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*Research Article*

# Machine Learning Strategy to Achieve Maximum Energy Harvesting and Monitoring Method for Solar Photovoltaic Panel Applications

**Bibhu Prasad Ganthia,[1] Sudheer Hanumanthakari,[2] Hemachandra Gudimindla,[3] Harishchander Anandaram,[4] M. Siva Ramkumar,[5] Monalisa Mohanty,[6] S. Raja Gopal,[7] Atul Sarojwal,[8] and Kibrom Menasbo Hadish[9]**

[1]*Department of Electrical Engineering, Indira Gandhi Institute of Technology, Sarang, Dhenkanal, Odisha 759146, India*
[2]*Department of Electronics and Communication Engineering, Faculty of Science and Technology, ICFAI Foundation for Higher Education, Hyderabad, Telangana 500029, India*
[3]*Department of Electrical and Electronics Engineering, M S Ramaiah Institute of Technology, Bengaluru, Karnataka 560054, India*
[4]*Centre for Computational Engineering and Networking, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Coimbatore, Tamil Nadu 641112, India*
[5]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Karpagam Academy of Higher Education, Coimbatore, Tamil Nadu 641021, India*
[6]*Department of Electrical and Electronics Engineering, Siksha 'O' Anusandhan D University, Bhubaneswar, Odisha 751030, India*
[7]*Department of Electronics & Communications Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh 522502, India*
[8]*Department of Electrical Engineering, FET, Mahatma Jyotiba Phule Rohilkhand University, Bareilly, Uttar Pradesh 243006, India*
[9]*Faculty of Mechanical Engineering, Arba Minch University, Arba Minch, Ethiopia*

Correspondence should be addressed to Kibrom Menasbo Hadish; kibrom.menasbo@amu.edu.et

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The choice of the optimal orientation of the solar panels is by far one of the most important issues in the practical application of solar installations. The use of phase changing materials (PCMs) is an efficient approach of storing solar thermal energy. Because PCMs are isothermal in nature, they provide better density energy storage and the capacity to function across a wide temperature range. Unfortunately, this feature is very rare on various solar power panels; however, ignoring it can reduce the performance of the panels to unacceptable levels. The fact is that the angle of incidence of rays on the surface greatly affects the reflection coefficient and, consequently, the role of unacceptable solar energy. In this paper, a smart energy harvesting model was proposed. In the case of glass, when the angle of incidence varies vertically from its surface to 30, the reflection coefficient is practically unchanged and slightly less than 5%, i.e., more than 95% of the radiation goes inwards. Furthermore, the reflection increase is noticeable, and the area of the reflected radiation by 60 doubles to almost 10%. At an angle of incidence of 70, it reflects 20% of the radiation, and at 80, 40%. For most other objects, the dependence of the reflection magnitude on the angle of incidence is approximately the same.

## 1. Introduction

Even more important is the so-called effective group area, viz. The intersection of the radiation flow was thereby blocked. This is equal to the actual area of the panel multiplied by the sine of the angle between its plane and the direction of flow (or, equally, perpendicular to the panel and by the cosine of the angle between the direction of flow) [1].

Therefore, if the panel is perpendicular to the flow, its effective area is equal to its actual area, the flow becomes 60% from the vertical—half of the actual area, and if the flow is parallel to the panel, its performance area is zero [2]. Thus, the significant deviation of the flow from the perpendicular to the panel increases the reflection, but reduces its effective area, which causes a more significant drop in output [3–5]. For our purposes, it is obvious that the fixed orientation of the panel perpendicular to the flow of sunlight is the most effective [6]. But this requires changing the position of the panel in two planes, because the position of the sun in the sky depends not only on the time of day but also on the season. Although such a system is certainly technically feasible, it turns out to be very complex, so expensive, and not very reliable [7–9]. Remember that there are many sources of renewable energy. By far, solar and wind are the most efficient, in general shown in Figure 1.

(i) Geothermal energy depends on the location of the tectonic plate on which it is located. Its main use is water heating for residential buildings and hospitals

(ii) On the other hand, we see hydraulic power. Hydraulic power is powered by the falls of the reservoirs. In Spain, due to drought, the amount of hydraulic energy produced is limited

(iii) As for solar thermal energy, the same happens with geothermal energy

However, at angles of occurrence up to 30, keep in mind that the reflection coefficient at the "air-glass" boundary is low and practically unchanged, and the angle of maximum sunrise above the horizon during the year deviates from the mean, not more than ±23. The effective area of the panel with a 23° deviation from the vertical is also very large—at least 92% of its actual area [10–12]. Therefore, one can focus on the average annual height of the maximum rise of the sun and rotate only in one plane, without losing efficiency in practice—at a speed of 1 revolution per day on the polar axis of the earth [13]. The angle of inclination of the axis of such rotation relative to the horizontal is equal to the geographic latitude of the space. For example, for solar panel, located at latitude of 56, the axis of such rotation must be inclined 56° northward (or, equally, deviate by 34% from the vertical) [14]. Such rotation is already very easy to organize, however, and requires a lot of space for a large group to rotate freely. In addition, it is necessary to arrange a sliding connection that allows you to divert all the energy received from the constantly rotating panel or restrict yourself to flexible communications with a fixed connection, but make sure that the panel returns automatically at night; otherwise, the deenergizing communication can be avoided by twisting and breaking [15–18]. Both solutions dramatically increase the problem and reduce the reliability of the system. As the power of the panels (hence their size and weight) increases, the technical issues become exponentially more complex [19]. Even if you just want to put up a few solar panels to save on electricity bills, investing in renewable energy is not cheap. Usually, the money invested pays for itself in the long run. The only positive aspect of renewable energies is that the price of photovoltaic panels has been reduced this year, as it was practically impossible to access them.

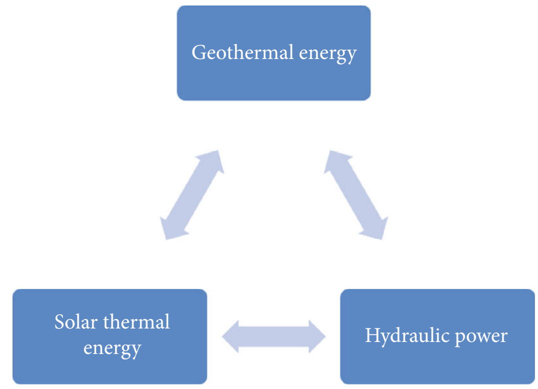

Figure 1: Important resources of renewable energy.

In connection with all of the above, the panels of individual solar installations are always mounted seamlessly, which ensures comparative affordability and high reliability of installation. However, here the choice of the angle of the panel space is especially important [20]. If the batteries are installed practically free of natural dust or washed in a timely manner by natural rain, they can work for many years without any maintenance. Another big advantage is the possibility of such a long operation in unattended mode [21]. The solar panels are capable of generating energy even in cloudy weather from dawn to dusk, while thermal solar collectors have slightly different temperatures from ambient temperatures [22]. Of course, compared to a clear sunny day, their productivity decreases many times over, but at least nothing is better than anything! In this regard, it is of particular interest to develop batteries with maximum energy transfer within the minimum solar absorption limits of the clouds [23–25]. In addition, when choosing solar photo converters, one should pay attention to the dependence of the voltage generated by them on the light—it should be as small as possible (when the light decreases, the current should fall first, not the voltage; otherwise at least some useful effect on cloudy days to obtain, expensive additional equipment must be used which forcibly increases the voltage sufficient to charge the batteries and operate the inverters).

## 2. Literature Review

The most important of the broad and ubiquitous barriers of energy harvesting solar photovoltaic solar panels is their high cost. Solar battery components are currently priced at a minimum amount and are subject to inefficient modifications regardless of the cost of assembling and installing the panels, as well as the cost [1]. The batteries charge controllers and inverters (converting manufactured low-voltage DC current to household or industrial standard). In most cases, for a minimum estimate of the actual cost, these should be multiplied by 3-5 times for self-assembly from individual photocells and 6-10 times for the purchase of ready-made equipment (plus installation cost) [2]. Every time we have less time. Fossil fuels are reaching their limits which present new demands. We have to think about how severe effects like climate change on a global scale are affected by the cost of excess pollution. This pollution can be reduced if renewable energies are further improved and developed.

The batteries in all components of the PV power supply system have a very short lifespan, but manufacturers of modern nonmaintenance batteries call the buffer mode a discharge of about 10 years (or traditional 1000 cycles working on a strong charge—if you count one cycle per year, in this mode they will last 3 years) [3]. It noticed that the cost of batteries is usually only 10-20% of the total cost of the whole system, and the cost of inverters and charge controllers (both are complex electronics, so there is some probability of their failure) too less. Therefore, taking into account the long service life and the ability to work long hours without maintenance, photo converters can pay more than once in their lives, not only in remote areas, but also in populated areas—continuing to grow at current rates [5]. It is the energy that interferes with the different caloric processes that occur when bodies of different temperatures come into contact. As long as the bodies maintain a friction between them, this energy spreads from one body to another. This is what happens when we place a hand on a surface. The gain or loss of this internal energy during operation is called heat. Thermal energy is derived from a variety of sources. Therefore, there is an internal energy inside everybody that has a certain temperature [6]. Alternative energy is considered capable of generating energy without polluting the environment. Additionally, it can be more efficient if it uses natural energy or waste (like biomass), solar, wind, hydroelectric, wave, geothermal, tidal energy, and others. However, they are not the only alternative energy sources that we can find in the world. In nature, there are sources of energy that we know or are accustomed to exploit. Figure 2 shows photovoltaic solar power generation.

It must think that energy is not created or destroyed, but is transformed. Thermal energy is generated in many ways. It is created by the motion of atoms and molecules of matter like a form of kinetic energy produced by random motions. When there is a large amount of thermal energy in a system, its atoms move faster [10]. Receiving thermal energy causes environmental damage to release carbon dioxide and radioactive waste. It is a kind of renewable energy that does not pollute or damage the environment [24]. Thermal energy can be converted into electrical energy. For example, fossil fuels generate electricity by burning and releasing. Electrical energy is supplied as a result of the potential difference between the two points and allows an electric current to be generated between the two when in contact with an electrical conductor [25, 26]. Thermal energy is a type of energy that is released in the form of heat, which can be obtained by contacting another body with high temperature at low temperature, as well as by different conditions or mechanisms as mentioned earlier [27, 28].

## 3. Proposed Model

Figure 3 shows the proposed model block. The proposed maximum energy harvesting and monitoring model consists of 4 different levels: level A—when observing the position of the sun around the polar axis (i.e., parallel to the earth's axis); level B—fixed horizontal panel; level C—a fixed vertical panel, facing south; level D—a fixed group sloping south at an angle of 40 to the horizon. The Helioculture is an alternative form of energy. This energy is achieved by creating a hydrocarbon fuel. This is achieved by mixing salt water, photosynthetic organisms, nutrients, carbon dioxide, and sunlight. After mixing all this, the result is a fuel that does not need to be directly refined. The natural process of photosynthesis is used to produce ready-to-use fuels [27]. Let us look at the insulation levels for different panel installation angles. Of course, the spinning team after the sun is out of competition (level A). However, even on long summer days, its efficiency is only about 30% higher than the performance of standard horizontal (level B) and optimally inclined (level C) panels. But there is enough heat and light these days! But during the period of the most energy shortage from October to February, the benefit of the rotary panel over the fixed ones is very small and almost incomprehensible. True, at this point, the organization of the oblique group is not a horizontal one, but a vertical group (level D). This is not surprising—the low rays of the winter sun glide along the horizontal panel, but they are well perceived almost vertically.

The output power is calculated using Kirchhoff's rules, as said in

$$A_a = A_b - A_c\{\exp\left[B(C_a + C_b D_s) - 1\right]\} - \frac{C_a + C_b D_s}{D_s}, \quad (1)$$

$$A = \frac{b}{\alpha * \text{solar power resistance}}, \quad (2)$$

where $A_a$ is the output solar power, $A_b$ is the parallel solar panel link, $A_c$ is the serial solar panel link, and $D_s$ is the serial power resistance.

Therefore, the vertical panel exceeds even the oblique one in its performance and is almost indistinguishable from the rotary one. In March and October, the days are longer, and the rotary panel is already confidently (if not more) starting to perform better than any standard options, but the performance of the sloping and vertical panels is almost identical. Only on long days from April to August, the horizontal panel is more forward than the vertical one and approaches the oblique and slightly higher than that in June, based on the energy obtained. Summer loss of the vertical panel is natural—after all, the day of the summer solstice lasts more than 17 hours, and the sun cannot be more than 12 in the front (working) hemisphere of the vertical panel. At angles of incidence greater than 60, the rate of light reflected from the surface of the panel begins to grow rapidly, and considering that its effective area is reduced by half or more, the effective absorption time for such a panel is no more than 8 hours—i.e., less than 50% of the total length of

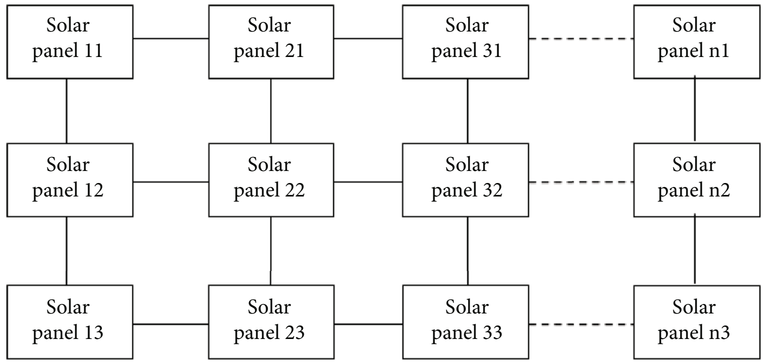


Figure 2: Photovoltaic solar power generation.

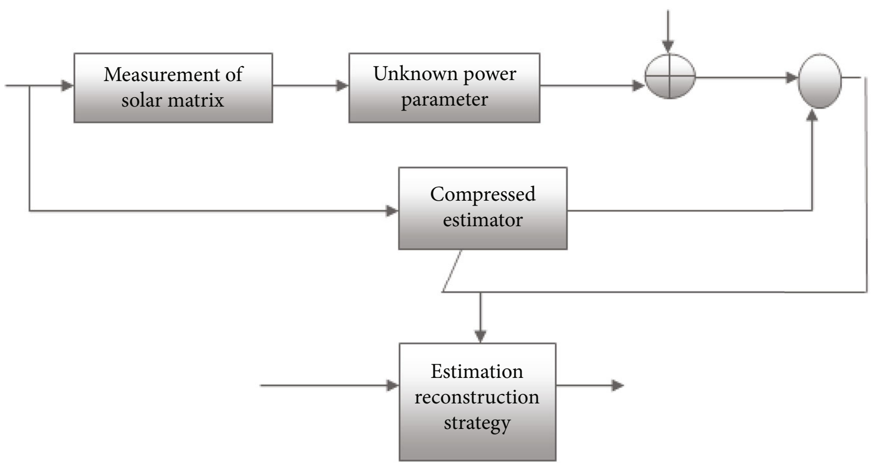


Figure 3: Proposed model block.

the day. The more people we have in the world, the more movements there are on a daily basis. We are continuously more than 7.500 million people. We can harness these human movements and displacements to generate energy. Piezoelectricity is the ability of some materials to generate a type of electric field in response to some mechanical stress [27].

The differences in light-generated solar power$A_a$ are needy on the experiential and referenced irradiance level parameters as chosen to follow

$$A_a = \left[ A_C + R_a (f - f_{\text{ref}}) \frac{\mu}{\mu_{\text{ref}}} \right]. \tag{3}$$

It all depends on when you need solar energy. If you want to use it only in hot weather (if, in the country), you should choose the "optimal" inclination angle, which is perpendicular to the average level of the sun between spring and autumn sunrises. It is approximately 10° to 15° lower than the geographical latitude and 40° to 45. If you need energy throughout the year, you should "squeeze" as much as possible during the energy-deficient winter months, which means you should focus on the average level of sun between autumn and spring sunrises and place the panels. Vertically close -5° to 15° higher than the geographical latitude (for solar panel it is 60° to 70°). If the tiles are constructed of materials with piezoelectric properties, they can be attached to heavily traveled paths. This way, we can generate force while walking with the sole friction of the shoes.

Figure 4 shows the proposed maximum energys harvesting and monitoring schematic. The current is flowing in the diode $A_c$ described by the Shockley equations, as shown in formula (3), where $A_c$ indicates the saturation current and is represented by

$$A_a = A_c \left( \frac{f}{f_{\text{ref}}} \right)^3 \exp \left( \frac{sR_G}{d\beta} \left[ \frac{1}{f} - \frac{1}{f_{\text{ref}}} \right] \right). \tag{4}$$

This explains the fact that the performance of the vertical panels is stabilized throughout the long days—from March to September. Finally, January is a bit off—this month; the performance of panels of all orientations will be almost identical. The truth is this month in solar panel is very cloudy, and more than 90% of all solar energy comes from scattered radiation, and for such radiation, the orientation of the panel is not so important (the main thing is not to send it to the ground). However, some sunny days, which still occur in

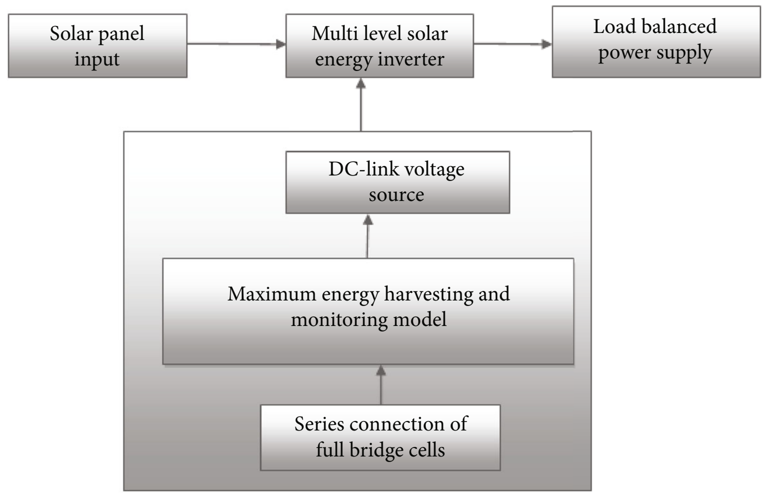


Figure 4: Proposed maximum energy harvesting and monitoring.

January, reduce the output of the horizontal panel by 20% compared to the rest and shown in

$$A_{PV} = \frac{R_a}{ASD \times \beta_a \times \beta_b}. \quad (5)$$

If, for architectural or structural reasons, this angle cannot be maintained and a slope angle of 40° or less is required to choose between, the vertical position should be preferred. At the same time, the "shortage" of energy during the long summer days is not so significant—there is a lot of natural heat and light during this period, and the need for energy production is usually not as great as winter and winter. This type of energy is a little better known. It is about harnessing energy from hot rocks. It is geothermal energy that is extracted by pumping salt and cold water towards rocks that have high temperatures due to the contribution of heat from the earth's mantle. When water is heated, the steam generated in the process is used to generate electricity in a steam turbine. One advantage of this type of energy is that it can be completely controlled [27]. Naturally, the slope of the panel should be south, although turning 10° to 15° east or west in this direction is slightly different, so this is more acceptable. In addition to the drastic reduction in energy production during the fall-winter period, dust accumulates rapidly on the horizontal panels, and even snow accumulates in the winter, and they can only be removed with the help of specially organized cleaning. If the slope of the panel is greater than 60, the snow does not last on its surface and usually collapses quickly, and the thin layer of dust is well washed away by rain.

## 4. Results and Discussion

In general, "solar battery" can be understood as identical modules that sense solar radiation and are fully integrated into a single device, including heating devices, but traditionally the term is assigned to panels of energy harvesting solar photovoltaic converters. Therefore, "solar battery" refers to energy harvesting solar photovoltaic device that always converts solar radiation directly into electricity. This technology has been actively developed since the middle of the 20th century. A major impetus for its development was space exploration, where only small-scale nuclear sources could currently compete with solar cells in power generation and duration of operation. During this time, the conversion efficiency of solar cells increased from one or two percent to 17% or more mass in relatively inexpensive models and over 42% in prototypes. Significantly, it increased the service life and reliability. The annual solar power fabrication and utilizations are shown in Table 1.

The main advantage of solar panels is their extreme design simplicity and the complete absence of moving parts. The result is a combination of a small specific weight and high reliability, as well as minimal maintenance requirements during simple installation and operation (usually it is sufficient to remove dirt from the accumulated work surface). This refers to flat elements of small thickness, which are most successfully placed on the slope of the roof facing the sun or on the wall of the house, practically do not require extra space for themselves and build individual bulky structures. The only condition is that nothing should obscure them as much as possible. The sun not only illuminates us within the earth but also illuminates it outside. Outside of earth, solar panels are not affected by day and night cycles. They are not affected by climate or the filters created by clouds or atmospheric gases. The idea is to create solar panels capable of orbiting the earth to continuously harvest solar energy. Table 2 shows annual power loss of solar electrical system.

Calorific value of a gas is the amount of energy released per unit mass or volume upon complete oxidation. This oxidation is not known for iron. This is very common when asking some chemists to think about oxidation. Oxidation is a concept that refers to the loss of electrons from a substance. When this happens, its positive charge increases and it is said to oxidize. This mentioned oxidation takes place in the combustion process. The efficiency of energy harvesting solar photovoltaic converters decreases during their service life. Semiconductor scales, in which solar cells

Table 1: Annual solar power fabrication and utilization.

| Production | kWh/ year | Percentage (%) | Consumption | kWh/ year | Percentage (%) |
|---|---|---|---|---|---|
| Energy harvesting solar photovoltaic solar system | 1882 | 90% | Demand of AC prime solar panel | 488 | 90% |
| Overall harvesting | 1986 | 96% | All other solar panels | 468 | 96% |

Table 2: Annual power loss of solar electrical system.

| Measure | Converter | Rectifier | Component units |
|---|---|---|---|
| Working duration in hours | 8457 | 0 | h/annum |
| Input solar power | 547 | 0 | h/annum |
| Output solar power | 482 | 0 | h/annum |
| Operational solar power loss | 54 | 0 | h/annum |

are normally formed, degrade and lose their properties over time, resulting in even lower efficiency of already nonexistent solar cells. Prolonged exposure to high temperatures accelerates this process. The proposed maximum energy harvesting and monitoring model (MEHMM) was compared with the existing optimized fuzzy logic control (OFLC), fuzzy logic control of standalone energy harvesting solar photovoltaic system (FLCSP), an improved fuzzy logic controller design (IFLCD), and fuzzy probabilistic-based semi-Markov model (FPSMM).

*4.1. Energy Harvesting Solar Photovoltaic Cells.* First, it was mentioned that this is a shortcoming of energy harvesting solar photovoltaic batteries; especially those that cannot recover "dead" energy harvesting solar photovoltaic cells are shown in Table 3. However, it is unlikely that any mechanical power generator will be able to demonstrate at least 1% efficiency after 10 years of continuous operation—often due to mechanical wear and, if not the bearings, requiring drastic repairs due to the brushes. And modern photo converters can maintain their performance for decades. According to reliable estimates, in 25 years, the efficiency of the solar battery will be reduced by only 10%, which means that after 100 years almost 2/3 of the original performance will remain if other factors do not intervene.

However, for mass commercial energy harvesting solar photovoltaic cells based on poly- and single-crystal silicon, honest manufacturers and sellers give slightly different aging after 20 years; 20% performance loss is to be expected (then, in theory, after 40 years, performance will initially be 2/3, halved in 60 years, and less than 1/3 of original productivity in 100 years). In general, the normal service life of modern photo converters is at least 25 to 30 years, so degradation is not so important and it is very important to wash the dust from them in a timely manner.

*4.2. Performance.* The same solar collector, with the right choice of shape and surface material, is capable of absorbing all the solar radiation that falls on it at almost full frequency. Solar cells, on the other hand, selectively convert energy—to stimulate the work of atoms, some photon energies (radiation frequencies) are required so that, at some frequency bands, the transition is very efficient, while at other frequency bands they are ineffective. In addition, the energy of the photons captured by them is used as a scale—its "surplus" exceeds the required level and in this case the harmful photo converter goes to the heat of matter. In many ways, this explains their low efficiency displayed in Table 4.

By the way, choosing the wrong material for the protective coating will significantly reduce the efficiency of the battery. Ordinary glass makes things worse by absorbing the high-energy UV of the range well, and this range is very suitable for certain types of photocells—the energy of the infrared photons is very small for them.

*4.3. Sensitivity to High Temperatures.* With increasing temperature, the efficiency of solar cells decreases like all other semiconductor devices. At temperatures above 100 to 125°C, they usually temporarily lose their ability to work, and high temperatures threaten them with irreversible damage. In addition, high temperatures accelerate the decay of solar cells shown in Table 5.

Therefore, it is necessary to take all measures to reduce the unavoidable heat under burning direct sunlight. In general, manufacturers limit the nominal operating temperature range of photocells to +70° to +90°C (i.e., heating the cells, and the ambient temperature, of course, must be very low).

*4.4. Sensitivity to Random Light.* As a rule, photocells are connected in series chains to obtain a battery voltage that is more or less convenient for use (12, 24, or more volts). The current in each such chain, and therefore its power, is determined by the weak connection—a photocell with poor properties or low brightness is shown in Table 6.

Therefore, if at least one element of the chain is in the shade, it significantly reduces the output of the entire chain—the losses are not compatible with the shade (and, in the absence of protective diodes, such an element will begin to scatter power). Unbalanced reduction in output can be avoided only by connecting all the photocells in parallel; however, the battery output will have a higher current at a much lower voltage—typically 0.5 to0.7 V for individual photocells of type and loading.

*4.5. Sensitivity to Pollution.* Even a delicate layer of dirt on the surface of energy harvesting solar photovoltaic cells or protective glass can absorb a significant amount of sunlight and significantly reduce energy production. In a dusty city,

Table 3: Energy harvesting solar photovoltaic cells.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 72.93 | 64.31 | 69.15 | 93.49 | 93.41 |
| 200 | 74.23 | 65.31 | 69.85 | 94.36 | 93.52 |
| 300 | 75.53 | 66.31 | 70.55 | 95.23 | 93.63 |
| 400 | 76.83 | 67.31 | 71.25 | 96.10 | 93.74 |
| 500 | 78.13 | 68.31 | 71.95 | 96.97 | 93.85 |
| 600 | 79.43 | 69.31 | 72.65 | 97.84 | 93.96 |
| 700 | 80.73 | 70.31 | 73.35 | 98.71 | 94.07 |

Table 4: Performance of solar photovoltaic cells.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 70.03 | 61.99 | 65.69 | 90.33 | 91.64 |
| 200 | 71.17 | 62.37 | 66.90 | 91.24 | 92.60 |
| 300 | 72.22 | 63.38 | 68.04 | 92.16 | 92.17 |
| 400 | 73.33 | 63.97 | 69.23 | 93.07 | 92.67 |
| 500 | 74.43 | 64.67 | 70.40 | 93.99 | 92.93 |
| 600 | 75.52 | 65.36 | 71.58 | 94.90 | 93.20 |
| 700 | 76.62 | 66.06 | 72.75 | 95.82 | 93.46 |

Table 5: Sensitivity to high temperature.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 68.36 | 59.38 | 64.12 | 87.63 | 90.47 |
| 200 | 68.69 | 60.88 | 64.71 | 89.50 | 91.51 |
| 300 | 69.02 | 62.38 | 65.30 | 91.37 | 92.55 |
| 400 | 69.35 | 63.88 | 65.89 | 93.24 | 93.59 |
| 500 | 69.68 | 65.38 | 66.48 | 95.11 | 94.63 |
| 600 | 70.01 | 66.88 | 67.07 | 96.98 | 95.67 |
| 700 | 70.34 | 68.38 | 67.66 | 98.85 | 96.71 |

Table 6: Sensitivity to random light.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 55.20 | 58.88 | 50.37 | 71.75 | 90.43 |
| 200 | 54.49 | 57.95 | 49.26 | 70.42 | 89.23 |
| 300 | 53.19 | 56.95 | 48.56 | 69.55 | 89.08 |
| 400 | 52.28 | 56.00 | 47.59 | 68.37 | 88.23 |
| 500 | 51.28 | 55.03 | 46.68 | 67.27 | 87.56 |
| 600 | 50.27 | 54.07 | 45.78 | 66.17 | 86.88 |
| 700 | 49.27 | 53.10 | 44.87 | 65.07 | 86.21 |

this requires frequent cleaning of the surface of the solar panels, especially those fitted horizontally or at a slight incline. Of course, the same procedure is necessary after every snowstorm and after a dust storm. The sensitivity in pollution is shown in Table 7.

Table 7: Sensitivity to pollution.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 57.39 | 60.27 | 52.72 | 73.58 | 90.96 |
| 200 | 56.25 | 59.89 | 51.51 | 72.67 | 90.00 |
| 300 | 55.11 | 59.51 | 50.30 | 71.76 | 89.04 |
| 400 | 53.97 | 59.13 | 49.09 | 70.85 | 88.08 |
| 500 | 52.83 | 58.75 | 47.88 | 69.94 | 87.12 |
| 600 | 51.69 | 58.37 | 46.67 | 69.03 | 86.16 |
| 700 | 50.55 | 57.99 | 45.46 | 68.12 | 85.20 |

However, in cities, industrial areas, busy roads, and other strong sources of dust at an angle of 45° or more, it will rain. It has the ability to wash natural dust off the surface of the panels, "automatically" keeping them very clean. The snow on such a slope, and moreover facing south, usually does not last long even on very frosty days. So away from sources of air pollution, solar panels can work successfully for many years without any maintenance.

*4.6. Solar Collectors.* The name "solar collectors" is derived from devices that use direct heat from the sun, single and stackable (modular). A simple example of a thermal solar collector is a black water tank on the roof of the aforementioned country shower (which can significantly increase the efficiency of heating the water in the summer rain by building a mini-greenhouse around the tank, at least from a plastic film, being desirable). The performance of the solar collectors is shown in Table 8.

Burning natural gas provides energy to generate electricity, hot water, etc. Therefore, it is important to know what a gas is capable of producing per unit mass or volume in order to determine its quality. The higher the calorific value, the less gas we use. This includes the importance of the quality of a gas in relation to economic costs.

## 5. Conclusion

As prices for solar equipment have been declining recently, it may be advantageous to use single panels of solar panels instead of a single field with large total capacities of adjacent (southeast and southwest) and opposite (east and west). It will provide more uniform output on sunny days and higher output on cloudy days, while the rest of the equipment will be uniform, designed for relatively low power, so will be more compact and cheaper. The proposed maximum energy harvesting and monitoring model (MEHMM) was compared with the existing optimized fuzzy logic control (OFLC), fuzzy logic control of standalone energy harvesting solar photovoltaic system (FLCSP), an improved fuzzy logic controller design (IFLCD), and fuzzy probabilistic based semi-Markov model (FPSMM). The proposed model was performed an analysis with the surface not smooth, but has a special relief, senses the side light very efficiently and can transmit it to the working elements of the solar panel. The most optimal is north-south (for vertical panels top to bottom), a type of linear lens (for vertical panels) with ripple

Table 8: Performance of solar collectors.

| No. of inputs | OFLC | FLCSP | IFLCD | FPSMM | MEHMM |
|---|---|---|---|---|---|
| 100 | 59.06 | 62.88 | 54.29 | 76.28 | 92.13 |
| 200 | 58.73 | 61.38 | 53.70 | 74.41 | 91.12 |
| 300 | 58.40 | 59.88 | 53.11 | 72.54 | 90.11 |
| 400 | 58.07 | 58.38 | 52.52 | 70.67 | 89.10 |
| 500 | 57.74 | 56.88 | 51.93 | 68.80 | 88.09 |
| 600 | 57.41 | 55.38 | 51.34 | 66.93 | 87.08 |
| 700 | 57.08 | 53.88 | 50.75 | 65.06 | 86.07 |

relief with orientations of protrusions and depressions. Corrugated glass can increase standard panel output by 5% or more.

## Data Availability

The data used to support the findings of this study are included within the article. Further data or information is available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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