Evaluation of Crash Risks and Outcomes for Electrical Vehicles: Is the Road Infrastructure Ready?

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INTRODUCTION

Definitions:

- **EV**: Electric Vehicle
- **BEV**: Battery EV
- **PHEV**: Plug-in Hybrid EV
- **ICEV**: Internal Combustion Engine Vehicle
- **DOT**: Department of Transportation
- **VIN**: Vehicle Identification Number
- **NHTSA**: National Highway Traffic Safety Administration
- **MASH:** Manual for Assessing Safety Hardware
- **KABCO Scale**: K(Fatal),A(Incapacitating), B(Non-Incapacitating), C(possible),O(property damage)

In recent years, EV sales have increased dramatically, and many automotive manufacturers intend to be fully electric within the next 15 years. Roadside infrastructure, including barriers, was not designed for EVs. There are differences in structural properties of EVs, especially BEVs, when compared to ICEVs. BEVs are heavier, have lower centers-of-gravity, and have different crush zones and undercarriage structure. There is concern that the current infrastructure is not equipped to safely handle EV crashes, which could lead to serious injuries, deaths, and fire.

OBJECTIVE

- Identify characteristics of BEV crashes and compare to ICEV crashes and determine if EV crashes are statistically similar (or different) to ICEV crashes
- Develop a database of crashes involving BEVs that will be used to request crash reports to study run-off-road collisions
- Based on results, evaluate existing infrastructure and determine if retrofits are required to prepare for EVs

METHODOLOGY

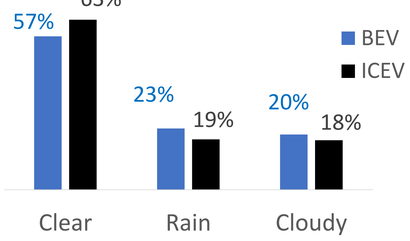
Obtain crash data from state DOT → Process and filter to develop a database → Write code using NHTSA's VIN Decode Program → Identify Crashes involving BEVs by Decoding VINs → Develop and use bulk statistics to identify areas of concern

CASE STUDY: WASHINGTON

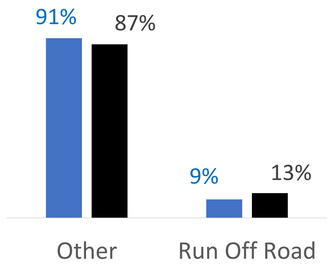
- Only vehicles manufactured in 2010 and later were included in this study
- PHEVs were included in the ICEV dataset

TOTAL CRASHES 2017-2021	ICEV: 328,106 (98.6%)	BEV: 3,350 (1 %)	UNKNOWN: 2,008 (0.4%)

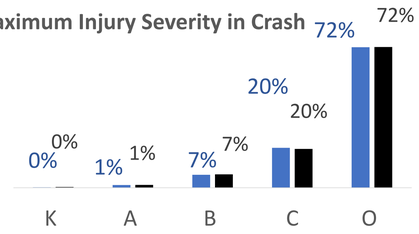
Effect of Weather on Crashes



Run-Off-Road Frequency



Maximum Injury Severity in Crash



FIRE RISK

	Crashes Resulting in Fire	Fires that Involved Injury
BEV	0.3%	90%
ICEV	0.3%	56%

INFORMATION CONTAINED IN A VIN

5YJ3EIEA9HF001912

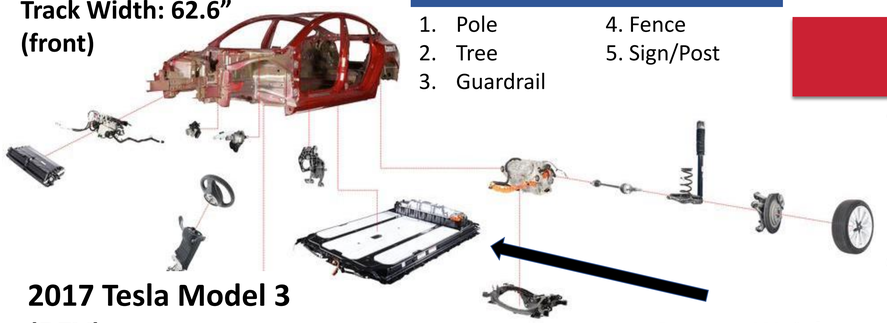
- 5YJ: World Manufacturer ID
- 3EIEA: Vehicle Attributes
- H: Model Year
- F001912: Sequential Number

2017 Toyota Avalon (ICEV)

Weight: 3505 lbs
Wheel Base: 111"
Track Width: 62.6" (front)

BEV Top 5 Roadside Features Struck

1. Pole
2. Tree
3. Guardrail
4. Fence
5. Sign/Post



2017 Tesla Model 3 (BEV)

Weight: 3900 lbs
Wheel Base: 113.2"
Track Width: 62.2" (front)

Battery Weight: 474 lbs

CONCLUSIONS

- There were no statistically-significant differences between BEV and ICEV crash causes, locations, time of day, day of week, weather, and injury level
- Impact conditions for BEVs are thus similar to ICEV impacts. MASH impact conditions for ICEVs should be applicable for BEVs and evaluation of roadside hardware.
- BEVs are not more prone to fire than ICEVs. In injury-level crashes, BEVs are more likely to catch fire. Fire events may be less correlated with crash severity for ICEV vehicles and more correlated with crash severity for BEVs
- Crashes that could not be identified as BEV or ICEV were excluded in diagrams. Analysis showed the unknown crashes were nearly indistinguishable from BEV and ICEV results. Unknown crashes likely have the same proportion of ICEVs and BEVs.

NEXT STEPS

- Increase the sample size to strengthen the validity of results by continuing to process crash data from other states
- Complete a detailed in-service performance evaluation of BEV crashes that had fire outcomes and severe crash events
- Overplot BEV and ICEV crashes to determine geographic crash trends and identify high priority retrofits
- Examine BEV crash data as vehicles age and sales increase. Monitor if older BEVs are more likely to be involved in crashes with severe or undesirable outcomes

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Tesla images and dimensions were taken from Caresoft Global's Iceberg Automotive Benchmarking platform. Toyota Avalon dimensions and image taken from www.cars.com