

# The impact of advanced technologies on the development of the Visegrad countries

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Hungary's leading vehicle engineering educational and research center

## Agenda

- 1) Vehicle industry - the driver of the V4 economies
- 2) Vehicle development process
- 3) „Virtual development” as the source of competitiveness
- 4) Current and upcoming challenges
- 5) What’s next?

- 1) Vehicle industry - the driver of the V4 economies**
- 2) Vehicle development process
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## **Vehicle Industry**

... a flagship of the EU and V4 economy

## **Global production numbers**

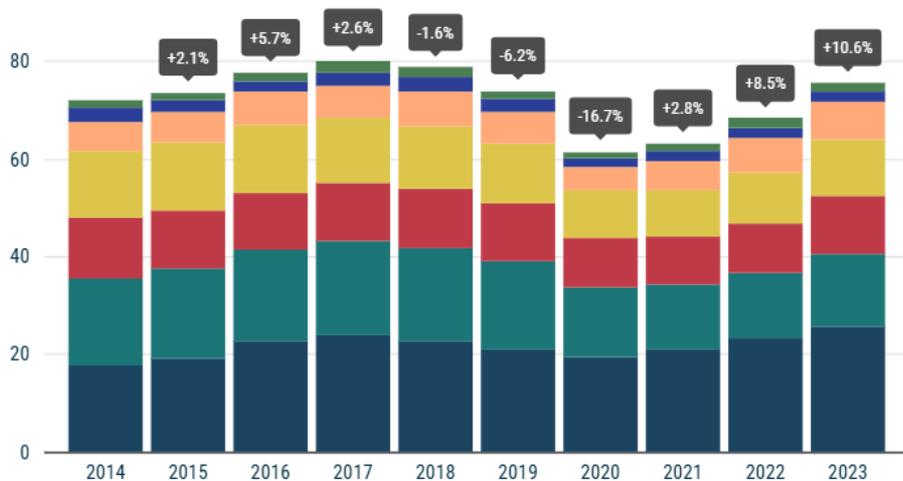
# Vehicle Industry

... a flagship of the EU and V4 economy

## WORLD CAR PRODUCTION

In million units, % change, 2014 – 2023

■ Greater China 
 ■ Europe 
 ■ Japan/Korea 
 ■ North America 
 ■ South Asia 
 ■ South America 
 ■ Middle East/Africa



Created with LocalFocus

Source: S&P GLOBAL MOBILITY

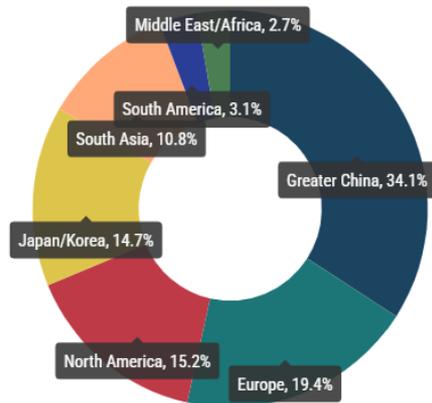
“  
 Nearly 20% of all cars produced worldwide are made in Europe.

# Vehicle Industry

... a flagship of the EU and V4 economy

## WORLD CAR PRODUCTION

% share / 2011 – 2022



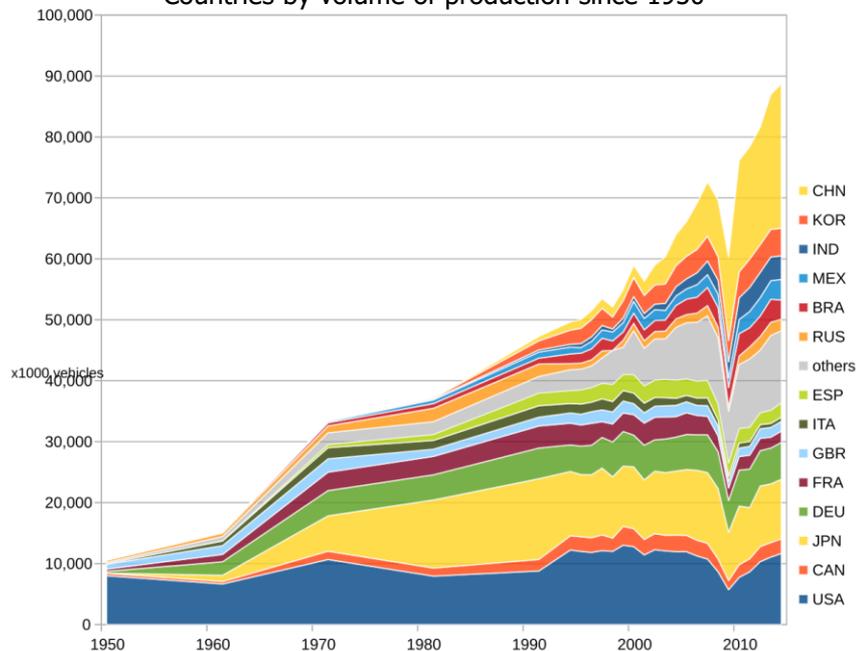
“

China produces 34% of the 69 million cars that are manufactured worldwide each year, followed by Europe [19%], and North America [15%].

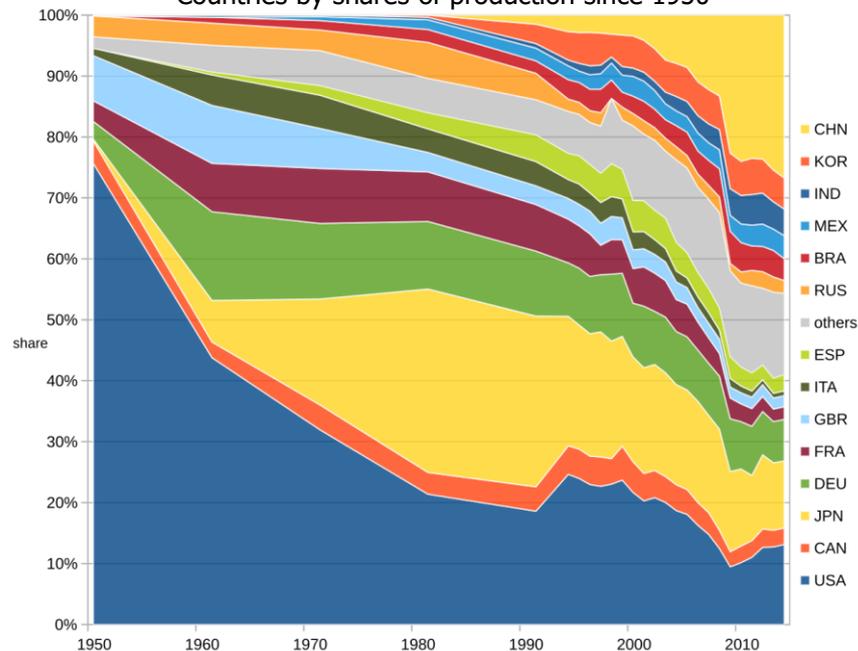
# Vehicle Industry

... a flagship of the EU and V4 economy

Countries by volume of production since 1950



Countries by shares of production since 1950



## **Vehicle Industry**

... a flagship of the EU and V4 economy

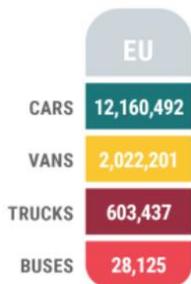
## **V4 Aspects**

# Vehicle Industry

... a flagship of the EU and V4 economy

## EU VEHICLE PRODUCTION

By country  
2023



### V4 Car Manufacturing (2023):

Poland:	233 182
Czechia:	1 397 631
Slovakia:	1 075 379
Hungary:	508 734

**TOTAL:** 3 196 926  
**EU share:** 26,3%

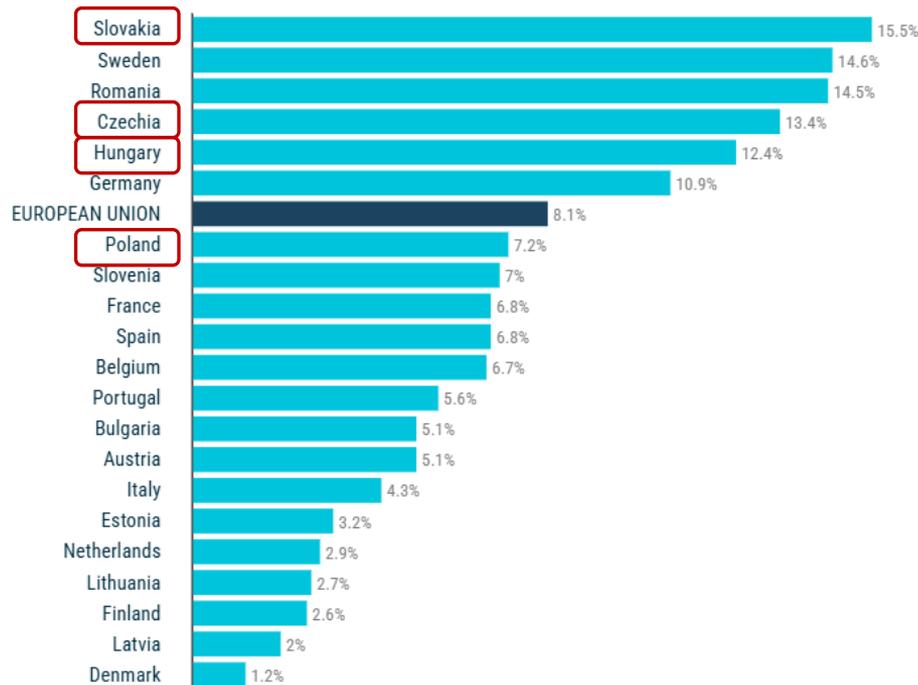
acea

# Vehicle Industry

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## EU DIRECT AUTOMOTIVE EMPLOYMENT

Share of total manufacturing by country, 2022



Top five EU countries with the highest share of direct automotive manufacturing jobs

- 1 Slovakia (15.5%)
- 2 Sweden (14.6%)
- 3 Romania (14.5%)
- 4 Czechia (13.4%)
- 5 Hungary (12.4%)

“

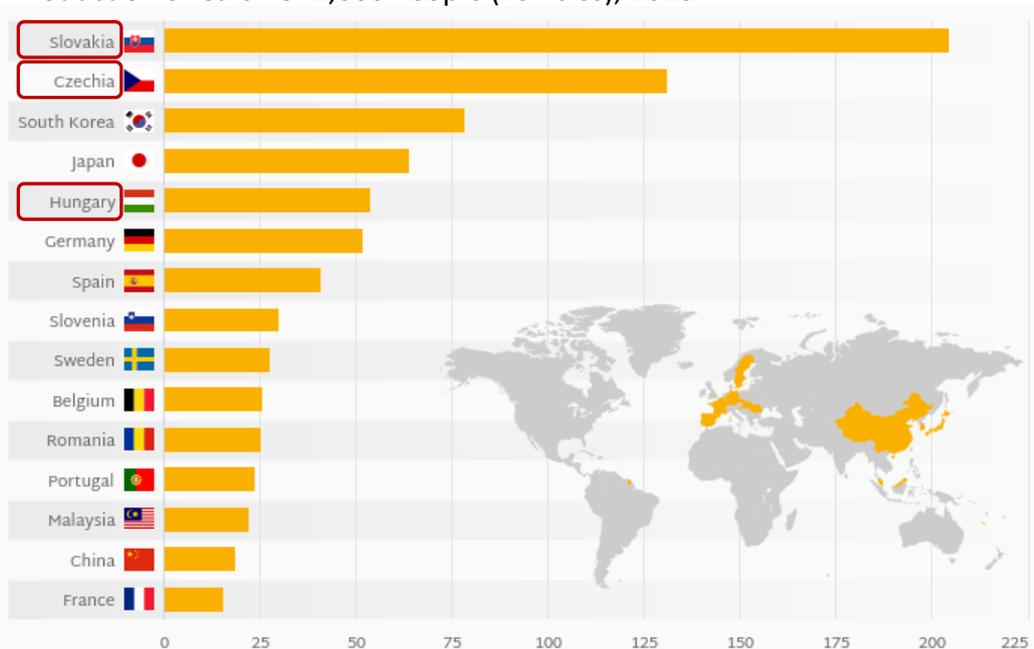
The 2.4 million direct manufacturing jobs in the automotive industry account for 8.1% of total EU manufacturing employment.

# Vehicle Industry

... a flagship of the EU and V4 economy

## What Nation Produces the Most Cars per Capita?

Production of Cars Per 1,000 People (vehicles), 2023



Source: National Statistical Office

HelgiLibrary.

## **Vehicle Industry**

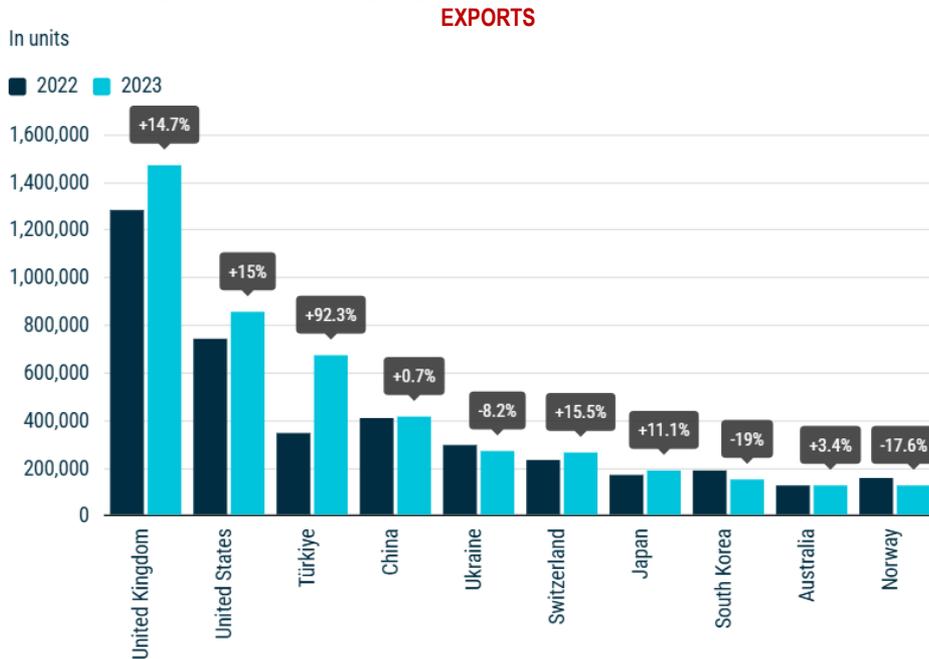
... a flagship of the EU and V4 economy

### **Economic Aspects**

# Vehicle Industry

... a flagship of the EU and V4 economy

## MAIN COUNTRIES OF ORIGIN OF EU VEHICLE IMPORTS



“

A fifth of EU vehicle exports go to the UK.

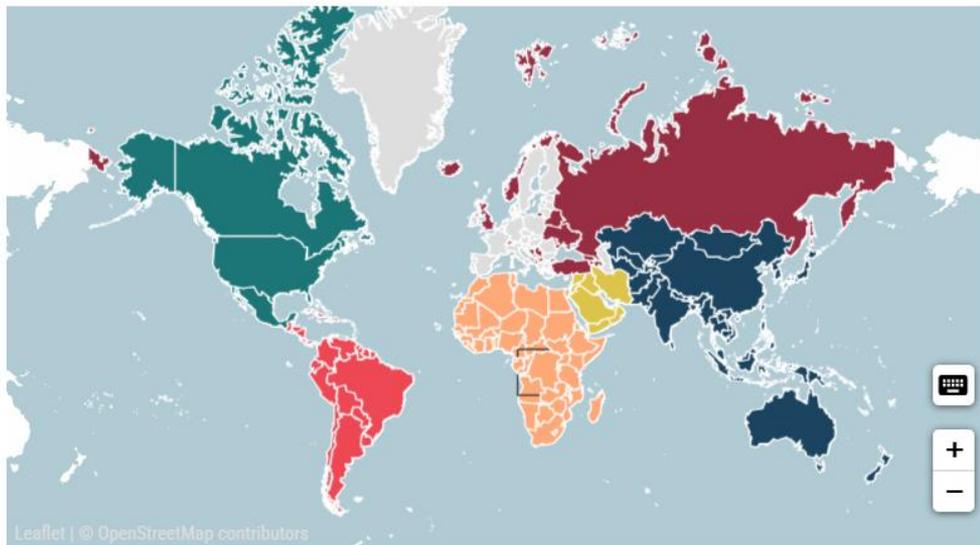
# Vehicle Industry

... a flagship of the EU and V4 economy

## MAIN DESTINATIONS FOR EU VEHICLE EXPORTS

Value market share, 2023

- Central and South America, 1.8%
- Asia and Oceania, 29.2%
- Africa, 4%
- EFTA, UK, and Eastern Europe (non-EU), 35.7%
- Middle East, 5.2%
- North America, 24.1%



“

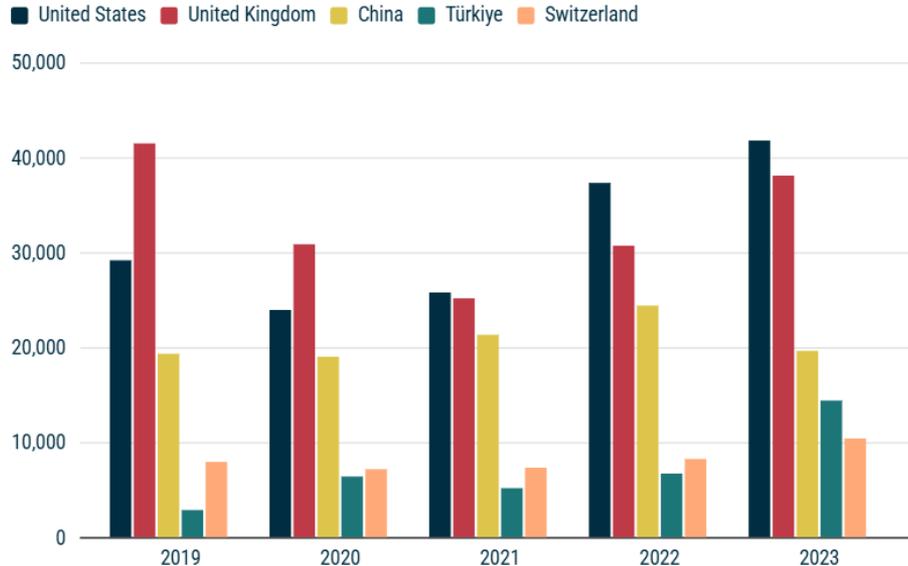
The auto industry generates an annual trade surplus of €106.7 billion for the EU.

# Vehicle Industry

... a flagship of the EU and V4 economy

## MAIN DESTINATIONS FOR EU VEHICLE EXPORTS

In million €, 2019 – 2023



Created with LocalFocus

Source: EUROSTAT

“

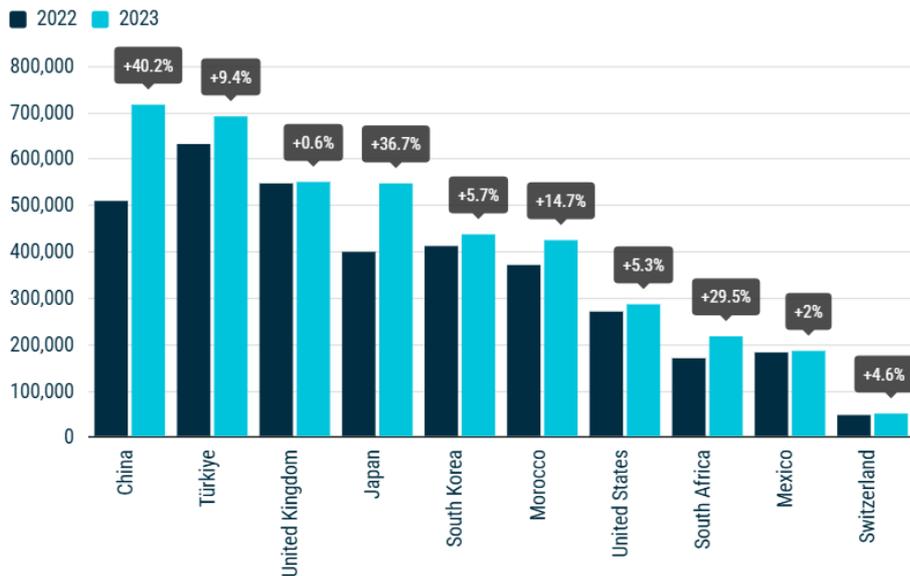
EU vehicle exports brought in €195 billion in 2023.

# Vehicle Industry

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## MAIN COUNTRIES OF ORIGIN OF EU VEHICLE IMPORTS

In units



“

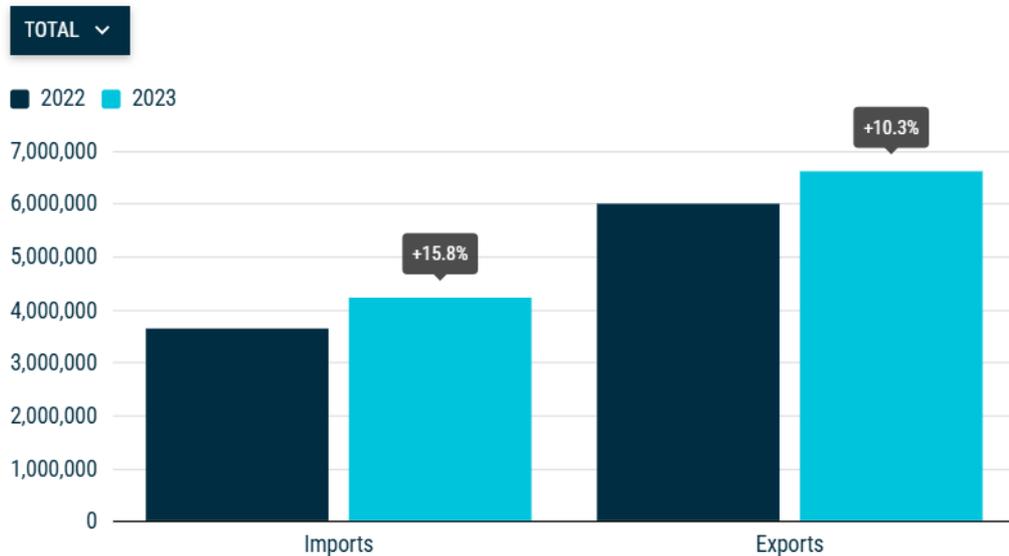
4.2 million vehicles were imported into the EU in 2023.

# Vehicle Industry

... a flagship of the EU and V4 economy

## EU VEHICLE TRADE

By type, in units, 2023



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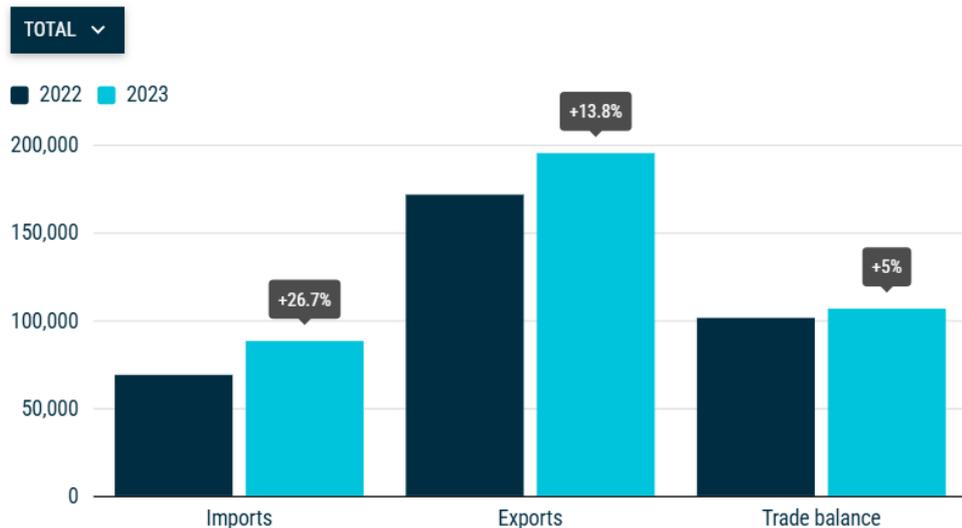
Source: EUROSTAT

# Vehicle Industry

... a flagship of the EU and V4 economy

## EU VEHICLE TRADE

By type, in million €, 2023



“

The auto industry generates an annual trade surplus of €106.7 billion for the EU.

## **Vehicle Industry**

... a flagship of the EU and V4 economy

## **Research and Development Aspects**

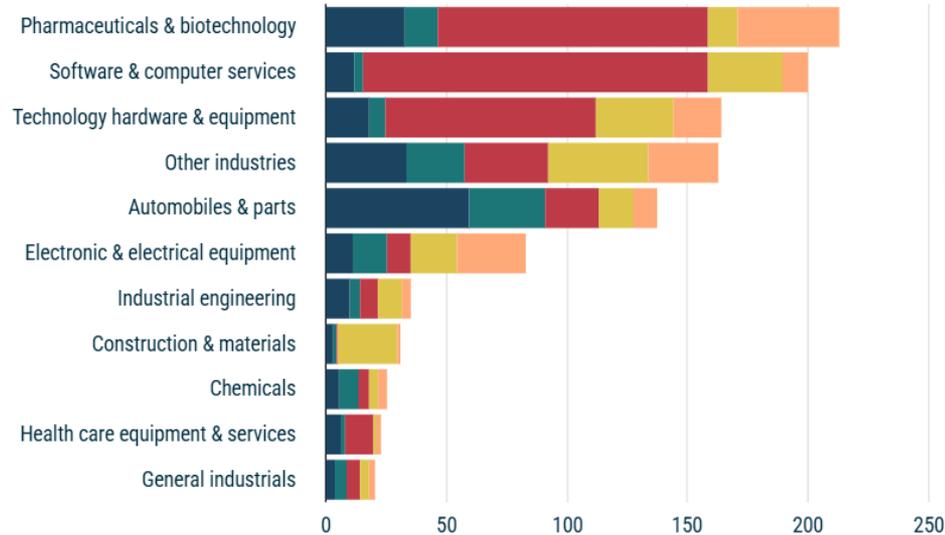
# Vehicle Industry

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## R&D INVESTMENT BY INDUSTRY AND WORLD REGION

In billion € / 2021

■ EU ■ Japan ■ US ■ China ■ Rest of the world



“

The European Union is by far the world's largest investor in automotive R&D.

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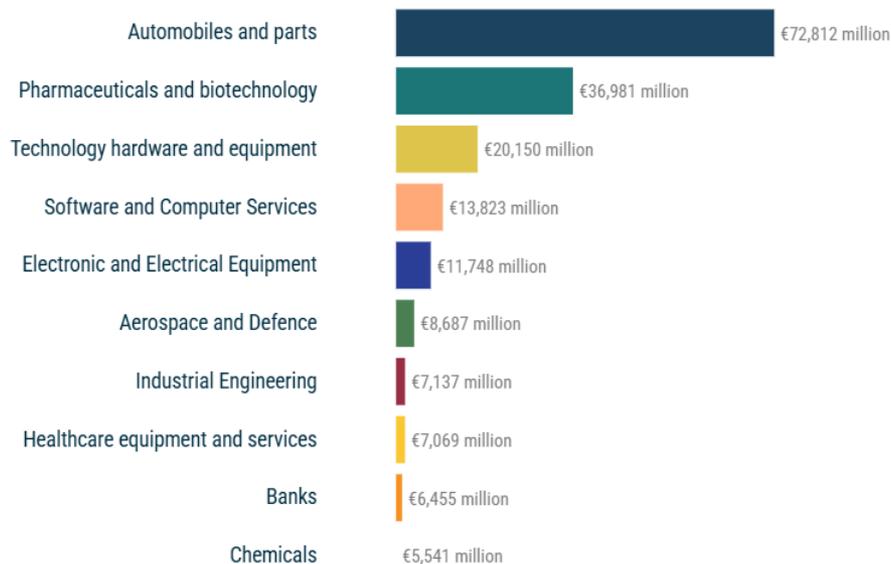
Source: THE 2022 EU INDUSTRIAL R&D INVESTMENT SCOREBOARD

# Vehicle Industry

... a flagship of the EU and V4 economy

## EU R&D INVESTMENT IN THE TOP 10 INDUSTRIAL SECTORS

In million € / 2022



“

Investing about €73 billion in research and development (R&D) annually, the automotive sector is Europe's largest private contributor to innovation, accounting for a third of total EU spending.

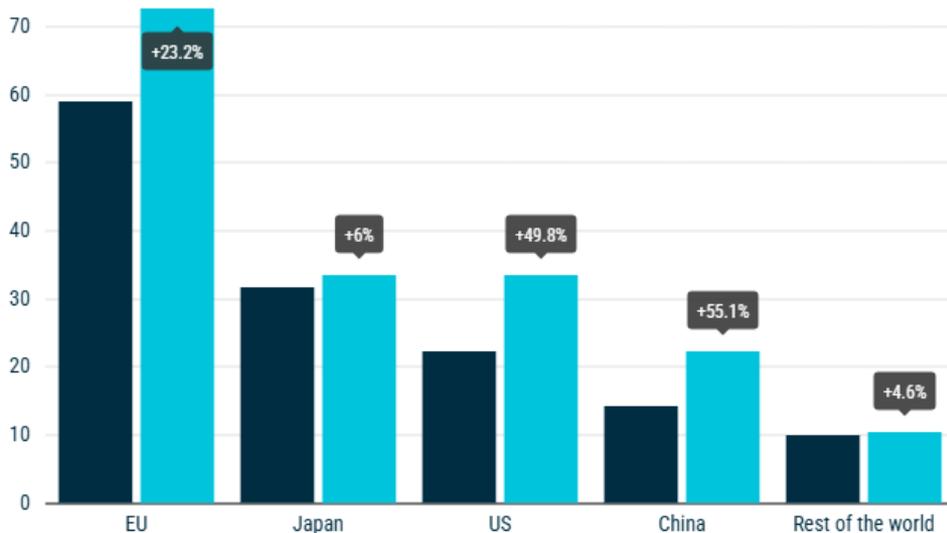
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## AUTOMOTIVE R&D INVESTMENT BY REGION

In billion €, % change

■ 2021 ■ 2022



Created with LocalFocus

Source: THE 2023 EU INDUSTRIAL R&D INVESTMENT SCOREBOARD

“

Europe remains the world's largest investor in innovation in the auto industry, surpassing Japan (€33.6 billion), the United States (€33.6 billion), and China (€22.2 billion).

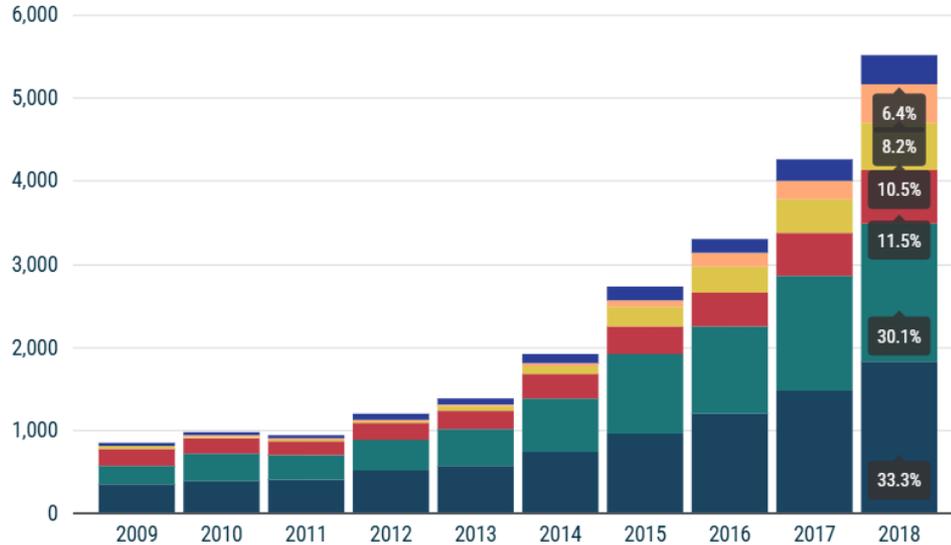
# Vehicle Industry

... a flagship of the EU and V4 economy

## Patent applications related to self-driving vehicles

NUMBER OF PATENTS, %SHARE / 2009 – 2018

■ Europe 
 ■ US 
 ■ Japan 
 ■ South Korea 
 ■ China 
 ■ Rest of the World



Created with LocalFocus

Source: EPO (EUROPEAN PATENT OFFICE)

“ Europe leads the world in patents for self-driving vehicles.”

## **Vehicle Industry**

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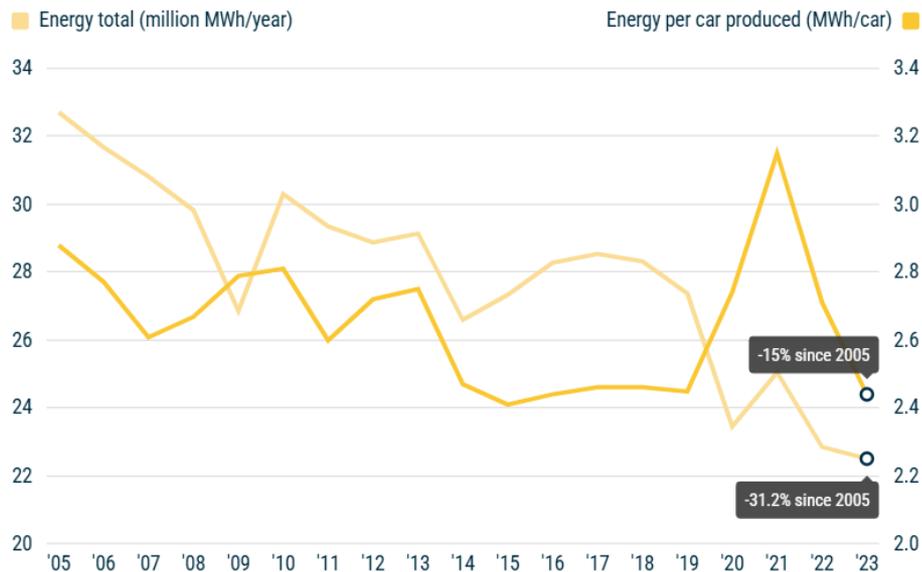
# **Societal Return of Investment from Research and Development**

# Vehicle Industry

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## CAR PRODUCTION: ENERGY CONSUMPTION

2005 – 2023



Created with LocalFocus

Source: ACEA

“

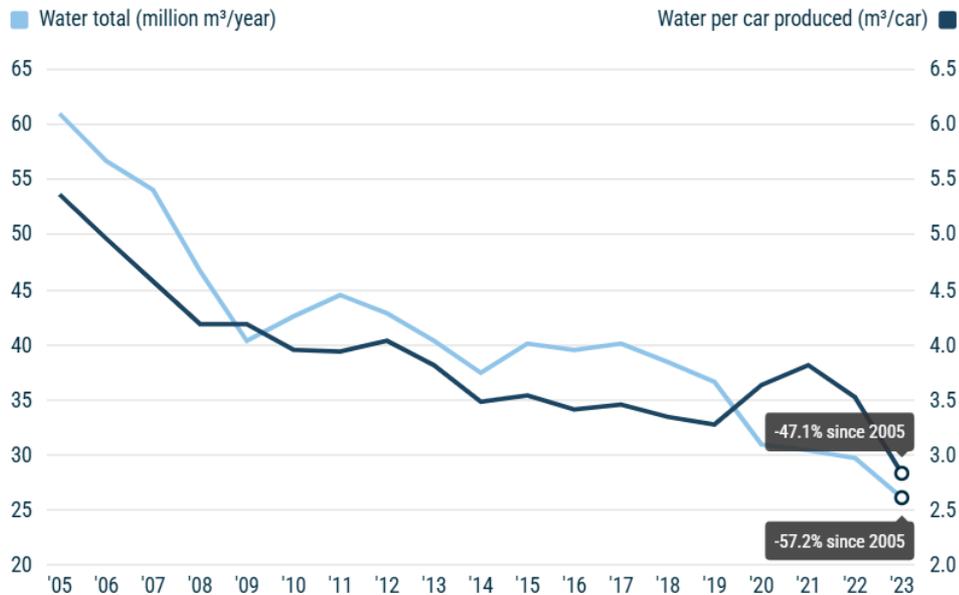
Total energy consumption from car production has been cut by almost 15% over the past 18 years.

# Vehicle Industry

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## CAR PRODUCTION: WATER CONSUMPTION

2005 - 2023



Created with LocalFocus

Source: ACEA

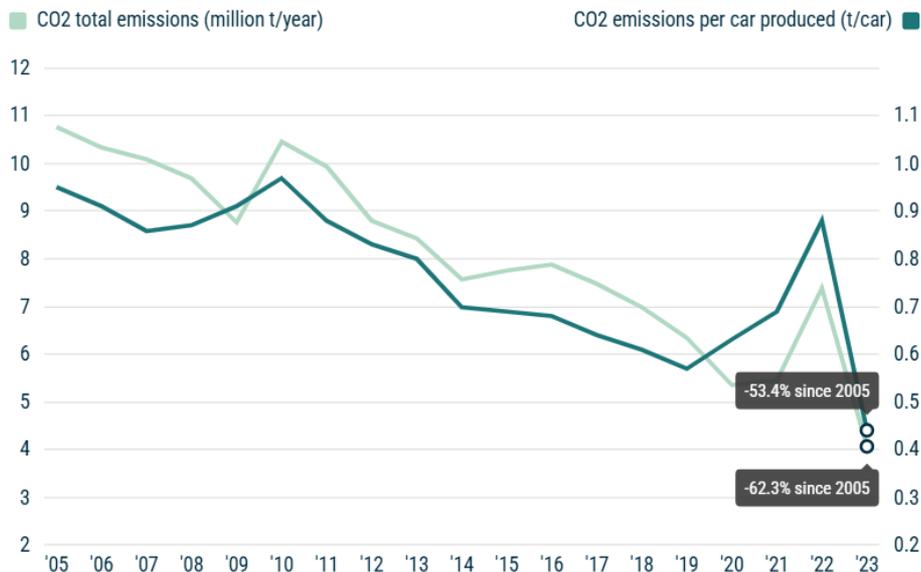
“  
The amount of water used to manufacture cars has been halved over the past 18 years

# Vehicle Industry

... a flagship of the EU and V4 economy

## CAR PRODUCTION: CO2 EMISSIONS

2005 – 2023



“ CO2 emissions from car production have been slashed by 53.4% since 2005.

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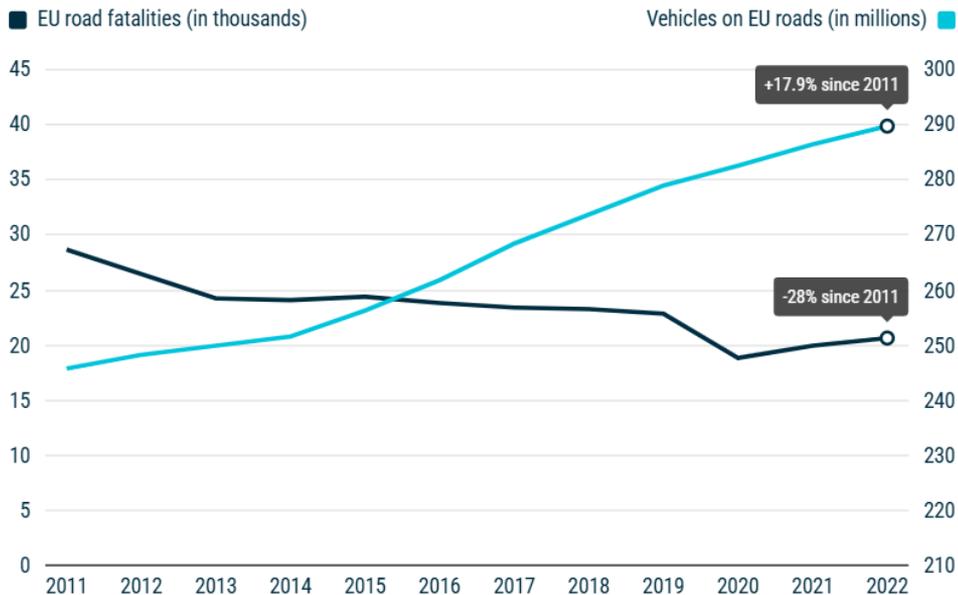
Source: ACEA MEMBERS

# Vehicle Industry

... a flagship of the EU and V4 economy

## NUMBER OF EU VEHICLES AND ROAD FATALITIES

2011 - 2022



“

While there are 43.9 million more vehicles on European roads now [+17.9%], road fatalities have fallen by 28% since 2011.

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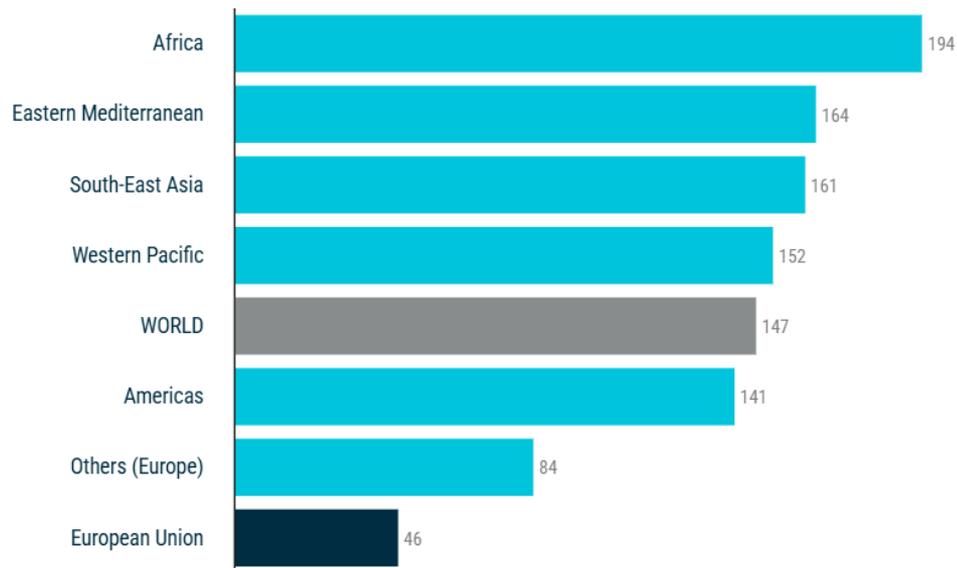
Source: ACEA, CARE (COMMUNITY ROAD ACCIDENT) DATABASE

# Vehicle Industry

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## ROAD FATALITIES PER MILLION INHABITANTS

By region, 2021, 2022



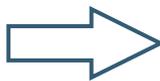
“

The European Union counts 46 road fatalities per million inhabitants annually, while the global average is 147.

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# Vehicle Development Process

... from sketch to mass production

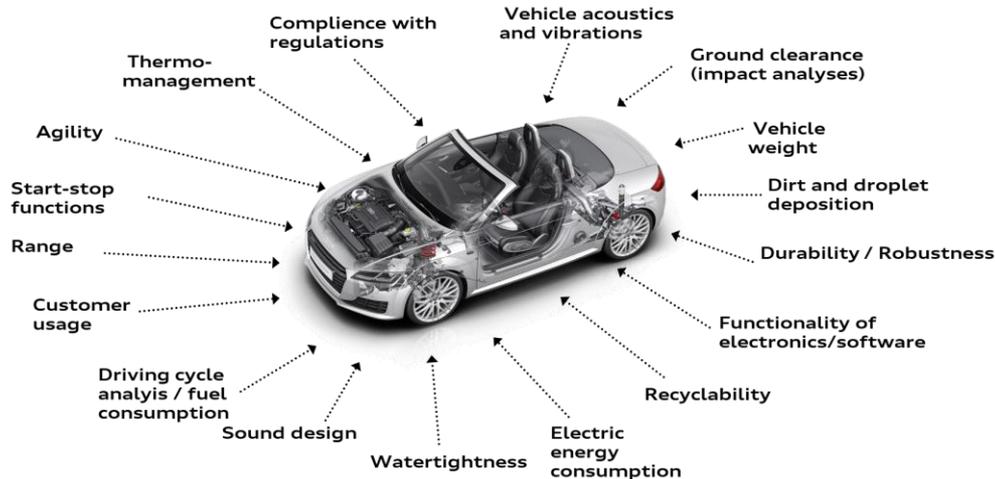


# Vehicle Development Process

... starting point: vehicle properties

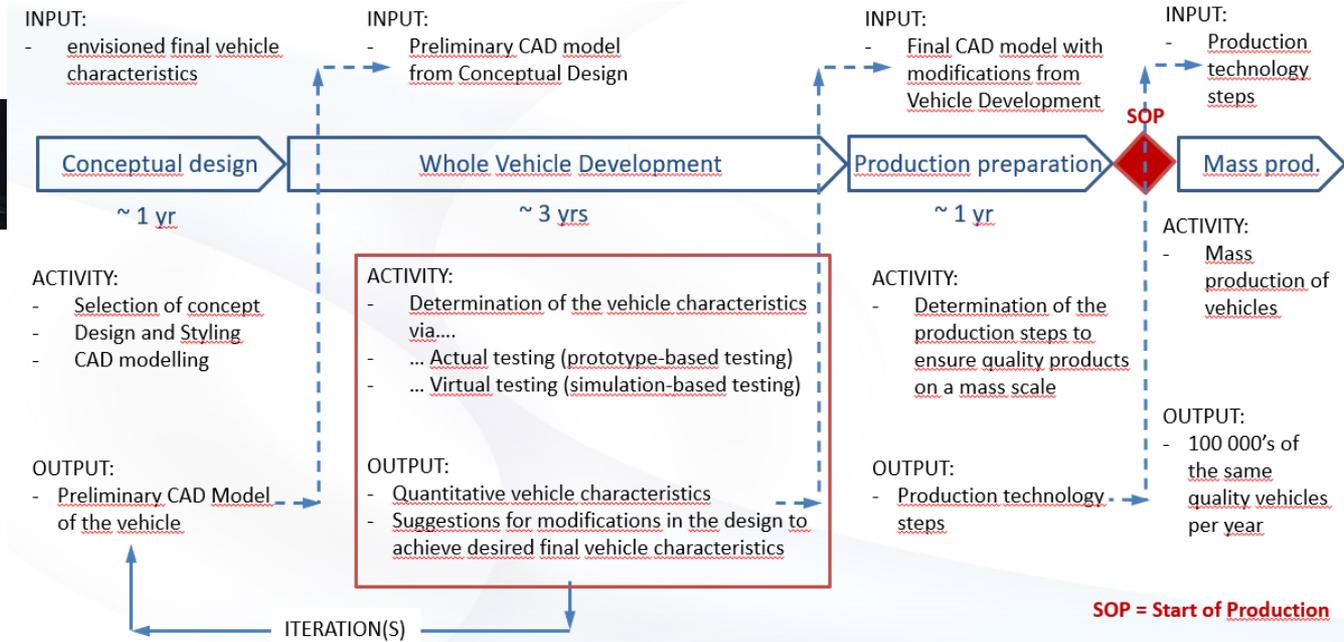
**Vehicle properties:** Those properties, which a non-expert customer would say about the car.

**Examples:** „so quiet” – means good acoustics  
 „I need to fill it up only once a month” – means long range, low consumption  
 „environmentally friendly” – means low CO2 emissions, etc.



# Vehicle Development Process

... a complex, resource-intensive process



# Vehicle Development Process

... a complex, resource-intensive process

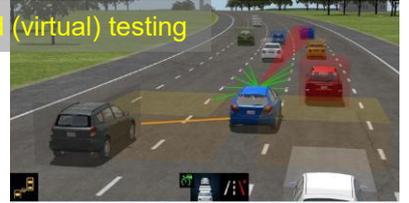
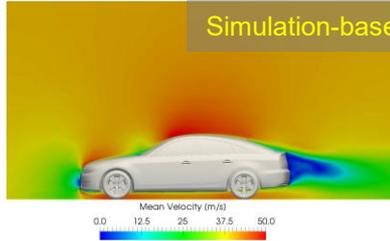


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# Vehicle Development Process

## Prototype-based vs. virtual testing





**SZÉCHENYI  
EGYETEM**  
UNIVERSITY OF CYÖR

## Vehicle simulation methods

### Electronics/Software simulations

Vehicle mass?

Electrical cabling mass?

ECU's (Electronic Control Units)?

Lines of codes?



Audi RS6

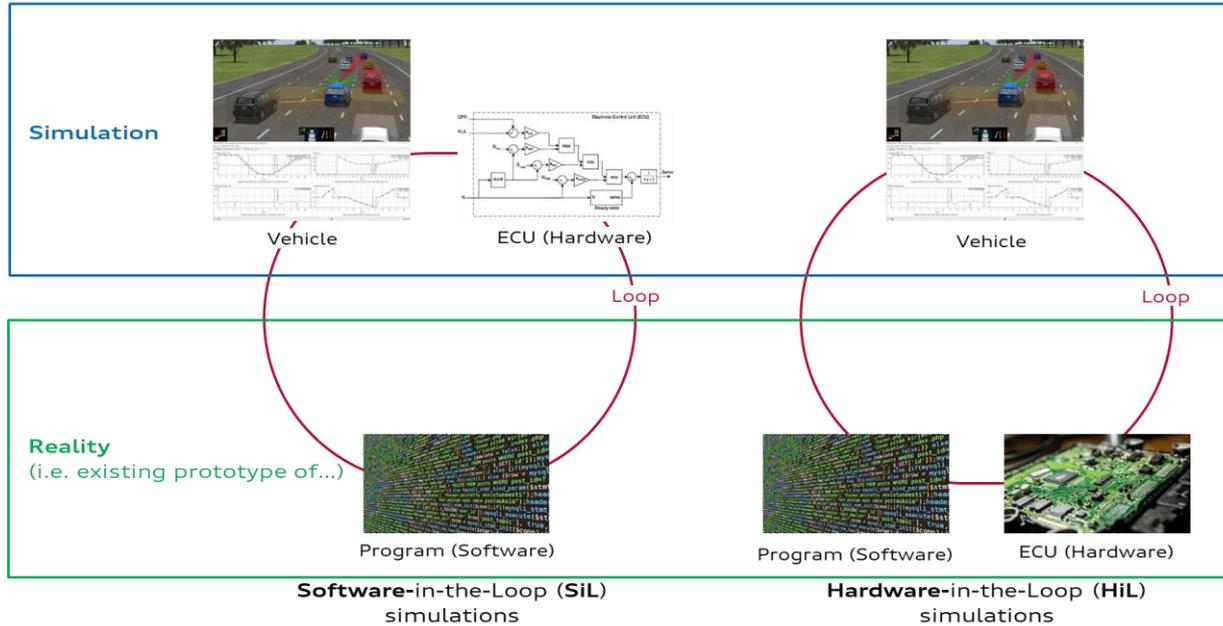
### Development Electrics/Electronics



# Vehicle simulation methods

## Electronics/Software simulations

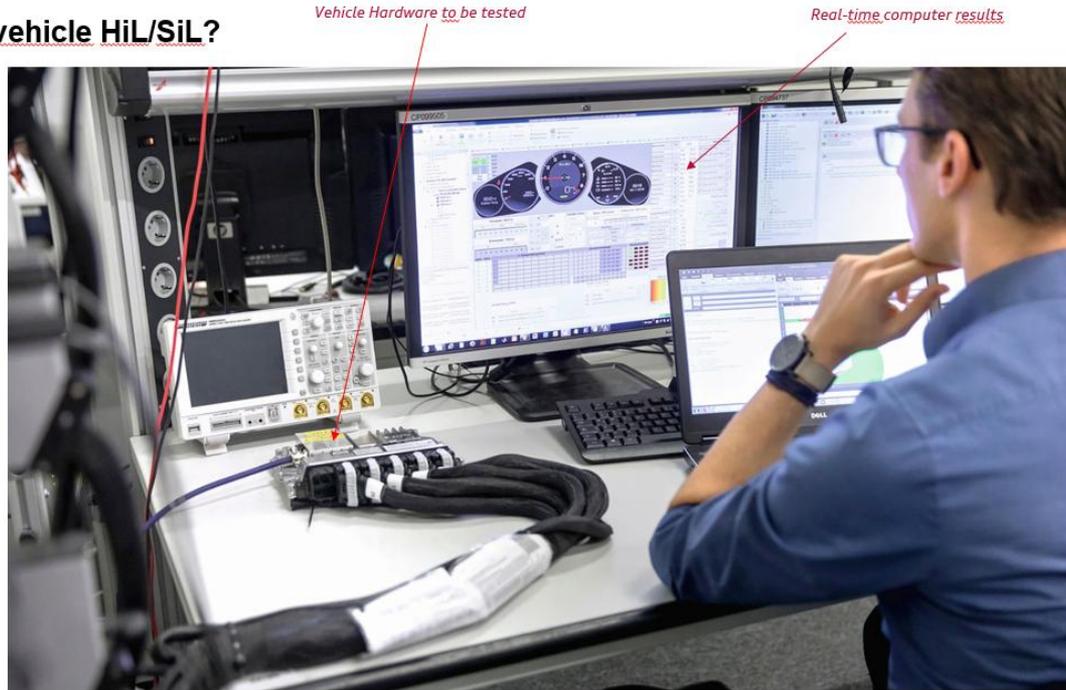
What does HiL/SiL based development mean?



# Vehicle simulation methods

## Electronics/Software simulations

### What is vehicle HiL/SiL?



*HiL (Hardware-in-the-Loop) test bench at Porsche.*

*(Source: [newsroom.porsche.com/en/2021/innovation/porsche-perfect-replica-hardware-in-the-loop-25159.html](https://newsroom.porsche.com/en/2021/innovation/porsche-perfect-replica-hardware-in-the-loop-25159.html))*

### What is vehicle HiL/SiL?

*Real-time computers with ECU Software*

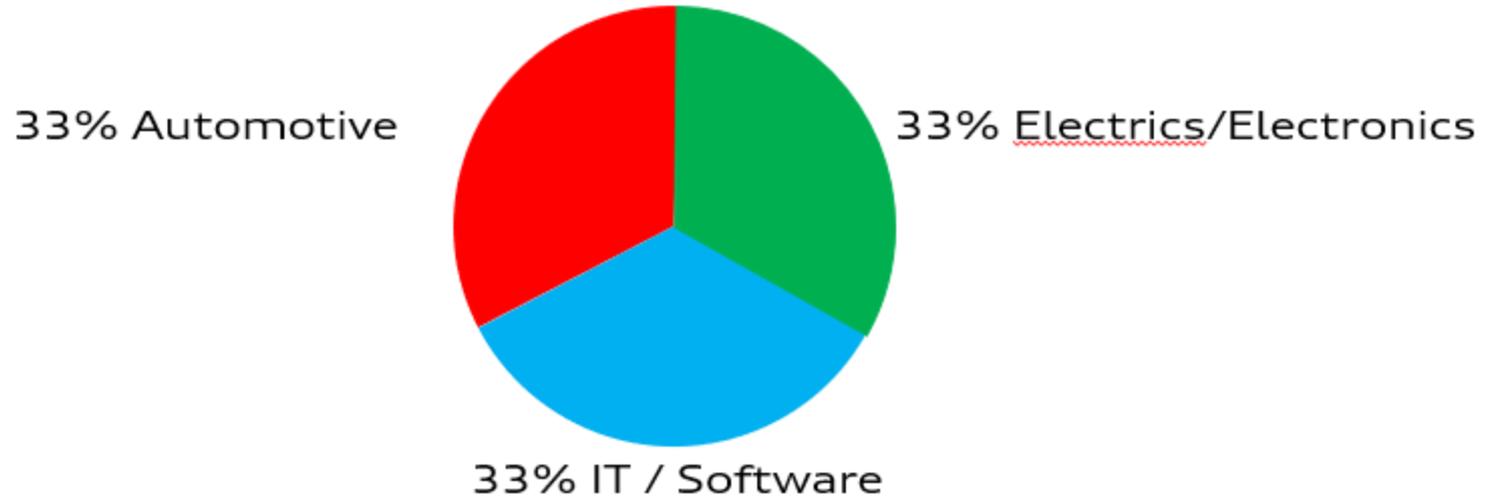
*Vehicle Hardware to be tested*



*HiL (Hardware-in-the-Loop) test bench from dSpace.  
(Source: dspace.com)*



## The Automotive Engineer of the future

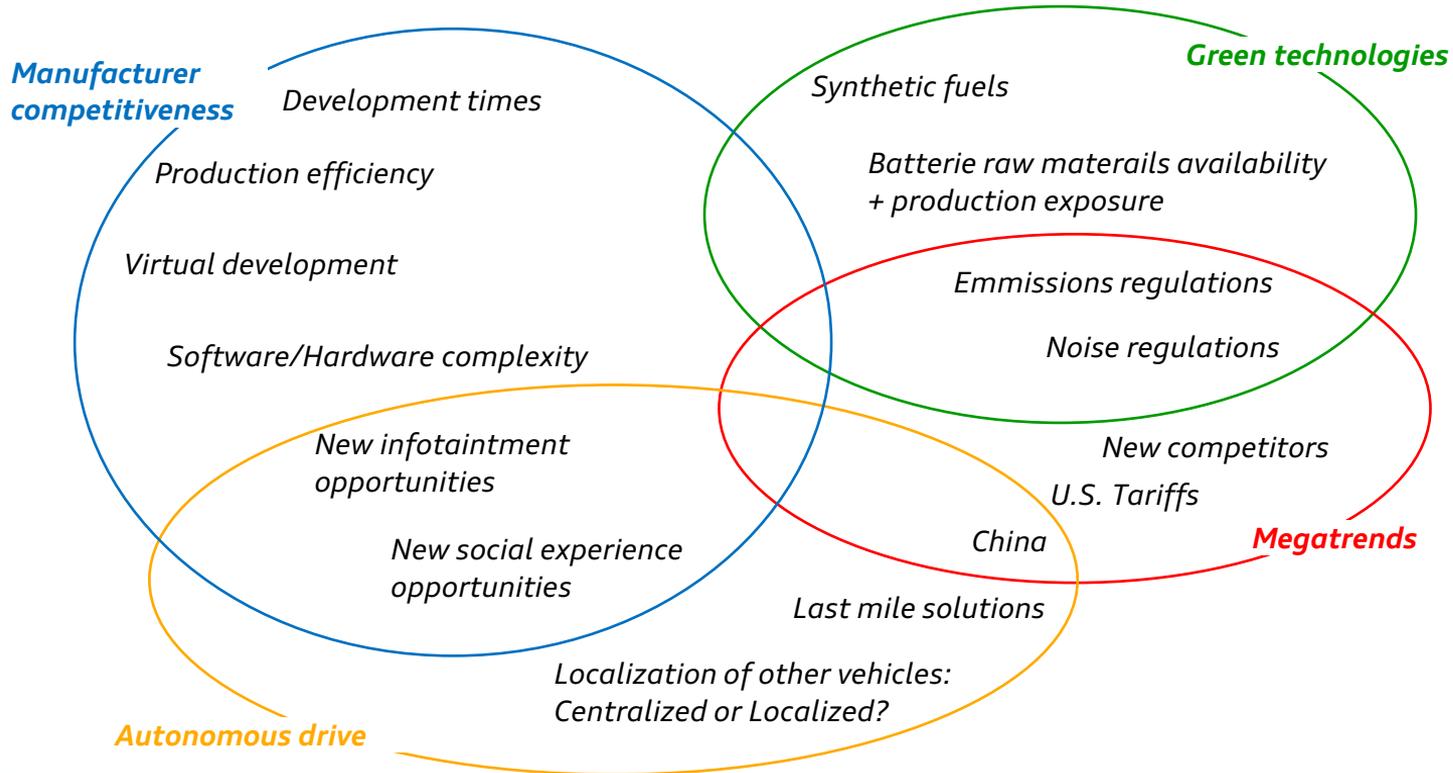


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# Vehicle industry

## Current and upcoming challenges



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# New Concepts

## Audi Grand Sphere



# New Concepts

## Audi Grand Sphere



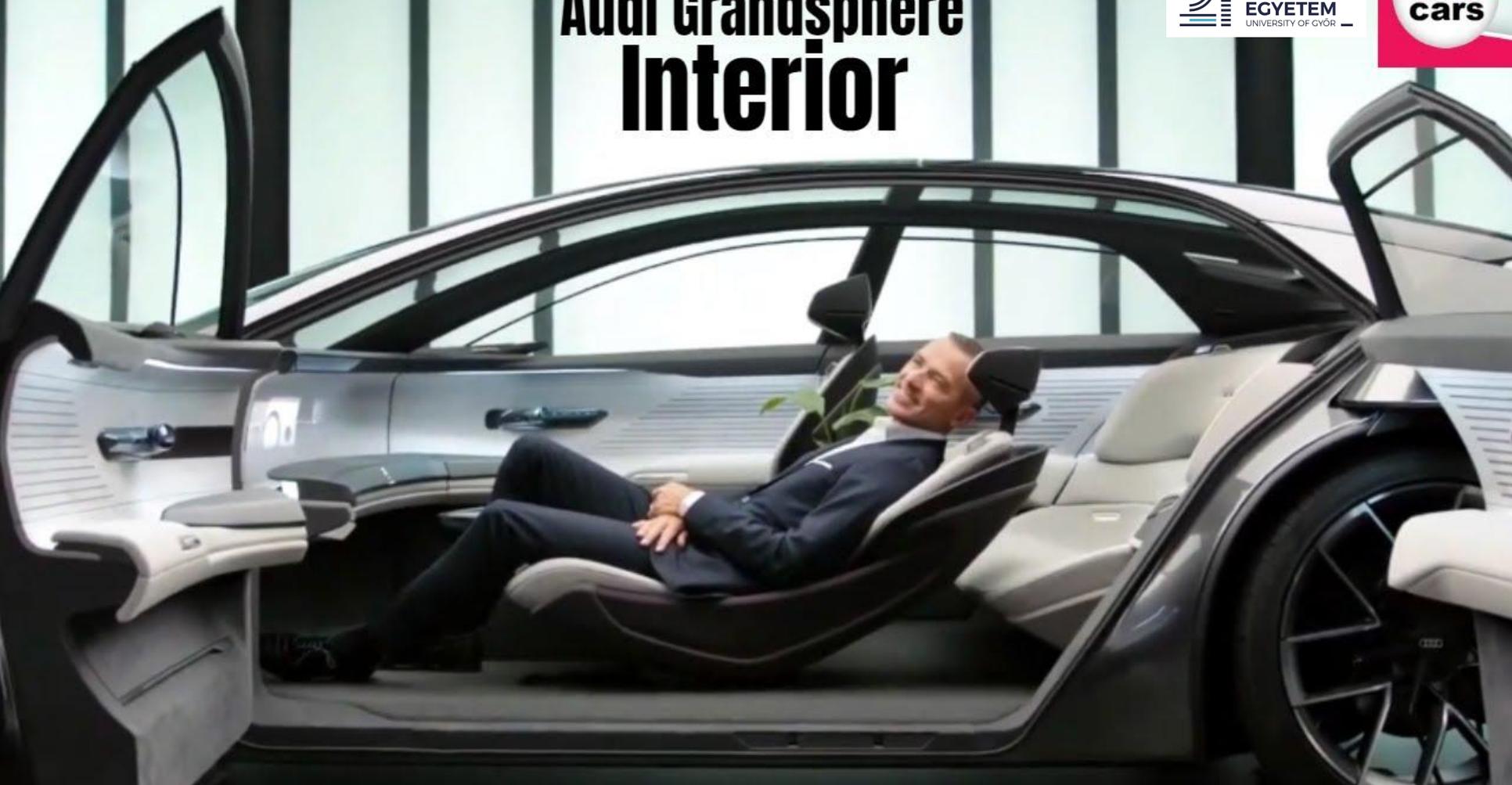
**New Concepts**  
Audi Grand Sphere



# Audi Grandsphere Interior

 SZÉCHENYI  
EGYETEM  
UNIVERSITY OF GYŐR

 DPC  
cars



# New Concepts Audi Grand Sphere

Celebrating Progress



# New Concepts

Audi Sky Sphere, Grand Sphere, Urban Sphere



**Just out...**  
Audi Q6 e-tron



**Just out...**  
Audi Q6 e-tron SUV



**Just out...**  
Audi A6 e-tron Avant



## What's next?

... What does the EU automotive sector needs?

“

To remain competitive globally, the EU must rethink how we regulate in Europe to avoid being left behind.

“

Mobility is key to wealth creation and must not be jeopardised: it should be affordable and accessible to all European citizens and businesses.

“

Embracing a technology-neutral approach – with widespread electrification at its core – is the most effective way to drive down emissions but also maintain Europe's competitiveness.

“

The time is now to craft a visionary EU industrial strategy that not only preserves but elevates our auto industry to new heights of competitiveness.

## **Vehicle Industry**

... a flagship of the EU and V4 economy

**Thank you for your attention**