Air Quality Monitoring Solutions To Reinforce Building Automation

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INTRODUCTION

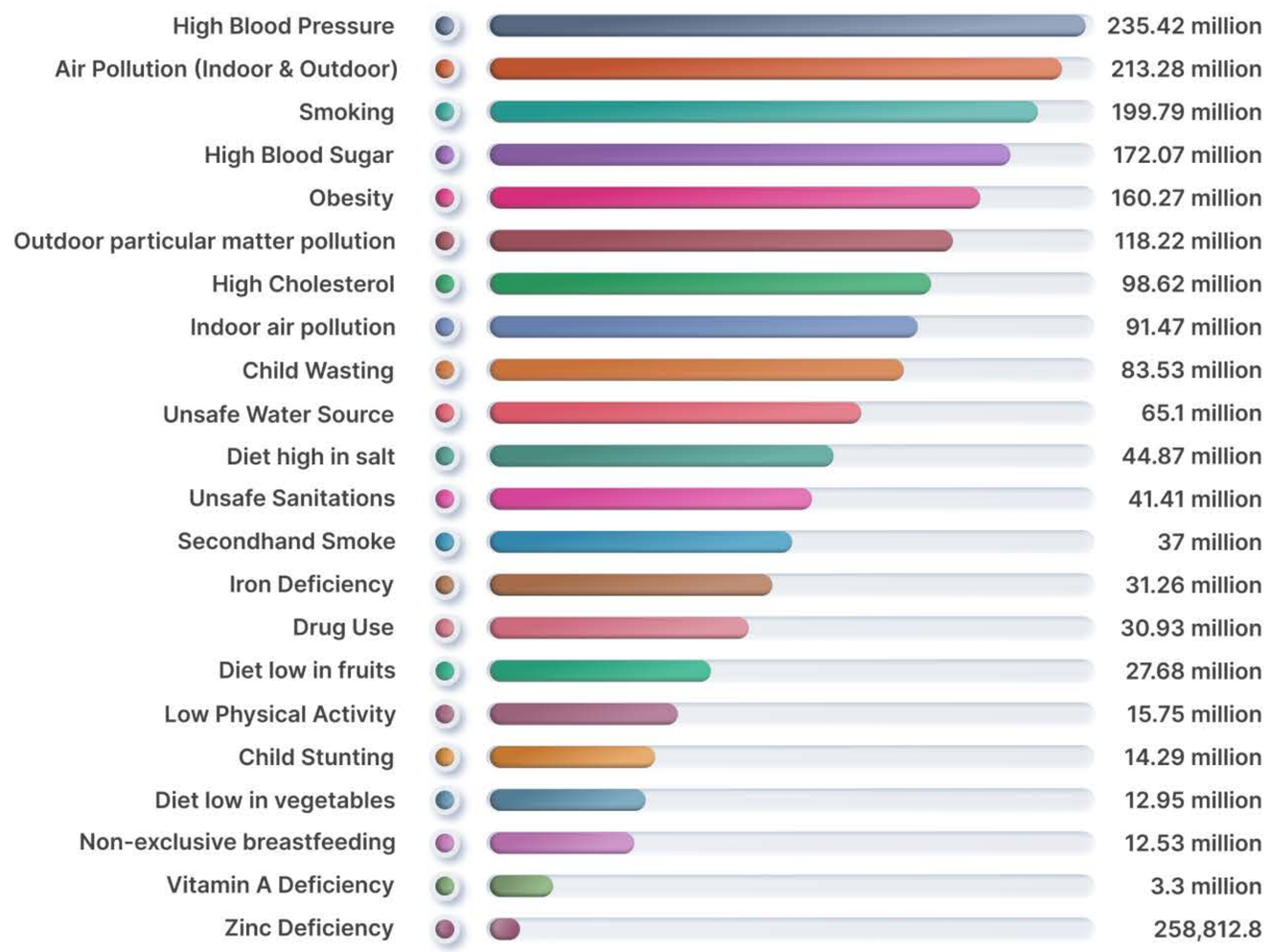
Over the years, it has been established that the day-to-day activities of humans in cities generate a large number of substances that modify the natural composition of the air. The burning of fossil fuels for transportation and power generation both industrially and domestically produces thousands of tons of pollutants that are emitted into the atmosphere daily.

Vehicles are the primary source of emissions, followed in importance by area sources, industry, households, and emissions from natural (biogenic) sources. The deterioration of air quality due to the presence of polluting substances has a negative effect on human health and the environment.

Various studies carried out in cities around the world have shown a relationship between the increase in the concentration of air pollutants and the increase in respiratory and cardiovascular diseases. Some contaminants, such as particulate matter, are also associated with increased emergency room visits and mortality.

Disease burden by risk factor, World, 2019

Disease burden is measured as Disability-Adjusted Life Years (DALYs). One DALY is the equivalent of losing one year in good health because of either premature mortality or disability. One DALY represents one lost year of healthy life.



Source: IHME, Global Burden of Disease

One way to protect the health of the population is through continuous monitoring and dissemination of the status of air quality. The objective of air quality monitoring is:

- To generate information to evaluate compliance with various environmental health national standards.
- Quantify the levels of exposure of the population to ambient air pollution.
- Inform and warn the population about the levels of contamination and its possible risks.
- Provide immediate information for the activation or deactivation of alerts or emergency procedures, derived from a concentration of pollutants associated with human activities and/or natural sources, which may represent a risk to health or the environment.

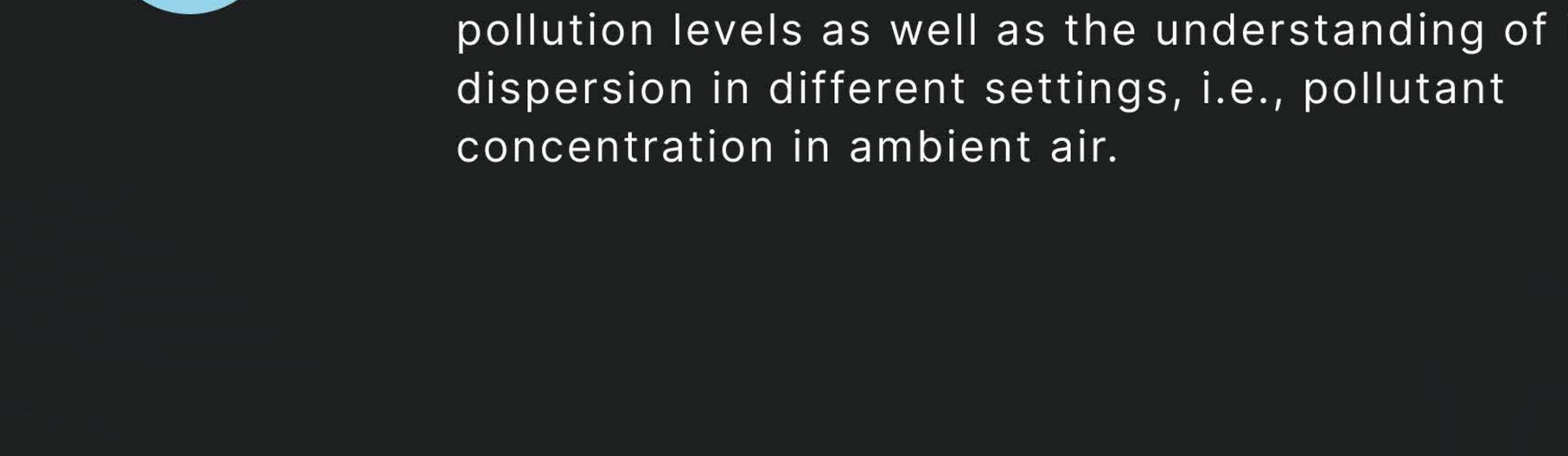
Other objectives of air quality monitoring include informing the population in a timely manner about the state of air quality, generating information for the evaluation of the spatial distribution and transport of atmospheric pollutants, providing reliable data for the evaluation and monitoring of air quality management strategies implemented in cities and metropolitan areas.

Problem statement

The measurement of air pollutants is a complex technical activity that involves the use of specialized equipment, qualified personnel for its operation, and adequate support and communications infrastructure. In addition to measurement, it is necessary to ensure that the data generated appropriately describes the state of air quality.

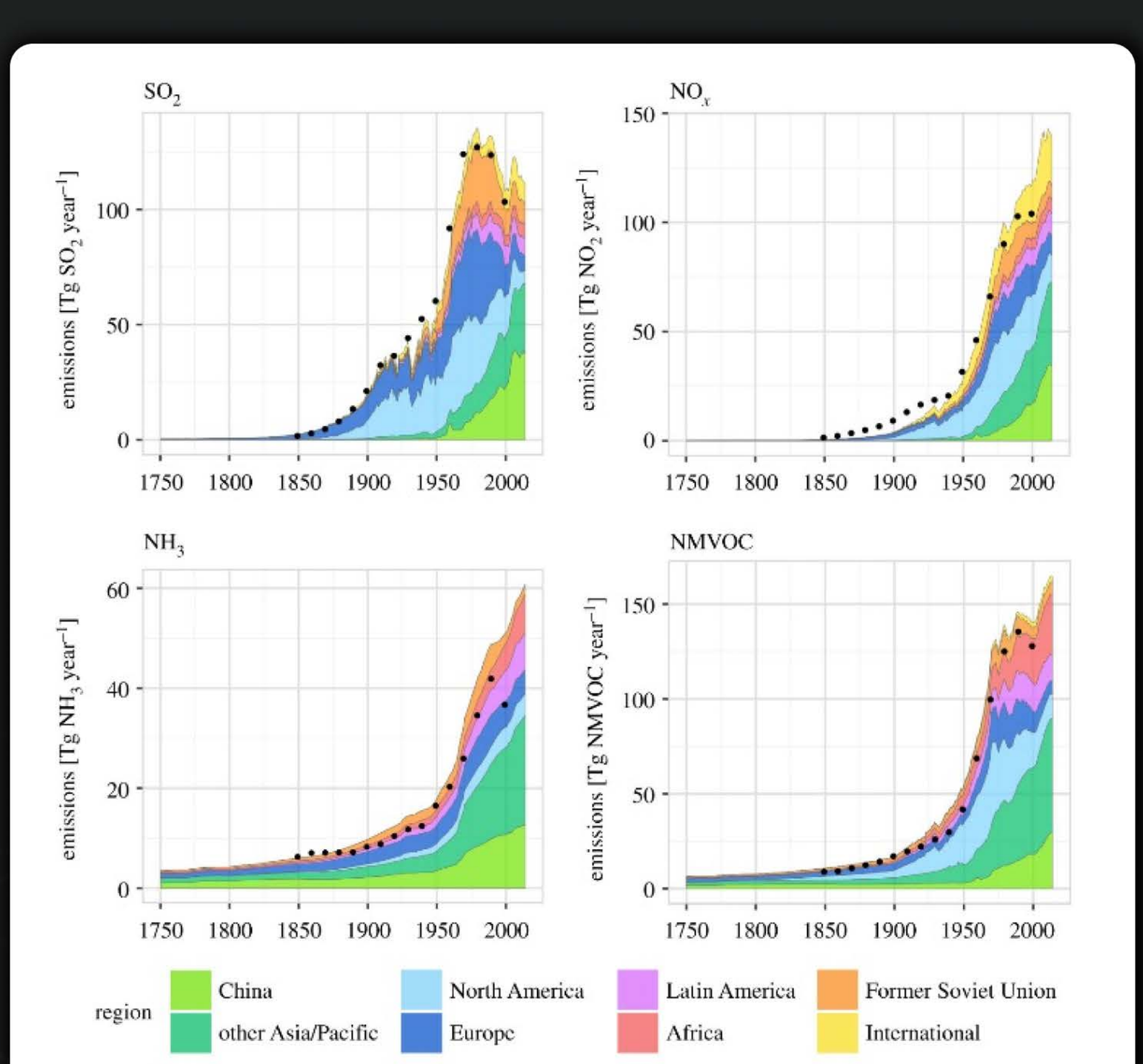
The current national air quality monitoring network is restricted in scope because the recorded values are indicative, with significant lag time in the reporting of data. Hence, real-time proactive measures cannot be taken. Additionally, the participation of diverse monitoring agencies, sampling equipment, personnel, chemical analyses, and data reporting introduces biases as well as uncertainty.

Therefore, the operation of the monitoring program requires methodologies and standards for measurement, as well as a continuous monitoring program and quality assurance. Protection of the atmospheric environment involves the control of pollution levels as well as the understanding of its dispersion in different settings, i.e., pollutant concentration in ambient air.



Why is air quality monitoring important?

Our air consists mainly of two gases: nitrogen (approx. 78%) and oxygen (approx. 21%). In addition to these two, humans breathe carbon dioxide and trace amounts of a number of other gases. When substances or gases are measurable in the air, air pollution can be tracked and controlled. Air quality refers to the concentration of contaminants in the air. Air quality indices and recommendations are based on scientific knowledge and evidence. This describes how air pollution affects people and the environment. Thus, the discussion about air quality, legal standards, and efforts to limit air pollution varies according to the country, the specifics of the environment (e.g., outdoors or in the workplace), and the length of time the areas are exposed to pollution.



Source: Global and regional emissions of SO2, NOx, NH3, and NMVOC between 1750 and 2010. Adapted from Hoesly et al. The dots show global estimates of an earlier study

Air pollution causes serious problems for human health and the environment. It is a complex problem with very diverse causes. Most air pollutants are toxic and harmful to human health in a number of ways. They also have a negative impact on ecosystems and the climate.

9/10 people worldwide breathe polluted air.

$5.0 trillion in annual economic damage

7 million deaths a year caused because of air pollution

50% productivity drop in offices with poor air quality

According to a study by the National University of Singapore, besides affecting health, prolonged exposure to air pollution can also reduce employees' productivity. The study also showed that daily variations in pollution levels did not instantly affect the productivity of workers. However, a significant drop in output was witnessed when measured for more prolonged exposures of up to 30 days. The finding suggests that workers are 5-6 percent more productive when air pollution levels are rated as good by the Environmental Protection Agency (AQI of 0–50) versus when they are rated as unhealthy (AQI of 150–200). This explains why air pollution is in 3 of the 17 UN Sustainable Development Goals, which were explicitly included. A growing number of governments, private organizations, and NGOs are recognizing the risks of air pollution threatening our society and are creating frameworks to protect residents, citizens, local ecosystems, and our planet.

The World Health Organization (WHO) sets recommended limits for harmful concentrations of hazardous air pollutants outdoors, indoors, and in homes; these are based on a global synthesis of scientific knowledge. The guidelines include annual and daily concentrations of particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and other pollutants. The international environmental laws and regulations that apply to air pollution include agreements on transboundary air quality, air pollution, and greenhouse gas emissions. Transboundary air pollution is addressed through a patchwork of regional instruments, notably in the EU (e.g. the “Air Quality Directive”; 2008/50/EC), the United Nations Economic Commission for Europe (UNECE), and South East Asia.

Comparison of Pollutant Limits Set by WHO, EEA, and USA

Pollutant	Averaging Period	WHO Limits	EEA (European Union) Limits	EPA (United States Limits)
Carbon Monoxide	8 hours	10 mg/m^3	10 mg/m^3	9 ppm or 10 mg/m^3
Lead	yearly	0.5 mg/m^3	0.5 mg/m^3	–
Nitrogen Dioxide	1 hours	200 $\mu g/m^3$	200 $\mu g/m^3$	100 ppb
Ozone	8 hours	100 $\mu g/m^3$	120 $\mu g/m^3$	0.07 ppm
$PM_{2.5}$	1 year	25 $\mu g/m^3$	25 $\mu g/m^3$	15 $\mu g/m^3$
PM_{10}	1 day	50 $\mu g/m^3$	50 $\mu g/m^3$	150 $\mu g/m^3$
SO_2	1 hour	–	350 $\mu g/m^3$	75 ppb

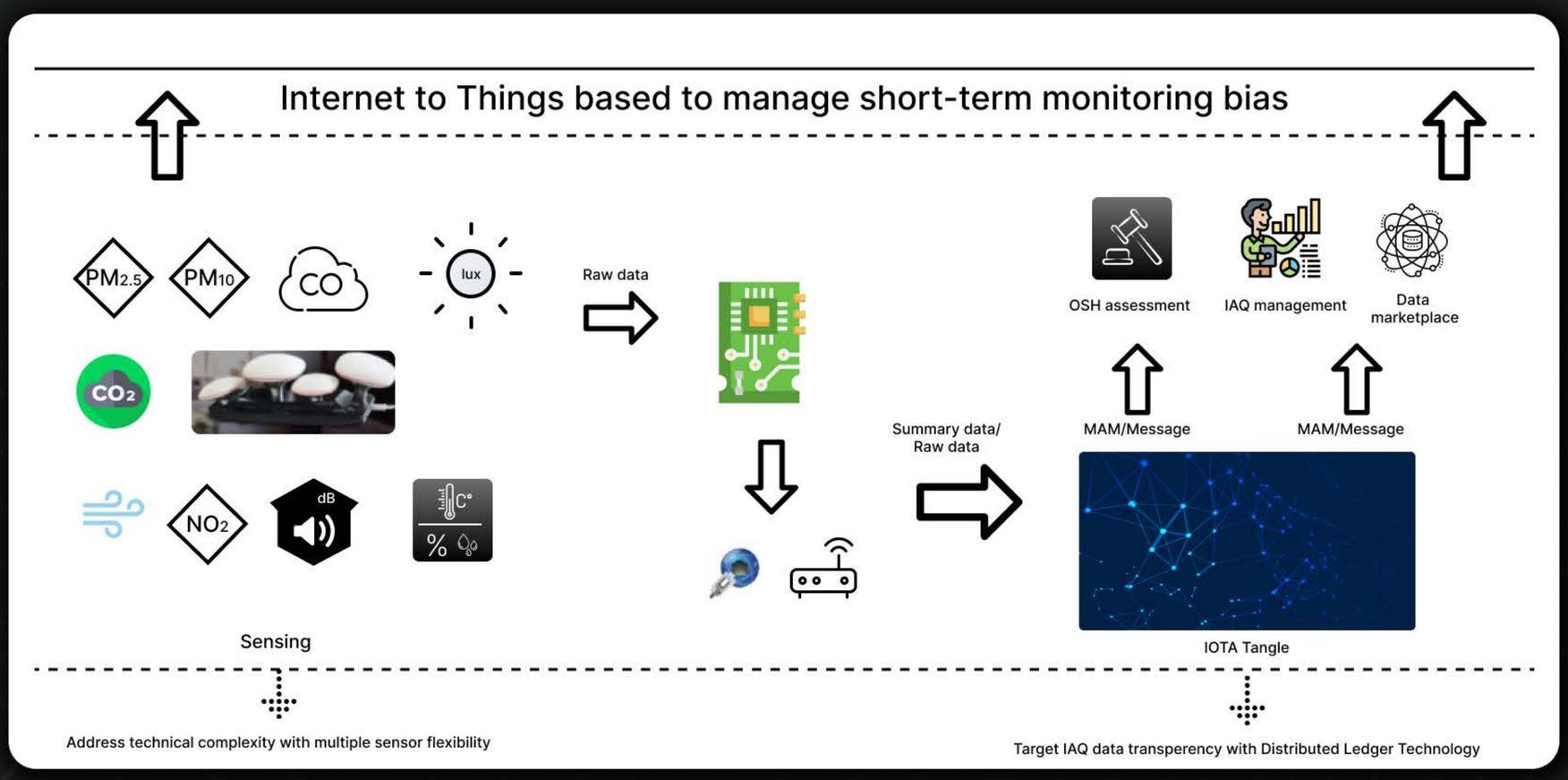
As air pollution is the greatest threat to the environment and health in our time, there are ways individuals and organizations must take action to prevent air pollution. In addition, monitoring air quality and air pollution levels is an essential part of air pollution control measures. Hence, it is believed that the best clean air strategies and action plans are based on accurate, comprehensive, and hyper-local data using automated air quality monitoring systems.

With air quality monitoring, there could be a robust assessment of the extent of pollution in line with the ambient air quality standards. These standards connote certain regulatory measures set for the reduction of pollution and attainment of clean air. Extensive monitoring assists in guarding against extreme events by getting people to be on alert and take action.

Why should buildings automate air quality monitoring?

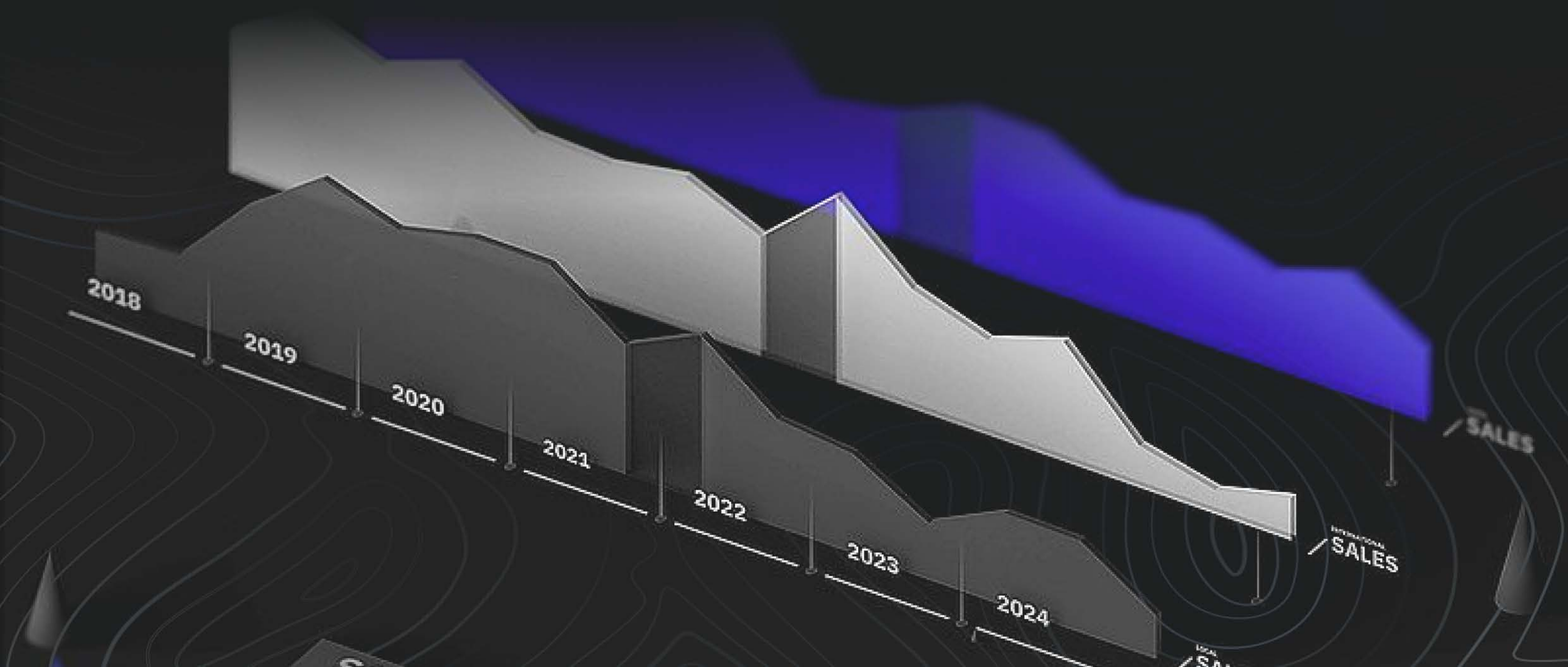
In order to protect people from air pollution, various technologies, regulations, and systems have been employed whose objective is to reduce polluting emissions into the atmosphere. One of these technologies is the automated air quality monitoring system, which serves as a better option when compared to manual and semi-automatic monitoring devices. The automated air quality monitoring device collects data and physically monitors the building, acting as an input device with almost zero human effort.

The goal of automated air quality monitoring is to provide real-time air quality data that helps create healthier and more energy-efficient buildings. The main objective of automation is to record the concentration levels of atmospheric pollutants in order to define air quality levels and to establish action plans if high levels of contamination are detected. Data on indoor air quality is communicated to other components of the automated air quality monitoring system via a protocol such as BACnet, where the data may cause changes to the HVAC system.



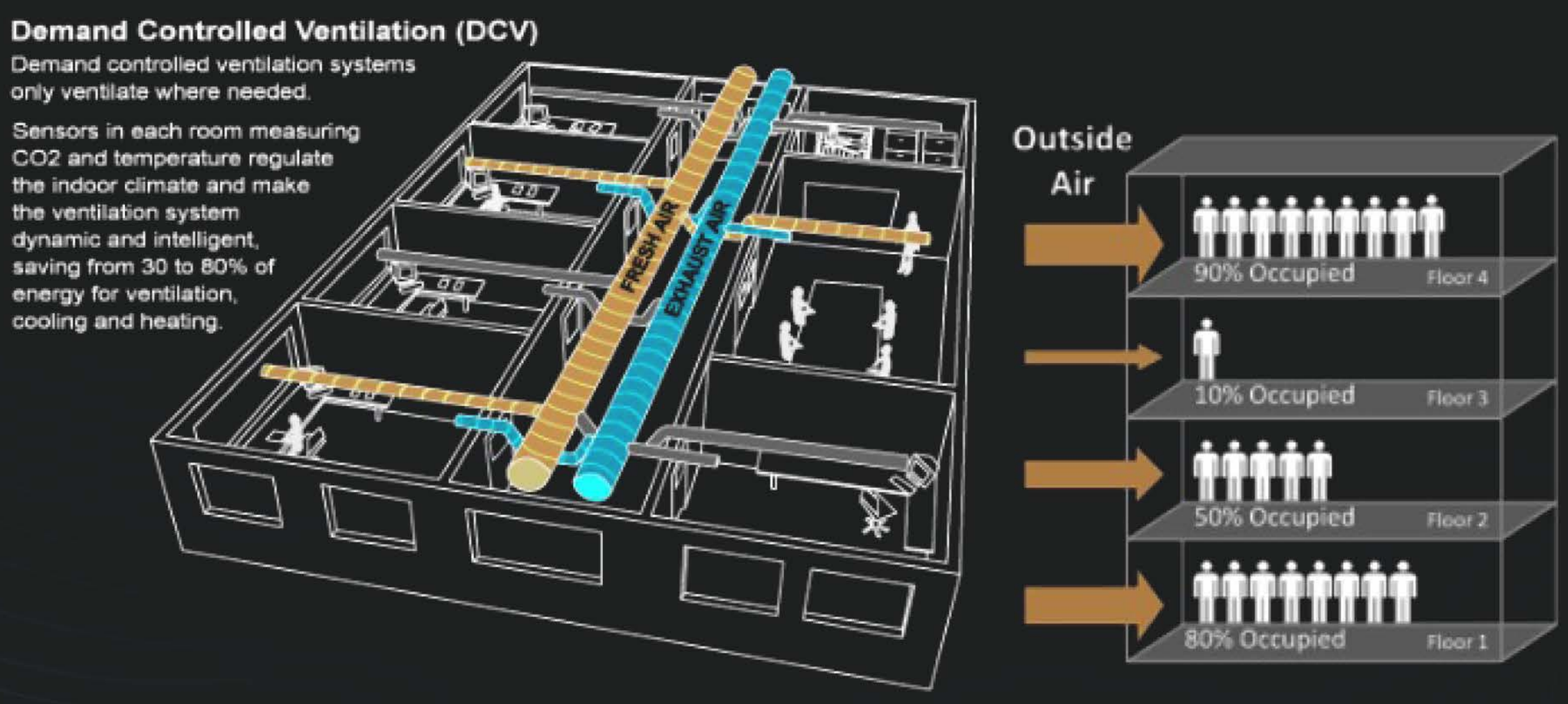
The automated air quality monitoring system is both cost-effective and smart. It makes use of mobile or stationary IoT-enabled sensors for mapping and monitoring air quality in buildings. Additionally, it can be integrated into the building structures where it performs its operations. Data from these sensors get transmitted, while big data capabilities can be applied to the information derived from the system in order to improve the understanding of the fluctuations as well as causes of air pollution.

The utilization of handhelds or manual monitoring methods is outdated and may be counter-productive. Nowadays, automated monitoring techniques harness easily configurable optical and sensor-based tools for the provision of highly accurate data. Additionally, the automated air monitoring system saves fieldworkers' stress, time, as well as resources. Personnel or project handlers will have less time working on getting air quality data, resulting in cost savings. An automated air monitoring system also provides two-way communication and automated reporting. A fully automated system with cloud-based access to live data, as well as analytics and reporting features, can help provide valuable, actionable information that keeps the building on track and in compliance with air quality standards.



There are several ways to operate automated air quality monitoring, depending on the air quality parameters being monitored. For example, demand-controlled ventilation is a common application of carbon dioxide data. Since building occupants are exhaling carbon monoxide as well as other dangerous and poisonous gases, data from air quality sensors can estimate their quantities so that necessary actions to eliminate these gases can be taken.

An automated air quality monitoring system can minimize ventilation rates and reduce CO2 levels to save energy and increase ventilation rates during high occupancy to ensure productivity levels at peak performance. It locates areas with contamination problems and helps people understand spatio-temporal changes in the environment. Compliance with legislation on air protection can then be achieved without hassles since results are readily available for necessary actions to be taken. In this way, pollution and contamination can be controlled. Regulations have also been published that require the purification of polluting emissions to minimize their impact. Hence, it is necessary to carefully monitor the chemical composition of the ambient air to certify that the levels of contamination do not exceed certain dangerous limits, also set by legal regulations.



Monitoring air quality in real-time will assist in the calculation of the air quality index towards issuing health advisories alongside action plan formulation towards meeting set standards. Through automation, air quality forecasting could be achieved using real-time data collected alongside the utilization of atmospheric chemistry transport forecasting models, having the ability to provide a 24-hour advance forecast of air pollutant levels.

Results of the automation

The main idea of automated air quality monitoring automation is to work smarter, not harder, to increase efficiency without sacrificing comfort and safety. In the framework of indoor air quality monitoring, home automation can save energy costs. One of the biggest benefits of building automation is energy savings. Changing the environmental conditions inside the building based on input from the IAQ sensor ensures that when the building is unoccupied, building systems are operating at minimum levels, reducing power consumption and overall building energy.

Through effective monitoring, automation champions accurate air quality data collection and supports impact assessment caused by poor air quality on public health. With automation, the burden on personnel is reduced and real-time data is generated, enhancing the reliability of results. It saves time by providing prompt access to determining whether an area is meeting the stated air quality standards, as data collected would primarily assist in identifying polluted areas, pollution levels, as well as the level of air quality. Automated air quality monitoring will also help in the determination of the potency of air pollution control programs employed in a locality—whether or not they are working efficiently. Additionally, automation helps in comparing the short-term and long-term disorders and diseases resulting from air pollution. On the basis of collected data, control measures can be formulated towards protecting the environment and the health of all dwellers.

Reduce environmental impact—air quality automation helps to reduce overall energy consumption while maintaining healthy air quality in the building. Not only does a reduction in energy consumption come about through lower energy bills, but the building's environmental impact is also reduced.

Boost well-being- Indoor air quality and occupants' well-being are fundamentally linked; better air quality will improve the productivity and health of employees.

Integrating continuous quality monitoring ensures that building occupants get better on a consistent basis, which won't necessarily happen with one-time IAQ testing. In addition to the three benefits above, integrating IAQ into building automation can also help to comply with energy codes and work towards building certifications.

Case study

Brigade Group identified that polluted air, especially in a workplace, can substantially reduce employees’ productivity and heighten the risk of lung diseases. They recognized that air pollutants from poor building maintenance, inadequate HVAC systems, and harmful construction materials should be dealt with immediately. The real estate and construction company used Ambee’s environmental & climate monitoring systems to create employee-friendly, fresh & anti-allergic workspaces. It allows the building management to manage viral transmissions via ventilation and take steps to reduce continuous exposure.
In partnership with Ambee, Brigade Group took the initiative to fight these problems and transition towards net-zero emissions. Read the case study to see how the duo worked together to get the result.

Read the Case Study

Conclusion

Take the fight against air pollution to the next level by leveraging the automated air quality monitoring system. The belief is that it provides the best clean air strategies and action plans on the basis of accurate, comprehensive as well as hyper-local data. Air quality monitoring is the first step toward understanding and controlling air pollution, and it is designed to provide an accurate idea of the level of pollution in the environment as well as assist building residents in becoming protected against a variety of dangerous diseases.

About Ambee Environmental and Climate Monitoring Systems

Air quality is dynamic. No two places have the same quality of air. Air pollution builds up in isolated pockets influenced by several local sources. These pockets add up to the overall air quality levels of the region. Poor air quality threatens the health of all living things, from humans to plants. Not only does it cause irritation in respiratory systems, but also makes it difficult to breathe, reducing employee productivity levels. Degrading air quality also threatens the health of individuals and has a significant impact on people's lives. These largely growing effects are the reasons why air monitoring is gravely necessary.

An autonomous 24/7, real-time monitoring of air quality aids businesses and communities to take suitable actions to prevent health issues, decrease air polluting sources, enhance strategic infrastructure planning, and implement adequate healthcare systems. Ambee provides air quality monitoring solutions and tools that include a cross-functional system of air quality monitors that track a wide array of pollutants and real-time analytics that reveal the percipience of air quality trends in spaces. This solution not only provides insights into the quality of air but also helps enable corrective actions when necessary.

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