Designing for Reliability in Extreme Environments

A responsive dashboard system for an Arctic solar-powered research station.

TESLA
ENERGY

My Design Approach

Discovery

Understand user roles, their goals, and data dependencies.

High-Level Design

Define the structure, layout, and information hierarchy.

Refinement

Polish the interface, optimize interactions, and validate usability.

Discovery: Understanding Users and Context

Objective: Identify what each user needs to see, decide, and act on during a battery fault scenario.

Discovery: Key Activities

User Role Research

Researched each role (Technician, Scientist, Administrator) to uncover three core factors shaping their experience:

1. Primary goal
2. Critical energy data needed to achieve that goal
3. Primary action required when a battery fault occurs

Information Flow Mapping

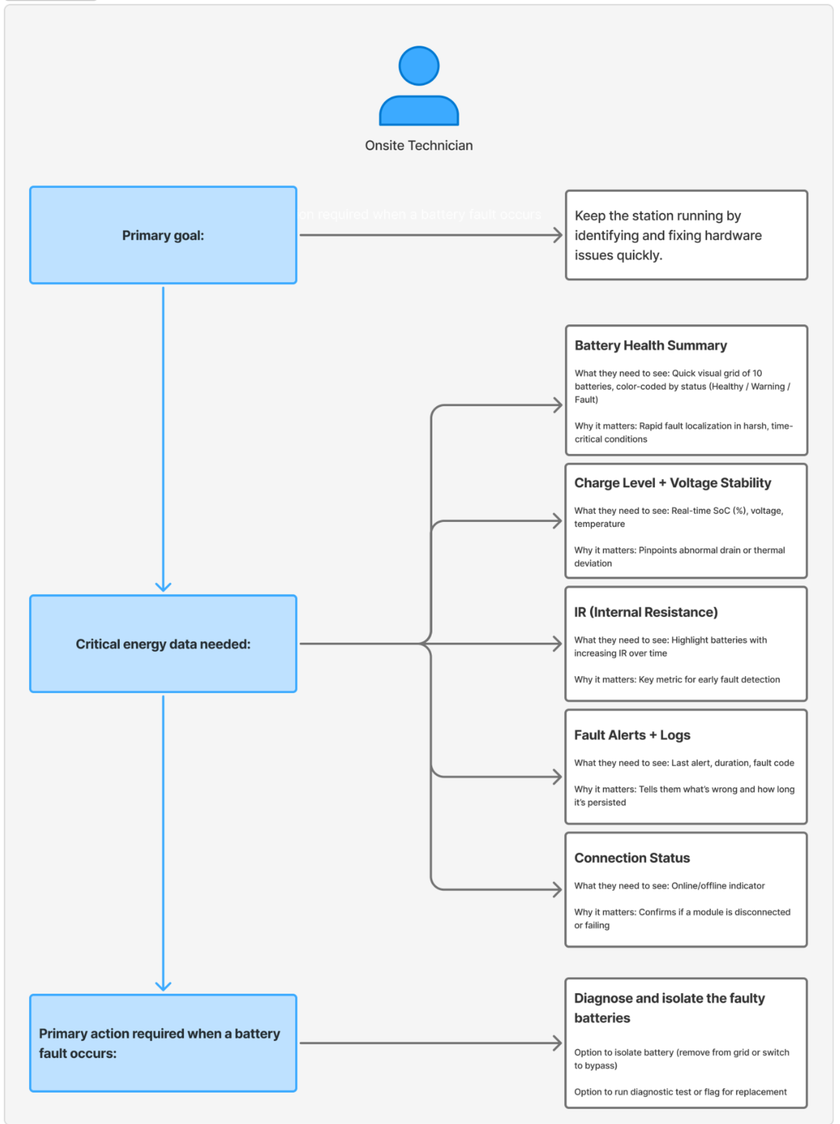
Mapped how data and decisions move between roles to understand dependencies and communication pathways during the fault-diagnosis process.

This clarified who needs what information, when, and why. Forming the basis for the system’s information hierarchy.

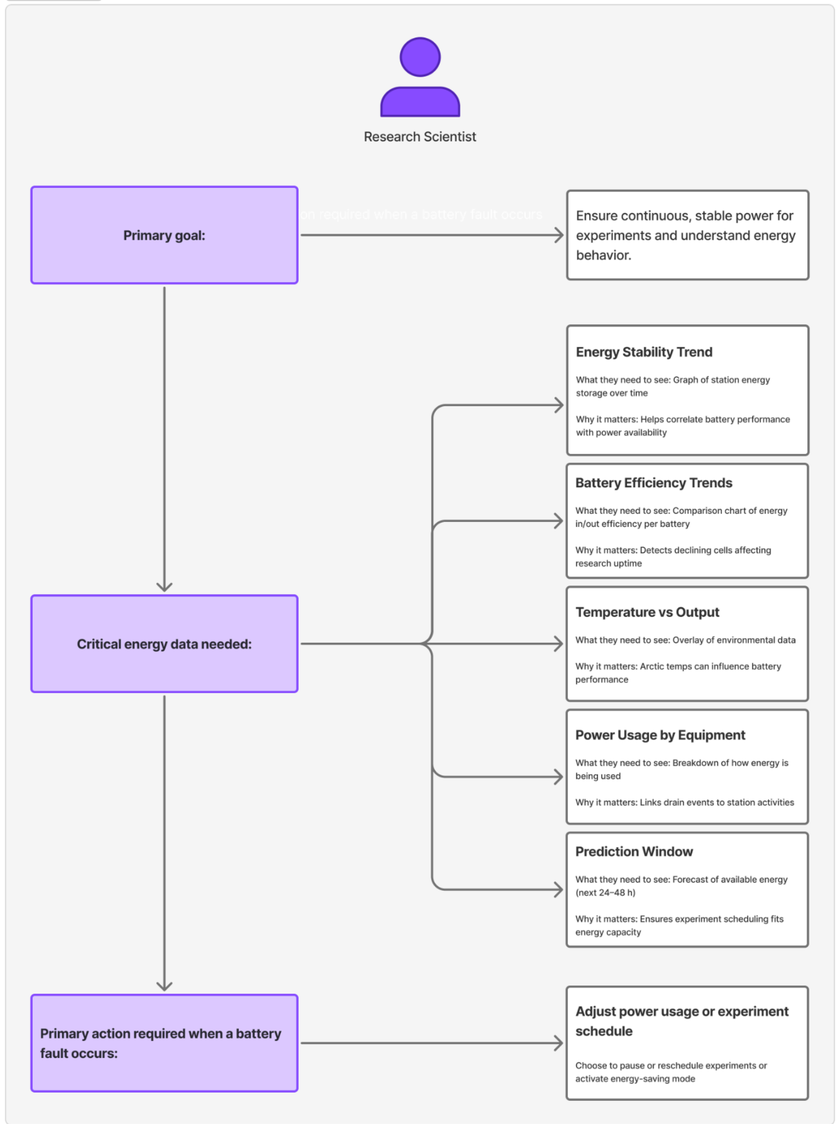
Outcome

A shared understanding of user priorities, cross-role relationships, and data dependencies that informed the design architecture.

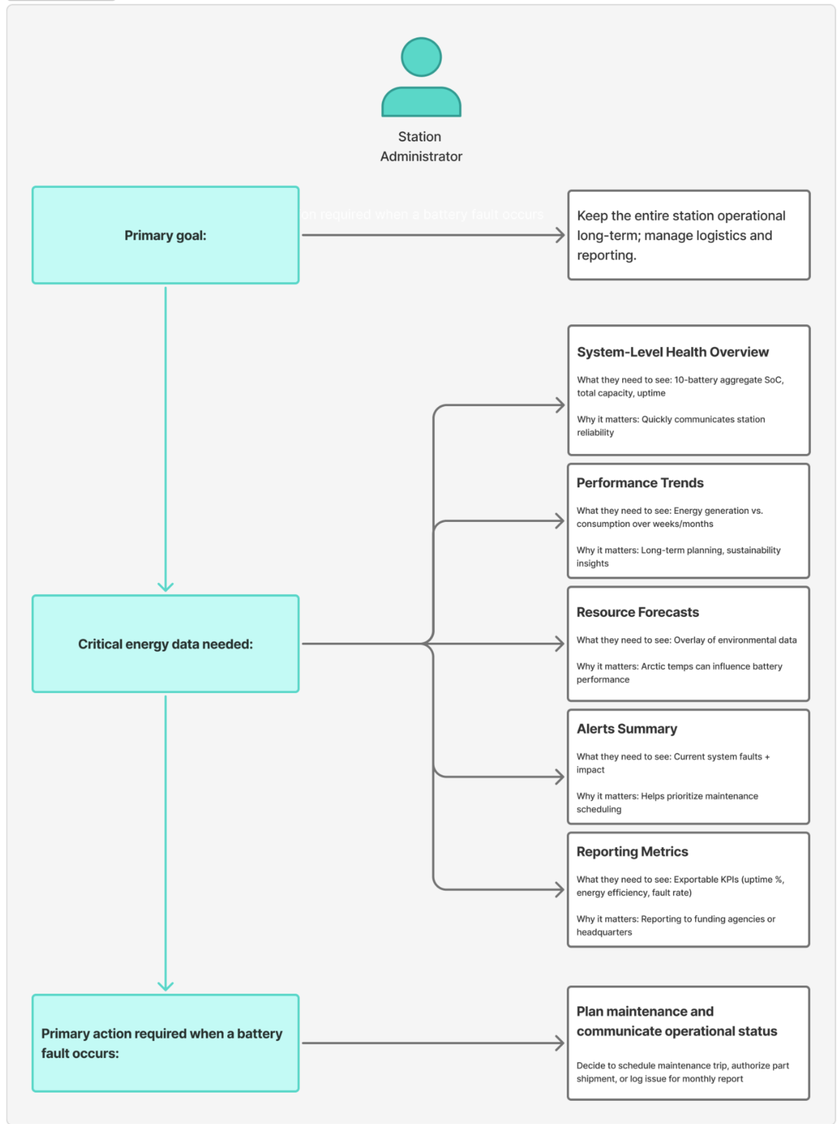
Onsite Technician



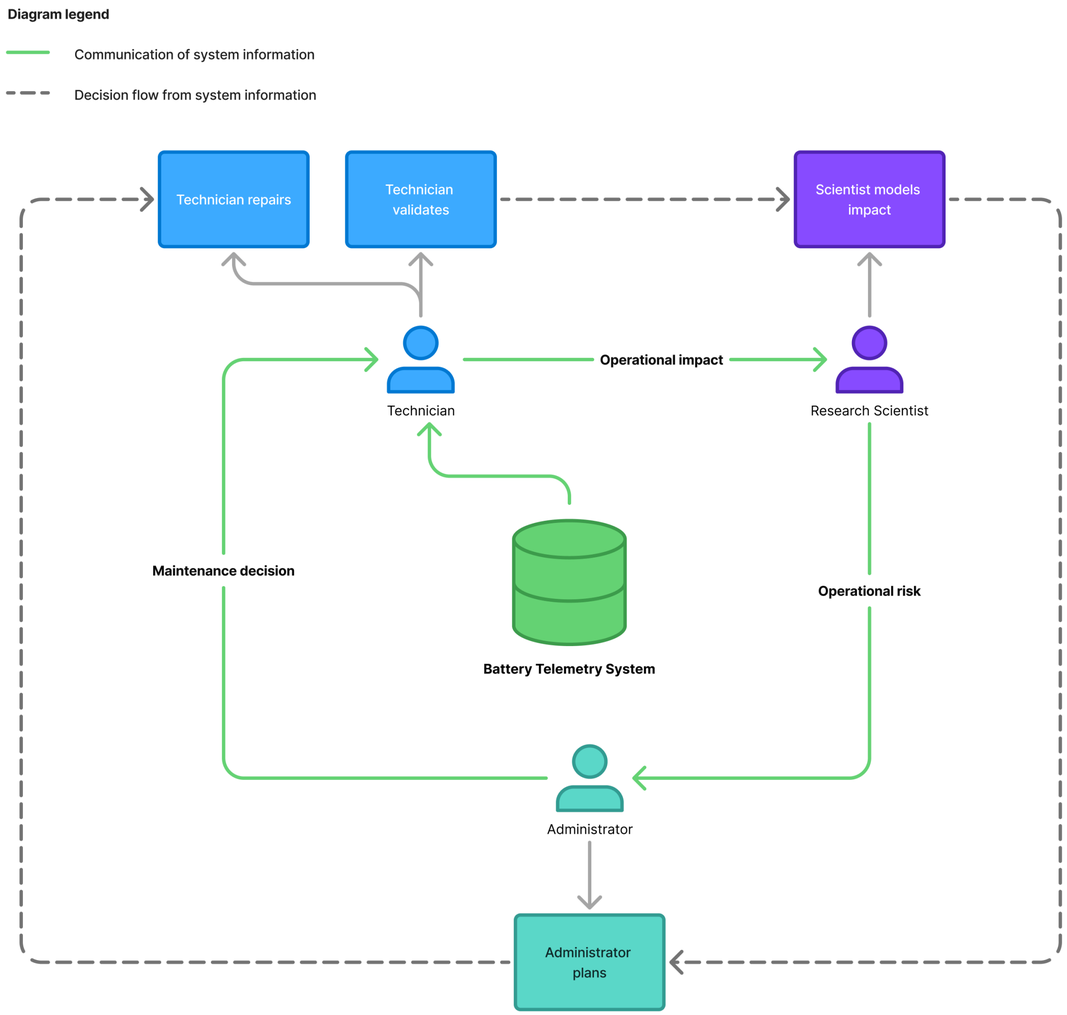
Research Scientist



Station Administrator



User Role Definitions



Fault Diagnosis Information & Decision Flow

High-Level Design: Structuring the Experience

Objective: Translate user and system insights into a clear, navigable design framework.

High-Level Design: Key Activities

Information Architecture & Layout Exploration

Defined how battery, energy, and fault data should be grouped and prioritized based on each user’s decision-making needs.

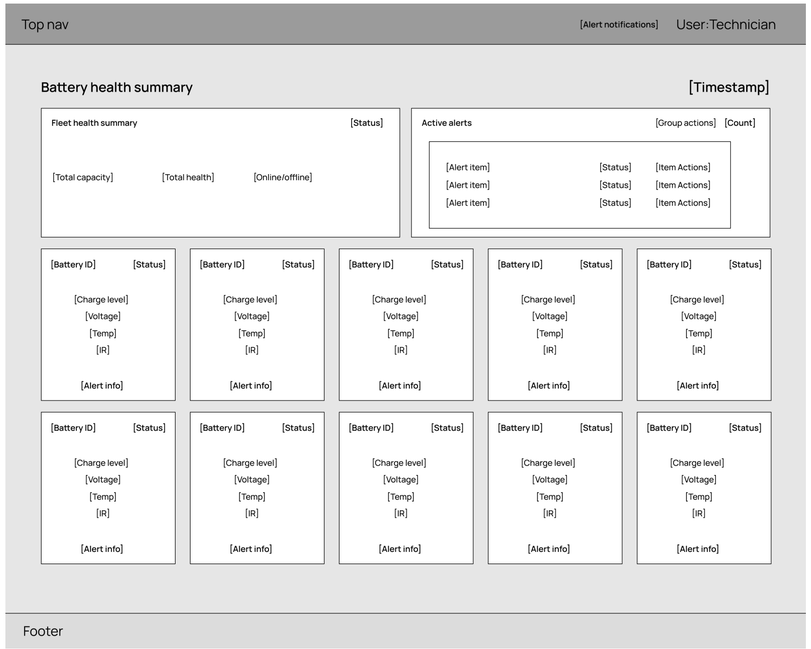
Created early wireframes to visualize the relationships between system metrics, alerts, and user actions.

Interaction Model Definition

Ensured the layout supported quick comprehension and intuitive task execution across all three roles.

Outcome

A unified system structure and design foundation aligning user goals, data hierarchy, and operational context.



High-level designs

Refinement & Interaction Design: Bringing the System to Life

Objective: Evolve high-level concepts into a polished, interactive experience focused on usability and clarity.

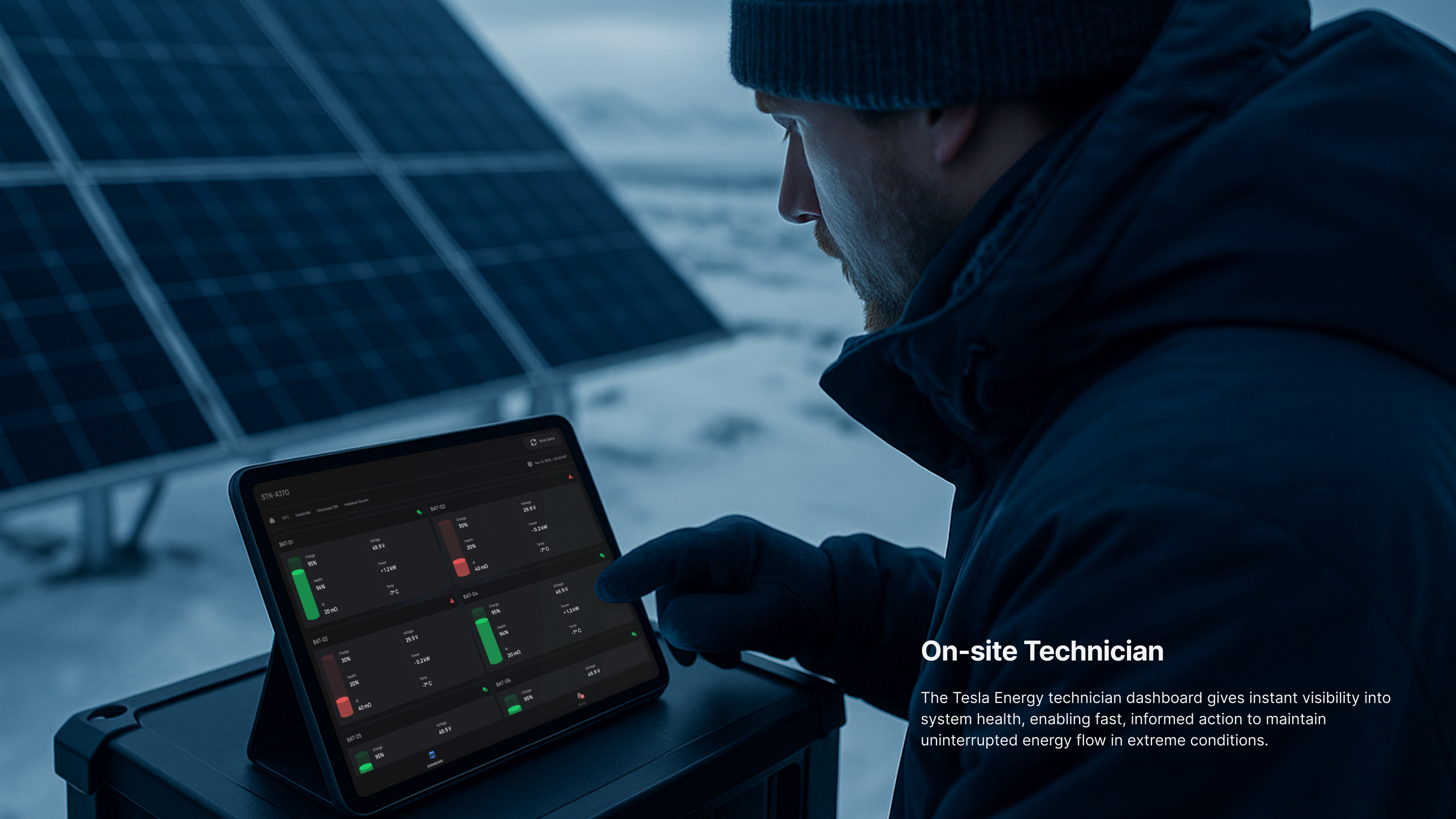
Refinement & Interaction Design: Activities

Visual & Interaction Refinement

Translated wireframes into high-fidelity mockups emphasizing hierarchy, state feedback, and energy visualization.

Outcome

A cohesive, production-ready design system that communicates energy state clearly, accelerates problem response, and adapts across user roles and screen sizes.



On-site Technician

The Tesla Energy technician dashboard gives instant visibility into system health, enabling fast, informed action to maintain uninterrupted energy flow in extreme conditions.

STN-A37G

SYNC DATA

2

-12° C | 14 km/h NW | Cloud cover 72% | Irradiance 154 w/m

Nov 12, 2025 • 20:05 PST

FLEET HEALTH

DEGRADED

ACTIVE ALERTS 2

ISOLATE SELECTED

Battery ID	Status	Last update
BAT-02	Capacity degradation detected	2025-01-14 14:32
BAT-03	Capacity degradation detected	2025-01-14 14:32

BAT-01

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-02

Charge 30% | Voltage 29.9 V
Health 20% | Power - 0.2 kW
IR 40 mΩ | Temp -7° C

BAT-03

Charge 30% | Voltage 29.9 V
Health 20% | Power - 0.2 kW
IR 40 mΩ | Temp -7° C

BAT-04

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-05

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-06

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-07

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-08

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-09

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

BAT-10

Charge 95% | Voltage 49.9 V
Health 94% | Power + 1.2 kW
IR 20 mΩ | Temp -7° C

10 Batteries • 2 Faults • Last Sync: 1m ago • Avg SOH: 92%

TESLA ENERGY

STN-A37G

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Nov 12, 2025 • 20:05 PST

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Power - 0.2 kW
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Temp -7° C

BAT-05

Charge 95%
Voltage 49.9 V

BAT-06

Charge 95%
Voltage 49.9 V

DASHBOARD

Alerts 2

STN-A37G

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BAT-02

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Health 20%
Power - 0.2 kW
IR 40 mΩ
Temp -7° C

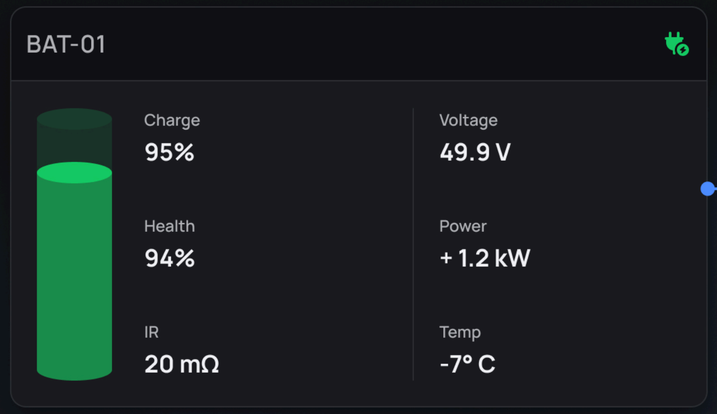
BAT-03

DASHBOARD

Alerts 2

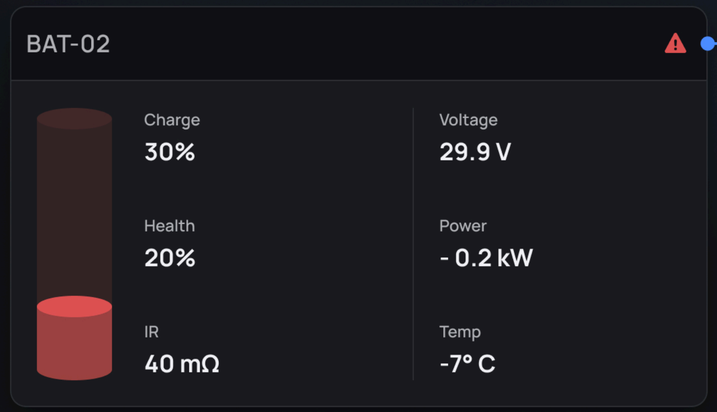
Battery data components

The battery data component presents the essential information technicians need to assess battery status and respond quickly and accurately.



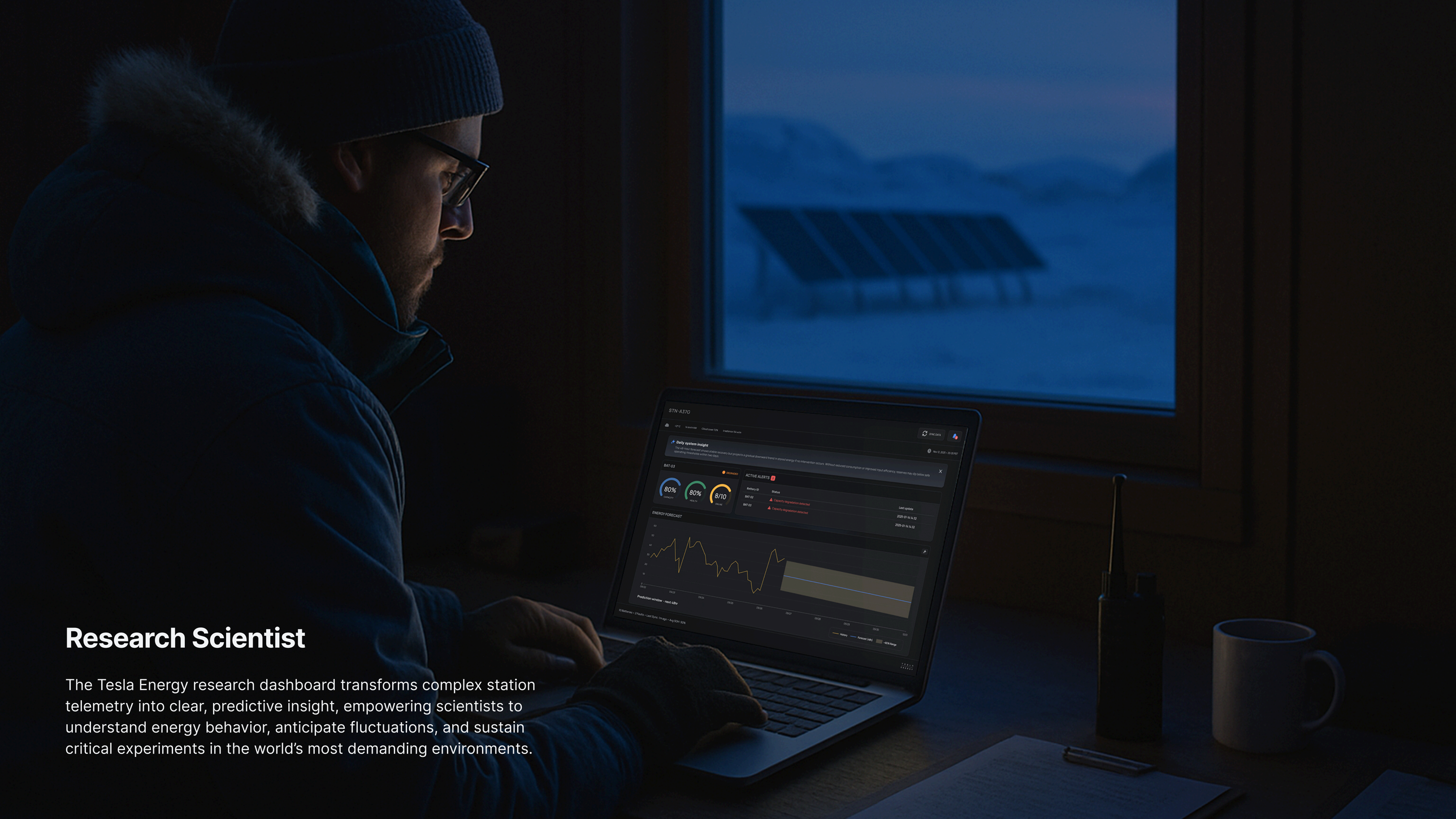
Clear hierarchy for rapid scanning

Key metrics are visually grouped to reduce cognitive load, with high-contrast values and consistent alignment that enable technicians to identify issues within seconds while minimal visual noise keeps attention focused on the most critical battery indicators.



Visual indicators for rapid identification

Color-coded indicators paired with clear iconography work alongside the structured layout to help technicians recognize status changes instantly, reducing scan time and improving situational awareness.



Research Scientist

The Tesla Energy research dashboard transforms complex station telemetry into clear, predictive insight, empowering scientists to understand energy behavior, anticipate fluctuations, and sustain critical experiments in the world’s most demanding environments.

STN-A37G

SYNC DATA

-12° C 14 km/h NW Cloud cover 72% Irradiance 154 w/m

Nov 12, 2025 • 20:05 PST

Daily system insight

The 48-hour forecast shows stable recovery but projects a gradual downward trend in stored energy if no intervention occurs. Without reduced consumption or improved input efficiency, reserves may dip below safe operating thresholds within two days.

BAT-03 DEGRADED

80% CAPACITY

80% HEALTH

8/10 ONLINE

ACTIVE ALERTS 2

Battery ID	Status	Last update
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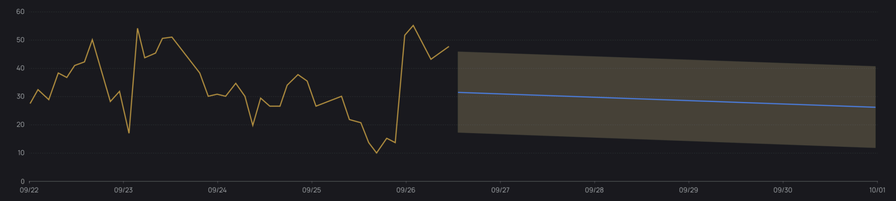
BAT-03	Capacity degradation detected	2025-01-14 14:32

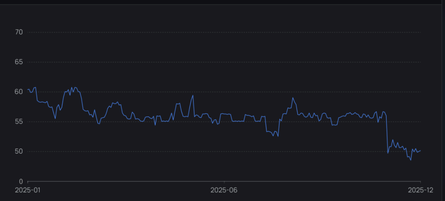
ENERGY FORECAST



Prediction window - next 48hr

History Forecast (48h) ~80% Range

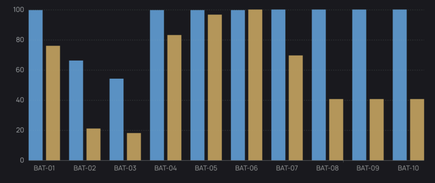
STABILITY



Station storage (%)

History

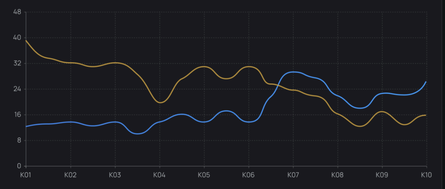
BATTERY EFFICIENCY



Charge vs Discharge (%)

power_in power_out

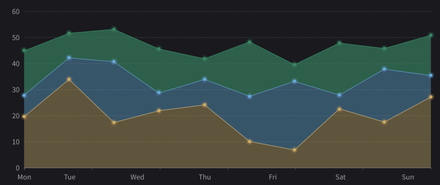
TEMPERATURE vs OUTPUT



Environmental overlay

Temp (C°) Output (kW)

POWER USAGE



Usage by equipment

Comms HVAC Lab instruments

10 Batteries • 2 Faults • Last Sync: 1m ago • Avg SOH: 92%

TESLA ENERGY

STN-A37G

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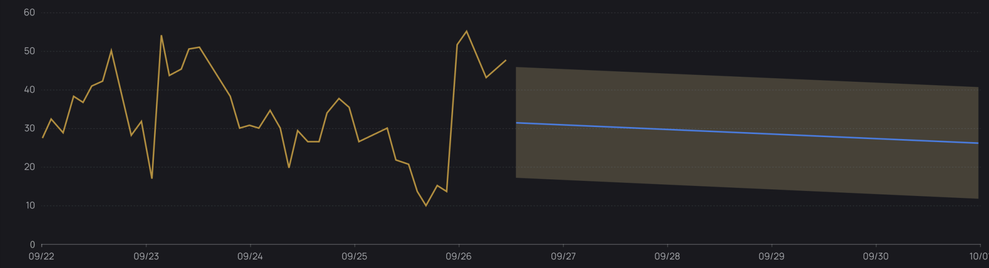

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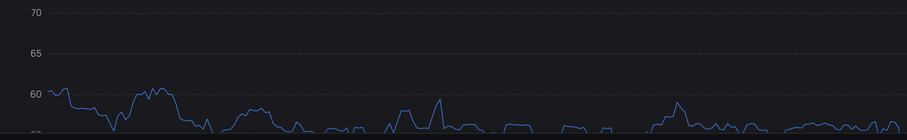


DASHBOARD

Alerts

Intelligent dashboards

This dashboard uses agentic components that interpret system data, surface the most relevant insights, and recommend timely actions. Rather than simply displaying information, it actively supports decision-making by adapting to each user's needs and the station's real-time conditions.

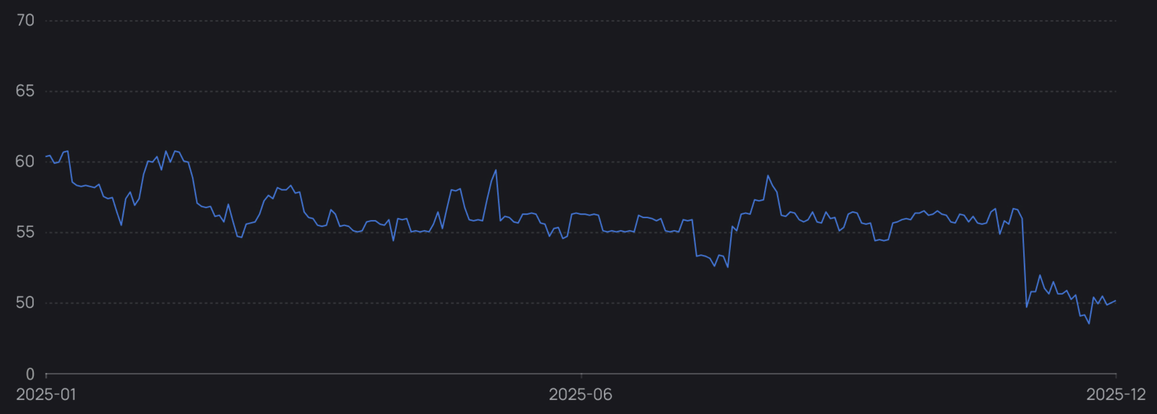
Daily system insight

The 48-hour forecast shows stable recovery but projects a gradual downward trend in stored energy if no intervention occurs. Without reduced consumption or improved input efficiency, reserves may dip below safe operating thresholds within two days.

Agentic system insights

A shared component across all user dashboards, with content tailored to each role's context and responsibilities. The platform agent generates a daily high-level summary based on system data, populating each user's dashboard with relevant insights.

STABILITY



Station storage (%)

Agentic data summaries

Users can generate clear narrative summaries directly from dashboard data, with telemetry automatically passed to the platform agent for concise, contextual reporting.

UPTIME

99.4%

System availability remained consistently high across the reporting period, with no major interruptions

↑ 0.5% this week

Role-specific insights that matter

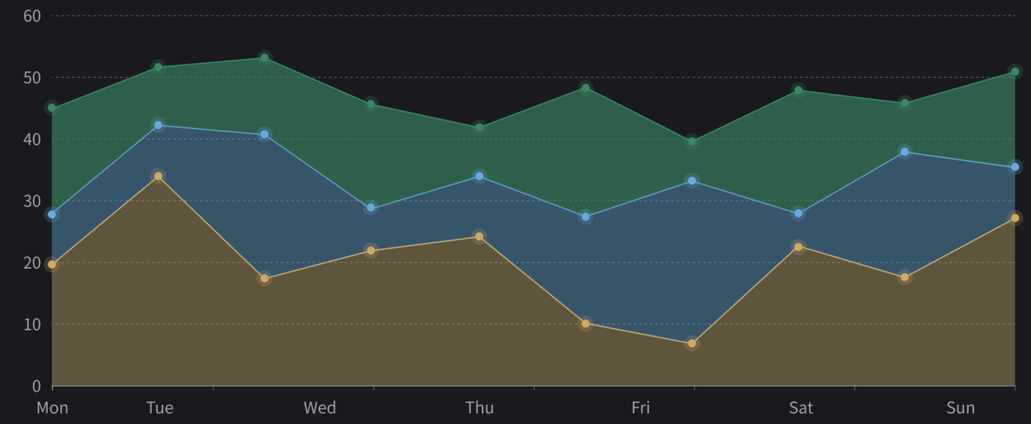
Each user type receives tailored data surfaced from the system, ensuring that technicians, scientists, and administrators see only the insights most relevant to their responsibilities, reducing noise and accelerating decision-making.

TEMPERATURE vs OUTPUT

Environmental overlay

Temp (C°) Output (kW)

POWER USAGE



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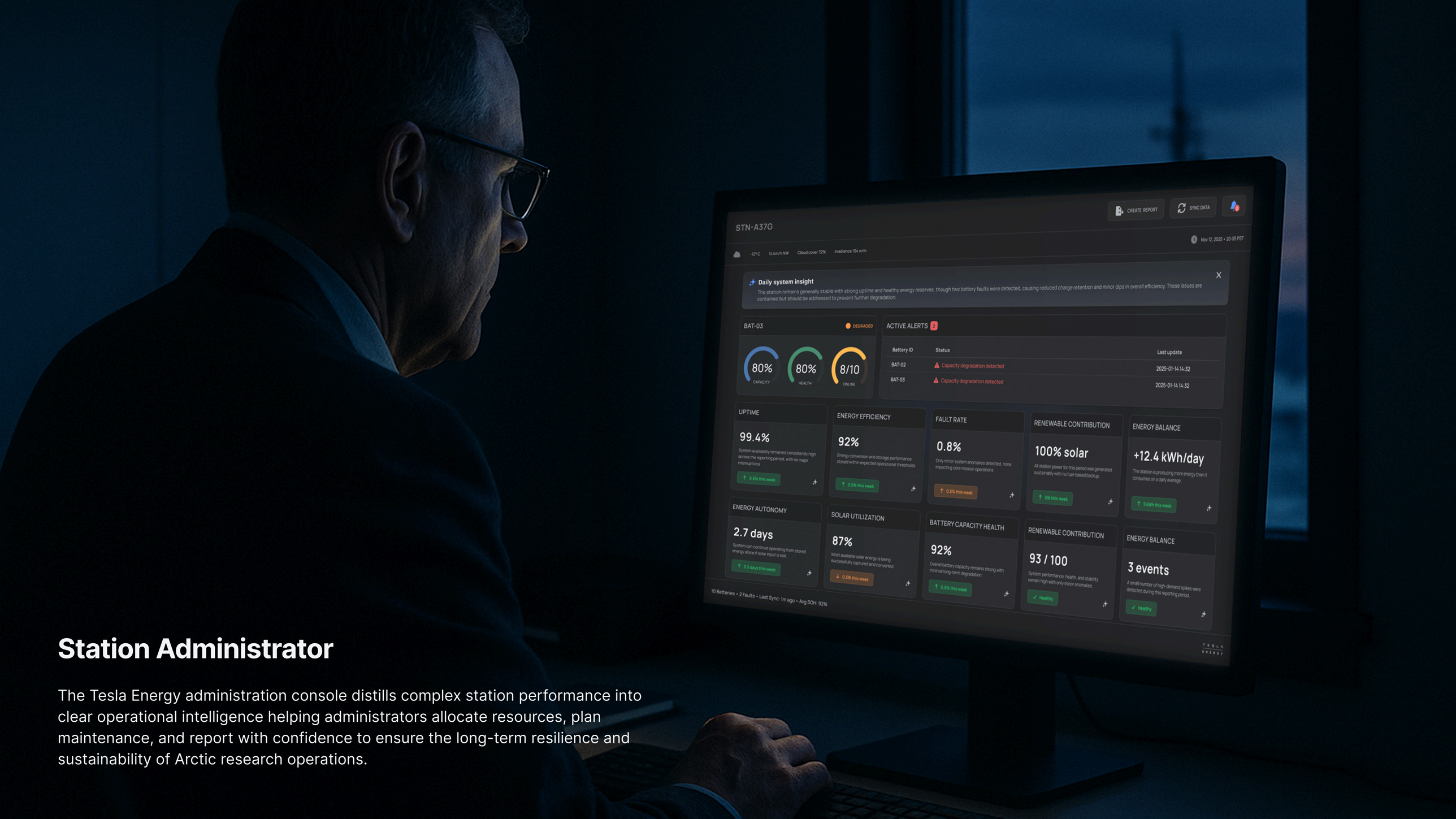

Station Administrator

The Tesla Energy administration console distills complex station performance into clear operational intelligence helping administrators allocate resources, plan maintenance, and report with confidence to ensure the long-term resilience and sustainability of Arctic research operations.

STN-A37G

CREATE REPORT | SYNC DATA

-12° C | 14 km/h NW | Cloud cover 72% | Irradiance 154 w/m

Nov 12, 2025 • 20:05 PST

Daily system insight

The station remains generally stable with strong uptime and healthy energy reserves, though two battery faults were detected, causing reduced charge retention and minor dips in overall efficiency. These issues are contained but should be addressed to prevent further degradation.

BAT-03

DEGRADED

80% CAPACITY | 80% HEALTH | 8/10 ONLINE

ACTIVE ALERTS 2

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ENERGY EFFICIENCY

92%

Energy conversion and storage performance stayed within expected operational thresholds.

↑ 0.5% this week

FAULT RATE

0.8%

Only minor system anomalies detected, none impacting core mission operations

↑ 0.5% this week

RENEWABLE CONTRIBUTION

100% solar

All station power for this period was generated sustainably with no fuel-based backup.

↑ 5% this week

ENERGY BALANCE

+12.4 kWh/day

The station is producing more energy than it consumes on a daily average.

↑ 5 kWh this week

ENERGY AUTONOMY

2.7 days

System can continue operating from stored energy alone if solar input is lost.

↑ 0.5 days this week

SOLAR UTILIZATION

87%

Most available solar energy is being successfully captured and converted.

↓ 0.5% this week

BATTERY CAPACITY HEALTH

92%

Overall battery capacity remains strong with minimal long-term degradation.

↑ 0.5% this week

RENEWABLE CONTRIBUTION

93 / 100

System performance, health, and stability remain high with only minor anomalies.

✓ Healthy

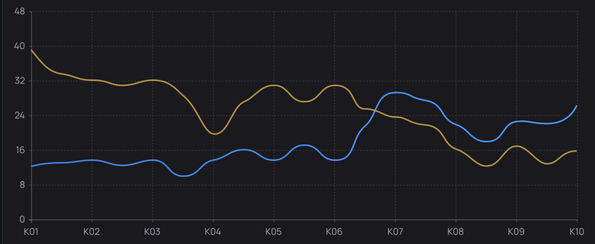
ENERGY BALANCE

3 events

A small number of high-demand spikes were detected during this reporting period.

✓ Healthy

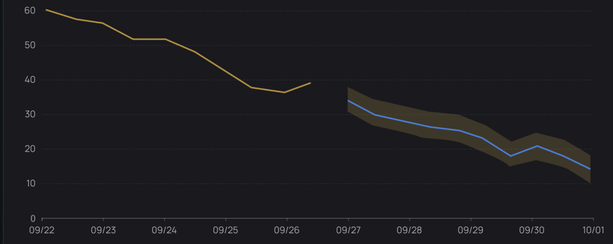
STATION PERFORMANCE



Energy vs Consumption

Consumption (KWh) | Generation (KWh

RESOURCE FORCAST



Estimated days of operation

Historical remaining days | Forecast remaining days

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TESLA ENERGY

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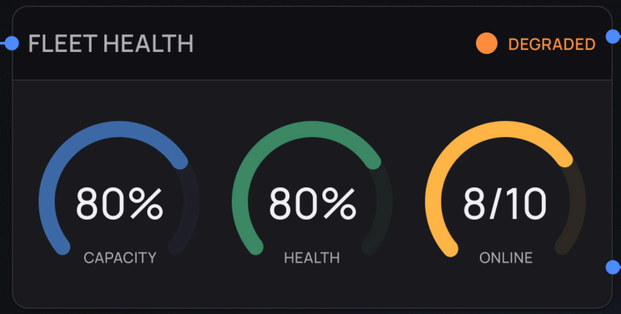
DASHBOARD | Alerts

Consistent system visibility

The Fleet Health component is shared across all user dashboards, ensuring every team member stays aligned on the station's overall health and operational status.



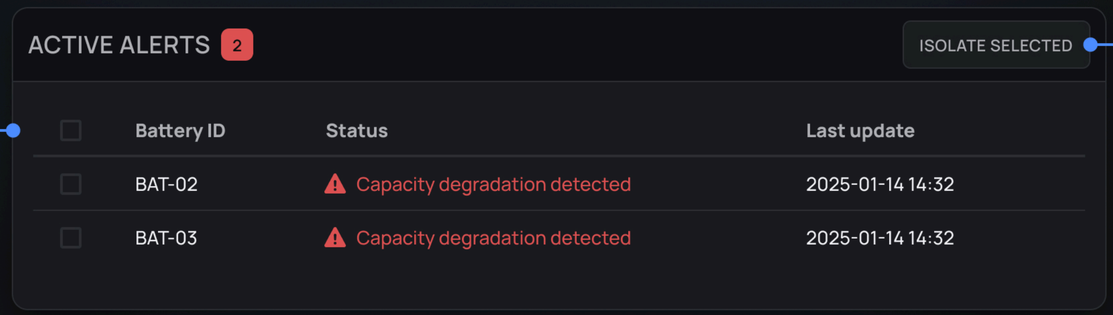
High-level aggregated metrics

Visibility into the system's overall status enables each team member to understand its impact on their responsibilities and make informed decisions.

Dynamic components

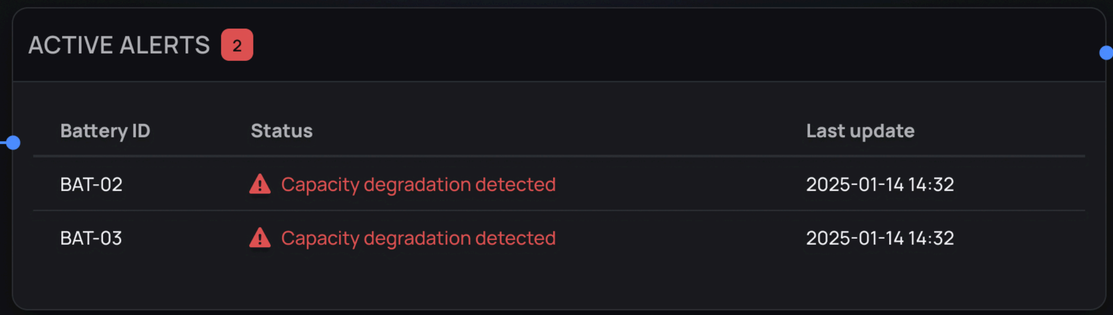
The component's functionality shifts between actionable and read-only states depending on the user's role, ensuring clarity and preventing unnecessary interaction.

This adaptability is made possible by a cohesive design system that keeps the dashboard scalable and consistent across all user types.



Station Technician view

The Active alert component is actionable, allowing the technician to take action to isolate faulty batteries.



Admin and Research view

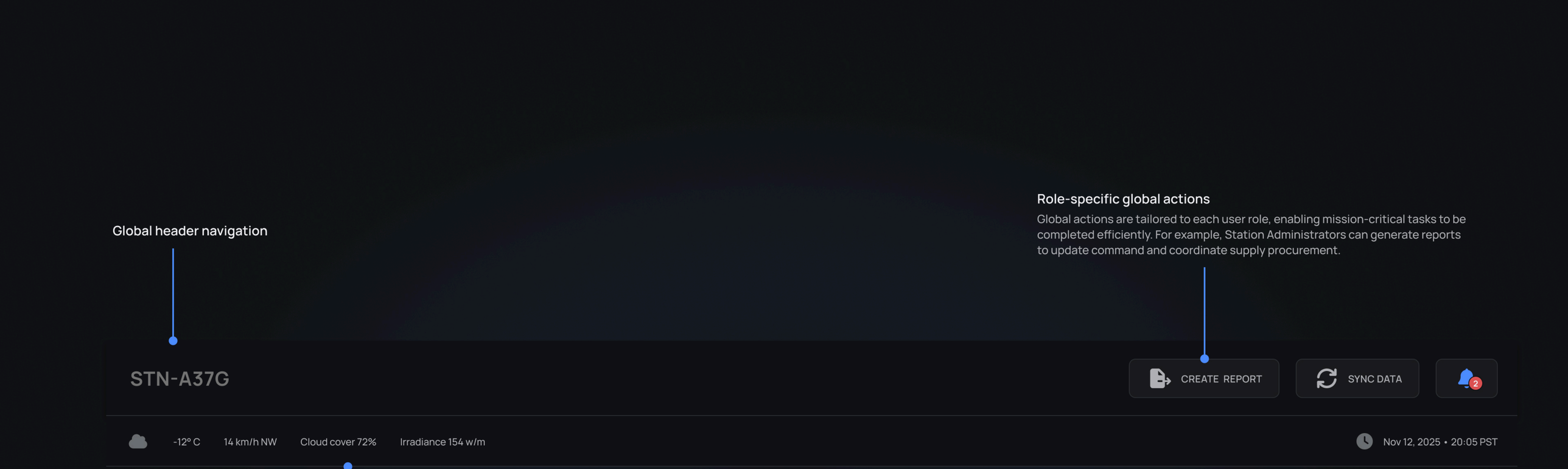
The Active Alert is read-only, giving Admin and Research roles visibility into system issues that may affect their work, while leaving corrective actions to the technician role.

Global header navigation

STN-A37G

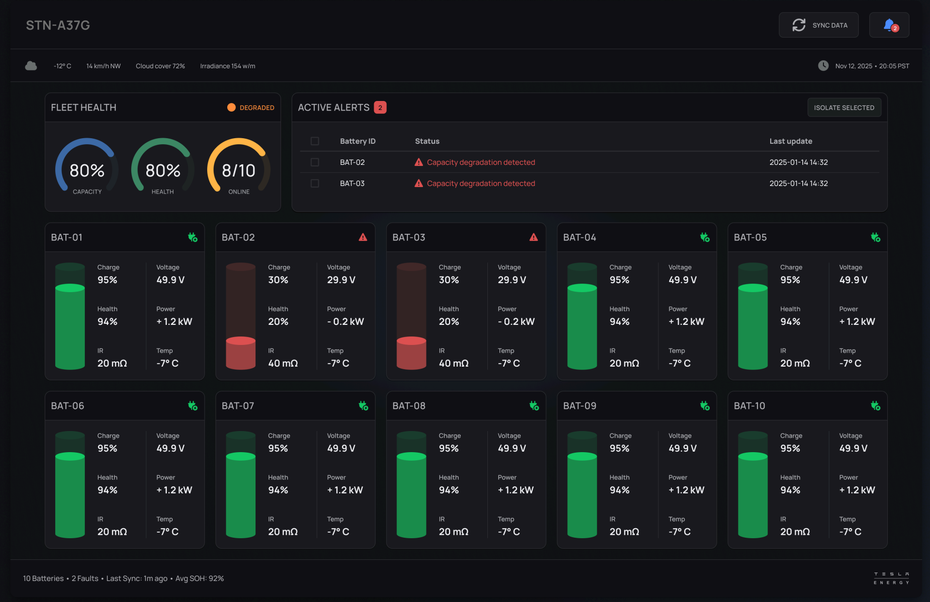
Role-specific global actions

Global actions are tailored to each user role, enabling mission-critical tasks to be completed efficiently. For example, Station Administrators can generate reports to update command and coordinate supply procurement.



Global tools

Global tools such as the weather strip provide real-time data that supports informed decision-making and enhances environmental awareness.



On-Site Technician

Research Scientist

Station Administrator