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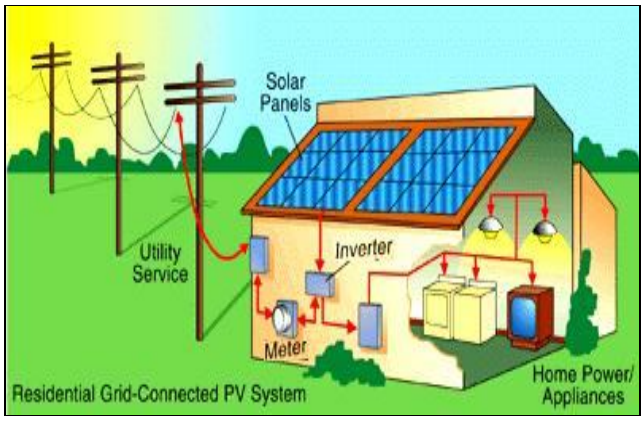

Solar Energy *for* Homes Electricity

"الطاقة الشمسية لكهربة المنازل"

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في ساعة واحدة تصل الارض طاقة من ضوء الشمس تفوق إستهلاكنا البشري لسنة من الطاقة. ومع إرتفاع كلفة الوقود والطلب المتزايد على الطاقة الكهربائية وتعثر إستمرارها أو تكرر إنقطاعها أو عدم توفرها في بعض المناطق جعل التفكير ببدائل توليدها أو تقليل الإعتماد على شبكتها (الوطنية) أمرا مرغوبا. ولأن الطاقة الشمسية أول البدائل المرغوبة في أنواع الطاقة المتجددة الأخرى، فإن إستخدامها لإنتاج الطاقة الكهربائية أصبح شائعا. فالعديد من المنازل والمكاتب تستخدم اليوم الطاقة الشمسية كبديل لتوليد الطاقة الكهربائية او لتقليل كلفتها. وبالإضافة إلى عدم إعتماد توليد الطاقة الكهربائية بإستخدام الطاقة الشمسية على أية أجزاء ميكانيكية متحركة (تحتاج إلى صيانة وتزييت)، فتوليدها نظيف بعدة معان. فلا غازات محترقة أو مواد رماد ملوثة، ولا اصوات تؤثر في راحة الآخرين.

والطاقة الشمسية مجانية تأتينا بدون كلفة ولا تحتل مكانا مميزا (عدا المساحة اللازمة لبطاريات الخزن الممكن صفها في رفوف). فألواح الطاقة توضع في مساحات سطح المنزل غير المستخدمة، ومن الممكن توحيد المنظومة مع شبكة المنزل والشبكة الوطنية مما ينتج خزن للطاقة الكهربائية (بيعا: عند عكس إتجاه سريانها وإنقاص الإستهلاك المسجل في المقياس) لدى الشبكة الوطنية عند عدم الحاجة لها وإسترجاعها (شراءً) عند الحاجة. وبذلك تكون المنظومات على نوعين. نوع متوحد مع الشبكة الوطنية يخزن الكهرباء المتولدة من المنظومة الشمسية لدى الشبكة الوطنية ليسترجعها عند الحاجة (وتكون في العادة في المناطق التي لا تنقطع فيها الكهرباء من أجل التوفير في دفع قوائم الكهرباء). والنوع الآخر (ويكون في المناطق التي تنقطع فيها الكهرباء أو لا تتوفر) يستخدم مجموعة من البطاريات (ذات النوع المخصص لهذه الخدمة) بحيث تخزن الطاقة الكهربائية المتولدة من الخلايا الشمسية في بطاريات المنظومة الشمسية لإستخدامها عند الحاجة.

وتتكون منظومة النوع الثاني من صف الخلايا الشمسية التي تتولى تحويل الطاقة الشمسية إلى طاقة كهربائية من نوع التيار المستمر (DC) التي تخزن كطاقة في بطاريات المنظومة. ويتوسط توصيلة الخلايا الشمسية بمجموعة البطاريات جهاز منظم الشحن (Charging Regulator) الذي يتولى تنظيم شحن البطاريات ومنع إرتداد شحنتها إلى الخلايا الشمسية. ويأتي بعد البطاريات جهاز المحول العكسي (Inverter) الذي يتولى تحويل تيار البطاريات المستمر (DC) إلى تيار متغير (AC) بالفولتية المرغوبة (120/240 VAC) والذي يقوم بتغذية الأجهزة المرغوبة والتي هي في الواقع جزء أو كل من أجهزة المنزل أو البيت. ويعتمد عدد الأجهزة على سعة المنظومة وقدرة تجهيزها.

إن الإعتماد على الطاقة الشمسية في توليد الطاقة الكهربائية له جواذب عديدة فهو بالإضافة إلى إعتمادة على مصدر طاقة مجاني هو حل يمكن الإعتماد عليه ولا يولد أية منغصات بيئية مما ورد ذكرها. وللحصول على هذه التقنية التي تستمر بعملها لسنوات عديدة، ترحب روافد للتكنولوجيا بأي إتصال أو إستفسار حول توفير وتركيب هذه التكنولوجيا.

للإطلاع على المقترحات الأخرى لشركة روافد للتكنولوجيا: تصفح الموقع الألكتروني

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1- Introduction

With rising fuel costs, climate change concerns and growing demand for electricity, renewable energy resources such as solar power are becoming an increasingly valuable part of the global energy mix. Around the world, businesses and home owners are harnessing the power of the earth's most abundant natural resource of sunlight to provide energy using solar power.

Solar modules are Photo Voltaic (PV), generate electricity using an inexhaustible, zero cost, and carbon free fuel power from the sun's rays. Solar panels reach peak production during the middle of the day, at the time when energy use and electricity costs are typically highest for home owners. Solar power is produced by collecting sunlight and converting it into electricity. This is done by using solar panels, which are flat panels made up of many individual solar cells. It is most often used in remote locations, although it is becoming more popular in urban areas as well.

Investments in solar energy offer many benefits. The simplest form of solar power or a home or business is a "utility-tied" or "grid-tied" system without batteries. In this type of system, any excess energy that is created when the sun is out is "stored" at the utility company as a credit. Your meter can actually spin backwards! When it is cloudy outside and at night the "stored" excess electricity in the form of credits is used first, which leads to a lower overall electric bill. Electricity generated from the sun reduces pollution and slows global warming by eliminating the need for fossil fuels. Solar power is a choice you can make individually, but contributes to the collective need to wean ourselves from foreign energy sources. Installing a "battery back-up" solar photovoltaic system in your home will provide an alternative source of power during outages. Solar panels also make a visible statement about your commitment to a cleaner environment, inspiring others to consider new energy sources.

Solar energy creates none of the air pollution associated with electricity from burning coal and natural gas (like mercury, sulphur dioxide (SO2), nitrogen oxide, Carbon Dioxide (CO2), coal ash, toxic particulates, etc). Solar energy systems also require no water and operate in total silence.

2- Facts

Sunlight is free and abundant. In one hour our planet receives as much energy from the sun as the entire human population uses in one year. Harnessing this plentiful source of energy is easy to do, and your roof is probably the best place to start. Solar energy systems allow you to generate your own electricity and store it for later use. Or, if you prefer to stay connected to the electric grid, any excess energy can be turned into credits at your local electric utility. and improving the reliability of the energy infrastructures.

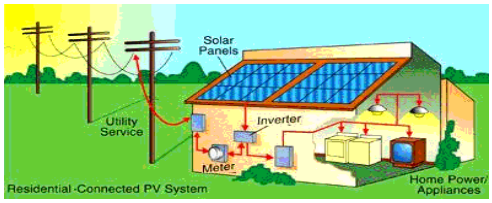
Solar panels have no moving parts, and therefore no potential points of mechanical failure. Preventive maintenance is usually limited to rinsing the panels twice a year to clean off any dust buildup. Most solar panel manufacturers offer lifetime warranties for over 25 years. Systems that include battery banks for energy storage will require some additional maintenance to ensure the batteries are properly cared for and life is maximized.

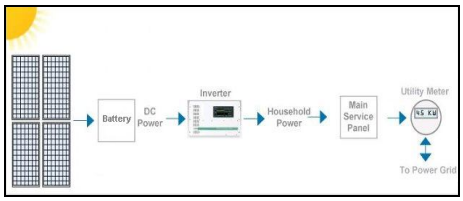
3- Benefits

- Freedom from Utility Electricity.
- Reduces or eliminates electric bill.
- Fixes electricity cost.
- Protects against utility rate hikes.
- Increases the value of home.
- Fights global warming.
- Reduces carbon emissions and energy impact.
- Reduces dependence on oil.
- Generates clean power.

4- System Architecture

The most basic system for proposed solar based residential solution is as shown in the below pictures. Sunlight from the sun is collected by the photovoltaic solar panels and gets converted to DC power. This DC power gets stored in a battery. The size of the battery may depends upon the quantity of the home power appliances. The DC power in the battery is converted to AC power by using a suitable inverter and is coupled directly to the home appliances. The most important benefit is that the size of the system can be easily expanded by adding the number solar panels to improve the total performance.

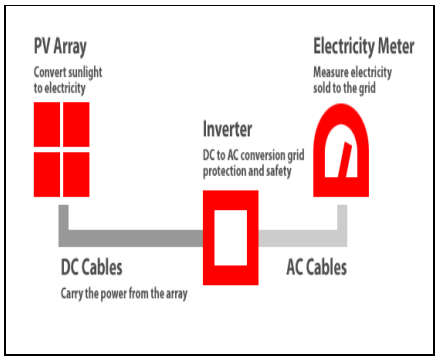




5- Types of PhotoVoltaic Systems

5.1 On-Grid Tie

- Most modern PV systems are grid-connected, meaning electrical energy is directed into the existing municipal power grid.
- Energy is effectively stored in the grid. When a grid-tie system is generating more energy than you need, your electrical meter turns backwards. Many large arrays are intended solely for use as power plants, enhancing or supplanting the need for conventional power plants.
- On Grid application systems may not need batteries and charge controllers.

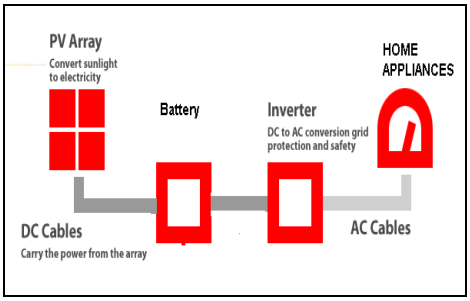


On-Grid Tie

5.2 Off-Grid Tie

- Many PV systems are used to energize remote homes, facilities, and devices.
- An example of an off-grid system includes a remote solar home.
- Military communication units with supplemental solar and wind are also off-grid.
- Monitoring or communication devices are off-grid.
- Energy is gathered from solar modules and is directed into energy storage devices for use when needed. These systems often supply the entire amount of energy required.

The below picture shows the architecture of a Off-Grid System,



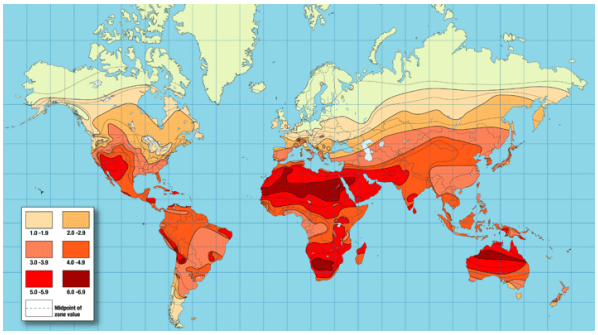
Off-Grid Tie

6- System Components Detail

A complete system includes different components that should be selected taking into consideration the specific application load needs, site location, climate, and expectations:

6.1 PV Solar Modules:

Converts sunlight instantly into DC electric power. To estimate the size of solar array, you need to know the number of Watt-hours (Wh) you plan to produce in one day and the insolation value (number of hours in a day that a solar panel will produce it's rated voltage) at your location. World solar insolation values are shown in the below figure.



Example: To produce 8 kWh per day as an example, divide that number by hours of insolation in your region (e.g. 4) i.e., 8/4= 2 kW. Allow for the normal energy losses and inefficiencies in a solar electric system by increasing the number of Watts by 30% to result 2kW * 1.3 = 2.6 kW. Therefore, you look for a 2.6 kWh system in order to produce on average 8 kWh per day. Notice that energy in kWh is the product of power in kilowatts and time in hours; it is not kilowatts per hours.

6.2 Charge Controller

Solar charge controllers are an essential element to any solar electric panel system. At a most basic level charge controllers prevent batteries from being overcharged (boiled) and prevent the batteries from discharging through the solar panel array at night. They further serve as voltage regulators (increase/decrease the batteries charging and connect/disconnect batteries charging). Charge controllers are specified by both amperage and voltage. You will need a charge controller that matches the voltage of your solar panel array and battery bank (usually 12, 24 or 48 VDC) and to make sure the solar panel charge controller has enough capacity to handle the current (in amps) from your solar panel array. The basic formula for sizing a solar panel charge controller is to take the short circuit current (Isc) of the array, and multiply it by 1.56. Be sure that the charge controller you select can handle at least that many amps. Controllers should be protected on both ends.

6.3 Batteries

Batteries are to stores DC electric power. Most home systems today are 24 or 48 VDC since the higher system voltage gives us a lot more flexibility as to how far away we can place solar modules from the battery bank as compared to a 12V system. For a given power output, a higher system voltage reduces your amperage flow (but not your power) which allows you to use a smaller and less expensive gauge wire for your solar to battery and battery to inverter wire runs. Of course, if you already have a lot of 12VDC loads, that may be your deciding factor as to what voltage you set your system up at. Most grid-tie systems operate at 48 volts or higher.

The energy stored in the batteries can then be used directly to power DC loads or it can be inverted to power AC loads. The batteries recommended for PV systems are deep cycle batteries (car's batteries are designed with thin plates to provide a very large amount of current through their surface areas for a short period of time while deep cycle batteries are designed with thick plates to provide a steady amount current over a long period of time. With their deep cycle they can deeply discharged over and over again (car batteries can not do). To ensure you have enough reserve capacity to provide the electricity you need, invest the time to size your battery bank properly. Because of the various conditions affecting battery bank sizing may be one of the more challenging calculations you'll have to do when planning Renewable Energy

(RE) system. Small size may require several cycles of charging/discharging that consume batteries over a short time.

6.4 Inverter

The inverter converts DC to AC, and also changes the voltage. In other words, it is a power adapter. It can allow a battery-based independent power system to run conventional appliances through conventional home wiring. There are many ways to use DC power directly, but if your electrical needs are beyond the simplest "cabin" level, you will need an inverter for many, if not all of your loads (devices that use power).

Here is a list of the important characteristics of inverters. These are the factors to consider when selecting an inverter.

Where is the inverter to be used?

- Home
- Recreational vehicle
- Marine
- Portable
- Emergency backup

Electrical standards

- DC input voltage
- AC output voltage and frequency

Power capacity (watts) (How much will it put out?)

- Continuous rating
- Limited duration ratings
- Surge rating (for starting motors/pumps)
- Expandability (modularity, stackability)

Power quality (waveform)

- Some inverters produce "cleaner" power than others.
- Sine wave inverters
    - Ideal, smoothly alternating AC (like swing of a pendulum)
    - Equivalent (or superior) to grid power relatively expensive
- Modified sine wave inverters
    - Inferior waveform, choppy alternation (like pendulum forced by hammers)
    - Inexpensive

- Adequate for many homes with simple needs, but about 5% of loads malfunction
- Generally reduces the reliability of appliances

Internal protection (How much abuse can it tolerate?)

- Overload and surge protection
- Low voltage shutoff

Inductive load capability

Some loads accept the AC wave with a slight time delay. These are called inductive loads. Motors are the most severely inductive loads.

- Starting large motors (well pump, washing machine, power tools, etc.)

Physical attributes

There are two ways that inverters are built:

- Transformer type inverters
  - Heavy, expensive
  - High surge capacity
  - Historically the most reliable
  - Makes buzzing noise
- High frequency switching type inverters
  - Light weight, inexpensive
  - Less reliable in cases of cheap consumer units
  - No audible buzz

Main Service Panel – the inverter feeds AC electricity into a breaker in your main electric panel, offsetting usage in the home.

7- Summary

Solar energy provides many environmental and economic benefits. Solar energy is reliable, clean, and sustainable. Not only is solar energy one of the best answers to global warming, it can also save money on energy costs.

A residential solar electric system allows you to generate your own electricity at home. The pre-packaged systems are designed either to interconnect with your existing utility service or act in a stand-alone environment. These solar packages include solar modules, inverters, wiring, and mounting kits. Off-grid packages will also include

batteries and charge controllers. A licensed electrician will be required to ensure the wiring is handled appropriately.

There are two standard ways of designing and building solar residential systems. One type of system is referred to as a "grid-tied" system. A grid-tied system powers your home during daylight hours, has no battery storage, and relies on electricity from your local utility when there is little sunlight. Another type of system is referred to as a being "off-grid". This type of system is not connected to the electric supply provided by the local utility. Off-grid systems power your home during daylight hours, but also have a battery backup designed to provide power to your home's critical loads, day or night. If the local utility experiences a power outage on a clear day, there will be no disruption of service. If the power outage happens when sunlight is minimal, only systems with battery backup will be able to continue providing electricity.

For customized system design and further load calculations and right components selection, contract R4T.

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8- Glossary of Commonly Used Terms

AC (Alternating Current): AC is a type of electric current which is reversed at regular intervals or cycles. Almost all residential appliances and motors are built to operate using alternating current.

Batteries: A battery is a chemical way of storing electric energy. It uses a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The batteries used for solar energy applications are typically offered in two varieties: *wet-cell* and *sealed*.

A deep-cycle **wet-cell** has thick lead plates and is flooded with an electrolyte and water mix. Wet cell batteries will give off gas as a natural result of charging; therefore the battery compartment should have some sort of ventilation. As the battery discharges and recharges daily, water loss will occur over time. The water level should be checked periodically and topped off with distilled water.

A deep-cycle gel cell or **sealed** lead-acid battery has the sulfuric acid converted to a jelly-like consistency surrounding the individual lead plates. This type of battery is typically used in environments preventing regular access and maintenance. Gel cell batteries will have slightly shorter life span than wet cell batteries.

Charge Controller: Solar charge controllers are used in battery based photovoltaic / solar electric systems. Charge controllers protect the batteries from overcharge and excessive discharge. The minimum function of the charge controller is to disconnect the solar electric array when the battery is fully charged and to keep the battery fully charged without damage.

DC (Direct Current): DC is a type of electric current that flows in a consistent direction. Electricity generated by solar panels is low-voltage DC. To make this electricity usable in a residence (since most household appliances operate using AC), an inverter is needed.

Grid ("On-Grid" vs "Off-Grid"): "On-grid", "grid-connected" or "grid-tied" means the solar electric residence is also connected to the utility electrical grid as a backup. "Off-grid" refers to systems that are not connected to the utility electrical grid and store unused energy in batteries that are maintained inside the house.

Inverter: Converts the solar panel's direct current (DC) power into standard alternating current (AC) power for use in the home. The inverter also ensures synchronization with utility power whenever the electrical grid is distributing electricity.

Main Service Panel: The inverter feeds AC electricity into a breaker in your main electric service panel, offsetting usage in the home before sending excess out to the utility meter.

Net Metering: Net metering measures the difference between the electricity you buy from your utility and that produced with a solar energy system. Net metering is applicable to grid-tied systems. Under net metering, any excess electricity produced by your solar energy system is delivered back into the utility grid, effectively spinning your meter backwards. The meter spins forward when the solar panels are not producing all of the electricity being used.

PV Modules / Solar panels: Photovoltaic (PV) refers to a technology that converts light energy into electricity. Photovoltaics are generally made from thin wafers of silicone, and when charged particles from the sun hit them, they convert the sun's photons into usable direct current (DC) electricity. Only about 14% of the photons that hit the photovoltaic cell are converted to electricity, but this is four times what it was five years ago,

This DC current can either be used immediately or stored for later use. With the addition of a solar inverter, the DC power can be converted into alternating current, or AC power, which is what most electrical appliances utilize. PV modules are versatile and can be mounted in a variety of sizes and applications, but are most commonly installed on the roof or awning of a building.