing, PLN encountered a significant loss in a financial aspect. Based on Indonesia's Energy Policy Briefing: July 2020, the decreasing electricity demand due to the COVID-19 crisis has stressed PT PLN financials, which, as a consequence, is renegotiating independent power producer contracts. The pandemic also puts the 35 GW plan at risk.

The phenomenon pandemic around the world also caused a slight decrease in world oil price, which has indirect correlation into geothermal energy development and exploration in Indonesia. The implementation of a large-scale social restriction or PSBB in Indonesia definitely affects the economic activity. The PSBB, issued on Government Regulation No 21/2020 for control COVID-19 spreads by minimizing social interaction and work from home activity. This hampered the mobilization process of a supply chain in field projects and the health protocol rules that must be applied in every area lead the labor productivity of the project decreases.

Geothermal energy as a part of the energy mix in Indonesia also affected by this pandemic. The geothermal project that was planned by government in 2020 was delayed and will be shifted and accelerated in 2021. Based on National Energy Mix by DEN 2020, to achieve the target of 23% renewable energy portion in energy mix, from geothermal industry and development of PLTP, the activities to support the target such as assigning BUMN/BLU to develop the PLTP, allocating the financial for geothermal development through PMN & loans to BUMN, improve the quality and quantity to survey the potential resource and reserve in geothermal field, conduct minimal 7 work area over years for auction activities, prepare minimal 4 geothermal work area for the recommendation, provide the preliminary study or exploration study to business entity, create the geothermal price (buy & sell) policy, and improve the preliminary study or exploration by government

In 2020, Indonesia Ministry of Energy and Mineral Resource states that there is no auction of geothermal working areas. In facts of pandemic, it also supports the delayed and hampered of geothermal utilization so that the target that was planned for achieving the renewable energy portion in energy mix Indonesia 2025 unlikely to be achieved. 3 PLTP projects were previously targeted for COD in 2020 to be postponed in 2021, where the 3 projects are targeted to add 140 MW in 2020. The three PLTPs that must be postponed are PLTP Rantau Dadap, PLTP Sorik Merapi, and PLTP Sokoria. In this pandemic COVID-19, ESDM EBTKE states that the exploration project (government drilling) will continue in 20 geothermal prospect area on 2020 – 2024, but this valid data is not available, so based on the author's opinions, this plan will have an effect for increasing capacity from geothermal energy in Indonesia after pandemic and helps to achieve the target of geothermal energy in renewable energy portion of energy mix Indonesia 2030.

#### **5. SUMMARY & RECOMMENDATION AFTER PANDEMIC COVID-19 OUTBREAK**

Based on the study literature from the author's, this pandemic will last quite a long time and is unlikely to return to normal, and obviously, if the pandemic COVID-19 has a decline curve in Indonesia it will give a significant impact on the various sectors, especially in energy sector. The economics of the country will be stable as soon as possible follows with an increase of investment in geothermal industry to support renewable energy in energy mix 2030. The targets that have been determined in 2025 will be quite difficult to achieve due to challenges in terms of social, funding, price and the pandemic COVID-19 occurs several problems such as supply chain disruptions, the unavailability of labors because of social distancing and work from home rules. The challenges of the geothermal industry in Indonesia come from the upstream aspect (exploration & development), downstream (economical tariff of the electricity) and this pandemic COVID-19.

The most influential aspect after this pandemic over are the government and the investor. The government is preparing a strategy for the sustainability of energy projects after the pandemic. According to the Ministry of Energy and Mineral Resources (MESDM) press release No. 163. Pers/04/SJI/2020, the MESDM through the Director of Energy Conservation of the Directorate General of New and Renewable Energy and Energy Conservation will issue a policy to increase the investment during a pandemic by providing incentives and easing project funding, especially in the development of NRE (ESDM, 2020). In order to achieve the target of geothermal energy industry, investment in geothermal field is an important thing to be prioritized, to engage more investment the government will suspend loan installments to reduce interest rates on NRE projects. Besides, the government provides other relief in the form of relaxation of commercial operation date (COD) and the removal of financial penalties to adjust the procurement mechanism of Independent Power Producer (IPP) (Hanan, 2020)

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