New studies on

New Energy Carriers

Maximilian Wietek

ILF Consulting Engineers Austria GmbH

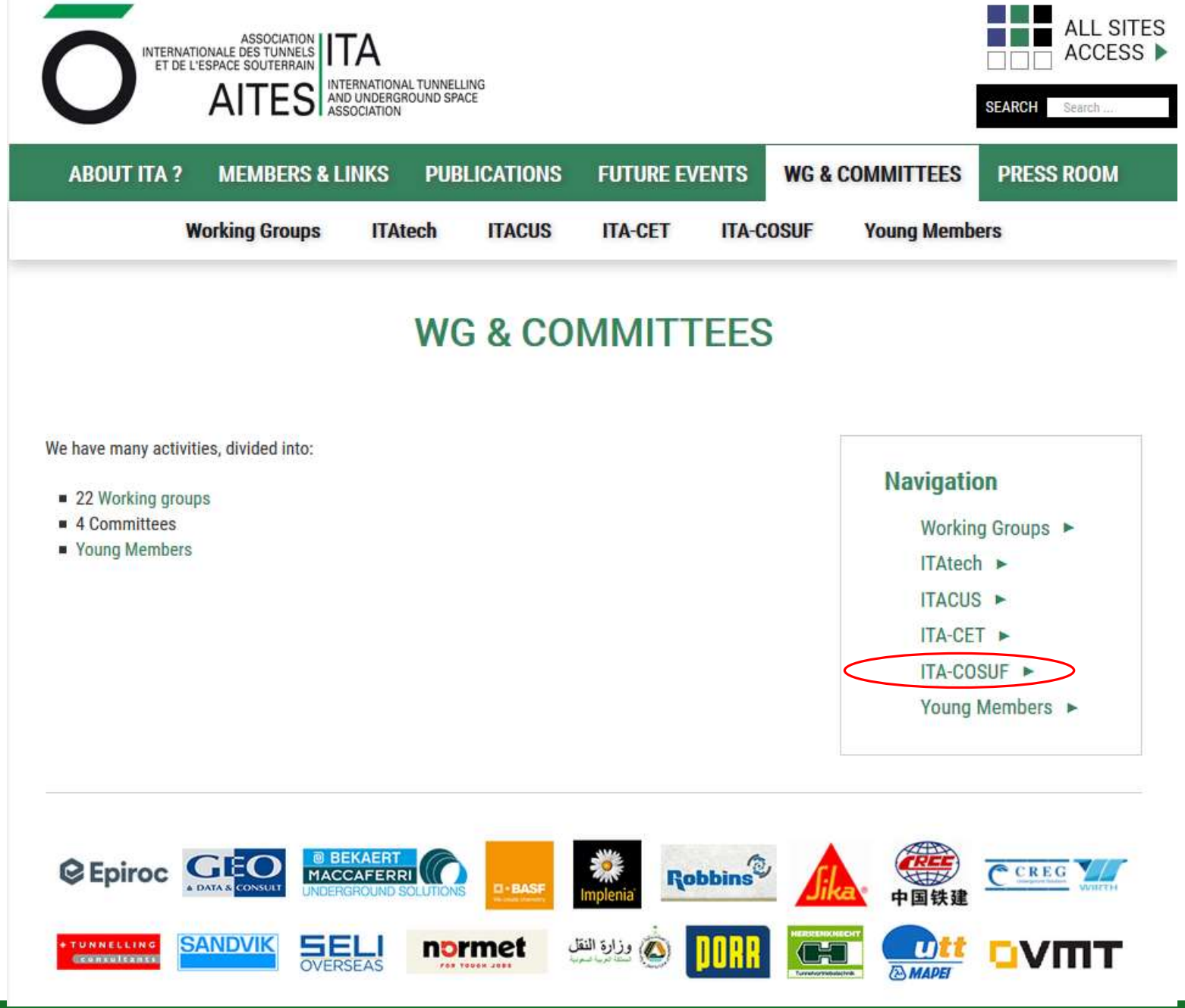
ITA-COSUF Chair

ITA-COSUF

the **C**ommittee on **O**perational **S**afety
of **U**nderground **F**acilities

of the **I**nternational **T**unnelling and Underground Space **A**ssociation

Maximilian Wietek, ITA-COSUF Chair


ASSOCIATION INTERNATIONALE DES TUNNELS ET DE L'ESPACE SOUTERRAIN
AITES
ITA
INTERNATIONAL TUNNELLING AND UNDERGROUND SPACE ASSOCIATION
ALL SITES ACCESS
SEARCH
Search ...
ABOUT ITA ?
MEMBERS & LINKS
PUBLICATIONS
FUTURE EVENTS
WG & COMMITTEES
PRESS ROOM
Working Groups
ITAtech
ITACUS
ITA-CET
ITA-COSUF
Young Members
WG & COMMITTEES
We have many activities, divided into:
22 Working groups
4 Committees
Young Members
Navigation
Working Groups
ITAtech
ITACUS
ITA-CET
ITA-COSUF
Young Members

ITA Supporting Organisations

- **The first committee of ITA**

  founded in 2005 GA Istanbul

- **Supported by PIARC**

  the World Road Association

- **Memorandum of Understanding** (PIARC/ITA):

  - ITA and PIARC activities are co-ordinated
  - PIARC represented in COSUF Steering Board
  - COSUF represented in PIARC Committee

    D.5 “Road Tunnel Operation”

ITA-COSUF

A joint initiative of 8 European research projects (FP5 / FP6)

Memorandum of Understanding, represented in Steering Board

ITA-COSUF – Strategic Positioning

- **Scope** — Covers all underground facilities
- **Members** — Authorities, consultants, academia, industry, contractors, operators, safety officers, etc.
- **Focus** — Underground safety & security

ITA-COSUF is THE platform for communication on operational safety & security

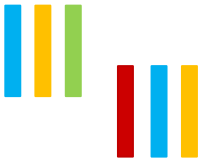
Main Objectives

- Exchange knowledge
- Facilitate cooperation
- Enhance R&D activities through combining national, European and international funding and support
- Promote Safety & Security through
  - Fostering innovation
  - Raising awareness of Safty & Security issues
  - Supporting the development of new regulations

Resulting activities

Activity Groups 1 2 3 4

- Workshops: - Internal: For members only
  - External: For the public



- Papers & Reports: - Position papers
  - Recommendations and Guidelines

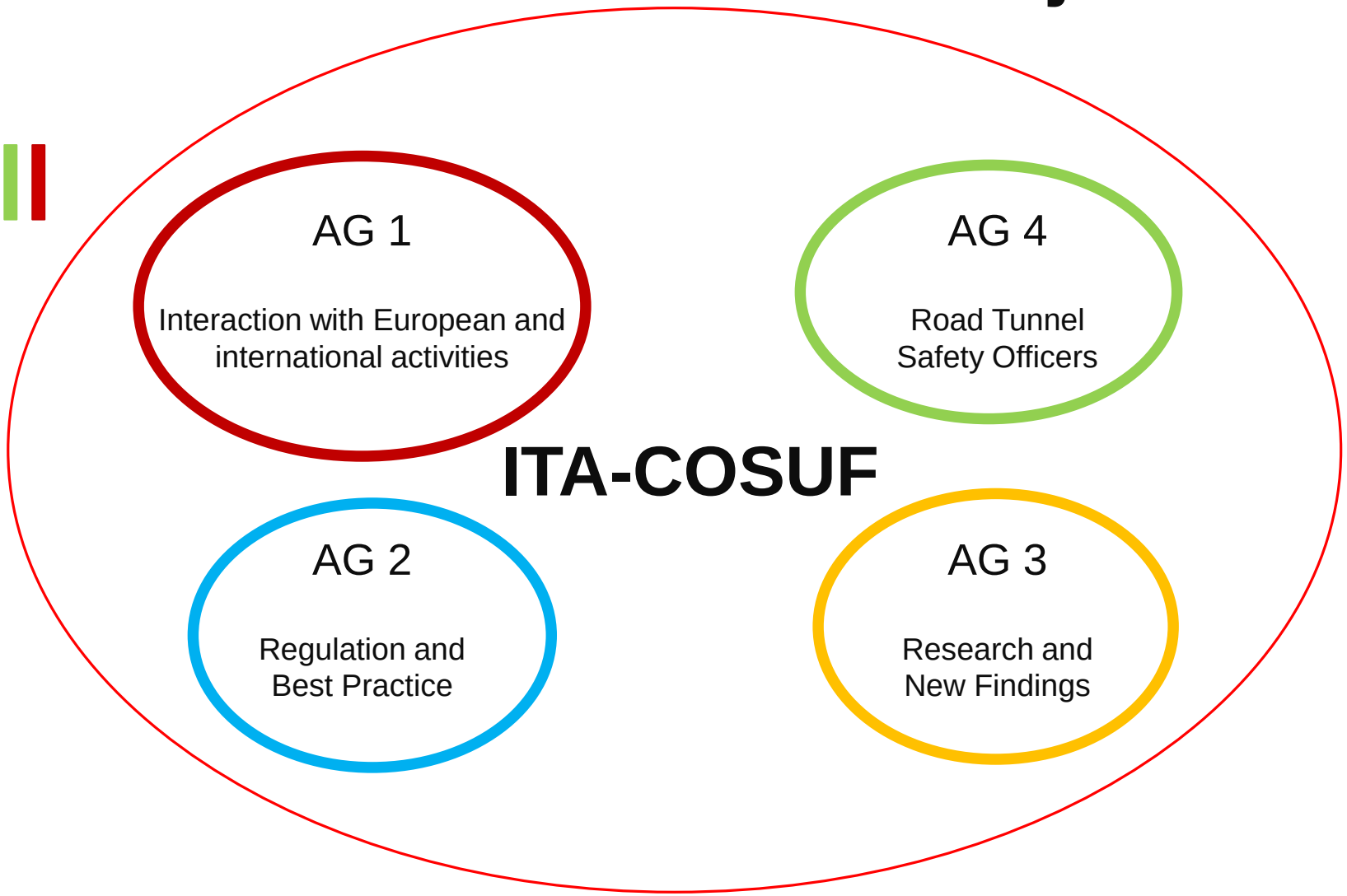
- Master Theses & Research Reports

- Award for young researchers

- Training with ITA-CET

- Endorsement of 3rd party events (related topics, non-commercial)

and how to achieve these objectives



ITA-COSUF – Activity Groups

- 4 AGs are open to all ITA-COSUF members
- 2 meetings per year at ITA-COSUF workshops

AG 1: Interaction with European and international activities

AG 2: Regulations and best practice

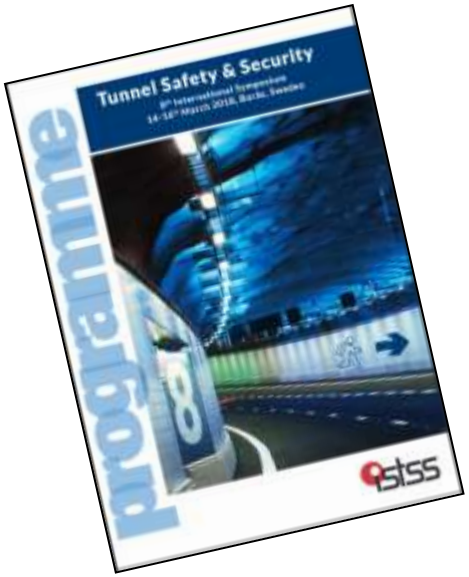
AG 3: Research and new findings

AG 4: Road Tunnel Safety Officers

More information: www.ita-cosuf.org

ITA-COSUF – Results

- Publications
- Workshops
- TSO Forums
- Endorsements



ITA-COSUF – Publications

- Engineering Methodology for Performance-Based Fire Safety Design of Underground Rail Systems

- Survey of Existing Regulations and Recognised Recommendations (on Operation and Safety of Road Tunnels)

- Best Practice Recommendations on Cross-Passage Design to Assure Safety in Rail and Metro Tunnels (in preparation)

ITA-COSUF – Private Workshops

- **One private workshop per year**
  (for members only)

Operating Road and Rail Tunnels in Helsinki

Presentations and visits of the operation center of the Finnish Transport Agency, the western extension of the Helsinki Metro, visit to a new metro station

ITA-COSUF – Public Workshops

AFTES Conference, Paris, 13th – 15th Nov. 2017

Workshop on “Operational Issues”

Round Table Discussion “Designing, Operating and Upgrading Complex Underground Hubs”

ITA-COSUF – TSO Forums

- 4th European Road Tunnel Safety Officers Forum (2016, Rotterdam)

- 5th European Road Tunnel Safety Officers Forum (2018, Madrid)

Other events endorsed by ITA-COSUF

ISTSS 2018, Boras, 14th-16th March 2018

International Symposium on Tunnel Safety and Security

PIARC International Conference on road tunnel operations and safety, Lyon, 3rd-5th October 2018

PIARC Technical Committee D.5 (Road Tunnel Operations)

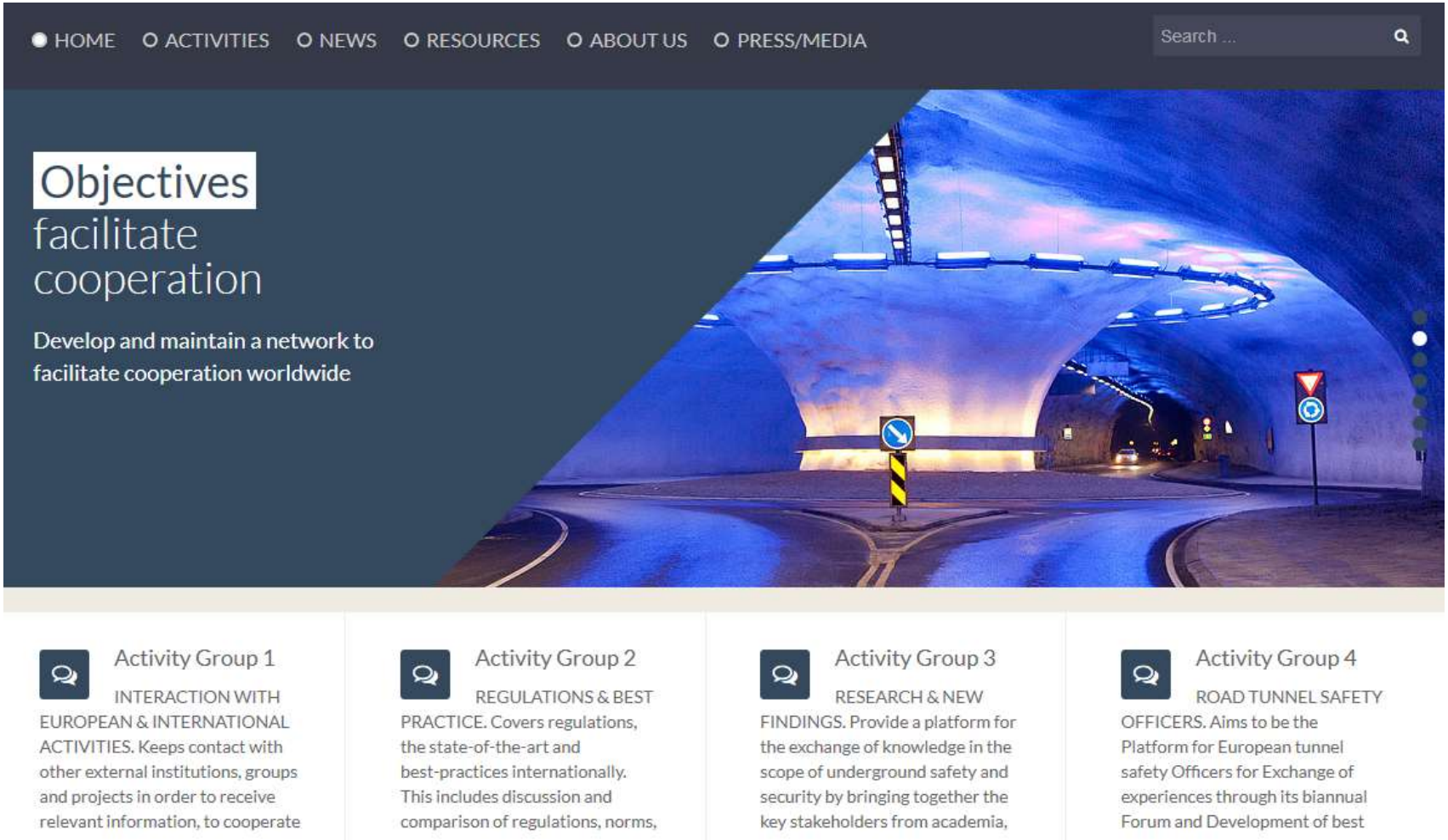
ITA-COSUF – Future Activities

Joint PIARC + COSUF Event

Conference on
"Road Tunnel Operations and Safety"

3rd – 5th October 2018, Lyon (FR)

ITA-COSUF – website: ita-cosuf.org



ITA-COSUF – Award

- **2015 Winner:** Karl Fridolf (28) for his thesis on “Evacuation in Rail Tunnels”
- **2016 Winner:** Wilson Rojas (26) for his thesis on “Ventilation Control in Tunnels using Helium-Technique in a small-scale models”
- **2017:** No thesis awarded
- **2018:** Call for theses open!

SUVEREN

„Sicherheit in unterirdischen städtischen Verkehrsbereichen bei Einsatz neuer Energieträger“

„Safety of New Energy Carrier Vehicles in urban underground transportation infrastructure“

SPONSORED BY THE

Federal Ministry of Education and Research

FKZ: 13N14393

SUVEREN

SUVEREN

New Energy Carriers – an issue for Railways, too?

SUVEREN

Consortium - Partners

- **BAM**

  Bundesanstalt für Materialforschung und -prüfung

- **FOGTEC**

  FOGTEC Brandschutz GmbH & Co. KG

- **STUVA**

  Studiengesellschaft für Tunnel und Verkehrsanlagen e.V.

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Consortium – Associated Partners

- **DB Station & Service AG**
- **Feuerwehr München**
- **CETU**

  Centre d´Etudes des Tunnels
- **INERIS**

  Institut national de l`environnement industriel et des risques

SUVEREN

Why SUVEREN?

1. New Energy Carrier Vehicles on the market

2. New Scenarios for safety assessment

3. Need for holistic safety assessment

1. New Energy Carrier Vehicles on the market

Acronym	Type of NEC Vehicle
BEV	Battery Electric Vehicles
CNG	Compressed Natural Gas Vehicles
FCEV	Hydrogen Fuel Cell (Electric) Vehicles
LPG	Liquified Petroleum Gas Vehicles
PHEV	Plug in Hybrid Electric Vehicles

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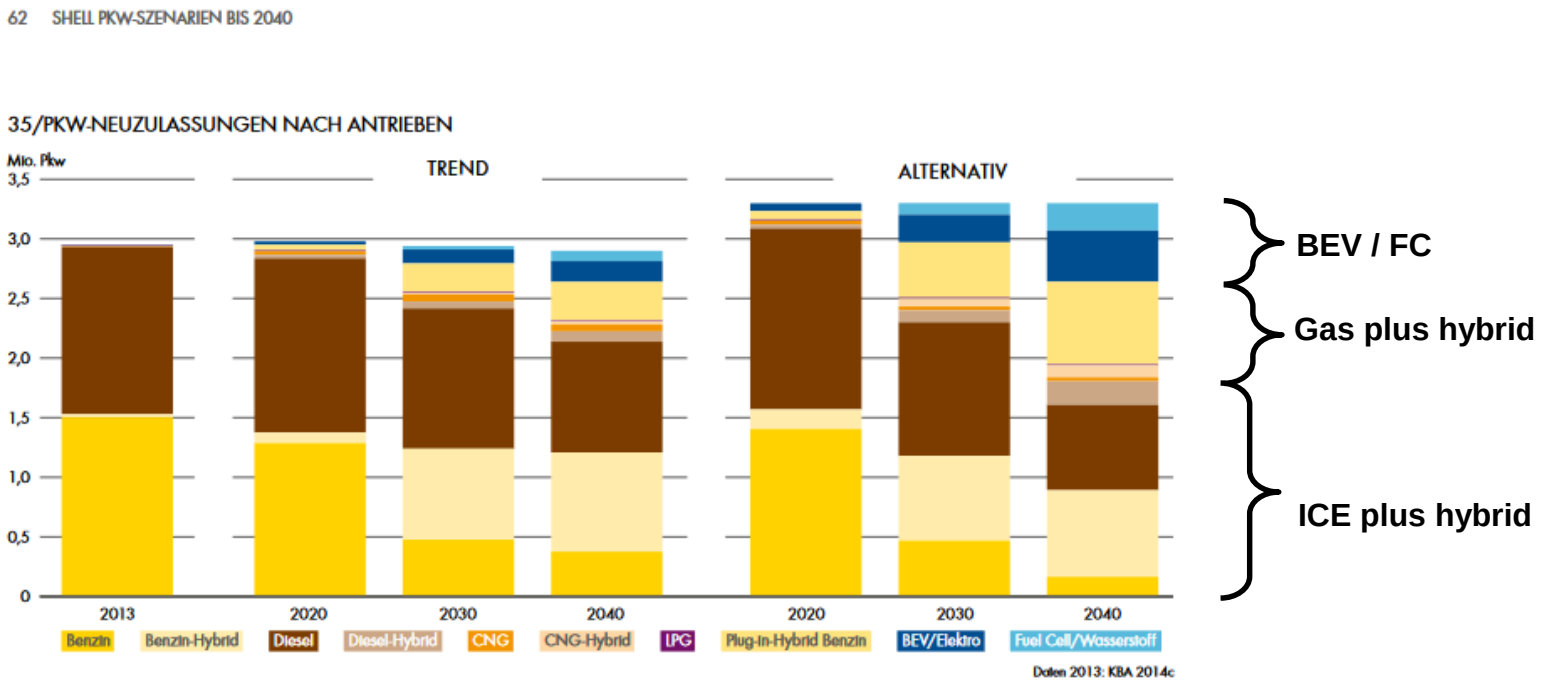
1. New Energy Carrier Vehicles on the market



1. NEC – What is changing or new?

	Name
Fuel	Diesel
	Petrol
Gas	Dimethyl Ether (DME)
	LPG (Propane)
	CNG/LNG (Methane)
	Hydrogen
Batteries	Lithium-Ion (Li-Po?)

Existing risks

New risks in terms of
- Toxic gases
- Fire
- Explosions

1. NEC – What is changing or new?

	Name	Rel. density	
Fuel	Diesel	7.0	
	Petrol	3.5	
Gas	Dimethyl Ether (DME)	1.6	↓
	LPG (Propane)	1.56	↓
	CNG/LNG (Methane)	0.6	↑
	Hydrogen	0.1	↑
Batteries	Lithium-Ion (Li-Po?)		

1. NEC – What is changing or new?

Operational apsects:

Flowing into sewer systems

Gas accumulation
- on the floor
- under the ceiling

Rel. density	
7.0	liquid
3.5	liquid
1.6	⬇
1.56	⬇
0.6	⬆
0.1	⬆

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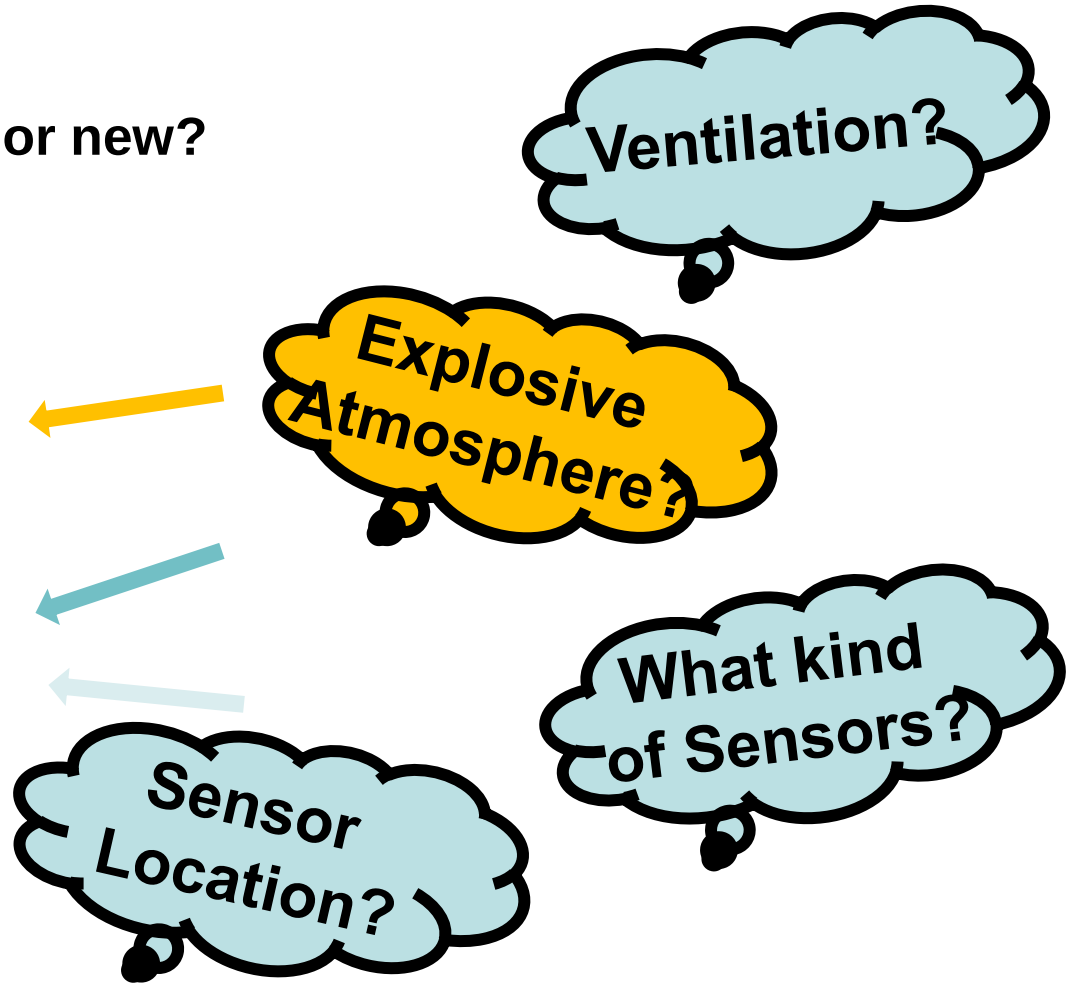

2. New Scenarios for safety assessment

(1) Battery Electric Vehicle

(2) Compressed Natural Gas Vehicle

(3) E-Bus at Terminal

(4) Storage of Batteries in enclosed spaces

SUVEREN

2. New Scenarios for safety assessment

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Subscenario 1.1: Lithium-Ion-Battery Fire
Subscenario 1.2: BEV Fire
Subscenario 1.3: BEV next to another car on fire
Subscenario 1.4: BEV on fire next to Fuel Cell vehicle

Subscenario 2.1: Collision and Fire
Subscenario 2.2: Collision, no Fire, Gas leakage
Subscenario 2.3: Collision and Fire, Gas leakage
Subscenario 2.4: Jet-flame and Water Mist

Subscenario 3.1: Bus Fire front part
Subscenario 3.2: Bus Fire rear part bottom
Subscenario 3.3: Bus Fire rear part top
Subscenario 3.4: Busses and different SOCs

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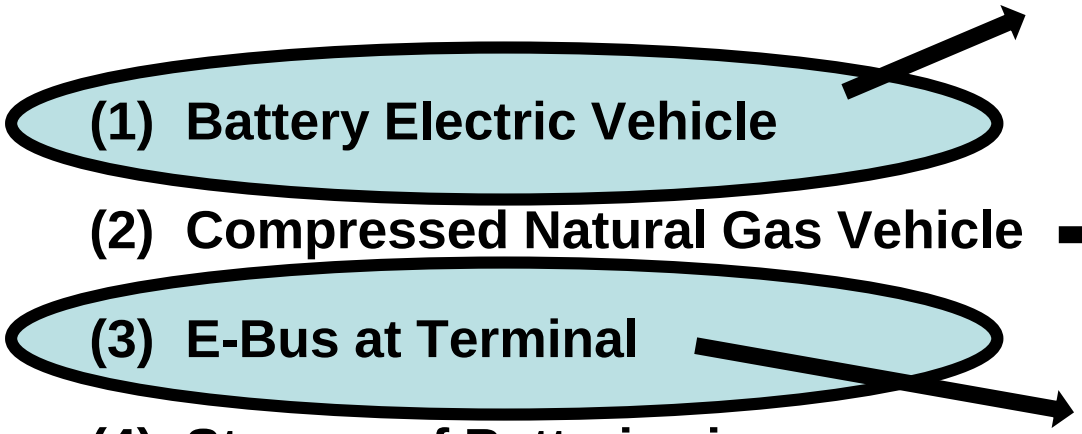
2. New Scenarios for safety assessment



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(1) Battery Electric Vehicle

Source: Website Fire Brigade Landeck, Austria

Situation awareness:

- **What kind of car?**
- **In case of a tunnel fire: How to identify the type of car?**
- **Impact on strategy?**

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(1) Battery Electric Vehicle

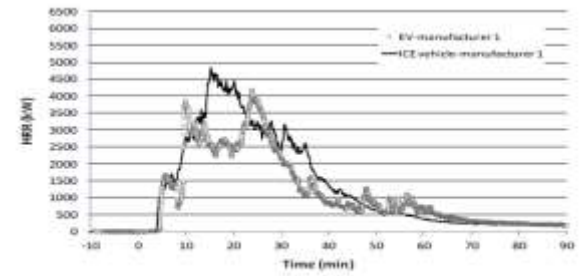

Figure 2 Comparison of the heat release rate vs. time for EV and analogous ICE vehicle tests for the car manufacturer 1.

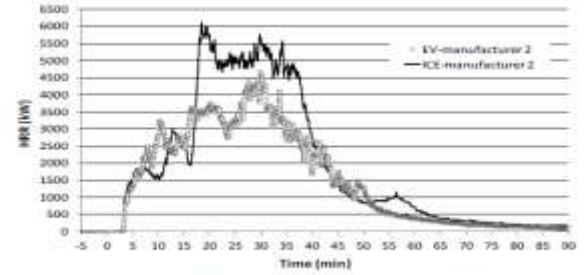

Figure 3 Comparison of the heat release rate vs. time for EV and analogous ICE vehicle tests for the car manufacturer 2.

Source: Website Fire Brigade Landeck, Austria

HRR comparison:

- **How big is the difference?**
- **How to measure HRR?**
- **Impact on**
  - **Users?**
  - **Tactics?**
  - **Structures?**

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(3) E-Bus at Terminal

- **Geometries of busses and infrastructure?**
- **Charging technology and sensor location?**

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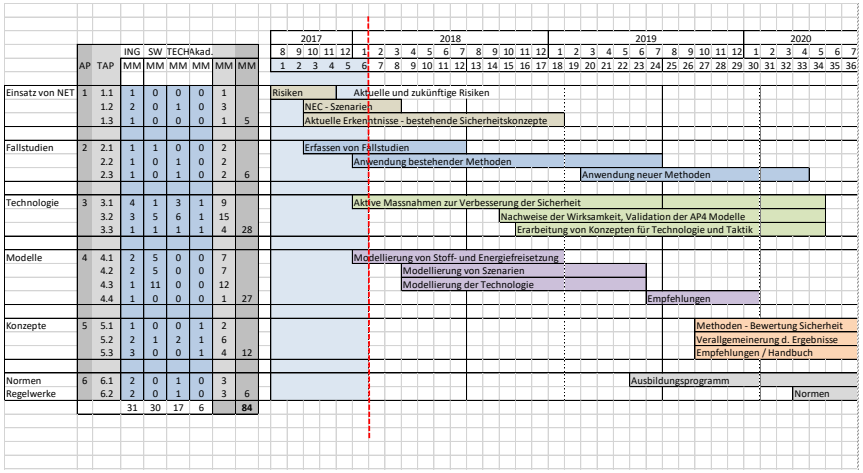
(3) E-Bus at Terminal

Case Study development with support of

- **Operational aspects**
- **Ventilation**
- **Charging and stored energy**
- **Sensors**
- **Fire protection systems**

3. Need for holistic safety assessment

- (1) NEC Risks
- (2) Case Studies
- (3) Technology (detection, mitigation)
- (4) 3D Modelling
- (5) Safety Concepts, Handbook
- (6) Standards, Trainings

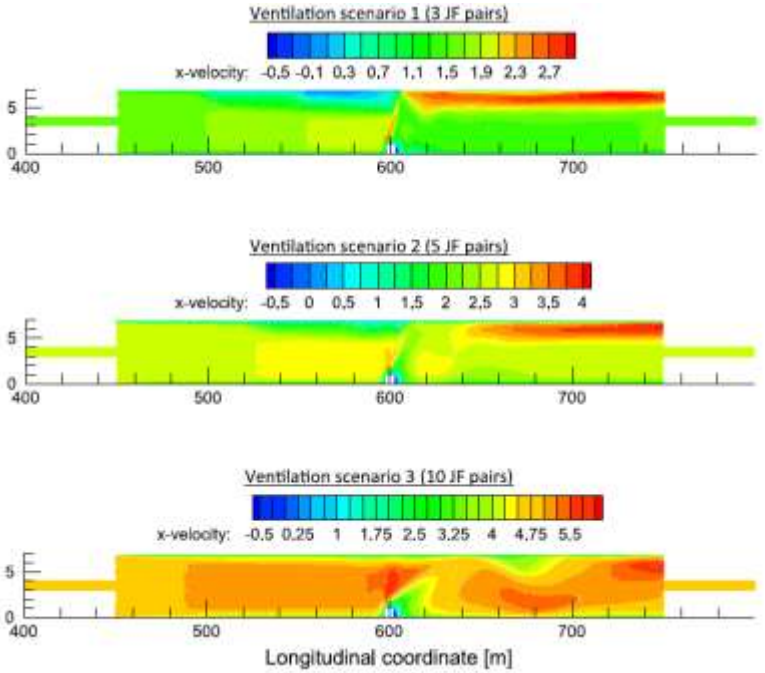


3. Need for holistic safety assessment

Modelling

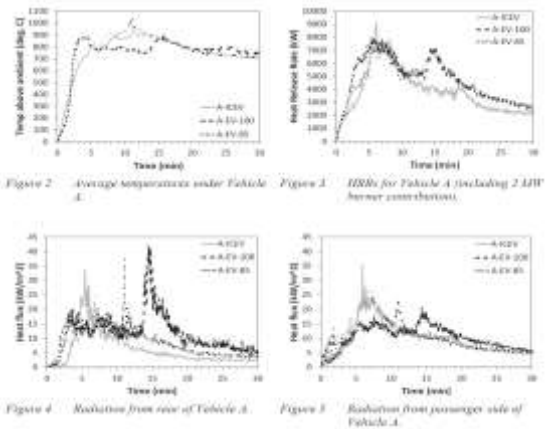
- **energy release of new energy carriers**
- **risk scenarios**
- **technologies to mitigate damages**

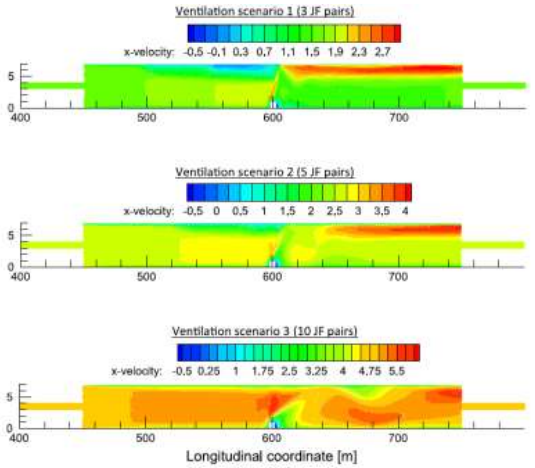
Recommendations for modelling new energy carrier risks



3. Need for holistic safety assessment

Validation of Model Simulations





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3. Need for holistic safety assessment

Drawing conclusions:

- **Discussion with Advisory Board**
- **ITA-COSUF Workshops on New Energy Carrier Vehicles Spring 2019 (Committee on Operational Safety of Underground Facilties)**
- **Discussion with European Tunnel Safety Officers (TSO Forum May 2018, Madrid)**

3. Need for holistic safety assessment

Drawing conclusions and contribute with

- **Guidelines**
- **Handbook for designers, owners, operators and first responders**

to the safe use of

New Energy Carrier Vehicles

ASTRA Research Project

Project title

E-mobility and tunnel safety

Partner

Amstein + Walthert, Zurich, Switzerland

Hagerbach Test Gallery, Flums, Switzerland

CETU - Centre d´Etudes des Tunnels

ASTRA Research Project

Topic

Reaction of energy storage devices in Battery Electric Vehicles

In case of

- **Fire**
- **Collission**
- **Shortcut**
- **Malfunction during charging**

ASTRA Research Project

Chemical products of Lithium-Ion-battery fire

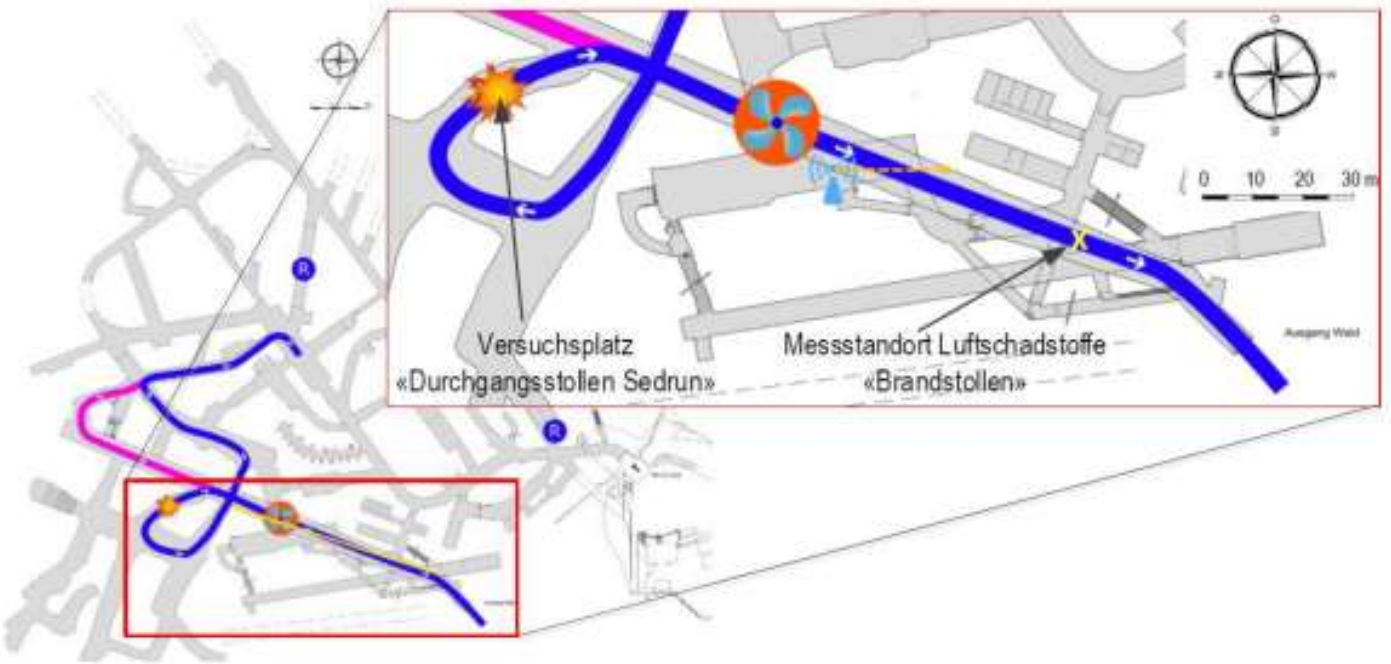
Fokus: Thermal Runaway

Mögliche Zersetzungsprodukte während eines Lithium-Ionen-Batteriebrandes

Stoff:	Formel:	Bemerkung:
Fluorwasserstoff	HF	toxisch
Phosphoroxidfluorid	POF3	
Phosphorsäure	H3PO4	
VOC		
Monophosphan	PH3	toxisch
Schwermetallaerosole	Li, Co, Mn	toxisch, persistent

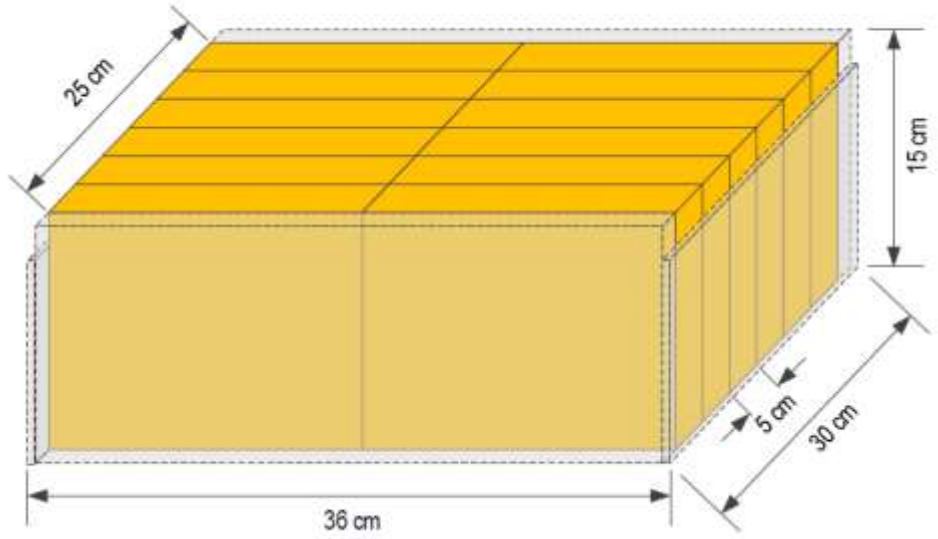
ASTRA Research Project

Versuchsort



ASTRA Research Project

Test series Battery Pack



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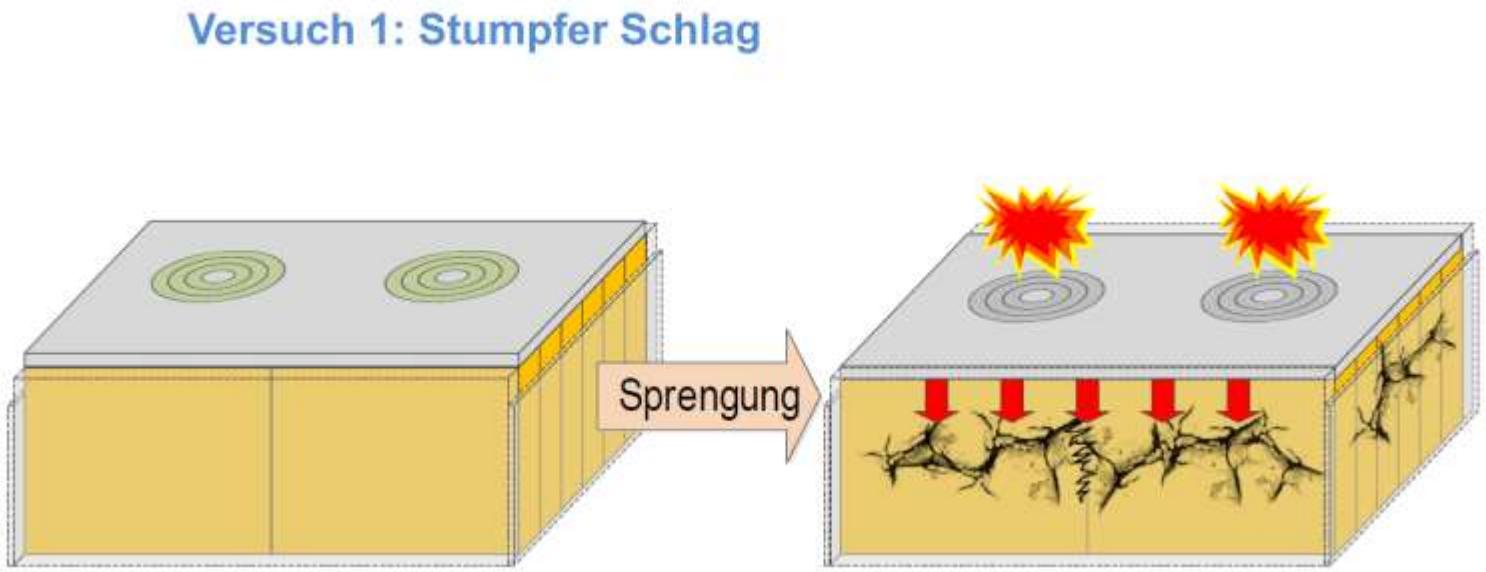

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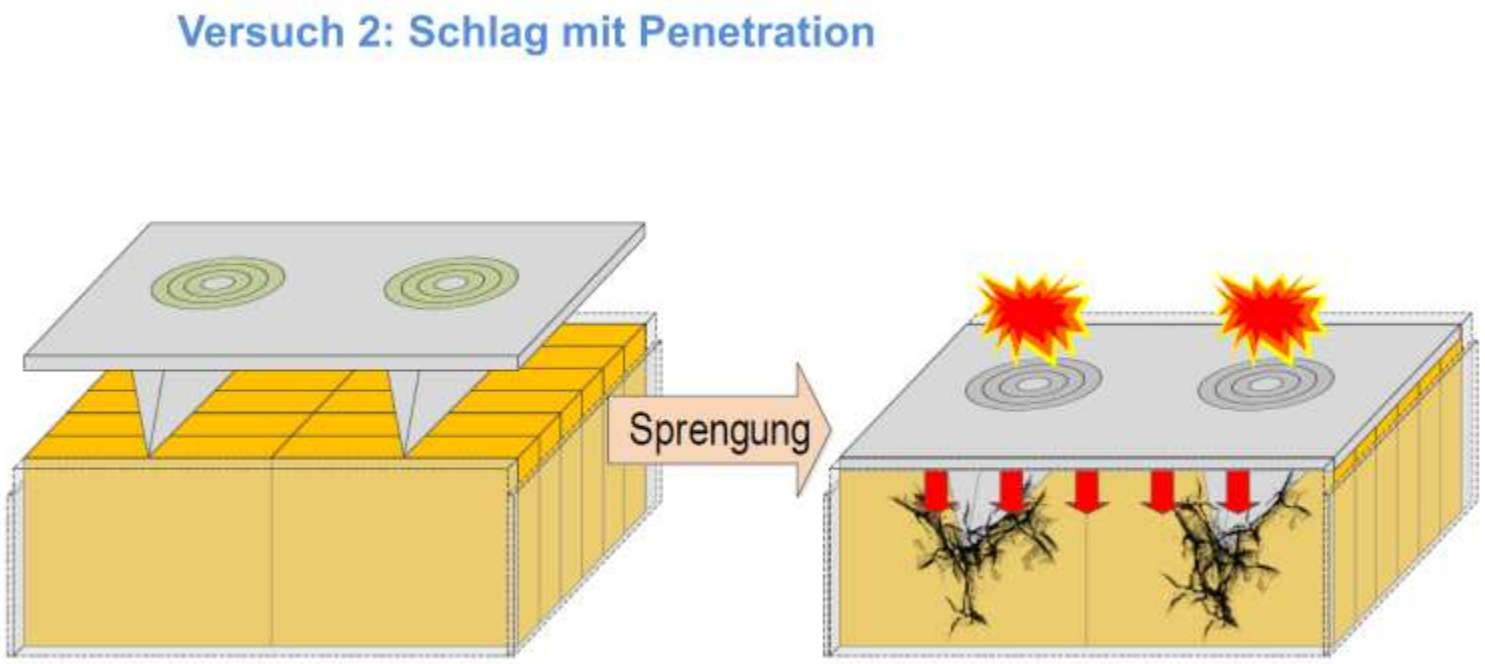

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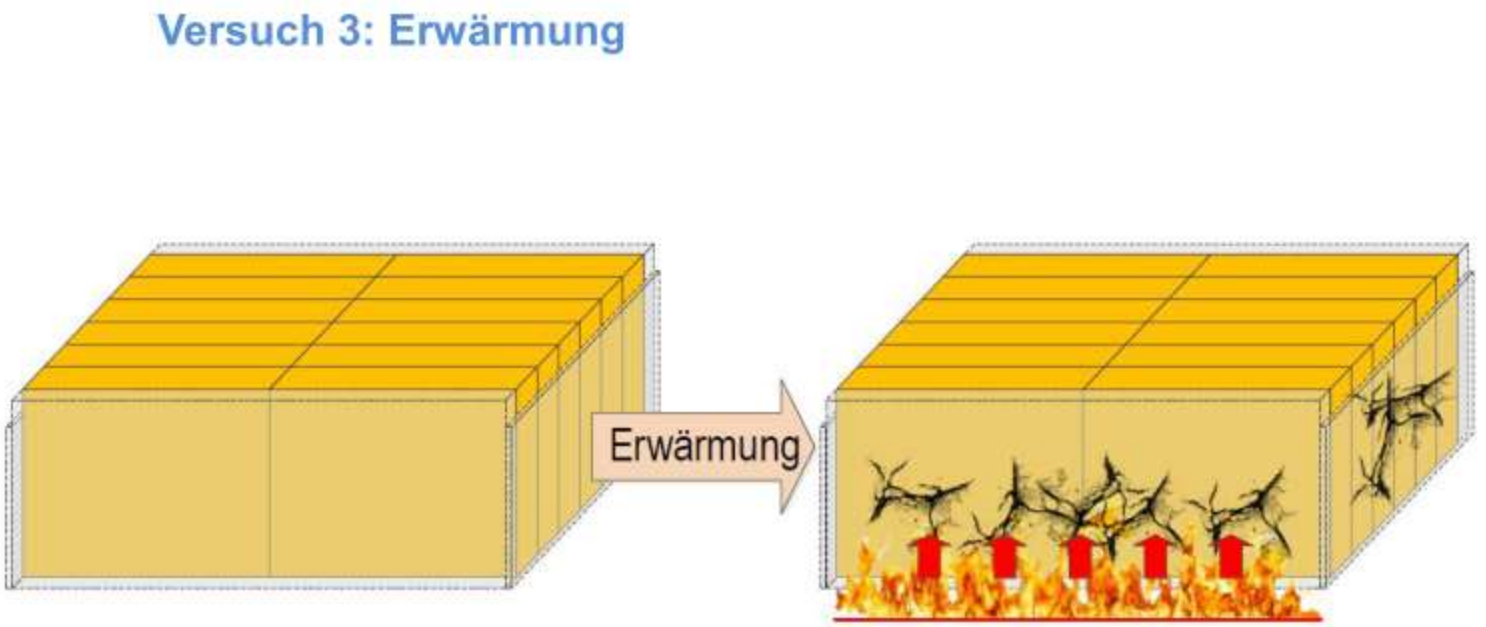

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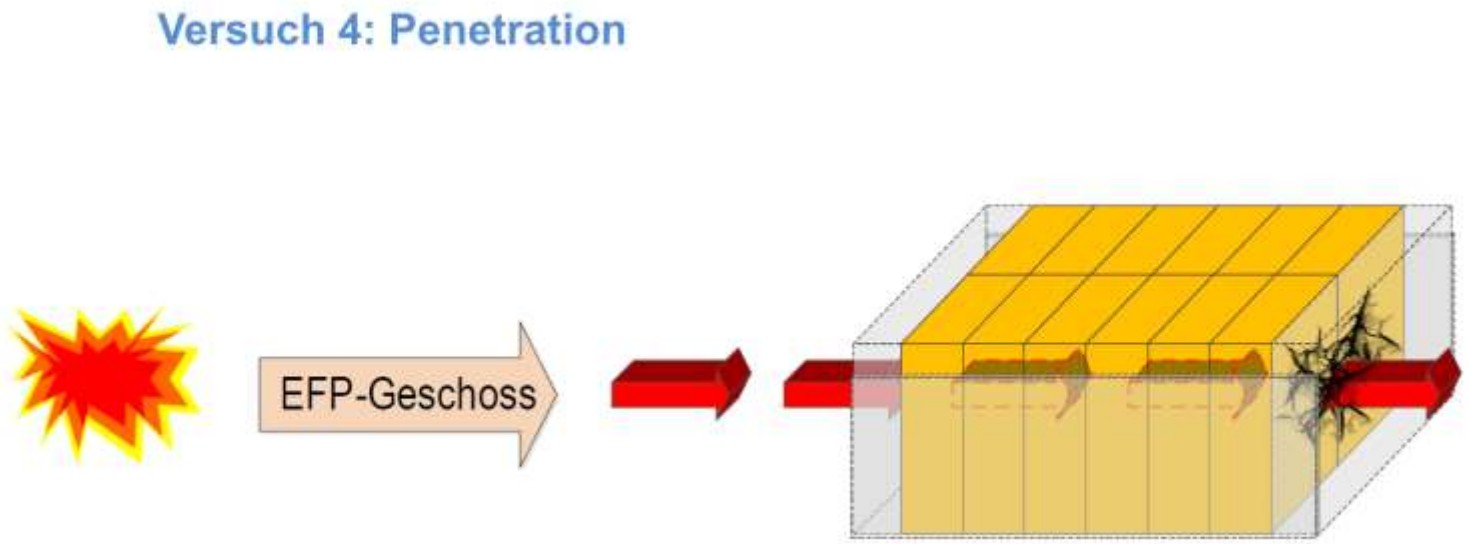

ASTRA Research Project

Results

***Tabelle 19** Fracht / Freisetzungsmengen*

Parameter	Versuch 1 («Keil»)	Versuch 2 («Platte»)	Versuch 3[11] («Durchschuss»)	Versuch 4 («Brand»)
PH_3 [g]	< 0.4	---	< 0.4	---
F^- als HF [g]	1.1	3.1	< 1	< 0.5
PO_4-P als H_3PO_4 [g]	< 1.5	< 1.5	11.3	< 1
Co [g]	457	567	190	364
Li [g]	107	124	42	92
Mn [g]	445	536	184	349
F^- Aerosol [g]	152	160	68	126
NO [g] [12]	0.8	1.1	0.1	1.5
NO_2 [g] [12]	0.4	0.2	0.2	0.6
CO [g] [12]	76	181	97	141
CO_2 [g] [12]	8'450	5'980	1'930	7'760
TVOC [g]	20	196	93	32
∑ Aromate [g]	1.6	8.6	3.2	3.1
Benzol [g]	1.1	3	1.6	1.7

Thank you very much for your kind attention

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