PROSTECH
Specialty materials and manufacturing solutions

Entrance to the future

Solutions for lightweight EVs

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I, The moving world - The changing demands

There was a time when cars were created with the main purpose of transporting people to their desired locations without encountering any issues. At that point, amenities such as in-car Wi-Fi, inductive charging mats, and vented seats were not even a consideration.

However, nowadays, cars are equipped with these features along with robust engines, improved safety measures, greater passenger comfort, enhanced climate control, and reduced road noise. It is undeniable that these additions add extra weight to the vehicles.

II, Automotive and its movements

Owners of automobiles are seeking enhanced gas mileage, and numerous governments are advocating for improved fuel efficiency and reduced emissions for better air quality.

With that demand from customers, design and process engineers in the transportation industry will face significant challenges. They must keep up with new innovations while also ensuring that their designs are safe, efficient, and environmentally friendly.

Especially, the landscape is changing rapidly for electronic vehicles (EVs). With modern technology, the demand for EVs is growing rapidly. There are now more EV options available for consumers, from affordable models to high-end luxury cars. The charging infrastructure is also expanding, making it easier for drivers to find a charging station on the go.

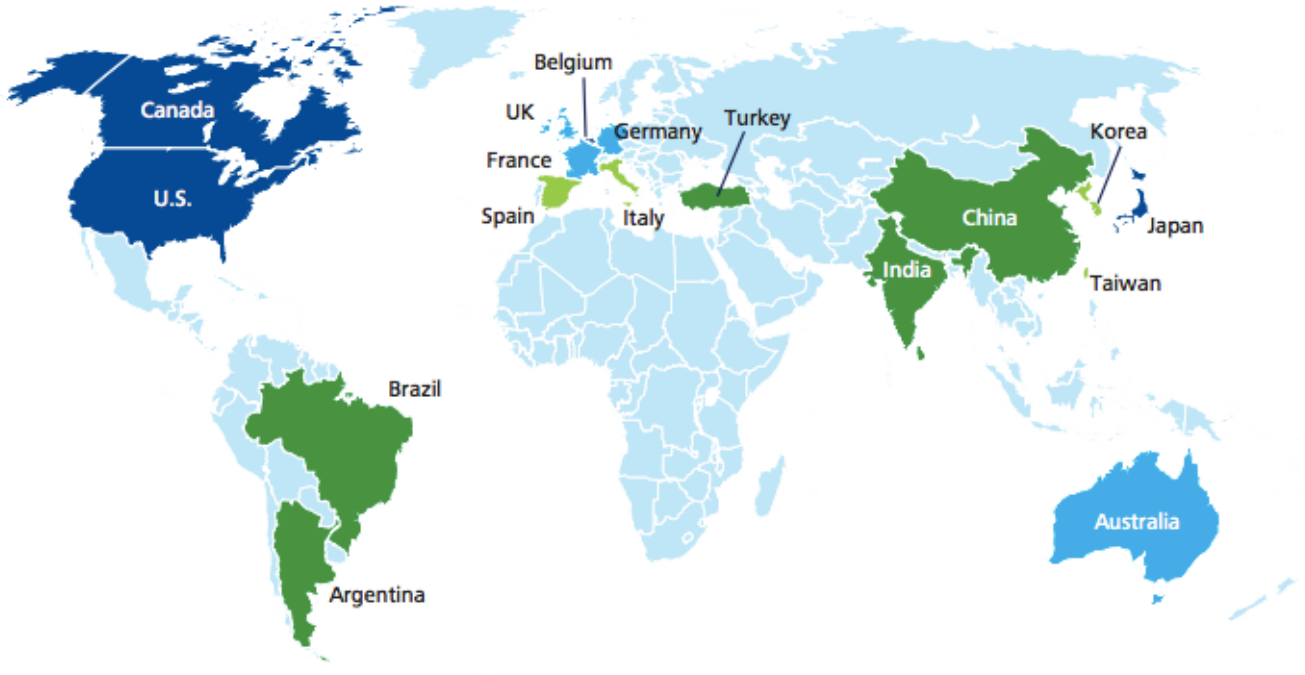
Additionally, governments and businesses are implementing policies and incentives to encourage the adoption of EVs. As a result, the market share of EVs is increasing, and the traditional automobile industry is starting to shift towards more sustainable options.

III, Customer demands - more advanced, more challenging

Buyers demand and anticipate an increasing number of advancements in their vehicles, such as Wi-Fi connection, panoramic sunroofs, heated and ventilated seats.

Prospective automobile buyers desire cars that are both fuel efficient and equipped with powerful engines while prioritizing safety features above all else. Additionally, these buyers have a budget and are only willing to pay a certain amount for their desired vehicle.

According to the Deloitte report, Global consumer interest is high, especially in the countries listed as below.



Percentages represent the summation of the "Potential first movers" and "Might be willing to consider" consumer segments

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

The top 3 customers' concerns are the range, charge time, and purchase cost of an electric vehicle.

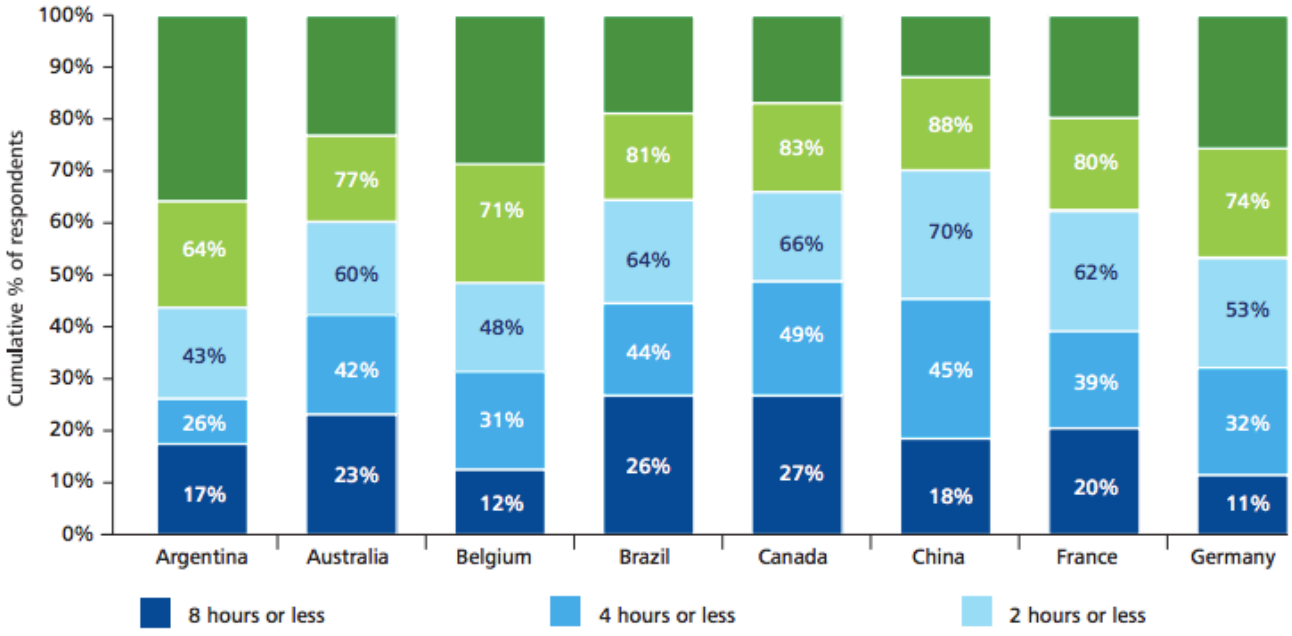
Range

Although a considerable number of consumers are open to electric vehicles (EVs), many are not willing to compromise on important factors such as range. Even though the majority of drivers surveyed travel less than 80 kilometers per day on average, car buyers still anticipate EVs to have a much greater range. Most of the people in the Global survey of Deloitte prefer an electronic vehicle that has the ability to perform higher than 160km.

Charge time

The majority of surveyed consumers anticipate that an electric vehicle (EV) should take no more than two hours to recharge its battery. In Japan, this expectation is even higher, with 37% of respondents stating that a 30-minute charge time is the longest acceptable. Only a small proportion of respondents in all countries consider eight hours, which is the current and longest charging time for typical EV batteries in vehicles today, as acceptable.

Figure 7: Majority of consumers expect electric vehicles to recharge in two hours or less
Survey question: Considering your expected vehicle use, what is the longest time to fully recharge the battery that you would consider acceptable when buying or leasing an electric vehicle?



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Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

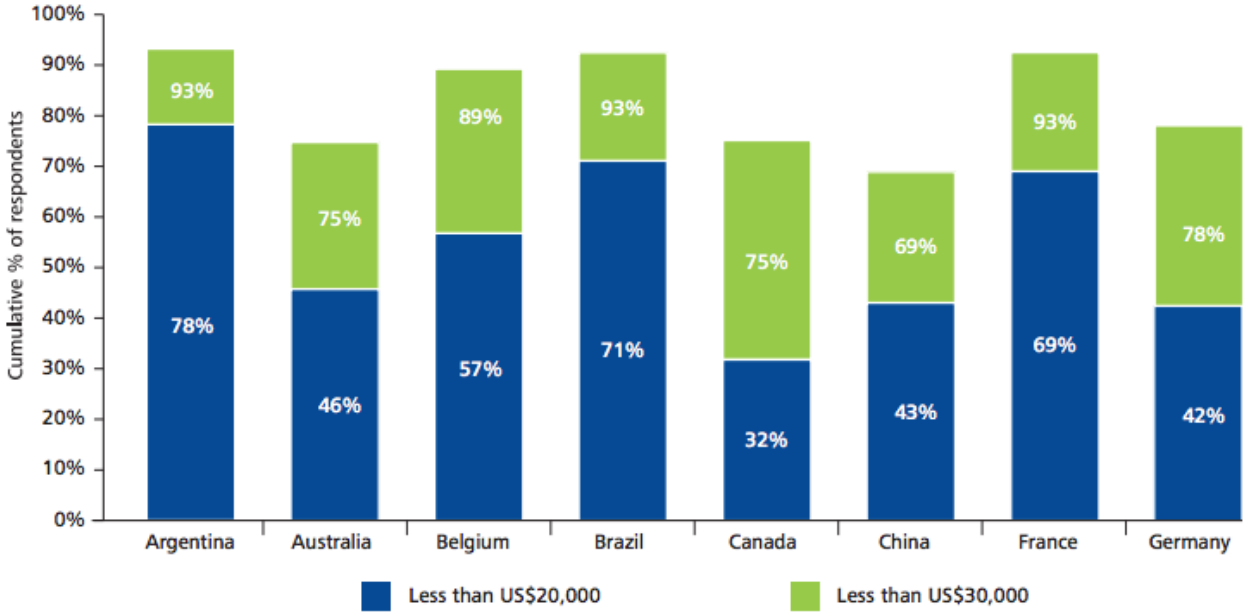
Price Purchase

Consumers tend to have lower price expectations for electric vehicles (EVs), with many expecting them to be among the cheapest cars on the market. In particular, 78% of Argentinean and 74% of Indian respondents surveyed expected EVs to be among the least expensive options. The US, Canada, and Japan appeared to be the least price-sensitive, with only a small proportion of respondents (34%, 32%, and 41% respectively) looking to purchase an EV for around US$20,000. Across the globe, the vast majority of respondents expected to pay no more than US$30,000 for a new electric vehicle.

Due to the cost of the battery, electric vehicles (EVs) are currently more expensive than their internal combustion counterparts and are expected to remain so for the foreseeable future. Despite this, most consumers are unwilling to compromise on key decision criteria, such as the purchase price, when considering buying an EV.

Figure 11: Consumers expect to pay less than $30,000 for an EV

Survey question: If you were considering buying or leasing an electric vehicle, in which of the following price ranges would you be shopping?



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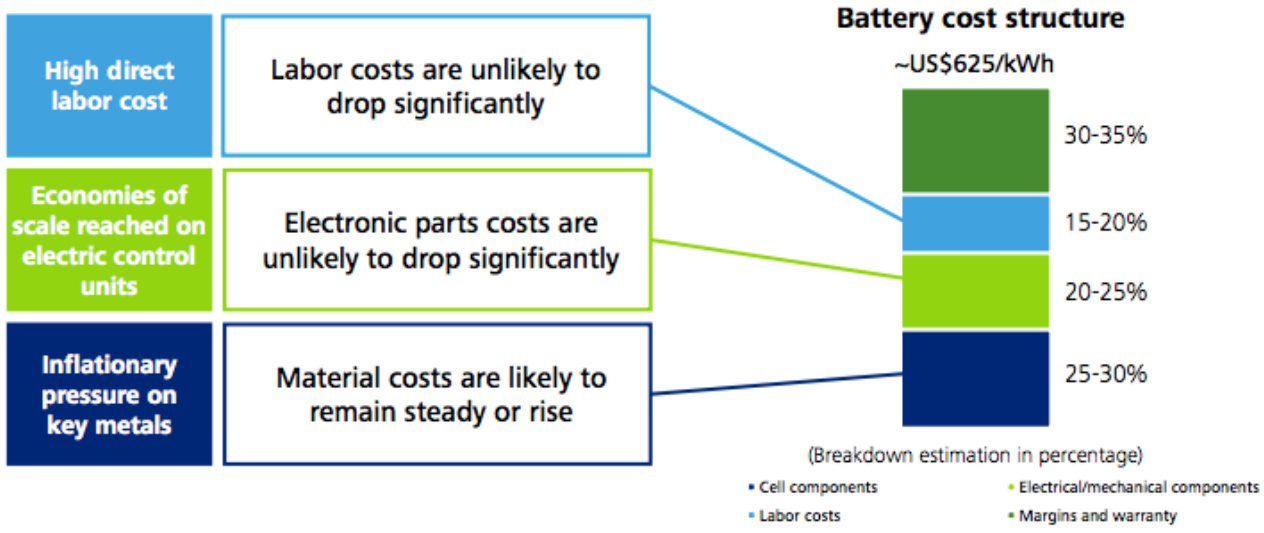
Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 12: Battery cost structure prevents significant decrease in EV price

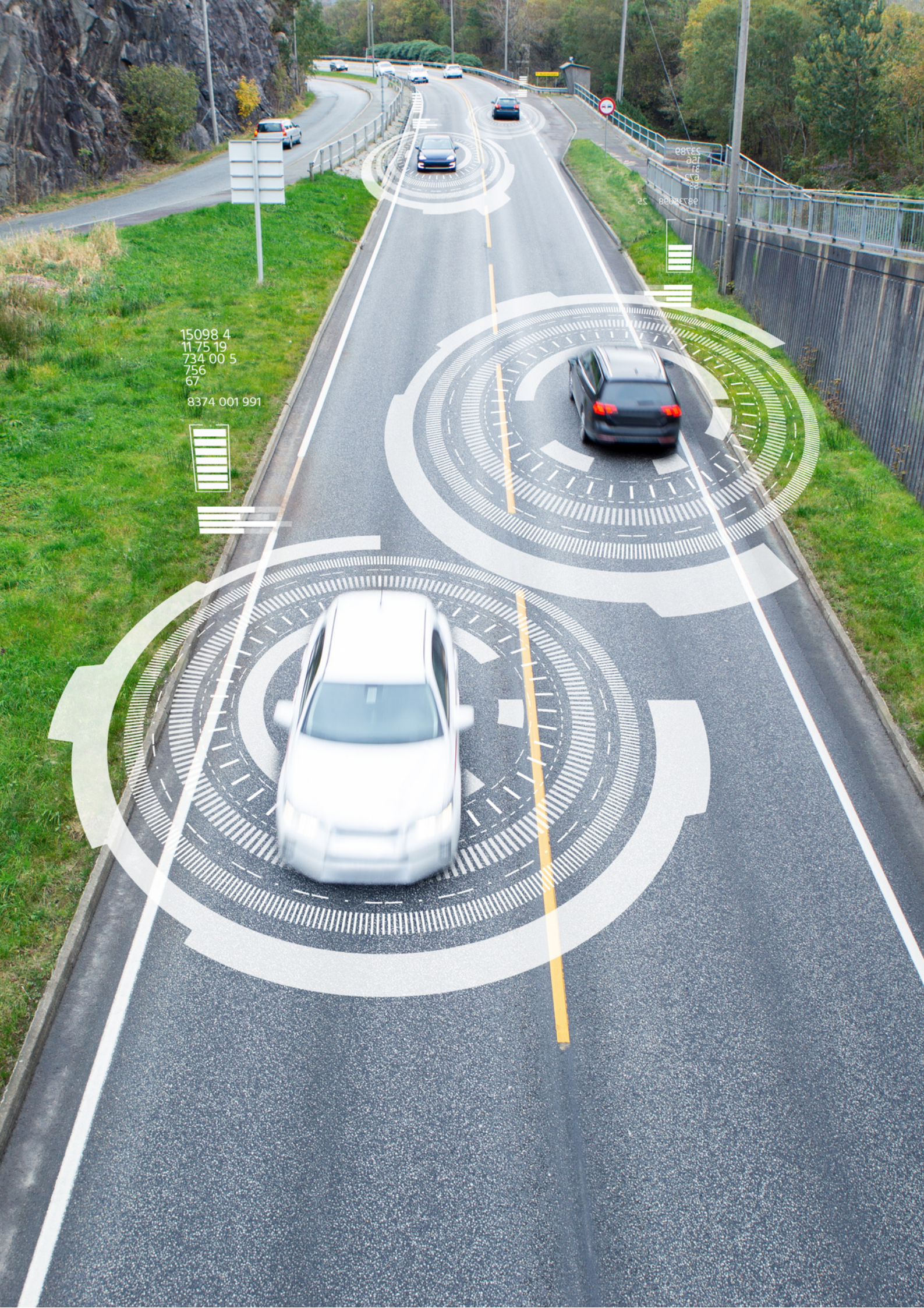
High direct labor cost, electronic parts, and inflationary prices of key metals will likely prevent battery prices to drastically decrease.



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis [ix]

"The reality is that when consumers actual expectations for range, charge time, and purchase price (in every country around the world included in this study) are compared to the actual market offerings available today, no more than 2 to 4 percent of the population in any country would have their expectations met today based on a data analysis of all 13,000 individual responses to the survey".

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis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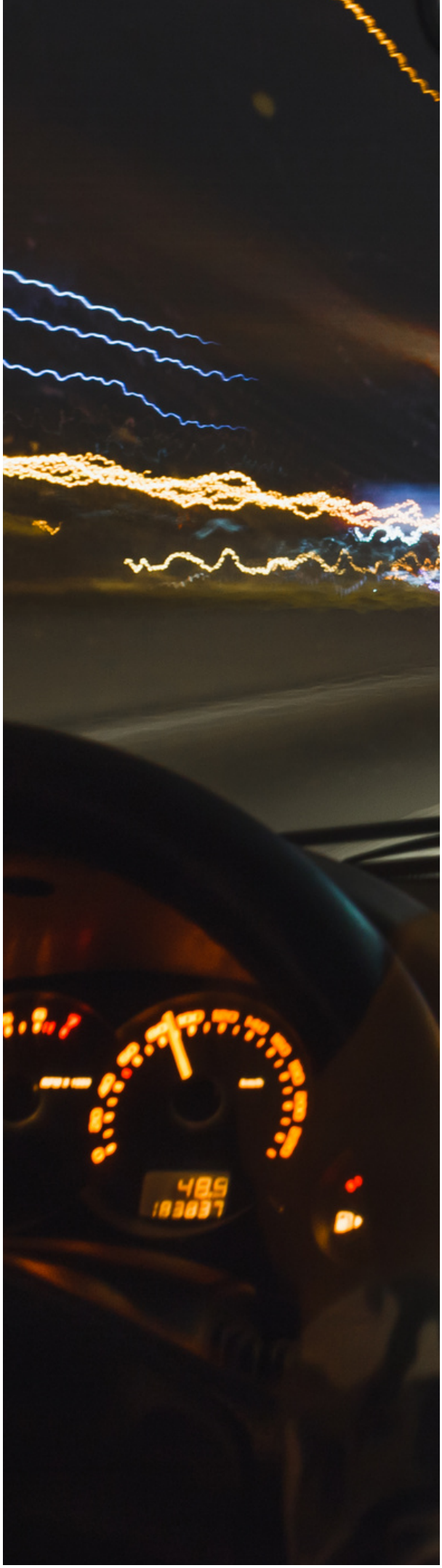


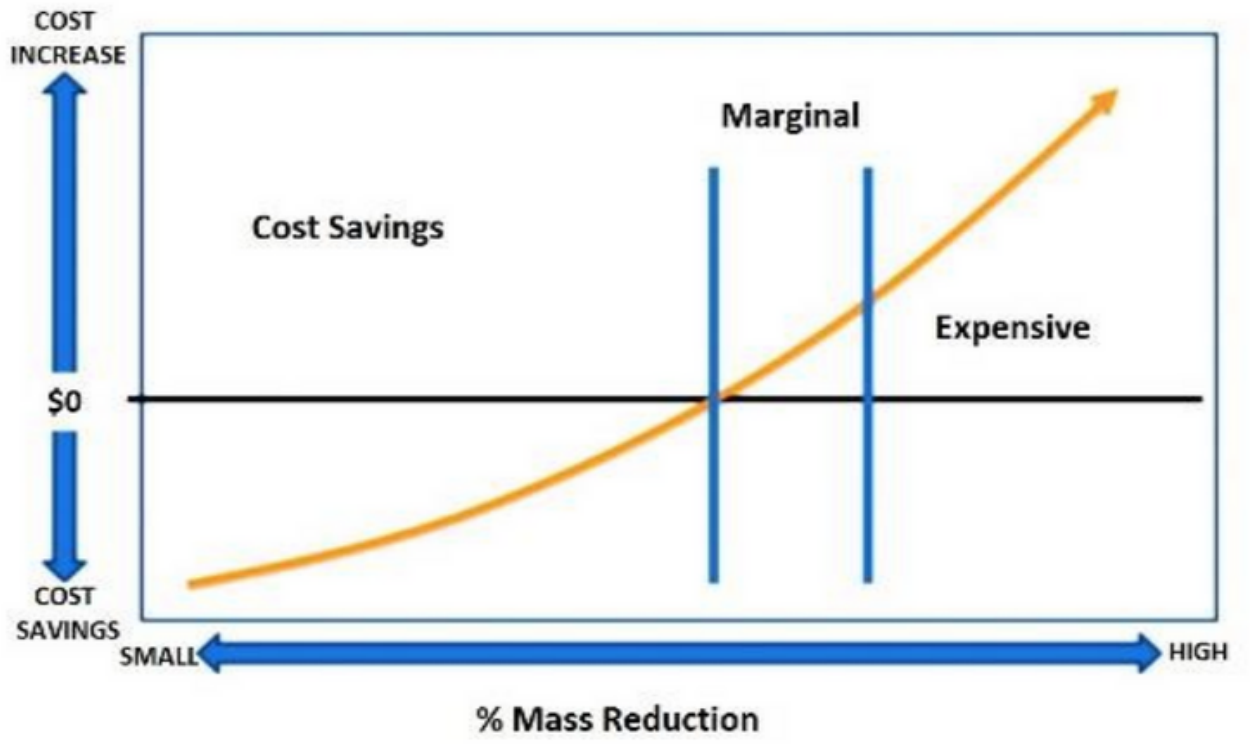
IV, Lightweight materials: Barriers and cost estimates

The cost of lightweighting

For many years, the automotive industry has focused on refining its processes for working with various materials and solutions. This includes expertise in fabrication, joining parts, and painting, among other things. As a result, manufacturers have developed a high level of skill in creating vehicles that are not only efficient, but also aesthetically pleasing.

The cost of implementing lightweighting technologies in the automotive industry is known to increase exponentially.

General Auto Manufacturer Cost Curve to Lightweight Vehicles



Source: CAR: Identifying Real World Barriers to Implementing Lightweighting Technologies and Challenges in Estimating the Increase in Costs

If fuel economy regulations require more aggressive lightweighting beyond market demand, automakers will need to move further up the exponential cost curve.

It would be beneficial for manufacturers to implement cost-saving technologies to reduce weight and avoid using technologies that are in the marginal zone. The reason the automakers accept some costs in this zone is to achieve advancements in vehicle performance, a major competitive requirement for consumer acceptance.

Materials mix

Advanced and ultra-high strength steels

The use of advanced high-strength steel (AHSS) and ultra high-strength steel (UHSS) in vehicle manufacturing can increase the strength of the car and better protect passengers and the car's cockpit in the event of a crash.

The benefits of using steel in automotive manufacturing are the strong characteristic, cost-effectiveness, and ease of use. Furthermore, it comes in various grades and thicknesses. The Office of Energy Efficiency & Renewable Energy (EERE) has stated that the application of Advanced High-Strength Steel (AHSS) in vehicle components could reduce weight by up to 25% compared to traditional steel

Advantages	Disadvantages
• Low material cost • High strength and stiffness • Outstanding formability • Infrastructure development in manufacturing and design - making it highly cost-effective for vehicle applications	• Joining, rolling, forming processes of UHSS grades are still inadequate. Current spot weld approach may lead to corrosion • Modeling and simulation software are not available for AHSS/UHSS to test their physical performance

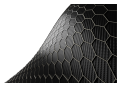
Source: Automotive world

Aluminium

In the past 10 years, automakers have significantly increased their use of aluminum throughout the automotive component value chain. Aluminum has become a popular alternative to steel due to the industry and consumers' focus on fuel economy and reducing carbon footprints. It is is a lightweight, durable, and corrosion-resistant metal commonly used in automotive hoods, trunk lids, and doors.

Advantages	Disadvantages
• Has density one-third of steel that can help in reducing weight in the range of 30%-40% for components made in aluminium	• Lack of formability • Limited strength at high temperature • Joining process is not fully developed • Investment in new machinery

Source: Automotive world



Carbon fibre composites

Carbon fiber reinforced polymer (CFRP), which is known for its high strength-to-weight ratio. It is about half the weight of steel and up to four times stronger, but it is also more expensive to produce and requires specialized manufacturing processes.

Carbon fiber is a material that has been used by premium automakers to reduce weight in high-performance cars, leading to improved efficiency. However, the high cost of the material and the complex recycling process make it less appealing for mass-produced cars.

Advantages	Disadvantages
• Material has strength to weight ratio that can be used to design components that are nearly 50% - 60% lighter than steel	• Value chain well established for aerospace industry. Value chain for automation industry is still evolving • Joining technologies to incorporate Carbon fiber in suspension/ body applications is still inadequate • Understanding of CF in crash environment is still insufficient. Technology to detect damage to CF parts and repair them is also still immature

Source: Automotive world

Carbon fiber composites 50–70% lighter

Aluminum & AL Matrix composites 30–60% lighter

Advanced high-strength steel 15–25% lighter

Other materials

Titanium alloys, nickel-based alloys, and metal matrix composites offer unique properties that other materials cannot match, and hold potential for use in the automotive industry. However, their implementation into mass production remains a challenge for automakers - who must consider their complex manufacturing processes.

There are barriers

Switching to lightweight materials matrix composites poses a challenge for OEMs (Original Equipment Manufacturer) in terms of joining these materials. This means that automakers have to carefully consider the investment in new technologies and machinery needed to integrate these materials into their existing manufacturing processes and value chain. However, the trend towards improved fuel economy and reduced emissions has made the use of lightweight materials more important for the automotive industry.

Using mixed materials can lead to significant challenges

Mixed-material joining

Corrosion

Thermal expansion

Cycle time

Cost

V, Bonding solutions

To cope with the use of mixed materials in vehicles, one of the biggest challenges that engineers face is the process of bonding these materials together.

The construction of modern vehicles involves extensive use of adhesives that replace traditional fastening hardware like bolts and welding.

The use of adhesives in vehicle construction has become increasingly important for lightweighting due to their ability to provide stronger and more durable bonds between parts and components. In addition to reducing weight, adhesives also offer enhanced design flexibility to OEMs by allowing for the combination of different lightweight materials, such as aluminum, magnesium, composites, and steel, while maintaining safety, performance, and passenger comfort.

Exterior solutions

1 Acrylic Foam Tape for exterior trim attachment

Moldings, sensor brackets, B pillar appliqué

2 Acrylic Foam Tape for Sealing and Weatherstrip

Body, door, trunk and deck lid seals

3 Auto Glass Film

Side and rear glass

4 Die-cuttable Acrylic Foam Tapes

Nameplate Attachment

5 Exterior Trim Film

Belt line moldings

6 Glass Bubbles in Plastic Parts

Sheet molded composite panels hood, trunk lid, engine cover

7 Paint Protection Film

Seam sealers, underbody coatings

8 Acrylic Foam Tape for exterior trim attachment

Hood, bumper, truck ledge, rocker panels

9 Paint Replacement Film

Door pillars, sashes and moldings appliqué

10 Structural Bonding Tape

Roof ditch molding clips appliqué

11 Wheel Weights

Lead-free wheel balancing

12 Tape-Attached Hardware

Mirror buttons, sensor brackets, locator pins

13 Fastener Adhesives

Adhesive pre-applied to threaded fasteners

Interior solutions

1 Boron Nitride Cooling Fillers

Heat dissipation and transfer for plastic display housings

2 Bumpon Protective Products

Glove box, center console, electronic spacer

3 Damping Foil Tapes

Doors, hoods, deck lids

4 Display Enhancement Films

Cluster, center stack

5 Reclosable Fasteners

Headliner, sunroof ring, closeout panels

6 EMI/ EMC Electronic Materials

Sensitive electronics and communications, wireless charging

7 Glass Bubbles

Center console, instrument panel, inner door panels

8 Interior Trim Film

Door and instrument panel trim

9 Laminating Adhesive

Low fogging adhesives (seats, headliner)

10 Light String

Doors, instrument panel, headliner

11 Optically Clear Adhesive

Displays, touch panels

12 Performance Label Materials

Warning and security labels

13 Thermal Interface Materials

Heat dissipation

14 Thin Bonding Tapes

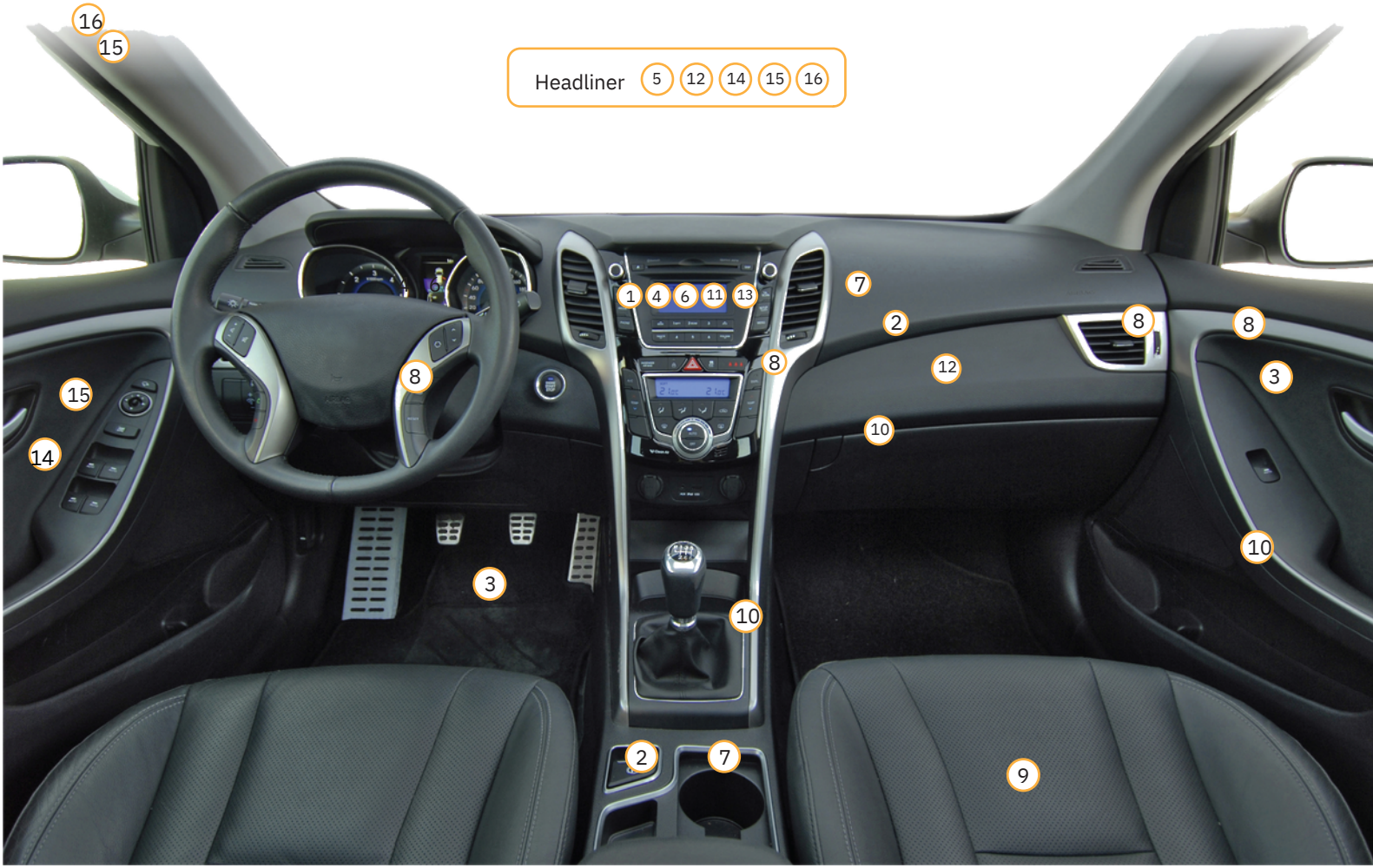
Trim and fabric attachment, buzz squeak ratte, headliner

15 Thinsulate Acoustic Insulation

Headliner, package tray, instrument panel, pillars, doors

16 Wire Harness Tapes

Headliner, pillars



Electrical Mobile

The structure of an EV powertrain can be understood by distinguishing between three major systems: **the battery system, the electric motor** (or electric drive system), as well as various **power conversion electronic components** (inverter, converter, on-board charger, battery management system).

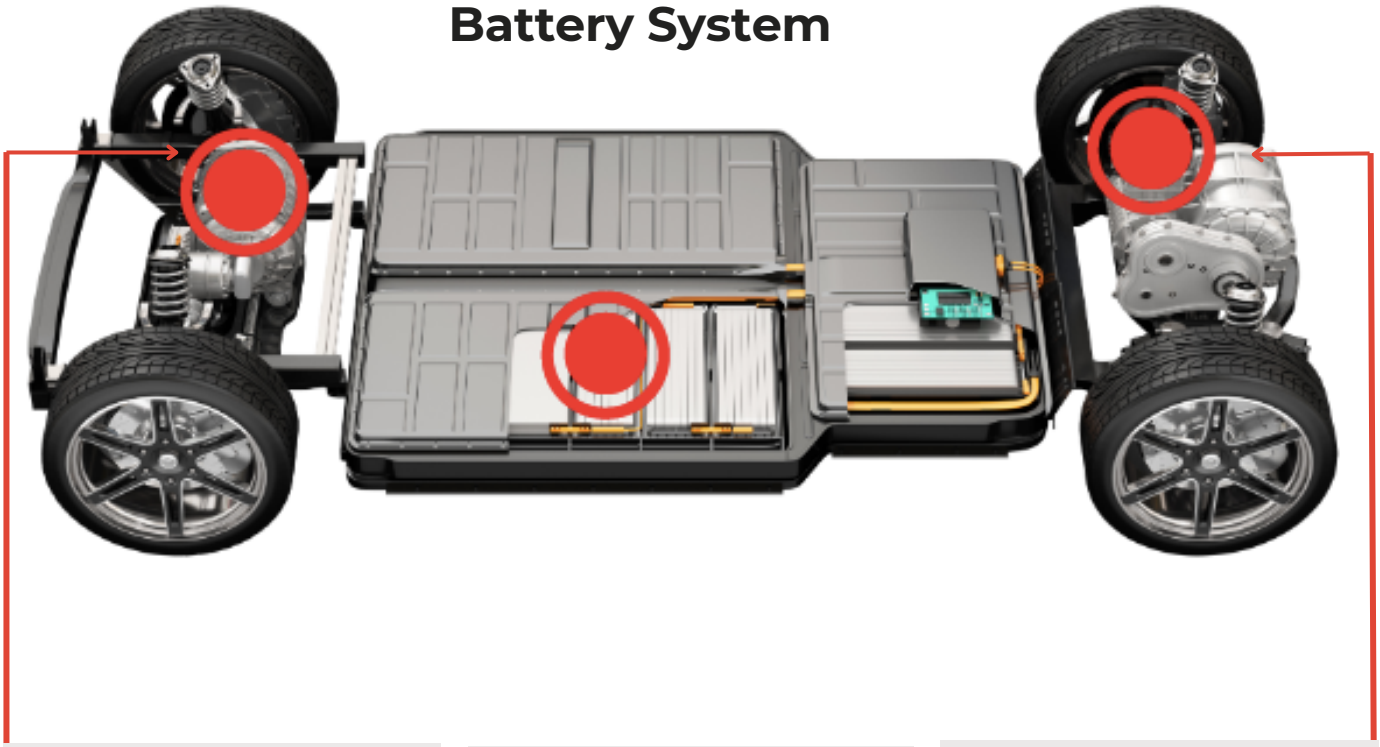
Key engineering challenges across EV powertrain components include efficient thermal management, integrating electric systems, miniaturization, total vehicle weight reduction, and ensuring safe and reliable vehicle performance. At the same time from a commercial perspective, electric vehicle prices need to be brought down by reducing overall system costs.

Custom Solutions we provide to help you envision and build the most advanced and capable electric mobiles.

Electric Motor

Power Conversation – Electronic Components (DCDC/ AC)

Battery System



We can solve your problems

- Gap filler: Battery module, battery cell
- Masking tape: Paint masking
- Thermal pad: Battery module, battery cell
- Structural adhesive

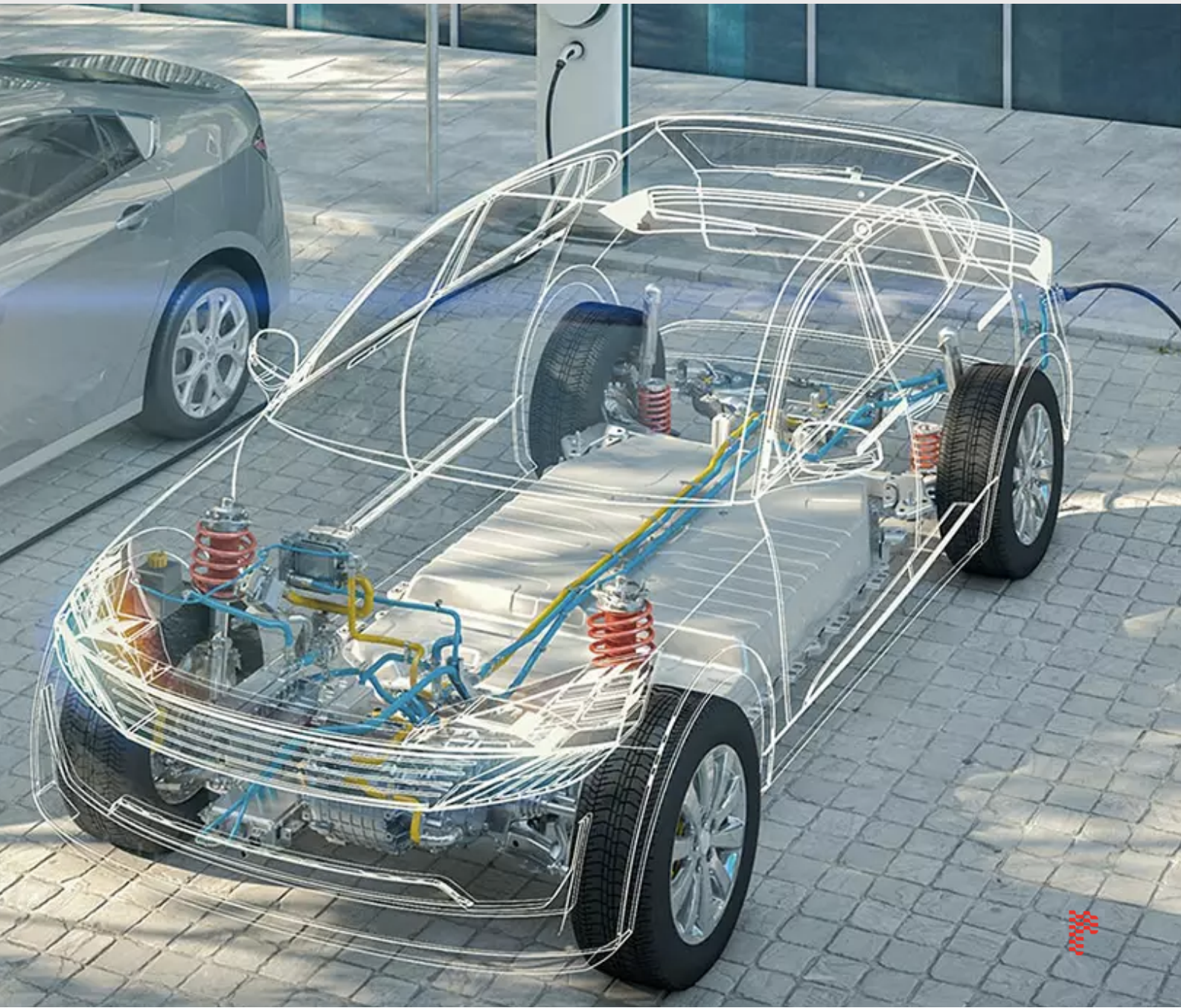
We can solve your problems

- Thermal interface materials (TIMs)
- Heat spreader
- EMI absorber
- Conformal coating

We can solve your problems

- Potting compound
- Encapsulant foam
- Sealing & Gasketing liquid
- Venting film

- Soldering
- Staking & Underfill
- Underfill
- Electrically insulating film
- Surface mount adhesives
- Sealing & Gasketing
- Potting & Encapsulant
- Impregnation
- Conformal coating
- Thermal Interface Materials (TIMs)
- LPM
- EMI Shielding
- Temporary masking materials
- Structural adhesive
- Venting film
- Flame retardant encapsulation foam



Sources

https://www.automotiveworld.com/articles/quest-ideal-automotive-material-mix/

https://multimedia.3m.com/mws/media/1542808O/the-promise-of-lightweighting-ebook.pdf

https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Manufacturing/gx_us_auto_DTTGlobalAutoSurvey_ElectricVehicles_100411.pdf

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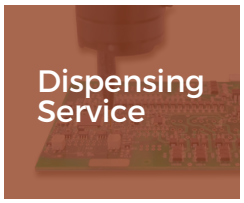

Internation Standard Certified Products

Non-Flamable

Military Grade

Medical Grade

Environment -Friendly

Europe Safety

Key Partners

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