International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review on Energy Storage Systems (ESS) - A Study on Effectiveness of ESS Solution in Vietnam's Solar Energy Storage

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ABSTRACT

In this paper we discussed the effectiveness of ESS Solution in Vietnam's Solar Energy Storage. Vietnam is one of Asia's fastest expanding energy markets. Vietnam's government predicts the electricity consumption to rise at a pace of 10-12 percent per year through 2030, making it one of the fastest-growing power consumption rates in Asia. The report from the national utility Vietnam Electricity (EVN) stated that the building of new transmission lines may not be able to keep up with the pace of new solar and wind power projects. So, energy storage is the suitable solution for non-hydro renewable energies (Minh, 2020). Battery storage has the potential to substantially enhance renewable energy's costs and dependability. To regulate Capacity merit and energy efficiency of Solar power it is integrated with the Battery Energy Storage Systems, so the intermittency can be greatly reduced and Zero Carbon Emission activity

Introduction:

The Global energy consumption is expected to rise by 4.6 percent in 2021according to the report of International Energy Agency(Choudhary, 2021) .Vietnam's installed power production capacity is over 56,000 MW. The overall installed power source capacity of the Vietnamese electrical system is around 69GW according to an Institute of Energy of Vietnam study from March 2021.Between 2021 and 2030, energy capacity is anticipated to grow at a 5.7 percent yearly average, reaching 129.5 GW by 2030. It also calls for USD 148 billion in investments between 2021 and 2030 to boost power generation and expand the electrical network, with 74 percent going to power sources and 26 percent to grid expansion.

Vietnam is one of Asia's fastest expanding energy markets. The country's rapid industrialization has driven a surge in energy consumption, particularly for electricity. Due to its huge population and rapid economic expansion, as well as rapidly diminishing reserves in its current oil and gas resources. Vietnam's power demand and consumption would rise, posing a threat to the country's energy security. Vietnam's government predicts the electricity consumption to rise at a pace of 10-12 percent per year through 2030, making it one of the fastest-growing power consumption rates in Asia.

Localized power shortages in Ho Chi Minh City's manufacturing center are projected to start in 2021, with a deficit of more than 10,000 megawatts or 7.5 percent of total capacity by 2030, according to Vietnam's Ministry of Industry and Trade (MOIT). The overall investment capital for the period 2021-2030 would be around USD 128.3 billion of which the cost for the power generation is 950 million and for the power grid it cost about 32.9 billion(Internation Trade Administration, 2021).

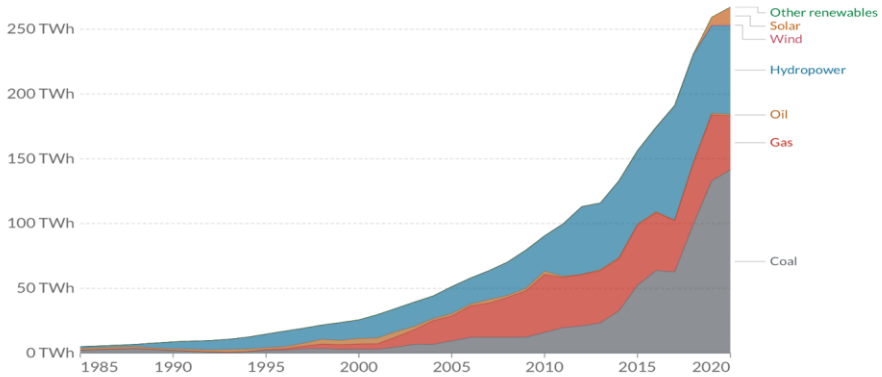

Figure 1:**Vietnam Energy Consumption by source** (Roser, 2020)

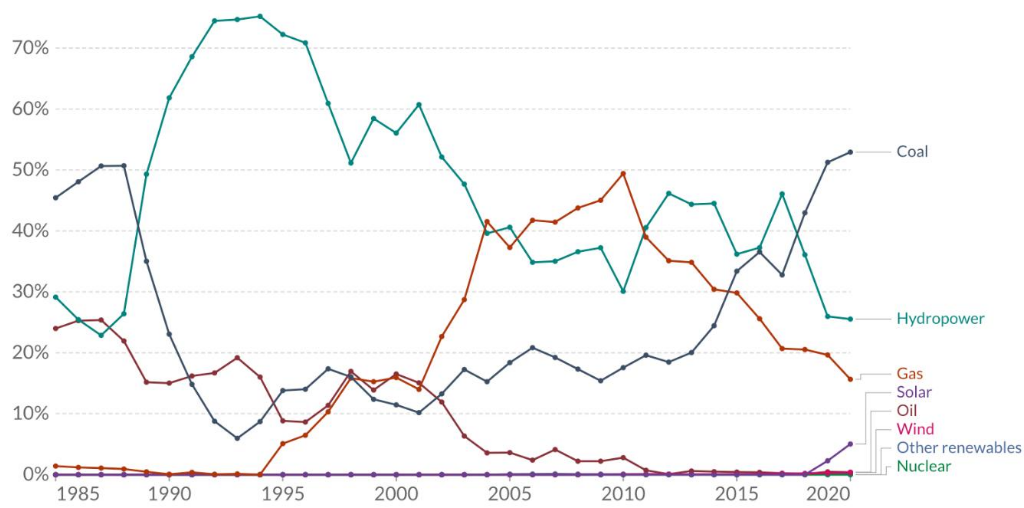

Figure 2: **Share of energy consumption in Vietnam over years** (Roser, 2020)

Vietnam may be thought of as a country having a lot of solar energy potential. Solar resources are equivalent to the countries like Italy, Spain and China In certain southern locations of Vietnam, peak irradiation levels of up to 5.5 kWh/m2/day have been recorded(Energypedia, 2015). The present solar PV market in Vietnam is projected to be approximately 5 MWp, with 80% of off-grid applications in rural regions.since larger ground-mounted PV systems are being developed and Solar energy has yet to be incorporated into national energy development initiatives such as the National Power Development Plan (Energypedia, 2019).

With the increasing growth of demand, the transmission system is being intensively used to balance the system's capacity. Demand is not evenly spread across the country. The North (with Hanoi) and South (with Ho Chi Minh City) both absorb roughly 45 percent of the electricity, while the Central section serves primarily act as a transmission corridor and a manufacturing location.

For the big solar power facilities, frequently constructed regions far from the load, resulting in a heavy and expensive transmission line. This power source is inherently unstable and fluctuating in considerable capacity over short periods of time, so the use of backup resources such as electrical storage devices is needed. Furthermore, Vietnam has limited expertise combining solar electricity. In order to integrate renewable energy, Vietnam must solve critical challenges such as network infrastructure development, energy storage system integration, and precise and flexible system management through grid automation.

The grid system, which currently receives 300 MW from solar power plants, could see a capacity increase of over 4 GW in 2019 from plants concentrated primarily in the Southern and Central regions, where the transmission grid systemhas not been developed to meet such a large capacity. The present grid can only take 2 GW of renewable energy, according to an EVN - Vietnam Electricity report. As a result, a significant portion of the capacity would be reduced, and the situation might deteriorate in the following years(Vu, 2019).

The report from the national utility Vietnam Electricity (EVN) stated that the building of new transmission lines may not be able to keep up with the pace of new solar and wind power projects. So, energy storage is the suitable solution for non-hydro renewable energies (Minh, 2020).

The one of the major Storage option is to use batteries, which might come from a fleet of electric cars on the one hand, and from specialist ESS - EnergyStorage Systems on the other. ESS is still in its early phases, thus the investment to acquire and manage the system is still rather costly, despite the tremendous potential for expansion and the market appearing to be expanding. This will necessitate improved performance as well as lower initial investment prices in order for ESS to be widely accessible to the vast majority of customers(Vu, 2019).

GE Power and the United States Trade and Development Agency (USTDA) announced that Vietnam Electricity has awarded a USTDA-funded battery storage feasibility study to GE's Energy Consulting unit. "We are working with Vietnam Electricity (EVN) on this feasibility study for battery energy storage and other technologies that can help the country enhance its system and meet its renewable energy integration goals," said Beth LaRose, General Manager of Energy Consulting in General Electric. When it comes to planning for the grid integration of huge volumes of renewable power, EVN continues to be a pioneer in Southeast Asia(General Electric, 2019). In this paper, various countries using batteries for energy storage are discussed. The main objective of this paper is the adaptation of battery energy storage system will provide an optimal solution for Solar energy in Vietnam will be concluded.

OVERVIEW OF ENERGY STORAGE SYSTEM:

Battery energy storage solutions would be a best way to deal with Vietnam's grid problems. Demonstrating the commercial feasibility of battery energy storage systems might enhance Vietnam's usage of renewable energy while lowering greenhouse gas emissions and coal usage(FundsforNGOs, 2021).The battery storage market size is expected to increase with CAGR of 34.04% from 1.53 Billion US dollar in 2021 to 8.62 Billion Us dollar by 2026 as per the latest report published. The storage system is considered as an assets since it is used to reduce the impact of intermittency and variability in solar power system which also provide a solution in supply the power grid using solar power, saving on cost for energy production and Zero Emission(Market Data Forecast, 2021).

The leading energy storage technology in electrochemical storage integrated with PV system are listed in a table below based on the maturity (i.e., based on development).

Technology Type	Technology	Maturity
Electro-Chemical	Electro-Chemical Capacitors	◑
	Lead Acid Batteries	●
	Lithium-Ion Batteries	◕
	Flow Batteries	◑
	Metal Air Batteries	◔
	Sodium Sulfur Batteries	●

Legend: ○ Very Low ◔ Low ◑ Medium ◕ High ● Very High

Figure 3:Leading ESS Technologies(Deloitte, 2019)

Solar Battery terms which are used for differentiating the battery type for various applications. The key terms are Cycles, Depth of Discharge, Life-span.

A **battery's cycle** is defined as a single discharge and recharge. The number of times a battery may be charged and drained before it has to be replaced is referred to as its life-cycle. Although all batteries may be drained to 100% capacity, many battery types should only be depleted to 70-90 percent. The depth of discharge is the term for this. Cycles are also significant since some manufacturers track warranty claims using the number of cycles.

The **depth of discharge** defined as how much energy is drained from a battery before it is recharged. Many types of batteries should not be drained entirely because this reduces the battery's lifetime. Lithium batteries, for example, should only be drained to 90% of their capacity before being recharged.

A battery's projected **life-span** is the amount of time it will endure before it has to be replaced. The length of a person's life can be measured in years or cycles. The lifespan of a lithium battery, for example, is predicted to be 13-18 years or 6,000-10,000 cycles.

The solar storage system consist of three main type of batteries are Lead acid, Flow and Lithium-ion.The **flow battery** is the most recent battery technology. A flow battery is made up of two tanks that are connected by a water-based liquid (Zinc Bromide).The discharge capacity and safety of a flow battery are two of its primary features. Flow batteries can be drained to 100% capacity without losing any of their capacity or lifetime. They're also safer since the liquid combination within is naturally fire-retardant, preventing thermal runaway.

The same sort of battery that powers your automobile is a **lead-acid battery**. They're an older technology that's mostly utilised for off-grid and DIY projects. Lead-acid batteries have been around for a long time, however they don't have the same energy density as their Lithium-ion counterparts. For the same amount of energy storage as a lithium-ion system, you'll need a lot more lead-acid batteries. Another disadvantage of lead-acid batteries is their lower discharge capacity and number of lifecycles. Most lead-acid batteries have a recommended discharge of 60%, which means that if you drain them below 60%, you'll shorten their lifespan. They also have a cycle life of only around a year.

Lithium-ion batteries are the same ones that power your iPhone, laptop, and other electrical devices. Because they can drain deeper and have more lifecycles than standard lead-acid batteries, they have become popular in the solar sector. A typical lithium-ion battery will last between 6,000 and 10,000 cycles at 90 percent discharge, giving it a lifetime of 13 to 18 years.Lithium-Iron-Phosphate (LFP) and Lithium-Nickel-Magnesium-Cobalt (LNMCC) are the two most popular kinds of lithium-ion batteries (NMC).The most popular battery type is LFP, which is favoured for its stability, longevity, and performance. They are less susceptible to thermal runaway, commonly known as overheating.

The second most widely used battery is NMC, which is favoured for its high energy density, cheap cost, and extended cycle life. Many businesses that currently manufacture batteries for other uses, like as Tesla, prefer NMC batteries since they already have the necessary infrastructure in place. These benefits made lithium-ion batteries are preferred most commonly for storage application(Zlatkov, 2021).

Electro-chemical capacitors, also known as super- and ultra-capacitors, store electrical energy in their material as an electrostatic charge rather than transferring it to another form. This results in a storage device that is both efficient and quick to respond, making it ideal for power applications that need frequent cycles and charge/discharge durations of one second or less. Although electro-chemical capacitors are still costly, they are increasingly being combined with longer-lasting battery energy storage technologies like lithium-ion and flow batteries to form hybrid systems.

To create energy**, metal air batteries** employ a chemical interaction between an electro-positive metal and oxygen from the surrounding air. Metal air batteries can offer up to three times the energy density of lithium-ion batteries while producing no harmful or ecologically dangerous materials. These batteries were designed for electric vehicles and power electronics applications, but they have the potential to become a competitive stationary storage solution in the next decade. Zinc-air chemistry is currently the most promising metal air chemistry.

Sodium sulphur (NaS) batteries, which have cycle lengths of four to six hours, have been the most frequently utilised battery storage technology for utility-scale energy storage applications during the previous decade. Flow batteries for applications needing discharge durations of more than four hours and lithium-ion batteries for shorter applications are likely to challenge sodium sulphur systems in the future. Sodium sulphur batteries, unlike these alternatives, are an established technology that is unlikely to see substantial cost or performance improvements in the near future(Deloittte, 2019).

A battery with an Energy Storage System (ESS) has one or more cells, modules, or battery packs that are managed by a battery management system (BMS). Typically, these batteries are enclosed in a casing with connections for connecting to other devices. A cooling and heating device may be included in some ESS batteries to avoid risk and ensure market access(TUV SUD, 2021).

Manufacturers & Suppliers of Industrial Battery Energy Storage Systems:

Tesla made headlines earlier this year when it announced the world's largest lithium-ion battery system in Australia, as well as its intention to put solar Powerwall 2 batteries in 50,000 homes throughout South Australia. Due to decreasing battery prices, energy storage has the potential to become a flourishing business, with innovative devices allowing consumers to produce and use more energy on-site. In the struggle of battery storage technology, Tesla is a well-known game changer.

LG Chem: LG Electronics, a well-known brand in appliances and consumer electronics, also sells energy storage solutions. Two high-voltage battery systems (RESU7H and RESU10H) and three low-voltage battery systems (RESU7H and RESU10H) are part of LG's Energy Storage System (ESS) line (RESU3.3, RESU6.5, and RESU10).Different inverters are included in the high-voltage designs, allowing users to convert solar Direct Current into useable Alternate Current.

Nissan is a car manufacturer. Nissan provides x storage rechargeable battery options that contain 4.2 kWh of energy. The storage was first sold in the United Kingdom, where Tesla and Mercedes-Benz both offer their battery alternatives. By utilising old battery cells in the x storage units, Nissan intends to set itself apart from its competitors as a sustainable battery provider. According to the business, x storage's capacity to manage when energy is taken from the grid and minimise peak usage helps users save money on electricity.

Hoppecke is a company that makes wet nickel-cadmium batteries. Available with capacities ranging from 10 to 1,100 amps per hour and operating temperatures ranging from -40 to +60 degrees Celsius.

Shield: Shield Batteries has been producing batteries in the UK for over 100 years, making it one of the industry's real professionals, with a depth of knowledge, skill, and success that few other firms can match. Shield Batteries is known for offering the highest quality and performance in every battery they supply, and they have a lengthy track record of doing so. Our consumers continue to put their faith in us to produce the finest products available utilising the best components. Batteries is well-known not only as a producer, but also as a distributor of batteries and related goods in a variety of sectors(Plant Automation Technology, 2021).

Battery Energy Storage Deployment in US:

Energy storage capacity deployed throughout the world totalled 173.7 GW. The energy storage capacity installed in 2020 in United States had over 24 GW of energy compared to 1,124 GW of total installed generation capacity.The rated power of EES systems is measured in megawatts (MW) and the energy storage capacity is measured in megawatt-hours (MWh). With 215 operating projects of 4.2 GW, California leads the United States in energy storage, followed by Hawaii, New York, and Texas. In 2021, there were 1,363 energy storage installations in operation across the world, with 11 more under construction. The United States accounts for 40% of operating projects.

The United States has many battery-related energy storage projects in operation which includes lead-acid, lithium-ion, nickel-based, sodium-based, and flow batteries. These projects will account for 0.79 GW of rated power in 2021, with round-trip efficiencies i.e. the ratio of net energy discharged to the grid to net energy required to charge the battery ranging from 60 to 95 percent.

Policy and standardization of ESS in U.S, California passed Assembly Bill 2514 in 2010, mandating the California Public Utilities Commission to set and achieve energy storage procurement objectives for investor-owned utilities totalling 1.33 GW finished by 2020 and installed by 2024.The Federal Energy Regulatory Commission - FERC of the United States issued Order No. 841 in 2018, requiring wholesale electricity markets to develop participation models that understand energy storage's physical and operational features.Maryland will establish the Energy Storage Income Tax Credit Program in 2020 as an incentive to deploy EES. In the case of residential properties, this equates to either 30% of total installation expenses or $5,000 for installing an EES, whichever is less.

According to one research, the economic worth of energy storage in the United States over a 10-year period is $228.4 billion The United States Department of Energy (DOE) used $185 million in American Recovery and Reinvestment Act (ARRA) funds to finance 16 large-scale energy storage projects with a total power capacity of more than 0.53 GW in research and development.The United States possesses 750,000 tonnes of lithium deposits, whereas the world has 21 million tonnes.Due to their high energy densities, high power, near-100 percent efficiency, and minimal self-discharge, lithium-ion batteries are one of the fastest-growing energy storage technologies(Center for Sustainable Systems, University of Michigan, 2021).

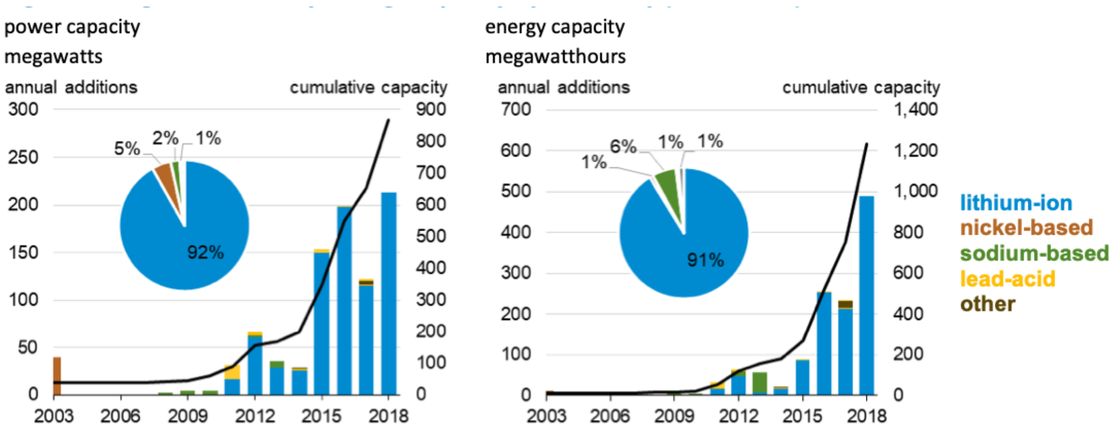

Fig 1. Large scale battery storage capacity - 2003–2018 (U.S. Energy Information Administration (EIA), 2021)

Battery Energy Storage Deployment in Japan:

According to the US Department of Energy's Global Energy Storage Database, Japan has the most battery-based energy storage installations. The majority of these battery energy storage installations have a capacity of more than 300 kW. In Japan's energy storage landscape, many battery technology types are represented. These include large-scale NaS sites with production capacities of up to 50 mW(Berre, 2016).

Site	Technology	City	Operator	Installed Capacity (kW)
Shiura Wind Park	Valve Regulated Lead-acid Battery	Shiura	Kuroshio Power	4,500
Yuza Wind Farm Battery	Valve Regulated Lead-acid Battery	Yuza	Shonai Wind Power Generation Co.	4,500
Okinawa Battery System	Lead-acid Battery	Okinawa	Okinawa Electric Power Company	2,000
Minami Hayakita Substation Vanadium Redox Flow Battery	Vanadium Redox Flow Battery	Abira	Hokkaido Electric Power Company	15,000
Hokkaido Electric Power- Sumitomo	Vanadium Redox Flow Battery	Abira-Chou	Hokkaido Electric Power Company	15,000
Tomamae Wind Farm	Vanadium Redox Flow Battery	Tomamae	Hokkaido Electric Power Company	4,000
Sumitomo Densetsu Office	Vanadium Redox Flow Battery	Osaka	Sumitomo Densetsu Co., Ltd.	3,000
Yokohama Works	Vanadium Redox Flow Battery	Yokohama	Sumitomo Electric Industries, Ltd.	1,000
Minami Daito Island Frequency Regulation	Nickel Metal Hydride Battery	Minami Daito	Okinawa Electric Power Company	300
Kyushu Electric - Buzen Substation - Mitsubishi Electric / NGK Insulators	Sodium-sulfur Battery	Buzen	Kyushu Electric Power Co.	50,000
Rokkasho Village Wind Farm - Futamata Wind Development	Sodium-sulfur Battery	Rokkasho	Tohoku Electric Power Company	34,000
Hitachi Automotive Plant	Sodium-sulfur Battery	Hitachinaka	Hitachi Ltd., Automotive Systems Group	9,600
NGK NaS: Morigasaki Water Reclamation Center	Sodium-sulfur Battery	Ota-ku	Tokyo Electric Power Company (TEPCO)	8,000

Fig 2 Japan’s Battery based Energy Storage Sites (Berre, 2016)

On Miyako Island, Okinawa Electric Power Company, Inc. (OEPC) installed a large-scale solar system to analyze the influence on the regular power grid and create a control system. Natural energy generating technology like photovoltaics provide for 16 percent of the island's peak consumption. On the Japanese mainland, this ratio is anticipated to be the same by 2030. The electricity generation system of Miyako Island is depicted in below figure. PV systems (3,000 kW), sodium-sulfur (NAS) battery systems (3,000 kW-7.2h), and a simulated distribution system are all part of the facility.

Fig 3 600 kVA power conditioning system (Noriko Kawakami, 2012)

The PVs (250 kW 4 sets), the NAS battery system (1,000 kW-7.2h), a lithium-ion battery system (100 kW), a Step Voltage Regulator (SVR), and a Static Var Compensator all work together to replicate the real load.The power conditioning system (PCS) for the NAS battery system and Batteries are needed to keep the system stable.

The New Energy and Industrial Technology Development Organization of Japan (NEDO) led a project, which was managed by Hokkaido Electric Power Company, Inc. The project's main goals were to assess the impact of large-scale PV systems on the power grid and to develop battery output power control technologies (proposed method) using solar radiation forecast and batteries. The system in Wakkanai mega solar includes a 5.02 MW PV system and a 1.5 MW-7.2 h NaS battery, as well as a prediction system. The system's output is linked to a 33 kV power line owned by the utility company (Noriko Kawakami, 2012).

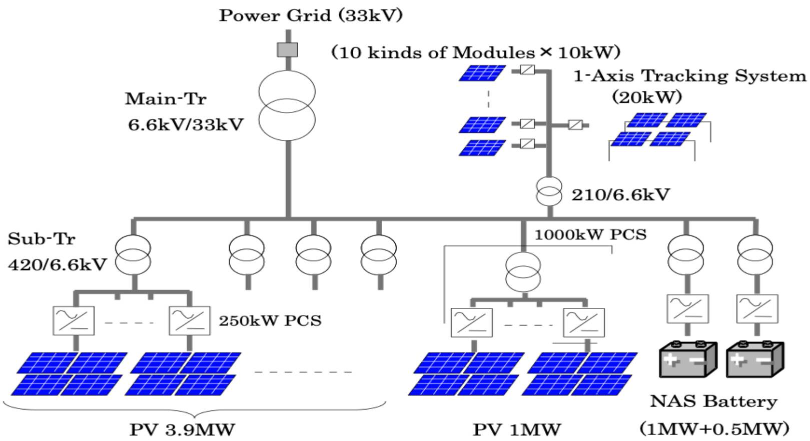

Fig 4 power system design in Wakkanai mega solar (Noriko Kawakami, 2012)

Battery Energy Storage Deployment in China:

In 2019, China's energy storage sector went through a phase ofrational adjustmentas overall development in new projects and capacity slowed, although the country nevertheless added 519.6MW/855MWh of new electrochemical energy storage capacity.In all, more than 1GW of new operational capacity was deployed in China, with batteries accounting for slightly over half of that amount. China's overall capacity increased by 3.2 percent, while the worldwide growth was just 1.2 percent. The industry entered — and is still in – a "period of reasonable adjustment," according to China Energy Storage Alliance - CNESA. The new Battery energy storage capacity of 464.4 percent of annual growth rate in 2018 in China as compared to 2019(Colthorpe, 2020)

Shanghai Electric-Gotion, a joint venture, is building its own lithium battery production plant in Nantong, Jiangsu province, for future storage development. The new plant began production of its first-stage project, with an annual capacity of 5 GWh, after ten months of construction and equipment modifications.The business debuted its newest storage solution at the Shanghai SNEC exhibition in 2021. The Megawatt Jadeite Award was given to its BMS for electrochemical energy storage for its unique design.The present grid will continue to offer physical support for energy power transmission in the future. Through bidirectional inverters, power consumers and generators will link to the grid for power consumption or contribution. Meanwhile, the inverter is linked to a storage system, which allows it to store excess electricity or send power to the grid dependent on pricing and grid demand(Shaw, 2021).

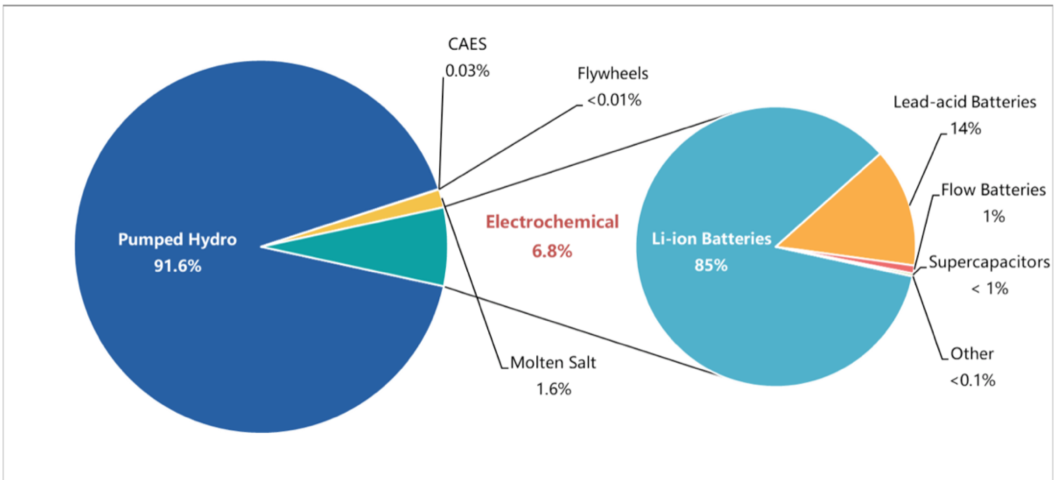

Fig 5 China's operational storage capacity (CNESA, 2020)

The projected 30 GW of non-PHES energy storage by 2025 would necessitate a fast expansion from the present installed base, which was just 2.0 GW at the end of 2020 and almost exclusively made up of battery storage. In comparison to IHS Markit's base-case projection of a 13 GW installed base by 2025, achieving the 30 GW objective by 2025 would push IHS Markit's predicted number forward by roughly three years. In this era, battery storage makes up a tiny portion of China's power grid.

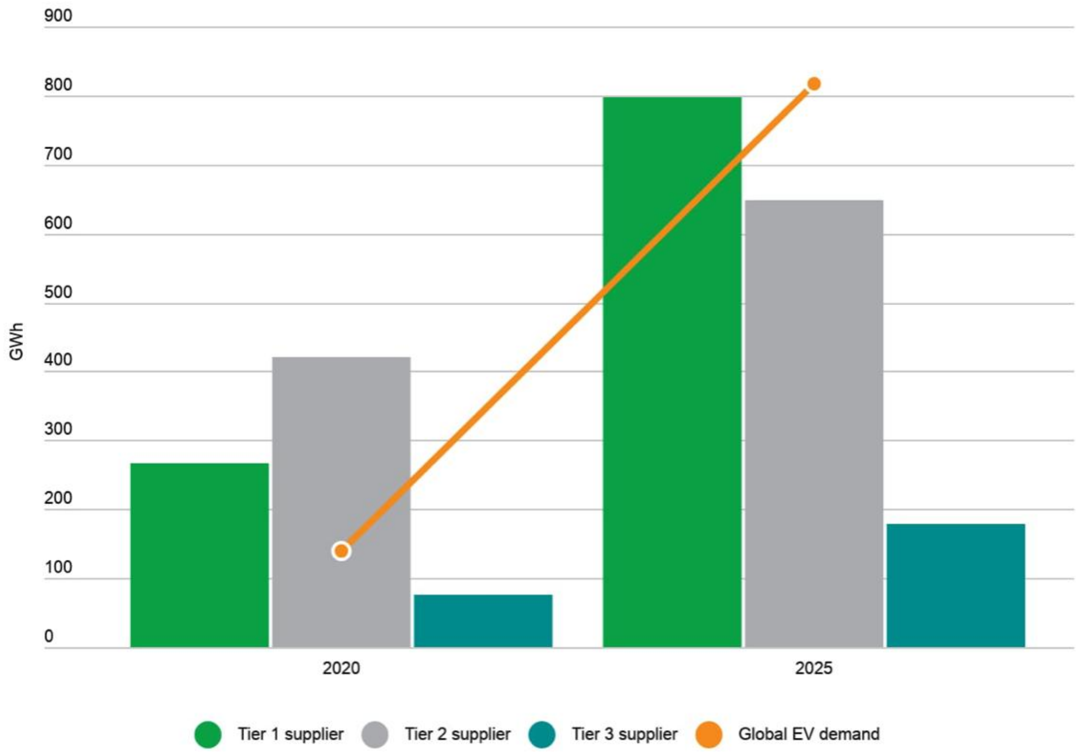

Fig 6 capacity outlook of Li-ion battery manufacture(Megan Jenkins, 2021)

Tier-1 cell manufacturers in Chinadefined as those that provided batteries to the top ten EV manufacturers in the world in 2020 have already made major commitments to EV manufacturers and are unlikely to have adequate spare capacity to fulfil this objective. However, China has around 70 tier-2 have at least one 3 GWh capacity production facilityand tier-3 have plants lower than 3 GWh capacity facilities, and the 30 GW objective may provide a chance for them(Megan jenkins, 2021).

Battery Energy Storage Deployment in Germany:

In Germany, sales of stationary battery storage systems surpassed those of pumped (hydro) storage for the first time in 2018.However, the battery storage market is still in its infancy, and determining prices and capacity can be difficult.That's the conclusion of a recent report published in the Journal of Energy Storage on Germany's battery storage sector. Also, the large-scale storage system has remarkable rise in Germany and there were around 59 large scale energy storage system with the capacity of 550MWh in the year 2018. The lithium-ion cost had reduced to 800 euros/kWh in LSS system(Waldholz, 2020).

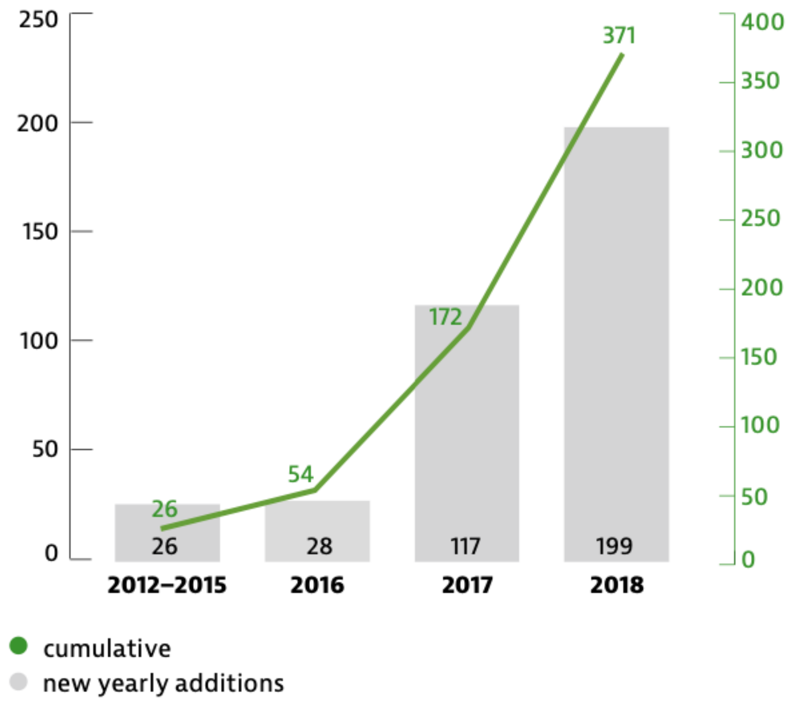

Fig 7 Germany's large scale battery power capacity in MW (Energy storage team -GTAI, 2019)

In 2020, Germany's power grid sector plans to increase large battery capacity to 517 megawatts (MW), up from 453 MW last year, which already exceeded forecasts by 19% (Eckert, 2020).

Superiority of Battery Energy Storage Systems:

Batteries are the finest since they are not only clean and efficient, but they can also deliver the stored energy instantly. The creation of new, extremely large, highly efficient batteries that can be used for utility-scale storage has become a huge business. AES Energy Storage (world leader in Lithium-ion based energy storage), for example, has 76 MW of storage in service or under construction as of this writing, with 500 MW more in planning (Siegel, 2013).

Battery storage allows customers to store excess energy generated by their solar panels and use it later during peak periods. One of the many reasons that battery storage technology has grown in popularity in recent years is because of this.Grid feed-in price cutbacks have caused many consumers to search for other ways to save money on their power bills. Based on several factors like Environment, Economical, Independence and Safety the BESS perks are explained.

Environmental:

Battery storage allows consumers to store extra solar energy for later use. This decreases dependency on coal-fired power plants, resulting in the majority of electricity being 'green'.

Batteries are split down into their separate components when recycled in order to waste as little material as possible. As a result, a greater level of sustainability is ensured.

Economic:

Customers may minimise their dependency on distributed electricity during peak hours by storing extra solar energy for later use.Integrating battery storage into an existing rooftop solar system protects against reductions in grid feed-in tariffs, allowing solar power savings to persist.Consumers who become more power independent avoid paying a premium for electricity during peak hours and save money on their electricity bills rapidly.

Independence:

Consumers may begin to become energy independent by storing extra energy and avoiding paying a premium for power during peak hours.Electricity costs have been gradually growing over the past decade and will continue to do so for the next ten years. One of the original selling aspects of solar power was the projected electricity savings.

Safety:

Only the safest and most stable chemistries of lithium batteries are utilised in home and commercial installations. However, if not properly cared for, any battery may be hazardous. Implementing a Battery Management System (BMS), which works as a controller to avoid any safety concerns, is one way to get around this(Sustainable Solar Services, n.d.).

Inferiority of Battery Energy Storage System:

Environmental:

Batteries do not endure indefinitely, and proper disposal is required to minimise severe environmental consequences.The pollution impact for extraction of raw material cause a major role.

Economic:

The initial expense of adopting battery storage devices is a drawback. The cost of batteries is falling across the board, and many financial experts believe that adopting this technology will have a clear economic advantage in the coming years.

Safety:

If mishandled or misused, lithium-ion batteries can experience thermal runaway. Thermal runaway occurs when a battery catches fire, which leads the battery to heat up and become even more difficult to extinguish. It is caused due to Overcharging, External heat issues and Impact damage such as crushing or penetration (Sustainable Solar Services, n.d.).

Recommendation:

Battery storage has the potential to substantially enhance renewable energy's costs and dependability.In January 2019, there were more than 330 solar power projects in different phases of approval and inclusion to the Power Development Plan, with a total registered producing capacity of 26,000 MW.Every year, the initiative helps to reduce roughly 304,400 tonnes of CO2 emissions into the atmosphere in Vietnam. it has a evaluated a capacity credit of 23.9 percent from the total power capacity in Vietnam. So, to maintain the capacity credit it should be added with BESS and to reduce intermittency in theses resources.Lithium-ion battery costs have dropped below US$200 per kWh of capacity, and during the next five to seven years, costs are anticipated to drop another 50%, to US$100 per kWh.so the low cost of these BESS system can be used provide intermittent load option in Vietnam(Vietnam Business Forum Power and Energy Working Group, 2019).

Conclusion:

Since Vietnam is the one of the leading Energy producers in Asia and the power capacity of Vietnam Solar resource were discussed so it is wise to install the BESS with the Solar Pv's and largest solar power facility in southeast Asia located in Ninh Thuan Province with more than 1 million panels with total investment of 7,000 billion VND which ensure a possibility of significant growth in the face of good regulations and present market circumstances.Given the relative economic advantage of renewable energy and energy efficiency (costs are dropping and can be set) (Vietnam Business Forum Power and Energy Working Group, 2019). To regulate Capacity merit and energy efficiency of Solar power it is integrated with the BESS so the intermittency can be greatly reduced and Zero Carbon Emission activity.

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