

Research Article

Deep Learning-Based Smart Hybrid Solar Water Heater Erection Model to Extract Maximum Energy

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Currently, we are trying to get electricity in alternative ways. Many solar powered water heaters have come up to use water heaters. However, these tools are not 100 percent fully effective. The device we have manufactured is an automatic device that runs in the direction of sunlight. The device runs automatically in the morning facing east and in the evening facing west. In this instrument, the defective one-inch tube lamp and the three-quarter-inch tube lamp are put together and connected in series. In this paper, a smart deep learning model was proposed to improve the performance of the solar water heater. The gap between the tube lights is filled with methane gas, and the tube inside is filled with water. The water thus filled is heated by sunlight. Methane gas acts as a fast conductor of solar heat. An electronic control device is placed to determine the temperature of the hot water and to expel the hot water. This device can heat at least 10 liters of water in 15 minutes. Increasing the number of incandescent tube lights can heat up a large amount of water when this device is set up, or it can be designed by replacing tube lights with a series of large glass tubes using the same technology. This tool can be manufactured at low cost so that people from all walks of life can use it.

1. Introduction

The greatest gift of nature is solar energy. From the environment of living things to the photosynthesis of plants, nothing happens without the help of solar energy [1]. We have now achieved the development of converting solar energy into electrical energy and using electrical devices [2]. Many solar-powered products have been discovered. Water heaters

are one of the most widely used home appliances [3]. Advances in the industry have led to the development of the new heat pump water heater. The existing smart connection allows you to control the water heater from anywhere [4]. It provides enough hot water for a house of three to five people. It helps to save a lot of money by reducing electricity usage. Many people say that drinking water in the sun gives you more energy and rejuvenates the body. But the other

truth is that water in bottled water has a negative effect when exposed to sunlight, say researchers [5–7]. This is because the plastic chemical BPA or bisphenol-A in the water bottle is harmful to the body. Although most plastic water bottles do not contain this chemical, PPA is often found in polycarbonate bottles [8]. Solar thermal energy contributes significantly to reducing costs, thereby saving energy and reducing CO₂ emissions that are responsible for global warming and climate change.

Another disadvantage is that the bacteria that can live in the sun increase its growth when exposed to sunlight in a water bottle [9]. The remaining DHW projects can be considered as compelling decisions dictated by circumstances, for example, saving in creating [10]. The researchers used plain bottled water and carbonated water. The bottled water was tested in sunlight for about 2, 6, and 10 days. There are no harmful aldehydes when placing the bed bottle with normal water in the sun. But chemical exposure to carbon dioxide when carbonated water is exposed to sunlight has been shown to contain harmful chemical molecules. When researchers further researched this, they studied the release of antimony at different temperatures [11, 12]. At the same time, the cost of developing and installing a water heater is low [13]. Inventors across the country have long used various installations to heat water. In the summer, when the temperature inside the car, such as closed rooms and garages, can reach 65 degrees Celsius, a toxic substance called antimony is formed inside the bed bottle [14, 15]. Thus this toxicity mixes with the water. Researchers have found that water bottles contain antimony. If the temperature is above 65 degrees Celsius in these two studies, the toxicity is likely to worsen [16]. They also insist that bottled water, like our groceries, be kept in a safe place out of direct sunlight. Whenever possible you should have copper, steel, and glass bottles instead of plastic water bottles [17, 18]. This will not harm us and will improve our health. Do not forget that it is better to drink water in a hygienic manner [19].

The population of the world is increasing day by day. Accordingly, the demand for electricity and fuel is rising [20]. As energy, diesel, petrol, and coal from crude oil are used. It is questionable how many more years the fuel will last for the millions of vehicles that run every minute around the world [21]. It is a boon that we get such unpolluted energy naturally from sunlight. At the same time, the need to use electricity sparingly is emphasized at various stages. Every drop of electricity that every individual saves cost [22]. Homes have new tools to prevent the water tank from overflowing. These can be fitted or a stop device can be used to accurately measure the water filling time [23, 24]. Instead of a 100 watt incandescent bulb, a 15 watt LED, low power bulb can be used. Use maximum sunlight during the day; avoid unnecessary lighting, lice, and AC operation. Street lights can use solar power in residential areas [25]. Sunlight transformers can be used to avoid lighting during the day. You can use sun-powered water heaters to get hot water. You can cook using solar cookers instead of electric cookers [26]. Many solar powered devices are currently on sale in the market. Using solar power in homes can save a lot of electricity [27].

The gas-heated boiler is installed only if the high power unit cannot be connected. This is a great and at the same time expensive option [28]. The power of the device directly determines its performance. An electric storage water heater is the easiest way to solve your hot water problem. Electricity is available almost everywhere [29]. Unlike gas appliances, this does not require any approvals or permits. Unlike direct flow, the storage water heater has a special tank equipped with heating elements and thermal insulation [30]. The water coming from the faucet enters the tank and then it enters the consumer through the drain fitting. This can occur under the influence of pressure and by gravity. In front of such a unit is installed a special thermometer, which allows you to determine the temperature of the water in the tank [31].

2. Literature Review

Solar energy refers to the simplest energy source we receive from the sun. By using solar panels, this energy is converted into electricity, which you can use for heating, cooling, or lighting. The best part about solar power is that it is clean and free from any pollution [1]. It is free, renewable, widely available, and used by many homeowners for a variety of purposes. Solar panels are one of the fastest growing energy sources and are used all over the world. It provides an alternative way to deliver energy to homes [2]. The sizes of panels vary to cover all homes, including large and small homes. Solar panels are also available for businesses used to generate electricity in office companies. When used for domestic purpose, the solar angle is installed on the roof at an optimal angle to receive sunlight [3]. This group captures sunlight and receives energy from it. This energy is then converted into electricity that you can use at home. Focusing your attention on the benefits of solar energy will always help you understand how installing a solar system in your home can benefit you [4]. Solar energy is stable and consistent throughout the year. This means that once you have solar power installed in your home you will never have a power shortage. Solar power can be easily used by home and business owners as the engine does not require advanced setup [5]. Solar energy is renewable in nature so you not only get electricity but also support a clean environment. The maintenance of the machine does not require special resources or expertise. You can own it without any professional experience [7]. For nearly half a century, the photovoltaic effect had no practical application for a simple reason—there was no technology to obtain materials with an unstable atomic structure. Opportunities for further research appeared only with the invention of semiconductors. The atoms of these materials have high electrons (n-conductivity) or lack thereof (p-conductivity). When using a two-layer system with an n-type layer (cathode) and a p-type layer (anode), the “explosion” of light photons strikes electrons from the atoms of the n-layer. Leaving their seats, they rush to the free orbits of the B-layer atoms and then return to their original positions by the attached load. As you all know, the movement of electrons in a closed circuit is electricity. But electrons can move electrons not because of the magnetic field,

but because of the flow of particles of solar radiation, not like electric generators [10]. When we talk about solar energy, the first thing we think of is solar panels. Photovoltaic solar energy is the most popular of all renewable energies, along with wind. However, another type of solar thermal energy is widely used in water heating.

Since the power of one photovoltaic module is not sufficient for electronic devices, a series connection of several cells is used to obtain the required voltage. In terms of current strength, this is increased by the parallel combination of a certain number of assemblies [11]. The power generation in semiconductors is directly dependent on the amount of solar energy, so not only are the photocells installed outside, they also attempt to direct their surface perpendicular to the incident rays [12]. To protect the cells from mechanical damage and atmospheric impacts, they are mounted on a solid foundation and protected by glass from above. When in operation, solar panels do not make noise and do not contain harmful chemicals [13]. The first solar cell was based on selenium (Se), but the low efficiency (less than 1%), the rapid aging and high chemical activity of selenium solar cells forced them to look for other, cheaper, and more efficient materials [14]. And they were found on the crystalline silicon (Si) face. Since this element of the schedule is a dielectric, its conductivity is added from various rare earth metals. Depending on the production technology, there are many types of silicon photocells. Nevertheless, there are some reasons why not everyone uses this wonderful source of energy. Defects associated with solar energy must be overcome, which will only ensure its extensive use [21].

3. Proposed Model

The highest level of refining is made by cutting thin layers from silicon ingots. Externally, single-crystal-type photocells resemble plain dark blue glass plates with a pronounced electrode grid. Their efficiency reaches 19%, and the service life is up to 50 years. Although, the performance of panels made on the basis of monocrystals are demonstrated. The monocrystalline solar cells have the same dark color and cut corners. These features do not allow them to be confused with other solar cells. In the production of polycrystalline solar cells, less pure, but cheaper silicon is used. The simplification of technology affects the appearance of the plates—they are not a uniform shade, but a lighter method of creating borders of multiple crystals. The efficiency of such solar cells is slightly lower than that of monocrystalline—no more than 15% and the service life is up to 25 years. It should be noted that the decrease in key performance indicators did not affect the popularity of polycrystalline solar cells. They benefit from low cost, no strong dependence on external pollution, low cloud cover, and orientation towards the sun. It is a form of renewable and clean energy that uses the sun's energy to generate electricity. Unlike solar panels where photovoltaic energy is used to generate electricity from photons of light found in solar radiation, this energy uses this radiation to heat a liquid.

Polycrystalline solar cells have a light blue color and a random shape, which is the result of their structure being

composed of many crystals. For solar cells made of amorphous Si, a crystalline structure is not used, but a very thin layer of silicon, which is encased in glass or polymer. Although this production method is inexpensive, such panels have a very short lifespan due to the combustion and decay of the amorphous layer in the sun. These types of photocells are not happy with its performance—their efficiency does not exceed 9% and decreases significantly during operation. The use of solar panels made of amorphous silicon is justified in deserts—higher solar activity sustains a drop in productivity, wider expansions make it possible to place solar power plants of any size in gradual decline, and batteries manufactured 40 years ago are still in operation, providing up to 80% of their original power. It has ability to spray silicone structure on any surface allowing you to create flexible solar panels. Further development of photovoltaic cell production technology is due to the need to reduce cost and improve performance. Film photocells today have the maximum performance and durability. The level management of proposed model is shown below in Figure 1.

- (i) Limited water level, which will create difficulties
- (ii) Excess water expenditure when discharging water from the cold tap in the faucet
- (iii) Flow type or direct flow units—they heat the moving fluid and load it directly into the water supply system
- (iv) Storage water heaters first supply the required water, followed by heating
- (v) Flow-accumulation type units are an integrated option, which allows the use of a more convenient method depending on the need, if required
- (vi) A good electric or gas water heater is based on both storage and flow type water heating. In the first case, the required amount enters the boiler and heats up after a while. If it is a flowing water heater, the water flow is sent through the heating element
- (vii) In electricity, so-called induction water heaters differ in that they have an exclusively flow-through mechanism for heating water

Solar panels are always one step behind their factory counterparts and for many reasons. First, well-known manufacturers carefully select photocells, weeding out cells with unstable or reduced parameters. Second, in the manufacture of solar cells, special glass with increased light transmission and reduced reflection is used—this is almost impossible to find on sale. Third, before starting serial production, all parameters of industrial designs are tested using mathematical models. When the sun's rays hit the liquid, it heats up, and this hot liquid can be used for various applications. To get a better idea, the energy consumption of a hospital, a hotel, or a house corresponds to 20% of hot water use. With solar thermal energy, we can use the energy of the sun to heat water and thus we do not need to use fossil or other

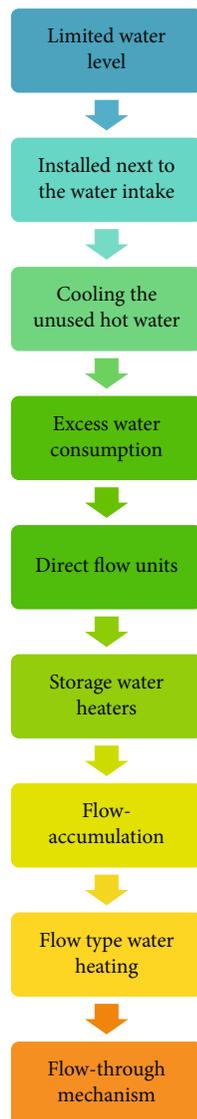


FIGURE 1: Proposed level management.

energy in this energy sector. As a result, the impact of cell heating on battery performance is minimized, the heat dissipation system is improved, the optimal cross-section connecting the phosphors is detected, and ways to reduce the decay rate of the photocells are explored. Such problems cannot be solved without a fitted laboratory and appropriate qualifications. The low cost of home-made solar panels allows you to create a plant that allows you to completely abandon the services of energy companies. Nevertheless, self-made solar panels show good performance results and are not far behind their industrial counterparts. In terms of price, here we have more than double the profit, i.e., at the same cost, home-made products will give twice as much more electricity consumed. Considering all of the above, a picture emerges of which solar cells are suitable for our conditions. Movies will disappear due to lack of sales and imageless—due to short service life and low performance. The crystalline silicon cells remain. I must say that it is better to use cheap “polycrystals” in the first home-made device.

After activating the technology and “filling your hand”, you should switch to single-crystal cells.

Inexpensive nonstandard photocells are ideal for running on technologies as well as high-quality devices that can be purchased at overseas trading sites. It is rare that there is no treasure chest with old radio components. But the diodes and transistors from older receivers and TVs are still the same semiconductors with p-n junctions, which, when illuminated by sunlight, generate current. Using these properties and combining several semiconductor devices, you can create a real solar battery. To make a low power solar battery, you can use the old element base of semiconductor devices. The attentive reader will immediately ask what it is. Why pay for factory-made mono or polycrystalline cells, if you use what is on your feet. As always, the devil is in the details. The truth is that the most powerful germanium transistors make it possible to obtain voltages not exceeding 0.2 V in bright sun at current strength measured in micro amps. To achieve the parameters that make up a flat silicon photocell, you will need several tens or hundreds of semiconductors. The battery made of old radio components is only good for charging the LED camping lamp or small mobile phone battery. Purchased solar cells are essential for the implementation of large projects. It is not uncommon for vendors to offer so-called damaged “B” class solar cells made of mono or polycrystalline solar panels. The lack of small chips, cracks, or corners practically does not affect the performance of the cells, but allows you to buy it at a very low price. For this reason they are best used in home-made solar panels. This is shown in Figure 2.

- (i) Install a rubber gasket between the glass and the box
- (ii) Dry run—to prevent overheating of the heating element if there is no water in the tank
- (iii) Pressure control systems—power consumption is turned off when the fluid overheats
- (iv) An integrated approach to security. The mechanical valve is filled by electronic sensors in the body or fitting
- (v) In addition, there should be a power unit designed for 180-240 V voltage and not just standard 220 V
- (vi) The boiler is fitted with a tap with a cold water supply and is additionally supplied to the outlet with a collector for hot water pipes to the consumption points. The main requirement for the body of a water heater is compression and adequate thermal insulation
- (vii) Polyurethane foam is the most effective from this point of view. High quality thermal insulation is important for the efficient operation of the boiler without unnecessary costs for heat loss

The flow heater has a simple operating scheme. Water is supplied through a copper pipe. In the form of a spiral, the

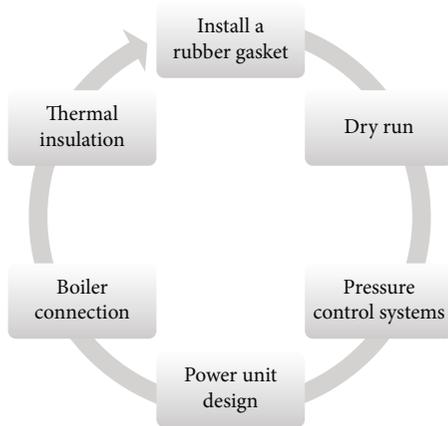


FIGURE 2: Proposed model flow.

tube itself revolves around an energy source: a gas burner or a heating element (in other words, a tube electric heater). An induction water heater uses the force of an alternating magnetic field, which acts on a material with a high resistance and heats it by the induction of an electric current. The current coming from the transformer is converted into high frequency current by the inverter and converted to a coil that generates an alternating magnetic field. The fluid pipe plays the role of center. Under the action of a magnetic field, the electricity excited in it heats it up and raises the temperature of the water. You will get enhanced energy if you drink water that has been dried in the sun.

- (i) There will be rejuvenation in your body
- (ii) It repairs the damage you have done to the cells
- (iii) Sunlight water is rich in antiviral, antifungal, and antibacterial properties. It is ideal for cleansing the skin and rinsing the eyes
- (iv) Sunlight drinking water has the power to improve your digestive energy and stimulate appetite. Destroys worms in the intestines and corrects problems like acidity and ulcers
- (v) Regulates skin inflammation and cures itching. This, in turn, results in glowing skin

Figure 3 shows enhanced energy of solar power. In a storage heater, the water first enters the tank, where it is gradually heated to the desired temperature. Also, according to the laws of physics, the warmer layers gradually move to the top of the tank, and the colder ones sink to the bottom. Gas water heaters have open and closed combustion chambers for the release of waste energy products. A chimney or coaxial metal sleeve may be used. Electric columns can vary in the types of heating elements: tubular or dry. The most common tube is a metal tube, inside of which is placed a conductor with a high electrical resistance. The tube is heated by the conductor and gives heat to the water. In this case the dielectric is sand, which fills the space between the walls of the conductor and the pipe. The heating elements contribute to the buildup of volume, which reduces the effi-

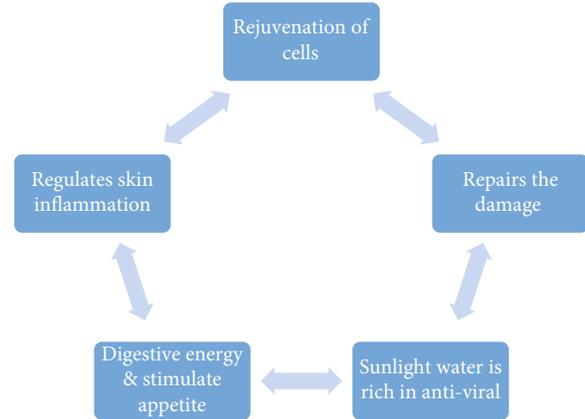


FIGURE 3: Enhanced energy of solar power.

ciency of the heater. The so-called dry heating element is not a tube, but a special flask, inside of which contains special oil or quartz sand. It is also called ceramic with very few shapes on the walls of the flask, and this option is recognized as highly electrically safe. The waters of rivers, lakes, and reservoirs are exposed to solar radiation, although of course you would think that they are not heated. To take advantage of this solar radiation, a special installation is necessary to help heat the liquids so that they can be used later.

4. Results and Discussion

The proposed hybrid solar deep learning approach (HSDLA) was compared with the existing building integrated photovoltaic (BIPV) system, temperature-based machine learning models (TMLM), deep learning neural networks (DLNN), and solar power generation prediction (SPGP).

4.1. Flat-Blade Collector Management. Daily power consumption is easy to detect. To do this, look at the invoice sent by the energy sales organization and divide the number of kilowatts indicated there by the number of days in the month. A hose and insulation are included. For the absorbent layer, black copper sheet with excellent thermal conductivity is used, which is suitable for creating solar panels. It is necessary to take into account the fact that the solar panel produces electricity only during daylight hours, and up to 70% of production is carried out as shown in Table 1.

The hydraulic circuit is the pipes that make up the circuit, where we carry the heat transfer fluid that takes care of the operation we are going to do. The circuit is normally closed in most installations. Therefore, we are talking about one-way circuits, from the group, and return circuits, to the group. This circuit is like a kind of water boiler that contributes to the heating of a space.

4.2. Integrated Collector-Storage Systems Management. Light cloud or fog will reduce the efficiency of the current output of the solar installation by 2-3 times, while the sky covered by solid clouds will trigger a 15-20 times drop in productivity. Under ideal conditions, a solar panel with a capacity of

TABLE 1: Flat-blade collector management.

No. of inputs	BIPV	TMLM	DLNN	SPGP	HSDLA
500	77.85	70.86	75.00	82.83	90.73
1000	77.14	69.93	73.89	81.50	89.49
1500	75.84	68.93	73.19	80.63	89.38
2000	74.93	67.98	72.22	79.45	88.52
2500	73.93	67.01	71.31	78.35	87.84
3000	72.92	66.05	70.41	77.25	87.17
3500	71.92	65.08	69.50	76.15	86.49

$11/7 = 1.6$ kW would be sufficient to generate 11 kWh of power. Taking into account the influence of natural factors, this parameter should be increased approximately 40-50%. In addition, there is another factor that should increase the size of the photocells used. First, do not forget that the battery does not work at night, which means that powerful batteries are required. Second, to run home appliances, you need 220 V current, so you need a powerful voltage converter (inverter). Experts say that the losses due to accumulation and conversion of electricity will take up to 20-30% of its total amount. Therefore, the actual power of the solar cell should be increased by 60-80% of the calculated value. Assuming an efficiency value of 70%, the nominal power of our solar panel would be equal to $1.6 + (1.6 \times 0.7) = 2.7$ kW as shown in Table 2.

The first thing to install is the collector or solar panel. This solar panel does not work like the well-known photovoltaic. It does not have a photovoltaic cell that collects photons of light to convert them into energy and circulate within them to allow us to capture solar radiation to start heating the liquid. There are different types of collectors and differences in their performance.

4.3. Exhaust-Tube Solar Collectors. The use of high-current lithium battery assemblies is a very elegant one, but by no means an inexpensive way to save solar power. To save electricity, you will need low voltage batteries rated at 12, 24, or 48 V. Their capacity should be designed for daily energy consumption and losses for change and conversion. In our case, an array of batteries designed to store $11 + (11 \times 0.3) = 14.3$ kWh of energy is required. If you use regular 12 V car batteries, you will need $14300 \text{ Wh}/12 \text{ V} = 1200 \text{ Ah}$ built-in, six batteries each rated at 200 Ah as shown in Table 3.

They are responsible for transporting heat through the circuit. A heat exchanger transfers the energy captured by the sun to the water. They are usually external to the tank (called plate exchangers) or internal (coil).

4.4. Reservation of High Energy. As you can see, even providing electricity for the household needs of an average family requires intensive solar power installation. As for the use of home-made solar panels for heating, at this point such an effort does not reach the limit of self-sufficiency, not to mention the fact that anything can be saved. The size of the battery depends on the required power and dimensions of the current sources. When choosing the latter, you will

TABLE 2: Integrated collector-storage systems management.

No. of inputs	BIPV	TMLM	DLNN	SPGP	HSDLA
500	81.71	74.86	78.92	87.36	92.43
1000	81.38	73.36	78.33	85.49	91.39
1500	80.04	72.25	77.35	84.66	91.26
2000	78.90	71.87	76.14	83.75	90.30
2500	78.07	70.57	75.36	82.40	89.72
3000	77.09	69.56	74.42	81.23	89.06
3500	76.11	68.55	73.49	80.07	88.41

TABLE 3: Exhaust-tube solar collectors.

No. of inputs	BIPV	TMLM	DLNN	SPGP	HSDLA
500	74.84	67.63	77.29	84.24	88.62
1000	73.54	66.63	76.59	83.16	88.46
1500	72.24	65.63	75.89	82.08	88.30
2000	70.94	64.63	75.19	81.00	88.14
2500	69.64	63.63	74.49	79.92	87.98
3000	68.34	62.63	73.79	78.84	87.82
3500	67.04	61.63	73.09	77.76	87.66

definitely pay attention to the different types of photocells proposed as shown in Table 4.

As the demand for solar energy is not always the same as for photovoltaics, it requires some energy storage system. In this case, solar thermal energy is stored in accumulators. This accumulator stores hot water to make it available when we need it. They are tanks with capacity and necessary insulation to avoid energy losses and keep water hot at all times.

4.5. Flow Management. Electric direct flow water heater does not have a storage tank and has a large capacity. Power consumption can reach 30 kW. This is a small unit that allows you to install directly under the washbasin. The use of such a heater is possible only in homes designed for electric stoves. Prior to installation, it is important to consult an electrician regularly. Another type of electric direct flow water heater is called induction columns. Unlike units with heating elements, this type has the highest efficiency, up to 98 percent. Saving electricity with such a heater can be up to 30-50 percent. Except for the inner wall of the pipe through which the supply is carried, the heating element does not come into contact with water. The variable type magnetic field does not allow deposits to form and heats the entire volume of the liquid simultaneously, which saves time. The water heats up very quickly as shown in Table 5.

To move fluid from one place to another, pumps are needed to overcome pressure drops in circuits, as well as frictional and gravitational forces. For use in home-made devices, it is very convenient to choose medium-sized solar cells. For example, 3×6 inch polycrystalline panels are rated for 0.5 V output voltage and current up to 3 A. When producing a solar battery, they are connected in series in modules of 30 pieces, making it possible to obtain the voltage of 13-14 V required to charge a car battery (taking into account losses). The

TABLE 4: Reservation of high energy.

No. of inputs	BIPV	TMLM	DLNN	SPGP	HSDLA
500	76.60	69.57	79.54	86.49	89.39
1000	75.55	68.56	78.40	85.57	89.82
1500	74.50	67.55	77.26	84.65	90.25
2000	73.45	66.54	76.12	83.73	90.68
2500	72.40	65.53	74.98	82.81	91.11
3000	71.35	64.52	73.84	81.89	91.54
3500	70.30	63.51	72.70	80.97	91.97

TABLE 5: Reservation of high energy.

No. of inputs	BIPV	TMLM	DLNN	SPGP	HSDLA
500	79.41	72.56	82.32	90.10	91.52
1000	79.08	71.06	81.73	88.23	90.51
1500	77.74	69.95	80.75	87.40	90.35
2000	77.07	68.58	80.03	85.88	89.62
2500	76.24	67.28	79.25	84.53	89.04
3000	75.40	65.97	78.46	83.18	88.45
3500	74.57	64.67	77.68	81.83	87.87

maximum power of such a module is $15\text{ V} \times 3\text{ A} = 45\text{ W}$. Based on this value, it is not difficult to calculate how many components are needed to build a solar panel of a given power and determine its dimensions. For example, to build a 180-watt solar electric collector would require 120 photovoltaic cells with a total area of 2160 square meters.

5. Conclusion

When the main heat is switched off in the summer, the usage of a heat exchanger becomes more problematic. It must modify and choose the boiler that will only function for the heat exchanger. The heat pump, like the water pump, expels heat. The heat of the sun heats the water. A pump fills the collection pipes with water, which is then heated to the proper temperature and discharged back into the common tank. Again, the solar collector warms up another component. Often, heat exchangers are installed just like electric heaters: the circuit between the pump and the pool. In some cases, it is better to use two heat exchangers at the same time. There is a vortex in the body of the heat exchanger. There is a space around, which should be filled with water from the pond. The boiling water passes through the vortex and due to the large contact area, the water from the pool heats up quickly. This is a very simple and popular method of raising the temperature in small pools, although an electric heater also has its drawbacks.

Data Availability

The data used to support the findings of this study are included within the article. Further data or information are 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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