Going Solar

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The need for power at RC fields that are often remote from local power corporation distribution networks is becoming a common challenge for many. As we slowly convert our RC fleets from nitro to electric it is becoming common to hear generators chugging away and see hoods of vehicles opened wide to allow access to their batteries. The club lawn tractors poor batteries are often a target for our growing need for a fix (charge).

This article is certainly not the first to be posted on this topic. It is just one more that I hope may be used as a reference for how others are achieving a ready supply of “free” power for club members. We have gone to some effort to document our charge station and our drawings, photos and circuit design are available to all who are interested either attached directly to this article or through our club website. Contact information is provided at the end of this article.

Decision – Go Solar?

Our use of batteries has grown significantly in the last 5 years. The need for a charge is driving many in the generator direction. Generators have the advantage of portability and, if you have a good back (50 pounds for a 2000 watt model), portability is often a requirement if your field is prone to security issues or if members move between multiple sites. However, generators, other than being heavy, have a noise associated with them (although the new ones are really very good) and of course you have to keep pumping gas into them. We have a member who is sensitive to exhaust fumes and this makes the generator route a challenge. When the club was debating the pros and cons of energy systems we also kicked around the importance of “going green”. Cost is a significant issue as well. We are an average sized club for the region, at 25 members, and spending many thousands of dollars, with ongoing consumable costs was not in the cards. We really did not want to shell out more than a generator costs, and that became our challenge.

The discussion to install a solar station began more than a year before we made the final decision. The existing posts and articles on the subject often throw out costs in the $2500 - $4000 range. Some preliminary investigation led to a final maximum budget figure of $1500; Optimistic, however, we felt achievable, and in fact, with a little scrounging, we came in under budget! Scrounging, by the way, was factored into the cost estimate process and should not be underestimated as a method to dramatically decrease the cost of your solar project. As you will see we have built a very robust and powerful system and associated structure. We did not go cheap, just frugal.

Design Considerations

Several articles on this subject often refer to never coming close to using all the capacity of the systems that were constructed. The over capacity this implies is a nice to have but is costly to build and maintain.

The need for expandability was apparent from the start as battery use will clearly continue to be a growing part of our hobby.

We are in Nova Scotia which does not have a very long flying season when compared with somewhere like Tucson. We enjoy a pleasant 4 month summer window and about a month either side as shoulder seasons – mid-May to mid-October is about it. And we have weather! Nova Scotia sticks out into the Atlantic Ocean. The saying here is if you don't like the weather wait ½ an hour and it will change.

The discussions with solar energy systems providers leaned in two different directions for our application. The first was small batteries and lots of panels. The cost of panels has dropped dramatically and power on demand is becoming more common with newer systems. That's great if you have 300 days of sunshine, we don't. However we generally only fly when it's nice out so the panels are working well generally during our "season" and, as we are not always at the field, the system would have lots of recovery time to recharge. The other option is lots of batteries and smaller/fewer panels. This would work well in our climate, with our usage, and with our season, however we end up with a potentially large ongoing expense and maintenance challenge with batteries that need moving, storing (off season), and replacing. We settled in the middle with a slight emphasis toward the more-panels-is-better approach.

Our service building at the field is filled to the brim with stuff, from mowers, to gasoline (flammable!), to tables and chairs, to shovels and rakes, to garbage cans; no room inside for anything else. A free standing structure was chosen as the best option.

Nova Scotia's optimal panel tilt is approximately 30 degrees; the panels need to be pointed 22 degrees west of magnetic south to line up with solar south. We wanted shade on the charge table and lots of room on the surface for chargers and batteries. Room to add more panels as our needs grow was a factor in the size of the roof chosen. We needed to be sure the structure would not blow over so ballast stored and attached low in the structure was a major consideration. And we need a relatively secure and locked up battery/electronics compartment with panels kept well out of the way, so they could not be easily accessed, and finally a DC charger distribution block that could withstand our weather and prying fingers.

Construction

Structure

The structure is topped by an 8x8 foot sloping shingled roof. It is supported by four 4x4 posts attaching it to a box/charge table that measures 7 feet long by 3 ½ feet wide by 32 inches tall. It has a 30 inch door in one side and is made of ¾ inch plywood. All the wood, other than the 2 sheets of particle board for the roof is pressure treated. Epoxy coated screws, galvanized lag bolts, and glue/industrial adhesive were used throughout – she is solid!

Figure 1 Roof framed up

Figure 2 Tar paper and drip edging installed

Stainless steel hinges and a deadbolt are fitted to the ¾ inch door. It is sitting on, and bolted to, five 24 inch square concrete blocks weighing 83 pounds each. The blocks are buried level with the ground (we are not allowed to sink concrete or tie downs into the farm land we are located on). The box contains all the charge control and distribution circuitry as well as the batteries and many 100's of pounds of concrete pavers and blocks to add ballast to the building, we have a big sail up in the air, and we maritimers know the power of a sail.

Figure 3 Lower compartment framed up

We built the structure in two parts. The box/charge table and upright roof supports were built and transported in a 4x8 trailer as one piece. The roof was built and shingled on the ground and transported separately to the site. Construction of both components took a total of 8 hours including shingling the roof, with a team of 10 club members. And it was fun; a great team building exercise! Note: A well prepared team leader with a plan is fundamental for success.

Figure 4 Roof supports going up and getting 30 degrees dialed in

Below are details of the components used and you will see the drawings attached for the structure.

1) Plywood, roof sheeting, 2x4's, 4x4's, concrete blocks, tie down brackets, lag bolts – 3 sheets of ¾ inch pressure treated were purchased and the 4th sheet required was a left over from a club

members project. Lumber was mostly scrounged and leftovers from club members decks and building projects. **Total cost with tax :$388**

2) Shingles, roofing material, glue, concrete screws – Almost all scrounged. Left over tar paper and shingles and roofing nails. **Total cost with tax : $58**

3) Door hardware, bolts, screws, and misc. bits and pieces, stainless steel hinges with covered pins, deadbolt, and door seal. These were likely scroungable with a little more effort. **Total cost with tax : $136**

Electrical System

The electrical system consists of lots of wiring, a charge controller, 3 solar panels with brackets, a 2 breaker electrical panel, a few switches, two deep cycle batteries, and 2 digital meters. All components were assembled and tested before installation in the box. The panels were pre-fitted to the roof and then removed before we transported everything to the field. Below are details of the components used and you will see the system schematic. It is important to have access to someone who knows what they are doing with electrical systems when designing and building your systems – component ratings are important and polarities are critical. Our original charge controller regulated the negative, rather than the positive lead. Again, you need help from someone who understand how electrical things work.

The system, including the distribution block, you see in the photos took about 2 weeks on and off of evening time to assemble, paint as required, and test. Don't underestimate the time it takes to do the small stuff.

1) Solar Panels – the 3 panels we settled on are 90 watt 12 volt dc units. We purchased them from an electrical contractor who does solar home conversions and buys them in bulk in shipping containers from China. They put out approx. 14.5 volts under load to the charge controller and are rated at 5.1 amps each in direct sunlight. They are 42 inches long and 22 inches wide, are glass covered with aluminum frame sides and plastic backs. They have a terminal box on the back to allow wire connections. They are rated for 30 year lifespan. They weigh about 15 pound each. The contractor supplied all stainless mounting brackets including the nuts and bolts to connect the brackets to the panels plus he threw in some wiring. **Total cost with tax : $587**

2) Charge Controller – The original was a very basic 30 amp 12 volt unit that was surprisingly CSA approved. In use it is took in up to 16 volts from the panels when the batteries are fully charged (14.5 volts under load) and within a day started to deliver 15 volts to the batteries with no load and fully charged – not good at all! A charge controller's job is to limit overcharging, typically to about a maximum of 13.7 volts. The contractor took the unit back and a replacement, a Nature Power 28 amp model, was purchased through Amazon. The nature power unit has the advantage of digital displays indicating what it is receiving and supplying and that is worth having for peace of mind if nothing else. The charge current has also turned out to be an interesting display for members to watch as the sky and time of day changes – a real education on solar power.

Note: We made the decision to provide 12 volts to the table top as many club members and visitors still have chargers with 18 volt or less maximum inputs. Also, all the newer chargers have buck boost circuitry and can easily up-convert the 12 volts to charge 6s 22.2 volt and larger packs. A small change to the wiring and replacing the controller would provide 24 volts to the table top. **Total cost with tax: $85**

3) Batteries – The original thought was to go with two 12 volt deep cycle marine batteries rated at 95 amp hours (not cranking amps) from Canadian tire. That is not what happened and here is where some scrounging comes in. A former club member who works with heavy diesel generators supplied us with two 2 year old Caterpillar 120 amp/hr. 110 pound monsters (1000 cold cranking amps). There are lots of sources of good used batteries around if you take some time to look. Ours were rarely used and have many years of service left in them. **Total cost with tax: ~~$300~~ $0**

Figure 5 Batteries

4) Distribution panel and breakers – Square D 120/240 volt AC breakers are rated for use up to 48 volts DC. That makes them very useful for our purpose! They are apparently the only manufacturer that makes their breakers that way. We lucked in again on the scrounging side and were able to purchase the panel and two 30 amp breakers through a local electrical contractor at his cost. The breakers feed two separate circuits/sets of charger connectors on the table top. **Total cost with tax: $92**

Figure 6 Panel – Green power 28 amp controller and two 30 amp circuits to the table through Square D breakers

5) Switches, wiring, connectors, digital meters, stainless steel rods (for members alligator clip charger connectors – rod purchased from a welding shop), banana jack terminals, misc. hardware – Largely scrounged, ebayed, and from dealextreme (the digital meters were $2:50 ea. shipping included ☺). We had to buy a few things but most club members and their relations have project left overs that were repurposed and work fine. We were very cautious with the quality of the components and their ratings. Everything that went into construction of the electrical was new or in new condition. **Total cost with tax : $30**

<u>Project total cost including 15% sales tax - $1376</u>
(Estimated savings attributed to scrounging – approximately $800)

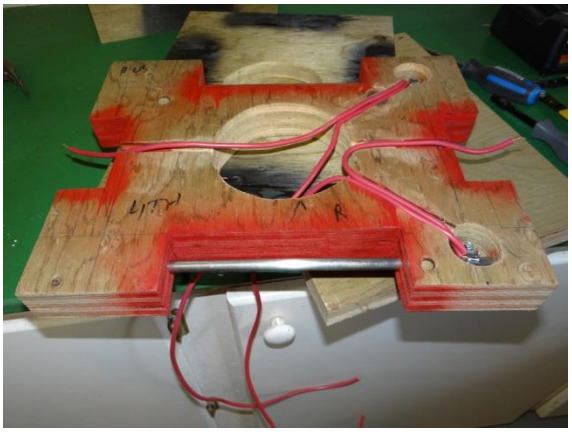

Figure 7 Charge Block Under Construction

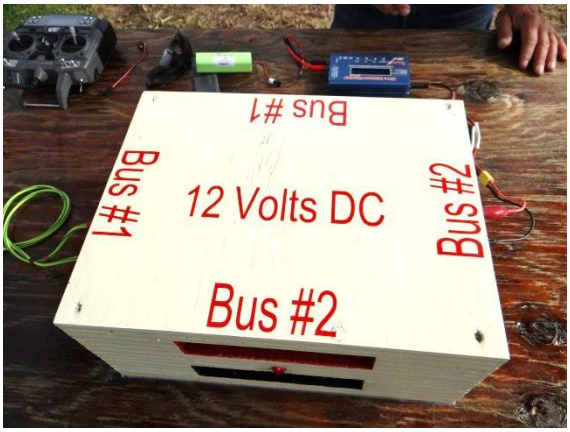

Figure 8 Charge Block Complete

Some Assembly Required

The second great club adventure was the loading of the component on trailers, the move (convoy) to the field, and an old-fashion barn (solar structure) raising. This was also a great team building exercise and lots of fun. We had almost all our members out for this event and their family in some cases as well. Like the original construction, having a well-organized and prepared team leader with a plan will ensure things go smoothly. It took 3 hours start to finish which included setting the concrete blocks, attaching the roof to the lower structure, attaching the panels, raising the structure and bolting it down. The final electrical was done the next day and took 2 people about 1 1/2 hours to finish and cover in.

Figure 9 Loading the roof

Figure 10 Loading the lower assembly

Figure 11 Leveling the blocks

Figure 12 Aligning with solar south, 22 degrees west of magnetic south in Nova Scotia

Figure 13 Installing the roof – industrial glue and very long screws

Figure 14 Panels going on – room for 2 ½ more as our need grows

Figure 15 Raising the system

Figure 16 Bolt down and final wiring

Power up

It was a beautiful sunny day and everything went smoothly. We were charging immediately. Battery voltage jumped from 12.6 volts to 13.5 in a half hour and we were charging banks of 22.2 volt lipos at more than 20 amps within an hour with almost no impact on the main battery voltage (0.1 volt drop).

Figure 17 Charging

The following day revealed the problem, mentioned above, with the original $35 dollar charge controller. The new one was on hand and installed within 4 days. The charge controller issue could have become quite serious if the batteries had been hit with 15 volts for an extended period. It is a good idea to monitor these systems closely in the early hours and days after start up. The replacement provided the added feature of charge current monitoring which is nice to have. We are now seeing a maximum of 20.1 amps charge in direct sunlight at noon. With a light but solid overcast 8 amps is normal and between 5 and 7 pm we typically see 4-6 amps going to the batteries with light clouds.

Big Roof

We get Nor'easters (big windy storms!) in Atlantic Canada and the roof as shown in some photos is not yet complete. We added diagonal bracing on the uprights to add rigidity and also provide additional snow load support. The picture below show the bracing added after the roof raising.

Figure 18 Bracing Added to Support Roof

Is Solar Right For You?

Its early days yet with our system, however, if you have a reasonably secure site we believe it is a great option. Within 3 days of going live the system is in constant use. We went to great lengths to build a tough structure that cannot be easily breached and is almost impossible to move. It is more than 13 feet tall at its peak and weighs well over 1500 pounds with ballast installed. Game/hunting cameras mounted up high can give you some extra security, or at least the feeling of it. We have mounted a dealextreme "security camera" on it and are exploring other options.

Figure 19 Our Camera

As solar technology improves we'll all have it in our lives in the next few years. Panels are improving and dropping in cost. Charge controllers and batteries are doing the same.

This was a great project for the club. It brought everyone together and definitely has a “cool” factor associated with it. I went down to the field at lunch to shows some folks at work what we built and there was another member there doing the same thing.

Figure 20 Ready to raise the roof - A great team!

Also, our new system will serve as a base for the next wave of field improvements. I see a cellular webcam in our future where members can hop on the internet and see who is out flying (or crashing). The wiring is already built-in to run power back up the cellular system on the roof (it’s a future mod and we have not figured out yet how to scrounge cell service). Members have plans for music, inverters, and one even has a 12 volt bar fridge in his sights, for pop of course.

Figure 21 End of a good build day!

Wrap up and Thank-you

I want to thank Mike Boulanger for his work on our behalf to turn our ideas into CAD drawing – you rock Mike. Also many thanks to Dwight at Fundy Electric for sourcing some key components and Dave Porter for those awesome batteries. Major kudos goes to the Wings of Wellington club members and their families who donated supplies and their time to this. It would have taken a very long time and double the cost without you and our shared vision!

Only time will tell if we have done everything right. Our confidence is high and we are expecting good things from our new system.

If you have any questions regarding what we achieved please feel free to touch base. My email is dann@xcountry.tv. The drawings and diagrams are on our website at http://www.wingsofwellington.org/.

Good luck with your project. Cheers.