Chapter 1 Preliminary

1.1 Background

In the daily life, electricity is a vital thing and something that never released from human activity. This energy source is a fundamental needs which support any activity. Figure 1.1 shows the total use of electricity in Indonesia from 2004 until 2012. There is an increase of electricity demand in each year which also indicates that the demand of electricity will continue increase in the future.

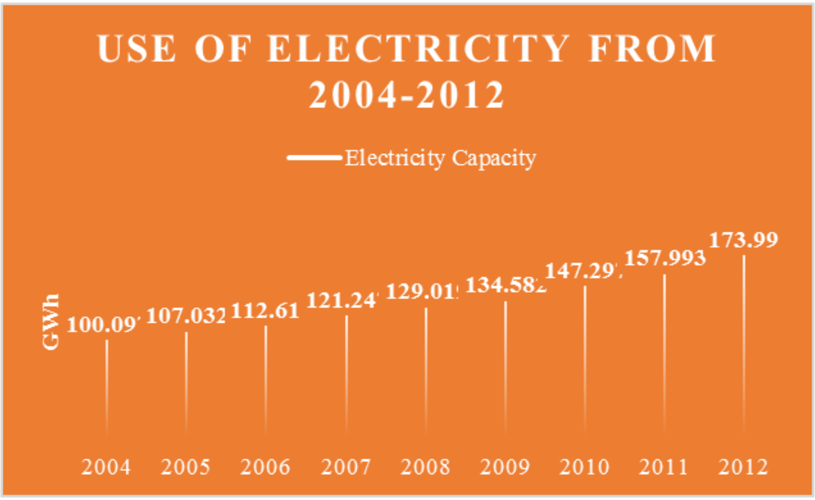

Figure 1.1 Use of electricity from 2004 until 2009 in Indonesia

Source: National Power Plant Statistic, DJK Statistic and Handbook of Energy

In Indonesia, there are various sources of power plant which also visible from Indonesian nature. Some of the types of power plants in Indonesia are: Hydropower, Steam Power, Gas Power, Combined Cycle Power Plant, Geothermal Power, Diesel Power. Figure 1.2 shows the amount of National Power installed capacity (MW) sorted by the type of power plant from 2007 until 2011. The largest power are come from Steam Power with 38%. While Geothermal Power Plant only got 3% from the whole power sources.

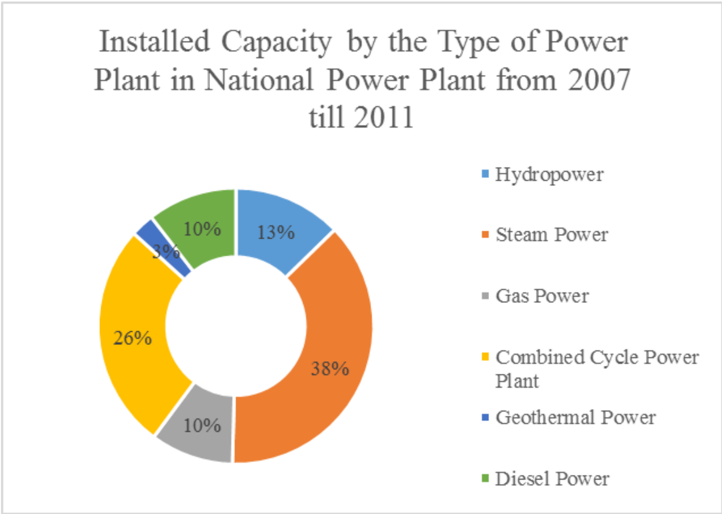

Figure 1.2 Installed capacity by the type of Power Plant in National Power Plant from 2007 until 2011

Source: BPS-Statistics Indonesia

Geothermal Energy is energy which hospitable with the environment because the residual fluid from power generation will be injected into the subsurface through injection wells. By this continues cycle so Geothermal Energy is also known as renewable energy or sustainable energy. In addition, the emissions generated are lower than emissions released by coal and petroleum. Figure 1.3 shows the comparison of the emissions generated by energy sources such as Coal, Diesel, Oil, Gas, and Geothermal. Geothermal produce the lowest emission compared to the other energy sources. Therefore, by using Geothermal energy can be ensured to reduce greenhouse emissions.

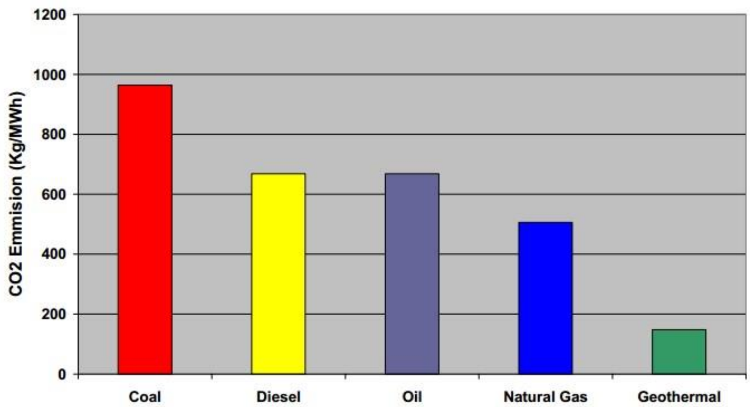

Figure 1.3 The content of emissions generated by some of the energy sources

Source: IPCC and Indonesia's First Communication Report 2009

Remembering Indonesia have so many potential natures, can be ensured that Indonesia still have so many potential energy source which has not been exploited. Table 1.1 shows how many potential areas in Indonesia as Geothermal sources and its capacity in Indonesia. There are 255 Geothermal potency areas and could reach until 28095 MWe. However many of them have not been explored yet.

This whole potential areas and its capacity can be well explored when the entire production facility is having good performance with well maintenance activity. However, the performance of production facility in each Power Plant must be measured first in order the maintenance activity can be done right on the target.

Geothermal Potential Sources areas and its Capacity in Indonesia								
No.	**Location**	**Total**	**Resources (MW)**		**Backup (MW)**			**Total (MW)**
			Speculative	**Hypothesis**	**Allegedly**	**Possisbly**	**Proved**	
1	Sumatera	84	4975	2121	5845	15	380	**13336**
2	Jawa	76	1960	1771	3265	885	1815	**9696**
3	Nusa Tenggara	21	410	359	973	-	15	**1757**
4	Sulawesi	51	1000	92	982	150	78	**2302**
5	Maluku	15	595	37	327	-	-	**959**
6	Kalimantan	5	45	-	-	-	-	**45**
7	Papua	3	75	-	-	-	-	**75**
Total		**255**	**8985**	**4380**	**11392**	**1050**	**2288**	**28095**

Table 1.1 Potential geothermal Sources areas and Its Capacity in Indonesia

Source: Volcanology & Pertamina Survey Directorat & EMR Media Center 2010, Handbook of Energy & Economic Statistic of Indonesia

Pertamina Geothermal Energy (PGE) is a subsidiary company of PT. Pertamina (Persero) established since 2006 which utilize geothermal resources to generate electricity in Indonesia. Until now, there are 14 work areas which is nine of them are managed by PT. Pertamina Geothermal Energy. Figure 1.4 shows the System Breakdown Structure (SBS) of Pertamina Geothermal Energy until it gets the systems of Unit 4 Kamojang Geothermal Power Plant which is consists of four systems then will be divided into 19 subsystems refers to its system.

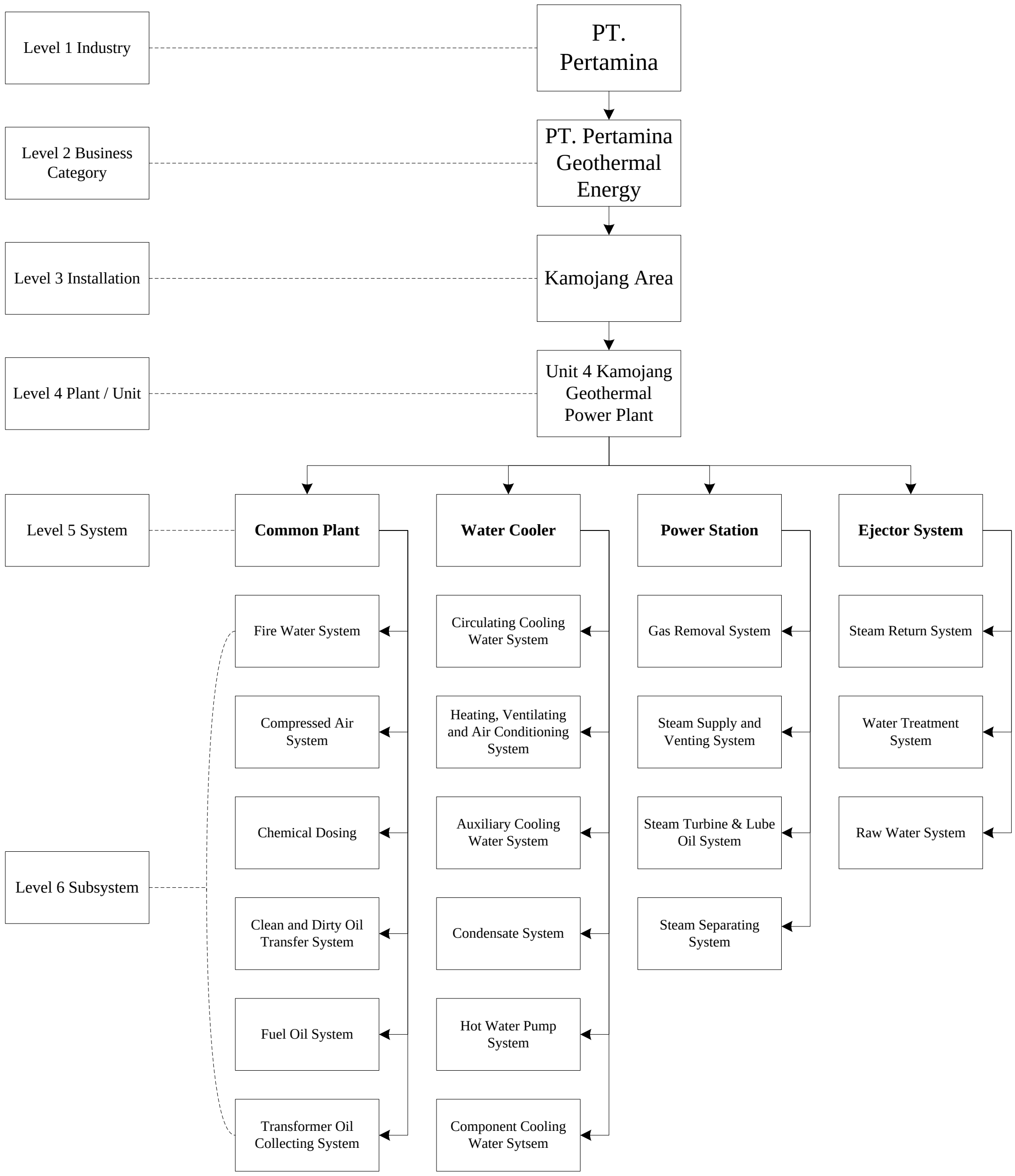

Figure 1.4 System Breakdown Structure

PT. PGE Kamojang is the first geothermal field which was inaugurated on January 29th 1983. Total generating capacity of Kamojang Power Plant is 200MW consist of Unit 1, 2, 3 with total of 140MW and 60MW from Unit 4.

The production process in Power Plant initially, the steam will come out from the well head pass through the tubes and valves towards Scrubber. The steam which is still consist of unnecessary particles such as sodium, potassium, calcium, silica, boron, ammonia, flour, etc. will be separated inside Scrubber. The steam that has been separated will be flowed to turbine and revolves the generator and later generate electrical energy. For another component that has been separated from steam, will be processed and disposed. The residual water will be injected into the ground later.

While operating, there is a value as performance measurement of Power Plant. Performance value that will be calculated as a function of time which is for one year is Reliability and Availability. Reliability is the probability that a component or system will not fail in a certain period of time. Availability is the probability that a components or system is performing it is required function at a given point in time when used stated operating condition (Charele E Ebeling 1997, Page 6).

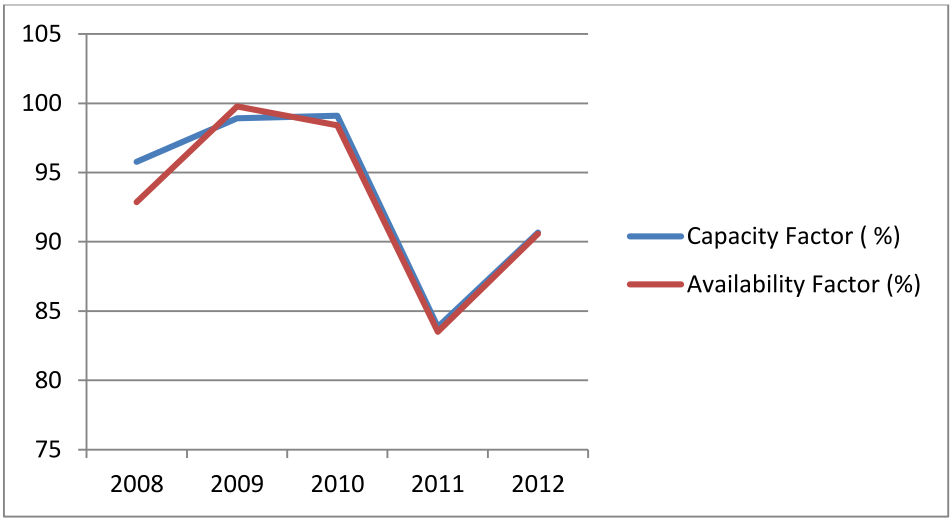

Figure 1.5 Availability factor and capacity factor performance at Unit 4 Power Plant Kamojang Geothermal

In Figure 1.5 can be seen that company Availability Factor measurement is still counted by the Capacity Factor from 2008, 2009, 2010, 2011, until 2012. In this case, equipment performance measurement is still generalized with the capacity size which controlled by operation department. At 2014 company will start to measure the equipment Plant Availability Factor by itself. Whereas the company has not specifically examine the equipment Reliability, so it need a proper Reliability analysis to measure equipment reliability and to analyze which equipment that is critical and which allegedly could disturb the production process. The method used for analyze performance equipment is Reliability, Availability, & Maintainability (RAM) Analysis. RAM Analysis is used to measure the value of Reliability, Availability, & Maintainability of the system or equipment. To do RAM

Analysis, we need to calculate the value of Reliability, Availability, & Maintainability based on failure data (Time to Failure) and repair time (Time to Repair) from system or equipment (Barbera et al, 2008), in this case is for Unit 4 Kamojang Geothermal Power Plant Main System.

In this research, the analysis using RAM Method will be centered in the using of Blocksim 9.0 software from Reliasoft. Blocksim 9.0 are software which provides a comprehensive and flexible platform to mode system and processes using Reliability Block Diagram (RBD) or Fault Tree Analysis. For knowing the Reliability and Availability, the tools that will be used is Reliability Block Diagram only.

RBD is a symbolic analytical logic techniques that can be applied to analyze system characteristics. In forming RBD is not affected by the flow of the system but only by the impact of the equipment when it fails for Power Plant Production and affected by the capacity of each equipment. Both of the factors will be discussed alter in the forming of Failure Mode and Effect Analysis (FMEA) and Equipment Configuration.

1.2 Problem Formulation

In this research can be found some problem, such as:

1. What is the Equipment Configuration of Mechanical Main System Unit 4 Power Plant Kamojang?
2. What is the Reliability Block Diagram (RBD) design of Mechanical Main System Unit 4 Power Plant Kamojang?
3. What is the Reliability Performance of Mechanical Main System Unit 4 Power Plant Kamojang?
4. Which equipment that could be critical in Mechanical Main System Unit 4 Power Plant Kamojang?
5. What is the Plant Availability Factor (PAF) of Mechanical Main System Unit 4 Power Plant Kamojang?

1.3 Research Purpose

1. To develop the Equipment Configuration from Mechanical Main System Unit 4 Power Plant Kamojang.
2. To develop the Reliability Block Diagram (RBD) design from Mechanical Main System Unit 4 Power Plant Kamojang.
3. To measure the Reliability Performance from Mechanical Main System Unit 4 Power Plant Kamojang.
4. To find out which equipment that could be critical from Mechanical Main System Unit 4 Power Plant Kamojang.
5. To measure the Plant Availability Factor (PAF) from Mechanical Main System Unit 4 Power Plant Kamojang.

1.4 Problem Boundary

1. The data that will be used is the data from OREDA, armypubs.army.mil and Power Plant Engineer Judgment
2. The distribution that will be used in this research of Unit 4 Power Plant Kamojang is Exponential Distribution.
3. The measurement are only for the Mechanical Main System of Unit 4 Power Plant Kamojang.
4. The model that will be used in this research are Reliability, Availability, & Maintainability (RAM) Analysis method and Reliability Block Diagram (RBD).
5. The software that will be used in this research is Blocksim 9.0
6. This research was not until the implementation and just limited to the research results.

1.5 Research Benefits

1. Unit 4 Power Plant Kamojang can find out what factors that could impact the value of Reliability, Availability, & Maintainability from Mechanical Main System.
2. Unit 4 Power Plant Kamojang can compile a future work system to improve the value of Reliability, Availability, & Maintainability from Mechanical Plant by improving maintenance activity.

1.6 Writing Systematic

Chapter 1 Preliminary

In this chapter will be examines the background of the research, problem formulation, study purpose, research boundary, the benefits of the research, and writing systematics.

Chapter 2 Basic Theory

In this chapter will be examines about the references for the research such as Reliability, Availability, & Maintainability (RAM) Analysis method, Reliability Block Diagram (RBD), Failure Mode and Effect Analysis (FMEA), Software Blocksim 9.0.

Chapter 3 Research Methodology

In this chapter will be examines about the research steps include: problem formulating stages, conceptual models development and problem solving systematic.

Chapter 4 Data Collecting and Data Processing

In this chapter will be examine about the data collecting and data processing. The data that will be collected is the Time to Failure, Repair Time, and Shipping Delay Time. For the data processing will be divided into Analytical Calculation and Simulation Using software Blocksim 9.0 helped by FMEA determination and Equipment Configuration determination.

Chapter 5 Analysis

In this chapter will be elaborated about the analysis of the data that already be processed in the previous chapter. The analysis is about the reasons and the causes why does the point in the previous chapter is appear.

Chapter 6 Conclusion and Suggestion

This chapter is the results or the answer of Problem Formulation that has been formed in the chapter 1. This chapter is also the final results of this research.