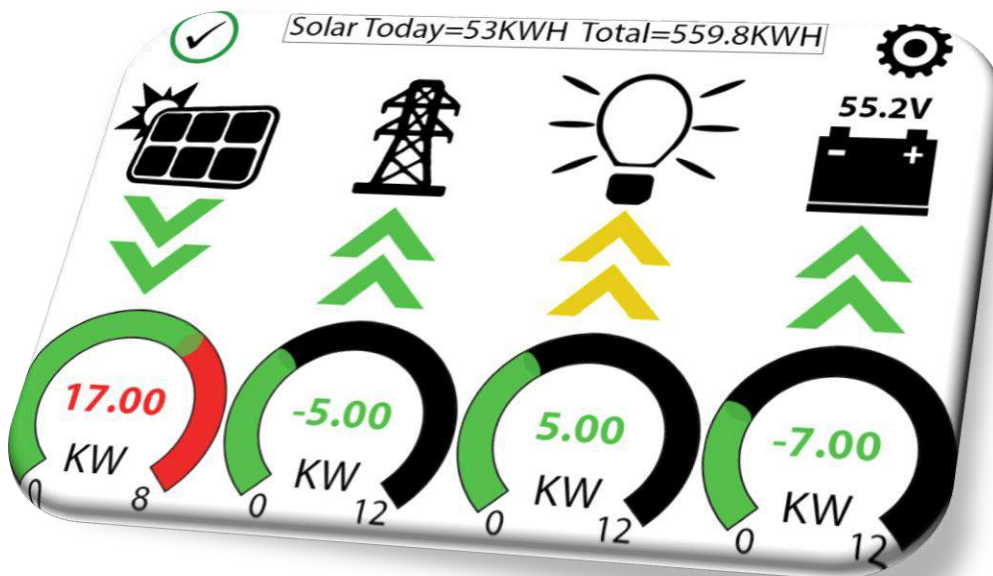


# BASIC PROGRAMMING GUIDE

SYSTEM WORK MODES AND TIME OF USE FOR SINGLE INVERTER INSTALLATIONS

Residential Inverter Systems



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# 1. System Work Modes

	Time	Power(W)	Batt	Charge	Sell
<input type="checkbox"/> Grid Sell 15000	01:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Limited Power to Home	05:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Limited Power to Load	09:00AM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Time of Use Setup	01:00PM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
	05:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
	09:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>

This Chapter will introduce the four System Work Mode settings and their basic functions when operating independently from each other. It is important to learn the basic differences of the work modes as the programming will heavily depend on the wiring configuration of the Sol-Ark System, the utility availability, the presence of batteries, and how the end user desires the system to behave in differing scenarios.

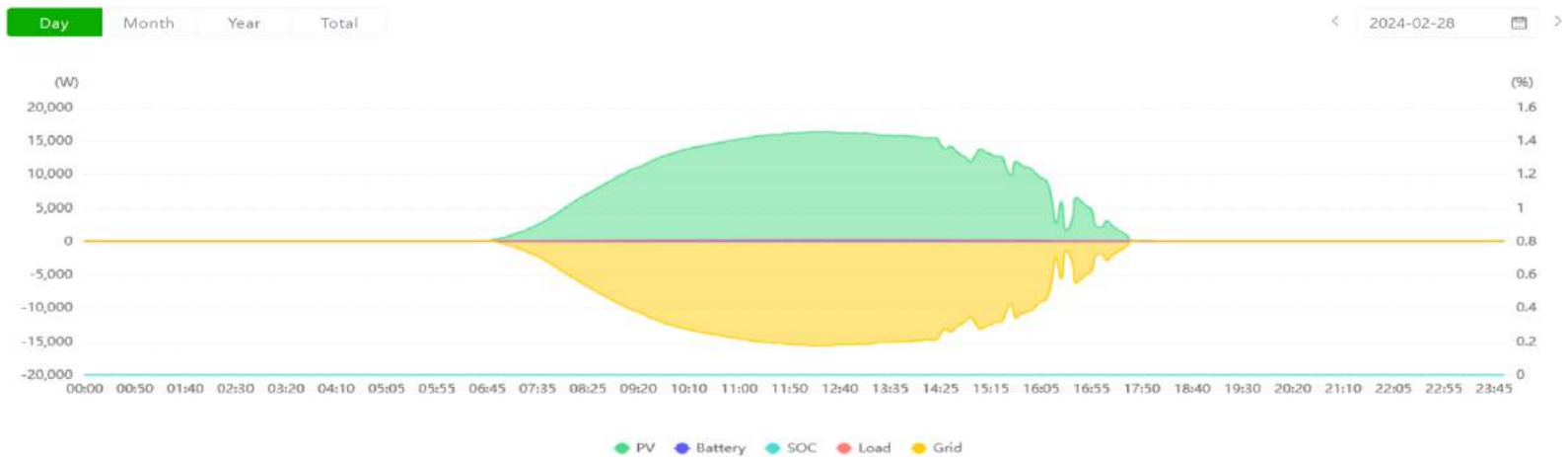
It is important to note that the Sol-Ark inverter **requires** a battery bank to curtail or limit the incoming DC solar power in any capacity. Without a battery, the Sol-Ark will act as a simple grid tie only inverter. It will not provide any back up power and many of the features are not applicable.

## Grid Sell

This work mode tells the inverter that it is allowed to sell solar power to the utility. **If the Sol-Ark does not have a battery, this should be the only work mode activated.** The Sol-Ark will allow as much solar power as possible to come in, and anything not used up by the home loads will get sold to the utility. When only the Grid Sell work mode is selected, all solar power that is pushed out of the GRID terminals of the inverter will be displayed as "sold" to the utility company. The Sol-Ark will behave like any other grid tie only inverter in this set up.

Below is an example of what a Sol-Ark with only PV panels and only the Grid Sell work mode selected can look like on our monitoring platform. Note with grid tie only inverters, the load readings will only be given for loads that are directly connected to the inverters LOAD terminals. The monitoring only works during the day time hours when PV is available to minimize parasitic power drainage. The inverter will record how much PV was brought in and how much power was pushed out of the inverters GRID terminals.

Energy Generation

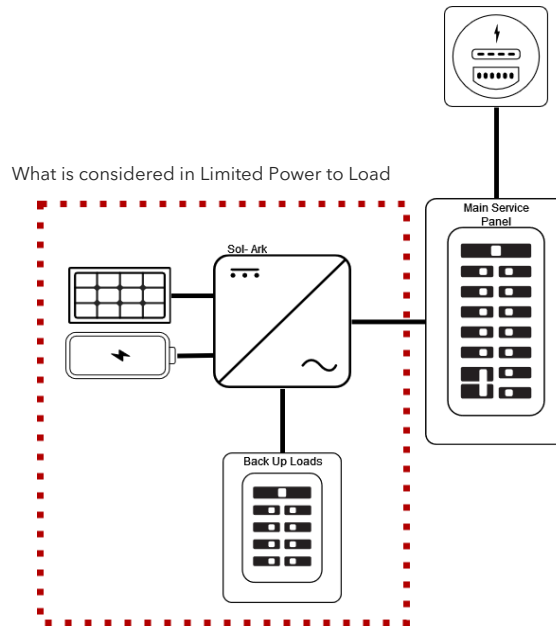


## Limited Power to Load

When Limited Power to Load is exclusively selected, the inverter will restrict incoming PV power to only charge the batteries and cover the appliances connected to the LOAD terminals of the Sol-Ark.

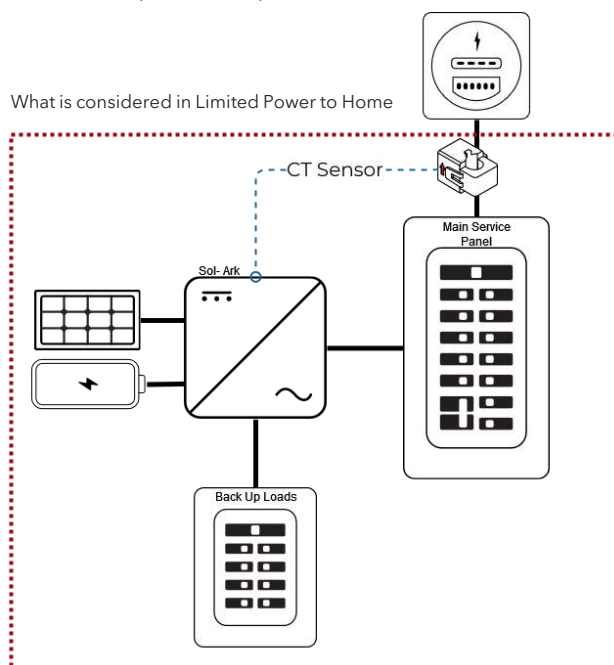
In other words, only the appliances that are backed up in the event of an outage will see solar power both on and off the grid. When the utility is active, the Sol-Ark will be able to rely on the utility to fill any gaps that solar is not able to provide, but no renewable power will be sold, and no power will be pushed out of the GRID terminal on the inverter.

When in Limited Power to Load, the inverter will only consider local readings in the data monitoring. For example, the Load value will only display the power that is leaving the LOAD terminal of the inverter. The Grid Value that is displayed may not reflect the total amount of utility usage on site, but instead reflects the grid power flowing through the inverters GRID terminals. **For this reason, Limited Power to Load is typically only recommended when the Sol-Ark is being used for a Whole Home Back Up.** This is where all the home appliances are attached to the LOAD terminals and there is no AC power source or load between the Sol-Ark GRID terminal and the utility meter. This is also the default work mode for any **completely OFF-Grid** system, as the inverter will only have access to appliances on the LOAD terminals anyway. Here is an example of what is considered in Limited Power to Load if you do not have a whole home back up.



## Limited Power to Home

When Limited Power to Home is selected, the system will take advantage of the externally placed Current Transformer (CT) sensors. Using the CT sensors, the inverter can determine the direction of power flow at the service entrance and capture the total power in and out of the property. This allows the Sol-Ark to offset **Non-Backed Up Loads** while the utility is still active without selling power to the utility company. Limited Power to Home can help reduce customer utility usage, without requiring the customer to purchase enough inverter and battery power to back up their entire home and without getting a net metering agreement from their utility company. During a utility outage the Back Up Loads panel is still the only panel to remain powered up from the Sol-Ark.



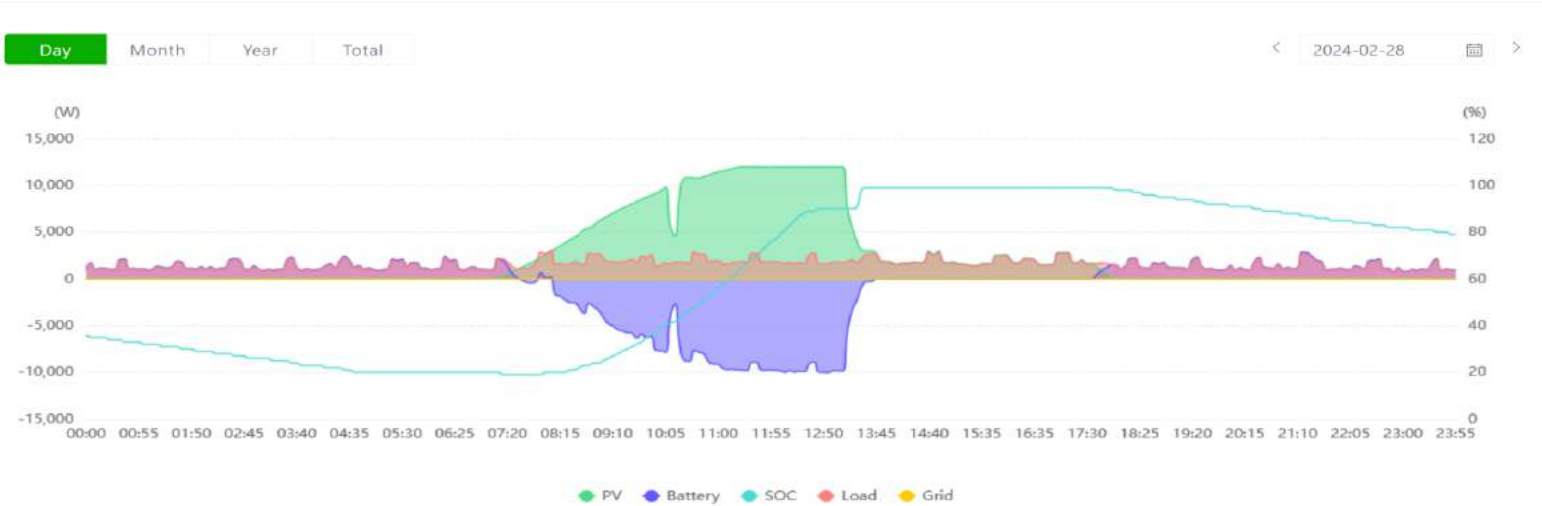
## Time of Use (TOU)

Time of Use can effect many features on the Sol-Ark inverter. Time of Use must be paired with either Limited Power to Home or Limited Power to Load and will be covered in more detail later. This section will explain the basics of how this work mode changes the Sol-Ark behavior.

The Time of Use work mode centers around controlling the battery usage in different states of operation. When TOU is **OFF**, the batteries will stay fully charged while utility power is available. The batteries will only discharge if utility power is lost and will keep the Back Up Loads Panel powered at night or whenever solar is not available.

When TOU is **ON** it allows the Sol-Ark to utilize the batteries even when grid power is still active, using battery power before resorting to paying for utility power. Below is an example of what the Energy Generation graph in our monitoring platform may look like with Time of Use enabled.

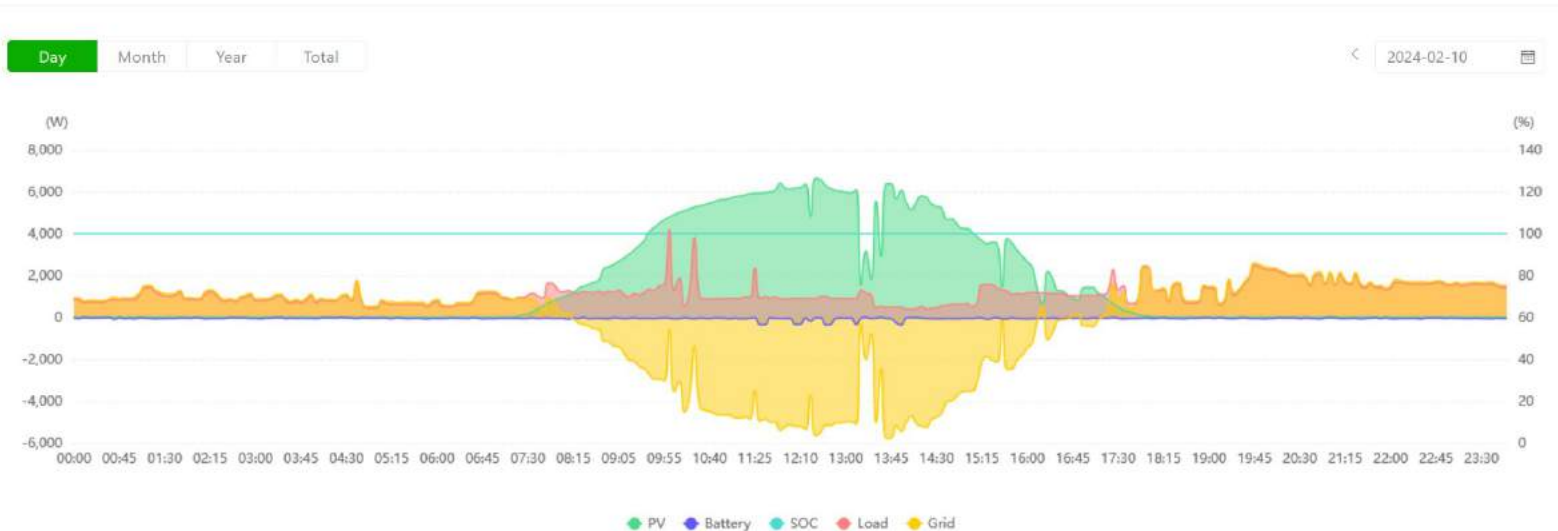
Energy Generation



Early in the morning the battery power is offsetting all of the loads. As the Sun comes up (around 7:30), PV power steps in to cover the loads and recharge the batteries. Once the batteries are full, the PV curtailed and only used to offset the loads (starting at around 13:45). That means this customer is not programmed to sell any excess solar power to the utility. Finally, as the Sun sets, battery power begins to take over the loads again. In this case grid usage is at an absolute minimum requiring the customer to buy the least amount of power from the utility company.

Another interesting example is what the graph may look like when the customer does have **Grid Sell** enabled, but they don't have **Time of Use** enabled. Essentially the opposite of the graph above. In the early morning hours, utility power covers all of the loads, but as soon as the PV panels start production (around 7:30), the Sol-Ark accepts all of the available power. The loads get covered first, and all the excess PV power get sold to the utility company. In the evening hours, as PV ramps down, the customer begins to use utility power again. (17:30).

Energy Generation

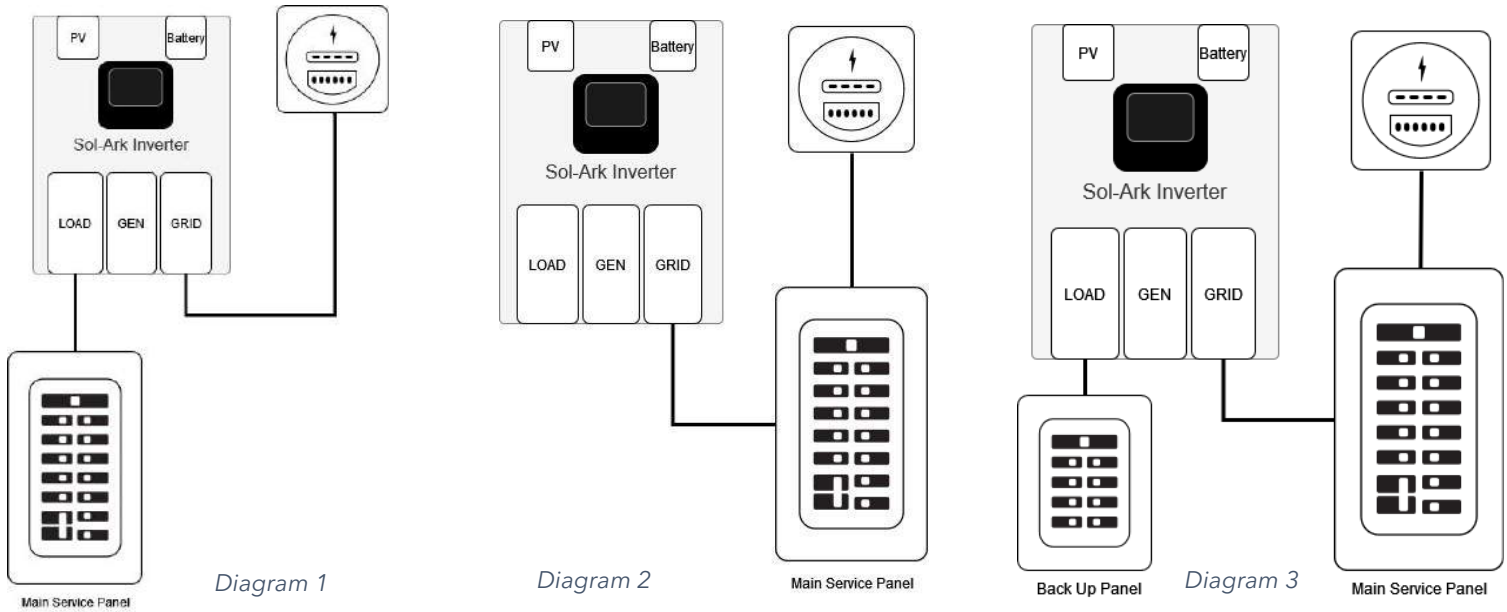


## 2. Visualizing and Programming

All Sol-Ark residential inverters, when paired with a battery, will provide Power to the LOAD terminals during a utility outage. However, often times programming the inverter on how to behave when utility power is still active is the most challenging part. This section will associate how the work modes will affect the Sol-Arks decisions on when and how to pull power from your PV and batteries. Each combination of System Work Modes will include a snapshot of what that work mode may look like on our monitoring app in an ideal case.

### Grid Tie Only - No batteries.

There are many configurations for grid tie-only systems, including systems that are grid tied only for now, but wired so that the customer can buy batteries in the future to get back up power (Diagram 1 or 3). **If there are no batteries, there will be no back up power during a utility outage.**



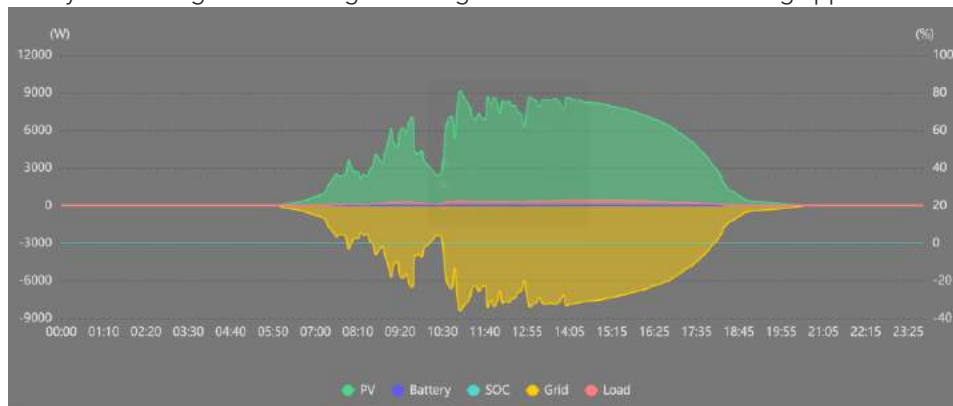
### Grid Sell

When operating a Sol-Ark without any batteries, select **only** the Grid Sell System Work Mode. The inverter can monitor how much DC PV is produced, how much PV is being pushed out of the Sol-Ark GRID terminal, and any appliances that are connected to the Sol-Ark Load terminals will be recorded as a load during daylight hours. When the sun goes down the Sol-Ark will cease reporting data to limit the amount of utility power it uses. The external CT sensors cannot be used without batteries, so any Solar Power that exits the GRID terminals of the Sol-Ark will be labeled as "sold" to the utility company in our monitoring platform. For [Diagram 1](#), this will yield a completely accurate Load and Grid selling reading.

For [Diagram 2](#) there will not be accurate grid sell readings as the Main Service Panel will use PV power that without the external CT sensors, the Sol-Ark cannot track. Additionally, because there is nothing connected to the LOAD terminals of the Sol-Ark, there will be no load readings at all on the monitoring app even during daylight hours. The monitoring will only accurately record the total incoming PV power.

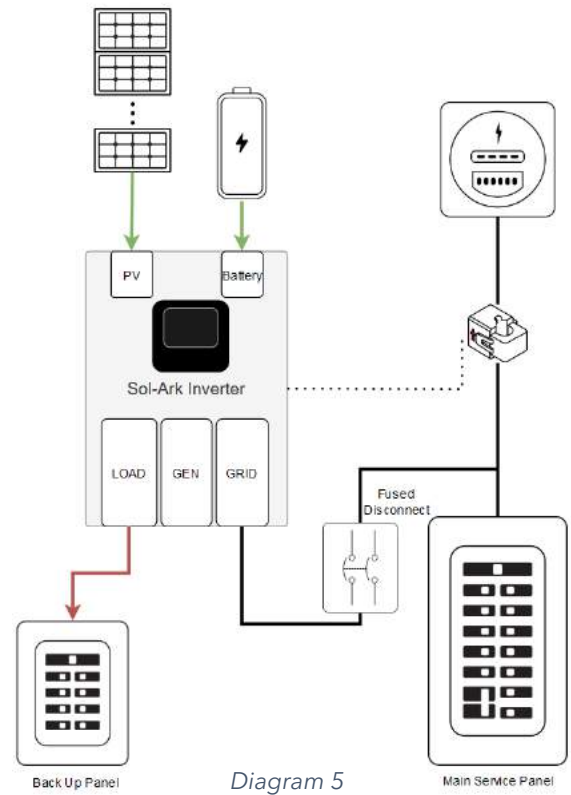
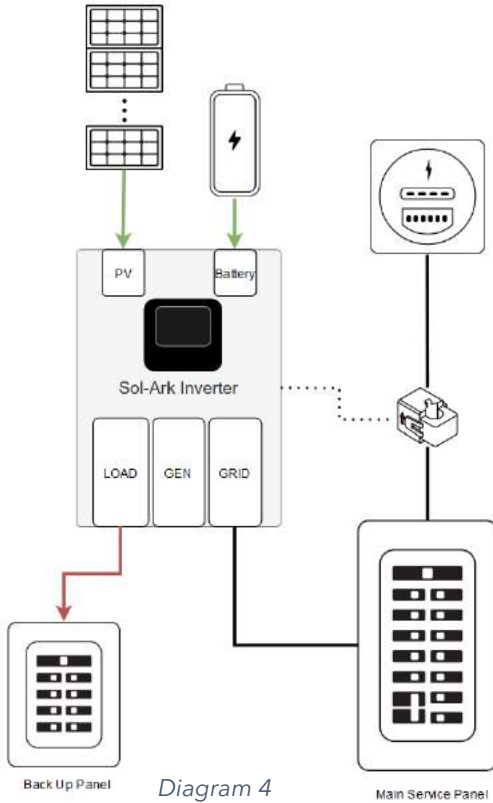
In [Diagram 3](#), the Sol-Ark can only determine how much power the "Back Up Panel" is using and will track this as a load during daylight hours in our monitoring app. The load reading in the app will not include usage in the Main Service Panel and any recorded PV power sold to the utility will only reflect PV power that was pushed out of the GRID terminals, not what actually reached the utility meter.

Here is an example of what a system configured like Diagram 1 might look like on our monitoring app.



# Installations that Utilize a Back Up Loads Panel

Many Sol-Ark users decide to only provide backup power to a certain portion of their appliances. When a backup panel is placed on the LOAD terminals of Sol-Ark that is separate from other panels/loads in the same electrical service, it is referred to it as a **Back Up Loads Panel**.



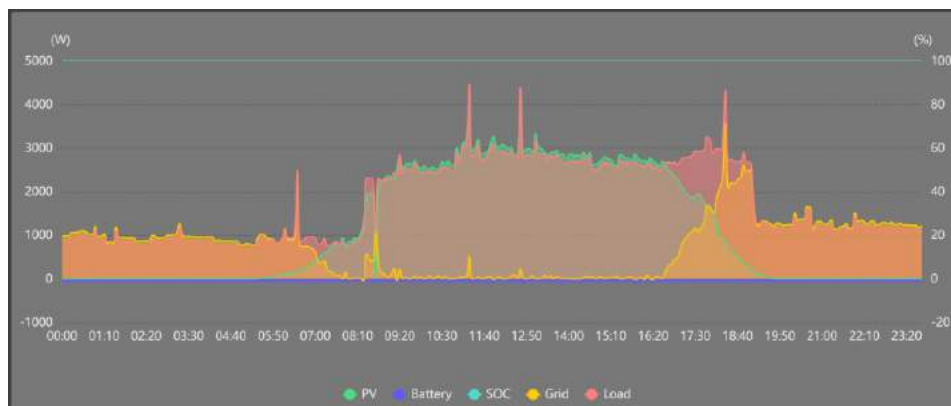
The two basic diagrams above are what a Back Up Loads Panel system might look like. In Diagram 4, the Sol-Ark inverter's GRID terminal would be connected directly to the utility through the main service panel and the LOAD terminals will go to the Back Up Panel. In Diagram 5, the Sol-Ark is configured for a Line Side connection. This is when the Sol-Arks GRID terminals are connected directly to the utility lines instead of through a breaker in the Main Service Panel. The LOAD terminals still go directly to the Back Up Panel. Functionally these diagrams are the same. In the event of an outage, the Sol-Ark will mechanically isolate from the main service panel or the utility lines and provide battery and solar power to the Back Up Loads Panel.

## Using Limited Power to Home

For all Sol-Ark systems that use the Back Up Panel configurations it is recommended to use Limited Power to Home so that the external CT sensors can be used to give accurate grid values and provide the customer with a load value that includes the Back Up Loads and the Main Service Panel Loads.

### Using Only Limited Power to Home

The batteries may charge up from PV power the first time the inverter is turned on. After the initial battery charge, they will rest at 100% or full voltage waiting to be used only when the utility power goes down. As the Sun rises, the Sol-Ark will only invert enough solar power to satisfy the Back Up Loads and the Main Service Panel loads. When the sun sets, the Sol-Ark will rely completely on the utility power to keep the all of the loads active in both service panels.



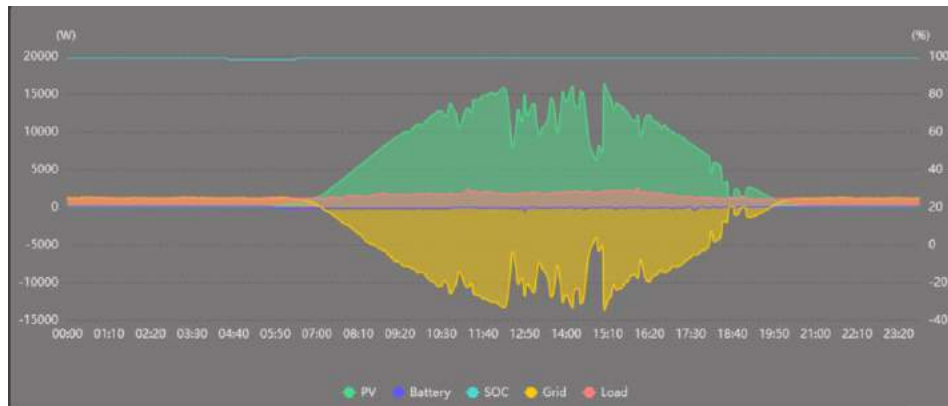
### Limited Power to Home with Time of Use

Limited Power to Home with TOU allows the batteries to discharge to cover the Back Up Loads and the Main Service Panel loads. The Sol-Ark will use PV power to offset the loads first. If there is not enough PV power, the Sol-ark will utilize the battery power to offset the loads. Finally, if both PV and battery power are not enough, the Sol-Ark will rely on the Utility power to cover the remaining power demand. How low the batteries discharge to, and how much power they are allowed to cover at a given time will be determined by the Time of Use table covered in section 3 of this guide.



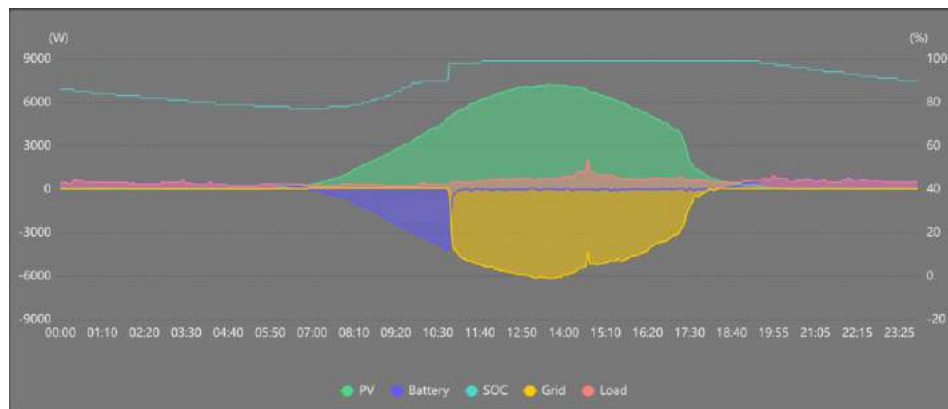
### Limited Power to Home with Grid Sell

The Sol-Ark will not inhibit the incoming PV power but will instead invert as much solar power as possible up to the inverter rating. The PV power will first go to the Back Up Loads panel, then any excess will be pushed out of the inverters GRID terminals where it will be used up by the loads in the Main Service Panel. Any remaining PV power after that will then go to the meter and sold to the utility. When PV power is not available, the Sol-Ark will rely on utility power to cover the loads.



### Limited Power to Home with Grid Sell and Time of Use (TOU)

The Sol-Ark will allow maximum PV power to be produced up to the inverter's rated output power. First the PV power will charge the batteries, then it will go to the Back Up Loads panel and the Main Service Panel. If there is excess PV power after offsetting all of the loads, it will be sold to the utility. If there is not enough PV power to cover any loads, TOU allows the batteries to step in and minimize grid usage. How far the batteries discharge and how much power they are allowed to cover will be determined by the Time of Use table. Finally if PV power and battery power can not keep up with the demand, utility power will cover any remaining power demand.





# Whole Home Back Up

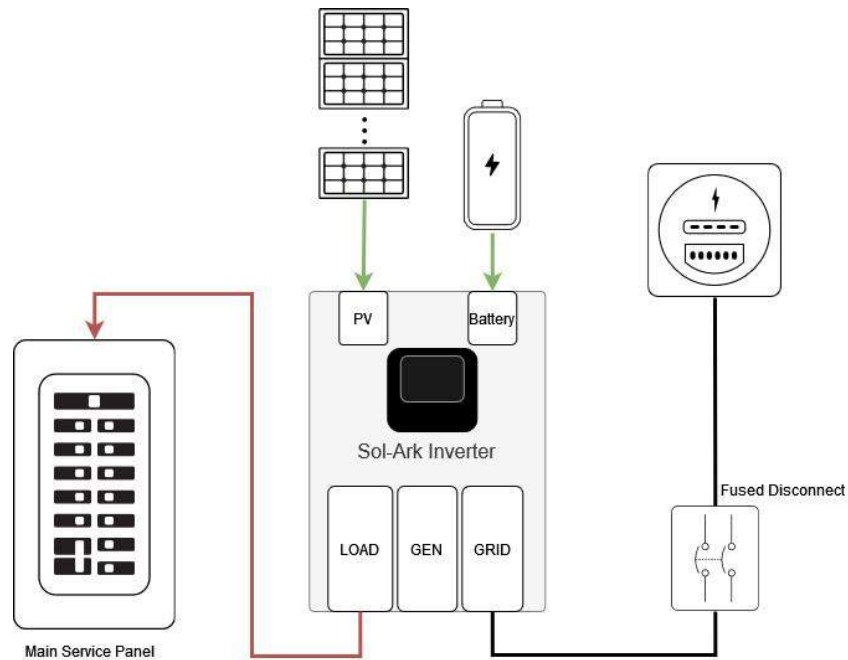


Diagram 6

Whole Home Backup applications are most often seen with the Sol-Ark 15K inverter, which was designed with this layout in mind. In Diagram 6, the Main Service Panel is the Back Up Loads panel. The utility meter is connected directly to the Sol-Ark GRID terminals. From there the Sol-Ark can supply solar, battery, and utility power to the entire Main Service Panel, through the inverters LOAD terminals. If there is a utility outage the entire Main Service Panel will have access to PV and battery back up power and the Sol-Ark will mechanically isolate itself from the utility lines.

## Using Limited Power to Load

For Whole Home Backup configurations it is recommended to use the Limited Power to Load system work mode. The Sol-Ark will not need to use the external CT sensors as the inverter can assume that all solar power leaving the GRID terminals is being sold, and everything going out to the LOAD terminals is for the total home load. The only exception would be parallel Sol-Ark installations, which is not covered in this guide.

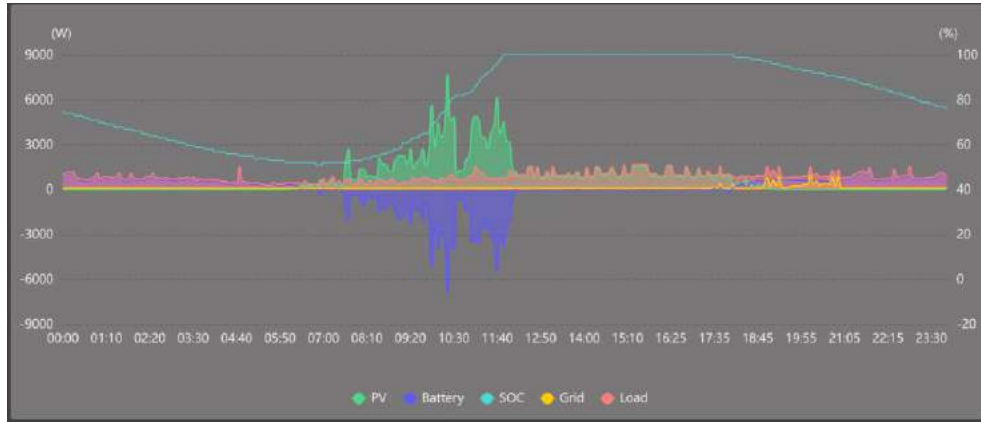
## Using Only Limited Power to Load

The batteries may charge up from PV the first time the inverter is powered on. After this initial charge the batteries will rest at 100% or full voltage. They will only discharge if there is a utility power outage. The incoming PV power will be limited to offset only the loads. PV power will never be sold to the utility. When PV power is not available or there is not enough to completely cover the loads, the Sol-Ark will rely on the utility company to power the remaining load demand.



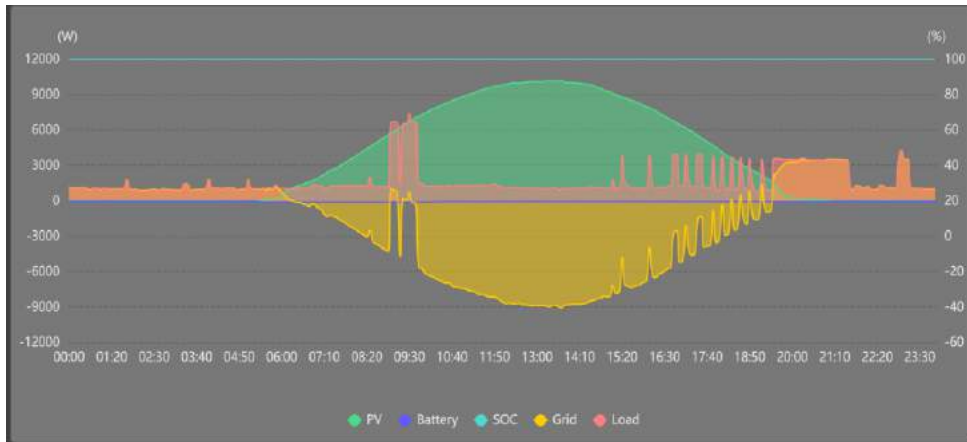
### Limited Power to Load With Time of Use (TOU)

Limited Power to Load with TOU allows the batteries to discharge to cover the loads even when utility power is available. The Sol-Ark will use PV power to charge the batteries and cover loads, but if PV Power alone cannot cover the loads or if no PV is available, battery power will step in before the grid power does. Finally, if both PV and batteries are not enough to completely offset the loads, the Sol-Ark will use the Utility power. How far the batteries discharge and how much power they are allowed to cover at any given time will be determined by the Time of Use table covered in section 3 of this guide.



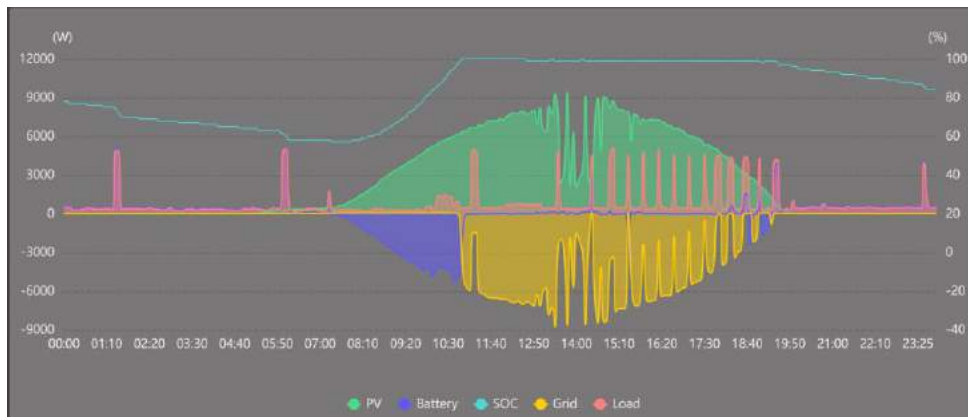
### Limited Power to Load with Grid Sell

The Sol-Ark will not inhibit the incoming PV power but will instead invert as much solar power as possible up to the inverter rating. The solar power will first go to the home loads, but any excess PV power will be pushed out of the inverter's GRID terminals to be sold. When the available PV power is not enough to cover the loads or the sun has set, the Sol-Ark will use utility power to power the home loads.

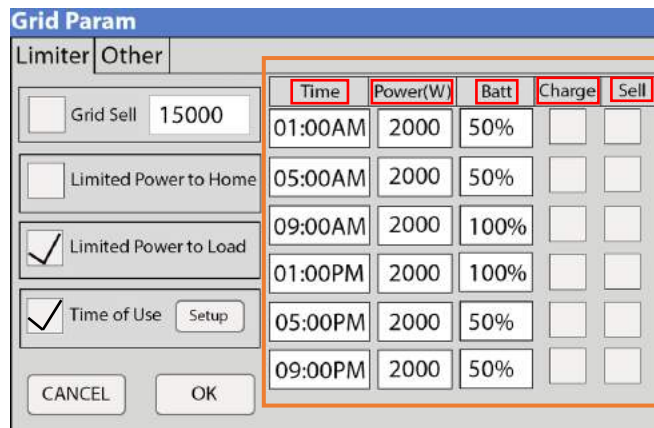


### Limited Power to Load with Grid Sell and Time of Use

The Sol-Ark will allow maximum PV power to be produced up to the inverters rated output power. First the solar power will charge the batteries if they need it and then it will go to the Main Service panel. If there is more PV power than there are loads to use it, the excess solar will be sold to the utility. Time of Use also allows the batteries to step in to cover loads if there is not enough PV power minimizing grid usage. How far the batteries discharge and how much power they are allowed to cover will be determined by the Time of Use table.



# 3. Programming Time of Use



The Time of Use Table can be found in the Limiter settings of the Sol-Ark, highlighted above in orange. The Time of Use Table has five distinct setting columns that correspond to six rows known as time slots. This chapter will break down the meanings of all five settings columns and how the inverter will implement the settings as the day progresses through the six time slots.

## Time

The Time column allows the user to adjust the starting point for each individual time slot. It is important to note that from top to bottom the time slots must be in sequential time. For example, in the picture above, Time Slot 1 starts at 1:00AM. This means starting at 1:00AM the inverter will follow all of the rules listed in that row. It will do so until 5:00AM when it will begin to follow the rules listed in the second row. For this reason, you cannot program out of order. Ex: 3:00AM in Time Slot 1 and 2:00AM in Time Slot 2. Incorrect programming will affect the inverter's logic. **Even if you only plan on discharging the batteries during 1 time period you still have to use and program all six time slots. Look in the Batt section of this chapter to see how to tell the batteries to not discharge during a specific time slot.**

## Power(W)

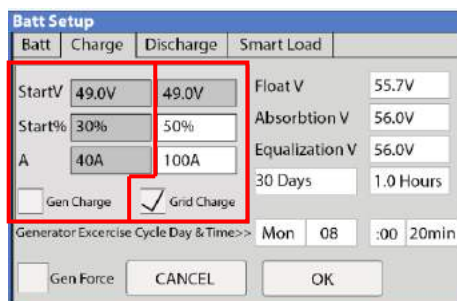
The Power(W) column dictates how many continuous AC watts the batteries are allowed to offset during that time slot. The inverter will use the batteries to cover any load that is at or lower than the programmed Power(W) value. The default value is 2000W, but the maximum value will depend on the model of the inverter and the batteries maximum discharge rate. As an example, assume there is no incoming PV power and 4000W is programmed as the Power (W) value in any given time slot. If there is a 2800W load, the Sol-Ark will offset all 2800W using the batteries. However, if a 6000W load comes on, the batteries will offset 4000W and the remaining 2000W will have to be covered by the utility. When Time of Use is activated, the inverter will prioritize using solar first, if there is not enough solar it will use the batteries, and finally the batteries reach programmed Power(W) limit, the Sol-Ark will rely on the grid to cover the remaining loads.

## Batt

Depending on if the Battery Settings in the Sol-Ark are configured for Voltage Mode or Percentage Mode, this column will display either voltage or percentage values. At the most basic level, this value dictates how low, in % or V, that the Sol-Ark is allowed discharge the batteries in order to offset the loads during that time slot. In the image above all the time slots that have 50% in the Batt Column with the Power(W) column set to 2000W will allow the batteries to cover up to 2000W of loads and will continue to do so until the batteries hit 50%. Then the inverter will stop using the batteries and only rely on PV power and the grid. To program a time slot to not discharge the batteries at all, simply program the Batt value to 100%, or to the batteries Float voltage value. **The meaning of this parameter changes depending on if Sol-Ark is charging the batteries from an AC source or not.** See the Charge selection below.

## Charge

The function of the Charge check boxes in TOU actually depend on settings in the Charge tab of Sol-Ark's the Battery settings. In the charge tab of the Battery settings, pictured below, the Grid Charge and Gen Charge check boxes tell the inverter it has permission to charge the batteries from an AC source coming from either the GRID or GEN terminals. It will only allow charging of the batteries once they reach the programmed **Start %** or **Start V** value. The **A** row dictates the maximum rate in DC amps the inverter is allowed to send to the batteries from the AC power source.



**When Time of Use is off**, the Grid and Gen charge starting parameters apply 24/7 and if the batteries reach the designated Start % or Start V the Sol-Ark will charge the batteries to near full from the designated AC source.

**When Time of Use is on**, the Grid Charge and Gen Charge starting parameters only apply in time periods where “Charge” check box is selected in the Time of Use Table. Additionally, when the batteries reach the Start % or Start V programmed for Grid or Gen charging, instead of automatically charging the batteries back up to near full, the inverter will only charge the batteries up to the Time of Use tables listed **Batt** percentage/voltage parameter for that time slot.

**If you have Time of Use and Gen Charge or Grid Charge selected together, you have to make sure the Start%/Start Voltage in the Battery Settings is lower than the “Batt” percentage/voltage programmed in the Time of Use table.** This is critical for programming but can be difficult to understand. In the next chapter there will be use cases that highlight how this works.

## Sell

The Sell check boxes tell the inverter that it is allowed to sell battery power to the utility. If 4000W is programmed in the Power (W) column with the sell check box selected in a Time Slot, the inverter will constantly push 4000W out from the batteries. When there is a 1500W load, then only 2500W gets sold to the utility. If there is a 6000W load, nothing gets sold to the utility company, but the inverter will still cover 4000W of the load while the grid contributes 2000W. **The Charge and the Sell Check boxes should never be selected in the same time slot.**

# 4. Time of Use - Common Applications

A majority of customers who plan on using Time of use fall under three specific categories. We will go over the applications, the programming, and how the inverters will behave under different grid conditions for all three common applications. Since batteries are required for Time of Use, assume all of the example systems below have a battery bank.

## On Grid with TOU - No AC Battery Charging

These customers have a Sol-Ark and use the batteries to offset their grid usage, however they don't have a generator connected to the system and they don't plan on using the grid to recharge their batteries. This means, if there is a long term grid outage, they are completely dependent on the Solar power to be able to cover loads and charge their batteries enough to get them through the night. Since the functionality here is at its simplest, the programming is also the most straight forward. Let's look at the example below.

The image shows two screenshots from a device's settings menu. The left screenshot, titled 'Grid Param', shows the 'Other' tab with a table of Time of Use settings. The right screenshot, titled 'Batt Setup', shows the 'Charge' tab with various battery parameters.

Time	Power(W)	Batt	Charge	Sell
01:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
05:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
09:00AM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
01:00PM	2000	100%	<input type="checkbox"/>	<input type="checkbox"/>
05:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
09:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>

StartV	49.0V	49.0V	Float V	55.7V
Start%	30%	30%	Absorbtion V	56.0V
A	40A	40A	Equalization V	56.0V
Gen Charge	<input type="checkbox"/>	Grid Charge	30 Days	1.0 Hours
Generator Exercise Cycle Day & Time>>	Mon	08	:00	20min

Limiter Settings: Example 1

Battery Settings - Charge Tab: Example 1

Looking at the Limiter Settings, this customer can Grid Sell any extra solar power to the utility. They are also in Limited Power to Home, which usually indicates there is a non-backed up panel in the same service as the Sol-Ark and the inverter will be using the external CT sensors to calculate loads and give accurate grid sell readings. Time of Use is enabled and when paired with Limited Power to Home the inverter is able to use battery power to offset the Back Up Loads and any Non-Backed Up Loads covered by the CT sensors. The Time of Use table has none of the Charge boxes selected preventing any Grid or Gen Charge sequences from starting. In the Battery Settings, the Charge tab shows that neither "Grid Charge" or "Gen Charge" is selected. Meaning that no charging of the battery from an AC source is allowed, even if Time of Use was turned off.

**While on grid**, the Sol-Ark will let the batteries cover up to 2000W worth of loads between the Backed Up and Non-Backed Up Loads panels until the batteries reach 50% state of charge. This applies during all hours except for 9:00AM to 5:00PM where the batteries are not allowed to be lower than 100%. This means if the batteries are below 100% PV will give priority to charging the batteries up. If there is excess PV from battery charging or if the batteries are full, that excess PV will be used to offset the loads. If the loads are then satisfied and there is still excess PV the remaining PV will be sold to the utility company.

**When Off Grid**, the inverter will rely completely on battery and PV power to keep the loads going. In this case Time of Use has no effect on off grid operation. There is no generator to control, meaning there is no possible AC charging. The inverter will try to keep the loads running as long as possible and drain the batteries down to the Shutdown percentage or voltage if necessary.

## Always Off Grid with TOU and AC Battery Charging

Most people who are completely off grid will not need Time of Use as the system will automatically discharge and use the batteries when a utility source is not detected. Many off grid customers will use an emergency generator during periods of limited sun to keep their batteries going until the next good solar day. If they are okay with letting the generator take the batteries to nearly full then they do not need Time of Use, but if they would like to have the generator stop charging the batteries once they reach a specific setpoint, they must enable Time of Use.

Grid Param						
Limiter	Other	Time	Power(W)	Batt	Charge	Sell
<input type="checkbox"/>	Grid Sell 15000	01:00AM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Limited Power to Home	05:00AM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Limited Power to Load	09:00AM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Time of Use <input type="button" value="Setup"/>	01:00PM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
		05:00PM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
		09:00PM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Limiter Settings: Example 3

Looking at the Limiter settings, the inverter is in Limited Power to Load so there are no external CT sensors in use. Grid sell is disabled as there is no utility to sell solar power to. Time of Use is on with all the charge boxes selected, and the "Batt" parameters for each time slot is set to 50%.

Batt Setup					
Batt	Charge	Discharge	Smart Load		
StartV	49.0V	49.0V	Float V	55.7V	
Start%	30%	30%	Absorbtion V	56.0V	
A	40A	40A	Equalization V	56.0V	
<input checked="" type="checkbox"/>	Gen Charge	<input type="checkbox"/>	30 Days	1.0 Hours	
<input type="checkbox"/>	Grid Charge				
Generator Exercise Cycle Day & Time>>>			Mon	08	:00 20min
<input type="checkbox"/>	Gen Force	<input type="button" value="CANCEL"/>	<input type="button" value="OK"/>		

Battery Settings - Charge Tab: Example 3

The Charge Tab of the Battery settings shows that Gen Charge has been enabled and the Start % has been set to 30%. This tells us the customer has a generator connected to the GEN terminal of the inverter and that they want the generator to activate and charge the batteries if they ever reach 30% SOC. A is set to 40A DC which dictates the maximum battery charge rate from the generator.

In this configuration the Sol-Ark will use solar and battery power to cover loads as long as possible. Since all the Time of Use charge check boxes are selected, the Sol-Ark has permission to use the generator to charge the batteries any time that they reach 30% SOC. The 50% "Batt" values in each time slot tell the inverter that if it needs to start charging the batteries, it is only allowed to charge them up to 50% SOC and not the default near full value it would normally go to. If a Gen Charge sequence is started, once the batteries hit 50% SOC the Sol-Ark will stop charging the batteries from the generator, disconnect from the generator, and if two wire start is attached to the Sol-Ark, it will also shut the generator off.

*If the customer does not have two wire start connected to the Sol-Ark it is up to them to start and stop the generator.*

## On Grid TOU - GEN/GRID AC charging of batteries.

These customers want to use their batteries to offset loads, but they also want to be able to charge the batteries back up from an AC source if it is needed. They either want the generator to be able to charge the batteries back up during a long term utility outage, or they want to use the grid to charge the batteries up if have discharged to a certain low setpoint. Often times this is to prepare for a sequential utility outage. This is one of the most complex configurations because there are so many variables that affect functionality. This example only covers one of the many types of scenarios customers may require, but it will cover the overall logic the Sol-Ark will go through.

### Grid Param

Other

Time	Power(W)	Batt	Charge	Sell
01:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
05:00AM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>
09:00AM	2000	100%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
01:00PM	2000	100%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
05:00PM	2000	50%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
09:00PM	2000	50%	<input type="checkbox"/>	<input type="checkbox"/>

Grid Sell: 15000

Limited Power to Home:

Limited Power to Load:

Time of Use:  Setup

CANCEL OK

### Batt Setup

Batt	Charge	Discharge	Smart Load
StartV	49.0V	49.0V	Float V: 55.7V
Start%	30%	30%	Absorbion V: 56.0V
A	40A	40A	Equalization V: 56.0V
<input checked="" type="checkbox"/> Gen Charge <input type="checkbox"/> Grid Charge		30 Days: 1.0 Hours	
Generator Exercise Cycle Day & Time: Mon 08 :00 20min			
<input type="checkbox"/> Gen Force		CANCEL OK	

Limiter Settings: Example 2

Battery Settings - Charge Tab: Example 2

Looking at the Limiter settings the customer has Grid Sell checked so they can sell excess solar power to the utility and because they are in Limited Power to Load, they are not using the external CT sensors for readings. This means the inverter will only consider the LOAD terminal usage for the load readings in the monitoring app and anything leaving the GRID terminals of the inverter will be considered in the monitoring as "sold the grid". Time of Use is enabled and when paired with Limited Power to Load the inverter will only use the batteries to cover the appliances connected to the LOAD terminal of the inverter.

This customer will also be attempting to charge the batteries from an AC source in certain situations. Let's look at Charge Tab of the Battery settings. The "Gen Charge" check box is selected, so if the utility is down, the inverter is allowed to use a generator to charge the batteries when they hit 30% State of Charge. **Note that if the grid is connected to the Sol-Ark, it cannot use the generator to charge the batteries.** The Sol-Ark can only sync to one external AC power source at a time, and the inverter will always prioritize connecting to the utility over a generator.

Looking at the Time of Use Table in the Limiter settings, only three of the "Charge" check boxes are selected. This means the Gen Charge settings only apply for these three time slots. In this example it will cover the time period between 9AM to 9PM. **If the batteries reach 30% state of charge outside of this time period, no AC charging from the generator will occur. If the charging process starts at 8:50PM, the Sol-Ark will start and continue to charge the batteries through the next time slot.** Once a charging process is started, it will always finish following the rules of the time slot that it started under.

Of the three time slots that have the Charge Box selected, the 9AM and the 1PM time slots have the "Batt" parameter set to 100%, while the 5PM time slot has the "Batt" parameter set to 50%. While utility power is active and the battery is not charging from an AC source, the "Batt" parameter determines how low the battery is allowed to get to offset AC loads. However, if the battery **is** charging from an AC source this "Batt" parameter determines how high the Sol-Ark is allowed to charge the battery from that AC source.

For the 9AM and 1PM time slots, if the batteries ever reach 30% during a utility outage, generator charging is initiated, and the Sol-Ark will charge the batteries up to 100%. For the 5PM Time slot, if there is a utility outage and the generator charging is initiated, the Sol-Ark will only charge the batteries up to 50% and then stop charging. **This behavior means if Time of Use is used with Gen Charge or Grid charge, the Start%/Start Voltage in the Battery Settings must be lower than the "Batt" percentage/voltage programmed in the Time of Use table.** This rule only applies for time slots that have the Charge box selected in Time of Use.

**While On Grid,** the Sol-Ark utilizes PV power to charge batteries, cover loads, and then will sell excess PV power. When PV power is low, the Sol-Ark will cover up to 2000W of the loads until the batteries reach 50% and the utility will cover the rest. The batteries will only offset loads during the Time of Use time slots where the Batt parameter is programmed to 50% (9PM -9AM). During the times where the Batt Parmeter is at 100% (9am -9pm), the batteries will never discharge and if there is not enough PV power available, the utility will completely cover the loads.

**While Off Grid**, the Sol-Ark will utilize PV and battery power to cover all the loads. If the batteries hit the programmed GEN Start percentage of 30% between 9AM and 9PM the generator will turn on and charge the batteries up.

If the batteries hit 30% between the hours of 9AM to 5PM, the Sol-Ark will use the generator to charge the batteries all the way to 100% as that is what the Time of Use "Batt" value is programmed to during these times. If the batteries hit 30% in between the hours of 5PM-9PM, the Sol-Ark will only charge the batteries up to 50%. If the batteries hit 30% during any other time period nothing will happen since the charge check box is not enabled.

Version	Author	Date	Details	Extra notes
VER 2	Carlos Zapata	06/24/2024	-	-