

IoT for Environmental Monitoring: Reducing Costs and Enhancing Eco-Protection



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Reading time 16 mins

Key Points

- IoT for environmental monitoring has paved the way for industries and businesses to transform their ability to respond to changes in their surroundings (e.g. pollution, water contamination, natural habitat loss/degradation) in real time and manage their resources (e.g. energy consumption) optimally.
- This involves using sensor-based devices to measure and monitor various environmental factors (e.g. soil, atmosphere, and water), catalogue and store data, and provide actionable insights.
- Diverse industries – from agriculture, energy, and transportation, to healthcare, retail, and waste management – are leveraging these technologies to improve operational efficiencies, reduce carbon footprint, and comply with government regulations.
- Key benefits include remote controllability, push/instant notifications, cost savings, and improved security.
- The market size for IoT-based environmental monitoring technologies was estimated at \$14.5 billion in 2021 and is forecasted to reach 17.9 billion by 2026, growing at a compound annual growth rate of 4.5%.
- Growth is driven by government regulations, increased public awareness regarding conservation and resource depletion, more companies prioritising sustainability, and a need to mitigate environmental risks and improve resilience.
- Challenges include security concerns, data privacy issues, and high initial implementation costs.

- However, these challenges open doors for opportunities, e.g. more secure and cost-effective IoT solutions.

Call us for cost-effective and user-intuitive environmental monitoring solutions to boost efficiency or expand your product range.

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In the past, environmental monitoring was mostly used for ecological purposes (e.g. measuring glacial melting) and was typically time-consuming with low accuracy levels. However, the Internet of Things (IoT) has emerged as a game changer: For industries and commercial enterprises needing to transform their ability to respond to changes in their surroundings in near-real-time, IoT for environmental monitoring has paved the way for innovative solutions to do just that. For example, smart sensors in manufacturing plants monitor air quality and emissions in real-time, ensuring compliance with environmental regulations, minimising carbon footprint and avoiding penalties.

At Ignitec, environmental monitoring is one of the foundational cornerstones of our work, the technologies we develop, and the solutions we provide. The numerous cost-saving, productivity-enhancing, and sustainability-building benefits of IoT for environmental monitoring might be new

territory for some. However, we've been navigating this terrain for over a decade and have the expertise to get our clients to their final destination on time, within budget, and in style! Call us for a quote.

Our work

Aarhus University

Autonomous Robotics

Environmental Monitoring Services

Environmental Sensors: A key innovation area in IoT

If you're new to our blog and unfamiliar with the Internet of Things (IoT), please read our previous blogs for more insights into how this technology has revolutionised almost every industry – from [agriculture](#) and [ocean deplastification](#) to [healthcare](#) and [household waste](#).

[Environmental monitoring](#) involves using sensor-based devices to measure various environmental factors (e.g. soil, atmosphere, and water). These sensors monitor and analyse the environment for purposes such as air quality management, agricultural and meteorological research, and environmental conservation. IoT for environmental monitoring:

- Facilitates the development of wireless, remote monitoring systems.
- Enables operations to remove much of the human interaction in system function, which reduces human labour.
- Increases the range and frequency of sampling and monitoring.
- Facilitates sophisticated on-site testing, provides lower latency, and connects detection systems to response teams
- Results in higher rates of disaster and contamination prevention.

Four [essential components](#) of any IoT-based environmental monitoring system (EMS):

1. **Monitor** the environment to gather and deliver critical information accurately and reliably.
2. **Measure** and evaluate critical data points that indicate everything from water, chemical, and toxic leaks to equipment failures.
3. **Catalogue** and store data for easy accessibility.
4. **Provide actionable insights** from data analysis such as alerts, notifications, and recommendations for action to conserve resources and prevent disasters.

How do different industries leverage IoT to monitor the environment?

The biggest appeals of IoT are its accessibility, versatility, and practicability. Environmental monitoring is one of the most significant concerns of our time. Thus, both public and private sectors are turning to technologies such as IoT to provide solutions – and they haven't been disappointed! Some examples include:

- 1. Agriculture:** IoT-enabled soil sensors provide farmers with precise data on soil moisture, nutrient levels, and temperature. This data-driven approach allows for optimised irrigation and fertilisation, reducing water and resource usage while maximising crop yield. Read our post on [IoT in smart agriculture](#) and the agritech technologies on the 'brink of explosive growth'.
- 2. Energy:** IoT devices on wind turbines collect data on wind speed, direction, and turbine performance. Real-time monitoring enhances predictive maintenance, improves energy efficiency, and ensures reliable energy production in the renewable energy sector.
- 3. Transportation:** Connected vehicles equipped with environmental sensors measure air quality levels during transit. This data helps municipalities identify pollution hotspots, implement targeted interventions, and improve urban air quality.
- 4. Healthcare:** IoT devices in healthcare facilities monitor and control environmental factors such as temperature and humidity. This ensures optimal conditions for patient comfort and the preservation of medical supplies, contributing to a healthier and more sustainable healthcare environment.
- 5. Water Management:** Smart water meters with IoT sensors detect leaks and monitor water quality in distribution networks. Water utilities can proactively address issues, reduce wastage, and ensure clean water delivery to consumers.
- 6. Construction:** IoT sensors monitor noise, dust levels, and vibration. This real-time data allows construction companies to implement measures to minimise environmental impact and adhere to regulatory standards.
- 7. Retail:** IoT-based energy management systems can monitor and control store lighting, heating, and cooling. This optimises energy consumption, reduces operational costs, and contributes to sustainable business practices.
- 8. Waste Management:** IoT sensors in waste bins and collection vehicles provide real-time information on fill levels. This data enables efficient route planning for waste collection, minimising fuel consumption and reducing the environmental impact of transportation.

Are you interested in leveraging IoT technologies to innovate and upgrade your product range? Call us for a quote for agile, efficient, and secure end-to-end solutions that will help you retain a competitive edge for years to come!

How do businesses benefit from using an environmental monitoring system (EMS)?

Soaring energy prices alone are reason enough to implement an environmental monitoring system – even if only to ensure we use appliances intelligently to reduce costs. However, the [benefits of IoT for environmental monitoring](#) go beyond that.

Remote controllability is the ability to remotely access, monitor, and control parameters such as temperature, humidity, and airflow by connecting from any device with an internet connection. For facilities that aren't continuously accessible and where environmental conditions are essential (e.g. data centres, warehouses, health and food stores), remote capabilities prevent the loss of unrecoverable data or merchandise damage.

Push/Instant notification features are configured for different parameters (i.e., quick actions in case of fire, water leakage, or unauthorised access versus SMS alerts for slight fluctuations in temperature).

Savings. Be it a reduction in energy consumption or the workforce needed to monitor, control, and report every environmental parameter, an EMS is fast becoming a must-have for every business tool kit. Add the ability to take quick action against problems that may lead to significant financial losses (e.g. warehouse fire) or a data security breach (e.g. banks); businesses without an EMS may face greater losses in the long run.

Security is a crucial part of every business. An EMS also provides control of situations such as unauthorised access, theft, power failures, fire, etc, due to equipment such as motion sensors, water leakage sensors, and smoke sensors.

Who are the leading companies in IoT for Environmental Monitoring?

Several companies are at the forefront of developing cutting-edge IoT solutions for environmental monitoring. These companies are not only contributing to the development of sophisticated sensors but also integrating data analytics and artificial intelligence to derive meaningful insights. [Top IoT companies worldwide](#) include:

[Microsoft's Azure IoT](#): Arguably, it is one of the largest ecosystems in the industry, with a network that benefits from thousands of partners. It deploys hundreds of proven, repeatable solutions for remote monitoring, predictive maintenance, manufacturing efficiency, facilities management, and connected products, allowing data to be exchanged between the product and its user, manufacturer, or environment.

[AWS \(Amazon Web Services\)](#): Collects, stores, and analyses IoT data for industrial, consumer, commercial, and automotive workloads.

[Siemens smart building IoT solutions](#) improve operational efficiency, increase staff productivity by enhancing well-being and optimise space and asset utilisation.

[Cisco](#): Best known for providing robust, simple, and secure end-to-end solutions to help businesses such as Audi to transform their operations and enhance efficiency and sustainability with new sensors and smart devices.

Top 10 emerging innovators of IoT environmental technologies

According to a [GlobalData Report](#) (published November 2022) on environmental sensors innovation and trends analysis, over 3.6 million patents were filed and granted in the technology industry three years prior. The report identified environmental sensors as a disruptive technology in its early stages of application that merited close tracking and highlighted ten companies – based on the number of patents they had filed – that were worth watching.

1. Nike: footwear with sensor systems.
2. SoftBank Group: temperature control products for better sleep.
3. MyOmega Systems GmbH: blockchain and sensor devices to track containers.
4. Xiaomi: smart face masks with sensors to protect against pollution and viruses.
5. Samsung Group: integrated multi-sensor module.
6. Honeywell International: air purification subsystems.
7. State Grid: power transmission equipment.
8. China General Nuclear Power: a warm water discharge monitoring buoy for nuclear power plants.
9. Continental: vehicle-mounted optical and sensor cleaning system
10. Hitachi: EMS with a plurality of sensors

Nike topped the list for being one of the leading patent filers in environmental sensors, with Continental and Hitachi having the biggest geographic reach. MyOmega Systems ranked the highest regarding application diversity, followed by Samsung and Nike.

What's the market size for IoT-based environment sensors?

The [global environmental monitoring market](#) was estimated to be worth \$14.5 billion in 2021 and is forecasted to reach 17.9 billion by 2026, growing at a compound annual growth rate of 4.5%. Market growth is being driven by:

- Companies rearranging their operations and ESG (environmental social governance) priorities.
- Increasing public awareness of health and sustainability implications of environmental pollution (i.e. soil, water, and air) and resource scarcity/depletion.
- Increasing need for efficient natural resource management
- Increasing government emphasis on compliance with pollution monitoring standards.
- Increased investment in environmental monitoring systems, solutions, and technologies
- An understanding that efficient use of natural resources minimises wastage and supports economic growth for countries that rely on it for revenue generation
- A need to mitigate risks and become more resilient.

The growth trend in the IoT for environmental monitoring market is expected to continue on an upward trajectory. As advancements in sensor technologies, connectivity, and data analytics continue to unfold, the market is poised for substantial expansion. The integration of IoT in environmental monitoring is becoming more sophisticated, allowing for real-time data collection, analysis, and proactive decision-making.

At Ignitec, our 10+ years of software and electronic hardware design and expertise in sensor integration to enhance system efficiency are world-class. Schedule a free consultation with an expert on our team to discuss the solutions to help your business cement its market positioning and contribute to industry growth.

Environmental sensors' market restraints, challenges, and opportunities

While IoT presents unprecedented opportunities for environmental monitoring, it is not without its restraints and challenges.

The ability to continuously monitor and measure variables over long periods is an essential function of any EMS, as long-term surveillance is critical. However, the performance efficacy of sensors in 24/7 monitoring mode can diminish over time, thus reducing their lifespan. In addition, security concerns, data privacy issues, and the high initial implementation costs are notable challenges.

However, these challenges and restraints open doors for opportunities, such as developing more secure and cost-effective IoT solutions and creating a dynamic market that fosters innovation and global accessibility.

Current Trends in IoT for Environmental Monitoring

Several trends are shaping the landscape of IoT for environmental monitoring. One prominent trend is the integration of machine learning algorithms to enhance the accuracy of environmental predictions. Additionally, drones equipped with IoT sensors are gaining traction, enabling efficient monitoring of remote or hard-to-reach areas. Cloud computing is also playing a pivotal role, facilitating the storage and analysis of vast amounts of environmental data.

IoT's Role in Monitoring Environmental Changes

The real-time monitoring capabilities of IoT are instrumental in tracking environmental changes across various ecosystems. Sensors can measure air and water quality, soil conditions, and wildlife behaviour, providing a comprehensive understanding of environmental dynamics. This data enables scientists, policymakers, and conservationists to make informed decisions, respond to emerging threats, and implement targeted conservation strategies.

Final thoughts on IoT technologies for monitoring the environment

Integrating IoT for environmental monitoring represents a paradigm shift in approaching eco-protection and ensuring a sustainable future. As leading companies, startups, and entrepreneurs continue to innovate and the market expands, the synergy between technology and conservation efforts will only strengthen. Challenges will be overcome, opportunities will be seized, ultimately leading to a more sustainable and resilient planet. The transformative power of IoT for environmental monitoring is not just about reducing costs but, more importantly, enhancing our ability to safeguard the environment for generations to come.

If you're keen to become a part of this paradigm shift – to improve the operational efficiency of your business or expand your product offerings into new markets – contact us. We'll tailor-make a solution to suit your needs, overcome restraints, and give you a competitive edge for years to come!

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FAQ's

Why is IoT for environmental monitoring important?

IoT for environmental monitoring is crucial because it enables real-time tracking of environmental parameters, helping us understand changes and implement timely interventions. This technology contributes to informed decision-making in conservation efforts and ensures the sustainable management of natural resources.

How does IoT aid in cost-effective environmental conservation?

IoT facilitates cost-effective environmental conservation by optimising resource utilisation, reducing energy consumption, and minimising waste through real-time monitoring. Predictive analytics also play a role in preventing environmental incidents, saving costs associated with clean-up and restoration efforts.

What role does IoT play in monitoring environmental changes?

IoT plays a pivotal role in monitoring environmental changes by deploying sensors that measure air and water quality, soil conditions, and wildlife behaviour. This data provides a comprehensive understanding of environmental dynamics, allowing for informed decision-making and targeted conservation strategies.

What are the current trends in IoT for environmental monitoring?

Current trends in IoT for environmental monitoring include the integration of machine learning algorithms for accurate predictions and the use of drones equipped with IoT sensors for efficient monitoring of remote areas. Cloud computing is also playing a crucial role in storing and analysing vast amounts of environmental data.

Which companies are leading in IoT for environmental monitoring?

Leading companies in IoT for environmental monitoring include IBM, Cisco, and Schneider Electric. These companies are at the forefront of developing sophisticated sensors and integrating data analytics and artificial intelligence to derive meaningful insights for environmental conservation.

When did the growth trend in the IoT for environmental monitoring market start?

The growth trend in the IoT for environmental monitoring market has been steadily increasing in recent years, driven by advancements in sensor technologies, connectivity, and data analytics. This trend reflects the rising awareness of environmental issues and the need for sustainable practices across industries.

How do IoT devices on wind turbines contribute to environmental monitoring?

IoT devices on wind turbines collect data on wind speed, direction, and turbine performance, contributing to real-time environmental monitoring. This data enhances predictive maintenance, improves energy efficiency, and ensures reliable energy production in the renewable energy sector.

Why are drones equipped with IoT sensors gaining traction in environmental monitoring?

Drones equipped with IoT sensors are gaining traction in environmental monitoring due to their ability to efficiently monitor remote or hard-to-reach areas. This technology provides a cost-effective and agile solution for collecting environmental data and identifying potential conservation challenges.

What challenges exist in IoT for environmental monitoring?

Challenges in IoT for environmental monitoring include security concerns, data privacy issues, and high initial implementation costs. Overcoming these challenges presents opportunities for the development of more secure, cost-effective, and innovative IoT solutions.

How do IoT-enabled soil sensors benefit agriculture?

IoT-enabled soil sensors provide farmers with precise data on soil moisture, nutrient levels, and temperature. This data-driven approach allows for optimised irrigation and fertilisation, reducing water and resource usage while maximising crop yield in the agriculture sector.

What is the market size of IoT in environmental conservation?

The market size of IoT in environmental conservation is projected to reach significant figures in the upcoming years, reflecting the increasing adoption of IoT technologies to address environmental challenges globally.

What are the benefits of real-time monitoring in IoT for environmental conservation?

Real-time monitoring in IoT for environmental conservation allows for quick identification of inefficiencies, enabling timely interventions and cost savings. Additionally, predictive analytics can help prevent environmental incidents, avoiding costly clean-up and restoration efforts in various industries.

How do smart water meters equipped with IoT sensors contribute to water management?

Smart water meters equipped with IoT sensors detect leaks and monitor water quality in distribution networks, contributing to efficient water management. This real-time data enables water utilities to proactively address issues, reduce wastage, and ensure the delivery of clean water to consumers.

What role does IoT play in healthcare environmental monitoring?

In healthcare, IoT devices monitor and control environmental factors such as temperature and humidity. This ensures optimal conditions for patient comfort and the preservation of medical supplies, contributing to a healthier and more sustainable healthcare environment.

Why are IoT sensors used in construction sites for environmental monitoring?

IoT sensors are used in construction sites to monitor noise, dust levels, and vibration, contributing to environmental monitoring. This real-time data allows construction companies to implement measures to minimise environmental impact and adhere to regulatory standards.

How do connected vehicles with IoT sensors contribute to urban air quality monitoring?

Connected vehicles with IoT sensors measure air quality levels during transit, contributing to urban air quality monitoring. This data helps municipalities identify pollution hotspots, implement targeted interventions, and improve overall air quality in urban environments.

What are the opportunities in IoT for environmental monitoring?

Opportunities in IoT for environmental monitoring include the development of more secure and cost-effective solutions. These opportunities drive innovation, creating a dynamic market that fosters advancements in technology for sustainable practices.

What is the growth trend in the IoT for environmental monitoring market?

The growth trend in the IoT for environmental monitoring market is expected to continue on an upward trajectory. Advancements in sensor technologies, connectivity, and data analytics contribute to the expanding market, facilitating real-time data collection, analysis, and proactive decision-making.

How does IoT contribute to energy efficiency in the retail sector?

In the retail sector, IoT-based energy management systems monitor and control lighting, heating, and cooling. This optimises energy consumption, reduces operational costs, and contributes to sustainable business practices in the retail industry.

Who benefits from IoT-enabled waste management systems?

IoT-enabled waste management systems benefit both waste collection services and the environment. Sensors in waste bins and collection vehicles provide real-time information on fill levels, enabling efficient route planning, minimising fuel consumption, and reducing the environmental impact of transportation.

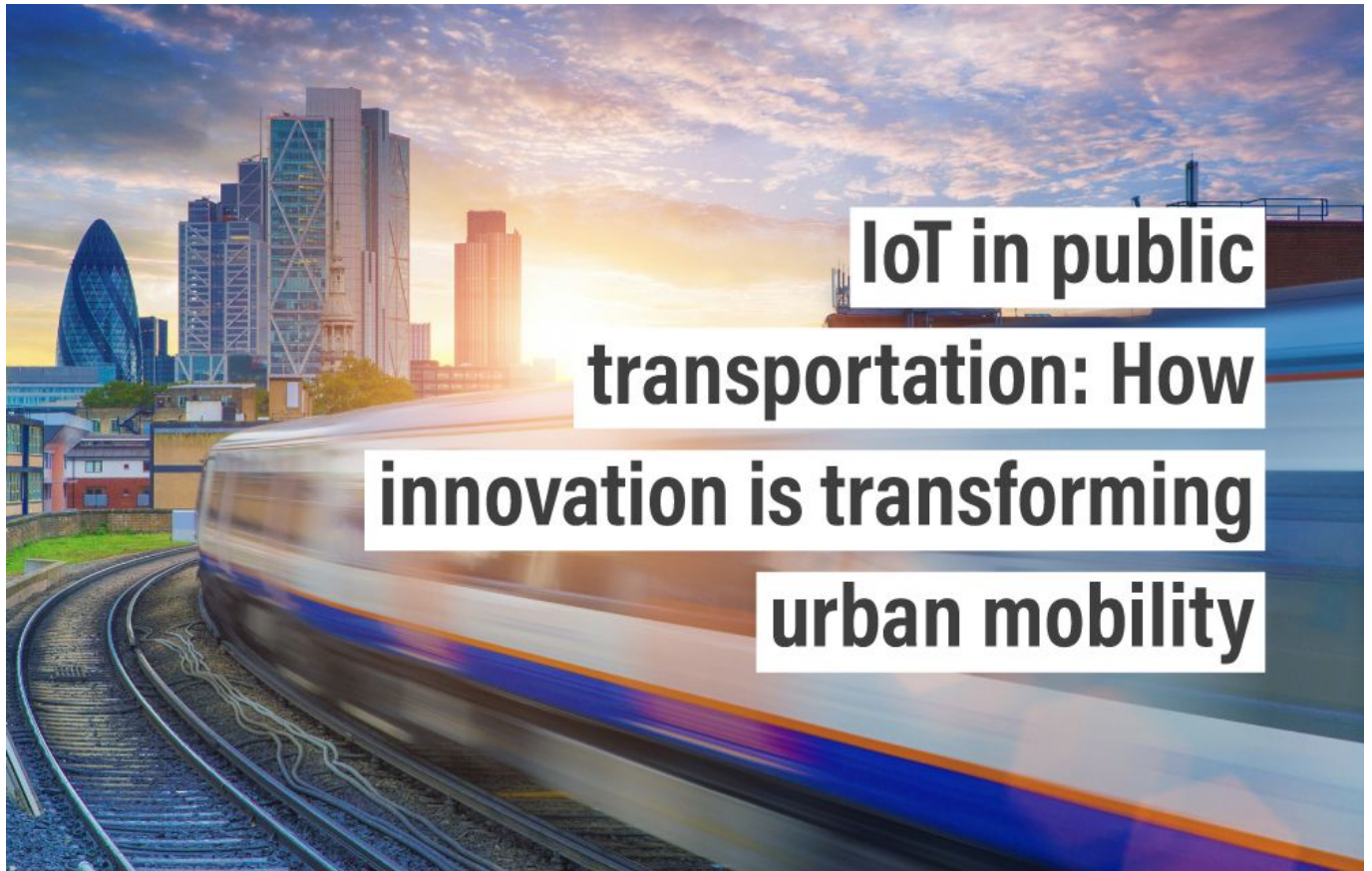
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