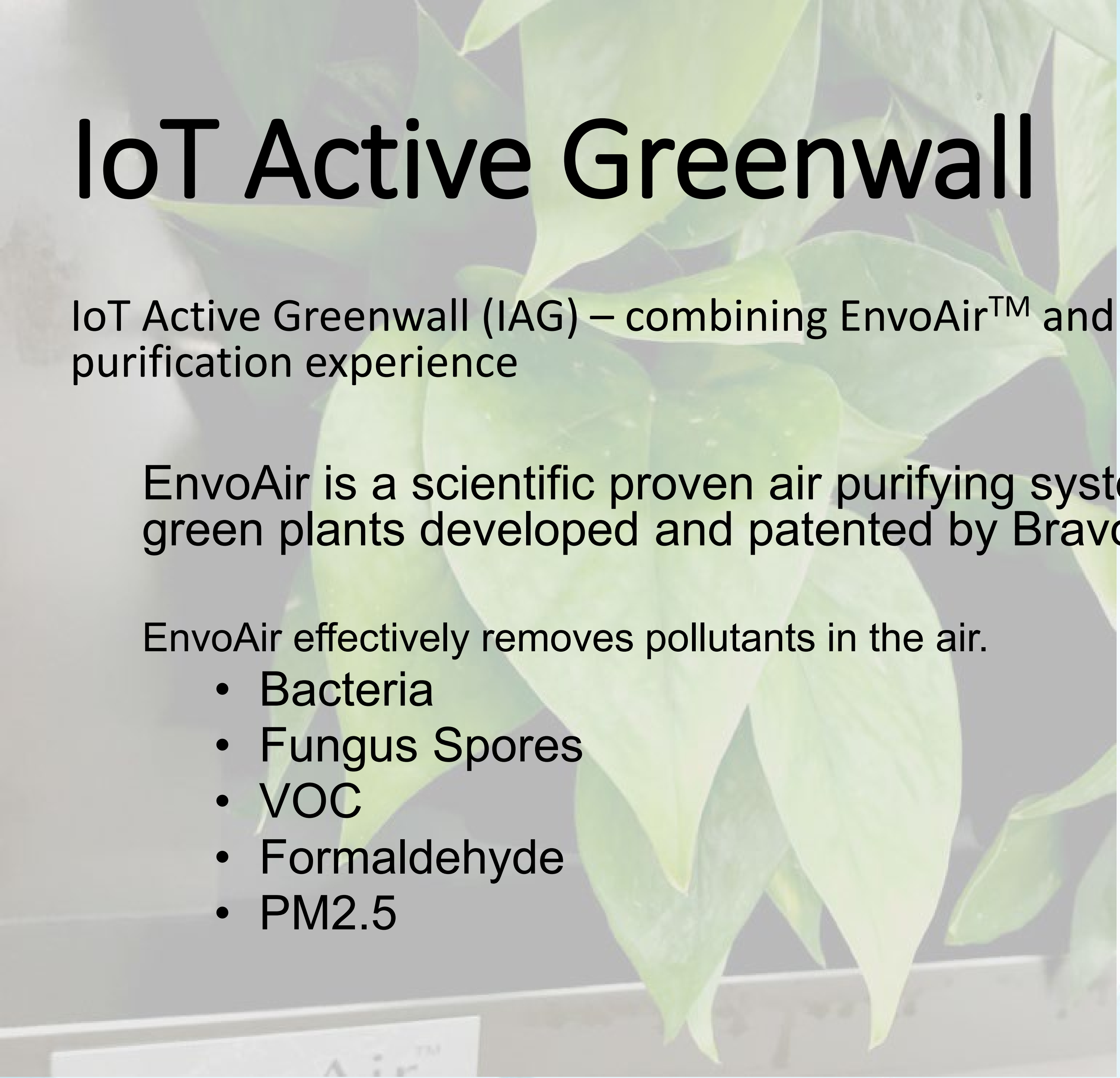
IoT Active Greenwall
IAG

EnvoAir™

Green filtration, Evergreen breathing

Andrew Kung
Chief Operating Officer
Bravolinear Tech Limited



IoT Active Greenwall

IoT Active Greenwall
IAG

IoT Active Greenwall (IAG) – combining EnvoAir^{TM} and IoT to provide an unique air purification experience

EnvoAir is a scientific proven air purifying system based on Root Zone of green plants developed and patented by Bravolinear Tech.

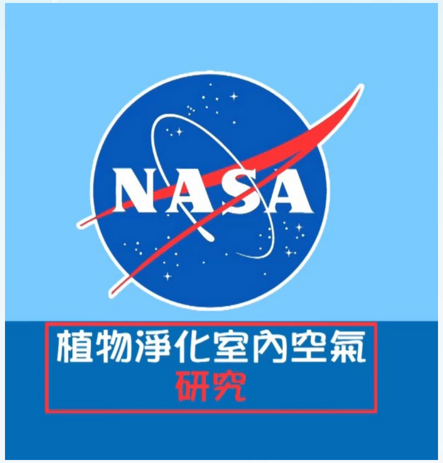
EnvoAir effectively removes pollutants in the air.

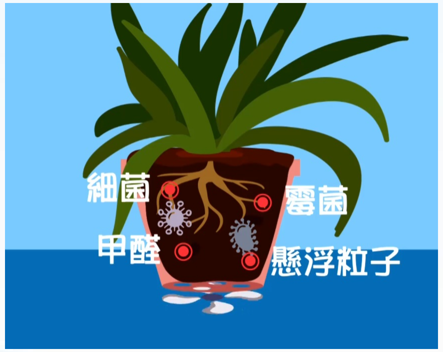
- Bacteria
- Fungus Spores
- VOC
- Formaldehyde
- PM2.5

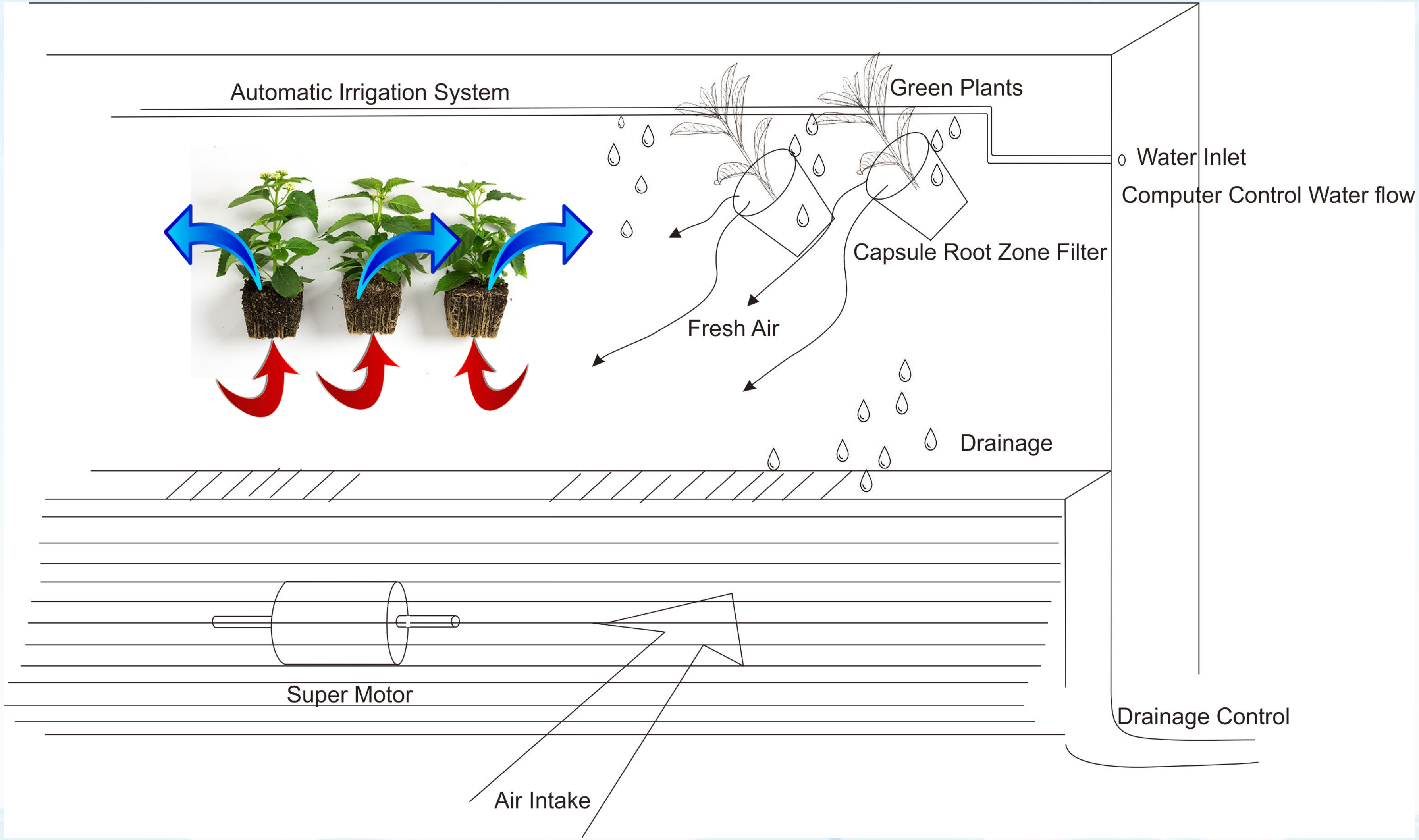
IoT Active Greenwall

IAG

EnvoAir™


NASA
植物淨化室內空氣研究


細菌
霉菌
甲醛
懸浮粒子


Automatic Irrigation System
Green Plants
Water Inlet
Computer Control Water flow
Capsule Root Zone Filter
Fresh Air
Drainage
Super Motor
Drainage Control
Air Intake

IoT

Enabling :

- Healthy Growth of Green Plants
- Performance of the Active Green Wall

- 24/7 IoT sensor monitoring and control
- Enhance maintenance of IAG green plants
- Advance notification for any preventive actions
- Data management for reports and analysis
- Notifications sent by WhatsApp for most immediate responses

Job References

HK Science Park
  - Management Office Main Lobby
  - Enterprise Place
  - Incubation Centre

China MinMetals Tower Main Lobby

EMSD Head Qaurter InnoStudio

Government Departments

E&M InnoStudio

IoT Active Greenwall

IAG

IoT Active Greenwall – Available in a WELL Property

IoT Active Greenwall
IAG

IAG – One of the property's "WELL" Feature

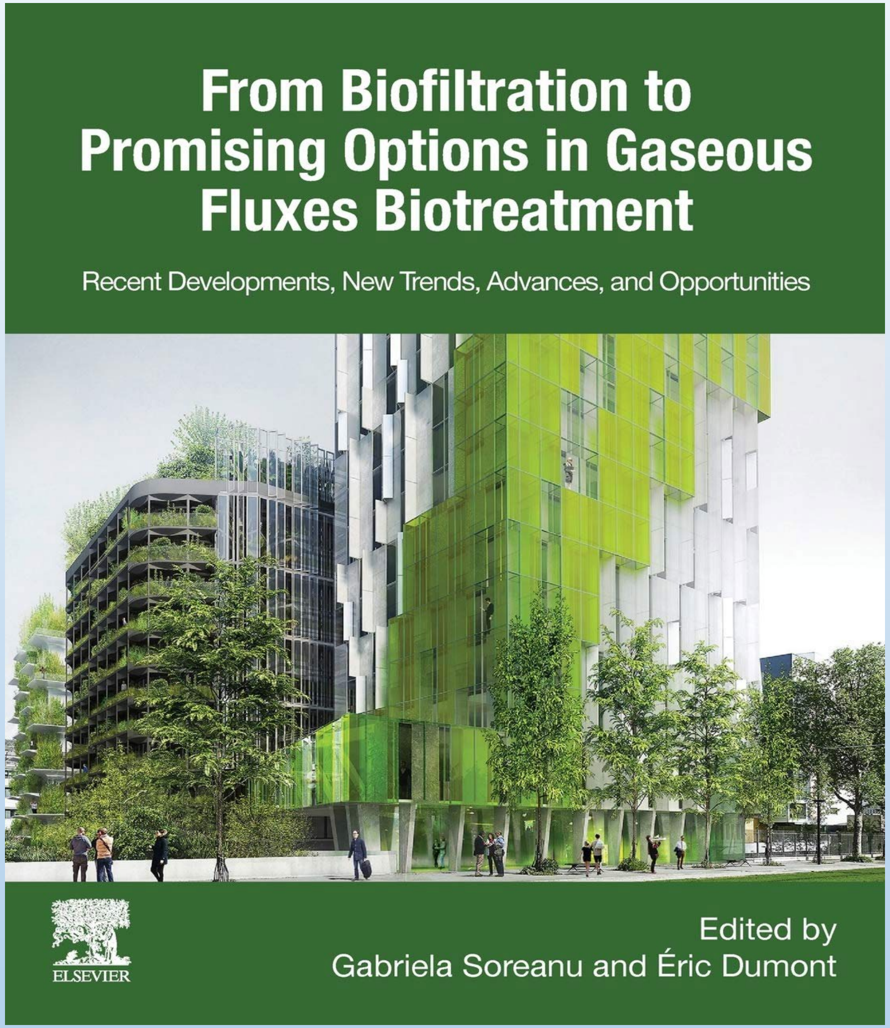
Studio
to have better air quality

Bravolinear's video of IAG : Help promote "Green" life

IAG : Main feature inside clubhouse play room

Harmonized among other GREEN features

Elsevier publication - 2020



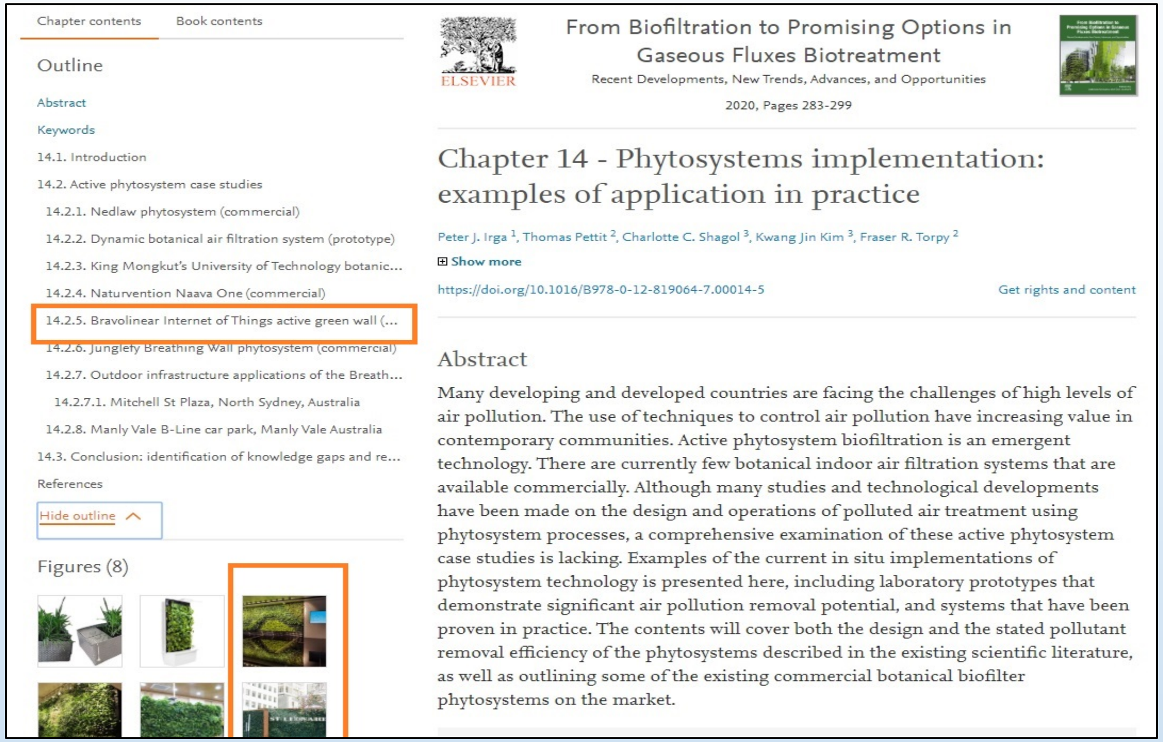
From Biofiltration to Promising Options in Gaseous Fluxes Biotreatment

Recent Developments, New Trends, Advances, and Opportunities

Edited by
Gabriela Soreanu and Éric Dumont

ELSEVIER

IoT Active Greenwall
IAG



Outline

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14.2. Active phytosystem case studies
  14.2.1. Nedlaw phytosystem (commercial)
  14.2.2. Dynamic botanical air filtration system (prototype)
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    14.2.7.1. Mitchell St Plaza, North Sydney, Australia
  14.2.8. Manly Vale B-Line car park, Manly Vale Australia
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From Biofiltration to Promising Options in Gaseous Fluxes Biotreatment
Recent Developments, New Trends, Advances, and Opportunities
2020, Pages 283-299

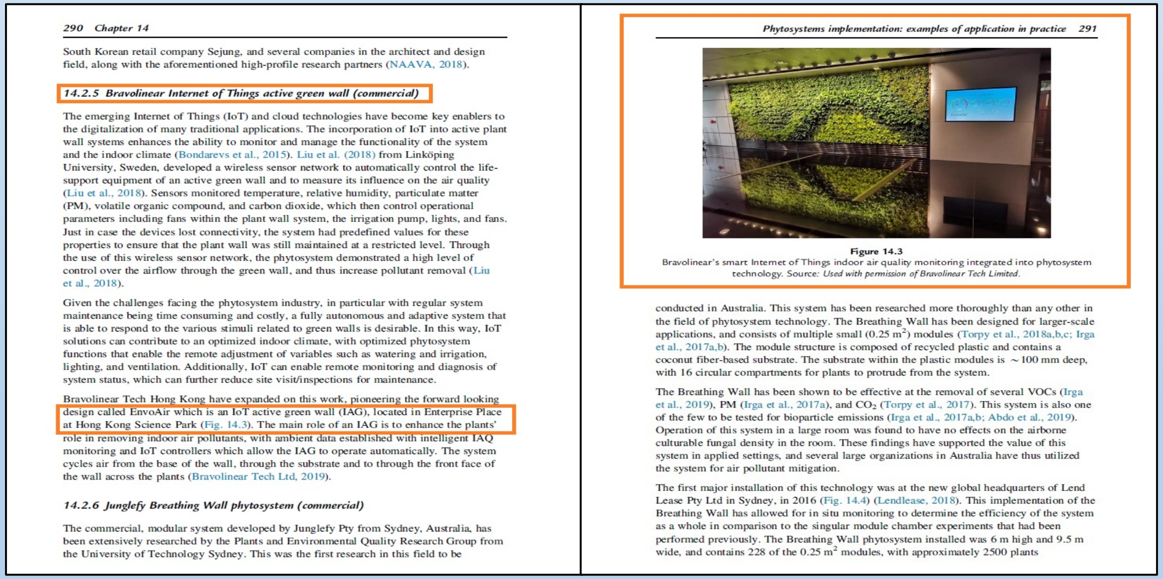
Chapter 14 - Phytosystems implementation: examples of application in practice

Peter J. Irga [1], Thomas Pettit [2], Charlotte C. Shagol [3], Kwang Jin Kim [3], Fraser R. Torpy [2]

https://doi.org/10.1016/B978-0-12-819064-7.00014-5

Abstract

Many developing and developed countries are facing the challenges of high levels of air pollution. The use of techniques to control air pollution have increasing value in contemporary communities. Active phytosystem biofiltration is an emergent technology. There are currently few botanical indoor air filtration systems that are available commercially. Although many studies and technological developments have been made on the design and operations of polluted air treatment using phytosystem processes, a comprehensive examination of these active phytosystem case studies is lacking. Examples of the current in situ implementations of phytosystem technology is presented here, including laboratory prototypes that demonstrate significant air pollution removal potential, and systems that have been proven in practice. The contents will cover both the design and the stated pollutant removal efficiency of the phytosystems described in the existing scientific literature, as well as outlining some of the existing commercial botanical biofilter phytosystems on the market.



290 Chapter 14

South Korean retail company Sejung, and several companies in the architect and design field, along with the aforementioned high-profile research partners (NAAVA, 2018).

14.2.5 Bravolinear Internet of Things active green wall (commercial)

The emerging Internet of Things (IoT) and cloud technologies have become key enablers to the digitalization of many traditional applications. The incorporation of IoT into active plant wall systems enhances the ability to monitor and manage the functionality of the system and the indoor climate (Bondarevs et al., 2015). Liu et al. (2018) from Linköping University, Sweden, developed a wireless sensor network to automatically control the life-support equipment of an active green wall and to measure its influence on the air quality (Liu et al., 2018). Sensors monitored temperature, relative humidity, particulate matter (PM), volatile organic compound, and carbon dioxide, which then control operational parameters including fans within the plant wall system, the irrigation pump, lights, and fans. Just in case the devices lost connectivity, the system had predefined values for these properties to ensure that the plant wall was still maintained at a restricted level. Through the use of this wireless sensor network, the phytosystem demonstrated a high level of control over the airflow through the green wall, and thus increase pollutant removal (Liu et al., 2018).

Given the challenges facing the phytosystem industry, in particular with regular system maintenance being time consuming and costly, a fully autonomous and adaptive system that is able to respond to the various stimuli related to green walls is desirable. In this way, IoT solutions can contribute to an optimized indoor climate, with optimized phytosystem functions that enable the remote adjustment of variables such as watering and irrigation, lighting, and ventilation. Additionally, IoT can enable remote monitoring and diagnosis of system status, which can further reduce site visit/inspections for maintenance.

Bravolinear Tech Hong Kong have expanded on this work, pioneering the forward looking design called EnvoAir which is an IoT active green wall (IAG), located in Enterprise Place at Hong Kong Science Park (Fig. 14.3). The main role of an IAG is to enhance the plants' role in removing indoor air pollutants, with ambient data established with intelligent IAQ monitoring and IoT controllers which allow the IAG to operate automatically. The system cycles air from the base of the wall, through the substrate and to through the front face of the wall across the plants (Bravolinear Tech Ltd, 2019).

14.2.6 Junglefy Breathing Wall phytosystem (commercial)

The commercial, modular system developed by Junglefy Pty from Sydney, Australia, has been extensively researched by the Plants and Environmental Quality Research Group from the University of Technology Sydney. This was the first research in this field to be conducted in Australia. This system has been researched more thoroughly than any other in the field of phytosystem technology. The Breathing Wall has been designed for larger-scale applications, and consists of multiple small (0.25 m^2) modules (Torpy et al., 2018a,b,c; Irga et al., 2017a,b). The module structure is composed of recycled plastic and contains a coconut fiber-based substrate. The substrate within the plastic modules is ~100 mm deep, with 16 circular compartments for plants to protrude from the system.

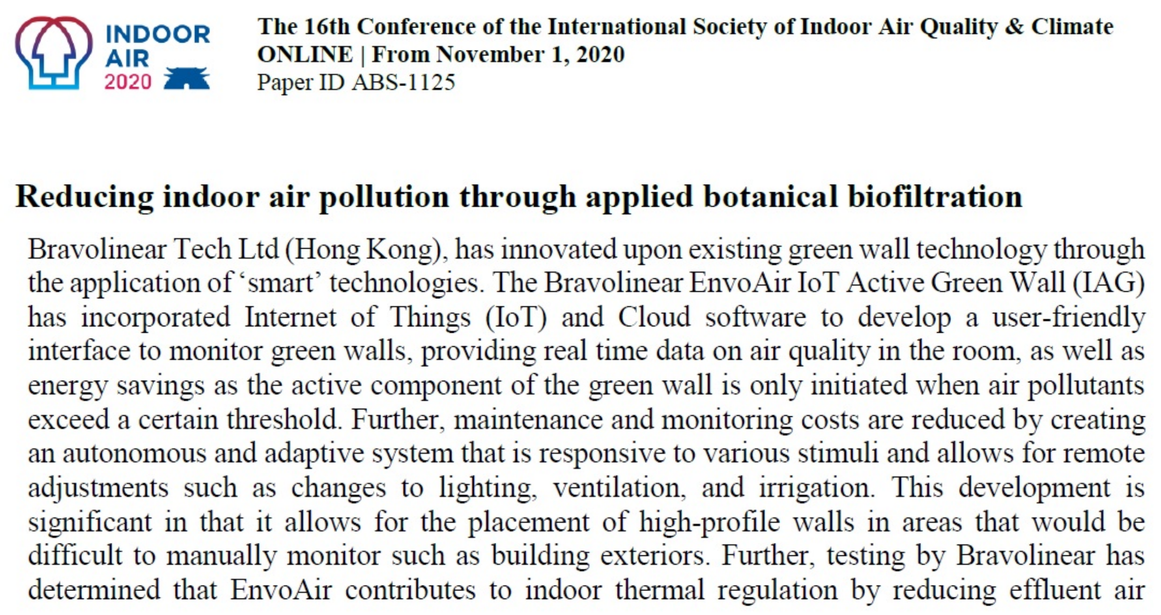
Phytosystems implementation: examples of application in practice 291

Figure 14.3
Bravolinear's smart Internet of Things indoor air quality monitoring integrated into phytosystem technology. Source: *Used with permission of Bravolinear Tech Limited.*

The Breathing Wall has been shown to be effective at the removal of several VOCs (Irga et al., 2019), PM (Irga et al., 2017a), and CO_2 (Torpy et al., 2017). This system is also one of the few to be tested for bioparticle emissions (Irga et al., 2017a,b; Abdo et al., 2019). Operation of this system in a large room was found to have no effects on the airborne culturable fungal density in the room. These findings have supported the value of this system in applied settings, and several large organizations in Australia have thus utilized the system for air pollutant mitigation.

The first major installation of this technology was at the new global headquarters of Lend Lease Pty Ltd in Sydney, in 2016 (Fig. 14.4) (Lendlease, 2018). This implementation of the Breathing Wall has allowed for in situ monitoring to determine the efficiency of the system as a whole in comparison to the singular module chamber experiments that had been performed previously. The Breathing Wall phytosystem installed was 6 m high and 9.5 m wide, and contains 228 of the 0.25 m^2 modules, with approximately 2500 plants

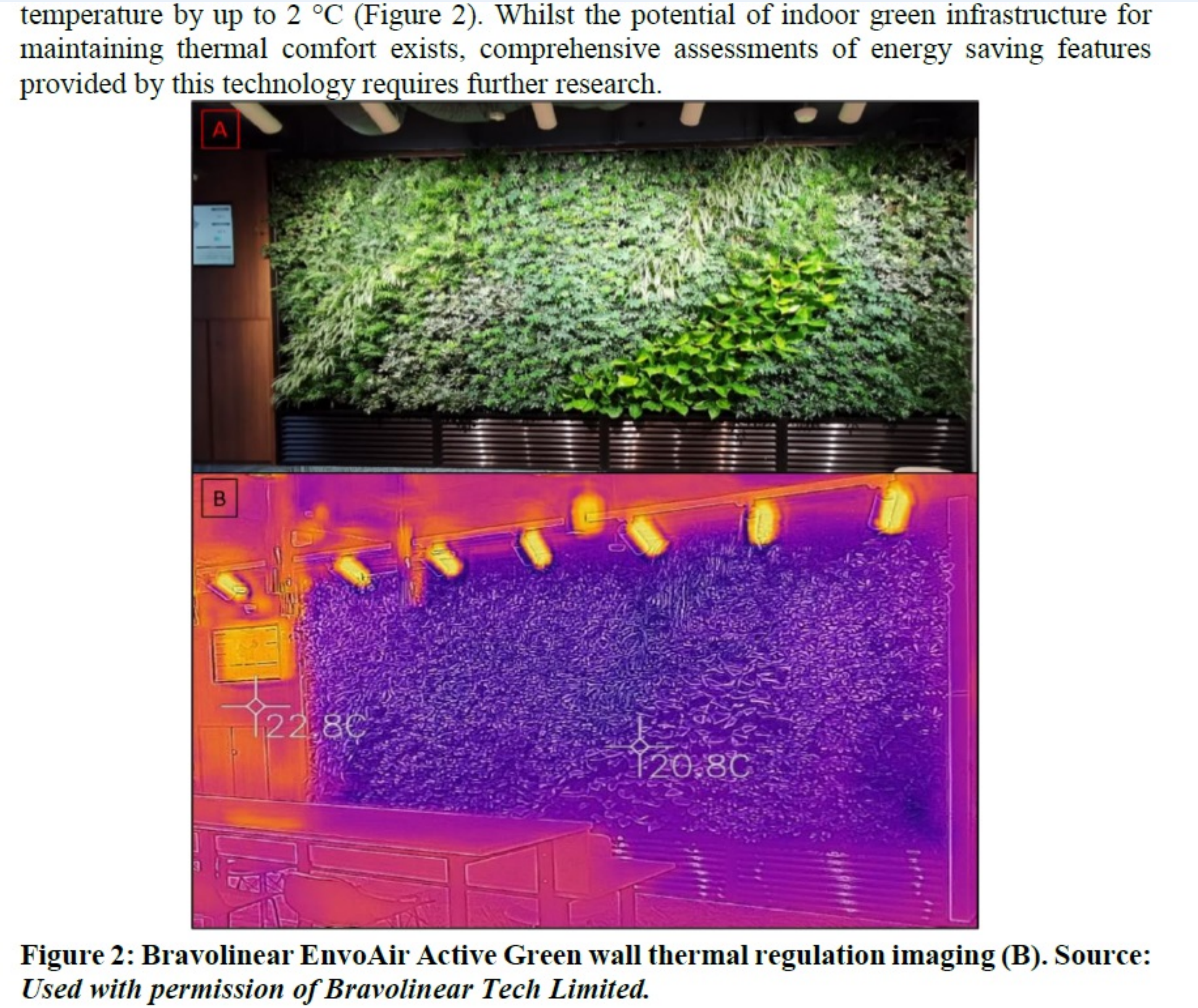
International Society of IAQ and Cliamte
Nov 2020



The 16th Conference of the International Society of Indoor Air Quality & Climate
ONLINE | From November 1, 2020
Paper ID ABS-1125

Reducing indoor air pollution through applied botanical biofiltration

Bravolinear Tech Ltd (Hong Kong), has innovated upon existing green wall technology through the application of 'smart' technologies. The Bravolinear EnvoAir IoT Active Green Wall (IAG) has incorporated Internet of Things (IoT) and Cloud software to develop a user-friendly interface to monitor green walls, providing real time data on air quality in the room, as well as energy savings as the active component of the green wall is only initiated when air pollutants exceed a certain threshold. Further, maintenance and monitoring costs are reduced by creating an autonomous and adaptive system that is responsive to various stimuli and allows for remote adjustments such as changes to lighting, ventilation, and irrigation. This development is significant in that it allows for the placement of high-profile walls in areas that would be difficult to manually monitor such as building exteriors. Further, testing by Bravolinear has determined that EnvoAir contributes to indoor thermal regulation by reducing effluent air

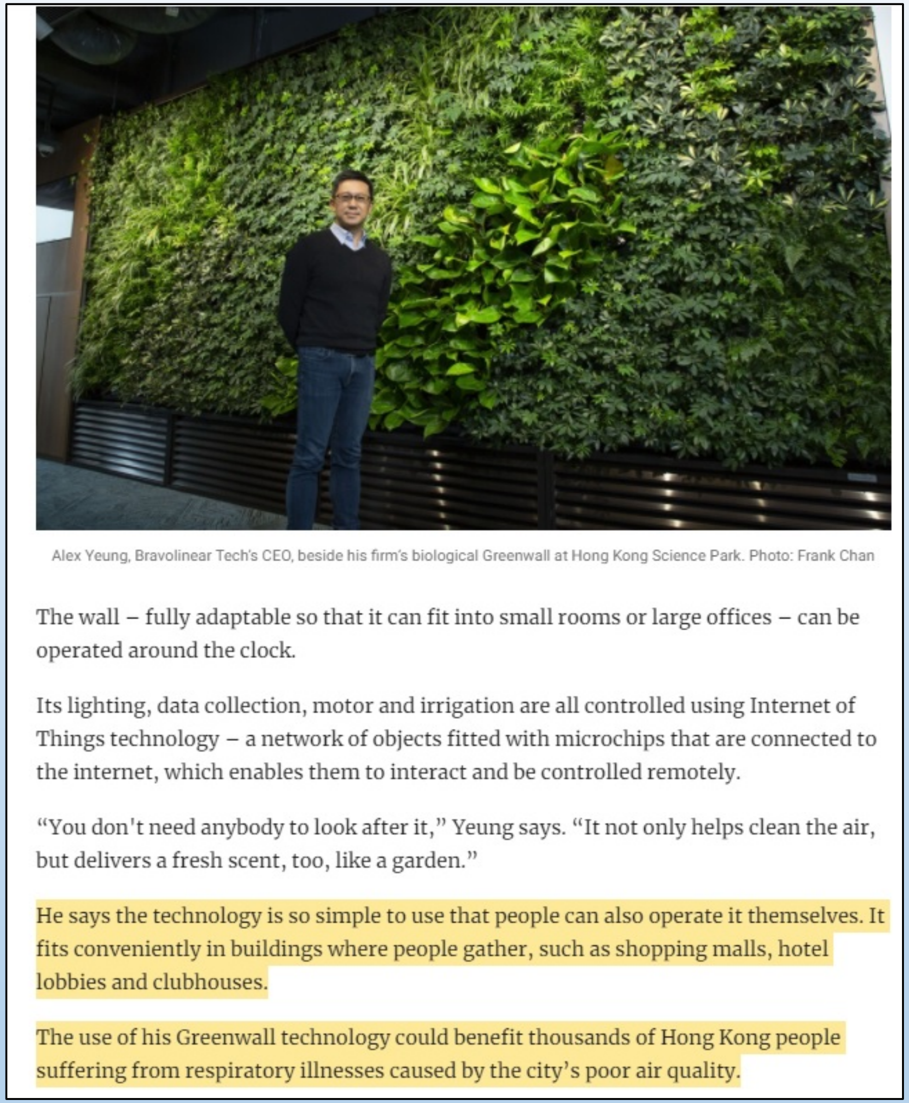


temperature by up to 2 °C (Figure 2). Whilst the potential of indoor green infrastructure for maintaining thermal comfort exists, comprehensive assessments of energy saving features provided by this technology requires further research.

A
B
22.8C
20.8C

Figure 2: Bravolinear EnvoAir Active Green wall thermal regulation imaging (B). Source: ***Used with permission of Bravolinear Tech Limited.***

Press and Media coverage of IAG – after the COVID-19 outbreak at 2020



Alex Yeung, Bravolinear Tech's CEO, beside his firm's biological Greenwall at Hong Kong Science Park. Photo: Frank Chan

The wall – fully adaptable so that it can fit into small rooms or large offices – can be operated around the clock.

Its lighting, data collection, motor and irrigation are all controlled using Internet of Things technology – a network of objects fitted with microchips that are connected to the internet, which enables them to interact and be controlled remotely.

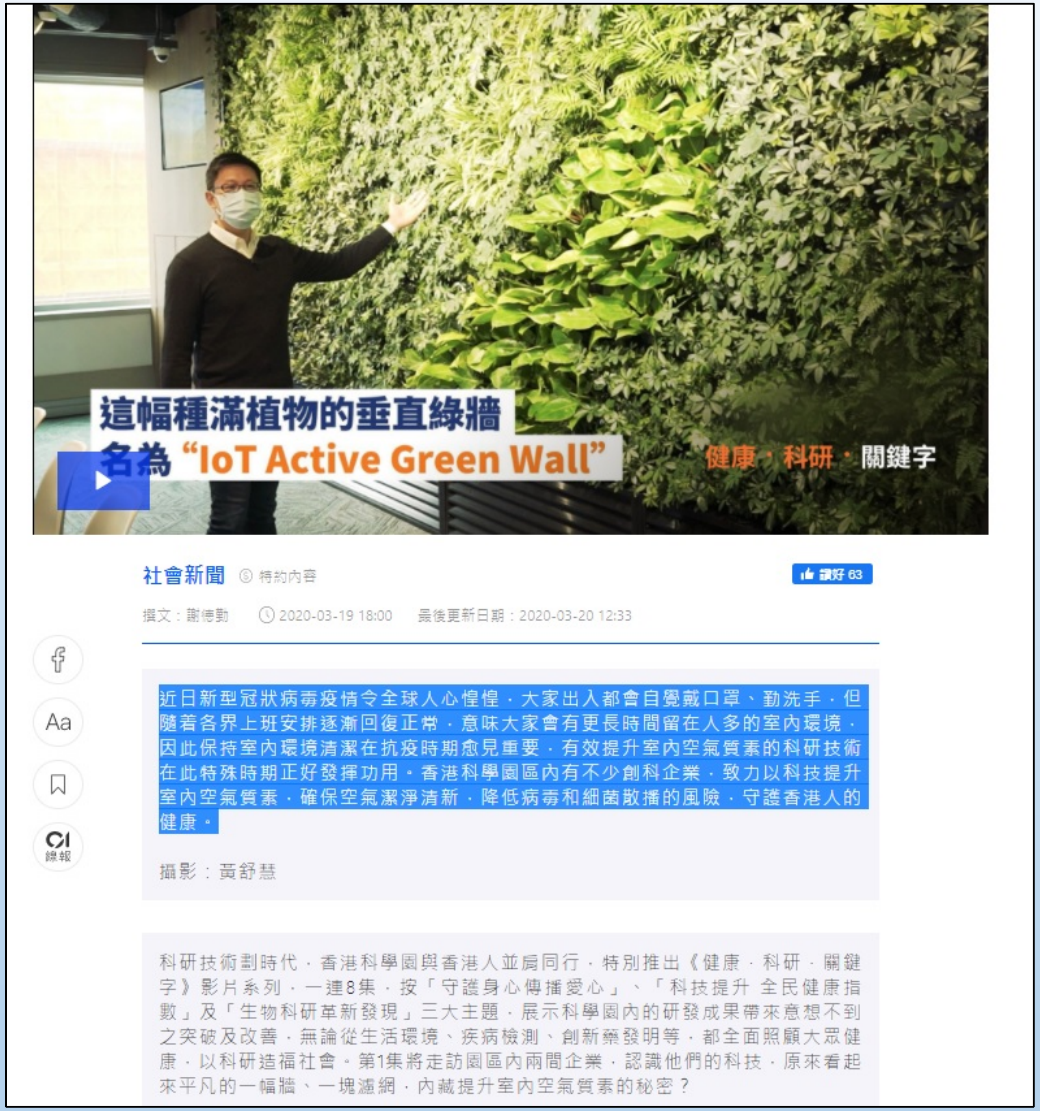
"You don't need anybody to look after it," Yeung says. "It not only helps clean the air, but delivers a fresh scent, too, like a garden."

He says the technology is so simple to use that people can also operate it themselves. It fits conveniently in buildings where people gather, such as shopping malls, hotel lobbies and clubhouses.

The use of his Greenwall technology could benefit thousands of Hong Kong people suffering from respiratory illnesses caused by the city's poor air quality.

SCMP

http://bit.do/fMati



社會新聞 特約內容

撰文：謝德勤　2020-03-19 18:00　最後更新日期：2020-03-20 12:33

近日新型冠狀病毒疫情令全球人心惶惶，大家出入都會自覺戴口罩、勤洗手，但隨着各界上班安排逐漸回復正常，意味大家會有更長時間留在人多的室內環境，因此保持室內環境清潔在抗疫時期愈見重要，有效提升室內空氣質素的科研技術在此特殊時期正好發揮功用。香港科學園區內有不少創科企業，致力以科技提升室內空氣質素，確保空氣潔淨清新，降低病毒和細菌散播的風險，守護香港人的健康。

攝影：黃舒慧

科研技術劃時代，香港科學園與香港人並肩同行，特別推出《健康・科研・關鍵字》影片系列，一連8集，按「守護身心傳播愛心」、「科技提升 全民健康指數」及「生物科研革新發現」三大主題，展示科學園內的研發成果帶來意想不到之突破及改善，無論從生活環境、疾病檢測、創新藥發明等，都全面照顧大眾健康，以科研造福社會。第1集將走訪園區內兩間企業，認識他們的科技，原來看起來平凡的一幅牆、一塊濾網，內藏提升室內空氣質素的秘密？

HK01

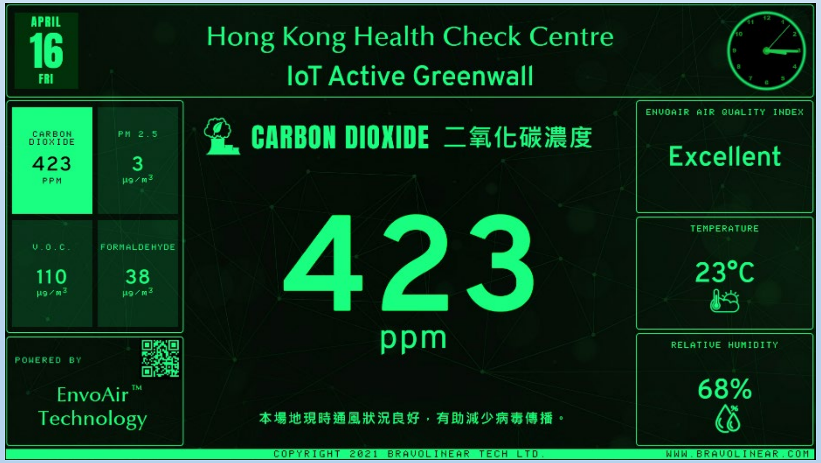
http://bit.do/fLK7x

IoT Active Greenwall Latest Installation – Health Care

Mid April, 2021 – Latest installation in a health checking group

Leveraging IAG, the group promote more health benefits to customers at their reception space

IAG and IoT sensing, IAQ data core value to customer / consumers



APRIL
16
FRI

Hong Kong Health Check Centre
IoT Active Greenwall

CARBON DIOXIDE 423 PPM

PM 2.5 3 µg/m³

V.O.C. 110 µg/m³

FORMALDEHYDE 38 µg/m³

CARBON DIOXIDE 二氧化碳濃度

423
ppm

本場地現時通風狀況良好，有助減少病毒傳播。

ENVOAIR AIR QUALITY INDEX
Excellent

TEMPERATURE
23°C

RELATIVE HUMIDITY
68%

POWERED BY
EnvoAir™
Technology

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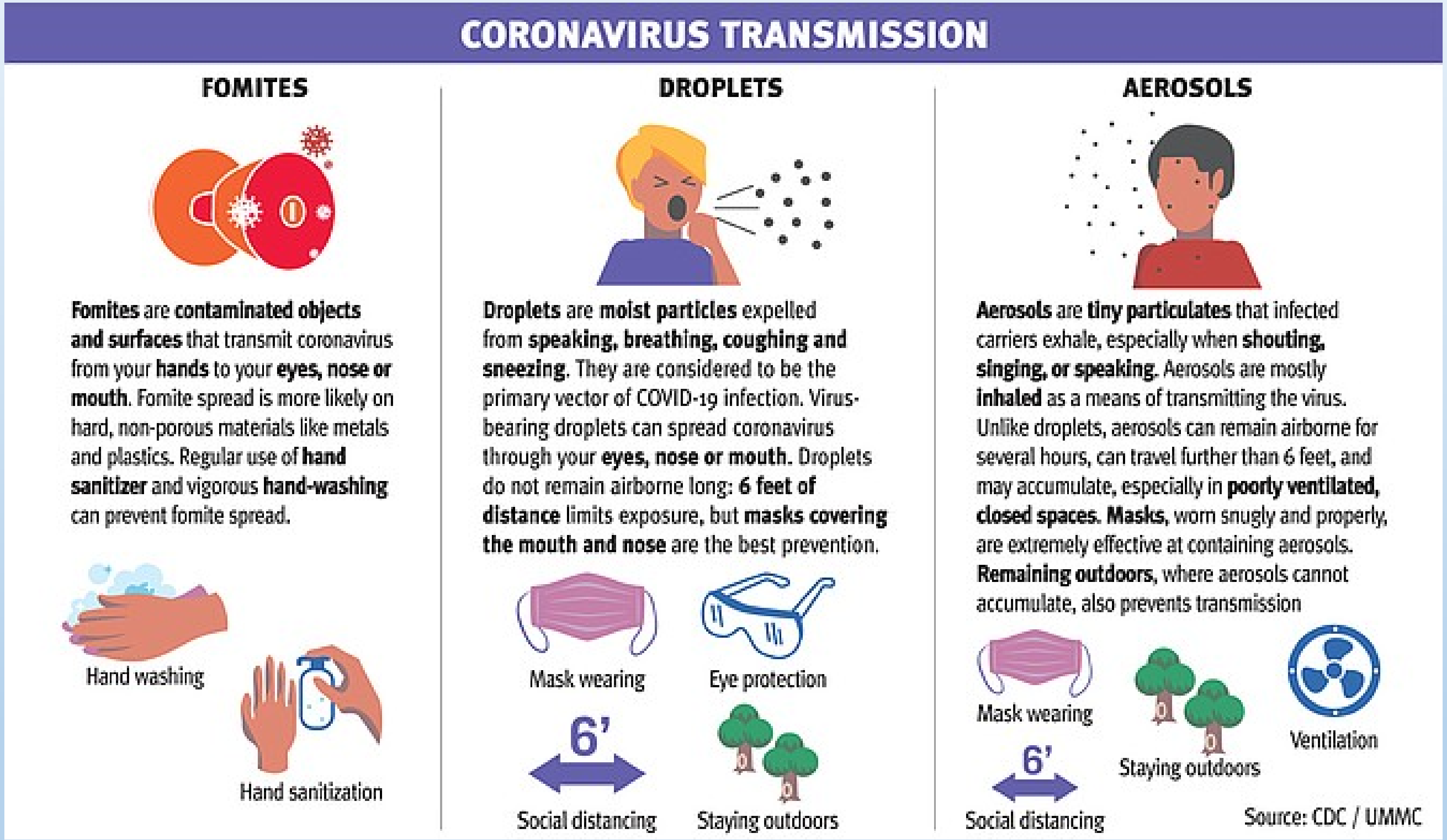
WWW.BRAVOLINEAR.COM

IoT processed Air Quality data for customers

COVID-19 : Transmission Mechanism



CORONAVIRUS TRANSMISSION

FOMITES

Fomites are **contaminated objects and surfaces** that transmit coronavirus from your **hands** to your **eyes, nose or mouth**. Fomite spread is more likely on hard, non-porous materials like metals and plastics. Regular use of **hand sanitizer** and vigorous **hand-washing** can prevent fomite spread.

Hand washing

Hand sanitization

DROPLETS

Droplets are **moist particles** expelled from **speaking, breathing, coughing and sneezing**. They are considered to be the primary vector of COVID-19 infection. Virus-bearing droplets can spread coronavirus through your **eyes, nose or mouth**. Droplets do not remain airborne long: **6 feet of distance** limits exposure, but **masks covering the mouth and nose** are the best prevention.

Mask wearing

Eye protection

6’

Social distancing

Staying outdoors

AEROSOLS

Aerosols are **tiny particulates** that infected carriers exhale, especially when **shouting, singing, or speaking**. Aerosols are mostly **inhaled** as a means of transmitting the virus. Unlike droplets, aerosols can remain airborne for several hours, can travel further than 6 feet, and may accumulate, especially in **poorly ventilated, closed spaces. Masks**, worn snugly and properly, are extremely effective at containing aerosols. **Remaining outdoors**, where aerosols cannot accumulate, also prevents transmission

Mask wearing

Staying outdoors

Ventilation

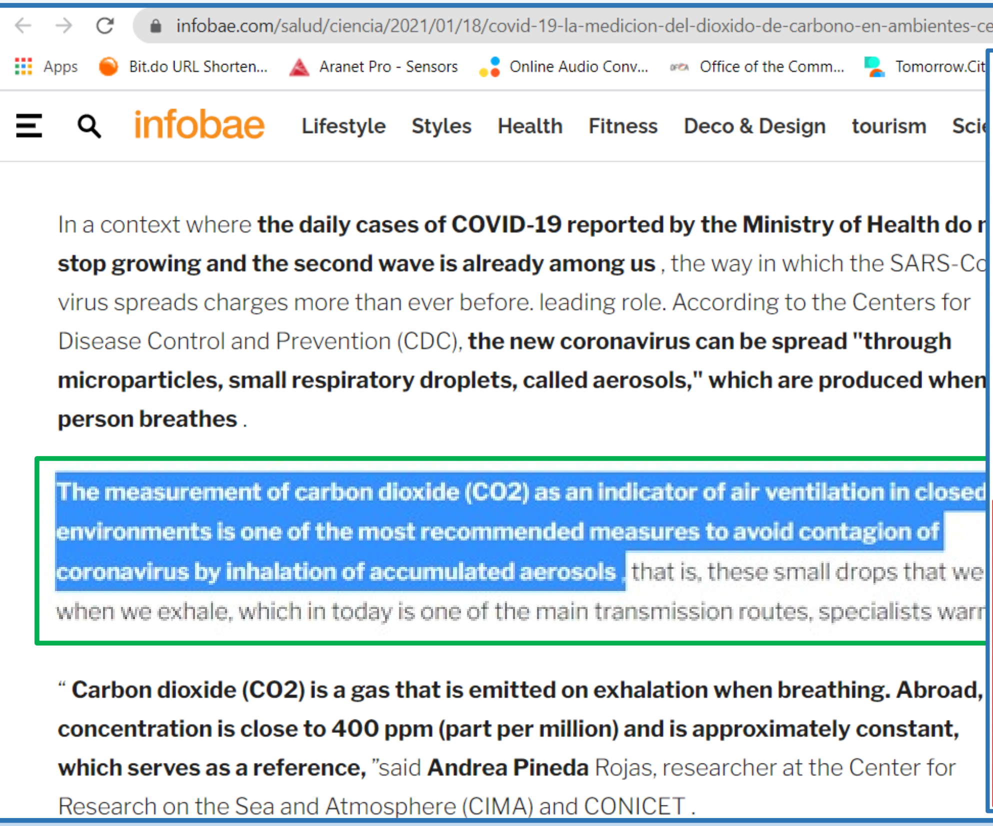
6’

Social distancing

Source: CDC / UMMC

Disclaimer : Please refer to official Health department’s information about COVID-19

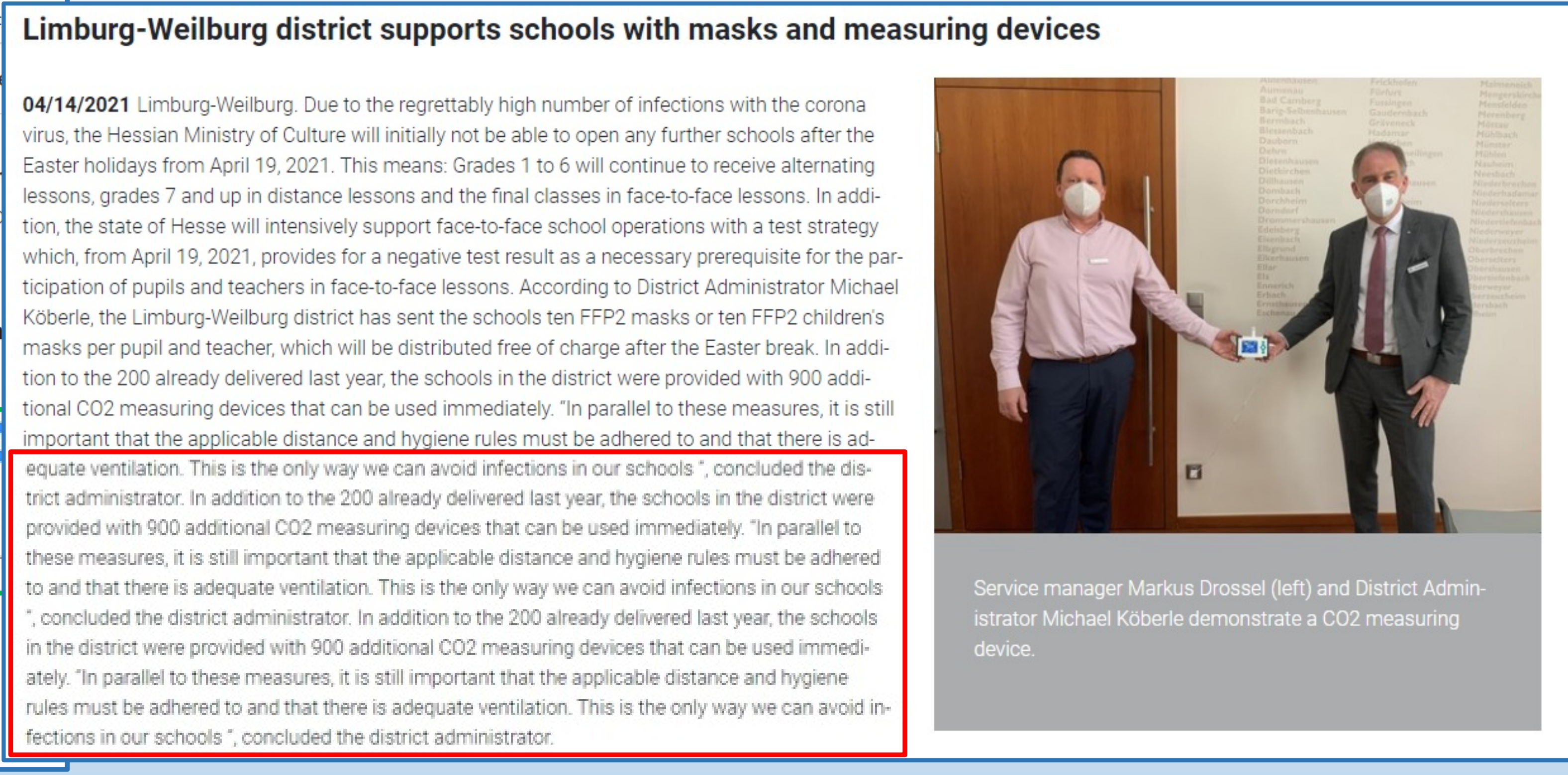
Indoor Ventilation / Aerosol : CO2 meters as Proxy Measurement



In a context where **the daily cases of COVID-19 reported by the Ministry of Health do n stop growing and the second wave is already among us** , the way in which the SARS-Co virus spreads charges more than ever before. leading role. According to the Centers for Disease Control and Prevention (CDC), **the new coronavirus can be spread "through microparticles, small respiratory droplets, called aerosols," which are produced when person breathes** .

The measurement of carbon dioxide (CO2) as an indicator of air ventilation in closed environments is one of the most recommended measures to avoid contagion of coronavirus by inhalation of accumulated aerosols , that is, these small drops that we when we exhale, which in today is one of the main transmission routes, specialists warn

" **Carbon dioxide (CO2) is a gas that is emitted on exhalation when breathing. Abroad, concentration is close to 400 ppm (part per million) and is approximately constant, which serves as a reference,** "said **Andrea Pineda** Rojas, researcher at the Center for Research on the Sea and Atmosphere (CIMA) and CONICET .



Limburg-Weilburg district supports schools with masks and measuring devices

04/14/2021 Limburg-Weilburg. Due to the regrettably high number of infections with the corona virus, the Hessian Ministry of Culture will initially not be able to open any further schools after the Easter holidays from April 19, 2021. This means: Grades 1 to 6 will continue to receive alternating lessons, grades 7 and up in distance lessons and the final classes in face-to-face lessons. In addition, the state of Hesse will intensively support face-to-face school operations with a test strategy which, from April 19, 2021, provides for a negative test result as a necessary prerequisite for the participation of pupils and teachers in face-to-face lessons. According to District Administrator Michael Köberle, the Limburg-Weilburg district has sent the schools ten FFP2 masks or ten FFP2 children's masks per pupil and teacher, which will be distributed free of charge after the Easter break. In addition to the 200 already delivered last year, the schools in the district were provided with 900 additional CO2 measuring devices that can be used immediately. "In parallel to these measures, it is still important that the applicable distance and hygiene rules must be adhered to and that there is adequate ventilation. This is the only way we can avoid infections in our schools ", concluded the district administrator. In addition to the 200 already delivered last year, the schools in the district were provided with 900 additional CO2 measuring devices that can be used immediately. "In parallel to these measures, it is still important that the applicable distance and hygiene rules must be adhered to and that there is adequate ventilation. This is the only way we can avoid infections in our schools ", concluded the district administrator. In addition to the 200 already delivered last year, the schools in the district were provided with 900 additional CO2 measuring devices that can be used immediately. "In parallel to these measures, it is still important that the applicable distance and hygiene rules must be adhered to and that there is adequate ventilation. This is the only way we can avoid infections in our schools ", concluded the district administrator.

Service manager Markus Drossel (left) and District Administrator Michael Köberle demonstrate a CO2 measuring device.

Føderationen af europæiske opvarmnings, ventilations og airconditionerings Foreninger (REHVA) anbefaler, at man bruger CO2-måling af enheder indendørs til vurdering af risici ved SARS-CoV-2 transmission via aerosoler. CO^2 er en gas der produceres når vi trækker vejret, og dets koncentration i lokalet kan være en god indikator for utilstrækkelig ventilation.

REHVA
Federation of
European Heating,
Ventilation and
Air Conditioning
Associations

01
CO₂ Monitor
678 PPM
Temp 25.8 °C
RH 38.4 %
02
EnvoAir
CO2
Unit: ppm
5/F
4/F
3/F
2/F
G/F
528
462
601
1210
479
959
655
796
505
729
617
1987
423
1151
03
04

🟦 Back to School, guarded by LPCO2

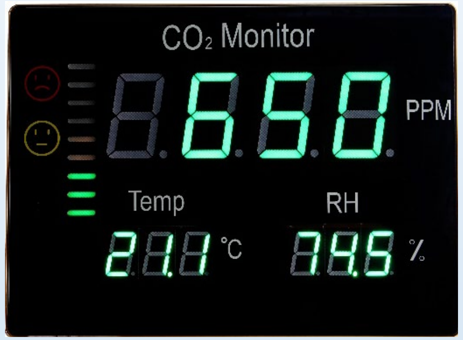
◼ Networked / Automatic monitored

🟦 Improve ventilation – Open Window

🟩 LPCO2 link to BMS – Auto Control

CO_2 Meters for Different Indoor situations

- LPCO2 – Large Panel – School / Halls / Lobby
- Desktop portable – Personal / Home use
- No display – Facility management
  - Wireless connection : WiFi / LPWA / 5G


CO₂ Monitor
650
PPM
Temp
°C
RH
%

10/27/2020
12:19:07
CO₂
592
PPM
Interval: OFF
27.93℃
55.79%RH
ENTER

Evergreen Breathing – Stay Green and safe