



Is cooking with gas bad for our health?

Felix Leach

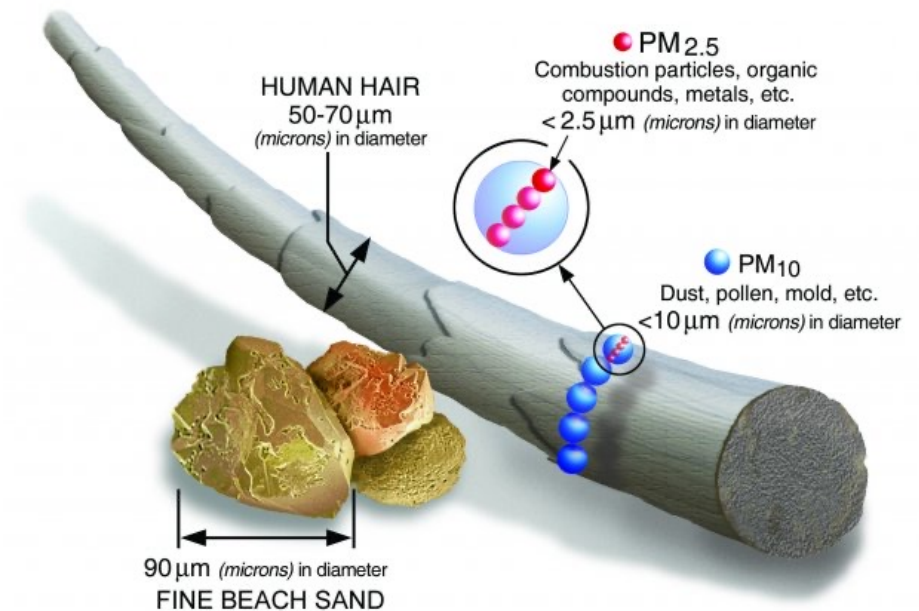
Low Carbon Oxford North

13 October 2026

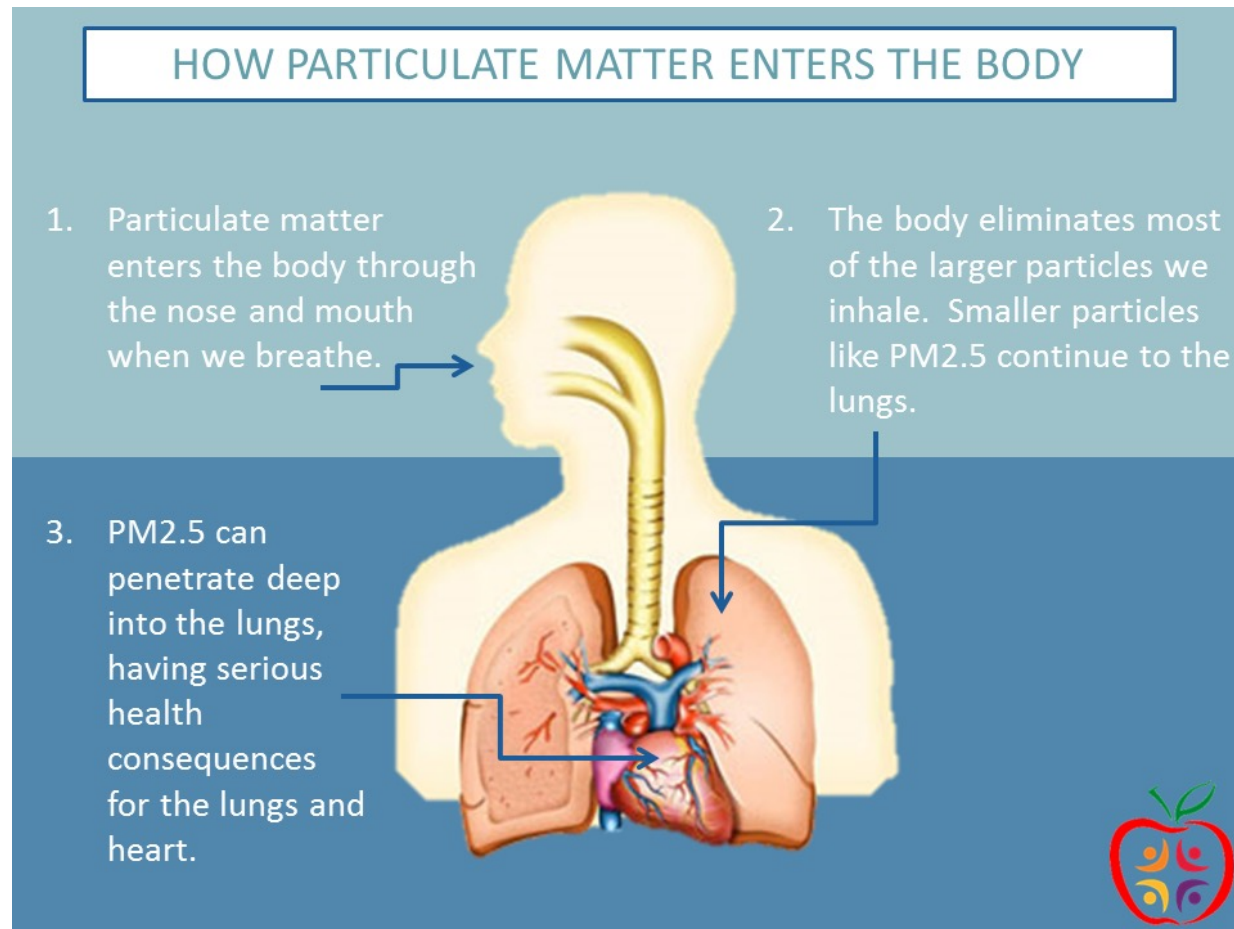


Indoor Pollution

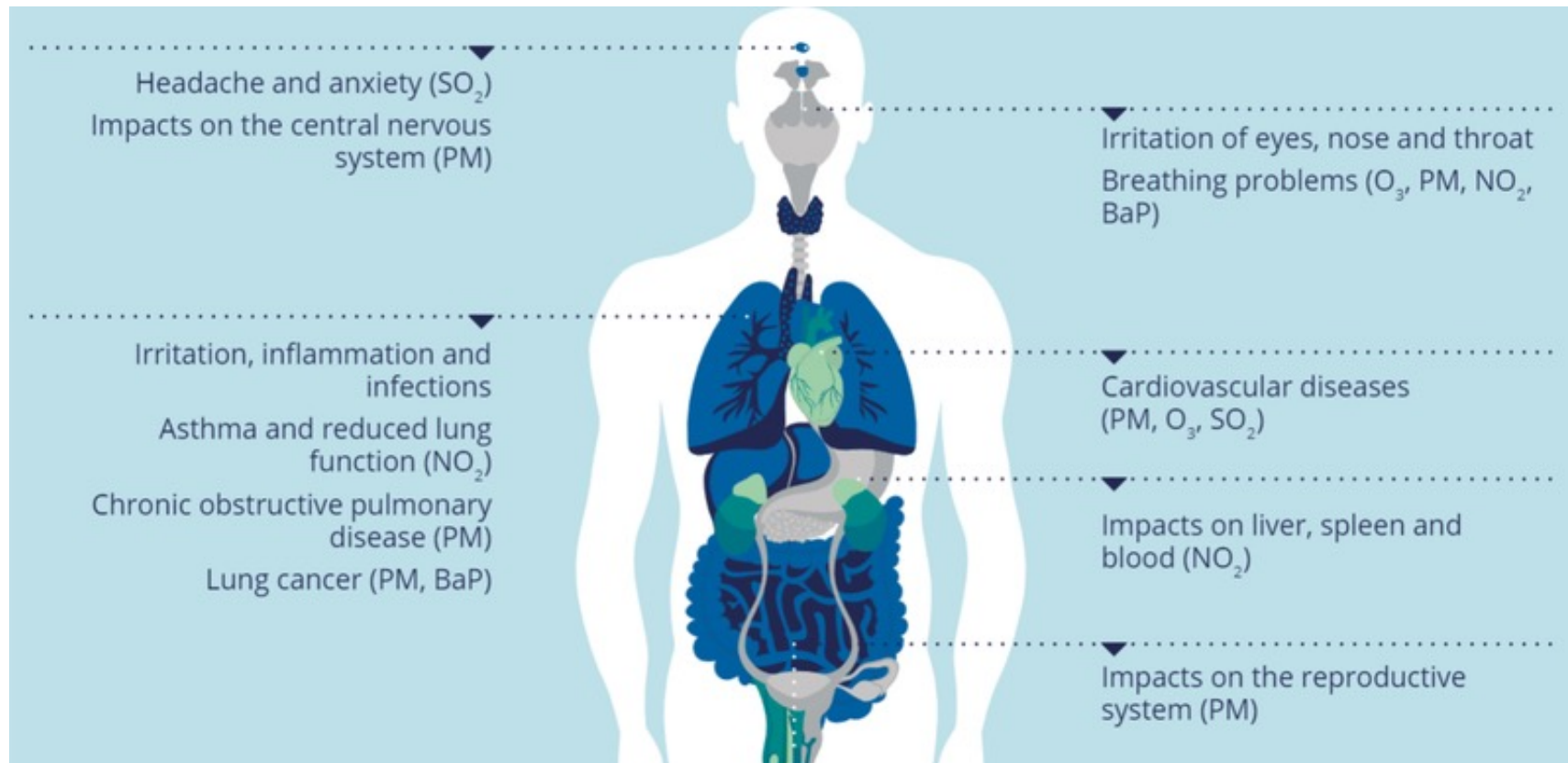
- Number of sources of pollutants indoors
 - Cooking
 - Heating
 - Aerosols
 - Hoovering
 - Smoking
 - Printing(!)
 - Pets
- I'm going to focus on NO_x and PM



Pollution and our health

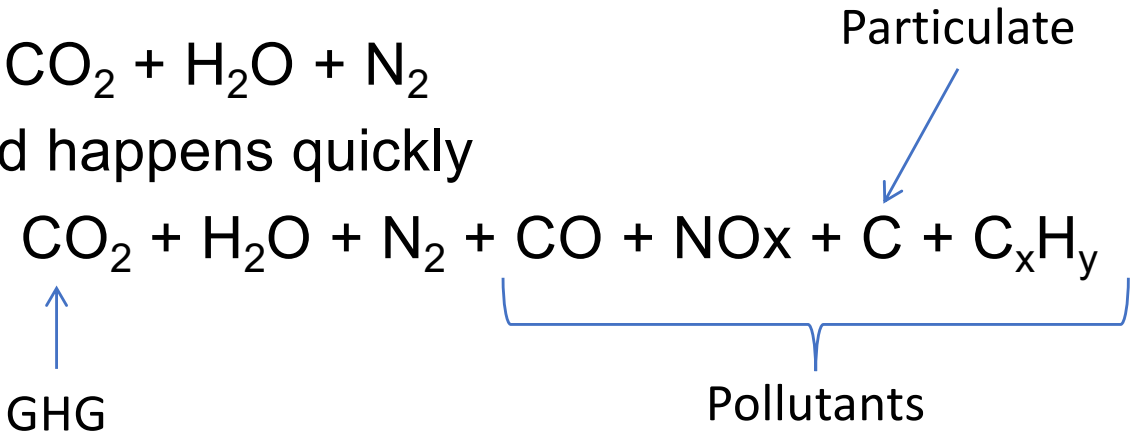


Pollution and our health

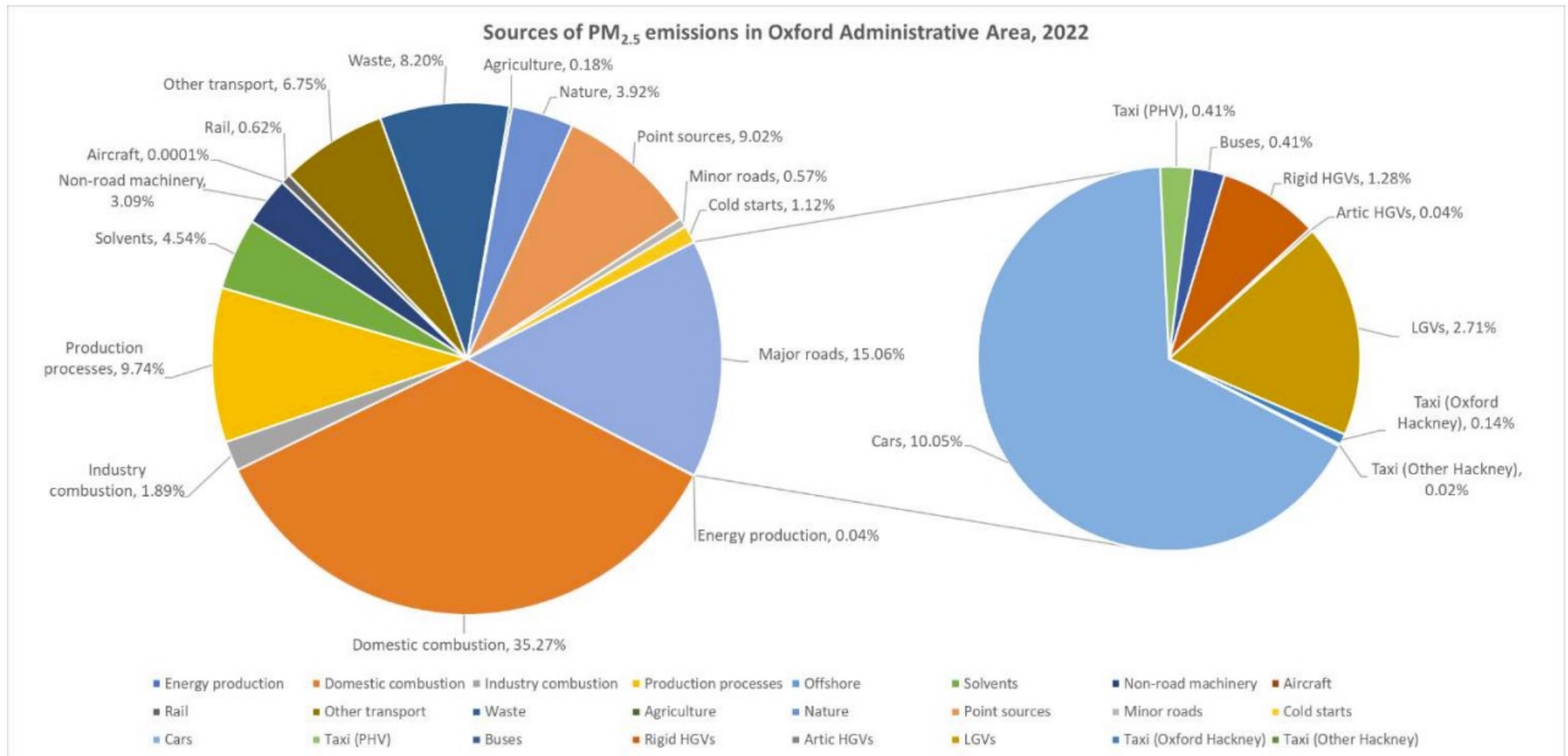


Where do emissions come from?

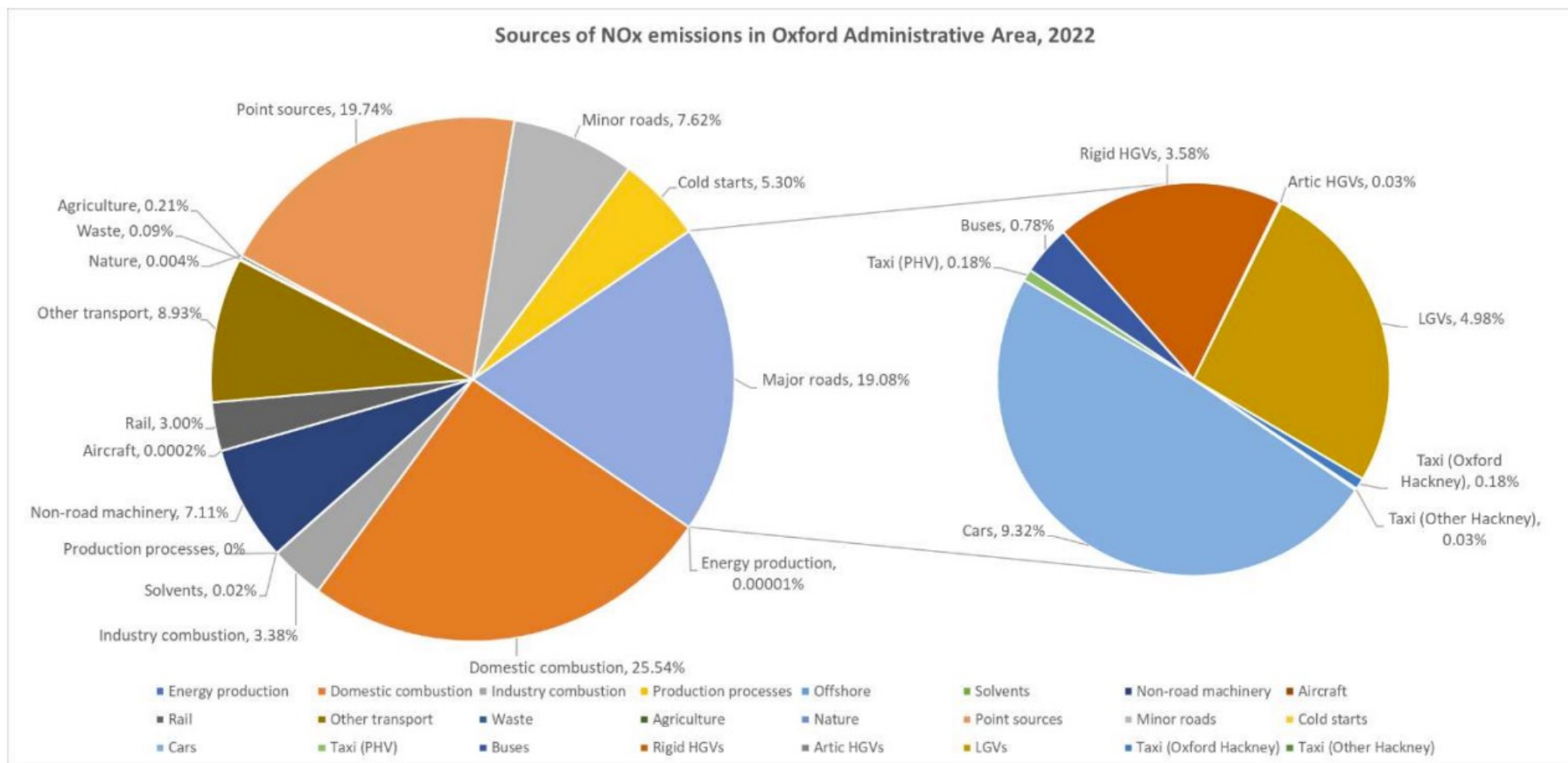
- Ideal combustion
- $C_xH_y + O_2 \rightarrow CO_2 + H_2O$
- Combustion in air
- $C_xH_y + [O_2 + (79/21)N_2] \rightarrow CO_2 + H_2O + N_2$
- Real combustion is hot and happens quickly
- $C_xH_y + [O_2 + (79/21) N_2] \rightarrow CO_2 + H_2O + N_2 + \underbrace{CO + NOx + C + C_xH_y}_{\text{Pollutants}}$
+ ...



The Oxford context – PM_{2.5}



The Oxford context – NOx



Why think about indoors?

- We spend so much time there
- Ventilation outside is great!
- Often, energy efficiency measures can negatively impact indoor ventilation (inadvertently)

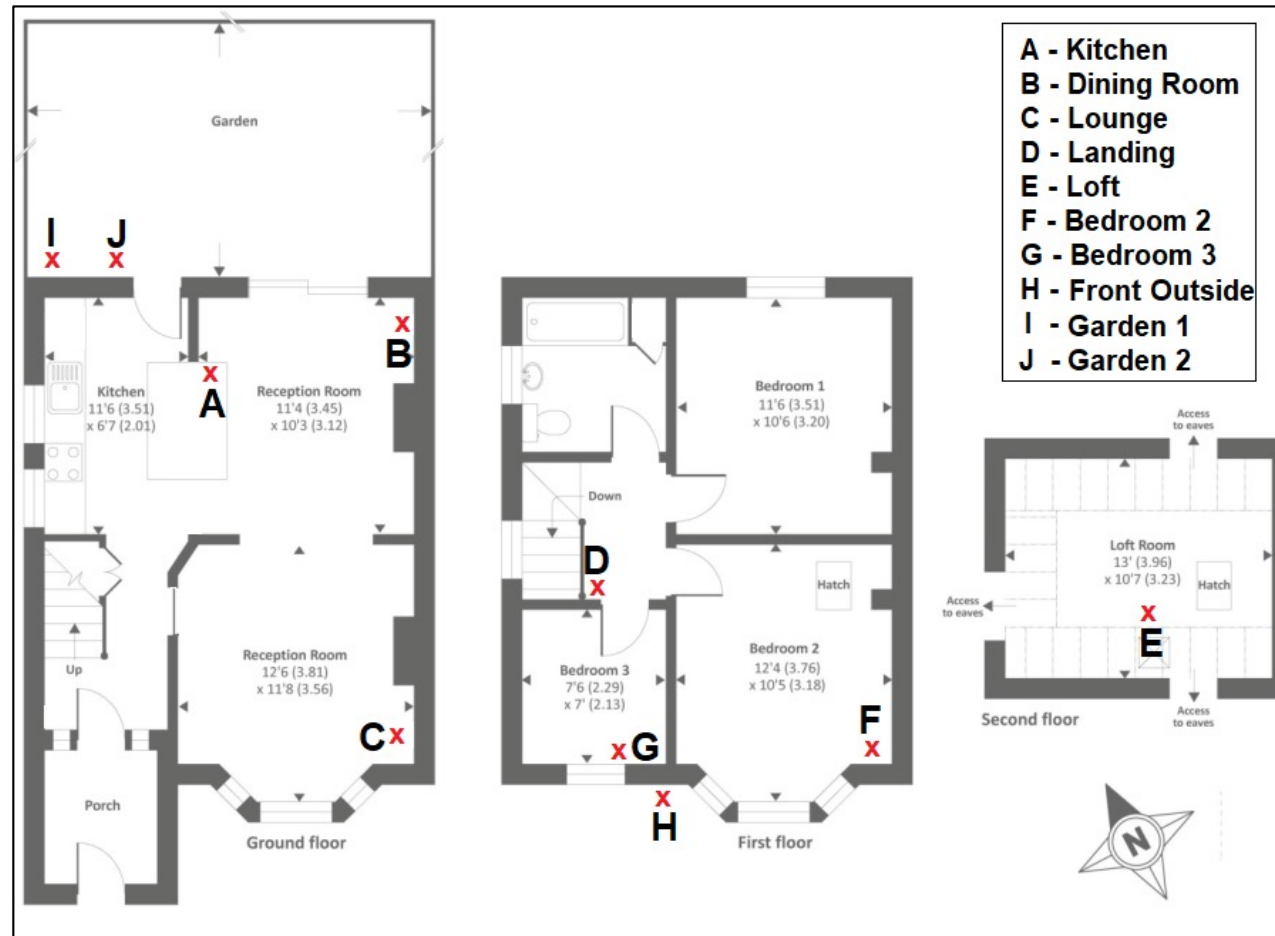


Sensors

- South Coast Science (now Emsol) Praxis
 - Measures NO_2 and $\text{PM}_{1/2.5/10}$ on a 15s basis
- About the size of a shoe box
- 10 sensors deployed
- “Low cost”
- Send data to cloud through 4G
- 3-pin power (low consumption)
 - ~6h backup battery



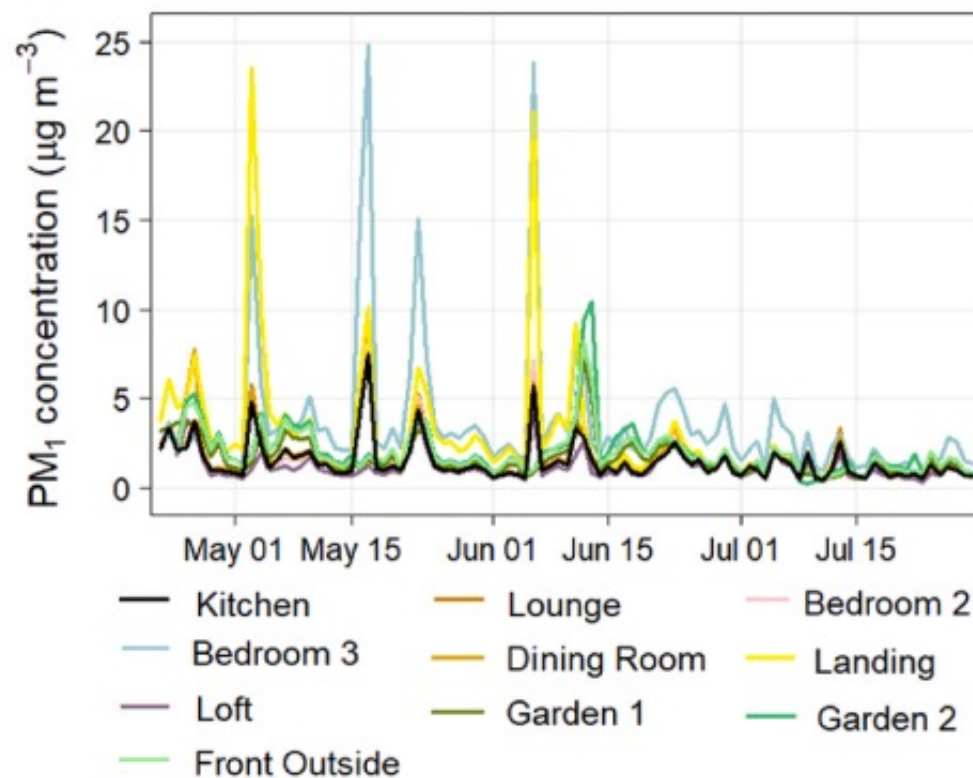
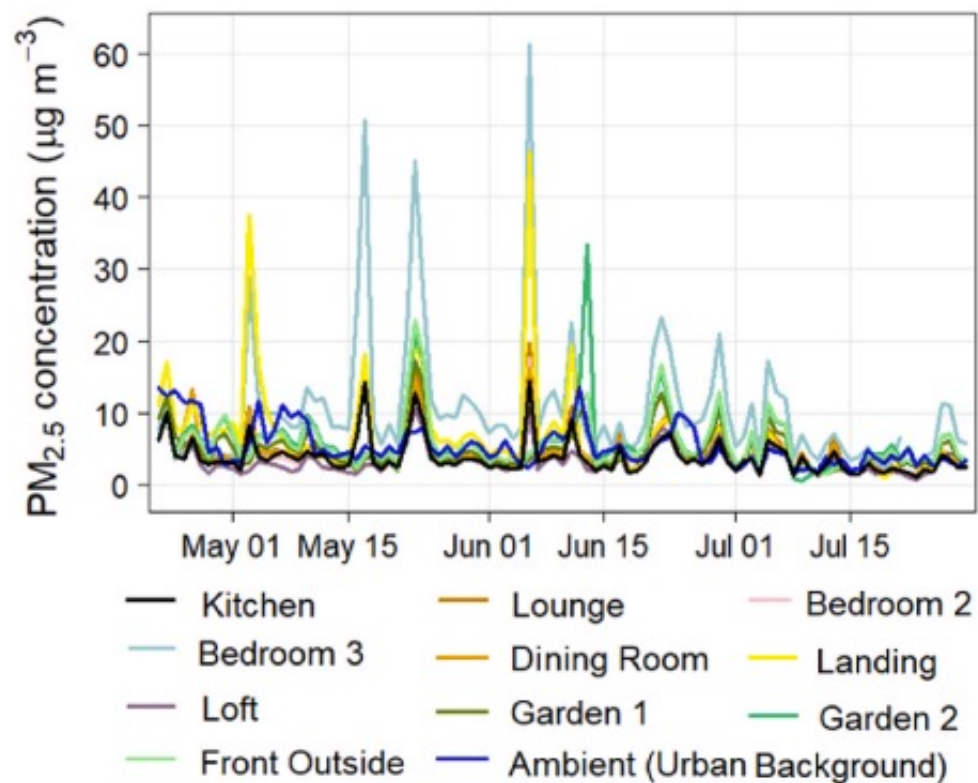
Sensor locations



Sensor locations

Location	Sensor reference	Primary activities/potential particulate and NO ₂ sources	Ventilation	Sampling location	Sensor height (m above floor level)
Kitchen	A	Cooking, cleaning	Window, door, recirculating exhaust fan	On countertop	1.05
Dining Room	B	Cooking, cleaning	Window, door	Table	0.75
Lounge	C	Cleaning	Window	Bookshelf	0.9
Landing	D	Cleaning, (gas) boiler	Window	Table	0.7
Loft	E	None	Window	Floor	0
Bedroom 2 (upstairs)	F	Cleaning	Window	Desk	0.75
Bedroom 3 (upstairs) – used as a study	G	Cleaning, printing	None	Filing cabinet	1.05
Front outside	H	Outdoor	N/A	On front wall of house facing road (8 m from road edge)	4.4 (above ground)
Garden 1	I	Outdoor	N/A	On floor under rain shelter	0
Garden 2	J	Outdoor	N/A	Under rain shelter	1.95

What do we see



What do we see

Hourly mean PM_{2.5}, PM₁ and NO₂ concentrations and summary statistics.

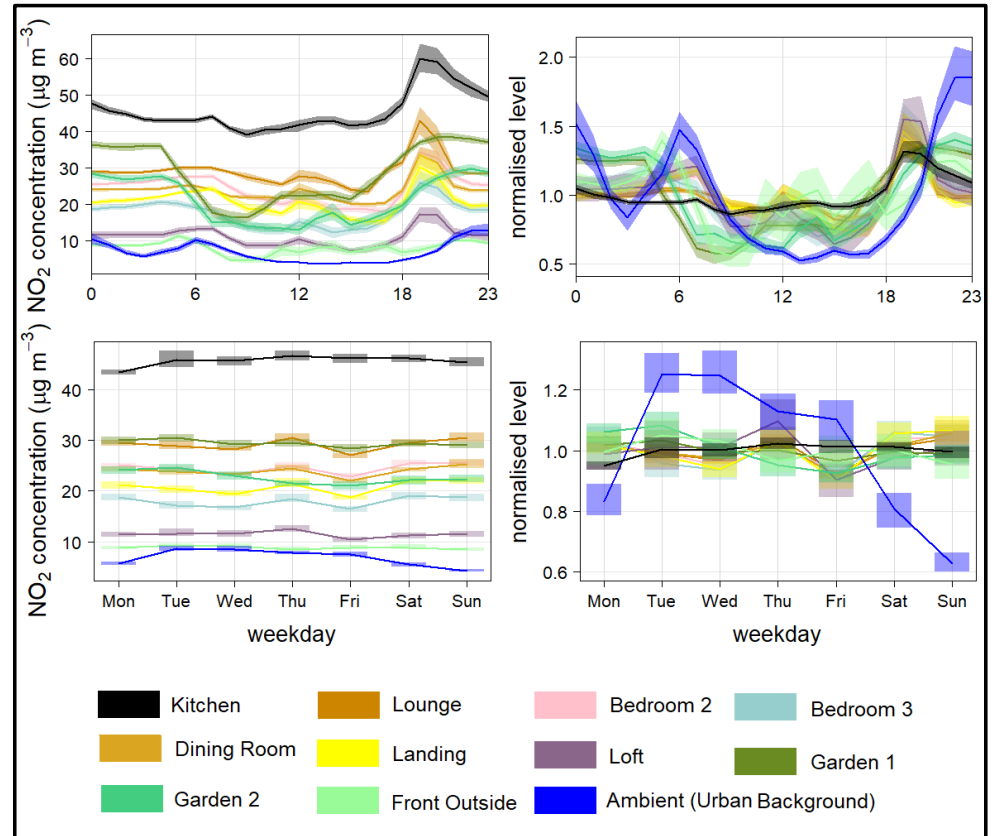
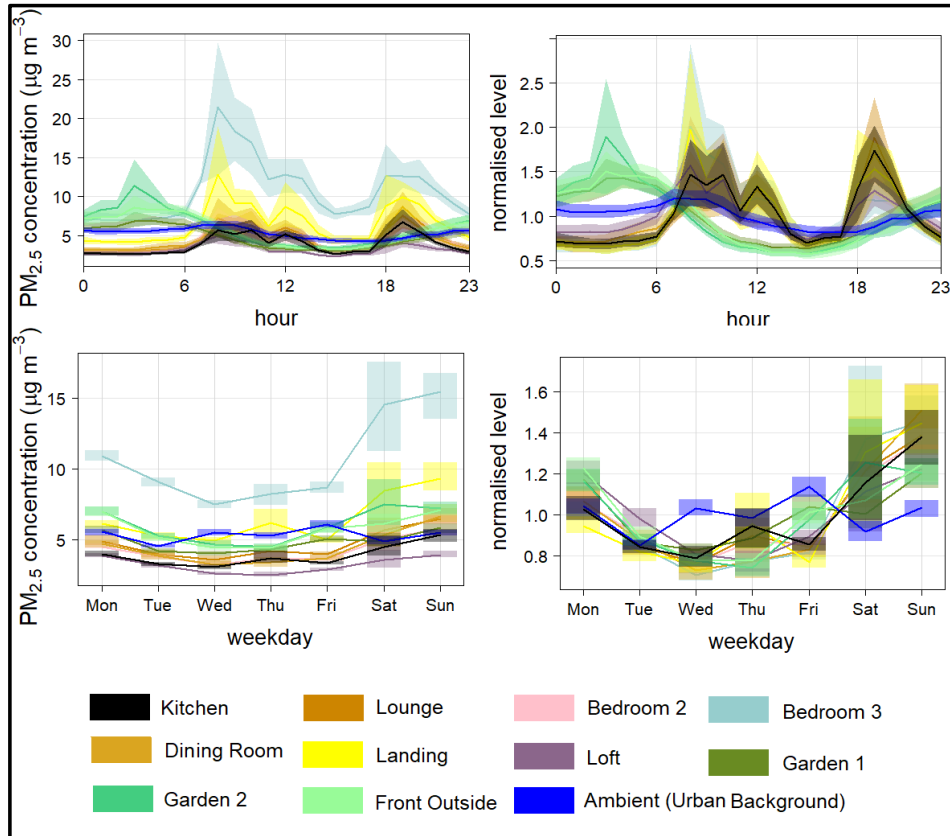
Location	PM _{2.5} (mean) in µg m ⁻³	PM _{2.5} (range) in µg m ⁻³	PM ₁ (mean) in µg m ⁻³	PM ₁ (range) in µg m ⁻³	NO ₂ (mean) in µg m ⁻³	NO ₂ (range) in µg m ⁻³
Kitchen (A)	3.87	0.26–127.13	1.50	0.10–52.10	45.58	5.15–221.07
Dining room (B)	4.41	0.26–148.53	1.63	0.11–55.91	23.91	1.91–184.04
Lounge (C)	4.65	0.26–222.94	1.68	0.10–75.99	29.18	0.84–238.87
Landing (D)	6.48	0.28–537.26	2.87	0.13–239.16	20.77	0.06–156.27
Loft (E)	3.21	0.24–104.94	1.15	0.10–43.18	11.50	0.05–95.20
Bedroom 2 (F)	4.22	0.32–172.70	1.62	0.14–71.73	24.52	0.24–105.97
Bedroom 3 (G)	10.68	0.57–769.07	3.67	0.21–300.99	17.93	0.03–152.2
Front outside (H)	5.72	0.54–111.52	1.96	0.21–39.15	8.87	0.05–36.23
Garden 1 (I)	4.83	0.47–69.38	1.68	0.15–29.63	29.42	0.04–75.70
Garden 2 (J)	6.00	0.10–86.40	2.10	0.10–66.38	22.71	0.07–86.47
St. Ebbe's urban background (AURN)	5.32	0.48–29.71	N/A	N/A	6.87	0.36–72.0

What do we see

Percentage of study days exceeding WHO Global Air Quality guidelines (24-h average) for PM_{2.5}/NO₂ concentrations during the study period.

Location	PM _{2.5} – Percentage of days exceeding the WHO Global Air Quality Guideline (24-hr average) value of 15 µg/m ³ from the total study period (100 days).	NO ₂ – Percentage of days exceeding the WHO Global Air Quality Guideline (24-hr average) value of 25 µg/m ³ from the total study period (100 days).
Kitchen (A)	2 %	100 %
Dining room (B)	2 %	35 %
Lounge (C)	3 %	80 %
Landing (D)	8 %	17 %
Loft (E)	3 %	3 %
Bedroom 2 (F)	2 %	50 %
Bedroom 3 (G)	15 %	5 %
Front outside (H)	3 %	0 %
Garden 1 (I)	1 %	78 %
Garden 2 (J)	3 %	28 %
St. Ebbe's urban background (AURN)	3 %	0 %

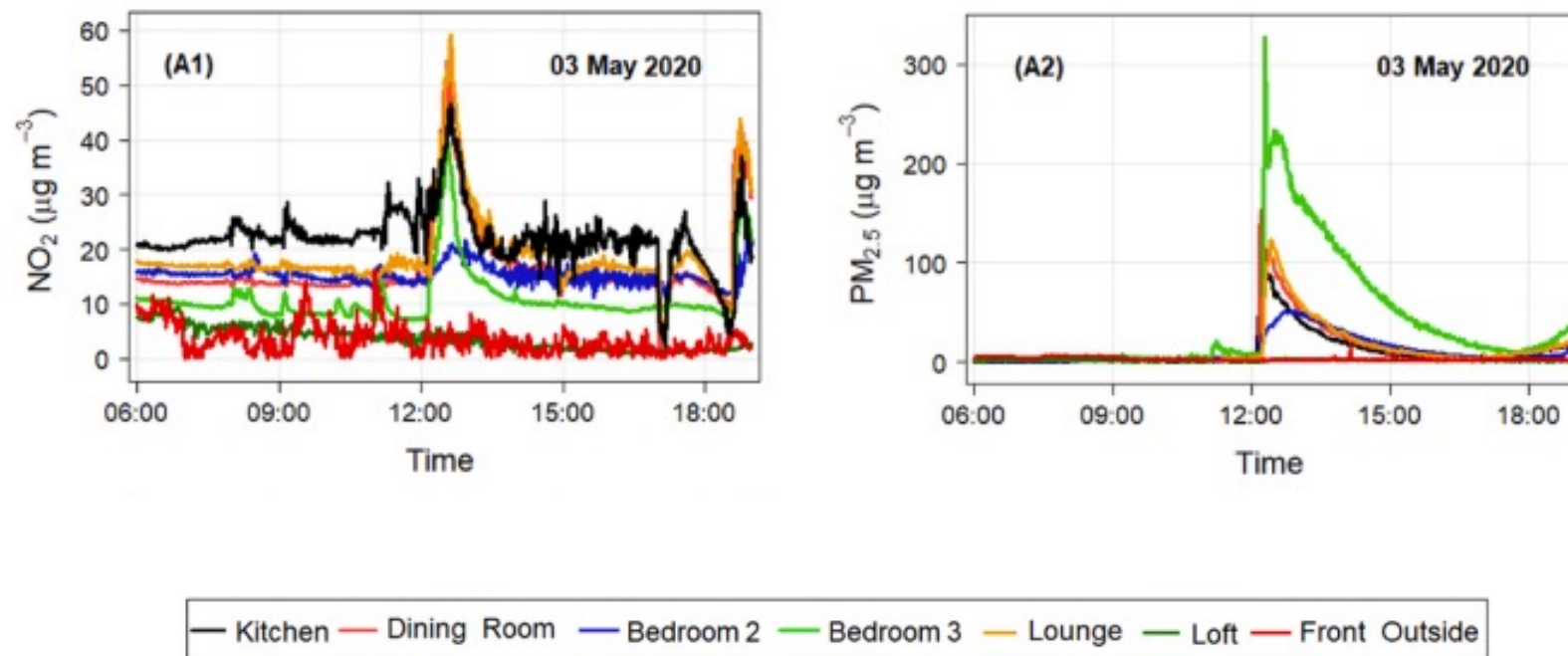
Time of day analysis



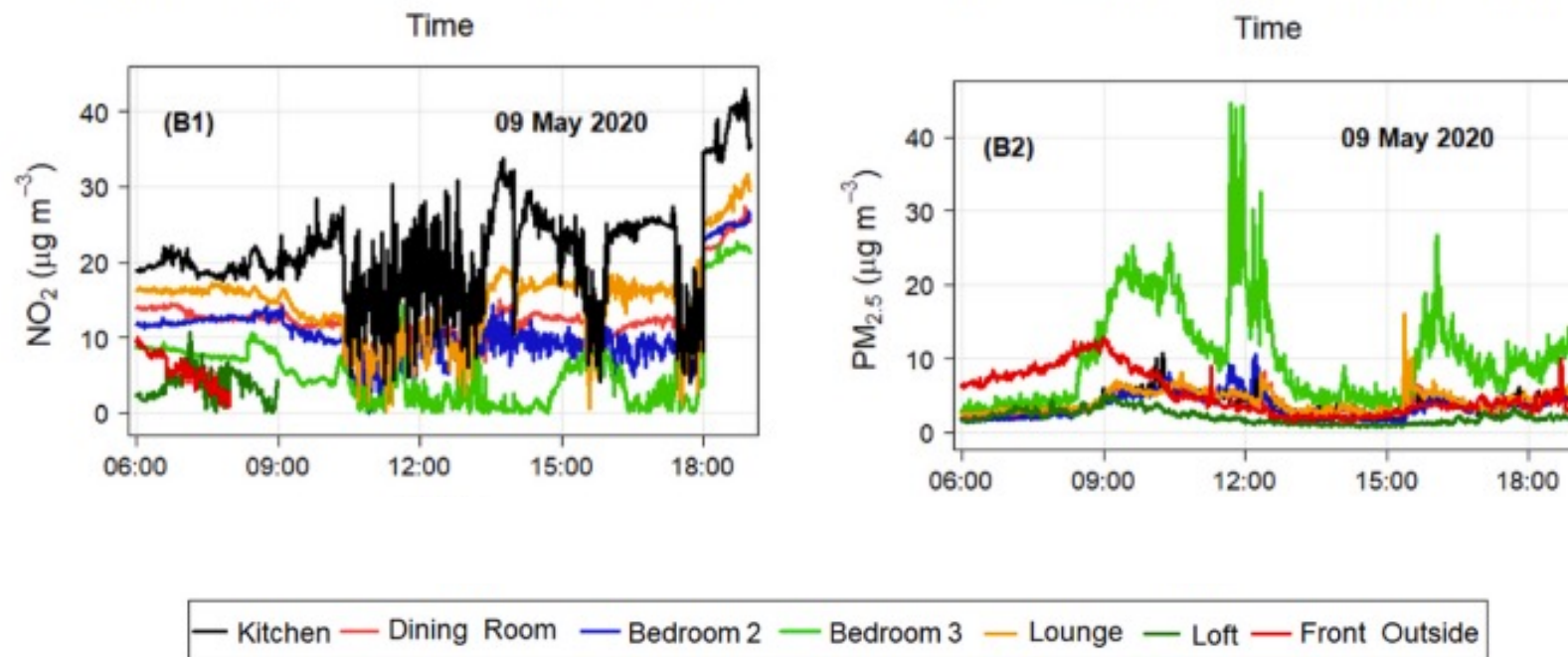
Indoor vs outdoors

I/O Ratios	PM _{2.5}	NO ₂
Kitchen (A)	0.93	11.55
Dining room (B)	1.10	6.11
Lounge (C)	1.22	7.49
Landing (D)	1.51	5.57
Loft (E)	0.77	2.95
Bedroom 2 (F)	1.00	6.20
Bedroom 3 (G)	2.63	4.73
Overall	1.28	6.54

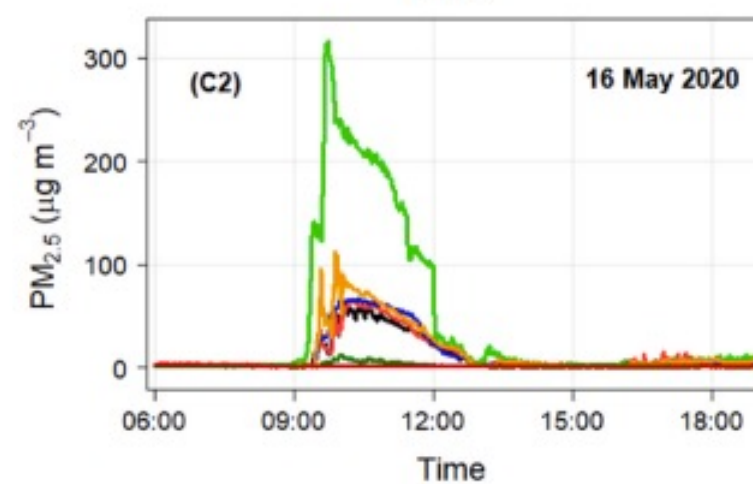
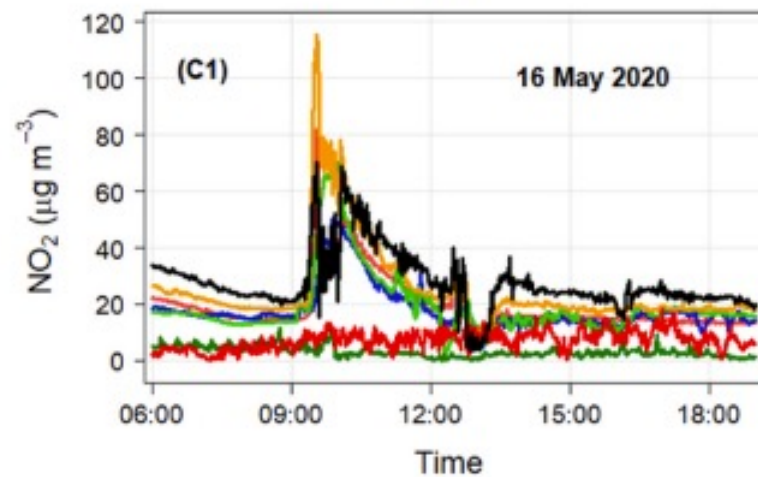
Impact of typical household activities: Frying with gas



Impact of typical household activities: Vacuuming

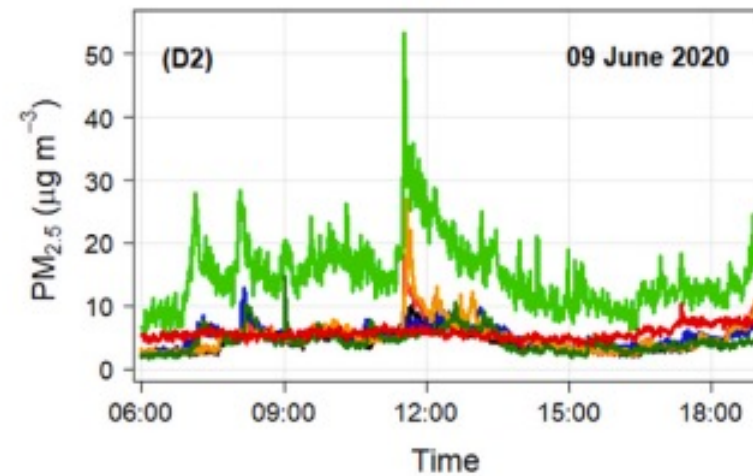
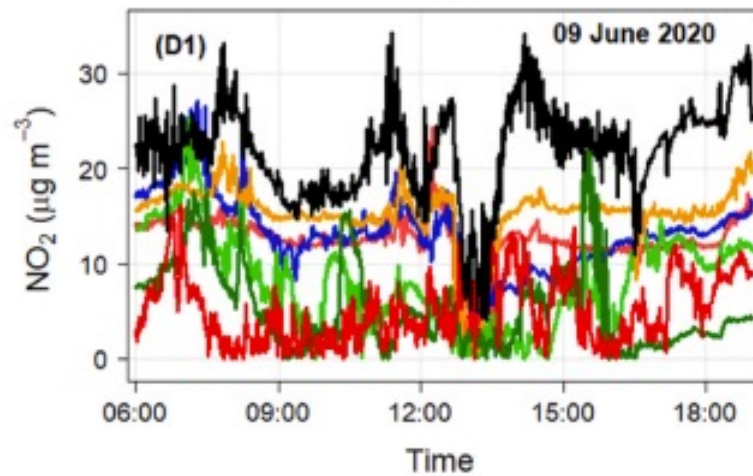


Impact of typical household activities: Burning my breakfast



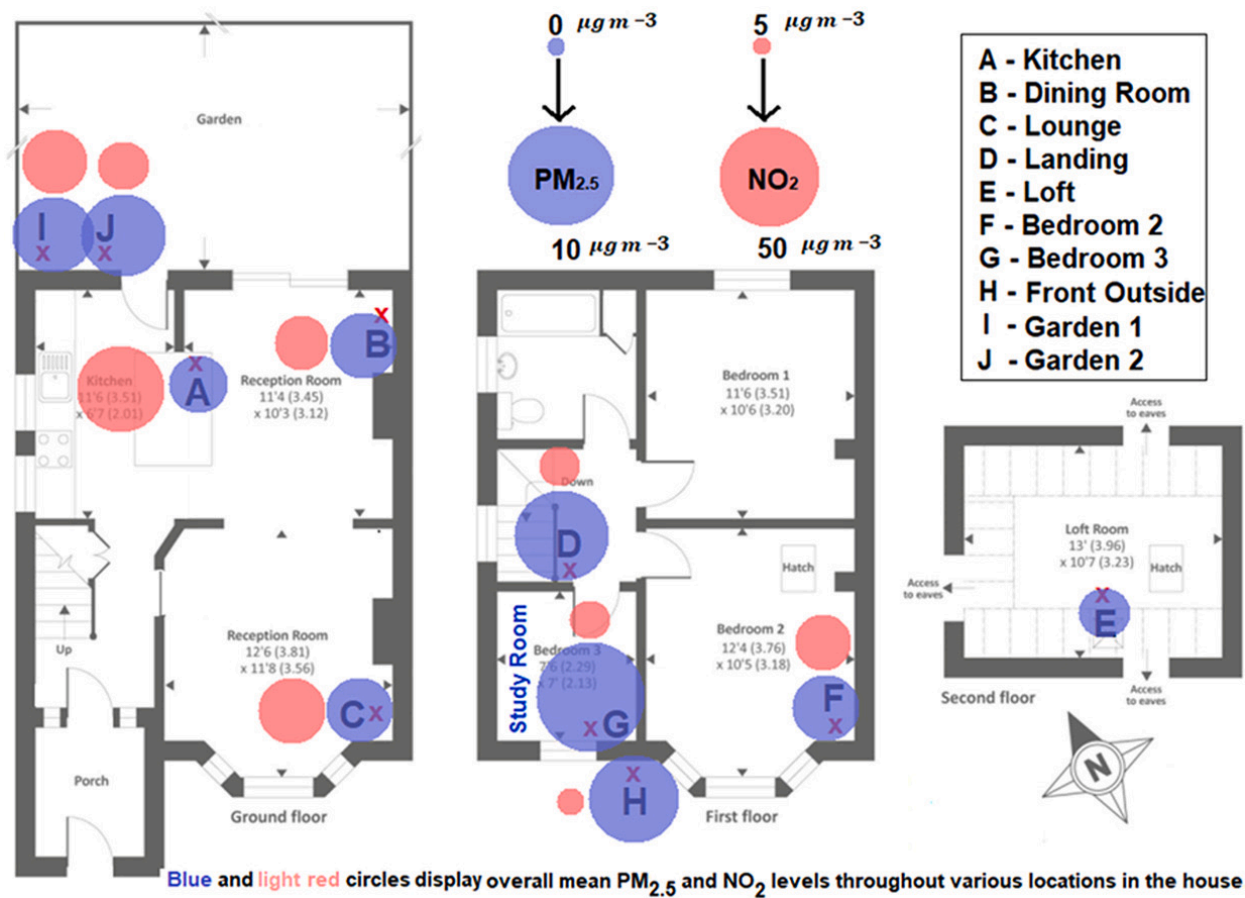
— Kitchen — Dining Room — Bedroom 2 — Bedroom 3 — Lounge — Loft — Front Outside

Impact of typical household activities: Printing



— Kitchen — Dining Room — Bedroom 2 — Bedroom 3 — Lounge — Loft — Front Outside

Overall results



Takeaways

- Ventilate, ventilate, ventilate
 - Helps with other things too
- If you can, take gas out of your home
 - Start with cooking
- It can take hours to revert to background levels
- Recirculating extract hoods don't help NO_x
- Burning anything indoors is bad



I want to know more



Contents lists available at [ScienceDirect](#)

Heliyon

journal homepage: www.cell.com/heliyon



Research article

Impacts of daily household activities on indoor particulate and NO₂ concentrations; a case study from oxford UK

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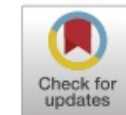
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Thank you



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