How-To

# Understanding Alternative Energy Sources

By Jack and Alex Wilken

When we converted our sailboat from diesel to electric power (which we wrote about in the October and November 2015 issues of *48° North*) filling the batteries took on a new significance. Whether your motivation is to be green here in our local waters or to be more autonomous on the open ocean, there are a variety of options and considerations involved in selecting an alternative energy source, storing it, and/or using your existing set-up more efficiently. There are four commonly discussed alternative sources: solar, wind, water, and fuel cells. All are renewable; so they are, in essence, self-contained, infinite sources of energy.

**Solar**

We have been looking at solar panels for more than 40 years. Atlantic Richfield Oil Co., now BP, was in the business way back then. Over the years, much has been written about the breakthroughs. Price seems to be the big fly in the ointment, but solar is much less expensive than it was in the past. In order to get maximum output from panels each one needs to have its own controller. That way a shadow on one panel will not affect the performance of the other(s). The shadow from one shroud is enough to downgrade a panel's output significantly. You see more and more sailboats with arches aft in an attempt to get the solar panels away from everything that can cast a shadow.

One of the most innovative possibilities is panels incorporated into the mainsail (Figure 1). These are very thin and flexible and have proven to hold up in stormy conditions. They are affixed to the sail or can be laminated into the fabric itself. The panels on the non-sunny side can put out as much as 30 to 40% of their rated output with ambient light and reflection.

There are also panels which have a non-skid surface so that they can be mounted on the deck and walked upon. The challenge is finding a place the will remain free of shadows. The big advantages are no moving parts, no noise, and the only required maintenance is washing off the surface when you wash your boat. These deck panels are also working for you whether you are underway or at anchor, as long as you have some sun.

The typical solar efficiency range is between 12 - 23%, but we have read printed specs as high as 28%. This basically relates to how many amperes you will get out of a given size of panel. Depending on the efficiency of the panel, you might expect from 9 to 13 watts per sq. ft. of output. A rule of thumb is to figure on full output for 5 hours a day. This can be better if your mount allows you to keep the surface of the panel at a right angle to the rays of the sun by changing position as the day goes on.

*Figure 1: Solar panels sewn or laminated into the mainsail. The arrow indicates the three rows of panels.*

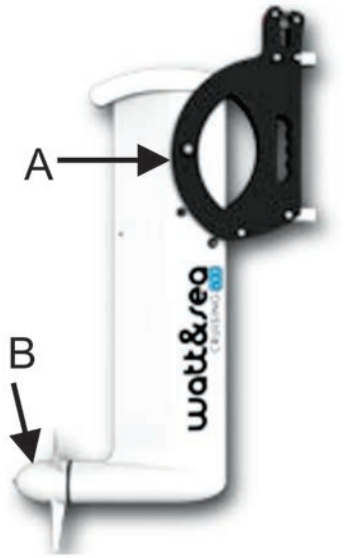


*Figure 2: "A" is a fixed unit mounted on the transom that can be swung down into the water. "B" is the propeller that is mounted directly to the sealed generator.*

**Wind**

Wind generators can put out a lot more power than solar for the same price, but they depend on wind speed for output. As long as the wind blows, it can generate day and night. The problem is we often seek to reduce the wind. Long distance trips are normally plotted so the prevailing wind (and current) are behind you, reducing the apparent wind. If you need more power from your wind generator, you could consider beating to windward for greater apparent wind; it could be more pleasant than running a diesel motor to make power! We have yet to hear of someone picking the windiest possible anchorage because of their wind generator. Newer models tend to be quieter, but, if the generator is spinning, it will make at least some noise. The wind is, of course, free.

**Water**

Trolling generators work on the same principle as wind generators-power made by spinning a propeller. This can be a dedicated trolling generator of which there are two main kinds: a taffrail trolling gen that is essentially a propeller towed on a line, or a fixed unit mounted on the transom that can be swung down into the water (Figure 2). If you have an electric drive, it can regenerate off the main propeller (Figure 3), or you can rig an alternator

to be powered off a pulley from the main drive shaft behind an engine. Normally, this would be geared to make the most of the rpms from the shaft while sailing and have the ability to disengage when powering. As long as your boat is moving through the water, it can make power. Normally, you need to get to at least 7 knots to make significant power (Figure 4). So, it won't do you much good at anchor. Also, like anything else that sticks out of the hull, it is vulnerable to impact.

**Fuel Cells**

Fuel cells are an interesting addition to the power possibilities. They use a chemical reaction to make electricity from a fuel. There are many versions running on many types of fuel. The unit itself is expensive and the fuel for the cells is normally more per watt than diesel, but fuel cells may be the power source you need with small diesel generators (less than 3 kw) becoming scarce. They provide a reliable backup for when it's overcast or calm and you need to keep your batteries alive till the wind and sun come back.

**Alternator and Battery Efficiency**

While it may not seem like an alternative power source, getting more power from an alternator for the same fuel consumption is an important part of the equation. At the moment, the main engine is the primary source of power on most boats. Standard regulators are usually automotive, which tend to be set to charge at full capacity for a short period to replace the starting amps and then drop way down for the rest of the time. Programmable, multi-stage charging from a cruising alternator regulator can reduce run time to fill batteries.

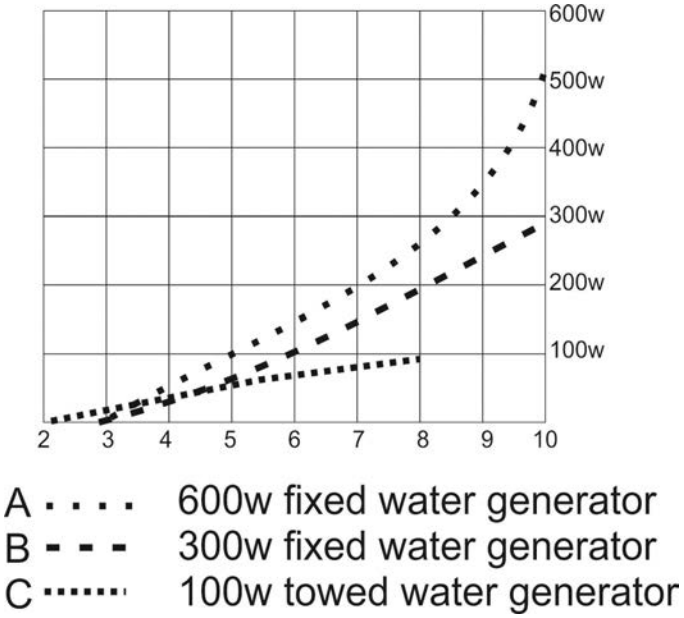


*Fig. 4: This graph shows the rated output of three water generators. "A" and "B" are fixed mount generators. "C" is towed, but the generator is also a sealed unit with the propeller mounted directly to it. These tend to be more efficient than traditional taft rail generators where the propeller is connected to the generator by a line.*

Batteries, in a way, are the ultimate alternative energy source. However you're generating power, batteries are the tank or storage facility that make the energy available to you when it is required or convenient. Any energy that is not being used or stored is being lost. So unless you only want to use power when you can make it, they are a necessity, and a critical one at that. There are many considerations for battery banks. The most important ones for alternative energy usage are size, charging times and memory.

The bigger the bank, the more excess energy can be stored and the longer it can be a power source till it must be recharged. The lower the battery's internal resistance, the faster it can absorb the charge available from a source. Even if the source is a fossil fuel powered generator, if the battery can recharge quickly, then you can stop burning fuel sooner. The most important consideration may be battery memory. Your battery capacity doesn't matter much if leaving your batteries at a partial state of charge will damage them. Lead acid batteries, with the exception of AGM carbon foam core, are susceptible to sulphation, which will reduce capacity. Lithium batteries are both immune to memory and can generally be charged in an hour. They are spendy, but they allow more flexibility.

Getting the most out of your batteries and power sources is only possible if you can monitor it, and voltage is a crude way to do so. A battery monitor can measure every amp in and out of a bank, plus, if setup correctly, a monitor can keep track of the state of charge, voltage amp hours used, and more. You want to know if your solar panels are keeping up with refrigeration? Or, can I use the inverter for another hour? A battery monitor is your friend and will help you figure out if you can avoid firing up the generator or engine.

So as you can see there are a variety of alternative power sources for your boat. The best one for you will be, as always, based on which compromises best fit your boat, usage, and budget.


*Fig. 3: Shows the Regen on our electric conversion Yamaha 33 sailboat while under sail at just over 5 knots. "A" is an arrow that points toward the battery symbol when charging is going on. "B" shows the amount of charging that is going on- in this case, 3.4 amperes plus .5 amperes that the system is using.*

*Jack and Alex Wilken are experienced boat builders and have cruised extensively. They hold USCG Captain's Licenses and are the owners of Seattle Boat Works LLC in Seattle.*