

Case Study

Expo 2020 Dubai

Managing & monitoring air pollution exposure at a mega event attended by over 24 million visitors

Overview

Expo 2020 in Dubai was the world's showcase for sustainability, safety and security, enabled by data-driven infrastructure that was supported in part by EarthSense Zephyr® air quality sensors, providing a global benchmark for future smart cities.



Figure 1: Crowd of people visiting Expo 2020 Dubai.

The Challenge

With more than 24 million visitors over 182 days, Expo 2020 Dubai is the definition of a mega-event, with its international profile and potential to reposition the city on the global stage. Such mega-events naturally have an impact on the host locality and event organisers are driven to

maximise the positive sustainability and legacy potential while minimising any possible negative effects. A mega-event inevitably affects air quality as a key element of overall health and safety of attendees, volunteers and other participants.

Researchⁱ that collected data at various locations in Dubai, with some as close as under 6 miles away (9.44 kilometres) from the Expo 2020 Dubai site, highlights some of the air quality challenges in Dubai.

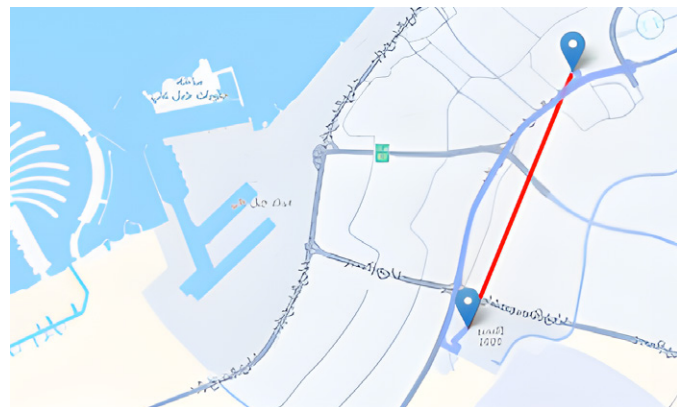


Figure 2: Evaluating the Contamination by Indoor Dust in Dubai, air quality monitor location close to Expo 2020 site.ⁱ

The studies indicate that indoor air quality is directly affected by outdoor air quality. And Dubai's weather conditions such as exceedingly hot summers, with temperatures often exceeding 40°C and limited rainfall also contribute to poor air quality increasing pollution levels such as PM_{2.5} and PM₁₀.

The Solution

Local EarthSense distribution partner, AQM World, installed an air quality monitoring network powered by Zephyr® sensors integrated with the Siemens industrial Internet of Things (IoT) system, MindSphere platform to ensure continuous monitoring for health and safety.



Figure 3: Mains powered Zephyr® deployed on a concrete wall in one of the underground areas at Expo 2020 Dubai.

AQM World installed Zephyr® units throughout the Expo 2020 site in the three primary districts of Sustainability, Opportunity, and Mobility. The company deployed 10 Zephyr® units indoors and in underground spaces, and two further units in ambient, park and plaza settings to measure indoor and ambient air quality concentrations.

The EarthSense Zephyr® units took live readings of temperature, pressure, and humidity as well as ambient air pollutants including nitric oxide (NO), nitrogen dioxide (NO₂), ozone (O₃), hydrogen sulphide (H₂S), sulphur dioxide (SO₂), total volatile organic compounds (TVOC) and particulate matter (PM₁, PM_{2.5} and PM₁₀). All of this data was then integrated via the EarthSense API into the Siemens MindSphere platform.

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The theme of Expo 2020 was ‘Connecting Minds and Creating the Future’ and represents innovation in sustainability, mobility, and opportunity. We are delighted that Expo 2020 chose EarthSense’s Zephyr® to gain real-time insights into air pollution.”

Faizal Hasham
General Manager, AQM

Outcomes

Expo 2020 Dubai built the most digitised, connected Expo in the event’s 167-year history, supported with data-driven infrastructure for sustainability, safety and security. It was a global benchmark of how smart infrastructure will form the foundation of our future cities.



Figure 4: Mains powered Zephyr® monitor deployed outside at Expo 2020 Dubai.

Experts from EarthSense and AQM World worked together to monitor air quality and compare Zephyr® measurements with other air monitoring stations in Dubai, to assess the characteristics of air pollution at the Expo site. They also compared concentrations throughout indoor spaces with ambient locations, to understand the interplay between indoor and outdoor air on site.

EarthSense Zephyr® measurements enabled the Siemens MindSphere platform to trigger alerts when air quality concentrations reached pre-established thresholds, helping to manage participant and attendee air pollution exposure. Authorised personnel could use the Expo 2020 smart city app for a range of detailed environmental data, including air quality and weather conditions, as well as electric vehicle charging, building occupancy, waste volume, and a range of other smart city data.

18% Increase of 'Green Days' in 2020, where pollutants did not exceed their standards compared to 2017

In 2020, the UAE reported 89% of 'Green Days' (AQI NO₂, SO₂, CO, ground level O₃) where certain pollutants did not exceed their standards. This was an increase of 8% from 2019 and 18% from 2017. For PM₁₀, 83.9% in 2020, an improvement of 2.9% from 2019 and 12.9% from 2018. For PM_{2.5}, 93.2% green days in 2020, a 5.2% improvement on 2019 and a 13.2% improvement on 2018ⁱⁱ.



Figure 5: Deployment of a Zephyr® air quality monitor at Expo 2020 in Dubai.

Long Term Benefits

While the specific impact of Expo 2020 on air quality in Dubai is yet to be examined, academic studiesⁱⁱⁱ from Expo 2010 Shanghai indicate that air quality measures were effective in Shanghai and surrounding provinces during the Expo period where pollution levels decreased during the event (Huang et al., 2013)^{iv}. It demonstrated that stringent emission control measures aimed at mega-events can achieve positive benefits on improving the air quality.



Figure 4: Expo 2020 Lake in Dubai

Expo 2020 Dubai was designed to be the most sustainable world Expo in history. The strategy of Respect, Impact, Safety, and Environment (RISE) was created to integrate a number of processes and methodologies across every aspect of operations to demonstrate how businesses, cities and even countries can transition into a green economy.



Figure 6: Mains powered Zephyr® deployed on a concrete wall in one of the underground areas at Expo 2020 Dubai.

At least 80% of Expo 2020's permanent infrastructure is being repurposed as a model global community for the future, District 2020, which will use state-of-the-art innovation, science, and sustainability to create a human-centric smart city.



Figure 5: Repurposed dubai exhibition centre infrastructure at Expo 2020.

Research into managing the sustainability of global events suggests “mega-events should act as a catalyst for behavioural change”. A study^v of environmental awareness of 1,108 Expo attendees was measured before and after the Expo. Results show that visiting the Expo has raised the environmental awareness of visitors and the Expo's visits increased environmental attitude.

Behaviour change combined with policy development pathways to reduce urban air pollution and emissions of air pollutants and greenhouse gases can help to continually improve air quality in Dubai after Expo 2020.

The planning and execution of sustainable mega events such as Expo 2020 Dubai provide an excellent framework to monitor and mitigate air pollution. EarthSense is proud to be supporting the UAE in its air quality targets to reach 90% compliance with national standard of $PM_{2.5}$ by 2040ⁱⁱ.

ⁱ Nazzal Y, Bărbulescu A, Sharma M, Howari F, Naseem M. Evaluating the Contamination by Indoor Dust in Dubai. *Toxics*. 2023; 11(11):933. <https://doi.org/10.3390/toxics11110933>

ⁱⁱ National Agenda for Air Quality 2031 for the UAE, Ministry of Climate Change and Environment, United Arab Emirates

ⁱⁱⁱ N Hao et al 2011 *Environ. Res. Lett.* 6 044004 DOI 10.1088/1748-9326/6/4/044004 and Ying Deng, S.W. Poon & H.W. Chan (2014) Synergising Functional and Environmental Planning for Mega-event Led Urban Renewals and Beyond: Lessons from the Expo 2010 Shanghai China, *International Planning Studies*, 19:3-4, 244-267, DOI: 10.1080/13563475.2014.894473

^{iv} Huang, K., Zhuang, G., Lin, Y., Wang, Q., Fu, J. S., Fu, Q., ... & Deng, C. (2013). How to improve the air quality over megacities in China: pollution characterization and source analysis in Shanghai before, during, and after the 2010 World Expo. *Atmospheric Chemistry and Physics*, 13(12), 5927-5942. <https://doi.org/10.5194/acp-13-5927-2013>

^v Al-Shihabi S, Aydin R, Hadj-Alouane A and Alshamsi A (2023) Sustainable technologies, mega-events, and environmental awareness—Lessons from Expo 2020 Dubai. *Front. Sustain Cities* 5:1192295. doi: 10.3389/frsc.2023.1192295

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