

An Overview of Indonesia Geothermal Development – Current Status and Its Challenges

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Keywords: Unlock, Geothermal, Potential, Environment, Energy Security.

ABSTRACT

Back in mid 80 and early 90, the government of Indonesia started with utilization of geothermal resources as an indirect use to produce electricity in order to support the power requirement. The demand of electricity has rapidly increased approximately 7% per year. During the period, the fossil fuel was still main consumption to generate the electricity, but, it has been noted that the fossil fuel as a non renewable energy, has also decreased rapidly and therefore the geothermal resources has become an important resources to generate electricity in the past 10 years. In early 90, the geothermal community saw the need to establish a non governmental organization in order to support the geothermal development. in early 1991, Asosiasi Panas Bumi Indonesia (API) or Indonesia Geothermal Association (INAGA) was established with its main function is as the partner of government, developer and other institution including universities to assist the government and other stake holder in accelerating the geothermal development. At the beginning, through the presidential decree no. 22/1981, Pertamina, as the State Owned Enterprise was appointed to carry out all the geothermal development in Indonesia. The first Geothermal Resources was successfully developed by Pertamina at Kamojang Geothermal Working Area and fully operational back in 1983. But then, for the rest of Geothermal Working Area that was given to Pertamina, It had required a huge financial commitment that made impossible for Pertamina to develop alone. Pertamina then introduced a Joint Operating Contract (JOC) model that gave an opportunity for the private sector to develop some of the Pertamina Geothermal Working Area such as Drajat block by Chevron and Wayang Windu block by Star Energy. After the world crisis in 1998, with new government, the law on geothermal which is Law no. 27 Year 2003 was issued and signed by the President of The Republic of Indonesia. However, the government regulation no. 59 that regulated all geothermal matters from survey, exploration up to the tendering process was just issued in 2007. On January 2010, The Presidential Decree no. 04/2010 was issued regarding the 2nd fast track of 10,000 MW electricity. Out of 10, 000 MW, the government has decided that 49 % should be from geothermal resources which is equal to 4900 MW. Then in 2012, the vision Of 25/25 was also introduced by government, that was interpreted as 25 % of energy need by year 2025, must be from geothermal resources and in other word, approximately additional 9000 MW of electricity should be able to be developed and produced from geothermal resources by 2025. The paper is intended to share and to update comprehensively all the geothermal matters in Indonesia including all related regulations, current status and also challenges that are being faced by the government and developers.

1. INTRODUCTION

In recognition of the importance of the role of geothermal energy as renewable and clean energy, and to promote energy mix in order meet National Energy supply Security through 2050, Indonesia's huge geothermal potential is facing risks and challenges to meet the target of development as expected, while Indonesia as non-annex one country committed to reduce GHG emission from 26% up to 41% by 2020.

INDONESIA GEOTHERMAL POTENTIAL					
POTENTIAL / ENERGY (Mwe)					
RESOURCES		RESERVE			
Speculative	Hypothetical	Possible	Probable	Proven	
12133		16484			
TOTAL : 28617					
SOURCE : GEOLOGICAL AGENCY DECEMBER 2012					

The perception that Indonesia's acceleration program has stalled that has also widespread among stakeholders. Currently, the best estimate by end of 2013 will be no more than **60 MWe**, added to the geothermal base electricity.

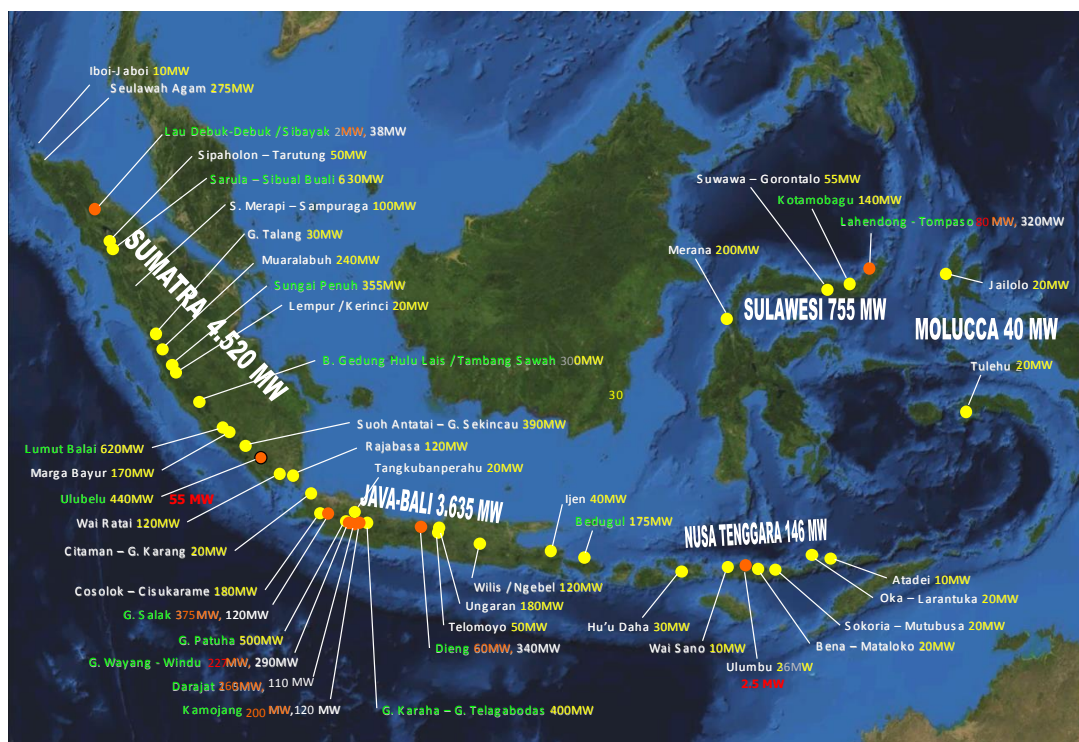
While the geothermal energy target in National Energy Policy keeps increasing to support electricity ratio, but the expected producing MW is stalled. It is due to geothermal as the domestic energy source can be displaced by other mean particularly fossil fuels, by reducing the foreign market.

Geothermal Energy is a domestic energy resource that can displace the use of fossil fuels as non renewable energy, of which the fossil fuel particularly for oil and gas has already reached net imported status. Geothermal energy becomes one of the important largest national sources of energy that will boasts energy consumer mix and balance the energy consumer, which will make steady the national *security of energy supply and support national economic growth*.

Enormous potential of this type of renewable energy, with little development progress in this type of clean energy, forced us to perform a study what have locked the development and once it is clear then continue with on how to unlock Geothermal Energy Acceleration toward year 2050 as stated in the National Energy Policy.

Increasing renewable energy mixed used, balancing with soaring fossil fuel prices will ease national financial condition. However Indonesia's dependence on fossil fuels to power its economy is not only economically viable but also unprotected energy security supply to energized national economic growth. Distribution of Geothermal Potential showed below, spread almost on all main Indonesian's islands ready to generate power and raise the national electricity ratio.

POTENSI CADANGAN PANAS BUMI TOTAL Δ = 28,99 GW, INSTALLED CAPACITY = 1281.5 MW (October - 2012)



SOURCE : ESDM, 2010

To generate power and increase national electricity ratio, developing geothermal has consequences and cross-sectional regulation conflict. Besides that, PT PLN (State Owned Company) as the single buyer for all different type of prime-energy to generate electricity has position in selecting type of prime energy, as well as price.

But developing this renewable and green energy with lack of market mechanism due to single buyer and on the other hand with multi seller position, through different type of energy, it will therefore make the *Government* roles become *Single Prime Mover* in order to make geothermal acceleration development program become possible and a study is required to support cross-sectional regulation so that the related regulations are able to align and support geothermal development. Currently Law no. 21 year 2014, a new geothermal law has been enacted, and Geothermal as renewable and clean energy has been placed as strategic energy under central government's jurisdiction.

It has been well known that geothermal energy is a domestic energy resource that does not require carbon-intensive fuel to operate power plant. Geothermal power can displace the use of fossil fuels, thereby reducing our reliance on foreign fuel markets. Also, as electricity becomes a larger part of our transportation system it can directly displace imported oil. Direct use of geothermal heat for certain commercial, industrial and agricultural uses, provides an alternative to other sources of thermal energy including electricity, natural gas, propane, or oil. By increasing the availability of indigenous fuels in the U.S., geothermal can improve our ability to control our economic future and improve our national security, while conserving our available oil and natural gas resources for high value uses, such as liquid fuels for transportation, chemical feedstock and pharmaceuticals.

2. ENERGY CONSUMPTION

Since year 2000 up to 2011, consumption of energy increased in average by 2.87% per year. The increase of energy consumption is derived from the sectors of industry, transportation and commercial. Meanwhile, energy consumption of the household sector experienced a decrease, possibly as the impact of the conversion of kerosene to Liquefied Petroleum Gas (LPG) for cooking. This is due to the high energy value of LPG compared to kerosene and the more efficient energy stoves available in the market (Figure 4).

The growth of motor vehicles that reaches 7% per year resulted in the high growth of energy consumption in the transportation sector as well as the rapid additions of shopping centers, office buildings and hotels impacted to the increase of energy consumption in the commercial sector. The high growth rate of motor vehicles requires special attention as their energy consumption uses subsidized BBM.

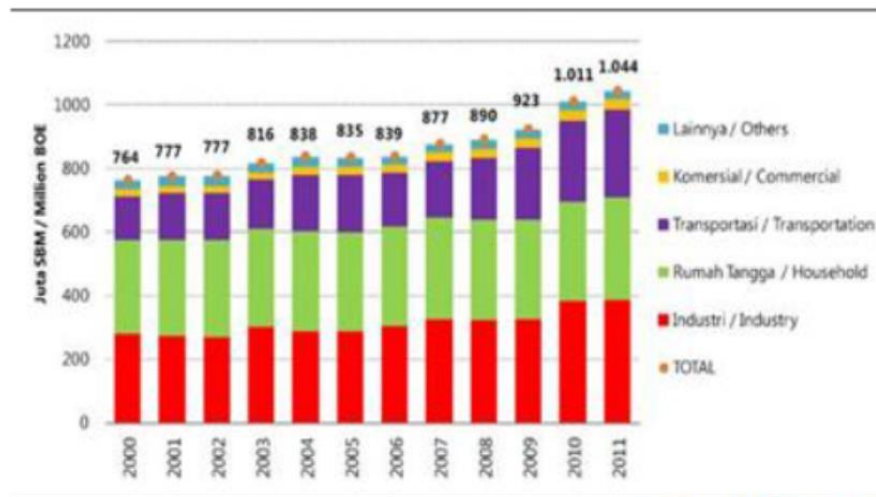


Figure 4: Final energy consumption by sector

During the period of 2000 – 2001 the energy consumption by type was still dominated by fuel oil. In total, fuel oil consumption was relatively constant in the range of 312-364 million BOE (barrel oil equivalent), but in line with the government policy experiencing composition changes from one type of fuel oil to the other types of fuel oil. In year 2000, the consumption of diesel fuel was the largest, followed by kerosene, gasoline, fuel oil and *avtur* (aviation fuel). Then, in year 2011 its sequence changed into diesel fuel and biodiesel, gasoline, aviation fuel, kerosene, and fuel oil.

The change in pattern of the fuel oil consumption was due to the high consumption rate of gasoline and diesel fuel by motor vehicles as the result of the growth rate of motor vehicles, the high mobility of people as the impact of economic growth and the lack of road infrastructures causing congestion. Likewise, the high consumption rate of *avtur*/avgas for airplanes as the impact of business pattern development of low cost carrier flights has changed people mindset, so that they prefer air transport that is faster with lower cost compared to the other transportation.

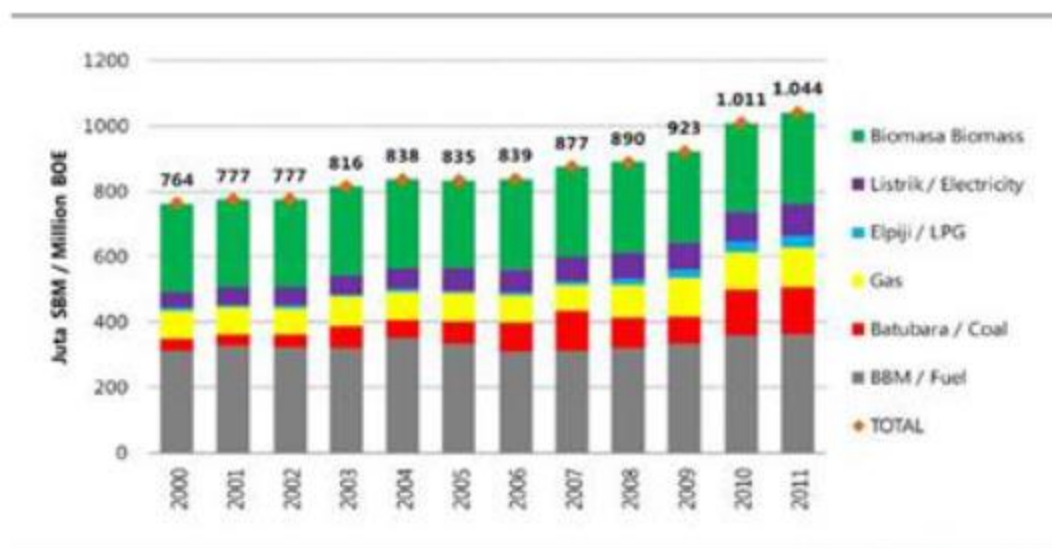
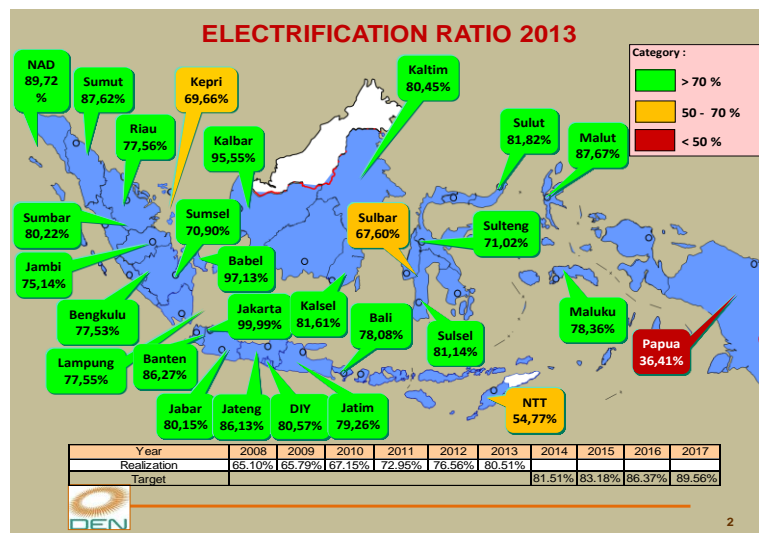


Figure 5: Final energy consumption by type

The consumption of coal increased 13.4% in average per year. All consumption of coals was to meet the energy needs from the industry sector conducted energy diversification in line with the increasingly expensive fuel oil price.

Meanwhile, the consumption of natural gas had a relatively limited increase during this period. Natural gas constitutes energy that highly required by the industry sector. The limitation of infrastructures resulted in limited natural gas supply to meet the industrial needs.

The consumption of electricity during the period of 2000-2011 experienced an average growth of 6.5% per year. The ratio of national electrification in year 2000 which remained at 57% has increased to 72.9% in 2011 with consumption per capita that was still very low (approximately 650 kwh/capita). Even at the end of September 2013, the ratio of electrification has reached 80.1%, although there were two regions, i.e. Papua (35%) and East Nusa Tenggara (56%) that still had a low ratio, whereas other regions were already above 60%. The improvement efforts of electrification ratio should be appreciated, provided that they do not use fuel oil or diesel power plants.



3. ENERGY SOURCE POTENTIAL

3.1 FOSSIL ENERGY RESOURCE POTENTIAL

Discussion on the energy potential of Indonesia's natural resources is always synonymous with its wealth in oil, gas and coal.

Indonesia's oil and gas reserves are spread out, especially in the islands of Java, Sumatra and Kalimantan. The total oil reserve during the last decade tends to experience a decline which mainly caused by the production of oil was far higher than the success in discovering new reserves.

As it can be seen in table 1, Indonesian oil proven reserve is no more than 4.04 Billion Barrels with the production of around 0.329 Billion Barrels or the comparison between reserve and production (R/P ratio) is no more than 12 years. Whereas, the Indonesia's natural gas proven reserve is 104.7 TSCF with production in average of 3.07 TSCF, thus, the R/P ratio should be 34 years.

Table 1: Potential and Production of Fossil Energy

NO	FOSSIL ENERGY	RESOURCES	PROVEN RESERVES	RATIO	PRODUCTION	RATIO (YEARS)
1	OIL (Billion Barrel)	56.6	4.04	7.18	0.329	12
2	GAS (TSCF)	334.5	104.7	31.30	3.07	34
3	COAL (Billion Ton)	161.3	5.53	3.43	0.353	16

From the above data, it clearly requires strong efforts to discover oil and gas reserves from the existing resources in order to increase production to support the continuity of energy supply.

Particularly for oil, it is indicated that the daily production is declining to the lowest level of 820,000 BPD each day. In year 2014, it is projected that the oil production will rise 870,000 BPD, supported by project development of Banyu Urip Field – Cepu Block. However, new proven reserves with large scale that can increase production have not been discovered yet. The new reserves that have been discovered can only restrain the declining rate of natural production.

The potential of coal resource in Indonesia is estimated 163,3 billion tons with proven reserves of 5,53 billion tons and an average production of 0,353 billion tons; its R/P ratio is no more than 16 years. However, in line with the increasing exploration activities, coal proven reserves are estimated to increase rapidly and should be able to reach to 21 billion tons.

Those coal reserves largely (53%) are found in Sumatra Island, while the rest is in Kalimantan. Therefore, the mining activities of Indonesian coal productions are centralized in those two regions. Although Sumatra is the region with the largest coal potential, and yet, Kalimantan is the largest coal production source.

3.2 RENEWABLE - NEW ENERGY RESOURCE POTENTIAL

In the General Provision stipulated in the Law Number 30 Year 2007 concerning energy, what it means by new energy source is the source of energy that can be generated by new technology, both derived from renewable energy source and non-renewable energy source, among others, nuclear, hydrogen, coal bed methane, liquefied coal and gasified coal. Whereas, what it means by renewable energy source is energy source produced by sustainably energy resource if managed well, among others, geothermal, wind, bioenergy, solar, water flow and waterfall, as well as fluctuations and sea surface temperature alterations.

Based on the data from *Badan Geologi – ESDM* (Geological Agency-Energy and Mineral Resources) (December 2012), the Indonesian geothermal reserve is 16,484 Mega Watt (MW) from the potential of 28, 617 MW. Installed capacities of geothermal power plants is 1,341 MW or 4.7% from the available potential. Meanwhile, hydropower potential (large scale hydropower) reaches 75,670 MW with installed capacities of 5,705 MW or 7.5% from its potential.

Table 2: NRE (New-Renewable Energy) Resource Potential in Indonesia

NO	SUMBER ENERGI	POTENSI	KAPASITAS TERPASANG	RATIO (%)
1	PANAS BUMI	28,617 MW (sumberdaya)	1,341 MW	4.7
2	HIDRO	75,670 MW	5,705 MW	7.5
3	MINI – MIKROHIDRO	769.7 MW (sumberdaya)	218 MW	28
4	BIOMASA	49,810 MW (cadangan)	1,644 MW	3.3
6	ENERGI SURYA	4.80 kWh/m2/days	22.45 MW	-
8	ENERGY ANGIN	3 – 6 M/S	1.87 MW	-
7	URANIUM	3000 MW	30 MW	(research)
8	GAS METANA BATUBARA	453 TSCF (sumberdaya)	-	-
9	SHALE GAS	574 TSCF (sumberdaya)	-	-

SOURCE : ESDM CONEX 2012

The potential of Mini / micro hydropower is 769.7 MW with the installed capacity that has reached 218 MW. Meanwhile, the potential of biomass for electricity reaches 49,810 MW with the installed capacity of 1,644 MW.

The potential of solar is quite high with an intensity of 4.8 kWh/m2/day and utilization only of 22.45 MW. Apart from that, Indonesia also has areas that have wind speed more than 3 m/s that can be utilized for power plants, such as NTB, NTT, Yogyakarta, Central Java, North Sulawesi and Southeast Sulawesi. Currently, the installed capacity of wind power is only around 1.87 MW.

Indonesia also has energy potential that is newly developed such as coal bed methane (CBM) and shale gas. The CBM potential has been identified as large as 453 TSCF, and shale gas 574 TSCF. Meanwhile, the potential of uranium has reached 3000 MW with the installed capacity of 30 MW in research scale (Table 2). Optimization and acceleration of NRE utilization is expected to be able to meet the energy supply guarantee for the present and the future

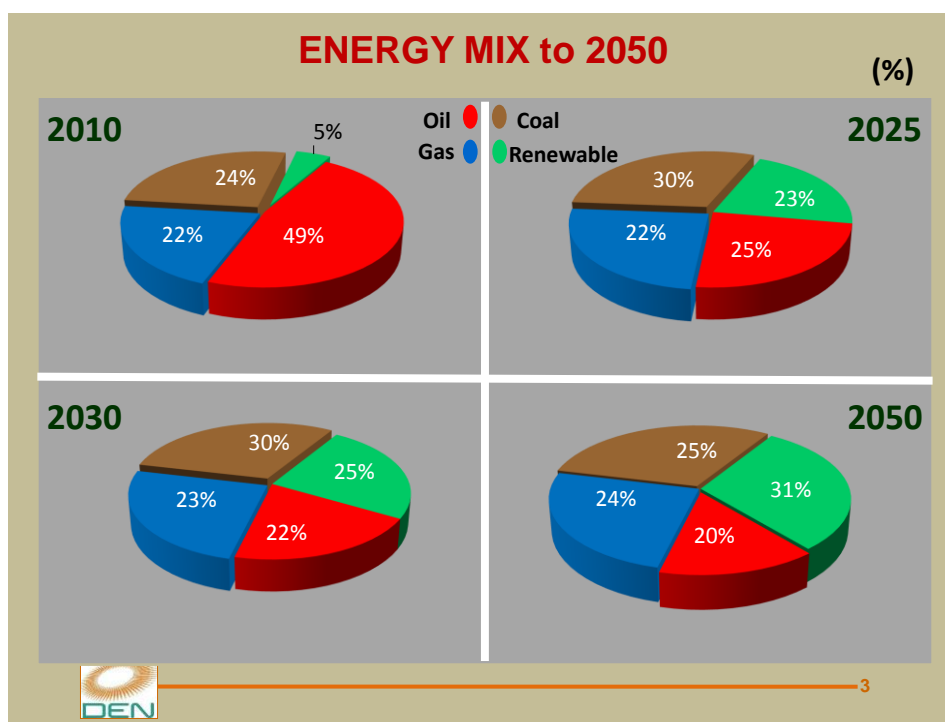
4. FACING GEOTHERMAL DEVELOPMENT CHALLENGES

Geothermal energy is the heat from the earth, as thermal energy, generated and stored in the earth and it is clean and sustainable by means with a proper reservoir monitoring and management, classified as renewable and clean energy.

The temperature difference between the core of the earth and its surface, form heat drives by continuous conduction of thermal energy and will continue to radiate for billions of years to come, ensuring supply of energy.

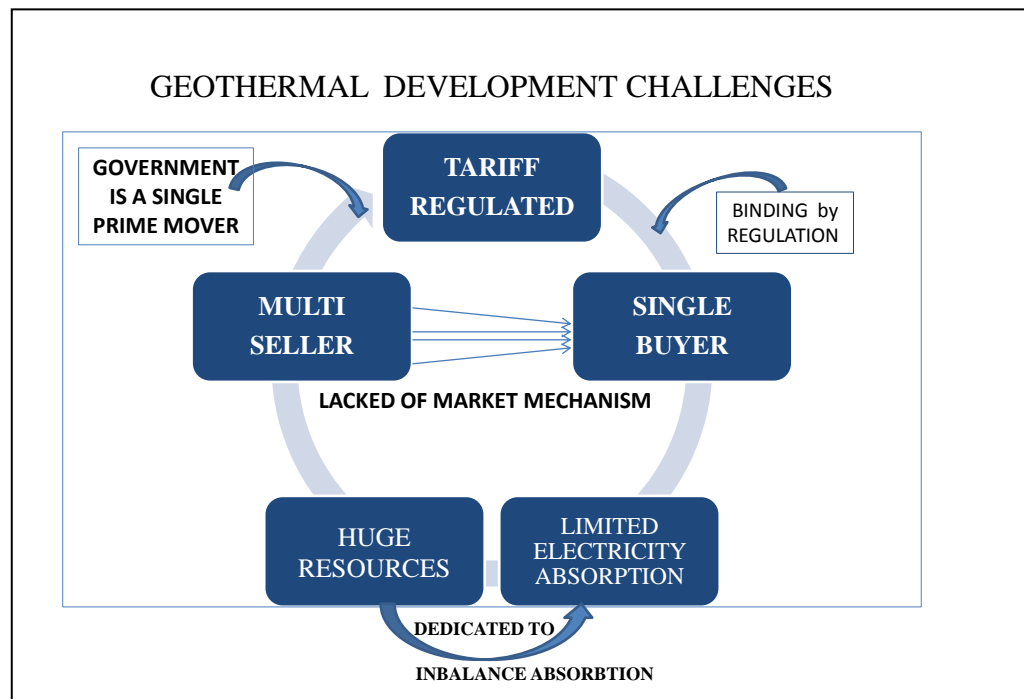
Among energy type, geothermal being renewable and clean energy serve and save the earth habitat environment, but with 241 million Indonesia's populations and 57% lived in Jawa, this emerging nation face among others the *energy security supply in the form of fuel fossil gasoline and electricity national/regional ratio*. When a power station harnesses geothermal power in the proper way is not harm to the environment, through *clean development mechanism introduced by first phase of Kyoto Protocol*, potentially helping to mitigate global warming if widely deployed in place of fossil fuels. Geothermal power generation can therefore reduce the use of fossil fuels.

Geothermal energy with huge domestic resources, theoretically more than adequate to generate electricity needs. Existing power generation dominated with fossil fuel as the primary energy distributed by 44% of coal, 23% of petroleum, 21% of natural gas and renewable energy contributed by hydro 7% and geothermal 5%. Energy Mix 2050 target (see figure below), with renewable energy in 2025 energy-mix expected to reach 23% of renewable energy contribution. (See Energy Mix 2050 figure).



By looking at the above National Energy Policy, Geothermal energy development faces challenges that need to be resolved. Without incremental electrification ratio, economic growth is prevented from happening. Forecasts for future geothermal power development depend on energy price, subsidies, technology, and mostly regulation alignment between these supporting ministerial departmental and become essential to support acceleration of geothermal development to reached expected 2050 energy mix.

International Geothermal Association (IGA) has reported that Indonesia as the third largest group of geothermal power plants in the world with 1341 MW in 2013 which is equal with 3,7% National Electricity production, it is therefore becoming obvious that Indonesia acceleration program needs to be realized. Figure below shows geothermal development challenges which required government continuous improvement, and clearly position the Government as the *Single Prime Mover*.



Geothermal Power consider as Public – Private Partnership (PPP) when a business relationship between a private-sector company and a government agency for the purpose of completing a project that will serve the public. Condition on single power generation government agency for the purpose to serve the public creates additional challenge to set appropriate regulation.

With multi geothermal developers produced electricity for State Owned National Electricity Company removed the existence of market mechanism and creates regulated tariff set by the government periodically to anticipate operating cost dynamic. Regulated tariff will not be able to satisfy both parties (Seller and Buyer) and the different of view on the level of risk between high risk in the geothermal exploration phase with calculated risk for the power plant added to the regulated tariff.

Considering geothermal activities as mining activities resulted other issue that in the conservation forest area became strictly prohibited for geothermal activities, which will then require an effort to define the geothermal activities by stating geothermal activities as an extraction thermal which should be differentiated from mining activities such as coal or mineral resources.

Permits to run geothermal activities involve many aspects, will also another issue that creates delay the process, and initiative to have “*clean and clear for complete permit*” is under evaluation into one door policy.

Besides all challenges, country’s geothermal resources consider one of the huge resources in the world as the advantages to develop geothermal power generation in Indonesia beside direct benefit such as hot spring water pool.

Geothermal that has been proven its reliability in the sector of electricity for instance, still experience constraints in its development. The overlapping between lands and protected forests and conservation areas of forests, and also national parks becomes the main problem in its development. Aside from that, several other problems that have been mitigated:

- Lack of Geological, Geophysical and Geochemical (GGG) data causing the low accuracy in determining the magnitude of potential.
- High resource risk (in upstream sector) level.
- High investment cost while energy price is less competitive, limited equity funds, and limited mechanism of funding and incentive.
- Uncertainty in legal aspects and the lack of cross-sector coordination.
- Lack of human resources that have specific competences in geothermal.
- Social issues.

Being the Single Prime Mover, intra and extra government, central and province government challenge to make the Geothermal Power Incremental improvement happened, and Geothermal Energy will promote National Energy Security.

5. PRIORITIES OF ENERGY DEVELOPMENT

In accordance with the spirit of National Energy Policy regulated in the Presidential Decree number 5 Year 2006 on the enhancement of renewable energy consumption and the reduction of the role of natural oil year 2025 in the scenario of primary energy mix, it is a challenge to strive optimally to accelerate the development of renewable energy. At once, this can be used to shift the paradigm that energy source is not solely for export commodity, but also as a capital of national development for the overall prosperity of the people.

This matter cannot be separated from the efforts to achieve independency of energy management and also to prevent threats against the assuredness of national energy supplies and in the efforts to prevent the accumulation of greenhouse gas in the atmosphere.

The priorities of energy development should be done through energy development by considering the balance of energy economics, security of supplies and sustainability of environmental function with principles as mentioned above, namely: optimizing the utilization of renewable energy with due regard to its economic level both of the oil fuel substitution for transportation and industry and of electricity, minimizing the utilization of oil.

In the General Provision stipulated in Law number 30 year 2007 concerning energy, what it means by new energy source among others: nuclear, hydrogen, coal bed methane, liquefied coal and gasified coal. While, what it means by renewable energy source among others: geothermal, wind, bioenergy, solar, water flow and waterfall, as well as fluctuations and sea surface temperature alterations.

The New Energy is still in the process of research and development, while Renewable Energy experiences obstacles in its development. Therefore, it requires a special attention and a breakthrough to its completion in order to have NRE development conducted in accordance with the National Energy Policy.

Indonesia has the largest geothermal potential in the world, which reliability has been proven for power plants of medium to big scale since 1982. Geothermal Power Plants is used as the base load and can be operated continuously without stopping. The development of this energy is currently constrained, and therefore it requires a special handling. Similarly, the energy from water (hydropower energy) also has huge potential that requires attention in helping to solve the existing problems so that it can be developed rapidly.

It requires synergy with State Owned National Electricity Company (*PT.PLN*) in preparing network infrastructure so that the development of power plants is in line with the readiness of high voltage interconnection network (150 or 275 KV).

The utilization of renewable energy source from the biofuel type to replace oil fuel currently already has contributed to the reduction of oil fuel import, and it needs encouragement to improve its role by providing incentive and adjustment of the existing regulation.

5.1 GEOTHERMAL

Indonesia has the largest geothermal potential in the world spreading in the volcano range in the islands of Sumatra, Java, Bali, Nusa Tenggara, Maluku and Sulawesi.

Table 3 – Geothermal Potential in Indonesia

INDONESIA GEOTHERMAL POTENTIAL

No	ISLAND	TOTAL LOCATION	POTENTIAL / ENERGY (Mwe)					TOTAL	INSTALLED CAPACITY
			RESOURCES		RESERVE				
			Speculative	Hypothetical	Possible	Probable	Proven		
1	Sumatera	90	3089	2427	6849	15	380	12760	122
2	Jawa	71	1710	1826	3708	658	1815	9717	1134
3	Bali-Nusa Tenggara	28	360	417	1013	0	15	1805	
4	Kalimantan	12	145	0	0	0	0	145	
5	Sulawesi	65	1323	119	1374	150	78	3044	80
6	Maluku	30	545	97	429	0	0	1071	
7	Papua	3	75	0	0	0	0	75	
	Total	299	7247	4886	13373	823	2288	28617	1336
			12133		16484				
			TOTAL : 28617						

SOURCE : BADAN GEOLOGY
DECEMBER 2012

The total geothermal potential is 28,617 MW although the installed capacity has only reached 1,341 MW through September 2013 (there is an additional 55 MW installed capacity on September 2014 that makes installed capacity became 1,396 MW). Out of the said potential, the probable reserve that has been identified by a preliminary survey is 13,373 MW, while possible reserve is 823 MW and proven reserve 2,288 MW spreading in more 300 locations now and divided into 65 Geothermal Working Areas (Table 3). This potential is the hydrothermal system potential which is utilized indirectly for power plants.

Fifteen Working Areas are developed by PT. Pertamina Geothermal Energy, both are developed on its own and by a Joint Operation Contract system with Chevron at Salak and Darajat, Star-Energy at Wayang Windu, Geodipa at Dieng and Patuha, commonly called Mining Working Areas (WKP) Existing.

The WKPs Existing are WKPs issued through Presidential Decree (*Keppres*) number 22/1981, *Keppres* 45/1991 and *Keppres* 49/1991 prior to the issuance of Law Number 27 Year 2003 concerning Geothermal, while New WKP constitutes WKP regulated through the Law 27 year 2003 on Geothermal. These WKPs are developed intensively, whereas some have been in operations with installed capacity of 1,341 MW (Table 4), while others are still in the exploration stages.

Table 4: Installed Capacity

					
No.	WKP, Lokasi	PLTP	Pengembang/ Operator	Kapasitas Turbin	Kapasitas Total (MW)
1	Sibayak – Sinabung, SUMUT	Sibayak	PT. Pertamina Geothermal Energy	1 x 10 MW; 2 MW(monoblok)	12
2	Cibeureum – Parabakti, JABAR	Salak	Chevron Geothermal Salak, Ltd	3 x 60 MW; 3 x 66,6 MW	377
3	Pangalengan, JABAR	Wayang Windu	Star Energy Geothermal Wayang Windu	1 x 110 MW; 1 x 117 MW	227
4	Kamojang – Darajat, JABAR	Kamojang	PT. Pertamina Geothermal Energy	1 x30 MW; 2 x 55 MW; 1 x 60MW	200
5	Kamojang – Darajat, JABAR	Darajat	Chevron Geothermal Indonesia, Ltd	1 x 55 MW; 1 x 94 MW; 1 x 121 MW	270
6	Dataran Tinggi Dieng, JATENG	Dieng	PT. Geo Dipa Energi	1 x 60 MW	60
7	Lahendong – Tompaso, SULUT	Lahendong	PT. Pertamina Geothermal Energy	4 x 20 MW	80
8	Waypanas – LAMPUNG	Utubelu	PT. Pertamina Geothermal Energy	2 x 55 MW	110
9	Ulumbu - NTT	Ulumbu	PT. PLN (Persero)	2 x 2,5 MW	5
TOTAL					1,341

Characteristics of geothermal energy that cannot be exported or imported, state the sovereignty status of geothermal energy, while the designation of indirect utilization of the energy is dedicated to power plants, shackled itself against *PT. PLN* condition as the single buyer.

In mitigating the risk of exploitation, there are two main risks that should be borne by the developers, i.e. technical and non-technical risks. Technical risk is mainly related to resource risk; infrastructure and land acquisition are the very severe risks that have to be borne by the developers, whereas the possibility of non-discovery of geothermal resource or the small reserve acquired after exploration is the most severe risk. The risks that also burden the developers are drilling operation failure as well as the high cost of investment for the road infrastructure and site location. Those are mainly due to the lack of Geological, Geochemical and Geophysical (GGG) data at the time of tender process, resulting in the inaccuracy of risk mitigation to determine the rate of return and in the end to determine the electricity selling price. The amount of resources available in the conservation areas such as forests is also another risk that needs to be considered. Up to today, the conservation areas have not been allowed to be used as geothermal development areas. Technically resources and reserves of geothermal in the middle of conservation areas of forests can be taken from the buffer zone by delineation drilling although the investment cost of drilling becomes very high in addition to the high risk of failure. Financial closing can only be conducted after exploration by drilling wells and obtaining proved reserves, followed by a feasibility study. Hence, the exploration activities shall be carried out using equity funds which amount shall be no less than 30% of the total investment.

Besides, in the Geothermal development process of Geothermal Power Plants it requires no less than 5 to 7 years as of the preliminary survey. For 3-5 years of exploration activities it shall be followed by delineation drilling and plants development of 2-3 years (Figure 8). The above has not included the identification of licensing issues both from the Central Government and Regional Government, protracted discussions on Power Purchase Agreement (PPA) with *PT. PLN* and even they can take 2-3 years. The long process of geothermal development requires funds with a long term loan scheme, with a low interest rate that up to now cannot be fulfilled by domestic banking.

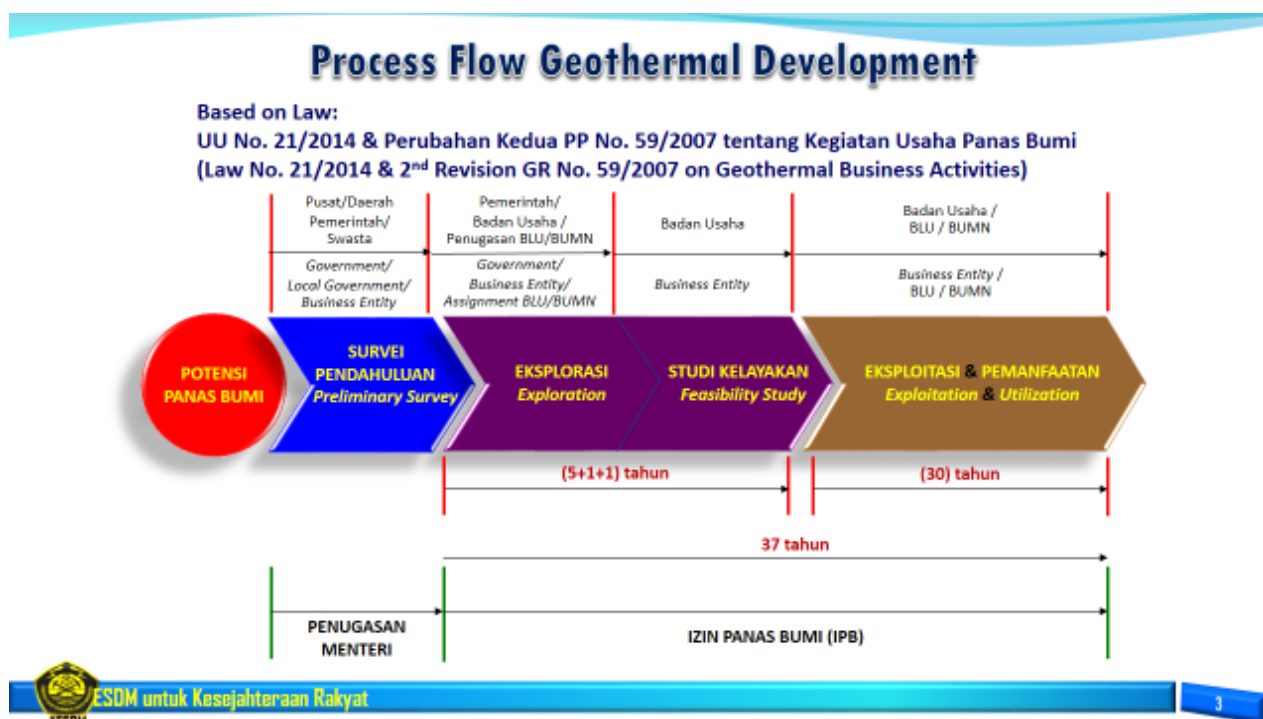


Figure 8: Process Flow of Geothermal Development

Incentive scheme, both fiscal incentive and other incentives is highly required in order to attract investors to develop geothermal. To accelerate the development of geothermal, the government has conducted several breakthroughs and one of them is by submitting a draft for amendment to Law Number 27 Year 2003 concerning Geothermal. This effort is much appreciated, but it should be followed by concrete measures of synchronization and coordination and also preparation of derivatives regulation implementation of the Law.

The draft for amendment Law on Geothermal was finally enacted on 17 September 2014 became Law Number 21 Year 2014 on Geothermal. However, the other breakthrough by the Government was to issue a new ceiling tariff of electricity from geothermal power plant through the Decree of Minister Energy and Mineral Resources Number 17 Year 2014, issued on July 2014, which is based on the regional and Commercial Operating Date (COD). (See below table on new ceiling tariff). It certainly with the expectation that the issued regulation can be applied immediately and it should constitute a regulation that facilitates all processes.

NEW GEOTHERMAL CEILING TARIFF

(Ref. Ministry Energy & Mineral Resource Regulation no.17/2017)

COD	CEILING TARIFF (cent USD/kWh)		
	Region I	Region II	Region III
2016	11.8	17.0	26.4
2016	12.2	17.6	26.8
2017	12.6	18.2	26.2
2018	13.0	18.8	26.6
2019	13.4	19.4	27.0
2020	13.8	20.0	27.4
2021	14.2	20.6	27.8
2022	14.6	21.2	28.2
2023	15.0	21.8	28.6
2024	15.4	22.4	29.0
2025	15.8	23.0	29.4

Region I : Sumatera, Jawa, Bali

Region II : Sulawesi, NTB, NTT, Halmahera, Maluku, Papua, Kalimantan

Region III : Region located in Region I and Region II were isolated and meeting the needs of most of the electrical power obtained from the diesel power plant (using fuel oil)

6. GEOTHERMAL BUSINESS OPPORTUNITY IN INDONESIA

The 2nd Phase of 10,000 MW Crash Program, through Presidential Decree No. 04/2010, has ordered to develop 4,000 MW from Geothermal Energy.

The Road Map for geothermal Energy in Indonesia as established by Government, has set the target through its vision 25/25 that by year 2025 additional 9,500 MWe must be achieved. It has also been supported by the revised National Energy Policy which set 23 % of Energy Mix must be from New and Renewable Energy, and 5% out of 23% must be from Geothermal Energy. Therefore, the

Government, in order to meet with the required target, will progressively establish several New Geothermal Working Areas to be put on tender in the near future. The new Regulation for new tender process is being prepared to be issued and once it is issued then those new Geothermal Working Areas will be immediately put on tender. Other New Geothermal Working Areas are also being finalized for establishment in due course.

Therefore, based on current and coming policies being prepared in the near future and also the 4,000 MWe from Crash Program, Road Map and National Energy Policy, Indonesia can be seen as the biggest investment opportunities in the geothermal Sector for at least in the next 10 – 15 years. By 2025, at least 6,500 MWe in total to be added to the National Energy Consumption. It will require for more than 18,5 Billion US Dollar to invest.

Beside financial, huge human resources are also needed. Means a comprehensive capacity building will be needed and for the next 3 to 5 years, at least 2,000 workers from all disciplines will be required to assist the development.

7. CONCLUSION

In summary, from the above discussions, it can be concluded as follows:

1. Indonesia has huge geothermal resources but to date (up to September 2014) only 1396 MWe or approximately 4.5 % of the potential, was installed.
2. The Potential of Geothermal in Indonesia from more than 300 locations are estimated approximately 29 GW.
3. Indonesia is still facing many challenges in developing geothermal energy, in term of data reliability, regulations, up to financing.
4. However, beside the challenges. There are a big opportunity for foreign investors to invest in the geothermal sector in order to support additional 6,500 MWe by 2025.
5. Indonesia also required support on the Capacity Building in order to increase the expertise and also to recruit a huge Human Resources that are ready to support the geothermal Development in reaching the vision 25/25.
6. There is a need to harmonize and to synchronize the regulation particularly across the Ministry Department such as Forestry Department, Finance Department etc.
7. Despite all the challenges, the geothermal development in Indonesia must be prioritized in order to reduce the Fossil fuel particularly Oil consumption which is rapidly decreasing and with fluctuation price.
8. The issuance of The Law No. 21 Year 2014 on Geothermal on 17 September 2014 and the Minister Energy and Mineral Resources Decree No. 17 Year 2014 on Ceiling Tariff for Electricity from Geothermal Power Plant were the breakthrough from the Government in order to unlock and to accelerate the geothermal development in Indonesia to meet the vision 25/25.

REFERENCES

- Pusdatin ESDM, 2012 Handbook of Energy & Economic Statistic of Indonesia. BPPT (2013), Outlook Energi Indonesia 2013
- Tatang H.Soerawijaya (2012), Dukungan Jangka Panjang Yang Diperlukan Untuk Litbang Teknologi Domestik Berbasis Keunggulan Komparatif Indonesia (*The required long term support for research and development domestic technology based on comparative superiority*)
- Tumiran – DEN (2011), Skenario Kebijakan Energi Nasional Menuju Tahun 2050 (*Scenario on National Energy Policy toward year 2050*)
- Ketut Budiarta – BPMIGAS (2011), Cadangan Minyak dan Gas Bumi Menuju 2050 (*The Oil & Gas Resources toward year 2050*)
- PLN (2012) , Readiness of PLN to Utilize Renewable Energy
- EBTKE – ESDM (2012), Program Pengembangan Energi Baru, Terbarukan dan Konservasi Energi (*The program on the Development of New, Renewable Energy and Energy Conservation*)
- Hasrul Laksana Azahari – EBTKE (2012), New and Renewable Energy Policies
- Satya W.Yudha (2013), Seeking Low Carbon Energy Security for Asia Pacific
- Hardiv Harris Situmeang – ACE (2013) , Asean Long Term Energy Path-The Need for the Increasing Role of Low Carbon and Zero Carbon Energy Technologies
- DEN (2013) , Road Map Kebijakan Energi Nasional (*National Energy Policy Road Map*)
- Abadi Poernomo – API (2013), Tantangan dan Peluang Pengembangan Panas Bumi (*The Challenges and the Opportunity on the Geothermal Development*)
- Abadi Poernomo – API (2013) , Prospek Panas Bumi dalam Ketahanan Energi (*Geothermal Prospect for Energy Security*)
- Abadi Poernomo – API (2013) , Tahapan, Resiko dan Kebutuhan Pendanaan Pengembangan Panas Bumi.(Stages, Risks and Funding Requirements on the Geothermal Development)