

# Low Emissions Energy Development for Global Climate Change Mitigation

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## Abstract:

This paper study on the potential of low-emission energy that can be developed in Indonesia, which comes from natural resources. This study is considered important as the attention of Indonesia to the increase in carbon emissions from energy and forestry sectors, as well as efforts to mitigate global climate change. Study of low-emission energy potential in this research are to: wind energy, energy mini / micro hydro, solar energy, geothermal energy, and biodiesel energy. Development of low emission energy has not reached the optimal point in the development of energy except the mini / micro hydro, and biodiesel. Development of low-emission energy in the future is expected to reach the target of national energy mix in 2025 through special policy and technology development.

**Keyword:** national energy mix, low-emission energy, the absorption of carbon emissions, the scenario optimization

## I. Introduction

National energy policy aims to guarantee the security of supply (security of supply) of energy in supporting the country's economy which is driving national development. As a country that many of its inhabitants and have a large area, distribution of development also means equal opportunity to obtain sufficient energy. One of the national energy development strategy is to increase diversification of energy with low emissions energy utilization. This is in line with the general policy that prioritizes energy utilization of domestic energy. While energy exports, especially oil and natural gas still plays an important role as a source of national income for national development.

Therefore, the development of renewable energy / low emission becomes very important and urgent to continue to be done. In addition to the national energy supply security interests in maintaining the sustainability of development, developing low-emission energy will participate took part in mitigating climate change caused by increasing concentrations of carbon dioxide gases in the atmosphere. As it is known that the burning of fossil fuels as the main source of increased concentrations of carbon dioxide (CO<sub>2</sub>). Therefore, the development of low emission renewable energy will be worth double for the national economy and global environment.

Indonesia has the potential of low-emission energy that is big enough, but its utilization to meet energy needs are still very

small. Utilization of low energy emission is still limited commercial geothermal and hydropower. The use of commercial biomass, energy biomass only for household and industrial wood (cogeneration). For that effort to develop alternative energy in Indonesia's energy structure is very important to continue to be done and developed. Some low-emission energy with the potential to be developed are: (1) wind energy, (2) mini / micro hydro, (3) geothermal, (4) biomass, (5) solar energy, (6) ocean energy. In this paper we will study all the low energy unless the energy of the sea.

This paper will provide an assessment on the low-energy emissions in Indonesia that face emission mitigation of global climate change with increasing CO<sub>2</sub> emissions in the atmosphere. The next section of the paper we will describe the carbon emissions from energy and forestry sector of Indonesia. Then on the third section will analyze the government's policy on energy mix by 2025. Furthermore, the fourth part will examine the potential of Indonesia and the emission of low energy absorption capability of carbon will be presented in the next section. Conclusions and future studies into the last part of this paper.

## 2. Carbon Emissions Projections in Indonesia

Indonesia has large reserves of oil, gas, coal and a significant moment. Existing gas will be in production until the next 70 years, in the current production level (EUSAI, 2001). Meanwhile, coal will become the mainstay of energy for domestic consumption in Indonesia (can be in production until 500 years into the future in the current production level). Meanwhile, oil energy will only survive in the next 17 years after the year 2000.

Indonesia's energy consumption is domi-

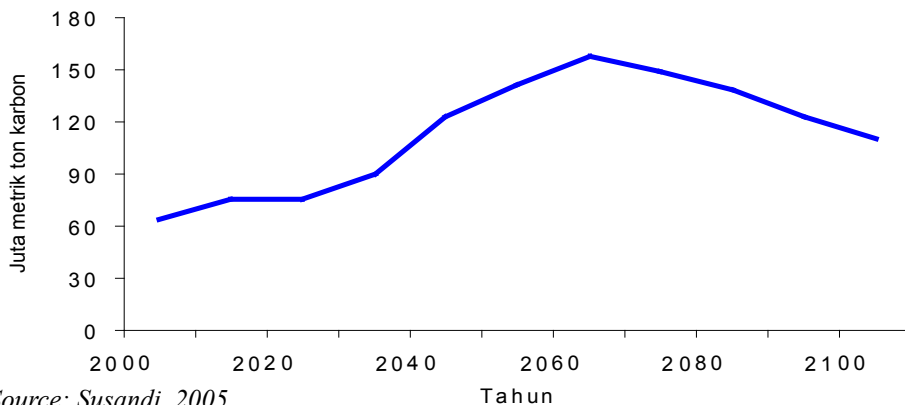
nated by energy from fossil fuels, which is about 3.9 quadrillion British thermal units (BTU) or about 95 percent of total energy consumption in Indonesia (DGEED, 2000). Oil up to now dominate the energy consumption of Indonesia, approximately 56% of the total energy in 2000. Furthermore, the gas is consumed by 31% and coal for 8% of total energy consumption in Indonesia (IEA, 2000).

From Indonesia's energy consumption level above, then in year 2000, total CO<sub>2</sub> emissions from Indonesia's energy requirement is equal to 62 million metric tons of carbon, 42% is derived from the energy industry (including power plants), the rate of growth of CO<sub>2</sub> from this source is sebesar 7% per year (other sources that an average of 3.3% per year). Furthermore, 25% of the industrial sector, 24% of the transportation sector, and 9% comes from household (SME-ROI, 1996). According to the Merge model, emissions from primary energy consumption in Indonesia amounted to 64 million metric tons of carbon (Figure 2.1). Carbon emissions from energy sector increased substantially until it reaches its peak in 2060, emissions reached about 158 millions metric tons of carbon. Furthermore, the role of emission free energy (Susandi, 2004) will dominate the next period on the market for Indonesian energy to replace fossil energy. At the end of the 21st century, emissions will decline gradually and reach 110 million metric tons of carbon (Figure 2.1).

Furthermore, from the Indonesian forestry sector also contributed no small amount of emissions, mainly from deforestation. In the report of the UNFCCC (SME-ROI, 1999) reported that changes in land use and deforestation activities has resulted in emissions of up to 42 million metric tons of carbon in 1994. In 2000, the merge of carbon emissions from deforestation activities

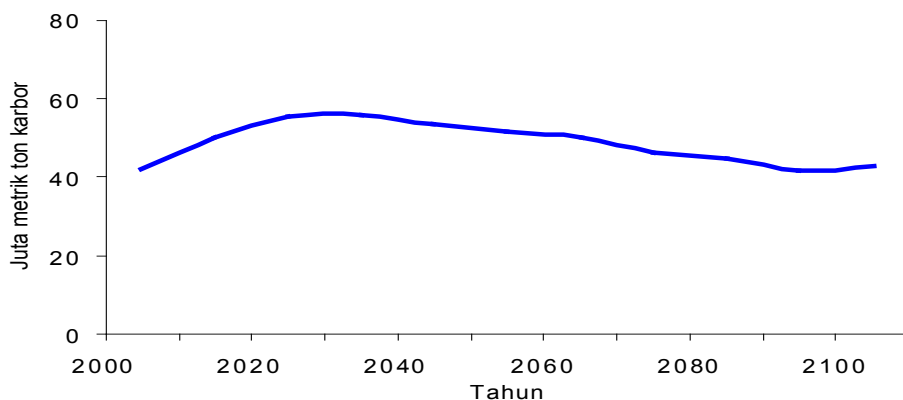
amounted to 42.1 million metric tons of carbon (Figure 2.2). In 2000 the deforestation in Indonesia is estimated at 2.3 million ha per year (Sari et al. 2001). Furthermore, deforestation activities is expected to in-

crease and reached the highest point in the year 2030 carbon emissions by 56 million metric tons. After that carbon emissions from the forestry sector will decrease gradually until the year 2100 (Figure 2.2).



Source: Susandi, 2005

Figure 2.1. Projection of carbon emission from energy sector



Source: Susandi, 2005

Figure 2.2. Projection of carbon emission from reforestation

### 3. Energy Potential Low Carbon Emission and Absorption

This section will then be assessed and quantified projections of low energy emission of Indonesia based on two scenarios, ie business as usual scenario (scenario) and the optimization scenario. Optimization

scenario developed here is a function of (1) economic growth (Y), (2) Population (P), and (3) improvement of technology (T). Each low-emission energy that will be studied below is a variation of the above functions and can vary from a low-emission energy with other low-emission energy. While the magnitude (mass) growth

is a function of the value / energy data previously. The approach used was developed with the econometric approach and the determination of the size variable using the principle of elasticity.

General equation used in the projection of low-emission energy / renewable energy (ET) is a national, as shown in equation (3.1) the following:

$$ET_t = ET_{t-1} * f\left\{\left[\frac{P_t}{P_{t-1}}\right], \left[\frac{Y_t}{Y_{t-1}}\right], \left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.1)$$

where;

$ET_t$  = Production of low-emission energy (ET) in year t

$ET_{t-1}$  = Production of low-emission energy (ET) in year t-1

$P_t$  = Population in the year t

$P_{t-1}$  = Population in the year t-1

$Y_t$  = Economic growth in year t

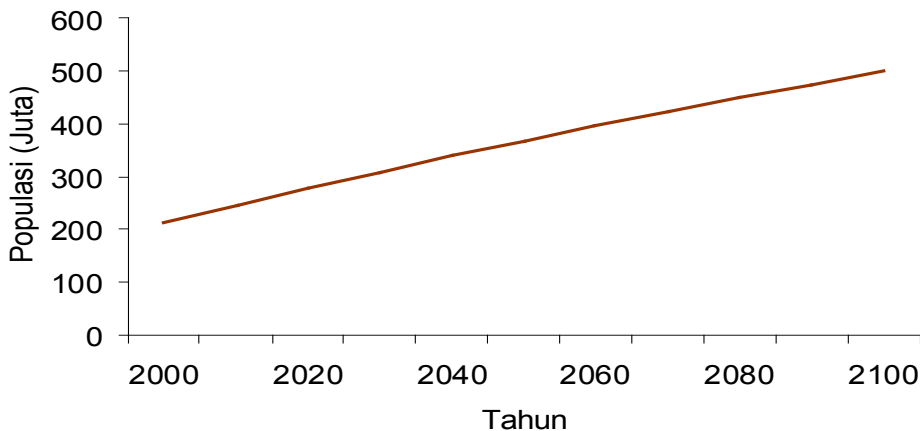
$Y_{t-1}$  = Economic growth in year t-1

$T_t$  = Improved technology in year t

$T_{t-1}$  = Improved technology in year t-1

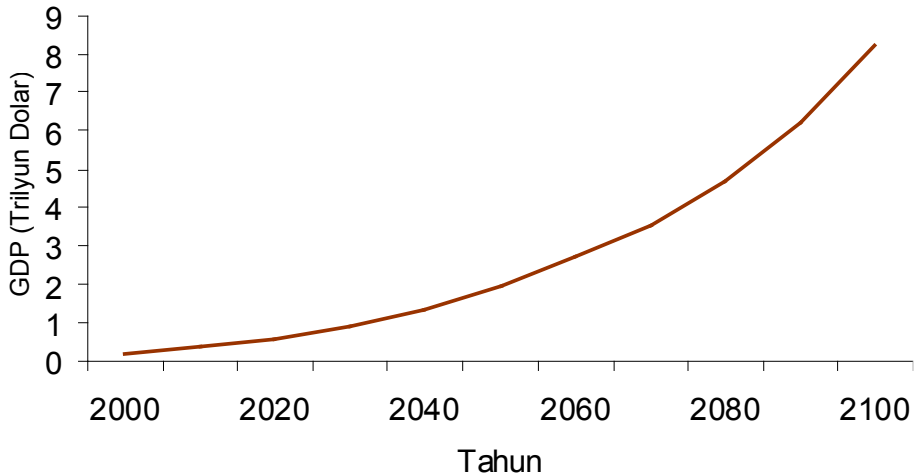
Population growth using the results of the study population and economic growth in Indonesia, which was obtained from the research Susandi (2004), while technology development is a function of per capita

economic growth in Indonesia. Population, economic development and economic per capita of Indonesia until the year 2100, respectively shown in Figure 3.1, Figure 3.2 and Figure 3.3.



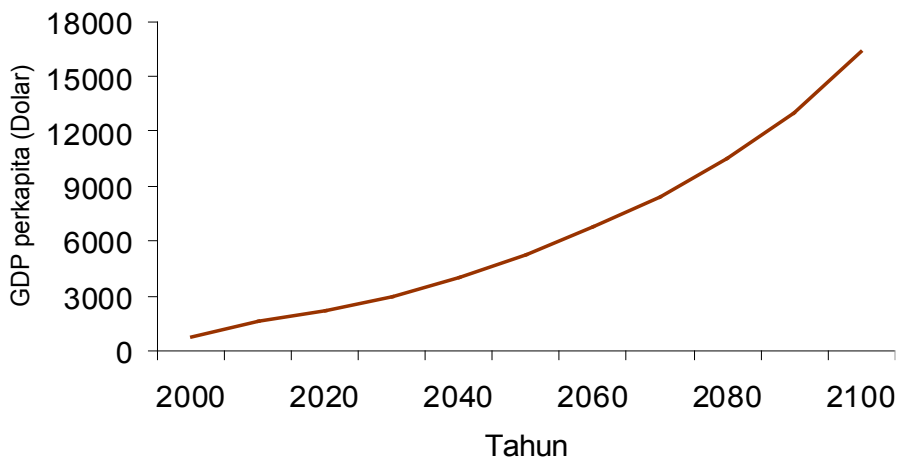
Source: Susandi, 2004

Figure 3.1. Indonesian Population Projection



Source: Susandi, 2004

Figure 3.2. Projections of Economic Growth (GDP) Indonesia



Source: Susandi, 2004

Figure 3.3. Projection of Indonesia's GDP per capita

Equation (3.1) is used as a general equation for the projection of each low-emission energy of Indonesia, which will be given in detail in the sections below.

### 3.1. Mini / micro hydropower

Energy installed capacity of mini / micro hydro power in the year 1998 amounted to 21 MW and an increase in the year 2005 amounted to 84 MW. Energy developments mini / micro hydro selected next is a function of population increment (P) and economic growth (Y). The equation used low-emission energy projections (scenario)

from the energy mini / micro hydro is the equation (3.2) as follows:

$$ET_{Mh(t)} = ET_{Mh(t-1)} * f\left\{\left[\frac{P_t}{P_{t-1}}\right], \left[\frac{Y_t}{Y_{t-1}}\right]\right\} \quad (3.2)$$

It is assumed that the business development of low energy emission from the mini / micro hydro through investment and financing policies pattern as proposed in this study will

be increased as a function of economic growth, then this scenario is referred to as the scenario optimization, so that equation (3.3) becomes:

$$ET_{Mh(t)} = ET_{Mh(t-1)} * f\left\{\left[\frac{Y_t}{Y_{t-1}}\right]\right\} \quad (3.3)$$

The projection development of low energy emission from the mini / micro hydro as given in Figure 3.4. follows:

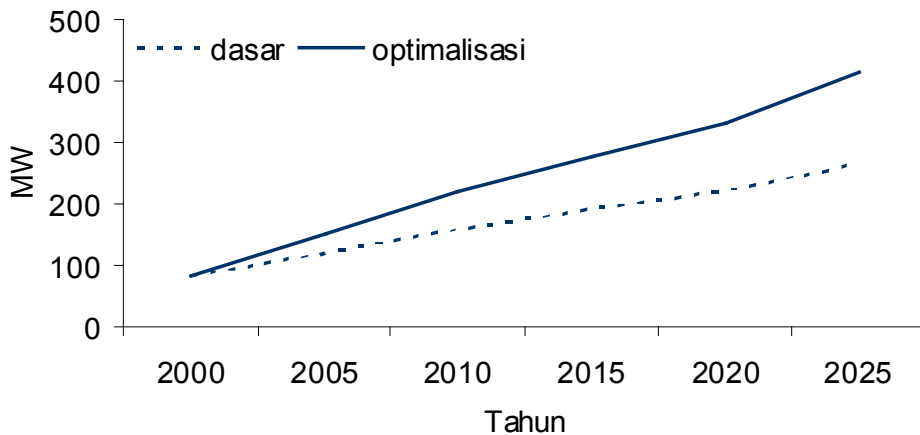


Figure 3.4. Energy Projections Mini / Micro Hydro Association and Optimization Scenario

Seen that the energy micro-mini / micro hydro rise to 264 MW (Off the Grid) or 0.08% of total national energy (target 0.1%) with the basic scenario in 2025 and reached 413 MW (Off the Grid) with the optimization scenario (exceeding the target, or 1.25%, while the target in this scenario amounts to 0.216% or a total of 330 MW (Off the Grid)).

### 3.2. Wind

Wind energy projections for the basic scenario is a function of economic growth (Y) and technological development (T), as given in equation (3.4) follows:

$$ET_{A(t)} = ET_{A(t-1)} * f\left\{\left[\frac{Y_t}{Y_{t-1}}\right], \left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.4)$$

While for the scenario optimization with the pattern of investment and funding sup-

port from governments is a function of economic growth (Y) only, see equation (3.5).

$$ET_{A(t)} = ET_{A(t-1)} * f\left\{\left[\frac{Y_t}{Y_{t-1}}\right]\right\} \quad (3.5)$$

Figure 3.5, shows projections for the basic conditions and optimization of conditions. Shown that wind energy contributes 2.1 MW (Off the Grid) in 2025 on the basic scenario and reached 2.5 MW (Off the

Grid) in scenario optimization or equal 0.014% lower than the target of 0.028%, amounting to 5 MW (Off grid), see Figure 3.5.

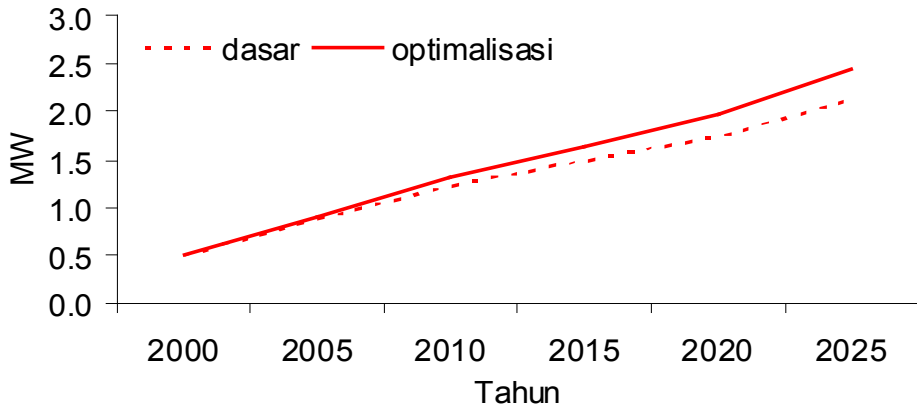


Figure 3.5. Projected Wind Energy Association and Optimization Scenario

### 3.3. Sun

Furthermore, econometric approach to the equation (3.6) will describe the low-energy projections of solar emissions, the function

$$ET_{S(t)} = ET_{S(t-1)} * f\left\{\left[\frac{P_t}{P_{t-1}}\right], \left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.6)$$

While for the scenario approach was used optimaslisasi technology functions (4.T) that spur the growth of solar energy, as the implications of government funding assis-

of the growth of population (P) and technological development (T).

tance in the development of this solar energy. Equation (3.7) describes the projection of solar energy.

$$ET_{S(t)} = ET_{S(t-1)} * f\left\{\left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.7)$$

Figure 3.7 shows the projection of the low energy emissions from solar to the second scenario, by 2025, solar energy will yield 0.007% of the total energy (primary) or na-

tional mix of 28.4 MW, while the target is to reach 0.02% or equal to 80 MW (Figure 3.3).

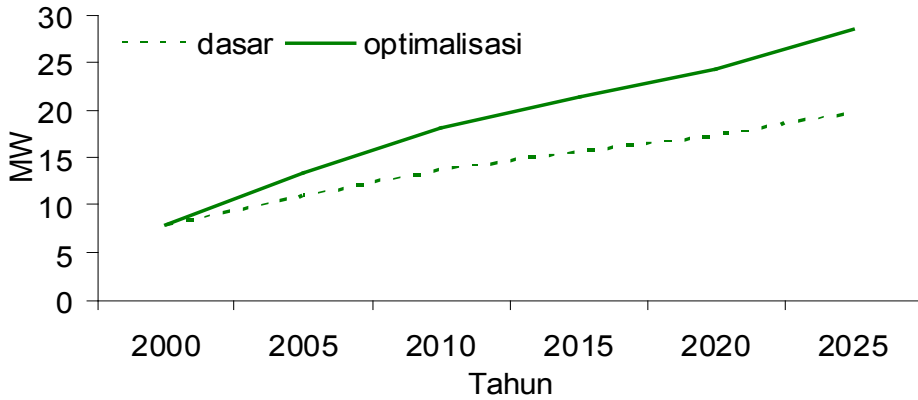


Figure 3.7. Solar Energy Projections and the Optimizing Primary Scenario

### 3.4. Biomass

Development of biomass energy is assumed to be berkembang with the growth of population (P) and increased development

of technology (T) from the biomass itself, therefore equation (3.8) provides projections for future biomass energy is the basic scenario.

$$ET_{B(t)} = ET_{B(t-1)} * f\left\{\left[\frac{P_t}{P_{t-1}}\right], \left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.8)$$

While for the optimization scenario, the development of biomass energy described

by equation (3.9).

$$ET_{B(t)} = ET_{B(t-1)} * f\left\{\left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.9)$$

Figure 3.8 shows the second projection scenario. Based on Figure 3.8, shows that the optimal scenario would increase the production of biomass reached 1175 MW

(1.111) in the year 2025 or surpass the target of 810 MW (0.766%), whereas in the basic scenario that is close to optimal target for 816 MW in 2025.



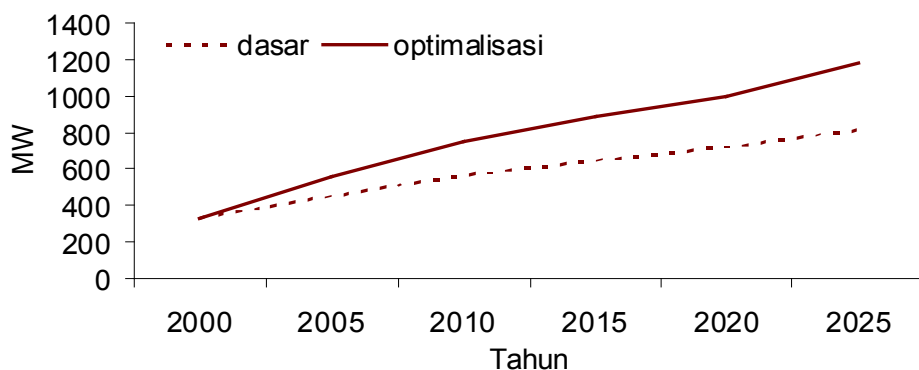


Figure 3.8. Biomass Energy Scenario Projections of Primary and Optimization

### 3.5. Geothermal

Based on an econometric model for the development of geothermal case of Indonesia, it is assumed that the development of geothermal energy in Indonesia is a

function of economic growth (Y) and technological development (T), heat the earth itself. Equation (3.10) and (3.11) provide for the basic scenario and the scenario optimization.

$$ET_{G(t)} = ET_{G(t-1)} * f\left\{\left[\frac{Y_t}{Y_{t-1}}\right], \left[\frac{T_t}{T_{t-1}}\right]\right\} \quad (3.10)$$

$$ET_{G(t)} = ET_{G(t-1)} * f\left\{\left[\frac{Y_t}{Y_{t-1}}\right]\right\} \quad (3.11)$$

Figure 3.10 showing projections of geothermal energy in the two scenarios.

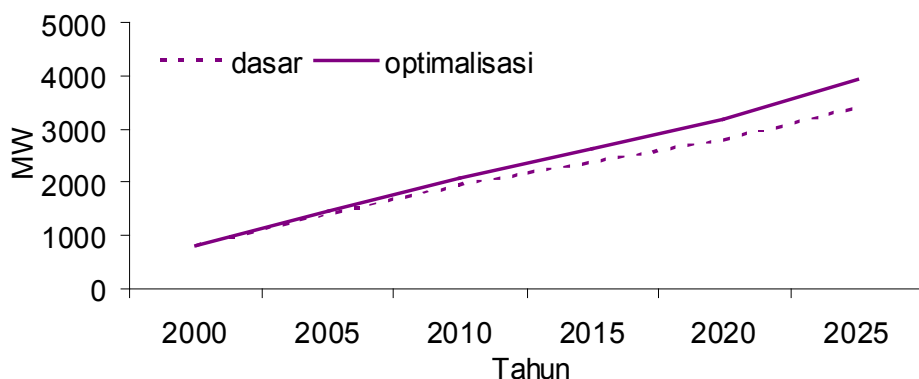


Figure 3.11. Geothermal Energy Projections and the Optimizing Primary Scenario

Seen that the Indonesian geothermal energy will only reach 3400 MW in the base scenario. While through the optimization of the model scenario shows that geothermal energy will reach 3940 MW, or contribute 1.6% of the total energy mix, lower than the target of 3.8% or a total of 9500 MW (Mineral Resources, 2005), see Figure 3.3 and Figure 3.9.

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