LPEA's Guide to Optimizing your Sol-Ark Battery System

Overview: This guide is intended to guide the programming of Sol-Ark power control systems that are paired with battery storage. The intended audience is the system installer who is programming settings on the member's behalf to qualify the member for LPEA's battery rebate and/or to maximize the member's financial savings from the use of batteries to avoid peak demand charges. *These recommendations are specific to LPEA's General Service residential rate. If the member is on the residential Time-Of-Use (TOU) rate or another rate, please reach out to communitypower@lpea.coop for personalized guidance.*

Because Sol-Ark's interface allows for a high-level of customization and because many parameters are dependent on the characteristics of the batteries used, this document should be treated as a guide which may require modification, not a prescriptive solution. Additionally, system owner goals around using the solar energy they generate, being prepared for outages, and supporting the grid may all dictate settings.

The required settings for the **LPEA Battery Rebate** are explicitly shown in this guide with a  icon. If proof of the setting is required in the Battery Rebate application, you will see a  icon.

Taking a screenshot of the Battery Setting and System Work Mode pages will capture all necessary information for LPEA's Rebate application.

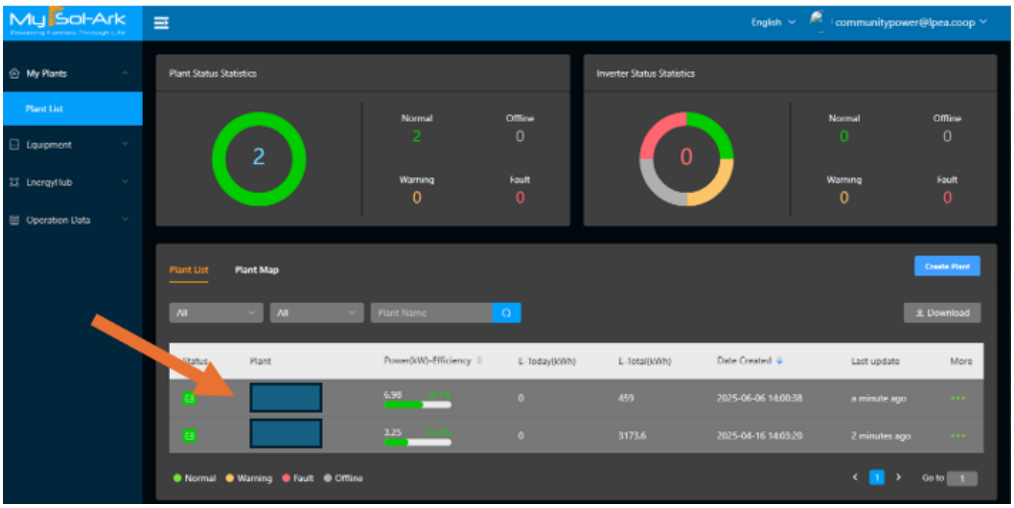
Additionally, there are several steps in this guide that have a  icon. This icon identifies situations where you need to choose how to operate the system based on your goals or the system's unique design.

If you are also applying for the **LPEA Bonus Battery Rebate** you will skip **Step 4** and instead follow **Step 6**.

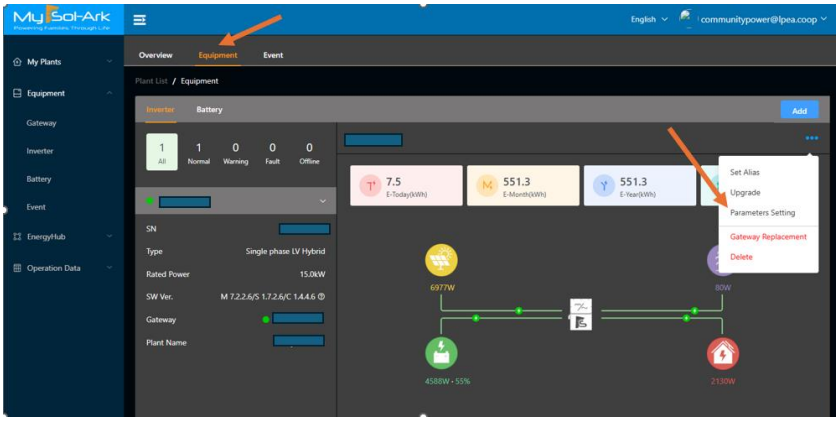
Step-by-Step Instructions

Step 1. Log into My Sol-Ark web portal

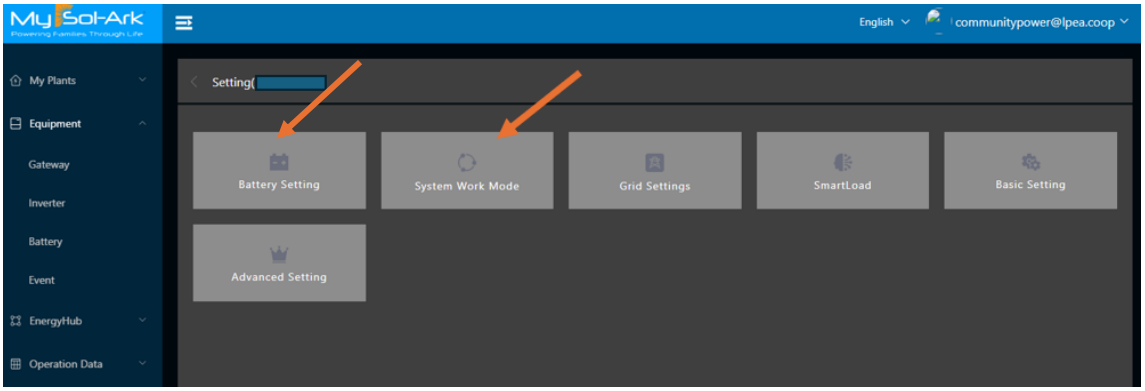
1. Select the desired Plant from the Plant list.



2. Once on the desired plant, click on "Equipment" and then Parameters Setting under the ••• icon.



3. For Step 2 select Battery Setting on the next screen and for Step 3 you will select System Work Mode.



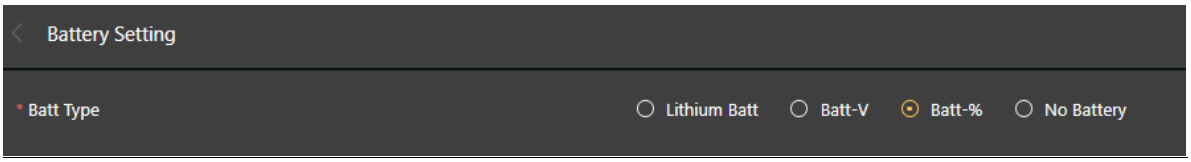
Step 2. Battery Settings

On the Battery Settings page there will be many parameters that need to be defined based on the characteristics of the batteries and OEM recommendations, the electrical systems they are connected to, and possibly the system owners desired system performance and desired system longevity.

**It is important to note that the Max A Charge value and Max A Discharge value will set the upper limit on battery charge and discharge rates. However, the Grid Start A value nested under Grid Charge, and the Power values listed on the System Work Mode can set lower limits on the charge and discharge rates of the batteries.*

If there is a BMS with closed-loop communication, that will take precedence over any listed values.

For the purpose of setting a schedule in the System Work Mode, all capacity thresholds will be set on a SOC % value. Select Batt-% to see this value.

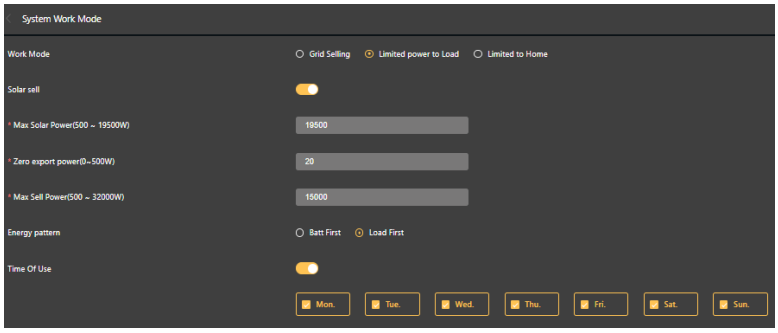


Step 3. Program System Work Mode

Return the System Parameter Settings page and select System Work Mode.

1) Select the appropriate **Work Mode**. If there is load between the Sol-Ark and the LPEA meter and external CTs sit between the load and LPEA meter, select **Limited to Home**. If there is no load between the Sol-Ark and the LPEA meter or if it is a partial home backup select **Limited Power to Load**.
2) Enable **Solar sell**.
3) For **Max Solar Power** enter in upper limit of the allowed range. *This will allow for a maximum solar DC to AC conversion and solar DC to DC charging of the battery.*
4) For **Zero export power** enter in 20 W. *This value is recommended from Sol-Ark technical support. It is the amount of power the system will try to pull from the grid at times when it's not allowed to export to the grid to ensure a 'buffer'.*
5) For **Max Sell Power** enter in the inverter rating unless there is a pre-existing solar PV system that is AC coupled to the Sol-Ark. In that case, list the combined AC nameplate of the AC-coupled and DC-coupled systems, or the export limit if this system was approved with an export limited interconnection.
6) For **Energy pattern** select **Load First**. *This will mean that if the system is below the desired Battery SOC and has load, it will direct solar power to meet the load first and then use any remaining to charge the battery. If "Batt First" is selected and the battery is below the desired SOC the battery will charge until the SOC is met before meeting any onsite load.*
7) Enable **Time of Use** and check every day because LPEA's Peak Demand charges can happen any day of the week.

To the right is an example of how this should look for a system that has an AC Nameplate of 12.15 kW and has no load between the Sol-Ark and utility meter. You should capture this screenshot.



Step 4. Program System Work Mode SCHEDULE

Sol-Ark allows for a high degree of customization in the operating schedule. Because of this, there is not a one size-fits-all solution for programming the system. However, t*o be eligible for LPEA's Battery Rebate your Battery SOC must be 30% or less for the 4-9pm (16:00-21:00) time interval and you must enable full Power during this interval*.

Other scheduling choices will be left to the members. Two sample schedules are provided below and explained to guide customization for each member's unique situation and goals.

Keep in mind that this is the schedule for battery discharge and charging behavior only and does not govern solar generation.

Overview of Schedule Settings

Charge: If a Time is checked in the Charge row, charging from the grid is allowed in the Time interval starting with that Time. Otherwise charging from the grid is prohibited.

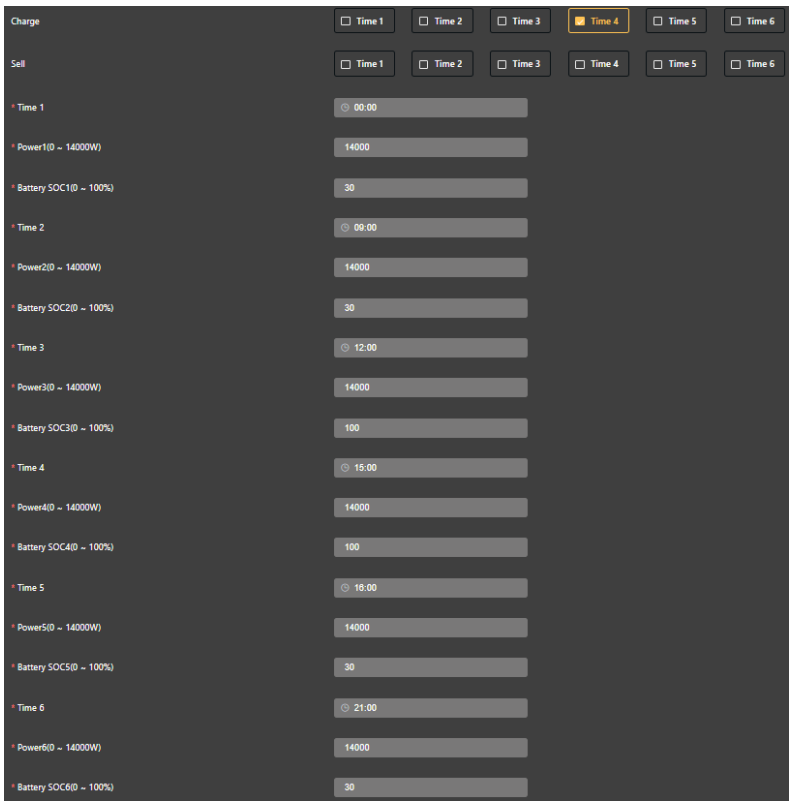
Sell: If a Time is checked in the Sell row, selling power from the battery to the grid is allowed in the Time interval starting with that Time. Otherwise discharging from the battery to the grid is prohibited.

Time: The Time values bound intervals. Power and Battery SOC settings are applicable for the interval between their start and end Times.

Power: The maximum charge or discharge rate of the battery during the time interval. The Power value governs the rate of battery charging from solar and discharging to meet home load. If the Charge and Sell boxes are checked for a given interval, the Power value also governs the rate of charge from or sell to grid, respectively. *Battery Settings (Step 2) take precedence over these values and can limit charge/discharge rates so make sure these are coordinated*.

Battery SOC: This is the target SOC minimum of the battery in this interval. If the SOC is 100% the battery will only charge during the interval and will never be discharged to meet load. If the SOC is below 100% and solar generation cannot meet load, the battery will be discharged to meet the load until the SOC value is reached. If the SOC is below 100% and Sell is checked, the battery will discharge to the grid until the SOC value is reached.

Sample A Goals: *Meet as much home load from self-generated solar as possible throughout the entire day and charge from the grid if not fully charged when approaching Peak Demand Time (4-9 pm)*



Power values should be set at the maximum of the listed range any time battery discharge is expected to meet home load. *See Step 2 Battery Settings to understand other limits on power.*

Time Interval 1 (0:00-9:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This guarantees at least 30% of battery will be available in the event of an outage at all times, while still using the battery to meet as much home load as possible through the night and into the morning.

Time Interval 2 (9:00-12:00) has the same goal as Time interval 1. *This interval could have been omitted but all time intervals must be used. This interval could also have the SOC set at 50% to transition between the goals of Time interval 1 & 3.*

Time Interval 3 (12:00-15:00) is prioritizing charging the battery up to 100% by the start of the Peak Demand time window, but only by charging from onsite solar generation. *Because Load First is the Energy pattern, solar power will first meet the onsite load and then charge the battery. On a typical sunny day generation will exceed load and the battery will charge. However, in the circumstance where onsite load exceeds solar generation, the battery will remain at its current SOC and additional power to meet load will come from the grid.*

Time Interval 4 (15:00-16:00) is prioritizing charging the battery up to 100% so that it is full going into the Peak Demand time window. With Time 4 checked in the Charge row, the battery can also charge from the grid during this interval, if needed. *The 1-hour window was established based on the member's battery capacity and charge rate. This could be extended to a 2-hour window with a lower SOC trigger to initiate grid charging earlier if needed. See Step 5 Enable Grid Charging to enable and customize these settings.*

Time Interval 5 (16:00-21:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This helps the member avoid any Peak Demand charges and supports the grid during a time of high usage. This is the one setting that must be in place to receive LPEA's Battery Rebate.

Time Interval 6 (21:00-0:00) is accomplishing the same goal as Time Interval 1.

Sample B Goals: *Satisfy LPEA rebate requirements and maintain maximum backup power at all other times*

Time interval 5 (16:00-22:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This helps the member avoid any Peak Demand charges and supports the grid during a time of high usage. This is the one setting that must be in place to receive LPEA's Battery Rebate.

All other time intervals have a SOC of 100% so the battery will not be discharged to meet load. Because no Charge boxes are checked (*and Grid Charge is not enabled on the Battery Setting page*), the battery will only charge from solar.

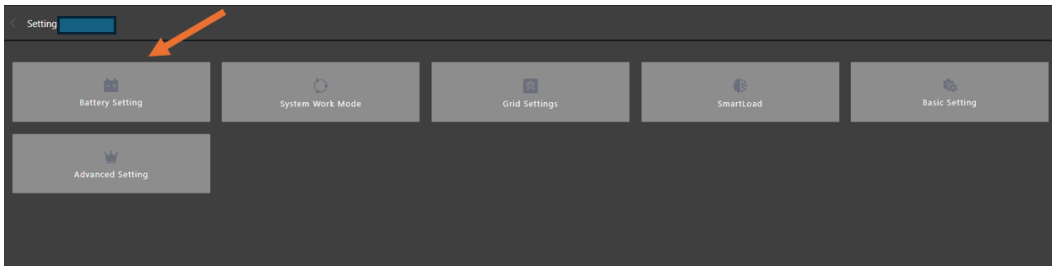
The member could have enabled grid charge in Time Interval 6 or 1 if they wanted to recharge the battery after the Peak Demand time window to have additional backup power.

They could also set a SOC minimum to recharge to other than 100% if they are comfortable with a different SOC in reserve capacity and still want the battery to mostly charge from solar generation the next day. The Power value for the Time Interval with grid charging can be customized based on the battery capacity (kWh) and how quickly the system owner wants to charge from 30% at the end of the Peak Demand time window to their desired SOC.

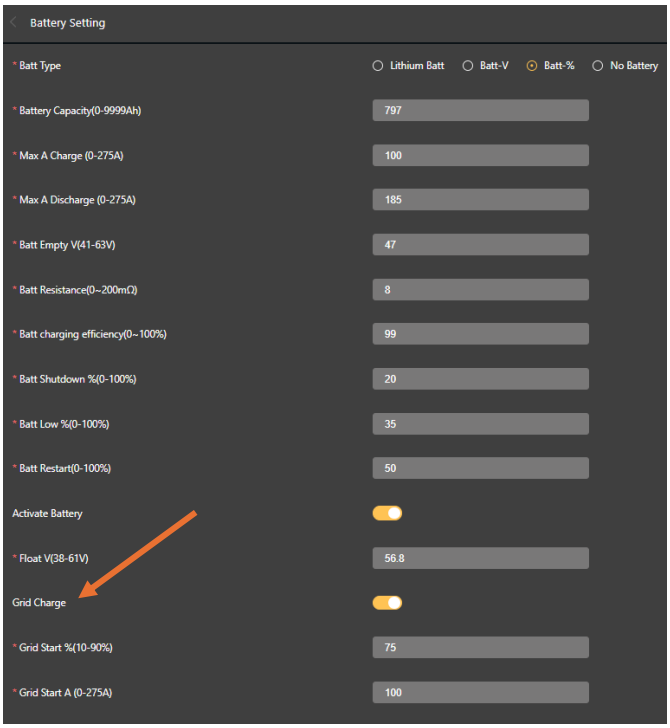
Step 5. ❓ Enable Grid Charging

This is an optional but recommended step. If you want to minimize potential Peak Demand charges and support the grid, complete this step. Enabling grid charge can be particularly valuable if it is cloudy or the panels are covered in snow for several consecutive days.

1) Return the **System Parameter Settings** page and select **Battery Setting**.



2) Enable **Grid Charge**. Once Grid Charge is enabled you will have two additional fields to fill out.



3) Set the **Grid Start %** at the SOC you want the battery to initiate charging from the grid at.

   For example, if you set this value at 50% the battery will only charge from the grid during a time interval in which charging is allowed IF the SOC is less than 50%. The higher you set this value, the less likely a grid charge will take place.

   You will want to align the **Grid Start %** and **Grid Start A** with the duration of the time interval(s) that allow grid charging, the power allowed during those intervals, the overall capacity of the battery, the member's typical peak usage, and their wishes around avoiding demand charges and charging from the grid to optimize this behavior.
   *In the above example the Grid Start % was set at 75% and grid charging is only available from 3-4pm. These settings are intended to make grid charging less likely, giving the solar a chance to fully charge the battery, while still ensuring that ~5.1 kWh (100A*51V*1hr) of energy can be added to the battery between 3-4 pm if the solar isn't charging the battery.*

Step 6. System Work Mode SCHEDULE *Bonus Battery Rebate Only*

If you are in an Interconnection Limited Zone (Orange or Red area) and are applying for the Bonus Rebate follow these additional instructions.

Sol-Ark allows for a high degree of customization in the operating schedule. Because of this, there is not a one size-fits-all solution for programming the system. However, t*o be eligible for LPEA's Bonus Battery Rebate you must meet two criteria*.

1) *Battery SOC must be 30% or less for the 4-9pm (16:00-21:00) time interval and you must enable full Power during this interval.*
2) *Battery must be in Sell mode from 9am-12pm (9:00-12:00) so that the battery delays its charging until afternoon. This helps reduce excess solar generation on the grid at times when local load is lowest.*
   This setting only needs to be in place for the Spring and Fall months of April, May, September and October. However, because Sol-Ark's seasonal scheduling only allows for 3 seasons, in practice this will need to be in effect from April to October.

Other scheduling choices will be left to the members. Two sample schedules are provided below and explained to guide customization for each member's unique situation and goals.

Keep in mind that this is the schedule for battery discharge and charging behavior only and does not govern solar generation.

Overview of Schedule Settings

Charge: If a Time is checked in the Charge row, charging from the grid is allowed in the Time interval starting with that Time. Otherwise charging from the grid is prohibited.

Sell: If a Time is checked in the Sell row, selling power from the battery to the grid is allowed in the Time interval starting with that Time. Otherwise discharging from the battery to the grid is prohibited.

Time: The Time values bound intervals. Power and Battery SOC settings are applicable for the interval between their start and end Times.

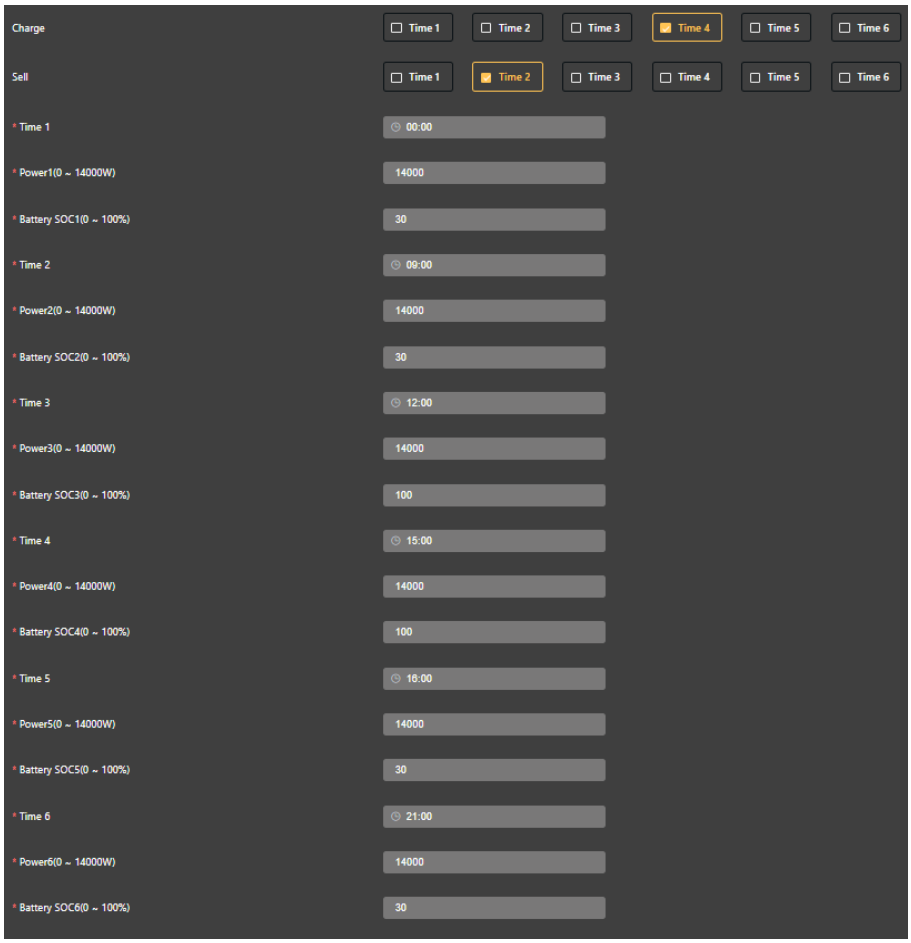
Power: The maximum charge or discharge rate of the battery during the time interval. The Power value governs the rate of battery charging from solar and discharging to meet home load. If the Charge and Sell boxes are checked for a given interval, the Power value also governs the rate of charge from or sell to grid, respectively. *Battery Settings (Step 2) take precedence over these values and can limit charge/discharge rates so make sure these are coordinated.*

Battery SOC: This is the target SOC minimum of the battery in this interval. If the SOC is 100% the battery will only charge during the interval and will never be discharged to meet load. If the SOC is below 100% and solar generation cannot meet load, the battery will be discharged to meet the load until the SOC value is reached. If the SOC is below 100% and Sell is checked, the battery will discharge to the grid until the SOC value is reached.

Spring, Summer & Fall Schedule

Goals: *Satisfy the bonus rebate requirements. Additionally, meet as much home load from self-generated solar as possible throughout the entire day and charge from the grid if not fully charged when approaching Peak Demand Time (4-9 pm)*

Power values should be set at the maximum of the listed range any time battery discharge is expected to meet home load. *See Step 2 Battery Settings to understand other limits on power.*



Time Interval 1 (0:00-9:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This guarantees at least 30% of battery will be available in the event of an outage at all times, while still using the battery to meet as much home load as possible through the night and into the morning.

Time Interval 2 (9:00-12:00) is prioritizing sending power to the grid and delaying the charging of the batteries because Sell is checked. The battery will stay at or above 30% SOC. This setting must be in place for the bonus battery rebate.

Time Interval 3 (12:00-15:00) is prioritizing charging the battery up to 100% by the start of the Peak Demand time window, but only by charging from onsite solar generation. *Because Load First is the Energy pattern, solar power will first meet the onsite load and then charge the battery. On a typical sunny day, the generation exceeds load, and the battery will charge. However, in the circumstance where onsite load exceeds solar generation, the battery will remain at its current SOC and additional power to meet load will come from the grid.*

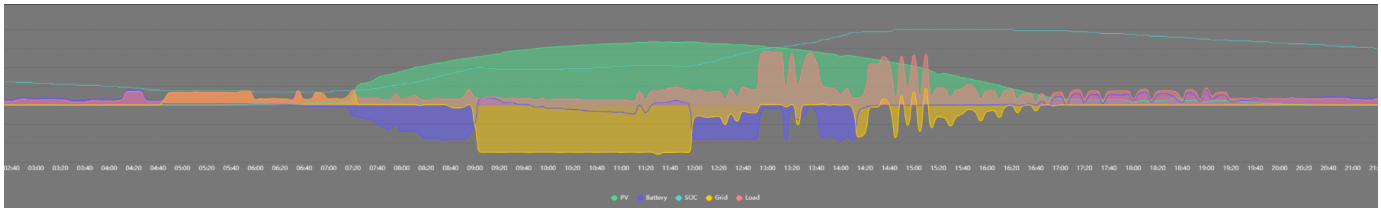
Time Interval 4 (15:00-16:00) is prioritizing charging the battery up to 100% so that it is full going into the Peak Demand time window. With Time 4 checked in the Charge row, the battery can also charge from the grid during this interval, if needed. *The 1-hour window was established based on the member's battery capacity and charge rate. This could be extended to a 2-hour window (14:00-16:00) with a lower Grid Start % to initiate*

grid charging earlier and for longer if needed. See Step 5 Enable Grid Charging to enable and customize these settings.

Time Interval 5 (16:00-21:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This helps the member avoid any Peak Demand charges and supports the grid during a time of high usage. This is the second setting that must be in place to receive LPEA's Battery Rebate.

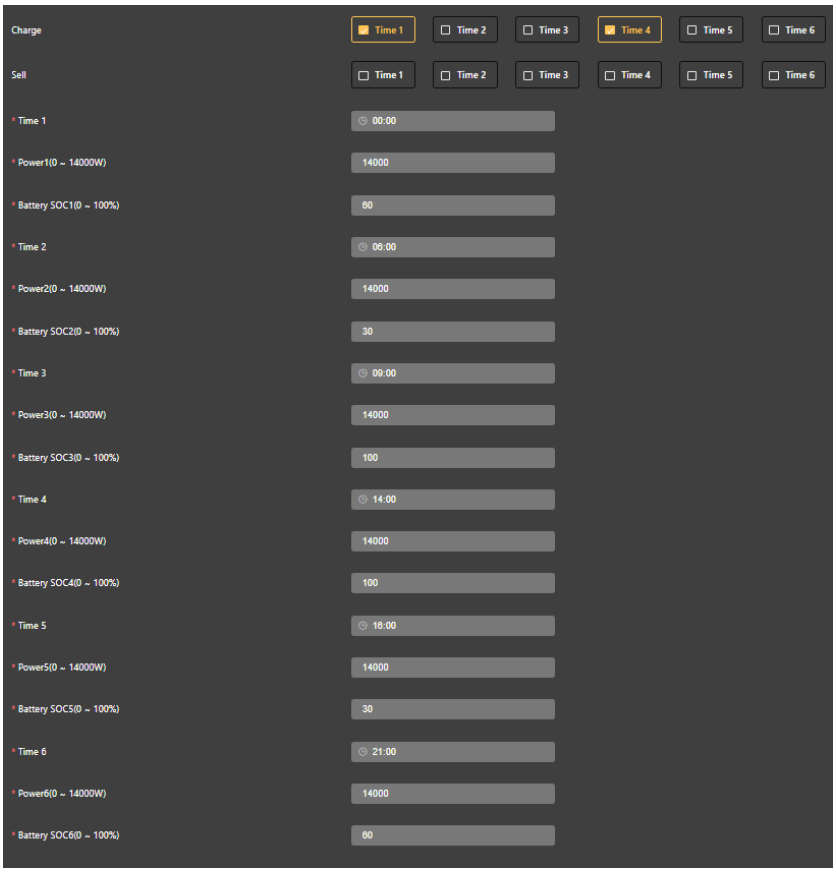
Time Interval 6 (21:00-0:00) is accomplishing the same goal as Time Interval 1.

Sample Behavior on Spring, Summer & Fall Bonus Rebate Schedule



Winter Schedule

Goals: *Maintain extra back up power at night, lower grid usage from 6-9 am and charge from the grid if not fully charged when approaching Peak Demand time window (4-9 pm)*



Time Interval 1 (0:00-6:00) has a SOC of 60% and Time 1 is checked in the Charge row, so if the battery is below 60% SOC it will charge from the grid until reaching that SOC and then hold, providing the possibility extra backup power from midnight through the morning.

Time Interval 2 (6:00-9:00) is meeting home load until the battery is discharged down to 30% SOC. The grid experiences high demand in the morning in the winter and this setting supports the grid.

Time Interval 3 (9:00-14:00) is prioritizing charging the battery up to 100% by the start of the Peak Demand time window, but only by charging from onsite solar generation.

Time Interval 4 (14:00-16:00) is prioritizing charging the battery up to 100% so that it is full going into the Peak Demand time window. With Time 4 checked in the Charge row, the battery can also charge from the grid during this interval, if needed. *The 2-hour window was established based on the member's battery capacity and charge rate and the consideration that in the winter it's more likely to be cloudy or the panels might be covered in snow so a longer charge window is required. This could be extended to a 3-hour window (13:00-16:00) with a lower Grid Start % to initiate grid charging earlier and for longer if needed. See Step 5 Enable Grid Charging to enable and customize these settings.*

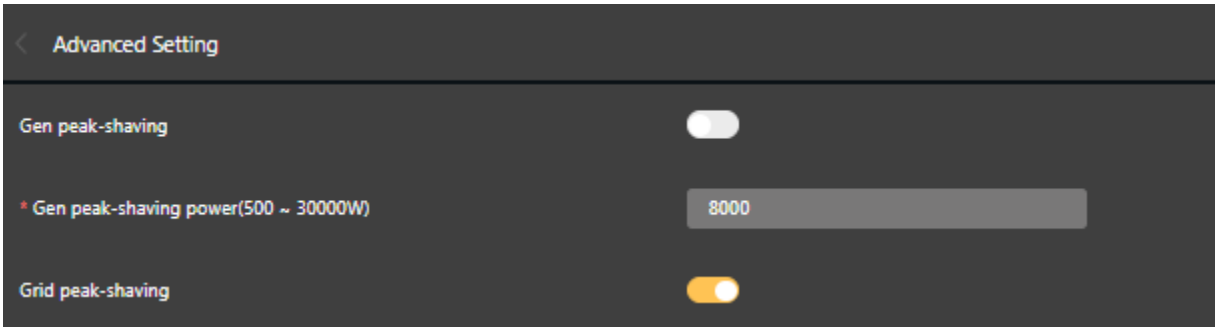
Time Interval 5 (16:00-21:00) is using the battery to meet any home load not met by solar until the 30% SOC minimum is reached. This helps the member avoid any Peak Demand charges and supports the grid during a time of high usage. This setting must be in place all year to receive LPEA's Bonus Battery Rebate.

Time Interval 6 (21:00-0:00) will still discharge the battery to meet home load IF the battery SOC is above 60%. If the battery SOC is below 60% the battery will remain idle at its current SOC. The battery will not charge from the grid at this time because Charge is not checked for Time 6. *These settings help keep a*

relatively high amount of backup power in the battery while also helping the grid avoid a bounce-back peak that could happen if lots of load, like batteries charging from the grid, came on right at 21:00.

Other Advanced/Optional Schedule or Configurations

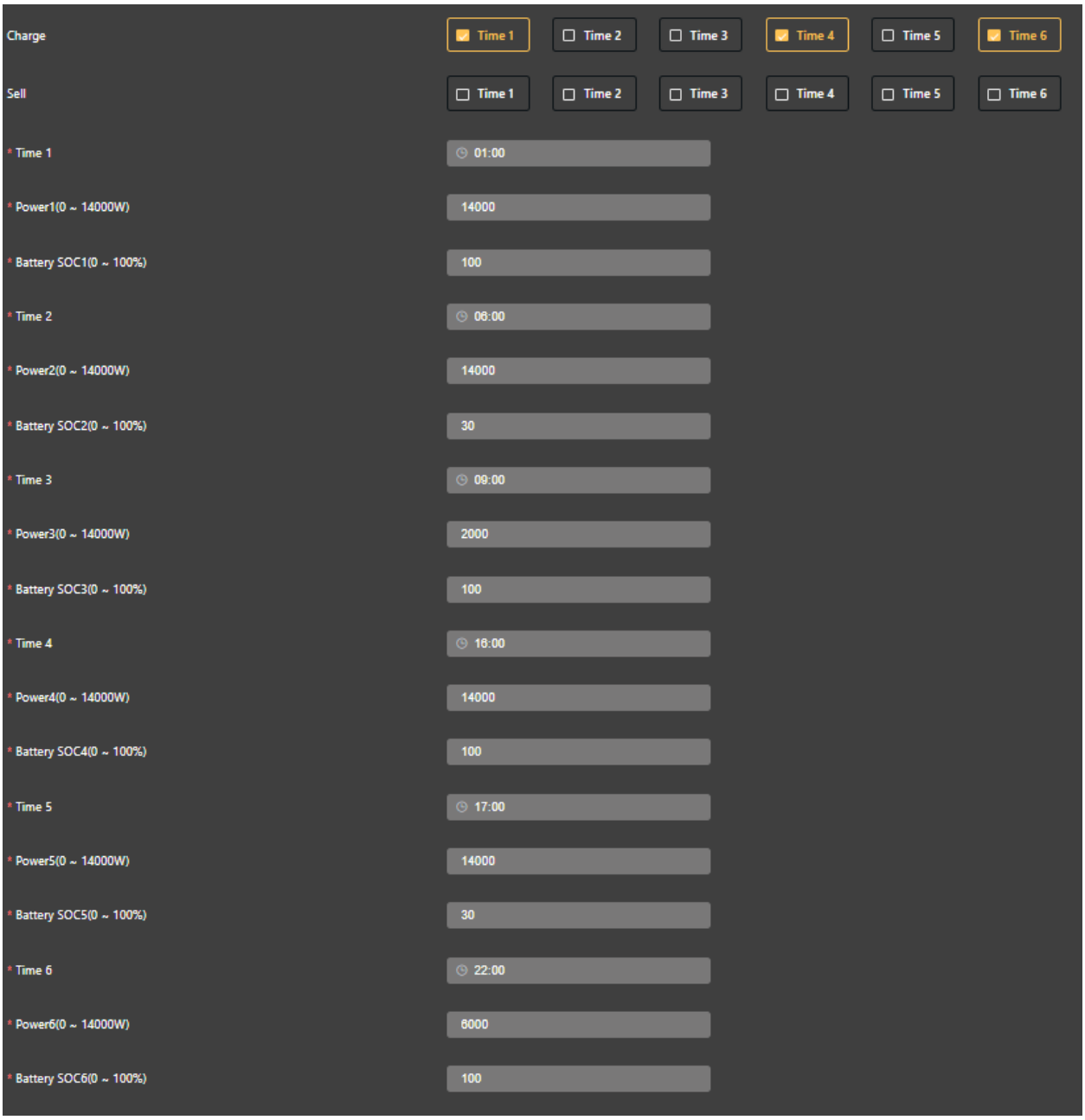
Grid peak-shaving can be used in conjunction with the other settings suggested in this document to minimize the magnitude of peak demand charges. Reach out to communitypower@lpea.coop for more information.



Other Possible Schedules

**Please reach out to communitypower@lpea.coop before instituting.*

TOU Settings: Charge from 4-5pm if not already charged. Recharge overnight from 10pm-6am, slower from 10pm-1am, then faster at 1am if not fully charged. Discharge from 6-9am and 5-10pm.



Avoid Winter Peak with current peak demand rate structure. More aggressive grid recharging.