Utilization of Hybrid Energy in Creating Self-reliance of Coastal Community in Yogyakarta, Indonesia through Tourist Villages

Dana Herdi

***Abstract*—Indonesia has the potential wind and solar energy sources provided fairly well. From the wind energy sector, there are at least 166 potential points and 34 points of which have above 50 m/s of wind speed. While for solar energy, almost the whole of Indonesia has potential intensity of sunlight for about 2000 kWh/m2. This is only in mountainous regions such as Sumatera and Papua, which have intensity of 1400 kWh/m2 below. The potentialities are almost located in the coastal areas of Indonesian Archipelago. However, 80% of the 10.666 coastal villages has not precisely have the electricity yet. The incapability of the government to develop any energy sources exept Power Plant powered by fossil fuels is one of the weaknesses. The government tends to focusses on the macro scale of electrification development to meet a demand for the electricity in Indonesia. The windmill tourism village program is a productive action to be an answer in the electrification fulfillment in rural area which is difficult to solve by the government all the time. The program is believed to be able to solve the electrification matter up towards the self-sufficiency of electricity in the rural area. Besides, the program can be used as the new tourism object resort to educate the public around and traveler concerning renewable energy through the coastal society approach.**

***Index Terms*—Coastal society, tourism, renewable energy, windmill village.**

I. Introduction

Tourism is a potential sector for Indonesia as a country which has strategic region in the Southeast Asia. The largest archipelago in the world, having the second largest tropical forest in the world, the fourth largest population in the world, and other various advantages that make Indonesia has great potential in the tourism sector. According to Trading Economics, foreign tourists visiting Indonesia until September 2016 is recorded about 1.006.700 inhabitants [1] The numbers are likely to increase in the following months. This is detected again by the Trading Economics that the three places in which become the main reason of the foreign tourists coming to Indonesia are Bali, Batam, and Jakarta. The reasons are in variety, for example business, entertainment, cultural attraction, and so on. This potentiality is then taken by Indonesian government as an opportunity to reap the maximum foreign exchange of the foreign tourists. The number of the foreign tourists of course has not been added with the number of domestic tourists who have been visiting various tourism object resorts in Indonesia. Besides, the middle class population in Indonesia has increased and one of the Indonesian habits is travelling.

Renewable energy is relatively rare for most Indonesian people as well as people in developed country such as in Europe. The government still loves to dally and relies on the fossil energy as an energy source of electrification supplier throughout Indonesia through power plant. Nowadays, Indonesian's electrification is full of fossil energy, especially the coal which reaches 75% and the rest is supplied by the geothermal energy in which the number is not too significant. The dependency of Indonesian society on the fossil energy will create the dependency that is difficult to remove if it is not started from Indonesian government in initiating a change of habit. Moreover, the increasing volume of vehicle, industrialization, and electrification compliance program in the era of Joko Widodo which reach up to 35.000 MW is a long-term plan should worry about. That worry is because the fulfillment of electrification will still come from the fossil energy and this means that the massive exploration will be carried out to accomplish the target of Joko Widodo's electrification program. In fact, the international world has in installments to gradually reduce the dependency on fossil energy. Vietnam, for example, has been cooperating with the Netherland Partnership Programme in 2003 in the field of Wind Power Plant [2]. The geographical position of Indonesia is located on the equator, making Indonesia become a tropical country and has two seasons. The wet season, potentially generates the power of wind from the sea and land that is strong enough and the dry season which is likely to produce the intensity of abundant heat.

The coastal area is area where many society of Indonesia is living in. this is because the geographical position of Indonesia as a maritime and has many beaches, therefore it makes the pattern of society prefer to inhabit the surrounding beach or waterfront. Commonly, their energy source uses generator as an electric source when the government is less able to reach that area. Indonesian electrification does not still fulfill the word of all can be electrified yet. Area with the highest level of electrification is DKI Jakarta, about 99% of the area is electrified. Meanwhile, Papua is an area with the lowest level of electrification, this is only about 43.46%.[3] The disparity becomes a phenomenon how electrification in Indonesia is less fulfilling. The three elements of tourism, renewable energy, and coastal society are expected to be component which can solve the electrification matter and the empowerment of the local society. Therefore, this paper will

Manuscript received December 6, 2016; revised May 1, 2017.

Herdi, Dana is with International Relations, Universitas Jember, Indonesia (e-mail: herdidana@gmail.com)

doi: 10.18178/ijssh.2017.7.6.858

discuss about that problem as well as the output and what obstacles faced by many sides.

II. Explanation

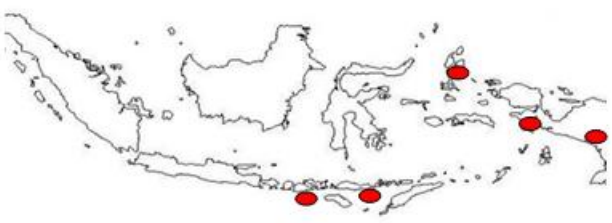
The compliance of Indonesian electrification program up to 35.000 Mw in the era of President Joko Widodo is the large target in the middle of the ability of Indonesia in producing the inadequate electricity. As results, the government keeps trying to develop the power plant project in macro to accomplish the target. The fossil energy has been considered as the unfriendly energy in environment. The emission often threatens the human and even there are so many people died because of the mining or living near the power plant. Apart from that, Indonesia should require innovations in the energy sector especially to help rural society to escape from the stigma in the village which does not install the electricity yet. The program of government to help rural area in order to install the electricity is listed in the Strategic Plan of the Indonesian Electricity Directorate under PT. PLN as BUMN which is in charge of the electric service provider in Indonesia. This is the following provinces in Indonesia with the electrification ration is still under 75%,

TABLE I: Source: Strategic Plan of Indonesia Electricity Directorate 2015-2019

Electrification ratio in 2014 under 75%	
Riau Islands: 74,06%	SouthEast Sulawesi : 66,78%
Central Kalimantan : 67,23%	West Nusa Tenggara : 68,05%
North Kalimantan : 69,64%	East Nusa Tenggara : 58,91%
West Sulawesi : 74,11%	Papua : 43,46%
Gorontalo : 74,65%	

The table shows that Indonesia requires alternative electrification rather than rely on electrification from macro power plant such as Steam Electricity Power Plant (PLTU), Hydroelectric Power Plant (PLTA), and other power plant. Furthermore, the percentage on the table covers the rural areas which still have inadequate electricity. The regions which are not listed on the table are also likely to have rural and coastal areas that have not been fully electrified by the government.

The following map is a map which has rural areas in Indonesia that have not been fully electrified and have been non-subsidized electrified by the government through National Electricity Company (PLN). Most of the area lies in the eastern Indonesia, especially Papua in which the electrification ratio is under 50%.



Graph 1. Map of Area which have not been inadequately electrified
Source: The author with the paraphrase of *Bangkapos.com*

A. The Wind Energy Potency in Indonesia

The wind potential in Indonesia covers various region throughout Indonesia. According to LAPAN wind data, it can be described as follows:

TABLE II: Source: LAPAN Wind Data

Resources Potential	**Wind Speed at 50m (m/s)**	**Number of Sites**	**Provinces**
Marginal	3,0-4,0	84	Maluku, Papua, Sumba, Mentawai, Bengkulu, Jambi, West and East Nusa Tenggara, South and North Sulawesi, North Sumatera, Central Jawa, Maluku, Yogyakarta, Lampung, Borneo (Kalimantan).
Fair	4,0-5,0	34	Central and East Java, Yogyakarta, Bali Island, Bengkulu, West and East Nusa Tenggara, South and North Sulawesi.
Good	>5,0	35	Banten, DKI Jakarta, West and Central Java, Yogyakarta, West and East Nusa Tenggara, South and North Sulawesi, Maluku.

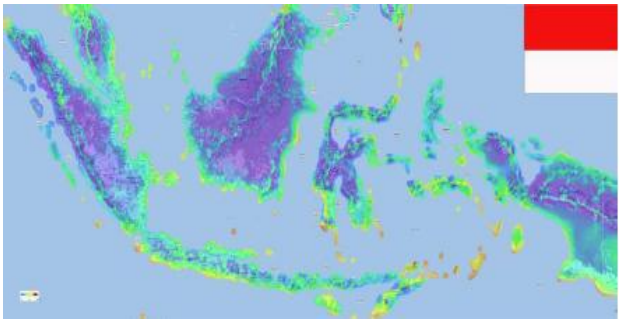


Fig. 1. Indonesia global wind speed meso scale
Source: 3TIER.

By combining the picture and the table above, the red and yellow gradation are the areas which have adequate wind intensity. This means that the potential of its resources is fairly good. Followed by green, light blue, and dark blue, it indicates that the intensity of the wind is in the position of fair and marginal. See in picture 1.1, good potential resources are located in almost all of the islands in Indonesia. The potential is based on the table 1.1. The south coast of Java island is more intensive rather than the north. Likewise throughout the southern area of Indonesia to Aru Islands has great potential resources. Moreover, the gradation of green indicates that the intention of the wind in those areas area relatively fair.

B. The Solar Energy Potency in Indonesia

Indonesia is a tropical country and underlined the equator so it has the potential intensity of sunlight throughout the year. However, the distribution of the intensity of sunlight varies in each region depending on the altitude and geography. Here is an overview of Global Horizontal Irradiation (GHI) and Direct Normal Irradiation (DNI) in Indonesia.

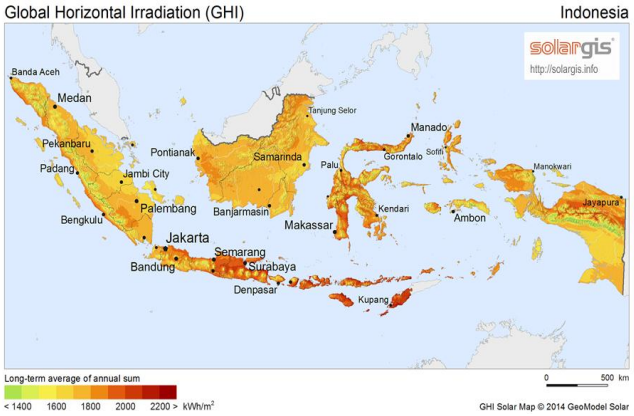


Fig. 2. Source: Solargis.com.

GHI is the total amount of shortwave radiation received from above by a surface horizontal to the ground.[4] If we look at the figure 1.2 above, Indonesia has the potential for a sizeable of GHI. Almost all parts of Indonesia has the potential absorption intensity solar radiation of 1.600 kWh/m^2 up to 2.200 kWh/m^2 proved in shades of yellow to dark orange. Few have the potential of 1.400 kWh/m^2 which is represented by the green. However, the GHI is the total number of the DNI and DHI *(Diffuse Horizontal Irradiation)* which uses a formula to determine GHI is:

GHI = DNI Cos Θ + DHI *(Diffuse Horizontal Irradiation)*

DHI is the amount of radiation received per unit area by a surface (not subject to any shade or shadow) that does not arrive on a direct path from the sun, but has been scattered by molecules and particles in the atmosphere and comes equally from all directions.[5] Abbreviations, DHI has a sense of other radiations bias results from various directions and very little influence on the accumulation of accretion by DNI in GHI Indonesia.

DNI is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky.[6] In short, the DNI is the intensity of sunlight that can be absorbed by solar panels. there is a striking difference between the images 1.2 to 1.3 but the data actually support each other. The question of why the DNI in Indonesia more areas with gradations of green than yellow or orange gradation because there are geographic factors in each region. In the picture DNI Indonesia, the region that has shades of green indicate that the region is contoured mountains and not flat. While the region with gradations of yellow or dark orange, indicated that the region has more flat land contours.

Referring to the formula GHI, DNI is very dependent on the angle of which is denoted by theta (Θ) and Cos functions. That is, the solar panel perpendicular to the direction of the beam, will make the DNI greater the potential is absorbed by solar panels. Back then, the potential of the solar panel perpendicular to the sun come up, affecting the DNI generated. That is why, in Fig. 1.3, the DNI in Indonesia, more green because of factors able to influence the geographical contours but overall, GHI is relatively abundant in Indonesia because Indonesia is located on the Equator line, which means getting the light intensity throughout the year.

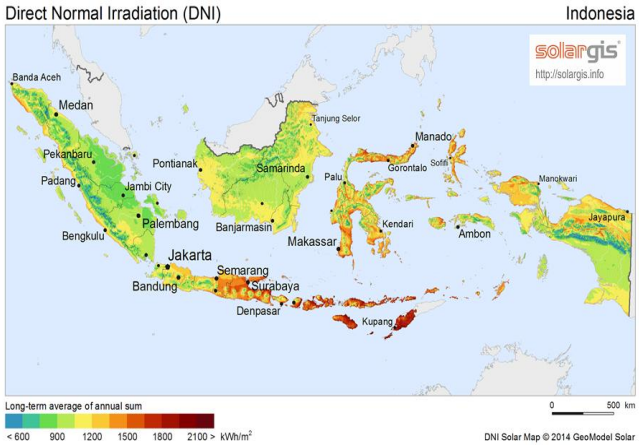


Fig. 3. Source: Solargis.com.

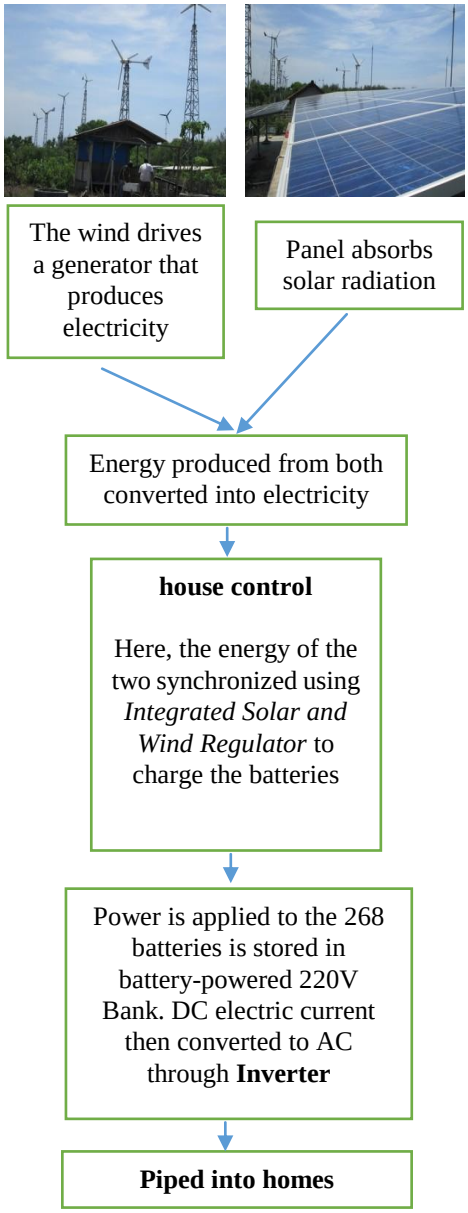
DNI is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky.[6] In short, the DNI is the intensity of sunlight that can be absorbed by solar panels. there is a striking difference between the images 1.2 to 1.3 but the data actually support each other. The question of why the DNI in Indonesia more areas with gradations of green than yellow or orange gradation because there are geographic factors in each region. In the picture DNI Indonesia, the region that has shades of green indicate that the region is contoured mountains and not flat. While the region with gradations of yellow or dark orange, indicated that the region has more flat land contours.

Referring to the formula GHI, DNI is very dependent on the angle of which is denoted by theta (Θ) and Cos functions. That is, the solar panel perpendicular to the direction of the beam, will make the DNI greater the potential is absorbed by solar panels. Back then, the potential of the solar panel perpendicular to the sun come up, affecting the DNI generated. That is why, in Figure 1.3, the DNI in Indonesia, more green because of factors able to influence the geographical contours but overall, GHI is relatively abundant in Indonesia because Indonesia is located on the Equator line, which means getting the light intensity throughout the year.

C. Energy Potential of Hybrid (Wind Energy and Solar Energy) to the empowerment of coastal communities in Indonesia

Wind and solar energy potential in Indonesia gives opportunities to develop coastal areas and the countryside to escape the problems of electrification. Meanwhile, the opportunity to build a hybrid energy derived from both sources is quite large because of its potential over many coastal region when looking at pictures that show the potential of wind and solar energy in Indonesia. As an example, the development of wind energy and solar hybrid is the Tourism Village Windmill in Yogyakarta, Indonesia has a successfull concept in empowering coastal communities. Overthere, wind potential ranges between 2-5 m / s in the daytime and 8-5 m/s at night. Windmill has installed a total of 39 units with a capacity of about 56 MW at the initiative from Ministry of Research and Technology and LAPAN. In addition, around 218 solar panels have been installed with a capacity of 27 MW. Total power that is able to be generated when

synchronized by 83 MW. The placement of solar panels at the Tourism Village is mounted on a fish pond in order to save the land and more efficient.



Graph 2. Systematics distribution tourism village Electrification windmills, Yogyakarta.

Currently, electricity is distributed from Hybrid energy in 100 stalls right there. Each stall get 1 Ampere and if lacking, will supply them from PLN. There is also, workshops of PLTH (Power Hybrid) and held several workshops to train people in repairing equipment windmills and solar panels like a propeller, windmill generators, and coils.

Ngentak coastal village communities, village of Windmill Fields, previously cultivated agriculture depends on rainfall. However, now with the PLTH could be irrigated at any time because the water can be pumped using electricity derived from PLTH. for three years after construction of PLTH, the villagers finally feel some changes, especially in the economic sector. Increased visitors and ultimately affect the sales turnover of merchandise sold throughout the Ngentak village, making people increasingly feel the positive impact of the presence of PLTH. In addition, The increasing of visitors to the village, not only have traveled, but both of them are around Yogyakarta students who want to do research about Renewable Energy. In the end, the existence of man-made technology is an effort to assist in meeting human needs itself to be more easily and efficiently. Sense of engineer for the sake of Humanity.

D. Challenges

1) High taxes. During this time, the solar panels are still in imports from Malaysia and Thailand so as to make the entry tax is high enough.
2) The ability of the commercial solar panel to convert solar energy into electricity until now only limited to 20-45% of the total radiation that is capable captured solar panels. For example, when the solar radiation in an area potentially produce 1.400 kWh/m^2 then the energy is converted into electricity capable of only about 560 kWh/ m^2.
3) Inverters are used frequently damaged was caused by the lightning when it rains and other factors.
4) Fossil energy Mafia like coal mafia in Indonesia is still in power. They have direct access to the government to continue the consumes of coal as an energy source by nationwide. So the government is reluctant to develop a hybrid energy especially renewable energy.
5) Indonesia actually requires a lot of investment from foreign firms to develop renewable energy in rural and coastal areas in Indonesia. However, investors who have invested in the renewable energy sector in Indonesia feel neglected. The reason is obvious, PLN fear that if the presence of investors in the field of electrification, especially renewable energy will be a tough competitor.

III. Conclusion

The potential of wind and solar energy in Indonesia provide great opportunities to be utilized in various fields. One of them is the empowerment of the coastal society proved by the existence of the windmill tourism village in Yogyakarta, Indonesia, with the hybrid both of the two energy sources. The output are giving the people opportunity to improve their economy through the tourism object resort. In addition, the society and tourists can learn about everything related to Hybrid Energy (Wind and Solar). Finally, the coastal society is empowered by the energy and economy, the standard of life increases as well. Hopefully, the innovation such as windmill village can be applied in the other regions in Indonesia which still have not installed the electricity or with minimal supply of the electricity. Furthermore, this opportunity is likely to be applied in all of the world with sufficient intensity of sunlight and wind power especially in Equator countries and tropics.

Acknowledgement

The researcher express his highest gratitude to Allah subhanahu wata'ala for blessing, love, opportunity, health, and mercy to complete this paper. The Researcher presenter firstly give appreciation to my beloved colledge, Jember University that has been giving me a support all the financial aspects and guarantee me during Conference. First, thank you

foSecond, I would like to thank to my paper adviser, Drs. Abu Bakar Ebyhara, M.A, Ph.D who helped patiently to finishing this paper. The last, thank you for my support system, my parents, friends, and another person that i could not attached here one by one.

REFERENCES

[1] Trading Economics. (2016). *Indonesia Tourist Arrivals*. [Online]. Available: http://www.tradingeconomics.com/indonesia/tourist-arrivals
[2] Australian Business Council for Sustainable Energy. (2005). *Renewable Energy in Asia: Vietnam Report*. [Online]. Available: http://sxsh.vn/en-US/Files/Download.aspx?ID=153
[3] Adapted from the Report of the Directorate of Electricity fo Indonesia 2015-2019 Strategic Plan.
[4] 3TIER. *What Is Global Horizontal Irradiation*. [Online]. Available: http://www.3tier.com/en/support/solar-prospecting-tools/what-global-horizontal-irradiance-solar-prospecting/
[5] 3TIER. *Glossary of Technical Renewable Energy Terminology*. [Online]. Available: http://www.3tier.com/en/support/glossary/#dif
[6] 3TIER. *What Is Direct Normal Irradiation*. [Online]. Available: http://www.3tier.com/en/support/solar-online-tools/what-direct-normal-irradiance-solar-prospecting/

Herdi Dana is a bachelor student of international relations, Universitas Jember, Indonesia. He is a volunteer of the NGO Greenpeace on the climate and energy sector since the middle of 2015. He has ever joined various activities related to the energy and climate change to the campaign against the construction of coal Steam Electricity Power Plant (PLTU) in Batang, Central Java. Besides, another activity currently is forming an environmental community in Jember, Indonesia with a campaign for human's behavior variety and many kinds of campaigns.