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ENERGIZING THE WORLD

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SUNFIND Off Grid Design and Planning Guide

Whether a farm, acreage, summer retreat, camp, or cabin, off grid living is reality for thousands of Canadians. With hundreds of systems operating, Sunfind Solar has used this expertise to develop industry leading systems for off grid living.

The first step to successful off grid living is education. Not all solar systems are equal. It is important to ensure a solar system is designed for the proper climate and application. Sunfind Solar Products offers a free Design and Product catalogue, which Is highly recommended for those looking at off grid living.

For additional education material, product info or pricing, please contact a SUNFIND solar professional today.

SUNFIND SOLAR PRODUCTS IS COMMITTED TO BECOMING CANADA'S LEADING SOLAR ENERGY PROVIDER. WE WORK HARD TO EARN OUR CLIENTS AND ARE VERY PASSIONATE ABOUT WHAT WE DO! WE HOPE WHEN IT COMES TO MAKING YOUR SOLAR ENERGY PURCHASE, YOU WILL PROVIDE US THE CHANCE TO EARN THAT BUSINESS!

OFF GRID DESIGN AND PLANNING GUIDE

New to Solar Energy?

Welcome to the world of Renewable Energy! Sunfind Solar Products provides solar and wind systems to meet a wide range of power requirements. Sunfind Solar Products has years of direct experience with solar energy and believes solar energy will play a major role in the world's energy mix. Canada's solar energy industry is rapidly expanding and Sunfind Solar Products is excited to lead the way.

This informational guide is intended to provide you, the consumer, with a comprehensive guide of why living off-grid is both a desirable and cost effective lifestyle. Technology has allowed off-grid living to become a reality for thousands of Canadians and with the continuous technological advancements in solar PV technology, inverter technology, battery technology and back-up technology, off-grid solar systems will become a popular choice for thousands of Canadians in the future.

Please take time to study the entire guide. This will allow you to properly plan your home or cottage. This guide includes the topics:

1. New to Renewable Energy?
2. Living Off Grid: Is It For Me?
3. Site and Building Planning
4. Solar System Planning
5. Solar System Sizing
6. What Does the Future Hold

OFF GRID

When it comes to solar jargon, off-grid refers to no utility power...there is no connection to the utility! All electricity is either developed via solar and/or wind systems or a hybrid system. A hybrid system refers to using several power generation sources: Solar and/ or wind and a traditional back-up generator that utilizes either propane, diesel, natural gas or gasoline.

In Canada, summer cottages / cabins typically will utilize solar and/or wind for power production. Many of these cottages / cabins will have a small, gasoline portable style generator that can be used if required. However, with Canada's long summer days, typically solar and/or wind will provide the required electricity throughout the summer.

Full time homes will typically have a propane or diesel generator that will provide back-up through the winter months. Sunfind Solar Products designs our SUNFIND HP Systems to utilize a back up generator that will run 200-400 hrs per year, with the majority of run time in November, December and January.

A properly designed off-grid solar energy system is extremely reliable and will provide cleaner, more reliable power when compared to utility power.

LIVING OFF GRID: IS IT FOR ME?

No, off-grid living is not for everyone. The most effective way to lower the cost of a solar system is to increase efficiency and conservation. For those that absolutely refuse to adjust their lifestyle, off-grid living will not be a satisfying experience.

Incorporating a solar energy system into a new home build is much more cost effective than adding a solar system to an existing home that was not designed for off-grid living.

One of the most frequent question that we receive is, "if I live off-grid, what conveniences do I have to give up?"

The answer….NONE! Today's modern conveniences don't have to be sacrificed, they just need to be used differently. You do need to be flexible and adaptive.

Off-grid Lifestyle...how do I live it?

· Turn off any lights that are not being used
· Use battery powered digital clocks instead of plugging them in
· Turn off any loads when not be used: computers, satellites, etc
· Use compact fluorescent lights instead of incandescent lights
· Utilize the highest rated ENERSTAR fridges / freezers
· Use battery powered smoke detectors instead of hardwired units
· Utilize switched outlets throughout the home
· Consolidate laundry days: only once or twice a week instead of every day
· Do laundry when the sun is shining = lots of power production
· Utilize gas dryers, ranges, water heaters/boilers.
· Hang-dry clothes on a clothes line.
· Have that home entertainment / theatre system on a switched outlet
· Utilize a gas spa (hot tub) instead of an electric spa

So yes, when living off-grid, the life style changes, but for the better! Living more energy conscious, while still enjoying modern conveniences, is one of the most satisfying and enjoyable lifestyles one can live!

SITE AND BUILDING PLANNING

I am in the planning stage for your new home and love the idea of utilizing solar energy...what do I do next?

The first order of business is to contact Sunfind Solar Products! However, to get the thought process started, see the below design information.

SITE PLANNING

The beautiful aspect about utilizing a solar system is you can locate that home / cottage anywhere...you're not constrained by utility lines!

The only catch is the solar array needs full sun exposure. That means the solar array needs to face DUE SOUTH (Northern Hemisphere) and receive full sun from morning to night. Any shading, at anytime of the year, will drastically reduce solar output.

SITE AND BUILDING PLANNING

1. Full sun exposure through out the day
2. No shading on modules...not even on a corner!
3. Full sun exposure during winter months. Take into account the Sun is much lower in the sky during winter months.
4. Array must face due south

HOME DESIGN

By designing the home bases on energy efficiency and conservation, tremendous savings can be realized. Rule of Thumb: For every $1 that is spent on energy conservation, roughly $4 will be saved on the solar system!

HEATING AND COOLING

Heating and Cooling can be one of the biggest loads/expenses placed on the home. This is where passive solar energy design becomes extremely important.

Heating:

1. Passive Solar...use the Sun! With a properly designed home, the Sun can take care of the majority of the homes heating. During the Winter when the Sun is low in the sky, it is able to heat the home throughout the day. With a properly insulated home, the heat generated during the day will slowly be released through the night.
2. Conventional Heating system. Since the skies are not cloud free everyday, it is important to have a conventional heating system in place. There are various options, some better than others

· Wood Fireplace: modern, efficient fireplaces burn much cleaner and use less wood. The wood fireplace can provide much of the required heat from a renewable source. A wood fireplace can be used with any other heating system and is highly recommended for off-grid living.

· Hydronic Heating: the most efficient system is a hydronic (in floor heat) heating system. By utilizing a gas boiler to heat the transfer fluid, the only electric draw are the circulation pumps, which are relatively low. The best option.

· Forced Air: with modern, ultra high efficient gas furnaces, gas consumption has drastically been reduce compared to older models. However, force air furnaces still require a blower (fan) to distribute the warm air through out the home, which can draw significant amount of electricity... …500-600W per hour.

· Outdoor Wood Boilers: there are several options available for wood burning outdoor boilers. Depending on size, these boilers can heat more than one building.

Bottom Line

When choosing a heating system, efficiency is the most important factor. The heating system that requires the least amount of electricity is going to be best suited for a solar system.

NOTE: Resistive heat loads, such as electric heaters, cannot be used. This is simply due to the amount of electricity that these type of heat sources use.

SITE AND BUILDING PLANNING

Cooling:

A properly designed passive solar home will take into account that the Sun is "high in sky" and not allow the Sun to drastically heat the home. Other design features, such as properly placed windows, will allow air circulation and cooling via convection.

It is possible to run an air conditioner off of a larger solar system, however, the run time might be relatively short. The air conditioner may be run an hour or two before bed. Of course, if an appliance like an air conditioner is a must, the solar system will have to be large enough to account for this.

Heating and cooling is a very important aspect in a home, so a
properly designed systems from the onset will save money and allow the solar system to provide adequate performance.

REFRIGERATION

Today's refrigerators and freezers are much more efficient than models 4-5 years old. When choosing refrigeration appliances, it is most important to choose appliance with the best ENER STAR rating available. A typical high efficient 18.8 cu ft fridge and freezer will consume around 325 kW per year.

APPLIANCES

Today's homes have a wide range of appliances. Off-grid homes can utilize these modern appliances too:

· Range / Oven: Gas with a automatic pilot light.
· Microwave, toaster, blender, vent fan, kettle are fine.
· Coffee Pots are fine...or better yet, try a French Press.
· Dishwashers can work. Many people choose to hand dry / air dry dishes instead of using the electrical heavy drying cycle.
· Most of the common appliances that typically are used for short amounts of time work just fine with solar.

WELL PUMP

Well pumps suck a lot of juice! A well pump that is mated to a poorly designed pressure system / domestic water system can result in excessive power consumption due to heavy well pump use. When it comes to drilling the well, it is best to only drill the well and install the pump at a later date. The pump can be installed once it is determined which pump will work the best with the home.

There are high efficient pump options, such as the Grundfos SQE, which is extremely efficient and ideal for use with solar. Although the pump is more expensive, the high efficiency ensures less solar system is required, thus saving money. It best to advise the drilling contractor of your solar plans and the need to utilize the most efficient pump system available.

The Golden Rule: "For every $1 spent on energy efficiency and conservation, $4 dollars will be saved on the solar energy system"

When planning a off-grid home, a focus on utilizing the most efficient building practices and appliances will drastically lower the cost of the solar energy system.

SOLAR SYSTEM PLANNING

This section will provide a brief overview on how to plan the installation of the various sub systems for a solar off-grid system.

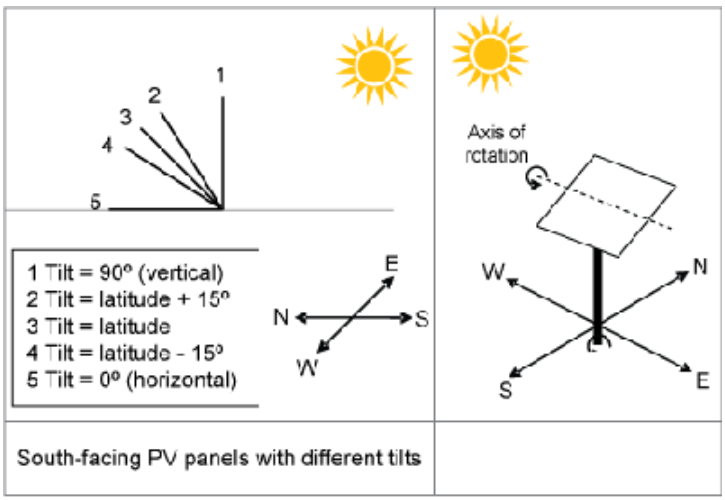
SOLAR PV ARRAY

Having a properly placed solar array will allow efficient energy production - which is critical when it comes to living off-grid!

1. DUE SOUTH: However, depending on the location, the solar array can deviate 15 degrees to the East or West. This may be done to avoid shading or to capture additional Sun that my be more prominent from a particular direction.

2. NO SHADING! Any shading, even an a small portion of one solar modules will drastically reduce output. It is important to do what is required to receive full Sun throughout the day. This may mean removing trees or elevating the solar array.
3. FULL SUN: It is important to receive sunlight from sunrise to sundown. At a minimum, full sunlight from 9am - 4pm.

MOUNT LOCATION: Mounts can be placed on the ground, on a wall or on the roof. Most off-grid system have the solar array mounted on the ground as this allows easy access for adjustments and cleaning; snow, ice and dirt. The mounts can also be integrated with a fence, building or other structure to help the array blend in with the surroundings. However, it is important to remember to situate the mounts so there is adequate air flow around the modules. As the temperature of the modules rise, they become less efficient.

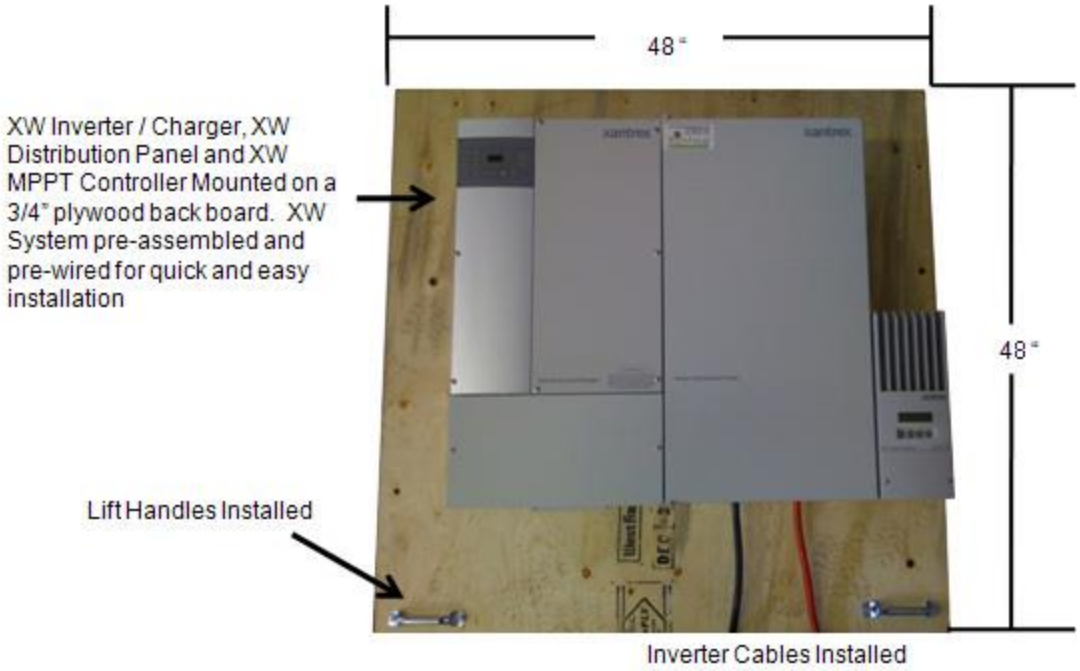


South-facing PV panels with different tilts

SOLAR SYSTEM PLANNING

INVERTER SYSTEM

The inverter system takes all that vital electricity stored in the battery bank and converters it to usable 120/240VAC for the home. It is imperative that a quality inverter system is used to ensure reliable, clean electricity for the home.



Sunfind Solar Products utilizes the Xantrex XW Power System, which we build onto a 3/4" plywood back plate. The XW Power System needs to be mounted within 10' of the battery bank. The inverter system simply feeds a 200 amp 120/240VAC split phase panel that is found in any standard home.

Once the inverter system is mounted on a framed wall, the lift handles can be removed and the plywood mounting plate can be dry walled over, making for an aesthetically pleasing installation. The inverter system needs to be mounted in a clean, warm location. Many people choose to mount the system in the home, garage, or detached shop. If the system is powering a mobile home, the system may be placed in a heated "power shed".

BATTERY BANK

The battery bank in any off-grid system is extremely important. Without a quality battery bank, living off-grid will not be enjoyable!

For the majority of our systems, Sunfind Solar Products utilizes a L16 size battery. These batteries are a 6v, 370AH battery. With proper sizing and maintenance, the average lifespan of the 6V batteries are 8-10 years.

SOLAR SYSTEM PLANNING

Mounting location

The battery bank needs to be within 10' of the inverter system. When building a new home, a specific area can be designed to house the batteries. As long as the batteries are house in a lockable, vented enclosure, the batteries are perfectly fine inside. It is important that the battery enclosure is designed for easy access to all the batteries for routine maintenance in the way of checking and adding battery fluid (distilled water).

For optimal performance, the batteries need to be house in a location that is kept at room temperature. This allows the batteries to store their full capacity, which drastically reduces generator run time, especially in the winter months. A properly housed and maintained battery bank will be extremely reliable and provide up to a decade of trouble free power storage.

SOLAR SYSTEM PLANNING: GENERATORS

With full time off-grid solar systems, a back-up generator is part of a properly designed system.

- Commercial: 1,800 RPM or 2,800 RPM: Great value.
- Industrial / Prime Power: 1,800 RPM. Most reliable.
- Residential / Stand-by: 3,600 RPM. Least Reliable.

How do I choose?

1. Commercial generators offer a great balance between prime power and stand by generators. With proper maintenance, these generators are able to offer over 6,000 hrs before rebuild. These generators are typically installed inside a heated building.

2. Industrial / Prime power generators are able to provide over 10,000 hrs before rebuilt. Diesel generators are capable of 20,000 hrs with proper maintenance. These generators are typically installed in a heated building.

3. Residential / Stand by generators, with proper maintenance, can last 3,000hrs. These generators are typically installed outdoors. (no warranty in off-grid applications)

Commercial generators generally offer the best value. These generators can automatically start and stop, providing seamless, automated operation and offer great reliability.

Generator location

- The generator AC output needs to tie into the XW Power System's AC Input, so closer to the XW Inverter / System means less cable
- Indoor installation in a heated building is ideal. This keeps the generator above freezing, making operation much more pleasant during the cold winter months. Reliability and longevity is also increase with indoor installations.

NOTE: The are proper building techniques which allow a stationary generator to be installed indoors. This needs to be done by qualified personal as the generator produces carbon monoxide, which can kill. The generator's installation manual is available from authorized generator suppliers.

Prime Power Generators

When it comes to a reliable, cost effective generator solution, a 1800 RPM, liquid cooled, diesel Northern Lights diesel generator will by far be the most cost effective over the system's life cycle. By following the installation manual and recommended maintenance schedule, these generators have proven, over and over, to operate up to 25,000 hours before any repairs need to be made. With this type of reliability and longevity, these generators will last as long as the PV system.

NORTHERN LIGHTS DIESEL GENERATORS

Northern Lights' unmatched reputation for durable and reliable power solutions began with the land-based line. From the extremes of the Arctic north slope to the deserts of the Middle East, Northern Lights industrial generator sets have proven their mettle for over four decades. With unmatched versatility and quality, Northern Lights industrials are engineered to keep the lights on with a emphasis on economic operation, but never at the expense of reliability. Whether your application is prime or stand by, Northern lights has a solution for you.

<u>6 kW NL673L3</u>

Is clean, small, and light. At less than 33 inches long, it will fit easily into your power shed or utility truck. And at 368 pounds, it can be moved between job sites without a trailer.

Ideal for the average off grid system.

<u>12 kW NL843NW3</u>

Just add a battery and fuel, and you have power at the touch of a button. To ensure ease of maintenance, all the key service points are on a common side. With proper maintenance, Northern Lights generator sets have logged over 25,000 hours.

Ideal for large off grid systems

NOTE: It is important to ensure diesel generators are run at 50-80% of rated capacity.

<u>GSC300 Auto Start Control Panel</u>

To ensure proper integration with the inverter system, it is important to ensure the GSC300 is utilized. Simply request the generator supplier to install the GSC300 control panel.

<u>Accessories</u>

Sounds enclosures, electric fuel pumps and more.

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Light Duty Generators

Light Duty generators will provide a fraction of the longevity as a Prime Power Generators. They come in both diesel and gas (gasoline / propane / natural gas). These generators utilize a 3600 RPM Engine and two pole generator. While these generators have a lower initial cost, in most PV systems, multiple units will be required over the life of the PV System (40 years).

NOTE: Sunfind Solar Products does not recommend light duty generators. This information is provided for informational purposes only.

Kubota GL Diesel Generators

If a 3600 RPM generator is required, a Kubota diesel will be the best option. With the recommended maintenance, this generator will provide up to 5,000 hrs of run time before repairs need to be made.

Pros:

1. Lower initial cost: $6,500
2. Can be purchase at most Kubota AG centers across Canada

Cons:

1. 5,000 hours of service: significantly less than a prime power unit
2. Difficult to automate with Inverter Systems. May have to manually start generator.

Stand By Generators: 3600 RPM, Air Cooled, Two Pole Generator

These type of generators offer the least reliability and longevity. These units also have NO WARRANTY when used off grid.

Cost: $2,500-$5,550 Expected Life: 500-2,0000 hours.

Manufacturers:

- Generac: *least reliable*
- Briggs and Stratton
- Onan (Cummins Onan): *Most reliable*
- Kohler

Contact Info

KOHLER

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Cummins Western Canada
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NORTHERN LIGHTS

Cullen Diesel Power Ltd
Campbell River, BC Tel: 250-286-0636
www.renownindustries.com

Marine Systems & Coastal Engine
Vancouver, BC Tel: 604-985-5326
www.marinesystems.ca

Renown Industries
Edmonton, AB Tel: 780-435-3447
www.renownindustries.com

Eco Diesel Solutions
Lethbridge, AB Tel: 403-329-4368
www.ecodieselcanada.com

Generators

GENERATOR RUN TIME

A back-up generator is required due to the amount of light we receive during seasonal changes. During the spring, summer and fall months, a solar system will typically generator enough power to meet the load's requirements. However, as winter approaches, generator run time will quickly increase.

Most applications that utilize a 2kW array will consume roughly 7kW per day during the summer months and roughly 14kW per day during winter months, with December typically be the highest generator run time month. During the winter, energy consumption will typically double due to the requirement for heating systems and lighting. During the coldest months, which typically are December and January, heating systems will contribute to the majority of electrical consumption.

THEY KEY TO REDUCING GENERATOR RUN TIME IS A PROPERLY DESIGNED SOLAR SYSTEM AND INTELLIGENT USE OF ELECTRICITY

DATA NUMBERS

All data is sourced from NASA's propriety Atmospheric Science Data Center.

- over 200 satellite-derived solar energy parameters
- 22 years of data
- solar energy data for 1195 ground sites from around the world

This is the data Sunfind Solar Products utilizes for all system sizes.

ALBERTA SOLAR INSOLATION

This is the available kilowatts per meter square per day in Alberta. This data tells us how much solar energy per day a particular solar array will produce.

JAN = 2.6 FEB: 3.7 MAR=4.8 APRIL: 5.7 MAY=5.8 JUNE=5.9
JULY=6.2 AUG=5.8 SEPT=4.8 OCT=3.7 NOV=3.0 DEC=2.8

The data shows us that during the summer months, there is 2-3 times the energy available vs. the winter months.

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Generators

GENERATOR RUN TIME CONTINUED…

GENERATOR RUN TIME:
Based on load consumption of 7kW per day during the summer and up to 14kW per day during the winter. A 2.0kW solar system is typically used in the application. Most common PV size for a off-grid home.

MONTH	PV GENERATION	CONSUMPTION	GENERATOR RUN TIME
January	156 kW	367 kW	76 hours
February	222 kW	315 kW	34 hours
March	259 kW	Less than generation	0 hours
April	273 KW	Less than generation	0 hours
May	278 kW	Less than generation	0 hours
June	283 kW	Less than generation	0 hours
July	297 kW	Less than generation	0 hours
August	278 kW	Less than generation	0 hours
September	259 kW	Less than generation	0 hours
October	222 kW	315 kW	34 hours
November	180 kW	368 kW	68 hours
December	168 kW	420 kW	92 hours

AVERAGE TOTAL YEARLY GENERATOR RUN TIME: 304 hours plus equalization. Typical generator run time per year is 200-400 hours.

It is more economical to increase the solar system to allow the generator to run 200 hrs / year verse allowing the generator to run 400 hrs per year.

NOTE: Generator run time was calculated using the Xantrex XW 4548. Generator run time will vary depending on inverter system and the size of the charger.

Generators

GENERATOR RUN TIME CONTINUED…

REDUCING GENERATOR RUN TIME

1. REDUCE CONSUMPTION

- Many off grid homes have a wood burning stove to compliment a traditional furnace / boiler system.
- Turn the heat down at night and when away
- Energy efficient lighting: Fluorescent and LED
- Adding an additional external charger to older inverter/chargers that have smaller chargers.

2. INCREASE ENERGY PRODUCTION:

- Add additional solar modules allows for more energy production, thus reducing generator run time
- Ensuring modules are orientated correctly. Due South. 65-75degree angle during winter months.

Our current SUNFIND HP systems utilize the Xantrex inverter systems. These system both provide energy production data as well as energy consumption data. This data can be compiled for troubleshooting and educational purposes.

IT IS IMPORTANT TO DISCUSS YOUR GENERATOR INSTALLATION WITH YOUR GENERATOR SUPPLIER TO ENSURE IT IS PERFORMED PROPERLY. ALSO, IT IS IMPORTANT THAT THE PROPER SAFETY CODES ARE FOLLOWED WITH ANY TYPE OF GENERATOR INSTALLATION.

There are two types of installation possibilities: OUTDOOR and INDOOR.

OUTDOOR:

This type of installation is relatively simple. This type of installation will require the generator to have a outdoor rated enclosure. Most modern stand-by and prime power generator are available with the proper enclosure from the manufacturer.

If the generator is going to be operating in colder temperatures (-5 Celsius or colder) a cold weather kit is required. It is recommended to always request this feature if your generator is going to operate in colder temperatures.

ADVANTAGES:

1. Relatively simple installation
2. Easy to supply generator with adequate air flow for cooling

Generators

DISADVANTAGES
1. Generator requires cold weather kit to allow proper operation in cold weather
2. Always the possibly of the generator not starting when required in extremely cold weather.

This type of installation are definitely most desirable for locations where below freezing temperatures are not too common. For those locations where cold weather is a concern, a decision will have to be made whether having the generator outside will be more cost effective than inside.

Points to Ponder:

1. Have the generator outside with the cold weather kit plugged in will utilize additional power. That means more generator run time during the cold months. We recommend that the cold weather kit is used if the temperature is going to be below -5 Celsius.
2. Having the generator outside does increase the chance of not starting when needed the most during the winter months.

<u>INDOOR:</u>
This type of installation is more technical and requires a little more planning.

NOTE:
DUE TO THE TECHNICALITIES OF INSTALLING A GENERATOR INDOORS, THE GENERATOR SUPPLIER / TECHNICIANS NEED TO BE INVOLVED IN THE PROCESS. ENSURE YOU DISCUSS THESE ISSUES WITH YOUR SUPPLIER SO THEY CAN PROPERLY ADVISE YOU DEPENDING ON YOUR GENERATOR TYPE.

ADVANTAGES
1. Generator is housed in a warm, safe location
2. Much easier starting during the winter months. No need to use a cold weather kit

DISADVANTAGES
1. Additional cost and planning for indoor installation: ventilation, cooling and safety.

INSTALLATION SCENARIOS:
<u>Central Power Shed</u>: This type of installation is common for installations with a mobile home. The inverter system and battery bank are housed in a insulated and heated shed. With a larger shed, the generator can be installed with the rest of the equipment. This would allow all the equipment, including the generator, to stay nice and warm even during the cold weather months.

Generators

Home with Garage: This is a common installation. While the generator should not be installed directly in the garage, a dedicated generator room can be built off of the garage. Typically this dedicated room will have a concrete floor with a heat loop installed in the floor from the main garage. This keeps the room above freezing during the winter months.

Home with Separate Shop: With a larger detached shop, a dedicated room can be built to house the inverter system, battery bank and generator. This allows the entire system to stay in a room that is heated.

TECHNICAL ASPECTS OF INSTALLING A GENERATOR INDOORS

NOTE: THESE ARE ONLY GUIDELINES. PLEASE CONSULT WITHYOUR GENERATOR SUPPLIER/TECHNICIAN TO ENSURE THE INSTALLATION IS SAFE AND WILL MEET THE GENERATORS REQUIREMENTS.

When a generator is installed and operated in an indoor environment, adequate ventilation for heat dissipation and combustion is required. Ventilation is typically done through the use of an air inlet, air outlet exhaust fan and/or other ventilation openings.

General Rules:

1. The air inlet must be capable of moving enough air through the room to provide the correct minimum Cubic Feet per Minute (CFM) cooling for the generator as specified by the generator supplier / manufacturer.
2. Locate air inlet, ventilation and air outlet opening in a structure so that already exhausted air will not be drawn back in.
3. Whenever possible, face the generator air inlet opening away from the wind.
4. When possible, position the engine of air cooled generators in line with the air inlet per manufacturer's recommendations.
5. Liquid cooled engines need to be positioned as per manufacturer's recommendations

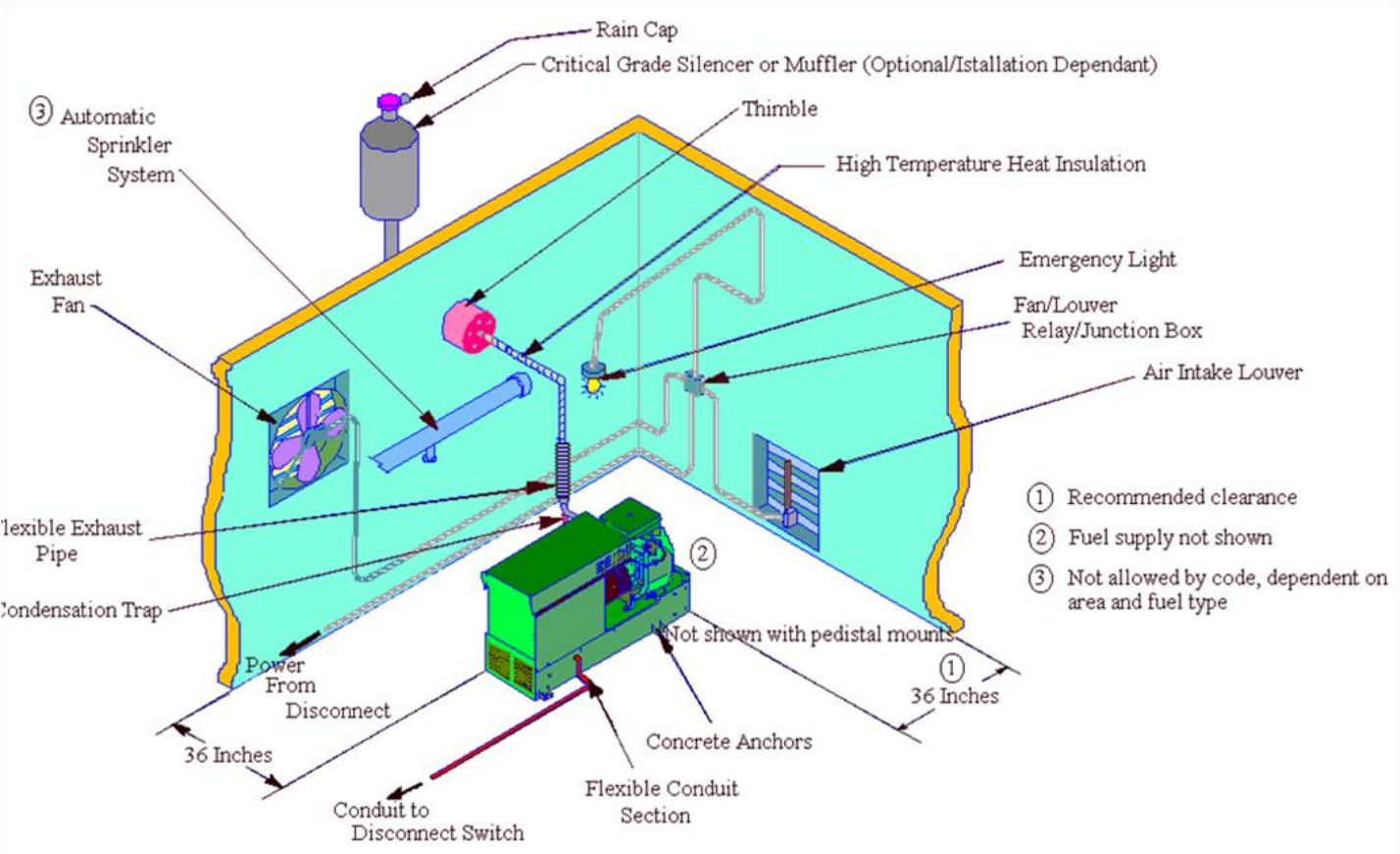
Generators

EACH GENERATOR WILL HAVE DIFFEENT REQUIREMENTS. CONTACT YOUR GENERATOR SUPPLIER FOR MORE INFO.

Some indoor installations may require the use of one more exhaust fans / air inlet louvers to provide adequate ventilation during generator operation. If the items are required, here are some general rules:

1. Exhaust fans must have the proper capacity for the specific application
2. Fans must me located so that engine exhaust gases will not re-enter the building.
3. Power is required to operate the exhaust fan / louvers. This power can be provided directly from the generator. This allows power to be applied to these loads only when the generator is running.

Ensuring that the generator is properly installed is going to ensure the generator system will operate easily and efficiently with the solar system. When it comes to installing the generator, generator installation requirements will need to be provided from the generator supplier.



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BATTERY CARE

It is critical to regularly monitor your battery bank to ensure proper performance and longevity. With proper maintenance and care, your battery bank can provide years of reliable and trouble free power. Two proper tools that are critical to battery maintenance: These tools can be had at popular outlets like Canadian Tire for around $30.00

1. A voltmeter-allows to you to measure DC voltage
2. A Hydrometer-measures the battery's specific gravity.

Hydrometer

It is important to choose a hydrometer with a weighted bulb and cylindrical stem, which will float upright in a glass cylinder. Fluid is drawn into the glass cylinder and the weighted bulb will float and registers the density of the electrolyte.

Voltmeter

This is just a simple voltmeter that allows you to measure DC voltage. Both these tools are critical to monitoring battery voltage. Both the hydrometer and Voltmeter can be purchased for less than $20.00.

It is critical to monitor Specific Gravity (SG), as specific gravity readings provide the battery's charge level and health. It is important that specific gravity test are performed once a month to ensure batteries are properly monitored and any deviations can be corrected before they become a problem.

CHARGING CYCLES

Most modern chargers have a 3-stage charging cycle:
1) Bulk 2) Absorb 3) Float

1. Bulk: The bulk cycle applies the full charge capacity to the battery bank until it reaches its bulk voltage setting. Bulk voltage is typically set at 58.8V / 29.4V / 14.7V

2. Absorb: During this cycle, the charge current is reduced as needed to maintain the absorb voltage. The Absorb cycle is where is where the battery capacity is fully restored. If the absorb cycle is not long enough, the batteries will experience constant undercharging, resulting in sulfated batteries. The absorb voltage setting is typically 58.8V /29.4V / 14.7V. Most absorb cycles are set at 120 minutes for the inverter / charger and 240 minutes for the solar charge controller.

3. Float: During this cycle, the batteries are considered fully charged, so a slight charge is applied to maintain charge. The voltage setting for this cycle is typically 56.4V / 28.2V / 14.1V

ADDITIONAL NOTES: ABSORB CYCLE

1. While typical absorb times are between 120-180 minutes, it is important to monitor the battery bank to ensure that your particular absorb cycle is correct.

2. How do I know my Absorb cycle is long enough?
As the battery reaches fully charged, the rate of charge is reduced. For most batteries, a rate of charge (ROC) of C/50 indicates a full battery. As a rule of thumb, once the ROC = C/50, the absorb charge cycle is complete. It is recommended when the system is first put into operation that the batteries specific gravity is checked once a week after the batteries transition to float. The specific gravity should return to 1.260-1.270. If the specific gravity has not reached this level when the absorb cycle is complete, the absorption time needs to be increased.

3. How do I calculate the Rate of Charge (ROC)?
ROC = Output from the charging source (either the solar array or inverter/charger) AND C = Battery bank capacity C/50 = ROC. If you have a 370AH battery bank, the formula is as follows: 370AH/50 = 7.4AH. So, with a 370AH battery bank, the charging source needs to remain in absorb until the charge rate reaches 7.4 amps. Take some time to monitor your system and ensure the absorb cycle remains in absorb until the rate of charge equals C/50.

4. Programming changes. If you need to change the absorb time, modern inverter / chargers can be supplied with a system remote, which will allow system programming changes. All SUNFIND CTTG and SUNFIND HP Systems include the appropriate system remote to make these changes.

It is important that the batteries experience the programmed absorb cycle each charge cycle. The reason for this is if a battery is continually undercharged, it will sulfate and its life will be significantly shortened with a noticeable performance drop. A sulfated battery also requires lengthy equalization cycles to restore the battery. And in some cases, the battery can be damaged beyond recovery. Battery denegation due to improper / undercharging is not covered under warranty! In the winter months, it is important to have the generator set-up to start charging if the batteries reach 50% of charge (48.5V / 24.3V)

INSPECTION AND PREVENTATIVE MANTENANCE:

Recommended Items:
Distilled Water
Voltmeter Hydrometer
Goggles & Gloves

CAUTION: Always wear protective clothing, gloves, and goggles when handling batteries.

When a battery is first received the cell acid levels should be checked and the battery should be put on charge. After removing from charge the specific gravity readings of each cell should be recorded and kept for the life of the battery. If the electrolyte levels are low before the battery is put into service do not add water but contact the battery manufacturer. Only add water as it is consumed.

BATTERY CARE

Preventive maintenance involves, at a minimum, checking the cell electrolyte level for correct acid volume once a month and equalizing according the “equalization schedule” on page 3 . The cells should be watered back to the original acid level which is 1/4 " below the bottom of the vent well. Distilled water is preferred but local water (not chlorinated) maybe acceptable if it is not "hard" or does not contain high iron levels. Use of non-distilled water can cause mineral build-up in the battery cell.

The minimum recommended preventive maintenance program is summarized as follows:
1. Water each cell to original level as required
2. Equalize according to the “equalization schedule”
3. Record the specific gravity readings of the “pilot cell” every month
4. Record the specific gravity of each cell before and after the equalization in September, December and April.

Occasionally cleaning the battery terminals and case / cover is a good practice and recommended. A weak solution of household baking soda and water can be used to neutralize any spilled acid. Make sure the vent caps are securely tightened and NO soda solution gets into the battery cells.

Good record keeping is stressed as review of these records can help to determine the "health" of the battery and can prove invaluable if system problems develop.

When the bank is first put into service a pilot cell should be monitored to assure the batteries are being properly charged. Measure and record the specific gravity of the pilot cell when the battery is thought to be fully charged (after the bulk charge) and compare this with the previous reading.

Specific Gravity Test
1. Do not add water at this time.
2. Fill and drain the hydrometer 2 to 4 times before pulling out a sample.
3. Ensure the hydrometer is not “sticking” to the side of the tube.
4. There should be enough sample electrolyte in the hydrometer to completely support the float.
5. Take a reading, record it, and return the electrolyte back to the cell.
6. To check another cell, repeat the 3 steps above.
7. Check all cells in the battery.
8. Replace the vent caps and wipe off any electrolyte that might have been spilled.
9. Correct the readings to 27 Degrees C (80 F):
10. Compare the readings to the chart

TEMPERATURE CONVERSIONS

Add .004 to readings for every 10 Degrees C over 80 Degrees F

Subtract .004 for every 10 Degrees below 80 Degrees F.

40F = 4.4C	70 F= 21.1C	100F = 37.8C	130F = 54.4C
50F = 10C	80F = 26.7C	110F = 43.3C	
60F = 15.5C	90F = 32.2C	120F = 48.9	

Percentage of Charge	Specific Gravity 27 Degrees C	Open Circuit Voltage (No load/charge)		
		12V	24V	48V
100	1.260-1.270	12.73	25.46	50.93
90	1.245-1.255	12.62	25.24	50.47
80	1.225-1.235	12.50	25.00	50.00
70	1.205-1.215	12.37	24.74	49.49
60	1.180-1.190	12.24	24.48	48.96
50	1.160-1.170	12.10	24.20	48.41
40	1.135-1.145	11.96	23.92	47.83
30	1.110-1.120	11.81	23.63	47.62
20	1.085-1.095	11.66	23.32	46.63
10	1.060-1.070	11.51	23.02	46.03

Temperature Compensation

As batteries are charged, and especially equalized, the temperature can increase significantly. Also, the increased heat also increases the battery's resistance to a charge. If batteries climb to 46 degrees Celsius, equalization needs to be stopped to allow battery bank to cool.

PREVENTATIVE BATTERY EQUALIZATION SCHEDULE

January:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

February:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

April:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

September:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

November:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

December:
equalize at 62 V / 31V / 15.5V for a minimum of 2 hours or until a Specific Gravity of 1.260-1.270 is reached.

CORRECTIVE EQUALIZATION

Corrective equalization needs to be performed if symptoms arise such as a constantly running generator (low capacity) or the battery bank will "not hold a charge". These symptoms are typical of a heavily sulfated battery.

If a battery is not being fully charged on a regular basis or limited equalization is performed using a generator, sulfation will occur from "deficit" cycling. This undercharge condition can take months before it becomes a major and noticeable problem. This under charge condition is caused when batteries are deficit cycled. The bank receives less of a charge each cycle and starts to sulfate. Eventually the sulfate will cause a resistance to charge and a "false high voltage" reading will occur.

The "false high voltage" is measured by the charge controller, which further lowers the charging current to maintain the voltage set point. This further increases the undercharge condition. This is one reason why specific gravity measurements are so important as "false high voltage" readings can be misleading.

Amperage hour meters can compound the problem and cause people to believe they are returning the correct amount of energy back into the batteries to maintain a good state of charge. Amp-hr meters should be thought of as simply a fuel gauge that does not measure state of charge directly but indirectly. You should always confirm, at least initially, state of charge by taking a specific gravity measurement of one cell when it is thought the bank is fully charged.

CORRECTIVE EQUALIZATION CONTINUED…

Corrective Equalization can take a very long time depending on the degree of sulfation.

1. Temperature should be monitored very, very closely and keep below 50ºC.
2. Once an hour, measure and record the specific gravity and temperature of a test cell. If the temperature rises above 46ºC and approaches 52ºC remove the batteries from charge. (For temperature measurement choose a center cell, if applicable)
3. If severely sulfated, it may take many hours for the specific gravity to rise.
4. Once the specific gravity begins to rise the bank voltage will most likely drop or the charging current will increase.
5. Continue measuring the specific gravity until 1.260-1.270 is reached.
6. Charge for another 3 hours.
7. Allow bank to cool and check and record the specific gravity of each cell.

NOTE: Adding distilled water will dilute the battery acid and alter specific gravity readings. It may be necessary to equalize the batteries a couple of times before the added distilled water is fully recombined with the battery electrolyte.

To avoid this situation it is recommended that a specific gravity reading of one pilot cell is measured and recorded once a month when the bank is fully charged. The measurement should be compared to previous readings. If the measurement is lower than the previous reading a longer absorption time and higher voltage setting should be used. Note as stated above, the longer the absorption time and the higher the bulk voltage, the more water will be consumed but less equalization will be required.

Note: the specific gravity should rise as the cells use water. Look for trends in the specific gravity over a period of time and make very small adjustments as necessary.

SOLAR SYSTEM SIZING

An improperly sized system is not going to meet expectations and will cause disappointment. Sizing can be monotonous and time consuming, however, in the end, it is worth the time and effort when the solar system is working exactly as intended.

The first step is determine the loads that are going to be run. Sunfind Solar Products can provide a sizing sheet in which to record the appropriate appliances and values. We keep the sizing process to a "hands on" process, as this yields the most accurate results.

In recent years with the tremendous focus in energy efficiency, many of today's common appliances are significantly more efficient than years past. These appliance also carry a EnerGuide rating stating the expected energy consumption per year.

APPLIANCES

Computers, Fridges, Freezers, Dishwashers, Furnaces / boilers, hot water heaters, etc now carry a EnerGuide rating stating the electrical consumption per year. With this figure, we can calculate the energy consumption per day. It is important to have this information available when sizing a system.

LIGHTING

Compact Fluorescent Lighting (CFL) is the most economical choice for solar energy systems. CFL bulbs use rough 1/5 of the energy and last 8 to 15 times longer than incandescent bulbs. The technology of CFL bulbs has improved allowing much better cold weather starting and light emission. Many "soft light" CFL bulbs produce light much closer to a traditional incandescent bulb.

Once all of the loads have been accounted for, along with the energy consumption, sizing can begin for the solar system that will meet the energy consumption needs.

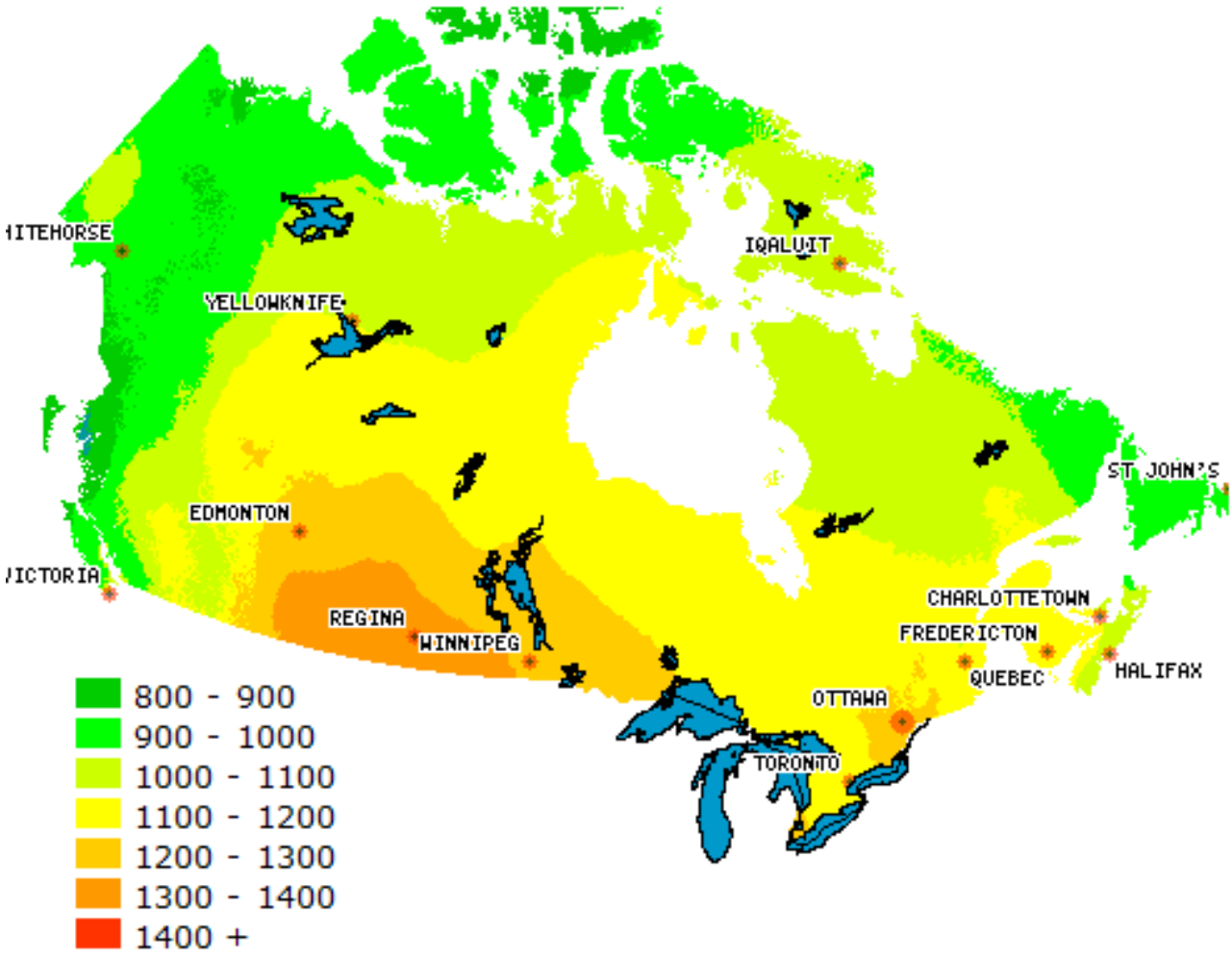
SOLAR PV ARRAY

Solar modules provide three main criteria when it comes to energy production:

1. Wattage
2. Voltage
3. Amperage

Solar module output will be determined by the time of day, weather, temperature, time of year and efficiency factors. Sunfind Solar Products utilizes comprehensive solar insolation data provided by NASA. This allows us to determine the solar insolation of points around the globe based on location coordinates. To properly size a solar array, solar insolation values are critically important.

The Illustration on the next pages provides a general overview of solar insolation across Canada.



The solar insolation chart provides estimated energy production across Canada on a annual basis based on a 1 kW array. So, a 1 kW solar array in Edmonton will produce between 1300-1400 kW per year. In Regina, a 1 kW solar array will produce 1400 kW and up. This figure is based on a fixed array angle equal to the location's latitude.

Adjustable solar arrays will allow increased power production as adjustment can be made in relation to the Sun's height throughout the year. By vertically adjusting a solar array for the winter months, solar output can be increased by 25-30%. A must for off-grid users!

SOLAR SYSTEM SIZING

INVERTER SYSTEM

When it comes to inverter sizing, it is important to take into account all of the loads that are going to be operating at any given time. The inverter's continuous load rating needs to exceed the continuous load draw from the home.

Peak loads, such as compressors, welders and other larger electrical loads, depending on size, may be able to run off of a single inverter configuration. If the home contains these larger loads, there are two options:

1. If the large electrical loads are used periodically, most people opt to run the generator when these loads are required.
2. The second option is to stack the inverters (combine multiple units together) to achieve the related capacity.

Sunfind Solar Products provides either a 4.5kW or a 6.0kW inverter system in our SUNFIND HP Systems, as this inverter size is suitable for the majority of systems. Of course, when we look over the sizing data, we ensure that our standard inverter system will meet the required needs.

BATTERY BANK

A poorly designed battery bank can be short lived and very expensive.

Design:

The battery bank needs to be designed in relation to solar generating capacity as well as desired back-up capability

· Have a battery bank which is too large in relation to solar array capacity will result in constantly under charged batteries, which will result in a lower service life.
· Too small of a battery bank will result in a lack of usable energy as the batteries will be drawn down too fast.

Sunfind Solar Products has designed our battery banks in our systems based on the solar-to-battery charge ratio, average back-up requirements and the ability to expand the system.

BACK UP GENERATOR

A well designed, quality back up generator system is just as important as the rest of the system. However, many people neglect this aspect and end up having a expensive and inefficient generator system. Years of experience designing and utilizing back-up generator systems has taught us what works and what doesn't.

How the Generator Systems Works:

The generators 120/240VAC output is connected to the XW Inverter System's 120/240VAC input. When the generator starts, the XW Inverter senses VAC input and automatically switches to charge mode. The charger will utilize 4,080W (85A @ 48VDC) from the generator to charge the batteries. The remaining capacity of the generator, around 4,400W, is passed through to the home.

When utilizing the sizing information, we will analyze what size of generator is required based on sizing information.

WHAT DOES THE FUTURE HOLD?

Sunfind Solar Products is extremely excited about what the future holds for those that choose to live off-grid. The next 10 years is going to provide some extremely exciting changes!

SOLAR MODULES

The cost of the solar energy, at the current rate, will be a grid parity in 10 years. With recent technical advances in solar technology, as well as manufacturing techniques, there is a growing sentiment that grid parity will be reached even sooner. Now that is exciting!

INVERTER SYSTEMS

The advancement of the inverter in the last decade has been remarkable. What is possible today, was not 4-5 years ago. Inverters also hold tremendous potential for cost reductions, as have all electronics over the last 20 years. Just think of the cost of a PC when they were first released; the cost of lap tops; the cost of flat screen televisions; the cost of cell phones and much more! The price fell exponentially over the years. We believe inverters will follow the same trend.

BATTERY SYSTEMS

With the current focus on developing clean technology, such as electric vehicles, there is a tremendous amount of effort going into developing better and more cost effective storage devices. Take for example EEstor that is developing electrical storage units that have the potential to completely eliminate the traditional battery and revolutionize the renewable energy industry. Exciting times!

Sunfind Solar Products envisions a future when a suburban home, facing a $6,000-$7,000 connection charge in a city cul-de-sac, are instead able to purchase a 3 kW solar system for around $10,000 and not have to connect to the utility.

We encourage those that want to learn more, please contact Sunfind Solar Products...we love to talk solar energy!

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Friday
7:30am-3:00pm MST