NZEB Ventilation

Emer Doyle

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Waterford and Wexford Education and Training Board (WWETB)

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WWETB's double success at the **SEAI Awards 2022**

Awarded both the **Service Provider** of the Year and the **Overall Product of the Show** award. The awards were given in recognition of WWETB's work on various aspects of **high-performance building construction**.

Delivered through Skills to Advance and contributes to Continuing Professional Development (CPD) points from the Construction Industry Federation.

Demand for training is high and we have over **3,100 learners upskilled in NZEB to date**.

nzeb@wwetb.ie

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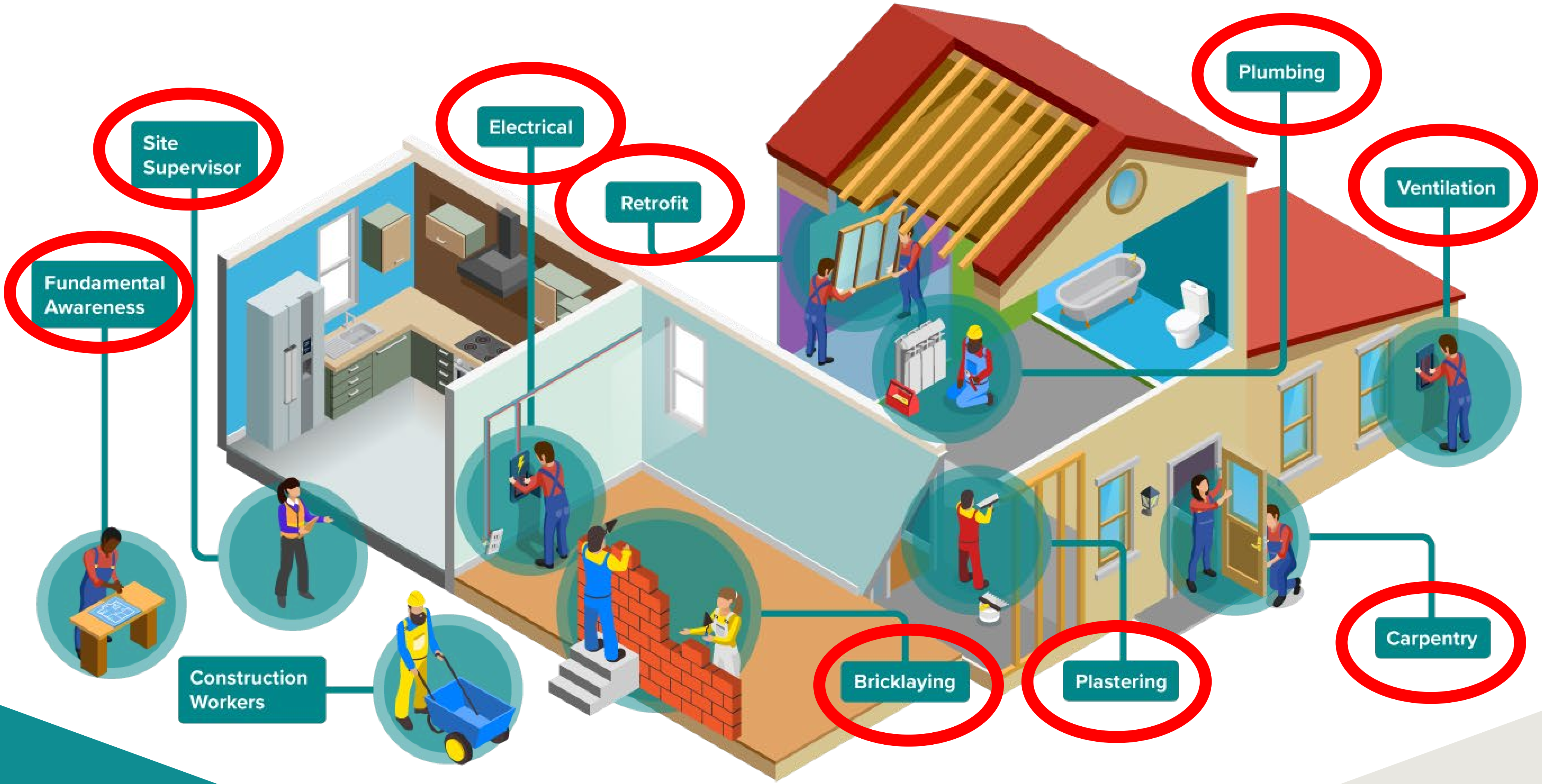

www.wwetbtraining.ie/nzeb

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Celebrating 30 years of high-performance buildings

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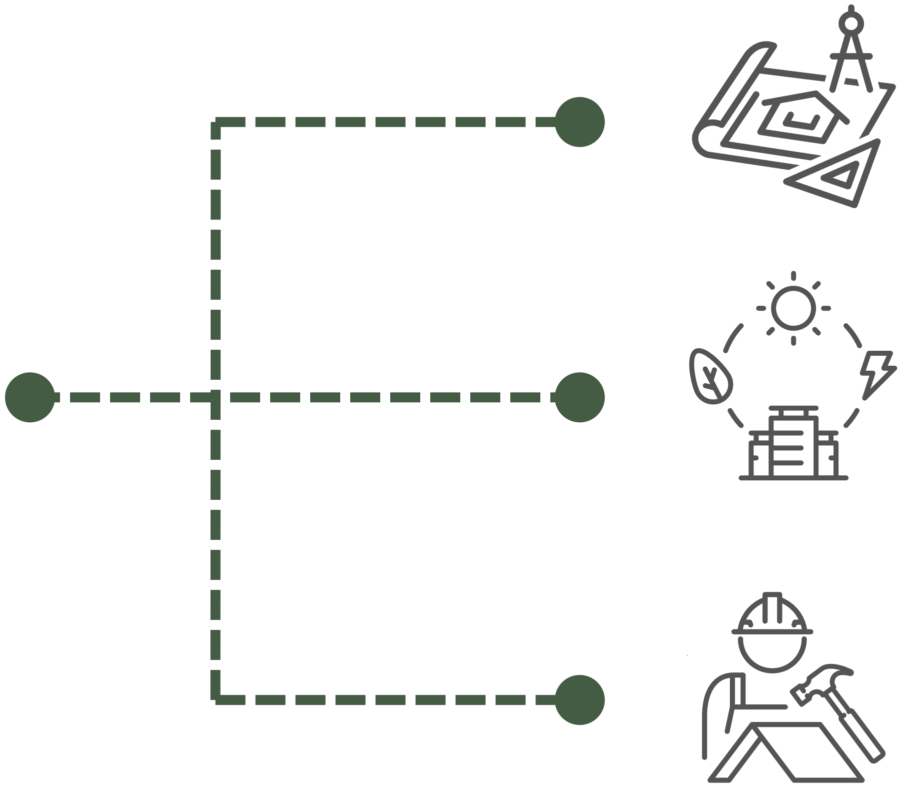
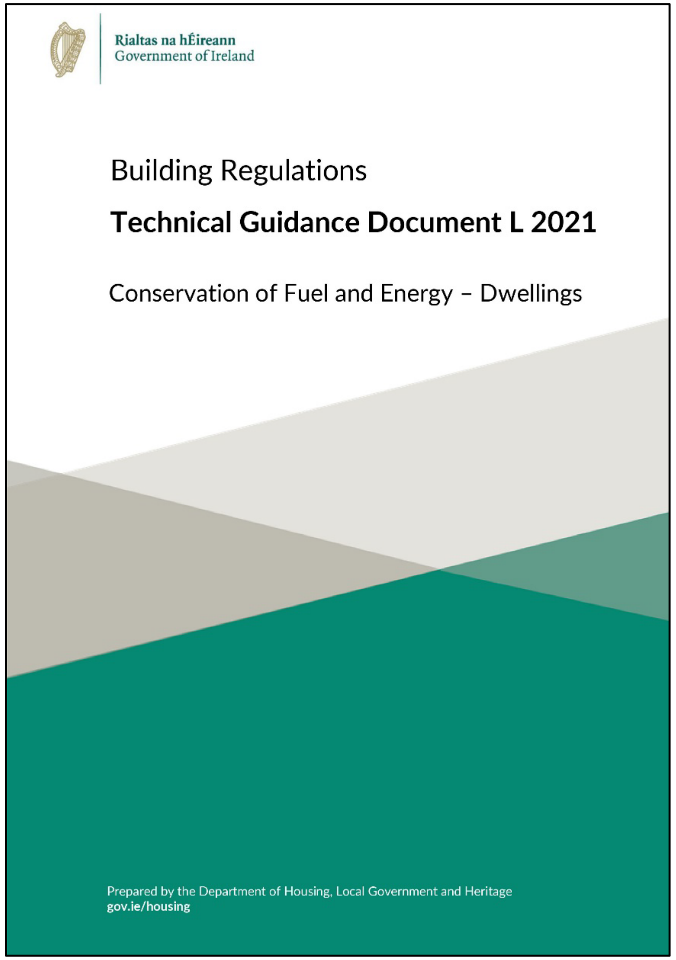
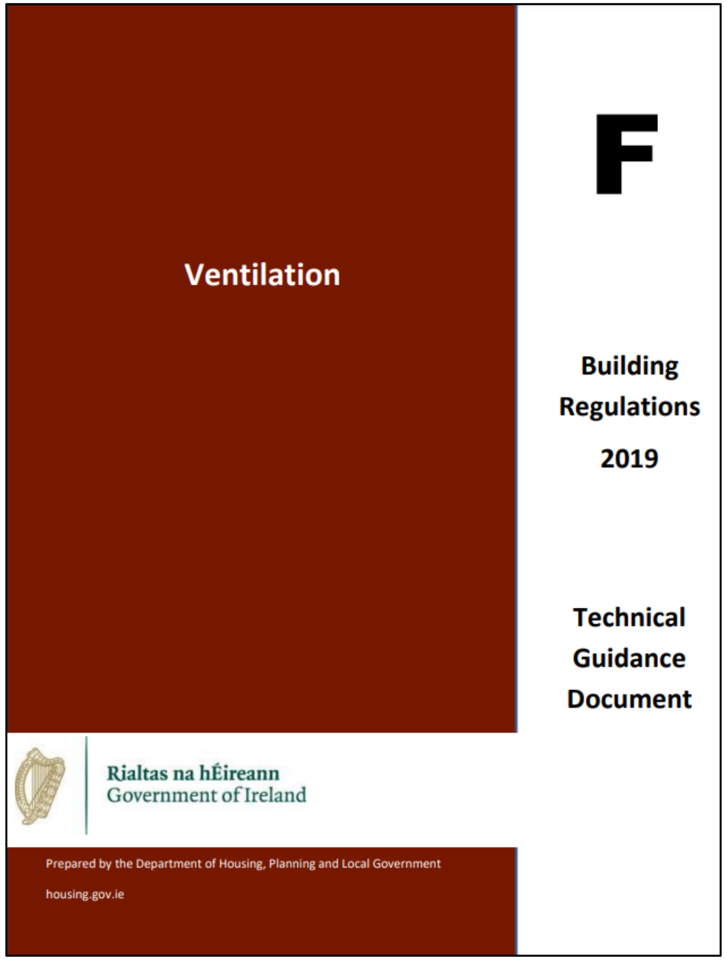
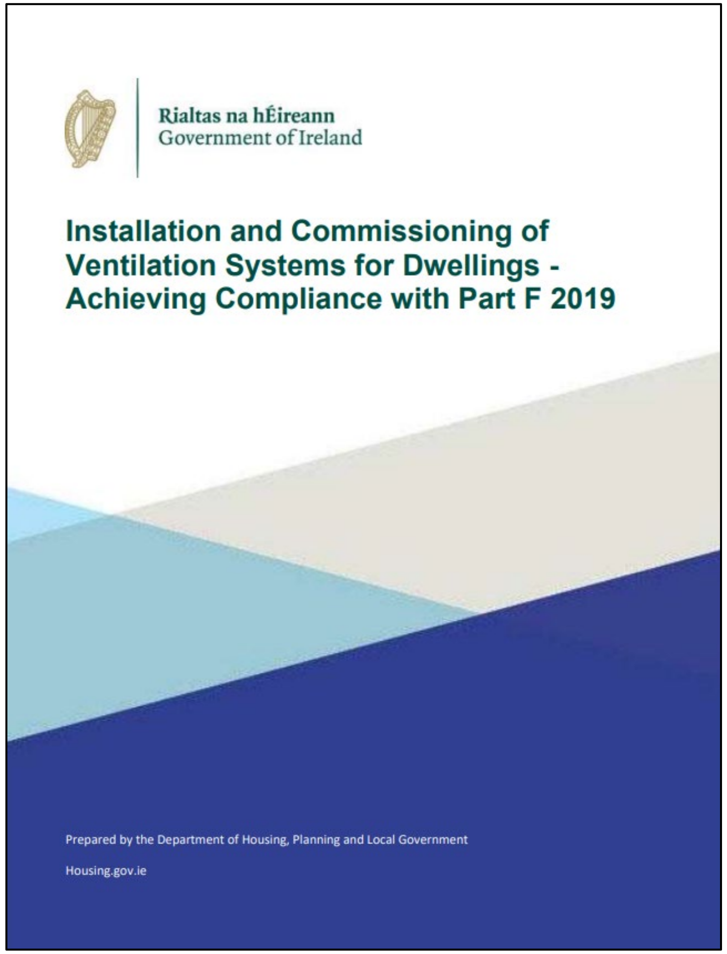


- Architecture
- Energy Consultancy
- Education

Supporting Documentation – NZEB Ventilation Course







Overlapping documents – used in unison

NZEB Ventilation Course

- In order to demonstrate competency, attendees must successfully pass an assessment.
- The assessment is made up of two parts:

Assessment	Description	Duration	Pass Rate
1. Theory Assessment	Written exam to test your knowledge on content covered during the NZEB Ventilation course	1.5 hours	70%
2. Practical Demonstration	Practical demonstration in commissioning of a ventilation system.	30 minutes	Pass/Fail

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Designing Ventilation Systems

Design

- Attic?
- Plant room
- Dropped ceilings
- Service cavities

Construction

- Materials
- Competency
- Airtight strategy
- Teamwork

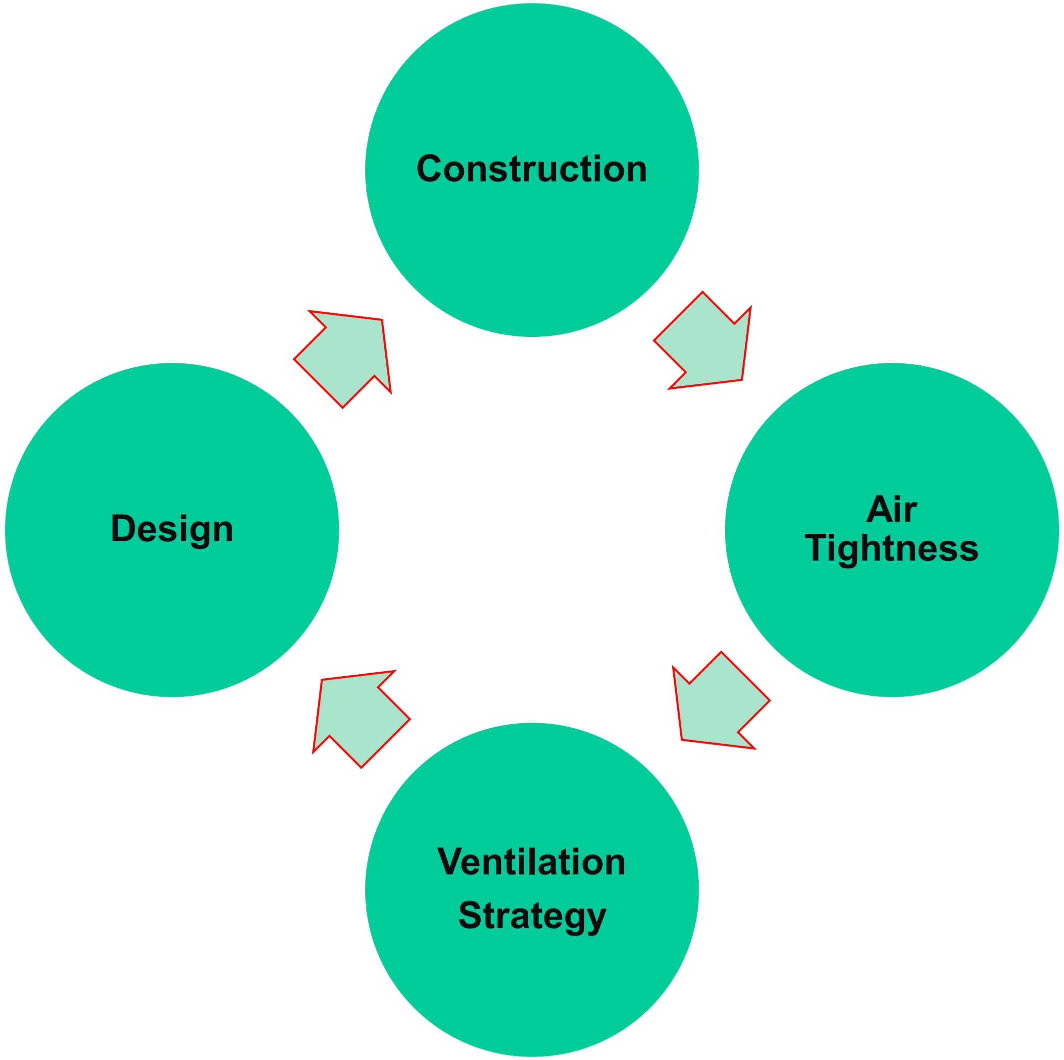
Ventilation Strategy

- Natural Ventilation
- CMEV
- MVHR
- Air permeability result?

Air Tightness

- Result
- Materials/workmanship
- Ventilation Strategy
- Re-design?

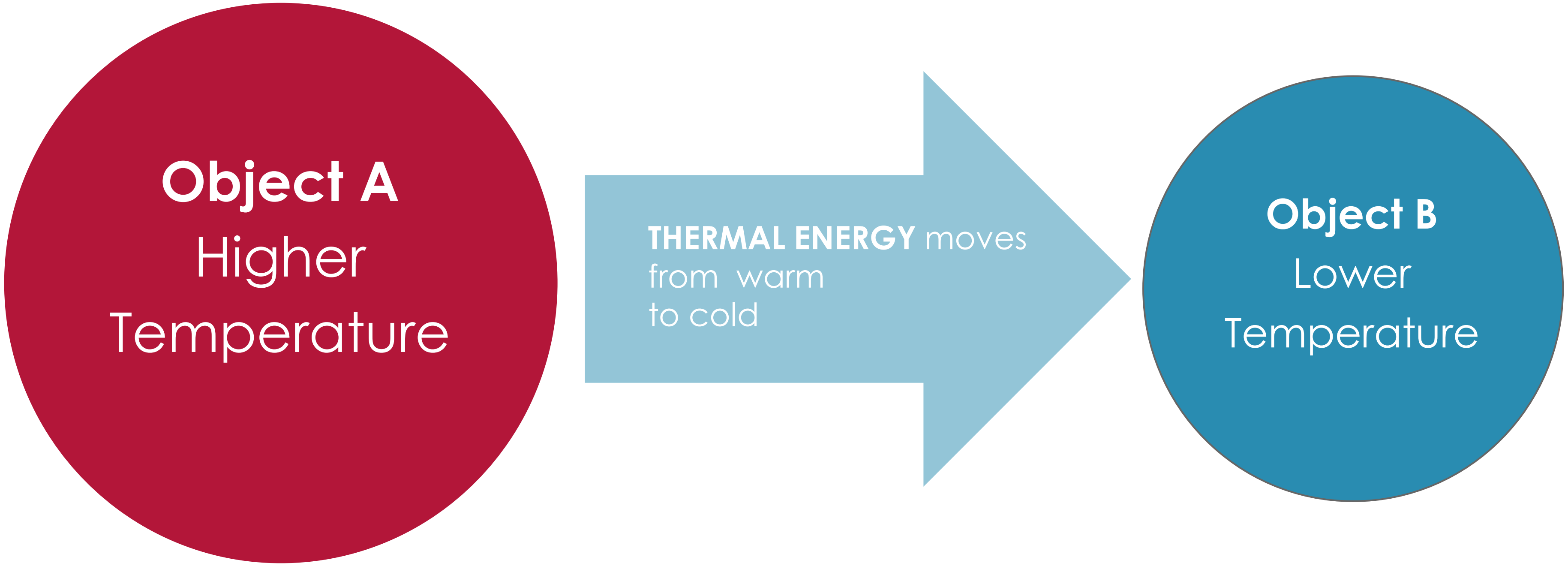
Air Permeablility & Ventilation Systems



Air Permeability & Ventilation Systems

Chicken or egg?

Air movement & Building Physics



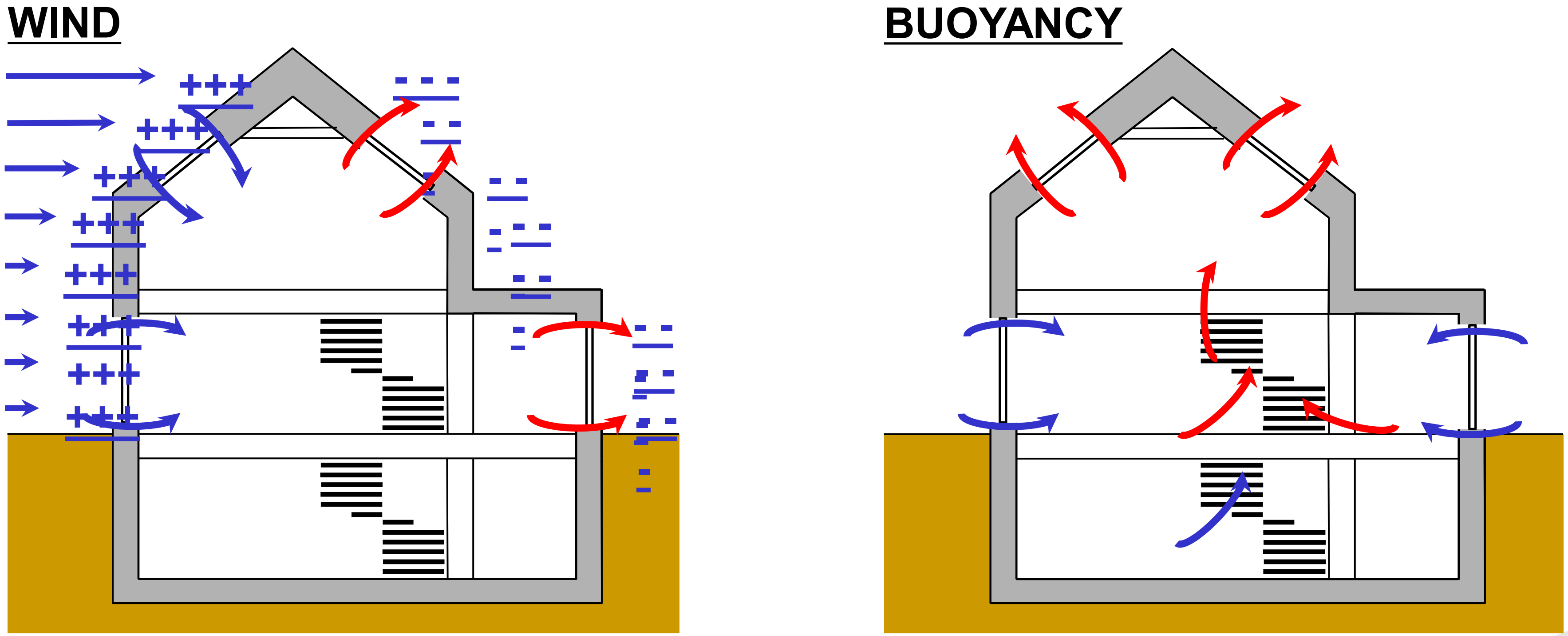
Thermal Energy always flows from the object or material with the higher temperature towards the object or material with the **lower temperature (***the Second Law of Thermodynamics*)..

Source: Zeller/Biasin

Air Leakage & Airtightness

Definition of Air Leakage

The **Uncontrolled** flow of air through **Gaps**, **Cracks** and **Holes** in the fabric of the Building



Infiltration and Exfiltration

Source: Zeller/Biasin

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Air movement & Building Physics

Water molecules are much smaller than air molecules, which is why airtight layers are completely airtight, but allow a small amount of vapour to pass through them.

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Source: Zeller/Biasin

Interstitial Condensation

Airtight/Vapour control layer VCL

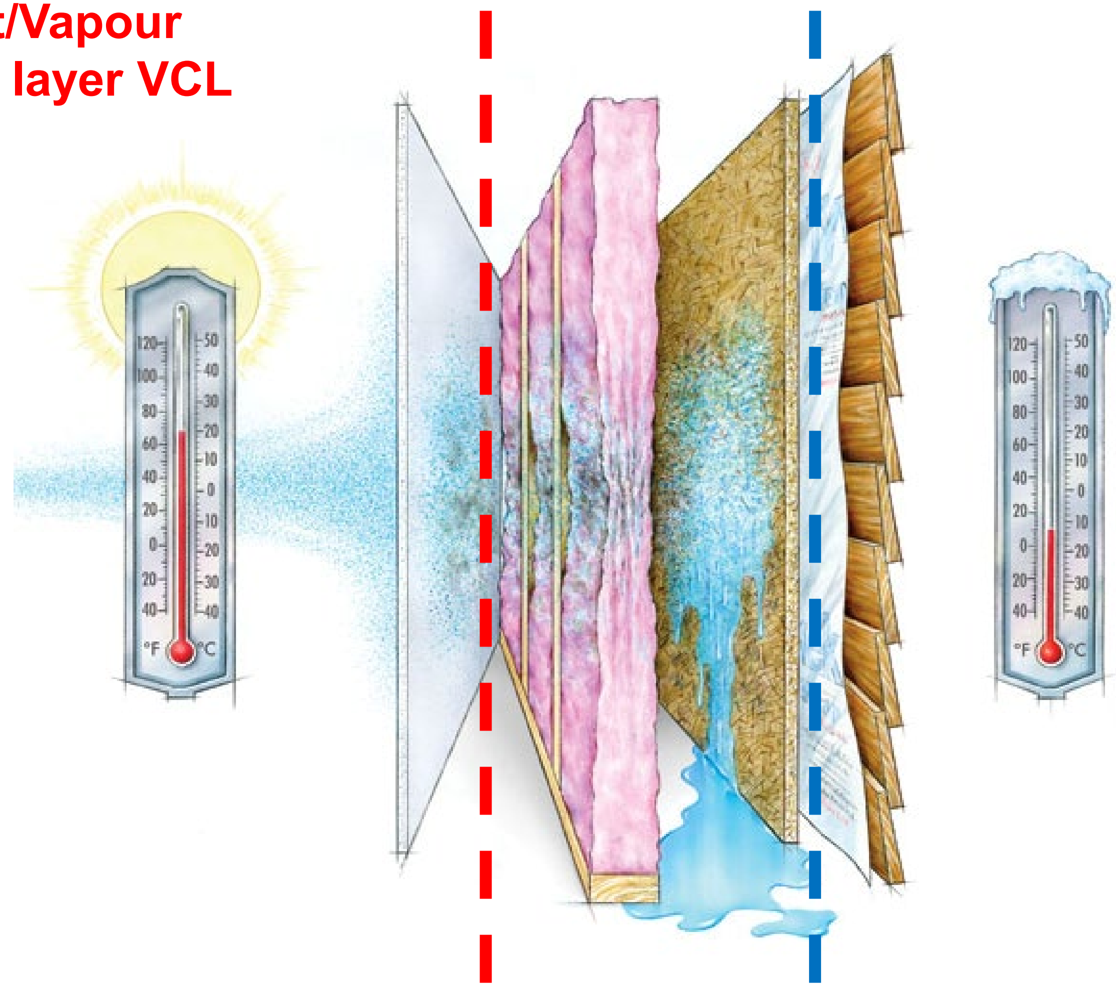

Image: Green Building Advisor

Windtight/Vapour Permeable

- If your building is not airtight, warm **humid air will leak** into the external envelope
- As the **air migrates to the outside**, the temperature decreases
- If the temperature reaches the **dew point, condensation can form**
- If the outside of the envelope is not vapour open, **condensation can build up** in the wall
- This is especially **critical in timber frame** buildings

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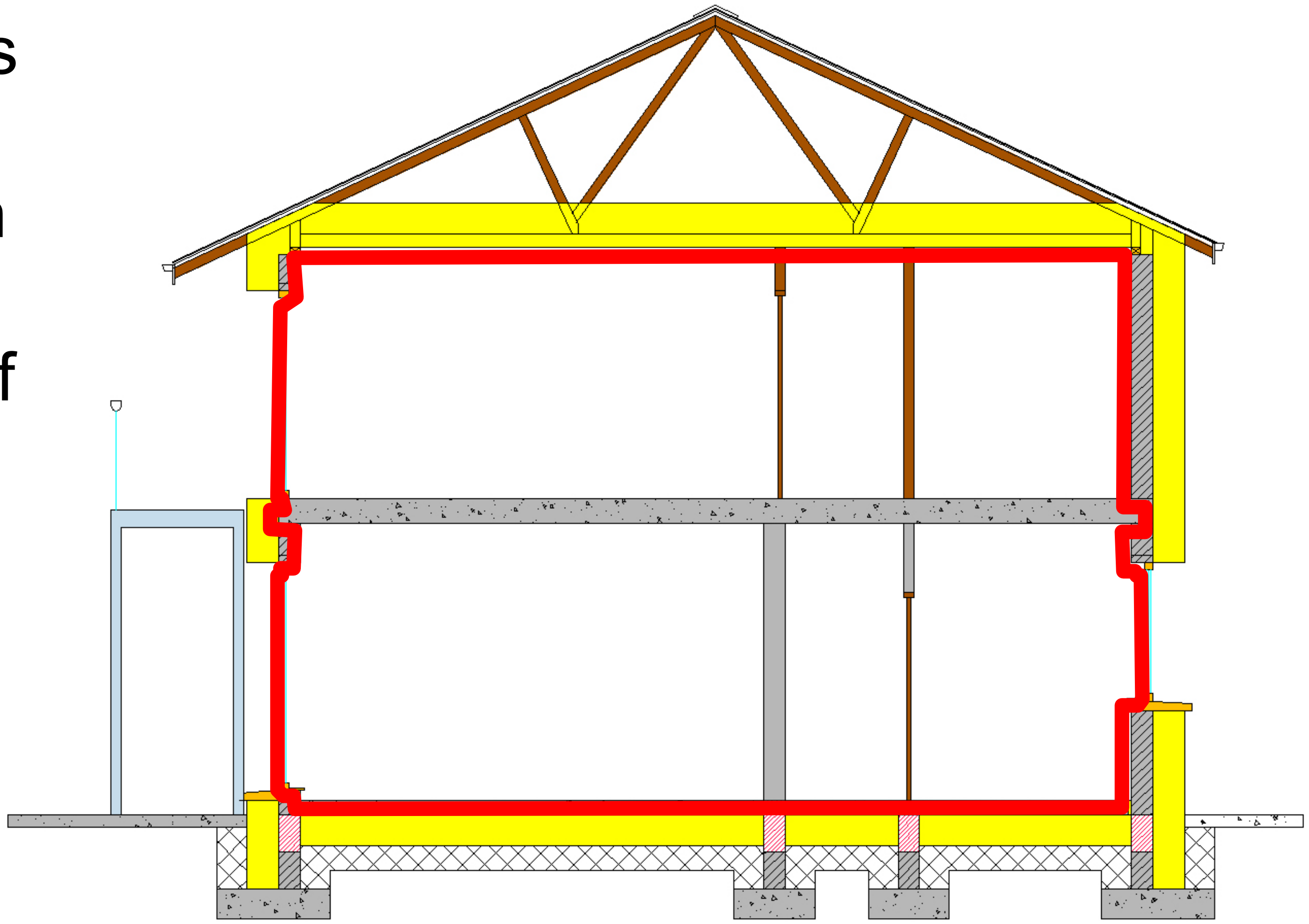
Location of the Airtight/VCL Membrane

One continuous airtight/vapour control layer on the warm (interior) side of the insulation



Testing Air Tightness

Must be completed by an **NSAI or INAB Accredited Tester**

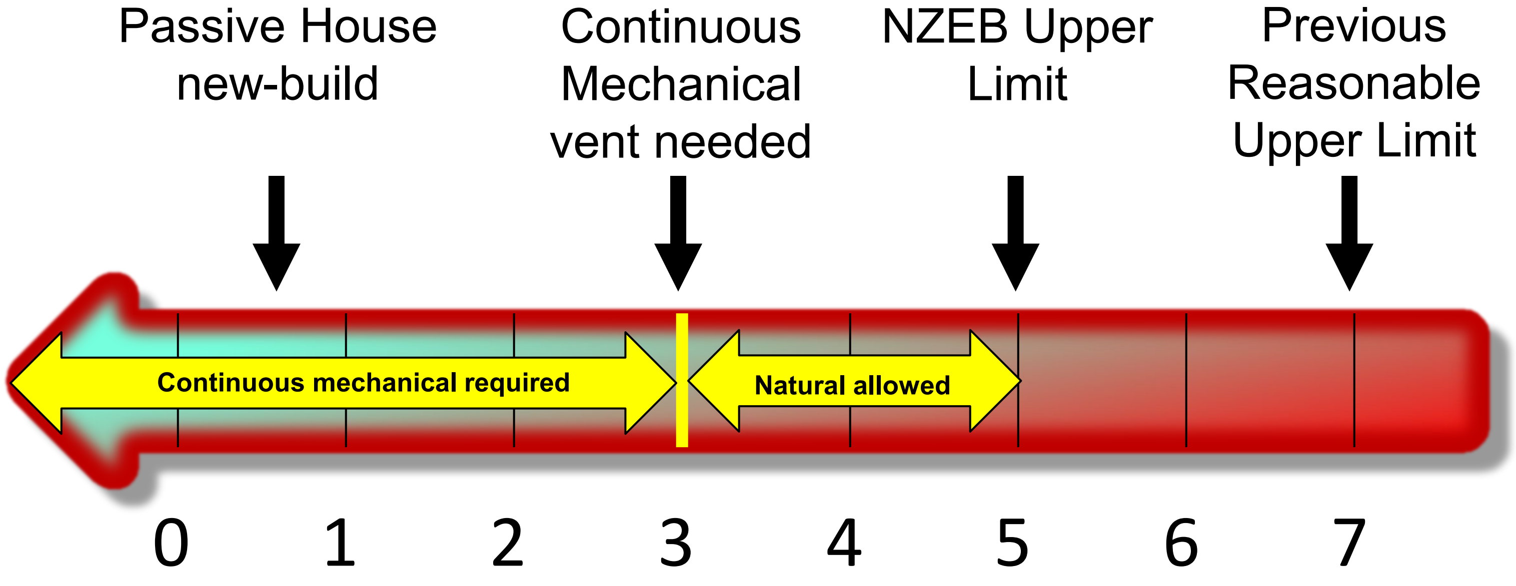
Measured at **50 Pascal**

Might need multiple tests if **first result is poor**

EN9972 recommends testing in both directions, but only requires **testing in one direction**

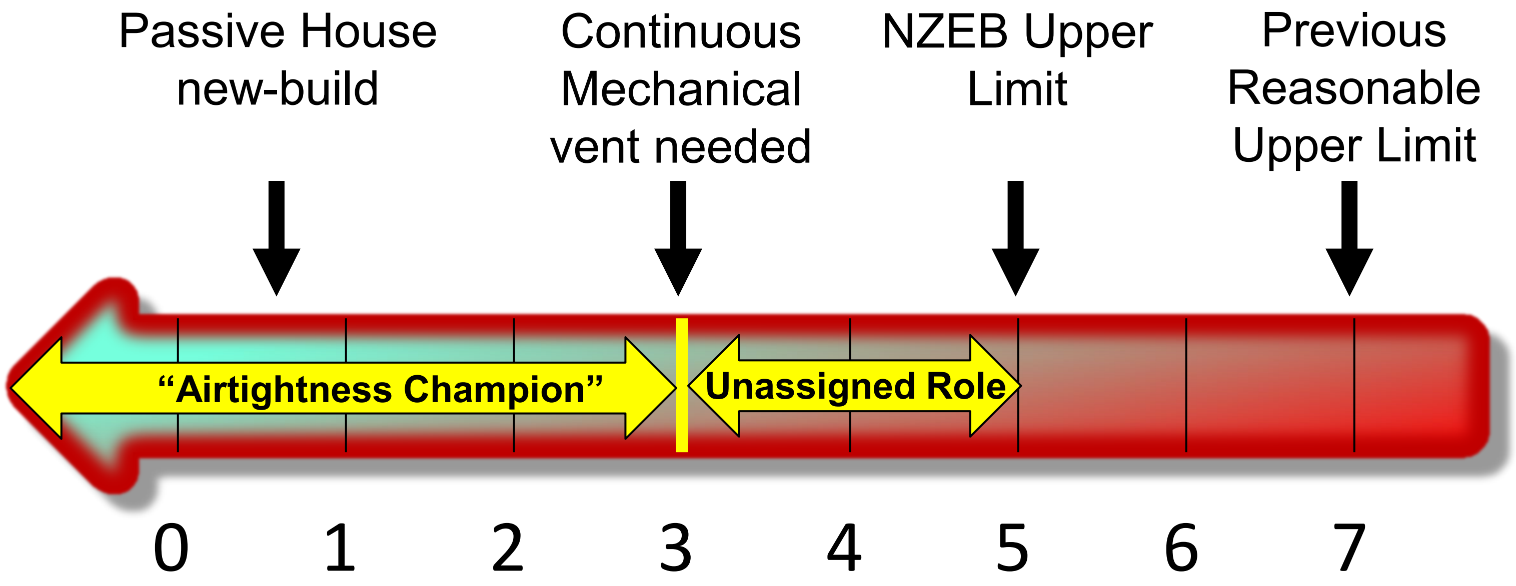
Every NZEB dwelling must be tested (no more default air permeability numbers)

Air Tightness & Ventilation



Air permeability q_E50 result: $m^3/hr.m^2$

Air Tightness & Ventilation



Air permeability q_E50 result: $m^3/hr.m^2$

“Build Tight – Ventilate Right”

< 3.0 m^3/hour.m^2 @ 50 Pascal

it is compliance to provide continuous mechanical ventilation

(ideally with heat recovery)

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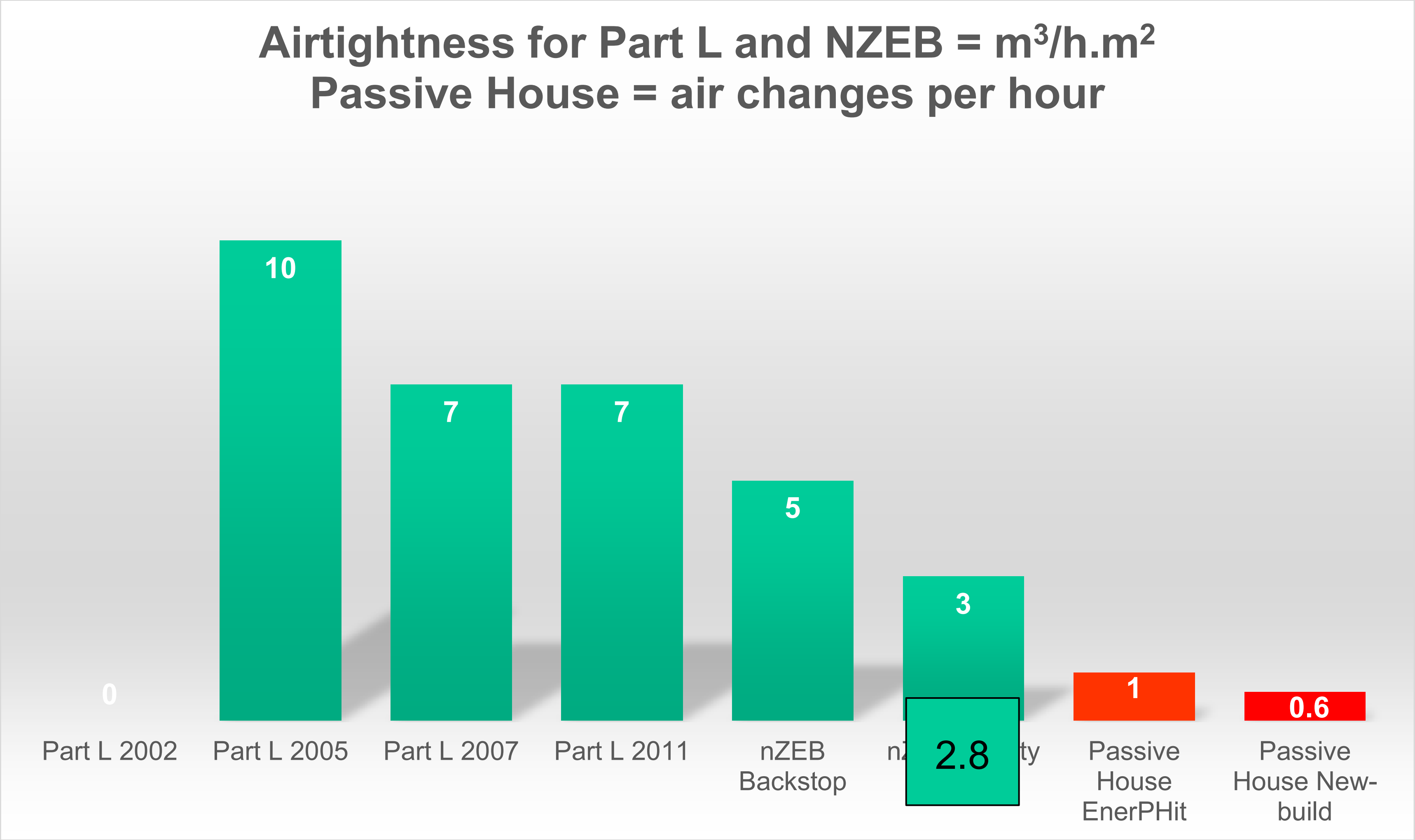
Evolution of Airtightness



NZEB '*reality*':

2.8 $m^3/hr.m^2$

Maximum permeability that is likely to be used on **cost effective construction projects**

= 3 $m^3/hr.m^2$

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Part F 2019

- Ventilation systems should be **designed** by competent designers.

- Systems should be **installed, balanced and commissioned** by competent installers

How to achieve competency?
Quality and Qualifications Ireland accredited or Education Training Board or equivalent.

All ventilation systems must be validated by independent third party - ***NSAI or INAB***

Independent Ventilation Validation

- Once the ventilation system of a dwelling has been commissioned independent validation must be scheduled.

- This process ensures that design airflow rates are being achieved in reality.

- The independent validator is not responsible for inspecting installation or confirming Part F compliance. This is the responsibility of Local Building Control.

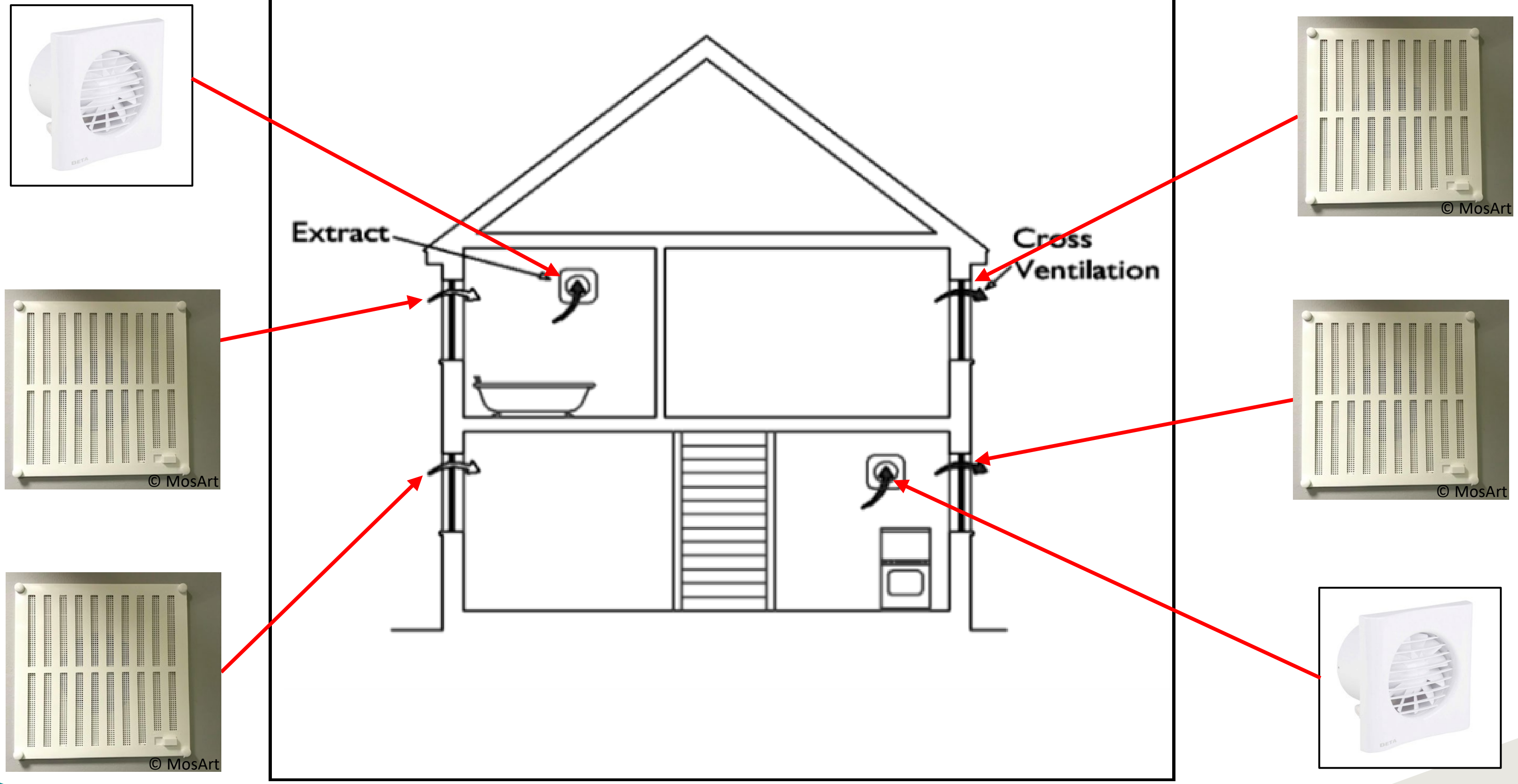
- Obtain and check design airflow rates from designer

- Measure air flow rates to ensure they comply with design airflow rates within measurement tolerances and design tolerances

Natural Ventilation

Habitable rooms are used for living or sleeping

Diagram 2c: Natural Ventilation with intermittent fans mechanical extract - House



Wet rooms are kitchens, utility rooms, bathrooms and sanitary facilities

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Natural Ventilation – Basic Ventilation Provision

Table 3: Basic ventilation provision using background ventilators and specific provision for extract and purge ventilation for $5m^3/hr/m^2$ > air permeability > $3m^3/hr/m^2$

Room or Space	General Ventilation Minimum equivalent area of background ventilator[a] (mm^2)	Extract ventilation Extract fan[b] - Minimum intermittent extract rate (l/s)[h]	Purge ventilation Opening window or external door - Minimum provision[g]
Habitable Room	*7000*[c,f]	-	*1/20th of room floor area*
Kitchen	*3500*[c,d,f]	*60l/s generally 30l/s if immediately adjacent to cooker (e.g. cooker-hood not recirculating)*	*Window opening section (no size requirement)*[d]
Utility Room	*3500*[c,d]	*30 l/s*	*Window opening section (no size requirement)*[d]
Bathroom	*3500*[c,d]	*15 l/s*	*Window opening section (no size requirement)*[d]
Sanitary Accommodation (no bath or shower)	*3500*[c,d]	*6 l/s*[e]	*Window opening section (no size requirement)*[d]

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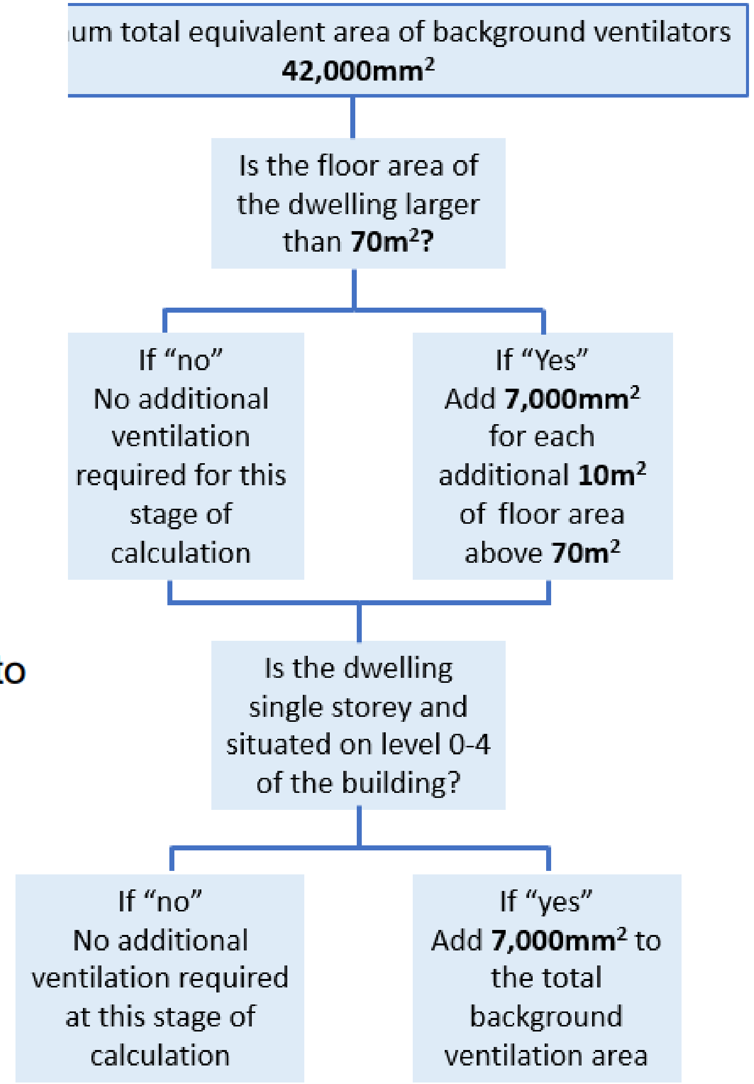
Natural Ventilation – Background Ventilators

1.2.4 Natural Ventilation

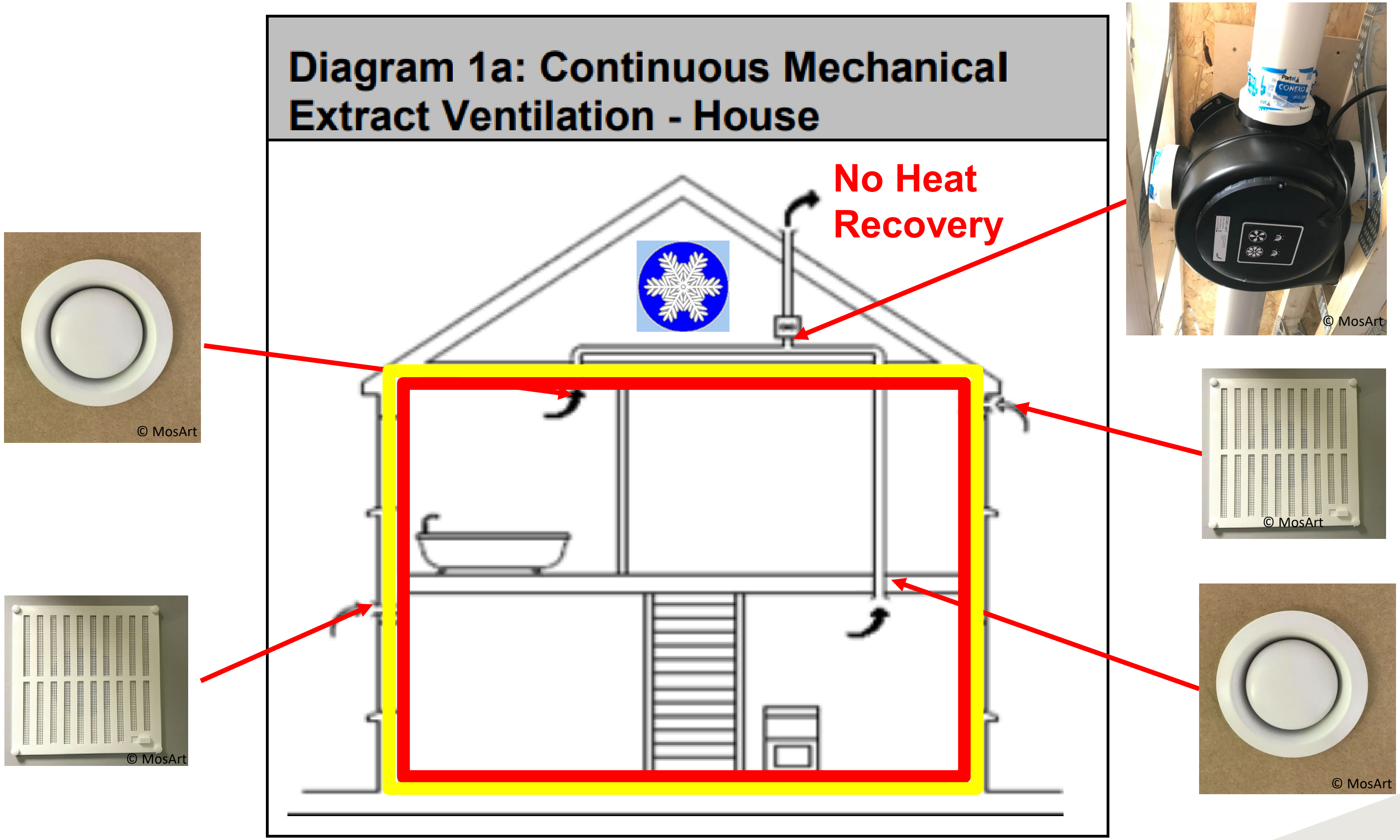
Ventilation Rates

1.2.4.1 Where the air permeability is greater than $3m^3/(h.m^2)$ and lower than $5m^3/(h.m^2)$, the minimum total equivalent area of background ventilators providing general ventilation should be $42{,}000mm^2$ with an additional $7{,}000mm^2$ for each additional 10 m^2 floor area above the first $70m^2$ of floor area measured. For single storey dwellings situated at ground level or on any storey up to four storeys, an additional 7,000 mm^2 per dwelling should be provided. As noted in Paragraph 1.1.15, the areas specified sho be increased by 25% where free area of ventilators is used instead of equivalent ar Example calculations are provided in Appendix 1.



If a dwelling has more than one exposed façade, **similar equivalent areas** should be located on **opposite or adjacent sides** of the dwelling in order to maximize airflow through **cross ventilation**

Centralised Continuous Mechanical Extract Ventilation (CMEV)



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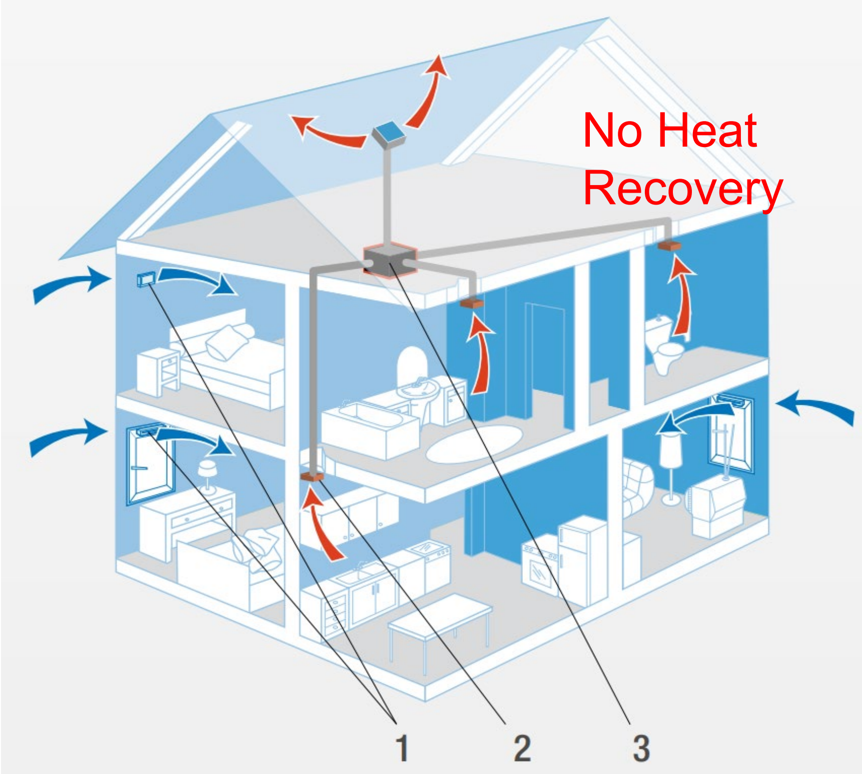
Demand Controlled Ventilation (DCV)



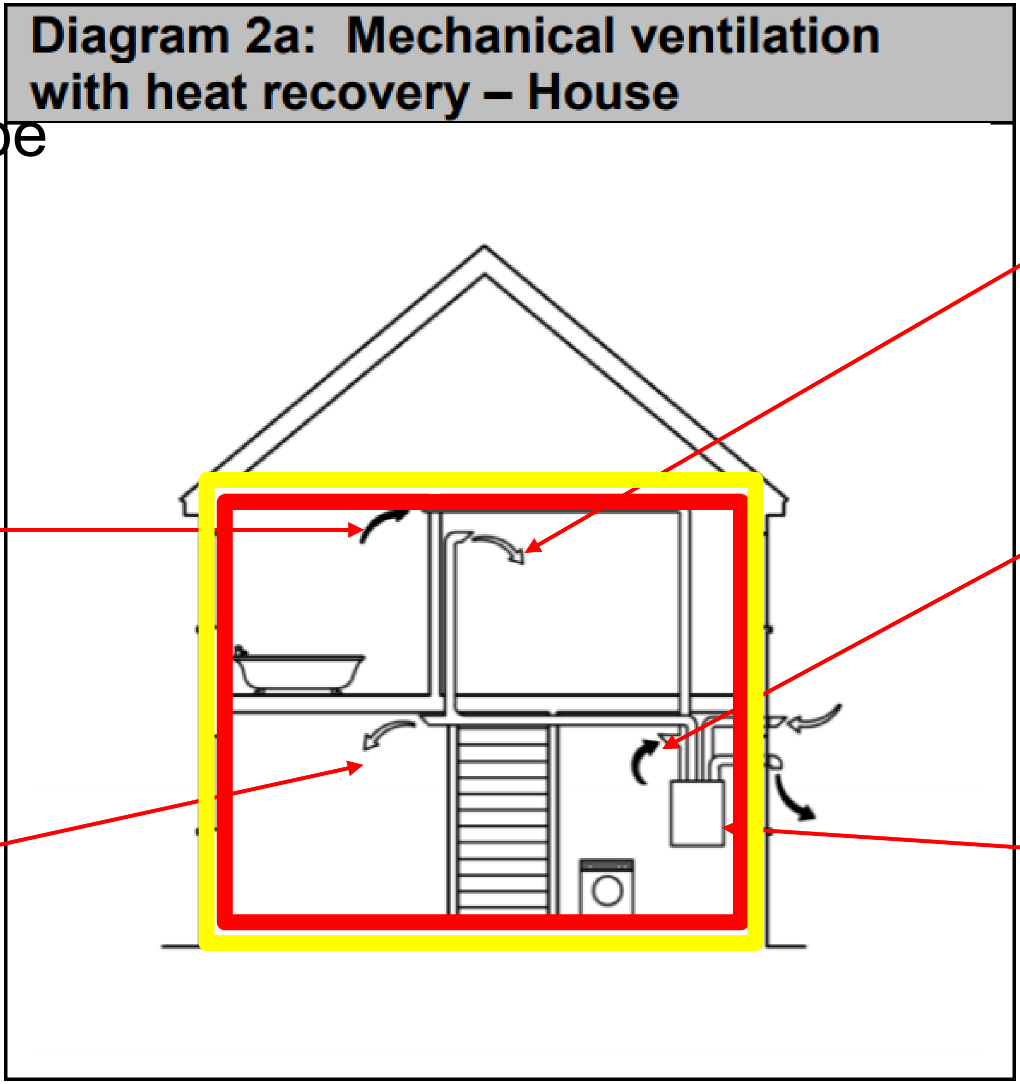
- 3 - Centralised exhaust fan operates continuously
- 2 - Extract rate adjusted according to relative humidity (can also remotely boost if needed)
- 1 - Supply vents in bedrooms and living rooms adjust depending on need

CMEV/DCV

No Heat Recovery

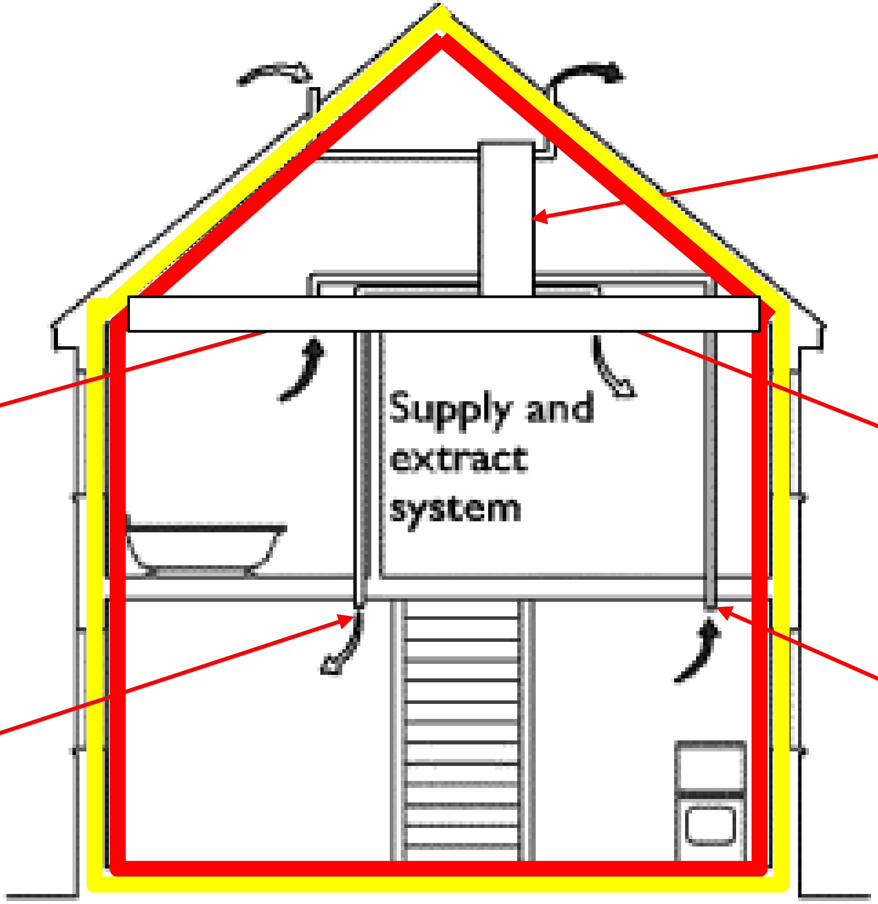
Mechanical Ventilation with Heat Recovery (MVHR)

Inside the thermal envelope

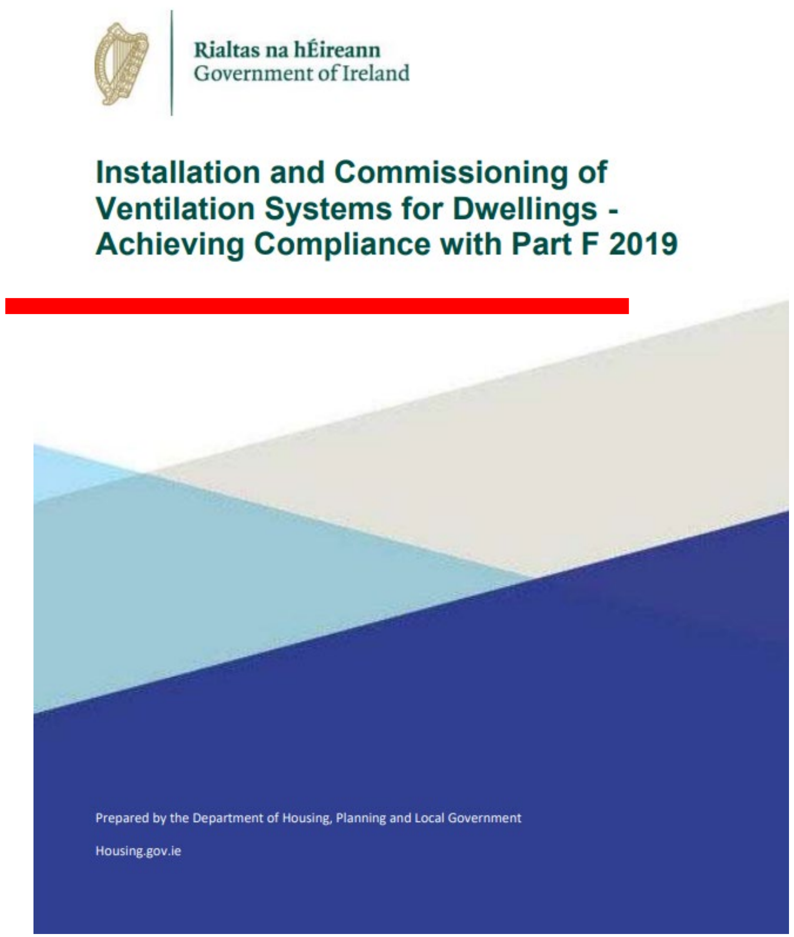


Mechanical Ventilation with Heat Recovery

Outside the
thermal envelope



Installation Guidance Document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Installation and Commissioning of Ventilation Systems for Dwellings - Achieving Compliance with Part F 2019

Prepared by the Department of Housing, Planning and Local Government

Housing.gov.ie

Mechanical Extract Ventilation

Mechanical Ventilation with Heat Recovery

Natural Ventilation

"The verification of flowrates by the independent third party should be included as ***part of the ancillary certificate*** *issued for the dwelling ventilation system"*

Location

Avoid putting Ventilation equipment in the attic – cold space outside thermal envelope – more ducts need insulating

Unilad

Access & Use

The location of the equipment should allow sufficient **space to allow access for maintenance** of filters and to remove heat exchanger

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Access & Use

The fan unit should be installed to allow **sufficient space for end-of-life replacement** of the whole unit or key mechanical/electrical components.

This should be achievable **without the need to remove fixed structures or significant lengths of connected ductwork.**

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Filters

Filters must be changed regularly.

Clogged filters will **reduce indoor air quality** and **increase fan power**

Poor maintenance

Frequency of cleaning MVHR filters can vary depending on the environment.

- **clean or replace the filters** every 6 to 12 months
- in certain environments with higher pollutant levels, **more frequent cleaning** may be necessary

Location

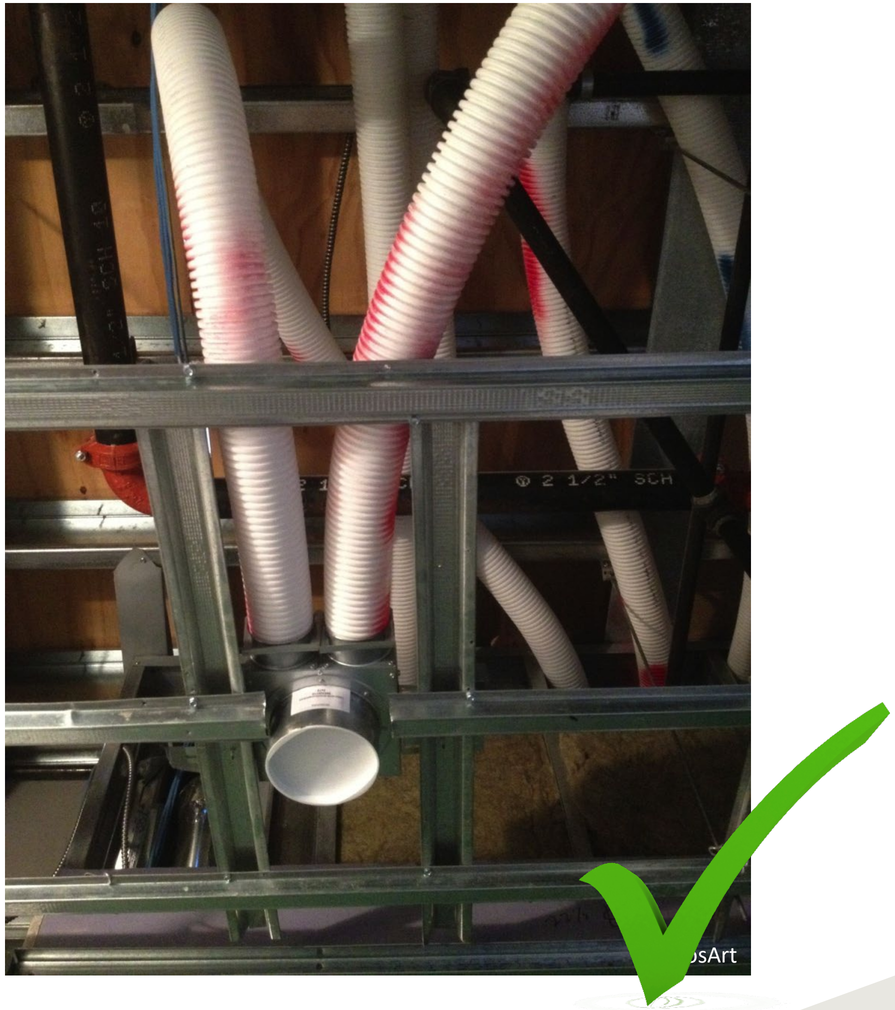
The fan unit should be installed on a suitable **sound structure**, which is stable and level.

The condensate drain(s) should be adequately secured and, where passing through an unheated space, must be **adequately insulated** to prevent freezing.

Ductwork

Minimise duct length and number of bends

Semi rigid ducting & rigid ducting ensure sharp bends on ducts do not occur



NZEB Ductwork

Rigid ducting is recommended in all locations with the exceptions of short lengths e.g. < 1m. in order to connect extract air grilles.

Insulating Ductwork

Additional insulation to reduce **heat loss** from the duct – MVHR

The insulation thickness will depend on the location and climate of the building.

The colder the climate, the thicker the insulation required to reduce heat loss.

Condensation

A **condensate drain** should be installed from the fan unit to an appropriate drain location.

The condensate pipe should be installed to have a minimum 5˚ fall from the fan unit.

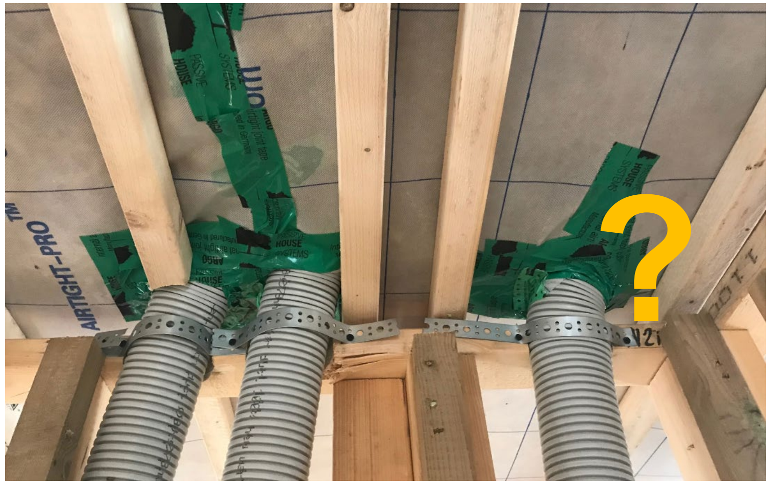
Slope horizontal ducting away from fan unit

Sealing ductwork

All **duct connections should be sealed**. Where ducts are installed against a solid structure this can be achieved by assembling and sealing ductwork prior to fixing.

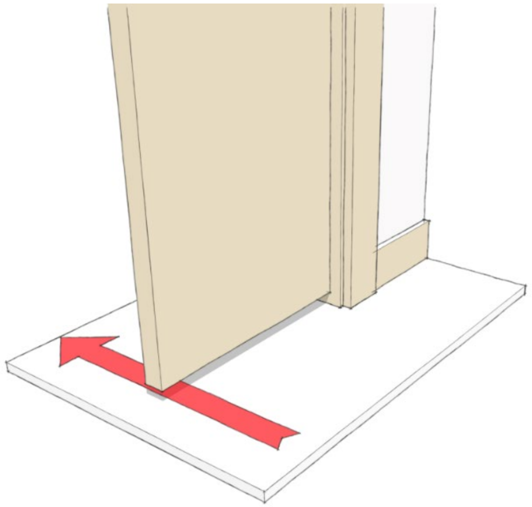
Ductwork & Airtightness

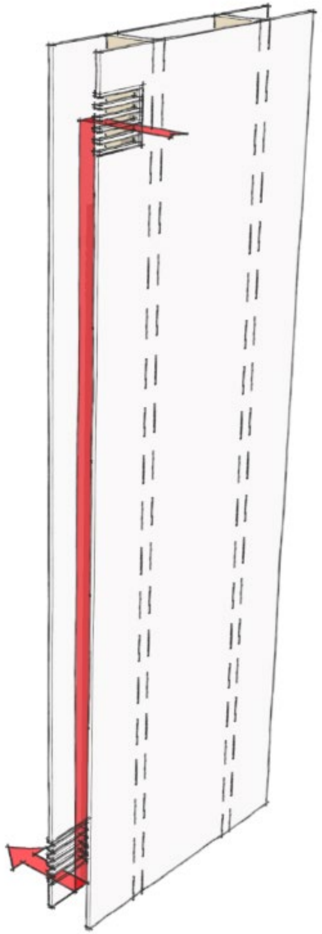
Ensure that ventilation **ducts are sealed to the air tightness barrier** with appropriate tapes or sealants.



Cross Ventilation - ALL Ventilation Systems)

To ensure adequate air transfer, **a gap 7,600mm² should be provided under internal doors** *(10mm on a 760mm wide)*





Doors which are required to achieve a fire rating determined by Part B **must achieve both the requirements of the fire door test certificate and the airflow requirements**.

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Location of terminals

Extract Terminals should be **installed in ceiling or as close to ceiling level** as practical to ensure warm moist air is removed.

No greater than **400 mm below** ceiling level.

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Control indicators – MVHR & CMEV

Control indicators should indicate to the occupant that the system is **operating correctly** and if **a fault has occurred.** Control indicators should be in a **visible location** to the occupant and not in a remote location such as in the attic or above the ceiling.

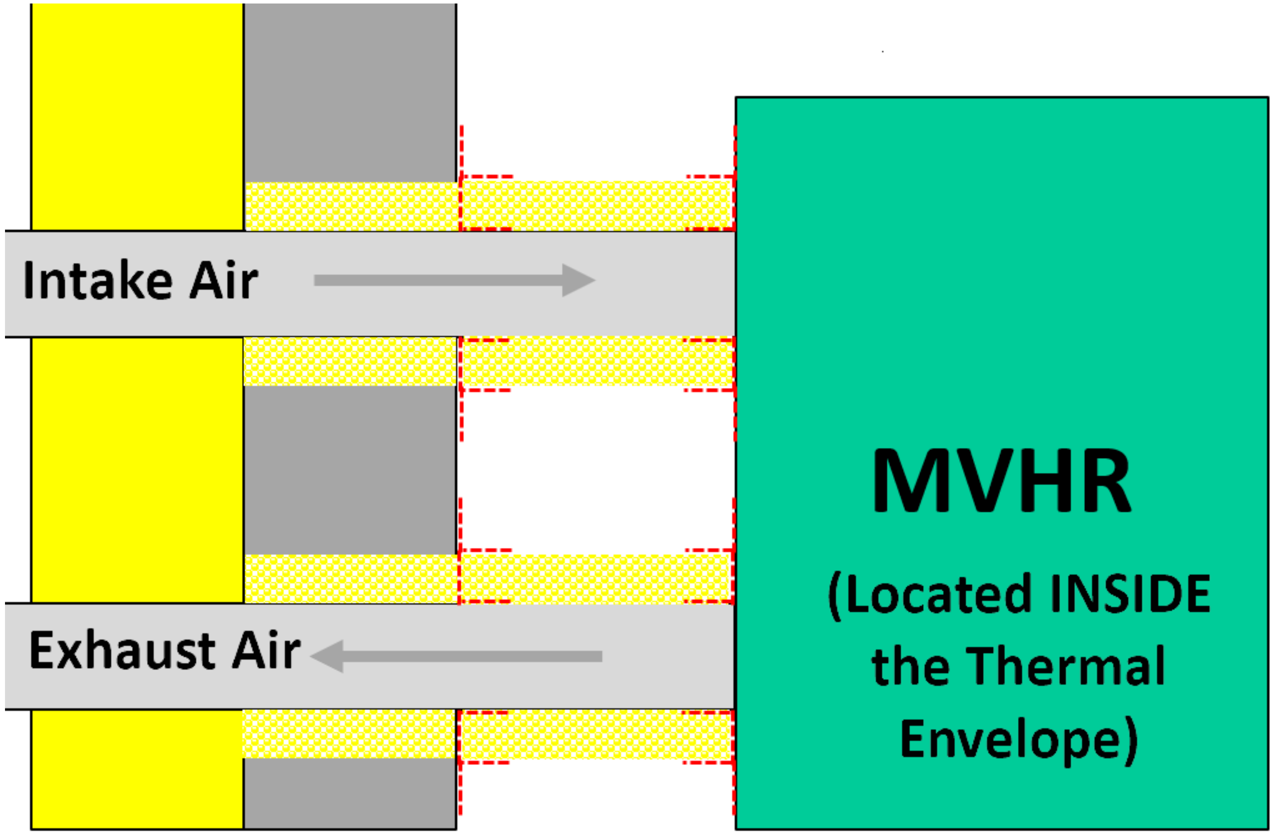
MVHR – It must show when **maintenance** is required

NZEB

Thermal bridging

The **continuity of the airtight barrier & insulation** - ease of achieving an effective seal should be considered before holes are drilled.

Cold air ducts should be wrapped additionally with a **vapour barrier outside the insulation**



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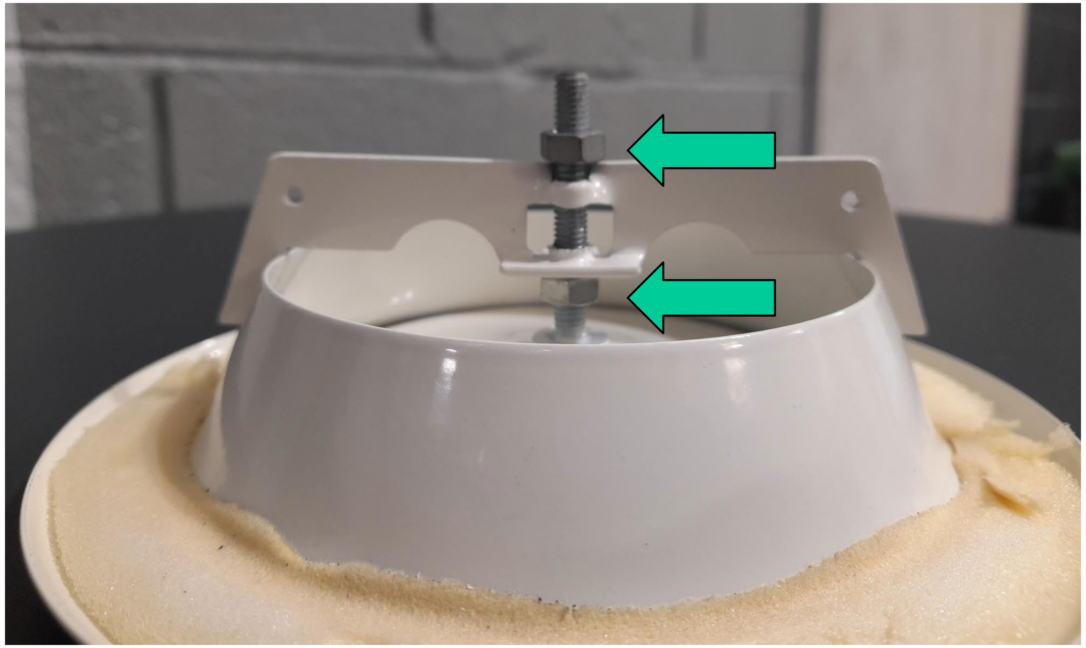
Cross contamination

Exhaust terminals should be so spaced as to **avoid short-circuiting** and in exposed locations, it is recommended that they are located on the same façade to reduce the effects of wind pressure.

Locking the system

Ensure each **terminal/grille can be locked** in its commissioned position once system balance has been achieved.

It is vital for the correct operation of the system that the **system remains balanced** in its commissioned state.

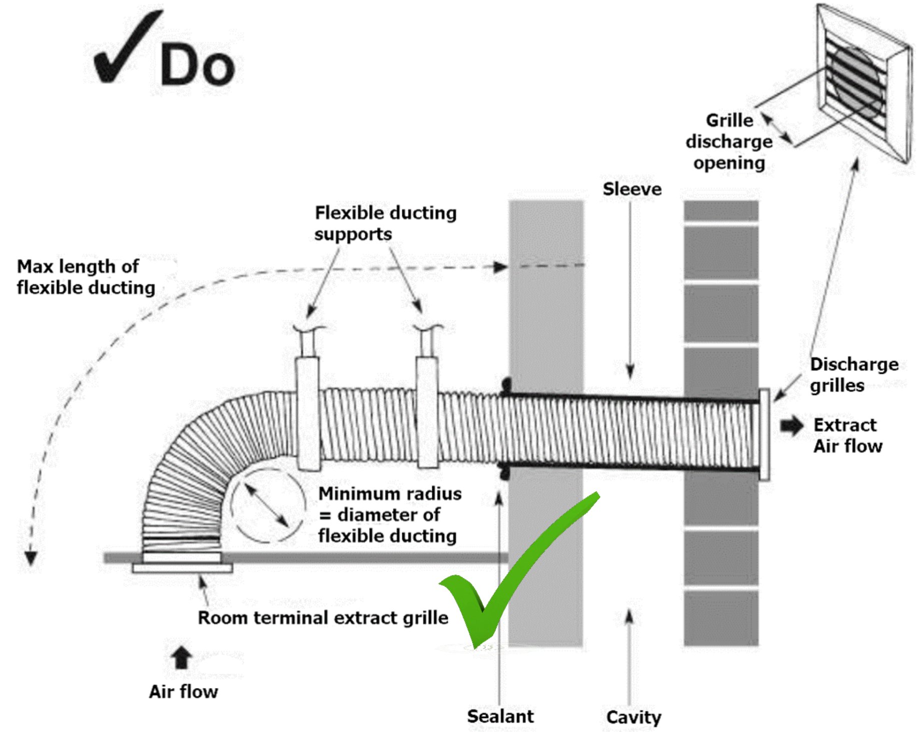


Natural Ventilation Extract Ducts

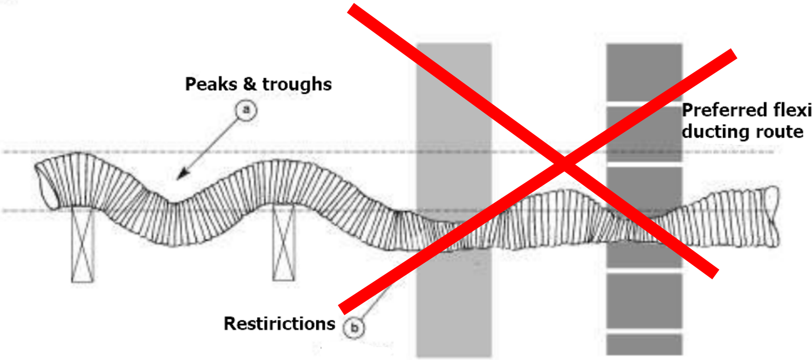
The **duct sleeve should be rigid**. In situations where this is not possible, flexible ductwork may be used if pulled tight

For through-wall units, the hole should have a **slight downward angle** towards the outside to prevent water ingress.

✓ Do



✗ Don't



Natural Ventilation Extract Ducts

Rigid ducts, rectangular or circular, should be used wherever possible. Circular ducts offer least resistance

Flexible ducts may be used, but **should be kept to a minimum**, to connect rigid ductwork

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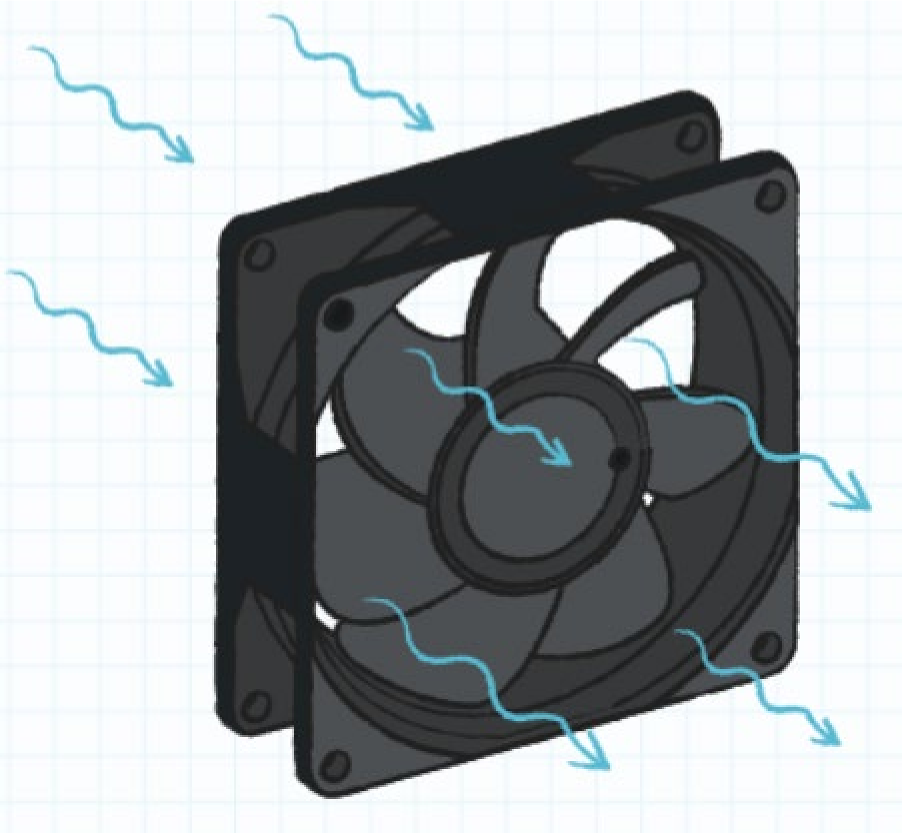
Natural Ventilation – Intermittent extract fans

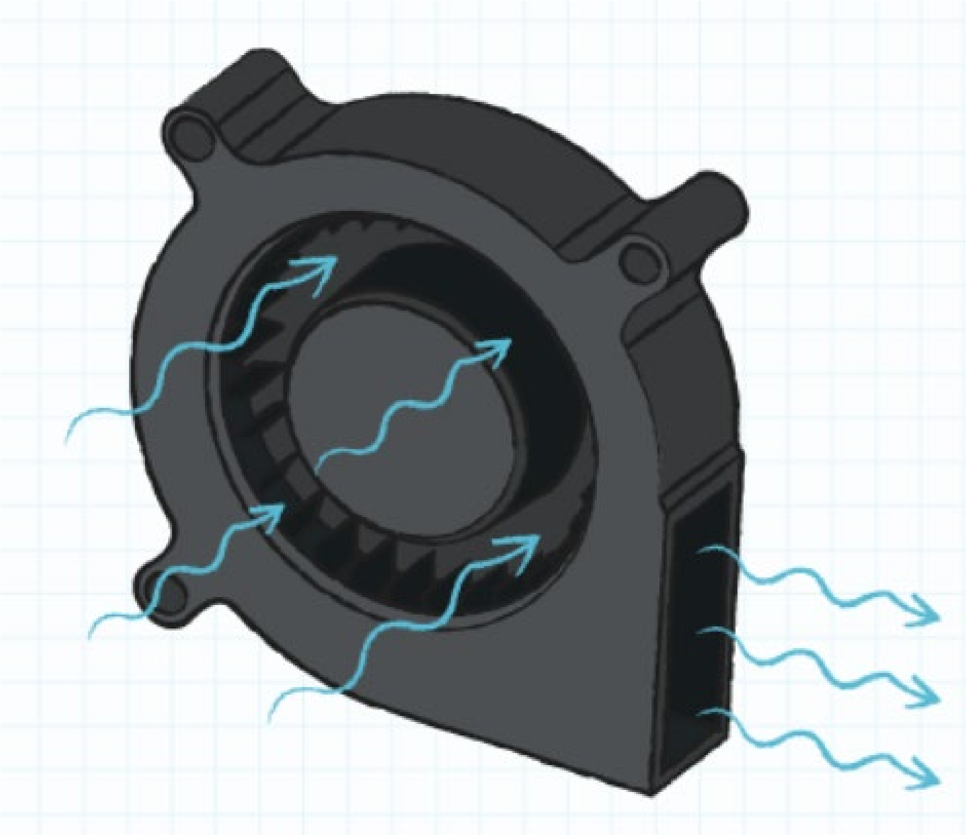
For flexible duct connected to **axial fans** the length is limited to **1.5 metres**



Axial fans extract air parallel to intake

Natural Ventilation – Intermittent extract fans

For flexible duct connected to **centrifugal fans** the length limit is **6 metres** (for extract rates 6 to 30 l/s), and **3 metres** (for extract rates 31 to 60 l/s).



Centrifugal fans expel air 90° from the intake

Extract Ventilation – Condensation

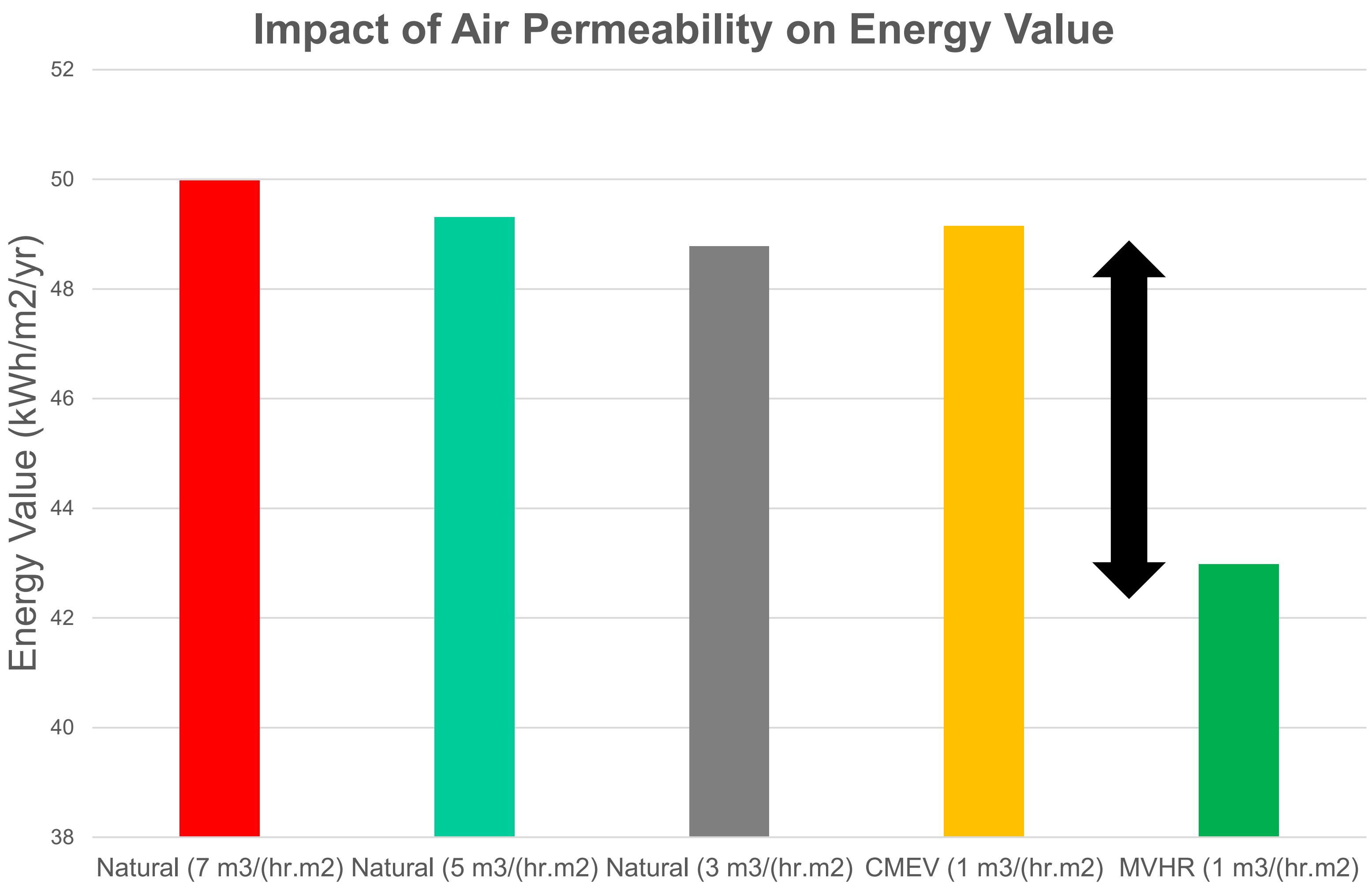
Insulate ductwork against condensation in unheated areas and voids e.g. attic spaces with the equivalent of at least 25mm of a material having a thermal conductivity of ≤0.04 W/m.K

System Completion & Handover

Operation and maintenance information for the system:

- should be included in the **Safety Plan** handed over to the **building owner** on completion
- should contain **specific instructions** for the end user on **how and when to use** the ventilation system
- the systems should **never be turned off**
- information on the intended use of **available fan settings**.
- system components should be **cleaned and maintained**

How does Ventilation influence energy performance?



6 kWh.m^2.yr

@ €0.3583 /kWh

200 m^2 house

€430.00 per year

25yrs > €10,000

Air Permeability & Ventilation Systems

Chicken or egg?

Questions?

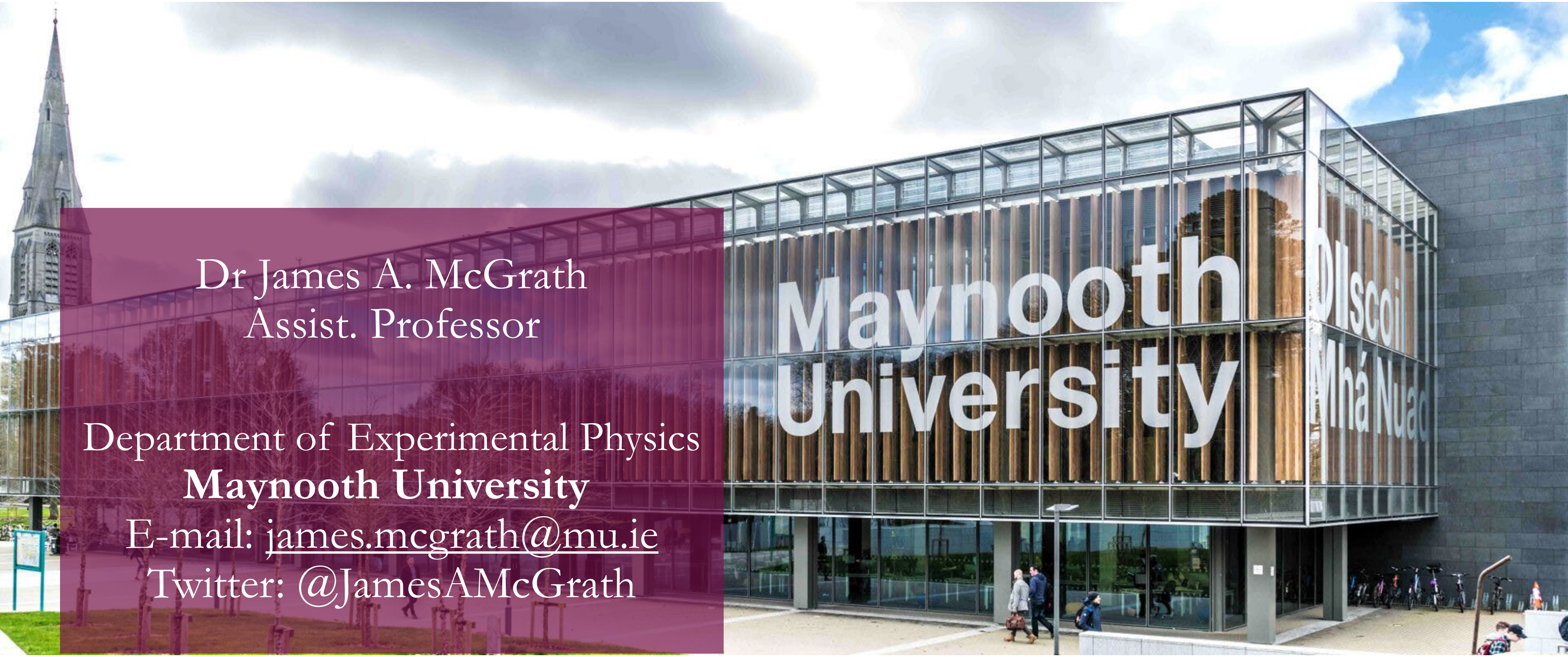
To book or enquire about an NZEB Ventilation course please contact WWETB or LOETB

LOETB - bkennedy@loetb.ie or 0858049519

WWETB – nzeb@wwetb.ie or 086 0787057

Thank you ☺

Emer Doyle



Dr James A. McGrath
Assist. Professor

Department of Experimental Physics
Maynooth University
E-mail: james.mcgrath@mu.ie
Twitter: @JamesAMcGrath

Energy Show 2024 – 21st of March 2024

James A. McGrath

- International Society of Indoor Air and Climate (ISIAQ) – Board of Directors
- Led Irish Participant in IEA EBC Annex 86 – Energy Efficient Indoor Air Quality Management in Residential Buildings
- Irish Representative on AIVC Board
- Advisory Board – NSAI/TC - Retrofit of Existing Dwellings Ventilation working group.
- External Advisor to the National Radon Control Strategy

INTERNATIONAL SOCIETY OF INDOOR AIR QUALITY AND CLIMATE

EBC

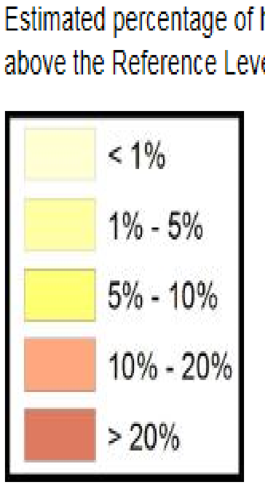
Energy in Buildings and Communities Programme

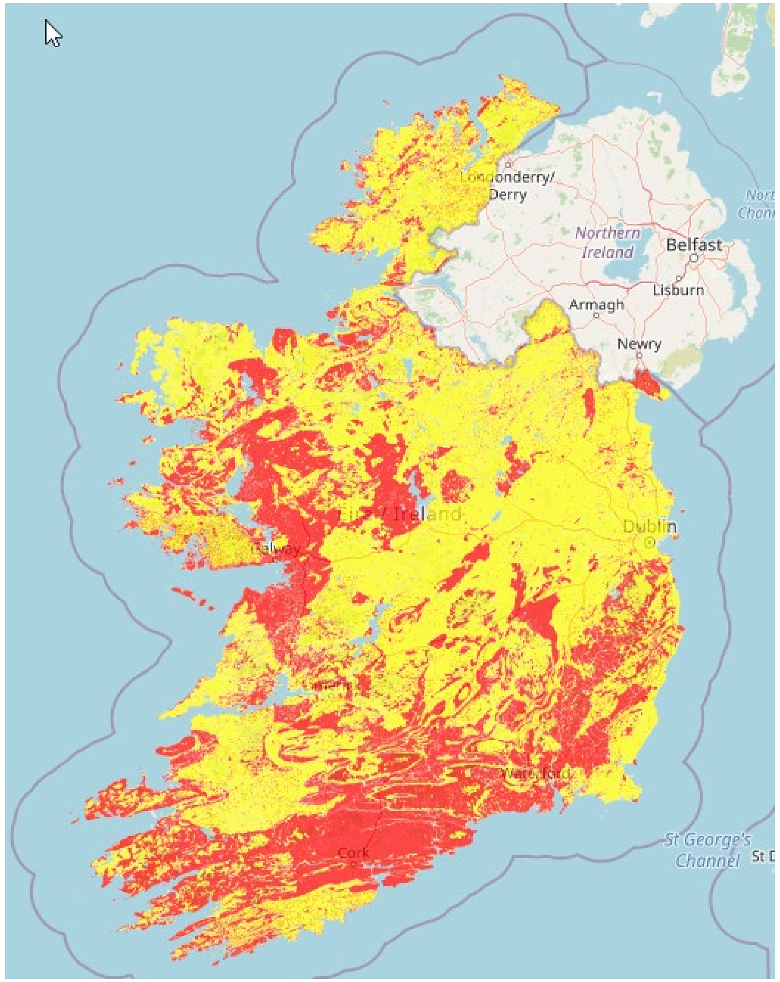
AIVC

The Aerosol Society

Maynooth University
National University of Ireland Maynooth

Specific Irish challenges – Radon





Average radon concentration

Irish homes 77 Bq/m^3

UK homes is 20 Bq/m^3

Worldwide average of 39 Bq/m^3

350 lung cancer cases per year

2nd leading cause of lung cancer

56% of the population's radiation exposure

Retrofits

Potentially greater risk due to substructure

Irish EPA Radon Measurements of Retrofit Dwellings

142 homes with both pre and post retrofit results

- Mean pre-retrofit radon concentration: 56 Bq/m^3
- Mean post-retrofit radon concentration: 50 Bq/m^3
- All measures ranged from ratios of 0.1 to 7.3

"test and re-test following energy retrofitting"

UNVEIL: UNderstanding VEntilation and radon in energy efficient buildings in IreLand

"The relationship, if any, between improved energy efficiency in buildings and indoor radon concentrations is not well understood"

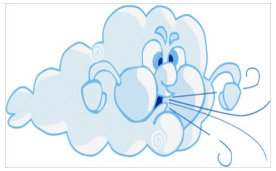
- A computational study examining the implications of radon concentration following energy efficient retrofit scenarios
- Incorporate pressure differential to simulate dynamic radon entry rates
- Simulations predicting indoor radon levels for a series of representative retrofit scenarios

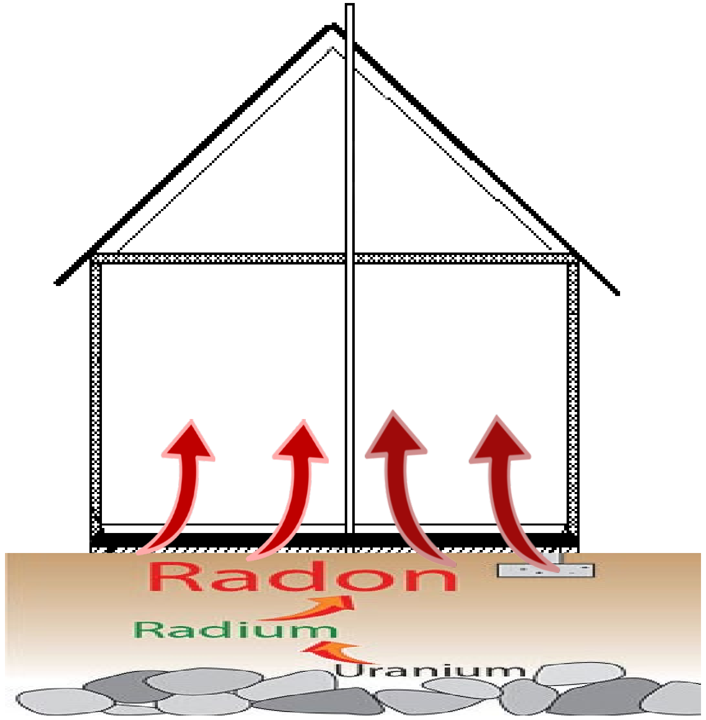
This research project (2015-HW-DS-4) is funded by Irish Environmental Protection Agency (EPA) under the STRIVE Programme.

Modelling Radon

Radon entry rates are reportedly influenced by

- Wind speed
- Moisture content
- Pressure differentials
- Soil type
- Ventilation system





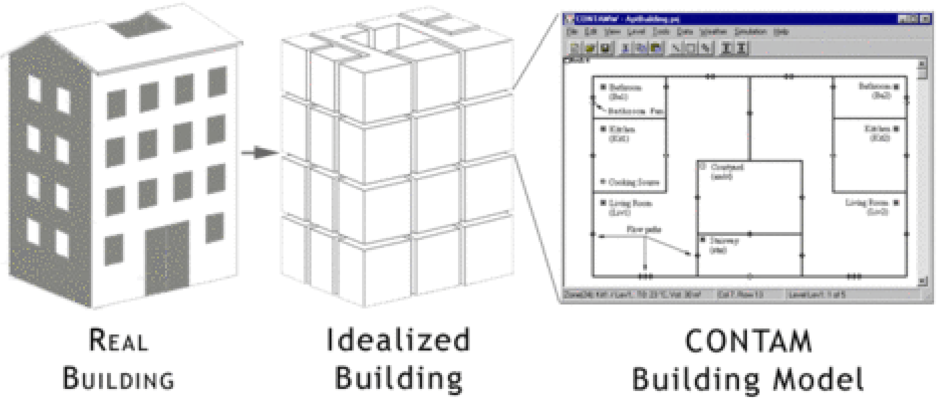


Table 30 - Guidance for the provision of ventilation for retrofit works with air permeability levels >5 $m^3/hr/m^2$

		Existing Dwelling Condition		
	Retrofit Works	**A. No existing background ventilation in some or all habitable rooms and no extract ventilation in wet rooms**	**B. Existing purpose provided background ventilation in each habitable room. No extract ventilation provided in wet rooms**	**C. Existing purpose provided background ventilation in each habitable room. Extract ventilation provided in wet rooms**
1	Internal/External/ Cavity Insulation for Walls	Background ventilation should be provided to rooms without background ventilation in accordance with Column 2, Table 31	No requirement to upgrade background ventilation	
2.	Replacement of Windows	It is advised to provide extract ventilation in wet rooms in accordance with Column 3, Table 31	It is advised to provide extract ventilation in wet rooms in accordance with Column 3, Table 31	No requirement to provide further ventilation
3.	Sealing/insulating of timber suspended floors	Where evidence of inadequate ventilation exists (e.g. mould, condensation) - extract ventilation should be provided to all wet rooms in accordance with Column 3, Table 31	Where evidence of inadequate ventilation exists (e.g. mould, condensation) - extract ventilation should be provided to all wet rooms in accordance with Column 3, Table 31	
4	Two or more of the above measures done in combination or separately	Background and extract ventilation should be provided in accordance with Table 31	No requirement to upgrade background ventilation Extract ventilation should be provided to all wet rooms in accordance with Table 31	No requirement to provide further ventilation

NOTE Covered/Damaged covers on ventilators should be replaced with equivalent or better. Deficiencies or faults in ventilator grills or fans should be rectified and returned to intended working condition.

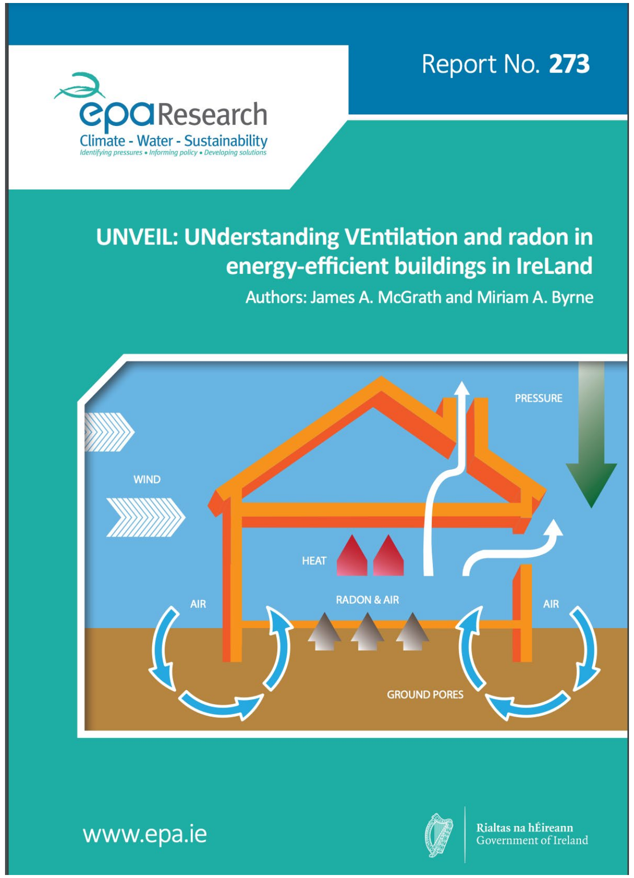
NOTE Where ventilation exists and severe conditions of condensation or mould growth have developed, specialist advise should be sought.

Scenarios	% change in averaged radon concentration		
	15 → 15 $m^3/(hr*m^2)$	15 → 10 $m^3/(hr*m^2)$	15 → 5 $m^3/(hr*m^2)$
Pre-retrofit case 1: No existing ventilation – Advantageous infiltration only			
No changes in ventilation post-retrofit.	3%	27%	70%

Scenarios	% change in averaged radon concentration					
	15 → 15 $m^3/(hr*m^2)$	15 → 10 $m^3/(hr*m^2)$	15 → 5 $m^3/(hr*m^2)$	10 → 10 $m^3/(hr*m^2)$	10 → 5 $m^3/(hr*m^2)$	5 → 5 $m^3/(hr*m^2)$
Pre-retrofit case 1: No existing ventilation – Advantageous infiltration only						
No changes in ventilation post-retrofit.	3%	27%	70%	4%	39%	4%
Installation of PPV only.	-14%	2%	24%	-16%	2%	-24%
Installation of PPV and EV.	-28%	-18%	-6%	-32%	-23%	-42%
Pre-retrofit case 2: Existing PPV ventilation only						
No changes in ventilation post-retrofit.	3%	22%	49%	4%	27%	6%
Installation of EV.	-14%	-2%	13%	-16%	-4%	-20%
Pre-retrofit case 3: Existing PPV and EV						
No changes in ventilation post-retrofit.	4%	19%	37%	5%	21%	6%

The UNVEIL Project: UNderstanding VEntilation and radon in energy efficient buildings in IreLand

- Building physics simulations to predict indoor radon levels for a series of representative retrofit scenarios
- Predicted increases of up to 107%
- Buildings' airtightness and ventilation were key factors
- Provided evidence to support previous observations
- Weather, terrain and wind profiles influenced radon level increases, by up to 37%



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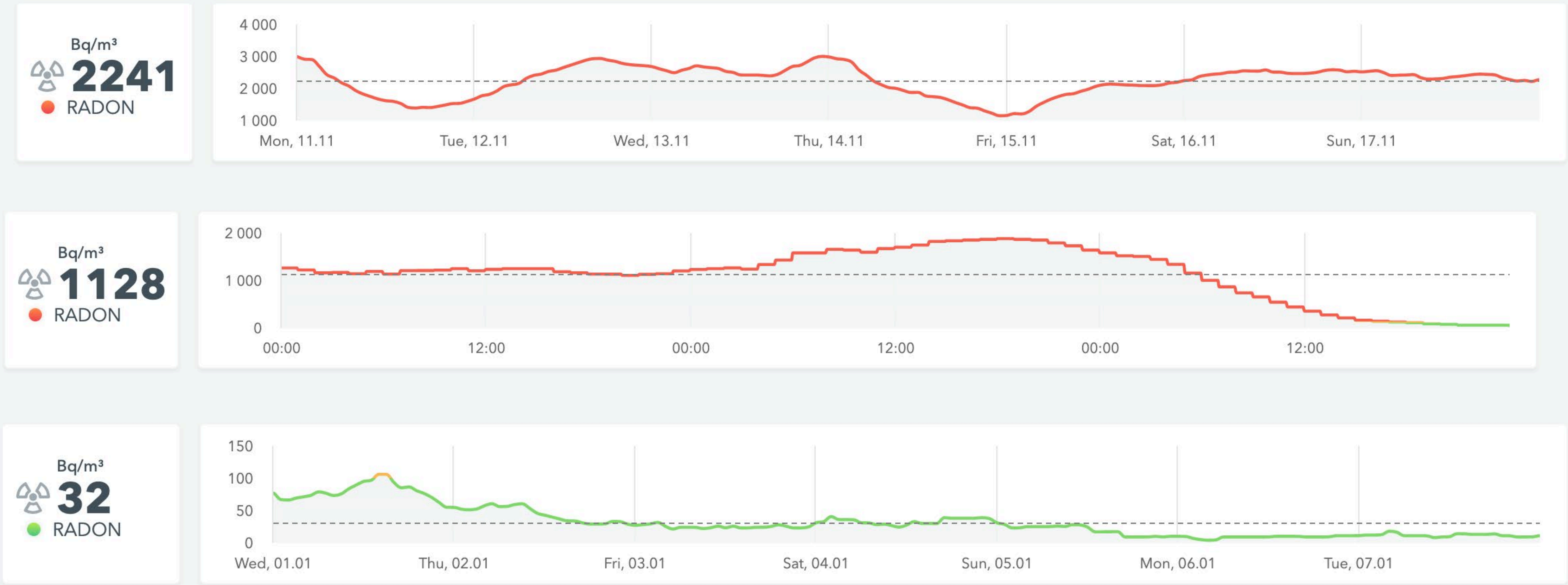
epa
Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

This research project (2015-HW-DS-4) is funded by Irish Environmental Protection Agency (EPA) under the STRIVE Programme.

Radon Case Study



The VALIDate Project: Assessment of VentilAtion effectiveness via a Longitudinal indoor environmental study in 'A' rated Irish Dwellings

- Monitored IEQ over two heating seasons and a cooling season
- Representation of whole-house ventilation effectiveness
- Monitor temperature, humidity, CO_2, TVOCs, radon and air pressure
- A combination of natural and mechanically ventilated dwellings
- 87 dwellings across Ireland

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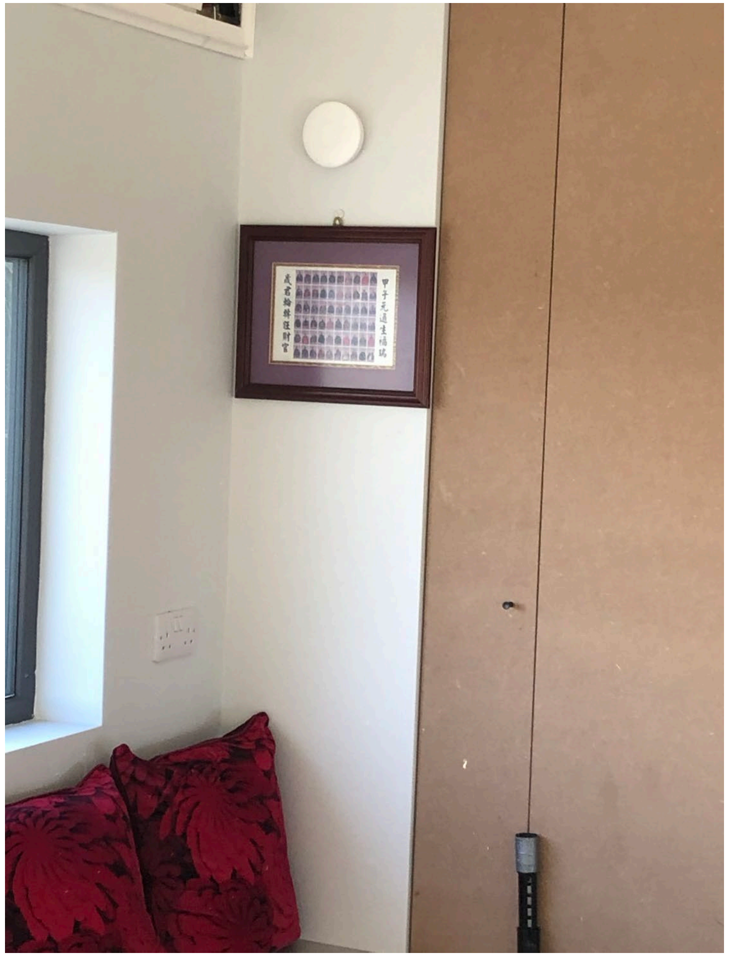
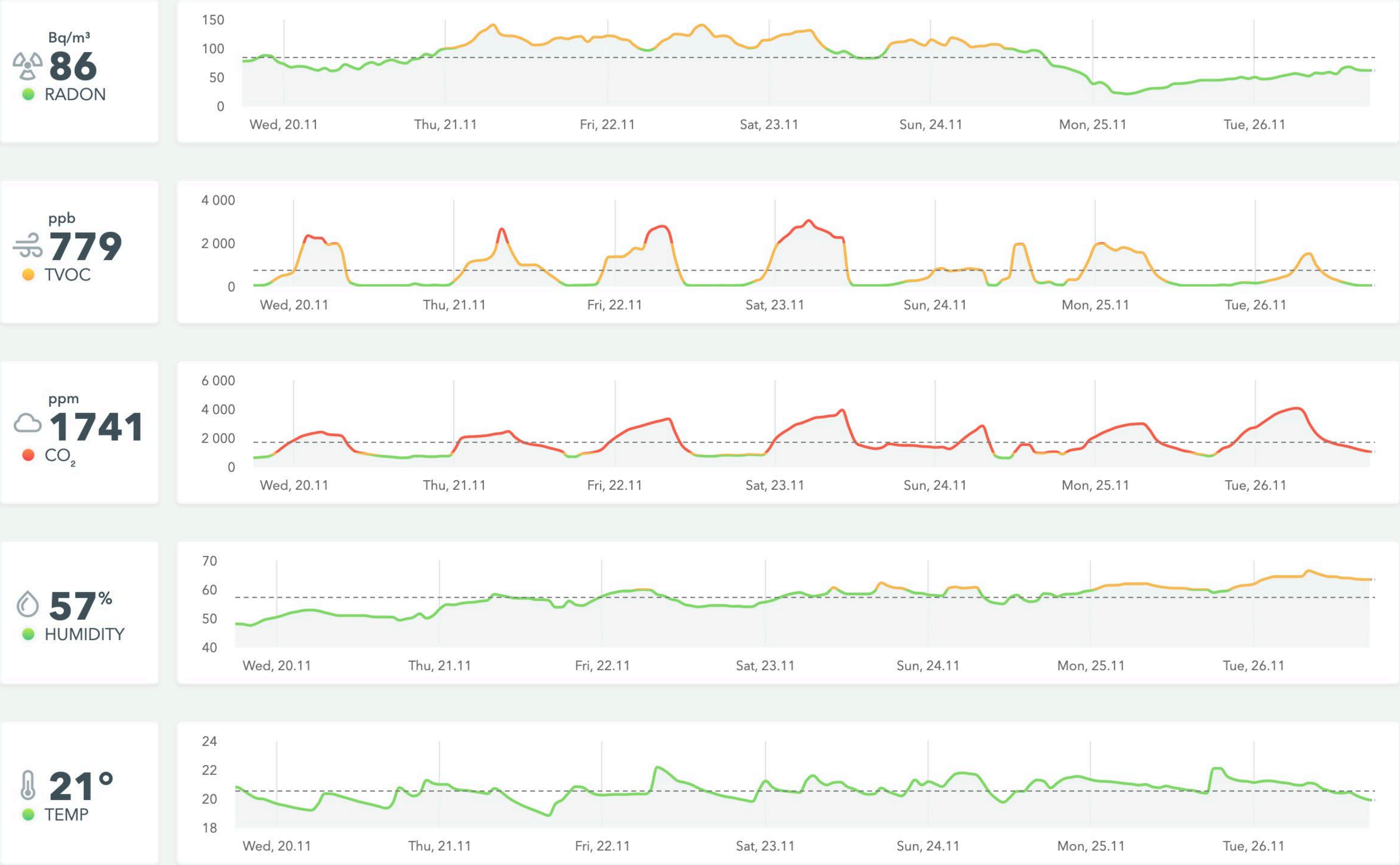
"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2018".



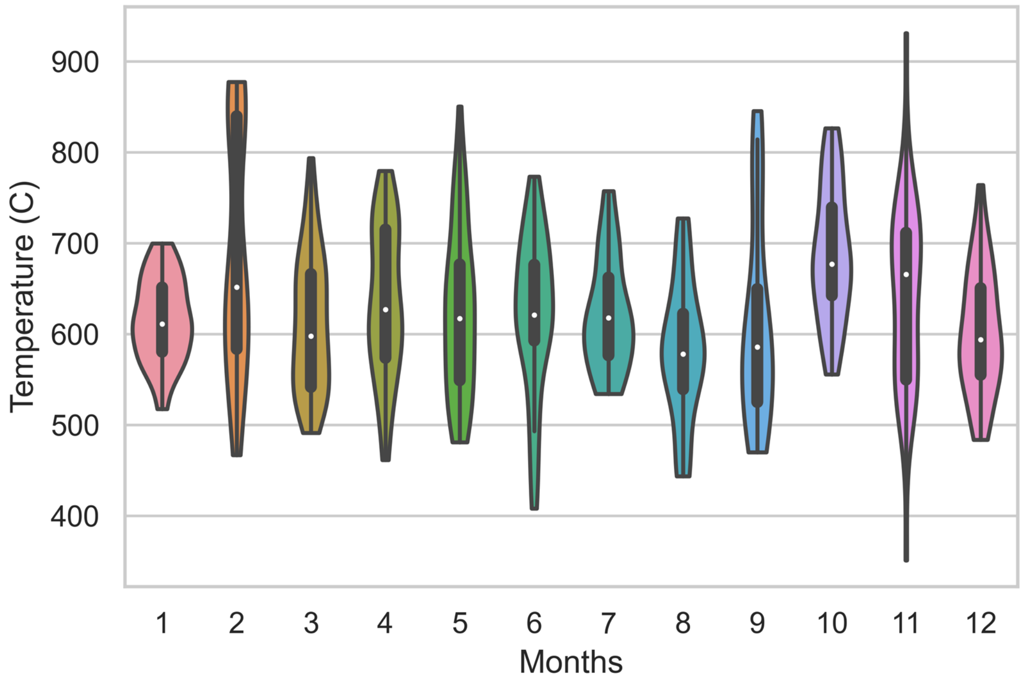


Bq/m³
86
RADON
150
100
50
0
ppb
779
TVOC
4 000
2 000
0
ppm
1741
CO2
6 000
4 000
2 000
0
57%
HUMIDITY
70
60
50
40
21°
TEMP
24
22
20
18
Wed, 20.11
Thu, 21.11
Fri, 22.11
Sat, 23.11
Sun, 24.11
Mon, 25.11
Tue, 26.11

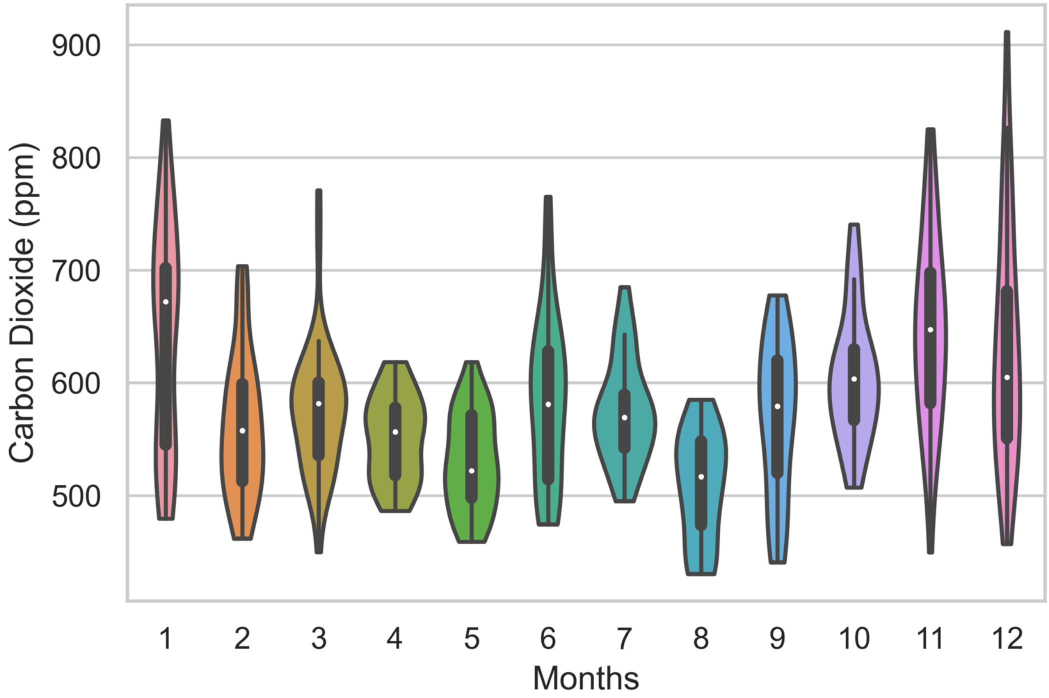
Bq/m³
51
RADON
200
100
0
ppb
678
TVOC
4 000
2 000
0
ppm
1313
CO₂
6 000
4 000
2 000
0
51 %
HUMIDITY
70
60
50
40
30
21°
TEMP
30
25
20
15
28.10
30.10
01.11
03.11
05.11
07.11
09.11
11.11
13.11
15.11
17.11
19.11
21.11
23.11
25.11

Living Room Daily Averages of CO_2 (Seasonal trends) Different Ventilation systems

Mechanical Ventilation



Natural Ventilation



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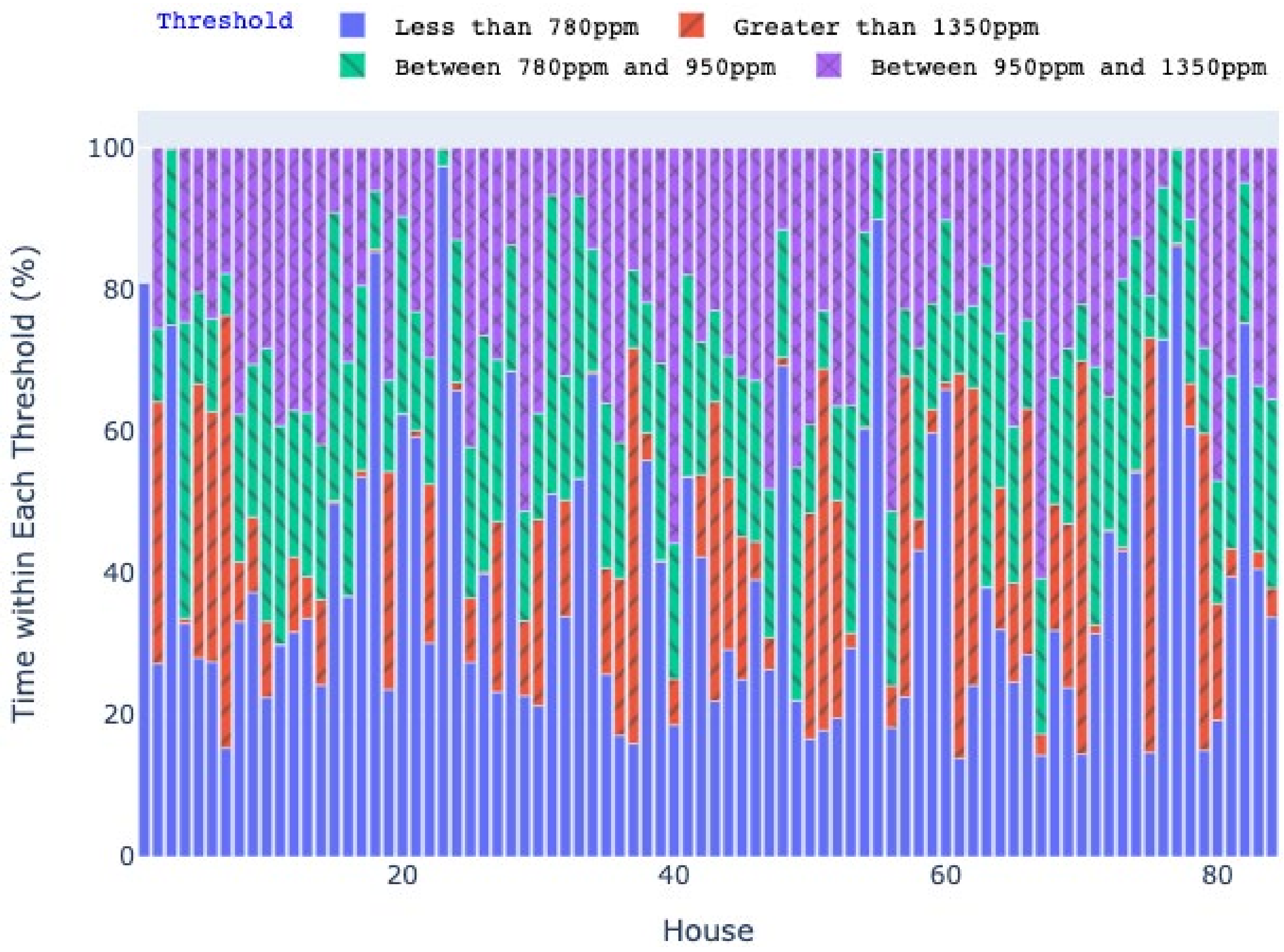
Bedroom CO_2 Concentrations



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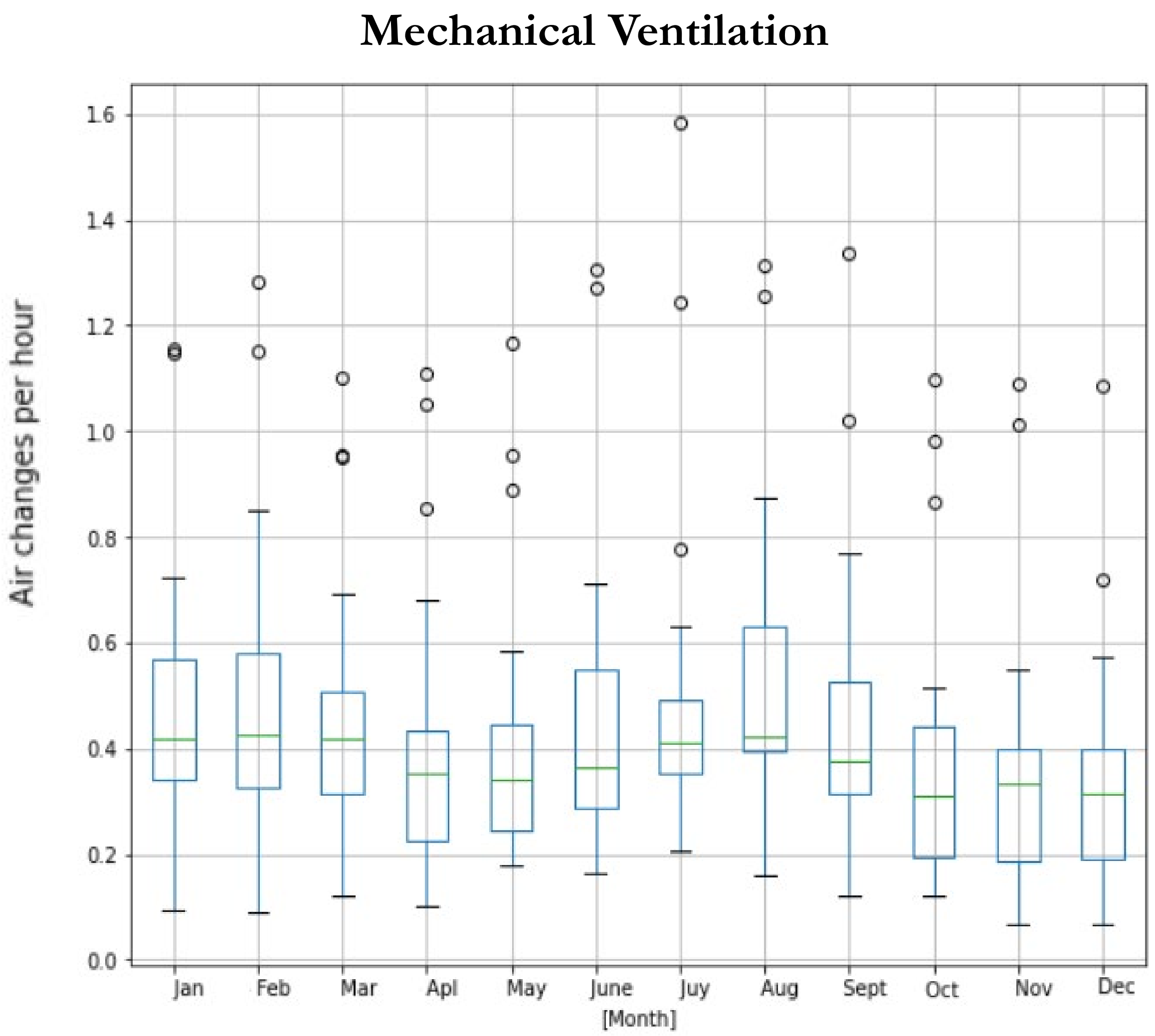
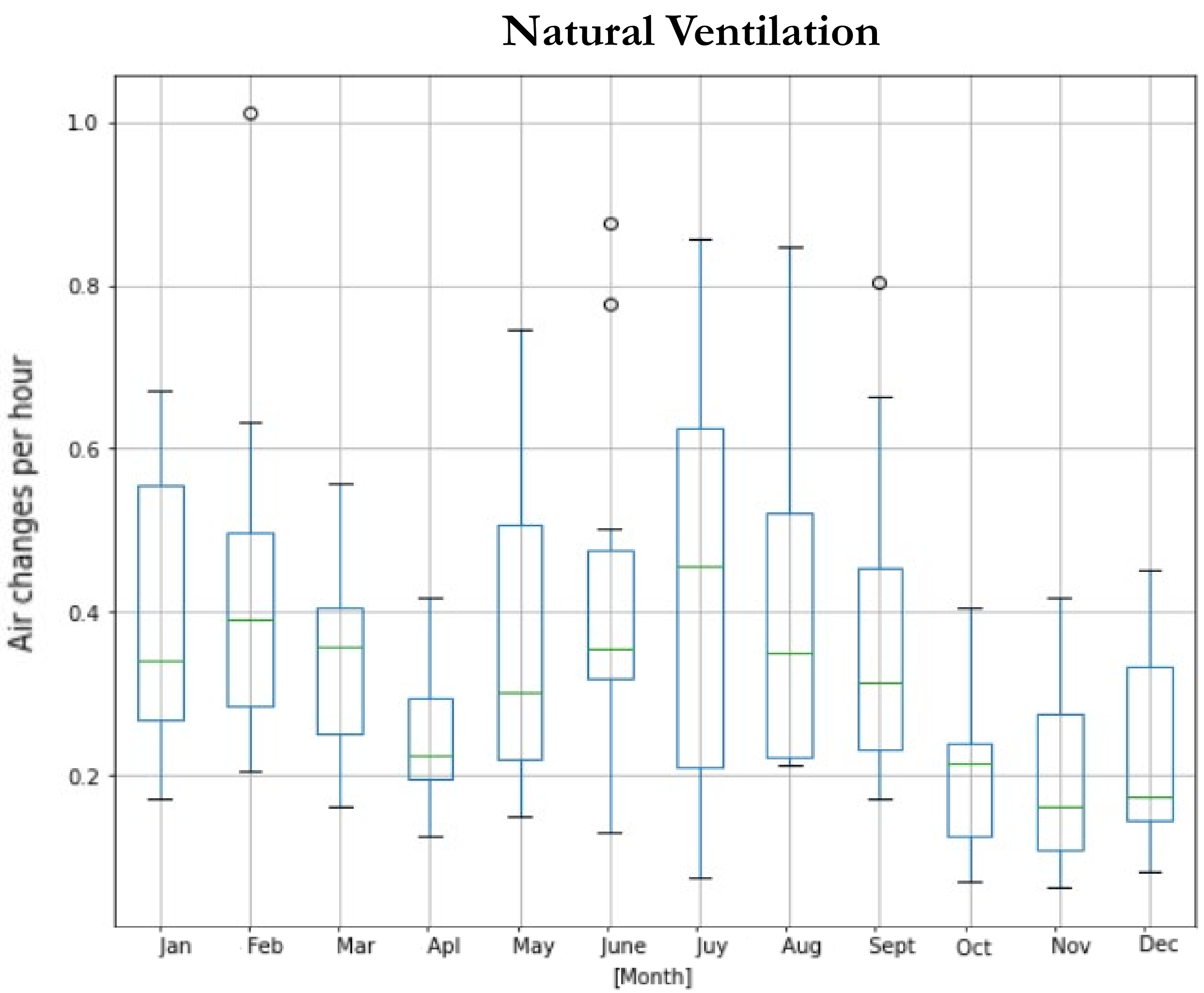
Ventilation Assessment





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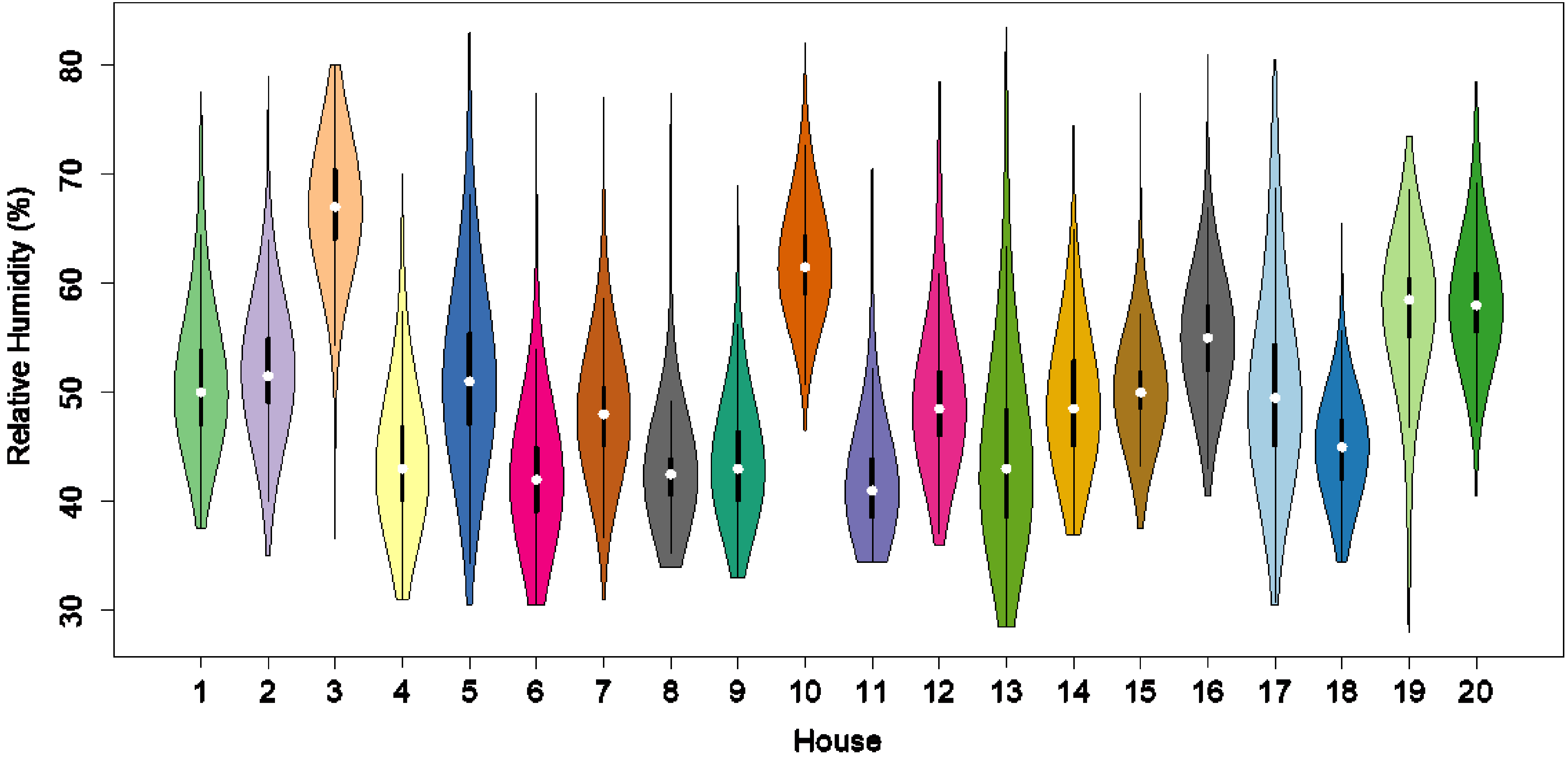

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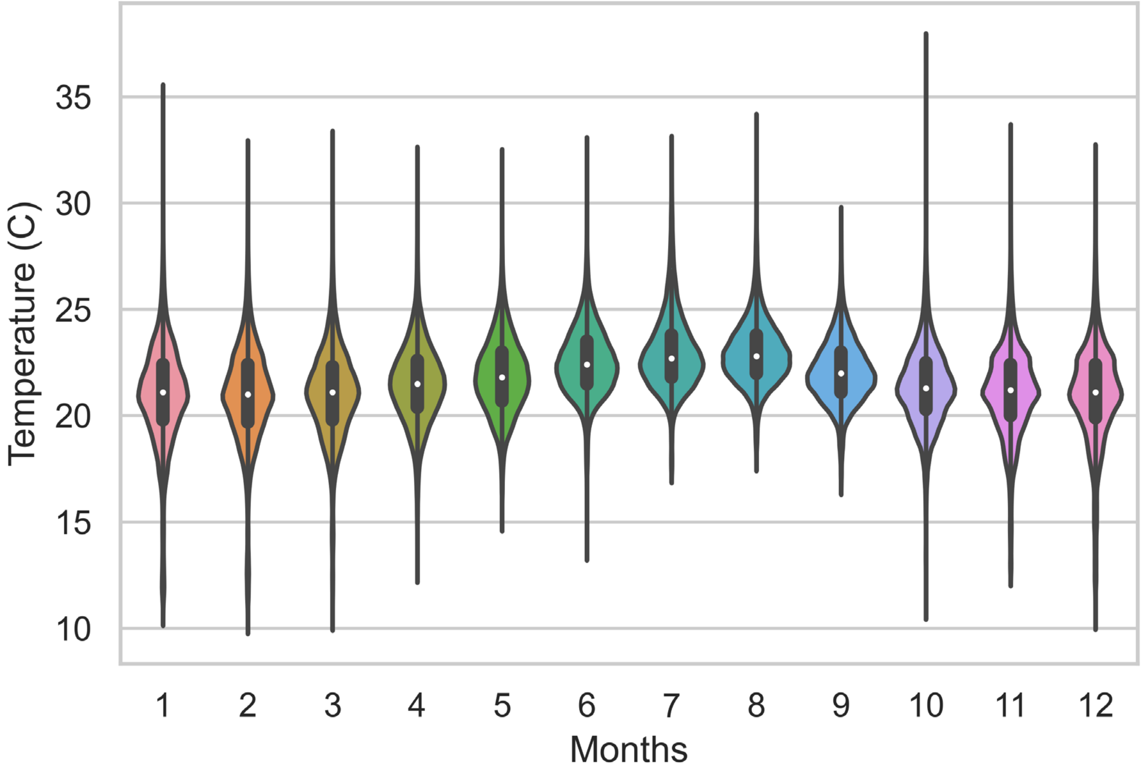
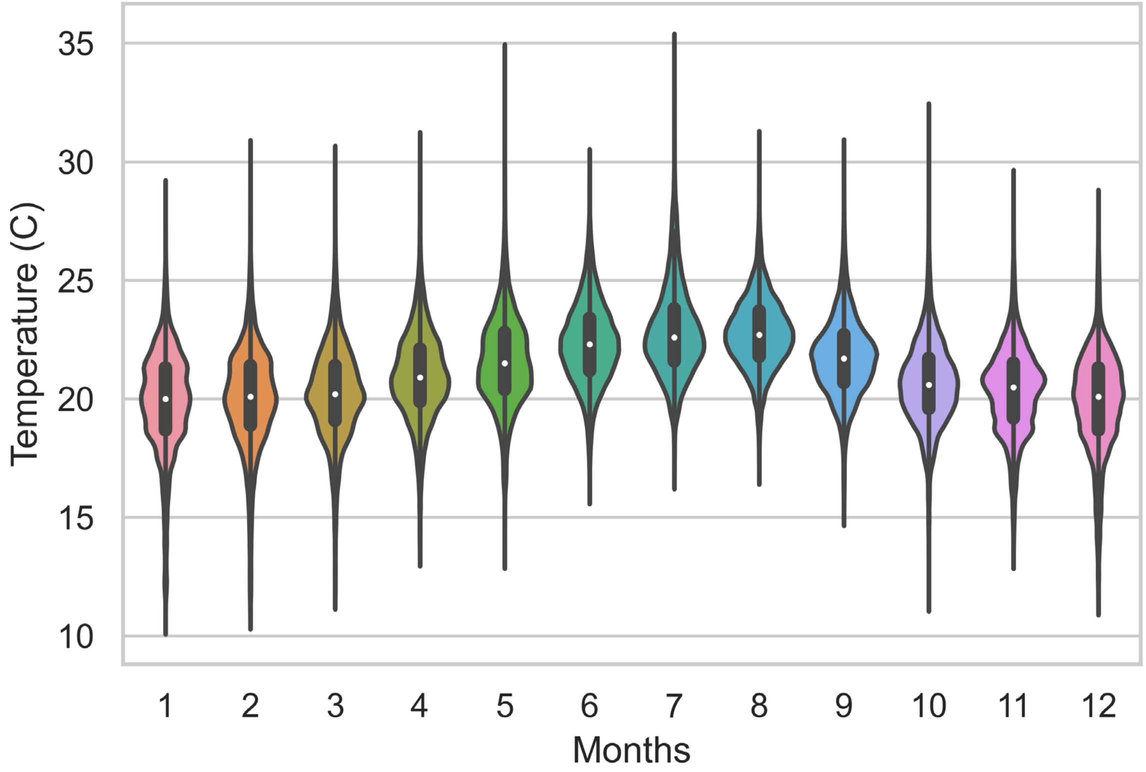
Analysis of Temperature

Living Room



Bedroom



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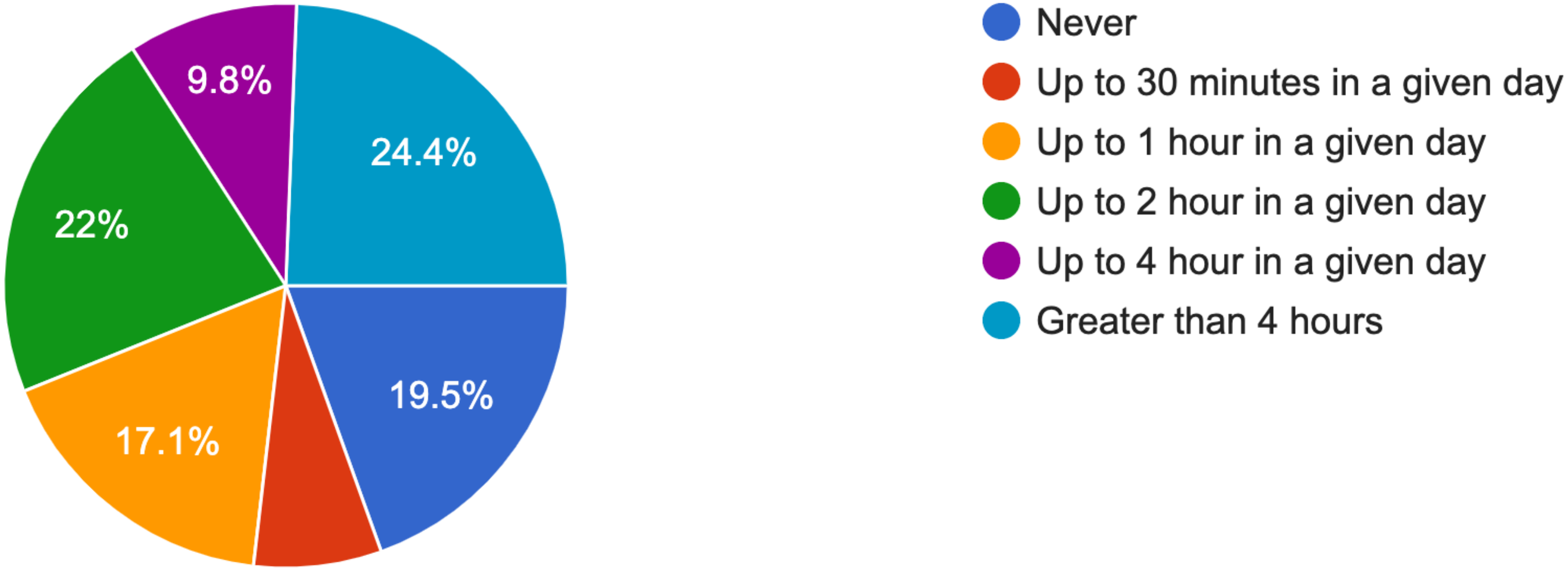
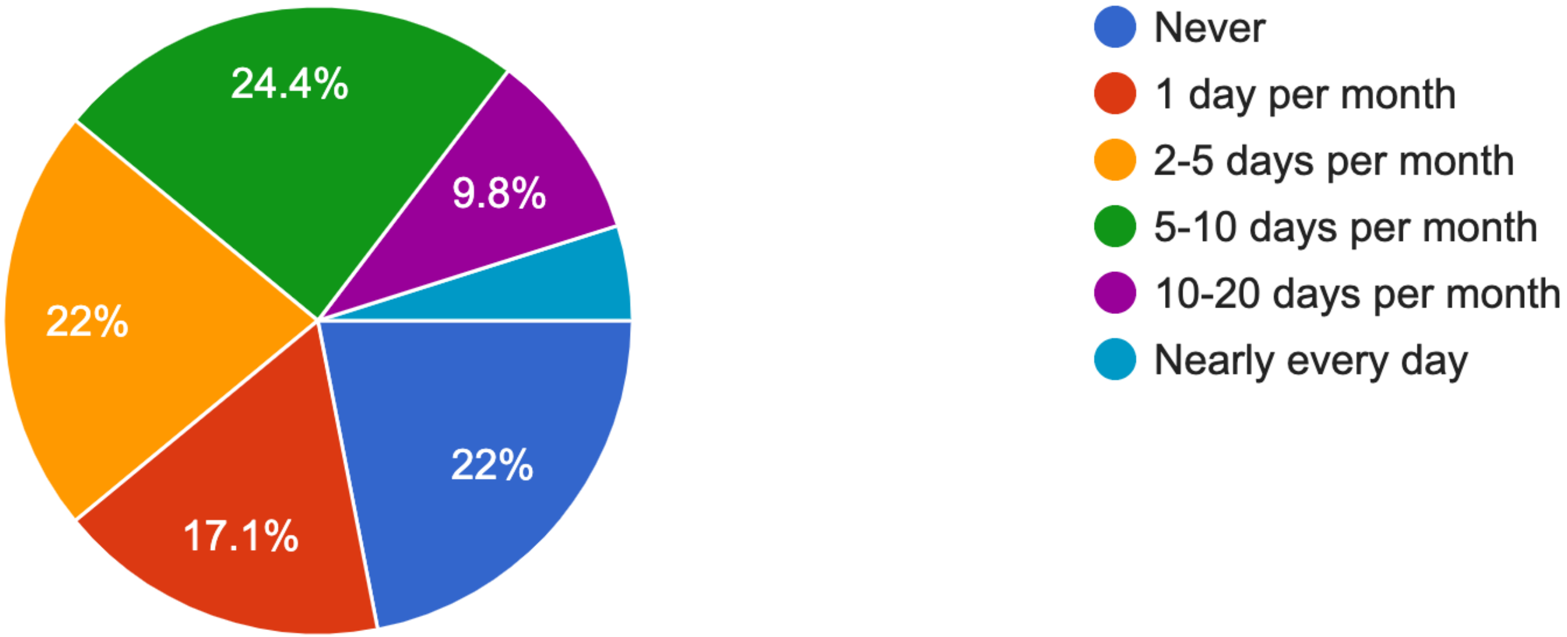
Thermal Comfort Survey

Have you experienced any periods where your home has overheated (too warm)? This can include a combination of different rooms.

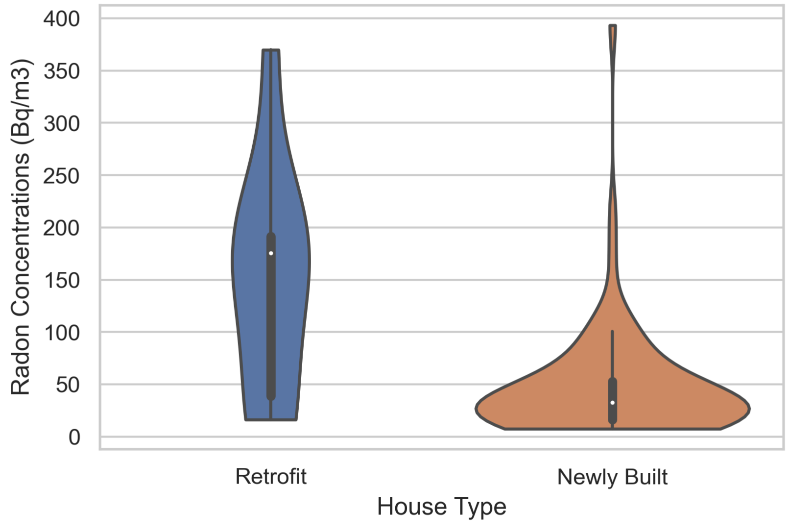


Thermal Comfort Survey

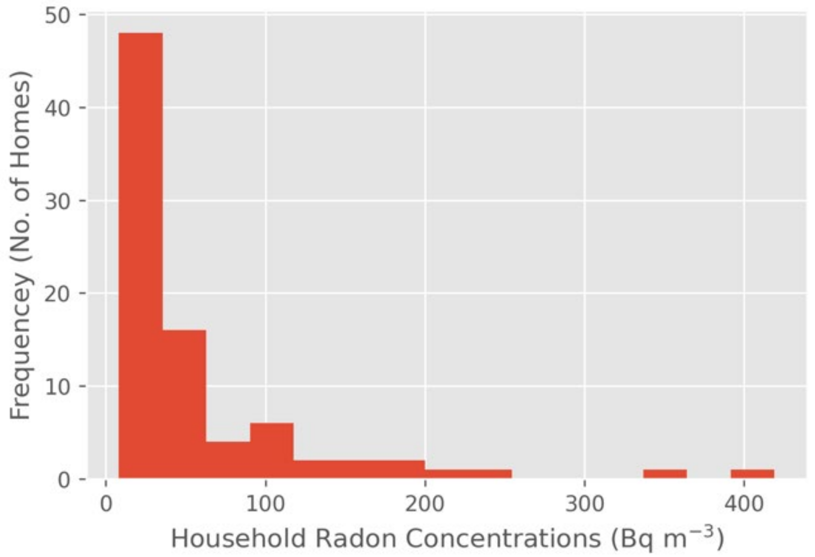
How many days would you feel the house overheats during the summer period?



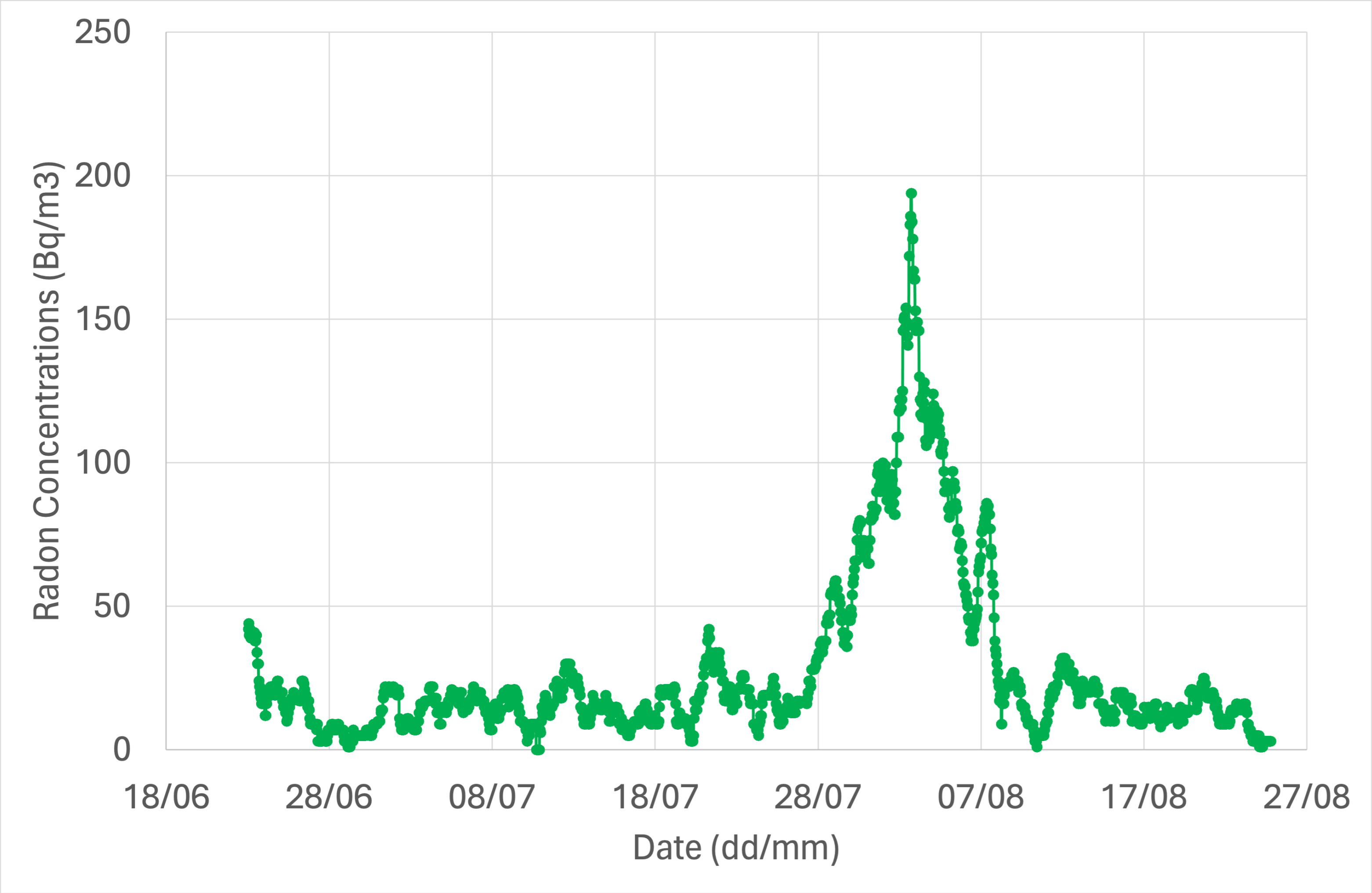
Radon Data



- Averaged radon was 71 Bq/m^3 (current national average radon 77 Bq/m^3)
- Six households exceeded 200 Bq/m3, slightly lower than the national average of 10%
- 4 exceedances had undergone energy retrofits
- Need to be mindful of survey locations



Mechanical ventilation system – Case Study

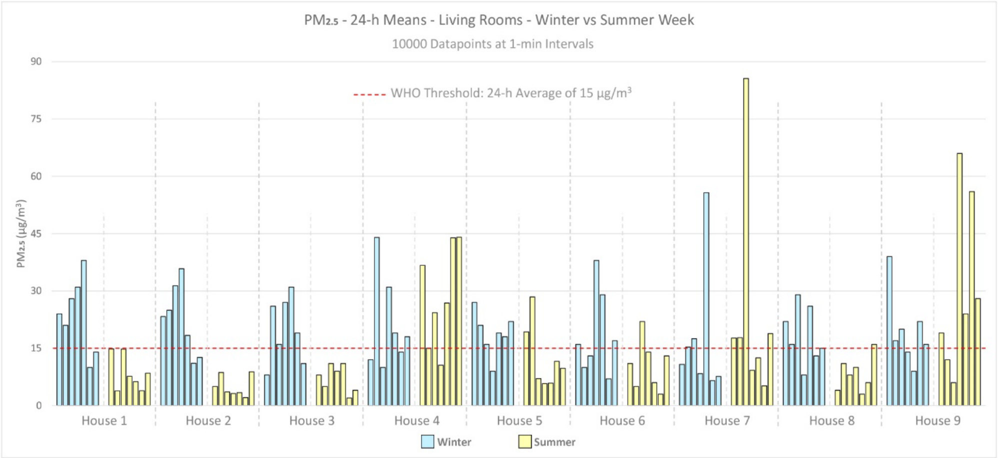


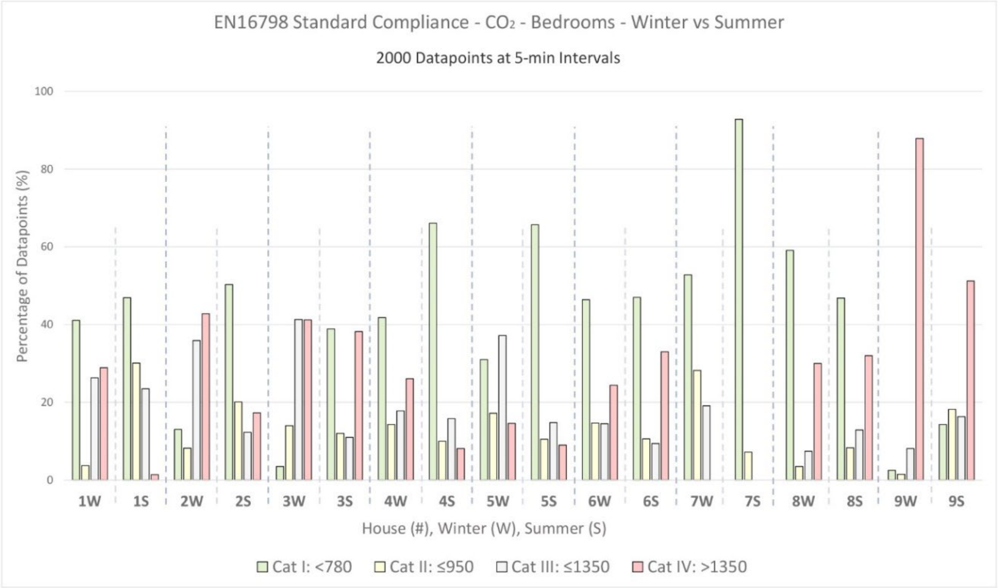
The VALIDate Project: Key finding

- Long-term data identifies changes in IEQ across different seasons reflective of occupant behaviour and meteorological conditions
- Higher radon levels in retrofitted dwellings
- Summer represents a new challenge (in Ireland) regarding overheating
- Bedrooms had higher CO2 concentrations
- Low relative humidity an issue in some homes with MVHR
- Occupants highlight a lack of knowledge surrounding maintenance and changing filters
- The 10 mm door undercut was not being observed in most dwellings

The ALIVE Project

- ALIVE: Assessing Indoor Environmental Quality and Energy Efficiency In a range of Naturally-Ventilated Buildings: A Multi-Disciplinary Approach
- Energy consumption, overheating and IEQ in natural-ventilated dwellings
- A hybrid approach; low-cost sensors and high-grade instrument





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"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2019".

BENEFIT

- Assess the consequences on indoor air quality and occupant comfort of energy retrofits of non-domestic buildings
- Evaluate indoor air quality from newly constructed dwellings and establish a baseline metric for non-domestic buildings
- Develop guidance for risk reduction regarding potential negative impacts of energy retrofitting on IEQ in buildings

BENEFIT PROJECT

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Acknowledgements









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epa Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

Ollscoil na Gaillimhe
University of Galway

https://aivc2024conference.org/

Maynooth University
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Thank You

Ollscoil na Gaillimhe
University of Galway

Breathing fresh air into Irelands Energy Retrofit programme

2015 - 2023

Dr Marie Coggins

University
*of*Galway.ie

60 bathtubs of air every day

74 are spent indoors

20 liters of air, breathed in by end of this presentation!

Photo by Elina Volkova: https://www.pexels.com/photo/dog-in-bathtub-8343331/

Cannot hold your breath!

Every year, in the EU, 2 million healthy life years

€200 billion lost.

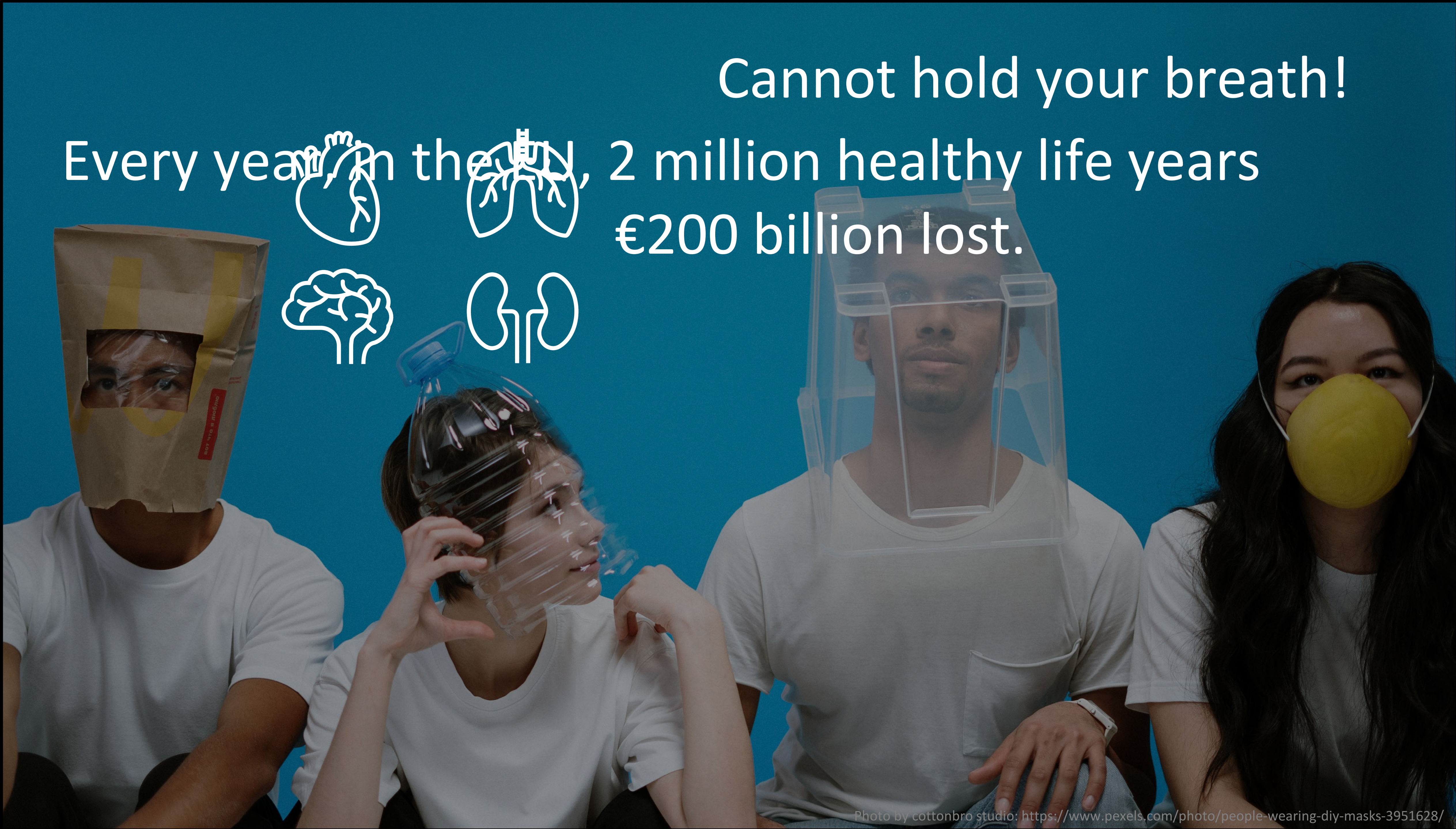
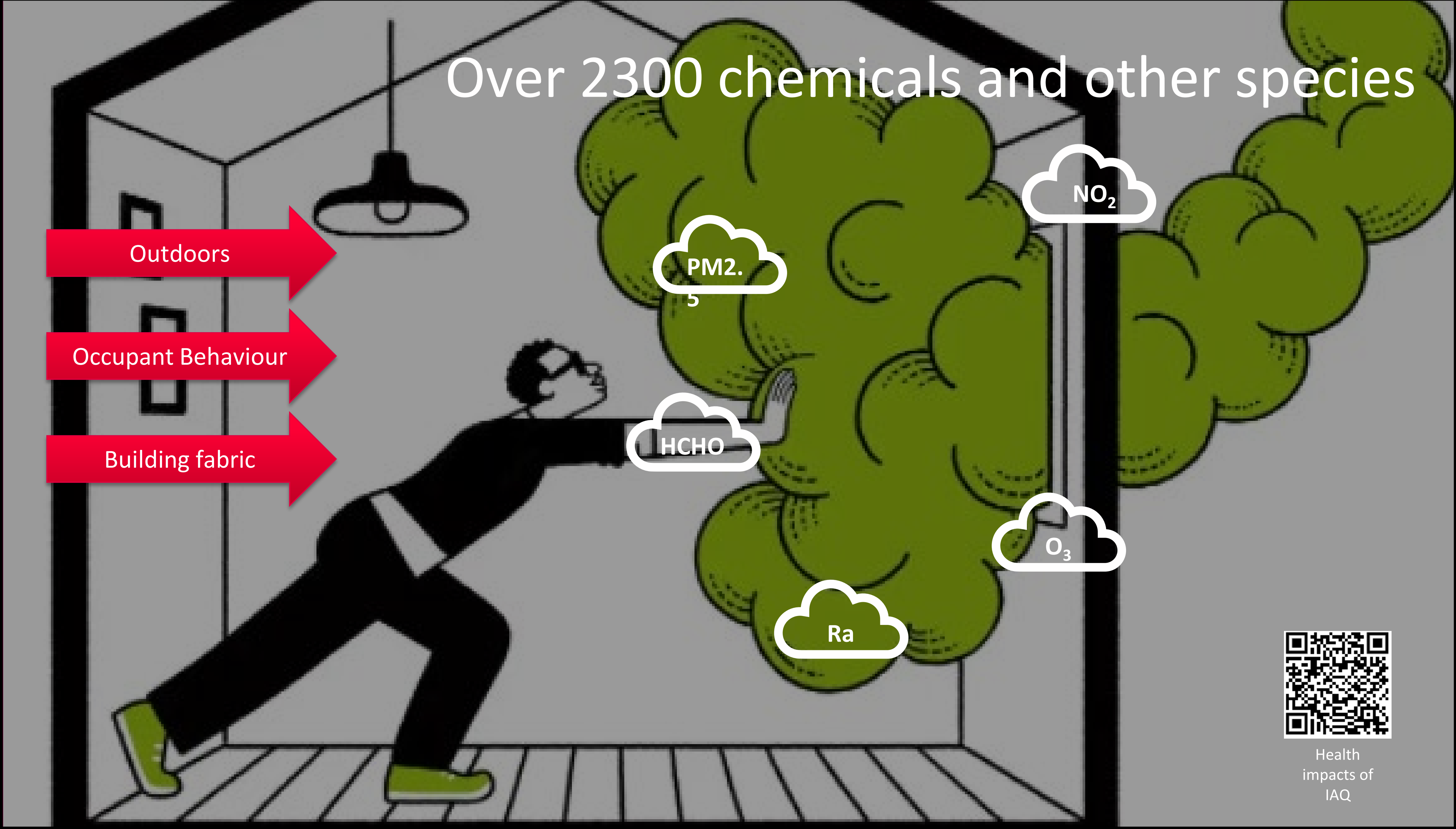


Photo by cottonbro studio: https://www.pexels.com/photo/people-wearing-diy-masks-3951628/

Over 2300 chemicals and other species



Health impacts of IAQ

O

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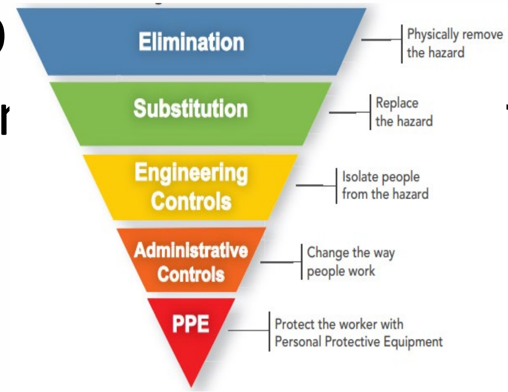
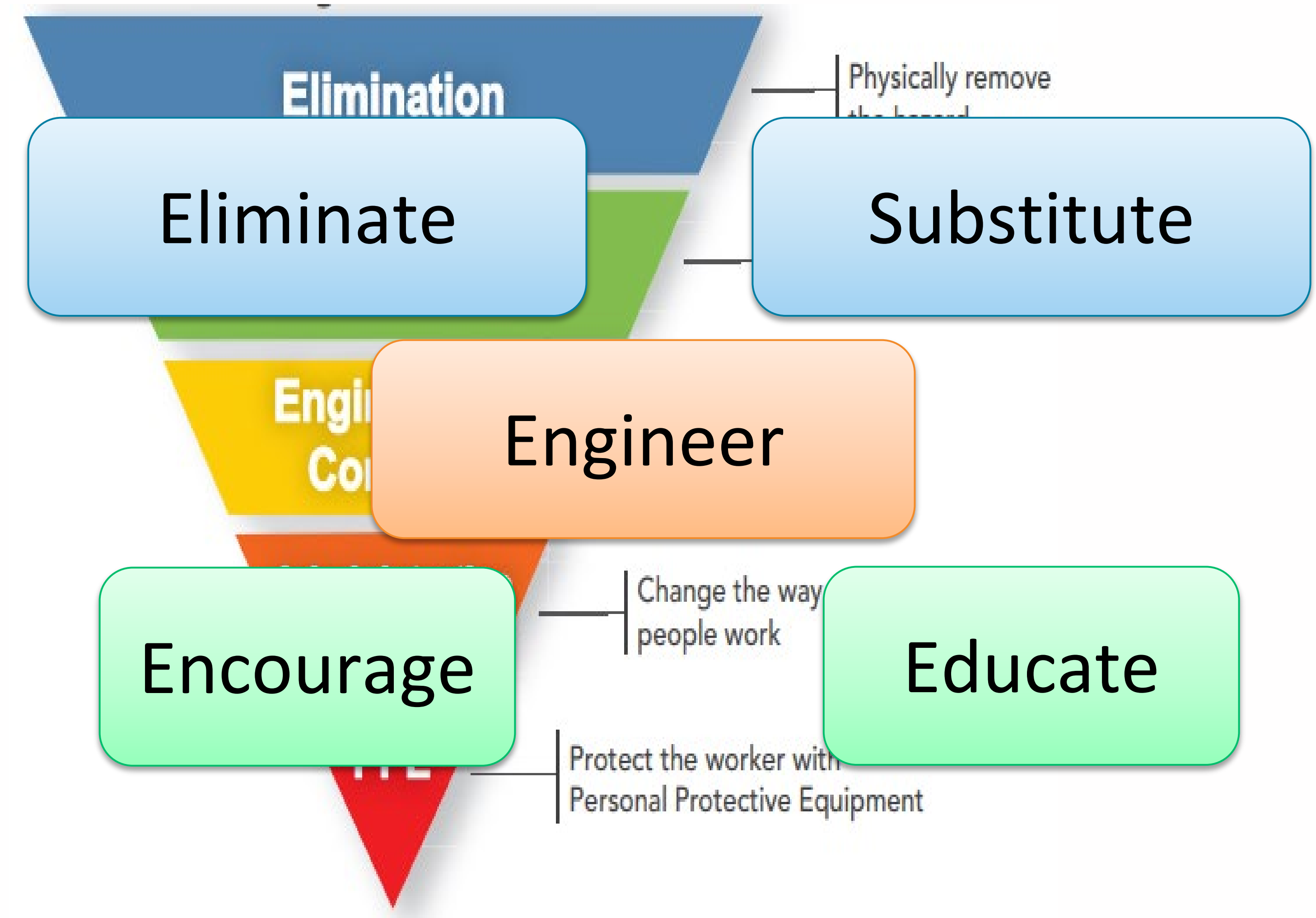


Hierarchy of Controls, NIOSH 2015

Indoor air pollutants at home



Hierarchy of Controls, NIOSH 2015

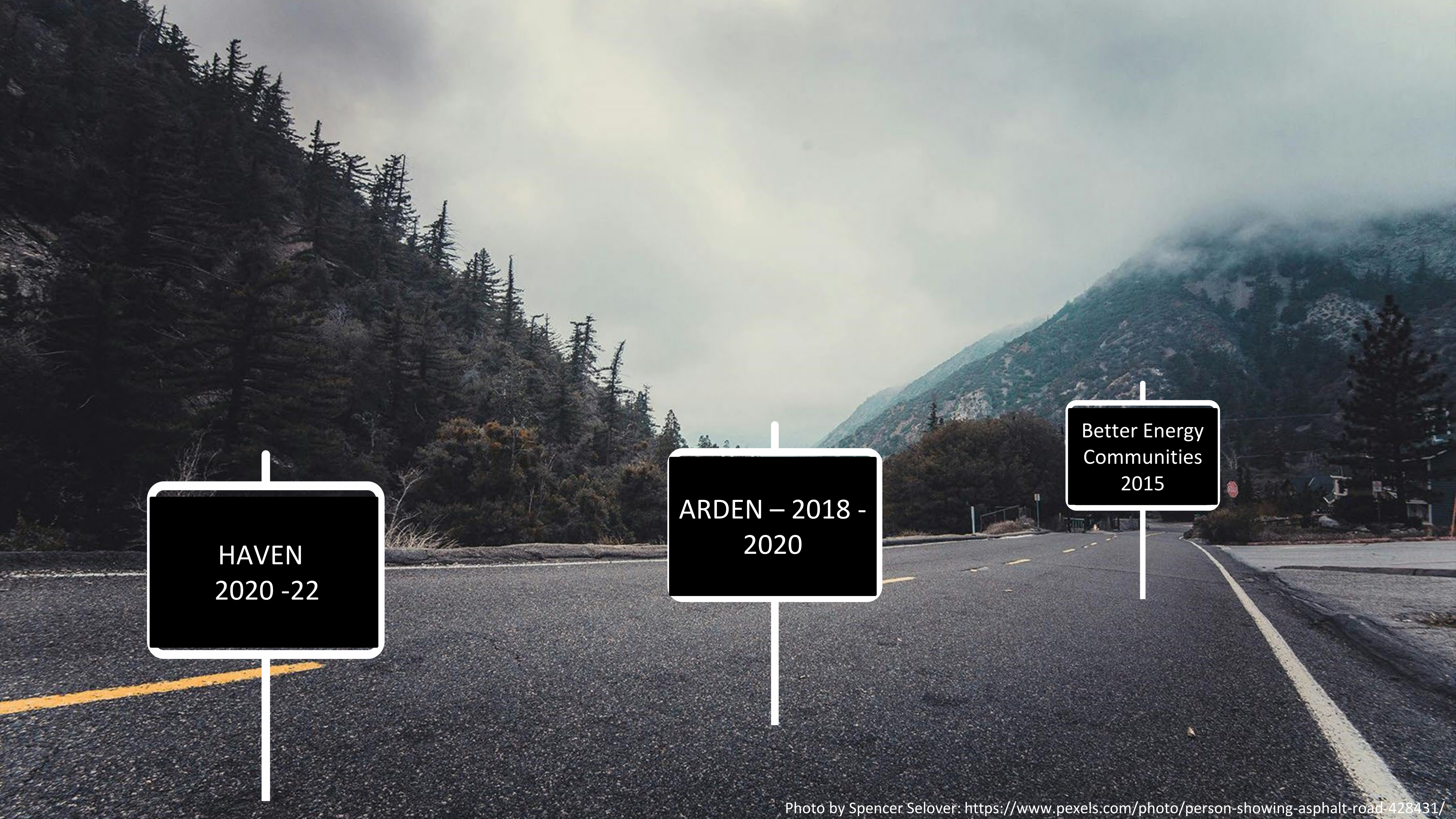


Photo by Spencer Selover: https://www.pexels.com/photo/person-showing-asphalt-road-428431/

Better Energy Communities

2015

15 dwellings (social housing), pre- and post-shallow retrofit

indoor air quality

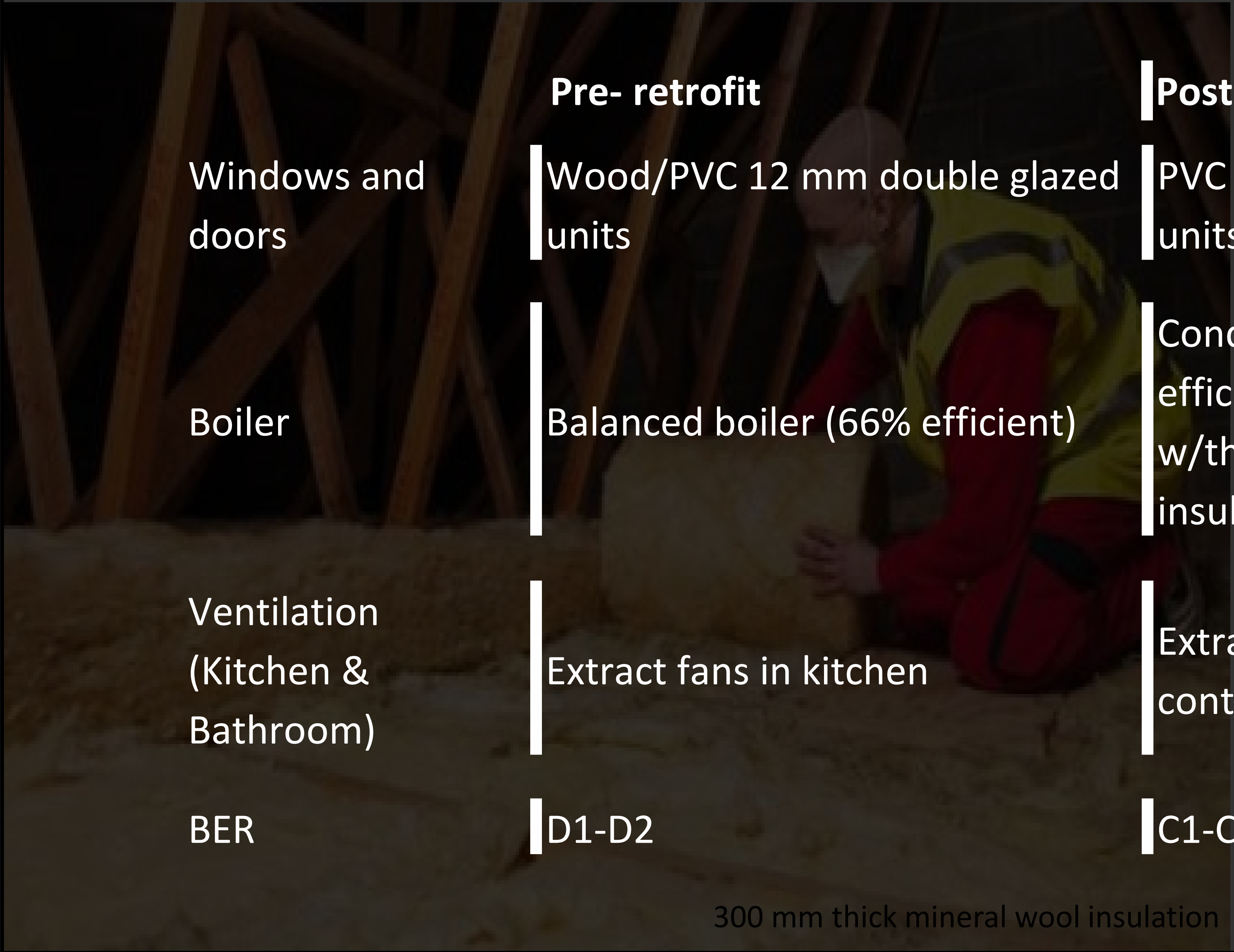
thermal environment

subjective feedback

epa Research

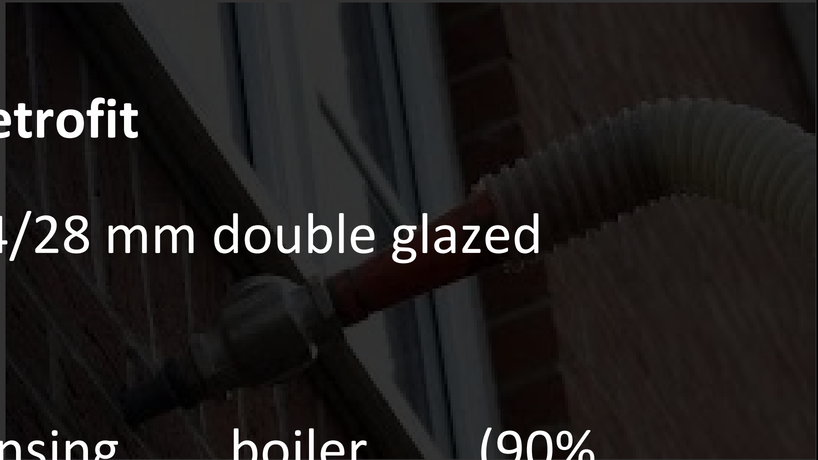
Ollscoil na Gaillimhe
University of Galway

The retrofit



	Pre- retrofit	Post-retrofit
Windows and doors	Wood/PVC 12 mm double glazed units	PVC 24/28 mm double glazed units
Boiler	Balanced boiler (66% efficient)	Condensing boiler (90% efficient), zoned heating w/thermostat, pipe work insulated
Ventilation (Kitchen & Bathroom)	Extract fans in kitchen	Extract fans with humidity control
BER	D1-D2	C1-C2

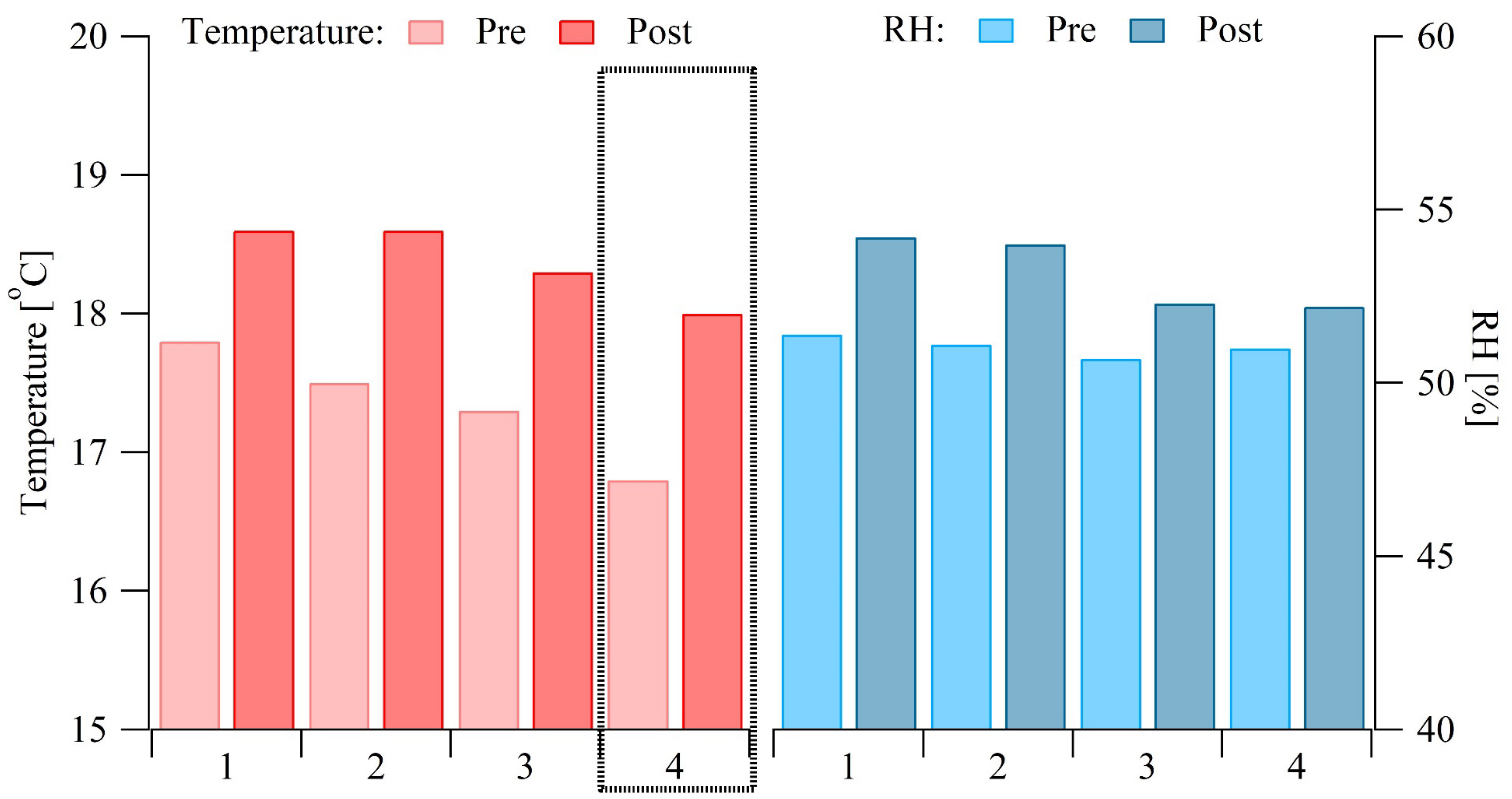
300 mm thick mineral wool insulation



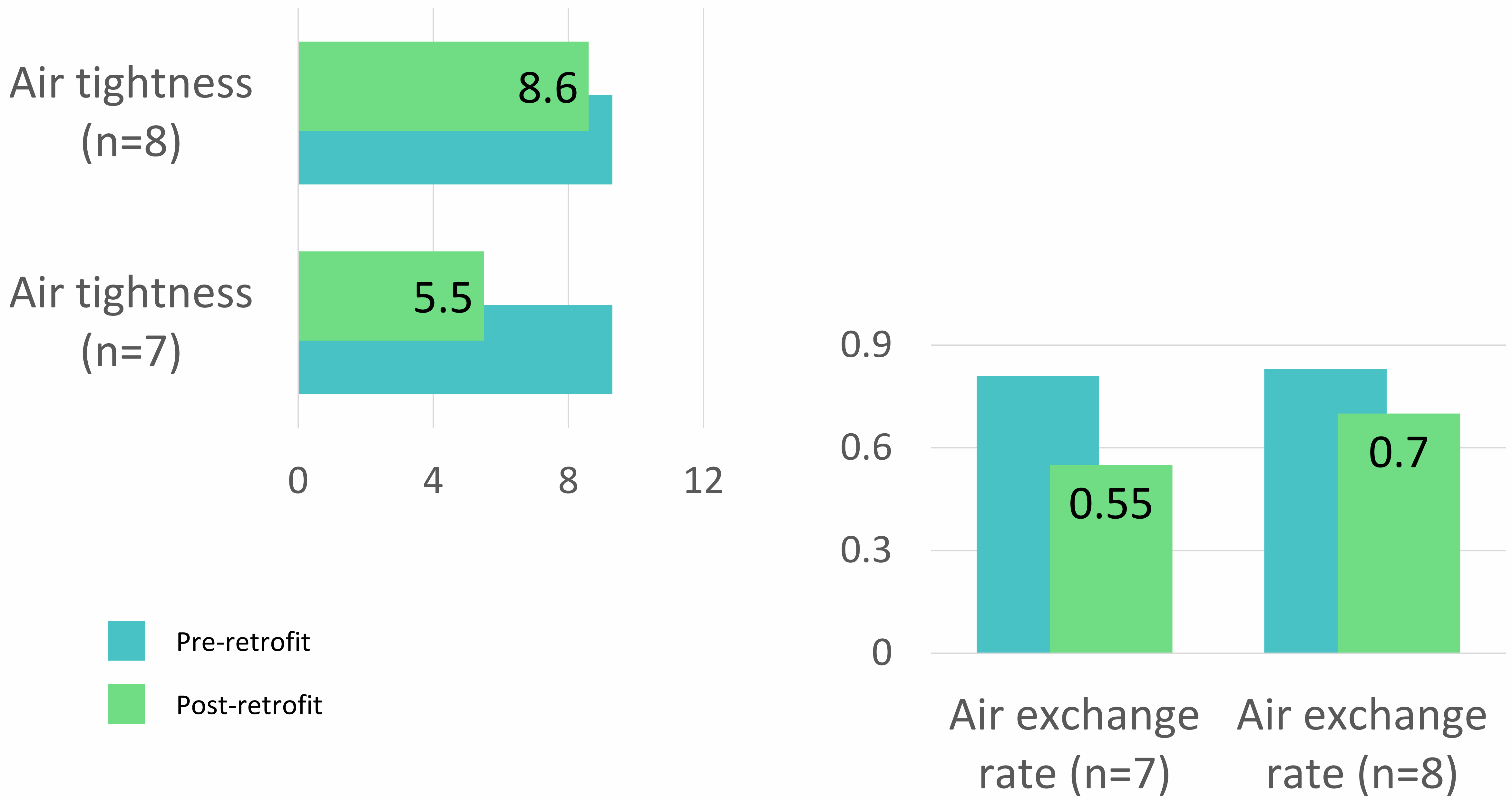
Residual 110 mm cavity filled with extruded polystyrene beads

125 mm core wall vents
Or vents were cleaned out and serviced

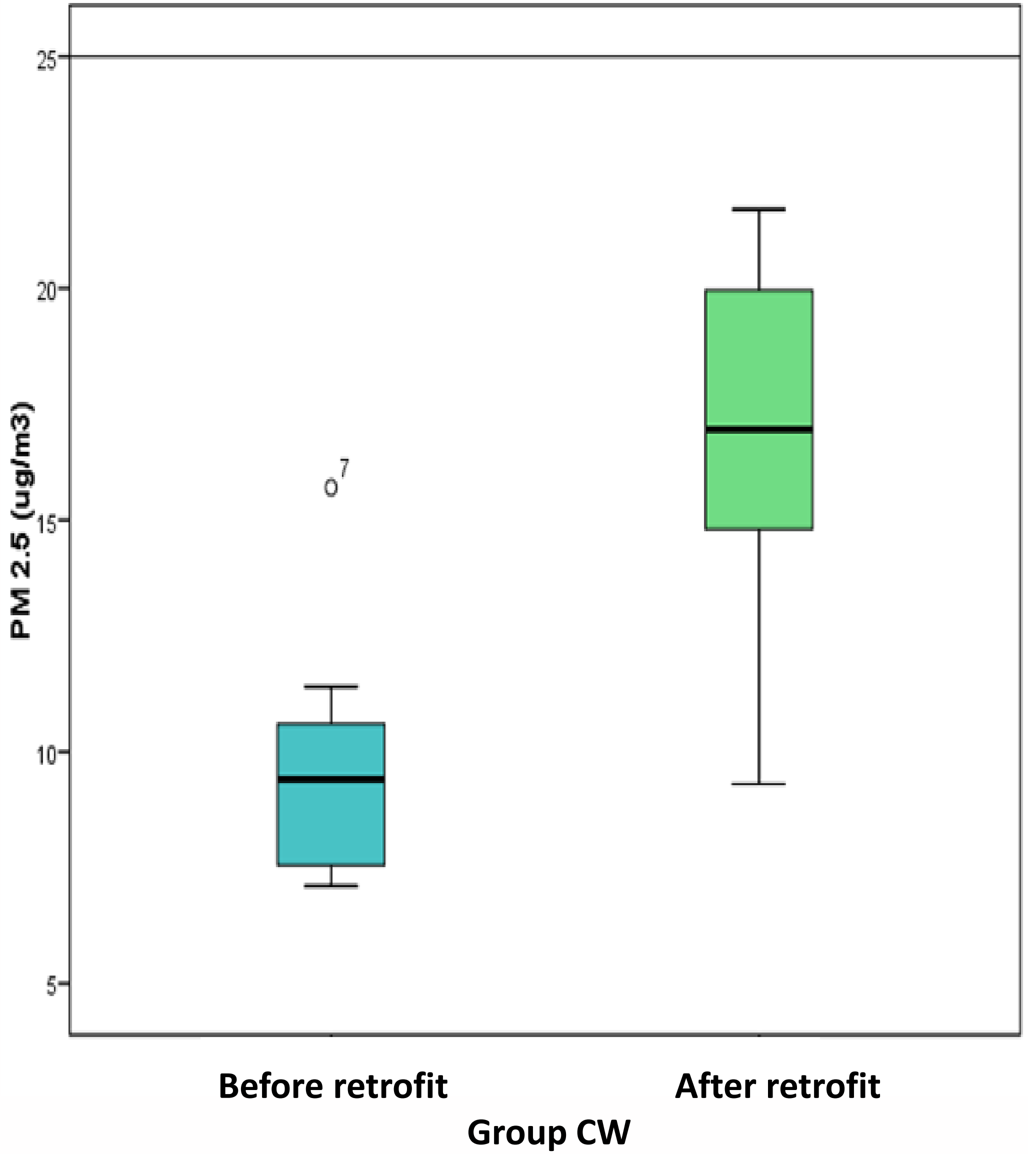
Indoor air Temperature



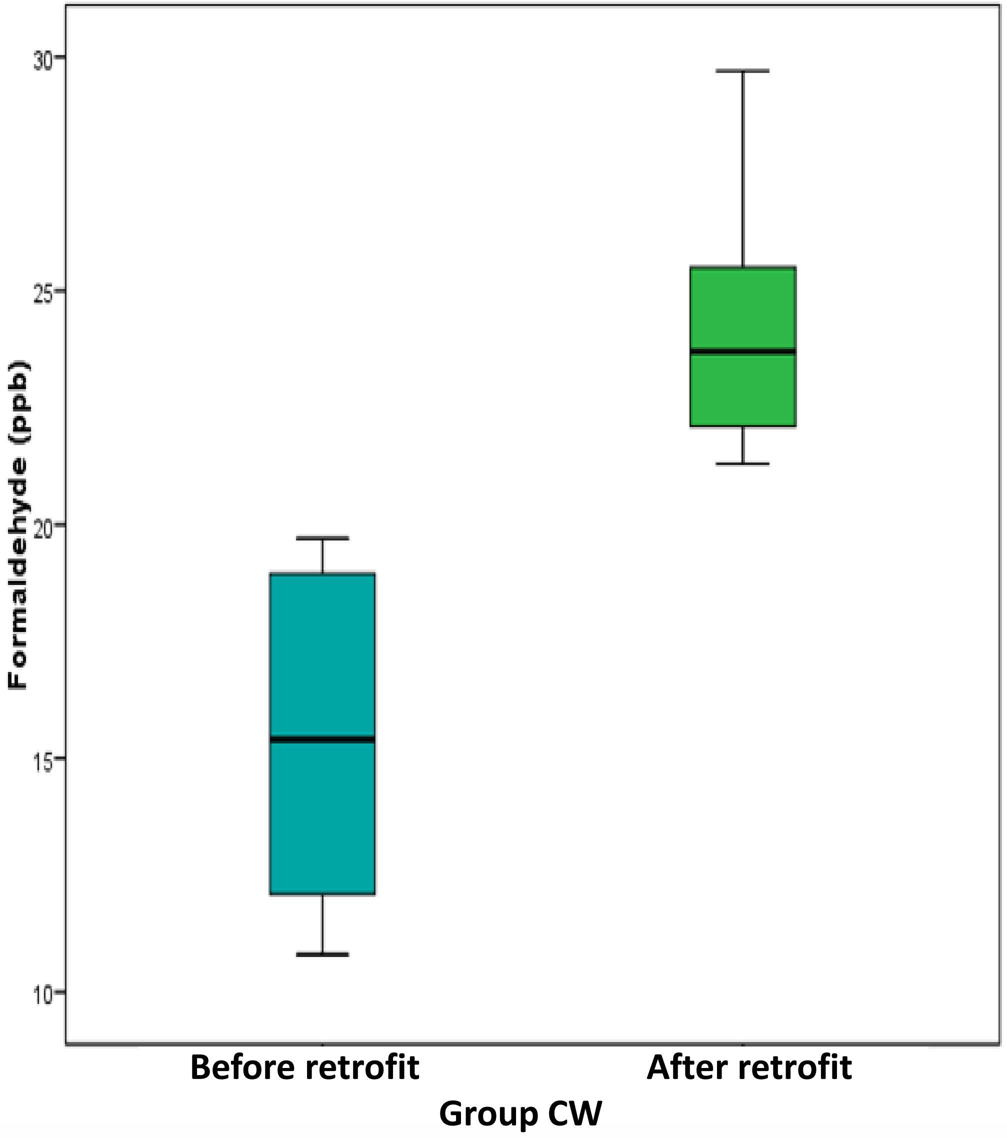
Retrofit and ventilation



Indoor Environmental Quality



PM $_{2.5}$ 24 hr average concentration



Formaldehyde 24 hr average concentration

Indoor **A**ir, Ventilation and comfo**R**t in Irish Domestic dwellings post **DE**ep Energy re**N**ovations – **ARDEN**

Ollscoil na Gaillimhe
University of Galway

Significant increase in building air tightness (2.4 - 5 $m^3/h.m^2$)

Significant improvement temperature & occupant comfort

Improvement in indoor CO_2 living areas

No change in bedroom CO_2

Photo by Lisa Fotios: https://www.pexels.com/photo/close-up-photography-of-person-wearing-pink-house-slippers-1444417/

Deep energy retrofitted Irish homes (BER A3 –A1)

HCHO

PM2.5

Higher concentrations post retrofit in all homes

Outdoor air pollution traffic/residential fuel

Bedroom and living room formaldehyde level correlate

Use of wood burning stoves

Cooking

Levels indicate noticeable off-gassing, even 3 years post retrofit

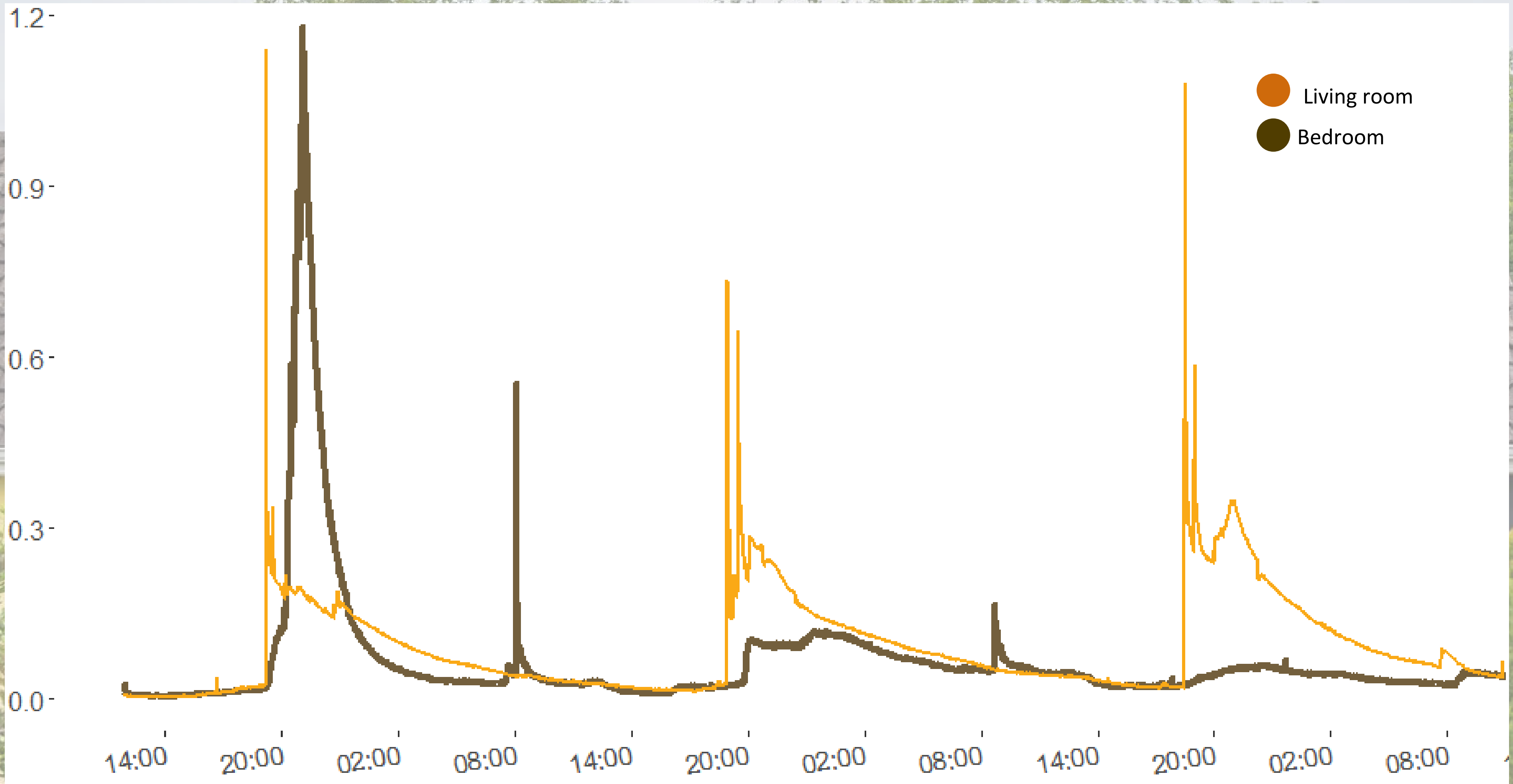
Photo by Ksenia Chernaya: https://www.pexels.com/photo/man-painting-walls-in-new-apartment-5691597/

Deep energy retrofitted Irish homes (BER A3 –A1) Ventilation

https://www.shutterstock.com/image-photo/dirty-old-yellow-used-round-ceiling-1671308539

Case Study 1

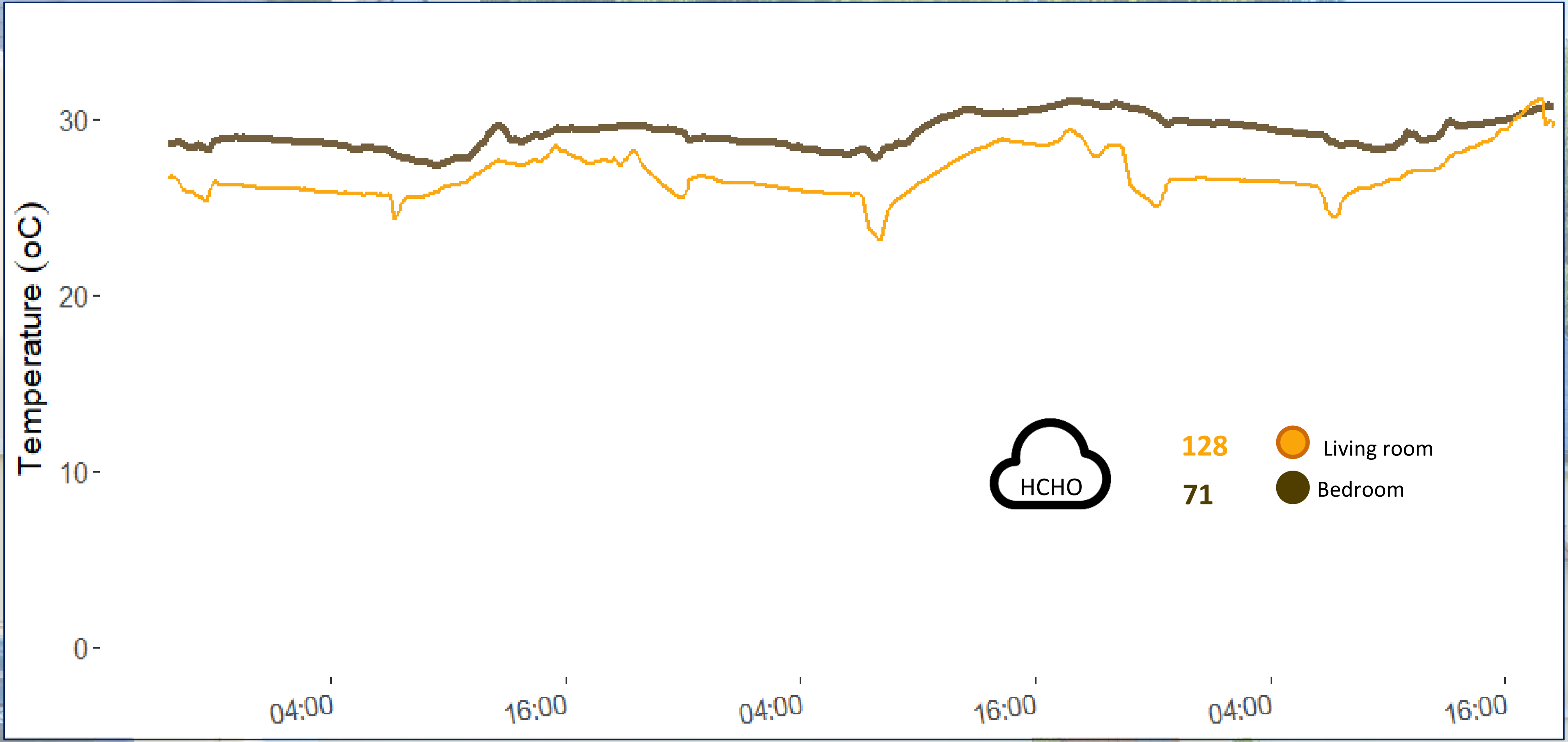
BER A3 A2W



Case Study 2

BER A2

A2W



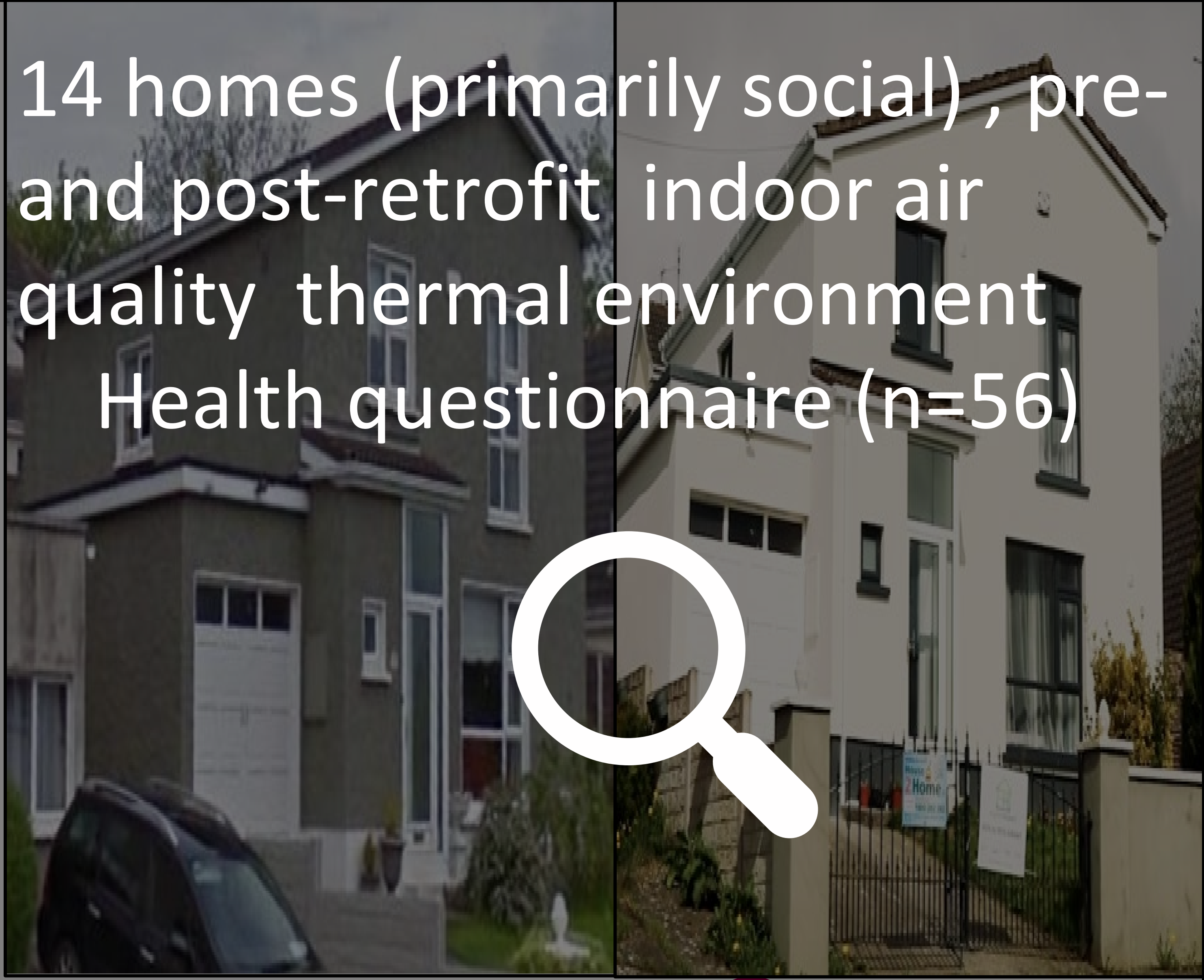
https://www.shutterstock.com/image-photo/editorial-use-only-bungalow-attic-conversion-1111593074

HAVEN

Health impact and associated benefits of energy renovation to BER B2

14 homes (primarily social) , pre- and post-retrofit indoor air quality thermal environment

Health questionnaire (n=56)



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Comfort surveys, 112 pre- and 56 post-retrofit responses

Post-retrofit:

Greater satisfaction with indoor temperature

Significant reductions in sources of thermal discomfort

Photo by Lisa Fotios: https://www.pexels.com/photo/close-up-photography-of-person-wearing-pink-house-slippers-1444417/

Retrofits, IAQ and occupant behaviour

PM2.5

	Pre-retrofit	Post-retrofit	Pre-retrofit	Post-retrofit
	36	66	39	53
	15	9	9	19

(Median values)

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Haven 14

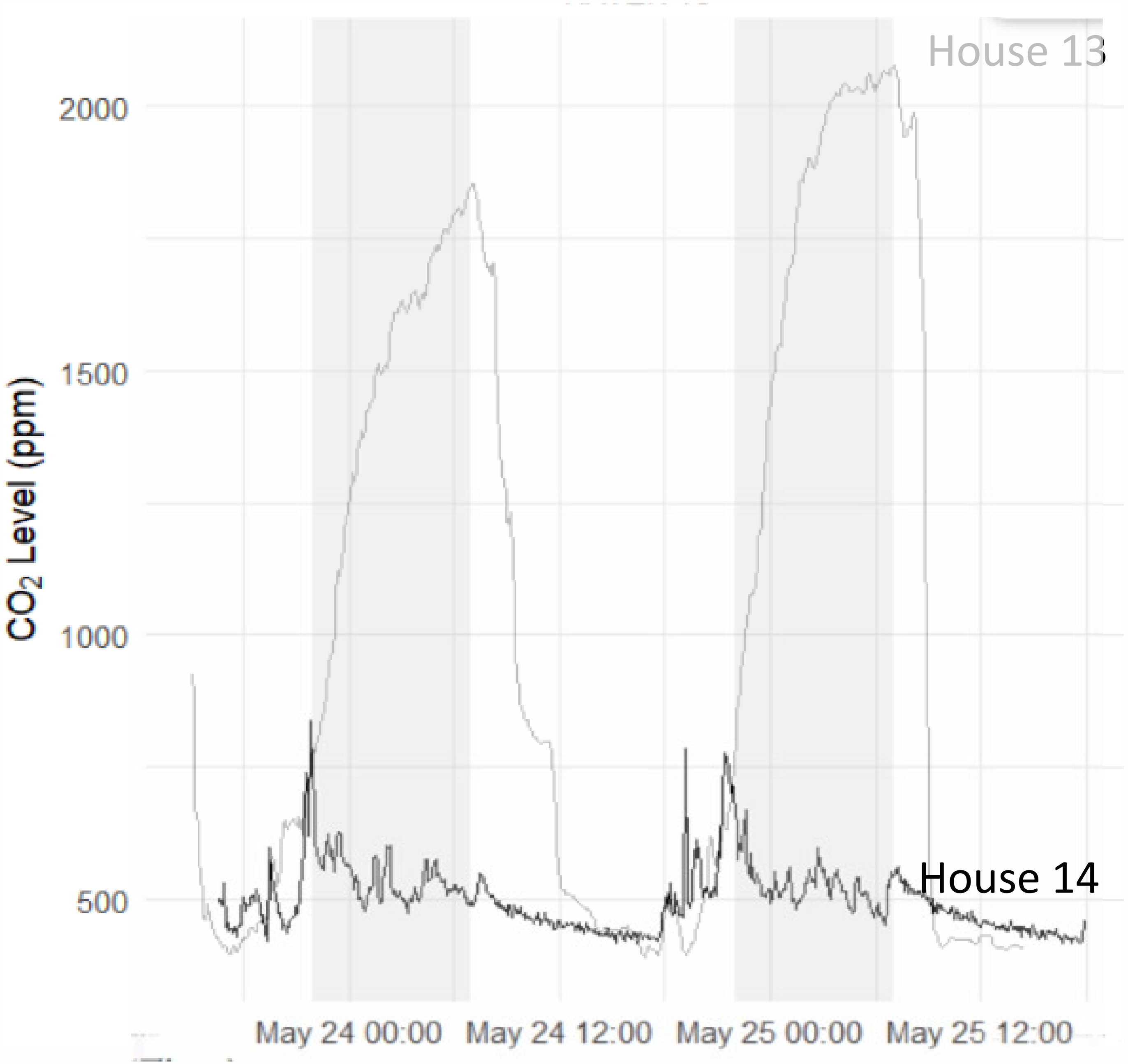
2001

C3 to B2

Heat pump, fire place decommissioned

Vent in bedroom closed three quarters (outdoor smells)
Otherwise, happy with the retrofit

CO_2 Time Series Profile in Bedroom for Houses 13 and 14



Haven 19

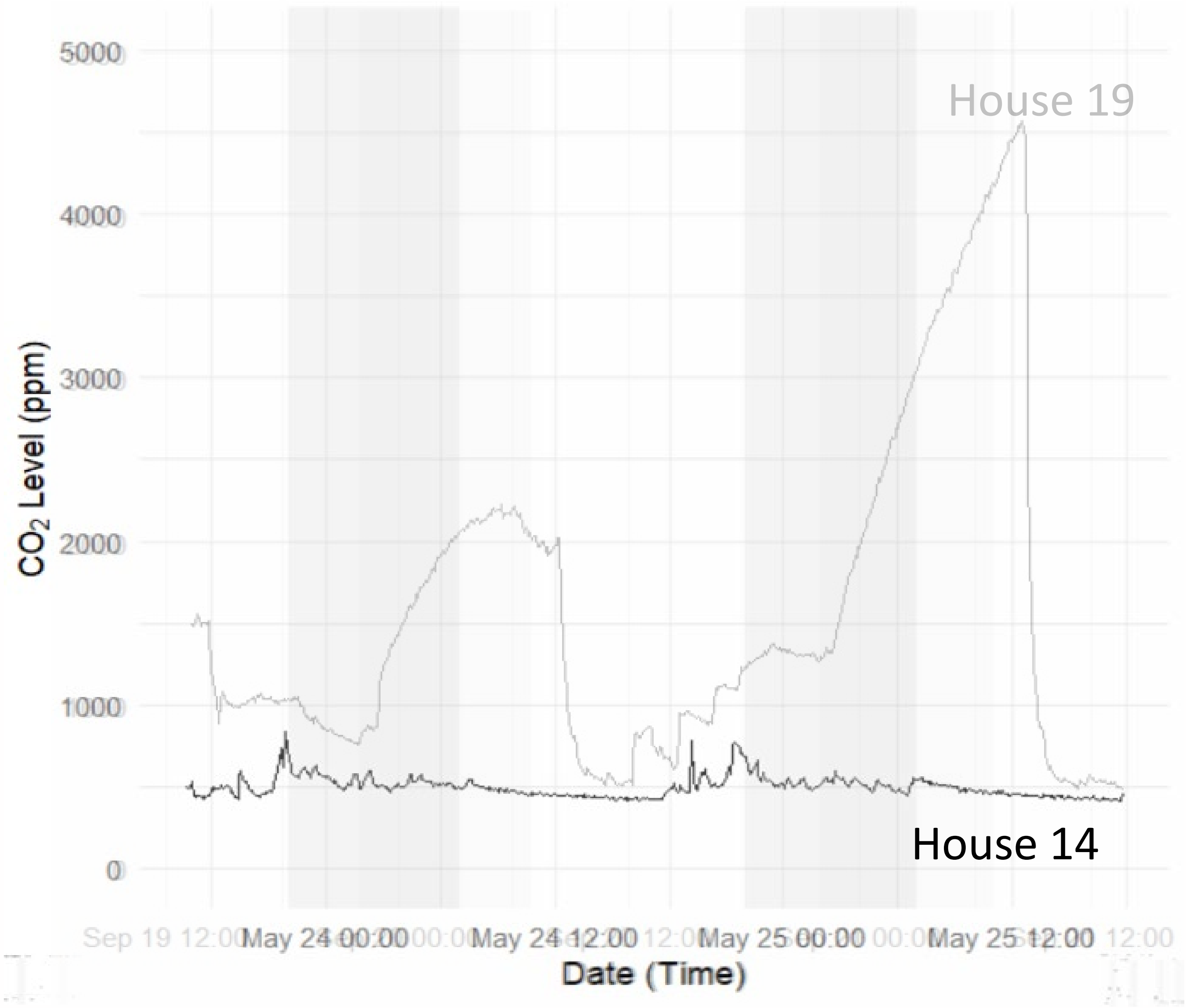
Built year 2000

E2 to B1

Heat pump, New windows and doors

Mould problems – progressed from summer 2023 to winter 2023

CO_2 Time Series Profile in Bedroom for Houses 19 and 14




Retrofits and the way ahead…
Warmer homes
Left over solid fuel
Inadequate handover
You Tube
to the rescue
can suffer
Occupant behaviour and material choice matters
VOC

Eliminate

- Replace fossil fuel-based heating systems
- Eliminate thermal bridging – mould

Eliminate

Substitute

- Selection of low VOC emitting products – EN 16516

Substitute

Engineer

- Comply with ventilation aspects of retrofit
- Radon mitigation

Engineer

Encourage

- Greater awareness IAQ
- Optimal use of ventilation systems
- 3rd party compliance checks on ventilation systems
- Building Regulations

Encourage

Educate

- Professionals & general public
- Tailored message
- Maintenance of ventilation systems

Educate

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All the homes owners who participated in our research

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University ofGalway.ie

NDP NATIONAL DEVELOPMENT PLAN

epa Environmental Protection Agency

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

What would improve awareness on IAQ?

A

Monitors

B

News outlets

C

Indoor displays

D

Rating system

Air Quality Matters

Unlocking Better Ventilation & Air Quality

Air Quality Matters

Simon Jones

AMIEnvSc, AMIAQM, WELL AP, Fitwel

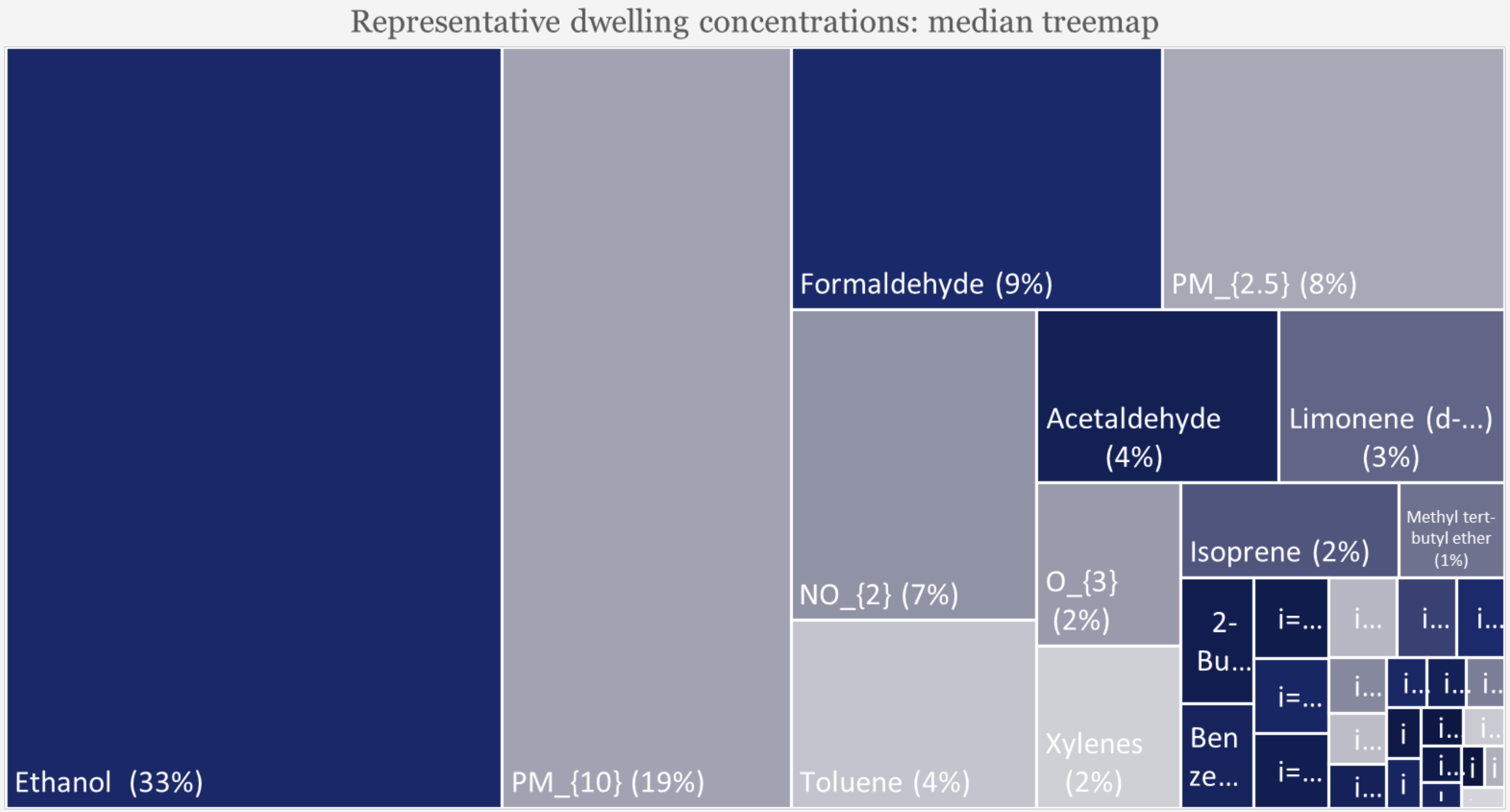
- Founder - Air Quality Matters
- Host - Air Quality Matters Podcast
- Chair - IEA Industry Advisory Committee AIVC & Scientific Committee and Guest Board Member AIVC
- Secretary General - Irish Ventilation Association
- Advisory Board - UKCMB
- Member - BESA Health and Wellbeing
- Member - CIBSE Natural Ventilation Group
- Member - Expert Group (Ventilation) Irish Government

Air Quality

80 Years
70 Indoors
55 At home
25 sleeping

Air Quality

Air Quality



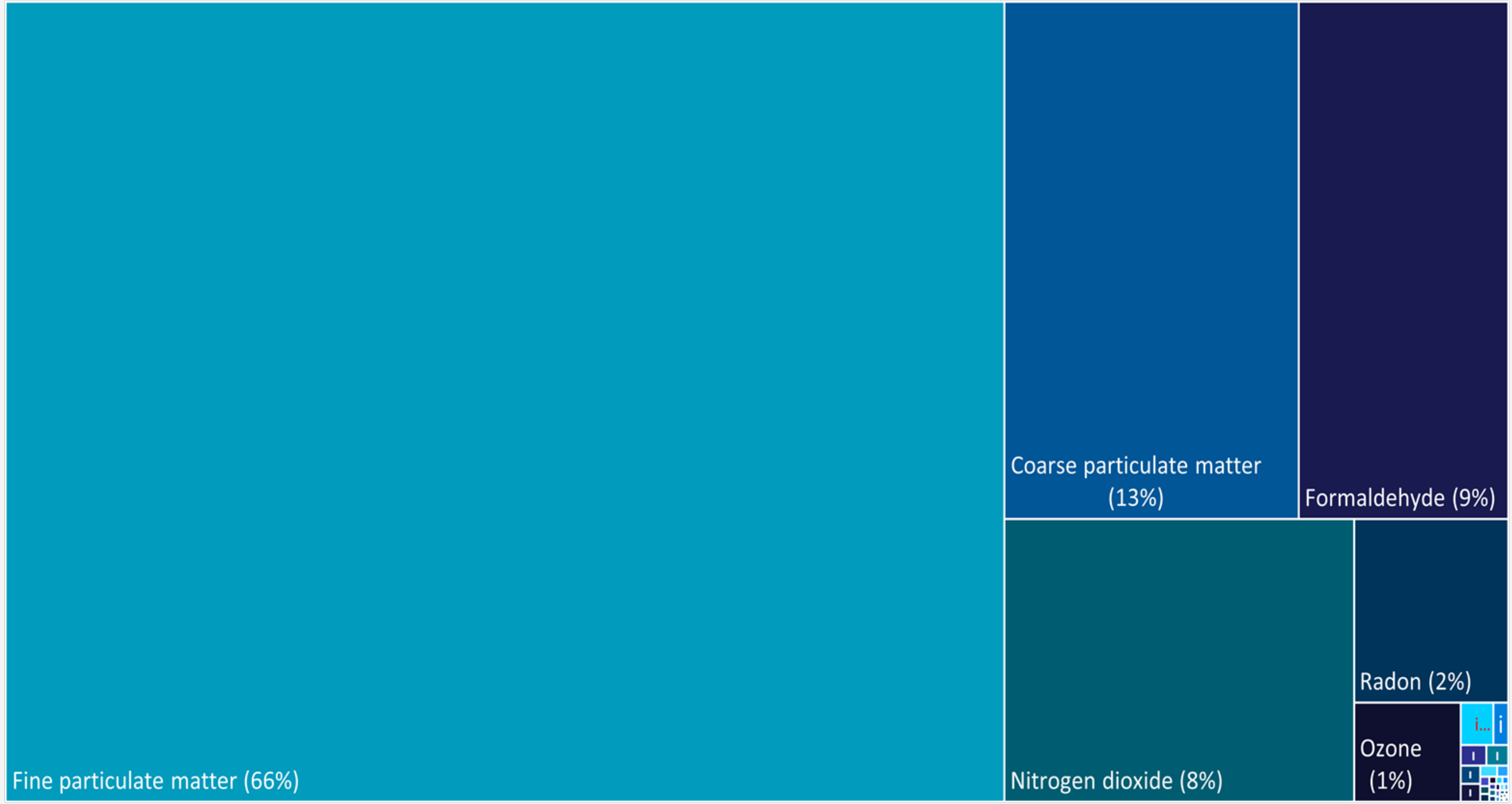
Credit: Ben Jones, Nottingham University

Air Quality

How do you measure harm

Air Quality

Pollutants by harm



Credit: Ben Jones, Nottingham University

Air Quality

The cost.

Air pollution, the largest single environmental risk.

Air pollution is the most significant environmental health risk in the WHO European Region. For 2019, 569 000 premature deaths can be attributed to ambient air pollution, and 154 000 deaths to household air pollution.

The cost of air pollution for Ireland was estimated at approximately €2.3 billion per year in 2015.

Air Quality

The cost.

Radon

According to the EPA, 300 cases of Lung Cancer per year in Ireland can be linked to Radon in our homes and workplaces. 1100 in the UK.

Asthma

According to the Asthma + Lung UK 5.4 Million people currently live with asthma, a disease we know is significantly exacerbated by poor indoor environments.

Every 4 minutes someone is admitted to hospital with asthma In Ireland(Asthma society Ireland 2021). This disease alone cost the UK 5 Billion.

Air Quality

The cost.

The death of Ella Adoo-Kissi-Debrah age 9 in 2013 and Awaab Ishak age 2 in 2020, has changed how we frame the impact of air quality in the UK.

Moisture in Buildings

In Ireland, 12.6% of the population, or 611,982 people live in rotting, damp or leaking dwellings.

Eurostat figures from 2017

Moisture Balance

- The concept that a building's healthy balance point is the target.
- Each will have a different balance point based on the building, its use and systems within it.
- There are multiple factors that can upset this balance and consequences to changing elements of it.

MOISTURE BALANCE

Ventilation Basics

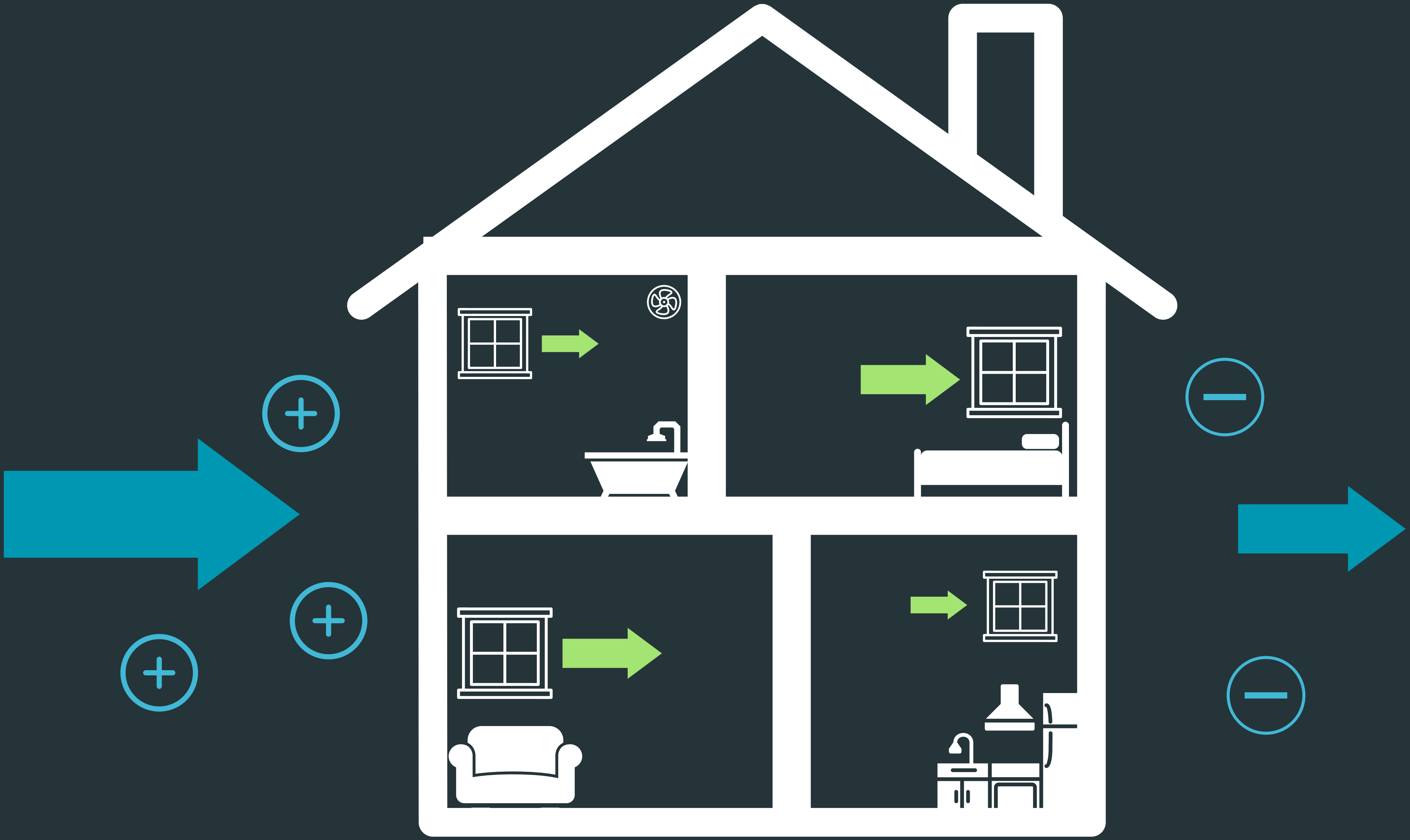
Natural Ventilation

Ventilation Basics

Natural Ventilation

Ventilation Basics

Natural Ventilation



Ventilation Basics

Continuous Mechanical Extract Ventilation De Centralised

Rules and Regs

TRUSTMARK
Government Endorsed Quality

bsi.

Rules and Regs

The intent of adequate ventilation.

- Extracting water vapour and indoor air pollutants from areas produced before they spread.
- Supply a minimum level of outdoor air for occupants' health.
- Rapidly dilute in habitable rooms through purge ventilation when required.

- Minimises the entry of external air pollutants
- Produces low levels of noise
- Offers easy access to maintenance

Rules and Regs

10mm

110m2 and 3 Bedroo

a) 5 l/s plus 4 l/s per person, e.g. 25 l/s for a five person, 3-bedroom semi-detached dwelling. This is based on two occupants in the main and second bedrooms, and a single occupant in the third bedroom. This should be used as the default value, if a greater level of occupancy is expected, then add 4 l/s per occupant.

Or

b) 0.3 l/s per m^2 internal floor area, e.g. 30 l/s for a 100 m^2 dwelling.

The system should be able to provide a capacity of at least:

- 25% over the calculated general ventilation rate in 1.2.2.2, and
- the overall minimum extract boost rate.

Table 1: Centralized continuous mechanical extract ventilation systems: minimum boost extract rates[1]

Wet rooms	Minimum extract rate (l/s)
Kitchen	13[2]
Utility room	8
Bathroom	8
Sanitary accommodation (no bath or shower)	6[3]

Notes:

1 The above are minimum boost extract rates and may need to be increased to achieve the general ventilation rate.

2. Excludes cooker hood extract.

3. As an alternative, an opening window provided for purge ventilation may be relied on for extract.

Environmental Monitoring

Environmental Monitoring

Provide a range of interfaces
Web, Mobile, Email, Reports, API

Actionable insight into
Fuel Poverty, Voids, Thermal Efficiency, Moisture Balance, Ventilation Performance.

Ventilation Strategy

Ventilation Strategy

Diagnosis Policy Actions

Diagnoses of the challenge

- Where does Ventilation go right and wrong
- How do we come into contact with Ventilation
- What stakeholders are there internally and externally
- What influence can we have over decisions and practices
- What could the consequences of certain actions have
- What is the scale of the challenge
- What are the costs and opportunities

Thankyou

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