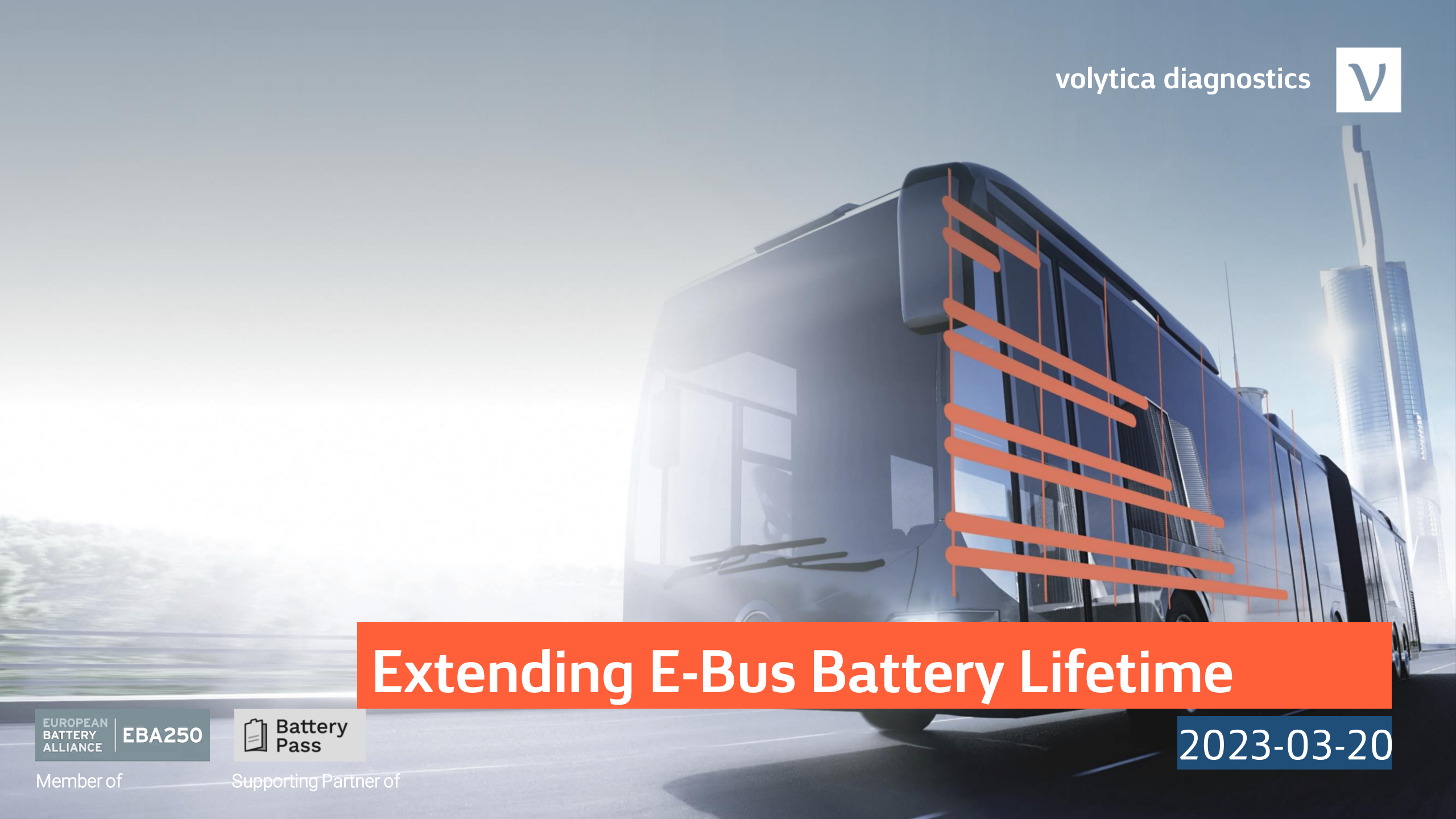


volytica diagnostics

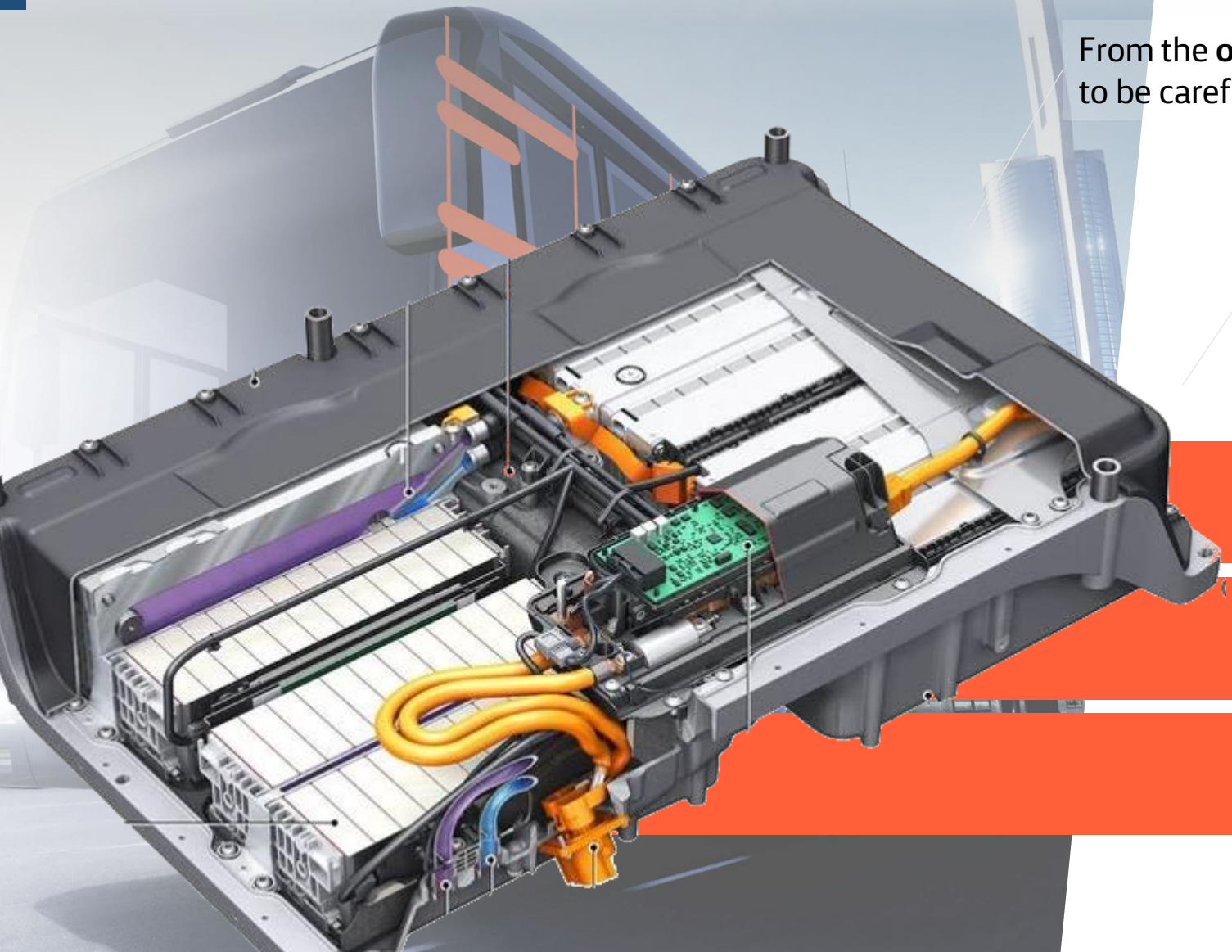
Extending E-Bus Battery Lifetime

2023-03-20

Member of EUROPEAN BATTERY ALLIANCE | EBA250

Supporting Partner of Battery Pass

Batteries are marketed as “maintenance free”. But they are complex masterpieces that deserve proper management.



From the **outside**, they appear to be carefree blackboxes.

Under the surface, they are carefully designed masterpieces: 1000s of cells, sensors and electronics must march in lockstep for up to 20 years!

Underutilization
due to overly cautious operation

Safety-critical long-term trends
are not sensed by electronics

End-of-life criteria
are set overly pessimistic by OEMs

Optimization Potentials

Small best-practice implementations can have a huge long-term effect

In the EU, at least 100 electric buses, worth >€50m, burnt down in the last 2 years.

This Stuttgart depot burnt down entirely due to a faulty electric bus in 2021: >€100m damage

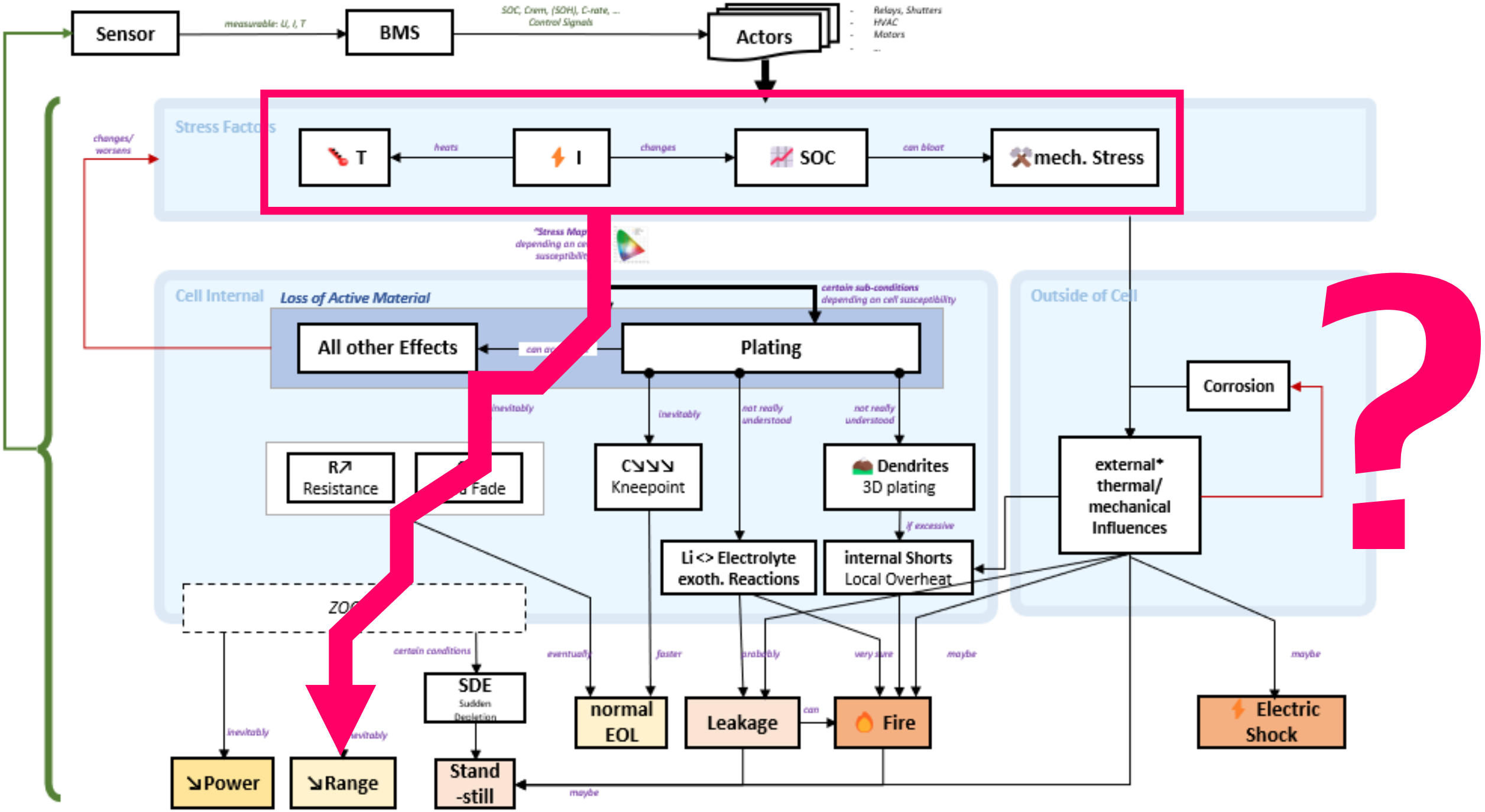
Owners don’t use the full potential

Batteries are replaced too early – years!

No 2nd-use & aftermarket exists

Battery safety is grossly neglected

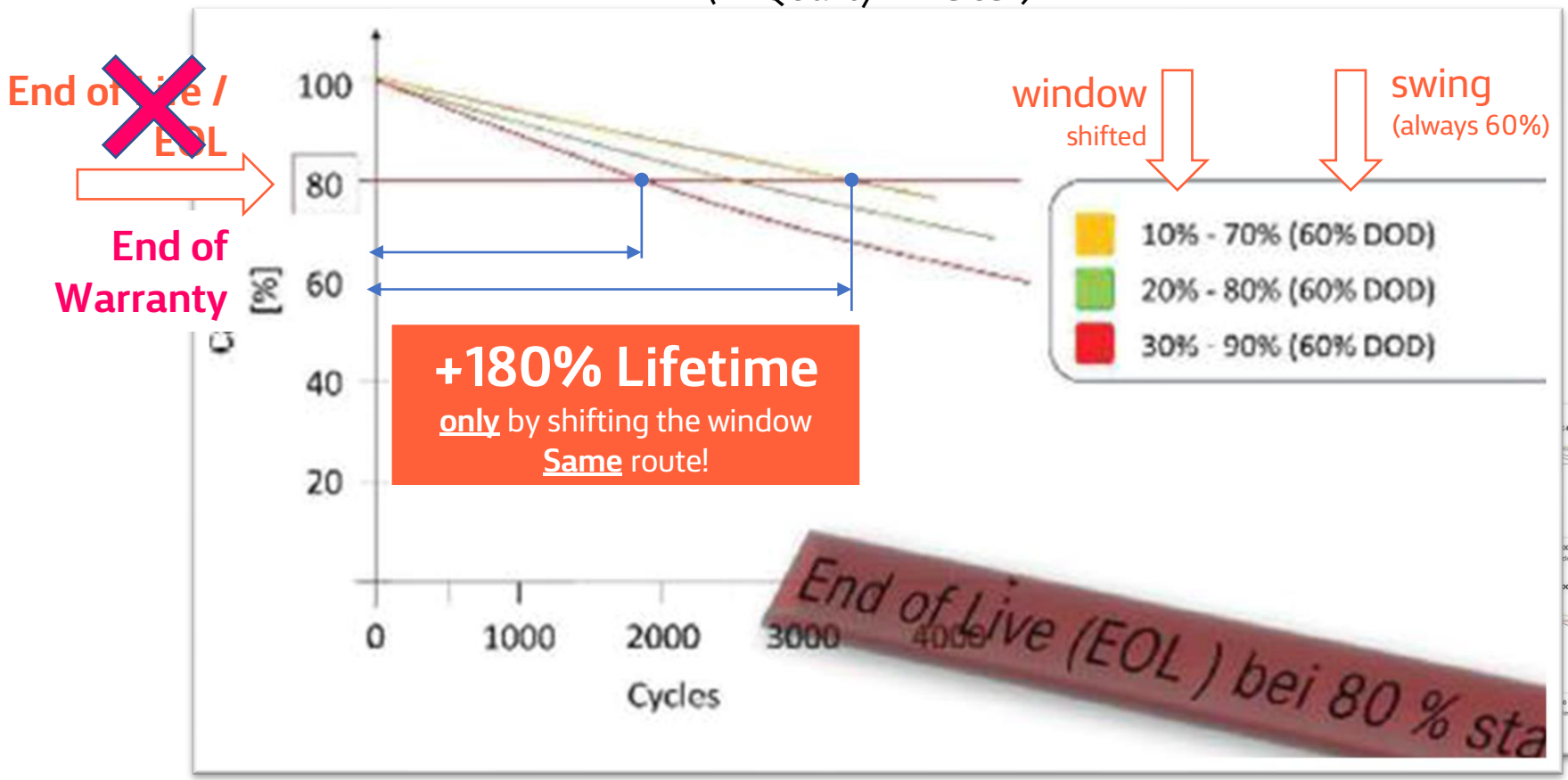
volytica’s supervision & management solution will unlock billions of unused potential and enable safe batteries at scale.

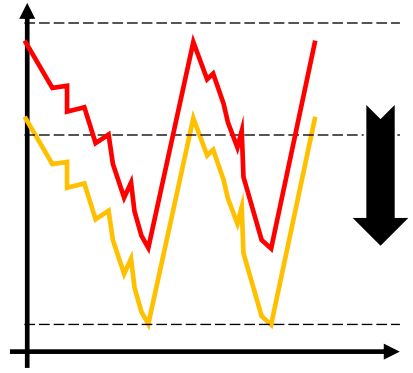

Sensor
measurable: U, I, T
BMS
SOC, Cnom, (SOH), C-rate, ...
Control Signals
Actors
Relays, Shutters
HVAC
Motors
Stress Factors
changes/ worsens
T
heats
I
changes
SOC
can bloat
mech. Stress
Cell Internal
Loss of Active Material
certain sub-conditions
depending on cell susceptibility
All other Effects
Plating
inevitably
inevitably
not really understood
not really understood
R↗ Resistance
C↘↘↘ Kneepoint
Dendrites 3D plating
if excessive
Li <> Electrolyte exoth. Reactions
internal Shorts Local Overheat
Outside of Cell
Corrosion
external* thermal/ mechanical Influences
certain conditions
eventually
faster
probably
very sure
maybe
maybe
SDE Sudden Depletion
normal EOL
Leakage
can
Fire
Electric Shock
inevitably
inevitably
↘Power
↘Range
Stand -still
maybe

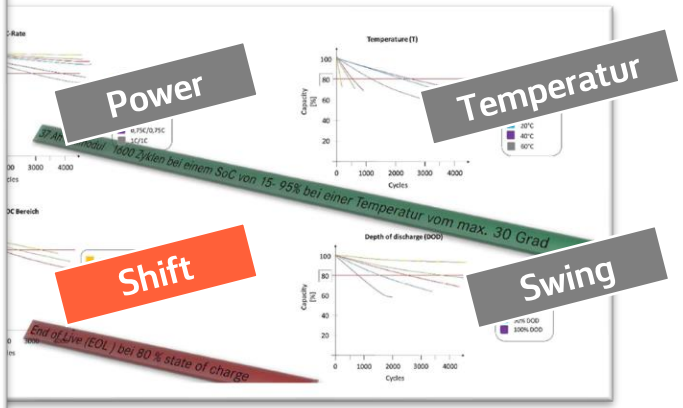
Example: Lifetime Extension

The usage profile has a huge impact on lifetime and performance.

From a Vehicle Data Sheet
(Hi-Quality NMC cell)





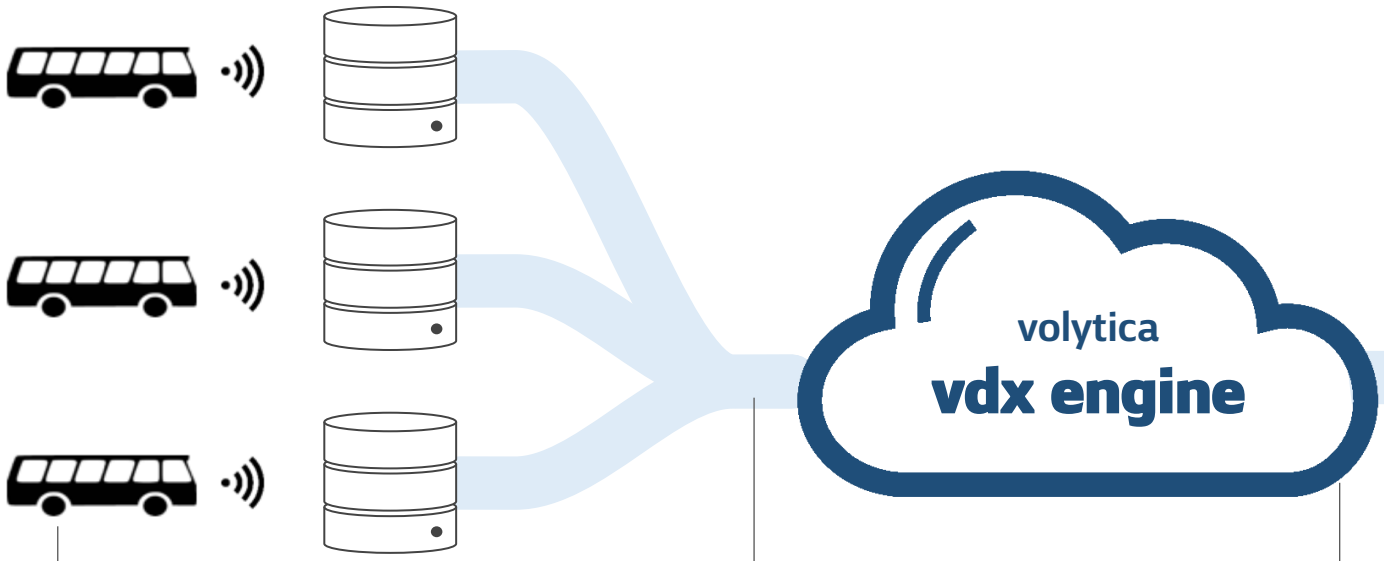


From procurement, to operation, to resell:
Battery data enables more profitable operation, higher availability, higher safety and more sustainability

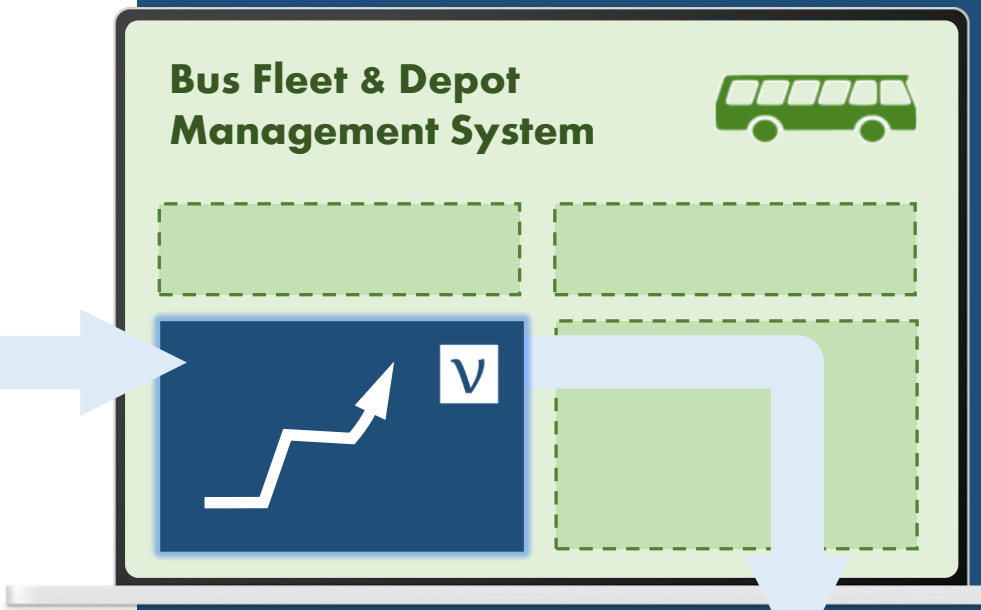
You must request data access to unlock potentials!

Our Solution

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



volytica
vdx engine



Existing Data
All commercial batteries transmit and store the relevant signals

No Hardware
Every Li-Ion battery is supported

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

Quick to Start
Cloud-based analysis tool for **systematical** battery quality analysis

Fraunhofer *inside*

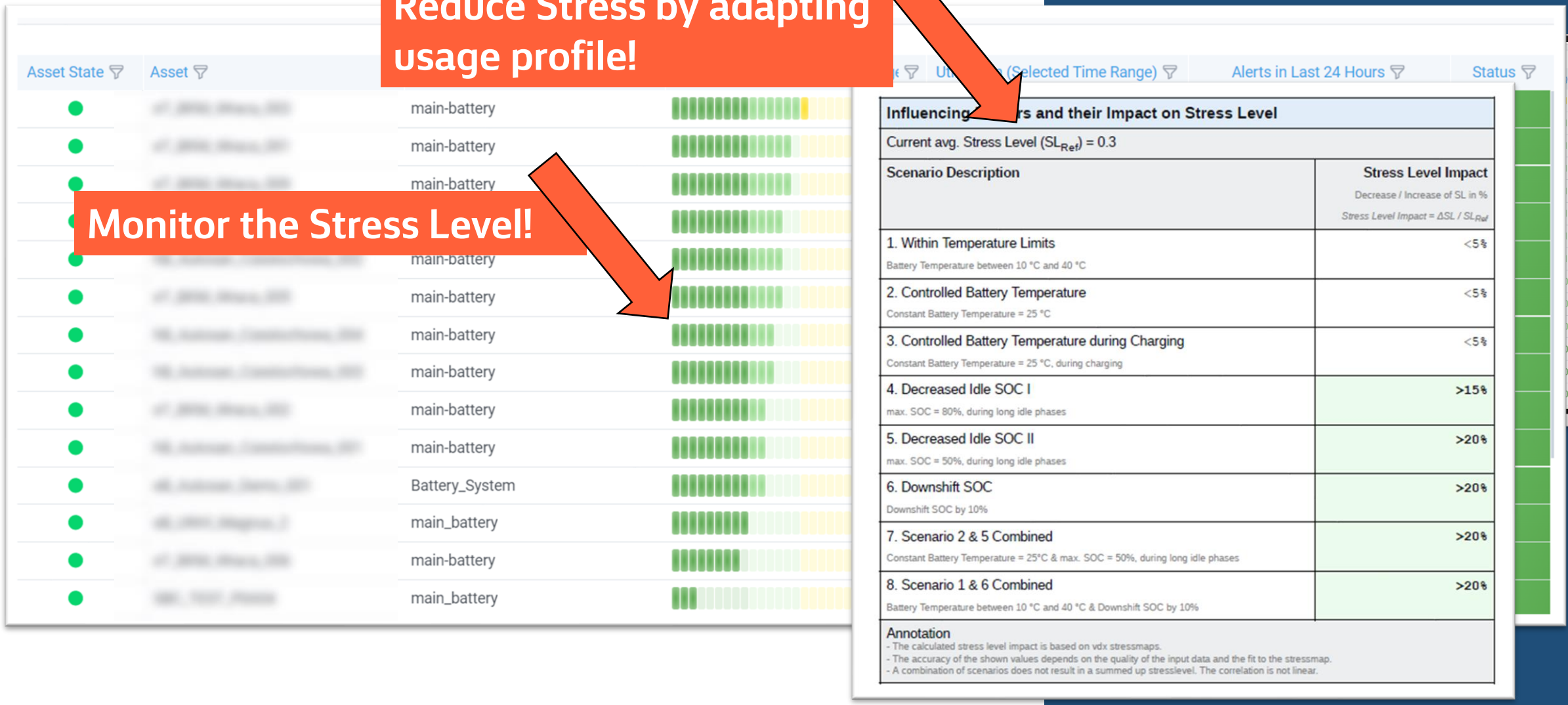
- Utilization & profit optimization
- Lifetime extension & replacement planning
- Residual value & 2nd life certification
- Safety & anomaly detection

Our Solution

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

Reduce Stress by adapting usage profile!

Monitor the Stress Level!



Asset State	Asset	Alerts in Last 24 Hours	Status
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	main-battery		
●	Battery_System		
●	main_battery		
●	main-battery		
●	main_battery		

Influencing ...rs and their Impact on Stress Level

Current avg. Stress Level (SL_{Ref}) = 0.3

Scenario Description	Stress Level Impact Decrease / Increase of SL in % *Stress Level Impact = ΔSL / SL_{Ref}*
1. Within Temperature Limits Battery Temperature between 10 °C and 40 °C	<5%
2. Controlled Battery Temperature Constant Battery Temperature = 25 °C	<5%
3. Controlled Battery Temperature during Charging Constant Battery Temperature = 25 °C, during charging	<5%
4. Decreased Idle SOC I max. SOC = 80%, during long idle phases	>15%
5. Decreased Idle SOC II max. SOC = 50%, during long idle phases	>20%
6. Downshift SOC Downshift SOC by 10%	>20%
7. Scenario 2 & 5 Combined Constant Battery Temperature = 25°C & max. SOC = 50%, during long idle phases	>20%
8. Scenario 1 & 6 Combined Battery Temperature between 10 °C and 40 °C & Downshift SOC by 10%	>20%

Annotation
- The calculated stress level impact is based on vdx stressmaps.
- The accuracy of the shown values depends on the quality of the input data and the fit to the stressmap.
- A combination of scenarios does not result in a summed up stresslevel. The correlation is not linear.

Data, data, data…

The most important message however is:

It is instrumental to request, during tender, the minimal vehicle and battery data set:

- **battery & cell voltages**
- **current & power**
- **temperature**

→ Get a full list from the organisers!

Summary

- Batteries are great ;)
- Watch them – not everything is in the power or responsibility of the manufacturer!
- Many things can be optimized to increase uptime, lifetime and profitability
- **But: No data, no nothing! You must request data access already during tendering phase**

Thank you!

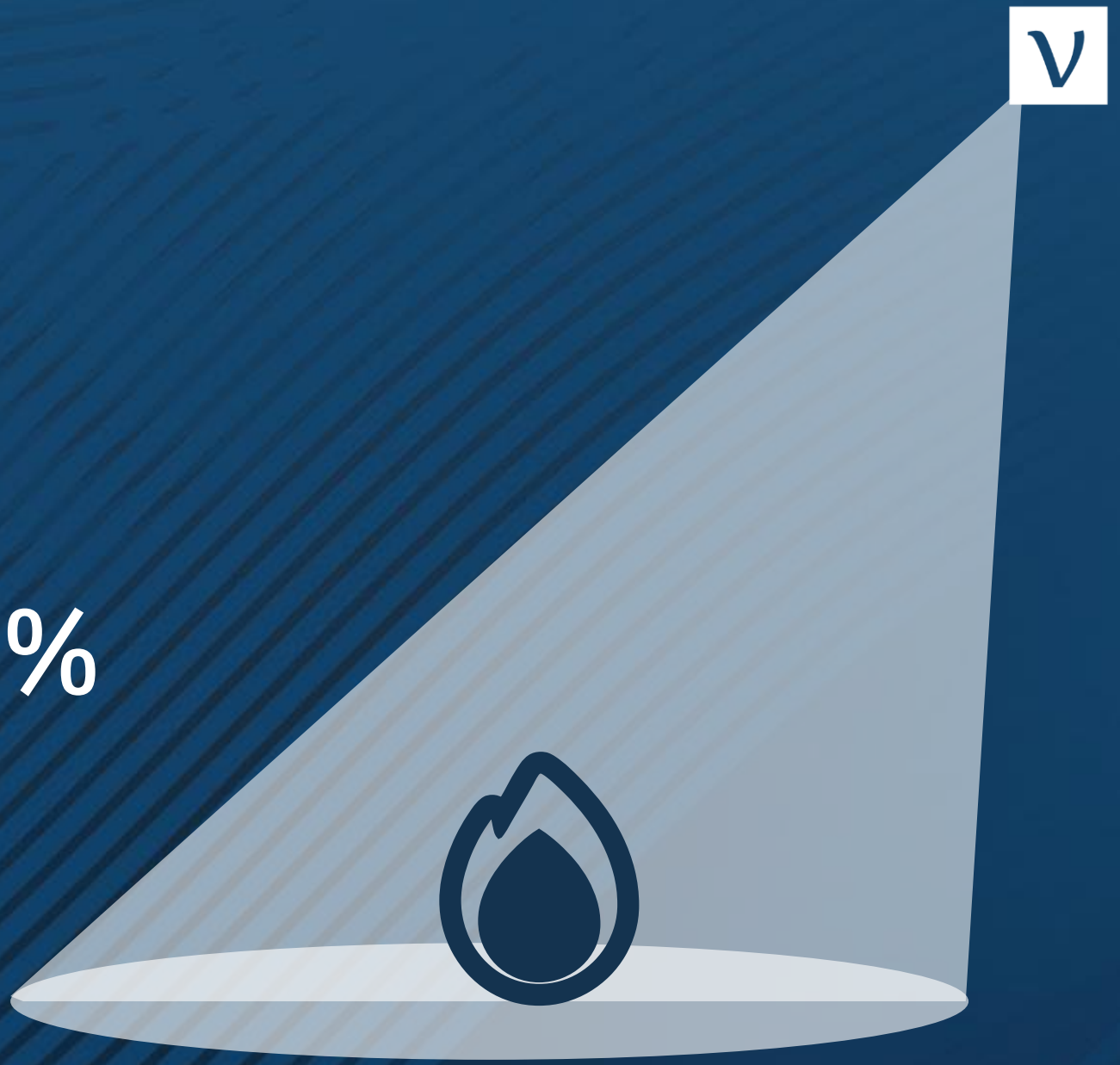
Get in Touch

claudius.jehle@volytica.com

+49 351 87 95 87 - 00

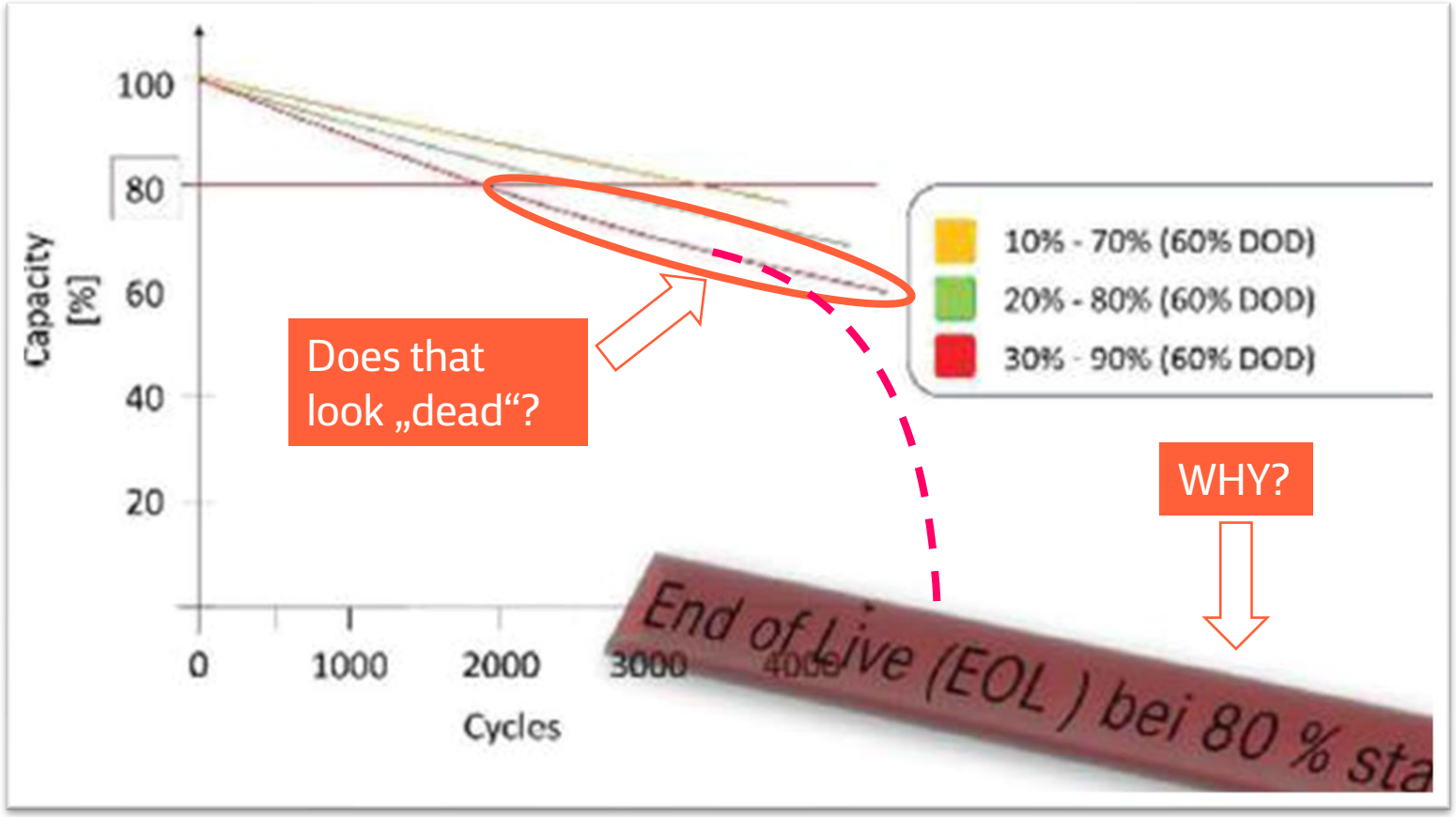
Bonus: EOL 80%

Where does this limit come from?



Bonus

Hang on … why “End of Life = 80%”?



Safety?

→ no, not really (see later)

Usability?

→ well, that depends on route, right?

It‘s weird, nobody really knows!

(There is a theory of a legacy test protocol from 1996 from USABC)

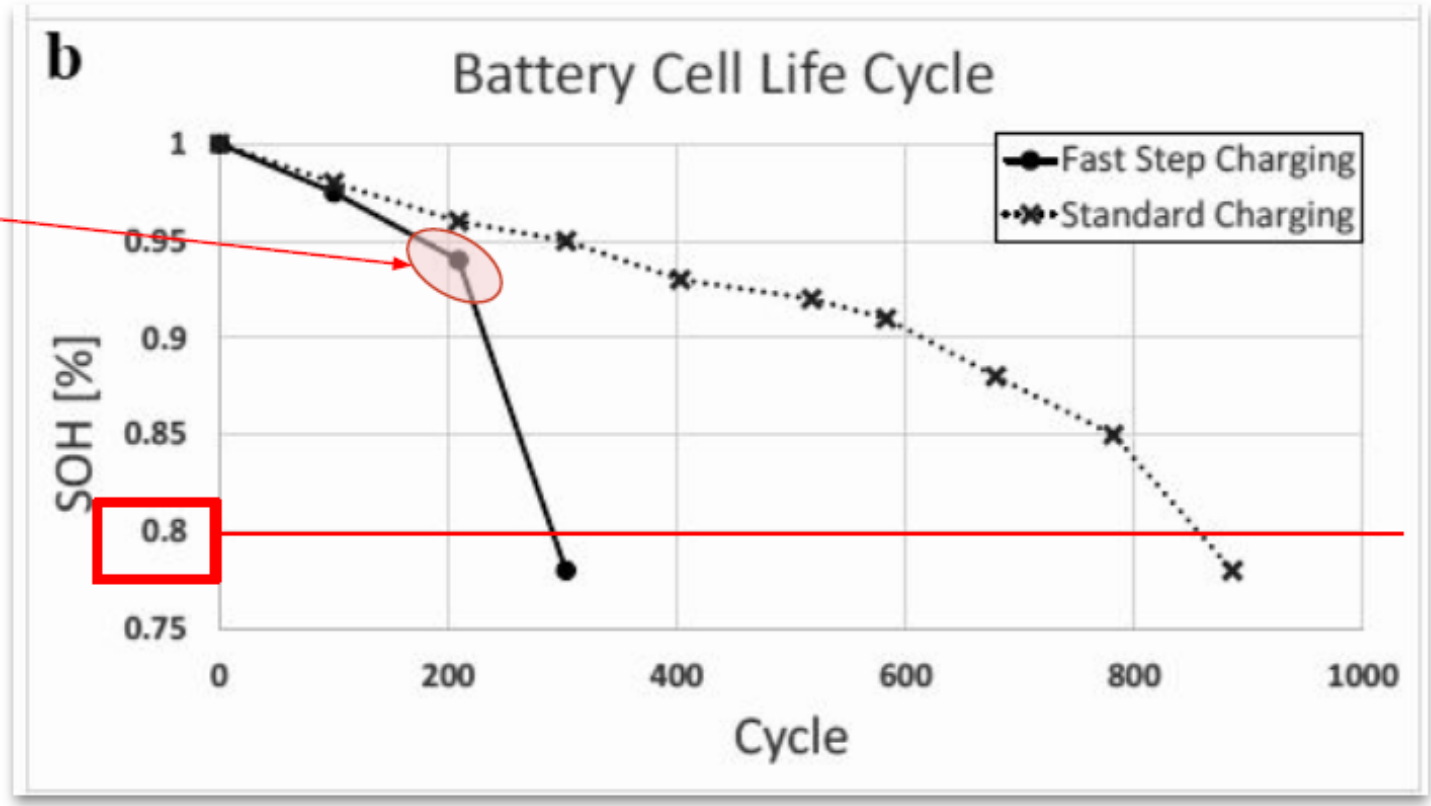
EoL Criteria need a makeover

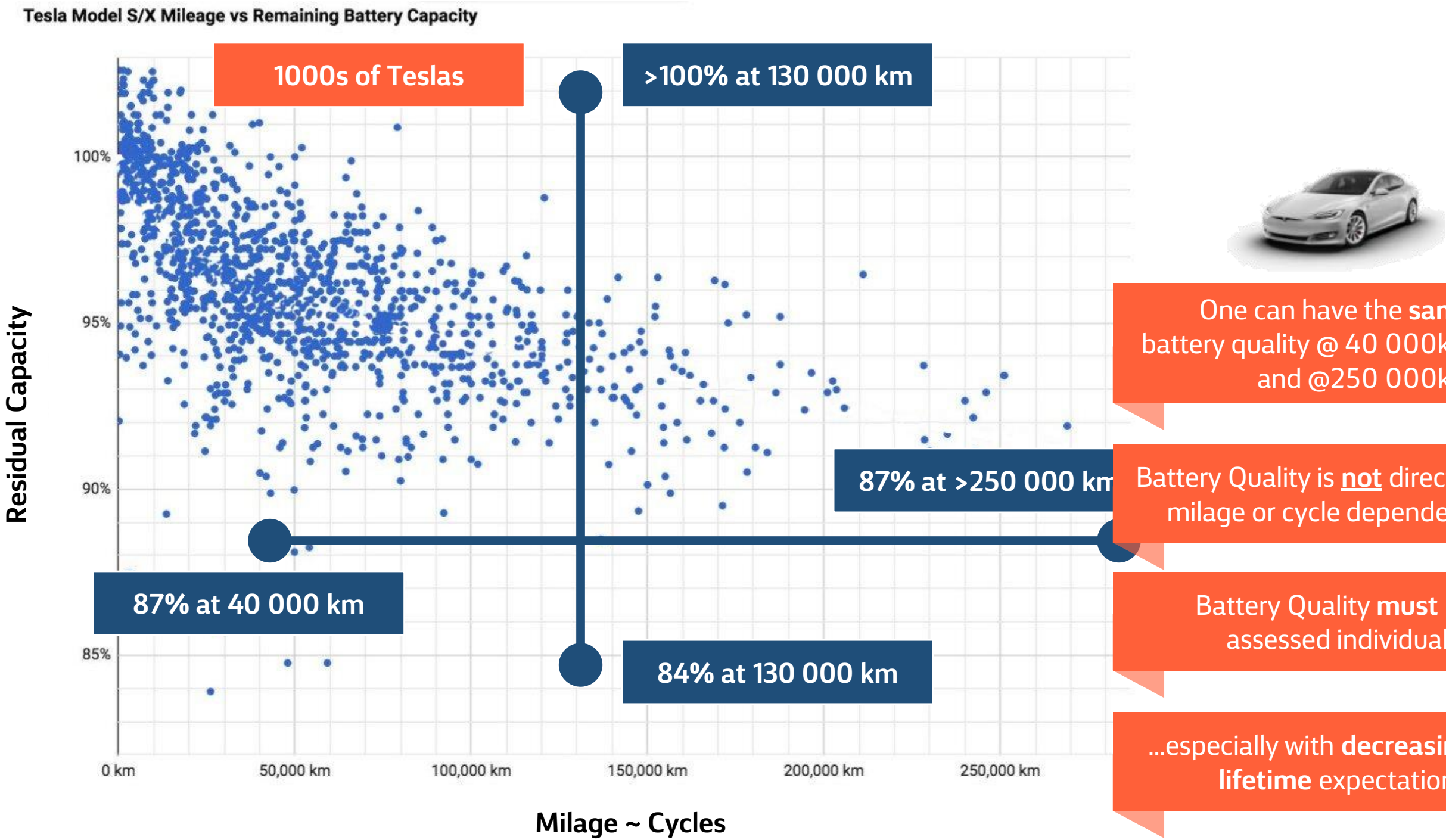
We waste €50bn by premature scrapping

We are working on it!

More bespoke EOL by monitoring

Stress- induced onset





One can have the **same** battery quality @ 40 000km and @250 000km

Battery Quality is **not** directly milage or cycle dependent

Battery Quality **must** be assessed individually!

...especially with **decreasing lifetime** expectations!