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Outlook for Zinc in Galvanized Autosteel (2022-2030)

Martin van Leeuwen, International Zinc Association

Industry Advisory Panel (IAP) Meeting, ILZSG 70th Session
Lisbon, Portugal
9 October 2025

Objectives of IZA's study

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- ✓To estimate the current and future market for light weight vehicles
- ✓To distinct between various regions with different growth & transition paths for ICE and xEV vehicles
- ✓To understand the effect of the ICE to xEV transition for galvanized automotive steel sheet
- ✓To determine developments in manufacturing technologies for automotive parts for ICEs and xEVs
- ✓To identify trends in galvanized coating types used in vehicles
- ✓To calculate the outlook for zinc use for automotive coatings until 2030

Agenda

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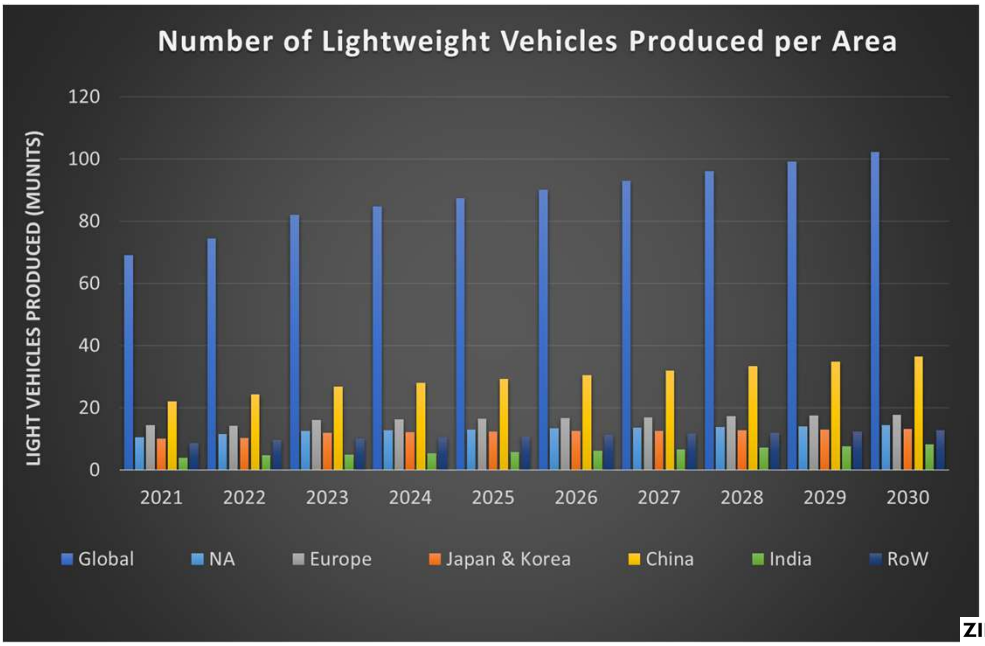
1. Transition of ICE to xEV
2. General lightweighting and substitution trends
3. xEV market introduction: from expensive premium to economical mass-produced
4. Adoption of galvanized steel in xEV: examples and opportunities (battery frame)
5. Effect of new automotive alloy coatings
6. Adoption of galvanized vs non-galvanized sheet in China and India
7. What does this all mean for galvanized steel and for zinc?
8. Cars have a weight problem; SUV & trucks are fastest growing segments
9. What else can we expect?
10. Key take-aways

Historically, vehicle production followed GDP growth



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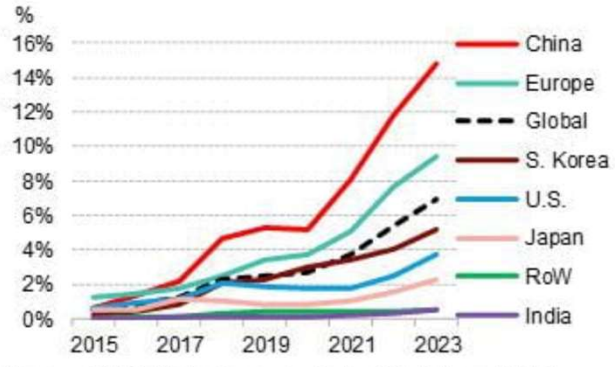
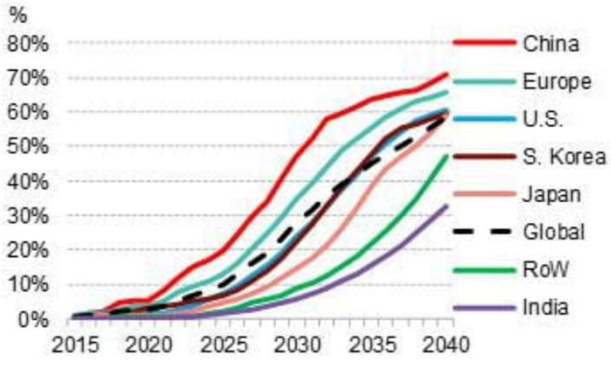
Transition of ICE to xEV

Figure 1: Global short-term EV share of new passenger vehicle sales by region



Source: BNEF. Note: Europe includes EU, U.K. and EFTA.

Figure 2: Global long-term EV share of new passenger vehicle sales by region



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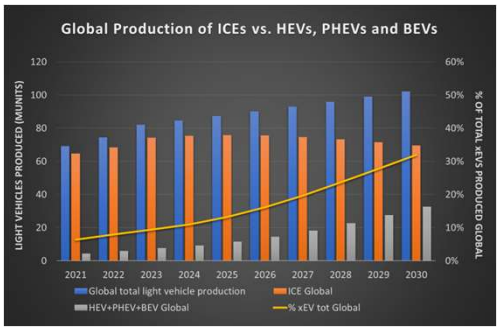
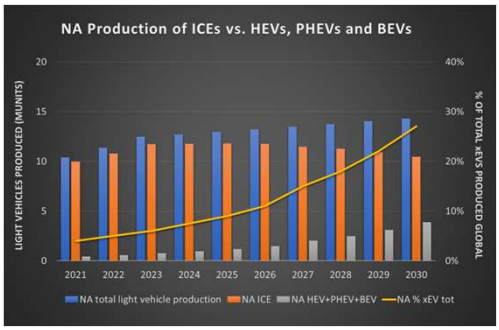
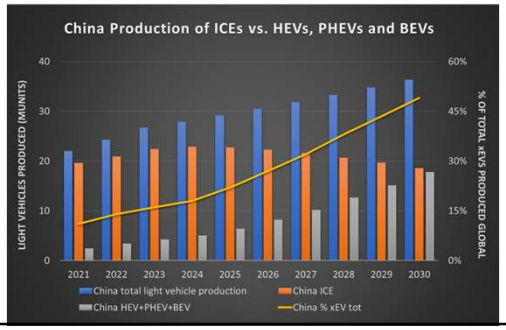
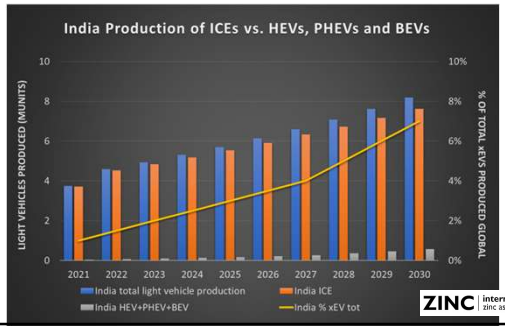
Transition of ICE to xEV









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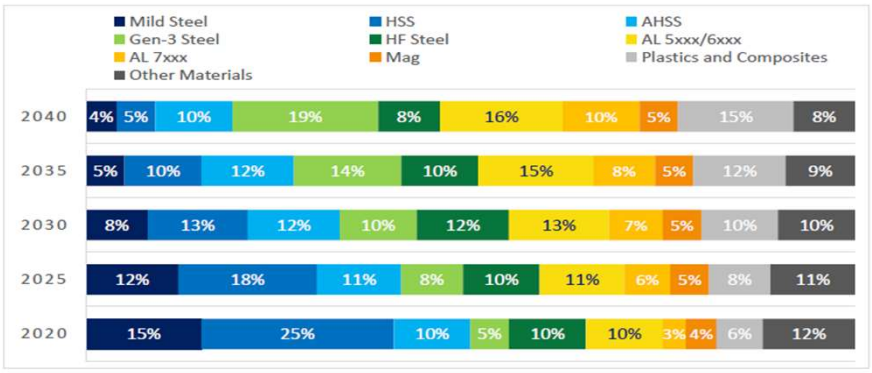
General lightweighting and substitution trends

- ✓Use of lightweight materials is expected to increase for both ICE and xEV
- ✓Mild steel & HSS will be substituted by both UHSS/AHSS, PHS and 3rd gen. steels
- ✓Trade-off between weight savings vs. extra costs

Figure 3: Average Vehicle Structure (Body-in-White and Closures) - Material Percentage by curb weight per vehicle



Other materials include dampeners, static sealers, adhesives, and glass

Note: 100% includes Body-in-White and Closures Only. Not included are powertrain/chassis, interiors, windshield, and dynamic sealers
Source: CAR Research

Material use in BIW and closures:
2020: 65% steel
2025: 59% steel
2030: 55% steel

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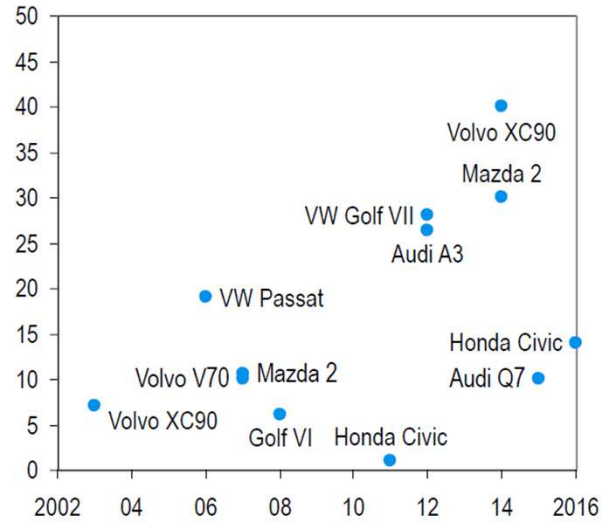
Adoption of PHS in automotive (hot formed)

Share of hot-stamped steel in BIW – Sample vehicles [%]



Comments

> Increasing share of hot-stamped steel in BIW is driven by certain beneficial attributes, including
  - High strength and crash resistance at relatively low cost
  - Low weight due to reduced material thickness
  - Reduced spring-back during manufacturing process (common in cold-forming process)
  - Best weight savings per additional cost compared to aluminum and plastic composites
> Also within specific models: e.g. in the Mazda 2, the current model has an approx. 30% share of hot-stamped steel, beating its predecessor model (approx. 10%) – parts made of hot steel include A-pillar, roof frame, rocker panels

Source: Roland Berger (2017)

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Lightweighting comes at a cost…

Assessment of lightweight materials

Material	Relative weight	Cost of weight saving [EUR/kg]	Key advantages	Key disadvantages
Traditional steel	100%	None	> Proven material, in use for decades > Good forming capabilities > Good availability	> High specific weight > Large number of process steps required (incl. tooling)
Hot-formed steel	75-85%	low – high	> Very high strength with good formability > Attractive cost-benefit ratio for weight-saving > Variable strength through sophisticated processing (e.g. tailored tempering)	> Higher investment, sourcing and operation costs > Use limited to structural BIW components
Aluminum	50-60%	low – high	> Low specific weight and good formability > Quite high strength when semi-hot or hot-forming (7.000 series)	> Greater technical effort to join with steel parts (rivet piercing vs. spot welding) > More sensitive to surface defects > Lower formability and higher spring back[1]
Magnesium	45-55%	low – high	> Lightest specific weight for metals used in automotive applications	> Very effective coating required to avoid magnesium oxidation > Lowest formability
Composite materials	Up to 25%	low – high	> Highest performance to weight > Lower parts count (higher amount of functional integrated parts)	> Bad recyclability > Very expensive > Limited crash performance (no structural integrity)

Further detailed

1) Compared to steel

Source: Roland Berger (2017)

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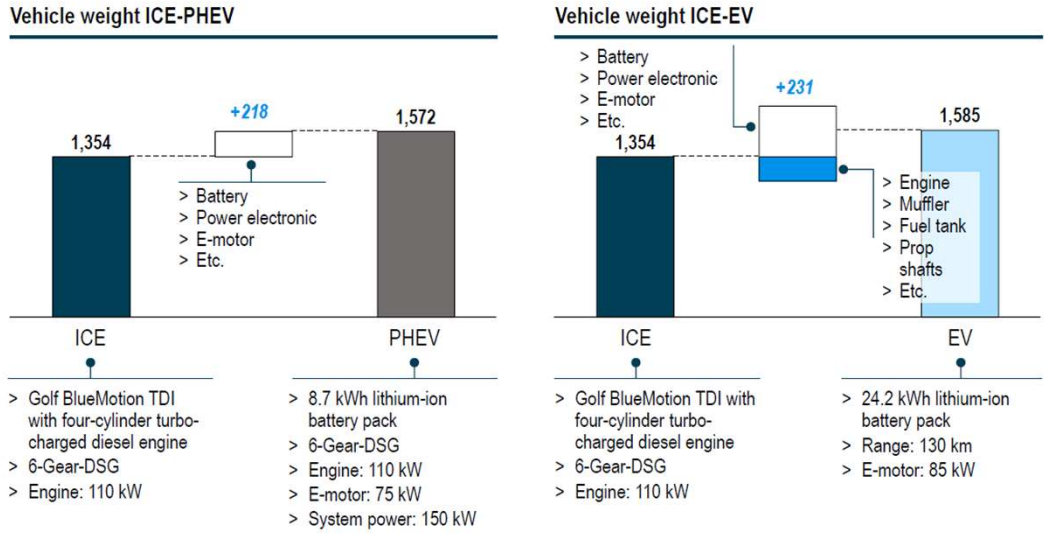
…but is required to compensate for the battery weight

Weight comparison of ICE, PHEV and EV – Example: VW Golf [kg]



Source: Roland Berger (2017)

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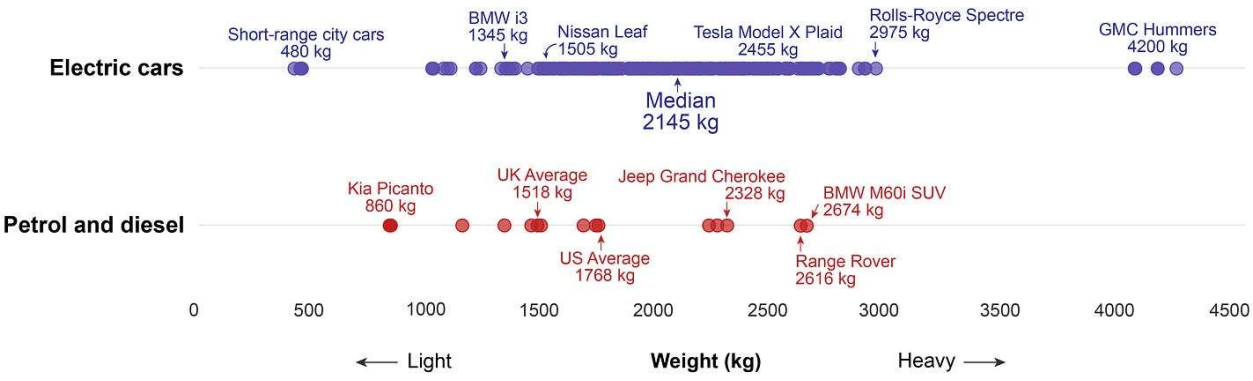
Are electric cars heavier than petrol and diesel cars?

Each blue dot is one model of electric car. In red is the average weight of cars across various countries, plus some of the lightest and heaviest vehicles on the market to show the range.



Note: Weights are given as the curb weight, which includes the weight of the battery, fuel and coolants. It does not include the weight of passengers or cargo.
Data sources: My EV Review; International Energy Agency (IEA); and industry market data.

Source: https://www.sustainabilitybynumbers.com/p/weighty-issue-of-electric-cars

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xEV market introduction: from expensive premium models to economical mass-market models

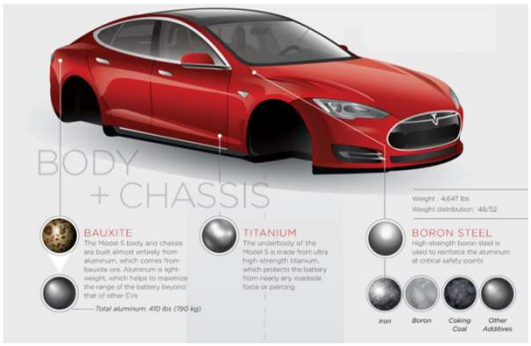
2016 Tesla Model S

End User News - Automobiles (Cars)

Tesla Model S electric car packs in 410 lbs aluminium

08 Mar 2016 , AL Circle ,

The Tesla Model S body and chassis are built almost entirely from aluminium, which comes from bauxite ore. Aluminium is lightweight, which helps to maximize the range of the battery beyond that of other EVs. The total amount of aluminium used in the car is 410 lbs (190 kg).



2018 Tesla Model 3

Tesla Model 3: here's the alloy mix of the Model 3 body

Fred Lambert | Aug 22 2017 - 4:02 pm PT | 0 Comments

With the Model 3, Tesla is moving away from the mostly aluminum chassis that it designed for Model S and Model X with some high-grade steel reinforcements.

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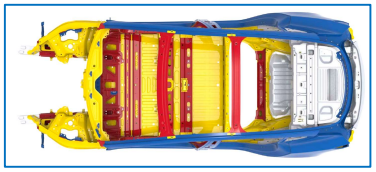
Galvanized steel: stronger, safer and lower costs

Tesla Model 3 in more detail

The Tesla Model 3 is primarily constructed from high-strength steel, with some aluminum components, while the Model S uses a predominantly aluminum structure. This choice is influenced by several factors:

1. **Cost**: Steel is generally less expensive than aluminum, which helps keep production costs lower for the Model 3, aimed at a more affordable market segment.
2. **Manufacturing Complexity**: Aluminum requires different manufacturing processes, which can complicate assembly. Using high-strength steel allows Tesla to streamline production and maintain efficiency.
3. **Weight Considerations**: Although aluminum is lighter, the high-strength steel used in the Model 3 is designed to be strong and safe. The weight difference is mitigated by the Model 3's compact design and battery placement.
4. **Market Positioning**: The Model 3 is positioned as a more affordable, mass-market vehicle, while the Model S is a premium offering. The materials used reflect their target audiences and price points.
5. **Structural Integrity**: The choice of materials also depends on safety and performance requirements. The steel structure of the Model 3 has been designed to meet safety standards while providing a good balance of weight and rigidity.

The grey-colored sections are aluminum. The rest are different grades of steel.



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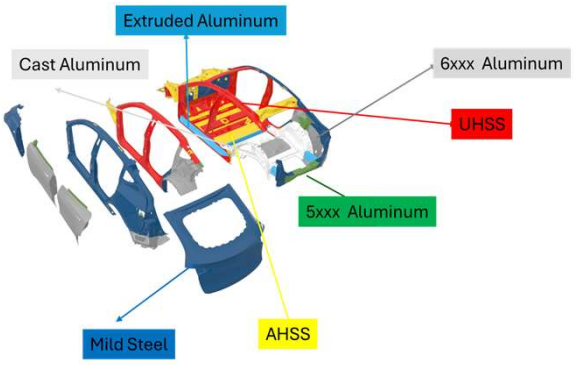
Galvanized steel: stronger, safer and lower costs

2025 Tesla Model Y



Body structure is composed mainly of Steel to allow repair operations

No Front Casting
Tesla has gone back to building a common body across the globe, increasing part interchangeability and reducing supply chain complexity across the four factories that produce the Model Y

Body Structure Materials and Allowed Operations

Tesla Eliminates Front Casting on New Model Y; Improves Rear Casting (March 2025)

Source: Tesla website

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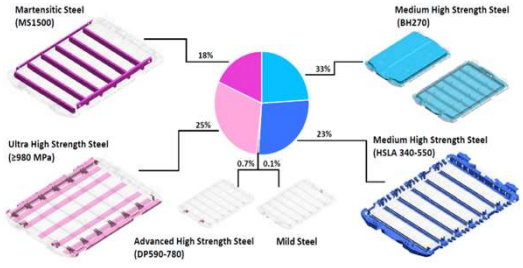
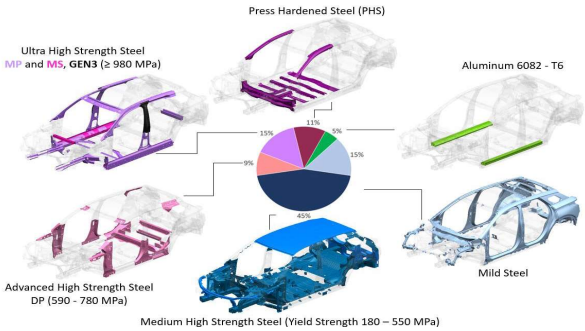
Galvanized steel: stronger, safer and lower costs

2024 Chevrolet Blazer EV Body Structure

Steel in Battery Rack



Steel in BIW



Weight of steel per vehicle: ~900 kg
- BIW + battery rack
- AHSS, UHSS, PHS and gen.3 steel

Zn used per vehicle in coated sheet ~ 13.5 - 14 kg

Source: GDIS (2024)

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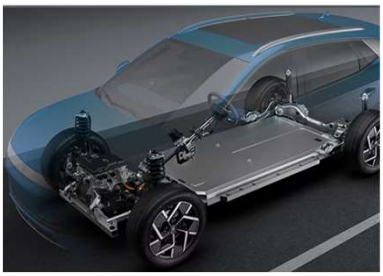
Galvanized steel: stronger, safer and lower costs

2025 BYD SEAL U

High-strength body and battery Pack

Key components are all made of high-strength steel with a tensile strength exceeding 1180MPa to ensure that, after a collision, there is space for the passenger compartment and improved passive safety



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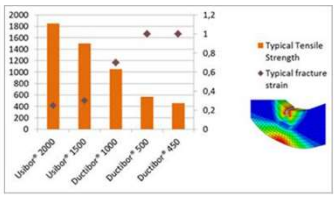
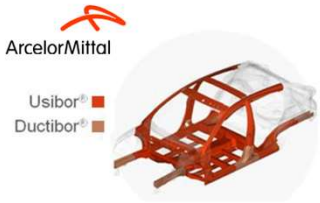
Automotive coating developments

From AlSi coatings for PHS....
(ArcelorMittal, late 1990s)





No cathodic protection

....to Zn coatings for PHS
(voestalpine, 2023)

phs-scalefree®
THE FIRST HOT FORMING STEEL UP TO 2000 MPa
WITH A THIN ZINC COATING

Cathodic protection

Source: ArcelorMittal, voestalpine

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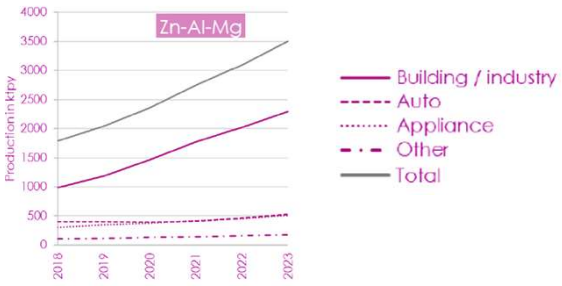
Automotive coating developments

AUTOMOTIVE
- Bare: Al 1-3% - Mg 1-2%

Requirements *(at least as good as GI)*
- Corrosion protection
- Global stamping, welding, bonding, painting process compatibility
- Surface quality for exposed part
- Cost saving

Typical applications
- Exposed surface



- ✓500ktpy ZM coated automotive steel is 1.3% of total zinc coated automotive steel production
- ✓Coating weight of Zn-Al-Mg automotive coatings are typically 30-40% lower than pure zinc (GI or GA)
- ✓A ZnAl1.5%Mg1.5% coating has 3% less zinc

Source: Fives (2024)

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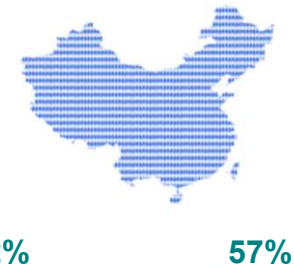
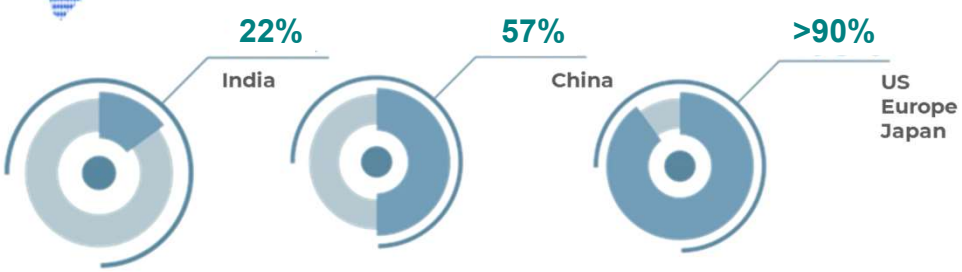
Adoption of galvanized automotive steel in China and India





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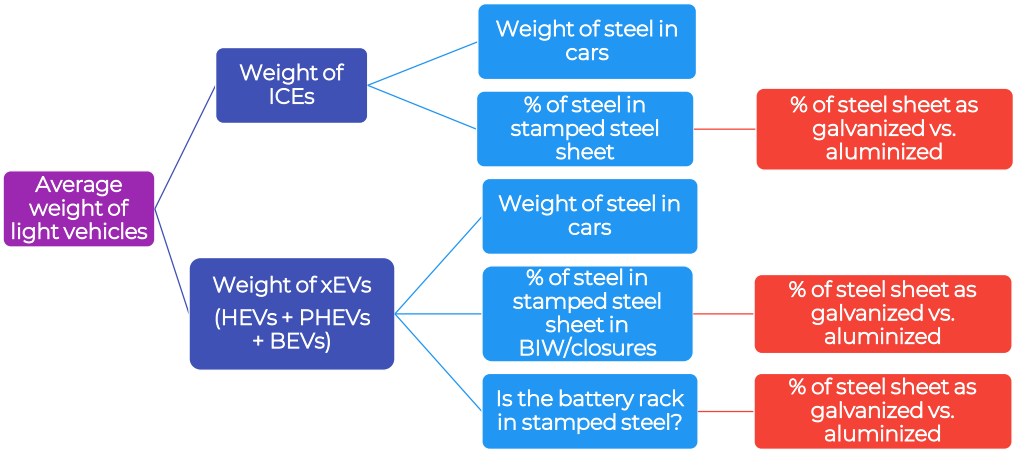
IZA's model assumptions – material choices



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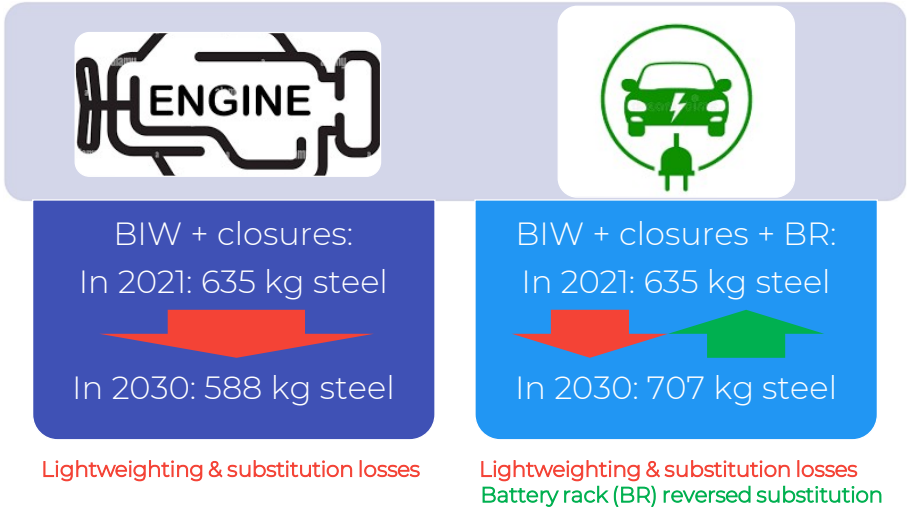
IZA's model assumptions – steel intensity



Lightweighting & substitution losses

Lightweighting & substitution losses
Battery rack (BR) reversed substitution

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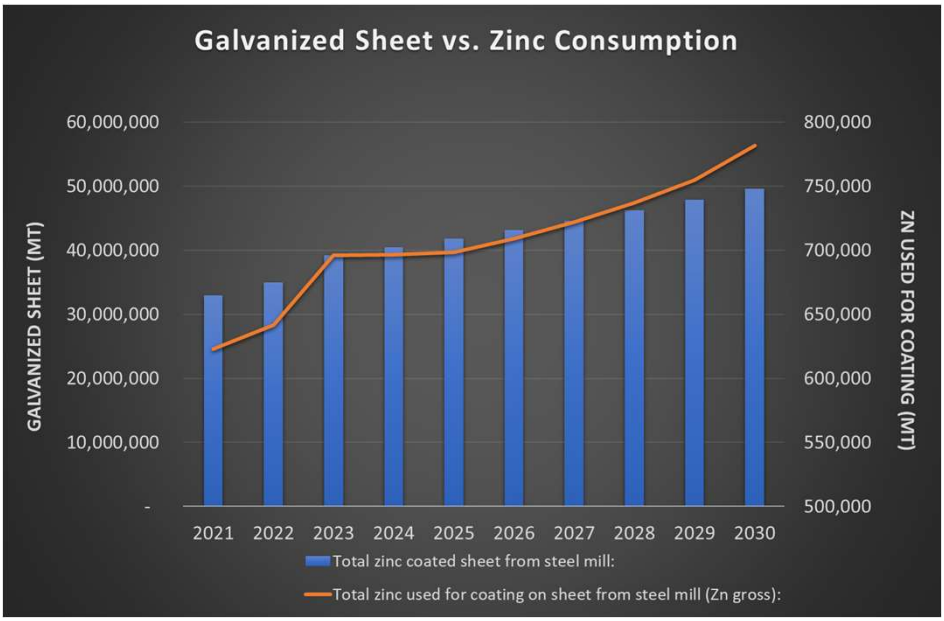
What does this all mean for galvanized steel?



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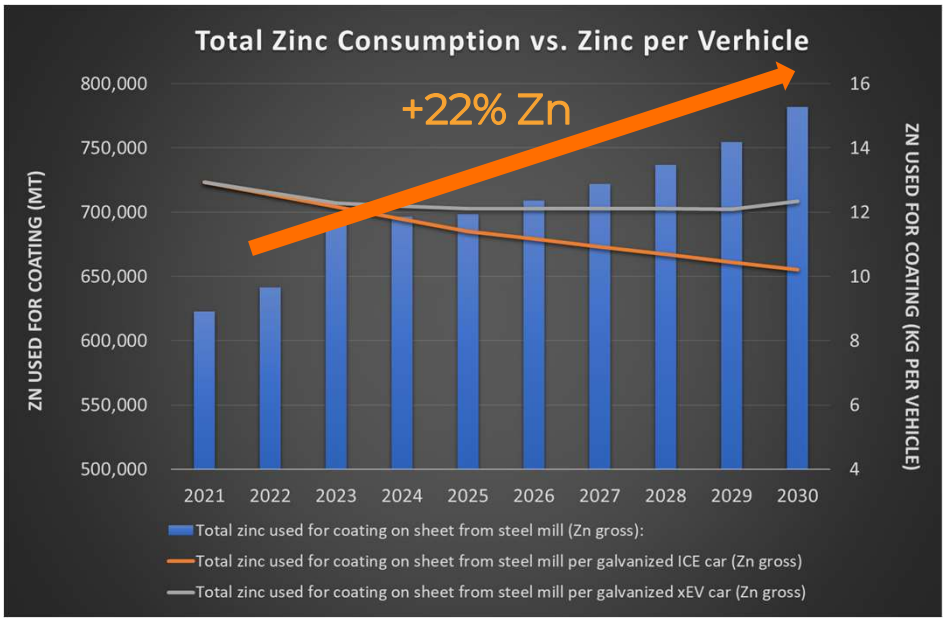
What does this all mean for zinc?



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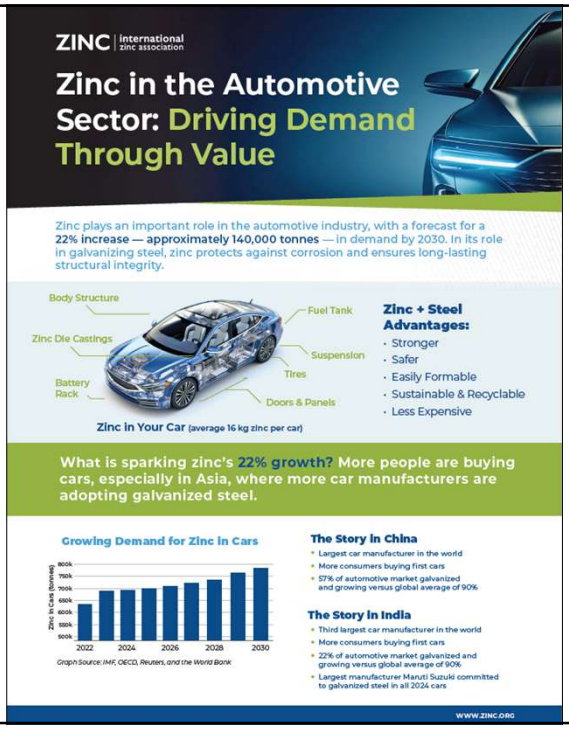
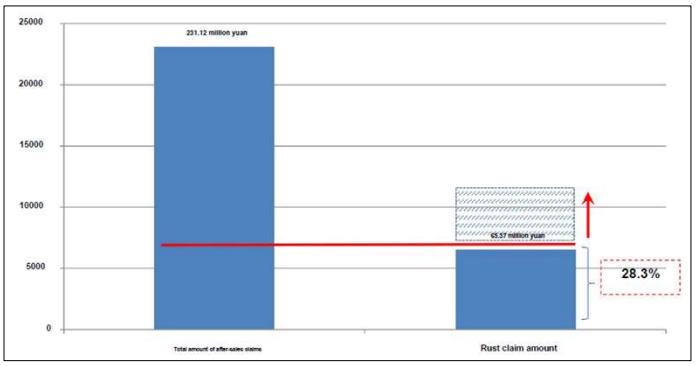


Rust never sleeps...



Common Corrosion Issues in Chinese Brand X:
"In 2010, the automaker's first three-box sedan suffered frequent complaints of corrosion after sales due to insufficient early design experience. Statistics of after-sales data from 2010 to 2017.
From mass production in 2010 to 2017, a total of 570,000 vehicles were sold. ***The amount of claims due to rust in the domestic after-sales market alone was 65.37 million yuan for 114,680 vehicles, accounting for 28.3% of the total after-sales costs.*** *" (~US$100 per vehicle)*

Source: China Auto Lightweight (Jiangsu) Automotive Technology Co., Ltd. (2025)

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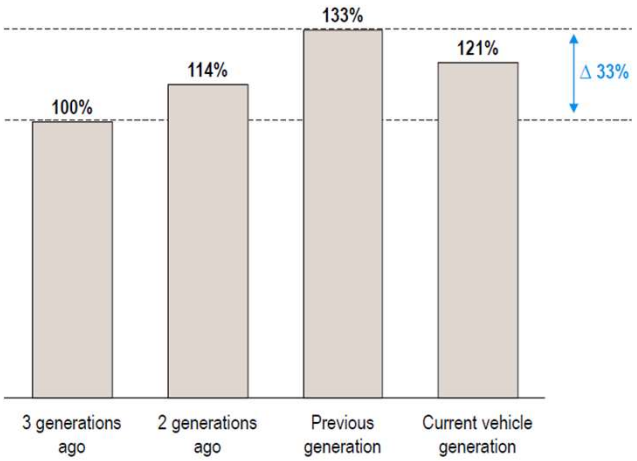
Cars have a weight problem…

Average curb[1)] weight development in Europe [mid sized volume vehicle – Indexed]



Comments

- Major drivers of additional weight in previous vehicle generations in the past
  - Stricter crash regulations
  - Increased safety features (e.g. ABS, ESP, higher brake performance)
  - Increased number of functions and convenience features (e.g. HVAC modules, electric window lifters, NVH dampening)
  - Increased vehicle dimensions
- Current tendency to reduce weight driven by various trends
  - Engine downsizing
  - Increased use of lightweight materials
  - Weight optimization-oriented vehicle design

1) Curb analysis based on following vehicles: Golf (Volkswagen); Astra (General Motors); 308, 306, 309 II (PSA); Megane (Renault/Nissan); Clio (Renault/Nissan)

Source: Roland Berger (2017)

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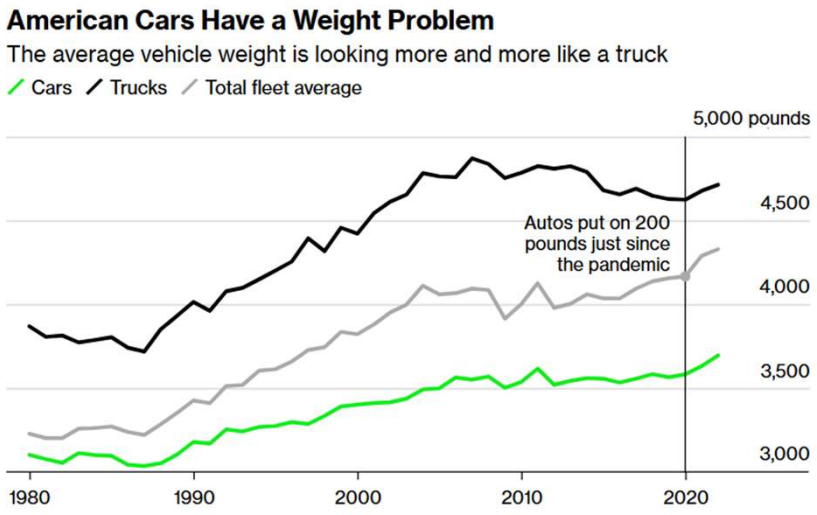
…and the SUV & truck segments are the fastest growing markets, not only in America



Source: Bloomberg (2023)

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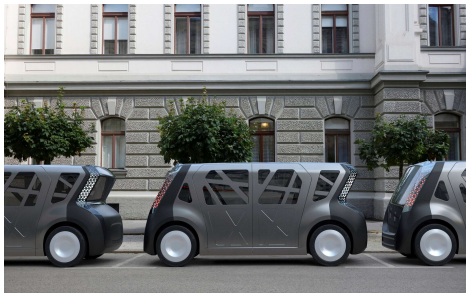
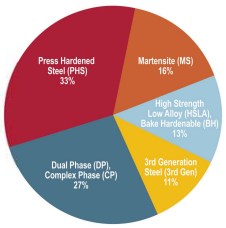
What else?





- ✓Mobility-as-a-Service (MaaS):
  - ✓ Increased car utilization
  - ✓ Higher mileage?
  - ✓ Lifetime? Corrosion impact?
- ✓Autonomous Driving:
  - ✓ Less human intervention
  - ✓ Increased safety systems
  - ✓ New safety concepts? Design impact?

Source & picture credits: Steel E-Motive (WorldAutoSteel)

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6 key take-aways to take home

1. Large regional variations in adoption and growth of xEV vehicles
2. Lightweighting of vehicles results in substitution of mild sheet & HSS into UHSS/AHSS, PHS and 3rd gen. steels, but also in non-steel lightweight materials
3. xEV segment adopts galvanized steel as a strong and cost-effective material for BIW, in particular for affordable, mass-market vehicles
4. Battery racks in xEVs are a large development potential for galvanized steel sheet (reversed substitution)
5. Strong growth in adoption of galvanized steel sheet, replacing non-galvanized steel sheet, in China and India
6. Zinc remains to play an important role in the automotive industry, and IZA forecasts a 22% increase — approx. 140,000 tonnes — in demand by 2030

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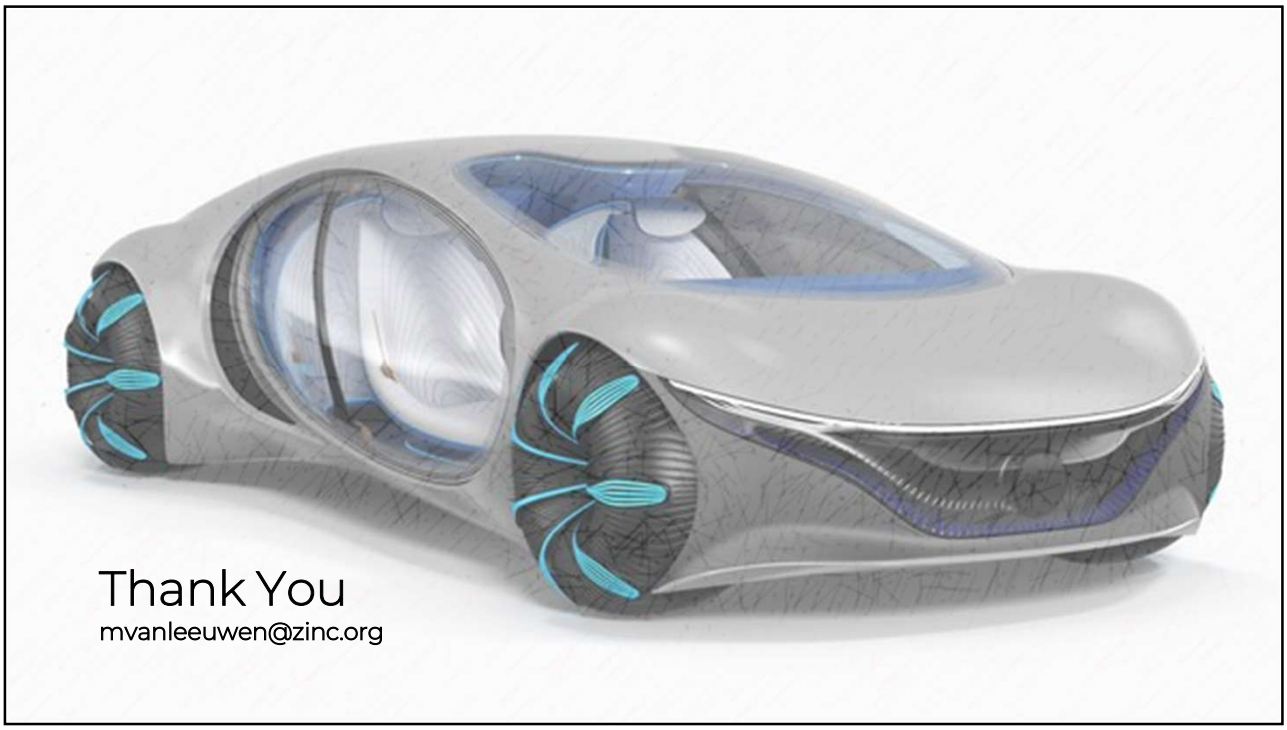
Thank You
mvanleeuwen@zinc.org