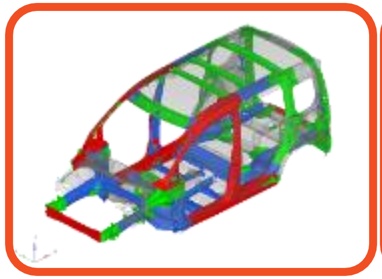
# FORD OTOSAN

Sancaktepe R&D Center

Vehicle Safety Team

# VEHICLE SAFETY - TEAM

## Crash Safety
## Front and Rear Impact



Energy management, load paths
Fuel system & HV systems integrity

## Occupant Safety
## & Side Impact

Restraints Development
Structure and Interior Trim integrity

## Pedestrian Protection
## & Low Speed Damageability

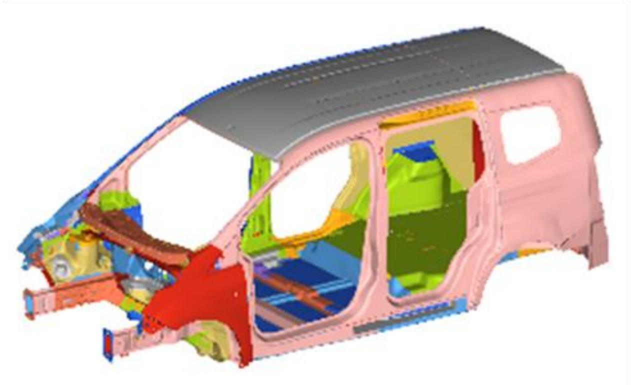
Studio interface, exterior systems
Concept development
GDV/Thatcham insurance ratings

**4 Safety teams**
**Total 36 safety engineers**

# VEHICLE SAFETY - DEVELOPMENT

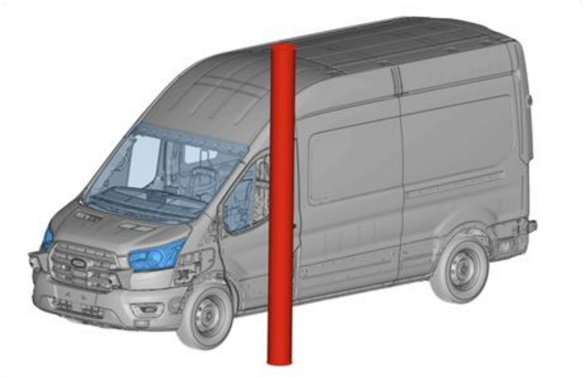
TMR TPS MR PS PSC PA FDJ FEC J1

## Concept Development



- Concept Development and Verification
- Load Path Strategy
- Program Content Definition

## Virtual Series



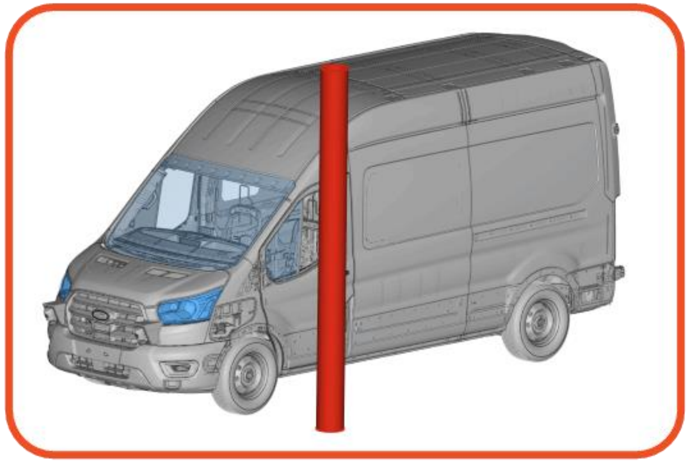
- Virtual Series (UNV/UPV CAE)
- Sled/Component Testing
- TPV Testing

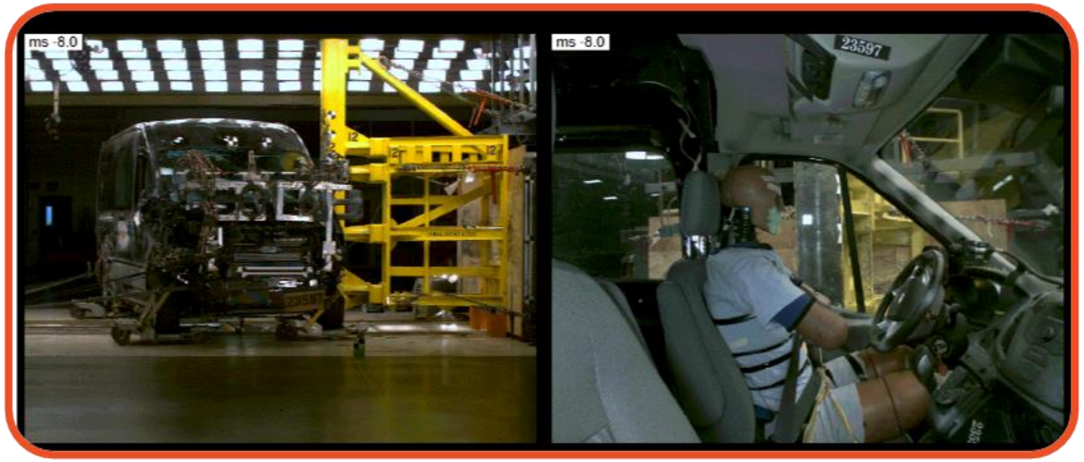
## Physical Verification

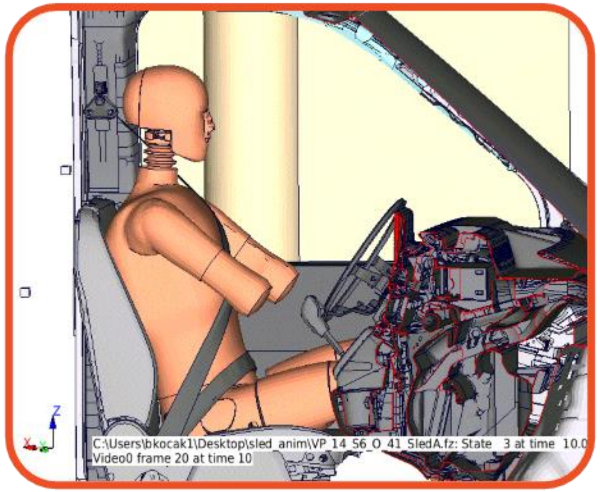
- Safety Sign-Off Testing
- Witnessed Homologation Testing
- Public Domain Testing (NCAP)

# VEHİCLE SAFETY - CAPABILITIES

## Side Crash Safety







### Brief Description

- Restraint System Development
- Side Structure & Interior Design Development
- CAE Simulations
- Component level & full vehicle level testing

### Customer Focus

- Homologation & certification completion on time
- NCAP stars for marketing
- Safer vehicles & customer satisfaction

FORD OTOSAN

# LCV BEV
# SIDE IMPACT DEVELOPMENT

TUBA MUMCU

OCCUPANT SAFETY TEAM MEMBER

# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introducing

**PROJECTS Participated as a Safety Engineer**

Ford Courier, side structure & occupant
Ford Transit, structure

**EXPERIENCE**

Occupant Safety Engineer - Ford Otosan Sancaktepe R&D Center, Oct 2018
Quality Assurance Engineer - Ford Otosan Eskişehir Plant, Jan 2017
Test Engineer – ODTÜ Teknokent, Aug 2015
Manufacturing Engineer – ODTÜ Teknokent, Sep 2014

**EDUCATION**

Master of Science – BOUN, Automotive Engineering, İstanbul
Bachelor of Engineering – METU, Mechanical Engineering, Ankara
Secondary Education – Kdz. Ereğli Anatolian High School, Zonguldak
Primary Education – Nimet Grammar School, Zonguldak

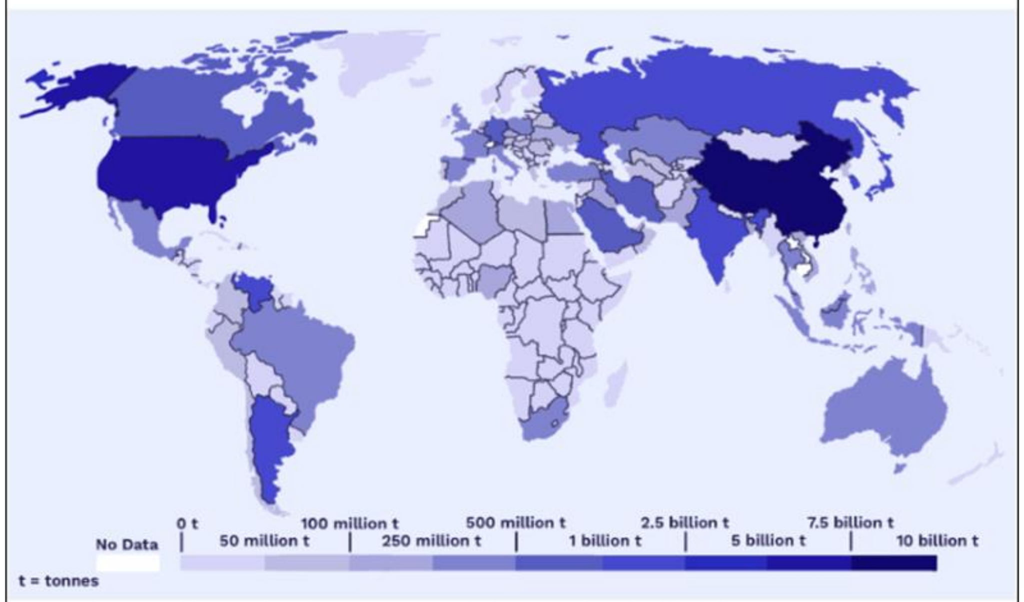
# LCV BEV - SIDE IMPACT DEVELOPMENT

## Content

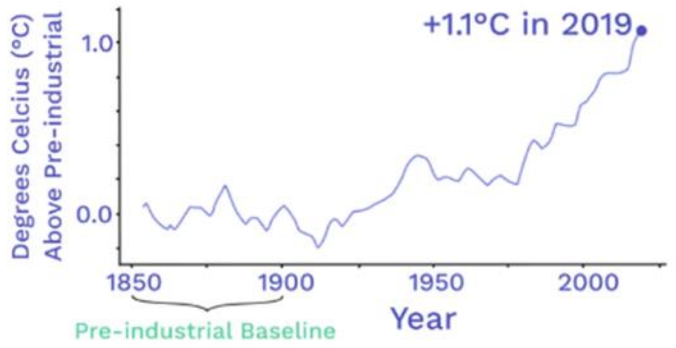
# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

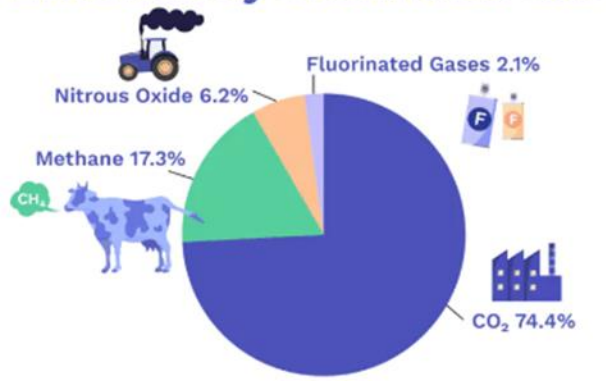
- The environmental impact of the petroleum-based transportation led to **renewed** interest in EVs.




Source: OWID - [CO2 and Greenhouse Gas Emissions] Accessed on [05/08/20]




Source: IPCC, 2018: Global Warming of 1.5°C.




Source: World Resource Institute- [World Greenhouse Gas Emissions: 2016]

# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

Scottish inventor Robert Anderson's the first full sized electric vehicle of the world, 1832

Electric cars being charged, 1907

# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

➢ Many countries made various plans to ban ICE vehicles and increase the number of EVs to reduce fossil $CO_2$ emissions.

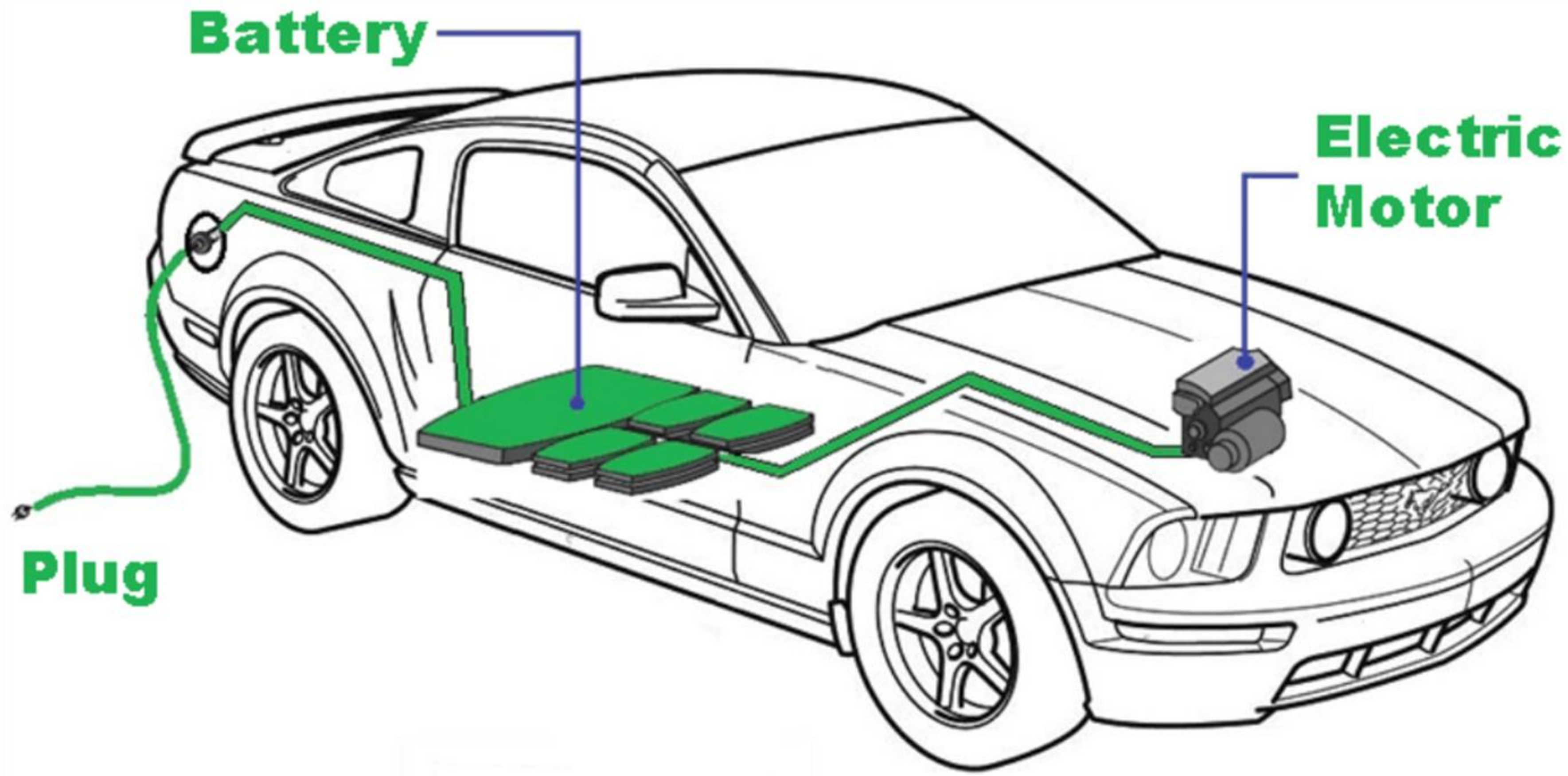
| Country | Current government proposals to ban ICE only vehicle sales |
|---|---|
| China | Actively considering and studying a ban |
| France | 2040 |
| Germany | 2030 |
| India | 2030 |
| Ireland | 2030 |
| Israel | 2030 |
| Netherlands | 2030 |
| Norway | 2025 |
| Scotland | 2032 |
| UK | 2040 |

*Sources: Thomson Reuters GFMS team, Thomson Reuters Eikon, and Reuters News. Data current as of March 20, 2018.*

# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

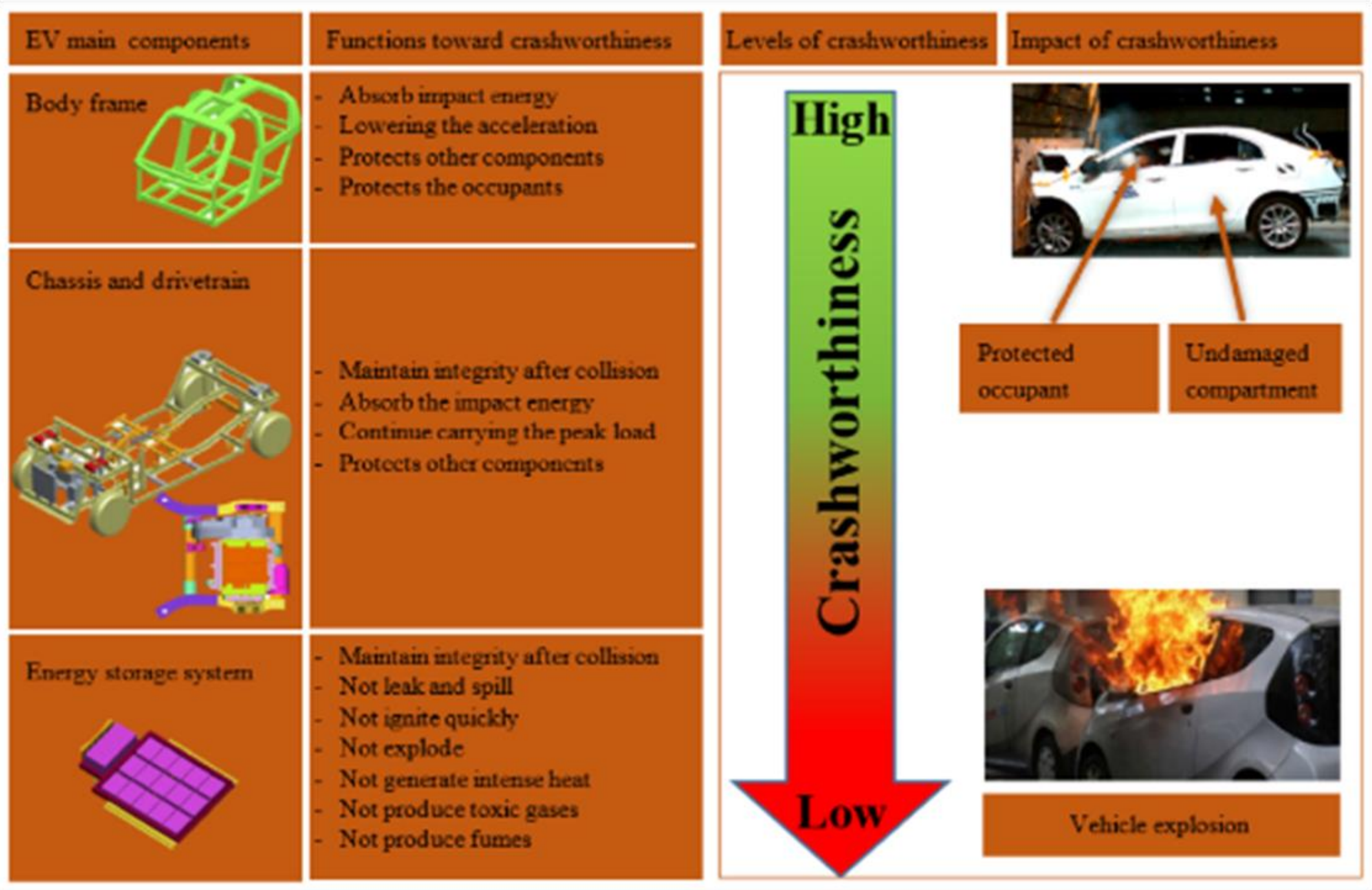
- BEV is remarkable due to HV battery as an only source of propulsion.
- Therefore, sizes enlarge.



# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

➢ Crashworthiness performance becomes one of the biggest challenges.




**Reminder:** Crashworthiness performance of the vehicle can be defined as the impact energy absorption ability by controlling the failure mechanisms and modes.

# LCV BEV - SIDE IMPACT DEVELOPMENT

## Introduction

- Energy must be absorbed **without damaging any battery array**. Otherwise, there may be an electric leakage, fire, or explosion when an accident occurs.

# LCV BEV - SIDE IMPACT DEVELOPMENT

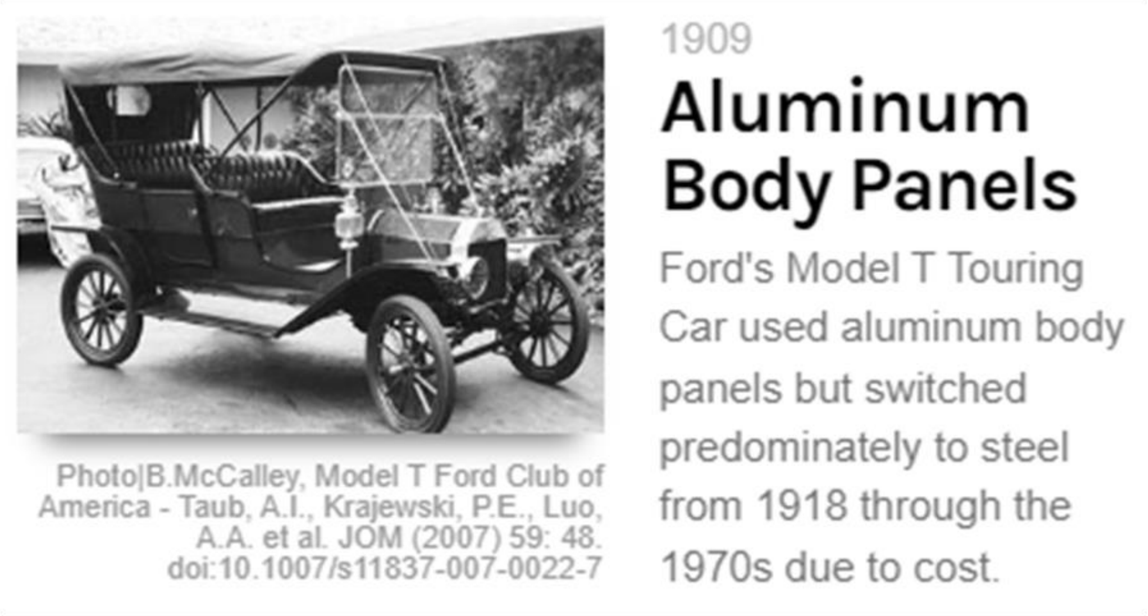
## Introduction

- Also requires **lightweight** to provide driving performance.

**Reminder:** Weight is directly proportional to the electric range.


| LIGHTWEIGHT MATERIALS | MASS REDUCTION |
|---|---|
| Magnesium | 30-70% |
| Carbon fiber composites | 50-70% |
| Aluminum and Al matrix composites | 30-60% |
| Titanium | 40-55% |
| Advanced high strength steel | 15-25% |

- **Al alloys** are desirable materials due to being a third lighter than steel but having a similar strength-to-weight ratio.
  - **Better corrosion resistance**
  - **Recyclability**
  - **Higher cost**



# LCV BEV - SIDE IMPACT DEVELOPMENT

## Purpose

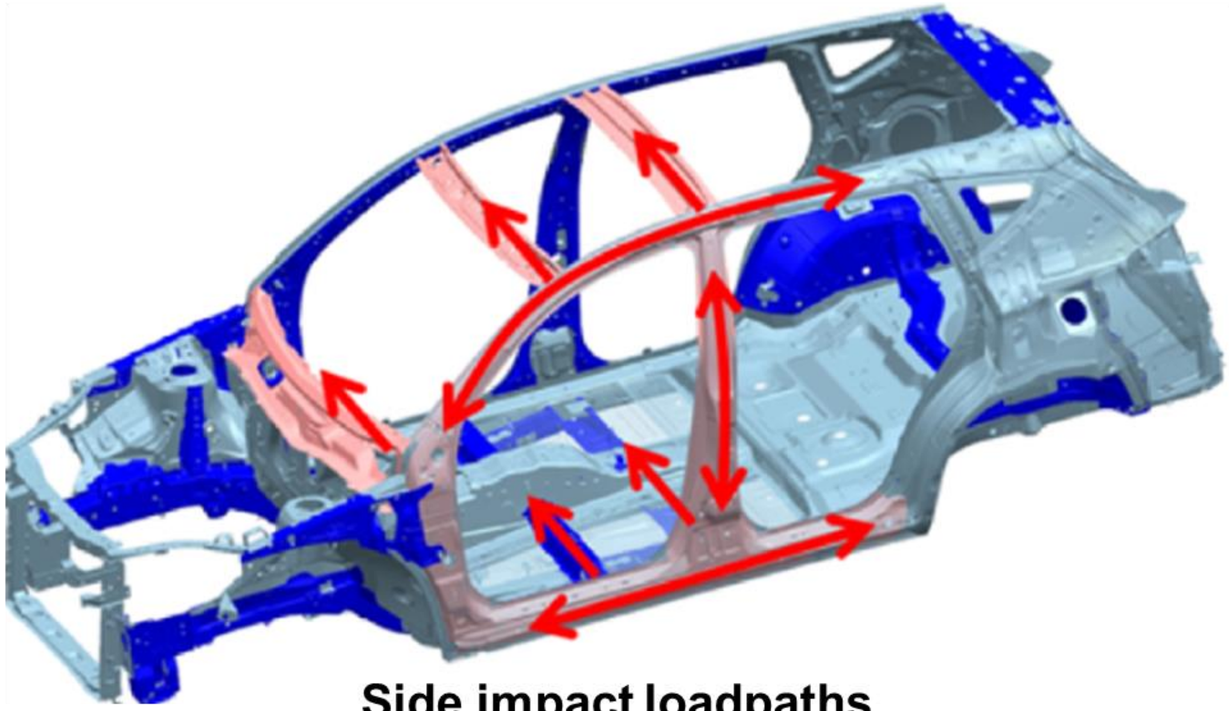
- The main purpose is **to reach an optimum tray design for HV battery of a B platform BEV which is evolved from an ICE vehicle.**
- **Al extrusion** is a clever option to build a battery tray.
  - **Uniform crashworthiness performance all along HV battery.**
  - **Lightweight**
- Final form of the **tray must fit to narrow gap.**
- **BEVs are heavier.** Therefore, **intrusion levels are higher.**
- **Optimization requires analyzing intrusion and acceleration which are inversely proportional.**

**Reminder:** Impact energy is equal to kinetic energy of vehicle or barrier.

# LCV BEV - SIDE IMPACT DEVELOPMENT

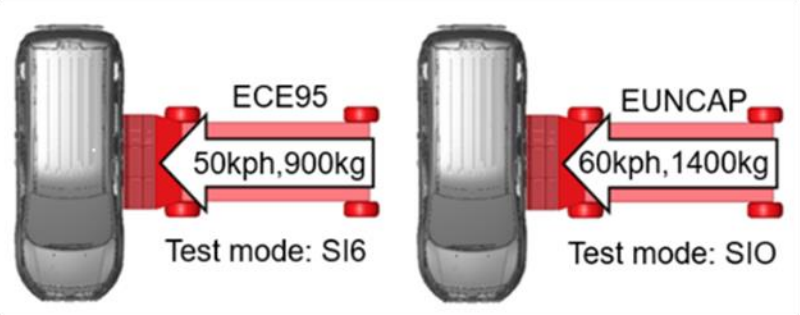
## Side Impact

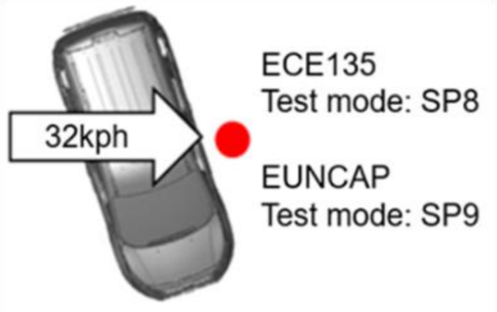
- Architectural development is primarily driven by side impact.



Side impact loadpaths

## Side impact modes

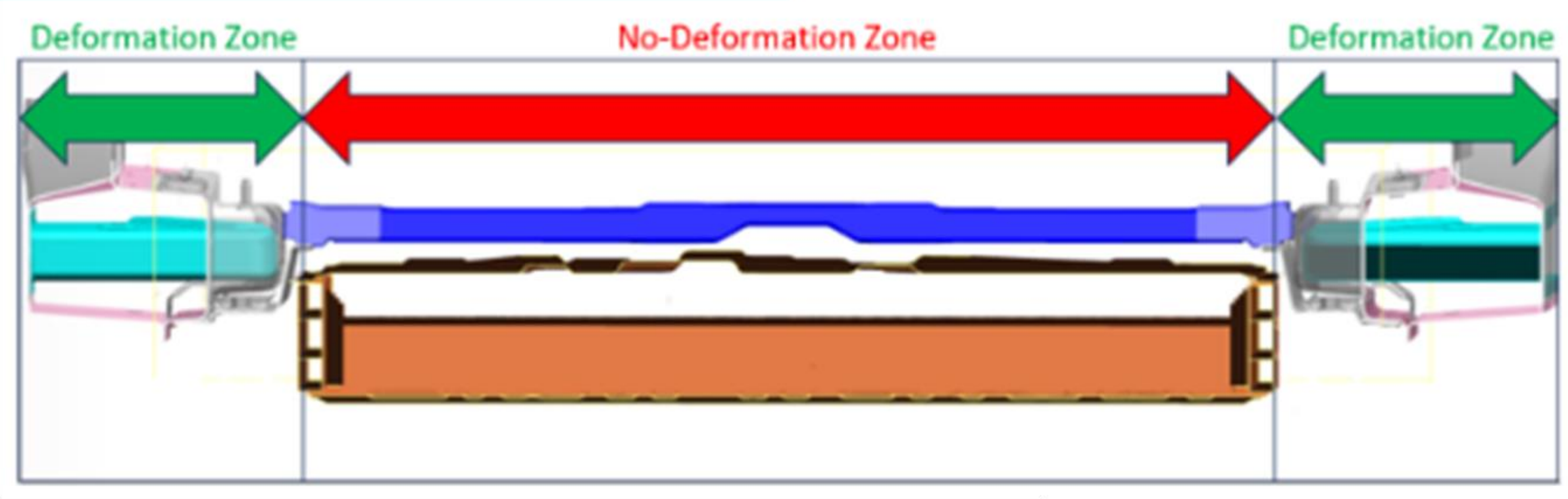



**Reminder:** Loadpaths transfer impact load from impact side to non-impact side of the vehicle.

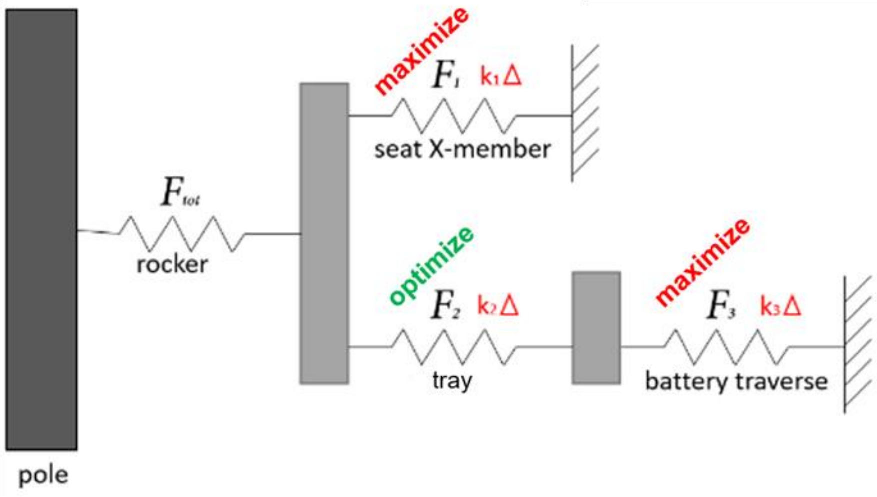
# LCV BEV - SIDE IMPACT DEVELOPMENT

## Impact Energy Management




➢ **Observations:**

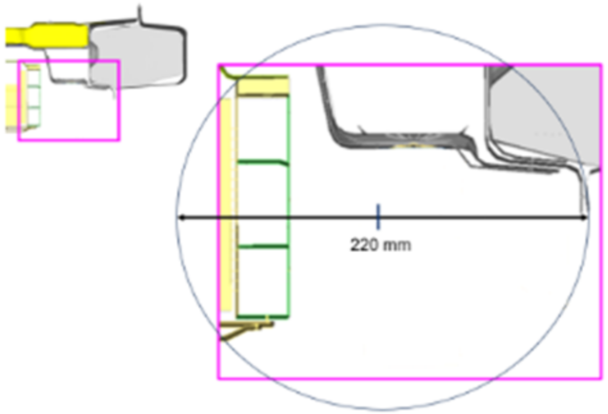
- Loadpaths must not be deformed in any way.
- Parts in deformation zone must be deformed to absorb energy.
- Tray must fit to deformation zone.



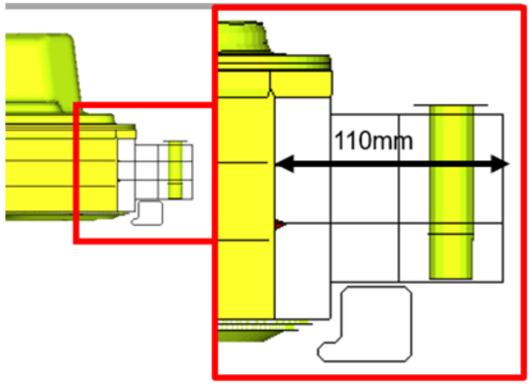
# LCV BEV - SIDE IMPACT DEVELOPMENT

## CAE – Initial Study

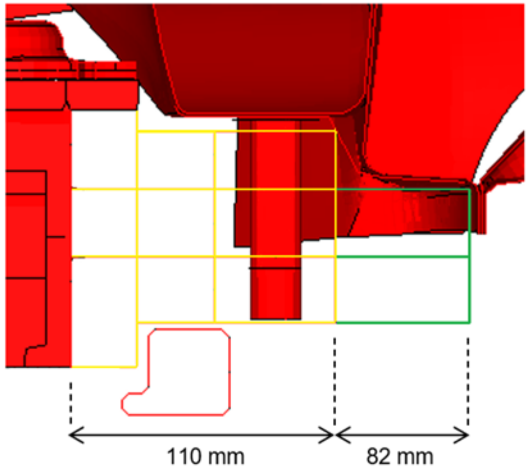
**manufacturing limits of the supplier**



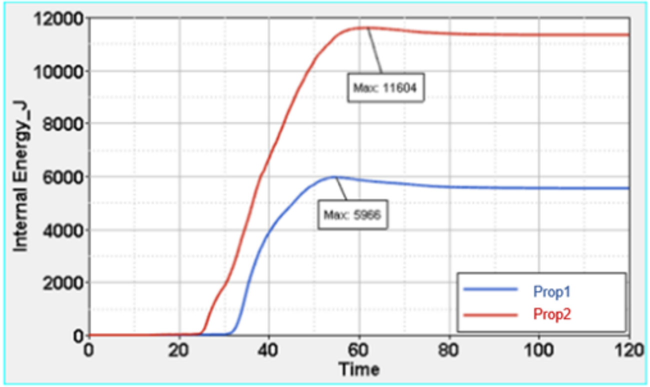

**ESE Delivery**




**Proposal**




- Proposals focus on:
  - maximizing the number of pockets of extrusion to absorb more energy,
  - enlarging extrusion in Y-direction up to AB-line to meet pole early and absorb additional energy.



# LCV BEV - SIDE IMPACT DEVELOPMENT

## Summary

- The main purpose is to achieve an optimum battery tray which is as light as possible and absorbs maximum impact energy in the meantime.
- Al extrusion is a clever option when crashworthiness and lightweight are considered. It can fit in a small gap between battery outer wall and rocker.
- Consider manufacturing limitations to achieve producible design.