

# Investigation of fires with electric vehicles in underground traffic areas

Lukas Fast, FOGTEC Fire Protection





# About me:

Lukas Fast

FOGTEC Fire Protection

Product Manager - New Energy Carriers

Responsible for the development of fixed fire fighting and fire detection solutions for projects involving new energy carriers like lithium-ion batteries.

# AGENDA

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Company Introduction

02

Science Project SUVEREN

03

Lithium Ion Battery Fire Protection

04

Impact on the vehicle recycling industry

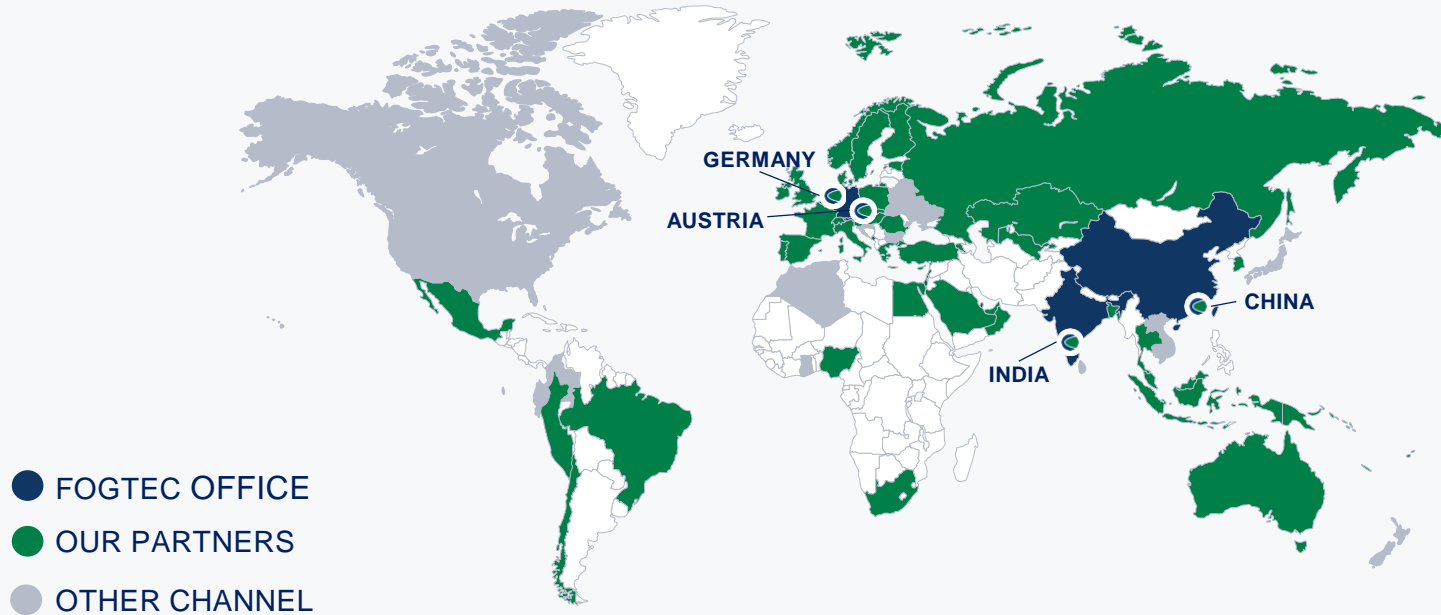
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# OUR COMPANY

- FOGTEC is an owner-managed company established in 1997 located in Cologne, Germany
- Team of mainly engineers and more than 45 partner companies all over the world
- Experts in engineering and design of complex fire fighting and fire detection systems
- Services include consulting and development of fire protection concepts including validation in full scale fire tests
- Within 20 years FOGTEC became in its markets one of the leading companies worldwide



# GLOBAL OFFICES



# OUR BUSINESS UNITS

## FIXED SYSTEMS



FOGTEC high-pressure water mist systems offer optimum protection for buildings, machines and entire industrial plants. The reasons for choosing a high-pressure water mist system for fire protection can be manifold.

## RAIL SYSTEMS



FOGTEC systems are used in the entire rail vehicle and beyond. Starting in the passenger compartments, through locomotives and technical areas to the associated infrastructure.

## TUNNEL SYSTEMS




FOGTEC automatic fire fighting systems in tunnels significantly increase their safety level and availability. They attack directly at the source of the fire and fight a fire as soon as it breaks out.



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## LITHIUM-ION FIRE PROTECTION KNOW-HOW THROUGH SCIENCE

A firefighter in full protective gear, including a helmet and a jacket with reflective yellow stripes, stands in the center of a thick, grey smoke environment. A bright light source, possibly a flashlight, is positioned in front of the firefighter, creating a strong lens flare and illuminating the smoke.

Battery Fire Tests Carried out by  
Leading Experts

# PROJECT **SUVEREN**

Safety of Urban Underground Structures due to the Use of New Energy Carriers

- Identification of current and future risks related to the use of new energy carriers in underground urban transport
- Fire testing with lithium-batteries and substitute fire loads
- Comparison between different detection methods and extinguishing agents
- Funded by the German Federal Ministry of Education and Research



Federal Ministry  
of Education  
and Research



Fire test with lithium-batteries in the SUVEREN Test Chamber

 [www.suveren-nec.info](http://www.suveren-nec.info)



# PROJECT **SUVEREN**

Safety of Urban Underground Structures due to the Use of New Energy Carriers

## Measurements:

- Heat Release Rate (HRR) measured by Oxygen Consumption Calorimetry (OCC) and Sensible Enthalpy Rise Approach (SERA)
- Air Temperatures on various heights
- Temperatures on different heights at the inner and outer walls
- Gas composition measured with Fourier-transform infrared spectroscopy (FTIR)
- Video and IR Camera



SUVEREN – Battery fire test chamber (calorimeter)

# PROJECT **SUVEREN**

## Testing of Various Extinguishing Agents

### Various detection and fire-fighting technologies were tested:

- Sprinklers
- Water mist (high & low pressure)
- F-500
- Foam
- CO<sup>2</sup>
- N<sup>2</sup>
- NOVEC
- Aerosol

The results and extinguishing capabilities were evaluated in comparison to the respective free burning tests and among each other.

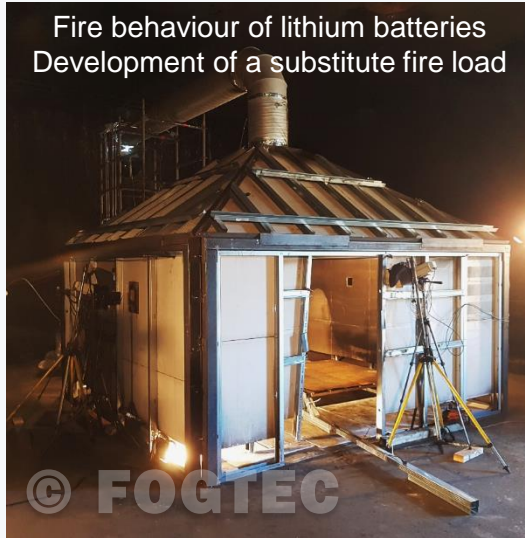


Image: Battery testing chamber

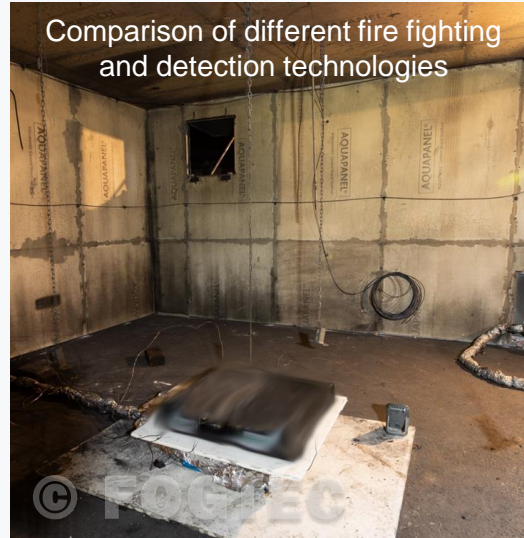
# PROJECT **SUVEREN**

Safety of Urban Underground Structures due to the Use of New Energy Carriers

Fire behaviour of lithium batteries  
Development of a substitute fire load



Comparison of different fire fighting  
and detection technologies



Fire tests with vehicle mock-up



# PROJECT

Fire test Impressions



Figure: Fire test with vehicle lithium-ion batteries in the calorimeter

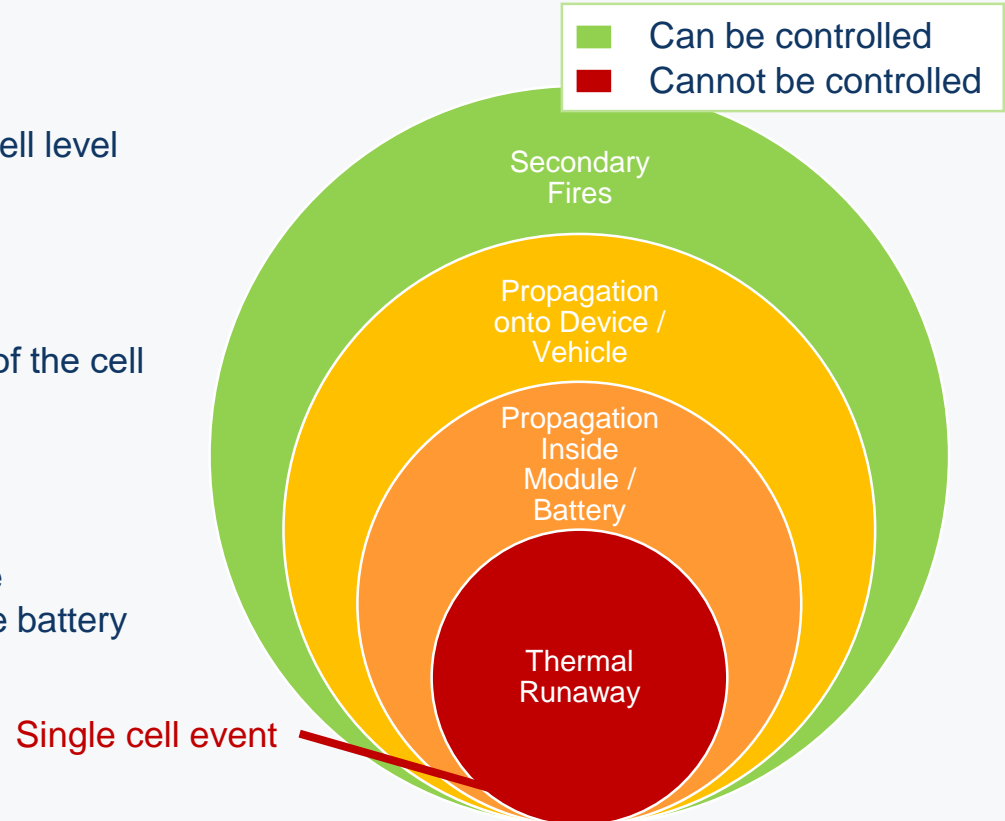


Figure: Infrared image of the fire test

# LITHIUM ION BATTERY FIRE PROTECTION

## Conclusion

- The Thermal Runaway takes place on a cell level
- Will typically not last longer than 1 minute
- Thermal Runaway (cell level) cannot be “extinguished” due to the shielding effect of the cell housing as well as the speed of reaction.
- **Objectives in order of importance**
  1. Prevention of secondary fires
  2. Prevention of full device / vehicle fire
  3. Slowing down / interrupting complete battery TR-propagation



# (BATTERY ELECTRIC) VEHICLE FIRES

From a Fire Safety Point of View

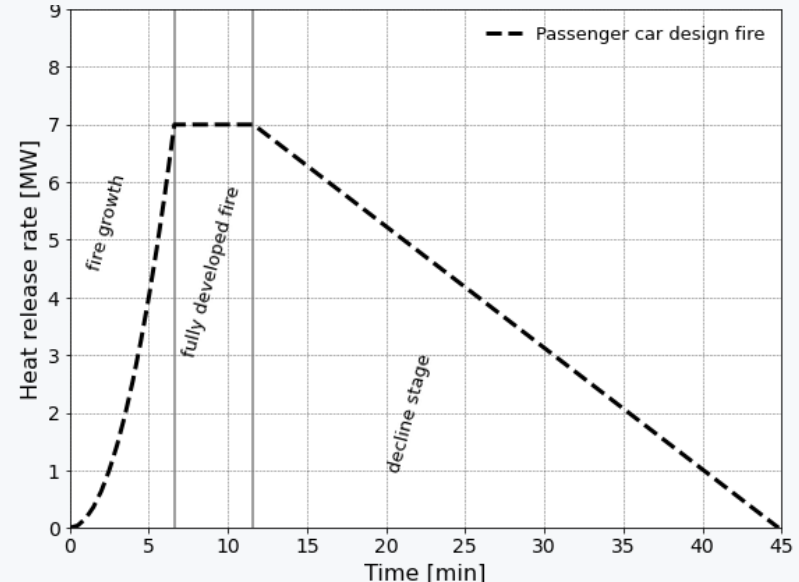
Passenger vehicles have significantly changed over the last couple of years:

- Size of models increased
- Average size of sold vehicles increased
- Plastic components increased
- New drivetrains (electric and gas vehicles)

In terms of fire protection the drivetrain is just one notable change in vehicle design

Can be used as an input for

- CFD-Simulations
- Fire Tests



Design fire curve for modern passenger vehicles, developed in SUVEREN



# HIGH PRESSURE WATER MIST IN ACTION

Impressions From a Full Scale Fire Test



Activation after detection



Quick filling of the entire space



Fire control

# STOPPING THERMAL PROPAGATION

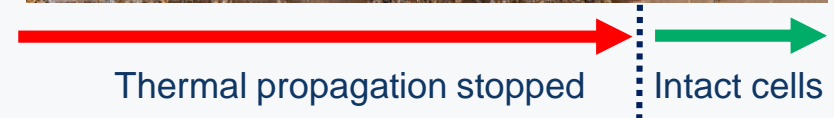
Through Extensive Cooling

## Cooling is essential

- Cooling of the battery pack is the only way to reduce TR-propagation
- Water is proven to be the best cooling agent

## Reduction of heat by suppressing open flames

- 50% of all energy from a battery fire is caused by the combustion of electrolyte gases
- Reduction of heat slows the TR-Propagation as well as secondary fires





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## LITHIUM-ION FIRE PROTECTION DERIVATION OF THE RESULTS FOR THE VEHICLE RECYCLING INDUSTRY

# WHAT IS THE RISK FROM CRASHED VEHICLES?

## Crashed vehicles

- Mechanical Damage very likely
- Unknown battery state of health
- Battery Thermal Runway possible at any time
- Delayed reaction possible, several weeks after crash
- Reignition possible at any time



Source: Fire Brigade of the City Landeck



# WHICH EXTINGUISHING AGENT IS MOST SUITABLE?

## If the battery pack is involved in a fire

- Cooling is essential
- Water is proven to be the best cooling agent

## Cooling options

- Extensive usage of water >10.000 Liters
- Flooding (container or open pit)
- High Pressure Water Mist (ambient gas temp.)



Photo: Brandweer Nederland (top), Helmut Kaczmarek (bottom)

# STORAGE OF DEFECTIVE BEV

## Current recommendation

- 5 – 15 meters distance between BEV and other objects (NFPA, OEMs)
- Quarantine period (>24 hours)

## Challenges

- Growing number of damaged BEV
- Possible delayed reaction or reignition
- Extended retention period due to clarification by insurance or questions of evidence (authorities)
- Monitoring during quarantine period



Scrap car lot



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# OUTLOOK

## Technical

- Solutions for the prolonged storage of damaged BEV in large numbers, spatial requirements are essential (unlimited space is not available)
- This includes
  - Fire Detection & Fire Protection
  - Enough space for several dozen crashed BEV

## Regulatory

- Clear definition on who is responsible for battery storage and monitoring after a fire
- Minimum technical requirements of storage

# Thank you!

If you have any questions, please  
contact me at  
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