1. General Scenarios

In the market there are two main categories for residential battery storage systems. One is that photovoltaic and photovoltaic inverters have been installed in the early stage. With the rise of energy storage, it is planned to install new battery storage systems to be used in conjunction with existing photovoltaic systems; the other is a new installation of photovoltaic and battery storage systems.

Scenario	Residential Power System	Homes with PV installed			Homes to install PV & battery storage	
		PV Installed (DC) （kWp）	Inverter Size （kW）		Planned PV installation （kWp）	
1	3-phase	20	15	Plan to add battery storage on top of installed PV	20	Plan to install both PV & battery storage at the same time
2	3-phase	13	10		13	
3	3-phase	10	10		10	
4	3-phase	6	5		6	
5	1-phase	13	10		13	
6	1-phase	10	8		10	
7	1-phase	6	5		6	

2. Solutions for homes with PV installed already and plan to add battery storage systems

For this kind of home application scenarios, in view of the existing grid-connected photovoltaic inverters, and considering compatibility issues, the AC coupling scheme is used to achieve adding battery storage on top of installed PV.

- **Single-phase AC coupling scenario**

  Since the series battery module is designed with a maximum charge and discharge current of 75A which matches the actual maximum current on the single phase PCS battery side. For large-capacity photovoltaic scenarios, parallel PCS applications need to be considered to avoid photovoltaic waste. (If PV solar energy can be back fed to the grid to sell electricity and the household load is not high enough, paralleling is not necessary)

  1) The power rating of the battery storage PCS can be less than that of the photovoltaic inverter, considering the load of the home;

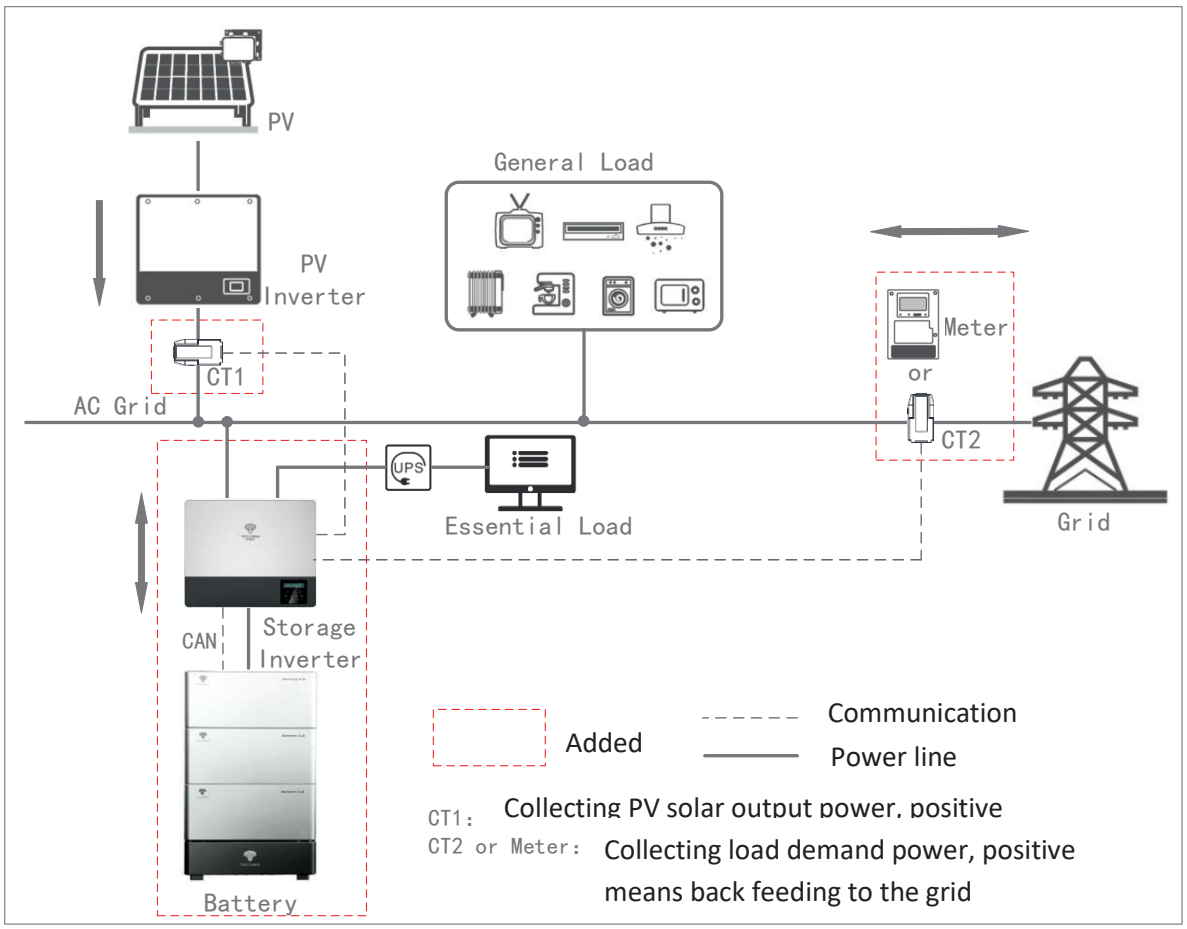
  2) considering the backup power, the battery storage energy capacity should be configured as minimum two hours of full power charge of the battery storage PCS;

  (to be specific, it should be decided by the household load)

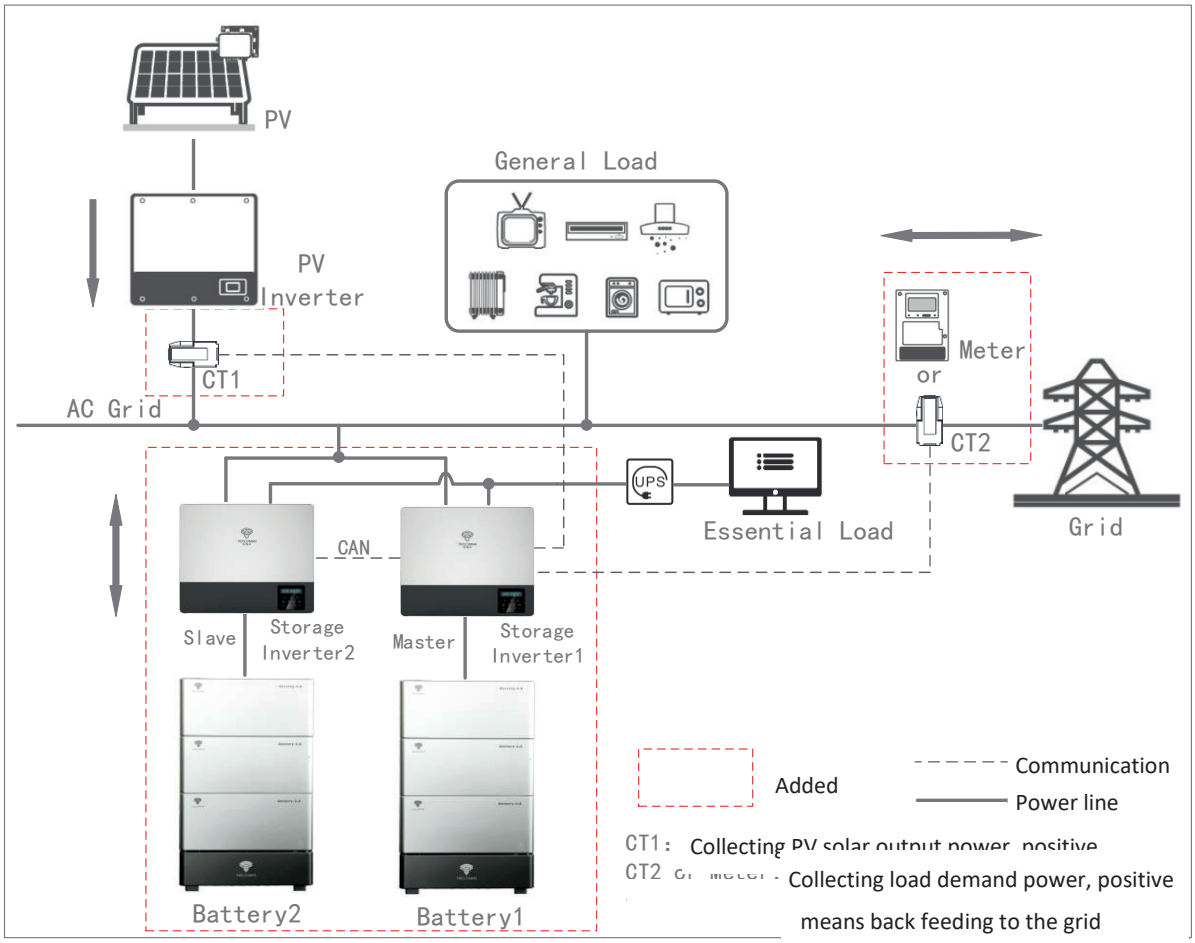
- Below are some configuration suggestions:

Residential Power System	Homes with PV installed				
	PV installed (DC) （kWp）	Inverter Size (AC) （kW）	Battery PCS to be added	Battery to be added	Note
1-phase	6	5	3.6k ACS （maximum AC output power 3.6kW）	7.2K (51.2V/7.2kWh)	one set of battery storage system
1-phase	10	8	3.6k ACS （maximum AC output power 3.6kW）	10.8K (51.2V/10.8kWh)	one set of battery storage system with bigger battery capacity for longer backup hours
1-phase	13	10	3.6k ACS*2 （maximum AC output power 7.2kW）	7.2K*2 (51.2V/14.4kWh)	two sets of battery storage system in parallel

- Single line diagram for 1-phase with one set of battery storage system



- Single line diagram for 1-phase with two sets of battery storage system



- Working principle

  from the power readings of CT1 and CT2 or Meter, the household load can be calculated. Through charging or discharging PV solar energy into or from the added battery storage system, the household can reduce its energy usage from the grid thereby reduce its electricity bills.

  1) If $P_{grid} > 0$, it means that $P_{pv} > P_{load}$ and the photovoltaic solar power generation is sufficient. After the household load is supplied, the surplus energy can be stored in the battery through the PCS. If the battery is full, extra energy can be fed into the grid to sell electricity.

  2) If $P_{grid} < 0$, it means that $P_{pv} < P_{load}$ and photovoltaic solar power generation is not enough to supply the household load, and the insufficient part can be released from the battery storage system to supplement the household electricity. If it is still insufficient, the utility power can be used.

  3) In the event of a mains power outage, the energy stored in the battery can be released through the PCS for essential household load.

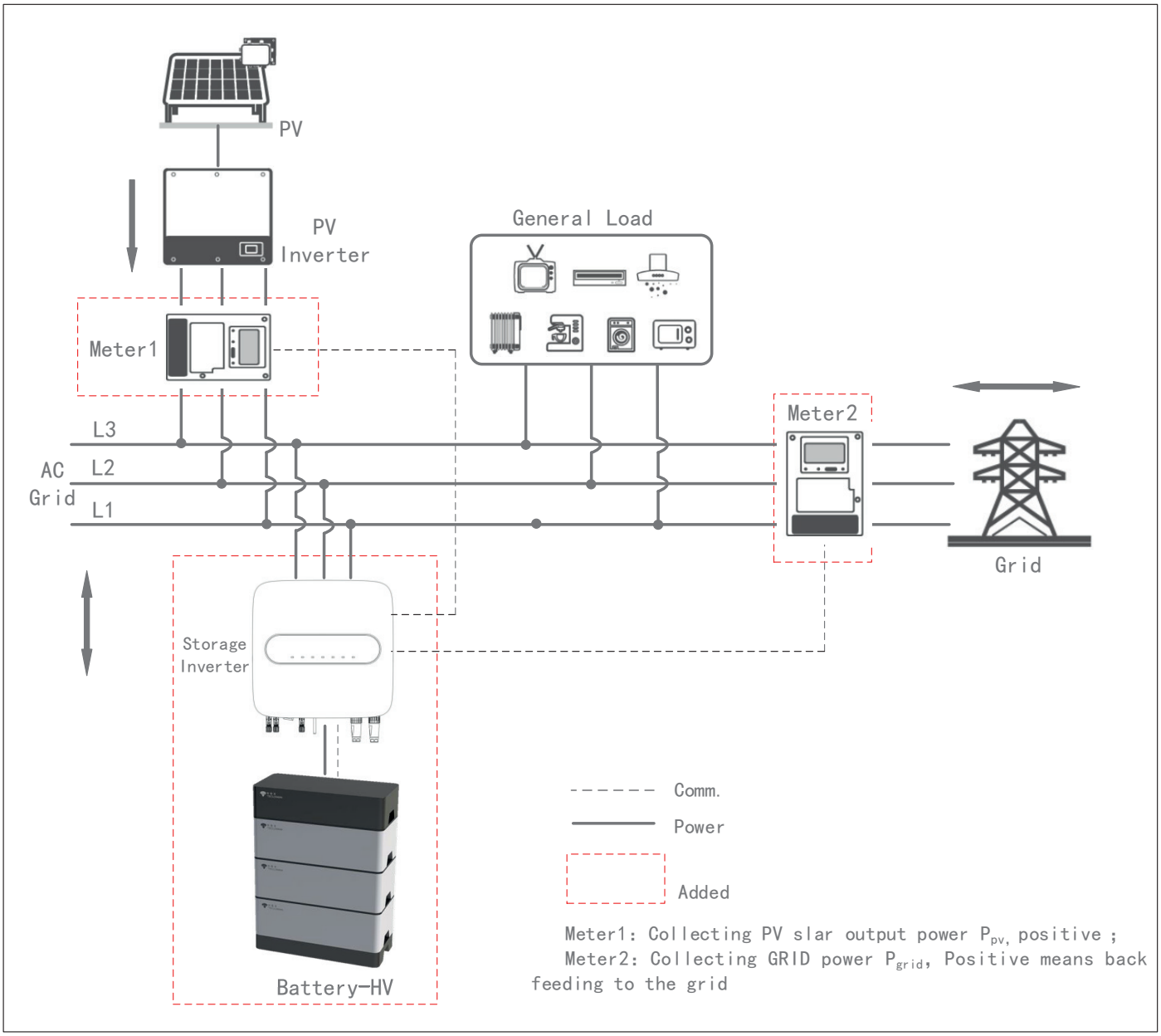
➢ **Three-phase AC coupling scenario**

There are currently no three-phase battery storage converters that can work with Tecloman's low-voltage battery storage system in the market. Currently, the 3.6k ACS PCS does not support the use of three phase operation. We recommend the use of high-voltage battery storage systems which are under development and will work with three phase converters.

- Below are some configuration recommendations:

Residential Power System	Homes with PV installed				
	PV installed (DC) （kWp）	Inverter Size (AC) （kW）	Battery PCS to be added	Battery to be added	Note
3-phase	6	5	SPA 4000TL 3BH （Maximum AC output power 4kW）	HV-4 （204.8V/15.36KWh）	one set of high-voltage battery storage system
3-phase	10	10	SPA 6000TL3 BH (Maximum AC output power 6kW）	HV-5 （256V/19.2KWh）	one set of high-voltage battery storage system
3-phase	13	10	SPA 6000TL3 BH (Maximum AC output power 6kW）	HV-5 （256V/19.2KWh）	one set of high-voltage battery storage system
3-phase	20	15	SPA 8000TL3 BH (Maximum AC output power 8kW）	HV-7 （358.4V/26.88KWh）	one set of high-voltage battery storage system

- circuit diagram for 3-phase with one set of battery storage system



- Working principle

The same as single phase scenarios above.

3. Solutions for homes to install PV solar and battery storage systems at the same time

For homes to install PV and battery storage system at the same time, considering system cost and efficiency, hybrid inverters are recommended. The hybrid inverters can be connected to photovoltaic and battery at the same time and has its own power collection function on the photovoltaic and battery side. Only power data from grid needs to be collected to make the battery storage system work.

- **Single-phase scenario**

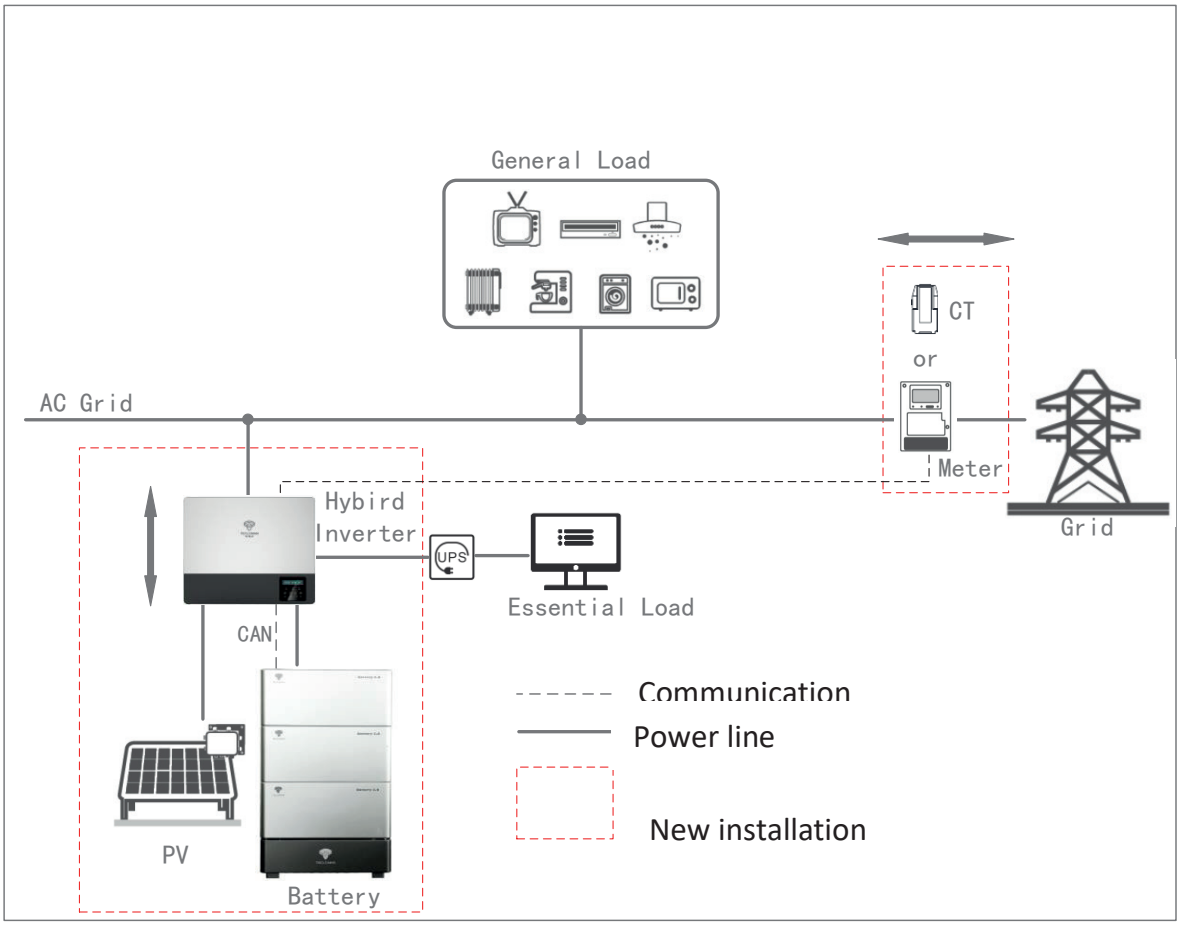
  for this hybrid inverter photovoltaic solar can be connected to a maximum of 8kW; therefore, the power of the energy storage side and the PV side power are limited. For large-capacity photovoltaic scenarios, parallel applications need to be considered to avoid photovoltaic waste.

  (If PV solar energy can be back fed to the grid to sell electricity and the household load is not high enough, paralleling is not necessary)

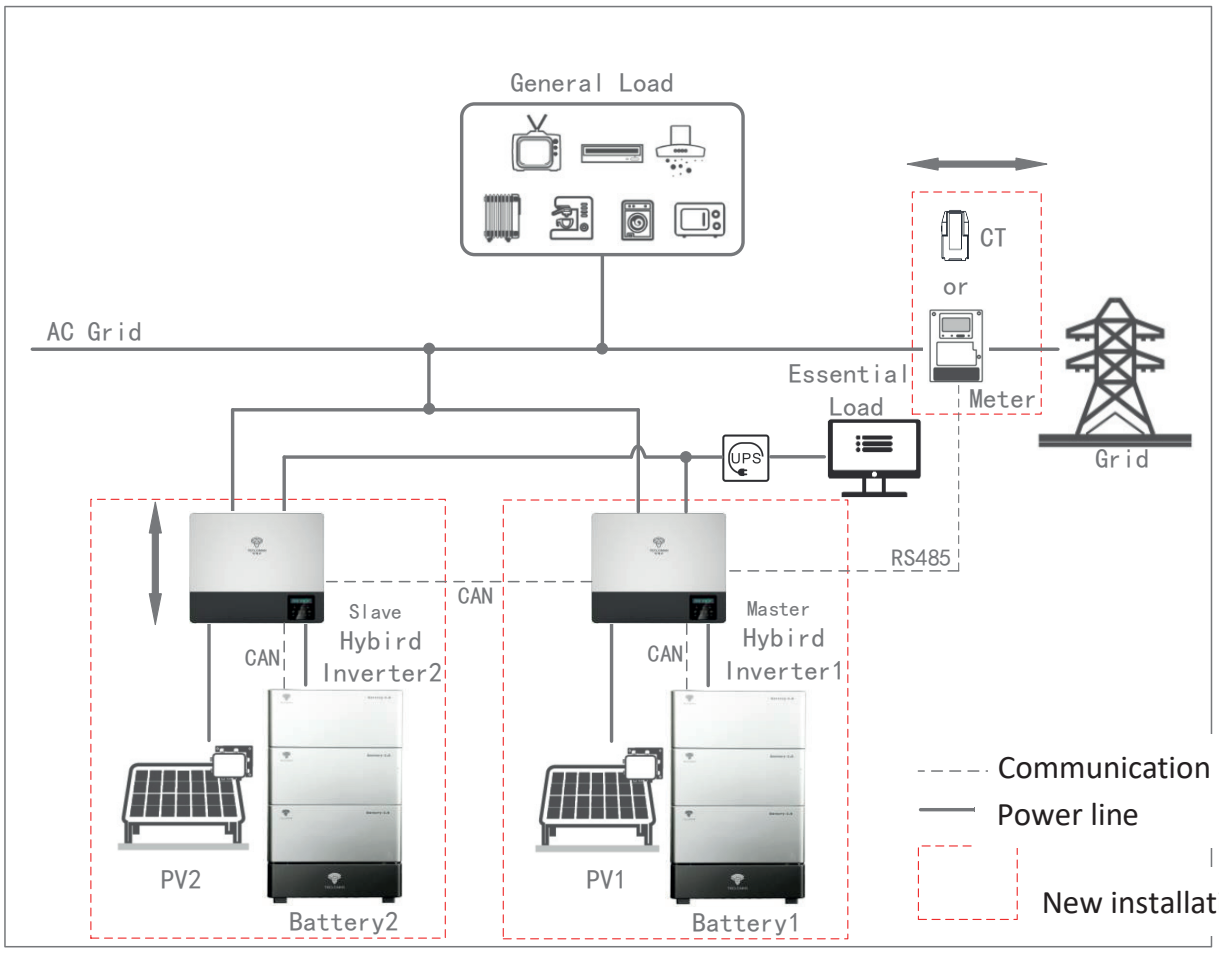
- Below are some configuration suggestions:

Residential Power System	Homes to install PV & battery storage			
	PV to be installed (DC)（kWp）	**Hybrid inverter to be installed**	**Battery to be added**	**Note**
1-phase	6	5K Hybrid（AC output maximum 5kW,PV solar maximum 6kW DC, battery DC input maximum 3.6kW）	7.2K（7.2kWh or bigger）	one set of battery storage system
1-phase	10	5K Hybrid（AC output maximum 5kW,PV solar maximum 8kW DC, battery DC input maximum 3.6kW）	10.8K（10.8kWh or bigger）	one set of battery storage system with bigger battery capacity for longer backup hours
1-phase	13	5K Hybrid*2（AC output maximum 10kW,PV solar maximum 13kW DC, battery DC input maximum 7.2kW）	7.2K*2（14.4kWh or bigger）	two sets of battery storage system in parallel

- Single line diagram for 1-phase with one set of battery storage system



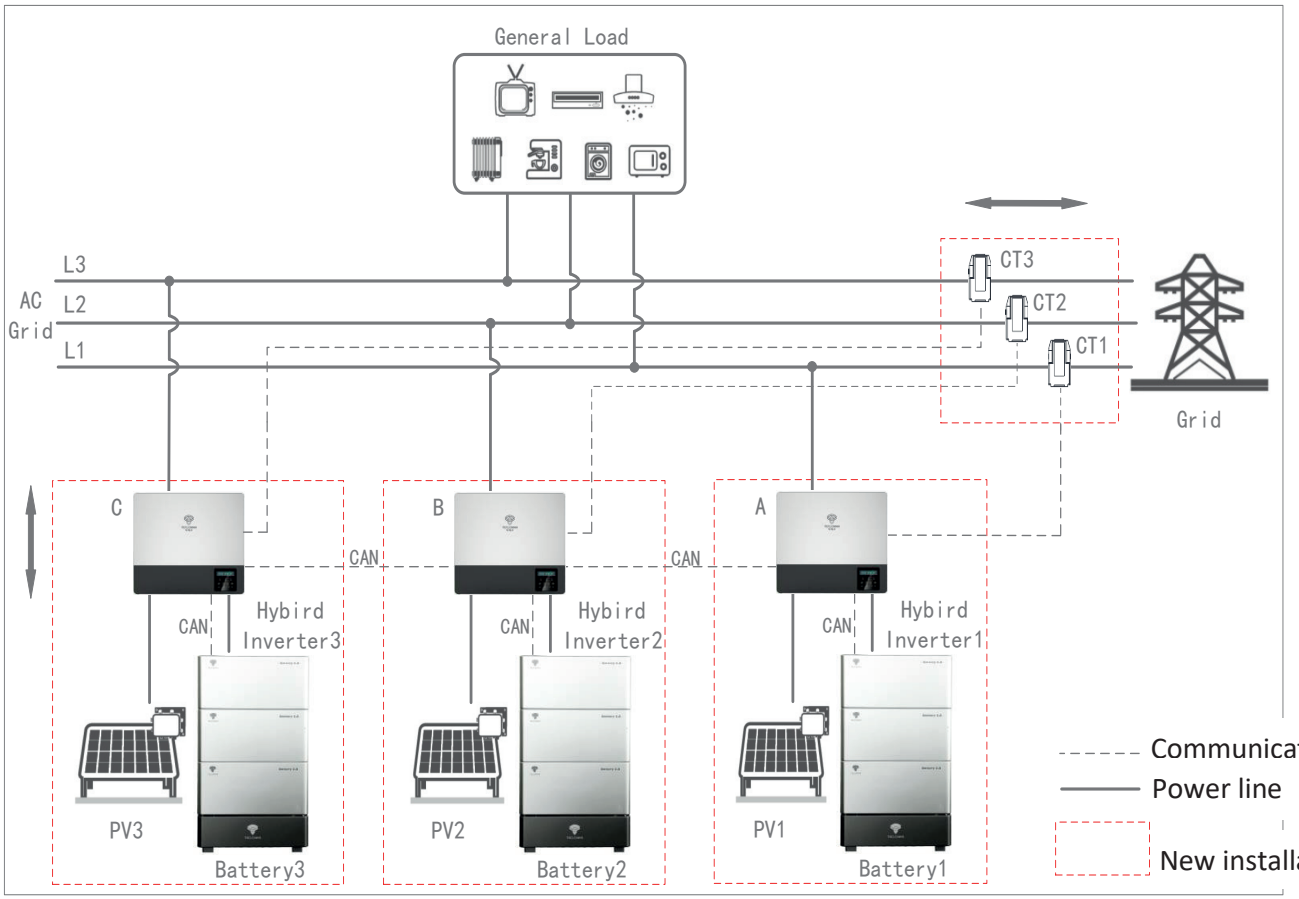
- Single line diagram for 1-phase with 2 sets of battery storage system



- Below are some configuration suggestions:

Residential Power System	Homes to install PV & battery storage			
	PV to be installed (DC) （kWp）	Hybrid inverter to be installed	Battery to be added	Note
3-phase	6	3k Hybrid*3 （each phase：AC output maximum 3kW，Solar input 2kW，battery maximum power1.8kW）	3.6K*3 （10.8kWh）	3 sets of single phase hybrid inverter to form a three phase hybrid inverter
3-phase	10	3k Hybrid*3 （each phase：AC output maximum 3kW，Solar input 3.3kW，battery maximum power 3.6kW）	7.2K*3 （21.6kWh）	3 sets of single phase hybrid inverter to form a three phase hybrid inverter
3-phase	13	5K Hybrid*3 （each phase：AC output maximum 5 kW，Solar input 4.3kW，battery maximum power 3.6kW）	7.2K*3 （21.6kWh）	3 sets of single phase hybrid inverter to form a three phase hybrid inverter
3-phase	20	5K Hybrid*3 （each phase：AC output maximum 5 kW，Solar input 6.7 kW，battery maximum power 3.6kW）	10.8K*3 （32.4kWh）	3 sets of single phase hybrid inverter to form a three phase hybrid inverter

- circuit diagram for 3-phase with 3 sets of battery storage system


General Load
L3
AC
Grid
L2
L1
CT3
CT2
CT1
Grid
C
B
A
CAN
CAN
CAN
CAN
CAN
CAN
Hybird
Inverter3
Hybird
Inverter2
Hybird
Inverter1
PV3
PV2
PV1
Battery3
Battery2
Battery1
Communicatio
Power line
New installation