International Journal of Scientific Engineering and Science
Volume 4, Issue 8, pp. 67-69, 2020. ISSN (Online): 2456-7361

Solar Cell Research and Its Application

Fitria Hidayanti[1], Kreshna Agusta Mulyo Adi[2]
[1, 2]Engineering Physics Department, Universitas Nasional, Pasar Minggu, Jakarta 12520, Indonesia.
Email address: [1]fitriahidayanti @ gmail.com

Abstract**—***In modern times, it is indicated that renewable energy will meet energy needs to support human activities in the near future. But renewable energy sources are still dependent on the weather and climate which is certainly uncertain and will have a lot of variability making renewable energy still doubtful to be sufficient to meet the energy demand that humans need, especially in a modern living culture which very dependent to electricity in many aspects, including the future of human transportation. To overcome the uncertainty problem of renewable energy, a hybrid power plant is created by combining solar, hydro and wind energy. Given the importance of solving these problems, this paper review begins with a brief of the research that have been made, formulates detailed definitions and key concepts, summarizes the direction of current research and ends with views on prospective research in the future.*

Keywords**—** *Solar Cell, Application, Research, Renewable Energy.*

I. INTRODUCTION

In recent times the term variable renewable energy sources (VRES) can appear which can be used as an alternative to being a supplier of additional energy power to the human electricity grid. VRES consists of solar, hydro and wind energy. However, VRES has problems for its dependence on weather, climate and the environment in the process of producing energy making VRES can only make a small contribution in increasing the supply of electrical energy to support human needs, most of which still depend on fossil energy.

Before discussing the problem of VRES dependence on the weather, it is necessary to first discuss how to make VRES, one of which is VRES that relies on solar or solar energy to convert photons into electrical energy using solar cells. Discussing solar panels, at present many types of solar panels are found that have different material specifications and efficiency, which will certainly affect the amount of power produced by solar panels [1-6].

The cost of making high-cost solar panels has also sparked a research competition to create low-cost solar panels with high efficiency. Until now, there are 5 types of solar panels that are widely known and have been used in a variety of applications.

Solar panels in the last ten years have become one of the production commodities in the industrial world because they have quite attractive sales prospects. In the process of producing solar cells themselves are designed to convert solar energy into electrical energy without using chemical reactions or moving parts, and all research on solar cells is currently almost entirely focused on improving the efficiency of solar panels.

The solar panel itself consists of several types of semiconductor materials where this material itself is a material that can conduct electricity when supplied with light or heat but can be an insulator when at low temperatures, almost 95% of solar panels in the world today are made with silicon (Si) material but some are made with Cadmium Telluride and Copper Indium Diselenide which have relatively low prices with efficiencies below 20% [7].

TABLE I. Comparison of Solar Cell Efficiency [7].

Material	Experimental Efficiency	Real Production Efficiency
Monocrystalline Silicon	24%	14%-17%
Polycrystalline Silicon	18%	13%-15%
Amorphous Silicon	13%	5%-7%

II. DISCUSSION

Silicon is the second most mineral material on earth and in its processing silicon will not have a serious impact on the environment. Silicon, when combined with other materials that have a positive or negative charge, can very easily become a solar panel production material at an affordable price. The process of making solar panel products (Fig. 1) is done by combining two silicon layers that have been combined with mineral elements other than silicon, the process of combining these two silicon layers will produce a p-n junction [8-13].

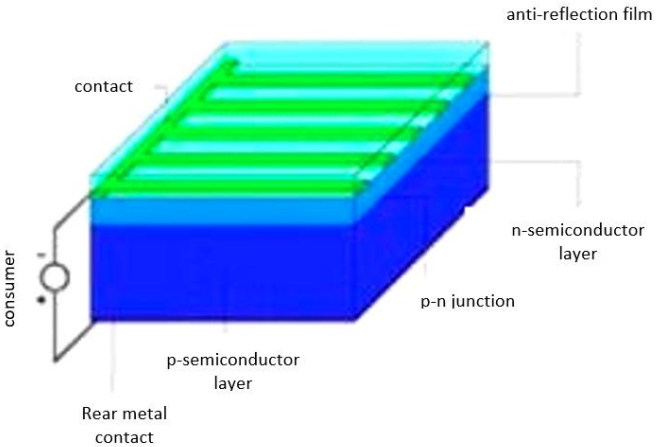

Fig. 1. Solar Cell Components [14]

By forming a p-n junction (Fig. 2), an electric field will arise due to differences in carrier charge on the two layers produced by light. If the p-n junction circuit is a closed circuit, then the current will be able to flow, the amount of current and voltage generated depends on the type of semiconductor

International Journal of Scientific Engineering and Science
Volume 4, Issue 8, pp. 67-69, 2020. ISSN (Online): 2456-7361

material used. Silicon can usually produce 2A per 100 cm^2 when getting radiation of 1000W/m^2 [14].

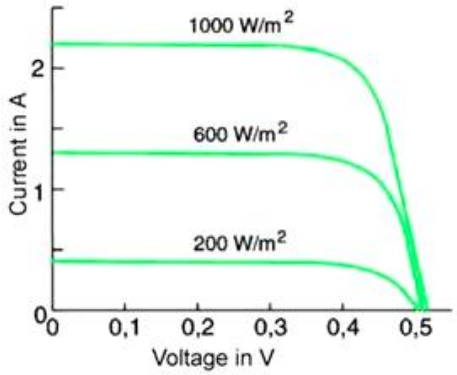

Fig. 2. Voltage and Current of Solar Cell [4]

The output voltage and current of solar cells are strongly influenced by temperature. High cell temperatures will cause lower output, thus reducing the efficiency of solar cells, low cell temperatures will give the opposite result. The level of efficiency itself is how much the amount of light radiation or photons from the sun that can be converted into electrical energy.

Many kinds of research were carried out to improve the efficiency of solar panels. It is undeniable that differences in material used or certain material combinations are only suitable for a particular range of the light spectrum, certain spectrum ranges cannot be used because photons do not have enough energy to activate the carrier charge, so in the end, some energy that does not turn into electricity it turns hot. In addition, there are also optical inefficiencies that occur such as the occurrence of shadows on the cell surface or the reflection of sunlight coming on the cell surface (Fig. 3), inefficiencies like this occur due to electrical resistance in semiconductors and cable connections are also included [15].

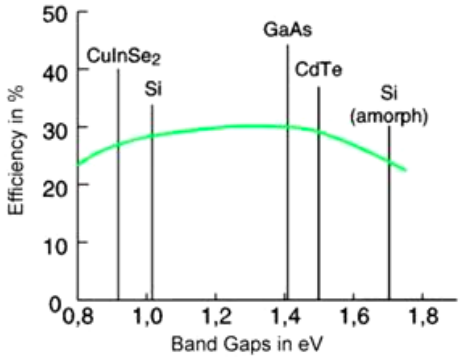

Fig. 3. Solar Cell Efficiency on various band gaps [15]

Good solar panels [16-17] in addition to being determined by the selection of material is also determined by (Fig. 4):

1. The surface structure design to reduce deflection inefficiency can use pyramid-designed materials such as gallium arsenide (GaAs), cadmium telluride (CdTe), copper indium selenide (CuInSe2) so that the incoming light can bounce off the surface several times.
2. Tandem or stacks cells can be used on a wide spectrum of radiation.
3. Inversion Layer Cells so that the electric field inside the cell is not produced by the p-n junction, but by the thin oxide layer junction in the semiconductor.
4. Gratzel cells to increase light absorption/photons.

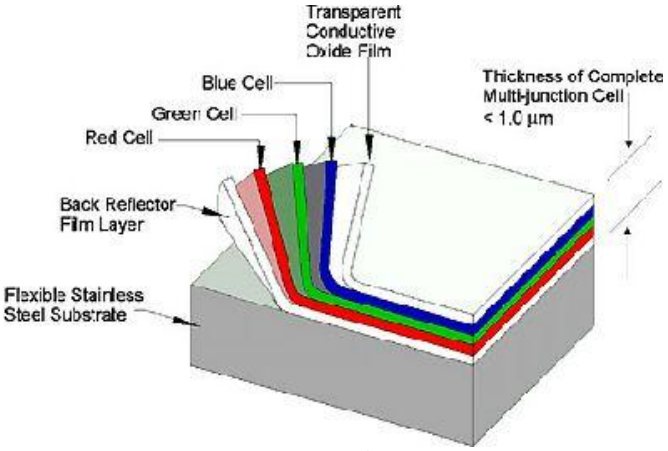

Fig. 4. Solar Cell Layers of Silicon Crystal [18]

With the existence of solar panels, solar energy can be utilized so that humans can create new types of plants that are environmentally friendly and economical by utilizing solar panels, these new types of plants use renewable energy not only from the sun but also from water and air which is certainly environmentally friendly and can save the environment from the exploitation of agricultural products on a large scale, all types of energy sources are called VRES.

However, VRES also has a natural problem that until now has not been solved, namely the problem of its dependence on weather, climate and the environment that can affect its ability to produce energy. The natural problem of weather dependence on VRES has led the world to a research competition to solve the case [19].

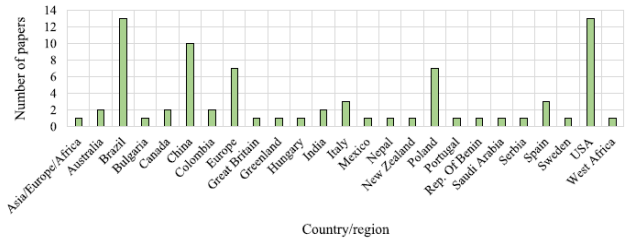

Fig. 5. The number of research article production of solar panels in each country [19]

Based on Fig. 5, it can be seen that countries on the American continent such as Brazil and the US are the two countries that produce the most written scientific research on research on solar panels and solar energy. Research conducted by the two countries on the American continent has also triggered China to research about solar panels and solar energy so that China becomes the third country in the world that produces the most scientific writing and is a leader in research on solar energy on the Asian continent, while the four are on the European continent [19].

It is undeniable that the development of research on solar panels in the American continent has made the United States as a country that has research on the most advanced solar panels in the world, its progress in this research allows the United States to create products that rely on renewable energy. For example, Tesla's electricity is a production electric car that can be purchased by consumers worldwide (Fig. 6).

Charging Station facilities that are made scattered in America by Tesla rely on solar energy obtained from solar panels produced by solar panel manufacturing companies with efficiencies approaching 45% where such efficiency is achieved by solar panel technology utilizing FAPBX3 (Formamidinium lead halide nanocrystals) [20].

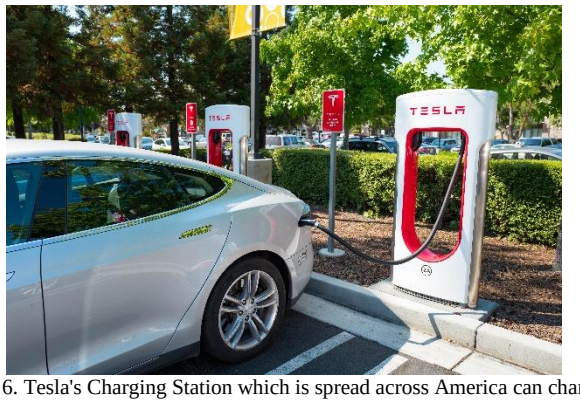

Fig. 6. Tesla's Charging Station which is spread across America can charge Tesla cars for free because it gets a free supply of electrical energy from the sun by utilizing solar panel technology [10]

III. CONCLUSION

In summary, solar panels can be used as a tool for supplying electrical energy in the future. However, the problem of efficiency and its dependence on weather and climate is still a barrier for humans to gain full advantage of the potential of the sun. This has an impact on the delay of fossil energy to be immediately replaced with renewable energy. Many countries are competing to solar panels research due to sunlight to be a source of energy in the future. At this time, research on solar panels can be done because of its ease in producing solar panels with research costs that are still affordable with extensive results and have excellent prospects for the future.

ACKNOWLEDGMENT

Thank you for Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) and our collegues in Faculty of Engineering and Science, Universitas Naasional, Jakarta for the support.

REFERENCES

[1] Zhao, C., Wang, Y., Li, M., Zhao, W., Li, X., Du, W., and Yu, Q. "Experimental study of a solar adsorption refrigeration system integrated with a compound parabolic concentrator based on an enhanced mass transfer cycle in Kunming, China". *Solar Energy*, *195*, 37-46. 2020.

[2] Hidayanti F., Wati E.K., and Miftahudin M. F. "Design of Energy Harvesters on Motorcycle Exhaust using Thermoelectric Generator for Power Supply Electronic Device". *International Journal of Renewable Energy Research*. 10(1), 251 - 259. 2020.

[3] Hidayanti F., Wati E.K., and Akbar H. "Energy Harvesting System Design for Converting Noise into Electrical Energy". *International Journal of Advanced Science and Technology*. 29(03), 4791 - 4802. 2020.

[4] Hidayanti F., Rahmah F., and Wiryawan A. "Design of Motorcycle Security System with Fingerprint Sensor using Arduino Uno Microcontroller". *International Journal of Advanced Science and Technology*. 29(05), 4374 - 4391. 2020.

[5] Hidayanti F., Santoso H. H., and Amalia D. "Induction Measurement of Extra High Voltage Air Duct". *International Journal of Emerging Trends in Engineering Research*. 8(4), 1424 - 1427. 2020.

[6] Hidayanti F., Rahmah F., and Sahro A. "Mockup as Internet of Things Application for Hydroponics Plant Monitoring System". *International Journal of Advanced Science and Technology*. 29(05), 5157 - 5164. 2020.

[7] Gómez-Hernández, J., González-Gómez, P. A., Briongos, J. V., and Santana, D. "Technical feasibility analysis of a linear particle solar receiver". *Solar Energy*, *195*, 102-113. 2020.

[8] Suárez-García, A., Díez-Mediavilla, M., Granados-López, D., González-Peña, D., and Alonso-Tristán, C. "Benchmarking of meteorological indices for sky cloudiness classification". *Solar Energy*, *195*, 499-513. 2020.

[9] Hidayanti F., Lestari K.R., and Anwar R. "Arduino Based Conductive Silver Lamination Device". *International Journal of Emerging Trends in Engineering Research*. 8(2), 265 - 270. 2020.

[10] Hidayanti F., Rahmah F., and Agusto J. "Design of Solar Tracker on Solar Panel with Fresnel Concentrator". *International Journal of Advanced Science and Technology*. 29(05), 1014 - 1025. 2020.

[11] Hidayanti F., Rahmah F., and Ikrimah M. "Dual-Axis Solar Tracking System Efficiency for Hydroponics Pump". *International Journal of Emerging Trends in Engineering Research*. 8(6), 2631 - 2634. 2020.

[12] Hidayanti F., "Performance of Portable Battery Charger of Monocrystalline Solar Panel". *International Journal of Emerging Trends in Engineering Research*. 8(7), 3181 - 3184. 2020.

[13] Hidayanti F., "The Effect of Monocrystalline and Polycrystalline Material Structure on Solar Cell Performance". *International Journal of Emerging Trends in Engineering Research*. 8(7), 3420 - 3427. 2020.

[14] Nie, F., Bai, F., Cui, Z., Zhao, Z., and Wang, Z. "Cold-state experimental study on discharge characteristics of solid particles in a gravity driven moving bed solar receiver". *Solar Energy*, *195*, 14-26. 2020.

[15] Hemaida, A., Ghosh, A., Sundaram, S., and Mallick, T. K. "Evaluation of thermal performance for a smart switchable adaptive polymer dispersed liquid crystal (PDLC) glazing". *Solar Energy*, *195*, 185-193. 2020.

[16] Montoya, D. M., Pérez-Gutiérrez, E., Barbosa-Garcia, O., Bernal, W., Maldonado, J. L., Percino, M. J., ... and Cerón, M. "Defects at the interface electron transport layer and alternative counter electrode, their impact on perovskite solar cells performance". *Solar Energy*, *195*, 610-617. 2020.

[17] Laporte-Azcué, M., González-Gómez, P. A., Rodríguez-Sánchez, M. R., and Santana, D. "Deflection and stresses in solar central receivers". *Solar Energy*, *195*, 355-368. 2020.

[18] Dang, S., Yi, Y., and Ye, H. "A visible transparent solar infrared reflecting film with a low long-wave emittance". *Solar Energy*, *195*, 483-490. 2020.

[19] Jurasz, J., Canales, F. A., Kies, A., Guezgouz, M., and Beluco, A. "A review on the complementarity of renewable energy sources: Concept, metrics, application and future research directions". *Solar Energy*, *195*, 703-724. 2020.

[20] Duan, J., Wei, J., Tang, Q., & Li, Q. (2020). Unveiling the interfacial charge extraction kinetics in inorganic perovskite solar cells with formamidinium lead halide (FAPbX3) nanocrystals. *Solar Energy*, *195*, 644-650.