

Grid Interactive Advanced Features

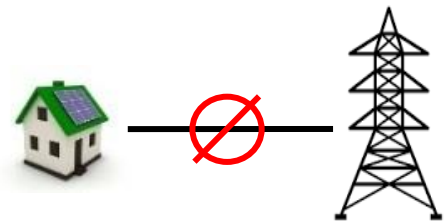
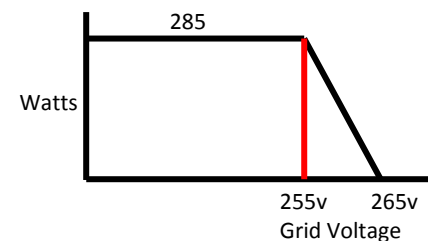
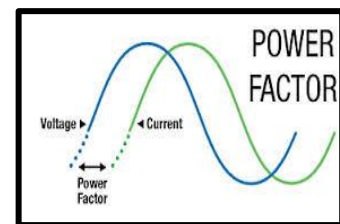
Self-Supply Mode

CHILICON POWER MICROINVERTERS AND CP-100 CORTEX GATEWAY SYSTEM

OVERVIEW

Chilicon Power Advanced Inverter functions

- **Power Factor Control:** -0.8 to $+0.8$ required in some jurisdictions as a rule-21 advanced inverter feature.
- **Volt-Watt Control:** Allows inverters to automatically back-off production in order to limit grid voltage rise.
- **CT Controlled Production Modes:** Controlling microinverter array production based on CT clamp information.



WHAT IS SELF-SUPPLY MODE?

In some jurisdictions, utility companies will not allow, or will enforce rate structures that penalize customers for exporting power backward past the utility meter. In Hawaii, for example, a new type of solar permit can be applied for in which the customer is allowed to install solar, but the installed system must be certified to operate with HECO rule-14 'Self-Supply Mode'. Chilicon Power's inverter and monitoring system are certified for this operation:

https://www.hawaiianelectric.com/Documents/clean_energy_hawaii/list_of_advanced_legacy_equipment.pdf

The Self-Supply Mode of operation means that the grid-interactive inverter system will at most match the local load, but will not exceed the local load. This condition guarantees that no export of current to the utility will occur.

THEORY OF OPERATION

In order to achieve no net export, which is equivalent to the solar production not exceeding the local load, CT clamps that measure total power consumption are used. These clamps should be placed between the utility meter and the customer's main panel:



Figure 1 Gen5 HEM Installation



Figure 2 Example of a valid CT Clamp Position

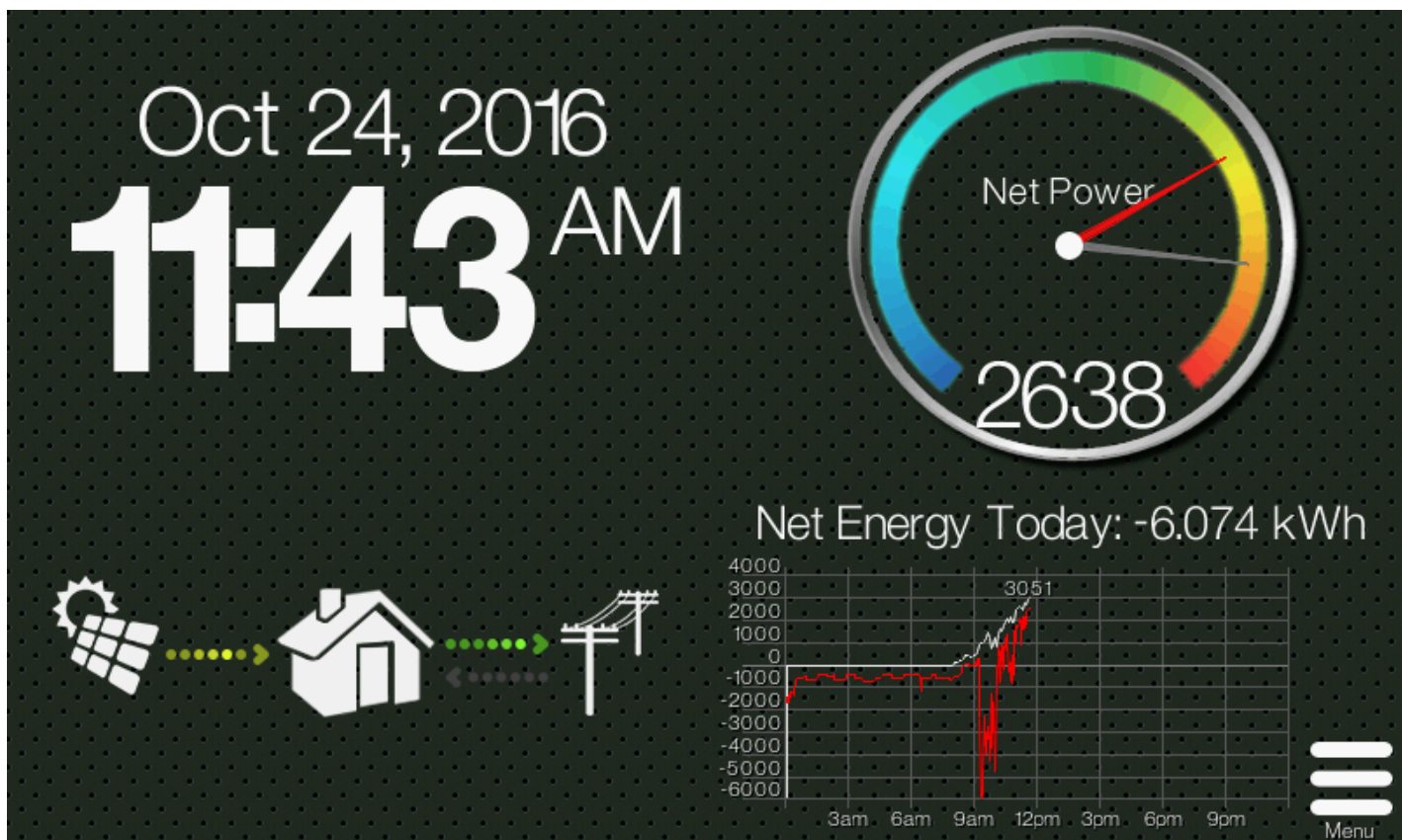


Figure 3 Example of 120V Voltage Sense Connection

Note that the Gen5 HEM should be installed outside of the panel if possible to allow best wireless transmission. Alternatively, it can be installed inside the panel if a repeater is installed immediately on the interior wall opposite the utility panel. Utility panels form a 'Faraday Cage' and can block the wireless RF transmission from the Gen5 HEM to the CP-100 gateway. This portion of the setup, in fact, is the most crucial to provide a robust and service-free installation both for consumption monitoring and self-supply mode operation. As we will describe, diagnostic tools on the gateway allow examination of the link quality and adjustments can be made, usually by adding repeaters or repositioning the CP-100 gateway, until the quality is sufficient. In the next section we describe how to pair to Gen5 home energy meter with the CP-100 gateway. This information can also be found in the quick start guide that ships with the CP-100 gateway.

INSTALLING Z-WAVE HOME ENERGY METER**PAIRING THE HEM (HOME ENERGY METER)**

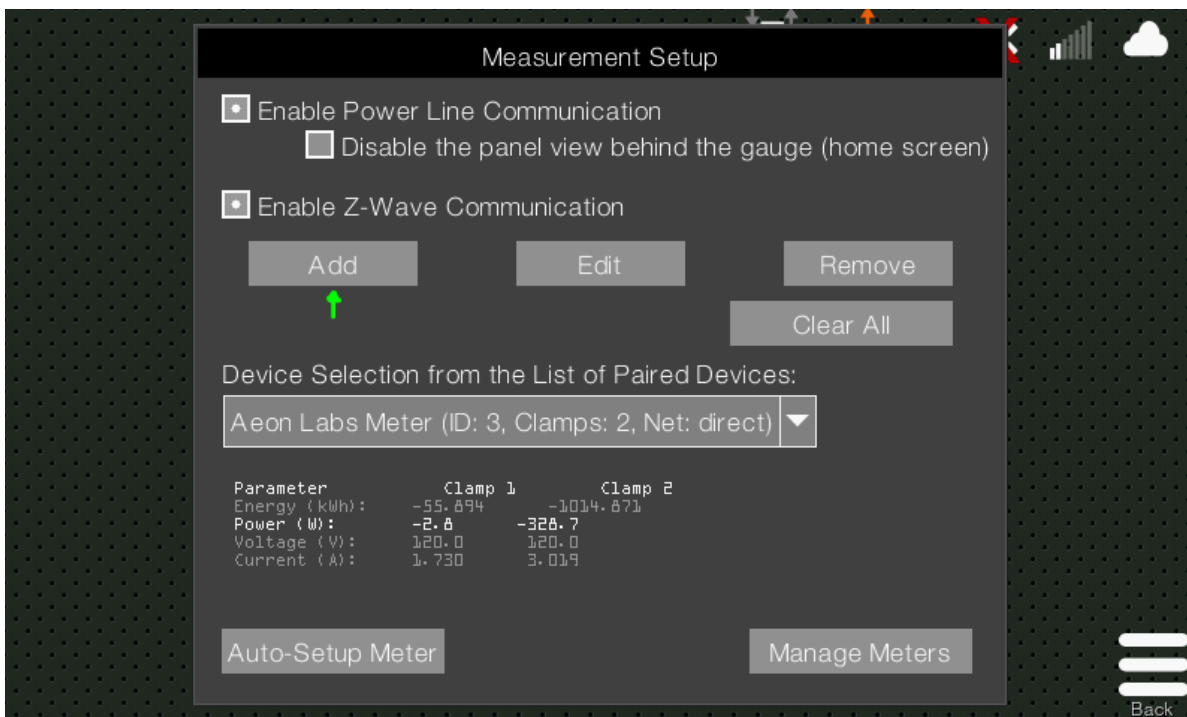
The first step is to pair the HEM with the Gateway so that they can communicate with each other over the Z-Wave wireless network. It is easier to pair HEM with the Gateway BEFORE installing them in the circuit box or disconnect panels. This ensures there are in range of each other and that the wireless link is strong. Only Gen2 (DSB28-ZWUS) and Gen5 (AEOZW095-US) Aeotec Home Meter Energy are currently supported by the Gateway but we highly recommend to use the Gen5 version since it is more reliable and has better RF range.



From the home screen, press the Menu button ☰. On the Settings screen, press "Advanced Settings" ⚙️ and then "Measurement Setup" 📊. The first step is to enable the Z-Wave communication hardware on the Gateway if that has not been done yet. For that, make sure the box in front of "Enable Z-Wave communication" is checked (a dot inside the box indicates it is checked). Below it will list the paired devices which at first will show that there are no devices paired yet.




The next step is to add the HEM to the list of paired devices. Press the “Add” button and then press the button on the back of the HEM device once. If your meter has been successfully paired to your network, its light will remain solid. If the pairing was unsuccessful, the light will blink. If that is the case, try repeating the procedure again.





Once the HEM is paired, you will be prompted to specify the number of clamps used (usually it will be 2) and whether the HEM is used for generation metering (PV array only) or consumption (net home metering or any home appliance). After exiting that window, the new paired device should show up in the list of paired devices. Note each HEM is associated with an ID number.


DEFINING LOGICAL METERS

The next step is to define the logical meters. This is most easily done by hitting 'Auto-Setup Meter'. Logical meter definitions are called 'logical' because they are not physical hardware but based on a mathematical expression containing HEM reported values. Logical meters are used to record and display the information gathered by the HEMs. To set up, press the "Manage Power" button. This opens up the logical meter setup. The first UI object is a pull down menu showing the list of defined logical meters. At first, there are none, so press the "New" button  to add a new logical meter. Typically, you will want to add two logical meters per HEM. One to measure the instant power and one for the total energy harvested (the sum of powers over time).


EXAMPLE OF LOGICAL METERS FOR NET METERING

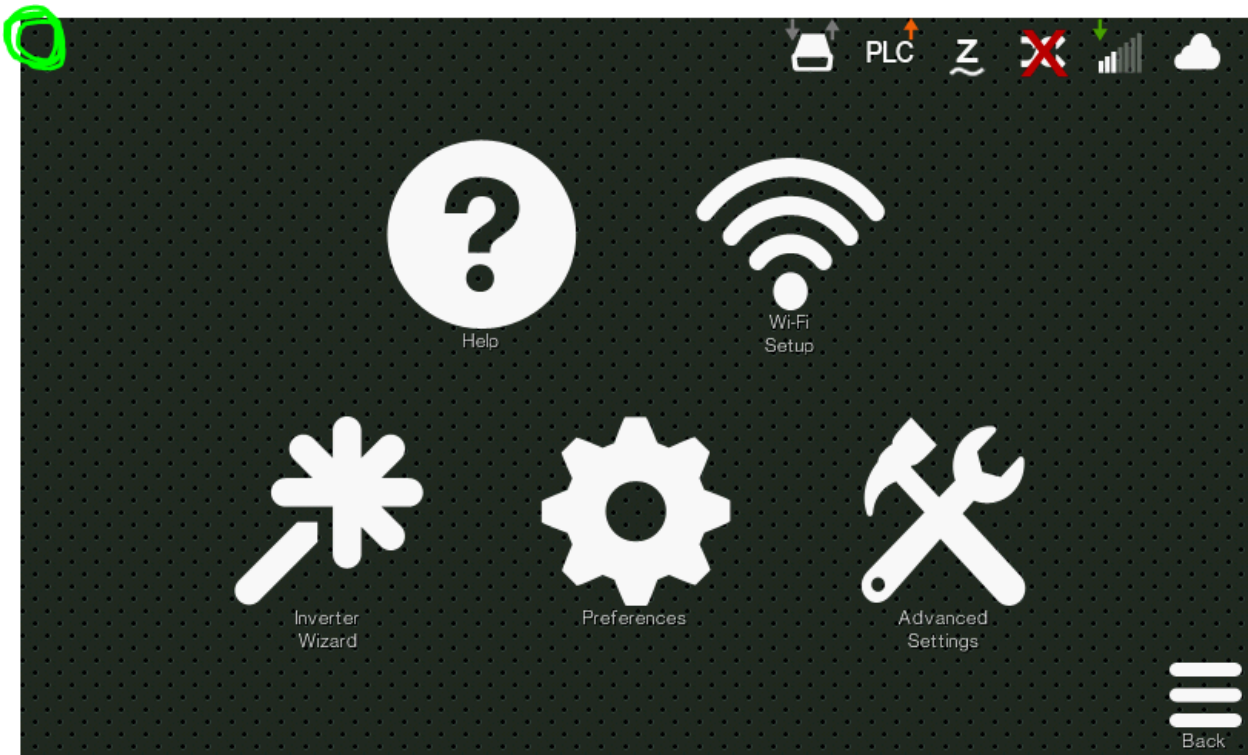
Let's assume you have installed a HEM to measure the entire house consumption (a net meter). Let's first setup a power meter. For that, let's call the new logical meter "Home Power". Enter that in the appropriate box. Then select the type as "Cons. Meter" for consumption meter.

Under expression, enter the expression that sums up the two clamp power values. For that, use the "node ID-clamp-param" pull down box and select "N4-1-W" assuming the HEM node ID is 4. Then press "Insert Device"  and it will add the term in the expression box. Then click on the expression box and a keyboard will pop up. Press the "+" key to add another term to the expression. Then add the second clamp power measurement by selecting "N4-2-W" from the pull-down box and press "Insert Device"  again. The expression is now complete. In order to tell the Gateway this is the meter of the entire home (net meter), we check the box "The Net Meter". Since the power measurement is an instant measurement, we also check the "Show Gauge Needle" box so that it appears on the large gauge display on the home page. In addition, we can plot it on the graph by checking the "Plot on Graph" checkbox.

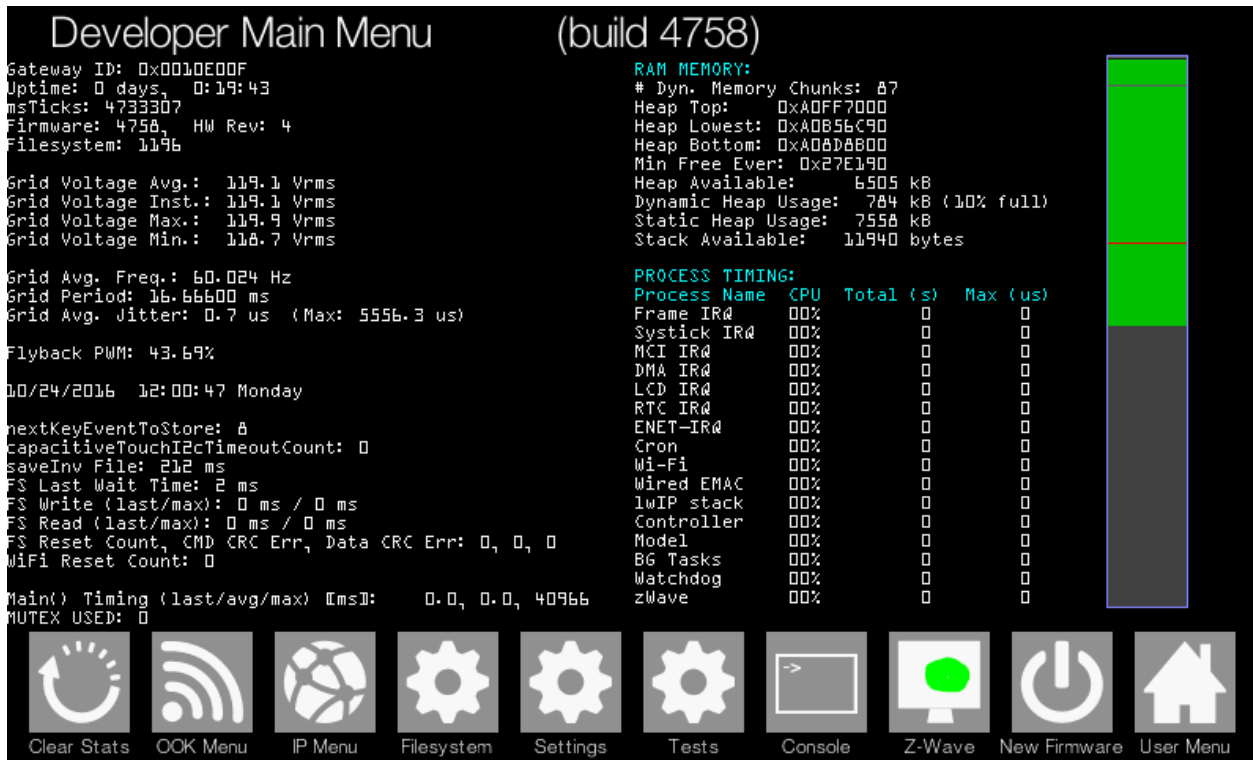
Now that the Home Power meter is setup, let's setup the Home Energy meter that measures the total energy ever consumed (or produced) as well as the daily usage (or production). Again, we press  to add a new logical meter. Under the name, enter "Home Energy". The type is also "Cons. Meter". Under expression, enter "(N4-1-kWh)+(N4-2-kWh)" to sum up the energy from both clamps. For the energy meter, check the "Energy Measurement" box and the "The Net Meter" one as well for this example. No need to check the other boxes because the gauge display and the graph are for displaying power.

VERIFYING THE INSTALLATION

There is a 50% chance that the power measurement for the two clamps will cancel each other leading to unexpected power measurements. Also, it's best to follow a consistent convention for export vs. consumption. At Chilicon, we view (-) negative power as consumption and (+) positive power as production. This can be checked, by traversing to the following screens, From the home screen, press the Menu button , then hold the UPPER LEFT CORNER (shown with a green circle), and ENTER PASSWORD "revolution"

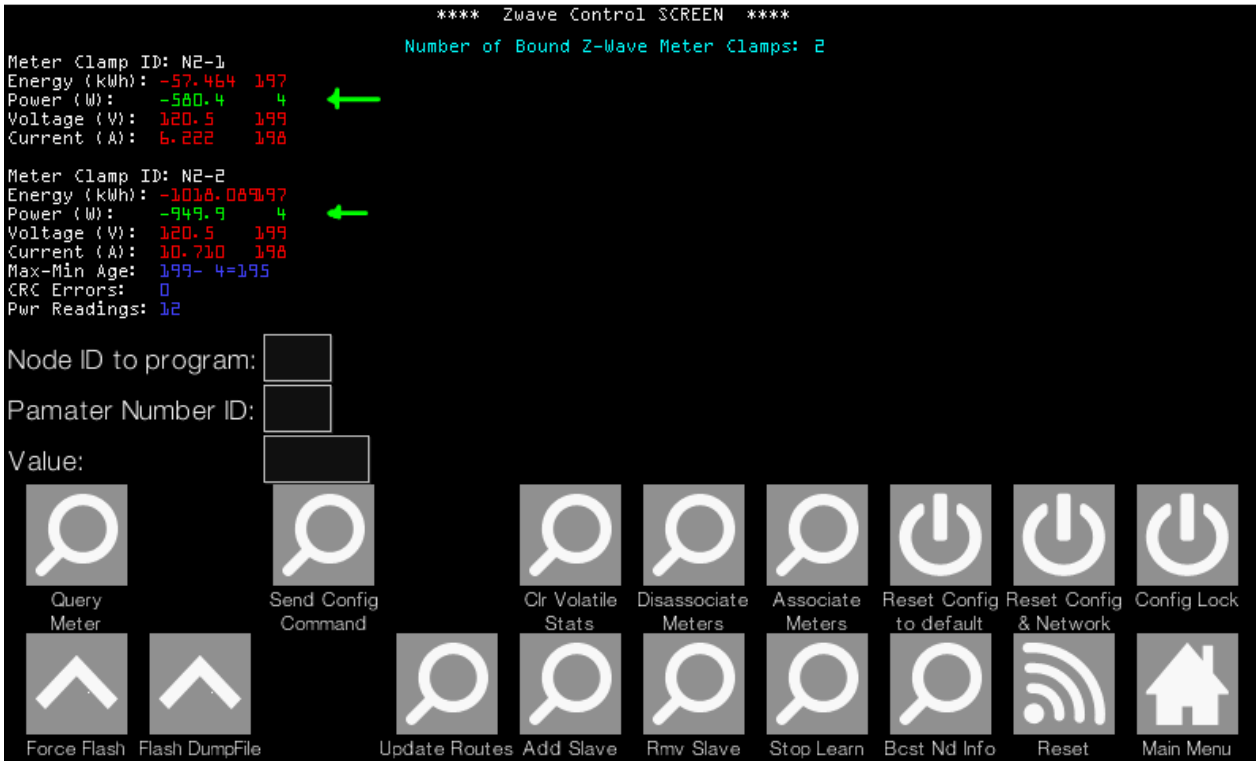


Then, on third from right icon on lower right shows 'zWave', hit this icon to enter the zWave Diagnostic Screen.



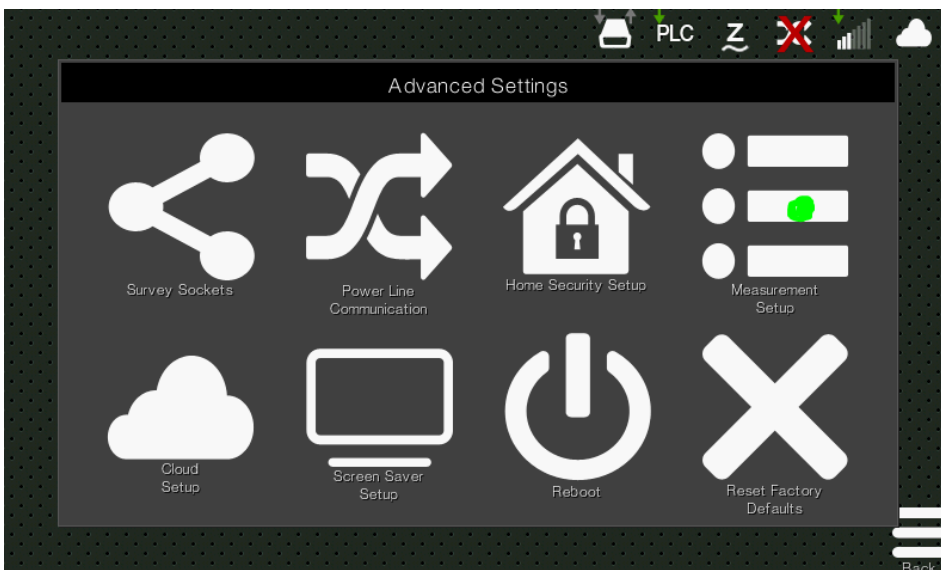
On this menu, you can see the polarity of the flowing current. At night or when the PV array is disconnected, you should see NEGATIVE values for watts. This is the convention for CONSUMPTION. If the sign in front of either clamp is positive when the PV array is disconnected, or it is night time, then reverse the direction of the corresponding clamp and confirm that the sign goes negative. Alternatively, change the logical meter expression by using a "-1*()" in front of the clamp that is reversed in the logical meter expression defined on the Manage Meters page.

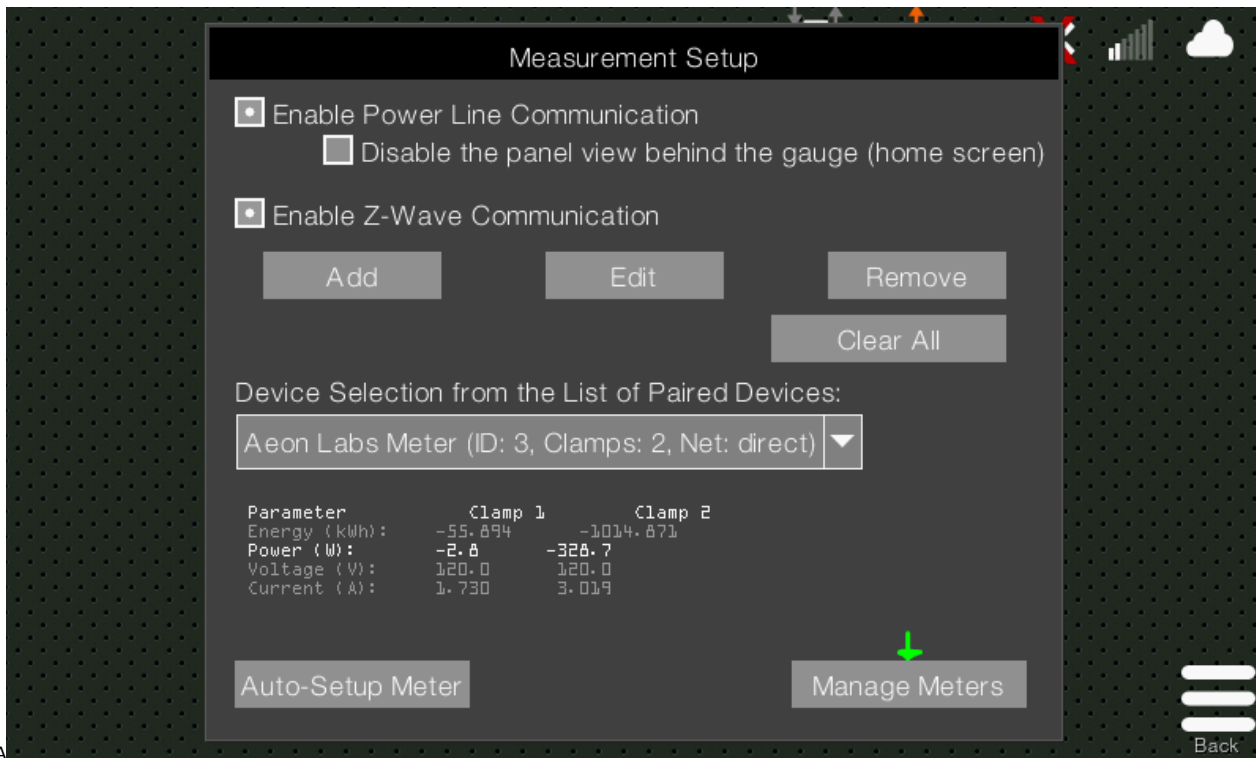
Also, you SHOULD VERIFY that the Power (W) fields ALWAYS UPDATES EVERY 5 seconds. If the update rate is slower, then the communication is spotty. To fix this, add zWave repeater modules in the path between the gateway and the Gen5 HEM, or relocate the gateway. You MUST have good zWave communication between the CP-100 gateway and the Gen5 HEM for self-supply mode to operate successfully.



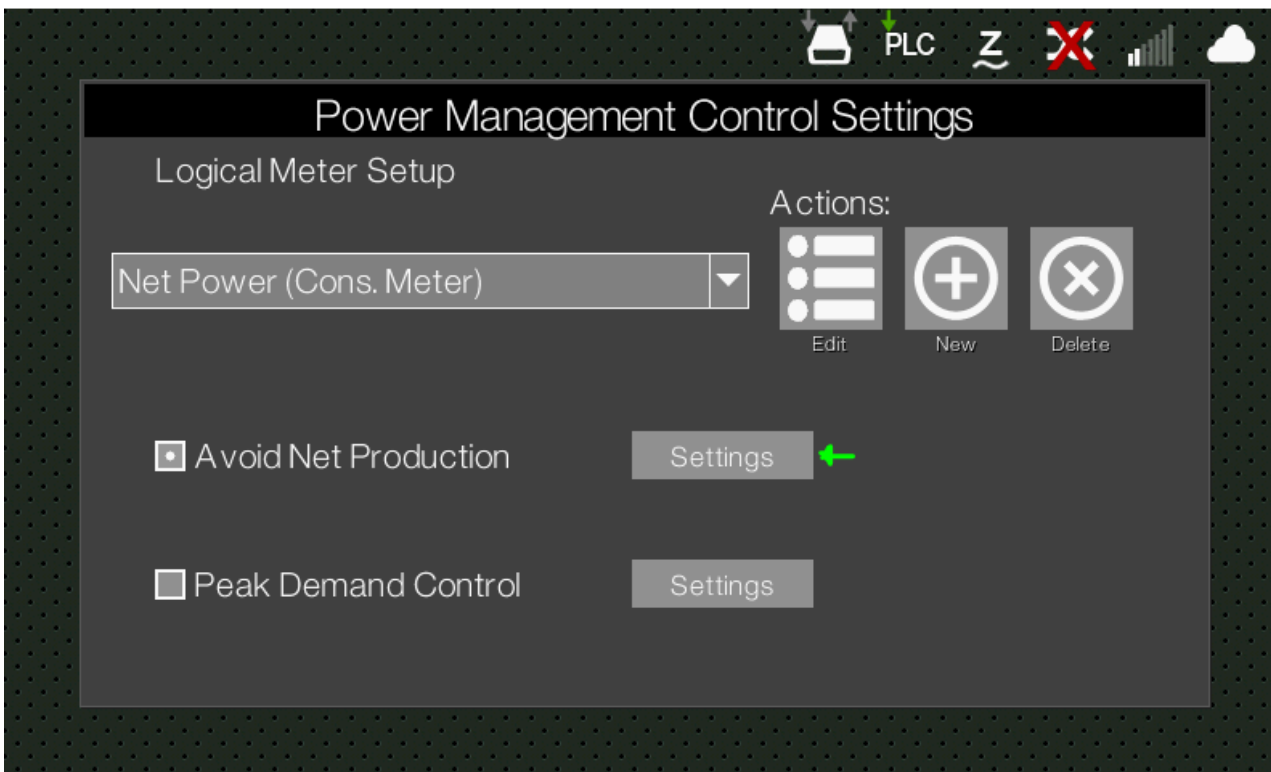
ACTIVATING SELF SUPPLY MODE

To activate Self Supply Mode, Menu button . On the Settings screen, press “Advanced Settings” and then “Measurement Setup” . Then hit “Manage Meters”



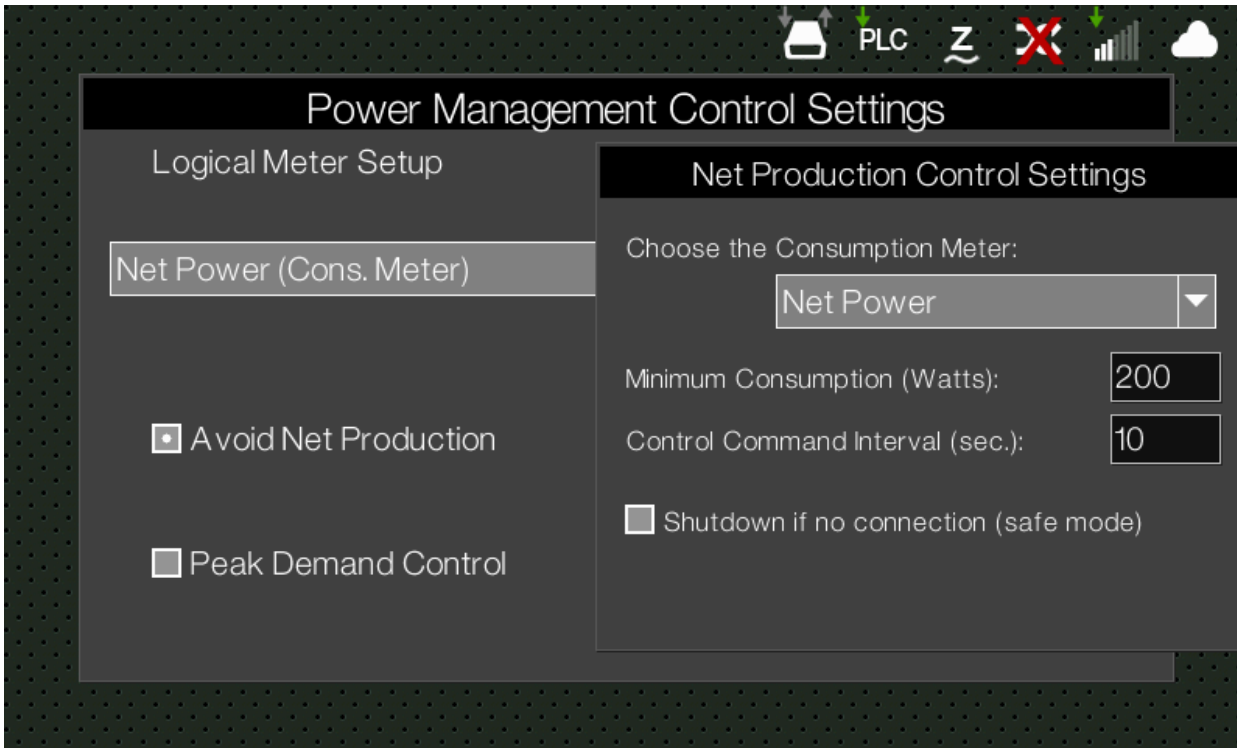


From the Power Management and Control Settings menu, click “Settings”.



The program the required minimum consumption, 0 Watts is the default, placing a larger value creates more margin to grid-backfeed events. 200 Watts is a reasonable number to use. In addition, make sure the check box 'Avoid Net Production' is selected. The system will no continually program the microinverters, based on the Gen5 HEM net meter information to prevent backfeed. You can also select 'Shutdown if no connection' if it is desired the

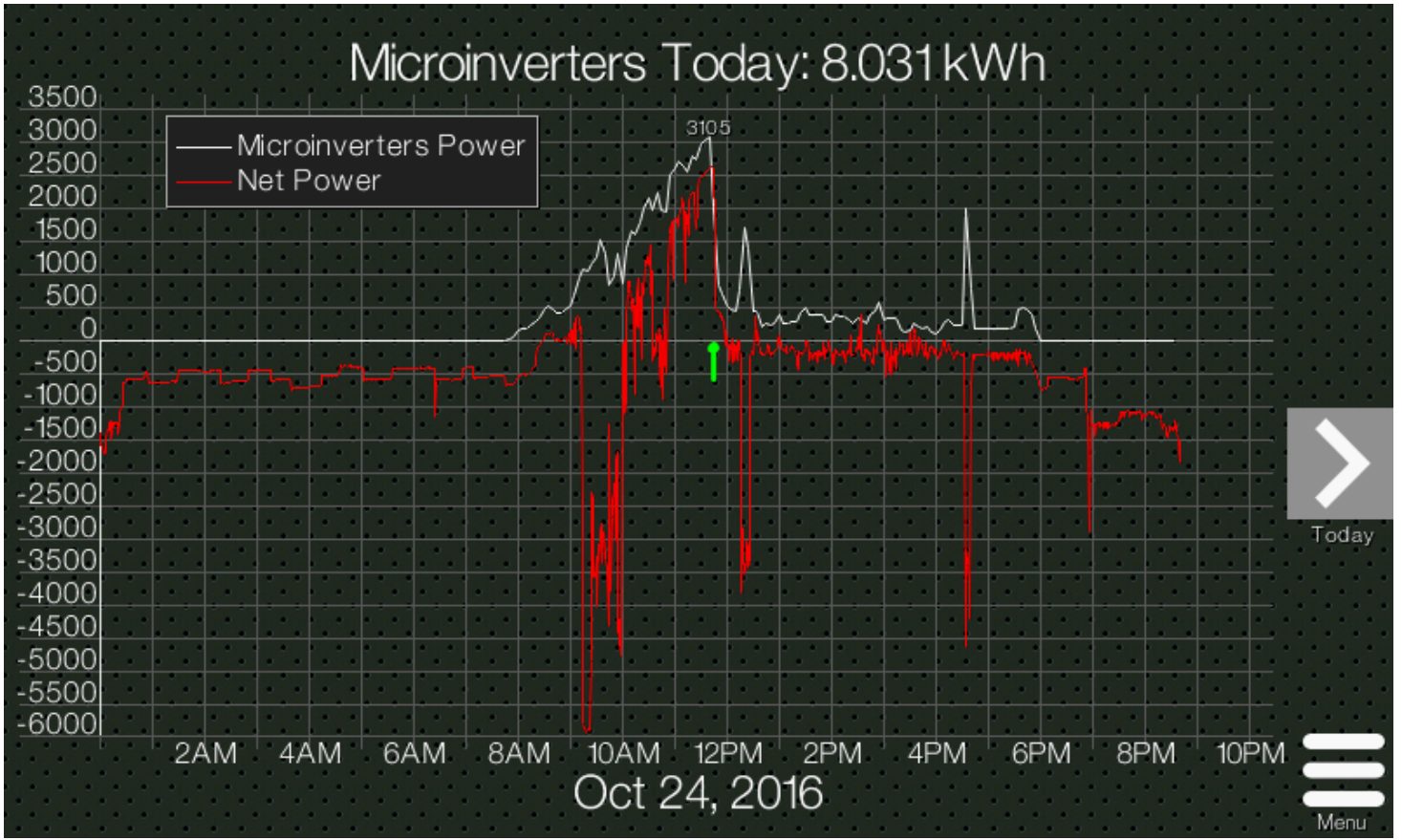
microinverters should automatically power off within 30 seconds on not receiving any update information from the gateway.



FINAL RESULT

The resulting typical operation of a system operating in Self-Supply Mode can be seen in the plot below, this plot can be viewed by clicking on the graph view on the gateway top level user menu, to make the view expand to full screen.

The Red curve shows NET power through the day. When above the 0W line, the system is backfeeding to the grid. At the time of the Green Arrow, "Avoid Net Production" was selected with 200W Minimum Consumption as the power budget parameter. Throughout the rest of the day, it can be seen that the red line stays below 0Watts, with only occasional short excursions above 0W, which are normal and within regulations that permit control loop actuation times. One can also see large load spikes that are countered to the extent possible by increasing microinverter power.



FURTHER SUPPORT

If you have further questions or if this document is not clear enough on certain aspects, please email support@chiliconpower.com.