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**Webinar 2023/12/05**  
**FOGTEC Systems for**  
**Energy Storage Systems**

**MARKUS METZLER**  
Product Manager - NEC

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# FOGTEC ESS FIRE PROTECTION

## AGENDA

01

Battery Background

02

Research and Fire Tests

03

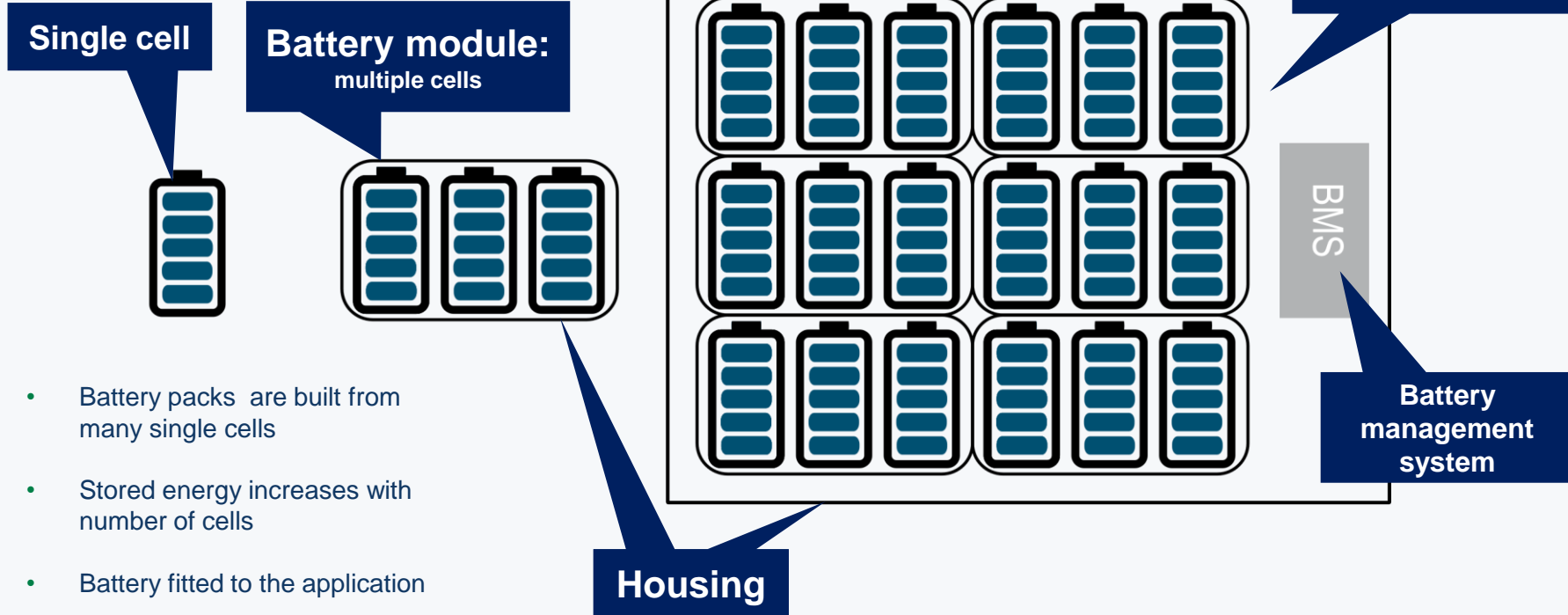
Firefighting ESS

04

Certificate and  
Summery

# BATTERY BACKGROUND

From Cell to Pack



- Battery packs are built from many single cells
- Stored energy increases with number of cells
- Battery fitted to the application

# BATTERY BACKGROUND

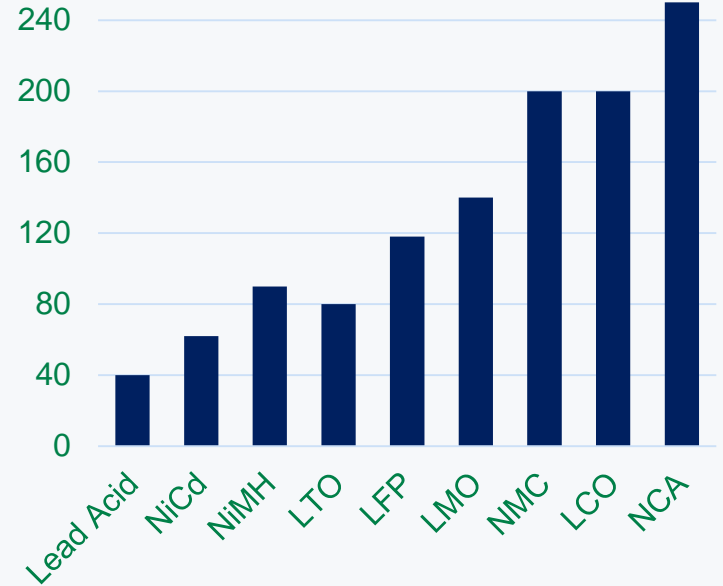
## Cell Chemistry of Secondary Batteries



*“Lithium-ion batteries are named after their active materials; the words are either written in full or abbreviated by their chemical symbols.”*  
 – battery university

The six most common types of secondary lithium-ion batteries:

LTO	Lithium Titanate ( $\text{Li}_2\text{TiO}_3$ )
LFP	Lithium Iron Phosphate ( $\text{LiFePO}_4$ )
LMO	Lithium Manganese Oxide ( $\text{LiMn}_2\text{O}_4$ )
NMC	Lithium Nickel Manganese Cobalt Oxide ( $\text{LiNiMnCoO}_2$ )
LCO	Lithium Cobalt Oxide ( $\text{LiCoO}_2$ )
NCA	Lithium Nickel Cobalt Aluminium Oxide ( $\text{LiNiCoAlO}_2$ )



Gravimetric Energy Density of different cell chemistries  
 Source: Dr. B. J. Züger: *Studie: Technologiefolgenabschätzung und Prüfrichtlinien von lithiumhaltigen Batterien*, 2017

# BATTERY BACKGROUND

## Background Battery Thermal runaway

- Thermal runaway starts at approx. 80 - 100 °C
- Thermal runaway is an **exothermal reaction**
- Resulting in propagation of thermal runaway and a rapid spread of fire
- Cells emit **toxic, flammable and explosive gases** (“Venting Gases”)
  - **up to 8,6 m<sup>3</sup>/kWh**
- Temperatures **over 1000 °C**
- Self-ignition is possible



Lithium-ion battery  
on fire

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# RESEARCH AND FIRE TESTS

Lithium-Ion Battery Research



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Federal Ministry  
of Education  
and Research

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

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# RESEARCH AND FIRE TESTS

SUVEREN Project (Part I-II)



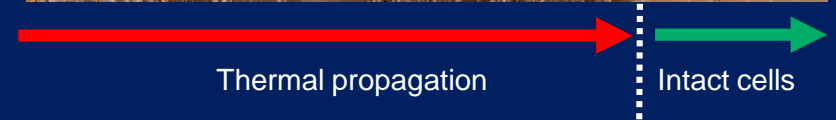
- Fundamental research on fire behavior
- Identification of risks and hazards
- Fire testing with batteries and reference fire loads
- Evaluation of different types of detection and extinguishing agents

# RESEARCH AND FIRE TESTS

Stopping Thermal Runaway Propagation

## Major findings from SUVEREN I-III

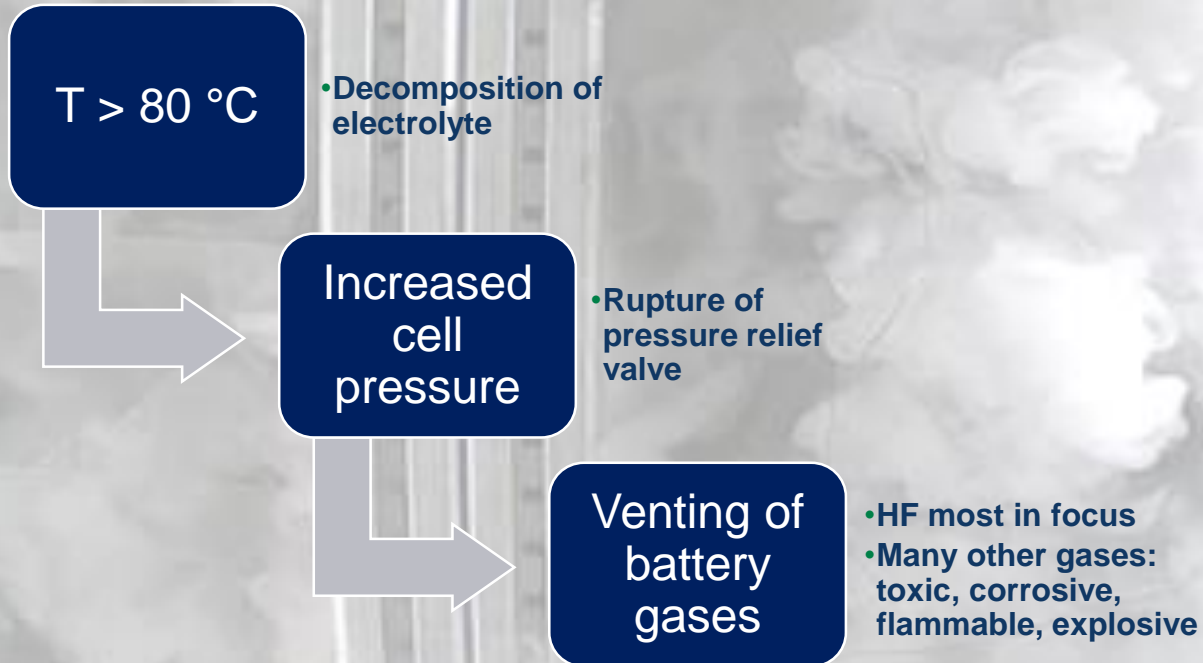
- **Cooling** of battery pack is essential to slow down or stop thermal runaway propagation
- Water is most efficient cooling agent
- 50% of all energy from a battery fire is caused by **combustion of electrolyte** gases
- Reduction of heat works against thermal runaway propagation and secondary fires





# RESEARCH AND FIRE TESTS

Hazards – Venting Gases



# RESEARCH AND FIRE TESTS

Projects based on SUVEREN

**SUVEREN**  **2use**



Supported by:



Federal Ministry  
for Economic Affairs  
and Climate Action

on the basis of a decision  
by the German Bundestag

**SUVEREN2use**

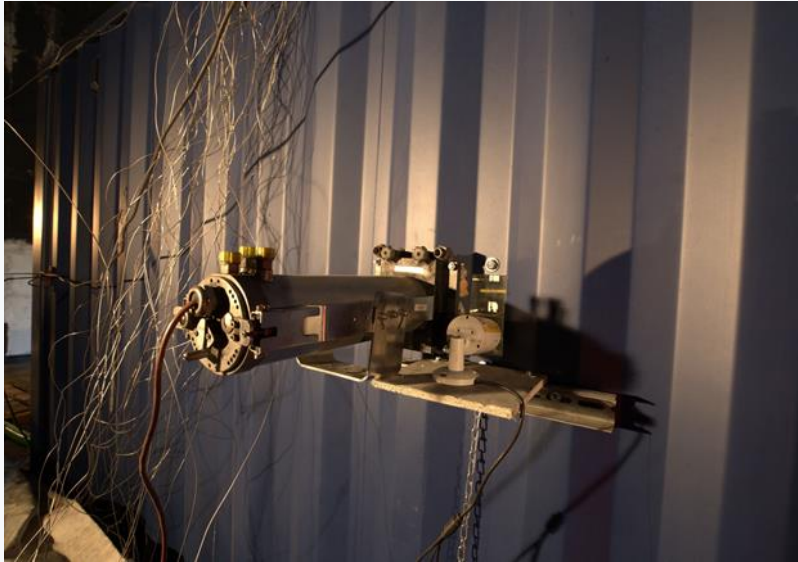
**SUVEREN**  **Storage**



**SUVEREN\_Storage**

# RESEARCH AND FIRE TESTS

Realistic Scenario – High Pressure Water Mist



IR-Camera and Thermocouples for Fire Test

- Rack structures for battery modules
- **Primary fire load:** Lithium-ion cells with representative energy content
- Closed battery modules
- **Target fire load:** Lithium-ion cells to evaluate fire spread
- Temperature sensors throughout container and in battery modules
- **Multiple detection systems**
- Gas analysis by **FTIR**



# RESEARCH AND FIRE TESTS

Realistic Scenario – High Pressure Water Mist

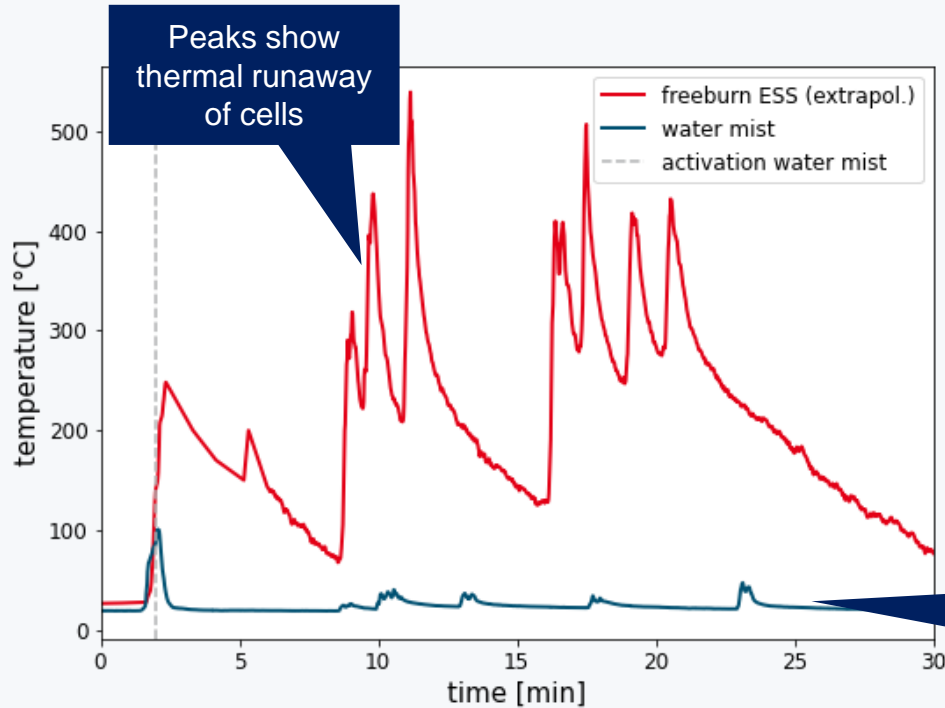
- **Efficient suppression** of Li-ion battery fire with high-pressure water mist
- Heat is continually absorbed
- Depending on safety objectives fire propagation is limited to
  - Slot
  - Rack
  - One side of the container
- Battery venting gases are partly washed out and vented through **explosion prevention openings (EPO)**



**Exhaust gases vented** through explosion prevention openings (EPO) during fire test with high-pressure water mist

# RESEARCH AND FIRE TESTS

Temperature curves from fire test



- Inerting effect only directly at the flame
- **Washing out (partly)** smoke gases and toxins
- Low water usage
- Works with **Explosion Prevention Opening**
- Safe for people: no pre-warning required

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# FIREFIGHTING ESS



Fire Protection for Stationary  
Energy Storage Systems (ESS)

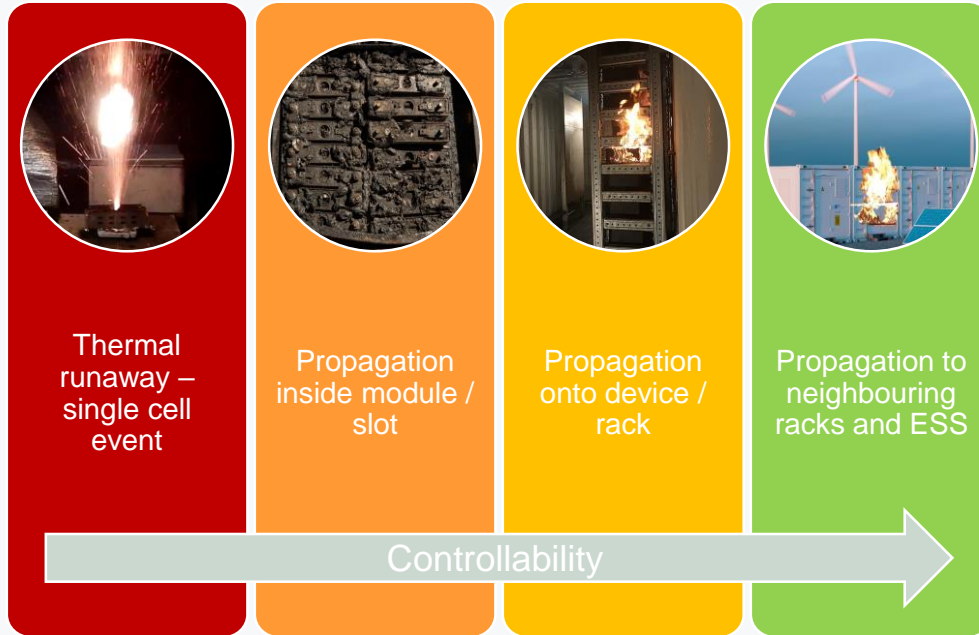
High Pressure Water Mist



*The Smarter Way Of Fire Fighting*

# FIREFIGHTING ESS

## Propagation



- Thermal runaway **inside a cell** cannot realistically be extinguished
- **Safety objectives** in order of importance
  1. Prevention of secondary fires
  2. Prevention of explosions
  3. Prevention of fire in device / rack
  4. Slowing down / interrupting complete battery thermal runaway propagation

# FIREFIGHTING ESS

Extinguishing agent comparison

## HPWM

- Highest cooling effect
- Minimal water usage
- Works with ventilation
- Safe for people

## Nitrogen

- Initial cooling effect by gas expansion
- Stops flames
- Sealed compartment required

## Aerosol

- Suppressing open flames
- Closed compartment required

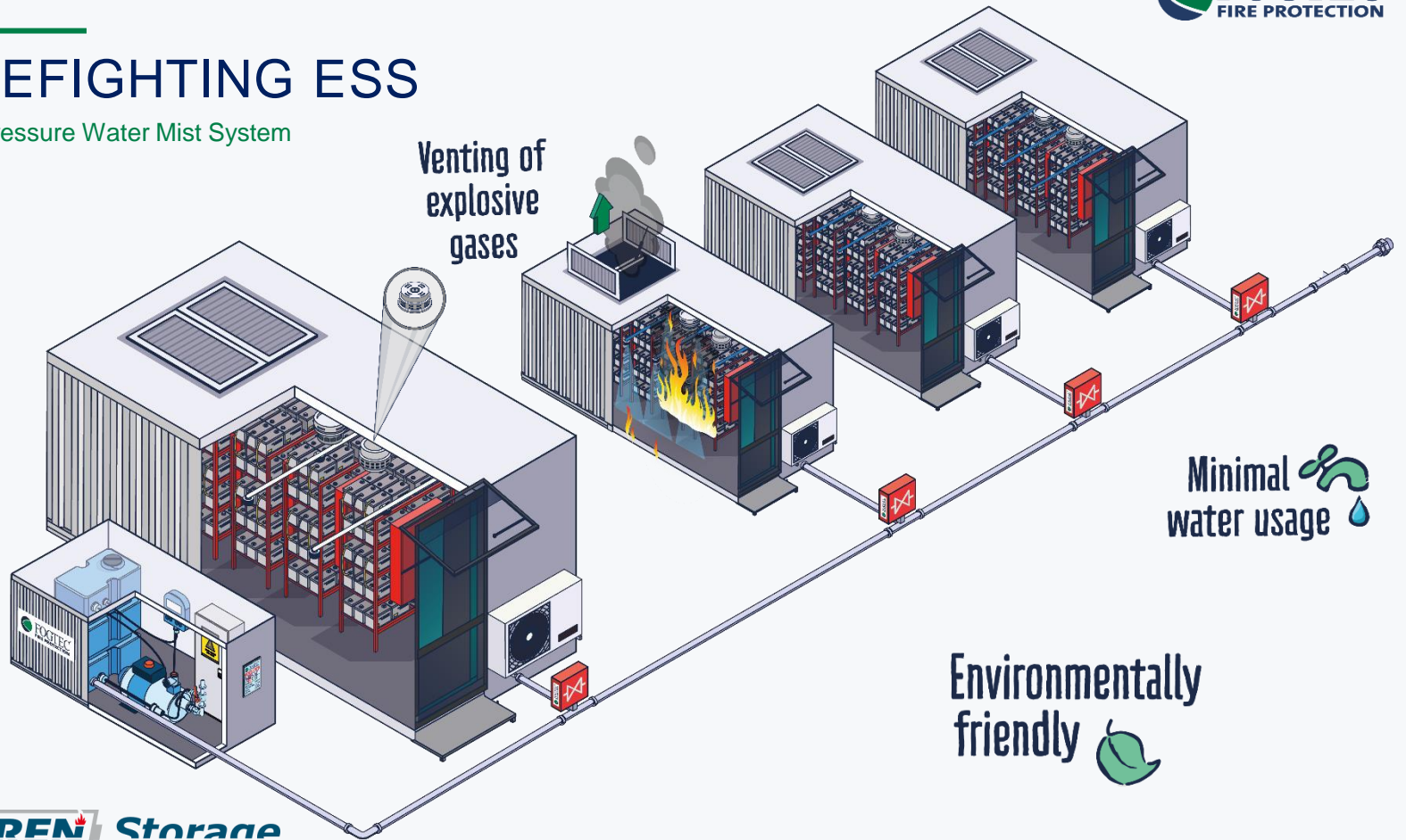
## NOVEC

- Decomposing at high temperatures
- Generating HF (highly corrosive)
- Sealed compartment required



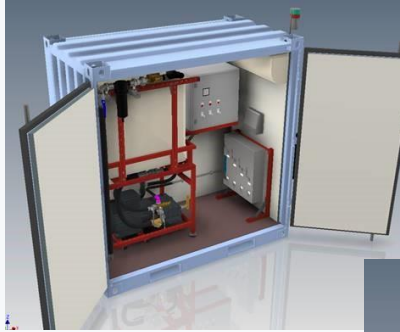
# FIREFIGHTING ESS

High-Pressure Water Mist System



# FIREFIGHTING ESS

High-Pressure Water Mist System



- Pump container with break tank and control unit
- Integrated section valves



- Special Nozzle Tube for object protection
- Filtration unit specially designed for Nozzle Tube



# CERTIFICATE AND SUMMARY



**IFAB** Certificate of Compliance **IFAB** Certificate of Compliance **IFAB**

## Certificate of Compliance

to EN 14972-1:2020

with fire tests under

EN ISO/IEC 17025:2017

for manufacturer

FOGTEC Brandschutz GmbH, Cologne, Germany

for the following Water Mist System

Product name: FOGTEC HPWM - LIB/ESS  
 System class: High pressure water mist fire suppression system  
 Applications: Energy storage systems with lithium-ion batteries in enclosures  
 Type of system: Deluge system with open nozzles  
 Under DIOM: Fire protection of energy storage containers with lithium-ion batteries

Fire test protocol applied:

as per EN 14972-1:2020, Annex A

Validity of this certificate: 01.08.2022 until 01.08.2027

The following annexes are integral part of this certificate:

- Annex I: DIOM with IFAB stamp (use by authorities having jurisdiction only)
- Annex II: Fire test report IFAB 2022/00298-FB2 dated 07.07.2022 (non-public)
- Annex III: EN ISO/IEC 17025:2017 certificate of IFAB
- Annex IV: ISO 9001:2015 certificate of manufacturer

**IMPORTANT NOTICE:**  
 The compliance with EN 14972-1:2020 of any installed system of the above type shall be checked by an independent third party having proven experience in water mist systems. This certificate only refers to the generic design of the system as documented to IFAB for the purpose of checking and the fire tests. The systems shall be documented as per EN 14972-1:2020, chapter 10 and inspected and maintained in line with EN 14972-1:2020, chapter 5.

Berlin, the 02.08.2022 IFAB GmbH

*Rajko Rohn*  
 Rajko Rohn  
 Managing Director & Certified Expert Fire Safety (TÜV)



Certificate number: 2022/016-Cert



Industrie Service

More Fire  
 Mehr Fortschritt

TÜV SÜD Industrie Service GmbH · Willystraße 30, Haus 1 · 13089 Berlin · Deutschland

**Bericht über die Begleitung und Begutachtung der Brandversuche in Faßberg**

**Auftraggeber:** Fogtec Brandschutz GmbH  
 Schanzstraße 19A  
 51063 Köln

**Prüfgegenstand:** Brandversuche für Energiespeicher Container System mit Lithium-Ionen-Batterien  
 Brandplatz IFAB GmbH  
 Bei DLR Trauen  
 Eugen-Silinger-Str. 50  
 29328 Faßberg

**Auftrag:** Auftrag lt. TÜV Angebot BER2022-0131

**Prüfungang:** Begleitung und Begutachtung der Brandversuche für Energiespeicher Container System mit Lithium-Ionen-Batterien bei Einsatz von einer Hochdruckwassernebelanlage (HDWN-Anlage)

**Zeitraum der Prüfung:** 24.05.2022

**Bearbeiter:** Dipl.-Ing. Michael Schulz

**Prüfergebnis (Kurzform):** Eine erfolgreiche Brandbekämpfung der Energiespeicher Container System mit Lithium-Ionen-Batterien mit der HDWN-Anlage wurde im Brandiszenario festgestellt.

Dipl.-Ing. Michael Schulz  
 Prüfsachverständiger  
 Niederlassung Berlin  
 Abteilung Elektro- und Gebäudetechnik

Datum: 18.08.2022

Unsere Zeichen:  
 IS-EG-BER/MS

TÜV Auftrags-Nr.: 3637626

Dieses Dokument besteht aus 7 Seiten.  
 Seite 1 von 7

Die ausstehenden Änderungen der Dokumenten und die Verwendung zu Weiterarbeiten bedürfen der schriftlichen Genehmigung der TÜV SÜD Industrie Service GmbH

Die Prüfobjekte bestehen aus ausschließlich auf die untersuchten Prüfgegenstände.

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 Willystraße 30, Haus 1  
 13089 Berlin  
 Deutschland



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# CERTIFICATE AND SUMMERY

High Pressure Water Mist and Nitrogen

- Battery fires **are controlled** or even limited to one battery module
- Cooling is essential: use of special **FOGTEC nozzles** for high-pressure water mist
- **Explosion Prevention Openings** are highly recommended to ensure safe access for fire brigade

# CERTIFICATE AND SUMMARY

Many different designs from ESS



- There are many different ESS designs
- We are happy to offer our support
  - In discussions with the customer
  - For the optimum design
  - ...





THANK YOU

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Product Manager - NEC



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www.FOGTEC.com