Master the Challenge of BEV Calibration with the Support of AVL-DRIVE™ VIORE

Robert Kurzmann

Public

Today's Presenter

Robert Kurzmann

Working at AVL GmbH since 2017

Test Driver

Test Engineer

Calibration Engineer

Today's Agenda

1 About Us	**5** Live Demo
2 BEV Calibration – The Challenges	**6** Summarized Benefits
3 AVL Approach – Objective Assessment	**7** Q&A
4 Example Use Case	

Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE

About Us

About Us

At AVL, we are one of the world's leading mobility technology companies for development, simulation and testing in the automotive industry, and in other sectors. Drawing on our pioneering spirit, we provide concepts, solutions and methodologies for a greener, safer and better world of mobility.

AVL at a Glance

1948
Founded

75
Years of Experience

26
Countries Represented

45
Global Tech and Engineering Centers

11,200
Employees Worldwide

68 %
Engineers and Scientists

11 %
Of Turnover Invested in Inhouse R&D
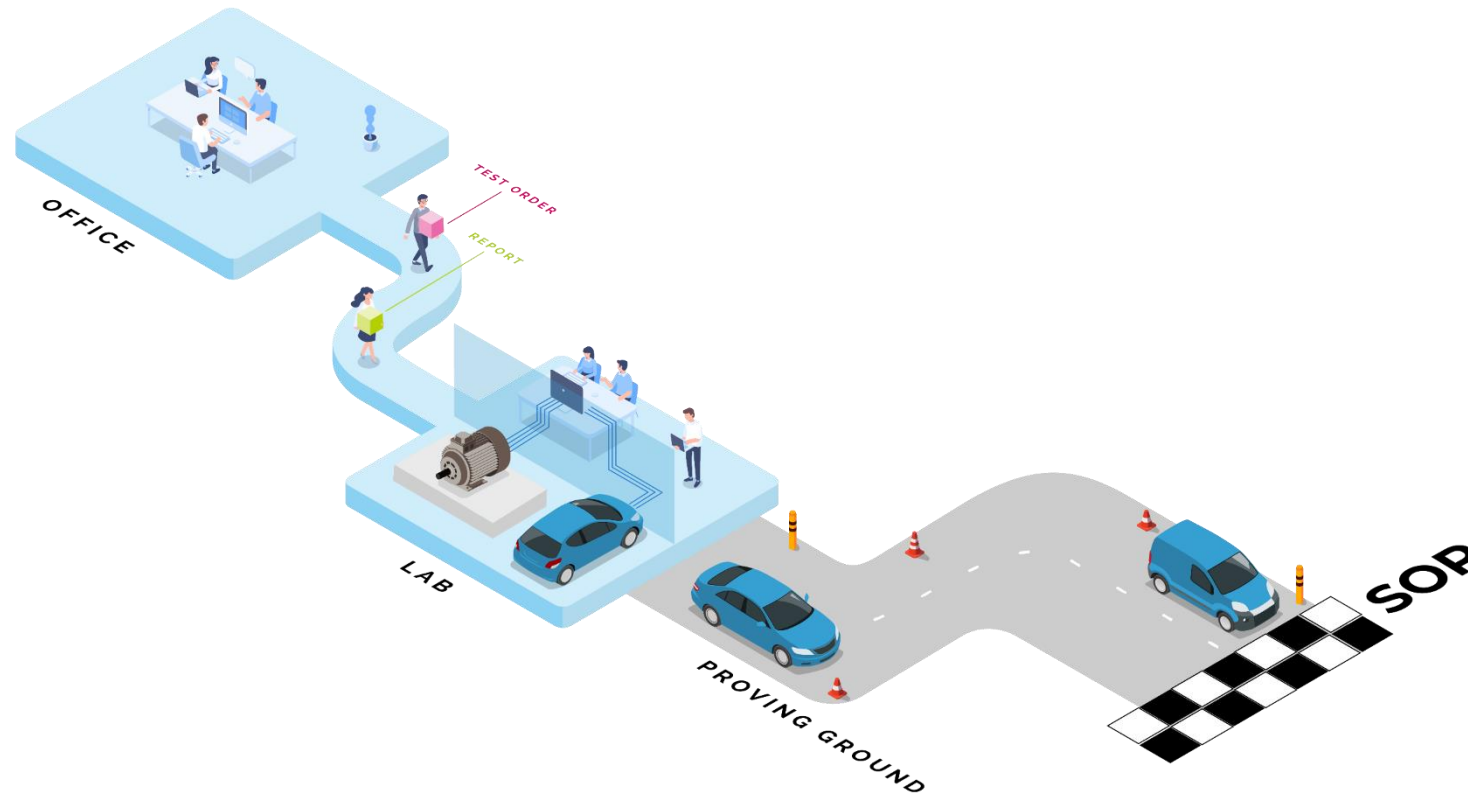
2,200
Granted Patents in Force

AVL

**Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE**

BEV Calibration – The Challenges

The Challenges
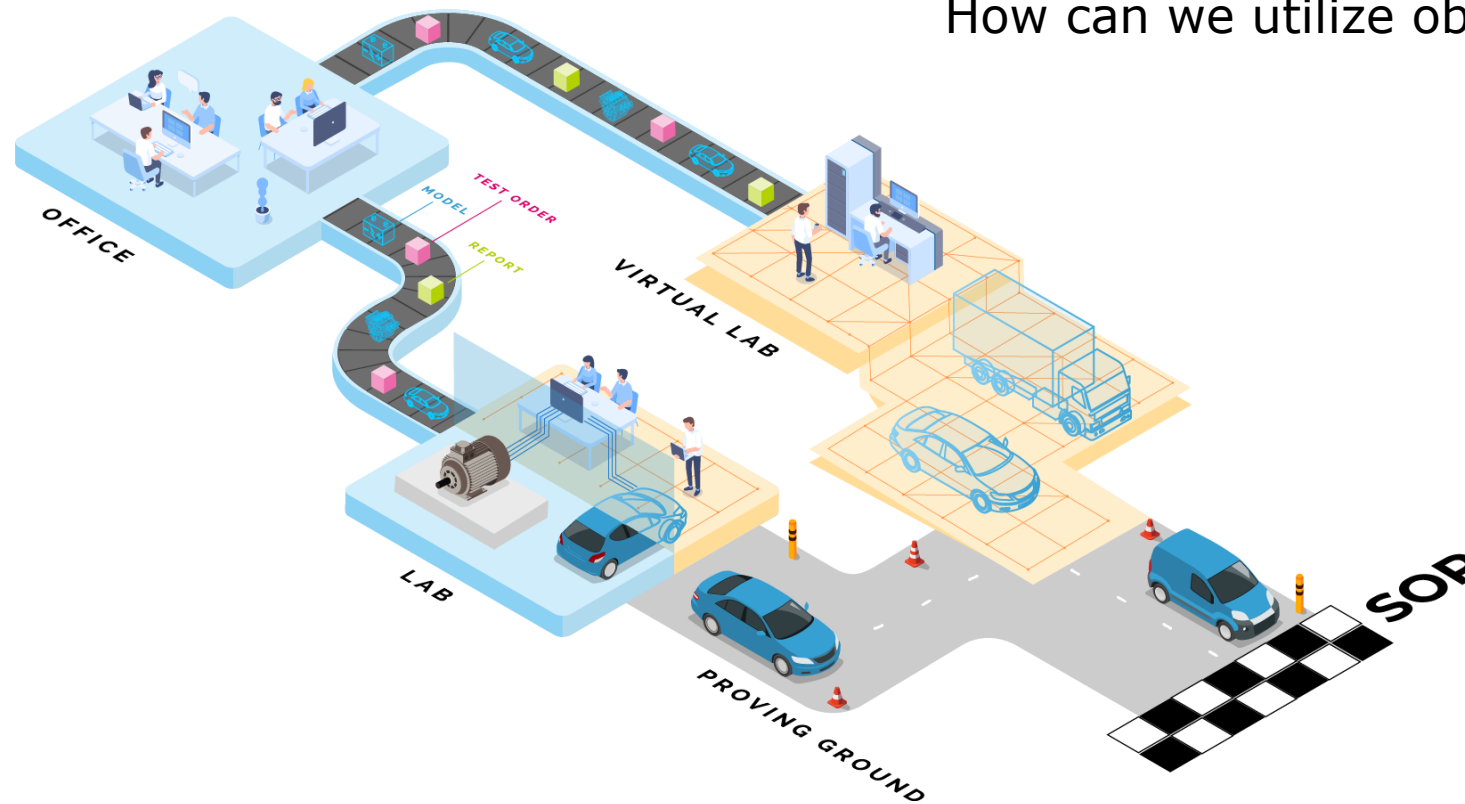## 1st Challenge – New Development Road

Traditional development road

The Challenges
1st Challenge – New Development Road

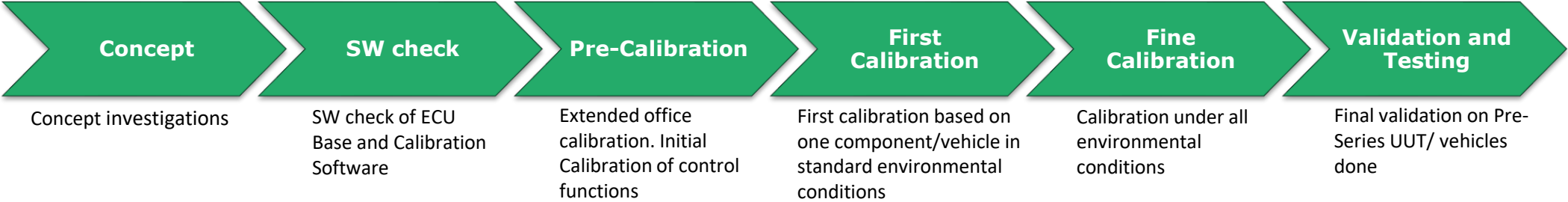How can we utilize objective assessment?
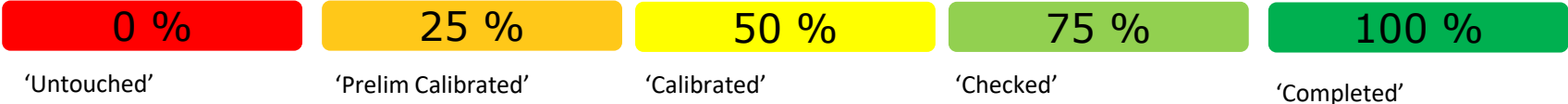

Modern development road

The Challenges
## 2nd Challenge – Progress Monitoring

CALIBRATION PROCESS

Concept	SW check	Pre-Calibration	First Calibration	Fine Calibration	Validation and Testing
Concept investigations	SW check of ECU Base and Calibration Software	Extended office calibration. Initial Calibration of control functions	First calibration based on one component/vehicle in standard environmental conditions	Calibration under all environmental conditions	Final validation on Pre-Series UUT/ vehicles done

CALIBRATION MATURITY LEVEL

| 0 %	25 %	50 %	75 %	100 %
'Untouched'	'Prelim Calibrated'	'Calibrated'	'Checked'	'Completed'

How can we measure and compare the calibration maturity level?

The Challenges
3rd Challenge – Complexity of Calibration

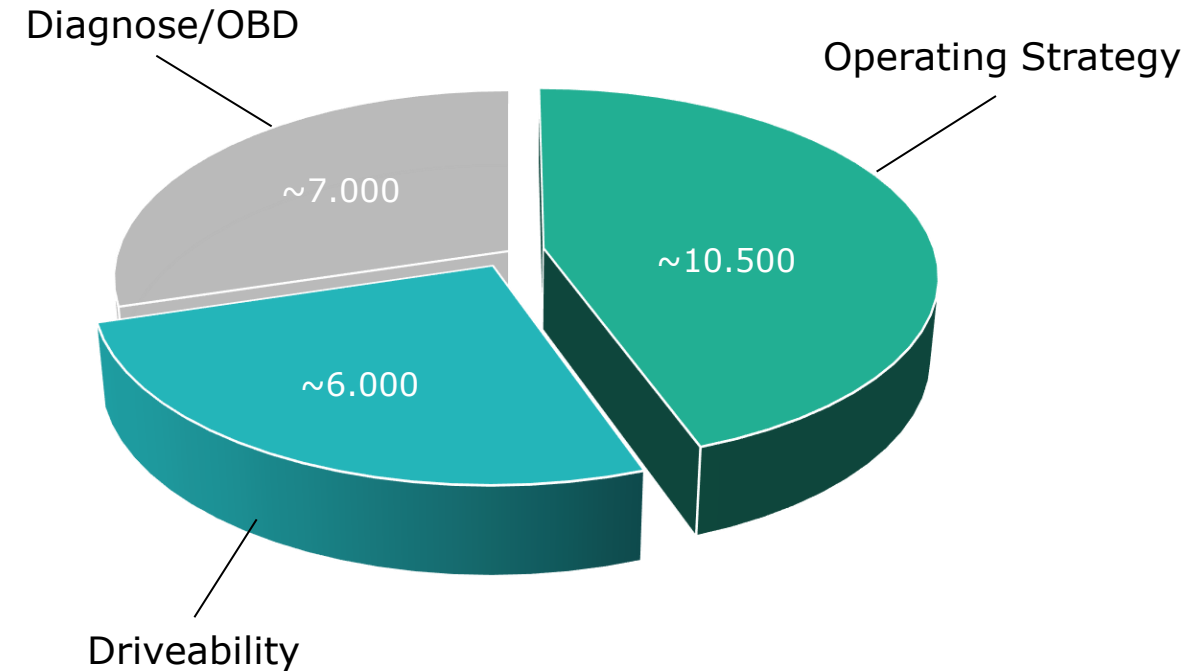Engineering effort of the main work packages (VCU)

Diagnose/OBD ~7.000

Operating Strategy ~10.500

Driveability ~6.000

The Challenges
3rd Challenge – Complexity of Calibration

Engineering effort of the main work packages (VCU)

Diagnose/OBD — ~7.000

Operating Strategy — ~10.500

Driveability — ~6.000
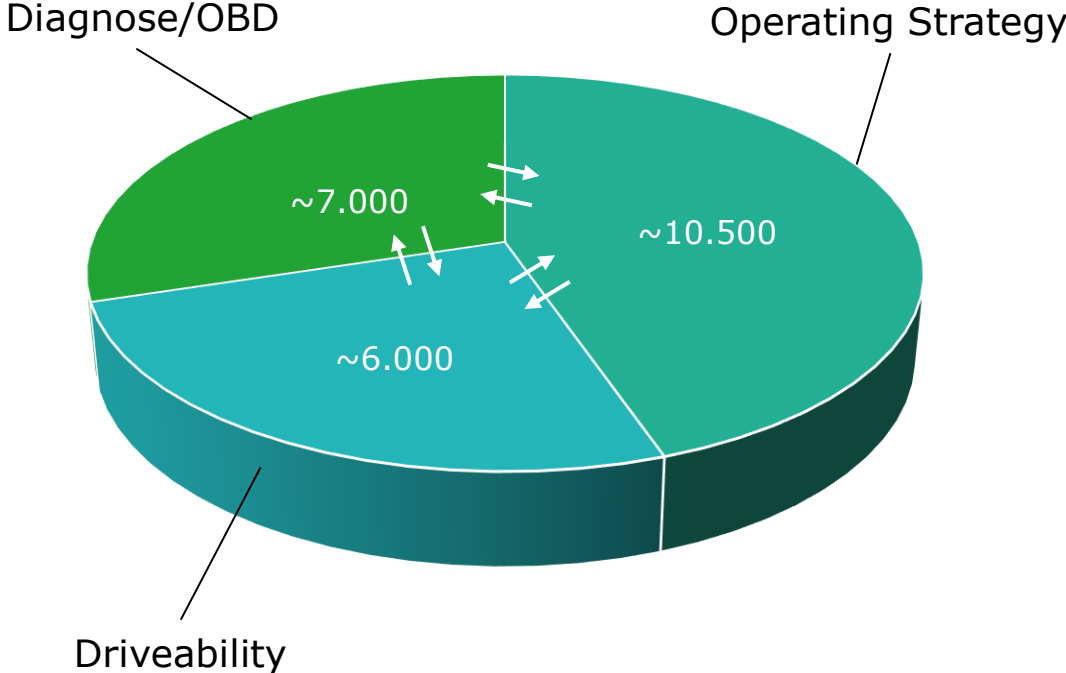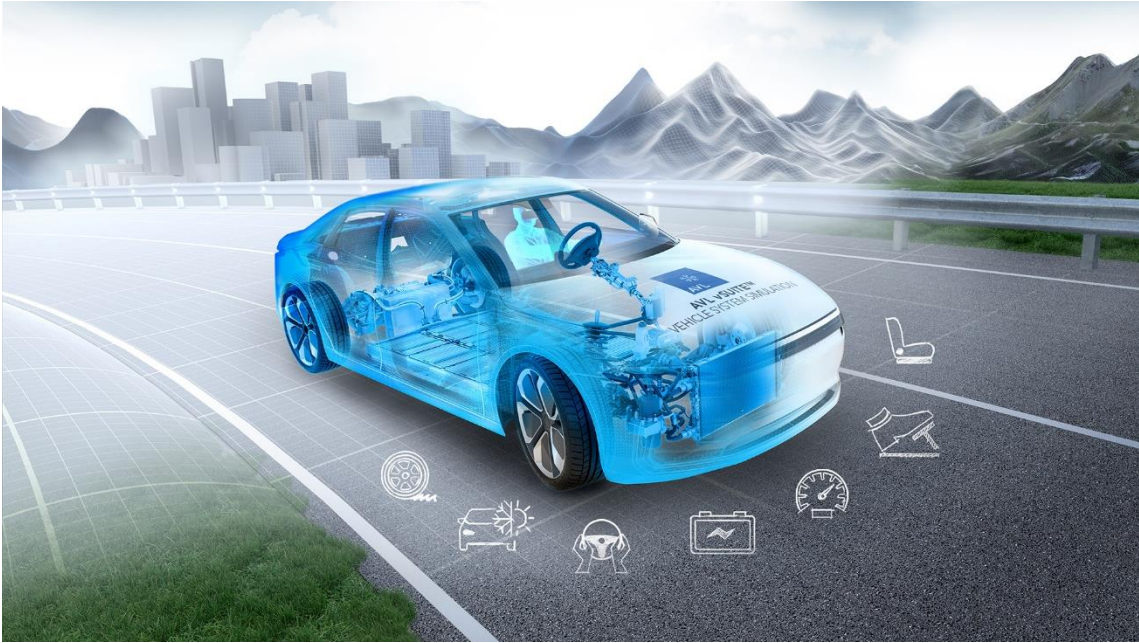
The Challenges
3rd Challenge – Complexity of Calibration

How can we define vehicle DNA to satisfy market expectation?

Below average   Average   Competitive   Leading

Energy Efficiency

Energy Consumption

Energy Recuperation

Driveability Acceleration

Driveability Recuperation

Driveability Tip-in / Tip-Out

Sporty Calibration

Economic Calibration
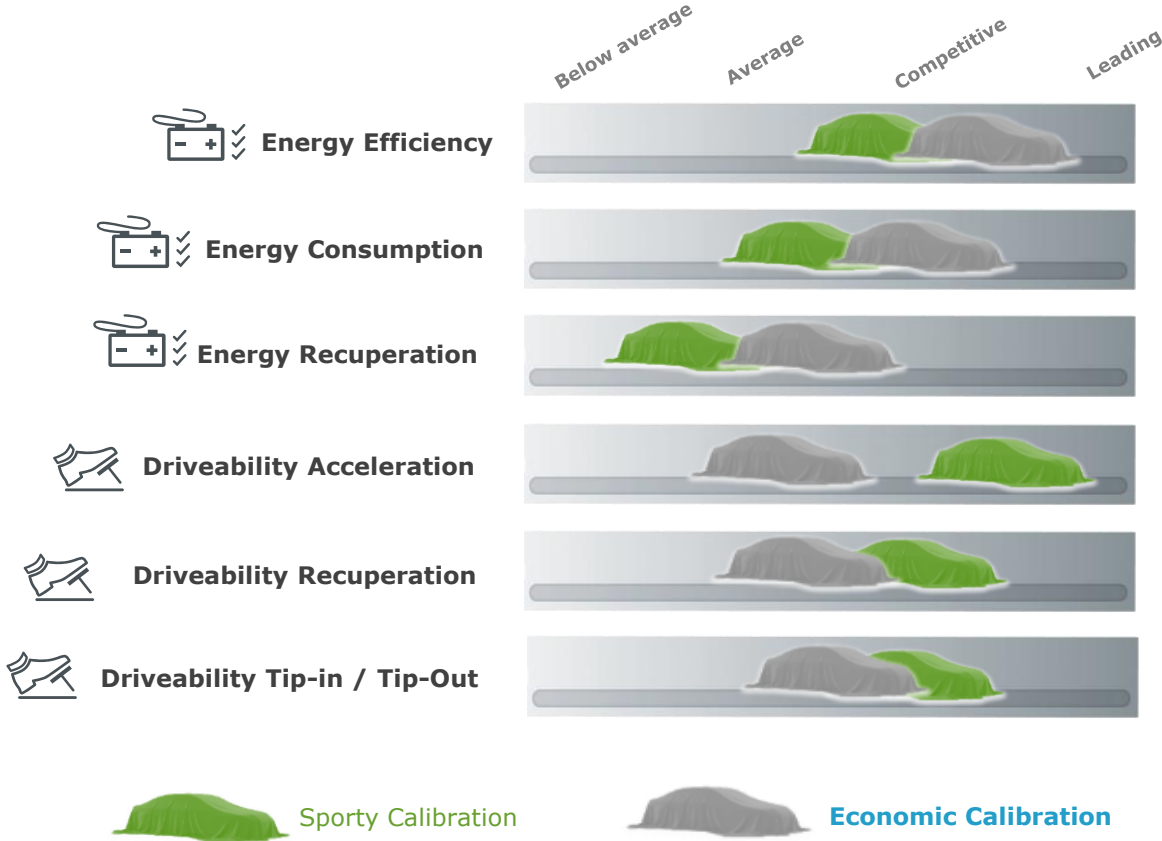
Brand DNA / Market expectation

The Challenges
Summery and Solution

	Virtual Calibration	Target Setting and Progress Monitoring	Product Quality and Positioning
Challenges	How can we utilize objective assessment in simulation environment efficiently?	How can we measure and compare powertrain strategy quality and robustness over the whole calibration process?	How can we define vehicle DNA to satisfy market expectation and benchmark our product?
Need	Making powertrain driveability and energy efficiency measurable		
Solution	AVL-DRIVE™ **VIORE** Toolbox		

Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE

AVL Approach – Objectiv Assesment

AVL Approach – Objective Assessment
Methodology and objective assessment

AVL Approach – Objectiv Assesment
AVL-DRIVE™ Product Portfolio for Vehicle Attribute Development

AVL-DRIVE™

Drive your brand DNA

Benchmarking & target driven
vehicle attribute development
to meet consumer requirements

Driveability
Powertrain development
for BEV, PHEV & ICE

ADAS/AD
Vehicle development
for ADAS / AD System
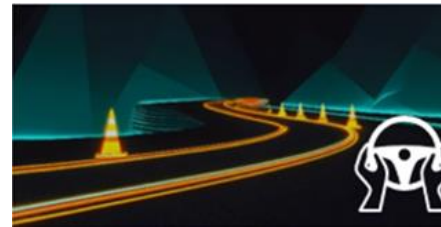
Handling
Vehicle development
for Handling

Ride Comfort
Vehicle development
for Ride Comfort

VIORE
Vehicle development
operation strategy & energy
management
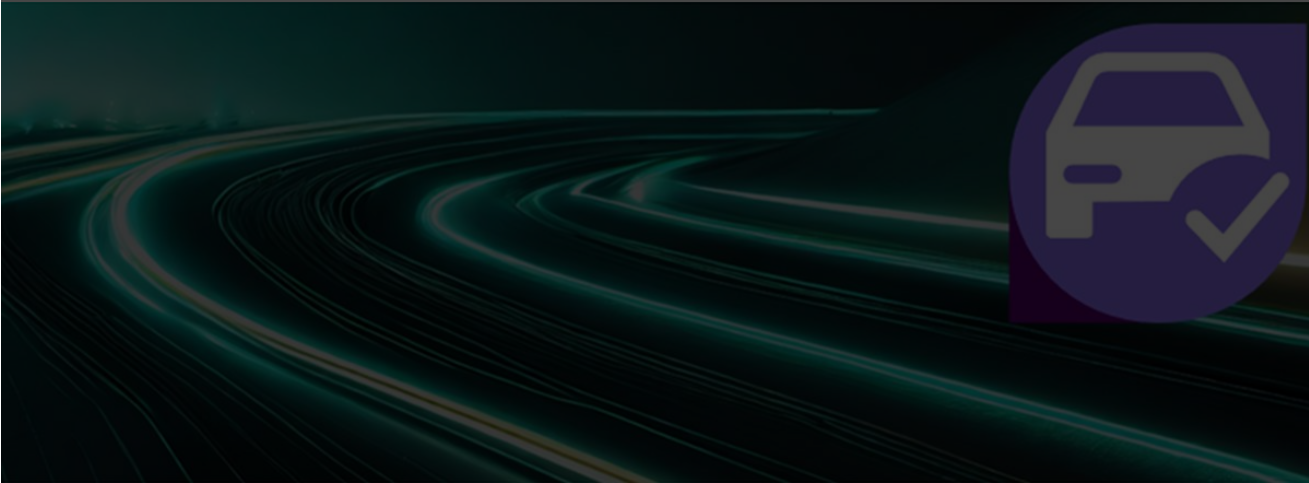
AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE

AVL-DRIVE™

Drive your brand DNA

Benchmarking & Target Driven
Vehicle Attribute Development
to meet consumer requirements

Driveability
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for BEV, PHEV & ICE

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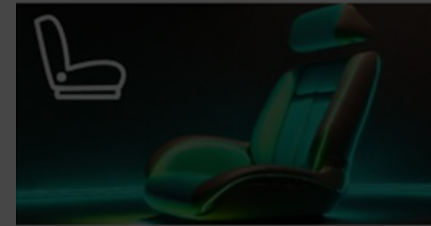
Ride Comfort
Vehicle Development
for Ride Comfort

VIORE
Vehicle development
operating strategy & energy
management

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE

In detailed Analysis with AVL-DRIVE VIORE including over 150 KPIs

AVL-DRIVE™ Driveability Assessment

DR	Evaluation	Description
9 – 10	excellent	The driveability exceeds all customer's expectations
8 – 9	good	The driveability meets all customer's expectations
7 – 8	satisfying	The driveability meets most customer's expectations
6 – 7	acceptable	Driveability at basic level only, does not meet most customer's expectations
5 – 6	poor	Some customers complain about driveability
4 – 5	unacceptable	Most customers complain about the driveability
3 – 4	defective	All customers complain driving the vehicle
2 – 3	unsafe operation	Only limited or unsafe vehicle operation possible
1 – 2	no operation	Vehicle not operational

VIORE
Vehicle Development
Operating Strategy & Energy
Management

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Workflow

Pre-processing

Assessment

- Define input data (on-road, chassis dyno or simulation data)
- Channel mapping
- Define vehicle parameters
- Assessment settings
- Validate input data

AVL
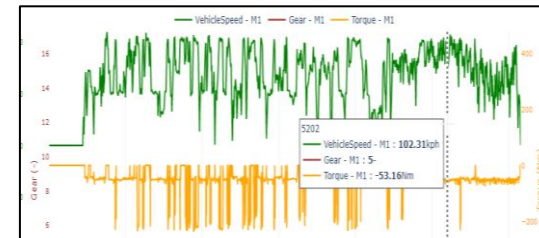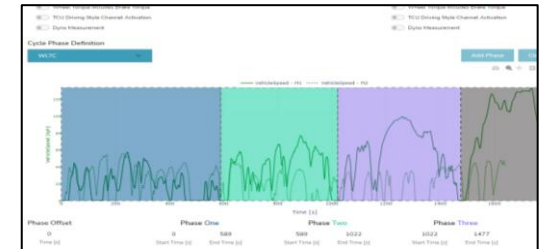
AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Workflow

Pre-processing

Assessment

Post-processing

Objective evaluation based on Criteria

Pure Electric Drive ✓

Recuperation Efficiency
E-Drive Efficiency
SOC Drop Accuracy
Remaining Driving Range Accuracy
OPD – Pedal Position Detection

Torque Behavior ✓

Handover to Mechanical Brake
Maximum Potential Recuperation
Recuperation Mode Difference
Deceleration Reproducibility
Constant Deceleration

Operation Strategy KPI Analysis (>150) ✓

Cycle Info
Energy Consumption
Auxiliary Consumption
Powertrain Efficiency
Electric Drive Range
E-Motor Operation
Wheel Energy Analysis
Battery Energy Analysis
Drive Modes Analysis
HV Charging Energy Analysis
HV Discharging Energy Analysis
Recuperation Energy Flow

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Workflow

Assessment

Post-processing

Report generation

Visualization and result interpretation

Overview

| VIORE Strategy |
| Vehicle Information |
| Cycle Information |
| Driving Style |

Torque Behavior

| Maximum Potential Recuperation |
| Recuperation Mode Difference |
| Handover to Mechanical Brake |
| Deceleration Deviation at Shifts |
| Electrical Torque Usage |
| Constant Deceleration |
| Deceleration Reproducibility |

Pure Electric Drive

| Remaining Driving Range Accuracy |
| E-Drive Efficiency |
| Recuperation Efficiency |
| SOC Drop Accuracy |
| OPD Position Detection |

131.95
Vehicle Speed : **15.31**km/h
Brake Position : **5.02**%
Recup (Inc. ICE) Power (C) : **-10.0510**kW
Available Recup Power (C) : **-5.5423**kW
ICE Power (C) : **0.0000**kW
SOC : **65.90**%

Prev 1 Next
126.59 - 133.08 s
Rating: 10.0

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Workflow

Post-processing
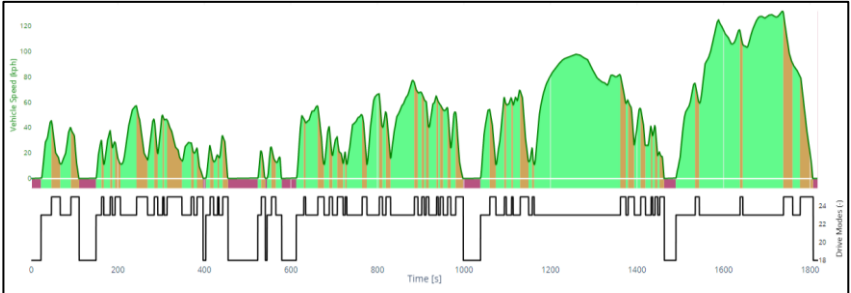
Report generation

✓ One click report generation

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Features

✓ Transparent monitoring & target setting via objective rating

Initial dataset with example event — DR: **7.7**
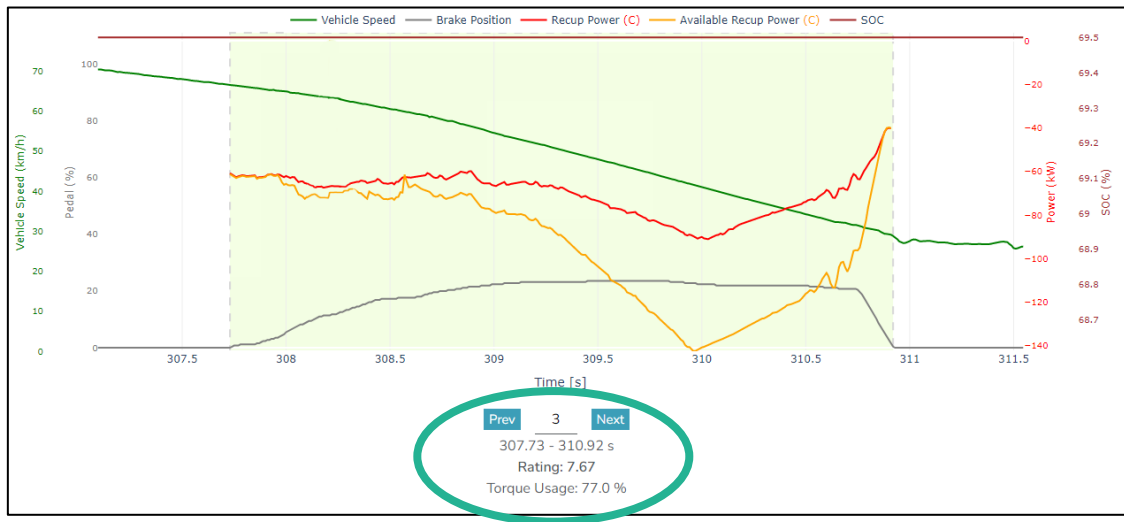
Improved dataset with example event — DR: **9.4**
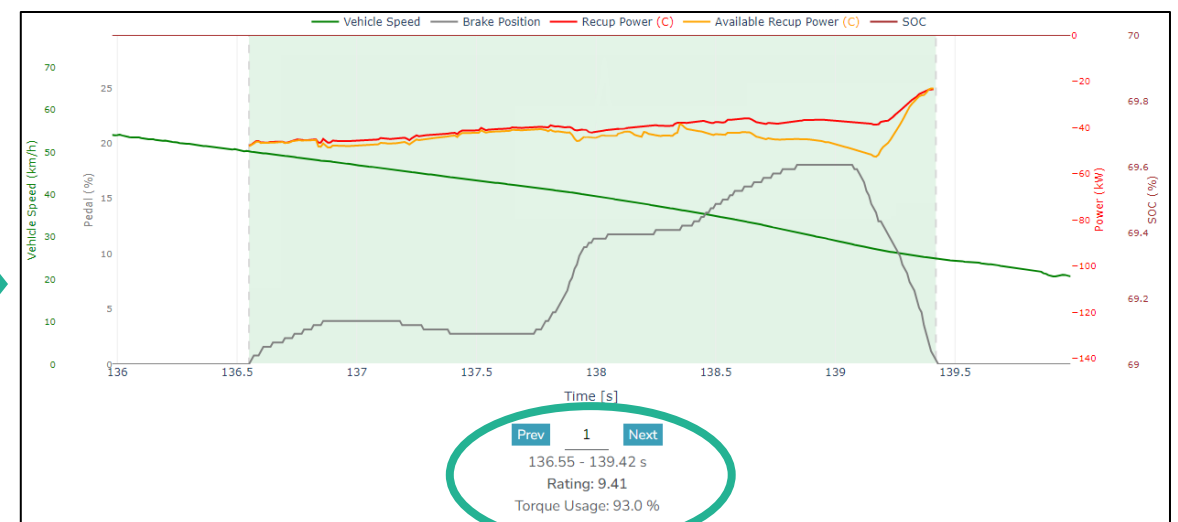
DR = AVL-DRIVE Rating from 1 to 10

AVL Approach – Objective Assessment
AVL-DRIVE^{TM} VIORE Features

✓ Quick event navigation
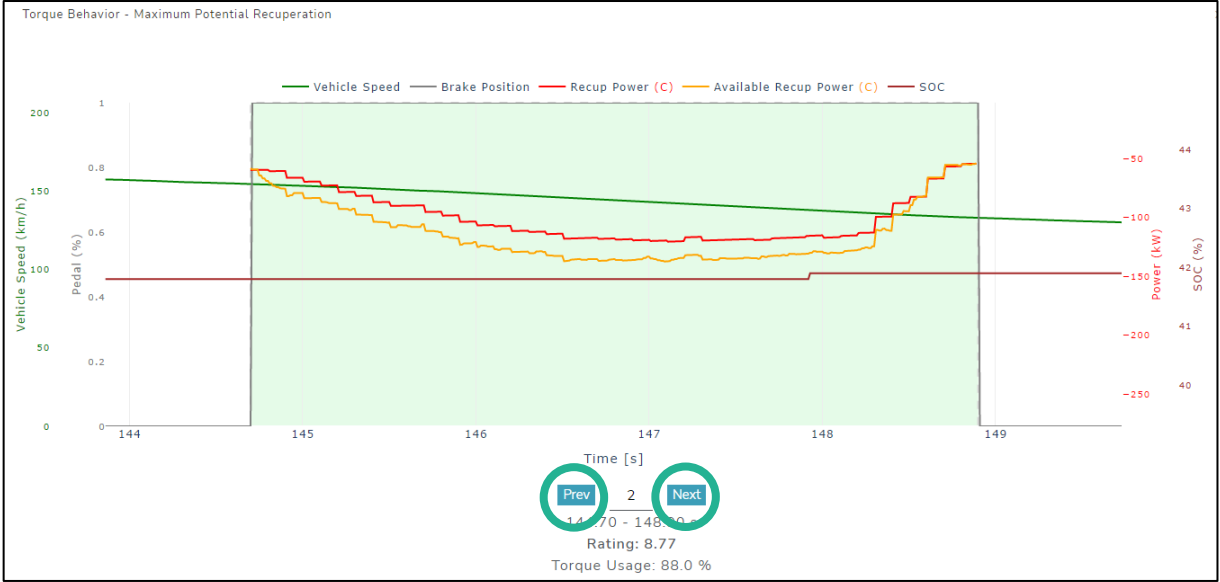
✓ Outlier detection
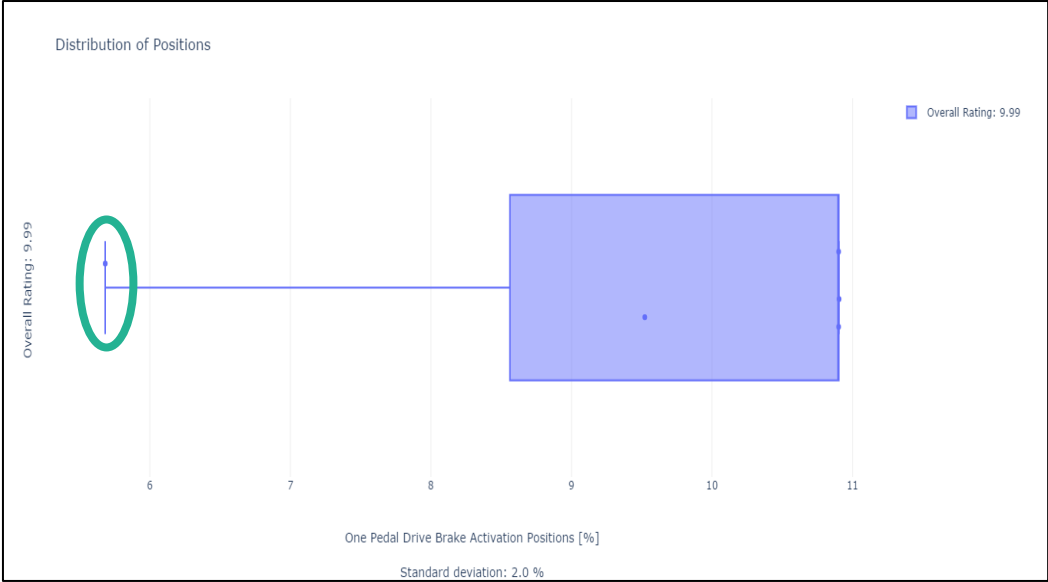
AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Features

✓ Topic specific visualization

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Features
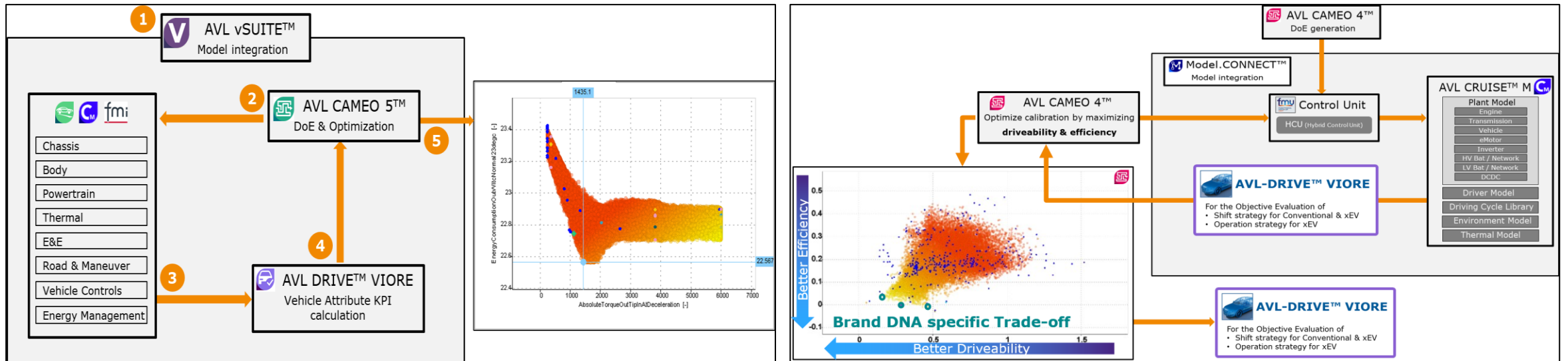
✓ Criteria rating comparison

✓ KPI comparison

AVL Approach – Objective Assessment
AVL-DRIVE™ VIORE Features

✓ Seamless integration to co-simulation environment and automated optimization workflow

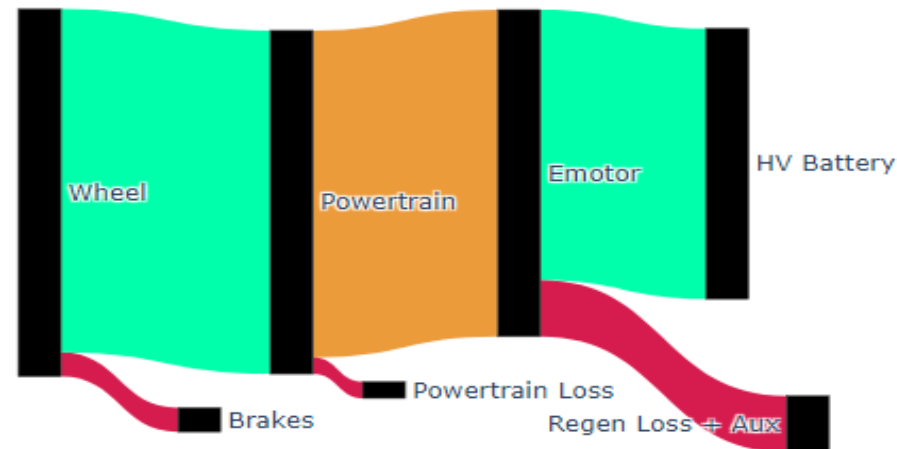Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE

Example Use Cases

Example Use Case
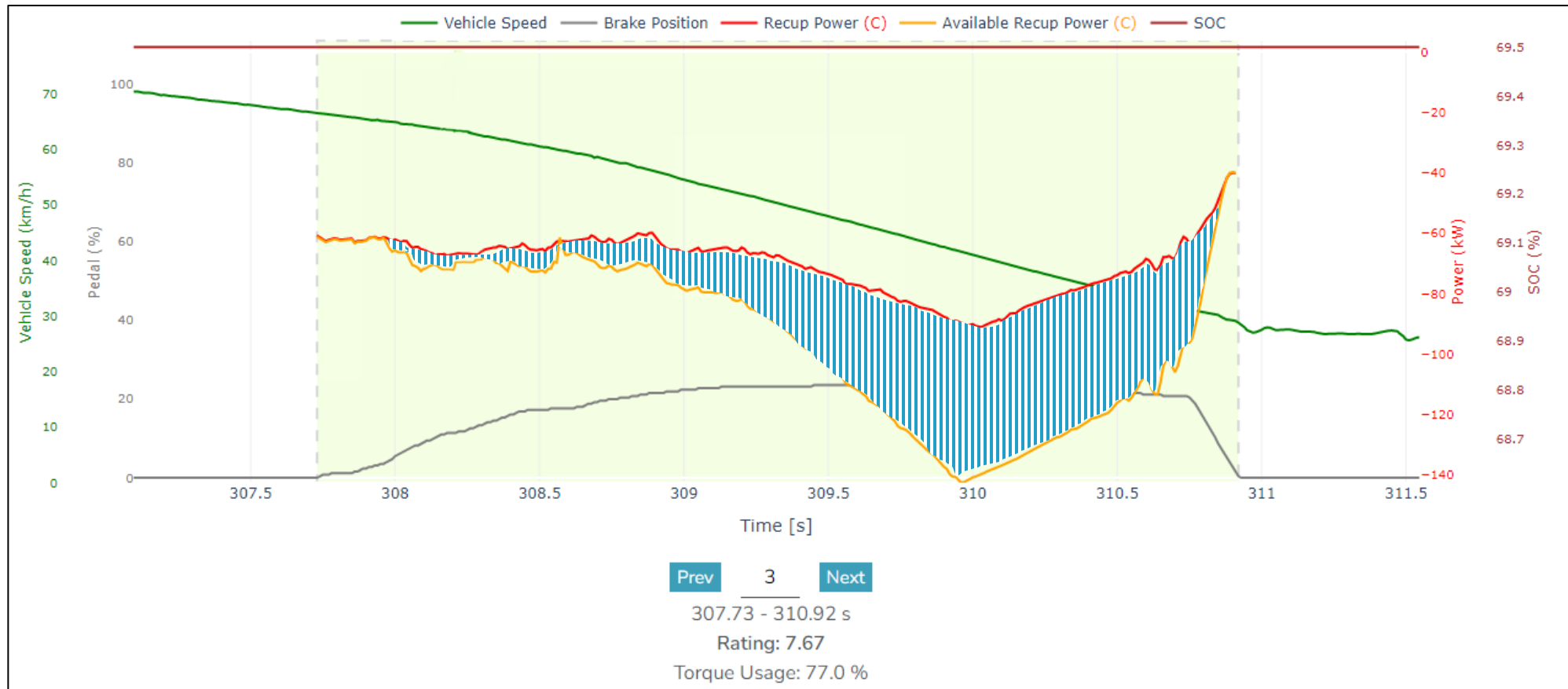## Recuperation

Criteria for recuperation:
- How much torque is provided by the e-motor during recuperation?
- Is the handover to the mechanical brake noticeable?
- Is there a significant different deceleration between the recuperation modes?
- Is the deceleration reproducible?

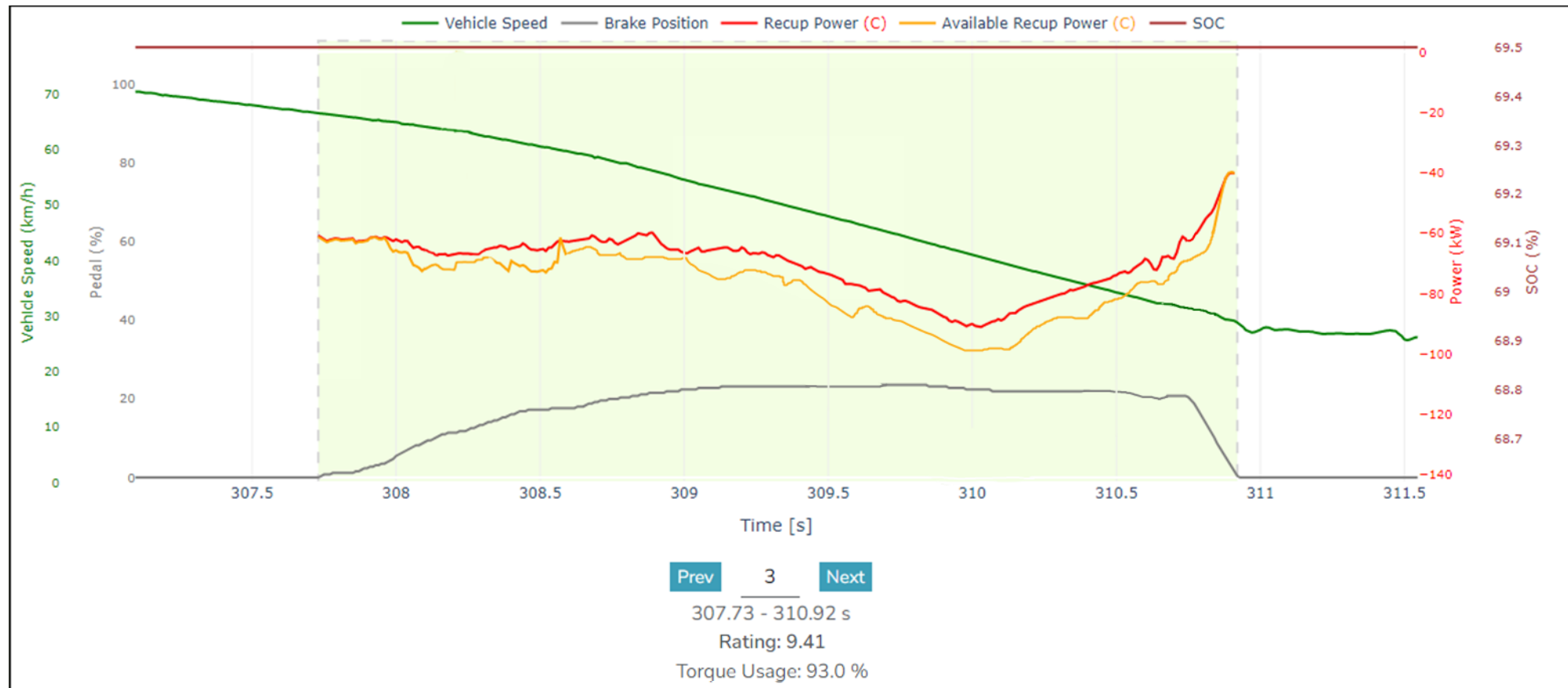# Example Use Case
Maximum Potential Recuperation

Goal: Gain as much as possible energy during braking

Example Use Case
Maximum Potential Recuperation

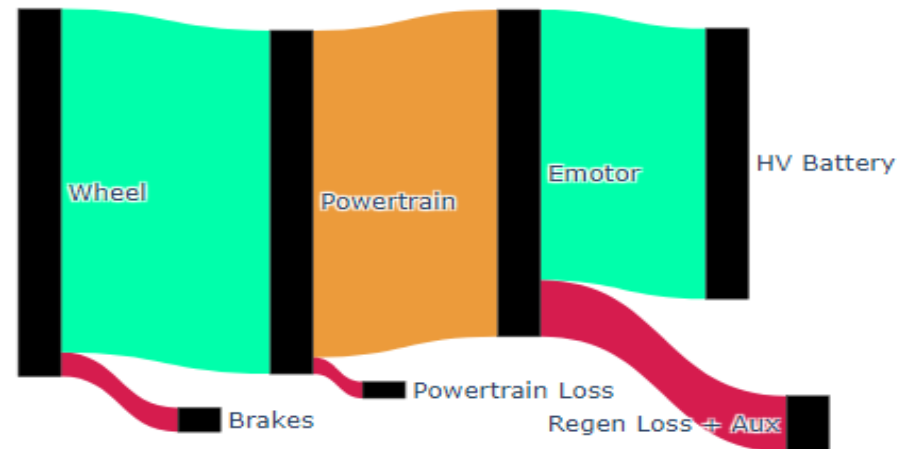Goal: Gain as much as possible energy during braking

AVL Approach – Objective Assessment
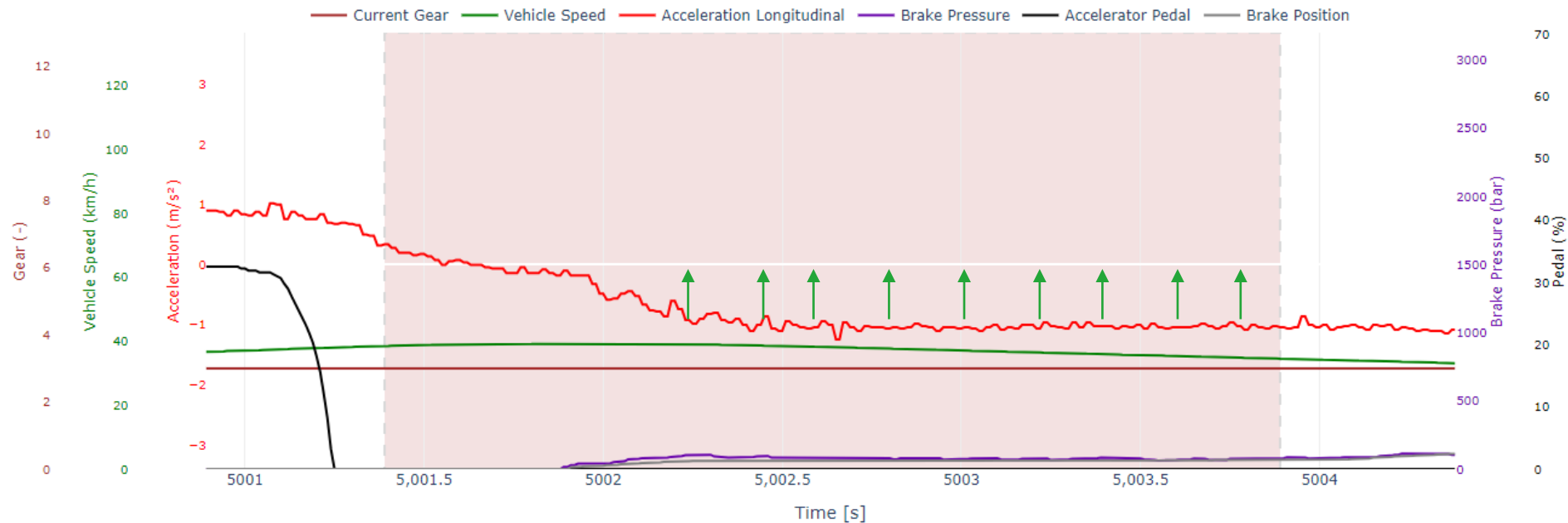## Example Use Case – Recuperation

Criteria for recuperation:

- How much torque is provided by the e-motor during recuperation?
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- Is there a significant different deceleration between the recuperation modes?
- Is the deceleration reproducible?

AVL Approach – Objective Assessment
Example Use Case – Handover to Mechanical Brake

Goal: The transition to the mechanical brake is not noticeable

AVL Approach – Objective Assessment
Example Use Case – Handover to Mechanical Brake

Goal: The transition to the mechanical brake is not noticeable

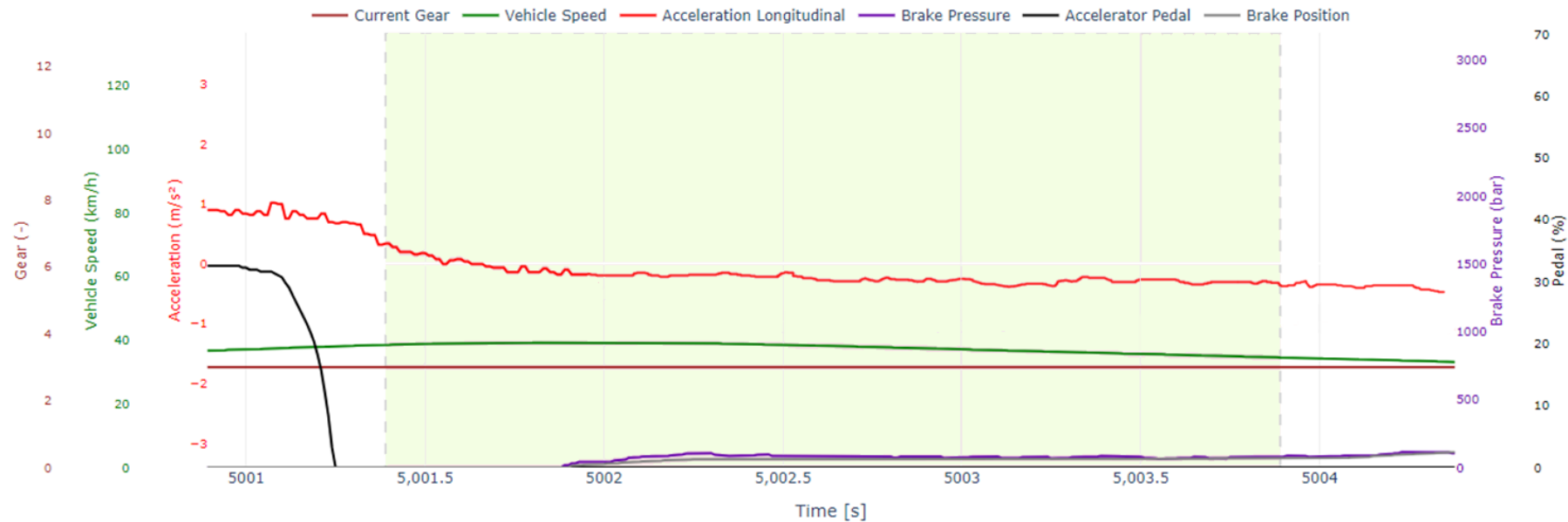# AVL Approach – Objective Assessment
Example Use Case – Recuperation

Criteria for recuperation:
- How much torque is provided by the e-motor during recuperation?
- Is the handover to the mechanical brake noticeable?
- Is there a significant different deceleration between the recuperation modes?
- Is the deceleration reproducible?

AVL Approach – Objective Assessment
Example Use Case – Recuperation Mode Difference

Goal: Noticeable different deceleration between the modes

AVL Approach – Objective Assessment
Example Use Case – Recuperation Mode Difference
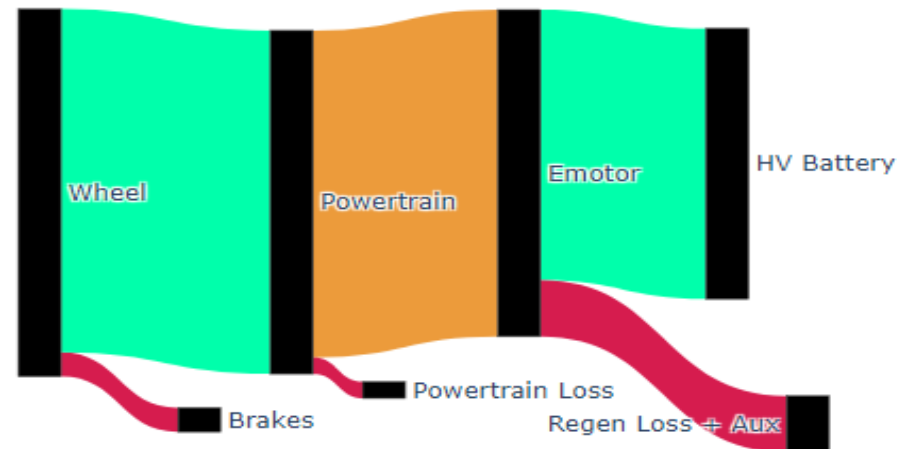
Goal: Noticeable different deceleration between the modes

AVL Approach – Objective Assessment
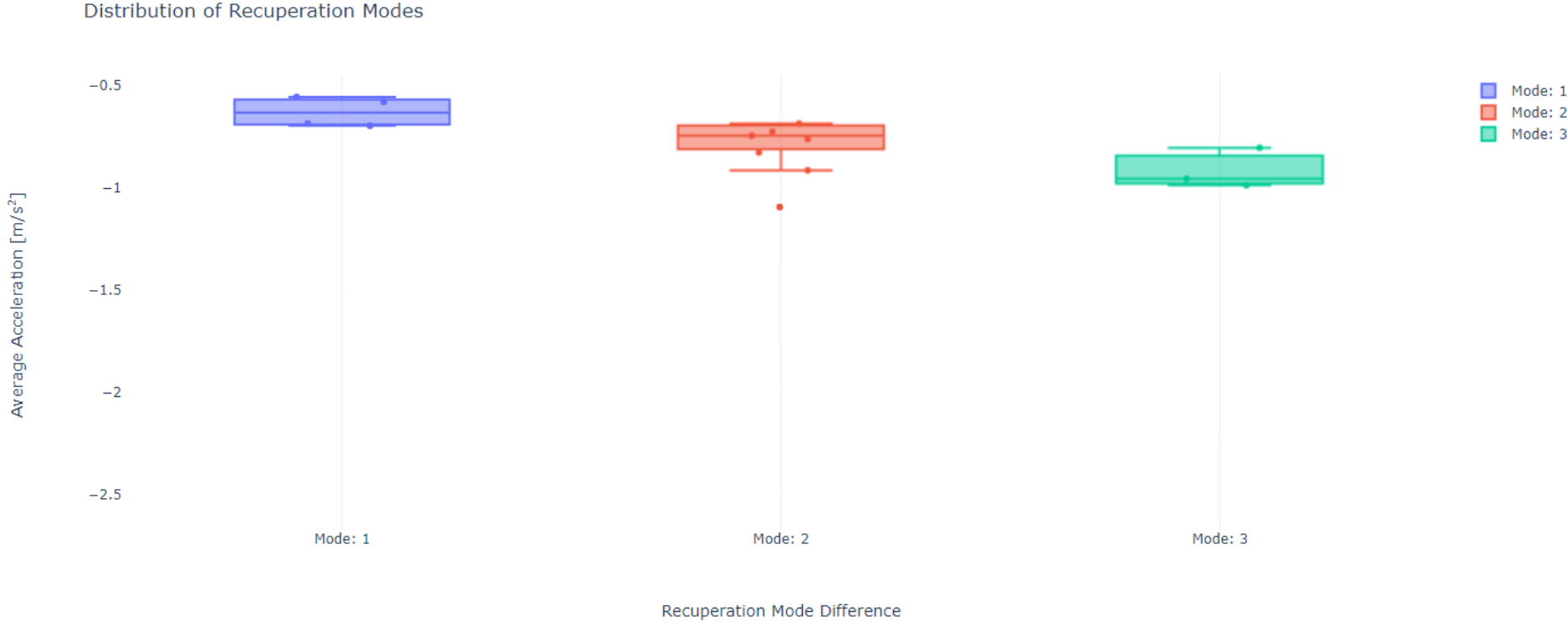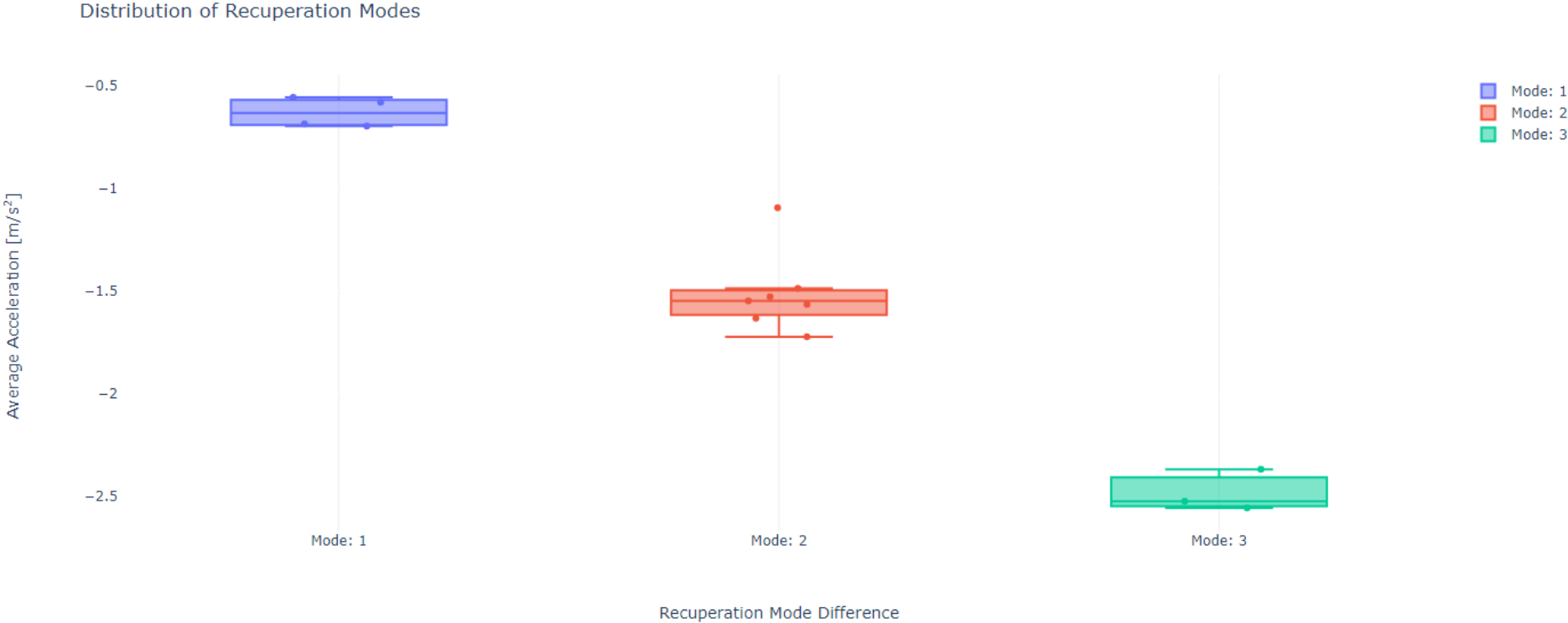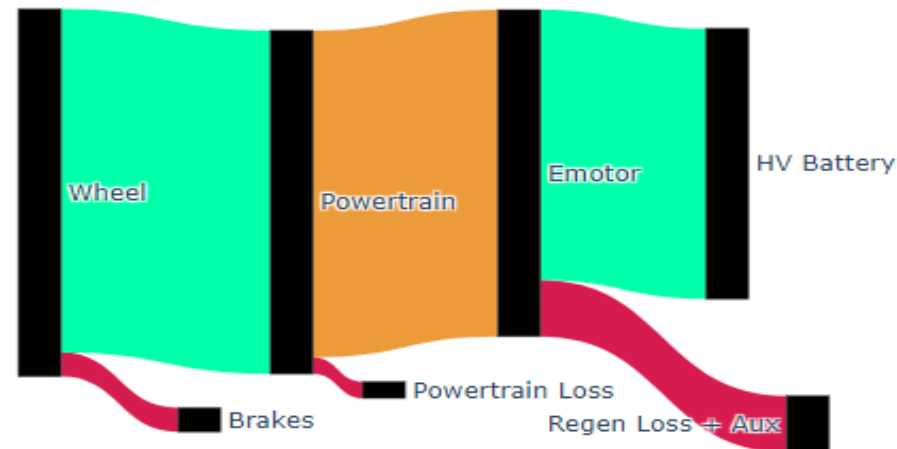## Example Use Case – Recuperation

Criteria for recuperation:
- How much torque is provided by the e-motor during recuperation?
- Is the handover to the mechanical brake noticeable?
- Is there a significant different deceleration between the recuperation modes?
- Is the deceleration reproducible?

AVL Approach – Objective Assessment
Example Use Case – Deceleration Reproducibility

Goal: Deceleration is reproducible and for the driver predictable

Distribution of Deceleration for Each Brake Position and Slope

AVL Approach – Objective Assessment
Example Use Case – Deceleration Reproducibility

Goal: Deceleration is reproducible and for the driver predictable

Distribution of Deceleration for Each Brake Position and Slope

AVL

Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE

Live Demo

Master the Challenge of BEV Calibration with the
Support of AVL-DRIVE™ VIORE

Summarized Benefits

AVL-DRIVE™ VIORE: Summarized Benefits

OBJECTIVE TARGET SETTING & MONITORING
Realistic target setting through transparent quality and progress monitoring

ENABLER FOR CALIBRATION IN THE VIRTUAL WORLD
Better and cheaper products through extensive simulation, efficient calibration and validation

OPTIMAL VEHICLE DNA
Better product positioning via objective powertrain strategy assessment and benchmarking

Master the Challenge of BEV Calibration with the Support of AVL-DRIVE™ VIORE

Q&A

Contact

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Thank you

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