A Review Of Solar Energy

Najeem O. Adelakun
Department of Electrical / Electronic Engineering,
The Federal Polytechnic, Ilaro.
Ogun State, Nigeria.
e-mail: adelakunnajeem@gmail.com

Banji A. Olanipekun
Department of Electrical / Electronic Engineering,
The Federal Polytechnic, Ilaro.
Ogun State, Nigeria.
e-mail: ufcitebanji@gmail.com

***Abstract*— Solar Energy is the prime important source of energy, and it has continued to gain popularity globally. As of 2018, about 486 GW of solar PV was installed worldwide. One of the key requirements for socio-economic improvement in any nation of the world is the provision of dependable electricity supply systems. Recently, there is a massive growth in access to solar electricity in several Africa countries, notably South Africa, Egypt, Morocco, and Algeria. As a result, it decreases the global population without access to electricity with an appreciable value. This paper review the present state of solar energy capacity in the world also identifies vital approaches of improving their functionality, reliability, and affordability as well as the essential method that policymakers may implement in the future. The result shows that there is a recurrent growth in solar energy annually and as at the end of 2018 Asia with the largest capacity of 56.58%, while Central America and the Caribbean have the lowest installed capacity of 0.36%. As the request for an uninterrupted supply increases in different regions, progressive builders are embracing solar photovoltaics (PV) renewable energy as an option for their customers.**

***Keywords*— Solar energy; electricity; capacity; growth**

I. INTRODUCTION

Recently, the need for a clean and environmentally friendly energy source has given Solar energy a massive growth due to both technological improvements resulting in cost reductions and government policies supportive of renewable energy development and utilization.

The solar energy system is the transition of sunlight into electricity, it can be achieved directly using photovoltaic (PV) panels or indirectly with the aid of concentrated solar power (CSP). Concentrated solar power systems with a total of 5,469 MW installed capacity worldwide which amour to 1.13% of the total solar energy installed globally. Solar Energy has an estimated world-wide average power potential of 24W/m^2 of the earth's surface [2]. As at the end of 2018 the solar power was about 486 GW globally. According to the International Renewable Energy Agency (IRENA) report, (2019) Nigeria with 19MW, South Africa 2959MW, Egypt 770MW, Morocco 735 MW, Algeria 435MW out of 6093 MW Solar Energy Installed Capacity in Africa 2018.

II. MATERIALS AND METHOD

The Photovoltaic system can be classified into two parts which are the PV array (this includes the PV panels and support structures) and the balance-of-system (BOS) components (which includes storage batteries, Charge controllers, inverters and wirings).

A. Basic Components of Solar Power

There are four basic components of a solar power system: Solar Panels, Charge Controller, Batteries, Power Inverter.

a) *Solar panels:* are composed of individual solar cells that are connected to form a solar module and multiple solar modules are connected to form a solar array, it can be connected in series, parallel or series-parallel combination for maximum power output.

b) *Charge Controllers:* Charge Controllers are used to preventing overcharge of the battery by preventing high voltage that damages the batteries. The minimum charge controller for home uses a technology called Pulse Width Modulation (PWM), but the best charge controllers use Maximum Power Point Tracking (MPPT) technology.

c) *Batteries:* Deep Cycle Batteries are needed for the storage of electricity, but more specialized batteries such as Tubular batteries are also gaining popularity for larger applications like powering your home.

d*) Power Inverters:* The electricity produced by the PV panel is Direct Current (usually 12V, 24V, or 48V, etc.), which is then converted to Alternating Current (AC).

However, Fig. 1.0 shows that DC load can be connected to the charge controller and battery storage system respectively, it is essential to incorporate a circuit breaker in between the charge controller and the battery storage system to prevent excess current to flow to the battery in case of short circuit. Which can be replicated at all the necessary points.

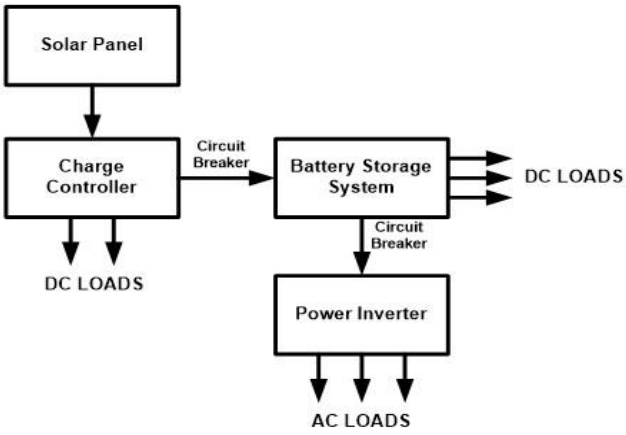

Fig. 1, Block diagram of a typical Photovoltaic System.

B. Advantages of Solar Energy

a) Low running cost
b) No Monthly Bills
c) It is renewable
d) Low Maintenance Cost
e) Environmental friendly
f) Source of Income
g) Value-Added Property
h) Improving Technology
i) Shared Solar
j) Improves the Economy
k) Job provision

C. Disadvantages of Solar Energy

a) It is expensive to setup
b) Intermittent in a cloudy weather
c) Low Efficiency
d) Occupy more space
e) Dependency on Latitude

TABLE 1. RENEWABLE ENERGY CAPACITY AND SOLAR ENERGY CAPACITY (2009 – 2018) IN GW

Year	Renewable Energy Capacity	Solar Energy Capacity
2009	1,136.226	23.371
2010	1,224.050	40.871
2011	1,329.202	72.683
2012	1,441.393	102.871
2013	1,563.122	139.602
2014	1,693.254	177.496
2015	1,848.157	225.820
2016	2,007.996	297.293
2017	2,179.448	391.063
2018	2,350.755	485.826

Source: International Renewable Energy Agency. [5].

TABLE 2. TOP OPERATIONAL SOLAR POWER CAPACITY IN DIFFERENT REGIONS 2018 (GW)

Region	Country	Solar Energy Installed Capacity in 2018
Africa	South Africa	2.96
Asia	China	175.03
Central America and the Caribbean	Honduras	0.52
Eurasia	Turkey	5.66
Europe	Germany	45.93
Middle East	Israel	1.08
North America	USA	51.45
Oceania	Australia	9.77
South America	Brazil	2.30

Source: International Renewable Energy Agency. [5].

TABLE 3. SOLAR GLOBAL CAPACITY BY REGIONS 2018 (MW)

Region	Solar Energy Installed Capacity in 2018	Solar Photovoltaic Installed Capacity in 2018	Concentrated solar power Installed Capacity in 2018
Africa	6,093	5,118	975
Asia	274,866	274,619	247
Central America + Caribbean	1,737	1,737	Nil
Eurasia	5,663	5,662	1
Europe	121,692	119,380	2,312
Middle East	3,181	3,025	156
North America	57,118	55,346	1,772
Oceania	10,006	10,001	5
South America	5,469	5,469	Nil
Total	**485,826**	**480,357**	**5,469**

Source: International Renewable Energy Agency. [5].

D. Nations with the most solar capacity

Table 4. shows that China has a bigger solar energy capacity than any other country in the world, these achievement are made easier by the fact that China is the world's largest manufacturer of solar panels and Japan follows with appreciable capacity and USA home to some of the world's largest solar power plants is the third, and it is visible from the table that three Asia countries are among the top five

nations with the most solar installed capacity which makes Asia the leading region with a total of 274,866 MW with 56.58% of the total installed capacity as shown in table 3. which is more than half of the total Solar Energy installed capacity in the world.

TABLE 4.0 SOLAR POWER CAPACITY BY TOP 10 COUNTRIES IN WORLD 2018 (GW)

S/N	Country	Solar Energy Installed Capacity (2018)	Region
1	China	175.03	Asia
2	Japan	55.50	Asia
3	USA	51.45	North America
4	Germany	45.93	Europe
5	India	27.98	Asia
6	Italy	20.13	Europe
7	United Kingdom	13.11	Europe
8	Australia	9.77	Oceania
9	France	9.48	Europe
10	Korea Republic	7.86	Asia

Source: International Renewable Energy Agency. [5].

III RESULT AND DISCUSSION

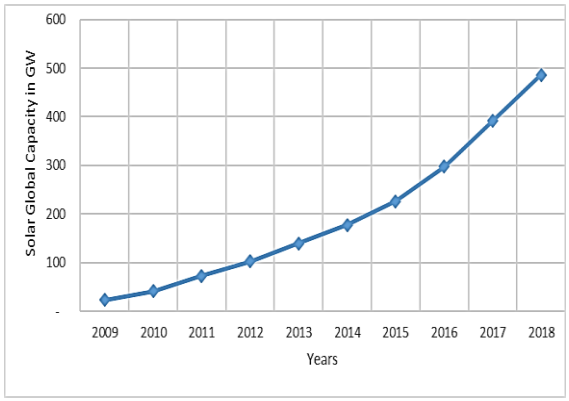

Fig. 2, Solar Power Global Capacity in MW

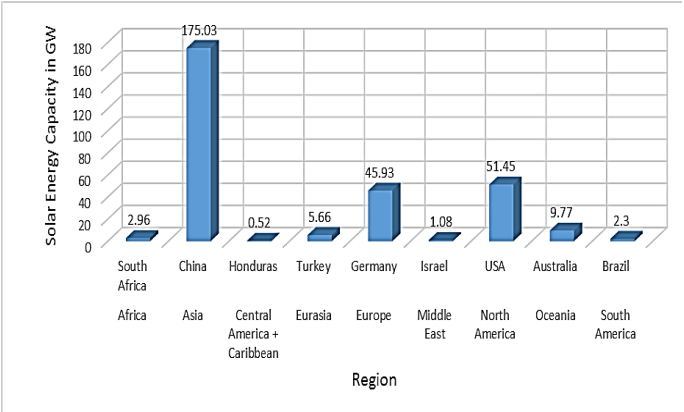

Fig. 3, Chart showing Solar Energy capacity by top countries and region in world 2018 (GW)

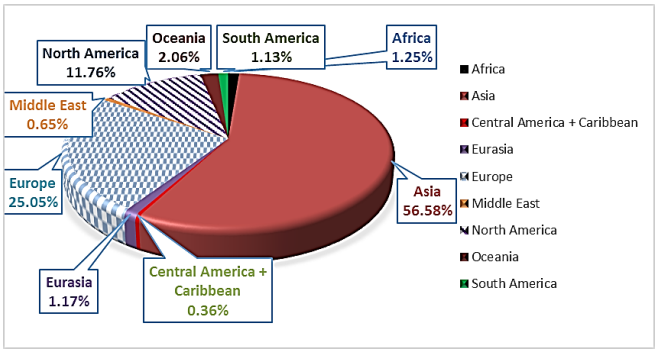

Fig. 4, Percentage of Solar Energy Installed capacity of different region in the world in 2018

There is a recurrent growth in solar power capacities yearly as shown in Fig. 2, China tops the world with the most capacity. Besides, Fig. 4, shows the percentage of solar power capacity by regions in the world, from the pie chart, Asia has the largest percentage with 56.58%, the difference is not far-fetched but since three countries from Asia is among the top five countries with much capacity of Solar energy in the world and Central America and the Caribbean with the lowest percentage of 0.36% respectively.

Fig. 5, implies that Solar Photovoltaic is the most common with 98.87% installed capacity and only 1.13% from the Concentrated Solar power system, and table 4, also depict that some regions of the world have not explored the CSP approach at all, but some with minimum installed capacity.

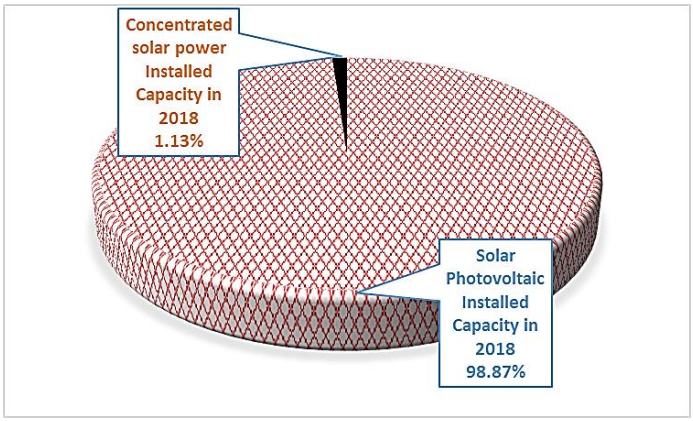

Fig.5, Percentage of Solar Photovoltaic & Concentrated Solar Power Capacity in MW (2018)

IV CONCLUSION

It is apparent that concerns about greenhouse effect and unavailability of constant conventional energy source have made renewable energy sources an alternative energy source to be adopted, solar energy been one of the fastest-growing renewable energy source as shown in the result with a recurrent growth

should be embraced owing to the benefits associated with it, from the total solar energy installed worldwide Asia has the largest installed capacity of 56.58%, while Central America and the Caribbean has the lowest installed capacity of 0.36%. As the request for an uninterrupted supply increases in different regions, progressive builders are embracing solar photovoltaics (PV) renewable energy as an option for their customers, moreover, if all the suggestions and recommendations stated in the paper is implemented, solar energy will be more functional, reliable and affordable which will also help the deployment on a large scale.

RECOMMENDATIONS

The following are suggested for improvement of Solar energy power technology:

a) Renewable energy power station such as solar (PV) should be actively encouraged.
b) There should be massive increase in manufacturing capacity and more effort has to be put into improving efficiencies while reducing the manufacturing costs.
c) Installation of LEDs bulb instead of incandescent or high power consume bulb.
d) Turn off all standby mode for used equipment.
e) Embraced the culture of energy efficient home.
f) High consumption devices should be run during the day when there is sun.

REFERENCES

[1] N. O. Adeniji, J. A Akinpelu; S. O Adeola, and J. O. Adeniji, “Estimation of Global Solar Radiation, Sunshine Hour Distribution and Clearness Index in Enugu, Nigeria,” Journal of Applied Science and Environmental Management, Vol. 23 (2), Pp 345-349, 2019.

[2] A. F. Agbetuyi, S. O. Oyedepo, C. O. A. Awosope, H. E. Orovwode, and J. O. Olowoleni, “The Vast Renewable Energy in Africa versus its Slow Pace of Harnessing,” International Electrical Engineering Journal, Vol. 8, No. 2, Pp. 2507 – 2512, 2018.

[3] GCEP, “An Assessment of Solar Energy Conversion Technologies and Research Opportunities,” Global Climate and Energy Project, Stanford University, 2006.

[4] IEA, IRENA, UNSD, WB, WHO, “Tracking SDG 7: The Energy Progress Report 2019,” Washington DC

[5] IRENA, “Renewable capacity statistics 2019, International Renewable Energy Agency (IRENA),” Abu Dhabi, 2019.

[6] Jäger-Waldau, A., “*PV Status Report 2019*, EUR 29938 EN,” Publications Office of the European Union, Luxembourg, 2019.

[7] MESIA, Solar Outlook Report 2019, Middle East Solar Industry Association, Dubai – UAE, 2019.

[8] C. U. Okoye, N. O. Adelakun, “Design and Evaluation of Electrical Services for an Energy Efficient Home,” Iconic Research and Engineering Journals, Vol. 3, Issue 6, Pp 95 – 102, 2019.

[9] REN21, “Renewables 2019 Global Status Report,” (Paris: REN21 Secretariat). 2019.

[10] S. M. Rompicherla, “Solar Energy: The Future”, International Journal of Engineering

Trends and Technology, Vol. 4, Issue 6, June, Pp 2513 – 2517, 2013.

[11] G. R. Timilsina, L. Kurdgelashvili, and P. A. Narbel, “A Review of Solar Energy Markets, Economics and Policies,” The World Bank Development Research Group Environment and Energy Team, 2011.

[12] J.K. Yohanna, and V.I. Umogbai, “Solar Energy Potentials & Utilization in Nigeria Agriculture," Journal of environmental issues and Agriculture in developing Countries. Vol. 2, No 2. 2010.

[13] https://www.finder.com/uk/nation-most-solar-power [Accessed October 6, 2019]