Fraunhofer ISIT

Optimal Thermal Control for Safe and Fast Charging

Electric Forklift Battery Pack

Enhanced battery safety, lifetime / Maximize power delivery

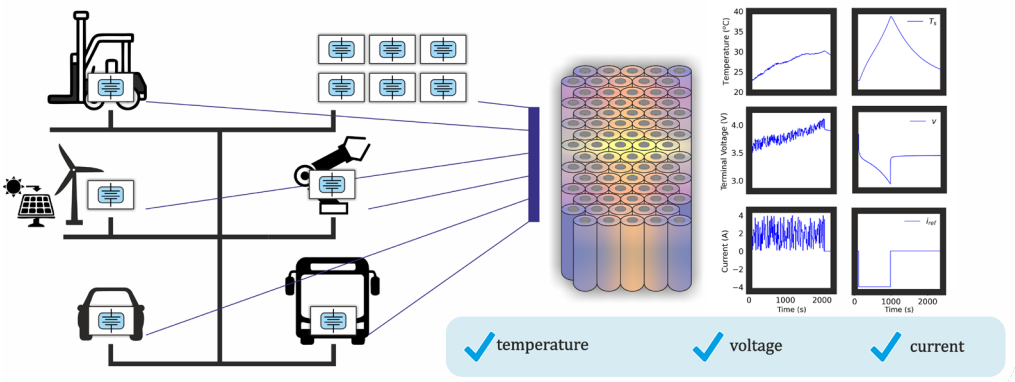
Enhanced battery performance with active thermal control technology surpassing conservative charging strategies

Fraunhofer ISIT has developed an innovative procedure that optimizes charging times by actively managing the thermal dynamics of battery packs. Effective temperature control is essential for battery safety, performance, and longevity. High temperatures accelerate chemical degradation, reduce capacity, and increase the risk of catastrophic failures such as thermal runaway. However, characterizing battery thermal behavior is complex, involving multiple models, experiments and coolant-specific configurations. This leads to overly conservative charging strategies, limiting power delivery to avoid overheating. ISIT's solution addresses these challenges by precisely modeling thermal dynamics and enabling faster, safer charging without compromising battery integrity, ensuring optimal performance and extended lifespan.

Key features & technical advantages

- **Accelerated charging** by dynamically maintaining safe temperature limits at the cell level
- **Optimal power management** tracking temperature and generating reference current in real time.
- **Data-driven modeling** creating in-situ thermal models using existing BMS data.
- **Rapid deployment** requiring minimal data (minutes to hours from typical battery use).
- **Predictive optimization** with highly accurate temperature-constrained maximum power delivery

In-situ data collection for optimal thermal models



Contact us for testing the optimal thermal control technology

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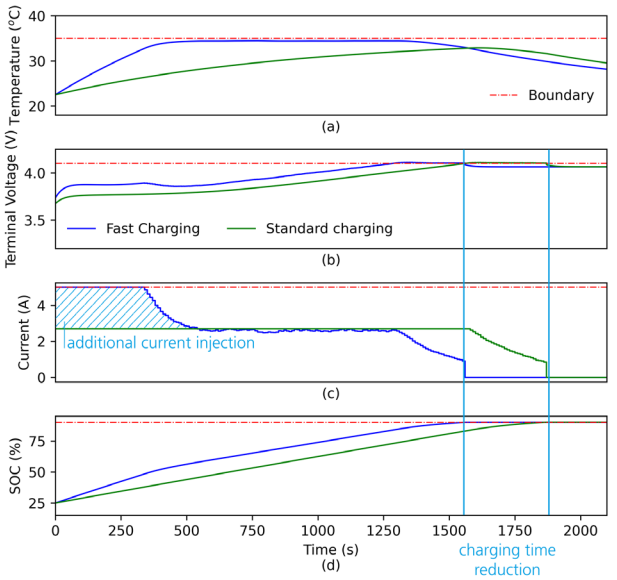
Data-driven approach for real-time thermal control

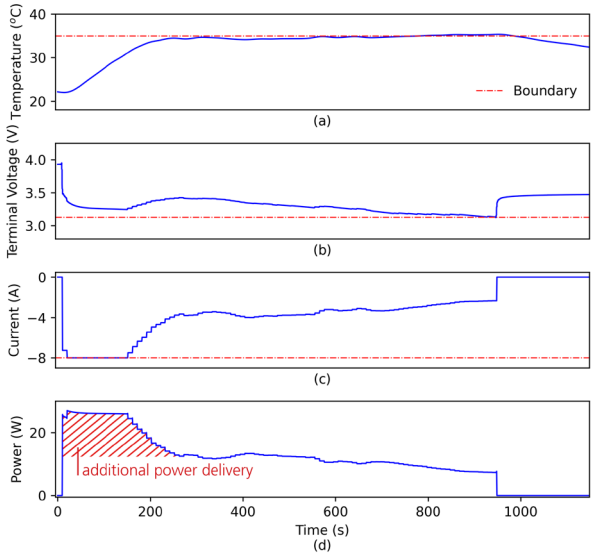
Our data-driven approach simplifies real-time thermal control, eliminating the need for conservative power constraints during charging or discharging. This solution does not rely on additional sensors; instead, it utilizes existing data from the Battery Management System (BMS). The collected data is processed by our algorithm, which generates a precise thermal model of the battery system.

Using this model, an optimization algorithm dynamically calculates the optimal current or power levels that adhere to thermal safety requirements. By continuously maintaining the battery within an ideal temperature range, this approach ensures efficient operation, enhanced safety, and a prolonged lifespan.

With its simplicity and efficiency, this methodology streamlines temperature management, making it indispensable for reliable and high-performing energy storage systems



Optimized charging strategy



Temperature constrained maximum power delivery

Applications - Key use cases

Grid-connected BESS: enabling fast ancillary services like frequency regulation by optimizing thermal management during rapid charge/discharge cycles.

Safety-critical systems: ensuring thermal safety and reliability in applications such as submarines, where failure is not an option.

Heavy-duty EVs: enhancing performance and safety in electric trucks, buses, and construction vehicles under high power demands.

Fast charging for robotics: supporting industrial robots and Autonomous Mobile Robots (AMRs) with optimized fast charging solutions.

High-Power EV Charging Infrastructure: improving throughput and safety in ultra-fast EV charging stations.

Tailor made for your customize battery pack

By applying our modeling and control strategy, charging time is reduced through the injection of additional current while adhering to the thermal constraints defined in the design. Furthermore, the data-driven model predicts temperature behavior, enabling proactive current adjustments that enhance safety by keeping the cell within the Safe Operating Area (SOA). Similarly, during discharging, the strategy increases maximum power delivery by operating the battery at the optimal maximum temperature specified in the design.