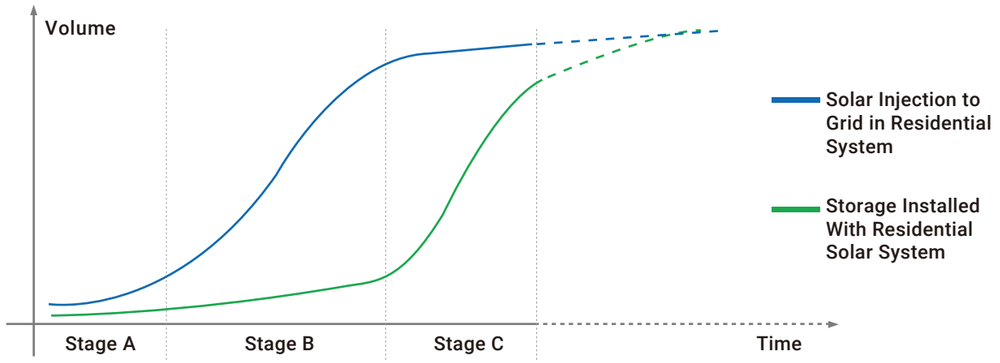
CHASING SMARTER SOLAR ENERGY

Energy Management in Storage System

—— Jack.Song

If we take a look at the history of photovoltaic development we can see a clear trend. Storage is catching up with pure solar installations in residential application scenarios and is projected to take the lead in this decade.

Generally speaking, the development of the PV industry can be broadly categorized in three different stages. The table below illustrates the early adoption of solar, storage and shows the tipping point that triggers the onset of Energy Management System. In this article we will explore the applications and developments of the latter (EMS) and their implications for the future of the industry.



Stage A: Initial Development - slow but steady adoption of solar tech

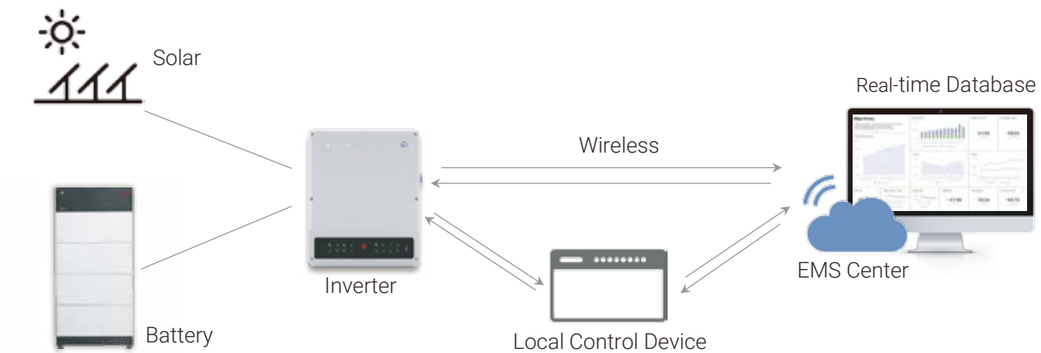
This applies to areas at the very early stage of development. In most examples this would take us back a few decades, when photovoltaic was still a relatively new idea and the cost was extremely high.

Stage B: Rise of Solar – Birth of Storage

As solar systems drop in price and become widely adopted, solar installations increase quickly. Power demand increases quickly and there is continuous financial support for FIT from governments. Storage increases slowly as battery costs are still very high at this stage.

Stage C: The Tipping Point – Energy Management

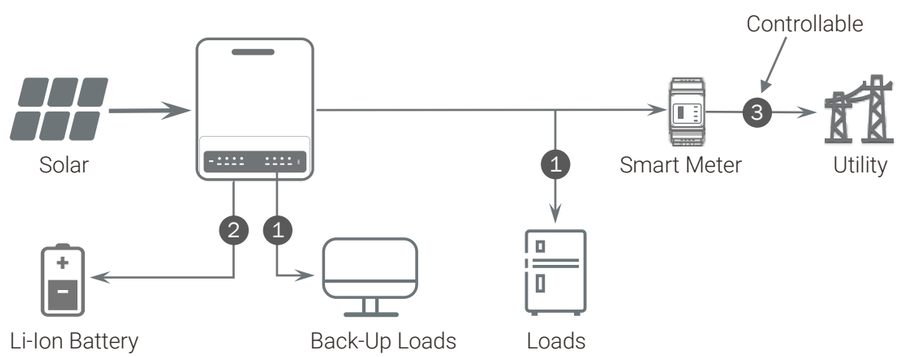
Solar installations develop so quickly that the stress on power transmission infrastructures reaches the limit. FIT support, as a result, drops. Under this background, residential storage and anti-reverse solutions are widely adopted to manage power injections and increase self-use of solar power. As a result, smarter and utility-friendly energy management systems gain in popularity; VPP, micro-grid system, frequency control, and also the methods in a specific market like FCAS service in Australia, RCR control in Germany, HEMS system in Japan and IEEE2030.5 requirement in USA market etc.



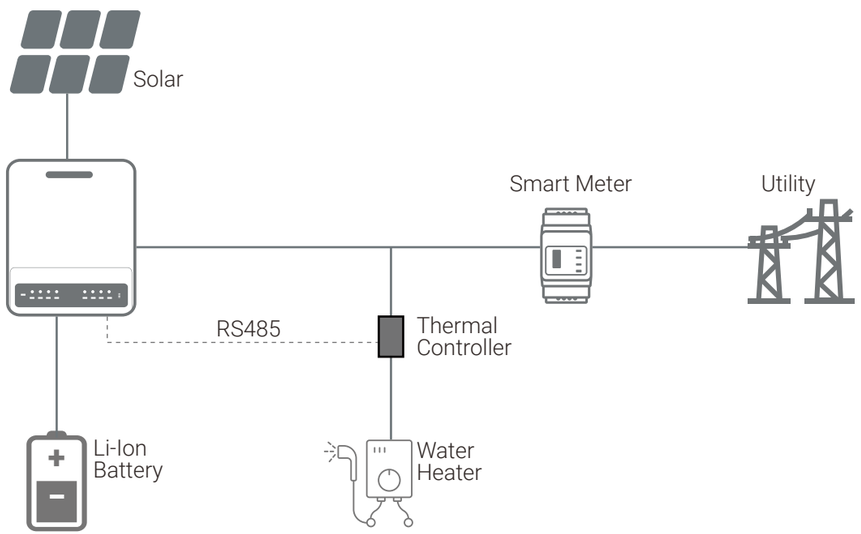
In an energy management system, the EMS center follows a real-time database to create dynamic control strategies, designed to cater for energy storage systems through wireless communication or local control devices. They also collect real-time data of energy production systems for further and more precise management logics.

MANAGEMENT IN A SINGLE STORAGE SYSTEM

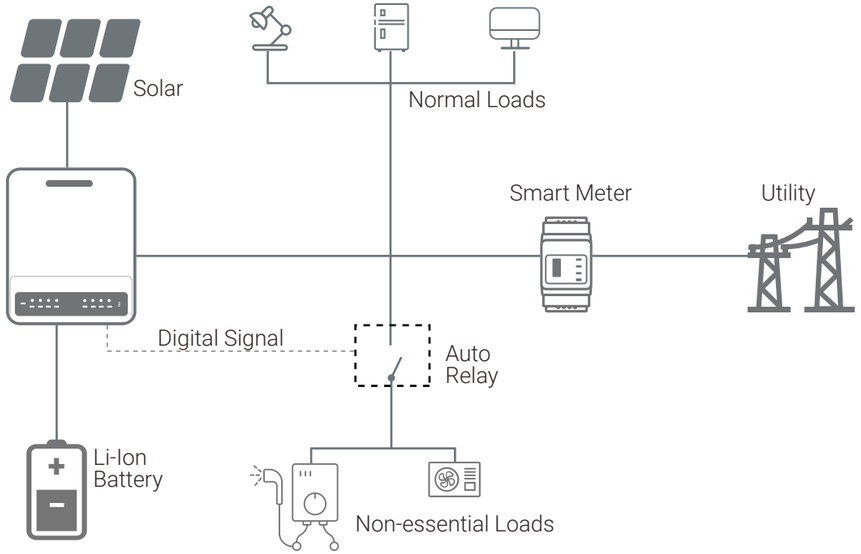
It is fairly simple to adopt an energy management strategy in a single storage system, as energy storage systems usually realize smart energy control logic, by which solar power prioritizes load consumption and stores excess energy in the battery. Export to grid is the last option if the battery is fully charged.



So in a single system, the smart energy management system is usually there to respond to load controlling or residential load shifting. A typical method is to shut down or start up specific loads (high-power but not essential loads) by controlling an external relay via DO port or work with specific load management devices such as thermal controller, solar pump or heat irradiator etc. to save on bills.



Solar + Thermal Management System Example



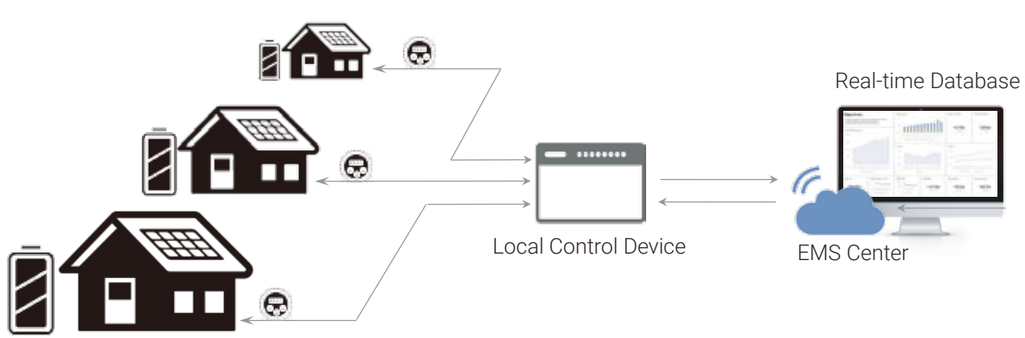
Load Management System Example

Load management system is an easier way to realize house load shifting. It requires an inverter and an external relay, a digital output ability to execute non-essential load cut-off or reconnection based on preset time range or meter power.

Thermal control systems are able to adjust heating power based on real-time solar and battery power supply ability or timing control. Communication with controllers can be connected directly to the inverter by MODBUS, SUNSPEC or other protocol. Alternatively, an external EMS controller is adopted between the inverter and the thermal controller.

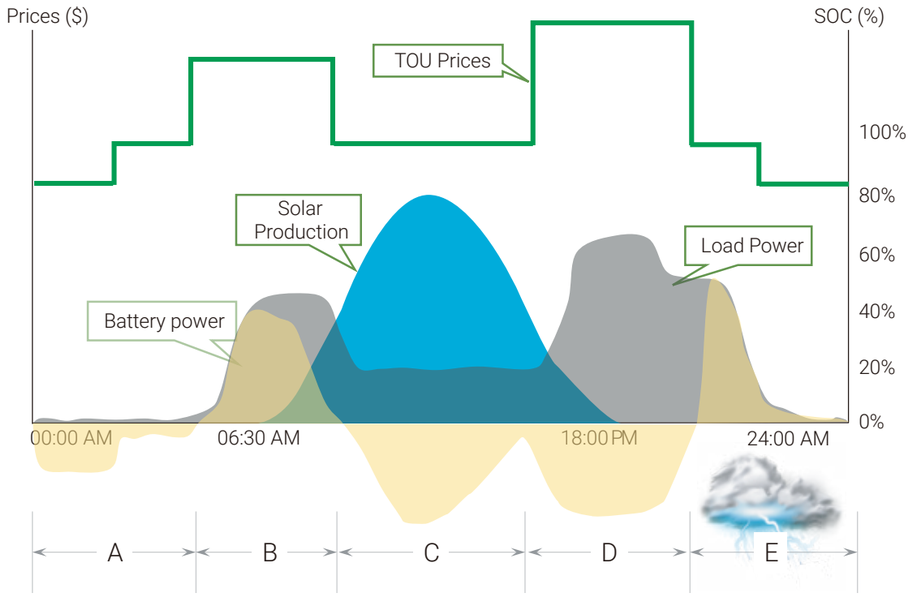
COMMUNITY MANAGEMENT OF MULTIPLE INSTALLATIONS

It is often built up as a community VPP system or regional energy optimization plan. It can be set up by governments, grid companies, or big investors or contractors to both save electricity bills and ease utility stress. Storage is adopted to regulate regional grid frequency or shave peak demand.
Community-level management systems can be set up for centralized or distributed installations.



Community Energy Management Based on Distributed Installations

Solar storage systems with energy management is being encouraged to optimize solar energy usage and keep utility systems healthy. In Australia, FCAS (Frequency Control Ancillary Services) is currently the leader in incentivizing this development. In Europe, RCR function is strongly required by German. Here we also see clear policies to support community VPP systems in Spain as well as Italian market.



Storage System Operation Example with Smart Controlling

A: Battery charge with lower-price electricity, ready for peak-demand time. Charge power is smartly controlled based on TOU prices

B: During peak demand time, battery, instead of utility, is used to support loads.

C: Excess solar power charges battery for peak-demand use.

D: Storm is coming - battery is kept fully charged and reserved for backup use.

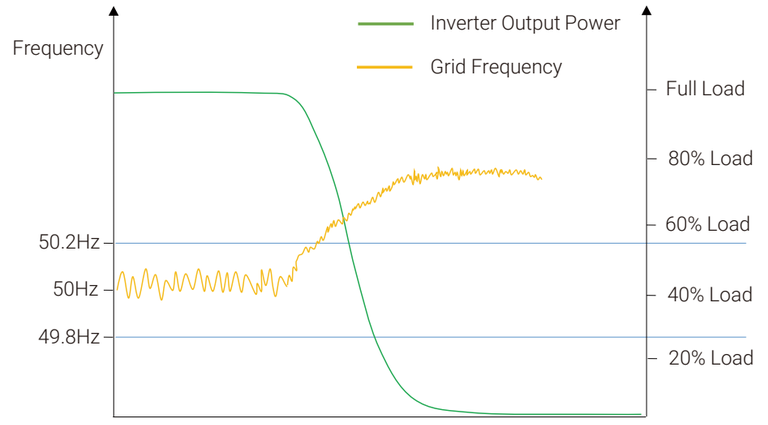
THE RISE OF AI

Most smart energy management systems are able to get real-time TOU prices, prediction of grid outage or grid frequency fluctuations from grid company databases and meteorological forecasts so that they give the right commands to the system to both secure power supply and save bills.

AI (artificial intelligence) has also been in the spotlight. Applications that learn the controlling behavior and create similar digital models to be followed in case of network failure are starting to be adopted.

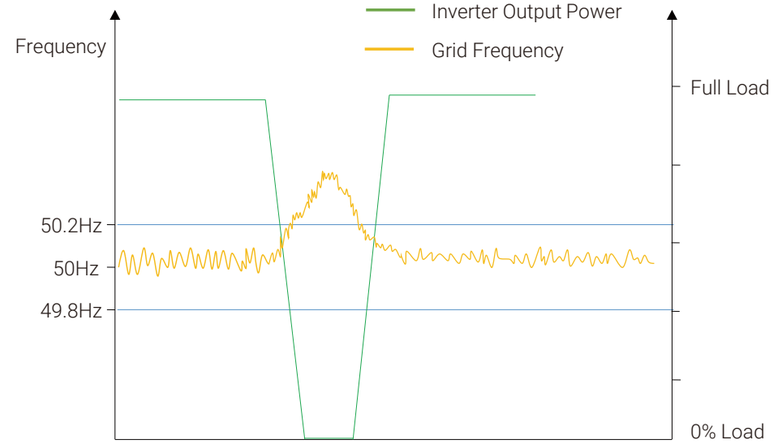
DROP AND STEP METHODS

In a community storage systems, the frequency control is usually required to keep utility frequency stable. It can be achieved easily with a storage system. It also requires the solar storage system to respond to direct frequency signals or interpret signals through an EMS controller. Storage systems respond by DROP or STEP methods.



DROP Method Schematic Diagram Example

DROP method in a storage system allows battery to charge (frequency higher) or discharge (frequency lower) depending on the real-time frequency, derating or uploading smoothly.



STEP Method Schematic Diagram Example

STEP method in a storage system only allows battery to charge or discharge at its maximum power.

Energy management controlling systems with storage is not only used to optimize solar self-consumption, save bills, shave peak demand, but is also a critical way to stabilize utility grid and secure power supply for essential loads.

There have been several solutions that have been tested and offer an insight into the future of the energy sector; from solar suppliers or independent institutions like SolarLog and Energybas from Europe, SwitchDin and Deposit from Australia, and CHINT, HUAWEI and GoodWe from China. They all have controllers or energy management system solutions for residential and commercial solar systems.