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environments for life

CIBSE BSG

Designing for Better Indoor Environmental Quality Buildings:

A Mixed-Mode Office Building with Exemplary IEQ

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Introduction

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Background

Exposure to Air Pollutants

Air Quality Analysis for a Mixed-Mode Building

Summary

Background - Case study

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- Office development in Kings Cross
- Floor area: 1,000,000 ft^2
- 10 floors
- Client willing to push boundaries

Background - Client Targets

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"Optimising capital and innovation to create a highly flexible, productive and healthy working environment, with low long-term operating costs and the smallest possible environmental impact"

"Environmental performance beyond anything else happening today or planned for tomorrow"

breeam

Pass Excellent Outstanding

'Aim: Outstanding'

- Representative of top 1% of non-domestic building stock
- > 85% total credits
- > 40% better than Part L as a minimum standard

U.S. GREEN BUILDING COUNCIL LEED USGBC

'Aim: Platinum'

- > 80% total credits
- Aiming for ~28% better than ASHRAE 90.1-2007 energy standard

Energy v's Indoor Environmental Quality

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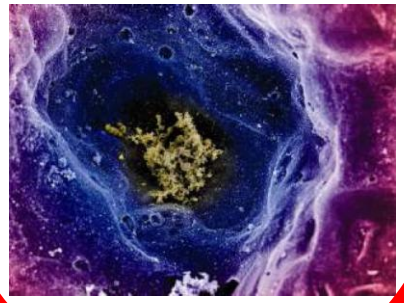
Mixed-mode

Openable windows

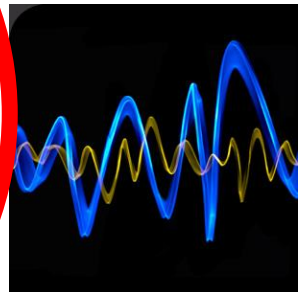
V's

Issues to consider

Air Quality



Acoustics



Other issues: Control scheme, Air tightness, Architectural considerations, Facade access, Maintenance, Cost and Complexity, etc.

Energy & CO2 Emissions

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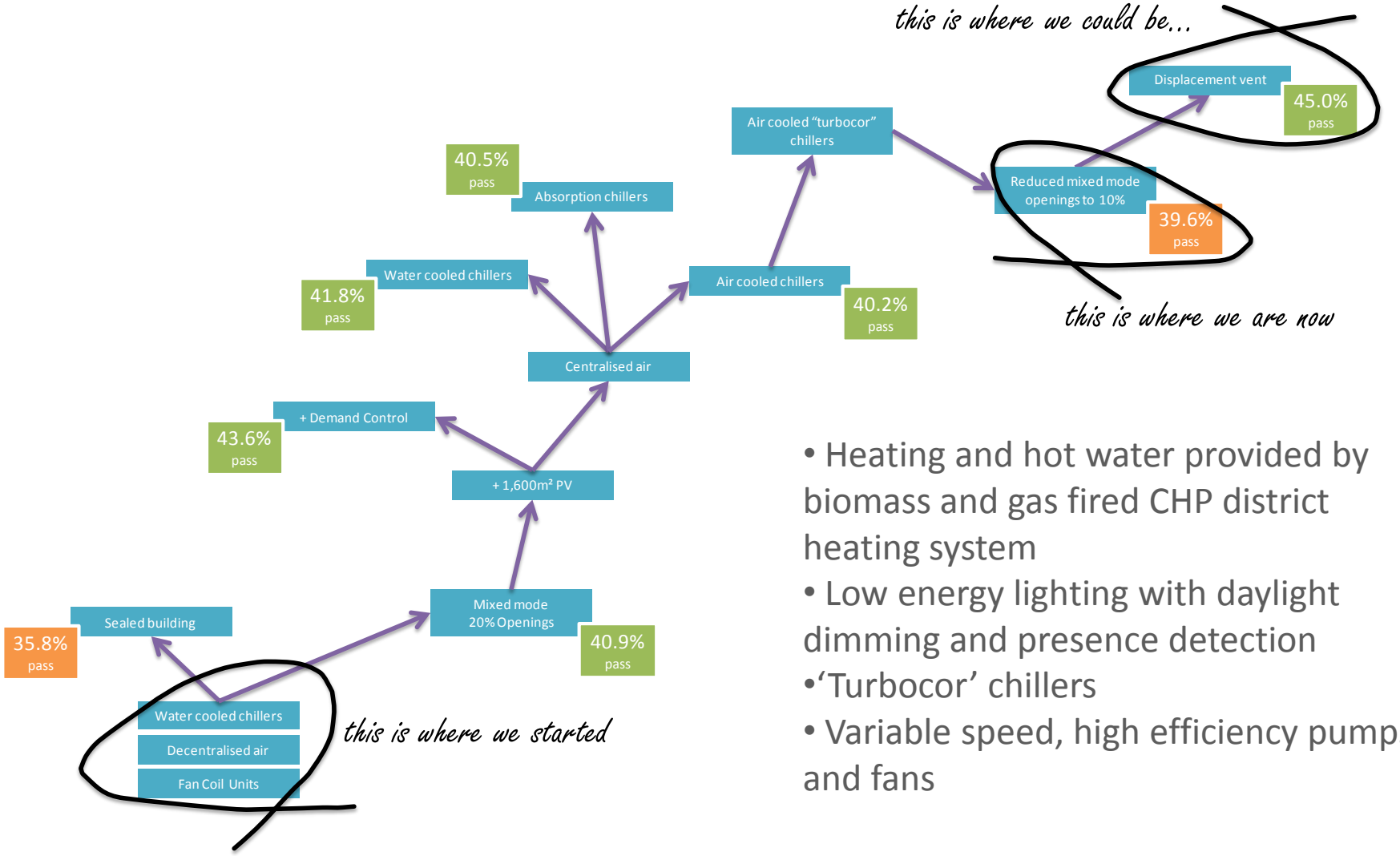

- Heating and hot water provided by biomass and gas fired CHP district heating system
- Low energy lighting with daylight dimming and presence detection
- 'Turbocor' chillers
- Variable speed, high efficiency pumps and fans

Air Quality - Exposure to Air Pollutants

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AIR QUALITY

Concentration of pollutants & Length of exposure

(one without the other is meaningless)

Pollutant	Concentration Limit	Measured as..
Nitrogen Dioxide (NO_2)	40 µg/m^3	Annual average
	200 µg/m^3	1 hour average
Particles (PM_{10})	40 µg/m^3	Annual average
	50 µg/m^3	24 hour mean
Ultra-Fine Particles ($PM_{2.5}$)	25 µg/m^3	Annual average
Sulphur Dioxide (SO_2)	125 µg/m^3 three times per annum	24 hour mean

NO_2 Standards

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Standard	Limit (µg/m³)	Measurement period
UK Air Quality Standard	40	Annual average (long-term)
	200 (not to be exceeded more than 18 times per year)	Hourly average (short-term)
European Union Standard	as above	
World Health Organisation	40	Annual average (long-term)
	200	98th percentile averaged over 3 years
California Ambient Air Quality Standard	60	Annual average (long-term)
	360	Hourly average (short-term)
Historical Client Operational Performance Requirement (OPR)	40	Annual average (long-term)
	200	Hourly average (short-term)

PM_{10} Standards

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Standard	Limit (µg/m^3)	Measurement period
UK Air Quality Standard	40	Annual average (long-term)
	50 (not to be exceeded more than 35 times per year)	24-hour average (short-term)
European Union Standard	as above	
World Health Organisation	20	Annual average (long-term)
	50	24-hour average (short-term)
California Ambient Air Quality Standard	20	Annual average (long-term)
	50	24-hour average (short-term)
Historical Client Operational Performance Requirement (OPR)	20	Annual average (long-term)
	50	24-hour average (short-term)

$PM_{2.5}$ Standards

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Standard	Limit (µg/m^3)	Measurement period
UK Air Quality Standard	25	Annual average (long-term) to be achieved by 2015
World Health Organisation	10	Annual average (long-term)
	25	24-hour average (short-term)
California Ambient Air Quality Standard	12	Annual average (long-term)
Historical Client Operational Performance Requirement (OPR)	10	Annual average (long-term)
	25	24-hour average (short-term)

Exposure to Air Pollutants

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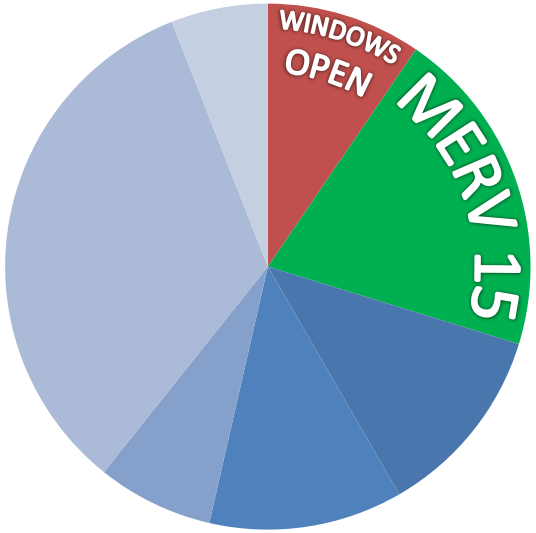
Approx 30% of our annual exposure is at work



for roughly 1/3 of that time the windows will be open….

….for the other 2/3 of that time the air quality will be very highly controlled

Filtration

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- CitySorb: 90% removal efficiency for NO_2
- 95% removal efficiency of PM_{10}

Concentration of Pollutants

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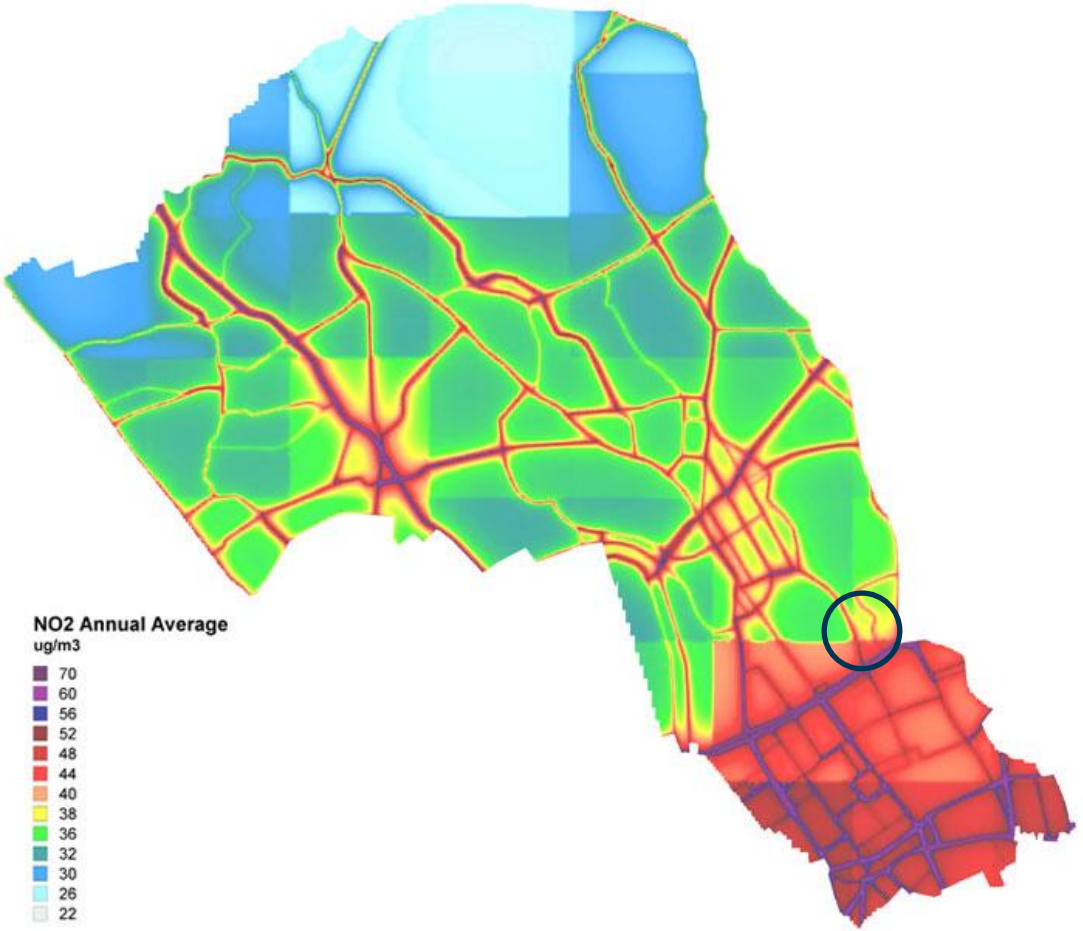
Nitrogen Dioxide - Camden



Concentration of Pollutants

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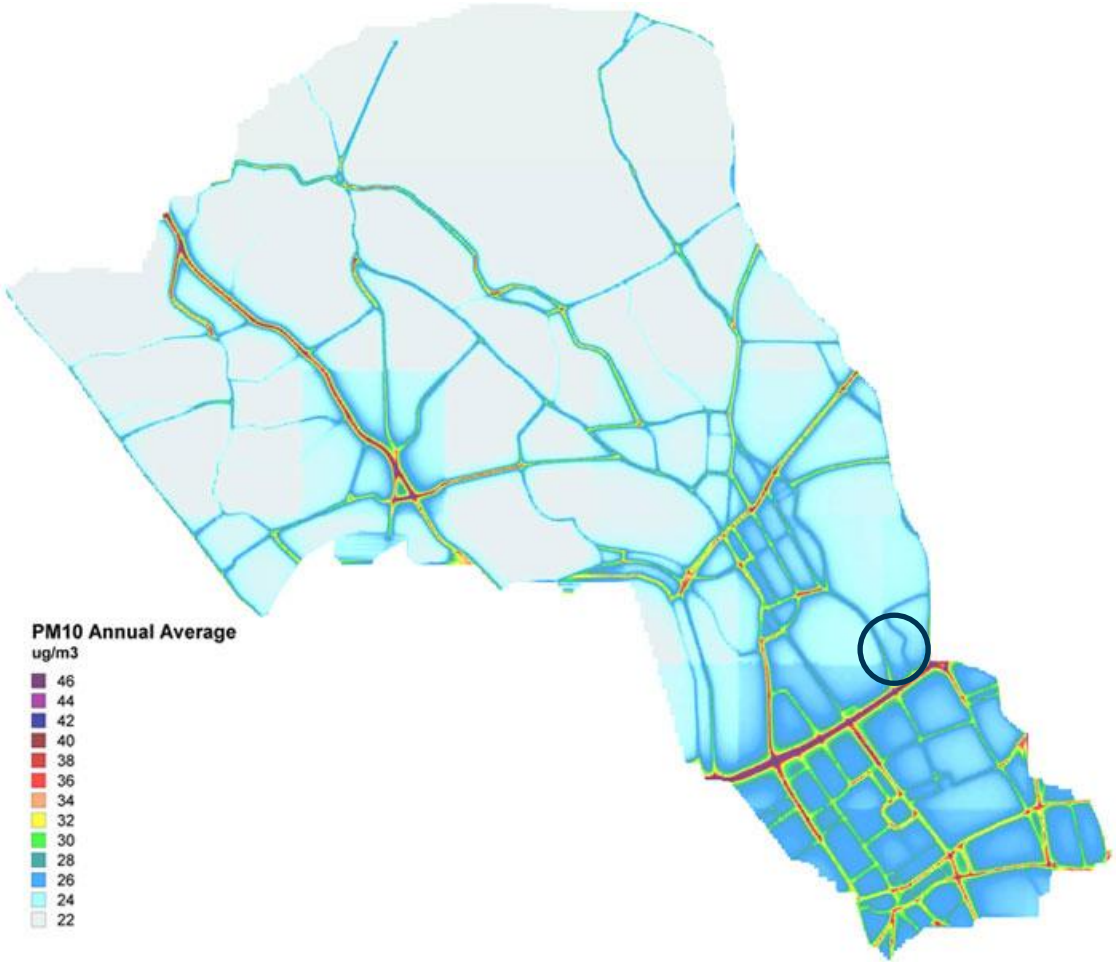
PM_{10} Particulate Matter - Camden



Nearby Monitoring Station

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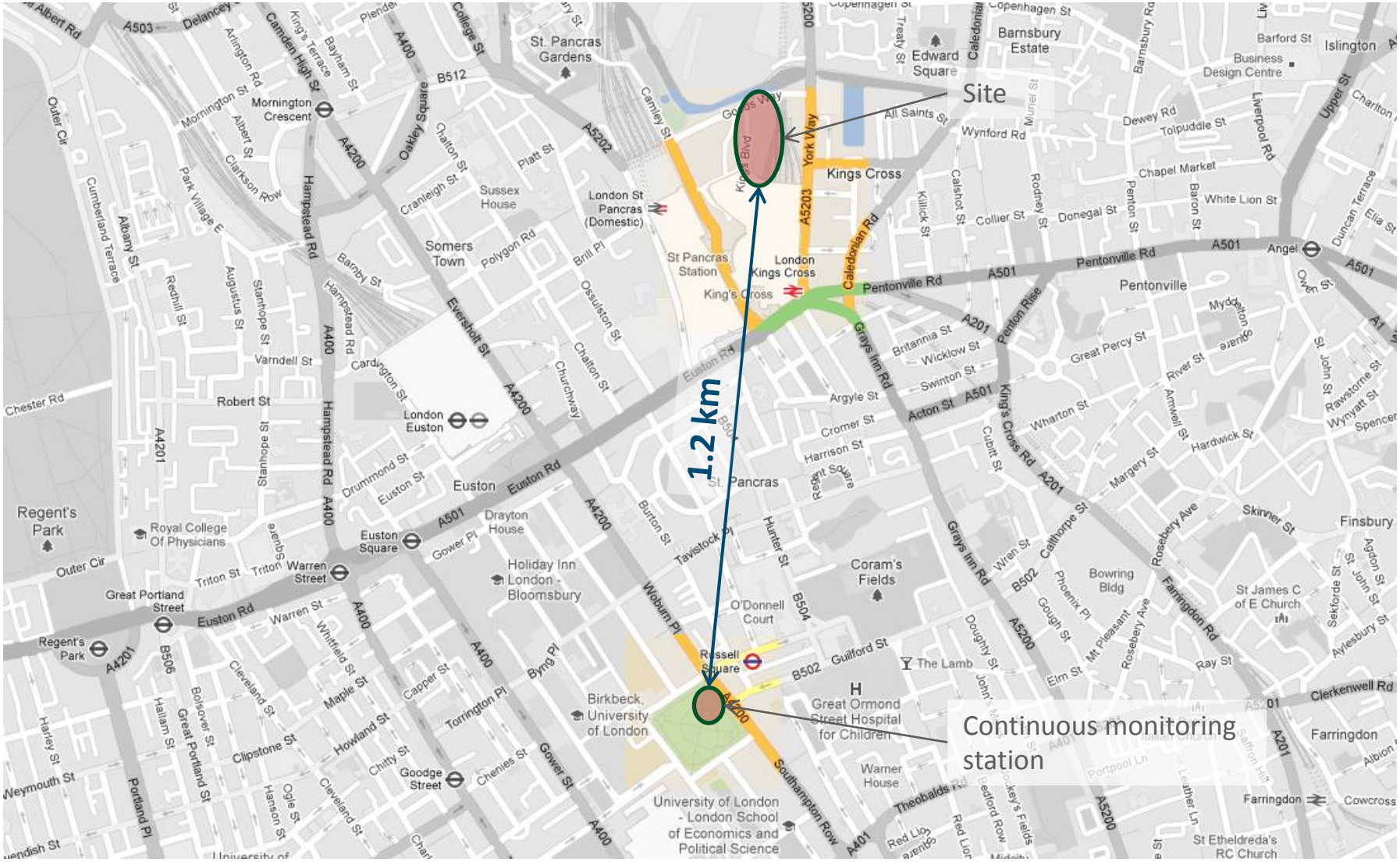

Onsite Monitoring

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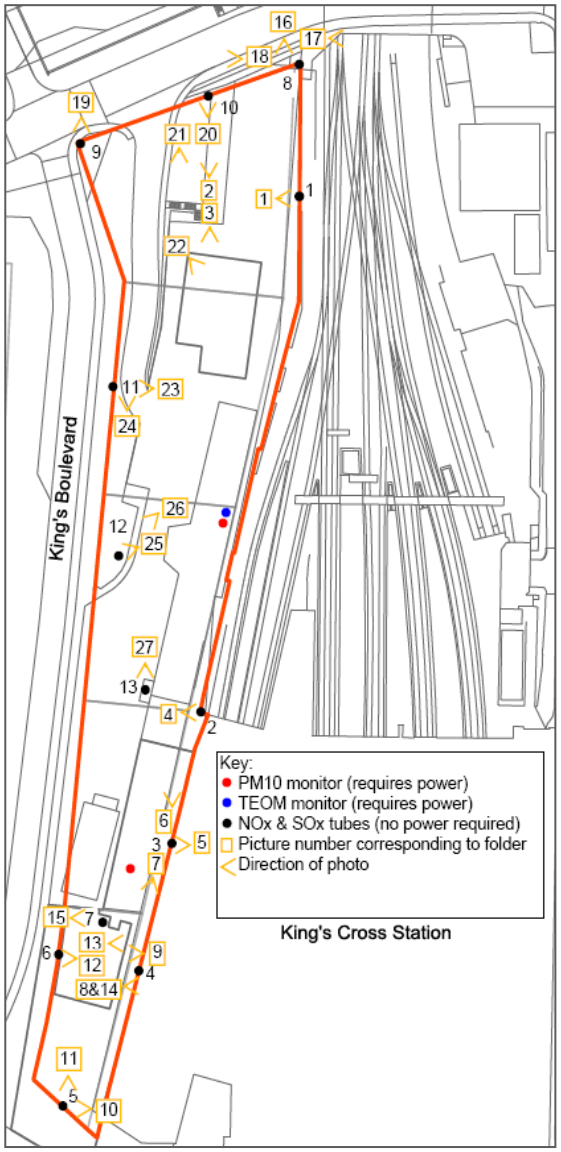

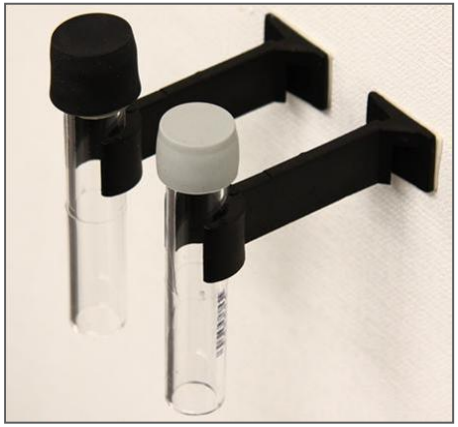

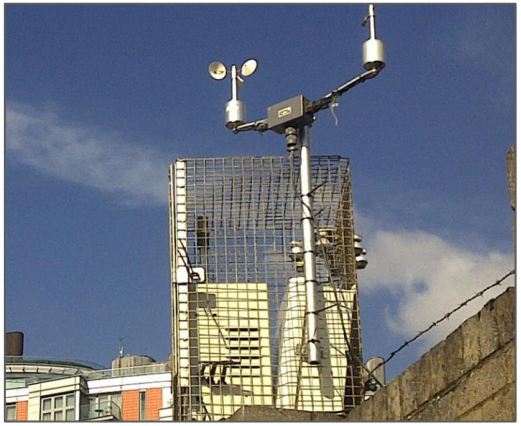

Monitoring Results – NO2

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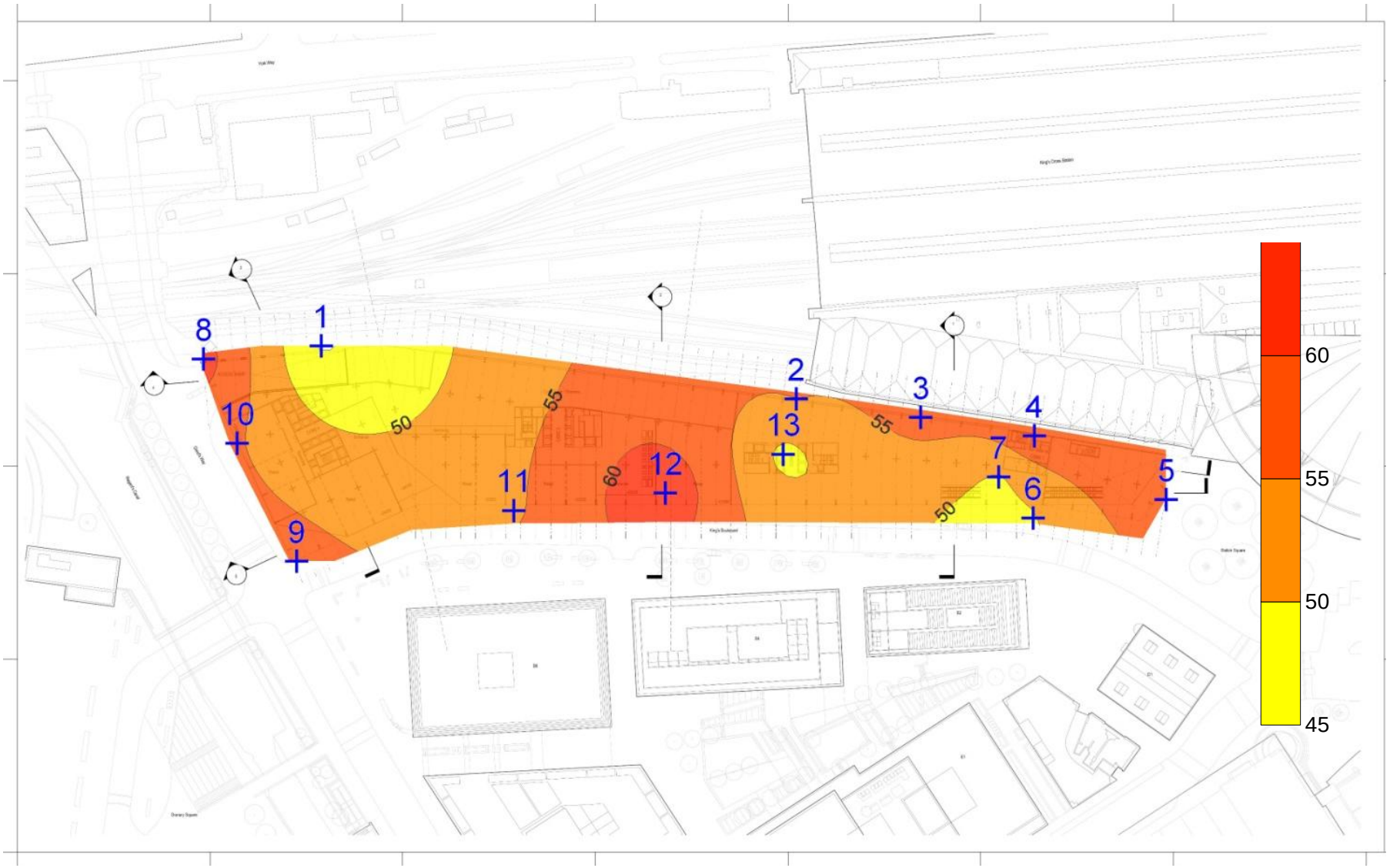

Monitoring Results – SO2

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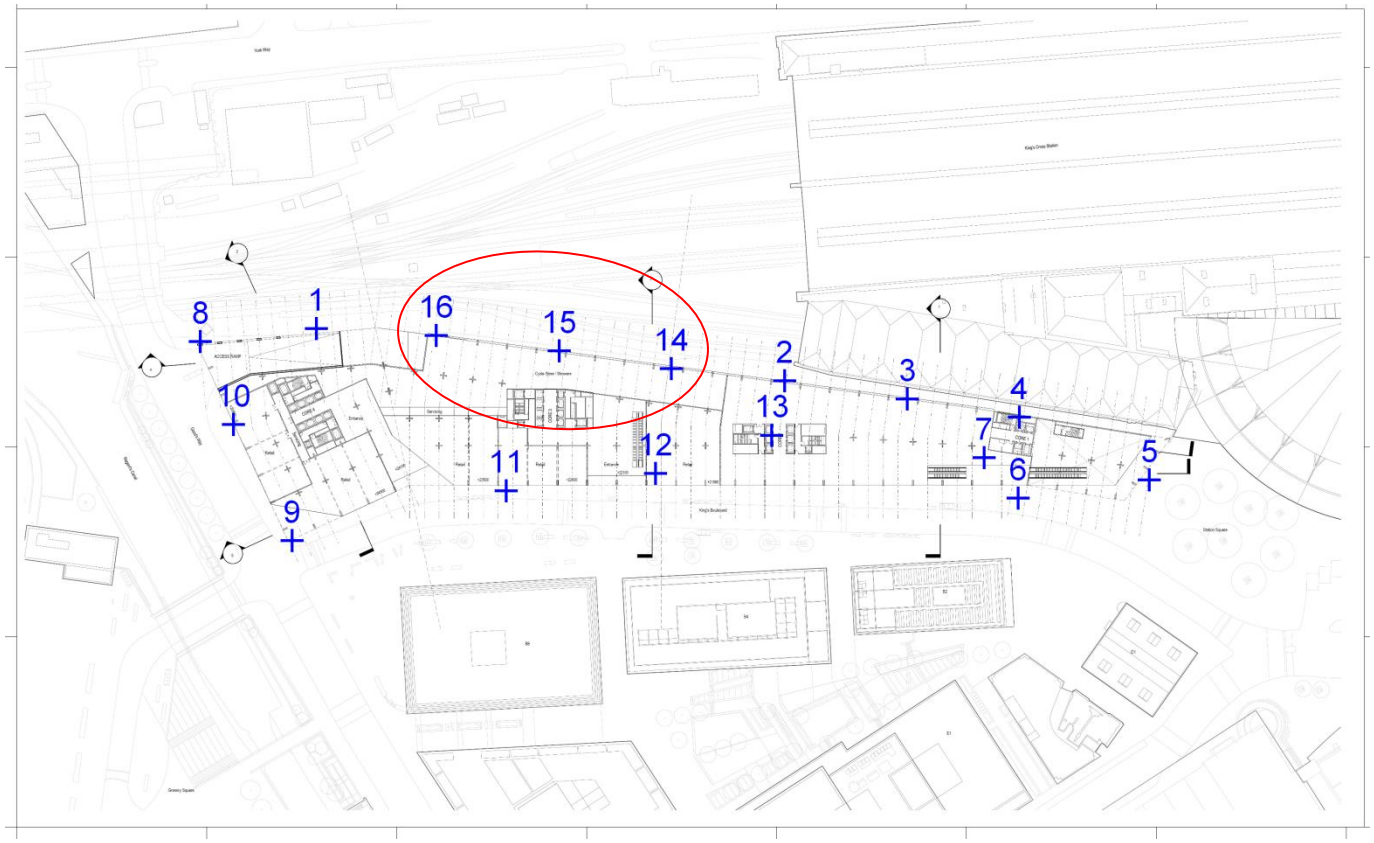

Location	SO2 Average (µg/m³)
1	1.5
2	1.2
3	1.1
4	1.2
5	1.2
6	1.1
7	1.0
8	4.1
9	1.7
10	2.2
11	1.2
12	1.2
13	1.2
14	1.7
15	1.3
16	1.2
Average:	**1.5**

	Oct-12	Nov-12	Dec-12	Jan-13	AQLV
15-min Peak	14	18	19	33	**266**
1-hour Peak	8	11	11	20	**350**
24-hour Peak	3	4	4	7	**125**

Monitoring Results – PM10

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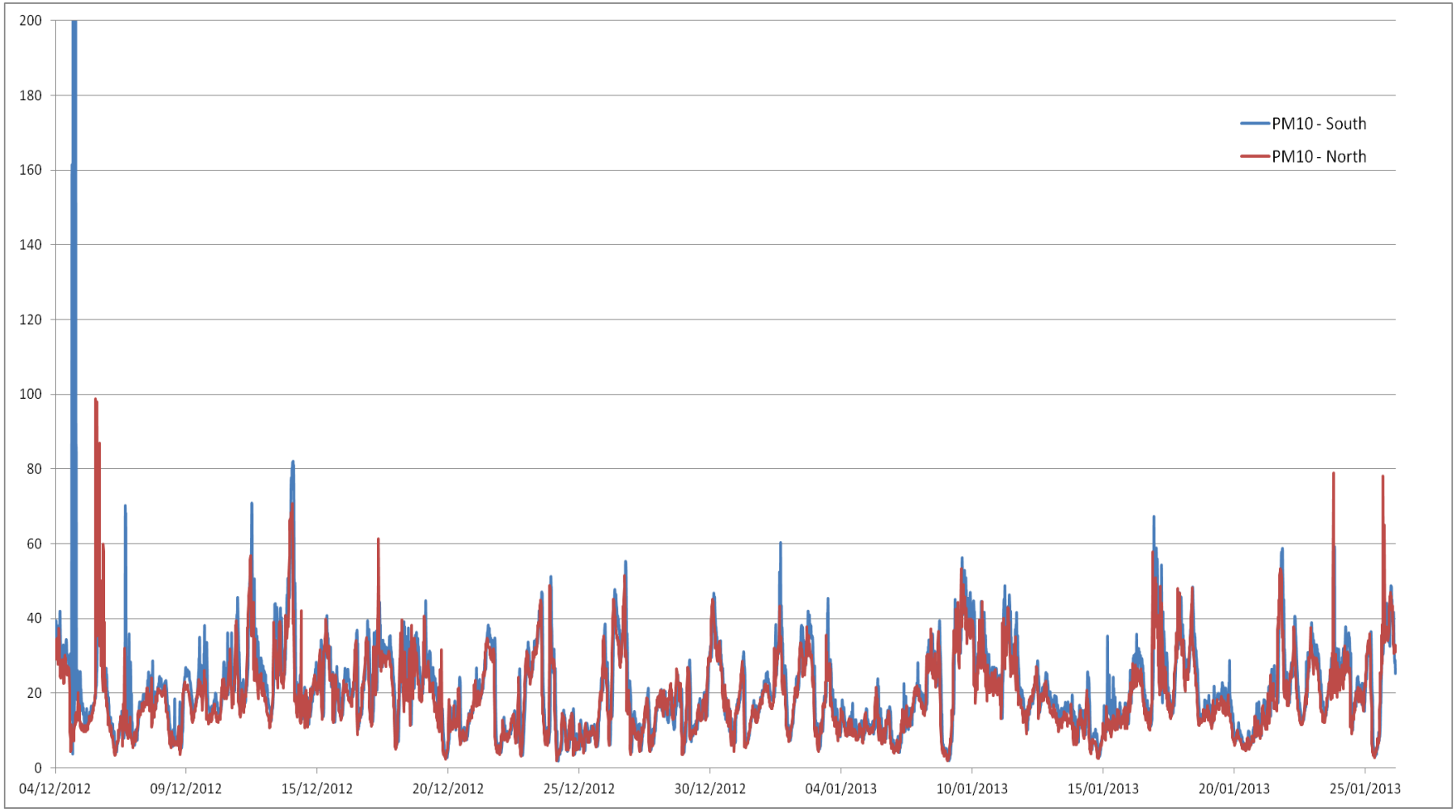

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Can we achieve good air quality levels within a mixed-mode building in central London?

Air Quality Analysis for a Mixed-Mode Building

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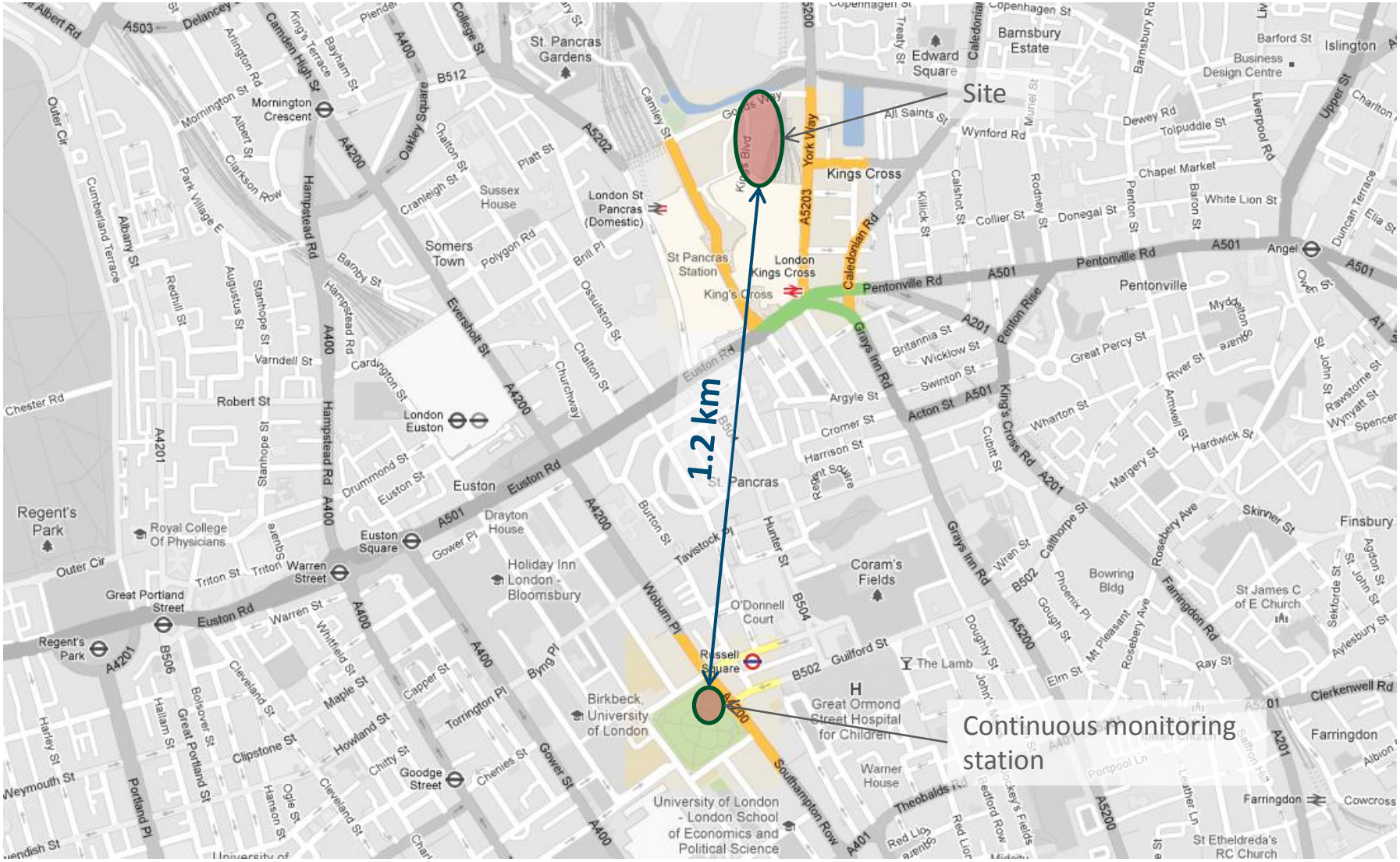

Air Quality Analysis for a Mixed-Mode Building

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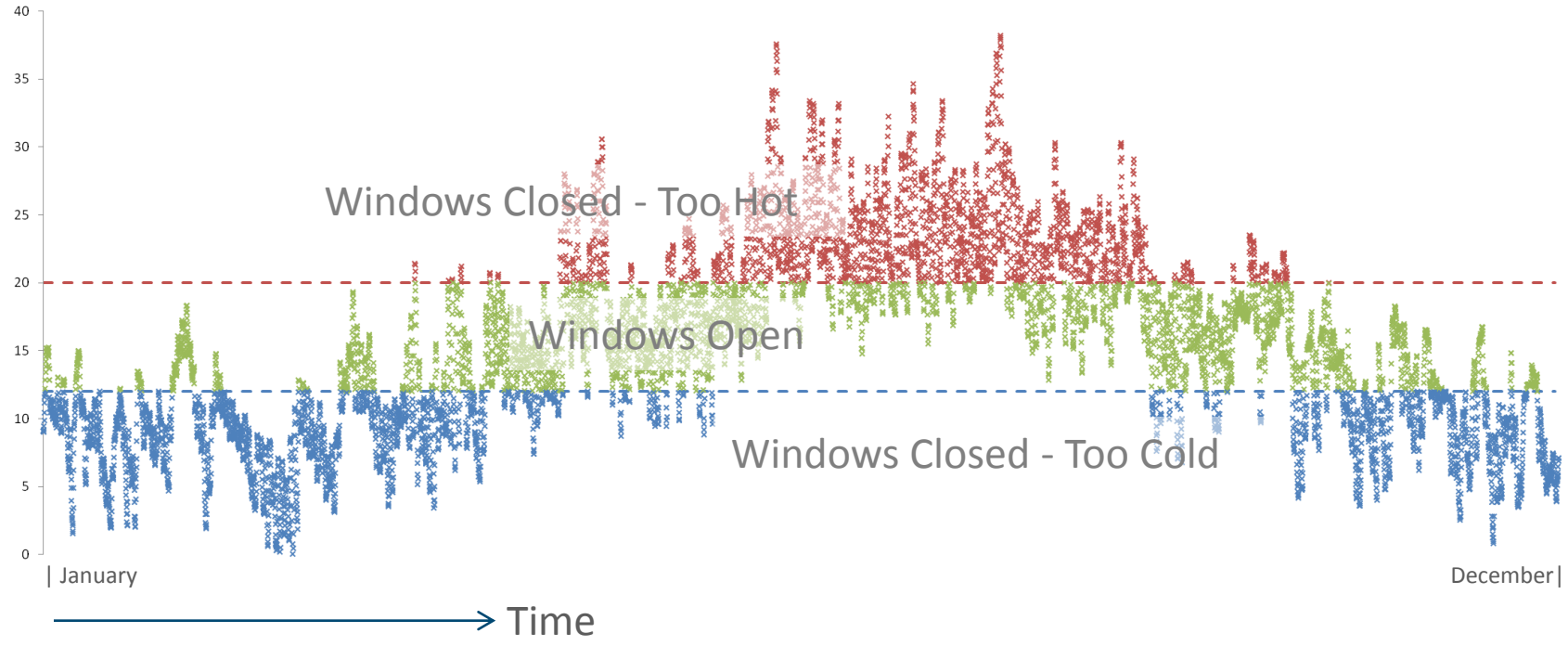
Temperature



Air Quality Analysis for a Mixed-Mode Building

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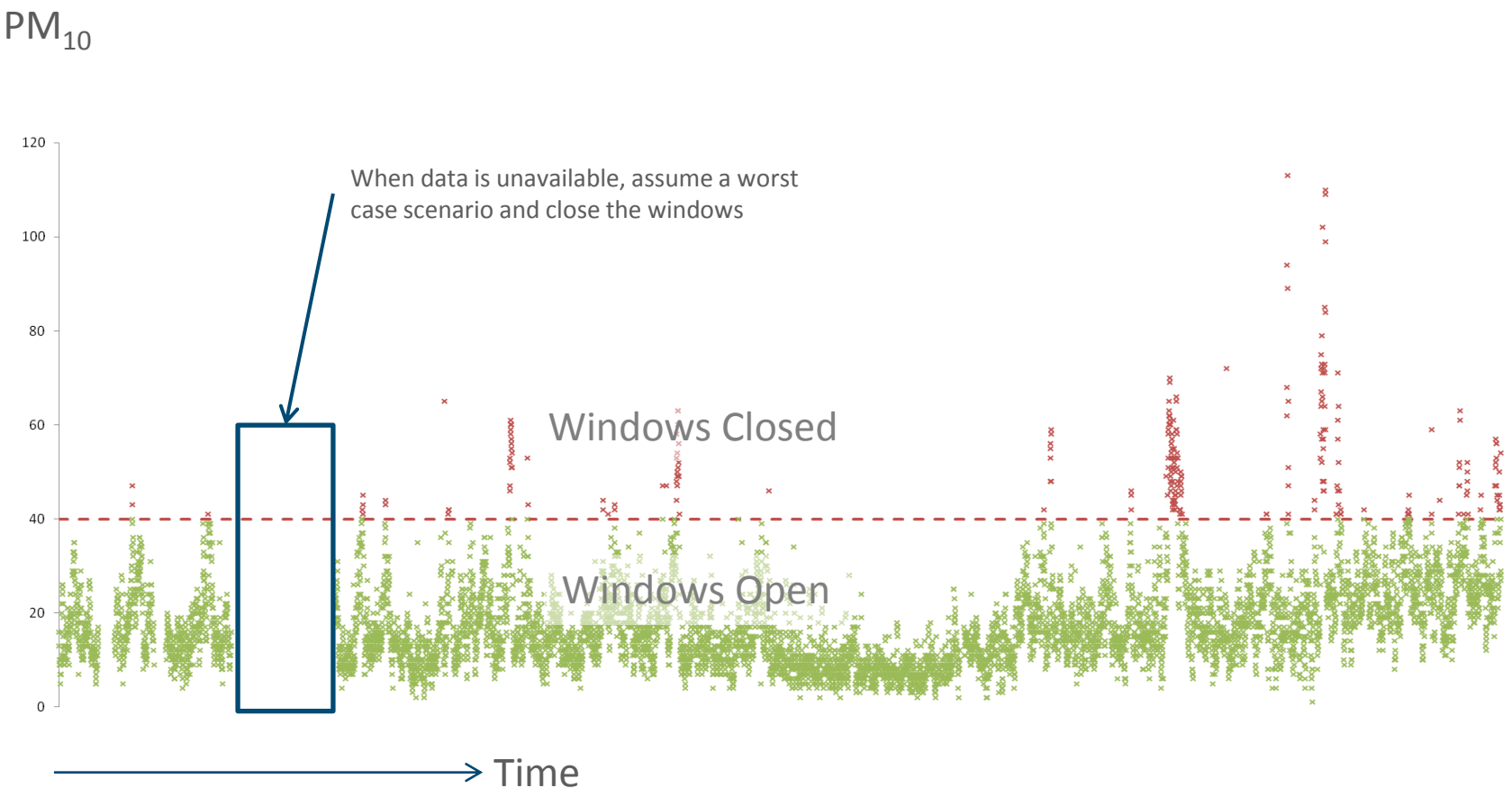

Air Quality Analysis for a Mixed-Mode Building

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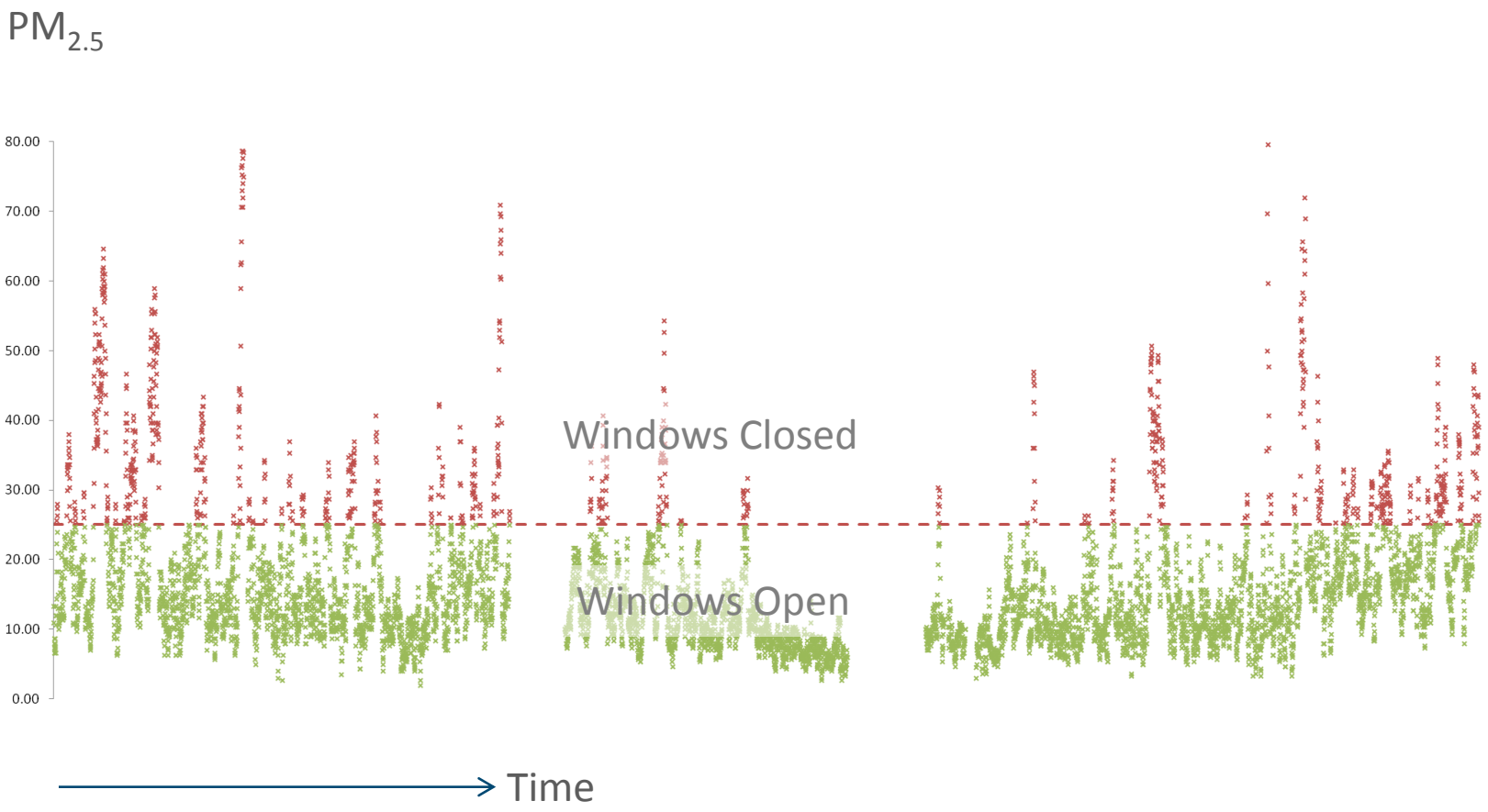

Air Quality Analysis for a Mixed-Mode Building

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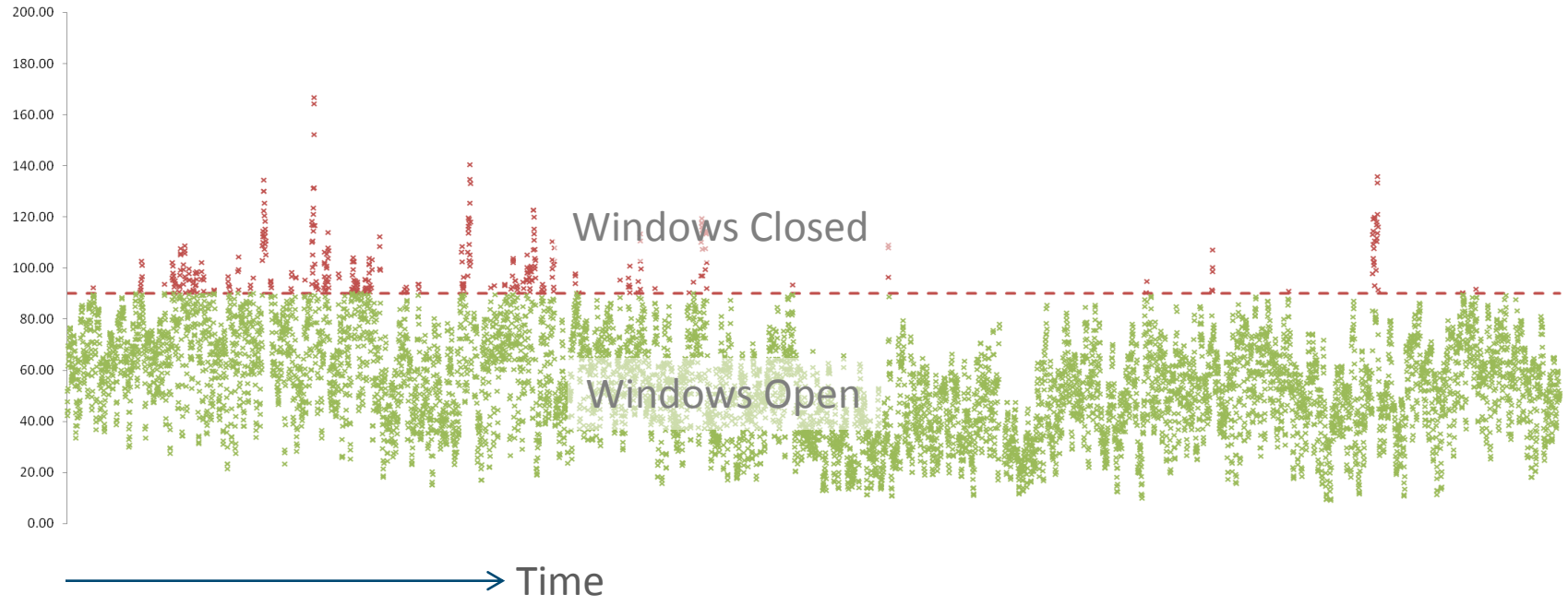
NO_2



Air Quality Analysis for a Mixed-Mode Building

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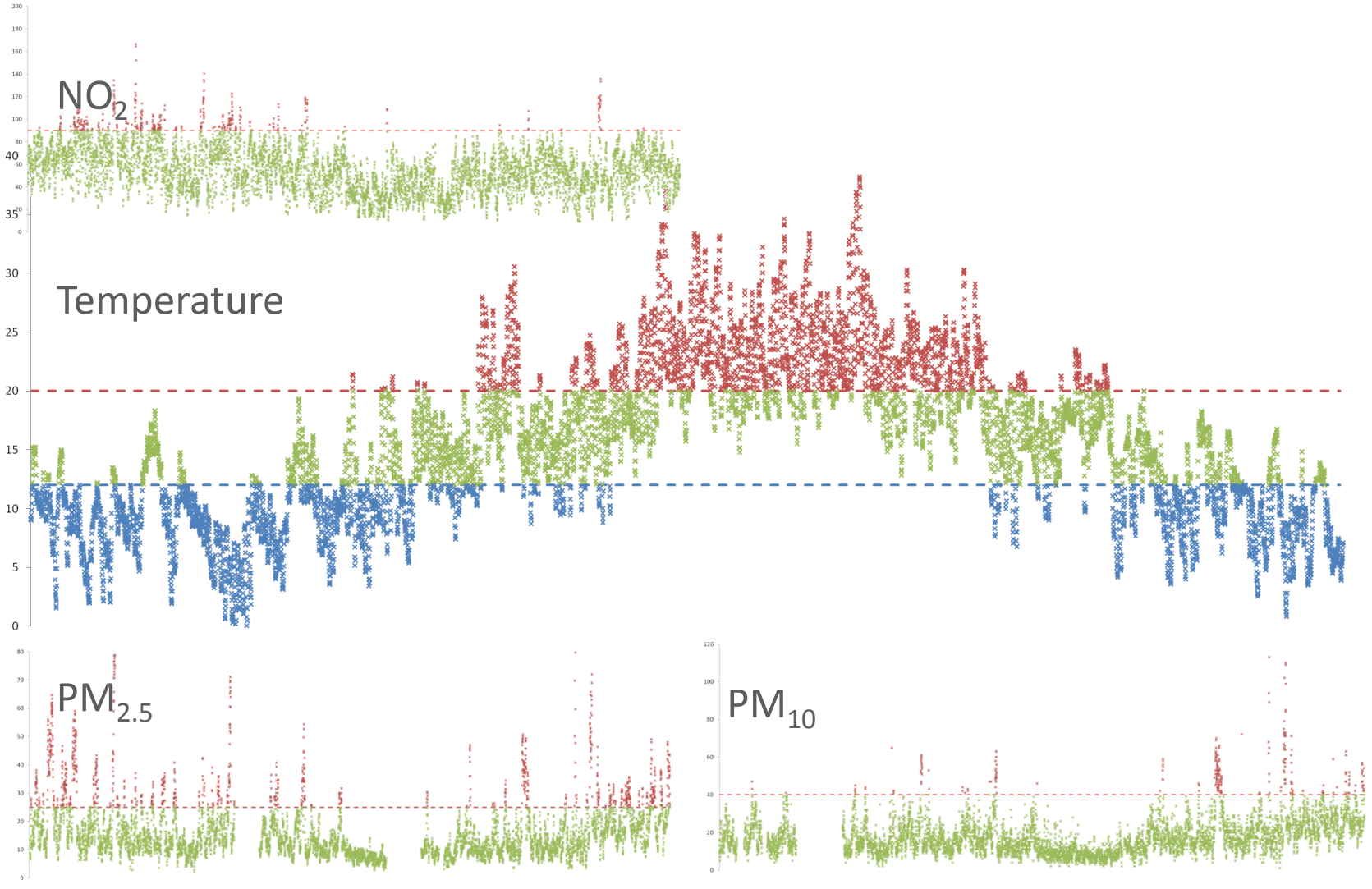

Air Quality Analysis for a Mixed-Mode Building

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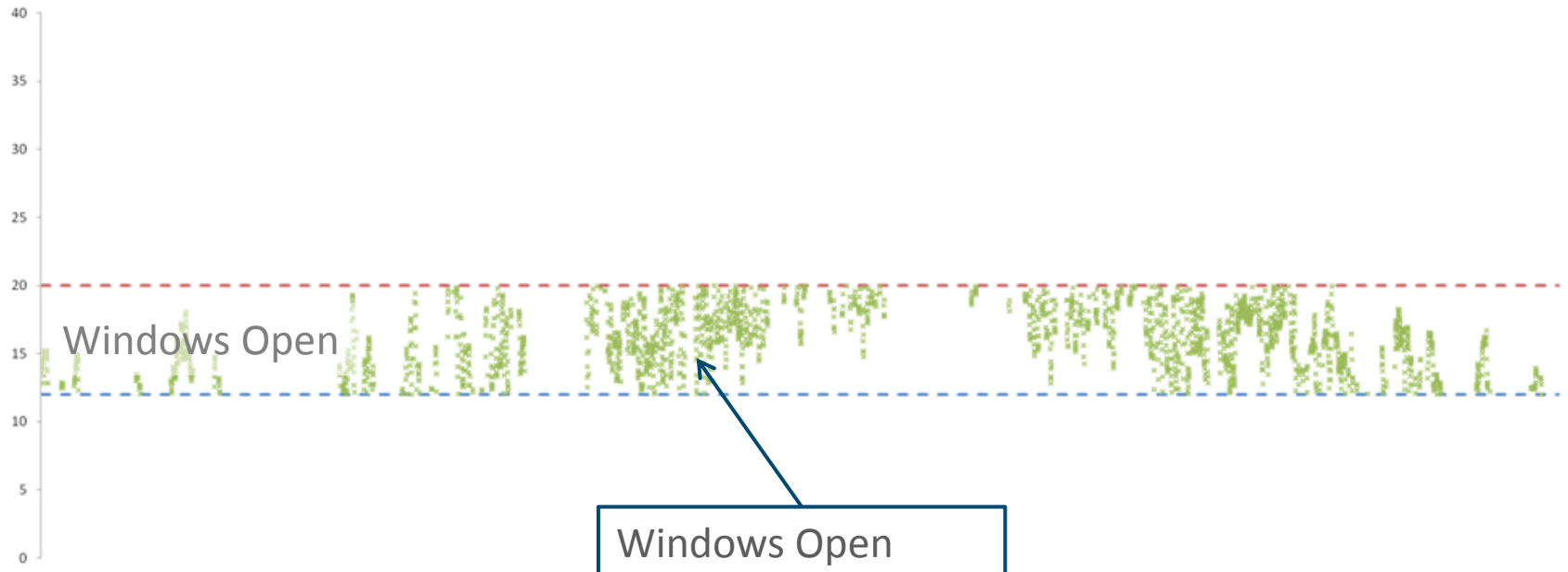
All Parameters (Temperature + PM_{10} + $PM_{2.5}$ + NO_2)



Windows Open
2631 hours
30.1% of the year
27.2% of occupied hours

Spreadsheet analysis...

Summary

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	Estimated Annual Concentration ($\mu g/m^3$)	UK Limit ($\mu g/m^3$)
NO_2	29	40
PM_{10}	9	40
$PM_{2.5}$	8	25

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Good air quality levels *are* achievable within a mixed-mode building in central London...

...in theory!

But is the concept of a mixed-mode building lost?

To be continued....

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Any Questions?