

COOCK | OPEN STAD



VALUABLE ENVIRONMENTAL INSIGHTS
THROUGH AN OPEN CITY APPROACH

CO2 sensing and analytics in smart buildings

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*90% of our time is spent
indoors*



INDOOR AIR QUALITY IS A TOP FIVE ENVIRONMENTAL RISK TO PUBLIC HEALTH
[SOURCE: EPA]



Air Quality in schools is among the
worst

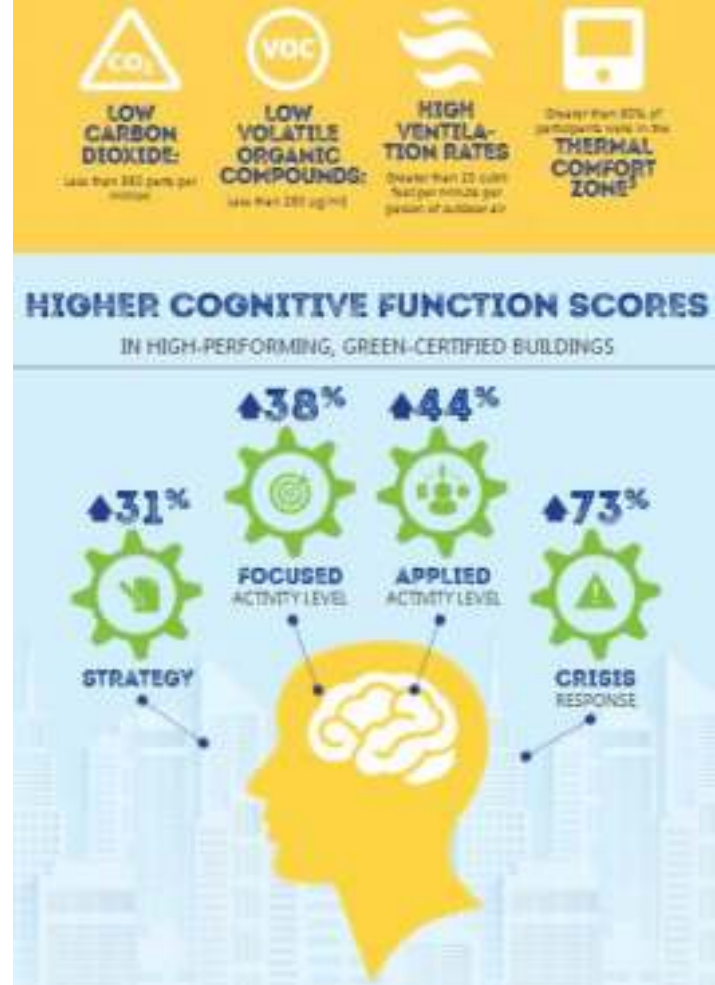
- WHO – “up to 30% of buildings have poor air quality, ... sick-building syndrome”
- ASHRAE 62.1-2016
Ventilation for Acceptable Indoor Air Quality
 - CO₂ in schools <1000ppm
 - CO₂ in offices <800ppm
 - Should never exceed 1200ppm

POOR INDOOR AIR QUALITY A PRODUCTIVITY KILLER



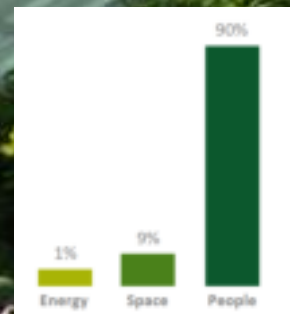
The New York Times

Is Conference Room Air
Making You Dumber?



90% of companies expenditure is employment cost.

Increasing productivity is biggest cost reduction opportunity.



CO2 MEASUREMENTS AS PROXY FOR COVID-19 TRANSMISSION RISK

- CO2 levels in buildings strongly correlate with airborne spread of infection.
- Higher CO2 levels in a room likely mean there is a higher chance of transmission if an infected person is inside.

Optimal Ventilation is key factor in lowering the risk.



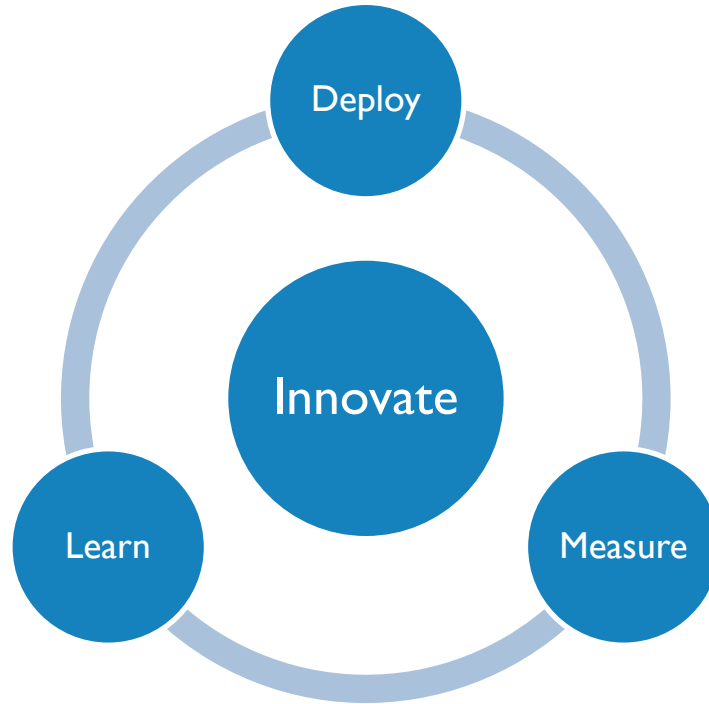
THE FUTURE OF AIR QUALITY MONITORING

FINE-GRAINED

REAL-TIME

COST EFFECTIVE

OUR APPROACH



TESTING IN THE FIELD: SOME OF OUR TESTBEDS



HOLST CENTRE EINDHOVEN



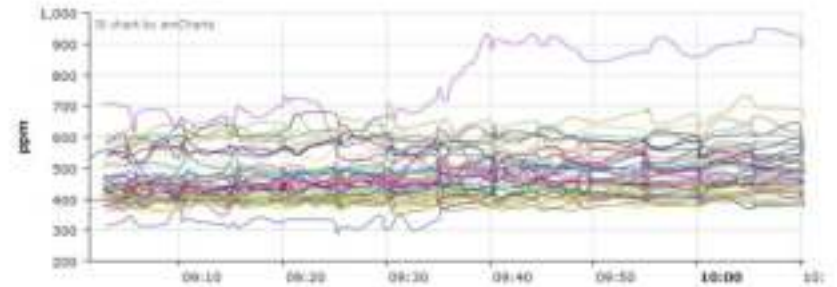
IMEC HOMELAB



DE KROOK LIBRARY - GENT

TESTING IN THE FIELD: HOLST CENTRE, EINDHOVEN 50 SENSORS

Each room is different → one sensor per room

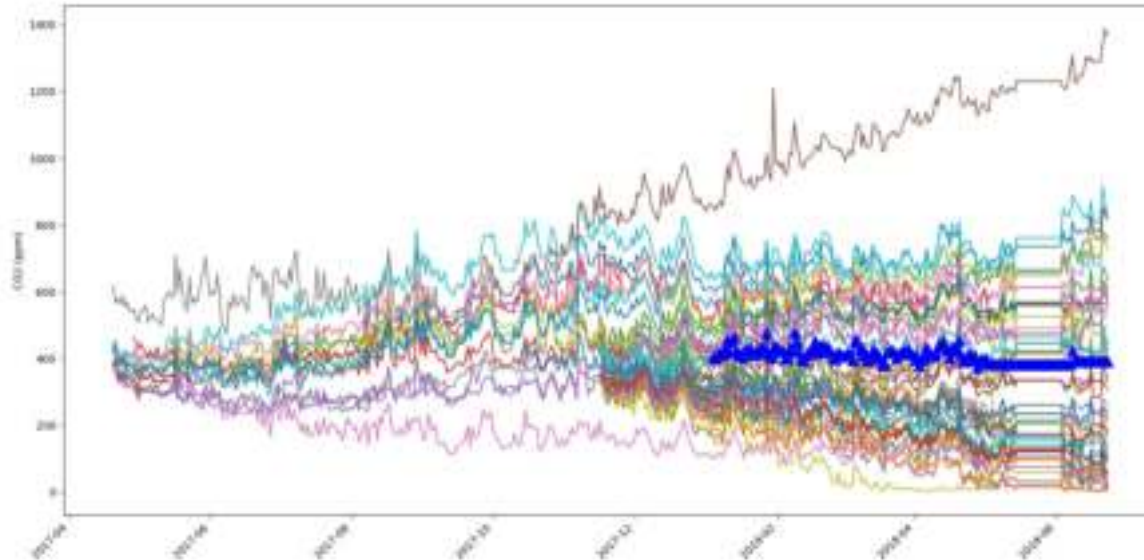


CO2 SENSOR BENCHMARKING IN THE LAB

- Gas Lab/Field experiments of Indoor Air Quality Sensors
 - Sensor characterization in Gas Lab
 - Sensor accuracy: gain and offset
 - Signal to noise ratio
 - Sensor-to-sensor variance
 - Humidity interference
 - Observation of Calibration algorithm in action
 - Comparing sensor with reference equipment
 - Benchmark sensor with other sensors
- Accelerated ageing
 - Temperature cycling, extreme temperatures

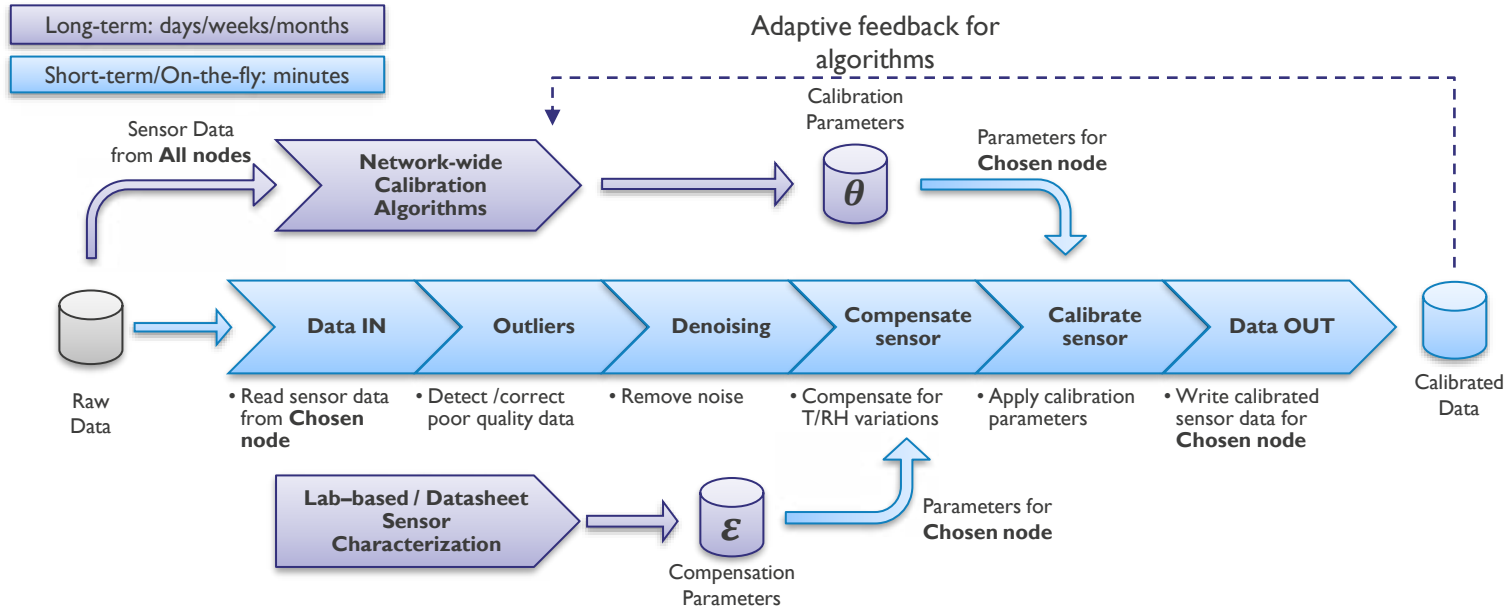


NDIR CO2 SENSOR DRIFT

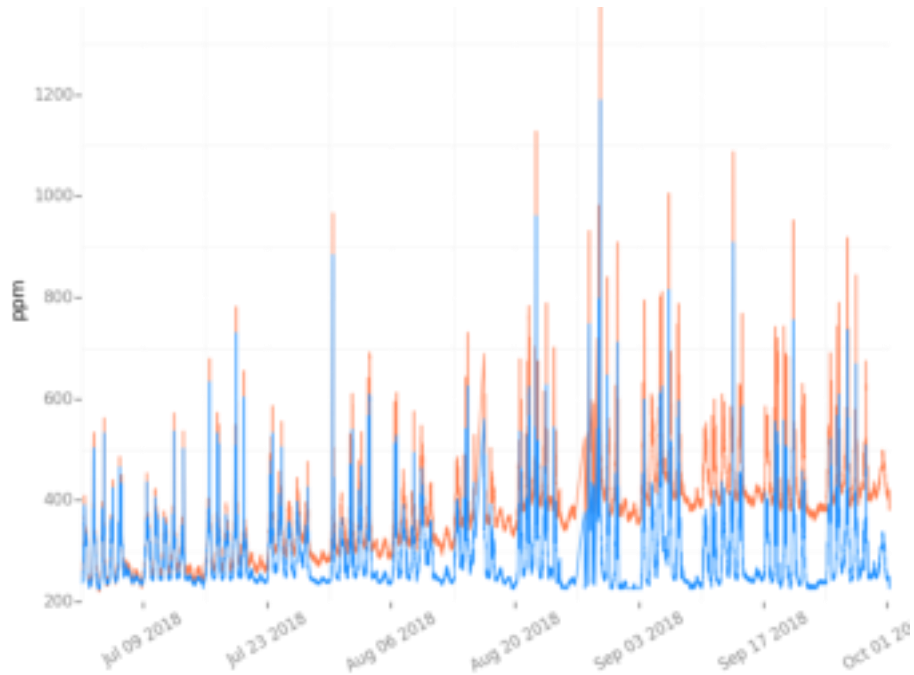


- NDIR CO2 sensor
- Drift from 400 ppm nominal value
- Drift up to 2ppm/day

CALIBRATION DATA PROCESSING PIPELINE



IMEC CLOUD CALIBRATION ALGORITHM



- Merge multiple sensor measurements in the cloud
- Automatically detect when/if/how to calibrate

CO2 PREDICTION MODEL

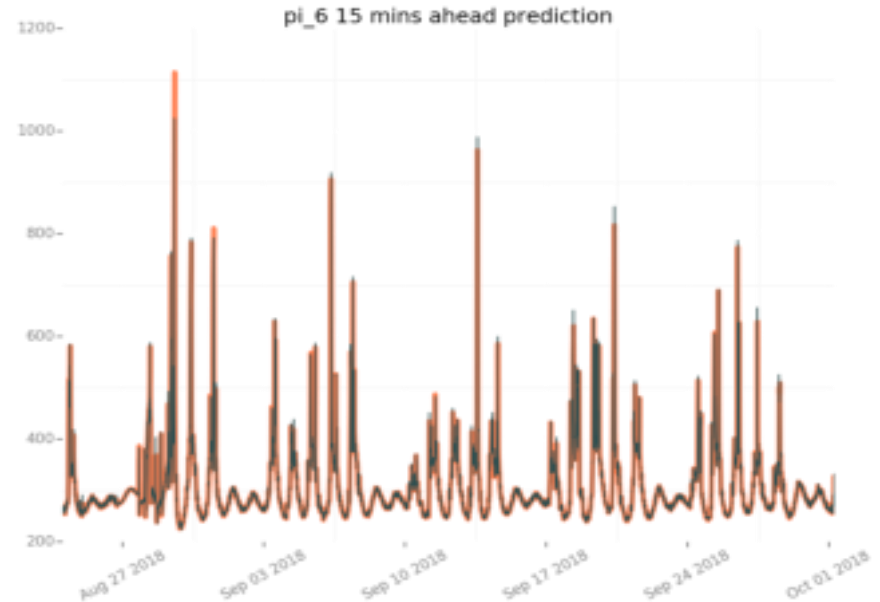
Input:

Historical data: last hours

Output:

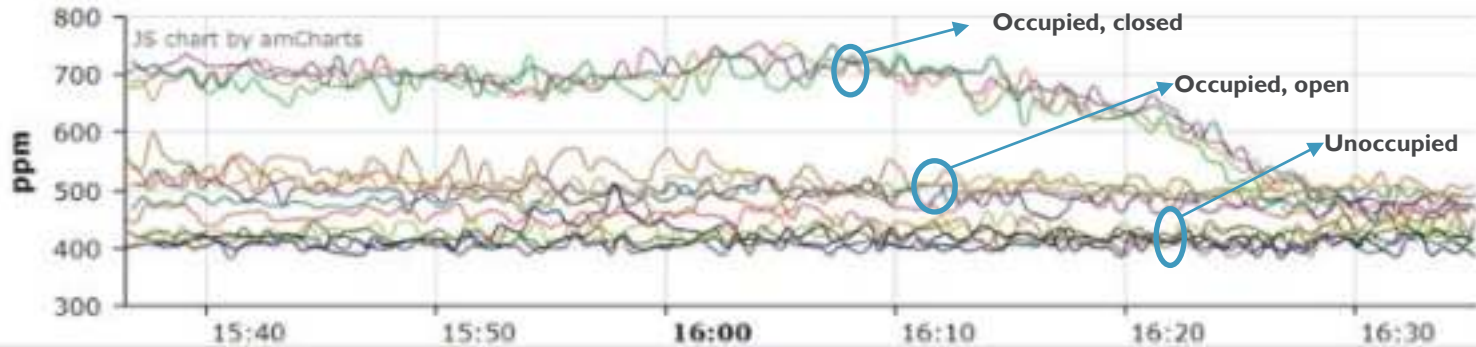
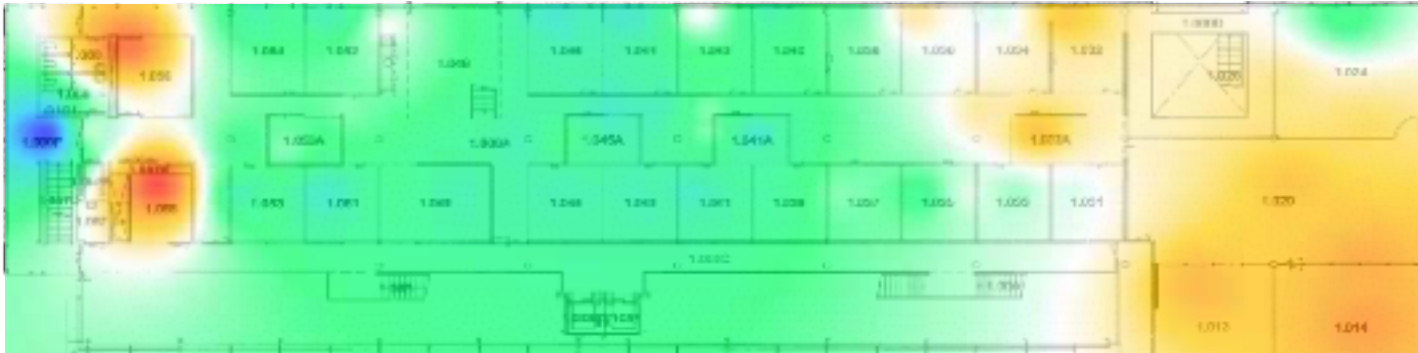
Predicted future 15 minutes room comfort level

→ trigger application-specific actions
(HVAC, User Notification, Window/Door control, ...)

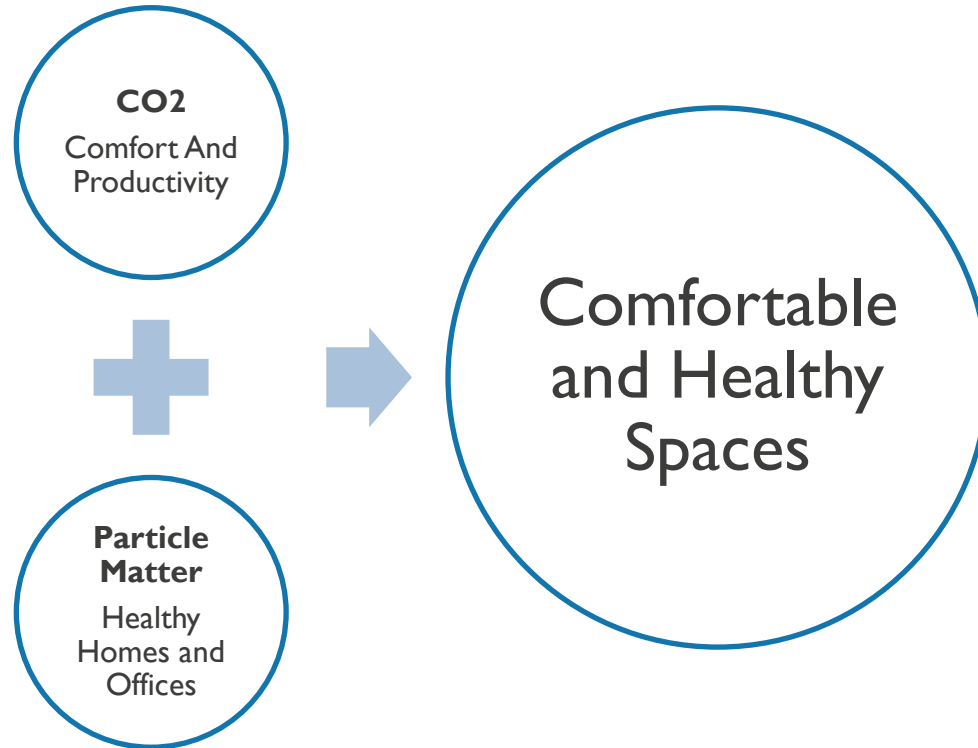


Fully Data Driven: Room characteristics can be learned

VISUALIZATION AND ANALYTICS



ADDING MORE SENSORS



EIT QUASIMODO: INDOOR-OUTDOOR POLLUTION



Philips
Home Air Purifier



Real-time Indoor-Outdoor
Air Quality Measurements



Early Warning
Signs App

60 Homes

3 Pilots

- Eindhoven
- London
- Helsinki



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imec **achmea**

Workplace Vitality Hub

FITT

HIGH TECH CAMPUS
EINDHOVEN

Fontys umec TU/e TNO



TAKE AWAY

- Healthy Buildings requires real-time cost-effective Air Quality Monitoring.
 - choose the right sensors
 - choose the right deployment for your application
- Sensors are not enough: data need to automatically calibrated.
- Software and Algorithms are key added value: same hardware, multiple services on top.

