# Potential of Wind Energy Power in Indonesia for Sustainable Energy Development

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## *Abstract*

*This research is to investigate on the development of wind energy power in Indonesia. We used and calculated the historical and satellite wind data for ten years (1995 – 2005) in the level of 10 m, 1000 mB, and 925 mB. Using the Grid Analysis and Displays System (GrADS) software, we produced the results of this study on spatial displays of four wind period over Indonesia region. Their resolutions are 2,5$^o$ x 2,5$^o$ at level 1000 mB and 925 mB. Furthermore, we measured the density of wind power due to assess the spatial value of wind power potential for Indonesian region. The value of wind energy power density for every periode has various, at 1000 mB the value is around 0.8 to 3.1 MW/m2 and at 925 mB is 0.8 to 3.6 MW/m$^2$. The results are also show that, the south region of Indonesia simply Bali island to Timor island have a huge potential to generate wind energy power at 1000 mB and 925 mB. Indonesia hopes that wind energy power has an important role for sustainable energy development..*

**Keywords** : *Power Density, Sustainable Energy Development, Wind Energy Potential,*

## I. Introduction

Recently, Indonesia's economic growth fasted modestly since 2003 in response to the economic regional growth up. Indonesia's real gross domestic product (GDP) grew at a rate of 3.1% in 2001, growth at 3.5% for 2002, and 5.5% for 2005. The population of Indonesia is now over 230 million.

Development of Indonesia needs more energy. Excessive consumption of fuel (oil and coal) in Indonesia for an energy resources has increasing the pollution of environment (Susandi, 2004). Increasing of economic development will impact to increasing of energy demand; will implication to consume more and more pollutant for environment as well.

Energy diversification are one of the solution to fulfill energy demand, in the same time, reduction of environmental polluting will be consideration. This research will study more detail on diversification of energy, particularly the potential of Indonesian wind energy. Assessment of wind energy power is included in this study.

Monsoons period trough over Indonesia all the year and direction will change during transition period of monsoons. In the coastal area, monsoons would more powerful while gather with sea breezes. The wind over coastal line has potentiality to convert be the electric energy. However, the research related to the wind energy potential on Indonesia is not much producing yet (ACE, 2000). So, some extended research are beneficial due to developing of wind energy power (Hadi et al., 2001)

In this research, we will describe the wind of velocity in spatial term over Indonesia region. Then, we will quantified the potential of energy from wind direction over Indonesia region, particularly on the area with a minimal wind velocity at 15 km/h or more than 4,16 m/s.

In addition to, the wind energy provides significant benefits in terms of improved air quality, increased diversity in electric energy sources, local and state revenues, and employment.

## II. Methodology

### *Research Design and Data*

In this research, we used the GrADS (Grid Analysis and Display System) Version 1.8. to describe wind data, including its direction and velocity. This software is used to analyze and show a earth data collection (Doty, 1995).

A region that will used in this research is Indonesian region located at $10^ON$ – $15^OS$ and $95^OE$– $150^OE$ (Figure 1). In this study, we have used wind data at 1000 mB and 925 mB from *National Center for Environment Prediction* (NCEP).

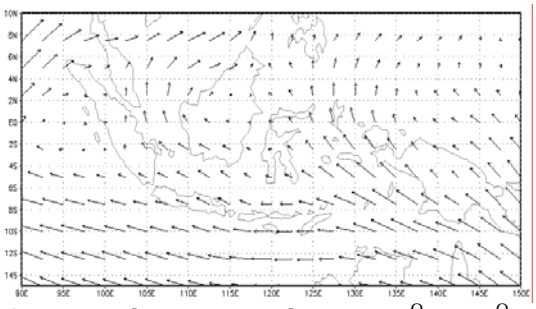

**Figure 1.** Indonesia region locate at $10^{O}$N – $15^{O}$S and $95^{O}$E– $150^{O}$E.

***Power Density***

The wind power over Indonesian region analyse will be converted to power density. We these formula below to calculate potential of Indonesia wind energy power.

The formula to calculate a wind *power density* :

$$P = 0.625\ v^3 \qquad (1)$$

where

$P$ = Power Density (W/m$^2$)
$v$ = Velocity (m/s)

(Source: Iowa Energy Center, 2006)

## III. Results

***Power Density at level of 925 mB***

The power density of wind energy at the level of 925 mB are show in the Figure 2.

The power density at the level of 925 mB is to 3.4 MW/m$^2$ (maximum value). It will occur during December, January, to February as shown in the Figure 2a. In this period, potential value of density could be convert to wind energy power is to 2.1 MW/m$^2$, because some area is located in the land. In addition to, during this period, the potential area which have a good potential wind energy spread out from south of Java island to Arafuru ocean and south-west of Borneo island (Figure 2.a).

In the month of March, April and May, this period show a maximum value of power density is to 1.1 MW/m$^2$, with a potential value could be converted be wind energy power is to 0.8 MW/m$^2$. The area are expansive from south of Bali island to Nusa Tenggara and some area at Arafuru ocean have the good potential wind energy (Figure 2.b).

During June, July and August, the maximum value of power density are higher than other months, is to 3.6 MW/m$^2$. The wind power energy is also higher than other date (is to 2.4 MW/m$^2$. During June, July, August, December, January and February the monsoons influences is higher than other months. The same area with the last period is the high potential to develop of wind energy power generation. The Figure 2 shows that location.

In the month of September, October and November, the maximum value of power density, that is low but still higher than during March, April and May. The Maximum of power density is to 1.7 MW/m$^2$, with the potential value for power generation is to 1.1 MW/m$^2$. Again, the area of south of Bali island to Nusa Tenggara and some area at Arafuru ocean have potential area that have a good potential wind energy power (Figure 2.d).

***Power Density at level of 1000 mB***

Figure 3 shows that the power density of wind energy at the level of 1000 mB.

During period of December, January and February show that the maximum value of power density is lower than 925 mB, that is to 2.1 MW/m$^2$, with a potential value for wind power generation is 1.7 MW/m$^2$. In the fact, the wind velocity is lower in the lower altitude than highet altitude. In this period, a potential area that have a good potential to develop the wind energy is located from south of Java island to Arafuru ocean and south-west of Borneo island (Figure 3.a).

In the March, April and May, conduct the maximum of power density is the same with 925 mB, is to 1.1 MW/m$^2$, but the area is wider than 924 mB area, so the potential value for wind energy power is higher (to 1.1 MW/m$^2$). South of Bali island, Nusa Tenggara and some area at Arafuru ocean (Figure 3.b) is the best location for wind energy development.

The lower altitude (1000 mB) during June, July, and August will be implicate to the lower maximum value of power density, compare to higher altitude (925 mB) is only to 3.1 MW/m2. Then the potential value for power generation is to 1.7 MW/m$^2$. In this period, a potential area that have a good potential wind energy spread out are lying from south of Bali island to Nusa Tenggara and some area at Arafuru ocean (Figure 3.c).

In the month of September, October and November, this period show the maximum of power density, the value is to 1.1 MW/m$^2$. During this period, the potential value for wind power generation is to 0.8 MW/m$^2$. In this period, a potential area that have a good potential for wind energy are spread out from south of Bali island to Nusa Tenggara and some area at Arafuru ocean (Figure 3.d).

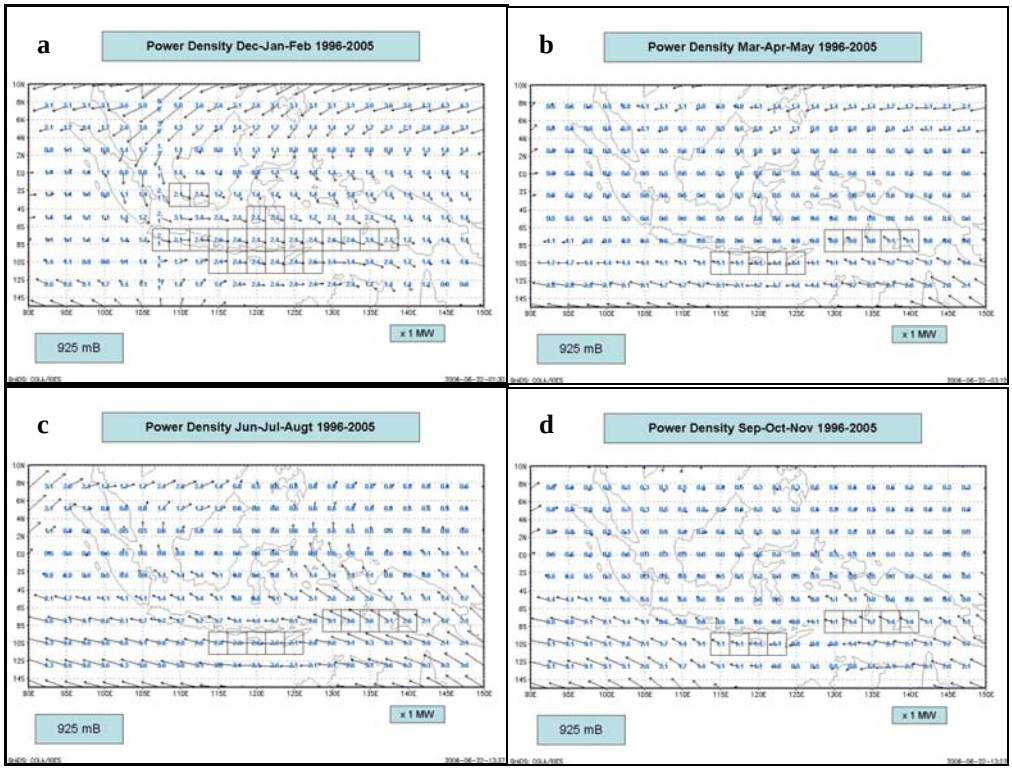


**Figure 2.** Map of Wind Power Density in Indoensia at Level 925 mB

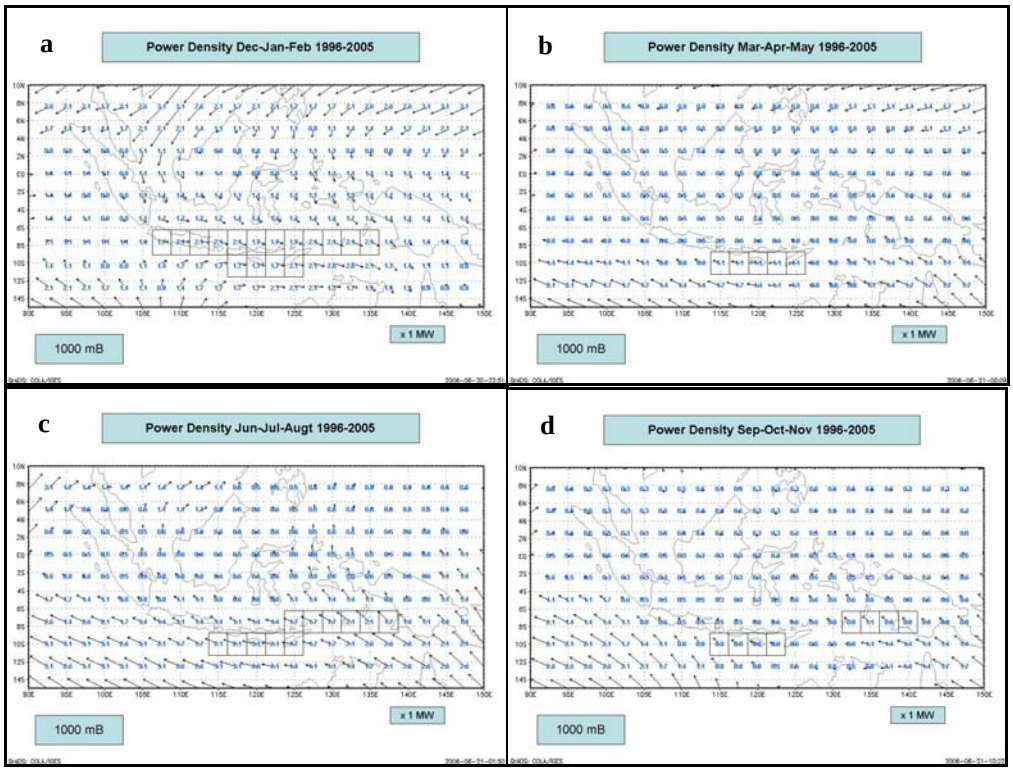


**Figure 3.** Map of Wind Power Density in Indoensia at Level 1000 mB

## IV. Conclusion

In this study was assess the potential of wind energy power over Indonesia, concerning to secure of its energy for sustainable development.

The potential of energy area in Indonesia at level level 925 mB spread out from south of Bali island to Nusa Tenggara. In this level, the maximum value of power density is 3.6 $MW/m^2$, with a potential wind power energy could be develop is to 1.1 $MW/m^2$.

In the other altitude, in the level of 1000 mB, the area from south of Bali island to Nusa Tenggara are still high potential to expand wind energy power generation.

Value of power density on period of December-January-February and June-July-August are bigger than period of March-April-May and September-October-November. The different value of two those period are caused by a monsoons. During the period of December-January-February, the velocity of wind are increased by monsoonal from north-east. And during the period of June-July-August the wind velocity are increased by a monsoonal from south-east.

Finally, Indonesia hopes that wind power generation has an important role to play in strengthening Indonesia's energy security for sustainable development.

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