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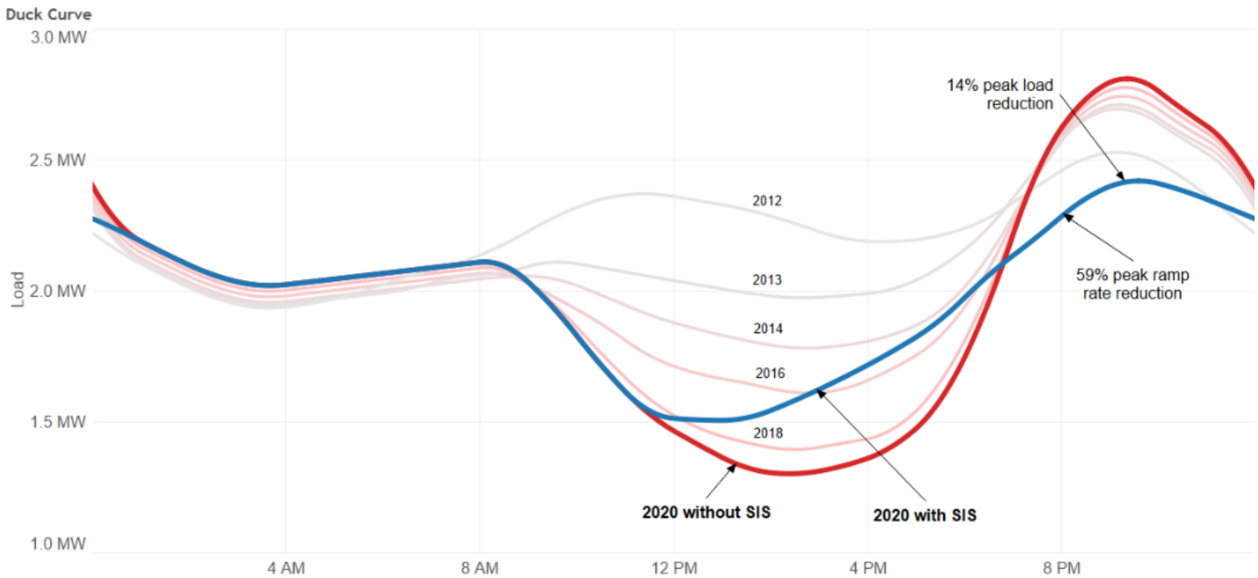
A peak into the red-hot Energy Storage System market

Energy Storage System (ESS) has been a hot topic in renewables over the past couple of years, and it is only getting hotter this year as the global energy crisis intensifies. The volume of added grid-scale energy storage installations in the United States has been multiplied by four between 1H 2021 and 1H 2022, setting up a new record. EUPD Research, a German sustainability consultant forecasts that 2.48 GW of new ESS solutions will be deployed across Germany in 2022 compared with 1.76 GW in 2021, a 41% YoY increase. In China, the installed capacity of electrochemical EES solutions increased by 70% YoY in 1H22. In mid-July, China Southern Power Grid Technology released its own 2022-2024 energy storage battery procurement plan, expecting to purchase 5.56 GWh of Lithium Ion Phosphate batteries (LFP) for large scale energy storage purposes. This is the most aggressive ESS-related procurement so far in China, and an indication that the construction of ESS plants is going to accelerate further.

Most renewable energies are subject to fluctuations, being intermittent by nature. They require energy supply systems to be very flexible. By increasing the number of solar panels and wind farms, any country is imposing a heavy burden on its electricity distribution grid. Energy storage systems enhance network stability, ease congestion on transmission lines and limit price volatility through energy arbitrage.

Below is a graph of a "Duck Curve". It shows power production over the course of a typical day, highlighting the imbalance between demand for renewable energy and production over 24 hours. Solar production ramps up with the sunrise, bringing down net demand for grid electricity – total demand minus wind and solar production. The duck curve gets more pronounced each year, as more renewables capacity is added. Net demand dips lower and lower at midday. When the sun sets, solar production wanes and the grid must ramp up production to compensate, sometimes over-stressing the grid. Energy storage solutions can fix these issues by storing excess solar energy produced during day time and using it at night.

Impact of Integrated Energy Storage on Duck Curve

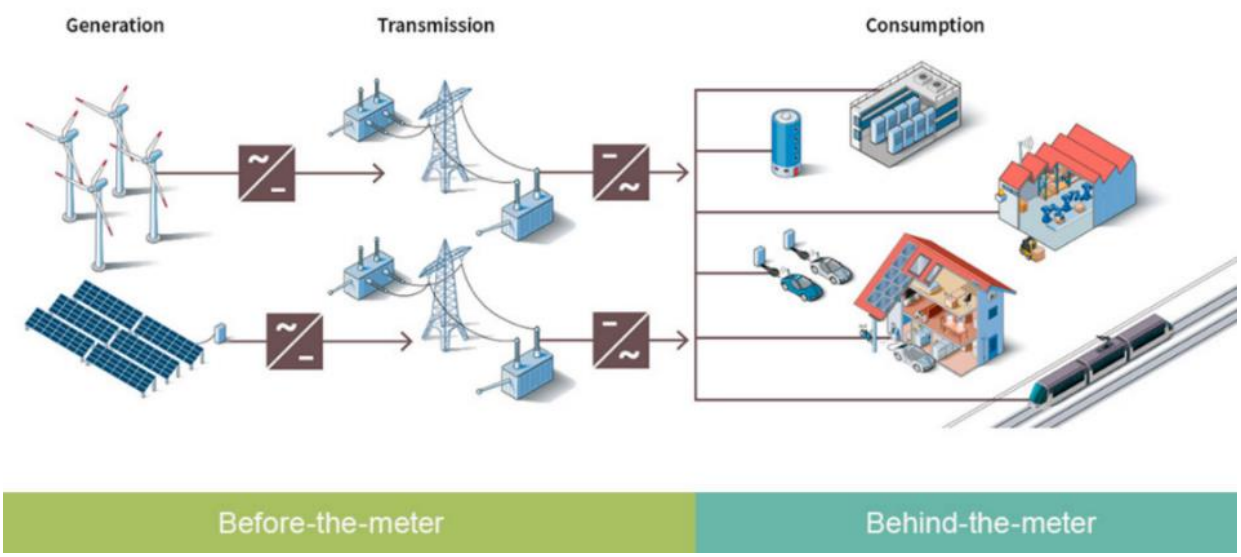


Source: Sunverge Energy

Battery-based ESS can be classified into two categories: "Behind-the-meter" and "Before-the-meter" systems.

On the generation side, ESS is typically combined with power generation turbines to regulate the production flow of electricity whenever new energy is used by consumers. On the transmission side, ESS is used to ease grid congestion and help to adjust power generation peak and valley curve. Energy storage solutions include independent energy storage power plants, substations, and mobile power vehicles. On the consumption side, ESS allows consumers to save money by reducing the peak-to-valley differentials while saving energy.

Energy Storage Systems categories along the energy supply chain



Source: infineon.com

Before-the-meter

In fact, there are already several energy savings solutions available. They can be classified into five broad categories including mechanical, electrochemical (or batteries), thermal, electrical, and hydrogen storage technologies. The suitable duration of storage, scale of systems and response time are technology dependent. The choice of the most appropriate technology depends on the application requirements and constraints.

Among all technology routes, pumped storage hydropower plants remain the most proven electricity storage solution. It was invented in Switzerland in the 1890s and first used in 1930 in the United States. It is a clever and relatively inexpensive electricity storage solution that was until recently the only way to store power on a large scale.

Battery storage systems is far more recent and remains a relatively expensive solution as batteries can only support a limited number of charging cycles. In the future, electric car batteries could also be used as temporary storage solutions for households: in the so-called vehicle-to-grid solution, excess energy produced through solar power and wind power could be stored in the batteries of electric cars, and fed back into the household when needed, most likely at night.

The conversion of electricity into various products has been gaining momentum lately. Energy can now be stored on a large scale in the form of hydrogen (gas or liquid) by using solar power or wind power to split water into hydrogen and oxygen.

By the end of 2021, the global installed capacity of ESS solutions was 209.4GW, up by 9% YoY. New types of ESS (i.e. excluding pumped storage hydropower) was 25.4GW, up by 67.7% YoY.

In China alone, installed capacity of ESS solutions was 46.1GW (i.e. 22% of global capacity) at the end of 2021, up by 25% YoY. New types of ESS was 10.5GW, up by 74.5% YoY.

Share of different energy storage routes

	China	Global
Pumped storage hydropower	86.3%	86.2%
Lithium-ion batteries	11.2%	11.1%
Lead batteries	0.7%	2.0%
Compressed air	0.4%	0.3%
Flywheel Energy Storage	0.0%	0.2%

Source: China Energy Storage Alliance

Energy storage solutions can generate revenue in four different ways:

1) Frequency regulation: A battery system will get paid for each hour it is being used;

2) Capacity payment: Energy storage companies sign a long-term contract with the grid, under which the ESS owner receives a fixed monthly fee based on its energy storage capacity;

3) Collocation of storage at a solar or wind power plant: A battery system is paired with a wind or solar plant to control the ramp rate at which the electricity is fed into the grid;

4) Energy arbitrage: The ESS owner can buy electricity during off-peak period when electricity is cheap and sell it back to the grid during peak hours when electricity is expensive.

In China, Shandong province (a province located in the Northeast of China, halfway between Shanghai and Beijing) is the most active when it comes to ESS investments. It has the largest installed ESS capacity within the country. Shandong's independent energy storage power stations can help regulate the power grid volatility and are getting paid RMB 200 (USD29) /MWh for doing so. The Internal Rate of Return for such investments is typically around 6% per annum. As independent energy storage power stations in other provinces have not entered the power spot market yet, their project IRRs is typically lower, around 3-4% per annum.

More provinces require wind and solar power plants to be connected to the grid, with minimum requirements to be met (typically 10 to 20% of the installed capacity must be made available to the grid for 2 to 4 hours per day). These requirements are such that grid parity has not been reached yet. In other words, it is only viable if the ESS operator receives government subsidies.

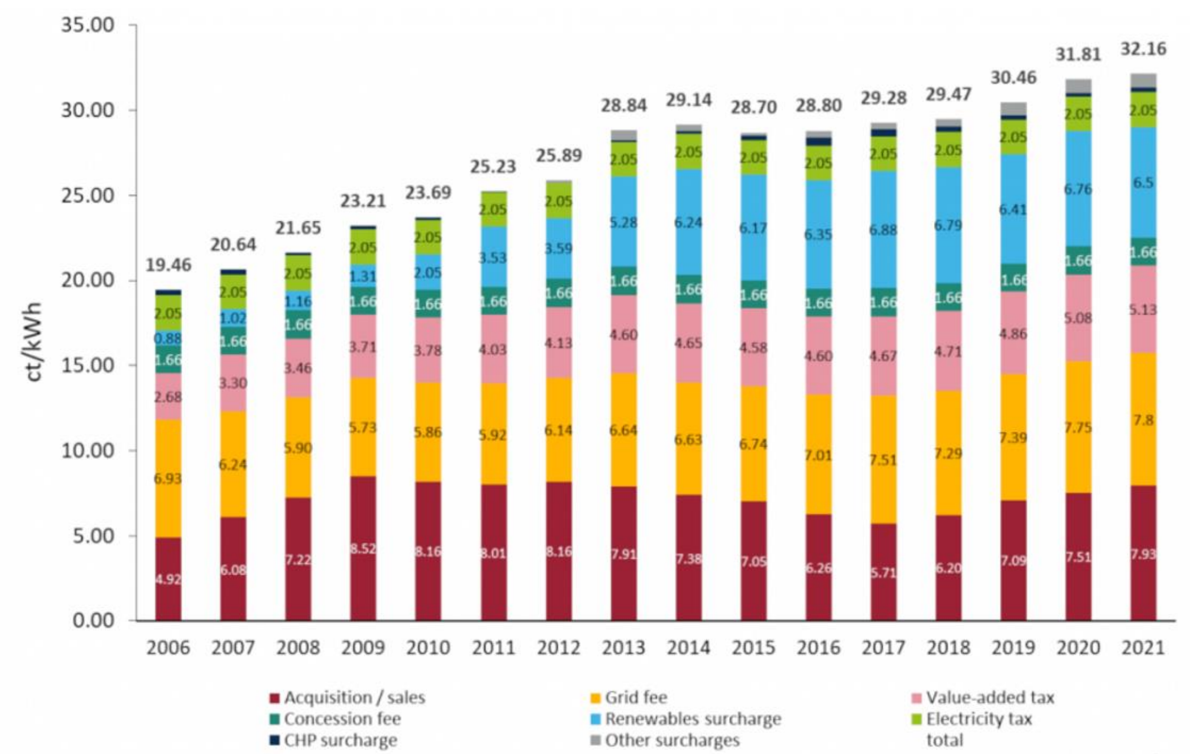
Behind-the-meter

For households (i.e. Behind-the-meter), the business model for ESS is relatively simple. Households can only generate revenue through energy arbitrage and by reducing the electricity purchased from the grid. The greater the difference between peak and valley electricity prices, the higher the local electricity price, and the more cost-effective the household ESS will be.

In China, more than 80% of the ESS installed capacity is on the power generation and transmission side (i.e. Before-the-meter) as household ESS is not economical yet.

Things are different in Germany: In 2021, 94% of the ESS installed capacity is within households, and almost 70% of home solar systems comes with energy storage solutions attached. This is because household electricity prices in Germany is the highest in Europe because of taxes and levies accounting for 40% of the electricity price (see the graph below). With the recent fear of natural gas shortages, household demand for home electrification has surged. The sales of household ESS solutions by US manufacturer Enphase Energy to German clients is up by 69% YoY. Still in Germany, the payback period for ESS installations is 7.6 years on a stand-alone basis.

Breakdown of electricity cost in Germany (in Euro cents per kWh) for a typical consumption of 3,500 kWh per year



Source: BDEW

Future technologies

Similar to the situation experienced by EV car battery makers, the rising price of lithium limits the economics of using it for energy storage. Sodium-ion batteries are emerging as a viable alternative to lithium-ion technology, especially for utility-scale energy storage where size is not really an issue. Na-ion and Li-ion battery technologies have much in common in terms of structure and working principles and can often even use the same manufacturing lines and equipment.

Sodium is cheaper and much more abundant than lithium, but its energy density is very low, it takes more space than Li-ion batteries. CATL has unveiled its first-generation sodium-ion battery solutions in July 2021 and plans to form a basic industrial chain by 2023. On 28th July 2022, the world's first GWh Na-ion battery production line was inaugurated by Hina Battery, in Anhui province.

Battery makers are also working on the development of Solid-State Batteries that will no longer use chemical elements in liquid form, hence providing greater stability, as well as batteries using manganese as well as different types of organic materials.

Supply chain

For lithium-ion battery energy storage solutions, battery packs using cells still account for 60% of the total cost. Power Conversion System (PCS) accounts for 20%, Energy Management System (EMS) accounts for 10% and Battery Management System (BMS) accounts for 5%. The top three cell producers in the world are CATL (from China), LG Energy Solution (from Korea), and Samsung SDI (also from Korea), the three of them controlling 60% of the global market.

However, system integrators which assemble and sell the final products are fragmented, with dominant suppliers existing in each region. Tesla and Enphase Energy dominate the US market while Sonnon and E3/DC are strong in Germany. Chinese players mostly act as upstream suppliers of cells, batteries and inverters and sell to local integrators.

Players in battery energy storage system industry chain

	Battery supplier	Inverter supplier	System integrator	Engineering, Procurement and Construction (EPC)	Operator
Utility-scale (Before-the-meter)	CATL	Sungrow	CATL	CATL	EDF
	BYD	Huawei	Fluence Energy	Fluence Energy	E.On
	Eve Energy	Sineng Electric	Sungrow	Sungrow	NextEra
	LG CHEM	Kstar	BYD	BYD	GE Power
	Samsung				
	CALB				
Household (Behind-the-meter)	Pylon	Sungrow	Segen	Segen	Sunrun
	BYD	Goodwe	Sonnen	Sonnen	Vivint
	LG CHEM	Ginlong	Sungrow	Sunrun	
	ATL	Tesla	Goodwe	Sunpower	
	Panasonic	Deye	LG CHEM	Vivint	
	Eve Energy		BYD	Tesla	
	Alpha-ESS		Tesla		
			Alpha-ESS		

Source: Companies websites

Mainstream home storage brand appearance comparison

Source: Companies websites

Outlook

Despite the recent surge in demand for ESS solutions across Europe, we should still be cautious about market players' aggressive expansion plans. The manufacturing barriers for energy storage systems are not high, and the storage inverters are basically the same structure as photovoltaic inverters used in solar panels. In the long run, there is a possibility that the household ESS market space becomes too crowded, with oversupply abound. ESS is designed to address the imbalance between electricity generation and consumption, but other solutions exist, some of them being more economical. The flexibilization of thermal power plants, the use of new energy vehicles as power carriers, and the use of virtual power plants to participate in scheduling and trading of renewable energy can achieve similar goals.