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A short review on the renewable energy resources and development of the solar house

Abstract

With the increasing population and standard of living, the energy demand is increasing. But the non-renewable resources are decreasing with the increasing demand for energy. So, we should focus on renewable energy resources. According to the report of REN21 in 2019, 73.8%of electricity is generated from non-renewable energy resources, and only 26.2%of electricity is generated from renewable energy resources where 15.8% is from Hydropower, 5.5% from Wind Power, 2.4% from solar PV (Photovoltaics), 2.2% from Bio-power and 0.4% from Geothermal, CSP and Ocean power. In this paper, we review the major renewable energy resources to determine effective and usable renewable resources. We especially focus on hydropower, wind power, and solar power, because those are the most used renewable resources at present. And finally, we develop a solar house system. To implement the solar house system, we used a solar array, a battery array, charge controller, inverter, and loads.

Keywords: Renewable resources, hydropower, wind power, solar power, solar house

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Al Mahmud Al Mamun,[1] Rakibul Hasan Md,[1] Salmond Samoy Hazra,[2] Anik Rana Md,[2] Mahfuza Sharmin,[2] Enamul Kabir Md,[3] Kamrul Hassan Md,[4] Rasel Hossain[5]

[1]Department of Computer Science and Engineering, Islamic University, Bangladesh
[2]Department of Electrical and Electronic Engineering, Daffodil International University, Bangladesh
[3]Department of Mathematics, National University, Bangladesh
[4]Department of Electrical and Electronic Engineering Bangladesh University of Business & Technology, Bangladesh
[5]Bachelor of Arts (B.A.), Department of English Literature, National University, Bangladesh

Correspondence: Mahmud Al Mamun Al, Department of Computer Science and Engineering, Islamic University, Bangladesh, Email almamun.ow@gmail.com

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Introduction

The use of energy is life-changing and the most amazing innovation made by humans. We need a huge amount of energy for living, transportation, manufacturing, communication, industrial, commercial, domestic, and many other purposes. It is difficult for us to spend a day without electricity. With increasing the population and standard of living the demand for energy is increasing.

In the present world, to generate power we mainly depend on non-renewable resources such as oil, natural gas, coal, and nuclear energy which are limited in nature. According to the report of REN21 in 2019, 73.8% of electricity is generated from non-renewable energy resources. The non-renewable resources are decreasing with the increasing energy demand. So, we should focus on renewable energy resources.

The useful energy collected from renewable resources is typically known as renewable energy. Renewable energy includes neutral sources such as sunlight, wind, rain, tides, waves, geothermal heat, etc. Renewable energy is used as a resource to generate electrical energy, heating or cooling of air and water, transportation service, and the rural energy service.

According to the report of REN21 in 2019, 26.2% (1.246 Terawatts) of electricity are generated from renewable energy resources where 15.8% is from Hydropower, 5.5% from Wind Power, 2.4% from solar PV (Photovoltaics), 2.2% from Biopower and 0.4% from Geothermal, CSP and Ocean power.[1]

In this paper, we review the major renewable energy resources to determine effective and usable renewable resources. We especially focus on hydropower, wind power, and solar power, because those are the most usable, available, and renewable energy resources in the world.

In the Hydropower system, turbine propellers are turned by falling and moving water, and the turned turbine turns the generator which generates the electricity. In the Wind Power system, turbine propellers are turned by the wind, and the turned turbine turns to the generator which generates the electricity.

In the solar energy system, the energy from the sun (radiant light and heat) is converted to electrical energy using many different technologies such as solar heating, photovoltaics (PV), solar thermal energy (CSP), artificial photosynthesis, solar architecture, and molten-salt-power plants. And finally, we develop a solar house system. To implement the solar house system, we use a solar array, a battery array, charge controller, inverter, and loads.

Review on renewable energy resources

Worldwide a huge amount of electricity is generated in 2019 from renewable energy resources such as Hydropower, Wind power, Solar PV, Bio-power, Geothermal, CSP, and Ocean power.

a. Hydropower

Hydro from the Greek word "ὕδωρ" means water, the power derived from the energy source of fast-running or falling water is known as Hydropower. From ancient times hydropower has been used for flour-grind and other tasks. In the late 18th century hydraulic power provided the energy source needed for the beginning of the Industrial Revolution.

The publication "Architecture Hydraulique" by Bernard Forest de Bélidor described vertical and horizontal-axis hydraulic machines in the mid-1770s, and the combination of water power, the water frame, and continuous production of Richard Arkwright in 1771 is played a significant part in the development of the factory system.[2] The world's first hydroelectric power intention was developed at Cragside in Northumberland by William Armstrong in 1878 which used to power a

single arc lamp for his art gallery.[3] The old Schoellkopf Power Station No-1, near Niagara Falls, began to generate electricity in 1881.[4]

In 1886, the United States and Canada used 45 hydroelectric power stations to generate electricity, and that became 200 in the United States alone in1889.[5]

In the Hydropower system, build a dam wall on a large river that has a large drop in altitude. The dam wall stores lots of water, near the bottom of the dam wall, has a water intake. Using gravity, water from the dam falls through the penstock. There is a turbine propeller at the penstock which is turned by the falling and moving water. The shaft from the turbine turns the generator, which generates electricity.

According to the report of REN21 in 2019, worldwide 15.8% of electricity is generated from Hydropower.

b. Wind power

The electrical power derived from the wind turbines to turn electric generators is known as Wind power. Between 1792 and 1750 BC, King Hammurabi's Codex mentioned windmills to generate mechanical energy.[6] In July 1887, the first windmill was built to produce electric power in Scotland by Prof James Blyth of Anderson's College.[7] In the winter of 1887-1888, Charles F. Brush designed and developed a larger machine across the Atlantic, in Cleveland, Ohio, and operated from 1886 until 1900.[8]

In the Wind power system, build a large wind turbine which is turned by the wind. The shaft from the turbine turns the generator, which generates the electricity.

According to the report of REN21 in 2019, worldwide 5.5% of electricity is generated from Wind power.

c. Solar energy

The energy derived from the energy source of the Sun (radiant light and heat) is known as solar energy.

The first development of solar technologies began in the 1860s. In 1878, a solar steam engine was demonstrated at the Universal Exposition in Paris by Augustin Mouchot. Charles Fritts developed the world's first rooftop photovoltaic solar array using selenium cells in 1884.[9]

In 1897, Frank Shuman built a small demonstration of a solar engine, and he formed Sun Power Company in 1908. The first solar thermal power station was built in Maadi (Egypt) by Frank Shuman from 1912 to 1913.

In 1916 Frank Shuman said, "We have proved the commercial profit of sun power in the tropics and have more particularly proved that after our stores of oil and coal are exhausted the human race can receive unlimited power from the rays of the Sun" [Frank Shuman, New York Times, 2 July 1916.[10]

The cost of generating electricity from solar energy was $96 (Adjusting) per watt in the mid-1970s.[11] In 2016, a wholesale purchase agreement was signed by Palo Alto California where the cost is 3.7 cents per kilowatt-hour, and large-scale solar-generated electricity sold for just $0.0299 per kilowatt-hour in Dubai.[12]

Generally, two technologies use solar power plants-Photovoltaic (PV): PV systems use solar panels where the sunlight directly converts into electric power. Concentrated solar power (CSP): CSP plants use solar thermal energy to make steam to run turbines that generate electricity.

Solar power plants also use hybrid systems. A hybrid system combines Photovoltaic (PV) and Concentrated Solar Power (CSP) with one another or other forms (diesel, wind, and biogas).

According to the report of REN21 in 2019, worldwide 2.4% of electricity is generated from solar power.

Table 1 Loads details

Items/Load	Rated power	Hours/Day	No. of loads	Watt-Hours
CFL	15	6	5	450
FAN	75	8	3	1800
TV(25")	150	2	1	300
Total	240	16	9	2550

Development of solar house system

System Design

To implement the solar house system, we use a solar array, a battery array, charge controller, inverter, and loads. In this system, the loads are connected with the inverter, the inverter connected with batteries, and the batteries connect with the charge controller which is connected with the solar array. The solar array receives the solar energy from the sun and converts the solar energy to electrical energy, and then the electrical energy of the solar array is stored in the battery array. The charging system is controlled by the charge controller. The loads take power from the battery array and the inverted perform as a bridge between battery and load. The inverter takes DC from the battery and supplies AC to the load. Overview of the system: To implement the solar house we mainly focus on the selection of the site of the project, loads, battery, solar panel, inverter, and charge controller.

Site: This is important for this project to find a site with enough sunlight because the whole system is completely dependent on sunlight.

Since the PV panel is set on top of the house, it should be set up in a suitable and safe place. To get the maximum performance we check and comprehend the suitable place and angle for the PV panel so that it can have sunlight each day of the year.

Loads: To design the Solar House System, at first, we find the total power and energy consumption of all loads. The complete system design depends on the required energy of the loads.

We also calculate the average energy demand for this project. To calculate the average demand, we focus - on the number of loads we are going to connect to the system, the operating voltage and current of the loads, and the daily working hours.

Battery: The energy we get from the solar array will be stored in the Battery. In this project, we need a rechargeable battery. Generally, lead-acid batteries are used in PV systems that have a lot of classifications. One of the important tasks is the selection of the type of battery appropriate for this project.

The battery used in the solar system can be run daily in a shallow cycle but on winter or cloudy days, it can run in a deep cycle. In a shallow cycle charge consumption of the battery is less but in the deep cycle charge consumption is more about 50%. Battery parameters 60% to 80% discharge, 12V, 100A lead-acid battery. DOD of 70%=0.70.

Useable capacity $= 100 \times 0.70 = 70A$

Energy from Battery

$$= Voltage \times Usable\ capacity = 12V \times 70A = 840\ watt/hour$$

Number of batteries required

$$= \frac{Total\ required\ energy}{Energy\ from\ battery} = \frac{2550}{840} = 3.04$$

Therefore, we need four batteries for this system.

Battery efficiency = 80% *to* 90% = 85% = 0.85

Energy to battery terminal

$$= \frac{Total\ required\ energy}{Efficiency\ of\ battery} = \frac{2550}{0.85} = 3000\ watt - hour$$

Solar Panel: The amount of electricity generated by the PV panel varies based on solar module rating and availability of sunlight. An hour when the intensity of sunlight is 1,000 watts per square meter is known as a peak sun-hour. The amount of solar radiation delivered by the sun depends on the sun's position in the sky, clouds, and other conditions.

PV panels efficiency 90% = 0.90

Energy from PV panels

$$= \frac{Energy\ supplied\ to\ the\ battery}{PV\ panel\ efficiency} = \frac{3000}{0.90} = 3333.33$$

Since, the system voltage = 24v

Energy of panel

$$= \frac{Energy\ supplied\ by\ the\ PV\ panels}{System\ voltage} = \frac{3333.33}{24} = 138.89$$

Input of solar radiation = 1000 w/m^2, and equivalent peak sunshine hours = 6 hours.

Then, the total current needed $= \frac{138.89}{9} = 23.15A$

Since, we using a panel with 75 Watt (15v, 5A)

Number of panels needed $= \frac{23.15}{5} = 4.63$

Therefore, we need five PV panels for this system.

Inverter: In this system, the loads get energy from the battery. The battery supplies DC energy but loads run with AC energy, so we use an inverter (DC to AC converter) with a maximum rating of 650. Inverter with rating 650 MAX, and efficiency = 93% = 0.93

Charge Controller: The charge controller is used to feed electricity from the array of solar panels to the array of batteries in the most efficient manner.

A charge controller will prevent the battery from overcharging by automatically disconnecting the module from the battery bank, and also prevent batteries from reaching dangerously low charge levels by stopping the supply of power to loads.

Conclusion

Due to the increasing energy demand, the non-renewable resources are decreasing. So, we should focus on renewable energy resources.

With our work, we review the major renewable energy resources to determine effective and usable renewable resources.

We develop a solar house system using a solar array to represent our opinion that solar energy is the most effective and useful resource of energy for the increasing demands.

Figure 1 Chief Joseph Dam near Bridgeport, Washington.

Figure 2 Windmill, Highway in the Netherlands.

Figure 3 ALGERIA: 5,600 MW of solar power plants.

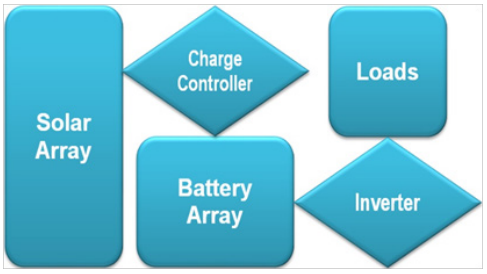

Figure 4 System Diagram.

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Conflicts of interest

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