

## Cruise Without Anxiety on a Generator Supported Electric Boat

By Jack and Alex Wilken

Last year, we converted our Yamaha 33 sailboat from diesel to electric propulsion. Since then, we've made it a diesel-electric serial hybrid by adding a generator. In recent months, we have gotten some nautical

got a late start so decided to spend the night tied up at Shilshole. It was only 4 nm from Lake Union through the locks to Shilshole, but this meant that we left the next morning with our batteries topped off. Shilshole to Ludlow is 26

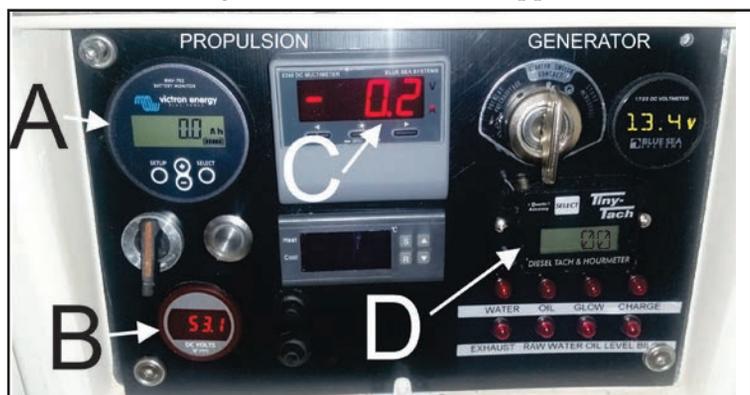


Fig. 1: "A" is showing ampere hours which, in this case, are expressed in negative numbers. "00" is full or no amps used. This is the equivalent of your fuel tank gauge. "B" is a voltmeter that is on even if the key for the electric motor is off. "C" shows amps going in or out of the batteries at any given moment. This is like a fuel flow meter and can be used to get the best efficiency from the propulsion system. "D" is an RPM meter for the generator that is not as important as "C".

miles under the keel, giving us more practical experience with the systems and the experience of cruising a hybrid to compare to last year's cruises on a purely electric powered sailboat.

These changes to the boat continue to affect change in us and how we cruise. Most of what follows is anecdotal rather than charts and formulas, because the conversion to electric propulsion is bigger than just the numbers. We feel a reorientation to boating and sailing that remains exciting and surprising. Additionally, we have some changes in the original installation. For example, some displays are easier to read than others (Figure 1) when you are out in the cockpit with bright sunlight.

This summer, three of us got underway for a 4-day shakedown cruise visiting Shilshole Bay Marina, Port Ludlow, and Eagle Harbor. We

2015 issue of *48° North*), we also started our trip with the same first night destination of Port Ludlow. On that trip we could not get to the dock and plug in quickly enough, as we were suffering from fuel tank anxiety. At that time, we had a 200amp hour (ah) battery bank.

Now we have increased it to a 300ah bank paired with a 7 kw 48vdc generator. This time, the anxiety disappeared and we anchored out.

The anxiety seems to come from at least a couple of

nautical miles. Ludlow to Eagle Harbor is another 31 nm, and then back to and through the locks to Lake Union made the trip a total of 73 nm. We anchored out at both Port Ludlow and Eagle Harbor.

In our article about cruising with purely electric power (from the November

things, one of which is the difference in fuel density between diesel and lead acid batteries; meaning for the same volume you can store more energy with diesel fuel than with a lead acid battery. Our cruising range got a lot shorter with solely electric propulsion, especially if cruising at the same speed as with diesel. We went from 275 nm with the diesel engine to 30 nm when we were using the original 200 ah hour bank. By increasing the bank to 300 ah, and, more importantly, adding the generator, we actually increased our cruising range by quite a bit in relation to the diesel-only configuration; so anxiety out, tranquility in.

The reason that there is no number for how much we increased the cruising range is because every time we stop in a marina and plug in, whether for the night or just a few hours, it is like the fuel tank elves magically fill you up.

Another anxiety producer was the availability of diesel over electricity. We felt more secure with our ability to find diesel fuel than electricity. The reality is that 110 ac current is available pretty much at every dock and marina, but for diesel you need to go to a fuel dock or lug jerry cans. We started with the same concerns, like this one, that many people interested in electric propulsion have expressed to us over the years. But, practical experience is beginning to allay them for us.

We don't tend to go to marinas for the night when we cruise in the San Juans. So, with the diesel engine, we had to run our engine almost two

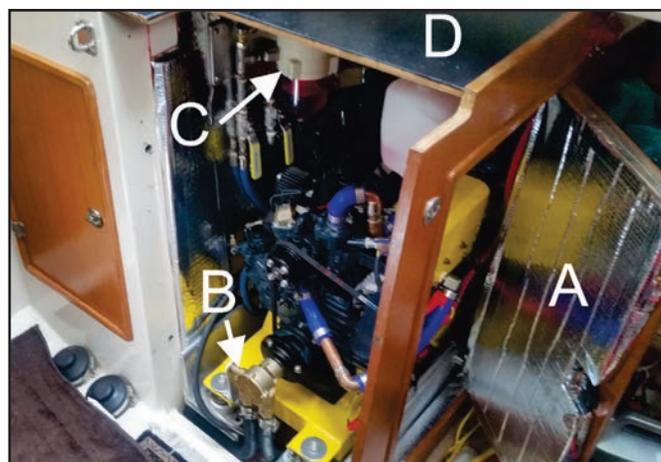


Figure 2: "A" opens to give side access, and the companion way stairs are removed for the front. "D" can also be removed to get to the top. "B" is the impeller pump and "C" is the fuel filter. Because of where we mounted the generator it can also be slid completely out for any major work.

hours each day to accommodate our normal energy usage. At anchor, this was a pain. We could have used less energy and gotten that down to one hour for refrigeration and lights, but I am 72 years old (my wife is, of course, much younger than that) and we like to watch movies or our favorite series. Also, we can increase our cruising time if we take some work, like this article, with us, but that means more energy too. Another result of age and the desire for comfort is that we use electric primary winches. All of these things are important for keeping us on the water and enjoying sailing.

In this year's case study cruiser, we did not have to run the engine or generator at anchor because of the increased battery capacity. We were able to use the propulsion bank to augment the house bank and never missed it because of the increased charge rates we experienced thanks to the dedicated generator. We could run the generator an hour a day when it was least noticeable, at times when we were underway and on deck. There are other times like going in or out of a harbor when your focus is more to the outside things like buoys, channels and other vessels when it is noticed less and therefore even less disquieting.

Apart from the night spent plugged in at Shilshole, all our electrical needs on this trip were satisfied by the larger bank, and four hours of running the generator and the propeller re-gen while sailing. The batteries were down by 1/2 their available amp hours when we arrived home. They were replenished after our trip was over by shore power overnight.

As we've cruised, we've continued to appreciate that we were able to install the generator in someplace convenient, since it no longer needs to be in line with the propeller shaft. We could mount the generator based on access, weight distribution and other conveniences (Figure 2), and we're happy with our chosen location.

There is a battery monitor on the 12vdc bank, giving us the information as to when we need to transfer energy from the 48vdc propulsion bank to the house bank. As you can see from (Figure 3), we had lots of loads to feed, not just propulsion. The electric motor is in both the "charge" and "load"

columns because of the charging that goes on when sailing and the propeller is turning.

Since this voyage, we have had many more and the pattern of charging and discharging has been consistent with the trip that we have just recounted.

I imagine you get the idea that we are enthusiastic about electric propulsion, but what is the case is that we were surprised by the difference between the abstract notion of it and the actual on-the-water experience.

The difference between sailing and motoring is no longer black and white. It is not a matter of starting and stopping the engine, but using the propeller to create inertia or using inertia to create electrons. "We torture ourselves getting somewhere,

and when we get there it is nowhere, for there is nowhere to get to." - D. H. Lawrence.

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.

CHARGE	BATTERY STORAGE	LOADS
1. 7 KW propulsion motor 2. 7 KW 48 V DC generator 3. 110 V AC to 48 V DC 20amp charger 4. 48 V DC to 12 V DC 20 amp charger	1. 300 amp 48 V DC propulsion battery bank 2. 300 amp 12 V DC house battery bank	1. Propulsion motor (Regen) 2. Refrigeration 3. Main sheet winches 4. Auto pilot 5. Computer navigation 6. GPS Plotter 7. Hydronics heater (hot water) 8. Lights 9. Pressure water

Figure 3: This chart shows the 3 elements we must balance. The batteries that we used have no memory and can be charged at their rated amp hour- 300 amps for our bank. This gives us a lot of flexibility because we can charge when it is available and not worry that we are damaging the batteries by not always returning them to a full state of charge.

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