International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 12, December-2014

Potential of Geothermal and Hydro Power Plant in South and West Sulawesi in Fulfillment of Electricity Demand

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***Abstract* – South and West Sulawesi (Sulselbar) power system is dominated by conventional power plant fueled by fossil fuel. Power plant diversification is considered as a solution to solve the consumption issue that the total need is bigger than the availability of fuel and the price become more expensive over time as well as carbon emission. The abhorrent of hydro and geothermal potential in South and West Sulawesi possibly the implementation renewable energy (RE) – based power plant to be developed for fulfilling electricity demand in the future. Yet, the power plant development has several challenges. This paper will discuss about the potential of implementation hydro and geothermal power plant, challenges and energy policy (Kebijakan Energi Nasional) within realizing energy mix to generate electricity.**

***Key Word*– Diversification, Renewable energy, energy policy**

I. INTRODUCTION

The large amount of electricity demand in Sulselbar power system is supplied by fossil fueled-based power plant. The domination of oil, fossil and gas-based power plant causes some issues. The decreasing of fossil fuel reservation, the price becoming higher and carbon emission are sustainability problem of Sulselbar power system.

The solution that can be conducted to guarantee the long-term availability of electricity within low carbon emission is optimizing the use of renewable energy (RE) as a power generation [1]. Not only to reduce the carbon emission, but also to overcome the high cost of fuel and relying on fossil. But, the use of the renewable energy can be developed in the potential region only.

Geothermal power is one of the prime resource that can be used as a solution to fulfill electricity demand within low carbon. Comparing to wind power and solar power plant, geothermal-based power plant can generate electricity without relying on weather so that, it can supply electricity to the costumer all day long.

Based on ESDM data, South Sulawesi has several potential spot to build geothermal power plant [3]. Total power can be generated approximately 371 MW. Beside geothermal, South Sulawesi also has quite large potential to build hydro power plant.

South Sulawesi has an abundant of nickel. Mining industry is an economic sector that led to the growth of gross domestic regional product (GDRP). To use this energy resource optimally, the electricity within high quality and reliability is very important to be provided. This paper discuss about potential of geothermal and hydro energy in Sulselbar, challenge in developing and national energy policy.

II. OVERVIEW OF SULSELBAR POWER SYSTEM

South and West Sulawesi are two provinces within Indonesian territorial. Both of provinces have a power system under interconnection transmission line. Nowadays, the electrification ratio of South and West Sulawesi are 81,14% and 67,60% respectively. In west Sulawesi, the electrification ratio is still under low condition. Peak load of Sulselbar power system in 2014 is recorded 816.40 MW.

Figure 1 illustrates capacity of every sort of power plant based on the prime mover. The Total installed capacity of power is 1.421 GW. 74.6% of total installed capacity is generated by fossil fuel, 31.4% of oil fuel, 28.8% of coal and 14.4% of natural gas. Meanwhile, contribution of hydro power plant to feed the load is 25.4%.

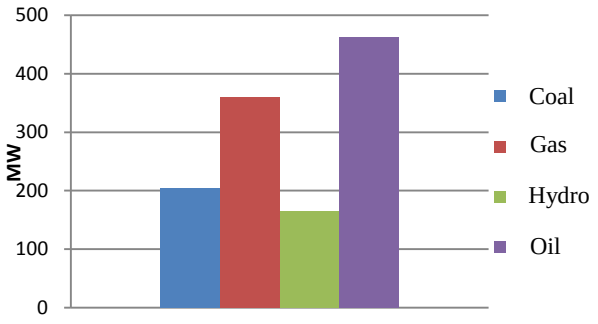

Figure 1. Power generation share in Sulselbar power System

The domination of fossil fuel-based power plant get an huge attention in mid of carbon emission reduction and sustainable energy issue. To decline the domination of fossil fuel in electricity generation, Indonesian government authorizes energy policy that is written in President decreed No. 5/2005 [1]. The regulation address to diversification of power plant by substituting renewable energy to oil such as geothermal, hydro power and the other alternative energy.

III. Growth of electricity consumption in Sulselbar

Operating the power system always try to make the power generated match with the demand in the system. The load of system becomes a problem have to be disposed first before generation development and operating system. The load will vary dynamically, caused by consumption behavior of the costumer. Peak load of the system in October 2012 reach is 732.58 MW as shown in figure 2 [5].

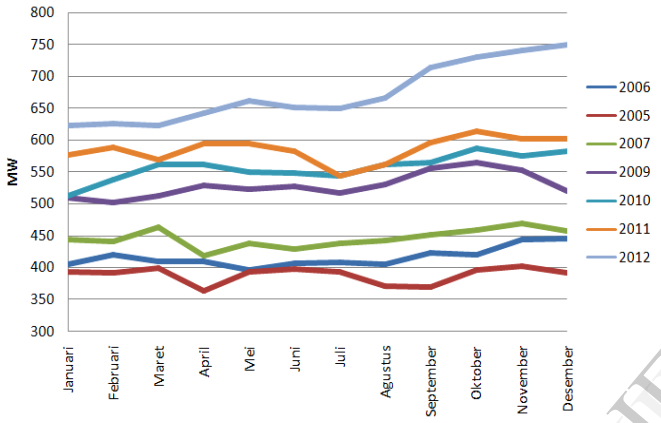

Figure 2. Grafic of peak-load

The growth of energy consumption in 2007-2013 is shown in Table I [5][6]. The consumption, number of population, the number of costumer and GDRP is increase time by time.

Table I. Growth of South Sulawesi power system

Year	Number of Population	Number of Costumer	GDRB (Billion)	Energy Consumption (GWh)
2007	7700255	1153108	1153108	41332426.3
2008	7805024	1171470	1171470	44549804.56
2009	7908519	1207786	1207786	47326078.93
2010	8034776	1274064	1274064	51199899.85
2011	8115638	1376625	1376625	55116919.78
2012	8223027	1464470	1461733	59718590.00
2013	8342047	1585608	1585608	68284430.00

Source : BPS

Most of electricity demand is majority from residential sector. In 2012, energy consumption of this sector twice to energy consumption by Industrial sector. But, the use of electricity in industrial is predicted experiencing a rapid growth. The growth is the impact of government policy that prohibits raw mine material export [4].

16.88% of the number of population in South Sulawesi live in city. Not only populous, the city is also considered as Industrial area and central of government. The data shows that almost a half of energy consumption in South Sulawesi comes from the city [4]. It is indicated that the city is the central of carbon emission concentration.

Compare to South Sulawesi, electrification ratio of West Sulawesi is under the ratio standard. But for several years the growth of costumer occurs. Figure 3 illustrates the increase of consumption in 2007 to 2012 [7].

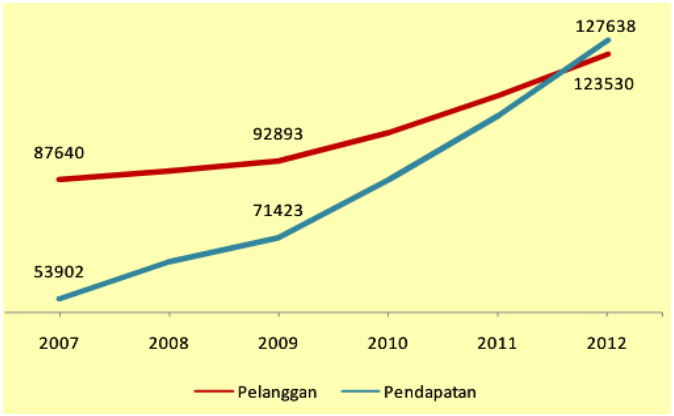

Figure 3. Growth of West Sulawesi system

IV. National Energy Policy

The first action taken by Indonesian government to supervise the use of energy based on fair fundamental, sustainable and environmental concept to create an independent and national energy sustainability is establish national energy policy. The policy is written in PP. No.5 2008 [8]. The regulation followed up by authorizing the Law No.30/2007 [9]. In 2008, based on president decree, Dewan Energy Nasional (DEN) is formalized. DEN is an nationalism and independent institution as well as responsible for national energy policy [10].

The object of regulation in PP. No. 5/2006 is actualizing mix energy optimally in 2025. Oil consumption must to be reduced by optimizing the use of renewable energy over 5% such us biofuel, geothermal, hydro power and etc. Natural gas and coal that have process by high technology is also expected to take apart in reduction of oil consumption.

Energy utilizing for electricity sector is set in Law No.30/2009. Prime energy resources to generate electricity are conducted by prior to renewable and non-renewable energy [8]. Non-renewable energy refers to the energy that process in high technology to reduce hazard substance emission such as Coal liquefaction, coal gasification and Nuclear.

Indonesia is a developing country belonged to Non-Annex membership. As a member, Indonesia has no compulsion to reduce carbon emission. Based on Protocol Kyoto in 1997, there are several developed country that must diminish production of carbon. Even though, Indonesia releases an unbounded commitment to joining in reduction of carbon emission by optimizing the use of renewable energy [11]. Mix energy in electricity generation is expected reducing the effect of greenhouse gas emission. Table II shows the comparison of carbon produce by specific power plant [2].

Table II. Comparison of carbon produtction

Power Plant	Emission during life cycle (g/kWh)		
	CO_2	SO_2	NO_x
Coal (Flue gas desulphurization and low NO_x	987	1,5	2,9
Oil	818	14,2	4
Gas (Combined cycle gas turbine)	430	-	0,5
Geothermal	79	0,02	0,28
Hydro (High scale)	3,6-11,6	0,009-0,024	0,003-0,006
Hydro (small scale)	9	0,03	0,07

V. HYDRO POWER

In Sulselbar power system, although there is a huge potential the utilizing of hydro to generate power plant is not optimal yet. Table III shows that any potential to build hydro power plant within high scale. The total of power capacity is approximately 2115.1 MW [3]. The equation to measure how much power can be generated is

$$P = Q.g.h$$

From the equation, power generated by using hydro power is depend of debit (Q) , the high of waterfall and gravitation acceleration (g).

Tabel III. Potensi Tenaga Hidro

Name	Stream of the river	Potential (MW)
Mong	Salo Walanae	255,6
Kalempang 1	Salo walane	15,5
Bonto Batu	Salo Sadang	228,3
Masuni	Salo Mapilli	53,4
Karama-1	Salo karama	800
Karama-2	Salo Karama	762,3
Total		2115,1

The debit itself is depend on topography, property of rock, tata guna lahan and rainfall. Rainfall has big influence to the amount of power generate by hydro power plant. Based on statistical report, the highest rainfall is 308 mm^3 occur in January. Meanwhile, the lowest rainfall is 3 mm^3 in august [6].

VI. GEOTHERMAL

Geothermal is power stored in the earth that is formed by tectonic activity and absorption of solar radiation. Under 6500 km depth to the surface of the earth can reach 7000^{O}C [13]. The lowest temperature that appear to the surface is often in spring manifestation use as a bathe. But for now, the thermal power from the earth is used to generate electricity.

Geothermal can be use to generate power because it has thermal energy that can rotate turbine directly or indirectly. But it is limited only to the region that has geothermal manifestation and located around tectonic plate. South Sulawesi is one of province in Indonesia that has several spot of geothermal potential. But the geothermal locates in non-volcanic area. It causes the capacity can be generated approximately 10-80 MWe [14]. Having such a potential, the model of geothermal power plant is suitable to binary steam plant. Table II shows geothermal potential in South Sulawesi

Tabel III. Potensi Panas Bumi

Site	Potential (MWe)	Site	Potential (MWe)
Limbong	*13	Malawa	25
Parara	*30	Barru	25
Pincara	28	Watampone	25
Bittuang	*12	Tedong	25
Sangalla	*25	Sinjai	**20
Watangsoppeng	25	Massepe	**80
Sulili	25	Danau Tempe	25
Lili Sepporaki	*119	Riso Kalimbua	**41

*) Hypotetic *)Possible

Most of the potential is remain in speculative statutes. But, Most of the potential is speculative statues. But there are several potential in hypotetic and probable statues. The biggest potential is Lili Sepporaki with a reservoir potential 119 MWe. To estimate how big MWe geothermal potential has, mathematically

$$P = A \times k \times (T_{reservoir} - T_{cut\ off})$$

A is width of reservoir, k is reservoir coefficient 0,1(conversion factor of thermal energy only in thermal fluid, meanwhile k=0.19 for thermal energy im fluid and rock formation. $T_{reservoir}$ is temperature of reservoir. $T_{cut\ off}$ is 180℃ [15].

Figure 4 Shows the map of potential location. The figure also illustrate topography of of Sulselbar power system.

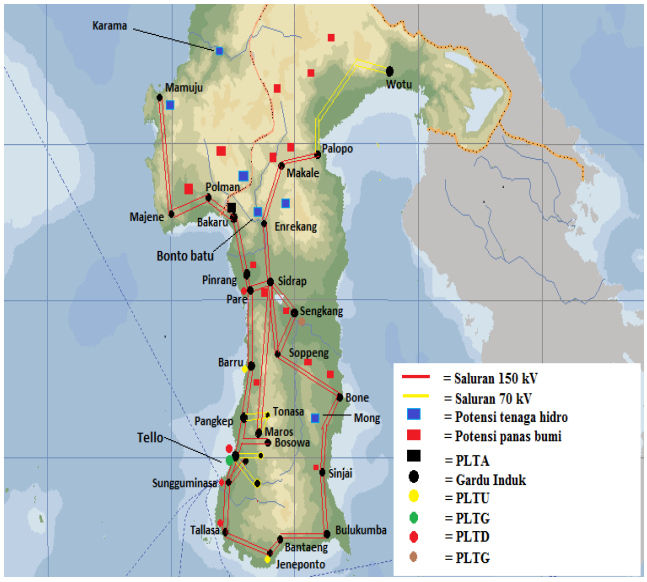

Figure 4. Topography of Sulselbar Power System and Potential

VII. CHALLENGE OF HYDROPOWER AND GEOTHERMAL POWER PLANT DEVELOPMENT

a. Topography of Sulselbar power system

Figure 4 shows the location of geothermal potential and grid connection. The transmission line consisted of 150 kV and 70 kV which is interconnected each other through substation. The system is supplied by gas , steam, combine gas and steam, diesel and hydro power plant. Micro hydro power plant with capacity under 10 MW and is connected to distribution line. That is why micro hydro power plant is not included in transmission system topography showed by figure 4.

The map of hydro power and geothermal potential shows that most of the potential located in north region. The potential is far from the big load which is in Makassar [4]. In present, most of power plants in south region consist of fossil fueled power plant which has high cost operation. This is indicated that system configuration tend to be bottleneck.

To get optimal operation, power plant that supply the load in peak-off condition done by power plant which has lower cost operation. The power plant with high cost operation supply the load to suffer the excessive load or in peak condition. Topography in fig.4 illustrate hydro power potential is far from the biggest load. It can lead to voltage drop and losses. Transmission planning is not separated to high scale power plant development.

b. Financial challenge

Geothermal development

Development of geothermal power plant has to face the financial challenge. The cost to build geothermal power plant is considered very expensive. Test drilling is one of stage of t that need more than two million dollars per well. Meanwhile test drilling need to bore at least three well [8]. Component cost is also need high cost because more components are imported abroad and also lack of skilled man in geothermal power technology causes the cost bigger.

Exploration with high cost and high probability of failure in geothermal development project make a worry to investor. Investor is doubt to invest their money to an high risk project. To solve this problem, the government gives an intensive in tax decrease. In 2010, government authorized regulation PMK 011/2010 about tax facilitation to the use of renewable energy activity. [16]. These facilities are Income tax (PPh) and value addition tax, custom and tax facility are suffered by government. This policy is taken to interest investor in geothermal power plant.

High cost development of geothermal power plant and subside in fossil fuel causes the price of electricity from geothermal is not competitive. South and West Sulawesi that is classified as region 2, the tariff of electricity is 17 cent U$/kWh in 2015 [17].

Another challenge that causes the delay in development project is the location of exploration. The project is rejected by the people who live around the area. Project area of geothermal power plant lies on conservation forest. To dissolve the problem, government legalized the law No.6/1012 that allows the power generation activity in the forest [18].

Financial problem faced in development project is paid attention by government. In 2011 government established Geothermal Fund program to support the survey activity in giving the accurate and credibility information of geothermal potential. This information is intended to ensure the investor about geothermal site.

Hydro power plant development

Comparing to the conventional power plant with similar size, operating and maintenance cost of hydro electric power plant is the lowest and has long life-time to operate [19]. Although that, the investment cost to construct a new hydroelectric plant with high scale is considerably expensive. Generally, two major cost in the project are civil work and electric-mechanic component cost.

Civil work is included DAM construction or reservoir. In development of high scale hydroelectric power plant, DAM needs a wide area and long construction time. It is different to micro hydro power plant (<10 MW), cost is lower and shorter construction time. Most of high scale power plant (>10 MW) is far from the load. The transmission expansion has to consider in development project.

Regulation taken by government to overcome the financial problem is authorized the policy with breakthrough approach. The government gives a chance to private sector to join in power generation project. To accelerate the use of hydroelectric plant, The government makes the license procedure easily and publish the regulation that manage price of electricity.

VIII. CONCLUSION

The growth of electricity utilization in Sulselbar power system increase year by year. The availability of geothermal and hydro power in South and West Sulawesi is expected can fulfill the demand in the future. In addition to reduce the operation cost of fossil fueled power plant, the use of renewable energy may lead to the realization of power plant diversification to reduce the depend of fossil fuel and carbon emission.

In development project there are technical and financial problem have to be solved. The government policy has main role to overcome the financial problem.

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