PRODUCT BRIEF

CellSage™

Advanced Battery Modeling, Simulation, and Analysis (MS&A) Software Application

Features and Benefits

- **Precision & Accuracy:** Proven to yield a 10-25% reduction in battery aging by refining Battery Management System (BMS) strategies.
- **Performance Optimization:** Battery life & warranty periods are optimized by investigating thermal management, string anomalies, & path dependent aging for complex duty cycles.
- **Improved Time to Market:** Proven to reduce time & cost expenditures associated with upfront cycle life testing and battery pack designs.
- **Unleash Innovation:** Accurately models more than 20 vital health metrics and path-dependent aging effects such as State-of-Charge (SoC), Capacity Loss, Thermal Hot Spots, Global Annual Temperature, Power Fade & several others!

General Description

CellSage™ is one of the first commercially available advanced battery health Modeling, Simulation, and Analysis (MS&A) tools on the market and allows for science-based evaluation and exploration of battery life cycles over near limitless combinations of aging conditions. Batteries are often the weak link in power systems, and Ridgetop Group is proud to offer proven and robust MS&A tools that aim to characterize these power systems during early-stage R&D and in the field.

Example of Path Dependent Capacity Loss for best-case, average-case, and worst-case scenario in CellSage™ GUI

Under license from the U.S. Department of Energy's Idaho National Laboratory (INL), Ridgetop has enhanced the underlying CellSage™ technology core and its advanced sigmoidal rate expression (SRE) algorithms to provide end users with easy-to-understand metrics, indicators, and alerts that show how a battery is aging and an accurate projection of how long the battery will last for a simulated duty cycle and mission. Through an intuitive Graphical User Interface (GUI), Ridgetop has now included a New Chemistry Import Feature that allows the cell chemistry library to be easily expanded with minimal upfront baseline testing data. This new capability has been used by battery researchers around the globe to create "what if" scenarios that determine how arbitrary operational and environmental stress factors impact battery performance and health. Such insights are used to select the most appropriate battery for primary and second use applications.

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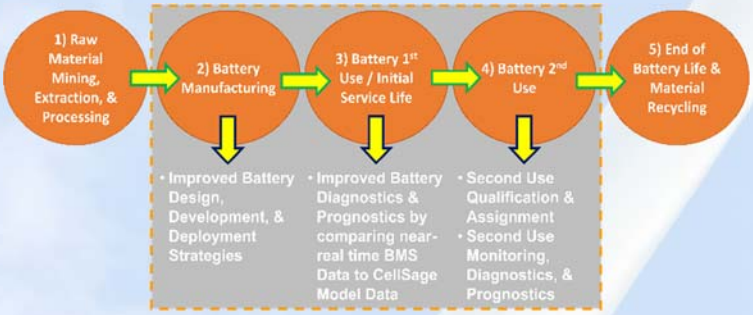
Commercial Impact

Targeted within several different energy storage sectors, there is a pressing need for innovative tools like CellSage™ involving robotics, grid/micro-grid systems, electric vehicles (EVs), battery manufacturers/consumers, and other applications where high-fidelity evaluations of battery health is required. To address this need, Ridgetop Group and INL continue to collaborate with industry leaders to adapt the technology for their own unique battery R&D applications. By utilizing a proven physical and mathematical approach to both battery diagnostics and prognostics, CellSage™ helps battery engineers and researchers determine optimal Battery Management System (BMS) strategies and replacement schedules for high-cost battery systems. In addition to helping with the early determination of such large expenditures, its small computing footprint also makes it feasible for use on laptop PCs, desktops, and other architectures for greater commercialization options.

Battery Management Systems

The ongoing shift towards clean and renewable energy sources is heavily reliant on batteries, which serve a crucial role in powering personal communication devices, electric and hybrid-electric vehicles, and providing essential backup energy storage for the grid. However, advance BMS development has lagged behind, creating a significant technological gap. CellSage™ emerges as a solution to bridge this gap, offering customers the means to enhance and optimize their BMS strategies. By integrating CellSage™ into BMS systems, real-time comparisons between actual BMS data and predictive models become possible, revolutionizing the monitoring of key parameters like cell voltages and State of Charge (SoC) at both module and system levels. Moreover, CellSage™ enables adaptive recharging protocols that can accommodate diverse battery cell types, dynamically adjusting to prevent issues such as overcharging and undercharging, while also addressing the challenges of managing mixed batteries with varying voltage outputs. In essence, CellSage™ stands at the forefront of advancing BMS control logic, driving efficiency, reliability, and sustainability in the clean energy transition.



About Ridgetop Group Inc.

Ridgetop Group is an **AS9100D and ISO:9001 certified** organization located in Tucson, Arizona. Since its founding in 2000, Ridgetop has specialized in providing best in class CBM, PHM, IVHM, and reliability engineering solutions to commercial and government organizations to increase safety, efficiency, and operational performance while also reducing maintenance and sustainment costs with the most innovative products and technology.

Our advanced diagnostic and prognostic methods are used to improve test coverage, improve reliability, reduce downtime, and reduce the mean time to repair (MTTR) of mission critical systems. These cost-saving methods are incorporated in products and services have been applied on numerous electromechanical systems and subsystems found in Aerospace, Defense, Transportation, Energy, Medical, and Industrial applications. Ridgetop also provides engineering design services for hardware, firmware, and software-based development programs related to the implementation of CBM, PHM, and IVHM strategies.

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