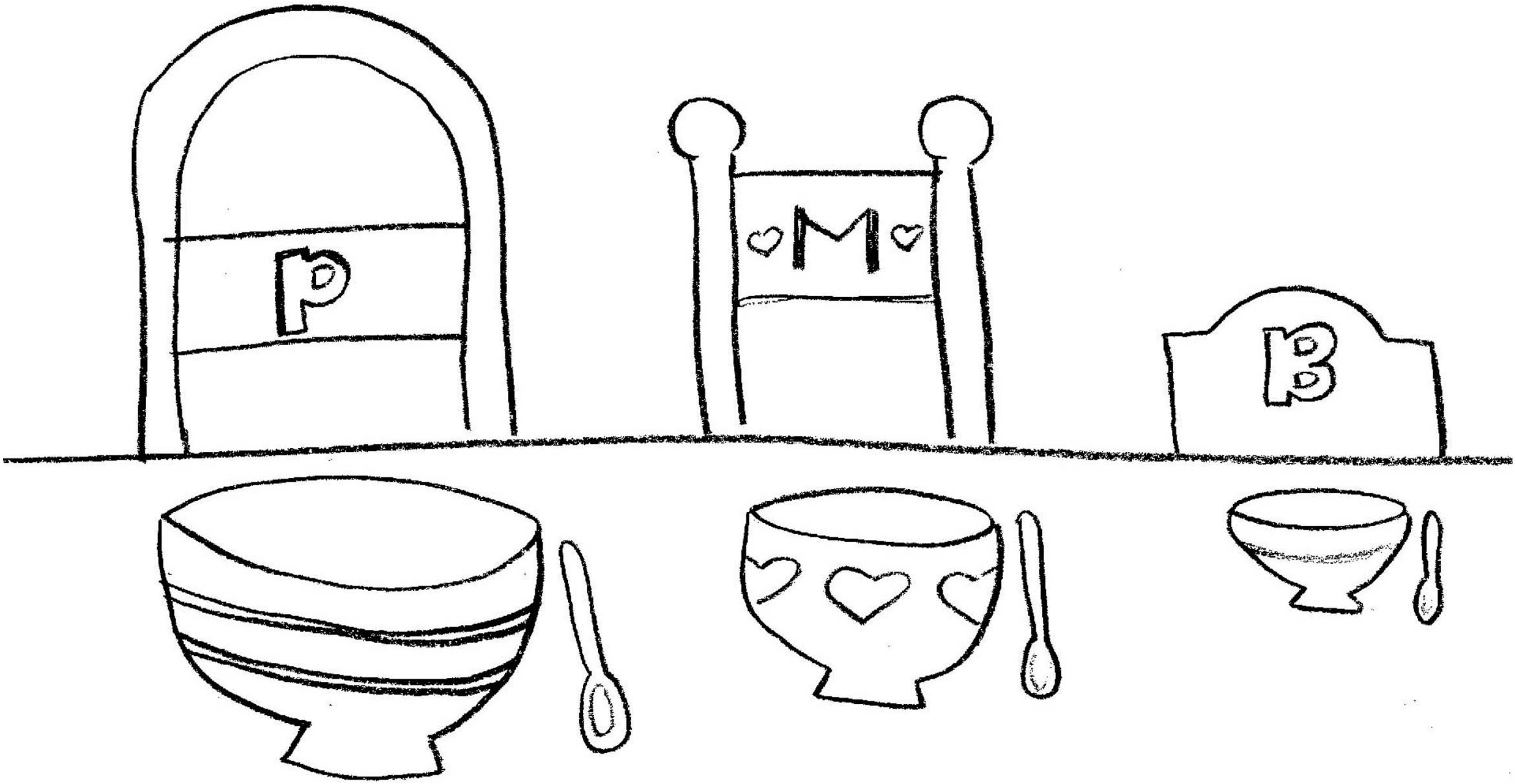
Goldilocks and the art of ventilation

not too much,

not too little but just right

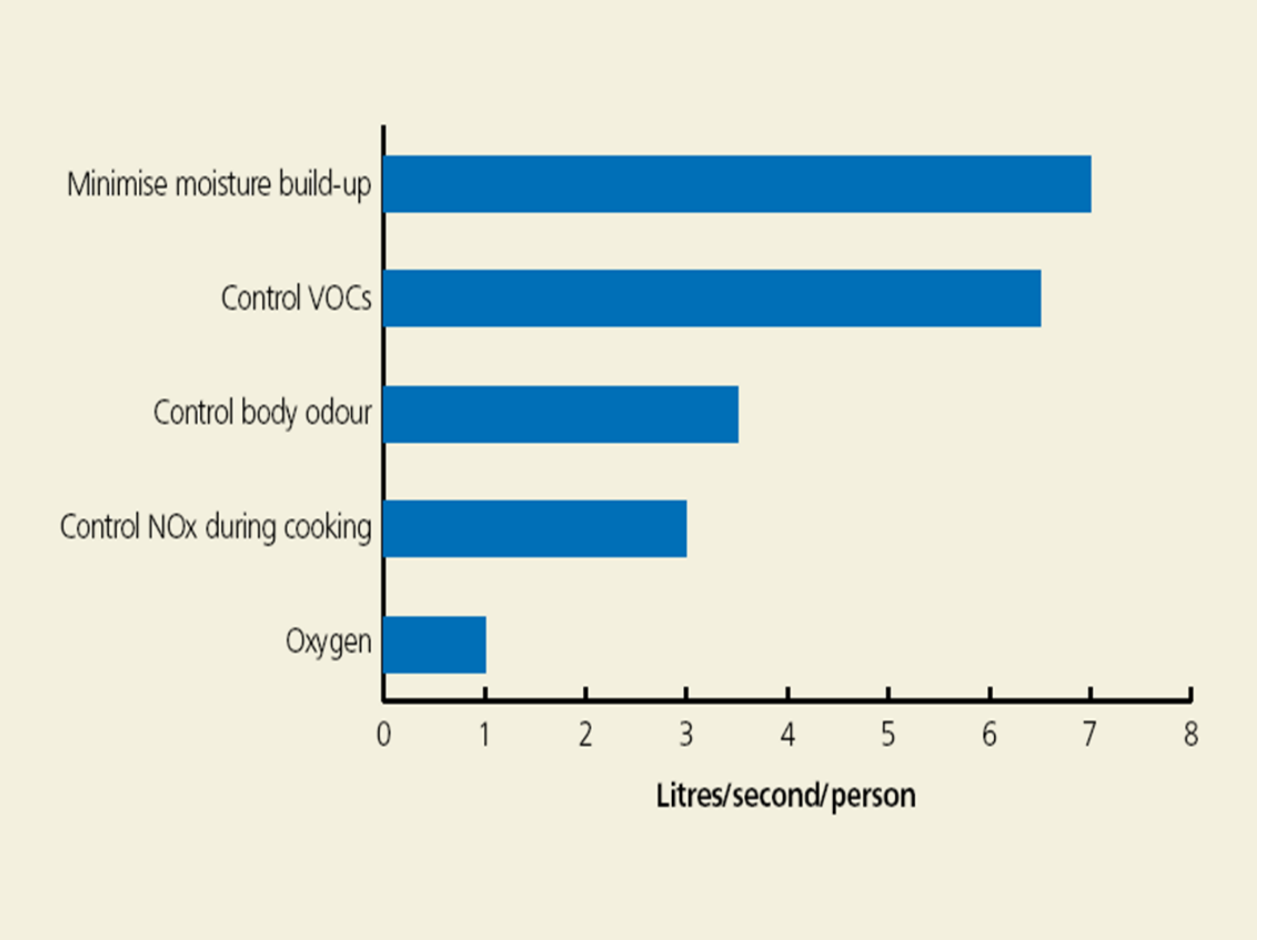
We need ventilation, but how much?



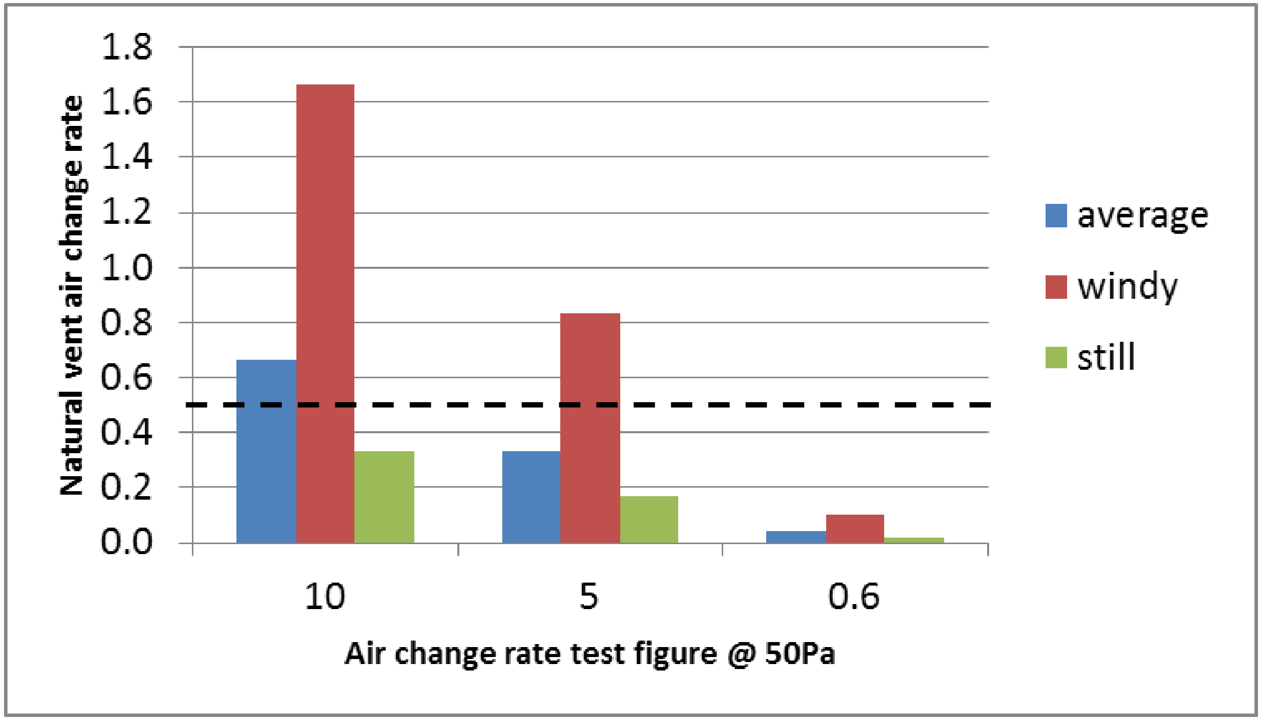
What are we ventilating for?

- **To remove pollutants**
  - Smells
  - Moisture
  - Volatile organic compounds (VOCs)
- **Mostly caused by occupants**
  - Primarily ventilate per person
  - Base level of vent to deal with materials offgassing

Some typical figures



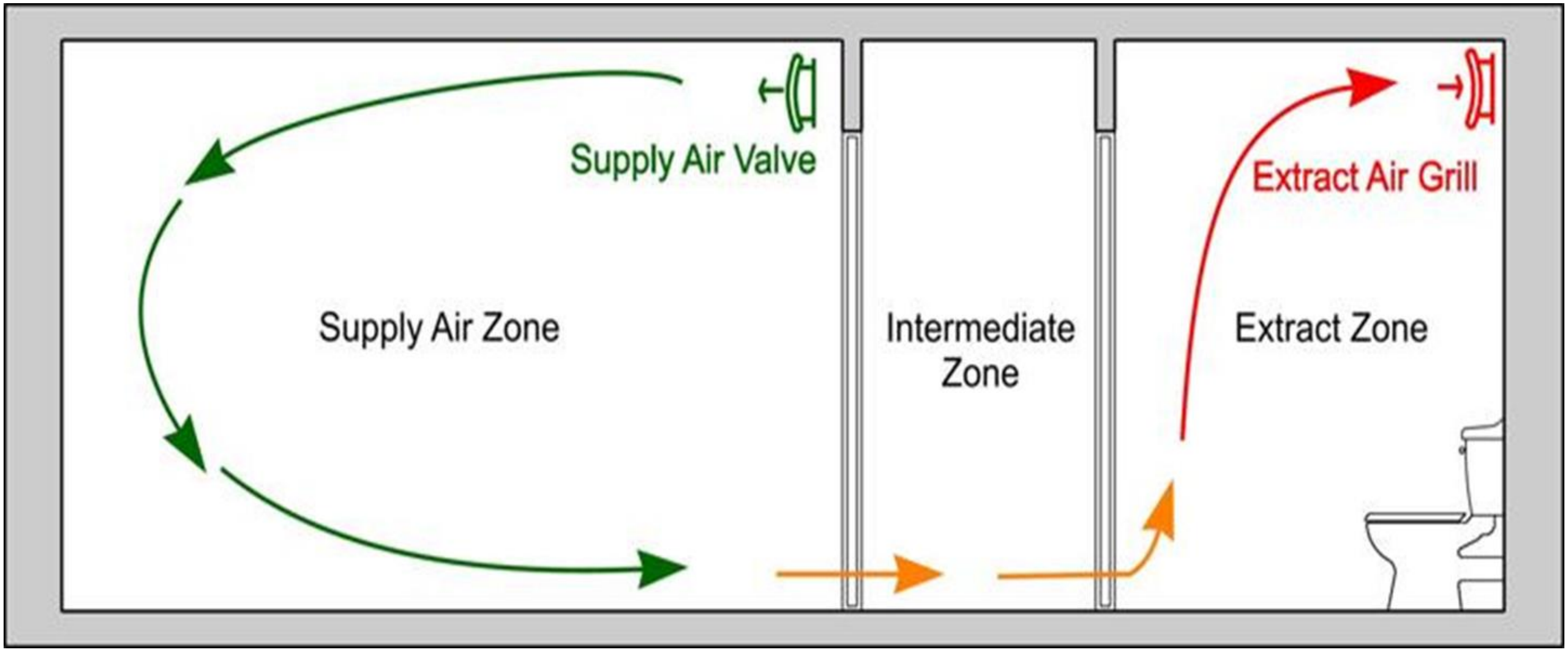
How does natural vent fare?



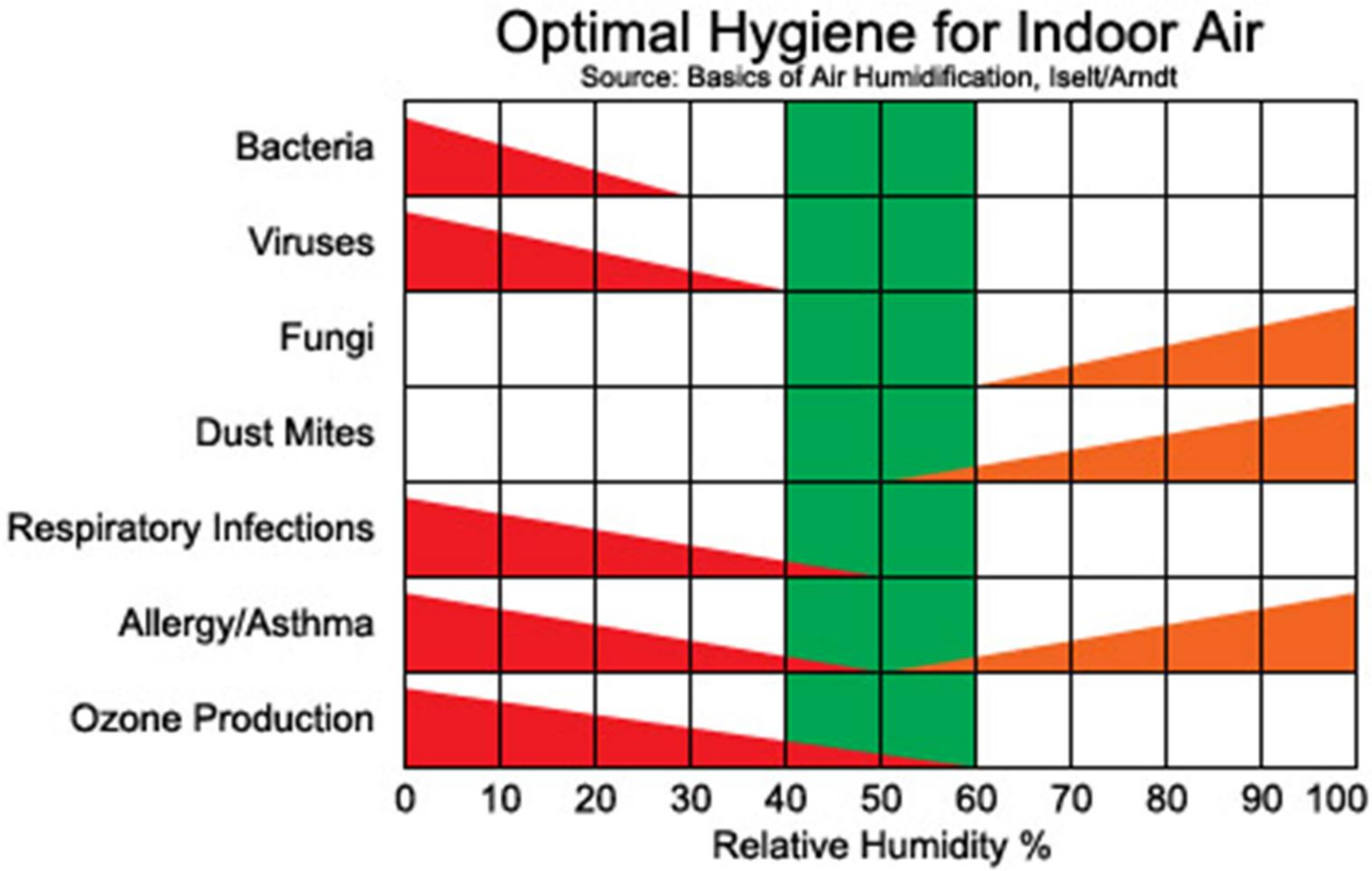
And do air changes = air quality?

"Some of the most air leaky, free-running houses I researched had very poor IAQ, while the tightest, free-running houses were at times doing better." – Kara Rosemeier

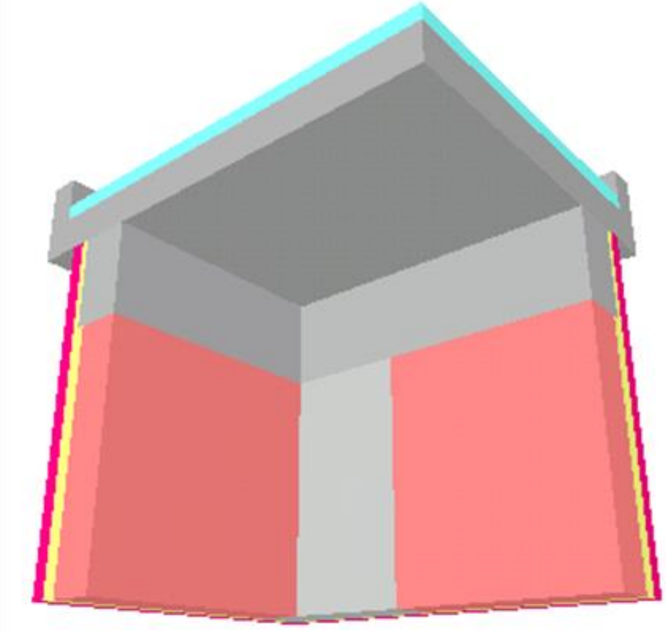
Designed ventilation



Humidity – what is our target?

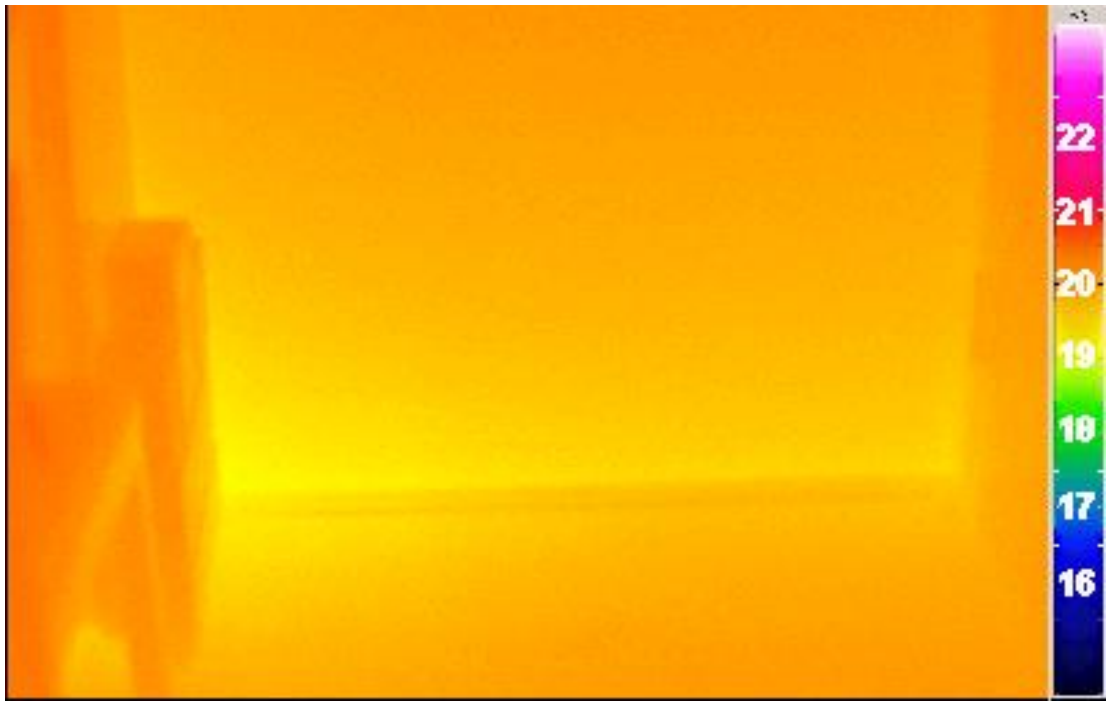


The bad old days



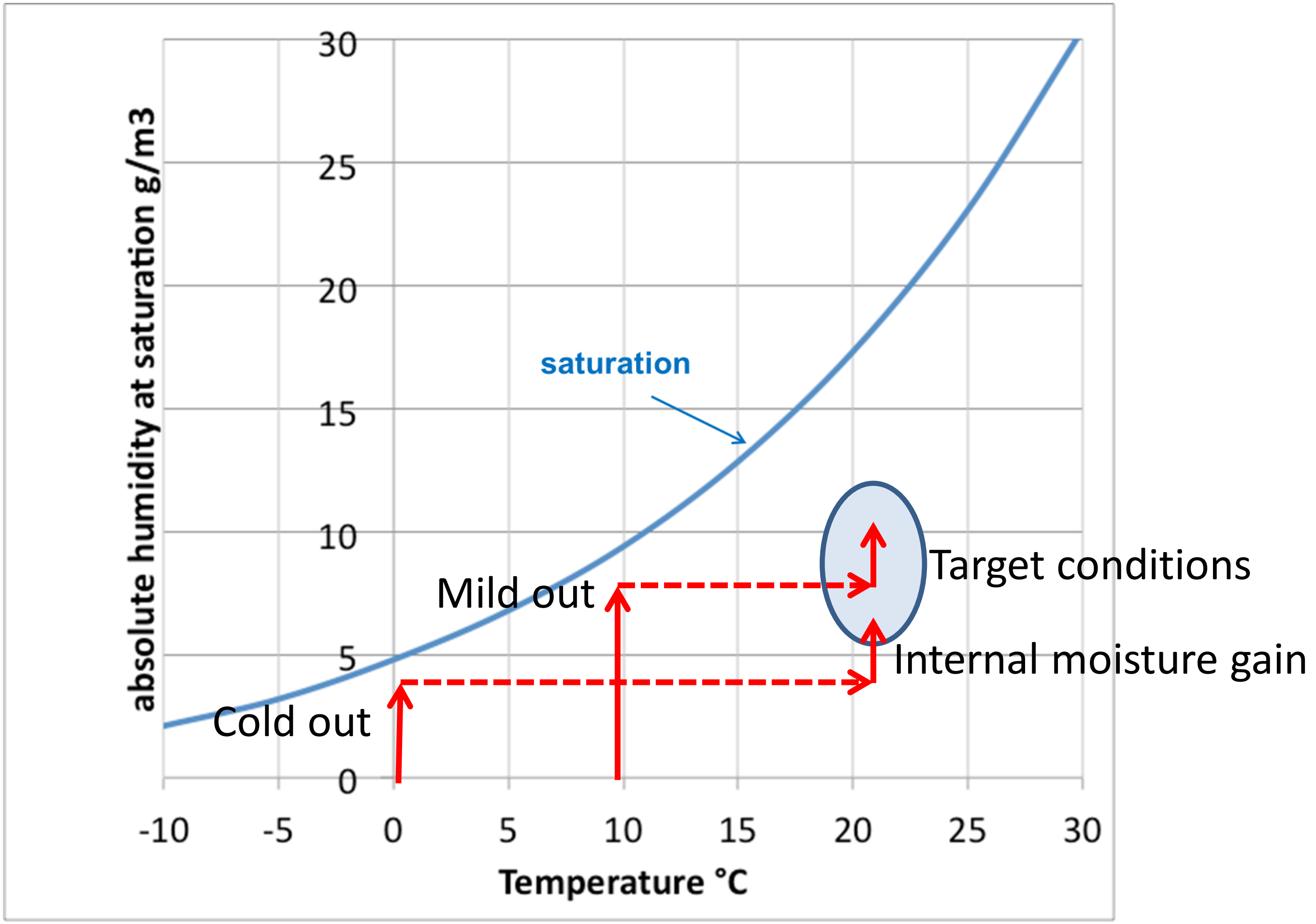
This picture shows a poorly insulated concrete frame
The mould isn’t caused by lack of ventilation, but by cold surfaces

Passivhaus surface temperatures



No chance of condensation here

Psychrometric chart



Relative humidity depends on:

- Internal moisture generation
- External absolute humidity
- Ventilation rate

So ideal ventilation rate is a function of both external and internal conditions

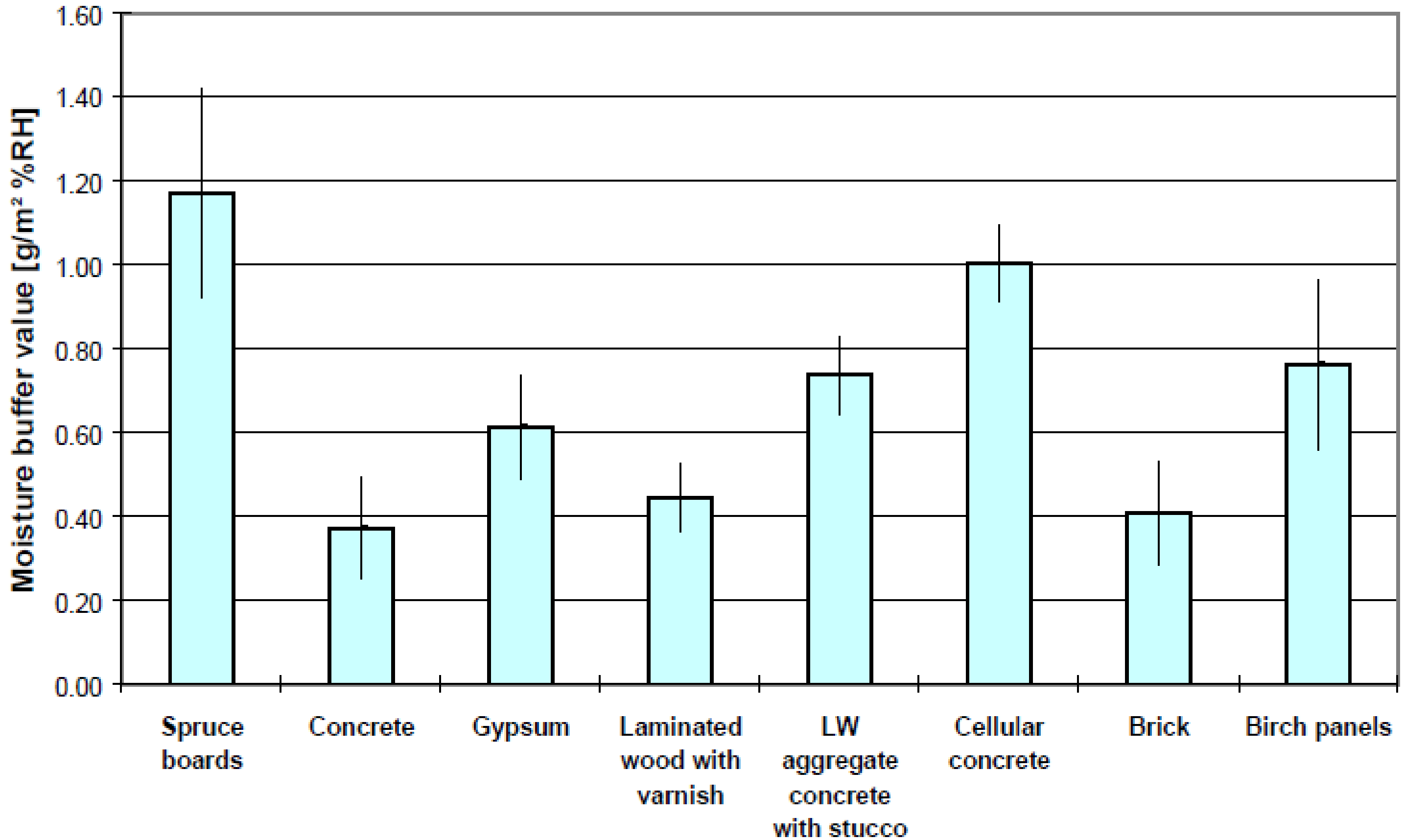
Internal air movement

- Inside a house typical air movement due to natural convection is at least 0.05 m/s
- Slow, but only 200 seconds to go 10m
- In practice water vapour gets mixed through the house
  - It doesn’t wait in the bathroom to be extracted
  - It does find cold surfaces where ever they are

Implications for ventilation

- Whole-house ventilation controls internal moisture levels well
- Intermittent extract fans have limited effect

Moisture buffering



What drives moisture in/out?

- Balance between moisture content and RH%
- Increase RH%, and moisture content increases in balance
- Measured results are for g/m^2 water absorbed/released for 1% change in RH

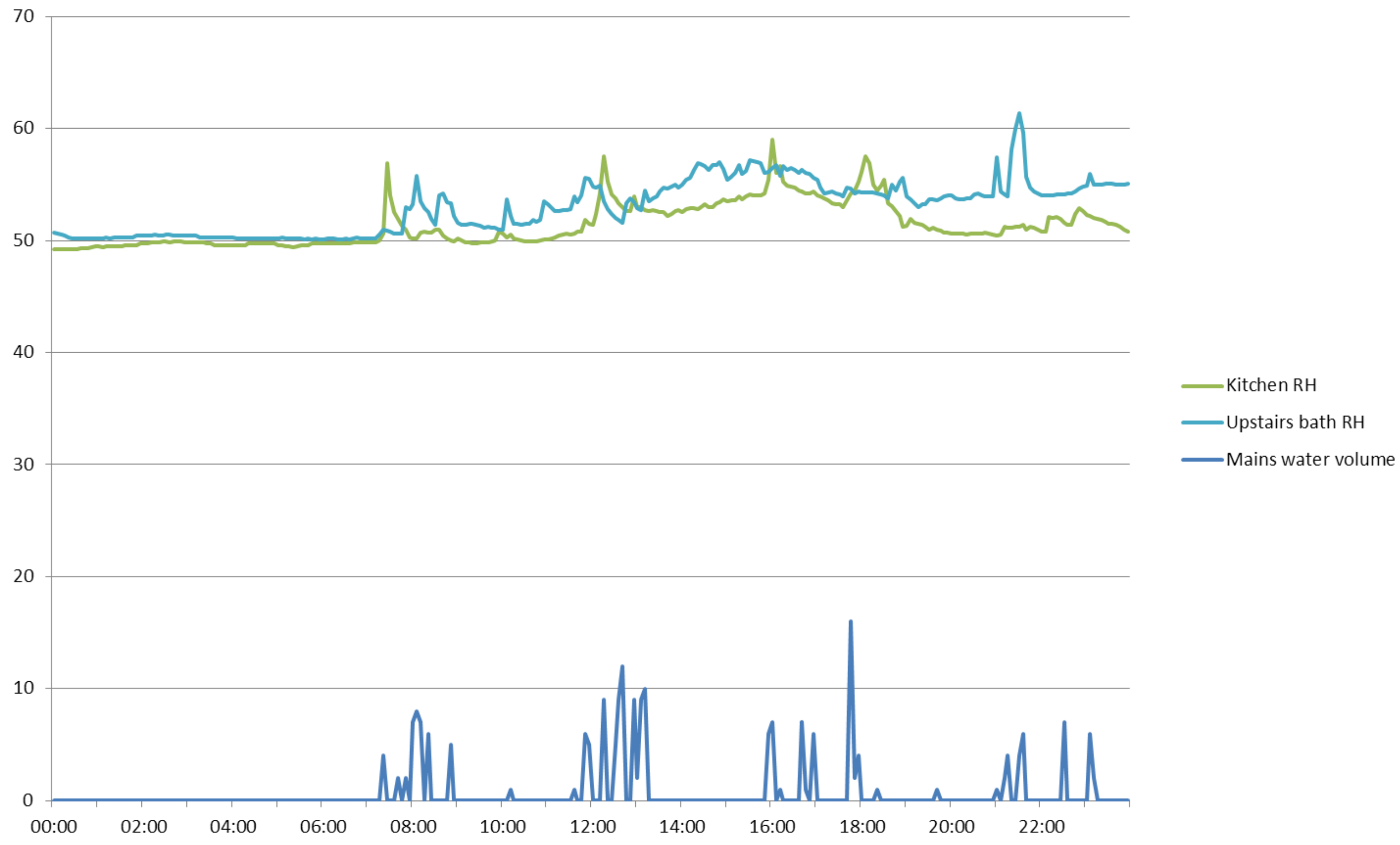
What is the effect?

- Have a shower, release 1.5kg water vapour
- Open shower door
- House has over 500m^2 surface area – floor boards, plaster, furniture, curtains, bedding…
- At 0.5 g/m^2%RH this leads to +5% RH

HVAC calculations too simple

- At low ventilation rates the ventilation engineers assumptions are too conservative
- Moisture buffering reduces peaks in RH%
- When room temp increases, air-fabric moisture balance *increases* air absolute humidity
- When room temp decreases, air-fabric moisture balance *decreases* air absolute humidity

Monitored conditions, constant vent

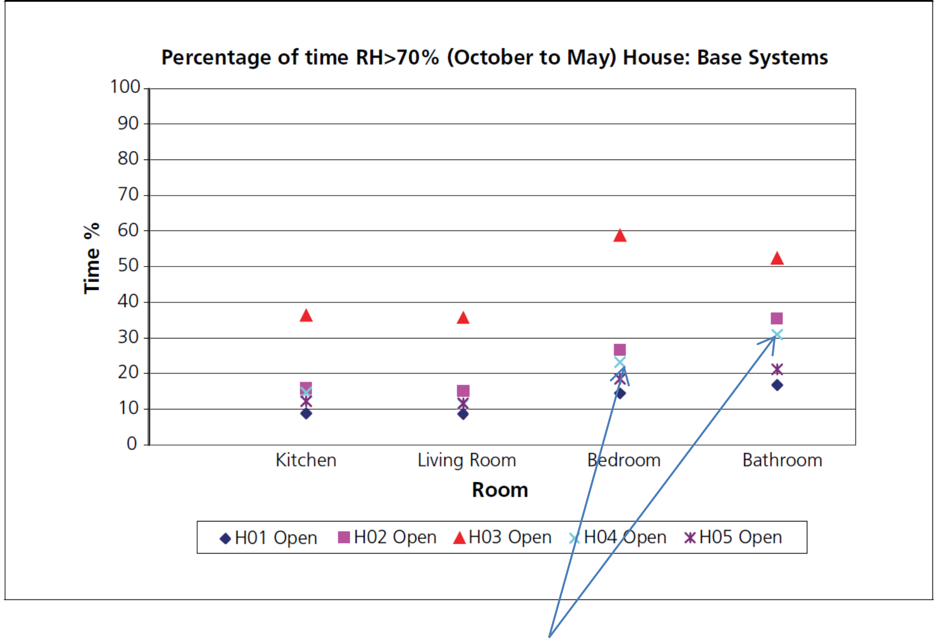


How do theory and reality compare?

The modelling says this (BD2523)

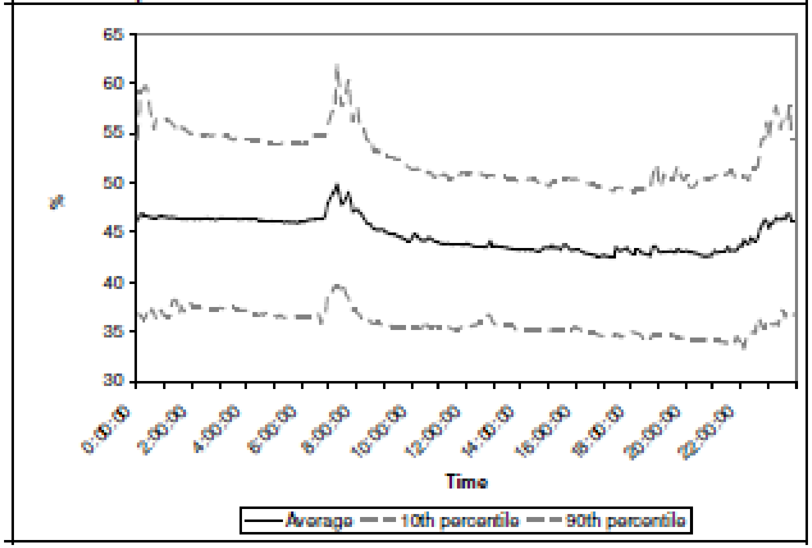
Monitored passivhaus

Figure 10 Percentage of time RH>70% house: base systems

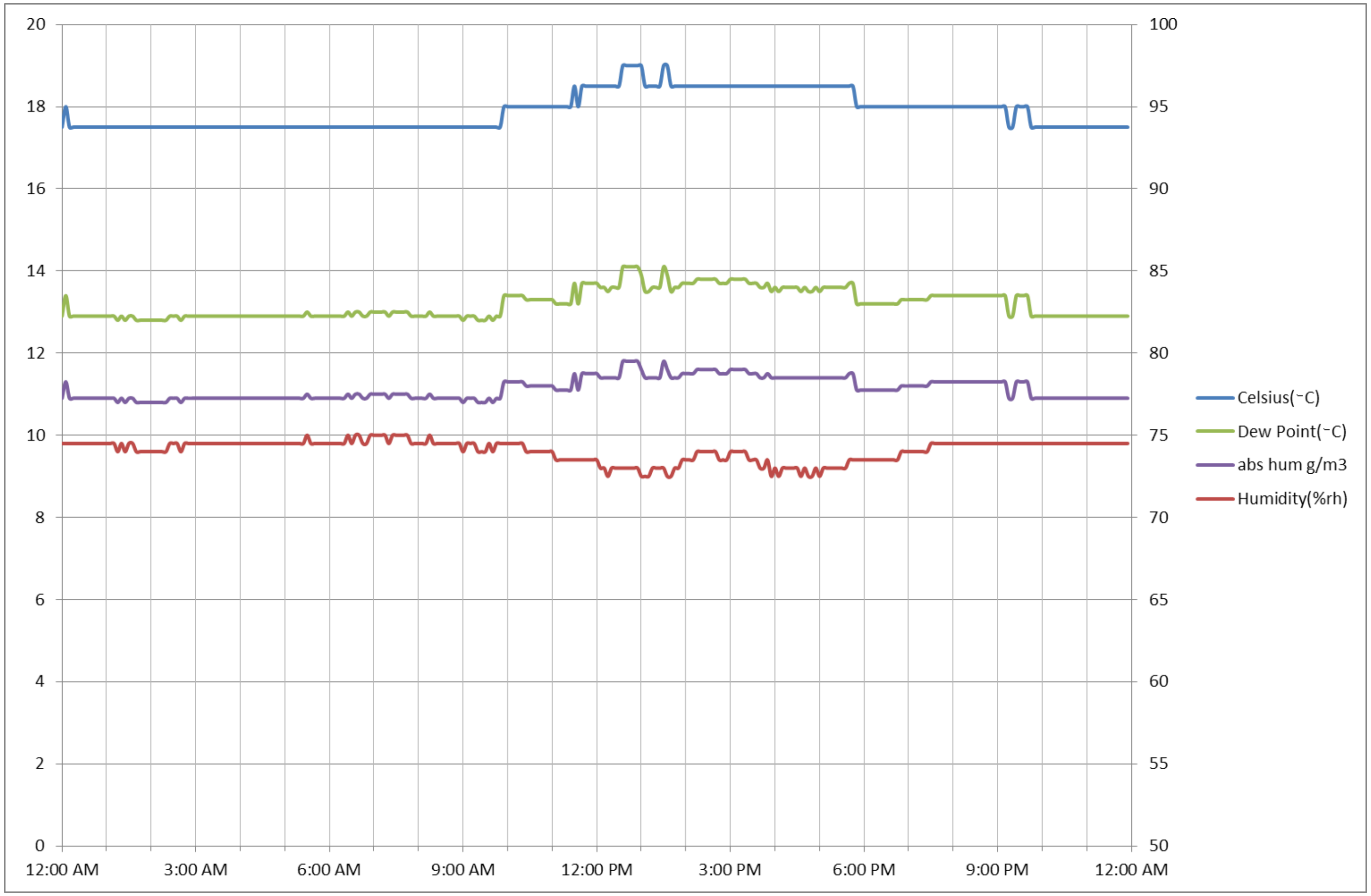


MVHR

Figure 17
Average hourly profile of Bath Room winter relative humidity



No vent, no moisture added:



Conclusions for humidity

- There is Goldilock’s zone for humidity!
- Ideal vent rate depends on moisture generation & on external conditions
- There’s no need to boost for 15mins after a shower – the building will look after itself

Suitable vent strategy for humidity

- Pick an average vent rate to suit number of occupants and lifestyle
- Turn vent down a bit in winter if feeling dry
- Remember to turn back up in spring
- That’s it.

VOCs…what are they?

- Volatile organic compounds
- ie released as gas from solid or liquid
- Typically solvents – in paint, wax, cosmetics, cleaning products, adhesives
- They are bad for you.

Research shows…

- Emission rates are very variable
  - Building materials
  - Repainting
  - Smoking
  - Cosmetics
  - Cleaning products

Part F

- Based on measured levels in naturally ventilated houses
- Indicates 0.3 $l/s/m^2$ is good level of vent
- Part F applies this to total floor area
- MVHR will deliver twice the whole house average of fresh air to occupied rooms
- Nat vent could do anything
- MEV probably delivers just average vent rate

Suggested vent rates for VOC

- MEV – stick with Part F
- MVHR – Passivhaus Institute thinks 0.3 ach is enough – looks like 0.2 $l/s/m^2$
- But occupied rooms typically see 0.6 ach – ie 0.4 $l/s/m^2$

Summertime

The livin' is easy…

- How about the ventilation?

What’s good about summer nat vent?

- No electricity needed
- Can get 5 air changes per hour with windows
- Night vent is temperature driven
  - more heat = more vent

Not so good:

- Security
- Noise
- Insects!

And mechanical vent

- Secure
- Automatic

But snags are:

- Low vent rate – 0.5 air changes per hour
- Summer bypass control algorithm
  - Doesn't do night cooling very well

Summer conclusion

- Use both if you can
  - Natural night vent to dump excess heat
  - Consider insect screens & secure shutters
  - Automatic bypass in daytime to either keep coolth in or bring in cooler air, to suit the conditions.

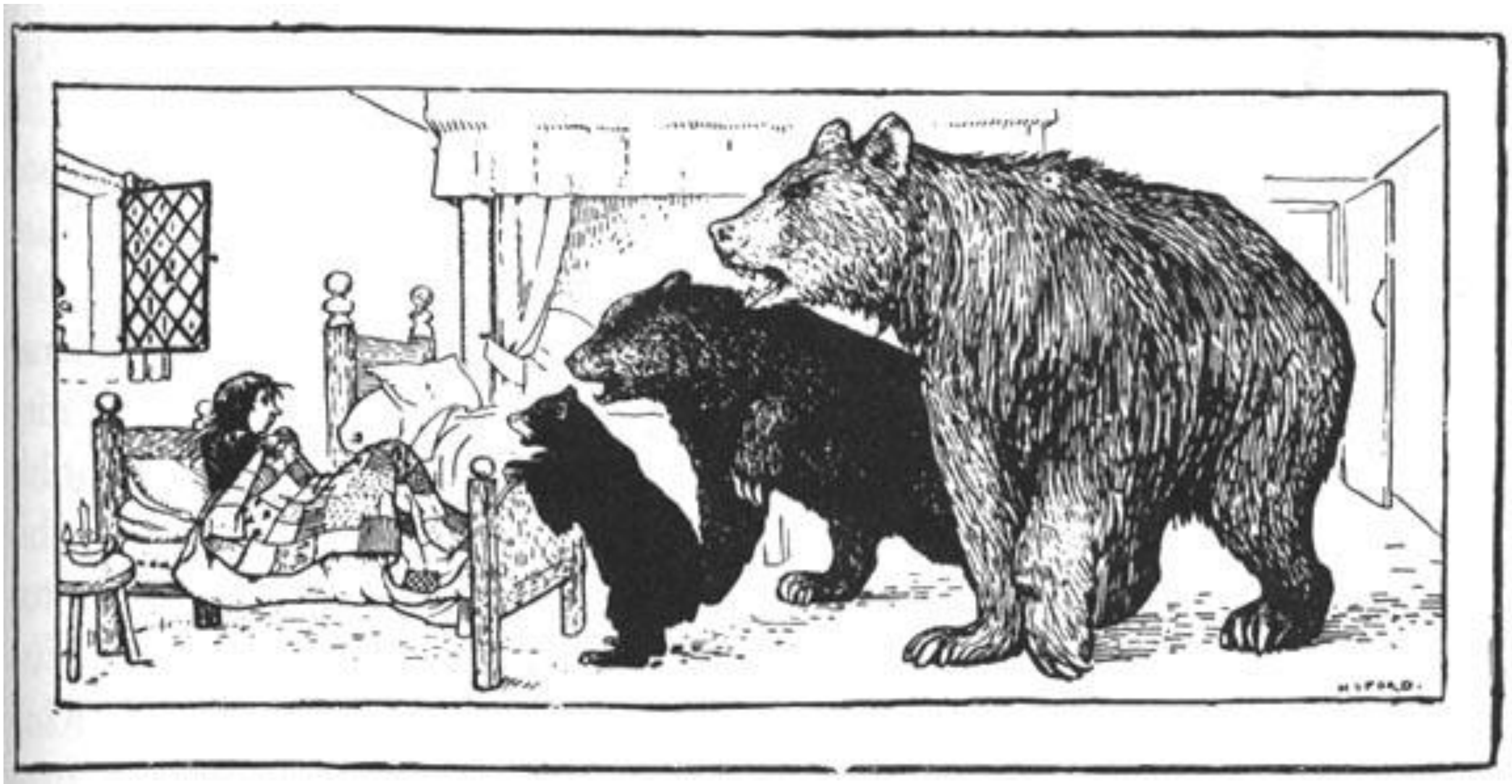
Health

Reports from Passivhaus social housing residents

- Asthma improved
- Comfortable without being stuffy
- No need to clean the house any more!

Conclusions

- Continuous ventilation is good
- Supply direct to living and sleeping rooms
- Close control not that important
- Need to adjust vent rate to suit occupancy and season
- Design for acceptable summer vent in mixed mode – mechanical + natural vent together



…Goldilocks jumped off the bed and ran to the window and climbed out