Research & Efficient Development for Sustainable Mobility

A3PS Wien, 25/11/2022

List, Georg

Efficient Development of Sustainable Mobility Solutions

- What are critical unresolved challenges of modern powertrain technologies?

- Research is tackling (many of) these, but with sufficient focus?

- How can we resolve the challenges fast and bring solutions to market?

Key take-aways from the presentation:

- The challenges are solvable, but not to be underestimated!

- Research remains critical to accelerate & boost sustainable mobility

- Fast, efficient & digital development is key

Challenges on the path
to sustainable mobility – examples ...

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CO2 Footprint
Affordability

Power Density
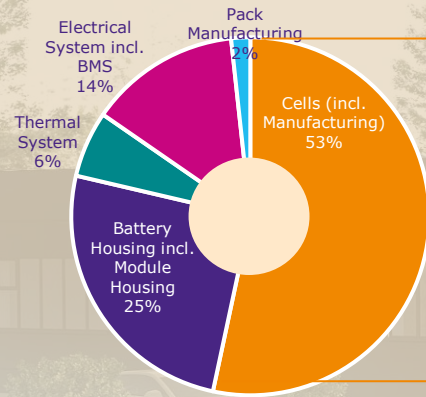Durability

Green H2
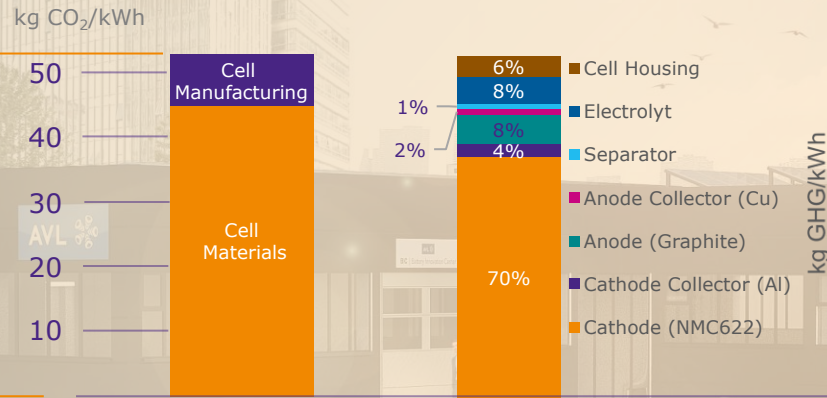Efficient P-to-X

E-motor
innovation

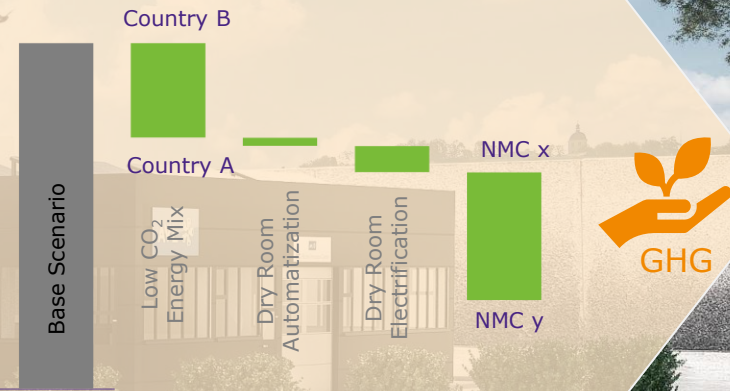# Battery Challenge: Balance GHG reduction and affordability AT PRODUCTION
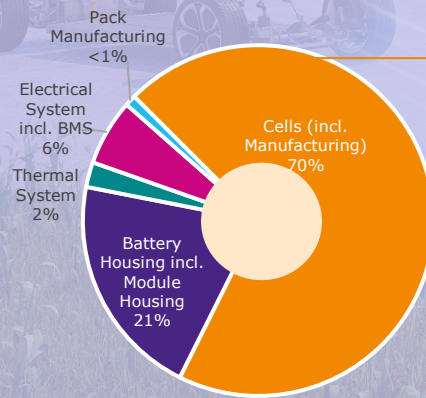
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GHG Share of Battery Pack*

- Pack Manufacturing 2%
- Electrical System incl. BMS 14%
- Thermal System 6%
- Cells (incl. Manufacturing) 53%
- Battery Housing incl. Module Housing 25%

GHG Share of Battery Cell

kg CO_2/kWh

- Cell Manufacturing
- Cell Materials

Values: 50, 40, 30, 20, 10

- Cell Housing 6%
- Electrolyt 8%
- Separator 1%
- Anode Collector (Cu) 8%
- Anode (Graphite) 2%
- Cathode Collector (Al) 4%
- Cathode (NMC622) 70%

Selected CO2 Reduction Potentials

kg GHG/kWh

- Base Scenario
- Low CO_2 Energy Mix
- Dry Room Automatization
- Dry Room Electrification
- Country A
- Country B
- NMC x
- NMC y

GHG

BALANCED

Cost Share of Battery Pack*

- Pack Manufacturing <1%
- Electrical System incl. BMS 6%
- Thermal System 2%
- Cells (incl. Manufacturing) 70%
- Battery Housing incl. Module Housing 21%

Cost Share of Battery Cell

€/kWh

- Cell Manufacturing
- Cell Materials

Values: 100, 80, 60, 40, 20

- Cell Housing 4%
- Electrolyt 12%
- Separator 17%
- Anode Collector (Cu) 9%
- Anode (Graphite) 4%
- Cathode Collector (Al) 3%
- Cathode (NMC622) 51%
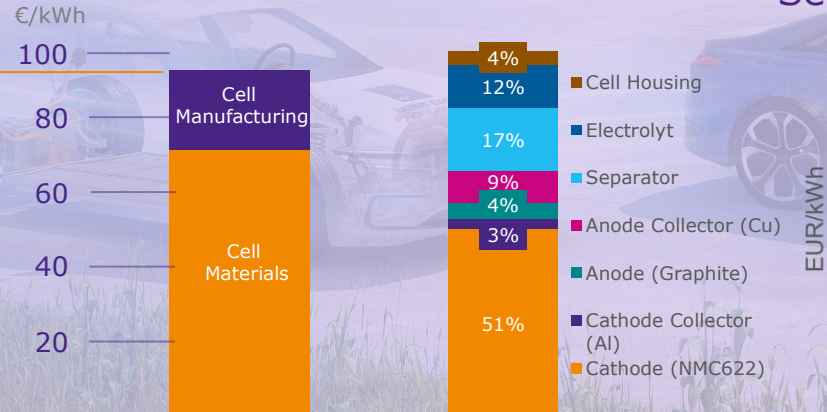
Selected Cost Reduction Potentials

EUR/kWh

- Base Scenario
- Low CO_2 Energy Mix
- Dry Room Automation
- Dry Room Electrification
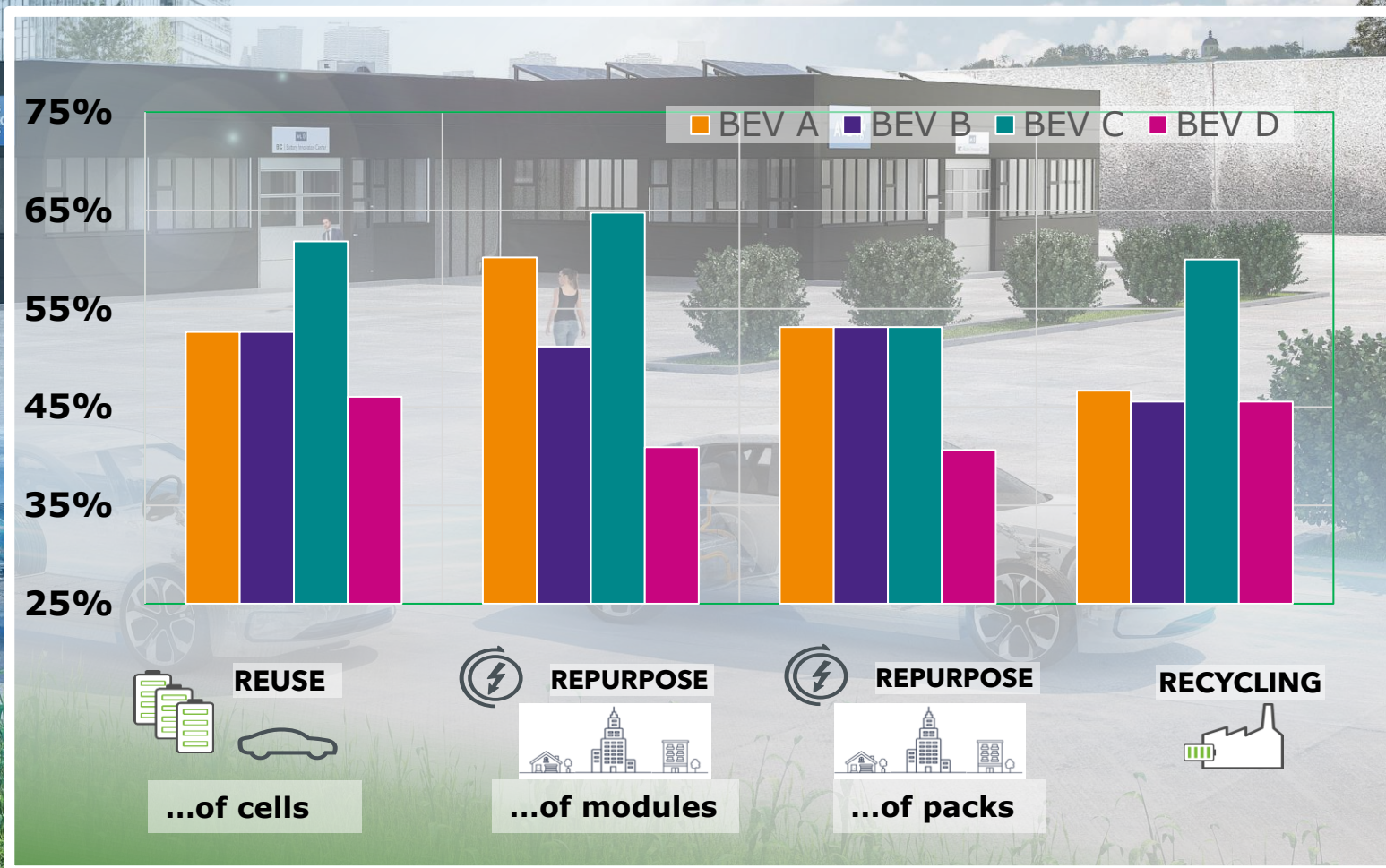- High Capacity Active Material

€

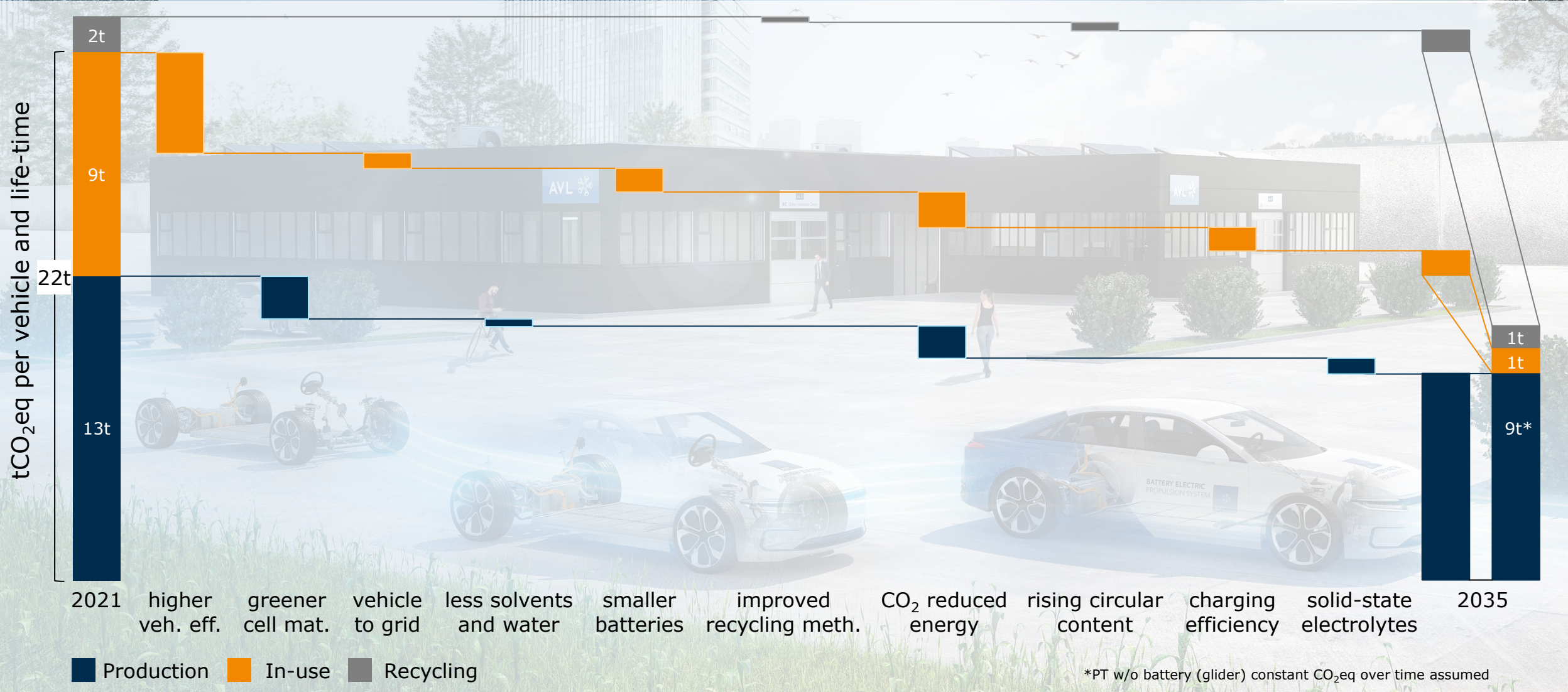*60 kWh battery pack size assumed with NMC622/G cells

Battery product & process development @ AVL Battery Innovation Center (BIC)

- Data driven production process optimization

- Decarbonization of process steps (modules / packs)

- Benchmarking

- Design for re-use / re-purpose (& re-cycle)

Legend: BEV A, BEV B, BEV C, BEV D

Chart axis: 25%, 35%, 45%, 55%, 65%, 75%

REUSE — ...of cells
REPURPOSE — ...of modules
REPURPOSE — ...of packs
RECYCLING

The solution must be batteries with a <u>much</u> better CO2 balance

tCO$_2$eq per vehicle and life-time

2t
9t
22t
13t

1t
1t
9t*

| 2021 | higher veh. eff. | greener cell mat. | vehicle to grid | less solvents and water | smaller batteries | improved recycling meth. | CO$_2$ reduced energy | rising circular content | charging efficiency | solid-state electrolytes | 2035 |

■ Production ■ In-use ■ Recycling

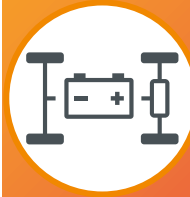*PT w/o battery (glider) constant CO$_2$eq over time assumed

Some of the key challenges across the different transport & mobility relevant sustainable solutions

High power density for efficient, affordable sustainable transport
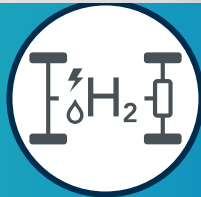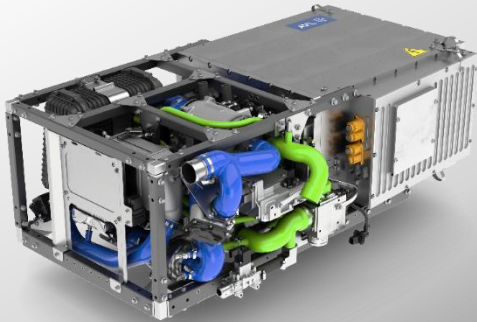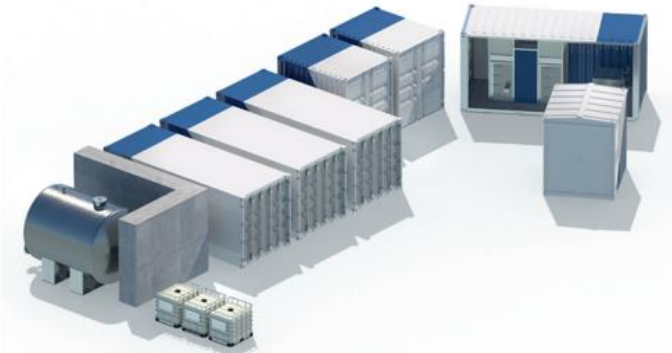
150kW HD Fuel Cell Syst. AVL Fuel Cell Test Center

Innovation of "mature" e-motor & power electronic technologies
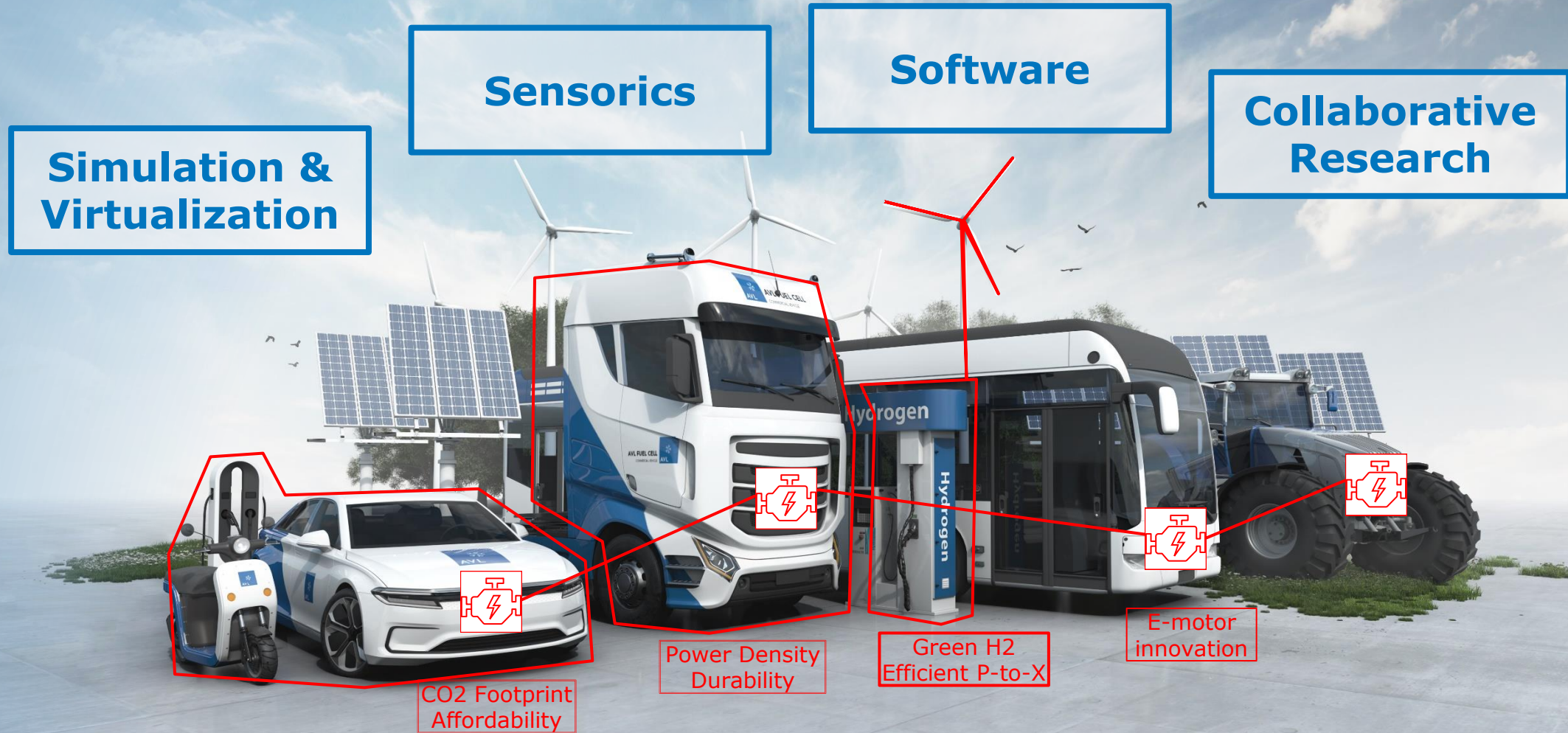
AVL Spectra & Inverter Testing

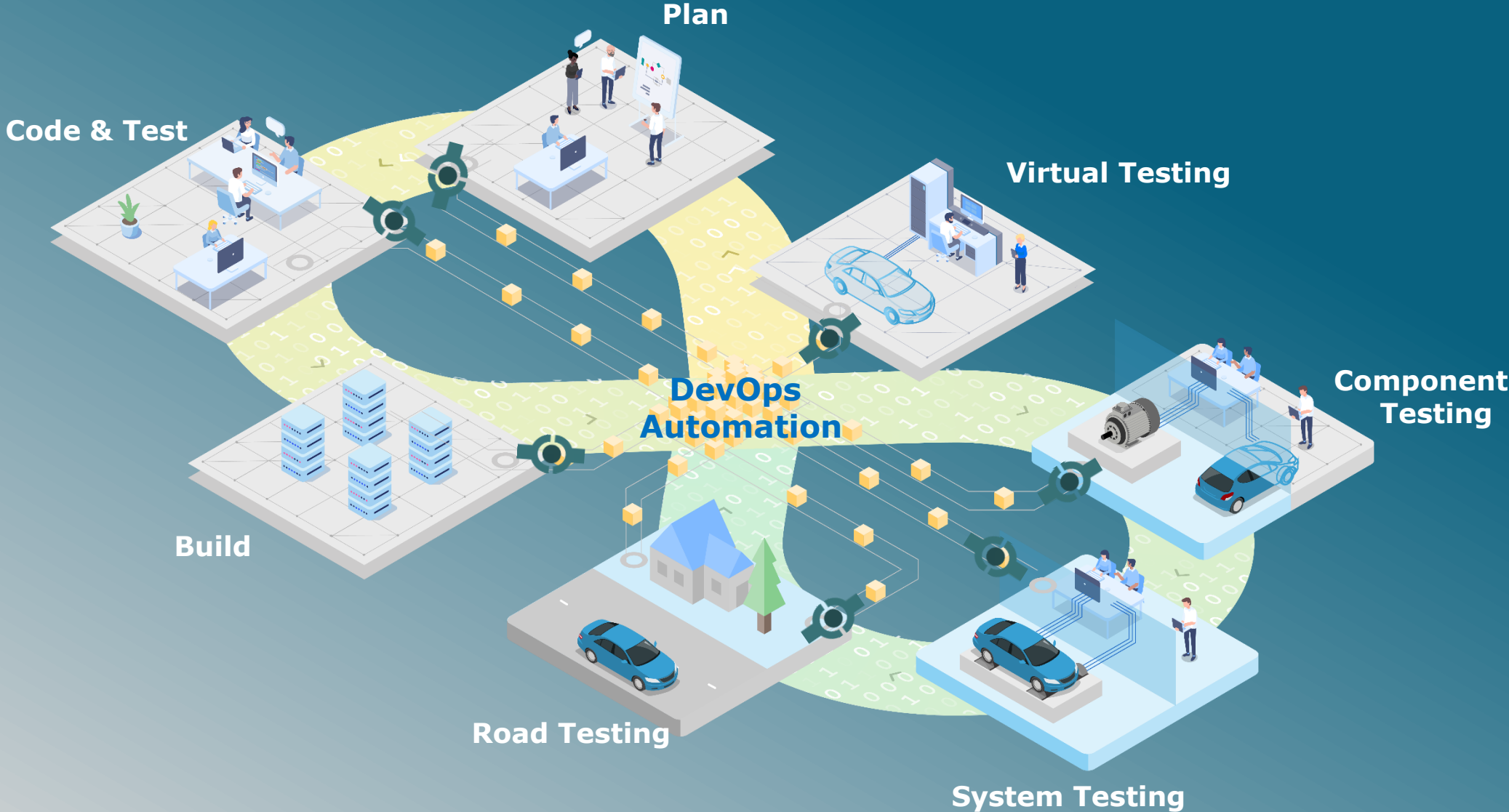Highly efficient SOEC Power-to-Liquid conversion

Innovation Liquid Energy Project Demonstrator

Challenges on the path to sustainable mobility – examples …

Simulation & Virtualization

Sensorics

Software

Collaborative Research

Hydrogen

CO2 Footprint Affordability

Power Density Durability
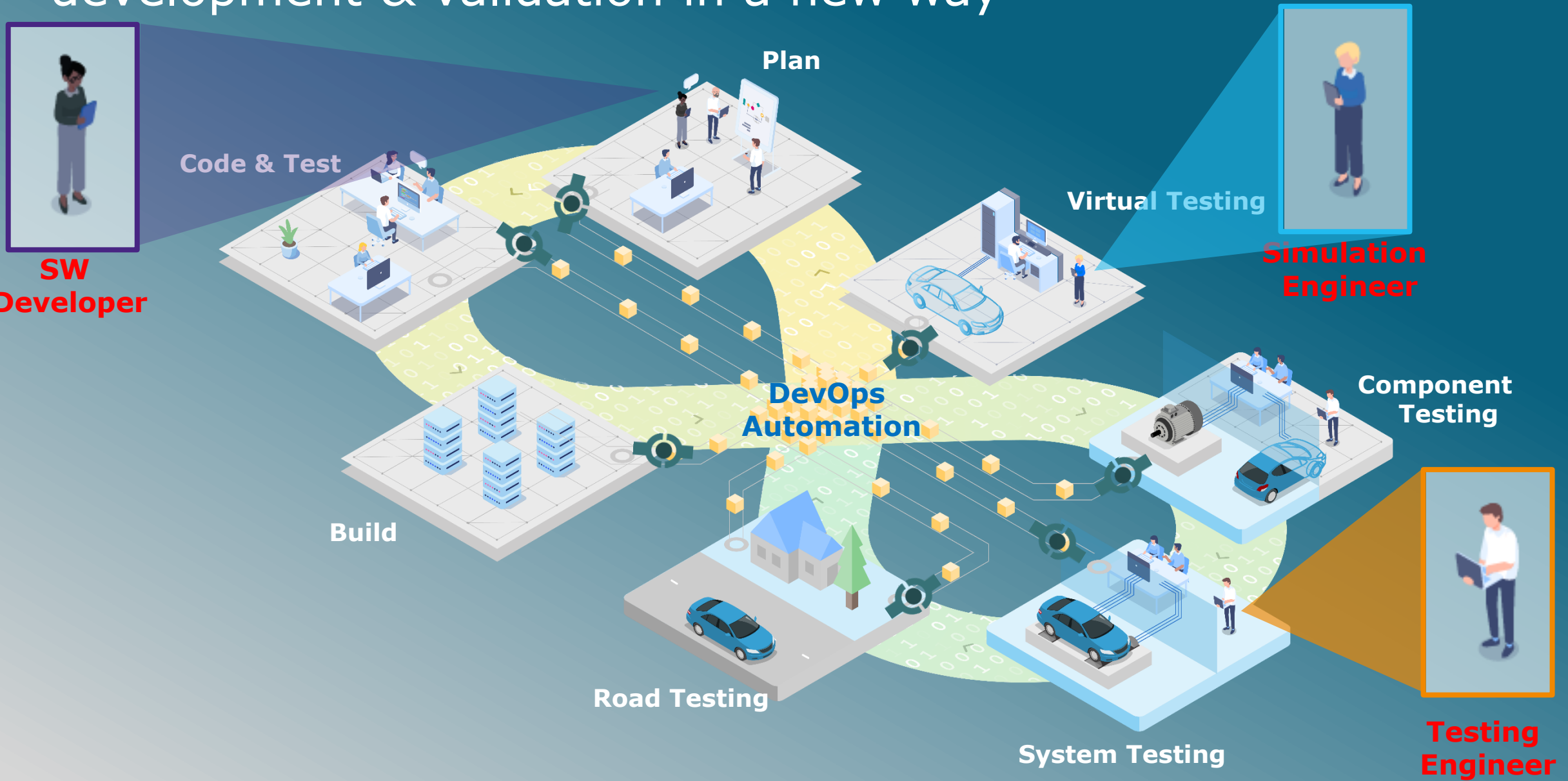
Green H2 Efficient P-to-X

E-motor innovation

… and some **Enablers** for innovation & efficient development

The shift to the **Software defined Vehicle** changes the development process flow in Automotive
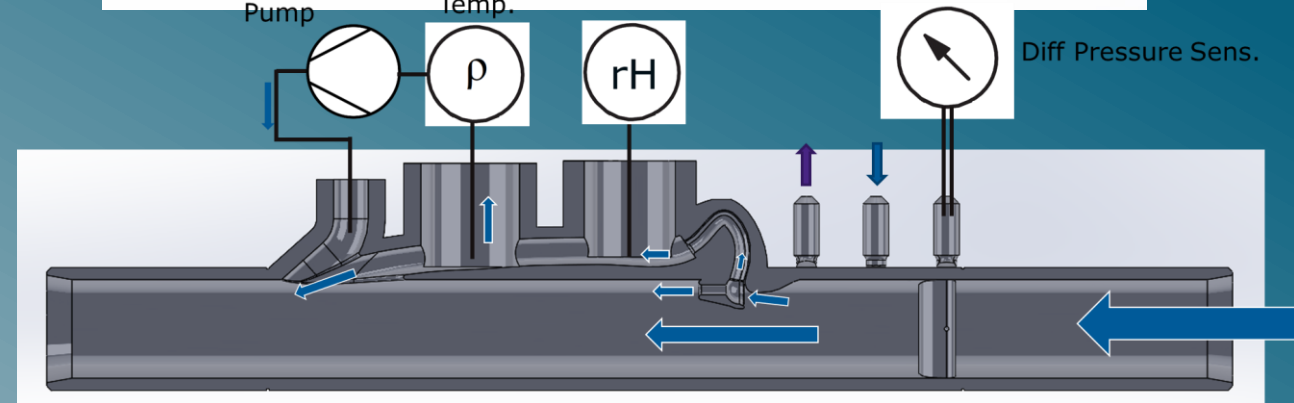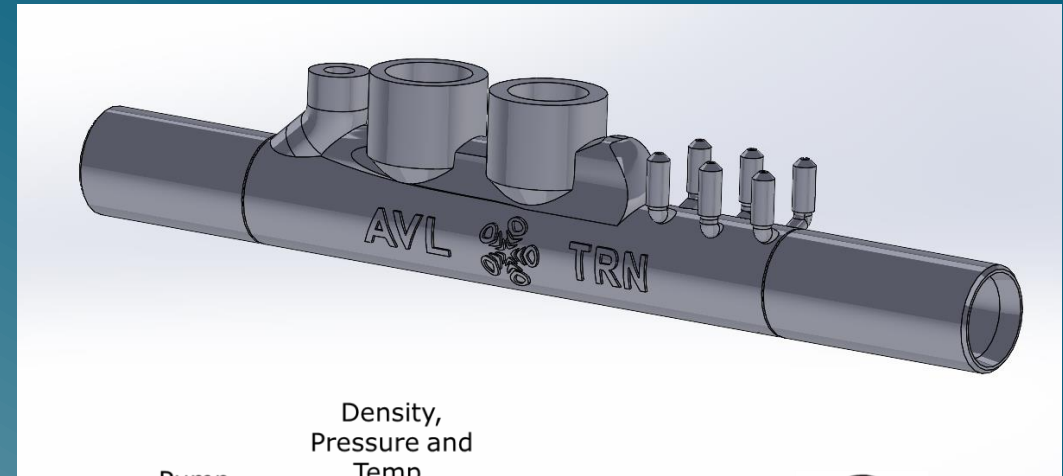
Plan

Code & Test

Virtual Testing

DevOps Automation

Build

Component Testing

Road Testing

System Testing

… and this "DevOps" thinking connects teams in development & validation in a new way

For real testing, very specific sensors are needed: Flow Rate Measurement (advanced manufacturing enabled)
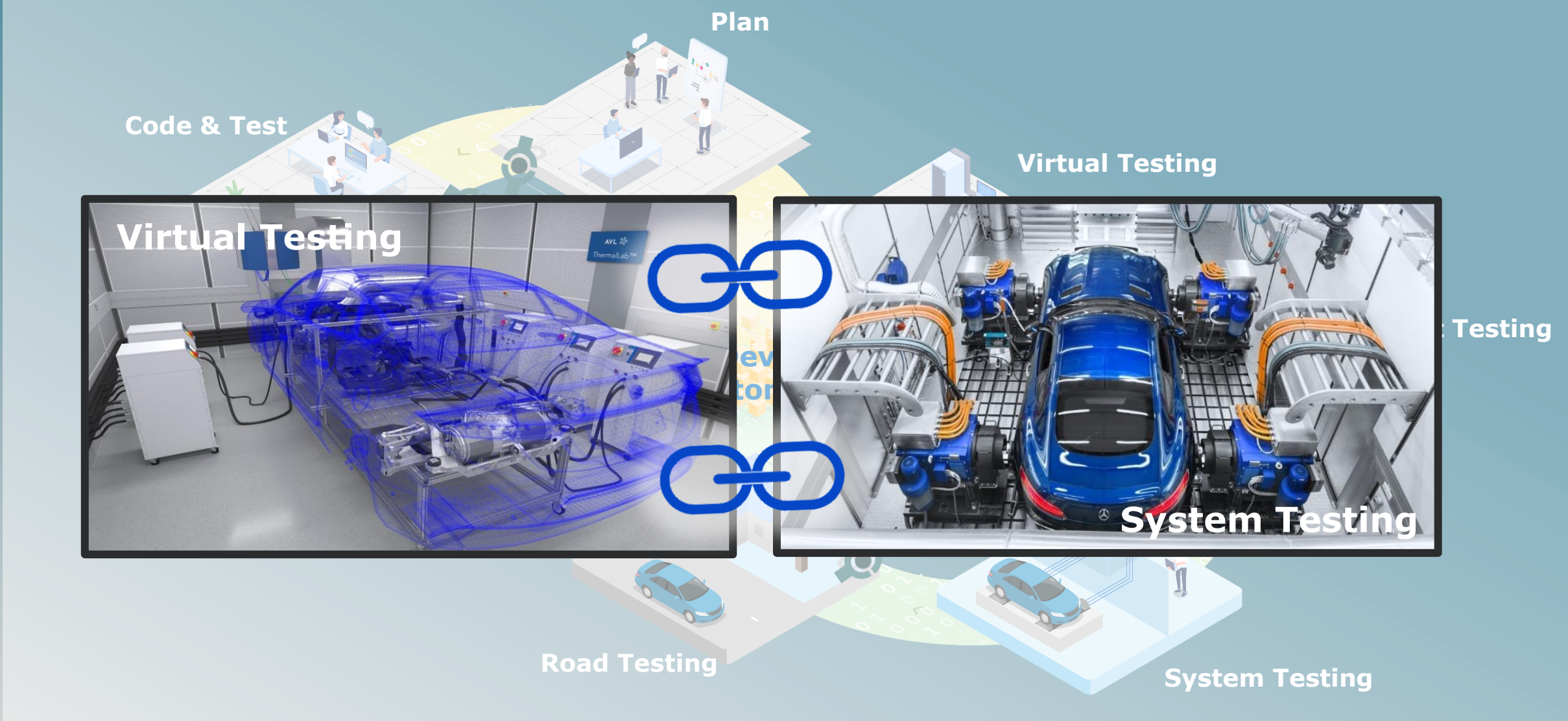
First AM-Enabled Concept


Measurement Parameters

→ Volume Flow Rate?
→ Mass Flow Rate?
→ Density?
→ Concentration?

→ Pressure?
→ Humidity?
→ Temperature?

2 Patents Granted
(AT524543B1 & AT524542B1)

Simulation is a key enabler; so is „blending" simulation with real testing for development & validation

For virtual testing high fidelity models are needed from concept to production in a seamless workflow

Concept

Virtual Product Development & - Optimization

Series-relevant Production & Integration
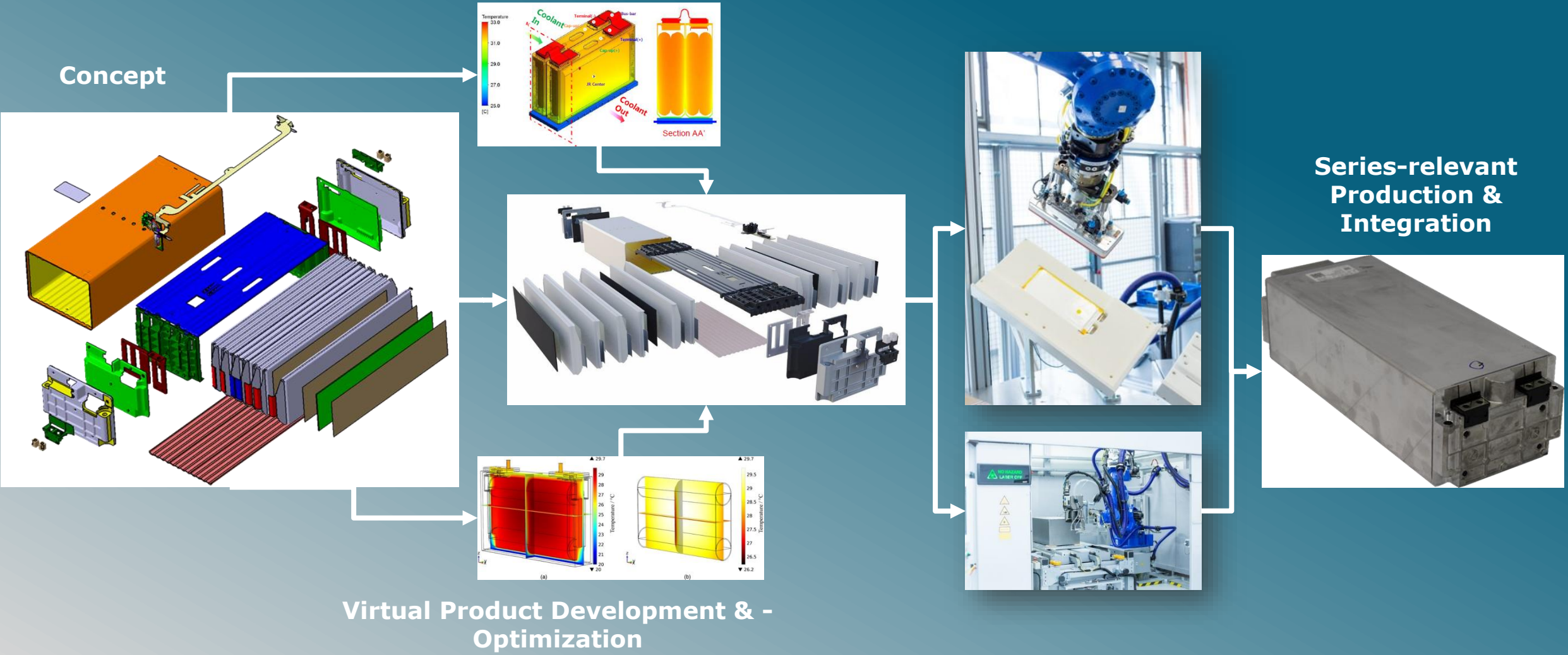
The specific challenge of automated driving requires specific solutions

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We take real sensors and virtually enhance them using AI

Perception (object detection) trained ("Waymo data")

RGB Image

LiDAR

AI supported refinement ("Domain Adaptation")

RGB Image

LiDAR
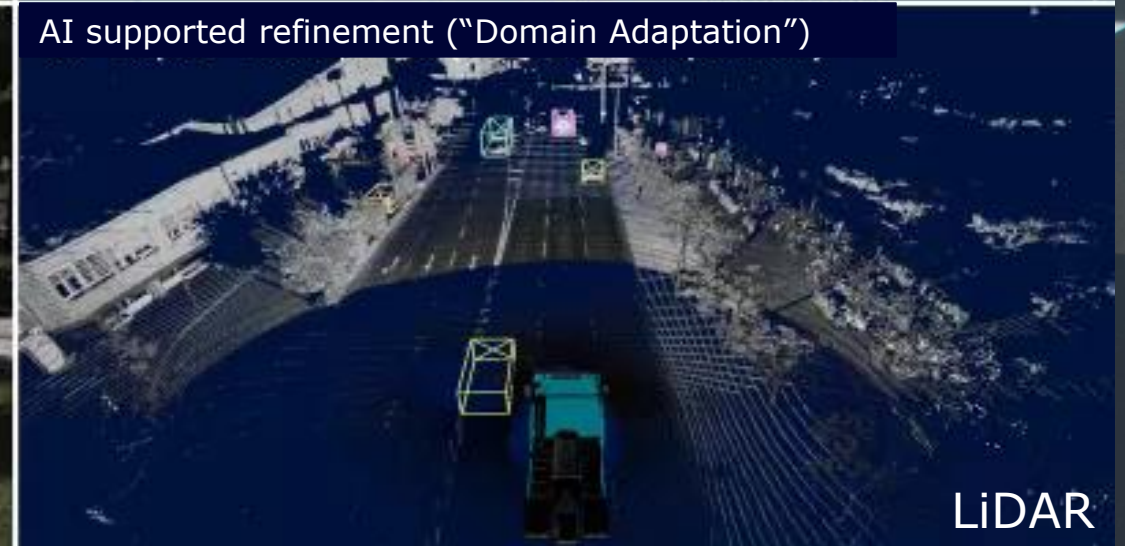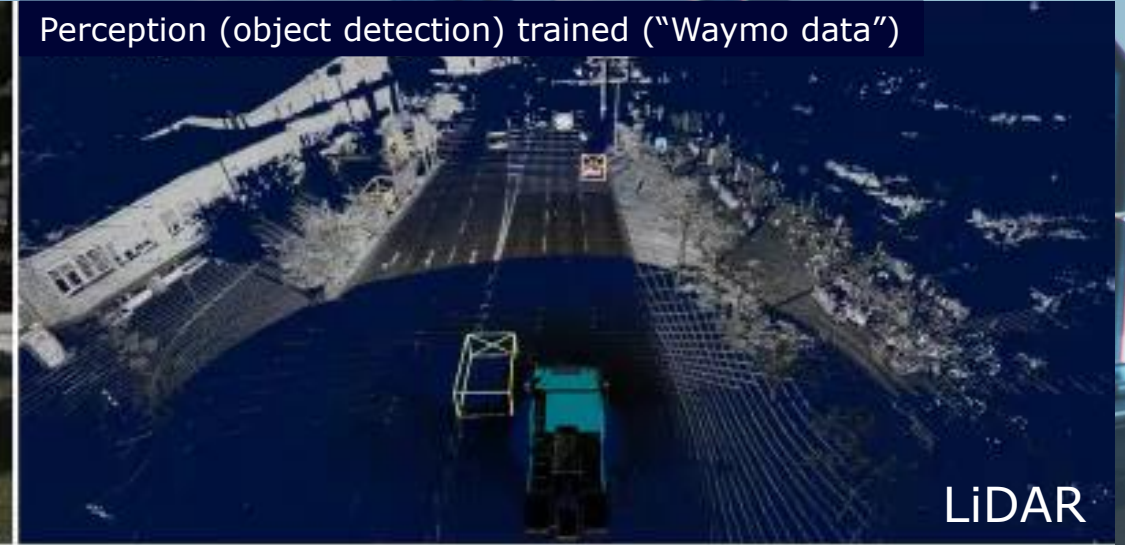
Software carries the application know-how that makes hardware from chip to vehicle successful

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Virtualization

Service defined
SW architecture

ADAS / AD

Intelligent solutions
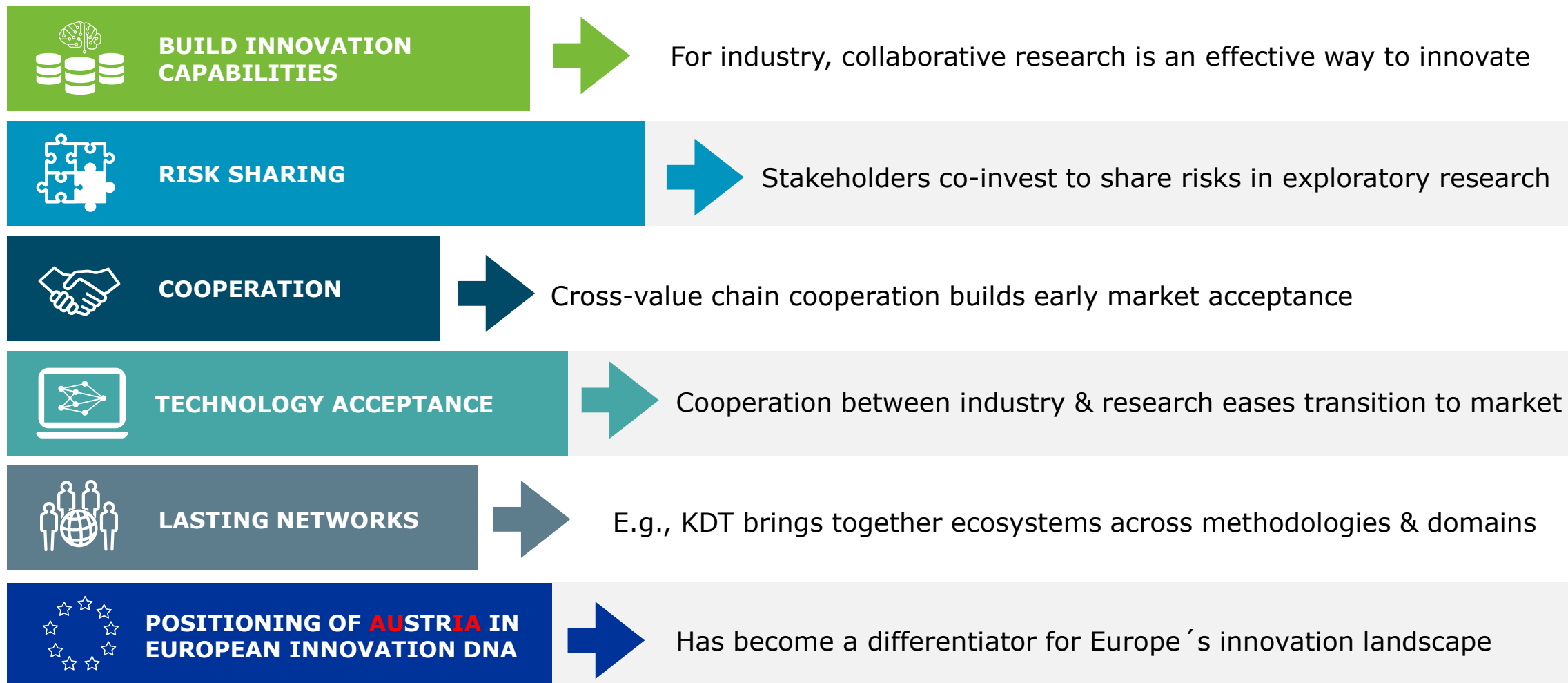(cognitive, smart,
adaptive products)

SaaS (Software as a service)

Cybersecurity

DaaS (Data as a service)

Collaborative Research strengthens European competitiveness and positions Austria as relevant innovation player

BUILD INNOVATION CAPABILITIES → For industry, collaborative research is an effective way to innovate

RISK SHARING → Stakeholders co-invest to share risks in exploratory research

COOPERATION → Cross-value chain cooperation builds early market acceptance

TECHNOLOGY ACCEPTANCE → Cooperation between industry & research eases transition to market

LASTING NETWORKS → E.g., KDT brings together ecosystems across methodologies & domains

POSITIONING OF AUSTRIA IN EUROPEAN INNOVATION DNA → Has become a differentiator for Europe´s innovation landscape

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Challenges & **Enablers** … lead us to the **SUMMARY**

What are critical unresolved challenges of modern powertrain technologies?

Research is tackling (many of) these, but with sufficient focus?

How can we resolve the challenges fast and bring solutions to market?

Key take-aways from the presentation:

▪ **The challenges solvable, but not to be underestimated!**

▪ **Research remains critical to accelerate & boost sustainable mobility**

▪ **Fast, efficient & digital development is key**

… and some **Enablers** for innovation & efficient development

Thank you!

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