Geneva Chong (geneva_chong@usgs.gov) and Daniel Gurganus (dgurganus@usgs.gov) have assembled this helpful set of instructions for creating a PhenoCam site at a location without power or internet, using solar power and a cell phone modem.

The battery and panel requirements may vary from site to site, depending on day length in winter, and the amount of direct sunshine received. To install the camera itself, see the field installation guide at http://phenocam.sr.unh.edu/webcam/tools/

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Shopping List

From solar-electric:

2 Solartech 40 Watt 12 Volt Multicrystalline Solar Modules (originally bought 1, but not sufficient)

Morningstar SS-10 Solar Charge Controller 10 Amp, 12 Volt

Ironridge Top of Pole Mount

http://www.solar-electric.com/12-2-tc.html ---note that you could also buy this at a local electronics/hardware store, only 2 to 3 feet are required and the site has a minimum order of 25 feet.

http://www.solar-electric.com/10fomc4excam.html

MC4 Junctions - buy both a M-M-F and F-F-M junction. These are used to connect the two panels.

MC4 Disconnect Tool – A tool to separate the wires in case of a mistake.

Amazon (These products, apart from the battery, are probably easily found in your local stores):

12 volt, 100 amp hour marine battery * - this has worked at the quickbird, WY, site through a winter: caution - VERY HEAVY.

(24-gallon action packer) WE ARE RESEARCHING A UTILITY BOX FOR INCREASED WEATHER PROTECTION, SECURITY AND EASE OF INSTALLATION. MORE SOON. WWW.MIERPRODUCTS.COM

Plastic “conduit” to protect wires (if wires near ground-level, please use metal conduit)

Sealant Putty

Surge protector: APC PNET1GB ProtectNet Standalone Surge Protector for 10/100/1000 Base - T Ethernet Lines

From local Staples:

(Wire Tray (or a similar wire file tray from Staples) – WAS ONLY NEEDED FOR ACTIONPACKER).

Velcro (also available at staples): TO MOUNT MODEM AND ANTENNA AND MANAGE WIRES INSIDE THE UTILITY BOX, ABOVE THE BATTERY.

From local Ace Hardware/Lowe's:

Terminal insulated 5/16" in – 3/8" in stud ring end (need 4 terminal ends total). Example: Ace Hardware Item
~7 foot, 4” diameter wood post. We purchased this from a local ranching store.

1 to 2, 60-pounds bags of dry concrete, 5 gallon bucket and sturdy “paddle” for mixing. Water.

*Was 35AH 12V DC DEEPCYLE SLA SOLAR ENERGY STORAGE BATTERY but not sufficient.

Cellular modem (see order sheet at end of document)
Site Construction

The Instructions below show a site construction using the ActionPacker box. If your site cannot accommodate for that box because of bears, high chance of rodent chewing, lack of space, etc. then you can look at purchasing a dust and water proof box from Mier Products. We’ve have gotten a quote for the BW-SL181610 (pictured) and its 4” diameter pole-mount BW-1816PM4 to be at $150 and $40 respectively to give you an idea of their costs if you would like to choose a different box. The pole-mount is rated at 80-100 pounds so it should be able to hold everything without fail. Using a box like this could draw less attention from bears as it won’t look like a cooler, and people may also be less interested in it. Using the pole mount can get everything off the ground and away from rodents to help prevent chewing.

These instructions are for setting up the remote phenocam site itself. This does not need to be adhered to strictly like the wiring instructions. This is a setup that we found to work easily for us and seems easily reproduced. Our idea for the interior of the box was to make it easy to manipulate and prevent any water damage if the box were to leak. [All the equipment is thus placed on an upside down wire tray, raising it off the bottom and letting any direct drips fall through.] Velcro is used as the adhesive to allow for easy maintenance.

Organizing the Box [This is written for the Action Packer. We will update for the utility box.]

1. Place the metal wired box (file tray) upside down in the bottom of the 24 gallon ActionPacker Rubbermaid box.
2. Velcro the bottom of the tray to the base of the box using Heavy Duty peel and stick Velcro
3. Velcro the car battery to an edge of the tray with the terminals facing the box edges (away from the center of the tray)
4. Velcro the modem and the power inverter to the tray
5. Velcro the SunSaver controller to the edge of the tray with the screws on the upper side
6. Velcro the antenna to the side of the wire tray, similar to the controller.
7. Scrape a ~1.5cm diameter hole in the side of the ActionPacker box on the side with the modem (the awl on a swiss army knife works well for this)
8. The wires which will run through this hole in the box are both the + and – terminals of the solar cell and the Ethernet cords from the camera
This shows how we organized it. You are welcome to come up with something different. Note the 100 amp hour marine battery fits where the 35AH battery is shown here.

The directions on the bags of concrete were thorough for installing posts.

The instructions for connecting the panel and mounting the panel are clear enough to follow, but we’ve provided pictures for our end product.
Make sure the threaded bolt is as even on both sides as possible to allow for easy tilting.

We tilted the tilt plates 47 degrees from vertical to get the best average angle throughout a year. You can find what angle yours should be by visiting http://solarelectricityhandbook.com/solar-angle-calculator.html
Waterproofing

1. When all wires are connected, place a golf-ball sized chunk of waterproofing putty around the wires in the hole in the box and the hole in the camera box. Place the putty on the interior of the box and the housing and cover with duct tape as best as possible.

This is what the putty looks like on the inside of our box.
For anchoring and insulating we partially buried a third of the box. The following pictures show the hole and the finished setup.
Wiring Instructions

Connecting Battery to Controller

1. Cut a length of the #12 AWG wire that will comfortably connect from the battery to the controller.
2. Strip about 6 inches of the black covering on the #12 AWG wire so that the two wires can reach a separate terminal of the battery.
3. Strip 3 inches of the black covering on the opposite end of the AWG wire so that the two wires can reach the two ports on the controller.
4. Strip about 1 cm of the red and black cover on both ends of the AWG wire.
5. Connect the ring terminal to the battery end of the red and black AWG wires by crimping it onto the ends.

On the left is the battery end of the AWG wire and the right is the end that will be connected to the controller.

6. Take the black AWG wire that’s on the controller end and put it into the negative battery port on the controller, no need to overtighten.
7. Take the red AWG wire that’s on the controller end and put it into the positive battery port on the controller.

Connecting Solar Panel to Controller

1. First connect the MC4 wires from the two panels together using the MC4 junctions, keeping positive with positive and negative with negative.
2. Cut the MC4 wire extension in half and strip about 1 cm from the ends of each half. You may cut each one to be shorter if your setup allows.
3. Connect the male and female ends of the extension wire to the solar panel. Note: this does not change the labeled polarity on the wires coming from the panel.
4. Connect the bare wire from the negative MC4 wire to the negative solar port on the controller.
5. Connect the bare wire from the positive MC4 wire to the positive solar port on the controller.
In the top picture is what it looks like after the two wires have been connected, and the middle picture shows the stripped, bare end of the wire. The controller after all connections have been made. Be sure to leave the jumper clip to the right in the controller as the batteries we are using are sealed. (This picture was previous to a second solar panel, so the image at the top is not perfectly accurate)
Preparing Modem

1. Strip about 3 to 5 inches off of the silver power cord (not Ethernet end) that attaches to the **modem** to expose four different color wires.
2. Strip about 1cm off the **red, white, and black** wires.
3. Nothing needs to happen to the **green wire**. **Do not** strip it. We had a wire twist on hand but it is not necessary.

Preparing Camera and Connecting With Modem Wires

1. The camera should have come pre-stripped and labeled with positive and negative wires. If not follow the sub-steps here.
   a. Leave the AC adapter connected to the wire, and strip a very small portion of cover off of each of the two wires. Leave some distance so you are not accidentally creating a short.
   b. Using a multimeter, set it to measure voltage. Attach each lead to a separate, now bare, wire. If the voltage measures positive the leads match polarity (the red lead from the multimeter is on the positive camera wire). If the voltage measures negative (or zero on an analogue multimeter) the leads are on the opposite polarity.
   c. Remember which wire is positive and negative. The pattern on the positive wire (at least for us) was a series of white bars.
   d. Cut the AC adapter off below where you measured the polarity and strip about 1cm of bare wire for each side.
2. Take the bare **positive camera wire** and twist it with the bare **red and white modem wires**. Place them into a terminal ring and crimp down so that they will not fall out.
3. Take the bare **negative camera wire** and twist it with the bare **black modem wire**. Place them into another terminal ring and crimp down.
What the wires look like after being connected to the terminal ends. Again, the twist cap on the end of the green wire is not necessary. This photo was taken prior to connecting the camera to it, there should just be an addition wire in each of the terminal ends.

**Connecting Controller and Modem to Battery**

1. Take the **black AWG wire** that now has a terminal ring on it and the **black modem wire** and use the screw provided with the battery to attach them to the **negative terminal**. The order of attachment should be screw top, followed by the battery terminal, then terminal rings of each wire (order of these does not matter), then flat washer, then lock washer, and nut.

2. Repeat step 1 for the **red AWG wire and red/white modem wire** on the **positive terminal** of the battery.

3. Check the lights on the controller and make sure you are not receiving any error. Refer to the **controller** instruction book on definitions of light displays.
This is what the negative terminal should look like after connecting the terminal ends. The lock washer is not in view, but it’s the first thing the nut touches.

**IMPORTANT:** If you need to disassemble, always disassemble in the reverse of these directions.