virtual vehicle

Enabling Future Vehicle Technologies

Components and Systems for Next Generation EVs

Sys2Wheel – Project summary & highlights,
HiPE – Project introduction

Alois Steiner, Christian Doppler, Bernhard Brandstätter

A3PS, Eco-Mobility 2022, 24.11.2022

www.v2c2.at

sys2WHEEL
co2 free city logistics

Integrated components, systems and architectures for efficient adaption and conversion of commercial vehicle platforms to 3rd generation BEVs for future CO2-free city logistics

Sys2Wheel – Project summary & highlights

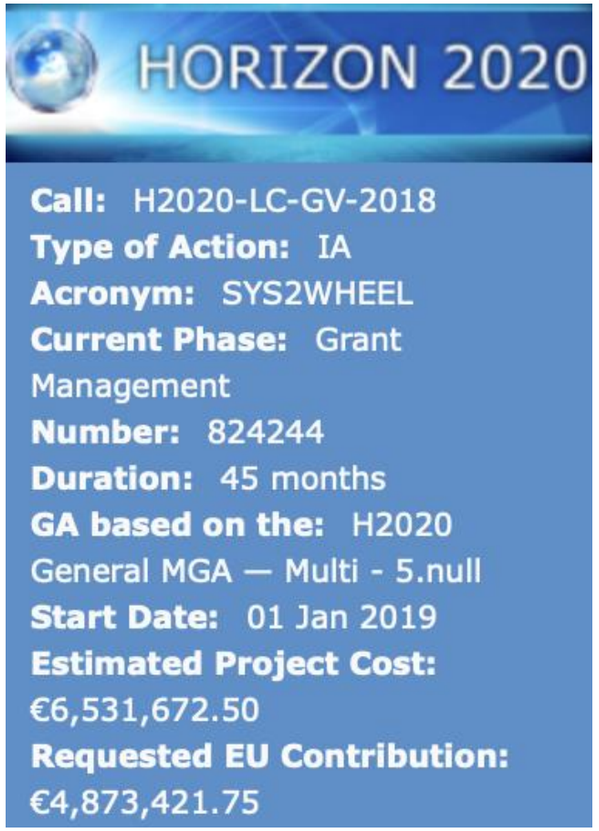
virtual vehicle
IVECO
FPT POWERTRAIN TECHNOLOGIES
LANCIA FIAT Jeep
TOFAŞ TÜRK OTOMOBİL FABRİKASI A.Ş
AVL
Applus IDIADA
elaphe Propulsion Technologies
UNIVERSITY OF SURREY
TTTechAuto
IESTA
HiWi tronics
R3E

Overall project introduction

Cost efficient, scalable electric drivetrains for commercial vehicles (N1 and N2) consisting of…

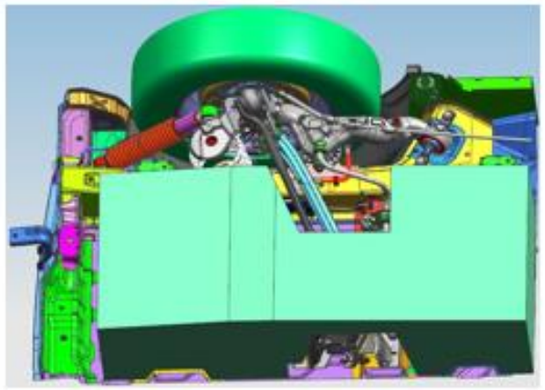
- **Electric axle**
- **In wheel-motors**
- **Advanced control strategies**

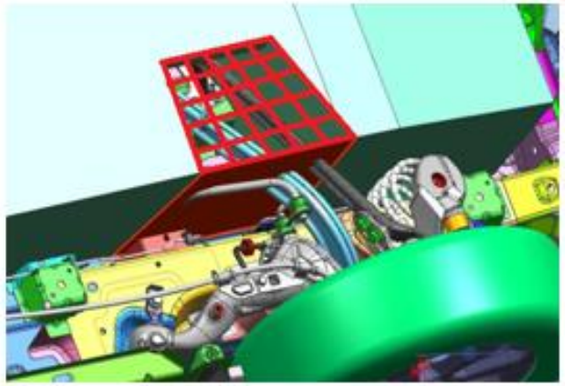
https://sys2wheel.eu



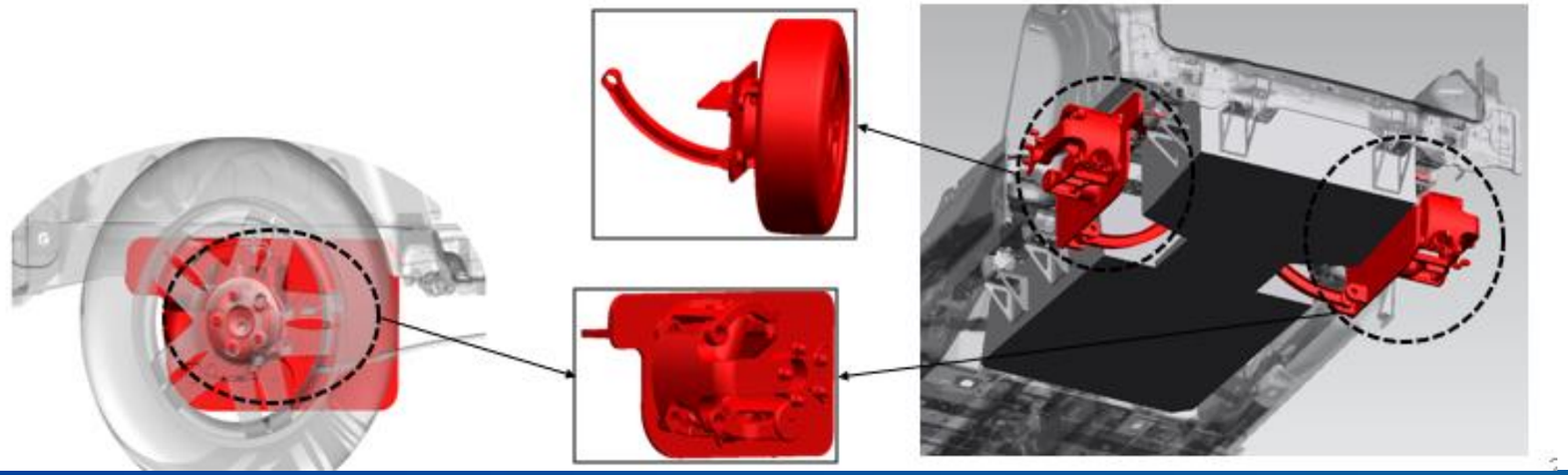
Overall project introduction

Innovations for N1 category vehicle

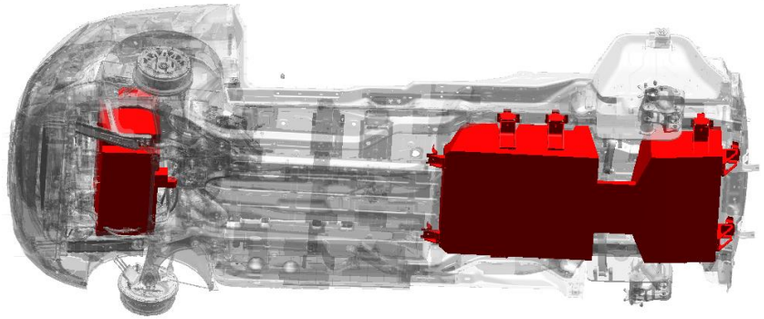




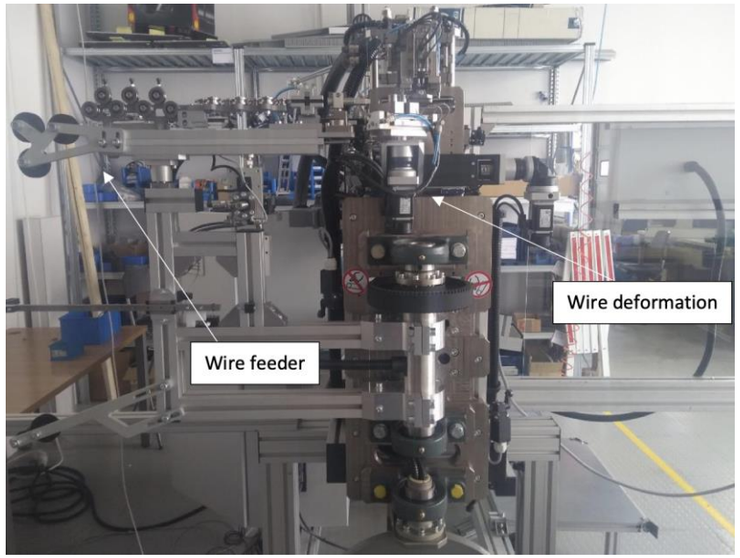
Close-to-wheel suspension for additional cargo and/or battery



Innovations for N1 category vehicle



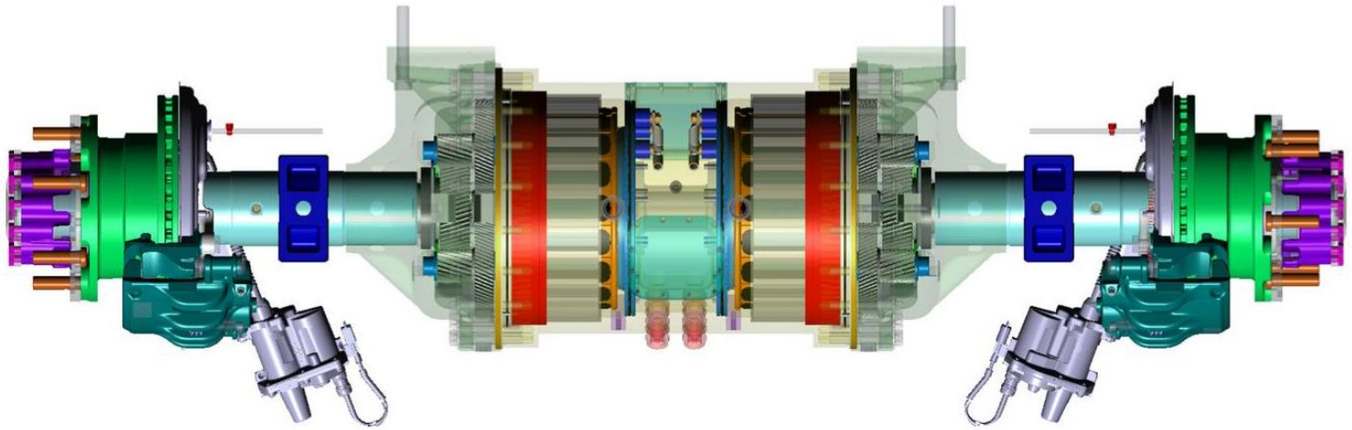
In-wheel motor: increased range via space for battery and efficiency increase



In-wheel motor: cost-reduction for motor components and production

Parameter	Value (VD1 EM design spec)	Unit
Supply Voltage (nominal)	355	V DC
Supply voltage (range) for motor	284 – 400	V DC
Boost torque (10 sec) @ 200 rpm	1050**	Nm
Continuous torque (> 30min) @ 780** rpm	500**	Nm
Boost torque phase current	300**	Arms
Continuous torque phase current	120**	Arms
Max. speed (no-load) @ 355 V DC	830** Max speed is simulated at temperature 40°C. At -40°C environmental temperature top speed will decrease by up to 10%. ** At +85°C environmental temperature, the top speed can be increased by 10%.**	rpm
Max. speed (no-load) @ 400 V DC	940** Max speed is simulated at temperature 40°C. At -40°C environmental temperature top speed will decrease by up to 10%. ** At +85°C environmental temperature, the top speed can be increased by 10%.**	rpm
Max. speed (with field weakening) @ 355 V & 300 Nm	1020 rpm** (@300 Nm); 1080 rpm** (no load) @ ID=-75A	rpm
Max. speed (with field weakening) @ 400 V & 300 Nm	1150 rpm** (@300 Nm); 1220 rpm** (no load) @ ID=-75A	rpm
Max. output power (Id = 0) (Net Power; ECE R85) (Torque, speed)	73,7 (640 rpm, 1100 Nm) **	kW

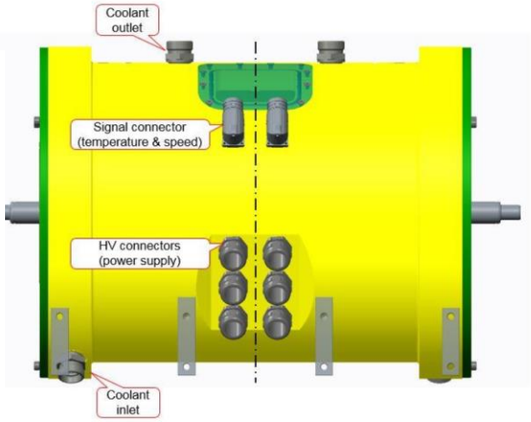
Fully Modular E-AXLE for N2 Vehicle

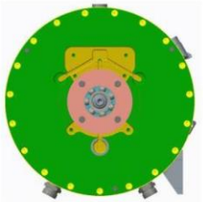


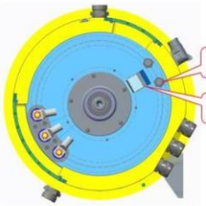
Highly efficient and cost effective e-motor for e-Axle

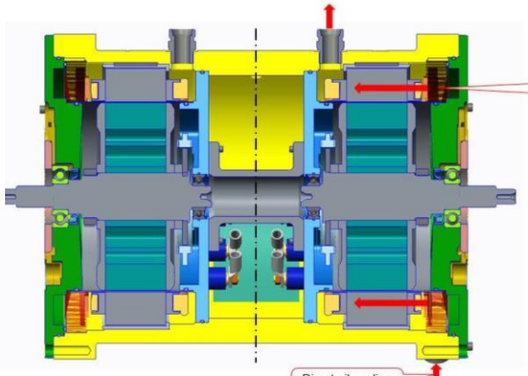
E-Motor (single)

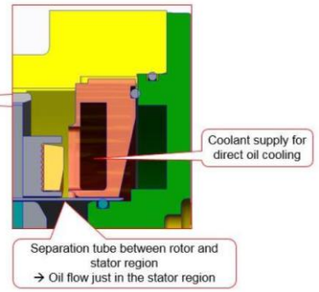
kind of machine	-	PMSM
max diameter (passiv)	m	0,3
max lenght (passiv)	m	0,18
max speed machine	rpm	8200
peak max motor torque	Nm	290
peak max power machine	kW	72,5
cont max motor torque	Nm	180
cont max power machine	kW	50
full performance voltage range	V	270 .. 400





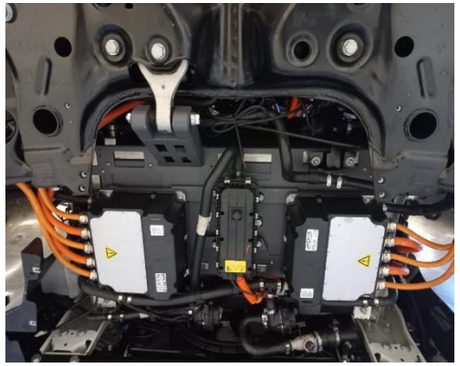






N1 demonstrator on test track

Innovations for N1 category vehicle



Additional features:

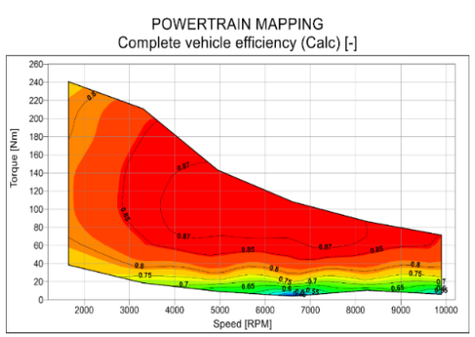
- Improved thermal management
- Time sensitive network (TSN)

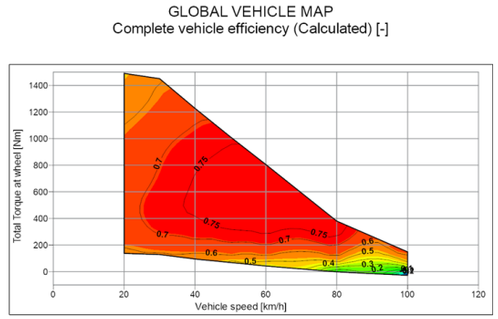
Vehicle Evaluation

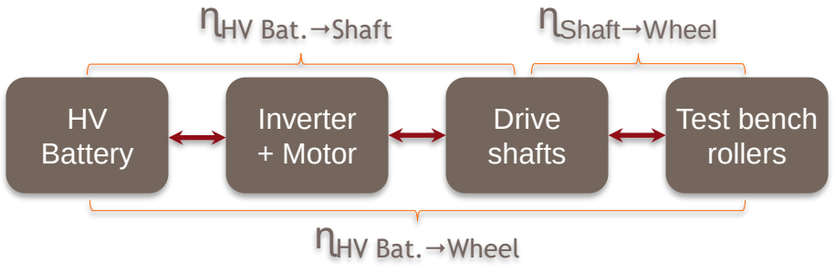
- Efficiency

Main goals

- Assess different methodologies to compare energy consumption
- Verify improvement of powertrain efficiency







Mid to long term expected impact of the project

Identifier	Expected impacts of H2020-LC-GV-01-2018 Call	Achievements of SYS2WHEEL to meet the impact
Cost reduction	20% cost reduction in mass production (in comparison to the best current generation components) and user friendliness in terms of reach and charging procedures.	• Scalable e-motor with **reduced rare earth material** content and fully automated production • **Fully scalable e-axle** • **Reduction of components on** vehicle level • **Fail Safe system** through deterministic ethernet leads to a reduction of cabling effort and control components ensuring safety
System Improvement	long duration trips (e.g. 700-1000 km day trips across different Member States) with not more than 60-90 minutes additional travel time and without additional degradation impact on the FEV powertrain including the battery	• In-wheel systems lead to **increased space for cargo** (business case for logistics companies) **or battery** (for customers with increased range need) • Advanced control developed in SYS2WHEEL increases efficiency
Efficiency increase	Significant advancements of e-powertrain technology	• **In-wheel system and fully scalable e-axle** • **Highly efficient e-motors**
Quality	Automotive quality enabled in the whole system with new functionalities.	• NVH consideration prior to integration • Fail safe functionality provided by time sensitive networks

Expected Market Uptake of Technologies by industrial partners

In-wheel motors	car makers	end of 2021	increase in number of sold motors
Cost effective e-motor	car makers	end of 2022	increase in number of sold e-motor solutions
E-axle system	car makers		end of 2022
Zero emission vehicle for last mile delivery	fleet operators	end of 2023+	new customers, and keeping existing customers
In-wheel energy harvesting device	Continuous measurement of wheel/road data	end of 2022	increased number of sold pieces per year (>50)
TSN	car makers	Already started	

virtual vehicle

Enabling Future Vehicle Technologies

Project introduction

HiPE - High Performance Power Electronics Integrations

Alois Steiner, Christian Doppler,
Bernhard Brandstätter

A3PS, Eco-Mobility 2022, 24.11.2022

www.v2c2.at

Introduction

Call Information:

- HORIZON-CL5-2021-D5-01-02: Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)
- Type of Action: Research and Innovation Action (RIA)
- Technology Readiness: Activities are expected to achieve TRL 5-6

Project Information:

HiPE - High Performance Power Electronics Integrations

Budget Total: 5.8 Mio€

Starting Date: 01.11.2022

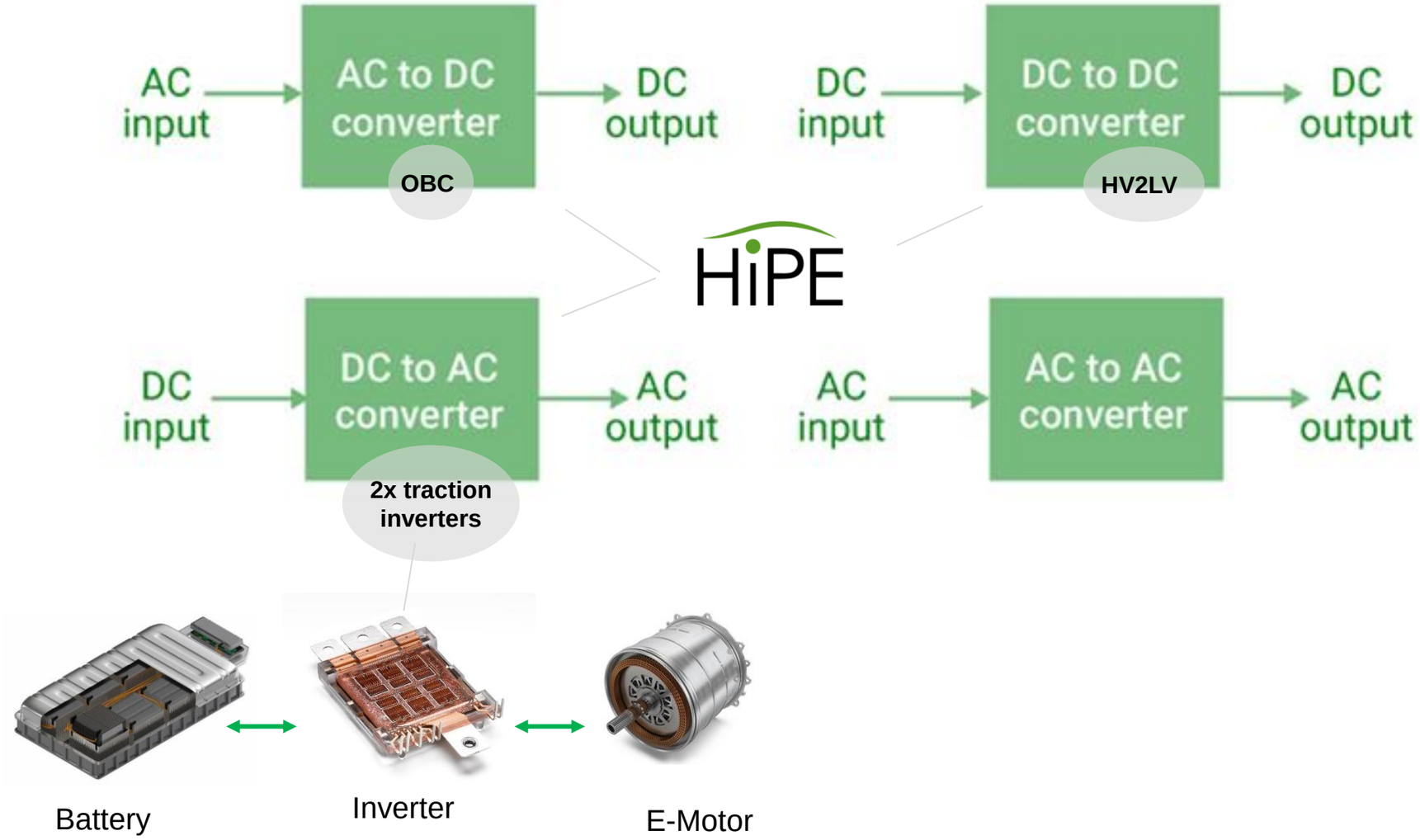
Duration: 3 years

HiPE

High Performance Power Electronics Integrations

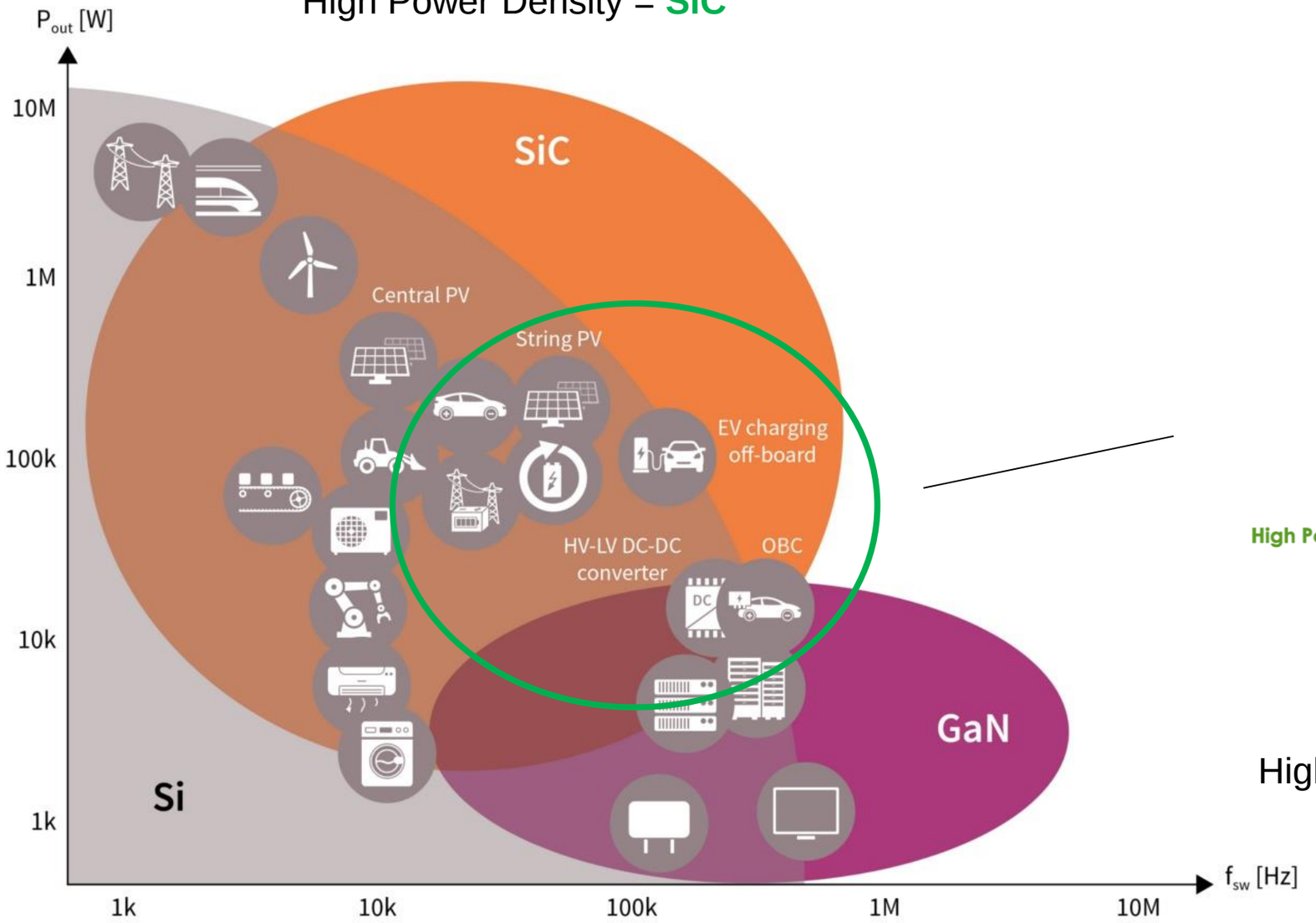
Background

There are 4 types of power electronics:



Background

High Power Density = **SiC**



https://www.infineon.com/cms/en/product/technology/wide-bandgap-semiconductors-sic-gan/

HiPE

High Performance Power Electronics Integrations

High Frequency = **GaN**

Consortium

HiPE consortium brings together **13 participants** from industrial and research
→ whole relevant value chain

to **develop a new family of** highly energy-efficient, cost-effective, modular, compact and integrated **wide bandgap (WBG) power electronics** solutions

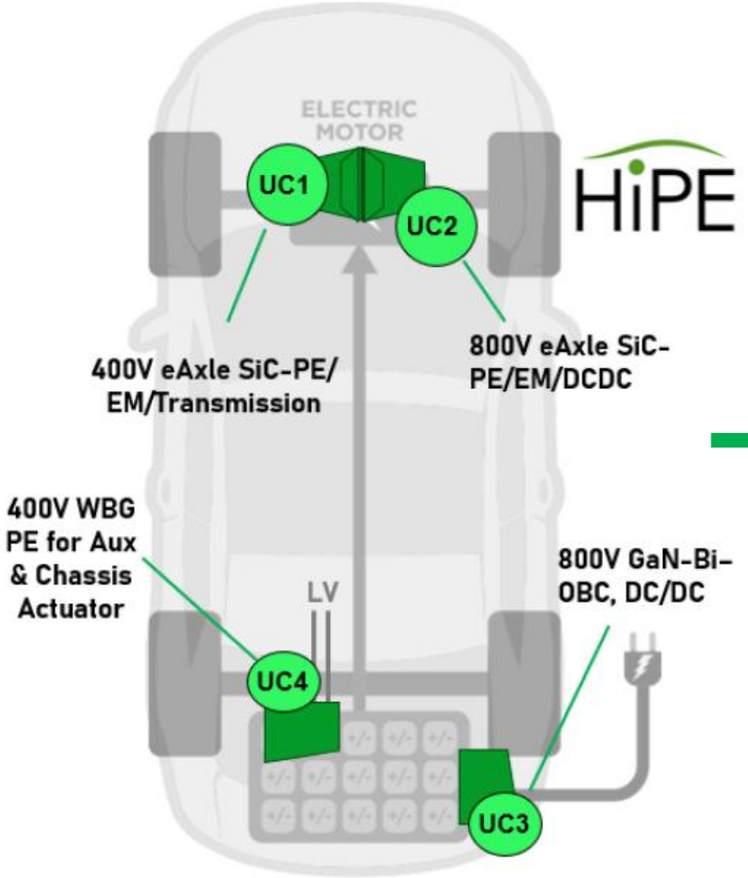
for the **next generation of battery electric vehicles (BEVs)**, and to facilitate a significant market penetration of WBG in the automotive sector.

Project Content

Scalable and modular family of WBG-based traction inverters

- Significantly **improved specific cooling performance** (integrated double-side pin-fin and immersion/impingement/two-phase cooling)
- Suitable for **400V, 800V** and 1200V applications
- Power ratings from **50 to 250 kW**
- **Innovation in circuit topologies**, electro-magnetic interference filters
- Stray inductance reduction, Improved DC-link capacitors, materials
- Intelligent and **predictive controllers** to optimize performance
- **Self-adaptive digital-twin-based** methodologies

The HiPE work plan includes four experimental Use Cases



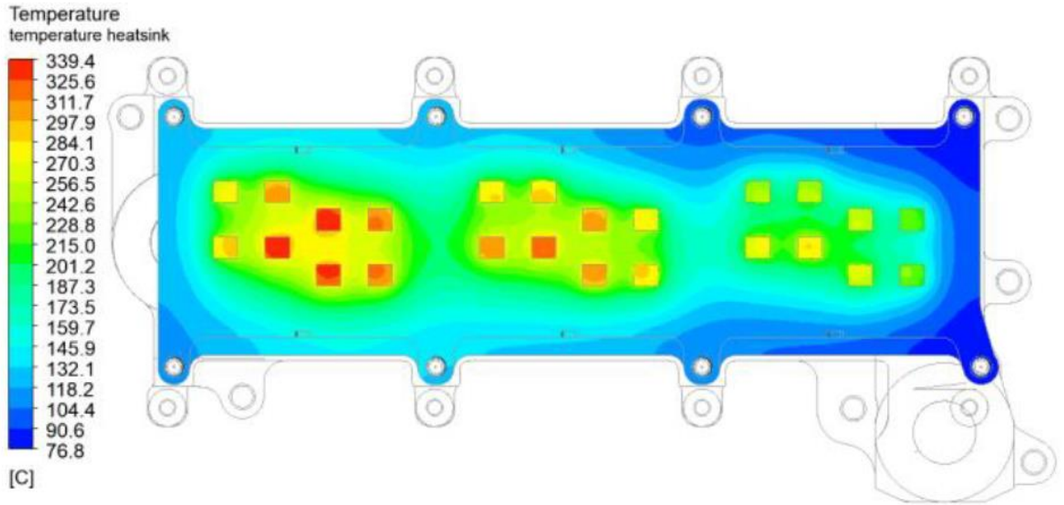
Two integrated 400V and 800V WBG-based electric axles **(Use Cases 1 and 2)**

Integrated WBG-based OBCs and HV/LV DC/DC converters **(Use Case 3)**

WBG-based actuation of ancillaries and chassis components **(Use Case 4)**

Thermal Management

Challenge: High-Temperature Spots (300°C) on Power Electronics

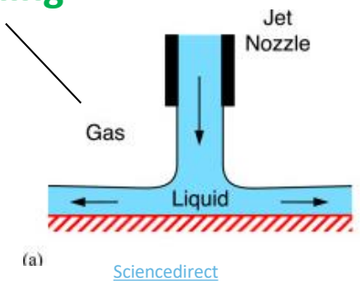


HiPE

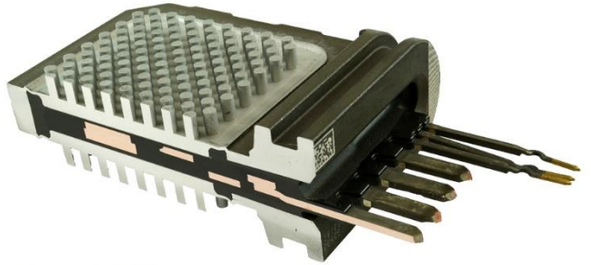
HiPE will provide **improved cooling** with integrated sensing and higher local heat rejection → higher currents and SiC material reduction and reduced load of auxiliaries

Improved inverter designs with pin-fin dual-sided, direct cooled transfer molded half bridge power modules

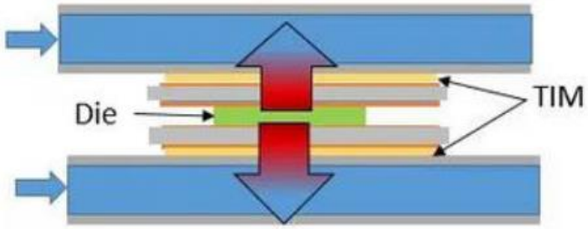
Investigate novel technologies like (free surface)
jet impingement cooling



Sciencedirect

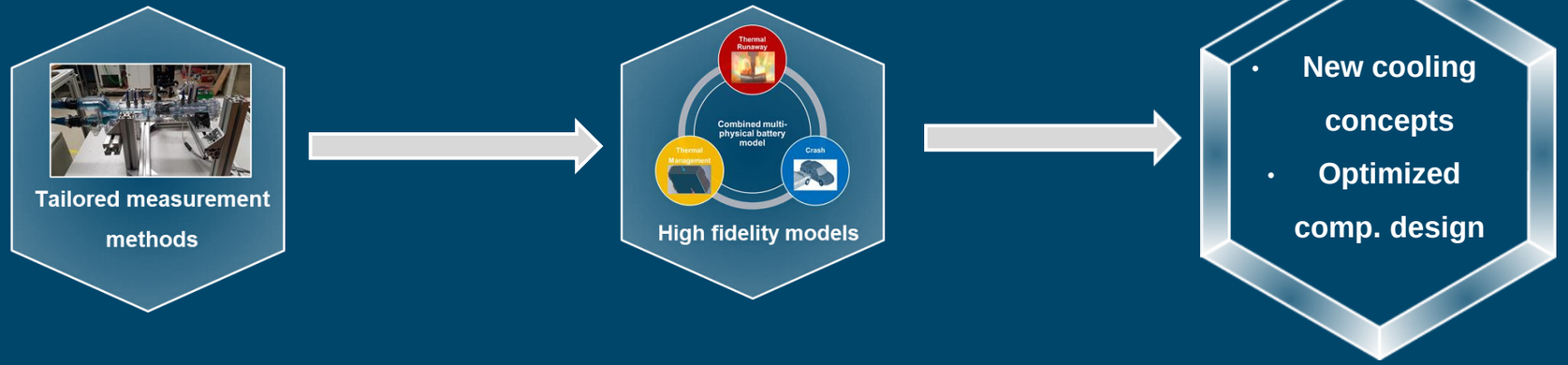


Systemplus.fr

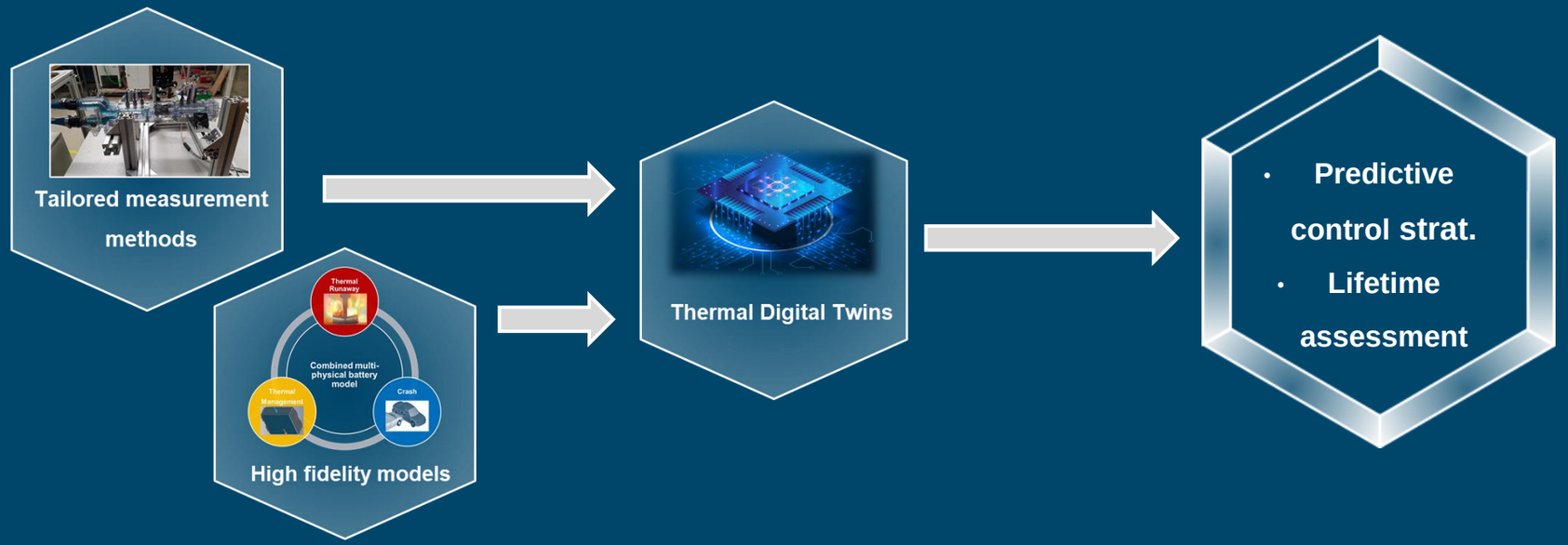


Cooling Lab applications

1. Local operation dependent temperature detection



2. Local operation dependent temperature prediction



virtual vehicle

Enabling Future Vehicle Technologies

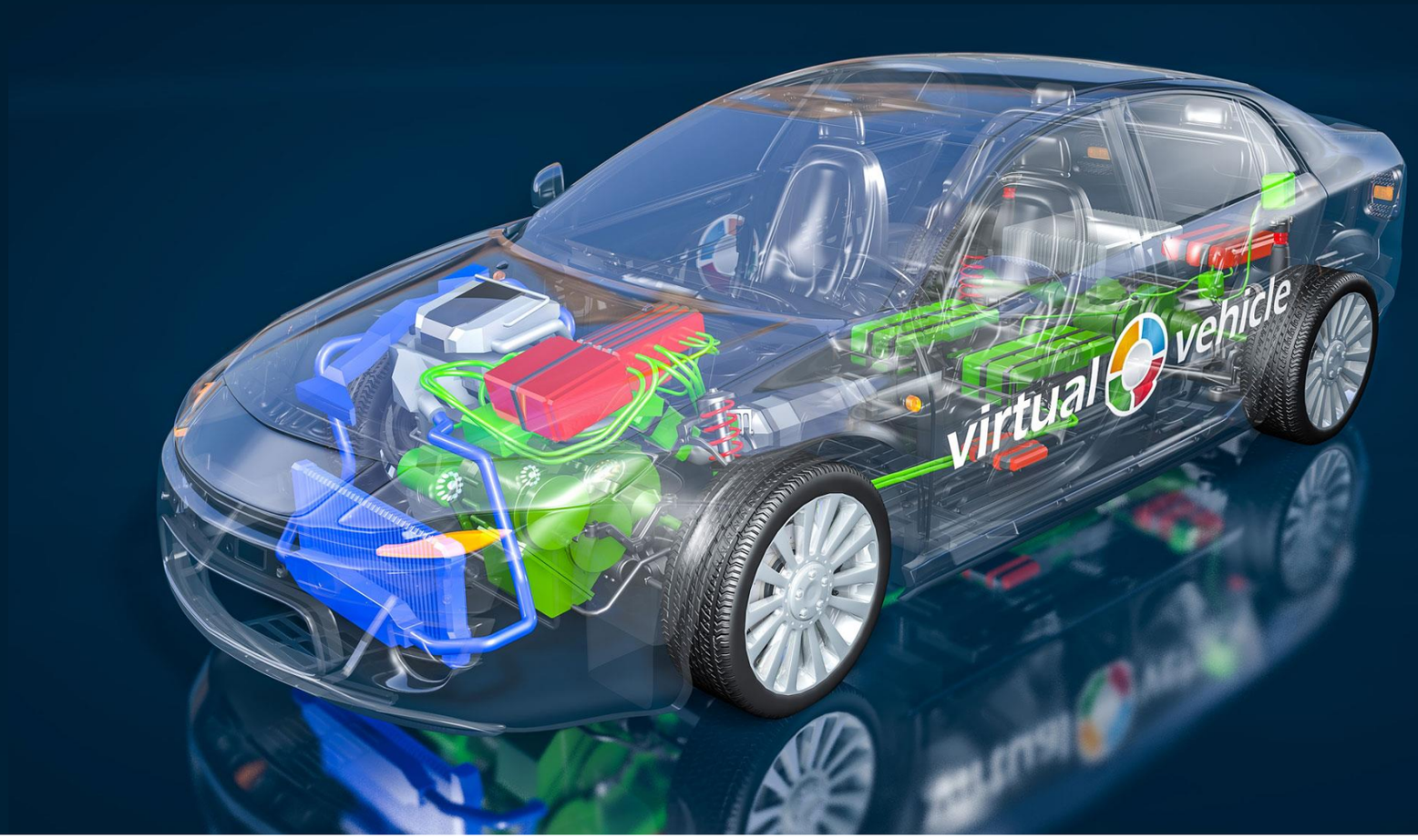
THANK YOU

Alois Steiner, Christian Doppler, Bernhard Brandstätter

Department Energy Efficiency & Human Centered Systems
VIRTUAL VEHICLE Research GmbH

christian.doppler@v2c2.at

24.11.2022



www.v2c2.at

Federal Ministry Republic of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology
Federal Ministry Republic of Austria Digital and Economic Affairs
FFG Promoting Innovation.
Das Land Steiermark
SFG
TU Graz Graz University of Technology

Virtual Vehicle Research GmbH has received funding within COMET Competence Centers for Excellent Technologies from BMK, BMDW, the Province of Styria (Dept. 12) and the Styrian Business Promotion Agency (SFG). The Austrian Research Promotion Agency (FFG) has been authorised for the programme management.