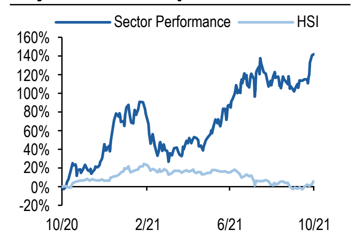
Renewable Energy Sector Insights

26 October 2021

Surging power storage demand a tailwind for lithium batteries in China

- **5-year plan on new forms of energy storage; lithium storage rides on policy tailwinds:** China's guidance on new forms of energy storage has laid out a 5-year plan that will widen the peak-valley power tariff gap in order to create more room for arbitrage on the user end. Electrochemical energy storage has wide-ranging uses. (1) Power supply end: due to the unstable power output, renewable energy must be equipped with large-scale power storage to improve penetration in energy mix. It is mandatory for newly-built power plants to carry electrochemical energy storage starting 2021, with higher standards set for marketized on-grid projects. (2) User end: energy storage for peak-valley tariff arbitrage has proven economics in some Chinese provinces. (3) Power grid end: energy storage frequency modulation is becoming economical, but peak adjustment cost has yet to ease.
- **Expect cost to drop continuously for electrochemical energy storage; lithium iron phosphate (LFP) as key technique given cost edges:** Among various technologies, electrochemical energy storage is the most promising; lithium battery storage is the dominant form. Energy storage batteries and power batteries (for electric vehicles) are similar in principle, but performance requirements differ. With LFP as main technical route, lithium energy storage projects have seen per-Wh investment drop to RMB1.5-2 in China. Improving battery cycle life and easing cost have sent cost down rapidly to ~RMB0.6/Wh, making wide adoption possible.
- **Renewable power to trigger electrochemical storage spike:** We estimate new installations of electrochemical energy storage will double YoY to 3.3GW/6.2GWh in 2021, and swell further to 25.0GW/55.3GWh by 2025 with 66%/73% 2021-25E CAGRs. The storage demand from the power suppliers will grow the fastest, making up >70% from 2023, fueled by renewable energy installed capacity, rising proportion of storage-equipped power projects, and higher energy storage power ratio/hours.
- **Lithium energy storage industry chain as key beneficiary:** In this industry chain, the most notable areas are batteries (>60%) and converters (>10%), which make up the highest shares of investment cost for energy storage system. Power battery leader Contemporary Amperex (CATL, 300750 CH/NR) also boasts the largest share in energy storage batteries in China by virtue of its technology and scale advantages. Sungrow Power (300274 CH/NR), leader of PV inverters and system integration, enjoys the largest market share of energy storage converters and system integration given sales channel and scale advantages.
- **Risk factors:** Weaker-than-expected policy support, renewables installed capacity, and cost drops; excessive entrants into energy storage causing overcapacity.

1-year sector performance



Source: FactSet

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Valuation summary

Company name	Stock code	Rating	TP (local ccy)	CP (local ccy)	EPS FY21E (rpt ccy)	EPS FY22E (rpt ccy)	P/E FY21E (x)	P/E FY22E (x)	P/B FY21E (x)	P/B FY22E (x)	Yield FY21E (%)
CATL	300750 CH	NR	NA	596.00	4.673	7.690	126.1	76.7	18.41	15.04	0.1
BYD	1211 HK	NR	NA	282.00	1.710	2.640	137.0	88.8	8.55	8.15	0.1
Sungrow	300274 CH	NR	NA	159.88	1.990	2.806	80.6	57.2	17.78	13.82	0.1
Eve Energy	300014 CH	NR	NA	112.88	1.696	2.510	67.2	45.4	12.34	9.89	0.1
Gotion High-tech	002074 CH	NR	NA	52.80	0.246	0.589	211.2	88.0	4.80	4.53	0.0
Sineng	300827 CH	NR	NA	120.97	NA	NA	NA	NA	NA	NA	NA
Average							**124.4**	**71.2**	**12.38**	**10.29**	**0.1**

Source: FactSet (consensus for NR stocks)

TABLE OF CONTENT

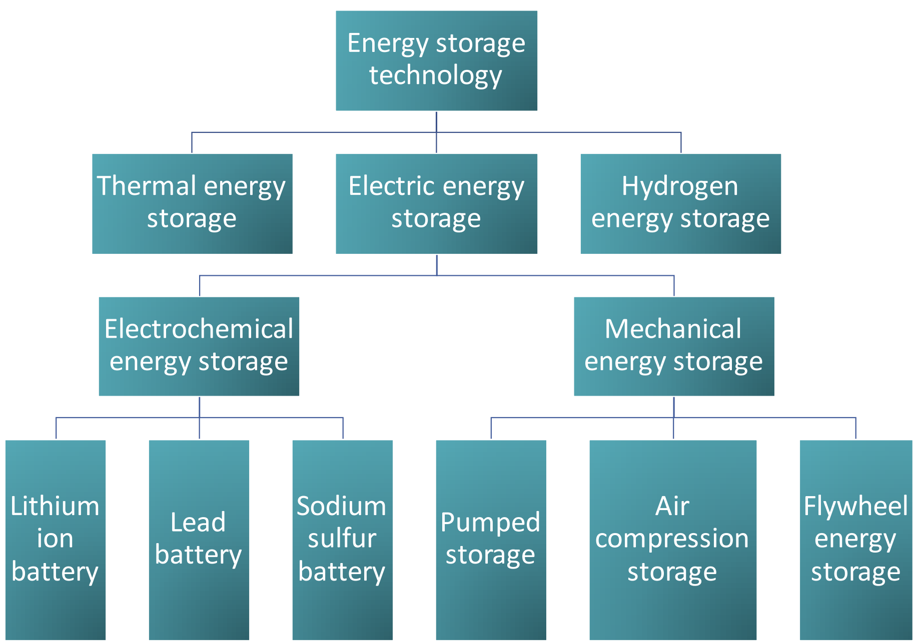
Lithium Storage the Dominant Form of Energy Storage

Electrochemical energy storage is the most promising method

Energy storage can be broadly classified into three major forms: electric energy storage, thermal energy storage and hydrogen energy storage.

Electric energy storage is the major form of energy storage. It can be further divided into electrochemical energy storage and mechanical energy storage according to different storage principles. Among them, electrochemical energy storage refers to a variety of secondary battery energy storage, encompassing lithium ion batteries, lead batteries and sodium-sulfur batteries; mechanical energy storage mainly includes pumped storage, air compression energy storage and flywheel energy storage.

Figure 1: Classification of energy storage technologies



Source: Pylon Technologies prospectus, BOCOM Int'l

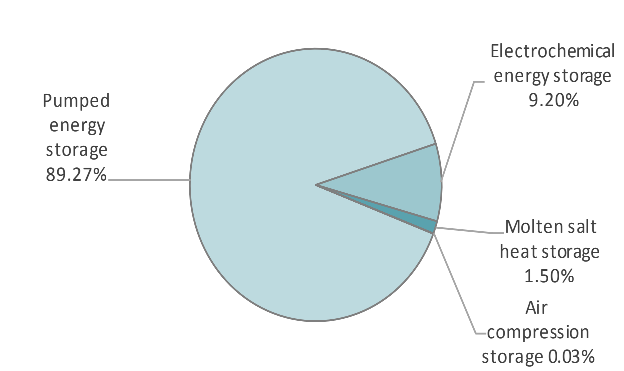
Pumped storage is the most mature technology to store electric power at present, which has been commercialized since as early as 1990s. Its current cost of energy storage per Wh is only RMB0.21-0.25, far lower than other energy storage technologies, but the downside is very limited. It is mainly used for peak shaving and valley filling, frequency modulation and phase modulation in power system and emergency backup. Pumped storage is also the technology with the largest installations, accounting for more than 90% of the world's cumulative installed energy storage scale. However, the construction of pumped storage power stations is subject to regional restrictions, requiring the upper and lower reservoirs to be in close proximity but have large vertical distance. However, if constrained by limited vertical distance, the energy density achieved by pumped storage power station would be minimal. In addition, *a single pumped storage power station has massive scale and takes 7-10 years to build out, which cannot meet the demand growth in near term. Therefore, we believe that pumped storage has limited development potential.*

Electrochemical energy storage is the most widely-adopted energy storage technology that holds biggest promises. Compared with pumped storage, electrochemical energy storage is less confined by geographical conditions and has a short construction cycle, so it can be flexibly deployed to different parts of the power system and in many other scenarios. At the same time, with continuous cost drops and increasingly mature commercial applications, the advantages of electrochemical energy storage have become entrenched. It has gradually developed into the mainstay of incremental energy storage installations. In the future, with the technological progress on lithium battery industry and rising economies of scale, cost downside is ample and thus prospects are rosy.

According to the statistics of China Energy Storage Alliance (CNESA), the cumulative installed capacity of operating energy storage projects in China increased from 24.3GW in 2016 to 35.6GW in 2020, of which 31.79GW, or 89.3%, is pumped storage, sharply down from 99% in 2016. The cumulative installed capacity of electrochemical energy storage increased from 0.243GW in 2016 to 3.269GW in 2020, with a rapid increase from 1.0% to 9.2% share of energy storage. In addition, molten salt heat storage (i.e. photothermal energy storage) has seen a small amount of installations, while those of air compression energy storage are negligible.

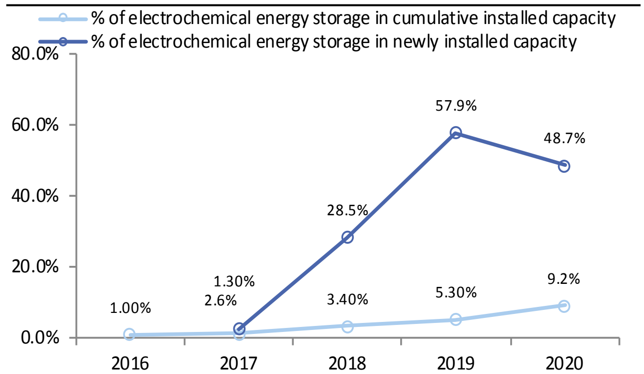
In terms of new installations, China's incremental energy storage capacity has seen swings due to fluctuations in pumped storage capacity. In 2020, 3.2GW was newly installed. The new capacity of electrochemical energy storage increased from 0.101GW in 2016 to 1.56GW in 2020, representing a CAGR of 98% for 2016-20 and YoY growth of 145% in 2020. In addition, its proportion in the new energy storage installations surged from 2.6% in 2017 to 48.8% in 2020. We expect this proportion to continue to rise, and electrochemical energy storage to soon rise to the top spot for newly-added energy storage capacity in China.

Figure 2: Breakdown of China's cumulative installed energy storage at end-2020; pumped storage still at nearly 90%



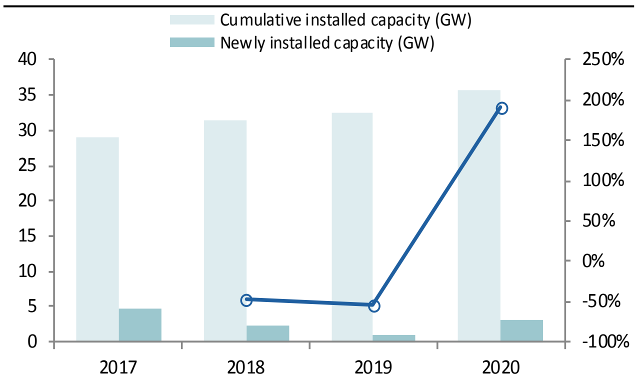
Source: CNESA, BOCOM Int'l

Figure 3: Electrochemical energy storage accounts for nearly half of newly-installed energy storage in China



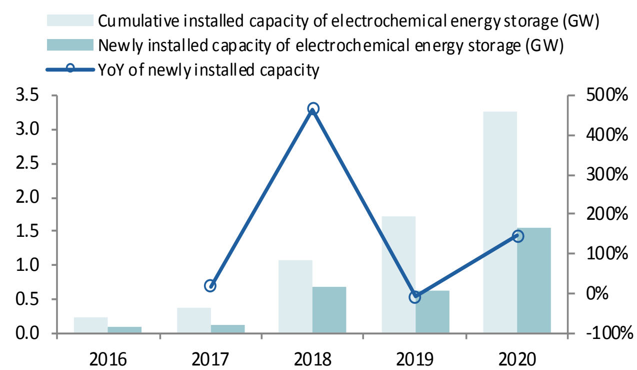
Source: CNESA, BOCOM Int'l

Figure 4: China's installed energy storage capacity; big swings in newly-installed capacity



Source: CNESA, BOCOM Int'l

Figure 5: Installed capacity of electrochemical energy storage in China; 98% CAGR for newly-installed capacity, 2016-20



Source: CNESA, BOCOM Int'l

Lithium ion energy storage is the dominant electrochemical energy storage technology

In electrochemical energy storage, lithium ion battery is the most feasible technological path. Lithium ion batteries have the advantages of high energy density, small self-discharge, no memory effect, wide range of operating temperature, fast charge and discharge, long service life-cycle, eco-friendliness and so on. With the innovation of battery manufacturing technology, lithium ion batteries have continuously improved the performance with the cost downtrend persisting and safety levels rising significantly. Thus, their application advantages have gradually firmed.

Lead battery is the oldest and most mature form of energy storage, with a history of 100 years. It is widely used as the starting power for cars, electric bicycles or motorcycles, backup power, lighting power and so on. Lead battery has good reliability, with easy access to its raw materials and low price, but it is difficult to meet the large-scale storage requirements on both performance and capacity. Also, it cannot be deeply charged and discharged, has a short life-cycle and causes heavy-metal pollution. Moreover, sodium-sulfur batteries, another energy storage technology, are less safe and not yet ready for large-scale use in China.

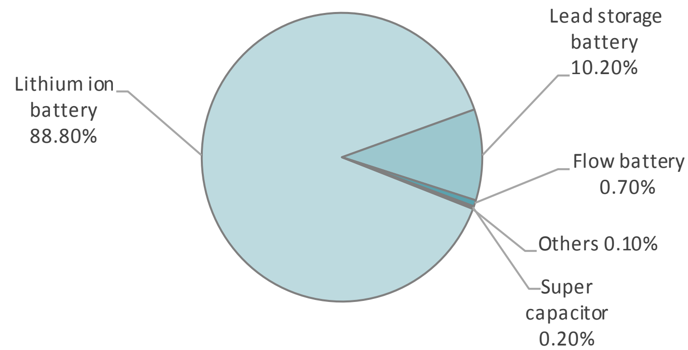
Figure 6: Principles and pros and cons of different electrochemical energy storage technologies

Technical types	Basic principles	Advantages	Disadvantages
Lithium ion battery	The positive and negative electrodes are composed of two different lithium ion embedded compounds. During charging, Li+ is deembedded from the positive electrode through electrolyte and embedded into the negative electrode. On the contrary, Li+ is deembedded from the negative electrode and embedded into the positive electrode through electrolyte	Long life, high energy density, high efficiency, fast response speed, strong environmental adaptability	The price is still high and there are certain security risks
Lead battery	The positive lead dioxide (PbO2) and the negative pure lead (Pb) of the lead battery are immersed in the electrolyte (H2SO4), and a potential of 2V will be generated between the two poles	Mature technology, simple structure, low price, convenient maintenance	Low energy density, short life, not suitable for deep charge and discharge and high power discharge
Sodium sulfur battery	The positive electrode is made up of liquid sulfur, and the negative electrode is made up of liquid sodium. The operating temperature of the battery should be kept above 300°C to make the electrode in a molten state	High energy density, long cycle life, good power characteristics, fast response speed	The metal sodium anode is flammable and operates at high temperature, so there is a certain safety risk

Source: Pylon Technologies prospectus

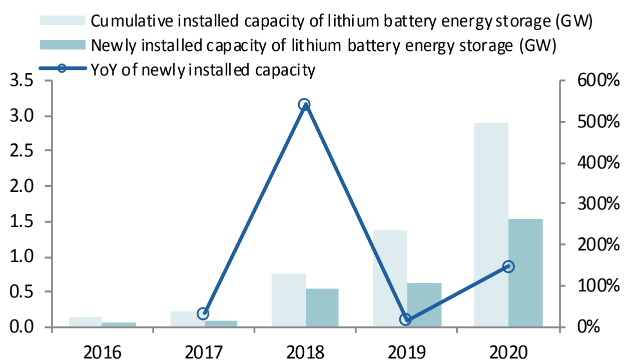
In the early phase of electrochemical energy storage development in China, lead battery once had a big market share due to its cost advantage, but in recent years, lithium energy storage has taken a firm advantage. The cumulative installed capacity of lithium energy storage in China increased from 0.14GW in 2016 to 2.90GW in 2020, and its proportion in the cumulative installed capacity of electrochemical energy storage increased from 59% to 89%. The newly-installed capacity increased from 0.06GW in 2016 to 1.52GW in 2020, with a 122% CAGR. Its proportion in newly-installed electrochemical energy storage increased from 62% to 98%, basically taking the whole market.

Figure 7: Breakdown of cumulative electrochemical energy storage installations in China at end-2020, with lithium as the mainstream



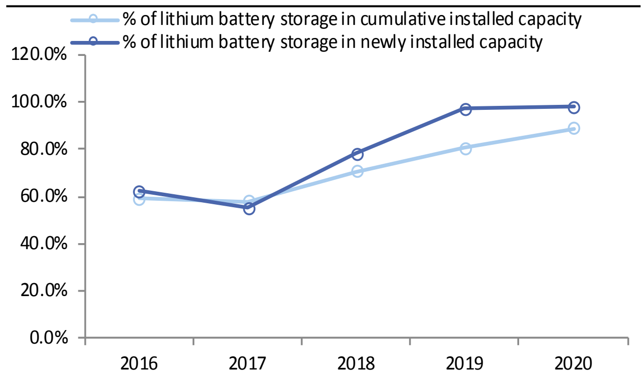
Source: CNESA, BOCOM Int'l

Figure 8: Installed capacity of lithium energy storage in China; new installation CAGR at 122% in 2016-20



Source: CNESA, BOCOM Int'l

Figure 9: Lithium energy storage accounts for a surging proportion of China's electrochemical energy storage installations



Source: CNESA, BOCOM Int'l

Energy storage batteries and power batteries have different performance requirements

Lithium batteries for power storage have similar operating principles to lithium power batteries, but their adoption scenarios and performance requirements differ:

(1) Power batteries installed in electric vehicles (EV) need to have higher endurance and shorter charging time on the premises of safety and economy, so they have higher requirements on energy density and charging speed. The application of energy storage batteries, however, requires frequent charge and discharge, and thus a longer cycle life and lower energy density due to the lack of movement.

(2) The battery capacity of a single energy storage project is much larger than that of a single EV, so energy storage batteries have higher requirements on consistency.

(3) As a part of consumer goods, power batteries have certain consumer goods attributes, while the fundamental purpose of energy storage is to make profits. Energy storage batteries have the properties of capital goods, which emphasize cost performance more than power batteries.

Figure 10: Power batteries vs. energy storage batteries

	Power battery	Energy storage battery
Application scenarios	EV	Energy storage station
Energy density	High	Normal
Power density	High requirements; for safety considerations, batteries of about 1C discharge capacity are generally used	For capacity-type usage scenarios, discharge rate is ≤0.5C; for power-type usage scenarios, the discharge rate is ≥2C; the two can be used together
Calendar life	5-8 years	~10 years
Cycles	2000 times	5000 times
Batteries	LFP batteries and ternary batteries	Mainly LFP batteries
BMS architecture	Centralized in one layer or distributed across two layers	Generally, two or three layers are used, and larger ones tend to use three layers
Characteristics of BMS	High response speed and SOC estimation accuracy are required	Good passive equilibrium conditions

Sources: cbea.com, BOCOM Int'l

Lithium iron phosphate is the main technical path for lithium energy storage battery

Lithium iron phosphate (LFP) batteries and ternary lithium batteries are the two most common lithium battery technologies. Although the energy density of LFP batteries is lower than that of ternary batteries, the former's cost, cycle life, safety and other aspects are superior to the latter, so it is a better fit for the performance requirements of energy storage batteries with clear advantages in the field of energy storage.

At present, almost all the lithium batteries used in China are LFP batteries, which accounted for 96% of the domestic shipments of lithium energy storage batteries in 2019. In contrast to China's situation, Samsung, LG Chemical, Panasonic and other overseas leaders in lithium-ion batteries have yet to make large-scale LFP layouts, while energy storage batteries and the more sizeable market of power batteries mainly use ternary batteries, but with the rapidly-growing demand for energy storage and rapid ascension of LFP in power batteries, we expect overseas players to also gradually turn toward LFP for energy storage.

Figure 11: Comparison of LFP and ternary lithium ion batteries

	LFP battery	Ternary lithium ion battery
Energy density (Wh/kg)	~ 140	~ 240
High temperature performance	Resistant to high temperature of 800C	Decomposition can occur at 300C
Low temperature performance	Lower limit of temperature -20C	Lower limit of temperature -30C
Cycle life (times)	~ 5000	~ 2000
Safety	High	Normal
Battery costs	Lower (no precious metals)	High (containing nickel, cobalt etc)

Source: Qianzhan Industrial Research Institute

Sodium ion batteries are expected to drive the cost of electrochemical storage down further

The rising retail sales of EV in China, coupled with the upcoming electrification of trucks and an impending spike in the demand for lithium storage batteries will result in a shortage of raw materials for lithium batteries, especially lithium. Industry giant CATL Times has recently unveiled its sodium ion battery, which we believe is in response to such a likely shortage.

Sodium ion batteries are better suited to applications that do not require high energy density but are more cost-sensitive. Accessories for sodium ion batteries are thus cheaper than those for lithium ion batteries. In addition, sodium compounds can be used as electrode materials, which is essential to reducing costs. Sodium exists in plentitude and is cheap, while LFP and ternary lithium batteries contain more expensive precious metals. Moreover, the operating mechanism of sodium ion batteries is the same as that of lithium ion batteries, and the existing production equipment of battery companies can be directly used to produce sodium ion batteries. There is little extra investment in equipment, but companies can easily use it as an alternative battery for production.

Overall, sodium ion batteries are more suitable for applications that require less energy density but are more cost-sensitive. Application scenarios may include EV with energy storage and low driving range. In CATL's sodium ion battery solution, BMS coordination of the sodium ion battery and lithium ion battery can be integrated into the same system, which we expect to also reduce overall cost, while the energy density can reach 200Wh /kg.

Figure 12: CATL's sodium ion battery

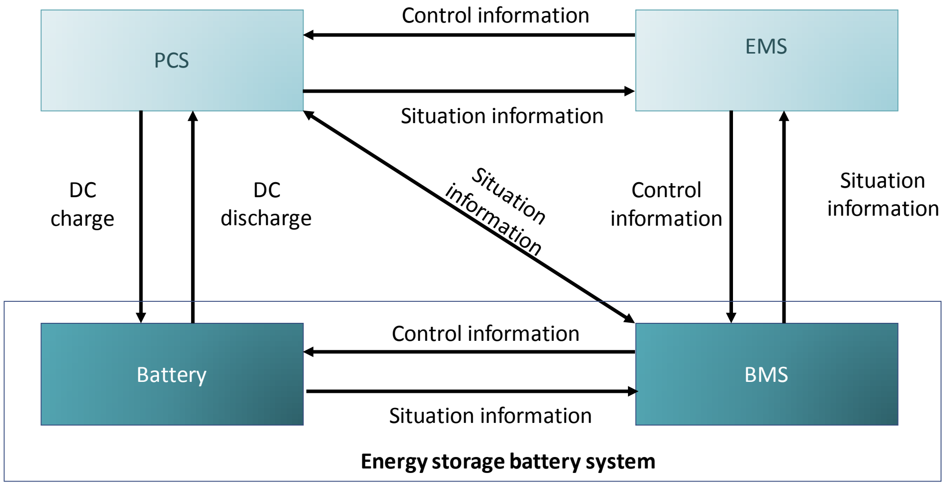
	Main points
Battery performance	160Wh/kg each, still has 90% capacity retention rate at -20 degrees Celsius, charges to 80% in 15 minutes
Structural design	AB battery solutions, sodium-ion electronics and lithium-ion batteries can be simultaneously integrated into the same system, coordinated through BMS
Next generation product	The energy density of the next generation is 200Wh/kg, and an industrial chain will be formed in 2023

Source: Company data

Fast-falling Cost of Lithium Energy Storage

The energy storage system is a comprehensive energy control system with battery at the core, and consists of the battery pack, battery management system (BMS), energy management system (EMS), power storage converter (PCS) and other electrical equipment. The battery pack is the most important component of an energy storage system. BMS is responsible for battery monitoring, evaluation, protection and balancing, etc. EMS is responsible for data acquisition, network monitoring and energy scheduling, etc. PSC controls the charging and discharging process of the energy storage battery pack and performs AC/DC conversion.

Figure 13: Schematic diagram of electrochemical energy storage system



Source: Pylon Technologies prospectus

Important technical parameters of electrochemical energy storage

Discharge depth: Discharge capacity/battery rated capacity, which determines the actual available battery power. At present, the initial discharge depth of lithium batteries is about 90%. The average discharge depth during the battery cycle life is about 77% because the battery capacity will degrade after a period of use.

Cycle life: Under specified conditions, it refers to the number of charge and discharge cycles a battery pack can carry out before a specific performance failure (generally capacity retention rate <70%), which is a material factor affecting the cost of energy storage per kWh and is negatively correlated with the discharge depth. The technical content of the cycle life is high, and the lithium battery produced by different companies may vary significantly in cycle life.

System efficiency: The ratio of discharge energy to charge energy of the energy storage system. Due to the power loss in the charging and discharging process, the efficiency of the current lithium battery system is about 88%.

Battery forms the bulk of lithium battery storage investment costs

The cost of lithium battery storage consists of initial investment and subsequent operation & maintenance costs, including energy storage system, power conversion, and construction. At present, the initial investment cost of lithium battery storage projects in China is ~RMB1.5-2/Wh (depending on the project scale), and the annual operation & maintenance cost is ~RMB0.03-0.04/Wh.

To illustrate, for an LFP battery storage project in late 2020, the unit investment cost is RMB1.55/Wh, the bulk of which is battery cost at RMB0.95/Wh (accounting for >60%), followed by converter at RMB0.35/Wh (11%) and BMS (nearly 10%).

Figure 14: Investment cost breakdown of a lithium battery storage project in late 2020 (5MW*2 hours)

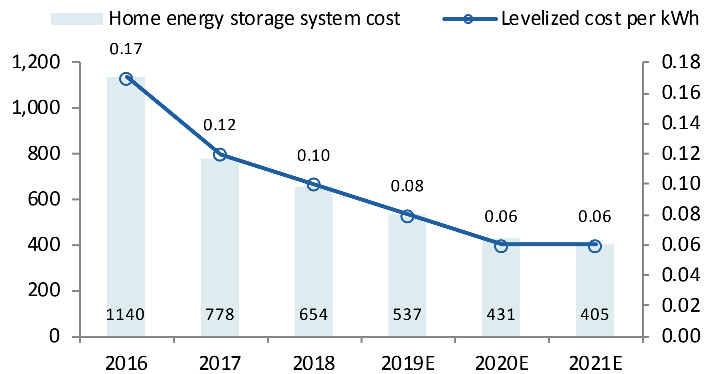
	Unit price	Specifications	Amount (RMB10k)	Proportion (%)
LFP battery	RMB0.95/Wh	10MWh	950	61.5
PCS	RMB0.35/W	5MW	175	11.3
BMS	RMB60000/set	25 sets	150	9.7
EMS		1 set	50	3.2
Accessories			90	5.8
Others (including construction and installation)			130	8.4
Total			1545	100.0
Investment cost/Wh	**RMB1.55**			

Sources: CNESA, BOCOM Int'l

Higher cycle life/lower cost of batteries to drive rapid decline in per-kWh cost of energy storage

In recent years, the cost of lithium battery storage has decreased rapidly, as improved technology and economies have facilitated large-scale commercialization. According to Bloomberg New Energy Finance (BNEF), as of 2018, the benchmark capital cost of a fully installed 14,000Wh household lithium-ion storage system is US$654/kWh, or a levelized cost of ~US$0.10/kWh, down ~42.6% from that in 2016. BNEF forecasts that costs will fall to US$405/kWh by 2021, a 38.1% cumulative decline over three years. With the acceleration of the automotive industry's electrification and the proliferation of lithium energy storage, super large-scale applications will accelerate the cost drop. BNEF expects the average price of lithium-ion battery packs to fall further to US$68/kWh in 2030, down 58% from 2020, the biggest driver of the cost decline for energy storage systems.

Figure 15: Benchmark capital cost of household lithium battery storage systems (US$/kWh)



Source: Pylon Technologies prospectus

Per-kWh cost of storage = life-cycle cost/life-cycle electricity discharge. Lower battery cost drives down the numerator, while higher cycle life drives up the denominator. In recent years, technological breakthroughs have greatly increased the cycle life of LFP batteries from 2000-3000 to 5000-6000 times, or even 10,000 times in some products, driving sharp decline in the per-kWh cost of energy storage.

Based on energy storage investment cost of RMB1.6/Wh, a cycle life of 6000 times, and one charge-discharge cycle per day, the cost of large-scale lithium battery storage projects has dropped to RMB0.56/kWh. If the cycle life is increased to 10,000 times, the cost would be further reduced to RMB0.4/kWh.

Figure 16: Cost per kWh of lithium battery storage project

An 1MWh LFP energy storage project		
Cycle life (times)	6,000	10,000
Annual discharge times	365	365
Service life (years)	16.4	27.4
System efficiency (%)	88	88
Discharge depth (%)	90	90
Equivalent capacity retention rate (%)	85	85
Life cycle average discharge depth (%)	77	77
Full life cycle discharge (MWh)	4039	6732
Unit investment Cost (RMB/Wh)	1.6	1.6
Investment cost (RMB0'000)	160	160
Annual operation and maintenance Cost (RMB/Wh)	0.04	0.04
Full life cycle operation and maintenance cost (RMB0'0000)	66	110
Full life cycle cost	226	270
Energy storage cost (RMB/kWh)	0.56	0.40

Source: china5e.com, BOCOM Int'l

In the future, there are many ways to reduce the battery cost, including improving the battery structure and process, increasing the material utilization, scale effect, electrode and shell structure which is easy to disassemble and recycle, and improving the salvage rate of the project. However, as the proportion of battery cost in the investment cost of energy storage continues to decrease, the contribution of battery cost to per-kWh cost reduction will diminish. Meanwhile, the cost hike of lithium raw materials also hinders the reduction of battery cost. Therefore, we believe that improving cycle life will become the primary means to reduce per-kWh cost in the long term.

The rapid reduction of per-kWh energy storage cost will make large-scale application of lithium battery storage possible in many scenarios, which will bolster the demand for lithium battery storage.

Cascade utilization of power battery to reduce energy storage cost

After decommissioning, power batteries generally still have 70-80% capacity left, which can be used for energy storage and other scenarios to maximize the utilization of residual capacity. However, China's cascade energy storage market is plagued by irregularities, lack of regulation, and immature technologies.

In Aug, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Ministry of Ecology and Environment, the Ministry of Commerce, and the State Administration for Market Regulation jointly issued “Administrative Measures for the Cascade Utilization of Automotive Power Batteries”. The document encourages cascade utilization companies, NEV makers and automotive recycling companies to share information and recycling channels, in order to recycle decommissioned power batteries for cascade utilization in an efficient manner. It also encourages power battery makers to participate in the recycling of decommissioned batteries.

In September, the National Energy Administration formally issued “Provisional Measures for Management of Renewable Energy Storage Projects”, removing the indiscriminate ban on new storage projects based on cascade utilization of power batteries. Yet, the document requires that new projects must follow the “whole life cycle concept”, build battery consistency management and traceability system, and obtain safety assessment report for battery cascade utilization, which provides room for the growth of battery cascade utilization.

Cascade utilization is generally suitable for LFP batteries with longer cycle life and low metal value. Based on a service life of 5 years, we estimate that the scale of newly retired and available-for-use LFP power batteries in China will be huge at 20GWh in 2025. The cost of decommissioned power batteries is significantly lower than that of new storage batteries, and their cascade utilization can significantly reduce the cost of energy storage. We believe the supportive policies on cascade energy storage will galvanize the growth of lithium battery storage.

Demand for Electrochemical Energy Storage to Spike in China

We estimate below the demand for electrochemical energy storage from the power supply, power grid and user sides.

Demand spike imminent; power supply side to grow the fastest

1) Power supply side: Formula: newly installed energy storage power ((newly installed PV capacity * proportion of centralized PV) + newly installed wind power capacity) * proportion of projects with storage * power ratio of energy storage projects. Newly installed energy storage capacity = newly installed energy storage power * storage duration. We estimate China's newly installed PV/wind power capacity will increase from 60/40GW in 2021 to 140/55GW in 2025. Considering the better prospects of distributed PV, the proportion of centralized PV will gradually decline. Considering the increasing difficulty of renewable energy consumption, the proportion of projects with storage will increase rapidly, and both power ratio and duration of energy storage will gradually increase.

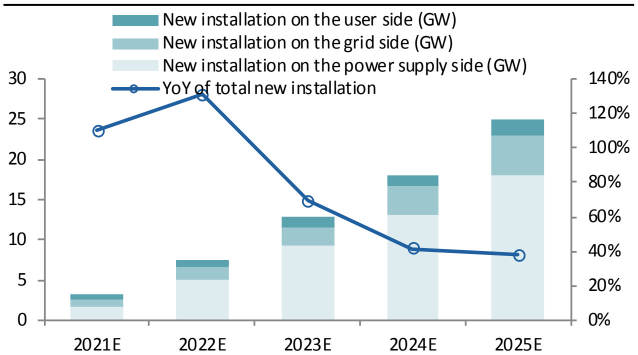
We expect newly installed energy storage capacity on the power supply side to reach 1.7GW/3.0GWh in 2021, up ~1.9x YoY, and to grow to 18.0GW/41.3GWh in 2025, with a CAGR of 81%/92% in 2021-25.

2) Power grid side: We estimate newly installed capacity of energy storage to reach 1GW/2GWh in 2021, and increase to 5GW/10GWh in 2025, with a CAGR of 50% in 2021-25, backed by increasing frequency modulation and peak modulation demand and penetration of electrochemical energy storage in a new electricity mix dominated by new energy.

3) User side: Enhanced economy of peak-valley tariff arbitrage is the main driver of demand. We expect the new installed capacity of user-side energy storage to reach 0.6GW/1.2GWh in 2021, 1GW/2GWh in 2022 and 2GW/4GWh in 2025, with a CAGR of 35% in 2021-25, driven by policy to expand the peak-valley tariff spread.

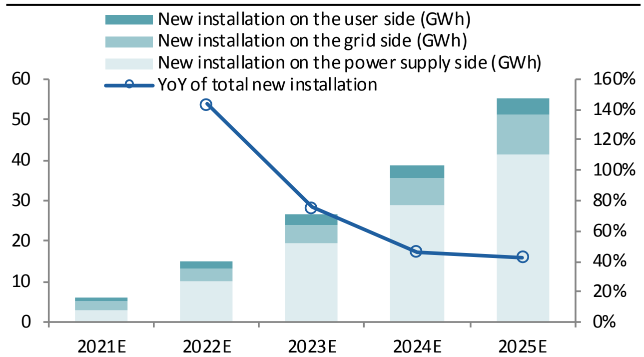
We expect newly installed capacity of electrochemical energy storage in China to reach 3.3GW/6.2GWh in 2021, more than doubling YoY, and hit 25GW/55.3GWh in 2025, with a 2021-25 CAGR of 66%/73%. Cumulative installation during the 14th FYP period is expected to reach 66.6GW/141.9GWh, bringing the cumulative installed capacity at the end of 2025 to 69.9GW, much higher than China's target of at least 30GW. Among them, the power supply side will account for the bulk of demand and grow the fastest, with share of newly installed capacity to exceed 70% beyond 2023 (from ~50% in 2021E).

Figure 17: Forecast of power of new installed electrochemical energy storage in China



Source: BOCOM Int'l estimates

Figure 18: Forecast of capacity of new installed electrochemical energy storage in China



Source: BOCOM Int'l estimates

Figure 19: Breakdown of projected newly installed capacity of electrochemical storage in China; power supply side to account for the bulk of demand and grow the fastest

	2020	2021E	2022E	2023E	2024E	2025E
The power supply side						
New PV installations (GW)	48.2	60	80	100	120	140
Proportion of centralized PV	68%	60%	58%	57%	56%	55%
New centralized PV installations (GW)	32.68	36	46.4	57	67.2	77
New wind power installations (GW)	71.67	40	40	45	50	55
New centralized renewable power installations (GW)	104.35	76	86.4	102	117.2	132
Proportion of projects with energy storage (%)		20	45	65	75	85
Power ratio of energy storage (%)		11	13	14	15	16
New energy storage installations (GW)	**0.58**	**1.7**	**5.1**	**9.3**	**13.2**	**18.0**
Energy storage duration (hours)		1.8	2	2.1	2.2	2.3
New energy storage installations (GWh)		**3.0**	**10.1**	**19.5**	**29.0**	**41.3**
The grid side						
New energy storage installations (GW)		1	1.5	2.3	3.4	5
Energy storage duration (hours)		2	2	2	2	2
New energy storage installations (GWh)		2	3	4.6	6.8	10
The user side						
New energy storage installations (GW)		0.6	1	1.2	1.5	2
Energy storage duration (hours)		2	2	2	2	2
New energy storage installations (GWh)		1.2	2	2.4	3	4
Total new installations of electrochemical energy storage (GW)	**1.56**	**3.3**	**7.6**	**12.8**	**18.1**	**25.0**
Total new installations of electrochemical energy storage (GWh)		**6.2**	**15.1**	**26.5**	**38.8**	**55.3**
Cumulative electrochemical energy storage installations (GW)	3.27	6.5	14.1	26.9	45.0	69.9

Sources: CNESA, NEA, BOCOM Int'l estimates

Wide-ranging uses of electrochemical storage

Electrochemical storage is widely used in many scenarios, among which power system energy storage is the most important one. The application of energy storage technology in power system is the key to ensuring the large-scale development of clean energy and the safe and economical operation of power grid.

Within the whole power system, energy storage can be applied to the power supply side, the power grid side and the user side. Among them, supply-side energy storage is mainly used for grid connection of renewable energy. Grid-side energy storage is mainly used for peak and frequency modulation to alleviate power grid congestion, and postpone the expansion and upgrade of power transmission and distribution equipment, etc. User-side energy storage is mainly used for self-use, peak-valley tariff arbitrage, capacity and tariff management, and power supply reliability improvement.

Figure 20: Wide-ranging scenarios of energy storage application

Application scenarios	Main purpose		Details
Power supply side	Grid connection of renewable energy	Smoothening renewable energy output	Equipping energy storage in wind and PV power stations to smoothen the fluctuations of renewable energy output and meet the requirements of grid connection, based on output prediction and energy storage charge/discharge schedules/
		Reducing wind/PV curtailment	The abandoned wind and PV power output will be stored for later connection to the grid, in order to improve the utilization rate of renewable energy/
Grid side	Peak shaving		Peak shaving and valley filling can be enabled with energy storage (charging the battery in the off-peak period of power load and releasing the stored electricity in the peak period).
	System modulation		The change of frequency will affect the safety, efficiency and lifespan of power generation and electric equipment, so frequency modulation is very important. Energy storage has high frequency modulation speed and can flexibly switch between charge and discharge states, making it an excellent means of frequency modulation.
	Auxiliary dynamic operation		It provides auxiliary dynamic operation, improves the operation efficiency of old units and delays the need to construct new units by combining energy storage and traditional units.
	Spare capacity		Reserve capacity refers to the active power reserve for ensuring power quality and safe and stable operation of the system in case of emergencies, in addition to meeting the expected load demand.
	Easing grid congestion		The energy storage system is installed at the upstream of the grid. When the line is blocked, the energy can be stored in the energy storage device. When the line load is less than the line capacity, the energy storage system will release electricity to the line.
	Delaying capacity expansion and upgrade of power transmission and distribution equipment		In the transmission and distribution system with load close to equipment capacity, the energy storage system can be used to effectively improve the power transmission and distribution capacity of the grid through a smaller installed capacity, so as to delay the construction of transmission and distribution facilities and reduce costs.
User side	Electricity generation for self-use		For households and industrial and commercial users installing PV, considering that PV generates electricity during the day and users generally have a high load at night, energy storage can be configured to make better use of PV power, improve the level of self-use and reduce electricity costs.
	Peak-valley arbitrage		In the power market with the implementation of peak-valley tariffs, the energy storage system can be charged when the price is low and discharged when the price is high, so as to realize the peak-valley arbitrage and reduce the electricity cost.
	Capacity charge management		Industrial users can use the energy storage system to store energy in off-peak periods and discharge in peak periods, so as to reduce the overall load and costs.
	Improving power supply reliability		When a power failure occurs, the energy storage can supply the reserved energy to the end user, avoiding power interruption during repair and ensuring the power supply reliability.

Sources: Pylon Technologies prospectus, BOCOM Int'l

Policies on renewable energy storage and peak-valley tariffs are blessings for electrochemical storage

New energy storage development guidelines set the direction for the next five years: In July, the NDRC and the NEA issued "Guidelines on Accelerating the Development of New Energy Storage", which outlines the development of new energy storage in the next five years. For the first time, China has proposed the target of new energy storage installation. According to the guidelines, the installed capacity of new energy storage shall exceed 30GW by 2025, more than eight times the 3.8GW by the end of 2020. This implies an average of >5.3GW of newly installed capacity per year during the 14th FYP period.

The guidelines aims to promote the cost decline and commercialization of relatively mature new energy storage technologies such as lithium-ion batteries, the construction of energy storage projects on the power supply side, the rational layout of energy storage on the power grid side, and support the diversified development of energy storage on the user side. According to the document, we believe the power supply side, notably energy storage of renewable power, will be the focus of development.

In view of the difficult cost transmission of energy storage and lack of clarity in business model, the guidelines also proposed to optimize the policy mechanism, including clarifying the independent market entity status of new energy storage, improving the price mechanism of new energy storage, and enhancing the incentive mechanism of "new energy + energy storage" projects. We believe that these measures will improve the economy of and incentivize investment in energy storage projects, and equipping energy storage in renewable power projects will provide certain compensation, rather than being a pure cost item.

Figure 21: Main contents of "Guidelines on Accelerating the Development of New Energy Storage"

The main target	By 2025, new types of energy storage will move from initial commercialization to large-scale development, with installed capacity above 30m kW. New types of energy storage will play a significant role in promoting carbon peak and neutrality. By 2030, new types of energy storage will be fully marketized, and the installed capacity can basically meet the needs of the new power system. New types of energy storage will become one of the key pillars to support the goals of carbon peak and neutrality.
Vigorously promote the construction of power supply side energy storage projects	Combined with the actual requirements of the system, a batch of system-friendly renewable energy power station projects with energy storage are built to ensure the efficient consumption and utilization of renewable energy through the coordinated optimization of energy storage, so as to provide capacity support and peak shaving capability for the power system.
Actively promote the grid side energy storage layout	Energy storage on the grid side is arranged at key nodes to improve the flexible adjustment ability and security and stability level of the system after large-scale and high-proportion new energy and large-capacity DC access. At the ends of the power grid and remote areas, the power grid side energy storage or wind/PV storage power stations are built to improve the power supply capacity of the power grid.
Actively support the diversified development of user-side energy storage	Encourage exploration of new scenarios for integrated development of energy storage for other end users, including distributed new energy, microgrid, big data center, 5G base station, charging facilities and industrial parks.
Clarifying the independent market entity status of new type of energy storage	To study and establish market entry criteria, trading mechanisms and technical standards for energy storage to participate in transactions in the medium - and long-term, in order to accelerate the entry of energy storage into various electricity markets.
Improving the new pricing mechanism for energy storage	Establish the tariff mechanism for independent energy storage power station on the grid side, gradually promote the energy storage station to participate in the power market; study the inclusion of the cost and income of alternative energy storage facilities of power grids in electricity transmission and distribution tariffs; improve peak-valley tariff policies to create more space for user-side arbitrage.
Improving the incentive mechanism for "new energy plus energy storage" projects	For new energy power generation projects with supporting or shared energy storage, dynamic evaluation of their system value and technical level can be given appropriate preference in competitive allocation, project approval (filing), grid-connection timing, system scheduling and operation arrangement, guaranteed utilization hours, and compensation assessment of auxiliary power services.

Sources: NEA, BOCOM Int'l

Enlarging the peak-valley tariff spread to create for room for user-side arbitrage: In July, the NDRC issued "Notice on Further Perfecting the Mechanism of Time-of-Use (TOU) Electricity Prices", which required local authorities to expand peak-valley tariff spread based on TOU. For places with peak-valley load spread of more than 40%, the peak-valley tariff spread shall be at least 4:1 in principle; for other places, it shall be no less than 3:1. For high peak hours, the tariffs need to be revised up by at least 20%, while a deep-valley tariff mechanism shall be formulated with reference to that for high peak hours. An all-season tariff mechanism shall be established.

As of end-September, eight provinces, including Guangdong and Zhejiang, had introduced new TOU pricing mechanisms. Take Guangdong as an example, the peak hours are 10:00-12:00 and 14:00-19:00, while the valley hours are 00:00-08:00; the rest are plain hours. The peak-plain-valley price spread was adjusted from 1.65:1:0.5 to 1.7:1:0.38, and the peak-valley price difference reached 4.5:1. The high-peak electricity price (25% above peak-hour price, 5.6:1 spread vs. valley-hour price) is implemented during 11:00-12:00 and 15:00-17:00 from July to September, as well as hot days (max. day-time temperature at 35^{o}C or above) in other months.

Widening peak-valley price spread will enlarge the profit space for user-side energy storage. Previously, due to the small peak-valley price difference, China's user-side energy storage development was slow. As power guzzlers will have more incentives to equip large-scale power storage to reduce electricity cost during peak (especially high-peak) hours, user-side energy storage will grow rapidly.

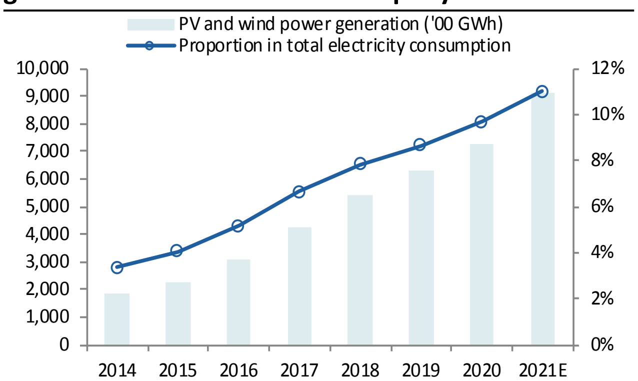
Power supply side: renewable power penetration makes energy storage mandatory

In recent years, China's renewable energy generation has grown rapidly. The CAGRs of wind power and PV power generation during 2014-20 was as high as 25.7%, and their proportion in China's power mix increased from 3.3% to 9.7% in the same period. We expect this to further increase to about 11% in 2021 and 80% in 2050.

However, due to the instability of wind power and PV power output, the higher the proportion of renewable energy is, the more difficult their consumption becomes. While the wind and PV curtailment rates in China decreased significantly from 15.0% and 12.6% in 2015 to 3.5% and 2.0% in 2020, the decline has slowed sharply since 2020. In 2Q21, the wind and PV curtailment rates in Qinghai, Hebei and other regions even showed a significant YoY increase. We project curtailment rates in China will rebound gradually and approach the reasonable level of about 5%.

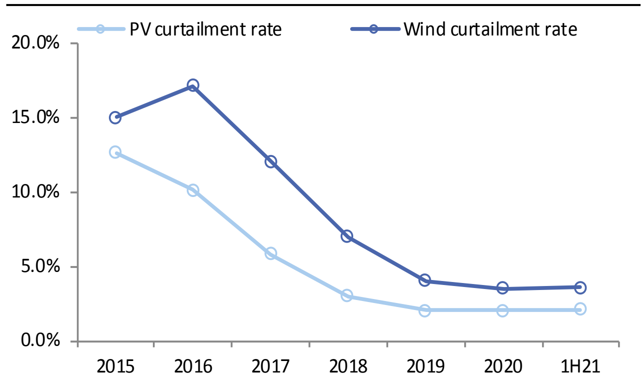
At present, the traditional thermal power peak modulation and other means can hardly meet the consumption demand of all renewable energy projects. The increase of renewable energy penetration from 20% to 50% will lead to a sharp increase in the instability of the power system, so large-scale energy storage becomes necessary.

Figure 22: The proportion of wind and PV power generation in China increases rapidly



Source: NEA, BOCOM Int'l estimates

Figure 23: The decline of wind and PV curtailment rates in China is slowing



Source: NEA, BOCOM Int'l

Figure 24: In 2Q21, wind and PV curtailment rates in some regions increased significantly YoY

	Wind curtailment rate (%)	YoY increase (%)
Hebei	4.6	1.6
Shanxi	1.6	1.5
West Inner Mongolia	7.2	1.0
Qinghai	11.5	7.1
Shaanxi	1.8	0.7
Ningxia	2.2	1.2
Northeast region	2.4	1.2
	PV curtailment rate (%)	**YoY increase (%)**
Hebei	2.0	1.2
Qinghai	13.2	3.6

Source: NEA, BOCOM Int'l

Energy storage will remain mandatory as a pre-requisite of grid connection: For renewable energy generation projects, energy storage can not only meet the grid connection pre-requisites, but also reduce wind and PV curtailment. The income per kWh of energy storage is equal to the feed-in tariff * increased on-grid electricity/electricity discharge. At present, as the per-kWh cost of lithium battery storage is still significantly higher than the feed-in tariff (RMB0.3-0.4/kWh) of renewable energy projects, the income still cannot cover the cost. Even if the energy storage cost drops below the feed-in tariff, if power curtailment is low, the increased on-grid power will be significantly lower than the electricity discharge, and the income can still hardly cover the cost. Therefore, we believe that in China where the feed-in tariff is relatively low, and without government subsidies, energy storage in renewable power generation will remain mandatory as a pre-requisite of grid connection.

In 2020, a small number of provinces required new centralized renewable energy projects to equip energy storage. Starting in 2021, most new centralized renewable energy projects are required to have energy storage.

In July, the NDRC and the NEA issued "Notice on Encouraging Renewable Energy Generation Enterprises to Build or Purchase Peak-shaving Capacity to Increase the Scale of Grid Connection", under which grid enterprises shall be the main entities responsible for the consumption of new grid-connected capacity each year. Subsequently, the scale and proportion of consumption by grid enterprises shall be reduced in an orderly manner. In the initial stage of market-based grid-connected projects, peak-shaving capacity shall be allocated based on a pegging ratio of 15% of power (more than 4 hours). Priority shall be given to grid-connected projects with pegging ratios of more than 20%, and such proportion shall be adjusted in due course after 2022.

Starting this year, new renewable power generation projects will be divided into guaranteed grid-connection projects and market-oriented grid-connection projects. Consumption of power generated by guaranteed projects are guaranteed by the grid, while market-based projects require energy storage to be equipped.

Although the central government does not require the guaranteed grid-connection projects to equip energy storage, a large number of provinces still require them to have energy storage or give some weight to energy storage in the competitive allocation scoring rules. The energy storage requirements are mostly 10-15% power *2 hours, which is significantly lower than the 15-20% power *4 hours requirement for market-oriented grid-connection projects.

Energy storage for renewable power grid-connection will vastly outgrow renewable power capacity: We expect that, with rising penetration of renewable energy generation, the power ratio and duration of energy storage required for both types of project will further increase. At the same time, the notice clearly stated for the first time that the proportion of guaranteed grid-connected projects will continue to decrease. In addition, although currently only centralized renewable power projects need to equip energy storage, the requirement could be extended to distributed projects in the future. Driven by the above factors, energy storage for renewable power grid-connection will vastly outgrow renewable power capacity.

Figure 25: Energy storage requirements for guaranteed grid-connection projects in selected provinces

Province	Power ratio	Duration (hours)
Inner Mongolia	15%	2
Henan	10%	2
Qinghai	10%	2
Xinjiang	15%	2
Jiangxi	10%	2
Hubei	10%	2
Ningxia	10%	2
Shandong	20%	2
Gansu	10% in Hexi area, 5% in other areas	2
Hebei	10% in southern Hebei and 15% in northern Hebei	2
Tianjin	10%	1

Source: Provincial energy bureaus, BOCOM Int'l

User side: peak-valley arbitrage profitable in some provinces and cities

The main profit model of user-side energy storage is peak-valley arbitrage. This means charging during valley periods of low tariff and discharging during peak periods of high tariff, so as to reduce electricity cost. Revenue per kWh = peak tariff - valley tariff/system efficiency. It is estimated that this model becomes economical when the peak-valley tariff difference exceeds RMB0.7. Beijing, Jiangsu, Guangdong and Zhejiang have already met this condition. With the gradual implementation of the national policy of expanding peak-valley tariff gap, the model will show further improving economics.

Figure 26: Peak-valley price difference in some provinces (RMB/kWh); a spread of >RMB0.7 is economical

	Industrial/commercial tariff (0-1kv)			Big industrial users' tariff (0-1kv)		
	Peak	**Valley**	**Spread**	**Peak**	**Valley**	**Spread**
Beijing	1.42	0.29	1.1	1.4	0.28	1.1
Xinjiang	0.66	0.17	0.5			
Jiangsu	1.11	0.30	0.8	1.07	0.29	0.8
Guangdong	1.1	0.32	0.8	1.07	0.31	0.8
Qinghai	0.62	0.19	0.4	0.61	0.19	0.4
Shandong	1.04	0.32	0.7	1.01	0.32	0.7
Zhejiang	1.21	0.38	0.8	1.16	0.35	0.8
Yunnan	0.74	0.25	0.5	0.72	0.24	0.5
Gansu	0.9	0.31	0.6	0.88	0.31	0.6
Henan				0.94	0.32	0.6
Shanghai	0.88	0.33	0.6	0.86	0.31	0.5
Anhui	0.97	0.37	0.6	0.95	0.36	0.6
Hebei	0.86	0.34	0.5	0.84	0.33	0.5
Shanxi	0.77	0.31	0.5	0.74	0.30	0.4
Ningxia				0.60	0.27	0.3
Tianjin	0.68	0.39	0.3	0.66	0.39	0.3
On average,	**0.88**	**0.32**	**0.5**	**0.85**	**0.29**	**0.3**

Source: Provincial NDRCs, BOCOM Int'l

User-side energy storage can also increase self-consumption of electricity and reduce electricity cost. Combined with rooftop distributed PV, user-side energy storage can transfer the electricity not used up during daytime peak power generation periods to other periods of the day. Its revenue per kWh = peak electricity price - PV feed-in tariff/ system efficiency.

For large industrial users who adopt dual-system electricity pricing, user-side energy storage can save capacity-based electricity charges. Under the dual-system pricing, electricity charge = capacity-based charge (maximum demand * basic tariff) + electricity consumption * electricity price, while energy storage can reduce the maximum demand. Assuming that 1-hour energy storage is equipped, the investment cost of energy storage is high at RMB2/Wh (due to its small scale), and the basic electricity price is low at RMB30/kW * month in China. We calculate that the payback period of investment is only 6.25 years, far shorter than the service life of the energy storage system, and hence has good economy.

Figure 27: Estimated investment payback period of saving capacity-based electricity cost by energy storage

	1 MW x 1 hour of energy storage
Maximum demand reduction (MW)	1
Basic electricity price (RMB/kW*month)	30
Annual saving of capacity-based electricity charges (RMB0'000)	36
Energy storage investment cost (RMB0'000)	200
Annual operation and maintenance cost of energy storage (RMB0'000)	4
Annual actual income (RMB0'000)	32
Payback period (years)	6.25

Source: BOCOM Int'l estimates

Power grid side: frequency modulation is becoming economical, while peak modulation awaits cost reduction

Energy storage on the power grid side is mainly used for peak and frequency modulation, and can obtain add-on service fees as revenue.

Peak modulation refers to the synchronous adjustment through extra power generation units due to the imbalance between power load and consumption, in order to maintain the power balance and frequency stability of the system.

Frequency modulation means that when the load fluctuates in a small range, the generator frequency will increase or decrease. The generator units need to adjust the frequency through the governor and AGC to restore the rated frequency to 50Hz. The combination of energy storage equipment and thermal power unit to provide frequency modulation service can improve the operation efficiency of thermal power unit and reduce wearing.

Energy storage peak modulation revenue per watt = peak modulation compensation price. At present, the peak modulation compensation price is RMB0.4-0.6/kWh in most provinces, while the peak modulation of lithium battery storage is not economical in most provinces, and the cost still needs to be further reduced.

Energy storage frequency modulation revenue = frequency modulation mileage * mileage compensation price. Mileage cost refers to the average cost of frequency modulation per mileage in the life cycle of frequency-modulation power storage station, which is the total cost/total frequency modulation mileage of energy storage power station. This is an important indicator to evaluate the economy of energy storage power station participating in primary or secondary frequency modulation of power grid. It is estimated that the mileage cost of lithium battery storage is ~RMB5/MW at present, while the mileage compensation price of provinces is mostly RMB5-8/MW. Frequency modulation of lithium battery storage is becoming economical in some provinces.

Huge Potential in Industry Chain of Lithium Battery Storage

The upstream of lithium battery storage industry chain mainly includes battery raw materials and production equipment suppliers; the midstream comprises suppliers of battery/battery management system, energy management system and energy storage converter; and the downstream players are energy storage system integrators, installers and end users.

We believe that the lithium battery storage industry chain will fully benefit from the rapid growth of demand, among which energy storage batteries and converters with the highest value share deserve the most attention. The demand for energy storage battery is measured by electricity amount, while that for converter is measured by power. As the distribution and storage time gradually increases, the demand for energy storage battery will grow faster than that for converter.

Battery: technology and scale are the major arenas; power battery leaders have higher market share

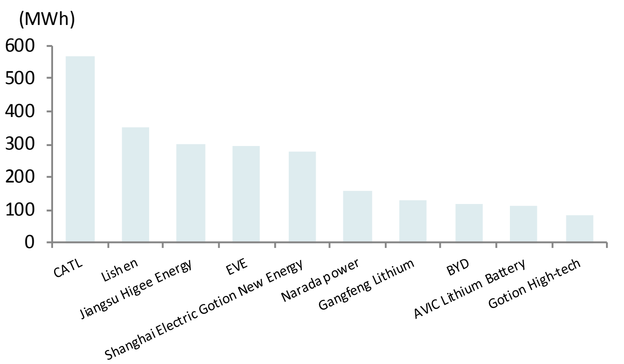
Battery is the core component of energy storage system, including positive electrode, negative electrode, electrolyte, diaphragm, structural parts and so on. We estimate that lithium batteries (including sodium batteries) will occupy 98% of the electrochemical energy storage market, and the domestic market size of lithium battery will increase from RMB5.9bn in 2021 to RMB41.5bn in 2025, with a CAGR of 63%. Due to the small scale of the previous energy storage battery market, the current manufacturers are basically power battery manufacturers.

Battery technology barrier is high as it takes long for the technologies to mature. Power battery makers with established experience in developing lithium batteries enjoy first-mover advantages. There is still a lot of room for improvement in the performance of energy storage batteries in the future. Technological progress is the main factor driving cost reduction, and it is also crucial to market competition. For example, as cycle life has a big impact on the per-watt cost of energy storage, batteries with a longer cycle life will enjoy premium. On the other hand, the battery industry has obvious scale effect. The raw materials of energy storage battery and power battery are basically the same, and the production process is similar. With massive power battery production capacity, the power battery leaders will enjoy obvious scale advantage in the production of energy storage battery.

Therefore, we believe that compared with pure energy storage battery makers, the power battery leaders are more likely to become the energy storage battery leaders. However, in the field of power battery, both the lithium iron phosphate and ternary lithium battery technologies are widely adopted in the market, while in the field of energy storage battery, only the lithium iron phosphate technology is used on a large scale. Therefore, only the power battery leaders with deeper layout on lithium iron phosphate technology has obvious advantages in the field of energy storage battery.

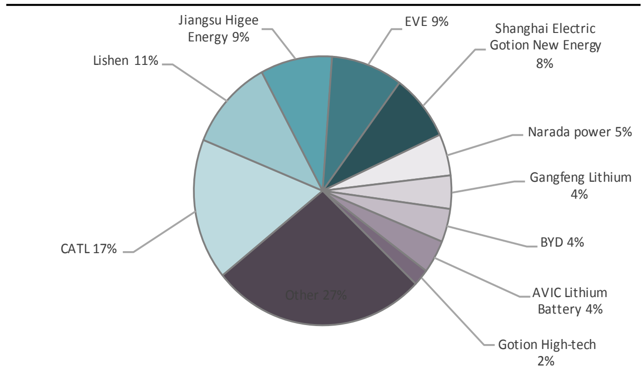
According to CNESA, CATL ranked first in the sales of energy storage batteries in China in 2020, accounting for 17% of the market, and its domestic sales of power batteries also ranked first. The top 10 power battery leaders also include Lishen, Eve Energy, Gotion High-tech, BYD and CALB. CR3, CR5 and CR10 were 37%, 54% and 73%, respectively. We expect the energy storage market to become more regulated, making the share of power battery leaders to shot up in the energy storage battery market.

Figure 28: Ranking of energy storage battery manufacturers in China (by sales volume), 2020



Source: CNESA, BOCOM Int'l

Figure 29: Market share of energy storage battery manufacturers in China (by sales volume), 2020



Source: CNESA, BOCOM Int'l

Energy storage converter: PV inverter manufacturers have obvious advantages in sales channels and scale

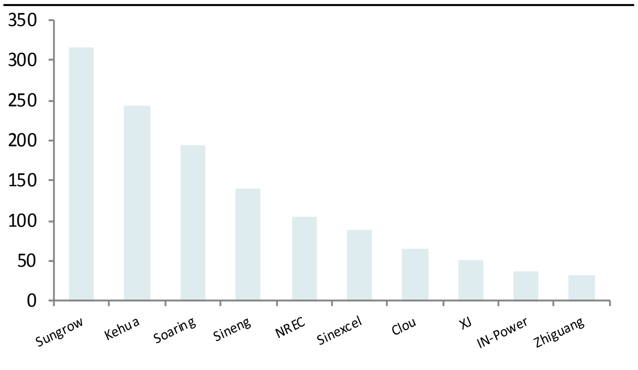
Energy storage converter is another core component of energy storage system, which can transform the DC current of battery system and the AC current of power grid. Upstream includes players of IGBT components, PMIC power chips, passive devices, structural parts, etc. We estimate that the domestic market size will increase from RMB1.1bn in 2021 to RMB7.5bn in 2025, with a CAGR of up to 60%.

Energy storage converters and PV inverters share the same technology and highly similar parts. To produce energy storage converters on the production line of PV inverters, it only needs to take 1-2 weeks to switch the production process. Their applications are also highly similar. Upstream component suppliers and downstream power plant developers and contractors can be shared. In addition, the current price of energy storage converters (~RMB0.35/watt) is much higher than the price of PV inverters (~RMB0.2/watt). Therefore, many PV inverter manufacturers have entered the field of energy storage.

The core technical parameter of energy storage converters is cycle efficiency, but there is little difference among manufacturers, so the cost and sales abilities are very critical. PV inverter manufacturers enjoy cost advantage with their large-scale inverter production capacities, as well as sales channel advantage as most of the demand comes from renewable energy customers.

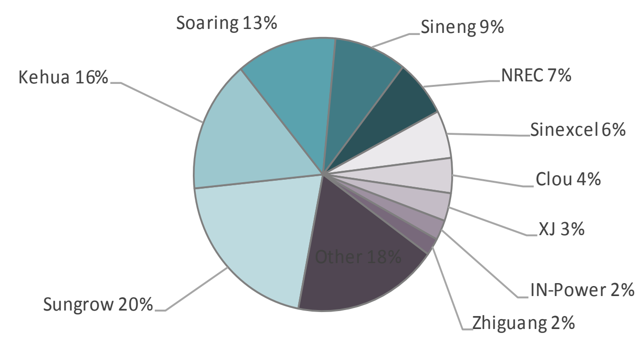
According to CNESA, in 2020, Sungrow ranked first by sales of energy storage converters in China, accounting for 20% of the market, and its global sales of PV inverters also ranked first. Top ten manufacturers include Kehua Data, Sineng Electric and Shenzhen Sinexcel. CR3, CR5 and CR10 were 48%, 64% and 82%, respectively. We expect that the market share of inverter manufacturers will further increase in the converter market.

Figure 30: Ranking of energy storage converter manufacturers in China (by sales volume - MW), 2020



Source: CNESA, BOCOM Int'l

Figure 31: Market share of energy storage converter manufacturers in China (by sales volume), 2020



Source: CNESA, BOCOM Int'l

System integration: competitive landscape is yet in shape with many participants from different fields

Energy storage system integration refers to the integration of various components of the energy storage system, which requires specific selection and installation strategy of battery packs, BMS, PCS and other equipment as well as design of system control strategy. The technological threshold is not high, but project experience is very important. We estimate that the domestic market size will increase from RMB9.6bn in 2021 to RMB69.1bn in 2025, with a CAGR of 64%.

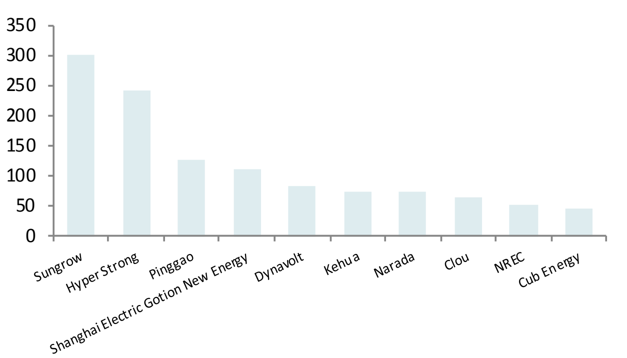
At present, energy storage system integrators come from a wide range of sources. One is the new energy system integrators, such as Sungrow (also an energy storage converter manufacturer), who expand the original new energy system integration business horizontally. Since new energy investors tend to entrust the construction of new energy power stations and supporting energy storage power stations to the same system integrator, we believe that such companies will have advantages in new energy distribution and storage.

Battery makers (including BYD and Shanghai Electric Gotion New Energy) and energy storage converter makers (such as Kehua Data and Clou Electronics) expand towards downstream to the system integration segment, which may promote the sales of energy storage batteries or converters.

Traditional power equipment manufacturers (including Pinggao Electric) have accumulated rich experience in traditional power plant integration and understand the operation characteristics of the grid. We believe that they will have an advantage in the grid-side market.

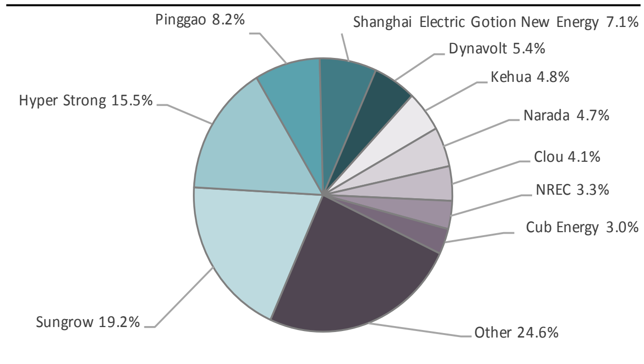
According to CNESA, in 2020, Sungrow ranked first in the domestic sales of energy storage converters, accounting for 19% of the market. CR3, CR5 and CR10 were 43%, 55% and 75%, respectively. The market concentration is not high as there are many participants, thus the competition landscape is not clear.

Figure 32: Ranking of energy storage system integrators in China (by sales volume - MW, 2020



Source: CNESA, BOCOM Int'l

Figure 33: Market share of energy storage system integrators in China (by sales volume), 2020



Source: CNESA, BOCOM Int'l

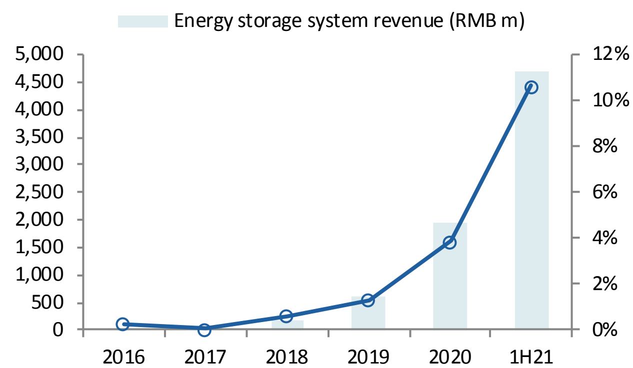
Companies in spotlight

- **CATL (300750 CH): the power battery leader that will excel in energy storage**

CATL has advanced technologies in energy density, cycle life, safety and cost control of power batteries, which are direct advantages in energy storage. For example, the CTP technology developed by CATL can greatly improve the volume energy density. And it has developed energy storage batteries with an ultra-long cycle life of 12,000 charging times, far more than the industry average of 5000-6000 times. On the other hand, CATL has a strong position in both the upstream and downstream of the power battery industry with its scale advantage, and its energy storage batteries will benefit from the company's power battery resource advantage. By the end of June 2021, the company's power battery and energy storage battery capacity reached 65.45GW, and has 92.5GW of capacity under construction. We expect that as a leader of power battery, CATL will make remarkable achievements in the field of energy storage.

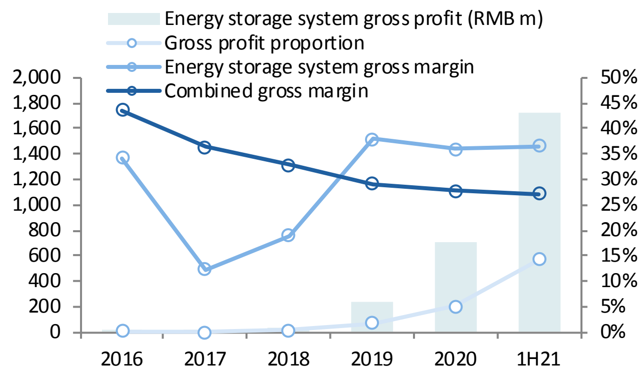
In recent years, energy storage revenue of the company has skyrocketed. In 2020, energy storage system revenue reached RMB1.943bn, up 219% YoY, and its energy storage battery sales ranked first in China. The revenue of energy storage system in 1H21 was RMB4.693bn, up 727% YoY, 2.4x that of 2020. Energy storage accounted for 10.7%/14.3% of total revenue/gross profit, and the gross margin was as high as 36.6%, far higher than the blended margin of 27.3%. Energy storage business will become an important growth point of the company.

Figure 34: CATL's revenue/share of revenue from energy storage business



Source: Company data, BOCOM Int'l

Figure 35: CATL's gross profit and gross profit margin of energy storage business



Source: Company data, BOCOM Int'l

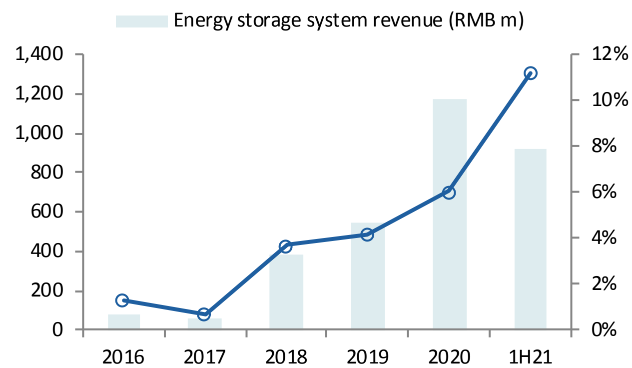
- **Sungrow (300274 CH): top player in both energy storage converter and system integration**

Sungrow is the world's largest PV inverter manufacturer and the top three PV system integrators in China. It entered the field of energy storage in 2014 and gradually expanded from energy storage converter to system integrator. As a leader in both PV inverter and PV system integration, Sungrow enjoys scale advantage in energy storage converter as it can share the same production technology and production lines. It is also advantaged in in the sales channels of energy storage converter and system integrator. The synergy effect among them is also prominent.

In 2020, the company ranked first in the domestic sales of energy storage converters and system integration, realizing RMB1.17bn of energy storage system revenue, up 115% YoY. In 1H21, the company realized RMB920m of energy storage system revenue, up 267% YoY. Revenue and gross profit accounted for 11.2% and 8.5% of total, respectively, and the gross profit margin was 21.2%, lower than the blended margin of 28.0%. Although the gross margin of energy storage converters is significantly lower than that of PV inverters at present, the unit price is much higher. With the rapid growth of energy storage market, we expect the gross margins of the two will be closer, and the gross profit per watt of energy storage converters will be significantly higher than that of PV inverters.

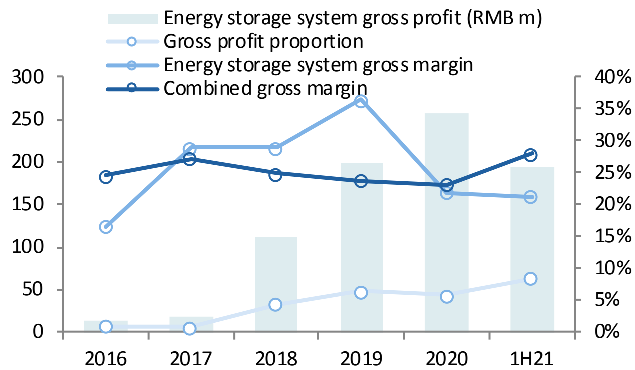
The company plans to vigorously increase the production capacity of energy storage converters to 15.3GW in 2023 from 0.3GW in 2020. It expects annual production to rise from 0.99GW in 2020 to 8.5GW in 2025. In our view, Sungrow's leadership in the energy storage market will send it on a sustainable and strong growth track.

Figure 36: Sungrow's revenue/share of revenue from energy storage business



Source: Company data, BOCOM Int'l

Figure 37: Sungrow's gross profit and gross profit margin of energy storage business



Source: Company data, BOCOM Int'l

Figure 38: Sungrow's capacity and production plans for energy storage converters

	2018	2019	2020	2021E	2022E	2023E	2024E	2025E
Capacity (GW)	0.30	0.30	0.30	5.7	9.9	15.3	15.3	15.3
Output (GW)	0.15	0.31	0.99	1.5	2.3	3.6	5.6	8.5
Capacity utilization rate (%)	50.3%	104.0%	328.6%	26.3%	23.2%	23.5%	36.6%	55.6%

Source: Company data, BOCOM Int'l

Risk Factors

Policy support becomes weaker than expected. The development of electrochemical energy storage in China is highly dependent on policy support. The distribution and storage of renewable energy at the power supply side are basically mandatory requirements of the government, and the proportion of distribution and storage projects, power distribution and storage ratio, and distribution and storage duration are all regulated by policies. The energy storage cost recovery mechanism at the power grid side also needs to be formulated by policies.

New energy installations fall short of expectations. The demand of renewable energy distribution and storage occupies the highest proportion in the newly installed electrochemical energy storage in China, which is highly related to the addition of new energy installations. Lower-than-expected new energy installations will lead to slower growth in energy storage demand.

Costs drop less than expected. Further reduction of the cost of electrochemical energy storage is an important prerequisite for the rapid growth of its demand. Slowing technological progress and rising raw material prices could lead to slower-than-expected reduction of energy storage costs.

Influx of entrants results in overcapacity. Explosive demand growth and low industry barriers attract a large number of manufacturers from different fields to enter the energy storage industry. Rapid capacity expansion may lead to excess capacity and intensify market competition.

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Analyst Stock Rating:	Analyst Industry Views:
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