Utilization of wind energy in Belu District to improve community welfare and support environmental friendly development

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Abstract. The border area geographic of Indonesia and Timor Leste, especially Belu District, has a large potential source of natural energy. But unfortunately, the potential of wind energy cannot be explored to improve people's welfare and to support sustainable development. This study found the potential for wind energy of 120 Megawatts which can be developed into electricity for the benefit of the people of Belu Regency, East Nusa Tenggara. The potential points are in Laktutus and Lookeu, Belu District. The research method used quantitative and qualitative participatory observations in the field study. If this wind potential can be developed by the local government of East Nusa Tenggara, it can encourage economic growth and home industries in Belu District. This finding is an important recommendation material for the East Nusa Tenggara Provincial Government in assessing development and implementing environmentally friendly and sustainable development activities.

1. Introduction

This research is an advanced stage of research from previous research that was completed in 2018 regarding "Mapping of green energy at the Indonesian border of Timor Leste" with a point in Ainiut Village, Timor Tengah Utara (TTU) District as a locus preliminary survey. An article has been published in scopus international proceedings with title “Mapping the potential of green energy to border societies of Indonesia and Timor Leste (a preliminary study) accessed on the MATEC Web of Conferences 197, 13006, 2018. [1]

Academically, the first research was successfully carried out. However, from the implementation aspect, it cannot be carried out properly for several reasons. There were problems at the first study site (Ainiut Village) due to the difficult geographic location and protected forest areas that the government did not allow a wind power plant to build there. Thus, the second stage of further research development point covers other geographic areas on the border of Indonesia and Timor Leste, which is focused on Belu District by considering the ease of access and the assumption that wind energy availability is assumed to be sufficiently available.

Secondary data (satellite photos) proves that there are several wind points scattered in the geographical area of Belu District. The provisional assumption is a satellite detection of the availability of wind energy at Laktutus and Lookeu with a total wind potential that is adequate to build the potential for electricity in these locations. Therefore, the purpose of further research at this stage is to map the location of wind points and install wind test kits to verify the wind potential found in Laktutus and Lookeu, Belu District. The measurement took 6 months to get the level of accuracy of wind potential that could be developed for the construction of a wind power plant in Belu District, East Nusa Tenggara Province.

The main research questions of this study are:

a) Is there wind energy potential in the Laktutus and Lookeu geographic areas?
b) How big is the wind potential in Laktutus and Lookeu to build a wind power plant?
c) What is the impact of this wind power plant development for community welfare and environmentally friendly development?

The general objective of this research is to map the availability of wind energy in Belu District, the border geography between Indonesia and Timor Leste. Meanwhile, the specific objectives of this research are: to prove the availability of wind energy in the Belu District area, to measure the potential for wind in Laktutus and Lookeu which has the potential to develop a wind power plant, and to identify the impact of wind power plant construction for local communities and environmentally friendly development.

2. Method
This research applies quantitative and qualitative methods, namely field research in the form of participatory observation in Belu District supported by relevant secondary references. Primary research using wind test equipment and observation at the research location in Belu District, Timor Island. Library research (secondary sources) uses books, journals and online media which contain research materials. The data analysis technique uses the reduction of the finding data as objective facts in the field and is combined with interpretive analysis to give meaning to existing research data.

3. Result & Discussion

3.1. Geographic area of Laktutus and Lookeu, Belu District, East Nusa Tenggara
The majority of the population in the geographic area of Laktutus and Lookeu are local indigenous people with several other immigrants from areas in Belu District and Malacca District and also North Central Timor (TTU). Road access is quite good, only a few roads are slightly damaged due to landslides during the rainy season. The Laktutus and Lookeu people live simply and are friendly to the environment and carry out traditional lives by relying on agricultural livelihoods as the main support for their lives.

The community grows various crops such as rice, corn, yams, bananas, orange papaya, coffee and vegetables. The community also raises cattle, pigs and chickens in this area. Even though there are many crops, people still find it difficult to market their products. Economic growth in this region is classified as slow, due to a lack of public purchasing power and inadequate infrastructure. People still need water, electricity and better-quality roads. "We really hope the government can help us to develop better economically," Fr. Christo Tara, the Catholic Priest in Laktutus.

Agustinus Berek (Head of Laktutus Village) said that the superior agricultural products in the area include: oranges, bananas, candlenuts, coconuts, coffee and other plants. These plants are of great economic value to local people in supporting their survival. Another thing that is also interesting is that the access roads that are paved are good enough to increase the smoothness of transportation to the city for the sale of agricultural products. Even though the produce and its natural beauty are like a painting of heaven, this area has not been explored further to find the legacy of Laktutus which is increasingly certain and definitive for the welfare of the community.

Kristo Tara and his community strongly object to mining in this area. "Mining is destructive to the land and is not environmentally friendly, so we reject every businessman who carries out mining activities here", said Pastor Kristo. He hopes that development activities in Laktutus pay attention to environmental ecological aspects and community wisdom and local culture.

Geographically, Laktutus and Lookeu is a location right on the border of Indonesia and Timor Leste. To the east, there is Fatumea Village, the Democratic Republic of Timor Leste. In Laktutus, there is also a border post that is closely guarded by the Indonesian National Army (TNI) which is tasked with maintaining security in the border area. Laktutus includes Nanaet Duabesi District, Belu Regency, East Nusa Tenggara Province.

Natural conditions are very fresh and beautiful because there are many forest areas. Located at an altitude surrounded by verdant hills, Laktutus has the potential to blow strong winds almost every
time, day and night. “The wind here is very strong. In the rainy season when there is a storm, the roof of the house is often blown by the harsh wind”, said Mr. Agus when interviewed some time ago.

Based on secondary research, obtained data on the existence of adequate wind potential in Laktutus-Lookeu-Belu Regency, East Nusa Tenggara Province. It is predicted that there is wind potential that can be explored to develop wind-powered electricity. There is an opportunity to build an 80-to-120-Megawatt wind power plant. Primary verification process using wind test power is required to ensure more accuracy (primary data). For this purpose, two (2) wind test towers were built, each 120 meters high at Laktutus and Lookeu to measure wind speed at the site.

3.2. Construction of wind test equipment and wind potential measurement

Mr. Yoseph, who is in charge of Laktutus, said that so far the measurement results were positive, so related parties needed to take important steps to immediately bring wind power plant to the welfare of the people at the border between Indonesia and Timor Leste. “There is a potential of 120 megawatts. If this wind power plant is finally established, it will have a big impact on improving the economy, tourism, culture and the lives of the people of Laktutus and Lookeu themselves,” said Yoseph. The same thing was emphasized by Mr. Adrianus who said that the wind gauge at Laktutus-Lookeu had been running well and showed positive results. Mr. Adrianus hopes that accelerated steps need to be taken, especially the licensing and construction of the West Timor wind power plant in the era of President Jokowi's volume II leadership.

![Figure 1. Mapping of wind potential locations in Lookeu](image-url)
Figure 2. Mapping of wind potential locations in Laktutus

Figure 3. Wind tower test at Laktutus
Figure 4. Wind tower test at Lookeu
3.3. Utilization of Wind Energy in Belu District to Improve Community Welfare and Support Environmentally Friendly Development

Research related to wind energy are quite widely developed by world scientists. Several recent international publications related to this field of wind energy research. The research at Laktutus and Lookeu, Belu District, is relatively new and has never been done by other researchers before.

Ge et al (2019) Wind power dispatching method based on high-voltage and large capacity electric heat storage[2], Ayyarao (2019) Modified vector controlled DFIG wind energy system based on barrier function adaptive sliding mode control[3], Lledo et al (2019) Seasonal forecasts of wind power generation[4], Rubert et al (2019) Wind turbine lifetime extension decision-making based on structural health monitoring[5], Xu et al (2019) Positive ecological effects of wind farms on vegetation in China’s Gobi desert[6], Perlman et al (2019) Socio-technical constraints in German wind power planning: An example of the failed interdisciplinary challenge for academia[7], Zarate-Toledo (2019) Justice, social exclusion and indigenous opposition: A case study of wind energy development on the Isthmus of Tehuantepec, Mexico[8], Tagliapietra (2019) Estimating the cost of capital for wind energy investments in Turkey[9], Lyu et al (2014) Wind power accommodation by combined heat and power plant with electric boiler and its national economic evaluation[10], Cai et al (2018) Improving wind power utilisation under stormy weather condition by risk-limiting unit commitment[11], Enevoldsen et al (2016) Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France[12], Sovacool et al (2017) Cost performance and risk in the construction of offshore and onshore wind farms[13], Manwell et al (2010) Wind Energy Explained: Theory, Design and Application[14], Jobert et al (2007) Local acceptance of wind energy: Factors of success identified in French and German case studies[15], Zoellner et al (2008) Public acceptance of renewable energies: Results from case studies in Germany[16], Enevoldsen (2016) Onshore wind energy in Northern European forests: Reviewing the risks[17].

It is predicted that the finding of 120 megawatts of wind power-based electricity can be further explored to support the achievement of increased community welfare and realizing environmentally friendly development activities. The Bishop of Atambua, Mgr Dr. Dominikus Saku, said that this power plant project was a starting point for realizing the common welfare of the community as well as being the best choice to no longer depend on black energy, fossil energy and petroleum for electricity needs and economic activities on the island of Timor. “The wind power plant is the answer to the concerns over the use of fossil energy and petroleum. Fossil energy sources are very limited, while...
wind energy has been prepared without limits in Belu district. In the future, the utilization of wind power potential is very prospective in overcoming the scarcity of electricity on the island of Timor” he said. [18].

Kristoforus Tara, OFM as Priest of the Sacred Heart Parish of Jesus Laktutus briefly explained that this cooperation plan is based on the choice of community economic development based on the local potential of the local community. The wind power plant was greeted enthusiastically by the community, who appeared when it was being socialized until the groundbreaking for the wind test tower. “The presence of wind power plant is expected to change the lives quality and society welfare of local people in various aspects. This project is also part of an effort to welcome a national program linked to investment in major strategic infrastructure projects in 4.0 industry at the border area, in disadvantaged, outermost, frontier areas, specifically in cluster three of North Central Timor, Belu, and Malacca districts“ Kristoforus said.

The construction of wind power plants in Laktutus and Lookeu, Belu District is relevant and urgent at this time, especially in the time of the Covid 19 pandemic where people were made aware to take environmentally friendly actions. Increasing community welfare needs to pay attention to environmentally friendly actions, including using environmentally friendly electrical energy such as wind energy.

The utilization of environmentally friendly energy sources based on wind power strengthens the theory of environmental ethics in contemporary environmental philosophical discourses. Environmental ethics is the discipline in philosophy that studies the moral relationship of human beings to, and also the value and moral status of, the environment and its non-human contents. This entry covers: (1) the challenge of environmental ethics to the anthropocentrism (i.e., human-centeredness) embedded in traditional western ethical thinking; (2) the early development of the discipline in the 1960s and 1970s; (3) the connection of deep ecology, feminist environmental ethics, animism and social ecology to politics; (4) the attempt to apply traditional ethical theories, including consequentialism, deontology, and virtue ethics, to support contemporary environmental concerns; (5) the preservation of biodiversity as an ethical goal; (6) the broader concerns of some thinkers with wilderness, the built environment and the politics of poverty; (7) the ethics of sustainability and climate change, and (8) some directions for possible future developments of the discipline.[19]. This paradigm also strengthens the thinking of the ecological philosopher Henryk Skolimowski who emphasizes the need for development activities to pay attention to the improvement of the economic quality of life by paying attention to environmentally friendly development patterns and approaches. Ecological philosophy aligns with the economy of quality of life, cares for the welfare of society and is responsible for the good of the cosmos as a whole [20].

4. Conclusion
From the field research data and studies that have been carried out, it can be concluded that (a) There is sufficient wind energy available in the areas in Laktutus and Lookeu, Belu District with a wind power potential of 120 Megawatts; (b) Two wind potential measurement test kits were successfully established at Laktutus-Lookeu and so far have provided positive indications for the development of a wind power plant; (c) Utilization of the wind power plants in Laktutus and Lookeu has a positive impact on improving the welfare of the local community, namely changing the quality of economic life, increasing the welfare of local communities towards environmentally friendly and sustainable development; and (d) It is hoped that the synergy with all parties between the governor as the provincial government, the regent as head of the district, church leaders, community leaders and all elements of the local community are expected to unite in supporting the construction of this wind power plant in Laktutus-Lookeu.
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References
[1] Fios, F 2018 Mapping the potential of green energy to border societies of Indonesia and Timor Leste (a preliminary study) MATEC Web of Conferences Vol. 197, article number 13006
[2] Ge W et al 2019 Wind power dispatching method based on high-voltage and large capacity electric heat storage Advances in Intelligent Systems and Computing Journal 921, pp. 826-836
[3] Ayyarao T S L V 2019 Modified vector controlled DFIG wind energy system based on barrier function adaptive sliding mode control Protection and Control of Modern Power Systems Journal 4, 4
[4] Lledo L et al 2019 Seasonal forecasts of wind power generation Renewable Energy Journal 143, pp. 91-100
[5] Rubert T et al 2019 Wind turbine lifetime extension decision-making based on structural health monitoring Renewable Energy Journal, Vol. 143, pp. 611-621
[6] Xu K et al 2019 Positive ecological effects of wind farms on vegetation in China’s Gobi desert Scientific Reports Journal 9, 6341
[7] F.H. Permien F H et al 2019 Socio-technical constraints in German wind power planning: An example of the failed interdisciplinary challenge for academia on Energy Research and Social Science, Vol. 55, pp. 122-133
[8] Zarate-Toledo E et al 2019 Justice, social exclusion and indigenous opposition: A case study of wind power development The Isthmus of Tehuantepec, Mexico on Energy Research and Social Science Journal 54, pp. 1-11
[9] Tagliapietra S et al 2019 Estimating the cost of capital for wind energy investments in Turkey Energy Policy Journal 131, pp. 295-301
[10] Lyu Q et al (2014) Wind power accommodation by combined heat and power plant with electric boiler and its national economic evaluation Dianli Xitong Zidonghua/Automation of Electric Power Systems 38 (1), pp. 6-12
[11] Cai X et al (2018) Improving wind power utilisation under stormy weather condition by risk-limiting unit commitment IET Renewable Power Generation 12, pp. 1778-1785
[12] Enevoldsen E and Sovacool B K 2016 Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France Renewable and Sustainable Energy Reviews 53, pp. 178-184
[13] Sovacool B K 2017 Cost performance and risk in the construction of offshore and onshore wind farms Wind Energy Journal 20 (5), pp. 891-908
[14] Manwell J F et al 2010 Wind Energy Explained: Theory, Design and Application http://onlinelibrary.wiley.com/book/10.1002/9781119994367
[15] Jobert A et al 2007 Local acceptance of wind energy: Factors of success identified in French and German case studies Energy Policy 35 (5), pp. 2751-2760
[16] Zoellner J et al 2008 Public acceptance of renewable energies: Results from case studies in Germany Energy Policy 36 (11), pp. 4136-4141
[17] Enevoldsen P 2016 Onshore wind energy in Northern European forests: Reviewing the risks Renewable and Sustainable Energy Reviews 60, pp. 1251-1262
[18] https://indonesia.ucanews.com/2019/05/10/keuskupan-atambua-dukung-pengembangan-listrik-tenaga-angin/
[19] https://plato.stanford.edu/entries/ethics-environmental/
[20] Fios F 2019 Manusia Ekologis Jakarta: Penerbit Hegel, pp. 63-64.