New Tasks for Intelligent Video Technology due to the Growing Market of Electric Mobility and E-Charging Infrastructure

White Paper

MOBOTIX

BeyondHumanVision

Content

1.	The future of e-mobility	3
1.1.	Global growth	3
1.2.	Goals and development in Europe	4
1.3.	Targets and development in the USA	5
1.4.	Development outside Europe/USA	6
1.5.	Not only passenger cars - more and more zero-emission buses and trucks	7
1.6.	E-charging stations of various types	8
2.	Safety as a basic need	9
2.1.	Copper cable theft	9
2.2.	Robberies, thefts	10
2.3.	Parking and shunting accidents	11
3.	Better processes for greater efficiency	12
3.1.	Video technology for process optimization	12
3.2.	Access control	12
3.3.	Statistics & market research	13
3.4.	Remote monitoring	13
4.	Special requirements for fire protection	15
4.1.	New technology creates new challenges	15
4.2.	Special risk „thermal runaway“	16
4.3.	Certified fire protection	17
5.	Cyber security & robustness	17
5.1.	Cyber security	17
5.2.	Robustness	18

1. The future of e-mobility

Alternative powertrains for vehicles of all types have been a key issue for many years due to climate change, lower CO2 emissions, and resource scarcity. While research continues on many types of propulsion, such as synthetic fuels or hydrogen, electricity has evolved to market maturity. Accordingly, the industry is growing and placing new demands, including video technology.

1.1. Global growth

E-mobility is a strong growth market worldwide, resulting in extensive charging infrastructure requirements. As markets for electric vehicles grow, access to public charging stations must keep pace. Consumers are increasingly demanding the same services, convenience, and autonomy for e-vehicles as already exist for internal combustion vehicles.

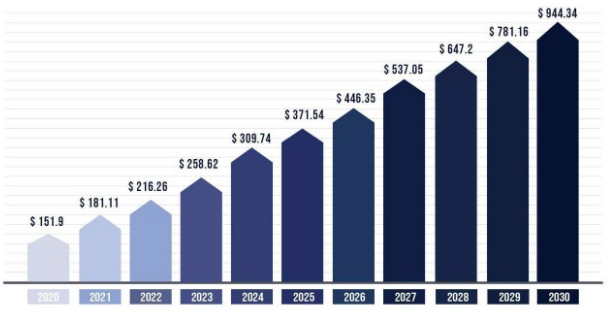
One in nine passenger cars sold globally now has an electric powertrain. 4.5 million, nearly 70%, are purely electric battery electric vehicles. In 2021, every second e-car worldwide was sold in China (3.34 million / +168% year-on-year). However, with a 15.5% electric share of total sales, the giant country lags behind Europe (EU, EFTA & UK), where the percentage of e-vehicles is now 19.2%.

Germany, with 682,000 (+73%) newly registered electric cars in 2021 (26% of the total vehicle market), and the US, with a volume of 607,000 e-vehicles (+97%, market penetration of 4.1%), are the strongest markets after China.

In Europe, more than 300,000 e-charging stations were ready for electric charging in 2021. This represents an increase of 30% compared to the previous year. In the United States, charging stations increased by 12% to 92,000 in 2021.

The global electric mobility (e-mobility) market was estimated at $151.90 billion in 2020 and is expected to reach nearly $950 billion by 2030, growing at a compound annual growth rate (CAGR) of approximately 20% from 2021 to 2030.

ELECTRIC MOBILITY MARKET SIZE, 2020 TO 2023 (USD BILLION)



Source: Precedence Research

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Fast charging stations for more flexibility

The fast charging station market is also dynamic. Fast charging is essential for greater autonomy and more freedom of movement. A well-developed network encourages even former skeptics to purchase e-vehicles, as range anxiety is removed as an obstacle. The number of public fast-charging stations in Europe increased by more than 30% year-on-year to nearly 50,000 units in 2021. More than 9,200 fast-charging stations exist in Germany and 7,700 in the United Kingdom. In the United States, there were approximately 22,000 fast charging stations in 2021 - nearly two-thirds of which are Tesla Superchargers. Also, Korea recorded an immense growth of 50%.

1.2. Targets and development in Europe

The European Green Deal, a package of EU policy initiatives, includes a milestone target of one million public charging points by 2025. Currently, only 23 percent of this milestone has been reached. There is still a need to catch up here in the coming years.

Summary

Population	Total land area	Highway (km)
447,000,000	4,225,000 km^2	106,650 km

Total passenger cars

286,807,270

Alternative fuel passenger cars

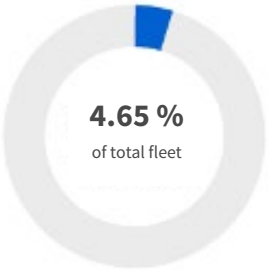
13,343,128

Data last updated

08 Feb 2023

Read more on the data sources

Alternative fuels vehicle share:



A further stimulus for the market is provided by another 2014 European Union directive on alternative fuels infrastructure (AFID), which regulates the use of public charging facilities for electric vehicles. The directive recommends that EU member states provide one public charging station for every ten e-vehicles by 2020. These should have a capacity of 1 kW per battery E-vehicle and 0.66 kW per plug-in hybrid electric vehicle (PHEV).

In 2021, the average ratio of e-vehicles to chargers in the European Union was 14, above the recommendation of 10. The average kW ratio per e-vehicle was already in line with the value proposed in the AFIR for 2030.

Some countries are already well advanced - such as the Netherlands (5 and 2.6 kW per e-vehicle) or Spain, where 20 e-vehicles per charger and 1.2 kW per e-vehicle with over 30% fast chargers are available (2021). The largest markets in Europe - France, Germany, and the United Kingdom - still need to reach the charger availability recommended by the European Union.

1.3. Targets and development in the USA

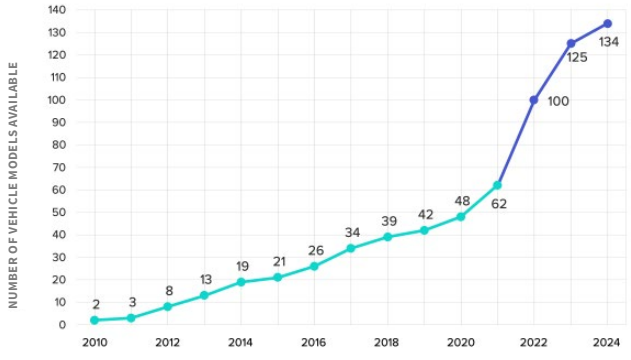
The Alternative Fuels Data Center lists nearly 50,000 electric vehicle charging stations in the United States. Almost all D.C. fast charging stations (99%) are publicly accessible. Many are located along highways (25%), reflecting the faster charging demand at these locations.

About 8% of the U.S. population lives more than 10 km from a public charging station. As specified in the target, nearly 1,200 additional stations would need to be built to reduce this to less than 5%.

The U.S. federal government wants to make half of all new vehicles sold in the U.S. emission-free by 2030. A network of 500,000 charging stations will be created to give all Americans access to e-vehicles for local and long-distance travel. On November 15, 2021, President Biden signed the Bipartisan Infrastructure Law, which includes $7.5 billion in new funding for e-vehicle charging stations and provides funding for numerous other e-vehicle-related initiatives.

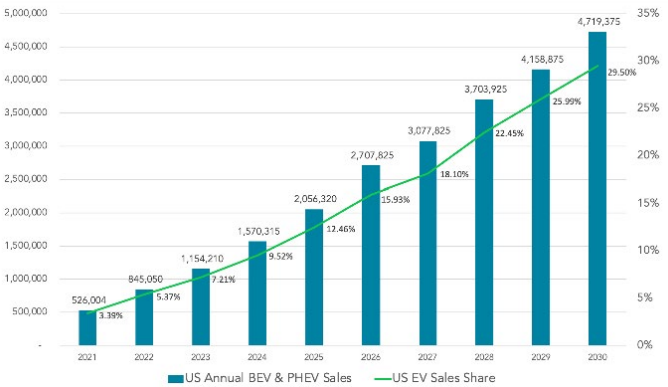
In 2022, U.S. Consumers Seeking an Electric Vehicle Expected to See a Notable Uptick in Their Options

Total number of electric vehicle models (**historic** and **projected**) in the U.S. market



Source: Electric Power Research Institute

US EVs (BEV & PHEV) Sales Share Forecast: 2021-2030



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1.4. Development in regions outside Europe/USA

Australia

In 2019, 6,800 e-vehicles were sold in Australia. By 2023, sales are expected to reach €1.9 billion. Annual growth (CAGR 2023-2027) of 22.3% will lead to a market volume of €4.3 billion by 2027.

Africa

Rising populations, urbanization, and poor rural connectivity pose particular challenges for the transportation sector in Africa. However, the continent's climatic conditions mean it has a good chance of moving directly into a climate-friendly mobility future. Electric mobility is a strong developing sector, especially for two- and three-wheelers and light vehicles, which require low charging capacities and can be provided easily and cheaply.

The market for electric vehicles in the Middle East and Africa was estimated at 35 million euros in 2020. It is expected to reach 79 million euros by 2036 (annual growth of over 15%).

South America

Sales for electric vehicles in South America will amount to around €932 million in 2023. By 2027, the market volume is expected to reach 1.9 billion euros, corresponding to annual growth of 19%. That's about 38,000 vehicles in 2027.

Asia, especially China, and India

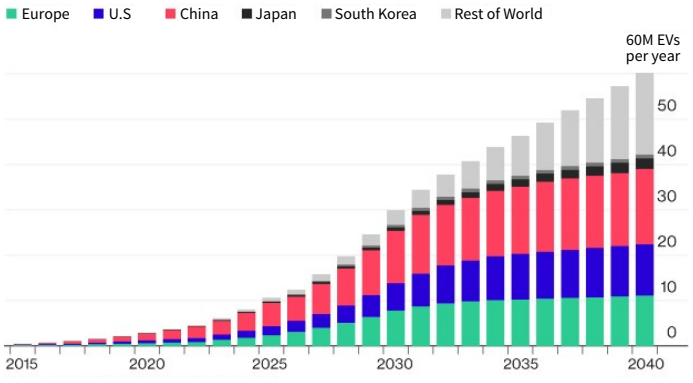
In Asia, sales for electric vehicles will be around 203 billion euros in 2023. By 2027, this will reach 345 billion euros. This annual sales growth is 14.24% (CAGR 2023-2027).

At 190 billion euros (2023), China is considered the largest automotive market in the world, even if growth has declined in recent years. This is mainly due to decreased subsidies and the relatively high price of e-vehicles. The Chinese government aims to generate a quarter of car sales from alternative-powered vehicles by 2030.

In populous India, 1.4 million electric vehicles were on the road in 2022. Almost all vehicles (1.3 million) were 2- and 3-wheelers. The value of the Indian market for electric vehicles is expected to rise to 6.6 billion euros by 2025.

Conclusion: Even if the markets differ in their requirements and composition, the global trend shows a clear development and is going upwards. Electromobility, the number of e-vehicles, and thus also the charging infrastructure are a growth market worldwide, from which video technology can also benefit and which can bring essential advantages for operators and users.

Globale Electric-Car Revolution Set to Take Off



Source: Bloomberg New Energy Finance

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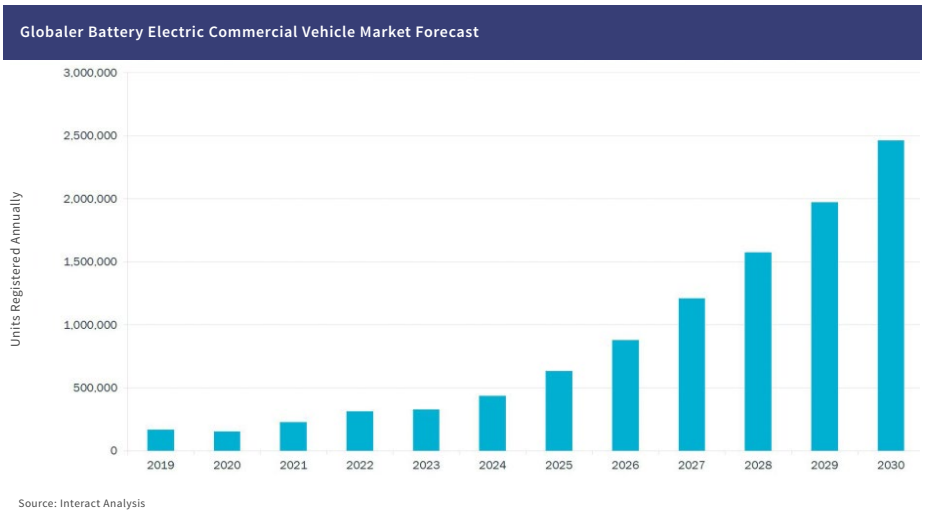
1.5. Not only passenger cars - more and more zero-emission buses and trucks

E-vehicles are gaining importance for passenger cars and the private sector. E-mobility also plays a leading role in future concepts for car sharing, commercial use (company cars, delivery vehicles), public passenger transport, and heavy-duty transport.

Registrations of electric buses increased by 40% worldwide in 2021 compared with the previous year. Medium- and heavy-duty electric trucks doubled in number. In 2021, there were 670,000 electric buses in operation worldwide. The fleet of heavy-duty electric trucks is 66,000, representing about 4% of the global fleet for buses and 0.1% for heavy-duty trucks. Trend: increasing.

In many places, development is being promoted by legislation. For example, the rise in electric bus sales in France, Germany, Spain, and the UK is fueled by national and local targets for procuring zero-emission buses only and the EU's Clean Vehicles Directive.



Electric truck sales in the United States and Europe have grown rapidly in recent years. There are more and more models available. Political support, rapid improvement in the technical environment, and the economic competitiveness of electric buses and trucks are encouraging development.

Electric vehicles in public transport and trucking benefit from successful deployment and evidence of economic and societal benefits (e.g., reduced noise and air pollution) in current applications, such as urban delivery trucks, shuttle and school buses, and garbage trucks. The next stage goal is to address longer distances with higher total energy storage requirements per day, e.g., regional and long-distance transportation. The infrastructure for faster charging and higher network capacity is under construction.

Stationary and mobile charging

Commercial vehicles are predominantly charged at the depot. In addition, the provision of high-speed charging stations along specific routes may be appropriate. This is appropriate for applications with longer but regular routes or predictable operations (e.g., shuttles, public transit, or school buses). Applications with variable routes, such as delivery trucks, rely more on publicly accessible charging stations.

Expand charging infrastructure along major transportation corridors

For regional and long-distance transport autonomy, coordinated expansion is needed first to the most heavily used main transport corridors along highways combined with rapid charging.

In addition, alternative systems such as battery swaps and electric road systems are currently being tested and built. For example, battery swap pilot programs are underway, particularly in Asia. A permanent power supply is also an option. For instance, electric road systems can transmit power via induction coils in the road, via connections between the vehicle and the road, or through overhead lines.

Field tests with overhead line systems have been used in real transport operations on highways in Germany since 2016. Three systems covering 13 km are currently in use. Germany has announced plans to equip hundreds of kilometers of the motorway with overhead lines and stationary charging and refueling facilities. The United Kingdom plans to test an overhead line system for heavy trucks. Some European countries, such as France and the Netherlands, have commissioned studies on electric road systems' economic viability and environmental impact.

1.6. E-charging stations of the most varied types

The e-charging station market is complex. From private charging stations to industrial companies, small local providers to franchises to large chains, all have different requirements and needs. The equipment of e-charging stations and charging stations is individual - from a pure charging station to a connection to a store, car wash, and workshop to a service area with a restaurant and much more.

The charging stations also differ in their location and power supply. The electric infrastructure exists on highways, at city entrances and exits, urban or "in the countryside." Some stations draw electricity exclusively from the grid, while others generate parts of the required electricity directly on-site via photovoltaics or wind power and appropriate intermediate storage. The versatility of e-charging stations also places different demands on the video technology used and its integration and network connection.

Video technology is also changing. Whereas video systems were previously primarily used for security purposes, they are now a key contributor to process control and service optimization too. They can even lead to improved sales potential. Above all, however, the systems need to be flexible and scalable. A gas station operator cannot afford to replace its systems with every relevant change. Ideally, technology has to keep up with change – whether it's a matter of modification, redeployment, adaptation, or growth.

MOBOTIX systems have always been pioneers in this area. Thanks to the decentralized approach and modular concept, they can be flexibly adapted to changing challenges. This can involve expanding or tweaking hardware (such as optical or thermal modules), or can also be solved by the software loaded onto the cameras. The open MOBOTIX 7 platform allows apps to be used in a flexible way. Even software applications, which are individually programmed to meet specific requirements, can be loaded onto the cameras. The MOBOTIX video systems are therefore ready for every conceivable application.

Summary:

- Demand for e-mobility is growing worldwide (individual markets)
- Charging infrastructure must grow with it (flexibility/autonomy)
- Legal requirements (EU, USA) promote the growth of e-mobility
- E-mobility goes beyond private use(public transport/ bus + freight transport)
- Charging stations with different equipment and locations

2. Security as a basic need

A fundamental motive for using video security systems at charging and e-filling stations is the safety of employees, customers, and property. Of course, fire protection, the handling of electricity, or the detection and prevention of violence and vandalism play essential roles. Another focus is on cable theft and robbery. Intelligent video technology can help to make these threats transparent, educate, and prevent them at best.

2.1. Copper cable theft

E-charging parks with multiple charging stations require a lot of copper. Charging facilities usually calculate with the parallel operation (simultaneity factor) to provide 200 kilowatts of power for each electric car. That calls for its strong wiring network. The coveted raw material makes charging parks an attractive target for thieves in the construction phase and subsequent operations. The high price of copper in recent years due to high copper demand is fueling this incentive. The reddish metal is the world's most important industrial metal. A charging park capable of supplying power to an average of eight electric cars requires up to five tons of copper for the cable routes. The copper price of 8,500 euros (on Feb. 28, 2023) corresponds to a material equivalent of more than 40,000 euros. These significant material assets require extensive security measures, especially since there is usually no on-site staff, unlike at classic service stations and charging parks. The problem of "cable theft" applies not only to the facility itself but also to the vehicles located there. Locked charging cables are stolen repeatedly, causing enormous damage to the customer's vehicle. Visible video systems are not only a deterrent. They can provide important evidence images day & night and help to convict the perpetrators.

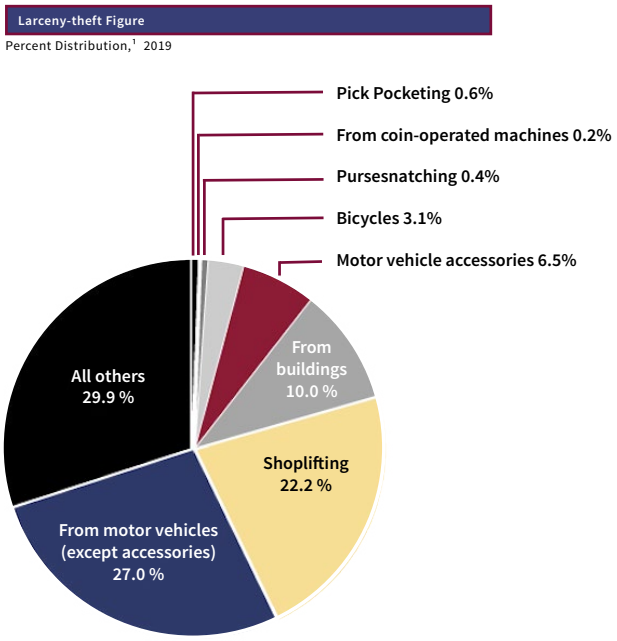
Copper price hits a record high *(In dollars per ton)*

Source: QUICK-FactSet

Intelligent video technology can even detect loitering persons, in the best case preventing thefts altogether. Corresponding micro and audio functions of MOBOTIX cameras or triggering events (e.g., alarm or light) enable direct intervention, even if no personnel are on site.

2.2. Robberies and thefts

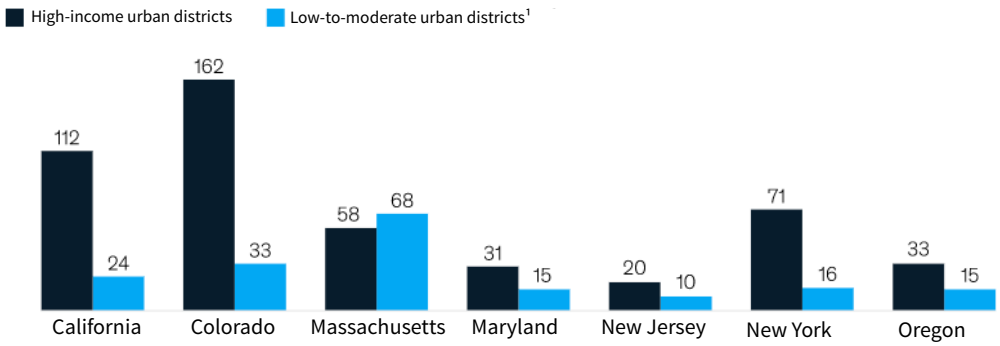
Unfortunately, the e-charging stations, which are usually somewhat out of the way and confusing due to the size of the areas, repeatedly attract potential perpetrators for robberies and thefts. It is not only the technical equipment of the charging parks or the vending machines located there that interest thieves, especially the vehicles parked for charging. Thefts related to cars account for a large proportion of the total number of these crimes. In addition, the target group, “owners of e-vehicles,” is considered to be in above-average financial standing, which makes them attractive to perpetrators.



Visible video systems deter potential offenders, give the user a sense of security and protect effectively. In their traditional role as security and surveillance systems, video cameras contribute to site security and help track and resolve incidents. The micro and audio functions of MOBOTIX cameras or the triggering of events (e.g., alarm or light) can be used to intervene directly if necessary. Of course, the connection to a control center or the alerting of security personnel is also possible.

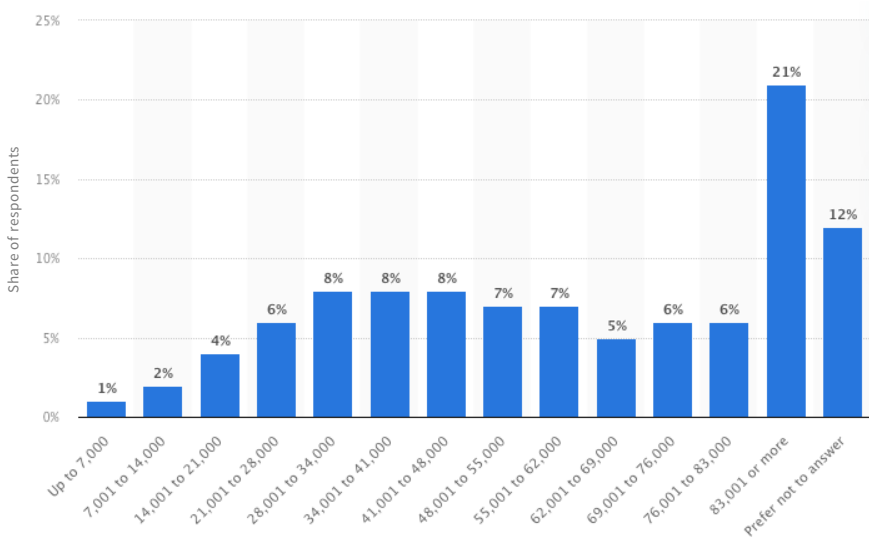
Public electric-vehicle chargers are currently concentrated in high urban areas.

Chargers per 100,000 households, by income level



[1] Defined as having income levels lower than 80% of the area media income (AMI).
Source: Alternative Fuels Data Center, US Census, US Department of Housing and Urban Development

Distribution of electric vehicle drivers in the United Kingdom by annual household income.



2.3. Parking and maneuvering accidents

As in conventional parking lots, accidents can also occur near the charging station when maneuvering vehicles and driving on the site. If cars or facilities are damaged, the events can be documented and traced using video surveillance. In the event of a hit-and-run, the vehicle causing the accident can be identified thanks to recognizing the license plate number and the manufacturer, model, and color.

Incidentally, a study by the Allianz Center for automotive supplier Continental in Germany has shown that almost every second accident involving property damage now occurs during a parking maneuver. For the research project, 3,500 traffic accidents were analyzed in collaboration with the Munich University of Applied Sciences and the Technical University of Munich.

3. Process control, monitoring, and economical operation

Cost efficiency, high utilization, best customer satisfaction, and low downtime make charging stations profitable. Intelligent video technology can make a decisive contribution to this.

3.1. Video technology for process optimization

Recognize and avoid operating errors

The incorrect operation causes a lot of damage to e-charging stations. A large potential for error lies in the long cables. Cars get stuck on the cables while charging or run over them. With video systems, operators can document and clarify incidents. MOBOTIX cameras have a voice and audio function that allows direct intervention when such errors are noticed.

Preventive maintenance prevents failures and saves money

If the video technology detects irregularities, such as energy storage overheating on site, the system can be checked before any major damage occurs. This is not primarily about fire protection but about predictive maintenance. If the systems are permanently and predictively maintained before damage occurs, the downtime of a system can be significantly reduced, which means hard cash for the operator. Such preventive maintenance can be effectively supported by video technology.

Service and ambiance

Customers value the safety, cleanliness, and cheerful ambiance of e-charging stations. With the help of video technology, operators can get a picture of the condition of their station around the clock and have trash removed or snow cleared if necessary. Video technology can also provide security, the best service in waiting areas, and self-service machines (snacks and drinks). This boosts the profitability of the entire facility.

3.2. Access control

Controlled access via license plate recognition with permission lists increases safety, improves service, enables documentation, and generates marketing data.

Automatic barrier opening

Video technology can support smooth operations at the access point if a barrier secures the site. For example, by comparing it with permission and blocking lists, the barrier opens only for e-vehicles and registered visitors. It remains closed if unauthorized non-e-vehicles or unwanted vehicles (previously attracting negative attention) request access.

Video technology can improve service to help secure base revenue. For example, the release of access for regular guests is possible via license plate and vehicle recognition. After automatic comparison with the release list, access can be granted at exclusive access times, in reserved areas, or via special prioritized entrances (no queue).

3.3. Statistics & market research (collect, link and analyze data)

In addition to the e-charging stations themselves, video technology can also be used to make data on the utilization and usage of the facility, for example the quantity of vehicles and dwell time. Likewise, the video data - for example, directly upon entering the site - provides profound data for market analysis. For example, the origin (license plate number) and type of vehicles (make, model, class) provide important starting points for market analysis and marketing.

3.4. Remote monitoring

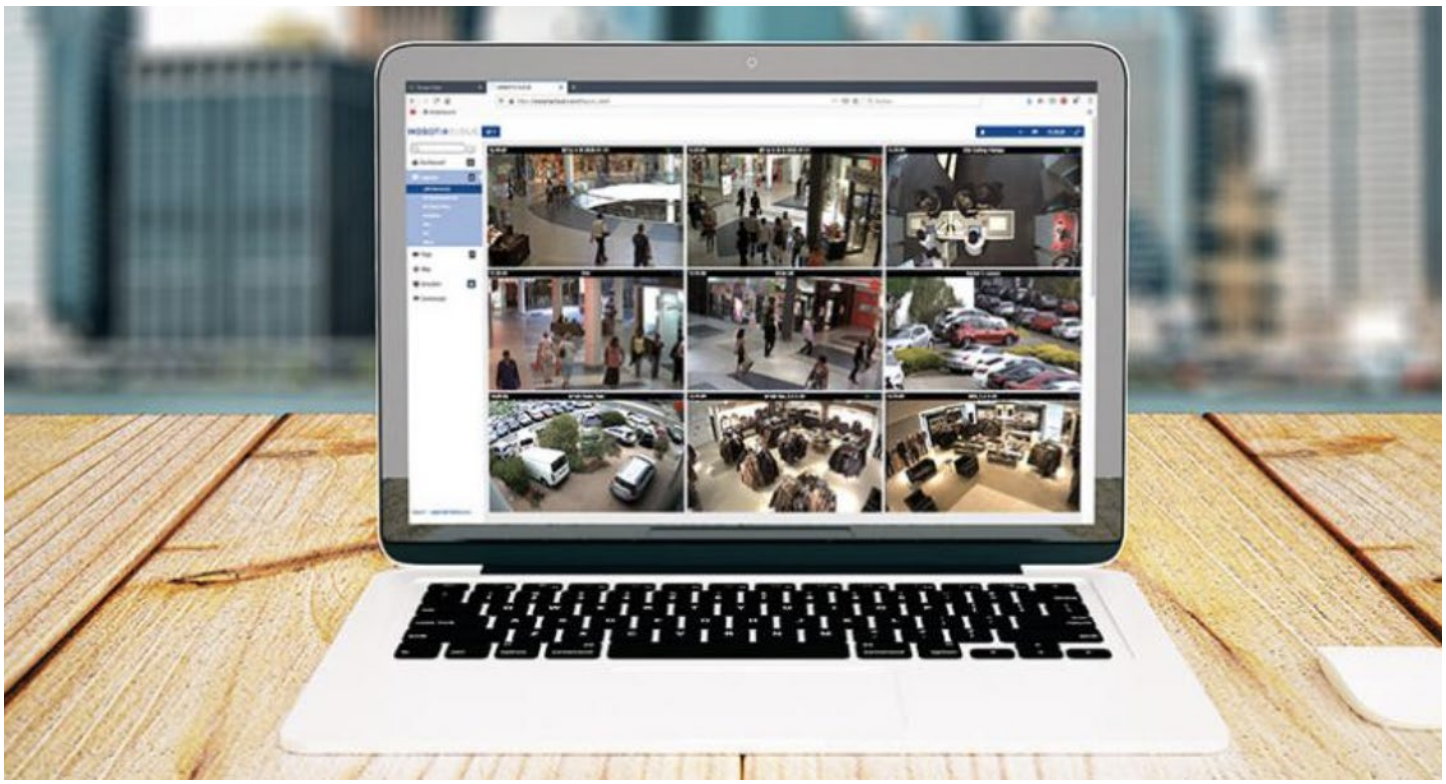
E-charging parks are operated with little staff or entirely autonomously. In addition, they are often multi-sites with multiple branches. Video technology makes it possible to monitor multiple sites simultaneously, around the clock, and cost-effectively.

Around-the-clock overview from anywhere

E-charging stations and charging parks can be conveniently monitored remotely around the clock, for example, via the cloud. MOBOTIX offers solutions here with day/night cameras, the MOBOTIX CLOUD, and MOBOTIX HUB, from single sites to complex multi-sites. The video technology enables immediate intervention in critical incidents (e.g., via micro and audio functions), even if no personnel are on site.

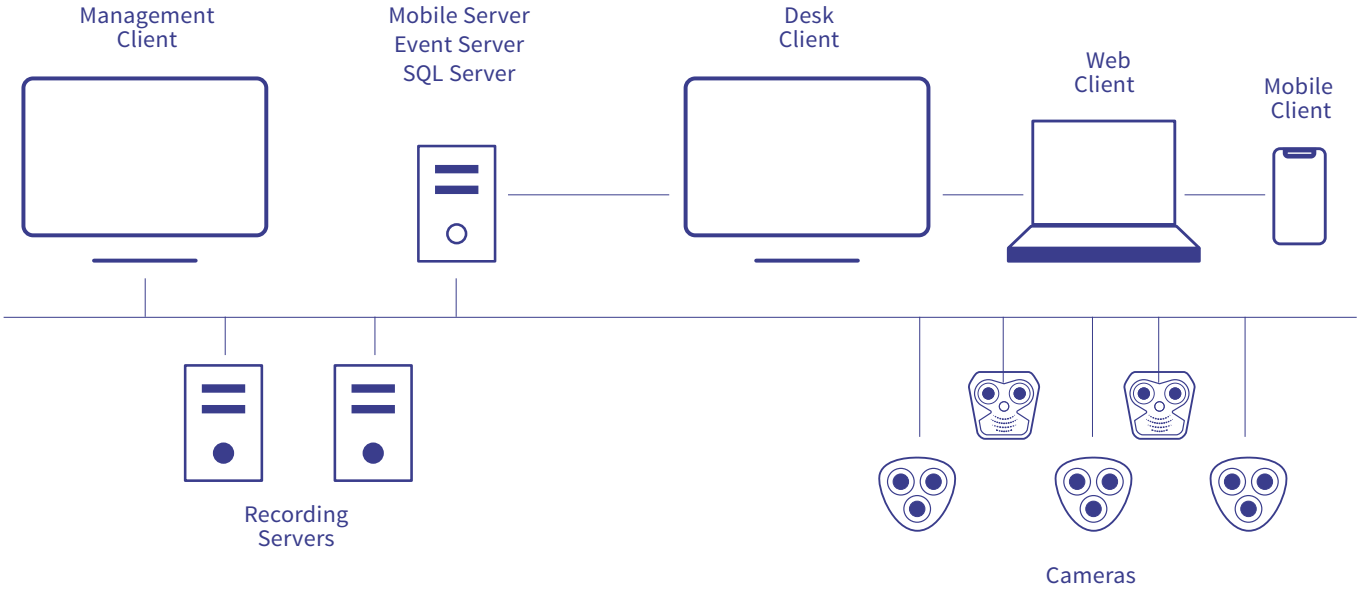
Parallel overview of multiple locations

MOBOTIX video technology allows you to monitor multiple locations simultaneously. You decide who should have which access. For example, local employees can only access local sites, while area managers or operators can have an overview of several or all locations. The event search based on metadata is cross-location, which makes accessing, merging, and evaluating data particularly convenient.



Smaller and medium-sized branch and franchise chains use the MOBOTIX CLOUD. It can be accessed from anywhere via smartphone, tablet or PC. For the operator and its employees, there is no need for local servers and no need to be IT savvy. The system is agile, flexible and scalable. Thanks to fast digital wrap-around visibility, it saves you from having to walk the routes previously taken during in-person on-site patrols.

Operators can use the MOBOTIX video management platform MOBOTIX HUB to retain a central overview of several branches. The platform allows all components (servers, cameras, users) of video security systems to be integrated, managed and controlled centrally – even across any number of sites. The system is particularly attractive for medium and large chains because it gives you control over the entire video security network at a glance. Even across 50, 100 or more sites. This too is done via mobile devices, a laptop or PC through to a large-scale video wall.



Conserve resources and save costs

Thanks to remote access, e-charging park sites can be operated in a way that conserves resources. Fewer on-site personnel are needed, and patrols/inspections are required less frequently. In addition, the leaner technical infrastructure without energy- and cost-guzzling storage and server infrastructure pays off for the operator.

4. Special requirements for fire protection

Fires are dangerous, especially when - as in electrical charging - batteries are involved. And that doesn't just apply to the fire itself. The resulting downtime is also a massive problem for operators. This is why qualified fire protection, effectively supported by MOBOTIX thermal cameras, is so important.

4.1. New technology creates new challenges

Lithium-ion batteries are steadily increasing in the industry through power generation and buffering - especially regarding using renewable energy and e-mobility. Incorporating, using and storing battery technology is challenging for companies, especially regarding fire risk and extinguishing operations. Specific risks exist in the life cycle of batteries, such as

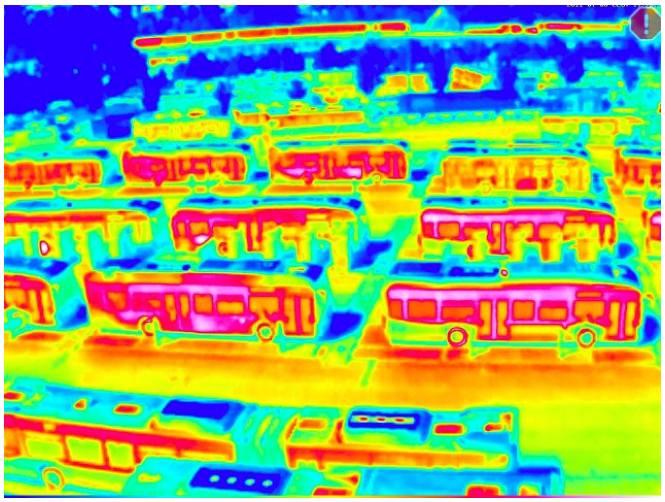
- Deep discharge
- Overcharging and overheating during charging
- Incorrect/defective chargers or incorrect operation
- Damage (due to temperature fluctuations, transport, production errors, physical impact).

Defective batteries can no longer provide full power. Damage and incorrect handling result in batteries having an increased risk of fire and explosion. Rapid fire detection is essential. It must be precisely matched to the requirements on site, take effect quickly and be reliable to protect values and, even more importantly, health and life.

Monitoring charging processes - focus on buses and trucks

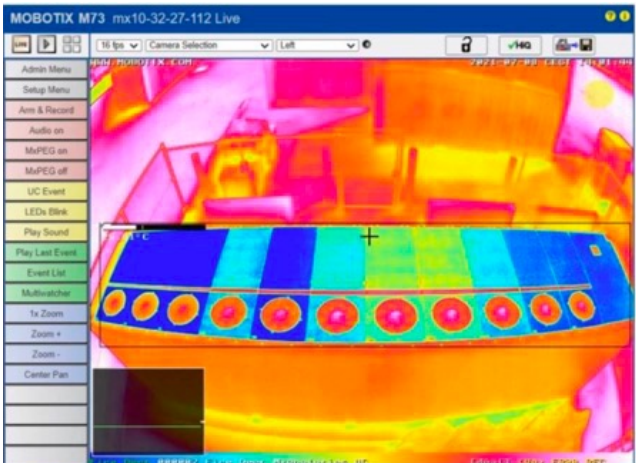
Overvoltage or overheating can occur during electrical charging. While video technology detection is uncommon for passenger cars because the battery is under the vehicle, it is useful for vehicles with larger or external energy storage devices. Overheating when charging buses (public transport, coaches) with the battery on the roof can be detected. Thus, thermal video technology can effectively support fire protection. The charging of vehicles in the depot should be monitored along the line networks (public transport) at the high-speed charging stations.

Fire protection is particularly interesting for battery packs (battery packages). This is a group of interconnected batteries in such a way that the accumulated capacity serves as an energy buffer. Such systems are used in solar and wind farms and wherever energy peaks occur due to high loads. Battery packs can also be used at e-charging stations where energy is temporarily stored.



Practical example:

An existing MOBOTIX project shows the monitoring of a battery pack via a bi-spectrum (VGA thermography and optical 4K camera) installed 1.60 m away from the BP at 7 m height. The thermographic module with a 90-degree field of view can completely cover the 7.70 m long BP. A decisive reason for choosing MOBOTIX technology in this project was that different angles of view could be flexibly covered depending on the requirements.



4.2. Special risk “thermal runaway”

The characteristic of lithium-ion storage is the high energy content per volume. A particular risk of battery fires is the “thermal runaway.” Such a chain reaction takes less than 60 seconds from start to explosion.

What is a Thermal Runaway?

An unstoppable chain reaction is set in motion in the case of a thermal runaway of lithium-ion batteries. The temperature rises signifi-cantly within seconds and the energy stored in the battery is released abruptly, with parts of the battery becoming gaseous. This results in a fire with temperatures of more than 1,000°C, which is difficult to extinguish by conventional means. The risk of a thermal runaway starts at around 60°C and becomes critical at 100°C and above. Whether and when a lithium-ion battery catches fire depends on the cause,environment, type, processing, and use of the battery.

up to 1.000°C and more	Fire with high temperature
More than 250°C (482°F)	Abrupt Release of energy, danger of thermal runaway
from approx. 200°C (392°F)	Exothermic reaction (fire) starts, danger of explosion
From approx. 125°C (257°F)	Function disturbed, decomposition of anode and cathode
60° C (140°F)	Heating of the battery/accu

The battery heats up quickly when it exceeds a specific temperature limit. The heat triggers further reactions, such as “thermal propagation,” when a cell with its thermal reaction spreads to other neighboring cells.

From 200 - 250° C, the battery ignites or even explodes so that burning parts can be thrown around. The exact temperature here also depends on the individual battery cell, the design and other external factors. Once a fire has started, it is tough to extinguish. Batteries, whether large or small, are doused with water. Above all, cooling is mandatory, as there is a risk of back ignition. Firefighters often monitor lithium-ion batteries until well after they have been extinguished. Affected batteries should always be moved to a safe location.

4.3. Certified fire protection

Qualified certifications in fire protection are prescribed in many laws, by insurance companies, and in building regulations, and also facilitate settlement in the event of damage. MOBOTIX is the first video system manufacturer with quadruple certification for fire protection. Certifications from VdS Schadensverhütung GmbH, the French National Center for Prevention and Protection (CNPP), the Austrian Federal Fire Brigade Association (PBST), and EN 54-10 approval, are proof of MOBOTIX's extensive fire protection expertise.

5. Cyber security & robustness

Just as important as on-site user and operator security are the cybersecurity and robustness of the systems used. This also applies to video systems.

5.1. Cybersecurity

Since e-cars and e-charging stations are part of the Internet of Things (IoT), prevention and defense against cyber attacks are mandatory. This also applies to video systems that are connected via the network. For devices and systems integrated into the network, cybersecurity should be included in the planning and construction of e-charging stations. Cyber attacks on the charging infrastructure can not only disrupt business operations through the failure of charging stations or entire charging parks but also damage the reputation of companies. The large number of market participants in electromobility and the increasing networking also reach automotive manufacturers, producers, and operators of charging infrastructure as well as energy suppliers (keyword: critical infrastructure) and billing service providers. Cybercrime can only be reliably combated with constant sensitivity and a cross-industry security concept. This includes MOBOTIX video systems, which are tested and certified for cyber security in regular penetration tests.

5.2. Robustness

Since the cameras operate all year round outdoors and are at best protected by a roof, the video systems must be robust and weatherproof. MOBOTIX cameras defy adverse conditions and reliably deliver outstanding image quality with high-resolution day and night. High-end cameras, such as MOBOTIX video systems, are made for ambient temperatures from -40 to + 65 degrees. Protection classes up to IP66 and IK07 ensure the best resistance to external influences (moisture and impact). Moreover, such video systems can be equipped with special vandalism or special housings, which make them ready for use in numerous applications, even in the most demanding environments.

For more information on the MOBOTIX E-Mobility solution package, please visit
https://www.mobotix.com/en/solutions/solution-packs/e-mobility

Sources

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