



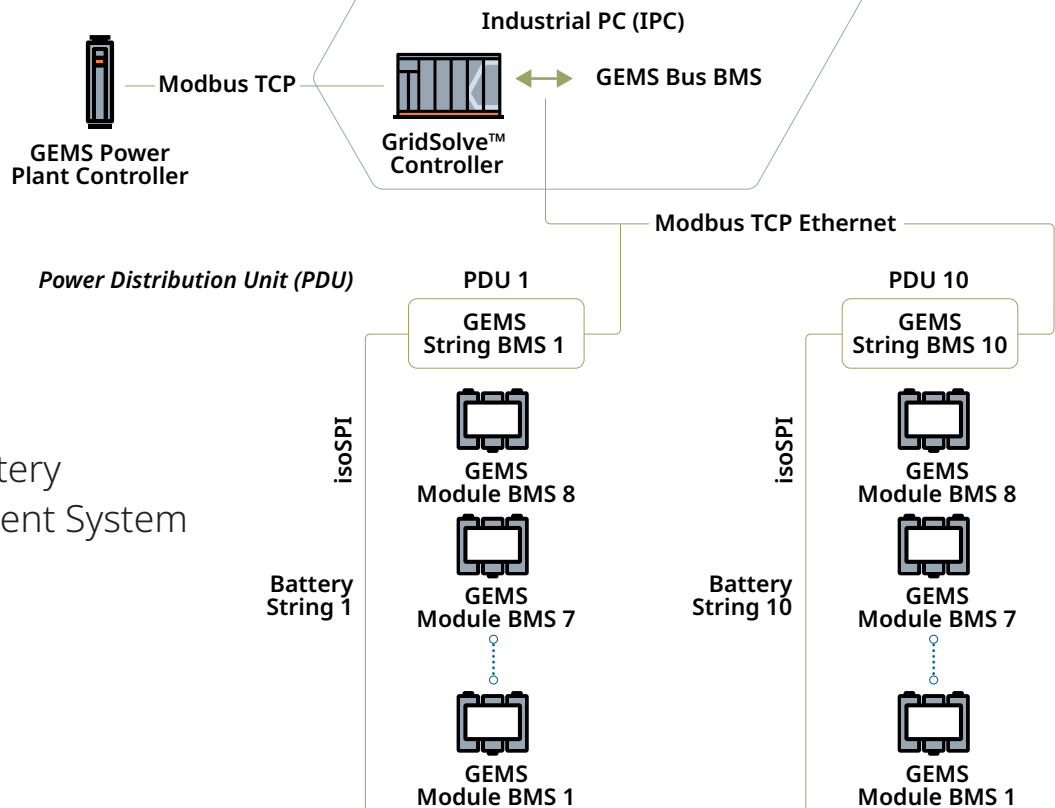
The GEMS Battery Management System (BMS)

Bringing industry-leading cybersecurity, accuracy, and asset longevity to your BESS investment



The growing prevalence of battery energy storage systems (BESS) has brought forth increased scrutiny around cybersecurity, performance, and long-term asset management. As these solutions become increasingly critical to grid function with the deployment of renewable energy, additional developments are needed to ensure that they remain secure, optimised, and well-managed. To meet the demand for safe and reliable solutions, Valo's GridSolve™ BESS will now be equipped with a U.S. designed and engineered BMS, the GEMS Battery Management System (BMS). Equipped with cutting edge cybersecurity features, superior state-of-charge (SoC) accuracy, and the flexibility that comes with continuous improvements, the GEMS BMS sets a new standard for cybersecurity and performance. The GEMS BMS also gives our customers the peace of mind that comes with knowing the system is fully engineered by Valo's world-class engineers, backed by Valo's supreme reputation for quality, and adaptable for years to come.

GEMS Battery Management System



Introduction

As the global demand for energy storage continues to rise, our customers increasingly rely on BESS to optimise energy generation, increase renewable energy penetration, and enhance grid reliability – all while generating revenue. System failures can not only lead to loss of power for industrial and residential users, but can result in heavy fines to system owners. As BESS applications continue to grow in complexity and projects grow in capacity, the importance of reliable and sophisticated software and hardware has never been greater.

Another priority as BESS systems scale is maintaining stringent cybersecurity standards. Since systems are only as reliable as they are safe, the GEMS BMS was designed with cybersecurity at the forefront, to ensure that critical data like state-of-charge (SoC) accuracy that inform trading and operational strategies are well-managed and safe. This paper outlines the advantages and key features of the GEMS BMS and how it sets a new standard for safety, efficiency, and intelligence in energy storage management.

Recognising these needs, Valo has developed a next-generation battery management system, the GEMS BMS, that offers:



Enhanced cybersecurity – safeguarding customers' battery assets at every level.



Superior battery measurement and performance – ensuring optimal performance and maximised tradable energy through increased SoC accuracy.



Continuous improvement capabilities – facilitating software upgrades to ensure long-term system optimisation and performance.



Cybersecurity: safeguarding critical infrastructure

In the modern digital world, cybersecurity is critical for the protection of both physical and digital assets. The GEMS BMS is the gateway between the battery cells in a BESS and the greater controls software, Valo's GEMS platform, making it a crucial point to protect from interference. Valo's BMS is fully designed and engineered in the United States by Valo's team of expert engineers. This additional layer of protection at the hardware level enhances the existing safeguards already implemented in the GEMS software.

Key features of the GEMS BMS cybersecurity protections:

- **Manufacturing transparency:** The GEMS BMS is fully engineered in the United States, where the Valo team has complete control over the design and procurement of all components, ensuring greater accountability and security. Manufacturing of the GEMS BMS is done by Valo's trusted manufacturing partner in Thailand.
- **Certified for functional safety:** The GEMS BMS is certified to UL 61730-1 Annex H. This standard guarantees that the system delivers functionally safe responses in the event of the critical safety operational violations: overtemperature, under-temperature, over current, overvoltage, and undervoltage.
- **Hardware-level control:** In response to a critical safety operational event, the GEMS BMS automatically prohibits both charge and discharge by opening the contactor relays to disconnect batteries from the DC Bus, effectively preventing any potential adverse operational condition from escalating.
- **Dedicated functional safety core:** The GEMS BMS partitions one CPU core purely for functional safety activities. This core accepts signals directly from cells and is impervious to

other functions of the BMS, preventing unsafe conditions from manifesting even if compromised.

The key cybersecurity features of the GEMS BMS act as an enhanced layer of protection against physical and digital threats. These features are additional safeguards to the existing protections provided by Valo's GEMS Digital Energy Platform:

1. **Valo's GEMS Power Plant Controller** features tamper-resistant physical security, password-protected access to BIOS and all databases, and high-availability / fail-over mechanisms. The GEMS Power Plant Controller has also been certified to IEC 62443 4-1 and IEC 62443 4-2 cybersecurity standards. IEC 62433-4-1 outlines strict processes for the secure development of industrial automation and controls systems, while IEC 62433-4-2 outlines technical control system component requirements for our GEMS Power Plant Controller. Our compliance has been certified by an external auditor, Exida.
2. **Valo's GEMS Power Plant Network** is designed to IEC 62443-3 and incorporates cybersecurity best practices such as security zone separation and network traffic permissions to provide top-tier protection from bad actors.
3. **Valo's GEMS Cloud Connect** incorporates perimeter firewall, strong end-to-end encryption, tamper-proof logging, stringent Role-Based Access Control and zero-trust design elements to provide state-of-the-art software protections.

This robust cybersecurity framework ensures that our customers' BESS assets are best protected from cyberattacks while maintaining smooth BESS operations.



Superior battery measurement and performance

State of charge (SoC) is a critical metric in battery management that directly impacts the performance, efficiency, and profitability of BESS. Accurate SoC monitoring is particularly important for asset owners looking to maximise the value of their assets through advanced bidding and energy trading.

Benefits of enhanced SoC accuracy:

- **Optimised bidding capacity:** With improved SoC accuracy, the GEMS BMS helps customers bid with confidence. Our customers can capitalise on the maximum tradable energy—without the risk of overbidding or underperforming.
- **Extended battery life:** Accurate SoC monitoring also prevents overcharging and overdischarging, thereby improving battery lifespan and keeping capacity high for the full lifespan of the battery.
- **High capacity:** While a traditional system might balance cells over the course of weeks, the GEMS BMS can balance fully during normal operations. This means the BESS is operating at its highest capacity for more of the time that it is in use.
- **Real-time feedback:** Instantaneous feedback from the GEMS BMS allows for dynamic adjustments in real-time, providing users with a more responsive and adaptive system.

This enhanced SoC accuracy enables customers to unlock the full potential of their BESS, ensuring not only better financial performance through optimised trading but also a longer system lifespan and reduced operational risks.



Continuous improvement and future upgrades

Energy storage technology is evolving rapidly, and a static system can quickly become outdated. To ensure that our customer's asset remains competitive over the long term, the GEMS BMS supports continuous improvement and future upgrades. While a traditional system is designed to the best contemporary practices and only upgraded in response to pressing challenges, the GEMS BMS is designed to adapt to new innovations, software features, and evolving battery technologies throughout the 20-year (or longer) lifespan of the asset.

Key features for future-proof technology:

- **Seamless upgrades:** With the GEMS BMS's robust hardware infrastructure, software upgrades are seamlessly integrated into existing systems, ensuring that customers are always able to capitalise on learning and optimisation from the full fleet of Valo's 100+ global BESS sites.
- **Long-term performance optimisation:** The GEMS BMS's ability to be remotely updated allows for continuous improvement, ensuring that the BESS is always operating at peak performance, so the asset retains its full operational potential throughout its lifespan.
- **Incorporation of emerging recommendations:** As new battery management algorithms and lifetime best practices emerge, the door is open to improve a commissioned site to utilise the latest advancements in performance, efficiency, and safety. An investment in the GEMS BMS acts as a key to these innovations to keep the BESS at the forefront of the energy storage market.

The flexibility to upgrade and improve the GEMS BMS system over time ensures that our customers' investments remain protected, and their BESS continues to operate optimally for the full lifespan of the asset.

| Conclusion

The GEMS BMS brings a new level of sophistication to energy storage management. By prioritising cybersecurity, enhancing state-of-charge (SoC) accuracy, and offering the ability to upgrade and adapt to new technologies, the GEMS BMS ensures that customers can maximise the value of their BESS throughout its lifespan.

The GEMS BMS is backed by a reliable, future-proof solution that has been designed, engineered, and manufactured in the United States. As energy storage plays an increasingly critical role in the global energy landscape, the GEMS BMS offers peace of mind with industry-leading security, accuracy, and asset longevity.

For more information on how the GEMS BMS can optimise your energy storage system and drive the success of your next-generation projects, [contact our team](#).