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Volume 3 Number 1 page 99 - 108

The New Renewable Energy Hybrid Systems for Simple Home Electricity Purposes

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ABSTRACT
The need for energy has now become a major problem that is increasingly complex in all countries in the world to support their economic growth. These various conditions require the need for new renewable energy that can answer these challenges. Wind energy and solar cells have become one of the solutions to reduce dependence on fossil energy. Wind energy and solar energy are actually the most promising sources of energy considering their sustainable nature and very large amounts to be used as electrical energy for lighting in simple people's homes. A wind turbine is a prime mover that utilizes wind energy to drive the turbine blades which are then transformed in the form of mechanical energy to rotate the turbine shaft. Solar energy is energy in the form of light and heat from the sun, which technology can be applied to a variety of energies, including solar thermal electrical energy. New and renewable energy with hybrid or combined systems for home-scale power plants is very much needed to ensure the continuity of the existence of electrical energy and efficiency. The combined and hybrid system models that have been developed and applied are hybrid solar cells and wind turbines.
Keywords: *New renewable energy, hybrid system, simple house*

International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

INTRODUCTION

The need for energy has become an increasingly complex problem when the increasing need from all countries in the world to support their economic growth actually makes the supply of conventional energy reserves such as fossil energy less and less. Currently the total energy demand worldwide reaches 10 Terra Watt (equal to 3 x 1020 Joule/year) and it is predicted that this number will continue to increase until it reaches 30 Terra Watts by 2030 (https://www.esdm.go.id/id/). The ever-increasing need for energy is in fact required to follow the needs of other human beings, namely creating a clean, environmentally friendly and pollution-free environment. These various conditions are the main reasons for the need to develop alternative energy sources from nature or new renewable energy that can answer these challenges. Wind energy and solar cells have become one of the solutions to reduce dependence on fossil energy. Solar cell is a power plant that is able to convert sunlight into electric current. Wind energy and solar energy are actually the most promising energy sources considering their sustainable nature and guaranteed sources. The sun is an energy source that can overcome the problem of future energy needs after various conventional energy sources are reduced in number and are not friendly to the environment. For Indonesia, the energy problem has become even more important and needs to be handled more specifically because (Saiful Manan, 2019):

- Approximately 80% of Indonesia's energy needs are met by oil (2002 data)
- Oil prices and consumption of petroleum which tends to increase rapidly every year.
- There are many alternative sources in Indonesia that need to be developed.

Wind Turbine

Wind mill is a prime mover that utilizes wind energy to drive turbine blades which are then transformed in the form of mechanical energy to rotate the turbine shaft. The rotation of the turbine shaft can be continued to drive the turbine shaft and can be transmitted to a generator (dynamo) as a power plant. Broadly speaking and generally based on the shape of the rotor and windmill, wind turbines can be classified into two main classifications, namely horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT) (Daryanto, 2007). Some examples of the types of HAWT and VAWT wind turbines can be seen in Figure 1, and Figure 2. There are three rotor models in this type of wind turbine, namely: Savonius, Darrieus, and H rotor. The Savonius turbine utilizes the drag force while the Darrieus and H rotors utilize the lift force (Mittal, Neeraj. 2001).

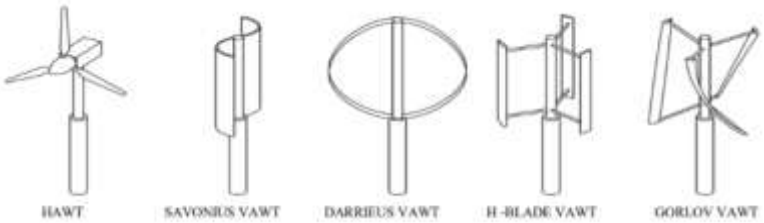


Figure 1. Various types of wind turbines Savonius, Darrieus, H rotor and others (Marco, 2016)

International Journal of Economic, Technology and Social Sciences
International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

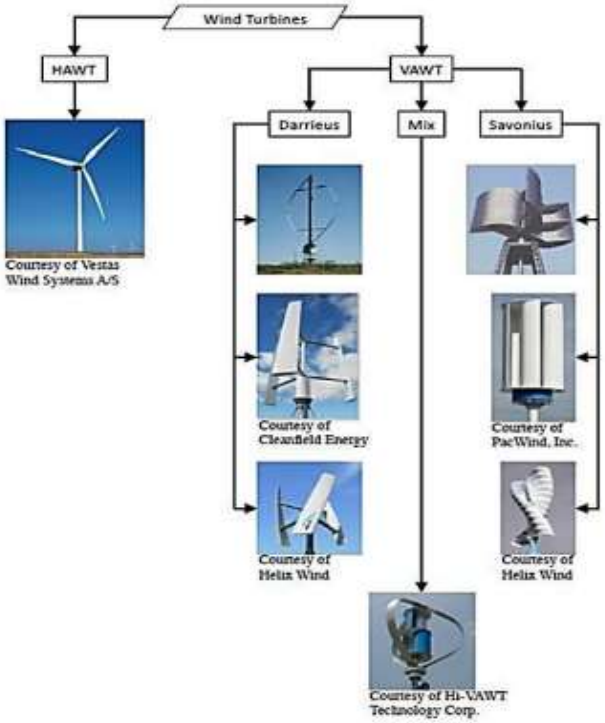


Figure 2, Various types of wind turbines HAWT and VAWT (Almotairi et al. 2016)

Solar Energy

Solar energy is energy that utilizes light and heat from the sun. This energy can be harnessed using a range of technologies such as solar heating, solar photovoltaic, solar thermal electricity, solar architecture, and artificial photosynthesis. Solar energy technology is generally categorized into two groups, namely passive utilization technology and active utilization technology. This grouping depends on the process of absorption, conversion, and distribution of solar energy. Solar energy has been developed and used in various regions in Indonesia in general and in the province of North Sumatra in particular, for example such as several places around Medan City, precisely on the Belmera Toll Road in Deli Serdang Regency on the road to Kuala Namu International Airport (Figure 3) . Solar cells in the places mentioned are used as a source of energy (power) for street lighting and traffic light on the road.

Figure 3, Solar Cell for lighting the road to Kuala Namu International Airport

International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

LITERATURE REVIEW

Solar Home System (SHS) is one of the solar power plant (PLTS) system applications for village electrification as an individual or decentralized home lighting system with a relatively small installed power of around 48-55 Wp. The total power of 50 Wp per household is expected to meet the needs of lighting, information (TV and Radio) and communication (Radio communication). The main components of SHS in Figure 4, consist of (Steve Dahlke, 2013):

a. Photovoltaic module as a power supply that produces electrical energy from the input of a number of solar energy,
b. Batteries as energy storage and conditioning,
c. Battery energy regulator (BCR) as an automatic regulating device, maintaining system reliability, and
d. Electrical loads such as TL lamps (DC), switches, radios, televisions and others.

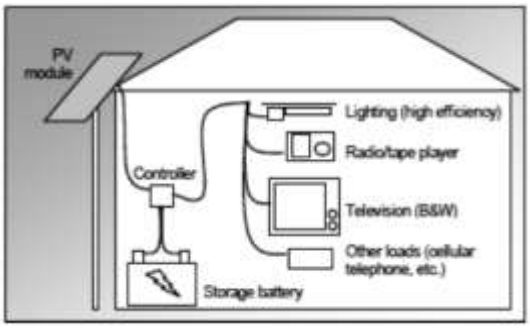
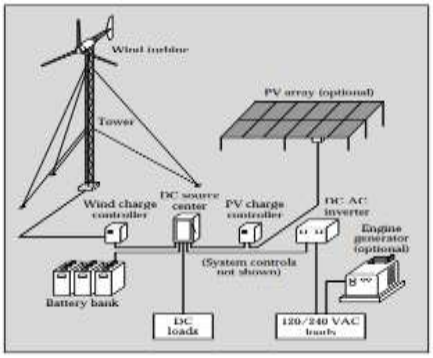


Figure 4, *Solar Home System* (Steve Dahlke, 2013)

Wind Turbine and Solar Cell Hybrid System

New and renewable energy with a hybrid or combined system for large-scale and home-scale power plants is very much needed to ensure the sustainability of the existence of electrical energy and efficiency. This is due to several considerations, including wind conditions and fluctuating sunlight. One time the wind is reduced and so is the sunlight which at one time is dim if it is going to rain and also at night. Several models of combined and hybrid systems have been developed and applied such as hybrid solar cells and wind turbines, hybrid solar cells and PLN, hybrid wind turbines and PLN and others. An example of a hybrid system is the case in Figure 5, below. As a comparison data between the capabilities of the Darrieus Wind Turbine and Savonius and PV Wind Turbine systems can be seen in Table 1.



Gambar 5, Hybrid System Vertical Wind Turbine and Solar Cell (DOE USA, 1997)

International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

Table 1, Comparison between of System Darrieus Wind Turbine and Savonius Wind Turbine and PV (Marco Casini, 2016)

Average Annual Wind Speed (m/s)	UGE 4K Darrieus Trubine			Helix Wind S594 Savonius			Schoot Perform POLY 250W PV Panel 2500 €/kW			
	Productivity (kWh/kW)	Produced Energy kWh/yr	Energy Cost (€/kWh)yr	Productivity (kWh/kW)	Produced Energy kWh/yr	Energy Cost (€a/kWh)yr	Annual Solar Irradiance kWh/mq	Productivity kWhe/kWp	Productivity kWhe/mq	Energy Cost (€/kWh)yr
1	0	0	-	0	0	-	500	446	55,78	5,60
2	250	1000	20,00	0	0	-	750	669	83,67	3,73
3	500	2000	10,00	0	0	-	1000	893	111,56	2,80
4	750	3000	6,67	10	45	300,00	1250	1116	139,45	2,24
5	1250	5000	4,00	110	495	27,27	1500	1339	167,34	1,87
6	1875	7500	2,67	220	990	13,64	1750	1562	195,23	1,60
7	2500	10000	2,00	445	2000	6,74	2000	1785	223,13	1,40
8	3250	13000	1,54	780	3510	3,85	2250	2008	251,02	1,24
9	4000	16000	1,25	1110	4995	2,70	2500	2231	278,91	1,12
10	4000	16000	1,25	1445	6500	2,08	2750	2454	306,80	1,02
11	4000	16000	1,25	1780	8010	1,69	3000	2678	334,69	0,93
12	4000	16000	1,25	2110	9495	1,42				
13	4000	16000	1,25	2445	11000	1,23				
14	4000	16000	1,25	2780	12510	1,08				
15	4000	16000	1,25	3110	14000	0,96				
16	4000	16000	1,25	3330	15000	0,90				

METHODS

This research is focused on the utilization of new and renewable energy sourced from wind and solar thermal energy and applied to the simple houses of rural underprivileged communities in need in the Patumbak Deli Serdang area. The location and geography of Patumbak District is with an area of 3o44'-3o52' North Latitude, 98o69'-98o72' East Longitude, with an area of 46.79 Km2 with a location above sea level is 11 meters. Patumbak District is one of the 22 sub-districts in Deli Serdang Regency (BPS Deli Serdang, 2020). The condition of the average number of rainy days and rainfall in Patumbak District by month for one year can be seen in Table 2.

Table 2, Average number of rainy days and rainfall by month in Patumbak District, 2020 (BPS Deli Serdang, 2020).

Bulan	Hari Hujan (Hari)	Curah Hujan (mm)
Januari	2	155
Februari	5	48
Maret	1	32
April	8	173
Mei	12	207
Juni	9	194
Juli	10	155
Agustus	9	202
September	10	345
Oktober	12	176
November	9	120
Desember	10	138

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This applied research will produce a new renewable energy system and the next stage is equipment that utilizes wind energy and solar heat to produce electrical energy. The system and development of this tool is planned for a household scale that can generate electricity for its main purposes, namely lighting in the simple house and non-main (periodic) electricity needs within the scope of general use at home and also that electrical energy can be available continuously.

Usually the amount of electricity needed for simple home lighting and other purposes is what will be a description of the electrical energy needs in this applied research, and the data for these needs are as illustrated in Table 3, below. For example, we can illustrate the needs of simple household electricity as

International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

follows:
1. Ordinary lighting with 8-point lamps of 15 Watts each = 120 Watts
2. Water pump engine with a voltage of 125 Watt
3. TV = 100 Watt
4. Rice Cooker = 50 Watt
5. Dispenser = 65 Watt
6. Electric iron = 250 Watt

Table 3, Illustration of electricity needs

No.	Penggunaan Listrik	Jumlah (Watt)	Keterangan
1	Pencahayaan rumah	120	Penggunaan utama
2	Mesin pompa air	125	Penggunaan periodik
3	TV	100	Penggunaan periodik
4	Rice cooker	50	Penggunaan dominan
5	Dispenser	65	Penggunaan periodik
6	Setrika listrik	250	Penggunaan periodik
	Total:	**710**	

The most dominant use of electrical energy is the use for lighting or lighting in a simple house. The use of electrical energy for other purposes, such as the use of electrical energy for water pumps, TVs, rice cookers, dispensers and electric irons is the periodic use of electrical energy. In this study, the main plan is to meet the needs of lighting or lighting in a simple house that is 120 watts. Based on the illustration of the electricity needs of a simple house above, a wind turbine is planned to meet the electricity needs of a simple house with a capacity of about 100-250 Watt. Furthermore, the planning of solar cells to meet the electricity needs of simple homes is by classifying a capacity of about 100-250 Watt. In the morning until the afternoon and sunny days, the sun's heat will produce electrical energy with the solar cell simultaneously with the wind mill or it can also be operated not simultaneously and this can be controlled in the system. The resulting electrical energy storage is stored in the battery. The battery capacity is adjusted to the module capacity and the desired amount of electricity usage, which is a maximum of 250 Watts.

RESULTS AND DISCUSSION

Results

Based on data from BMKG, the average wind speed in the Deli Serdang area is 37 km/hour or 10.278 m/s as shown in Table 4, so it is in accordance with the plan with the Savonius wind turbine which has a few blades as shown in Figure 6.

Tabel 4, Weather overview2020 (http://kualanamu.sumut.bmkg.go.id/)

No.	Rata-Rata Kecepatan Angin Permukaan Bulanan	Arah angin Terbanyak	Penyinaran Matahari Bulanan (jam)	Penyinaran Matahari Harian (jam)	Suhu Udara
1	20 kt (37 km/jam)	Timur	166	5.5	Maksimum: 33.2 °C Rata-Rata: 27.5 °C Minimum: 22.2 °C

International Journal of Economic, Technology and Social Sciences
International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

Figure 6, Wind Turbine Savonius 2 blades

The wind turbine planned in this applied research is the Savonius type with a design as shown in Figure 6, with consideration of the data between VAWT and HAWT in Table 5, with consideration for the use of high efficiency, no need for a high mast, low wind speed, not noisy and other advantages, the plan for the 2-blade Savonius type is appropriate to be able to generate electrical energy of approximately 200 Watts.

Tabel 5 Comparison between VAWTs and HAWTs (Bhutta et al., 2012)

	Vertical axis wind turbine (VAWT)	Horizontal axis wind turbine (HAWT)
Tower sway	Small	Large
Yaw mechanism	No	Yes
Self-starting	No	Yes
Overall formation	Simple	Complex
Generator location	On ground	Not on ground
Height frum ground	Small	Large
Blade's operation space	Small	Large
Noise produced	Less	Relatively high
Wind direction	Independent	Dependent
Obstruction for birds	Less	High
Ideal efficiency	More than 70%	50-60%
Wind velocity for start	Very low	Relatively high

In this paper, the solar power plant (PLTS) system that will be applied according to the conditions of a simple house and its application is quite large, easy to develop, affordable prices, individual home lighting systems and others is the Solar Home System (SHS) system as shown in Figure 7.

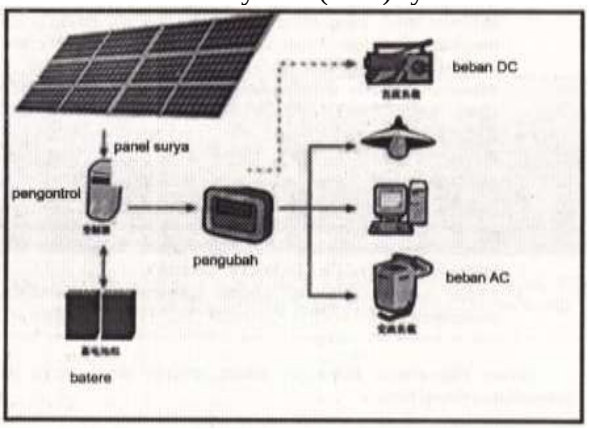

Figure 7, SHS scheme for simple household
(Sukandarrumidi, et al. 2015)

International Journal of Economic, Technology and Social Sciences
International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

Discussion

In this discussion, the main components of the solar cell solar home system and their functions are as described in Table 6 below.

Tabel 6. Main components and function

No.	Bahan	Fungsi
1	Modul fotovoltaik kapasitas 50 Wp	Pembangkit listrik tanaga surya dan energi *photovoltaic* (PV)
2	Battery	Menyimpan energi yang dihasilkan oleh panel surya agar dapat didistribusikan ke beban listrik pemakai pada saat panel listrik tidak menghasilkan listrik yang cukup, sebagai cadangan (*back up*), dan lain-lain
3	Solar charge controller atau BCR	1. Menyesuaiakan arus listrik yang masuk ke dalam baterai, supaya baterai tidak mengalami *overcharge* atau kelebihan pengisian yang berakibat beterai bisa cepat rusak. Dengan begitu, baterai selalu dalam keadaan kondisi penuh, tetapi tanpa harus *overcharge*. 2. Menghindari baterai *Over Discharge* atau baterai dalam keadaan lemah. Artinya, apabila baterai dalam kondisi lemah atau tegangannya turun terlalu rendah, SCC akan menghentikan aliran ke beban. Ini penting, kerena apabila baterai dalam kondisi tegangan sangat rendah, beterai akan cepat rusak. 3. Menghentikan arus terbalik ketika tidak ada sumber energi matahari yang memadai. Ketika mendung yang sangat gelap atau pada malam hari, beterai tidak bisa di *charge*. Itu memungkinkan terjadinya aliran listrik dari baterai ke solar panel. Dengan adanya SCC, hal itu tidak akan terjadi.
4	Inverter	Alat yang mengubah arus DC menjadi AC sesuai dengan rencana keperluan peralatan listrik yang akan digunakan. Alat ini mengubah arus DC dari battery menjadi arus AC untuk keperluan beban-beban listrik yang menggunakan arus AC.
5	Kabel	Merupakan komponen standar sebagai penghubung tempat mengalirkan arus listrik
6	PV Mounting hardware atau framework	Sistem dan komponen pendukung Pembangkit Listrik Tenaga Surya (PLTS) yang berfungsi untuk tempat meletakkan panel surya secara aman dengan mempertimbangkan arah matahari. Mounting sistem dapat diaplikasikan diberbagai tempat menyesuaikan dengan keperluan dan aplikasi PLTS (Gambar 4.5).

The ability of energy that can be generated by the photovoltaic module in SHS is highly dependent on the conditions of solar radiation, which is approximately 140 to 180 Watt hours per day. The hybrid model of New and Renewable Energy power plants, namely wind turbines and solar cells that can meet the electricity needs of a simple house in Patumbak Kampung is with a capacity of 100-250 Watt. If the electricity needs are illustrated to a maximum of 250 Watts, then the wind turbine will generate a minimum of 150 Watts of electricity and the SHS solar cell as shown in Figure 7, can generate a minimum of 150 Watts of electricity. The Savonius wind turbine and SHS solar cell from solar energy according to a suitable plan for the main purpose of lighting in a simple house will be applied to the house in Figure 8.

International Journal of Economic, Technology and Social Sciences
International Journal of Economic, Technology and Social Sciences
url: https://jurnal.ceredindonesia.or.id/index.php/injects
Volume 3 Number 1 page 99 - 108

Figure 8, Simple house in Patumbak village

CONCLUSION

The condition of energy consumption which has increased drastically along with increasing economic and industrial developments and the decline in world fossil energy reserves, including Indonesia, requires real steps to regulate and immediately utilize alternative energy from new and renewable energy. New Renewable Energy that has been available from the past until now and is relatively common to be developed, used and technologically already available in the market and relatively inexpensive is wind energy and solar energy and solar heat. This energy source is used to meet the electrical energy needs of a simple community with a simple house. The electrical energy needs in question are the main electrical energy needs, namely the needs of the simple community for home lighting. New and renewable energy power plants for simple homes is to adopt the development of hybrid energy wind turbines and solar cells. Based on the need for electrical energy in the simple house and the development of a hybrid energy design with wind and solar heat conditions on average every month, it was found that the hybrid wind turbine and solar cell system was able to produce the electrical energy needed by the simple house of 100 rice. – 250 Watts.

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