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Connecting communities to the environment

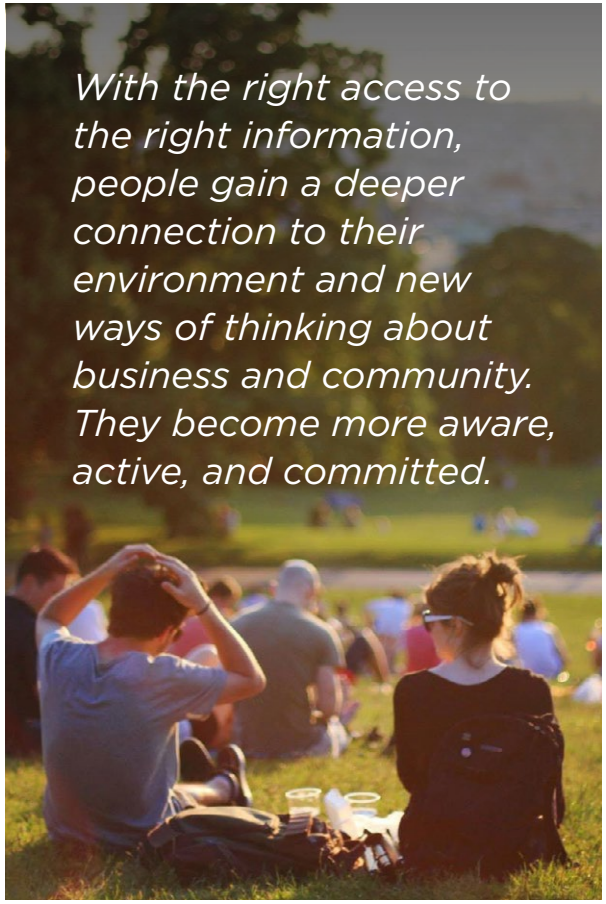
The ultimate guide to modern, dense air quality networks

Air quality is urgent for everyone

Air quality is an essential factor in creating smarter, healthier communities. This is due in part to the urgency of air quality problems — 9 out of 10 people in the world live in areas with unhealthy air — but it's also because air quality measurement is such a good place to start when leaders and citizens want to create change. Improvements are immediately attainable and highly impactful.

The benefits of enhanced air quality measurement go beyond health and safety. With the right access to the right information, people gain a deeper connection to their environment and new ways of thinking about business and community. They become more aware, active, and committed. This is especially important as people strive for smarter communities while dealing with significant global trends like climate change and rapid urbanization.

This guide explains the principles, benefits, and technologies of dense air quality sensor networks, which are key to enabling modern, effective air quality management. Hopefully, it also gives readers more confidence that smarter, healthier communities are possible almost anywhere.



91%
of the world's population lives in areas where the quality of air is below acceptable (WHO)

4.2 MILLION
Number of deaths air pollution causes per year globally

$225 BILLION
Estimation of global economic losses due to air pollution

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The many purposes of air quality measurement

At its best, air quality measurement changes how governments regulate industries and manage growth. It impacts traffic and infrastructure decisions. It empowers citizens to make better decisions for themselves and their families. And it affects entire ecosystems on which many kinds of life depend.

Areas of special interest for air quality sensing are those with permanently or occasionally elevated emissions, often referred to as hot spots. Air quality sensors are excellent tools for creating a wide, general monitoring network across a city or large geography; they also can provide highly localized data at known areas of interest, such as roads with heavy traffic, industrial areas, airports, ports, landfills, and major building sites. Some modern sensors can even be used and moved on a project-by-project basis, dramatically enhancing their value.

Another category of interest involves locations where sensitive groups of people are exposed to polluted air, such as daycare centers, schools, hospitals, and other types of healthcare facilities. These populations are often unaware of their risks and unable to advocate for change, so proactive air quality measurement is a social good that can relieve pressure on health networks.

For many reasons, then, accurate, real-time air quality data improves decision-making from the highest levels of government and business to the private dinner-table conversations of families.

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Health
Alerting for air quality episodes and avoiding local hot spots of particulate matter and toxic gases to drive down the exposure to poor air quality.

Traffic
Monitoring of $PM_{2.5}$ and NO_2 to verify the effectiveness of clean air zones. Re-routing traffic to limit and prevent the creation of local traffic hot spots and street dust (PM_{10}).

Public awareness
Sharing air quality data, route finders, and other services for the public.

Infrastructure
Optimizing HVAC and indoor air quality in large residential, office, and public complexes by taking into account local air quality; ensuring that people at recreational areas, hospitals, schools, and other public places avoid suffering from air quality challenges.

Air quality data improves decision-making from the highest levels of government and business to the private dinner-table conversations of families.

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The crucial relationship between air quality and weather

Air quality is always connected to the weather. Conversely, weather also affects air quality.

Because of this, air quality measurements are much more valuable if they are accompanied by real-time data about wind speed and direction, temperature, humidity, and other factors that directly affect pollution and its travel.

This is why Vaisala allows customers to integrate our next-generation air quality sensor (AQT530, explained below) with versatile, reliable weather sensing solutions. Vaisala Beacon™ Station, for example, is our compact, plug-and-play weather station that has become crucial to many industries and applications. It uses the industry-leading Weather Transmitter WXT536, along with Air Quality Transmitter AQT530 to produce full-spectrum air quality and weather intelligence. This provides a much more intelligent understanding of air quality, its fluctuations, and the drivers affecting it.

Weather drivers affecting air quality

Wind direction and speed are important as main factors influencing pollution dispersion but additionally for deciding on network locations and creating alerts or interventions during times of heavy pollution.

Precipitation can cause pollutants from the atmosphere to be washed downward and can sometimes reduce street and road dust emissions.

Temperature impacts the behavior of air and the pollution gases and particulates or pollution it carries. It can be used to make infrastructure decisions, map patterns and variations throughout an urban landscape, and even understand the movements and needs of people throughout a community.

Atmospheric boundary layer (ABL) behavior defines the air volume into which pollutants are diluted. Combining ABL and air quality observations improves situational awareness and the quality of forecasts and advisories. Boundary layer height can be monitored with our ceilometers and integrated with certain solutions mentioned in this guide.

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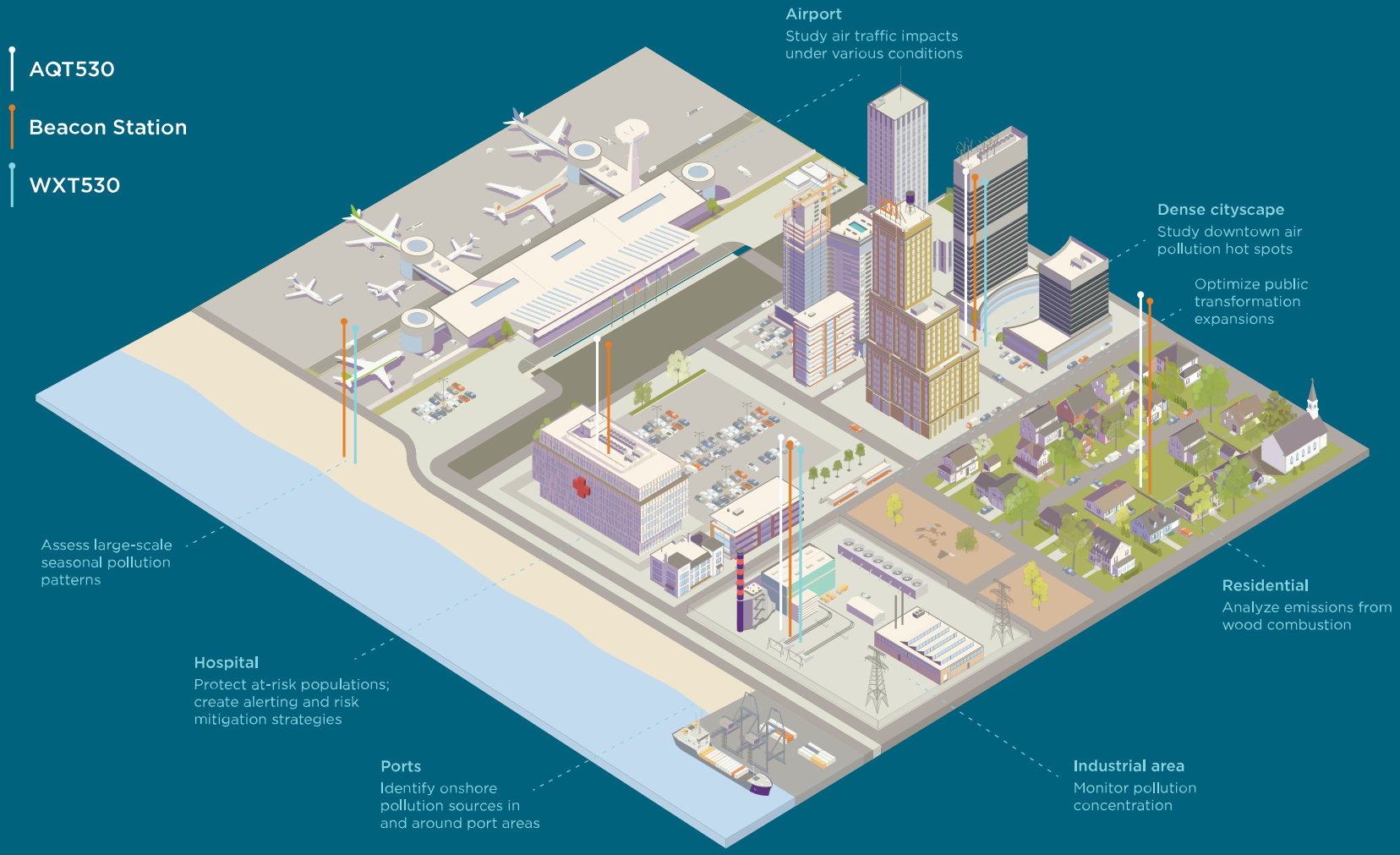
Principles of building a dense air quality network

Many cities already have reference-grade measurement stations, but these are typically organized in sparse networks that don't cover all the desired areas or account for small-scale variations. Often, they provide good accuracy, but are expensive to procure and manage.

Fortunately, the technology for small, cost-effective air quality sensors has developed in the last several years. Today, the sensors provide significant benefits while supplementing the existing air quality monitoring networks. The sensors can easily be deployed on lampposts, streetlights, buildings, or wherever else they are needed, to complement reference-grade stations. Or, sensor-based air quality monitoring networks can be used as standalone solutions in smaller cities.



Compact sensors like the AQT530 are especially valuable when small-scale variations matter a great deal, such as when tracking pollution distributions near a busy street or a street canyon. Cost-efficient sensors enable you to build a dense network to get a detailed picture of air quality and valuable data for modelling.

Different community environments also require different air quality insights and management practices, and this requires flexibility and cost-effectiveness. For example, a suburban residential environment will likely have different pollutant sources and levels (as well as different regulatory pressures) than a dense, highly active industrial environment. This is due to the drift of local emissions and pollutants based on weather conditions and topography.

Ultimately, intelligent planning and measurement in local communities can play a significant role in education and citizen outreach — enhancing shared awareness and ownership of air quality, health, and progress.

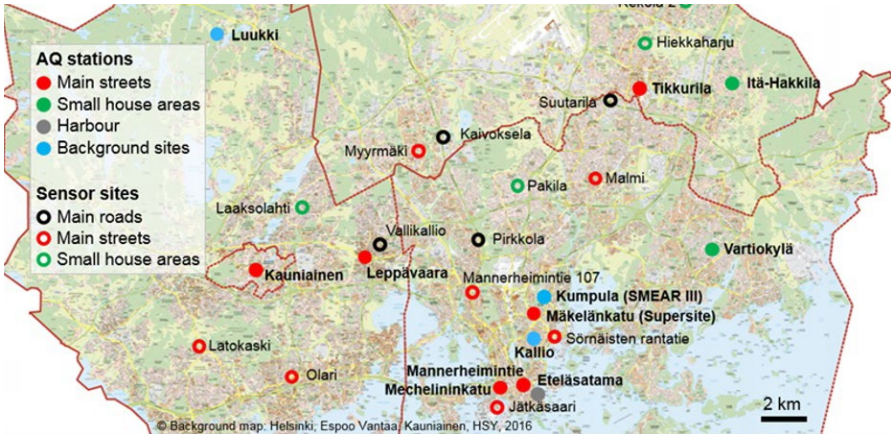
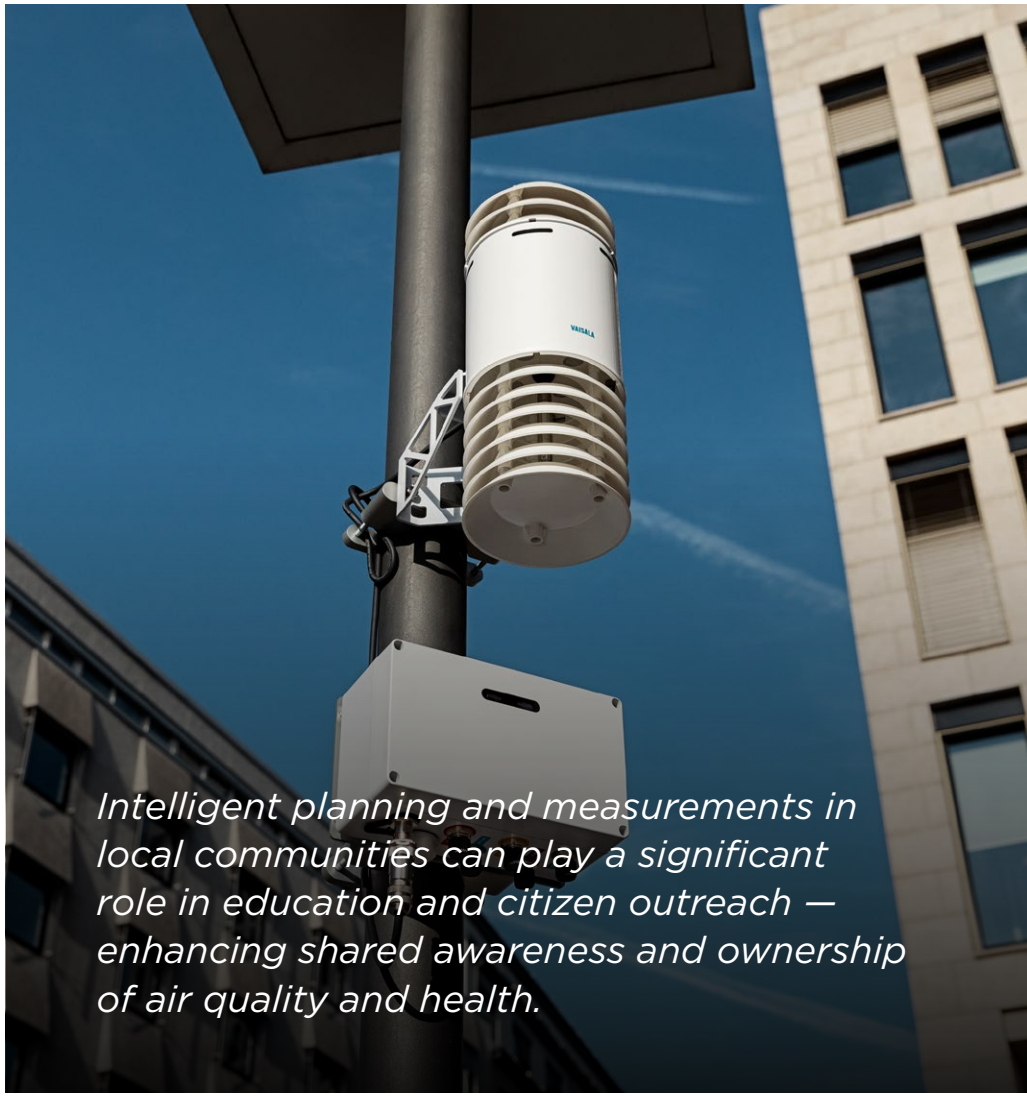


Figure 1 *An example of a complementary air quality sensor network. Full circles represent the fixed reference stations, open circles the complementary sensor sites. Different colors indicate different location types. (Source: Helsinki Metropolitan Air Quality Testbed HAQT project)*



Components of Vaisala air quality monitoring systems

Vaisala solutions are unique in their ability to provide holistic air quality and weather insights for dramatically improved decision-making. The core technologies below can be tailored according to a customer's needs and easily expanded or revised as those needs change.

Vaisala Air Quality Transmitter AQT530

The AQT530 is Vaisala's next-generation air quality sensor providing reliable measurements about top-priority pollutants.

Vaisala's AQT530 air quality sensor can be connected to your own system or used with Vaisala Beacon Station connectivity and data management system. When paired together with Vaisala Beacon Station and Wx Beacon data management and visualization service, users gain access to accurate and reliable measurement of pollutants like nitrogen dioxide (NO_2), nitrogen monoxide (NO), ozone (O_3), and carbon monoxide (CO), as well as $PM_{2.5}$ and PM_{10} particulate matter.

It uses proprietary, advanced algorithms to ensure accuracy and reliability, as well as mature, intelligent technology to ensure reliability in almost any conditions. For example, the sensor automatically compensates for ambient conditions, and its intelligent humidity management improves the lifetime of electrochemical cells, decreasing the need for maintenance in high humidity conditions.

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Components of Vaisala air quality monitoring systems

Vaisala Beacon™ Station

Beacon Station provides weather and environmental observations depending on what sensors are attached to it. The station consists of a powering unit and edge gateway to ensure a safe data path to the cloud-based Wx Beacon web service. Beacon Station forms a scalable platform for weather and environmental observation stations, as more stations can be easily added later, and stations can be relocated as needed.

Vaisala Weather Transmitter WXT530 Series

Vaisala WXT536 is a robust and accurate multi-parameter weather transmitter. It measures the six most important weather parameters — wind speed and direction, air pressure, temperature, humidity, and rainfall — all in a compact, affordable package. Vaisala WXT536 utilizes solid-state technologies to minimize operating and maintenance costs. Integration with Beacon Station is easy and flexible through the digital interface. It is virtually maintenance-free and offers an exceptionally long mean time between errors. So far, tens of thousands Vaisala transmitters have been delivered to more than one hundred countries around the world.

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Vaisala ceilometers for boundary layer measurements

Vaisala Ceilometers CL31, CL51, and CL61

Boundary later data is crucial for a complete picture of factors affecting air quality. Ceilometers measure variations in the boundary layer and provide insight into the volume and quantity of air in which pollutants can be mixed — ultimately affecting the concentration of pollutants.

Vaisala ceilometers accurately measure ceiling or base height of cloud layers, and they leverage pulsed diode lidar technology and single lens optics. They are engineered to deliver highly accurate data on multiple cloud layers even when conditions limit physical visibility.

Automated backscatter profiling captures detailed measurements on cloud base height and vertical visibility for multiple cloud layers — even in harsh conditions. Thousands of Vaisala ceilometers have been installed in over 110 countries around the globe. Whatever your needs, we offer a ceilometer that will support the outcome.

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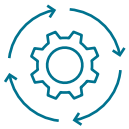
Air quality has never been more important. The technology for assessing it has never been better.

Your communities, customers and consumers rely on you to provide solutions for the most reliable and accurate air quality information available. You can rely on Vaisala for the globally recognized, reliable technology you need to succeed, even when communities and industries are changing rapidly.

Why Vaisala?



Exceptional products grounded in science and innovation

Vaisala's scientific leadership and innovation in inventing unrivaled weather and environmental products have reflected the spirit of our company for 85 years. Our founder established a ground breaking new technology category to solve problems that no one had ever solved and made meteorology modern. Vaisala has been creating accredited products to empower communities across the world ever since.

Champions for smarter, safer, and more sustainable urban communities

Vaisala empowers businesses and community leaders, helping them to fulfill their operational missions for their cities. Our innovations support an enhanced quality of life, safety, efficiency, and sustainability — all of which make communities more resilient given today's environmental challenges. Vaisala's spirit of partnership and world-class service has earned the trust of leaders in more than 170 countries, from the north pole to the south pole and even on Mars.

Insight every day

The combined power of our weather and environmental solutions provides dependable intelligence people can confidently act on, enabling businesses and communities to make better decisions. With Vaisala, you can count on our 360-degree solutions that are extensively put to the test across the world and proven to consistently provide superior performance.

The Finnish way

Finland has boldly demonstrated that a culture of resilience and a connection to nature can create new ways of smarter, sustainable living. Vaisala began in true Finnish character with honesty, curiosity, and determination; exploring the unknown and pushing the boundaries of innovation. We continue to honor this tradition today with our commitment to providing trusted, unsurpassed weather and environmental solutions that improve daily lives in urban communities across the world.

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