

The Solar Panel How To Guide

by www.solarpanelsbook.com

For Questions about solar panels visit:

www.solarpaneltalk.com

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I. Intro

Solar panels are a major investment and just like anything you invest in, it's wise to learn as much as you can about the investment. I wrote this How-To guide to get you started on the path of a cleaner and brighter future and by the time you are finished reading it, you will have a thorough understanding from how solar panels work to how you get them producing electricity and lowering your bills. It's time to put your home on a kilowatt diet and doing your part in making the planet a better place to live for you and future generations.

How do solar panels work?

Solar panels are made up of photovoltaic cells that convert sunlight directly into electricity by using a semiconductor, usually made of silicon. The term photovoltaic comes from the Greek meaning “light” (photo) and “electrical” (voltaic). When the sunlight hits the photovoltaic cells, part of the energy is absorbed into the semiconductor. When that happens the energy loosens the electrons which allows them to flow freely. The flow of these electrons are a current and when you put metal on the top and bottom of the photovoltaic cells, we can draw that current to use it externally.

Future of Solar Panels

Solar energy production has been doubling every two years, increasing by an average of 48 percent each year since 2002, making it the world's fastest-growing energy technology. One day of sunshine produces enough energy to power the planet for a year and solar panel technology is improving drastically to harness this powerful source of clean energy. The cost of electricity from your utility company is always going to go up, and as the demand for solar panels grow, the less expensive they will become.

II. Why Solar Panels?

There are many challenges that come along with the scarce resources that are currently being used for our electricity supply and solar panels are one of the answers to overcoming these challenges we are facing.

World Benefits

Aside from the fact that your electricity bill will always continue to rise unless you make a change, there are more important factors that come into play and I'll outline a couple for you.

-Solar Panels do not contribute to global warming, as it does not contaminate the air by releasing carbon dioxide or other pollutants. The fossil fuels such as coal, oil, and natural gases that are being used for our electricity emit 10.3 million tons of sulfur dioxide, 3.9 million tons of nitrogen oxides, 2.4 billion tons of carbon dioxide, and over 50 tons of mercury a year. Not only is this dangerous for the environment but it's a danger to your health because these emissions are toxic. Every single year the

emission of these gases rise considerably. Fossil fuel electricity generation is responsible for 36% of the country's emissions of carbon dioxide and the single largest contributor to global warming. (Statistics taken from the Official Energy Statistics from the US Government; <http://www.eia.doe.gov/>)

-Over its 35-year expected life, a 10 kW solar panel system will provide the equivalent CO₂ reduction as planting 1450 trees. (Based on typical utility pollution) It will produce 575,000 kilowatt hours of electricity, as much as would be generated by burning 583,000 lbs of coal.

-Solar Panels are one of the cleanest sources of alternative Energy. There is absolutely zero pollution to the environment, which makes a better way of living for your children and generations beyond.

Personal Benefits

-It's free renewable energy unlike the source that is powering your current power supply. As long as the sun is around, you can take advantage of completely free energy.

-Slash your electricity and fuel bills by great numbers or get rid of them completely.

-According to a recent survey by California Solar Institute, for every \$1 of savings from your energy bill annually, you get an increase of \$20 in your home value. Hence, this means that a savings of \$1500 or more will equate to an increase of \$30,000 in your home sale value.

-A bill was just passed that provides people who purchase solar panels to take advantage of great tax credits, so when you buy solar panels, you automatically get a nice chunk of change taken off the cost right away.

-Once the initial cost of purchasing the panels are paid in full, the electricity it produces for the remainder of the system's lifespan, which is decades, is absolutely free!

-Solar panels make it possible to live off-grid, which means living in a self-sufficient manner without reliance on one or more public utilities. With the advent of global climate change, it has become more important that we do whatever we can to reduce the pressure on our atmosphere from the emission of greenhouse gases.

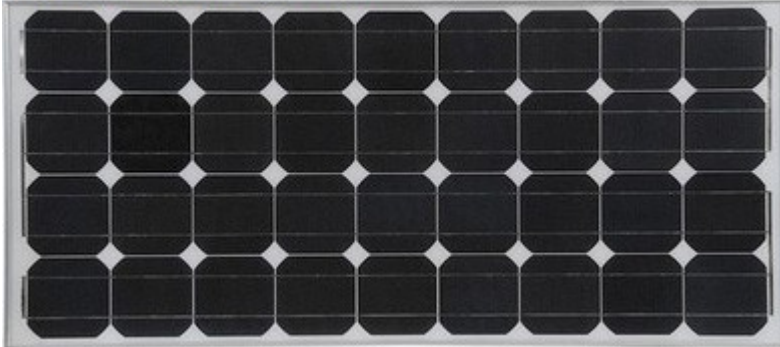
-For people who have their solar panels tied in with the utility company, the benefits begin from the moment the system comes online, potentially eliminating monthly electric bills or, and this is the best part, actually earning the system's owner additional income from the electric company. If you use less power than your solar electric system produces, that excess power can be sold, sometimes at a premium, to your electric utility company. So, let's say you've got some solar power panels up on your roof for the summer but you decide to go on and take a vacation for a month. All the power that is being generated gets credited to your account. At the end of the year, if you use as much power as you feed back into the grid, your power bill is negligible.

-No more spoiling your food due to power outages

-The use of solar energy for homes and businesses can help reduce transport of fuel that would otherwise be used for heating, further reducing carbon emissions.

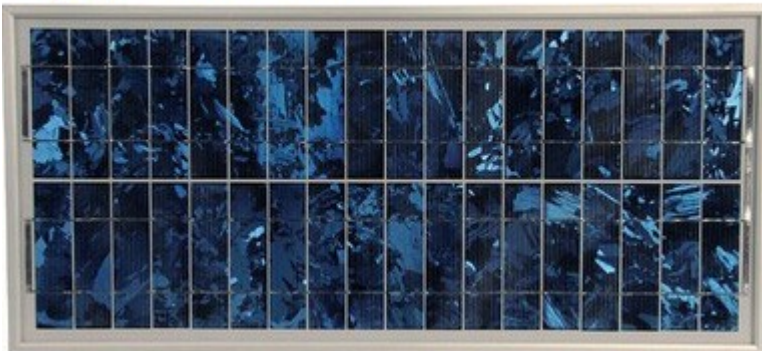
III. Types of Solar Panels

Monocrystalline Solar Panel



Monocrystalline Solar Panels are made from a large crystal of silicon. These type of solar panels are the most efficient as in absorbing sunlight and converting it into electricity, however they are the most expensive. They do somewhat better in lower light conditions then the other types of solar panels.

Polycrystalline Solar Panel



Polycrystalline Solar Panels are the most common type of solar panels on the market today. They look a lot like shattered glass. They are slightly less efficient then the monocrystalline solar panels and less expensive to produce. Instead of one large crystal, this type of solar panel consists of multiple amounts of smaller silicon crystals.

Amorphous Solar Panel



Amorphous Solar Panels consist of a thin-like film made from molten silicon that is spread directly

across large plates of stainless steel or similar material. These types of solar panels have lower efficiency than the other two types of solar panels, and the cheapest to produce. One advantage of amorphous solar panels over the other two is that they are shadow protected. That means that the solar panel continues to charge while part of the solar panel cells are in a shadow. These work great on boats and other types of transportation.

Efficiency

Solar Panel efficiency is the percentage of solar energy that is captured and converted into electricity. It's difficult to give an exact number, so the numbers below are an average percentage of efficiency that the different types of solar panels output. Thin film solar panels will generally degrade approximately 1% each year, whereas crystalline panels degrade at approximately .5%. Below are the approximate percentages for each type of solar panel:

Monocrystalline- 18%

Polycrystalline- 15%

Amorphous (thin-film)- 10%

IV. Grid Tie or Off Grid?

When installing a solar panel system you can either choose to hook up into the “grid” or go “off the grid.”

Grid tie

Grid tie means that your solar panel system is hooked up directly to your electricity provider. Your system will use the energy produced by the solar panels first during the day and draws whatever else it needs from your utility company during the hours the solar panels aren't producing electricity. During the day, if your solar panels system produces more electricity than is used in your home, the extra electricity is fed into the utility grid generating a credit on your electric bill. When this happens, you will be able to see your meter literally spinning backwards. This is great especially if you're on vacation. One advantage of not having battery storage is not having to deal with the regular maintenance of the batteries.

If your budget allows it, you can buy batteries for energy storage as well. If your electricity goes out, your inverter will switch to battery power to supply your home's need. That way you can keep your important equipment running during these blackouts. The battery storage is a great solution for those homes that don't have easy access to a utility grid or is located in an area that has frequent outages.

If your electricity shuts down because of storms or blackouts, your solar panels system without the

batteries will shut down with it. This safety measure occurs to prevent surges of power traveling the grid and causing injury to a repair person working on the lines or other types of damage. If you have backup batteries, you won't experience this inconvenience. When the electricity shuts down, your solar panels system will automatically disconnect itself from the utility companies grid and extract power from the battery storage. When the electricity comes back on, your solar panels system will reconnect automatically.

If the grid tie option is what suits you best, then there are a couple of things you need to do. First, call your utility company and find out if they allow you to hook up solar panels into their electricity grid. Most do because of the national law that allows connectivity to the grid, however some rural electricity companies are exempt from this law. Second, ask your electricity company if they buy the energy your solar panels produce at the retail rate or wholesale. Ideally you'll want the electricity company to buy back any excess electricity that your solar panels produce at the same retail rate that you buy electricity from them at. This is called "Net Metering" and it's the simplest way to setup a solar panels system. In this particular type of solar panels system you only have one utility kWh meter and it's allowed to spin in either direction depending on if you are buying or selling energy.

If your electricity company buys the energy you produce at wholesale rates, you'll be required to install a second kWh meter to record any excess energy that you will sell back to them. Usually the wholesale buy back rate is only a few cents per kWh produced.

You can call your electricity company or check out www.dsireusa.org to see if your state offers either "Net Metering" or wholesale buy back, and while your at the website, check for other incentives for installing a solar panels system. Recently a federal bill was just extended and updated that gives grid-tied systems a 30% tax rebate on their new solar panels installation. Unfortunately for those off the grid, this incentive doesn't apply.

Off the grid

Off the grid means living in a self sufficient manner, producing all of the power yourself without relying on utility companies. Your solar panels are not hooked into the grid and all the electricity you produce is stored in battery cells. All of your electric power is produced using solar panels, wind, hydro, and/or generators etc. Your water source comes from a stream, well or lake that is filtered.

Every year more people are choosing to go off grid, whether it be their residence or vacation cabin. There are many reasons people choose to go off the grid. It can be a very powering and liberating experience knowing your not relying on anyone to provide your power. Plus not receiving all of those monthly bills doesn't hurt. A rough estimate of people living off the grid in the United States is said to be over 200,000 and rising. As the electricity prices keep rising and the cost of equipment to live off the grid is falling, going this route is starting to look like the more economical and cleaner route to take in contributing to a greener future.

V. How Many Solar Panels?

In this section you will learn tips on reducing your electricity usage before figuring out how many solar panels you need. The more you reduce prior to getting them, the less solar panels will be needed.

Reducing Electricity Usage

Before figuring out how many solar panels you need, it's best to reduce your current electricity usage as much as possible. Doing this will make your solar panel system more cost effective. Making small and simple changes to your electricity usage can make a huge impact on both the environment and your electricity bill.

On the more expensive end of the spectrum, you can make improvements such as replacing bad insulated windows with more modern ones, insulating walls and ceilings, replacing old central heating units, etc. This is more of a long term investment, and once they you get your payback, it's just extra money in your pocket.

The next step would be making changes with your big appliances. They are a major part of your electricity consumption and you can make big gains by switching to more efficient models. Switching to Energy Star compliant appliances is a great way to go about it.

There are a lot of small investments and also personal habits that you can do right now that take a big part in reducing your electricity usage. What a lot of this comes down to is habit. Just like many people have habits of wasting electricity whether they realize or not, those habits can easily be reversed by starting more energy saving habits. Lets take a look at a few things for starters:

-Turn off lights in rooms not being used. You could take it a step further by purchasing compact florescent bulbs. They are a little more expensive but the payment is very quick.

-Get in the habit of turning off your computer monitor. Instead of leaving your computer on, make sure you have it in sleep mode, or better yet, turn it off when not in use.

-Close your blinds if parts of the house are getting direct sunlight. It heats the house up and will make your air condition kick on more.

-Run your dishwasher and wash your clothes at night. A lot of utility companies have rating scales where they will charge you more during peak hours. Find out from your utility company when the lowest rates apply.

-Insulate your water heater. For about \$10-\$20 you can buy a installation wrap that goes around your water heater so it doesn't work as hard to heat the water.

-Get a shower curtain rod, set it up in your utility room and start air drying clothes.

-Use warm and cold water to wash clothes rather than hot

-Turn your refrigerator down. Use a thermometer to set your refrigerator temperature as close to 37 degrees and your freezer as close to 3 degrees as possible. Make sure that its energy saver switch is turned on.

-Clean or replace air filters when needed.

-Use low-flow shower heads so you use less hot water

-Take showers instead of baths, they use half the amount of hot water.

Figuring Out How Many Solar Panels are Needed

If you plan on tying your solar panels into the grid, then one way going about it is just buying what you can afford. Then when you have enough money saved just add another one, and so on. That way what ever electricity you are producing your electricity company will just credit you. For example in my state, they just credit back what you produce on the next months bill. Doing it this way is fun and motivating to watch those bills start decreasing.

If you plan on going big, then there are a few steps that you will have to follow to find out about how many solar panels you will be needing to compensate for all the energy used in your home. Once you have this part down, it will all start to come together and become easier to understand how this all works. If you have any problems or questions with the following steps, make sure to go to www.solarpaneltalk.com to post your question and it will be answered promptly by people knowledgeable of solar panels.

1. Make a list of all the electrical appliances that you use, how many watts each one uses and estimate how many hours per day you use them. You can find the amount of watts it uses by looking at the label on the back or bottom of the electrical product. You'll be looking for something that looks like (1450W) for example. Of course all the numbers will vary depending on how many watts that particular product uses. Some power adapters won't tell you how many watts it uses, instead it will tell you the amount of volts and amps. (for example +13v ... 1.3A) If this is the case, you will want to multiple the volts x amps to get your watts. Keep in mind all of these labels are slightly different, so if you are still having trouble on a particular appliance, check the manual or call the manufacture to get the amount of watts. The labels on the electrical items approximations, which is fine, but if you would like a more precise number, using a kill-a-watt electronic device works wonders! This device plugs into your electrical outlet, and then you plug the electrical item into the kill-a-watt meter and it gives you an exact reading of how many watts it uses. This meter is extremely handy and very inexpensive.
2. Multiply the total watts times the hours used for each particular electrical product. So for example if you use a radio for 2 hours a day while working out and it uses 14W, then you would multiply 14x2 to get a total of 28watts per day for the radio. Once you do this for each item, add them all up to get the total amount of watts that you use per day.

3. Look at the following table to determine the amount of average sunlight you get in your area.
4. Now divide the total amount of watts used per day as you figured out in step 2, by the average amount of sunlight. So if you use 1000watts per day in your home and the average sunlight is 4.3, then you would do $3000/4.3=698$. This means you will need atleast 698Watts of solar panels to get enough solar energy to power your entire house.

VI. How to Find the Best Price

You may have looked around for companies that sell solar panels and will notice the same repetitive sales pitch. It may go something like this, cheapest solar panels!, best deals!, lowest price on the net!, etc. It could get confusing so I'll show you how to figure out the best watt for your buck.

The best way to determine a good price for solar panels is dividing the amount the company is charging for a solar panel by the amount of watts. For example if a company is selling a 130watt solar panel for \$600, the math would look like this: $600/130=4.62$. That means their price for that panel is \$4.62 per watt.

Now your question might be, What's a good price per watt? Right now in the United States the higher end of the retail price per watt is at \$4.85. (according to the data research here: <http://www.solarbuzz.com/Moduleprices.htm>) So anything below that is a good price and of course the lower price per watt, the better.

So while you are shopping around just do this simple math for a few different companies that are selling solar panels and find the lowest price per watt.

Once you figure that best price, it would be a good idea to find out if the particular company you picked is in good standing. A good way to do this would be to Google the company and make sure you don't find negative remarks about the way they do business.

VII. Pre-Installation

Permits

Before going forward with your solar panel installation, you will need to check with your local building or zoning department to find out the requirements to go forward with the installation. If you are having a solar panel installation company putting up the solar panels for you, then most likely they will be taking care of this for you. If you are doing them yourself, this step is especially important. While it is your right to install them, there are seperate requirements outlined in different areas. Mainly they want

to check things like making sure your roof will withstand the weight, the wiring is done properly, and other safety precautions.

If you lived in a planned development, you'll need to check with the Homeowners Association, because they may have additional requirements.

VIII. Installation

Ok, so now that you learned the basics about solar panels, figured out how many you need and found the place your going to purchase your solar panels system, it's time to get those sun soaking puppies up and running.

There are a few different options when it comes to installation and you can choose to do it yourself if you feel comfortable or pay someone to do it for you which costs usually \$1000+ depending on the size of the job. You can have the solar panels installed:

- With a ground mounted system if the area gets enough sunlight and clear from obstructions.
- Mounted on the roof, which requires holes through the roof and mounted into the rafters
- With thin film solar panels that are literally glued to the top of your roof

Ground Mounted System

With ground mounted solar panels, they are affixed on poles that are cemented into the ground. There are a couple different options you can choose from if you decide to go with a ground mounted solar panel system.

Static Mounted System

The most cost efficient is just using a static setup that point the solar panels in the most efficient area for sunlight exposure. There are a few different variations of this type of system, for example your solar panels could sit on top of a single pole, on the side of a single pole, or panels on multiple adjustable, supporting legs. You would just choose whatever works best for your situation.

Active Solar Tracker

For a few thousand dollars you can purchase Active Solar Trackers which are ground mounted, however, they have a special optical sensor that follows the sun throughout the day and maximizes the energy absorbed. Keep in mind the more mechanically complicated the system is, the more that could go wrong with it. This type of ground mounted system is best for individuals who are handy or know of someone that could maintenance it.

Passive Solar Tracker

Another more costly option, but not as much as the Active Solar Trackers are Passive Solar Trackers. This type of system uses the sun's heat to move liquid from side to side inside the tracker, allowing

gravity to turn it and follow the sun, using no motors, no gears and no controls to fail. By using either type of solar tracker you'll help your solar panel get the most sun possible throughout the day as it automatically points your solar array to a perpendicular line with the sun.

Mounted on Roof

Solar panels can be mounted on many different types of roofs. Shingle roofs are the easiest to work with and tile roofs can be a bit more challenging. Ideally it would be best to have the solar panels installed while your in the process of having your roof built, but the majority of us aren't sitting at our computer desk looking up at the stars, so let's move on.

The mounts will go through the roof with stainless steel bolts that are secured into the rafters. It can be a tricky process locating the rafters on your roof so if your not experienced or know a little about carpentry, you could Google different ways to find the rafters and do whatever you feel the most comfortable with or try to find a friend or relative to give you a hand. Another option is finding the closest solar panel installation company and pay them to do it.

Thin Film Panels Glued on Roof

Although thin film solar panels don't absorb the sunlight with as much efficiency as others, there are a lot of benefits to installing these types of solar panels. Unlike monocrystalline panels, you don't have to mount the thin film solar panels on your roof. The thin film panels are literally glued onto the roof which means no holes. Putting holes in your roof can void your warranty and even damage it if it's not done correctly. Also, thin film solar panels don't weigh as much as other panels that contain large amounts of silicon with structural support. Thin-film panels work better than conventional panels in very hot climates, such as Southern Nevada and Arizona. Thin film solar panels also do a better job of producing energy at the beginning and end of the day during times of non-direct sunlight.

A good idea for anyone buying solar panels is getting a friend or better yet a neighbor to go in on buying the solar panels with you. The more quantity you buy the less expensive they will be. If your neighbor purchases solar panels with you, you could even save on installation by working out a deal with the company you are using since you are side by side.

How to Face Solar Panels

You will get the maximum output of your solar panels if they are pointing to a "true south," perpendicular to the sun during midday. There are a couple different methods you can use to go about doing this.

First of all, magnetic south (that you find on a compass) is different from true south. True south is where the sun is. The most accurate way to go about doing this is finding your magnetic declination where you are installing the solar panels. Grab a compass and find out your magnetic declination by visiting the following website: <http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp>. This is a

calculator where you simply type in your zip code and it calculate the magnetic declination for you.

For example you may see something like 14° 33' E. So if your compass is pointing to south at 180 degrees, you simply add 14 degrees to 180. That means your true south is at 194 degrees. If your location is West instead of East like my example, you would subtract the numbers. So if it showed 10° 20' W, and your compass pointed south at 180, you would subtract 10 from 180, leaving your true south at 170. Now find your true south on the compass and thats where you will want to point your solar panels. If your solar panels are going on your roof and not facing your true south, it is usually more effective to install the solar panels in the same plane as the roof direction, instead of having an awkward mount to position them to true south. If the solar panels aren't facing your true south, that is fine, but they just won't produce the maximum amount of energy they are capable of. Having them ground mounted is usually the easiest method to assuring they are facing exactly where you want them to be.

Another way of finding your true south would be to look at a shadow cast by a perfectly vertical object (a telephone pole for example) at noon. The shadow will run perfect with true south.

IX. Rebates

To check federal rebates and rebates that your state gives out visit:

<http://www.solarpanelsbook.com/solar-panel-rebates.htm>

X. Maintenance

One of the great advantages of solar panels is they require very little maintenance. It's a good idea to spray them down once every couple of months. Most of the time the rain will be enough to do the work for you. If you live in a desert region that gets really dusty or have new construction around your house you may have to rinse them off a little more. Don't spray them with water when the panels are very hot and do not walk on them when cleaning them. You can use soap if you want to, but just don't use anything hard or abrasive methods of cleaning. Solar panels are tested for high winds and hail so you don't need to worry about that, plus they have warranties for 20+ years.

Testing Solar Panels Output

If you are wanting to test your solar panels and make sure they are working properly, you can do the following:

First, you'll need to pick up a multimeter. You can pick them up for around \$20. Keep in mind you'll want to test your panels on a nice sunny day.

Take your solar panel out into the sunlight. At this point it will not be connected to anything. Point the panel directly towards the sun.

Measure the voltage, and make sure it is around the amount of voltage that it says on the back of the solar panel or the manual. Keep in mind it's not always completely accurate and having the numbers a little below what it's suppose to be is ok. Now switch your voltmeter to current and measure the current.

Multiply the voltage times the current to calculate the power. The number you come up with should be close to what the wattage of what your solar panel is. So for example if you are testing a 200W panel, you'll have a voltage of approx 56 and your amps let say are 3.5. You will multiple 56×3.5 which equals 196. Like I said it's normal to be a little bit under the wattage, so this solar panel would test out ok.

XI. Feedback

If you have any questions about solar panels or have suggestions/ideas that need to be added to the book, please visit www.solarpaneltalk.com and make a post.

Also, if you are in the process of setting up your solar panels and need help, visit the “Do it Yourself” forum on www.solarpaneltalk.com and ask away. There are experienced people who will answer your question(s) promptly.

Thanks for reading! Make sure to bookmark Solar Panels Book and share the link with friends and family.

XII. Vocabulary

Altitude- the elevation of ground level

Alternating Current (AC)- used to indicate an alternating potential rather than a current. The electricity used in your home.

Amorphous Solar Panels- solar panels made from molten silicon that is spread directly across large plates of stainless steel or similar material.

Azimuth- an arc of the horizon measured between a fixed point (as true north) and the vertical circle passing through the center of an object usually in astronomy and navigation clockwise from the north point through 360 degrees

Current- a flow of electricity through a conductor.

Deflection- a term that is used to describe the degree to which a structural element is displaced under a load

Direct Current (DC)- power derived from a battery or rectified source where electrons flow only in one direction. This is the type of electricity generated by common batteries such as flashlight batteries

Grid Tie Inverter- an electrical device that allows solar power users to complement their grid power with solar power.

Insolation- solar radiation received at the earth's surface.

Irradiance- the density of radiation incident on a given surface usually expressed in watts per square centimeter or square meter

Monocrystalline Solar Panels- solar panels made from single crystals of silicon

Net Metering- where a utility company buys back any excess electricity that your alternative energy system produces at the same retail rate that you buy electricity from them at.

Off the Grid- refers to living in a self-sufficient manner without reliance on one or more public utilities.

Photovoltaics- the field of technology and research related to the application of solar cells for energy by converting sunlight directly into electricity.

Polycrystalline Solar Panels- solar panels from multiple amounts of silicon crystal

Solar Noon- the moment when the sun appears the highest in the sky

Solar Thermal- using solar energy to convert into heat energy.

Voltage- Voltage is a representation of the electric potential energy per unit charge. If a unit of

electrical charge were placed in a location, the voltage indicates the potential energy of it at that point. In other words, it is a measurement of the energy contained within an electric field, or an electric circuit, at a given point.

Watt- a unit of power that measures a rate of energy conversion.