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RESEARCH & CONSULTING

Lightweighting Trends in EVs

North American BEV Material Insights

APRIL 13-15, 2021
WCX DIGITAL SUMMIT

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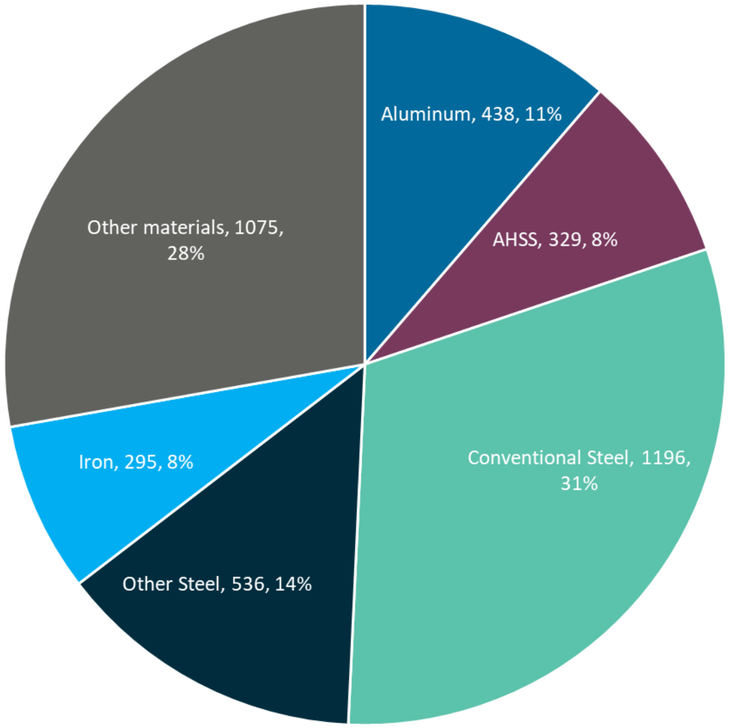
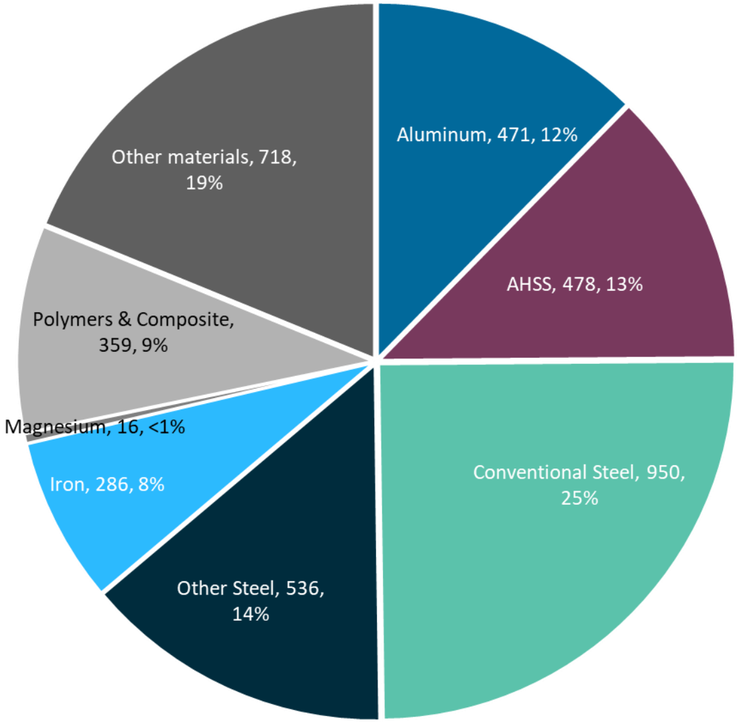
Material Content Evolution in NA

Total aluminum increased by ~32 pounds between 2018 and 2022 whereas, steel content declined by ~68 pounds in the same time-period

2018 Average Vehicle Curb Weight: 3,869 Material Pounds



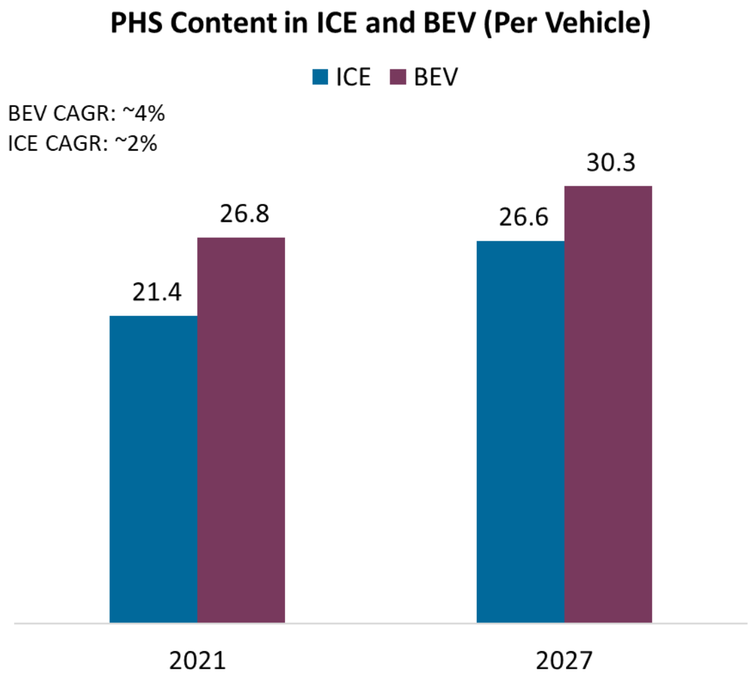
2022 Average Vehicle Curb Weight: 3,814 Pounds



Source: Ducker April 2020 data, Aluminum Association 2020 Report | Abey Abraham: aabraham@ducker.com

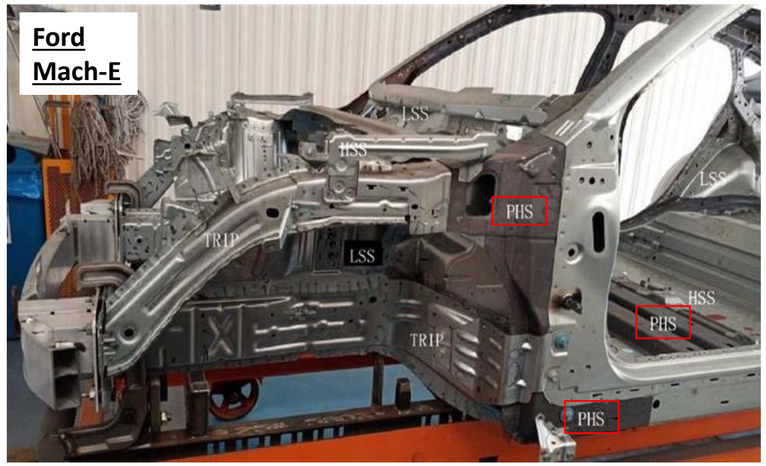
BEV vs. ICE parts per vehicle growing

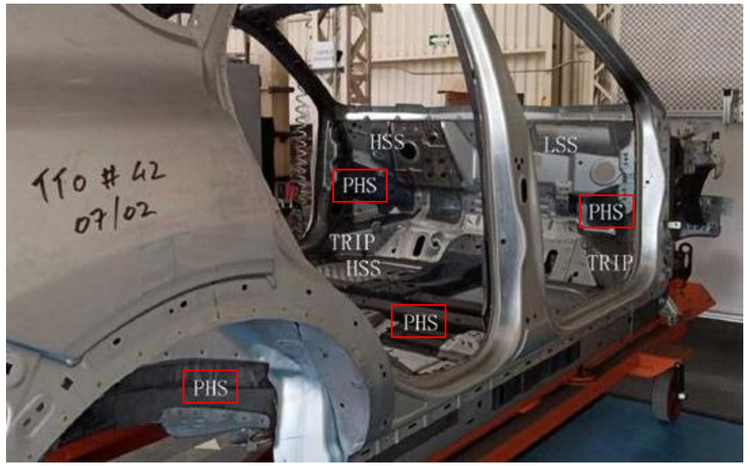
- PHS are expected to increase intensity on BEVs, and the average content of PHS per vehicle to be greater than ICE variants
- In addition to the PHS in the occupant cage frame, PHS is also heavily utilized in chassis and floor structure to aid in battery tray deformation



Source: Ducker, Tesla, Ford | Abey Abraham: aabraham@ducker.com

Ford Mach-E



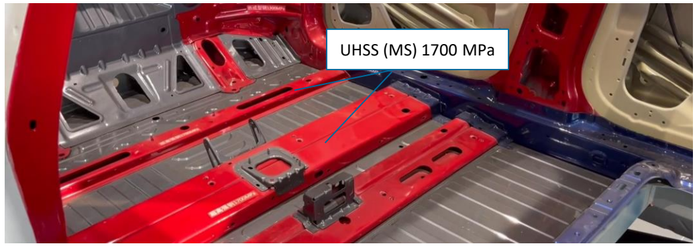


Tesla Model 3

Figure 1 (Front quarter exploded view)

Aluminum | Mild Steel | High-Strength Steel | Ultra High-Strength Steel

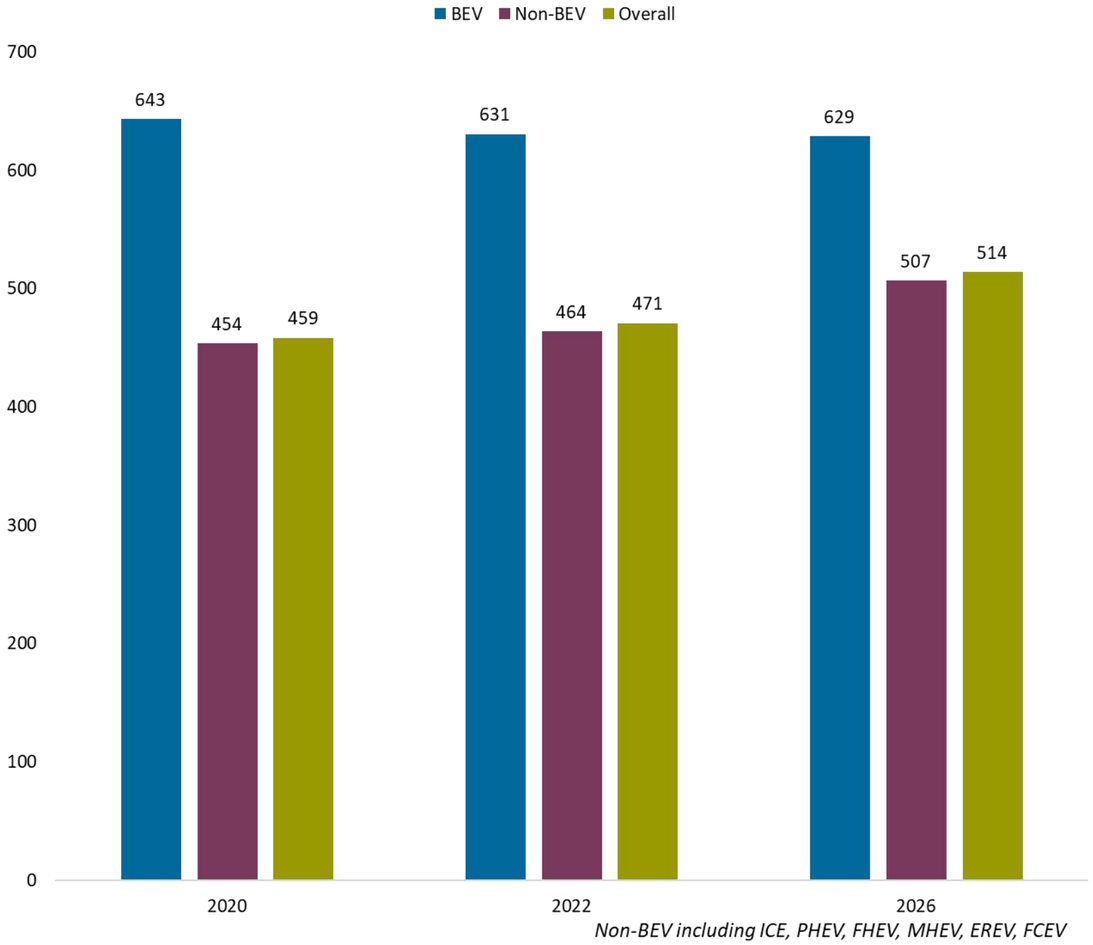
All red parts are PHS except for two cross beams



Aluminum Content Evolution in NA

Vehicle aluminum content - BEV vs. ICE based

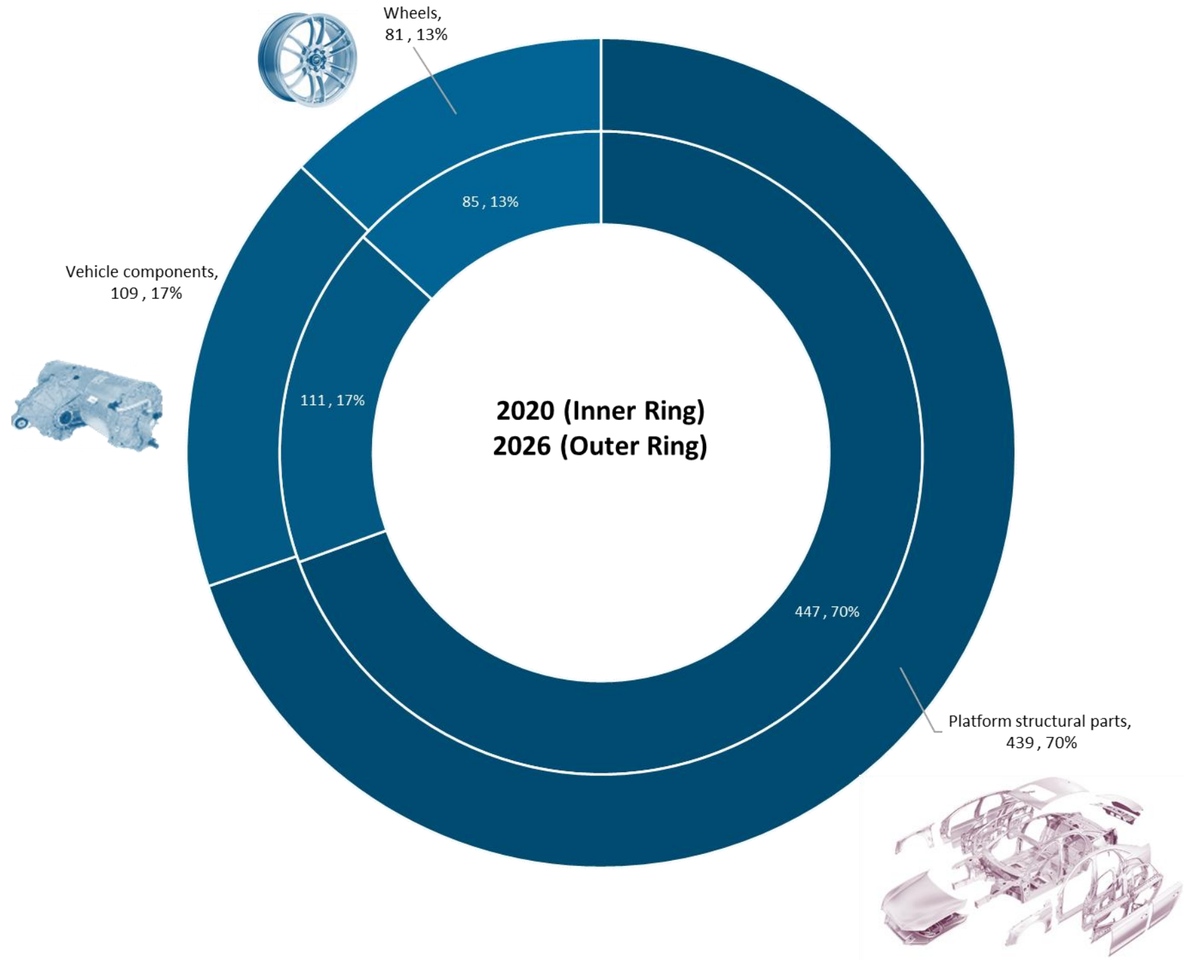
Weight in pounds per vehicle (PPV)



Non-BEV including ICE, PHEV, FHEV, MHEV, EREV, FCEV

BEV aluminum content - Share by Part Family

Weight in pounds per vehicle (PPV)

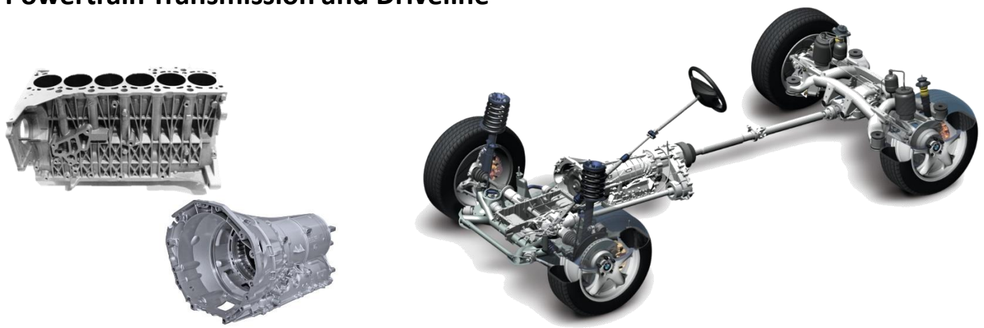


Source: Ducker April 2020 data, Aluminum Association 2020 Report | Abey Abraham: aabraham@ducker.com

From ICE to BEV, the Aluminum Trade-Off (NA)

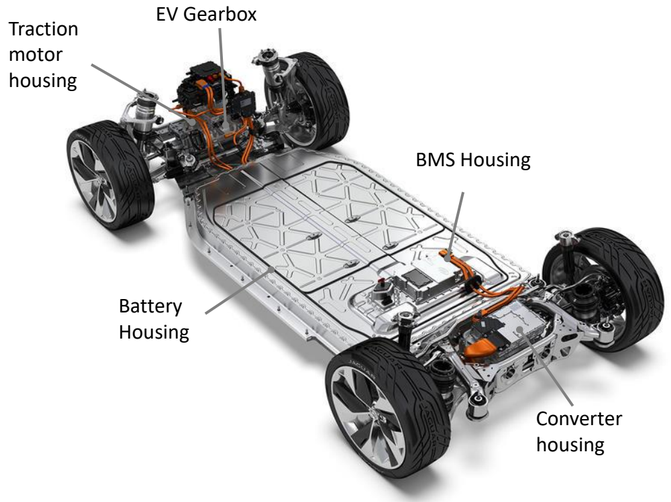
Eliminated ICE Parts

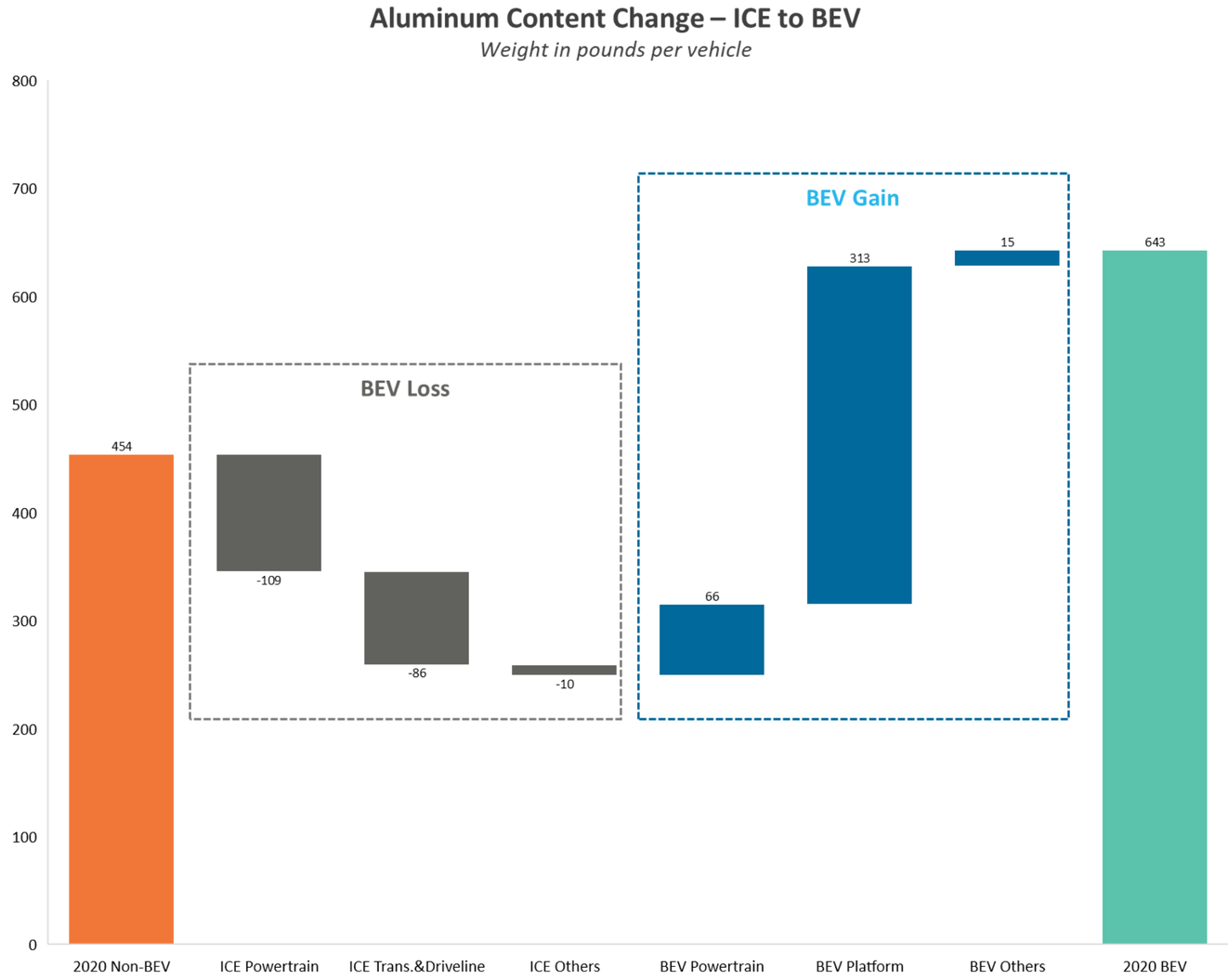
Powertrain Transmission and Driveline



Added BEV Parts

BEV Platform and Powertrain





Source: Ducker April 2020 data, Aluminum Association 2020 Report | Abey Abraham: aabraham@ducker.com

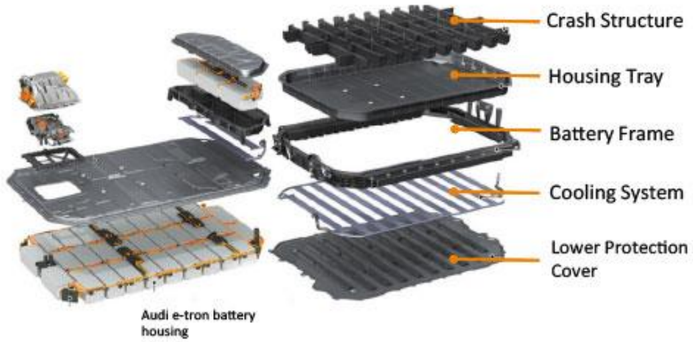
EV Platform & Housing Designs

EV Platforms

Platform	Traditional Versatile Platform ICE, MHEV, FHEV, PHEV, FCEV, BEV	Traditional Dedicated EV Platform BEV and FCEV	Skateboard Platform (dedicated) BEV only
Description	• Highly scalable and low cost • Existing manufacturing capabilities • Battery not structural	• EV integrated architectures • Battery can be structural • Cost efficiency and weight reduction	• EV native platforms • Battery is structural • Threatened by solid-state technology
Example	 **Hyundai 3rd Generation PF**	 **2020 Nissan Leaf**	 **Volkswagen MEB**

Battery Housing Designs

Tray Design



Audi e-tron battery housing

+

Simple and efficient sealing with tight tray/lid

Greater serviceability than assembled design

–

Tray generates additional weight in the housing

Low scalability; one tool set for one size

Frame Design

+

Better use of space

Highly scalable

–

Complex joining and sealing processes

Lower serviceability (maintenance cost)

Sources: Ducker, Audi | Abey Abraham: aabraham@ducker.com

Battery Housing Design Requirements

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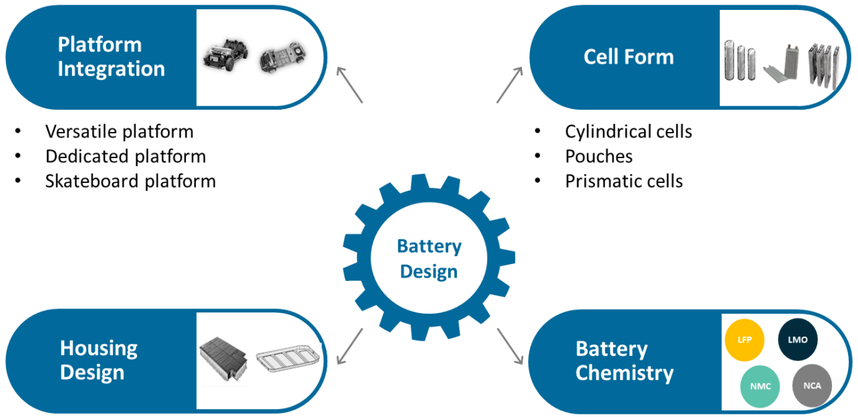
Battery Housing Design Influences



- Versatile platform
- Dedicated platform
- Skateboard platform

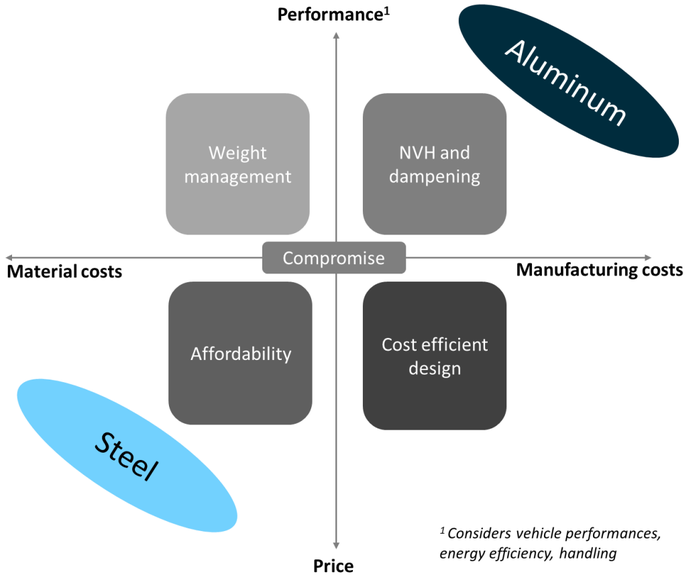
- Cylindrical cells
- Pouches
- Prismatic cells

- Frame battery design: multilayer structure with a frame around the battery
- Tray battery design: bottom cover used as the side construction of the housing

- LFP reaching up to 120Wh/kg
- LMO reaching up to 150Wh/kg
- NMC reaching up to 220Wh/kg
- NCA reaching up to 260Wh/kg

Technical Requirements

Drivers leading the compromise for material selection



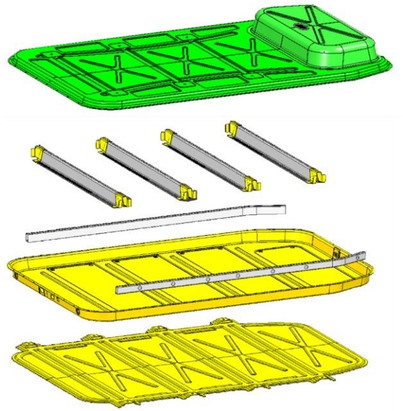
[1] *Considers vehicle performances, energy efficiency, handling*

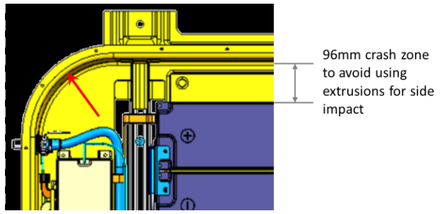
Source: Ducker | Abey Abraham: aabraham@ducker.com

Material Price Trade-off

Price competitiveness for each material is the result of the combination of specific costs and savings OEMs can achieve through different housing designs:

	Aluminum	Steel
Pros	• Weight • High heat dissipation • Battery housing incumbent material • Simplified assembly processes	• Material cost • Manufacturing experience • Thermal inertia for preconditioning • Fire mitigation
Cons	• Material cost • Manufacturing investments • Additional crash absorption areas • Energy for preconditioning	• Weight • Corrosion protection required • Assembly & sealing process costs • Low heat dissipation





Designs are based on the platform integration requirements and the material selected making the price comparison between aluminum and steel almost impossible to achieve

Sources: Ducker, Novelis, Constellium | Aluminum Association 2020 Report | Abey Abraham: aabraham@ducker.com

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THIS CONCLUDES OUR PRESENTATION.
THANK YOU.

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