AEDIVE

LITHIUM BATTERIES SAFETY AND FIRE RISK PREVENTION.

Batteries play a key role in the energy transition from fossil fuels to cleaner sources.

The adoption of renewable energy sources, with the significant current and future development (especially in the use of the sun and wind) as well as the intermittency in the generation of these sources (neither always sunny nor windy), make the development of energy storage of vital importance.

Electrical energy can be easily produced, transported and used. However, for it to be stored, A proccess of transformation is needed. In a battery, this process consists of transforming electrical energy into chemical energy. This process is easily reversible to change from chemical energy to electrical energy again. In this sense, through reversible chemical reactions and the corresponding charge and discharge cycles, we manage to store it.

Bearing in mind the expected growth of the battery market, this document aims to address the risks and necessary preventive measures to avoid and mitigate battery fires.

The arrival of the electric vehicle has promoted debate on the difficulty of extinguishing lithium ion battery fires. However, data show that the number of fires in electric vehicles is currently lower than in combustion vehicles, based on the total number of existing vehicles. There are also a number of myths about the risk of battery fires that should be clarified from a technical and statistical point of view.

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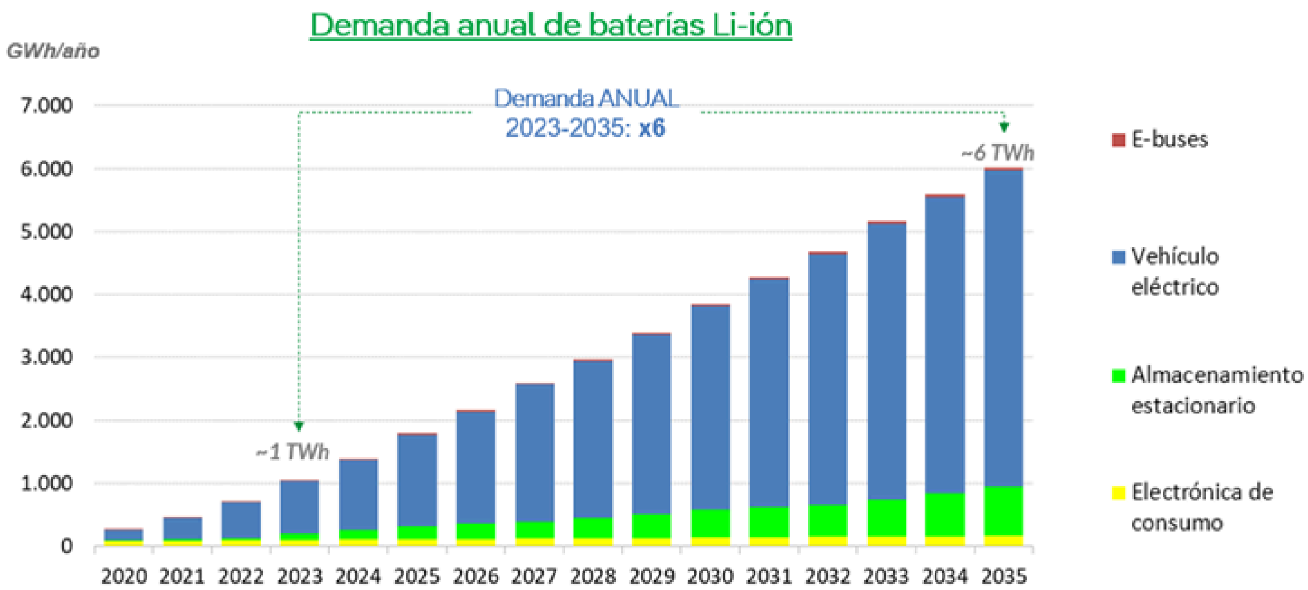
Relation with the electric vehicle.

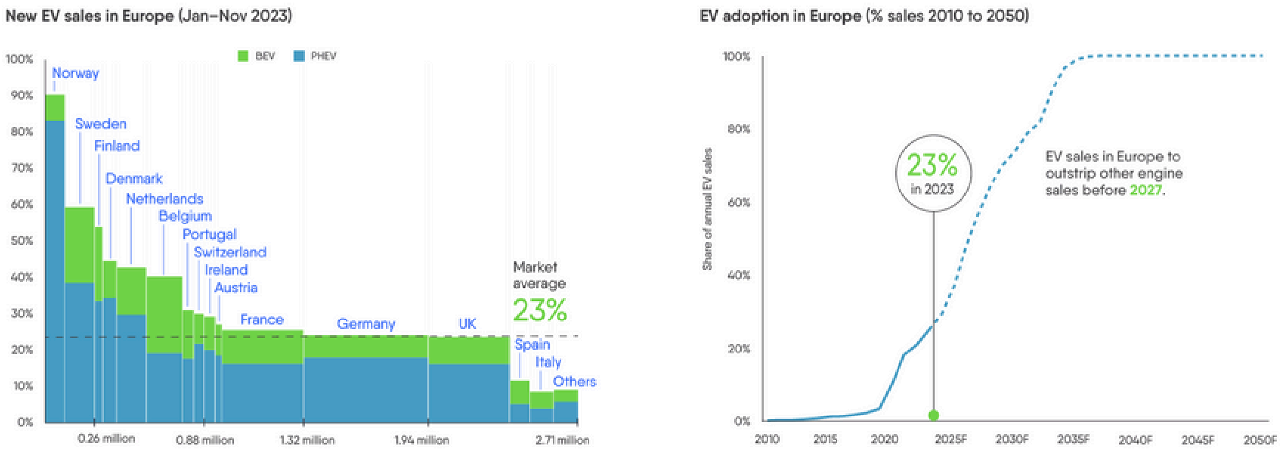
Lithium has a high electrochemical potential and can store large amounts of energy. Lithium-ion batteries are lightweight, highly efficient and increasingly cost-effective. Lithium ion is therefore today's leading storage technology. It is estimated that between 2023 and 2035, the annual demand for lithium-ion batteries will increase six-fold, mainly due to the growth of the electric vehicle market.



In Europe (the EU 27 plus the UK, Norway and Switzerland), battery EVs (BEVs) and plug-in hybrid EVs (PHEVs) accounted for more than one in five new cars sold in 2023. Between January and November, sales grew by 25% to account for 23% of all vehicle sales, up from just over 21% in 2022.

Relation with the electric vehicle.

A steep trajectory of EV adoption is outpacing predictions, with sales set to outstrip all other vehicles by 2027

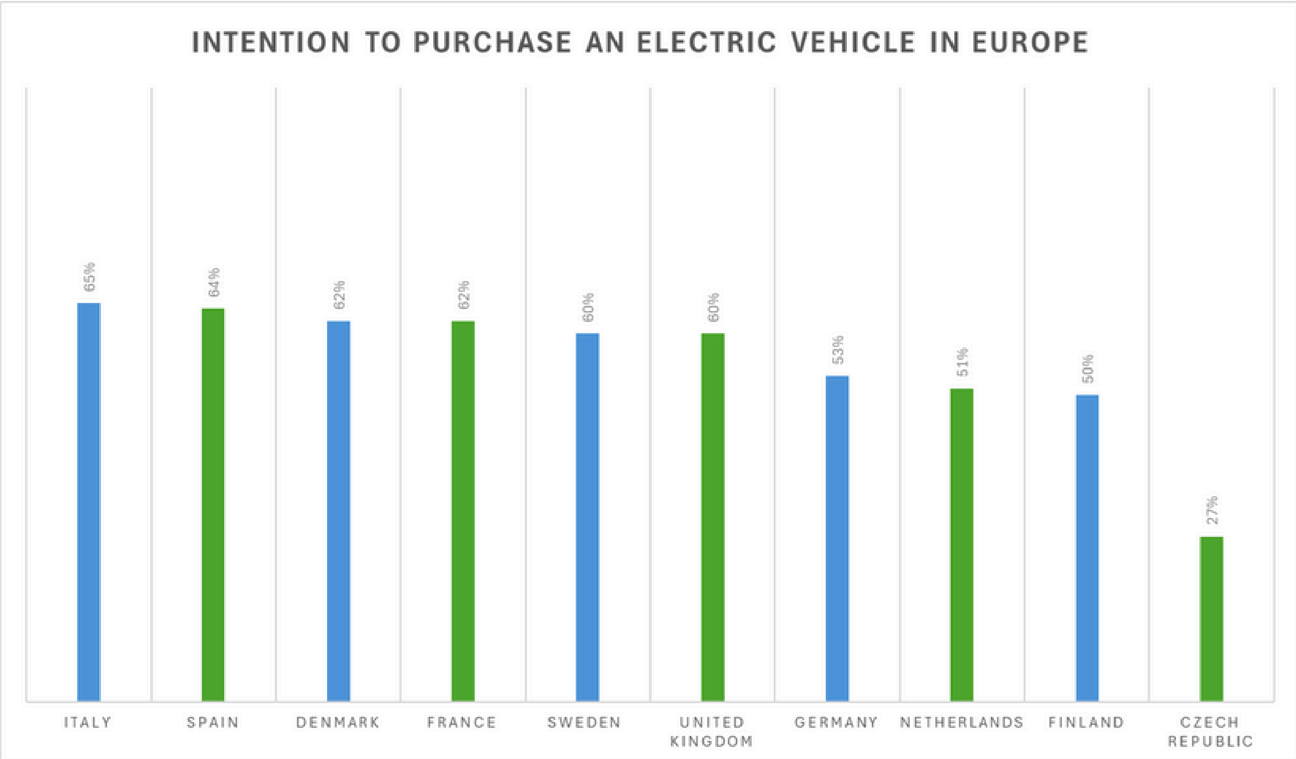


Source: EY Knowledge analysis of the European Automobile Manufacturers' Association (ACEA) data and the EY Mobility Lens Forecaster 2023.

According to this chart, the adoption rate of electric vehicles in Europe varies. We observe that the countries with the highest number of users interested in purchasing electric vehicles are Italy (65%), followed by Spain (64%), Denmark (62%), and France (62%).

The European country with the lowest intention to adopt electric vehicles is the Czech Republic (27%), as there is a greater interest in hybrid vehicles in this country.

Relation with the electric vehicle.



EY Mobility Consumer Index 2024

Globally, in 2023, there are a total of 40 million electric vehicles in use, representing a 55% increase compared to the previous year.

Technology is not standing still. The use of solid electrolyte, metal-air batteries, anode-free batteries, the emergence of sodium as an alternative to lithium (the relative abundance of this mineral and its low cost position it as the next revolution in energy storage), among others, marks the lines and trends of research.

Similarly, there are major technological advances in solid-state batteries, which use both solid electrodes and electrolytes and represent greater safety, higher density and lower temperatures compared to lithium batteries. In the coming years, we will experience technological changes with major advances in battery design, which will condition the autonomies and capacities of the electric vehicles of the future.

Recharging infrastructures will foreseeably also provide a response to heavy electric vehicles for the transport of people and goods, which will lead to an increase in the use of electric vehicles, in turn favouring the decarbonisation of the system.

There are various charging typologies for electric vehicles, each with its own uses and charging speeds (depending on the power).

slow or standard: this is the one that is carried out in alternating current with a power up to 3.7 kW.

semi-fast: it is the one that is carried out in alternating current with a power between 7.2 kW (single-phase) and 22 kW (three-phase).

fast: it is the one that is carried out in alternating current with a power of 44 kW (three-phase) or in direct current, from 50 kW of power.

ultrafast: We are seeing increasingly higher charging power in the charging infrastructure. From the battery perspective, thanks to technological advancements, electric vehicles can handle these high charging powers. Many models in Europe already support charging at 150 kW, and some even reach up to 400 kW.

Charging standards are evolving towards higher charging powers. The MCS standard, MegaWatt Charging System, will allow charging ranges above 1000 kW.

HOW DOES FAST CHARGING IMPACT ON BATTERIES?

Battery degradation in electric vehicles is influenced by various factors, including a parameter that results from the quotient of the charging power (kW) divided by the battery capacity (kWh). In other words, the higher the charging power and the smaller the battery size, the higher the risk of degradation.

Therefore, striking a balance between recharging speed and correct battery condition is essential to maximise the safe and lifespan of electric vehicle batteries. Battery management systems (BMS) are therefore evolving and aim not only to improve energy efficiency, but also to optimise charging safety and battery longevity. With ultra-fast recharging, the BMS battery management system regulates the charging power to prevent any overheating or incidents during the charging process.

Political momentum in Europe.

The energy transition in the current decade is one of the European Union's priorities. This technological revolution and the strong political support for the deployment of electric vehicles means that battery markets are growing worldwide.

There are several initiatives aimed at the specific development of these technologies. Examples are the 'European Battery Alliance (EBA 250)', the 'Clean Energy for All Europeans' package or the 'European Strategy for Energy System Integration'. All of these highlight the role of battery storage as one of the keys to the energy transition.

It should be noted that energy storage is included in the strategic lines of the State Plans for Scientific and Technical Research and Innovation (PEICTI) 2021-2023 (currently under development) and 2024-2027. These Plans are the Administration's main instrument for the development and achievement of the goals of the Spanish Science and Technology and Innovation Strategy 2021-2027.

Market mechanisms.

It is estimated that energy storage will need to increase six-fold by 2035. This large-scale need for storage systems presents significant market opportunities along the entire value chain, both in the electric mobility sector (in a very dominant way) and in the industrial or building sector, mainly linked to energy self-consumption and the decarbonisation of processes.

Along these lines, to foster the integration of storage into the energy market, Europe has introduced several mechanisms, including competitive tenders and subsidies. Research, development and innovation levers will be needed to accelerate the technological development necessary for the deployment of energy storage, as wel as deepen into technological leadership in renewable technologies.

Another mechanism for the promotion and implementation of energy storage technologies and projects is the creation of testbeds where pilot projects are developed in order to facilitate research and innovation of new storage technologies, systems and services, in a safe and conducive space, where stakeholders can experiment their innovative solutions without being subject to prevailing regulatory requirements.

Finally, it should be noted that there are both calls for European aid (H2020, Horizon Europe) and initiatives such as SET Plan, Mission Innovation or EBA250, which present opportunities as levers for technological development.

Technical capabilities.

The decarbonisation of the energy system implies a paradigm shift. The need for greater electrification, placing energy efficiency at the heart of the challenge; the shift in the role of the consumer to a more active one, digitalisation or the use of renewable energy... All of tme are necessary for the decarbonisation of energy and society, including sectors such as transport and industry.heart of the challenge;
the shift in the role of the consumer to a more active one

Electrochemical storage systems will play an important role in this regard. However, the paradigm shift in the energy sector and the expansion of conventional battery applications faces a number of challenges that are currently being addressed, including the following ones:

Safety: user perception of these new systems is fundamental to their expansion. One of the main challenges is to provide information on the safety of battery storage systems, as well as on the continuous technological evolution and improvements achieved in recent years in terms of risk control.

Regulatory and market changes: that allow viable business models for the integration of the systems into the grid without disturbing its development, improving the services that can be provided to consumers.

Technological: for the development of new batteries that improve technical and safety capabilities, with an increase in functionalities for each of the application sectors.

Environmental: to address the fact that the transition to green energy must be addressed at all stages of the value chain.

Value chain: reducing the impact of the use of critical materials and increasing the reusability and recyclability of energy storage systems.

Despite the fact that billions of personal devices (computers and mobile phones) continue to use lithium-ion batteries, the energy sector now accounts for more than 90% of the annual demand for this type of battery, thanks to improvements in performance (higher energy densities and longer lifespans) and a significant reduction in costs, estimated to have dropped by 90% since 2010.

Due to the availability and price of minerals, the market share of lithium iron phosphate (LFP) batteries is expected to increase significantly. LFP batteries contain lithium ions and do not contain nickel or cobalt, offering lower flammability and a longer lifespan. This type of battery provides greater stability due to its high iron content, although it initially has lower energy density. However, ongoing research and improvements are enabling their application in sectors such as the automotive industry.

It is worth highlighting the strong state commitment to improving technical capabilities with two driving initiatives:

Call for PERTE VEC grants that have supported the development of the electric vehicle value chain, with a significant impact on industrial and R&D&I projects related to the manufacturing of next-generation batteries.

Creation of the Iberian Energy Storage Research Centre (CIIAE) in Cáceres, a research centre focused exclusively on the field of storage and which contributes fundamental value to the R&D strategy in this area at European level.

This will place Spain in a strategic position in terms of green energy production, storage and distribution, strengthening public-private partnerships at national and international level.

In summary, Spain and Europe are making significant progress in expanding their battery storage capacities, supported by comprehensive policy frameworks, financial incentives and innovative market mechanisms. This expansion is crucial for the transition to a renewable energy-based grid and for achieving its long-term climate goals.

Intrinsic safety in the battery.

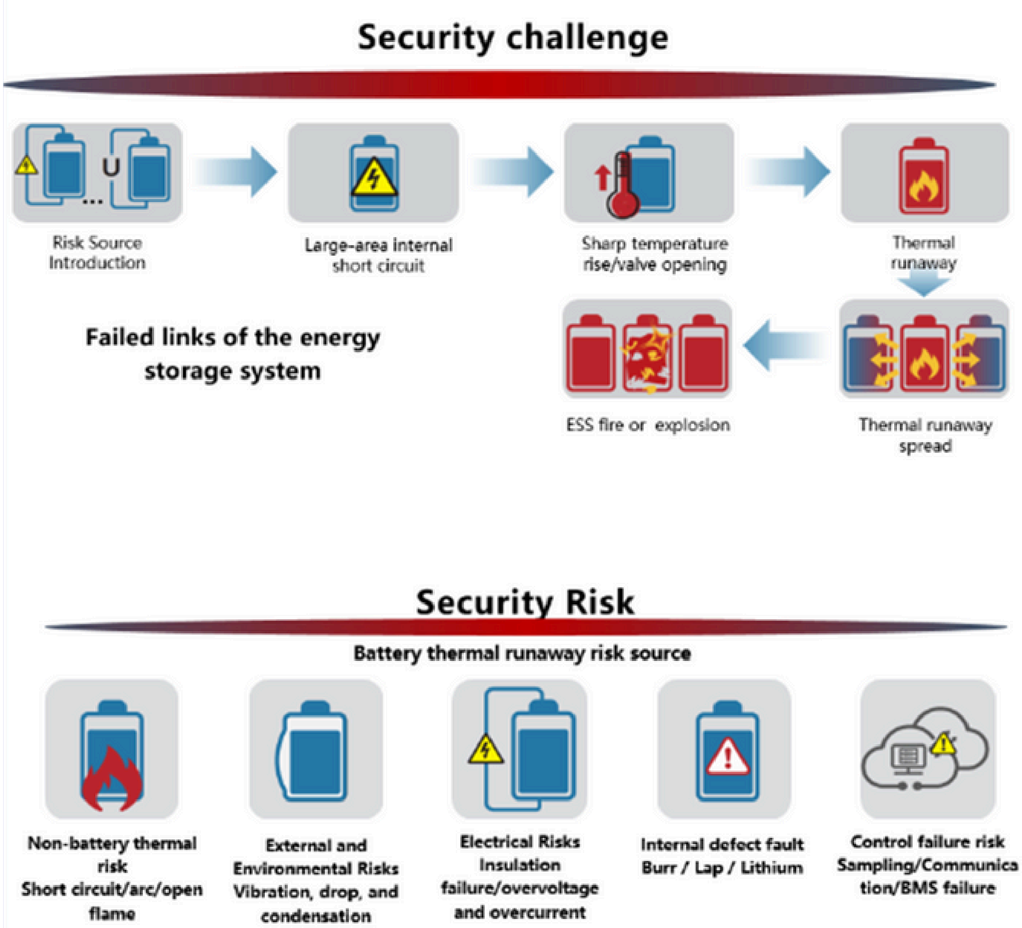
Due to the physico-chemical configuration of a lithium battery, exothermic reactions occur inside during operation. Installers and integrators of battery equipment must be aware of the associated risks and work with technologists to understand the particularities of each battery in terms of risk control.

The intrinsic safety of the battery is related to the safety of its component cells. The concept of safety must be incorporated from the beginning: in engineering, design and manufacturing, including the necessary controls throughout the process.

It is vitally important, in this sense, to certify the materials and tests on the cells and to comply with all the quality controls, thus avoiding failures.

Additionally, one of the key points in the design phase of a battery is focused on the monitoring systems for the correct early detection of any incident, thus facilitating action. Technologies such as real-time monitoring and management of the operating data of the battery cells, intelligent prediction of possible failures in the cells that make up the battery and prior warning of possible incidents based mainly on temperature monitoring are used.

In this way, data sampling, management and processing techniques are used. In addition, the system uses the 'sampling failure' detection algorithm to identify possible faults in the control system itself (BMS board, sensors, communications, etc.) and acts accordingly.



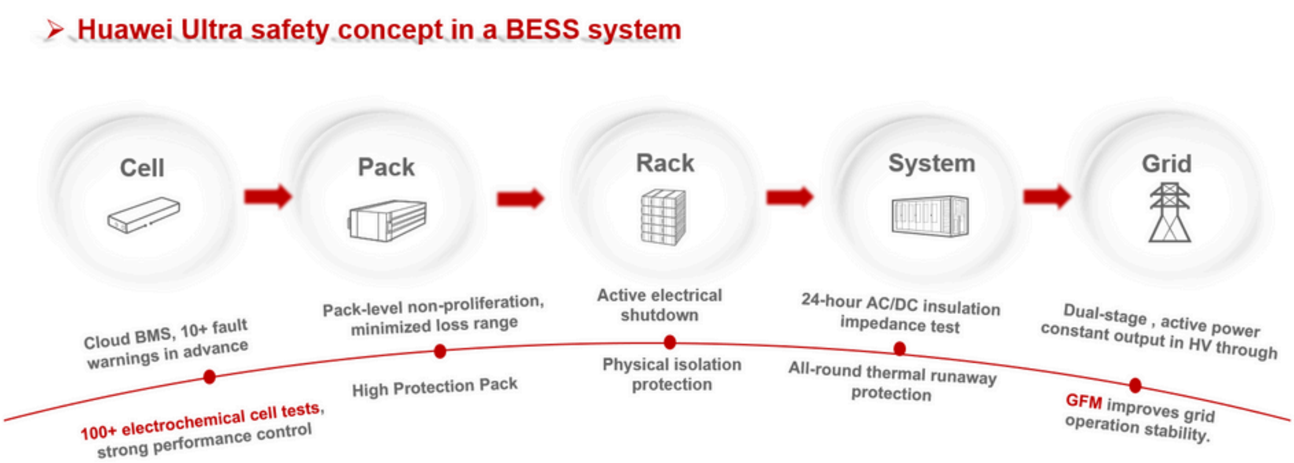
Integral analysis and prevention of sources of risk.

It is necessary to know the risks associated with the battery and to assess these risks. Many risks are already controlled by the proper design of the battery, in terms of materials and chemical configurations used, physical layout of components, electrical insulation elements, connections, etc. For example, batteries with a LFP (lithium iron phosphate) chemical configuration at the cathode have a high level of structural stability due to the presence of iron and phosphate, which greatly simplifies action in the event of a fire.

Several factors can trigger a fire in a battery or even cause "thermal runaway" (a chain reaction during a fire), including thermal risks unrelated to the battery, external and environmental risks, electrical risks, internal defects, and risks from control system failure.

All these factors can cause overheating and short circuits when the battery is in operation and must be considered by technologists, analyzing each risk individually and applying the appropriate control measures. For example, the control of electrical risk is managed through electrical insulation measures at various points, as well as automatic protection actions to disconnect systems that may present any anomaly.

For a comprehensive analysis and prevention in storage systems, it´s recommended that `E2E´(End-to-End) solutions focus on addressing the cell sum in its pack, rack, system, and grid connection in an integrated manner. This approach tackles the solution from the perspective of power electronics and digitalization (sensing, algorithms, AI, etc.), as these are fundamental to the solution and will enable us to properly assess, manage, and respond to risks or defects in these systems.



RISKS TO BE AWARE OF

Thermal hazards not related to the battery
+ Short-circuits at any point external to the battery
+ Heating / arcing at connection points
+ High external temperature
+ Other environmental hazards.
+ Vibration / shock / falls
+ Immersion in water / condensation / corrosion / dust

Incorrect operation

Electrical hazards
+ Short circuits in general
+ Insulation failure
+ Connection fault
+ Overvoltage

Internal battery defects
+ Poor finish
+ Overlapping between critical elements (poles, casings...)

Risks due to lack of control
+ Sampling failures/communication failures
+ BMS software / hardware failures

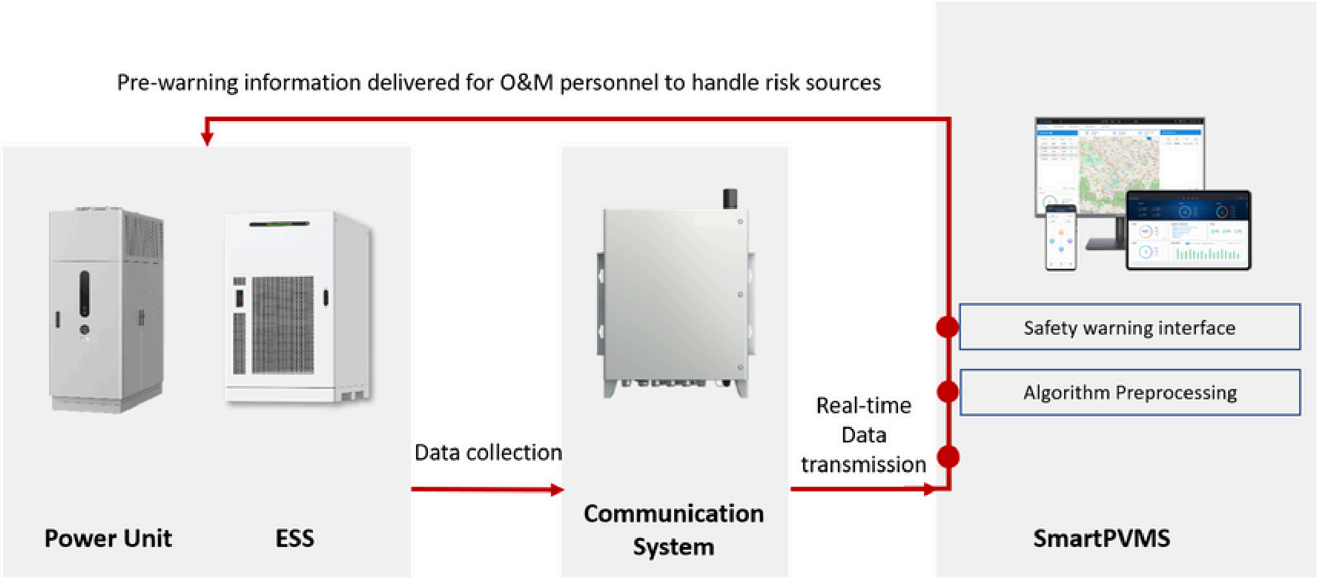
BMS systems. Rapid fault detection and isolation.

Monitoring of the cells is essential. The control of parameters such as current, voltage and temperature of some components is key to verify if they are out of the expected values. Knowing the cell status is the main basis of battery management. The battery control system must monitor key parameters and transmit this data for analysis, processing and action through safety devices and automatic disconnection.

In a battery, the origin of a fire and/or thermal runaway is located in a specific cell. From this start, the risk is that the fire will spread to the cell pack and then to adjacent cell packs, forming a chain reaction, leading to 'thermal runaway'. The risk can be minimised if the spread is quickly stopped. Therefore, the design of batteries provides for insulation systems in different parts, controlling the risk of propagation.

In this way, the protection system will act on different levels, with the appropriate design (both from a software and hardware point of view) to make the protection performance as precise and selective as possible.

All these functionalities are part of a BMS (Battery Management System), and there are very advanced solutions with greater digitalisation that are more secure thanks to their high level of sensorisation, connectivity, AI algorithms and even cloud services, for example, being able to detect a possible thermal overflow of a cell in advance.



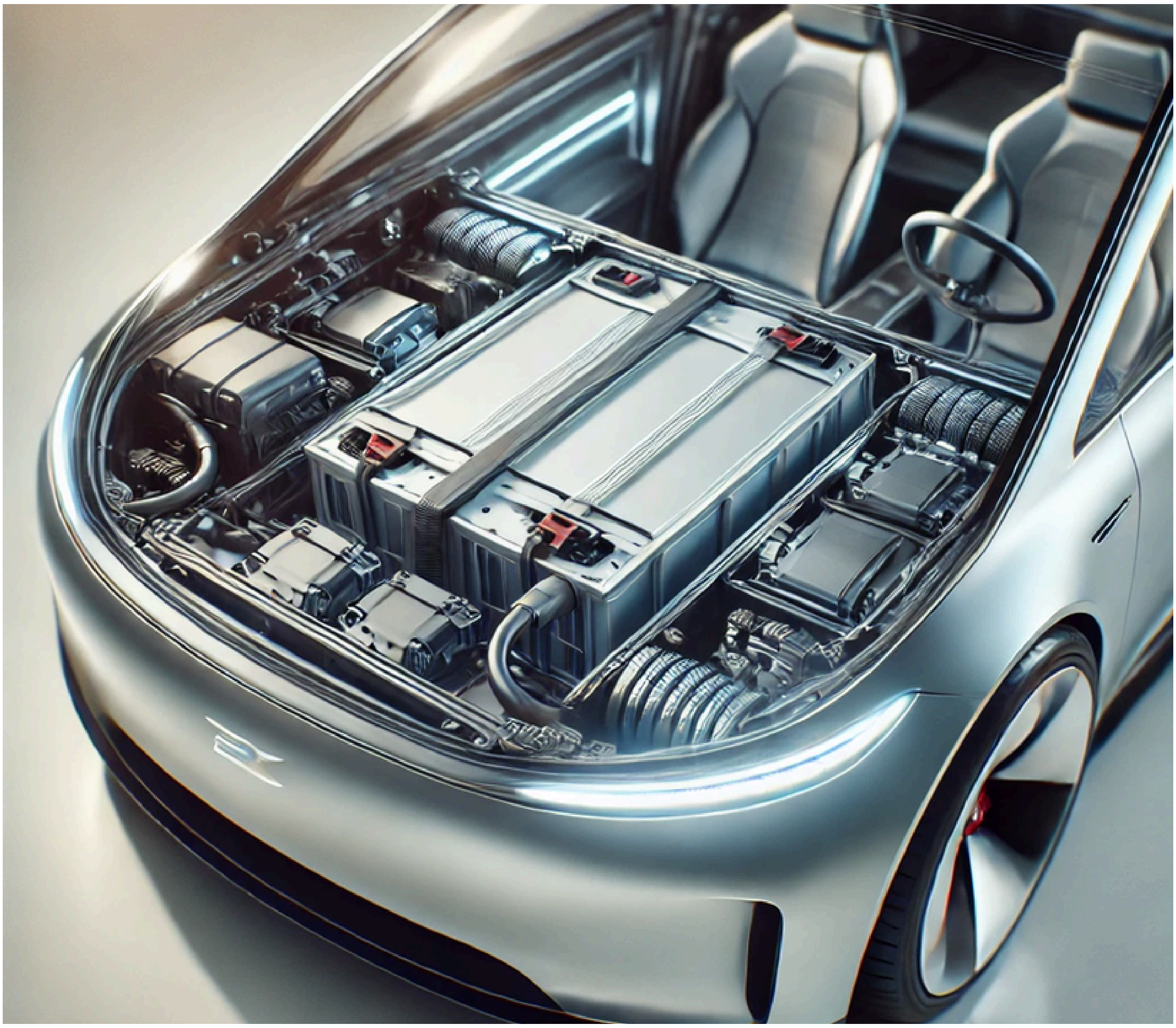
Connection monitoring.

The battery is connected so that electrical power flows to other components through cables and connecting devices.

All connection points and elements (cables, components...) are critical points to be monitored. A bad connection can cause local overheating of the wiring harnesses and even cause a fire.

Thermal monitoring of certain points can help prevent a failure that can lead to a fire.

It is essential that technologists qualify and certify installers with appropriate knowledge and training in these systems. In fact, some suppliers have certification processes in place to enable them to properly operate their solutions.



Fire fighting equipment [1/2].

TEAM	PROS	CONS
4 kg portable CO2 fire extinguisher.	Extinguishing the fire is possible in the early stages. It does not compromise the visibility of the area.	Limited battery cooling effect. Very limited effectiveness when fire is fully developed.
Portable dry powder fire extinguisher 9 kg.	Limits the growth and development of the fire, extinguishing it in its early stages. Most common fire fighting equipment at hand.	Difficulty in reaching to apply directly to the battery. Dust cloud may hinder operations due to poor visibility.
6-litre portable foam fire extinguisher.	Quite effective, as the liquid state helps to reach high temperature areas. Good cooling effect.	It is not very common in public spaces. Depending on the type of blowing agent, treatment is necessary from an environmental point of view environmental treatment.
Fire blanket 6x8 m	Good effectiveness for automotive fires in general, in particular for engine/passenger/hood compartment fires. The large size, typically 6 x 8 m, allows a safe approach as long as there is a surrounding perimeter free of flames. Contains flames in case of re-ignition. Reduces the amount of smoke in the space and does not generate additional vapour. Stabilising effect in case of fire/car without visibility. If the application can be done quickly, short exposure time of the extinguishing crew to heat/smoke. Good option, if the water system supply is not operational.	A major fire scenario may jeopardise the deployment of the blanket. As firefighters need to be close to the car to apply the blanket, it is not possible to do so with a fully developed fire, without prior extinguishing with water fully developed fire, without prior extinguishing with water. It picks up the smoke underneath at the time of application and can direct it to unwanted places. Requires manual activities on all sides of the fire scene, making tactical ventilation difficult. Requires personnel: 2 firefighters for application and in a developed fire condition, 2 additional protective hose operators if water protection is needed for application and return. Limitation with vans and vehicles of a certain height to deploy the blanket without problems.
IR Handheld Infrared Camera	Good for confirming the presence of fire or hot spots. It is necessary to follow the evolution of the fire behaviour by taking periodic measurements.	A busy hand is needed to carry the device. Additional equipment needs to be added which will reduce the comfort of the firefighter in a stressful situation.

Fire extinguishing equipment [2/2].

TEAM	PROS	CONS
Water lance water mist	Good fire protection/blocking efficiency. Can penetrate surfaces and be left inside enclosures for efficient extinguishing/cooling. Allows unidirectional entry and exit. Short exposure time of the extinguishing squad to heat/smoke.	Unlikely but dangerous possibility of battery pack penetration. No open/close valve on the nozzle. Depending on the situation and space, preparation of the hose may be difficult. If protection or water return is required, this must be provided by additional hose/equipment.
Manual wáter nozzle and hose	Versatile tool for manual fire extinguishing. Can provide remote extinguishing. Can offer heat protection to the brigade. Smaller hoses, e.g. 25 mm, can be easier to manoeuvre and pull between vehicles avoiding jamming. Allows approach and egress in one direction.	Depending on the situation and space, hose preparation may be difficult. Requires continuous presence of the fire brigade. At least 4 firefighters are needed for a dynamic firefighting strategy. Smaller hoses are lighter, but have a higher pressure drop.
Manifold and cooling nozzles	Allows one-way approach/exit and, if pushed with tool to be positioned pointing towards the battery, avoids close contact with the burning vehicle. Limited brigade exposure to heat/smoke. Allows participation in the developed fire stage. Allows localised approach Protective water shield provided by the device itself on entry. Can be used for cooling. Usable with different charging configurations. Suppresses energy bursts in case of re-ignition.	Availability of these items (manifold with hose quick coupling and nozzles pointing at the battery) is required for fire protection in a car. Will not extinguish fire inside the vehicle, as it is aimed directly at the battery. Requires 2 team members for application and in a developed fire state, 1 additional protective hose operator, if water protection is required on return. Depending on the situation and space, hose preparation may be difficult. Risk of reduced local visibility and fire evolution.

Environmental security.

Lithium batteries contain fluorinated electrolytes and transition metals, which are wastes that need to be treated. The proper management of damaged or end-of-life batteries and their correct recycling are essential to minimise their environmental impact, so waste management regulations must be followed at all times.

According to these rules, waste containing lithium is considered as hazardous waste. Royal Decree 27/2021 adds the national LER codes 16 06 07 and 20 01 42 for the identification of accumulators, cells or batteries containing lithium in any form.

When a lithium battery catches fire, chemical reactions are triggered which give rise to toxic and corrosive substances, which, although they may not be highly dangerous in small quantities, it is important to properly manage the risk in order to avoid environmental contamination.

Preventive measures or actions to be implemented can focus on the following different levels:

+ Proper storage, using specific safety containers for lithium batteries that can contain any leakage or fire.

+ To have early fire detection systems, together with a protection plan that includes in its scope both correct training of personnel and specific emergency procedures in the event of a lithium battery fire.

+ Containment of the water used for extinguishing, such as physical barriers, water drainage and storage systems, or specific absorbent materials for chemicals.

The implementation of these measures can help to minimise the risk of environmental pollution from the discharge of the substances originating from the fire by facilitating their collection, but it is important to remember that they must be treated as hazardous substances or waste by authorised managers for their neutralisation or elimination.

Safety during use.

As users of these types of electric devices, we can visually check the condition of the device (e.g., looking for any damage that might affect the battery), avoid exposing the device to high temperatures (especially during summer months), and always follow the technologist's instructions for daily operations, including battery charging.

Electric devices are equipped with safety elements responsible for "monitoring and verifying" correct operation. Knowing how to identify alarms and the information provided by safety systems, and contacting qualified personnel at any symptom of malfunction, is key to preventing incidents.

Regarding maintenance, it is essential to perform preventive maintenance according to the technologist’s recommendations, as well as corrective maintenance in response to any incidents.

Batteries, whether for stationary storage or electric mobility (cars, trucks, buses, motorcycles, personal mobility vehicles, etc.), consist of several "packs" made up of lithium-ion cells connected in series and parallel to achieve the appropriate voltage and current for their intended operation.

Batteries are equipped with safety systems, whose primary function is to prevent malfunction and, above all, to avoid a fire. Based on experience and after analyzing different types of vehicles and incidents, it is not recommended that the user themselves handle or modify any electronic components, and under no circumstances should they tamper with the battery. This task should only be carried out by qualified professionals with specific training for this activity.

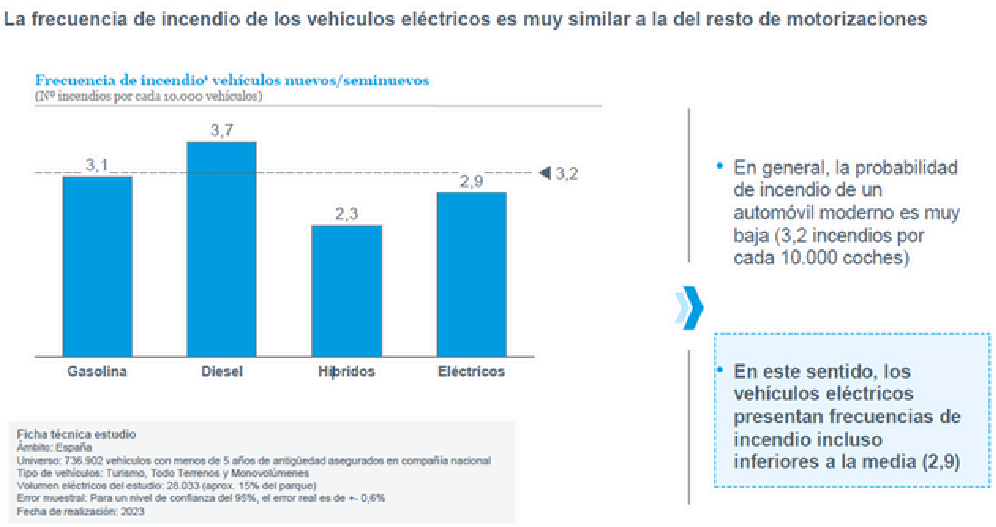
It is essential to be familiar with and adhere to regulations, both in terms of installation and maintenance. For example, current regulations often limit the installation of stationary storage systems indoors when dealing with large amounts of lithium; safety spaces and distances between systems are recommended. Once again, it is important to rely on properly trained professionals who are knowledgeable about and comply with the guidelines and manuals for storage systems.

We address some of the common misconceptions about fires in BEVs (Battery Electric Vehicles).

1 · "BEVs catch fire more frequently than ICEVs (Internal Combustion Engine Vehicles)"

Current statistics from Sweden indicate that the likelihood of a BEV catching fire is lower than that of a fire occurring in an Internal Combustion Engine Vehicle (ICEV). Some of the most frequent causes of vehicle fires include arson, overheated brakes, or the combination of flammable liquids and hot surfaces, as well as electrical failures in the engine compartment (Ahrens, 2020; Brzezinska et al., 2020; National Fire Data Center, 2018).

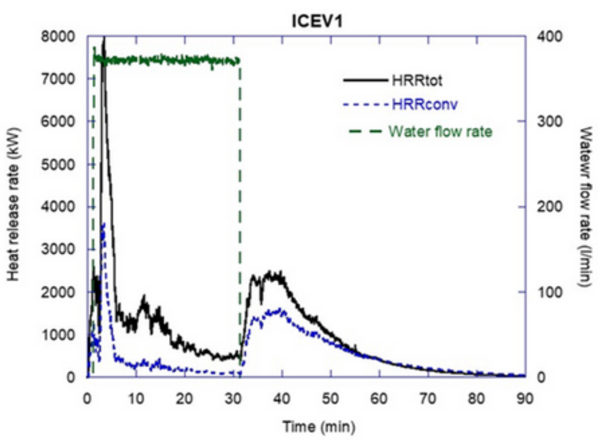
In Spain, the first sets of data are beginning to emerge.

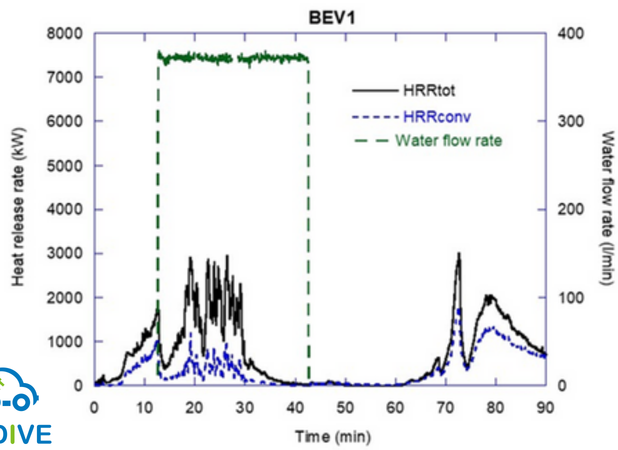


2 · "BEV fires are more intense than ICEV fires"

All modern vehicles carry a significant amount of chemical energy in the materials used, such as seats, cabin interiors, and tires, for example. Most of the chemical energy in an average-sized passenger car does not come from energy storage. The total heat release for modern BEVs and ICEVs ranges between 3.3 and 10 GJ and is independent of the propulsion energy (Willstrand et al., 2020).

Differences in Heat Release Rates in ICE vehicles and EVs





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3 · "Flames from BEV fires will spread faster than ICEV fires"

Different types of fuel have different fire spread behaviors. For example, liquid fuels like diesel or gasoline can spread fire through leaks and pool fires as the liquid fuel spills.

Pressurized gas storage and lithium-ion batteries may be prone to flames due to the expansion of gaseous elements, which could spread the fire. The risk needs to be addressed individually in each case.

4. "Battery fires cannot be extinguished, and a sprinkler-based suppression system cannot control BEV fires"

A fire originating from a battery requires the injection of water or another extinguishing agent directly into the battery area. This is relevant both for the extinguishing process itself and for cooling the materials.

However, it should be noted that the fire is most likely not to start in the battery. Therefore, rapid suppression of the fire at its source is crucial, as this will prevent the fire from spreading and potentially affecting the batteries of the BEVs. A compilation of existing data by Arvidson shows that early extinguishing actions also hinder fire spread, as they can extinguish the fire and cool nearby vehicles (Arvidson, 2022).

Data indicate that early activation of extinguishing measures will prevent the spread of the fire by suppressing it and cooling the surface where the vehicle is located, as well as nearby vehicles (Gehandler et al., 2022).

5. "BEV fires produce very high temperatures and can melt the chassis or bodywork"

The temperature of a fire will vary and depend on several factors, such as the fuel source, atmospheric pressure, adjacent temperatures, oxygen content, and more. There is no data suggesting that BEV fires reach higher temperatures than ICEV fires.

6. "You can suffer an electric shock while extinguishing a BEV with water"

Electric vehicles are equipped with advanced safety systems that will automatically disconnect power and isolate the battery pack when a collision or short circuit is detected. If the vehicle were submerged in water or if water somehow reached the battery pack or electrical system and caused a short circuit, direct contact with a live part would be necessary to experience an electric shock, which is highly unlikely (Report Section 2.6).

7. “Hydrogen fluoride produced by BEV fires is highly toxic”

It is true that hydrogen fluoride (HF) is highly toxic and has been detected in greater quantities in BEV fires than in ICEV fires. However, the combustion gases and effluents from all types of vehicle fires (both BEVs and ICEVs) are toxic

Carbon monoxide (CO) and hydrogen cyanide (HCN) are common causes of death when smoke is inhaled during a fire accident (Eckstein & Maniscalco, 2006; Jonsson et al., 2016; Lawson-Smith et al., 2011). In all fires, regardless of the vehicle's energy source, it is crucial to stay away from the smoke plume and use appropriate personal protective equipment when dealing with burning or burnt vehicles.

8. “Firefighting equipment is not protected against BEV fires with standard firefighter suits”

Regarding protection through fire-resistant clothing against hydrogen fluoride (HF), the Swedish Defense Research Agency (FOI) studied the health risks of HF. Fully dressed firefighters equipped with self-contained breathing apparatus conducted various exercises in an area contaminated with HF, and the penetration of HF through the clothing was measured. According to the authors, a person wearing only self-contained breathing apparatus would need to inhale smoke for 14 hours at 100 ppm of HF to achieve a lethal dose of HF through skin absorption (Wingfors et al., 2021).

*Underwear, thick socks, flame-resistant suit pants, flame-resistant suit jacket, boots, flame resistant balaclava/hood, helmet, and gloves.

9. “Overcharging a lithium-ion battery can cause thermal runaway”

This is true at the cell and module level if safety systems are not in place. A lithium-ion battery pack in a vehicle is equipped with a Battery Management System (BMS) that will prevent this phenomenon.

There have been reports of fires starting in a BEV "while charging." It is important to note that fires in such situations can have multiple causes, such as electrical malfunctions in the charging infrastructure, issues with the cable, connections, or other general causes of vehicle fires. During charging, the vehicle communicates with the charging system to monitor the entire process and interrupt charging in the event of any detected anomalies.

10 · “Electric vehicles should be kept away from other vehicles to increase safety”

As the fleet of BEVs continues to grow, it will not be feasible to confine all BEVs to a specific area of the parking lot.

However, if a BEV has sustained mechanical damage (such as in an accident) or has been involved in a fire, it is important to inspect the vehicle (particularly the battery), as the battery and its safety systems may have been compromised, posing a risk to the vehicle itself and those nearby.

11 · “The aging of BEV batteries will increase the risk of fire”

There is still limited statistics on aging lithium-ion batteries, and there is no data on the potential impact of battery aging as a triggering factor for fires.

The aging of battery materials can lead to capacity loss and increased impedance (Xiong et al., 2020). The aging mechanisms of lithium-ion batteries are diverse and complex. Furthermore, the aging mechanisms are linked to highly variable factors, such as the type of battery and operating conditions, making general predictions challenging and necessitating individual assessment in each case.

Batteries are fundamental in the energy transition toward cleaner sources, especially with the increase in renewable energy and the intermittency of its generation. It is estimated that the annual demand for lithium-ion batteries will multiply by six in the next decade, primarily due to the growth of the electric vehicle market. In light of this expansion, society and the media have shown growing concern about battery safety, particularly regarding the risk of fires.

As It occurs with other forms of energy, batteries present fire risks that must be managed properly.

First and foremost, it is important to understand that different types of fuel have different modes of fire propagation, and therefore, the risk must be addressed specifically in each case.

Fires in batteries can be caused by various factors, including short circuits, internal defects, insulation failures, high temperatures, and external circumstances, which occur quite frequently. A fire in a battery requires the injection of water or another extinguishing agent directly into the battery area. This is relevant both for the extinguishing process itself and for cooling the materials. Ultimately, it is essential that extinguishing measures are applied directly to the battery.

It is important to keep in mind that rapid suppression of the fire at its source is essential, as this will prevent the fire from spreading and potentially affecting the vehicle's batteries. Early detection is crucial to minimize these risks. Here, battery management systems play a fundamental role, as electric vehicles are equipped with advanced safety systems for real-time monitoring of cell operating data, fault prediction, and warnings of potential incidents. These systems automatically disconnect the power and isolate the battery pack when a collision or short circuit is detected.

It is important to ensure the rapid suppression of fire at its source, as this will prevent the spread of the fire and potential damage to the vehicle batteries. Early detection is essential to minimize these risks. Here, battery management systems are crucial, as electric vehicles are equipped with advanced safety systems for real-time monitoring of cell operating data, fault prediction, and warning of potential incidents. These systems will automatically disconnect power and isolate the battery pack when a collision or short circuit is detected.

Preventive and predictive maintenance is of particular importance. To avoid issues, it is crucial that qualified professionals carry out the recommended maintenance according to the manufacturer's instructions.

Another important aspect associated with battery fires is environmental safety. Proper management of battery waste and the toxic substances generated during a fire is necessary to minimize environmental impact.

On the other hand, there are misconceptions that spread primarily through social media. For example, there is a myth that electric vehicles catch fire more frequently than internal combustion vehicles. Current statistics from countries with significant electric vehicle penetration indicate that the likelihood of an electric vehicle catching fire is lower than that of a combustion engine vehicle (with regard to the total number of vehicles).

Another common myth is that the intensity of the fire is greater when the battery of an electric vehicle ignites compared to when an internal combustion vehicle catches fire. However, published studies suggest that the total heat release is similar in both types of vehicles.

In summary, while lithium-ion batteries do present fire risks, these can be eliminated or controlled through proper design, advanced monitoring systems, and rigorous safety measures. Analyses conducted to date show that electric vehicles, with their advanced safety systems, pose a lower fire risk than internal combustion engine vehicles.

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