Monitoring a solar installation by tapping into a SunPower PVS5 or PVS6

> Updated (5/29/24): Documented new knowledge about other open ports, add configuration to haproxy for those ports, included a reference to “sunpower-ess-monitor” (monitors a Sunpower ESS system and publishes to an MQTT broker). Also included information about a known and confirmed firmware problem with logging storage filling up and causing reporting to Sunpower to stop.
>
> Updated (5/25/2023): Documented Pi Zero W works as well. Updated configuration of haproxy to include possible output compression. Updated instructions to set timezone, locale and hostname for Pi.
>
> Updated (1/27/2023): Some additional photos and explanation of PVS6 versions without Ethernet.
>
> Updated (12/25/2022): Newer PVS6 models without Ethernet ports were introduced in 2022. I have added documentation for using dongles to make Ethernet available on those models.
>
> Updated: I have been working with an owner with a SunVault ESS battery system. The networking is slightly different, and the device details amd cabinets are as well. This update adds additional devices seen by the PVS6 and the below documents this as best as currently known.

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Introduction

The following describes how to set up a way to issue HTTP commands to a SunPower PVS5 or PVS6 monitoring system. This information was gathered from several different places on the Internet but is presented here in an attempt to provide a single comprehensive document. The most notable sources used were:

- Monitoring a SunPower Solar System (https://blog.gruby.com/2020/04/28/monitoring-a-sunpower-solar-system/)
  - Describes Scott's experience, and configuring a Raspberry Pi3, and how he uses Home Assistant with Grafana to build a dashboard
- SunPower PVS5x/PVS6 Notes (https://github.com/ginoledesma/sunpower-pvs-exporter/blob/master/sunpower_pvs_notes.md)
  - Documents using a Raspberry Pi3 as a bridge to the PVS5x or PVS6 system as well as some of the API commands (with a few errors)
  - The GitHub repository also contains some code

- Sunpower PVS6 Installation Instructions (https://us.sunpower.com/sites/default/files/sunpower-pv-supervisor-6-installation-instructions-531566-reva_0.pdf). This is for the (older) model equipped with Ethernet ports.
- Sunpower PVS6 Residential Installation Instructions (https://fccid.io/YAW539848-Z/User-Manual/Users-Manual-rev-6022499.pdf). This is for the newer model (2022) not equipped with Ethernet ports, but with USB ports that accept certain dongles..
- https://us.sunpower.com/sites/default/files/sunpower-pvs5x-install-and-quick-start-guide-522351_0.pdf
- Commissioning EquinoxTM Systems using WiFi (https://us.sunpower.com/sites/default/files/tech-note-commissioning-equinoxtm-systems-using-wifi-534241-004_0.pdf)
- Equinox Installation Support (https://us.sunpower.com/support/install/equinox)
- Conext XW Pro Hybrid Inverter (https://www.se.com/ww/en/product-range/66297-conext-xw-pro/?parent-subcategory-id=7010&filter=business-7-solar-and-energy-storage#overview)
- Conext Battery Monitor (https://www.se.com/ww/en/product-range/65504-conext-battery-monitor/?parent-subcategory-id=7040&filter=business-7-solar-and-energy-storage#overview)
- Conext Gateway (https://solar.se.com/us/en/product/conext-gateway/). This is listed as a discontinued product but may still contain information relevant to its replacement.
- Thanks to Dean Ott who confirmed to me that he has all this working with a PVS5 system (he uses two cables: one for outbound access for the PVS5 (instead of WiFi), and one to a Raspberry inside his wiring closet).
- Thanks to Phill West who owns a system with a SunVault ESS battery system.

The basic reason for even wanting to bother with all this is the finding that the SunPower mobile app or website that is offered to customers is extremely limited in functionality. It only offers insights into current solar production, current consumption (only if a metering kit was installed which oftentimes is not the case, so you would have to ask for it), and some historical graphs showing kWh produced or power output. There is no information about individual system components regarding their functional state, and no detailed performance metrics. Additionally, it appears that the SunPower data on the app or website may only be updated in less than real-time.

Using the approach described here, more detail and data with higher frequency are available. I first describe the basic functioning of the PVS system and how one can "tap" into it, and then discuss the specific solution using a Raspberry Pi3 (and, later, a Pi Zero W). Finally, I document the API that becomes available using this approach. The API can be used by custom code you or somebody else writes. One such example is an integration called SunPower, for Home Assistant (https://github.com/krbaker/hass-sunpower).

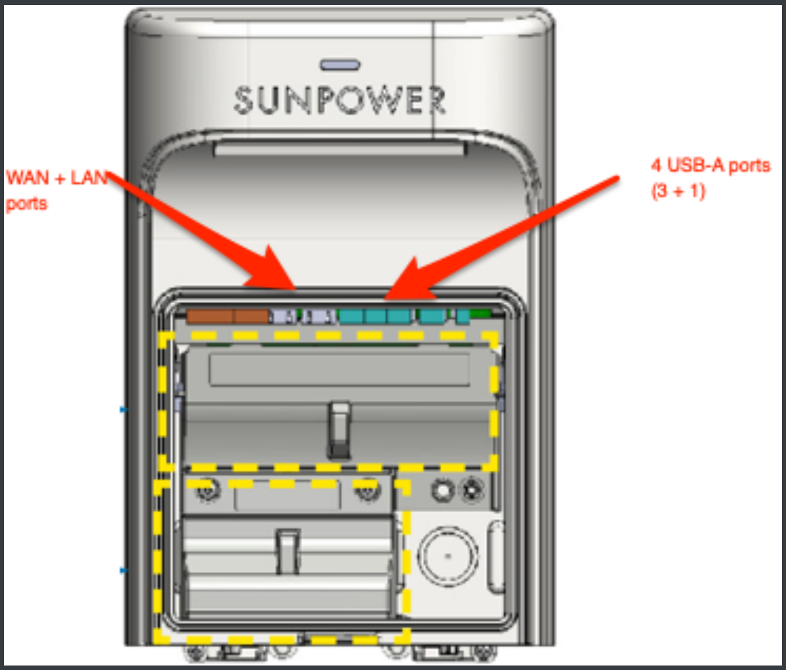
The PVS6 system

What follows may not precisely describe how things are for the PVS5 series. Although it seems very similar concerning the functionality described here, I don't have one so could not test it (but I have confirmation things work basically the same). The system is a separate box (except in ESS-based installations), typically installed near the (sub)panel where the wiring from the solar array is hooked up. Inside it generally contains connections to one or two circular magnets/coils, called Current Transformer (CT) that are installed around the PVS wires so that the energy produced can be monitored. There may also be a set around the incoming wires from the utility (a so-called metering kit). The latter is oftentimes omitted, unless you have battery storage, in which case it is needed to properly decide where to route energy produced by the PV system (i.e. to battery and/or grid). The system will be powered via its private breaker circuit.

The system has several I/O ports inside (remove front cover). Most notably there are two Ethernet ports labeled WAN/LAN2 and LAN1, and 4 USB-A ports. Also available is a wireless radio (for WiFi access), and a cellular system, which will most of the time not be equipped with a SIM unless you have cellular as your only option to connect to the Internet for monitoring by, and uploading to SunPower. Finally, there is also a facility to access the PVS monitoring system through PLC (Power Line Communication). The latter is also how the monitoring system communicates with all the microinverters for the panels. The USB ports do not appear to be used and probably come as part of a fairly generic motherboard used inside. They can come in handy though, as you will see later.

In the most basic setup, the PVS monitoring system needs Internet access to communicate with SunPower's cloud. In many, if not most, customer installations this is achieved by connecting to the customer's WiFi network. Where this is not possible, or not desirable, an Ethernet cable from the WAN port to the customer network is another option (but often a cumbersome one as the panel will likely be outside, so a cable will have to be routed to a suitable location inside). In both cases the PVS monitoring system will act as a DHCP client on the customer network to obtain its IP address, although it is also possible, using installer access via the specialized mobile app, to configure a static IP address. Generally, it is advisable to leave things as DHCP but configure your home router or WiFi with a statically reserved DHCP address so the box always gets the same IP address. Failing the above two solutions a PLC-based connection is the next option, and finally, there is cellular. Only the latter will not make the PVS monitoring system available on the customer network and everything discussed here cannot be used.

While the WAN port is for wired communication between the PVS monitoring system and the customer network, the LAN port is meant for the installer of the system. A laptop can be plugged into it directly. To support this mode of operation, the PVS monitoring system runs a DHCP server on this port, so the laptop can obtain a suitable IP address, routing information (the PVS monitoring system is the gateway), and DNS (so that a lookup of www.sunpowerconsole.com will work). The port presents a network with address 172.27.153.0/24 (netmask 255.255.255.0) and the PVS monitoring system will be at the gateway address supplied by DHCP (this seems to always be 172.27.153.1). The laptop will get a suitable address on the same network.


SUNPOWER
WAN + LAN
ports
4 USB-A ports
(3 + 1)

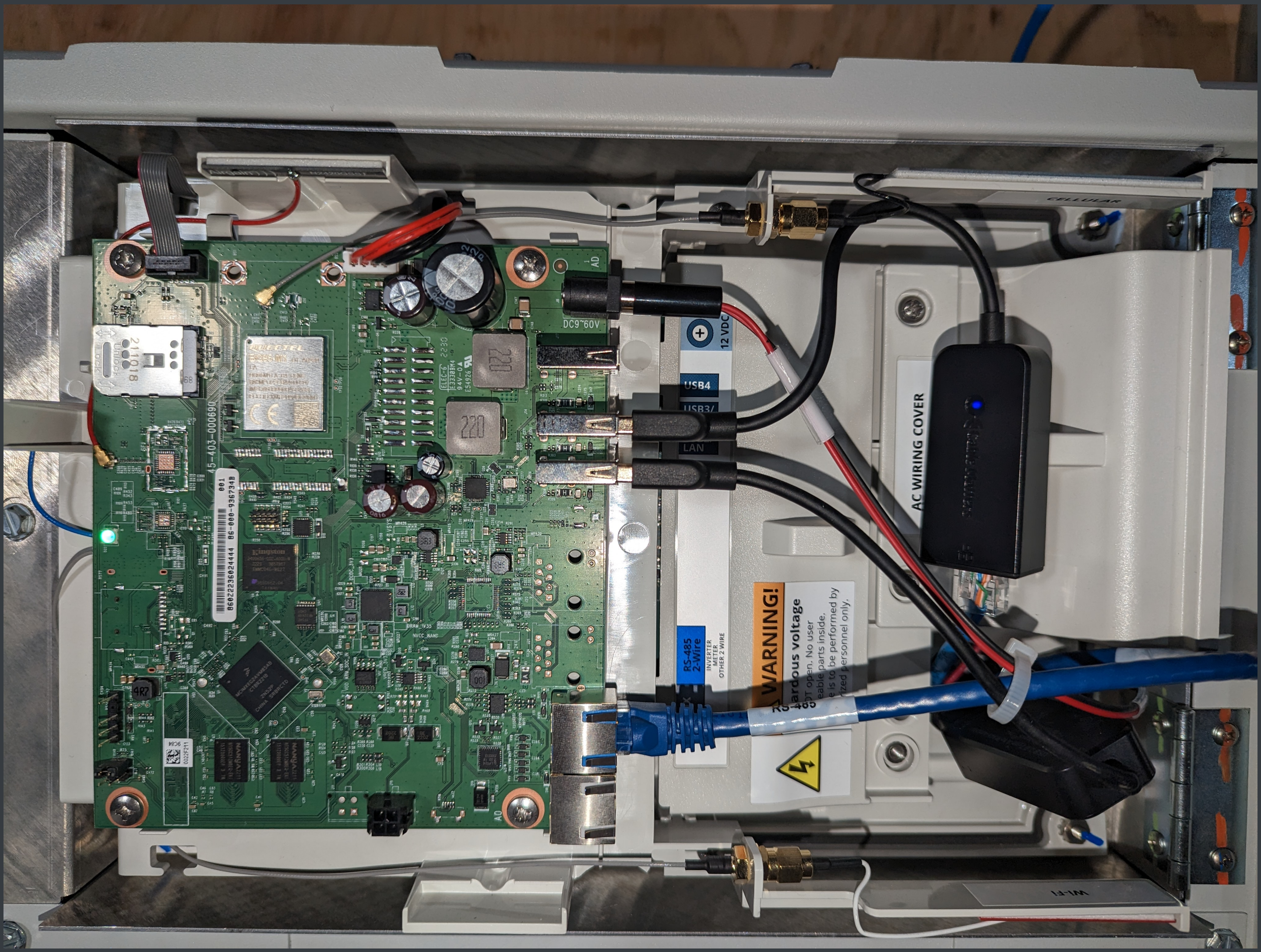
The black port is LAN1, and the yellow port is WAN/LAN2! Raspberry powered from USB port 1. Using short cables, plenty of space.

NOTE: I have reports of a newer version of the PVS6 being used. This newer version lacks the two ethernet ports. Its insides look like this:

Note that the traditional ethernet ports are no longer there, but there are two USB ports that are also labeled LAN and WAN respectively. Of course, USB does not equal ethernet so the suspicion is that the USB ports can accept ethernet adapters, but so far those that have tried to use ethernet this way have not been successful.

> **NOTE:** It seems that the ports will indeed take USB Ethernet adapters, but only certain brands/models will work.

The above picture is from the standalone PVS6, a newer version, without Ethernet ports. Here is a picture inside the “modern” ESS installation of the same PVS6, but exposing more of the inside:



Visible here on the right side of the green PCS, from top to bottom (corresponding with right to left in the picture above it):

- Power adapter port
- USB port (nothhing plugged in here)
- USB port with Ethernet dongle plugged in (ostensibly for WAN/Internet access). This one is optional
- USB port with what appears to be a second dongle plugged in (for connection to the ESS Gateway). This one is required
- RS-485 cable (looks like Ethernet, but it is not Ethernet) for serial communication with Inverters and ESS sub systems
- D-AUX port, nothing plugged in

The laptop tapping into this port is the legacy way of configuring the system. These days installers can use a mobile app available from the iOS app store, and I assume there is also an Android version. The app initially uses BlueTooth to connect. It will obtain the name of a WiFi network presented by the system and subsequently, your mobile device will need to be configured to connect to that network to access the needed functionality. While you can download this app yourself, soon after you start it it requires you to login to the SunPower portal with a qualified installer account. An account that they presumably will not give to an end user.

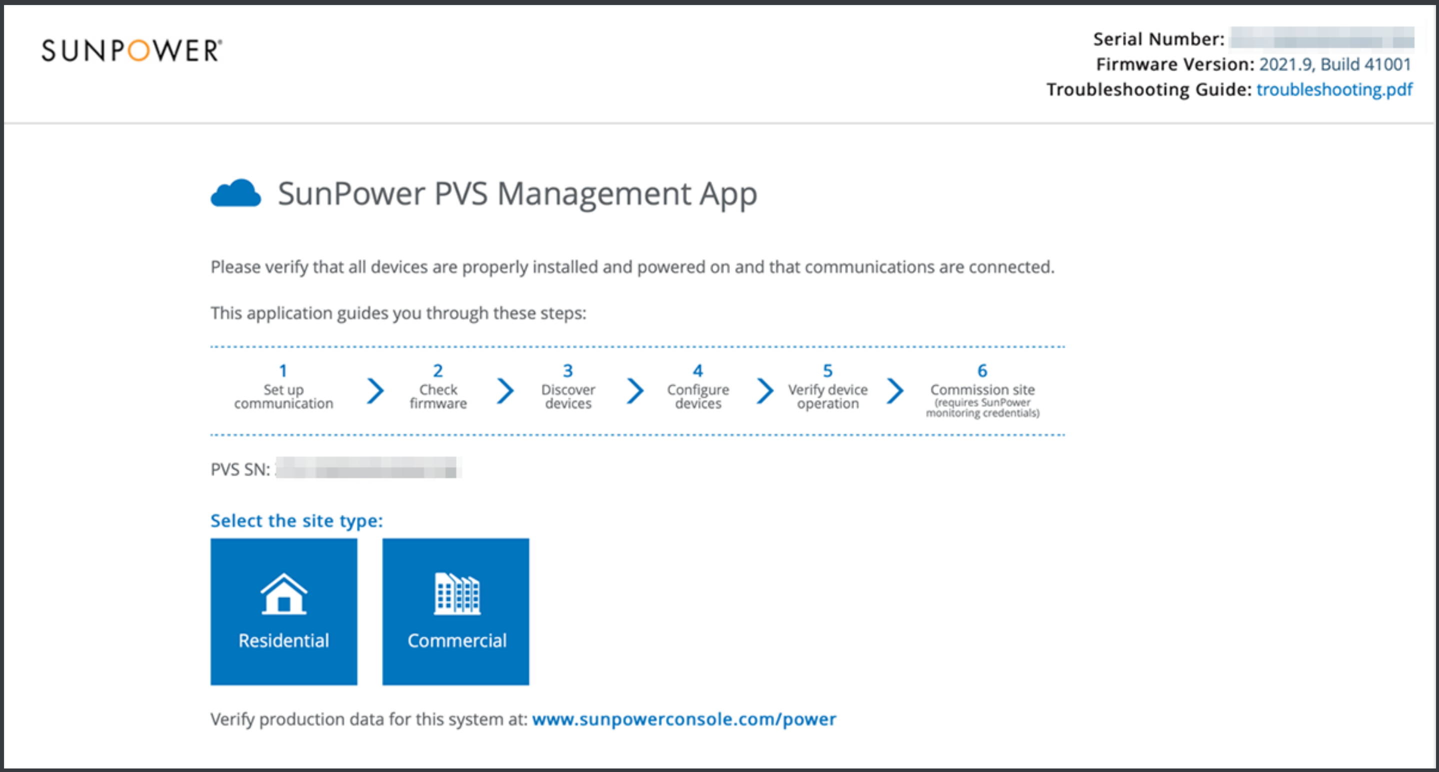
I also found a https://us.sunpower.com/sites/default/files/tech-note-commissioning-equinoxtm-systems-using-wifi-534241-004_0.pdf (from August 2019) detailing how to connect to the PVS6 using laptop and WiFi. Apparently during commisioning the box provides a WiFi network. Using the serial number found on a sticker(s) on the box, numbering its characters from left to right, starting at 1 (we'll use sample `ZT190585000549A6185`):

- Characters 5, 6, followed by last 3 characters appended to "SunPower" will be the SSID to connect to (Example: `SunPower0518)
- Characters 3, 4, 5, 6 followed by last four characters will be the password to use (Example: `19056185`)

This WiFi network is apparently available for four hours after power up unless commisioning is complete. If commisioning is started in that window, it will stay active. If you go beyond the window, you can reboot (power cycle) the PVS6 and a new 4 hour window will start.

> **NOTE:** It appears that, at least in early 2024 on my PVS6, this network is no longer deactivated after 4 hours. This is likely to provide mobile phone access for installers without requiring them to power cycle the PVS system.

The way the LAN port works is that the monitoring system runs a web server, which listens on port 80 (standard http port) and 443 (standard SSL port). If one accesses www.sunpowerconsole.com from a browser on the laptop you will see something like this:



Unless you can see this, something is wrong with your setup! Other urls available:

- http://www.sunpowerconsole.com/#/summary: leads to (step 5 of 6) summary of status page
- http://www.sunpowerconsole.com/#/landing: leads to the landing page
- http://www.sunpowerconsole.com/#/firmware: checks for an applies firmware update
- http://www.sunpowerconsole.com/#/network/config: leads to network setup page
- http://www.sunpowerconsole.com/#/rma-device-selection: allows request equipment RMA
- http://www.sunpowerconsole.com/#/devices/inverter-micro: returns mostly empty results for me with callback errors to “https://pvsmgmt.us.sunpower.com/”

> **NOTE:** I don’t know when this changed exactly, but I suspect somewhere in the second half of 2023, these URLs no longer work. They all return a “403 Forbidden” response in newer firmware versions. This is likely coincident with the notion that SuUnpower does not want installers to use a laptop anymore, but rather use the “SunPower Pro Connect” phone application. For this purpose also, the PVS system seems to now always have its WiFi network on (meaning its management WiFi

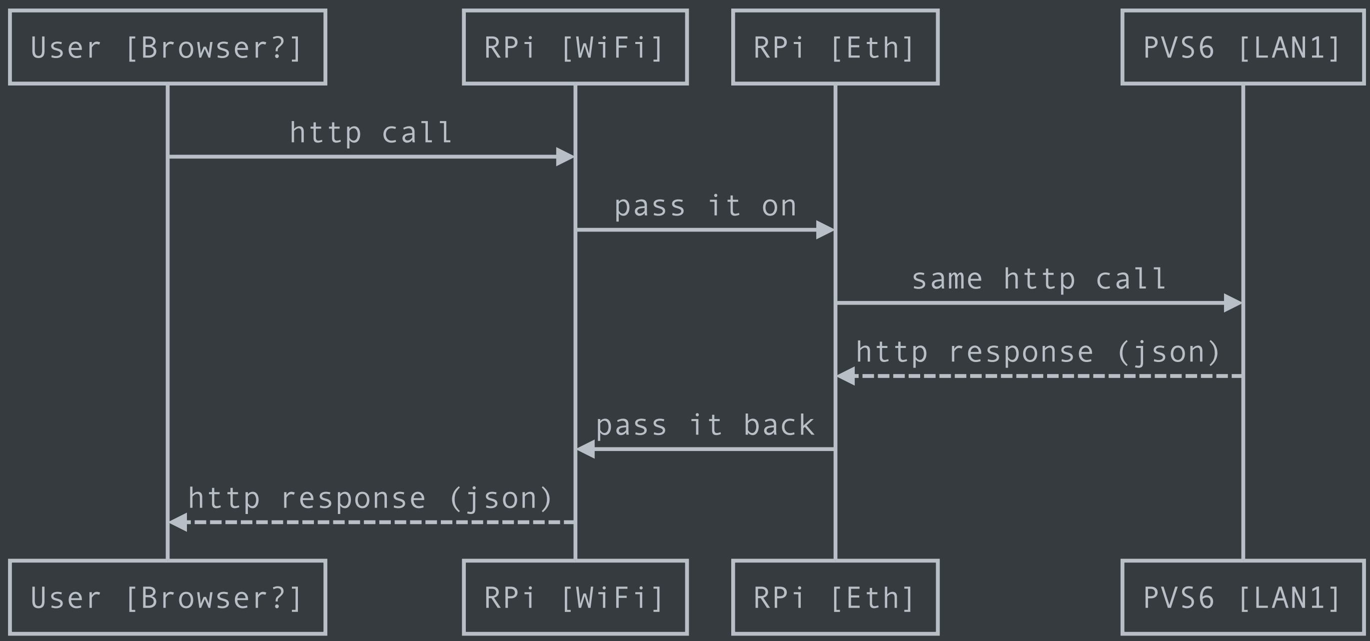
> network).

Now, you could stand out there, with your laptop, and play with this console or issue API commands, but it is not very practical beyond some basic testing. So, how to proceed? You want to create a situation where you can directly access this port from within your network. If you are connected via WiFi you are, effectively, talking to the WAN port, where neither console nor API is available. So, somehow you must connect to the LAN port. Forgetting the inconvenience (to some) of installing a cable, you can use a cable, but there are some problems you will need to get around. You cannot just plug this cable into a switch on your network as the PVS monitoring system has its own address and runs a DHCP server. You probably already have one, and chaos with networking problems will ensue. It is possible to get around this by using a dedicated port on your router or switch and configuring proper routing from your network to this network (possibly involving VLAN solutions). Since your computer stays on your network, nobody will be using the PVS-supplied DHCP server and you should be fine. You will have to make assumptions about network addresses and setup, and you will not have DNS to resolve sunpowerconsole.com for you. There are workarounds to all of this, but I consider them out of scope for this write-up.

There is another solution that is relatively cheap and easy (as described in this paragraph it does not apply to installations with a SunVault ESS). Use a very small form factor computer with at least one ethernet port and with WiFi and install it inside or near the PVS monitoring box. Ethernet connects to the PVS LAN1 port, and WiFi needs to be configured to connect to your WiFi. With some proper configuration that computer can act as a proxy between both networks. The address of that little box on your WiFi becomes, effectively the http access to the PVS system. Any HTTP query sent to the little box is forwarded to the LAN port, and any responses are forwarded back to whoever asked. A very commonly suggested solution involves a Raspberry Pi3. Principally because it is small, cheap, and comes with Ethernet and WiFi. Older models Raspberry can be equipped with a USB-based WiFi dongle fairly cheaply too, so if you have one of those lying around it can also be made to work. In the remainder, I will describe the Raspberry-based solution, but the principles should apply to almost any other small computer.

There are reports from one user with a Raspberry Pi model 4 who experienced intermittent problems due to the USB port not providing enough power. It is probably best to stay with a less power-hungry model. Very little is required from the “proxy computer” so even the smallest Raspberry Pi Zero will work. There are also reports of some USB Ethernet adapters not working. I have only tested with the one mentioned here. That one works for me, and at least one of the users with problems reported that after switching to this adapter things worked.

In this setup the small computer acts as bridge (or proxy) to the PVS6 internal network (RPi = Raspberry, and [] denotes the network interface):



The following ports/interfaces will be in use:

- PVS6 LAN1: Installer/Console port, represented with IP address: `172.27.153.1`
- PVS6 WAN/LAN2: Customer/WAN port using WiFi (IP addressed assigned by your WiFi network and used for uploading to SunPower, not otherwise relevant in this document)
- RPi LAN1: Ethernet port, directly connected too PVS6 LAN1. Will receive an IP address from the PVS6 system in the network `172.27.153.0/24`.
- RPi LAN2/WiFi: Raspberry customer-facing interface. This is where you will browse to, or execute API commands. IP address assigned by customer WiFi (static reservation?)

PVS6 with SunVault battery system (ESS)

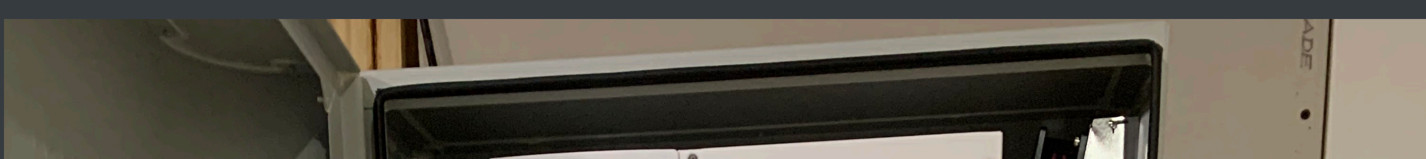
If you have a SunPower setup with SunVault Energy Storage System (ESS), you will generally have these two large boxes/cabinets:

The one on the right is referred to as the HUB+, and the one on the left is a battery cabinet. Depending on your battery storage capacity you may have more than one of these. Each cabinet contains two batteries and an inverter.

This is the HUB+ with the top panel removed (basically what you see here is the inside circuitry of the stand-alone version of the PVS6):


USB4
USB3
USB2
USB1
WAN/LAN1
AC WIRING COVER

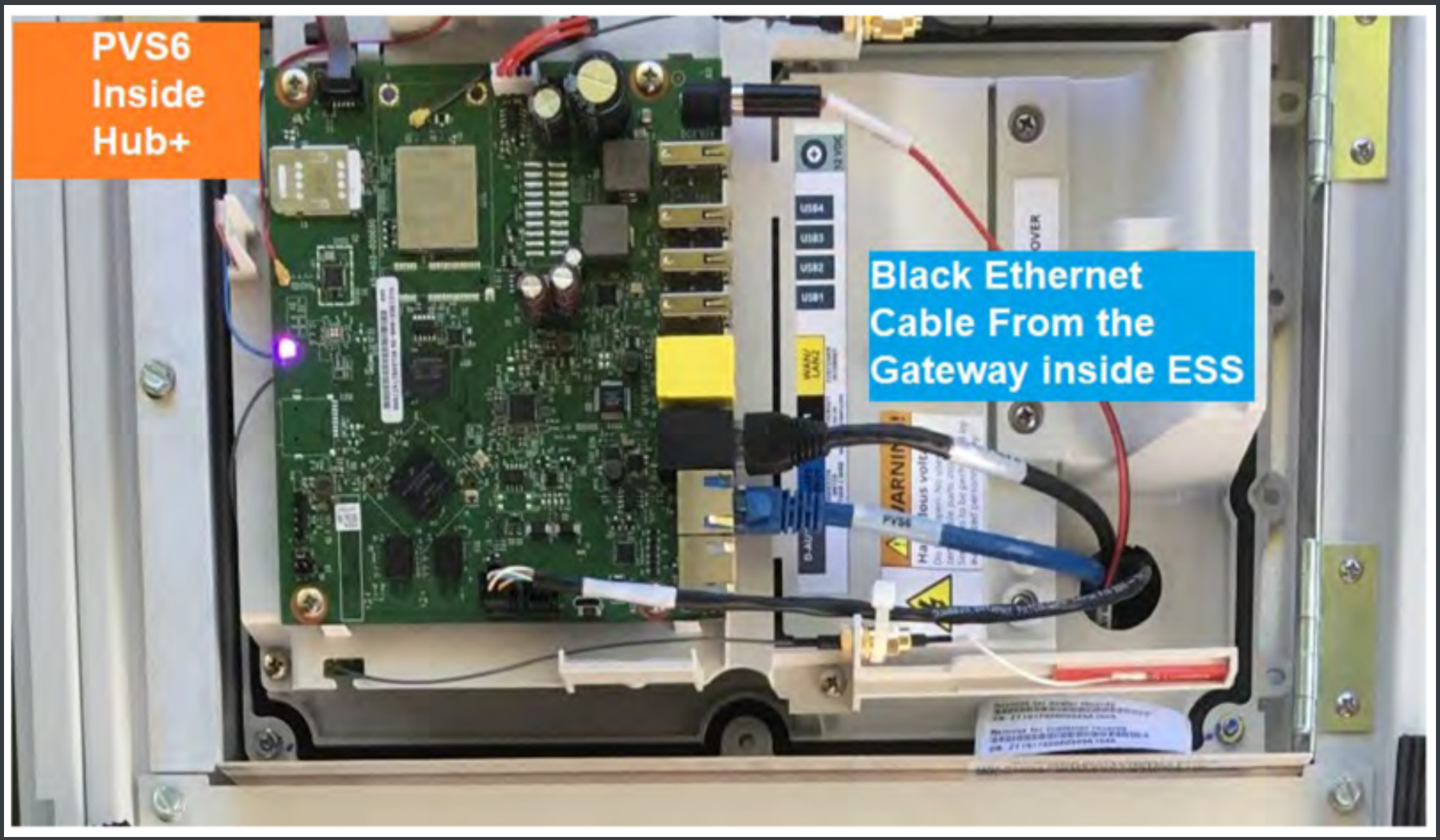
This is the inside of the main battery cabinet. The light-colored module in the top half is the inverter, below are two batteries. The small-ish light-colored box on top of those is the Conext Gateway device.



Inside the HUB+ you will find the following components:

- Sub-panel for backed-up loads. This will have to be wired to all circuits on the premises you desire to be backed up by battery power in the event of a utility power outage. This is the top section labeled “BACKUP LOAD PAN”.
- Sub-panel for the PV system. Typically connects both phases of the PV system and the PVS6 monitoring module. This is the middle section labeled “GENERATION PAN”.
- Sub-panel for the non-backed-up loads. This is the bottom section, labeled “NON-BACKUP LOAD PAN”.
- Microgrid interconnect device. This is a screwdriver-operated rotation switch to completely disconnect the microgrid (your PV system plus batteries) from the rest of the electrical installation
- PVS6. This is the same monitoring system mentioned elsewhere in this document. The ESS-based solution does not have its own PVS cabinet, but rather its printed circuit board is integrated with the HUB+ behind a removable panel on the top. You will need to remove/open this panel to access network connections.

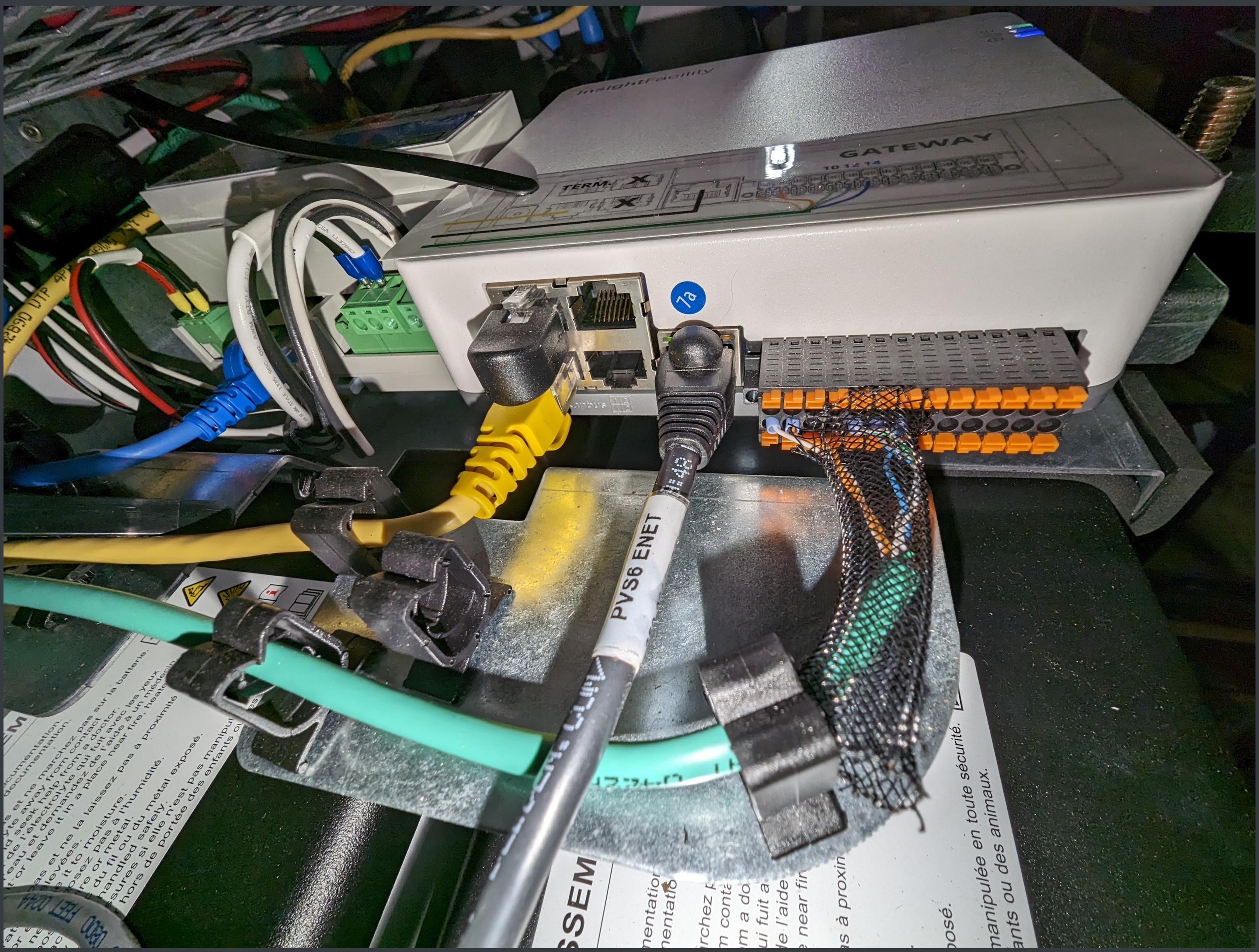
The PVS6 still performs all functions and is the entity to communicate with the SunPower portal, but we do need to change the networking approach a little to make the rest of what we describe possible.



In this picture, the black cable is in the LAN1 port and it goes to the Conext Gateway device located inside the battery cabinet. The two metal-colored connectors below it (the top one of which contains the blue cable) are for RS-485 serial communications (labeled in blue with “RS-485 2-wire”, and in white with “INVERTER METER OTHER 2 WIRE”). This is the “modbus” communication system referred to elsewhere in this document. The blue cable connects the PVS6, via this serial communications channel, with the first inverter (inside your first, and perhaps only) battery cabinet. If you have more than one such cabinet there should be an additional cable from the second port in the first cabinet to the next battery cabinet. The RS-485 serial communications system is a daisy-chained channel/bus.

In some other installations the blue cable may not be used, but the black one (or perhaps other color) runs to the inverter. In this case ethernet communications is used between all devices. The instructions that follow (i.e. installing a switch etc.) don’t change, except that you could possibly leave out the switch by utilizing the unused ethernet port in the last inverter in your setup. I have not seen this myself, but documentation suggests that each inverter has two ethernet interfaces for this purpose. Overall you might be best off following a path that changes the least in your installation (which I suggest is the switch based installation).

Here are some more pictures of the insides of a more receent ESS setup using the non-Ethernet PVS6 version:



The networking setup now will require a switch (anything simple and unmanaged will do). This switch needs a minimum of 3 ports:

1. This will be cabled to the PVS6 LAN 1 port and replaces the black cable in the picture
2. This will be cabled to the ESS box and you can use the original black cable removed from the LAN1 port for this.
3. This will be the port to connect the Raspberry to, or a laptop for testing, or a cabled solution to your home network (requires a router with an “extra” port). Alternatively an unused ethernet port in the battery cabinet on the inverter.

After placing cables (1) and (2) the PVS6 needs to “reset” its networking. This can be accomplished by rebooting the PVS or possibly by power cycling the switch. In a non-ESS setup, you can reboot the PVS6 by using the breaker to power cycle it. In a non-ESS setup power cycling using the breaker has been tested and works. In a SunVault ESS-equipped system there is a breaker, but I am not sure if cycling it is a good idea (and it has not been tested). Instead, you could remove power from the switch, wait 5 seconds, and re-establish the power. This will not do the same as a power cycle/reboot, but it will cycle the network connections and may well do the job.

Another report says a power-cycle is possible for ESS systems by both unpluggin the DC plug power from the PVS6 and by cycling the breaker in the HUB+.

After this you want to use your SunPower app to confirm the system is still reporting to their portal normally (this may take a few minutes though).

Once you decide what to plug into the third port (Raspberry approach or cabled approach), you can proceed with the instructions below substituting plugging your Raspberry's network cable, or your cable to your home network into the third (or any) port of the switch instead of the PVS6 LAN1 port. Everything else remains the same.

> **NOTE:** Another individual has made available source code for these ESS-equipped installations that will allow monitoring of the ESS system state and battery information. It does this by "snooping" on the modbus messages, intercepting the relevant ones, and publishing messages to an MQTT broker. Solutions such as Homeassistent can then interface with the broker to get the information and do something useful with it, such as logging in to a database, displaying graphs, etc.

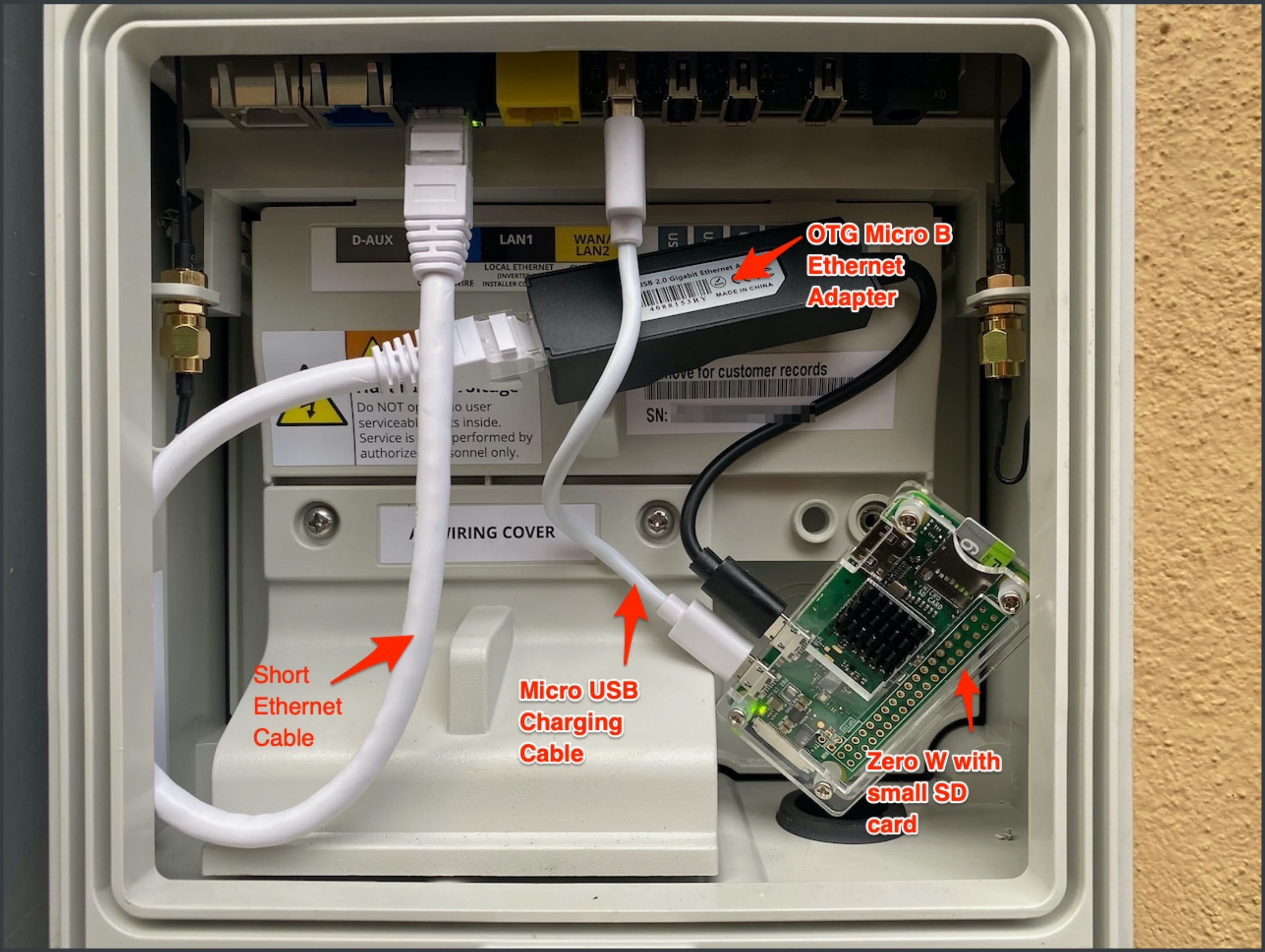
Setting up the Raspberry

For hardware you will need:

- Raspberry Pi3, preferably in a small enclosure. I mention this model because it has built-in WiFi and an Ethernet port. Other models may well be used for this function as well. For example the Pi Zero 2 W, at US $15, combined with an Ethernet dongle for another US $15 or so may well do the job. The Zero 2 W has the same processor as the Pi3, but less memory. After experimenting with the Pi3 successfully, I opted for this solution (Pi Zero 2 W) in the end because it is more compact, uses less power from the PVS6, and generates less heat. Ultimately, I repeated the replacement with a Raspberry Pi Zero W, which is even cheaper and has lower power demands. Part list:

  - Raspberry Pi Zero W, from vilros.com
  - OTG Micro B Ethernet Adapter for Linux Raspberry Pi Zero W, Windows 10 Tablet from amazon.com
  - Cat6 Ethernet Cable 0.6 Feet from amazon.com
  - One of Micro USB Charging Cable, CableCreation 6-Pack(0.5/0.5/4/4/6/6ft) High Speed USB to Micro USB Charging Cord (I used the 0.5 ft version) from amazon.com
- A power supply ending in a micro USB-B connector. Usually, you buy this with your Raspberry. You can also use a USB-A to micro USB-B cable with the A end plugged into a suitably equipped USB port (must be able to provide enough power, often 700mA is enough for Pi 3, or < 500 mA for Pi Zero W). Frankly, for a permanent installation, you will need the latter anyway.
- A micro SD card to load the software on. It seems an 8GB card is enough, may be even a 4GB. In my final (for now) install I used a Pi Zero W, which has only 1.4G used on its file system.
- A (short) ethernet cable to connect the Raspberry to the PVS monitoring system

This is what my final installation looks like (not quite, I replaced the Pi Zero 2W shown here, with a Pi Zero W; same footprint, same case:



Prepare the software on the Raspberry

1. Download the Raspberry Pi Imager or use balenaEtcher.
2. Select the Raspbian Lite image (or any other that you like and prefer, but this is good enough). Note that for a Pi Zero W you need a 32-bit version and Raspian Lite may be your only choice (and it works just fine).
3. Write the image to an SD card using the imager.
4. If you used Raspberry Pi Imager your resulting SD card wil now be mounted on your system and wil be accessible there. If you used balenaEtcher use Disk Utility to mount the volume first.

5. Create a file, at the root level of the SD card (it will be copied into the right place once the Raspberry boots). Call it `wpa_supplicant.conf`, and give it the contents listed below. This will enable the Raspberry to connect to your WiFi.
6. Create an empty file named `ssh` at the root level also. This too will be removed after boot, but causes SSH access to be configured.
7. Eject the SD card from your desktop or laptop
8. Install SD card in Raspberry
9. Connect Raspberry Ethernet port to your network
10. Boot the Raspberry by applying power to it
11. While not critical, you may use the command `sudo raspy-config` to change the configuration to reflect your local timezone, and locale, and edit the hostname of the system.

The `wpa_supplicant.conf` contents:

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
country=US

network={
 ssid="<Name of your WiFi>"
 psk="<Password for your WiFi>"
}
```

Setup networking

You will need to configure things to know the IP address for your Raspberry on your network. There will be two addresses, one on the Ethernet cable and one on the WiFi (if you set everything up correctly). The best way is to make so-called static reservations for both connections in your DHCP server (typically on your WiFi router or other router). To do this, you need the MAC addresses for the Ethernet and WiFi.

If you do not have those you have to figure them out first. There are various options to do so, and methods vary a little between Windows and Mac or Linux, although the latter two may be quite similar. I suggest looking into arp -a or using the command 192.168.1.255 or similar, depending on your network settings. Once you have found the appropriate MAC addresses you can make the static DHCP reservations. How to do that depends on your equipment and I won't discuss it here.

If you can find the IP address for either of the two ports, you should be able to log in to the Raspberry using the username pi and password "raspberry." If you did the SSH step above correctly, this should work. Now is a good time to change the default password to something of your liking: type `passwd` and follow the prompts.

Reboot the Raspberry to have it find its now reserved IP address. From now on, you should be able to use SSH with that address. You might even go one step further and set your router to "publish" a name for it for your convenience. This typically involves the DNS configuration of your router. Verify you can connect to either of the two IP addresses.

Setup networking to access the PVS6

To allow the Raspberry to be the proxy we described above:

1. Login to the Raspberry and update the OS: `sudo apt-get -y update; sudo apt-get -y upgrade`
2. Install `ha-proxy`: `sudo apt-get install haproxy` (note: no dash in the name here!)
3. Modify the networking setup for the ethernet port so that it will not configure the gateway address supplied by the PVS6 DHCP server. If you do not do this or do this incorrectly, the WiFi connection will not work. If that happens, use an ethernet cable to log in and fix it. The change requires you to edit `/etc/dhcpd.conf`, add two lines to it, and save:
    1. `interface eth0`
    2. `nogateway`
4. Next, add the content shown below to `/etc/haproxy/haproxy.cfg`
5. Reboot the Raspberry: `sudo shutdown -r now`

Content to add to `/etc/haproxy/haproxy.cfg`:

```
frontend http-in
    bind *:80
    bind *:9002
    bind *:19531
    bind *:48888
    default_backend backend_servers

backend backend_servers
    server pvs6 172.27.153.1:80
    compression algo gzip
    compression type text/html text/plain text/css application/json

listen stats
    bind *:8080
    stats enable
    stats uri /
    stats refresh 10s
    stats admin if LOCALHOST
```

> **NOTE:** You see bindings here for port 80, the standard web port where all API calls would go, and some additional ports. Port 19531 will provide the contents of a system log to your browser. The other two ports are for WebSocket connections, whose purpose and protocol are unknown.

Install the Raspberry inside/along the PVS6 system

Open the PVS monitoring system by releasing the clip at the front bottom. This will expose the inside where the ports are. For now, it will be most straightforward to hook everything up provisionally and worry about stashing everything away later.

Plug a (short) ethernet cable from the Raspberry into the LAN(1) port. Provide a power source to the Raspberry:

- Use a (short) USB-A to micro B. I tested this with ports 3 and 4, but I think any of this will work. It seems to supply enough power for the Raspberry (at least in the manner it is used here) or
- Use the supplied power brick. This likely won't work well for a permanent installation inside the PVS monitoring box because there is no power outlet there, but for now, it can work.

Power up the Raspberry.

Testing

You should now be able to open a browser on your desktop, laptop, tablet, or phone and browse to the WiFi IP address that you set up for your Raspberry. When you do, use http, not https, as we have not configured that. You should see the SunPower console landing page shown earlier. If you don't, something is wrong with your setup. Retrace all steps to troubleshoot.

Now that, presumably, the Raspberry proxy setup works, you can use it to try and use the console (I did not bother, so I don't know if you could do everything an installer does or whether passwords are needed). You can also access the built-in API to request information.

You can try this out by browsing to:

```
http://<your pi3 IP address on WiFi>/cgi-bin/dl_cgi?Command=DeviceList
```

That will produce some output that starts like this (or looks like it with some different numbers in it):

```
{
    "devices":  [{
```

```
                "DETAIL":   "detail",
                "STATE":    "working",
                "STATEDESCR":   "Working",
                "SERIAL":   "ZT01234567890ABCDEF",
                "MODEL":    "PV Supervisor PVS6",
                "HWVER":    "6.02",
                "SWVER":    "2021.9, Build 41001",
                "DEVICE_TYPE":  "PVS",
                "DATATIME": "2021,10,28,07,31,48",
                "dl_err_count": "0",
                "dl_comm_err":  "0",
                "dl_skipped_scans": "0",
                "dl_scan_time": "0",
                "dl_untransmitted": "6108",
                "dl_uptime":    "34",
                "dl_cpu_load":  "0.87",
                "dl_mem_used":  "33352",
                "dl_flash_avail":   "67546",
                "panid":    1234567890,
                "CURTIME":  "2021,10,28,07,33,52"
            }, {
    ...
```

There is a lot more there, but not shown. I used a fake serial number and "paid"! Seeing this output (it may take a few seconds) again confirms where access to detailed data is.

A browser is not necessarily the best vehicle to interact with this API. For simple testing, it works, and you can study the output. Below, you will find documentation for everything I have found. I use a tool called "Paw" for Mac to make interaction and experimentation easier, but you can also use curl, wget, or a programming language of your choice (Python seems quite popular for this).

Confirming the above works may be enough for you. If, for example, you now wish to integrate your SunPower information with Homeassistant, you can do so.

Instructions for cabled connection

These instructions cannot be precise and complete without knowing exactly what equipment you use. If you are going this route, you are probably fairly conversant in networking, and using these “hints,” you can figure it out.

Using an (old) intermediary router

Basically follow these steps:

- Connect router WAN port to PVS6 LAN1 (installer) port by cable
  - Configure with a static address of `172.27.153.2` and netmask `255.255.255.0`
  - Configure with gateway `172.27.153.1`
  - Configure with DNS server 1 `172.27.153.1` and optional server 2 something like `8.8.8.8` (Google DNS), or `1.1.1.1` (Cloudflare DNS)
- Connect router LAN port to your regular network
  - Configure with available static address on your local LAN, or use your configure as dynamic (DHCP) and configure your regular network’s DHCP server with an appropriate static reservation
- Turn off DHCP and possibly WiFi on old router. You won’t be using/needing these.
- On the old router, set up a “static route” for `192.168.1.0/24` to its LAN port (as that is where your regular network is). NOTE: I used the commonly used `192.168.1.0/24` as an example. Substitute with your correct network. This route will tell it how to route responses to requests coming from that network.
- In your regular router, set up a “static route” for 172.27.153.0/24 to the address of the old router’s LAN port (as that is where the PVS6 connection now is). This route will tell it how to send packets for the PVS6 network to the old router, which will then send them to the PVS6.
- Setup your DNS to map `sunpowerconsole.com` to `172.27.153.1`

You should now be able to browse to `http://sunpowerconsole.com` as described.

Using your regular router with extra port

If you don't have an additional router, but your regular router has an extra port you can likely configure it as described for the "old" router above (Turn off DHCP for that port only). This is not typically an option with provider-supplied routers. The ports on those are just part of a switch and cannot be managed. I use an EdgeRouter POE which is fully manageable and could do this (but I am using the Raspberry approach). Somebody else is using a TP-Link Omada router with the necessary extra ports and, of course, there are others. Still, your typical cable modem, etc. will not have the necessary ports or configurability.

With that setup (but even without the cable to his extra router port), he plugged a laptop into that same switch and used the "curl" command to interact with the API, confirming the setup works.

A key point from the "old router" setup above is that a LAN-to-WAN transition is used in that router. This causes the router to apply Network Address Translation (NAT). This causes all packets to 172.27.153.0/24 from 192.168.1.0/24 (or equivalent in your case) to be remapped and, once on the 172.27.153.0/24 appear to be coming from the old router's WAN port. Therefore, responses will go back there and then be "unmapped" and sent back to the original requester. Without NAT replies would have to go back to a 192.168.1.0/24 address. This is not on the PVS6 network, so they will be forwarded to the default gateway for handling. This is the PVS6, and it has no clue about this other network, so things go into a black hole and don't work.

Therefore, if you wish to do this with an extra port on an existing router, you must figure out how to configure that port to have NAT happening. Sometimes, this can be easily achieved by declaring this port a WAN port, but beware. If your router has multiple WAN ports, it may want to try and load balance traffic for the internet between the two, and that may not work or may not be what you want. If you can, configure it as a LAN port and configure NAT. The precise details of how to do this vary from router to router and are beyond this writeup's scope.

What about no Ethernet ports available on PVS?

This can happen with the newer (or very old) style PVS system. The newer style PVS6 has USB ports that will accept (certain) Ethernet dongles, thus making ethernet available again. The start of this document contains links to documentation for both old-style and new-style PVS6 systems. Sunpower says:

> The SunPower PVS6 monitoring device now utilizes a plug-in dongle port for Ethernet connection. The PVS6 with the dongle port is part number 60232 and has a W in its serial number (for example, ZT214385000549Wxxxx). The traditional PVS6 without the dongle port is part number 529027 and has an A in its serial number (for example, ZT214385001823Axxxx).

It goes on to explain two approved dongles:

- Plugable USB2-E1000
- Cable Matters 202023

Dongles must be connected when PVS6 is off because they will not be dynamically detected. A power cycle after connecting should also work. If no SunVault system is present, the system will *NOT* come with a dongle, but once you acquire one, it should go into port 3, labeled (WAN/LAN2) of the PVS6 unless you have an SMA US-40 inverter present; in that case, it goes into ethernet port 2 (labeled LAN1). If a SunVault component is present, a dongle should be pre-installed in port 2 (labeled LAN1) of the Hub+.

All other instructions should apply with dongle(s) installed properly (see earlier pictures). If you do not have dongles, do not wish to use them, or have a very old PVS system that cannot accept dongles, you must integrate using Modbus. A description of accessing and getting data through the RS485 bus available on one of the connectors follows. This requires using the ModBus protocol. I have not done this myself, so the following is based on information I have scraped together from other users.

Hooking up RS485/Modbus hardware

One user bought a $20 RS845 gateway to plug into the port. One side will “speak” RS485 and the other will speak Ethernet. You can then connect the Ethernet cable, as described for the Raspberry, or use a Raspberry to talk to the TS485 ModBus and have it also run a web server with some API you would have to create that can be contacted/integrated with HomeAssistant. Alternatively, you can make that Raspberry put MQTT messages for consumption elsewhere.

Two adapters I have seen mentioned:

- Waveshare Industrial serial server, RS485 to RJ45 Ethernet, TCP/IP to serial, rail-mount support, with POE function(optional)
- https://www.pusr.com/products/1-port-rs485-to-ethernet-converters-usr-tcp232-304.html

Once you have the appropriate hardware, you can write or combine the necessary software with available software. User Nihar Meta describes his setup using those adapters as follows:

Nihar Meta’s Setup

He runs the YasdiMQTT software on any Linux host (possibly using docker) along with the Yasdi IP driver. His particular inverters like to communicate over RS485 over 19200 baud, but your mileage may vary. Try other speeds until you get something working.

He uses a second such gateway to “talk” to the PVS6. It seems to want1200 baud communications. His SMA branded converters publish data that in MQTT show up like this:


```
{
    “sn”:XXXXXXXXX,
    “time”:1667780271,
    “values”:{
        “A.Ms.Amp”:1.1010000522946939,
        “B.Ms.Amp”:1.1370000540046021,
        “A.Ms.Vol”:416.35999069362879,
        “B.Ms.Vol”:364.48999185301363,
        “A.Ms.Watt”:458,
        “B.Ms.Watt”:414,
```

“Pac”:832,
“GridMs.W.phsA”:416,
“GridMs.W.phsB”:416,
“GridMs.W.phsC”:0,
“GridMs.PhV.phsA”:124.04999722726643,
“GridMs.PhV.phsB”:123.82999723218381,
“GridMs.PhV.phsC”:0,
“GridMs.PhV.A2B”:247.89999445900321,
“GridMs.PhV.B2C”:0,
“GridMs.PhV.C2A”:0,
“GridMs.A.phsA”:3.3600001595914364,
“GridMs.A.phsB”:3.3600001595914364,
“GridMs.A.phsC”:0,
“GridMs.Hz”:59.979998659342527,
“GridMs.TotVAr”:0,
“GridMs.VAr.phsA”:0,
“GridMs.VAr.phsB”:0,
“GridMs.VAr.phsC”:0,
“GridMs.TotVA”:832,
“GridMs.VA.phsA”:416,
“GridMs.VA.phsB”:416,
“GridMs.VA.phsC”:0,
“GridMs.TotPF”:0.999000047449954,
“Serial Number”:1913069271,
“E-Total”:64595.131068103947,
“GM.TotWhOut”:0,
“Op.EvtCntUsr”:15187,
“Mt.TotTmh”:34065.9578104291,
“Mt.TotOpTmh”:33506.823379693815,
“Op.EvtNo”:0,
“Op.EvtNoDvlp”:0,
“Op.TmsRmg”:0,
“Mode”:”Mpp”,
“Error”:”---“,

```
        “Op.Health”:”Ok”,
        “Op.Prio”:”NonePrio”,
        “Op.GriSwStt”:”Cls”,
        “Inv.TmpLimStt”:”NoneDrt”,
        “InvCtl.Stt”:”On”,
        “PlntCtl.Stt”:”On”,
        “Op.BckOpStt”:”ModGri”,
        “PCM-DigInStt”:”None”
    }
}
```

Remaining things to figure out are the pinouts on RS485 of the devices to the gateways. He describes:

- If you are using the SB5000TL-22 with the RS485 interface, its pins 2,5,7 (D+,Gnd,D-) and your existing serial connection should be connected to the inverter
- You will need to find the matching pins on your PVS
  - PVS2x documentation shows that on the PVS, pins (3,4,5) are (D+,D-,Gnd) respectively
  - Additional DB9 male and female breakout modules are allow wires to be used to easily create the desired connections for experimentation.
  - For PVS5/6 see the quickstart guide mentioned earlier in this document.
- For -40 style inverters, SMA prodivdes a direct connection to ModBus over TCP, so no adapters needed, but you will need an intermediary system (e.g. rPi) to interact with ModBus and broker results to an MQTT system.
- As for the configuration with Libyasdi, Configure the gateway as a UDP (or UDP Server) on port 24272 which is the default SMAData Port This is what the gateway device listens on. For the Destination IP/Port , use your host IP and port 24273
  - Depending on your brand gateway device, (I am using Wavelink for now), on advanced settings, I UNselected RS485 Multi-host and Bus Conflict Detection.
  - Power cycle the inverters, with a minimum 2 minute “off” period

- Configure yasdi.ini

```
[DriverModules]
Driver0=yasdi_drv_ip

[IP1]
Protocol=SMANet
Device0=192.168.1.58

[Misc]
#DebugOutput=/dev/stdout
```

- Docker-compose (if using docker):

```
version: “3”
services:
yasdi2mqtt:
# You may also check out :latest, :stable or build: ".", if
:latest fails
image: “pkwagner/yasdi2mqtt:alpine”
volumes:
  – “./devices:/etc/yasdi2mqtt/devices”
  – “./yasdi.ini:/etc/yasdi2mqtt/yasdi.ini:ro”
  – “/etc/localtime:/etc/localtime:ro”
  – “/etc/TZ:/etc/timezone:ro”

ports:
  - 24273:24273/tcp
  - 24273:24273/udp
environment:
  YASDI_CONFIG: "/etc/yasdi2mqtt/yasdi.ini"
  YASDI_DRIVER_ID: 0
  YASDI_MAX_DEVICE_COUNT: 2
  YASDI_UPDATE_INTERVAL: 31
```

```
MQTT_TOPIC_PREFIX: "solar/inverters"
MQTT_SERVER: "192.168.1.25"
MQTT_PORT: 1883
MQTT_USER: "mqtt"
MQTT_PASSWORD: "MQTTPASSWORD"
TZ: "America/Los_Angeles"
```

- It seems newer SMA inverters use ModBus/RS485 or ModBus/IP
- Older ones use SMData protocol

Integrating with Homeassistant

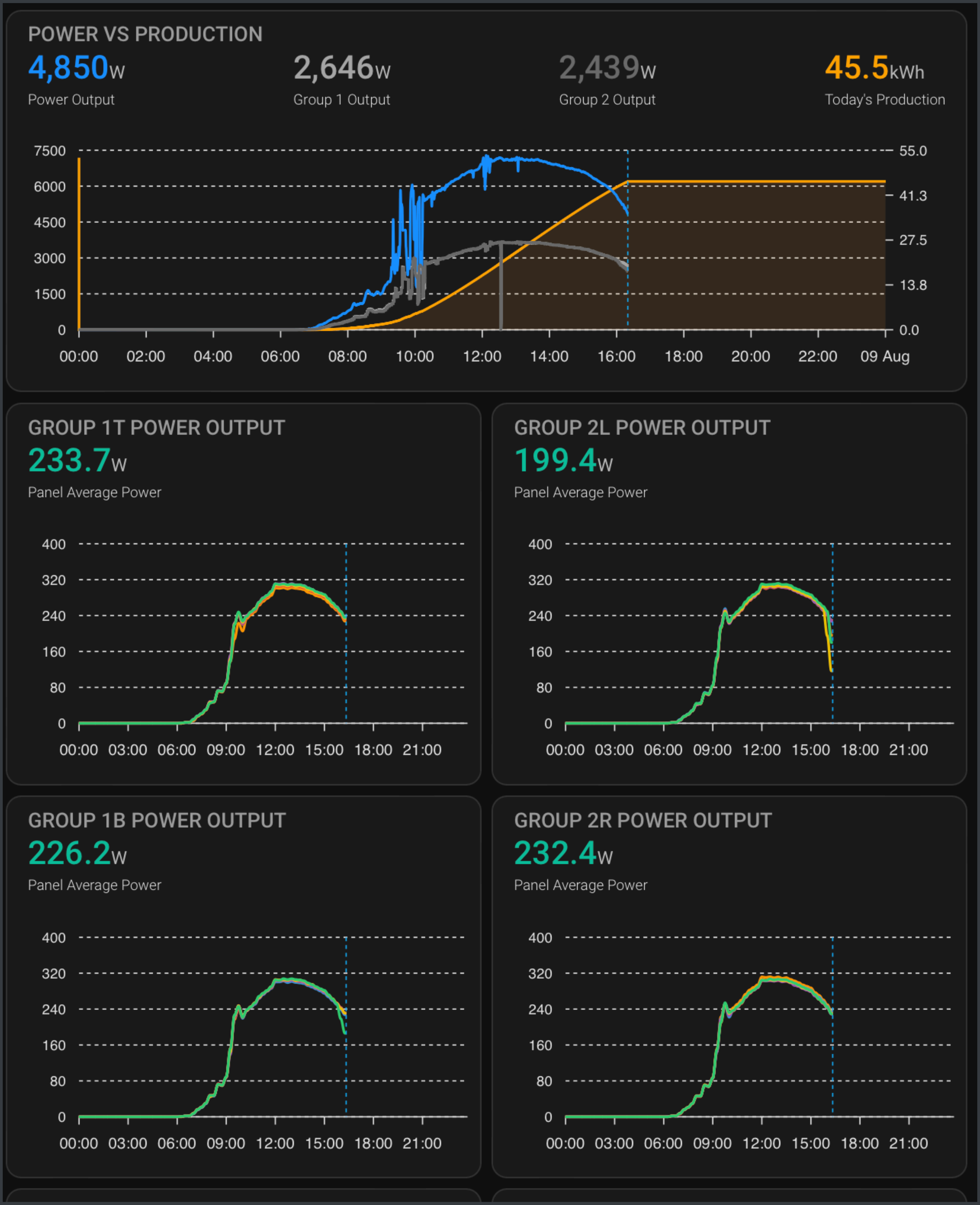
Integration is pretty straightforward if you already have an HA instance up and running. Make sure https://hacs.xyz (Homeassistant Community Store) is installed and operational. Configure the repository from https://github.com/krbaker with the URL https://github.com/krbaker/hass-sunpower.

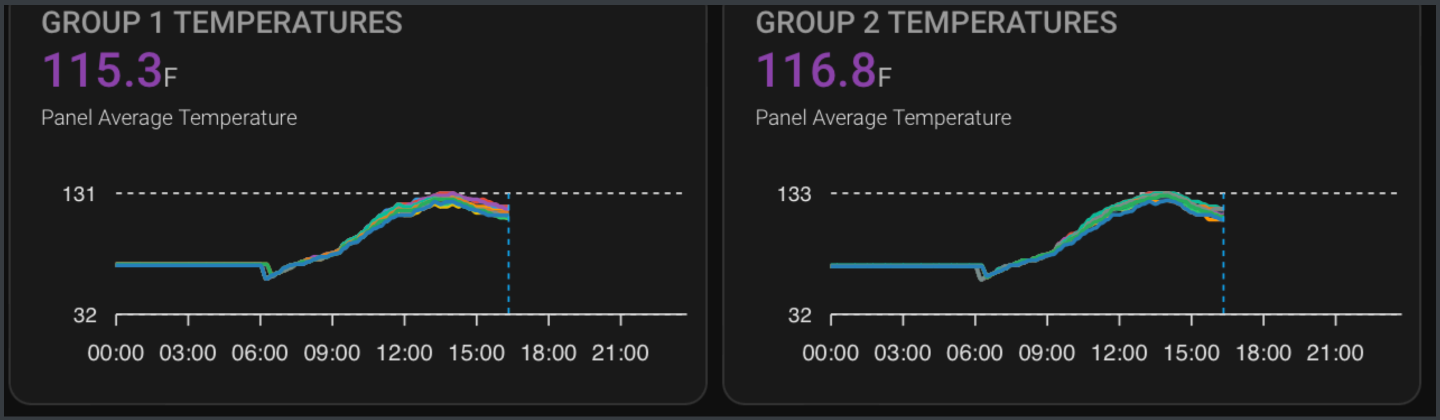
Follow the steps to install and restart HA. You can now go to “Configuration > Integrations”, click “+” in the bottom right corner, and search for “SunPower.” You will then be asked for a host IP address. You need to input the address of your Raspberry’s WiFi connection unless you are using a more complex network setup, in which case you would directly use the SunPower console IP address of `172.27.153.1`.

After this is all done, you should see your PVS monitoring system and associated devices for the supervisor, power production meter, power consumption meter, and micro-inverters. Information for each individual micro inverter is available. Note that their state might be listed as “error” if your PV system is not yet switched on (breaker(s) in the off position). This might be the case between completion of installation and your utility’s permission to operate is granted.

At this point, I do not know (yet) if any of the “extra” devices in a battery-equipped setup will show up as sensors through this integration. Nor do we know if/how this battery-related information can be integrated with the Energy dashboard in HA.

Once you have this setup done, the rest is up to your imagination. I created a page like this, for example:





I have 24 panels in two groups, each of 12 panels. It is hard to see, but each panel is graphed, and when you hover over them, you can see individual readings.

Other integrations

I have not personally investigated other integrations. If you need something that works out of the box, you'll have to Google around and give things a try. If you can do a little programming, look at the resources mentioned at the start of this writeup. Several of them have GitHub repositories with code in them. At the very least it will show you how it is done, or you can modify the code to suit your needs.

API information

The Sunpower Console API recognizes a bunch of specific commands. The commands are issued by executing a `GET` request over HTTP to the URL that looks like this:

```
http://<rpi address>/cgi-bin/dl_cgi?Command=<command name>
```

Below, I document each command I know about. Some commands require their name as the Command query parameter, and some require adding your system's serial number using SerialNumber. See documentation. In the `DeviceList` command, I will show full response headers and body, but in subsequent documentation, I will only show the body and explanations of what you see there.

The headers indicate that not only GET commands but also POST, DELETE, and PUT are allowed. This would suggest this is a full so-called REST API. I have not attempted to do any of those interactions. If they even work, there is potential for messing something up. Since my system is not for experimentation but rather for power production, I do not want to take that risk. Be warned!

You will note that several commands return data with some keys listed in all uppercase and others in all lowercase. It appears the UPPERCASE ones are device properties/attributes and the lowercase ones are performance indicators.

GET /cgi-bin/dl_cgi?Command=DeviceList

This command gets a complete list of all known PVS devices and their status and performance descriptors. There seem to be three device types:

1. Supervisor. This seems to be the main entity that controls everything
2. Power meter, which comes in a production and consumption version. The latter will show up even if no consumption metering kit is installed, but kWh information should stay at 0.
3. Inverter. There may be as many of these as you have micro-inverters (panels).

The output body below has fake serial numbers and omits all but the first inverter. This way, you can see an example of each device type in the output. Details are discussed below the body.

You will also note the `result` part of the response. I have never seen anything but `success` but it stands to reason that if it says anything but `success`, the rest of the response should not be interpreted.

> **NOTE**: This command may take quite a while. On my PVS6 system with 24 panels it takes between 6 and 7 seconds to return all results!

- Response 200 (application/json)
    - Headers

```
HTTP/1.1 200 OK
Content-Type: application/json
Access-Control-Allow-Methods: GET,POST,DELETE,PUT
Pragma: no-cache
dlcgi-build-time: Sep 15 2021 00:05:00
Access-Control-Allow-Origin: *
Access-Control-Allow-Headers: Content-Type
Cache-Control: no-cache, no-store, no-cache, must-revalidate,
post-check=0, pre-check=0
Server: lighttpd/1.4.51
```

- Body


```
{
    "devices":  [{
            "DETAIL":   "detail",
            "STATE":    "working",
            "STATEDESCR":   "Working",
            "SERIAL":   "ZT01234567890ABCDEF",
            "MODEL":    "PV Supervisor PVS6",
            "HWVER":    "6.02",
            "SWVER":    "2021.9, Build 41001",
            "DEVICE_TYPE":  "PVS",
            "DATATIME": "2021,10,27,07,25,00",
            "dl_err_count": "0",
            "dl_comm_err":  "480",
            "dl_skipped_scans": "0",
            "dl_scan_time": "1",
            "dl_untransmitted": "5539",
            "dl_uptime":    "85428",
            "dl_cpu_load":  "0.28",
            "dl_mem_used":  "73704",
            "dl_flash_avail":   "67599",
```

```
        "panid":    1234567890,
        "CURTIME":  "2021,10,27,07,28,13"
    }, {
        "ISDETAIL": true,
        "SERIAL":   "PVS6M12345678p",
        "TYPE": "PVS5-METER-P",
        "STATE":    "working",
        "STATEDESCR":   "Working",
        "MODEL":    "PVS6M0400p",
        "DESCR":    "Power Meter PVS6M12345678p",
        "DEVICE_TYPE":  "Power Meter",
        "SWVER":    "3000",
        "PORT": "",
        "DATATIME": "2021,10,27,07,28,12",
        "ct_scl_fctr":  "50",
        "net_ltea_3phsum_kwh":  "11.34",
        "p_3phsum_kw":  "0",
        "q_3phsum_kvar":    "0",
        "s_3phsum_kva": "0",
        "tot_pf_rto":   "1",
        "freq_hz":  "60",
        "CAL0": "50",
        "origin":   "data_logger",
        "OPERATION":    "noop",
        "CURTIME":  "2021,10,27,07,28,13"
    }, {
        "ISDETAIL": true,
        "SERIAL":   "PVS6M12345678c",
        "TYPE": "PVS5-METER-C",
        "STATE":    "working",
        "STATEDESCR":   "Working",
        "MODEL":    "PVS6M0400c",
        "DESCR":    "Power Meter PVS6M12345678c",
        "DEVICE_TYPE":  "Power Meter",
```

```
        "SWVER":    "3000",
        "PORT": "",
        "DATATIME": "2021,10,27,07,28,13",
        "ct_scl_fctr":  "100",
        "net_ltea_3phsum_kwh":  "0",
        "p_3phsum_kw":  "0",
        "q_3phsum_kvar":    "0",
        "s_3phsum_kva": "0",
        "tot_pf_rto":   "0",
        "freq_hz":  "60",
        "i1_a": "0",
        "i2_a": "0",
        "v1n_v":    "116.5863",
        "v2n_v":    "116.4296",
        "v12_v":    "233.0139",
        "p1_kw":    "0",
        "p2_kw":    "0",
        "neg_ltea_3phsum_kwh":  "0",
        "pos_ltea_3phsum_kwh":  "0",
        "CAL0": "100",
        "origin":   "data_logger",
        "OPERATION":    "noop",
        "CURTIME":  "2021,10,27,07,28,14"
    }, {
        "ISDETAIL": true,
        "SERIAL":   "E00123456000001",
        "TYPE": "SOLARBRIDGE",
        "STATE":    "error",
        "STATEDESCR":   "Error",
        "MODEL":    "AC_Module_Type_E",
        "DESCR":    "Inverter E00122125092032",
        "DEVICE_TYPE":  "Inverter",
        "PANEL":    "SPR-X22-360-E-AC",
        "SWVER":    "4.21.3",
```

```
            "PORT": "",
            "MOD_SN":   "R36M20579663",
            "NMPLT_SKU":    "",
            "origin":   "data_logger",
            "OPERATION":    "noop",
            "CURTIME":  "2021,10,28,09,03,43"
        }],
    "result":   "succeed"
}
```


Detail for supervisor

Most of the properties are self-explanatory. The `DATATIME` indicates the timestamp when the presented information last changed, whereas `CURTIME` should be the timestamp of the request (or something close to it). The timestamps are in UTC! Observation of `DATATIME` on my system shows that the minutes component is always a multiple of 5 minutes and seconds is always 0. So, if you are interested in getting timely information, perform the call after the start of each 5-minute interval. You can interrogate more often, but if timing is not important, don't stress the PVS6 by constantly asking for `DeviceList`.

The meaning of the performance indicators can only be guessed by observation and a little knowledge (dl probably means "data logger"):

- `dl_err_count` : Number of errors since last report?
- `dl_comm_err` : Number of communication errors? (Not sure what kind)
- `dl_skipped_scans` : Best guess this counts when the supervisor scans the PLC network for inverters and it decides it needs to skip a scan
- `dl_scan_time` : Probably related somehow to the above mentioned scan
- `dl_untransmitted` : Number of not yet transmitted (to SunPower) events/records?

- `dl_uptime` : The number of seconds the data logger has been running. I observed it being lower than a previously seen value (the prior value was almost 24h, the new value was a little over 1.5h). I was not aware of a power outage in between, so either there was a restart for power reasons or something else, or perhaps the device restarts itself periodically (somewhat lousy safeguard against memory leaks), or something else. Also, see the remark below.
- `dl_cpu_load` : CPU load average as it existed (possibly averaged over 5 minutes) at `DATATIME`
- `dl_mem_used` : amount of memory in use. Assuming the motherboard has little memory this is probably in kiB
- `dl_flash_avail` : amount of free space on flash device. Assumed in kIB

During experimentation I occasionally encountered this response:

```
HTTP/1.0 503 Service Unavailable
Cache-Control: no-cache
Connection: close
Content-Type: text/html

<html><body><h1>503 Service Unavailable</h1>
No server is available to handle this request.
</body></html>
```

That would stay that way for a few minutes. After a successful retry, I would see `dl_uptime` as a very low number, indicating that the supervisor/datalogger had apparently restarted. It is not clear if I caused the crash/restart, or it “just happens”.

Detail for power meter

Reports show that power meter data is updated more frequently than supervisor information. Reports indicate at least every 5 seconds. The power meter's properties are fairly self-explanatory. One thing to note is that the `DESCR` property contains the meter's serial number inside its name. The name ends with the letter "p," indicating this is the "production" meter, or the letter "c," indicating the consumer meter. Ditto for the `MODEL` property. Also present, as described for the supervisor are `DATATIME` and `CURTIME`.

The `CAL0` property indicates the sensor's current capacity for the calibration-reference CT sensor. It will be "50" (50A) for the production meter, and either "100" or "200" for consumption. Note that the `ct_scl_fctr` contains the capacity for the actual sensor.

The meaning of the performance indicators can only be guessed by observation and a little knowledge:

- `ct_scl_fctr` : Current capacity for the actual CT sensor used
- `net_ltea_3phsum_kwh` : Net cumulative energy, in kWh, across all three phases
- `p_3phsum_kw` : Average real power
- `q_3phsum_kvar` : Cumulative "reactive" power, in kVA or kW, across all three phases (since ?)
- `s_3phsum_kva` : Cumulative "apparent" power, in kVA or kW, across all three phases (since ?)
- `tot_pf_rto` : Power factor ratio, defined as `real power` divided by `apparant power`
- `freq_hz` : Operating frequency (typically around 60 Hz in the US)

The above performance indicators are present in both production and consumer meters. The following are additionally available in the consumption meter:

- `i1_a` : Supply current, in A, on CT1 lead
- `i2_a` : Supply current, in A, on CT2 lead
- `v1n_v` : Supply voltage CT1 lead (relative to neutral, typically in the 110-120 V range)
- `v2n_v` : Supply voltage CT2 lead (relative to neutral, typically in the 110-120 V range)

- `v12_v` : Supply Voltage sum across CT1 and CT2 leads (typically in the 220-140 V range)
- `p1_kw` : Lead 1 average power in kW. Can be positive (excess back to utility) or negative (used from utility)
- `p2_kw` : Lead 2 average power in kW. Can be positive (excess back to utility) or negative (used from utility)
- `neg_ltea_3phsum_kwh` : Cumulative energy, in kWh, across all three phases, consumed from utility
- `pos_ltea_3phsum_kwh` :Cumulative energy, in kWh, across all three phases, supplied to utility

Note that "net" utility consumption can be computed by subtracting the `ltea_3phsum_kwh` numbers.

The "production" meter only measures power produced by the PV array. At night, when there is no production, this number can go slightly negative. This is the energy consumed by the PV electronics (inverters). It has been reported in the -15 W range, but that may be specific for a certain number of panels and model micro inverters. Since this power is always needed, that would mean that on a daily basis, 24 x 15 Wh = 0.36 kWh from production is never available to supply the home or back to the utility. If you insist you can try to factor this into any calculations, but I will suggest it is too low to worry about. In a 6 kW system, this would represent 15 / 6000 = 0.25%.

Detail for micro inverter

The information for the inverter(s) has the usual UPPERCASE properties. It should be noted that when the panels are not powered, the returned `STATE` will be error. This presumes that, at some point, the power was on (typically during initial installation and commissioning), and the actual devices were discovered.

The following performance data seems to be available (but is not included where `STATE` is not "working"):

- `module_serial` : Equal to `MOD_SN` and contains the inverter module serial number (first seen in version 2021.11)
- `hw_version` : Hardware version number (first seen in version 2021.11)
- `freq_hz` : Operating Frequency in Hz (typically around 60 Hz in the US)
- `stat_ind` : Status indicator (first seen in version 2021.11)
- `i_3phsum_a` : AC Current (in A)
- `p_3phsum_kw` : AC Power (in kW)
- `vln_3phavg_v` : AC Voltage (in V)
- `ltea_3phsum_kwh` : Total energy (in kWh)
- `i_mppt1_a` : DC Current (in A) for MPPT (Maximum Power Point Tracking)
- `v_mppt1_v` : DC Voltage (in V) for MPPT (Maximum Power Point Tracking)
- `p_mppt1_kw` : DC Power (in kW) for MPTT (Maximum Power Point Tracking) (first seen in version 2021.11)
- `p_mpptsum_kw` : DC Power (in kW) for MPPT (Maximum Power Point Tracking) (seems replaced by `p_mppt1_kw` since version 2021.11)
- `t_htsnk_degc` : Heatsink temperature (degrees Celsius)

Additional devices for battery equipped systems

You will find additional devices in the response if you also have an attached ESS battery system (not shown above). These devices have been "seen" in such an installation and details follow below:

1. HUB+
2. EQUINOX-MI0 (That is an O for Input/Output)
3. PV-DISCONNECT
4. GATEWAY: Controller device for everything the PVS6 does not manage (batteries/inverter etc)
5. SCHNEIDER-XWPRO: Inverter/charger

6. EQUINOX-BMS: BMS = Battery Management System
7. BATTERY: An actual battery, there may be multiple of these
8. EQUINOX-ESS: ESS = Energy Storage System

Detail for HUB+

The HUB+ is described as a model “SunPower MIDC” with the device type “HUB+.” The cabinet houses a sub-panel for the battery-backed-up loads in your house, controls the solar + storage system for optimal performance, and manages transitions from utility power to battery power.

It also houses the MIDC (Microgrid Interconnect Device Controller). It connects to the PVS6 via port J8 for the 12 VDC power supply and port J13 for the CAN bus (not to be confused with the ModBus). Finally, J10 is the RS-485 connection from the PVS6.

The device manages the microgrid (everything in the system that possibly generates power, including PV panels and batteries) and the MID or Microgrid Interconnect Device. The latter device will decouple the utility side from the PV/Battery side in case of a utility shutdown. The MIDC commands this decoupling. However, there is also a physical switch in the MID, operated by a screwdriver, for manual disconnect: turned to the left, it is in the disconnected state.

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "SY01234567890ABCDEF",
    "TYPE": "HUB+",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "SunPower MIDC",
    "DESCR":    "HUB+ SY01234567890ABCDEF",
    "DEVICE_TYPE":  "HUB+",
```

```
        "hw_version":   "1.5.0",
        "interface":    "ttymxc5",
        "slave":    220,
        "SWVER":    "0.7.22",
        "PORT": "P0, Modbus, Slave 220",
        "origin":   "data_logger",
        "OPERATION":    "noop",
        "CURTIME":  "2022,05,26,14,50,32"
    }
```

Note that this “device” and others described here list “STATE” as “error”. This is most likely due to the limited test setup. We will work to capture output in the regular state.

Clearly, there is no performance-related data here, so the attribute of most interest would be the “STATE”.

Detail for EQUINOX-MIO

The MIO is described as a model “SunPower MIO” with device type “ESS Hub. “MIO” stands for “Multi I/O.” It is connected to the HUB+ (J1 connector) and possibly to the MIO in other battery cabinets (J2 connector). Not all functions are clear, but there are connections between this component and two fans inside the cabinet. It also has CAN bus connections to the gateway, battery, and LED board (in the door).

The data section generally looks like this:

```
    {
        "ISDETAIL": true,
        "SERIAL":   "SY01234567890ABCDEF",
        "TYPE": "EQUINOX-MIO",
        "STATE":    "working",
        "STATEDESCR":   "Working",
        "MODEL":    "SunPower MIO",
        "DESCR":    "ESS Hub SY01234567890ABCDEF",
```

```
        "DEVICE_TYPE":  "ESS Hub",
        "hw_version":   "0.4.0",
        "interface":    "ttymxc5",
        "parent":   11,
        "slave":    221,
        "SWVER":    "0.7.10",
        "PORT": "P0, Modbus, Slave 221",
        "DATATIME": "2022,05,26,14,50,20",
        "t_degc":   "36",
        "humidity": "20",
        "v_dcdc_spply_v":   "11.43",
        "v_spply_v":    "11.364",
        "v_gateway_v":  "11.419",
        "fan_actv_fl":  "0",
        "fw_error": "0",
        "event_history":    "2112",
        "origin":   "data_logger",
        "OPERATION":    "noop",
        "PARENT":   "00001ABC1234_01234567890ABCDEF",
        "CURTIME":  "2022,05,26,14,50,32"
    }
```

The performance data seems to include:

- `t_degc` : External/ambient (to the cabinets, not necessarily outside) temperature in degrees Celcius.
- `humidity` : External/ambient humidity in percent (0-100)
- `v_dcdc_spply_v` : The DC to DC supply voltage (i.e. what the batteries provide) before the inverter
- `v_spply_v` : Another form of supply voltage, unclear to what
- `v_gateway_v` : Voltage to/for the gateway
- `fan_actv_fl` : Fan active flag, 0 for inactive, 1 for active (needs to be verified)

- `fw_error` : Error count for firmware
- `event_history` : Count of “events” seen so far

Detail for PV-DISCONNECT

The PV-DISCONNECT is described as a model “SunPower PV Disconnect Relay” with the device type “PV Disconnect.” It represents the circuitry or functionality that disconnects the PV system from the grid tie when reverting to battery operation and vice versa when resuming grid connection. As such, it would be commanded to do so by one of the other system components.

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "SY01234567890ABCDEF",
    "TYPE": "PV-DISCONNECT",
    "STATE":    "working",
    "STATEDESCR":   "Working",
    "MODEL":    "SunPower PV Disconnect Relay",
    "DESCR":    "PV Disconnect SY01234567890ABCDEF",
    "DEVICE_TYPE":  "PV Disconnect",
    "hw_version":   "0.2.0",
    "interface":    "ttymxc5",
    "slave":    230,
    "SWVER":    "0.2.13",
    "PORT": "P0, Modbus, Slave 230",
    "DATATIME": "2022,05,26,14,50,30",
    "event_history":    "32",
    "fw_error": "0",
    "relay_mode":   "0",
    "relay1_state": "1",
    "relay2_state": "1",
```

```
        "relay1_error": "0",
        "relay2_error": "0",
        "v1n_grid_v":   "123.1",
        "v2n_grid_v":   "122.5",
        "v1n_pv_v": "122.8",
        "v2n_pv_v": "122.5",
        "origin":   "data_logger",
        "OPERATION":    "noop",
        "CURTIME":  "2022,05,26,14,50,32"
    }
```

The performance data seems to include:

- `relay_mode` : Flag with 0 suspected meaning utility operations, 1 battery operations
- `relay1_state` : State of relay 1 (0 or 1)
- `relay1_error` : Error count for relay 1
- `relay2_state` : State of relay 2 (0 or 1)
- `relay2_error` : Error count for relay 2
- `v1n_grid_v` : Voltage differential between phase 1 neutral and grid
- `v2n_grid_v` : Voltage differential between phase 2 neutral and grid
- `v1n_pv_v` : Voltage differential between phase 1 neutral and PV system
- `v2n_pv_v` : Voltage differential between phase 2 neutral and PV system
- `fw_error` : Error count for firmware
- `event_history` : Count of “events” seen so far

Detail for GATEWAY

The GATEWAY is described as a model “SchneiderElectric-ConextGateway” with the device type “Gateway.” This product ties together the whole battery system, including the inverter (not to be confused with the PV micro inverters). It provides an interface for configuration and performance observations. It also provides a " Modbus " mechanism (Module Bus or Modular Bus). This interface allows accessing certain components attached to it (you can see this in the “PORT” specifications for the various device details). This is an RS-485-based serial bus.

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "BC1234006789",
    "TYPE": "GATEWAY",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "SchneiderElectric-ConextGateway",
    "DESCR":    "Gateway BC1234006789",
    "DEVICE_TYPE":  "Gateway",
    "interface":    "sunspec",
    "mac_address":  "d8:a9:ab:cd:12:34",
    "slave":    1,
    "SWVER":    "V1",
    "PORT": "P0, SunSpec, Slave 1",
    "origin":   "data_logger",
    "OPERATION":    "noop",
    "CURTIME":  "2022,05,26,14,50,33"
}
```


There appears to be no meaningful performance data, outside the communication port specification.

Detail for SCHNEIDER-XWPRO

The SCHNEIDER-XWPRO is described as a model “SchneiderElectric-XW6848-21” with the device type “Storage Inverter.” This is the DC to AC inverter (and vice versa) used to feed the backed-up circuits (panel inside the HUB+) during battery-only operations. It converts (what appears to be a 12V battery) to 120V AC. It also functions as the charger circuitry for the batteries.

It is a 120/240V/60Hz pure sine wave inverter that can operate in single-phase, split-phase, or three-phase modes and produce up to 6,800 W of continuous power.

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "00001ABC1234",
    "TYPE": "SCHNEIDER-XWPRO",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "SchneiderElectric-XW6848-21",
    "DESCR":    "Storage Inverter 00001ABC1234",
    "DEVICE_TYPE":  "Storage Inverter",
    "interface":    "sunspec",
    "mac_address":  "d8:a9:ab:cd:12:34",
    "parent":   11,
    "slave":    10,
    "SWVER":    "V1",
    "PORT": "P0, SunSpec, Slave 10",
    "origin":   "data_logger",
    "OPERATION":    "noop",
    "PARENT":   "00001ABC1234_01234567890ABCDEF",
    "CURTIME":  "2022,05,26,14,50,33"
}
```

There appears to be no meaningful performance data outside the communication port specification.

Detail for EQUINOX-BMS

The EQUINOX-BMS is described as a model “EQUINOX-BMS” with device type “ESS BMS.” This is the battery management sub-system.

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "BC12340067893375104O",
    "TYPE": "EQUINOX-BMS",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "SchneiderElectric-SP1",
    "DESCR":    "ESS BMS BC01234567890ABCDEF",
    "DEVICE_TYPE":  "ESS BMS",
    "interface":    "sunspec",
    "mac_address":  "d8:a9:ab:cd:12:34",
    "parent":   11,
    "slave":    230,
    "PORT": "P0, SunSpec, Slave 230",
    "origin":   "data_logger",
    "OPERATION":    "noop",
    "PARENT":   "00001ABC1234_01234567890ABCDEF",
    "CURTIME":  "2022,05,26,14,50,33"
}
```


There is no meaningful performance data outside the communication port specification.

Detail for BATTERY

The BATTERY is described as a model "POWERAMP-Komodo 1.2" (in this particular installation at least) with the device type "Battery." This represents an actual battery in the system, and as such, there may be multiple such entries (in a single cabinet installation, there are two entries, one for each battery inside the cabinet).

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "M00122109A0355",
    "TYPE": "BATTERY",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "POWERAMP-Komodo 1.2",
    "DESCR":    "Battery M00122109A0355",
    "DEVICE_TYPE":  "Battery",
    "hw_version":   "4.34",
    "interface":    "none",
    "parent":   11,
    "SWVER":    "2.8",
    "PORT": "P0, None, Slave -1",
    "origin":   "data_logger",
    "OPERATION":    "noop",
    "PARENT":   "00001ABC1234_01234567890ABCDEF",
    "CURTIME":  "2022,05,26,14,50,34"
}
```


Note that there is no performance type data, and battery entries only seem to differ in their serial numbers. The port specification indicates that they are not directly (individually) addressable. However, information about them might be available through the Modbus system (via the Gateway or the BMS).

Detail for EQUINOX-ESS

The EQUINOX-ESS is described as a model “SPWR-Equinox-model” with the device type “Energy Storage System.” It is not clear to me yet what this represents. It seems all other components comprise the whole system, so perhaps this is just an entry representing the “whole.”

The data section generally looks like this:


```
{
    "ISDETAIL": true,
    "SERIAL":   "00001ABC1234_01234567890ABCDEF",
    "TYPE": "EQUINOX-ESS",
    "STATE":    "error",
    "STATEDESCR":   "Error",
    "MODEL":    "SPWR-Equinox-model",
    "DESCR":    "Energy Storage System 00001ABC1234_01234567890ABCDEF",
    "DEVICE_TYPE":  "Energy Storage System",
    "hw_version":   "0",
    "interface":    "none",
    "SWVER":    "0",
    "PORT": "P0, Parent, Slave -1",
    "origin":   "data_logger",
    "OPERATION":    "noop",
    "CURTIME":  "2022,05,26,14,50,35"
}
```


Note that there is no performance type data.

GET /cgi-bin/dl_cgi?Command=Get_Comm&SerialNumber=ZT01234567890ABCDEF

This command requires the addition of the serial number. If there are multiple supervisors on the internal SunPower network, it can select the correct one. The command returns information about the available network interfaces.

- Body


```
{
    "result":   "succeed",
    "networkstatus":    {
        "interfaces":   [{
                "interface":    "wan",
                "internet": "down",
                "ipaddr":   "",
                "link": "disconnected",
                "mode": "wan",
                "sms":  "unreachable",
                "state":    "down"
            }, {
                "interface":    "plc",
                "internet": "down",
                "ipaddr":   "",
                "link": "disconnected",
                "pairing":  "unpaired",
                "sms":  "unreachable",
                "speed":    0,
                "state":    "down"
            }, {
                "interface":    "sta0",
                "internet": "up",
                "ipaddr":   "192.168.10.239",
                "signal":   "-48",
                "sms":  "reachable",
                "ssid": "Starfield",
                "status":   "connected"
            }, {
                "interface":    "cell",
                "internet": "down",
                "ipaddr":   "",
```

```
                    "is_alwayson":  false,
                    "is_primary":   false,
                    "link": "connected",
                    "modem":    "MODEM_OK",
                    "provider": "UNKNOWN",
                    "signal":   0,
                    "sim":  "SIM_READY",
                    "sms":  "unreachable",
                    "state":    "DOWN",
                    "status":   "NOT_REGISTERED"
                }],
            "system":   {
                "interface":    "sta0",
                "internet": "up",
                "sms":  "reachable"
            },
            "ts":   "1635315583"
        }
    }
```


GET /cgi-bin/dl_cgi?Command=Start

This command starts a configuration session. I am not sure what that means, but I am guessing it is related to the ability to use this as a REST API where any changes made using PUT, POST, and DELETE cannot be done until a session is started version and are not made permanent until (a) the result is a valid configuration, and (b) the session is “stopped” (see below).

- Body


```
{
    "result":   "succeed",
```

```
        "supervisor":   {
            "SWVER":     "2021.9, Build 41001",
            "SERIAL":   "ZT01234567890ABCDEF",
            "MODEL":     "PVS6",
            "BUILD":     41001,
            "FWVER":     "1.0.0",
            "SCVER":     16504,
            "EASICVER": 131329,
            "SCBUILD":  1185,
            "WNSERIAL": 16,
            "WNMODEL":  400,
            "WNVER":     3000
        }
    }
```


GET /cgi-bin/dl_cgi?Command=Stop

This command stops the configuration session. Not (yet) clear what that is.

- Body


```
{
    "result":    "succeed"
}
```


GET /cgi-bin/dl_cgi?Command=CheckFW

This command checks if a firmware update is available. If not, it returns “none,” otherwise, it returns the URL for the firmware file.

- Body

```
{
    "url":  "none"
}
```


GET /cgi-bin/dl_cgi?Command=DeviceDetails&SerialNumber=ZT01234567890ABCDEF

I found this command mentioned somewhere, but I have not gotten it to work

- Body


```
{   "result":   "unknown command"}
```


GET /cgi-bin/dl_cgi?Command=GridProfileGet

This command exposes the currently selected/active grid profile (for a full list see the `GridProfileRefresh` command).

- Body


```
{
    "result":   "succeed",
    "active_name":  "IEEE-1547a-2014 + 2020 CA Rule21",
    "active_id":    "816bf3302d337a42680b996227ddbc46abf9cd05",
    "pending_name": "IEEE-1547a-2014 + 2020 CA Rule21",
    "pending_id":   "816bf3302d337a42680b996227ddbc46abf9cd05",
    "percent":  100,
    "supported_by": "ALL",
    "status":   "success"
}
```


GET /cgi-bin/dl_cgi?Command=GridProfileRefresh

This command seems to “refresh” in the internal database of supply grid profiles. The profiles have a unique ID, a descriptive name, refer to a file with metadata about the profile (filename), and have a list of zip codes (`zipcodes`) to which it (may) apply.

- Body


```
{
    "result":   "succeed",
    "success":  true,
    "creation": 1600704253,
    "profiles": [{
            "selfsupply":   true,
            "zipcodes": [{
                    "max":  96898,
                    "min":  96701
                }],
            "default":  false,
            "filename": "8c9c4170.meta",
            "id":   "8c9c4170457c88f6dcee7216357681d580a3b9bd",
            "name": "HECO OMH R14H (Legacy)"
        }, {
            "selfsupply":   true,
            "zipcodes": [{
                    "max":  96898,
                    "min":  96701
                }],
            "default":  false,
            "filename": "f169fe0d.meta",
            "id":   "f169fe0dc993987c5f105df9d651a284e8031c5a",
            "name": "HI GSUI OMH R14H 2018"
        }, {
            "selfsupply":   true,
            "zipcodes": [{
                    "max":  96898,
```

```
                "min":  96701
            }],
        "default":  false,
        "filename": "2d8a06aa.meta",
        "id":   "2d8a06aa4812913510c7955cabaf114e5432fe67",
        "name": "HI GSUI OMH R14H 2018 + V/W"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  96162,
                "min":  90001
            }],
        "default":  false,
        "filename": "816bf330.meta",
        "id":   "816bf3302d337a42680b996227ddbc46abf9cd05",
        "name": "IEEE-1547a-2014 + 2020 CA Rule21"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  -1,
                "min":  -1
            }],
        "default":  false,
        "filename": "db54e057.meta",
        "id":   "db54e057f901db5d7907af561688f0af555c563d",
        "name": "CA CPUC R21 Reactive Power Priority"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  -1,
                "min":  -1
            }],
        "default":  false,
        "filename": "43daefaa.meta",
```

```
            "id":   "43daefaa4404f4674edd2ad89c175a65f3cebc51",
            "name": "California CPUC Rule21"
        }, {
            "selfsupply":   false,
            "zipcodes": [81121, 81122, 81128, 81130, 81137, 81147,
81157, 81235, 81301, 81302, 81303, 81326, 81328, 81329],
            "default":  false,
            "filename": "954a2a24.meta",
            "id":   "954a2a240698d9c006afb72fc93febc622b296eb",
            "name": "La Plata Electric Assn"
        }, {
            "selfsupply":   false,
            "zipcodes": [17302, 17309, 17314, 17527, 18014, 18054,
18073, 18074, 18076, 18084, 18901, 18902, 18910, 18912, 18913, 18914,
18915, 18916, 18917, 18922, 18923, 18925, 18926, 18928, 18929, 18931,
18932, 18933, 18934, 18936, 18938, 18940, 18942, 18943, 18944, 18946,
18947, 18949, 18950, 18951, 18954, 18956, 18957, 18958, 18963, 18964,
18966, 18969, 18971, 18974, 18976, 18977, 18979, 18980, 18991, 19001,
19002, 19003, 19004, 19006, 19007, 19008, 19009, 19010, 19012, 19013,
19014, 19015, 19016, 19017, 19018, 19019, 19020, 19021, 19022, 19023,
19025, 19026, 19027, 19028, 19029, 19030, 19031, 19032, 19033, 19034,
19035, 19036, 19037, 19038, 19039, 19040, 19041, 19043, 19044, 19046,
19047, 19048, 19049, 19050, 19052, 19053, 19054, 19055, 19056, 19057,
19058, 19060, 19061, 19063, 19064, 19065, 19066, 19067, 19070, 19072,
19073, 19074, 19075, 19076, 19078, 19079, 19080, 19081, 19082, 19083,
19085, 19086, 19087, 19088, 19089, 19090, 19091, 19092, 19093, 19094,
19095, 19096, 19098, 19099, 19101, 19102, 19103, 19104, 19105, 19106,
19107, 19108, 19109, 19110, 19111, 19112, 19113, 19114, 19115, 19116,
19118, 19119, 19120, 19121, 19122, 19123, 19124, 19125, 19126, 19127,
19128, 19129, 19130, 19131, 19132, 19133, 19134, 19135, 19136, 19137,
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        "name": "Xcel Energy PF (-0.91 absorb var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "8e37cfa7.meta",
        "id":   "8e37cfa7b3d2a7214eba74a8eeabf671fb5ef0e7",
        "name": "Xcel Energy PF (-0.92 absorb var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
```

```
        "default":  false,
        "filename": "41958f46.meta",
        "id":   "41958f469b9721b2e68e47f779e0bf0065f9efb5",
        "name": "Xcel Energy PF (-0.93 absorb var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "fcd040c2.meta",
        "id":   "fcd040c2ab28790d88ce358174a3691da2c9db60",
        "name": "Xcel Energy PF (-0.94 absorb var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "d36a869e.meta",
        "id":   "d36a869eb424e73d36c8b4133592819ce89df94d",
        "name": "Xcel Energy PF (-0.95 absorb var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "4ae087e9.meta",
        "id":   "4ae087e915460658a614abc48c43d16c89e938fc",
        "name": "Xcel Energy PF (-0.96 absorb var)"
```

```
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "e361783c.meta",
            "id":   "e361783cb19dc76046f81de9be5614b959e3e217",
            "name": "Xcel Energy PF (-0.97 absorb var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "80aeebb4.meta",
            "id":   "80aeebb4b426a3a2520f67a1040fc1b483e3f089",
            "name": "Xcel Energy PF (-0.98 absorb var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "2a5becc6.meta",
            "id":   "2a5becc64606014fc7bfa132ce9cbf00a8102289",
            "name": "Xcel Energy PF (-0.99 absorb var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
```

```
                "min":  80001
            }],
        "default":  false,
        "filename": "7c23f824.meta",
        "id":   "7c23f824b69a5864f851010597e6d7407020db2a",
        "name": "Xcel Energy PF (1.0 Unity)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "a908f0dc.meta",
        "id":   "a908f0dc7ceb5d70dedef20a37ace7a8f1d02a02",
        "name": "Xcel Energy PF (0.90 provide var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "e3e54c42.meta",
        "id":   "e3e54c42084e68c326a774df3f55e093cd917c91",
        "name": "Xcel Energy PF (0.91 provide var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "90e93fd2.meta",
```

```
        "id":   "90e93fd2926de5a464f591bfa433659cbdca24dc",
        "name": "Xcel Energy PF (0.92 provide var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "e114f6db.meta",
        "id":   "e114f6dbded8129202ff352d1adde03b5365b041",
        "name": "Xcel Energy PF (0.93 provide var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "aac6b45c.meta",
        "id":   "aac6b45cf9cfe41812afe6d8f90ca99f14d54b7a",
        "name": "Xcel Energy PF (0.94 provide var)"
    }, {
        "selfsupply":   false,
        "zipcodes": [{
                "max":  81699,
                "min":  80001
            }],
        "default":  false,
        "filename": "eb88ba39.meta",
        "id":   "eb88ba3987f10536bce7eff548953fe1746f5a08",
        "name": "Xcel Energy PF (0.95 provide var)"
    }, {
        "selfsupply":   false,
```

```
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "3e2404d4.meta",
            "id":   "3e2404d455101fec65b656d4014485722772ef02",
            "name": "Xcel Energy PF (0.96 provide var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "4557857a.meta",
            "id":   "4557857a86d79ccdeff01bace9108f434f58f930",
            "name": "Xcel Energy PF (0.97 provide var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
            "default":  false,
            "filename": "241bcb43.meta",
            "id":   "241bcb432a5cac09a6be33a8fded6f67597a6737",
            "name": "Xcel Energy PF (0.98 provide var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  81699,
                    "min":  80001
                }],
```

```
            "default":  false,
            "filename": "f2963273.meta",
            "id":    "f2963273ffd35ee64ec2177dc8b6afa86cd66396",
            "name": "Xcel Energy PF (0.99 provide var)"
        }, {
            "selfsupply":   false,
            "zipcodes": [{
                    "max":  999999,
                    "min":  0
                }],
            "default":  false,
            "filename": "471080f6.meta",
            "id":    "471080f62a24d8be88f58864c398717c11bb876b",
            "name": "IEEE-1547a-2014"
        }]
}
```


GET /cgi-bin/dl_cgi?Command=GetCellPurchased

This command determines (it looks like) whether the customer has purchased cellular based data access to this monitoring system.

- Body


```
{   "cell_purchased":   "null"}
```


GET /cgi-bin/dl_cgi?Command=GetDiscoveryProgress

This command shows the progress status of the device discovery process. In the example below, it shows that the discovery of micro inverters is 100% done, and none (new) were found. Since the progress is an array, I imagine other kinds of discovery may be reported here as well (probably only during commissioning or changing the system setup).

- Body

```
{
    "progress": [{
            "TYPE": "MicroInverters",
            "PROGR":    "100",
            "NFOUND":   "0"
        }],
    "complete": true,
    "result":   "succeed"
}
```

GET /cgi-bin/dl_cgi?Command=SetCellPurchased&SerialNumber=ZT01234567890ABCDEF

This command sets the purchase status of cellular data support. If done using a GET, you get the result below. To actually make a change, it may be necessary to issue a POST command with a body, and that probably needs to happen inside an active session.

- Body

```
{
    "cell_purchased":   "null",
    "result":   "succeed"
}
```

Alternative API

Reportedly it is also possible to retrieve information from the Cloud-based SunPower servers. The reported URL is `` `https://elhapi.edp.sunpower.com/v1/elh/address/<address id>/components `` where `< address id>` is a system-specific 6-digit code for your system. You can discover the correct code by using the regular portal, setting your browser in developer mode, and looking in the “network” tab. You will be able to see the code and data that flows.

I was not able to replicate the above, but in my situation, using the same developer tools approach I saw a call to `https://edp-api-graphql.edp.sunpower.com/graphql` . It appears that with the request, a body needs to be sent. It looks like this:


```
[
  {
    "operationName": "FetchPartyData",
    "variables": {
      "partyId": "<a UUID>"
    },
    "query": "query FetchPartyData($partyId: String!) {\n  party(partyId: $partyId) {\n    partyId\n    displayName\n    email\n    phone\n    sites {\n      siteKey\n      hasWifi\n      hasLivedata\n      siteName\n      siteType\n      address1\n      city\n      state\n      postalCode\n      systemSize\n      commissioningDate\n      timezone\n      currentWeather {\n        sunrise\n        sunset\n        dateTime\n        __typename\n      }\n      battery {\n        operationMode\n        backUpReserveSocLevel\n        backupTimeLeft {\n          formatted {\n            days\n            hours\n            minutes\n            __typename\n          }\n          __typename\n        }\n        socAndChargeCapacity {\n          customerStateOfCharge\n          stateOfChargePercentage\n          __typename\n        }\n        __typename\n      }\n      assignments(assignmentType: COMMISSION) {\n        deviceSerialNumber\n        deviceType\n        deviceKey\n        assignmentEffectiveTimestamp\n        devices(deviceType: \"logger\", deviceStatus: true) {\n          dvcKey\n          comProto\n          __typename\n        }\n        __typename\n      }\n      __typename\n    }\n    __typename\n  }\n}\n"
  }
]
```

Notice that it basically sends a data query, identifying the “party” for which data is needed using a “UUID.” I have not investigated how to find this number, but of course, you can look at this data once and write it down. It is unique for your installation and won’t change.

The response looks like this (lots of inverter entries removed):


```
[{
    "data": {
        "party": {
            "partyId": "<UUID>",
            "displayName": "<your name here>",
            "email": "user@gmail.com",
            "phone": null,
            "sites": [{
                "siteKey": "E_1234",
                "hasWifi": true,
                "hasLivedata": true,
                "siteName": "Dolf Starreveld Residence",
                "siteType": "production",
                "address1": "<real address here>",
                "city": "<city here>",
                "state": "CA",
                "postalCode": "<zip here>",
                "systemSize": 8640,
                "commissioningDate": "2021-10-14T17:10:50",
                "timezone": "America/Los_Angeles",
                "currentWeather": {
                    "sunrise": 1635431362,
                    "sunset": 1635470052,
                    "dateTime": 1635445811,
                    "__typename": "CurrentWeather"
                },
                "battery": {
```

```
                        "operationMode": null,
                        "backUpReserveSocLevel": null,
                        "backupTimeLeft": null,
                        "socAndChargeCapacity": null,
                        "__typename": "Battery"
                    },
                    "assignments": [{
                        "deviceSerialNumber": "ZT213585000549A0748",
                        "deviceType": "DATALOGGER",
                        "deviceKey":
    "ZT01234567890ABCDEF_ZT01234567890ABCDEF_PV SUPERVISOR PVS6",
                        "assignmentEffectiveTimestamp": "2021-10-
    15T00:10:50.120Z",
                        "devices": [{
                            "dvcKey":
    "ZT01234567890ABCDEF_ZT01234567890ABCDEF_PV Supervisor PVS6",
                            "comProto": "MQTT",
                            "__typename": "Device"
                        }],
                        "__typename": "Assignment"
                    }],
                    "__typename": "Site"
                }],
                "__typename": "Party"
            }
        }
    }]
```

Without explaining everything here, this is basic site/party data and identifies the supervisor device only. This device apparently communicates back to SunPower using the MQTT protocol.

Another request fetches alerts (`FetchAlerts`) and produces:

```
[{
    "data": {
        "site": {
            "siteKey": "E_1234",
            "alerts": [{
                "alertType": "CommunicationOutageInverterICE",
                "alertStatus": "Open",
                "eventTimestamp": "2021-10-21T02:27:58-07:00",
                "__typename": "Alert"
            }, {
                "alertType": "CommunicationOutageInverterICE",
                "alertStatus": "Open",
                "eventTimestamp": "2021-10-21T02:27:59-07:00",
                "__typename": "Alert"
            }],
            "assignments": [{
                "deviceSerialNumber": "ZT01234567890ABCDEF",
                "devices": [{
                    "dvcKey": "ZT01234567890ABCDEF_ZT01234567890ABCDEF_PV
Supervisor PVS6",
                    "prodMdlNm": "PV Supervisor PVS6",
                    "lastRcvdEps": 1635447600,
                    "meterType": null,
                    "__typename": "Device"
                }, {
                    "dvcKey":
"ZT01234567890ABCDEF_E00122125120472_AC_Module_Type_E",
                    "prodMdlNm": "AC_Module_Type_E",
                    "lastRcvdEps": 1634679600,
                    "meterType": null,
                    "__typename": "Device"
                }, {
```

```
                    "dvcKey":
"ZT01234567890ABCDEF_PVS6M12345678p_PVS6M0400p",
                    "prodMdlNm": "PVS6M0400p",
                    "lastRcvdEps": 1635446700,
                    "meterType": {
                        "type": "GROSS_PRODUCTION",
                        "level": "1",
                        "__typename": "MeterType"
                    },
                    "__typename": "Device"
                }, {
                    "dvcKey":
"ZT01234567890ABCDEF_PVS6M12345678c_PVS6M0400c",
                    "prodMdlNm": "PVS6M0400c",
                    "lastRcvdEps": 1635446700,
                    "meterType": {
                        "type": "NOT_USED",
                        "level": "0",
                        "__typename": "MeterType"
                    },
                    "__typename": "Device"
                }],
                "__typename": "Assignment"
            }],
            "__typename": "Site"
        }
    }
}, {
    "data": {
        "site": {
            "hasWifi": true,
            "siteKey": "E_1234",
            "assignments": [{
                "assignmentType": "COMMISSION",
```

```
                "deviceSerialNumber": "ZT01234567890ABCDEF",
                "assignmentEffectiveTimestamp": "2021-10-
15T00:10:50.120Z",
                "devices": [{
                    "dvcKey": "ZT01234567890ABCDEF_ZT01234567890ABCDEF_PV
Supervisor PVS6",
                    "dvcTy": "logger",
                    "prodMdlNm": "PV Supervisor PVS6",
                    "lastRcvdEps": 1635447000,
                    "deviceStatus": {
                        "pvStatus": true,
                        "essStatus": false,
                        "netIntfRptCtnt": {
                            "currNetIntfEnum": "STA0",
                            "__typename": "NetworkInterfaceReport"
                        },
                        "__typename": "DeviceStatus"
                    },
                    "__typename": "Device"
                }],
                "__typename": "Assignment"
            }],
            "__typename": "Site"
        }
    }
}, {
    "data": {
        "environmentalSavings": {
            "costSaving": null,
            "co2": {
                "value": 0,
                "unit": "Pounds",
                "__typename": "EnvironmentalSavingsItem"
            },
```

```
            "tree": {
                "value": 0,
                "unit": "Trees",
                "__typename": "EnvironmentalSavingsItem"
            },
            "mile": {
                "value": 0,
                "unit": "Miles",
                "__typename": "EnvironmentalSavingsItem"
            },
            "gas": {
                "value": 0,
                "unit": "Gallons",
                "__typename": "EnvironmentalSavingsItem"
            },
            "__typename": "EnvironmentalSavings"
        }
    }
}, {
    "data": {
        "energy": {
            "energyDataSeries": {
                "production": [
                    ["2021-10-28T00:00:00", "0", "0"],
                    ["2021-10-28T01:00:00", "0", "8"],
                    ["2021-10-28T02:00:00", "0", "0"],
                    // more omitted
                ],
                "consumption": [
                    ["2021-10-28T00:00:00", "0", "100"],
                    ["2021-10-28T01:00:00", "0", "100"],
                    ["2021-10-28T02:00:00", "0", "100"],
                    // more omitted
                ],
```

```
                "storage": [
                    ["2021-10-28T00:00:00", "0", "100"],
                    ["2021-10-28T01:00:00", "0", "100"],
                    ["2021-10-28T02:00:00", "0", "100"]
                    // more omitted
                ],
                "grid": [
                    ["2021-10-28T00:00:00", "0", "0"],
                    ["2021-10-28T01:00:00", "0", "0"],
                    ["2021-10-28T02:00:00", "0", "0"],
                    // more omitted
                ],
                "__typename": "DataSeries"
            },
            "totalProduction": 0,
            "totalConsumption": 0,
            "energyMixPercentage": 0,
            "totalGridImport": 0,
            "totalGridExport": 0,
            "netGridImportExport": 0,
            "totalStorageCharged": 0,
            "totalStorageDischarged": 0,
            "netStorageChargedDischarged": 0,
            "__typename": "Energy"
        }
    }
}, {
    "data": {
        "power": {
            "powerDataSeries": {
                // Formatted as above
                "__typename": "DataSeries"
            },
            "__typename": "Power"
```

```
        }
    }
}]
```

You will note that a lot of information is available here as well. It may, however, be subject to data aggregation in an interval longer than the frequency with which data changes when you directly query the PVS6 system.

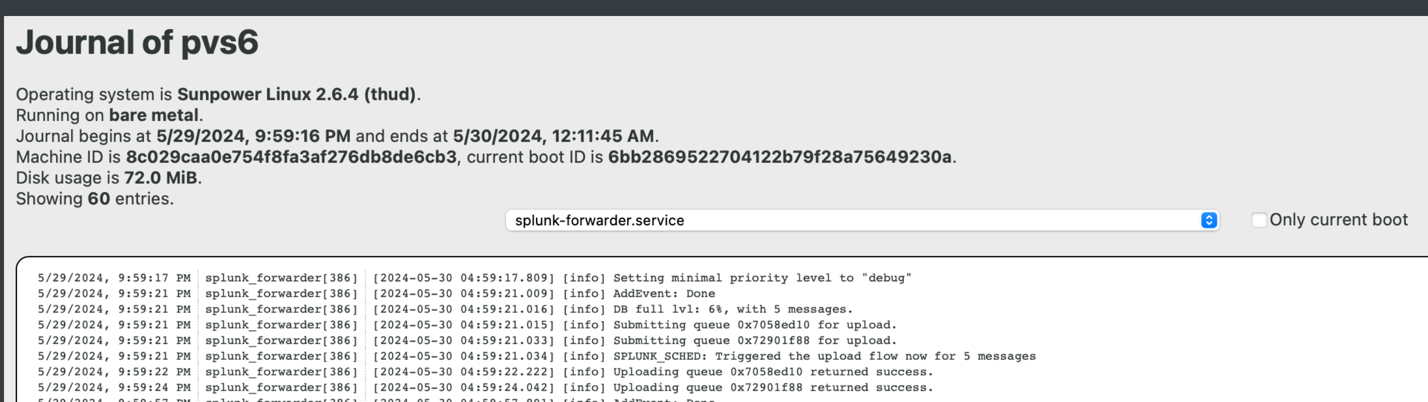
You can see that the data in the site section (may) contains “Alerts” (containing a type, status, and time stamp in ISO format), while “Assignments” seem to list all known devices that belong to the “site.”

Another command is `FetchPowerData`. It appears to return time series data for plotting power and energy graphs.

Since I am not using this approach, this is as far as I will take the documentation.

Log contents

By browsing to http://sunpowerconsole.com:19531, you will be presented with an interface that allows you to inspect internal log messages on the PVS. It is pretty basic and looks like this:



At the present time (May 2024), a bug related to this logging can cause your PVS system to stop uploading data to the Sunpower “mothership.” The consequence is that the “mySunPower” app and portal stop displaying analysis information until the situation is resolved. SunPower has confirmed this bug, which is essentially a bug in the firmware that should be fixed. No promises have been provided if and or when this may happen.

One cause for this bug that has been identified and acknowledged is a situation in which, for one reason or another, the PVS is not successfully uploading buffered (on its local file system) so-called “splunks,” causing the local storage to become full. This condition then causes further logging to fail and has the side effect of stopping the regular data uploads as well. One known condition that can cause this situation is an interruption of Internet connectivity for the PVS (via your WiFi or cable). If this period is long enough for the log storage to fill up, the problem occurs. If you are deploying the solutions described in this document and frequently request the device list data, this can happen rather quickly as the full content of the response is logged.

Unfortunately, a power cycle reboot will not clear the condition, and at least one user involved in discovering this has had to have their PVS system replaced to fix the issue. I have had long periods of no reporting to Sunpower, which, at seemingly random times, resolved themselves. One such time, I used the installer interface (which is no longer working) and noticed a failed firmware upgrade. I initiated that upgrade, and after that, the reporting functionality also resumed. I believe any firmware update can resolve the situation as it appears to clear the necessary storage areas, but I have not been able to confirm this positively.