

volytica diagnostics



BMS Limitations: Case Studies for Battery Monitoring

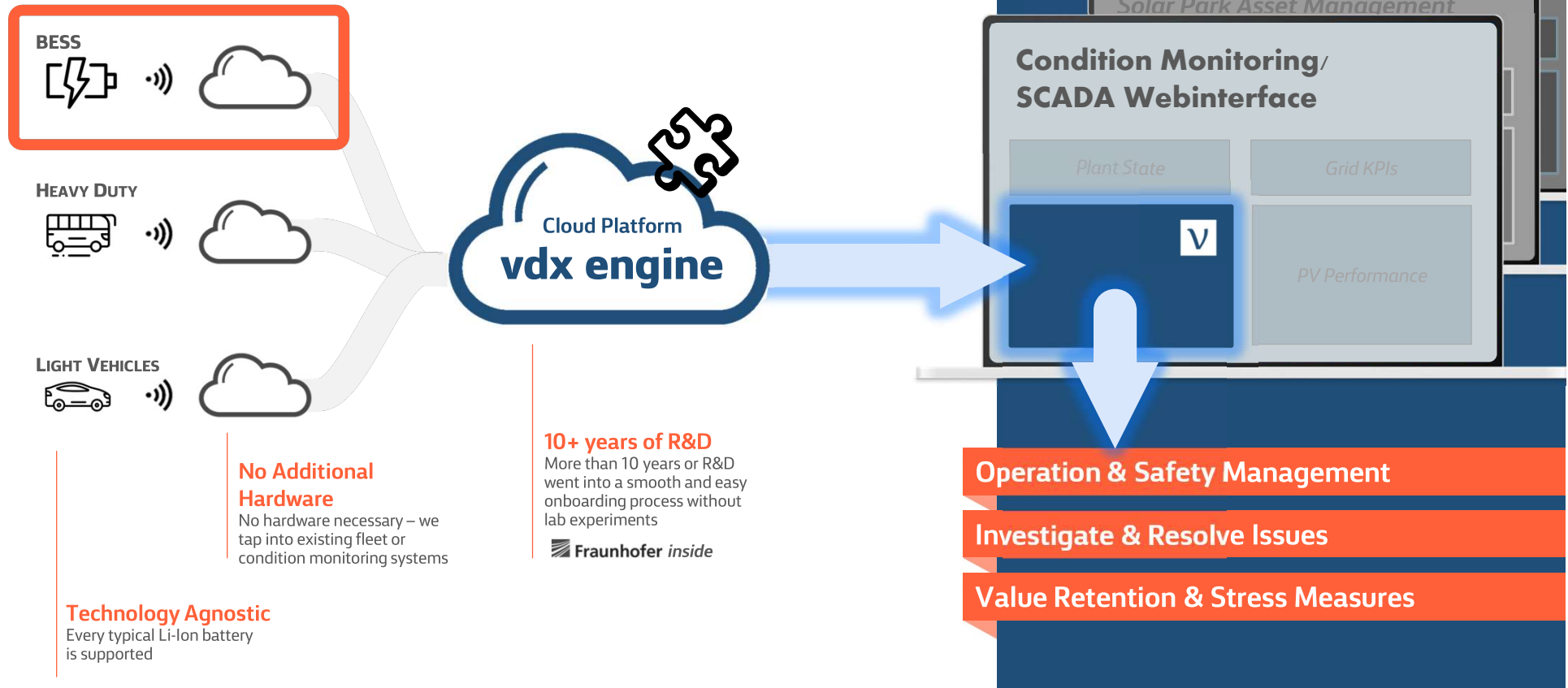
Claudius Jehle, CEO, volytica diagnostics GmbH

 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



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)



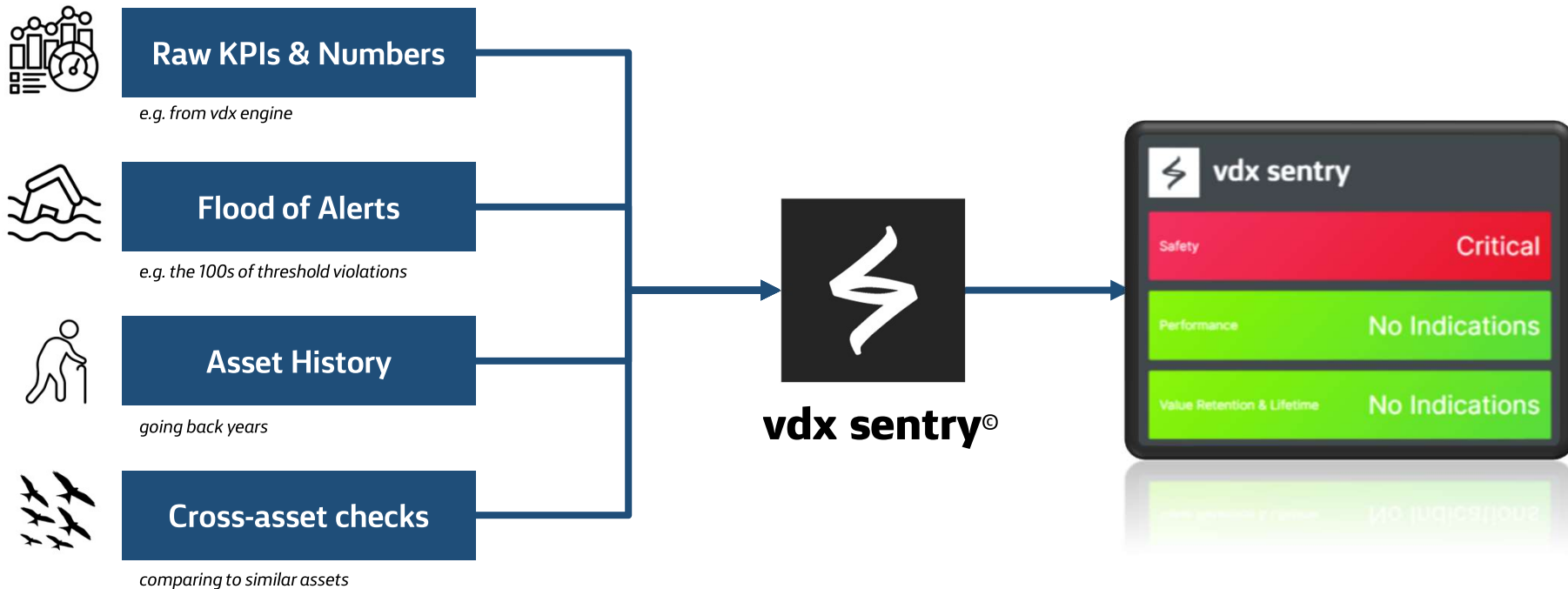
vdx sentry

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

The screenshot shows an email interface with the following content:

- Subject:** [vdx sentry] WARNING: Safety Risk at [redacted] 7360 - battery 7360 - Action Required
- From:** mail-send@volytica.com (07:43 (33 minutes ago))
- Translate to German:** [button]
- Volytica Diagnostics Logo:** A blue square with a white 'V' followed by the text 'volytica diagnostics'.
- Safety Risk detected.** (in red text)
- Risk Type:** Safety
- Severity:** Warning (indicated by a yellow circle)
- 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:** (in a light blue box)
 - 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

BASEL ERFAHREN
BVB

galp

BVES
Energy Storage Systems Assoc.

eit InnoEnergy

QUANZEN



Fraunhofer
IVI

TÜVNORDGROUP

MAHLE

Forum für Verkehr
und Logistik

SINO
VOLTAICS

CarMedialab

enel x

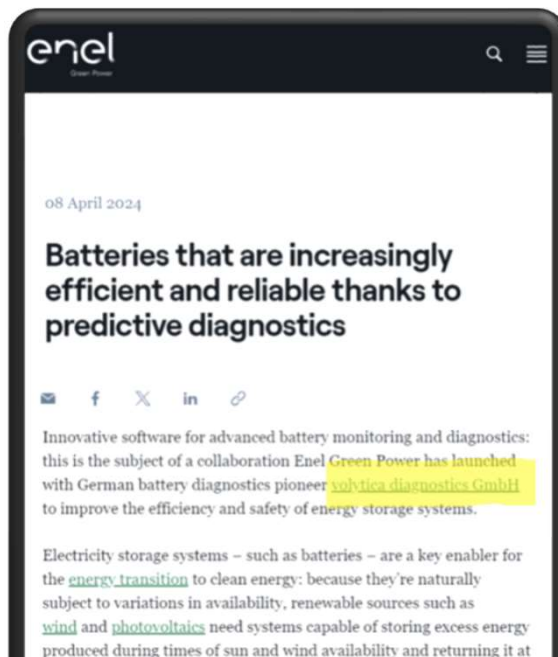
NANO
POWER

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

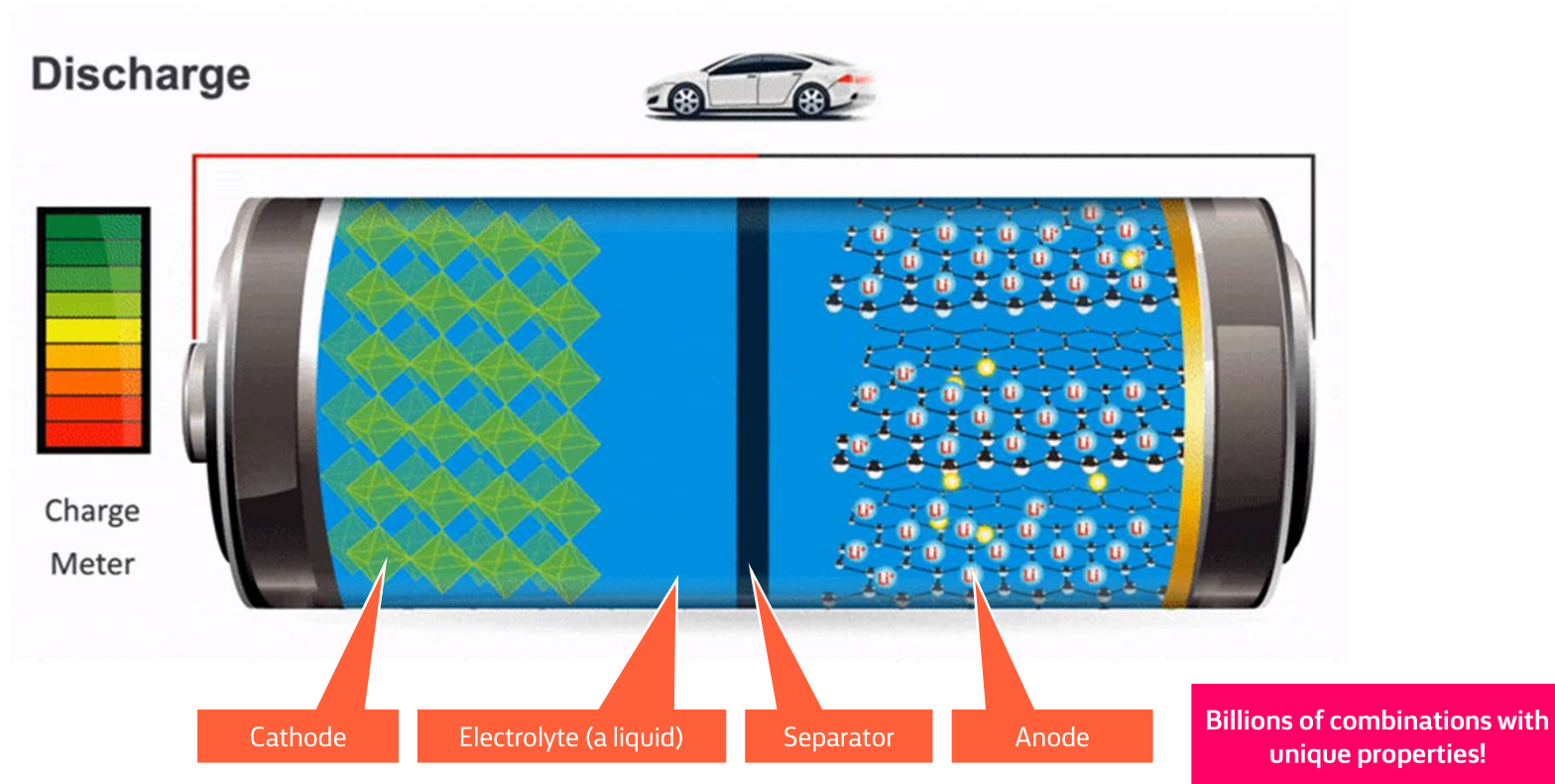
→ With **enspired**, we are combining best-in-class trading algorithms with battery stress algorithms

| Battery Degradation

What is he talking about?

1 Slide on Electrochemistry

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



The "Jungle"

Every combination and every innovation comes with particular and peculiar strengths and weaknesses!



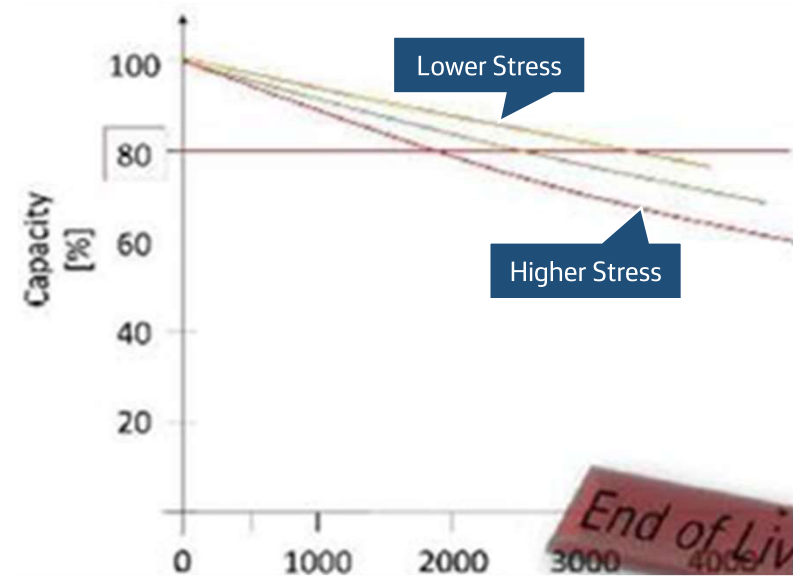
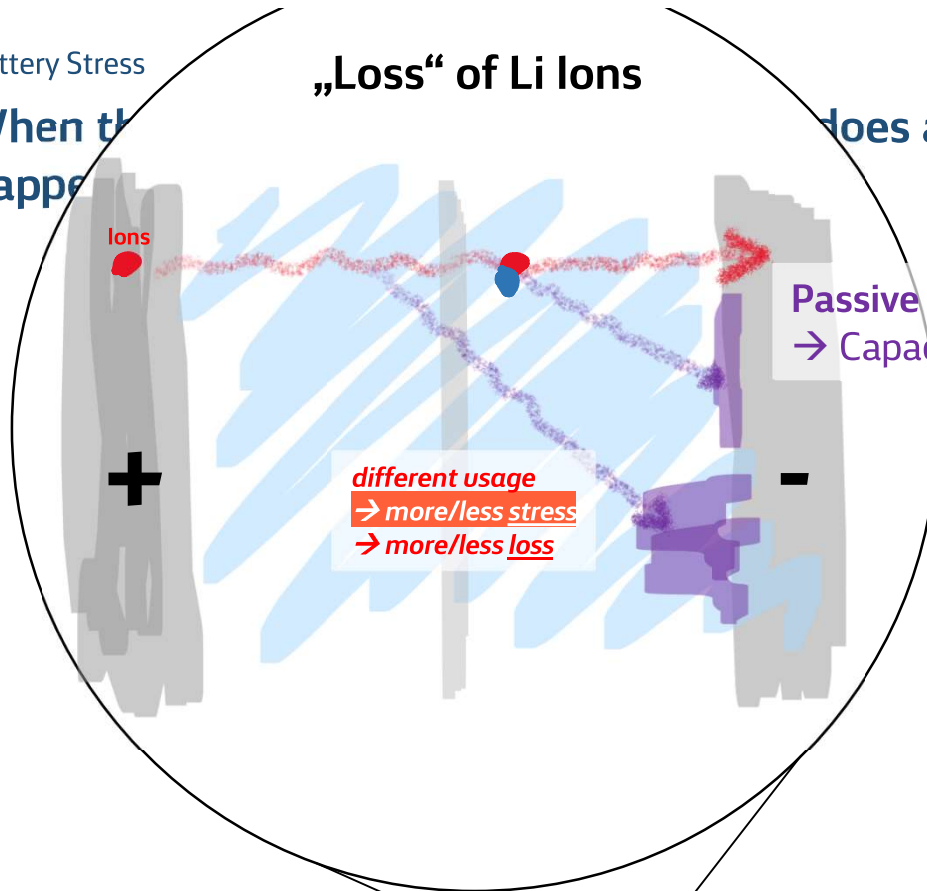
Battery Stress

When the
happens

„Loss“ of Li Ions

does actually

V

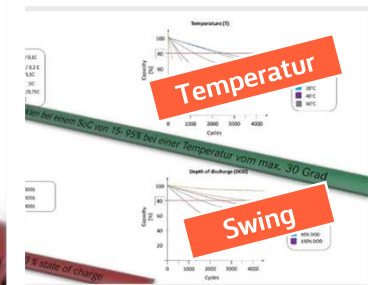
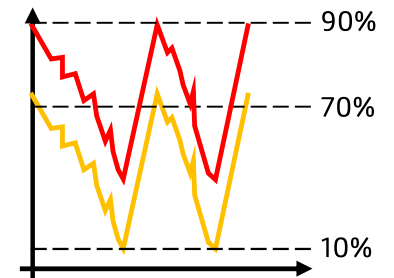
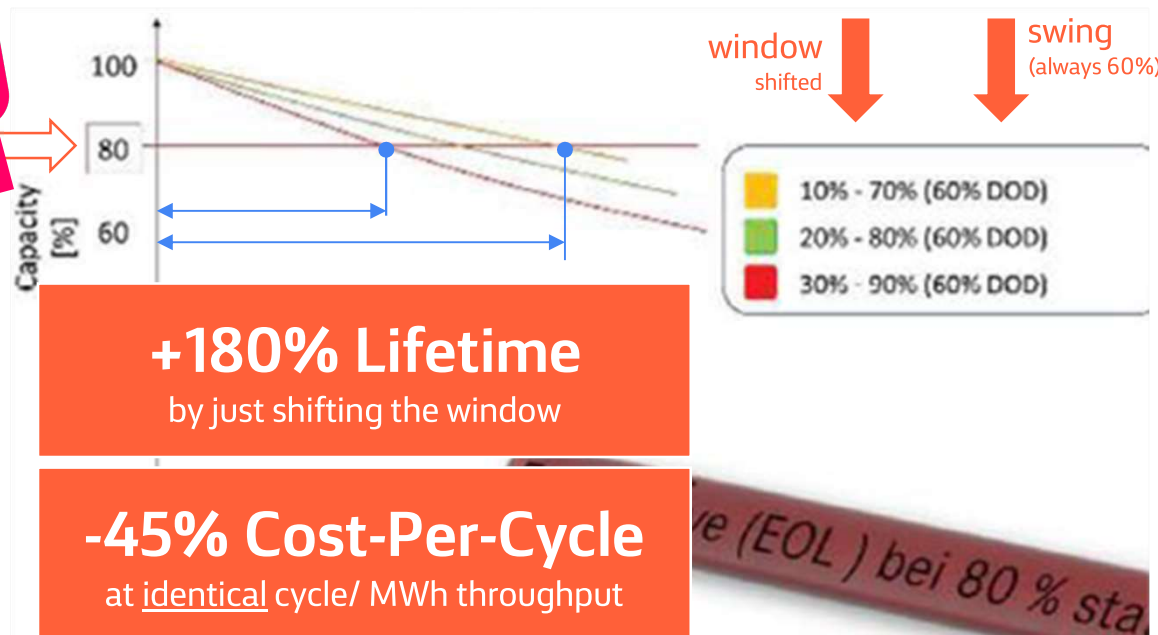


Example: Some “standard” NMC cell

Minor Changes can have Major Impact!

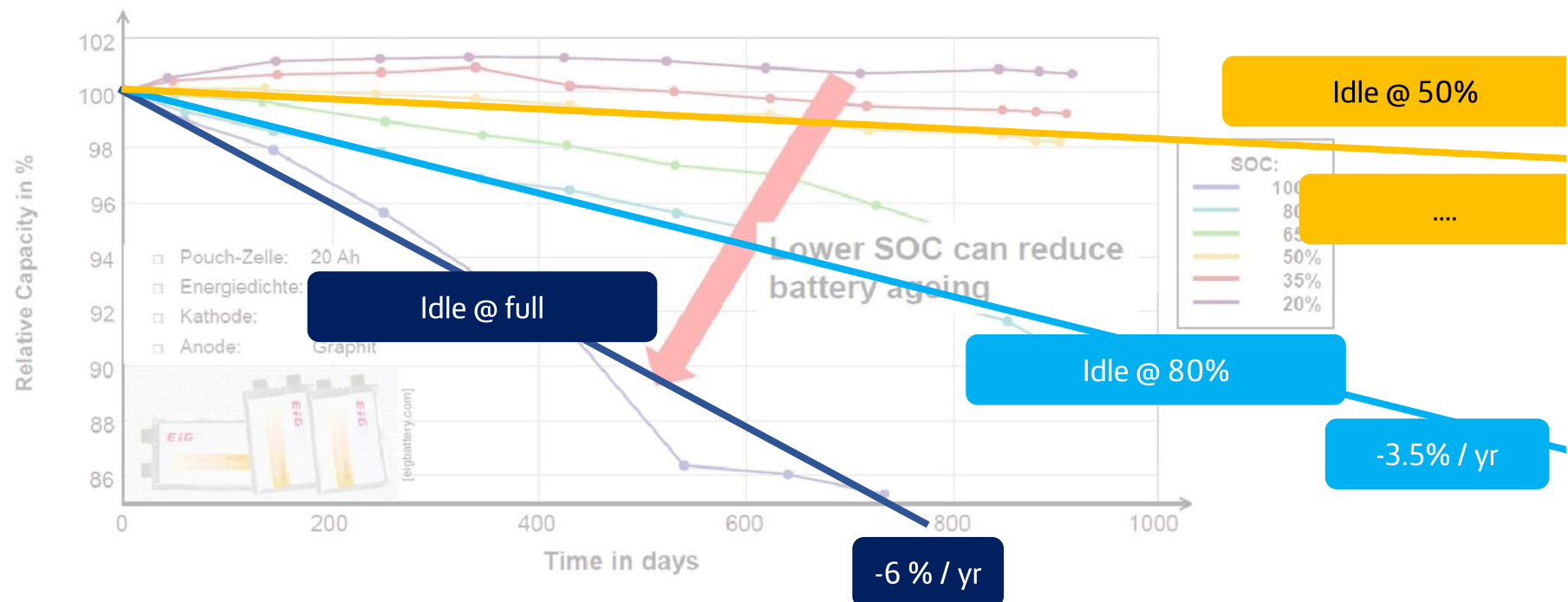


End of Life / EOL
“End of Warranty” / EOW



Example: Lazy idling ^{zz1}

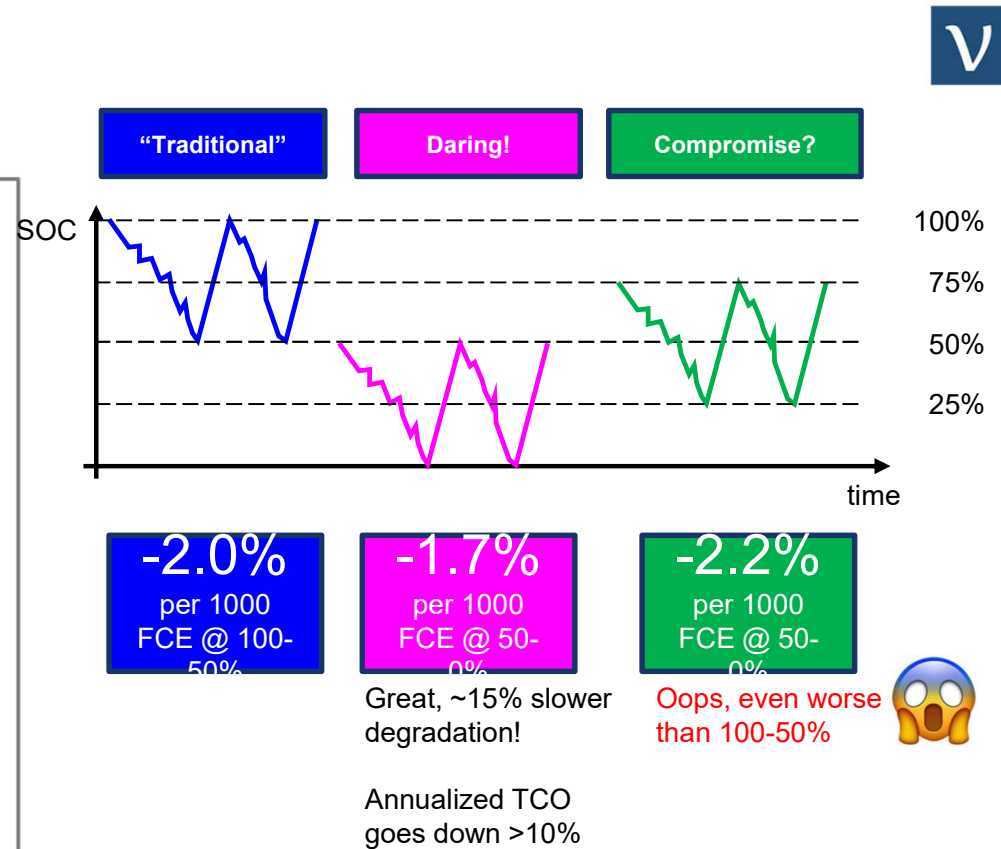
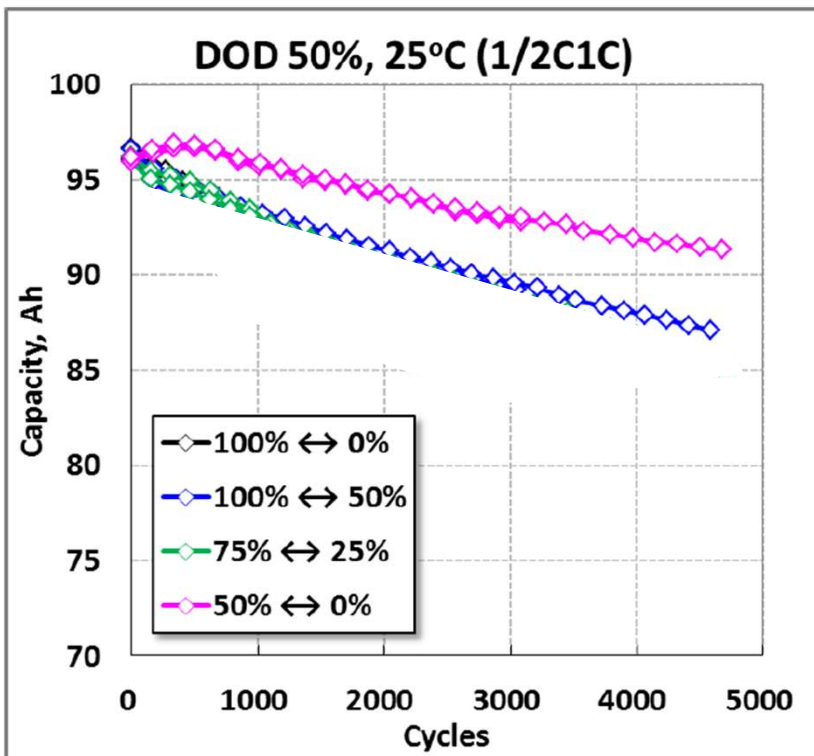
Batteries are made for working.
They keep degrading while idling.



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





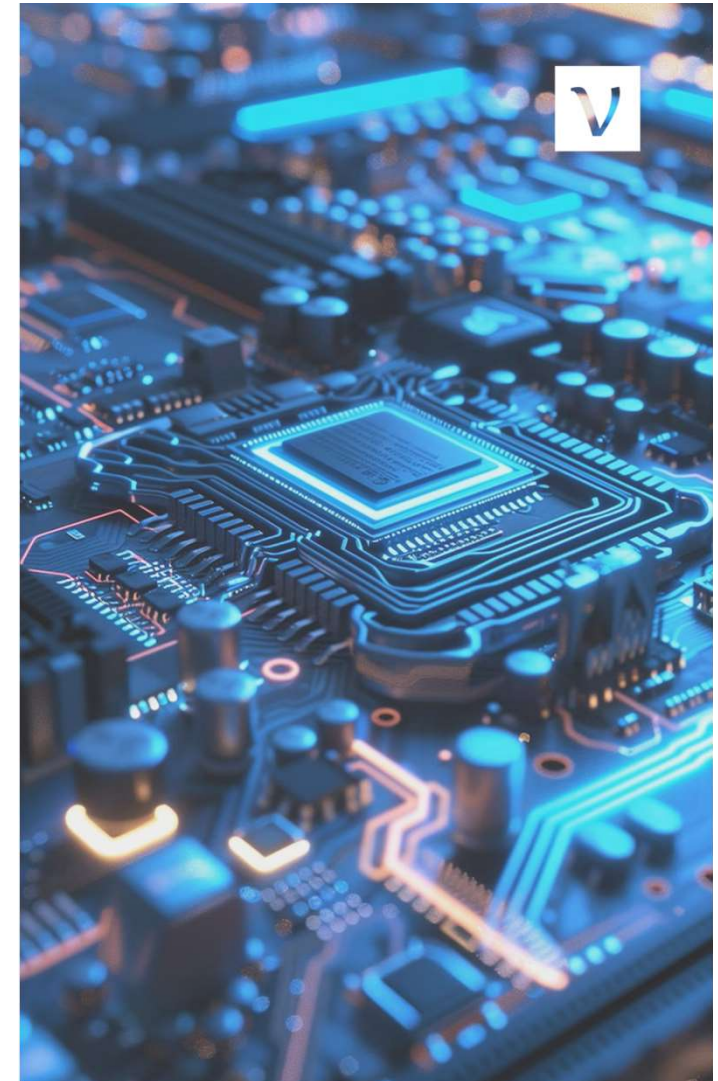
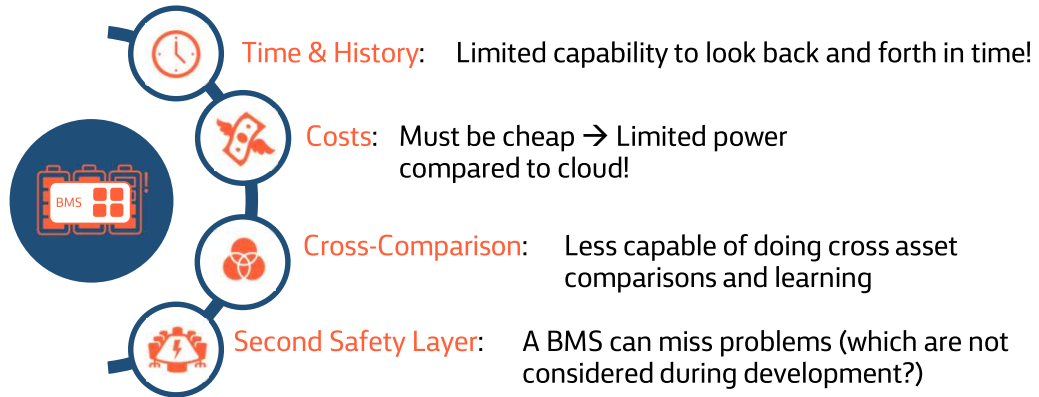
“SOH” is not a good
indicator for Safety!



Evergreen Question

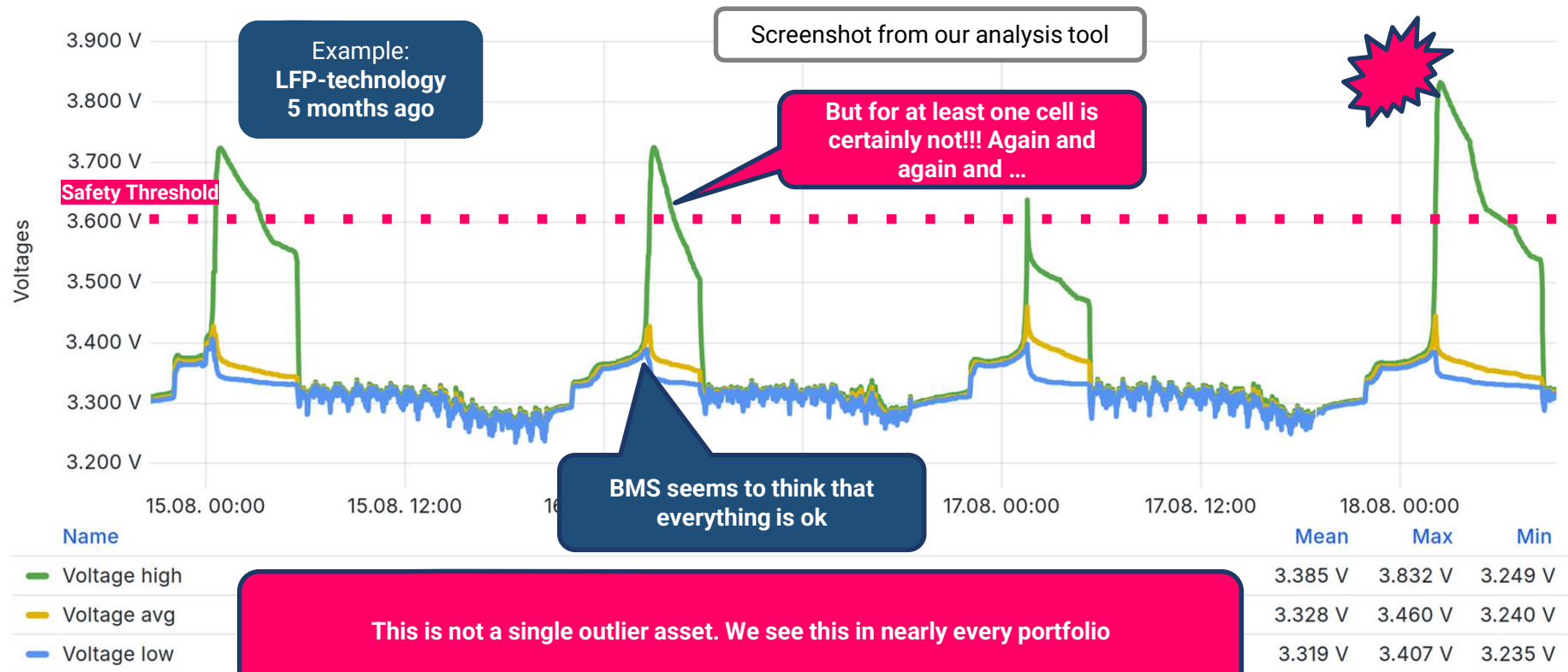
But isn't the BMS taking care of all of that?

- 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

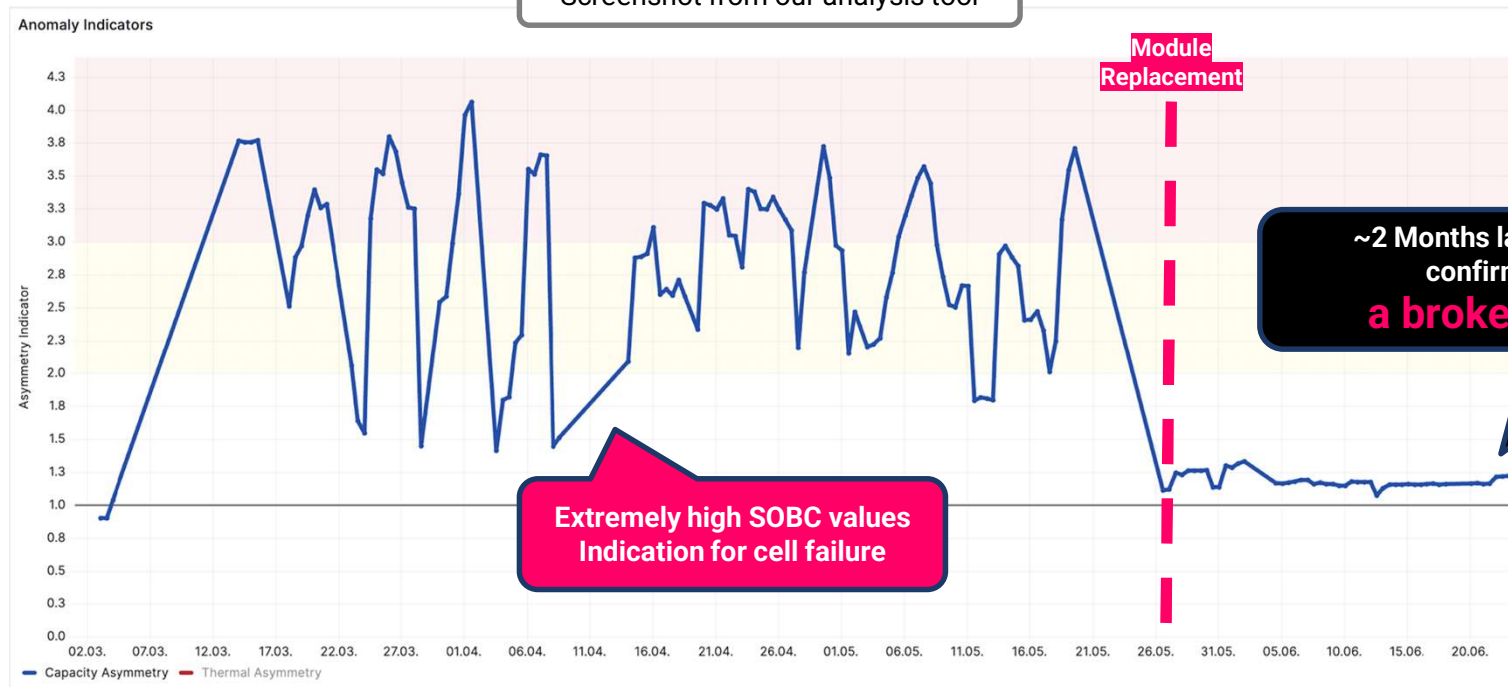


Detecting Problems

Practical Example: In 2022 – Defect Cell



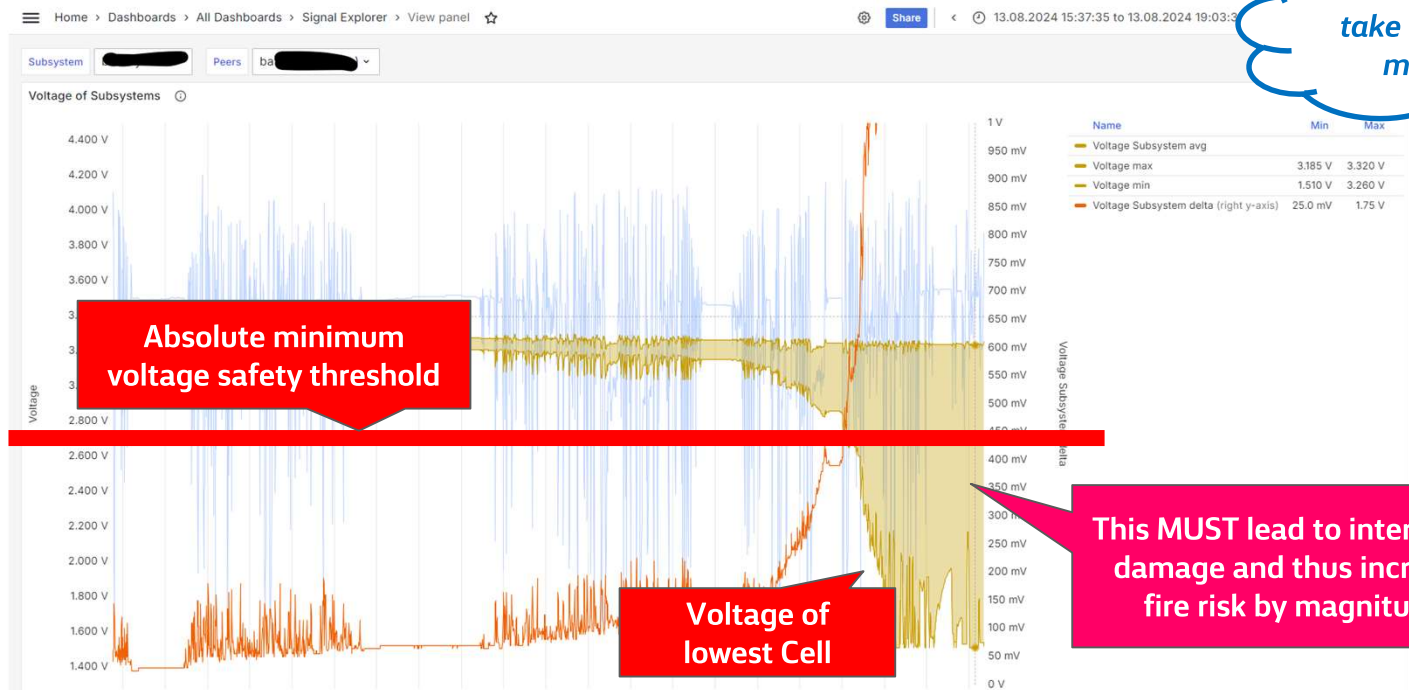
Screenshot from our analysis tool



vdX sentry – Examples

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

We see almost unbelievable BMS malfunctions every day

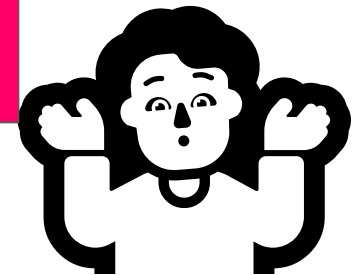


Should the BMS not take care of safety monitoring?

Yes, but it doesn't!

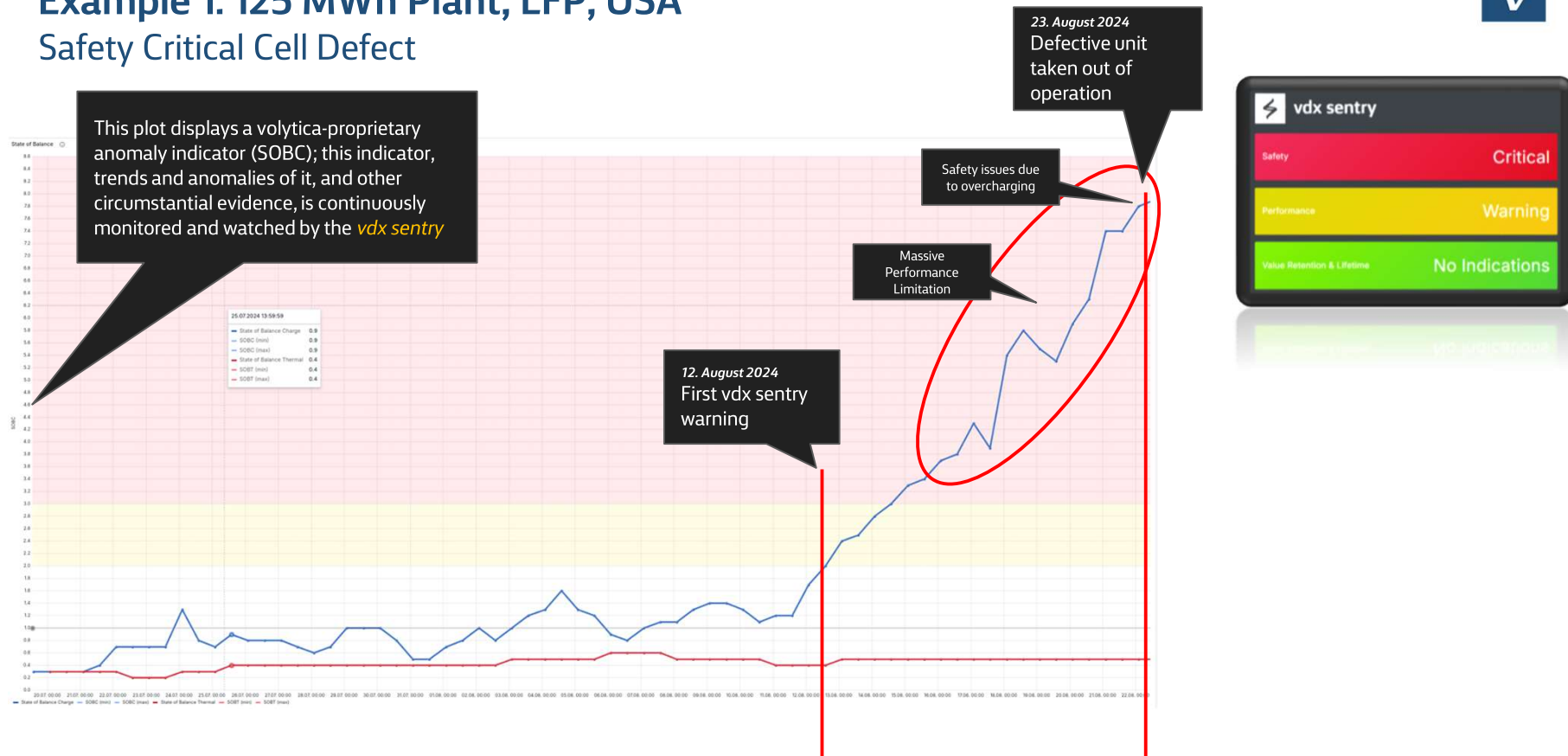


This MUST lead to internal cell damage and thus increases fire risk by magnitudes



vdX sentry – Examples

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



vdx sentry – Examples

Example 1: 125 MWh Plant, LFP, USA

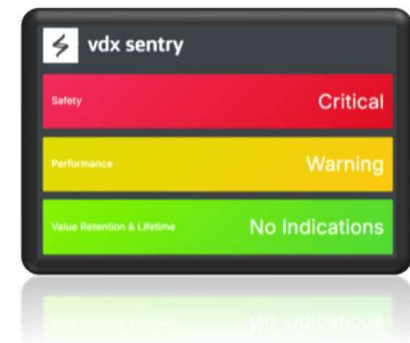
Safety Critical Cell Defect



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 volytica platform analyses and detects manifold issues and warns the user.

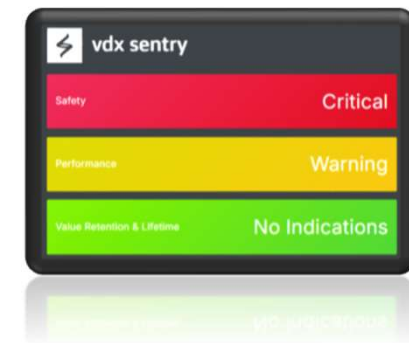
In many cases, operators are reacting swiftly, yet in other cases, there is a general lack of awareness and urgency.



vdX sentry – Examples

Example 2: 90 MWh Plant, LFP, Italy

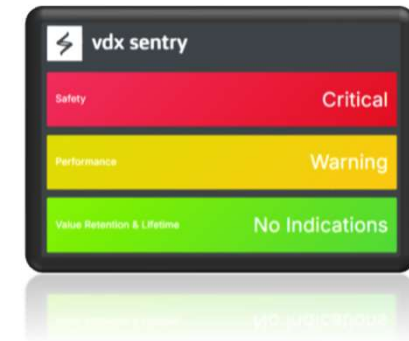
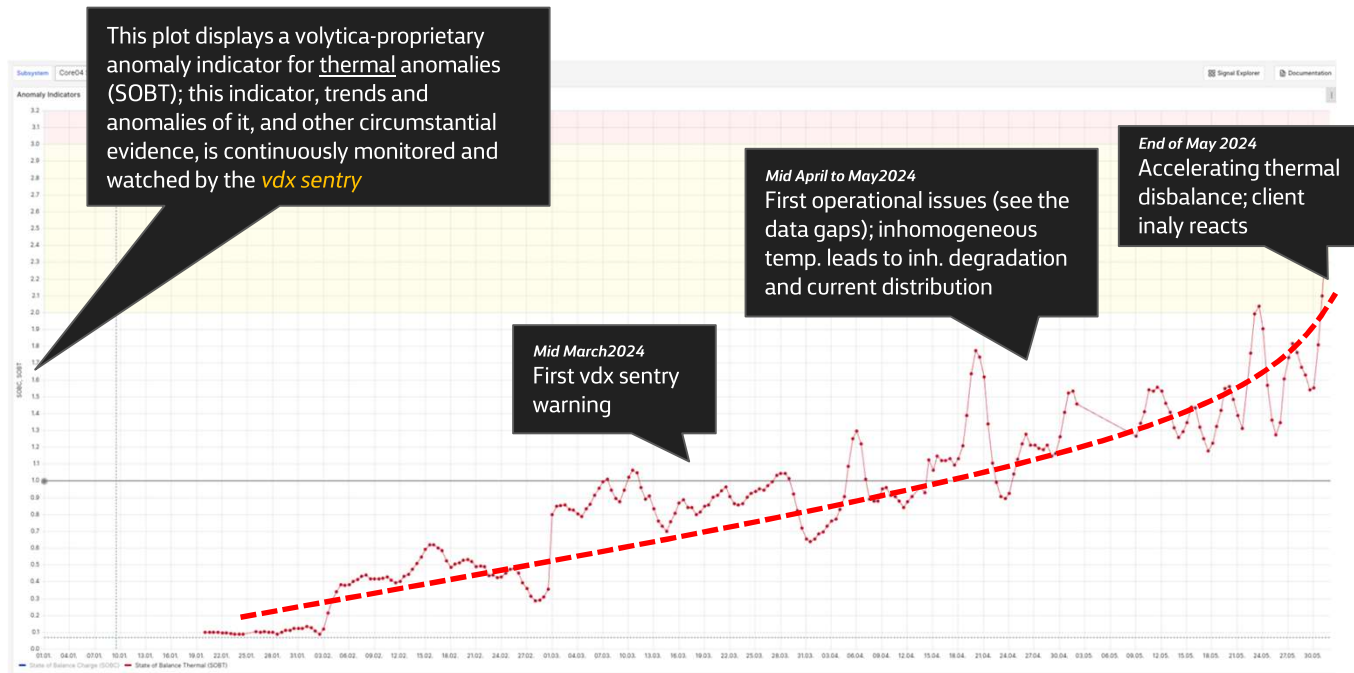
Safety Critical Cell Defect



vdX sentry – Examples

Example 3: 250 MWh Plant, LFP, USA

Creeping Thermal Anomaly

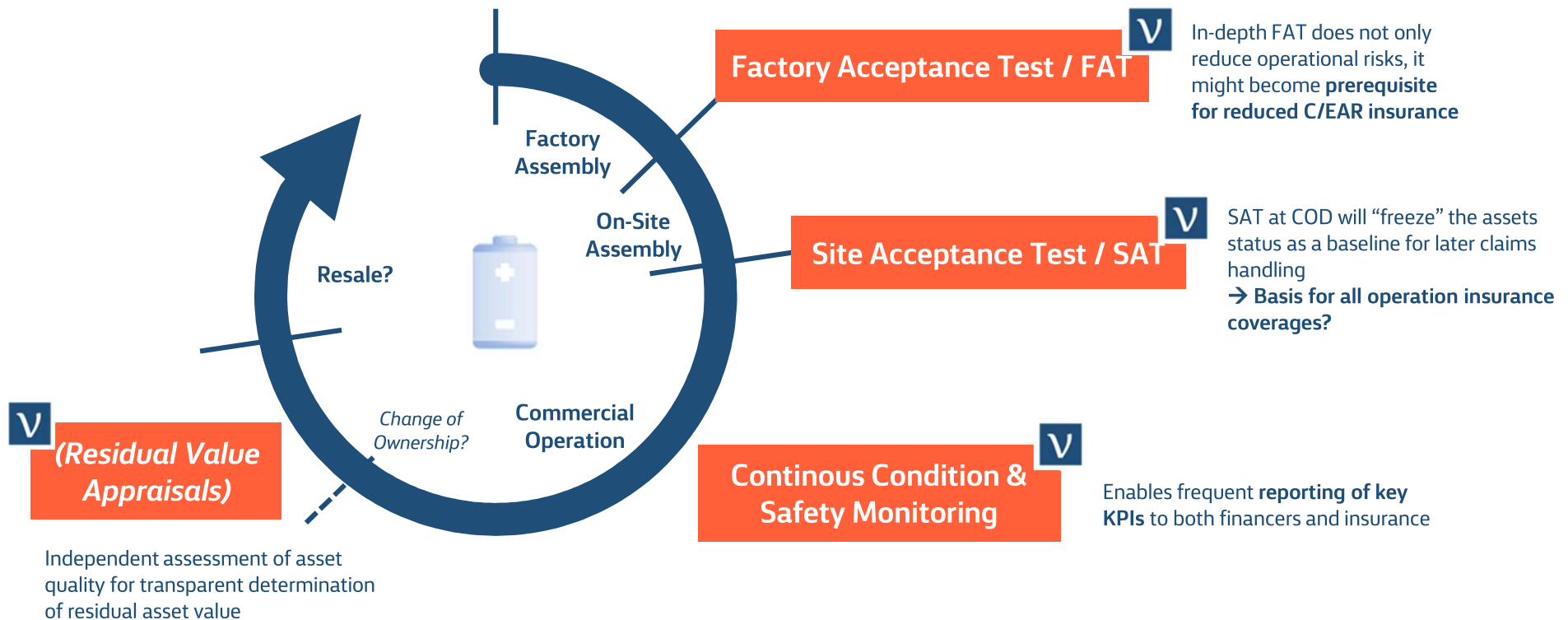


| Coupling to Insurance & Finance

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**

V

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



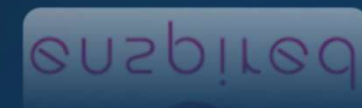
Ongoing Operation

Post-COD Services*

- Continuous safety monitoring
- Performance optimization
- Lifetime management

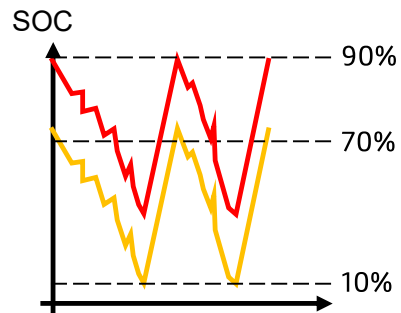
| Another Use Case

From Revenue- to Profit-Optimization



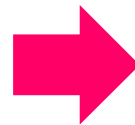
Impact on Business Models

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



... and ...

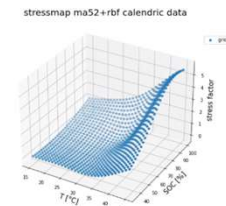
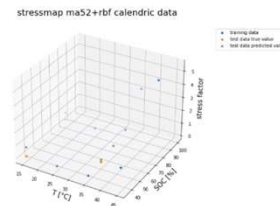
- Temperature,
- Idle SOC,
- Charging Power,
- Discharging Power,
- ...



vdX stresslevel © engine

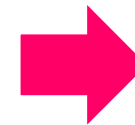
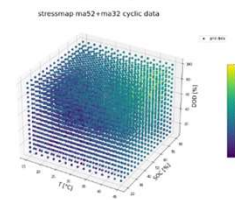
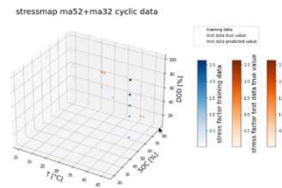
Calendric data

- Stressmap to compare prediction and true value
- Stressmap generated



Cyclic data

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



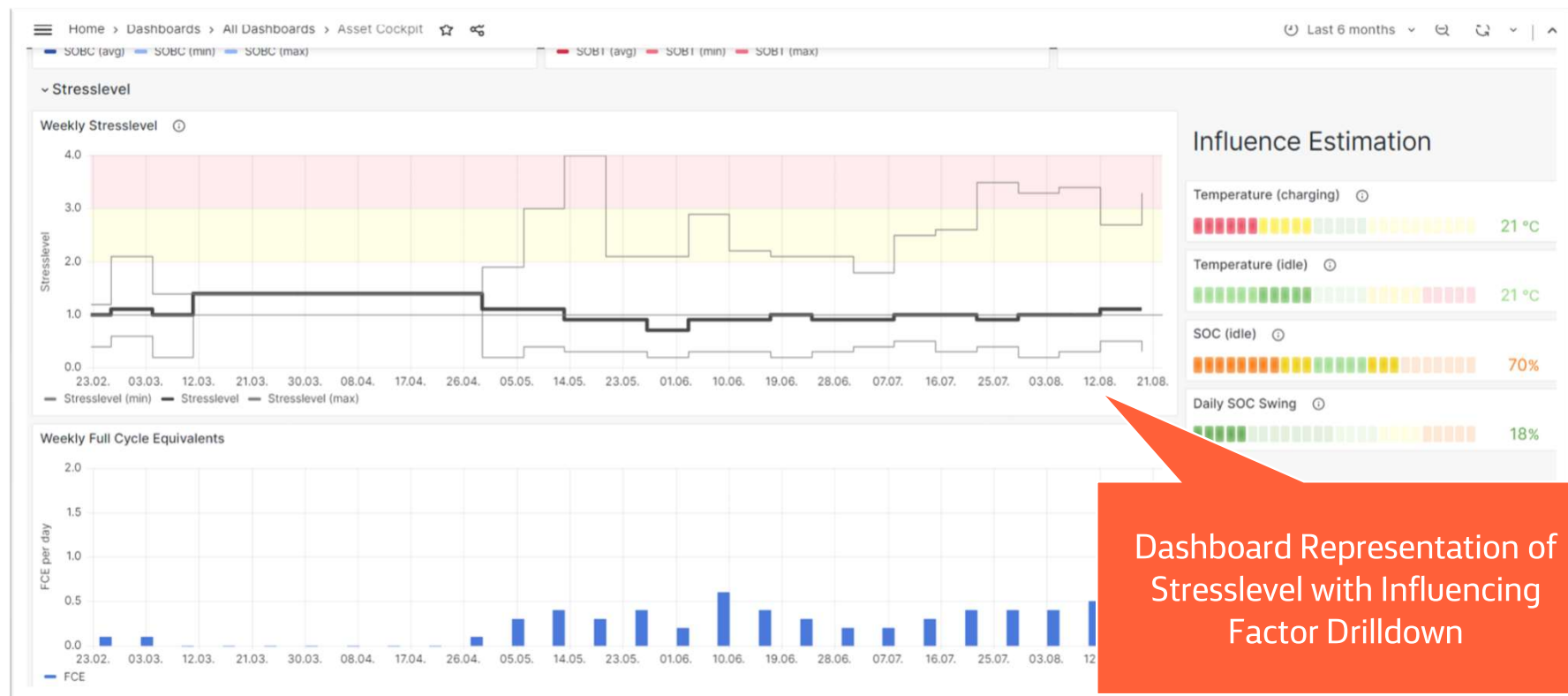
Stresslevel
1.7

* 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



volytica diagnostics GmbH
Theresienstrasse 18
01097 Dresden
Germany

contact@volytica.com
+49 351 87 95 87-00

Booth

B2.470

Drinks on
Thu. 17:00

