

volytica diagnostics



**BMS Limitations: Case Studies for Battery Monitoring**

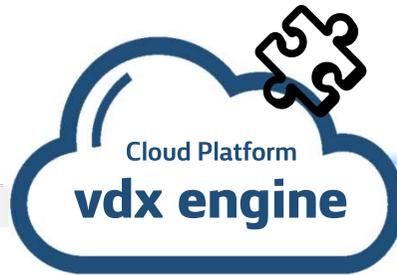
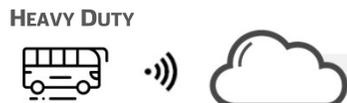
Claudius Jehle, CEO, volytica diagnostics GmbH

 OUR VISION

*Every battery must be used to its true potential.*

Our Solution

We crack abundant data that others discard, using our proprietary battery algorithms



**No Additional Hardware**

No hardware necessary – we tap into existing fleet or condition monitoring systems

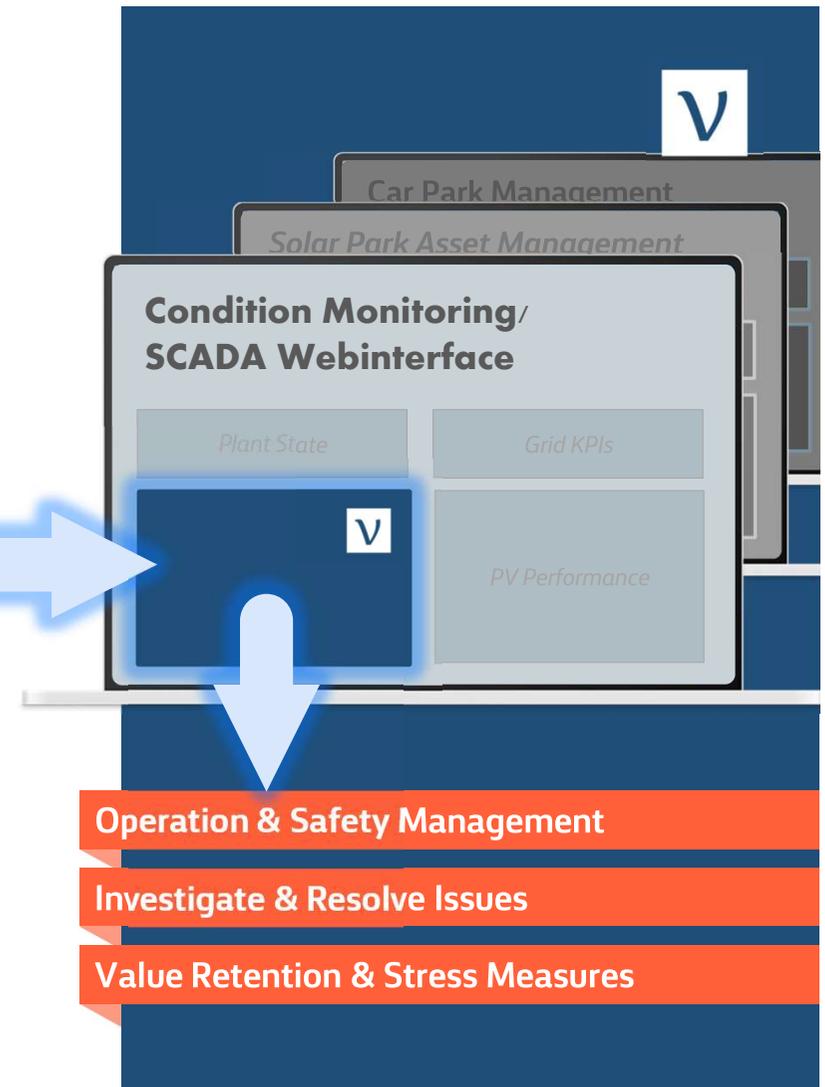
**10+ years of R&D**

More than 10 years of R&D went into a smooth and easy onboarding process without lab experiments

 **Fraunhofer inside**

**Technology Agnostic**

Every typical Li-Ion battery is supported



Solutions at a glance – process chain



We crack abundant data that others discard, using our proprietary battery algorithms to provide **actionable insights integrated in your system.**



### Collect & Connect

#### Use of Existing Data

- All commercial batteries transmit and store the relevant signals

#### Hardware Agnostic

- Every telematic and Li-Ion battery is supported

### Analyze

#### Quick to Start

- Cloud-based analysis tool for systematical battery quality analysis

#### Plug-and-Play

- Our algorithms are self-learning
- We don't need the typical 6 months lab tests

### Integrate

#### Embed into your System

- We integrate input data and results via inbound API and share results via outbound API

#### Customer First

- We offer complete white labeling

### Act

#### 'vdx sentry'

- Customize 'vdx sentry' alert filters and receive recommendation and explanation
- Prevent safety risks/ issues
- Optimize uptime, residual value and profits
- Extend battery lifetime

vdx sentry

Applications

## Our solution is modular; it is based on the essential Monitoring Suite, and offers 3 optional packages



### Operation & Safety

For operation, dispatch & mission control

- Monitoring of all operation & safety-related parameters (up to real time)
- Short-term notification of breakdown risks or risk of performance limitations
- Next best action recommendations

includes vdx sentry



### Investigate & Resolve

For maintenance & expert departments

- Optimal support for root cause analysis
- Predictive action and maintenance to avoid breakdowns and safety events
- Support in warranty claims handling

includes vdx sentry



### Lifetime Management

For long-term planning & reselling

- Long-term tracking of degradation evolution
- Extrapolation of lifetime forecast (*remaining warranted lifetime*)
- Recommendations for stresslevel reduction and lifetime extension

includes vdx sentry

### Battery Essentials

Basis module containing calculation of all essential battery quality KPIs (SOH, RTE, stress level)

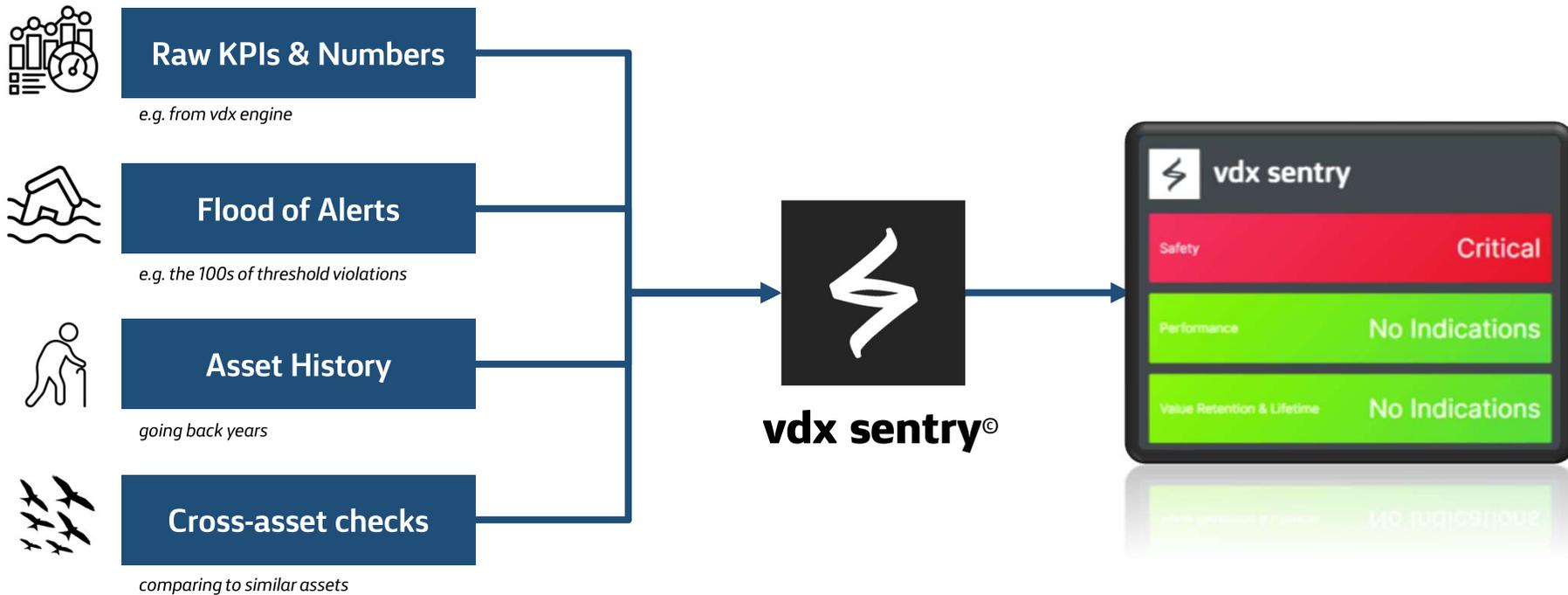


**vdx sentry**

**Guiding you from volts to value.**

vdX sentry – Your integrated, virtual expert

## Less, but better alerts and recommendations: The *vdX sentry* covers your back and tells you what to do



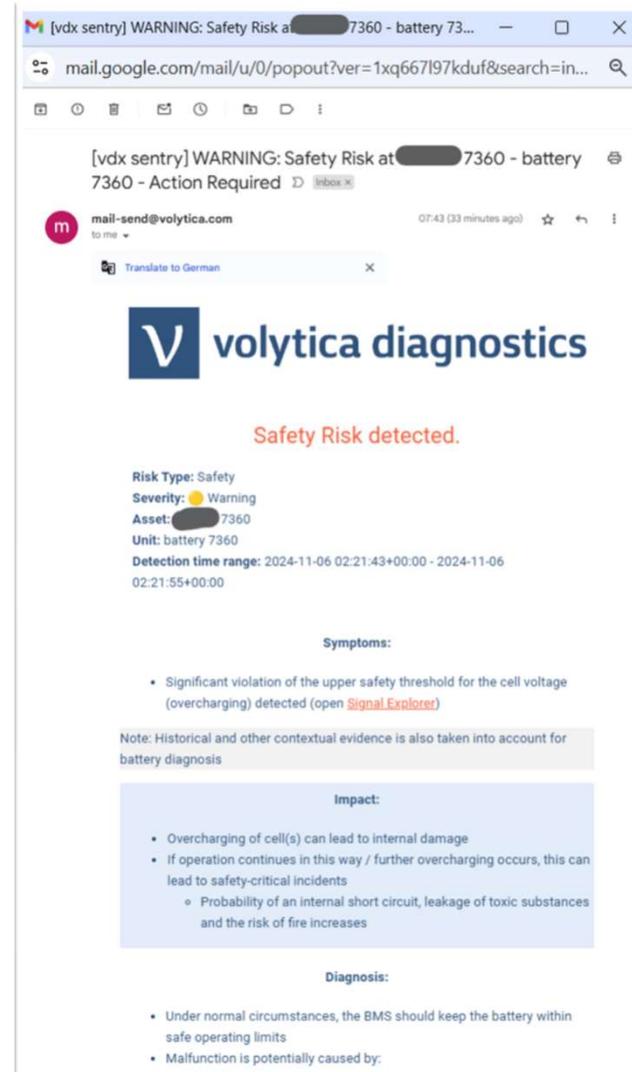
vdX sentry – Your integrated, virtual expert

## Less, but better alerts and recommendations: The *vdX sentry* covers your back

### Automated notifications, including

- List of detected symptoms
- Detailed list of impact and diagnosis analysis
- Recommendations for treatment, check lists and reaction time

 **24/7 calling service available**



[vdX sentry] WARNING: Safety Risk at [redacted] 7360 - battery 7360 - Action Required

mail-send@vdylytica.com 07:43 (33 minutes ago)

Translate to German

**vdylytica diagnostics**

**Safety Risk detected.**

Risk Type: Safety  
Severity: Warning  
Asset: [redacted] 7360  
Unit: battery 7360  
Detection time range: 2024-11-06 02:21:43+00:00 - 2024-11-06 02:21:55+00:00

Symptoms:

- Significant violation of the upper safety threshold for the cell voltage (overcharging) detected (open [Signal Explorer](#))

Note: Historical and other contextual evidence is also taken into account for battery diagnosis

Impact:

- Overcharging of cell(s) can lead to internal damage
- If operation continues in this way / further overcharging occurs, this can lead to safety-critical incidents
  - Probability of an internal short circuit, leakage of toxic substances and the risk of fire increases

Diagnosis:

- Under normal circumstances, the BMS should keep the battery within safe operating limits
- Malfunction is potentially caused by:



EnBW New Ventures

enel  
Green Power

FTTF

ROCK  
road



PI LABS

ATLANTIC  
LABS

webfleet

BVES  
Energy Storage Systems Assoc.

BASEL ERFAHREN BVB

galp



eit InnoEnergy

QUANZEN

Fraunhofer  
IVI

TUVNORDGROUP

MAHLE

Forum für Verkehr  
und Logistik

SINO  
VOLTAICS

CarMedialab

enel x

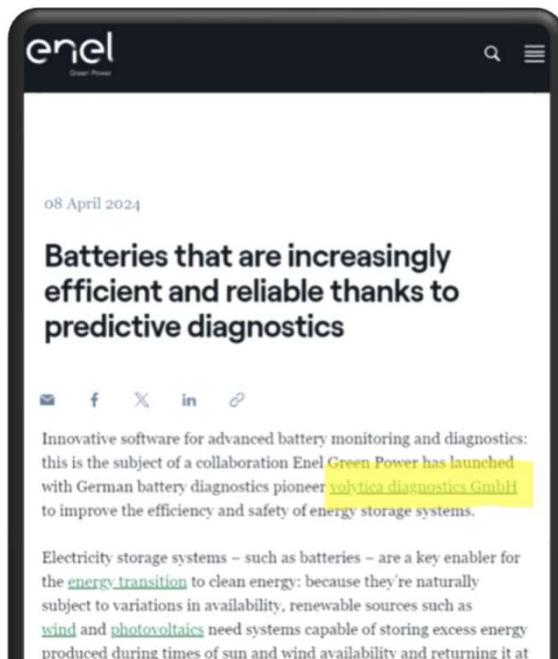
NANO  
POWER

volytica diagnostics

## 3 showcases of what we also do: Pre- and Post-COD support, and insurance coverage



Continuous  
Monitoring



FAT /  
Commissioning

- BESS module quality assessment
- Pre-COD / in-factory (FAT) and on-site (SAT)
- 100% depth (all modules analyzed)
- No additional tests necessary: Conventional dynamic load test

→ Greatly reduces **commissioning phase time**, risk of premature **failures** and can reduce pre-COD **insurance costs**



Stress-reduced  
Trading Optimization

- Currently, most trading algorithms do not take the degradation effects of the executed trades into account!
- While a trade might give good revenue, it might overly damage the battery

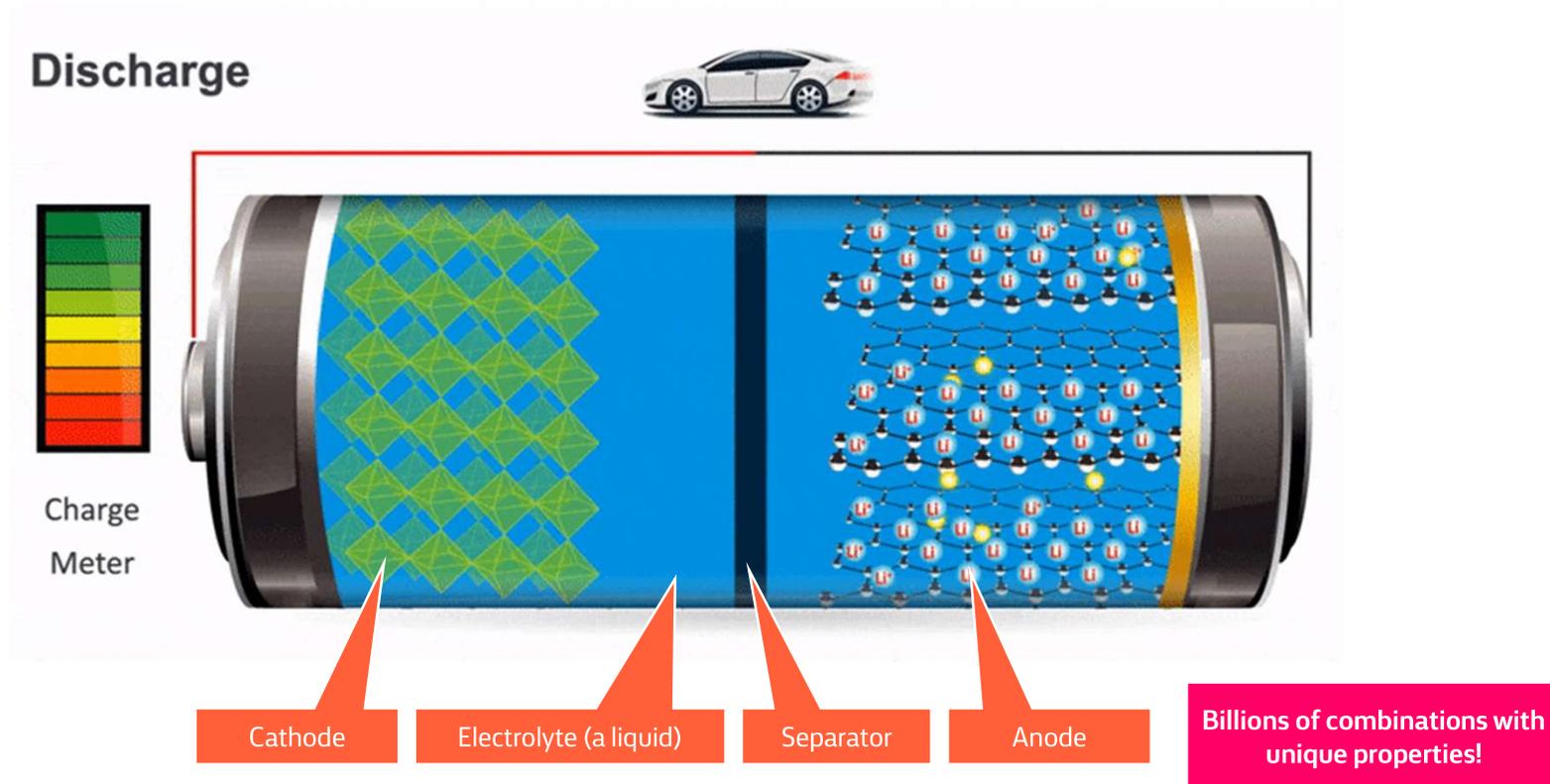
→ With **enspired**, we are combining best-in-class trading algorithms with battery stress algorithms

# | Battery Degradation

What is he talking about?

1 Slide on Electrochemistry

# Li-Ion is not Li-Ion: There are virtually billions of possible subspecies!



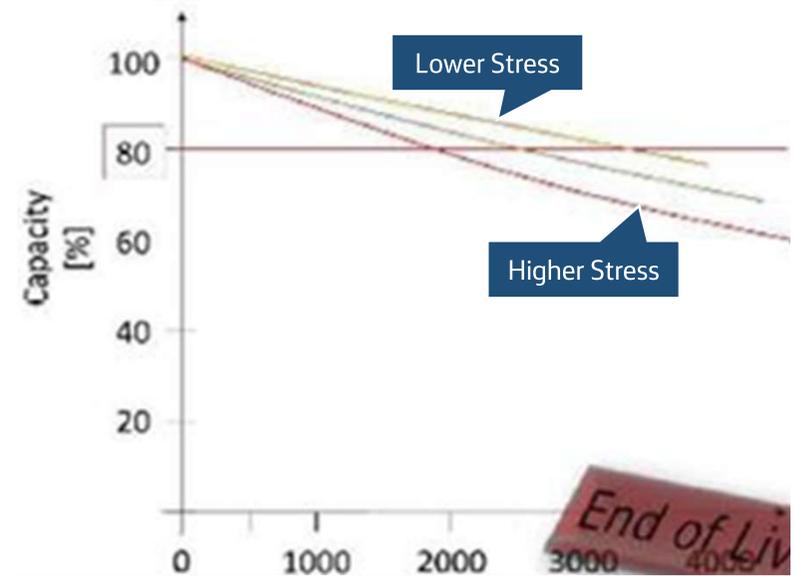
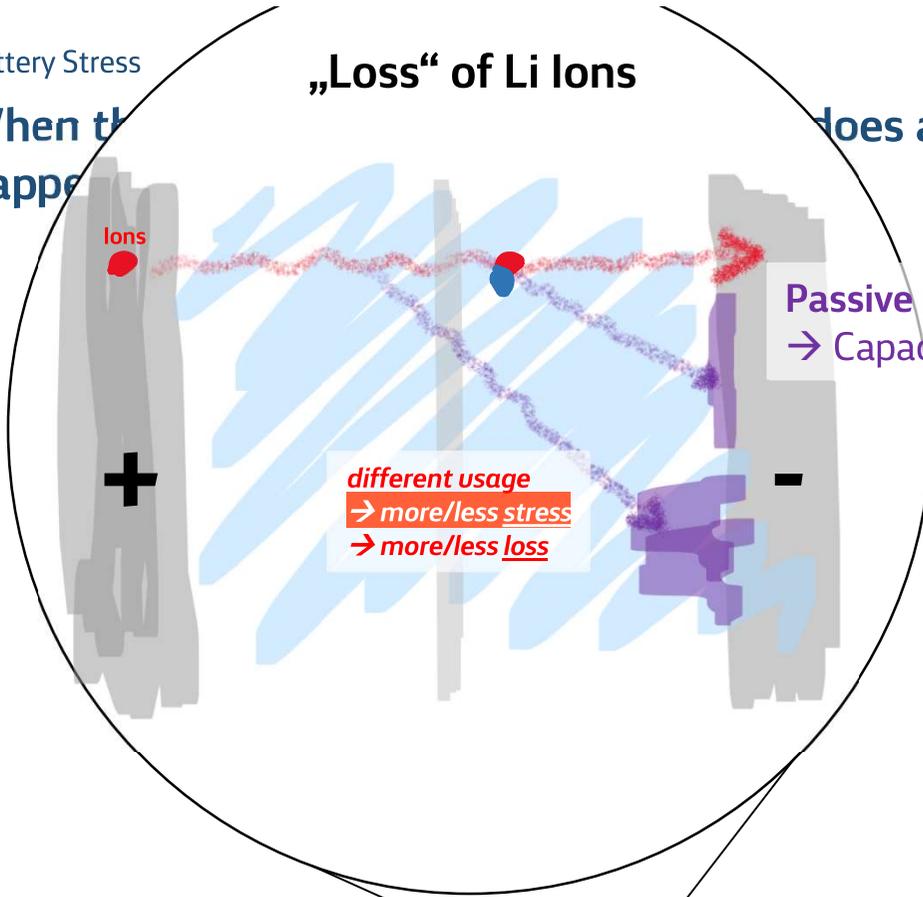


Battery Stress

When the  
happens

„Loss“ of Li ions

does actually

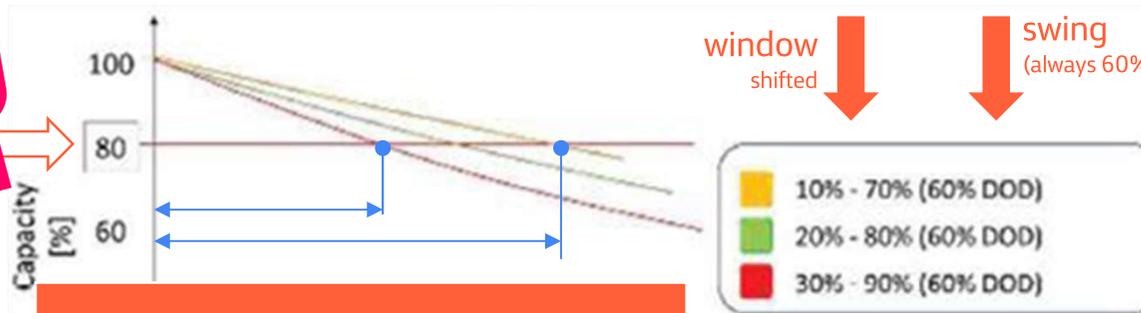


Example: Some "standard" NMC cell

## Minor Changes can have Major Impact!

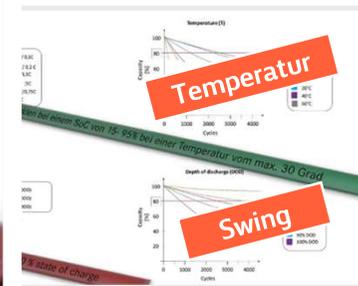
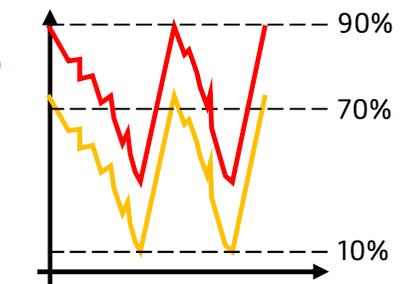


End of Life / EOL  
"End of Warranty" / EOW



**+180% Lifetime**  
by just shifting the window

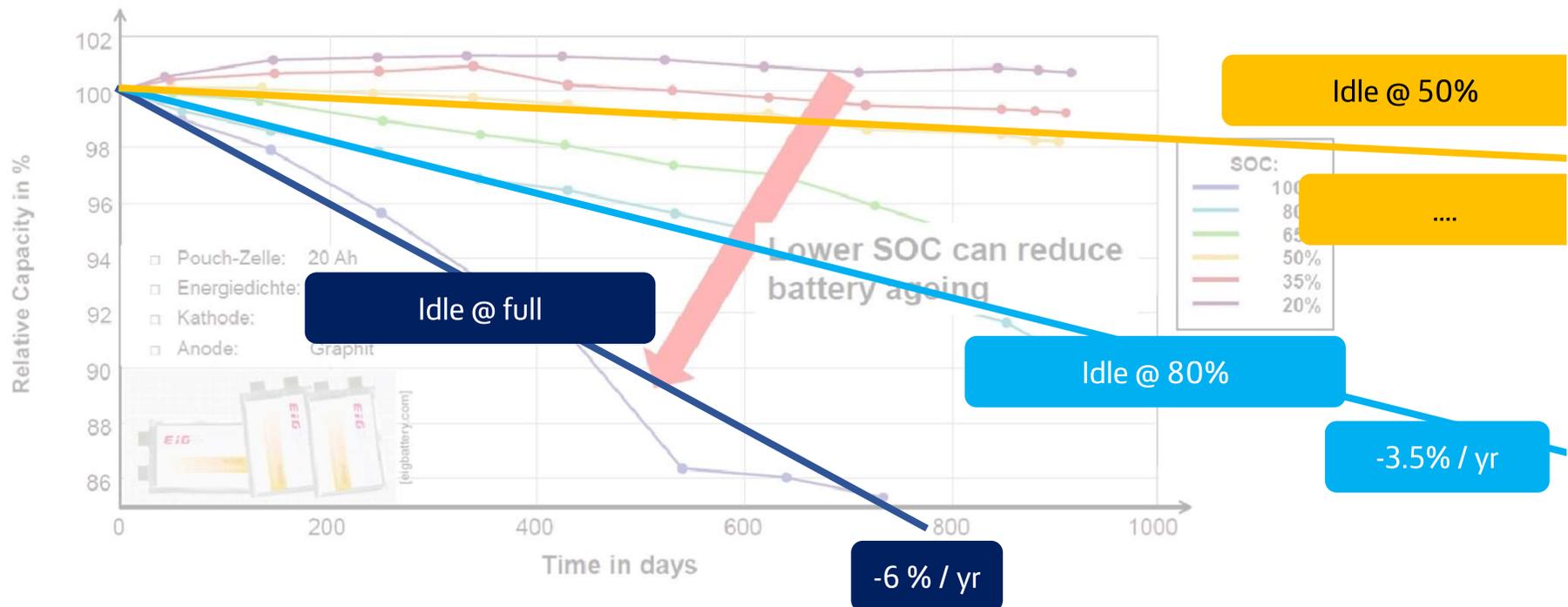
**-45% Cost-Per-Cycle**  
at identical cycle/ MWh throughput



... (EOL) bei 80 % sta

Example: Lazy idling <sup>zZ</sup>

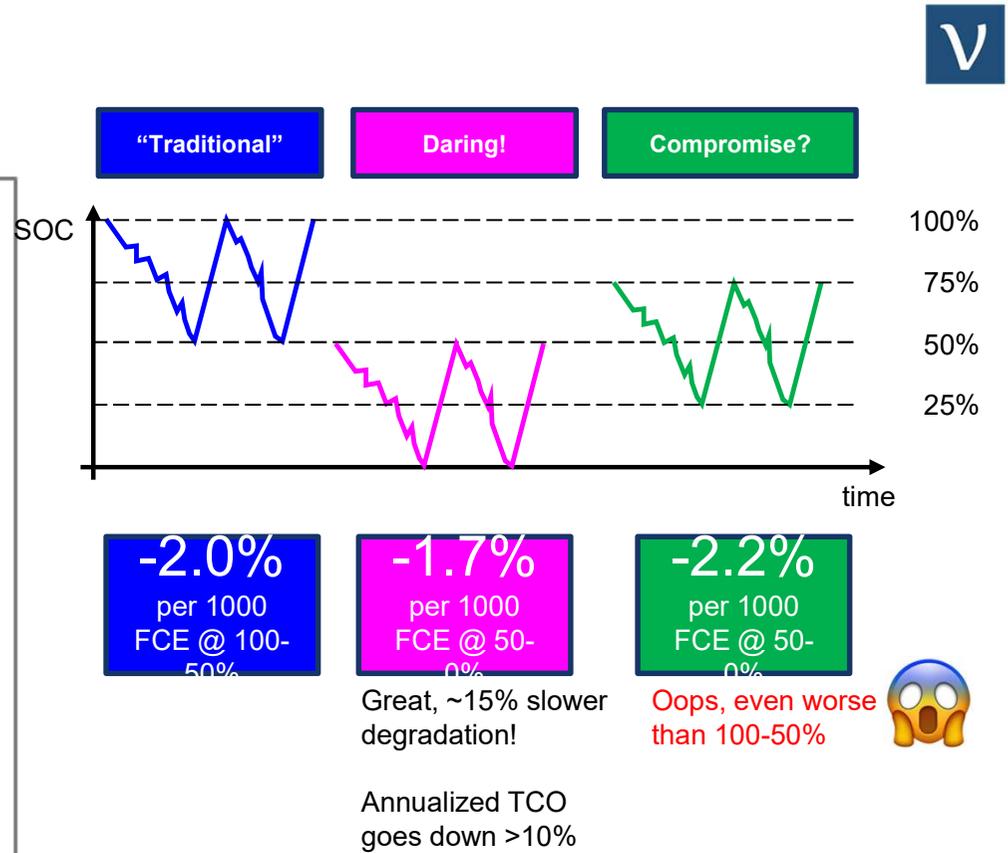
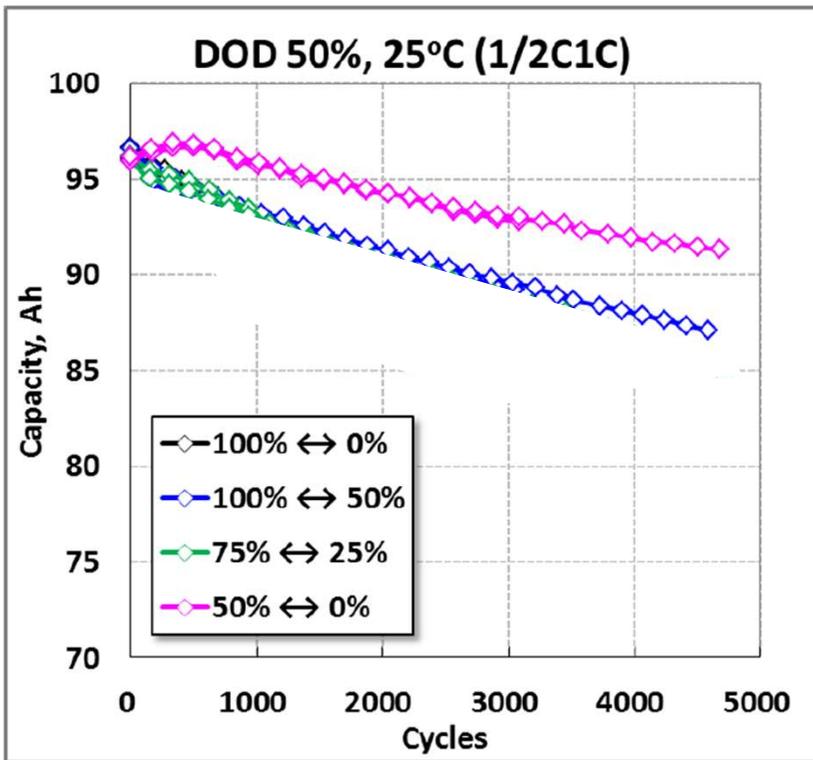
**Batteries are made for working.  
They keep degrading while idling.**



A. J. Warnecke, „Degradation Mechanisms in NMC-Based Lithium-Ion Batteries“, Dissertation, RWTH Aachen University, 2017

Example: SOC influence 

## Brief Breakout: Why does SOC damage a battery?



# | Prevention, not only Mitigation

Das Gruselkabinett





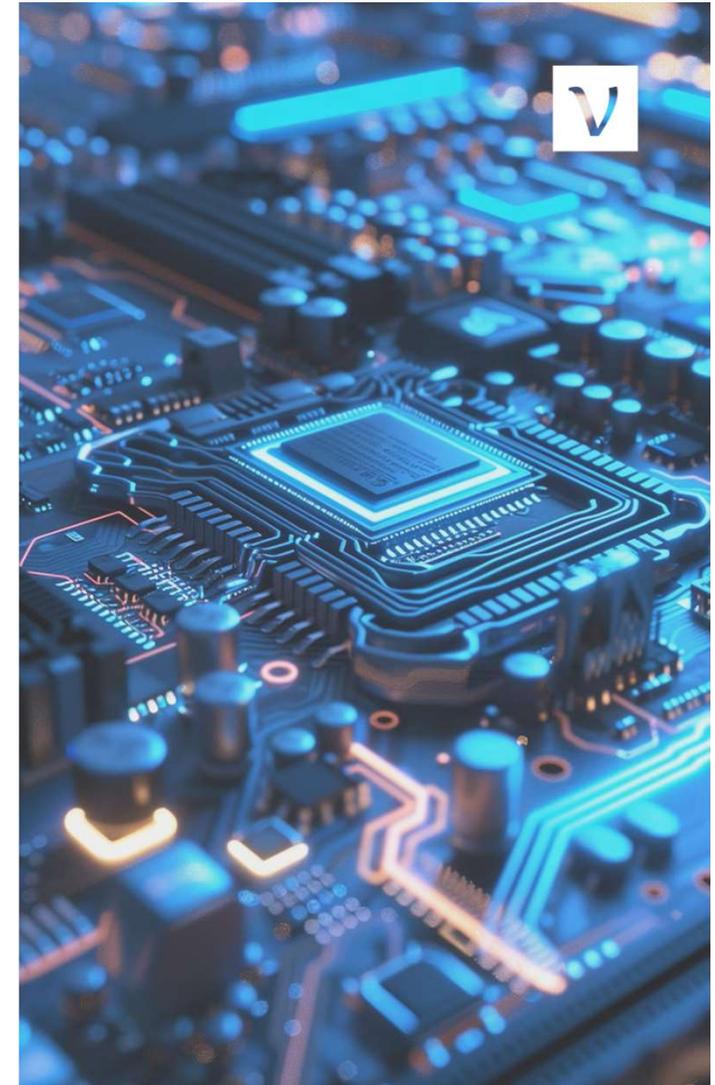
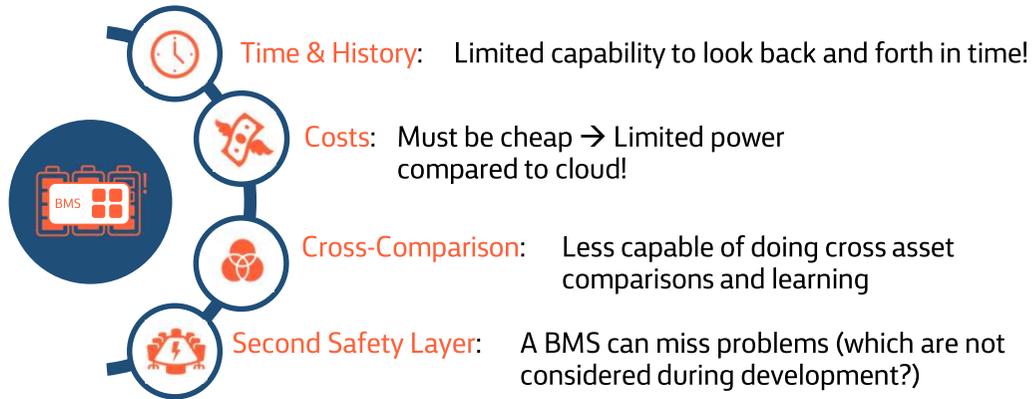
# “SOH” is not a good indicator for Safety!



Evergreen Question

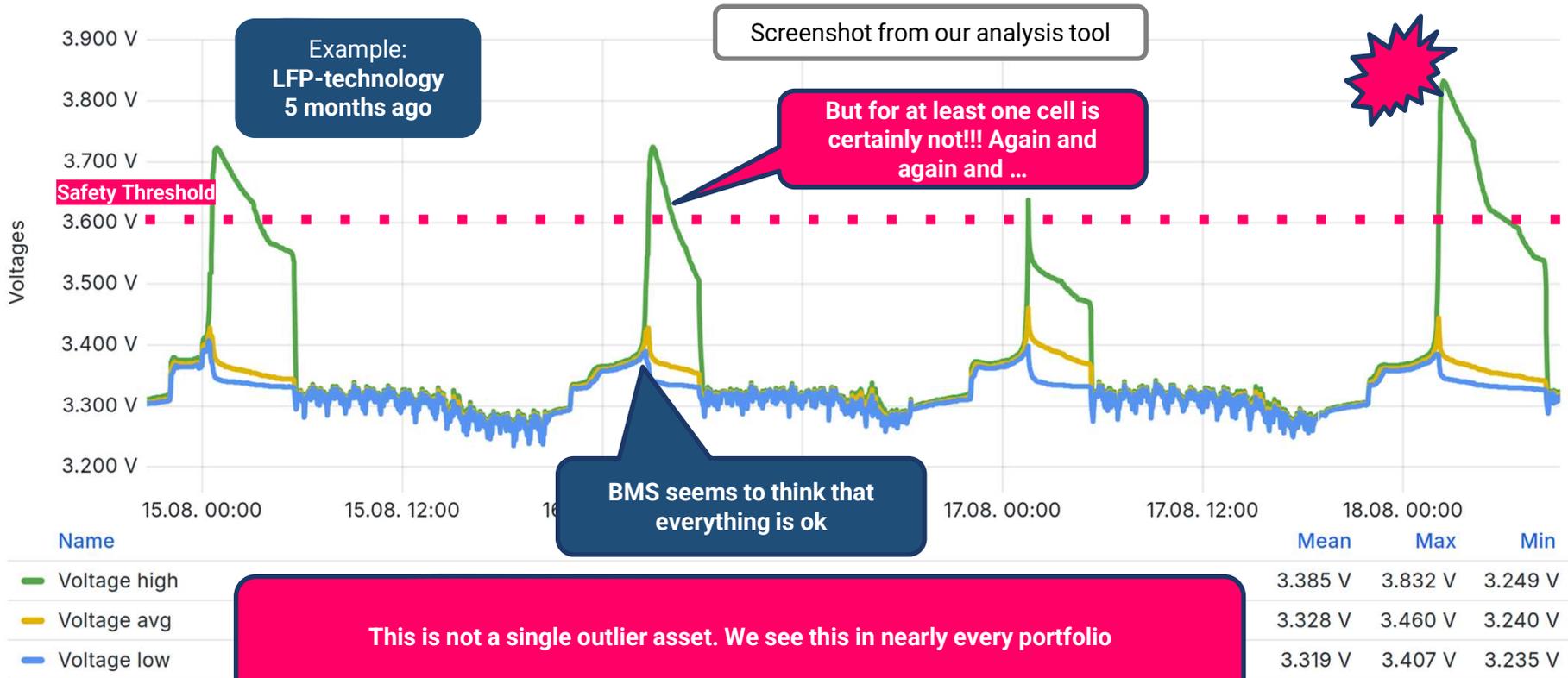
## But isn't the BMS taking care of all of that?

- The Battery Management System (BMS) is an (or: THE) crucial controlling component of every Li Ion battery
- It is the foundation of a multi-layered safety and controlling scheme
- However – **there are limitations:**



Detecting Problems

# Practical Example: Massive overvoltage



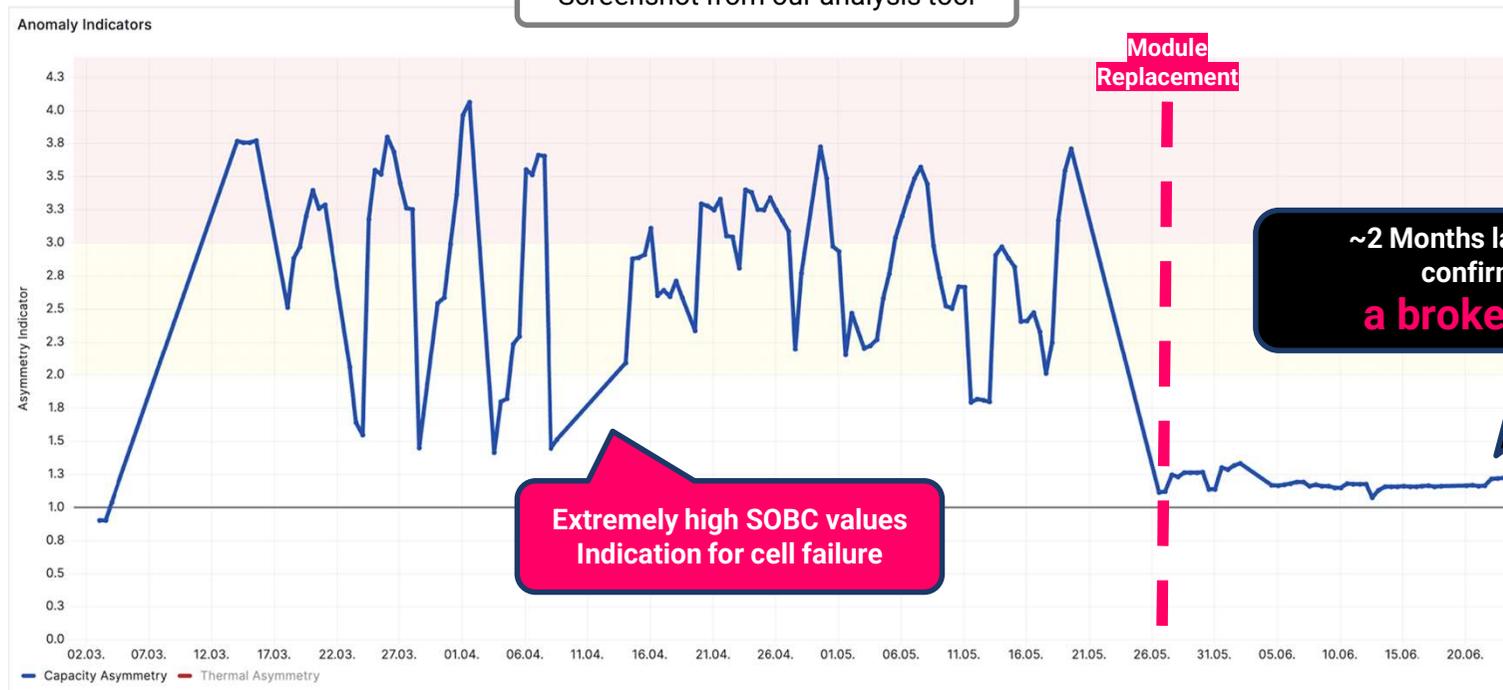
**This is not a single outlier asset. We see this in nearly every portfolio**

Detecting Problems

## Practical Example: In 2022 – Defect Cell



Screenshot from our analysis tool



vdX sentry – Examples

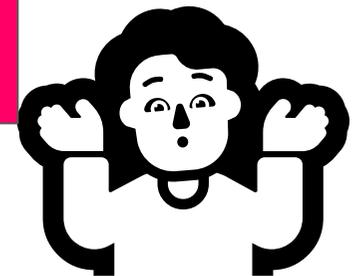
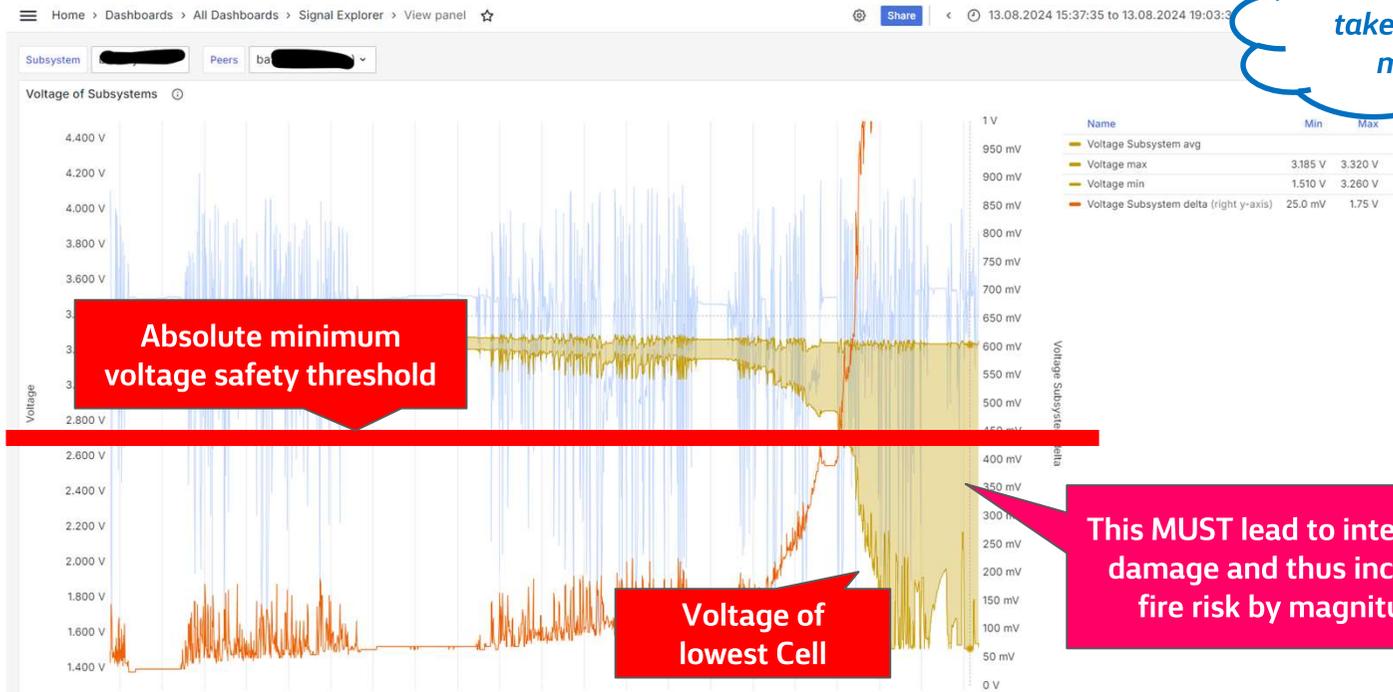
## Evergreen question: *Should the BMS not take care of ... ?*

We see almost unbelievable BMS malfunctions every day



Yes, but it doesn't!

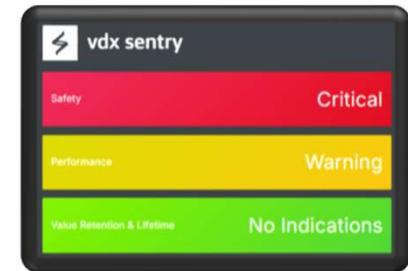
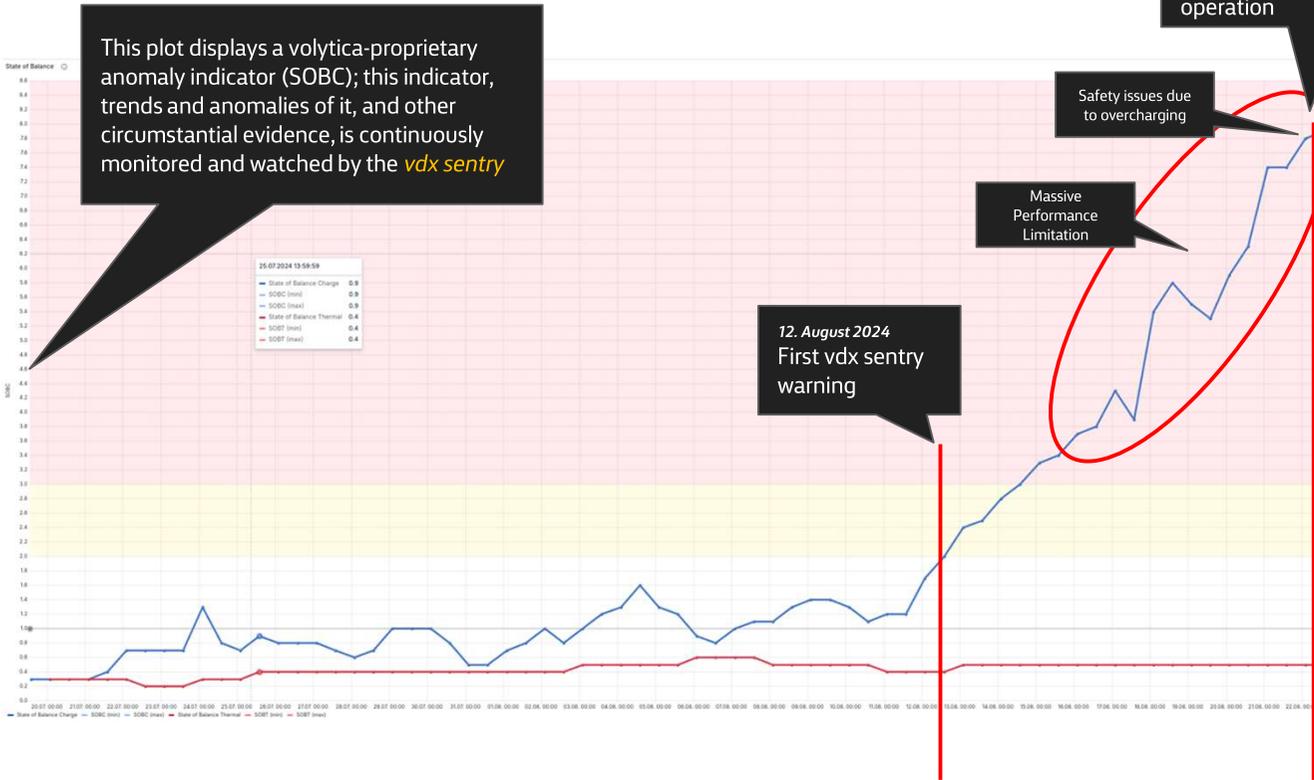
Should the BMS not take care of safety monitoring?



vdX sentry – Examples

# Example 1: 125 MWh Plant, LFP, USA

## Safety Critical Cell Defect



vdX sentry – Examples

## Example 1: 125 MWh Plant, LFP, USA Safety Critical Cell Defect



Event Statistics	
Type	Amount
SAFETY WARNING: QUICK_TREND_IN_THERMAL_INH...	6
SAFETY CRITICAL: SEVERE_DEEP_DISCHARGING	6
ENVELOPE_TCELL_LO_HIT	6
EXPERT_ASSESSMENT_CELL_DEFECT	5
CAPACITY_SYMMETRY_NO_DATA	5
SAFETY WARNING: SIGNIFICANT_OVERCHARGING	5
EXPERT_ASSESSMENT_OVERVOLTAGE	4
STRESSLEVEL_WEEKLY	4
SAFETY CRITICAL: SEVERE_OVERCHARGING	4
SUMMARY_REPORT	2
SAFETY WARNING: SIGNIFICANT_DEEP_DISCHARGING	2
ENVELOPE_TCELL_HI_HIT	1

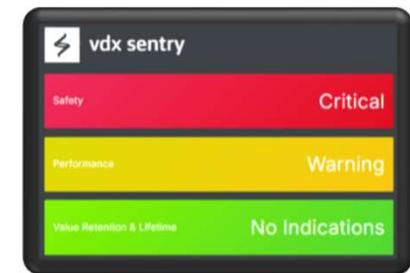
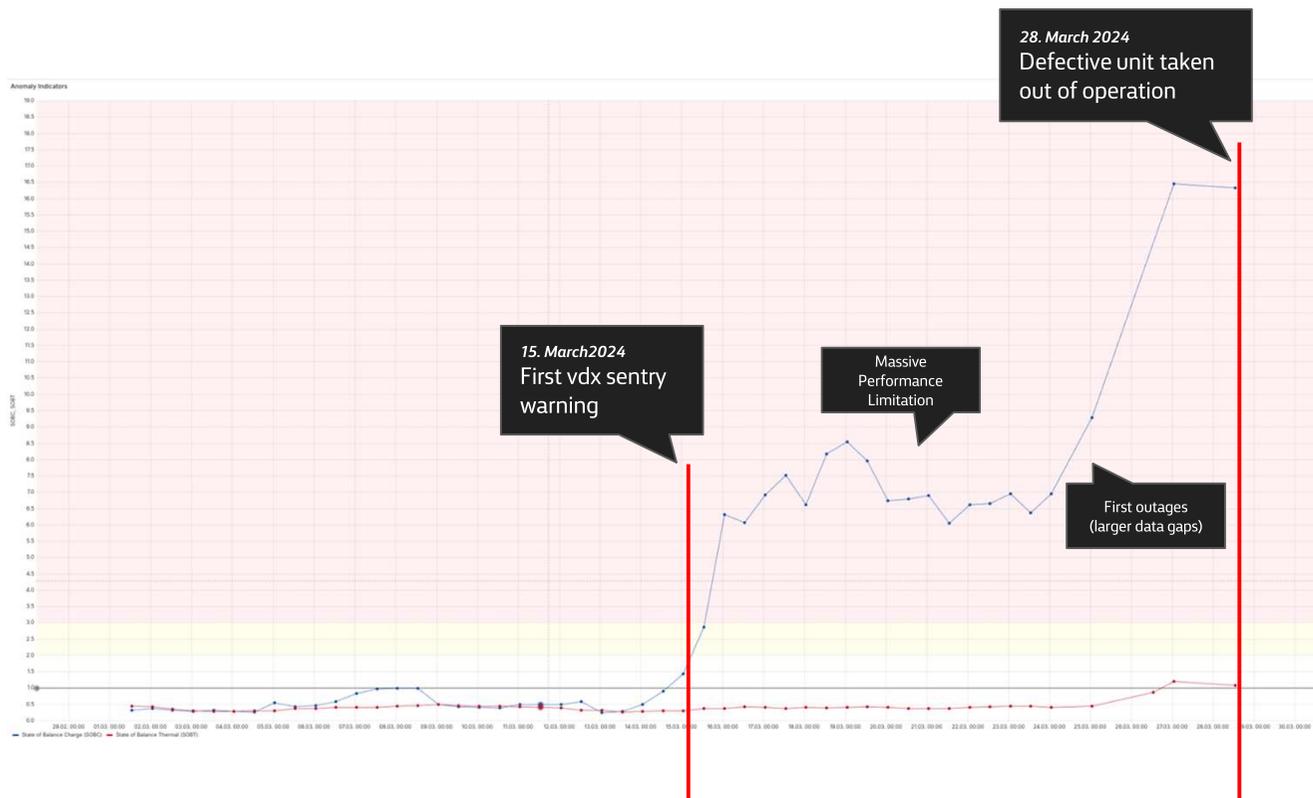
Excerpt of the assets logbook: the vdytica platform analyses and detects manifold issues and warns the user.

In many cases, operators are reacting swiftly, yet in other cases, there is a general lack of awareness and urgency.



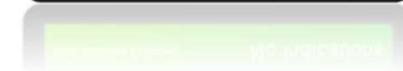
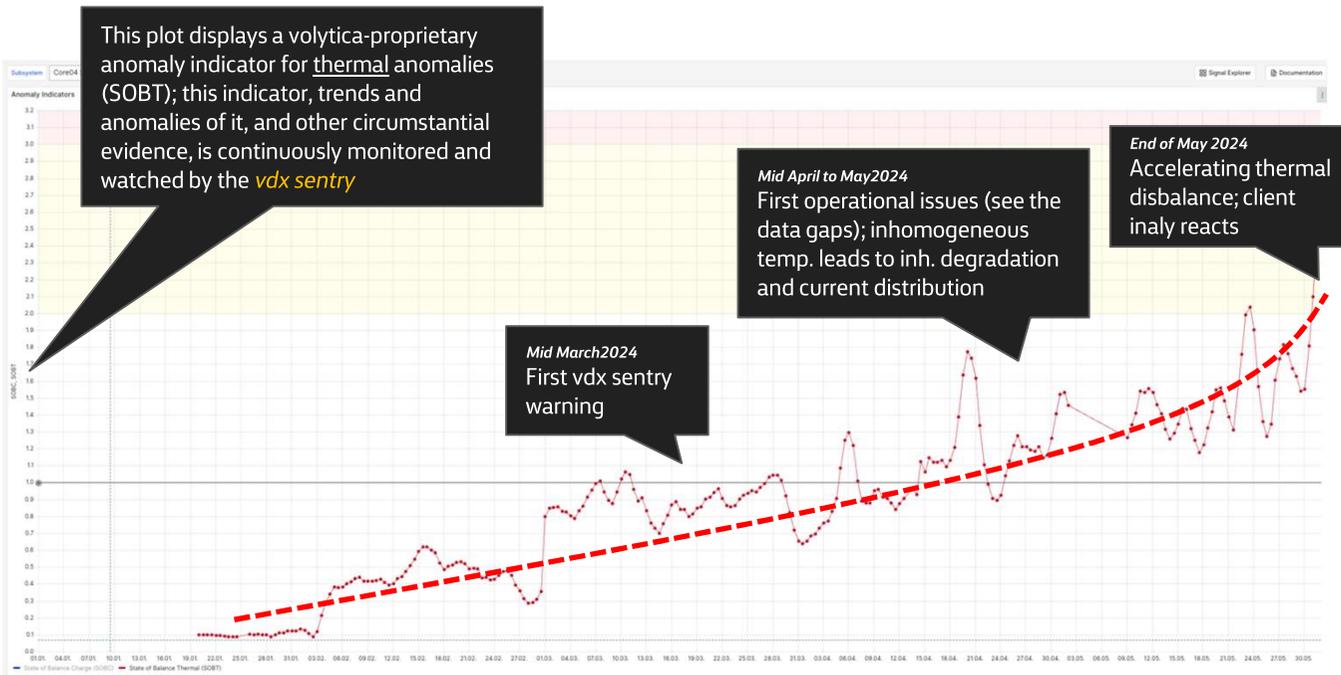
vdx sentry – Examples

## Example 2: 90 MWh Plant, LFP, Italy Safety Critical Cell Defect



vdx sentry – Examples

## Example 3: 250 MWh Plant, LFP, USA Creeping Thermal Anomaly

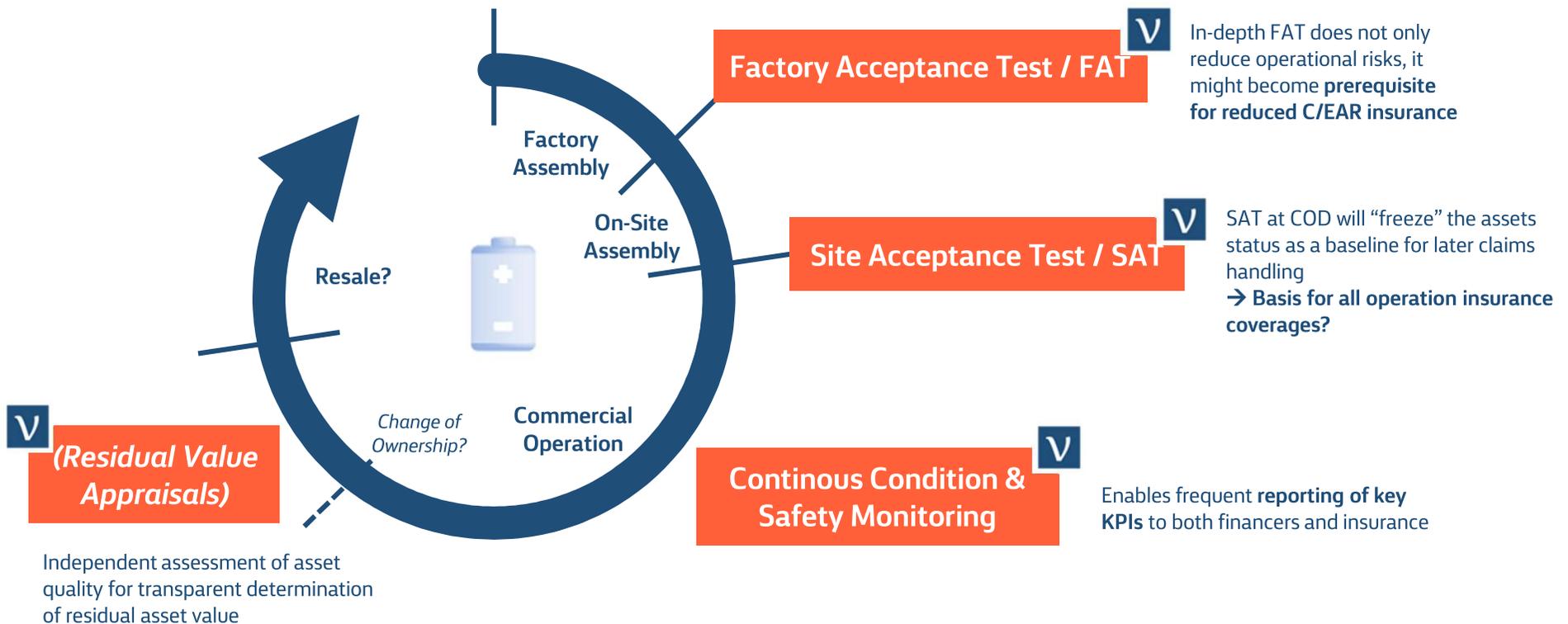


# | Coupling to Insurance & Finance

Battery Risk Management is the perfect match



# Where Battery Condition Monitoring and Insurance / Financing come together



Insurance & Finance

A coupling between battery condition assessment & monitoring  
and insurance products will come – **just a matter of time**



**CONFIDENTIAL**



Insurance & Finance

## Where Battery Condition Monitoring and Insurance / Financing come together

Get a copy of our Offerings & Insurance Fact Sheet



### Optimizing Risk Management with Continuous Battery Monitoring

#### Challenges of BESS Operations

Battery Energy Storage Systems (BESS) are complex and diverse, making fragmented manual monitoring unmanageable. Standard Battery Management Systems (BMS) and OEM dashboards often fail to provide the comprehensive insights required for effective risk and performance management.

#### How volytica Supports Your BESS Risk Management

Use our comprehensive approach with the vdx sentry:

##### EARLY DETECTION, LOWER RISK

- Proactive failure detection
- Predictive Maintenance
- Maximum uptime availability

##### BEYOND BMS CAPABILITIES

- Self-learning algorithms
- Peer group comparisons
- Risk-adjusted recommendations

##### INDEPENDENT MONITORING

- Integration of multiple vendors
- Data consolidation
- Independent data analysis

#### Tailored Services for Every Phase

We provide independent analysis of the BESS during the critical phases of installation and ramp-up and ensure comprehensive ongoing monitoring.

Before Commissioning

##### Pre-COD Services\*

- Factory Acceptance Testing
- Site Acceptance Testing

\* Commercial Operations Date

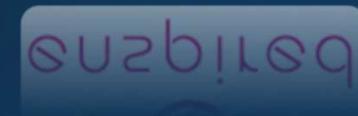


Ongoing Operation

##### Post-COD Services\*

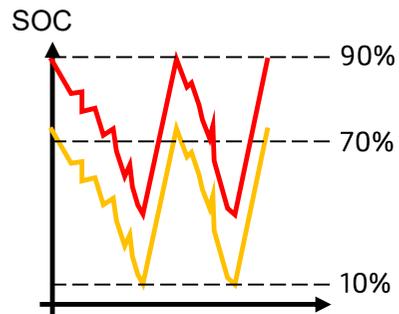
- Continuous safety monitoring
- Performance optimization
- Lifetime management

**| Another Use Case**  
From Revenue- to Profit-Optimization



Impact on Business Models

# volytica coined the “stresslevel”: How damaging (=costly) is the current operation?



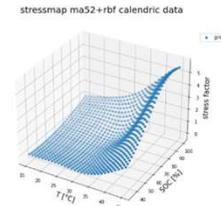
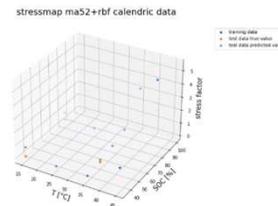
... and ...

- Temperature,
- Idle SOC,
- Charging Power,
- Discharging Power,
- ...



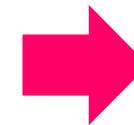
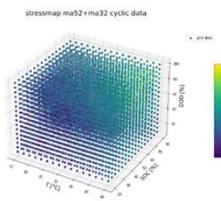
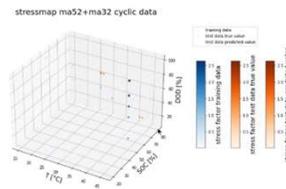
### Calendric data

- Stressmap to compare prediction and true value
- Stressmap generated



### Cyclic data

- Remark:
- 6-dimensional problem
  - Some variables must be left out for the representation.



Stresslevel  
**1.7**

\* Example

- ➔ ~70% faster degradation than planned & designed
- ➔ ~70% higher **costs-per-cycle** than planned

Impact on Business Models

## volytica coined the “stresslevel”: How damaging (=costly) is the current operation?



Integration with  **enspired**

The combination of Stresslevel calculation and trading optimization is a match made in heaven



 **volytica diagnostics**

**Cost-per-Cycle**  
via stresslevel



**Revenue Optimization**



**Profit-Optimized Trading**

volytica diagnostics



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Booth

**B2.470**

Drinks on  
Thu. 17:00

