FREE SOLAR POWER

You can do it yourself. Get free power, be independent of electric company, free of being spied on

In above picture this house gets free electrical power, free hot water and free light.

And the electric company's spy meter (the radio meter) can't inform Big Brothers of when you are home and when you leave and what you are doing in your home. Privacy is Alive again!

What do you need?
Knowledge Much of it is below.
Costs begin about $300. for partial free power such as lights only. But for full independence and running refrigerator, freezer, dishwasher, coffee maker and air conditioners can cost over $3,000.

Yes there is a 30% fed tax deduction.

Parts needed in general:
Solar panel/s $100-3,000 See **Home Depot,** Costco, Amazon.com for best deals at any moment.
Battery/s used car battery $25, or deep discharge $100. More than one better
Wiring, light bulbs, sockets, extension cords, mounting hardware such as brackets, screws, switch, fuse, charge controller $30-$450 to regulate prolong battery life

Note LED light bulbs can use a mere 9.5 watts to replace a 65 watt tungsten bulb and have same

luminosity. That is about 1/7 the power.
If you just replace the bulbs you have on most of the time with LED bulbs you can cut your electric bill. These screw in to your regular AC sockets.

You can use solar to charge your battery then convert it to AC current with an inverter and use these bulbs just mentioned. You will need an electrician's help if you are going to merge your two AC systems being the one from the electric company and your solar powered one. This is called “On the Grid”. You can also sell electricity back to the electric company. Of course you have to get permits, inspections etc.

Or you can make an off the grid system using a separate AC circuit if you want to send power to AC bulbs and devices like your refrigerator, coffee maker, freezer and air conditioner. You need a bigger inverter to convert the DC from the batteries to AC power. One problem is that inverters are only about 80% efficient so there is a loss of energy.

Simple old folks like me who just want to do mostly lighting can do everything with the direct 12 volts of DC power. I can run 1/3 to ½ of my household which is my most frequently used lights and a couple of notebook computers and if I want quite a few low powered electronic devices such as tablets, cell phones, DC coffee maker, DC fan (was $15 at Kline's). Some people use a wood stove for emergency heat or supplemental or their entire heating. There is lots of wood around for free pickup. The problem is that the wood has to be cut up, and the fire tended at least every half hour. If you have bottled gas or natural gas for your stove, furnace or boiler you do not require a lot of electricity and can easily power those with solar. Solar power, a wood stove and your own well make you independent of the utility companies. And you can easily survive when your neighbors are suffering and moving to motels in a crisis. Add chickens, a garden and rabbits and you can grow your own food. OK enough I am starting to sound like that great magazine Mother Earth News which has more great ideas. Here is their website http://www.motherearthnews.com/

If you want to efficiently heat water just put in a solar water heater which is literally a radiator up on the roof that heats a coolant in pipes which then heats are piped into a water tank thereby heating the water in the tank all free. There is a picture of one at the very top of this document

You can get 8 watt automobile work lights with plugs and 10 foot cord.
12 Volt Work Light
by Pit Bull
8 Watt Fluorescent
14ft cord with cigarette lighter adapter
Battery clip
Shatter proof plastic
Not super bright but can light up an area. I use mine on my desk and it it is perfect. Only used 8 watts so is very stingy on electricity.

Walmart sells a Bayco very bright 13 watt work light with spotlight and broad light and hook and with 20 foot cord and 12 volt plug . Or get it online. Around $10. or you can get one with a backup battery inside $19 that will run for many hours and can be portable to use in any room without wires and can be recharged by 12 volt solar or AC power.

Bayco SL-512 12-Volt 13-Watt Fluorescent Work Light
12 volt cool running fluorescent work light
Instant start electronic ballast
Rocker on/off switch
20-foot 18/2 SPT-1 cord with 12 volt cigarette lighter adapter
Uses cool running 12 volt 13 watt 10,000 hour rated 6500K fluorescent bulb.
(included)

This LED flashlight is very bright. Charges up on 12V DC or AC
is portable. This is the brightest and best flashlight I ever had.
These Rechargable stick lights feature Dual-Mode, Flashlight or Floodlight. The Bright white LEDs average a 35,000 hour life with a brilliant Light Color - 6500 Kelvin. Safety orange housing and impact/chemical resistant bodys make this product outlast all others. Each light includes a removable hanger-hook, Rechargeable high quality NiMH battery, home and car adapters

Flashlight: 1 LED = 65 Lumens, Floodlight: 60 LEDs = 120 Lumens, Run-time 4 hrs. flashlight, 4 hrs. floodlight, Charge time 4 hours Length: 11.5"
I got this at Walmart for $29. plus tax.

If you used these mounted higher up they would also be great interior lights all with potentially free power and can be used while charging. It is so bright it hurts to look at it. Mine is black.

Kline's RV had 12 volt DC splitter cords with 2 sockets at $7.50 cheaper than Walmart's $9.99.
Kline was the only one locally to have an 25 foot 12 volt extension cord They charged me $15.69
Kline's is at 2001 E 13 Mile Warren Mi 48092 toll free phone number 877 217 6994
their web site is http://www.klinesrv.com/

The greatest choice for batteries in Warren Michigan area is Batteriesshack at 44478 Mound Road - Sterling Heights, MI 48314 (586) 580-2893 their website http://www.batteriesshack.com/
They have good deep cycle batteries from $59-over $200

- **Deep Cycle Battery**
- Size 24
- Size 27
- Size 31
- and also other sizes

For regular wiring, hardware, etc. Home Depot has many things but my local store did not have 12 volt plugs and MC4 connectors (these are the standard DC connectors) batteries or charge controllers. They do offer these online. Home Depot does have in stores LED bulbs at about same price as Walmart.

Working with the heavier wire needed for DC requires long nose pliers and if you are going to join wires twist connectors or wire clamps which Home Depot has. Either of these makes joining the bigger wire easier and more reliable. Suggested wire to be used for DC us usually 8 or 10 size. An engineer told me that 8 size wire is good for 50 feet. Soldering gives a superior connection but is not cecessary.

I used an automotive 12 volt fuse holder and fuse for safety on the battery side. Of course one can buy a fancy circuit breaker also.

I use a battery shut-off on each battery in case of emergency as it would be quicker than trying to use pliers. As a former fireman we just cut wires in emergencies but you have to have a big cutter to do that. I found cheap and good 12 volt cutoff at Meijers automotive for $4.99

Selecting a solar panel

Read the section further down and educate yourself about them. New ones come out monthly and so do better deals. My best deal when I VOUGHT WAS Home Depot. Now I see looking at Amazon.com and other sites that as of this writing a 100 watt panel best price is around $139. Some places give you free shipping. The **monocrystalline silicon panel is the most efficient for the current price. Read about them further down.** Thin film is more efficient but since they have to go on the roof how are you going to mount them? Will they be protected against sun damage and UV damage, are they guaranteed? Size is a factor an Engineer talked me into getting 265 watt panels because they were the most efficient on the market at the time I was buying. Then me being old came to realize that I dare not try to put these nearly 50 pound big bulky monsters on a slanted roof which I can easily do with a 100 watt panel at one half the weight and size. Or just hire a contractor or solar installer but you will need deep pockets and permits etc.

How many panels will you need? Panels are about 80% efficient so a 100 watt panel will give you 80 watts an hour on sunny days. Perhaps half of that on cloudy days. None at night. And count on only 4 .5 hours of peak wattage as the sun gets at an angle causing wattage to drop significantly. See scientific notes further down. First decide if you are just charging electronic devices. A panel smaller than 100 watts can do this for you. Are you going to just power a few LED lights? What wattage and for how long? One or two 100 watt panels can do that. Add up the number of watts of each light then multiply by the number of hours you need to use it. That gives you the watt hours. See online calculators and power requirements of devices at
http://www.millerwelds.com/products/generators/powercharts.html
Here is what how stuff works says http://home.howstuffworks.com/green-living/question418.htm

Shop around and when you have found the best deal wait a day and search again so that you are buying from knowledge not emotion.

Batteries summary of types

LI-ion and similar new batteries are great however I don't want a big one in my house as if it every catches fire neither you or the fire department can put it out. They should be used in fireproof containers inside or near anything burnable.
Lead Acid batteries are the cheapest but you need deep cycle type to be long lasting. They give off dangerous hydrogen and need to be re-watered.
The best choice for many persons is the Agm battery which does **not** need to occasionally have water

added. No explosive Hydrogen gas forms outside of the battery. They are usually just a little more expensive than the lead-acid batteries but supposedly safer.
Here is what Wikipedia has to say.

A **VRLA battery** (**valve-regulated lead-acid battery**), more commonly known as a **sealed battery** or**maintenance free battery**, is a type of lead-acid rechargeable battery. Due to their construction, they can be mounted in any orientation, and do not require constant maintenance.[1] The term "maintenance free" is a misnomer as VRLA batteries still require cleaning and regular functional testing. They are widely used in large portable electrical devices, off-grid power systems and similar roles, where large amounts of storage are needed at a lower cost than other low-maintenance technologies like lithium-ion.

There are two primary types of VRLA batteries, **gel cells** and **AGM**. Gel cells add silica dust to the electrolyte, forming a thick putty-like gel. These are sometimes referred to as "silicone batteries". AGM (absorbed glass mat) batteries feature fiberglass mesh between the battery plates which serves to contain the electrolyte. Both designs offer advantages and disadvantages compared to conventional batteries, as well as each other.

VRLA batteries are prone to thermal runaway which can cause sudden and large scale failure.

Lead-acid cells consist of two plates of lead, which serve as electrodes, suspended in diluted sulphuric acid, which is then the electrolyte. In conventional lead-acid cells, the diluted acid is in liquid form, hence the term "flooded" or "wet" cells. VRLA cells have essentially the same lead-acid chemistry, but the diluted acid electrolyte solution is immobilized, either by soaking a fiberglass mat in it (hence: glass-mat batteries), or by turning the liquid into a paste-like gel by the addition of silica and other gelling agents (hence: gel batteries).

When a cell discharges, the lead and diluted acid undergo a chemical reaction that produces lead-sulphate and water (see lead–acid battery for details of the chemical reaction). When a cell is subsequently charged, the lead-sulphate and water are turned back into lead and acid. In all lead-acid battery designs, charge current must be adjusted to match the ability of the battery to absorb the energy. If the charging current is too great, some of it will be wasted decomposing water into hydrogen and oxygen, in addition to the intended conversion of lead sulphate and water into lead dioxide, lead, and sulphuric acid which reverses the discharge process. If these gases are allowed to escape, as in a conventional flooded cell, the battery may need to be topped up with water from time to time. In contrast, in VRLA batteries the gases are retained within the battery as long as the pressure remains within safe levels. Under normal operating conditions the gases can then recombine within the battery itself, sometimes with the help of a catalyst, and no topping-up is needed[3][1]. However, if the pressure exceeds safety limits, safety valves open to allow the excess gases to escape, and in doing so regulate the pressure back to safe levels (hence "valve-regulation" in "VRLA").

In flooded lead-acid batteries, the liquid electrolyte is a hazard during shipping and makes them unsuitable for many portable applications. Furthermore, the need to maintain water levels makes them unsuitable for maintenance-free applications. The immobilized electrolyte in VRLA batteries addresses these problems. At the same time, since VRLA cells can't be "topped off" with water, any hydrogen lost during outgassing can't easily be replaced. To some extent, this can be compensated for by overprovisioning the quantity of electrolyte, but at the cost of increased weight. The main downside to the VRLA design is that the immobilizing agent also impedes the chemical reactions that generate current. For this reason, VRLAs have lower peak power ratings than conventional designs. This makes them less useful for roles like car starting batteries where usage patterns are brief high-current pulses (during starting) followed by long slow recharging cycles. VRLAs are mostly found in roles where the charge/recharge cycles are slower, such as power storage applications.

Both flooded and VRLA designs require suitable ventilation around the batteries; both to prevent hydrogen concentrations from building up (hydrogen gas is highly flammable, and is an asphyxiant), and to ensure that the batteries receive adequate cooling.

A **Lithium-ion battery** (sometimes **Li-ion battery** or **LIB**) is a member of a family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Li-ion batteries use an intercalated lithium compound as oneelectrode material, compared to the metallic lithium used in a non-rechargeable lithium battery. Theelectrolyte, which allows for ionic movement, and the two electrodes are the constituent components of a lithium-ion cell.

Lithium-ion batteries are common in consumer electronics. They are one of the most popular types of rechargeable batteries for portable electronics, with a high energy density, no memory effect, and only a slow loss of charge when not in use. Beyond consumer electronics, LIBs are also growing in popularity for military, battery electric vehicle and aerospace applications.[6] For example, lithium-ion batteries are becoming a common replacement for the lead acid batteries that have been used historically for golf carts and utility vehicles. Instead of heavy lead plates and acidelectrolyte, the trend is to use lightweight lithium-ion battery packs that can provide the same voltage as lead-acid batteries, so no modification to the vehicle's drive system is required.

Chemistry, performance, cost and safety characteristics vary across LIB types. Handheld electronics mostly use LIBs based on lithium cobalt oxide (LiCoO
2), which offers high energy density, but **presents safety risks, especially when damaged.** Lithium iron phosphate (LFP), lithium manganese oxide (LMO) and lithium nickel manganese cobalt oxide (NMC) offer lower energy density, but longer lives and inherent safety. Such batteries are widely used for electric tools, medical equipment and other roles. NMC in particular is a leading contender for automotive applications. Lithium nickel cobalt aluminum oxide (NCA) and lithium titanate (LTO) are specialty designs aimed at particular niche roles. The new lithium sulphur batteries promise the highest performance to weight ratio.

Lithium-ion batteries can be dangerous under some conditions and can pose a safety hazard since they contain, unlike other rechargeable batteries, a flammable electrolyte and are also kept pressurized. Because of this the testing standards for these batteries are more stringent than those for acid-electrolyte batteries, requiring both a broader range of test conditions and additional battery-specific tests.[7][8] This is in response to reported accidents and failures, and there have been battery-related recalls by some companies.

The Fuel Cell will replace all of the above in the future but they are not affordable at the moment.

Temporarily until this page is done here are my notes.

How solar panels work from Wikipedia
Solar modules use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most solar modules are rigid, but semi-flexible ones are available, based on thin-film cells. These early solar modules were first used in space in 1958.

Electrical connections are made in series to achieve a desired output voltage and/or in parallel to provide a desired current capability. The conducting wires that take the current off the modules may contain silver, copper or other non-magnetic conductive transition metals. The cells must be connected electrically to one another and to the rest of the system. Externally, popular terrestrial usage photovoltaic modules use MC3 (older) or MC4 connectors to facilitate easy weatherproof connections to the rest of the system.

Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated.

Some recent solar module designs include concentrators in which light is focused by lenses or mirrors onto an array of smaller cells. This enables the use of cells with a high cost per unit area (such as gallium arsenide) in a cost-effective way.

Efficiencies

See also: Solar cell efficiency

Depending on construction, **photovoltaic modules can produce electricity from a range of frequencies of light, but usually cannot cover the entire solar range** (specifically, ultraviolet, infrared and low or diffused light). Hence much of the incident sunlight energy is wasted by solar modules, and they can give far higher efficiencies if illuminated with monochromatic light. Therefore, another design concept is to split the light into different wavelength ranges and direct the beams onto different cells tuned to those ranges. This has been projected to be capable of raising efficiency by 50%. Scientists from Spectrolab, a subsidiary of Boeing, have reported development of multijunction solar cells with an efficiency of more than 40%, a new world record for solar photovoltaic cells.[1] The Spectrolab scientists also predict that concentrator solar cells could achieve efficiencies of more than 45% or even 50% in the future, with theoretical efficiencies being about 58% in cells with more than three junctions.

Currently the best achieved sunlight conversion rate (solar module efficiency) is around 21.5% in new commercial products[2] typically lower than the efficiencies of their cells in isolation. The most efficient mass-produced solar modules[disputed – discuss] have power density values of up to 175 W/m2 (16.22 W/ft2).[3] Research by Imperial College, London has shown that the efficiency of a solar panel can be improved by studding the light-receiving semiconductor surface with aluminum nanocylinders similar to the ridges on Lego blocks. The scattered light then travels along a longer path in the semiconductor which means that more photons can be absorbed and converted into current. Although these nanocylinders have been used previously (aluminum was preceded by gold and silver), the light scattering occurred in the near infrared region and visible light was absorbed strongly. Aluminum was found to have absorbed the ultraviolet part of the spectrum, while the visible and near infrared parts of the spectrum were found to be scattered by the aluminum surface. This, the research argued, could bring down the cost significantly and improve the efficiency as aluminum is more abundant and less costly than gold and silver. The research also noted that the increase in current makes thinner film solar panels technically feasible without "compromising power conversion efficiencies, thus reducing material consumption".[4]

Efficiencies of solar panel can be calculated by MPP(Maximum power point) value of solar panels

Solar inverters convert the DC power to AC power by performing MPPT process: solar inverter samples the output Power(I-V curve) from the solar cell and applies the proper resistance (load) to solar cells to obtain maximum power.

MPP(Maximum power point) of the solar panel consists of MPP voltage(V mpp) and MPP current(I mpp): it is a capacity of the solar panel and the higher value can make higher MPP.

Micro-inverted solar panels are wired in parallel which produces more output than normal panels which are wired in series with the output of the series determined by the lowest performing panel (this is known as the "Christmas light effect"). Micro-inverters work independently so each panel contributes its maximum possible output given the available sunlight.[citation needed]
Crystalline silicon modules
Main article: Crystalline silicon

Most solar modules are currently produced from solar cells made of polycrystalline and monocrystalline silicon. In 2013, crystalline silicon accounted for more than 90 percent of worldwide PV production.[5]
Thin-film modules
Main articles: Thin film solar cell and Third generation solar cell

Third generation solar cells are advanced thin-film cells. They produce a relatively high-efficiency conversion for the low cost compared to other solar technologies.
Rigid thin-film modules

In rigid thin film modules, the cell and the module are manufactured in the same production line.

The cell is created on a glass substrate or superstrate, and the electrical connections are created in situ, a so-called "monolithic integration". The substrate or superstrate is laminated with an encapsulant to a front or back sheet, usually another sheet of glass.

The main cell technologies in this category are CdTe, or a-Si, or a-Si+uc-Si tandem, or CIGS (or variant). Amorphous silicon has a sunlight conversion rate of 6-12%.
Flexible thin-film modules

Flexible thin film cells and modules are created on the same production line by depositing the photoactive layer and other necessary layers on a flexible substrate.

If the substrate is an insulator (e.g. polyester or polyimide film) then monolithic integration can be used.

If it is a conductor then another technique for electrical connection must be used.

The cells are assembled into modules by laminating them to a transparent colourless fluoropolymer on the front side (typically ETFE or FEP) and a polymer suitable for bonding to the final substrate on the other side. The only commercially available (in MW quantities) flexible module uses amorphous silicon triple junction (from Unisolar).

So-called inverted metamorphic (IMM) multijunction solar cells made on compound-semiconductor technology are just becoming commercialized in July 2008. The University of Michigan's solar car that won the North American Solar Challenge in July 2008 used IMM thin-film flexible solar cells.

The requirements for residential and commercial are different in that the residential needs are simple and can be packaged so that as solar cell technology progresses, the other base line equipment such as the battery, inverter and voltage sensing transfer switch still need to be compacted and unitized for residential use. Commercial use, depending on the size of the service will be limited in the photovoltaic cell arena, and more complex parabolic reflectors and solar concentrators are becoming the dominant technology.[citation needed]

Flexible thin-film panels are optimal for portable applications as they are much more resistant to breakage than regular crystalline cells, but can be broken by bending them into a sharp angle. They are also much lighter per square foot than standard rigid solar panels.

The global flexible and thin-film photovoltaic (PV) market, despite caution in the overall PV industry, is expected to experience a CAGR of over 35% to 2019, surpassing 32 GW according to a major new study by IntertechPira.[6]
Smart solar modules
Main articles: Smart module and Solar micro-inverter

Scientific Solar Breakthru (modern spelling) Research is now being done on solar cells made of a newly formulated family of materials called "perovskite." This is going to provide the following benefits: lower cost in manufacturing, can be made in colors, can absorb more colors of light, can be flexible, can be made in tape form, have higher efficiency, can be transparent, can be in windows, on roofs and on outside walls and other surfaces. Even better you will be able to print it on a printer with plastic instead of paper and perovskite ink.

Several companies have begun embedding electronics into PV modules. This enables performing maximum power point tracking (MPPT) for each module individually, and the measurement of performance data for monitoring and fault detection at module level. Some of these solutions make use of power optimizers, a DC-to-DC converter technology developed to maximize the power harvest from solar photovoltaic systems. As of about 2010, **such electronics can also compensate for shading effects, wherein a shadow falling across a section of a module causes the electrical output of one or more strings of cells in the module to fall to zero, but not having the output of the entire module fall to zero**.

Module performance is generally rated under **standard test conditions (STC): irradiance of 1,000 W/m², ** solar spectrum of AM 1.5 and module temperature at 25 °C.

The USA gets thousands times the energy from the sun every day than we use. What area of square miles would be sufficient to power the entire USA. Several sources state that the size of the state of Rhode Island or under 1,500 square miles would be more than sufficient to provide all of the power the US needs. For the world it would be the size of Spain or about 195 thousand sq. miles roughly 500,000 sq. KM. However just putting solar at present efficiency on roofs un the USA would provide 1/3 of the power needed. Panels on waste land and over retention ponds and reservoirs would provide the rest.

The World Meteorological Organization uses the term "sunshine duration" to mean the cumulative time during which an area receives direct irradiance from the Sun of at least 120 watts per square meter.[1]
The total amount of energy received at ground level from the sun at the zenith depends on the distance to the sun and thus on the time of year. It is about 3.3% higher than average in January and 3.3% lower in July (see below). If the extraterrestrial solar radiation is 1367 watts per square meter (the value when the earth-sun distance is 1 astronomical unit), then the direct sunlight at the earth's surface when the sun is at the zenithis about 1050 W/m2, **but the total amount (direct and indirect from the atmosphere) hitting the ground is around 1120 W/m2.**[3] In terms of energy, sunlight at the earth's surface is around 52 to 55 percent infrared (above 700 nm), **42 to 43 percent visible** (400 to 700 nm), and 3 to 5 percent ultraviolet (below 400 nm).[4] At the top of the atmosphere, sunlight is about 30% more intense, having about 8% ultraviolet (UV),[5] with most of the extra UV consisting of biologically damaging short-wave ultraviolet.[6]

Direct sunlight has a luminous efficacy of about 93 lumens per watt of radiant flux, higher than most artificial lighting, including fluorescent. Multiplying the figure of 1050 watts per square metre by 93 lumens per watt indicates that bright sunlight provides an illuminance of approximately 98 000 lux (lumens per square meter) on a perpendicular surface at sea level. The illumination of a horizontal surface will be considerably less than this if the sun is not very high in the sky. Averaged over a day, the highest amount of sunlight on a horizontal surface occurs in January at the South Pole (see insolation).

Looks to me as 42% of 1120 W/m^2 =470.4 W/m^2 1m^2= 10.76391ft^2 1ft^2= 0.09290304m^2
2496 sq inches   2496 Square Inches = 17.333333333333332 Square Feet
1640 mm*990 mm = 1623600 sq mm = 1.623600m^2 1.6*2 = 3.2

Electrical characteristics include nominal power (PMAX, measured in W), open circuit voltage (VOC), short circuit current (ISC, measured in amperes), maximum power voltage (VMPP), maximum power current (IMPP), peak power, Wp, and module efficiency (%).

Nominal voltage refers to the voltage of the battery that the module is best suited to charge; this is a leftover term from the days when solar modules were only used to charge batteries. The actual voltage output of the module changes as lighting, temperature and load conditions change, so there is never one specific voltage at which the module operates. Nominal voltage allows users, at a glance, to make sure the module is compatible with a given system.

Open circuit voltage or VOC is the maximum voltage that the module can produce when not connected to an electrical circuit or system. VOC can be measured with a meter directly on an illuminated module's terminals or on its disconnected cable.

The peak power rating, Wp, is the maximum output under standard test conditions (not the maximum possible output). Typical modules, which could measure approximately 1x2 meters or 2x4 feet, will be rated from as low as 75 watts to as high as 350 watts, depending on their efficiency. At the time of testing, the test modules are binned according to their test results, and a typical manufacturer might rate their modules in 5 watt increments, and either rate them at +/- 3%, +/-5%, +3/-0% or +5/-0%.[7][8][9][10]

Solar modules must withstand rain, hail, heavy snow load, and cycles of heat and cold for many years. Many crystalline silicon module manufacturers offer a warranty that guarantees electrical production for 10 years at 90% of rated power output and 25 years at 80%.[11]

PRODUCT OVERVIEW Model # GS-S-265-Fab1x2   Internet # 205481288
The Grape Solar 265-Watt 2 piece savings pack bundles 2 Grape Solar GS-S-265-Fab1 panels together for even greater savings. The Grape Solar 265-Watt Mono-crystalline Solar Panel uses high efficiency solar cells (approximately 19%) made from quality silicon material for high module conversion efficiency, long term output stability, and reliability. Virtually maintenance free. High transmittance, low iron tempered glass for durability and enhanced impact resistance.

2 piece Grape Solar GS-S-265-Fab5 panels bundled together for even greater savings
Positive power output tolerance of 0% to +3%
Outstanding electrical performance under high temperature and weak light environments
Can withstand snow and wind loads greater than 50 lbs. per 2 ft.

Unique frame design for easy installation
Rigorous quality control to meet the highest international standards
Positive and negative leads equipped with MC4 connectors
When charging 12-Volt battery systems with this panel, an MPPT charge controller must be used

SPECIFICATIONS
Dimensions

Panel Height (in.)	1.6	Product Depth (in.)	67
Panel Width (in.)	39	Product Height (in.)	12
Panel length (in.)	64.6	Product Width (in.)	42

Details

Amperage (amps)	**8.5**	Panel weight (lb.)	44
Charge controller included	No	Portable	No
Electrical Product Type	Solar Power Panel	Returnable	90-Day
Inverter included	No	Solar panel type	Monocrystalline silicon panel
Low voltage audible alarm	No	Voltage (volts)	**31.2**
Mounting frame included	No	Wattage (watts)	**265**
Number of Panels	2		

Warranty / Certifications
Manufacturer Warranty 10 year limited product warranty on materials and workmanship. 25 year warranty on >80% power output and 10 year warranty on >90% power output.

High efficiency solar cells (approx. 18%) with quality silicon material for high module conversion efficiency and long term output stability and reliability.

Positive power output tolerance from 0% to +3%.

Rigorous quality control to meet the highest international standards.

High transmittance, low iron tempered glass with enhanced stiffness and impact resistance.

Unique frame design with strong mechanical strength for greater than 50 lbs/ft2 wind load and snow load withstanding and easy installation.

Advanced encapsulation material with multilayer sheet lamination to provide long-life and enhanced cell performance.

Outstanding electrical performance under high temperature and weak light environments.

CERTIFICATIONS ISO 9000:2000 CE

MECHANICAL SPECIFICATIONS

Characteristic	Details
Cell Size	156mm x 156mm (6.14” x 6.14”)
Module Dimension (LxWxT)	1640mm x 982mm x 40mm (64.6” x 38.7” x 1.6”)
No. of Cells	6 x 10 = 60
Weight	19.4 kg (42.8 lbs)
Cable Length	900mm (43.3”) for positive (+) and negative (-)
Typed of Connector	MC-IV Junction Box IP65 or IP67 Rated
No. of Holes in Frame	4 draining holes, 8 installation holes, 2 grounding holes, 16 air outlet holes

Electrical Specifications (STC* = 25 ºC, 1000W/m2 Irradiance and AM=1.5)

Characteristic	Details
Max System Voltage	1000V / 600V
Max Peak Power Pmax	260 W (-2%, +2%)
CEC PTC Listed Power	231.6 W
Maximum Power Point Voltage Vmpp	**31.6 V**
Maximum Power Point Current Impp	**8.23 A**
Open Circuit Voltage Voc	37.9 V
Short Circuit Current Isc	8.67 A

Module Efficiency (%) 16%
Temperature Coefficient of Voc -0.128 V/ºC (-0.34% /ºC)
Temperature Coefficient of Isc 3.63x10-3 A/ºC (0.04% /ºC)
Temperature Coefficient of Pmax -1.25 W/ºC (-0.48% /ºC)
Other Performance Data

Power Tolerance	Operating Temperature	Max Series Fuse Rating	NOCT*
-2% / +2%	-40 ºC to +85 ºC	15 A	45 ºC ±2 ºC

*Normal Operating Cell Temperature

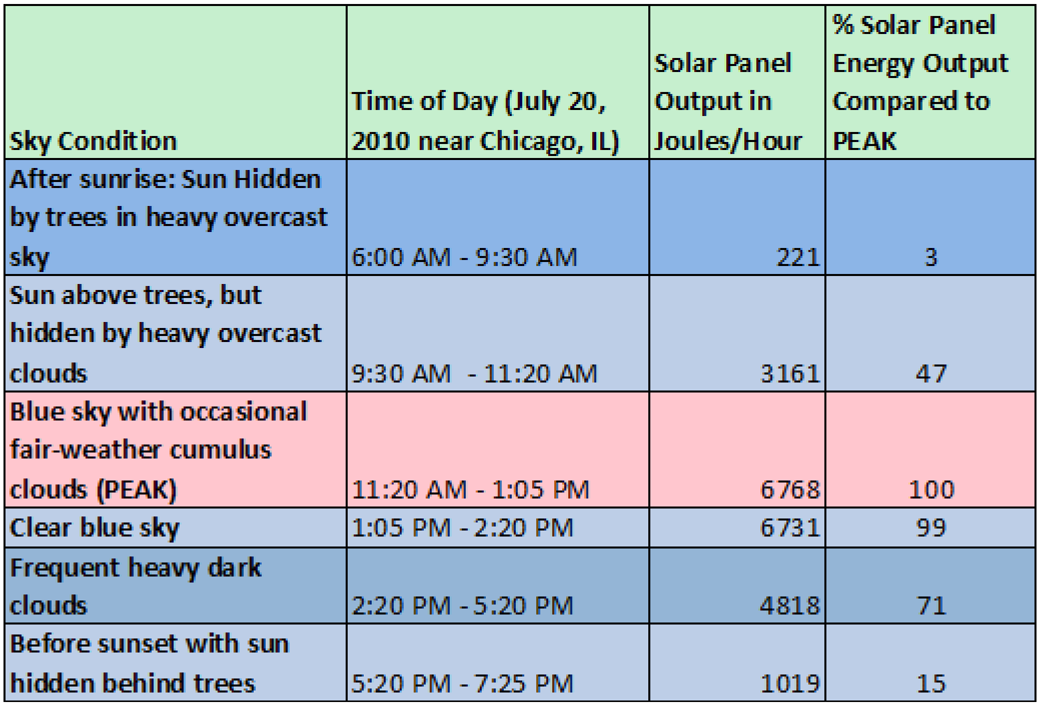
Cloudy Days

Solar panels generate the most electricity on clear days with abundant sunshine (not surprisingly). But, do solar panels work in cloudy weather? Yes… just not quite as well **On a cloudy day, typical solar panels can produce 10-25% of their rated capacity.** The exact amount will vary depending on the density of the clouds, and may also vary by the type of solar panel; some kinds of panels are better at receiving diffuse light. SunPower solar cells, for example, have been designed to capture a broader range of the solar spectrum. By capturing more red and blue wavelengths, their solar panels can generate more electricity even when it's overcast.

Ultraviolet light also reaches the earth's surface in abundance during cloudy days (if you've ever been at the beach when it's cloudy and gotten a sunburn, you've experienced this firsthand). Some solar cells are in development that can capture UV rays, although these are not out on the market yet. **Even with a standard solar panel on a cloudy day, though, you will be able to generate some power when it's daylight.** The same thing is true in foggy weather. If you live in a city with frequent fog, like San Francisco, you'll still be able to generate electricity when the fog rolls in.

A silver lining to that cloud: how the "edge of cloud" effect can produce more solar power than a sunny day

If you have solar panels and keep a close watch on your power output, you may have noticed a strange phenomenon: on a partly cloudy day, it's possible to exceed your solar system's power rating and produce more power that you could on a sunny day. Known as the "edge of cloud" effect, this happens when the sun passes over the outer edge of a cloud, magnifying the sunlight. The intense light causes your solar system to boost power output temporarily, which can help balance out losses from full cloud cover.

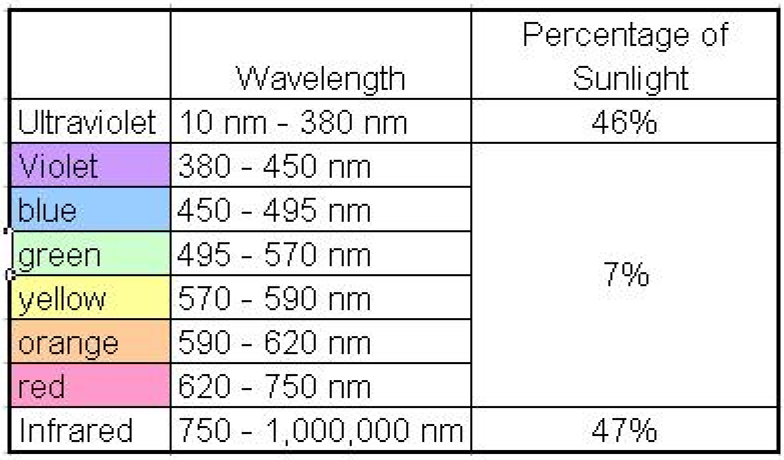


Sky Condition	Time of Day (July 20, 2010 near Chicago, IL)	Solar Panel Output in Joules/Hour	% Solar Panel Energy Output Compared to PEAK
After sunrise: Sun Hidden by trees in heavy overcast sky	6:00 AM - 9:30 AM	221	3
Sun above trees, but hidden by heavy overcast clouds	9:30 AM - 11:20 AM	3161	47
Blue sky with occasional fair-weather cumulus clouds (PEAK)	11:20 AM - 1:05 PM	6768	100
Clear blue sky	1:05 PM - 2:20 PM	6731	99
Frequent heavy dark clouds	2:20 PM - 5:20 PM	4818	71
Before sunset with sun hidden behind trees	5:20 PM - 7:25 PM	1019	15

	Monocrystalline	**Polycrystalline**	Amorphous	CdTe	CIS/CIGS
Typical module efficiency	**15-20%**	**13-16%**	6-8%	9-11%	10-12%
Best research cell efficiency	25.0%	20.4%	13.4%	18.7%	20.4%
Area required for 1 kWp	**6-9 m2**	**8-9 m2**	13-20 m2	11-13 m2	9-11 m2
Typical length of warranty	25 years	25 years	10-25 years		

Lowest price 0.75 $/W 0.62 $/W 0.69 $/W
Temperature resistance Performance drops 10-15% at high temperatures Less temperature resistant than monocrystalline Tolerates extreme heat Relatively low impact on performance
Additional details Oldest cell technology and most widely used Less silicon waste in the production process Tend to degrade faster than crystalline-based solar panels
Low availability on the market
Lowest price is based on listings of wholesalers and retailers on the Internet (June 3, 2013). Best research cell efficiency is data collected from National Renewable Energy Laboratory (NREL).[1]

Wavelengths



	Wavelength	Percentage of Sunlight
Ultraviolet	10 nm - 380 nm	46%
Violet	380 - 450 nm	7%
blue	450 - 495 nm	
green	495 - 570 nm	
yellow	570 - 590 nm	
orange	590 - 620 nm	
red	620 - 750 nm	
Infrared	750 - 1,000,000 nm	47%

Photovoltaic & Amorphous Solar Cells

Solar cells are made out of N-type and P-type semiconductor material that use the visual light spectrum to generate electricity. Solar radiation with wavelengths of 380 nm to 750 nm (violet to red) strike the material with enough energy to knock electrons from their weak bonds and create an electric current. The unused wavelengths (ultraviolet & infrared) do not have enough energy to dislodge the electrons and are absorbed as heat.

Multi-layer Amorphous Solar Panels

Thin layers of amorphous semiconductor can be applied on top of one another. Each layer is specifically doped to take advantage of a certain wavelength. Light will travel through each layer until it strikes the appropriate layer where it frees one electron and makes an electric current. This stack-up makes use of all of the various wavelengths and holds promise to creating more efficient solar panels.

Full-Spectrum Photovoltaic Material

With existing solar cells, the unused ultraviolet and infrared wavelengths are not converted into electricity but rather wasted as heat. A recent discovery of a new semiconductor material made from indium, gallium and nitrogen can convert virtually the full spectrum of sunlight - from the far ultraviolet to the near infrared - into electricity. One panel can use the entire electromagnetic spectrum and holds promise of being the most efficient solar panel ever created.

A newly established low band gap for indium nitride means that the indium gallium nitride system of alloys (In1-xGaxN) covers the full solar spectrum.

http://www2.lbl.gov/Science-Articles/Archive/MSD-full-spectrum-solar-cell.html

Many factors limit the efficiency of photovoltaic cells. Silicon is cheap, for example, but in converting light to electricity it wastes most of the energy as heat. The most efficient semiconductors in solar cells are alloys made from elements from group III of the periodic table, like aluminum, gallium, and indium, with elements from group V, like nitrogen and arsenic.

One of the most fundamental limitations on solar cell efficiency is the band gap of the semiconductor from which the cell is made. In a photovoltaic cell, negatively doped (n-type) material, with extra electrons in its otherwise empty conduction band, makes a junction with positively doped (p-type) material, with extra holes in the band otherwise filled with valence electrons. Incoming photons of the right energy -- that is, the right color of light -- knock electrons loose and leave holes; both migrate in the junction's electric field to form a current.

Photons with less energy than the band gap slip right through. For example, red light photons are not absorbed by high-band-gap semiconductors. While photons with energy higher than the band gap are absorbed -- for example, blue light photons in a low-band gap semiconductor -- their excess energy is wasted as heat.

The maximum efficiency a solar cell made from a single material can achieve in converting light to electrical power is about 30 percent; the best efficiency actually achieved is about 25 percent. To do better, researchers and manufacturers stack different band gap materials in multijunction cells.

Dozens of different layers could be stacked to catch photons at all energies, reaching efficiencies better than 70 percent, but too many problems intervene. When crystal lattices differ too much, for example, strain damages the crystals. The most efficient multijunction solar cell yet made -- 30 percent, out of a possible 50 percent efficiency -- has just two layers.

At first glance, indium gallium nitride is not an obvious choice for solar cells. Its crystals are riddled with defects, hundreds of millions or even tens of billions per square centimeter. Ordinarily, defects ruin the optical properties of a semiconductor, trapping charge carriers and dissipating their energy as heat.

In studying LEDs, however, the Berkeley Lab researchers found that the way indium joins with gallium in the alloy leaves indium-rich concentrations that, remarkably, emit light efficiently. Such defect-tolerance in LEDs holds out hope for similar performance in solar cells.

To exploit the alloy's near-perfect correspondence to the spectrum of sunlight will require a multijunction cell with layers of different composition. Walukiewicz explains that "lattice matching is normally a killer" in multijunction cells, "but not here. These materials can accommodate very large lattice mismatches without any significant effect on their optoelectronic properties."

Two layers of indium gallium nitride, one tuned to a band gap of 1.7 eV and the other to 1.1 eV, could attain the theoretical 50 percent maximum efficiency for a two-layer multijunction cell. (Currently, no materials with these band gaps can be grown together.) Or a great many layers with only small differences in their band gaps could be stacked to approach the maximum theoretical efficiency of better than 70 percent.

It remains to be seen if a p-type version of indium gallium nitride suitable for solar cells can be made. Here too success with LEDs made of the same alloy gives hope. A number of other parameters also remain to be settled, like how far charge carriers can travel in the material before being reabsorbed.

Indium gallium nitride's advantages are many. It has tremendous heat capacity and, like other group III nitrides, is extremely resist to radiation. These properties are ideal for the solar arrays that power communications satellites and other spacecraft. But what about cost?

"If it works, the cost should be on the same order of magnitude as traffic lights," Walukiewicz says. "Maybe less." Solar cells so efficient and so relatively cheap could revolutionize the use of solar power not just in space but on Earth.

Amorphous Silicon Solar Panels

Last updated June 26, 2013 by Mathias Aarre Maehlum

Amorphous silicon (a-Si or a-Si:H) solar cells belong to the category of silicon thin-film, where one or several layers of photovoltaic material are deposited onto a substrate.

Some types of thin-film solar cells have a huge potential. These technologies are expected to grow rapidly in the coming years as they mature. In 2011, amorphous silicon solar cells represented about 3% of market.[1]

The word “amorphous” literally means shapeless. The silicon material is not structured or crystalized on a molecular level, as many other types of silicon-based solar cells are.

Most pocket calculators are powered by thin film solar cell made out of amorphous silicon. For a long time, the low power output of amorphous silicon solar cells limited their use to small applications only.

This problem is partially solved by “stacking” several amorphous solar cells on top of each other, which increases their performance and makes them more space-efficient.

In laboratory conditions, scientists have pushed efficiency rates to 12.5%.[1] The efficiency of amorphous silicon solar cells that are manufactured in high-volume processes ranges from 6% to 9%.[1] Oerelikon set the world record for stable amorphous solar cells to above 10% in 2009.[2]

42 degrees N lattitude 83 W 42 28 23 83 1 15 if it produces 220 84.2 hours = 924

3. Divide the number of watts of power you use each day by the average hours of sunlight per day. This will be the number of watts you need to produce per hour. Continuing the example, suppose that you get about three full hours of sun per day. 10,904 watts / 3 hours = 3,635 watts / hour. Computer 100 + lights 50 = 150 *16 hrs = 2400/4.2 = 571

4. Divide the watts you need to produce per hour by the rating of the panels you want to purchase and round up. This will tell you how many panels to use. Different panels will have different watt ratings, so you have choices about which ones to purchase. For the example, if 500-watt panels were being purchased, you would need 3,635 / 500 = 8 panels.

571/220 = 2.5

When connecting panels, you can do either of the following:

Increase the Voltage, by connecting panels with the same AMPS, in series
or
Increase the Amps, by connecting panels with the same Vmax in PARALLEL.

example
Series: 18V, 3A & 17V, 3A & 26V, 3A = 61V @ 3A
–

Parallel: 18V, 3A & 18V, 20A & 18V, .6a = 18V @ 23.6A
-end example- Begin truism :

A series string is limited by the lowest amp panel, and the voltages all add together

A parallel string is limited to the lowest voltage panel, and the amps add together.

Schottky diodes are best for direct charging batteries, to keep the battery from backfeeding the array at night, and draining the batteries.

Setting up batteries in parallel

One engineer told me that battery banks smooth out the battery charging in solar and put less stress on the batteries. I didn't mention that they were of different types. Assuming it would be a simple solution thought I would be smart and hook up my new AGM in parallel with my fairly new car battery so I did. More power and more reserve.

But it seemed to take forever to charge them. Did some reading around and discovered that most apparently knowledgeable people state that one should not mix different types of batteries, or batteries of different manufacturers, or batteries of different ages, sizes and even state of charge. The reason is that each of these then has a different charge rate and amperage need. Mixing batteries can drag down the new batteries and shorten their life. Also the battery closest to the load and charger gets more drain and more charging than the batteries at the end of the chain. Depending on charging needs some batteries will get too much or have too much drain on them causing earlier failure and dragging down the system. Woah! there goes the simplistic idea of hooking up different battery types.

Banks of the same battery type and size, manufacturer and age do work fine in parallel if properly hooked up as shown in the following article.

Here is the most accurate and best article I found. Source SmartGauge Electronics

How to correctly interconnect multiple batteries to form one larger bank.

Two things I have noticed in my (more than) 20 years in this business are that:-

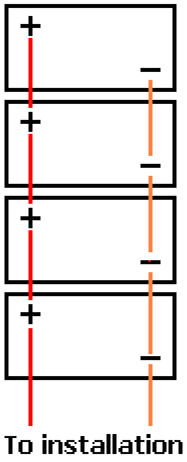
A. Many "specialists" simply tell you..... "do it this way, this is the correct way" without ever showing **why** they consider it to be the correct way, and often it isn't, which is perhaps why they couldn't show you why it is(!)

B. Some things have been done for so long, in a certain manner, that it seems they **must** be the best way of doing it. Otherwise why hasn't another method appeared?

Here at **SmartGauge Electronics** we always show you **why** one method is better. We don't expect you to take our word for it. We will happily use practical examples, theory, maths or whatever else it takes to show the results of various ways of doing things.

Interconnecting multiple batteries to form one larger bank is one case in point. Though in this case, newer methods have emerged over the years. Unfortunatley they still aren't perfect.

Here is a diagram showing the old way of interconnecting 4 batteries to form one larger bank. This is a method that we **still** see in many installations.



Method 1

Notice that the connections to the main installation are all taken from one end, i.e. from the end battery.

The interconnecting leads will have some resistance. It will be low, but it still exists, and at the level of charge and discharge currents we see in these installations, the resistance will be significant in that it will have a measurable effect.

Typically the batteries are linked together with 35mm cable in a good installation (often much smaller in a poor installation). 35mm copper cable has a resistance of around 0.0006 Ohms per metre so the 20cm length between each battery will have a resistance of 0.00012 Ohms. This, admittedly, is close to nothing. But add onto this the 0.0002 Ohms for each connection interface (i.e. cable to crimp, crimp to battery post etc) and we find that the resistance between each battery post is around 0.0015 Ohms.

If we draw 100 amps from this battery bank we will effectively be drawing 25 amps from each battery. Or so we think.

In actual fact what we find is that more current is drawn from the bottom battery, with the current draw getting progressively less as we get towards the top of the diagram.

The effect is greater than would be expected.

Whilst this diagram looks simple, the calculation is incredibly difficult to do completely because the internal resistance of the batteries affects the outcome so much.

However look at where the load would be connected. It is clear that the power coming from the bottom battery only has to travel through the main connection leads. The power from the next battery up has to travel through the same main connection leads but in addition also has to travel through the 2 interconnecting leads to the next battery. The next battery up has to go through 4 sets of interconnecting leads. The top one has to go through 6 sets of interconnecting leads. So the top battery will be providing much less current than the bottom battery.

During charging exactly the same thing happens, the bottom battery gets charged with a higher current than the top battery.

The result is that the bottom battery is worked harder, discharged harder, charged harder. It fails earlier. The batteries are not being treated equally.

Now in all fairness, many people say "but the difference is negligible, the resistances are so small, so the effect will also be small".

The problem is that in very low resistance circuits (as we have here) **huge** differences in current can be produced by **tiny** variations in battery voltage. I'm not going to produce the calculations here because they really are quite horrific. I actually used a PC based simulator to produce these results because it is simply too time consuming to do them by hand.

Battery internal resistance = 0.02 Ohms
Interconnecting lead resistance = 0.0015 Ohms per link
Total load on batteries = 100 amps

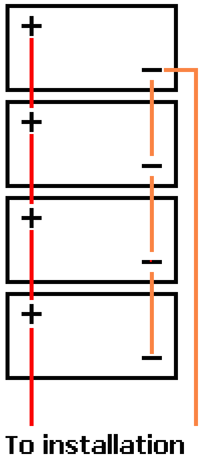
The bottom battery provides 35.9 amps of this.
The next battery up provides 26.2 amps.
The next battery up provides 20.4 amps.
The top battery provides 17.8 amps.

So the bottom battery provides over twice the current of the top battery.

This is an enormous imbalance between the batteries. The bottom battery is being worked over twice as hard as the top battery. The effects of this are rather complex and do not mean that the life of the bottom battery will be half that of the top battery, because as the bottom battery loses capacity quicker (due to it being worked harder) the other three batteries will start to take more of the load. But the nett effect is that the battery bank, as a whole, ages much quicker than with proper balancing.

I have to be honest now and say that when I first did this calculation in about 1990 I completely refused to believe the results. The results seemed so exaggerated. So much so that I wired up a battery bank and did the experiment for real, taking real measurements. The calculations were indeed correct.

Method 2



All that has changed in this diagram is that the main feeds to the rest of the installation are now taken from diagonally opposite posts.

It is simple to achieve but the difference in the results are truly astounding for such a simple modification.

The connecting leads, in fact, everything else in the installation remains identical.

Also, it doesn't matter which lead (positive or negative) is moved, Whichever is easiest is the correct one to move.

The results of this modification, when compared to the original diagram are shown below. Only that one single connection has been moved.

After this simple modification, with the same 100 amp load....

The bottom battery provides 26.7 amps of this.
The next battery up provides 23.2 amps.
The next battery up provides 23.2 amps.
The top battery provides 26.7 amps.

This is quite clearly a massive improvement over the first method. The batteries are much closer to being correctly balanced. However they are still not perfectly balanced.

How far is it necessary to go to get the matching equal?

Well, the better the quality of the batteries, the more important it becomes. The lower the internal resistance of the batteries, the more important it is to get them properly balanced.

So that now leaves the question of whether or not there is a wiring method to perfectly balance the batteries.

Before getting to that, it should be pointed out that doing the calculation is not actually required in order to arrive at the ultimate interconnection method. I simply did them to show the magnitude of the problem.

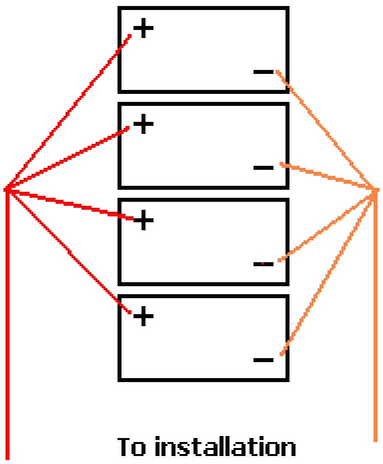
In order to get a better balancing it is simply necessary to get the number of interconnecting links as close as equal between each battery and the final loads.

In the first example the power from the bottom battery passed through no interconnecting links. The top battery passed through 6 links.

In the 2nd example (the much improved one), the power from the top and bottom battery both passed through a total of 3 links. That from the middle 2 batteries also both passed through 3 links which begs the question "why were they not therefore perfectly balanced?". The answer is that some of the links have to pass more total current and this therefore increases the voltage drop along their length.

And now we get to the correctly wired version where all the batteries are perfectly balanced.

Method 3



This looks more complicated.

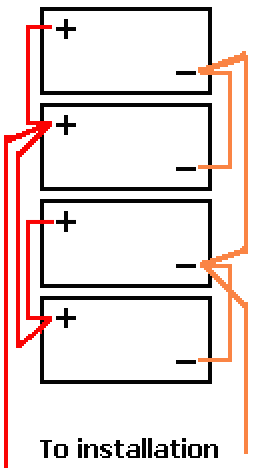
It is actually quite simple to achieve but requires two extra interconnectng links and two terminal posts.

Note that it is important that all 4 links on each side are the same length otherwise one of the main benefits (that of equal resistance between each battery and the loads) is lost.

The difference in results between this and the 2nd example are much smaller than the differences between the 1st and 2nd (which are enormous) but with expensive batteries it might be worth the additional work. Most people (myself included) don't consider the expense and time to be worthwhile unless expensive batteries are being fitted or if the number of batteries exceeds 8.

This method isn't always so easy to install because of the required terminal posts. In some installations there is simply no room to fit these. So, thanks to a colleague, we can also present another wiring method that achieves perfect battery balancing...............

Method 4



And here it is.

This looks odd but it's actually quite simple. What has been done here is to start with 2 pairs of batteries. Each wired in the proper "cross diagonal" method. Then each pair is wired together, again in the cross diagonal method.

Notice that for each individual battery, the current always goes through a total of one long link and one short link before reaching the loads.

This method also achieves perfect balance between all 4 batteries and may be easier to wire up in some installations. Many thanks to "smileypete" from www.canalworld.net/forums for this idea.

There really is no excuse whatsoever (apart from, perhaps, incompetence or laziness) for using the first example given at the top of this page.

The other three methods achieve much better balancing with the final two achieving perfect balancing between all four batteries.

I think I am right in saying that this is the only example I have ever come across where doing something the correct way actually looks less elegant than doing it incorrectly.

Finally, if you only have 2 batteries, then simply linking them together and taking the main feeds from diagonally opposite corners cannot be improved upon.

Once the number of batteries gets to 3 or more then these other methods have to be looked at.

With a large number of batteries it may be necessary to go to the 3rd method shown above.

Even with 8 batteries it is possible to get reasonable balancing by placing the main "take off" feeds from somewhere down the chain instead of from the end batteries. Remember, count the number of links each battery needs to run through to reach the final loads and get these as equal as possible.

Finally, if your battery bank has various take off points on different batteries, change it now! It is extremely bad practice. Not only does it mess up the battery balancing, it also makes trouble shooting very much more complicated and looks awful.

And finally, finally, we keep getting asked where the chargers should be connected to. We didn't address this question because it seemed so blatantly obvious where they should be connected that it never occurred to us that anyone might be unsure. The chargers should **always** be connected to the same points as the loads. Without exception.

SmartGauge Electronics Page last updated 04/03/2009.