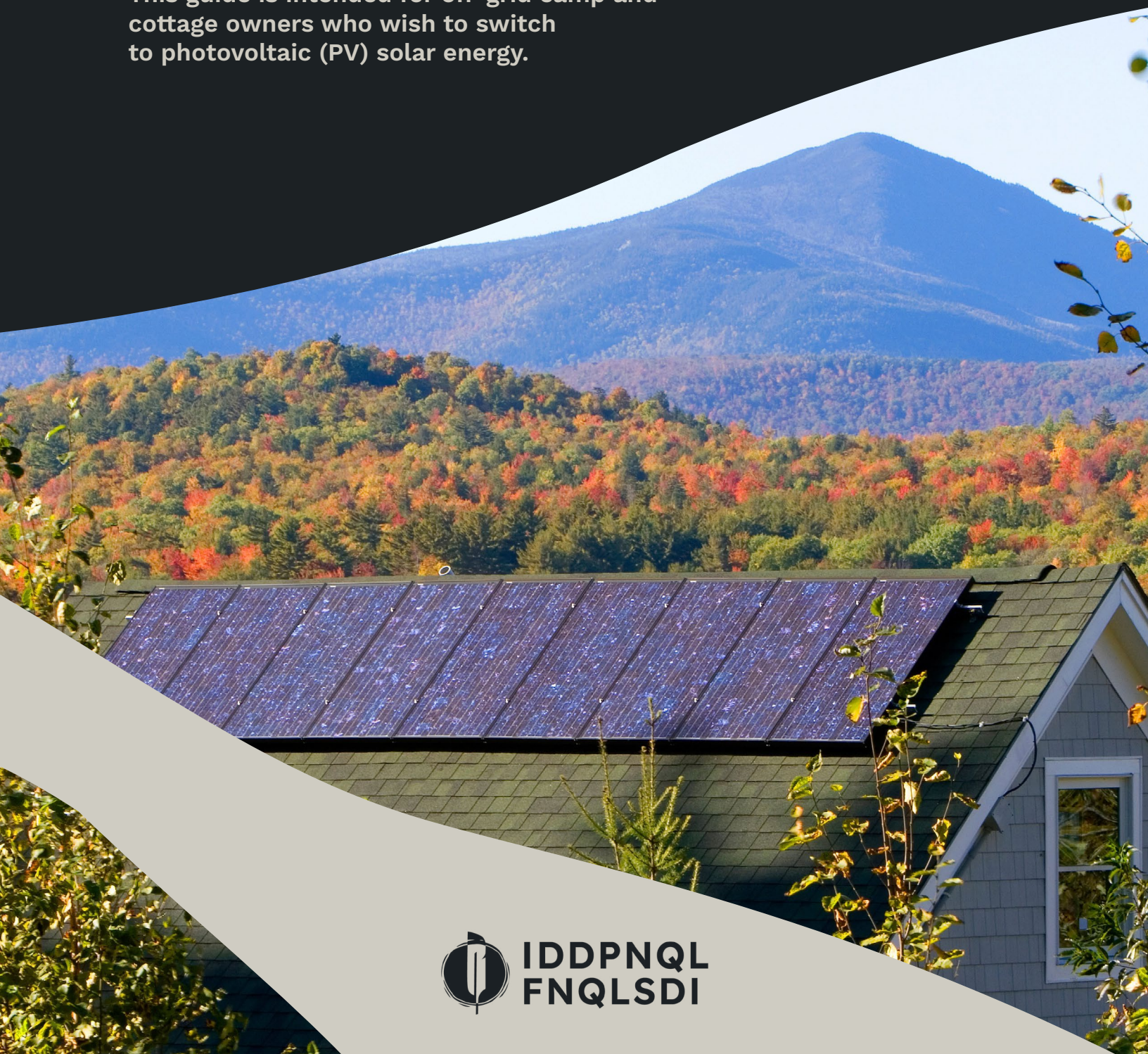
Practical guide

Solar Power for Off-Grid Cabins

This guide is intended for off-grid camp and cottage owners who wish to switch to photovoltaic (PV) solar energy.



IDDPNQL
FNQLSDI

Table of contents

Being Off-Grid

Being off-grid means that your building is not connected to Hydro-Québec's power grid, as it is often the case at a cottage or a camp.

The amount of energy available is limited, and you won't be able to run as many appliances as you would at home.

To power your electrical needs, you need to generate your own electricity, either with:

- A fossil fuel generator (gasoline, diesel, propane)
- A renewable energy system such as solar photovoltaic (panels, batteries).

The Fossil Fuel Generator

Running a generator all day for weeks on end is expensive. Fuel costs can easily reach $100 per week or more. On top of that, you will have to transport the fuel, maintain the generator and put up with the constant noise when it is running. Then there is the risk of toxic oil or gasoline spills.

An of course there is global warming, which is aggravated by everything that burns fuels like gasoline, diesel or propane.

Source: CC-BY-NC-SA David Dodge, Green Energy Futures

Solar Power - Advantages and Drawbacks

Photovoltaic solar energy offers several advantages:

→ Supplies electricity without noise

→ Does not emit pollutants

→ Lowers your fuel costs

→ Contributes to your energy autonomy.

However, there are certain limitations:

→ The energy available is limited by the power of the panels and the capacity of the batteries - so saving energy is essential.

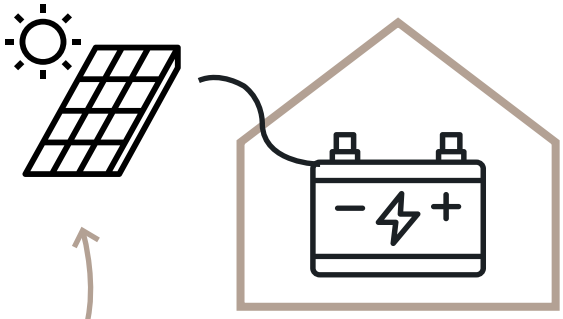
→ Solar radiation is reduced on cloudy days and in winter, sometimes requiring a back-up generator for a couple of hours a day.

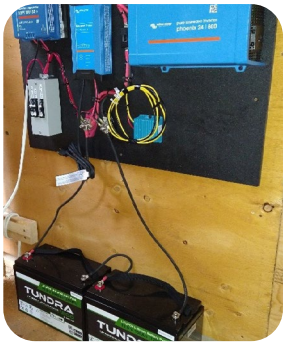
→ The system (panels, batteries and equipment) must be correctly sized and installed to meet your daily needs.

Source : sinovoltaics.com

Solar Photovoltaic Power Systems: The Basics

Photovoltaic solar power systems generally consist of two parts:

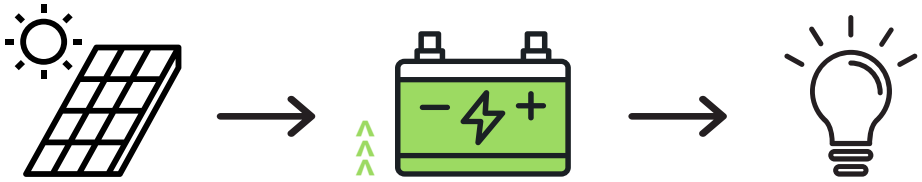




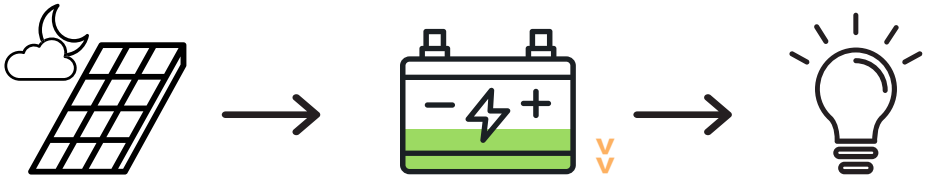
Solar photovoltaic panels that convert the sun's radiation into electricity

Batteries and electronic components which store the panels' electrical energy and make it available to use.

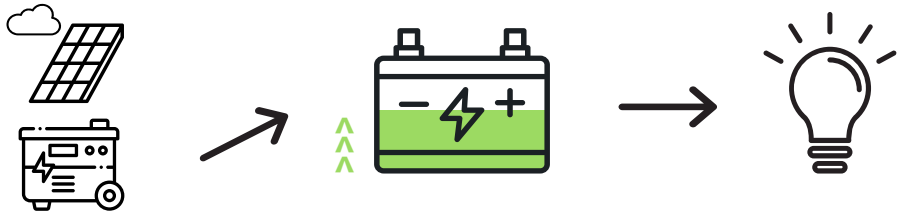
On sunny days, the panels will charge the batteries.



During the night and on cloudy days, electricity from the batteries will power your appliances. The more electricity you use, the faster the batteries will drain.



If the batteries are empty and there's no sunlight to capture with the panels, you can use the gasoline generator to recharge them. This recharge usually takes between 1 and 2 hours, after which the generator should be shut down, leaving the batteries to power your devices again.



Even without sunshine, an solar power system with batteries can save a lot of fuel, because the generator will run much less!

What are the Options for Solar Power

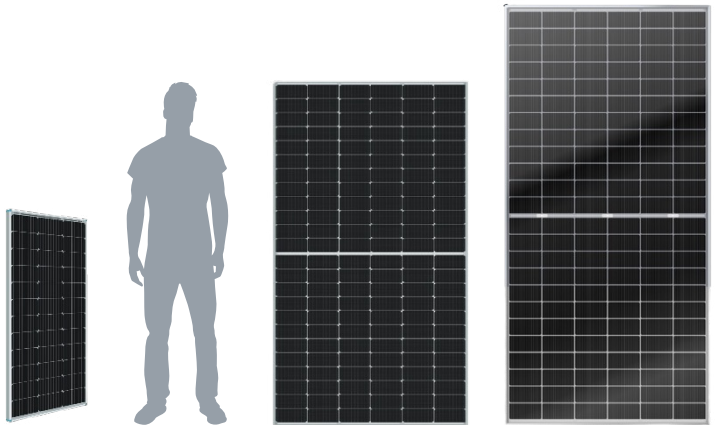
Solar Panels

The cheapest (per watt) and longest-lasting solar panels are rigid glass panels with an aluminum frame. Portable, foldable plastic panels are more expensive and last only a few years, while glass panels last at least 25 years.

Smaller panels (100 W to 200 W) can be bought over the Internet and shipped easily, while larger panels (300 W and more) must be purchased from solar equipment suppliers.

Larger panels offer a better price in dollars per watt ($/W). You can find them at $ 0.75 / W and below, while smaller panels may cost $ 1.20 / W and above.

Since large panels are expensive to ship, the ideal solution is to pick them up directly from the supplier or have them delivered in larger quantities (via a group purchase, for example).



~ 100 W **~ 400 W** **~ 550 W**

Source: Renogy, Longi Solar, Thornova Solar

Batteries and electronic components

In recent years, an alternative to classic modular systems has become available: thanks to the use of the lighter, more durable lithium batteries, portable power stations (sometimes called *solar generators*) offer a simple soution.

Source: youtube.com/@footprinthero

Modular Custom-built Solar Power Systems

These systems include: Batteries, inverters, chargers, solar charge controllers, energy monitors, battery protectors, fuses and cables, all assembled by hand on a plywood panel.

Source: Men et fils Électrique

Flexibility: Modular, custom-built systems offer the possibility of increasing storage capacity by adding batteries, or increasing solar yield by adding panels. They also make it possible to combine products from different brands.

Durability: In a modular system, you can replace broken components, and build in redundancies.

Simplicity: You need technical knowledge and special tools to assemble a modular system.

Mobility: Modular systems are permanently installed in the cabin.

Initial Cost: Even if you assemble a modular system yourself, the price will be higher than a portable power station with comparable features.

Long-term cost: Modular systems can last much longer than portable power stations. Usually only the batteries will have to replaced at the end of their life.

Portable (Solar) Power Stations

This system has more or less of the same functionality as a modular system, integrated in a box.

Source: bluettipower.ca, ca.ecoflow.com, anker.com/ca, ca.jackery.com

Flexibility: Portable power stations usually cannot be upgraded with additional batteries or additional solar charge capacity. You are dependent on one brand.

Durability: Portable power stations are very difficult to repair.

Simplicity: Portable power stations are plug-and-play. You only need the right extension cables to connect solar panels.

Mobility: Although quite heavy, portable power stations are... portable! You can (and should) bring them home, where they're protected from theft, and you can use them during power outages.

Initial Cost: Portable power stations are assembled in factories, which makes their price competitive.

Long-term cost: Portable power stations don't last as long as modular systems: the built in battery will last 10 to 15 years and can't be replaced.

How to choose?

Modular Custom-built Solar Power Systems

Opt for a modular custom-built system if:

→ You want a durable, modular option despite higher costs

→ You are able to assemble, maintain, and repair your own system

→ Your cottage is used several months a year (justifying a higher investment)

→ You have a lot of electrical appliances running at your cottage

Portable (Solar) Power Stations

Choose a portable power station if:

→ You have little technical knowledge, nor the interest to learn

→ You don't use many electrical appliances at your cottage

→ You prefer a portable solution (reduced risk of theft, multiple usage scenarios)

What System Size do I Need?

A solar system is defined by two essential parameters:

→ Panel power, measured in watts (W).

→ Battery capacity, measured in watt-hours (Wh) or kilowatt-hours (kWh).

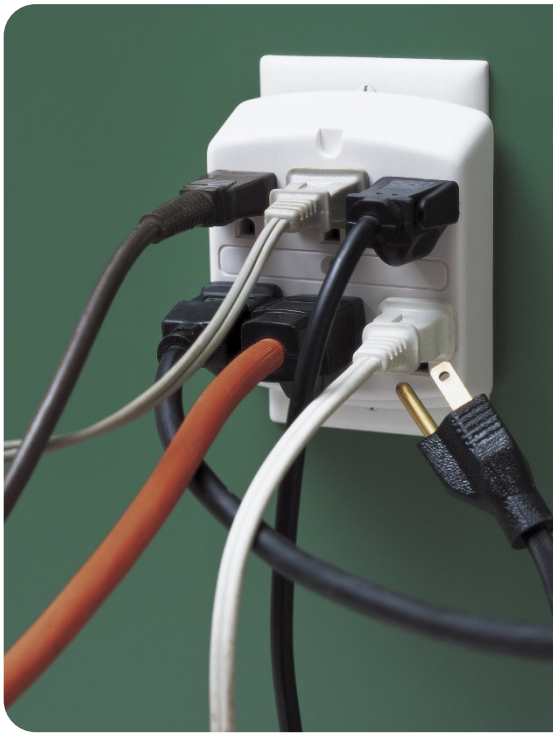
A typical system for a cottage usually looks like this:

→ Solar panels: 800 to 2,400 W (2 to 6 panels of 400 W)

→ Batteries: 2,000 to 5,000 Wh (or 2 to 5 kWh)

→ Material cost: $3,000 to $10,000

Once installed, this system can replace the generator **~90%** of the time, allowing the investment to pay for itself.



Source: Holiday Fire Safety CC-BY State Farm

Evaluate your Energy Needs

To correctly size your solar system, it's essential to understand and calculate your energy needs.

Your energy consumption depends on two key factors:

1. Appliance power

Each appliance has its own power consumption. For example:

→ A television consumes the equivalent of 10 LED bulbs

→ An electric heater can consume up to 200 times more than an LED bulb!

2. Duration of use

Some devices run all day while others only run a few of minutes.

→ Examples for continuous use: refrigerator, lighting, Internet, fan

→ Examples for occasional use: toaster, microwave, miter saw

The higher your energy consumption, the more solar panels and batteries you need. This is why energy efficiency is very important; it allows you to optimize the size and reduce the cost of your installation. See the Energy-savings section for our tips.

To find out how many panels and batteries you need, you need to calculate your typical daily electricity consumption.

To help you do that, we have developed an easy-to-use Excel calculator:

1. Download the Excel file to click here or scan the QR code below.
2. See the "Instructions" tab if you are not sure how to use it.
3. Fill in how many devices you have, and for how long you use them.
4. Optimize your choice of appliances by reading the chapter on Energy-savings.

Scan to download our calculator:

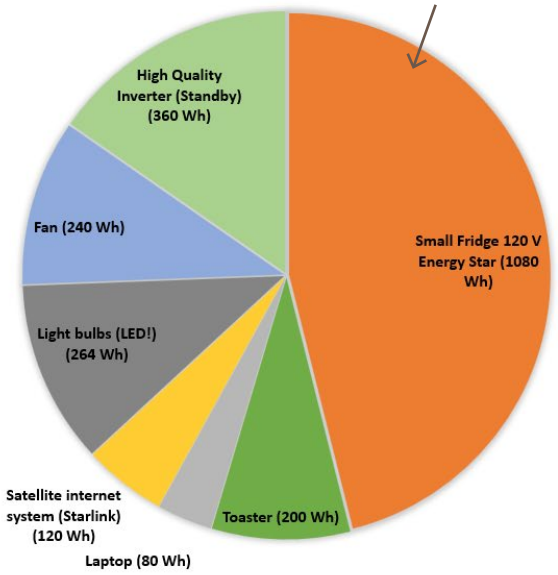
Using the Energy Calculator:

Enter the number of devices here

Enter the daily minutes or hours of use (on average) here

Here you can see which of your appliances consume the most energy. (Example) This will help you identify energy-hungry appliances.

Kitchen		Qty	Usage per day			
Fridge 12 V	12 V	0	24	h	25	
Small Fridge 120 V Energy Star	120 V	1	24	h	45	1080
Chest Freezer 12 V	12 V	0	24	h	30	
Chest Freezer 120 V	120 V	0	24	h	50	
Coffee maker	120 V	0	10	min	1500	
Toaster	120 V	1	10	min	1200	200
Microwave oven	120 V	0	5	min	1800	
Range hood fan	120 V	0	20	min	150	
Electric waterkettle	120 V	0	15	min	1500	
Electronics		**Qty**	**Usage per day**			
Sound system	120 V	0	6	h	20	
Television	120 V	0	3	h	70	
DVD player	120 V	0	3	h	20	
Game console (PS5)	120 V	0	1	h	250	
Laptop	120 V	1	2	h	40	80
Satellite internet system (Starlink)	120 V	1	2	h	60	120
Cell signal amplifier	120 V	0	12	h	20	
FM Radio	120 V	0	4	h	5	
Cell phone charging	120 V	0	1	h	15	
Other		**Qty**	**Usage per day**			
Light bulbs (LED!)	120 V	4	6	h	11	264
Water pump	120 V	0	0	h	800	
Surveillance camera	120 V	0	24	h	15	
Power tool battery charger	120 V	0	1	h	50	
Fan	120 V	1	4	h	60	240
CPAP	120 V	0	8	h	70	
Space heater (bad!)	120 V	0	2	h	1600	
Inverter (for 120 V, pick one!)		**Qty**	**Usage per day**			
Low Quality Inverter (Standby)	12 V	0	24	h	50	
High Quality Inverter (Standby)	12 V	1	24	h	15	360



Energy usage	1984 Wh
	1.984 kWh

Instructions | 1. Appliances and usage | 2. Solar PV and Batteries

In the Excel file, once you've filled in the table in the "**1. Devices and Usage**" tab, you can open the "**2. Solar PV and Batteries**" tab. Here you'll find our estimate of the number of solar panels and battery capacity you'll need.

Solar Array			
Min Solar Power (60 deg, no shading)		1300	W
Best Solar Power (Year Round Living)		3500	W
Battery Bank			
	Min energy capacity (Usable)	3100	Wh
12V	Min Battery Ah @ 12 V Lithium	260	Ah
	Min Battery Ah @ 12 V Lead-Acid	430	Ah
24V	Min Battery Ah @ 24 V Lithium	130	Ah
	Min Battery Ah @ 24 V Lead-Acid	220	Ah
48V	Min Battery Ah @ 48 V Lithium	70	Ah
	Min Battery Ah @ 48 V Lead-Acid	110	Ah

Instructions | 1. Appliances and usage | 2. Solar PV and Batteries

Here you will find the minimum recommended solar power: In this example it could be 3 panels of 400 W.

If you have a site with a lot of shade, or spend a lot of time there in winter, follow this recommendation.

Here you'll find the watt-hours (Wh) required in a portable power station.

These results will help you decide which portable power station to buy, or to contact a vendor or solar installer for a bid.

Note : Even if you have calculated your needs carefully and the installation is well planned, you may still have to use your generator from time to time. This is particularly true in winter, when sunshine is minimal, or during periods of higher-than-usual consumption. This situation is normal - sizing a solar system for these rare occasions would make it unnecessarily expensive.

Too Expensive?
The initial investment for a big solar power system is indeed considerable, and if you use your cottage only for a few weeks per year, it might not make sense to spend thousands of dollars.

Here are two strategies for reducing the cost of your installation while still enjoying the benefits of solar power:

1. Buy a small portable power station (as seen on page 6) and one or two 100 W solar panels (to power LED lighting and charge cell phones) for less than $500.

2. Repeat the Excel calculation, but only for appliances that are running for extended periods, such as the refrigerator and lighting. If you want to use an electric coffee machine or toaster in the morning, you might need to run the generator during breakfast, but the costs for your solar power system will be lower.

Energy-savings Tips

When generating your own energy with a solar system, saving energy is essential, especially on dark, cloudy days. Here is our advice:

Lighting

→ Use LED lighting, all other types of lighting use too much energy.

→ Always turn off lights you don't need!

Electronic Devices

→ Smart phones are already energy efficient

→ Charge laptops during the day, and use their battery at night.

→ Televisions consume less energy when the screen is smaller

→ Satellite Internet consumes a considerable amount of energy, especially if it is turned on 24 h per day. Turn it off when you don't use it!

→ Modern gaming consoles (Xbox, PlayStation, etc.) use a lot of energy: avoid using them!

Refrigerators and Freezers

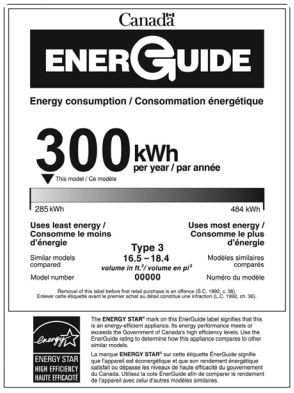
Technologies to Avoid:

→ Propane refrigerators don't use electricity, but they use a significant amount of propane over the year.

→ "Propane + Electric" refrigerators, frequently installed in RVs, are essentially propane refrigerators. The operation in electric mode is very energy intensive.

→ Thermoelectric coolers (often with heating and cooling functions) generally don't produce enough cold, and consume a lot of energy.

Recommended Technology:



→ Only refrigerators and freezers that use a compressor are efficient enough for off-grid use.

→ Normal refrigerators and freezers (120 V) are generally efficient and affordable. They must carry the ENERGY STAR symbol and consume less than ~400 kWh per year. These appliances require a high-quality inverter (e.g. Victron Energy) capable of supplying 120 V efficiently.

→ 12 V / 24 V refrigerator or freezer models are the most efficient, but due to their higher price, we recommend them only for minimalist, very efficient modular systems that don't rely on an inverter.

Usage Advice

- Don't put hot food in the fridge or freezer!
- Don't use the fridge in winter when there's little solar energy. Keep your food cold using the environment!

Kitchen

Every device that produces heat consumes a lot of energy!

Especially in winter, try using your wood-burning or propane stove for cooking or boiling water.

The appliances below use a lot of power, but it is possible to run them for a few minutes, if you have an inverter that is strong enough (2000 W and more):

→ Toaster

→ Coffee maker

→ Microwave oven

Heating and Hot Water

No matter if you are using a solar power system or a generator:

Electric heating devices should not be used off-grid!

Do not use:

→ Electric baseboard heaters

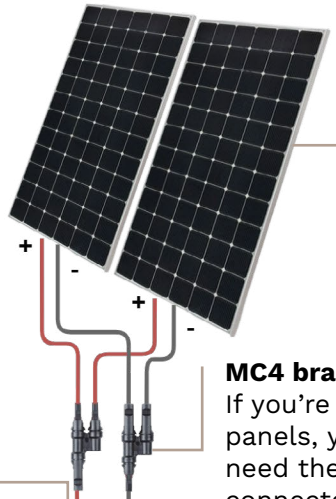
→ Electric radiators or space heaters

→ Electric water tanks

Use a wood stove or a propane water heater instead.

Portable Solar Power Stations

Portable power stations are the easiest way to use solar power at your cottage. You don't need an electrician for this installation.



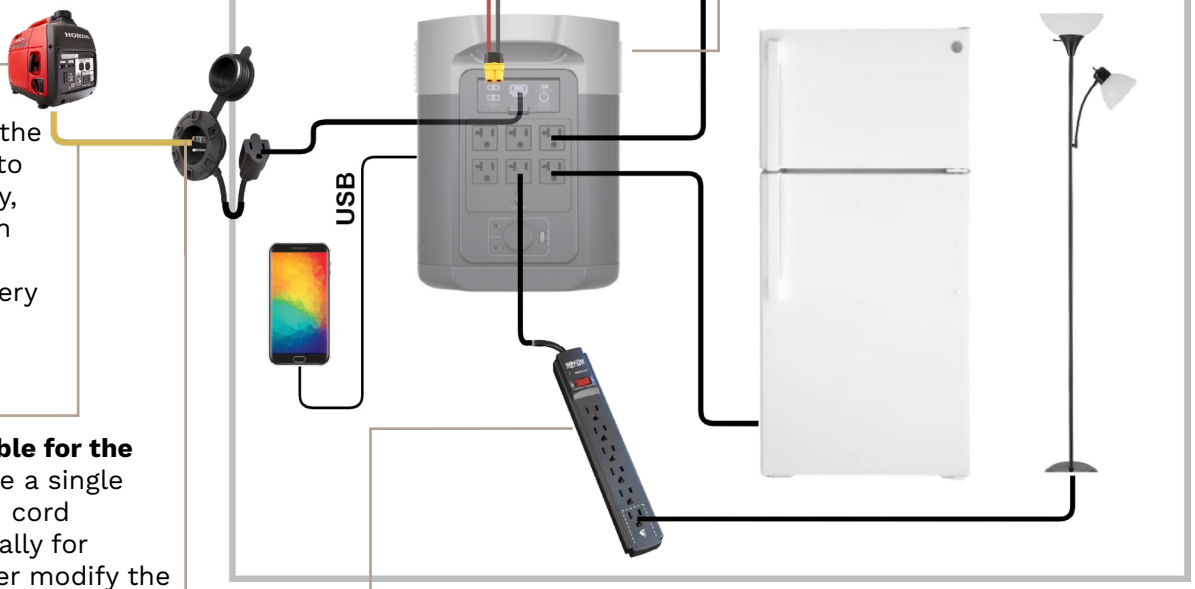
Solar panels: must be installed facing the midday sun, without shade between ~10 AM and ~2 PM. (See Where to install section)

Solar cables: bring electricity from the panels indoors. Portable power stations often come with a cable.

Portable power station: Everything you need (except solar panels and cables) in a portable box. We recommend a battery of 2000 Wh or more.

MC4 branch connectors: If you're connecting two panels, you probably need these branch connectors.

MC4 extension cable: You probably need an extension to connect the panels outdoors.



Gasoline generator: When the sun isn't enough to charge the battery, you can switch on the generator to recharge the battery quickly.

The extension cable for the generator must be a single 12 AWG extension cord designed specifically for outdoor use. Never modify the extension cord (dangerous!).

Port plug: a good way to bring electricity from the generator through the cabin wall to charge the portable power station inside.

Power bars and extension cords: You can use them to distribute electricity in your cabin, but bear in mind that the more devices you run, the faster the battery will drain!

Note: Even without solar panels, a portable power station will go a long way in reducing noise, emissions and fuel consumption, because the gasoline-powered generator will only run for one or two hours a day to charge the portable power station's battery.

Solar Panel Installation

Where to install?

Solar panels convert sunlight into electricity. This means they need **direct, unshaded sunlight** to work properly.

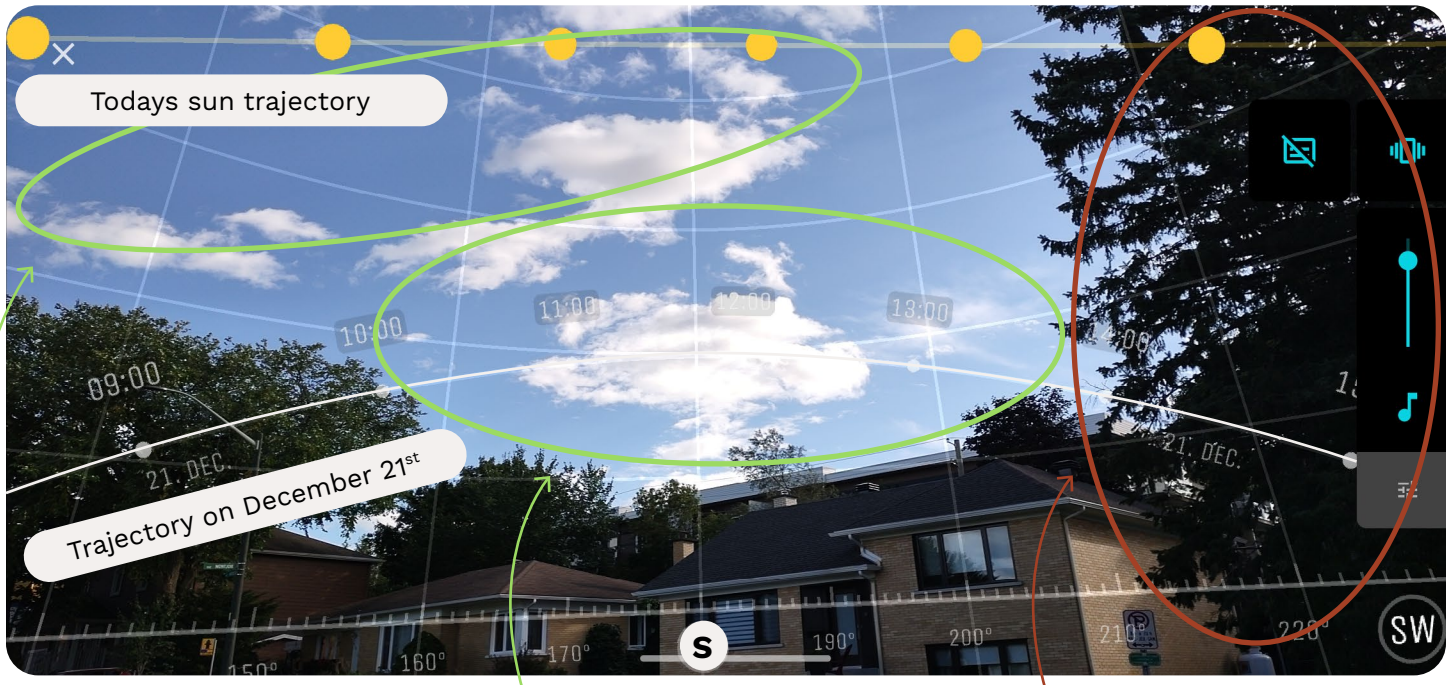
The sun is strongest around midday when it is highest in the sky. We need to find a place where there's **no shade between ~10 AM and ~2 PM**.

The midday sun is always to the south. It stands higher in summer, and much lower in winter. The panel should ideally face southwards, although east and west are also acceptable for the summer period.

How to choose the location:

Stand where you plan to install them and look south. You should be able to see the sky, unobstructed by trees, mountains and buildings.

You can use a mobile application like *Sun Position* (Android, paid version), which can show you the sun's trajectory throughout the year, thanks to augmented reality.



During the fall and spring mornings, this location is well exposed to the sun.

Even in winter, this location receives 3 hours of sunshine.

This tree throws shade in the afternoon.

How to install?

For three-season cottages, the simplest solution is to install panels on the roof, provided they are vaguely south-facing and are unshaded for several hours.

Winter is very difficult for solar production:

→ The sun doesn't rise very high and isn't very powerful

→ The days are short

→ There might be snow on the panels

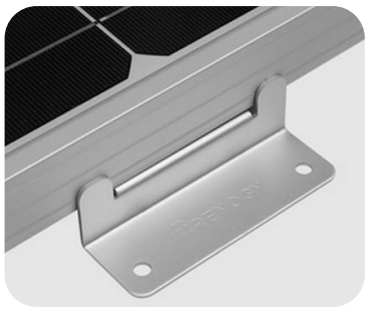
→ There are often prolonged cloudy periods

Expect to use the generator more often to charge your batteries.

Rooftop Installation

The simplest and cheapest option to attach panels to roofs or walls are Z-shaped brackets ($20-30 for 4, in online stores). These are bolted to the panel frame, then the brackets are screwed directly to the roof or wall. Be sure to use caulking between the bracket and the roof to ensure a watertight seal!

If you're working on the roof, make sure you wear properly secured fall arrest gear!



Source: ca.renogy.com

Ground Mounts

For four-season cottages, it's best to install the panels **facing south**, at an angle of at least **60 degrees**, to shed snow.

A ground mount gives you greater flexibility in terms of positioning, orientation and inclination. For 1 to 4 large panels, a wooden support is the simplest option. Mount the panels well above snow level, and make sure the structure is secured against strong winds.

Source: 3ne.ca

Frequently Asked Questions

Is solar power better than a generator?

Solar energy is clean, silent and 100% free once the equipment is purchased. However, a gasoline-powered generator is still useful in the following situations:

- → If you temporarily need a lot of power, such as on a construction site
- → As a backup or emergency power source, for example to recharge your solar system batteries on cloudy days.

Do solar panels work on cloudy days?

Not very well. On a dark, cloudy day, panel output drops to almost zero.

Do solar panels work well in cold weather?

Yes, the panels perform even better in cold weather, given there is sunshine. The problem in winter is not the cold, but shorter, darker days.

Do the panels work in the shade of trees?

Very poorly. Even small areas of shade drastically reduce energy production. Panels should be fully exposed to sunlight, and be free of leaves, branches, snow and dust.

How do I clean my solar panels?

Install them at least with a slope of 10° degrees. In low-dust areas, rain will clean them naturally. If necessary, rinse them with lots of water and scrub with a soft brush.

How do I remove snow from my solar panels?

Use a soft brush (the ones for cars). If a layer of ice remains: let the sun melt it. Never scrape!

Are solar panels toxic? Does water that touches them become toxic?

No. Solar panels are essentially made of glass and aluminum, two non-toxic materials. Only the electrical connections contain a tiny amount of lead, well encapsulated inside the panel. Water running off the panels is therefore non-toxic.

Does manufacturing solar panels consume a lot of resources?

Manufacturing and transportation do use resources, but generally much less than gasoline-powered generators, which involve extracting and transporting fossil fuels.

How long do solar panels last?

Guaranteed for 25 years, they can last even longer.

How long do batteries last?

→ Lead-acid and AGM batteries: 4-7 years

→ Lithium batteries (LFP, in portable power stations): 10-15 years

What's more, batteries are largely recyclable. Remember to bring them to the eco-center at the end of their life.

Do batteries contain toxic materials?

Yes, especially lead-acid and AGM batteries. Bring batteries to the eco-center at the end of their life to protect the soil and the water!

Are batteries dangerous?

Flooded lead-acid batteries emit a small amount of gas when charged. They must therefore be installed in an area ventilated to the outside.

AGM or LFP (lithium) batteries do not have this disadvantage and produce no gas when charged.

LFP lithium batteries (used for off-grid systems) are safer than other types of lithium batteries, but in extreme cases of mechanical damage (e.g. pierced with a nail), they can catch fire and produce toxic smoke.

Does battery production consume a lot of resources?

Battery production and transport require the extraction of considerable resources and energy. However, compared with fossil fuels, the use of electricity, which is made possible by batteries, has two advantages:

→ The use of electricity does not contribute to climate change.

→ Battery materials can be recycled and reused.

Notes

IDDPNQL
FNQLSDI

174, rue Chef-Aimé-Romain
Wendake (Québec)
G0A 4V0

Telephone: 418 843-9999
Fax: 418 843-3625

www.iddpnql.ca
info@iddpnql.ca