The Benefits of Intelligent Video Technology in the Waste Management and Recycling Industry

White paper

MOBOTIX

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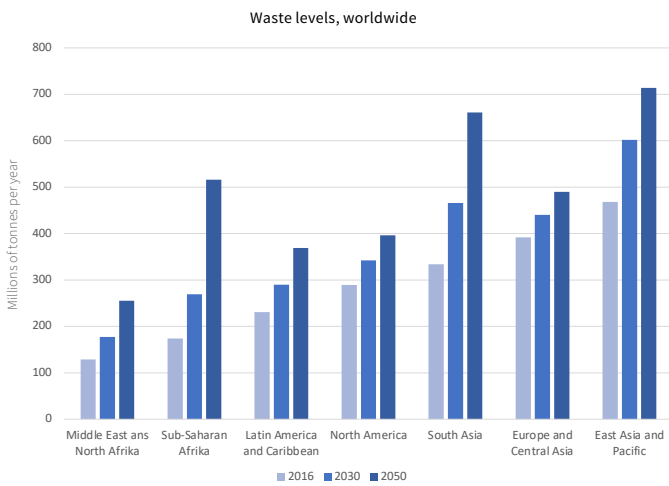
CONTENTS

1. Tomorrow's problem? Why we shouldn't keep putting off dealing with waste!

The future of each one of us depends now more than ever on how we deal with the future of our waste. As an integral part of sustainable development, only targeted, effective waste management can reduce our global footprint. In 2010, the global population produced around 3.5 million tons of waste per day. In 2016, this reached 5.6 million tons. By 2030, the fo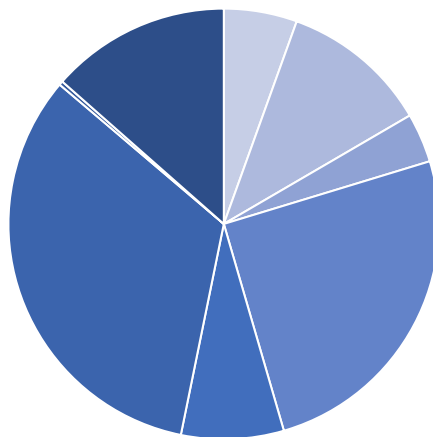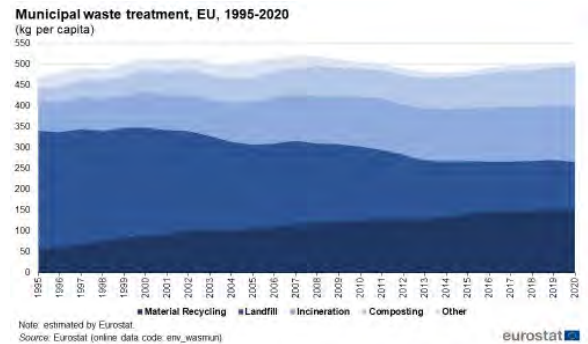recast predicts 7.2 million tons per day, and this will continue to rise. Waste management is a major challenge for our future. Around the world, the industry is being called upon to help overcome this problem using modern and pioneering concepts. Intelligent AI-based video technology can be a key factor in taking on this mammoth task, and we will be looking at how this can work in this white paper.

Waste levels, worldwide

Millions of tonnes per year

Middle East ans North Afrika · Sub-Saharan Afrika · Latin America and Caribbean · North America · South Asia · Europe and Central Asia · East Asia and Pacific

■ 2016 ■ 2030 ■ 2050

Waste is a complex issue. There are several different types of waste arising in different contexts and which also have to be disposed of or treated in different ways. They can be split into four main categories: Domestic waste consists primarily of paper/cardboard, plastic and various types of organic waste, whether garden or kitchen waste. Commercial waste consists mainly of paper, plastic and other packaging material. Industrial waste consists largely of industrial sludge and ash. Construction debris is another key area. Hazardous materials (hazardous waste) often come from industry or from other areas such as hospitals. These components can be highly toxic and pose risks to people and the environment if handled incorrectly.

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From disposal to reuse

One of the main causes of the waste problem is the wasteful use of raw materials by the "throw-away society." Today, around 60 billion tons of raw materials are consumed annually. Compared to 30 years ago, this marks an increase of around 50 percent. Until the 1980s, the main focus of waste policies was the disposal of waste through landfill sites and incineration. After this, a paradigm shift led to a gradual rethinking. Waste prevention, repair, treatment and recycling are increasingly becoming the priority.

Municipal waste treatment, EU, 1995-2020
(kg per capita)

Note: estimated by Eurostat.
Source: Eurostat (online data code: env_wasmun)

eurostat

- Composting
- Controlled Landfill
- Sanitary landfill (with landfill gas collection)
- Other
- Incineration
- Landfill (unspecified)
- Open dump
- Recycling

One thing is clear: Recycling and treating waste also requires at least temporary waste storage. This is carried out by waste management and recycling companies or, in some cases, directly in industry. Waste can cause a range of problems, for example, if it is toxic to people and the environment. There is also the possibility of the waste being infectious, chemically reactive, combustible or explosive. All of this requires special handling, monitoring and protection, which can be effectively supported by intelligent video technology.

The waste management industry is dynamic and constantly changing in terms of the composition of waste, handling of waste and amount of waste. This means that the video systems used also have to be adaptable, flexible and scalable to meet these changing market structures.

Summary:

- Waste volumes are expected to grow by 2030
- Shift from disposal to recycling
- Storage or intermediate storage of waste is required

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2. Dirt, dust, weather — whenever technology is required

Dirt and dust cannot be avoided anywhere that waste is collected, processed and stored. Heavy-duty machines, bulk materials and crushed or shredded materials create substantial amounts of dirt and dust. In addition, waste processing takes place in large halls or in open spaces where dirt and dust occur naturally.

As most of the storage is outside, video systems used in waste management are exposed to all kinds of weather conditions, meaning they have to be resistant to moisture, cold and heat. This is all the more true in the field of waste incineration, where dust plays a key role.

For example, MOBOTIX video cameras are used by the municipal waste management company ZAK in Kaiserslautern. The cameras are used in the shelter area where materials are collected for incineration, monitoring the high temperatures that can result from fermentation processes. MOBOTIX cameras are also exposed to particularly harsh working conditions at the Lohbrügge wood-fired power plant, especially the camera looking into the combustion chamber. A highly temperature-resistant camera with fan cooling is used there to visually inspect the combustion process.

High-end cameras, such as the MOBOTIX video systems, are designed to withstand ambient temperatures between -40°C and +65°C. IP66 and IK07 protection classes ensure maximum resistance to external influences (humidity and shock). Furthermore, these kinds of video system can be equipped with vandalism-proof housings or special housings which make them fit for numerous applications, even in the most demanding environments.

Summary:

- Harsh environments caused by dust and dirt
- Moisture, heat and cold in outdoor areas and in halls
- Rugged MOBOTIX video systems are weatherproof and shockproof

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3. Materials and raw materials are attractive for burglars

The large amount of materials and raw materials stored, especially for treatment and recycling, makes waste management companies a potential target for burglars.

As expected, potential thieves continue to focus on metals and electrical waste, since these can be resold for a profit. But even materials that are not generally considered attractive to thieves can spark interest in criminal networks. For example, in Madrid, where 67,000 tons of waste paper disappears every year, worth an average of 10 million euros. Forecasts predict that the annual value of (legal) trade in recycled cardboard and paper will rise from 4.3 billion US dollars in 2017 to 5.4 billion US dollars by 2024. An attractive growth market like this also makes materials attractive to illegal traders.

Effectively protecting large premises against intruders is challenging, but this is where intelligent video technology shows its strengths. It keeps a watchful eye on the premises around the clock and can reliably detect intruders by day and by night, even in complete darkness or in the event of visual obstructions caused by dust or fog.
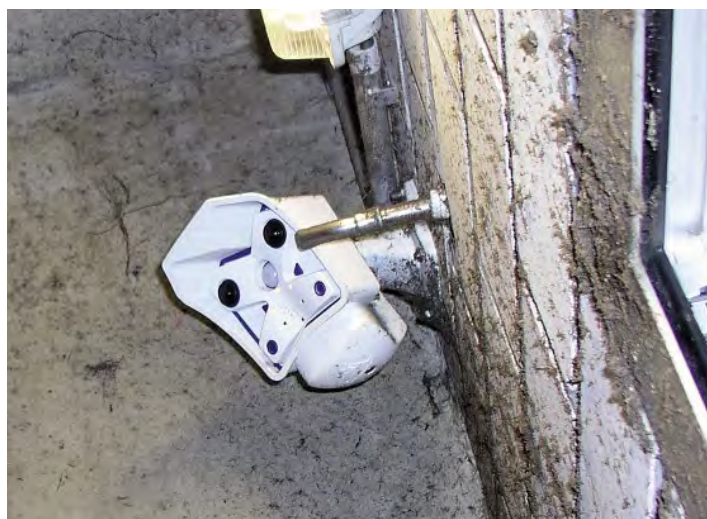
During the day and in good visibility, visual sensors watch over the premises. Supported by intelligent analysis software such as motion and object detection, video systems ensure optimal perimeter protection. Thanks to reliable distinction between people and animals, false alarms can also be effectively avoided.

Thermal imaging technology boasts excellent strengths in nighttime perimeter protection, allowing threats to be detected early, even in complete darkness or poor visibility conditions caused by dust, fog or smoke. Thermal imaging cameras can detect objects from great distances. Any suspicious individuals hiding behind bushes or in the shadows can be detected by a thermal imaging system based on their thermal characteristics. Premium thermal cameras enable perimeter protection even in complete darkness, and they can also be used in very large outdoor areas without additional lighting. They can also detect from distances of up to several hundred meters, i.e. over large and hard-to-reach areas, all while maintaining privacy. The temperature profile generated by thermal cameras does not provide any details for identifying people. As soon as an object moves into a relevant surveillance area, MOBOTIX dual-camera systems can automatically switch from thermal sensor to optical sensor and record high-resolution video while maintaining privacy.

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How thermal imaging works:

Thermal imaging is a contactless imaging process that makes it possible to see thermal radiation from an object or body otherwise invisible to the human eye (mid-wavelength infrared). With thermal imaging, temperature distribution across surfaces and objects is captured and displayed. In terms of the number of pixels, the bolometer matrix (image resolution) is considerably lower than that for cameras capturing the visible spectral range.

Unlike cameras with optical image sensors, a thermal camera has the ability to capture the slightest differences in temperature and to produce an image that displays these differences using colors. MOBOTIX thermal cameras can even visualize minimal temperature differences as low as 0.05°C, giving them the cutting edge over other cameras currently available for general use.
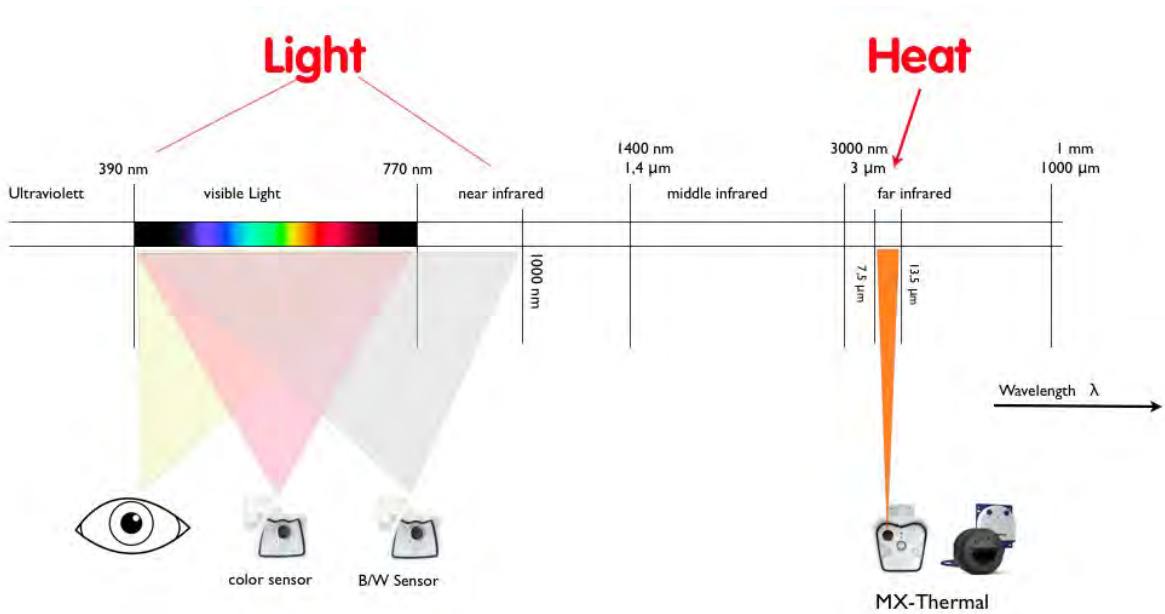
Summary:

- Disposal and recycling companies are a focus for burglars
- Optical sensors for perimeter protection by day
- Thermal technology for visibility even in complete darkness

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3. Fire protection as a key issue in waste management

Fire protection poses particular challenges for companies in the waste management and recycling industry. One key aspect is the large open spaces, with many premises extending over several hectares of land. The waste is stored and processed in large halls or in outdoor areas. Conventional fire alarm systems and detection devices reach their limits in these areas. Smoke detectors either do not work at all, or do so late or only to a limited extent — especially since the video systems can issue an alert before smoke even develops. Linear heat detectors and appliances with probes or sensors also fail to provide valid results in outdoor areas and with large quantities of waste.

What if fire travels with you? – Garbage truck fires

Garbage trucks set on fire time and time again during waste collection as a result of fires developing when loading or transporting waste. Cargo fires are the most common type of truck fire found in the waste and recycling industry. There is often little indication of a problem until the material has been dumped into the truck. Air is then fed in through the airstream. Often, batteries also pose a risk. Garbage trucks crush the waste using onboard compactors. This damages batteries, which can cause them to ignite the surrounding waste. As a result, the fires can quickly develop into a free-burning problem. Once the fire has started, the only safe way to put it out is to tip the waste onto the ground where the fire department can extinguish it. A sample study from California showed that garbage truck fires have increased there. Now, one in every 14 fires is a mobile fire in a vehicle. Mobile camera systems with thermal technology can help to detect fires like these as early as possible or to avoid them altogether.

Type of Facility Affected by Year
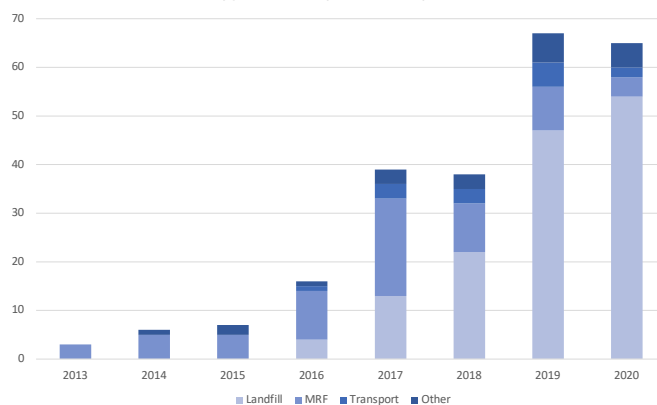
How thermal technology can overcome large areas and amounts of material

The sheer volume and weight of bulk materials overwhelms many detection and monitoring systems. In this area, systems are needed that can reliably capture the whole picture. Cameras with thermal or thermal TR technology prove to be effective tools for early fire detection. MOBOTIX systems with thermal radiometry (TR) technology and calibrated, industry-standard, high-end thermal sensors with a NETD of 50 mK measure thermal radiation throughout the entire imaging area and assign a temperature value for each pixel. Up to 20 different temperature events can be configured simultaneously in thermal radiometry windows or over the complete sensor image with a temperature range from -40°C to 550°C. This allows critical situations to be analyzed in advance and the next steps for fire prevention to be initiated. Even large detection areas such as halls or bulk material pits can be covered in this way. Using intelligent video technology, false alarms can also be avoided or drastically reduced. Vehicles such as forklifts or trucks can be detected in this way. If the hot exhaust pipe or warm engine has previously triggered an alarm, this can be avoided by using analysis software based on deep learning.
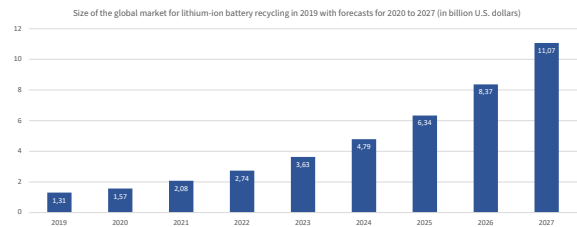
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Fire hazard: Electrical waste and batteries

Digitalization is causing mountains of electrical waste to pile up. Even countries with official systems for electrical waste management often face low collection and recycling rates. In Germany, for example, the figure is currently around 50%. However, the increasing consumption of electrical products, their short service life and difficulties in having electrical appliances repaired are exacerbating this effect. One key aspect is the disposal and recycling of batteries. The use of lithium-ion batteries is steadily increasing in industry and in private households — especially with regard to the use of renewable energies and electric vehicles. The use and storage of battery technology poses a challenge for industrial and waste disposal/recycling companies, especially in terms of fire hazards and extinguishing processes.
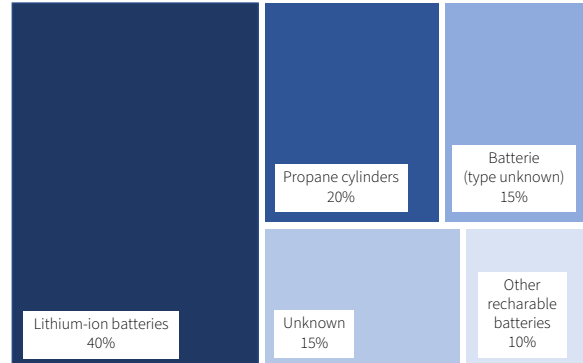
Damaged lithium-ion batteries are a recurring fire hazard in waste disposal and recycling, especially when batteries are disposed of incorrectly or when they are disposed of with other types of waste without being detected. Batteries often inadvertently end up in household waste and therefore pose a constant potential risk for landfill sites—and as mentioned previously, for garbage trucks—that is not visible to the naked eye or by purely visual monitoring. When it comes to batteries, being able to immediately detect rising temperatures is crucial. A characteristic feature of lithium-ion batteries is the high energy density. Thermal runaway poses a particular risk of battery fires, since this kind of chain reaction takes less than 60 seconds from start to explosion. This increased risk warrants special attention.

Temperature	Description
up to 1.000 °C and more	Fire with high temperature
More than 250°C	Abrupt Release of energy, danger of thermal runaway
from approx. 200°C	Exothermic reaction (fire) starts, danger of explosion
From approx. 125°C	Exothermic reaction (fire) starts, danger of explosion
60° C	Heating of the battery/accu

Size of the global market for lithium-ion battery recycling in 2019 with forecasts for 2020 to 2027 (in billion U.S. dollars)

2019	2020	2021	2022	2023	2024	2025	2026	2027
1,31	1,57	2,08	2,74	3,63	4,79	6,34	8,37	11,07

Recurring fire hazards — a hot topic

The California Product Stewardship Council, an organization which advocates stronger end-of-life management for products, conducted a survey regarding fires at waste disposal facilities in California in 2018 (California Product Stewardship Council, 2018). 83% of the waste disposal plants surveyed reported that a fire had broken out at their plant in the last two years. 40% of these fires had been caused by lithium-ion batteries, while another 25% were caused by other types of batteries (see Figure).

Lithium-ion batteries 40%
Propane cylinders 20%
Batterie (type unknown) 15%
Unknown 15%
Other recharable batteries 10%

For more information about MOBOTIX thermal imaging solutions, visi
https://www.mobotix.com/en/solutions/solution-packs/batteries

Summary:

- Large areas, large amounts of different types of materials
- Risk of fire during mobile operations (garbage trucks)
- Extensive fire protection using thermal TR technology
- Avoiding false alarms caused by vehicles
- Particular risk posed by lithium-ion batteries

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5. Process optimization for greater efficiency and sustainability

Like many other industries, the waste management and recycling industry is under extreme cost pressure, not least because many businesses, whether municipal or state-owned, pay particular attention to their budgets derived from taxpayers' money or fees. Waste management and recycling companies also have to find innovative ways to reduce costs and increase efficiency. Strict regulations regarding environmental and climate protection, health, safety and occupational safety are also forcing the industry to look for new ways to be cleaner, safer and more efficient. Technological innovations such as intelligent video technology can be a key factor in businesses meeting these growing demands.

Video technology as a process optimization tool

From a financial point of view, each of the above fire incidents has a negative impact on a company's economic performance. Despite insurance, machine downtimes, necessary adjustments to waste removal routes caused by a lack of trucks and damaged material from fire-fighting operations all lead to additional expenditure or losses. But far beyond theft and fire protection, video systems with intelligent analysis software can help companies save money and make processes more effective.

For example, intelligent video technology can help companies to make effective use of their space. For example, color coding for containers or bulk material pits can be used to automatically determine whether these unloading points are full and need to be emptied. This saves time and effort, especially for large sites. Determining whether certain storage points are being used ineffectively is almost even more interesting. For example, there may be containers or pits that are too empty. This enables you to make adjustments to containers and to find alternative uses for the space.

Intelligent video analysis can be used to automatically detect how full containers and bulk material pits are. For this purpose, the corresponding containers have been provided with colored markings. The camera's analysis software then detects whether the markers are visible or hidden and is able to draw conclusions based on this.

Access control

Due to the materials and substances stored combined with heavy-duty equipment and dangerous machinery, access for employees and visitors is strictly controlled. In addition, there are special safety-critical work areas that can only be accessed by authorized/trained personnel. Using video technology in conjunction with other access control systems enables a wide range of different access control solutions.

These range from simply identifying people or vehicles at entrances to automatic locks and barriers activated by prequalified facial and license plate recognition. Documentation can also be automated in this way.

Occupational safety and employee management

When it comes to the safety and management of employees, companies use video in many areas. Incidents are recorded accurately and can be used as part of staff training. Videos showing best practice processes help new employees to act properly and avoid errors and accidents. Sometimes it is incredibly easy to see how not to do something. Videos are also useful for capturing and clarifying workplace incidents and providing evidence for further analysis. Today, intelligent video technology is even capable of detecting protective clothing such as helmets or safety vests. If this equipment is missing, the relevant employees can be notified automatically.

Summary:

- Profitability in waste disposal and recycling
- Process optimization (examples of area container management)
- Access control
- Occupational safety and employee management

Sources

Bayerischer Rundfunk; BBC News; California Product Stewardship Council; Statistics of German Social Accident Insurance; EPA United States Environmental Protection Agency; European Commission; Eurostat; EUWID Europäischer Wirtschaftsdienst GmbH 2022; Forti V., Baldé C.P., Kuehr R., Bel G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam; Gilium & Hinternberger; Global Waste Management Outlook United Nations Environment Programme, 2015; Innofact market research; Recyclingnews; Reisinger & Krammer; Spiegel Magazine; Statista; UNU Global E-Waste Monitor; US Pipeline and Hazardous Materials Safety Agency

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