GSMA

# IoT and Essential Utility Services:
# **Kenya market case study**

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# Introduction

**GSMA Intelligence forecasts that smart utilities Internet of Things (IoT) connections will total 3.5 billion globally by 2030, up from 1.7 billion in 2021**. Growth will be particularly strong in low- and middle-income countries (LMICs), where many companies are still in the early stages of their IoT journeys. In Sub-Saharan Africa, for example, smart utilities connections will increase almost six-fold between 2021 and 2030, reaching 152 million. By 2030, utility solutions will account for nearly 30% of IoT connections in the region.

**Mobile-enabled digital solutions are uniquely placed to address the challenges facing utility sectors**, including water shortages, lack of sanitation, unreliable power and insufficient waste management. IoT is pivotal to many digital solutions, often working in tandem with other mobile technologies.

**This case study is one of five detailed market case studies examining IoT deployments in 17 key use cases across five verticals:** energy, water, transport, sanitation and waste management. It also examines broader market conditions and enablers of IoT solutions.

**This case study is a stand-alone document, but can also be read alongside two recent GSMA reports on IoT deployments:**

— *IoT for Development: Use Cases Delivering Impact* – this report provides a more detailed discussion of the solution architecture for IoT, data on the connectivity options in 62 LMIC markets in Sub-Saharan Africa and South and Southeast Asia, and discusses use cases across the climate, health, agriculture and humanitarian sectors.

— *IoT and Essential Utility Services: Opportunities in Emerging Markets* – this report summarises the IoT opportunity across the the utilities sectors and draws together lessons from the five market case studies.

**The 17 IoT use cases we examined are in no way an exhaustive list**, but were selected as the use cases most likely to be implemented in the five markets we reviewed, and have significant benefits for utility providers and customers. Annex 1 provides additional details on the use cases and key benefits that can be expected from IoT deployments.

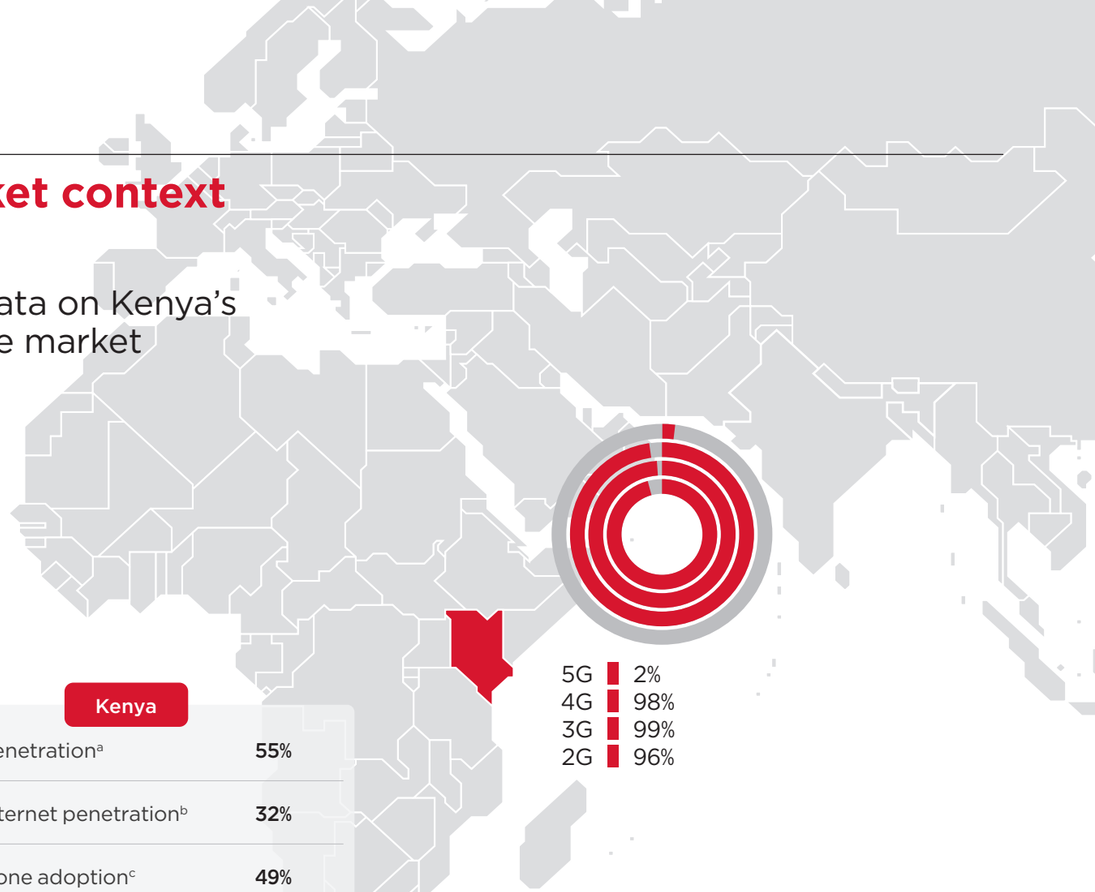
This case study begins by discussing the national context and trends across use cases before turning to discuss the sector verticals and key IoT deployments identified within them.




# Market context

Figure 1

Key data on Kenya's mobile market




| Kenya | |
|---|---|
| Mobile penetration[a] | 55% |
| Mobile internet penetration[b] | 32% |
| Smartphone adoption[c] | 49% |
| Made or received a digital payment | 69% |
| GSMA Mobile Connectivity Index (MCI) score (out of 100)[d] | 53 |
| LPWANs: | NB-IoT, Sigfox, LoRaWAN (open community network only) |

Notes on indicators: a) defined as unique mobile subscribers as a percentage of the population, b) defined as unique mobile internet subscribers as a percentage of the population, c) percentage of connections, d) the GSMA Mobile Connectivity Index measures the performance of 170 countries – representing 99% of the global population – against key enablers of mobile internet adoption: infrastructure, affordability, consumer readiness and content and services. More details can be found at: mobileconnectivityindex.com.

Source: GSMA Intelligence for all indicators except "made or received digital payment", which is from the World Bank's Findex Database 2021. Data accurate as of December 2022.

**In 2021, the Kenyan government outlined their Digital Economy Strategy, which aims to increase the contribution of the ICT sector to GDP from 2% in 2020 to 10% by 2030**.[1] This will require Kenya to accelerate the adoption of mobile technologies, including IoT, across multiple areas of the economy. The Digital Economy Strategy identifies three policy areas to maximise the potential of IoT: i) ensuring allocation and effective management of spectrum resources; ii) increasing efforts to standardise affordable IoT devices and sensors; and iii) supporting the local assembly of end-user hardware.

**Kenya continues to make progress on several of the dimensions important to IoT deployments.** First, investments in mobile broadband coverage and strong adoption of mobile money payments have enabled decentralised utility services to scale. LPWA technologies are becoming steadily more available thanks to roll-outs from Safaricom (NB-IoT) and Liquid Telecom (Sigfox), and there has also been a recent expansion in data centre capacity.[2] Both these connectivity providers offer IoT platforms and integration services. Liquid Telecom also manufactures IoT devices, an area

1. Ministry of Information, Communication, Technology, Innovation and Youth Affairs. (2021). *Digital Economy Strategy*.
2. Swinhoe, D. (20 January 2023). "Africa Data Centres breaks ground on Nairobi expansion in Kenya". *Data Centre Dynamics*.

where Kenya's ecosystem is still nascent. Another area where there is room for improvement is the affordability of mobile internet services and devices. According to the GSMA Mobile Connectivity Index, Kenya currently ranks lowest among the five study countries on this indicator, thereby limiting mobile internet adoption.[3]

**Fast-growing access to mobile and mobile technologies has provided fertile ground for IoT innovation in Kenya**. The country is a regional leader in many areas, including the use of microgrid technology and pay-as-you-go (PAYG) solar. IoT innovation should continue, spurred by the roll-out of LPWA technologies and a burgeoning IoT hardware ecosystem.

**Still, there are significant obstacles to IoT adoption in some areas**. Like many utility providers, Kenya's energy and water utilities operate in challenging financial environments that make it difficult to justify investments in new technologies. In other sectors, such as sanitation and waste, hardware costs and a limited local ecosystem have prevented the adoption of IoT at scale.

3. GSMA Mobile Connectivity Index: https://www.mobileconnectivityindex.com/

Figure 2

## Heatmap of IoT in Kenya's utilities sectors

| | Focus areas | | | |
|---|---|---|---|---|
| **Energy** | Smart metering | Smart grids | Microgrids | PAYG cooking |
| **Water** | Smart metering | Water ATMs | Water treatment | Supply network monitoring |
| **Sanitation** | Wastewater monitoring | Smart toilets | Pit fill level monitoring | - |
| **Waste management** | Smart bins | Smart recycling | - | - |
| **Transport** | Smart public transport systems | Electric vehicles (EVs) | Asset tracking | Drones for deliveries |

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**Factors assessed**: Number of deployments, suitability of connectivity options, hardware avaibility, number of solutions provider, funding requirements

**Source: Authors' assessment based on market research and interviews with key actors**



# Energy

**Kenya Power owns and operates most of the electricity transmission and distribution system in Kenya and sells electricity to more than 8 million households**. Although the use of IoT in their operations remains limited, Kenya Power has recently deployed smart meters to 55,000 small and medium enterprise (SME) customers as part of a World Bank-funded project.[4] Kenya Power also recently issued a tender for another 700,000 meters.[5] A recent proposal from Safaricom provides an alternative funding model, whereby the mobile operator pays for the installation of a smart metering system and then splits the savings from reduced energy losses with the utility service provider.[6] KenGen, the country's largest power producer, has also integrated IoT at some of their geothermal sites for remote monitoring.[7]

**Broadening energy access by linking microgrid technology with mobile payments and IoT is a key part of Kenya's energy strategy**.[8] Kenya is the regional leader in terms of microgrid deployments, accounting for two-thirds of microgrids identified by the Africa Minigrid Developers Association (AMDA).[9] Few of the large-scale meter companies provide affordable household meters to suit the demands and conditions of minigrids. This has contributed to the rise of specialist companies, such as SteamaCo, which have built IoT platforms that combine smart hardware and cloud-based technology.

**Kenya has also pioneered the use of PAYG solar home systems (SHS) to provide cost-effective energy solutions**. These small solar photovoltaic (PV) systems are capable of powering light bulbs and small appliances in addition to charging mobile phones. The rapid growth of PAYG solar has been enabled by Kenya's high uptake of mobile money, which allows customers to pay in instalments, and the use of IoT, which enables companies to remotely control and monitor the SHS. The model of using mobile phones to make clean energy accessible and affordable through mobile payments and IoT is also being replicated in other sectors in Kenya, such as water (CityTaps), irrigation (SunCulture) and clean cooking (M-Gas and SimGas). This drives the adoption of mobile money services and supports new revenue streams for mobile operators.[10] Kenyan company PowerPay are is building an IoT module that can turn productive use and e-cooking devices into IoT- and PAYG-enabled, paving the way for more opportunities.

# Water

**A range of LPWA technology supports Kenya's water utilities and innovators**. For example, Safaricom's narrowband IoT (NB-IoT) network has been used for smart meter pilots in Kisumu,[11] Embu[12] and Eldoret,[13] among others, and has led to an IoT product line for water. Additionally, CityTaps has leveraged LoRaWAN connectivity for their smart meter solution and Liquid Telecom has demonstrated how their Sigfox network, which covers 90% of Kenya's population, could be used for a range of solutions in the water sector using hardware from Kamstrup.[14] Smart meters have also been deployed by various utilities, but usually focus on large water consumers, such as kiosk providers and businesses.[15] Providers such as Maji Milele are also providing water ATMs independently and in partnership with utilities and other providers.

**Despite the range of connectivity options available, smart metering deployments have struggled to move past the pilot stage**. This reflects the challenge of generating a return on investment from these deployments given Kenya's low water tariffs and relatively high cost of smart

4. Smith, T. (24 January 2022). "Kenya Power to start smart meter rollout for businesses". *ESI Africa*.
5. Mutua, J. (13 February 2023). "Kenya Power to get smart meters from local firms". *Business Daily Africa*.
6. Nhede, N. (12 October 2021). "Safaricom wants to install smart meters for Kenya Power". *Smart Energy International*.
7. Cariaga, C. (24 August 2022). "Yokogawa completes IoT systems installation at Olkaria geothermal complex". *Think Geoenergy*.
8. In December 2018, the government launched the Kenya National Electrification Strategy (KNES), a roadmap for achieving universal access to electricity by the year 2022.
9. AMDA represents 30 companies (encompassing all market leaders) that are operating minigrids across 12 African countries. Data from: AMDA. (2021). Benchmarking Africa's Minigrids.
10. Snel, N. et al. (2020). The Value of Pay-as-you-go Solar for Mobile Operators. GSMA.
11. White, Z. and Lemasagarai, J. (2022). *Water Utility Digitalisation in Low- and Middle-Income Countries: Experiences from the Kenyan water sector*. GSMA.
12. Safaricom. (3 June 2020). "Smart meters are helping to track water on the internet. Here is how."
13. Microsoft. (5 October 2021). "Upepo Technology Company Limited". *Customer stories*.
14. Liquid Telecom. (2021). "Connected Water".
15. White, Z. and Lemasagarai, J. (2022). *Water Utility Digitalisation in Low- and Middle-Income Countries: Experiences from the Kenyan water sector.* GSMA.

meter deployments. This is demonstrated by the cost of smart meter hardware. Local company Mobi-Water sells smart meters to water utilities and water kiosks for prices starting from Ksh 12,500 ($100), while interviews with local stakeholders indicate that the price of smart meters from global manufacturers that sell hardware via Kenyan channel partners ranges from $50 to $200 per unit depending on functionality.

Spotlight 1

## IoT innovations in the Kenyan water sector

**Smart metering**: CityTaps has developed a solution called CTSuite that combines a smart and prepaid water meter (CTMeter) and an integrated software management system (CTCloud) that processes PAYG payments through mobile money. The solution is connected via LoRaWAN, leveraging Kerlink's Wirnet iBTS outdoor gateways. CityTaps has worked with water utilities in Kenya, such as MAWASCO, as well as organisations in Burkina Faso, Mali, Niger and Senegal.

**Smart metering**: In October 2019, Safaricom began a pilot with Upepo Technology to provide remote monitoring of water consumption for EWASCO. The pilot used NB-IoT to relay real-time data from smart meters in 20 households to the Microsoft Azure Cloud with analytics powered by Esri Eastern Africa's ArcGIS Platform.

**Water ATMs**: Majik Water is a Kenyan social enterprise that specialises in air-to-water technologies in arid and semi-arid regions. They have built a machine that draws in air and forces it through an electrostatic filter. From there, the air goes through a condensation coil where a compressor circulates refrigeration. As the units are frequently installed in remote corners of the country, sensors are used to monitor the relative performance of the units, enabling issues to be detected remotely.

**Smart metering aside, Kenyan water utilities have been relatively cautious about testing IoT applications**. A recent GSMA study of four water utilities in Kenya, selected based on their size and recent efforts to digitalise their operations, showed that only one had introduced sensors across their network to get a better view of the flow of water throughout the system.[16] Furthermore, there is limited evidence of utilities in Kenya using IoT for other use cases, such as water treatment and purification.

# Sanitation

IoT activity in the sanitation sector has been concentrated in and around Nairobi's informal urban settlements, which have absorbed much of the capital's population growth in recent years. This is creating an urgent need for solutions that improve sanitation facilities. Implementing more advanced IoT use cases, such as fill level monitoring to detect overflows, has proven challenging. Placing sensors in toilet and pit latrines requires customised mounting and installation, as well as the additional costs of placing protective casing around the sensors to guard against the corrosive environment. Mobile Alert Toilets (MAT) built their own custom sensors and software for fill level monitoring, which cost roughly $145 per unit.[17] However, it was ultimately unable to scale operations to the level needed to reduce sensor costs, so it stopped using the technology

# Waste management

**Of the five utility sectors in Kenya, IoT is least prevalent in waste management**, reflecting the constrained budgets of the municipalities and private companies responsible for collecting waste. This is indicative of the use of IoT in waste management in Africa as a whole. The ecosystem is nascent with few local solution providers or hardware makers. Organisations responsible for waste collection must therefore look outside the region for relevant partners.

16. Ibid.
17. For more information, see: Klu, J., Wamburu, D. and White, Z. (9 March 2021). "Mobile Alert Toilets: Using sensors to improve waste management in sanitation". *GSMA Mobile for Development Blog.*



Spotlight 2

## Smart waste management in Kenya

Kenyan waste management company TakaTaka Solutions recently announced a partnership with Evreka, a global software-as-a-service (SaaS) company providing smart waste management solutions, such as waste container monitoring and waste vehicle tracking. This partnership is the first step in Evreka's expansion into Africa.

TakaTaka has deployed Evreka's UG-03 monitoring device, which embeds various sensors in their ultra-durable casing to support smart waste management. For example, a long-range ultrasonic transducer is used to measure fullness levels. This data, together with temperature and motion sensors, are combined, allowing the cloud platform to detect important incidents such as (unauthorised) container location changes, fire or sudden movements. A monitoring device with these kinds of capabilities typically costs around $150.

Evreka's solution incorporates global IoT connectivity modules, SIM cards and data plans from Telit that support 4G networks. This option means that Evreka does not have to manage relationships with mobile operators in the more than 20 markets in which it operates. Rather, it can use the same modules and SIM cards from Telit for all deployments, saving time and reducing complexity.

While it is too early to gauge the success of TakaTaka's partnership with Evreka, the partnership is a sign of growing interest from global companies in applying IoT-based waste management solutions in Sub-Saharan Africa. This is likely to be an important driver of IoT growth in the sector.

**Figure 3,** Evreka UG-03 device and platform

**Source: Evreka**[18]

# Transport

**The transport sector has emerged as a key vertical for mobile operator IoT strategies in Kenya. Safaricom and Airtel offer a range of fleet management and asset tracking solutions** via 2G, 3G and 4G networks. Liquid Telecom offers similar solutions, having deployed their Sigfox network across major transport routes in the country.

**Connectivity providers in Kenya are supported by a growing ecosystem of Kenya-based hardware and software companies with local teams.** Examples include Navitrac, Numeral IoT, Safetrac Limited and Tramigo. Growth in the sector underlines the importance of transportation to the Kenyan economy. As the main cargo hub for Eastern Africa, the sector contributes around 8% of GDP, making it the second highest contributor behind agriculture.

**Implementing IoT solutions for public transport in Kenya is more challenging**. The country's public transport system is dominated by privately owned public service vehicles that include buses and minibuses (known as matatus). The fragmented nature of this system makes it harder to use IoT technologies to build an integrated transport network. Instead, efforts have focused on using IoT to improve public transport safety (e.g. Smart Matatu) and connect point-of-sale terminals on buses (e.g. Mobitill Transit).

**Electric vehicles (EVs) are an emerging sector in Kenya, with leading start-ups breaking ground**. Kenyan companies like Roam, Basi-go and Kiriev are introducing EV manufacturing and supply, as well as pay-as-you-drive financing. Rwanda-based EV manufacturer Ampersand has also recently launched operations in Kenya,[19] partnering with Bboxx to address the financing barrier.[20] Additionally, the first beyond visual line of sight (BVLOS) flight certification for a drone delivery service was just issued, paving the way for the deployment of other drone use cases.[21]

18. For more information, see: https://evreka.co/wp-content/uploads/2021/01/Evreka-Sense-1.pdf
19. Associated Press. (11 February 2023). "Kenya's Electric Transport Plan for Clean Air, Climate". *VOA*.
20. Bboxx. (12 October 2022). "Bboxx partners with Ampersand to provide thousands of taxi e-motos for drivers in Rwanda". Press release.
21. ADS Advance. (1 June 2022). "Skyports and partners launch Kenya's first BVLOS drone deliveries".

# Annex 1:
# Use cases considered in the research

| Sector | Use case | Description | Benefits | Device(s) |
|---|---|---|---|---|
| **Energy** | Smart metering | • Accurately records and automatically transmits energy usage data in real time | • No longer need to send staff to customers' premises to read their meter or rely on customers to report the meter reading themselves<br>• Allows utilities to introduce time-based tariffs to manage demand<br>• Allows for alternative energy planning and modelling<br>• Allows for cost savings, energy theft monitoring, etc. | Meters |
| | Smart grid | • Tracks the distribution network in real time, providing measurements of voltage sags, swells, interrupt information and other metrics | • Enables energy companies to redirect resources when demand on the grid is increasing<br>• Find and resolve faults more quickly, improving the customer experience<br>• Reduced risk of fines from service level agreement (SLA) breaches | Sensors (e.g. current, voltage) |
| | Microgrids | • Sensors embedded on solar photovoltaic (PV) installations (e.g. a microgrid run by a smallholder or large-scale solar farm) to monitor production and distribution | • Avoids fossil fuel-derived emissions (mostly coal)<br>• Optimises power consumption at residential and industrial premises by using stored energy (rather than relying on the grid) | Meters, sensors (e.g. current, voltage) |
| | PAYG cooking and SHS | • IoT-enabled devices include connected LPG cylinders and electromagnetic induction stoves<br>• Solutions collect usage data and relay information to users (e.g. reminders to charge battery, make payments) | • Make services more affordable for poor consumers because they can make micropayments<br>• Enables credit scoring for unbanked users<br>• More effective revenue collection for service providers | Meters, sensors (e.g. temperature), GPS |



| Sector | Use case | Description | Benefits | Device(s) |
|---|---|---|---|---|
| **Water** | Smart metering | • Accurately records and automatically transmits water usage data in real time | • Lower staff costs and improved reading accuracy<br>• Leaks are easier to identify and fix, enabling utilities to reduce their NRW costs<br>• Introduce new services (e.g. a PAYG option for lower income customers)<br>• Provides visibility into water contamination and pH levels | Meters |
| | Water ATMs | • ATMs automatically dispense water for which customers prepay<br>• ATMs are IoT-enabled, allowing real-time monitoring | • Provides visibility into the volume of water dispersed and number of users<br>• Measures leakage and water quality<br>• Some solutions combine water ATMs with a water treatment solution for purifying water | Meters, connected water purifiers, pH sensors |
| | Water treatment | • Tracks filter usage to ensure filters are replaced on time to avoid contaminants entering the system<br>• Measures the chemical properties of downstream water | • Helps to prevent compliance issues by keeping alkalization of water within permissible levels and avoiding potential health risks<br>• Reduces system downtime and maintenance | Connected water purifiers, pH sensors, oxidation reduction potential (ORP) sensors |
| | Supply network monitoring | • Monitors water pressure and flow in pipes to detect leaks and predict bursts<br>• Measures the temperature of the output of the safety valve, which falls rapidly before leakage occurs | • Enables the early detection of faults to avoid unscheduled shutdown and maintenance<br>• Improves uptime of water pipe network | Water flow meter, sensors (pressure, temperature) |
| **Sanitation** | Wastewater monitoring | • Placing sensors in sewer lines and waterways to monitor the flow of sewage, breakage and leakage | • Improves understanding of pathogen levels in rivers<br>• Improves understanding of sewage value for upcycling | Sewer level monitoring sensor, acoustic sensor, camera |
| | Smart toilets | • Provides insights into public toilet usage and cleanliness | • Automates toilet cleaner, reducing maintenance needs | Ambient monitoring sensor, motion sensors |
| | Pit fill level monitoring | • Use of IoT devices to monitor and send alerts on fill levels and overflows<br>• Can be combined with real-time tracking of service vehicles | • Ensures safer and more efficient disposal of faecal sludge for a cleaner and healthier city | Fill level sensor, vehicle tracker |

| Sector | Use case | Description | Benefits | Device(s) |
|---|---|---|---|---|
| **Waste management** | Smart bins | • Enables the location and fill level of waste containers to be monitored remotely<br>• Often combined with real-time tracking of service vehicles | • When a waste container is almost full, an alert is set to arrange a pickup even before the pre-scheduled time<br>• Understanding the geography of emptying patterns helps to forecast future needs | Trackers (container, vehicle, workforce), fill level sensor, temperature sensor |
| | Smart recycling | • IoT devices can be used to weigh recyclable waste<br>• More sophisticated machinery can be used to automate waste segregation | • Increases recycling rates<br>• Reduces open degradation of organic waste (and the growth of microorganisms) | Scales, sensors (e.g. ultrasonic, colour), servomotor |
| **Transport** | Smart public transport | • Real-time tracking of public transport vehicles allows transport operators and commuters to see where vehicles are<br>• Transport operators can receive additional data on how vehicles are driven | • Passengers benefit from a more predictable and reliable public transport service<br>• Enriches the quality of long-term public transport and urban planning<br>• Onboard cameras can improve driver and rider safety | Vehicle tracker, CCTV cameras |
| | EVs | • Sensors on EVs to monitor fuel consumption and routing<br>• EV charging point sensors provide location beacons for passing EVs | • CO2 savings from substituting fossil fuels for electricity and embedding sensors in EVs<br>• Charging point sensors avoid wasted emissions from searching for a charging point | Charging point sensors, EV sensors |
| | Asset tracking | • IoT devices can be attached to shipping containers, trailers, pallets and even individual packages to monitor transportation | • Reduces lost items<br>• Helps companies ensure their products are being transported under the right conditions | Trackers and sensors (e.g. temperature, humidity, moisture) |
| | Drones for deliveries | • Drones can be used to deliver items (e.g. medical supplies) from one location to another | • Provides a more environmentally friendly and efficient delivery service (in certain conditions) compared with traditional methods | Light detection and ranging (LiDAR) sensors, GPS/ GNSS, gyroscopes, accelerometers |

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