Ventilation Performance - does MVHR work?

Prof. Tim Sharpe

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Sometimes..

Thank You.

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Context

- Energy reduction targets
- Performance Gaps - energy and environmental performance

- Increasing importance of ventilation - energy and health
- Emphasis has been on energy benefits
- 90% efficiency!

- Indoor Air Quality an increasing issue
- Potential unintended negative consequences?

Relevant recent projects

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- EPSRC Assessment of Environmental and Energy effects of Domestic Laundering (100 + 40 houses)
- AHRC Study, sunshine and well-being in housing (40 houses)
- Scottish Building Standards - Guidance for Occupants of Low Energy Homes
- Knowledge Transfer Partnership with Cartwright Pickard Architects, London (20 houses on 5 sites)
- Scottish Building Standards - Research Project To Investigate Occupier Influence On Indoor Air Quality In Dwellings (200 + 40 houses

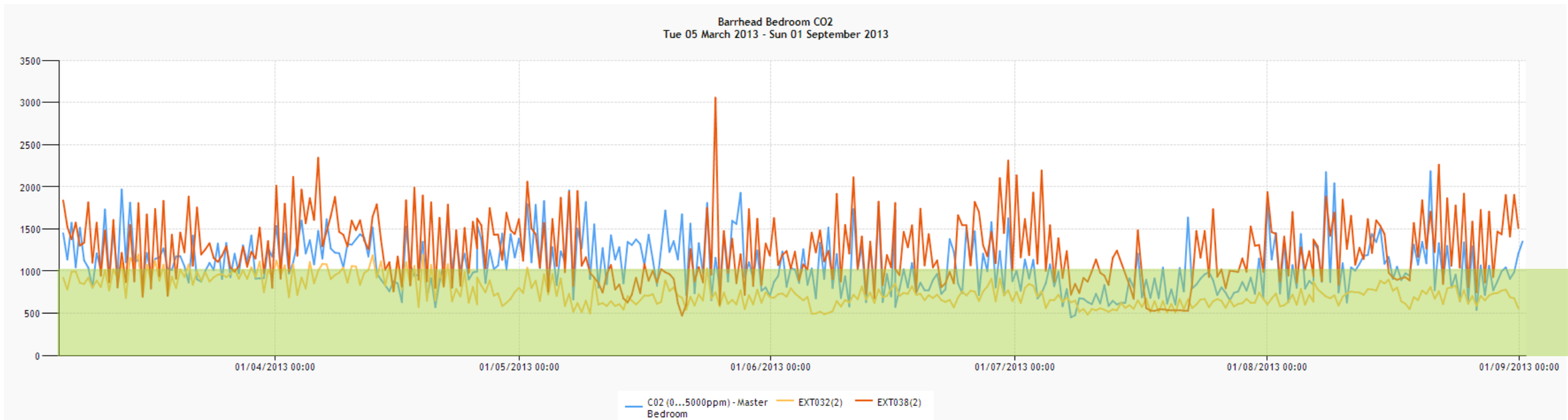
- Technology Strategy Board (Innovate UK) Building Performance Evaluation Programme
  - Expert Evaluator
  - The Glasgow House (Phase 1)
  - Inverness expo (8 houses)
  - Bloom Court Livingston (2 + 6 houses)
  - Ti-na-Cladich, Dunoon (3 houses)
  - Queens Cross, Glasgow (6 houses)
  - Murray Place, Barrhead (3 houses)
  - Dormant Park (4 houses)
- Meta study of MVHR system in Domestic properties

Innovate UK
Technology Strategy Board

Ventilation observations

- IUK PBE studies
- Observed through measurements of CO_2
- Under 1000ppm = 8 l/s/p = good ventilation

"..ventilation rates above 0.4 h-1 or CO_2 below 900 ppm in homes seem to be the minimum level to protect against health risks based on the studies reported in the scientific literature" Wargocki, P. The Effects of Ventilation in Homes on Health. *Int. J. Vent.* **2013**; *12*, 101–118.



Bedrooms

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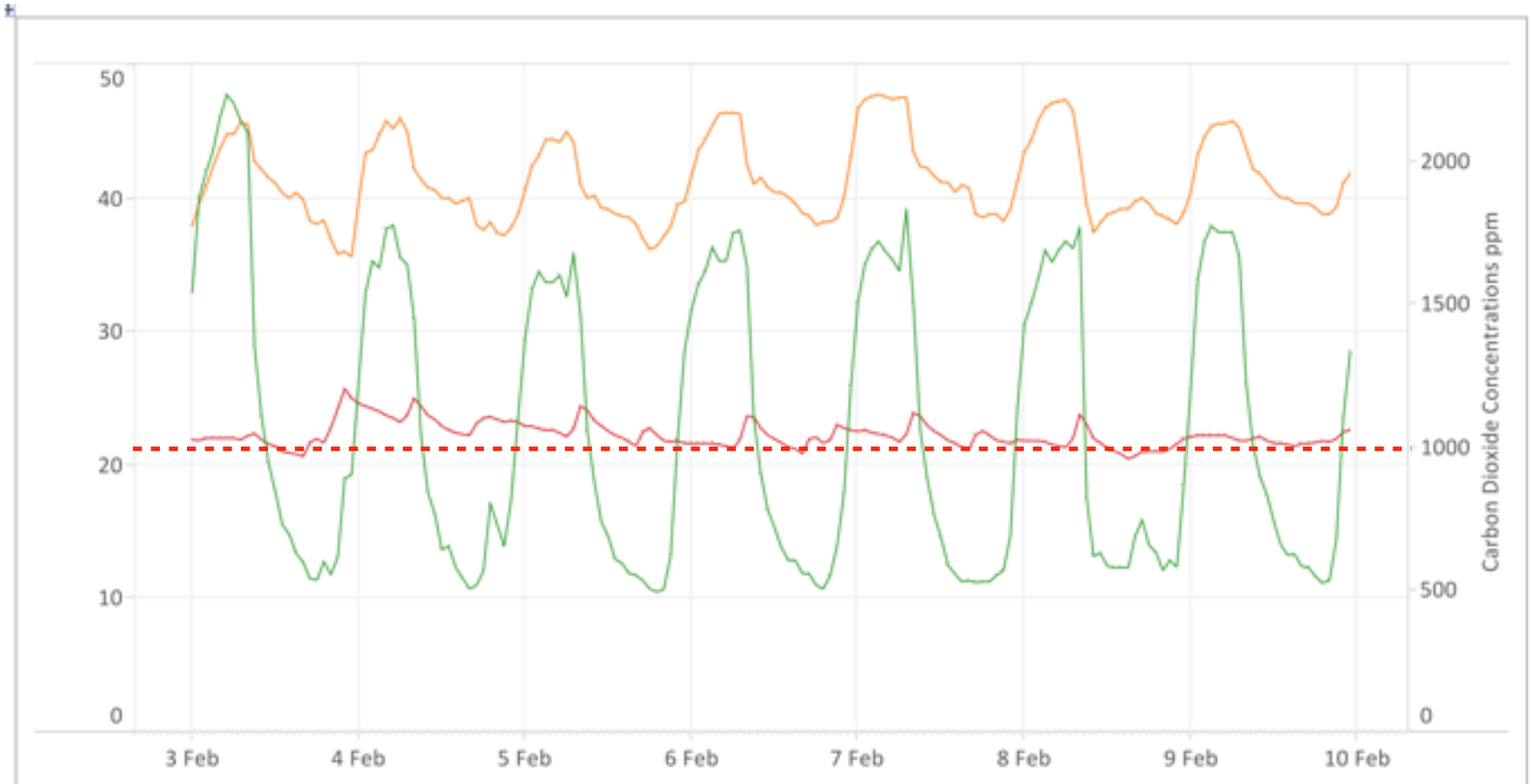
- Focus on bedrooms
- Clear periods and intensity of occupation
- Of interest due to the occupied length of time



ID2 – Master Bedroom Environmental Conditions 3rd – 9th February 2014

Legend
- Carbon Dioxide Concentrations pp..
- Relative Humidity %
- Temperature °C

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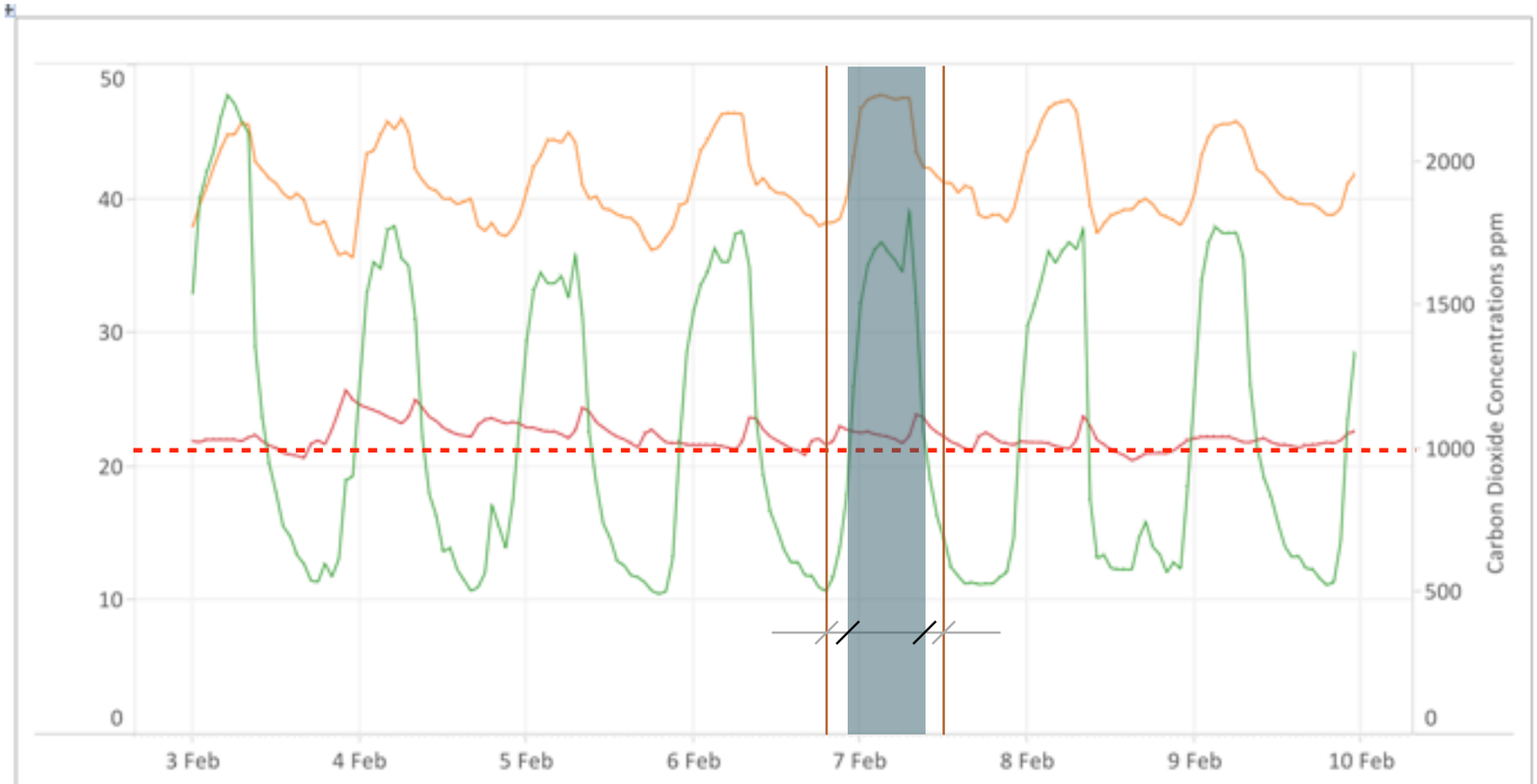
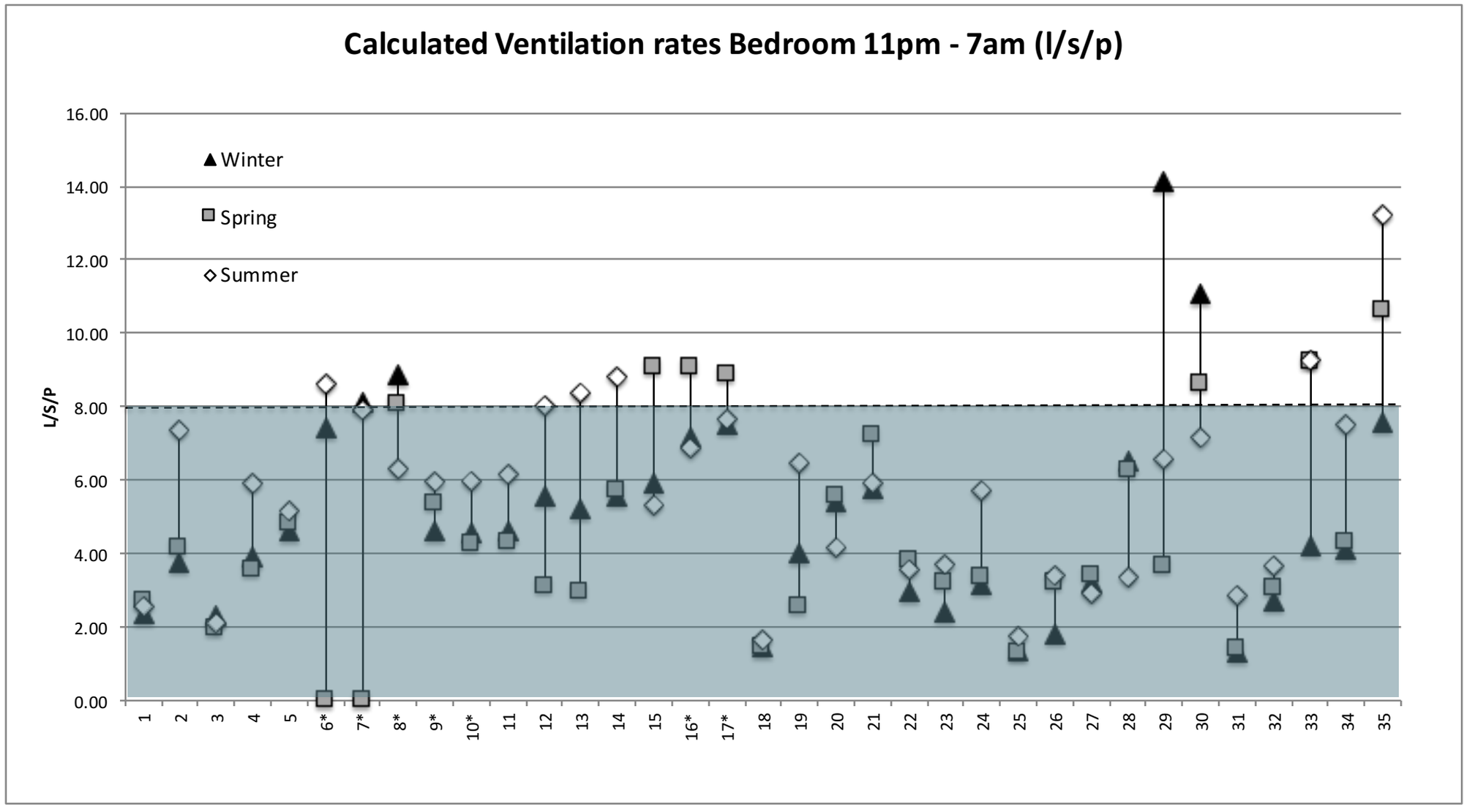


ID2 – Master Bedroom Environmental Conditions 3rd – 9th February 2014

Legend
- Carbon Dioxide Concentrations pp..
- Relative Humidity %
- Temperature °C

Ventilation effects

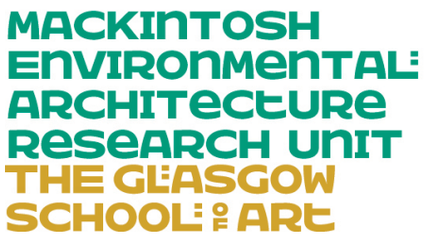
- Resulting ventilation rates are generally poor
- Mitigated mainly by window opening



Meta-Study Of Dwellings With MVHR Systems

Innovate UK

Tim Sharpe, MEARU
Ian Mawditt, Fourwalls
Rajat Gupta, OBU



MVHR meta study

- Good distribution across the UK
- 54 Study dwellings across 34 developments
- Development sizes range from 1 to 700
- 237 dwellings with MVHR
- 51 projects with detailed information
- 22 with consistent monitored data

- Limitations with the data
- General comparative analysis
- Still in analysis

- What do the CO_2 levels look like?
- What is the energy use?

Mechanical Ventilation

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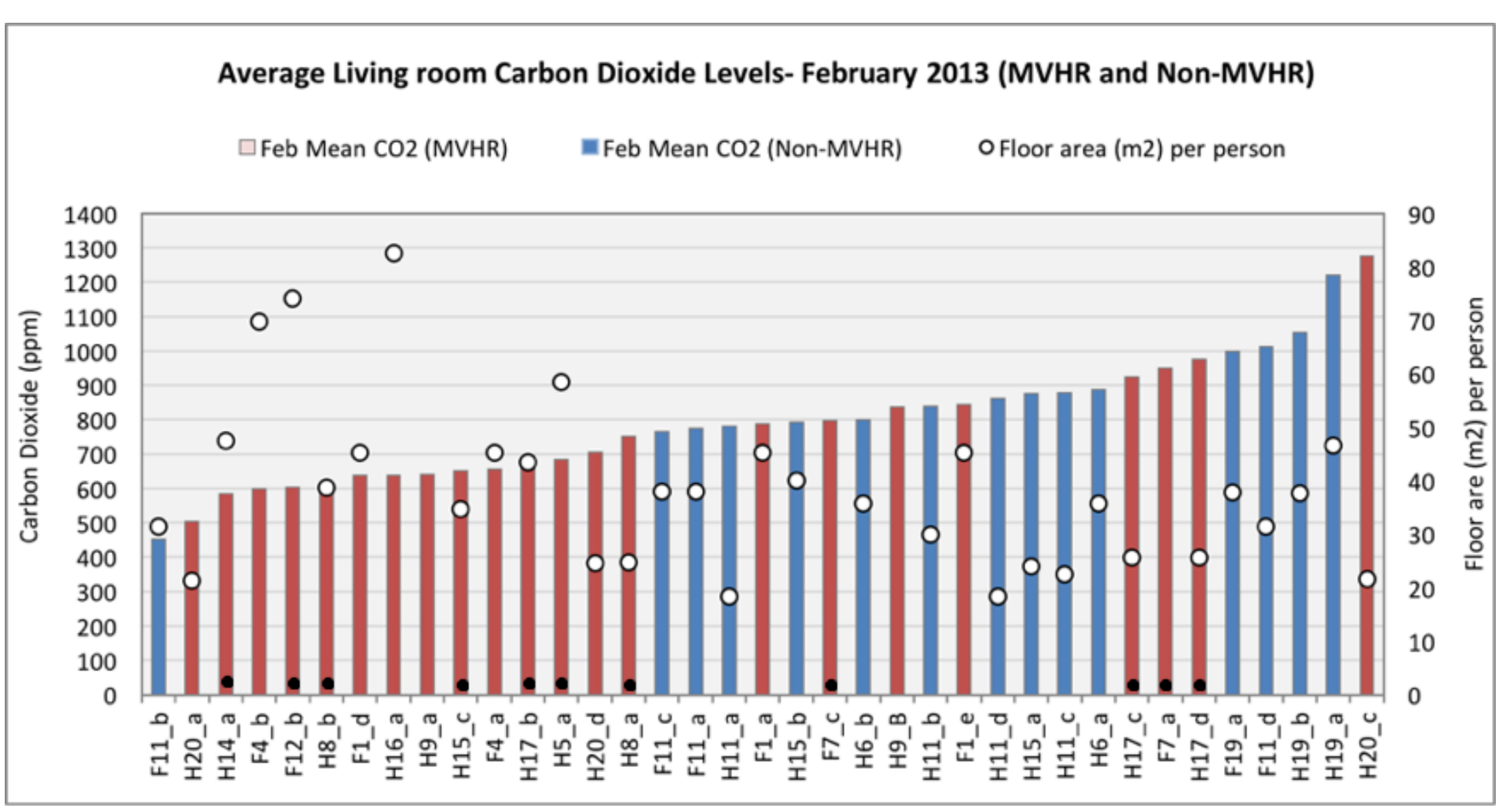
- Comparison of average and peak CO_2 levels in living rooms of MVHR and non MVHR*



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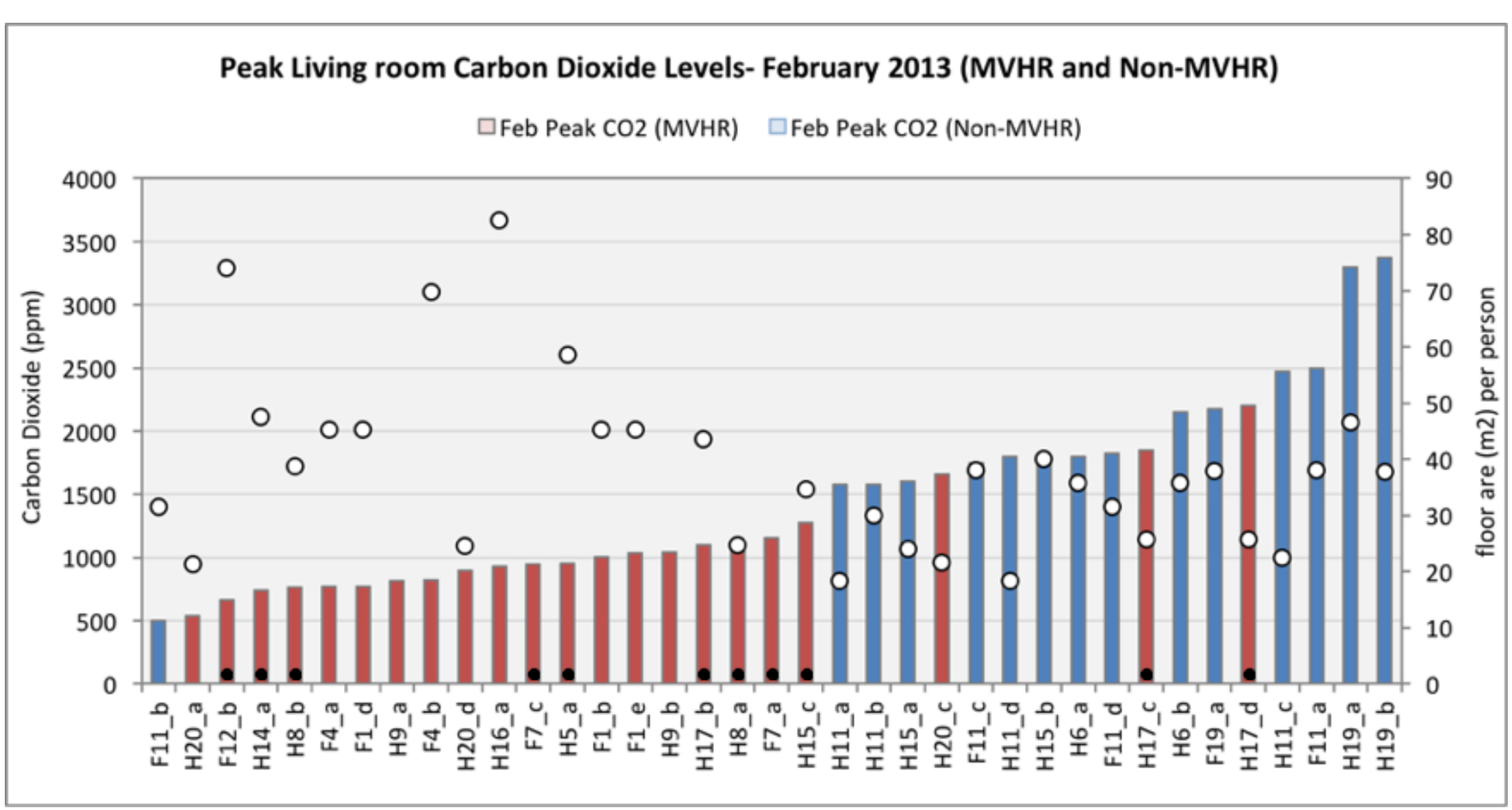

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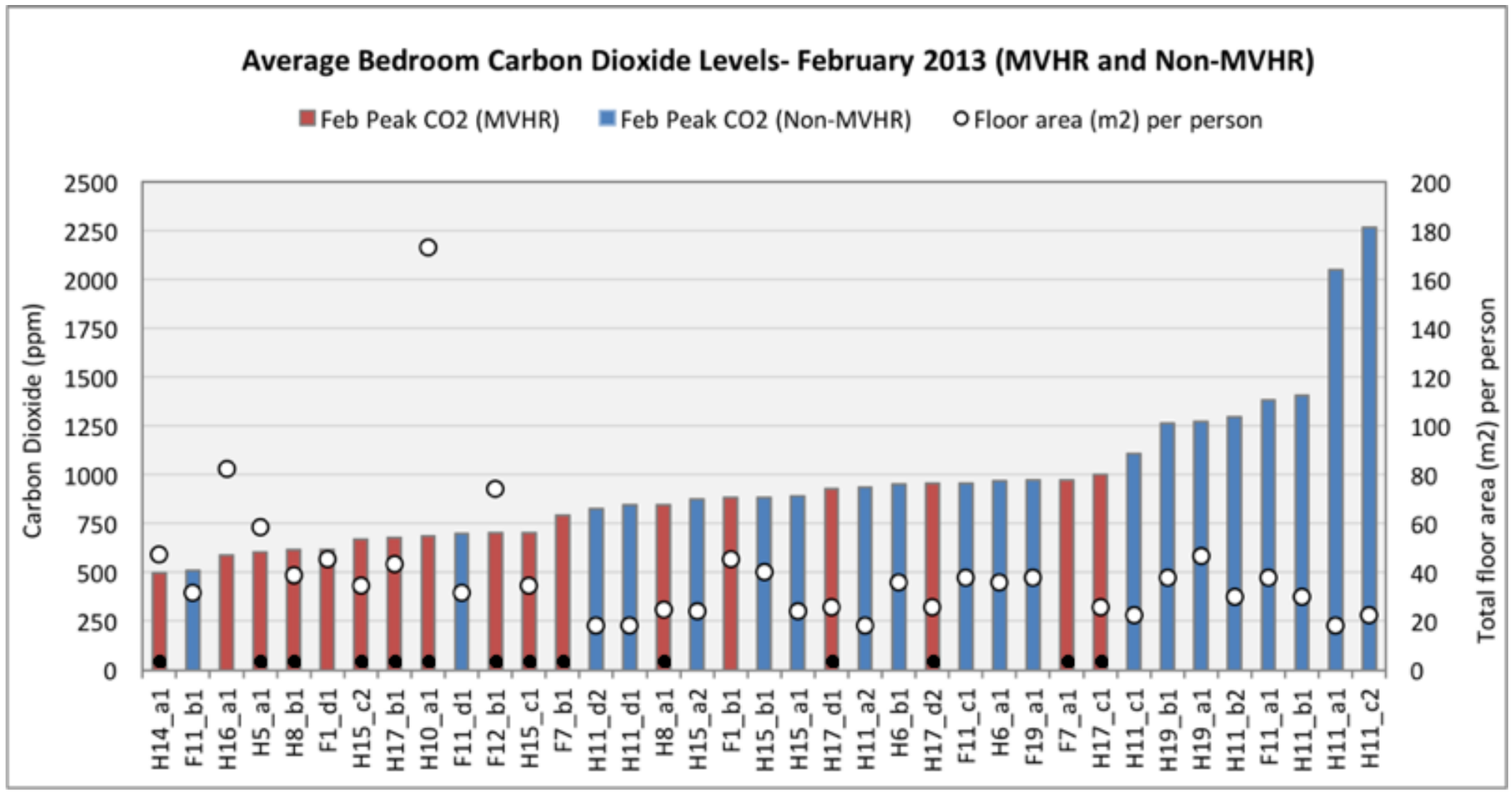

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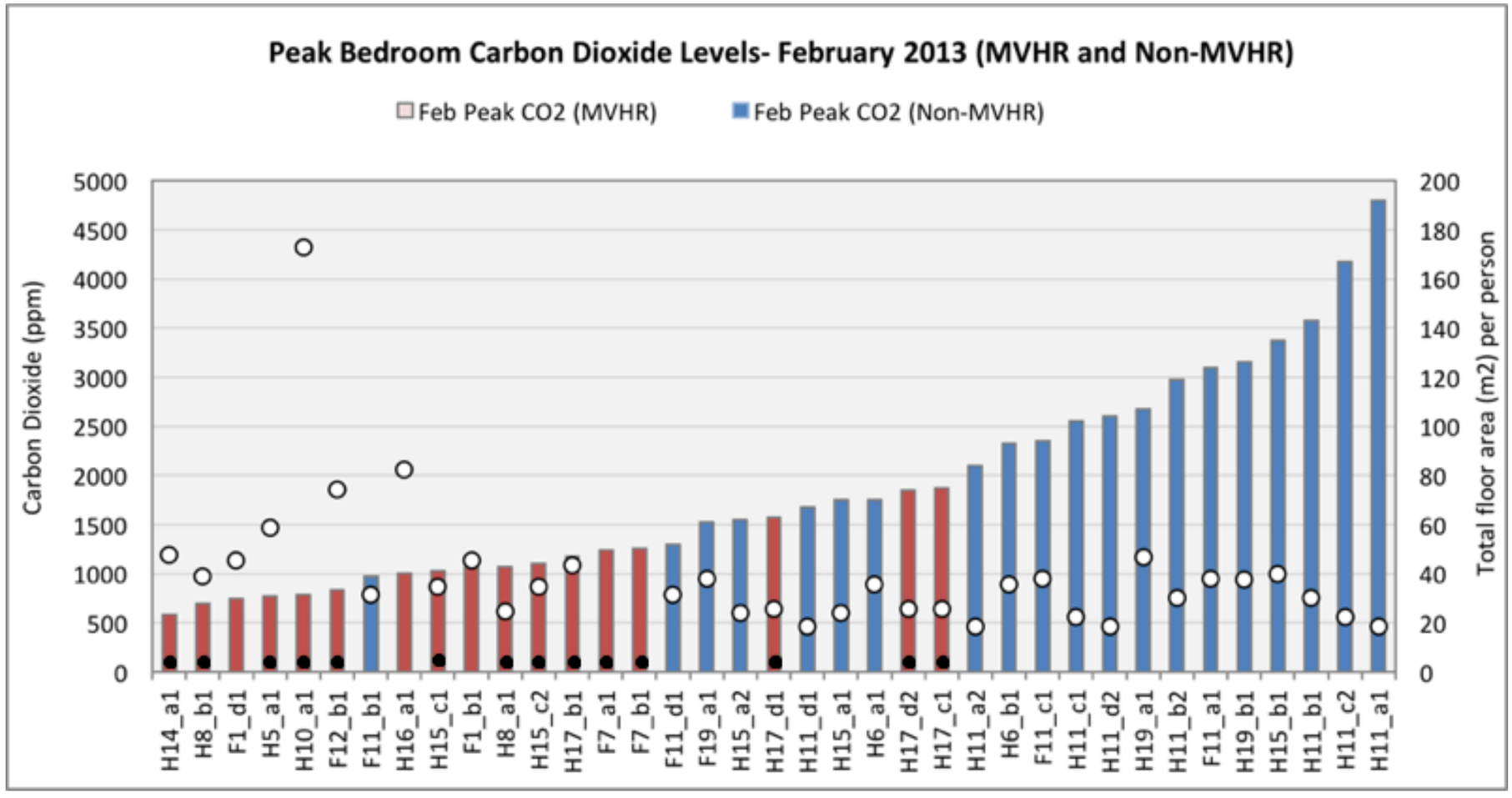
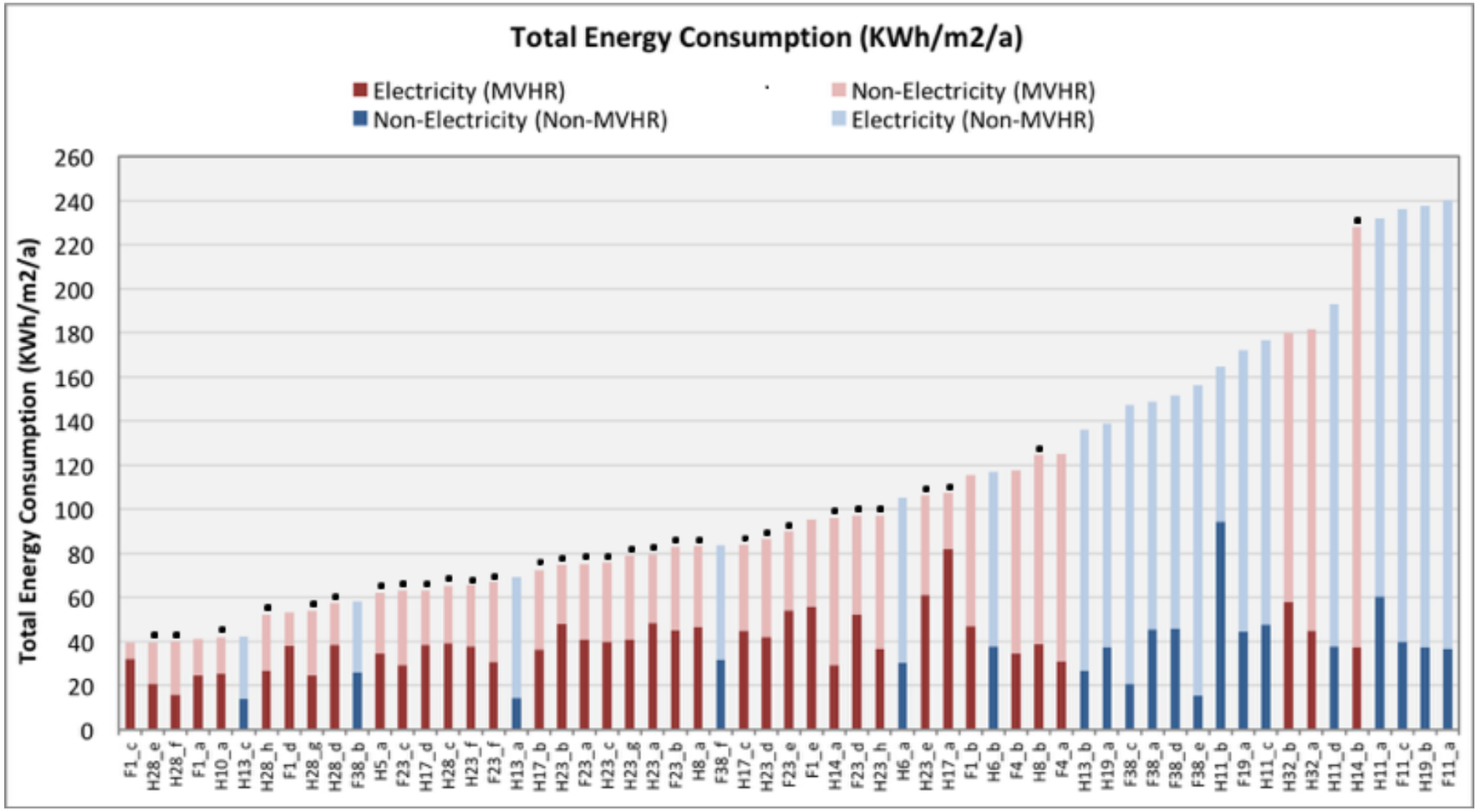


Mechanical Ventilation

- Comparison of energy consumption of MVHR and non MVHR*



Mechanical Ventilation

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- Mechanical Ventilation with Heat Recovery

Mechanical Ventilation

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- Mechanical Ventilation with Heat Recovery

Ventilation observations

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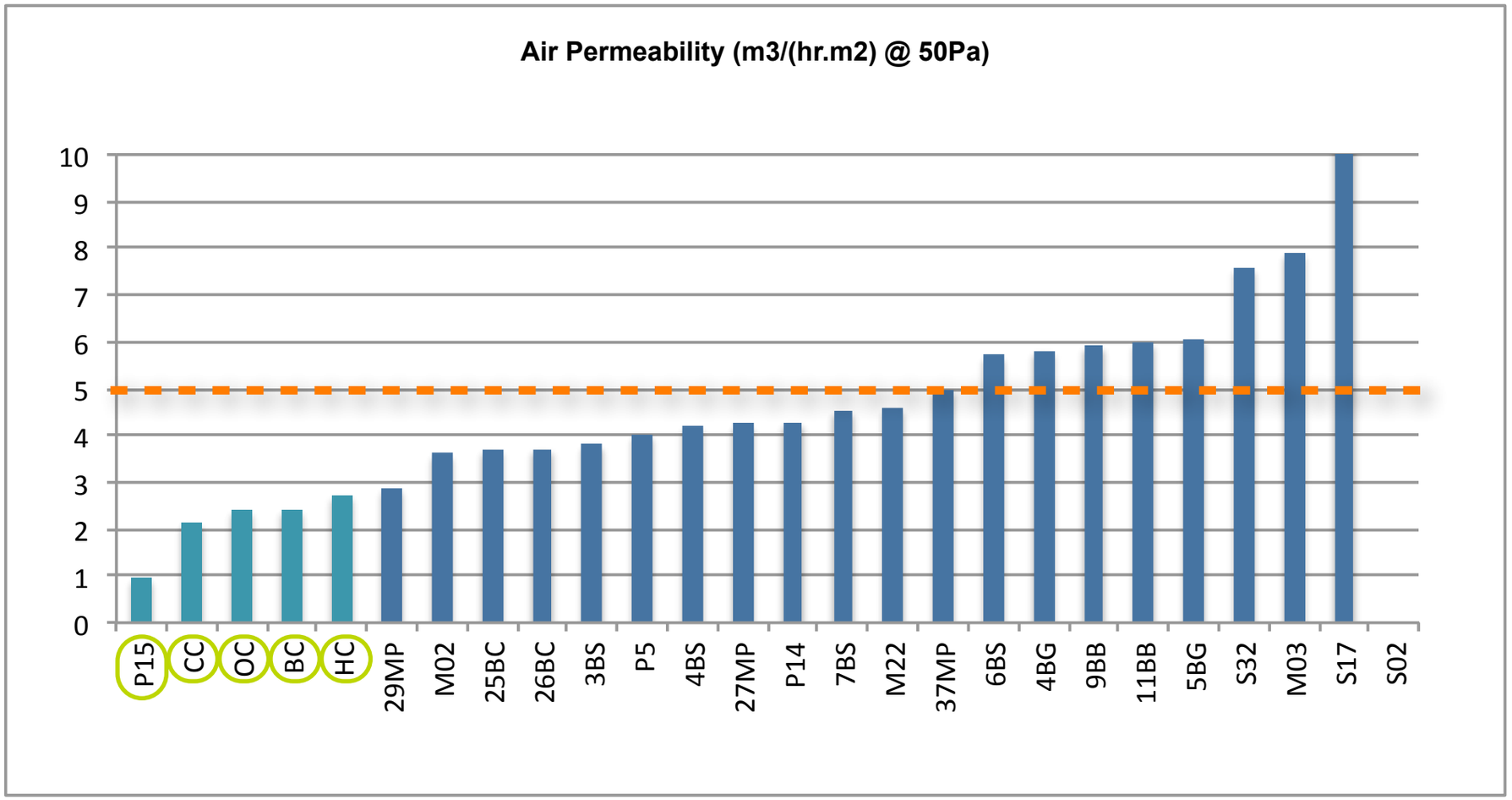
- Scottish Regulations: below 5$m^3/m^2/hr$@50Pa a ‘planned ventilation’ strategy is required
- Two-thirds have ‘overshot’ the regulation - not checked.



Ventilation observations

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Mechanical extract systems

- 83% underperforming
- 71% failing design performance criteria

Dwelling	Fan	Avg	Design	Pass/Fail
IA1	Kitchen	25.60	60	Fail
	Utility	29.40	30	Pass
	Shower	7.50	15	Fail
	Bathroom	7.50	15	Fail
IA2	Kitchen	34.50	60	Fail
	Utility	31.90	30	Pass
	Shower	3.70	15	Fail
	Bathroom	4.60	15	Fail
IB1	WC	3.20	7	Fail
	Bathroom	4.90	15	Fail
IB2	WC	5.20	7	Fail
	Bathroom	4.00	15	Fail
	Kitchen	62.60	30	Fail
IC1	Kitchen	5.80	60	Fail
	Bathroom	7.30	15	Fail
IC2	Kitchen	8.50	60	Fail
	Bathroom	5.90	15	Fail
ID2	Kitchen	26.10	60	Fail
	Bathroom	6.90	15	Fail
BC1	Bathroom	11.83	15	Fail
	Kitchen	64.27	60	Pass
BB1	Bathroom	17.30	15	Pass
	Kitchen	71.87	60	Pass
BA1	WC	12.40	15	Fail
	Bathroom	2.80	15	Fail
	Kitchen	0.00	60	Fail
GB3	Bathroom	9.20	15	Fail
	Kitchen	32.57	60	Fail
GB1	Bathroom	11.13	15	Fail
	Kitchen	41.43	60	Fail
GB2	Kitchen	30.10	60	Fail
	Bathroom	16.30	15	Pass
LA5	Kitchen	67.80	60	Pass
	Bathroom	4.60	15	Fail
LA6	Kitchen	73.80	60	Pass
	Bathroom	7.40	15	Fail

Research Project To Investigate Occupier Influence On Indoor Air Quality In Dwellings

Building Standards Directorate

Prof Tim Sharpe MEARU
Jonathan McQuillan Anderson Bell Christie
Dr. Stirling Howieson, University of Strathclyde
Paul Farren ASSIST DESIGN ARCHITECTS
Dr. Paul Tuohy ESRU, Strathclyde University

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anderson bell+christie architects

University of Strathclyde Engineering

ASSIST DESIGN ARCHITECTS

Key Findings

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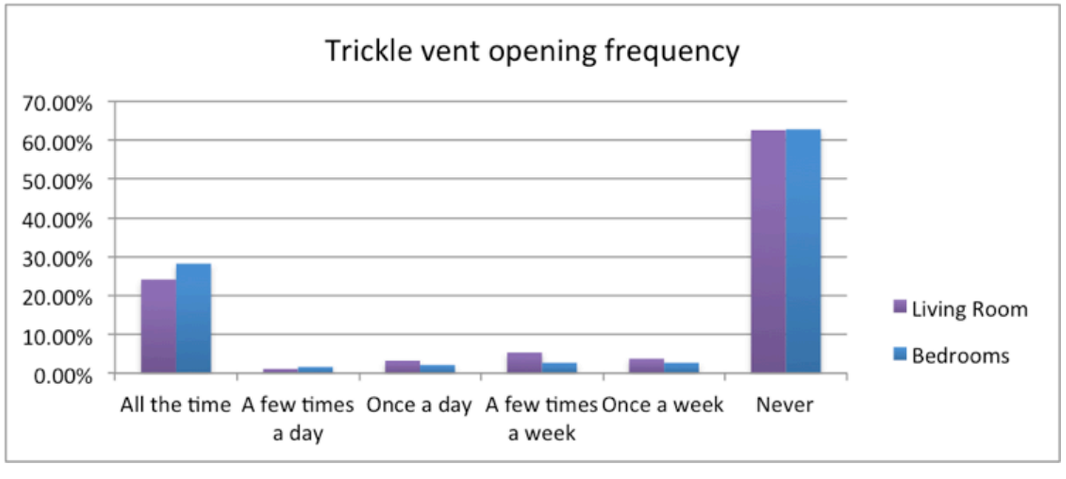
- Survey of ventilation habits

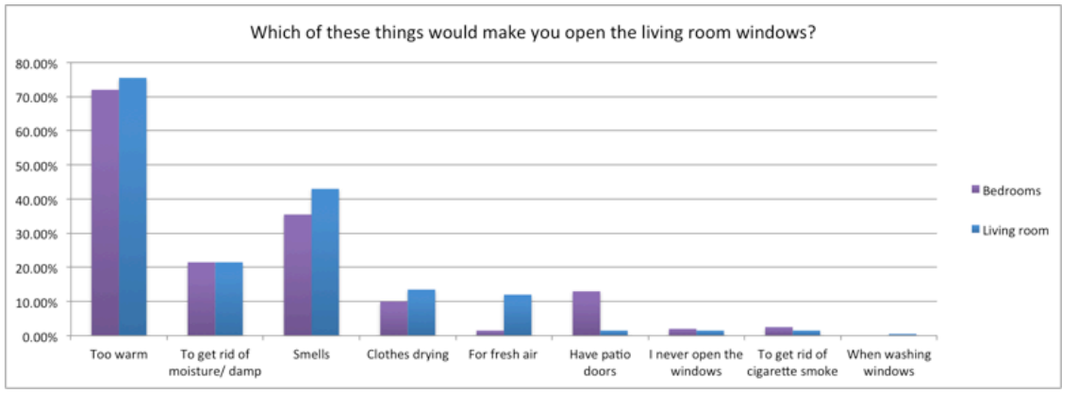
- Most trickle vents closed - 63% closed
- Hardly every changed

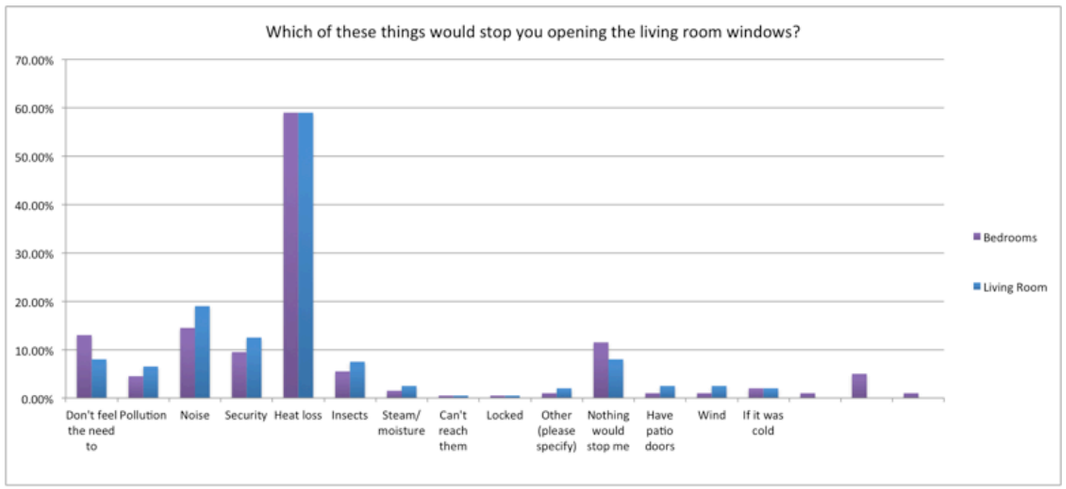
- Window opening more frequent - daily
- Drivers - temperature
- Barriers - heat loss
- 20% leave bedroom windows open at night

- Lack of knowledge - 82% had received no advice on ventilation

- No perception of Indoor Air Quality

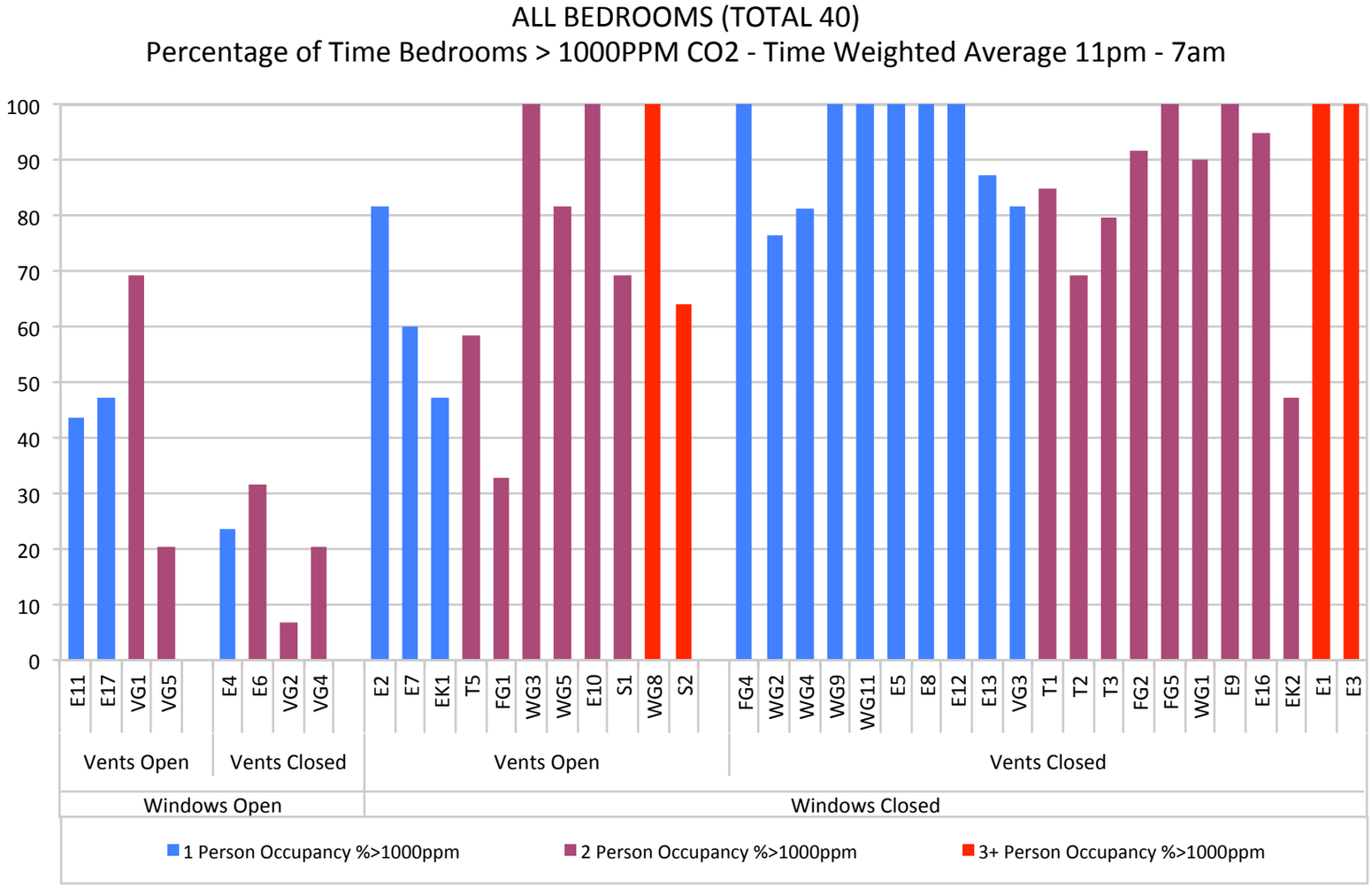






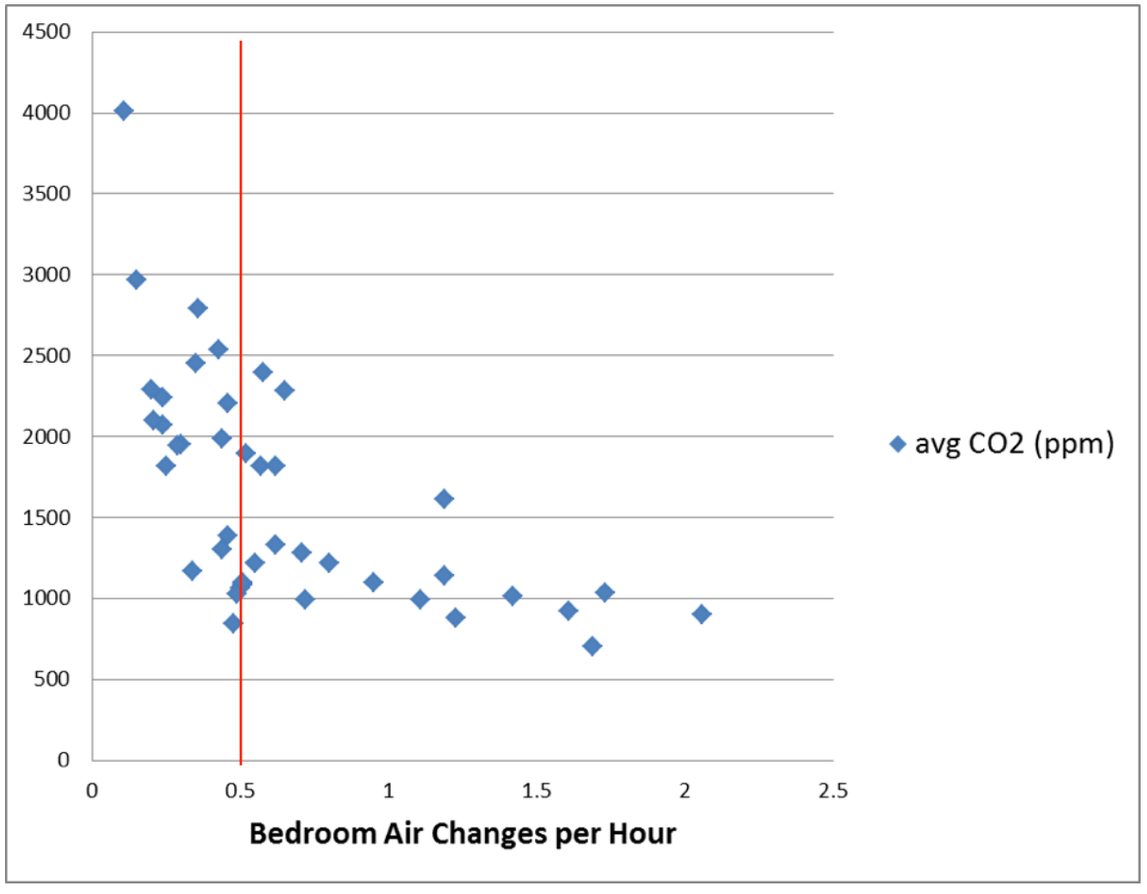
Trickle vent performance

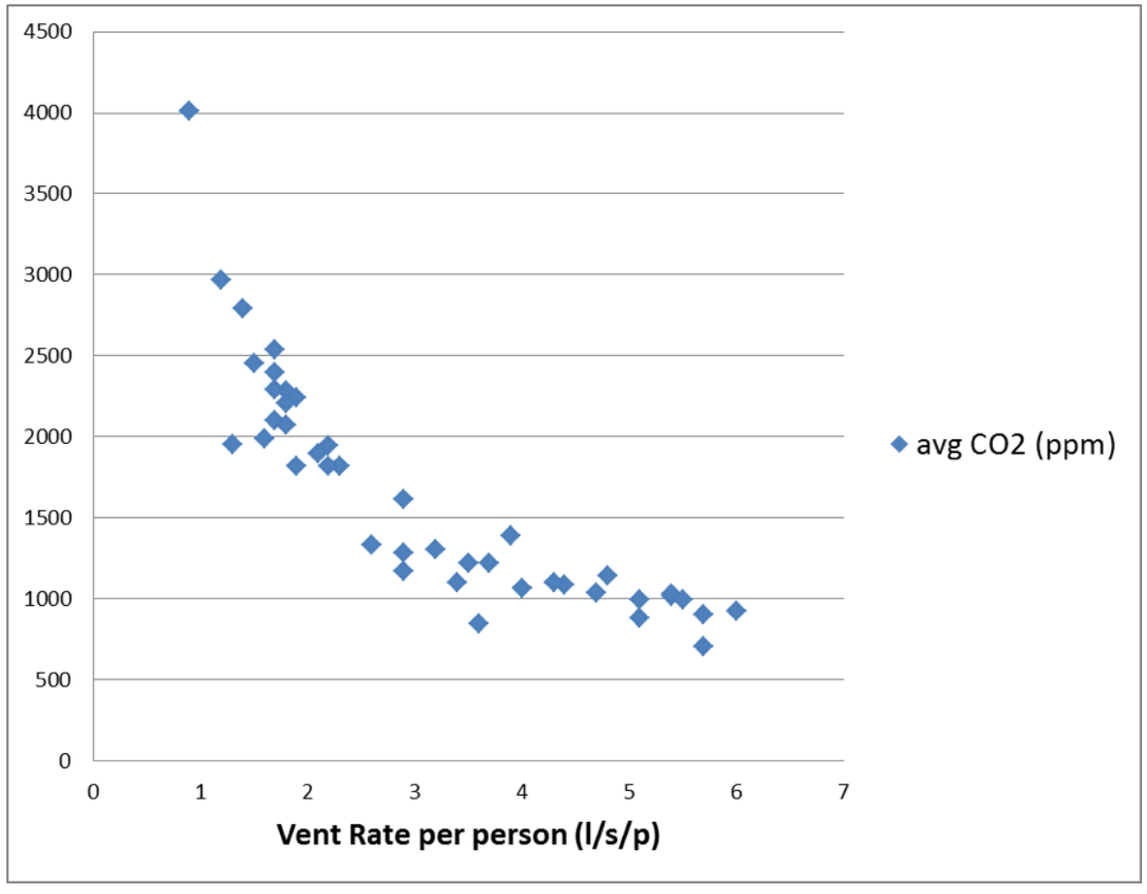
- % time over 1000ppm at night
- Significant periods of time with low ventilation
- Mitigated by window opening
- Better with open vents - but not effective



Resultant air change rates

- House with closed windows but open trickle vents
- No houses met requirement for IAQ = 8 l/s/p
- 42% below requirements for moisture control





Meta Study Survey - Design Issues

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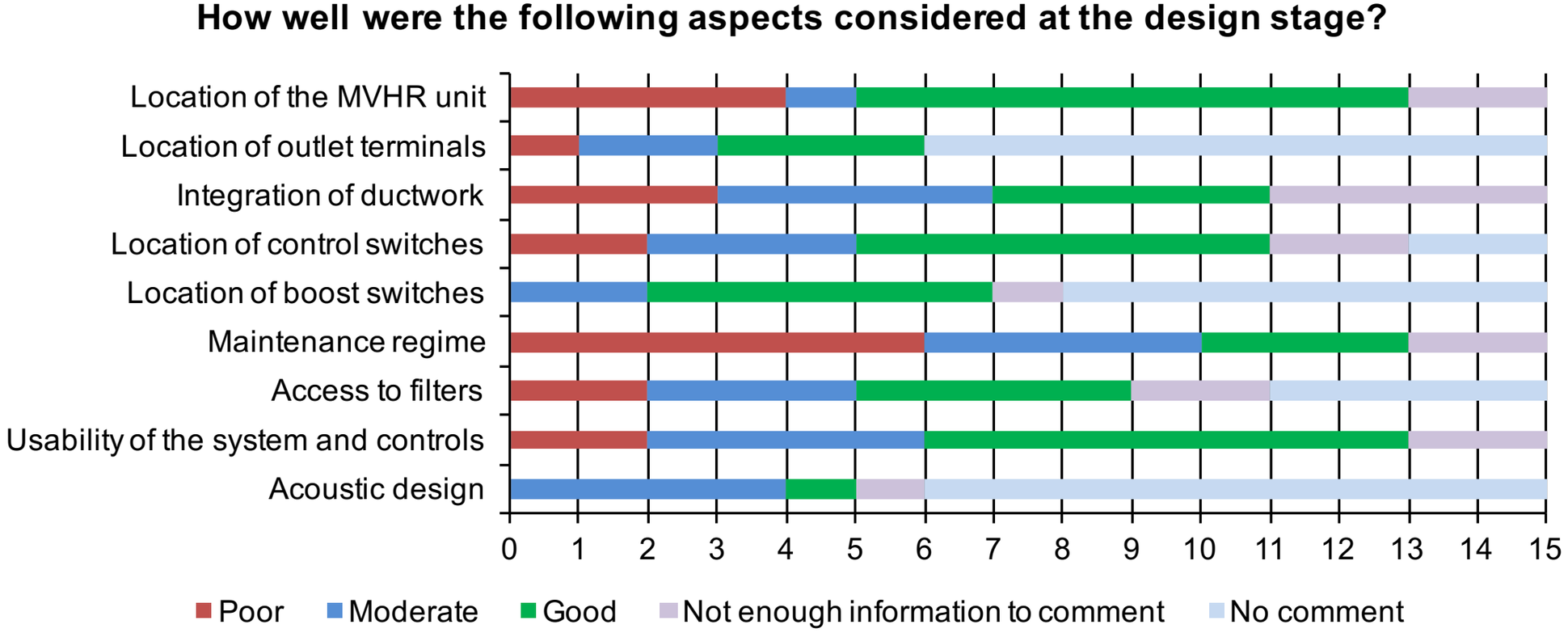
- Passivhaus (PH) projects: n=7 / Non-PH projects: n=8
- Acceptable IAQ was the most important reason for choosing MVHR.
- Most considered at design stage: location of MVHR unit
- Least considered at design stage: Maintenance



Meta Study Survey - Operational Issues

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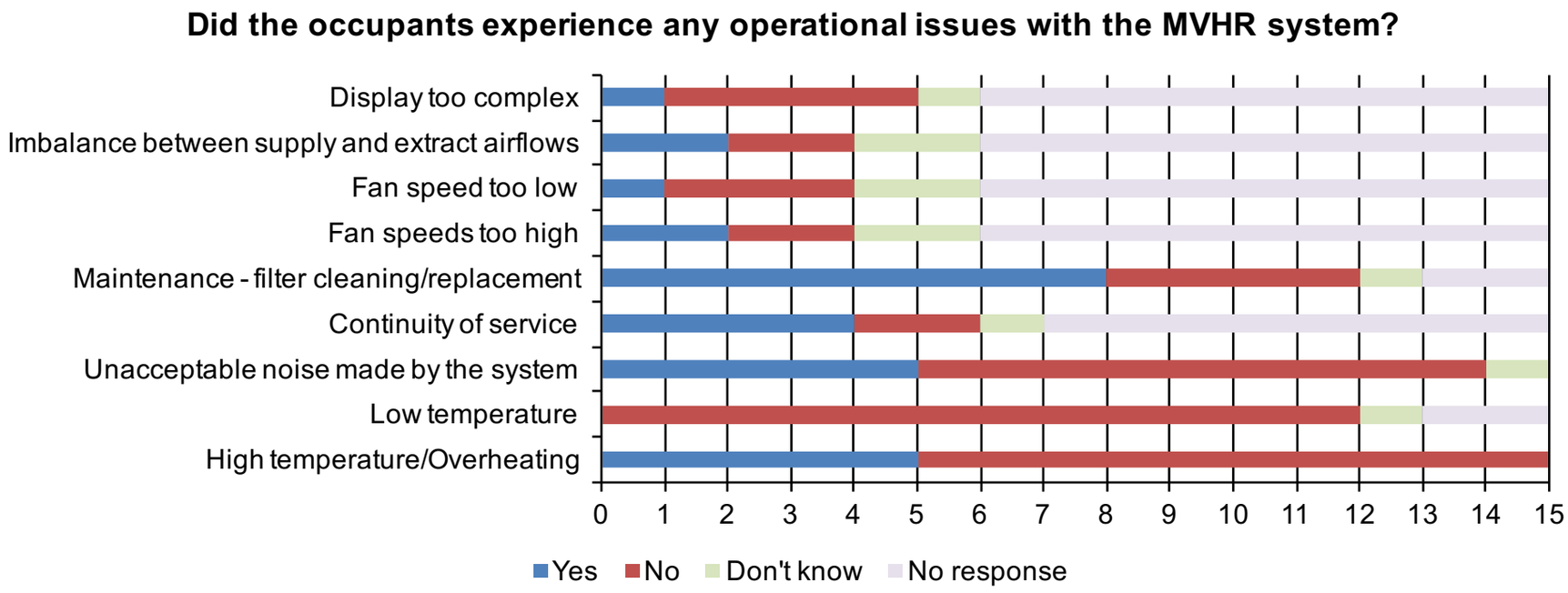
- Maintenance related to filter cleaning / replacement
- Unacceptable noise made by the system (5 projects)
- High temperature/overheating (5 projects)

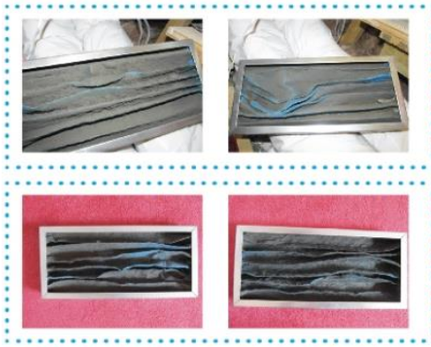


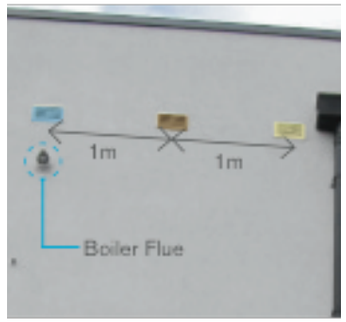
MVHR issues

- Design intentions
- Design integration
- Ducts type and size

- Missing vents in bedrooms
- Unbalanced systems
- Unit location for filter cleaning
- Construction debris

- Noise
- Occupant understanding
- Lack of maintenance strategy





The Glasgow House - Phase 1 project

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- What happens when it fails
- Scenario testing
- Occlusion
- Disabling

Scenario 2

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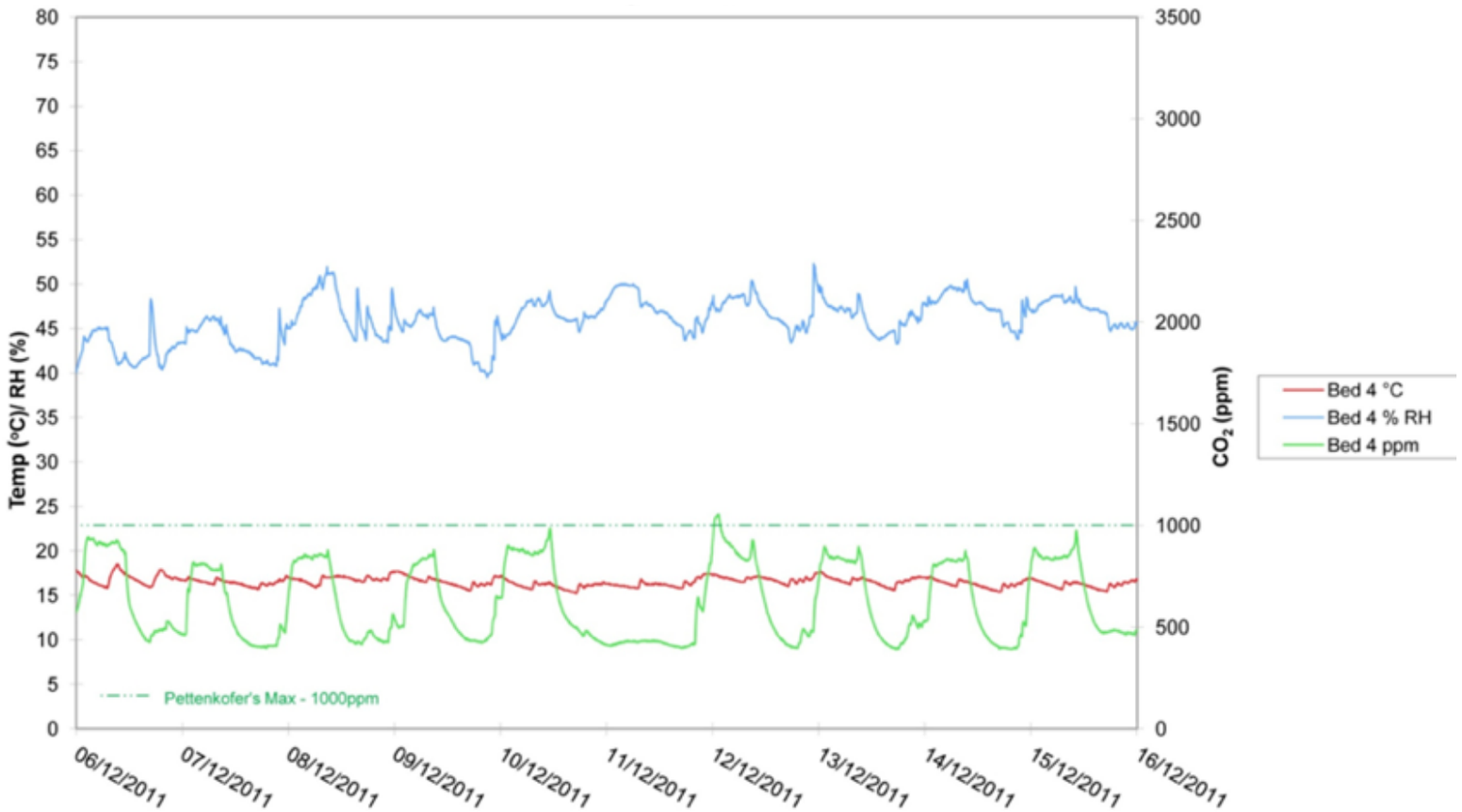
- Base Case
- Week 1 - occluded
- Week 2 - disabled



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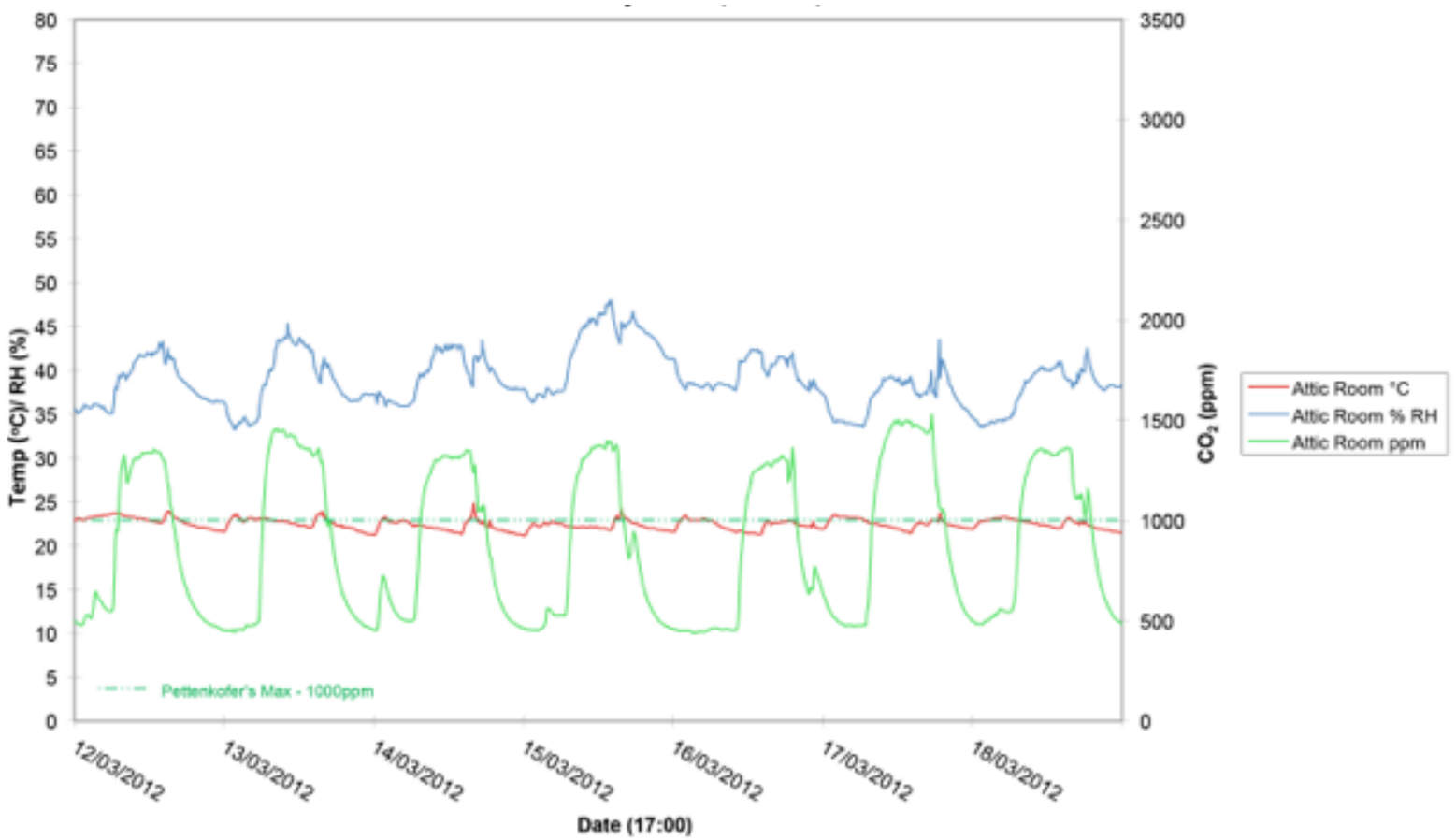

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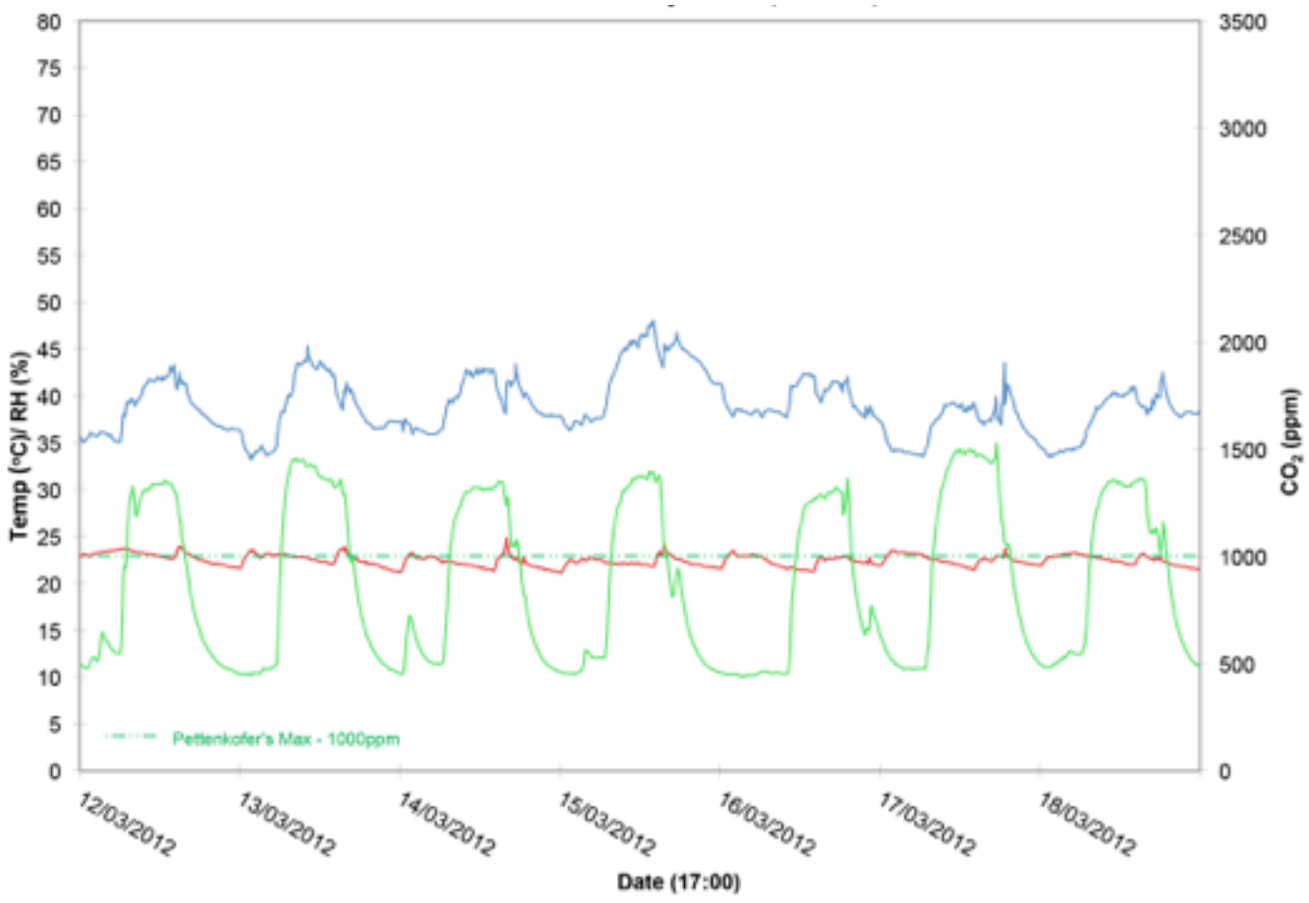

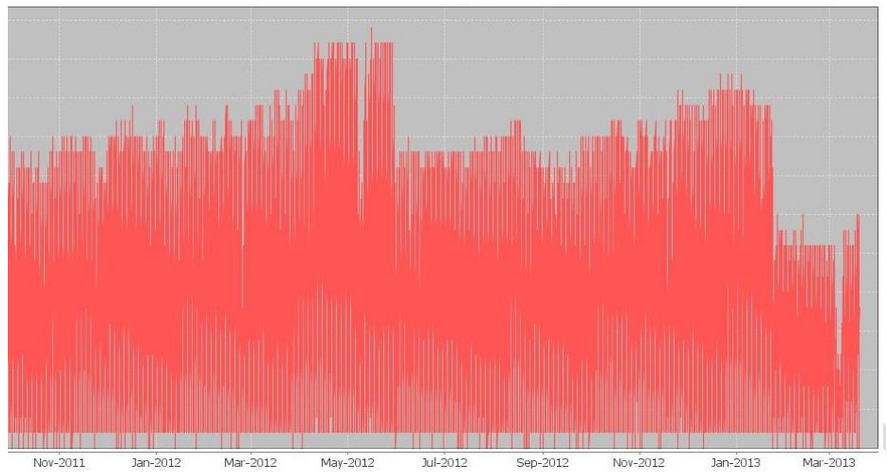

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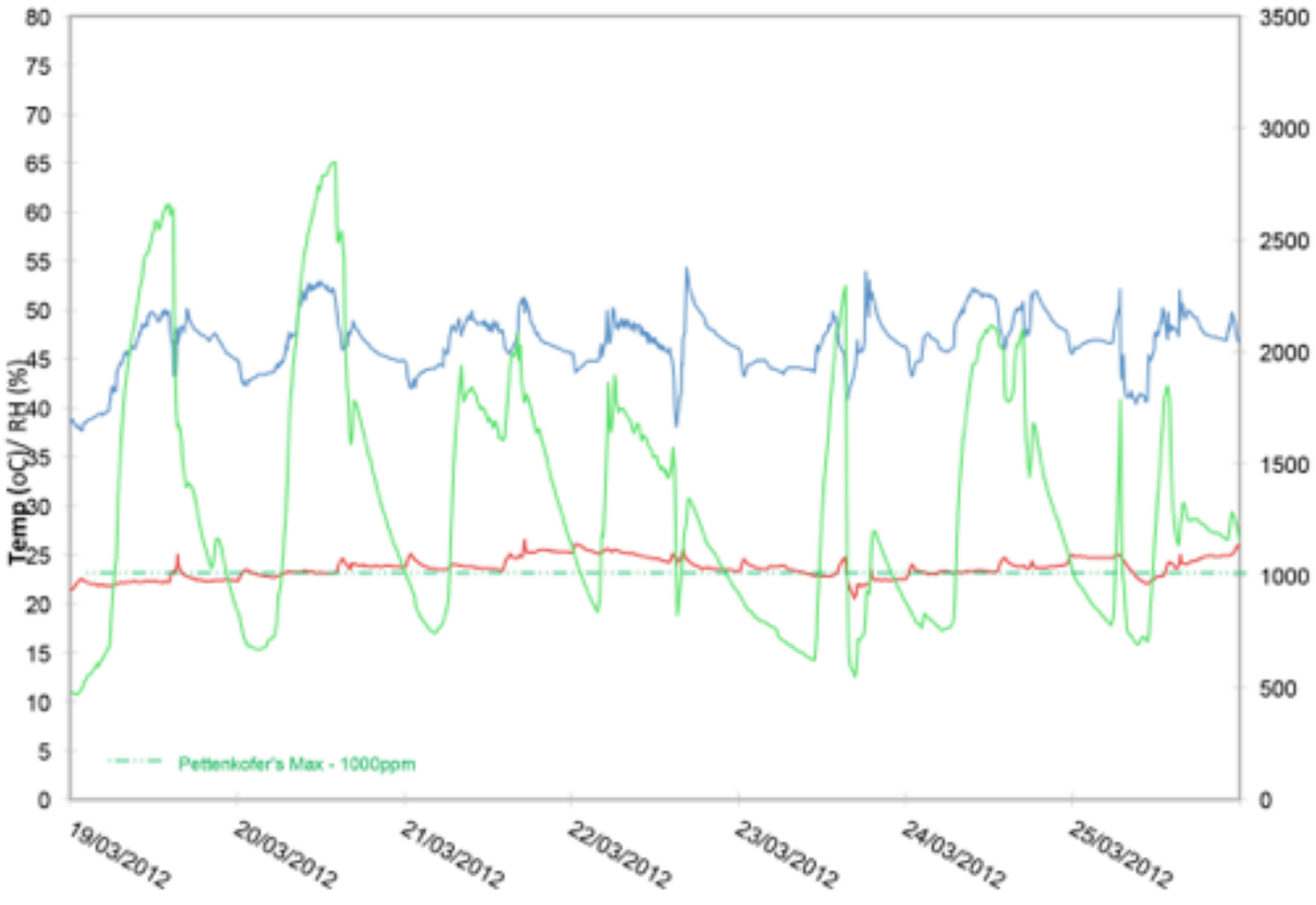

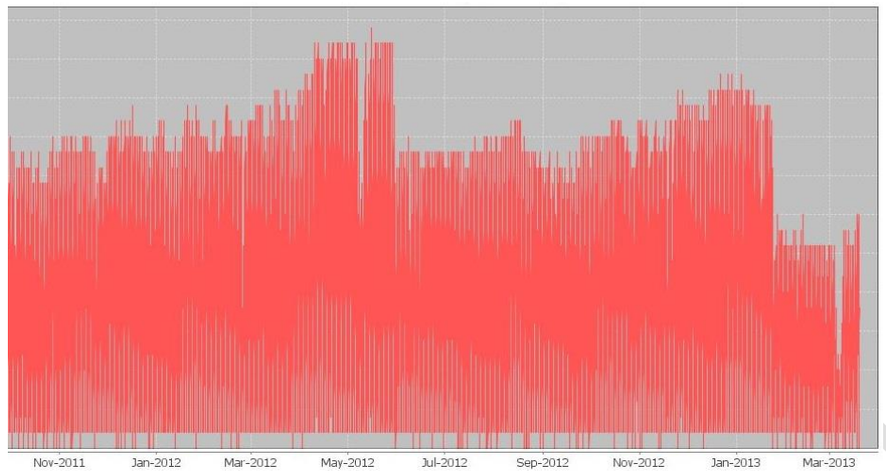

Attic Room °C
Attic Room % RH
Attic Room ppm

Glasgow House - MVHR testing

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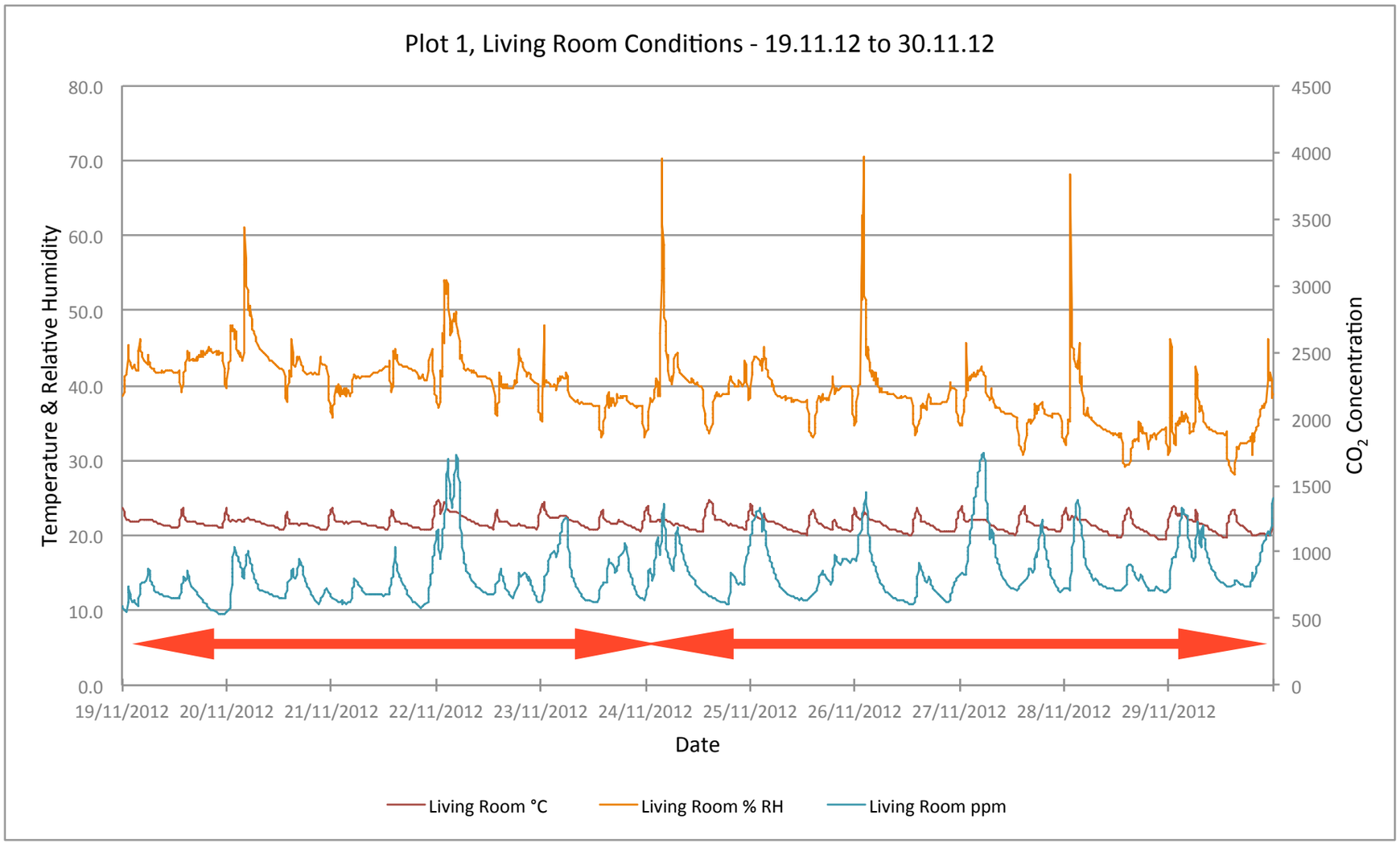
- **SC6**: Comparison of MVHR (week 1) vs window opening (week 2)
- Week 2 - better perception, but measured values worse

- Energy consumption Plot 1 - 1.1x higher, Plot 3 - 2.8x higher



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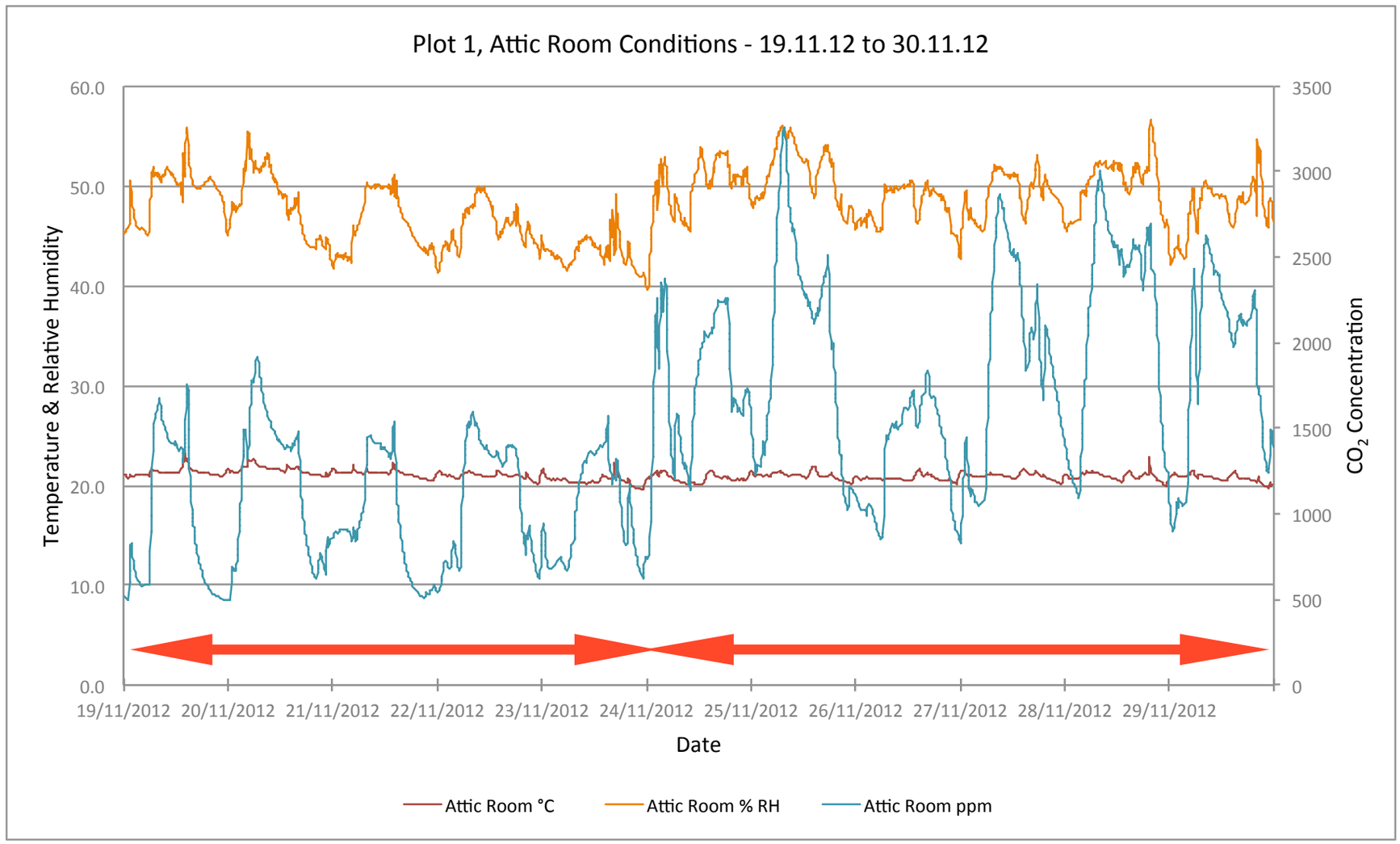


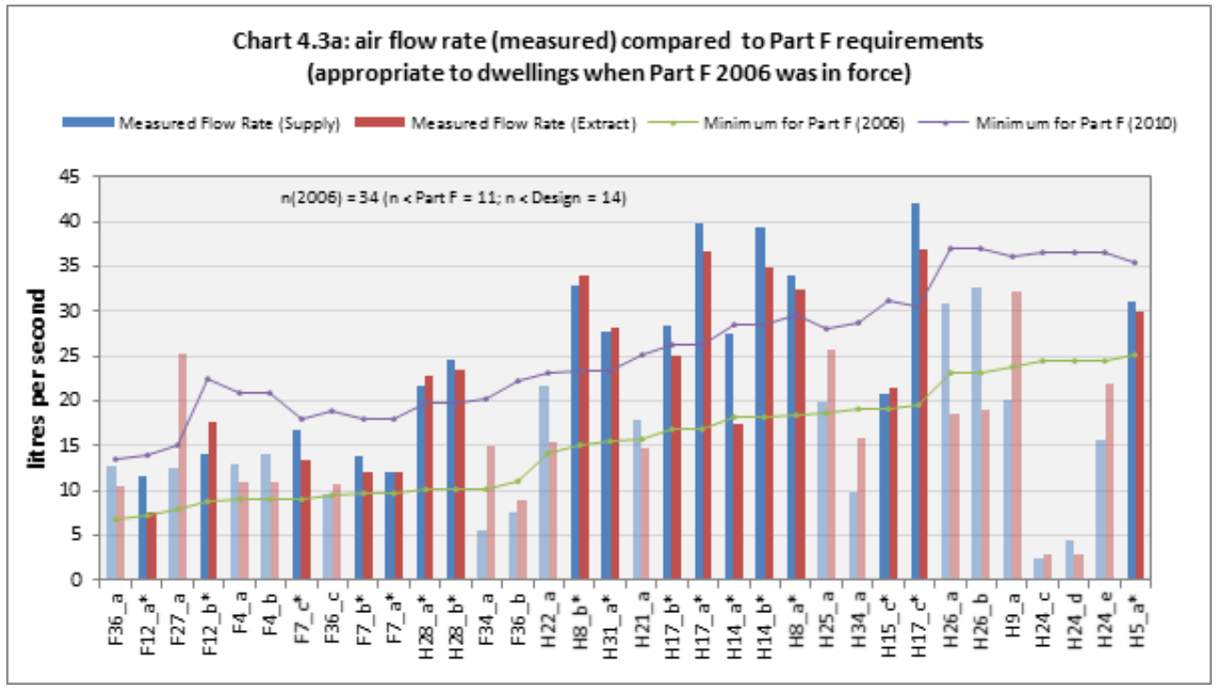
Meta Study - flow rates

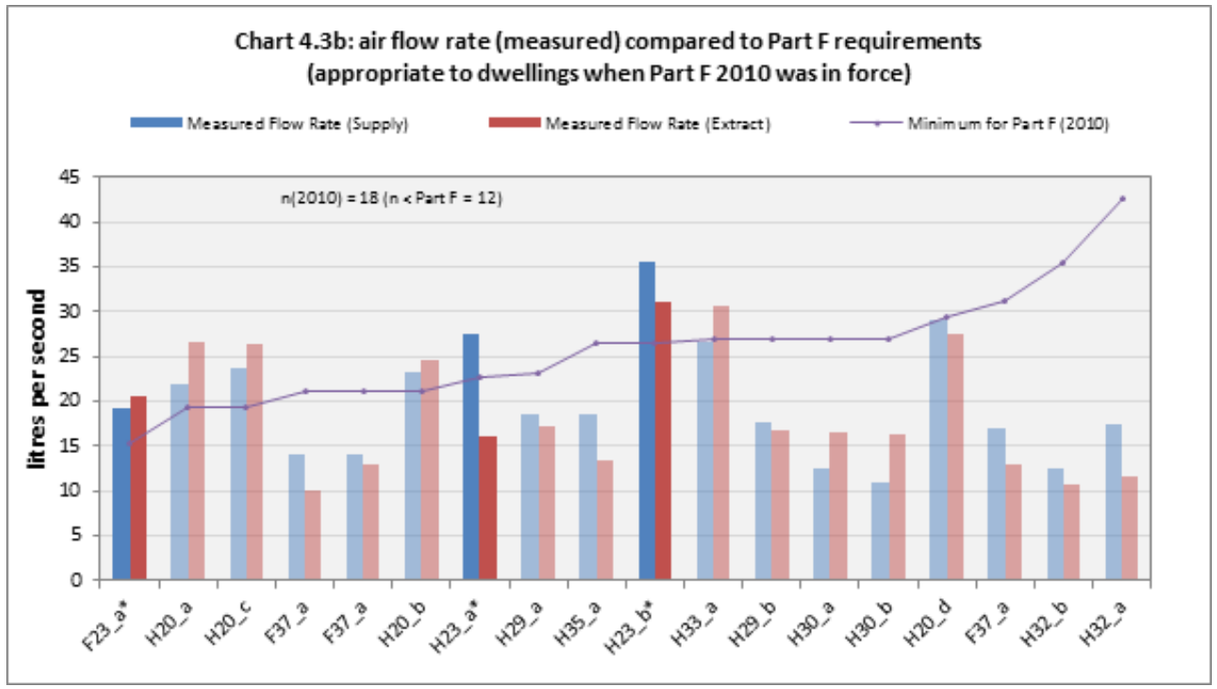
- Building to 2006 and 2010 standards

- For 2006 buildings 32% below
- For 2010 buildings 67% below

- Extract rates below standards:
- 56% kitchens
- 39% bathrooms
- 70% ensuites and 62% utilities

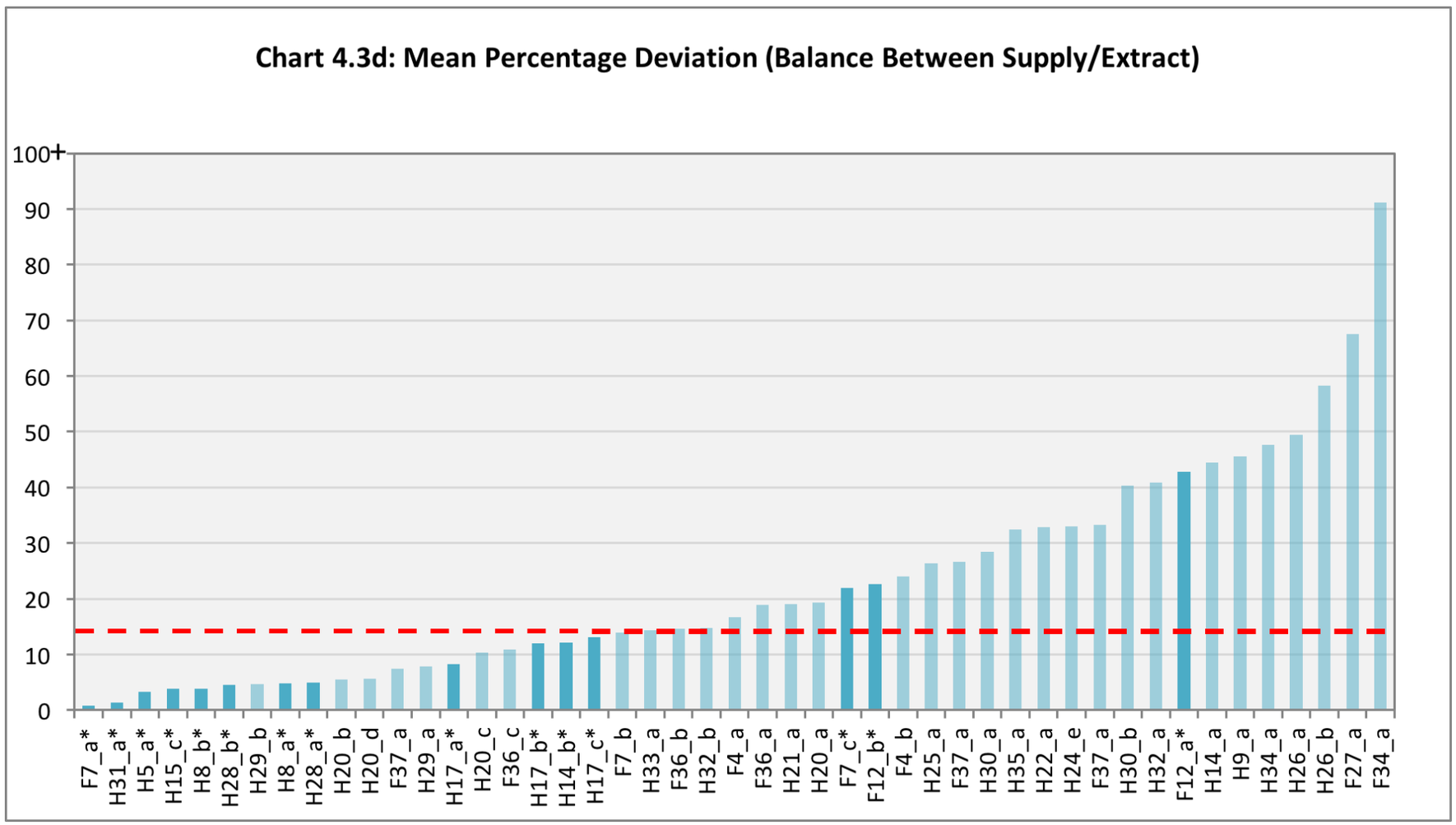
- Passivhaus is generally better, 85% met regs





Meta Study - balance

- 60% more than 15% out of balance
- Imbalance will impact on energy recovery - hard to quantify



Meta Study - air permeability

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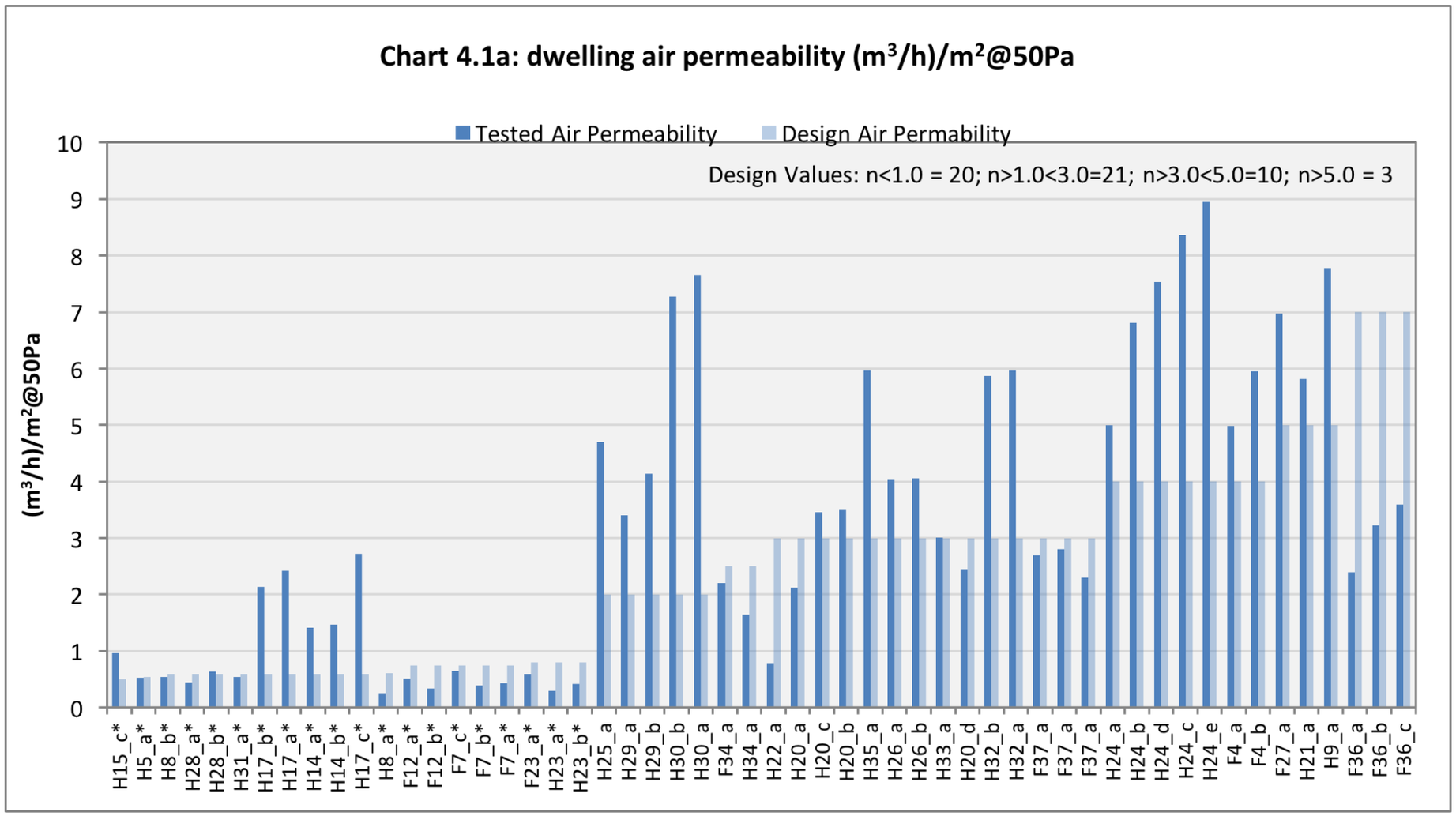
- 44% > 3 (m^3/h)/m^2@50Pa
- 27% > (m^3/h)/m^2@50Pa
- All passivhaus < 3 (m^3/h)/m^2@50Pa



Meta Study - passivhaus

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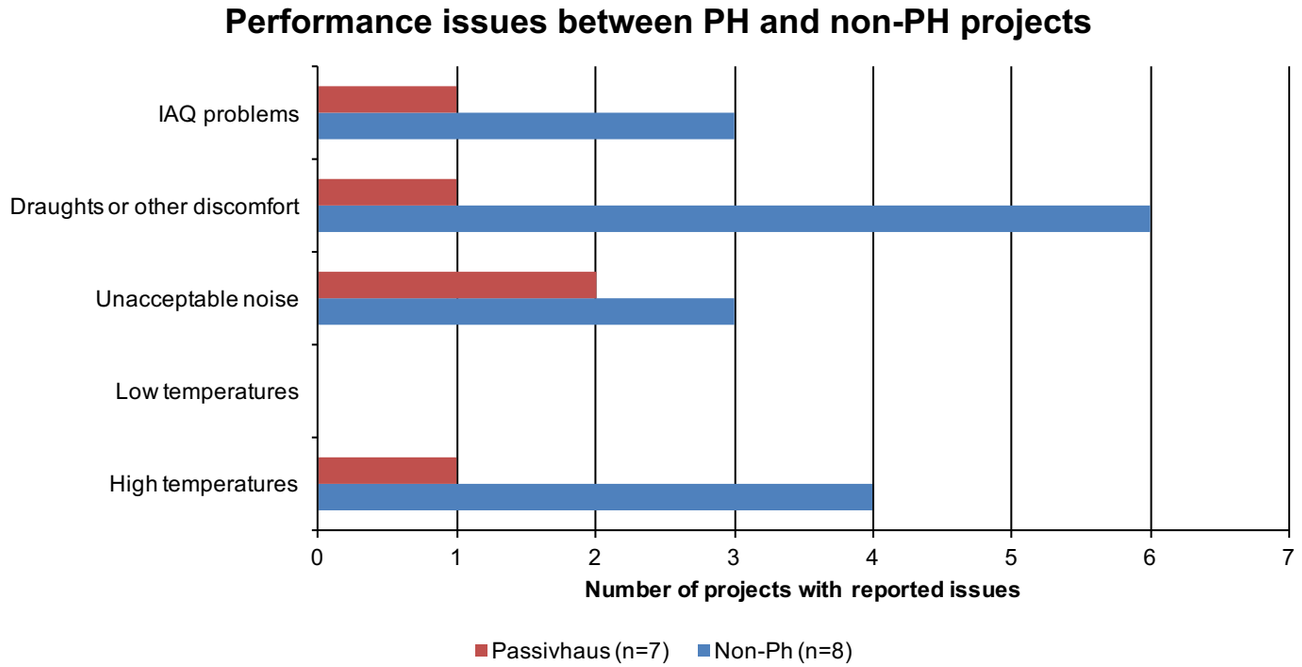
- Passivhaus performs at the better end of the spectrum
- But not immune

- Energy befits are hard to quantify - balance, filters, maintenance, electricity

- High quality
- Someone cares!

- What happens when we mainstream?
- Capacity and skills?



Conclusions

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- Does MVHR work?

- Yes, when it works well.
- But a lot can go wrong
- And failure of a ventilation system in a house with no backup may be a problem

- Are flow rates adequate for IAQ?
- Long term reliability?
- Real energy benefits?
- Value is energy AND ventilation.

- ‘you can always open the windows..’
- What if you can’t?

- Design, client and occupant knowledge is the most essential component

Progress

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- Simple guidance for occupants of low energy homes for Scottish Building Standards
- http://www.gov.scot/resource/doc/217736/0116377.pdf
- CO_2 awareness raising

How Your Low Carbon Home Works

- Overview
- Heating
- Ventilation
- Hot Water
- Energy Saving Features
- Keeping it Working

How your home works:

Ventilation

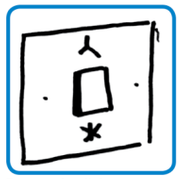
The house is ventilated by a **Mechanical Heat Recovery system** (MVHR) and windows that can be opened. The building is designed so there are no leaks or draughts, so it's important that the ventilation system is used properly. The Mechanical Heat Recovery System sucks stale air out of the kitchens and bathrooms and brings fresh air in through the vents in the ceiling, but keeps the heat from the old air. It runs all the time, there are switches in the kitchen and bathrooms to boost the system to get rid of moisture or smells.

- **DO** turn on the extract fan when cooking
- **DO** use the boost switch in the bathrooms
- **DO** make sure that you clean the filters regularly
- **DO** open windows in the summer to get more ventilation
- **DON'T** turn off the MHRV system, it can lead to smells, mould and poor air quality

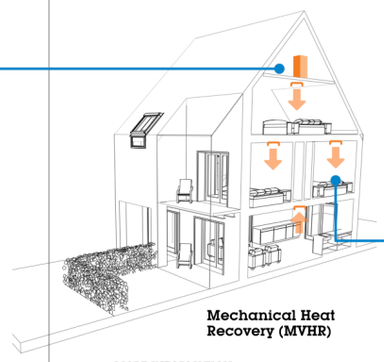
Mechanical Ventilation System
LOCATION: In loft (use a ladder to access it)
This very low power fan unit powers the ventilation system, it needs no adjustment. It has filters to ensure the air in your house is clean, you need to clean the filters (located behind flaps on the front of the unit) every month.

(Manufacturer and model number here)

Ventilation Boost ✱
LOCATION: Bathrooms and kitchen.
The boost button helps clear the steam and smells. Use it when you are using the bathroom or the kitchen and turn it off when you are finished.

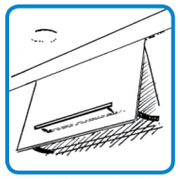


Engraved switch



Mechanical Heat Recovery (MVHR)

MORE INFORMATION:
See Manufacturers website at: (Website here)
See Manufacturers website at: (Website here)



(Manufacturer and model number here)

✱ **Cooker hood**
LOCATION: Above hob in kitchen.
In addition to the ventilation system, there is a cooker hood to help remove smells from the kitchen. It cleans the air and recirculates it into the room. Pull the handle out to turn the unit on.

(Manufacturer and model number here)

Vents
Most rooms have a vent that supplies or extracts air. Do not adjust these or block them up.

MACKINTOSH ENVIRONMENTAL ARCHITECTURE RESEARCH UNIT
THE GLASGOW SCHOOL OF ART

Thank you

- http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchenviro/oiaqd

- Occupant Interactions and Effectiveness of Natural Ventilation Strategies in Contemporary New Housing in Scotland, UK
- http://www.mdpi.com/1660-4601/12/7/8480

- Building tight – ventilating right? How are new air tightness standards affecting indoor air quality in dwellings?
- http://bse.sagepub.com/content/early/2013/11/27/0143624413510307

- An assessment of environmental conditions in bedrooms of contemporary low energy houses in Scotland
- http://ibe.sagepub.com/content/23/3/393