Solar Boating 101

By Alex Borton

People always ask us “how far can your boats go?” For true solar boats, this is the wrong question. But understandable, because that is how regular electric boats work. Regular electric boats are inherently limited by their battery capacity and their efficiency. They have to return to shore power to charge. Until recently, solar was not capable of severing the tie to shore power, so it was only functional for extending range, or for partial charging. But *it’s now possible to produce a solar boat with reasonable speeds and accommodation that can continuously cruise without ever charging from the shore. Ever.* Sustainable Energy Systems has been producing boats like this since 2012. As long as it is daylight our boats get enough energy from the sun to go, even on overcast and rainy days.

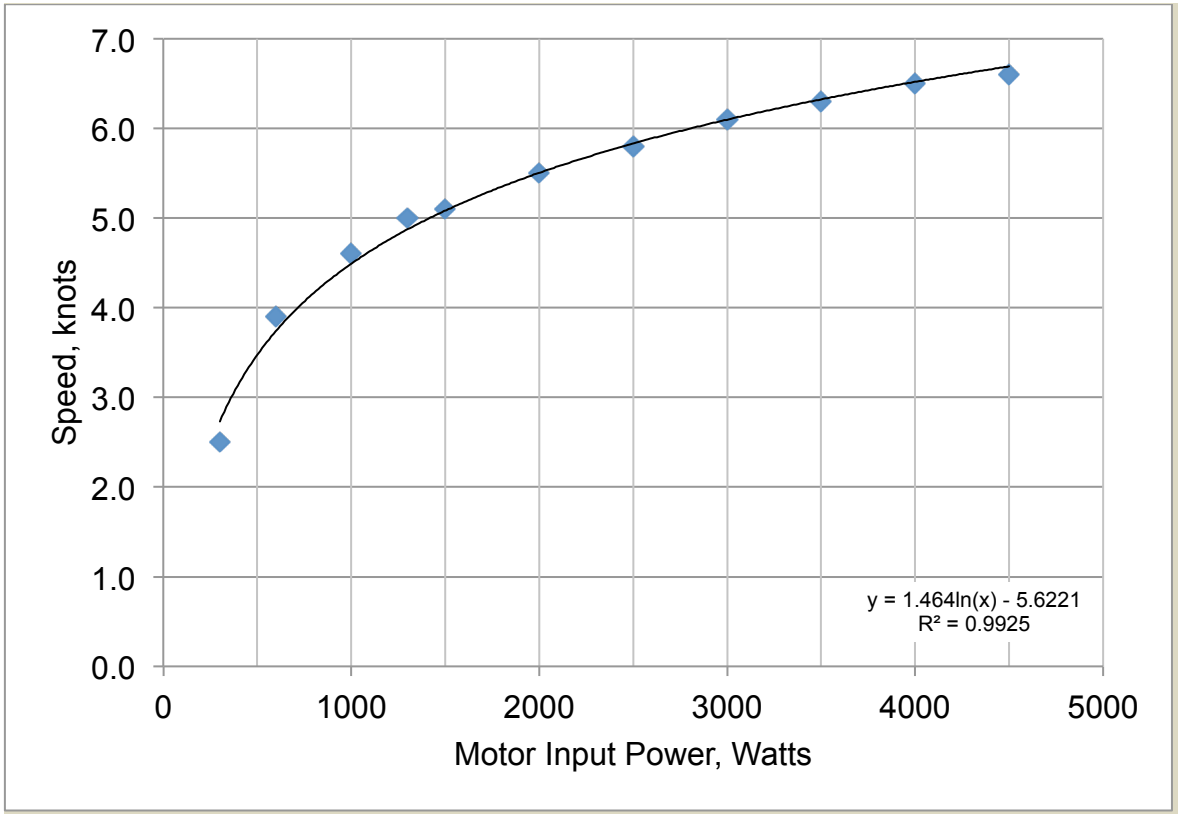
This article uses Wayward Sun as an example. She is a Solar Sal 27 model designed and built by Devlin Boat. One incomplete answer to the “how far” question is that Wayward Sun will go 80-100 nautical miles on a full charge – that is if we threw our solar panels overboard. But practically this number is not really relevant because we are always getting solar input. Empty batteries will charge in 2 sunny days, or overnight on shore power. Again, this is not the most important consideration because on a cruise we almost never drain the batteries all the way.

The relevant question for solar boats is “how fast can you go?” The unsurprising answer is faster when it is sunny and slower when it is cloudy. Let’s say we threw our batteries overboard. On a sunny day we collect enough power to move our boat between 4.5 and 5 knots. On an overcast day we get enough power to go between 2-3 knots, depending on the thickness of the clouds. Now if we assume both the batteries and solar panels manage to stay onboard - we can adjust our speed and daily distance travelled to match the conditions. Indefinitely. This is what solar boating expert Joe Grez calls solar sailing.

Below are some data and graphs that further explain how this works. Also, we are taking Wayward Sun on a 1000 nm journey from Bellingham WA to Juneau AK, embarking May 23, 2021. Follow us at www.solarsal.solar. Please note we will strictly adhere to all of the rules for a transit-through passage through Canadian waters during this pandemic. After all, we never need to stop to refuel.

On any electric boat it is easy to measure the exact power the motor is producing in Watts. Light bulbs are also measured in Watts. The graph below is actual collected data for Wayward Sun averaged over several repetitions in waters without wind or current. All electric boats have a similar curve. (All power boats also have a similar curve; it is just harder to measure the exact power of a gasoline or diesel motor at an exact speed).

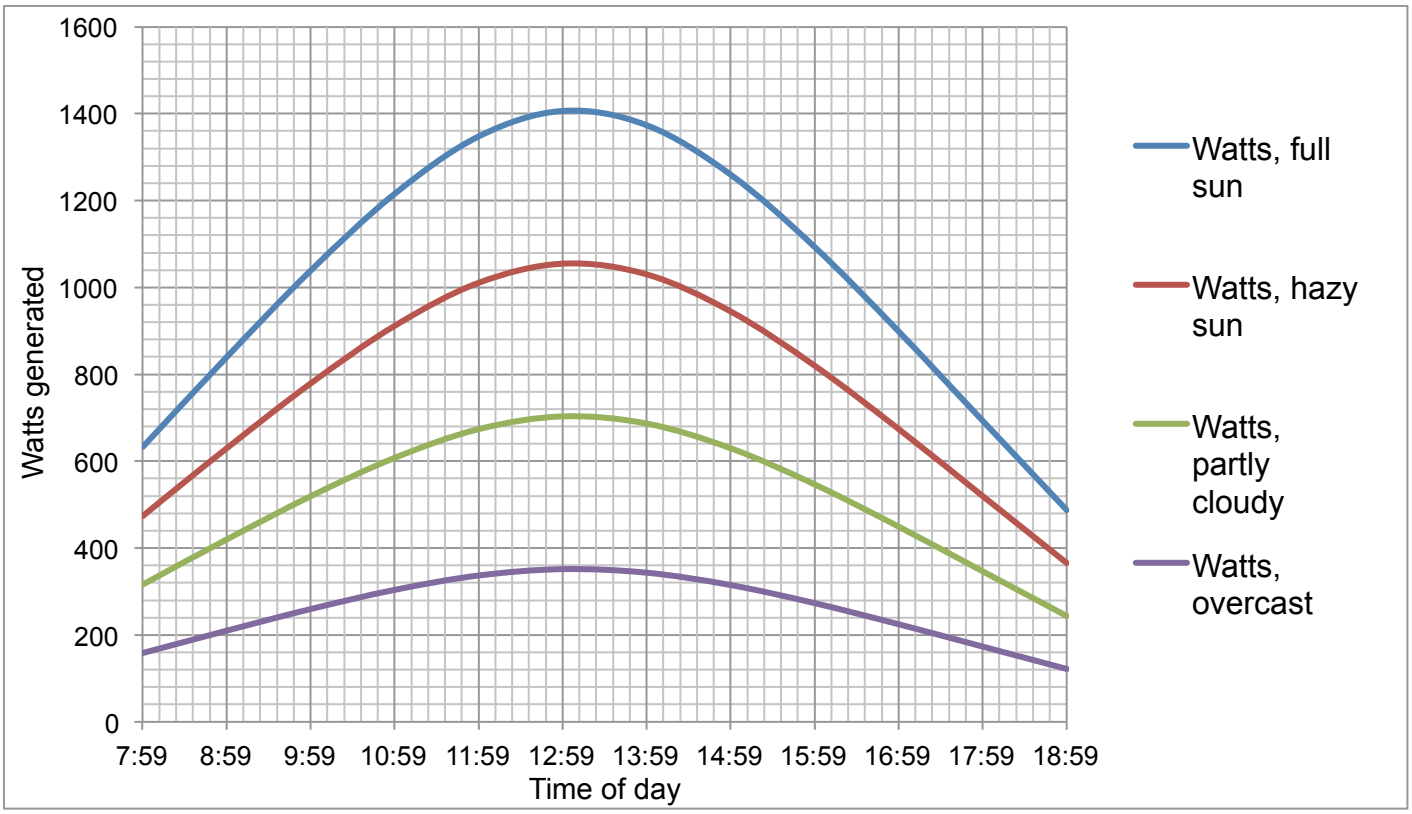
Wayward Sun's Speed vs. Power curve

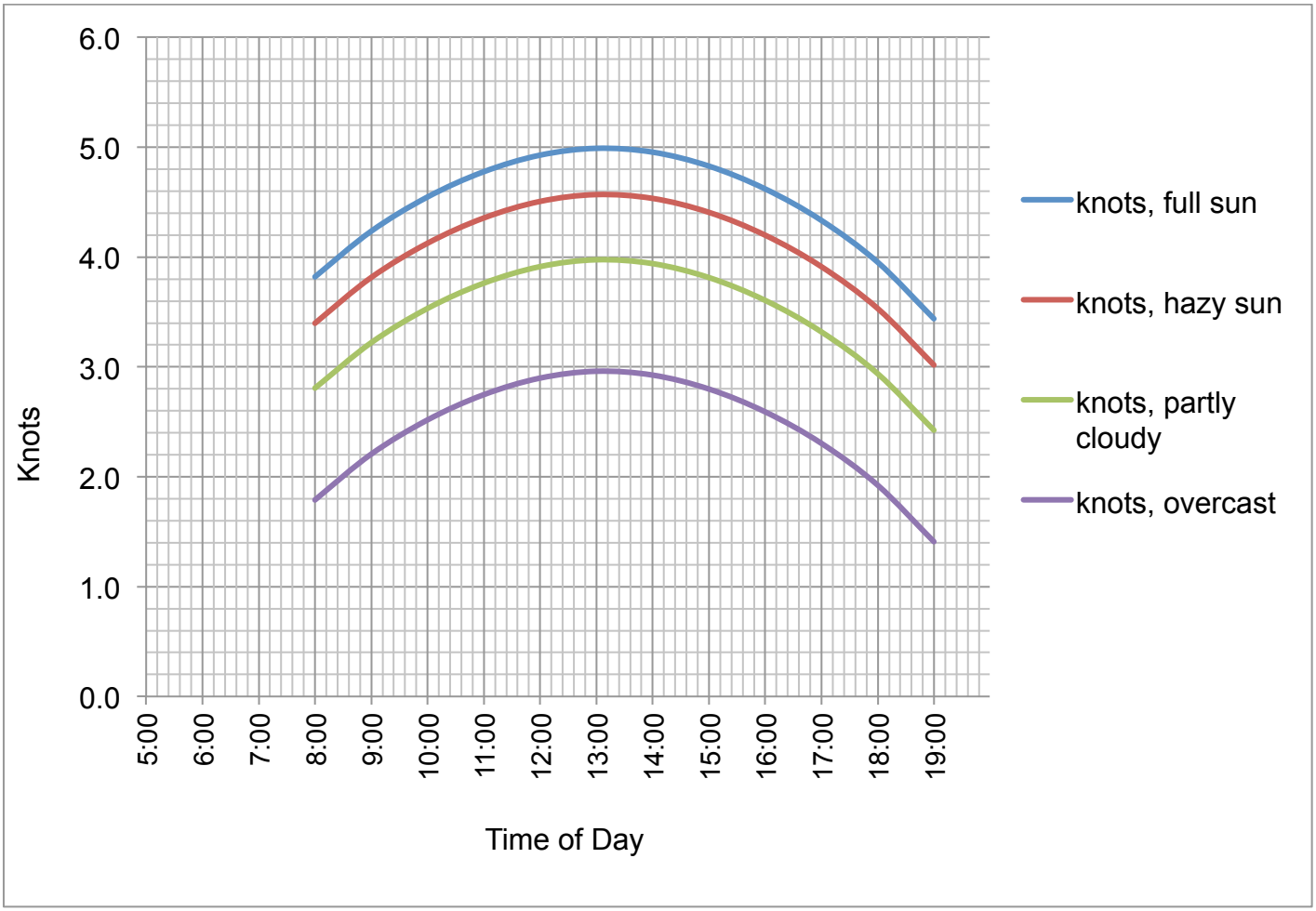


As you can see, Wayward Sun will go 4.5 knots at 1000 Watts and 5 knots at 1500 Watts. Doubling the power from 1500 Watts to 3000 Watts will gain just over an additional knot of speed. Add another 1500 Watts gets you only get another half knot to max out our top speed of 6.5 knots at 4500 Watts of power. For Wayward Sun, the sweet spot on the curve is around 4.5 knots. Notice that it takes only 300 Watts to move our boat at 2.5 knots.

These next graphs are predictions of insolation (incoming energy from the sun) for a given location at a given time, with a given percentage of cloud cover. These graphs are specific to Ketchikan Alaska on June 20, 2021, about the time we will arrive there. It is calibrated to the number of solar panels we have on Wayward Sun. This tool, created by Joe Grez at EP Carry, predicts the power our panels will produce.

Note that there can be a 4:1 difference in power generated under various conditions and time of the day. While this would seem to suggest poor performance on a cloudy day, remember it only takes 300 Watts to move Wayward Sun at 2.5 knots. It is the nature of our solar boats that they have a reasonable progress rate even in cloudy conditions.


1600
1400
1200
1000
800
600
400
200
0
Watts generated
7:59
8:59
9:59
10:59
11:59
12:59
13:59
14:59
15:59
16:59
17:59
18:59
Time of day
Watts, full sun
Watts, hazy sun
Watts, partly cloudy
Watts, overcast


6.0
5.0
4.0
3.0
2.0
1.0
0.0
Knots
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
Time of Day
knots, full sun
knots, hazy sun
knots, partly cloudy
knots, overcast

The second graph eliminates the power axis by mapping time of day directly to speed and so it's the solar cruiser's most direct way to predict their route for the day, or to plan a trip in advance.

Here is the key point: on a completely overcast day we can travel at between 2 and 3 knots for 9 hours *without drawing on our batteries at all*. On a sunny day we can do between 4 and 5 knots for 9 hours without any battery use. In reality, we use our batteries to suit our needs by adjusting the throttle. Maintaining around 50% state of charge is good practice.

This will get us to Alaska. In the summer time, sailboats traversing this route will typically motor more than sail, at somewhat similar speeds. But Wayward Sun makes no vibration or exhaust, is quiet, and we will spend nothing on fuel. Stay tuned for regular reports.

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