NOVA
NEWSLETTER OF THE VANCOUVER CENTRE RASC | VOLUME 2008 ISSUE 4 | JULY/AUGUST 2008

INSIDE

Looking Ahead

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in the GMSO.

July 10: Aaron Clevenson, Astronomy Professor at Lonestar College in Houston, Texas: Great Moments in Planetary Exploration.

Aug. 14: TBA

Next Issue Deadline

Material for the September Nova should be submitted by Monday, Sept. 1, 2008. Please send submissions to:

Gordon Farrell (gfarrell@shaw.ca)

Title image: Bob Parry

Portable Power 101, Part 2

by Jason Rickerby

[Continued from the March/April 2008 issue – Ed]

The Language of Electricity

How to Choose a System

Voltage – For most portable applications, 12-volts is a good match of battery voltage to the equipment to be powered. Most automotive electronics in North America are 12-volt. For high current applications, higher system voltage, such as 24-volts, may be desirable. The solar panels in the system need to have a higher voltage than the batteries to be charged. The exact voltage to the batteries will be regulated by the charge controller or battery charger.

Amps – The rate at which electricity flows. The greater the flow, the quick a battery is charged or discharged. As amps is referring to actual moving electricity, high current activities require heavy gauge wires to avoid losses due to heat. High current with insufficient wire gauge can be a serious safety issue.

Watts = Voltage × Amps (Current) = **Power**, or "work done." Most AC devices will specify their maximum power consumption in watts. Because watts is a relationship of voltage and current, as voltage increases, current decreases. This is why long-distance power lines are high voltage—to reduce current. Consider the humble hair dryer: 120 volts at 10 amps = 1200 watts = 12 volts at 100 amps!

Capacity (Measured in **amp hours – A·h**) – amps × time = amp hours. For example, a 2 amp hour battery can deliver 2 amps of current for 1 hour, or 0.5 amps for 4 hours.

Hour Rate – The time in hours used to discharge the battery when specifying the batteries amp hour capacity (20 hours is realistic, 100 hours is pure marketing). When a battery is discharged very rapidly, it will have a lower amp hour capacity than the same battery discharged over a longer period.

(C)CA – (Cold) cranking amps is the number of amps a starter battery can deliver for 30 seconds and not drop below 7.2 volts. This measurement is almost like specifying a 30-second hour rate, so not very relevant for indicating a battery's useful amp hour capacity.

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Reach for the Stars

by Suzanna Nagy

Volunteers are essential to the services and programs that RASC membership offers. Without volunteers, the RASC wouldn't exist. Each and every person involved in the administration of Vancouver Centre does so on a volunteer basis. Our time is donated because we love the hobby/science of astronomy and we wish to see Vancouver Centre thrive and grow.

Also, public outreach is part of the RASC's mandate which is *"to stimulate interest and to promote and increase knowledge in astronomy and related sciences."* The organizing and/or attending of public outreach events is also essential to maintain our charitable status by donating to the public good.

Why be a volunteer? Because there are benefits such as:

- It gives you a chance to understand the RASC better.
- You can help build the RASC.
- Meet fellow peers and make friends.
- Educate children and the general public about the night sky.
- Teach new members how to use a telescope or where objects in the night sky can be found.
- Gain commendable work-related skills and experience. Volunteerism is useful on your resume.
- But most importantly – It's personally rewarding, satisfying and FUN!

A little does go a long way. The more hands helping, the easier the job becomes. We don't expect anyone to contribute 40 hours a week. If you join a committee, likely as little as 2 – 4 hours per month are required. Or you could volunteer at one of our public events and as little as one evening a year may be requested of you.

Volunteer Opportunities include:

- Sidewalk Astronomy with your telescope
- Telescope operator
- Data entry
- Newsletter assistance
- Website management

If you would like to volunteer one evening for a Sidewalk Astronomy event, or if you would like to donate some of your skills and experience in other areas, please contact me personally or by email at snagy@slatervecchio.com, or speak to any member of your Council. ✸

2008 GA

by Doug Montgomery

The 2008 GA was held in Toronto this year and hosted by three different centres. Hamilton, Mississauga, and Toronto put on a very good show for all the guests and delegates. They even had an east-west ball hockey game (won by the hated east team).

But down to business. As you know, there was much to look after with charitable status and other legal woes with the tenant at 136 Dupont St.

All the motions were passed, most with large majorities. Motion 1—which we opposed—was not opposed by any other centre. All the rest of the motions went unopposed until the election of the auditor but it did pass. I do want to thank everyone that took the time to fill out a proxy—the proxy votes outnumbered the delegate votes. It was good to see that many people cared enough to vote on the issues.

In closing, I would like to say thanks to Bonnie Bird, our outgoing executive secretary, and wish her and Andreas all the best in their retirement. And welcome to Jo Taylor, our new executive secretary—all the best. I would also like to thank all the volunteers from all the centres that made the GA such an enjoyable event. ✸

President's Message

We have had a couple of great observing evenings, so I was happy to see the Milky Way at least once recently! The weather is keeping any observational astronomy at bay and we are hoping that it will cooperate and give us some decent weather on **July 25th and the 26th. That is when our Vancouver Urban Star Quest will be happening at Fort Campground in Langley**. So if the seeing is good, you may want to dust off your telescope or binoculars and come on down. As well, if you just want to observe using one of the telescopes that will be there, you are welcome to join us. If you are staying for any nights, you will have to make your own camping arrangements with Fort Campground. Please call or email Doug Montgomery (dougmont@shaw.ca) if you have any questions about the upcoming Star Quest.

May was a busy event month. We had another successful Astronomy Day and I wanted to thank our volunteers including Sally Baker, Ron Jerome, Doug Montgomery, William Fearon, Jim Bernath, Ted Stroman, Suzanna Nagy, David Dodge, Gil Biderman, Bill Burnyeat, Wayne Lyons, Jason Rickerby and Bob Parry and youth volunteers Gwen Rickerby and Tara Weinmar for their generous help throughout the day. As well, thanks to Vancouver Telescope who donated an amazing 12" SkyWatcher Dobsonian telescope

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About RASC

The Vancouver Centre, RASC meets at 7:30 PM in the auditorium of the H.R. MacMillan Space Centre at 1100 Chestnut St., Vancouver, on the second Thursday of every month. Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $62.00 per year ($36.75 for persons under 21 years of age) and can be obtained by writing to the Treasurer at the address on page 5. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address on page 5.

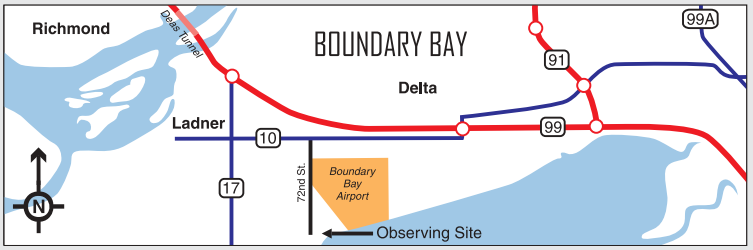
Advertising

Nova encourages free use of its classified ads for members with items for sale or swap. Notify the editor if you wish your ad to run in more than one issue.

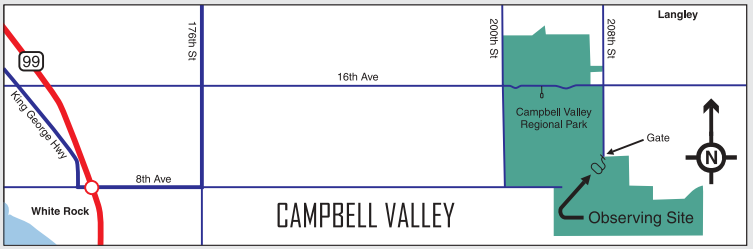
Commerical Rates

1/4 Page: $15.00 per issue
1/2 Page: $25.00 per issue
Full Page: $40.00 per issue
Rates are for electronic or camera-ready files. Payment, by cheque, must accompany ad material. Make cheque payable to:
RASC Vancouver Centre.

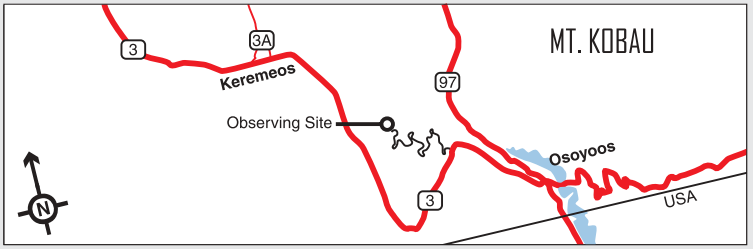
OBSERVING SITES



Site of the regular Saturday night star party. On the dike at the foot of 72nd St.



Our alternate observing site. Contact Bruce MacDonald (604-882-3820) to see if this site is in use.



Site of the annual Mt. Kobau Star Party organized by the Mount Kobau Astronomical Society

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for our main door prize, by Miro. As well, thanks to Celestron for donating a set of 20x80 binoculars which were won by Jason Rickerby. And like father, like daughter, so we had Gwen winning the one year RASC Youth Membership!

RASC National is delivering a number of administrative changes and an unfortunate fee increase. Our National Representatives on National Council are Doug Montgomery and Jason Rickerby. Doug has prepared a more detailed report which can be found in the Nova.

At our June Council meeting, we received word that our application for Charitable Status had been received at government offices. We expect to have approvals on this by September of this year, after which we will be able to provide charitable receipts for donations to Vancouver Centre. Recent donations to Vancouver Centre are from the estate of Martha Ellen Pearse who passed away suddenly on May 31, 2007, in Edmonton one month short of her 97th birthday. Vancouver Centre is very grateful for her generosity.

Some of donated funds will be put to good use for International Year of Astronomy 2009. We are busy evaluating initiatives to celebrate what will be a "global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo

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Galilei. The aim of the Year is to stimulate worldwide interest, especially among young people, in astronomy and science under the central theme, 'The Universe, Yours to Discover'" (http://www.astronomie2009.ca). Vancouver Council has agreed to purchase 100 Galileoscopes which will be specially manufactured for IYA 2009. The small telescope, with good optical quality, will be delivered as a kit consisting of only 15 individual parts. The expected cost is in the $10-$20 range, excluding an optional tripod. The aim of IYA 2009 and the Galileoscope initiative is to give 10 million people their first look through an astronomical telescope in 2009. We will be partnering with Simon Fraser University, who have ordered 500 Galileoscopes, to coordinate a related education programme for public outreach, especially to schools. If you would like to be involved in this project in any way, please let me know or you can also contact Ron Jerome (jerome3292@shaw.ca) who is coordinating our IYA 2009 activities.

I will be up at the Mount Kobau Star Party, which is taking place the week of August 4th this year. It is always breathtaking to see the density of our Milky Way. Usually, it takes me a while just to get oriented. I like to start observing in Sagittarius since I hardly ever get the opportunity to do so anywhere else. **Vancouver Centre will be hosting a pancake breakfast**

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CENTRE SERVICES

LIBRARY

The centre has a large library of books, magazines and old NOVAs for your enjoyment at the GMSO. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

RASC-VC on the Internet

http://www.pcis.com/rascvan/ or
http://www.rasc.ca/vancouver

H.R. MACMILLAN SPACE CENTRE

The Pacific Space Centre Society is a non-profit organization which operates the H.R. MacMillan Space Centre and Gordon M. Southam Observatory. Annual Membership ($30 Individual, $80 Family) includes a newsletter, discounts on Space Camps, special programs and lectures, Vancouver Museum discounts, and free admission to the Space Centre. Admission to the Space Centre includes: Astronomy shows, Motion Simulator rides, multimedia shows in GroundStation Canada, and access to the Cosmic Courtyard Exhibit Gallery. For Membership information, call Mahi Jordao at 604-738-7827, local 237 for information. You can also reach them on the Internet at http://www.hrmacmillanspacecentre.com/

MEMBERSHIP HAS ITS PRIVILEGES!

New members, did you know? The Vancouver Centre has 8 telescopes available for loan free of charge! We have telescopes ranging from 60mm to 10" diameter. For more information see Bob Parry, Director of Telescopes in the meeting room of the GMSO *after* the members meeting. All telescopes are to be picked up and returned at the GMSO. The loaner period is for one month, to be returned after the next meeting. Telescopes are not allowed to circulate outside of these meetings. You can now reserve two different telescopes per year and use what is left at the end of the meeting anytime. Bob can be reached at 604-215-8844.

Your greatest opportunity as a member of the R.A.S.C. is to take advantage of the company of other enthusiasts to increase your knowledge, enjoyment and skill in astronomy.

The best thing you can do to gain the most from your membership is to get active! Take in the club meetings; engage other members with questions; come out to observing sessions (also known as "star parties"), and, by all means, volunteer to take part in our many public events.

Observing takes place at Boundary Bay on the dike at the south end of 72nd St. in Delta (see map on p. 4). We are there most clear Friday/Saturday nights. Contact Jason Rickerby at 604-502-8158.

RASC
1100 Chestnut Street
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UPCOMING EVENTS

July
25-27 – Vancouver Urban Star Quest @ Fort Camping in Ft. Langley.

August
2-10 – Mt. Kobau Star Party
12 – Perseid meteor shower
30-Sept. 7 – Merritt Star Quest

September
20 – Sidewalk Astronomy at the Inukshuk at Sunset Beach

December
11 – AGM

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Load – As a rule, an AGM battery supply should be three times the capacity of the load (before recharging; see "Planning a System" below). If the load is 10 amps for 1 hour (10 A·h), the battery should be 30 A·h. Without recharging, if the load is 0.5 amps for 5 days, 0.5 amps × 24 hours × 5 days = 60 A·h, there should be 180 A·h of battery capacity (notice this will discharge the battery supply by only 33%, providing a generous safety margin over 50%).

Using Your Stored Power

The choices: 12-volt DC equipment, or an "inverter" to provide 120-volts AC. The most efficient way to utilize battery power is to use it at the voltage the battery(s) provides. In other words, with 12-volt batteries, using 12-volt devices is the most efficient. However, 12-volt DC devices and large gauge wiring may not be cost effective. 12-volt devices include:

- Telescopes, dew heaters, cameras, filter wheels, focus motors.
- LED and florescent lighting (LEDs are MUCH more efficient).
- AA/AAA/C/D/9V battery chargers, radios, TVs, VCRs, laptop power adapters.

12-volt devices also include the following, but these don't make a lot of sense:

- Coffee maker, microwave (550 watt), slow cooker, sandwich maker, refrigerators.
- Curling iron, hair dryer, razor.

Important: It may be better to use an inverter and a 120-volt AC appliance/device. The reason is wiring! As you will recall from the above, the humble hair dryer. Remember how much current 1200 watts means at 12-volts? You will need REALLY BIG WIRE for moving 100 amps around (4 AWG wiring for less than 5% voltage drop!). It is better to use an inverter to increase the voltage close to the physical location of the batteries and then use 120-volt AC wiring to distribute the power to high-wattage devices. A 120-volt compact fluorescent light bulb is much cheaper than a 12-volt version. Low-voltage LEDs still make the most sense for lighting, so try not to go exclusively 120-volt AC.

If a desired device is only available in a 120-volt AC version, an "**inverter**" can be used to take the DC power from the batteries and convert it to 120-volt AC. The inverter must have enough output for the most demanding appliance. Look at continuous output ratings, not peak output ratings. Most inverters include high/low voltage disconnect capabilities to protect the inverter and the batteries. While modern inverters are quite efficient, power is still lost in the conversion process—usually as heat.

Sensitive electronics generally like "clean" 120-volt AC power. "Clean" means the power output of the inverter should represent a smooth continuous sine curve. In marketing terms, this is often referred to as a "true sine wave output." Any AC appliance with an AC electric motor (food mixer, power drill, etc.) will work much more efficiently with clean power. Cheap inverters do not provide nice sine waves, rather they change their output voltage in large steps. This can cause issues with some AC equipment. As will be obvious, "true sine wave" inverters can be much more expensive than their non-sine wave counterparts.

Important: It is possible to discharge a battery too much! To pre-

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vent this, a device called a "**Low Voltage Disconnect**" (LVD) will terminate power to equipment when the battery charge level reaches it maximum safe discharge level (low voltage). An LVD should be built into your charge controller and inverter, but this should be verified.

Wiring Considerations

A significant source of power loss and potential safety hazard is the wrong gauge of wiring. Transmitting 12-volts DC, 10 amps for 25 feet over 14 AWG wire will result in a 10% voltage drop! Shortening this run to 12.5 feet reduces the voltage drop to 5%. Changing to 10 AWG wire for the 25-foot run results in a 4% voltage drop. Transmitting 120-volts AC, 10 amps for 25 feet over 14 AWG wire will result in only a 1% voltage drop. (If there was ever evidence that Thomas Edison was not as smart as he's often made out to be, his idea of DC power distribution was a very bad one. Be grateful to Mr. Tesla and his understanding of mathematics.)

Given the above examples, it may make sense to use the batteries and an inverter to create 120-volts, rather than using larger gauge wiring for 12-volt operation. Copper is expensive and heavy. Keep wiring as short as is reasonable to avoid unnecessary power loss. When connecting battery chargers, charge controllers and inverters to batteries, physically locate them as close to the batteries as practical to keep wiring as short as possible to reduce power losses. A reasonably large gauge of wire may be required between the solar panel(s) and charge controller.

Planning a System

How many watts of solar panels are needed, and how much battery capacity? As asking how much is appropriate to eat for dinner, power system design is dependant on the user. A broad generalization would be, "as much as you can afford," as human nature is to generally take advantage of whatever is available. In most of theses calculations, we'll omit system losses to keep things simple. Total system losses should not exceed 20%.

Create an inventory of equipment needed at the remote location. Document how much power (watts) each device needs and how long each day the device will be used, in hours. Multiply the device wattage by time used to get a watt/hours per device. Add up the device watt/hours, and this is the total watt/hours needed per day for the power system.

"Device watts" × "Usage time in hours" = "Device watt/hours"

If the intention is to have the smallest power system possible, it may be worthwhile to actually measure device power consumption. Often equipment specifications indicate worst-case consumption or are intentionally overstated. In reality, some devices specifications may be understated!

Assuming AGM batteries are used, multiply the watt/hours calculation by at least 3 to determine the "daily load." But wait—battery capacity is in amp hours! Simply take the daily load and divide it by the battery voltage, this will provide the daily load in amp hours. Without any recharging, a battery capacity equalling this figure can be reasonably used for 1.5 days before the batteries are 50% discharged.

"Daily load" × 3 ÷ "Battery voltage" = "AGM battery capacity required, in amp hours"

If the intention of the remote power system is to operate indefinitely, the power generation needs to equal the daily load, plus a percentage (10 – 20% ?) for system losses in charging, conversion, etc. Note: When considering large-scale systems with irregular usage patterns, this power generation figure would usually be considered excessive.

"Daily load" × 1.2 = "Daily power generation in watt/hours"

If the power system does not need to operate indefinitely, the daily power generation can be smaller than the daily load, however eventually the batteries will be discharged to 50% and the system should be unused until additional charging can occur.

Remember hour rate? The amount of power being drawn from the batteries at once will impact how long the charge will last.

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So if possible, try not to use all the power-consuming devices at the same time.

Portable Power and Astronomy

Going back to astronomy on top of a mountaintop, in practical terms what do we need? We can anticipate needing to run telescope electronics, dew heaters, cameras, laptops, etc.

Phase 1 – Getting Started

1. By now, you should have an idea on how to calculate your power requirements for your astronomy equipment. Calculate the number of watt hours you will need between charging opportunities. Don't forget to multiply this by two or three so the battery is not discharged more than 50%.
2. Decide on your battery supply, will it be AGM or flooded? A deep cycle marine battery at Costco will be flooded. A Canadian Tire "Motomaster Eliminator 600A PowerBox" is an AGM-type battery and includes an AC charger.
3. How quickly do you want to recharge the battery? With the example of the 20 A·h Motomaster, the maximum charging rate should not exceed 2.5 amperes.
4. From Step 1, we should know the battery capacity requirement in watt hours. Now that it is time to recharge the battery, if solar power is the option, how many hours a day will there be sunlight available? (Assume the battery has been discharged 33%—7 amp hours / 84 watts. We will estimate 6 hours a day of sunlight at our theoretical location and we have only 1 day to recharge.)
5. To determine the required solar panel size, divide the battery capacity consumed (84 watts) by the number of hours to charge (6 hours). 84 watts / 6 hours = 14 watts/hour.
6. Since there may be some loss of efficiency in the charging system, add 20% to the solar panel size. For the example, a 20 watt solar panel should provide 120 watts over 6 hours to recharge our 33% discharged 20 amp hour battery. Also note that 20 watts / 12-volts = 1.7 amps—below the 2.5 amp peak charging rate for this AGM battery.
7. The 20 A·h Motomaster PowerBox uses an AGM battery, so a solar charge controller with an AGM mode will be required. As the charging current and solar panel size are small, a 6 amp charge controller would be sufficient, however as the price of a 10 amp unit is only a couple of dollars more, it might be worthwhile to have the extra capacity for future expansion.
8. At this moment we have a 20 amp hour AGM battery, a 20 watt solar panel and a 10 amp charge controller. What else do we need? Wiring for a start. Remember, have the appropriate gauge for the current and distance required. Assuming a maximum of 15 feet between the solar panel and the charge controller, a wire of 18 to 16 gauge or larger (smaller number) would be preferred.
9. The above components can be connected together to provide a basic solar recharged battery supply. It may be advisable to install an in-line fuse between the charge controller and the battery to avoid mishaps. Let's assume that in a worst case scenario you want to discharge 50% of the battery in 1 hour—this will require a 10 amp fuse between the battery and the charge controller. Alternately, the charge controller may be disconnected from the battery when the battery is used to power a device. The devices connected to the battery, such as your telescope, should have power cords with fuses.
10. Consider a small plug-in style inverter for lower power AC equipment, such as battery chargers for digital camera batteries.

Phase 2 – Refinements

1. Given the number of components that may be required, consider building an enclosure that contains: 4 automotive-style 12-volt power outlets; fuses between each power outlet and the charge controller load output (remember the LVD feature?); the charge controller; a unique

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jack and cable from the solar panel to the enclosure; a different style of jack and cable from the battery to the enclosure; a fuse between the battery and the charge controller. When constructing an enclosure, consider damp ground and dew—whatever is built needs to be able to tolerate some moisture.

2. Regarding connectors with the battery and solar panel, remember that as power increases, the amount of current moving around can get quite dramatic. Make sure whatever components are selected can handle the current.
3. Consider purchasing an inexpensive electronic multi-meter/multi-tester, one that can measure DC voltage and DC current to at least 10 amps. With a bit of understanding about basic electronics, this can be used to check the status of a simple charging system. Alternatively, consider purchasing a higher end charge controller with a built in status display.

Phase 3 – Expansion

What happens if you have more than one battery to recharge? Here are some things to consider:

1. Is the battery the same type that the charge controller was initially configured for? In the example mentioned above, the charge controller is configured for AGM; is this additional battery AGM? If the additional batter is not AGM, the there are two options:
   a. Charge each battery, one at a time, changing the charge controller configuration each time between the flooded and AGM settings. Don't forget to change the configuration!
   b. Purchase a second charge controller and configure it for this different battery type.
2. If additional batteries are the same type as the original configuration, they can be connected in parallel to be recharged. However, without additional solar panels the total time required to charge the multiple batteries will take longer.
3. Are additional solar panels needed to charge the batteries in a timely manner? It is probable that a larger solar panel can be added to the system that has a similar operating voltage to the initial panel purchased. If so, the two solar panels can be connected in parallel to operate as a single larger power source. Just make sure your charge controller is large enough for the combined current output of the two solar panels.
4. With a larger power source, two charge controllers can be connected in parallel to charge two different types of batteries at the same time (this is starting to get complicated).

Various Solar Power System Examples

Please keep the following in mind when reviewing these options:

- These examples are "back of napkin" ideas, not engineered solutions, but should provide a feel for what is possible.
- The assumption is that the usable capacity will be consumed daily! These medium and larger systems are truly decadent and most likely excessive! Normally, solar power systems have many times more usable battery capacity than daily solar power generation.
- Remember, calculate how much power you need per day, then how many days you will need it. This will help decide the amount of batteries and amount of solar panels required.
- The suggestions below do not constitute a detailed bill-of-materials. Additional parts may be required.
- Most of the component prices are from a large US-based online retailer that has been selling internationally for a decade.
- Solar panel daily output is assuming 8 hours on a sunny, summer day.
- The "usable" battery capacity is anticipating a 50% maximum discharge. As mentioned last issue in the section "Batteries as a Power Source," discharging 80% of the battery capacity is possible, but not

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recommended.

- The power ratings and run times are estimates. Reality is probably more pessimistic. Don't forget system losses due to charger and inverter inefficiency, etc.
- Installation hardware for securing solar panels, batteries, etc. has not been considered.
- The "golf cart" batteries mentioned in some systems are flooded batteries, not AGM, but they are very inexpensive.

Possible power system components:

- Solar Panel(s)
- Generator
- Batteries
- Charge controller/meter/high-low voltage disconnect
- Inverter
- Battery charger/inverter
- Charger-inverter remote control
- Status meter
- DC disconnect
- Transfer switch
- Fuses/circuit breaker panel
- Auto generator start module
- Shunt (for use with generators, windmills, micro-hyrdo, etc.)
- Wiring/wiring kit
- Mounting brackets, battery box, AC power connections, 12-volt outlets, etc.
- Additional fuel storage for generator

See the table on page 11 for the configuration details.

#1: An entry-level capacity 12-volt DC system charged by solar

For a small trailer with simple needs such as lighting and the use of low consumption devices, such as a radio, etc., a simple 12-volt DC system is probably appropriate. Make sure all your devices are 12-volt DC compatible, or can use a really small inverter (<75 watts). The solar panel is oversized for the battery capacity to provide poor weather power generation, or capacity to charge an additional battery or two.

#2: A small capacity 12-volt DC system charged by solar

For a trailer with simple needs such as lighting and low consumption devices, such as a radio, etc., a simple 12-volt DC system is probably appropriate. Just make sure all your devices work at 12-volt or with a small inverter (<150 watts). As in the previous configuration, the solar panel could be considered oversized for the application. (In theory, during a sunny day, a 19" LCD TV could operate from the charge controller load output, with no battery at all.) Notice the battery weighs 63 lbs.

#3: A medium capacity 120-volt AC system charged by solar

This is a power system you can live off in an RV, as long as the refrigerator, stove and hot water is propane powered. For a situation where 120-volt AC power makes the most sense, an inverter can be permanently installed to provide 120-volt AC power with this larger battery capacity. In practical terms, two 60 or 80 watt panels are probably better than a single really large panel, but would be slightly more expensive.

#4: A medium capacity 120-volt AC system charged by solar or AC mains/generator

Similar to the previous 120-volt system, a large Inverter / Battery Charger has been substituted to optionally use a 120-volt AC source for charging the batteries. The solar panel is also larger to provide reasonable power on cloudy days, or higher daily battery utilization. As with the previous system, multiple smaller panels may be more practical, as a single 195 watt panel weighs 34 lbs. This system could be easily improved with more battery capacity.

#5: A large capacity 120-volt AC system charged by solar or AC mains/generator

By large, we're talking monster RV or little cottage/observatory. Similar to the 120-volt system above, but double the solar power and battery capacity.

#6: Living off the grid? 120-volt AC, with automated switching and generator

Have a cottage/observatory with no chance of AC mains power? With a system of this scope, it is definitely time for professional assistance from an "alternate power system" vendor. Due to the

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System	Solar Panel	Batteries	50% Capacity (Watt hours)	Charging/ Inverter	Accessories	Runtime 90-Watt Laptop	Total Price
	20 Watt 160 watts/day	12-volt 20 amp hour AGM	120	· 10 Amp Charge Controller with LVD	· Wiring · Fuses	> 1 Hour	$405
1	40 Watt 320 watts/day	12-volt 32 amp hour AGM	192	· 10 Amp Charge Controller with LVD	· Wiring · Fuses	> 2 Hours	$495
2	80 Watt 640 watts/day	12-volt 92 amp hour AGM	552	· 10 Amp Charge Controller with LVD	· Wiring · Fuses	> 6 Hours	$869
3	123 Watt 984 watts/day	2x 6-volt 225 amp hour flooded	1350	· 45 Amp Charge Controller with Status Display · 1000 Watt Modified Sine Wave Inverter	· RV Inverter Wiring Kit 12-volt 600 - 1000 Watt · Wiring, outlets, fuses, etc.	15 Hours	$1660
4	195 Watt 1560 watts/day	2x 6-volt 225 amp hour flooded	1350	· 45 Amp Charge Controller with Status Display · 1200 Watt Modified Sine Wave Inverter/70A charger · Inverter/Charger Remote Control	· RV Inverter Wiring Kit 12-volt 1100 - 1800 Watt · Wiring, outlets, fuses, etc.	15 Hours	$2695
5	2x195 Watt 3120 watts/day	4x 6-volt 225 amp hour flooded	2700	· 45 Amp Charge Controller with Status Display · 1200 Watt Modified Sine Wave Inverter/70A charger · Inverter/Charger Remote Control	· RV Inverter Wiring Kit 12-volt 1100 - 1800 Watt · Wiring, outlets, fuses, etc.	30 Hours	$3938
6	3x195 Watt 4680 watts/day 1600 Watt Generator	2x 6-volt 683 amp hour flooded	4098	· 45 Amp Charge Controller with Status Display · 2500 Watt Modified Sine Wave Inverter/70A charger · Inverter/Charger Remote Control	· 30 Amp Automatic Transfer Switch · Auto Generator Start Module · Wiring, outlets, fuses, breaker panel, etc.	45 Hours	$10050

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complexity of the system and the number of components required, this solution is also getting expensive. In reality, one would have much large battery capacity and an industrial gas or diesel generator, windmill or micro-hydro to get through the winter.

Approximate component prices as of 1-Feb-2008 – shop around:

Solar Panels:

- 20 watt (1.2 Amp) Solar Panel - $175
- 30 watt (1.8 Amp) Solar Panel - $269
- 40 watt (2.4 Amp) Solar Panel - $280
- 50 watt (3.0 Amp) Solar Panel - $309
- 64 watt (3.9 Amp) amorphous Solar Module - $358
- 80 watt (4.7 Amp) multi crystal Solar Panel - $449
- 123 watt (7.1 Amp) multi crystal Solar Panel - $614
- 195 watt (7.96 Amp) multi crystal Solar Panel - $929

Charge Controllers:

- 6 Amp Charge Controller with LVD - $58
- 10 Amp Charge Controller with LVD - $60
- 20 Amp Charge Controller with LVD - $89
- 45 Amp Charge Controller with LVD and Display - $156

Batteries:

- Canadian Tire Motomaster Eliminator 600A PowerBox, 12-volt 20-Amp hour AGM Battery - $170
- Canadian Tire Motomaster Eliminator 1,200A PowerBox, 12-volt 60-Amp hour AGM Battery - $300
- Cotsco 95 Amp Hours 12 Volt Deep Cycle Flooded Battery - $89
- Cotsco 115 Amp Hours 12 Volt Deep Cycle Flooded Battery - $100
- Kendrick 12-volt 33-Amp Hour AGM Battery - $307
- 32 Amp Hour 12 Volt Deep Cycle AGM Battery - $125
- 54 Amp Hour 12 Volt Deep Cycle AGM Battery (39 lbs.) - $200
- 78 Amp Hour 12 Volt Deep Cycle AGM Battery (53 lbs.) - $265
- 92 Amp Hour 12 Volt Deep Cycle AGM Battery (63 lbs.) - $310
- 104 Amp Hour 12 Volt Deep Cycle AGM Battery - $345
- 2-volt 1766 Amp Hour Wet Battery (94lbs. dry, 208lbs. Wet) - $893
- 6-volt 225 Amp Hour Flooded (Golf cart) Battery (62 lbs.) - $140 x2 - $280 for 12-volts.
- 6-volt 683 Amp Hour Wet Battery (217lbs. dry, 271lbs. Wet) - $1094

12-volt Inverter, Inverter/Chargers:

- 300 Watt Modified Sine Wave Inverter - $50
- 300 Watt Pure Sine Wave Inverter - $265
- 600 Watt Modified Sine Wave Inverter - $90
- 600 Watt Modified Sine Wave Inverter (Better quality) - $197
- 600 Watt Modified Sine Wave Inverter / 30A charger w/GFI - $424
- 600 Watt Pure Sine Wave Inverter - $530
- 1000 Watt Modified Sine Wave Inverter - $265
- 1000 Watt Pure Sine Wave Inverter - $624
- 1000 Watt Pure Sine Wave Inverter / 50A charger - $960
- 1200 Watt Modified Sine Wave Inverter / 70A charger - $750
- 1500 Watt Pure Sine Wave Inverter - $1,010
- 2500 Watt Modified Sine Wave Inverter / 100A charger - $1,477
- Inverter / Charger Remote Control - $184

Transfer Switch, etc.

- 30 Amp Transfer Switch - $94
- 30 Amp Automatic Transfer Switch - $250
- RV Kit 12-volt 600 – 1000 Watt: $145
- RV Kit 12-volt 1100 – 1800 Watt: $160
- Auto Generator Start Module: $259

Generators:

- (Costco) Champion 3,000 Watt Generator, 15L tank, 53kg (117lb.) - $300
- (Costco) Champion 6,500 Watt Generator, 25L tank, 100kg (220lb.) - $700
- Honda EU1000ic, 900 Watt Generator, 2.3L tank, 13.2kg (29lb.) - $1,100
- Honda EU2000ic, 1600 Watt Generator, 4.1L tank, 21kg (46.3lb.) - $1,749
- Honda EU3000isCA, 2800 Watt Generator, 13L tank, 59kg (130lb.) - $2,419 ✸

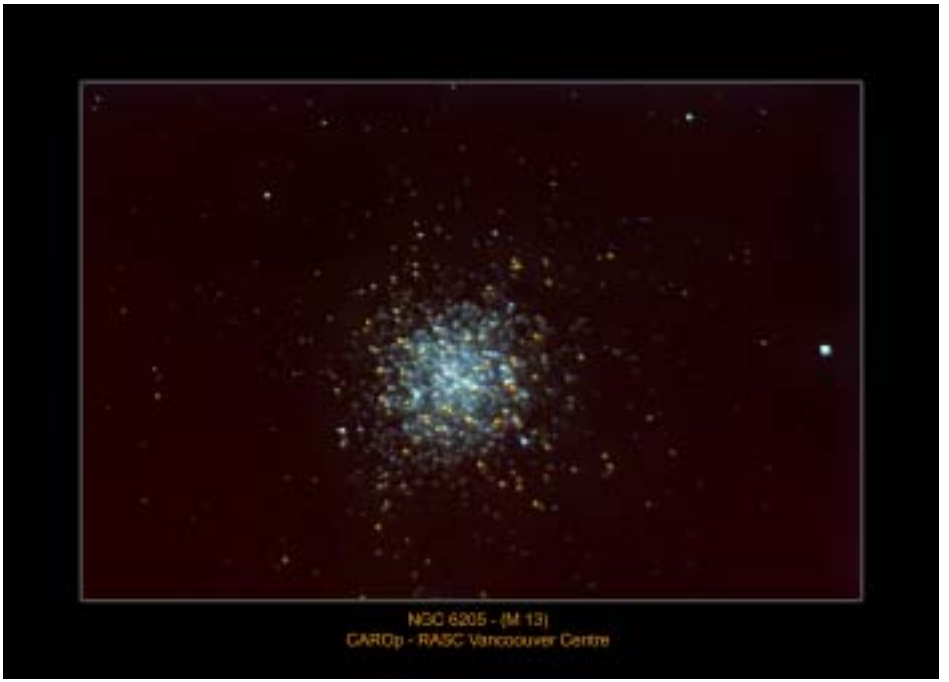
CAROp Observatory

by Wayne Lyons

Training at the observatory has been progressing, but a little slower than I was hoping for. The Spring's bad weather didn't help much for actually doing some observing. I have not been able to put together a work party at the observatory but with the longer evenings of the Spring we have managed to do a little maintenance work around the observatory while we wait for darkness. There has been the occasional clear evening when we have managed to get up to the observatory and do some imaging.

The FLI imager has been inconsistent in taking images and currently is with Eric Fuller. It has been functioning OK for him and I'm hoping to find out exactly what is happening to prevent a reoccurrence of the problem.

With the imager gone we have been working at using alternate imaging equipment. Mark Eburne has tried out a Meade Deep Sky Imager and Brett Spratt is looking at using a webcam. I have taken an image with a Canon Rebel XT. This photo of M13 is a composite of 20 – 30 second exposures and about 8 hours of image processing. Focusing the cameras is the big issue and we are working at making adapters that will bring each camera into the same focal plane so the primary mirror does not need to be adjusted. After much work at bringing the image to focus, the photo of M13 does still show coma in the stars.



I have been busy with the Sidewalk Astronomy presentation at the Roundhouse on June 6th and an observing session at the Loon Lake Outdoor Education Facility at the UBC Research Forest on June 29th. These events have been very rewarding. Special thanks to the following volunteers that helped to put on these events: Alan Jones, Suzanna Nagy, Ron Jerome, Cameron Widen, Bruce MacDonald, Carl Miller, Sheetal Rawal and Brett Spratt. ✸

M42 (Orion Nebula)
Masoud Ravandi

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again on the morning of August 9th up at Mount Kobau. If you are going to be there and are from Vancouver Centre, please contact me to volunteer to flip pancakes! It was a successful event last year where we flipped nearly 200 pancakes, so please help out if you can.

Here is hoping for clear skies!

– Pomponia ✸

M8 (Lagoon Nebula)
Bob Parry