Newsletter 10

Validating Battery Intelligence: From Research Results to Engineering Services

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Quality First: The Automotive Imperative

In automotive engineering, speed matters — but quality decides. A battery-related field failure can trigger safety concerns, warranty exposure, reputational damage, and recall costs that far exceed the effort required to prevent it. For battery systems, where degradation affects range, safety, residual value, and customer trust, the threshold for deployment is especially high.

This is the starting point for R3-MYDAS. A promising algorithm is not enough. To become relevant for automotive customers, a diagnostic method must be verified, validated, benchmarked, and embedded in a repeatable engineering process. It must prove that it can move from research evidence to reliable service delivery.

Verification and Validation: Building Trust

Verification and validation answer different questions — and both are essential if AI-supported diagnostics are to be trusted in an automotive environment.

Verification asks whether *the system* was built correctly**.** It checks whether a model, method, or software implementation conforms to its specification — for example, whether signal processing, thresholds, and software behavior are implemented as intended.

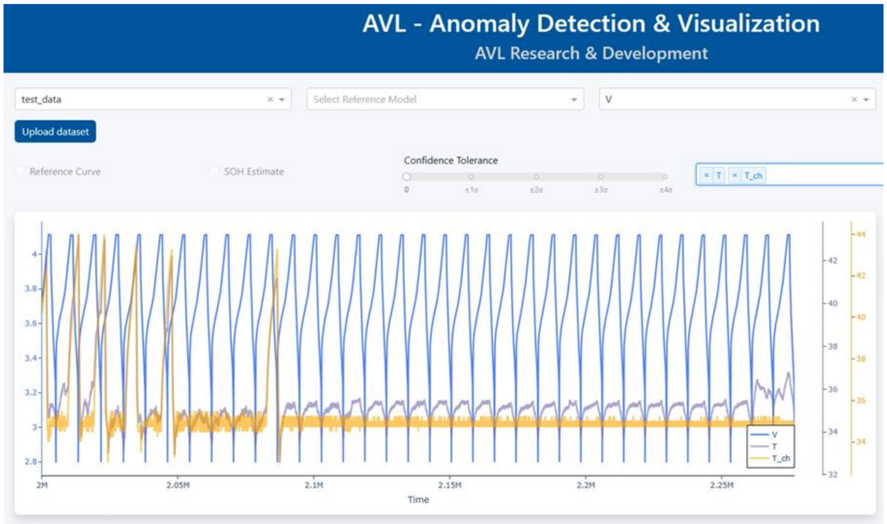
Validation asks whether *the right system* was built. It tests whether the method solves the real-world problem it is intended to address, using independent data, benchmark datasets, or operational evidence from the target application environment.

Deliverable D3.1, *Design of the Battery Development Process*, anchors this logic in the battery lifecycle. It defines quality gates from early concept and prototyping to manufacturing readiness, including Design Validation Testing and Production Validation Testing before scale-up. State-of-health assessment and anomaly detection, therefore, do not stand outside the development process; they must pass through it.

Benchmarking the Methods: Evidence at Scale

R3-Mydas uses benchmark-driven validation to show that its AI methods are not only technically promising, but robust enough for automotive engineering use. The evidence base combines public reference datasets, large-scale cell testing, peer-facing publication, and industrial proof-of-concept discussions.

Anomaly Detection for Battery Cell Testing



AVL's anomaly-detection work has already been presented to the international battery community. At AABC Europe 2024, the R3-MYDAS-funded approach was introduced publicly through the presentation of *AI-based Battery Digital Twin Anomaly Detection and Diagnostics for HV Battery Behavior and Performance*. The work was also presented at the JSAE 2024 Annual Congress, extending its visibility beyond Europe.

The validation scope presented at AABC Europe 2025 is substantial:

- more than 300 battery cells;
- more than one year of continuous testing;
- more than 95,000 charge and discharge cycles; and
- multiple cell geometries and chemistries.

The method detects voltage, temperature, and energy-throughput anomalies and assigns a numerical anomaly score to each cycle. This is the type of evidence automotive customers need: proof that a diagnostic method can operate across large volumes of heterogeneous test data.

State-of-Health Estimation: Benchmarks and Speed

For state-of-health estimation, R3-Mydas validates its approach against two public benchmark datasets that are widely used in battery research:

Dataset	**Cells**	**Chemistry**	**Capacity**
NASA Li-ion Battery Aging	34 cells	Li-ion (LCO)	1.4–2.0 Ah
Toyota / Stanford	~350 cells	Li-ion (LFP)	1.1 Ah

These datasets enable direct comparison with published state-of-the-art methods. That comparison is central to the validation claim: the method is not only effective internally, but benchmarkable against independent work.

The state-of-health method has also been filed as a patent, signaling both technical novelty and commercial intent. Together with graph neural network-based condition reasoning and LLM-supported decision support, it forms one of the technology pillars highlighted at the project's sixth plenary meeting in Vigo in June 2026.

One benchmark result is especially relevant for industrial adoption: the feature-based state-of-health method works with partial charging cycles and enables 24× faster SoH identification compared with conventional full-cycle methods. For workshops, refurbishment centers, and second-life operations, this directly reduces diagnostic time, labor cost, and process bottlenecks.

From Research Result to Engineering Service

The V&V task has a strategic purpose beyond project reporting: it creates the evidence base for customer discussions. WP3 status reporting already notes proof-of-concept negotiations with a major passenger car OEM for anomaly-detection services — a clear signal that benchmarked, published, and validated methods are credible in commercial engineering conversations.

Three customer segments stand out. Each has different operational needs, but the same core requirement: fast, reliable, and explainable battery intelligence delivered as an engineering service.

Automotive OEMs and Tier-1 Suppliers

For cell development, pack qualification, and supplier audits, anomaly detection helps replace labor-intensive manual inspection with targeted engineering review. Instead of screening raw time-series data, test engineers can focus on ranked anomaly flags and supporting evidence. AVL delivers this as an engineering service: models are configured, calibrated, integrated into test infrastructure, and maintained by AVL engineers, with anomaly scores and health-state assessments provided as actionable engineering outputs.

Battery Remanufacturing, Refurbishment, and Second Life

The case for battery remanufacturing has moved from circular-economy aspiration to industrial necessity. Three forces are converging.

Raw material exposure. Battery supply chains remain highly concentrated. For European manufacturers, extracting more usable value from batteries already in circulation is both a resilience strategy and a sustainability strategy.

Regulatory pressure. EU Regulation 2023/1542 establishes a comprehensive lifecycle framework for batteries, including end-of-life responsibilities and digital battery passport requirements. From February 2027, covered EV and industrial batteries will require battery-passport information, including state-of-health data. Reliable SoH determination therefore becomes a compliance enabler, not only a technical service.

Market scale. As the first wave of mass-market EV batteries approaches end-of-first life, more packs will require rapid assessment. Many will retain substantial usable capacity and may be suitable for stationary storage, industrial applications, or remanufacturing before final recycling. The bottleneck is the ability to assess conditions quickly, consistently, and economically.

This is where battery diagnostics address a central operational challenge: rapid, reliable, chemistry-aware SoH determination at intake. Refurbishment centres receiving packs from different OEMs, often with incomplete service histories, cannot rely on slow full-cycle testing as the default path. Faster SoH identification translates directly into operational value: more packs assessed per shift, lower cost per unit, and faster routing decisions for reuse, second-life storage, remanufacturing, or recycling.

The anomaly-detection layer adds a safety and quality filter beyond capacity alone. It helps identify cells with latent faults that may not be visible in conventional charge–discharge measurements, reducing warranty exposure and improving confidence in remanufactured products.

Workshops and Off-Board Diagnostic Equipment

A further opportunity lies in workshop measurement and diagnostic devices. Today, technicians often have limited visibility into battery cell health. Integrating AVL's diagnostic methods into off-board tools would allow workshops to:

- flag cells approaching end-of-life before customers experience significant range degradation;
- distinguish genuine pack degradation from a faulty BMS reading; and
- issue objective SoH evidence for used-vehicle transactions, warranty decisions, and future battery-passport workflows.

The deployment stack presented at AABC Europe 2025 — an *AI* model execution environment for off-board SoH monitoring, second-life assessment, and cell-test analytics — therefore points toward a coherent engineering-service, not a standalone research demonstrator.

Executive Takeaway

R3-Mydas shows how battery intelligence can be industrialized: rigorous V&V, benchmark validation, large-scale testing, and engineering-service delivery. The result is a credible pathway from research to automotive value — faster diagnostics, better quality decisions, stronger second-life business cases, and reliable evidence for future battery lifecycle regulation.