The Opportunities and Constraints of Wind Energy

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Abstract. One of the most dominant energy sources is the fossil energy. However, fossil energy based power plant is one of the primary contributors of greenhouse gas which is the main cause of global warming. Besides that, the supply of fossil energy keeps on depleting along the year. Because of that, the availability of New and Renewable Energy (NRE) sources to overcome these problems are vital. Up until this moment, several types of NRE such as water energy, geothermal, and bioenergy have been utilized. However, the utilization capacity is pretty low and needs to be enhanced, either by optimizing the existing NRE or by exploring other type of non-fossil energy source as alternative NREs. One of the non fossil energy sources that have the potential is the wind energy. Indonesia has many areas that have the potential for developing PLTB because they have an average annual wind speed of 3.4-4.5 seconds or have an energy between 200 kWh / m to 1000 kWh / m. In operation, the exhaust emissions produced by wind power plants in the form of sulfur dioxide, nitrogen oxides and atmospheric pollutants are less when compared to power plants using fossil fuels. In addition, carbon dioxide emissions from wind power plants are only one hundredth of that of fossil fuels. Thus, it can be said that the development of electricity with wind power has good prospects to be applied in several regions in Indonesia.

1. Introduction

Up until this moment, wind energy is highly popular in a lot of countries all over the world, especially countries with high velocity and consistent frequency of wind for a long period such as Denmark. Indonesia is one of many countries that are trying to utilize wind at an optimum level. In Indonesia, the utilization of wind energy is pictured by building Wind Energy Power Plant. Wind energy is a non-conventional energy, developed to replace conventional energy which possesses limited amount of availability. On early 2004, the global production of wind energy is enough to fulfill the needs of 47 million people all over the world. Then why the utilization of wind energy as NRE in Indonesia is still very low?

The commitment of stakeholders is stronger by the involvement of Asian Development Bank, Norwegian Embassy, and Millenium Challenge Account Prosperity Project since 2012. As stated by Middle Sumba Regent, Umbu Sappi Pateduk, in Jakarta (25/02), “The government will fulfill every requirement stated in the memorandum of understanding because the project is vital for the prosperity of the people.” Similarly, Southwest Sumba Regency has been able to improve electricity connectivity up to 30-40% because of their “Illuminated Village” program. This achievement illustrates the effort...
of numerous parties. The case is not only more than 650 thousand of people in Sumba live in isolated areas, but they also scattered all over the island. Besides that, with the average income per capita of 2,213,104 million Rupiahs (2012; BPS), Sumba island is categorized not only as one of the poorest areas in Indonesia, but also one of the poorest in East Nusa Tenggara. “In Java, one electric pole is able to serve 50 houses, meanwhile in Sumba, 50 electric poles is required to light one house,” as mentioned by Danny Suhandi, the chief of East Nusa Tenggara Energy and Mineral Resources Agency. “If the procurement of electrical poles for 50 meters is at 30 million Rupiahs, the single cost of poles already reaches 750 million Rupiahs.” The effort has been lighter, thanks to the strong faith at institutional and individual levels. We should pay attention to the story of Sulaiman’s “adventure” to locate waterfall in 1990s as Sumba State Electricity Company manager. Thanks to him, the company was able to install 8 micro-hydro installations with total capacity of 1,800 KW. “Sumba represents the problem of energy and electricity access in East Nusa Tenggara which is already categorized in an emergency condition,” as revealed by Danny Suhandi. With the potential of 37 MW of renewable energy, SII not only act as a model for 1092 islands in East Nusa Tenggara, but also for all Indonesian islands - the chance for new partnerships and investments to realize it.

Slowly but surely SII's new renewable energy initiative is creating changes in these conditions. In 2011-2014, the electricity connection ratio in Sumba was close to 40% - an increase from the previous 25%. Importantly, nearly 10% of it comes from clean energy, i.e., 15 thousand solar power plants, 1,173 biogas installations, 100 wind power plants, and 12 micro-hydro power plants that are currently installed. The impact was clear. Since the micro-hydro supply they worked together with HIVOS and IBEKA, the maternal and child mortality rates in Kamb Sophisticate have dropped.

Unfortunately, diesel fueled generators are still the mainstay of almost all health facilities in Sumba, even though some schools, churches and villages already use solar panels. dr. Alhairani also wondered. "We need 80,000 watts for the hospital. What comes to mind: what if the diesel runs out? Can we process energy from human waste or recycle waste such as infusion bottles? " A challenge as well as an opportunity for new partners and investors to join SII and develop Sumba's new renewable energy which has a potential of up to 37 MW. (YS / FI)

2. Literature review

Four years after the NRE initiation marked with Sumba Iconic Island program is launched, electrification rate in Sumba Island is increasing up to 40% - almost 10% of this amount comes from renewable energy source. This achievement is way above the previous rate before the memorandum of understanding signing by Sumba local government, East Nusa Tenggara Governor, State Electricity Company and HIVOS, which is only 25% in 2011. Surely this achievement is driven by the installations of 15 thousand solar panels, 1,173 biogas, 100 units of wind power plant, and 12 units of micro-hydro power plant.

The actual capacity is at 4.87 MW - 15% of the targeted 32.57 MW as stated in 2014 roadmap. The 2013-2014 report of stakeholders mentioned several challenges, for example the negotiation between State Electricity Company and Ministry of Energy and Mineral Resources, or the inadequate national policy of wind sector scheme. The same thing happens with the uncertainty of investors, also geological and geographical conditions. Whereas, the available water, solar, wind and biomasses resources have the potential to reach 32 MW of electricity production, which according to the calculation of East Nusa Tenggara Energy and Mineral Resources Agency is twice of Sumba electricity requirement in 2020.

From Andri's research [1] wind energy comes from kinetic energy that is converted and is present in the form of wind. Then the wind is processed into a more useful or useful form. Meanwhile, from Kholiq Imam's research [2], it is generally stated that Indonesia is in the category of a windless country, given that the minimum average wind speed that can be economically developed as an energy service provider is 4m / s. However, there are several areas where wind energy sources are likely to be feasible to develop. These include East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), South and Southeast Sulawesi, the North and South Coast of Java and Karimun Jawa.
Wind power utilization scale is generally categorized into small, medium, and high utilization scales.

Table 1. Wind Utilization Scale Groups [4].

| Class                        | Wind Speed (m/s) | Specific Power (W/m²) |
|------------------------------|------------------|-----------------------|
| Less Potential               | < 3.0            | < 45                  |
| Low Potential (Small Scale)  | 3.0 - 4.0        | < 75                  |
| Medium Potential (Middle Scale) | 4.1 - 5.0      | 75 - 150              |
| High Potential (High Scale)  | > 5.0            | > 150                 |

Wind potential is abundant in coastal areas of Indonesia, however the total installed capacity in the wind energy conversion system is currently less than 800 kW. Based on data from AWS Truepower, wind speed in Indonesia at an altitude of 200 meters resolution is less than 6 m/s [3].

At the end of 2014, the Director of RSK Lindimara in Waingapu was not only worried about health problems. The reduced supply from Pertamina to Sumba results in a shortage of fuel. Long lines are stretched at gas stations and authorized agents. 52,755 people in the capital city of East Sumba are threatened with not getting health services.

3. Result and Discussion
Based on surveys and wind data that have been carried out since 1979, Indonesia possesses many areas with high potential as Wind Power Plant development areas because they have an annual average wind speed of 3.4-4.5 seconds or energy potential between 200 kWh/m to 1,000 kWh/m. Areas that have good wind speeds are shown in Table 2.

Out of 34 Provinces in Indonesia, East Nusa Tenggara is the most potential area, followed by several small islands in Java. Jakarta is the least potential if compared with any other provinces in Indonesia.

Table 2. Wind energy potential data in 34 provinces in Indonesia.[5]

| No. | Province                  | Potential | No. | Province       | Potential |
|-----|----------------------------|-----------|-----|----------------|-----------|
| 1   | East Nusa Tenggara        | 10,188    | 18  | Riau Islands   | 922       |
| 2   | East Java                 | 7,907     | 19  | Central Sulawesi | 908      |
| 3   | West Java                 | 7,036     | 20  | Aceh           | 894       |
| 4   | Central Java              | 5,213     | 21  | Central Borneo | 681       |
| 5   | South Sulawesi            | 4,193     | 22  | West Borneo    | 554       |
| 6   | Maluku                     | 3,188     | 23  | West Sulawesi  | 514       |
| 7   | West Nusa Tenggara        | 2,605     | 24  | North Maluku   | 504       |
| 8   | Bangka Belitung Islands   | 1,787     | 25  | West Papua     | 437       |
| 9   | Banten                     | 1,753     | 26  | West Sumatera  | 428       |
| 10  | Bengkulu                  | 1,513     | 27  | North Sumatera | 356       |
| 11  | Southwest Sulawesi        | 1,414     | 28  | South Sumatera | 301       |
| 12  | Papua                      | 1,411     | 29  | East Borneo    | 212       |
| 13  | North Sulawesi            | 1,214     | 30  | Gorontalo      | 137       |
| 14  | Lampung                    | 1,137     | 31  | North Borneo   | 73        |
| 15  | Yogyakarta                | 1,079     | 32  | Jambi          | 37        |
| 16  | Bali                       | 1,019     | 33  | Riau           | 22        |
| 17  | South Borneo              | 1,006     | 34  | Jakarta        | 4         |

Total 60,647.0
Dennis's research [6] shows that in more specific areas, 8 large areas with 17 special areas have sufficient potential. In table 3 below, the areas with the greatest potential for wind energy are Tanah Laut, South Kalimantan with a potential of 90 MW, followed by the Bantul area in Yogyakarta with a potential of 50 MW. This data is important to consider the selection of areas with good wind energy potential.

| No | Areas                        | Potential |
|----|------------------------------|-----------|
| 1. | DIY Yogyakarta               |           |
|    | Gunung Kidul                 | 10 MW     |
|    | Bantul                       | 50 MW     |
| 2. | Belitung Timur               | 10 MW     |
| 3. | Tanah Laut                   | 90 MW     |
| 4. | Selayar                      | 5 MW      |
| 5. | Buton                        | 15 MW     |
| 6. | Nusa Tenggara Timur:         |           |
|    | Kupang                       | 20 MW     |
|    | Timur Tengah Selatan         | 20 MW     |
|    | Sumba Timur                  | 3 MW      |
| 7. | Maluku:                      |           |
|    | Ambon                        | 15 MW     |
|    | Kei Kecil                    | 5 MW      |
|    | Saumlaki                     | 5 MW      |
| 8. | Tual, Saumlaki,              | 3455.8 to 11861.4 watt |
|    | Bandaneira, dan Naha         | day/year  |

Establishment of wind resources and approval for wind farm procurement is the longest process for wind energy project development. This can take up to 4 years in the case of large wind farms and requires extensive environmental impact studies. In its operation, the exhaust emissions produced by wind power plants in the form of sulfur dioxide, nitrogen oxides, atmospheric pollutants are less when compared to power plants using fossil fuels. In addition, carbon dioxide emissions from wind power plants are only one hundredth of that of fossil fuels. However, this wind power plant is not completely environmentally friendly; there are several problems that occur due to the use of wind energy sources as power plants, including visual impacts, noise, some ecological problems, and beauty. Visual impact is one of the most criticized. The use of wind farms as power plants requires a large area of land and is impossible to hide. Apart from disturbing the view due to the installation of turbine rows, land use for wind generation can reduce agricultural land and settlements. This is what limits wind power generation on land. Several regulations regarding building height have also hampered turbine construction. The use of high poles for wind turbines can also cause disruption of sunlight entering people's homes. In addition, it causes flickering sunlight and can disturb the views of local residents.

The use of a gearbox and generator can cause mechanical noise as well as electrical noise. In certain circumstances wind turbines can cause electromagnetic interference, interfere with television signal reception or microwave transmission for communication. The determination of the height of the wind turbine is done by analyzing wind turbulence and wind strength data. Aerodynamic noise is a function of many factors such as propeller design, rotational speed, wind speed, inflow turbulence. Aerodynamic noise is an environmental problem; therefore the rotational speed of the rotor should be limited to below 70m/s. Some scientists argue that the large-scale use of wind power generation can change the local and global climate because it uses wind kinetic energy and changes the turbulence of air in the atmosphere.

The ecological effect that occurs from the use of wind power is on bird and bat populations. Birds and bats can be injured or even killed by flying past a rotating propeller. However, this impact is still
smaller when compared to the deaths of birds due to vehicles, power transmission lines and other human activities that involve burning fossil fuels. In several studies that have been conducted, the existence of this wind power plant can disrupt the migration of bird and bat populations[7]. The construction of wind generators on land with less good soil structure can also cause land damages in the area.

Offshore wind farms have their own problems that can irritate seafarers and sailing ships. However, it is hoped that offshore wind farms can become a place for the growth of new fish seeds. Since fishing and sailing in the area around wind farms is prohibited, fish species can be preserved by overfishing in the sea[8]. Rural and isolated areas are potential areas to develop renewable energy sources because of several reasons [9] such as: it gives a chance to increase added value of renewable energy source in rural areas, renewable energy technology offers a benefit of low operational cost, also categorized as environmental friendly energy because it causes no pollution, which would increase awareness of environmental preservation and several renewable energy usages can be practiced by utilizing high local wisdom availability.

The main obstacle is the society’s lack of understanding on renewable energy’s technical, economical, or characteristic (for example: the site specific, fluctuative, and intermittent natures of renewable energy). Renewable Energy Potential in Indonesia is huge. The potential and utilization of Renewable Energy based on the Ministry of Energy and Mineral Resources is described in the following table:

| No | Type of Energy | Potential (MW) | Capacity Installed (MW) | Percentage |
|----|----------------|----------------|-------------------------|------------|
| 1  | Geothermal     | 29,000         | 1440                    | 5%         |
| 2  | Bioenergy      | 34,000         | 1740                    | 5.1%       |
| 3  | Hydro (Water)  | 19,000         | 5250                    | 27.6%      |
| 4  | Sea            | 61,000         | 0.28                    | 0.0005%    |
| 5  | Wind           | 107,000        | 3.61                    | 0.0034%    |
| 6  | Solar          | 560,000        | 70                      | 0.0125%    |

Source: Ministry of Energy and Mineral Resources, 2016

4. Challenges
The use of fossil energy sources in the country will face various obstacles, increasingly expensive prices, complex energy distribution and often experiencing weather constraints, and increasingly heavy environmental burdens. By looking at this fact, renewable energy will increasingly have a strategic meaning, especially for sustainable rural economic development. With the growing use of renewable energy for energy supply and electricity in rural areas, it is hoped that it will encourage on the one hand an increase in domestic capacity for the design and fabrication of Renewable Energy technology and reduce the initial investment costs for the Renewable Energy technology system, on the other hand.

The prospect of wind power development is quite high even though there are several obstacles. In Indonesia, there are several obstacles or challenges such as:

- Low wind velocity.
  To rotate the turbine blades or blades, a minimum wind speed of 5 m / s is required, while the average wind speed in Indonesia is 3 m / s, therefore further research is needed on the type of blade that should be used for the Indonesian region, especially mountainous areas or beach.

- High investment cost.
  Research to develop wind technology currently still requires a large amount of money, while energy management in Indonesia for renewable energy is still incomplete. The 2025 energy mix plan does not specify what and how to develop wind power in Indonesia. How much is the allocation of funds and how it will be managed is still a question mark.
If the solutions to these two challenges can be found, then the development of electricity with wind power will have more prospects in the future, although not on a large scale. The use of this wind technology will be suitable to be applied in areas of Indonesia that have wind speeds that are quite large or that are not easy to reach with ordinary electricity distribution networks such as the Maluku Islands and North Sulawesi.

5. Conclusion

Although these environmental impacts are a threat in the development of wind power plants, but when compared to the use of fossil energy, the impact is still much smaller. In addition, the use of wind energy in electricity has also contributed to reducing exhaust emissions. The use of innovation in technology, however, always raises new problems that require new technological solutions. Therefore, we as people who are engaged in Science and Technology must be able to continue to develop technology that is more environmentally friendly which has the least possible negative effect. Thus, it can be said that the development of electricity with wind power has good prospects to be applied in several regions in Indonesia.

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