Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-30 April 2010

# Geothermal in Indonesia: Government Regulations and Power Utilities, Opportunities and Challenges of its Development

Surya Darma[1], Sugiharto Harsoprayitno[2], Herman Darnel Ibrahim[3], Agusman Effendi[4] , Agus Triboesono[5]

[1] Director of Pertamina Geothermal Energy, [2]Director of Geothermal Business and Ground Water Management, [3]Former Director of T& D PT.PLN & Member of DEN, [4]Indonesian Parliament& Member of DEN, [5]Director of Electricity Business

[1]Suryadarma@pgeindonesia.com; [2]sugiharto@djmbp.go.id, [3]Hdarnel@yahoo.com; [4]aefendi@centrin.net.id; [5]atriboesono@djlpe.go.id

**Keywords:** Geothermal Resources, Regulations, Opportunities and challenges of Development

## ABSTRACT

After more than 30 years geothermal development and utilization in Indonesia, since 1978, at which the first geothermal power plant is commissioned in Kamojang, West Java, only 1187.3 MW installed capacity is established. It is caused by the unattractiveness of the use of geothermal rather than diesel, and other sources of energy due to subsidize policy on the primary energy use. Since 1982, geothermal development in Indonesia has been expedited by government regulations that allow the participation of the private sector, both local and international, to attract investors to develop geothermal in Indonesia that may have 27 000 MW electric respectively, the highest geothermal potential in the world. But, no much additional power plant is operated, except the upgrading of the existing combined installed capacity from 807 MW installed in 1997 and a few additional capacity commissioned in 2000, and 2007 to 2009 which is increasing its capacity to 1187.3 MW respectively.

The severe economic crisis that started in late 1997 has adversely affected power sector demand and growth in Indonesia. This has resulted in significant delays to several geothermal projects in the advanced exploration and development stages. Changes in the regulatory environment for the geothermal industry and the resolution of the economic crisis are the major issues affecting the growth of the Indonesian geothermal industry.

In spite of the issues, increasing in power demand and electricity tariff in the last three years may indicate that business climate has changed being more conducive for investment. In addition, the issuance of new Regulations on Geothermal No.27/2003, Government Regulation on electricity sector Year 2005 and National Energy Policy No.5 Year 2006, Ministry of Energy Decree No.14 Year 2008 and Ministry of Finance Decree No.177 & No.178 Year 2007, keep Indonesia being still interested in doing business in developing geothermal power. It is also a prospective of geothermal development, due to the energy crisis and the increase of international oil price to more than $100/BBL in the middle of 2008.

The issuance of those policy may attract the foreign investors to meet the increase of energy demand and PLN's (national electricity company) plan to substitute of Diesel power plant and substitute it with coal fire power plant and or another alternative energy source up 10,000 MW in the near three years.

This paper presents current Indonesian geothermal prospective, government regulation and power utilities, outlines the resulting geothermal and energy policies of with geothermal resources and overview the opportunity and challenges in its development in Indonesia.

## 1. INTRODUCTION

Indonesia is made up more than 17,000 islands with the population of 220 millions and distributed in 62,916 villages. Located between the eastern end of Mediterranean Volcanic Belt and western side of Circum Pacific Volcanic Belt, this country is blessed with abundant geothermal resources. Trial calculations indicate that forty percent (equivalence of approximately 27,189 MWe ≈ 13 Billion BOE) of geothermal energy in the earth's crust is released in the Indonesian archipelago and neighboring areas and put this country as the biggest geothermal energy potentials in the world. This country needs to be balanced in the energy mix to benefit from the clean geothermal energy. The use of renewable geothermal energy would eliminate the dependency on a single source of fossil fuels to generate electricity and meet Indonesia's growing energy demand. Therefore, the investment opportunity is now here and stands to benefit from developing its abundant and indigenous geothermal resources to provide for the country domestic needs. This geothermal energy of choice will obviously enable Indonesia to export its more portable fuels for much-needed hard currency.

To speed up geothermal development, a new regulation on the power sector and geothermal development is introduced. We hope these regulations will open the opportunities and challenges and encourage investor to develop geothermal energy in order to fulfill an increasing electricity demand of Indonesia.

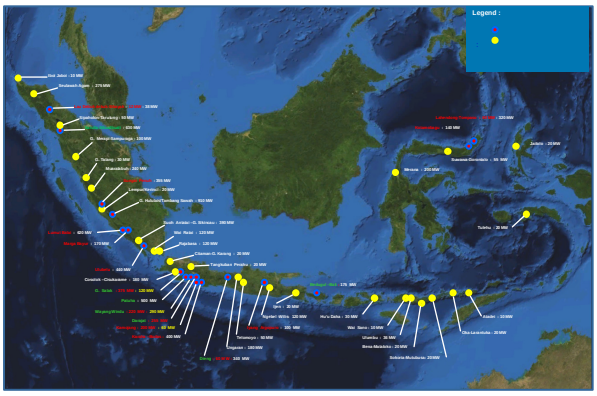


**Figure 1: Exploitable geothermal resources potential (50 fields)**

## 2. POWER REGULATION

### 2.1 Power Utilities

In the last few decade (1966 – 1998) Indonesia's GDP 6,2% per year cause the growth of electricity is 14% per year and the tariff is about 7,4 cent USD/kWh at IDR 2.400/USD). In this period, an electrification ratio is 38,7%. Total installed capacity is 21.104 MW. This condition cause the GOI and PLN agreed to process 27 Independent Power Producer (IPP) project. Since the economic crisis and transition period (1999 – 2004), GDP decrease to 1,5% per year and electricity growth demand only 1,5% per year and tariff jumped to only 2 cent USD/kWh (IDR currency is 12.000/USD). The electrification ratio is about 45%. This condition cause the negative growth at there is not any new power plant is built.

During the economic recoveries in 2000 to 2004, GDP growth is 6% per year and electricity growth is 6.6% per year. This cause 27 IPP project were re-evaluated and re-negotiated and electricity tariff are also revaluated and has been increased twice from 2 cent to 7 cent USD/kWh. This activities create the electrification ratio to be 54.8% and the installed capacity is increase to be 24.824 MW (3.720 MW addition since 1998). The issuance of the Electricity Law No. 20/2002 has been stopped by Constitution Supreme Court and reactivated Law No.15 Year 1985 and the issuance of Government Regulation No. 3 Year 2005.

Since the last 4 years, GDP growth is 6.2% peryear, electricity growth is 7.1% per year, electricity tariff is 6.86 USD cent/kWh, while PLN's production cost is 10.30 cent USD/kWh. The electrification ratio increase to 64.3% and total installed capacity 29,885 MW (additional of 5,061 MW since 2004).

In order to have the basic rules in developing power plant, GOI and PLN have issued National Electricity General Planning and General Planning for Supplying Electricity in 2004 and 2009 base on GR No. 3/2005 and No. 26/2006. In this case, GOI launched 10,000 MW accelerating crash program project, even only 10 project were on construction, 37 project were on financing step from 76 IPP project.

### 2.2 Indonesia Geothermal Law

Indonesia has the world-greatest potential geothermal, i.e. approximately 40% of the world's reserve or around 27 GWe or 13 billion barrels of equivalent oil for 30 years from successful operations of the potential energy coming from the geothermal resources of high temperature type. The utilization of such energy should be potentially improved in order to reach more than 3-4% of the today's position in the energy mix, in particular for satisfying the supply of energy to the remote areas. The development of geothermal energy in Indonesia has undergone its ups and downs owing to the lack of consistent legal basis, security for the operators that might increase the risks in their investment, and aggravated by the economic crisis that affects the commercial aspect. It is worth noting that the recent political and structural changes in Indonesia have created a business environment that is more conducive than ever before to convincing the stakeholders regarding the value of restructuring the energy sector in support of the national economy. Furthermore, the implementation of the Indonesian regional autonomy starting January 1, 2001 will give impetus to various energy projects that contribute to regional development.

The issue of commitment to and clarity of the Indonesian Government's vision, and the efforts to introduce law reforms for creating a healthy and competitive investment conditions will be an important aspect to be discussed in the developing of geothermal industry. The objective condition that has recently been developing indicates the presence of chances for the resurgence of geothermal business in Indonesia. The efforts the Government is making to gradually decrease the subsidy in Oil Fuel and Electricity would make geothermal energy to be competitive against diesel-powered electricity generating station. The Indonesian Government is fully aware that operators in the energy sector are largely dominated by global and multi-national companies, which will not only consider good business prospects when investing, but also the support of a more reliable and stable Government, and better security and certainty of law.

In order to support this effort, the legal basis required for geothermal exploitation/utilization needs to be strengthened with Geothermal Law since 23 of October 2003.

This Law regulates the upstream business of geothermal. This regulation provide certainty of law to the industry because the huge of potentials of Indonesia's geothermal resources and it vital role to ensuring Indonesia's strategic security of energy supply, and its ability to add value as an alternative energy to the fossil fuel for domestic use. In the following paragraphs we will summarize the geothermal business activities and its correlate to electricity business.

#### 2.1.1. Geothermal Business

The permit is granted to the company upon winning the tendering process to conduct economic activities for exploring and exploiting geothermal energy in specific working area. Government or Regional Government, depending on the coverage area of geothermal prospect, can issue the permit, namely IUP, whether it covers more than one region, and the utilization of the geothermal resources. Geothermal business activities has been define clearly in the Government Regulation (GR) No.59 Year 2007.

### 2.3 Energy Law

At present, the government also issued an Energy Law No.30 Year 2007 following the 2003 National Energy Policy. This law regulate the optimizing use of energy resources in Indonesia. The Law might regulate to ensure the security of energy supply even by increasing of the utilization of the renewable energy.

### 2.4 Government Regulation

The geothermal law stipulates that there shall be at least 5 implementing Government Regulations:

1) Article 9 (3) – Provisions regarding guidelines, boundaries, coordinates, area extent, procedures and requirements pertaining to offers, procurements and preparation of tender documents, and implementation of tenders
2) Article 10 (6) – Provisions on Direct Use in connection with the utilization of Geothermal Energy
3) Article 13 (3) – Provisions regarding the extent of a Work Area that may be retained for the Exploration stage and changes to the extent of an IUP area in each stage of Geothermal Energy Mining Business
4) Article 30 (4) – Provisions regarding the types and rates of Non-Tax State Revenues
5) Article 33 – Provisions regarding guidance and supervision of work and of the execution of business activities with respect to compliance of applicable laws and regulations

### 2.5 Pricing and Autonomy

Investment in geothermal development faces substantial uncertainties and continuing challenges. The industry has identified high prices, high capital costs, mining risk, long payback periods for investment, financing mechanisms, a lack of market opportunities, insufficient law and regulation, and regional autonomy as major issues impeding geothermal development.

#### 2.5.1 Pricing Policy

The pricing of steam is the main obstacle to the development of geothermal energy in Indonesia. The price needs to be competitive with other energy alternatives, and at the same time offer the contractor or producer an attractive rate of return. According to PLN, the average cost of electricity produced in 2008 is Rp.1300/kWh. On the other hands, the PLN's rupiah selling price in early 2004 is already about Rp 750 (US $0.068)/KWh, while the negotiated price is US$ 0.042/KWh in 2002 for negotiated ESCs, and as high as US $0.085/KWh for original IPP terms. IPP and ESC electricity prices have risen in rupiah terms as the rupiah depreciated. PLN is currently succed in negotiating to bring down tariff rates on various geothermal IPPs, with the intent of lowering prices from US 6-8 cents/KWh agreed under PPAs and ESCs to around US$ 5 cents/KWh. But, for the new power plant development, the attractive price for economic viable is vary from 7-9 cents/kWh. To make its happen, GOI issued the GR No.59/2007 to mandate PLN to take any power produce from geothermal. This regulation is push down a compulsory to PLN as a single off taker. The price of the energy is stipulated in Minister Energy Regulation No.14/2008 as it is revised by regulation No.5 year 2009. Even the price is done business to business, there are some needs for PLN to secure the least cost.

#### 2.5.2 Regional Autonomy

The concept of regional autonomy is still undefined and ambiguous. Investors, however, expect Regulation No. 22/1999 on Regional Autonomy to enhance prospects for development geothermal projects, since they can contribute to regional development. This is other high risk factors, unresolved decentralization issues and the potential implemented regulatory changes that are brought by a new Tax policy are able to be feasible major disincentives to the investor in geothermal projects. Once regional autonomy is fully implemented, geothermal is expected to offer a viable alternative supplying the energy needs of many of Indonesia's remote areas and does not become disincentive.

The autonomy law allows the regional government to exercise control over the development of electricity infrastructure.

## 3. POWER UTILITIES AND DEMAND

### 3.1 Energy Supply

Energy supply comes from two sources of energy that are fossil energy (oil, natural gas and coal) and renewable energy such as biomass, hydro power and geothermal. However the energy supply is mostly come from fossil energy. In the year 2002, the contribution of fossil energy to the total energy mix is around 709,825.9 BOE (94.8%), which consist of oil 392,114.4 BOE (52.2%), natural gas 169,892.7 BOE (22.6%) and coal 147,788.8 BOE (19.7%). The contribution of renewable energy is 41,638.9 BOE (5.6%) which is mostly from hydro power plant 29,843.8 BOE (4.0%) and geothermal 11,795.1 BOE (1.6%).The **table 1** shows that although the share of oil is gradually decreased, however its contribution is still dominant in supplying energy supply. On the other side, the contribution of gas, coal and renewable energy is gradually increased.

### 3.2 Energy Demand

Similar to energy supply, the growth demand of energy is also relatively high. During the period 1970-2002, the average growth rate of energy demand is around 7.3% per year. The energy demand by type of energy and users can be seen in **table 2 and Figure 2.**

## 4. GEOTHERMAL DEVELOPMENT, PPORTUNITIES AND CHALLENGES

The formed process of geothermal law is aimed at removing any obstructions that will make the competition in this sector more challenging and rewarding. For example, new opportunities for investments will emerge in the geothermal energy sector, underlying vast opening in the upstream activities and the release of the downstream sides to private sector. This is also true in oil/gas and coal mining as well as electricity business.

Academic, education, and comparative geothermal development study have bring insights on the national challenges and opportunities in the energy reform currently underway in Indonesia.

### 4.1 The National Energy Policy (NEP)

Realizing present energy condition, Government has launched the National Energy Policy (NEP) in order to enable the coordination and synergy of all stakeholders in energy sector. **The vision of the policy is guaranteeing the sustainable energy supply to support national interest**; while the **missions** are: (1) guaranteeing domestic energy supply; (2) improving the added value of energy sources; (3) managing energy ethically and sustainable way and considering preservation of environment function; (4) providing affordable energy for the poor; and (5) developing national capability.

**Table 1. The Use of Primary Energy for Electricity ( in Percentage of 2008).**

| PRIMARY ENERGY | YEAR | | | | | | |
|---|---|---|---|---|---|---|---|
| | *2008* | *2009* | *2010* | *2011* | *2012* | *2013* | *2014* |
| **COAL** | **45** | **46** | **57** | **59** | **63** | **63** | **68** |
| **FUEL OIL** | **27** | **15** | **3** | **1** | **1** | **1** | **1** |
| **Gas** | **18** | **29** | **28** | **27** | **22** | **19** | **13** |
| **WATER** | **7** | **7** | **7** | **7** | **7** | **7** | **7** |
| ***GEOTHERMAL*** | **3** | **3** | **5** | **6** | **7** | **9** | **11** |

The targets of NEP are: (1) improving the role of energy business toward market mechanism to increase added value; (2) achieving electrification ratio of 90% by the year 2020; (3) reaching renewable (non large hydro) energy shares in energy mix at least 5% by 2020; (4) realizing energy infrastructure, which able to maximize public access to energy and energy use for export; (5) increasing strategic

partnership between national and international energy companies in exploring domestic and export energy resources; (6) decreasing energy intensity by 1% per year therefore the elasticity to be 1 by 2020; and (7) increasing the local contents and improving the role of national human resources in the energy industries.

To reach the energy targets, strategies have to be taken namely: (1) restructuring energy sector; (2) implementing market based economy; (3) developing regional empowerment in energy sector; (4) developing energy infrastructures; (5) improving energy efficiency; (6) improving the role of national energy industry; (7) improving national energy supporting activities (services and industries); and (8) empowering community.

To ensure the achievement of the targets, the policy measures to be pursued are: (1) intensification measure is taken to increase the availability of energy in parallel with the national development and population growth;

**Table 2. Final Energy Consumption by Type (in Thousands BOE).**

| Year | Biomass | Coal | Natural Gas | Petroleum (Oil Fuels) | LPG | Electricity | Total |
|---|---|---|---|---|---|---|---|
| 2000 | 269,042 | 36,135 | 87,499 | 316,138 | 8,261 | 48,555 | 765,632 |
| 2001 | 268,935 | 37,098 | 84,541 | 327,695 | 8,280 | 51,841 | 779.409 |
| 2002 | 270,207 | 38,778 | 65,971 | 325,202 | 8,744 | 53,418 | 762,320 |
| 2003 | 271,974 | 32,159 | 91,700 | 321,384 | 8,766 | 55,473 | 781,456 |
| 2004 | 271,765 | 55,428 | 89,637 | 354,317 | 9,187 | 61,393 | 841,727 |
| 2005 | 271,094 | 65,862 | 90,537 | 337,976 | 8,453 | 65,644 | 839,567 |
| 2006 | 276,271 | 89,194 | 94,210 | 314,046 | 9,414 | 70,670 | 853,804 |

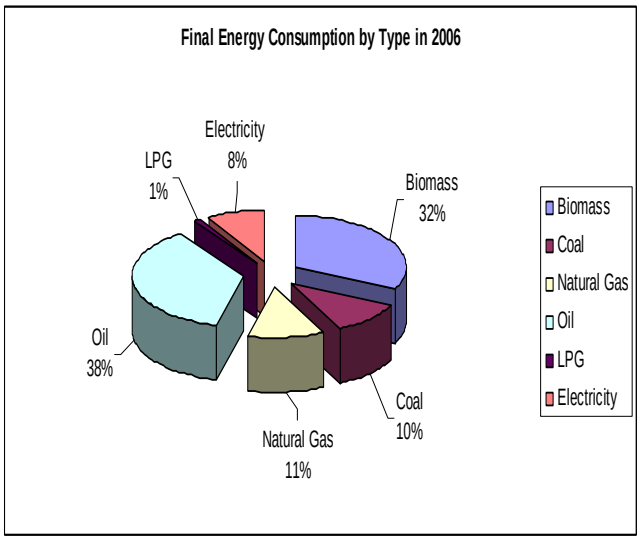


**Figure 2: Final energy consumption by type (in percentage)**

(2) diversification measure is taken to increase coal and gas shares, which have a larger potential than oil and to increase renewable energy share, which has a huge, potential and clean; and (3) Conservation measure is taken to improve energy efficiency by developing and using energy saving technology both in upstream and downstream sides.

In line with the strategies, several action plan have to be done: (1) upstream side (oil, gas, coal, geothermal, hydro power, other renewable energy resources, nuclear energy, other new energy resources); (2) downstream side (petroleum, gas pipeline, gas fuel and LPG, electricity); (3) energy utilization (household and commercial sector, industry sector, transportation sector); (4) human resources development; (5) research development; and (6) community development in supplying energy to empower the local society.

**4.2 Power Sector Development Challenges**

The main challenges of power sector and geothermal use are:

a. The energy sources are located out of the Java Island in which the highest demand of energy in the country that might cause to build some additional infra structure for electricity.

b. The transmission grid is still unsolicitaed.

c. 39.7% of population is out side of Java island which is un economically energy supply.

d. Affordability of the people is low.

e. Electricity tariff is not represented an economic viability due to the subsidy policy.

f. Renewable energy price is in-compete to other source of energy.

g. Indonesia has the world largest geothermal potential reserves, yet only 3 - 4% of these reserves have been developed for power generation.

h. Geothermal energy is a renewable and environmentally clean energy that could substitute depleting fossil energy. Its utilization produces low air emission thereby it is entitled for Clean Development Mechanism.

i. The utilization of geothermal energy as a substitute of oil fuel will reduce oil fuel domestic consumption and thus add value through higher export of crude oil and other fossil fuels.

j. Geothermal energy utilization is side specific, can only be used within its discovery area, either for direct usage or indirect usage for generating electricity.

k. The Upstream Geothermal Energy Business undertakings are similar to the upstream oil and gas business: capital and technology intensive with high risk.

l. Geothermal reserves can be found in certain remote areas that are remote from oil fuel supply facilities; its utilization could give positive impact to remote area development.

m. Geothermal energy business is different from other energy business whereby it should be managed as an integrated business from the upstream to the downstream.

n. To attract this high risk investment and produce usable energy at affordable price certain incentive programs based on law, including tax facilities, are required.

o. To be competitive with non-renewable fossil energy in the electrical power market, the geothermal business competition should be based on its "level of playing filed".

p. Geothermal Energy is a natural heat energy that is contained in hot water, water vapor, and rocks, together with by-product minerals and other gasses, all of which are genetically inseparable in Geothermal Energy systems. Its utilization requires a mining process.

q. The geothermal heat and fluid are non-mineral materials. As in the case of crude oil and natural gas which are non-mineral energy resources, it is prudent that geothermal energy business is regulated by its own law.

### 4.3 Objectives of Power Sector Development

The objective of power sector developments are: to achieve and increase the electrification ratio target from 66.3% (2009) to 67.2% (2010) and 93% (2025), while the rural electrifications are 96.8% (2009) and 100% (2010). On the regulation side, government pushes to support the investment in energy use by issuance of a regulation that might conducive to the investors. In addition, the target in renewable energy use is increasing about 0.8% per year of total national energy mix.

### 4.4 Opportunities

Energy plays an important role in achieving social, economic and environment goals for sustainable development. In most countries including Indonesia, domestic energy demand is met mostly from fossil energy sources, particularly for oil while proven reserve of oil is limited. Although contribution of oil has gradually decrease from 87.7% (1969/1970) to 54% (2002), and 37% (2008). However, totals oil consumption is relatively higher with the growth rate 6.1% per year followed by natural gas and coal. On the other hand, Indonesia's renewable energy potential are relative abundant, however, its utilization is still far below its potential.

In additional, the fact that during the period of 1990-2002, the average growth of energy demand and supply is about 6% to 7% respectively. This higher growth was particularly due to the economic growth and population growths. However, the per capita energy consumption was relatively low or about 3.37 BOE per capita, while the energy intensity is 3.39 BOE/thousand US$.

The growth rate of geothermal development for electricity in Indonesia is relatively slow until 1994, in which government stresses on a guideline for national energy policy, namely intensification; diversification of energy by means of reducing on oil depending utilization and promoting through development utilization and customary use of substitute fuel. Since geothermal is environmental friendly and reducing the global warming, the government is always modify the role of geothermal development by issuance of President Decree (PD) No.16/1974, PD No.22/1981, PD No.23/1981, PD No. 45 in 1991, PD No.49/1991, PD No.76/2000, and PD No.15/2002 . These PD were attracted 12 private sectors have signed 12 contract areas that are mostly big scale geothermal development and committed to develop and utilize geothermal energy by 3800 MW electric relatively.

The development and utilization of geothermal energy in Indonesia is of great importance, as it is expected to be capable of overcoming the domestic energy problems including those arising from the difficult access to the remote areas, replacing the role of fossil energy that can be exported for earning foreign exchange due to the state. Secondly, in anticipation of the condition in Indonesia where it is going to encounter the ever-increasing need for energy, which causes Indonesia to become a "net oil importer" nation. Government seriously support in decreasing utilize fuel oil by even such coal or renewable energy. Since 2006, government issued a regulation to allow support to develop 10,000MW crash program coal power plants. Even the government is focusing in increasing of coal fire plant, it does not mean without seeking for clean coal technology. It is only diversify energy use from oil fuel to coal. Thus, the use of renewable energy is expected to become 17% in 2025. Therefore, the utilization of geothermal energy needs to have high priority in the national energy policy for sustainability development. In addition, the participation of the private sectors to develop power plant is highly supported by government instead of PLN.

**Table 3. Geothermal Areas that Pointed the Private Sectors to Help Conduct of Preliminary Surveys.**

(dalam MW)

| No | Lokasi | Kabupaten | Provinsi | Sumber Daya* | | Cadangan* |
|---|---|---|---|---|---|---|
| | | | | Spekulatif | Hipotetif | Terduga |
| 1 | Guci | Tegal | Jawa Tengah | - | - | 100 |
| 2 | Muara Laboh | Solok Selatan | Sumatera Barat | - | - | 194 |
| 3 | Baturaden | Brebes | Jawa Tengah | - | - | 185 |
| 4 | Pematang Belirang | Lampung Selatan | Lampung | 225 | - | - |
| 5 | Kalianda | Lampung Selatan | Lampung | - | 40 | 40 |
| 6 | Rantau Dadap | Muara Enim | Sumatera Selatan | 225 | - | - |
| Total | | | | 450 | 40 | 519 |
| | | Total Potensi | | 1009 | | |

Keterangan :

* Data Pusat Sumber Daya Geologi-Badan Geologi-DESDM (2006)

### 4.5 Ten Thousands MW Crash Program Power Project Development.

The total capacity of power plant to install is 10,000 MW of coal fire power plant. This is a first generation of the accelerating crash program project. In order to fulfill the increase of electricity demand, it is accelerated by the next generation of 10,000MW crash program power plant project. It compose of 30% coal fire power plant, and 70% of renewable energy consist of geothermal and hydro. Geothermal power plant is expected about 4,733MW to be commissioned within five years since 2009 to 2014 (Table 3).

### 4.6 Future Development Planning

Up to now, energy is solely evaluated by cost competitiveness; however, this criterion will no longer be meaningful in the 21st century. We must evaluate energy by the cleanness to the global environment. From this viewpoint, geothermal energy can be regarded as one of the excellent energy sources. Cleanness of geothermal power in terms of carbon dioxide emissions ranks it second among various energy sources, following medium to small-scale hydropower. Compared to the present energy composition, geothermal power is the most effective energy to reduce emissions of carbon dioxide in terms of cost.

Economic-driven development has solely dominated in the energy production field. However, to solve the global environmental problems, government commitment development must replace it. From this viewpoint, geothermal power development could play a worldwide role in the global environmental issue, so that future development could be expected not only by market force but also by government commitment.

Government Regulation No.59/2007 on Geothermal Business Activities has been issued in 2007. Accordingly, the Geothermal Blueprint and Road-map of Geothermal Development in Indonesia until the year of 2025 were declared in 2006. In the short, medium and long-time planning of these two guidance show that government encourage the geothermal industries to explore and develop geothermal field in Indonesia.

Indonesia will be facing shortage of power in the near future due to the fact the sector has not been able to make adequate developments/investments in the power supply capacity to meet its growing electricity demand of beyond 9 percent per year. The Indonesian Government also permits other agencies and private developers to undertake geothermal preliminary studies and development for power generation or other utilization.

**Table 4. Future Development Planning and Installation of Geothermal Plant for 10,000 MW Crash Program.**

| System | 2009 (MW) | 2010 (MW) | 2011 (MW) | 2012 (MW) | 2013 (MW) | 2014 (MW) |
|---|---|---|---|---|---|---|
| Java – Bali | 117 | 5 | 0 | 330 | 445 | 1240 |
| Sumatera | 0 | 60 | 105 | 550 | 330 | 1240 |
| Sulawesi | 0 | 0 | 45 | 70 | 0 | 80 |
| Nusa Tenggara | 0 | 5 | 8 | 3 | 20 | 40 |
| Maluku | 0 | 0 | 0 | 20 | 0 | 20 |
| Total | 117 | 70 | 158 | 973 | 795 | 2620 |
| Kumulatif | 117 | 187 | 345 | 1318 | 2113 | 4733 |

In addition, the Government has initial plans to develop geothermal power plants with 2,000 MW of capacity in 2008, 3442 MW in 2012, 4600 MW in 2016, and 6000 MW in 2020. By 2025, Indonesia is expected to install 9,500 MW of power plant. PLN and GOI are expected to invite investors for tender, with electricity prices is estimated by PLN with reference to international standards as stipulated in MEMR regulation No.5 Year 2009. This regulation is issued to attract the increase of investment in facing 4733 MW geothermal plant in 2014. The future development and power plant installation expected are shows in the Table 4 below.

### 4.7 CDM Prospect

Indonesia, due to its attractive geothermal potential and geothermal expansion plans, has started to prepare for Clean DevelopmentMechanism (CDM) implementation as promoted by Kyoto Protocol. The CDM has the potential to become a powerful incentive for geothermal projects compared to other renewable energy types. Indonesia has the potential to reduce greenhouse gas (GHG) emission about 17.1 million tons of carbon dioxide (tC) along the period 1995-2025 at a cost of about US $0.80-0.78/tC using hydropower power plants. On the other hand, geothermal power plant can potentially reduce GHG emissions by 100.9 million tC at a cost of US $0.439/tC. Geothermal energy has so far not been promoted actively as means to reduce greenhouse gas emissions. This is due to the absence of groups stressing the geothermal potential at international climate negotiations. Indonesia also hopes to participate in a strategy to sell Greenhouse Gas (GHG) emissions reduction via the Clean Development Mechanism (CDM) to reduce investment costs.

The political will to develop renewable and climate friendly power projects need to be reflected in the overall energy policies. The Government of Indonesia is committed to facilitate geothermal investors in building new clean power plants and to collect their earned additional cash inflow from CDM.


There are 106 project proposals that have been submitted to the Designated National Authorities (DNA) or Komnas MPB for endorsement, of which 5 (five) are geothermal projects. In addition, from the submitted proposals, 103 have been endorsed by the DNA and forwarded to the CDM Executive Board in Germany, including 4 (four) geothermal proposals. Furthermore, from the DNA endorsed proposals, 24 projects have been registered by the CDM Executive Board, including 1 (one) geothermal project: Darajat Unit 3 (Chevron). How ever, from the registered projects, three have received CERs but no geothermal project yet.

### 4.8 Problems and Solutions of Geothermal Development

It is only for the last thirty years that geothermal potentials have been explored and developed in Indonesia. Half of these potential are found on Java and Bali, the most densely populated islands in Indonesia, which are in dear need of energy resources. The exploration and development activities are projected to solve the problem in increasing electrical demand and diversification of energy resources from oil to geothermal.

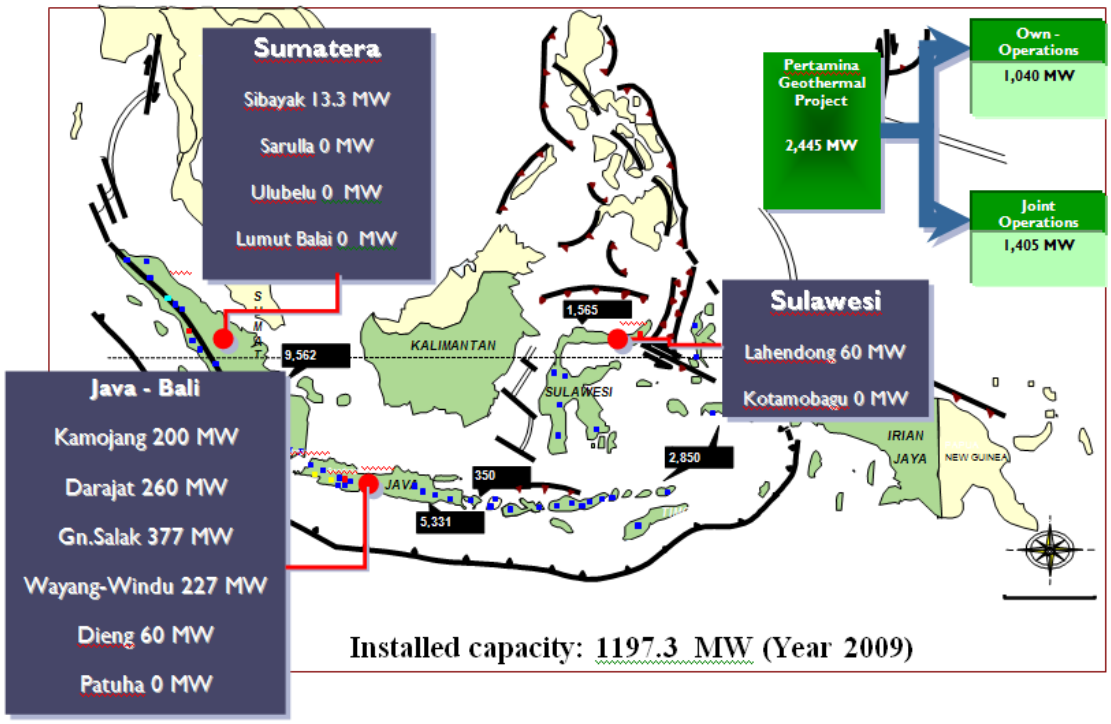


**Figure 3: The location map of Indonesian Geothermal Resources and its installed capacity**

Today, the geothermal electric installed capacity in this country has increased from 852MW in 2004 to approximately 1187.3 MW for the last six years. The developed geothermal locations distribute in 7 areas: Kamojang, Darajat, Wayang Windu and Salak in West Java; Dieng in Central Java; Sibayak in North Sumatera and Lahendong in North Sulawesi **(Fig. 3)**. It is quite apparent that the geothermal resources in Indonesia have been underdeveloped and neglected in spite of their huge potential. Due to the fact that our hydrocarbon resources, quite substantial, are not abundant, and since there is a limit to the amount of coal that we can burn. Therefore, geothermal energy has become more attractive to be trapped as an important source of energy for the first decade of this century. Accordingly, we have drawn up plans to further develop these resources, and to develop them fast.

The energy business has always been and will always remain capital intensive. It is always associated with high risk anywhere in the world. The economics of resources development is therefore playing a decisive role. Geothermal development in Indonesia is no exception to the rule. As a result of the relatively remote locations and the applicable technology, geothermal steam as an energy resource, at the present is relatively more expensive than other sources of energy available in Indonesia. We are currently in the process of improving the economics of geothermal development in order to enable geothermal power to compete with other sources of domestic energy. From the economic side, government has been gradually increase electricity price and lift-up oil subsidiary and will became marketed price. Furthermore, the Government Regulation No.3/2005 states that it gives a priority to renewable energy sources including geothermal to fulfill the domestic electricity demand. It is an obligation to the - electricity company to use at least 5% of its production come from renewable energy sources.

In an effort to accelerate geothermal development, the government has invited private participation, instead of Pertamina Geothermal Energy (PGE), national geothermal company. A Memorandum of Understanding (MOU) between Government of Indonesia (GOI) and the Government of Iceland was also signed in 2007. It is followed-up by MOU between GOI and Iceland Ministry of Energy in 2005 during the World Geothermal Congress in Antalya Turkey. This was followed by the MoU between PGE and Reykjavik were interested in geothermal areas like: Kotamobagu (North Sulawesi) and Hulu Lais in South Sumatra.

Regional autonomy starting January 1, 2001 has give significant impact on district infrastructure development. More industries will expect to grow and consequently more energy is needed. Diversification of fuel is a must to ensure a stable and economically priced electric power.

### 4.9 Investment Opportunities

The Government of Indonesia (GOI) considered to build any new big scale hydro power plant. It is contrast with its policy in the last few years due to it is seasonal dependent and also require a large area. In addition, tick river sediment causes shallower many water dams that force to temporary shutdown the power generators during the dry season. However, GOI seeking for other energy sources like geothermal to fulfill the rapid increasing demand of electricity in many areas.

To develop 4733 MW within five years, it need about 13 Billion USD to installed the power plant. There are about 19 new geothermal areas instead of 18 existing working areas that are now develop.

Investment opportunities in the indicated main businesses mention above are very high due to government's limited funds. In addition, opportunity in the field of supporting related business such as engineering, testing and other services is also open.

## CONCLUSIONS

In conclusion, we expect geothermal, being renewable energy resource, to become a significant contributor to the country's energy and livelihood sector for the future. Considering that the bulk of utilization of this particular energy source is still on high-enthalpy fields, then, much remains for development. In this respect, we invite the private sector to actively participate in geothermal exploration and development activities in Indonesia.

The new Indonesia Energy Policy, Geothermal Law and geothermal development guidance will give impetus to geothermal projects that contribute to regional development such as off-grid rural electrification and geothermal direct uses for agribusiness.

We look forward to a fruitful cooperation on technology transfer and information exchange on exploration, production and development of geothermal energy.

## ACKNOWLEDGMENT

The authors wish to thank the Ministry of Energy and Mineral Resources of Republik of Indonesia, and Indonesian Geothermal Association for their permissions to publish the paper.

## REFERENCES

Abadi Poernomo, 2009, CURRENT STATUS AND FUTURE PROGRAM GEOTHERMAL BUSINESS IN INDONESIA, Geothermal incentive Seminar, Department of Finance, May 2009, Jakarta.

Agus Purnomo, 2009, CDM FINANCING FOR GEOTHERMAL, Geothermal incentif Seminar, Departmen of Finance of Republic of Indonesia.

Fauzi, A., Bahri, S., Akuanbatin, H., 2000, Geothermal development in Indonesia : An overview of industry status and future growth; in Proc. World Geothermal Congress.

Fauzi, A., 1998, Geothermal development in Indonesia: An overview; Geothermia, Rev de Geoenergia, Vol 14(3), pp. 147-152.

Ibrahim,R.F., Fauzi,A., Suryadarma, 2005, The Progress of Geothermal Resources Activities in Indonesia; in Proceedings World Geothermal Congress, 2005, this volume.

INAGA, 2003: Comparative Study of Geothermal Development, New Zealand, API in house report.

MoE, 2003: Indonesian Geothermal Law No.27 Year 2003.

MoE, 2003: National Energy Policy, Ministry of Energy and Mineral Resources of Indonesia.

MoE, 2003: Road Map of Indonesian Geothermal Development year 2004-2020, Ministry of Energy and Mineral Resources of Indonesia.

Pertamina, 2003, Business Profile "PERTAMINA GEOTHERMAL INDONESIA : Publication of Pertamina Geothermal Division.

Pratomo, Y, 2004, National Electricity General Plan – A New Direction of Indonesian Electricity Development, Ministry of Energy and Mineral Resources of Indonesia, Jakarta.

Purwono, J, 2003: Energy Restructuring in order to increase the investment of Energy Sector.

Surya Darma, Abadi Poernomo, et al., " The Role of Pertamina Geothermal Energy (PGE) in completing Geothermal Power Plant in Achieving 10,000 MW Project in Indonesia", Proceeding World Geothermal Congress 2010, Bali - Indonesaia.

Surya Darma, Sugiharto Harsoprayitno, et al., 2009, Geothermal Energy up date: geothermal energy development and utilization in Indonesia, Proceeding WGC 2010, Bali – Indonesia.

**Table 1. Energy Supply in Indonesia (In a Thousand BOE).**

| Year | Oil (avg.) | % | Natural gas (avg.) | % | Coal (avg.) | % | Hydro (avg.) | % | Geothermal (avg.) | % | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969-1973 | 54,323.9 | 88.8 | 3,226.5 | 5.4 | 723.2 | 1.2 | 2,745.7 | 4.5 | - | - | 61,019.2 |
| 1974-1978 | 101,560.3 | 87.7 | 10,420.4 | 8.3 | 714.1 | 0.6 | 3,752.4 | 3.4 | - | - | 116,447.2 |
| 1979-1983 | 158,424.5 | 78.5 | 35,269.2 | 17.4 | 989.1 | 0.5 | 7,195.4 | 3.5 | 280.4 | 0.1 | 202,158.8 |
| 1984-1988 | 175,638.7 | 65.8 | 60,993.4 | 22.8 | 11,165.1 | 4.0 | 18,977.2 | 7.1 | 960.8 | 0.3 | 267,735.2 |
| 1989-1993 | 244,080.6 | 64.1 | 81,330.0 | 21.4 | 29,389.7 | 7.7 | 23,603.8 | 6.2 | 2,136.9 | 0.6 | 380,541.0 |
| 1994-1997 | 293,959.2 | 59.2 | 127,550.2 | 26.9 | 40,511.4 | 8.3 | 24,383.2 | 4.8 | 3,906.6 | 0.8 | 517,753.1 |
| 1998~2002 | 368,885.5 | 55.8 | 162,574.6 | 24.6 | 94,879.1 | 13.9 | 27,444.2 | 4.2 | 9,541.2 | 1.4 | 663,324.6 |

**Table 2. Energy Demand by type of Energy in Indonesia (In a Thousand BOE).**

| Year | Oil fuel (avg.) | % | N. Gas (avg.) | % | Coal (avg.) | % | Electricity (avg.) | % | LPG (Avg.) | % | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1969-1973 | 45,154.2 | 94.7 | 520.3 | 1.1 | 504.3 | 1.1 | 1,434.7 | 3.0 | 39.5 | 0.1 | 47,653.0 |
| 1974-1978 | 85,309.6 | 93.3 | 3,304.8 | 3.6 | 467.8 | 0.5 | 2,313.7 | 2.5 | 297.2 | 0.3 | 91,693.1 |
| 1979-1983 | 132,598.5 | 87.5 | 11,838.4 | 7.8 | 791.0 | 0.5 | 5,761.0 | 3.8 | 610.4 | 0.4 | 151,599.3 |
| 1984-1988 | 137,784.9 | 78.8 | 19,410.1 | 11.1 | 4,354.4 | 2.5 | 11,887.0 | 6.8 | 1,594 | 0.9 | 175,030.9 |
| 1989-1993 | 190,555.2 | 76.0 | 23,937.1 | 9.5 | 11,218.8 | 4.5 | 21,855.8 | 8.7 | 3,234 | 1.3 | 250,801.6 |
| 1994-1997 | 245,458.7 | 74.3 | 31,752.5 | 9.7 | 15,435.6 | 4.7 | 31,204.0 | 9.6 | 5,420 | 1.7 | 348,888.7 |
| 1998~2002 | 309,447.5 | 71.9 | 38,890.1 | 9.0 | 27,889.2 | 6.5 | 46,277.9 | 10.7 | 8,458 | 2.0 | 430,963.5 |

**Table 3. Energy Demand by Sector of Energy in Indonesia for year 2001 (In a Thousand BOE).**

| | Industry | % | Household | % | Transportation | % | Total |
|---|---|---|---|---|---|---|---|
| Oil fuel | 81,158.7 | 25.5 | 72,851.7 | 22.9 | 163,746.3 | 51.5 | 317,756.7 |
| Natural gas | 44,881.6 | 97.5 | 871.2 | 1.9 | 297.7 | 0.7 | 46,050.5 |
| Coal | 35,972.8 | 99.7 | 124.8 | 0.3 | 0.0 | 0.0 | 36,097.6 |
| Electricity | 22,860.4 | 25.5 | 21,051.1 | 74.4 | 0.0 | 0.1 | 43,911.5 |
| LPG | 2,507.9 | 52.1 | 73,15.8 | 47.9 | 6.9 | 0.0 | 9,830.6 |
| Total | 187,381.4 | 41.3 | 102,214.6 | 22.5 | 164,050.9 | 36.2 | 453,646.9 |

**Table 5. 19 New Geothermal Areas Are Ready to be Tendered by Local Government to the Investors. Two others are Hu'u Daha and Sorik Marapi.**

| No. | Nama | Provinsi | Potensi Pengembangan |
|---|---|---|---|
| 1 | Ijen | Jawa Timur | 185 |
| 2 | Citaman - G. Karang | Banten | 20 |
| 3 | Batukuwung | Banten | 170 |
| 4 | G. Endut | Banten | 225 |
| 5 | Rawo Danau | Banten | 115 |
| 6 | G. Karang | Banten | 170 |
| 7 | G. Pulosari | Banten | 100 |
| 8 | Segala Herang | Jawa Barat | 185 |
| 9 | G. Masigit-Guntur | Jawa Barat | 70 |
| 10 | Mangunan | Jawa Tengah | 92 |
| 11 | G. Arjuno - Welirang | Jawa Timur | 130 |
| **Subtotal Jawa Bali** | | | **1,462** |
| 12 | Sipoholon | Sumatera Utara | 70 |
| 13 | Liki Pinawangan | Sumatera Barat | 412 |
| 14 | Semurup | Jambi | 208 |
| 15 | Lempur/Kerinci | Jambi | 40 |
| 16 | Gunung Talang | Sumatera Barat | 94 |
| 17 | Bukit Kili | Sumatera Barat | 58 |
| 18 | Danau Ranau | Lampung | 222 |
| 19 | Suoh Sekincau | Lampung | 430 |
| **Subtotal Sumatera** | | | **1,534** |

**Table 6. The Investment Opportunities in Developing Geothermal Field and Its Power Plant.**

| No | Nama Lapangan | Kota / Kabupaten | Provinsi | Target Pengembangan |
|---|---|---|---|---|
| 1 | Seulawah Agam | Aceh Besar | NAD | 160 MW |
| 2 | Jailolo | Halmahera Barat | Maluku Utara | 75 MW |
| 3 | Telaga Ngebel | Ponorogo dan Madiun | Jawa Timur | 120 MW |
| 4 | Gunung Ungaran | Semarang dan Kendal | Jawa Tengah | 50 MW |
| 5 | Gunung Tampomas | Sumedang dan Subang | Jawa Barat | 50 MW |
| 6 | Cisolok Cisukarame | Sukabumi | Jawa Barat | 45 MW |
| 7 | Tangkuban Perahu | Subang, Bandung dan Purwakarta | Jawa Barat | 100 MW |
| 8 | Jaboi | Sabang | NAD | 50 MW |
| 9 | Sokoria | Ende | NTT | 30 MW |
| | | | **Total** | **680 MW** |