
# Enabling 2X warranted life on Intercity Electric Buses

altergo

# Overview

## Challenges

Battery Management Systems (BMS) in electric buses are designed with a primary focus on technical reliability and safety.
Due to stringent safety standards, these systems often employ established and vetted electronic components.
While these components ensure dependable performance, they often reach their computational limits. As a result, **a leading global OEM for trucks, buses and construction equipment** employed a universal program across all its electric bus assets without specific adaptability to each bus's unique behaviour.

Consequently, the OEM provides a uniform warranty duration for all buses. An ideal scenario would allow the OEM to offer tailored warranty extensions for each individual bus.

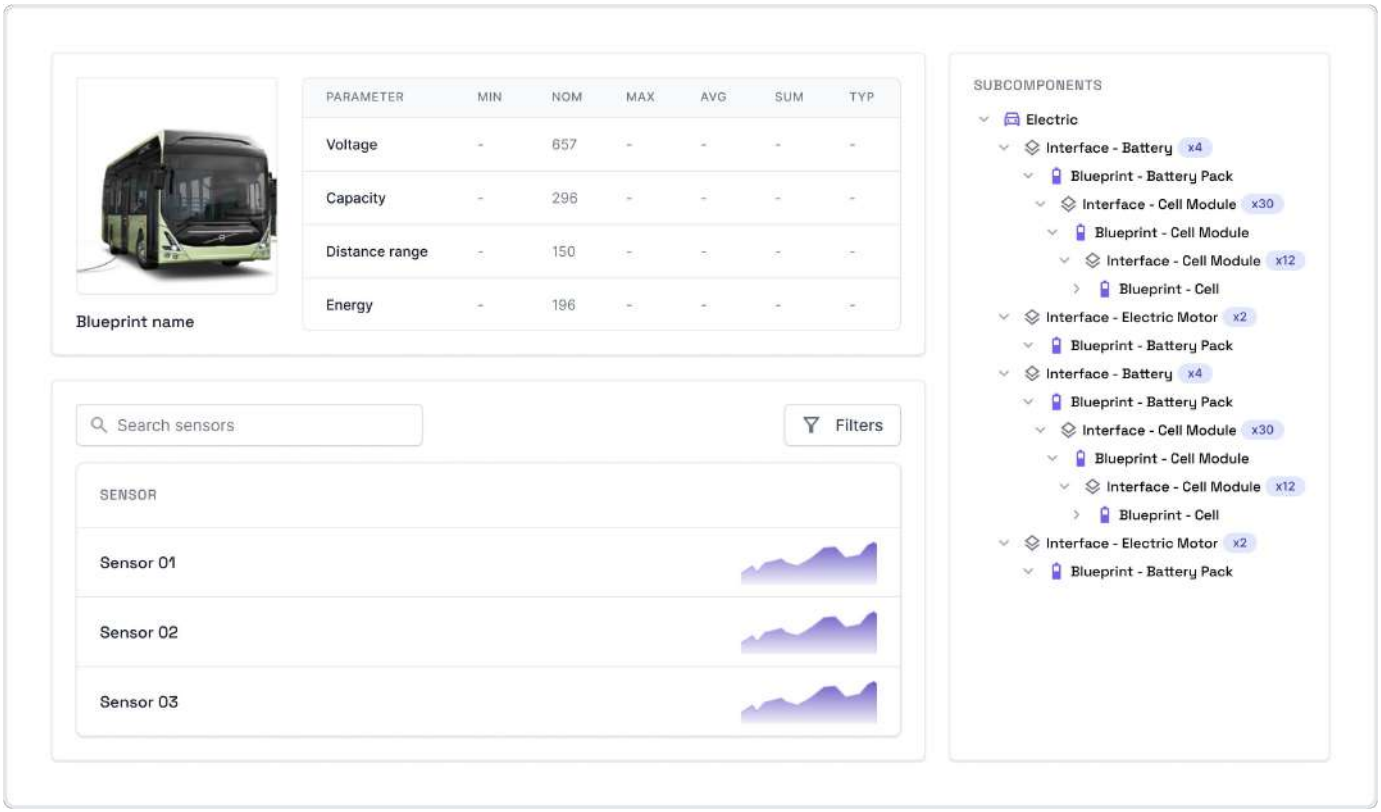

## Altergo's Solution

Recognizing these challenges, **Altergo** offered a comprehensive solution. By integrating with **Altergo's** platform, users gained access to advanced **State of Health (SoH)** models.
Thanks to **Cloud computing** these models drew from the same data pool that traditional BMS accessed, but with a marked improvement in the accuracy of SoH estimations thanks to limitless computational power.
Such a deep understanding enabled more calculated adjustments, directly benefiting battery lifespan and allowing the OEM to propose significant warranty extensions

### Key Altergo Features:

- The **System Digital Twin**, enabling real-time performance analysis.
- **Data Ingestion & Audit functions**, validating the data emerging from the electric buses.
- Enhanced **SoH Estimation** and Prediction capabilities.
- KPIs and Report Generation tools, offering actionable insights for informed operational decisions

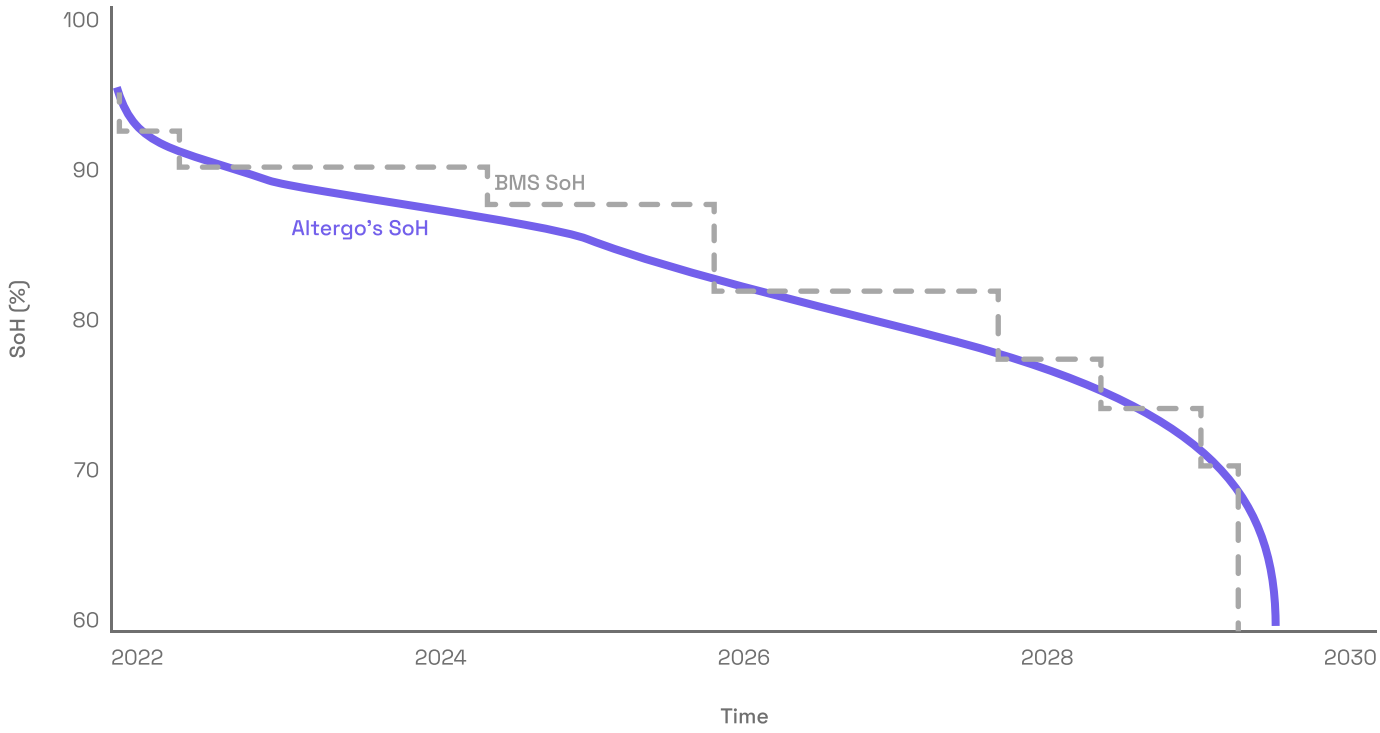
# Digital Twin Creation




As a first step, we created multiple digital twin classes representing the Buses
The digital twin creation is done directly on the platform and facilitated through a step-by-step wizard specialized in battery design.

These digital twins are useful in multiple ways. They act as a container for all telemetry data coming from the field. They also ensure interoperability between this data and **Altergo's** safety monitoring systems, such as the **Alert Engine** and **Temperature Transient Monitoring System.**

# Virtual BMS



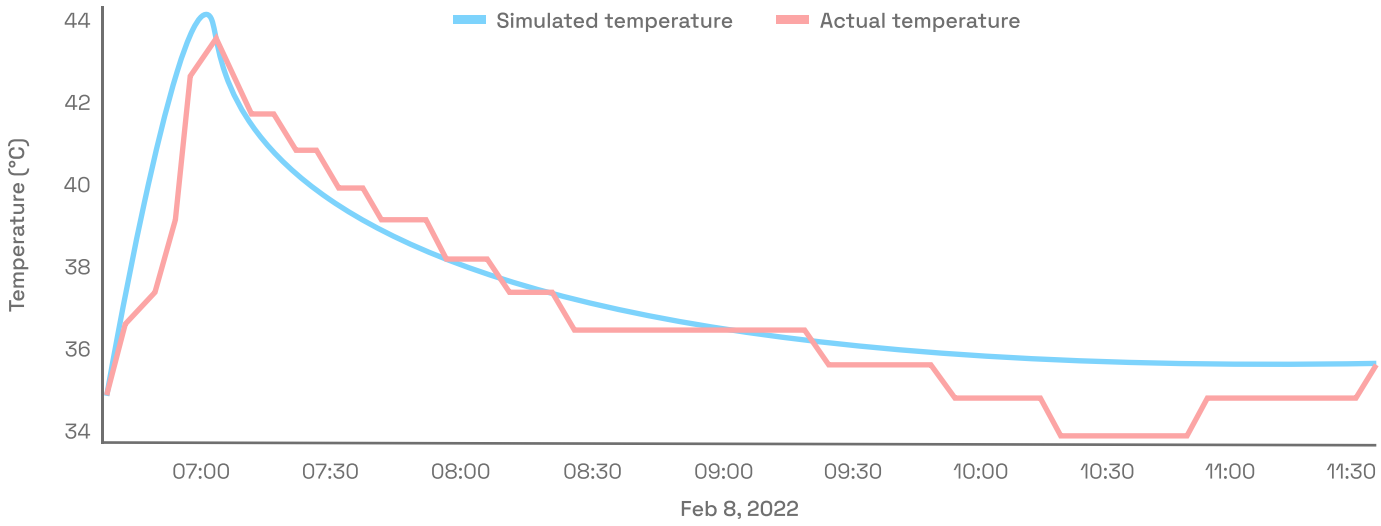

Virtual BMS SoH estimation vs BMS SoH

UPTO
**99%**
Accuracy

**100x**
Faster

Traditionally the BMS calculates all state estimators of the battery. It often relies on pivot tables, static counters and very optimized functions in the embedded software of the electronics to come up with an SoH. Depending on the overall capex of the asset, **the BMS** can have more advanced estimators but due to consumption constraint and limited computation capabilities the accuracy of the result will always be **limited.**

# Virtual BMS




Simulation example (configured for 100% SoH & Datasheet impedance)

## State Estimators

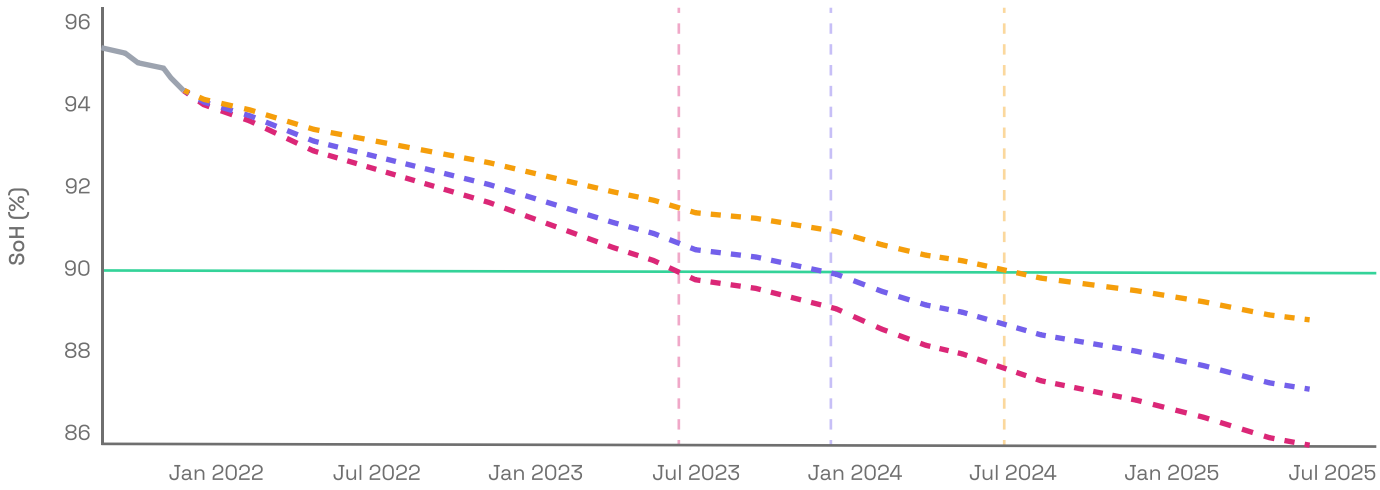
By leveraging historical and real time data gathered from the buses' telematics boards we are able to run Cloud based algorithms with the same data available to the BMS but without any computational constraint.
This allows us to provide a **98.5% accurate State of Health**. Using the same data Altergo also calculates a "no compromise" State of Charge of the battery.

## Voltage, Current, Temperature

All the parameters of the virtual BMS can be selected from the digital twin sensor list directly and seamlessly on the Altergo Platform.

Apart from the state estimators the Virtual BMS computes the Voltage of the battery (down to individual cells), the Current depending on the load, and the Battery Temperature, depending on C rates, Battery voltage, environmental temperatures and the battery mechanical properties such as the mass and surface.

# Forecasting SoH & remaining useful life




State of Health Simulation

Upto
**10** yrs prediction

Designed with a **broad spectrum of inputs**, this model delivers reliable SoH predictions across different **environments** and battery **types**. It adapts to various **operating conditions** and improves with the inclusion of more historical data, ensuring enhanced **accuracy** for diverse battery technologies.

## Operating conditions

Altergo allowed the fleet manager and engineers to create simulated environments for deployed buses. In order to do impact studies of varying parameters on the performance of the battery.

- Environmental temperatures
- Resting SoC
- Charge regimen
- Maximum SoF

## SoH Simulation

With the OEM's Team, we ran multiple simulations to figure out the operational boundaries of the buses.Using the virtual BMS we can plug the battery to those virtual operating conditions and receive an accurate representation of the Battery's estimators and telemetry.

# Estimating life expectancy of assets

## Altergo Life management


## Warranty

OEMs will generally provide a blanket warranty period before they consider an Asset has reached EoF (End of Function).

To ensure their customers that the Health of their battery will not be the cause of a loss of function this period is usually conservative and not representative of each individual asset's performance

## Altergo SoH prediction

Thanks to the combination of the previously mentioned **Estimation**, **Simulation** and **Prediction, Altergo** is able to compute an individualized **Performance Index score** against the OEM warranty.

A score of **5/10** indicates an asset is going to reach its real End of Life. However in the OEM's case we were able to identify that over 50% of their Buses had a score above 7**/10**.

With these results, the OEM is able to confidently propose **Warranty extensions** to their customers with a very limited risk factor

UPTO

**X2**

**Warranty extension time**

# Conclusion

This engagement demonstrated that **Altergo** can be used to derive strategic & practical insights resulting in augmenting the lifespan of batteries as well as improving the understanding of the performance of the buses overtime.

Engineering teams are now equipped with tools that offer real-time updates, and predictive analytics, ensuring batteries operate at their **optimal best** & influencing the next generation of vehicle design.