

Role of IAQ in Sustainable Future City

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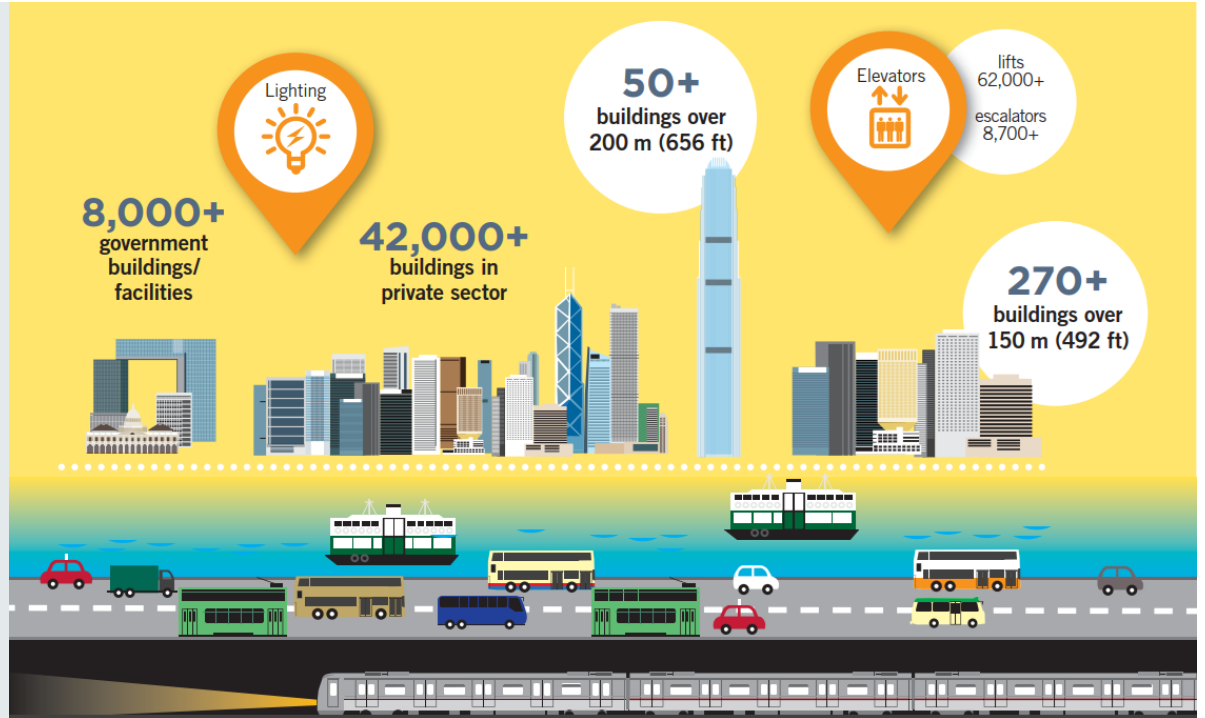
IAQ issue doesn't stand alone

Energy consumption in built environment

90% of total electricity consumption for buildings

- air-conditioners, lifts, lighting, and various electrical appliances

60%+ of carbon emissions is attributable to generating electricity for our buildings.



IAQ issue doesn't stand alone

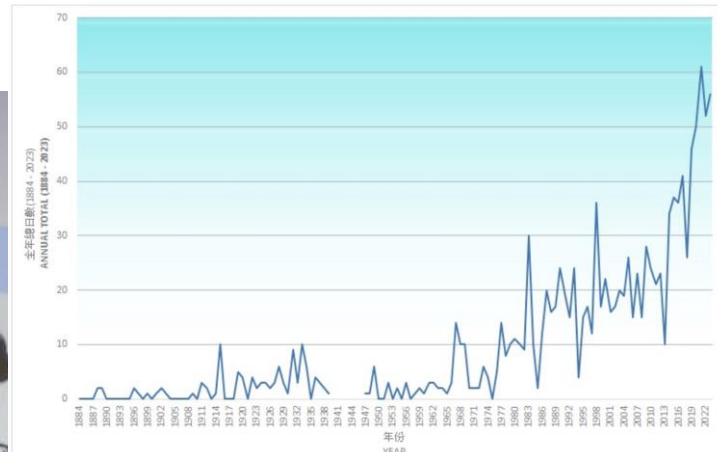
Climate Change burden on Hong Kong

Hot nights up to **48** days in 2040/49
from **32** in 2011/20.



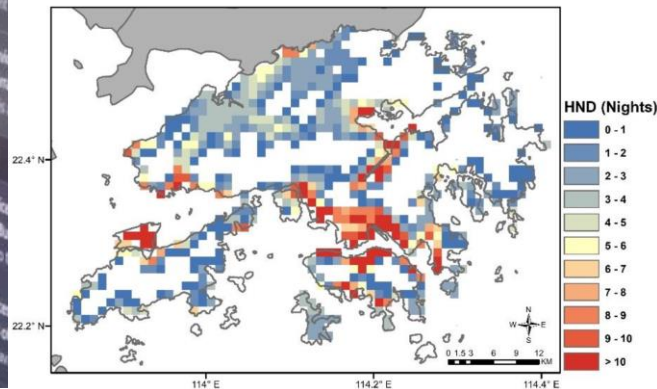
Annual total number of Hot Nights since 1884 at HKO

Daily mean Temperature $\geq 28^{\circ}\text{C}$



Hot nights in Hong Kong in 2040/49

2040-49



IAQ issue doesn't stand alone

Role of building in Carbon Neutrality roadmap



By 2030
Peak carbon



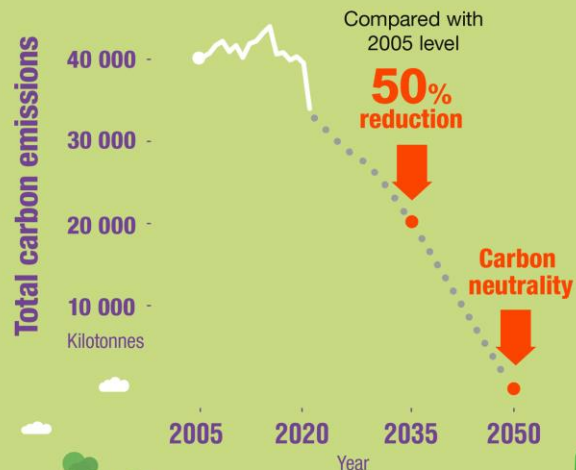
By 2035
Per-head GDP to match
"moderately developed nations"*



By 2060
Carbon neutrality



Hong Kong's Roadmap to Carbon Neutrality



IAQ issue doesn't stand alone

SARS and COVID memory | importance of building ventilation

Poor Ventilation In Restaurants And Buses: A Major Factor In COVID-19 Transmission, Says Hong Kong Study

Pandemics & Emergencies 21/07/2020 · Kyra Dupont/Geneva Solutions

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A **new study** by researchers at the University of Hong Kong (HKU) has documented how poor building ventilation plays a role in indoor transmission of Covid-19. The study looked at the air flow and infection dynamics from three important Covid-19 outbreaks in China and Japan, concluding that spread of the virus was "definitely favored by poor air ventilation".



More droplet particles may remain airborne and travel further in poorly ventilated spaces

Hong Kong declares a state of emergency in response to five confirmed coronavirus cases

Globally, the number of confirmed coronavirus cases has risen to 1,354.

Source: Vox, 25 January 2020

Coronavirus: Hong Kong to limit public gatherings to four and shut cinemas, gyms and other social spots as cases jump by 65

- Tough new measures aimed at enforcing social distancing as the city records its largest daily rise in infections

Source: South China Morning Post, 27 March 2020



Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals

[Yuan Liu](#), [Zhi Ning](#) , [Yu Chen](#) , [Ming Guo](#), [Yingle Liu](#), [Nirmal Kumar Gali](#), [Li Sun](#), [Yusen Duan](#), [Jing Cai](#), [Dane Westerdahl](#), [Xinjin Liu](#), [Ke Xu](#), [Kin-fai Ho](#) , [Haidong Kan](#) , [Qingyan Fu](#)  & [Ke Lan](#) 

[Nature](#) 582, 557–560 (2020) | [Cite this article](#)

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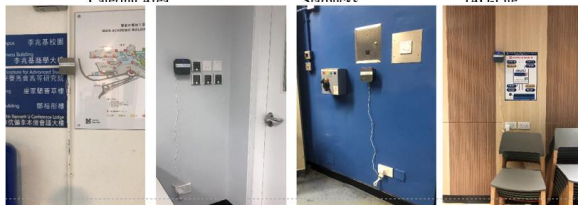
Rethinking of the Metrics for Indoor Environment

| Indicator | Parameter | Building Management System | Target |
|--------------------|--|---|--|
| Indoor Air Quality | PM _{2.5} , PM ₁₀ CO, NO ₂ , O ₃ , TVOC | Building Ventilation and Air Purification System | Continuous monitoring for next generation IAQ management and green building |
| Ventilation | CO ₂ Pressure, Flow Speed | Building Ventilation System | Energy Saving |
| Environment | Temperature, Relative Humidity | Building A/C System | Human Conform |
| Human Activities | Light, Noise | Building Lighting System | AI and Smart City |

Rethinking of the Metrics for Indoor Environment

Example of Smart IAQ in HKUST campus

| Categorization | Location | Sensor System Model |
|----------------|--------------|---------------------|
| Catering Area | LG1(A) | IAQ-Lite |
| Catering Area | LG1(B) | IAQ-Lite |
| Catering Area | LG7 | IAQ-Lite |
| Catering Area | LG5 McDonald | IAQ-Lite |
| Catering Area | Starbucks | IAQ-Lite |

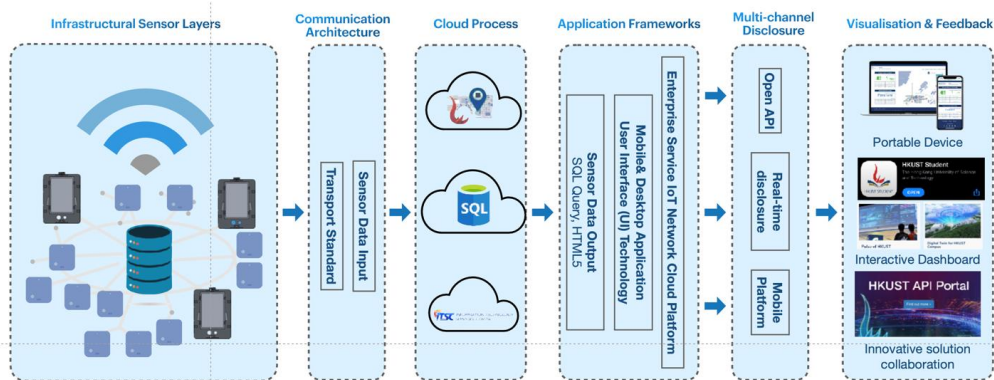


| Concourse | Classroom | Lecture Hall | Canteen |
|--------------|-----------|--------------|----------|
| CYT | | CYT G010 | IAQ-Lite |
| CYT | | CYT L1L | IAQ-Lite |
| Lecture Hall | | LTA | IAQ-Lite |
| Lecture Hall | | LTB | IAQ-Lite |

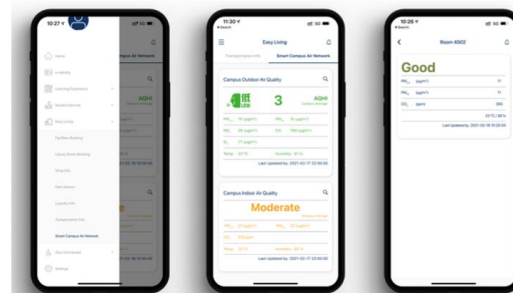
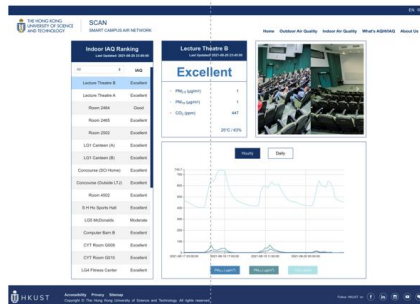


| Conference Lounge | Atrium | Bus Station |
|-------------------|------------------------|-------------|
| Outdoor | Conference Lodge | NAS-AF300 |
| Outdoor | Atrium | NAS-AF300 |
| Outdoor | North Gate Bus Station | NAS-AF300 |

Monitoring locations in SCAN



Smart Campus Air Network Architecture

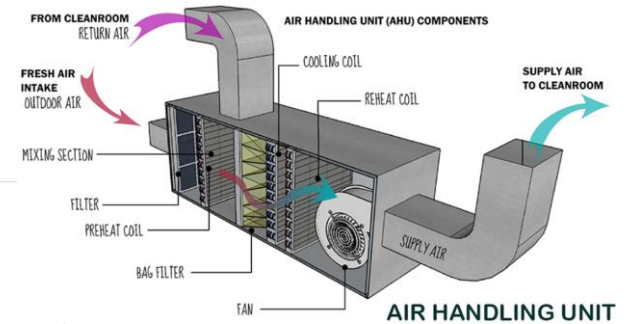
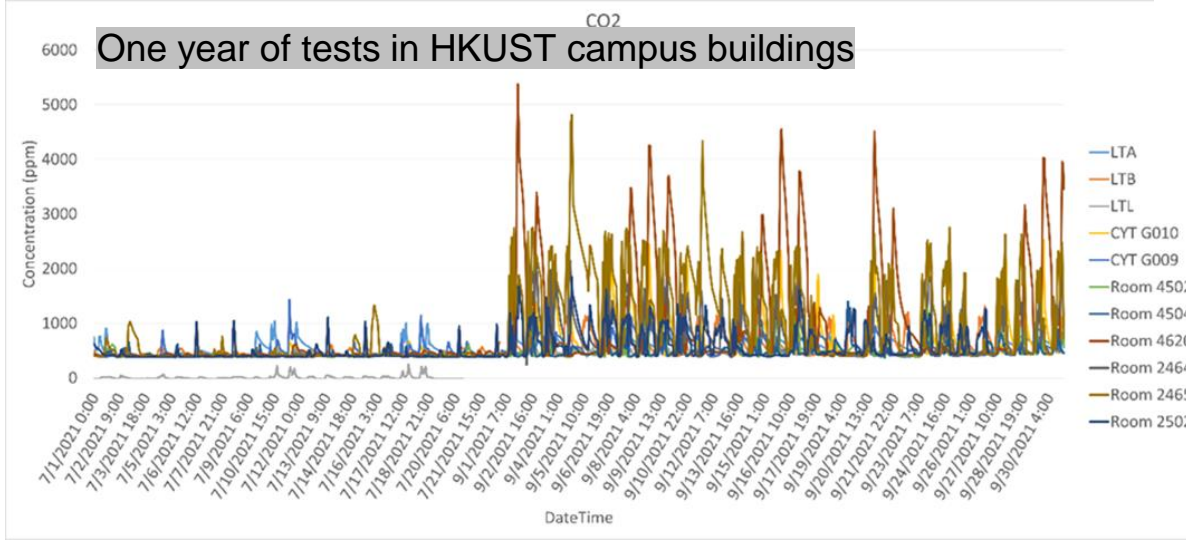


Air Quality Information - web platform (left) & mobile app (right)

Rethinking of the Metrics for Indoor Environment

Example of Smart IAQ in HKUST campus

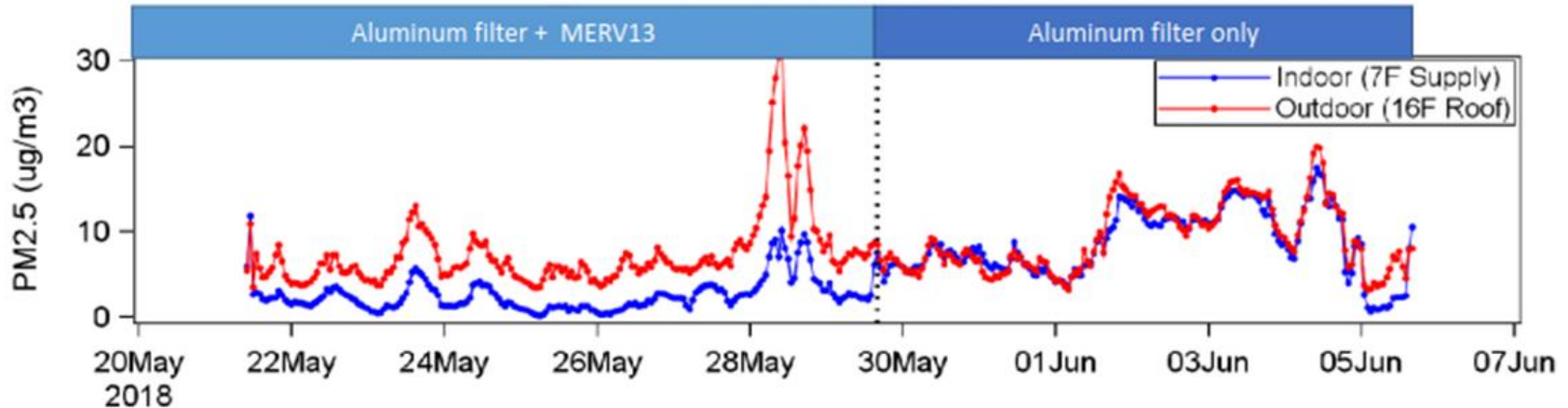
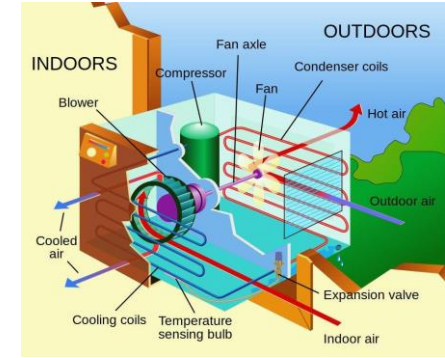
- Fresh air damper (FAD) is opened when air-con is ON.
Function : To lower indoor CO₂
Consequence : Energy waste
- Open when needed (CO₂ >800 ppm)
- Close the FAD during low occupancy



Rethinking of the Metrics for Indoor Environment

Future for building HVAC and indoor air quality

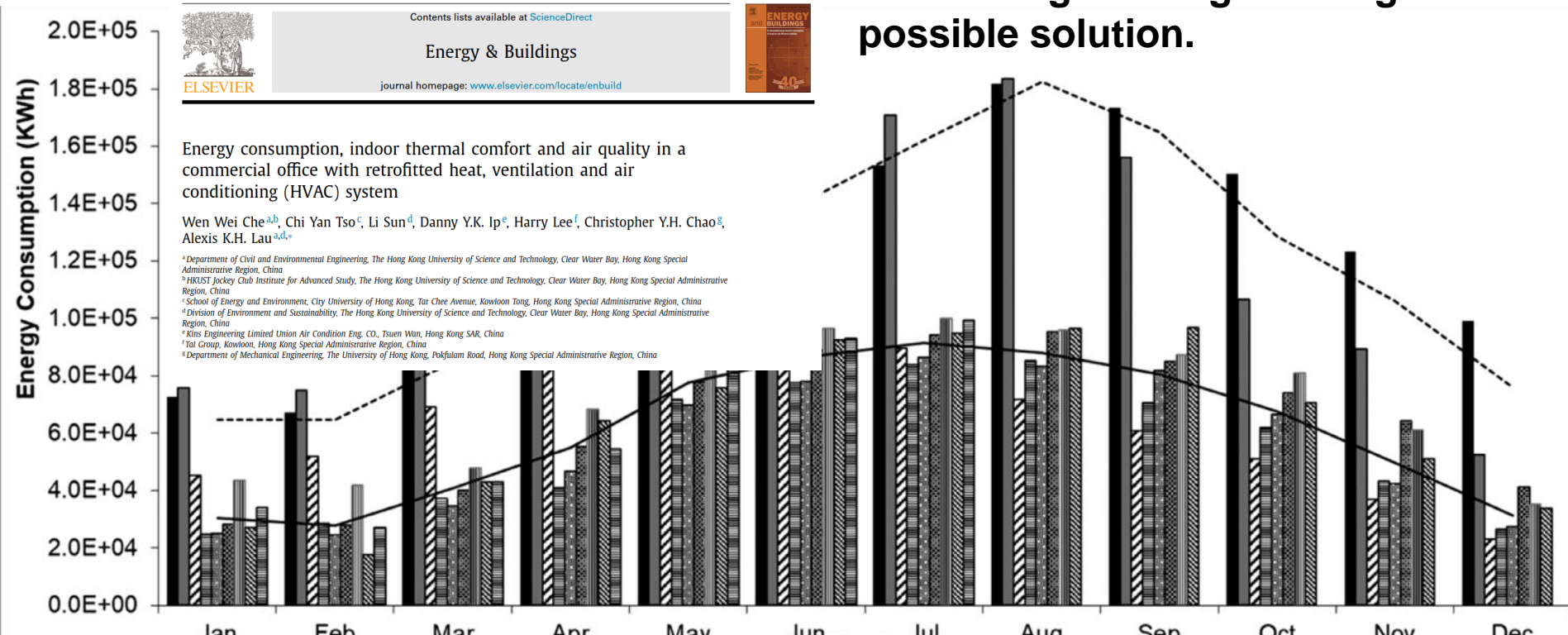
- Indoor/Outdoor coordination systems can help improve IAQ without additional energy consumption.



Rethinking of the Metrics for Indoor Environment

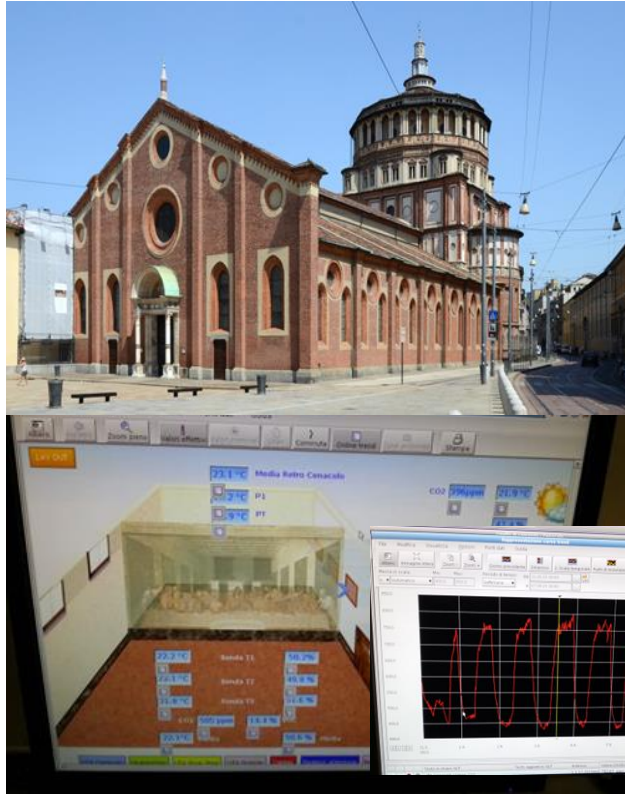
Co-benefits of energy consumption and indoor environment

Retrofitting existing buildings are possible solution.



Rethinking of the Metrics for Indoor Environment

IAQ matters beyond energy and air quality



Summary

- IAQ issue goes beyond indoor environment itself.
- Significant role of IAQ in energy sustainability for the city's future and carbon neutrality target
- Technological solutions are required for co-benefits of different factors.