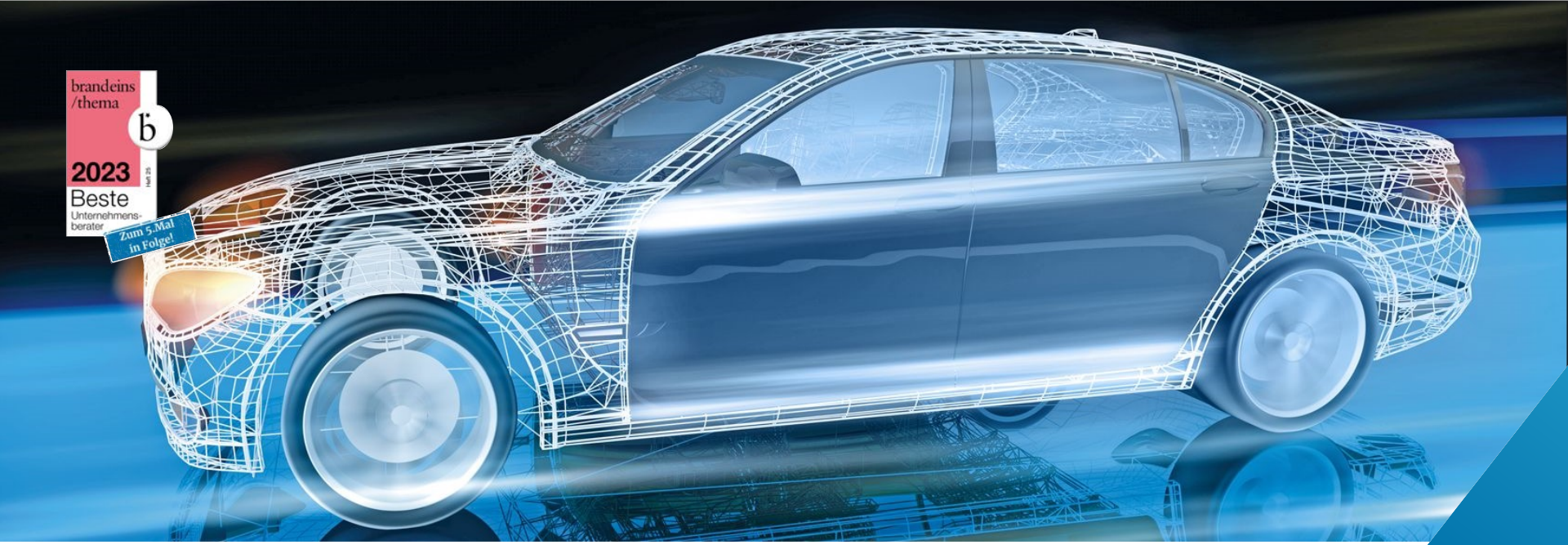


Market Analysis Automotive 2023

FOURMANAGEMENT Analysis on Automotive Market Trends & Technology

„Material shortages were yesterday. Market weakness, energy peak prices (in Germany) and interest burden is today.

Maximum entrepreneurial flexibility is required. “

Agenda

01 Initial Situation

02 OEM-Trends

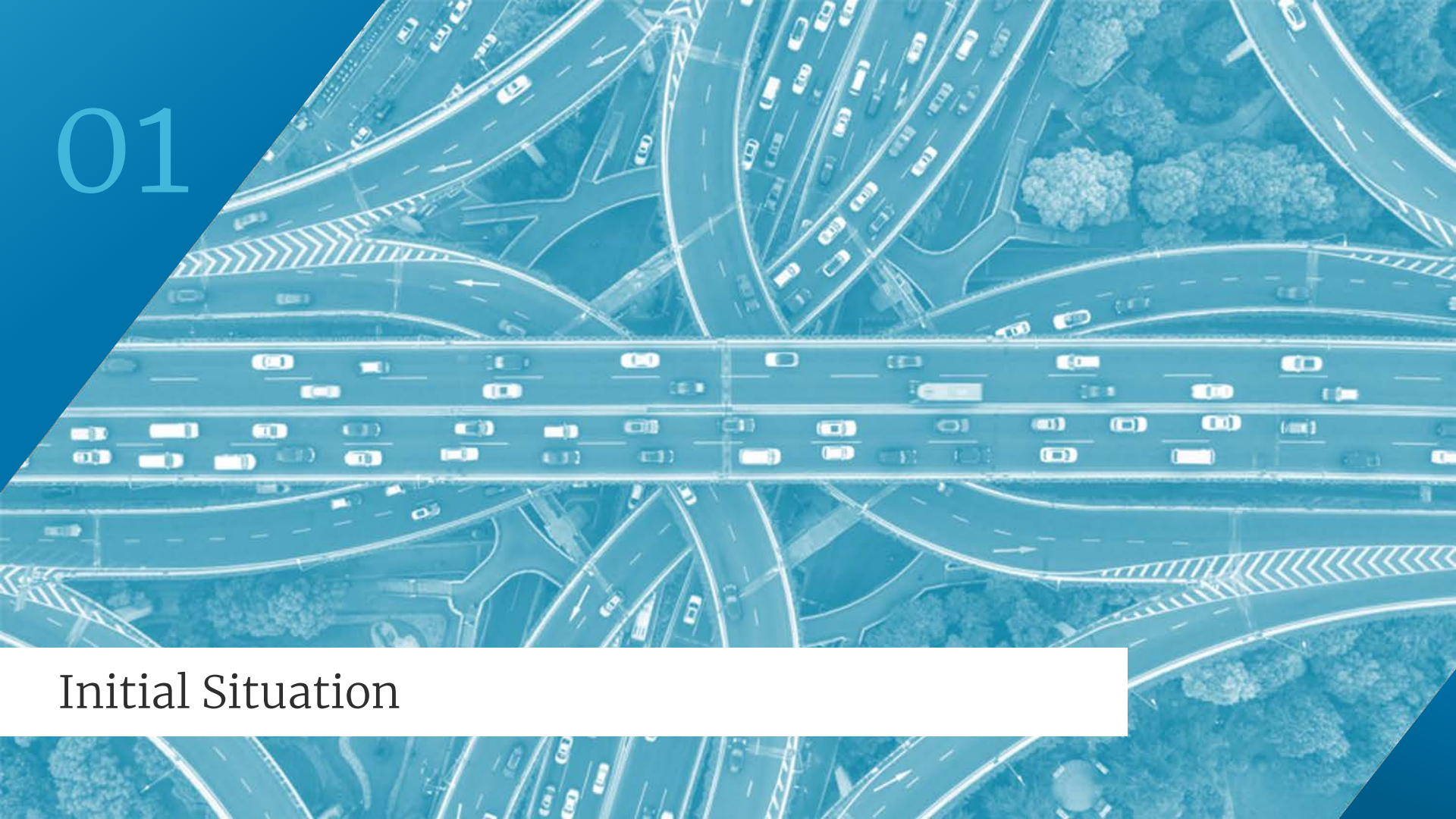
03 Technological Trends

04 E/E Market

05 IT-Security

06 Recommendations

01



Initial Situation

Initial Situation

"Material shortages were yesterday. Market weakness, energy peak prices (only Germany) and interest burden is today. Maximum entrepreneurial flexibility is required."

INITIAL SITUATION IN THE AUTOMOTIVE MARKET

- Positive assessment of demand in the automotive sector
- Profitability for manufacturers more pressured due to:
  - Interest impacts
  - inflation & energy costs (partly)
- Price parity for BEVs with conventional cars will be delayed due to:
  - Underestimated supply constraints
  - The Russia-Ukraine war caused battery prices to increase five years back
- Electric car share in new car registrations to increase due to:
  - Price braking Chinese EV brands going global
  - Tesla`s global price decrease by 25%

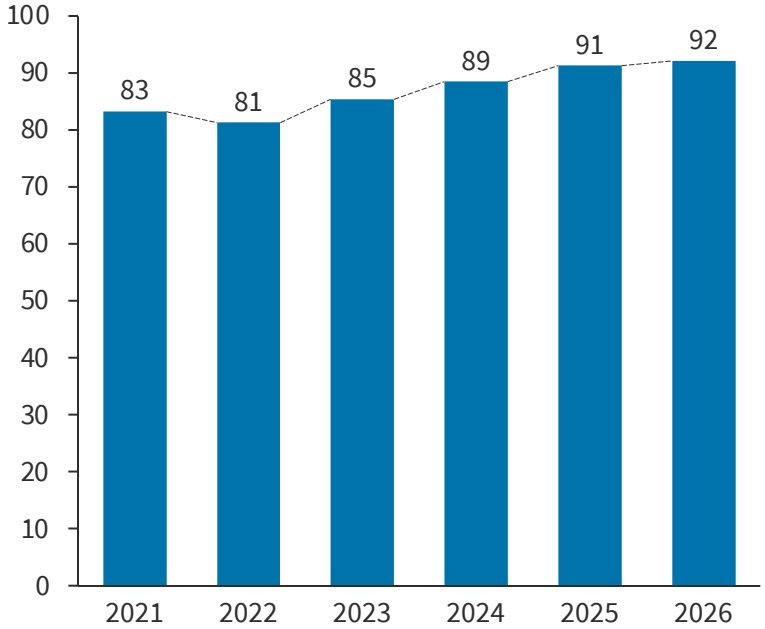
Source: The Economist 2023 | BEV: Battery Electric Vehicle

Automotive Industry – Volume Forecast

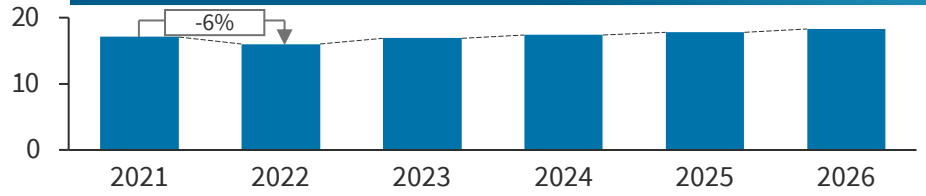
Forecasts indicate an uplift in the vehicles segment following challenging conditions in 2022, which were primarily driven by the effects of the COVID-19 pandemic

Global vehicle sales forecast until 2026:

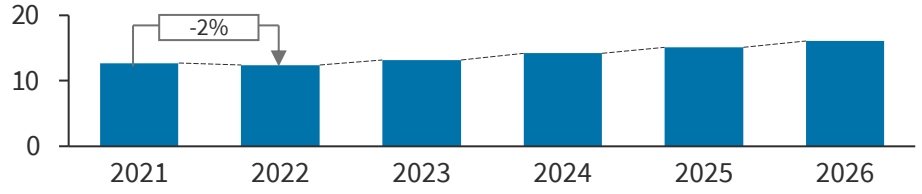
in millions



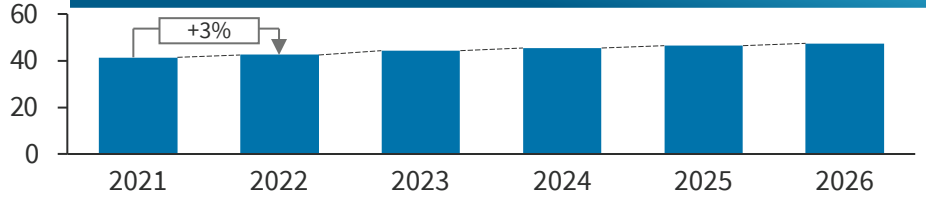
US vehicle sales forecast until 2026



WEU vehicle sales forecast until 2026



Asia vehicle sales forecast until 2026

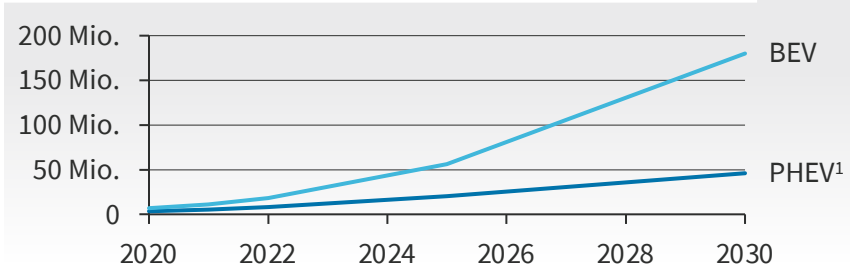


Source: ABI | US: United States | WEU: Western European Union

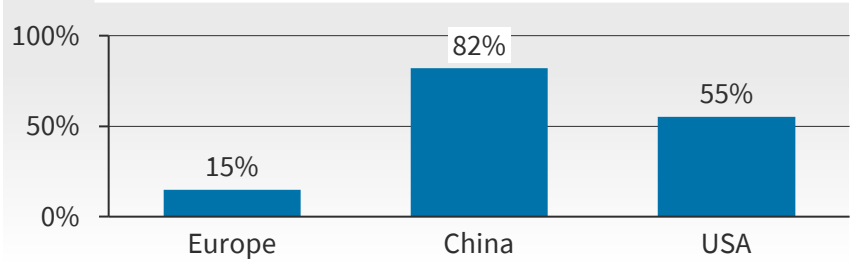
Electromobility Market Expectation

The projected exponential growth of BEVs and PHEVs aligns with the upward trajectory of electric car sales observed in the past year, prompting the inquiry of manufacturers' true dependence on China in light of this evolving landscape

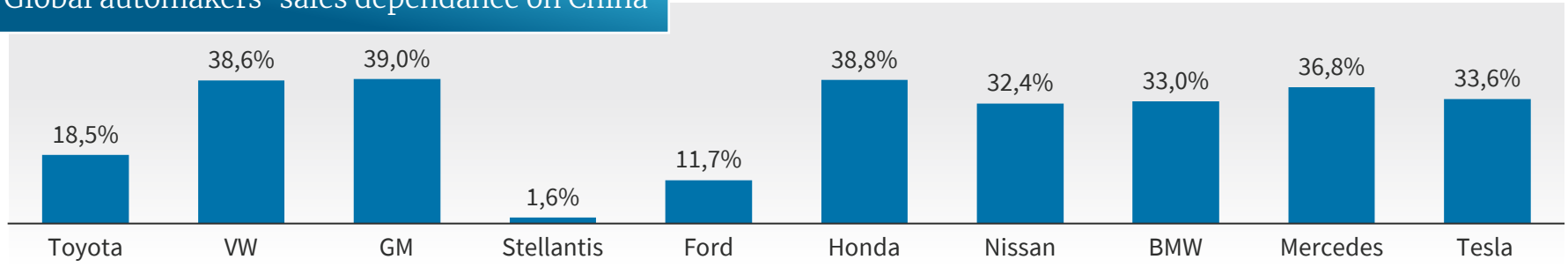
Number of electric cars worldwide and forecast



Increase in electric car sales 2021 to 2022



Global automakers‘ sales dependance on China



Source: Statista; IEA; CAAM | BEV: Battery Electric Vehicles | PHEV: Plug-in Hybrid

Automotive Industry Outlook

In 2022, slower global demand resulting from high interest rates and a shift to inventory banking is evident. Consequently, it is crucial to be vigilant of potential upside and downside risks that may arise throughout the year

Key burdens

- Automotive Industry will **remain vulnerable** to:
  - Supply chain disruptions
  - Slower global demand, compared to 2019 (pre covid), due to high interest rates
- New car sales to **increase marginally** due to growth in Asia

Could ease during 2023

- Level 3 self-driving cars hit the roads and level 4 will undergo tests
- Automakers expected to shift from „just-in-time“ to **„inventory banking“** to protect themselves from further supply chain disruptions
- European auto industry turns to cost saving mode

Downside risk for 2023

- **Separation of markets:**
  - Escalation of Russia-Ukraine war
  - Escalation of Taiwan-China conflicts
- End of life battery recharging is lagging

Upside risk for 2023

- Governments to **restructure their incentive schemes** for BEVs
- Battery swapping (e.g. Nio) and charging stations will expand
- **Local sourcing** -> Domestic semiconductor production and research (especially US)

Source: The Economist 2023 | BEV: Battery Electric Vehicle

Germanys Over-Regulation of the Energy Market

The high regulation of the market enables control, while a deregulated market fosters self-regulation driven by intense competition. However, given the prevailing energy crisis, re-evaluating this strategy may be appropriate

3 main regulatory bodies in Germany

1. EnWG

- Regulates the generation, transport, distribution and sale of energy

2. EEG

- Regulates the promotion of renewable energies
  - Stipulates that energy utilities must obtain a certain proportion of their energy from renewable resources

3. REMIT

- Regulates trading in energy
- The Act stipulates that trading in energy must take place on an exchange market

Comparison to other countries

- The US have State-dependant energy regulations
  - Some states are not regulated
  - Energy prices fluctuate daily
  - High competition between energy suppliers

Fast innovation in the energy sector and coherent markets

High security of supply

Strict environmental standards

Relatively stable energy prices

Highest energy prices

Not competitive structures in the energy market

No motivation for any innovation in the energy/network sector

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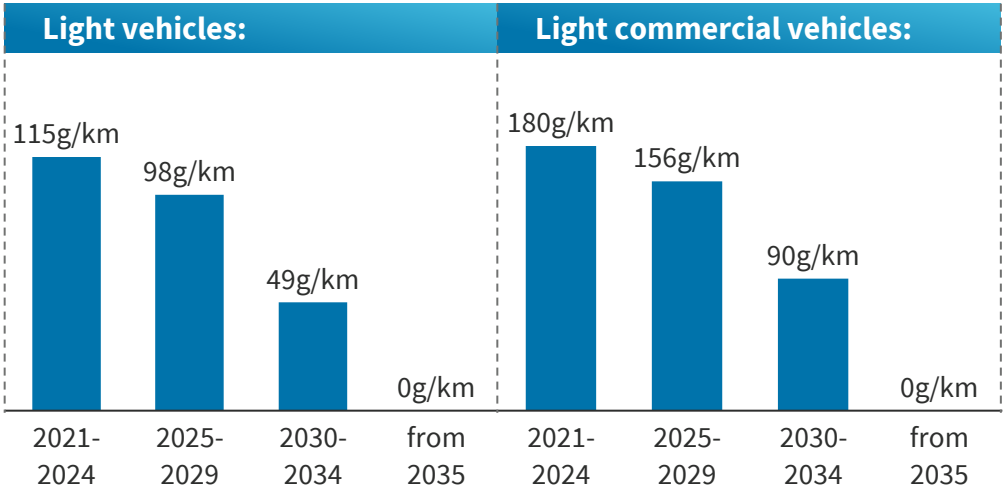
Source: Own Research | EnWG: Energiewirtschaftsgesetz | EEG: Erneuerbare-Energien-Gesetz | REMIT: Integrität und Transparenz des Energiegroßhandels

Why does the EU have strong EV Protagonists?

The stringent regulations and guidelines imposed by the EU provide protagonists with a platform to openly express their opinions

Regulation:
Only zero-emission passenger cars and light commercial vehicles may be newly registered as of 2035



Reasons for protagonism

Government incentives

- Uncertainties on EV taxes in the near future; no more funding necessary because of mandatory rules

Strong environmental regulations

- Environmental protection due to EV regulation will pay a high price for EU society

Shorter distances

- Compared to the US, Europeans travel shorter distances which makes EVs more practical

Growing infrastructure

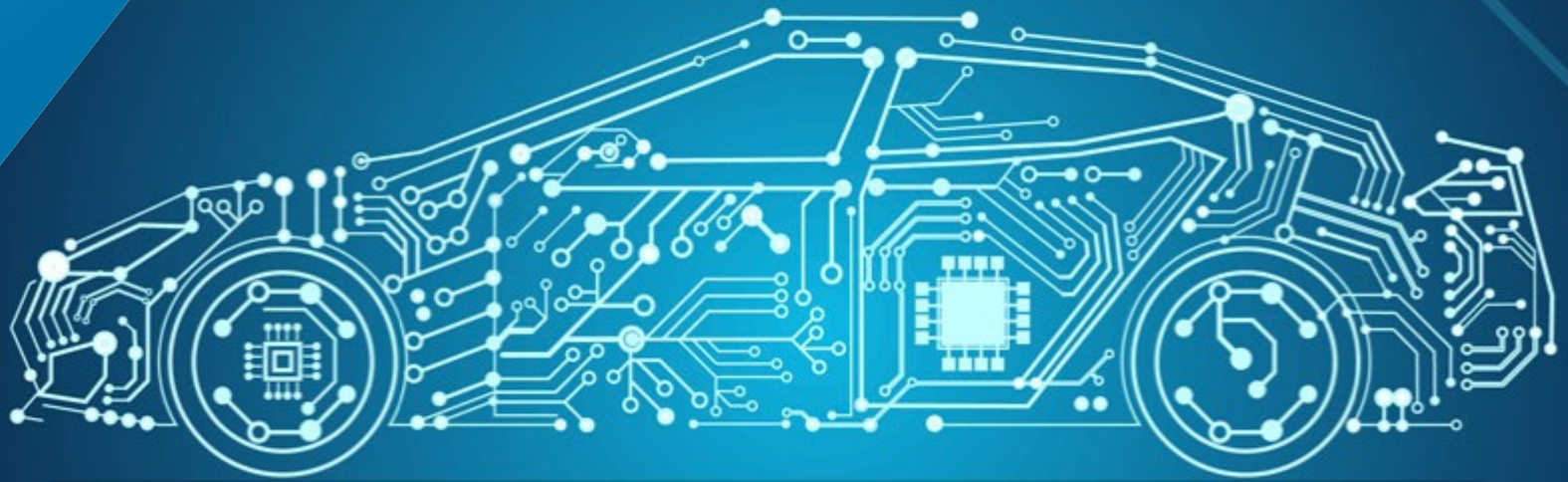
- Unaffordable EV Charging infrastructure &regulation slows down investor's appetite

Strategy

- Only EU goes the EV only way. APAC develops totally different and conquers the global car market successfully in a short amount of time.

Source: BMUV | APAC: Asia-Pacific Region | EV: Electric Vehicle

02



OEM -Trends

Market Situation in Europe

The market for PC and CV shows signs of recovery, however it is currently facing new challenges. Policymakers responsible for PC and charging locations for CV must now re-evaluate and adapt their strategies to address these emerging issues effectively

Passenger Cars

- European passenger **car market recovery**, in the first quarter of 2023, from the impact of the COVID pandemic
- Easing of supply chain constraints and reduction in the high order backlog
- **Europe** to experience **7% growth**, reaching **12 million vehicles** in 2023
- Calls for **greater speed** and **determination from policymakers** to address challenges:
  - **Reduction** in electricity tax to european minimum
  - **Securing raw material** supply through partnerships

Commercial Vehicles

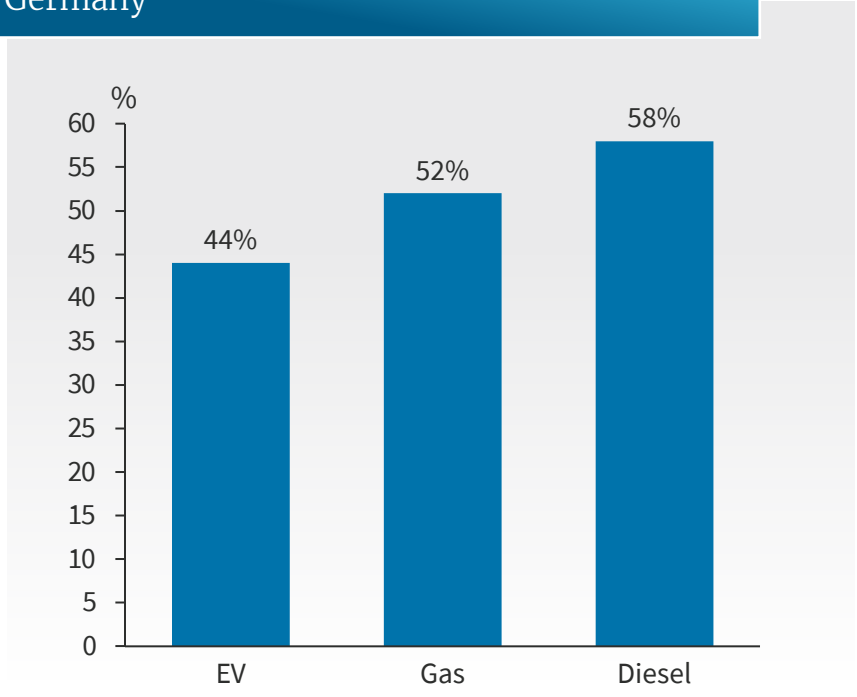
- **Few charging and refueling locations** are still appropiate for commercial vehicles
- **Still increasing need** for material transportation
  - Driving up commercial vehicle sales in Europe
- With Germany being the largest segment by Country, the expected **CAGR until 2028 is 3.5%**
- Market is very consolidated with **five companies occupying 70%** of the market
- **Chinese players** entering the market successfully

Source: McKinsey; Mordor Intelligence | PC: Passenger Car | CV: Commercial Vehicle | CAGR: Compound Annual Growth Rate

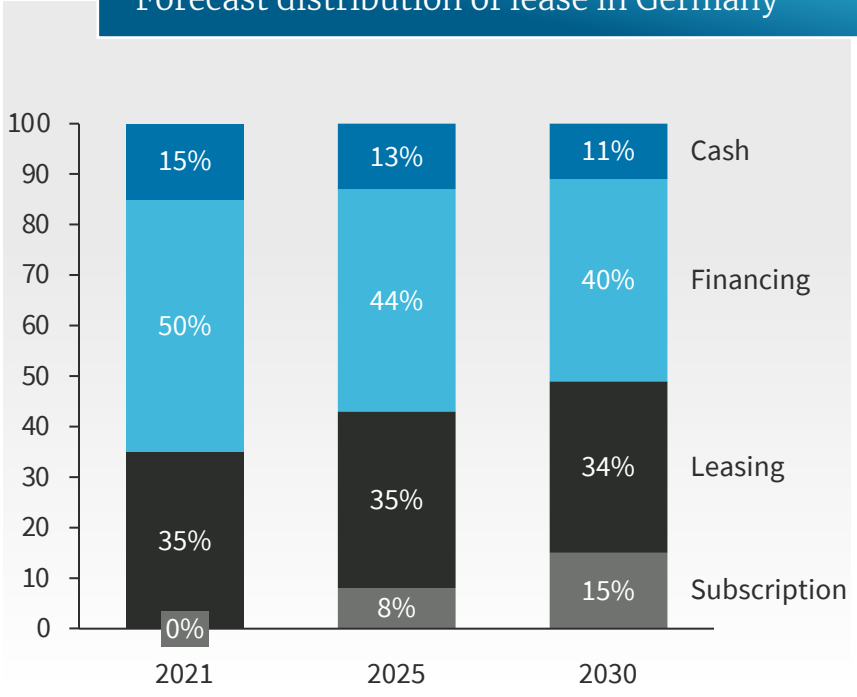
Challenges Bear Residual Values due to Interest Increase

The current data for a three-year lease and 100,000 km; fleet managers are encountering challenges due to rising lease prices; however, long-term forecast statistics depict an upward trend in the inclination towards non-ownership of vehicles

Germany



Forecast distribution of lease in Germany

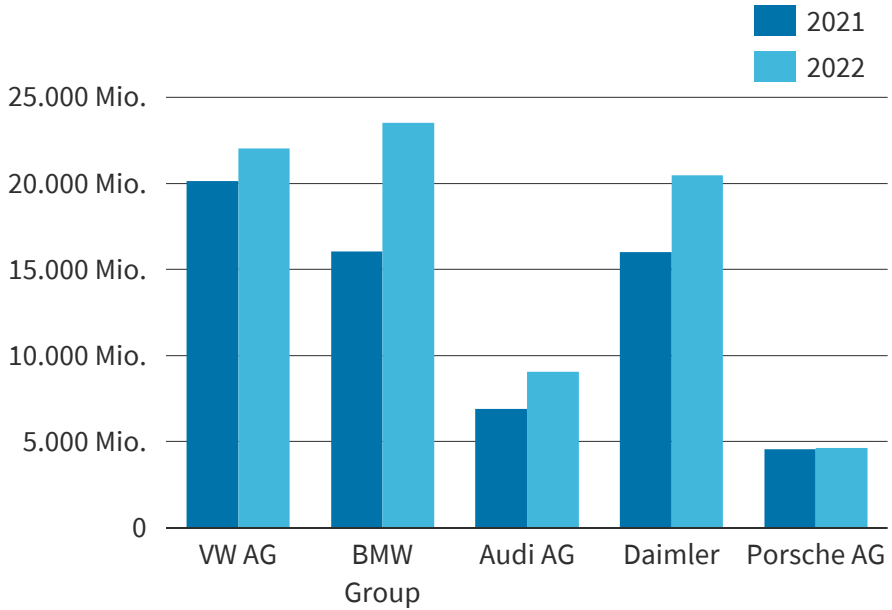


Source: Own Research; Statista

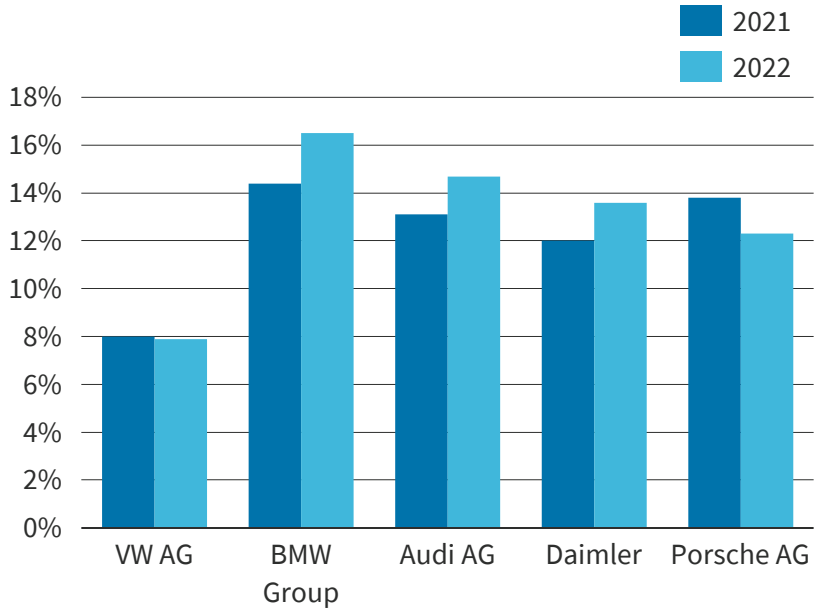
Profitability (EBIT) of German OEMs as of 2021 to 2022

In 2022, there is a discernible overall increase in EBIT and EBIT margin. A relatively small increase or decrease in EBIT margin may signal that significant investments have been made to secure the future of the company

EBIT comparison 2021 to 2022



EBIT Margin comparison 2021 to 2022



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Source: Annual Reports | EBIT: Earnings Before Interest and Taxes

Current Market Situation Automotive

Car manufacturers, automotive suppliers, and Chinese car manufacturers entering the EU market are all proactively updating their independent and general strategies to sustain continuous growth or achieve exponential growth in the forthcoming years

Volkswagen

- Big issue: MEB platform seams to be **not competitive globally**
- Plant for EV cars in US
- **7%** of all vehicles delivered in 2022 were BEVs; **market issues in China**
- New **unified battery cell** will be used in 80% of VW Group models by 2030
  - To cover demands, VW plans to **build six gigafactories**
- By 2025 **45.000 high power charging** points in europe
- Electric vehicles to act as a **mobile power** bank as a storage unit
  - Build up **energy ecosystems** for decarbonized mobility

Daimler

- Assumes market for sustainable **luxury will grow**
  - Expand customer base by growing top-end luxury segment
- Focus on digital **network mobility solutions**
- **Lead electric drive** for efficient full electric cars
- Integrated **online customer experience**
  - Enable customers to buy/finance/lease and insure their cars online
- Most important markets in 2022 (unit sales):
  - China 37%; US 15%; Europe 31% (11% Germany); South Korea 4%

Stellantis

- Transformation into a **sustainable mobility tech** company
- 2022 released it's 2030 strategic plan
  - **100%** of passenger cars **in europe** to be BEVs
  - 50% of it's passenger and LCV to be BEVs
- R&D focus shifted to **electrification** and related technologies
  - **Reduce** overall vehicle **energy demand**
- BEV ranges of up to 800km in development
- Partnership with 2 suppliers:
  - Faurecia for **hydrogen storage** system; Symbio for **fuel cell** system

Nio

- Game changer for **EV market in EU**
- One of the first companies in China to offer **enhanced ADAS** capabilities
- **Subscription business** in leasing programs for customer expansion in europe
- **Battery as a service**
  - Allows customers to purchase Nio vehicle without a battery
  - Subscribe to battery subscription and switch batteries at Nio Battery swap stations
- Vehicle **sales** show an **increase of 37%** from the previous year
- 3 new models for **EU expansion**

Source: Annual Reports | MEB: Modular Electric Drive Toolkit | ADAS: Advanced Driver Assistance System | EV: Electric Vehicle | LCV: Light Commercial Vehicles | BEV: Battery Electric Vehicle | VW: Volkswagen

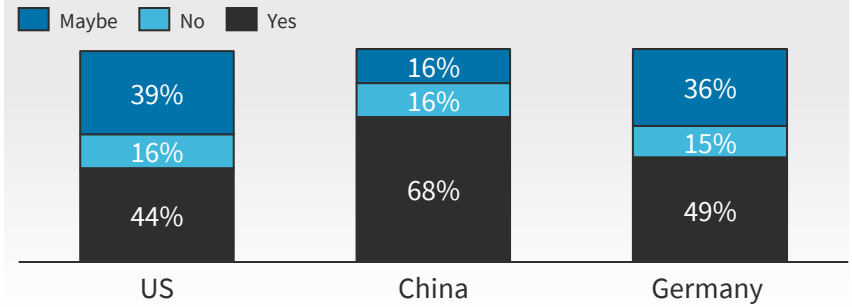
03

Technological Trends

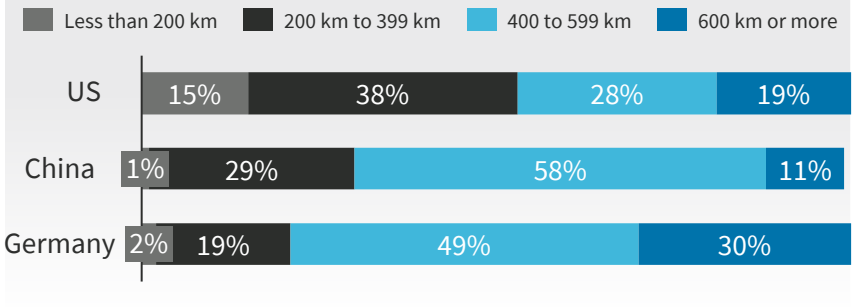
Consumers Wants and Expectations

Before delving into technological trends, it is imperative to first understand consumers‘ wants and expectations, as well as the subsequent requirements and focal points for manufacturers

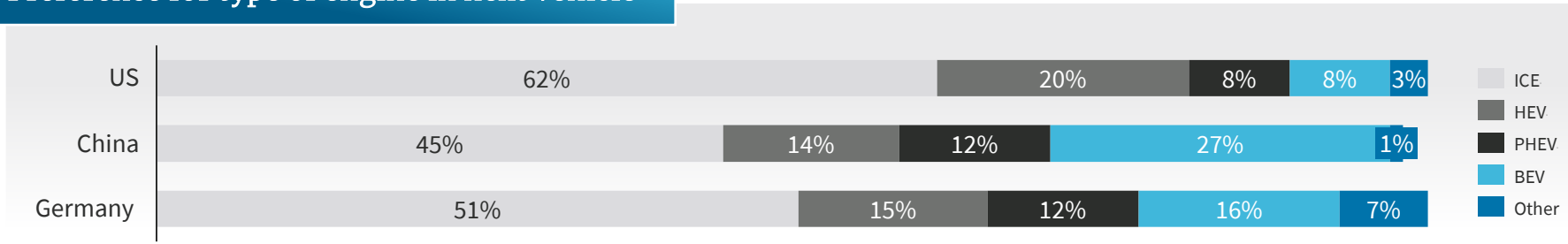
% Purchase of EV if e-fuel alternative present



Consumer expectation of BEV driving range



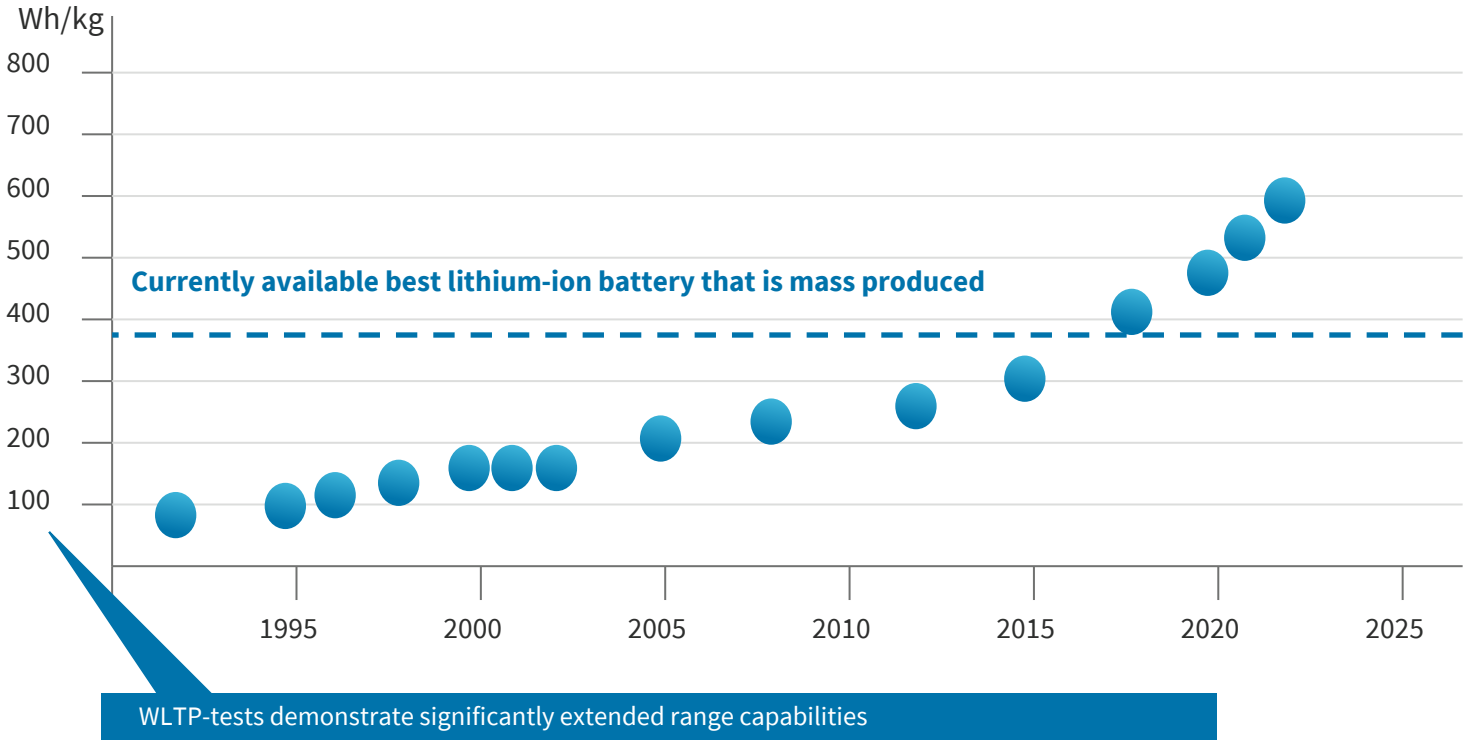
Preference for type of engine in next vehicle



Source: Deloitte 2023 | ICE: Internal Combustion Engine | HEV: Hybrid Electric Vehicle | PHEV: Plug-in Hybrid Electric Vehicle | EV: Electric Vehicle | BEV: Battery Electric Vehicle

Increasing Energy Density

Improvements in the lithium-ion-battery since 1990, many announcements took place whereas development remained moderate

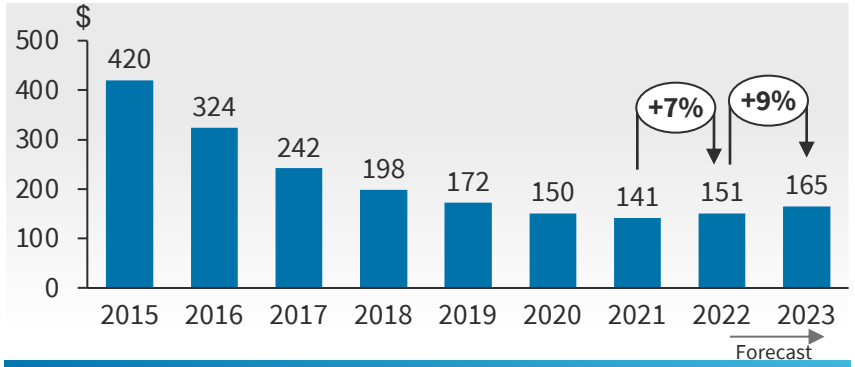


Source: Automobilwoche | : Development steps for the lithium-ion battery in each case. Best value achieved per year | WLTP: Worldwide harmonised light vehicle test procedure | Wh/kg: Watt hours per kilogram

Delay in Price Parity for BEVs with ICEs

Although lithium-ion batteries are experiencing improvements, the delay in achieving price parity for BEVs with ICEs can be attributed to supply constraints resulting from underinvestment and the separation of markets

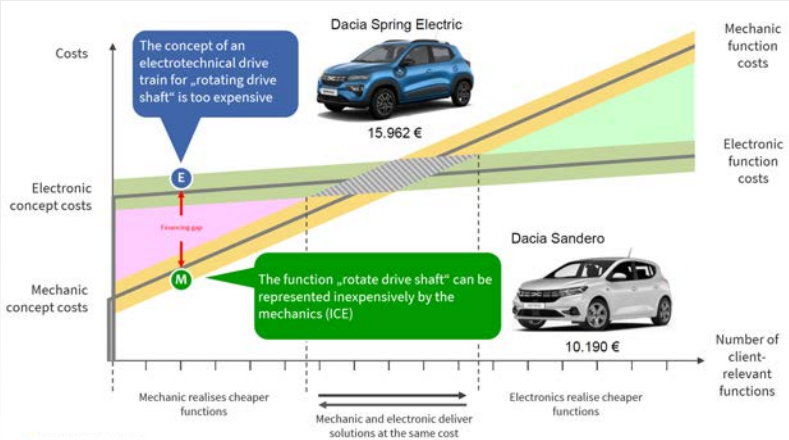
Volume weighted average lithium-ion battery and cell price:



1. Supply constraints due to underinvestment

- Lithium **prices remain high** due to persistent supply chain constraints
  - Supply chain **capacity expansion is crucial** for improving battery technology and **reducing costs** in the next decade
- Investments made during covid were predominantly directed towards achieving **immediate short-term effects**
  - Investing in the supply chain holds **strategic significance in the long term**, therefore **initiating such investments without delay** is a crucial imperative

Cost disadvantage of e-mobility



2. Supply constraints due to seperation of markets

- Geo-politics and **trade tension are uncertainties** affecting battery prices in the short term
  - Resolving these tensions (ie. Russia-Ukraine war) could help **stabalize prices** in 2023 and beyond

Source: Bloomberg | ICE: Internal Combustion Engine | BEV: Battery Electric Vehicle

E-Fuels(1 of 2)

E-fuels market introduction needs a strategic move of OEM (e.g. BMW & Porsche) covering whole E-fuel supply chain

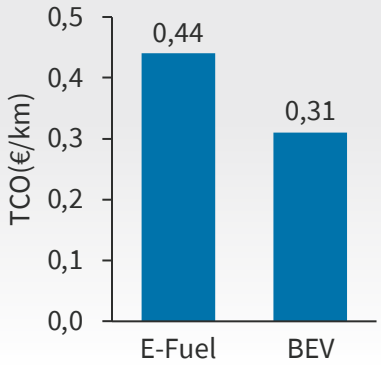
Are E-fuels in cars a viable alternative?

E-fuel is a **synthetic alternative** that can be made from air (CO_2) and water using electricity

- ✓ Diversification of energy sources
- ✓ Compatability with existing infrastructure
- ✓ Storing CO_2
- ✓ **Opportunitiy for zero emission on whole global fleet shortly**
- ✗ No intra-national initiative up to now
- ✗ Uncertain regulation impact in general emissions

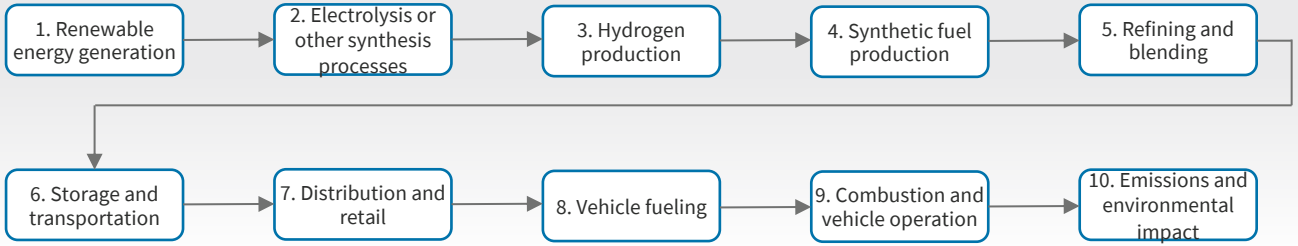
Cost efficiency of e-fuels right now (no mass production)

- The cost/ km for e-fuels is already in range of BEVs.
- E-fuel will be the only way to to **decarbonise** the global fleet even in third world shortly
- Prices are still on a research level; Prognoses 0.75 ct/ltr FOB



E-fuel investment along the supply chain

As e-fuel is the only **viable option** compared to EVs, e-fuel **investment** throughout the **supply chain** is crucial to drive innovation, improve efficieny, and ensure a **sustainable transition** by **reducing carbon emissions in existing vehicles** and enabling **CO_2 Storage**



Source: Transport & Environment | TCO: Total Cost of Ownership | FOB: Free on Board– Without any Taxes | BEV: Battery Electric Vehicle | EV: Electric Vehicle

E-Fuels(2 of 2)

E-fuels market introduction needs a strategic move of OEM (e.g. BMW & Porsche) covering the whole E-fuel supply chain

E-fuel investment by BMW

„Diversity means resilience“
Oliver Zipse, CEO BMW

- **BMW‘s investment**
  - BMW invested $12.5 million in the e-fuel startup Prometheus fuels
- **Germany‘s copernicus project**
  - Involved in e-fuel development
  - Goal of carbon-neutral economy by 2025
- **P2X Research**
  - P2X (Power-to-everything) aiming to convert electricity to various energy carriers
- **Efficiency goal**
  - The P2X program is developing water-splitting electrolysers to maintain a conversion efficiency of aroung 65% while reducing iridium use
- **Iridium reduction**
  - Investment and research of BMW aims to seek e-fuel as a viable option compared to EVs and to eliminate the use of expensive iridium in the process

E-fuel investment by Porsche

- **Porsche leading e-fuel development**
  - Porsche at the forefront of e-fuel development
  - Mature e-fuel production project in Punta Arenas, Chile
  - Strong wind energy operates windmills 270 days per year
- **Collaborative investment and process**
  - The project is backed by partners ie. Siemens energy and Exxonmobil and is owned by HIF global
  - A 3.4-megawatt Siemens windmill generates electricity for hydrogen production through electrolysis
  - Furthermore wind energy powers CO_2 capture and the conversion of hydrogen and CO_2 into liquid methanol
- **E-fuel for existing vehicles**
  - Porsche emphasises e-fuels‘ role in decarbonising existing vehicles
- **E-fuel production plans**
  - Initial production of 130.000 liters of e-fuel
  - Porsche‘s investment in HIF expected to scale up production to 55 million litres in two years

Source: SAE; FAZ | OEM: Original Equipment Manufacturer | HIF global: Global e-fuel company

04

E/E-Market

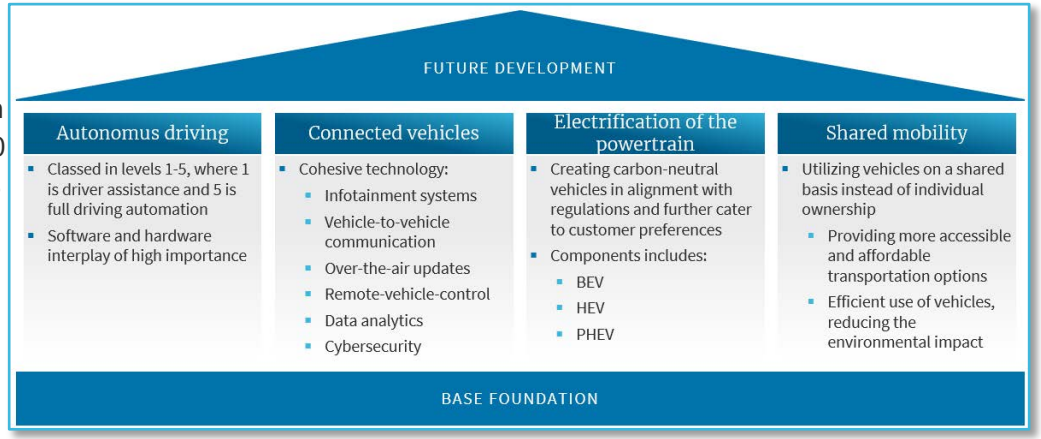
Software

By 2030, the global automotive software and electronics market is expected to reach $462 billion, representing a 5.5% CAGR from 2019 to 2030

Software disruptions contribute to the rapid growth of automotive and software electronics

This reality reflects a significant shift in the future of mobility

- The adoption of driver assistance systems and AD will be fueled by changing customer preferences
- The automotive software market is projected to more than double in size from $31 billion in 2019 to $80 billion in 2030
- Specifically for LiDAR, cameras and radars, the automotive sensor market is expected to grow from $23 billion in 2019 to $46 billion in 2030
- Established 1st tiers shift to form cooperations with tech companies
- New rental concepts, pay by use, etc. are now conquering first markets



AD: Autonomous Driving | HEV: Hybrid Electric Vehicle | PHEV: Plug in Hybrid Eletric Vehicle | CAGR: Commpound Annual Growth Rate | LiDAR: Light detection and ranging

Critical View of the E/E Market

It is crucial to critically view the different developments and tensions of two regions in this market to facilitate short- and long-term analysis

China is facing advantages

China has shown significant progress in their car software

- China had **20% level 2** ADAS in 2021 and is expected to have **11% level 4 ADAS by 2030**
- Affordability
  - China has reached **price parity** between ICEs and BEVs as early as 2017 and now continuously **produces cheaper BEVs** than ICEs

Europe hangs behind

European car manufacturers striving to hold the lead amidst the trend of car software

- Due to the **increase in lithium-ion battery prices**, the price parity between ICEs and BEVs has been **delayed**
- Portfolio management **lagging behind** due to the **discontinuation** of **small car models**

China‘s upside risk

China‘s upside risk depends on the China-Taiwan conflicts

- Europeans **surrendering** small car models and **operational structure**
- Taiwan accounts for **77% of semiconductor** production for Europe
  - Should China attain full control, its authority may impact **chip output to Europe**, giving them more control over other car manufacturers

However, rising power of China **spurs other nations** towards greater **independance**

Europe‘s upside risk

European car manufacturers to use AI to make up for their software deficits

- European car manufacturers to **build an ecosystem** of excellence and trust around AI
  - **AI as a stepping stone** for software developments
- AI to initiate and **facilitate the ongoing advancements** in software enhancements

Source: IHS Markit; ACEA | AI: Artificial Intelligence | ADAS: Advanced driver assistance system | ICE: Internal Combustion Engine | BEV: Battery Electric Vehicle

Software Development

Software improvements not only offer benefits to consumers but also present earnings opportunities for car manufacturers. The extent to which these opportunities can be capitalized upon relies heavily on the manufacturer's position in the market

Income per vehicle if earnings opportunities from software are fully captured

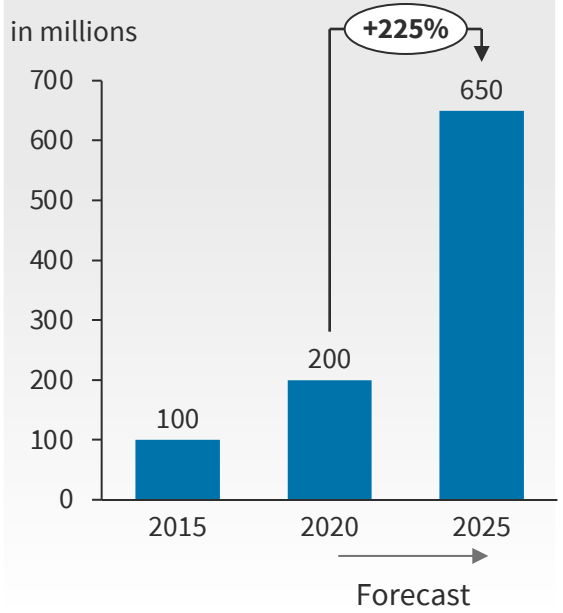
IPV as of now **$1750** → **$3750** IPV with captured earnings opportunities

That level of improvement boosts operating margins from **7% to 12%**

- ✓ Car manufacturers with **scalable products** will have an **advantage** in ramping up quickly
- ✗ Car manufacturers operating in multiple regions and **handling diverse models and powertrains** may face **challenges** in adapting to the realignment

Not every manufacturer will **benefit equally** from this realignment

Lines of code for cars

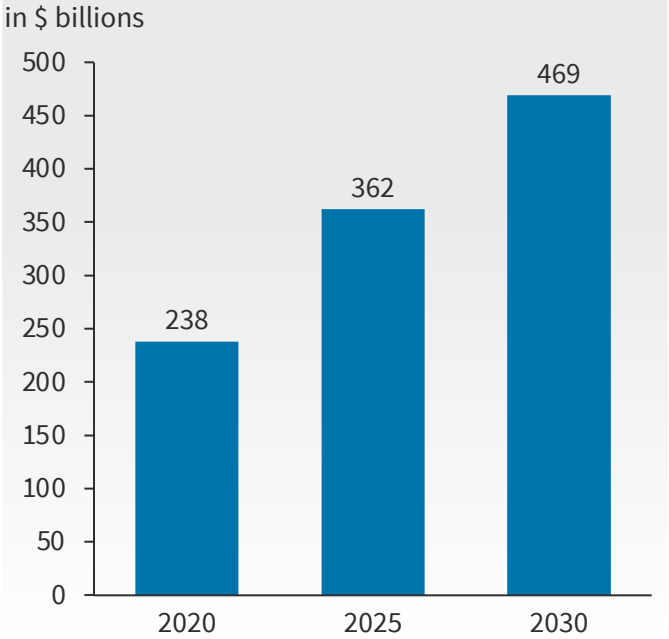


Source: Goldman Sachs; JP Morgan | IPV: Income per Vehicle

Software Replaces Hardware(1 of 2)

The software and the E/E market are poised to undergo a strong growth trajectory as an increasing number of software solutions replace hardware components. In light of this transition, the allocation of responsibilities becomes a matter of high importance

E/E market growth forecast with a CAGR of 7%:



Examples of software replacing hardware

ANALOG DIALS AND GAUGES	DIGITAL DASHBOARD
ANALOG AUTOMATIC TRANSMISSION	SOFTWARE TRANSMISSION[1]
OVER THE AIR UPDATES	INSTEAD OF PHYSICAL HARDWARE CHANGES

Considerations when software replaces hardware

Compatability and integration	**Performance and efficiency**	**Reliability and redundancy**	**Security**
Scalability	**Maintenance and updates**	**Training and adaptation**	**Cost analysis**
Regulatory compliance	**Testing and validation**	**Backup and recovery**	**User experience**

Source: WiWo | Software Transmission[1]: Automatic Shifting through Software Input to Increase Efficiency | CAGR: Commpound Annual Growth Rate

Software Replaces Hardware(2 of 2)

When implementing software-driven solutions intended to replace or overwrite preexisting hardware, the present case exemplifies the critical significance of the factors that must be taken into consideration during such undertakings

Background

- **VW founded** the software company **„Cariad“** in 2016
- The goal was to **accelerate software development** and establish VW software-driven vehicles

Challenges

- „Cariad“ operated **independantly** from VW, with **separate** leadership and operations
- Recent events highlighted **software issues causing delays** in car production
- Delays had **cascading effects** on VW group subsidaries

Solution

- VW leadership decided to **replace „Cariad“ leadership team**
- „Cariad“ shifts from being independant to **integration** within the VW group
- Aim to regain **competitive position** in the market

What „Cariad“ lacked

- **Compatability and integration**
- **Performance and efficiency**
- **Reliability and redundancy**
- **Maintenance and updates**
- **Training and adaptation**
- **Cost analysis**

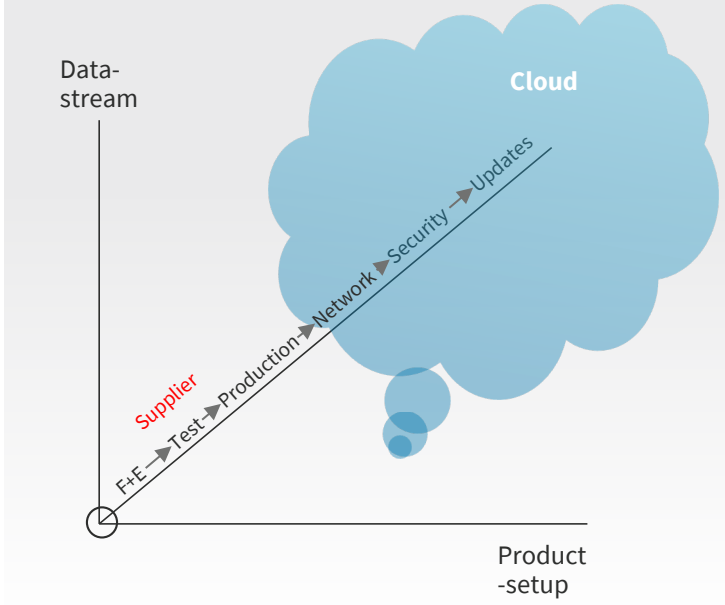
- This example case highlights the **importance** of what to **consider** when **implementing** software driven solutions
- When developing an internal software solution **„Compatability and integration“** should be of main focus to **ensure no time lag** between the **integration into hardware systems**
- An increasing number of established 1st tiers are strategically **pursuing collaborations** with tech/software firms. As a result, the **significance** of these considerations is **progressively amplified**

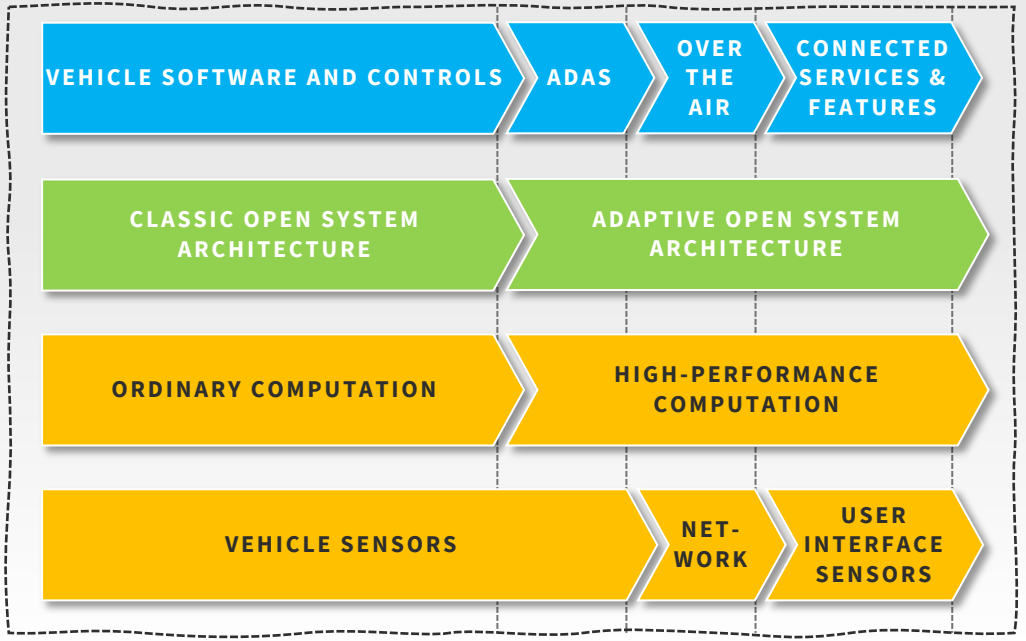
Source: WiWo | VW: Volkswagen

Process and Data Flow

The process and data flow of automotive OEMs have undergone significant changes, with OEMs needing to discerningly determine which processes can be cloud-enabled and allocate appropriate resources to execute those processes

Software infrastructure tiers





Source: Own Research | : Software Application; : Software Platform; : Hardware Platform
OEM: Original Equipment Manufacturer | ADAS: Advanced driver assistance system

1st tiers Initiating Cooperations

More and more OEM and tech players are working together exclusively. Established 1st tiers shift from being free riders to initiating cooperations

Agreed cooperations of established 1st tiers

Source: Own Research | : 1st Tier; : Cooperation Partner

Software Overwriting Hardware

Software companies face a pivotal choice: Develop their own cars with integrated software or provide software solutions that complement, or even overwrite, existing hardware, defining and occupying a new market role for themselves

Apple patents „electrical steering wheel“

- The patent is described as a „steer-by-wire“ system with multiple steering actuators
- In the patent filing, Apple says that steer-by-wire systems can eliminate or disconnect a physical connection between a steering wheel and the road wheels

What does this mean for Apple?

- Create a wireless steering wheel that **replaces normal steering** wheels
- Apple‘s OS software **integrates/over-writes** the cars hardware to implement their technology
- **Huge impact** on consumer satisfaction
- Apple creates and **occupies new market role** for themselves

Is an OEM cooperation more lucrative for tech/software companies than developing an own car?

- **Specialization**
  - Software companies can focus on their core competency
- **Market accessibility**
  - Developing software allows software companies to enter the automotive industry without the complexities of vehicle production
- **Rapid iteration**
  - Quick updates and improvements enabling companies to respond faster to market demands
- **Scalability**
  - Scaling software products is more straightforward than scaling car production, allowing software companies to reach a broader market quickly
- **Ecosystem integration**
  - Software that replaces hardware can seamlessly integrate with existing car models and ecosystems, enhancing user convenience

Source: US Patents; Own Research

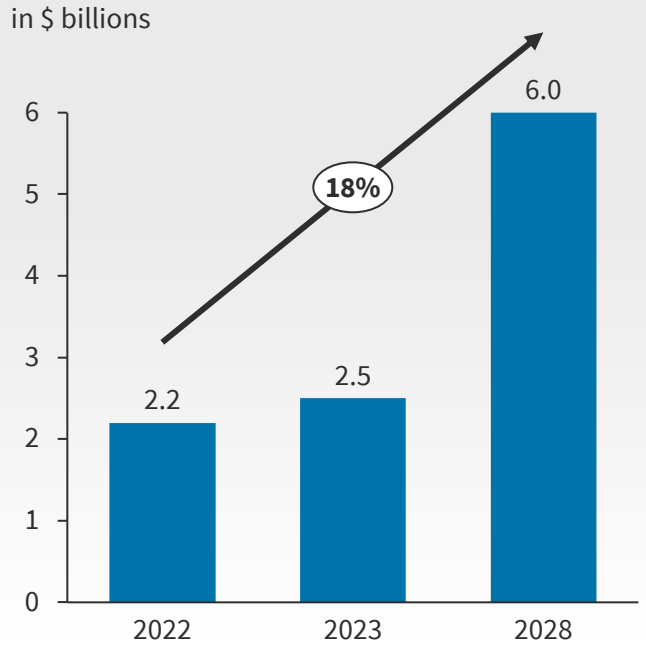
05

IT-Security

Components of the IT-Security Market

IT-Security is a rapidly growing market, driven by the increasing prevalence of newer, modern vehicles equipped with fundamental software

The cyber security market to grow with a CAGR of 18%



Why cyber security is gaining importance

- **Connected vehicles**
  - Modern vehicles equipped with advanced technologies that enable connectivity create potential entry points for cyber attackers
- **Autonomous vehicles**
  - Development relies heavily on software and sensor systems. Hackers may exploit vulnerabilities in the car‘s systems, leading to unauthorized access
- **Data privacy**
  - Ensuring data privacy and protection from unauthorized access is crucial to maintain customer trust and comply with data regulations
- **Industry standards and regulations**
  - Governments regulatory bodies worldwide recognize the risks associated with connected vehicles and setup adequate measures to protect from cyber threats
- **Supply chain vulnerabilities**
  - Cybersecurity vulnerabilities in any part of the supply chain can expose vehicles to potential threats
- **Reputation and brand protection**
  - Companies investing in robust cybersecurity measures demonstrate their commitment to customer safety

Source: MAM | CAGR: Commpound Annual Growth Rate

Market Dynamics

In a dynamic market, new potentials flow in, but understanding the drivers, restraints, opportunities, and challenges only becomes clear through active engagement

Driver: EVs more vulnerable to cyber attacks

- Electric vehicles equipped with **advanced connected vehicle software**
  - This connectivity **increases the vulnerability** of vehicles to cyber threats
- Demand for automotive IT-Security is likely to **grow along** with the growing demand for electric vehicles

Restraint: Complex integration risks

- Development of countermeasures is challenging because of the **lack of standardization** in IT-Security solutions
- The solutions for cybersecurity **depend on the specifications** given by the automotive OEMs
  - These solutions vary due to the **use of different platforms** in the same vehicle

Opportunity: Advent of software-defined vehicles

- Automotive sector shifting focus toward **software-centric vehicles**
- The benefits arising from software-centric vehicles will **increase their demand further**
- Automotive IT-Security companies must **seize the growth opportunities**
  - **Can TISAX bridge the gap?**

Challenge: Time lag in cybersecurity updates

- Car manufacturers are **only responsible for integrating** the cybersecurity solution with the hardware of the vehicle
  - The rest is the responsibility of the **IT-Security providers**
- Thus meaning **time lag in rectifying the identified vulnerabilities** increases

Source: MAM | TISAX: Trusted Information Security Assessment Exchange | EV: Electric Vehicle | OEM: Original Equipment Manufacturer

IT-Security Process (1 of 2)

The IT-Security system comprises four sequential steps that must be diligently followed to establish an effective and robust IT - Security infrastructure with the help of TISAX

1 **Risk analysis**
Accurate and thorough assessment and identification of potential risks

2 **Risk management**
Administrative, physical and technical security measures to reduce risks and vulnerabilities to these risks

3 **Sanction policies**
Appropiate sanctions and repercussions for those that violate policies and procedures

4 **System auditing**
Verifying and auditing log files and access records for security incidents and the implementation of procedures to ensure proper access

TISAX cybersecurity standards

TISAX is an assessment and exchange mechanism for information security in the automotive industry

- Maturity level 0 – Incomplete
- Maturity level 1 – Conducted
- Maturity level 2 – Controlled
- Maturity level 3 – Established
- Maturity level 4 – Predictable
- Maturity level 5 – Optimising

- Cryptography → To what extent is information protected during transmission?
- Operations security → To what extent are IT systems protected against malware?
- System acquisitions, requirement management and development → To what extent are requirements for network services defined?

Source: ENX; TISAX | : Maturity Level of the Process; : IT-Security experts from TISAX
TISAX: Trusted Information Security Assessment Exchange

IT-Security Process (2 of 2)

The IT-Security system comprises four sequential steps that must be diligently followed to establish an effective and robust IT-Security infrastructure with the help of ISA 62443

1

Risk analysis

Accurate and thorough assessment and identification of potential risks

2

Risk management

Administrative, physical and technical security measures to reduce risks and vulnerabilities to these risks

3

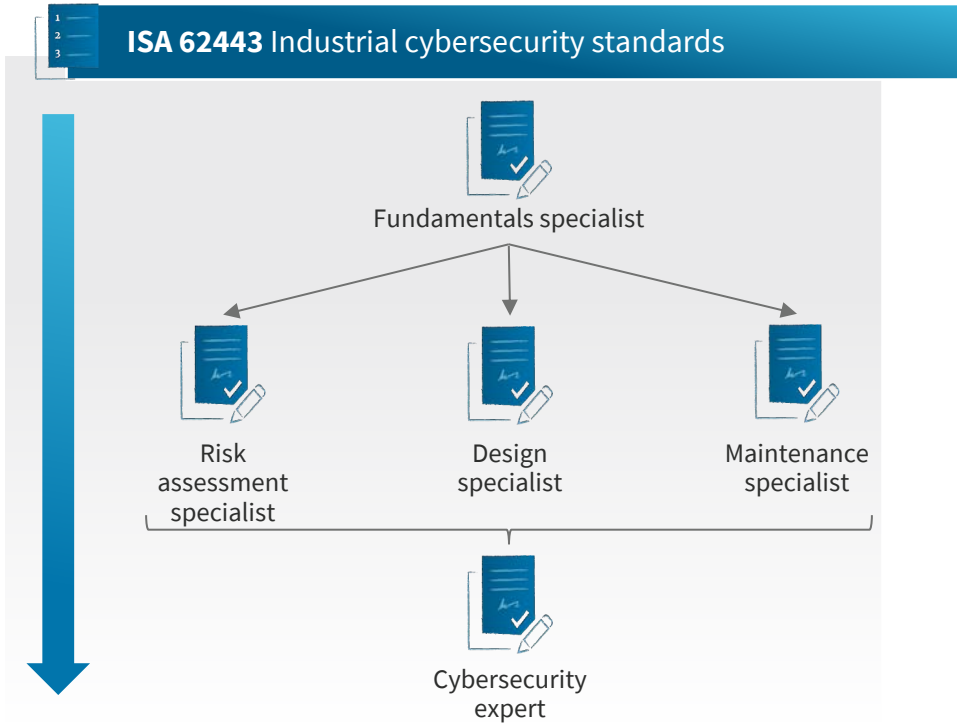
Sanction policies

Appropiate sanctions and repercussions for those that violate policies and procedures

4

System auditing

Verifying and auditing log files and access records for security incidents and the implementation of procedures to ensure proper access



Source: ISA

Key Market Players

Key market players in the IT-Security area and approaches a car manufacturer can take in order to fulfill its IT-Security requirements are essential considerations in today's digital landscape

Key market players IT-Security

ARILOU Automotive Cyber Security Part of NNG Group
GUARD KNOX
Upstream
escrypt SECURITY. TRUST. SUCCESS.
Symantec.
Trillium
HARMAN A SAMSUNG COMPANY
IOActive Hardware | Software | Wetware SECURITY SERVICES
ARGUS CYBER SECURITY

Emerging market players IT-Security

- **Software companies**
  - Software-only companies **venturing into the automotive market**
- **Administrative organisations**
  - ie. TÜV in Germany to handle **certifications** regarding IT-Security **requirements**
- **International accounting & professional service firms**
  - Consult and **develop IT-Security** driven solutions

In-House IT-Security

- Large car manufacturers have the resources and expertise to develop and implement IT security measures internally

Outsourced IT-Security

- Smaller car manufacturers might opt. to outsource their IT-Security needs to specialized IT-Security firms to ensure full IT-Security coverage

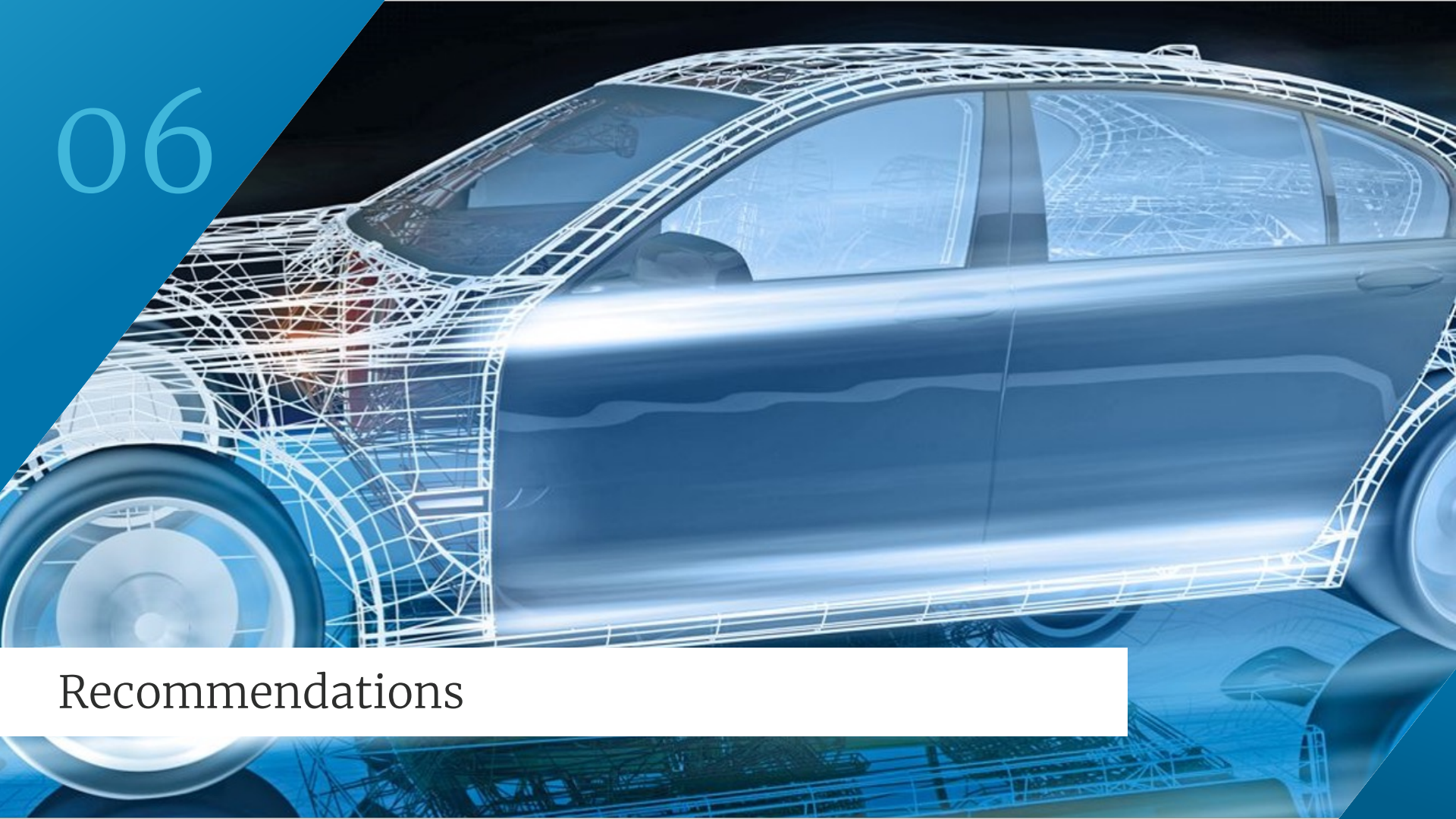
Hybrid approach

- Combined in-house expertise with external partners
- In this case the internal IT-Security team oversees and coordinates with external experts to ensure a comprehensive IT-Security strategy

Source: Own Research

06

Recommendations



Recommendations for action

Recommendations for action pertaining to future trends and corresponding responses, tailored for OEMs, suppliers, dealers and service firms

OEM

- **Customer-centric innovation:** Leverage data analytics to identify evolving customer expectations
- **E/E architecture and scalability:** Develop a flexible and scalable e/e architecture that accommodates integration of new features and functionalities
- **Collaboration and partnerships:** leverage external expertise to accelerate innovation

Supplier

- **Technological leadership:** Stay abreast of technological trends
- **E/E integration expertise:** Offer modular components and systems that can easily be integrated into various vehicle architectures
- **Innovation ecosystem:** Work closely with innovative tech companies to be able to keep up with trends

Dealer

- **Adaptive inventory management:** Monitor technological trends and market shifts to align inventory with upcoming demand
- **E/E awareness for sales staff:** E/E features and trends as USP
- **Data security and privacy:** Safeguard customer data through robust IT-Security measures

Service firms

- **Holistic IT-Security solutions:** Offer colaborative and comprehensive IT-Security services to protect the digital integrety of vehicle systems
- **Tech-integrated diagnostics and support:** Advanced diagnostic tools and remote support systems to OEMs (ie. OTA updates)
- **E/E integration expertise:** Consulting services to OEMs

USP: Unique Selling Point | OTA: Over the Air | OEM: Original Equipment Manufacturer

4MANAGEMENT
STRATEGY. PROCESSES. ORGANIZATION. PEOPLE.

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