**CLEAN ENERGY ADVISORY # 2**

# Solar+Storage

## What is "Solar+Storage"?

Solar+Storage is a new way of thinking about rooftop solar photovoltaic (PV) electricity systems. It is different from either off-grid solar or grid-tied solar. It is a rooftop solar-plus-storage system that regards the grid as a back up to the home rather than the reverse (*i.e,* as a home battery to back-up grid power). It is sometimes also referred to as "Battery–Grid Backup," "Grid Backup Solar," or "Grid Zero."

*Solar+Storage* is not the same as "off grid" because by using the grid as a backup power supply, the batteries can be downsized to make them relatively economical. Solar+Storage has the benefit of providing electricity when the grid goes down, but it is not intended to provide full ongoing power. It is intended to provide ongoing partial power, or to power "protected" loads.

## Why use this *Solar+Storage* system?

The typical home follows the one-third/two-thirds rule: one third of the electricity is used during the day and two thirds is used at night. This means the during the day, solar systems are over-producing, yet the house must draw grid power at night to function. Solar+Storage allows the house to capture all or a portion of the daytime overproduction and feed it to the home's electrical system at night. This can allow the home to avoid selling power back to the grid, as in a net metering system, when the grid may not need it.

A Solar+Storage system can be configured to sell power to the grid at any time, as with conventional net metering, but its real goal is to protect the full retail value of the kWhs produced by the solar system. Storage will become very important as net metering tariffs are changed to reduce customer sell-back rates or as time-of-use rates and/or demand charges are introduced. In the near future net metering will likely become more restricted or simply not offered at all by some utilities. [1]

Solar+Storage systems offer the additional benefit that they can provide some level of continuing power to the house when the grid is down. If the homeowner wants more nighttime capacity they can increase the battery size.

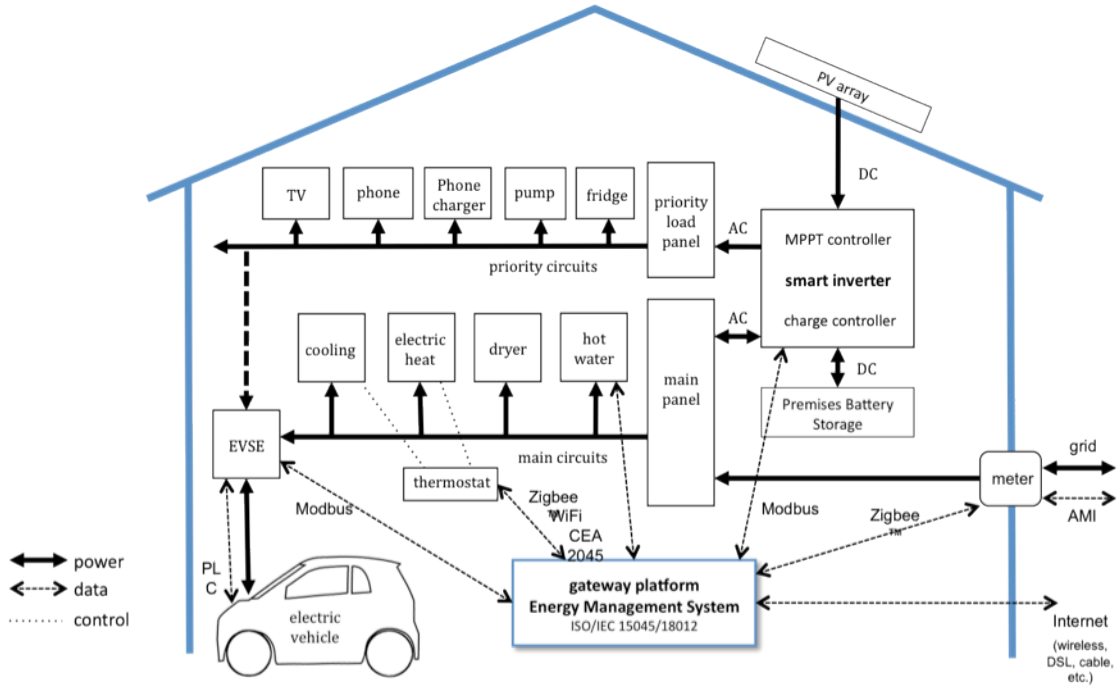
## What is needed for a system?

- Solar array
- Inverter/charger
- Battery
- Charge controller
- Auxiliary or priority-loads electrical distribution sub-panel
- Energy management system (optional)

[1] In any case, net metering is not really the best solution for the long-term future of the electricity system. Net metering does not discriminate about when power is drawn from or fed to the local grid and thus it can lead to over-production and make grid stabilization more difficult.

A conventional net-metering system consists of only the solar array and inverter. In such systems, all the solar production is made available to be used by the house through its electrical panel, with any excess then sold to the grid through the net meter. In the event of a grid failure, the solar production is not available to be used by the house and is simply wasted.

Previous to *Solar+Storage*, only off-grid systems included the additional items shown above to use the solar power in the event of grid failure. Most solar installer/dealers are not selling these kinds of systems yet… but all will be soon.




**Solar+Storage System Architecture**

**How does this system work?**

The house solar PV produces more power that the house needs during the day so the system stores as much as possible in the battery (before selling it back to the grid, if net metering is used). Then, during the evening and night, the system draws from the battery rather than buying from the grid. The system includes a separate "priority loads panel"[2] that separates certain circuits in the house to receive power if the grid goes down.

The sizing of the battery and the separation of circuits or appliances are highly dependent on the lifestyle of the resident and on the kinds of appliances or electrical usage found in a particular household. The system is not intended to support the entire house, although this is a cost-benefit trade-off. Another factor would be whether the system is set up to do net metering or not. The system can be set up to never feed power to the grid or to only do so at certain times (*e.g.*, in the

[2] The "priority" load panel separates circuits that are to be supported in the event of a grid failure.

case of time-of-use rates) or under certain Conditions. Some battery inverters already have this feature programmed into them.

Typically the system might be designed for about 4 to 12 kW of solar production and possibly about the same battery capacity. The priority loads might typically include some lighting, TV, computer, phone chargers, refrigeration, a well pump, non-electric heating, some outlets and possibly an electric vehicle charger. Low priority would be given to air conditioning (operate during the day only), electric heating, space cooling-oriented fans, clothes dryer, hot tub, pool pump, and other non-essential equipment. In a larger system, some priority might be given to electric hot water heater, cook stove, or dryer.

**Are these systems available?**

Yes, and they are being installed throughout the United States and the world. Solar system installations are very specific to the site and need to be configured by professional installers in order to make sure the various components are properly matched. The components include:

*Solar array*

Solar panels are widely available and the price is improving rapidly. Installations include attachments such as solar modules (PV panels), racking, ground mounts, wiring to a junction box (or combiner box), a rapid disconnect switch, then to the inverter and battery.

*Inverter*

Some appropriate "smart" inverters (*e.g.,* Schneider *Conext XW*™ series, SMA *Sunny Island*™, *Transverter*™) are widely available, although not all inverters used in either grid-tied net meter or off-grid systems are well suited. The best are inverters that can draw power from DC sources (e.g., batteries, solar panels, etc.) and also serve as battery chargers. These new generation inverters can also help the loca grid by providing voltage and frequency stabilization, power factor compensation and grid-disconnect features (*e.g.,* compliant with IEEE/UL 1547 "anti-islanding" standards).

*Battery*

Batteries are becoming more available and improving in price. An installation would include a battery box and peripherals such as venting mechanism if needed. In case of wet cell batteries, a distilled watering system to refill cells is might be desirable.

Conventional lead-acid batteries are widely available and quite mature. Nickel-Iron and Nickel-Zinc are also established technologies and offer some advantages over Lead-Acid batteries in terms of lifetime and charge cycling. These are a being installed by some solar installer/dealers, particularly those specializing in off-grid applications. Lithium-Iron Phosphate batteries offer many advantages and are also becoming available. Lithium-ion batteries (commonly used in cars, computers, and phones) are developing rapidly and may be feasible in the near future for home use, though discharge rates in current versions are different than the typical home's usage requirement.

*Charge controller*

Charge controllers are widely available. They are devices that optimize the output of solar panels using a technique called MPPT (maximum power point tracking). They also can monitor battery conditions and work with an inverter to optimize the charging of batteries. Battery

charging methods are very specific to the type of battery being used. A battery capacity monitoring device is commonly used.

*Priority load panel*

Priority load panels (also called "critical" or "protected" load panels) require some significant installation work by an electrician. This consists of a circuit breaker panel/sub-panel that separates certain circuits in the house to receive preference over others in the event of a grid outage.

*Energy management system (optional)*

Energy management systems (EMS) are electronic controllers that are very new and specialized at this point. These devices can manage and balance electrical use among various appliances in the house according to the needs of the resident. They will become more available as appliance manufacturers begin to offer more "smart" appliances that can communicate with the EMS systems.

In the future, EMS devices will also be able to coordinate the home with external grid conditions such as demand response protocols, variable rate structures (e.g., time-of-use (ToU) electricity rates, demand rates, critical peak pricing, transactive energy (TE) protocols and tariffs, etc.) and control of "smart" appliances according to user interfaces of various kinds (e.g., smart thermostats, mobile phones, etc.).

**Conclusion**

Solar+Storage is already cost competitive in many retail electricity markets globally. Deutsche Bank projects that it will become a $5 trillion market by 2030 and will displace large amounts of fossil fuels. They call it "…the next killer app that could significantly accelerate global solar penetration…"

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