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Overview of fire risks related to electric vehicles in garages

Vincent Mans
European Fire Safety Week
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FIRE SAFETY IN E-MOBILITY ON THE MOVE...

-continuous growing EV market

-pushed by green horizon political objectives

-understood and demanded by the society !!!

Battery Fires Make Headlines as Electric Vehicle Sales Take Off

By David Stringer | October 20, 2020

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FIRE OCCURRENCE IN E-VEHICLES MAINLY IN GARAGES

	parked and/or charging	driven	post crash
fire incidence (a)	60%	20%	20%
fire incidence(b)	52%	26%	22%

(a) A review on battery fires in electric vehicles. 2018
Fire Technology 56, P. Sun, H. Niu, R. Bisschop, X.Huang,

(b) Fire Safety LIB in road vehicles/ RISE report 2019/51
R. Bisschop, O.Willstrand, F. Amon, M. Rosengren

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THE FUTURE

5. (a) Houston's Tranquility Park Garage with GRIDbot charging stations [173], and (b) hund
new EVs parked in a public area in Wuhan, China, showing a high fire risk [155].

ACTUAL FIRE SAFETY REGULATIONS IN GARAGES

Regulated by MS and based on the Construction Eurocodes

- *90-120 min REI for >100m2*

- *120-180 min REI for robotic parking*

- *Class B s1 d0 for reaction to fire –walls,..*

- *Cca-s1b,d1,a1 EN 50399 – Cables*

Ventilation requirements >100 m2

*Factors: **fire load,** geometry, evacuation.*

FIRE LOAD…FUEL AMONG THE FACTORS

No fuel, but 400 l containing organic electrolytes….

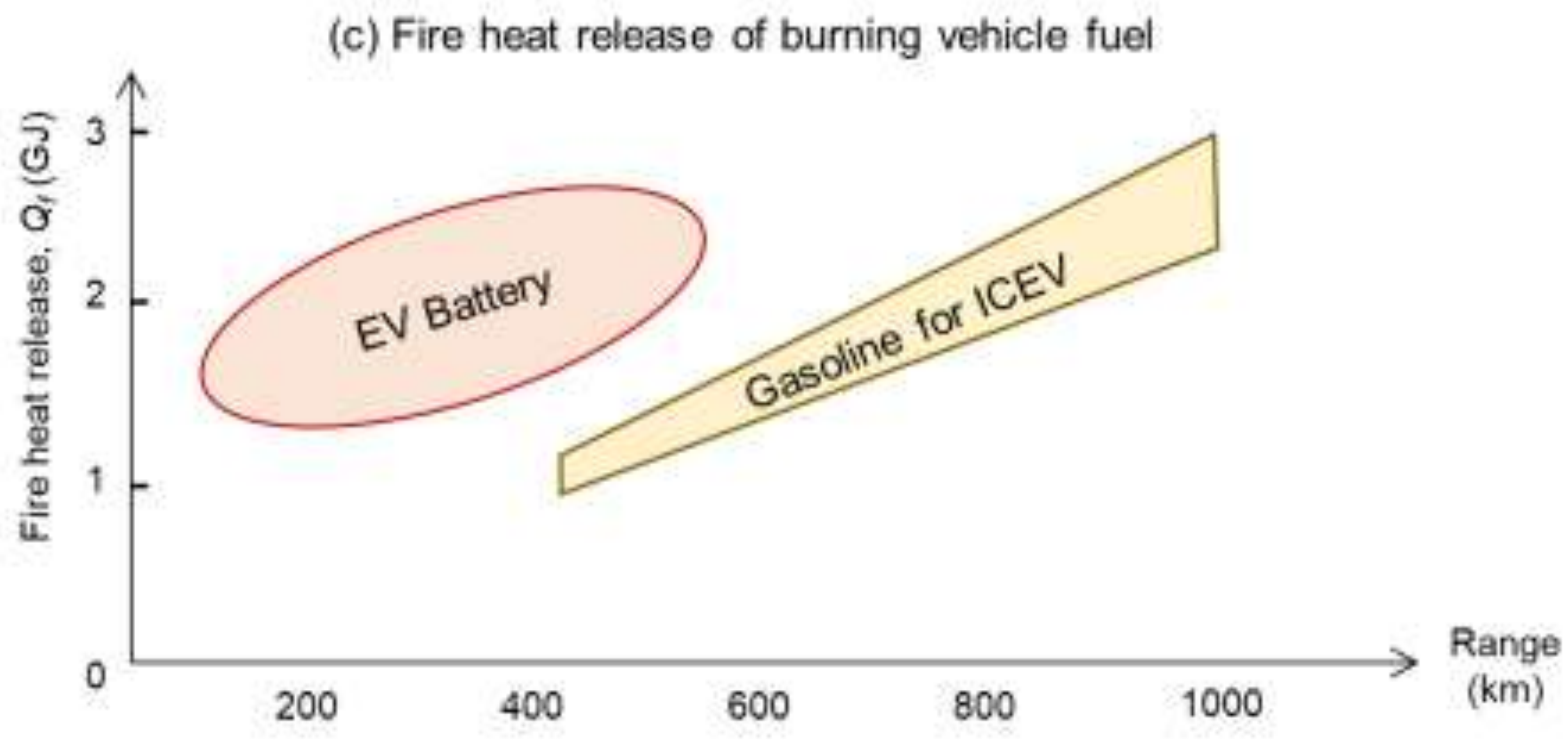
A Zotye M300 EV having its batteries replaced

EASY TO IGNITE? COMPARATIVE FLASH POINT EV / ICEV

Table 7 Flammability data for the electrolyte solvent in LIB cells and data for conventional automotive fuels for comparison.

Organic Electrolyte Solvents	Boiling Temperature [°C]	Autoignition Temperature [°C]	Flash Point [°C]	Flammable Limits, Lower / Upper [%]
Ethyl Acetate (EA) [37] [38]	77	427	-3	2.2 / 9
Dimethyl Carbonate (DMC) [37] [38]	91	458	16	4.22 / 12.87
Ethyl Methyl Carbonate (EMC) [37] [38]	110	440	24	-/-
Diethyl Carbonate (DEC) [37] [38]	126	445	25	1.4 / 14.3
Ethylene Carbonate (EC) [37] [38]	248	465	143	3.6 / 16.1
Propylene Carbonate (PC) [37] [38]	242	455	132	1.8 / 14.3
Gasoline [39]	30 to 210	> 350	< -40	1.4 / 7.6
Diesel [40]	>180	240	>61.5	0.7 / 5

HRR HIGHER IN EV FOR SAME RANGE



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P. Sun, R. Bisschop, H. Niu, X. Huang* (2020) *A Review of Battery Fires in Electric Vehicles*, **Fire Technology**, 56 Invited Review https://doi.org/10.1007/s10694-019-00944-3

ICEV VEHICLES SIMILAR HRR THAN EV IN REAL TESTS

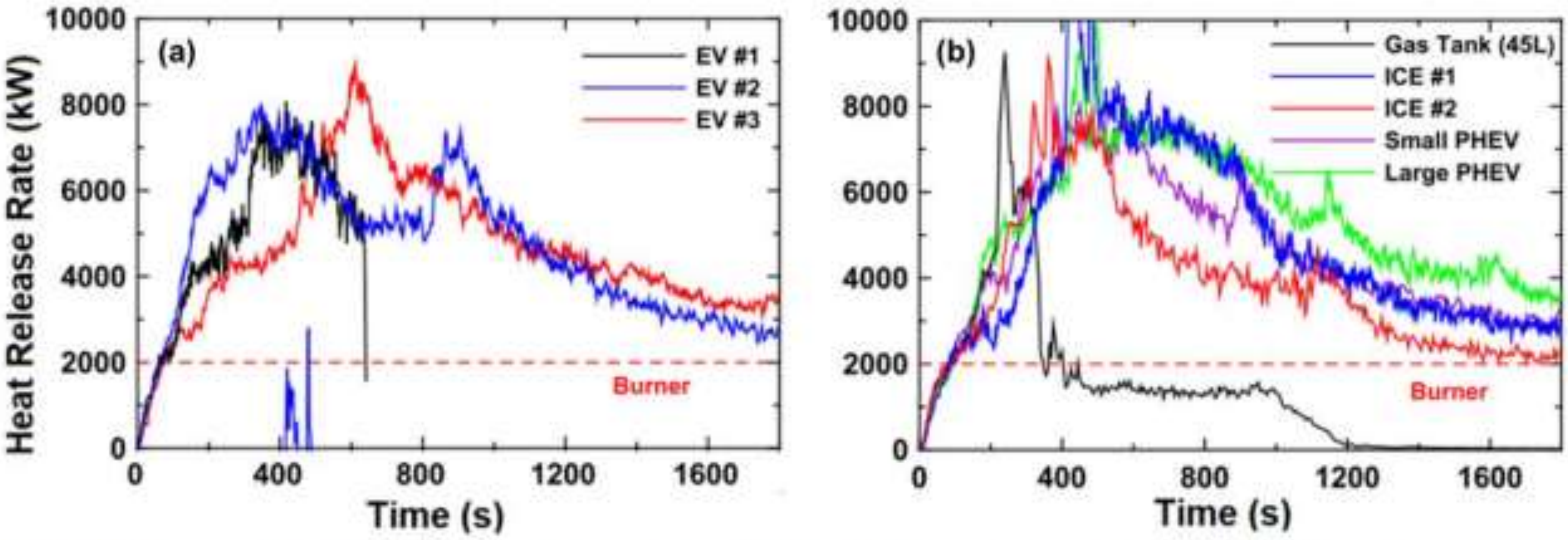

Figure 20. Evolution of HRR versus time for test vehicles which were suspended over a propane burner of 2 MW: (a) three different pure battery EVs, and (b) a small PHEV and a large PHEV compared with the gas tank and internal combustion engine (ICE) vehicles [91].

P. Sun, R. Bisschop, H. Niu, X. Huang* (2020) *A Review of Battery Fires in Electric Vehicles*, **Fire Technology**, 56 Invited Review https://doi.org/10.1007/s10694-019-00944-3

CHARGERS, CONVERTERS, CABLES…

Standards specific for e-Mobility :

IEC 62196 Type 2 official EU connector

IEC 62196-1   Glow wire test

For garages:

Reaction to fire > Cca-s1b,d1,a1. EN 50575

Comparison between extended Combo2 – DC Charger (left) and normal Type 2 – 1–3 phase AC Charger (right).

VENTILATION IN GARAGES

Actual situation:

Actual Regulations intended for opacity (evacuation) EN 1366-1

Toxic fumes not considered

What is coming with e-mobility:

More and toxic smoke

Higher fire risk

HF EMISSION DOUBLE IN EV

Table 6. List of toxic gas emissions from full-scale EV fire tests [95].

Vehicle	Weight	Battery or fuel capacity	Total CO (kg)	Total HF (kg)
Unknown BEV	1122	16.5 kWh	10.4	1.5
Unknown ICEV	1128	Full tank of Diesel	12.0	0.6
Unknown BEV	1501	23.5 kWh	11.7	1.5
Unknown ICEV	1404	Full tank of Diesel	15.7	0.8

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LOT OF WORK AHEAD….

Toxic gases from fire in electric vehicles

The aim of the project is to raise the level of knowledge regarding toxic gases generated by fire in electric vehicles and to investigate how this affects fire fighting operations.

The project results are expected to create a basis for relevant risk assessment. The results are also expected to be used in other areas such as

Summary

PROJECT NAME
E-TOX

STATUS
Active

RISE ROLE IN PROJECT
Coordinator

PROJECT START
2019-10-01

DURATION
1 year

LIGHT WEIGHT MATERIALS IN EV

Increased number of polymeric pieces in EV

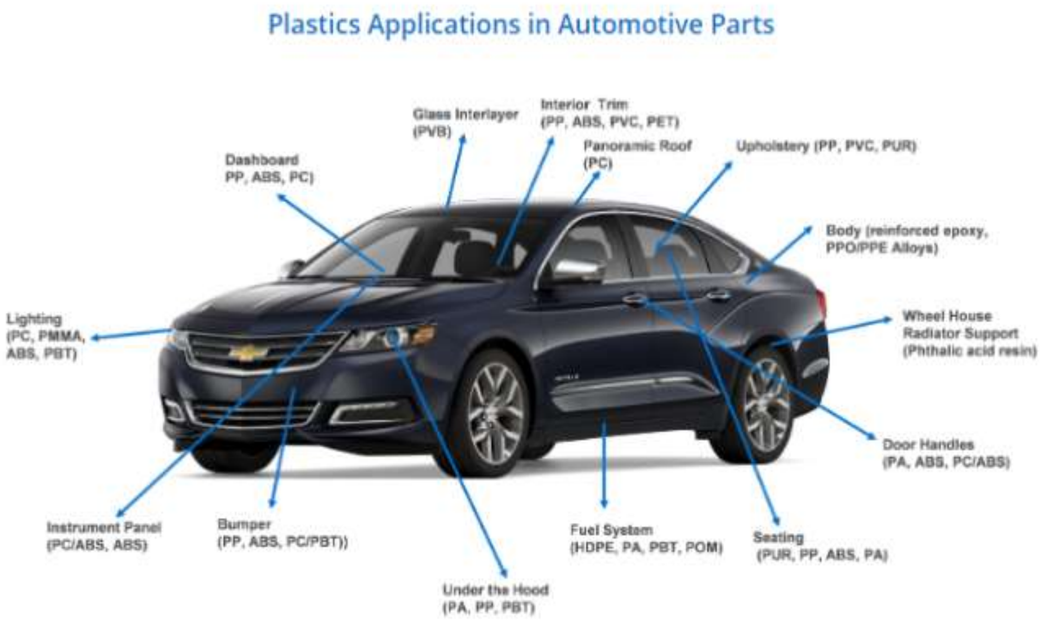
↓

Contribute to the total fire load

Reinforced polymers (carbon, glass fibres,..)

- toxic fumes

- nano particles/ fibres



TO CONCLUDE....

EV fires in **closed areas, like garages,** is the worst and most probable fire scenario.

Reaction/Resistance to fire of all elements in garages is **quite well regulated** although a slightly higher fire load for EV may suggest a future revision.

Smoke emission is the issue. **Mainly for toxicity**

Need for ventilation designs beyond actual standards

Need for more research regarding extinguishing systems

Need for more research regarding firemen exposure

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BACK UP

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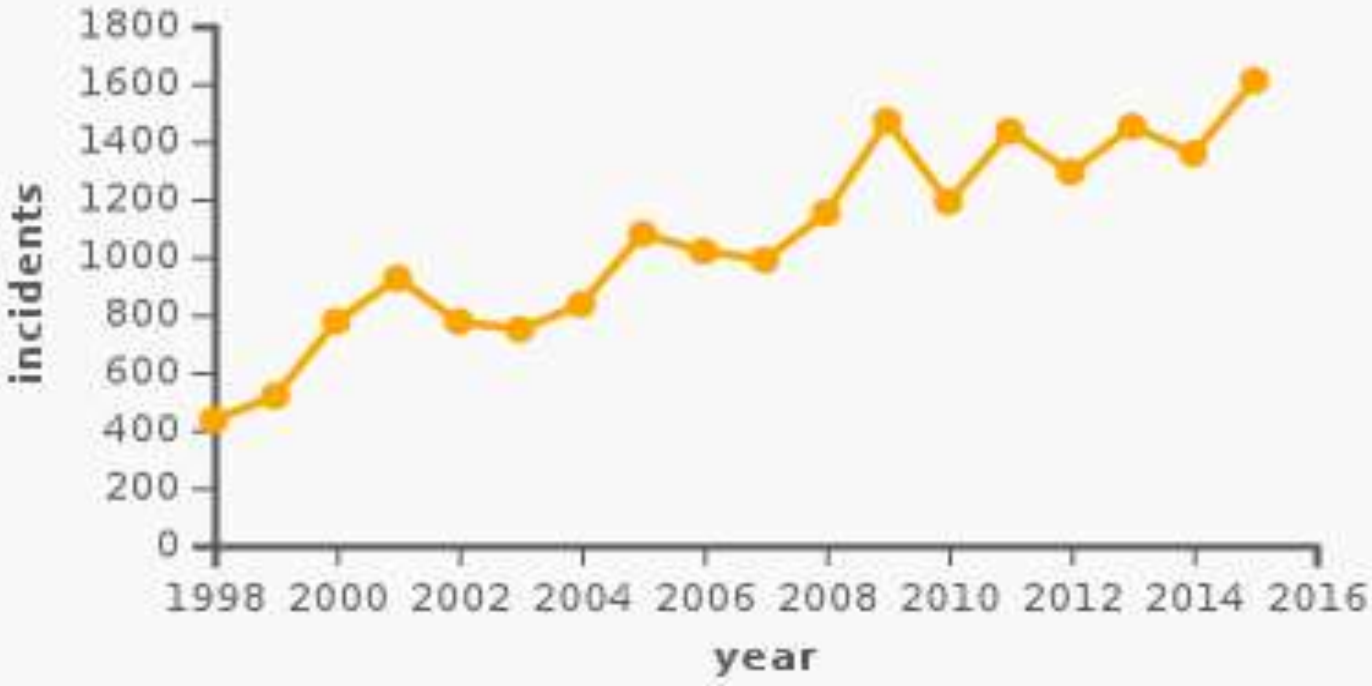
FIRE IN ALL VEHICLES IS AN OLD CONCERN

Number of 1998-2015 vehicle fire incidents in Sweden, intentional burning



Source: Swedish Civil Contingencies Agency statistics database.[1]

- To perform simulations and analysis of test results and realistic fire scenarios, for example what concentrations can be expected at different positions in a parking garage with certain geometry and ventilation.

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Fires in EV

60% parked/ charging
20% driven
20% post crash

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WHERE ARE THE FIRE RISKS IN E-MOBILITY?

Batteries

AC/DC electric systems

Chargers

Weight reduction