airveda

Smart Control Systems

Namita Gupta
Co-Founder & CEO Airveda Technologies Pvt. Ltd.
An end-to-end air quality monitoring Company


DRAWDOWN
https://drawdown.org/
THE WORLD'S LEADING RESOURCE
FOR CLIMATE SOLUTIONS
Peatland Protection and Rewetting

According to Drawdown

- #1 solution for reversing climate change
  - **Refrigeration material use, storage and disposal in Air Conditioning Industry** (not reforestation, or efficient thermal power plants, or renewable sources of energy)
  - Potential to **reduce 89.74 Gigatons** CO2 by 2050 **and savings worth $903B**.

- **Building Automation is #45**
  - Per the Inter-govt panel on Climate Change, **buildings are responsible** for
    - roughly **one third of global energy use** and
    - **one fifth of global greenhouse emissions.**

  - If done right by 2050, automation can
    - **Save 4.62 Gigatons of Reduced CO2** .
    - **Give 13x savings in costs:** Net costs are estimate to be 68.1B USD and Net savings 880.6BUSD

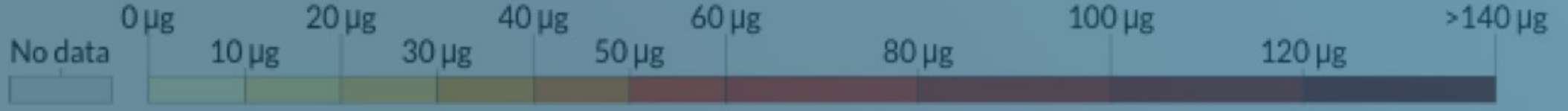
Air pollution is one of the

Biggest Health Hazards of our times.

8.8 Million
Extra deaths each year. More than smoking (7M)

92%
of the world population lives in polluted regions

Increased risk from COVID-19
- Higher risk of Mortality.
- Higher spread in polluted regions
- Compromised lungs and immunity



Indoor Air Quality is Often Worse Than Outdoors.

Particulate Matter

From outdoor air pollution as well as carpets, curtains, cooking, agarbattis etc.

High Carbon dioxide levels

Reduce cognitive function and productivity

VOCs (Volatile Organic Compunds)

From paints, cleaning products, room freshners etc. lead to long term health problems like kidney/liver, nervous system issues and even cancer.

Temperature & Humiidity

Human experience and comfort. High humidity can also lead to mould which is associated with many allergies and health problems. Low humidity can dry out respiratory passages.

Good News: This is solvable

- People spend **95%** of their time indoors.
- While cleaning pollution outdoors is a much harder problem, **we can clean indoor environments**
- **Reduce overall exposure** for occupants by 95% - significantly improving their health and life span.

Viral transmission indoors

- More and more studies show greater viral transmission indoors.

- **Good news:** Studies have found conditions under which we can reduce viral transmission.

Problem Definition: Goal is to to Balance

Energy

Ensure overall system as well as every sub-system runs at max Energy efficiency.

Disease Resilience

Meet IAQ Standards for

- **Particulate Matter**
- **CO2 (Cognitive development)**
- **TVOCs (Sick building syndrome)**

Reduced Viral Transmission

- **Temperature (24-30deg C)**
- **Humidity (40%-60%)**
- **Additional Ventilation**

Comfort

Ensure comfortable

- Temperature (22.5+-2.5deg C)
- Humidity (30-70%)
- lighting, noise, air flow etc.

for occupants

airveda

Why this cannot be done manually?

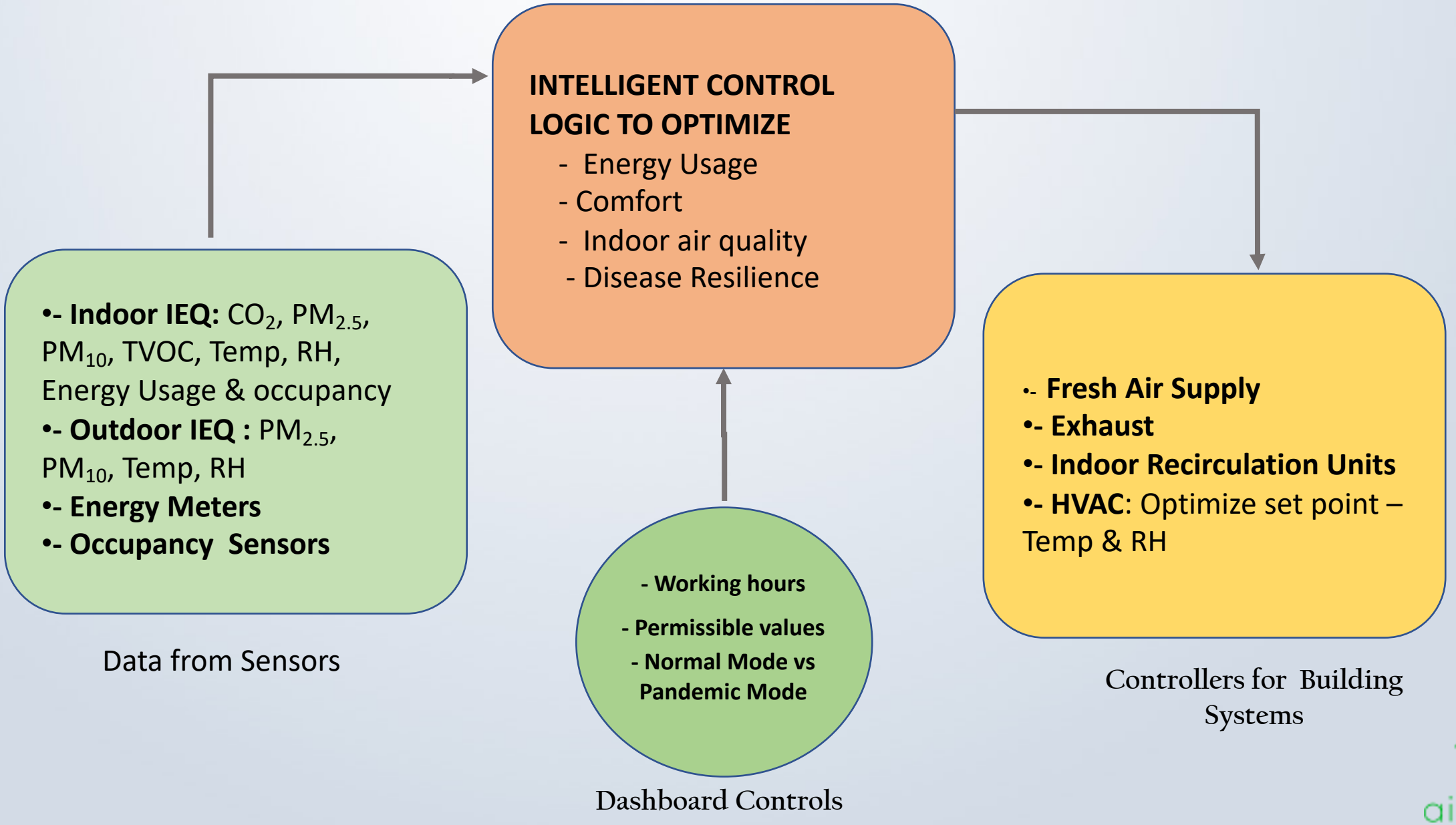
- Standard practice in North India:
  Open dampers during winters and close during summers
  - Great for energy efficiency but poor for disease resilience.
  - Winters worse time for air quality and summer is good clean fresh air.

- Set point temp
  - Temp at 20-24 deg makes sense for max comfort of occupants
  - During Pandemic higher temp (24-30) for viral transmission.
  - Studies show ideal set point temp varies with outdoor temperature.

- Buildings are dynamic – affected by seasons, occupancy, COVID etc. How do you make the right decisions to ensure comfort, disease resilience and energy efficiency?

airveda

Need to think through the problem holistically



airveda

1. Controllers & System

- Define the parts of the system that can be controlled and set up controllers.
- Expose functioning data so they can be monitored for fault detection & other analysis.

Fresh Air System	Exhaust	Indoor Recirculation Units	HVAC	Other systems

• **Controls**
  • ON/OFF
  • Fan speed
  • Temp, Rh set point
• **Functioning data**
• Pressure differential across filters
• Air quality data - inlet & outlet
• **Energy usage**
	• Energy consumption
	  • ON/OFF
	  • Exhaust air flow
	• **Energy usage**
		• **Controls**
		  • ON/OFF
		  • Speed of Recirculation
		  • Differential pressure across filters.
		• **Energy usage**
			• **Controls**
			  • ON/OFF
			  • Temperature set point
			  • Humidity set point.
			  • Differential pressure of filters
			• **Energy usage**
				• Lighting
				• Security
				• **Energy usage**

airveda

2. Data from Sensors

We need real-time sensors that are continuously giving us information about the functioning of the building.

Sensors	Usage
Occupancy Sensors	Optimize energy usage for occupied floors
Air Quality sensors – Indoor/Outdoor	Ensure you are meeting ISHRAE IAQ Standards.
Temp, Humidity sensors – Indoor/Outdoor	Ensure comfort/Pandemic mode Ability to set setpoint temp/humidity based on outdoor and indoor temp/humidity
Energy Meters	In every sub component of the CAC system to ensure that we can optimize energy usage at every level.

airveda

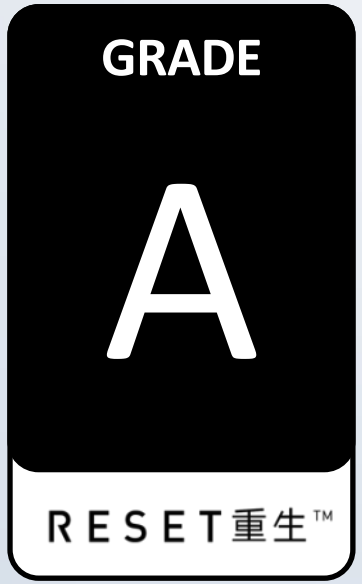
Air Quality sensors & deployment

Monitor Type	Commercial Interiors	Core & Shell
	Goal: Ensure Indoor air quality is healthy for occupants and filtration systems are working.	**Goal:** Ensure effectiveness of filtration system and save energy via automation and timely replacement of filters.
Indoor monitors	Measure what occupants are breathing in the occupied space.	Sometimes used in AHU rooms to measure return air quality.
Outdoor monitors	Measure Outdoor air quality for comparison with indoor air quality to know if filtration is working.	Measure Outdoor air quality for comparison.
Duct Monitors	NA	Measure quality of return & supply air.

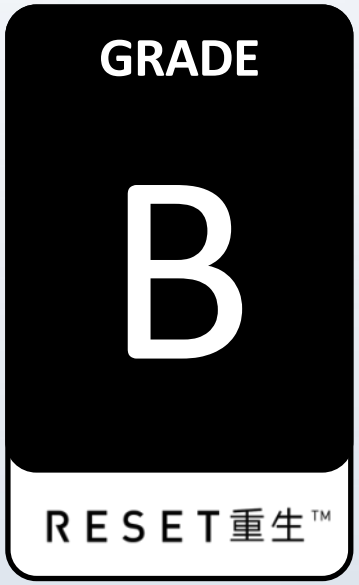
airveda

Monitoring hardware & Standards (Indoor & Duct)

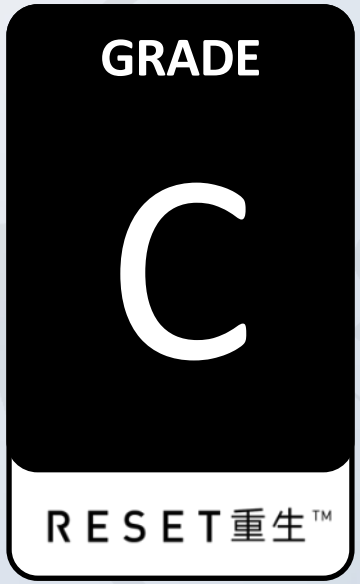
The accuracy of monitors is of critical importance to human health and building operations, especially when readings are used to guide building automation and user behaviour. Given the wide range in the quality of market-available monitors, RESET™ sets standards for sensor performance and calibration. Only Grades A & B are acceptable for use in RESET™ projects.



Calibration grade monitors:
Used in labs and manufacturing.



Commercial grade monitors:
Used in commercial projects.



Consumer grade monitors:
Portable mass market monitors.

Source: RESET™ Air STANDARD for Commercial Interiors 2.0

airveda

Key parameters to monitor

Below are key parameters for IAQ with ISHRAE IEQ standards.
Other parameters like CO, HCHO, noise, lux etc. Other standards also exist like WELL, RESET, WHO etc.

Parameter	Why?	UNIT	ISHRAE IEQ CLASS A	ISHRAE IEQ CLASS B	ISHRAE IEQ CLASS C	RESET (Acceptable/High performance)
PM2.5	Severe health issues	µg/m3	<15	<25	<25	<12 / <35
PM10	Upper respiratory diseases	µg/m3	<50	<100	<100	-
Carbon dioxide	Reduced cognitive function & productivity	ppm	Ambient + 350	Ambient + 500	Ambient + 700	<400 / <500
TVOC (Volatile organic compounds)	Sick building syndrome.	µg/m3	<200	<500	<500	600 / 1000
Temperature	Thermal comfort	Deg C	24 +- 2.5	24 +- 2.5	24 +- 2.5	-
Humidity	Comfort plus leads to molds, allergies	%	30-70	30-70	30-70 or 80% occupant satisfaction with humidity	-

airveda

Deployment standards based on RESET

1. **One monitor per 500 sq meter** of open space. (Well building recommends one monitor per 350sq meter)

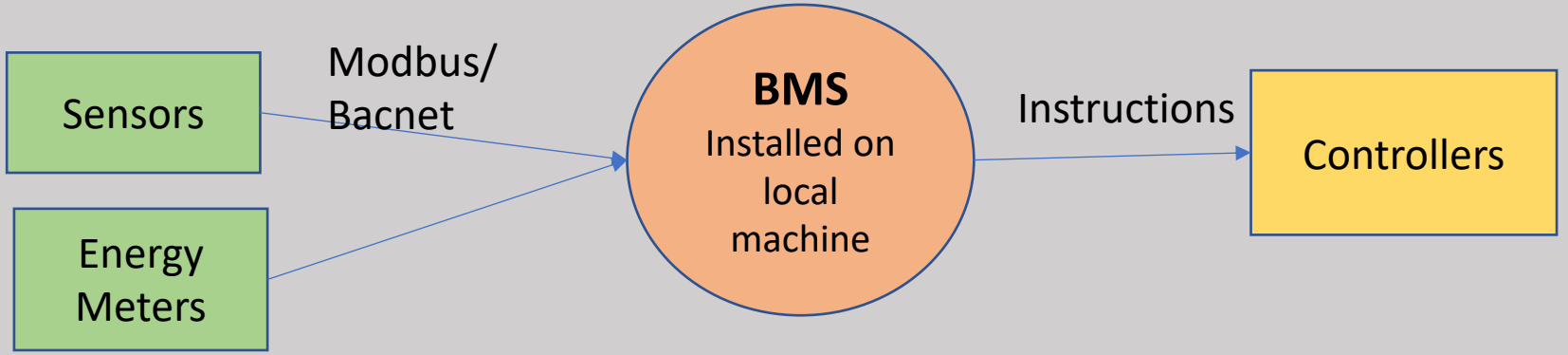
2. **At least one monitor in every space type** for e.g. meeting rooms, open staff area, private office, reception, guest rooms etc.

3. **Should cover 80% of regular occupants**
   - Exceptions:
     - In cases like banks, hotels and hospitals where a large number of identical spaces exist, client may target 30% of regular occupants.
     - Further, in such cases where there is a large number of repeat rooms, case may be made to justify using 1 monitor per 5 or 10 rooms, as long as, air quality across the rooms can be explained to be similar - due to delivery method or HVAC system setup.

airveda

3. Communication with central systems

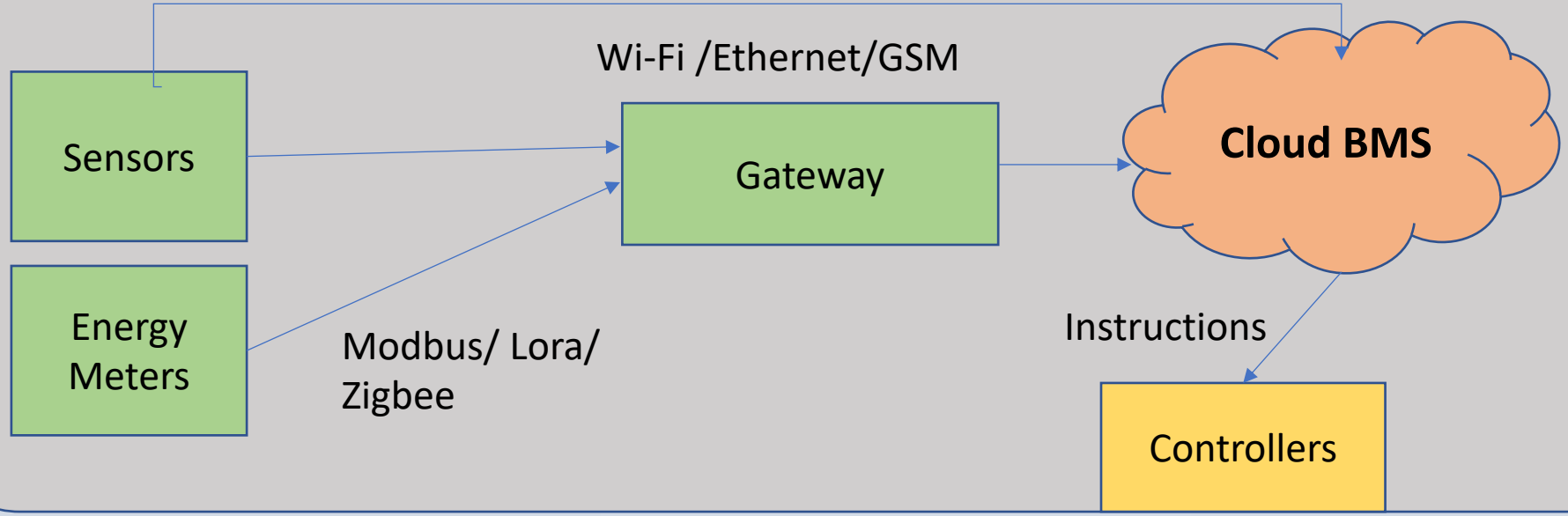
Traditional



Advantages

- Better security of data.
- One-time cost of software.

Modern Systems



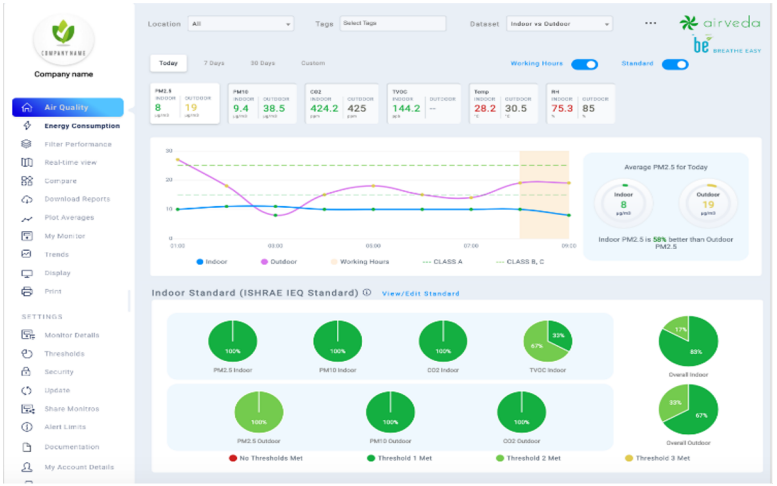
Advantages

- Better data analysis
- Present it in a format that is easy and quick to understand.
- Over-time trained to perform at higher efficiencies
- Regular updates

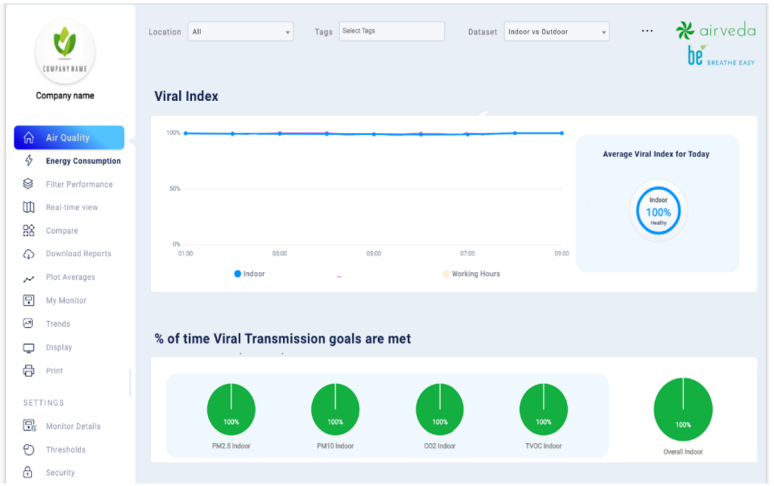
airveda

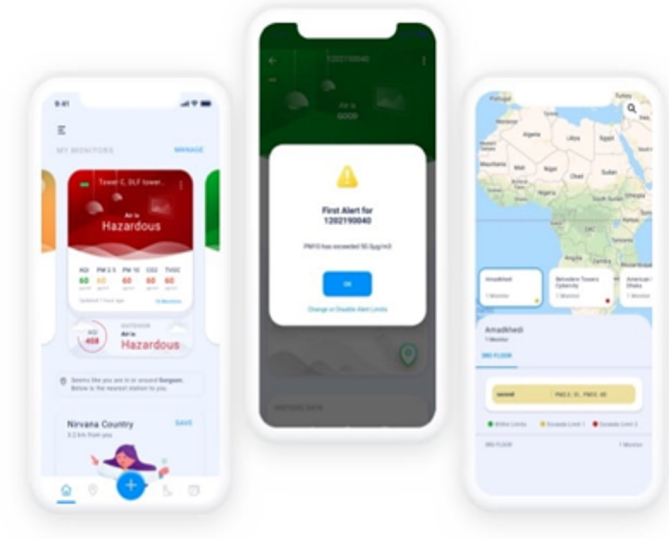
4. Analytics & dashboards for operators & occupants

Indoor Air Quality



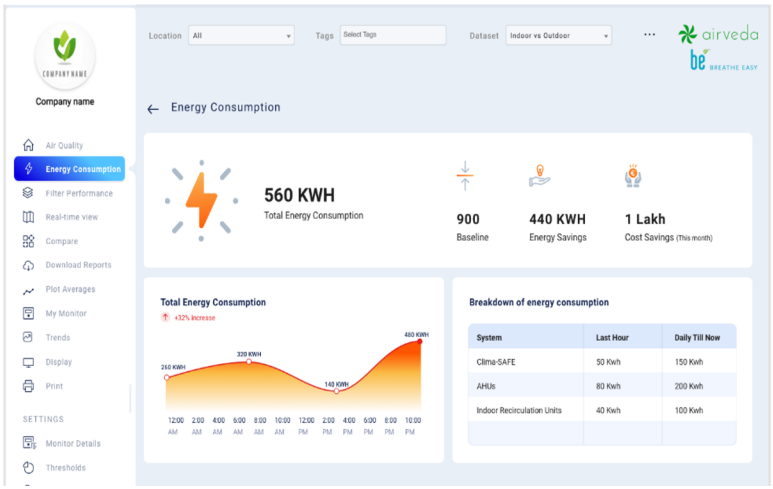
Disease Resilience



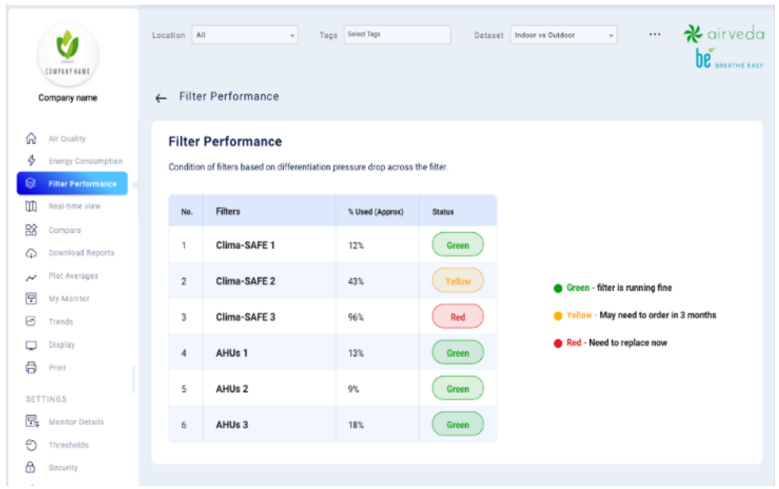


Mobile App (iOS/Android)

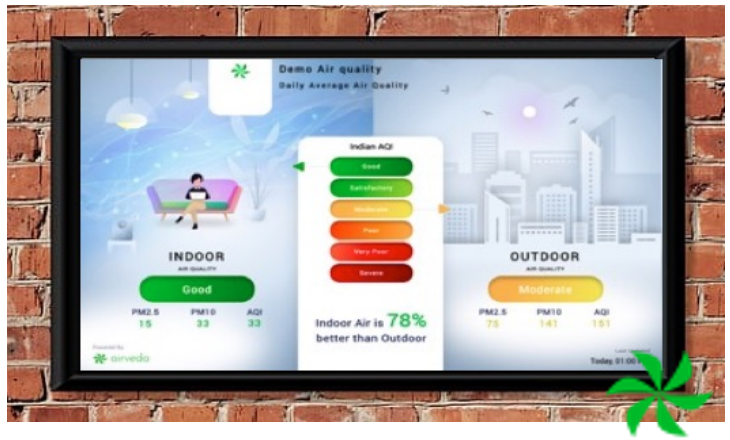
Energy Consumption



Filter Maintenance Indicator



Dashboards for Operators



TV Displays for Occupants

Key Goals for dashboard systems

Real-time system performance tracking

Fault detection & Pre-emptive equipment maintenance

Timely alerts for issues.

Diagnose Issues to quickly find problem

Remote access to performance & alerts

Controls & Overrides

- Working hours, permissible values, pandemic/normal mode

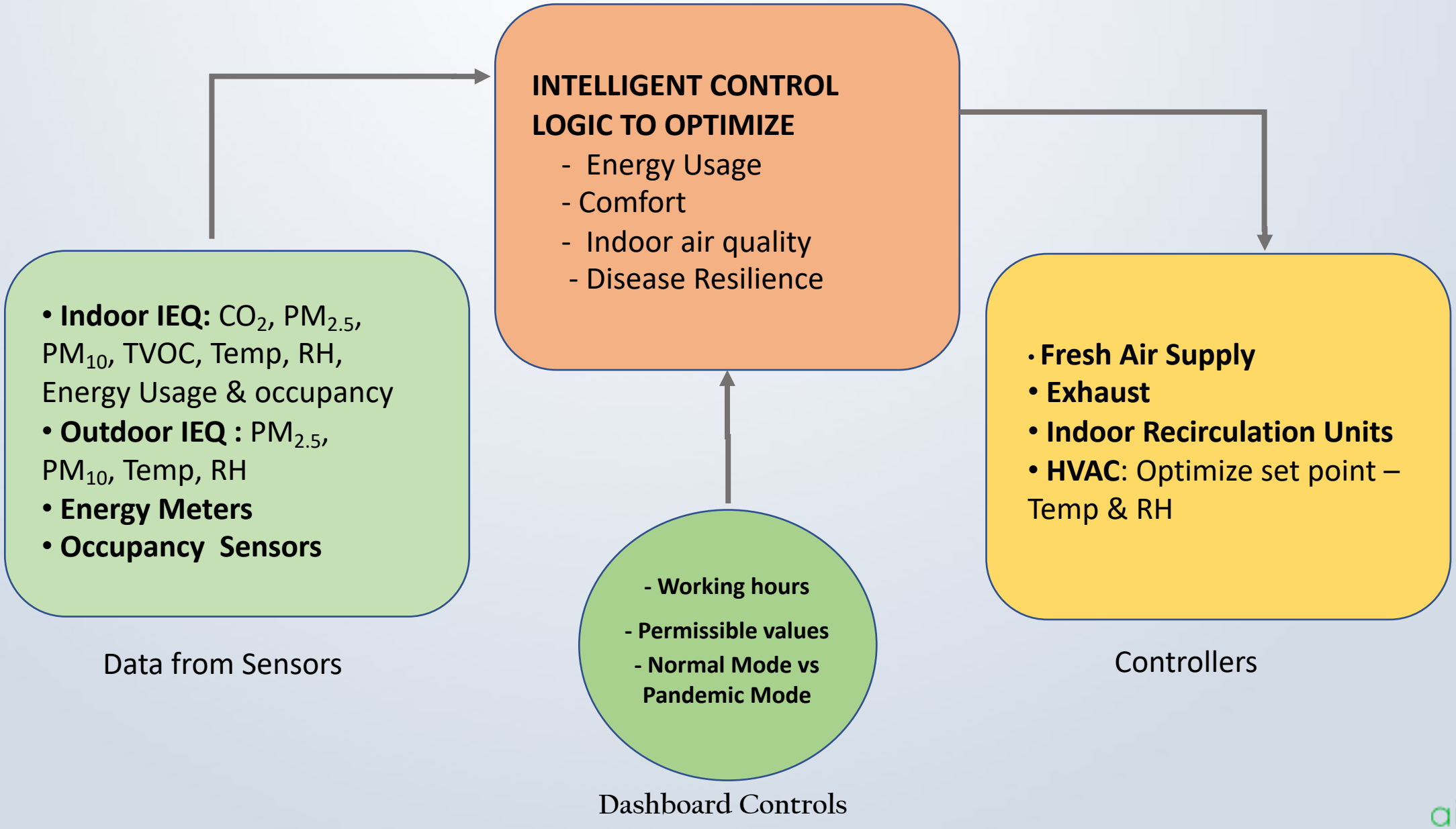
Viewer vs Administrative security controls

Easy to setup, use, interpret with intuitive user interface

Easy to provide upgrades and continuously improve

airveda

5. Control Logic – Brain of the system



airveda

Controlling logic – Rule based system

- **IF (**CO2 > 800 ppm) **THEN**
  open the damper to allow ventilation.

- **IF** (Pandemic Mode) **THEN** set point temp = 26deg
  ELSE IF (normal mode) **THEN** set point temp is 22 deg C

- **IF (**occupancy in a floor =0)
  THEN reduce damper to 10% **&&** turn lighting off.

- **IF** (time= start time -2 hours)
  THEN flush the building.

- **IF** (time = end time + 2 hours)
  THEN flush the building.

airveda

Fault detection – AI/ML

- **Manual =>** Oh no system broke.
- **If rule based system =>** If certain conditions are met then alert that this system needs changing

- All functioning parameters of the system
- Train it with supervised learning data on what parameters caused it break

ML Model trained with fault data

Improve probability of knowing if system is about to break.

machine	temperature (◦C)	pressure (psi)	machine fault
17987	60	7.65	N
34672	100	25.50	N
08542	140	75.50	Y
98536	165	125.00	Y

airveda

Opening fresh air dampers – AI/ML

- **Manual =>** If summer close damper all the time. If winter then open damper all the time.
- **If rule based system =>** If CO2 > 800 ppm then open the damper to allow ventilation.

- Indoor Temp & humidity
- CO2
- PM2.5
- Energy usage
- Outdoor PM2.5
- Outdoor Temp, humidity
- Occupancy
- TVOC
- Season

ML Model trained with historic data

rewards for energy, comfort and disease resilience.

Right time to open

close the damper

- This slowly learns over time, and will bring in fresh air when outdoor temp is lower in the day, or when PM2.5 is lower.
- It will make different decisions based on the season to ensure comfort, disease resilience and energy efficiency.

airveda

Set Point temp/humidity – AI/ML

- **Manual =>** If summer set set point temp to x. If winter set set point temp to y
- **If rule based system => If outdoor temp > x then set point temp is y.**

- Indoor temp
- Outdoor temp
- Season
- time of day
- Occupant satisfaction/number of complaints.
- pandemic mode or normal mode
- energy usage

ML Model trained with historic data

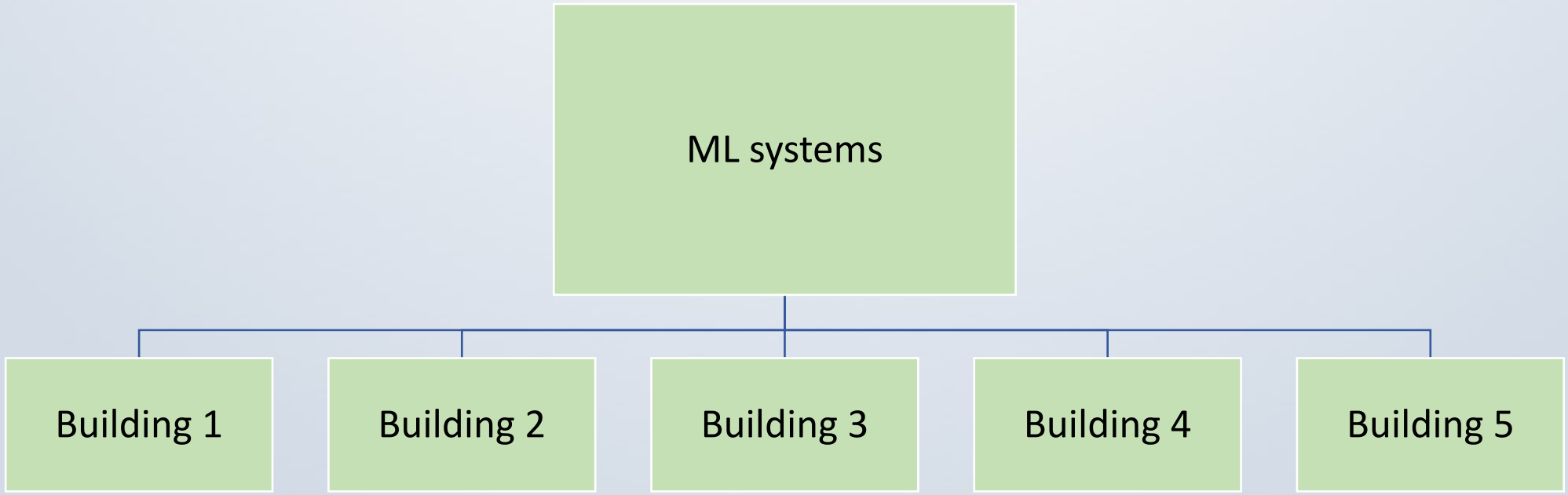
Optimize for comfort, energy usage and disease resilience

Optimum Set point temp and humidity

airveda

Driving efficiencies of scale

Longer term such data from multiple buildings can help train the system to become more and more smarter and drive greater energy efficiency across buildings.



airveda

Components of a Smart Control System

- Data and Controllers for each component.
- Real-time sensors and energy meters.
- Communication with central system
- Analytics & Dashboards
- Control logic

airveda

In conclusion

Smart Building automation systems can save our planet, save money, keep occupants healthy and comfortable.

Cloud based systems can provide

- Better visualizations, intuitive UI
- Drive greater use in buildings
- Scales of efficiencies in the future.

airveda