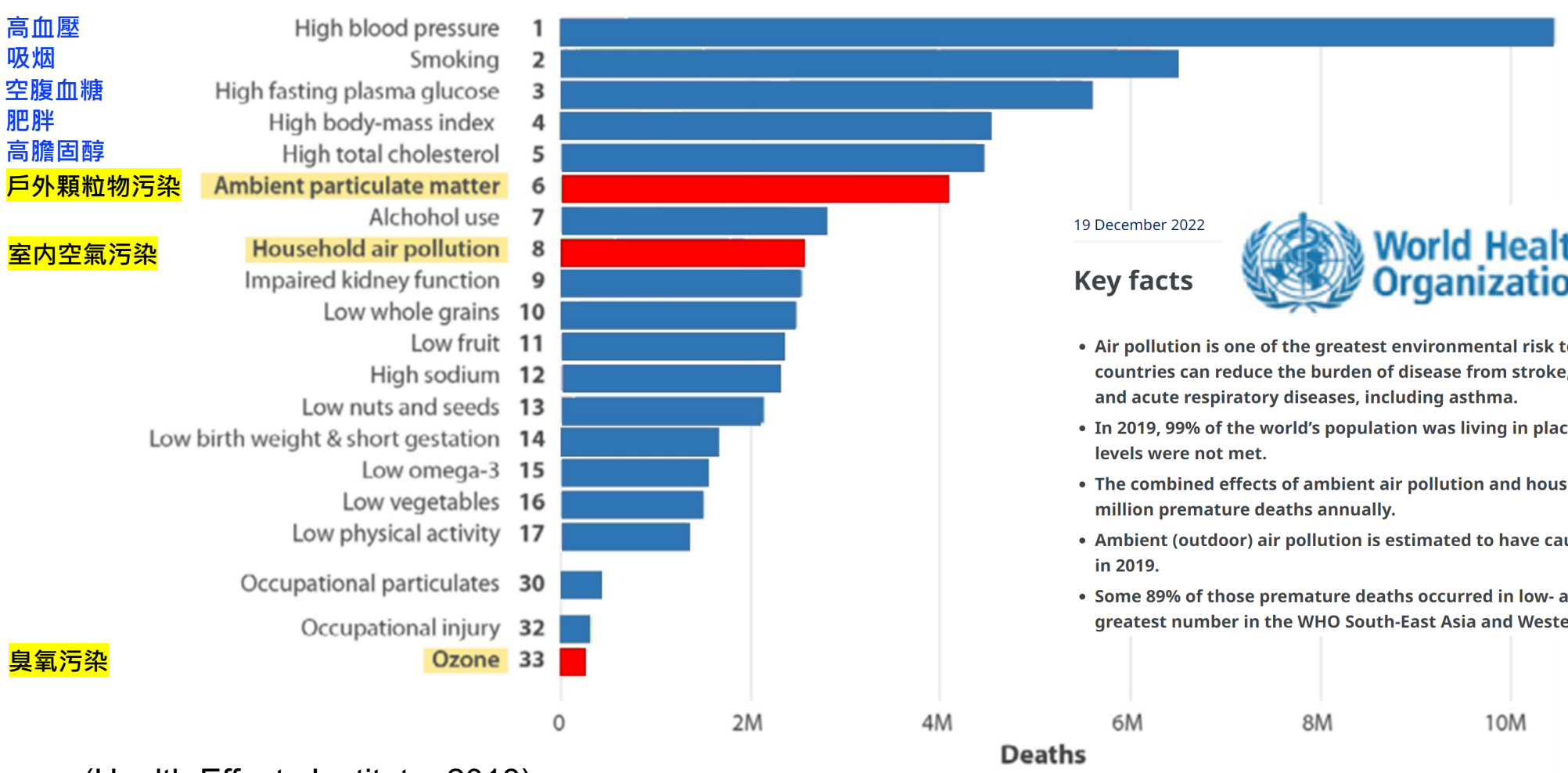
Coupling Clean Air and Decarbonization Opportunities in IAQ and Green Buildings

Alexis Lau

Division of Environment and Sustainability

The Hong Kong University of Science and Technology

Leading risks for global mortality



19 December 2022

World Health Organization

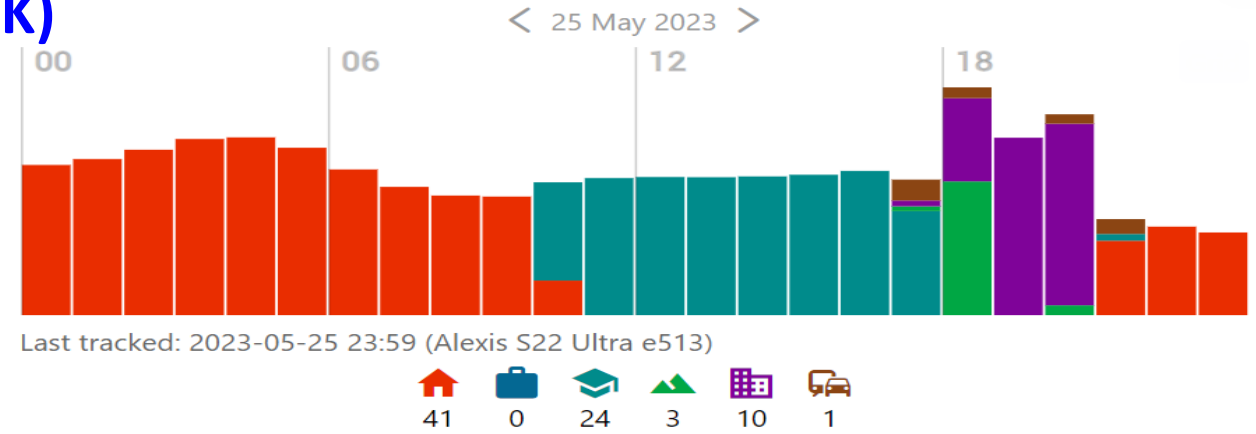
Key facts

- Air pollution is one of the greatest environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma.
- In 2019, 99% of the world's population was living in places where the WHO air quality guidelines levels were not met.
- The combined effects of ambient air pollution and household air pollution are associated with 6.7 million premature deaths annually.
- Ambient (outdoor) air pollution is estimated to have caused 4.2 million premature deaths worldwide in 2019.
- Some 89% of those premature deaths occurred in low- and middle-income countries, and the greatest number in the WHO South-East Asia and Western Pacific Regions.

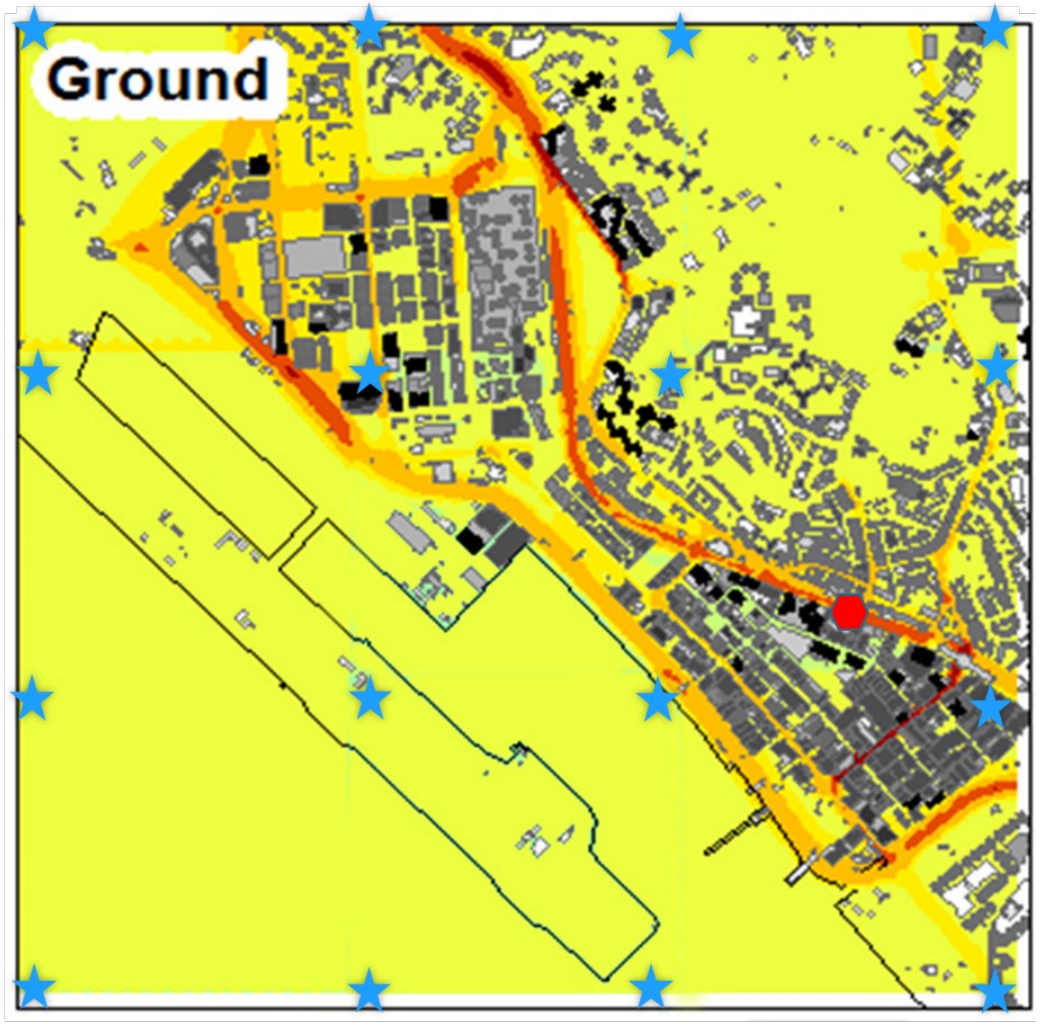
(Health Effects Institute. 2018)

Environment and Sustainability @HKUST

Personalised Realtime Air-quality Informatics System for Exposure for Hong Kong (PRAISE-HK)



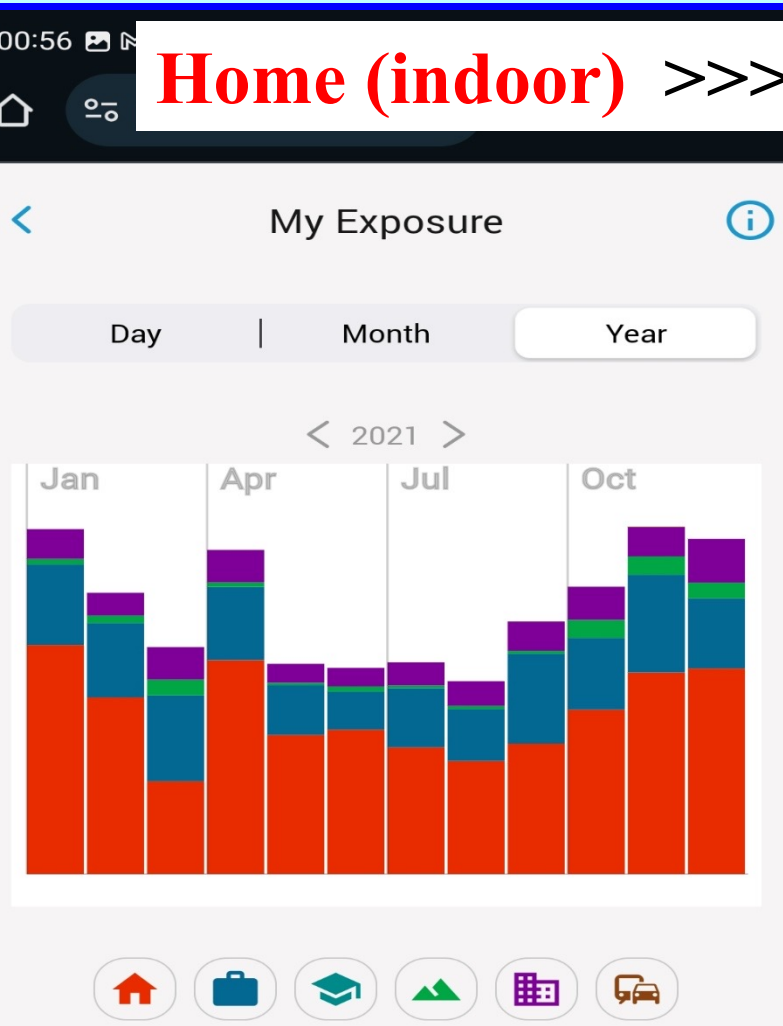
First mobile app to analyze for users their personalized air exposure budget throughout their day, to alert them of upcoming pollution episodes, to advise what they can do to reduce exposure health risks.

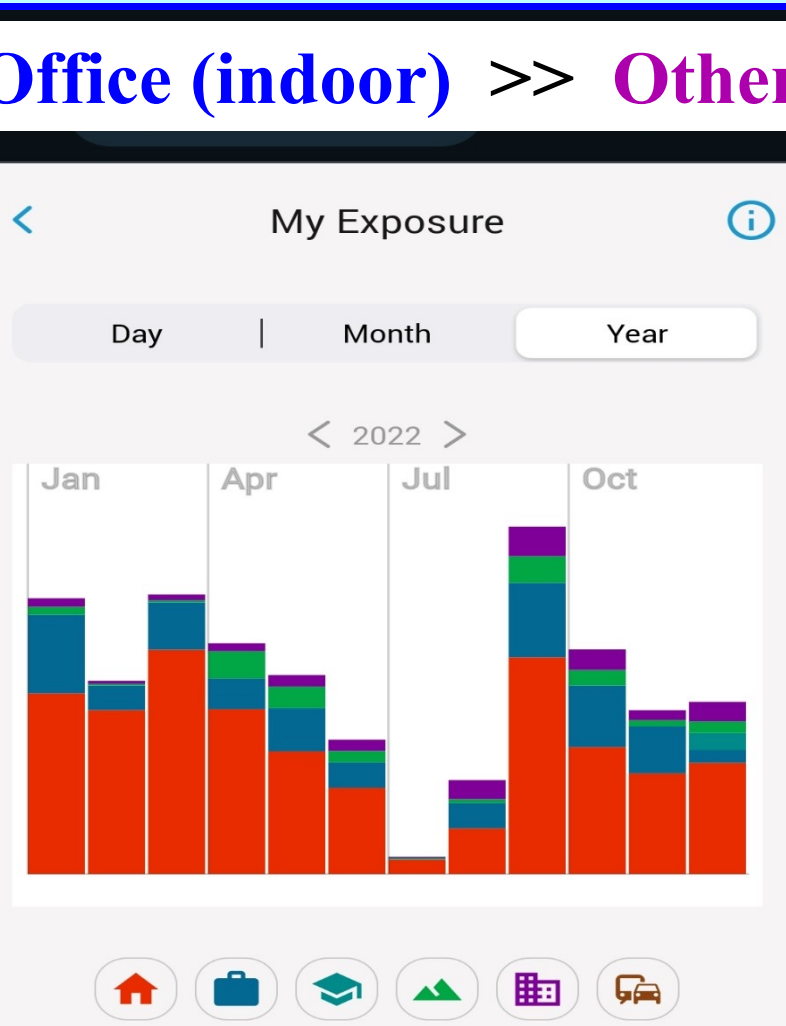


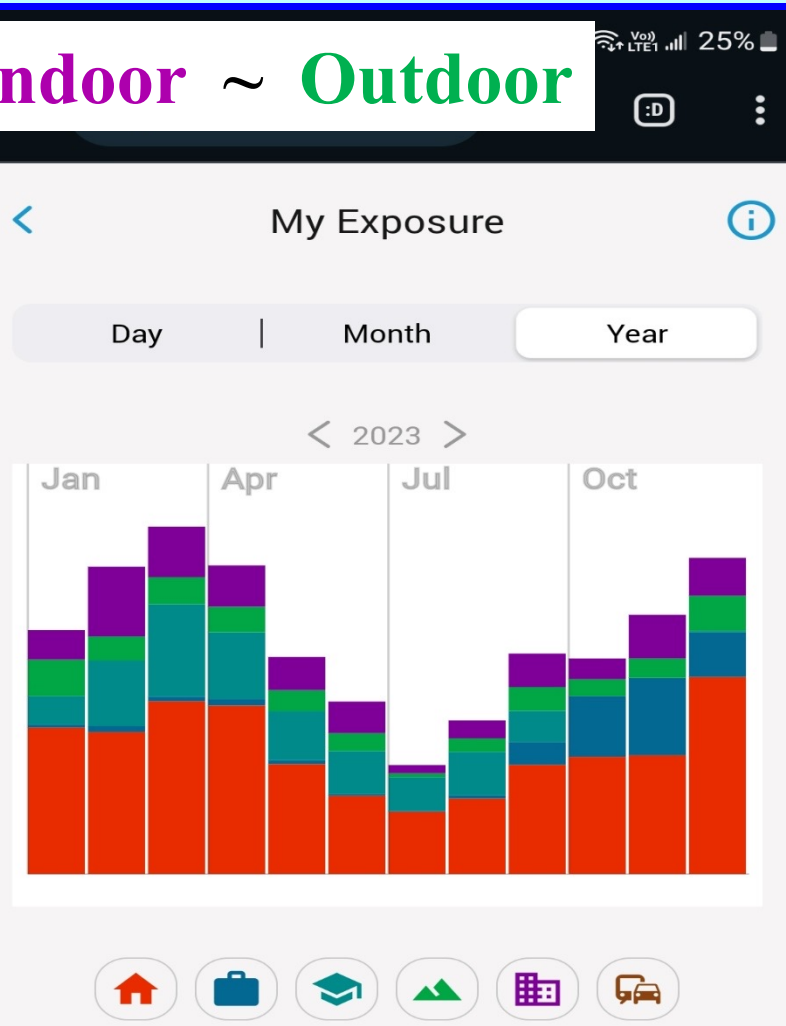
Won the Gold Award in the Public Sector and Social Innovation category of the Asia Smart App Award 2022/23

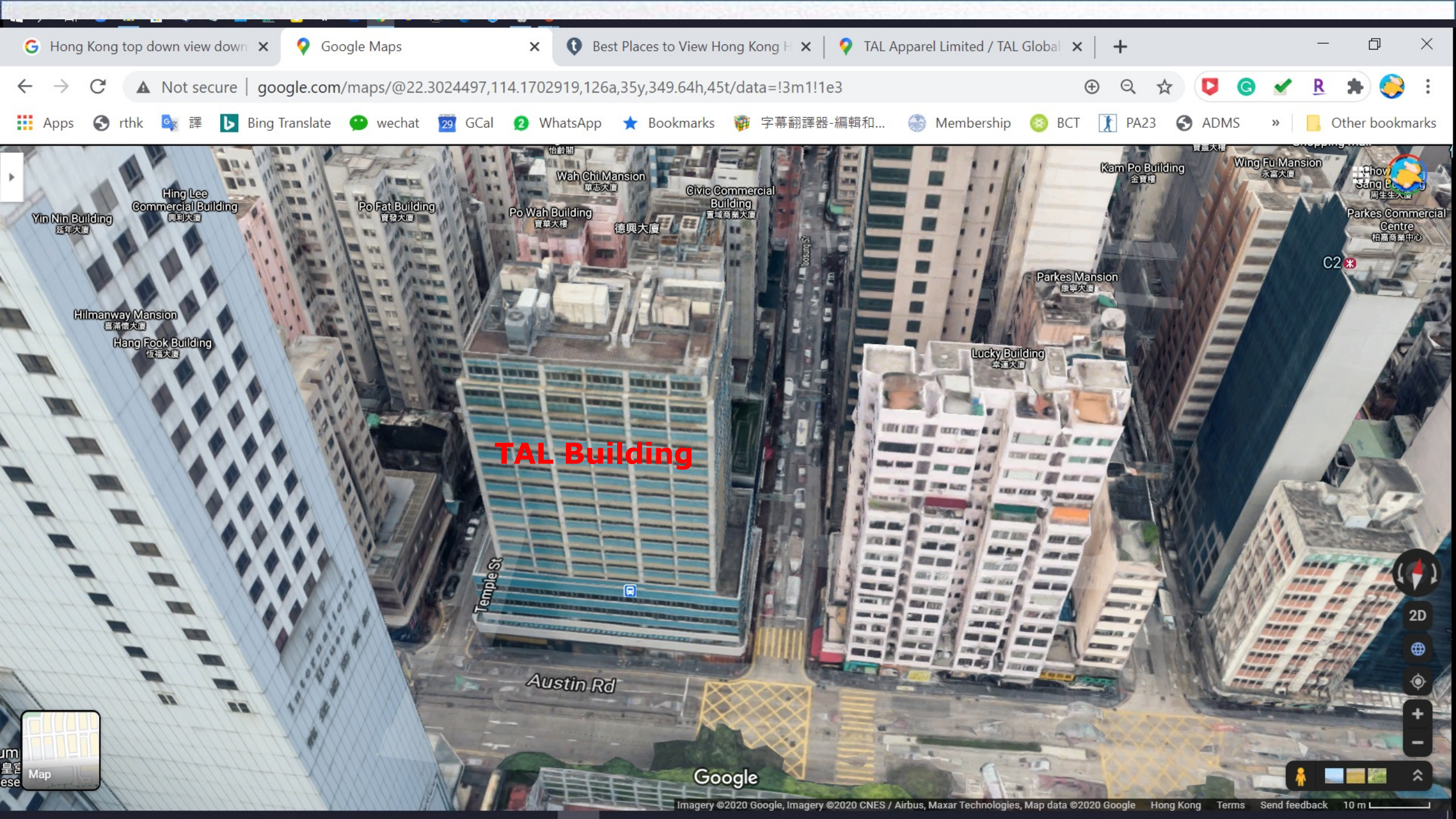
My Air Exposure Risks by Different Micro-Environments

Home (indoor) >>> Office (indoor) >> Other Indoor ~ Outdoor

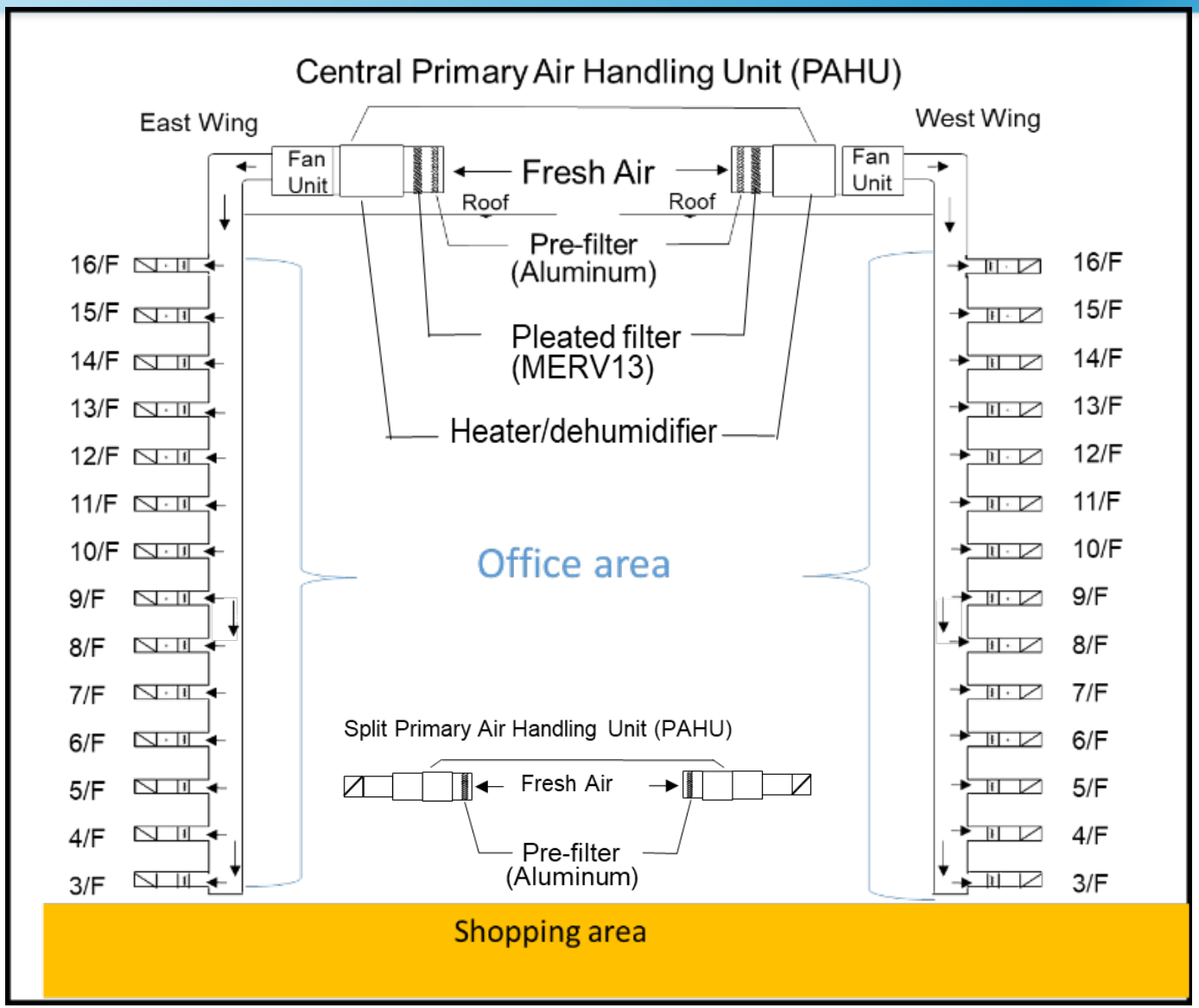







Hong Kong top down view down
Google Maps
Best Places to View Hong Kong H
TAL Apparel Limited / TAL Global
Not secure | google.com/maps/@22.3024497,114.1702919,126a,35y,349.64h,45t/data=!3m1!1e3
Apps
rthk
譯
Bing Translate
wechat
GCal
WhatsApp
Bookmarks
字幕翻譯器-編輯和...
Membership
BCT
PA23
ADMS
Other bookmarks
Yin Nin Building
延年大廈
Hing Lee Commercial Building
興利大廈
Po Fat Building
寶發大廈
Wah Chi Mansion
華志大廈
Po Wah Building
寶華大樓
德興大廈
Civic Commercial Building
置域商業大廈
Kam Po Building
金寶樓
Wing Fu Mansion
永富大廈
Parkes Commercial Centre
柏嘉商業中心
C2
Parkes Mansion
康寧大廈
Hilmanway Mansion
喜滿樓大廈
Hang Fook Building
恆福大廈
Lucky Building
幸運大廈
TAL Building
Temple St
Austin Rd
Map
Google
2D
Imagery ©2020 Google, Imagery ©2020 CNES / Airbus, Maxar Technologies, Map data ©2020 Google
Hong Kong
Terms
Send feedback
10 m

TAL Retrofit Project information



- Retrofit measures:

(1) A two-stage filtration system for particles

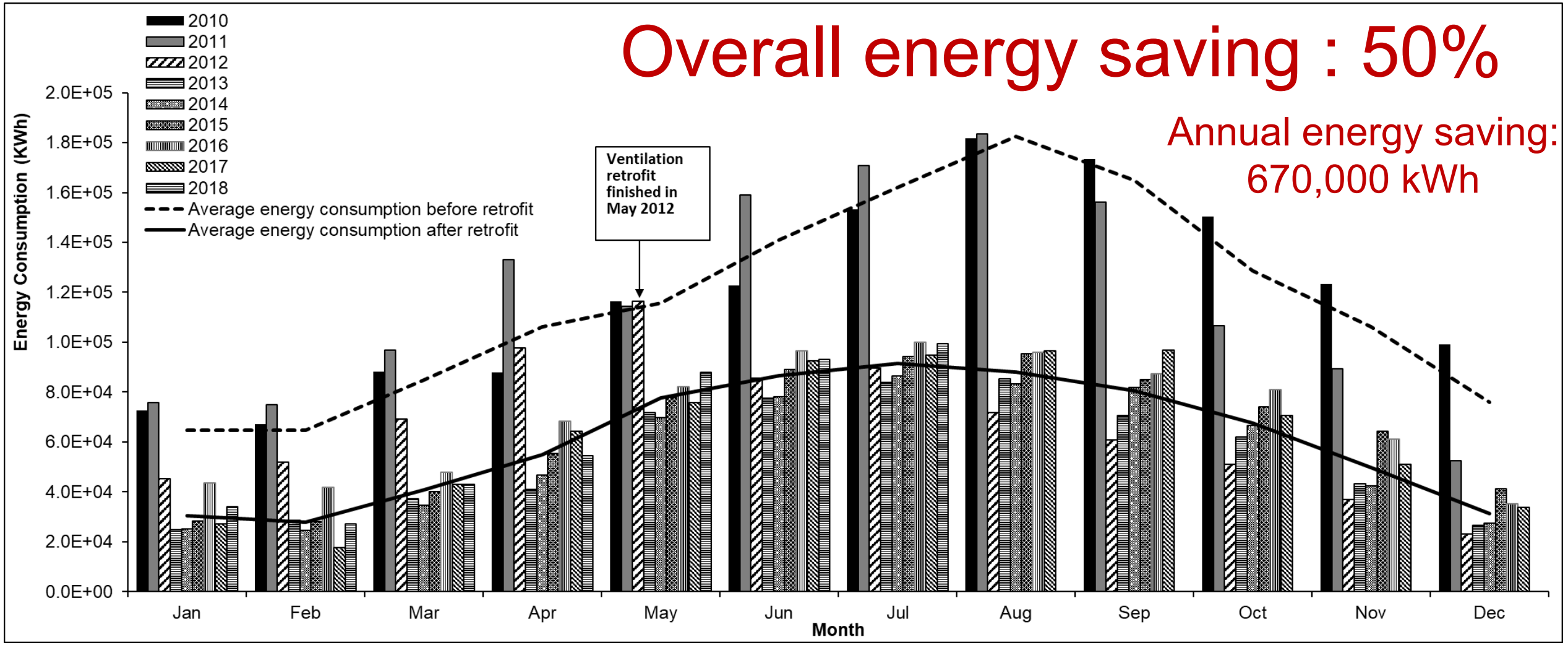
(2) Specially designed cooling coils to dehumidify the fresh air

(3) Adding a split PAHU on 5/F for enhanced ventilation

(4) Building management system (BMS) to monitor and control ventilation and air conditioning

(5) Maintain positive pressure

Energy saving



Energy & Buildings 201 (2019) 202–215

Contents lists available at ScienceDirect

Energy & Buildings

journal homepage: www.elsevier.com/locate/enbuild

Energy consumption, indoor thermal comfort and air quality in a commercial office with retrofitted heat, ventilation and air conditioning (HVAC) system

Wen Wei Che[a,b], Chi Yan Tso[c], Li Sun[d], Danny Y.K. Ip[e], Harry Lee[f], Christopher Y.H. Chao[g], Alexis K.H. Lau[a,d,*]

[a] *Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong Special Administrative Region, China*

[b] *HKUST Jockey Club Institute for Advanced Study, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong Special Administrative Region, China*

[c] *School of Energy and Environment, City University of Hong Kong, Tat Chee Avenue, Kowloon Tong, Hong Kong Special Administrative Region, China*

[d] *Division of Environment and Sustainability, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong Special Administrative Region, China*

[e] *Kins Engineering Limited Union Air Condition Eng. CO., Tsuen Wan, Hong Kong SAR, China*

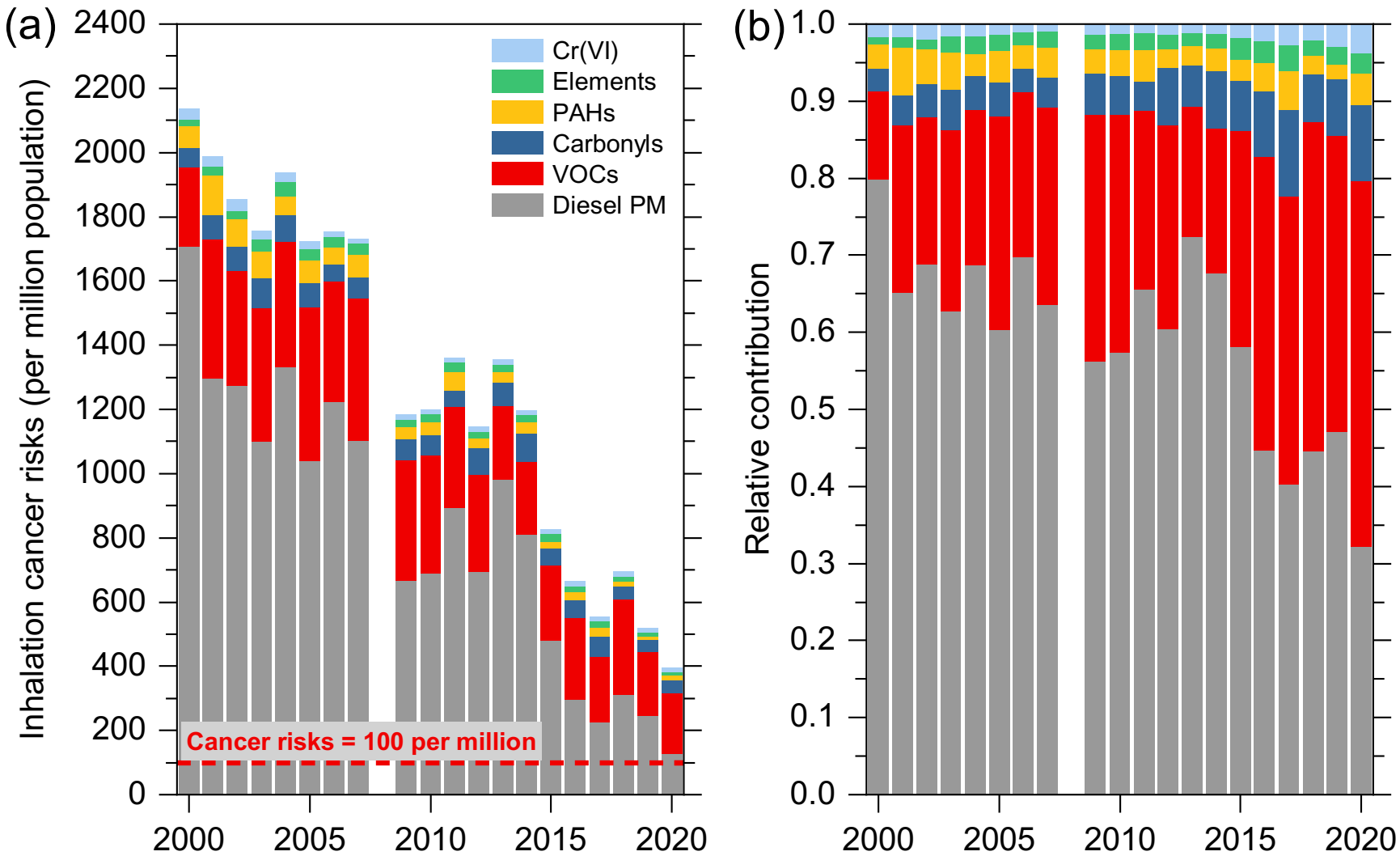
[f] *Tal Group, Kowloon, Hong Kong Special Administrative Region, China*

[g] *Department of Mechanical Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong Special Administrative Region, China*

Beyond Criteria Pollutants

Air Toxics

Inhalation cancer risks: 2000–2020

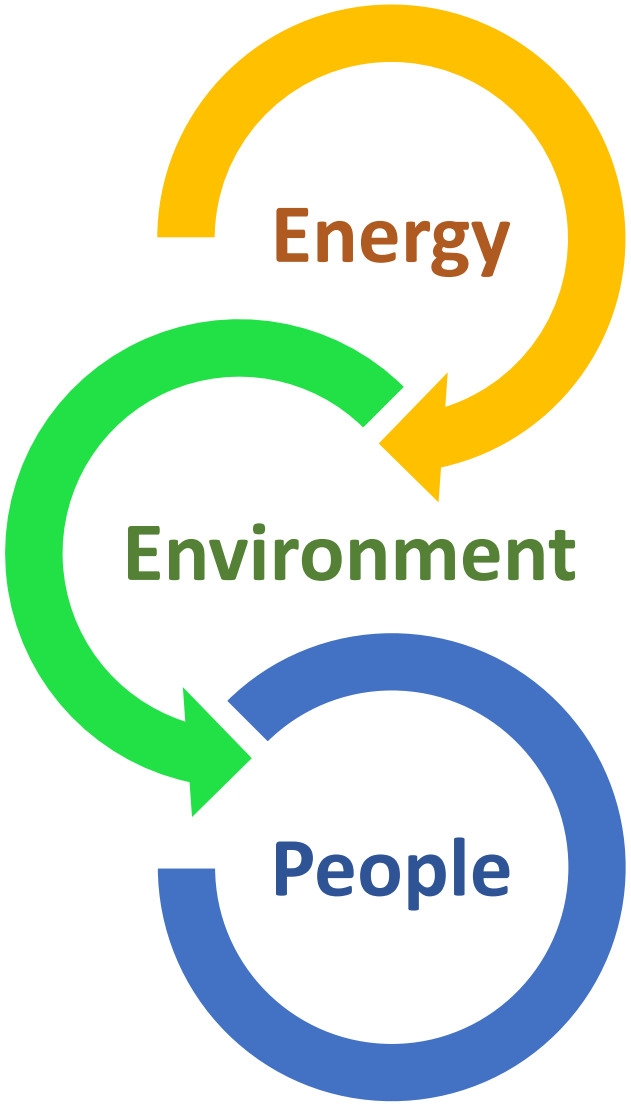


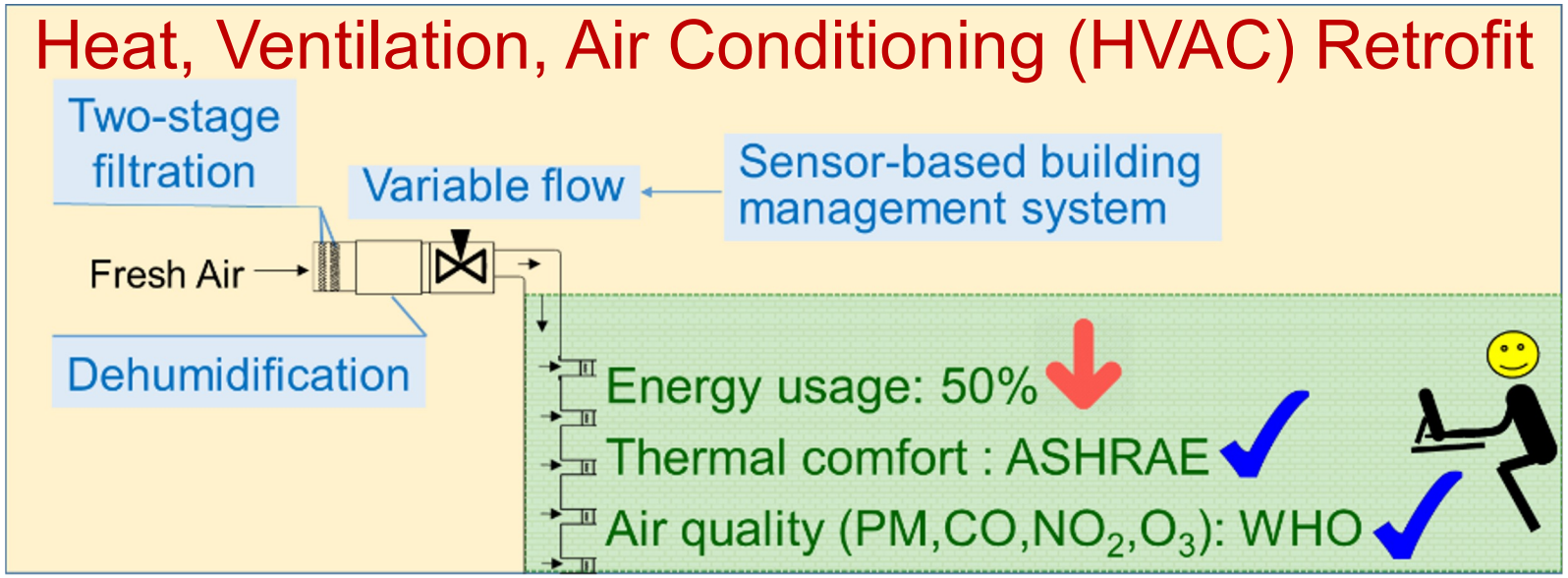
$$Inhalation\ cancer\ risks = Concentration \times Unit\ risk\ factor$$

- Control of diesel PM resulted in significantly lower cancer risks
- ~500 additional cancer cases per million population in recent years
- VOCs have growing importance

Wong et al. (2023)

PRAISE ⟷ Sustainable and healthy indoor Environment

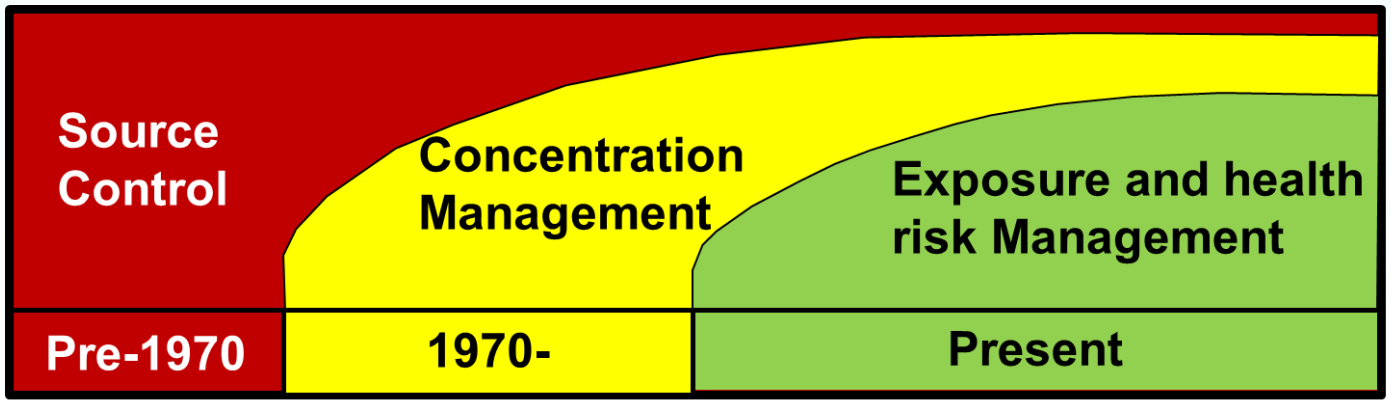




- **Coherent thinking**
- **Collaboration**
- **Co-benefits**
- **Buildings to improve outdoor air !!**

Air Quality Management

- **Before Clean Air Act (1970)**
  - Source control – Maximum Achievable Control Technology (MACT)
- **Clean Air Act Amendment (1970)**
  - National Ambient Air Quality Standards
  - Concentration management of criteria pollutants
- **Clean Air Act Amendment (1990)**
  - 189 species of air toxics - MACT



WHO Air Quality Guidelines (2005)

Hong Kong Air Quality Objectives (2013)

Pollutants	Averaging time	WHO AQGs			
		IT-1	IT-2	IT-3	AQG
SO_2 ($\mu g/m^3$)	10-min	--			500
	24-hr	125	50	--	20
PM_{10} ($\mu g/m^3$)	24-hr	150	100	75	50
	Annual	70	50	30	20
$PM_{2.5}$ ($\mu g/m^3$)	24-hr	75	50	37.5	25
	Annual	35	25	15	10
NO_2 ($\mu g/m^3$)	1-hr	--			200
	Annual	--			40
O_3 ($\mu g/m^3$)	8-hr	160	--	--	100

All units are $\mu g/m^3$

Thank you