



Piera
S y s t e m s

What's in your Air?



CLIMATE CHANGE IS THE DEFINING PROBLEM OF THIS CENTURY

“AIR POLLUTION IS A PANDEMIC IN SLOW MOTION”

8 million deaths/year¹

\$5 trillion in welfare costs²

Untold damage to human health

Reality is Even Worse

We focus on what we see

AQI only reports PM10 and PM2.5
Tells you it's bad but not why

What we don't see is even more dangerous

"Fine particles, less than PM2.5, pose the greatest risk to health." – EPA

"Ultrafine particles, less than PM1, can penetrate into tissues and organs, posing an even greater risk of systemic health impacts." - WHO

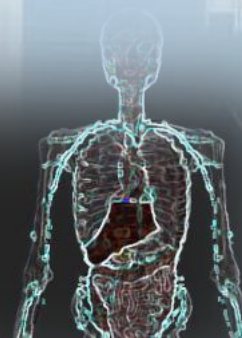
PM10



PM2.5



PM1 & below



Let's Talk About Air



Clearly, bad air for many



Bad air locally



What about this one?

Simple answer is, we don't know ...
... not until we measure it

Here's why ...

Let's Talk About Air



PM10

Vehicles
Industries
Construction
Sandstorms
Pollen



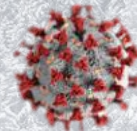
PM2.5

Fires, Wild and Controlled
Vehicles
Industries
Bacteria & Fungi
Biomass



PM1.0 - PM0.1

Cigarette & Vape Smoke
Wood Burning
Allergens
Cooking
Viruses



Why not measure it all?

What Are We Measuring?



PM10



PM2.5



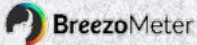
PM1.0 – PM0.1



EPA uses gravimetric and reference instruments co-located to report **only PM2.5 & 10.0**
Hundreds of miles apart, expensive, labor-intensive, and not real-time



Ubiquitous low-cost sensors used indoors & outdoors in air purifiers and AQMs
Precision and accuracy susceptible to temp, humidity, drift, variance, etc; cannot measure below PM1.0; mass concentrations are only estimates



Measurement Blackhole

any current readings are
guesstimates

“What’s In Your Air?”



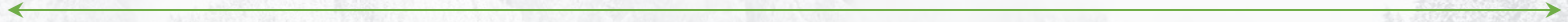
PM10



PM2.5



PM1.0 – PM0.1



Only way to get the whole picture

1. Accurately measure mass concentration
2. Measure coarse, fine, and ultrafine particles
3. Count individual particles, not just mass

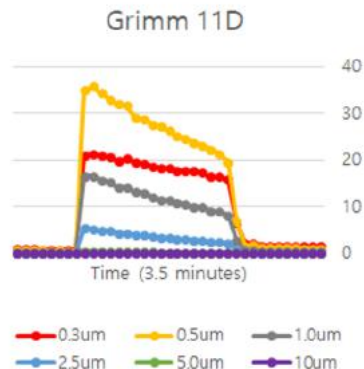
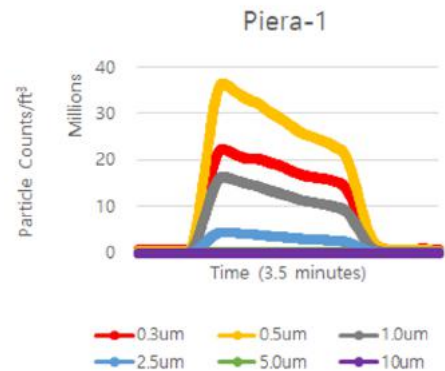
A highly accurate, affordable, easy-to-use particulate sensor did not exist ... until now

Break-through Family of Sensors



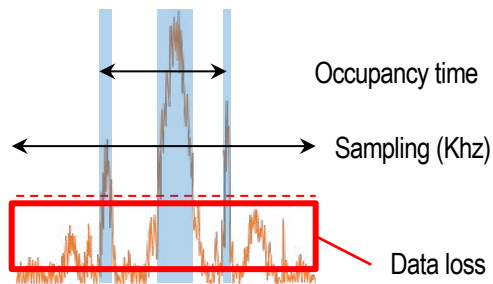
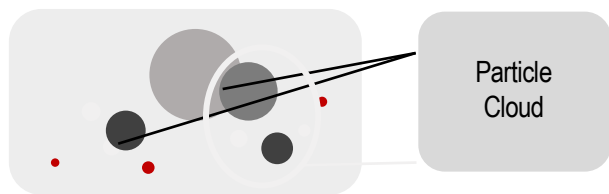
- Highly Accurate
- PM10 to PM0.1
- Particle counts and size, not just mass
- Software Defined
- $>6000 \mu\text{g}/\text{m}^3$
- $<\$30-\95

World's only certified sensor that accurately counts every particle from 0.1 μm - 10 μm in real-time



Custom Photon Counting Processor

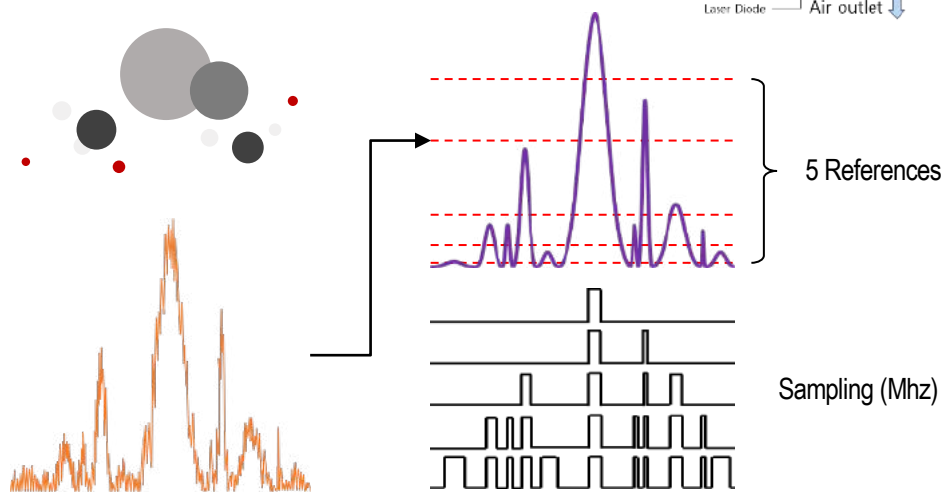
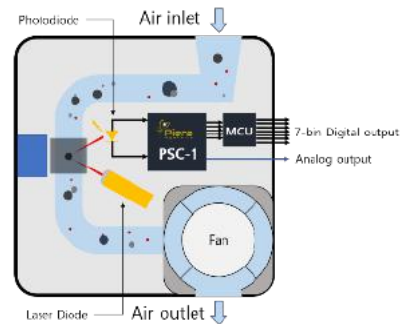
Competition



Estimated Concentration
PM2.5 only



Piera



Software-Defined bin sizes
count every particle

Nothing Else Comes Close



Detection Capability	Response Time	Accuracy	Particle Classification	Cost Effectiveness
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●

Ways to Partner With Us



Integrate our Sensors

Build our easy-to-use,
highly accurate,
affordable sensor into
your product



Deploy our AQMs

Ready-for-deployment,
fully integrated with the
cloud and a powerful UI;
lease, buy, or resell

Canãree: Next Generation Air Quality Monitors

Canãree A1 for Aruba access points



7cm x 5cm x 1.4cm (2.75" x 2" x 0.5")

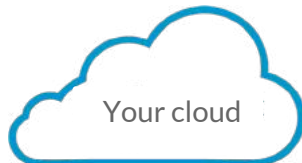
35 grams (~1.2 ounces)

- Highly accurate indoor air quality monitor
- Leverages existing wireless access
- SenseiAQ™ real-time dashboard for alerts and insights
- Vape/smoke detection in real-time
- Secure cloud-based storage and analytics
- Flexible pricing models

Complete Solution for AQM



Connect to wireless access points,
PC's, mobile devices, or integrate
into your product



Data aggregated in the cloud,
yours or ours



SenseiAQ Dashboard



PM data analyzed and
displayed on intuitive tools

SenseiAQ Software and Dashboard

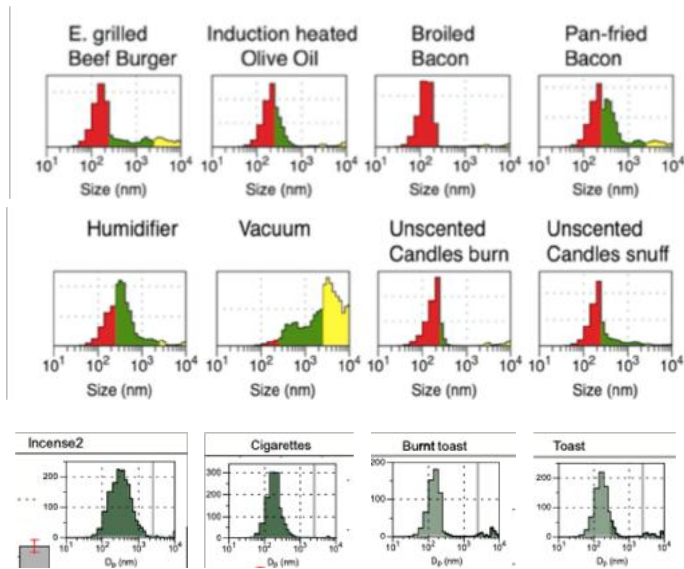
- Browser application for Windows/Mac
 - iOS, Android apps (Q2 '21)
- Standalone or connected to cloud
 - Our cloud or yours
- Dashboard: EPA AQI, vape/smoke, alerts
- Detailed analytics tab and logging capabilities
- Manage Canãree installation, setup, control
 - Maintenance, OTA updates, cleaning, monitoring
- API for integration with other applications



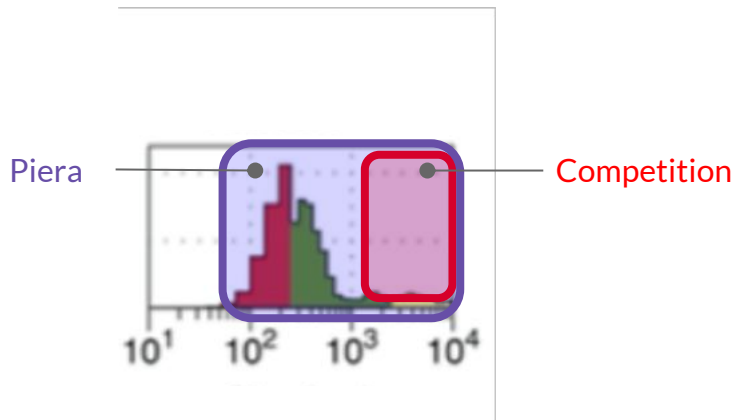
sensei.pierasystems.com

Classification is the New Frontier

Particle Count + Particle Size + Number of Bins = Particle Classification



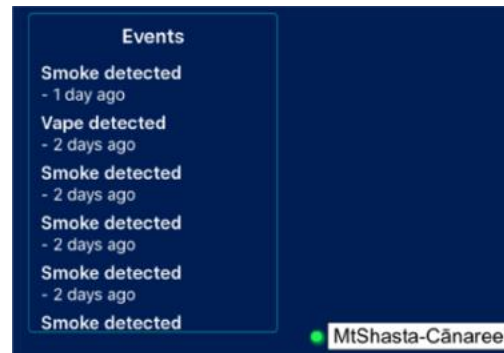
Pollutant signatures from Lawrence Berkeley National Laboratory



Only Piera can measure PM0.1-1.0
Competition cannot classify particles

Vape/Smoke Detection

- Highly accurate event detection; within 30 seconds
- Distinguishes smoke from vape with proprietary algorithms
- SenseiAQ displays events as they happen and logs them
- LED on Canaree flashes **red** for smoke and **purple** for vape



SenseiAQ Cloud Dashboard enables event detection from remote sensors

Applications & Markets



Smart Buildings



Asthma Triggers



Construction Dust



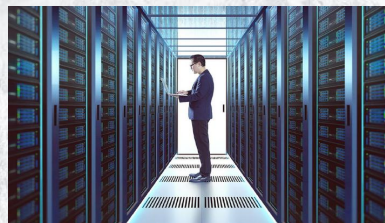
Hotels / Homeshares



Wildfires



Smart Cities



Data Centers



Rental Cars / Rideshares

Indoor Air Quality Critical to Health

Indoor air quality has a much bigger health impact than outdoors

Air quality indoors is subject to drastic, and rapid, changes

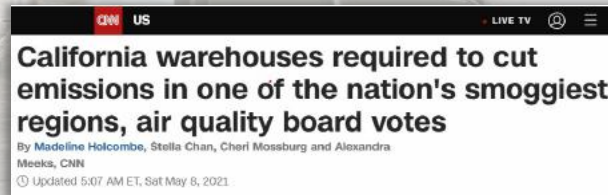
Filtration systems optimized for energy conservation not removal

Many air-cleaning products are ineffective

Each buildings is different; continuous monitoring is essential

Indoor Pollutants

- Diesel particulates
- Human behavior
- Viruses
- Cooking and fuel use
- Outdoor air infiltration
- Construction/machinery dust
- ...



HVAC Systems need the Accuracy

“... we found very strong correlation of submicron particulates with occupancy, unlike larger particles (>1micron) that did not correlate with occupancy.”

“Some fraction of these small particulates are respiratory, and our experiment showed that we could reduce their concentration through both increased fresh air ventilation and improved filtration (MERV13).”

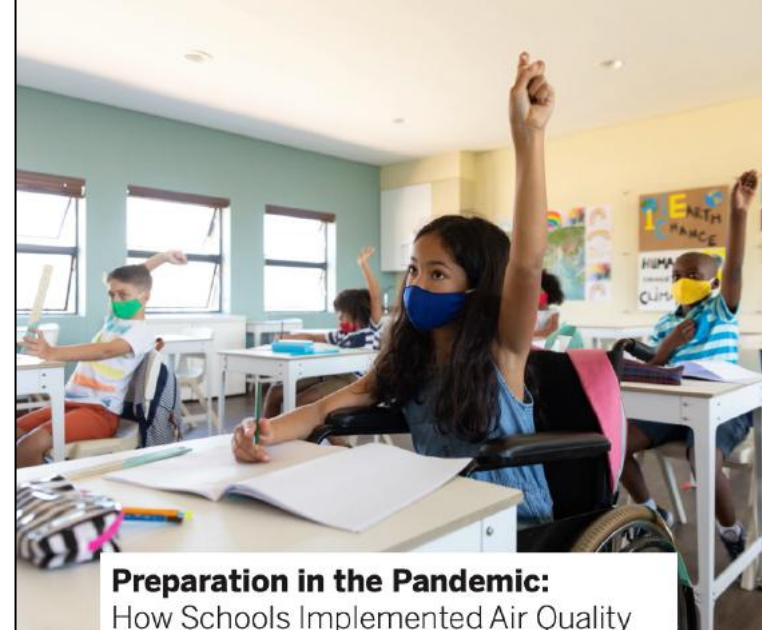
“... we think today's standards are half of what they should be ...”

“Air cleaning products require in-situ monitoring and control”

ASHRAE Report on Schools

- 4k schools, 2.5 M students, 24 states
- 6 IAQ Strategies: increase fresh air, filtration
- Array of Guidance from multiple sources
- “Many vendors selling snake oil”
- IAQ Monitoring was basic: not real-time; CO2 not PM
- “Investments in school infrastructure needed to address indoor air quality”

We found that school districts relied heavily on their mechanical systems to implement air quality measures. Using mechanical ventilation to increase fresh air was most commonly adopted by schools, followed by filtration measures to remove airborne contaminants from recirculated air. The most frequently cited challenge to implementing protective air quality measures at schools was that school buildings were not designed to support the strategies that were being recommended.



Preparation in the Pandemic: How Schools Implemented Air Quality Measures to Protect Occupants from COVID-19

ANNIE HOANG

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MPH Candidate, Harvard TH Chan School of Public Health
MD Candidate, University of California – San Francisco School of Medicine (UCSF)

ANISA HEMING

Director, The Center for Green Schools



AQM - Buildings

Challenge

Keep employees safe and healthy by monitoring air quality and eliminating pollutants

Studies show poor air hinders employee productivity; concerns significantly heightened due to pandemic

Solution

Only Piera can detect ultrafine particles

- classify vape and cigarette smoke in real-time
- accurately monitor and improve indoor air quality
- seamlessly integrate into HVAC systems, air purifiers, and building management software

For healthy spaces you need Piera



AQM – Access Points

Challenge

Keep employees safe and healthy by monitoring air quality and eliminating pollutants

Studies show poor air hinders employee productivity; concerns significantly heightened due to pandemic

Leverage existing wireless access points

Solution

Canāree and Aruba deliver secure, affordable AQM solution

- accurately monitor and improve indoor air quality
- classify vape and cigarette smoke in real-time
- seamlessly integrate into HVAC systems, air purifiers, and building management software

For healthy spaces you need Piera

PARTNER SOLUTION OVERVIEW

ARUBA & Piera Systems

Indoor Air Quality Monitoring and Reporting

THE NEED FOR INDOOR AIR QUALITY MONITORING

Employees, customers and the general public are now aware of the need to Monitor, Measure and Improve indoor Air Quality. Wildfires, Climate Change, Covid-19 and the increasing amount of time spent indoors has created a 'tipping point' for companies to take action. The source of most poor Air Quality is due to Particulate Matter (PM) a mixture of airborne solid particles and liquid droplets that can be inhaled and causes serious health problems. The World Health Organization (WHO) reports airborne particulate matter (particulate from 0.1-10 micrometer in size) as a Group 1 carcinogen and as the biggest environmental risk to health, with responsibility for about one in every nine deaths annually.

The EPA monitors and reports Outdoor Air Quality but not Indoors and their monitoring stations are quite far apart, expensive and do not update in real-time. The EPA's Air Quality Index (AQI) is a simple, easy to follow metric for classifying Air Quality and can be applied indoors. However, it doesn't classify sources of poor Air Quality. To do so requires more detailed information about particle size and count. A new class of Air Quality Monitors based on more accurate, higher resolution, real-time data about particle size and count has been developed by Piera Systems leveraging existing wireless access points from Aruba to quickly and cost effectively allow monitoring of Indoor Air Quality.

A BREAKTHROUGH IN AIR QUALITY MONITORING: CANAREE

Canāree™ is a low cost, Air Quality Monitor that when connected to Aruba Access Points operates as an IoT device that measures Air Quality instantly, calculating EPA's AQI and can leverage MS Azure cloud services for secure data storage and remote access to data. Piera's **SenseiAQ™** software application running on Azure is a Real-time dashboard that reports AQI together with additional analytics and alerts about indoor Air Quality. Canāree installs by simply plugging into an existing Access Points side USB connector without the need to remove the AP to install. Power and secure IoT communications are provided by the AP and Mobility Manager. Data is logged and stored on Azure IoT Hub for easy integration with existing Building Management Systems. Canāree is easy to install, configure, maintain and update and a network of Canāree sensors monitored by SenseiAQ can be easily reconfigured as needed.

WHY ARUBA AND Piera Systems

- Highly accurate Indoor Air quality monitoring & management
- Leverage existing wireless access points to reduce costs, simplify installation and deliver real-time analytics
- SenseiAQ™ application provides real-time dashboard, alerts and Insight to take action and improve indoor air quality
- Vape/Smoke detection in real-time
- Secure, Cloud-based storage and analytics integrates with existing IT and Facilities Management applications
- Flexible business models allow own/ rent/lease for short or long-term business requirements



Figure 1 Canāree

Canāree utilizes Piera Systems **Intelligent Particle Sensor (IPS)**, an optoelectrical sensor based on laser scattering. IPS utilizes Piera's proprietary **Particle Counting Integrated Circuit (PCIC)** a custom ASIC specifically developed for photon-counting and processing (3 granted US patents). PCIC can identify different sized particles and their concentration by directly counting pulses of different levels of photon energy, featuring superior accuracy, resolution and true real-time data acquisition compared to other sensors using a less accurate, slower LPO technique that 'estimates' overall Air Quality.

Canāree's real-time data on PM is stored on Microsoft's Azure IoT hub and SenseiAQ can classify its components and take actions to improve it. Canāree can identify uniquely vape and cigarette smoke using proprietary ML/AI algorithms. Alerts identify it's presence, concentration and persistence (how long it remains in the air). Knowing the source of PM, its location and severity provides insight and mitigation including changing HVAC systems, adding air purifiers, removal of the source or limiting access to areas with poor Air Quality.

Intelligent Home Monitors

Challenge

Indoor air quality has a huge impact on your health and current measurement methods are ineffective

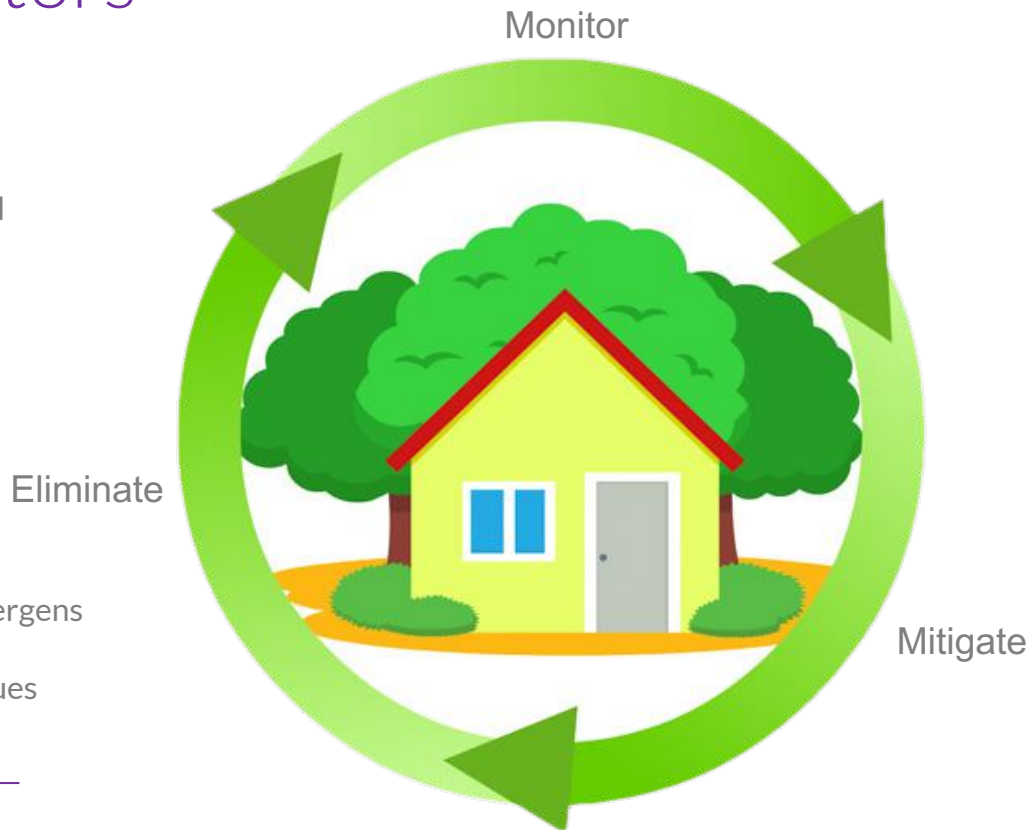
Pollutant sources and intensity of indoor air pollution continues to rise

Solution

Accurately detect and mitigate indoor pollutants

- Vape and smoke detection in real-time
- Measure wide range of pollutants from pollen to allergens to viruses
- Ensure efficiency and efficacy of mitigation techniques including air purifiers, HVAC Filters

Intelligent and healthy homes need Piera



ELI Report on Cooking

- Protect residents from unhealthy levels of cooking pollution
- Kitchen Ventilation reduces exposure
- Policies and Programs for New Homes and Existing ones
- Building Codes, Green Buildings, Housing Codes
- DOE Project: [Smart Range Hood with sensors](#)
- Financial Assistance
- Information and Outreach are Vital to Reducing Exposure

Campaigns might also incorporate low-cost air quality sensors... which can be a powerful tool for residents to assess the effectiveness of their kitchen ventilation systems, as well as to increase awareness of the problem.”

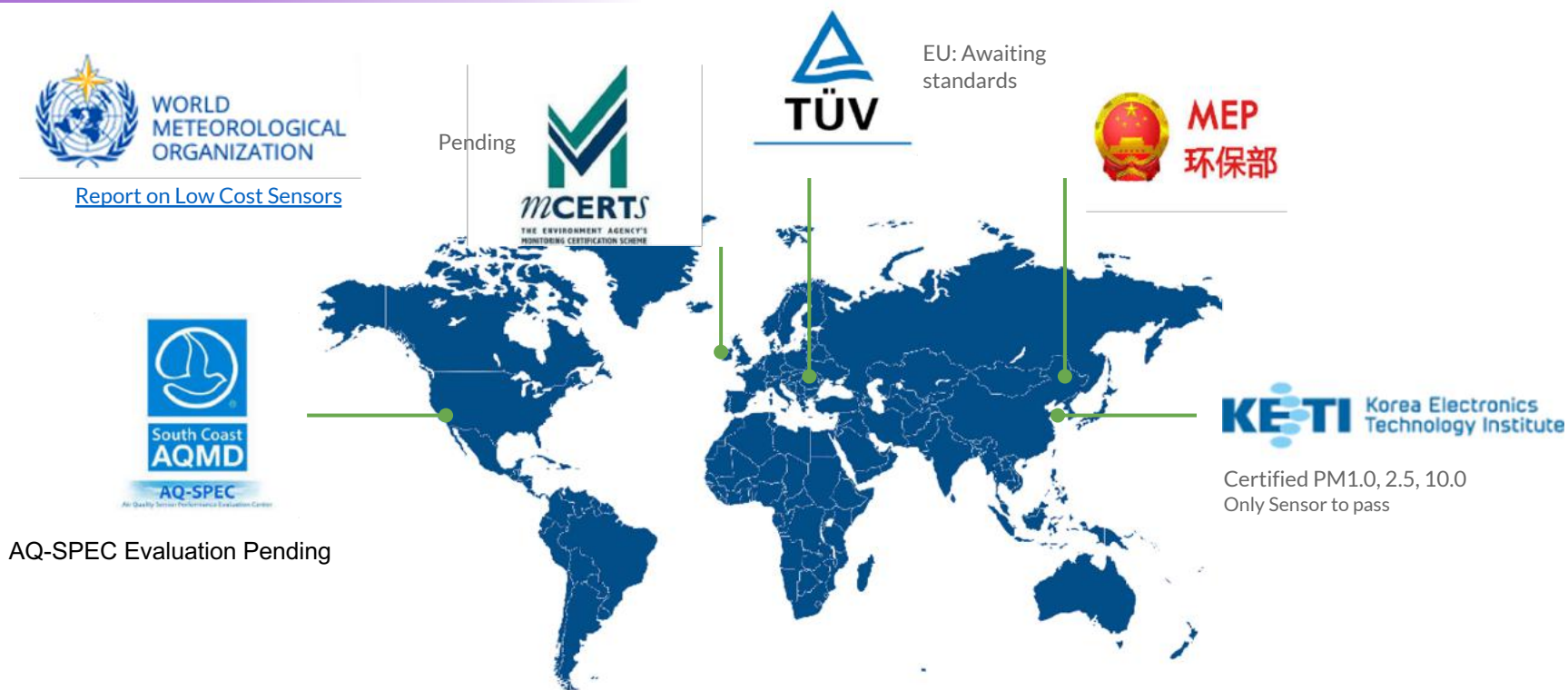


Reducing Exposure to Cooking Pollutants

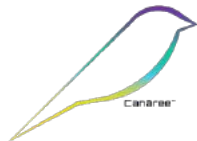
Policies and Practices to Improve Air Quality in Homes



Certifications and Reports



Canãree Roadmap



Canãree A1

Now

Get started with easy install on existing APs



7cm x 5cm x 1.4cm (2.75" x 2" x 0.5")

Canãree I1

July '21

Expand coverage to non-AP areas



8cm x 5cm x 2cm (3" x 2" x 0.75")

Canãree I5

July '21

Particulates + temp/press/RH/VOC/CO2



Useful links

Our home: www.pierasystems.com

Canaree A1 product page: www.pierasystems.com/canaree-a1

Canaree for Aruba APs [brochure](#)

IPS-7100 sensor [datasheet](#)

Vape / smoke detection [video](#)

Questions?

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No more guessing, know exactly 'What's in your Air'

- Most accurate, scalable particle sensor in the world

Future-proof your products

- Fine and Ultrafine particle detection is the future, be ready

Let's partner on new possibilities

- Our disruptive technology empowers new markets and applications

A wide-angle photograph of a calm body of water at dusk or dawn. The water is a deep blue and reflects the sky and the lights from a building and trees in the background. The background features a line of bare trees and a building with several warm, yellow lights on. The lights are reflected in the water, creating a series of bright, vertical streaks. The overall scene is peaceful and serene.

Additional Applications

Data Centers

Challenge

Direct Cooling requires good quality outdoor air to increase efficiency, lower costs.

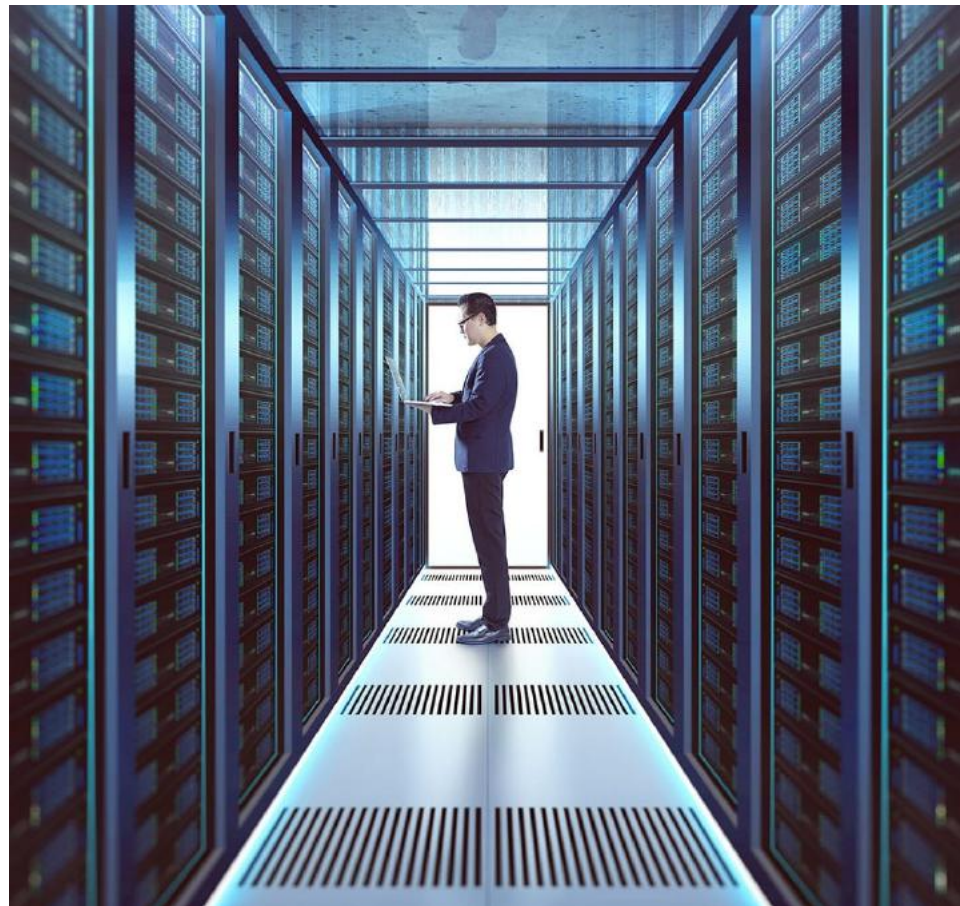
Indoor Air Quality < PM1.0 affects reliability, uptime and operational efficiency

Solution

Only Piera has the algorithms and accuracy to identify PM for both outdoor and indoor emissions

- Measure efficiency of Direct Cooling
- Precisely time-stamp events
- Provide deterrent against events occurring at all
- Assurance of a clean indoor environment

For data center operations you need Piera



Construction Dust

Challenge

Prolonged exposure to fine construction dust endangers workers' health

Regulators are requiring accurate monitoring of construction environments to protect workers

Solution

Only Piera can detect ultrafine particles like silica dust

- accurately monitor and classify dangerous particles
- alert unsafe work conditions
- verify mitigation before workers return

For safe construction sites you need Piera



Wildfires

Challenge

Climate change is increasing duration and intensity of wildfires around the world

Wildfires produce significant PM2.5 and below emissions which are 10x more harmful than vehicle emissions

Solution

Only Piera can detect fine, ultra-fine particles in wildfire smoke

- Build accurate region-wide hotspot maps which lead to better evacuation plans and safer conditions
- Industry's highest mass concentration limit ($>6000 \text{ ug/m}^3$) means high reliability during wildfire season

To stay safe from wildfires you need Piera



Asthma

Challenge

339 million people have asthma; over 400,000 deaths a year; hundreds of billions in costs

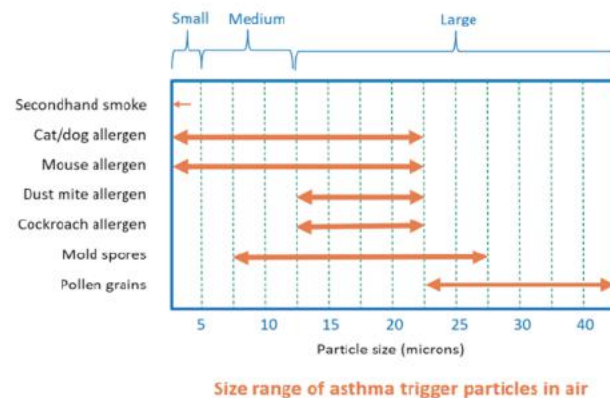
Wide range of triggers for asthmatics causing severe impact on quality of life

Solution

Only Piera can detect entire range of asthma triggers

- Vape and smoke particle detection in real-time
- Identify safe and trigger zones in real-time
- Accurate classification of asthma triggers for better mitigation

To prevent asthma attacks you need Piera



Pollen

Challenge

EPA reports pollen but not locally
Pollen finds its way indoors
Wide range of particle size
Pollen peaks coincide with other 'events' (Yellow Sand)

Solution

Piera sensors detect pollen particle size and count
IPS-7XU is programmable from 0.5u to 100 u
Pollen count 'events' vs others

During pollen season you need Piera

