CELLSAGE
BATTERY HEALTH MODELING SIMULATION & ANALYSIS TOOL

PRODUCT BRIEF

# Ridgetop Group Inc
ENGINEERING INNOVATION

CellSage™

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

Features and Benefits

• Precision & Accuracy: Proven to yield a 25% reduction in battery aging by refining Battery Management System (BMS) strategies.

• Comprehensive Health Metrics: Accurately model over 20 vital health metrics, including State-of-Charge, State-of-Health, capacity loss, thermal hot spots, global annual temperature, and power fade.

• Improved Time to Market: Proven to reduce time & cost expenditures associated with upfront cycle life testing and battery pack design

• New Chemistry Import Feature: Quickly expand the cell chemistry library with minimal testing data, enabling rapid analysis for various battery chemistries and conditions.
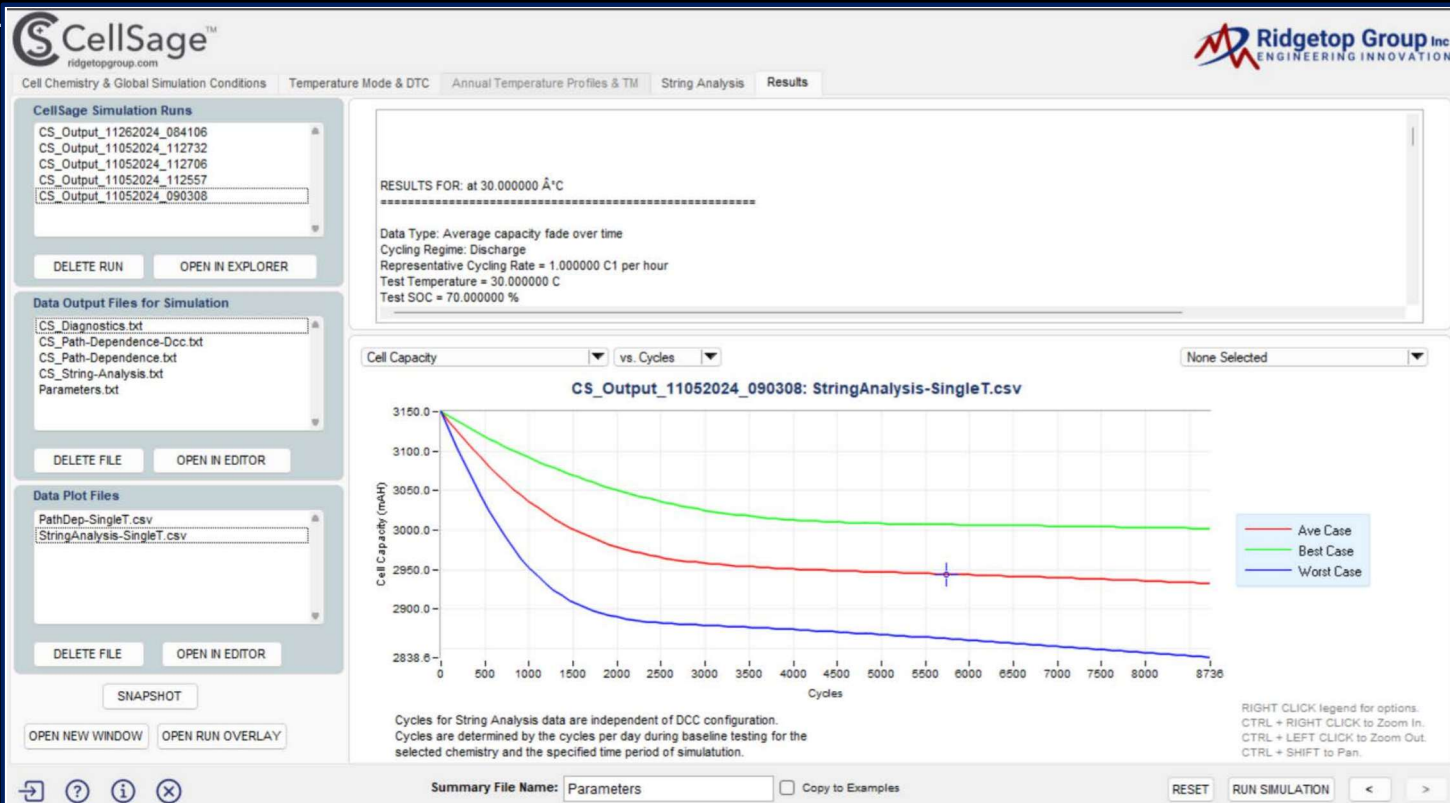
Example of Path Dependent Capacity Loss for best-case, average-case, and worst-case scenario in CellSage™ GUI

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. 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. Ridgetop's intuitive GUI now includes a New Chemistry Import Feature, enabling easy expansion of the cell chemistry library with minimal baseline testing. Researchers worldwide use this capability to explore "what if" scenarios, assessing how stress factors impact battery performance and health, guiding optimal battery selection for primary and second-use applications.

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.

LFP Aging in Select US Cities

Without Thermal Management   **With Thermal Management**
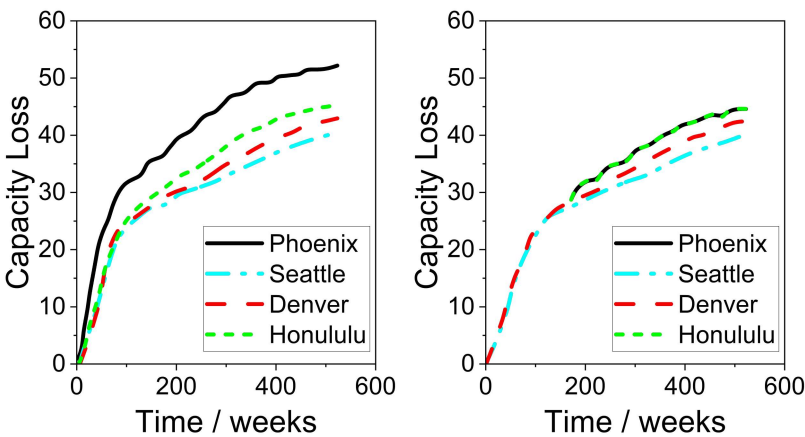
Thermal management at the shown conditions compresses the capacity loss curves to a more consistent basis, allowing the battery to be used in diverse geographical regions

Battery Management Systems

Real-Time Data Integration: Compare actual BMS data with predictive models for precise monitoring of cell voltages and SoC at both module and system levels.

Adaptive Recharging Protocols: Implement dynamic recharging protocols that prevent overcharging and undercharging, accommodating mixed battery types and voltage outputs.

Improved BMS Control Logic: Enhance the efficiency, reliability, and sustainability of energy storage systems by advancing BMS control logic with CellSage™

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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