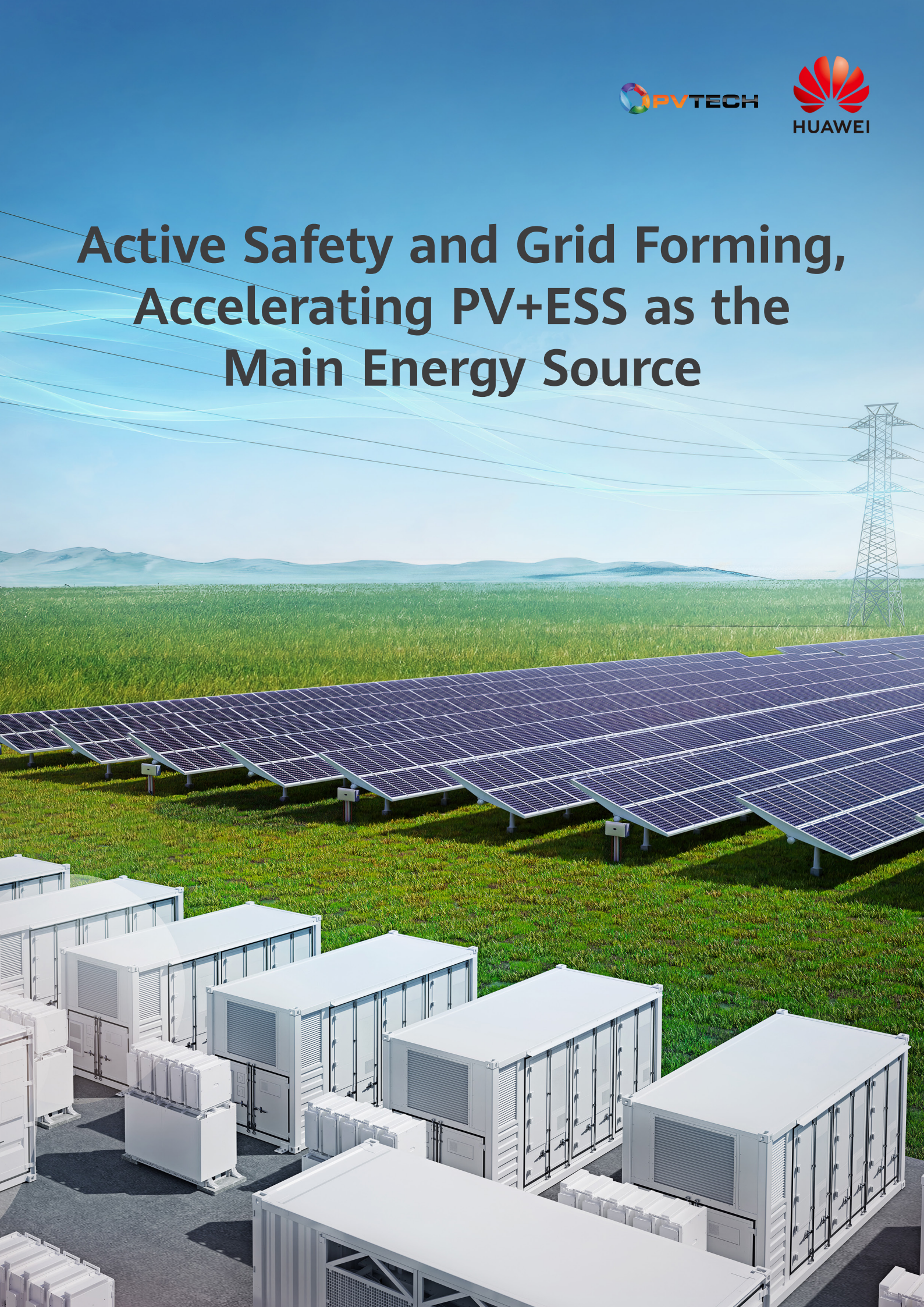
Active Safety and Grid Forming, Accelerating PV+ESS as the Main Energy Source



HUAWEI

Building a Fully Connected, Intelligent World

Smart String Energy Storage System

Designed for Safety

LUNA2000-200KWH

- Active Safety
- Reliable Power
- More Energy
- Smart O&M
- One-stop Solution

Introduction

Low-carbon, electrified, digital, and intelligent development are the four key paths for energy evolution and transformation. The energy world and the digital world will be deeply integrated to drive the energy industry to enter a new era of digital power. Huawei Digital Power adheres to the positioning as a technology product company, leverages its long-standing technical advantages, integrates digital technologies and power electronics technologies, as well as data flows and energy flows, and works with partners to provide global customers with all-scenario low-carbon products and solutions for a carbon-neutral future.

Huawei Digital Power promotes green and low-carbon transformation of the industry by adhering to the concept of “bit manages watt”. Huawei Digital Power converges bit, watt, heat and battery technologies, focuses on core technologies and products, continuously innovates in fields such as clean power generation, mobility electrification, green ICT energy infrastructure, and integrated smart energy, and provides reliable, efficient, green and smart solutions.

In terms of clean power generation, Huawei leverages its advantages in digital and power electronics technologies and integrates its established digital technologies with PV and ESS technologies. Huawei offers intelligent FusionSolar PV+ESS solutions for utility-scale, commercial & industrial (C&I) and residential scenarios in power generation, transmission, distribution and consumption, bringing customers lower levelized cost of electricity (LCOE) and levelized cost of storage (LCOS), grid-forming technologies and active safety. The solutions reduce the LCOE of PV plants over the lifetime and improve the grid forming performance, enabling PV as a main energy source.

Huawei Digital Power’s vision and mission are to integrate digital and power electronics technologies, develop clean power, and enable energy digitalization to drive a revolution in energy for a better, greener future.

Making the most of every ray!

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FusionSolar Residential Smart PV Solution

A Home that Always Shines

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Bright future growth for energy storage after passing 100GWh mark

Having passed the 100GWh mark, the global boom in demand for battery energy storage systems is going from strength to strength. Tom Kenning looks at some of the market and technology trends shaping this dynamic sector

Energy storage has become a 100GWh global market for the first time with growth faster than ever and China continuing to dominate but the stage is set for other storage markets across the globe to boom. Price declines continue to support stationary battery storage deployment while lithium iron phosphate (LFP) batteries are enjoying ever-increasing market share.

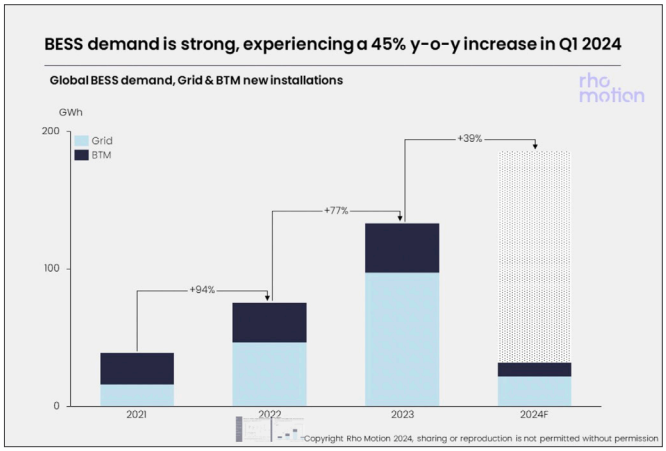
Global energy storage deployments in 2023 saw a tripling of capacity from the prior year with 44GW/96GWh installed, marking the largest ever year-on-year jump, according to research organisation BloombergNEF (BNEF). This was supported by the lowest-ever prices. Furthermore, strong growth is expected to continue in the year to come.

A combination of low prices, government policies and subsidies are driving the demand, with the Inflation Reduction Act (IRA) ramping up progress in the US and the Chinese market growing under regional obligations for solar and wind energy to be co-located with energy storage projects. Other supporting schemes are coming into play across Europe, Australia, Japan, South Korea, and Latin America.

'Momentum despite doom and gloom'

Last year already saw energy storage reach the 100GWh mark with a "massive" 133GWh installed across the grid and behind-the-meter markets, according to Iola Hughes, head of research at UK-based battery and storage focused research house Rho Motion.

"It shows the scale in terms of how fast this market has grown. When we go back to even 2018, you're looking at a market closer to 10GWh. There are a lot of markets which don't even have any storage installed on the grid yet and



Credit: Rho Motion

Figure 1. Battery energy storage global demand outlook, grid and behind-the-meter installations

Credit: Sembcorp Industries

Sembcorp Energy Storage System in Jurong Island, Singapore

that's where we see the upside for this market in the coming years," adds Hughes.

While stationary storage used to be seen as a surplus market where leftover batteries from the EV space were funnelled into the stationary market, Hughes says it is now very much a "standalone market" with specialised cells meeting this demand and contributing to the declining prices that are driving yet more storage deployments.

"It's overall a very positive image across the board," she says.

In 2023, storage capacity in on-grid applications reached 97GWh and behind-the-meter applications such as residential storage, data centres, and UPS reached 30GWh. Meanwhile, in 2024, Rho Motion forecasts 143GWh for the grid market and 40GWh of behind-the-meter capacity. This year, there are 22 projects of over 1GWh capacity set to come into operation, up from four projects of that scale in the previous year.

Despite the less positive sentiments in the EV market, "battery demand marches on, setting a solid foundation for 2024", adds Hughes.

Costs drop amid fierce competition

The prices of energy storage have continued to come down, mainly enabled by the emergence of LFP batteries, and this remains key to driving more deployment worldwide, writes Nelson Nsitem, BNEF's energy storage analyst. LFP batteries do not require nickel and they are taking market share from lithium-ion batteries using nickel manganese cobalt (NMC).

BNEF also reports in its '1H 2024 Energy Storage Market

Outlook' that the average cost of a two-hour turnkey energy storage system in China – not excluding EPC and grid connection costs – was US$115/kWh in February 2024, down 43% from a year prior. The analysts said it was unclear whether this rate of price drops would continue in China or spread to other geographies.

Cell prices have seen "really impressive" declines, says Rho Motion's Hughes, noting that while last year an LFP cell cost US$100/kWh, they are now regularly in the range of US$50-60/kWh. There are even rumours of LFP cells in China reaching as low as US$40-45/kWh.

"The main reasons we've been seeing this price decline, firstly is down to the metals prices," adds Hughes. "Lithium carbonate is very cheap right now. The expectation for the rest of this year is that price will stabilise somewhat and perhaps see some improvements. That obviously has a knock-on effect. And the other key reason is there are a lot of tier-two battery manufacturers looking to gain market share and you have a price war essentially going on between these players."

However, there are expectations that the declining cell prices will "bottom out" in the coming months or years.

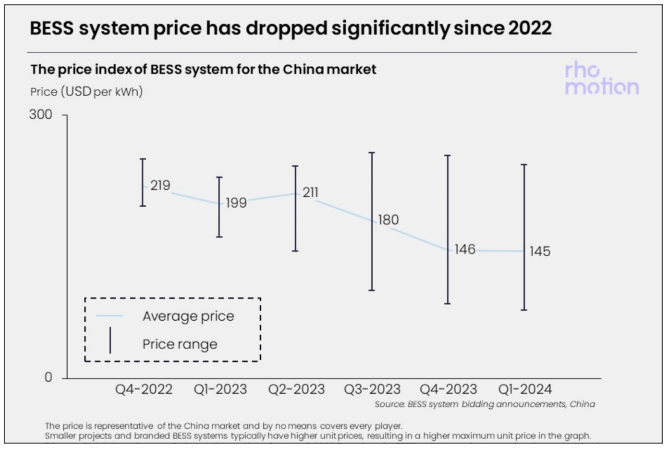
"Going below that floor of prices where we are now seems relatively difficult, but we've been surprised before," notes Hughes.

There have also been "really impressive" price drops in terms of energy storage systems. Since Q4 2022, prices for systems in China have dropped by about 32% on average. Average system prices now stand at around US$140/kWh, but there is a large range within this category (see chart below).

Like with cells, there is fierce competition in the Chinese energy storage system market with various players trying to attain market share. Branded models are still selling for a premium compared to lesser-known models creating this large range of prices.

"It's not just a Chinese story," says Hughes.

Price declines are also transmuting into other markets, despite developers in Europe and North America being willing to pay a premium for big-name integrators such as Fluence, Tesla and Powen. These premiums are typically around 15 to 20% higher than a Chinese system. Nonetheless, the price declines of Chinese cells have allowed the likes of Fluence and Tesla to also drop their own system prices.



Credit: Rho Motion

Figure 2. Battery storage system prices in China are declining but with a large range

"In terms of the different storage technologies on offer, LFP looks set to dominate the stationary storage market at least until the end of the decade"

Other enabling factors to the price declines include economies of scale and the optimisation of both cells and systems. Firstly, the rise of larger capacity tenders is helping to bring down prices. Secondly, many new >5MWh systems have been announced in recent months, often in the form of second-generation upgrades from traditional 3-4MWh systems, with larger format cells and improvements in BMS. Since fewer containers are needed to hold the same amount of capacity in these systems, this has reduced the footprint of a storage asset and, therefore, also reduced the cost of land acquisition. China-based energy storage battery provider CATL, for example, has produced 6.25MWh system.

An LFP story

In terms of the different storage technologies on offer, LFP looks set dominate the stationary storage market at least until the end of the decade. In 2023, LFP share globally increased to 88% across the grid and behind-the-meter markets with this expected to keep rising this year, according to Rho Motion.

"It's very much a story of LFP, the dominant chemistry," says Hughes.

The rise of this technology is driven by LFP cells being cheaper than the competing NCM-based cells and LFP's optimisation for long-life durability. Some new cells have cycle lives of 10,000-15,000 cycles. Having a storage system that can last as long as the solar project it is connected to can have huge lifetime cost savings.

Other up-and-coming chemistries include flow batteries and sodium ion. Flow batteries are mainly focused in China, where around 3GWh across five projects are under construction at present – a "relatively significant" amount, according to Hughes. Moreover, Rho Motion has tracked 15GWh of such projects in the pipeline.

Flow batteries were once seen as the potential answer to the shorter duration of lithium-ion batteries. However, LFP systems are showing increasing duration ability with 6-10-hour systems emerging to fill that gap instead. Flow batteries are also disadvantaged by their higher cost than lithium-ion batteries.

"It starts to raise the question of where will flow batteries actually fit in," says Hughes. "They do really well on things like high temperature and low temperature environment, so it might be more of a niche."

After great excitement and investment in sodium-ion battery technology when lithium carbonate prices were very high at the end of 2022, the cost benefit has become less clear as lithium prices have come down. There are a few projects being worked on in China, but at present, sodium ion is not cost-competitive; it falls short in energy density, and its lifecycle is just 3,000 to 6,000 cycles compared to competitors with 12,000-15,000 cycles.

"The economics of installing sodium ion is not great, but

Geographic trends

In the first quarter of 2024, once again, China left other markets in its wake by growing 25% year-on-year and accounting for just under 50% of global battery, according to Rho Motion's 'Battery Demand Quarterly Summary: Q1 2024'. Meanwhile, the US and Canada saw year-on-year growth of 20%, despite a relatively weak start to the year for the stationary storage market. The weakest growth was seen in Europe, increasing 9% year-on-year partly due to BEV subsidies being removed in Germany.

China, California, Texas and the UK, to some extent, totally dominate on-grid energy storage with a huge gap between them and the next frontrunners. However, there is momentum building in Australia where a strong renewables rollout combined with decommissioning of coal and gas peaker plants are driving activity. In May, Australia had a tender that was 32 times oversubscribed showing "very strong" interest, says Iola Hughes, head of research, Rho Motion. In terms of the Latin American market, Chile has the most eye-catching activity to date.

Energy storage action in Europe has been dominated by the UK and Ireland, though Germany and Italy are beginning to heat up and many commentators are seeing these countries as big new players in Europe, says Hughes. Other areas with promising activity include the Nordic countries and the Balkans where renewable energy plans are driving demand with Greece leading the way.

According to 'The Energy Storage Report' from Solar Media's news outlet Energy-Storage.news, while the UK has been the early mover in deploying short-duration energy storage resources, other major economies in Europe are also set to ramp up their deployments over the coming few years. Italy is also set to become one of the busiest grid-scale BESS markets in the coming years.

Brussels-based organisation the Energy Storage Coalition has laid out 'Policy Priorities 2024-2029' in which it calls for the removal of regulatory hurdles across Europe, such as "double charging", where energy storage is taxed twice: both when energy is stored and again when it is re-injected to the grid to be consumed. It has also called on governments to provide clear frameworks with long-term visibility for energy storage projects.

Elsewhere, according to Wood Mackenzie, Africa's project pipeline remains healthy, while Israel and the UAE have set ambitious renewable targets that will support storage deployment.

BNEF's Forecasts for the global energy storage landscape up to 2030:

The Asia Pacific (APAC) region leads with annual additions rising slightly to 52% in 2030, from 51% in 2024. BNEF estimates cumulative deployment for APAC of 402GW/1,111GWh by 2030. China will account for most of this capacity, driven by mandates to pair utility-scale wind and solar projects with energy storage. South Korea in 2023 had its strongest year since 2020, following the introduction of policies and auctions to promote energy storage. Australia and Japan are holding auctions for new firm clean energy capacity, which will drive investment in energy storage projects.

Europe, Middle East, and Africa (EMEA) will see annual additions rise to 19% by 2030, from 11% in 2024, reaching 165GW/377GWh cumulatively by the end of 2030. Led by Germany, residential batteries will continue to be the largest source of storage demand in the region. 0Italy, Austria, Switzerland, Belgium, Sweden, Spain, and the UK will also see strong residential deployment. Utility-scale projects are also picking up in newer markets driven by more than €19 billion (US$21 billion) of targeted subsidies across Italy, Spain, Hungary, Greece, and others since 2022.

The Americas has slower growth than other regions with its share of annual installations falling to 19% in 2030, down from 28% on a gigawatt-bour basis in 2024. The region will hit 148W/527GWh cumulatively by 2030. The US leads the way driven by state targets, utility procurements and attractive economics in states such as Texas. Reforms in Chile are supporting a shift towards larger energy storage additions.

it is still early days," says Hughes. "You're looking at Gen 1 products versus very optimized LFP systems so as the market progresses, as the supply chain builds and people launch their gen 2, Gen 3 sodium ion cells, we can expect more of them to come through in the market as well."

Having once been the undisputed king of stationary energy storage, lithium-ion batteries using NMC chemistries are losing market share to LFP, with specialist Chinese LFP battery makers now "aggressively expanding overseas", according the BNEF report. NMC is epxected to account for just 1% market share by 2030.

Future projections

Looking forward, BNEF also expects strong global growth in energy storage with 67GW/155GWh to be added in 2024, up 60% in gigawatt-hour terms from 2023. The record additions from 2023 will be followed by a compound annual growth rate of 20.9% up to the end of 2030, with annual installations reaching 137GW/445GWh that year. This is double the growth rate of solar and triple that of wind, whose compound annual growth rates are forecast to be 8.9% and 6.6% respectively. BNEF also expects the future market to be shaped by battery overproduction and overcapacity.

A future headline number also comes from Wood Mackenzie's 'Global energy storage market outlook update: Q1 2024', which forecasts that global cumulative energy storage capacity will reach the significant threshold of 1TW/3TWh by 2033.

Smart String & Grid-Forming ESS solution accelerates the transition toward a new energy system

Grid-forming technologies such as those pioneered by Huawei will be essential to maintain the future stability of the grid as the penetration of renewables increases

Huawei's technology actively mitigates frequency and voltage fluctuations and enables PV power generation to transition from grid-following to grid-forming

Renewable energy technologies, such as PV and wind power, are rapidly replacing traditional energy sources, and a clean, low-carbon, safe and efficient new energy system is gradually being built amid a new round of energy transformation. The International Energy Agency (IEA) estimates that renewables will surpass coal to become the largest source of global electricity generation by early 2025. Traditional power systems using synchronous generators will be replaced by new power systems featuring a higher penetration rate of renewable energy and more power electronic equipment.

Grid integration of variable renewable energy at a large scale will impact the stability of power grids. Some of the typical problems at present include wideband oscillation, transient overvoltage, power quality deterioration and power supply instability of islanded PV and energy storage systems (ESS). In many countries and regions, the key to the sustainable development of renewables is to improve the grid integration performance of wind, PV, ESS and other power systems that use power electronics equipment.

Huawei Digital Power has long been committed to enhancing the safety and stability of renewable integration. By combining digital and power electronics technologies and cooperating with global power companies, grid enterprises and electricity providers, Huawei Digital Power draws on its experience in new materials, chip design and active/passive components. In this way, Huawei has continuously promoted the development of grid connection technologies.

Grid following

- 2014 — Huawei completed the industry's first distributed grid-connection harmonic test and obtained the first GB/T 29319-2012 certification from the China Electric Power Research Institute in the 9 MW project for CGN in Jiaxing, Zhejiang Province, China.
- 2014 — Huawei cooperated with the China Electric Power

Research Institute and the Qinghai Electric Power Research Institute in carrying out a series of tests and passed the zero-voltage ride-through test, low-voltage ride-through test, frequency disturbance test and power quality test in a MW-level plant, making it the world's first inverter brand that has passed the zero-voltage ride-through certification.
- 2015 — Huawei applied the low short circuit ratio (SCR) adaptation algorithm for the first time in the industry in the Fengwei 100MW PV plant project in Inner Mongolia, China.

Grid supporting

- 2018 — The AI BOOST active harmonic suppression algorithm is developed to eliminate the risk of harmonics exceeding the threshold in weak power grids.
- 2019 — Australia released a new power grid standard, which was said to be the strictest grid connection standard in the world. Huawei obtained the admission license this year, making it the world's first and the only PV inverter brand in China with an active license.
- 2020 — Huawei was awarded the first GB/T 37408-2019 certificate by the China Electric Power Research Institute, and Huawei inverters became the first product that passed the new national standard in the industry. In the same year, Huawei worked with the China Electric Power Research Institute to launch the weak power grid (SCR = 1.5) adaptability feature of PV inverters to ensure plant stability under transient and steady-state impact in extremely weak power grids, avoiding chain faults and improving renewable integration capability.
- 2021 — Huawei won the first series compensation adaptability algorithm certification from the China Electric Power Research Institute (SCCR = 0.7, SCR = 1.2), improving the stability and capability of long-distance renewable power distribution.

Grid forming

- 2021 — Huawei participated in the "Research on Large-Scale Energy Storage Supporting Safe and Stable Operation of Power System with a High Proportion of Renewable Energy", led by the Qinghai Electric Power Company. An in-depth study was carried out on the impact of hardware specifications and control policies of the electrochemical energy storage system on grid safety, stability, and integration capability of renewables.
- 2022 — Huawei participated in the construction of the world's first GW-level microgrid project using grid-forming technologies in the Red Sea Project, Saudi Arabia.
- January 2023 — At Gonghe, Qinghai, China, Huawei cooperated with the China Electric Power Research Institute, the Qinghai Electric Power Research Institute, and China Resources Power to complete the world's first onsite test of the grid-forming PV+ESS solution, which proves that grid-forming systems can play a key role in strengthening the operation of the power grid and achieving large-scale renewable integration.

The new power system with renewable energy as the main source is crucial to achieving the goal of carbon peaking and carbon neutrality. Compared with synchronous generators, renewable energy features low controllability and low inertia. Nevertheless, as the renewable penetration rate increases, a conventional renewable energy system cannot proactively support the voltage and frequency like synchronous generators when a fault occurs. And as a result, such systems fail to meet the requirements of large-scale application of renewables, bringing risks in safety and stability.

To cope with the preceding challenges, Huawei has launched its innovative Smart String & Grid-Forming ESS Solution by leveraging its own expertise in PV, energy storage, and particularly, grid-forming technologies. This solution integrates Smart String ESS, Smart PV Controller, Smart Power Control System (PCS), Smart Power Plant Controller (SPPC), smart energy management system, and grid-forming algorithm to change renewable energy control from current source to voltage source, actively mitigating frequency and voltage fluctuation and enabling PV power generation to transition from grid-following to grid-forming. With these technologies, Huawei helps customers achieve optimal ROI, intelligent O&M, safety, reliability, and grid stability.

Based on intelligent algorithms such as internal voltage setup and power oscillation damping, Huawei's Smart String & Grid-Forming ESS Solution supports three times reactive current for 10 seconds, equivalent inertia with a maximum time constant of 20 seconds, and wideband oscillation damping of 0.1–100 Hz. These features redefine the stability of voltage, frequency, and power angle, and make the renewable energy system equivalent to or even partially better than the control solution of the synchronous generators, achieving higher yield, full integration, and stable control.

In February 2024, Huawei collaborated with China Resources Power to build the world's first 100MWh smart string grid-forming energy storage plant in China. Considering the multitude of 100MWh projects that have gone into operation recently, grid-forming technology has evolved from the technical verification phase into the large-scale application phase. In October 2023, the Red Sea Project, the world's largest microgrid project and the world's first GW-level grid-forming off-grid project, was delivered in Saudi Arabia. Huawei provided a complete set of equipment and consulting services for the project, including 400MW PV inverters, 1.3GWh ESSs, and transformer stations. Through the application of a series of cutting-edge technologies, such as GW-level black start and off-grid continuous fault ride-through, the Red Sea Project has achieved 100% PV+ESS power supply and become a global benchmark for large microgrids.

It takes the collective efforts of the entire industry to address the grid connection challenges. Huawei adheres to the concept of "triple convergence": the convergence of power electronics and digital technologies, the convergence of PV and energy storage, and the convergence of energy flow and information flow. Huawei's Smart String & Grid-Forming ESS Solution redefines voltage and frequency stability. In addition, Huawei continuously innovates technologies such as wideband oscillation damping, fault ride-through and batch black start to improve renewable integration stability and capability and works with partners throughout the industry chains to accelerate PV evolution to a main energy source.

Stepping into the OASIS: Unleash every ray, empower every industry

Huawei's FusionSolar OASIS Solution is a one-stop solution for commercial and industrial applications, combining optimizers, inverters, energy storage and chargers

With the rapid decline in the cost of PV power generation and the growing consensus on the development of renewable energy worldwide, the commercial and industrial (C&I) PV market is expanding rapidly. C&I enterprises typically have high energy demand and large rooftop areas, which are key factors in promoting the application of PV power. Enterprises also strive for the achievement of carbon neutrality goals. We hope that every industry can easily embrace energy transformation through the use of PV energy, unlocking more possibilities of PV in various industries.

When energy transformation occurs, a PV system can bring about both fertile soil-like nurturing capabilities and oasis-like ecological surges, allowing thousands of industries to realize flexible and diverse business leapfrogging on the energy oasis, and empowering thousands of industries with technological innovations, so that green energy can fully be used and electricity can fully be utilized. A PV system helps an enterprise generate green electricity and enables diverse business operations. Therefore, we have upgraded the C&I Smart PV solution to Huawei FusionSolar OASIS Solution, which has the following meanings:

- "O" is for One-stop solution: With the most comprehensive solution capabilities, we provide customers with a one-stop solar energy solution.
- "A" is a variant of the number 4: It represents the four core products of inverter, optimizer, energy storage, and EV charging.
- The first "S" is for Safety: Safety is the top priority for C&I products and a technical principle that runs through the solution.
- "I" is for Intelligent. Our intelligent solution helps C&I owners easily transition toward clean energy and smart energy management.
- The last "S" is for Solar: The ubiquitous sunlight is the source of solar energy, which makes it possible for the energy transition of various industries.

Huawei FusionSolar OASIS Solution is a one-stop solution for customers through optimizers, inverters, energy storage systems (ESSs), and chargers, focusing on the three core values of improving the green power supply capability, guaranteeing the safety of energy use in C&I campuses, and enhancing the efficiency of energy use. Huawei is committed to leveraging comprehensive and innovative solution capabilities to meet the highest industry standards and bring long-term and stable benefits to partners and customers. We believe that ubiquitous PV+ESS, ubiquitous safety and ubiquitous intelligence will be the future trend for C&I.

The Huawei FusionSolar OASIS Solution is aimed at C&I campuses

In the future, PV+ESS power plants will be ubiquitous. In addition, requirements for profit maximization, property and personnel safety, and operation and maintenance (O&M) are raised. The market requires highly safe and intelligent solutions. The high-quality development of the C&I energy storage system (ESS) is centred upon systematic safety, refined management, and digital and intelligent applications.

Huawei integrates the digital technology and string concept into the energy storage system and pioneers the Smart String ESS. The solution uses power electronics technologies to resolve the inconsistency and uncertainty of lithium batteries. In the C&I scenario, we focus on five core values: active safety, more energy, long-term reliability, optimal revenue and simple O&M, and combine PV and ESS to lead industry development, facilitating low-carbon transformation of various industries for sustainable business operations.

In addition, FusionSolar energy storage products have the following features:

1. **Active safety:** The system safety is enhanced from three levels: device, asset, and personal safety. For example, the top venting design similar to "airbag" includes explosion relief panels at the top of the cabinet and five-point door locks to prevent explosion and ensure personal safety in extreme cases.
2. **More energy:** Huawei pioneers the industry's first smart string architecture. Each battery pack has a built-in energy optimizer, increasing the system usable energy by 5%.
3. **Simple O&M:** The pack-level energy optimizer can implement automatic SOC calibration without manual site visits.
4. **Optimal revenue:** SmartEMO1.0 supports multi-mode overlay, including maximum self-consumption, TOU, and peak shaving, increasing the revenue by over 10% compared with the traditional single mode.

Setting the global apex for usable energy capacity

The Huawei Smart String Energy Storage System LUNA2000-7/14/21-S1 and Huawei FusionSolar Residential Smart PV & ESS Solution set a new standard in home energy storage systems

Leading the charge in home energy storage, the Residential S1 Battery is the first in the industry to incorporate an ultra-large 280Ah battery cell. This advancement not only offers larger energy capacity but also significantly extends the product's lifespan, setting a new industry benchmark with up to 15 years of service life, which means homeowners can get more years of return on investment*. When it comes to the number of cycles, i.e. how many times battery cells can charge and discharge, it breaks the record by exceeding 12,000 cycles.**

Integrating a 280Ah battery cell into a residential ESS is far from straightforward; it presents numerous technical hurdles. For instance, traditional architectures fail to achieve the necessary operating voltages for the system and also struggle with heat dissipation and insulation challenges due to the battery cell's high throughput.

To address these complexities, Huawei has taken a trailblazing approach by implementing a Module+ architecture. This innovative design is equipped with a built-in energy optimiser that ensures independent optimisation at the pack level. Moreover, Huawei's patented separate temperature control system allows effective thermal management, which is critical for the system's performance and longevity.

Innovative Module+ architecture, with built-in energy optimiser

The ultra-large 280Ah battery cells demand higher voltages to operate effectively and necessitate sophisticated management systems to ensure their safety and efficiency. At the heart of the new ESS lies the cutting-edge Module+ architecture with built-in energy optimiser.

The Model: LUNA2000-7/14/21-S1 is crafted with a DC-coupled configuration, allowing for parallel connectivity. Within each power module, eight battery cells work in concert with a battery management system and an energy optimiser. This trio ensures that the battery cells operate within a safe and stable environment, achieving the longest possible lifespan and peak efficiency.

- **Individual battery management:** Each battery pack charges and discharges separately in parallel circuits, effectively avoiding disruption of the whole circuit caused by one dysfunctional battery pack.
- **Built-in energy optimiser:** Inside each battery pack, there's a smart system that manages the energy, making sure that each pack uses its power fully and efficiently. This smart energy handling means less waste and more mileage out of each battery.
- **Fewer batteries needed:** The system only requires eight battery cells per pack to independently achieve the system operating voltage of 350-980 V. Using fewer batteries means it's simpler and could lead to fewer problems. The failure rate is ≤20% of the industry norms for the same kWh.

Five-layer safety protection system

As the electricity capacity of an ESS system increases, so does the complexity of its safety requirements. Ensuring higher battery quality becomes imperative, alongside enhanced measures to mitigate external causes of thermal runaway and robust emergency protocols should thermal runaway occur.

The Model: LUNA2000-7/14/21-S1 sets a new standard for resilience with its five-layer safety protection system. This comprehensive suite includes cell-level protection, electrical protection, structural protection, active protection and emergency protection measures. Engineered to thrive in challenging environments, this product complies with stringent industry standards such as VDE 2510-50, ensuring unparalleled safety and reliability.

Cell-level protection: Huawei provides a robust first line of defence against the risks associated with battery usage by utilising LFP (lithium iron phosphate) cells, known for their low heat generation and high thermal thresholds. Each cell is subject to a rigorous selection process, ensuring comprehensive safety.

Electrical protection: The electrical protection system features a robust array of defences, shielding against overcharging, overvoltage, overcurrent, overheating and the perils of external short circuits. The protection is tiered in three distinct levels to combat external short circuits and overcurrent risks effectively:

- **String-level short circuit protection:** This acts swiftly to

interrupt electrical flow in the event of a short circuit within individual strings, thereby averting potential damage.

- **Module-level short circuit protection:** If a fault occurs in one module, this mechanism ensures that the issue is contained within that module alone, preventing the fault from affecting the rest of the system.
- I**ntelligent overcurrent protection:** It employs dynamic measures to prevent overcurrent situations before they escalate, ensuring the system operates within safe parameters.

Structural protection: The product is the world's first residential ESS with an IP66+ rating, ensuring complete dust resistance and allowing up to 40cm of submersion for 72 hours. This helps consumers easily cope with rain and water splashes in daily usage and ensures device safety in case of waterlogging, ice and snow coverage. The ESS can also resist pressures of up to 5 tons without deformation or damage and survive a 20% hydrogen explosion test, ensuring unwavering reliability.

Active protection: The system delivers seamless, real-time management of temperature and voltage down to the cell level, ensuring a full spectrum of lifecycle health protection.

Emergency protection: The system is equipped with an emergency fire suppression module and world-leading active pressure release technology. These features are designed to exhaust oxygen from the battery pack in case of thermal runaway, to form an oxygen-free environment. Subsequently, an automatic sealing function is activated to prevent oxygen from re-entering, ensuring the area remains oxygen-free. Together, these measures effectively remove the risk of fire by eliminating combustibles in the event of thermal runaway.

Effortless installation and superior user experience

As a residential ESS, Model: LUNA2000-7/14/21-S1 is designed with both the installer and the end user in mind. Installation is a breeze, thanks to the cable-free, plug-and-play setup.

Huawei has engineered its product with a three-layer orientation design for effortless docking. This ensures that installers can connect components quickly and accurately without the hassle of lifting and aligning multiple times.

Horizontal adjustability features are built into the base, allowing for easy adaptation to various terrains. The power module wiring experience has also been vastly improved, transitioning from dual-sided to single-sided operations. Cable connections are clearly labelled and arranged in a straightforward, linear fashion, eliminating the confusion often associated with complex wiring.

The product is designed to function across a temperature range from –20°C to +55°C, excelling in extreme climates.

Effective heat management is crucial for the performance and longevity of any ESS. Huawei has addressed this challenge with its patented separate temperature control system. This operates so efficiently that it eliminates the need for a fan, which is traditionally used to cool such systems.

One-stop smart home energy management

The FusionSolar Residential Smart PV& ESS Solution revolutionises smart home energy management with its comprehensive product ecosystem. This complete suite of products provides a one-size-fits-all approach that encompasses everything from power generation and storage to charging and consumption. At the heart of the ecosystem is the smart energy controller, which acts as the brain of the entire operation. Available in both single-phase and three-phase variants, the single-phase controller can manage up to 10kW, while the three-phase version supports up to 25kW.

The last part is the expansive home energy ecosystem. This includes a diverse array of home appliances that use electricity, Huawei's SmartGuard as a whole-home power backup solution, and the company's AI Energy Management Assistant (EMMA), which integrates communication and meter function, as well as the intelligent management of PV, ESS, chargers and all connected devices.

**Warranty conditions may vary by region and temperature. Please refer to the warranty letter for details.*

*** Theoretical values from Huawei's internal laboratories in specific test environments.*

Safe and secure – stability and reliability at the heart of Huawei's inverter and energy storage solutions

Huawei's inverter and energy storage solutions help ensure longevity and safety in power plants through an unwavering commitment to quality and a range of smart capabilities

The reliable design and high quality of Huawei's inverters enable them to withstand extreme weather conditions

With its rich solar resources, China's Qinghai province is an ideal location for PV development. However, the high altitude, cold climate and frequent sandstorms present unique challenges for constructing and operating power plants.

Inverters are the core components of PV systems. They are essential in connecting PV arrays to the power grid, facilitating AC/DC conversion, providing power control and switching the system on/off the grid. In such harsh conditions, inverter stability and reliability are crucial because their failure can significantly impact power plant operations. Industry standards indicate an average failure rate of about 2%, with many plants experiencing core inverter failures within three to five years. In stark contrast, the Golmud PV Plant, using Huawei string inverters, boasts an annual failure rate below 0.1% over the past decade, significantly lower than 1/10th the industry average.

The Golmud Plant's Phase 3, operational since December 2014, incorporates 4,939 Huawei SUN2000-28KTL inverters with a DC capacity of 138MW, using 255W and 260W polycrystalline silicon PV modules.

According to the plant personnel, the reliable design and high quality of Huawei inverters can withstand extreme weather conditions. "This inverter has generated 332,593kWh of electricity since 2015, with an average annual utilisation of 1,486 hours. Huawei string inverters feature multiple MPPT circuits. They are particularly effective in utility-scale plants, reducing shading, dust, and string mismatch impacts, thus enhancing energy yield by over 5%."

The superior performance of Huawei string inverters extends beyond their essential functions. When central inverters are used, the maintenance of a single 500kW unit requires shutting down the entire system. Conversely, string inverters not only maintain high efficiency and stability but also allow for rapid and convenient repairs. This enhances the O&M efficiency by 80% compared to central inverters.

In the event of a failure, Huawei string inverters can be easily and quickly replaced by plant O&M personnel, typically within 0.5 to 2 hours. In a scenario involving a 1MW project with 40 inverters, if one fails, the others continue to function normally, preventing significant energy losses. In contrast, a central inverter failure can take about a week to repair, leading to substantial energy yield losses. Huawei string inverters are easy to maintain, save on troubleshooting time, and incur low O&M costs. Their decade-long operational data showcases a range of benefits, including efficient power generation, safety, reliability, and a low failure rate, thus earning customer trust.

The growing adoption of Huawei inverters, first seen in the Golmud PV Plant, is a testament to their reliability.

In Quyang, Hebei Province, China, the China Three Gorges New Energy's 200MW mountainous PV plant has averaged 1,272 operational hours annually over the past eight years. Using 1,097 Huawei inverters, which are designed without vulnerable components, the plant has significantly reduced device failure rates, maintaining an annual average failure rate below 0.1%.

In Ganzi Prefecture, Sichuan Province, China, Huawei collaborated with Yalong Hydro Company on the first phase of the Hydro-Solar Hybrid Project at Lianghekou Dam on the Yalong River – Kela PV Plant. This project boasts the world's largest installed capacity at the highest altitude, with 1GW of installed PV capacity. It generates 2 billion kWh of energy

Huawei Digital Power aims to shift the industry's focus from low cost to high value

annually, saving over 600,000 tons of standard coal and reducing carbon emissions by more than 1.6 million tons.

The Red Sea Project in Saudi Arabia, the world's largest microgrid energy storage project, is a notable example of Huawei's Grid-Forming Solution. It achieves 100% PV+ESS supply and features 400MW PV and 1.3GWh ESS. This project marks a significant step toward a 100% renewable energy future.

The PV industry's prospects are bright, with significant growth expected over the next decade. As per PV InfoLink, the installed PV capacity is projected to increase tenfold, with global capacity additions potentially reaching 1,246 to 1,491GW by 2050. In this context, high-quality power plants become pivotal for tapping into new markets, shaping the future power landscape, and constructing advanced power systems.

Huawei Digital Power stands at the forefront of these developments, showcasing leading technical prowess and commitment to quality. The company is poised to continue merging digital and power electronics technologies. With its FusionSolar solutions, Huawei Digital Power aims to shift the industry's focus from low cost to high value, advocating for smart string design as the global standard. By reducing the levelised cost of electricity (LCOE) across the PV plant lifecycle and enhancing grid support performance, Huawei Digital Power is positioned to make PV solar energy a main energy source.

Storage safety

Meanwhile, the large-scale application of energy storage systems (ESS) and the upgrade of safety standards require safety from the cell level to the grid level. In recent years, the rapid development of energy storage technologies has also brought a series of safety challenges. Accidents occur from time to time. Some are caused by internal cell management and some are caused by failed high/low-voltage ride-through (HVRT/LVRT). ESS are an important part of a new power system. Its safety must be designed from cell level to grid level across scenarios and dimensions, with effective management and control measures, to ensure the safety of the entire power system.

ESS safety design needs to integrate power electronics, digital, thermal, electrochemical, and AI technologies to implement refined monitoring and management at the cell, battery pack, battery rack, ESS, and power grid levels to ensure ESS safety, efficiency, and grid forming capability.

At the cell level: System specifications such as the number of cycles and efficiency have been given more attention in projects. However, as cell capacity increases, the energy density of the system increases as well. This means the quality and performance of batteries have a great impact on ESS safety. To ensure battery safety, strict tests and quality control must be performed to ensure the safety and reliability of cells, which are the first line of defence.

At the pack level: Passive balancing is widely used in the industry to solve the inconsistency and uncertainty between cells. The battery packs must be protected by refined proactive control and shutdown capabilities to isolate faulty units promptly to minimise the impact and property loss.

At the rack level: The rack-level battery protection is implemented in both hardware and software. That is, the BMS actively manages and physical isolates individual batteries, using circuit breakers and fuses to quickly disconnect faulty components in case of faults, such as short circuit and overcurrent.

At the system level: The ESS charge and discharge, consistency, and health need to be diagnosed from multiple dimensions. The AI technology is used to build a prediction model to identify risks and generate warnings in advance. At the same time, end-to-end protection measures after thermal runaway must be considered from multiple aspects to prevent further deterioration of the situation.

At the grid level: ESS plays a significant role to maintain grid stability. Therefore, it should not only focus on the safety of BESS and PCS, but also the issues in real grid operation need to be considered as well, such as wide-band oscillation, transient overvoltage, power quality deterioration, and stability issues of islanded PV & ESS system, and HVRT/LVRT. We need to use grid algorithms and technologies such as adaptive HVRT to support ESS grid forming and improve grid stability.

ESS early fault detection

In 2023, a 100 MW energy storage project in Hubei province in China used Huawei's battery risk warning function to implement a cell-level fault warning. This function can identify more than 10 faults in advance, such as internal short circuits, abnormal temperature and overcurrent. If an HVRT occurs during the ESS operation, the bus voltage can be dynamically adjusted based on the DC/DC+DC/AC dual-stage architecture of the ESS and the PCS adaptive HVRT algorithm to ensure stable active output.

A 100MW BESS in China's Hubei project used Huawei's battery risk warning function

The Red Sea Project: a green miracle in the desert

A Huawei energy storage system is at the heart of a microgrid that will help power a new city in Saudi Arabia entirely by renewables

The Red Sea project is located in Tabuk Province, western Saudi Arabia, encompassing an area of 28,000 square kilometers. It is a key project in Saudi Vision 2030 and aims to build a new city entirely powered by renewable energy that will receive millions of tourists worldwide every year.

The Red Sea Project consists of 400MW PV installations and 1.3GWh energy storage system (ESS) using Huawei's Smart PV+ESS Solution, making it the world's first GW-level stand-alone microgrid project for 100% renewable power supply.

It is hard to imagine the technical challenges to overcome for a microgrid project of such a scale built in the desert from scratch. This project has innovated power generation, storage and consumption with various interdisciplinary technologies, making breakthroughs in related standards and key technologies. With continuous R&D investment in grid-forming energy storage technologies, Huawei works with customers and partners to create a green miracle in the desert at the Red Sea.

The Red Sea Project uses diesel generators only for emergency backup. This means that the PV+ESS system must be able to operate stably under various steady-state and transient-fault conditions. Faced with complex grid conditions in the new city, the Red Sea Project uses grid-forming energy storage technology to make the PV+ESS system a reliable voltage source. The stable microgrid can implement continuous off-grid fault ride-through and support GW-level black start, enabling minute-level power recovery and avoiding loss caused by power outages. In addition, the PV+ESS system is challenged by the inrush current caused by frequent connection/disconnection of transformers as well as startup/shutdown of motor-type loads, resulting in the risks

The Red Sea Project, using Huawei's Smart PV+ESS Solution, is the world's first GW-level standalone microgrid system

of microgrid collapse. The advanced grid-forming energy storage algorithm resists such inrush current and ensures a stable power supply without increasing the number of power conversion systems (PCSs).

The highest summer temperature in the Red Sea region exceeds 50°C, and the project is only 100 metres away from the sea. The high temperature, humidity, salt fog and sandstorms are major challenges to the transportation, construction and O&M of the ESS, which are crucial to ensuring the system's capacity and service life. The Red Sea Project uses Huawei's Smart String ESS with a protection level of IP55 and C5 anti-corrosion capability. The distributed cooling design ensures stable operation even in hot climates.

Last but not least, ESS refined management and safety are crucial. Huawei's Smart String ESS adopts modular architecture to avoid mismatches between batteries connected in series and parallel and maximize usable energy. Huawei uses innovative designs such as battery pack-level optimization, rack-level management, and four-level safety protection to implement refined monitoring and charge and discharge management, achieving higher available capacity and meeting higher safety standards.

Saudi Arabia, a country with abundant fossil fuels and a long history, has initiated a project of using 100% renewable energy for an entire city. This demonstrates Saudi Arabia's ambition, courage and action to move toward a sustainable future and carbon neutrality. Huawei Digital Power is honoured to participate in this project and help Saudi Arabia build a greener and better future through technological innovation.

Inside Southeast Asia's largest energy storage system

In late 2022, Huawei was one of the technology providers for Southeast Asia's largest energy storage system project, on the island of Singapore. Koh Chiap Khiong, CEO, Singapore & Southeast Asia, Sembcorp Industries, discusses the project aims, technology and record deployment time

The largest energy storage system (ESS) in Southeast Asia was officially commissioned in December 2022 in Singapore. Sembcorp Industries (Sembcorp) was appointed by the Energy Market Authority of Singapore (EMA) to commission the large-scale ESS on Jurong Island and Huawei is the technology provider for the 115MW/146MWh Smart String ESS Solution located on one of the system's two sites.

Huawei's innovative Smart String ESS solution is a cumulation of the extensive experience and deep technological capabilities of Huawei in the field of power electronics, digital technologies and energy system. The modular design features an optimizer for every battery pack and a dedicated controller for each rack. This increases the available power of the system by more than 15% within its lifecycle. In frequency regulation scenarios, the solution helps generate a longer-lasting constant power, assisting customers to achieve more benefits.

A quadruple-layered protection at the cell, pack, rack, and system level maintains a high safety standard while providing higher performance in the ESS. The containerized ESS solution also passed Singapore's rigorous fire safety standard to obtain the certificate of conformity.

Koh Chiap Khiong, CEO, Singapore & Southeast Asia, Sembcorp Industries, answers some questions about the company's role in the project.

PV Tech: How's your business in Singapore & Southeast Asia? What are your future deployment targets in the coming years?

Sembcorp is a leading energy and urban solutions provider. We are led by our purpose to drive the energy transition and grow our global installed renewables capacity to 25GW by 2028 in our key growth markets of China, India and Southeast Asia.

Across the Southeast Asian countries Sembcorp currently operates in, we support the various governments' net-zero ambitions through our renewables capabilities, with a gross portfolio across Singapore, Vietnam and Indonesia exceeding 1GW.

In Singapore, Sembcorp's renewables portfolio currently comprises more than 727MWp of solar projects and 289MWh of energy storage systems, making the company a key contributor to Singapore's national solar target of 1.5GWp by 2025.

Please provide some details on the background to this project: what was the need for the battery system and what functions will it perform, especially for system security?

The Sembcorp ESS spans two hectares of land in the Banyan and Sakra regions on Jurong Island and is Southeast Asia's largest ESS by capacity.

In May 2022, the EMA had launched an Expression of Interest to build, own and operate an ESS in Singapore and subsequently appointed Sembcorp as the ESS developer and operator. The ESS was commissioned within six months and is the fastest in the world of its size to be deployed.

The primary function of the Sembcorp ESS is to enhance power grid stability and resiliency. With a maximum storage capacity of 285MWh, the ESS can meet the electricity needs of around 24,000 average households for one day, in a single discharge. Its rapid response time to store and supply power in milliseconds is essential in mitigating solar intermittency caused by changing weather conditions in Singapore's tropical climate. The ESS can also provide reserves to the power grid.

We believe that the Sembcorp ESS plays a significant part in supporting Singapore's transition towards cleaner energy sources as it complements efforts to maximise solar adoption by storing and delivering energy, given the intermittent nature of solar power.

Why did you choose Huawei as the technology provider for the system?

We worked with multiple partners to develop the Sembcorp ESS. As a global technology leader with a track record in ESS around the world, we worked with Huawei specifically on the Banyan site leveraging their technology, such as the pre-fabricated ESS container solution and the decentralised temperature control system, which maintains the batteries' temperature difference within a specified range to ensure an optimum battery lifespan.

The project was deployed in a very short space of time – just six months. How was this tight deadline achieved and how did the technology used help expedite completion of the system in such a short space of time? What technical and other challenges did you encounter in realising this project?

The project was delivered in record-breaking time, all thanks to the global and local partners who believed in Sembcorp's project execution capabilities.

More than 400 workers from our various partners were working in parallel on-site and together, we achieved 235,000 safe man-hours during the construction of the ESS. Sembcorp also worked closely with various local government agencies, playing a key part in keeping the project on track for

Sembcorp Industries used Huawei's Smart String ESS solution on the 115MW Banyan battery project in Singapore

commissioning. The Sembcorp ESS was the result of an intense collaboration among like-minded stakeholders including technology providers, engineers, contractors, regulatory bodies and consultants coming together for the very first time.

Innovative ideas were adopted through these partnerships. An example was to use a pre-cast method during construction of the ESS structural support system, which then eliminated the need for piling. This resulted in substantial cost savings and time.

As with all large-scale projects, there were also unforeseen challenges like Typhoon Muifa, which affected the delivery of raw materials for the project and Singapore's record highest rainfall in 40 years that disrupted construction on-site. However, the ecosystem of reliable vendors like Huawei, who rallied around the project, and the Sembcorp team worked together to overcome these challenges by leveraging supply chain networks and motivating the various teams to deliver under less-than-ideal weather conditions.

Please provide some insights into the technology used in the system. Now that the system has been running for a little over a year, what insights have you gained into the operation of such a large system and the benefits offered by Huawei's technology? Has the system operated as expected?

The Sembcorp ESS is a modular system that can be easily configured to meet different customer needs and adapted to support on-grid or off-grid systems. This feature also helps mitigate operational risks, such as reducing downtime and shortening the turnaround response time when replacing defective batteries.

Digitalisation is key to operating such a large system. The facility can be remotely operated, monitored, and controlled using a supervisory control and data acquisition (SCADA) platform. Together with an energy management system (EMS), the Sembcorp ESS provides energy management, frequency regulation, and reserves to the national grid. Battery operation data is collected from the SCADA and EMS to help improve the efficiency of daily operations and battery shelf life.

In its first year of operation, the Sembcorp ESS on Banyan's discharge capacity and round-trip efficiency met the required performance parameters.

Would you use Huawei's solutions for projects such as this?

Developing and deploying renewable energy technologies such as ESS require specialised technical expertise and skills. Having the relevant technological know-how and skilled talent will have a long-ranging impact on the adoption of renewable energy technologies to support smooth integration into the power grid. Various departments within Sembcorp had the opportunity to learn from Huawei as a technology leader.

By leveraging Huawei's expertise and resources, the construction of the Sembcorp ESS contributes to the growth of the renewable energy sector in Singapore. The ESS's efficient and smooth operations hinge not only on the batteries' health but also on a comprehensive ecosystem of components and skilled labour to support Singapore's solar deployment targets.

As a testament to a productive partnership, Sembcorp and Huawei Digital Power signed a memorandum of understanding (MOU) in 2023 to collaborate on innovations and improvements on photovoltaic systems and battery ESS technologies, microgrids and other applications. Under the MOU, both companies will conduct research and implement practices in maintaining the resilience and stability of power grids, as well as enhance PV integration through grid-forming ESS.

The hydro-solar hybrid project bringing more green electricity to West Africa

50MW ground-mounted PV plant in phase 1 of the Bui hydro-solar hybrid project

A hybrid hydro-PV-storage system located in Ghana demonstrates the potential of colocation for meeting growing energy demand in West Africa

Ghana is one of the fastest-growing countries in Africa. With its energy demand increasing dramatically, Ghana is also at the forefront of renewable energy development in Africa.

The Bui Dam is Ghana's second largest hydropower plant and is planned with 250MW PV capacity and 50MWh energy storage systems (ESS), making this project the first and largest hydro-solar power plant in West Africa. The PV and ESS installations are located in the open space 2 km away from the dam and all use Huawei's Smart PV+ESS Solution. Currently, the first phase has been running stably for two years, which consists of 50MW ground-mounted and 5MW floating PV installations with an annual energy yield of up to 78GWh. On top of that, a 10MWh ESS has been put into operation at the end of 2023.

Dr. Matthew Opoku Prempeh, Minister of Energy Ghana, said that this groundbreaking project was a major milestone in Ghana's universal electricity access. It will provide stable power supply for northern Ghana and resolve the local power crisis, contributing to Africa's clean energy transition.

Ghana was severely affected by the climate crisis. In the past 40 years, the average temperature in Ghana has increased by 1.2°C, and extreme climate events such as storms, rainstorms and long-term droughts occur frequently. Droughts have led to a 60-70% reduction in hydropower generation in Ghana, making it one of the main threats to the country's energy supply.

The Bui Hydro-Solar Hybrid Power Plant is a significant supplement to Ghana's hydropower generation. By utilising hydropower, PV, and ESS, the power plant can provide a stable power supply for the power grid day and night, ensuring Ghana's energy security. Currently, 43% of the population has no access to electricity in Sub-Saharan Africa. Bringing the Bui Hydro-Solar Hybrid Power Plant online means that Ghana is on course to achieve its targets of full access by 2025 and 10% renewables in the energy mix by 2030, way ahead of the UN Sustainable Development Goal of universal electricity access by 2030.

Ghana is located in the tropics and experiences little seasonal variation year-round but has alternating rainy and dry seasons. In addition, the local power grid infrastructure is underdeveloped. It is a key challenge for Ghana to feed stable renewable energy into the power grid so as to optimize its energy mix. The grid-tied PV plant is prone to unstable power output due to cloudy and rainy weather, which has a great impact on the weak power grid in Ghana, undermining the efficiency and dispatch of the PV plant.

Huawei's Smart PV+ESS Solution helps solve the challenges in renewable integration, peak shaving, and power stability. The ESS can smooth out the variable energy output and significantly reduce impact on the power grid, and the integrated hydropower and PV power supply maximizes the utilization rate of the distribution lines. Huawei's Smart PV Controller features stable operation and grid connection under all-scenario grid conditions such as SCR ≥ 1.1, as well as high-quality output power, significantly improving economic benefits of the power plant.

Backed by Huawei's technical advantages and experience, the Bui Hydro-Solar Hybrid Power Plant has become a benchmark for Ghana to unlock its clean energy potential and achieve green energy transition. The pioneering project has not only provided Ghana with a sustainable energy supply, but also new opportunities for Africa in the development of a green economy.

Chicken farm in the sun

A chicken farm in the Netherlands installed a combined PV and energy storage system using Huawei batteries to gain new revenue streams and contribute to carbon neutrality

Huawei and its partner, Energie+Dak, developed a 400kW PV and 800kWh ESS project to provide green electricity for a local chicken farm in the Netherlands.

Combining PV with various industries, such as farming, helps customers diversify revenue sources and create greater economic benefits. The co-location of PV and agriculture provides a promising new option for agricultural development and climate protection.

"Currently, the Netherlands is number one in the world for the amount of solar energy per capita," says Hugo van Straten, senior business development manager, Huawei Netherlands Digital Power

"For every one person in the Netherlands a staggering 1,400Wp of solar PV is installed. This comes up to around 3.5 solar panels per person. Because the Dutch are connecting so much unpredictable renewable energy to the grid, this creates a high fluctuation in the availability of energy. But also, the stability of the energy grids and prices of electricity during a sunny and windy day can become negative, meaning you will get money by taking energy from the grid due to oversupply."

Because of fluctuating energy prices and a grid that is reaching its limits due to the high input of renewable energy sources, Huawei's FusionSolar C&I Smart PV Solution with LUNA2000-200KWH is be the answer to many of the challenges that entrepreneurs and companies are facing in their energy management.

"The LUNA2000-200KWH system is a proven concept, and many sites have already been commissioned in the Netherlands and the rest of Europe. This is thanks to its high reliability, our teams' local support and, most importantly, a very high safety standard," concludes van Straten.

Chicken farm owner

The owners of the farm that benefited from the combined PV and ESS say the installation has brought a range of benefits: "As farmers, we are constantly looking to optimise

The combined PV+ESS at the Netherlands chicken farm has brough benefits including new revenue streams and a route to decarbonisation

The safety and reliability of the Huawei's FusionSolar C&I Smart PV Solution made it an attractive choice for the farm

our business, avoid risks and gain new revenue streams. With the energy storage system of Huawei that got installed, all three benefits are being met, which makes it a logical investment. Aside from the fact that it helps the business, we chose Huawei specifically for its safety, reliability and system integration, which makes it a secure investment for the coming years. Plus, it will help us to reach carbon neutrality for the future."

Huawei partner

Energie+Dak, Huawei's partner on the project, specialises in energy solutions in the Dutch market, focusing on commercial, industrial and agricultural companies and projects. For battery projects, the company has a strong cooperation with Huawei.

"Huawei delivers us a high standard quality of energy storage systems, with good performance, a low failure rate and easy installation and maintenance," says Dirk van Lierop, the company's representative for the south Netherlands area.

"At this farm, we installed four batteries. The advantage of this battery is that it has 12 individual packs, each one with its own optimiser. With this structure, the customer is always sure of 100% of the promised energy storage and optimal safety. Next to that, you can see the temperature and performance of each pack. If one pack has an issue, the other 11 packs can just keep working without being held back.

"Huawei gives us the security of a safe and trustworthy system, by giving us the right warranty terms on the amount of cycles. But also, the state of health after the warranty period or maximum cycle amount. We are very happy with the cooperation between Huawei and Energie+Dak."

Pioneering the low-carbon development of Peru's mining industry

Huawei was technology partner for a peak-shaving energy storage project in Peru

The Huawei FusionSolar energy storage system at La Morena, Peru

In November 2023, the first energy storage project for peak shaving in La Morena, Peru was put into operation.

This 4MW/8MWh project, which uses Huawei FusionSolar Smart String Energy Storage System (ESS), is a milestone for Peru's mining industry. Poderosa is the first mining company to take advantages of the benefits of peak shaving and integrate an energy management system (EMS). The EMS obtains real-time data from the COES to automatically identify and arrange the optimal charge and discharge time.

This project has encountered various challenges during development and construction. The energy storage equipment was transported to La Morena at an altitude of 1,900m across the Andes Mountains and the Marañón River over a distance of more than 900km with some extremely narrow roads. The project is located on a slope and requires special materials to fix the ESS. Cranes cannot be used for installation due to limited space. It was the joint effort of multiple parties that helped overcome those difficulties and ensure the smooth operation of this project.

This energy storage project brings many benefits. For example, in terms of economy, electricity costs can be reduced by 14% each month, saving US$800,000 each year, because batteries are charged during off-peak hours and discharged during peak hours. The payback period is only four years. In addition, Huawei FusionSolar energy storage products are highly reliable, boasting a service life of at least 16 years. In addition, less diesel fuel is used, which saves US$600,000 fuel costs each year and contributes to environmental protection. The ESS also provides emergency power backup during power outages to ensure uninterrupted mining operations.

The unique and important project has pioneered sustainable mining operations for Poderosa and helps enhance Poderosa's reputation as a responsible company that is committed to technology, innovation and sustainability. It is a milestone for Poderosa, since it is aligned with its strategic objective of transition toward clean energy with zero emissions by 2030, exploring a feasible pathway for the green transformation of Peru's mining industry.

Poderosa is also planning a 7MW PV project to leverage abundant solar energy and charge the ESS with PV electricity. The convergence of PV and ESS will help Poderosa use clean energy more efficiently.

The system is used for peak shaving and to provide emergency backup power during power outages

PV+ESS-integrated factory's road to carbon reduction

Huawei FusionSolar helped a business in China's Jiangsu Province build a smart PV and energy storage system that ensures stable and safe power supply and helps it achieve carbon neutrality

The PV+ESS has helped reduce power costs by 14% at the Jiangsu Province site in China

Enterprises are the key entities to achieving "carbon peaking and carbon neutrality". All walks of life are accelerating the establishment of sustainable development strategies to actively respond to the trend of green and low-carbon development. Centuray, a local enterprise in Jiangsu Province, China, has also developed carbon reduction strategies.

Thanks to the stable running of the 1.6MW PV system and 8MWh energy storage system (ESS), Centuray has taken the lead in implementing PV+ESS integration in Jiangsu Province. As the largest manufacturer of high-speed railway contact networks and cables in China, Centuray has high requirements for the continuous production of equipment. To ensure stable and safe power supply for continuous production of key equipment, Huawei FusionSolar helped Centuray build a PV+ESS project and facilitate traditional power plants to go smart. Huawei integrates smart module controllers, smart string inverters and smart string ESSs into the C&I smart PV solution.

Shao Qing, Vice President of Centuray, states that PV+ESS is a critical link for an enterprise to build "low-carbon factories" and "green factories". The self-consumption rate of the PV+ESS plant in Centuray exceeds 80%, providing stable and reliable power supply for factory production. In this way, Centuray can actively cope with the pressure and uncertainties caused by the energy transformation crisis. In terms of economic benefits, green and low-carbon factories and refined energy management with peak shaving can also reduce production costs.

Shao Qing also indicates that the annual power consumption cost of power generation facilities in the PV+ESS plant has been reduced by 14%, saving about €0.26 million per year. The second phase of the 8MWh project is also under development. After the plant is completely constructed, the production and daily operation of the company's factory will be powered by the PV+ESS plant, and the ESS will maximize the utilization of PV power.

The ESS plant completely adopts Huawei Smart String ESSs, which deeply integrates digital, power electronics and energy storage technologies to resolve the inconsistency and uncertainty of lithium batteries. Through refined management, one management unit manages only 16 cells, maximizing the battery charge and discharge capacity.

In addition, FusionSolar ESSs use distributed cooling systems to enable independent heat dissipation of battery racks, extending the battery service life by 50%. The modular design facilitates O&M and prolongs the ESS lifespan. As a result, the LOCS is reduced by more than 20%.

Shao Qing expresses his trust in Huawei ESSs in terms of system safety. He says that Huawei's BMS and big data technologies can identify derivative and unexpected internal short circuits one day and 10 seconds in advance, respectively; and quickly locate and accurately isolate faulty cells, reducing fire risks by more than 90% to ensure system safety.

The introduction of the PV+ESS integrated system accelerates Centuray's construction of a modern energy management system, reduces the overall energy consumption of the company's products, and helps the company achieve green production as soon as possible.

Case study gallery

A round-up of some of the many projects around the world where Huawei's energy storage solutions have been deployed

Utility-scale PV+ESS projects

Hainan, China

The 100MW agrivoltaics and 25MW/50MWh energy storage demonstration project in Hainan, China, generates more than 174 million kWh of clean electricity each year, supporting regional energy supply and relieving power shortages.

Qinghai, China

The multi-renewable energy synergy project in Qinghai, China integrates PV, CSP, and wind power, and is equipped with a 50MW/100 MWh ESS. It has verified the supporting role of grid-forming energy storage in the large-scale grid integration of renewable energy.

Hubei, China

The 100MW/200MWh energy storage demonstration project in Hubei, China has been put into operation, bolstering the regional power grid structure. It sets the tone for peak shaving and improving power grid operation flexibility.

Commercial and industrial

Huawei Johannesburg Campus, South Africa

Huawei's Johannesburg campus in South Africa uses four LUNA2000-200KWH energy storage systems to replace diesel generators for power generation, saving US$96,000 in fuel costs every year. It significantly improves energy power supply capacity and utilisation efficiency, achieves long-term stable power supply and helps the campus transform into a green and low-carbon environment.

Mahidol University, Thailand

Mahidol University in Thailand has built Asia-Pacific's largest single-site C&I PV and ESS plant, which includes a 12MW PV system, a 600kWh ESS, and optimisers configured for all PV modules from Huawei FusionSolar. The plant fully complies with Thailand's new national electrical safety code, setting a milestone for the large-scale application of PV and ESS integration in Thailand.

Baraclit Concrete Factory, Italy

The 2.4MW PV and 1000kWh ESS maximize self-consumption of the Baraclit Concrete Factory in Italy. It saves €90,000 in electricity costs each year and achieves a 42% green power ratio.

Residential

Spain

A villa in Spain has adopted Huawei's solution with a 6kW PV system, full-configuration optimisers, 10kWh ESS, chargers, and EMMA home energy management assistant to increase the proportion of PV power for home appliances, achieving a self-consumption rate of nearly 100%.

Chongqing, China

An 11.88kW PV and 10kWh energy storage system in Chongqing, China provides uninterrupted power supply for a low-carbon lifestyle.

Nanjing, China

A 20.24kW PV and 15kWh energy storage system in Nanjing, China brings a better life and unlimited green power.

HUAWEI

Fusionsolar

Making the Most of Every Ray

All-Scenario Grid-Forming Solutions