Future Forward: Energy Management Innovation Showcase

AI-Optimized Battery Management

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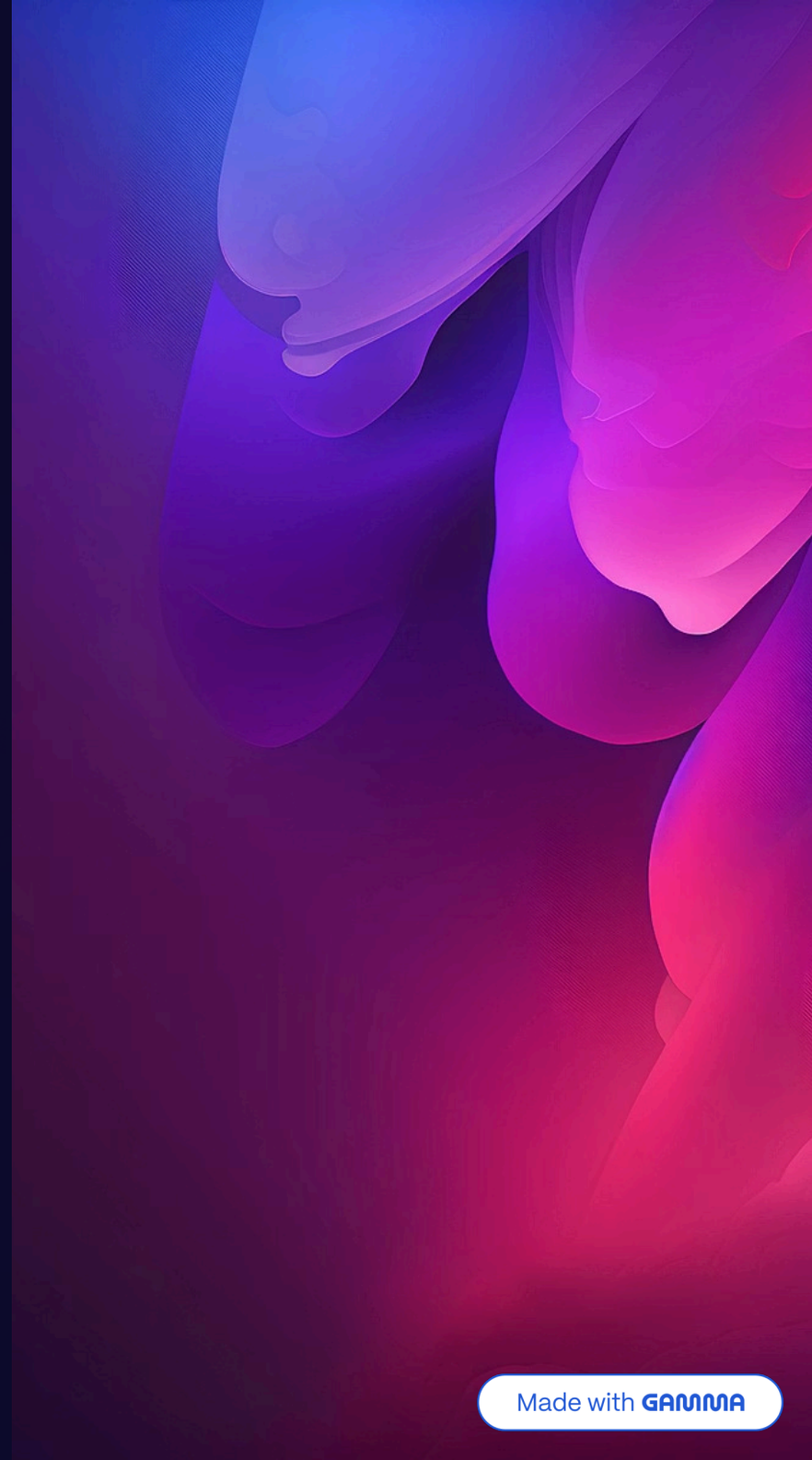
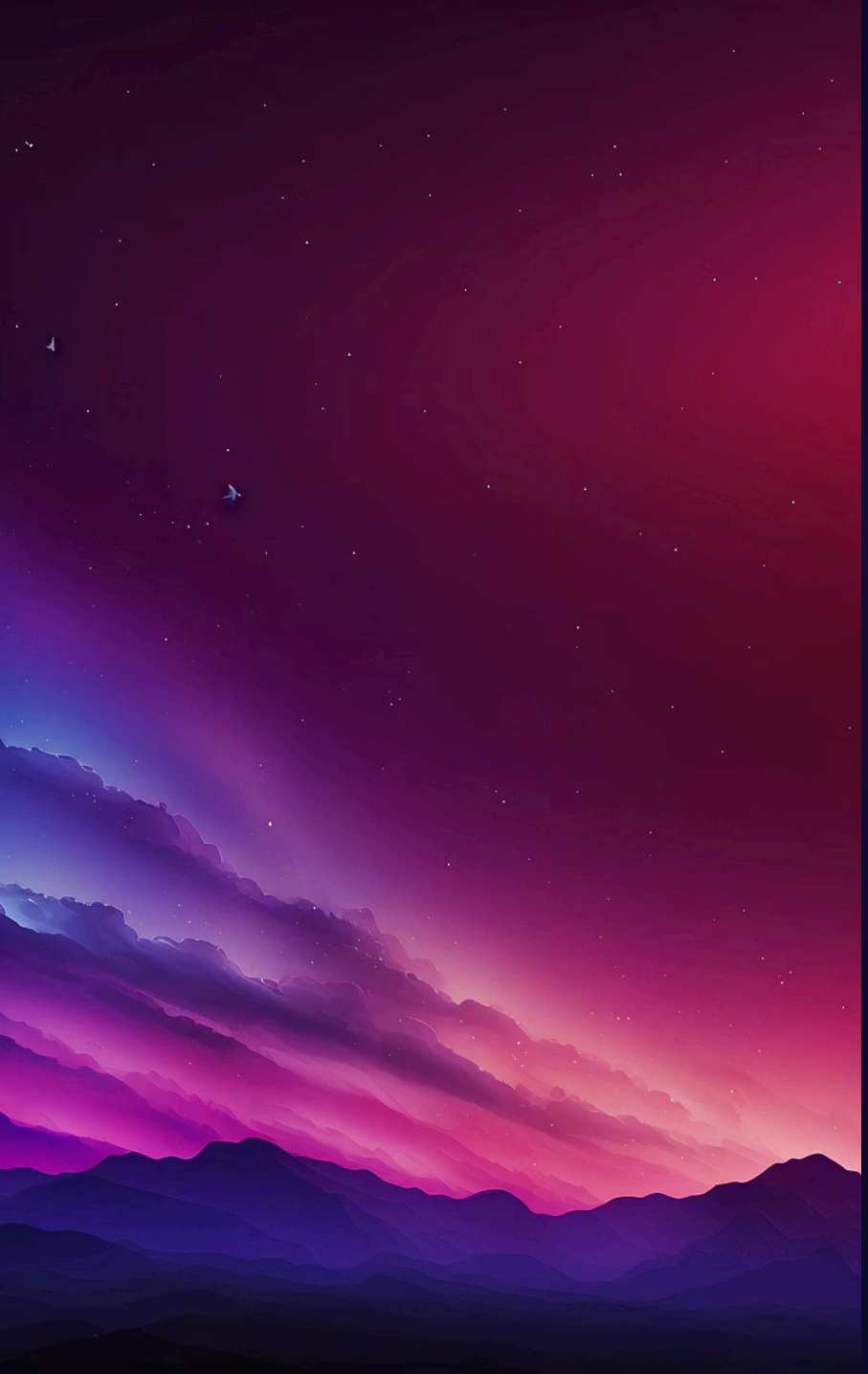




Challenge Identification

For this challenge, the problem we are trying to solve is

> How can AI optimize the use and application of **battery storage technologies** in real-world energy challenges?

But - what is battery storage technologies exactly? In short word, it's **everything about the battery.** Here are some real-world applications:

- Microgrid Optimization with Battery Storage
- Intelligent Energy Dispatch for Battery Systems
- AI-Enhanced Battery Management Systems (BMS)
- Smart Home Energy Management with Battery Integration
- Electric Vehicle (EV) Smart Charging and Grid Services
- Second-Life Battery Applications

For this challenge, we are picking one of the topics integrated with AI solutions to improve battery storage technologies.

SPT

Project

Solar, Storage, and Charging Integration

-Combines solar power generation, energy storage systems, and electric vehicle charging functions

-Provide an efficient, convenient, and environmentally friendly energy solution

-Achieve energy self-sufficiency and intelligent management.

EV Smart Charging

> Combines solar power generation, energy storage systems, and electric vehicle charging functions

Develop an AI feature, focusing on the battery storage bank at a charging station, and apply it to real-world challenges.

Innovation Idea

Features across different dimensions: tackling fundamental challenges, leveraging market opportunities, enhancing reliability, and envisioning a more interconnected and optimized energy future

Multi-Objective Optimizer

Health-Aware Charging

Energy Trading AI Agent

Microgrid Collaboration

Predictive Maintenance Scheduler

Multi-Objective Optimizer

Uses AI to balance conflicting objectives in battery storage management.

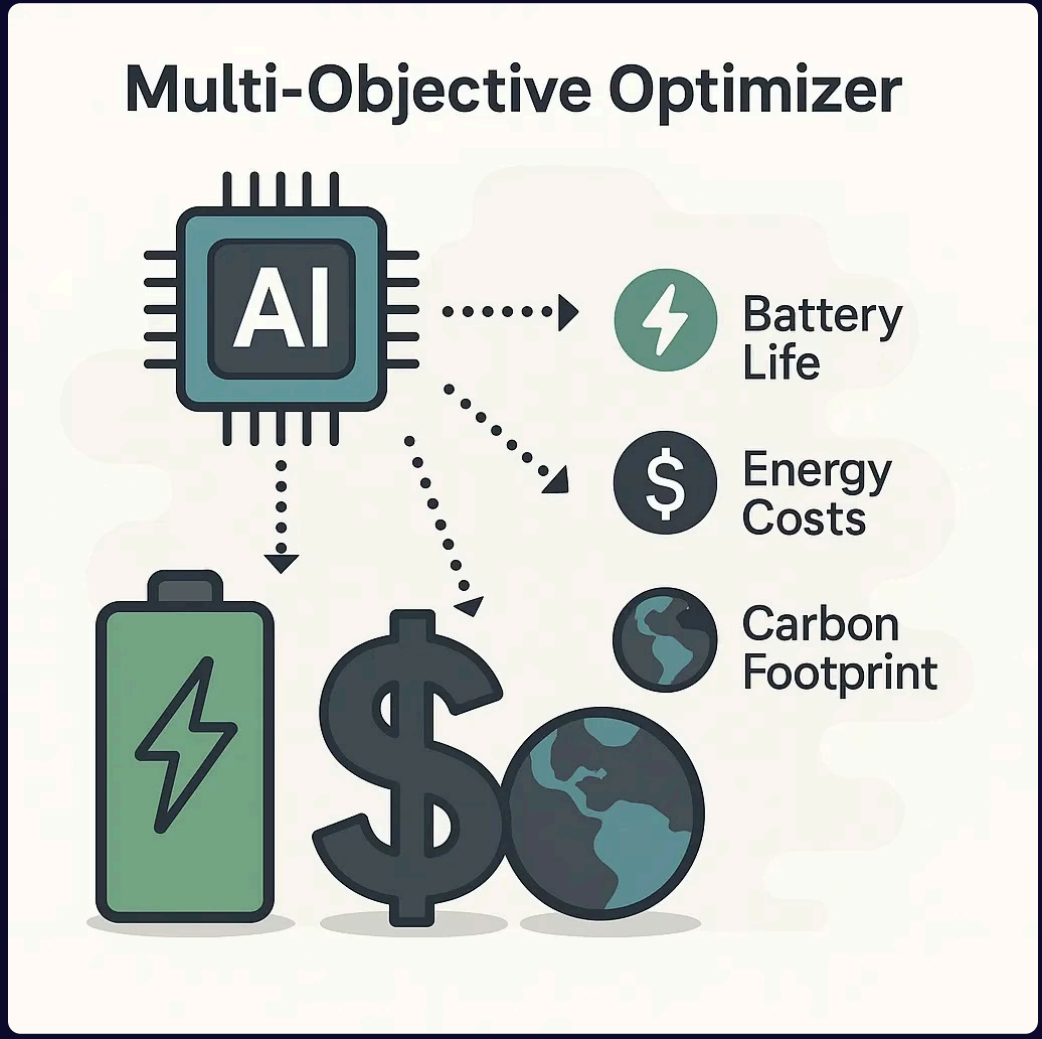
Rather than optimizing for a single objective (e.g., cost), it finds the optimal balance between multiple objectives in real time.

20-30%

Expected energy systems can improve efficiency

10-20%

Expected extended battery life

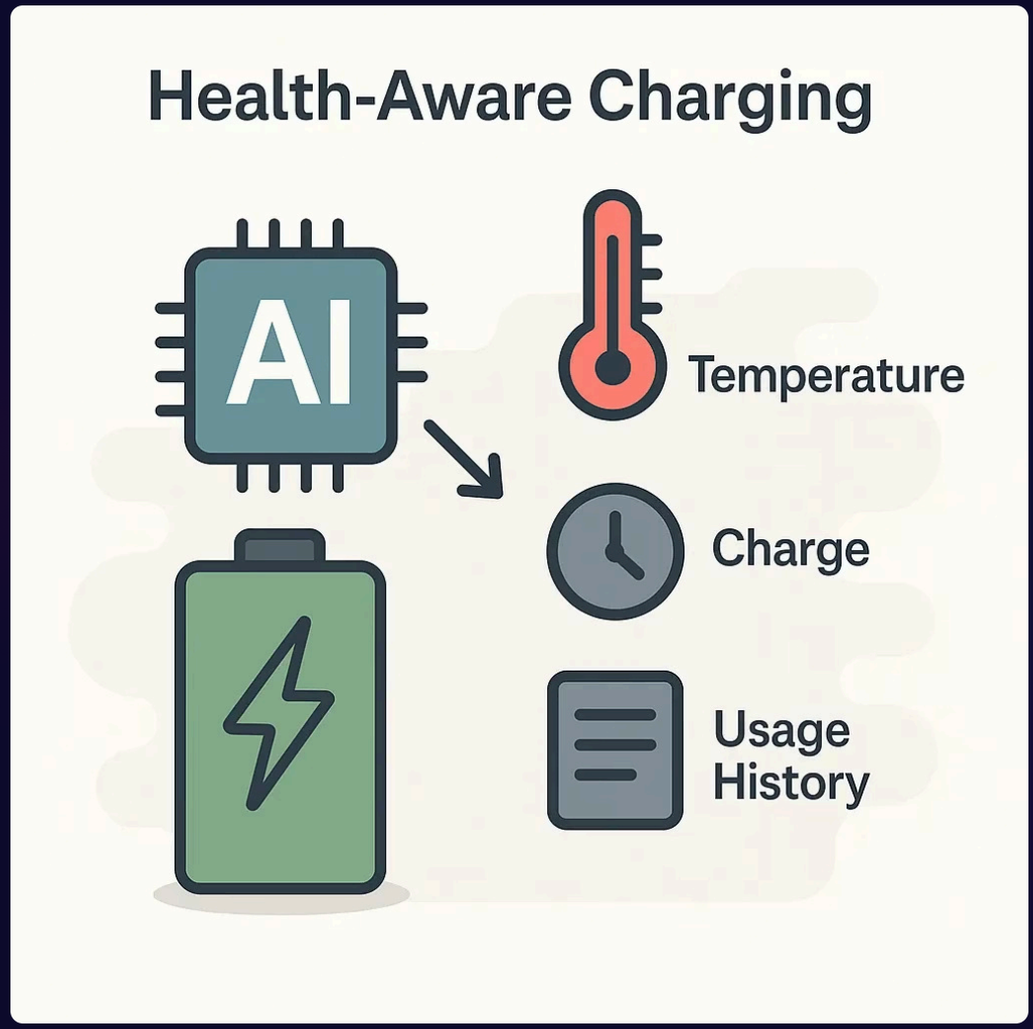


Health-Aware Charging

Integrates AI technology to adjust the charge rate, depth, and duration based on the battery's current condition, temperature, and usage history.

The goal is to minimize long-term battery performance degradation, avoid thermal stress, and extend battery life, rather than always aiming for the fastest possible charge rate.

Expected extend battery lifespan



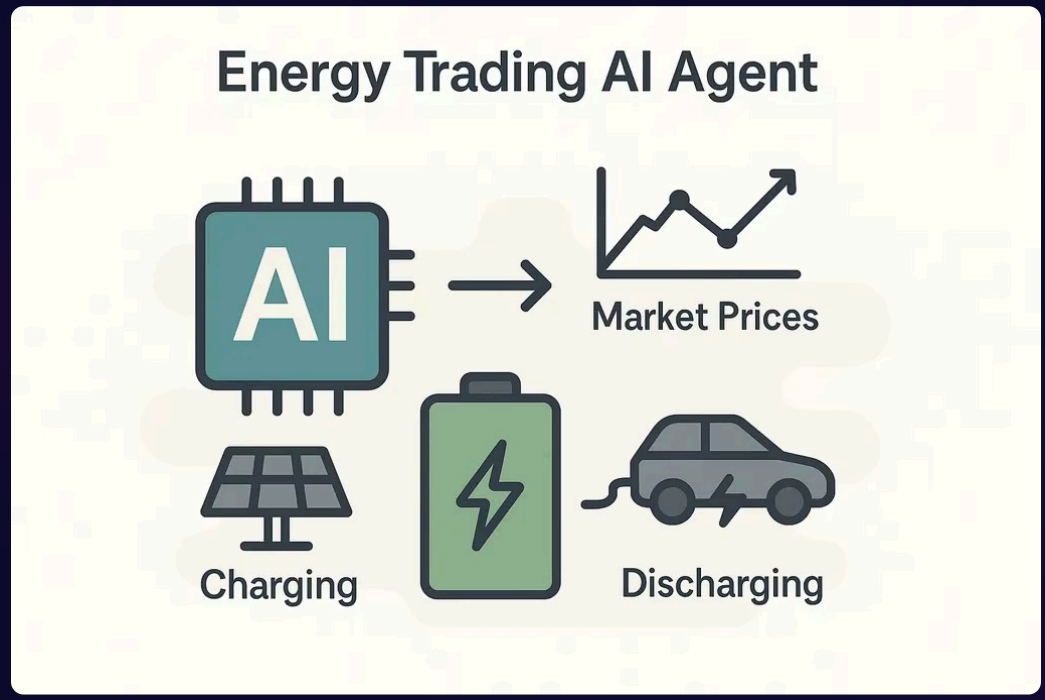
Energy Trading AI Agent

Determines when to charge or discharge battery storage systems based on real-time market prices.

> Buy on low, sell on high

It learns to buy low (charging) and sell high (discharging) to participate in time-of-day tariffs, demand response, and wholesale energy markets to maximize revenue or reduce operating costs.

Expected improve profitability



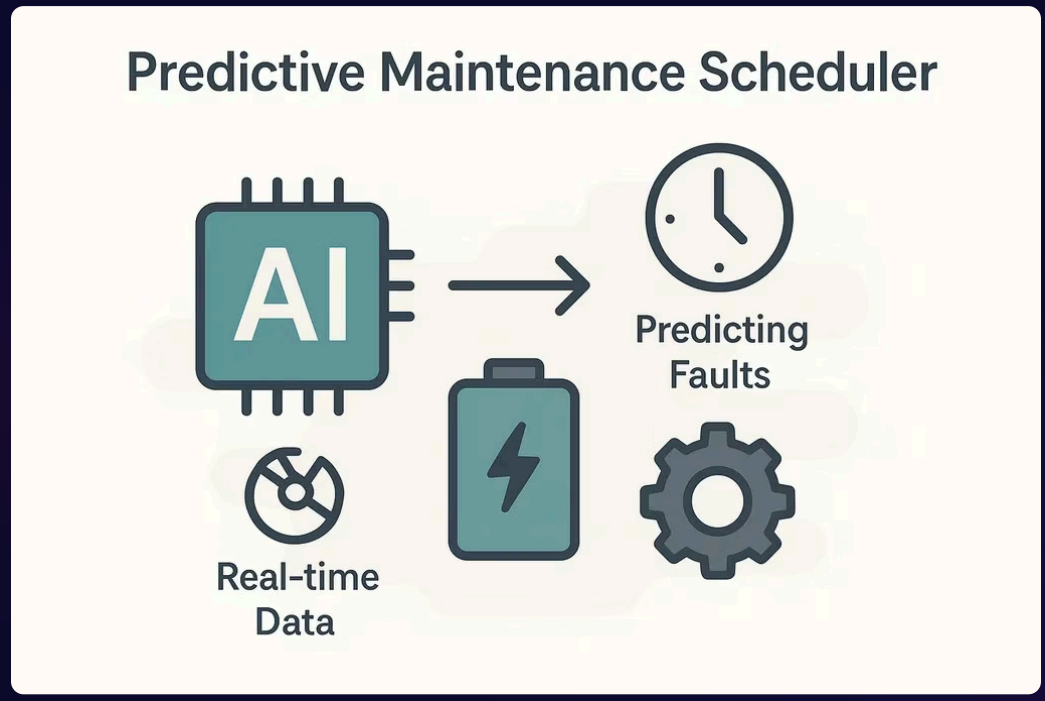
Predictive Maintenance Scheduler

Uses AI to monitor the battery system's performance and predict when a failure, fault, or performance drop will occur.

Instead of waiting for components to fail or using fixed schedules, the system uses real-time data (temperature, capacity, cycle count) to schedule inspections or replacements, increasing uptime and safety proactively.

Expected reduce unexpected failures

Expected lower maintenance costs



Microgrid Collaboration

Uses AI to coordinate how batteries across multiple stations share energy smartly

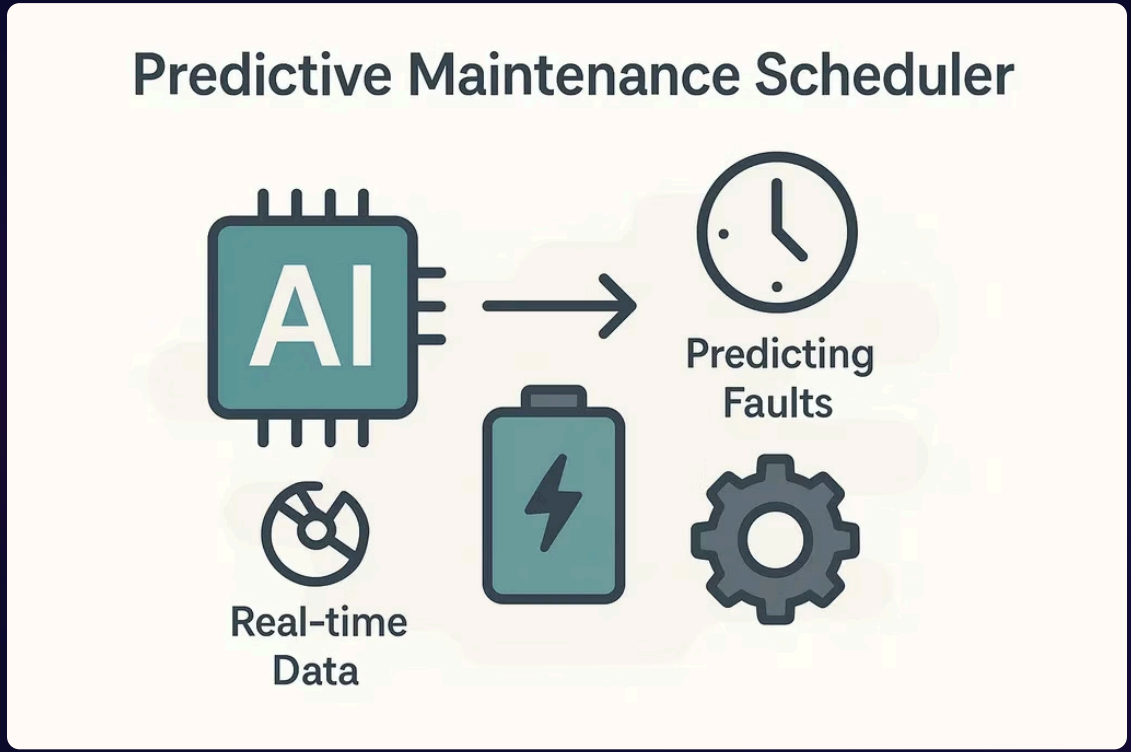
Instead of managing each battery separately, the AI predicts demand, storage levels, and solar output across the local microgrid and balances charging/discharging to improve efficiency, reliability, and grid stability.

15-30%

Expected reduce energy costs

20-40%

Expected improve battery system utilization

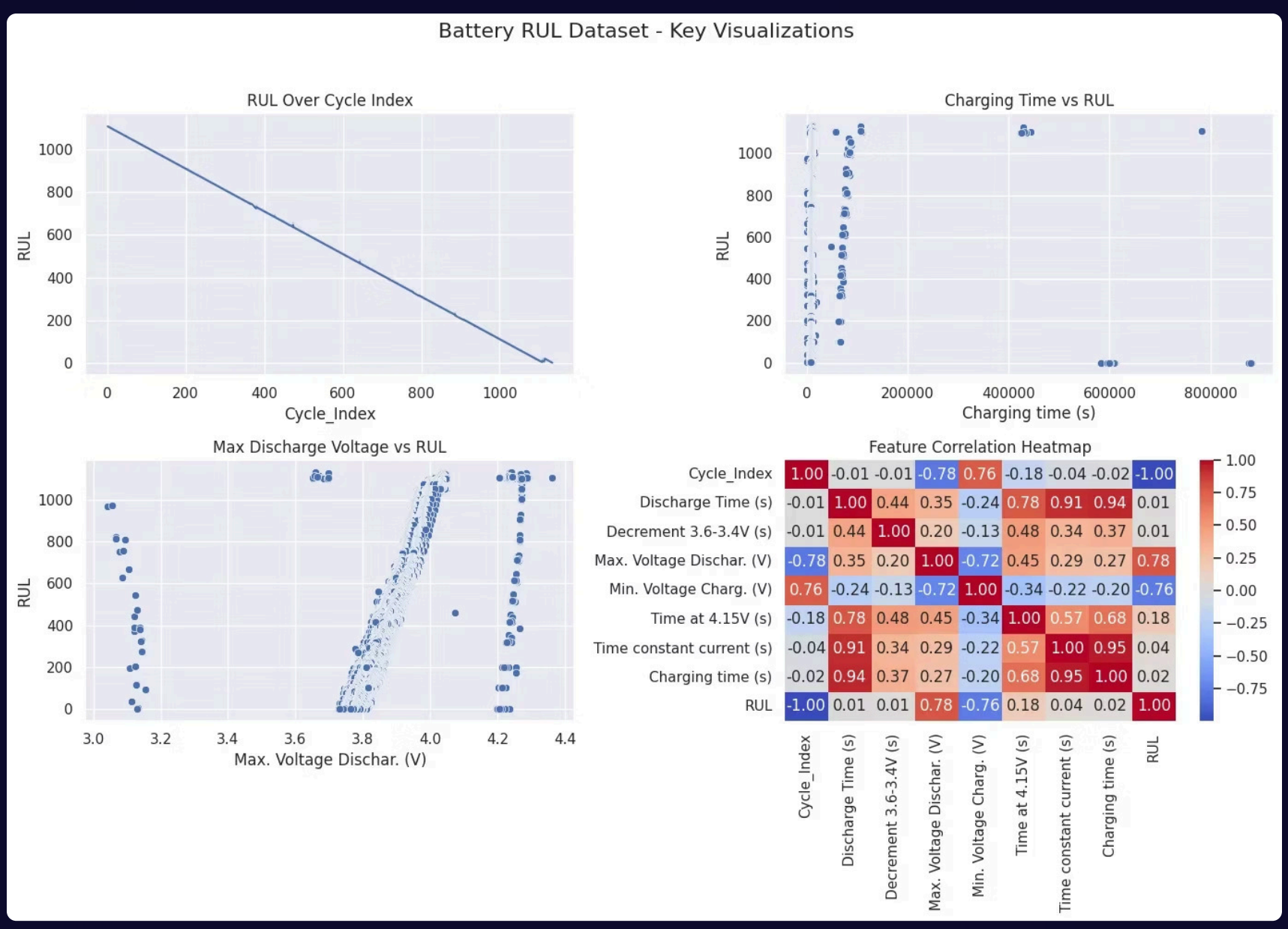


Model & Implementation

After having that idea, I found a dataset online and ran 2 sample models to support my idea.

Dataset

Overview of Dataset



Reference

www.kagg...

Battery Remai...

Predict the RUL of batteries by...

Scan If interested

For this sample model showcase, I run 2 models for two features:

- XGBoost for Health-Aware Charging
- LSTM for Predictive Maintenance Scheduler

XGBoost for Health-Aware Charging

The first model I run is for Health-Aware Charging using XGBoost, which integrates AI technology to adjust the charge rate, depth, and duration based on the battery's current condition, temperature, and usage history.

The result and model preference are following:

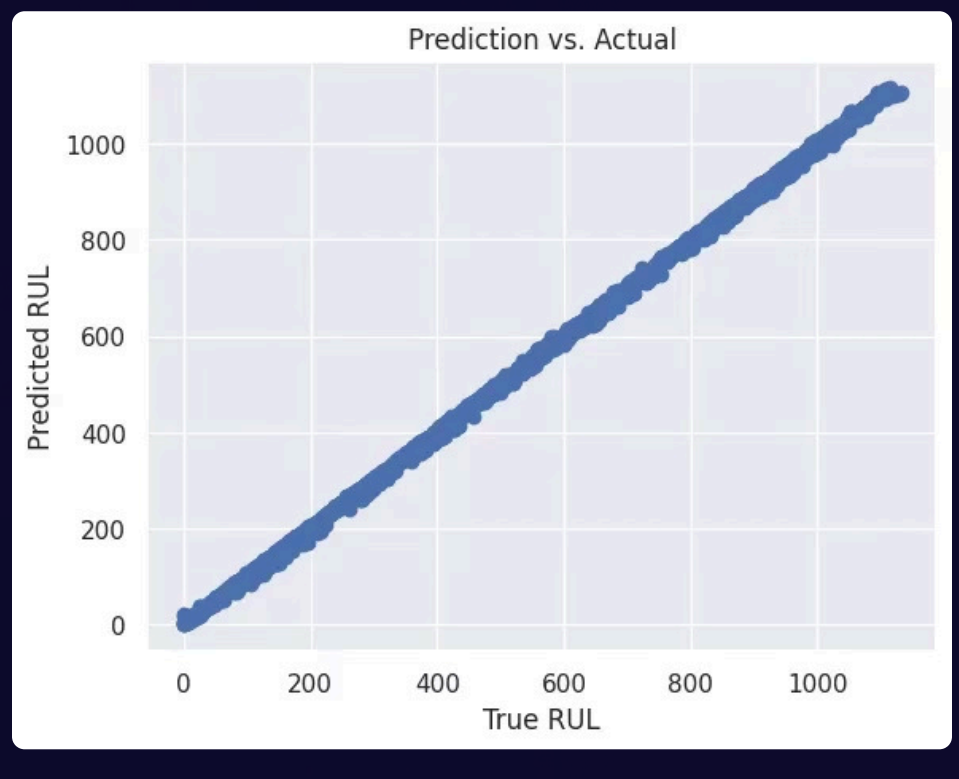
XGBoost Model Mean Squared Error: 5.35
XGBoost Model R^2 Score: 1.00

LSTM for Predictive Maintenance Scheduler

The second model I run uses LSTM for Predictive Maintenance Scheduler, which uses AI to monitor the battery system's performance and predict when a failure, fault, or performance drop will occur.

The result and model preference are following:

LSTM Model RMSE: 3.76
LSTM Model R^2 Score: 1.00
LSTM Model RMSE: 3.76
LSTM Model R^2 Score: 1.00



From both results, the R^2 are still very high and even the same as XGBoost, the curve Predicted vs Actual is also perfect. A RMSE of 3.76 means there are fewer than 4 units off on average, which is very accurate.

THANK YOU

Any Questions?

Full documentation

Source code