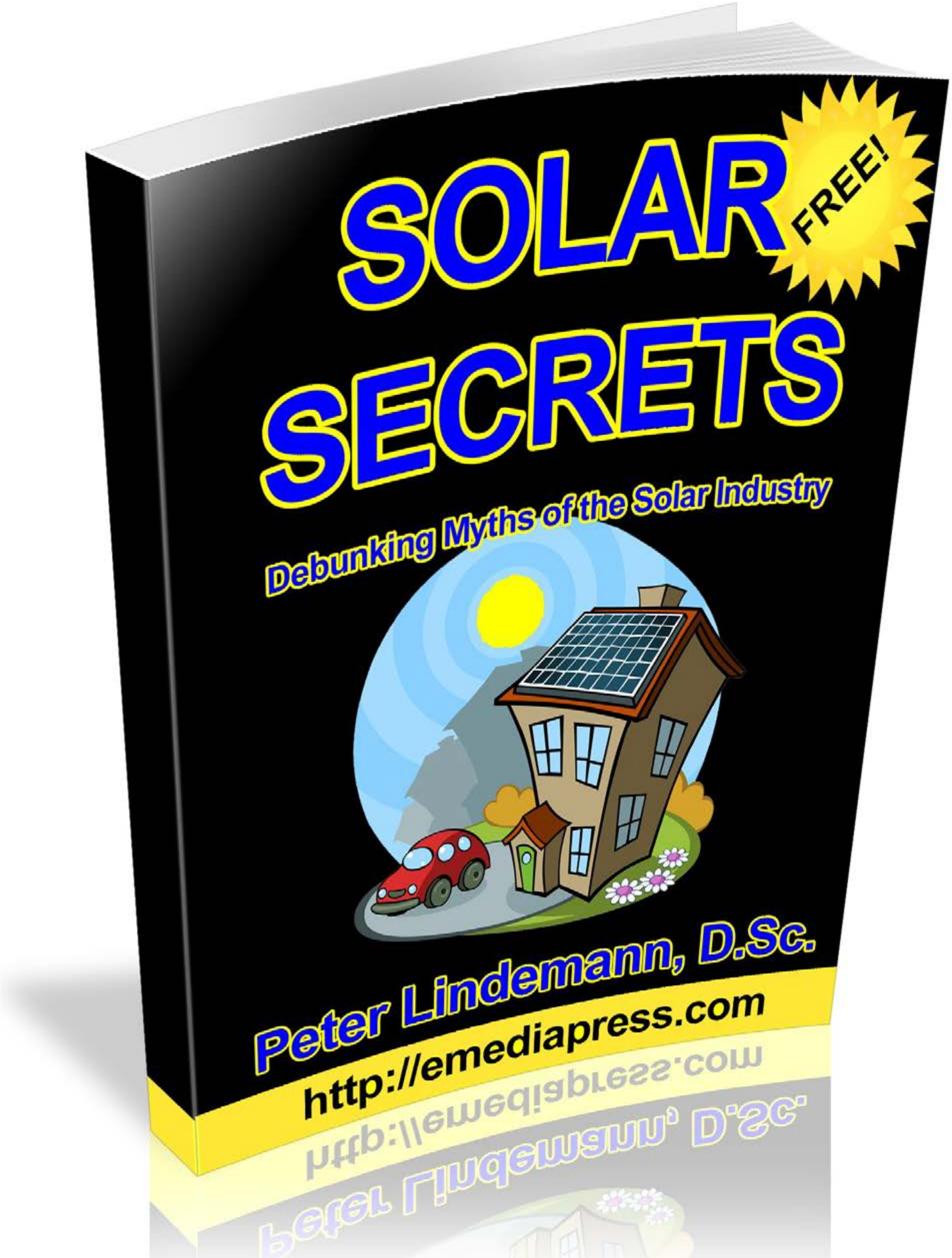
SOLAR
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Debunking Myths of the Solar Industry
Peter Lindemann, D.Sc.
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Solar Secrets

Debunking Myths of the Solar Industry

by

Peter Lindemann, D.Sc.

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The author would like to acknowledge his Mentor and close friend, John C. Bedini, whose relentless experimentation has brought this information to light.

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Foreword

For the last fifteen years, it has been my honor and privilege to know and work with both John Bedini and Peter Lindemann. During that time, they have both shared with me publicly disclosed and proprietary technologies that have been nothing short of life-changing. As usual, the discoveries are completely out-of-the-box and work in ways that conventionally trained scientists and engineers are not able to easily understand.

In particular significance to this ***Solar Secrets*** eBook, it has been my pleasure to have personally watched the evolution of various battery charging technologies and methods that only became possible through millions of dollars in funding. Much of the core understanding behind the art and science of battery charging surfaced about ten years ago when Peter Lindemann was working at John Bedini's company and when the first computer monitored battery cycling tests were being run around the clock, on a daily basis, for months at a time. This research and development actually continues to this day.

Oftentimes, I would visit the company, which wasn't too far from my home, and I would look at the battery charging graphs to see the progress from one experiment to the next. It was extremely exciting to see ten year old golf cart batteries that were doomed for the dump come back to like new condition in a relatively short period of time using John's methods. This was revolutionary and completely blew away everything else in the battery charging market.

These developments involved thousands of hours of experiments with countless prototypes and much of it was simply to learn the real way that batteries like to be charged. After all, if a battery can be brought back to its like new condition after every charge, its physic age ceases to be relevant!

One of the most important points that John Bedini and Peter Lindemann uncovered after millions of dollars in research and development is that understanding what the battery actually is and how it likes to be charged is the very key that unlocks the possibility to have a real sustainable solar power system!

Only when the battery is understood can a solar charge controller be made that doesn't slowly kill the batteries over time. In other words, you must understand the battery FIRST before you can design a solar system or it will be an expensive effort in futility and there is no one that is more qualified to translate the science behind these most important discoveries to the layman than Peter Lindemann.

You are about to learn, probably for the first time, the real ***Solar Secrets*** that let you have a truly sustainable solar power system with a battery bank that will last for many, many years and outperform everything else the conventional solar industry is currently promoting.

Sincerely,

Aaron Murakami
A & P Electronic Media

PS…Since this ***Solar Secrets*** eBook is FREE, please help it go viral by sending this to everyone you know so they will be fully informed about how to make Solar Energy a viable electricity source. Better yet, send them to http://freesolarsecrets.com/ so they can get on the mailing list and stay in the loop for future information releases and ***other free giveaways***!

PPS...Make sure to sign up for the FREE Energy Times newsletter - you'll be let in on a lot of hard to find and revolutionary energy technology information - http://www.emediapress.com/energytimes.php

Introduction

We have all been told that Solar Energy is the Future and that Solar Energy will one day power our entire civilization with clean, renewable, low cost energy from the Sun. We all know that most of the Satellites in orbit around our planet are solar powered and that at least some of them have been operating perfectly for *decades* generating all of the electricity the Satellite needs for FREE, without any maintenance or other costs.

So it seems completely reasonable that we should believe that Solar Energy should work just as well here on the surface of the planet as it does in orbit. Right? Isn't that the Promise of Solar Energy - to be an endless, reliable supply of electricity once the equipment is purchased and installed?

Haven't we all been encouraged to believe this?

Sure, we all know that Solar Energy is still expensive to install because very few people are installing it. But that isn't the real reason people don't use it. The main reason more people don't install and switch over to Solar Energy is the extremely high *ongoing cos*t of using Solar Energy.

So, what's up with that? Why is a technology that works perfectly for free in outer space so expensive to use down here? What aren't we being told?

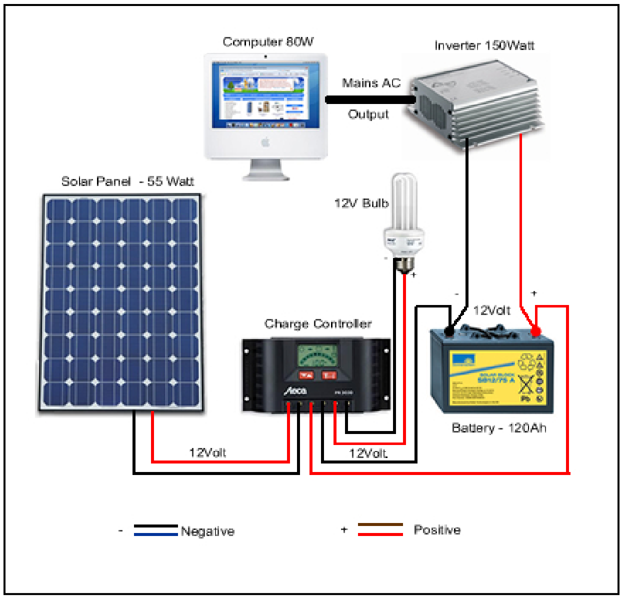
That is what this eBook, ***Solar Secrets***, is all about. You are about to see a complete breakdown of the technology and a dismantling of the industry supported lies that have kept you from understanding what this technology can do and how you can afford to start using it right now.

So, let's get started because actually, bringing you up to speed won't take that long.

Chapter One

Components of a Solar Power System

If you are reading this, you probably know the basics of putting a solar power system together. Pictured here is a diagram of a simple, stand-alone solar energy system.



It starts with the **Solar Panel** on the left, which produces 12 volts of Direct Current electricity (DC).

The panel is connected to the next component, which is the **Charge Controller**. This device regulates how the electricity from the solar panel is applied to the battery, so that the battery charges while the sun is out, but does not over-charge.

The next component is, of course, the **Battery**. It stores the electricity, so you can use the electricity produced by the solar panel, even after the sun goes down.

Next is the **Inverter**. This component converts the 12 volts DC in the battery up to the standard form of electricity we normally use, which is 120 volts of Alternating Current electricity (AC). The electricity coming out of the Inverter can be used by most all of our standard electrical devices, like a computer, as shown.

So, this shows the basic components of a Solar Energy System. Again, these components are 1) the solar panel, 2) the charge controller, 3) the battery, and 4) the inverter.

The diagram above also shows that with a system like this, it is possible to use 12 volts DC directly to power some things, like the light bulb connected to the charge controller.

The industry involved with producing these various components is growing rapidly and there are hundreds of companies building and selling solar panels, charge controllers and inverters. The batteries used in these systems are produced by a smaller number of established manufacturers, but there is growing innovation in battery technology, as well.

So, with all of these choices to pick from, it can be a daunting task to design your own solar energy power supply for a camp site, boat, mobile home or off-the-grid cabin or house.

We at **A & P Electronic Media** are constantly being asked for our recommendations in this situation and this Free **Solar Secrets** eBook is our answer to this growing need. But instead of just telling you what we recommend, like go out and buy parts A, B, and C, we'd like to share with you the result of our years of research into this industry, so you can really understand the recommendations and act accordingly.

Chapter Two

The Standard Industry Recommendations

The Solar Energy Industry is a multi-billion dollar industry, but it is really just a small sub-set of the entire global Energy Industry, the global Battery Industry, and the global industry that supplies emergency back-up power using portable generators. Until recently, the Solar Energy Industry has been nothing more than a "drop in the bucket" and a side-bar to these much larger market forces.

So, it is not too hard to believe that components to optimize a solar power system didn't exist for a long time. In fact, the industry has only recently attempted to address some of the main problems that routinely show up in "off-the-grid" solar powered homes.

Currently, most businesses selling Solar Power Systems to individual customers focus their marketing strategy on the idea of selling the components with the **highest efficiency**. From a pure science point of view, this seems like the obvious solution. After all, if you are going to spend all of that money for Solar Energy, you want to get the most out of it, right?

So, of the four basic components we discussed before, high efficiency solar panels and high efficiency inverters are always stressed. That's because the charge controller is a relatively simple device, and the batteries, like the standard lead-acid type, are the same as they have always been, so no improvement in performance is expected there.

Solar Panel Efficiency

Every type of standard solar photovoltaic panel is rated for efficiency and these numbers are plastered all over industry literature and the internet.

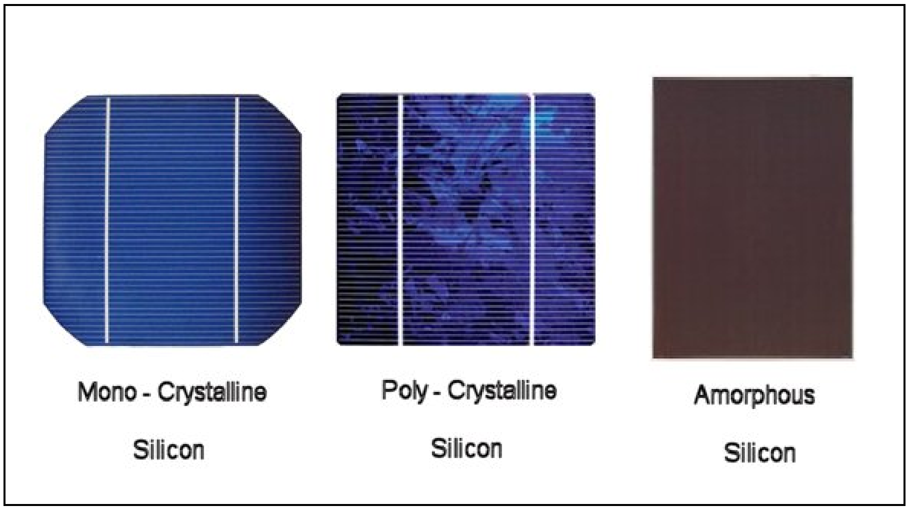
They are as follow:

- Mono-Crystalline Silicon Cells 25% Efficient
- Poly-Crystalline Silicon Cells 23% Efficient
- CIGS Thin Film Cells 18% Efficient
- CdTe Thin Film Cells 16% Efficient
- Amorphous Silicon Thin Film 15% Efficient

At best, these numbers are an approximation, since every manufacturer publishes different values and rates their own products the best. There are also dozens of new, experimental solar panels being tested which show even higher efficiency numbers. So, the future looks like the efficiency of panels is going to keep rising. Of the five listed above, the three types of panels that are readily available in the USA in 2014 are:

- Mono-Crystalline Silicon Cells 25% Efficient
- Poly-Crystalline Silicon Cells 23% Efficient
- Amorphous Silicon Thin Film 15% Efficient

Thin Film CIGS panels and Thin Film Cadmium Telluride panels are mostly manufactured overseas, which makes them less available in the USA.



So, of the panels shown here and listed above, you can see why the "Mono-Crystalline Silicon" panels are the most popular. They are clearly rated as the "most efficient" and since they sell the most, their cost per panel is quite often the lowest as well.

Inverter Efficiency

Solid-state DC-to-AC inverter technology is used wherever direct current electricity (DC) is converted to alternating current electricity (AC). They are obviously used in the solar industry, but also in the much larger markets including RVs, motor homes, and boats. Since the main electrical losses in an inverter are in the solid-state switches used, their overall efficiency can be raised by starting with the highest input voltage possible. In a solar power system, that means using a battery bank with either 24 or 48 volts.

With these two issues in mind, we can see why the Mono-Crystalline Silicon solar panels and the 48 volt battery systems and inverters are so often recommended by companies that sell and install solar power systems to individual customers. These recommendations are based on "sound science" and are the industry standards.

So, "High Efficiency" is the marketing angle and Mono-Crystalline Silicon solar panels and 48 volt battery systems and inverters are recommended for all systems above 2 kilo-watts.

The question we all should be asking is, "How is that working for everyone out in the real world?"

Chapter Three

Problems with the Standard Method

A good friend of mine summed it up simply in a phone conversation a few weeks ago. He said:

> "I have too much power in the summer and not enough in the winter. I run my propane generator most of the winter. It costs a lot for the propane and makes a lot of noise. My batteries need to be "equalized" about once a week, and I am looking at replacing my batteries again. This batch lasted about 4 years. When all of my real costs are factored in, I'm paying over $1 per kWh for electricity. This is not what I wanted or expected."

Mind you, this friend has 4,000 watts worth of Mono-Crystalline Silicon solar panels and a 48 volt battery bank and inverter. In the winter, he is lucky to get 500 watts from the panels in North Idaho. He followed all of the standard recommendations, yet he can't afford to run the system!

This is a specific case of course, but it illustrates the kinds of problems that show up in the real world when trying to "live the dream" of having an off-the-grid home powered by solar energy. The reality is that the average off-the-grid home ends up being partly powered by Solar Energy and partly powered by a back-up generator. The *ongoing fuel expense of running this generator* is only one of several very large ongoing costs mentioned in the Introduction. The other very large ongoing cost of a solar system configured this way is the *recurring cost of replacing the batteries*.

So we can see that the problems confronting a Solar Energy System aren't the efficiency of the panels or the efficiency of the inverter at all. They are the low electricity production during "off-peak" light conditions and the failure of the batteries to last as long as the manufacturer's say they should.

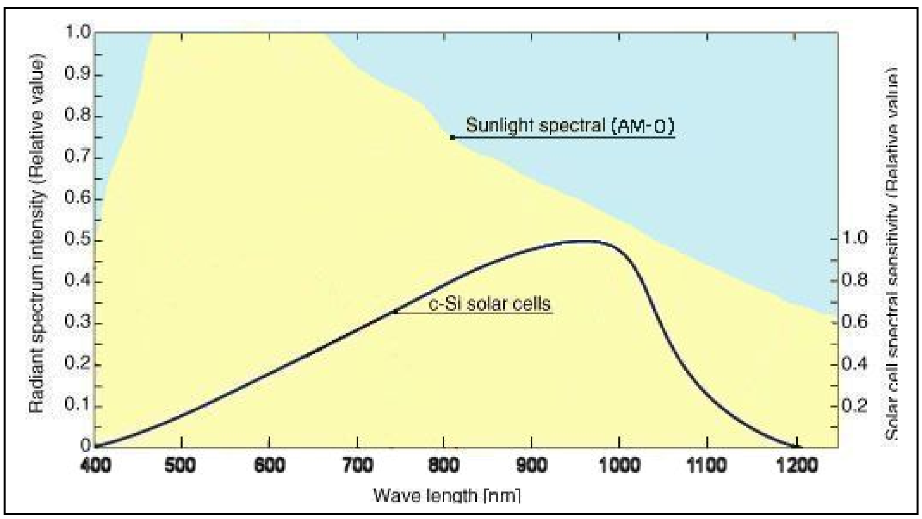
Chapter Four

Busting the Myths of "High Efficiency"

We know that solar energy works perfectly in space, and has powered hundreds if not thousands of satellites in orbit for decades without maintenance or back-up generators. We also know that the way the public is being told to set up their solar energy systems back on Earth does *not* work because it requires a lot of maintenance and back-up power. So, what's the difference? How can both of these things be true? Why can't Solar Energy live up to its promise of providing continuous power without maintenance or extra costs? We think it can, so let's find out how.

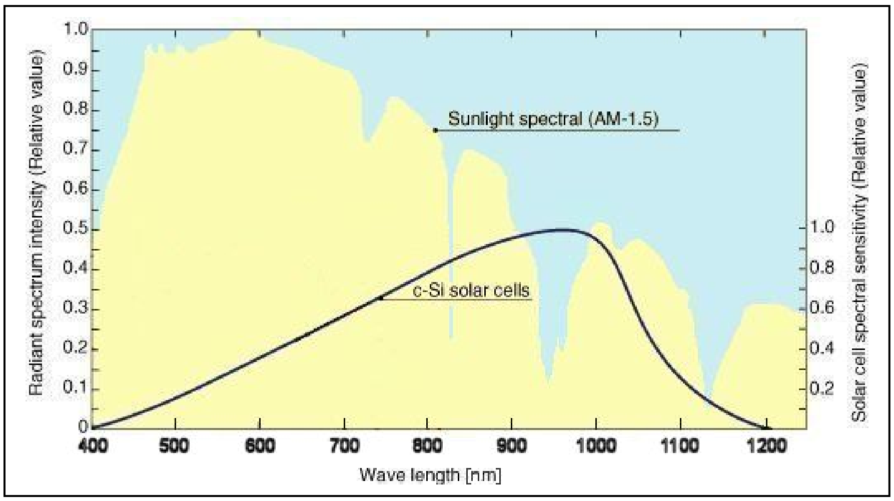
Solar Panel Myths

The Mono-Crystalline Silicon Solar Panels are recommended the most so let's see what they do. As stated before, this type of solar panel technology was developed by the US Space Agency NASA to power satellites in orbit.

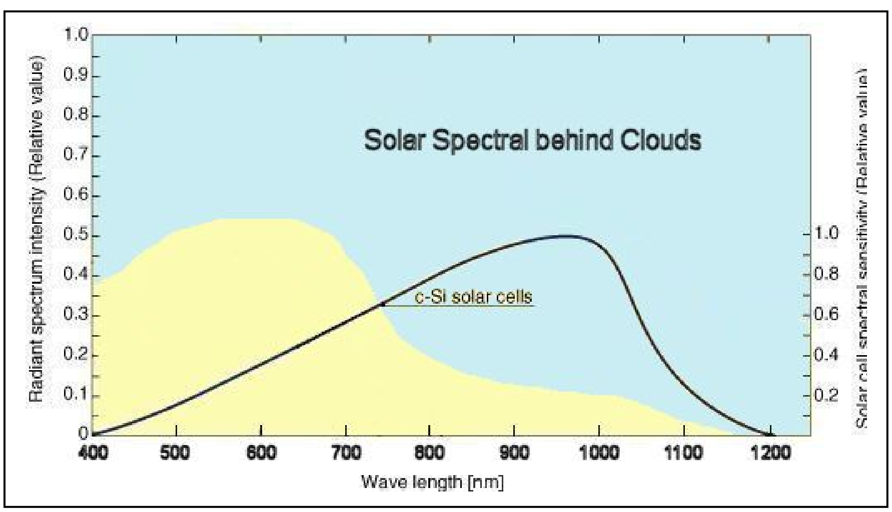


This graph shows the relationship between the light coming from the Sun and the sensitivity of the Crystalline Silicon panel to it. The wave length of the light is listed on the bottom of the graph in nanometers (nm). As a reference, visible light is between 400 and 700 nm. The yellow area represents the light spectrum in space and is listed as "Sunlight spectral (AM=0)." The AM=0 notation means "air mass = zero", which means the light outside the Earth's atmosphere. The graph shows that the spectral sensitivity of the Crystalline Silicon panel peaks between 900 and 1000 nm, and by the area under the curve, we can see that less than 20% of its electricity producing capability is in the visible spectrum of light between 400 and 700 nm.

The simple truth is, this kind of solar panel is not even designed to operate on visible light! They really convert Infrared Radiation into electricity, since 80% of its sensitivity is between 700 and 1100 nm. Outside the atmosphere, this works great to power satellites. But what happens when we try to use it at ground level?

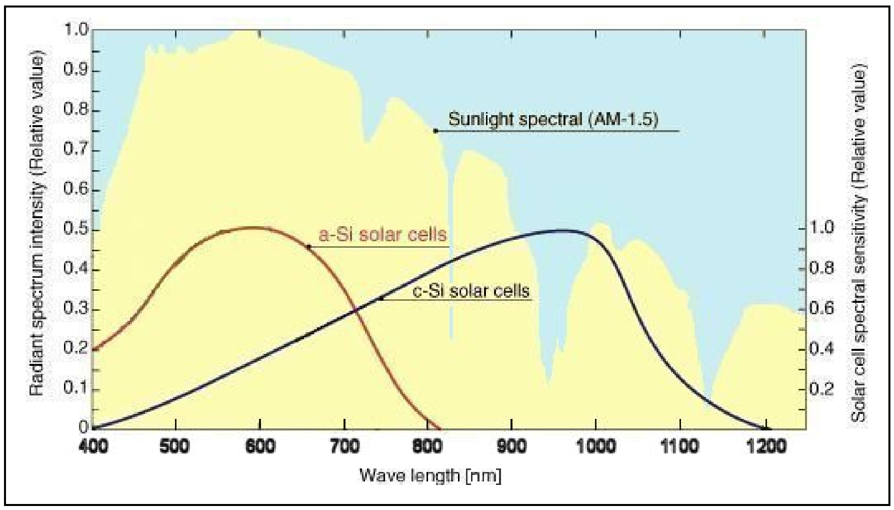


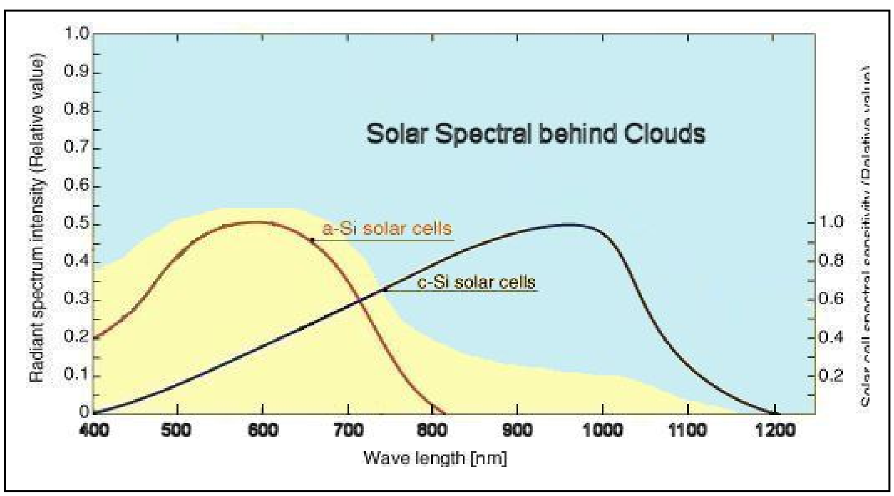
Here is the graph of the Sunlight that gets through the atmosphere and the spectral sensitivity of the Crystalline Silicon panel. You can see that there are several areas of the spectrum that are not making it through to the Earth's surface and the largest obvious range is between 900 and 1000 nm, which is exactly what the Crystalline Silicon panels are designed to use! These "notches" represent the frequencies of Solar Radiation that are either reflected or absorbed by the atmosphere. And finally, here is the graph of how much of the Sunlight is available from



behind a cloud. This is why the power drops off rapidly for this type of Solar Panel when the sun is blocked by clouds. Crystalline Silicon Solar Panels operate mostly on INFRARED RADIATION, which is represented as the wave lengths between 700 and 1100 nm. Only about 20% of their power comes from light in the visible spectrum. So, when a cloud goes by and blocks the heat from the Sun, these panels practically TURN OFF.

That is why they work great outside the atmosphere to power satellites and not so great down here on Earth. We can see now that the "25% efficiency" rating of this type of panel is really only in full sunlight conditions and they actually drop to about 5% efficiency or less in off-peak conditions.





Now let's look at the Spectral Sensitivity of the Amorphous Silicon Panel, shown as the RED LINE on this graph. As you can see, this type of panel is sensitive to frequencies all the way through the visible spectrum, which peaks between 550 (green) and 660 nm (red). This technology was developed for producing high output under low light conditions for pocket calculators and other portable electronic devices. They also have their highest sensitivity range right where the Sunlight is the brightest. That means even if the Sun is partially blocked by overcast conditions or a passing cloud, the

Amorphous Silicon panel can still produce between 50% and 80% of its peak output! It is in these off-peak conditions where the Amorphous Silicon panels completely outperform the Crystalline Silicon panels. But if the Amorphous Silicon panels work better in real world conditions, why are they rated as having lower efficiency?

Here's why... The efficiency ratings of the panels are all based on the idea that the TOTAL ENERGY coming from the Sun hits the Earth at a rate of 1000 watts per square meter. That is a measurement of energy density in relationship to the area illuminated. If we make a Crystalline Silicon Solar Panel that is exactly one square meter in size, it produces approximately 250 watts in full Sunlight, which is 25% of the 1000 watts of energy that is theoretically available. An Amorphous Silicon panel that is one square meter in size will produce about 150 watts in full Sunlight, which is about 15% of the 1000 watts available. So, that is where the efficiency numbers come from. They are a ratio between the area taken up by the panel and the electric power output during peak conditions.

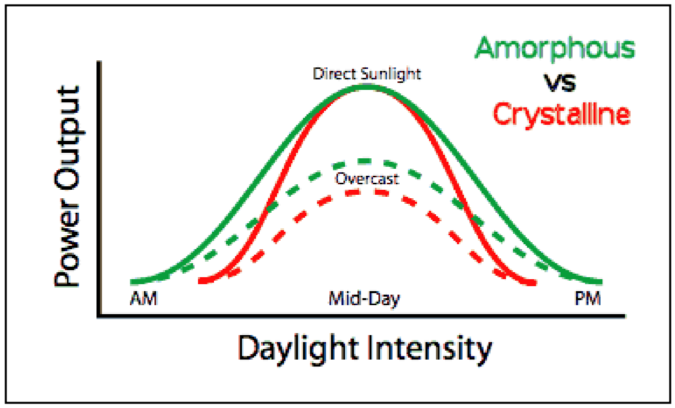
So, a 1000 watt solar panel using the Crystalline Silicon technology will take up about 4 square meters of your roof and a 1000 watt solar panel using the Amorphous Silicon technology will take up about 6.6 square meters of your roof. The Crystalline Silicon panel is physically smaller, but only works well in direct Sunlight. The Amorphous Silicon panel is 60% larger, but works well in direct Sunlight AND in a wide variety of indirect lighting conditions, as well.

So that's it! The Amorphous Silicon panel has to be physically larger than the Crystalline Silicon panel to produce the same number of watts under full sun. However, the Amorphous Silicon panels are way more efficient than the Crystalline Silicon panels during all other light conditions other than full sun.

So the way the current method of rating solar panels is being used only applies under perfect laboratory conditions where the sun is always shining, but this has nothing to do with the real world. It's like rating the efficiency of your car by how small it is rather than by its fuel economy. It's ridiculous!

Year-on-year, in real world conditions, the Amorphous Silicon panels will provide 30% to 60% *more* electricity than a similarly rated Crystalline Silicon panel will. If they rated the panels based on how many kilo-watt-hours they produce in a year, the Amorphous Silicon panel would be rated #1!

This graph illustrates the point fairly well. It shows that the Amorphous Silicon panel produces power longer when the sun is shining and produces more power all day when there are clouds.



Since it produces more power every day, no matter what the weather, that is just **better performance**!

So, here is a situation where the criteria for rating efficiency is so screwy that the panels rated for "low efficiency" are obviously superior. They cost a little more, but they provide the best solar energy production your money can buy right now.

Charge Controller Myths

Evidence that the Amorphous Silicon panels perform better is all over the internet, but very few people have put all of the pieces together and cut through the "efficiency" smokescreen. The solar industry has been aware of the off-peak power issues with Crystalline Silicon panels for some time, and remedies have been attempted.

The most popular remedy is the emerging market dominance of the new MPPT Charge Controllers. MPPT stands for Maximum Power Point

Tracking. The units are used with solar panels wired in series to raise the input voltage to 100 volts or higher. The strategy here is to make sure that the Crystalline Silicon panels can produce enough voltage, even under clouds, to pass some power to the batteries. The MPPT Charge Controllers are essentially a regulated DC-to-DC down converter which take whatever the input voltage is and produce a regulated output to charge the batteries.

The MPPT controllers work fairly well for what they do, but since their main purpose is to try to make up for the fundamental drawbacks of the Crystalline Silicon panels, their use doesn't increase the off-peak power production as much as simply using Amorphous Silicon panels.

In the end, the MPPT controllers are a band aid on a problem that is too big to fix that way. What is really needed is better energy production during low light conditions and better management of the battery's charging process with the energy available. While most MPPT charge controllers have adjustable output settings, none of them use the settings needed to charge the batteries properly as the default setting. In the end, the MPPT charge controller appears to be nothing more than an unnecessary technology designed to fix the wrong problem.

48 Volt Inverter Myths

Solid-state DC-to-AC inverter technology is limited in efficiency by a number of very simple circuit constraints. The major energy losses in this type of circuit are the "voltage drops" across the electronic switching components and the output transformer (I^2R losses). These losses usually account for about a 1.2 volt drop from the input voltage. In a 12 volt system, that is a 10% loss right off the top. Whereas in a 48 volt system, that 1.2 volt loss is only 2.5%. So you can see that theoretically, a higher input voltage should lower the inherent loss of the circuit.

And up until recently, it was true. But in 2014, these arguments are no longer valid. Advances in electronics in the last 5 years have leveled the playing field completely. Pure sine wave inverters operating with input voltages of 12 volts are readily available with ratings of 90% to 95% efficiency these days. These ratings go straight up the scale to 24 and 48 volt systems as well. So, there is no longer any reason, based on efficiency, to choose a 48 volt system!

Battery Failure Myths

Batteries are like everything else; they just wear out at some point. We expect this, right? All we are trying to do is make them last as long as they can. From a purely scientific and chemical point of view, this is way less true than most people believe.

The fact is, most people who install a large solar power system in their home have no idea how to operate a large, battery based electricity storage system! What was common knowledge back in the 1920's and 30's has since faded from the public mind. The battery industry fully embraced "planned obsolescence" in the 1950's and ever since, has been happy to sell you a new battery whenever you needed one.

Regardless of what you have been led to believe, the Lead-Acid Battery is one of the most perfect and durable "chemical machines" ever devised. It is easily capable of being charged and discharged more than 5,000 cycles, which translates to being charged and discharged once a day for 15 years without special maintenance or replacement. And here is the punch line: **batteries do not fail all by themselves**. They are killed by the misuse and abuse of people who do not know how to use them properly!

Premature battery failure is completely preventable, which means that the cost of battery replacement can easily be reduced to ZERO.

My analysis should be fairly plain by now. It looks like the solar industry is using the wrong solar panel technology, it is using the wrong charge controller technology, it is using the wrong inverter systems, and it is blaming all of the subsequent problems on the batteries. POPPYCOCK!

Chapter Five

The REAL Reasons Solar Power Systems Fail

OK, let's get to it! The real reason solar power systems fail is that they aren't getting enough electricity into the batteries during the charge cycle on a day-to-day basis. There are a number of overlapping reasons for this, which have to be looked at closely and understood individually so their combined effect can be fully appreciated.

Mind you, we're going to assume a few things. First, let's assume that the user of the solar power system knows that they cannot take more electricity out of the batteries than the solar panels put in on a daily basis. In other words, we're going to assume that the capacity of the solar panels is roughly equal to the electrical loads they are designed to power. This means that taking too much energy out of the system is not happening, therefore, it can't be the reason the system fails.

Let's also assume that all of the equipment is installed correctly. And finally, let's assume that the user of the solar power system DOES NOT KNOW how any of this equipment really works, which is why they don't know why it fails!

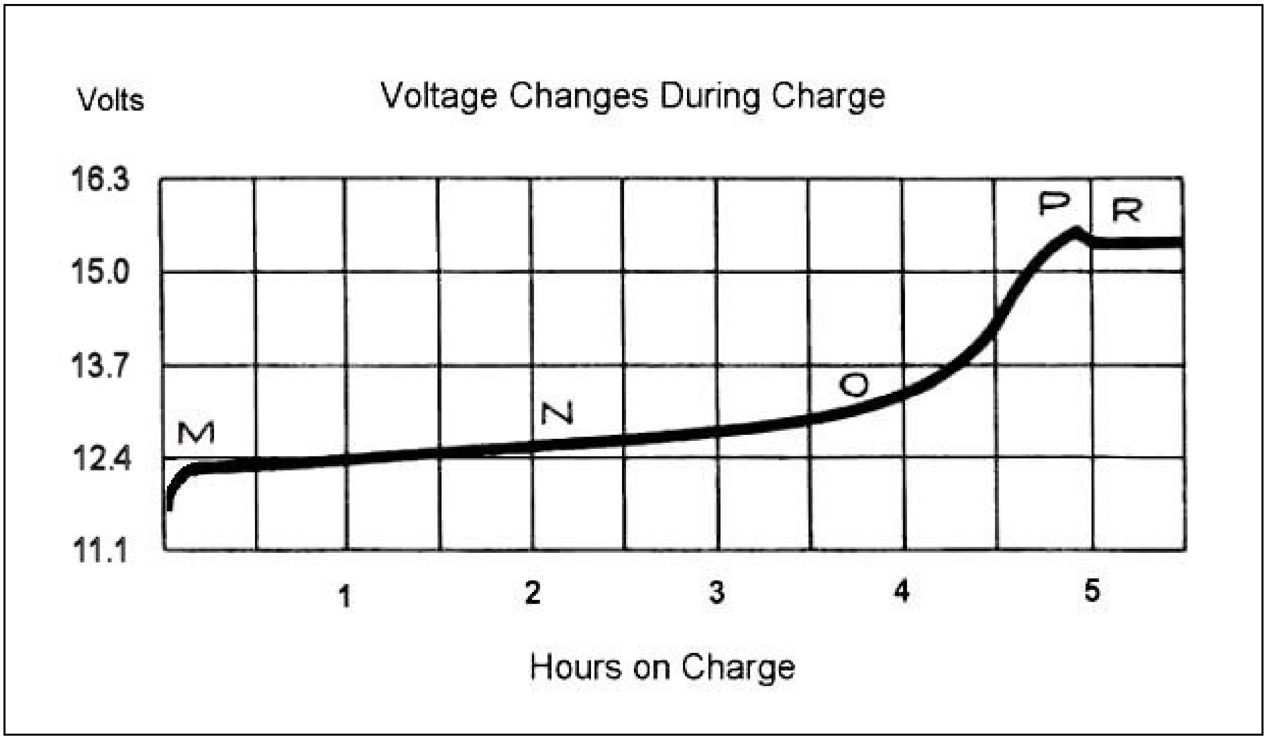
Re-cap of the Failure Scenario

- Insufficient power produced during off-peak solar conditions
- Batteries not fully charged at the end of the day
- Batteries need to be equalized on a regular basis
- Batteries eventually fail and need to be replaced

In spite of the fact that all of these problems are happening *to the batteries*, the batteries are *not the cause* of any of these problems.

The inability of the Crystalline Silicon solar panels to produce their rated power when there are clouds blocking the sun has already been discussed. So this is the beginning of the chain of events that leads to battery failure.

But lack of power coming from the panels is *not* the only reason the batteries are not fully charged at the end of the day! Technically, this is the job of the Charge Controller, as its name implies. A 12 volt Lead-Acid Battery charges according to a very specific set of specifications, the details of which are well known.



This graph illustrates this process. The complete explanation is in the appendix of this book (page 36), but the process can be summarized here. While most of the energy enters the battery along the slow ramp along line M – N – O, the charge process finishes when the voltage rises quickly to point P and then dips back slightly to point R. This is the electrical indicator that ALL of the chemical changes in the battery have finished and that the "charge process" is done. As the graph suggests, this voltage is a little above 15 volts! If the charge controller never lets the battery voltage rise to 15.2 volts, the charge process will <u>NEVER</u> finish.

Anytime a battery is charged without letting the voltage rise to point P and then settle back to point R, a small amount of sulfation is left in the plates and this represents an incomplete charge cycle. This is the fundamental event that, when repeated over and over, eventually kills the battery.

It is the Charge Controller's Fault!

So, a charge controller that does not bring the battery to its natural "topping voltage" at the end of each charge cycle is the first step toward battery failure.

The next step in the battery's failure comes from the fact that the battery is made up of individual electrical cells. Each of these cells produce about 2.1 volts when completely charged. A standard Lead-Acid battery has 6 of these electrical cells packaged together in one plastic case and these individual electrical cells are connected to each other so that their voltages add together. So, a standard Lead-Acid battery is called a "12 volt" battery, but actually has a standing voltage of 12.6 volts when fully charged.

When the group of individual battery cells is left slightly under-charged, that under-charged condition can be unevenly shared between the cells. Eventually, the voltages produced by each individual cell start to become "unequal." An example of this would be that instead of having 6 individual cells that each have a voltage of exactly 2.10 volts, one or more cells might have a voltage of 2.09 volts and others may have a voltage of 2.11 volts. This means that more of the unresolved sulfation is showing up in the cells with the lower voltages.

When this situation becomes severe enough, this "unequal" distribution of power in the series connected cells must be "equalized" again so that all of the cells in the battery work together more evenly. So, the battery needing to be "equalized" regularly is the second step of this downward spiral toward battery failure.

To summarize, the problem is chronic, incomplete charging of the battery. The result is that some sulfation is left unresolved on the plates at the end of each charge cycle. This unresolved sulfation distributes itself unevenly in the various series connected cells which make up the battery.

This uneven distribution of sulfation in the cells is accentuated by having more cells connected in longer series strings. What that means is that as you raise the voltage of the battery bank from 12 volts to 24 volts or to even 48 volts, the problem of uneven distribution of unresolved sulfation becomes more severe and harder to correct.

In spite of the fact that incomplete charging is the underlying problem, 48 volt battery systems fail more quickly than 24 or 12 volt systems. In fact, long series strings of cells, like 48 volt battery systems, are simply more difficult to maintain in "like new" condition for long periods of time.

The process of "equalization" is likewise, an incomplete solution. (The complete solution is what we call "Battery Rejuvenation" where all of the sulfation is electro-chemically resolved and the battery plates are returned to their original composition.) For more info, see: http://batterysecrets.com

Equalization is an attempt to do this, but without allowing the battery to rise to its natural topping voltage. Typically, an equalization process would bring a 12 volt battery system up to 14.8 volts and boil it there for an hour or two. This process uses a lot of electricity that can't be used to power other loads, but NEVER resolves all of the sulfation because the voltage is never allowed to rise high enough for that. So the benefits are temporary and the process needs to be repeated more and more often.

Batteries that are charged to their topping voltage at the end of each charge cycle never need to be equalized because the individual cells in the batteries are always chemically and electrically equal at the end of the charge. By simply topping the battery each time, a huge amount of solar generated electricity isn't wasted and becomes available to power loads.

Final Summary of the Failure Scenario

Solar power systems fail because the batteries are not charged to their "topping voltage" on a daily basis, or at least, as often as possible. The complex, contributing factors are:

1. Crystalline Silicon solar panels leaving the batteries grossly under-charged on cloudy and shorter winter days simply because they do not provide the power levels they were rated for under these operating conditions
2. The Charge Controllers not providing the proper "topping voltage" conditions to the battery, even when the power is available
3. The battery banks set-up in unnecessarily high voltage arrangements, like 48 volt systems, to cater to the myth about higher inverter efficiency that no longer exists with modern electronics

As stated at the end of the last section, the solar industry is using the wrong solar panel technology, it is using the wrong charge controller technology, it is using the wrong inverter systems, and it is blaming all of the subsequent problems on the batteries.

So, it should be fairly clear by now that the entire solar power system should be designed around providing the batteries what they need to last for their full, 5000 cycle lifetime. **THAT** is what makes a solar powered home operate most effectively, with extremely low maintenance and no extra costs!

That is how to bring reliable, independent Solar Energy out of orbit and down to Earth!

Chapter Six

The REAL Solar Energy Solution

It *is* possible to build and install a completely independent electricity supply for your off-the-grid home using solar energy without the need for a back-up generator. This system includes the following components:

Solar Panels that produce power under all of the possible conditions that your location normally experiences. For most of us, that includes sunny days, partly cloudy days, total overcast days, rainy days, and shorter days in the winter. The only solar panels that are readily available that can do this are the Amorphous Silicon thin film "low light" panels.

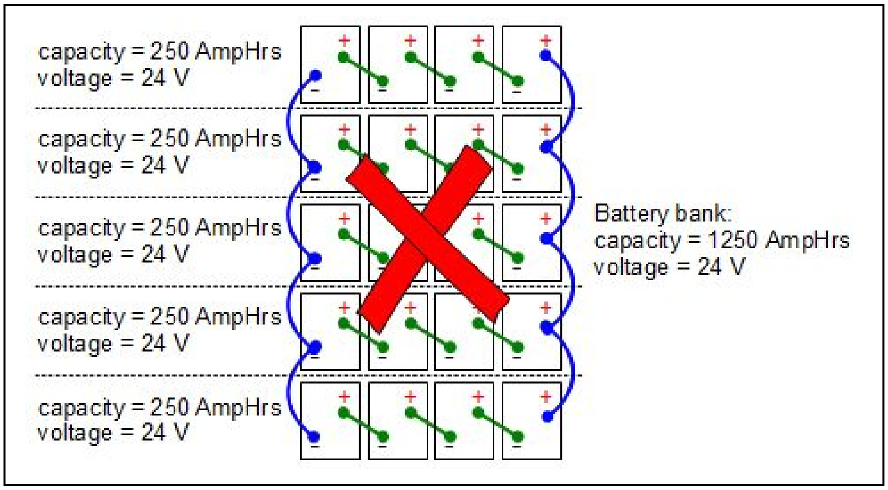
To be fair, the CIGS thin film panels can also do this, but they are more expensive and even more difficult to find than the Amorphous Silicon panels. So, my recommendation is the Amorphous Silicon panels.

A **Charge Controller** that carefully brings the battery up to the topping voltage *without* over-charging it or causing heat or excessive off-gassing. Ideally, it would also protect the battery from dropping out of the charging mode when the system needs to power loads during the day.

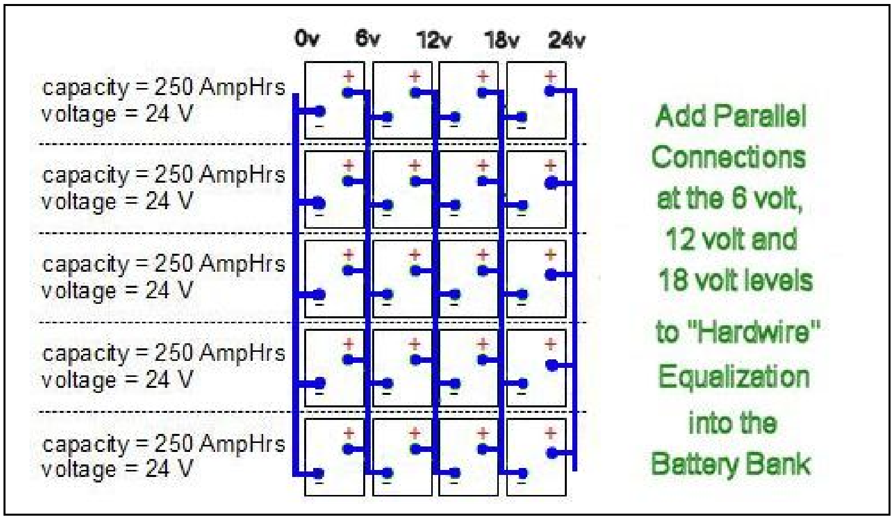
The charge controller has to be designed around two imperatives. The first is recovering the maximum electricity from the solar panels and the second is providing the batteries with their ideal environment to enhance and lengthen their life-span. My recommendation is the **Tesla Solar Tracker 5** line of solar charge controllers, designed by John Bedini.

The **Battery Bank** should be set up in a low voltage configuration in either 12 or 24 volt systems. Long series connected battery banks should be avoided because of the "equalization" problems discussed before.

Some commentators on the internet say that multiple parallel strings of batteries should be avoided as well. Here is a typical image depicting this idea. The big red **X** suggests there is a limit as to how many series strings of batteries can be paralleled before the currents aren't shared equally. The truth is, the currents always seek out the lowest resistance path, so the good batteries get most of the power and the weaker batteries get worse with every charge cycle. This way of wiring the battery bank promotes battery failure and the need for equalization, hence the big red **X**.



Luckily, there is a way to make the batteries share the currents. Depicted here is the method we call "hardwiring equalization into the battery bank."



By adding extra parallel connections at the 6 volt, 12 volt, and 18 volt levels to the parallel connections that already exist at the 0 volt and 24 volt levels, each battery is electrically forced to stay at the same voltage as all the other batteries. In other words, no battery can get ahead of or fall behind any other battery in the group.

Using large diameter wire, copper to copper connections, and spraying all connections and terminals with a sealant to prevent the formation of corrosion, produces a battery bank that stays equalized and needs almost no attention at all. Checking the batteries once in a while for water level may be all the maintenance that is necessary.

The **Inverter** is the last component in the system. Solar systems based on the industry standard model need some way to constantly monitor the batteries and automatically switch on a back-up generator. This produced the need for the so called "smart inverters" that are able to charge the batteries from the solar panels or the back-up generator and even equalize the batteries when needed. Since the average owner does not really understand these functions, the smart inverters were designed to do all of this automatically.

With a system that only has a solar panel input, a battery topping charge controller, and a battery bank that never needs equalizing, the "smart inverter" isn't necessary. The only thing the Inverter really needs to do is its original job, which is converting the DC electricity into AC to power the loads. As we said before, pure sine-wave inverters that operate in the 90% to 95% efficiency levels are readily available in 12 volt and 24 volt models and are less expensive now than at any time in the past.

Summary

So here are the components of a REAL, independent, solar power supply.

1. An Amorphous Silicon Solar Panel System
2. A battery topping Charge Controller
3. A low voltage battery bank with equalization hardwired into it
4. Use of large diameter wire and low resistance circuit protocols
5. An ordinary sine-wave Inverter

This grouping of equipment can provide electricity to an off-the-grid home 24 hours a day, 365 days a year with extremely low maintenance and no ongoing costs for 15 years or longer. That is real, low cost, independent POWER!

A Few More Considerations

To be fair, there are a few people out there who have figured out how to make their solar power systems work using Crystalline Silicon solar panels and MPPT charge controllers. But they usually have a back-up generator and they set their equalization voltage at about 15.4 volts. As long as they periodically top the battery bank (equalize at 15.4 volts), the remaining sulfation can be resolved in the batteries, and their useful life extended. Systems that equalize with a setting below 15 volts are slowly killing the batteries.

But this only proves my point. Resolving ALL of the sulfation in the battery plates on some sort of regular basis is the KEY to battery longevity. Not mentioned by anyone, however, is this. All of the electricity used for equalization has to come from somewhere, and is energy that cannot be used to power loads in the house. So, any system that needs to equalize the batteries is operating at a lower system efficiency than one that does not need to equalize.

Wiring the battery bank for equalization and gently bringing the voltage to the topping event on every day that sufficient solar energy is available IS the most efficient way to operate a solar power system in your home. There is no science based evidence that refutes this conclusion.

The only thing missing is the method to honestly assess how large an amorphous solar panel system really needs to be to provide back-up free power to the home. In order to provide sufficient power during off-peak conditions, a system should probably be scaled to top the batteries at about 2 PM on full sun days. Loads in the house can be designated as "essential" and "optional" and the latter only used when supplies are sufficient. Energy waste throughout the house must also be minimized.

It is possible to live in a Solar home in harmony with the Natural World that supplies its energy. The technology exists today.

Chapter Seven

Components for Independent Solar Power

In order to keep all of the information in this eBook current and up-to-date, a number of web pages have been created that list our recommendations in each of the categories below. That way, you will always have access to the best solutions our research has uncovered!

Solar Panels: http://teslachargers.com/solarpanels.html

Charge Controllers: http://teslachargers.com/teslasolartracker5.html

Batteries: https://www.google.com/search?q=12v+35ah+deep+cycle

Inverters: http://www.invertersrus.com/

Ongoing Educational Materials:

Learn everything you need to know to keep your batteries working perfectly, and even restore batteries for your friends, for fun and profit: Battery Secrets and Battery Rejuvenation

Learn how to cut energy waste in your home so your real energy use can drop by 50%, making your solar energy project cost way less than you ever dreamed! Save on Home Energy

Interested in cutting edge science? Look at the amazing catalog of one-of-a-kind products at: A&P Electronic Media

Chapter Eight

Final Thoughts

Where do I start?

If the information in this book has intrigued you and you are ready to find out if Solar Energy really can work as well as I say, the best place to start is small. Build a small system to test out all of the features of the method and prove to yourself how much free electricity can be available to you on a steady basis.

The simplest place to start is with a 50 watt system. Keep checking the Tesla Chargers Solar Panel page to see when the 52 Watt panels are available. In the meantime, Harbor Freight sells a small 45 watt system that has three 15 watt amorphous panels, a charge controller and a few CFL lights. You can periodically get these, with the right coupon, for as little as $189.00 or less. To round out the system, you need:

- an S3A12 Tesla Solar Tracker 5 charge controller ($125.00)
- a 35 AH lead-acid battery ($70.00)
- a 200 watt modified sine inverter ($29.00)

With shipping and a little luck, you can get all of this for about $450.00.

You can see a number of videos of a system exactly like this at this link:
http://www.teslachargers.com/teslasolartracker5.html#s3a12

This is a great "entry level" system that demonstrates all of the features discussed in this book. In an emergency, you could easily run some LED lights, charge your cell phones, and keep a well-insulated refrigerator going during a power outage.

100 Watt System

For just a little more, you can put together a portable system that produces about 100 watts. (http://teslachargers.com/solarpanels.html). A system like this consists of:

- a 100 watt amorphous panel (about $350.00)
- an S10A12 Tesla Solar Tracker 5 charge controller ($460.00)
- a 100 AH lead-acid battery ($189.00)
- a 400 watt true-sine inverter ($149.00)

So, for around $1,150.00, you could have a system that would run LED lights, charge your computers and phones, and keep a refrigerator cold. A system like this could help you and a neighbor get through an emergency, power a campsite, or even power a clinic in a remote village somewhere. The cost of a system like this has never been lower!

Beware of Rip-offs

As you start looking around the internet for systems like this, you are bound to run into some "Ready-made Solar Kits" on places like eBay. But watch out, some of these systems are grossly mislabeled. Some systems promoted as a "10,000 watt system" are nothing of the sort. They may have a 10,000 watt inverter, but the solar panel and battery that come with it may not be able to run it for more than 30 minutes a day!

When shopping for the various components of a solar power system, make sure the components are all "proportional" in size to each other. The battery should be able to be charged by the panels in one day, and the size of the inverter should not encourage use that drains the battery too quickly.

As shown above, good proportions include a 100 watt solar panel, a 100 AH battery, a 10 amp charge controller and a 400 watt inverter. Scaled up, a 1,000 watt solar panel could be mated with a 1,000 AH battery, a 100 amp charge controller and a 4,000 watt inverter.

Just don't fall for someone telling you a 10,000 watt inverter connected to a 600 watt solar panel and a 200 AH battery is a "10,000 watt solar power system!" It is not……. But it is a RIP-OFF, so be careful.

What is so special about the Tesla Solar Tracker 5?

As stated on page 27, the charge controller has to be designed around two imperatives. The first is recovering the maximum electricity from the solar panels and the second is providing the batteries with their ideal environment to enhance and lengthen their life-span.

The Tesla Solar Tracker 5 charge controllers accomplish both of these tasks. Here's how. The units use a proprietary technology John Bedini calls his DC Linear Amplifier circuitry. The circuit can literally be used as an amplifier for music, but in this case, he uses it to regulate the DC currents coming from the Solar Panels.

The circuitry creates a "voltage wall" at about 15.2 volts. Below this voltage, nothing will pass to the batteries. This may seem bad, but the solar panels see a "no load" condition until that voltage is reached, which means they can reach it easily. It also means that they deliver all of their current to the batteries at that voltage or above. Since they deliver their current to the battery at a higher voltage, they force the panel to produce more WATTS for the same current! So, this is how the Tesla Solar Tracker 5 gets the most out of the solar panels.

The second thing this "voltage wall" accomplishes is that it encourages the inverter to take power from the panels first when the sun is available, and this protects the battery from dropping out of the "charge mode" during day-time energy use. This means the battery stays charging all day.

The third thing this "voltage wall" accomplishes is that it acts as a natural current regulator, so as the battery voltage rises the current delivered to the battery naturally drops off until the battery is simply held at 15.2 volts, without over-charging! This "tops" the battery safely, every day, and establishes the conditions for the battery to last for 15 years or more.

There is simply no other Solar charge controller available in the market today that can do all of this.

The Tesla Solar Tracker 5 delivers pure DC current to the batteries, so there are never any pulses or spikes to glitch an attached inverter.

Tesla Solar Tracker 5 Specifications

If you are interested in learning more about the Tesla Solar Tracker 5 line of charge controllers, here is a quick synopsis.

The model names are an overview of their capacity. So, for instance, the model **S3A12** is a solar charge controller (S), the 3A means it is rated for 3 amps, and the 12 means it is for use with 12 volt systems. The **S80A24** is a solar charge controller rated for 80 amps to be used in a 24 volt system.

12 volt units are designed to be connected to solar panels that produce about 21 volts in full sun when there is no load. This is called the Open Circuit Voltage, or Voc. So, 12 volt Tesla Solar Trackers need a Voc = 21. The solar panels should be able to produce about 18.5 volts when delivering current.

24 volt units are designed to be connected to solar panels that produce about 42 volts in full sun when there is no load. So, 24 volt Tesla Solar Trackers need a Voc = 42. The solar panels should be able to produce about 37 volts when delivering current. In general, these specifications should not be exceeded.

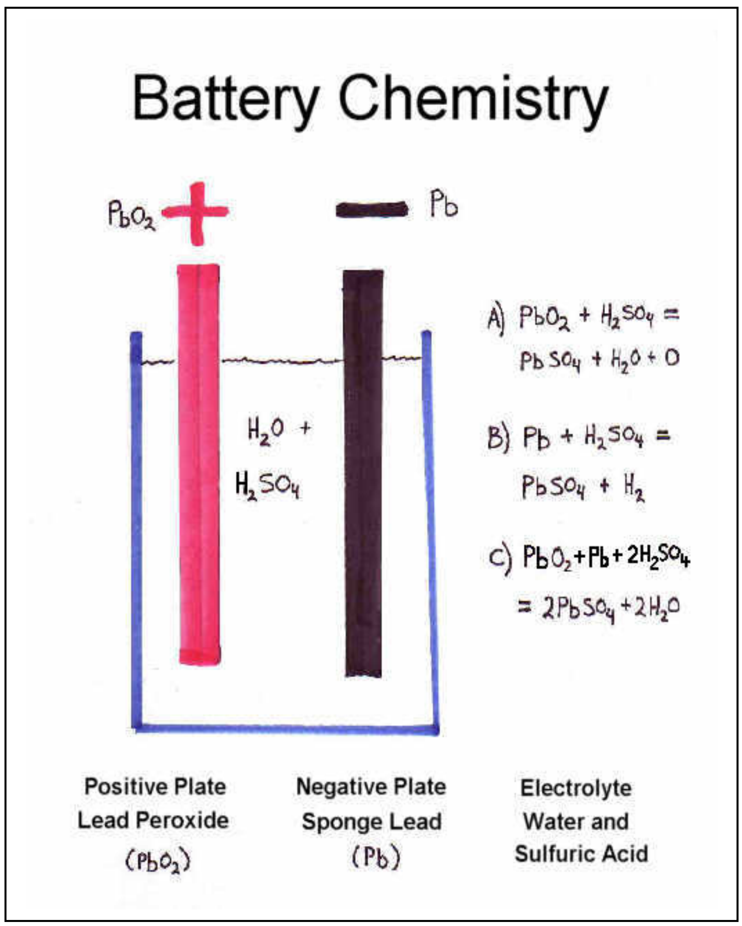
Total wattage ratings for the individual models are on the Specification Sheets which can be downloaded from the website:
http://teslachargers.com/teslasolartracker5.html

Appendix

Lead-Acid Battery Basics

Since making your solar power system work properly is 100% dependent on the battery bank operating in a fully charged, continually equalized condition, it is worth reviewing the simple chemistry of why this is true and what the system needs to do to maintain these conditions.

The physical construction of a battery is fairly simple. It consists of an outer, plastic case, a positive plate made of Lead Peroxide, a negative plate made of pure lead, and a liquid solution of water and acid called the electrolyte.



This diagram shows the construction of a single cell of a lead-acid battery. It produces about 2 volts. When 6 of these cells are connected together so that their voltages add up, it forms a 12 volt battery.

The term "battery" comes from the old military terminology where a group of large guns, like cannons or mortars, were arranged together to form a group. That group of guns was referred to as a "battery of guns" and its military effect was much larger than that of a single cannon or mortar. Modern electrical batteries are also more effective when multiple electro-chemical cells are used together.

The following image explains what happens when electricity is taken out of a battery. The formulas, a, b, and c, are a symbolic expression of the same information that the words are describing.

(a). At the Positive Plate: Lead peroxide and sulphuric acid produce lead sulphate, water, and oxygen, or:

$$(a).\quad PbO_2 + H_2SO_4 = PbSO_4 + H_2O + O$$

(b). At the Negative Plate: Lead and sulphuric acid produce lead sulphate and Hydrogen, or:

$$(b).\quad Pb + H_2SO_4 = PbSO_4 + H_2$$

The oxygen of equation **(a)** and the hydrogen of equation **(b)** combine to form water, as may be shown by adding these two equations, giving one equation for the entire discharge action:

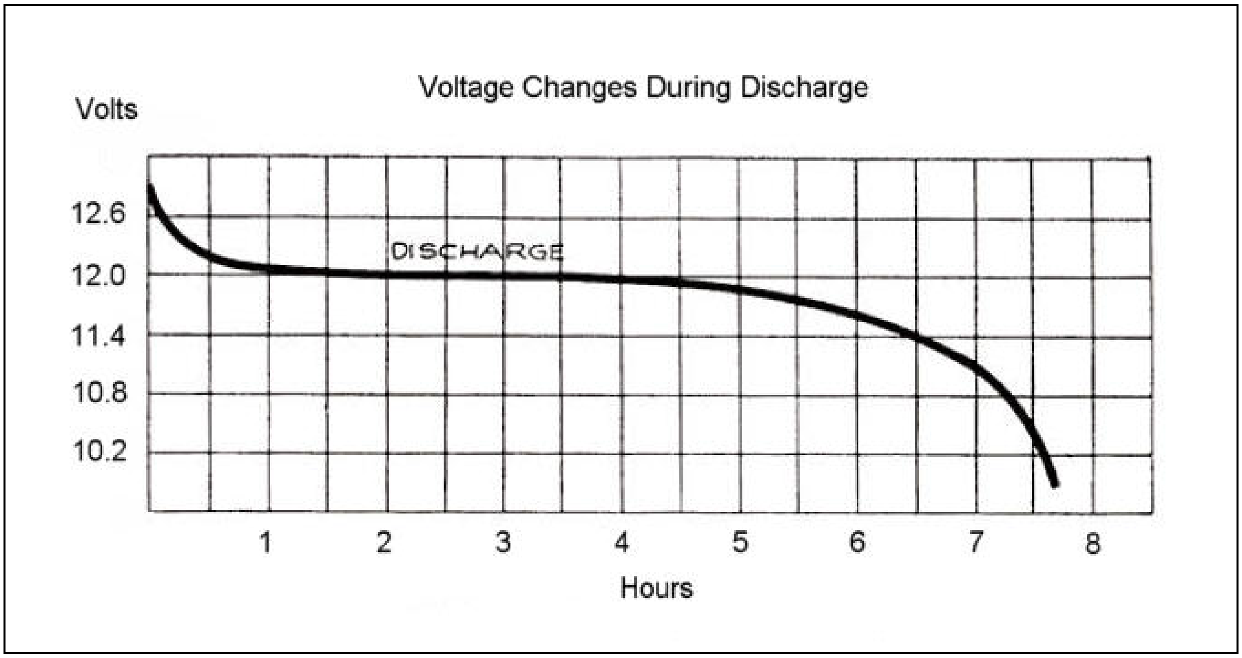
$$(c).\quad PbO_2 + Pb + 2H_2SO_4 = 2PbSO_4 + 2H_2O$$

So, what happens when electricity is taken out of a battery? The answer is expressed above in equation (c). Two molecules of the acid in the electrolyte combine with the lead materials of the positive and negative plates to form two molecules of water and two molecules of lead sulfate.

[Editors Note: The image above is taken from a book printed in 1922 where the older spelling form of the words "sulfate" and "sulfuric acid" are shown as "sulphate" and "sulphuric acid." Please don't let these spelling differences confuse you. We are talking about the same thing. Thanks.]

So, electricity becomes available to use outside of the battery when a water molecule is produced inside the battery. This is the "little secret" of the battery industry. Lead-acid batteries are essentially, a reversible "water fuel cell." The question is, how many times can this process be cycled? The answer will amaze you.

So, this is what happens to the voltage when the battery is discharged.



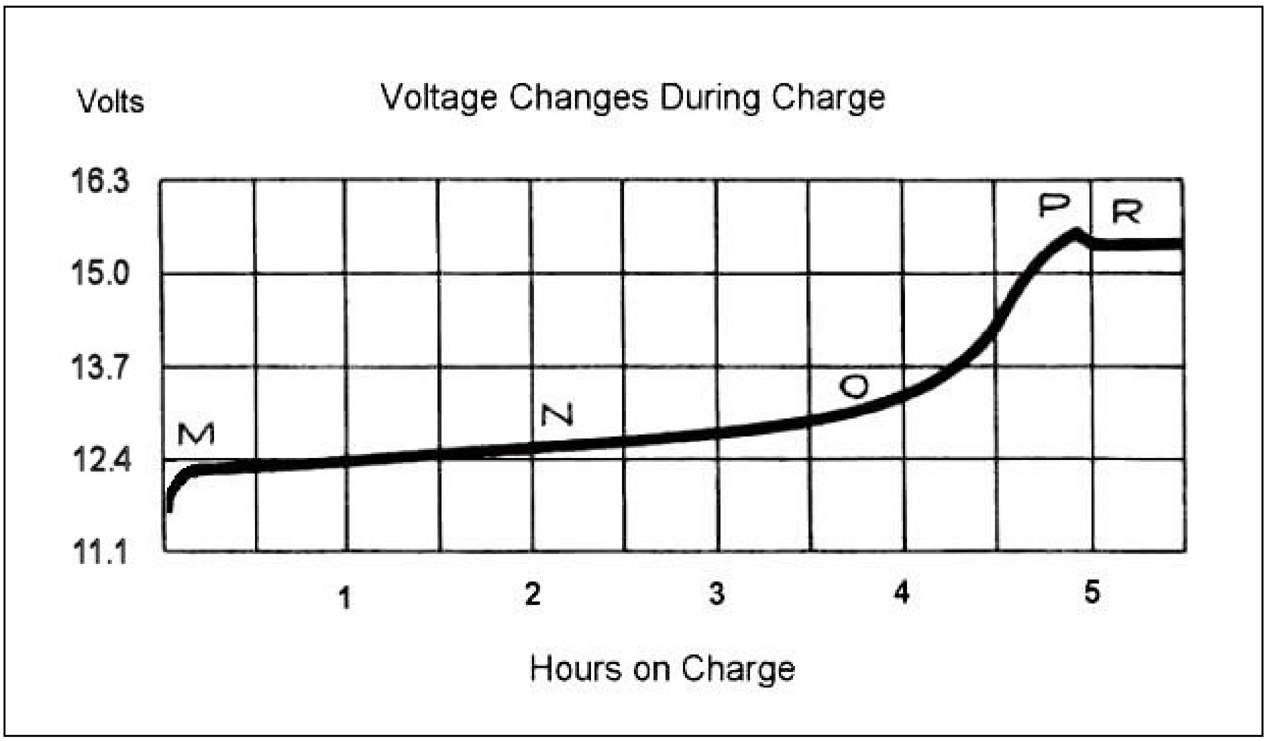
As you can see from the graph, as soon as a load is connected to the battery, its voltage drops a little. Then the voltage stabilizes and remains constant for a long time before dropping off more at the end.

The first voltage drop indicates that the chemical changes we discussed earlier have started to happen. The long, stable voltage period indicates that these chemical reactions are taking place fast enough to supply the necessary amounts of electricity to power the loads, and that there are plenty of materials available for the chemical processes to happen. When the voltage starts to drop near the end of the discharge time, this indicates that the battery is running out of acid in the electrolyte to react with the plates, and it is time to charge the battery.

Actually, there are two things happening in the battery that cause the voltage to drop. First, we have to remember what makes the voltage in the first place. The voltage is just the electrical "potential difference" that indicates the physical "chemical difference" between the positive and negative plates. When we started, the positive plate was 100% Lead

Peroxide and the negative plate was 100% pure Lead. As the electrical discharge proceeds, Lead Sulfate deposits on both plates as water molecules "water down" the electrolyte. So, the battery plates are losing their "chemical difference" because the same material, Lead Sulfate, is building up on both of them. As the "chemical difference" slowly disappears, so the "electrical difference" disappears as well. And that "electrical difference" disappearing IS the voltage drop.

That is what happens when the battery discharges. OK. So, what happens when the battery is charged up again? The following graph shows what happens to the voltage when the battery is charged.



So, the voltage starts at "M" and will rise a little bit as the charge starts. How much it rises depends on the battery's condition and the strength of the charge being applied. Then, it rises very slowly through "N" until it reaches "O." This is the primary charge plateau, and most of the time during the charge will be spent here. At "O" the voltage starts rising faster until it reaches "P", which is the highest value the voltage can reach. After "P" the voltage may drop slightly to "R", indicating the charge process has finished.

As the electricity is applied to the battery to initiate the charging process, the water molecules start being broken down to produce hydrogen and oxygen again. But this is only the first step. If these gasses simply bubble out, the battery is NOT being charged.

The Oxygen must recombine with the Lead at the positive plate to produce Lead Peroxide, and these newly re-formed Lead Peroxide molecules must mechanically connect to the other Lead Peroxide material that is there. The Hydrogen must stay in the electrolyte, as a charged ion, and strip the sulfate ions out of both plates to re-form the sulfuric acid. Only when these two processes happen after the water molecule is broken down is the battery really being "charged."

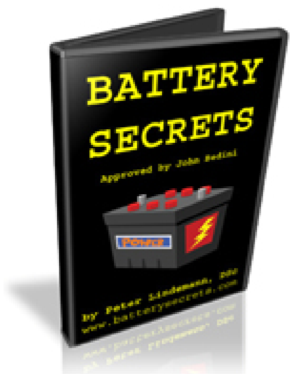
From the graph you can see that the voltage of a lead-acid battery will approach 15.2 volts as the charging process finishes. Point "P" on the graph is the indicator that there are NO MORE sulfate ions in the plates and that 100% of the chemistry has been reversed from the last discharge.

If the charge process is stopped before point "P" is reached, it means that some sulfate ions are still left in the plates. If, for any reason, the voltage is prevented from rising to the finishing level, the charge will NOT complete.

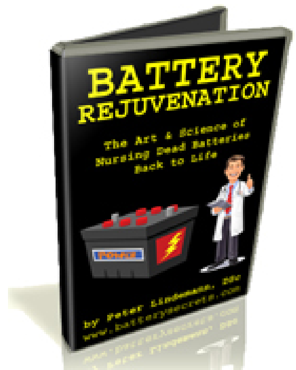
This is another "little secret" of the battery industry. By limiting the voltage that most battery chargers provide to 14.6 volts, they know that the batteries will only last for a certain number of cycles, because a small amount of the sulfate ions are (purposely) being left in the plates at the end of each charge.

So, repeated, incomplete charging is what causes most batteries to fail. A Lead-acid battery that is charged to a finishing voltage at the end of each charge cycle can easily operate for 5,000 charge and discharge cycles, which is over 15 years of service. This is how to make your batteries last a very long time.

Here are just a few of our book & video packages...



[BATTERY SECRETS]



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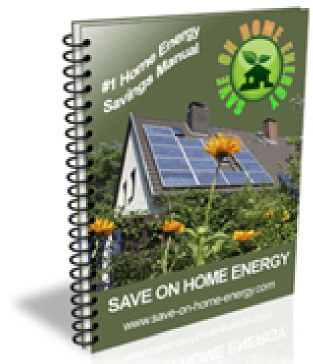

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