Design and Analysis of High Performance Home Solar Energy System.

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ABSTRACT.

Rising energy prices and growing environmental concerns are making solar electric systems more attractive to homeowners. A solar electric system reduces high energy costs and keeps your home up and running during power out-ages. The advantages to buying a solar electric system include: Saving a significant amount on your electric bill. Increasing your home's appraisal value. Enjoying reliable, clean, free power for 25 to 30 years. Helping and assist to boost our economy by creating jobs and new solar companies.

A solar electric system is typically made up of solar panels, an inverter, battery, charge controller, wiring, and support structure. The three most common types of solar electric systems are grid-connected, grid-connected with battery backup, and off-grid (stand-alone). This work presents design and analysis of high performance of home solar energy, that include: the orientation and pitch of the southernmost facing roof to maximize solar gain, the roof vents, chimneys, gables or other obstructions in order to sit to the north side of the planned array. Ensure that the roof structure is strong enough. Structural support into the roof to handle the weight of a rack-mounted system. The space for inverters and disconnects near the main service panel. Finally comparison between these systems with other sources of energy.

Keyword: Solar Electric System, Solar Energy, energy cost.

1. INTRODUCTION.

Solar electricity is produced by changing sunlight to power using the photovoltaic (PV) effect. The PV effect causes an electrical current to flow through a solar cell when exposed to sunlight. Solar cells power everything from calculators and remote highway signs to homes, commercial buildings, and large power plants. Solar cells power all satellites in space, making them responsible for the world's communications products.

Most solar electric systems last 30 years and pay for themselves in 4 to 5 years after tax credits and rebates. That means homeowners can enjoy free electricity for years. If you install batteries to back up your solar electric system, it will provide emergency power in areas with frequent storms, hurricanes, and other natural disasters. In addition, going solar adds value to your home. According to the Appraisal Journal, a solar electric system increases your home's value by $20 for every $1 in annual utility bill savings, which means a system almost pays for itself with the appraisal value increase in some cases. See the Costs and Financial Incentives section. Solar power reduces America's dependence on foreign oil and fossil fuels, making our nation more secure while reducing air pollution and greenhouse gases [1].

Solar companies make solar panels by combining many solar cells together. Several solar panels combined make a solar array. When solar panels are strung together in series and combined with other components, they become a solar electric system or solar array. A solar electric system can meet part or all of a home's electricity needs, offset by 25% to 50% of most homeowners' power with solar electricity [2].

2.TYPES OF SOLAR ELECTRIC SYSTEMS.

A solar electric system is typically made up of solar panels, an inverter, battery, charge controller, wiring, and support structure. The three most common types of solar electric systems are grid-connected, grid-connected with battery backup, and off-grid (stand-alone). Each has distinct applications and components.

2.1. Grid-Connected.

In this system, the solar panels are connected to your local utility electrical grid to complement your normal power supply from your utility company. Grid-connected systems consist of (see **Fig.(1)**):

- Solar panels mounted on the roof.
- An inverter to convert electricity produced by the system from direct current (DC) energy into alternating current (AC) energy.
- A junction box that connects the solar panel wiring to the breaker panel on the home.
- A power meter that displays how much power the home produces and uses.
- A disconnect switch that, for safety reasons, prevents the system from sending power to the grid during power outages (this is called islanding).

2.2.Grid-Connected with Battery Backup.

Very similar to the grid-connected system, this system adds a "battery bank" to collect the power generated from the solar panels. Power stored in the batteries can be used during power outages. The battery bank collects power produced by the solar panels, sends it to the breaker box, and then into the house power system. The components of this type of system consist of [3]:

- Solar panels mounted on the roof.
- An inverter to convert solar electricity from DC energy into AC energy.
- A battery bank for power storage.
- A charge controller to prevent overcharging the battery.
- A junction box that connects the solar panel wiring to the breaker panel on the home.
- A power meter that displays the amount of power used, produced, and stored in the battery bank.
- A disconnect switch to prevent islanding during power outages.

2.3. Off-Grid or Stand-Alone.

Off-grid systems are not tied to any utility power lines and are most common in re-mote areas where connecting to the utility grid is more expensive than purchas-ing an off-grid system. In off-grid systems, the solar electric system represents the home's main source of power. Batteries store unused solar energy for use at night. Generators, small wind systems, and other backup fuel sources are sometimes used as backup power when the solar power stored in the batteries is not enough to meet household needs. These systems consist of the following [1]:

- Solar panels mounted on the roof.
- An inverter to convert electricity produced by the system from DC into AC energy.
- A rectifier (sometimes used to change AC to DC and back again to get the most use out of a system).
- A charge controller to prevent overcharging the battery.

• A junction box that connects the solar panel wiring to the breaker panel on the home.
• A junction box for backup power supply from a generator.
• A power meter that displays the amount of power used, produced, and stored in the battery bank.
• A disconnect switch to prevent islanding during power outages.

3. SOLAR ELECTRIC (PHOTOVOLTAIC OR PV).

Systems are made up of modules containing PV cells that generate direct current (DC) electricity when exposed to sunlight. An inverter converts the DC power to the alternating current (AC) electricity that's necessary to power the home. These PV systems have been tested to rigorous standards by public and private organizations. They have no moving parts, require almost no maintenance, and last for decades. A solar energy system will have nearly the same output in year 25 as it did on day 1.

Today's PV systems come in a range of efficiencies and configurations. PV systems with modules that are mounted on top of existing roofing are still the most common, but building integrated photovoltaic (BIPV) systems are gaining in popularity. In a BIPV system, the modules do double duty they generate electricity AND can replace traditional building materials such as roof shingles and window awnings.

4.HOW A PV SYSTEM WORKS.

Solar electric systems, also known as PV systems, convert sunlight into electricity. Because they are made up of individual modules, PV systems can be designed to meet most electrical requirements, both large and small. The size of a residential PV system is expressed in terms of kilowatts (kW) of power, and the electricity produced by a PV system is expressed in kilowatt hours (kWh) of energy. Systems are said to be "grid-connected" when they remain plugged into the local utility (see **Fig.(2)**). Grid-connected PV systems may have a battery back-up system, but most do not. Battery back-up is typically used for off-grid systems and provides power at night when the sun is not shining. Grid-connected systems rely on their utility to provide power at night. The diagram on the right illustrates a basic PV system installation. Maintenance requirements for PV systems are minimal: they may require occasional cleaning for optimal performance, and often require a new inverter after 10-15 years. The best way to ensure a PV system is working well is to install a monitoring device that tracks the electricity output of the system. Numerous online system monitoring tools are available, and some are included in the cost of the installation.

5.BENEFITS OF A PV SYSTEM.

Installing a PV system on the roof or in the yard provides several benefits to a homeowner. Because you are producing your own electricity, your utility bills will be lower. PV systems can last for 30 years or longer, and therefore provide long-term protection against rising electricity rates your utility may charge as worldwide energy markets change. A PV system may also increase the value of your home. Finally, a PV system produces electricity without a emitting any pollution, including greenhouse gases [3].

6.THE HOMEOWNERS' BENEFITS.

• Positive annual net cash flow from a higher mortgage payment offset by lower utility bills
• Higher home resale value
• Contribution as environmental stewards
• Substantial tax credits for new buyers

7. PV CELL TYPE AND EFFICIENCY.

Two categories of PV cells are used in most of today's commercial PV modules: crystalline silicon and thin film. The crystalline silicon category, called first-generation PV, includes monocrystalline and multicrystalline PV cells, which are the most efficient of the mainstream PV technologies and accounted for about 84% of PV produced in 2008 (Bartlett et al. 2009). These cells produce electricity via crystalline silicon semiconductor material derived from highly refined polysilicon feedstock. Monocrystalline cells, made of single silicon crystals, are more efficient than multicrystalline cells but are more expensive to manufacture [4].

The thin-film category, called second-generation PV, includes PV cells that produce electricity via extremely thin layers of semiconductor material made of amorphous silicon (a-Si), copper indium diselenide (CIS), copper indium gallium diselenide (CIGS), or cadmium telluride (CdTe). Another PV cell technology (also second generation) is the multijunction PV cell. Multijunction cells use multiple layers of semiconductor material (from the group III and V elements of the periodic table of chemical elements) to absorb and convert more of the solar spectrum into electricity than is converted by single-junction cells. Combined with light-concentrating optics and sophisticated sun-tracking systems, these cells have demonstrated the highest sunlight-to-electricity conversion efficiencies of any PV technologies, in excess of 40%.

Various emerging technologies, known as third-generation PV, could become available commercial options in the future, either by achieving very high efficiency or very low cost. Examples include dye-sensitized and organic PV cells, which have demonstrated relatively low efficiencies to date but offer the potential for substantial manufacturing cost reductions.

The efficiencies of all PV cell types have improved over the past several decades, as illustrated in **Fig. (3)**, which shows the best research-cell efficiencies from 1975 to 2009. The highest-efficiency research cell shown is a multijunction concentrator at 41.6% efficiency. Other research-cell efficiencies illustrated in the figure range from 20% to almost 28% for crystalline silicon cells, 12% to almost 20% for thin film, and about 5% and to 11% for the emerging PV technologies organic cells and dye-sensitized cells, respectively.

8. PV OPERATIONS AND MAINTENANCE.

Operations and maintenance (O&M) is a significant contributor to the lifetime cost of PV systems, and reducing the O&M costs of system components is an important avenue to reducing lifetime PV cost. The data, however, are difficult to track, because O&M costs are not as well documented as other PV system cost elements (which is due in part to the long-term and periodic nature of O&M)[6].

9. PV OPERATIONS AND MAINTENANCE NOT INCLUDING INVERTER REPLACEMENT.

During the past decade, Sandia National Laboratories has collected O&M data for several types of PV systems in conjunction with Arizona Public Service (APS) and Tucson Electric Power (TEP) **Table(1)**. Because O&M data were collected for only 5–6 years in each study, data on scheduled inverter replacement/rebuilding were not collected; inverters are typically replaced every 7–10 years. Therefore, the information in Table1 does not include O&M costs associated with scheduled inverter replacement/rebuilding. This issue is discussed in the next section of this report.

As shown in **Table (1)**, annual O&M costs as a percentage of installed system cost ranged from 0.12% for utility-scale generation to 5%–6% for off-grid residential hybrid systems. The O&M energy cost was calculated to be $0.004/kWh(ac) for utility-scale generation and $0.07/kWh(ac) for grid-connected residential systems; note that this is simply annual O&M

cost divided by annual energy output, not LCOE. For all the grid-connected systems, inverters were the major O&M issue. Following are brief summaries of four recent studies on O&M that provide additional context [7].

10. NEW DEIGN FOR PV SYSTEM.

- **Conditions.**

If your roof is more than 15 years old, you may want to consider replacing it when you purchase your solar electric system. Most solar vendors recommend using roof-ing material that will last as long as the system, which is about 25 to 30 years. Make sure the roof can hold the weight of the system, which is estimated at 3 to 5 pounds per square foot, depending on the type of technology used and installation methods.

Shading a panel reduces its performance because it blocks sunlight. The most common items that shade solar panels are trees, chimneys, nearby buildings, and electrical cables, as well as heating and cooling equipment. Also check shading from pipes, skylights, and vents. To determine possible shading problems, consult a solar professional who uses a software program that can estimate site shading. Some people will examine a proposed location throughout the day and year to see how the area shading changes. For example, shading in an area can change from summer to winter because the sun's path changes (see **Fig. (4)**).

If you don't have a south-facing roof or enough roof space, consider a ground or pole-mounted solar system, which can be installed with the same orientation and tilt as a roof-mounted system. Ground-mounted systems are great for homes with large yards. Some systems come mounted on a tracker that follows the sun's movement.

- **Modeling of Solar Cell Current.**

Solar-Induced Current

The model of a single solar cell as a resistance Rs that is connected in series with a parallel combination of the following elements [8]:

- Current source.
- Two exponential diodes.
- Parallel resistor R_p.

The output current I is:

$$I = I_{ph} - I_{s1} * (e^{(V+I*R_s)/(N_1*V_t)} - 1) - I_{s2} * (e^{(V+I*R_s)/(N_2*V_t)} - 1) - (V + I * R_s)/R_p \quad (1)$$

where:

I_{ph} is the solar-induced current:

$$I_{ph} = I_{pho} \times \frac{I_r}{I_{ro}} \quad (2)$$

The quality factor varies for amorphous cells, and is typically 2 for polycrystalline cells.

The block lets you choose between two models:

An 8-parameters model where the preceding equation describes the output current

A 5-parameters model that applies the following simplifying assumptions to the preceding equation:

The saturation current of the second diode is zero. The impedance of the parallel resistor is infinite. If you choose the 5-parameters model, you can parameterize this block in terms of the preceding equivalent circuit model parameters or in terms of the short-circuit current and open-circuit voltage the block uses to derive these parameters.

All models adjust the block resistance and current parameters as a function of temperature.

Temperature Dependence

Several solar cell parameters depend on temperature. The solar cell temperature is specified by the Fixed circuit temperature, TFIXED parameter value.

The block provides the following relationship between the solar-induced current I_{ph} and the solar cell temperature T:

$$I_{ph}(t) = I_{ph} * (1 + TIPH_1 * (T - T_{meas})) \tag{3}$$

where:

$TIPH_1$ is the First order temperature coefficient for I_{ph} , T_{meas} is the Parameter extraction temperature, T_{meas} parameter value.

The block provides the following relationship between the saturation current of the first diode Is and the solar cell temperature T:

$$I_{s1}(T) = I_{s1} * \left(\frac{T}{T_{meas}} \right)^{\left(TXIS\, 1 / N_1 \right)} * E^{\left(EG * \left(\frac{T}{T_{MEAS}} - 1 \right) / (N_1 * V_T \right)} \tag{4}$$

where $TXIS1$ is the Temperature exponent for I_{s1}.

The block provides the following relationship between the saturation current of the second diode Is2 and the solar cell temperature T:

$$I_{s2}(T) = I_{s2} * \left(\frac{T}{T_{meas}} \right)^{\left(TXIS\, 2 / N_2 \right)} * E^{\left(EG * \left(\frac{T}{T_{MEAS}} - 1 \right) / (N_2 * V_T \right)} \tag{5}$$

where $TXIS_1$ is the Temperature exponent for I_{s2}.

The block provides the following relationship between the series resistance Rs and the solar cell temperature T:

$$R_P(T) = R_P * \left(\frac{T}{T_{meas}} \right)^{(TRP_1)} \tag{6}$$

where T_{RS1} is the Temperature exponent for R_S , T_{RS1} parameter value.

he block provides the following relationship between the parallel resistance Rp and the solar cell temperature T:

$$R_P(T) = R_P * \left(\frac{T}{T_{meas}} \right)^{(TRP_1)} \tag{7}$$

Where TRP_1 is the Temperature exponent for Rp [9].

❖ **Modified Model of Solar Cell.**

Two heat transfer mechanisms from the fire generated hot upper glass layer to the window glass convection at the interior surface and radiation absorption through the thickness of the glass. Heat is also transferred through the glass by conduction. Finally, heat is transferred from the heated glass to the external environment by means of convection at the exterior surface. See **Fig (5)**.

The convective heat transfer coefficient at the interior surface of the glass is dependent on the temperature of the fire environment and on the velocity of the hot gasses. A simplified correlation can be used to estimate this coefficient as follows:

$$h_I = h_{\min} + (h_{\max} - h_{\min})\frac{(T_u - 300)}{100} \quad (8)$$

Where, the temperature of the upper layer, T_u is measured in Kelvin and the values of h_{min} and h_{max} are 5 and 50 W/m^2.K respectively. This correlation describes a linear increase in the coefficient between h_{min} at 300 K and h_{max} at 400 K. The coefficient is capped at h_{max} and similarly cannot below h_{min} (see **Fig. (5)**). The true value of the coefficient would depend on the exact air flow on the exterior surface and thus on wind speeds and direction and surrounding geography atmospheric conditions and building geometry [7].

- **The Affect Of Mirror On PV System Efficiency With Simulation Results.**

The simulation of new form of solar cell is achieved by using MATLAB Ver. 2010a and the parameter setting is implementing with the following definition [8]:

1. By s/c current and o/c voltage, 5 parameter provide short-circuit current and open-circuit voltage that the block converts to an equivalent circuit model of the solar cell. This is the default option.
2. By equivalent circuit parameters, 5 parameters provide electrical parameters for an equivalent circuit model of the solar cell using the 5-parameter solar cell model that makes the following assumptions:

The saturation current of the second diode is zero.

The parallel resistor has infinite impedance.

3. By equivalent circuit parameters, 8 parameters provide electrical parameters for an equivalent circuit model of the solar cell using the 8-parameter solar cell model.

Short-circuit current, I_{sc}

The current that flows when you short-circuit the solar cell. This parameter is only visible when you select by s/c current and o/c voltage, 5 parameter for the parameterize by parameter.

Open-circuit voltage, V_{oc}

The voltage across the solar cell when it is not connected. This parameter is only visible when you select by s/c current and o/c voltage, 5 parameter for the parameterize by parameter.

Diode saturation current, I_s

The asymptotic reverse current of the first diode for increasing reverse bias in the absence of any incident light. This parameter is only visible when you select one of the following settings:

- ☒ By equivalent circuit parameters, 5 parameters for the parameterize by parameter
- ☒ By equivalent circuit parameters, 8 parameters for the parameterize by parameter

Diode saturation current, I_{s2}

The asymptotic reverse current of the second diode for increasing reverse bias in the absence of any incident light. This parameter is only visible when you select By equivalent circuit parameters, 8 parameters for the Parameterize by parameter.

Solar-generated current, I_{pho}. The solar-induced current when the irradiance is I_{ro}. This parameter is only visible when you select one of the following settings: [8].

- o By equivalent circuit parameters, 5 parameters for the parameterize by parameter
- o By equivalent circuit parameters, 8 parameters for the parameterize by parameter

Irradiance used for measurements, I_{ro}. The irradiance that produces a current of Iph0 in the solar cell.

Quality factor, N_1 The emission coefficient of the first diode.

Quality factor, N_2 The emission coefficient of the second diode.

This parameter is only visible when you select by equivalent circuit parameters, 8 parameters for the Parameterize by parameter.

Series resistance, R_s. The internal series resistance.

Parallel resistance, R_p

The internal parallel resistance. This parameter is only visible when you select by equivalent circuit parameters, 8 parameters for the Parameterize by parameter.

First order temperature coefficient for I_{ph}, $TIPH_1$

The order of the linear increase in the solar-generated current as temperature increases. The value must be greater than or equal to 0.

Energy gap, EG

The solar cell activation energy. The value must be greater than or equal to 0.1.

Temperature exponent for I_{s1}, $TXIS_1$

The order of the exponential increase in the current from the first diode as temperature increases. The value must be greater than or equal to 0.

Temperature exponent for I_{s2}, $TXIS_2$

The order of the exponential increase in the current from the second diode as temperature increases. This parameter is only visible when you select by equivalent circuit parameters, 8 parameters for the Parameterize by parameter. The value must be greater than or equal to 0.

Temperature exponent for R_s, TRS_1

The order of the exponential increase in the series resistance as temperature increases. The value must be greater than or equal to 0.

Temperature exponent for R_p, TRP_1

The order of the exponential increase in the parallel resistance as temperature increases. This parameter is only visible when you select By equivalent circuit parameters, 8 parameters for the Parameterize by parameter. The value must be greater than or equal to 0.

Parameter extraction temperature, Tmeas

The temperature at which the solar cell parameters were measured. The value must be greater than 0.

Fixed circuit temperature, TFIXED

The temperature at which to simulate the solar cell. The value must be greater than 0.

Fig. (6) Presents the simulation of the solar cell model in the Simulink / Matlab with two windows of for parameters setting of this model. This simulation is executing with limited time with initial condition of model with the range of temperature { 0^o, 25^o ,75^o , 85^o }and plot the result of current / voltage for solar cell.

Fig. (7) explains the simulation without modified for cell where this cell not fulfill the optimal values for output, The modified results can seen at **Fig.(8)**, where the output and optimal case similarity with high accuracy. This procedure is repeated with many times and the modification of parameters can be explain in the **table (2)**. From the table can be seen that the model has stable output and the changes in initial condition values has minimum affect on the output therefore this

model can take under consideration with practice application specially with large surface of solar cells.

11. CONCLUSION.

From the results were showing in above can be concluded that the solar electric system can be modified to get more stable and high performance by modified the solar cell with mirror surface, where the intensity of sun radiation will be increased the output of cell is increasing. This model has high efficiency with home model solar electric where the home model has large surface of solar cell therefore the surface of mirror will become more large and the intensity of radiation will be increased and the output becomes high more than small size mode.

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13. SYMBOLS DESCRIPTION.

Symbol	Description
Ir	Is the irradiance (light intensity) in W/m2 falling on the cell.
Ipho	Is the measured solar-generated current for the irradiance Ir0.
Is1	Is the saturation current of the first diode.
Is2	Is the saturation current of the second diode.
Vt	Is the thermal voltage, kT/q, where:
K	Is the Boltzmann constant.
T	Is the device operating temperature parameter value.
Q	Is the elementary charge on an electron.
N1	Is the quality factor (diode emission coefficient) of the first diode.
N2	Is the quality factor (diode emission coefficient) of the second diode.
V	Is the voltage across the solar cell electrical port.

Table (2): Summary of Arizona PV System O&M Studies, Not Including O&M Related to Inverter Replacement/Rebuilding [5].

System Type (Reference)	O&M Data Collection Period	Scheduled O&M	Unscheduled O&M	Annual O&M Cost as Percentage of Installed System Cost	O&M Energy Cost[51]
Grid-Connected Residential, Fixed Tilt (Moore and Post 2008)	2002–2007	Visits by category: general maintenance/inspection (45%), pre-acceptance checks required for SunShare program (55%)	Visits by category: inverter (90%), PV array (10%)	1.47%	$0.07/ kWh (ac)
Grid-Connected Commercial, Horizontal Tracking (Moore et al. 2005)	1998–2003	Inverters were the primary maintenance issue; most systems required inverter adjustments during initial setup for up to 6 months after installation, after which the inverters generally performed well. Minimal maintenance was associated with modules. Maintenance for tracking components started higher during early part of development effort, but decreased over time.		0.35%	Not Reported
Utility-Scale Generation, Fixed Tilt (Moore and Post 2007)	2001–2006	Mowing native vegetation, visually inspecting arrays and power-handling equipment	Costs by category: inverter (59%), data acquisition systems (14%), AC disconnects (12%), system (6%), PV (6%), module junction (3%).	0.12%	$0.004/ kWh (ac)
Off-Grid Residential Hybrid (Canada et al. 2005)	1997–2002	Quarterly generator service (oil change, filter, adjustment, and inspection), battery inspection and service, inverter inspection, overall system inspection; repairs/replacements made when problems noted.	Costs by category: system setup, modification, and removal (41.4%); generator (27.8%); inverter (16.5%); batteries (4.7%); controls (4.2%); PV modules (2.7%); system electrical (2.6%).	5%–6%[52]	Not Reported

Table (3): Simulation results for output of solar cell with different initial values.

parameters		Test 1		Test 2		Test 3	
		Initial values	Final values	Initial values	Final values	Initial values	Final values
Main parameters	Is	3×10^{-7}	7.97332×10^{-7}	4×10^{-7}	7.97332×10^{-7}	4×10^{-7}	7.97332×10^{-7}
	Iph	3.85	3.8025	4.0	3.80252	4.0	3.80252
	ec	1.75	1.48383	1.9	1.48383	1.9	1.48383
	Rs	0.008	0.00328396	0.008	0.00328396	0.008	0.00328396
	Rp	15	13.1462	15	13.1462	15	13.1462
Tem. parameters	TIPH1	0.005	0.00085128	0.005	0.00084337	0.004	0.000843475
	EG	1.5	1.0444	1.5	1.0586	1.95	0.829915
	TXIS1	3.5	6.7367	3.5	6.2419	3.85	14.3744

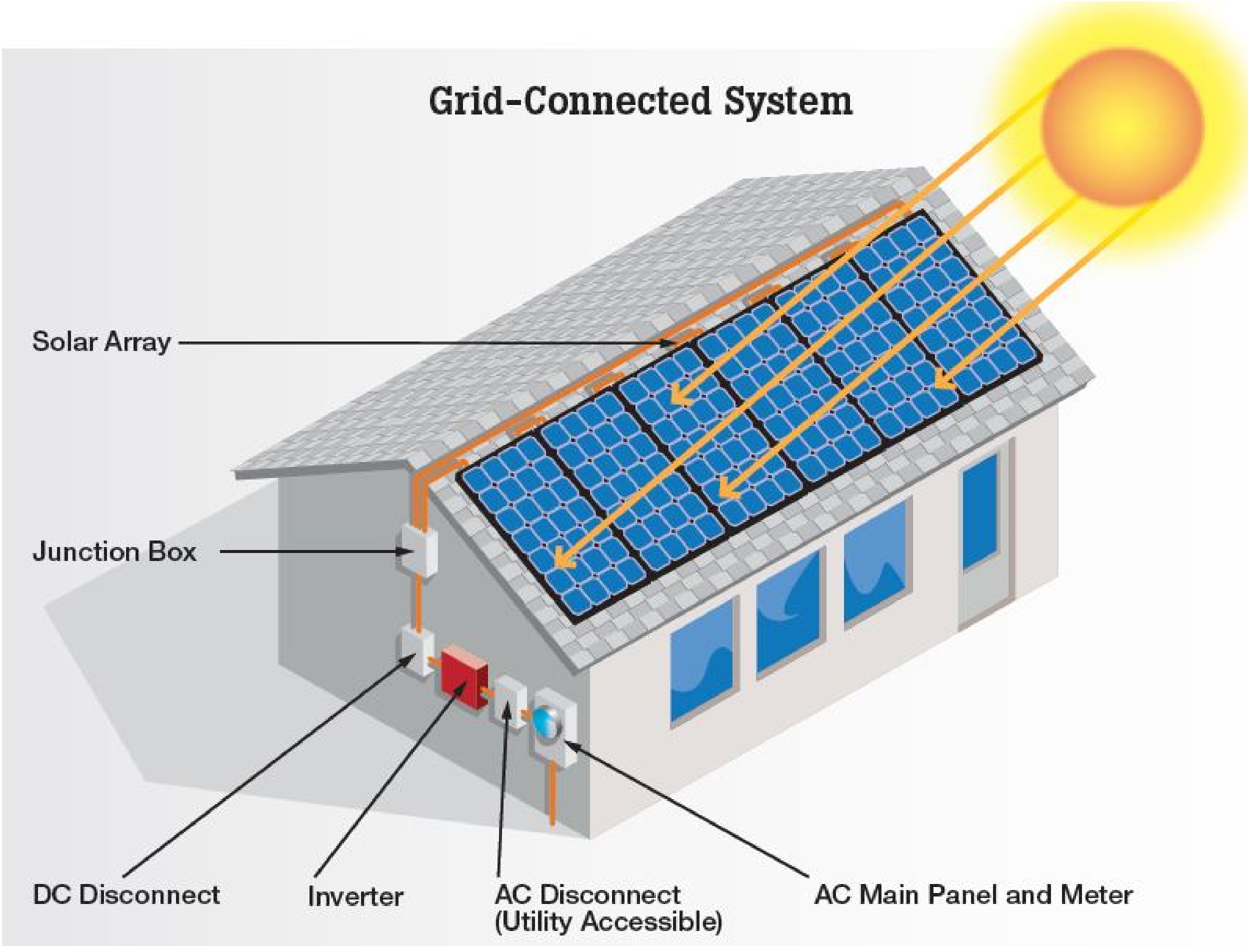


Figure (1): Grid connection system [1].

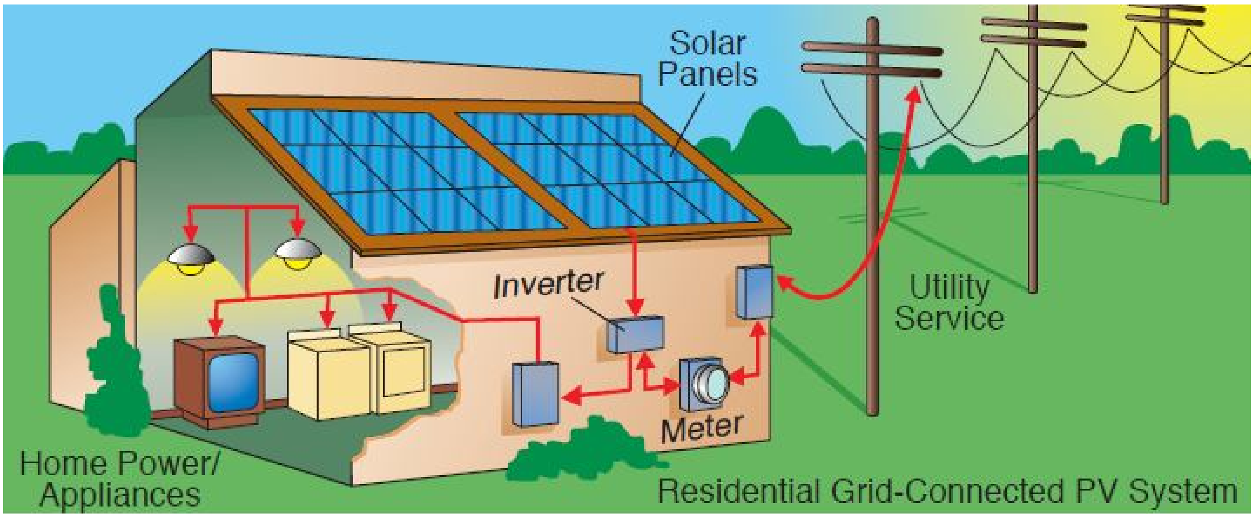


Figure (2): The connection of PV system [2].

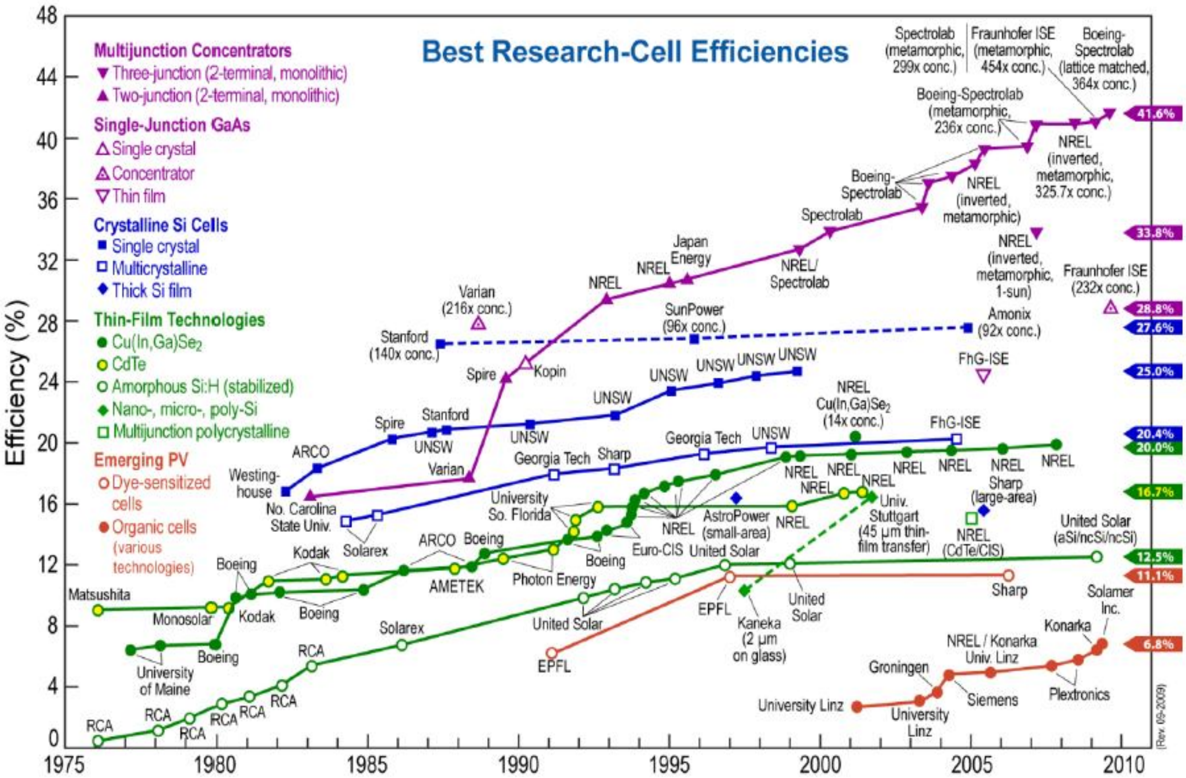


Figure (3): The best research of the efficiency history for solar cell (1975-2009) [5].

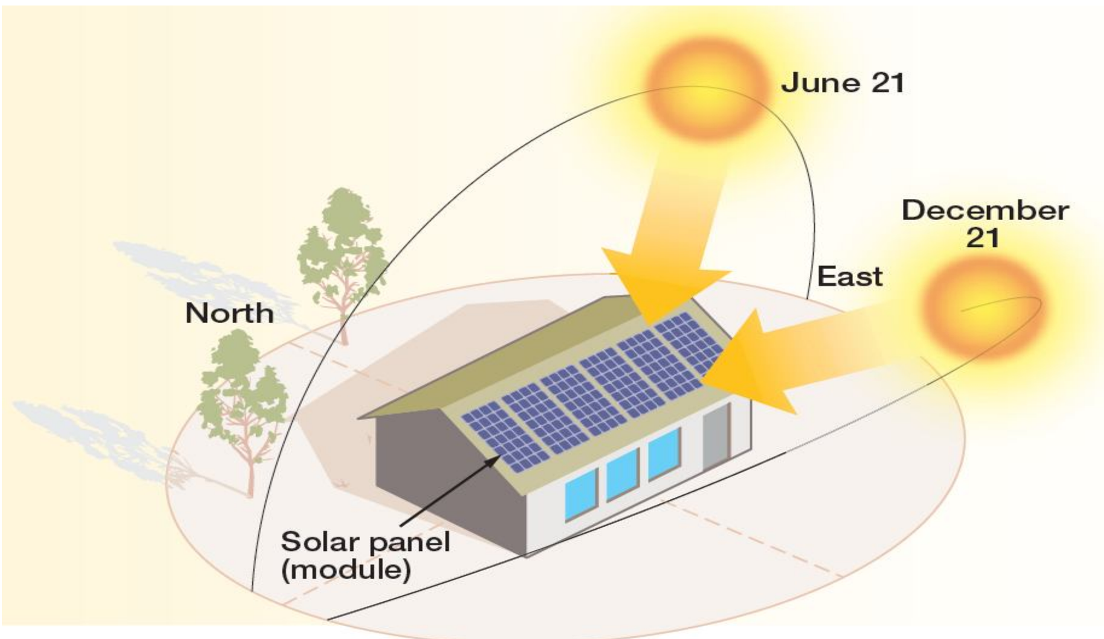
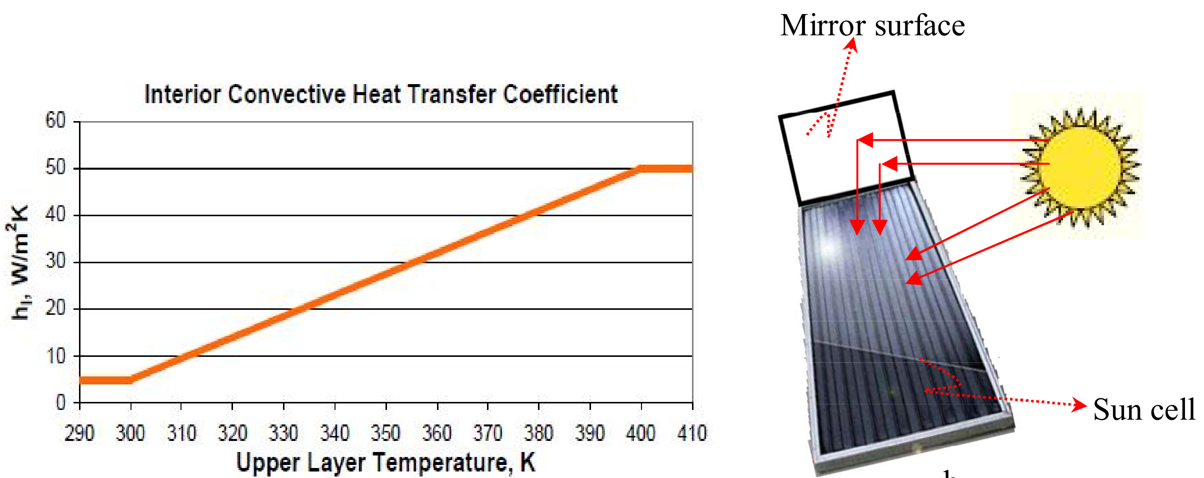


Figure (4): Sun’s Path During Summer and Winter [1].



- a - [7]

- b -

Figure (5. A): Heat transfer coefficient for layer solar cell. b. Modified model for solar cell.

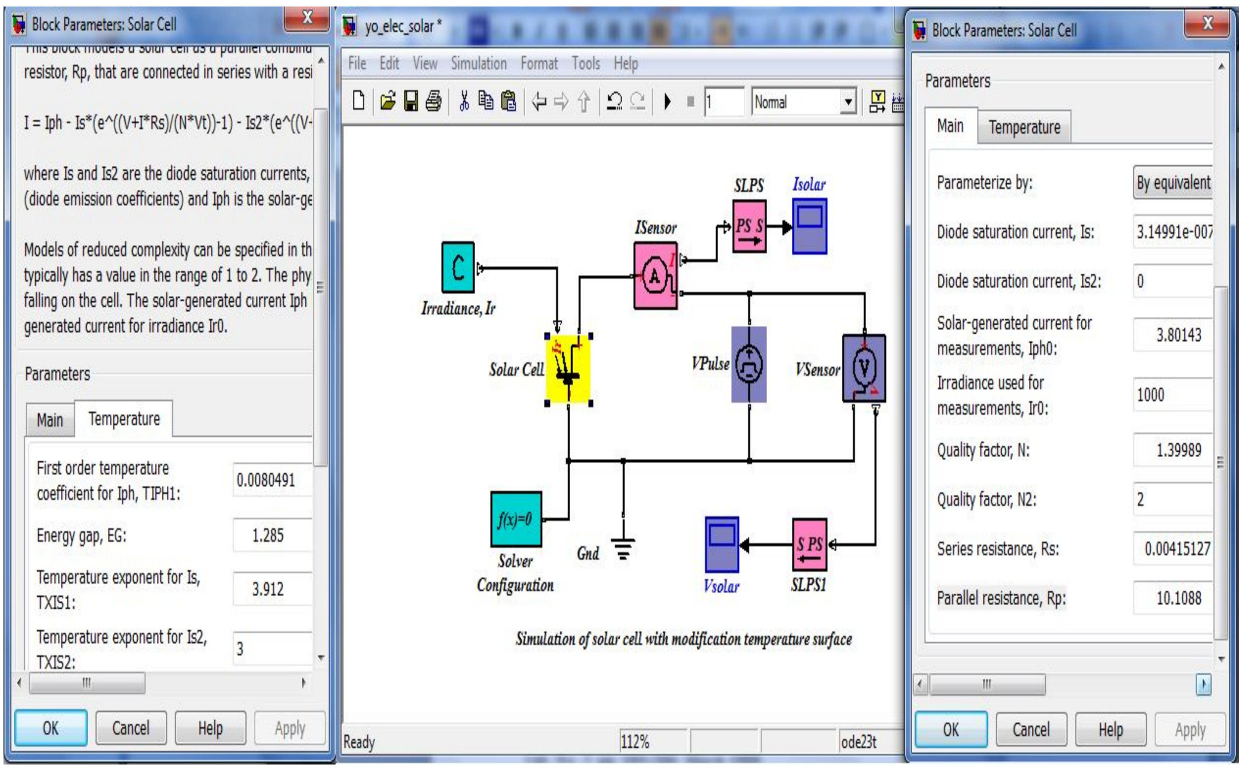
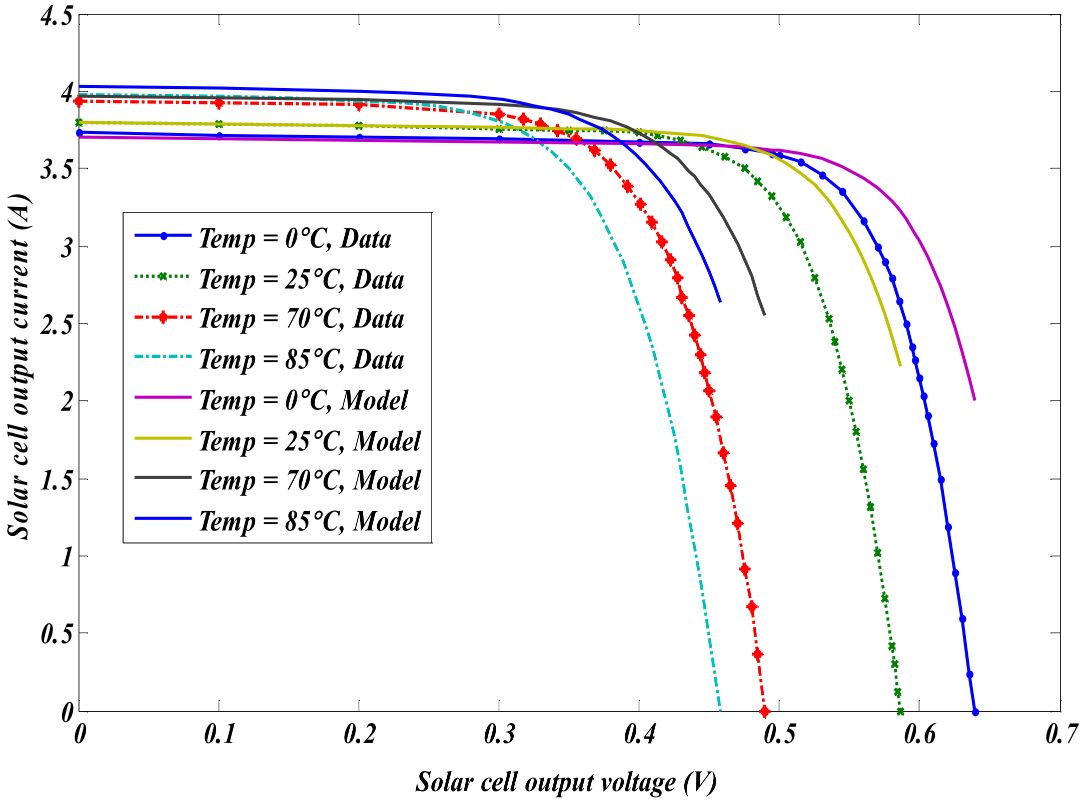


Figure (6): Simulation of solar cell.



Figure(7): Model with Initial Parameter Values.

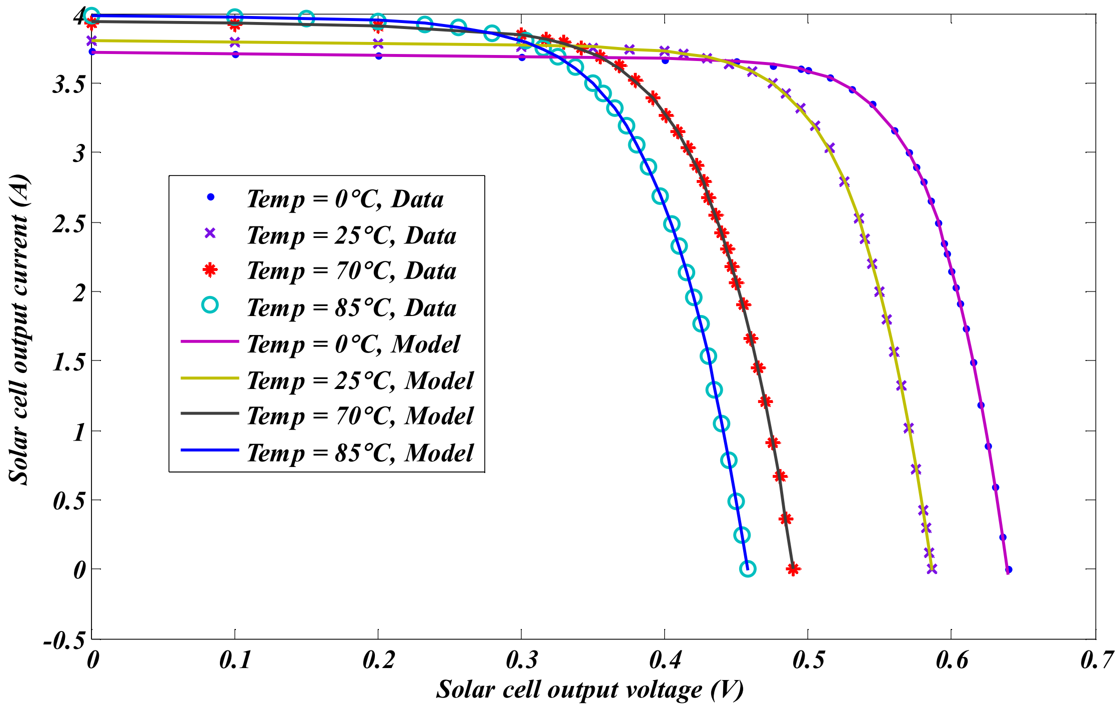


Figure (8): Model with Modified Parameter Values.

تصميم وتحليل الأداء العالي لمنضومات السخان الطاقة الشمسية المنزلي

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الخلاصــة.

إن الزيادة في أسعار الطاقة الكهربائية زاد من أهمية الطاقة الشمسية في الاستخدامات المنزلية، حيث إن الاستغلال المثالي لها أدى إلى انخفاض تكاليف الطاقة الكهربائية خاصة في المنازل وخلال فترة انقطاع التيار الكهربائي المستمر، ومن مميزات شراء منظومة طاقة شمسية :

تقليل الكلفة المادية للمستهلك، زيادة سعر المنزل، توفر طاقة نظيفة ومستمرة لفترة 25–30 سنة بالإضافة إلى توفير فرص عمل عن طريق الشركات العاملة بهذا المجال.

المنظومة الكهربائية الشمسية تتكون من ألواح فوتوفولتائية، عاكس، بطارية، مسيطر شحن، أسلاك توصيل، والهيكل المعدني لتثبيت الأجهزة المذكورة، والأنواع الثلاث الأساسية للمنظومات الشمسية هي :

ربط مع الشبكة بدون بطاريات، ربط مع الشبكة مع بطاريات خزن ومنظومة منفصلة (غالباً ما تستخدم في المناطق النائية).

هذا البحث يتناول تصميم منظومة طاقة شمسية منزلية تشمل :

توجيه اللوح الشمسي باتجاه الشمس للحصول على أعلى إشعاع شمسي، تبريد الألواح، تحديد أفضل مكان للتنصيب بدون عوائق، التأكد من صلابة حوامل الألواح الفوتوفولتائية لتحمل وزن ومساحة الألواح ضد المتغيرات الجوية، أهمية وجود العواكس والموصلات قرب الألواح الشمسية لتقليل الخسائر وأخيراً مقارنة النتائج مع الأنظمة الأخرى للطاقة.

الكلمات الرئيسية: النظام الكهربائي الشمسي،الطاقة الشمسية، خسارة الطاقة.