In2Air
The air we breathe

The impact of 'net-zero' household energy intervention on indoor air quality, health and well-being

The In2Air team:

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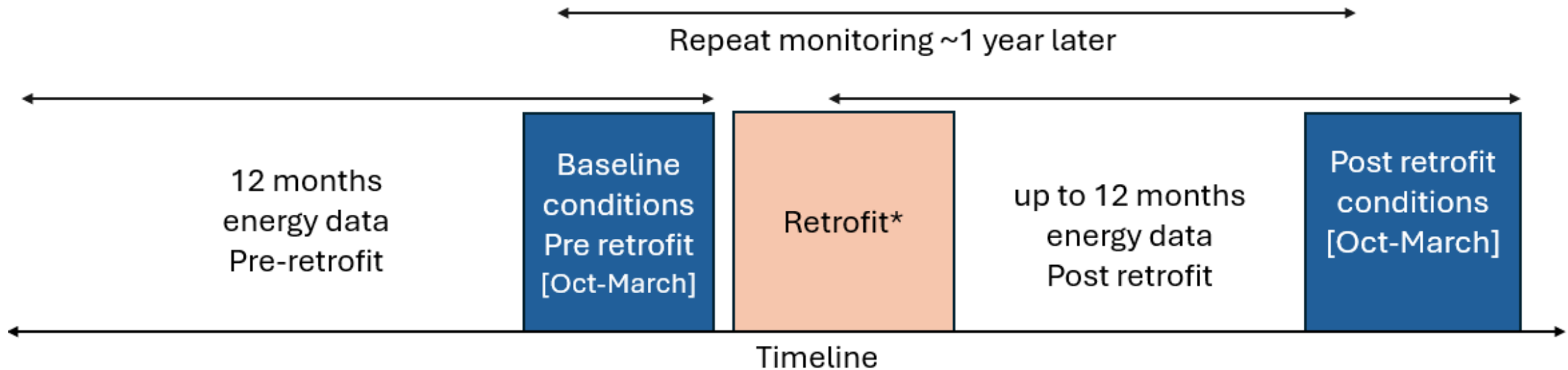
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The In2Air study

- **Aim:** Evaluate changes in indoor air quality, energy consumption, health and well-being resulting from 'fabric-first' household energy efficiency interventions*

- **Study Design:** non-randomized natural experiment; social housing in North-East, UK

- **Sample Size:** 90 study homes and 90 control homes

Repeat monitoring ~1 year later

| 12 months energy data Pre-retrofit | Baseline conditions Pre retrofit [Oct-March] | Retrofit* | up to 12 months energy data Post retrofit | Post retrofit conditions [Oct-March] |

Timeline

*Retrofit funded through the UK Government's Social Housing Decarbonisation Fund

Outcome Measures

- **Primary:** Change in indoor concentration of $PM_{2.5}$

- **Secondary #1:** Change in indoor conc. of CO_2, temp., relative humidity.

  Indoor [and 'paired' co-collected outdoor] air quality monitors (IQAir)

- **Secondary #2:** change in general health and wellbeing metrics

  Standard 'validated' surveys: ICECAP-A (UoBristol), SF-36v2 (QualityMetric)

  Use of Health and Care Services survey

- **Secondary #3:** change in energy consumption in homes (kW/h)

  12 months of gas/electric statements (before & again after retrofit)

Economic Evaluation – Overview

To evaluate cost-effectiveness and broader economic impact of installing retrofitting interventions, through quantification of resources used and consequences, to estimate overall social return on investment (SROI).
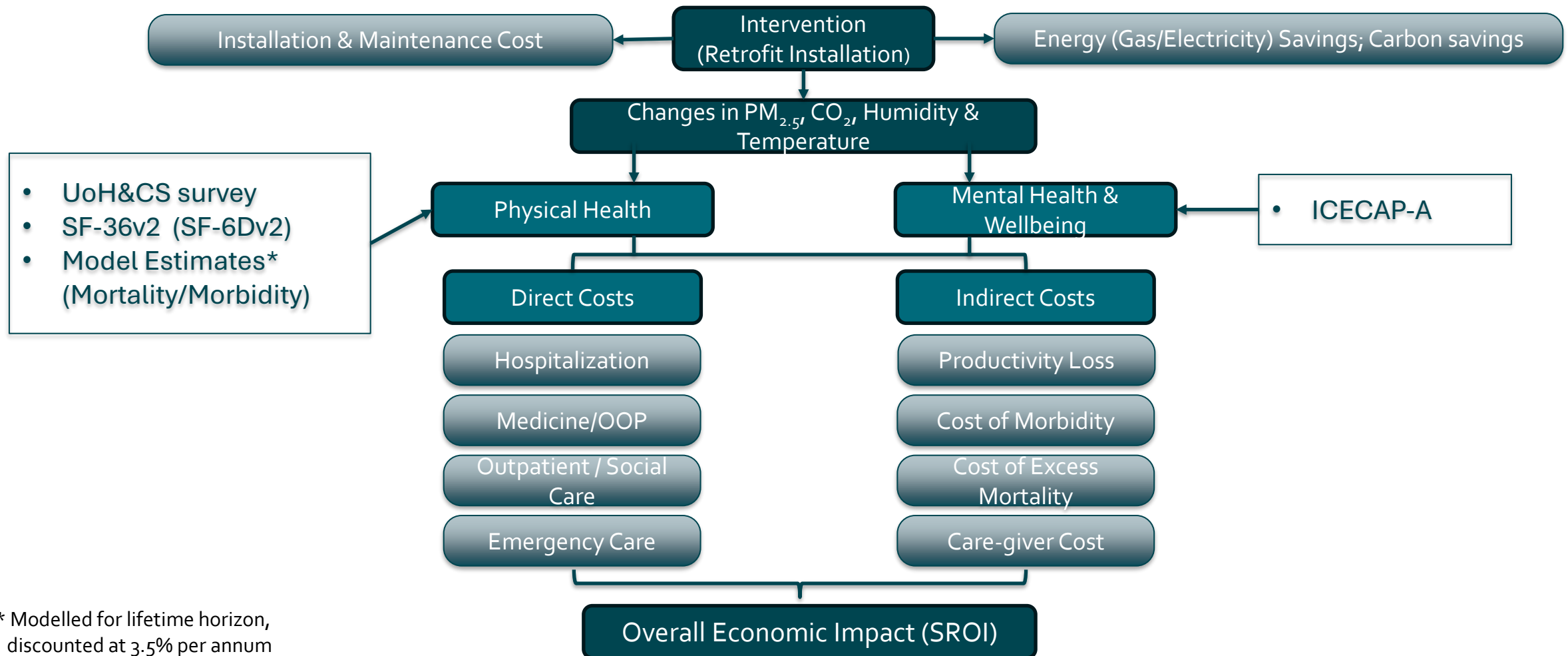
* Modelled for lifetime horizon, discounted at 3.5% per annum

Participant Recruitment & Journey

Phase 1: Initial Contact
- Letter from housing provider
- Community specific event(s)
- Participant expresses interest

Phase 2A: In-home Enrolment Visit
- Informed consent
- Home & Household Survey
- Sensors installed
- Level 1 Energy Audit
- Health & Wellbeing Surveys

PAS2035 'Fabric First' Energy Efficiency & Post-retrofit 'settling-in' period

~3 weeks later

Phase 2B: End of Monitoring Visit
- Retrieve sensors
- Post-monitoring Survey 1
- Energy bills
- Thank you voucher

PM2.5 alerting threshold

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PAS2035 'Fabric First' Energy Efficiency & Post-retrofit 'settling-in' period

Home results in feedback letter

Personalised Feedback

Phase 3A: In-home Post-Retrofit Visit
- Repeats 2A

~3 weeks later

Phase 3B: End of Monitoring Visit
- Repeats 2B, but with
- Post-monitoring Survey 2 & semi-structured interview
- Thank you voucher

Personalised Feedback

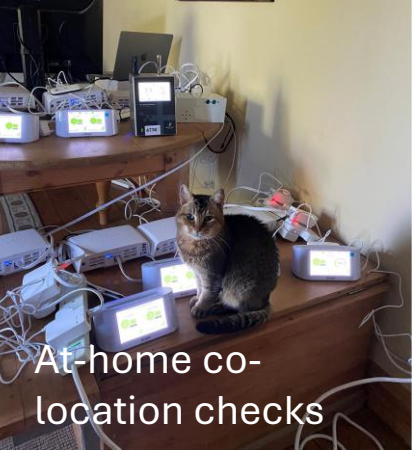# Year one update: QA procedures

BRE environment test chamber

BRE set-up

At-home co-location checks

Co-location comparison data for PM$_{2.5}$ and CO$_2$

- CO$_2$ concentration range: 429 to 2306 ppm
- PM$_{2.5}$ concentration range: 2 to 100.5 μg/m^3
- Source of PM test atmosphere: Salt aerosol generated within the chamber from a TSI model 8026 particle generator

Homes, with an EPC rating of D or below, are receiving a mix of **'fabric-first' upgrades**:

- New doors and/or windows (A+ rating with trickle vents)
- Additional loft insulation
- External wall insulation

As well as **upgraded ventilation** (e.g. extractor fans in 'wet' areas ie bathroom and/or kitchen)

Renewable heating: PV Solar panels/air-source heat pumps

Tower blocks

Terraced bungalows ('the Greens')
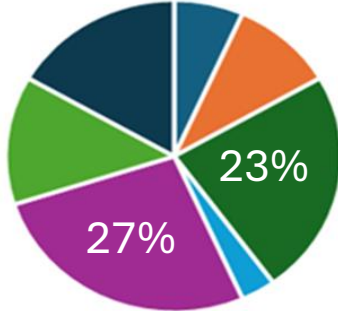

Semi-detached

Year one update: participants
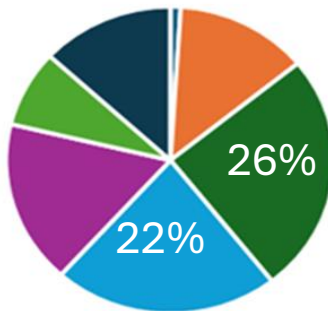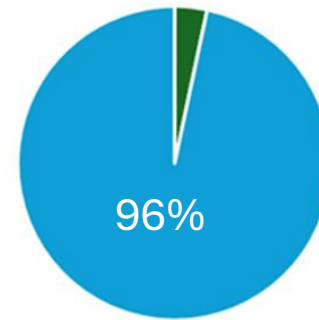

Age of Participants (years)

Bungalows N= 30 — 90%

Towers N= 20 — 23%, 27%

Controls N= 49 — 26%, 22%

Legend: ■ <16 ■ 16-24 ■ 25-34 ■ 35-44 ■ 45-54 ■ 55-64 ■ 65 +
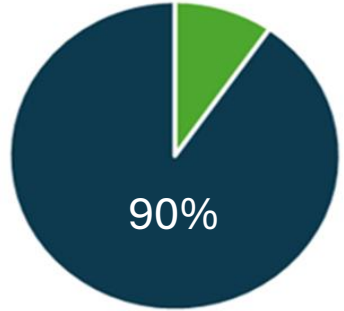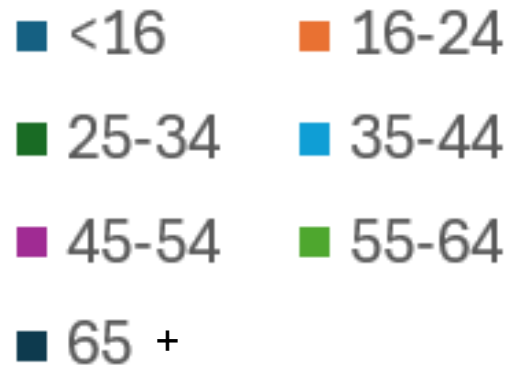
Ethnicity of Participants

Bungalows — 96%

Towers — 47%

Controls — 77%

Legend: ■ Asian ■ Black ■ Mixed ■ White ■ Other
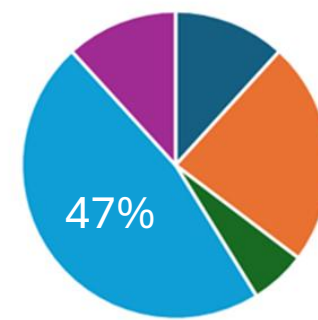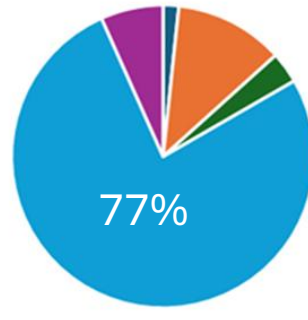
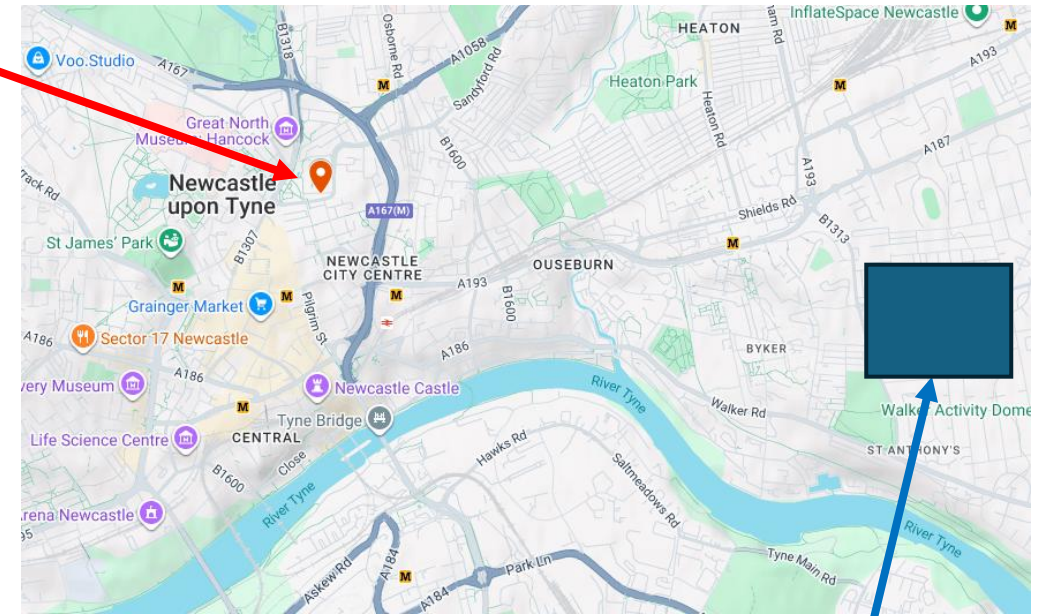# Year one update: Daily ave. indoor PM₂.₅ at baseline
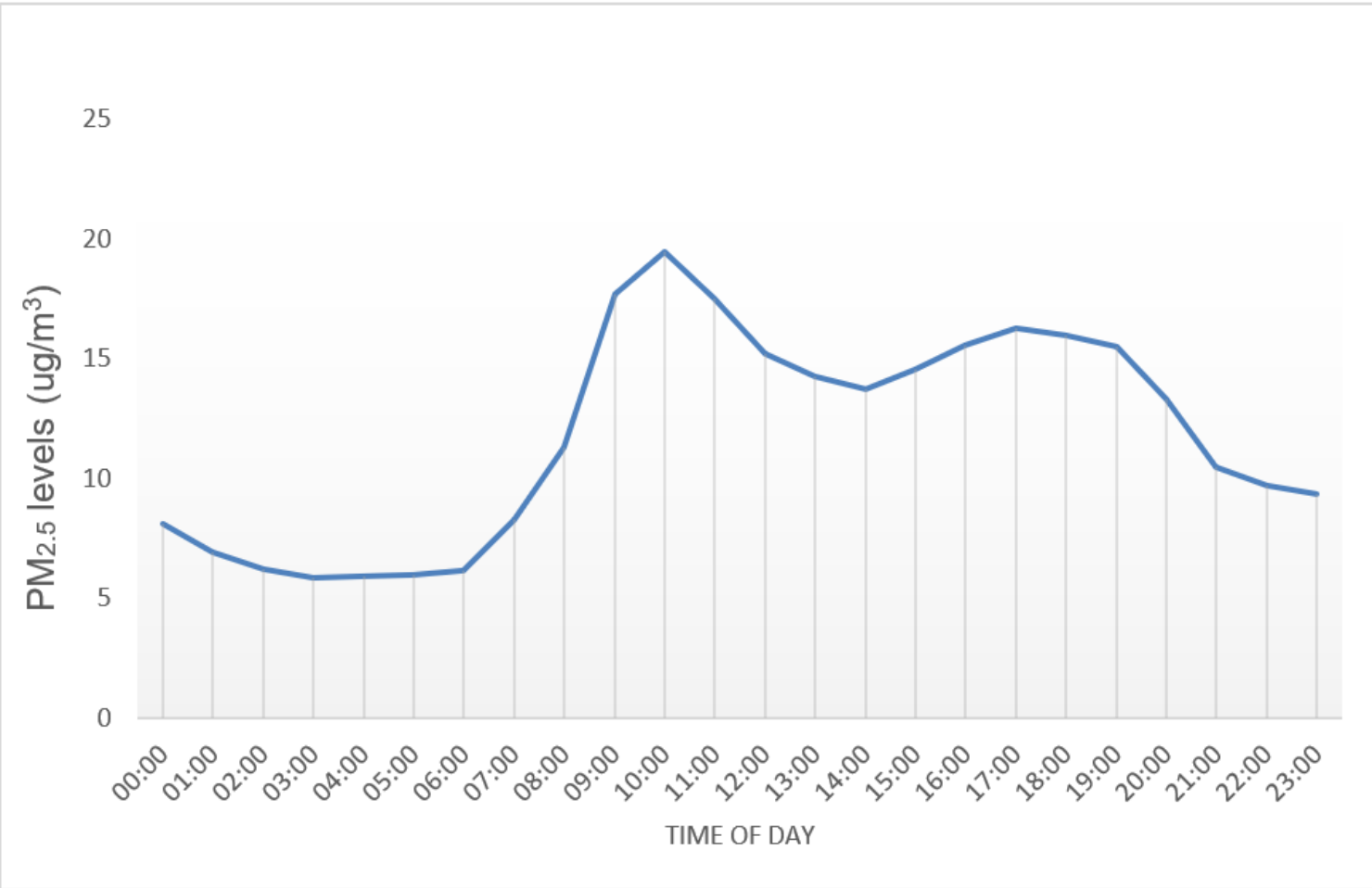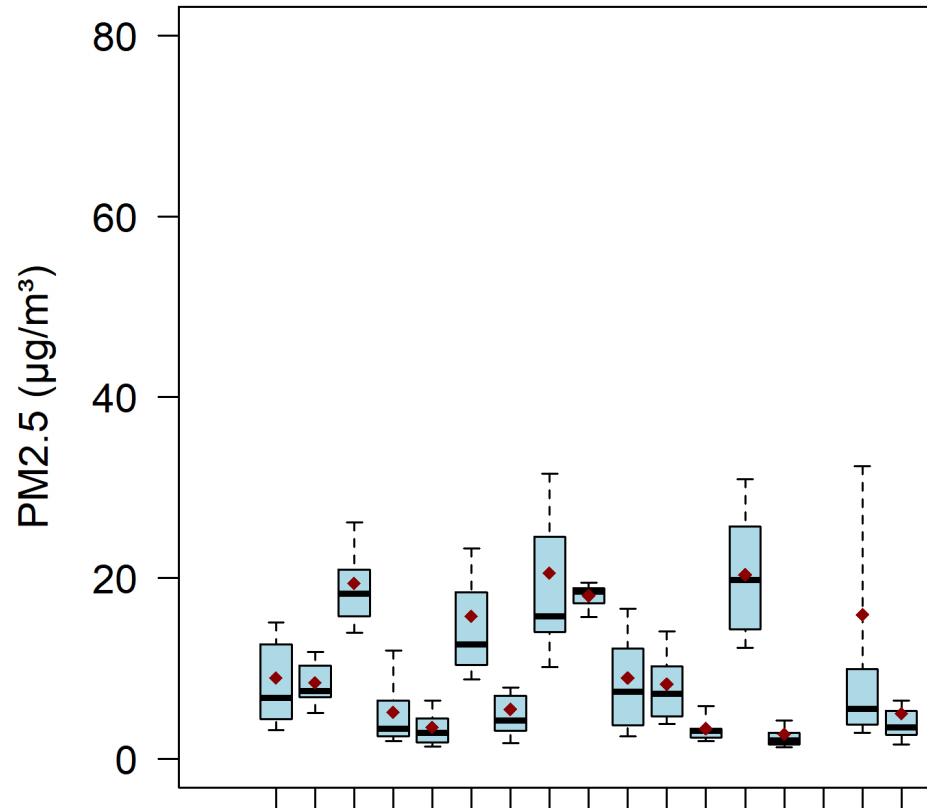
Unpublished data

Outdoor data Greens vs AURN

Issues to work through:

How best to incorporate weather conditions in the analysis?

AURN site

Greens sites 3 km away
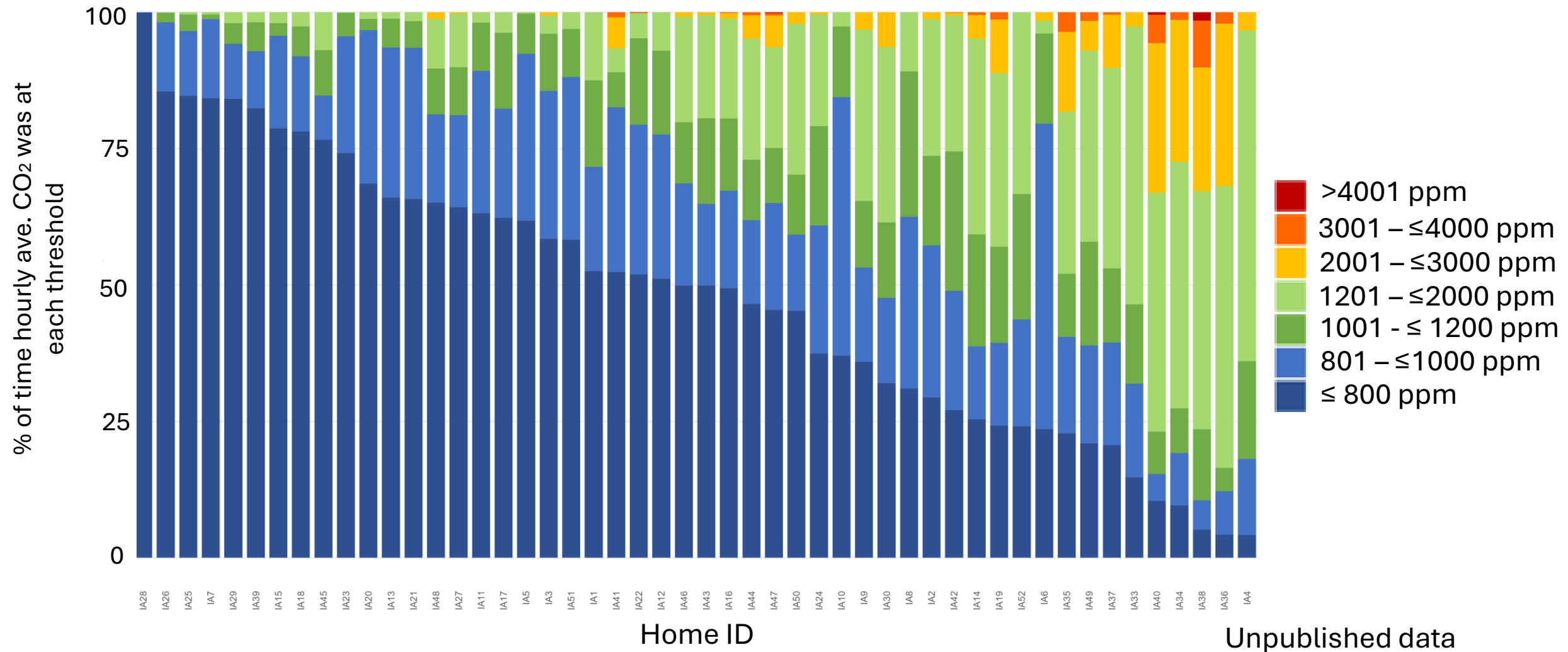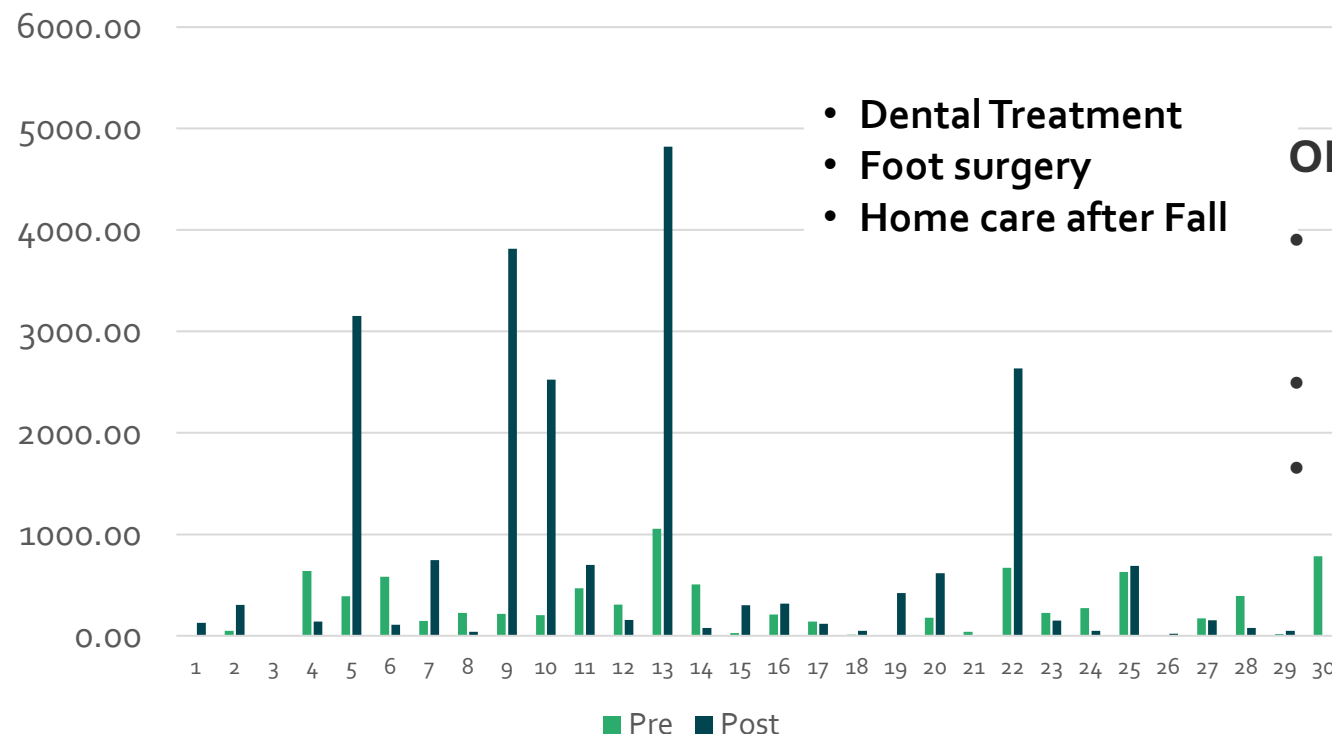
PM$_{2.5}$ in the AURN background and Monkchester homes 2025
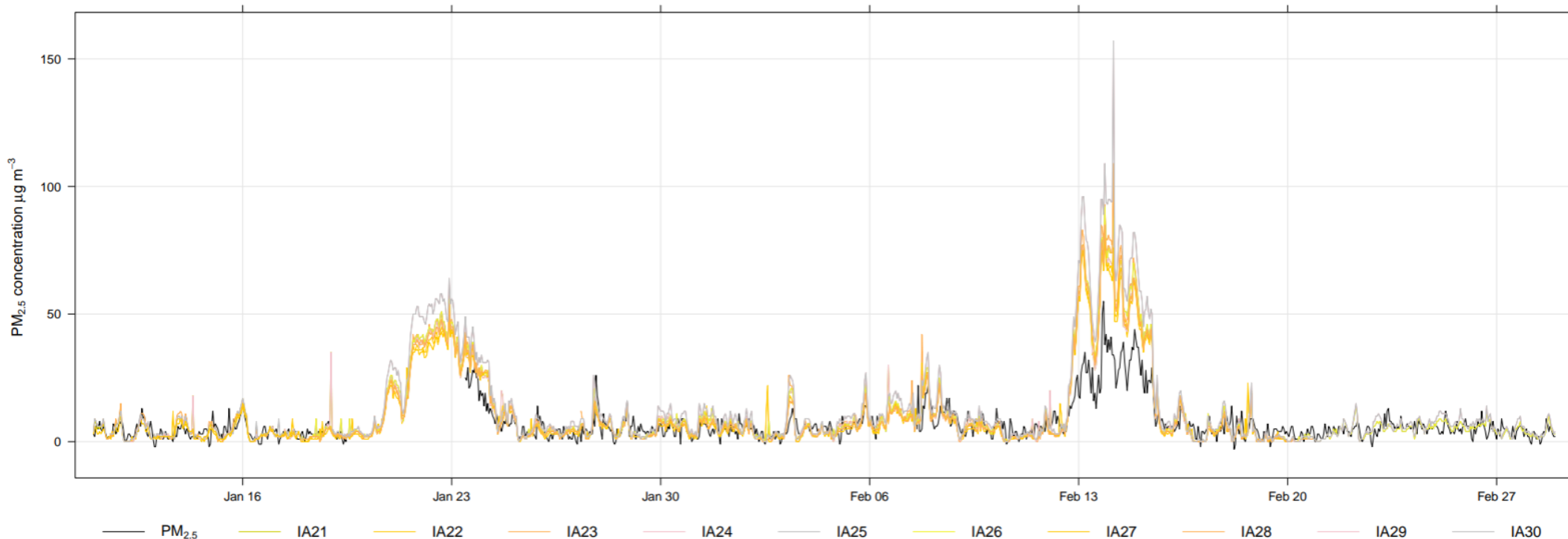
Year one update: Hourly ave. indoor CO_2 at baseline

50% of households where below 1000 ppm for at least 75% of the time

% of time hourly ave. CO_2 was at each threshold

Home ID

Unpublished data

Legend:
- >4001 ppm
- 3001 – ≤4000 ppm
- 2001 – ≤3000 ppm
- 1201 – ≤2000 ppm
- 1001 - ≤ 1200 ppm
- 801 – ≤1000 ppm
- ≤ 800 ppm

Year one update: Economic Evaluation – Progress

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Preliminary Results: Utilisation of Services – Pre and Post Costs (£) in the bungalow cohort

- **Dental Treatment**
- **Foot surgery**
- **Home care after Fall**

Legend: Pre, Post

	Pre	Post
Median	£ 212.63	£ 152.46

Observations and issues to work through:

- Identification of health/care costs not associated with indoor air quality – sensitivity analysis?

- How do we adjust for smokers – sensitivity analysis?

- Can one-year follow-up data be projected to estimate long-term health impacts?

Unpublished data

Next Steps……

- Baseline monitoring with Gentoo (in Sunderland) and Northumberland County Council (in Blyth) just getting underway

- Post-retrofit monitoring of the tower blocks to start in January.

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Thank you

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