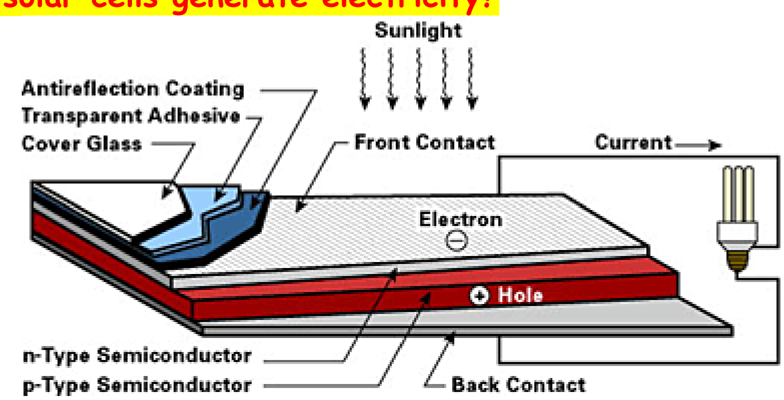
SOLAR FREQUENTLY ASKED QUESTIONS

Renewable Energy (RE) may seem puzzling to some people that are not familiar with it. To help those of you that are being exposed to solar and wind power for the first time, we have compiled a dozen of the most frequently asked questions (with their answers) that we hear at Kyocera Solar everyday. We hope this FAQ file is helpful to you.

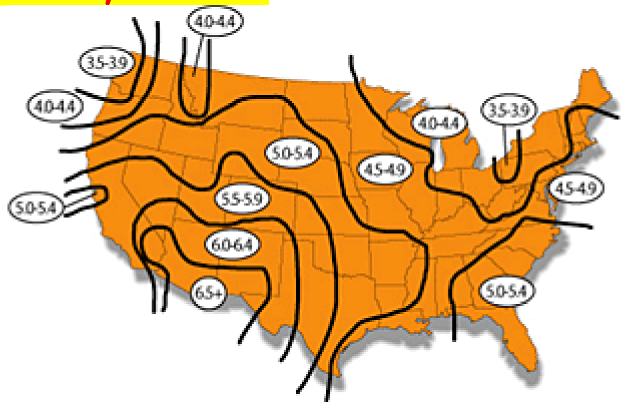
Q1: How do solar cells generate electricity?
Q2: Will solar work in my location?
Q3: How much will a system cost for my 2000 square foot home?
Q4: Can I use all of my normal 120/240 VAC appliances?
Q5: What components do I need for a grid-tie system?
Q6: What components do I need?
Q7: What type of solar module mounting structure should I use?
Q8: Where should I mount the solar modules and what direction should I face them?
Q9: Should I set my system's battery bank up at 12, 24 or 48 VDC?
Q10: Should I wire my home for AC or DC loads?
Q11: Can I use PV to heat water or for space heating?

Q1: How do solar cells generate electricity?



A1: Photovoltaics or PV for short can be thought of as a direct current (DC) generator powered by the sun. When light photons of sufficient energy strike a solar cell, they knock electrons free in the silicon crystal structure forcing them through an external circuit (battery or direct DC load), and then returning them to the other side of the solar cell to start the process all over again. The voltage output from a single crystalline solar cell is about 0.5V with an amperage output that is directly proportional to cell's surface area (approximately 7A for a 6 inch square multicrystalline solar cell). Typically 30-36 cells are wired in series (+ to -) in each solar module. This produces a solar module with a 12V nominal output (~17V at peak power) that can then be wired in series and/or parallel with other solar modules to form a complete solar array to charge a 12, 24 or 48 volt battery bank.

Q2: Will solar work in my location?



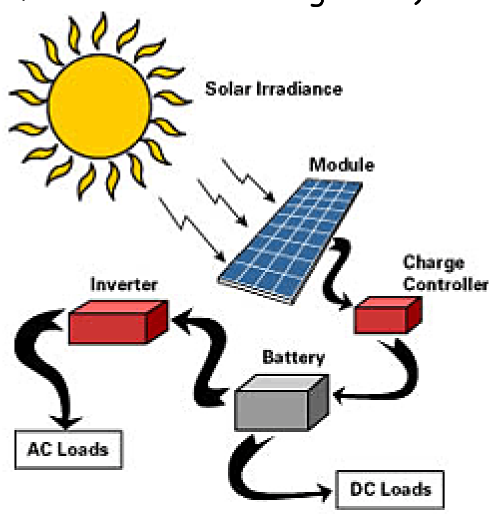
A2: Solar is universal and will work virtually anywhere, however some locations are better than others. Irradiance is a measure of the sun's power available at the surface of the earth and it averages about 1000 watts per square meter. With typical crystalline solar cell efficiencies around 14-16%, that means we can expect to generate about 140-160W per square meter of solar cells placed in full sun. Insulation is a measure of the available energy from the sun and is expressed in terms of "full sun hours" (i.e. 4 full sun hours = 4 hours of sunlight at an irradiance level of 1000 watts per square meter). Obviously different parts of the world receive more sunlight from others, so they will have more "full sun hours" per day. The solar insulation zone map on the right will give you a general idea of the "full sun hours per day" for your location.

Q3: How much will a system cost for my 2000 square foot home?

A3: Unfortunately there is no per square foot "average" since the cost of a system actually depends on your daily energy usage and how many full sun hours you receive per day; And if you have other sources of electricity. To accurately size a system to meet your needs, we need to know how much energy you use per day. If your home is connected to the utility grid, simply look at your monthly electric bill. Using this information, we can design a system to meet you needs.

Q4: Can I use all of my normal 120/240 VAC appliances?

A4: Maybe. Many older homes were not designed or built with energy efficiency in mind. When you purchase and install a renewable energy system for your home, you become your own power company so every kWh of energy you use means more equipment (and hence more money) is required to meet your energy needs. Any appliances that operate at 240 VAC (such as electric water heaters, cook-stoves, furnaces and air conditioners) are impractical loads to run on solar. You should consider using alternatives such as LP or natural gas for water/space heating or cooking, evaporative cooling instead of compressor based AC units and passive solar design in your new home construction if possible. Refrigeration and lighting are typically the largest 120 VAC energy consumers in a home (after electric heating loads) and these two areas should be looked at very carefully in terms of getting the most energy efficient units available. Great strides have been made in the past 5 years towards improving the efficiency of electric refrigerators/freezers. Compact fluorescent lights use a quarter to a third of the power of an incandescent light for the same lumen output and they last ten times longer. These fluorescent lights are now readily available at your local hardware or discount store. The rule of thumb in the renewable energy industry is that for every dollar you spend replacing your inefficient appliances, you will save three dollars in the cost of a renewable energy system to run them. So you can see that energy conservation is crucial and can really pay off when considering a renewable energy system.



Q5: What components do I need for a grid-tie system?

A5: Grid-tie systems are inherently simpler than either grid-tie with battery back-up or stand-alone solar systems. In fact, other than safety disconnects, mounting structures and wiring a grid-tie system is just solar modules and a grid-tie inverter! Today's sophisticated grid-tie inverters incorporate most of the components needed to convert the direct current form the modules to alternating current, track the maximum power point of the modules to operate the system at peak efficiencies and terminate the grid connection if grid power is interrupted form the utility.

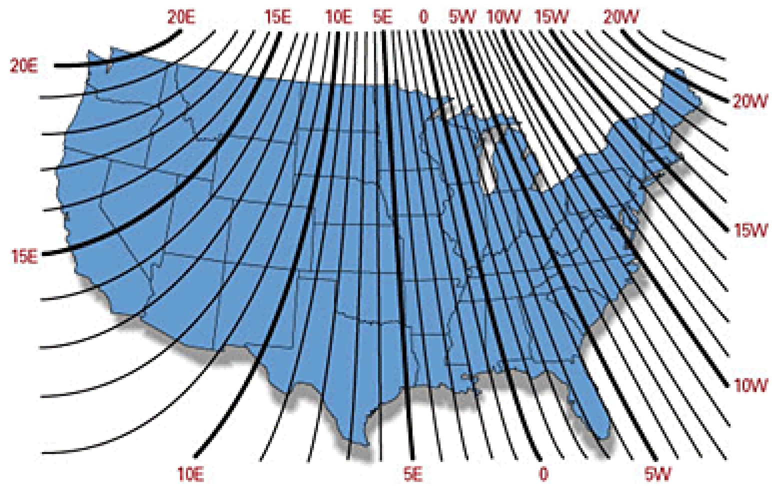
Q6: What components do I need?

A6: There are many components that make up a complete solar system, but the 4 main items are: solar modules, charge controller(s), batteries and inverter(s). The solar modules are physically mounted on a mount structure (see question 7) and the DC power they produce is wired through a charge controller before it goes on to the battery bank where it is stored. The two main functions of a charge controller are to prevent the battery from being overcharged and eliminate any reverse current flow from the batteries back to the solar modules at night. The battery bank stores the energy produced by the solar array during the day for use at anytime of day or night. Batteries come in many sizes and grades. The inverter takes the DC energy stored in the battery bank and inverts it to 120 VAC or 220VAC to run your AC appliances.

Q7: What type of solar module mounting structure should I use?

A7: There are four basic types of mount structures: roof/ground, top-of-pole, side-of-pole and tracking mounts, each having their own pros and cons. For example roof mount structures typically keep the wire run distances between the solar array and battery bank to a minimum, which is good. But they also require roof penetrations in multiple locations (a potential source of leakage) and they require an expensive ground fault protection (GFP- device to satisfy article 690-5 of the National Electrical Code- NEC). On the other hand, ground mounted solar arrays require fairly precise foundation setup, are more susceptible to theft/vandalism and excessive snow accumulation at the bottom of the array. Next are top-of-pole mounts which are relatively easy to install (you sink a 2-6 inch, 5-15cm, diameter SCH40 steel pole up to 4-6 feet, 1.2-1.8m in the ground with concrete). Make sure that the pole is plumb and mount the solar modules and rack on top of the pole. Top-of-pole mounts reduce the risk of theft/vandalism (as compared to a ground mount). They are also a better choice for cold climates because snow slides off easily. Side of pole mounts are easy to install, but are typically used for small numbers of solar modules (1-4) for remote lighting systems where there already is an existing pole to attach them to. Last but not least are the trackers, which increase the daily number of full sun hours and are used for solar water pumping applications. Trackers are extremely effective in the summer time when water is needed the most. In the northern U.S., and Canada typical home energy usage peaks in the winter when a tracker mount makes very little difference as compared to any type of fixed mount (roof, ground or top-of-pole). In this situation, having more modules on a less expensive fixed mount will serve you better in the winter than fewer modules on a tracker. However, if you are in the southern U.S. and your energy usage peaks in the summer, then a tracker may be beneficial to match the time of your highest energy consumption with a tracking solar array's maximum energy output.

Q8: Where should I mount the solar modules and what direction should I face them?



A8: If your site is in the Northern Hemisphere you need to aim your solar modules to the true south direction (the reverse is true for locations in the Southern Hemisphere) to maximize your daily energy output. For many locations there is quite a difference between magnetic south and true south, so please consult the declination map below before you setup your mount structure. The solar modules should be tilted up from horizontal to get a better angle at the sun and help keep the modules clean by shedding rain or snow. For best year round power output with the least amount of maintenance, you should set the solar array facing true south at a tilt angle equal to your latitude with respect to the horizontal position. If you plan to adjust your solar array tilt angle seasonally, a good rule of thumb to go by is latitude minus 15° in the summer, latitude in the spring/fall and latitude plus 15° in the winter. Most mount structures provide for a seasonal adjustment of the tilt angle from horizontal to 65°. To determine if your proposed array site will be shaded at any time of the day or year you should consider using the Solar Pathfinder.

Q9: Should I set my system's battery bank up at 12, 24 or 48 VDC?

A9: The PV industry really began with the 12V recreational vehicle market. These systems were typically small (1-2 solar modules) and had all 12 VDC loads. As the solar industry matured and entered the home market, systems became much larger (16+ solar modules) and no longer used DC loads exclusively. Most home systems today are 24 or 48 VDC since the higher system voltage gives you a lot more flexibility as to how far away you can place your 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-tied systems operate at 48 volts or higher.

Q10: Should I wire my home for AC or DC loads?

A10: It depends on the size of the system and what type of loads you want to run. DC appliances are usually more efficient than AC since you don't have to worry about the loss through the inverter, but DC loads are typically more expensive and harder to find than their AC counterparts. Small cabin and RV systems are typically wired DC while most home systems are wired for AC loads exclusively. With improvements in inverter efficiency and reliability in the last 5 years, AC is the way to go for a home system. Another advantage AC has over DC is that the voltage drop for a 120VAC circuit is much less than a 12VDC circuit carrying the same power, which allows you to use smaller gauge wire.

Q11: Can I use PV to heat water or for space heating?

A11: No. Photovoltaic converts the sun's energy into DC electricity at a relatively low efficiency level (14-16%), so trying to operate a high power electric heating element from PV would be very inefficient and expensive. Solar thermal (or passive solar) is the direct heating of air or water from the heat of the sun and is much more efficient for heating applications than photovoltaics.