Foster + Partners

Brett Ormrod: Senior
Mechanical Engineer

Presentation

“Bloomberg Building: lessons learnt in relation to MAGIC”

Seminar March 21st 2018

Why include natural ventilation?

Natural Ventilation BoD
Occupant Wellbeing

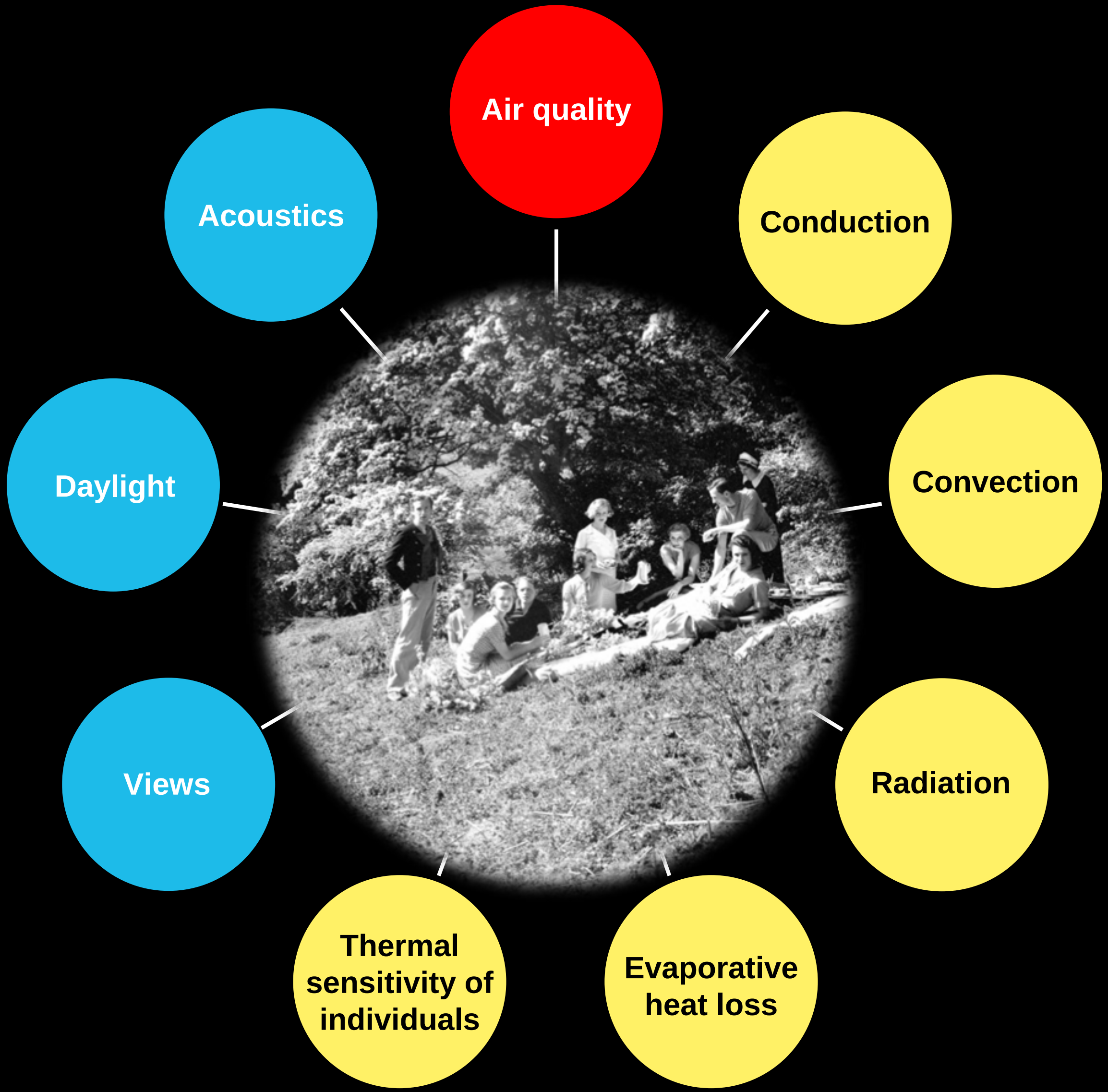
The primary reason for the introduction of a natural ventilation system is to enhance occupant wellbeing and comfort. This is supported by recent research that has shown improved occupant productivity and reduced energy use, in comparison to continuously mechanically ventilated buildings.

The natural ventilation system is expected to operate when the outside air temperature is between 10°C and 24°C.

The lower limit is based upon contemporary practice, and the level of prevailing internal heat gains help to warm up incoming fresh air supplies. Similarly, the upper limit is based upon contemporary UK natural ventilation design.

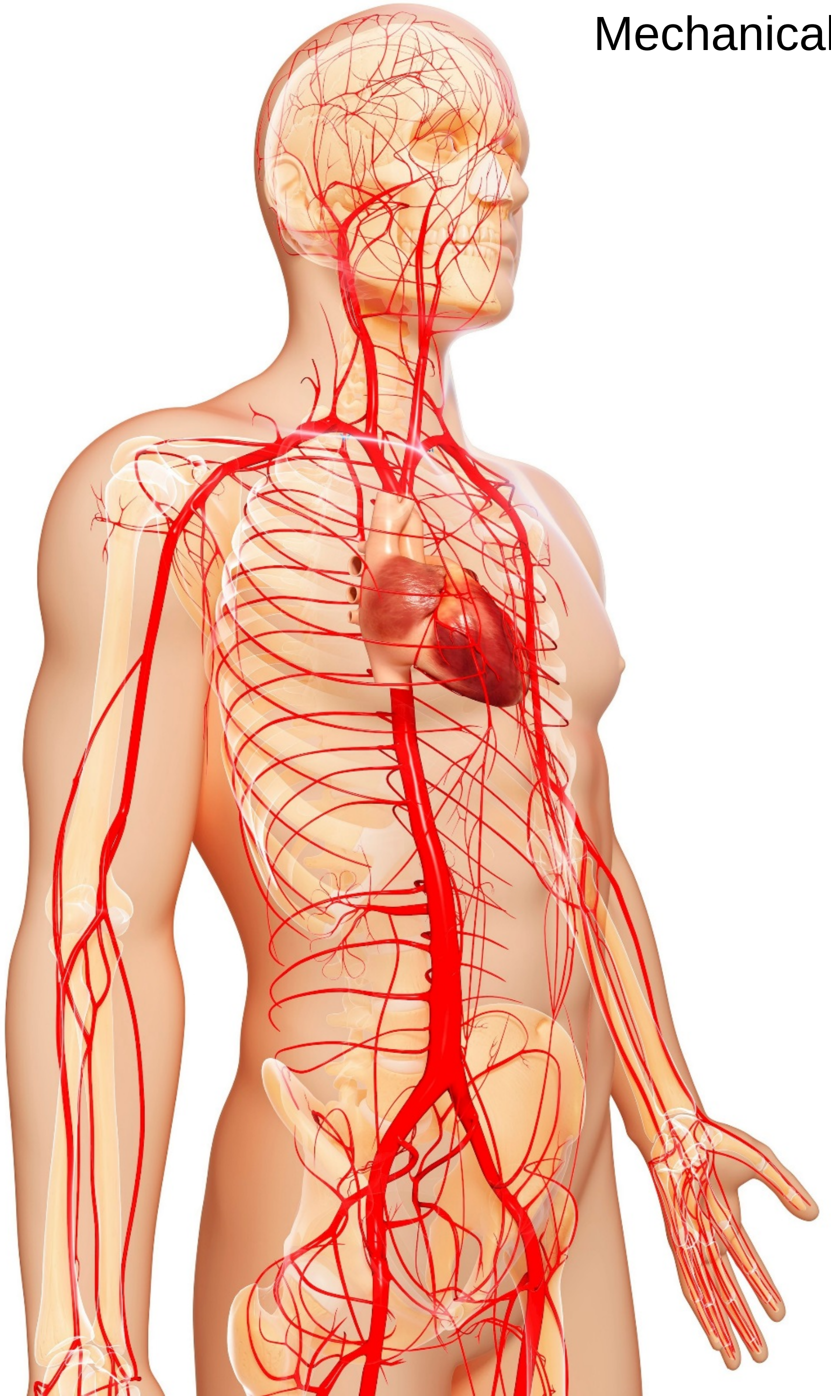
Between these temperatures limits, the design aims to use natural ventilation, including during periods of rainfall to maximise operation during the year, reverting to the mechanical ventilation system during periods when driving rain is detected.

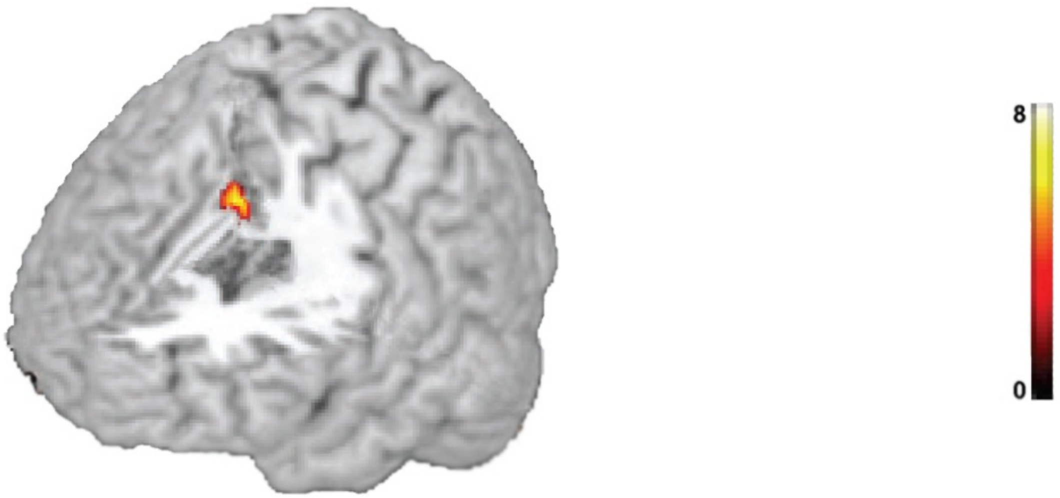
The natural ventilation apertures have been designed with acoustic and throttling features to exclude noise disturbance and excessive flow due to high wind speed.



Health, wellbeing and productivity

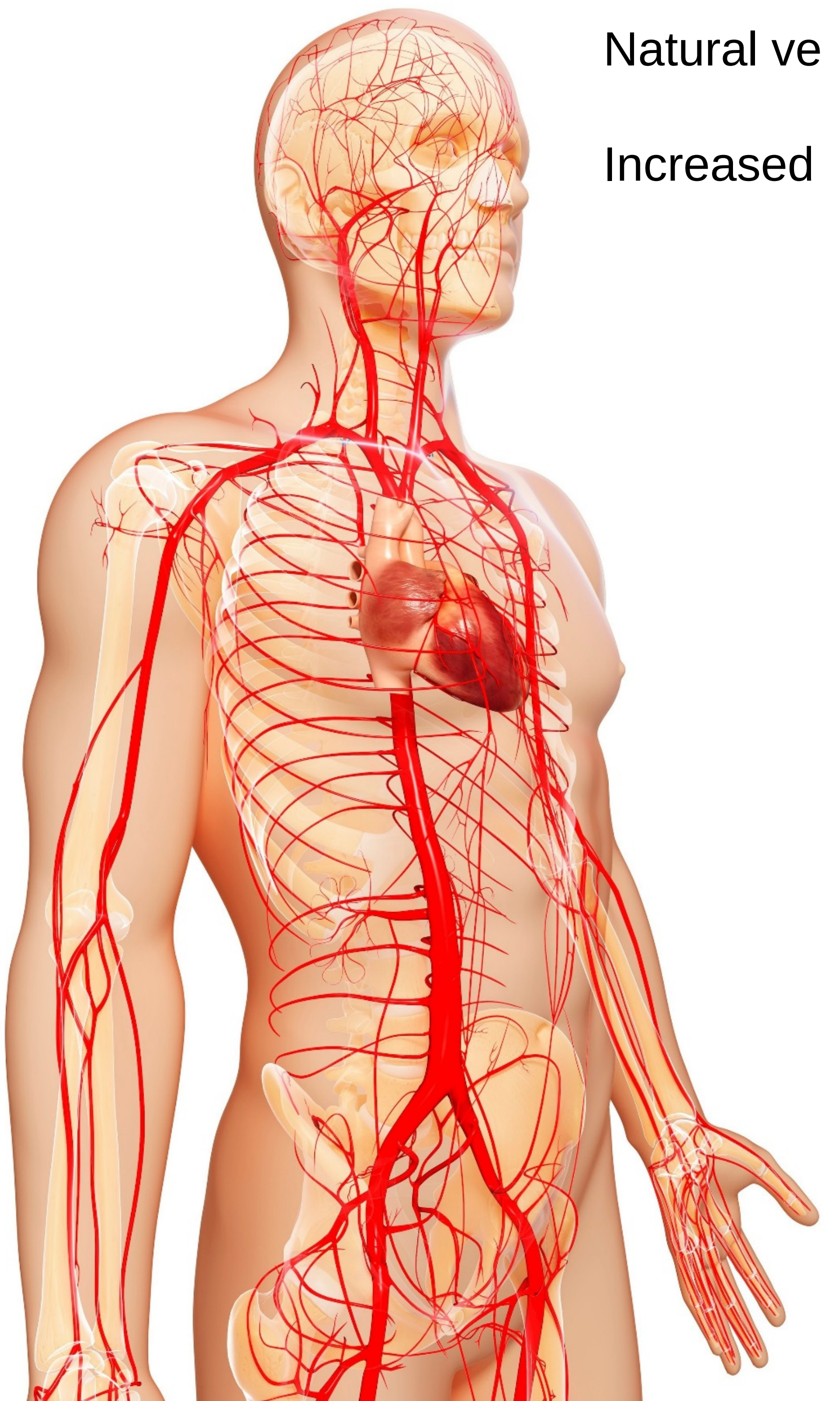
Mechanical ventilation = thermal neutrality

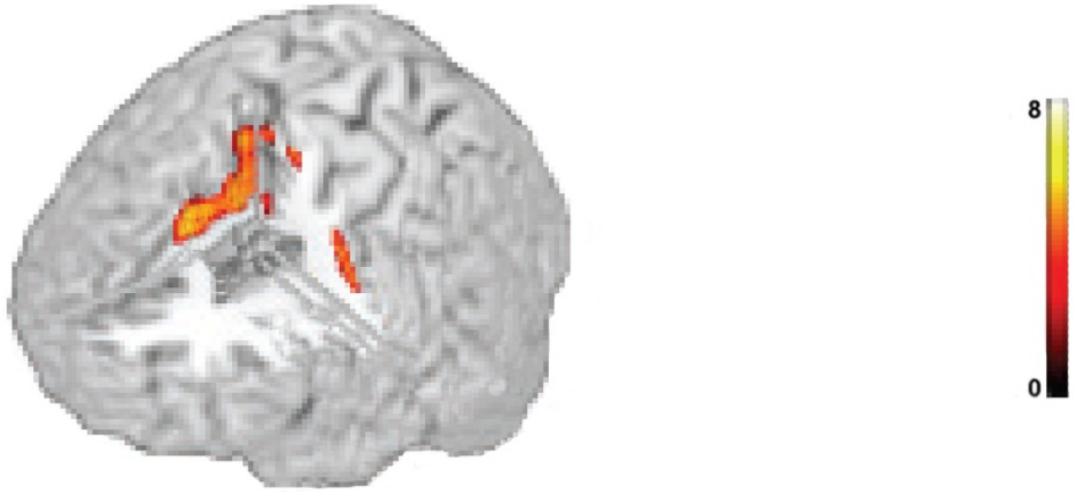


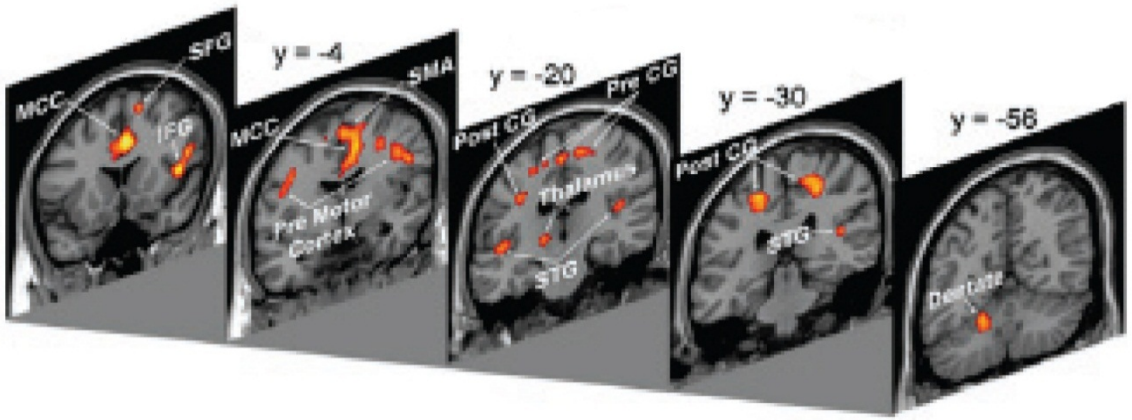


Natural ventilation = thermal stimulation

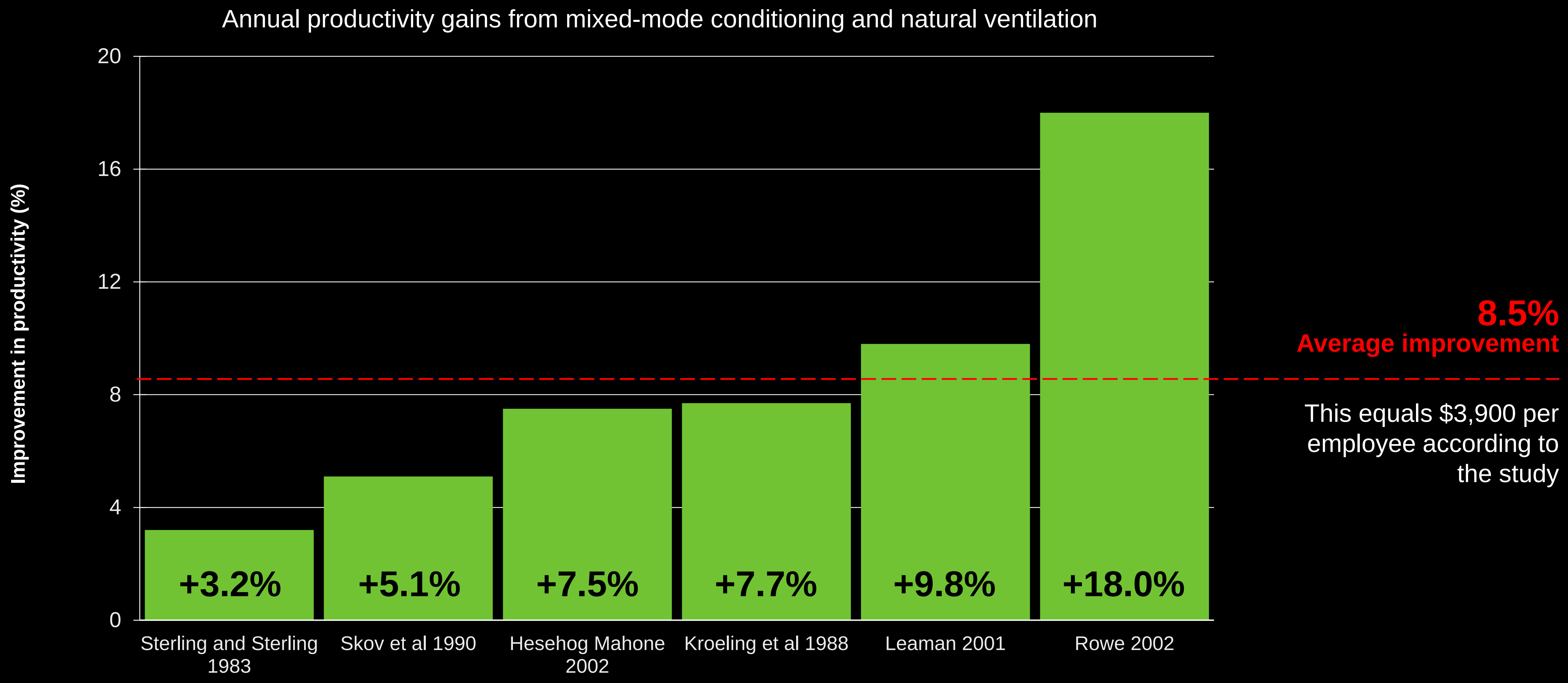
Increased comfort in natural ventilation is **physiological** not psychological





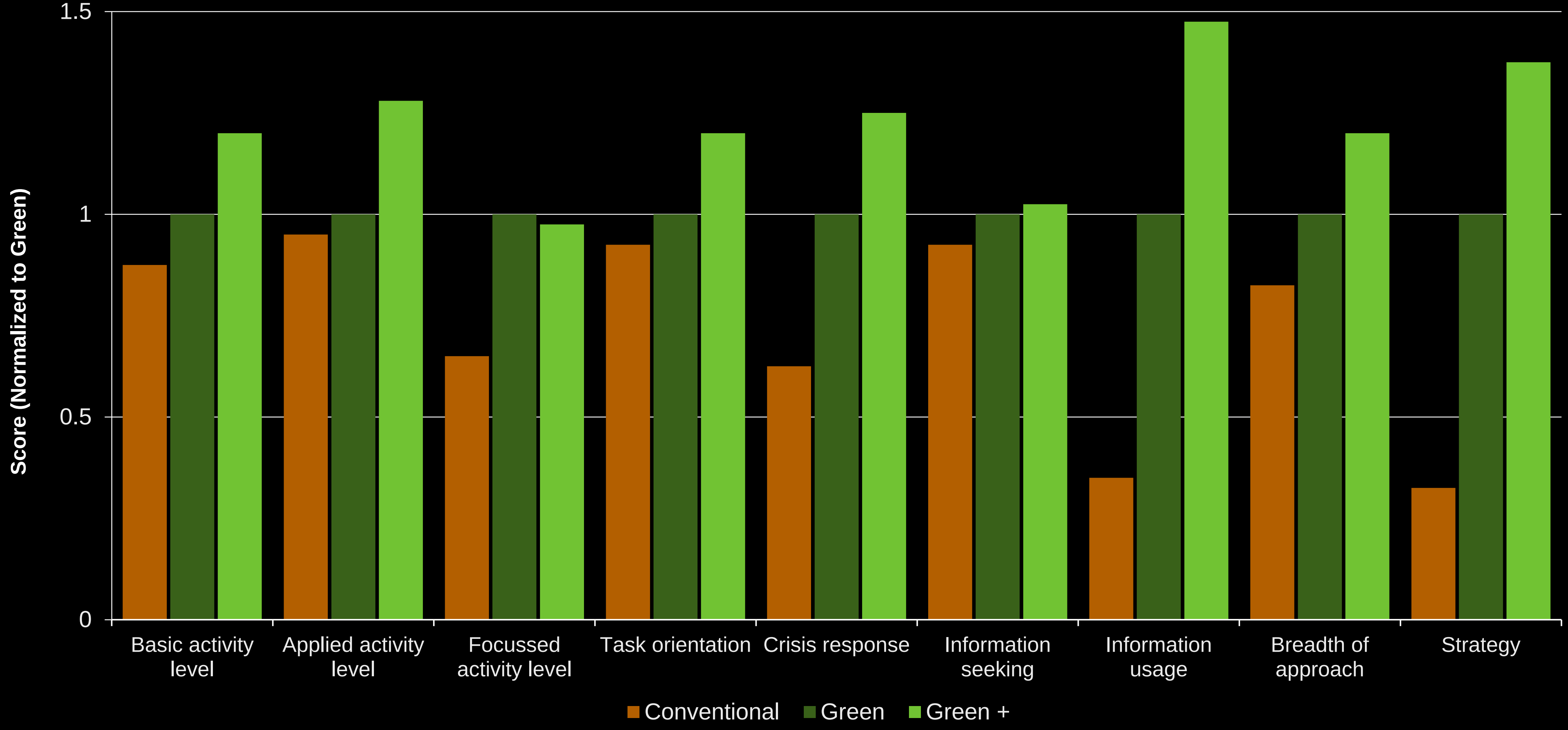


Studies show natural ventilation increases occupant productivity



Sources: Carnegie Mellon University E-Bids Project CBPD/ABSIC BIDSTM

Studies show natural ventilation increases occupant productivity

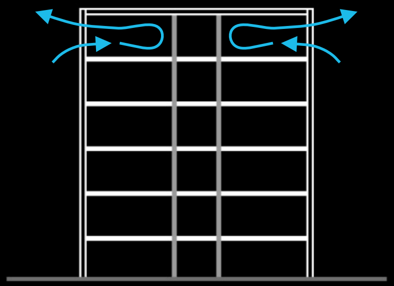


26 October 2015

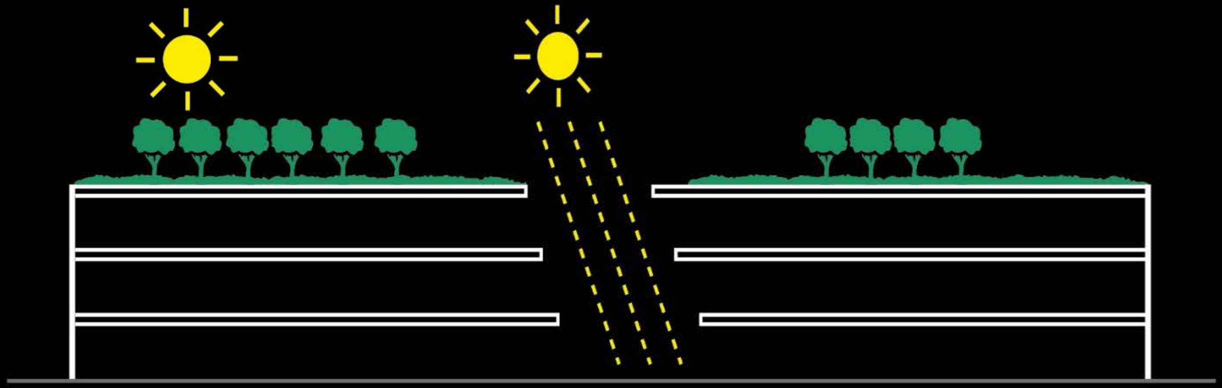
Bloomberg is pushing the boundaries to provide natural ventilation for a deep plan building in an urban context

TYPOLOGIES TYPICALLY ASSOCIATED WITH NATURAL VENTILATION

Shallow breathing

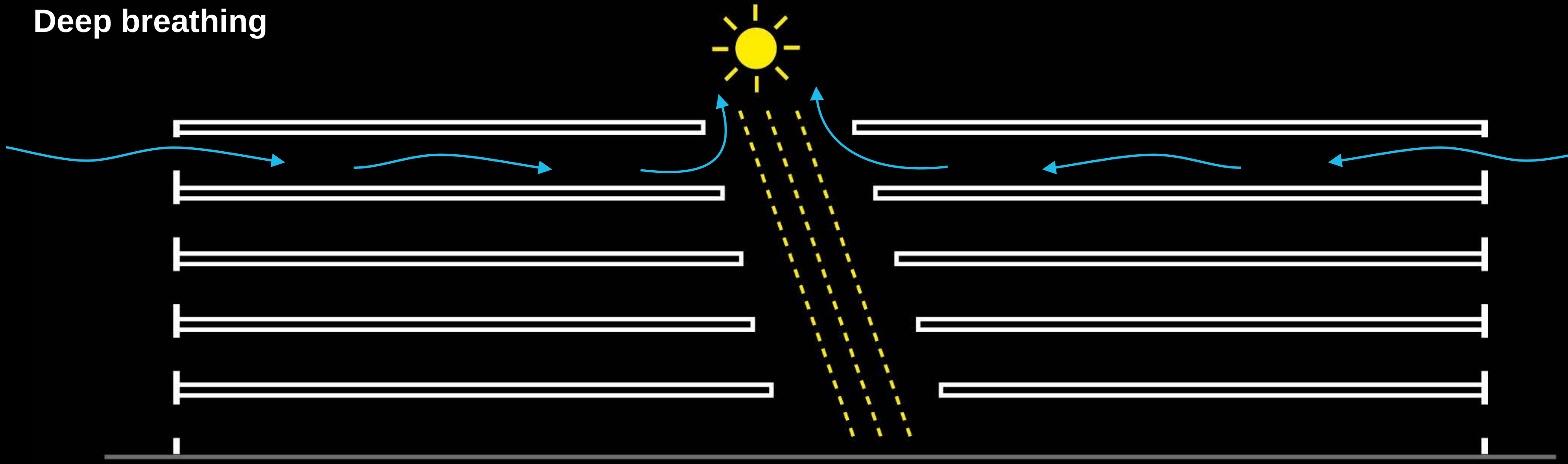


Deep sealed

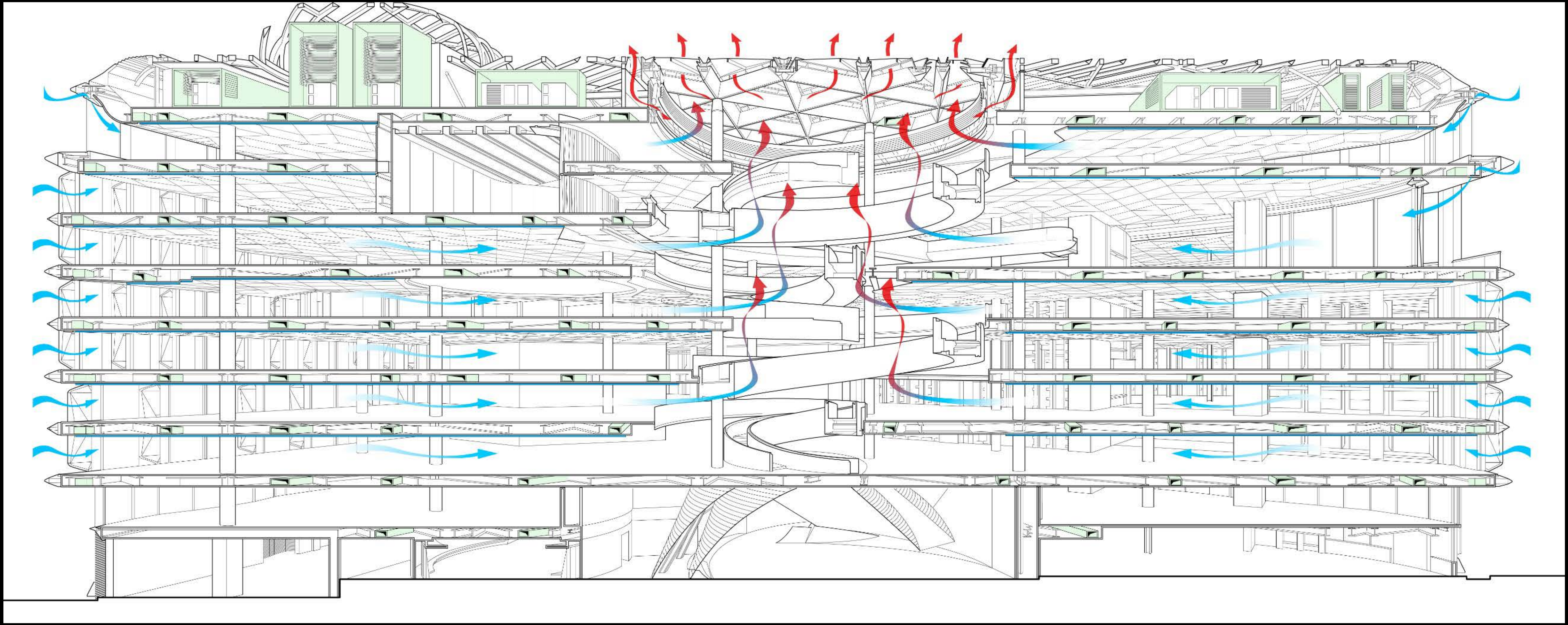


BLOOMBERG: INNOVATIVE APPROACH TO NATURAL VENTILATION

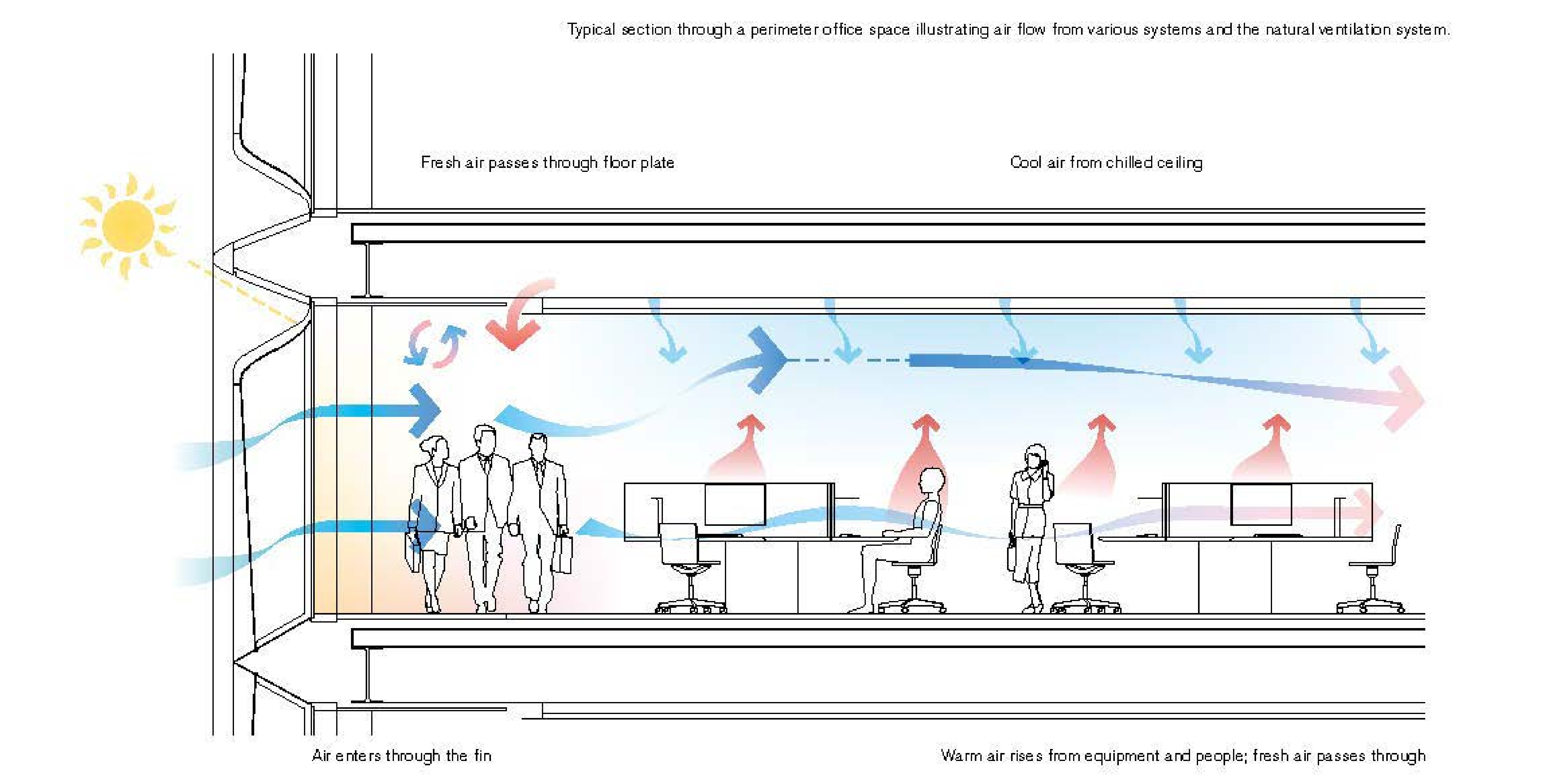
Deep breathing

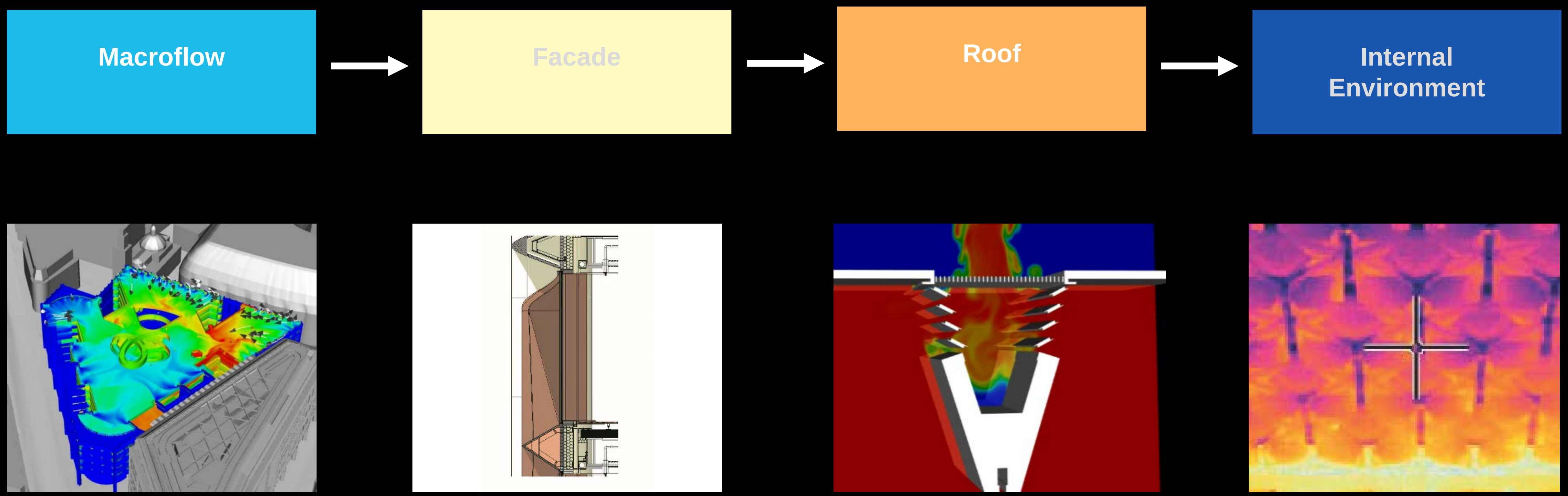


Innovation required a new approach to building design and extensive research and development



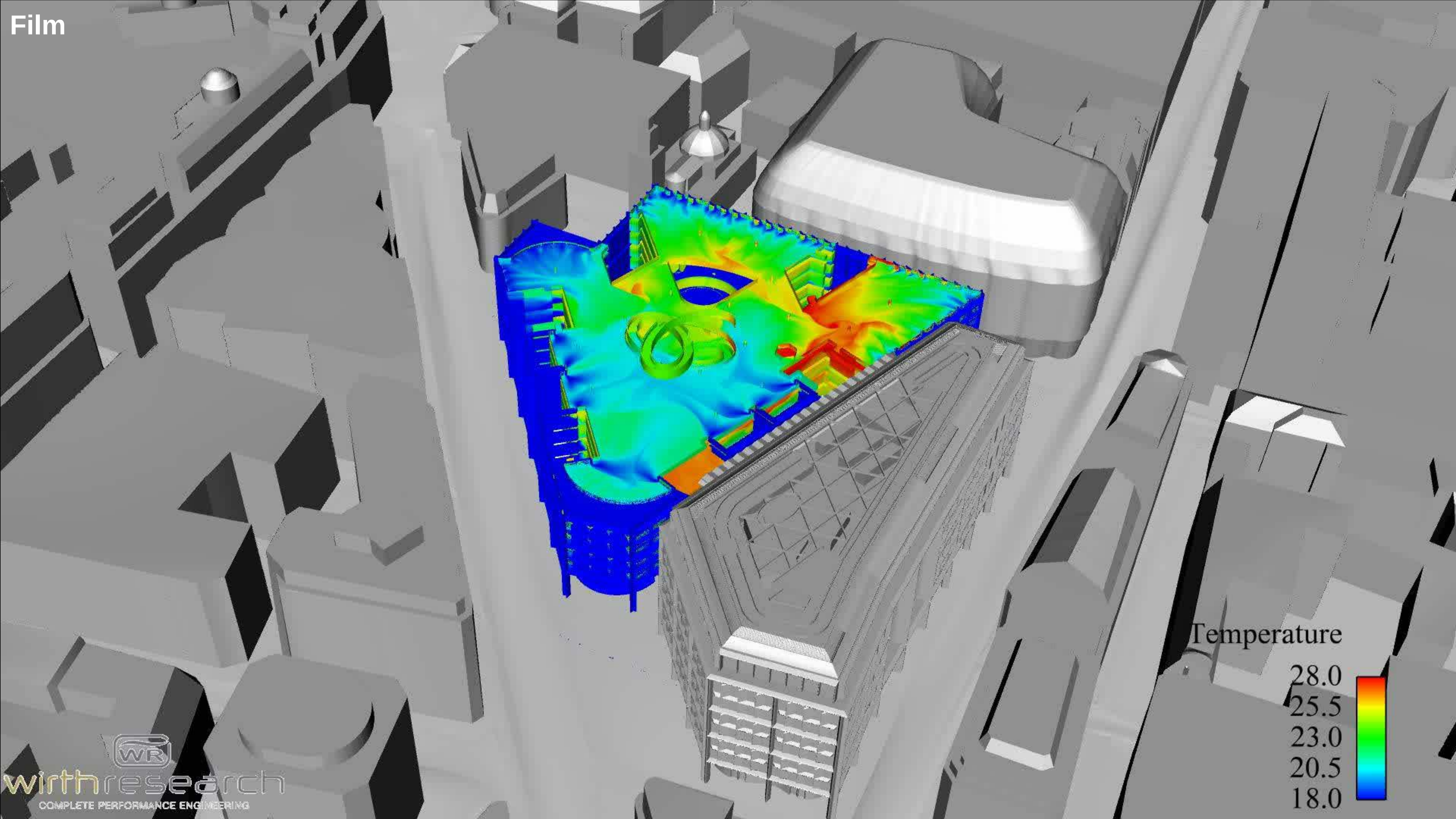
To create a natural ventilation strategy



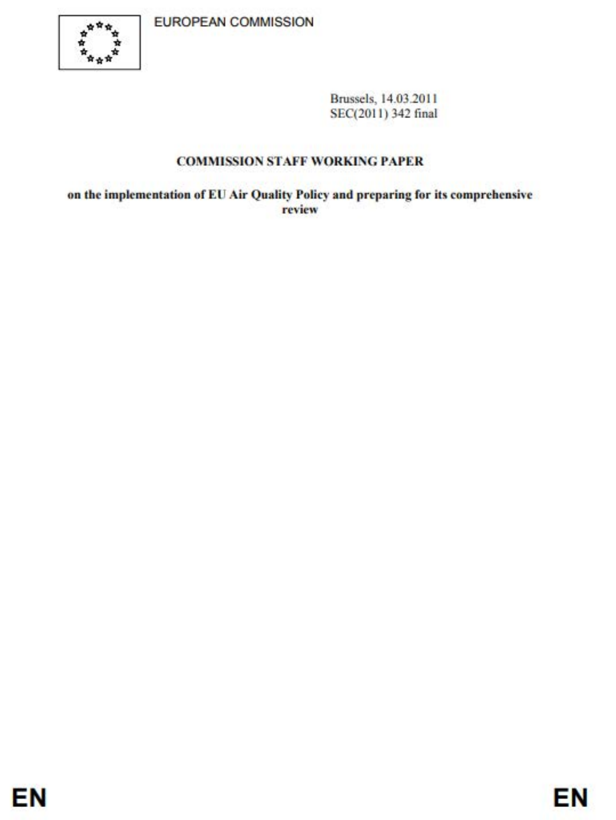

Macroflow
Facade
Roof
Internal Environment

Macroflow

Film


Temperature
28.0
25.5
23.0
20.5
18.0
wirthresearch
COMPLETE PERFORMANCE ENGINEERING

Understanding Local Air Pollution – What are the guidelines



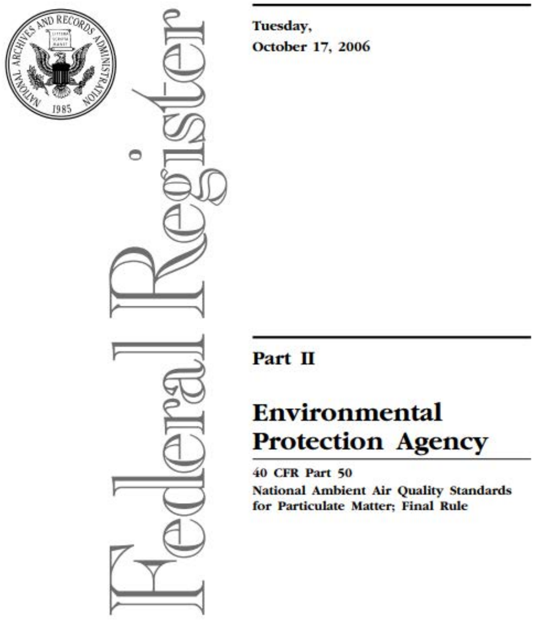
EUROPEAN COMMISSION

Brussels, 14.03.2011
SEC(2011) 342 final

COMMISSION STAFF WORKING PAPER

on the implementation of EU Air Quality Policy and preparing for its comprehensive review

EN EN



Federal Register

Tuesday,
October 17, 2006

Part II

Environmental Protection Agency

40 CFR Part 50
National Ambient Air Quality Standards for Particulate Matter; Final Rule

European Guidelines vs US (EPA) Regulations

	European Guidelines	US (EPA) Regulations
Carbon Monoxide	25 ppm [1 hour] 10 ppm [8 hour]	35 ppm [1 hour] 9 ppm [8 hour] Not to be exceeded more than once in a year
Nitrogen Dioxide	0.1 ppm [1 hour] 0.02 ppm [1 yr] (equivalent to 40ug/m³)	 0.05 ppm [1 yr] (equivalent to 95μg/m³)
Ozone	 0.064 ppm [8 hour]	0.12 ppm [1 hour] Not to be exceeded more than once in a year 0.08 ppm [8 hour]
$PM_{2.5}$	 25 μg/m³ [1 yr]	35 μg/m³ [24 hour] 15 μg/m³ [1 yr]
PM_{10}	50 μg/m³ Not to be exceeded more than 35 times in a year 40 μg/m³ [1 yr]	150 μg/m³ [24 hour]
Sulphur Dioxide	0.048 ppm [24 hour] 0.012 ppm [1 yr]	0.14 ppm [24 hour] Not to be exceeded more than once in a year 0.03 ppm [1 yr]

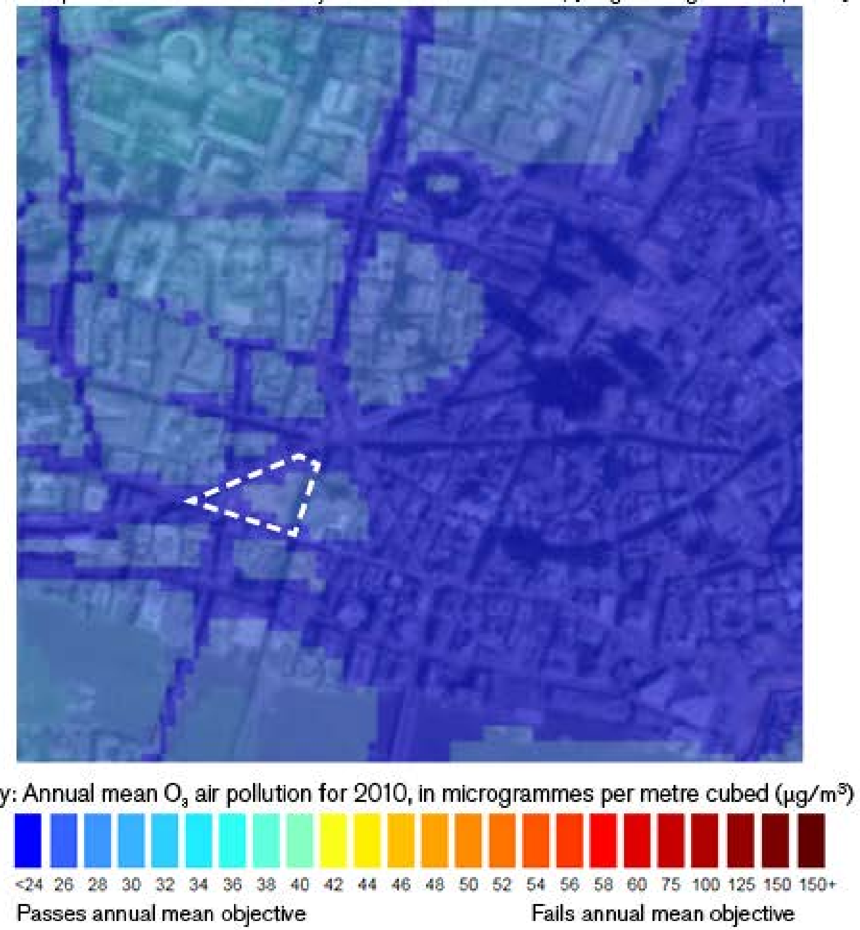
(From ASHRAE 62.1- 2010 and London Air Quality Network data, [ASHRAE, 2010]. These regulations and guidance are appropriate for outdoor air conditions, however the European guidance also applies to internal air conditions)

Air quality stations around Bloomberg, London

Air quality around Bloomberg, London

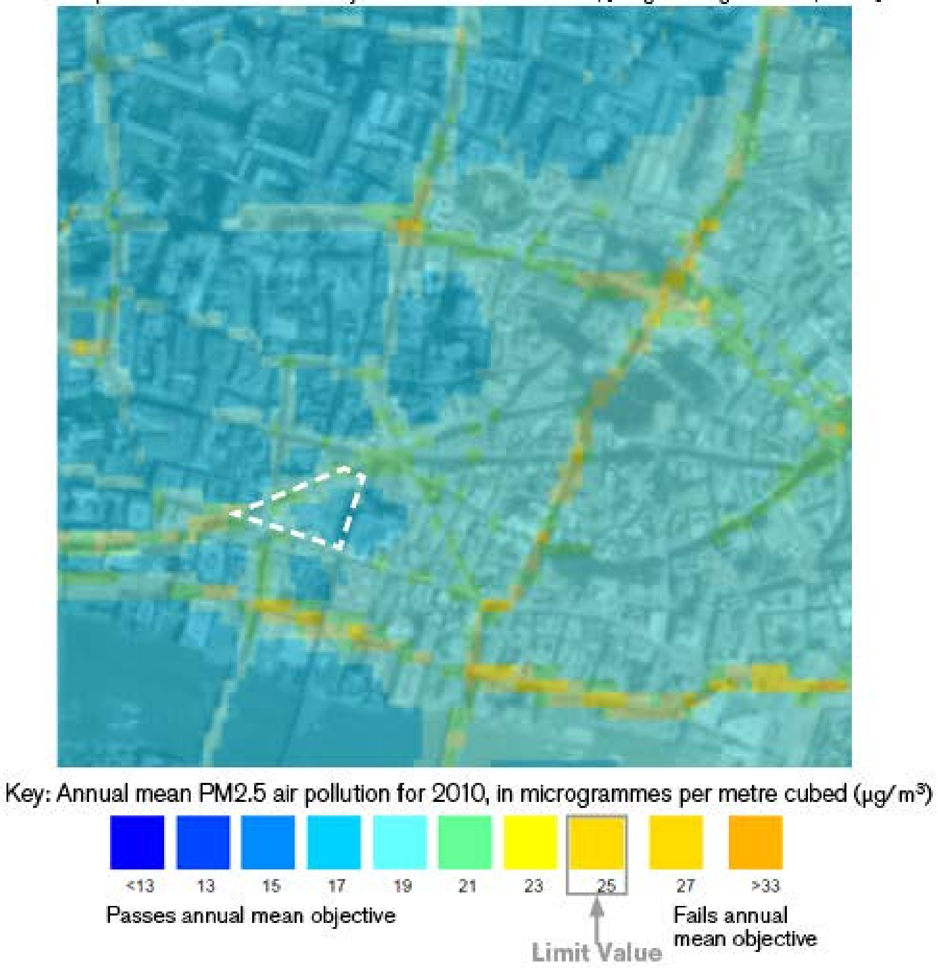
European Ozone Air Quality Guidelines: Achieved

Source is part of the London Air Quality Network online resources, [King's College London, 2014]



European $PM_{2.5}$ Air Quality Guidelines: Achieved

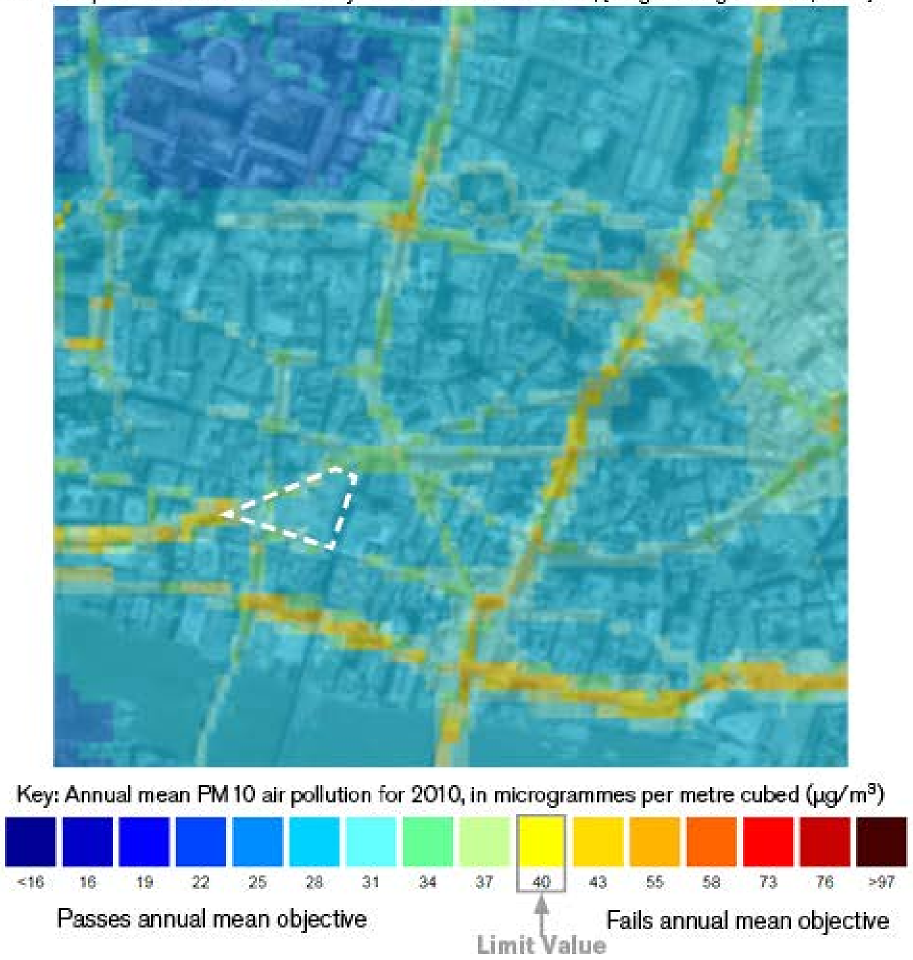
Source is part of the London Air Quality Network online resources, [King's College London, 2014]



Air quality around Bloomberg, London

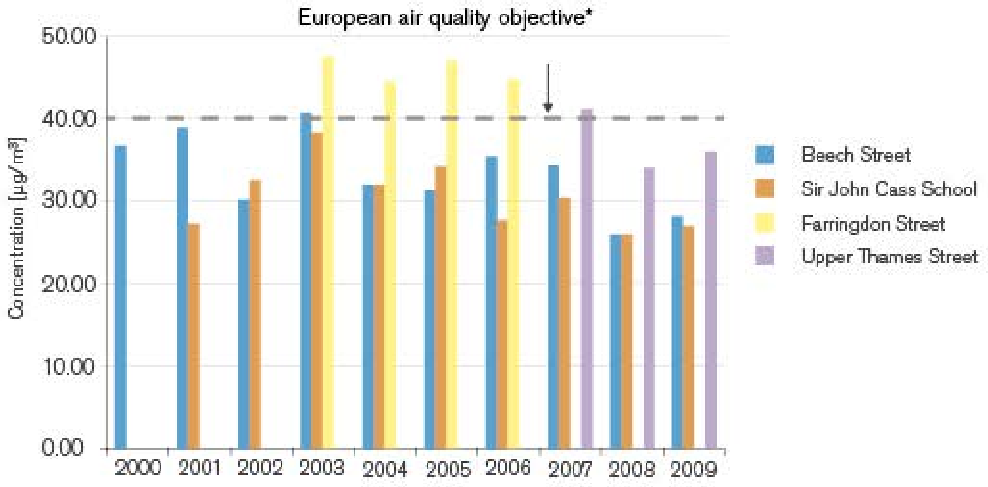
European PM_{10} Air Quality Guidelines: Achieved

Source is part of the London Air Quality Network online resources, [King's College London, 2014]



Annual PM_{10} data in the City of London in 2010

Data taken from the [City of London, 2011].



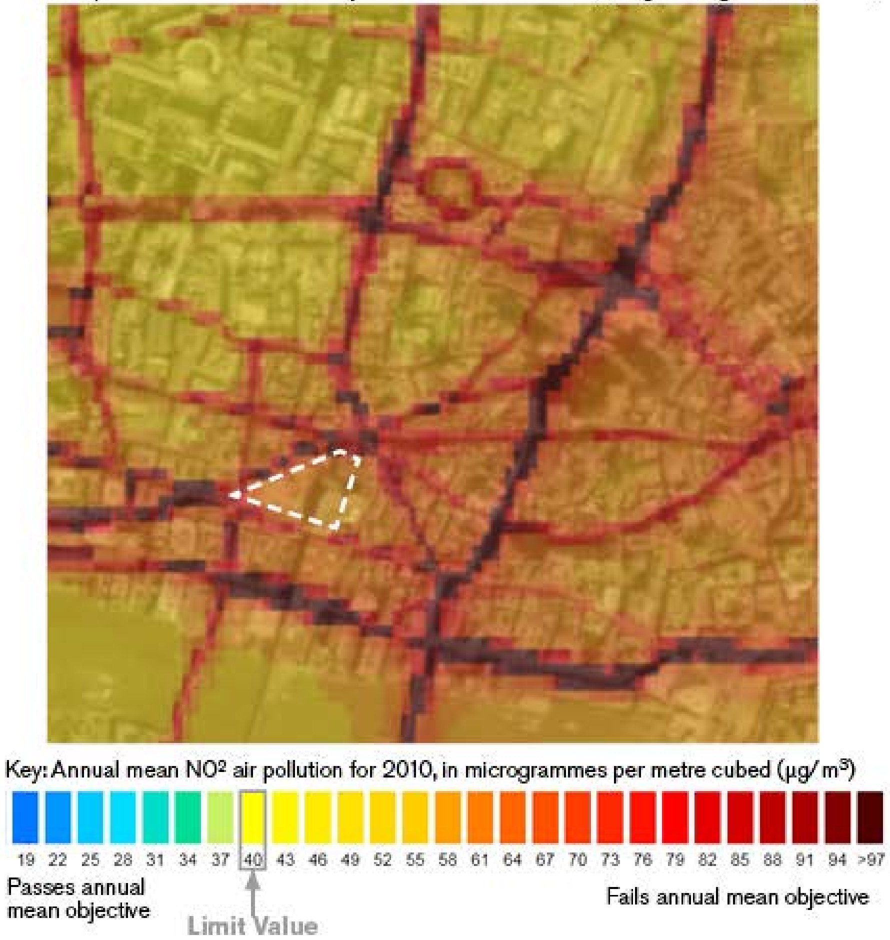
*No US equivalent regulation listed in ASHRAE 62-1, [ASHRAE, 2010]

The closest monitoring sites for PM_{10} are Sir John Cass School which is considered to be a background site and Upper Thames Street, which is a **priority location** in the Mayor of London's air quality strategy, both were below the Limiting Value in 2009.

Air quality around Bloomberg, London

European NO_2 Air Quality Guidelines: Not Achieved

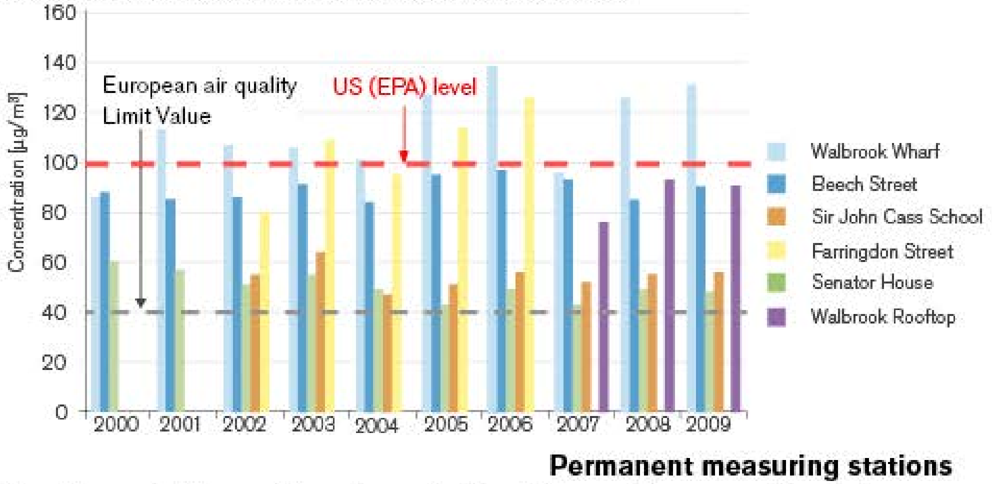
Source is part of the London Air Quality Network online resources, [King's College London, 2014]



The most recent available data shown on the adjacent extract from the LAQN data set, show that the site, together with many of the surrounding areas do not meet the European Limit value for NO_2.

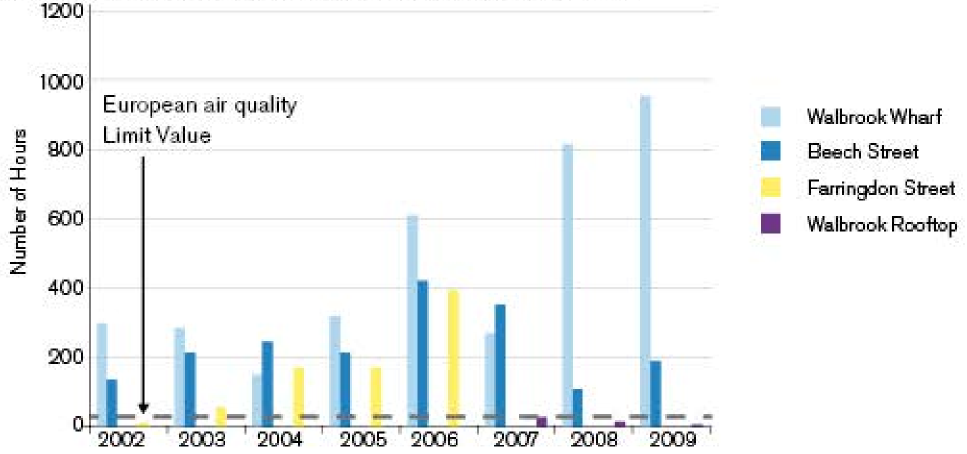
Annual nitrogen dioxide data in the City of London: 2000-09

Source taken from publication by City of London [City of London, 2011]



Number of times the hourly limit for nitrogen dioxide was breached: 2002-09

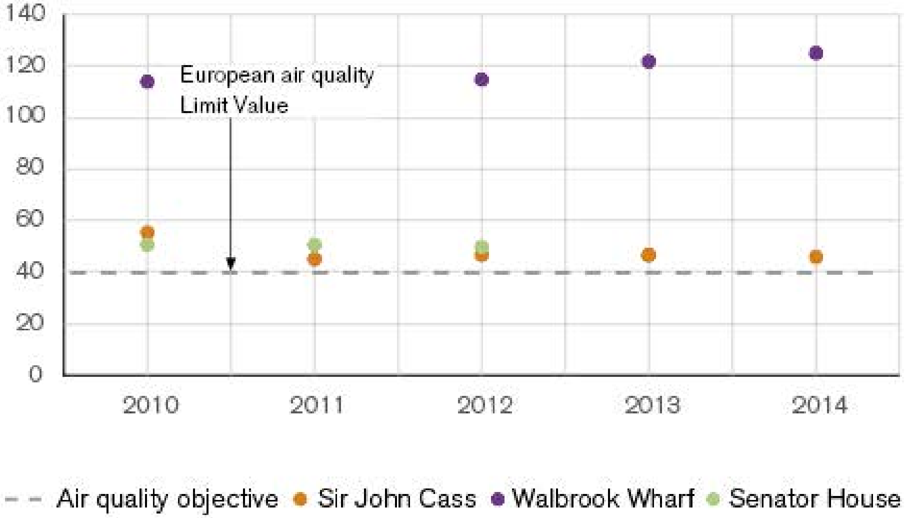
Source taken from publication by City of London [City of London, 2011]



Air quality around Bloomberg, London

Annual nitrogen dioxide data in the City of London, 2010 to 2014

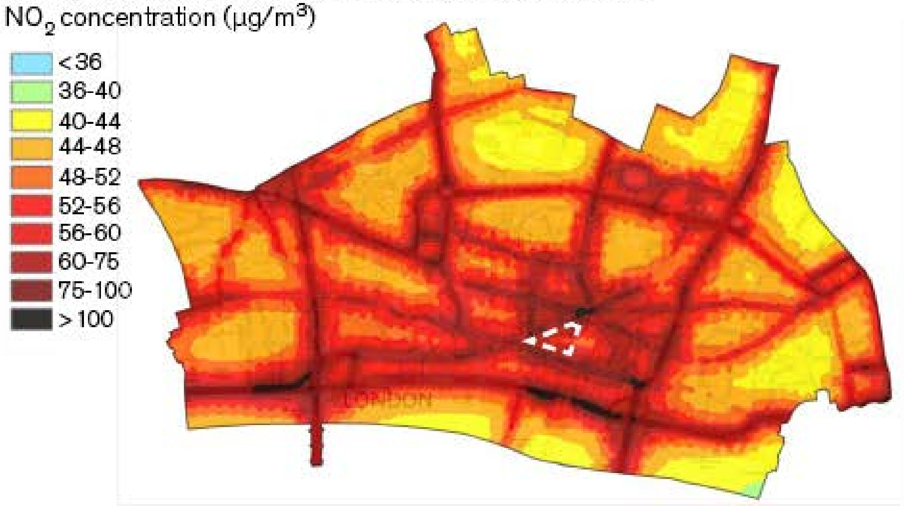
Source taken from data collected by King's College London, 2014



The data suggest that site is a marginal fail in relation to the European Limit Values at **road level**. St. John Cass School and Senator House are likely to be the most suitable comparisons. Walbrook Wharf is very different and the reasons are explained later.

Predicted NO_2 in 2015

Source taken from publication by City of London [City of London, 2011]



As a result: "In 2015, the Major proposes to introduce an emissions standard for NO_x (Euro IV for NO_x across London) into the Low Emission Zone for HGVs, buses and coaches. This would be subject to a suitable certification and testing regime, and also subject to Government funding." [City of London, 2011]

Why is Walbrook Wharf not a precedent?

We believe that three factors contribute to the **high localised emissions levels** recorded and predicted at the Walbrook Wharf and Senator House monitoring stations on Upper Thames Street:

1) Strategic roads that experience high traffic volumes

2) **Geometry** of the **surrounding buildings.**

3) **No pollutant dispersion** from wind.

Strategic Roads, Air Quality Hotspots

City of London roads that are part of GLA network highlighted.

Bloomberg Place site

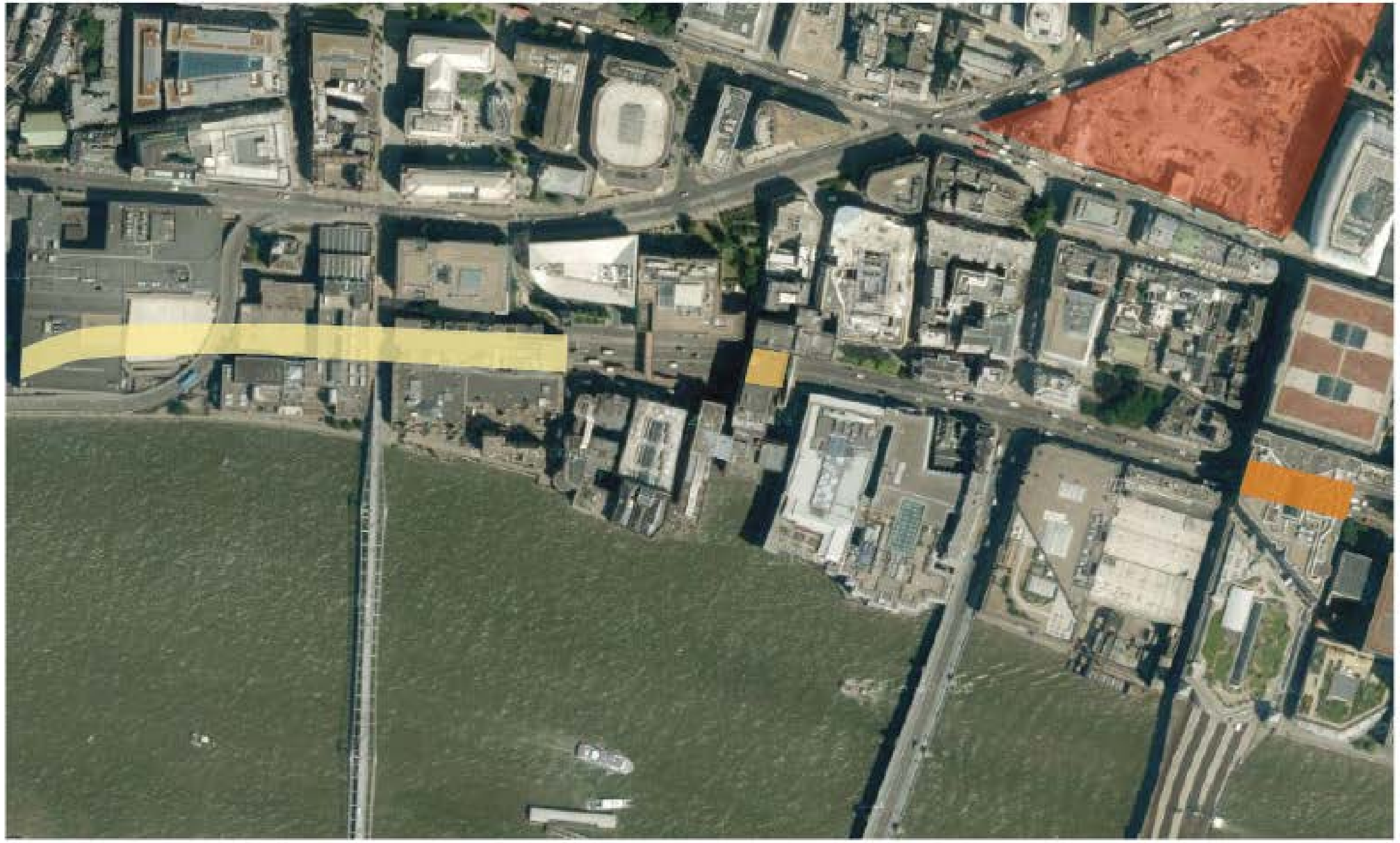
Walbrook Wharf: Localised Concentrator Affect

Three major underpass structures on Upper Thames Street (formed by air-rights building over) cause elevated localised emission levels. Pollution emitted by vehicles is trapped within and between these underpasses along Upper Thames Street.

1) **Blackfriars underpass**
300m tunnel that joins Victoria Embankment and Upper Thames Street

2) **Queensbridge House overpass**
30m overpass

3) **Cannon Bridge overpass** 60m overpass



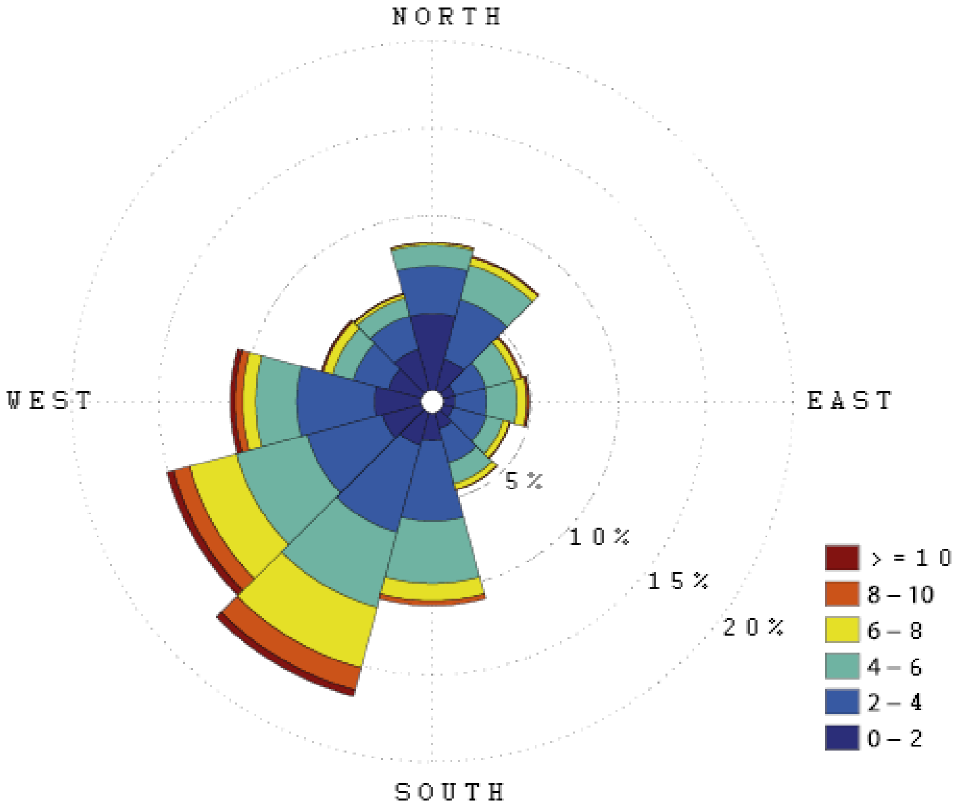
Bloomberg Place site

Blackfriars underpass

Queensbridge House underpass

Cannon Bridge underpass

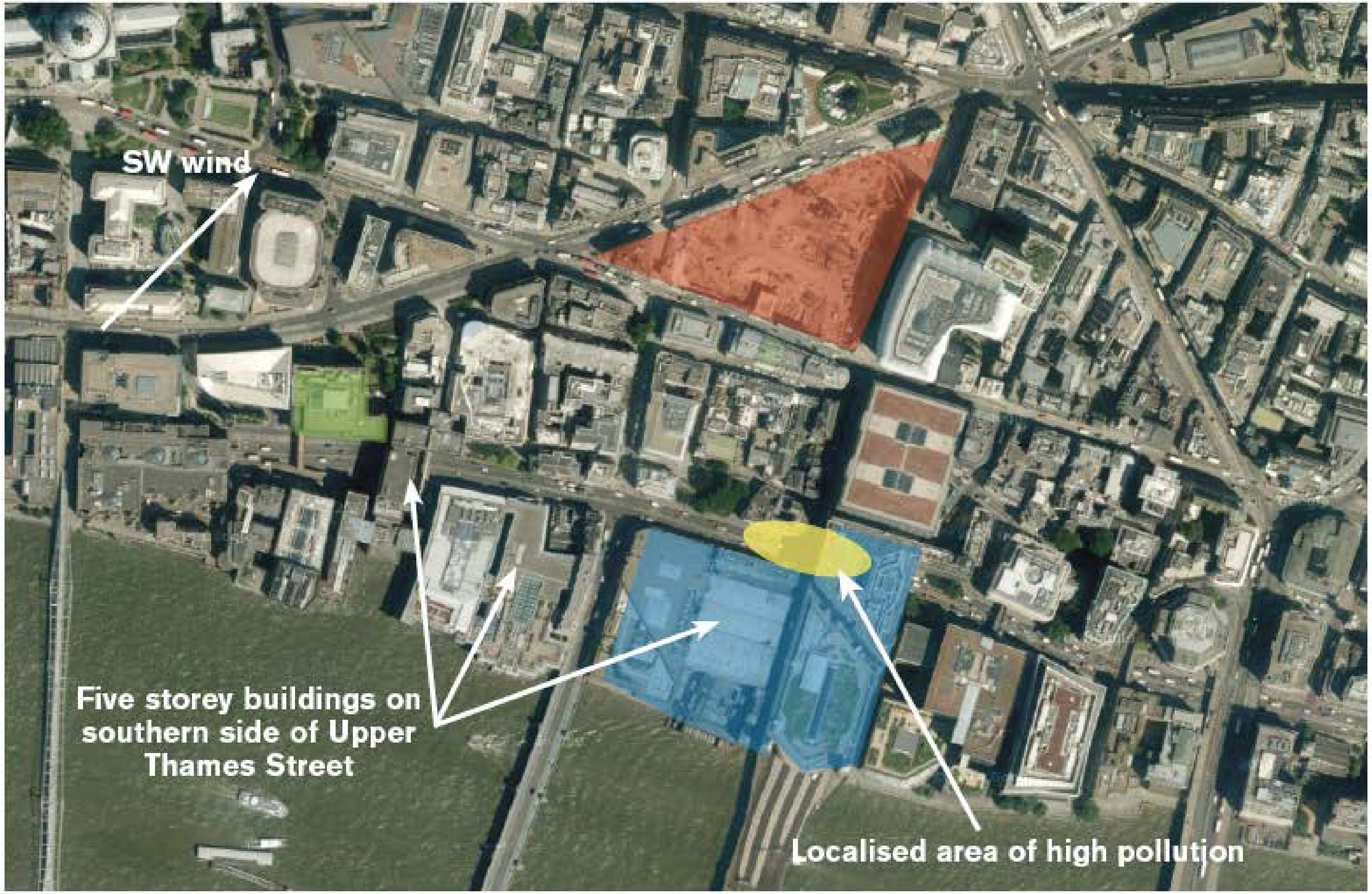
Wind lee: Limited Dilution



The prevailing wind direction in London is south westerly wind that blows approximately 14% of the time at an average annual daytime wind speed of 4.28 m/s. Wind flow effects the dispersion of pollutants. CIBSE TRY London

Wind lee: Limited Dilution

High rise buildings on the southern edge of Upper Thames Street impede prevailing westerly wind from dispersing pollutants creating a concentrated hotspot in Walbrook Wharf. The combination of high rise buildings and narrow streets perpendicular to Upper Thames Street limit the dilution of pollution provided by southerly/ westerly winds.

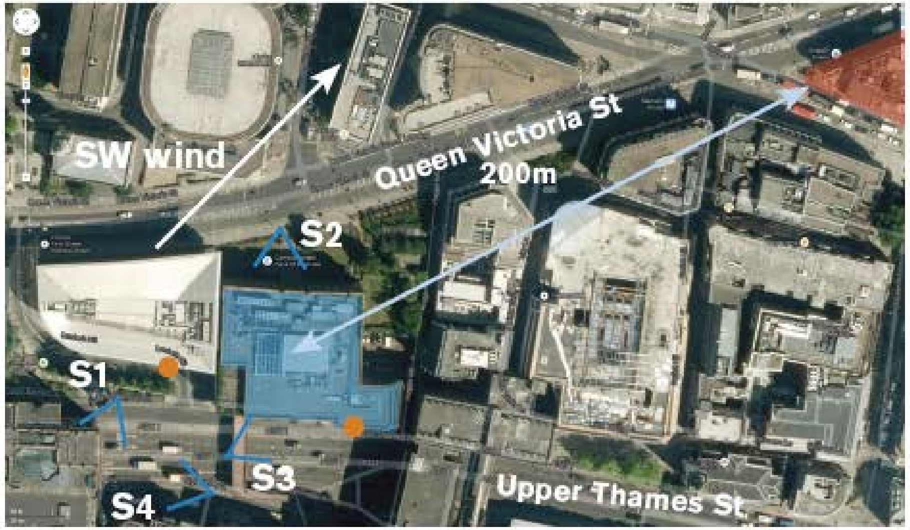


Bloomberg Place site

Senator House

Walbrook Wharf

Senator House photographic evidence



Car parking entrances/exits

Blackfriars underpass eastern entrance/exit

Senator House northern entrance on Queen Victoria Street

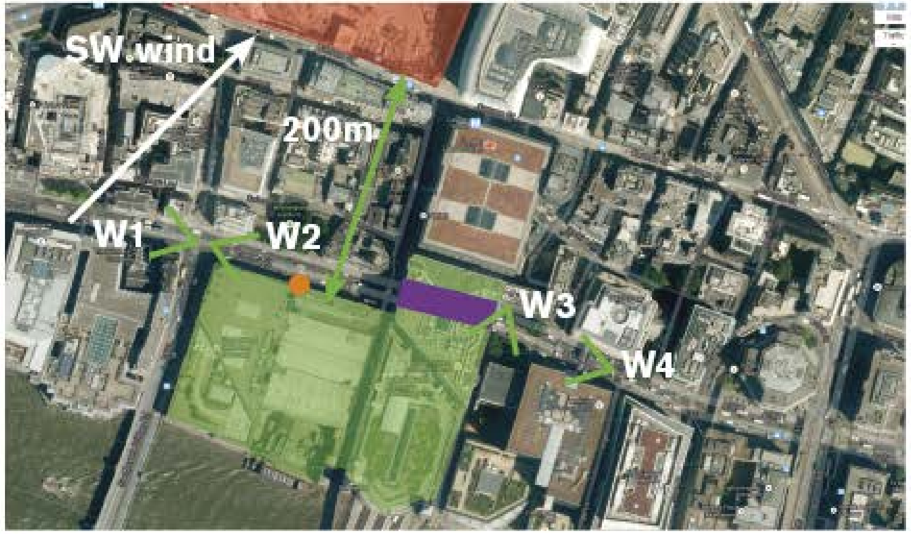
Partial view of Queensbridge House underpass western entrance/exit

Senator House photographic evidence

Blackfriars underpass eastern entrance/exit
(Google maps image)

High traffic zone with many cars stationary (idling)

Walbrook Wharf photographic evidence



Car parking entrances/exits   Cannon Bridge Overpass

View towards Queensbridge House underpass eastern entrance/exit

View towards Cannon Bridge underpass eastern entrance/exit

Narrow streets limit lateral dispersion of pollutants

Walbrook Wharf photographic evidence

View towards Cannon Bridge underpass western entrance/ exit (Google maps image)

High traffic zone with many cars idling near Cannon Bridge underpass

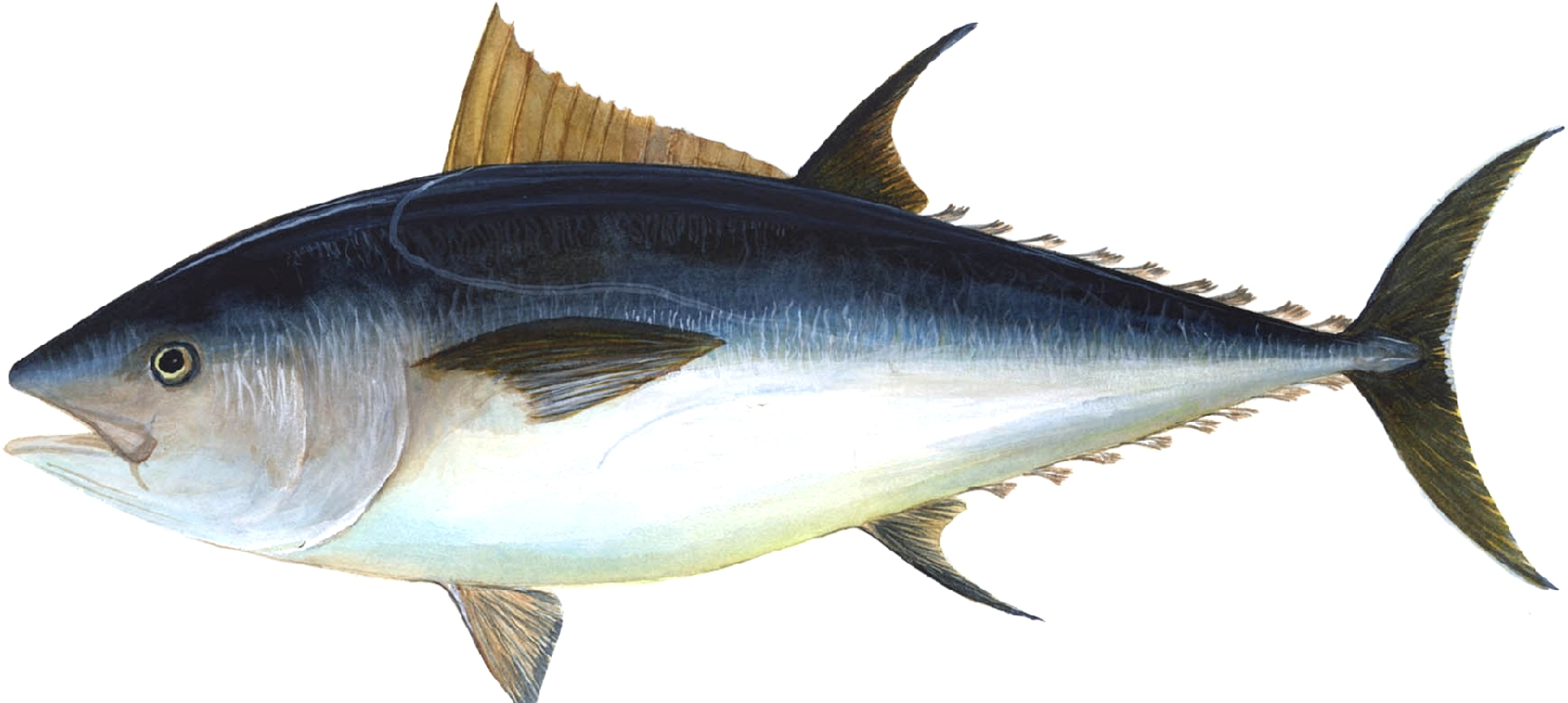
Conclusions

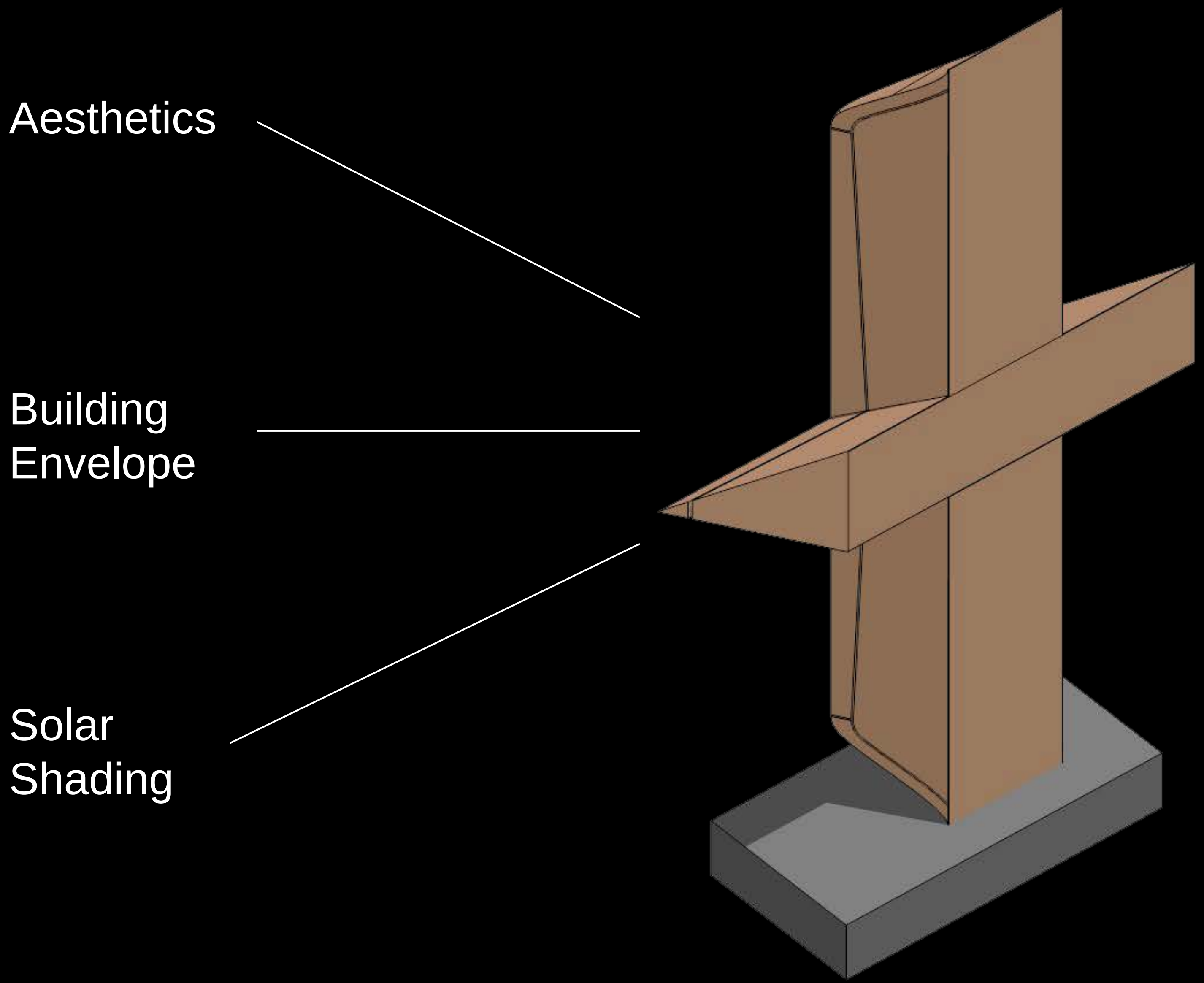
The following conclusions were drawn to explain the high emission readings on Upper Thames Street at the air quality monitoring stations at Senator House and Walbrook Wharf:

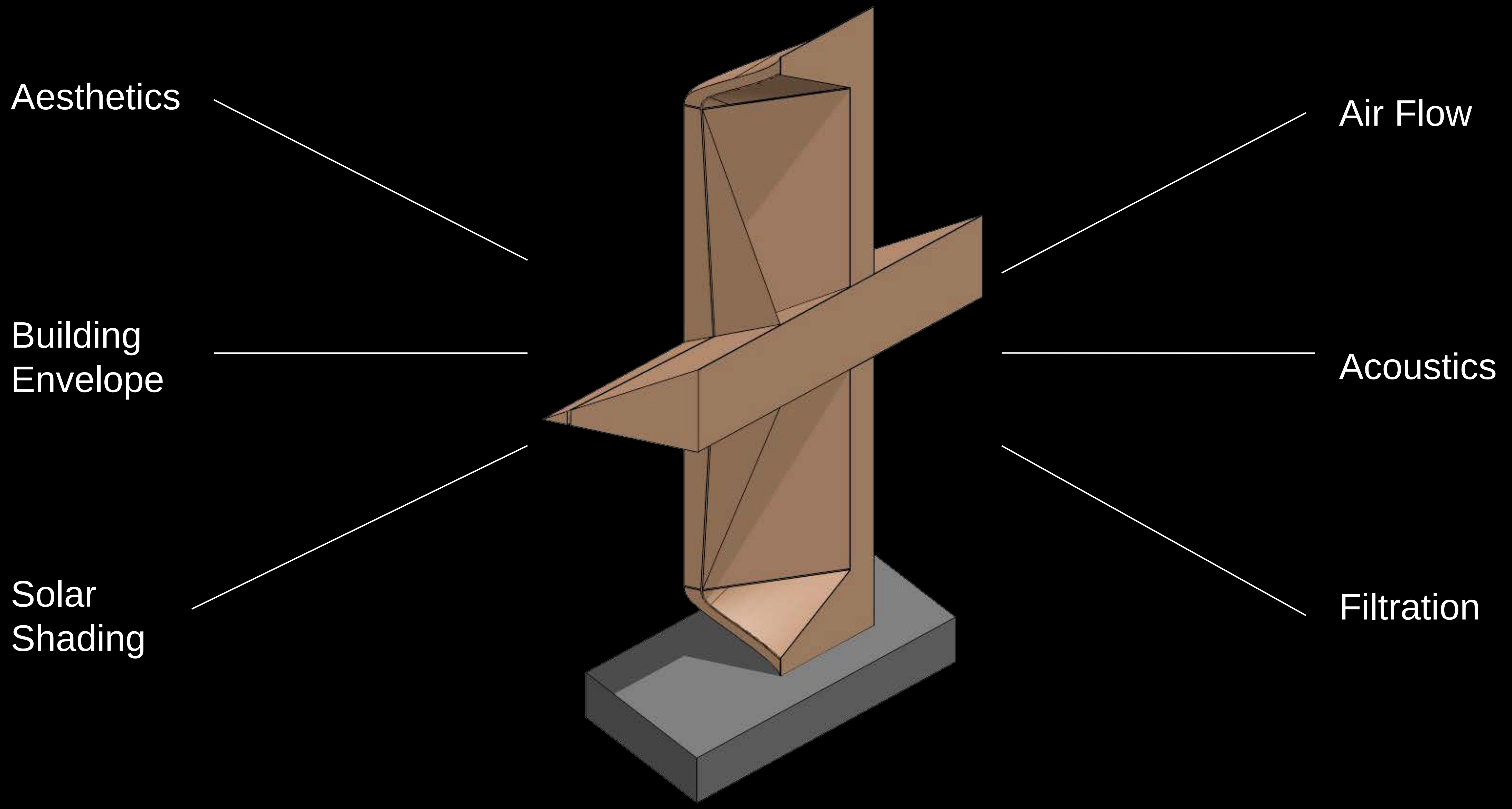
- High traffic volume on Upper Thames Street, often with vehicles idling for extended periods. Idling vehicles emit more emissions in a given length of roadway than vehicles moving at speed.
- Tunnels increase localised emission readings as pollutants can not easily disperse between buildings and along the tunnels.
- High rise buildings on Upper Thames Street impede prevailing south westerly wind from dispersing pollutants as it does in the surrounding areas

We think that the high NO_X emission levels recorded and predicted at Walbrook Wharf are **extremely localised and do not represent typical NO_X levels at Bloomberg London.**

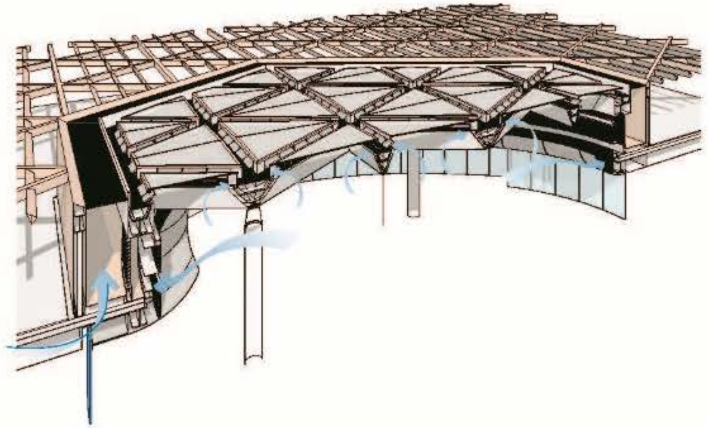
Facade

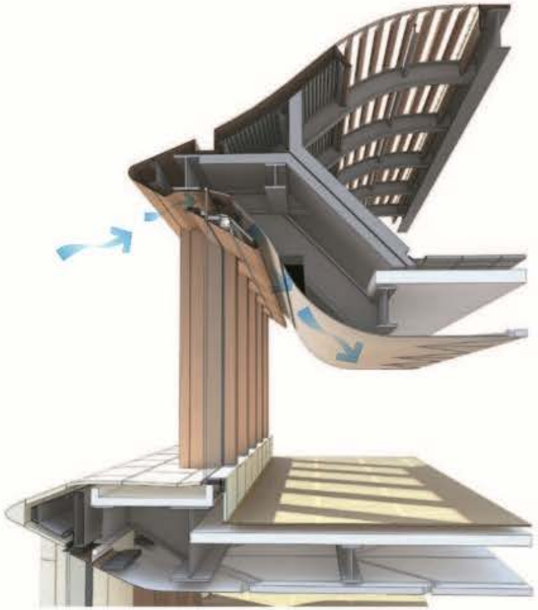


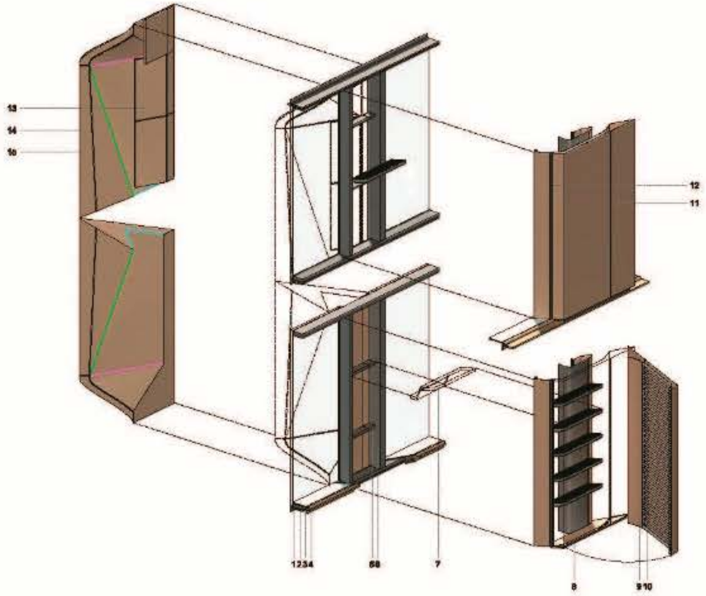

Aesthetics
Building Envelope
Solar Shading

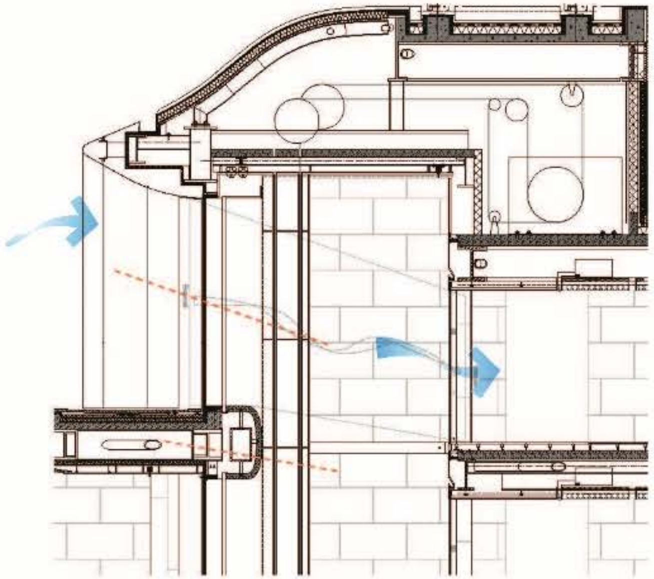

Aesthetics
Building Envelope
Solar Shading
Air Flow
Acoustics
Filtration

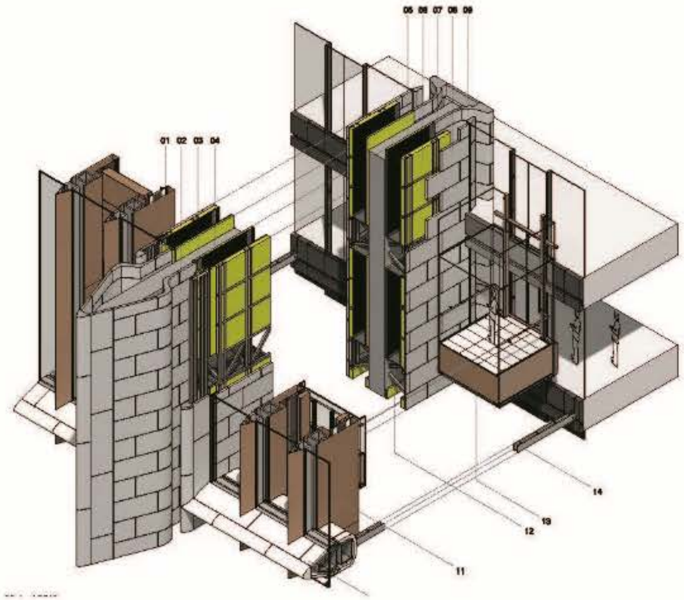
A range of inlets and outlets were designed, analysed and tested

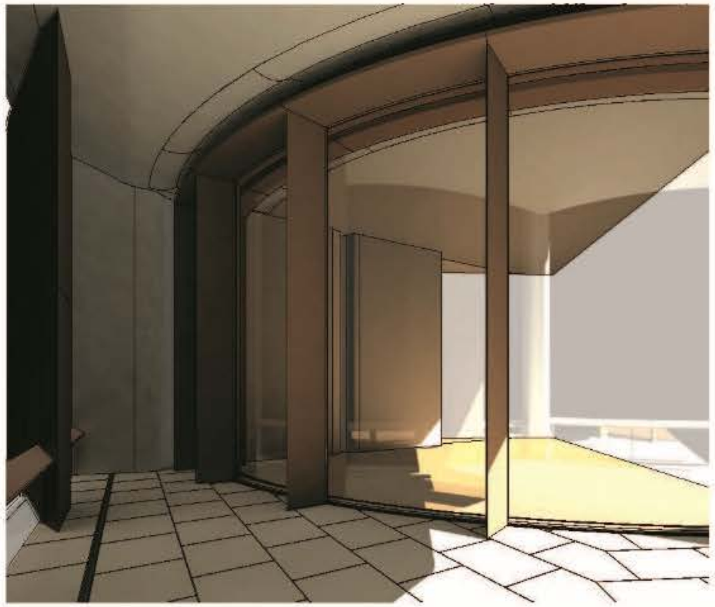








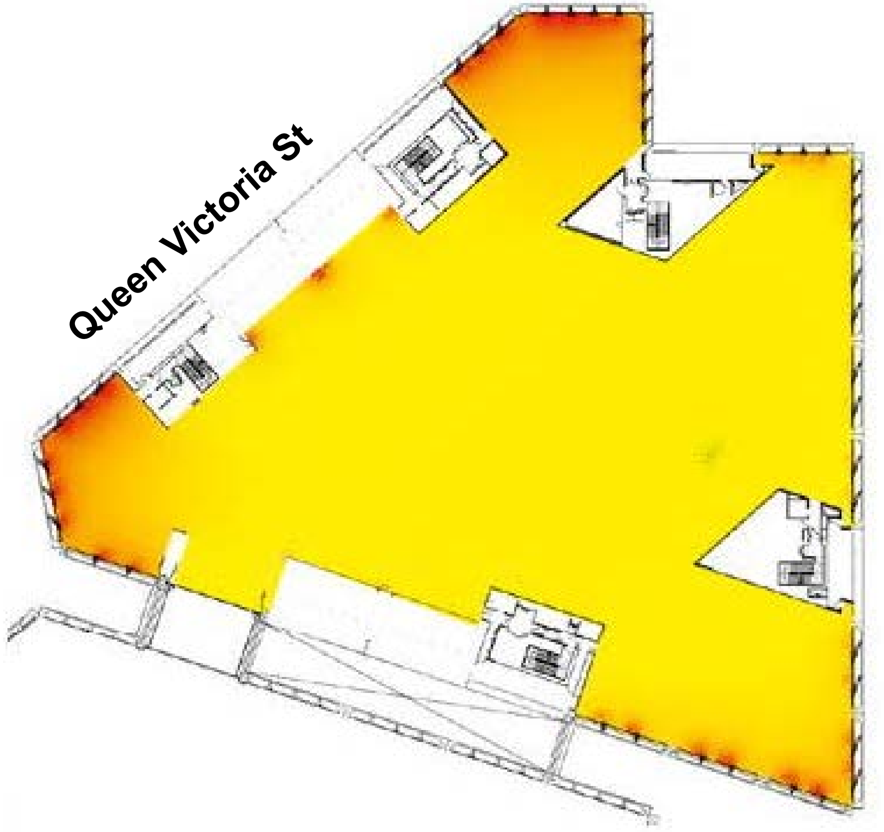




Addressing Noise

The busy urban environment increases the challenge as attenuation is required to mitigate the noisy adjacent streets

The natural ventilation design was required to reduce ingress of street noise



Air Pollution Guidance

BREEAM®

Code for a Sustainable Built Environment
www.breeam.com

BREEAM UK New Construction

Non-Domestic Buildings

Technical Manual
SD5076: 0.1 (DRAFT) - 2014

BRE Global welcome feedback in relation to the technical content of this draft. As a draft a number of formatting issues exist which will be rectified as part of the development of the final manual.

BREEAM Excellent rated Hadyn Ellis Building Cardiff University. Image: IBI Nightingale

bre

Hea 02 Indoor air quality

Number of credits available	Minimum standards
Building type dependent	No

Aim

To recognise and encourage a healthy internal environment through the specification and installation of appropriate ventilation, equipment and finishes.

Assessment criteria

This issue is split into two parts:

- Minimising sources of air pollution (4 credits)
- Adaptability - potential for natural ventilation (1 credit)

Note:

- The potential for natural ventilation credit does not apply to buildings on a prison development.

The following is required to demonstrate compliance:

Minimising sources of air pollution

One credit - Indoor air quality (IAQ) plan

1. An indoor air quality plan has been produced, with the objective of facilitating a process that leads to design, specification and installation decisions and actions that minimise indoor air pollution during occupation of the building. The indoor air quality plan must consider the following:
   a. Removal of contaminant sources
   b. Dilution and control of contaminant sources
   c. Procedures for pre-occupancy flush out
   d. Third party testing and analysis
   e. Maintaining indoor air quality in-use.

One credit- Ventilation

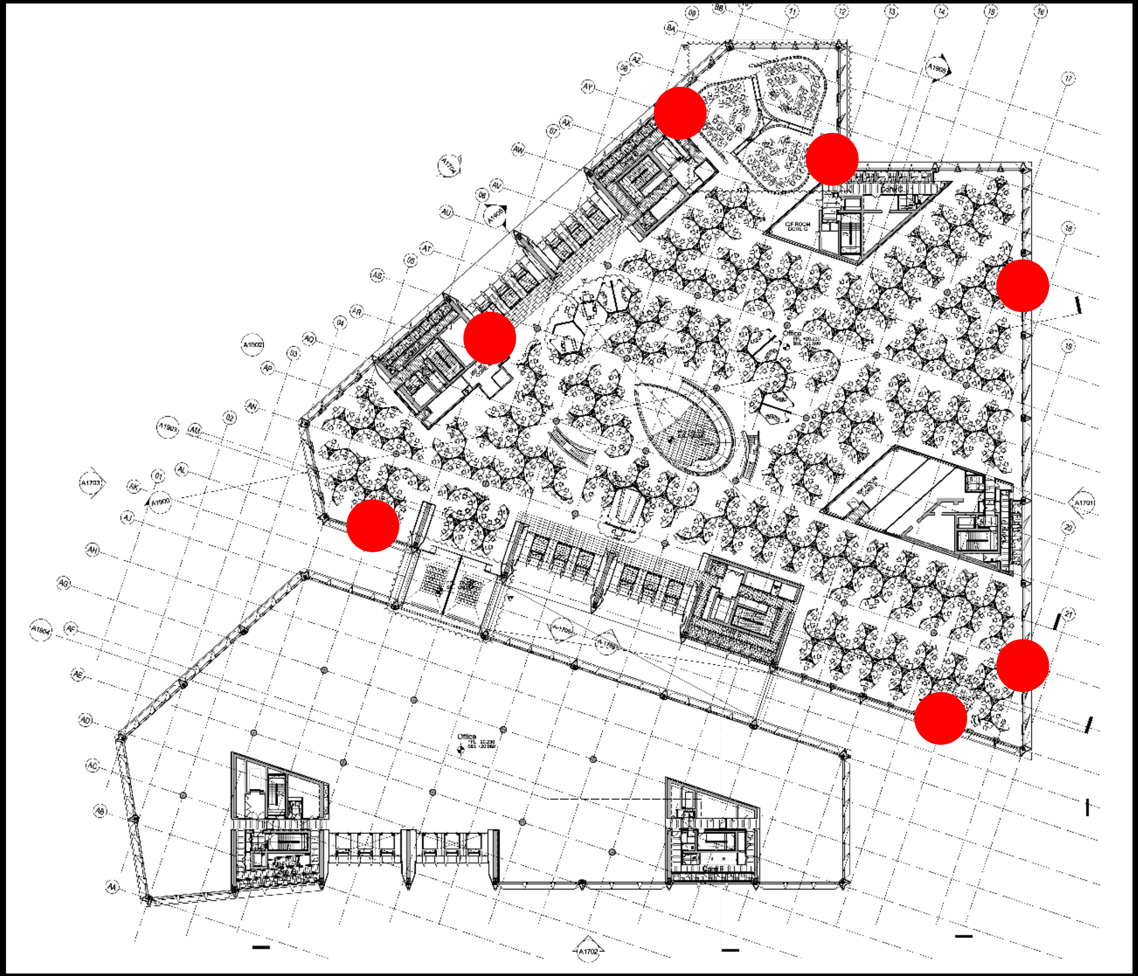
The building has been designed to minimise the concentration and recirculation of pollutants in the building as follows:

2. Provide fresh air in to the building in accordance with the criteria of the relevant standard for ventilation.
3. Design ventilation pathways to minimise the build-up of air pollutants in the building, as follows:
   a. In air-conditioned and mixed-mode buildings/spaces:
      i. The building's air intakes and exhausts are over 10m apart and intakes are over 20m from sources of external pollution. OR
      ii. The location of the building's air intakes and exhausts, in relation to each other and external sources of pollution, is designed in accordance with BS EN 13779:2007[1] Annex A2.
   b. In naturally-ventilated buildings/spaces: openable windows/ventilators are over 10m from sources of external pollution.

[1] BS EN 13779:2007 Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems

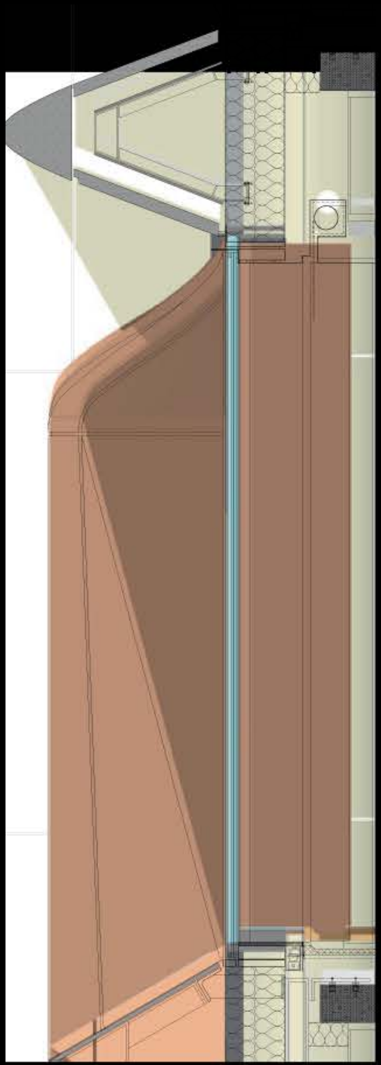
Air Quality Sensors – Level 2

Carbon monoxide sensor locations



NOx sensor locations

Gill Fin

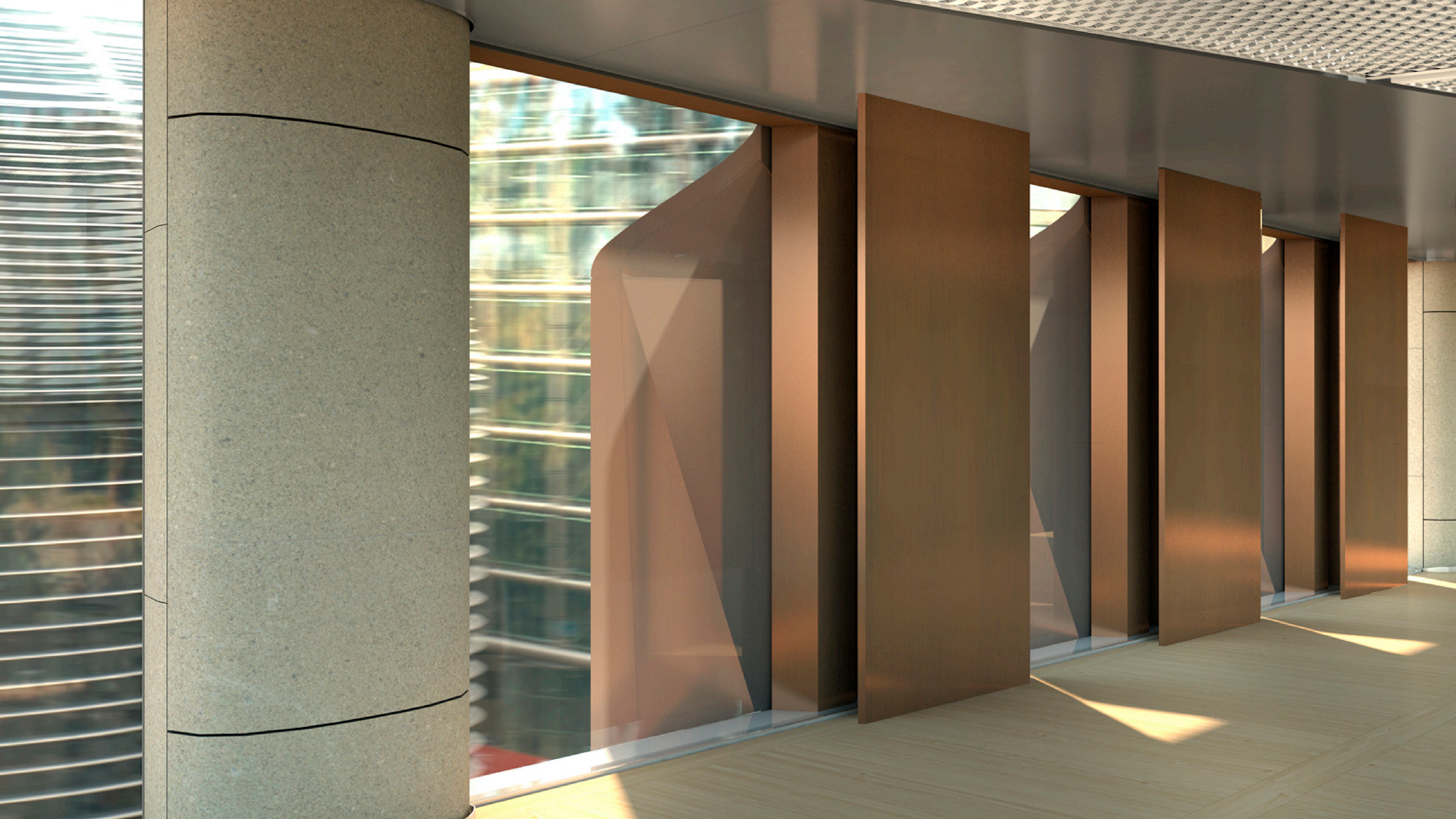


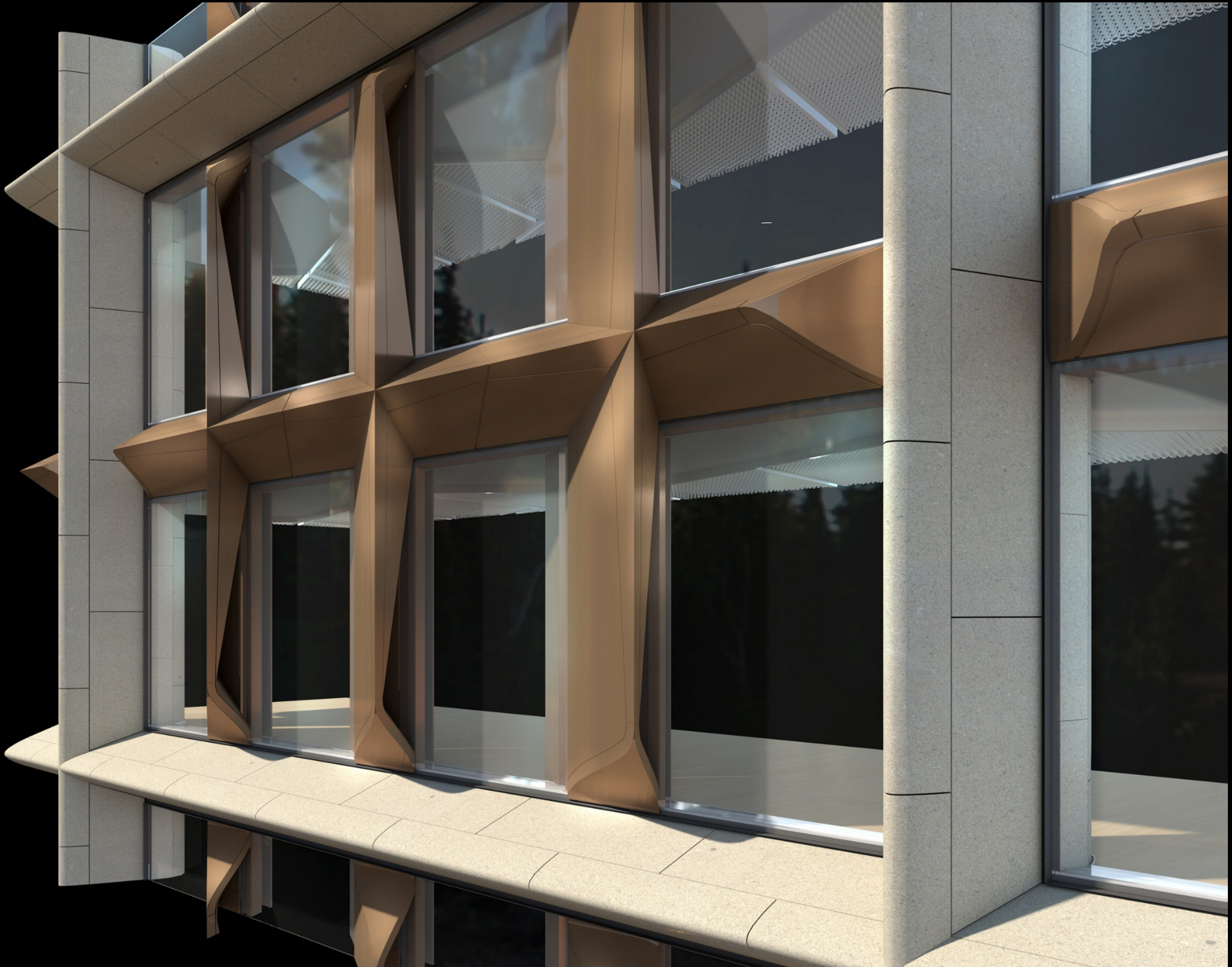
Design

Prototype

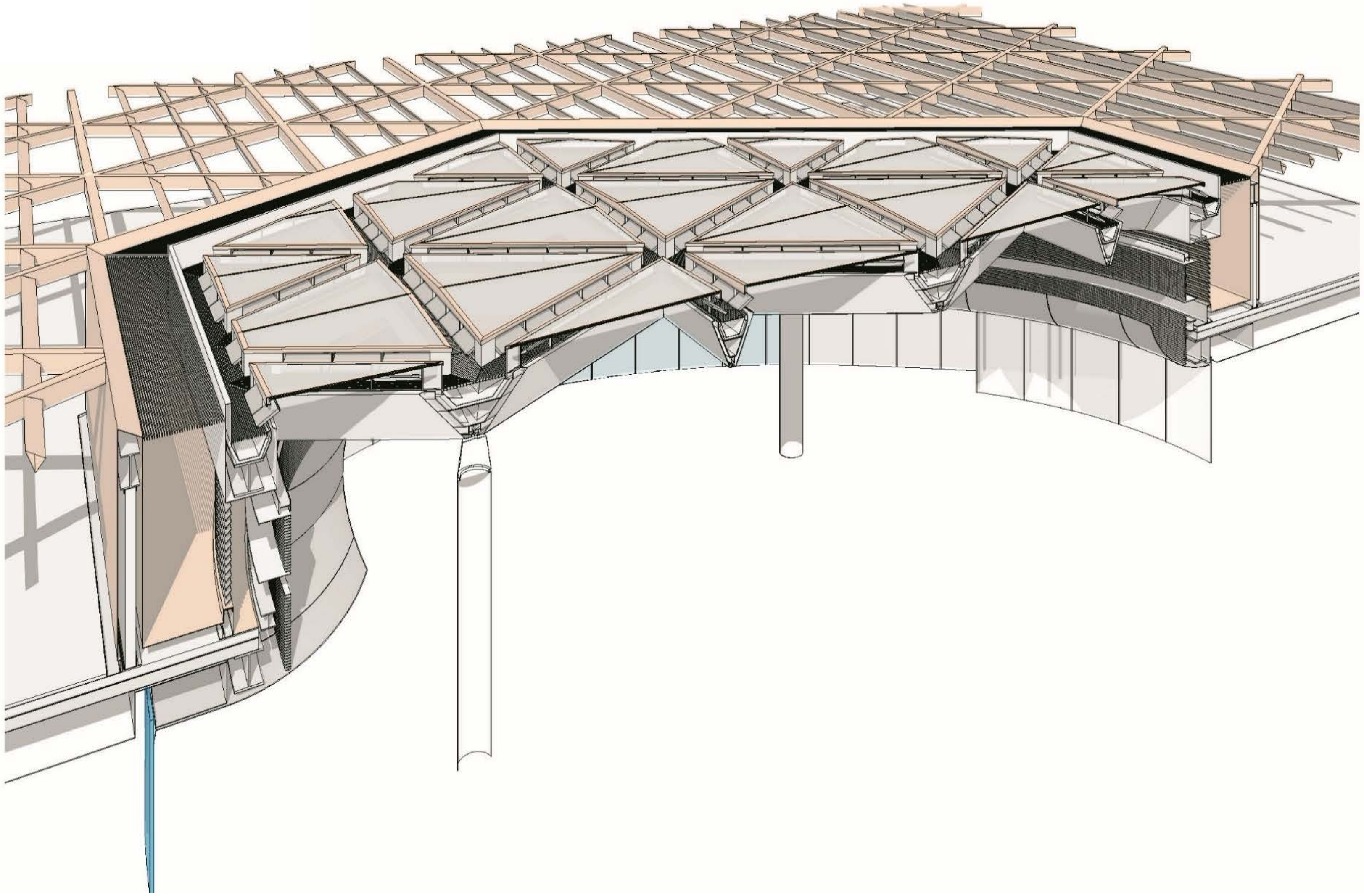
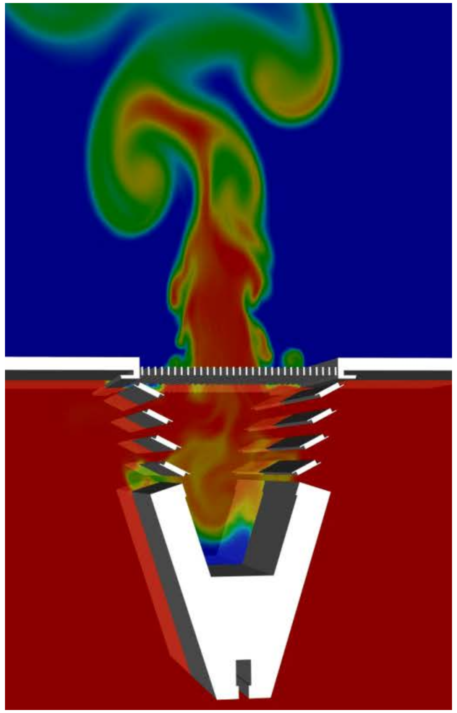
Visual Mock Up

Pre-Commissioning



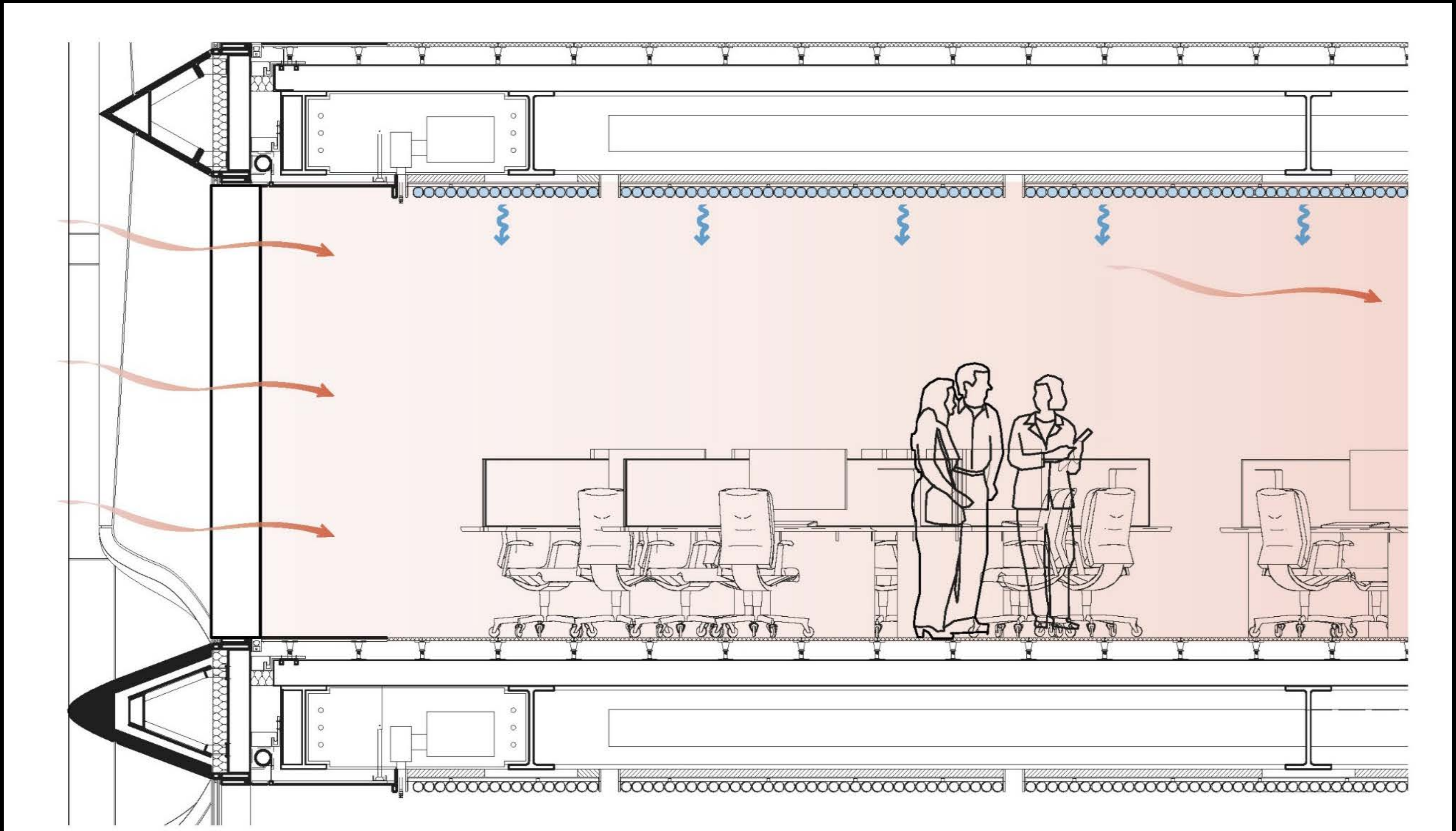


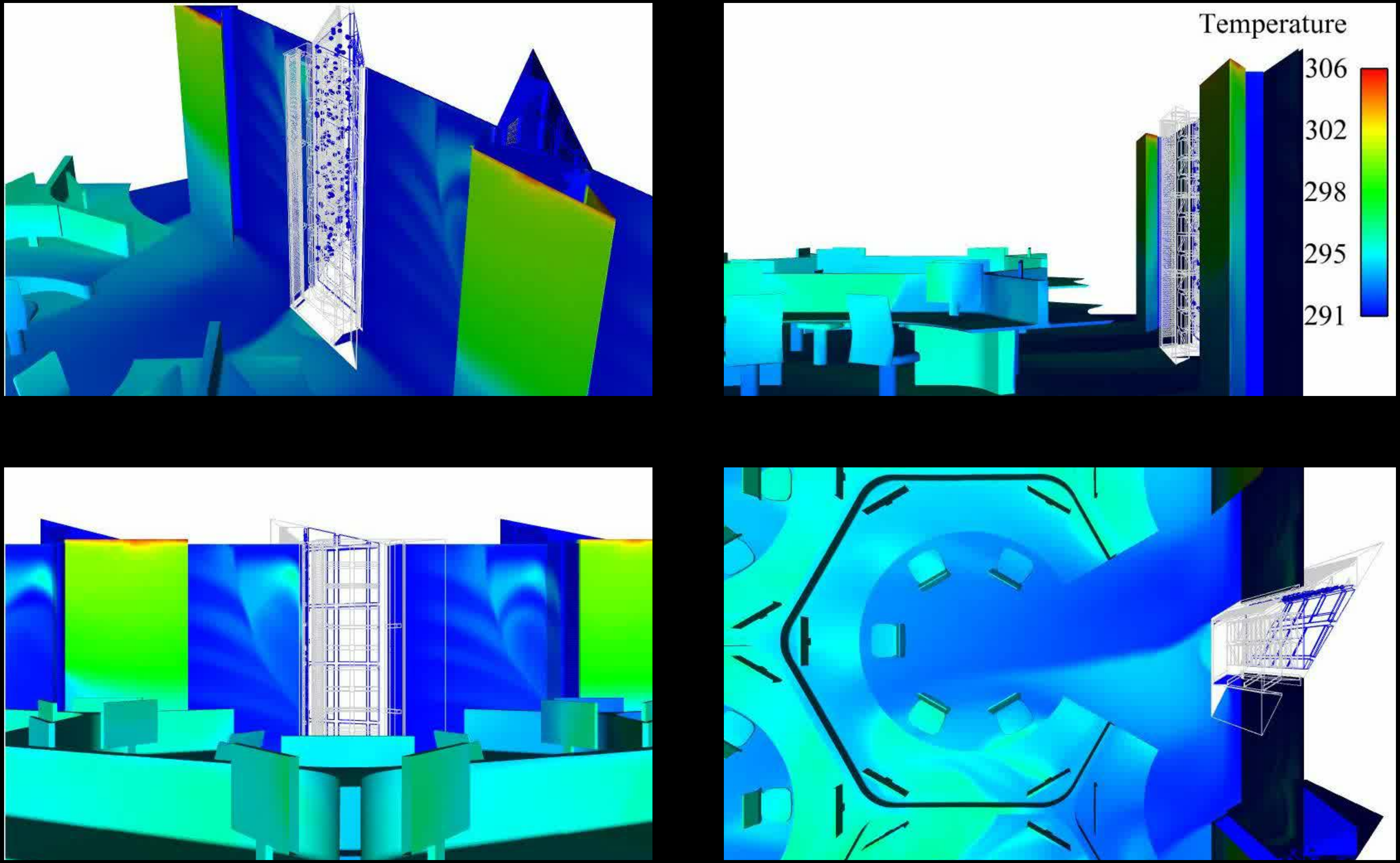
Roof

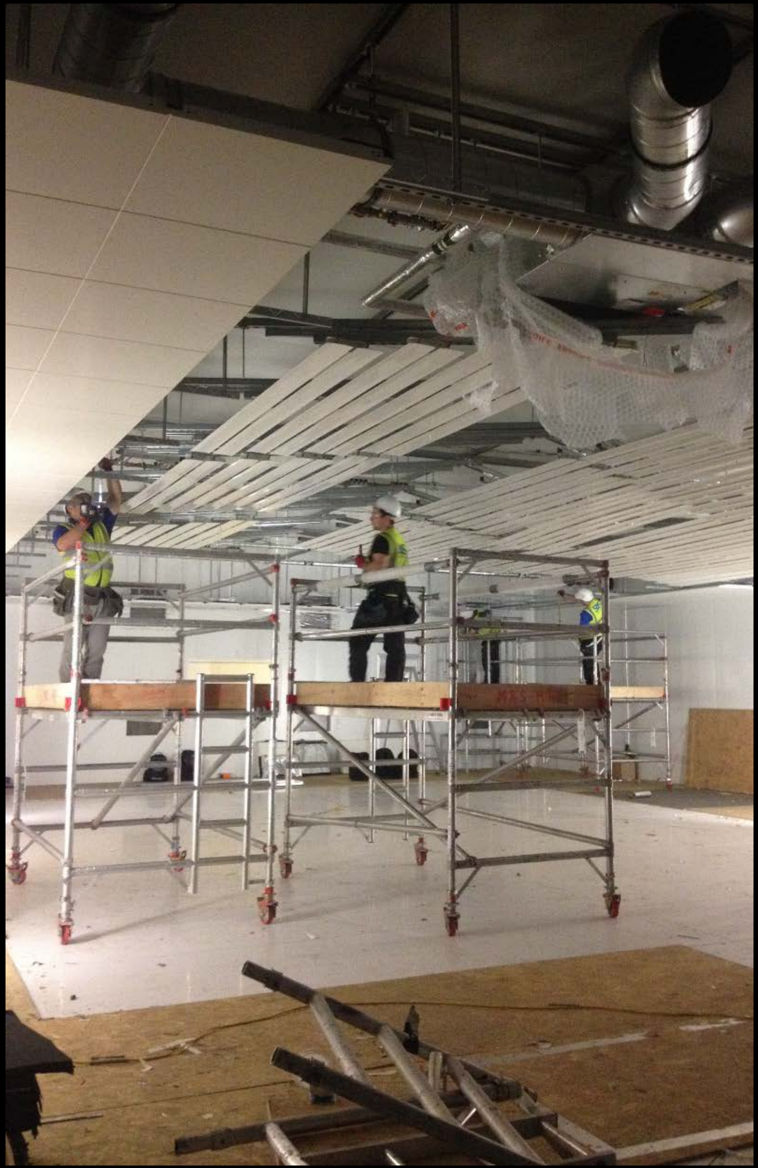
Internal environment

Controlling Indoor Thermal Comfort




Temperature
306
302
298
295
291

A full scale mock up using the final components was build and used for testing




Fire exit
19
17
20
10
7
2
12
6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Thank you for your time,
any questions?

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