Assessment of Indoor Air Quality in Small Commercial Buildings: A Case Study of Delhi NCR

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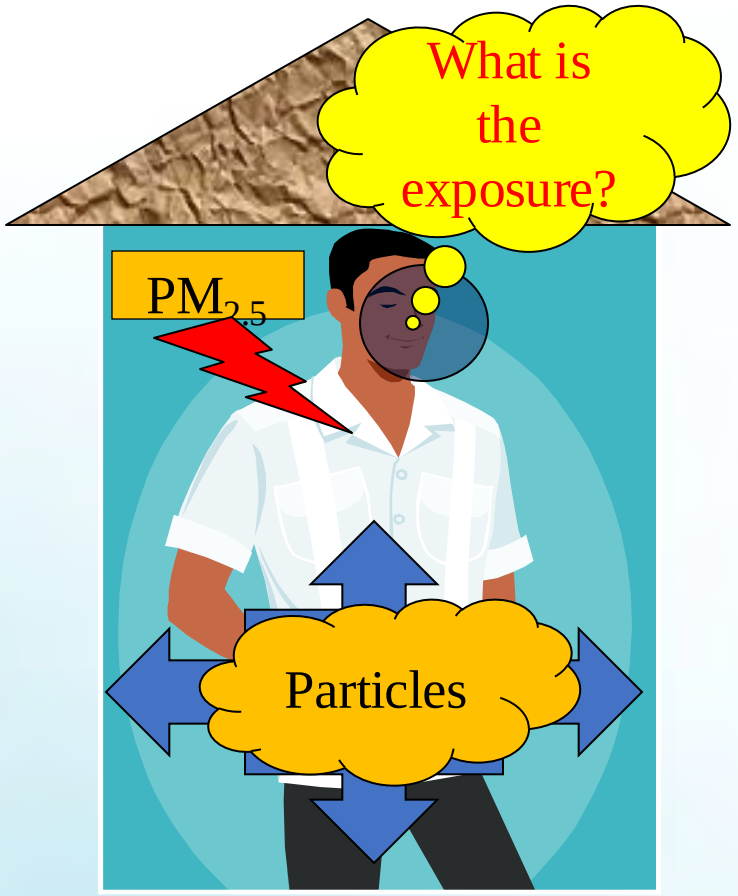
Importance of IAQ



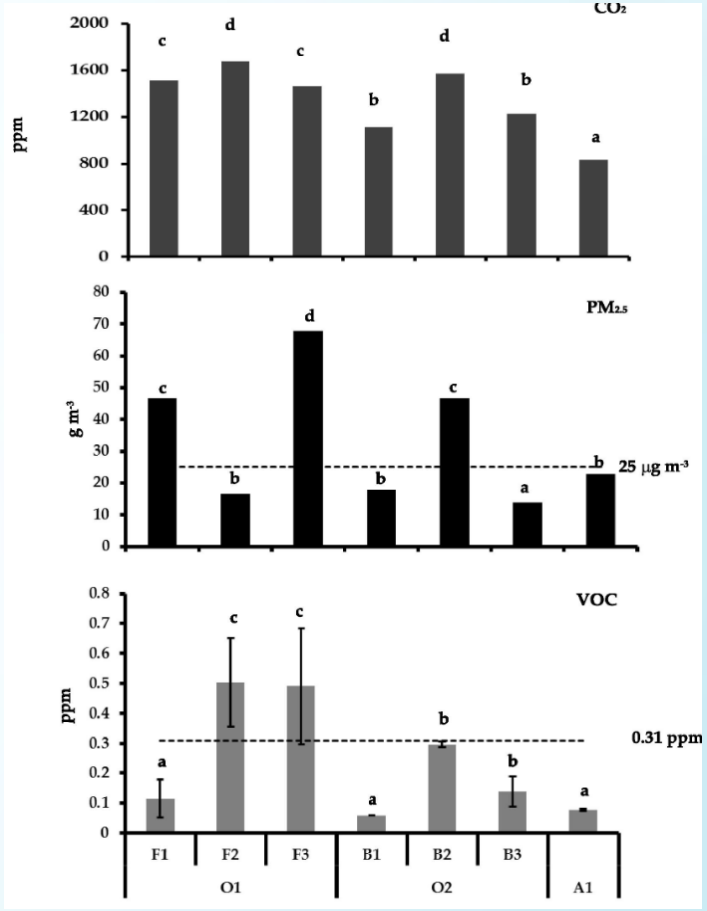
Personal Exposure

- On average, **27% more pieces** compared to workers in firms without air purifiers
- **27% treatment effect**, the average firm-level gains in **productivity amount to $5,710**

(Source: World Bank)

- A **10-unit increase** in AQI leads to a **0.35% decline** in the number of calls handled by service center workers
- Workers are **5%-6% more productive** when air pollution levels are rated as 'good' (AQI 0-50) versus 'unhealthy' (AQI 150-200)

(Source: Infosys)



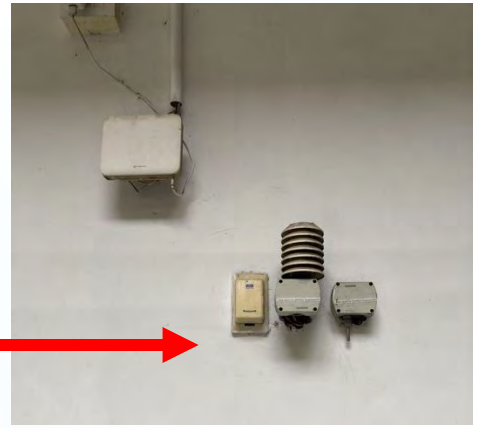
Data Monitored in Office Buildings in Delhi

(Source: Datta et al.)

Current IAQ Adoption and Trends

Source: [Kaiterra Market Research]

Indoor Thermal Comfort and Air Quality Instruments

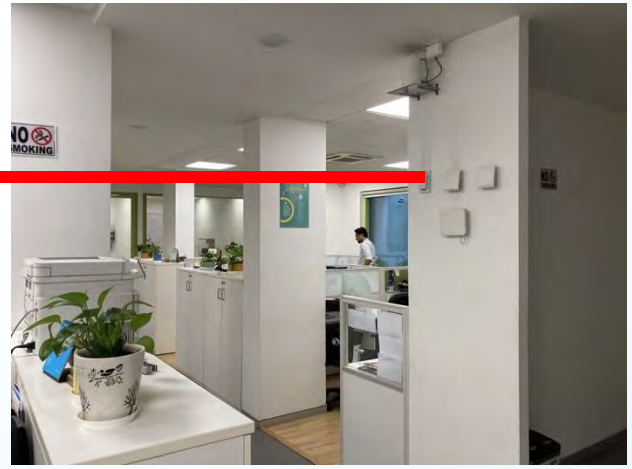


Outdoor measuring device

Monitoring Parameters

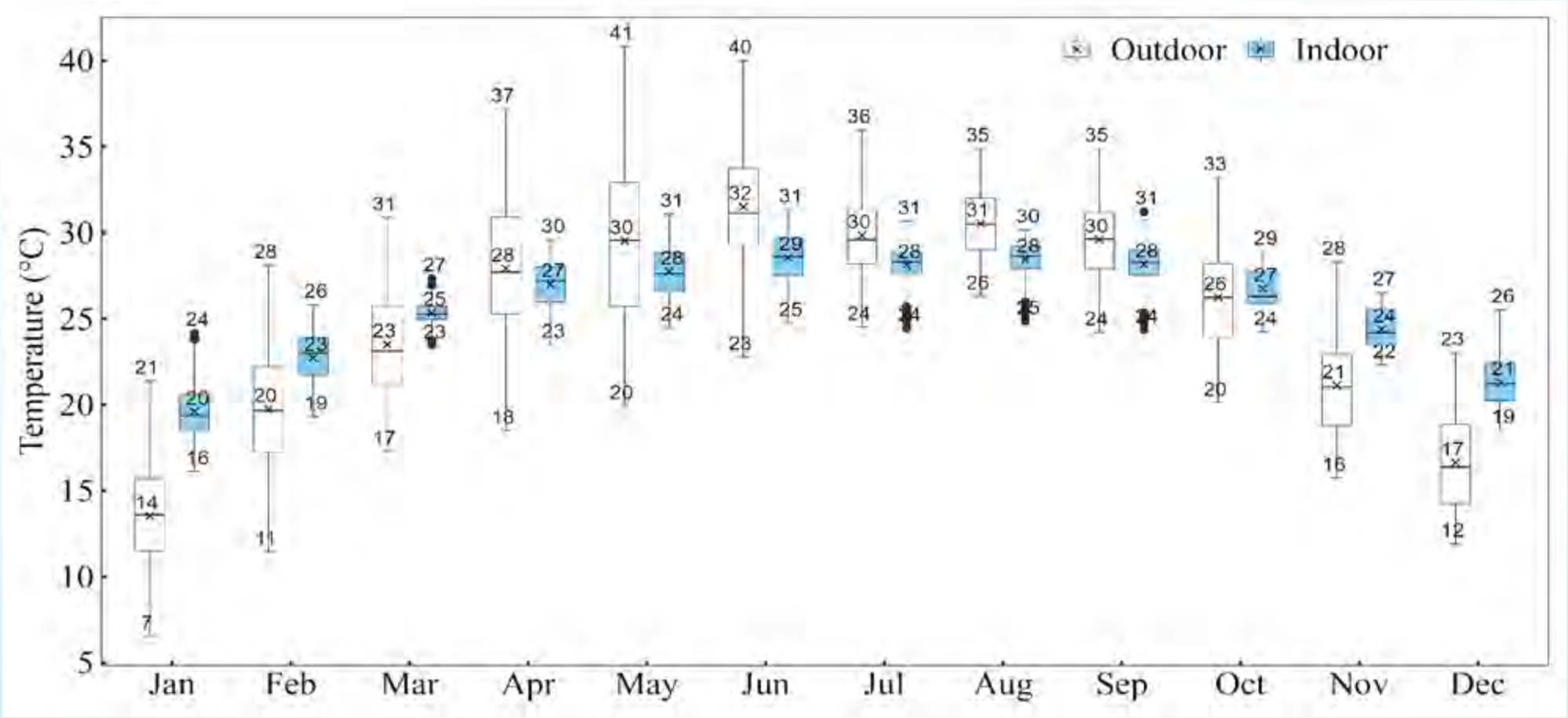
1. Air temperature
2. Relative humidity
3. Carbon dioxide
4. Particulate Matters 2.5, and 10

Indoor measuring device

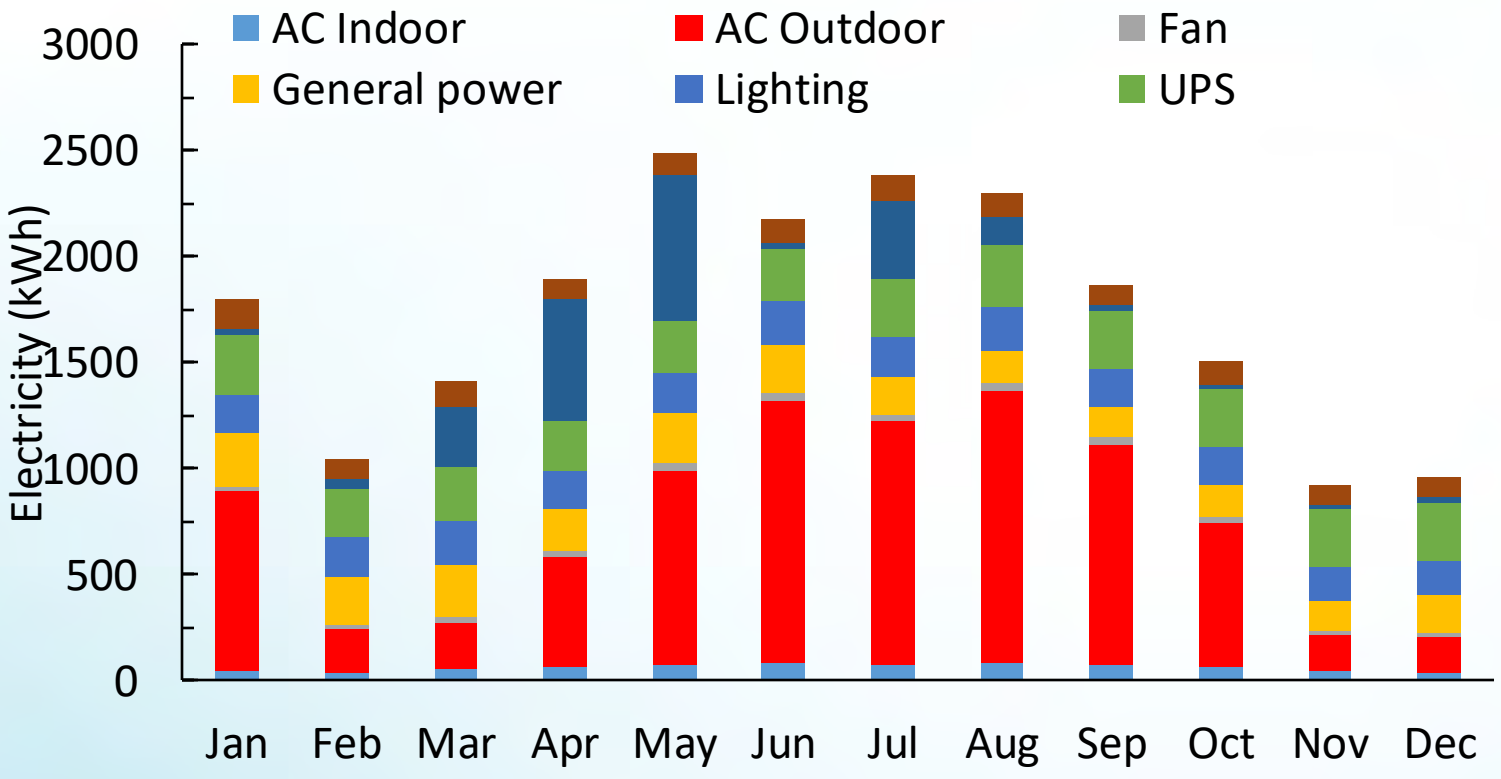


Energy measuring device

Outdoor and Indoor Temperature (Year 2023)



Electricity Consumption (Year 2023)



Monthly electricity consumption of AEEE office for year 2023

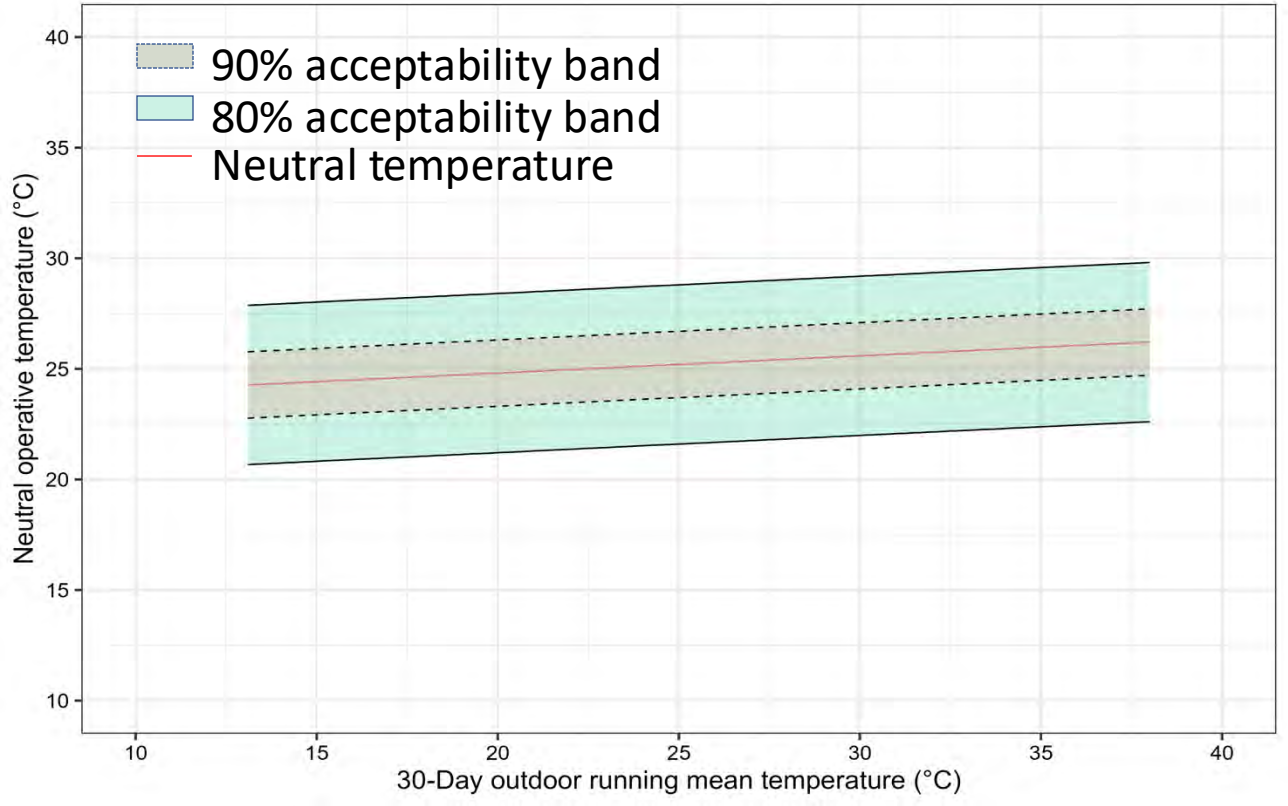
Energy Performance Index (EPI)

$$EPI = \frac{annual\ energy\ consumption\ (kWh)}{building\ area\ (m^2)}$$

AEEE office EPI for the year 2023 (measured)

EPI = 62 kWh/m^2

Indian Model for the Adaptive Comfort



IMAC model for Air conditioned buildings

Neutral temperature for AC Buildings (T_{nut})

$$T_{nut} = 0.078 \times T_{30dormt} + 23.25\ (°C)$$

where,

$T_{30dormt}$ = 30-day outdoor running mean temperature (°C)

IMAC 80% acceptability band

Upper limit = T_{nut} + 3.6 (°C)

Lower limit = T_{nut} - 3.6 (°C)

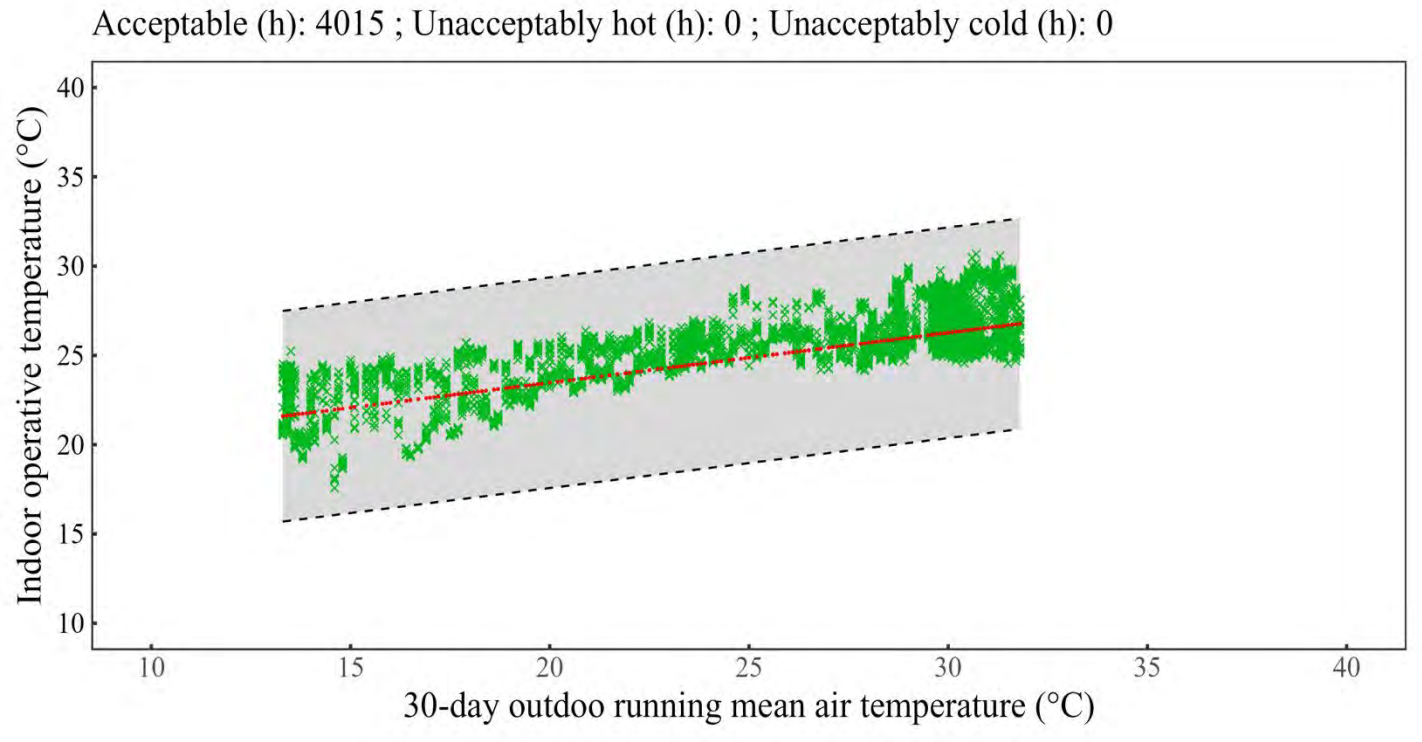
IMAC 90% acceptability band

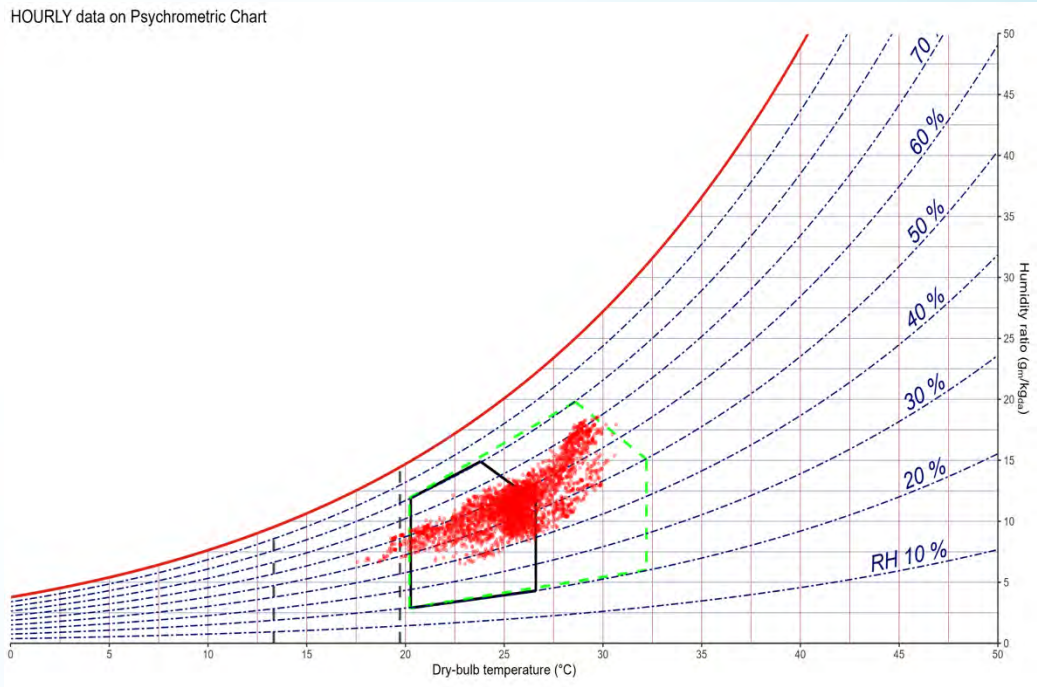
Upper limit = T_{nut} + 1.5 (°C)

Lower limit = T_{nut} - 1.5 (°C)

Source:-ECBE 2017

Thermal Comfort (during office hours 08:00 to 18:00)

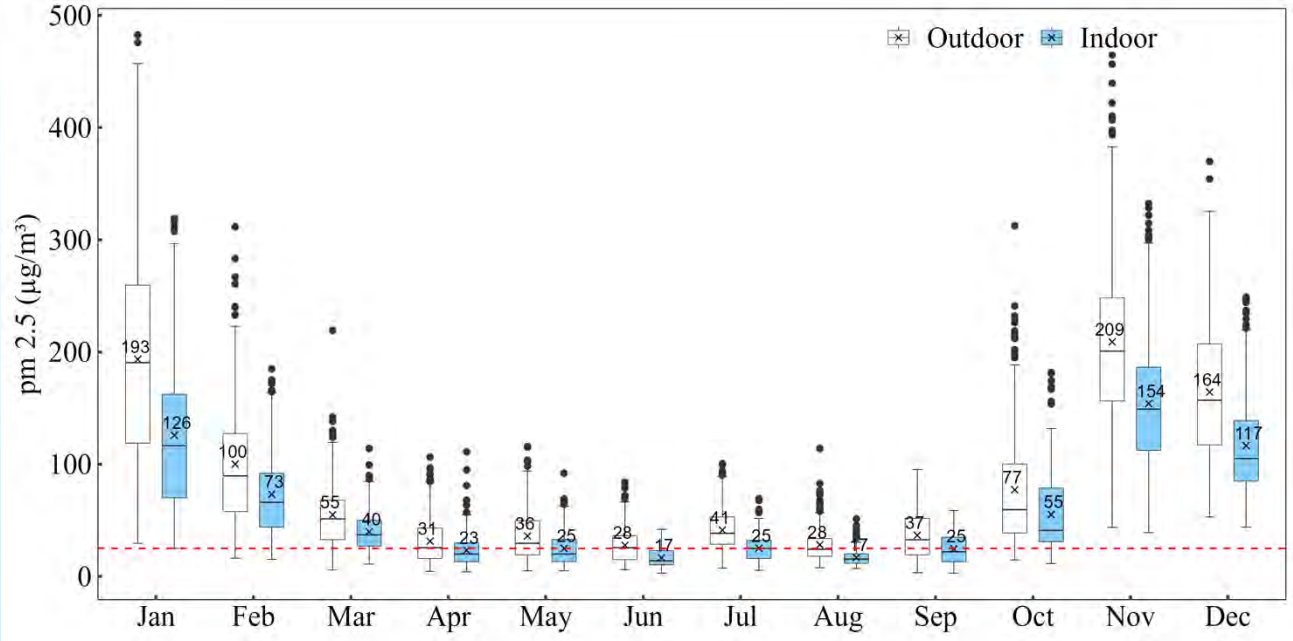




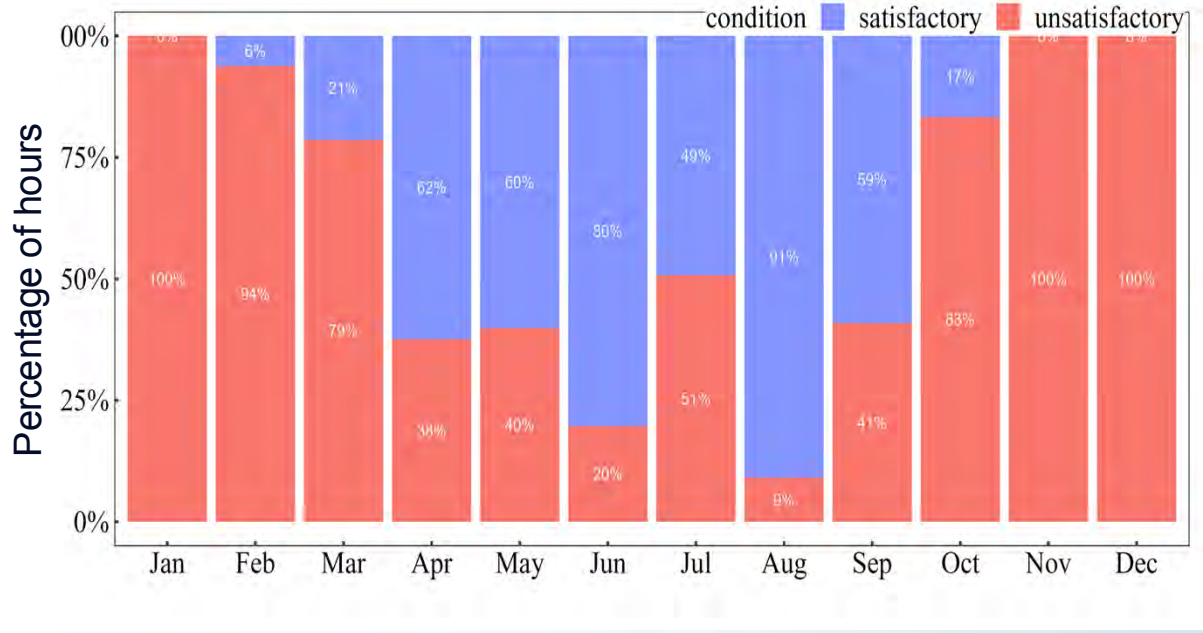
IMAC for the AEEE office workstation thermal comfort

Outdoor and Indoor pm 2.5 (during office hours)

The recommended indoor threshold for pm 2.5 as per ISHRAE IEQ Std. 2024 (for Class B Buildings) should be less than 25 µg./m^3



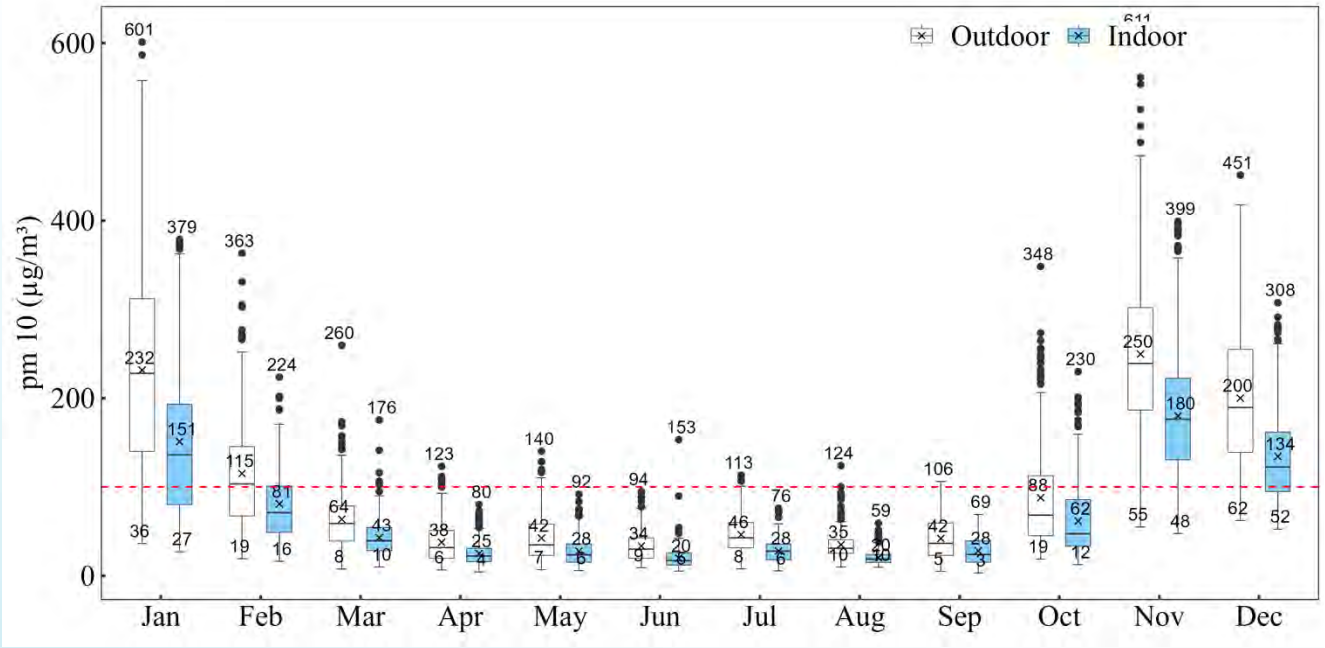
Boxplots of the monthly variations of the outdoor and indoor pm 2.5 concentration. The mean pm 2.5 values are also shown using the cross (×) symbol



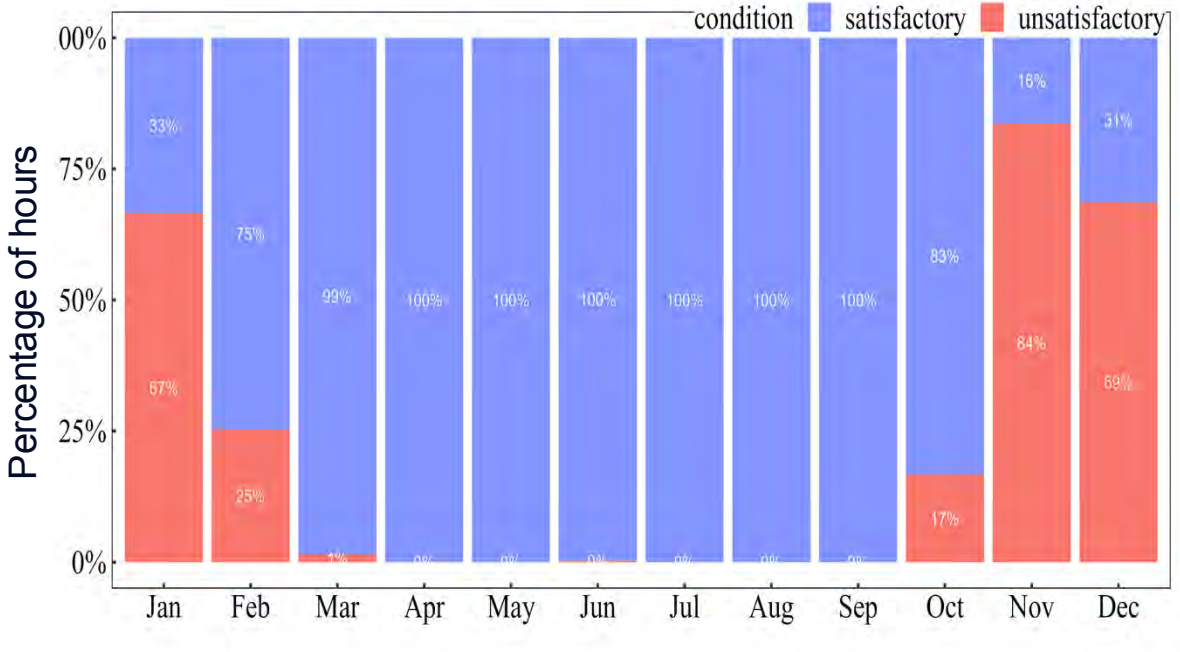
Assessment of satisfactory and unsatisfactory conditions in workstation areas based on pm 2.5 concentration levels

Outdoor and Indoor pm 10 (during office hours)

The recommended indoor threshold for pm 10 as per ISHRAE IEQ Std. 2024 (for Class B Buildings) should be less than 100 µg./m^3



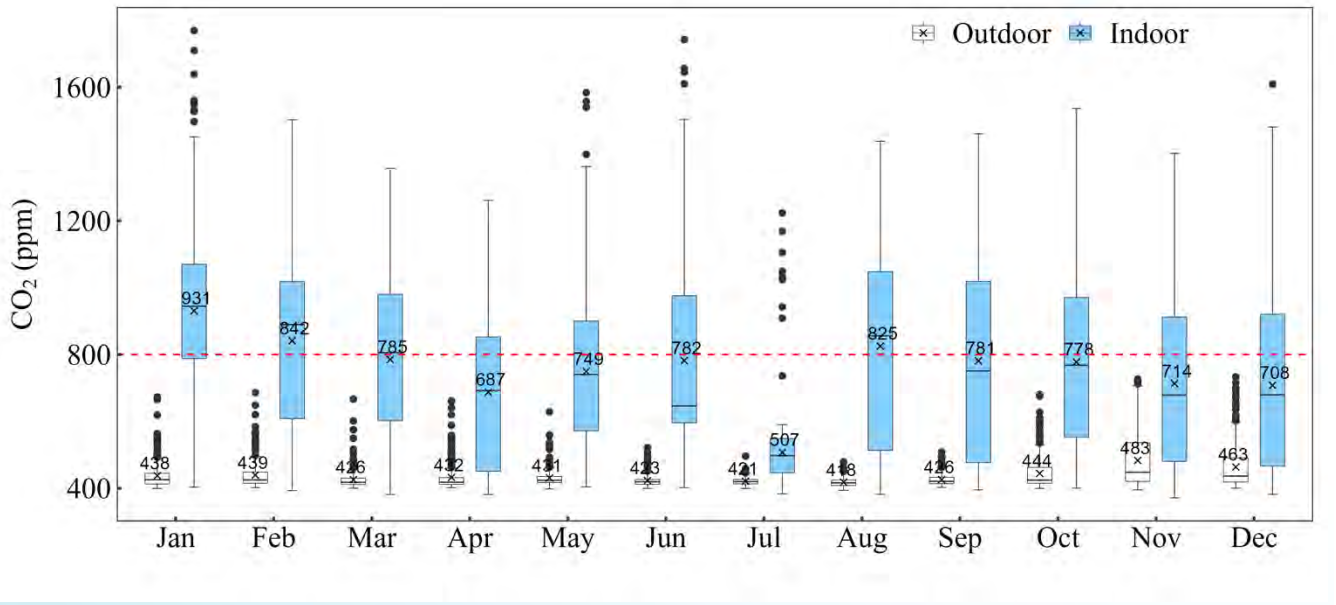
Boxplots of the monthly variations of the outdoor and indoor pm 10 concentration. The mean pm 10 values are also shown using the cross (×) symbol



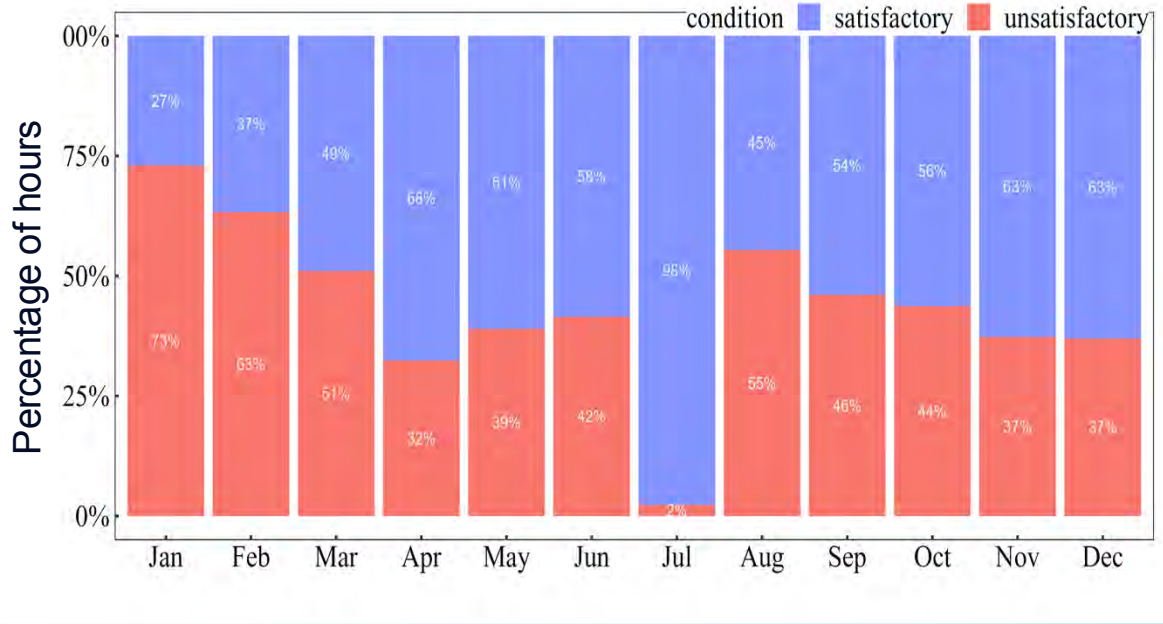
Assessment of satisfactory and unsatisfactory conditions in workstation areas based on pm 10 concentration levels

Outdoor and indoor pm 10 (during office hours)

The recommended indoor threshold for CO_2 as per ISHRAE IEQ Std. 2024 (for Class B Buildings) should be less than ambient + 500 ppm

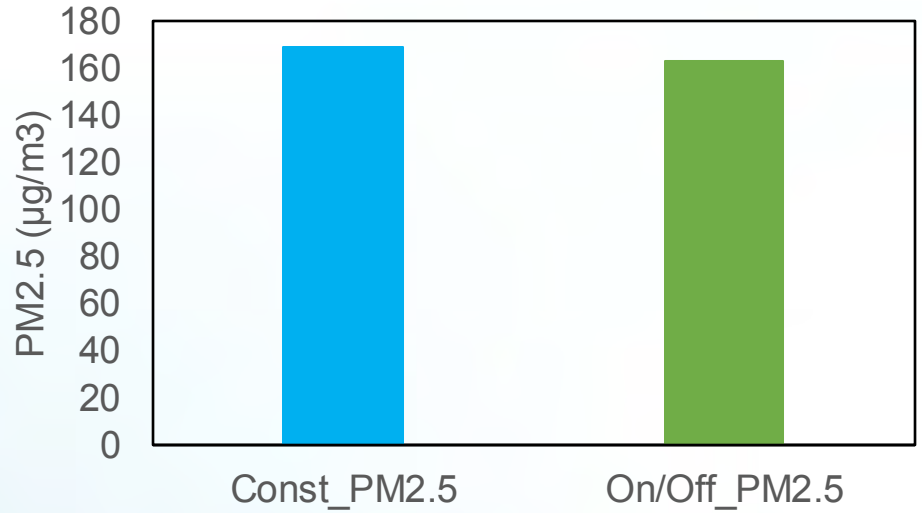


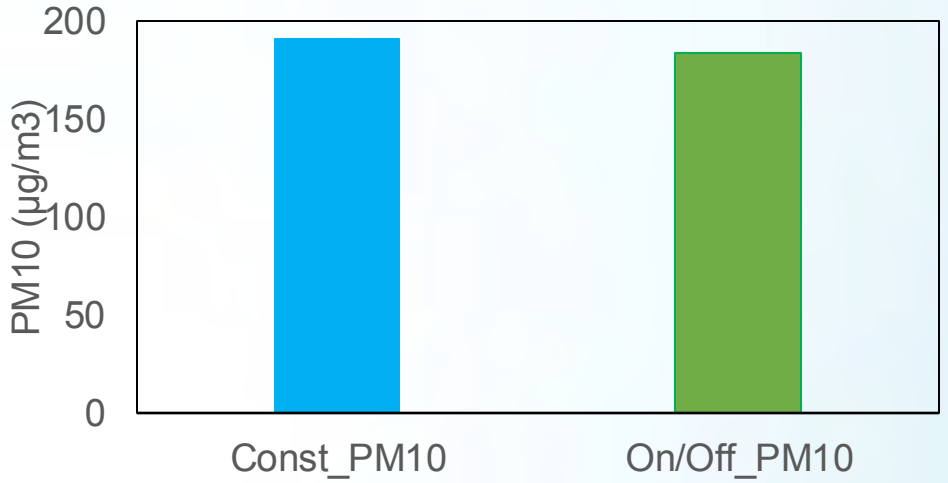
Boxplots of the monthly variations of the outdoor and indoor CO_2 concentration. The mean CO_2 values are also shown using the cross (×) symbol

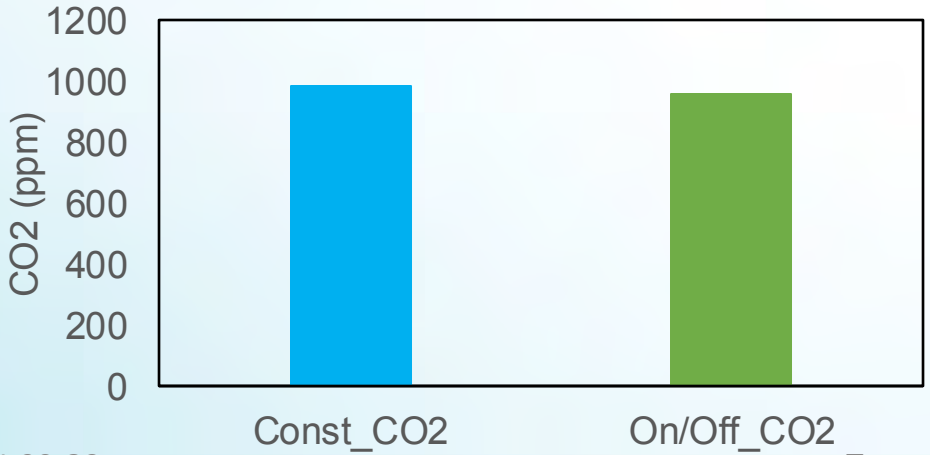


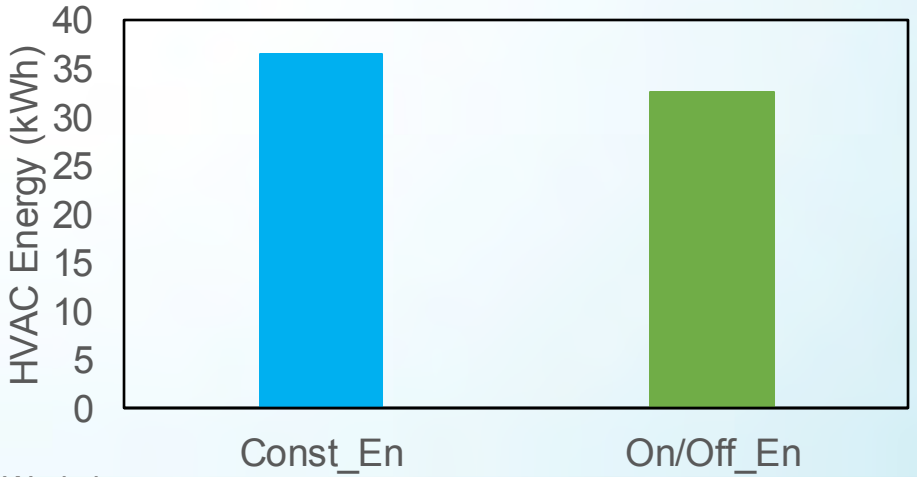
Assessment of satisfactory and unsatisfactory conditions in workstation areas based on CO2 concentration levels

Food for thought?









Initiative by

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Nexus between IAQ, Occupants' Health, and Air-Conditioning Energy Consumption

Objectives

- Assess IAQ Parameters
- Productivity, health impact and IAQ
- Measure Energy Consumption
- Correlation Analysis
- Identify Opportunities for Improvement
- Influence Policy for IAQ

Relevance to the Project Partners

- Facilitation of Buildings for monitoring
- Facilitation and development of low cost Monitoring equipment (IAQ sensors and monitoring dashboard)
- Facilitation of different types of filters to evaluate their impact on IAQ, Energy and Airborne Pathogens
- Evaluation of types of Air handling Units and their relation with IAQ and Energy
- Cost benefit analysis for different interventions to improve IAQ
- Total cost of ownership of running the systems

Thank you!