



# Vehicle Benchmark of the BMW iX

How functions & features contribute to high level of driving excitement and efficiency

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# Today's Presenters

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## **Stefan Pfragner**

Project Manager Vehicle  
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Mechanical Engineering at Graz  
University of Technology

19 years of working experience  
in the automotive industry



## **Christian Juwan**

Product Manager Vehicle  
Benchmarking

Mechanical Engineering at Graz  
University of Technology

25 years of working experience  
in the automotive industry

# Agenda

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**1**

**About AVL**

**2**

**Introduction and Measurement Set-up of BMW iX**

**3**

**Objectives of BMW iX Benchmarking Investigation**

**4**

**Summary and Conclusion**

# Agenda

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- 1** **About AVL**
- 2** **Introduction and Measurement Set-up of BMW iX**
- 3** **Objectives of BMW iX Benchmarking Investigation**
- 4** **Summary and Conclusion**

# Facts and Figures



## Global Footprint

Represented in 26 countries

45 Affiliates at over 93 locations

45 Global Tech and Engineering Centers (including Resident Offices)

1948

Founded

10,700

Employees Worldwide

12%

Of Turnover Invested in Inhouse R&D

70+

Years of Experience

68%

Engineers and Scientists

2,500

Granted Patents in Force

97%

Export Quota



# Solutions for all Customer Segment



Passenger Cars



2 Wheelers



Racing



Construction



Agriculture



Commercial Vehicles



Locomotive



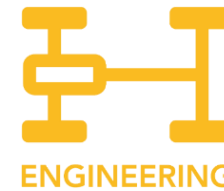
Marine



Power Plants



SIMULATION



ENGINEERING



TESTING



ELECTRIFICATION



AUTOMATED DRIVING



SOFTWARE INTELLIGENCE SECURITY



EFFICIENT DEVELOPMENT

# Agenda

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# Introduction

## **Benchmarking the brand new BMW iX**

AVL recently performed a comprehensive benchmark study of the 2021 BMW iX xDrive50 to provide insight into the vehicle's overall performance, efficiency and operating strategies. Among that we will show you the standing of the iX compared to the competitor landscape.



## **Key topics and takeaways:**

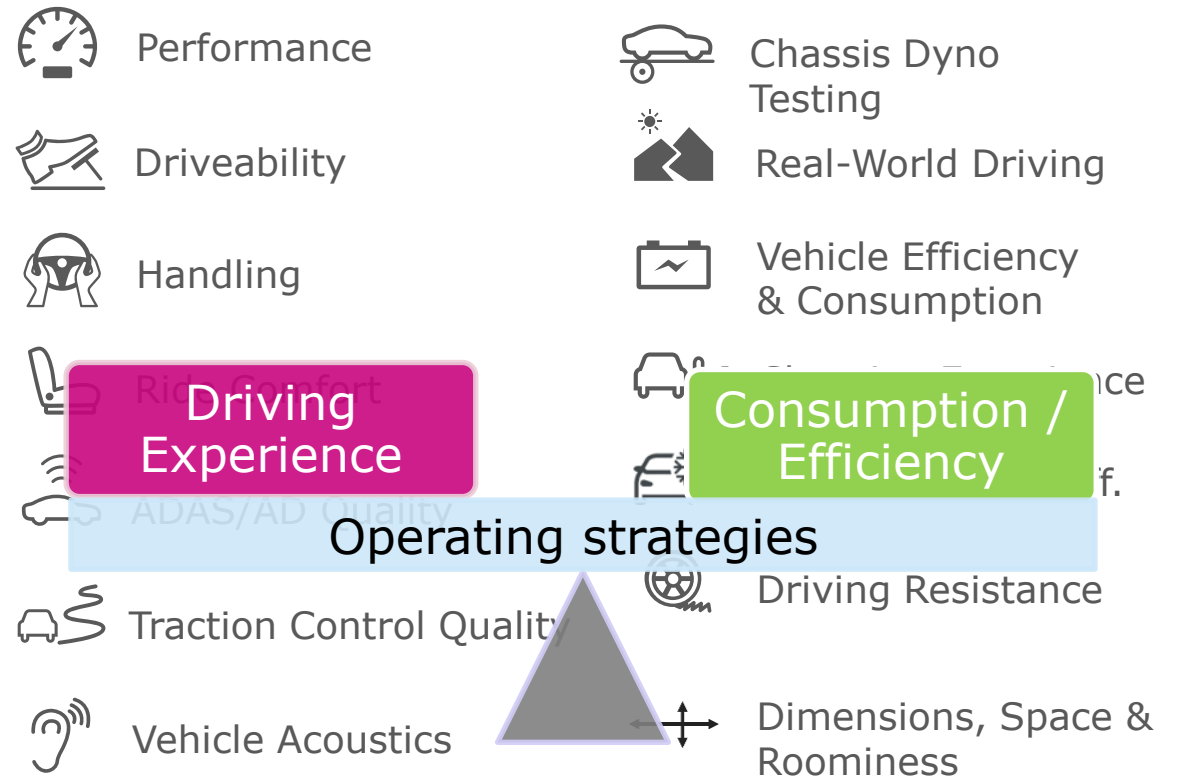
- Gain insight into the BMW iX's driving performance, as well as its efficiency in the competitive landscape
- Understand BMW's strategies to provide energy according to driving demand
- Discover how integrated technologies, features and functions influence the vehicle's character
- Learn about AVL's benchmarking services and solutions

# 2022 BMW iX xDrive50

## AVL Global Vehicle Benchmarking Program



### Objective Benchmarking in Functional Vehicle Attributes



# 2022 BMW iX xDrive50

## AVL Global Vehicle Benchmarking Program



### BMW iX xDrive50 Technological Highlights

EES Motors



Rear Wheel Steering

Brake by wire

Air suspension



[www.bmw.de](http://www.bmw.de)

Adaptive recuperation



[www.electricdrivemagazin.de](http://www.electricdrivemagazin.de)

Interior panel heating



[www.automoblog.net](http://www.automoblog.net)

**Benchmarking focus on integrated technologies, features and functions characterizing the vehicle**

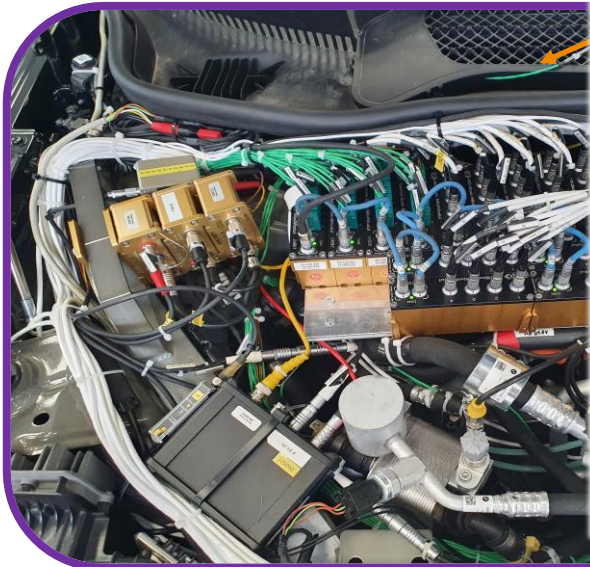


# 2022 BMW iX xDrive50

## Comprehensive Instrumentation for Deep-dive Analysis



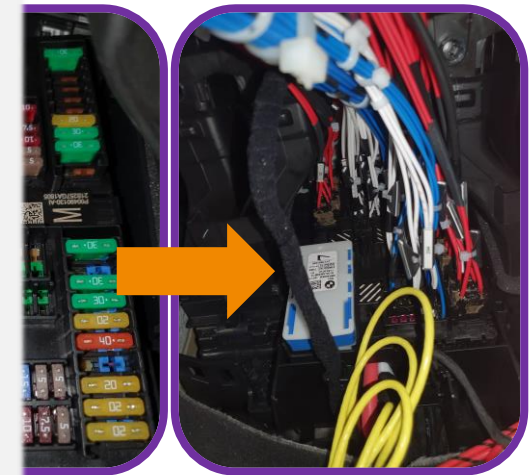
Detail on vehicle instrumentation - Front



> **250 channels in 100 Hz sampling rate**

- Pressure transducers
- Fluid flow meters
- Temperature sensors
- Accelerometers
- Optical sensor (fan speed)
- HV & LV current measurement
- CAN Bus information
- Power analyzer for charging

Detail of fuse box instrumentation for low voltage investigation



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# BMW iX compared to competitors



**BMW iX xDrive50**  
Foto: BMW Konfigurator /www.bmw.de

VS



**Mercedes EQC 400**  
Foto:MB Konfigurator/www.mercedes-benz.de



**NIO ES8**  
Foto:NIO Konfigurator/www.nio.com



**Audi etron 55**  
Foto:Audi Konfigurator/www.audi.de



**Hyundai Ioniq 5 AWD**  
Foto:Hyundai Konfigurator/www.hyundai.de



**Audi etron S**  
Foto:Audi Konfigurator/www.audi.de



**VW ID.4 GTX**  
Foto:VW Konfigurator/www.volkswagen.de



**Tesla Model X P100DL**  
Foto:Tesla Konfigurator/www.tesla.com



**Jaguar I-Pace**  
Foto:Jaguar Konfigurator/www.jaguar.at

# Global Vehicle Benchmarking

## BMW iX xDrive50 Overview of Technical Specification

		BMW iX xDrive50		Below Average	Average	Competitive	Leading
Vehicle	Base vehicle price	[€]	102.500			●	
	Wheelbase (CoC)	[mm]	3000				●
	Length (CoC)	[mm]	4935			●	
	Width excl. Mirrors (CoC)	[mm]	1967			●	
	Height (CoC)	[mm]	1996		●		
	Trunk Capacity	[l]	500		●		
	Number of Seats		5		●		
	Trunk Capacity incl. Back Seats	[l]	1750		●		
	Curb Weight (AVL)	[kg]	2585		●		
	Gross Vehicle Weight (CoC)	[kg]	3145			●	
	Payload	[kg]	560			●	
	Range WLTC (CoC)	[km]	626				●
	Official Grid Cons. (CoC/AVL)	kWh/100km	21.3				●
	Max. Speed	[kph]	200			●	
	Performance 0-100kph	[s]	4.6				●
Chassis	Suspension front/rear		Air/Air				
	Brakes front/rear		Disc/Disc				
	Tire Size, front		275/40 R22				
	Tire Size, rear		275/40 R22				
	Tire Make & Model		ECO-Bridgestone Potenza				
	Official Turning Radius	[m]	12.8		●		



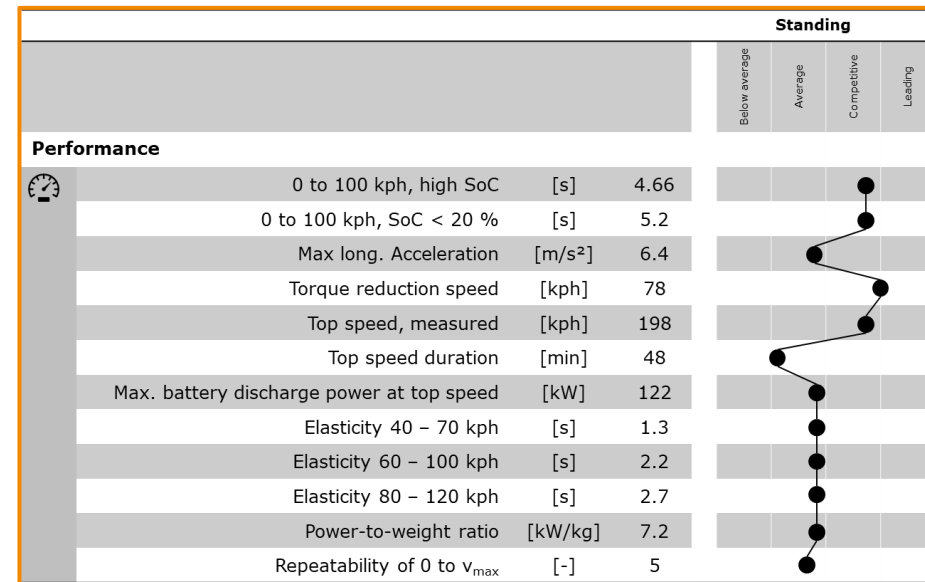
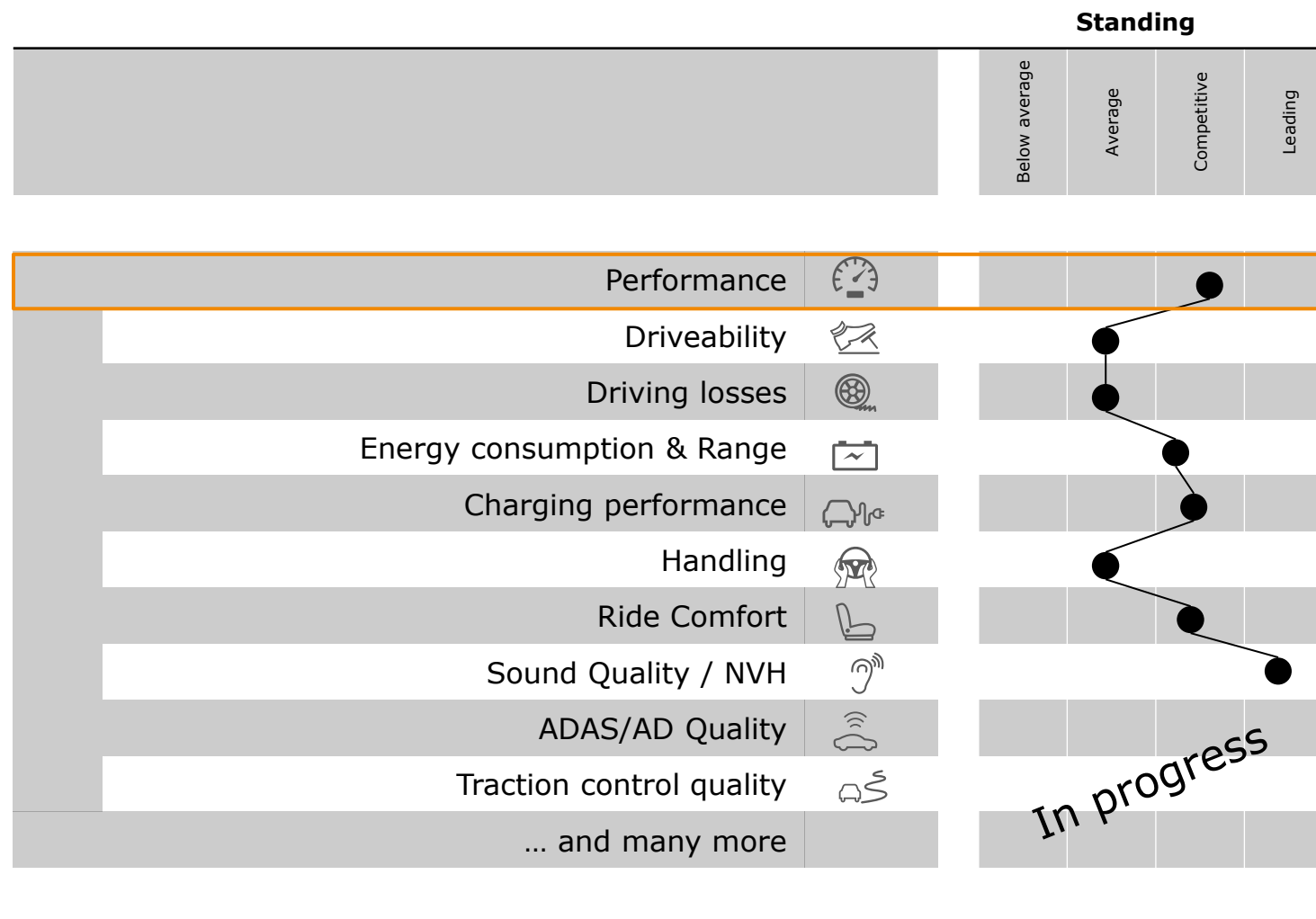
# Global Vehicle Benchmarking

## BMW iX xDrive50 Overview of Technical Specification

	<b>BMW iX xDrive50</b>		Below Average	Average	Competitive	Leading
Powertrain	Drive Layout		AWD			
	Electric Motor Type - Front/Rear		ESM/ESM			
	Max. Power/Torque, front	[kW]/[Nm]	190/365			
	Max. Power/Torque, rear	[kW]/[Nm]	230/400			
	Max. System Power/Torque	[kW]/[Nm]	385/765			
Battery	Official Capacity (installed/usable)	[kWh]	111.5/105.2			
	Battery Voltage (nominal)	[V]	369			
	Weight	[kg]	643.3			
	Cell layout		100s5p			
	Thermal Layout		Liquid Cooling			
Charging	AC-Charging Port		Type 2			
	DC-Charging Port		CCS2			
	Min. DC Charging Duration (0-80% SOC, 23°C)	[min]	39			
	Max. DC Charging Power	[kW]	195			

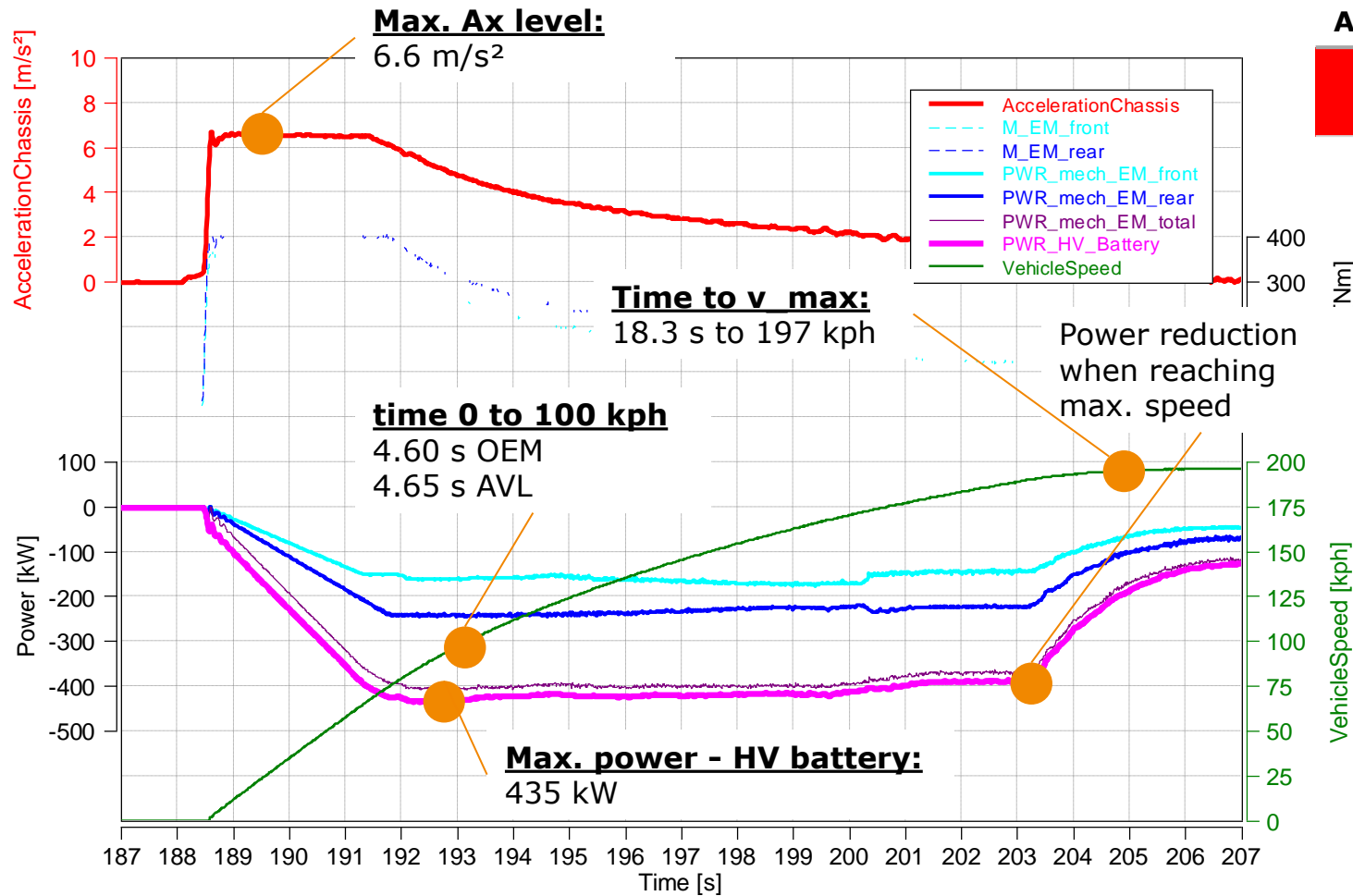
# Global Vehicle Benchmarking

## Executive Results and Standing of BMW driving attributes

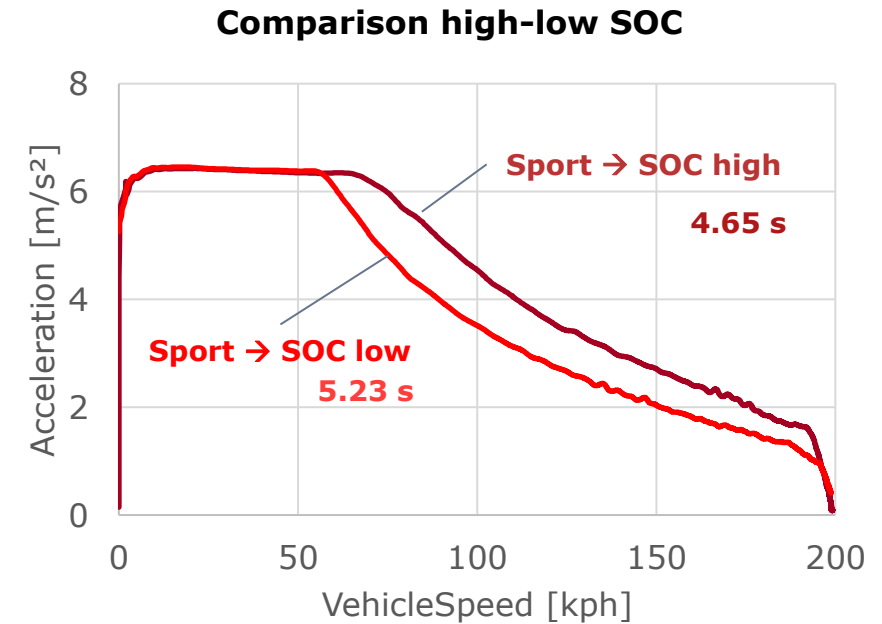


# Performance – Full Load from Standstill

SOC max. 0 to  $v_{max}$



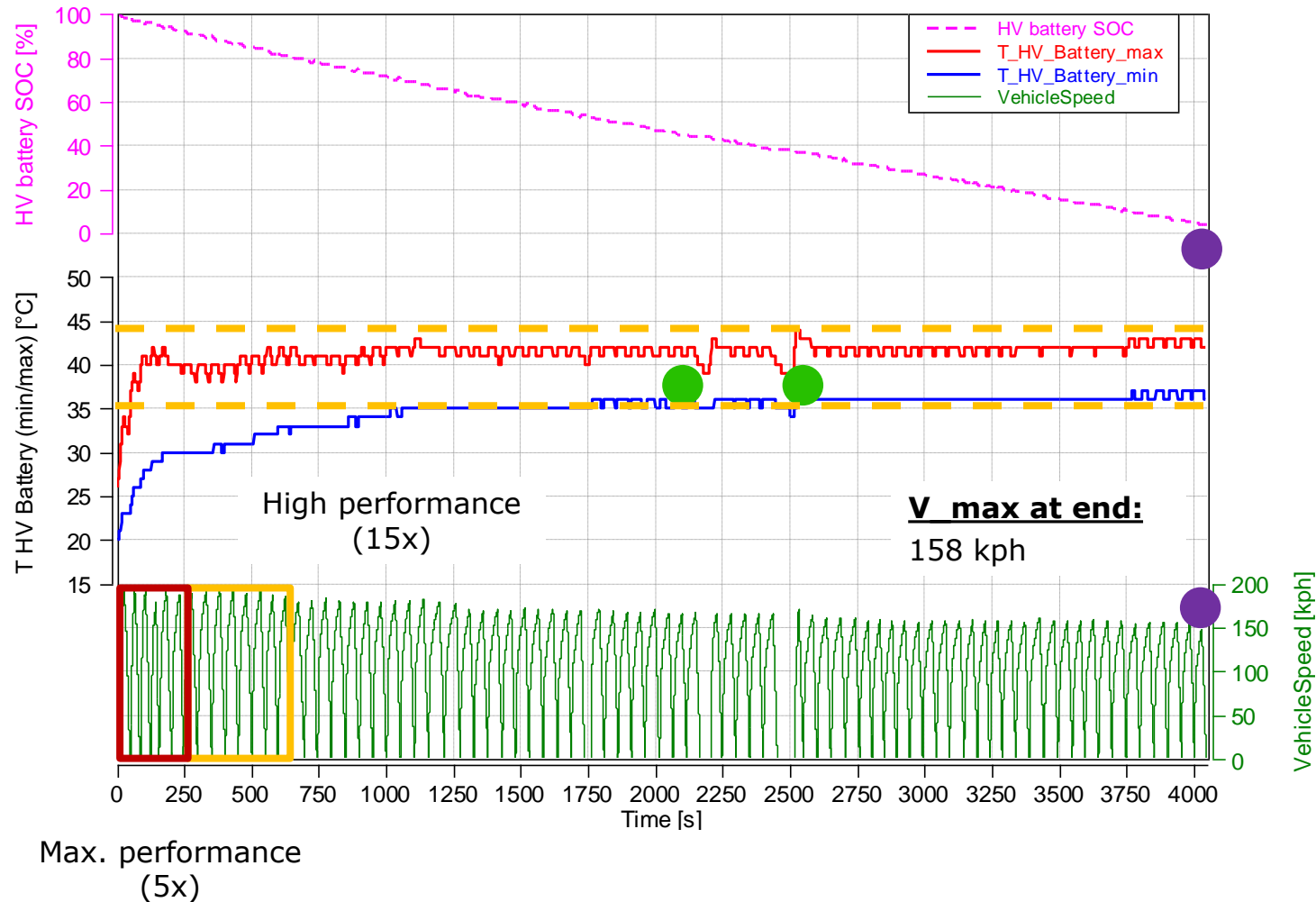
AVL results		System	Front / Rear	OEM
Sport mode	$M_{max}$	765 Nm	365 / 400 Nm	765 Nm
	$P_{max}$	405 kW	165 / 240 kW	385 kW



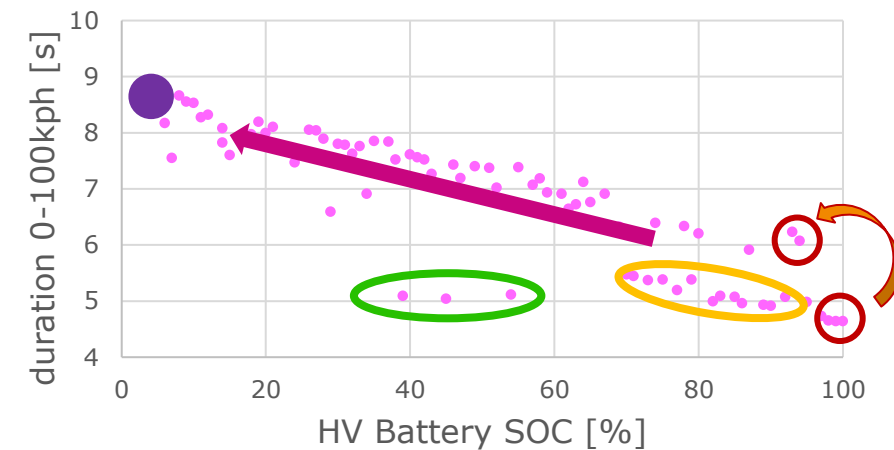
12.5 [%] performance reduction was measured with decreasing SOC

# Performance

## Derating Strategy – Battery

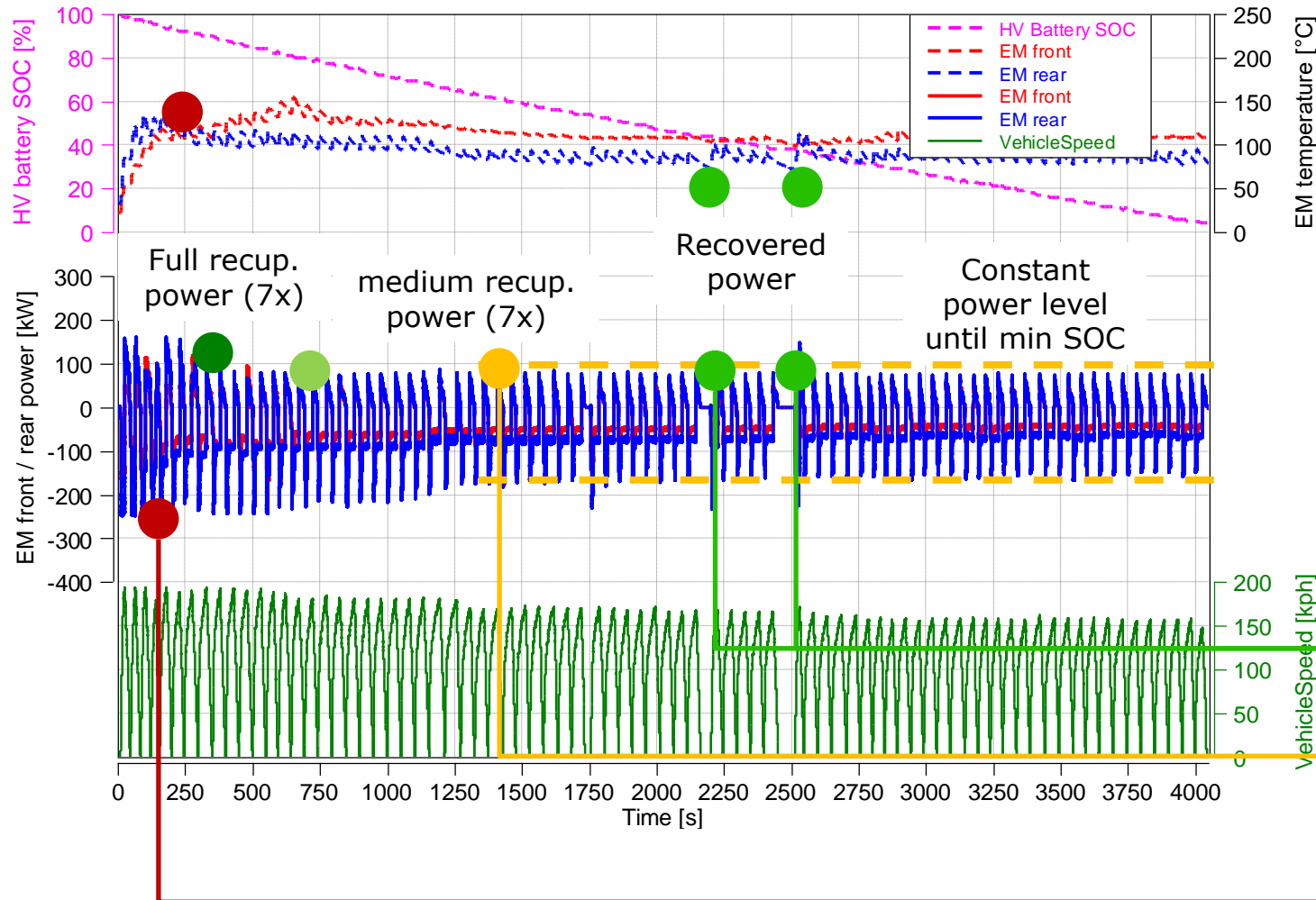


- After 5 maneuvers, some performance loss (duration increases by >+10%)
- Performance decreases independent of the battery temperature with decreasing SOC
- Vehicle recovers after a short brake
- No derating at 10% SOC
- Battery temperature is uncritical  
→ Sufficient cooling performance also for hot regions and towing

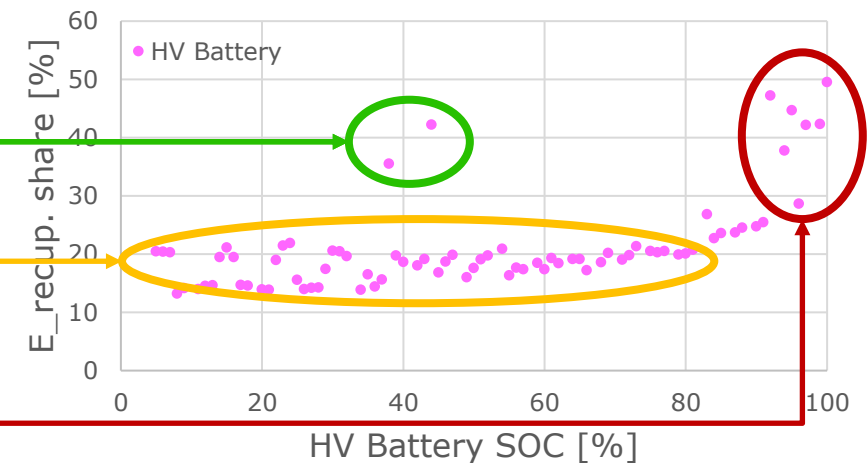


# Performance

## Derating Strategy – EDUs

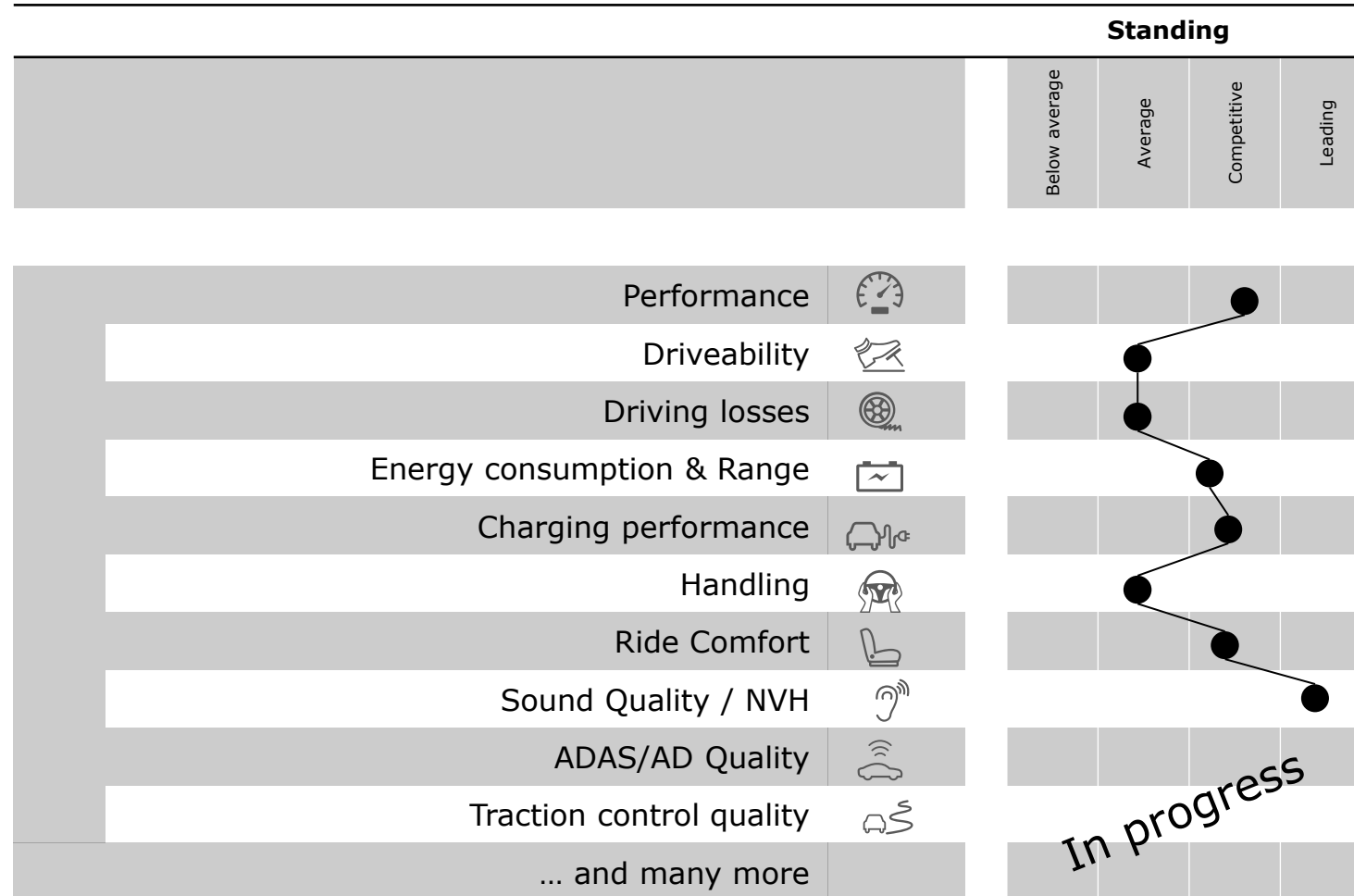


- Max. performance is limited by high motor temperature
- Max. recuperation power for 7 repetitions
- Front motor maintains max. recuperation for 14 repetitions
- After the recovery phases of 40 and 60 seconds the rear motor reaches max. recuperation again
- Energy-recuperation-ratio: 50% at start constant share of ~15-20% when warm



# Global Vehicle Benchmarking

## Executive Results and standing of BMW driving attributes



Let's have a deeper look

# Global Vehicle Benchmarking

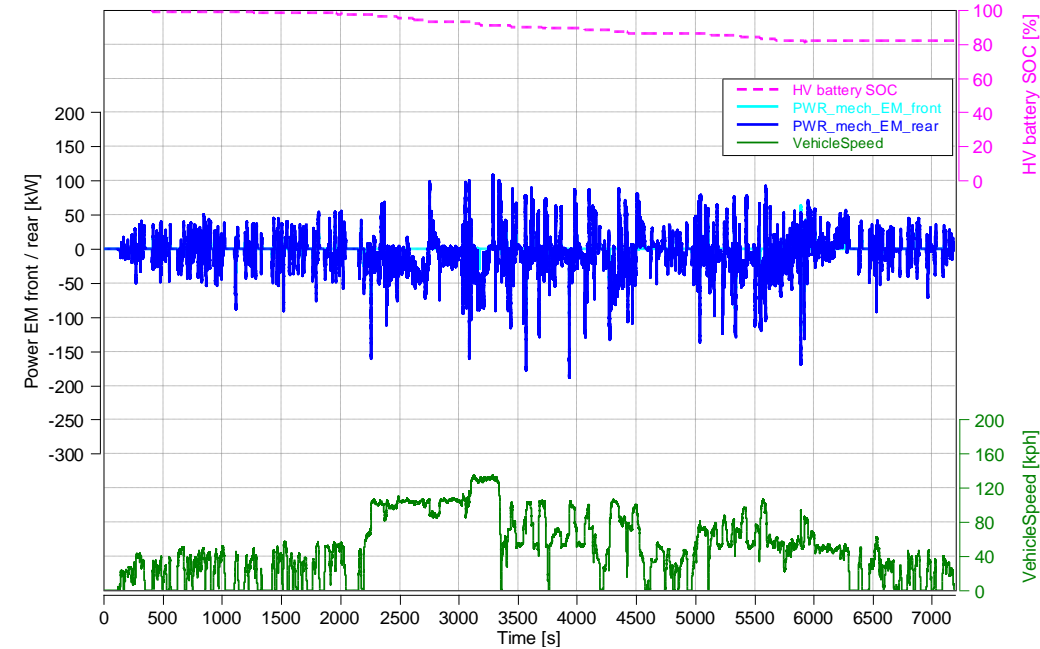
## Executive Results and standing of BMW iX

### Real-World Driving Cycle

#### Energy Management

State of charge			
Start	[%]	100.0	
End	[%]	72.0	
Battery energy demand			
Driving	[kWh]	18.8	
Recharging	[kWh]	19.3	
Grid energy demand			
On-Board-Charger - In	[kWh]	20.9	
Total consumption			
	[kWh/100km]	21.5	
LV-system energy demand	[kWh]	1.2	

Results of all other driving modes available as well



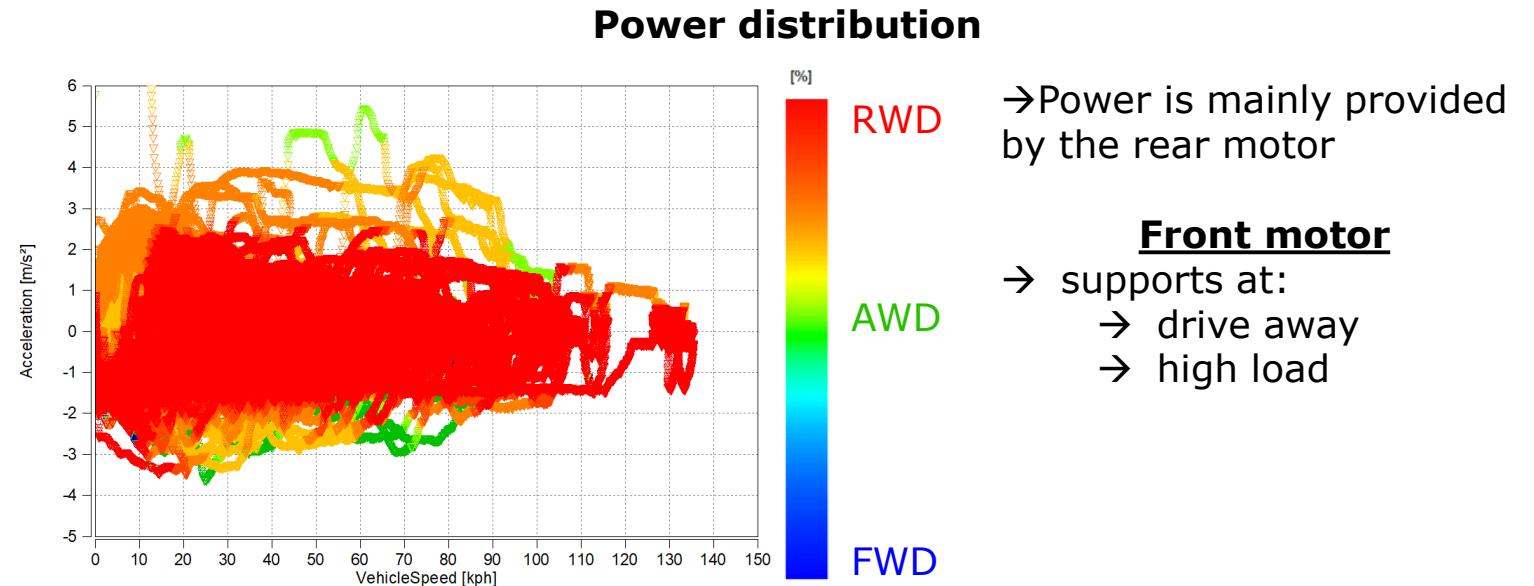
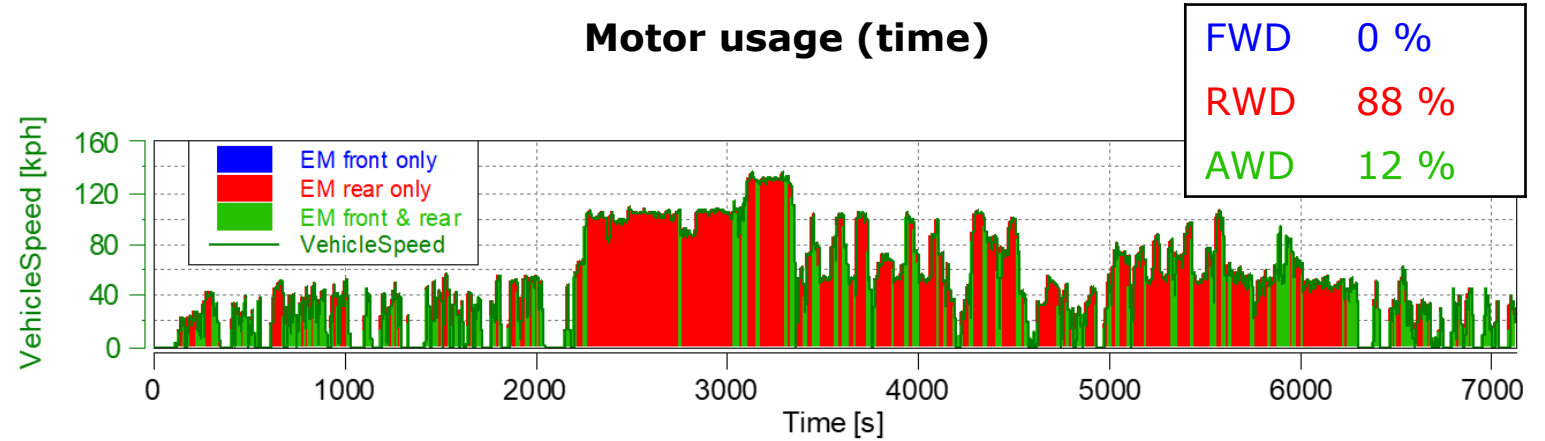
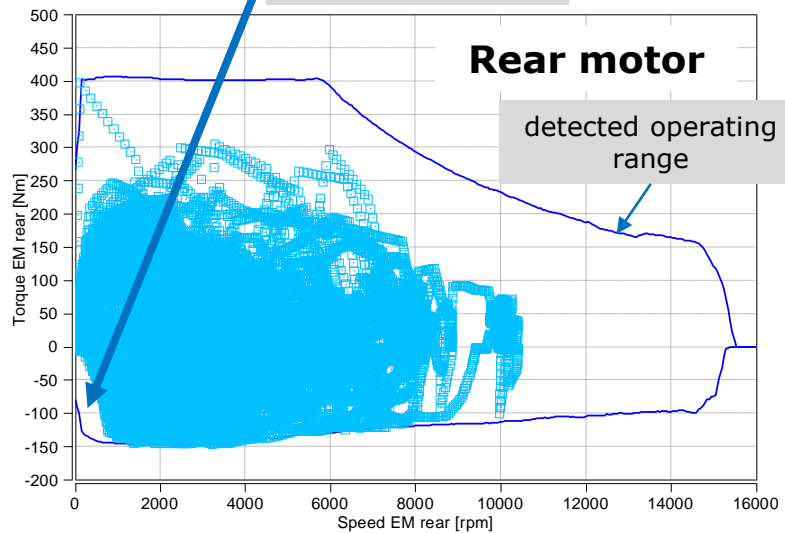
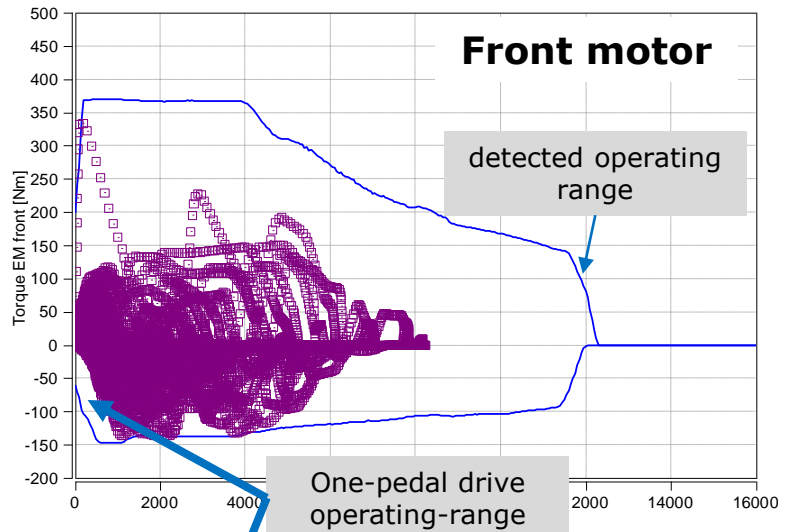
#### Test conditions/settings

Ambient temp.	22 °C
Settings	A/C auto 22 °C
Drive mode	Personal
Driving style	Moderate
Recuperation level	Auto
Re-Charging	AC 11.0 kW at 23 °C



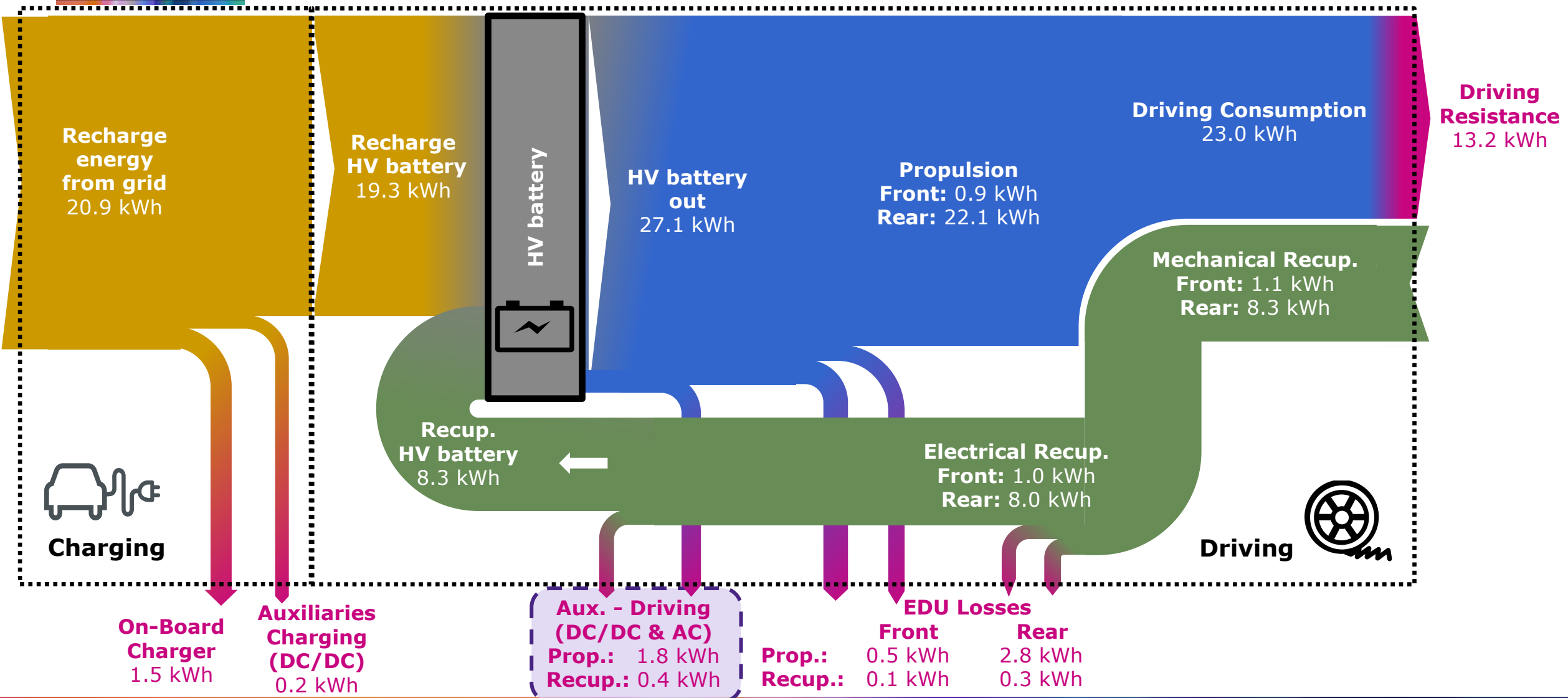
# Energy Management

## Usage of individual e-axes



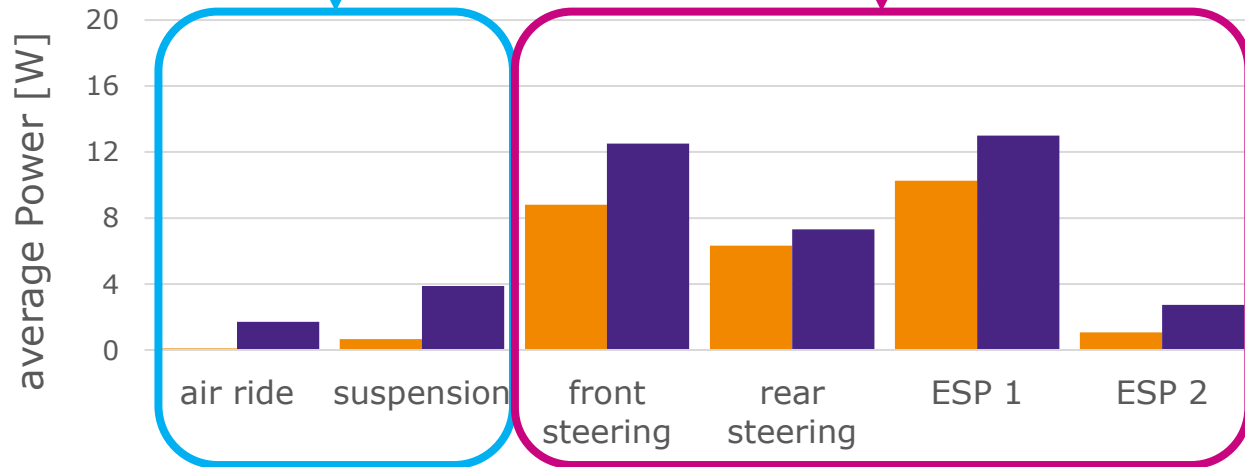
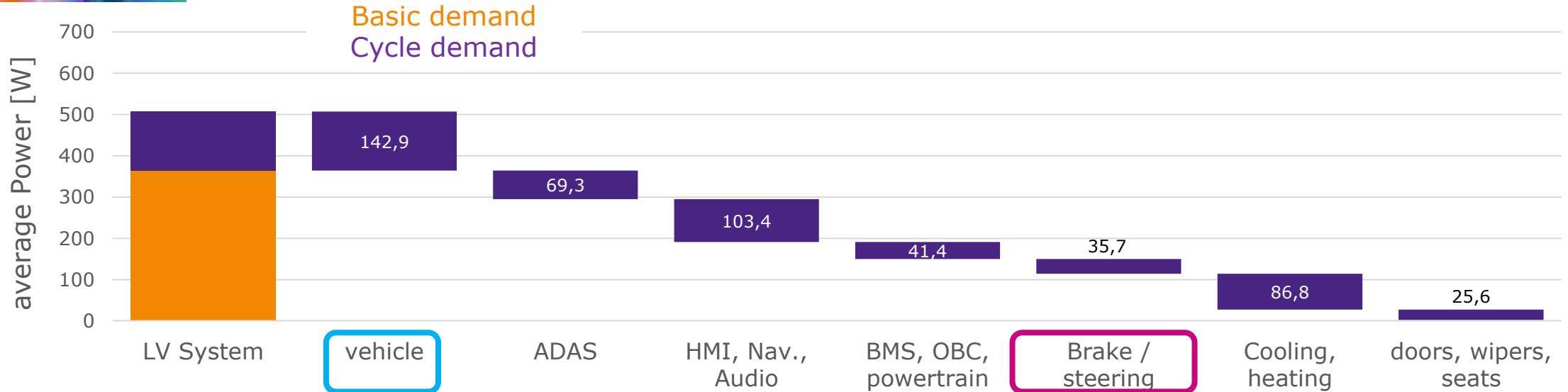
# Energy Management

## Energy flow and losses



# Energy Management

## Aux. & LV power demand



Average power demand increases to ~500W.

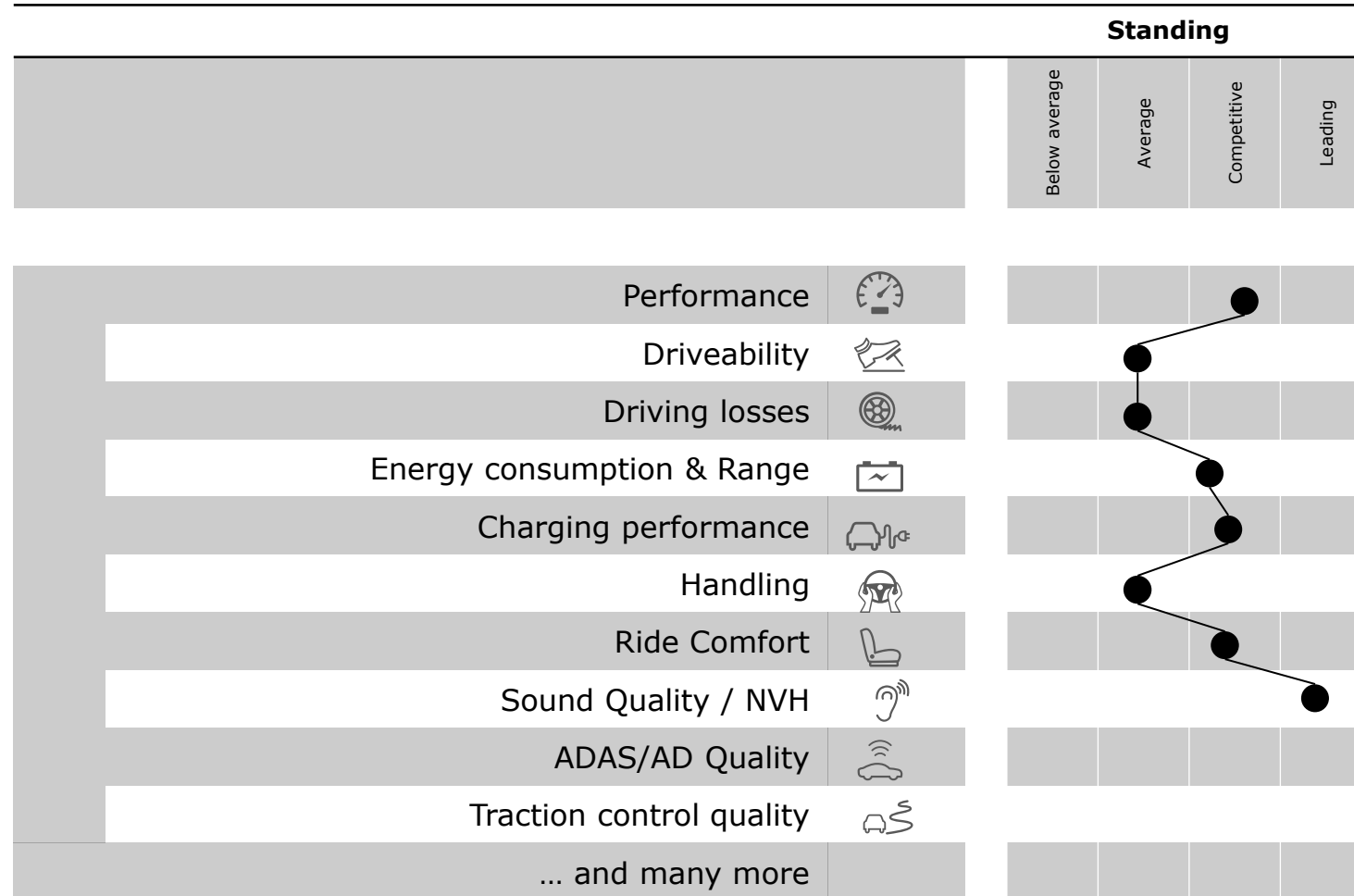
Highest additional demand:

- Body control unit
- HMI
- Cooling fan & blower

How does steering/braking & suspension influence the consumption in RDE cycles? → +15W

# Global Vehicle Benchmarking

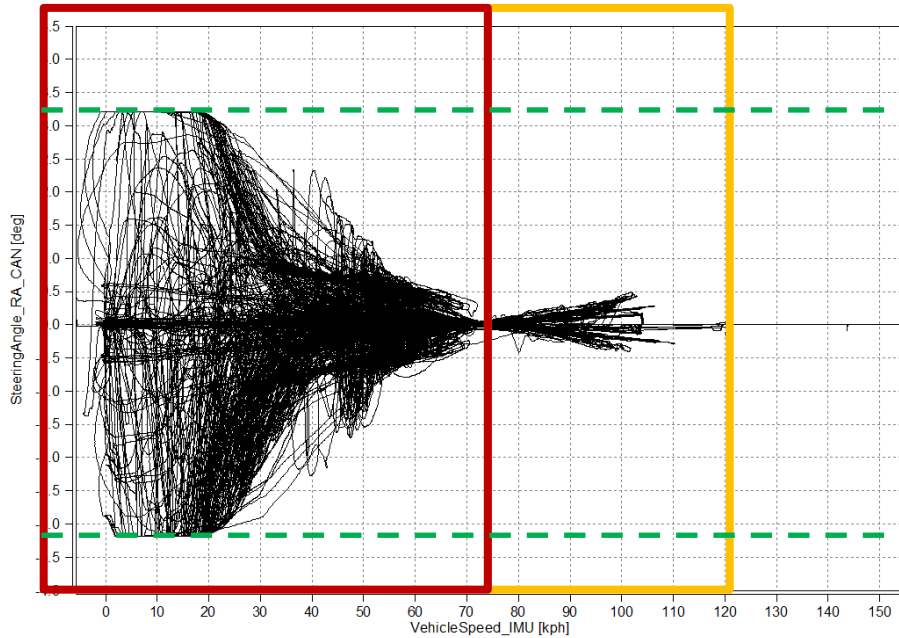
## Executive Results and standing of BMW driving attributes



Let's have a deeper look

# Handling

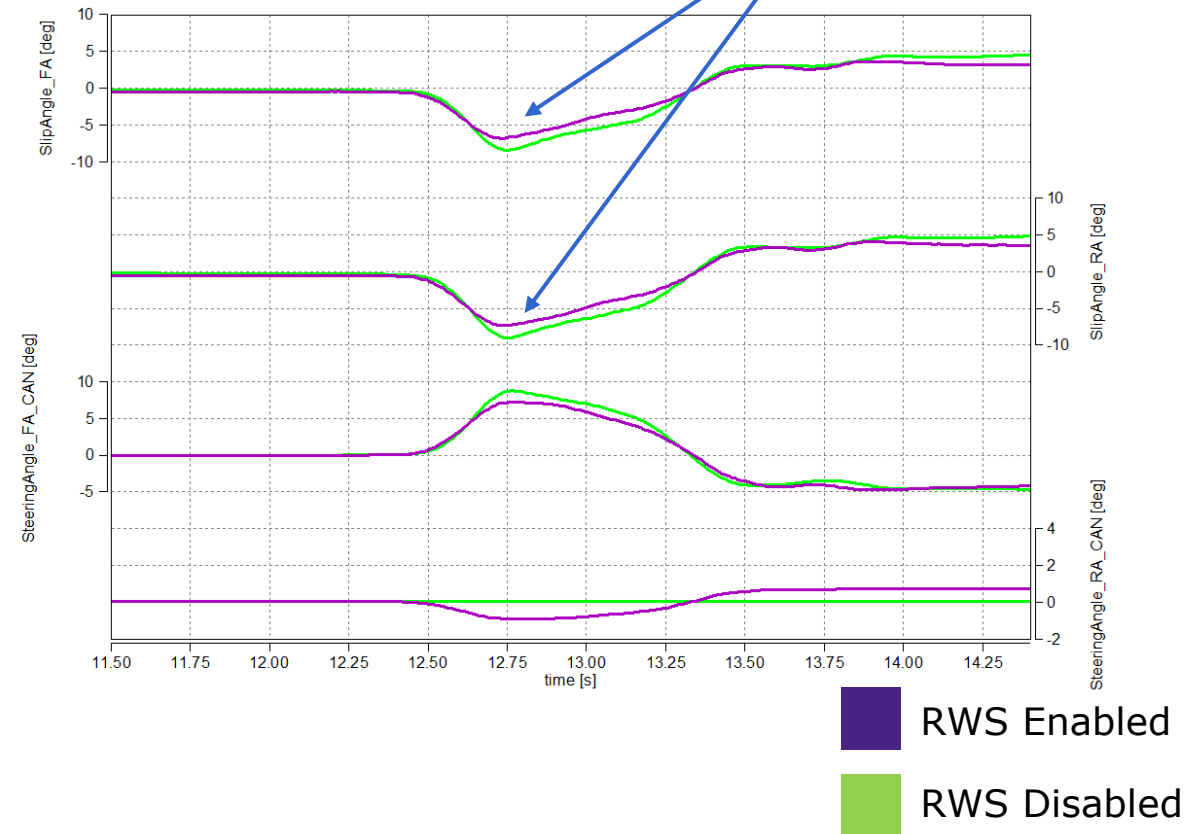
## Double Lane Change – Effect of Rear Wheel Steering



### Rear Wheel Steering:

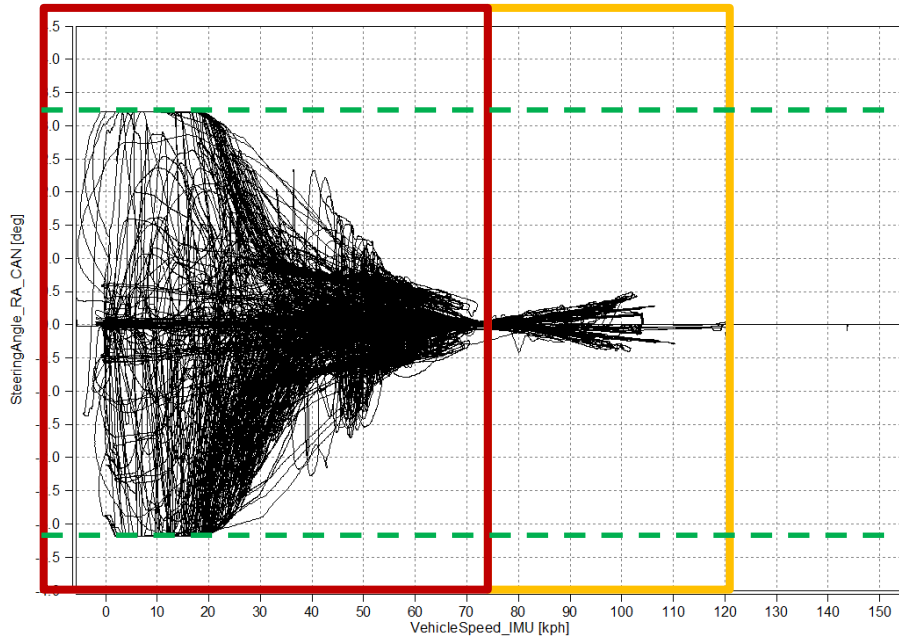
- Max. 3.2 deg up to 25 kph
- Supporting effect  $\leq$  72 kph
- Stabilizing effect  $>$  72 kph

- Reduced front wheel steering-demand when rear wheel steering is active
- Rear Wheel Steering results in less side slip angle on both axes → reduced under/oversteer in 2<sup>nd</sup> and 3<sup>rd</sup> lane



# Handling

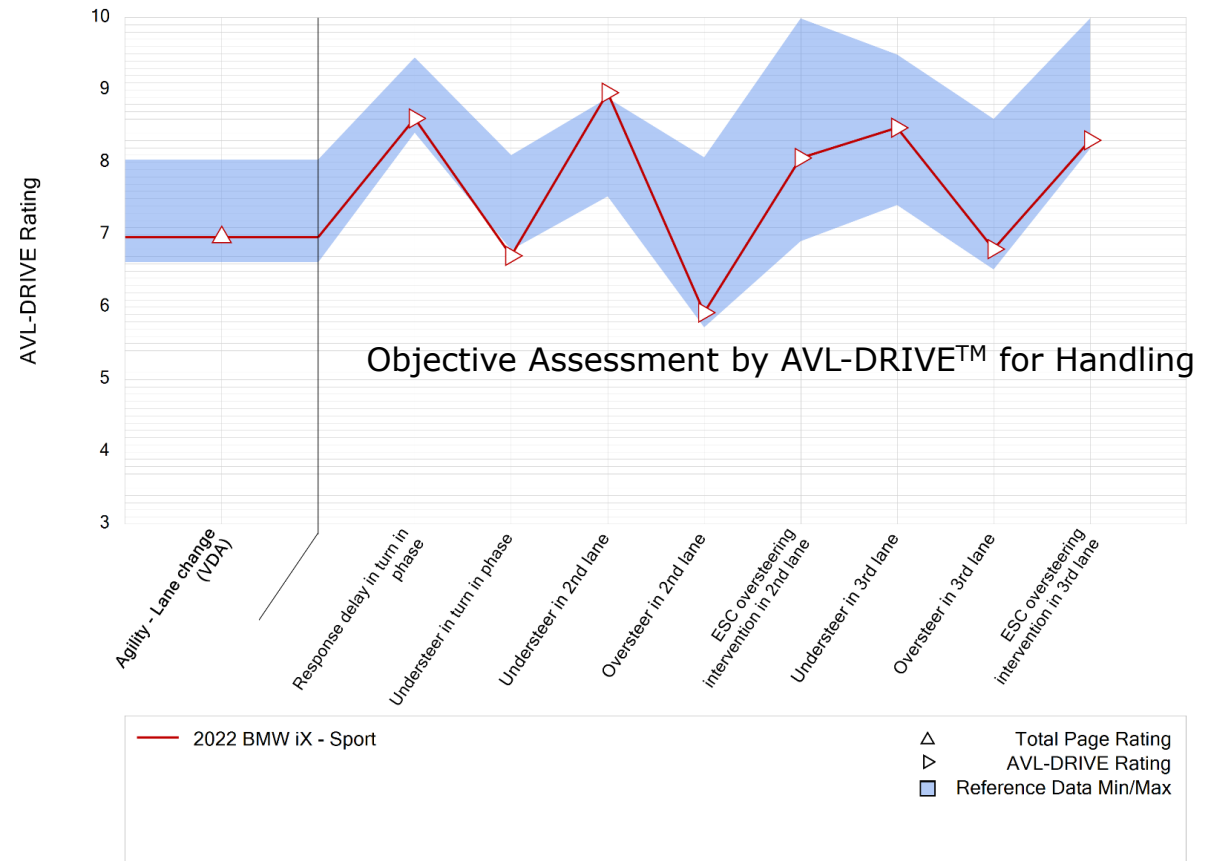
## Double Lane Change – Effect of Rear Wheel Steering



### Rear Wheel Steering:

- Max. 3.2 deg up to 25 kph
- Supporting effect  $\leq 72$  kph
- Stabilizing effect  $> 72$  kph

Rear Wheel Steering enables good VDA-lane change behavior considering high vehicle weight and eco-tires



# Agenda

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# Summary and Conclusions

## Performance

- High performance is achieved due to a robust battery and thermal system
- Standing in AVL's Scatterband → Competitive

## Energy Consumption

- Well balanced motor usage ensures high driving pleasure with AWD and low consumption with RWD, considering the high vehicle weight advanced operating strategy and balanced LV system leads to competitive energy consumption
- Standing in AVL's Scatterband → Competitive

## Handling

- Rear wheel steering reduced the trade off between high weight / eco-tires ensuring good and save dynamics.
- Standing in AVL's Scatterband → Average

# AVL Global Vehicle Benchmarking

## BEV Database

Available now (samples from MY2018-2021)

Mercedes	EQC	2020	EU	SUV
Audi	e-tron 55 quattro	2019	EU	SUV
Audi	e-tron S	2020	EU	SUV
NIO	ES8	2019	CN	SUV
ROEWE	Marvel X	2019	CN	SUV
Tesla	Model Y	2020	US	SUV
Jaguar	I-Pace	2018	EU	SUV
Porsche	Taycan Turbo S	2020	EU	Sport
VW	ID.3 1 <sup>st</sup> Pro	2020	EU	C
Polestar	2	2020	US	D
Tesla	Model 3 75	2019	US	D
VW	ID.4 GTX	2021	EU	SUV
Hyundai	Ioniq 5 AWD	2021	EU	SUV
Toyota	Mirai FuelCell 2	2021	EU	D

## Benchmark highlights in progress

Europe



Mercedes EQS

USA



Tesla Model S Plaid



BMW iX xDrive50



Lucid Air



<https://app.avl.com/benchmarking-program>



How functions & features contribute to high level of driving excitement and efficiency on the BMW iX

# Q&A

# Contact

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