Design and Development of Solar Lighting System using Automatic Tracking System

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ABSTRACT

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy. Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 1 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions. Only a very small fraction of the total radiation produced reaches the Earth. The radiation that does reach the Earth is the indirect source of nearly every type of energy used today. The exceptions are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was dependent upon the sun. Much of the world's required energy can be supplied directly by solar power. Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloudcover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container.

Keyword: - *Sustainability, Design Parameters, Energy Optimization*

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1. INTRODUCTION:

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Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 1 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions.

Only a very small fraction of the total radiation produced reaches the Earth. The radiation that does reach the Earth is the indirect source of nearly every type of energy used today. The exceptions are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was dependent upon the sun. Much of the world's required energy can be supplied directly by solar power. More still can be provided indirectly. The practicality of doing so will be examined, as well as the benefits and drawbacks. In addition, the uses solar energy is currently applied to will be noted. Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloudcover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container. Methods of collecting and storing solar energy vary depending on the uses planned for the solar generator. In general, there are two types of collectors and many forms of storage units.

The two types of collectors are flat-plate collectors, conical plate collectors.

Flat-plate collectors are the more commonly used type of collector today. They are arrays of solar panels arranged in a simple plane. They can be of nearly any size, and have an output that is directly related to a few variables including size, facing, and cleanliness. These variables all affect the amount of radiation that falls on the collector. Often these collector panels have automated machinery that keeps them facing the sun. The additional energy they take in due to the correction of facing more than compensates for the energy needed to drive the extra machinery.

Conical plate collectors are essentially flat-plane collectors with optical devices arranged to maximize the radiation falling on the focus of the collector. These are currently used only in a few scattered areas. Solar furnaces are examples of this type of collector. Although they can produce far greater amounts of energy at a single point than the flat-plane collectors can, but they have high cost.

2. LITERATURE REVIEW

Almost 70% of India's population depends on agriculture either directly or indirectly. While 44% of the 140 million sown hectares depend on irrigation, the rest relies on the monsoons. Irrigation, therefore, is essential for good crop yield. Most electrical consumption in this sector goes towards operating pump sets for irrigation. In 2006–7, India's agricultural sector accounted for 22% of the total electricity consumption, up from 10% in the 1970s. There are about 21 million irrigation pump sets in India, of which about 9 million are run on diesel and the rest are grid-based. Grid electricity for agriculture in India is provided at very low tariffs – in most cases, flat rates are charged based on the ratings of the pump. This is largely due to logistical difficulties faced with metering and charge collection. But this practice of providing electricity to farmers at highly subsidized rates has led to increasingly high consumption patterns and widespread use of inefficient pumps across the nation. Also, pumps of lower ratings are used to power applications requiring higher power. These factors, among others, have led to an invidious irrigation–energy nexus. Apart from this, limited and unreliable supply of grid electricity has led to farmers' extensive dependence on diesel for water pumping. In addressing this challenge, the efforts of the Gujarat government are noteworthy. They introduced the Jyotigram Yojana, a programmed that seeks to provide a reliable supply of power for agricultural and domestic purposes in rural areas.

The MNRE has a programmed for the deployment of various solar PV applications, including water pumping systems. However, the deployment has been sparse thus far, with only 7,334 solar PV water pumps having been installed across the country as of March 2010.Water demand for irrigation is correlated to bright sunny days. Hence, solar-based pumps make sense. Even so, small buffer storage might be needed to replace diesel satisfactorily. A solar PV water pumping system consists of a PV array, motor pump and power conditioning equipment, if needed. The power conditioning equipment is used to stabilize the fluctuating electrical energy output of the array. Depending on the total dynamic head and the required flow rate of water, the pumping system can either be on the surface or submersible and the motor can run on either alternating current (AC) or direct current (DC). For AC pumping systems an inverter is required. Ratings of

pump sets are chosen depending on the water requirements, size of field, total dynamic head, type of irrigation (drip irrigation, use of sprinklers), etc

It consists survey of the various types of solar thermal collectors and application is presented. Initially, an analysis of the environmental problems related to the use of conventional sources of energy is presented and the benefits offered by renewable energy systems are outlined. A historical introduction into the uses of solar energy is attempted followed by a description of the various types of collectors including flat-plate, compound parabolic, evacuated tube, parabolic trough, Fresnel lens, parabolic dish and heliostat field collectors. This is followed by an optical, thermal and thermodynamic analysis of the collectors and a description of the methods used to evaluate their performance. Typical applications of the various types of collectors are presented in order to show to the reader the extent of their applicability. These include solar water heating, which comprise thermosyphon, integrated collector storage, direct and indirect systems and air systems, space heating and cooling, which comprise, space heating [1] and service hot water, air and water systems and heat pumps, refrigeration, industrial process heat, which comprise air and water systems and steam generation systems, desalination, thermal power systems, which comprise the parabolic trough, power tower and dish systems, solar furnaces, and chemistry applications. As can be seen solar energy systems can be used for a wide range of applications and provide significant benefits, therefore, they should be used whenever possible.

Algeria encourages the development of renewable energies and in particular photovoltaic solar energy and this with an aim of answering at the request of electricity of the most stripped places and where the advance of electricity is difficult. Many scientists and researchers do not cease developing various methods of calculating for collect the maximum solar radiation and to optimize the electric power extracted of the photovoltaic generators. They develop in our study the effect of the slope and the orientation on the maximum power extracted from a photovoltaic module. they present the simulation of the sun trajectory tracking with a PV panel, keeping continuously the panel surface oriented face the sun.[2]

A solar tracking concentrator (STC) has to adapt to the changes in the sun’s position throughout the day and even more so, throughout the year. The function of sun tracking isto keep the sun’s rays perpendicular to the absorber’s cross-sectional area through a constant orientation, which requires an accurate electro-mechanical system that increases the cost of the whole concentrator. Sun tracking enables solar radiation to be concentrated in a limited and well-defined area of a receiver where the thermal energy collected is stored and then transformed into other kinds of energy. This heightens the prospects for the STC to use as little energy and movement as possible for solar tracking so as to achieve such a concentration. For this reason, a semi-passive solar tracking concentrator (SPSTC) whose configuration requires a minimal mechanical effort and reduced movement for sun tracking is proposed. It mainly consists of a micro-heliostat array, a Fresnel lens and a receiver. The array tracks the position of the sun to reflect the sun’s rays toward the Fresnel lens, which remains horizontal, reducing wind loads over the whole system. The receiver, located on the lens focus, remains stationary, releasing its weight on the sun tracking system and thus reducing the energy required for movement. The SPSTC’s kinematics for both altitude and azimuth tracking on a 25°39’15’’N latitude is analyzed. An optimum fixed array’s tilt of 49.054° was found to maximize the effective Fresnel lens area by reducing blocking and shading, both caused by the position of the array above the lens [3].

3.DESIGN AND COST ESTIMATION

Sr.no.	Part Name	Raw Material Size	Weight (kg)	Quantity	Rate	Amount
1	Angular Adjustment	125x80x3	0.16	2	75	24
2	Side Plate	160x125x3	0.32	2	75	48
3	Supports	20x10x135	0.22	2	75	34
4	Arms	30x12x190	0.54	2	75	34
5	Intermediate Shaft	D15x90	0.13	1	80	10
6	Bearing Holder	D25x30	0.12	2	80	20
7	Gear Holder	D20X40	0.1	1	75	8
8	Bearind Holder	20X50X95	0.78	1	75	52
9	Shaft	D25X90	0.35	1	75	25
10	Frame	25X25 sq pipe	20 ft	1	75	400
Total						655

Table-1 Cost of the components

8.2 Manufacturing Cost

Sr no.	Part Name	Quantity	Rate/Unit	Amount
1	Angular adjustment	2	72	144
2	Side plate	2	95	190
3	Supports	2	50	100
4	Arms	2	50	100
5	Intermediate shaft	1	175	175
6	Bearing holder	2	85	170
7	Gear holder	1	60	60
8	Bearind holder	1	90	90
9	Shaft	1	100	100
10	frame	1	750	750
Total				1969

Table-2 Manufacturing cost of the components

8.3 Brought Out Cost

Sr no.	Part Name	Quantity	Rate/Unit	Amount
1	Motor	1	4300	4300
2	Relay	1	1450	1450
3	Timer	1	2600	2600
4	Connector	1	180	180
5	Limit Switch	2	360	720
6	Gear (66 Teeth)	2	150	300
7	Gear (18 Teeth)	2	50	100
8	Solar Panel	1	3200	3200
9	Solar Lantern	1	3800	3800
10	Wires	--	120	120
11	Switch Board	1	90	90
Total				16860

Table -3 Brought out cost of the components

Other expenditure = Rs. 1000
Rotal Cost = Raw Material Cost + Manufacturing Cost + Brought Out Component Cost + Other Expenditure
Total cost = 655 + 1969 + 16860
Total cost = 19484.00 Rs

4. RESULT AND DISCUSSION:

For full charging of battery tests has been carried out in two ways, without tracking and tracking with the use of light sensors, and required time has been taken

Tests were carried out on 14th , 15th, 16th March 2026

Full battery charging without tracking system

- 14th March – 9:30 am to 11.45am 2.15 hrs
- 15th March – 11:15 am to 1:03 1.48 hrs
- 16th March – 3:30 pm to 6:02 pm 2.32 hrs

Full battery charging with light sensor tracking system

- 14th March – 9:30 am to 11.06am 1.36 hrs
- 15th March – 11:15 am to 12:55 pm 1.40 hrs
- 16th March – 3:30 pm to 5:28 pm 1.58 hrs

From the above observations we can see that time required by the system without tracking system is more as compared to light sensor tracking system

5.Conclusion

Following are the reading taken for different Hrs. getting different radiation

Sr no	Time (Hrs)	Time (min)	Intensity Of Beam Radiations (I_b)
1	11:30	00	701
2	11:31	01	701
3	11:32	02	711
4	11:33	03	714
5	11:34	04	720
6	11:35	05	731
7	11:36	06	728
8	11:37	07	729
9	11:38	08	730

10	11:39	09	730
11	11:40	10	732
12	11:41	11	728
13	11:42	12	725
14	11:43	13	726

6Table-5 Change in radiation as per time

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