Healthy air in zero carbon ready homes

LOCO
HOME RETROFIT

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Glasgow
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Welcome

- Please keep your microphone muted.

- Please put questions in the chat for the Q&A at the end.

LOCO HOME RETROFIT

Glasgow's Retrofit Co-operative

- Owned and governed by members: homeowners, trades, professionals
- Co-operating to advance owner-occupier retrofit
- Benefits: learning, bulk buy, software tools and more
- Join the co-operative https://locohome.coop/join
    - £10 for 12 months (£1 max liability).

LOw CO_2 → LOcal action hub → LOCO HOME

LOCO HOME RETROFIT

Barbara Lantschner, BArch, MSc, CEPH

- Building performance specialist & Retrofit Coordinator
- Leads the Hab-Lab building performance evaluation service at John Gilbert Architects
- Winner, Saltire Society Innovation in Housing Award 2016
- Extensive experience in Passive House projects including the Niddrie Road tenement retrofit
- Contributor to the HEMAC/ SEDA air quality guide.

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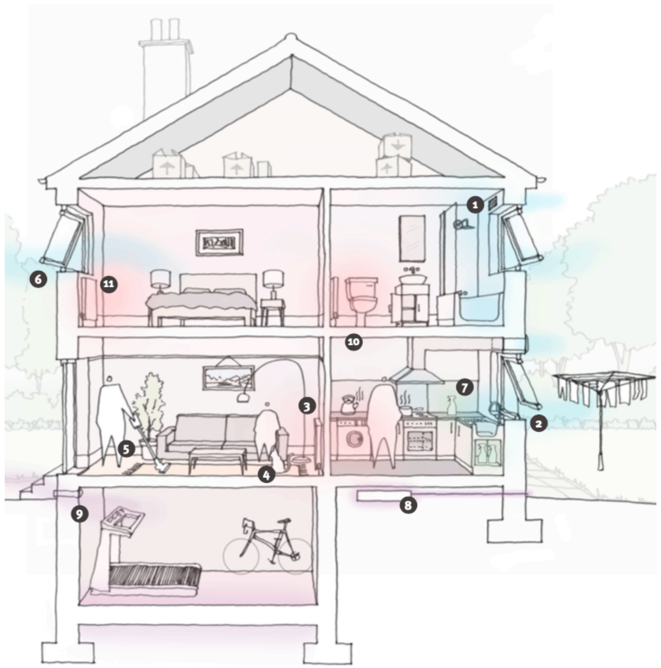

Indoor air quality and ventilation

LocoHomes Webinar

02 February 2022

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John Gilbert ARCHITECTS

Content

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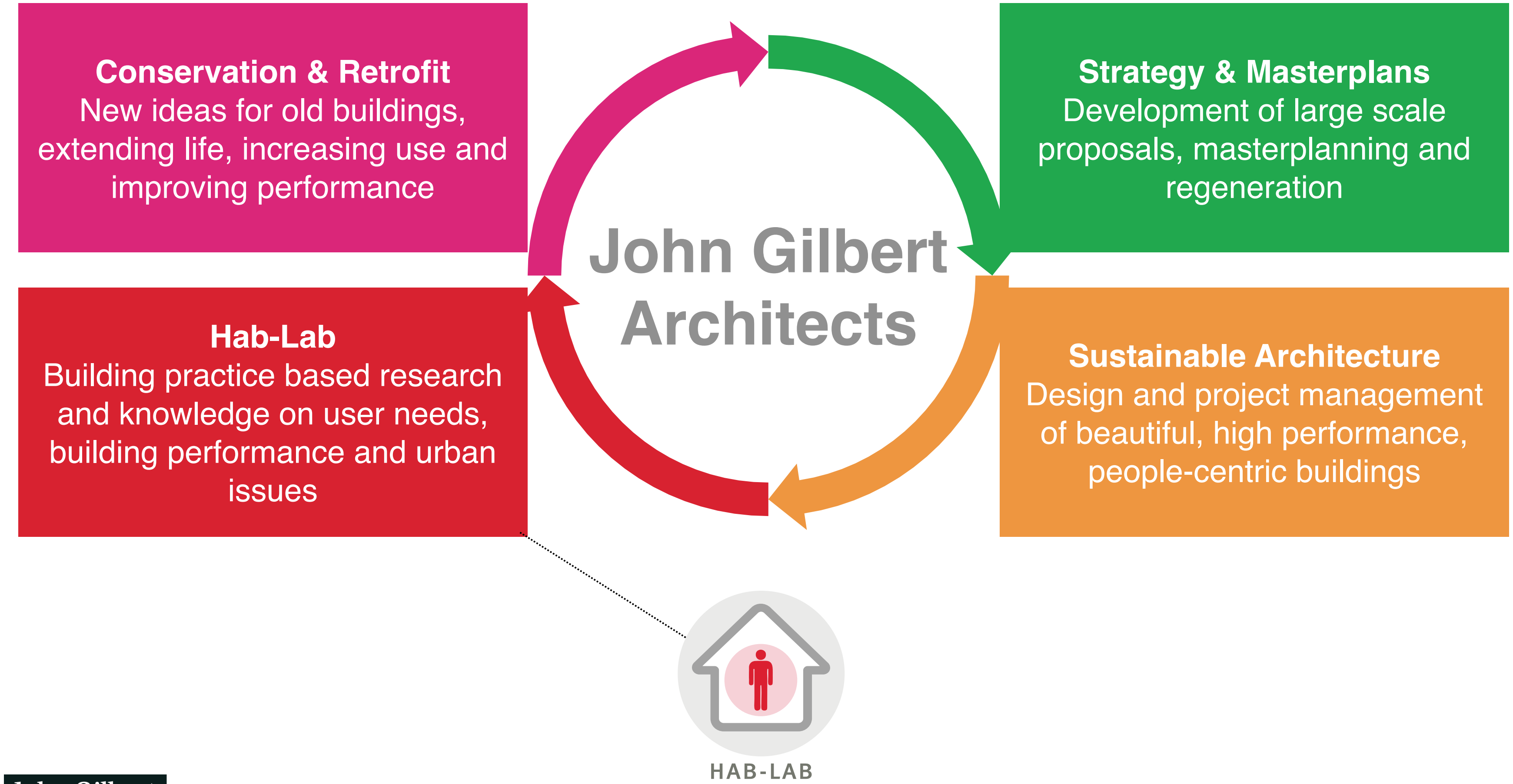
1. Context



Conservation & Retrofit
New ideas for old buildings, extending life, increasing use and improving performance
Strategy & Masterplans
Development of large scale proposals, masterplanning and regeneration
John Gilbert Architects
Hab-Lab
Building practice based research and knowledge on user needs, building performance and urban issues
Sustainable Architecture
Design and project management of beautiful, high performance, people-centric buildings
HAB-LAB

1. Context

Why is Ventilation/ Retrofit important?

Housing accounts for over **70%** of land use in most cities (UN-Habitat)

Housing is the 4th largest sector of GHG emissions in the UK , accounting for 14% of the overall emission (BEIS)

80% of the homes we will be using in 2050 already exist

Poor housing costs the NHS over £600 million each year (BRE)

18% of the UK population is aged 65 and over, of which 32% are living alone (ONS)

28,000 - 36,000 early deaths / year in UK due to Indoor Air Pollution

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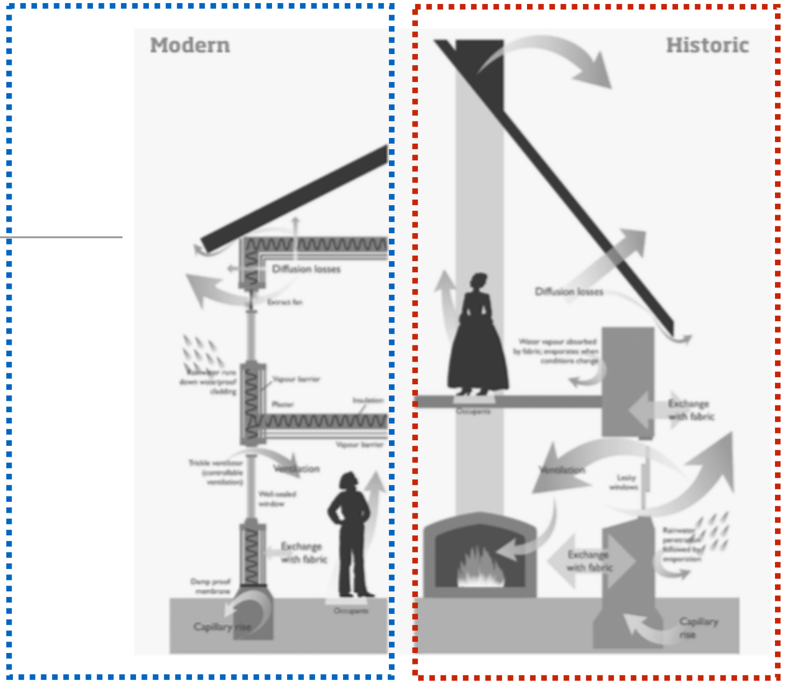
1. Context

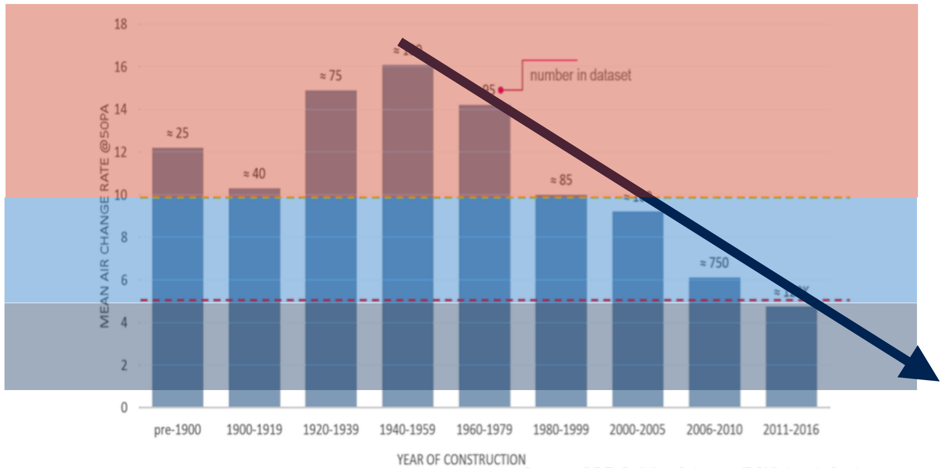
Energy reduction targets

- Reductions in uncontrolled ventilation heat loss have resulted in reduced energy bills and heating demand.
- However, once uncontrolled ventilation is reduced, sufficient ventilation/ fresh air must be provided through controlled means.
- There is an increasing importance of ventilation - both for energy efficiency and health
- Leaky buildings don't necessary ensure good indoor air quality
- Retrofit works might affect the original nature/ ventilation strategy of the buildings and this should be considered to void unintended negative consequences



- Ventilation= controlled means
- Can ensure good indoor air quality
- Is energy efficient

- Infiltration=uncontrolled means
- Does not ensure good indoor air quality
- Not energy efficient



Sources: BRE; Building Sciences (RSK); Leeds Beckett University; ATTMA

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1. Context

Technical Handbook for Domestic (Scotland):

- Building Regulations outline the minimum required standards/ performance for ventilation:
- **“Every building must be designed and constructed in such a way that ventilation is provided so that the air quality inside the building is not a threat to the building or the health of the occupants”.**
- A dwelling should have provision for ventilation by either:
  a. natural means, or
  b. mechanical means, or
  c. a combination of natural and mechanical means (mixed-mode).
- Not very stringent standards lead to poorly design, installed and performing ventilation systems
- No in-situ measurements required! How do we know how healthy and well ventilated our homes are?

1. Meeting specified ventilation rates
2. Following the specified system guidance
3. Using a system that is demonstrated to achieve the specified indoor air quality criteria

- **...Is this enough?**

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1. Context

The Retrofit Standards

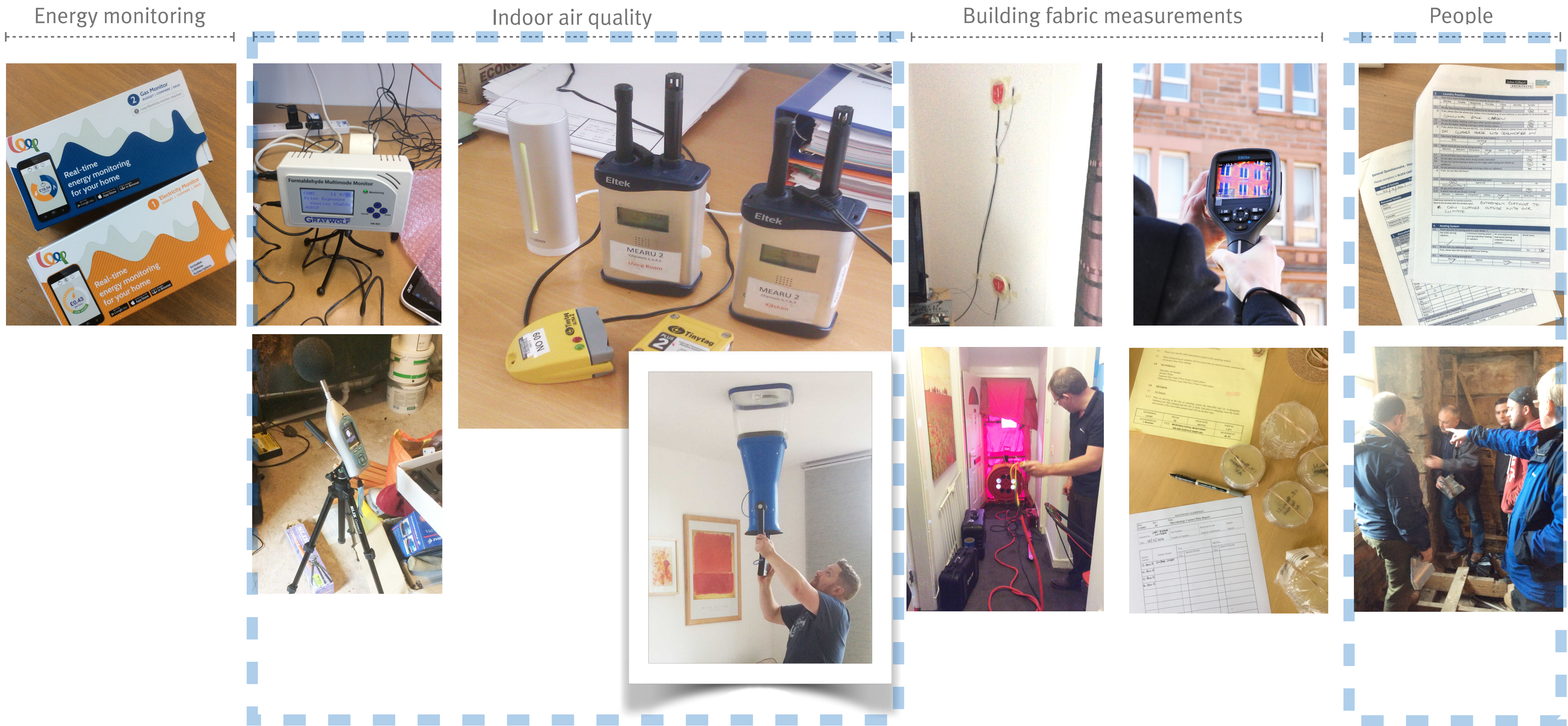
- Shallow retrofit does not require ventilation strategies
- Existing measuring and modelling tools are inadequate and also lead to performance gap issues. Ventilation and airtightness are generally underestimated in existing compliance tools such as SAP/ RdSAP
- Whole house/ deep retrofit standards focus on holistic strategies and this includes ventilation systems.
- PAS 2035, LETI Climate Emergency Retrofit Guide | EnerPHit, Energie Sprong, AECB, etc.
- PHPP provides a more accurate prediction, which allows to model improved airtightness and ventilation strategies

Name/ Reference	Description	Space Heating Demand	EUI kWh/m²/ year	Compliance method	When to use
Retrofit Guidance					
PAS 2035:2019 bsi.	Best Practice Guidance and a Quality Assurance process for retrofit	N/A	N/A	Employment of suitably qualified Retrofit Designer and Retrofit Coordinator to manage the Retrofit Process.	Any level of retrofit. Mandatory for government procured schemes from 2021. Should be used, at minimum, for large scale and/or high-risk retrofit where there are significant levels of intervention to the building fabric and ventilation.
LETI	LETI best practice guidance for safe and effective retrofit	50 kWh/m²/yr (up to 60 when constrained)	50 kWh/m²/yr (up to 60 when constrained)	Demonstrated either by modelling or the constituent element method. No certification or QA scheme offered.	Use the LETI flowchart in Figure 4.4 to determine when to use: LETI best practice constrained and unconstrained targets; LETI exemplar targets; and whether to use the energy targets (modelling method) or fabric and system targets (constituent element method).
	LETI exemplar guidance	25 kWh/m²/yr	40 kWh/m²/yr		
EnerPHit Certified Retrofit	Independent Construction Standard for retrofit	20-25 kWh/ m²/yr	EUI equivalent 35-45 kWh/m²/yr. (EnerPHit standard uses primary energy targets)	Demonstrated by PHPP modelling. Integrity of modelling and quality of construction independently verified by PH Certifier. Various routes to compliance inc. space heat demand and component approach, and a step-by-step option for both.	Exemplar levels of retrofit are being targeted, modelling in PHPP can be undertaken and quality assurance is to be achieved through an independent QA process. The range of routes to compliance make this widely applicable in the UK, this can be used to meet LETI exemplar targets and for projects following the PAS 2035 methodology.
energiesprong uk	Methodology based on fitting external panels, replacing windows/ doors, installing ventilation.	40* kWh/ m²/yr	No EUI target, but scaled targets for hot water and appliance load.	Home owner or landlord enters into a [illegible] which guarantees levels of performance specified. Thus compliance is by in-use assessment.	Good levels of retrofit are being targeted and the nature of the building itself lends itself to external cladding.
AECB building knowledge	Independent Construction Standard for retrofit	50 kWh/m²/yr (with possible exemption up to 100)	No EUI target, but likely to be 50-70 kWh/m²/yr	AECB Retrofit standard: Published se[illegible] accompanying criteria. Modelled using PHPP and addresses other retrofit risks including moisture. Requires Retrofit or Passivhaus expert.	Good level of retrofit is being targeted, PHPP modelling can be undertaken and a recognised certification is required. The required level of quality assurance will be achieved with some additional QA processes.

Climate Emergency Retrofit Guide | LETI

2. Hab-Lab & Findings

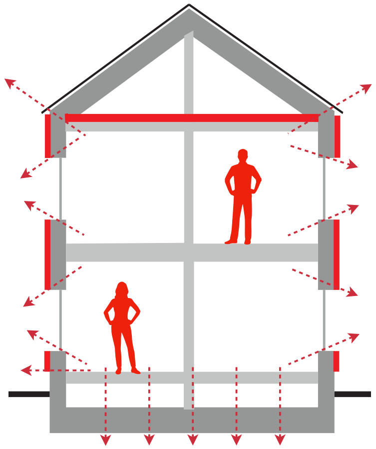
Real world information & making POE accessible

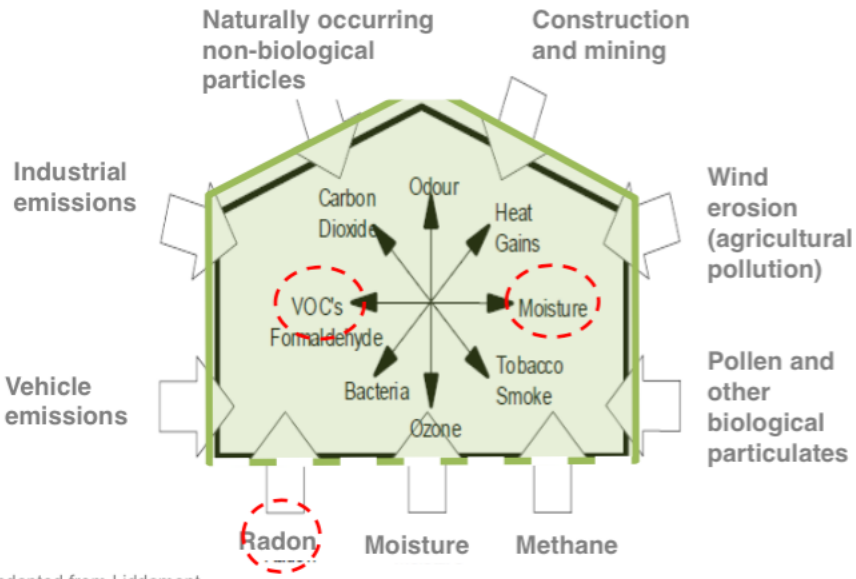


2. Hab-Lab & Findings

Health Risks

- Warmer, more airtight buildings can exacerbate health risks associated with indoor air pollution and moisture, **if not designed correctly**
- Ventilation is very rarely a priority for designers & installers
- Buildings are generally more airtight, but not designed and built correctly. Gaps concentrate building fabric risks associated with moisture and heat losses.
- This leads to increased risks of condensation, mould, House Dust Mites, VOCs and other known air quality hazards
- Increased likelihood of asthma, COPD and other health problems





© Diagram adapted from Liddament, M. AIVC

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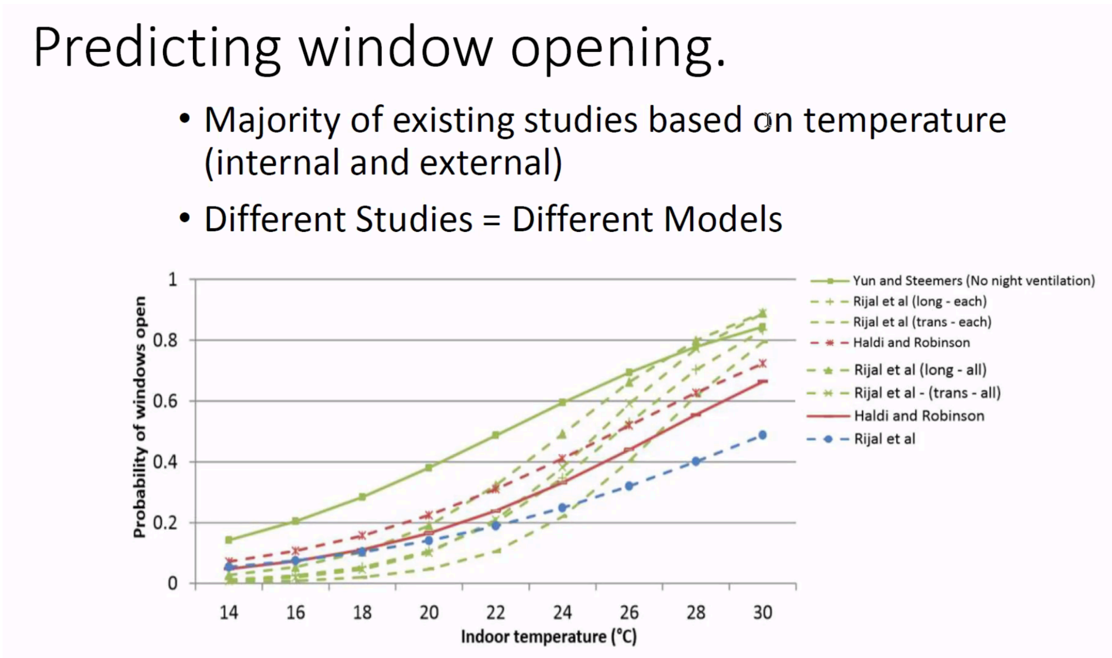
2. Hab-Lab & Findings

Indoor Air Quality Findings

- Drivers - temperature
- Barriers - heat loss
- Lack of knowledge - majority of residents/ home owners had received no advice on ventilation
- Also occurs in recently retrofitted homes



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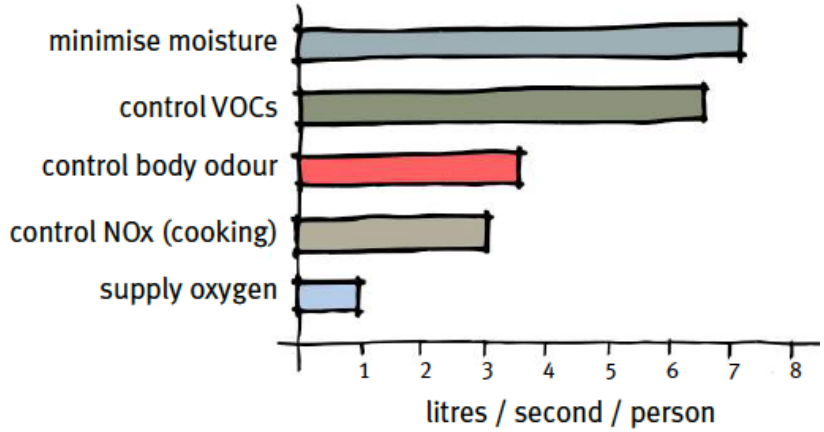
3. Ventilation Strategies

What is Ventilation and IAQ?

- **Ventilation is the controlled supply and removal of air from a building.**
- Ventilation is required:
  - To provide outside air for breathing
  - To dilute and remove pollutants in the air, including odours
  - To control excess humidity (not only in bathrooms and kitchens!)
  - To ensure energy efficient and healthy homes



- **Good IAQ requires:**
  - "air with no known contaminants at harmful concentrations" (CIBSE)
  - Low pollutant emission rates from internal sources, including materials (natural materials ensure source control!)
  - Ventilation to dilute and remove pollutants. **Again, not only from wet rooms!!**

JGA/ BPE findings

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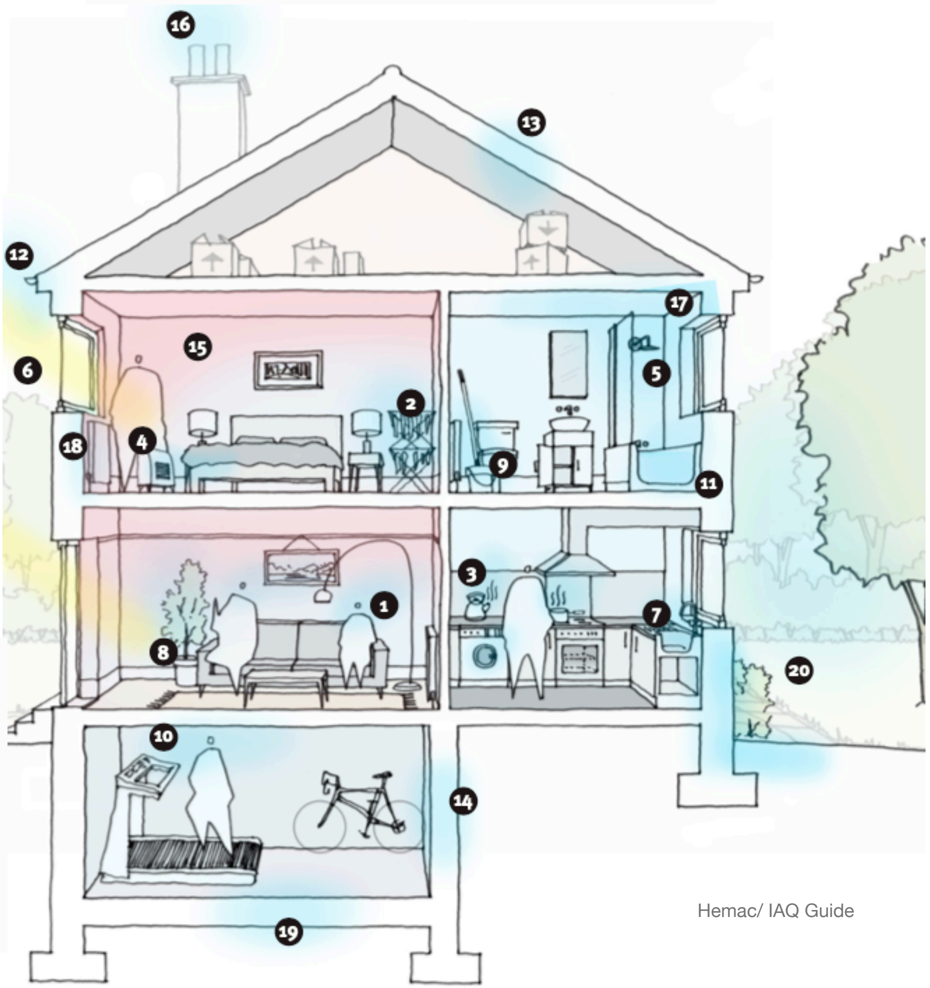
3. Ventilation Strategies

Source Control

- If there are pollutants in our homes which can harm our health, the first thing we should do is try and reduce them appearing in the first place - source control.
- Minimise sources of moisture and specify low pollutant emission rates from internal sources, including materials. This includes:
    - Overheating + Moisture
    - Biological + Natural
    - Combustion Products
    - VOCs + other chemicals

Overheating & Moisture Diagram – potential risks



1. Humans and pets breathing
2. Clothes drying inside
3. Cooking and boiling kettles
4. Portable gas heating
5. Bathing and showering
6. Unshaded southerly windows leading to overheating
7. Dishwashing
8. Watering indoor plants
9. Floor and surface cleaning
10. Exercising indoors (breathing increased, sweating)
11. Damaged internal drainage or leaks
12. Damaged gutters overflowing
13. Damaged external envelope
14. Groundwater penetrating walls or floors
15. Upper rooms can overheat without high level ventilation
16. Uncapped chimneys or flues
17. Condensation in wet or cold rooms or at thermal bridges
18. Moisture in building fabric
19. Flooding or high water tables
20. Shaded or overgrown external areas

Hemac/ IAQ Guide

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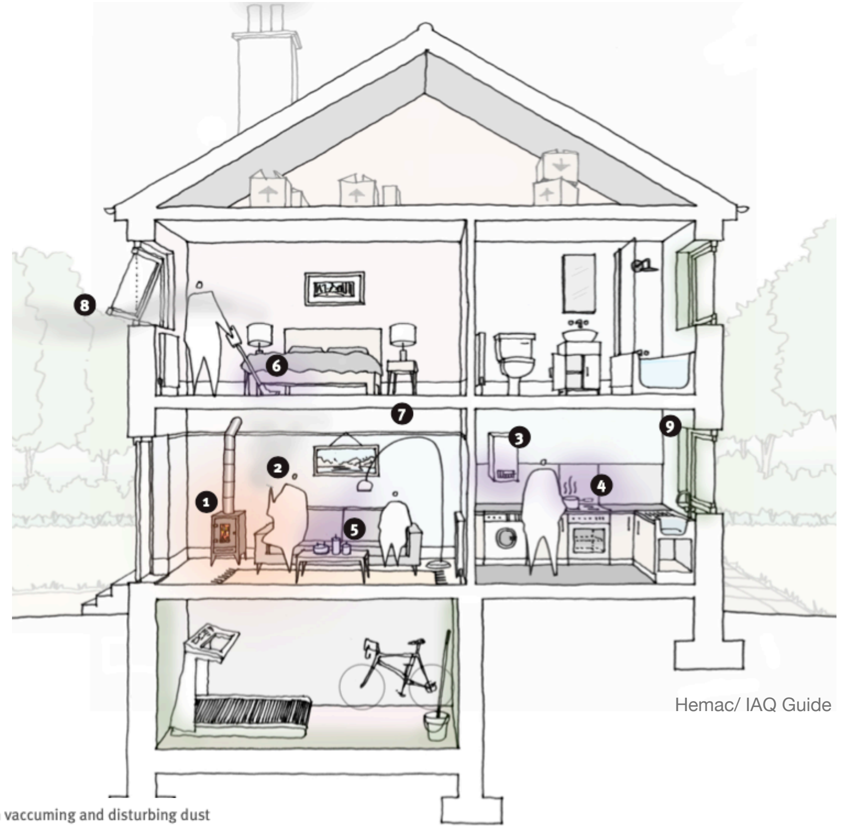
3. Ventilation Strategies

Source Control

- Combustion products & particles in a home can include:
  - Carbon dioxide
  - Carbon Monoxide
  - Nitrous oxides
  - Sulphur Dioxide
  - Environmental Tobacco Smoke
  - Particulates

- The Hemac Guide for IAQ includes a list of recommended materials and source control strategies for homes

Combustion Products & Particulates Diagram – potential risks



Hemac/ IAQ Guide

1. Solid fuel stove a potential source of CO_2, CO, NO_x, SO_2 and PAHs
2. Many pollutants from smoking or second hand smoking
3. Boiler is a potential source of CO_2, CO, NO_x and SO_2
4. Gas hobs and ovens are a potential source of CO_2, CO, NO_x and SO_2
5. Particulate matter (PM) from burning candles
6. PM from vaccuming and disturbing dust
7. Asbestos in 'Artex' ceilings and many other possible locations, for homes built pre-2000
8. External air is a potential source of CO_2, CO, NO_x, SO_2, PM and PAHs, especially in urban areas, near traffic or industrial processes
9. Inadequate ventilation from kitchen

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3. Ventilation Strategies

Which system should I specify/ install?

- **Many installed systems are inadequate, mainly because the current standards are not stringent enough:**
- **Problems arising with types of ventilation:**
  - A greater risk of natural ventilation providing insufficient ventilation in airtight homes
  - Mechanical ventilation being complex, leading to incorrectly sized fan units, poor installation and lack of user understanding of the system.
- **Clear and detailed specification is needed to:**
  - Ensure the ventilation strategy is in line with the design air permeability
  - Ensure design is followed, check products, layout, operational controls.
  - Ensure that commissioning is undertaken correctly by a competent professional, using suitable calibrated air flow instruments.
  - Ensure that clear instructions are prepared for the residents

JGA/ BPE findings

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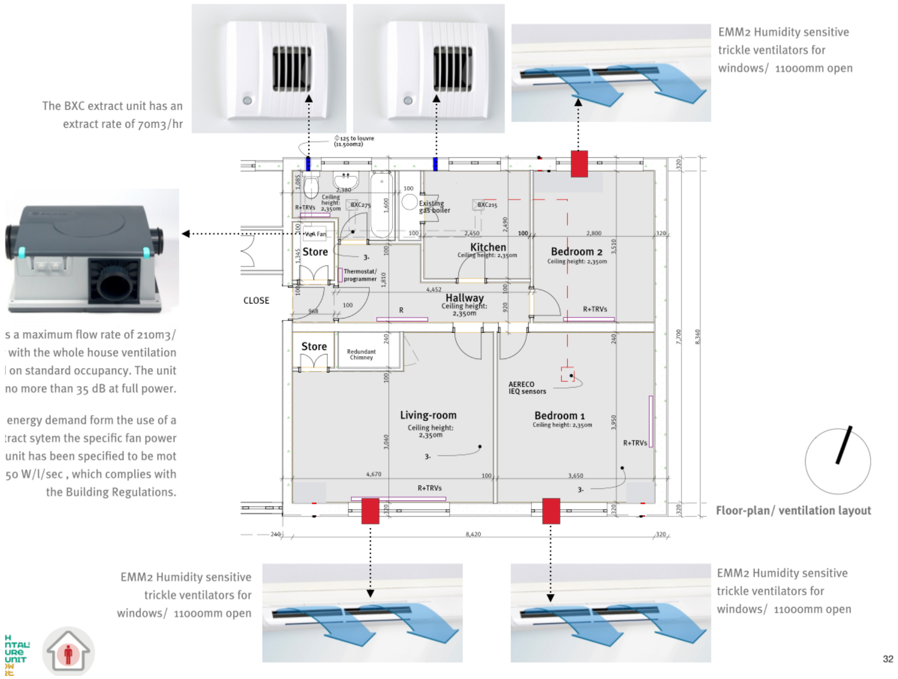
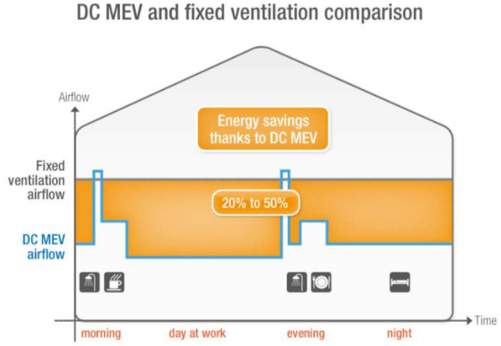
3. Ventilation Strategies

Best Practice Ventilation Design

- **If you want to consider a natural ventilation, you should definitely seek professional advice, as the air movement in, through and out of your home is greatly affected by its layout and volume**
- If you are targeting an efficient and airtight house, you should consider a continuous mechanical system to maintain good air quality.
- A well-designed, well-installed continuous mechanical system will reduce the risk of lower air quality.
- Centralised systems: ducting requires careful thought, particularly in older homes: a poorly-installed system may not deliver the required air flow and could be noisy.
-





By adjusting the rate of air exchange according to what happens in the dwelling, **DCV saves between 20% to 50% by not over ventilating, leading to energy savings.**

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3. Ventilation Strategies

Band	Air permeability (m³/hr/m²@50Pa)	Described condition
A	Less than 3	Very airtight
B	Between 3 and 5	Fairly airtight
C	Between 5 and 10	Acceptably airtight
D	Between 10 and 20	Not airtight – a leaky building
E	Above 20	Very leaky

Ventilation Systems

1 INTERMITTENT EXTRACT SYSTEM

Suitable Band B – E

- Most common domestic system
- Extract fans in wet rooms
- Usually sited on wall or ceiling
- Ceiling-mounted fans need to be ducted to outside

Pros

- Easy to install
- Low cost
- Easy to use

Cons

- Fan noise
- User can choose not to use

2 PASSIVE STACK VENTILATION (PSV)

Suitable Band B–C

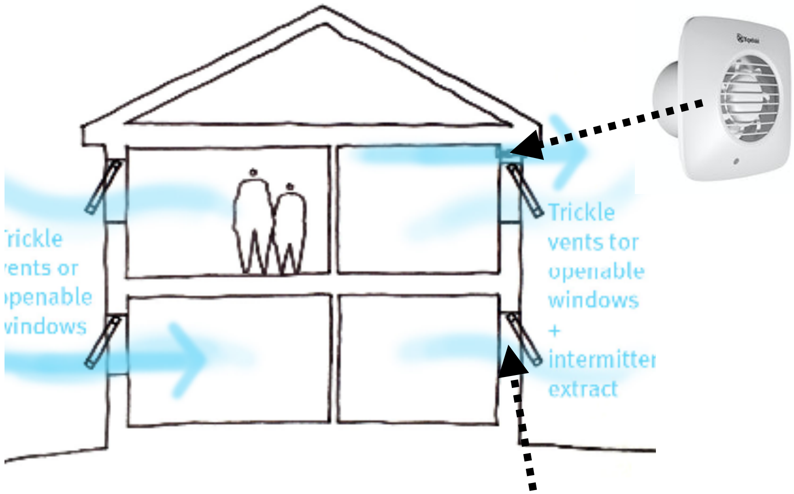
- Natural ventilation openings in wet rooms
- Connected to vertical ducts that lead up to roof
- Warm, wet air drawn up ducts by a combination of wind and 'stack' effect (vertical pressure differences that drive warm air upwards)

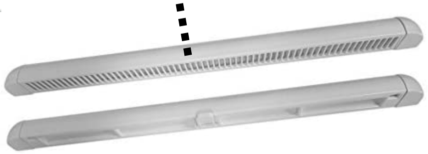
Pros

- Easy to install (in top-floor wet rooms)
- Silent
- Continuous
- Low cost

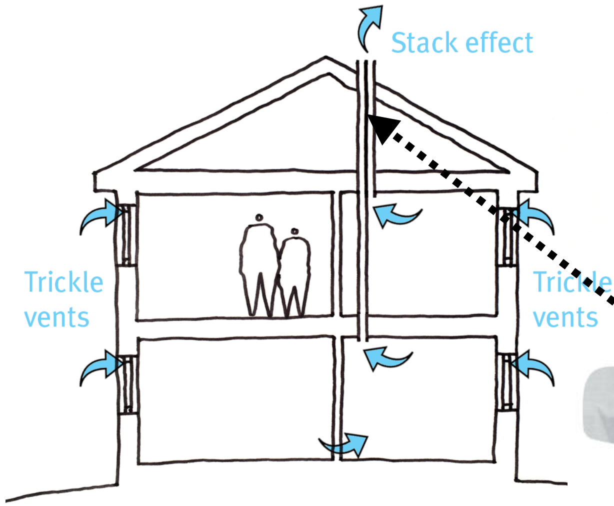
Cons

- Hard to accommodate vertical ducting (in ground-floor wet rooms)
- May not provide enough ventilation in summer





ouse Diagram – natural ventilation



House Diagram - stack ventilation (natural)

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Hemac/ IAQ Guide/ FourWalls presentation

3. Ventilation Strategies

Band	Air permeability ($m^3/hr/m^2$@50Pa)	Described condition
A	Less than 3	Very airtight
B	Between 3 and 5	Fairly airtight
C	Between 5 and 10	Acceptably airtight
D	Between 10 and 20	Not airtight – a leaky building
E	Above 20	Very leaky

3 CENTRALISED MECHANICAL EXTRACT VENTILATION (MEV)

Suitable Band A–C

- Ducted ventilation grilles in wet rooms
- Connected to continuously-running central fan located in a store or void space
- Warm, wet air removed by fan and ducted to outside
- Ceiling-mounted fans need to be ducted to outside

Pros

- Potentially easy to install
- Continuous
- Maintains background ventilation
- Simple to operate
- Medium cost

Cons

- Requires ducting, which may be hard to accommodate
- Uses electricity
- Potential fan noise

DECENTRALISED MECHANICAL EXTRACT VENTILATION (DMEV)

Suitable Band A–C

- Similar to centralised MEV but fans installed in wet rooms rather than one centralised unit
- Similar in simplicity to Intermittent Extract System, as local fans require only local ducting
- Can be suitable replacement for Intermittent Extract System

Pros

- Easy to install
- Less ducting than centralised system
- Continuous
- Maintains background ventilation
- Simple to operate
- Low cost

Cons

- Uses electricity
- Room-side fan: increased potential for fan noise

5 WHOLE-HOUSE MECHANICAL HEAT RECOVERY VENTILATION (MVHR)

Suitable Band A–B

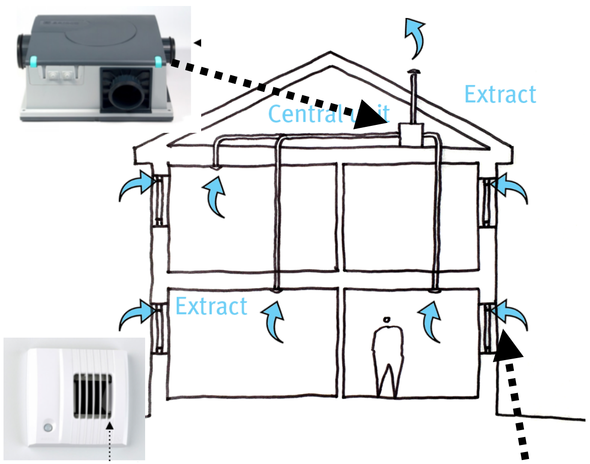
- Combines supply and extract ventilation in one system
- Air extracted from wet rooms via ducting
- Heat from extracted air is recovered and transferred into supply air
- Only suitable for airtight homes

Pros

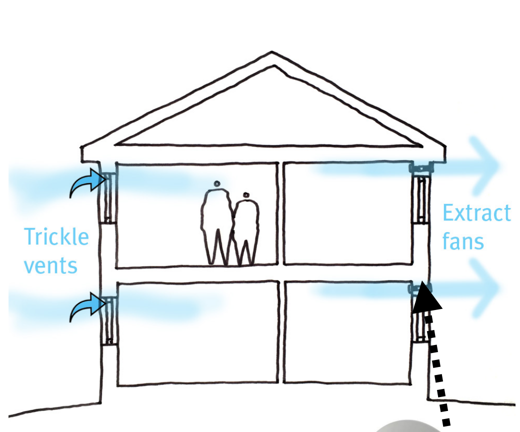
- Air quality – intake air is filtered
- Comfort – air movement and exchange throughout home
- Efficiency – heat recovery reduces heat demand and tempers incoming air

Cons

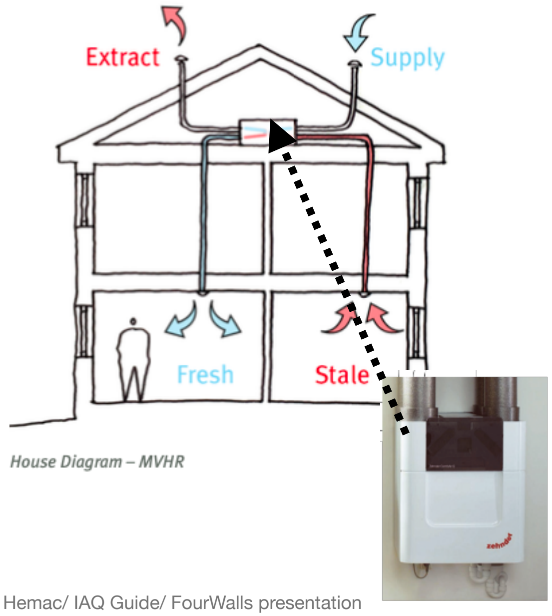
- Requires ducting to most rooms in the house
- Most expensive system
- Correct commissioning can be complex
- Potential fan noise
- Uses electricity



House Diagram - CEV



House Diagram - dMEV



House Diagram – MVHR

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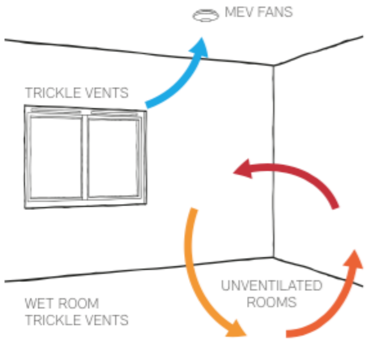
Hemac/ IAQ Guide/ FourWalls presentation

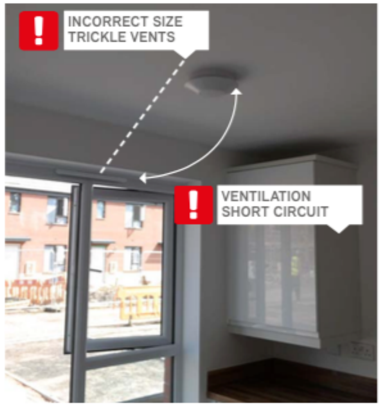
3. Ventilation Strategies

Decentralised systems

PROBLEMS TO AVOID

- Ventilation short circuit

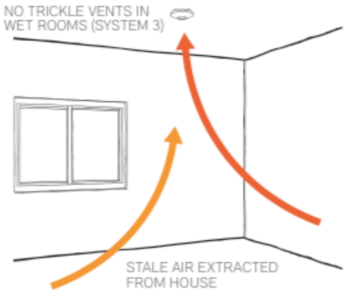




WHAT TO DO?

- Check window schedule and window order for trickle vents
- Tape up trickle vents during construction to protect from dust
- Explain use of trickle vents to occupants – keep open to ensure adequate ventilation

NOTE: Refer to part F for sizes depending on dwelling size, windows and airtightness



RULE OF THUMB FOR TRICKLE VENTS:

System 1 = large trickle vents: areas from AD(F),

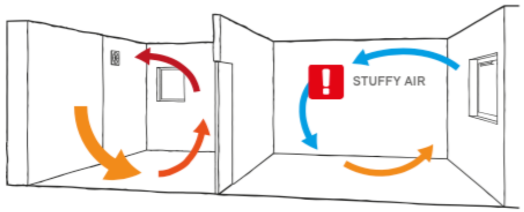
System 2 = trickle vents to provide background air for passive stack

System 3 MEV = 2,500mm² for each room except wet rooms

System 4 = no trickle vents

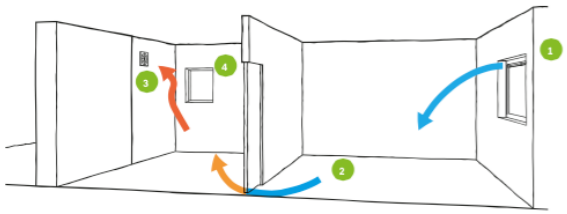
PROBLEMS TO AVOID

- No door undercut will prevent transfer of air between rooms with rooms becoming stuffy



WHAT TO DO?

- Trim all doors to achieve a clear gap of 10mm: at least 25mm without finishes fitted



1. Background ventilation = trickle vents correct size
2. Transfer = Door undercut at 10mm
3. Extract fan, duct and grille correct size
4. No trickle vents in wetrooms

3. Ventilation Strategies

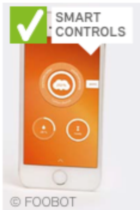
Controls

PROBLEMS TO AVOID

- Fan controls not labelled
- Controls not obvious and unmarked
- Appliances left on standby with excessive power consumption in un-occupied homes
- Controls with no feedback that ventilation is operating

WHAT TO DO?

- Label controls and switches for easy use and maintenance
- Install whole house shut down unit to prevent wasted electric use by occupier
- Consider automatic demand control with CO_2 and humidity sensors



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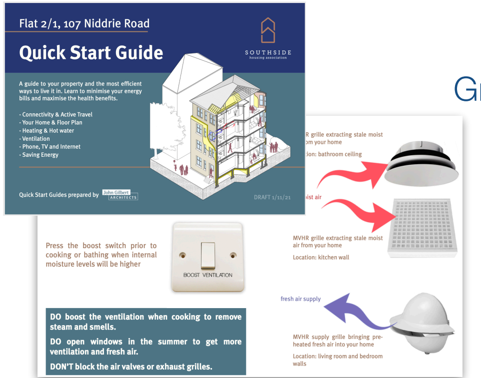
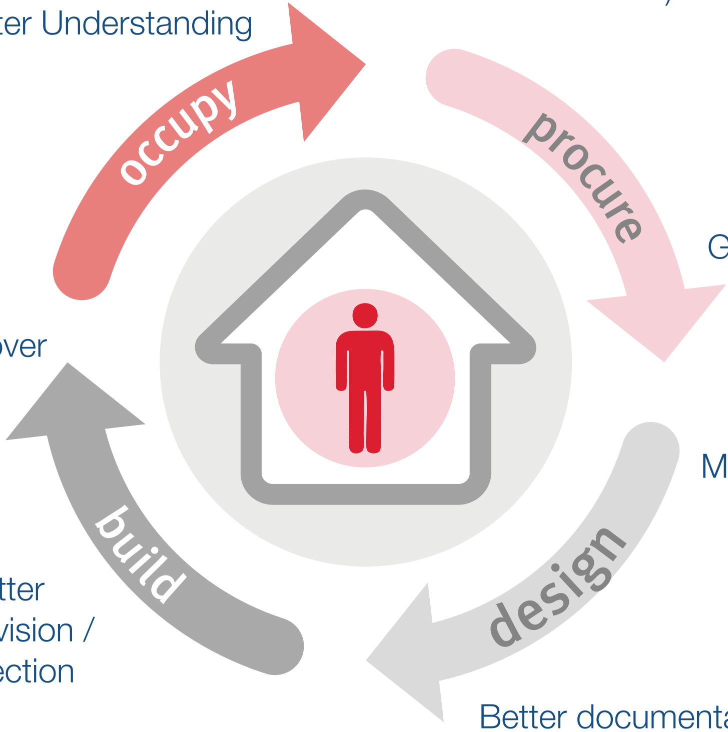
3. Ventilation Strategies

Engaging with People (it's not only about the system!)





Greater Understanding

Hire a competent professional (new build & retrofit!)

Guidance on Briefing

More accurate modelling

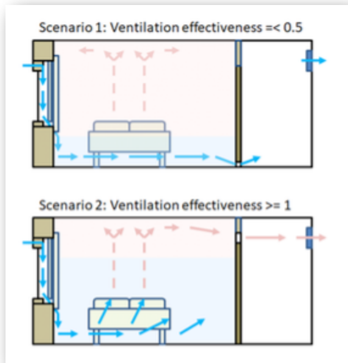
Better documentation for Contractors

Design and specify 'user-friendly' systems

Contractor Training / Toolbox talks

Better Supervision / Inspection

Improved Handover



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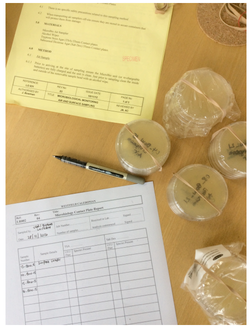
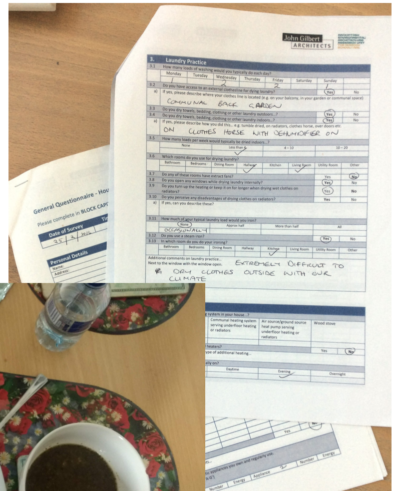
4. Measuring/ Monitoring IAQ

How do we know if IAQ is OK?

- **Basic studies can include temperature, RH and CO2 (affordable sensors available!)**
- Detailed studies can include formaldehyde, VOCs, PM2.5 and PM10, fungi, bacteria, etc. to evaluate the concentration of specific pollutants
- Occupants surveys to understand how residents use their homes, how this impacts on the building performance and to understand comfort levels





HAB-LAB IAQ monitoring techniques

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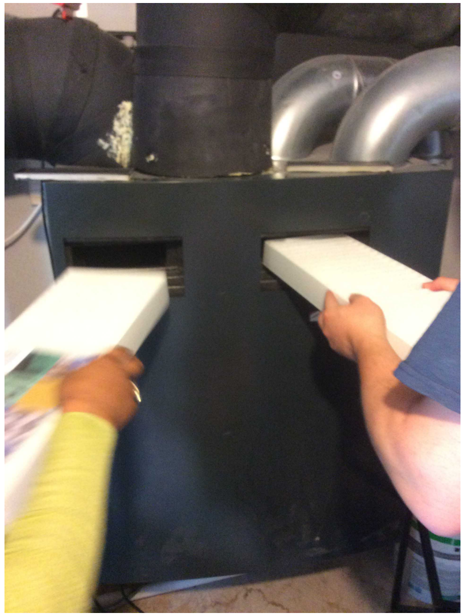
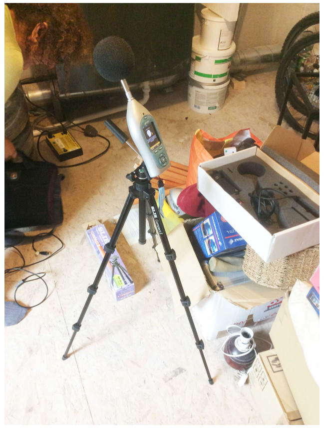
4. Measuring/ Monitoring IAQ

How do we know if the vent system is OK?

- **Visual inspection (by a competent professional!)**
- **Some filters can be checked/ cleaned by home owners**
    - Airflow measurements at each grille MEV unit.
    - Noise level measurements
    - Energy consumption measurements

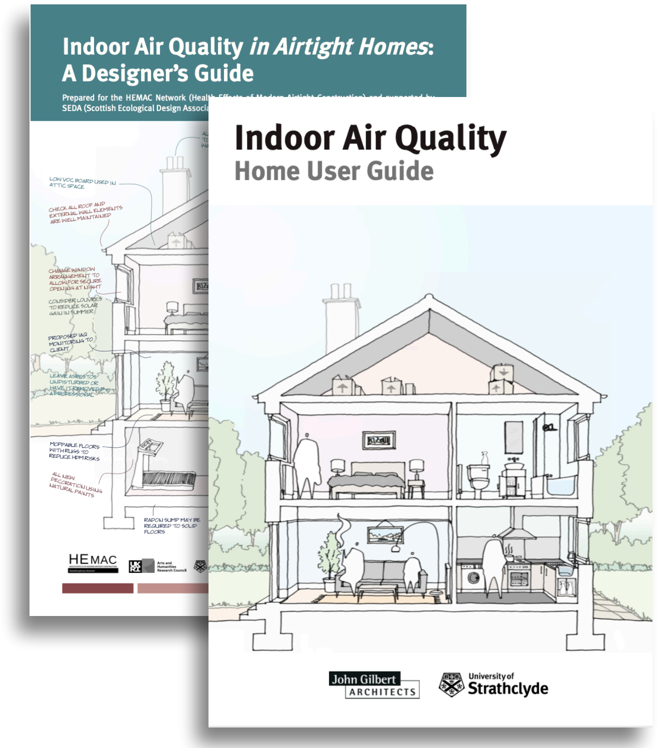



HAB-LAB BPE/ ventilation techniques

John Gilbert ARCHITECTS

5. Conclusions

- Better airtightness leads to fewer draughts, but can also stuffier air / increased health risks (if not designed correctly!)
- Adopt whole house retrofit strategies to ensure good IAQ
- Ventilation strategies should be based on real performance and must be designed specifically for each home, in line with the airtightness strategy
- Specification of user-friendly systems and guidance minimise performance risks
- Home owners can try basic IAQ monitoring at home!
- Hemac IAQ Guide: free guide, provides guidance on:
  - Source Control + Ventilation
  - IAQ Home User Guide & Occupancy Support Checklist (for residents and designers)



Hemac/ IAQ Guide

www.hemacnetwork.com

Thank you!

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