

Lithium-ion Battery State of Health Using Impedance

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Introduction

Global Battery Market Growth:

- Battery production projected to grow from 2.6TWh to over 6.5TWh by 2030.
- Driven by EV adoption and energy storage needs.

End-of-Life (EOL) Battery Management:

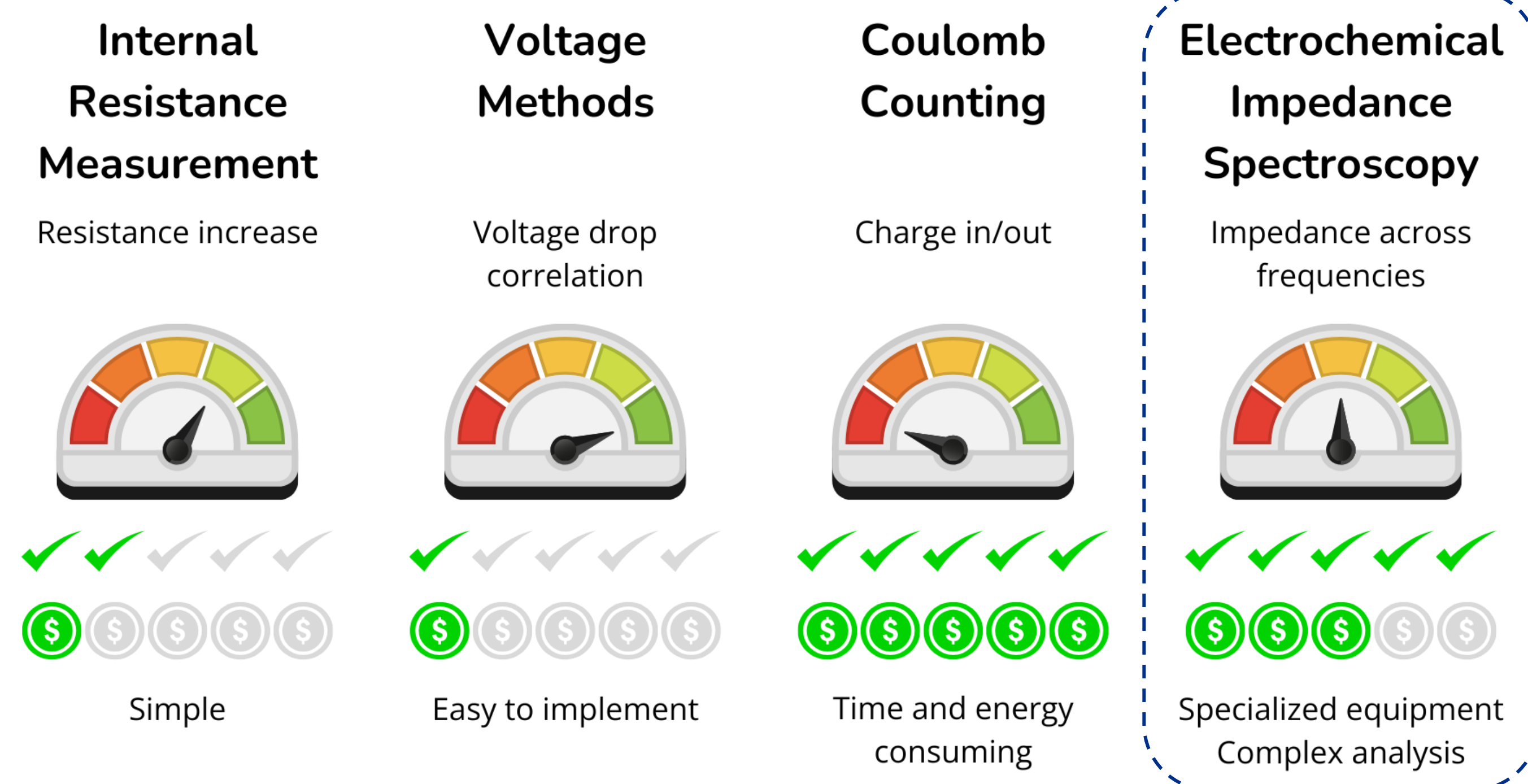
- EOL EV batteries at 70-80% State-of-Health (SOH) can be remanufactured for less demanding applications.

Challenges in SOH Characterization:

- No standard definition of SOH.
- Information in battery management system are not readily accessible.



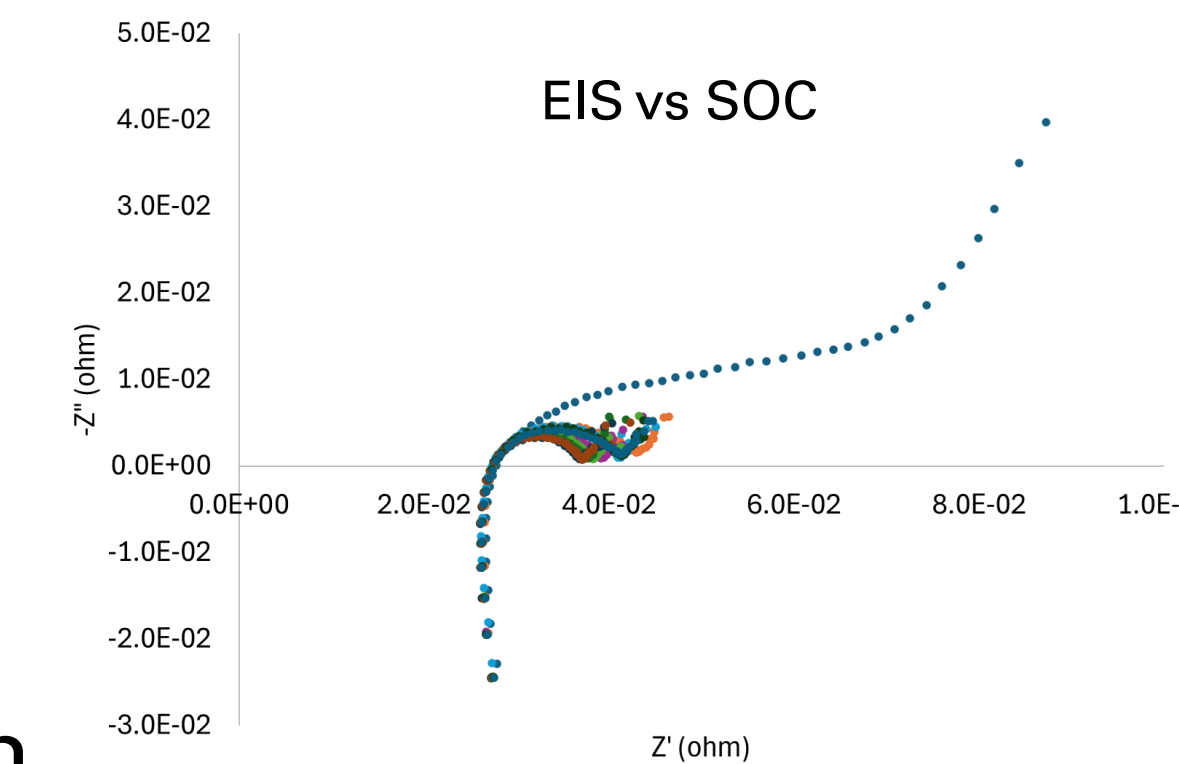
SOH Estimation Methods



Challenges in EIS based SOH estimation

Influenced by:

- Temperature
- State of charge
- Relaxation times
- Environmental conditions
- Impedance meters calibration
- Differences in battery manufacturing processes

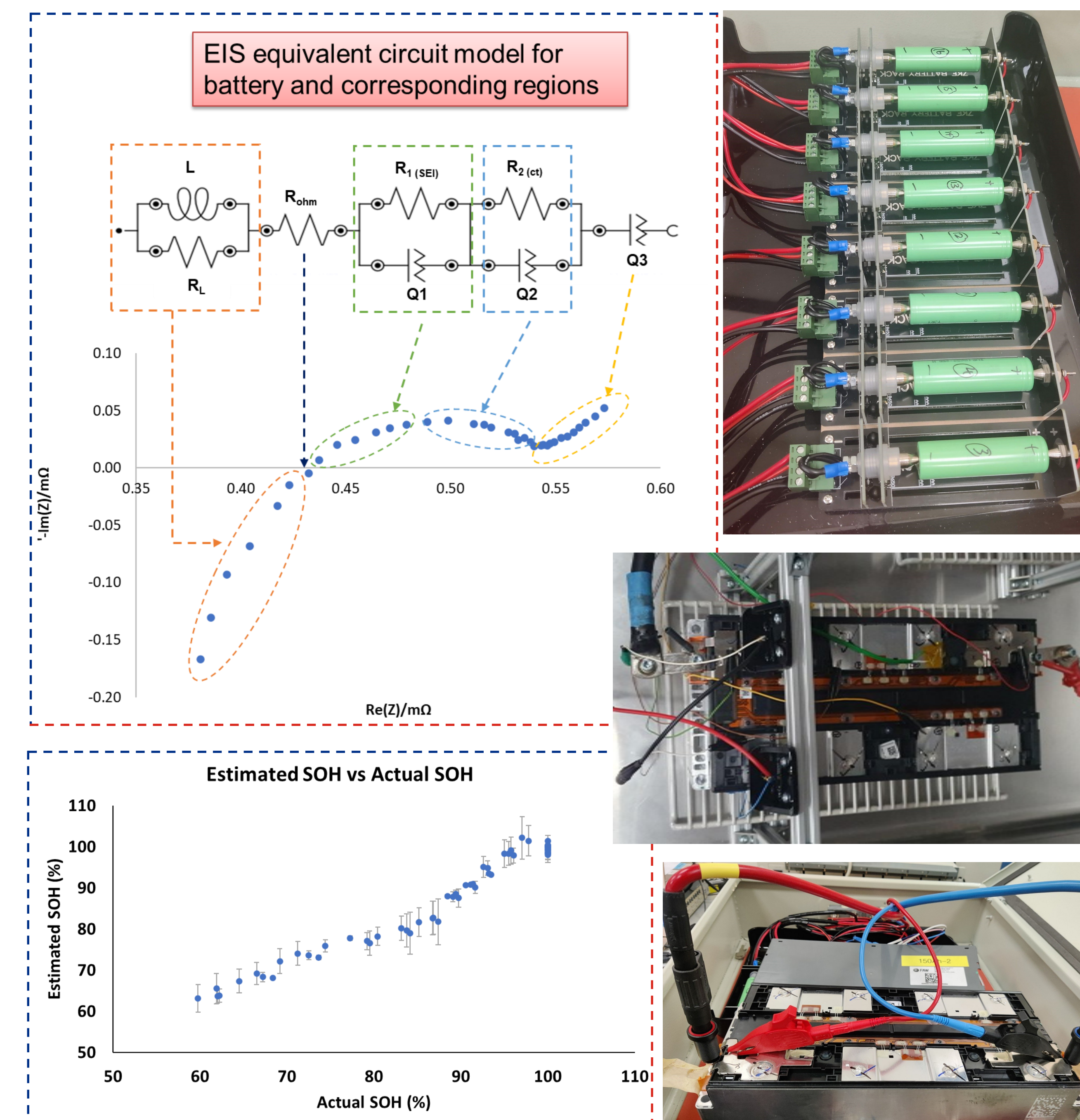


Methodology and Results

Li-ion batteries were aged by charge-discharge cycling. Impedance measurements taken at regular intervals, and fitted into an equivalent circuit model.

The fitted values were used to estimate the SOH.

Accuracy of up to $98.3\% \pm 1.9\%$ was achieved.



Recent Advancements

Development of low impedance standards to cover pure resistive, pure reactance and arbitrary phase angles. Traceable measurements in the sub-mΩ range, at different phase angles. Development of calibration and measurement procedures of EIS meters.

Future Work

Extension of EIS SOH estimation to modules. Reliability of results across different batches of battery. Testing using different battery chemistries and brands. A combination approach to improve accuracy, and allowing flexibility of measurement. Application of artificial intelligence to reduce complexity of fitting EIS data.



Outlook

Real-time, in-situ monitoring of battery SOH. EIS database for different battery models. Advancement in sensor technology and DAQ for high-precision EIS measurements.

References

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