UK Passivhaus Conference, Tuesday 15th October 2013

User Friendly Design

Justin Bere of **bere:architects** twitter: @jbere & @bere:architects | www.bere.co.uk

PRESENTATION INCLUDES CONTENT FUNDED BY THE TECHNOLOGY STRATEGY BOARD'S BUILDING PERFORMANCE EVALUATION PROGRAMME http://goo.gl/ny5vG

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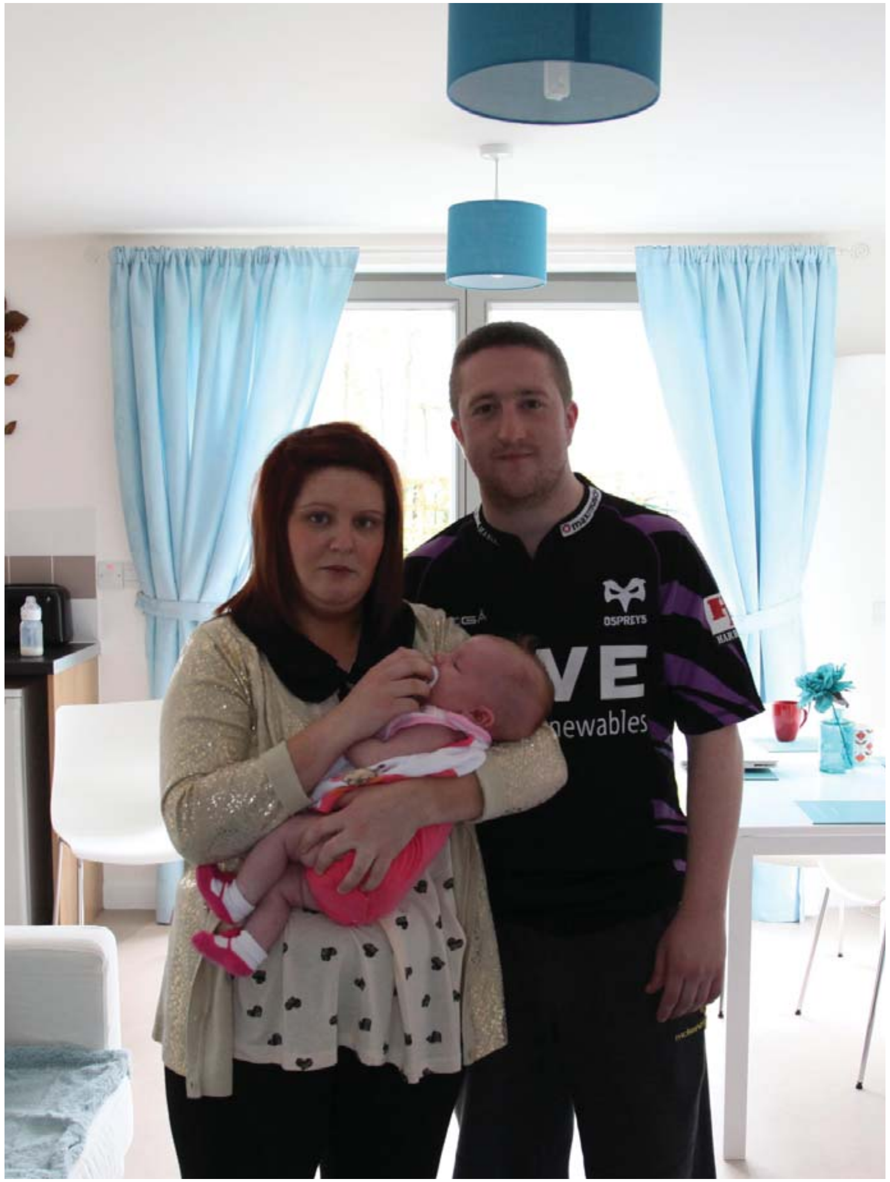
User-friendly design: Learning from Building Performance Evaluation

Question:

What did we learn from the feedback about the architectural design, services design and controls strategy for each project?

Question:

Having studied the buildings in use, and learnt more about occupant preferences, what is our current thinking about the best strategies for users of different kinds of domestic and non-domestic buildings



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User-friendly design: Ranulf Road House

Feature:

Large, south facing windows with retractable external shading

Critique:

- **Occupants leave external blinds at ground level closed all year round (privacy concern - garden wall omitted) and also internal blinds to first floor.**
- **However, surprisingly, specific heat load is as predicted and occupants enjoy coming home to high summer temperatures; throwing open living room doors for the evening, while south bedroom is cooler due to use of external blinds.**

Lesson learnt:

- **Design surprisingly robust against unexpected patterns of use.**

User-friendly design: Ranulf Road House

Feature:

Heat recovery ventilation

Critique:

- **Excellent indoor humidity & CO_2 levels maintained throughout year.**
- **Installing ventilation unit ouside the thermal envelope works well.**
- **Boost buttons outside bathrooms are liked but not much used or needed**
- **No measured pressure loss in spite of dirty appearance of filters after 6 months use**

Lesson learnt:

- **Occupants love the indoor air quality**
- **Well commisioned system is robust**

Pre-filter after 6 months

Main filter after 6 months

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User-friendly design: Ranulf Road House

Feature:

Heat recovery ventilation

Critique:

- **Air quality testing found low indoor levels of VOCs.**
- **Air quality testing found low indoor levels of particulates - 4 times better than parents conventional house when comparing bedrooms, 3 times better when comparing living rooms.**
- **Indoor particulates count found to be 3 times lower than external count on day of testing**

Lesson learnt:

- **Some evidence that heat recovery ventilation improves indoor air quality**


Pre-filter after 6 months


Main filter after 6 months

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User-friendly design: Ranulf Road House

Feature:

Heat recovery ventilation

Critique:

- Leaving ventilation switched off (air tester error) for 22 days resulted in 9 short CO_2 spikes of approx 5000ppm

Lesson learnt:

- Failure of ventilation is not a serious health risk, but fitting an obvious warning light might be a good idea?

1000ppm - 0.1% - Prolonged exposure can affect powers of concentration

5000 ppm - 0.5% - The normal international Safety Limit (HSE, OSHA)

10,000ppm - 1% - Your rate of breathing increases very slightly but you probably will not notice it.

15,000ppm - 1.5% - The normal Short Term Exposure Limit (HSE, OSHA)

20,000ppm - 2% - You start to breathe at about 50% above your normal rate. If you are exposed to this level over several hours you may feel tired and get a headache.

30,000ppm - 3% - You will be breathing at twice your normal rate. You may feel a bit dizzy at times, your heart rate and blood pressure increase and headaches are more frequent. Even your hearing can be impaired.

40,000-50,000ppm - 4-5% - Now the effects of CO_2 really start to take over. Breathing is much faster - about four times the normal rate and after only 30 minutes exposure to this level you will show signs of poisoning and feel a choking sensation.

50,000-100,000ppm - 5-10% - You will start to smell carbon dioxide, a pungent but stimulating smell like fresh, carbonated water. You will become tired quickly with laboured breathing, headaches, tinnitus as well as impaired vision. You are likely to become confused in a few minutes, followed by unconsciousness.

100,000ppm-1,000,000ppm - 10-100% - Unconsciousness occurs more quickly, the higher the concentration. The longer the exposure and the higher the level of carbon dioxide, the quicker suffocation occurs.

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User-friendly design: Ranulf Road House

Feature:

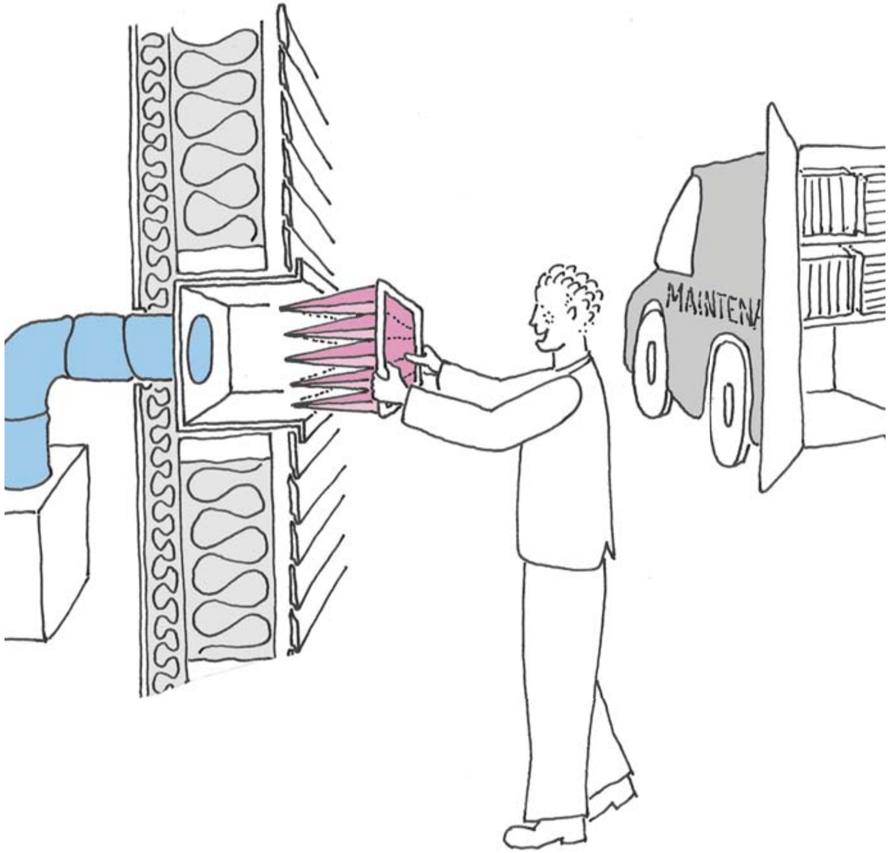
Long-life ventilation filter

Critique:

- **Deep bag filters require changing less often than standard filters**
- **Installing a pre-filter with easy access from outside would enable maintenance to be carried out at longer intervals under a maintenance contract, without the need for an appointment**

Lesson learnt:

- **The installed prototype has minimal capital cost and reduces annual maintenance costs. It could be developed as a standard product for a larger housing project.**



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User-friendly design: Ranulf Road House

Feature:

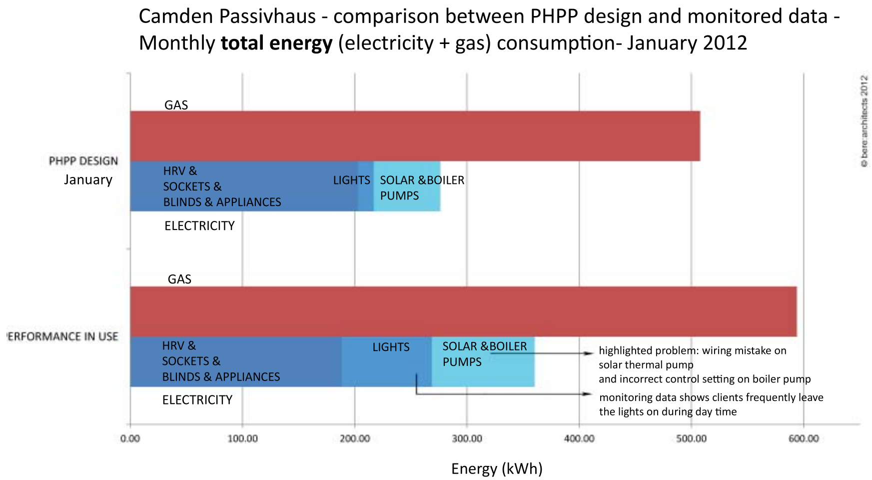
Heat supply (via ventilation)

Critique:

- **Low heat demand matches design**
- **Weather compensation feature not required. When changing the manufacturer's standard controller, manufacturer forgot that controller for UK export was specially adapted and the plumber also made a wiring mistake that left the solar pump running continuously.**

Lesson learnt:

- **Use product manufacturer's standard controls -no changes!**
- **Commissioning checks should include early performance analysis of submetering**



DATA MONITORING PICKED UP A WIRING ERROR

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User-friendly design: Larch House

Feature:

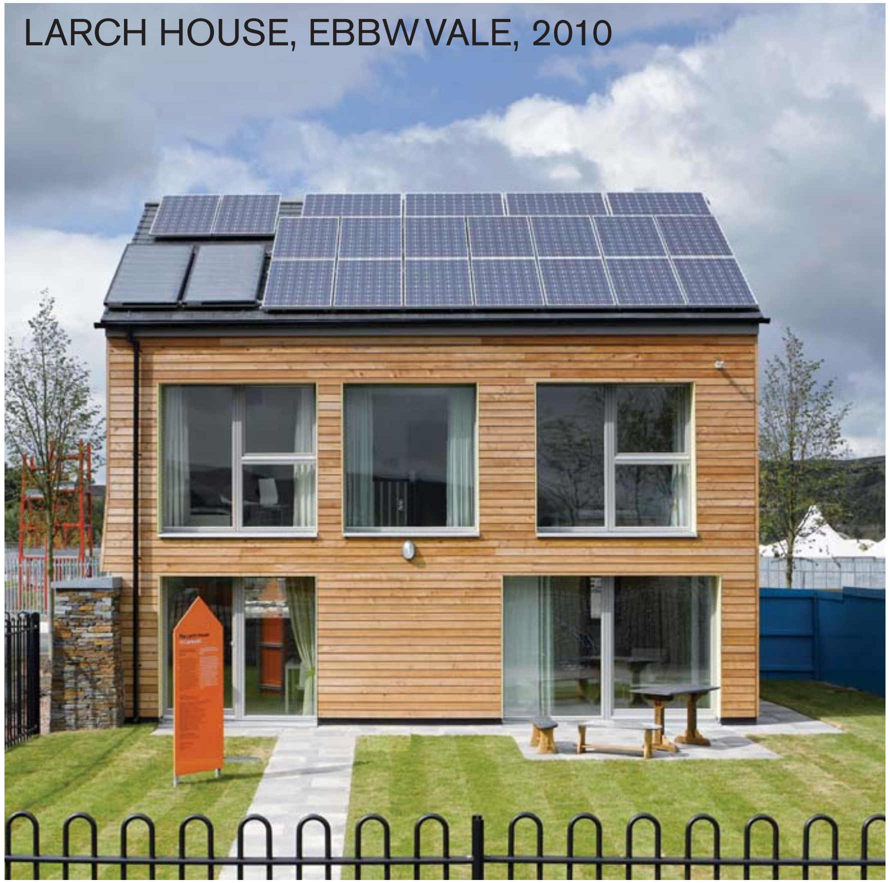
Large, south facing windows with retractable external shading

Critique:

- **Occupants don't use the blinds to their best advantage.**
- **Children afraid of spiders so don't open windows at night in summer to benefit from purge cooling.**
- **Large windows nevertheless loved by occupants**

Lesson learnt:

- **Good results from Lime House (smaller windows) suggest smaller windows are more robust as well as cheaper to buy and install.**



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User-friendly design: Larch House

Feature:

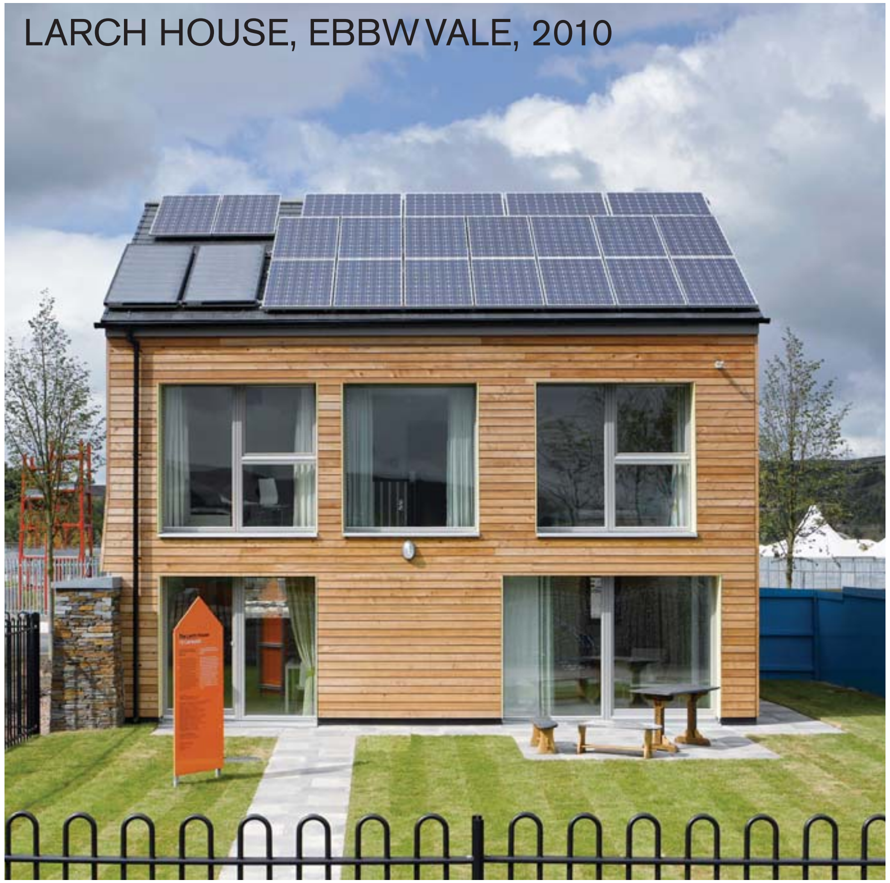
- Heat recovery ventilation

Critique:

- Excellent indoor humidity & CO_2 levels throughout year
- Children afraid of spiders so don't open windows at night in summer to benefit from purge cooling.
- Large windows nevertheless loved by occupants

Lesson learnt:

- Good results from Lime House (smaller windows) suggest smaller windows are more robust as well as cheaper to buy and install.



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User-friendly design: Larch House

Feature:

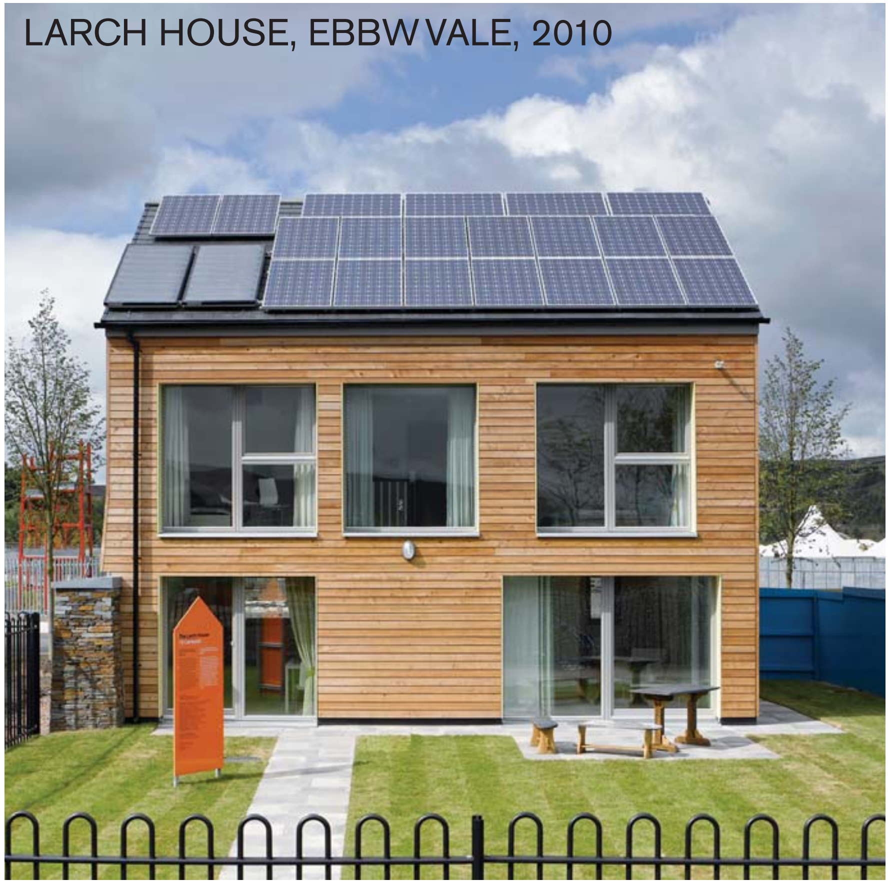
Heat supply (via ventilation)

Critique:

- **Low heat demand matches design**
- **Air heater battery supplied directly by the boiler - so some risk of cycling if boiler is not programmed carefully**

Lesson learnt:

- **Lime House was built after Larch House and it was decided to warm the heater battery from the dhw tank which provides a better buffer and reduces the risk of cycling from poor commissioning of the system**



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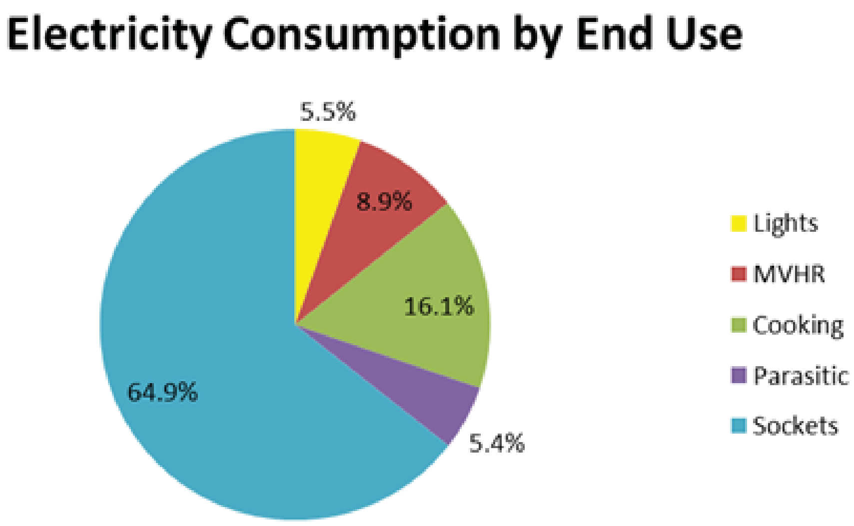
User-friendly design: Larch House

Feature:

Electricity consumption

Critique:

- Much higher plug socket loads than predicted (almost 3000kWh/yr out of total of 4500kWh/yr = 3x space heat) due to large plasma tv, tvs in each bedroom, more occupant light fittings and gadgets than expected, significantly higher cooking each afternoon and early evening than current UK household benchmarks.



Lesson learnt:

- More energy efficient cooker hob would be advantageous where family cooking is a feature.
- Users seem surprisingly disinterested or unable to reduce electrical socket loads

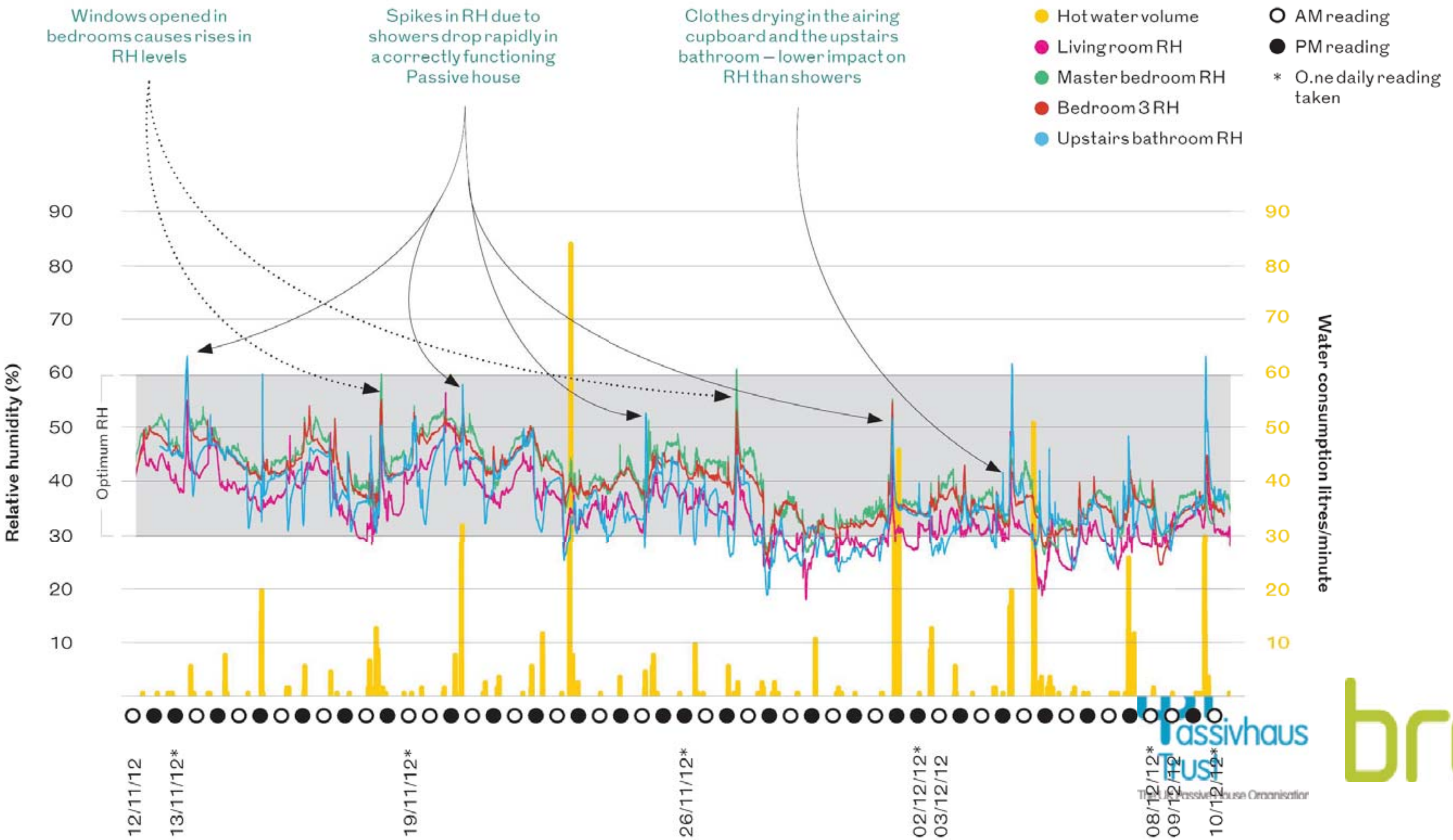
User-friendly design: Larch House

Feature:

- Moisture and clothes drying

Lesson learnt:

- This is not an issue in a PH



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User-friendly design: Lime House

Feature:

Standard size, south facing windows with no need for external shading

Critique:

- **Less risk of summer overheating than Larch House because occupants don't have to learn any new techniques.**

Lesson learnt:

- **Good summer results from Lime House suggest standard sized windows require less occupant interaction and are therefore more robust in use, as well as cheaper to buy, install and maintain.**
- **Standard sized windows seems to be the best approach for social housing**


LIME HOUSE, EBBW VALE, 2010

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User-friendly design: Lime House

Feature:

Heat recovery ventilation

Critique:

- **Occupants love the boost button in living room- it seems to give them a feeling of control, and risk of error is minimal because it defaults to standard running after a fixed period.**
- **Excellent indoor humidity & CO_2 levels in spite of young baby and constant clothes drying**

Lesson learnt:

- **Well designed and commissioned heat recovery ventilation seems robust, low maintenance, easily understood and liked by users.**
- **Surprising how dirty the rural air is.**

⑤ Ventilation boost switch

Press this rocker switch to give a ventilation boost of 15 minutes during a long period of showering or intensive cooking. The boost feature speeds up the fan of the heat recovery system to extract air more rapidly. These are located outside bathrooms and in the kitchen area.

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User-friendly design: Lime House

Feature:

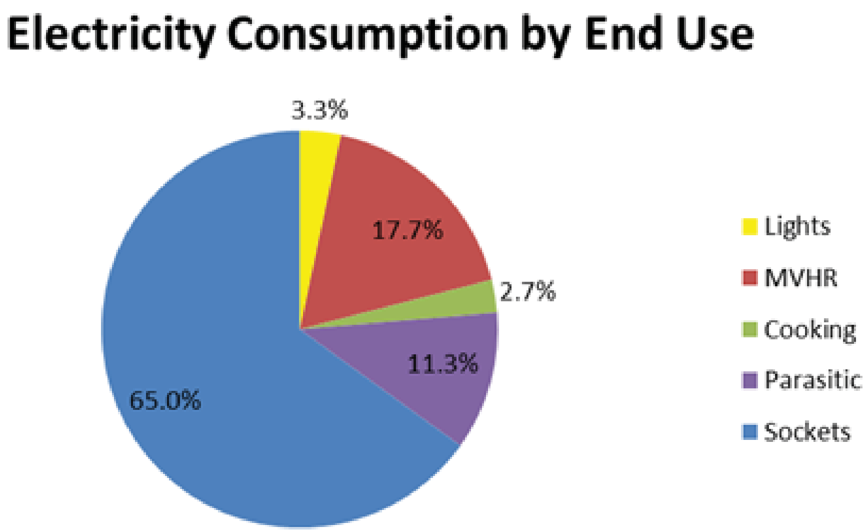
Electricity consumption

Critique:

- Again much higher plug socket loads than predicted due to boiling of water and electrical drying rack for baby's nappy washing.
- Internal gains from electricity 3x higher than predicted, 6W/m2 as opposed to design of 2W/m2. In total 2883kWh electricity is used per year, almost 3 times the design load.

Lesson learnt:

- Cheap imported electrical gadgets, kettle boiling and baby nappy drying are all risk factors for increased home electrical usage.



User-friendly design: Lime House

Feature:

Hot water consumption

Critique:

- Solar thermal heating is still not working at all after a year of occupancy.
- It is possible that 1000kWh of gas and 190kg of CO_2 emissions could be saved annually if the solar thermal system was installed correctly. This is equivalent to the designed annual space heating load for the house!

Lesson learnt:

- Domestic hot water usage is more significant than space heating in a PH. Therefore great care should be taken to employ reputable solar thermal installers.

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User-friendly design: Lime House

Feature:

Heat supply (via ventilation)

Critique:

- **The occupants like to open windows in master bedroom even in the winter months. They do this at night and also sometimes during the day**
- **This practice doubles the heat demand of the building. It is possible that 1000kWh of gas and 190kg of CO2 emissions could be saved annually by keeping windows closed in the winter.**

Lesson learnt:

- **We are trying to get agreement from United Welsh to try out a programmable thermostat that will turn back the temperature at night as this would provide cooler fresh air.**
- **Although winter window-opening is frustrating, the occupants are pleased by their low energy bills and it should be recognised that this remains a very low energy house.**

User-friendly design: Mayville Community Centre

Feature:

Large, south facing windows with retractable external shading

Critique:

- Occupants are slowly learning to use the blinds, lowering them before they get too hot.
- Rain sensors on rooflights were not working until the end of the summer, so night purge cooling could not operate. This contributed to some overheating during the summer.

Lesson learnt:

- People seem less forgiving of summer overheating than high winter fuel bills and CO2 emissions!
- Summer vents, where manual, get left open in winter -automate?

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User-friendly design: Mayville Community Centre

Feature:

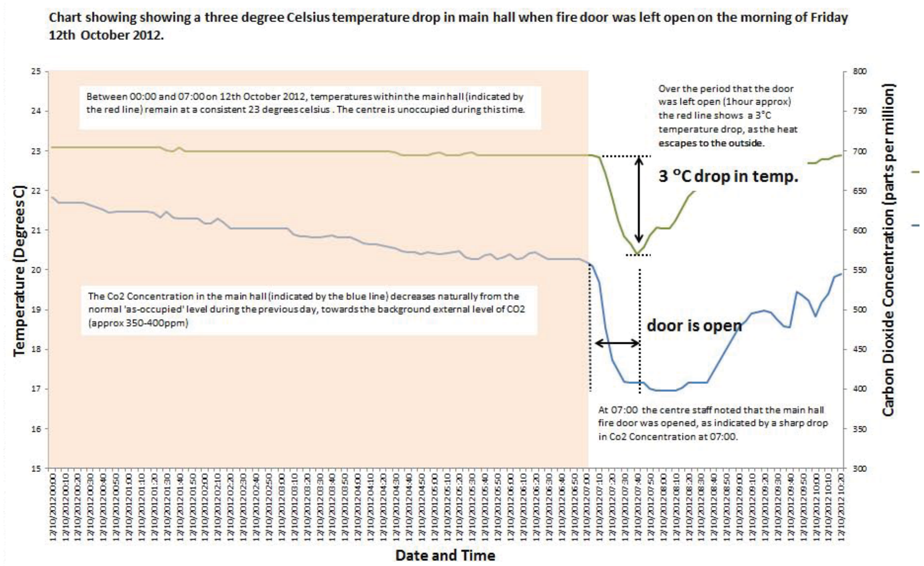
Heat recovery ventilation

Critique:

- Designed to 'ventilate the people' as opposed to 'ventilate the building'. ie ventilation operates only during normal hours of occupancy.
- CO2 sensors boost the air supply in main hall and dining area by means of volume control valves, at times of high occupancy.

Lesson learnt:

- Override switch needed to extend operation of ventilation for late party use - now fitted as an after thought.
- Summer /winter switch should really be automated as would be forgotten if we were not tenants of building.



User-friendly design: Mayville Community Centre

Feature:

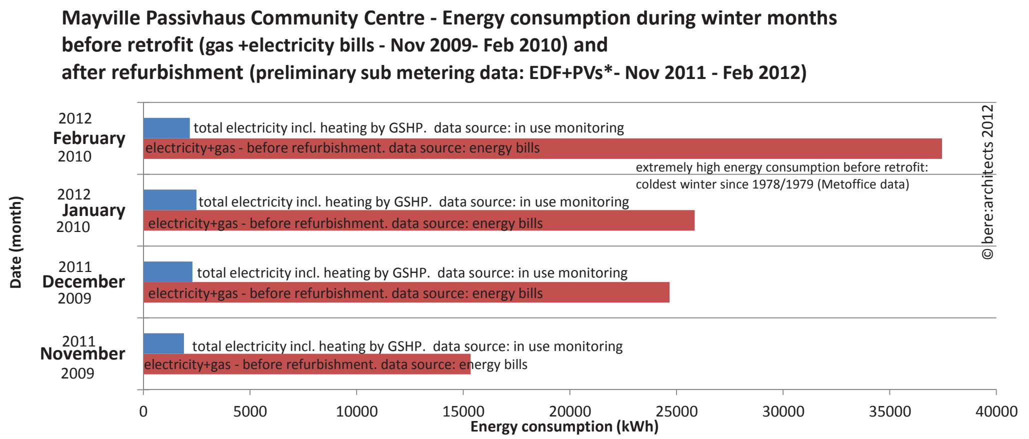
Heat supply (via radiators & GSHP)

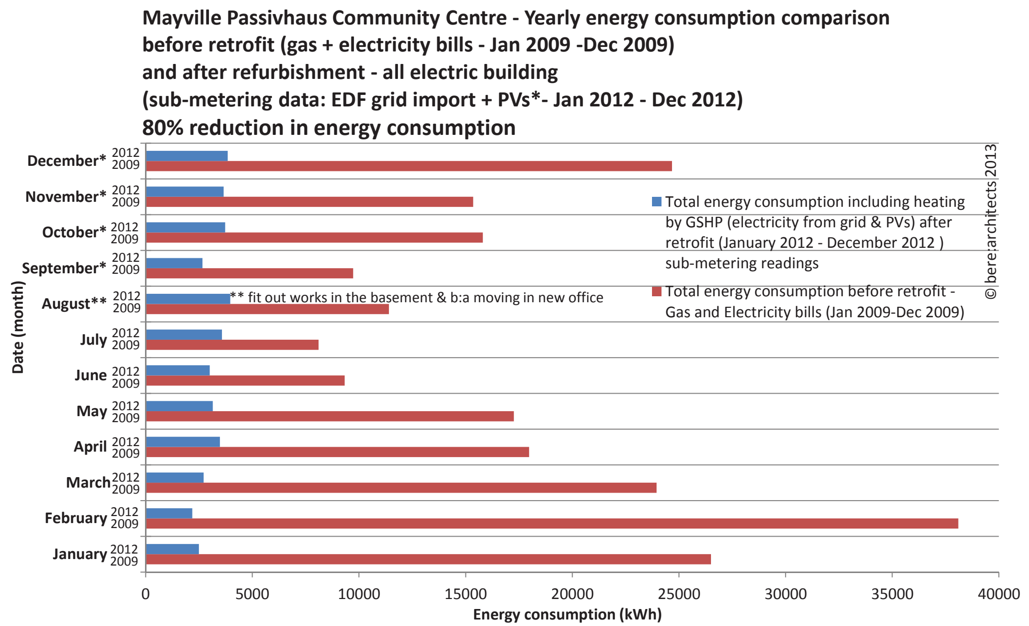
Critique:

- Extraordinarily low heat demand (2.6kWh/m2/yr) due to very high socket loads
- GSHP feeds buffer tank for maximum efficiency at 40 degrees.

Lesson learnt:

- If some people are aware that a radiator is cold in winter this feels wrong to them, even if the air temperatures are comfortable!
- Our basement offices have no radiators at all. Lowest temperature on coldest Monday morning in winter was 19.75 degrees!





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User-friendly design: Mayville Community Centre

Feature:

Controls generally

Critique:

- **No Building Management System!**
- **Designed to run on domestic room thermostats and time controllers for ease of maintenance.**
- **Lighting manual on, manual off, with presence detectors.**

Lesson learnt:

- **Simplicity of controls is generally a success, although thermostat should perhaps be less accessible as some people want to turn it up when radiators are cool, while others want to turn it down!**

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User-friendly design: Conclusions

- **Simplicity needs to be defined:**

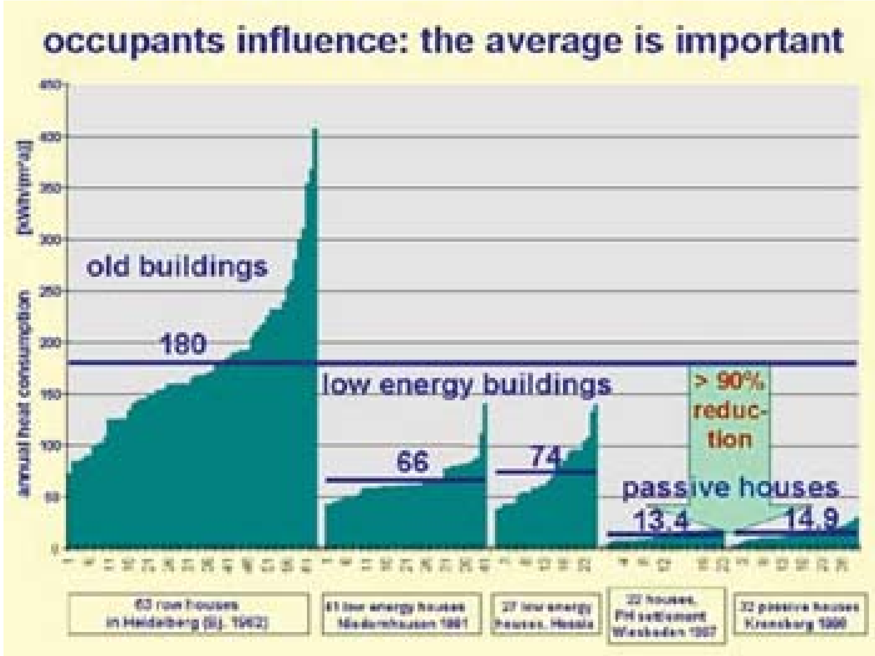
  Simple controls? **Uncomplicated, standard manufacturer's equipment helps usability and maintenance.**

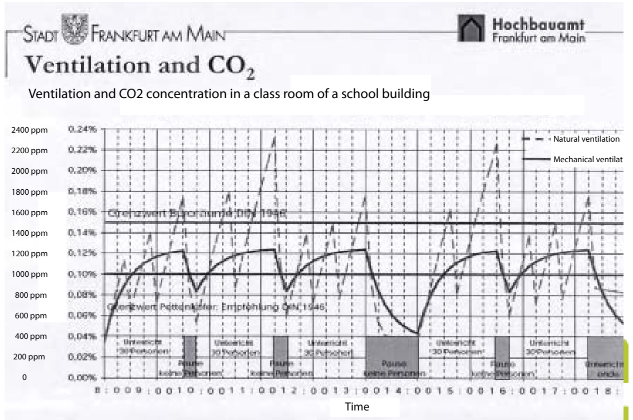
  Simple user experience? **Simple automation may bring further improvements in the future.**

- **PH systems seem very robust.**

- **Unregulated electrical energy use from plug-in appliances remains a problem in PH as it does in ordinary buildings. It's just more obvious in a PH where everything else is reduced.**

- **Increased energy use does result from unsympathetic usage, but even if energy use were double the design, a PH would remain an exceptionally low energy user and offers exceptionally high occupant comfort at the same time.**





Graph compares CO2 concentration in a mechanically ventilated class room with CO2 concentration in a naturally ventilated classroom, where both are occupied at maximum capacity.
- the mechanical ventilation supplies fresh air at a rate of 20m3 per hour and per person
- the natural ventilation supplies fresh air with opening windows

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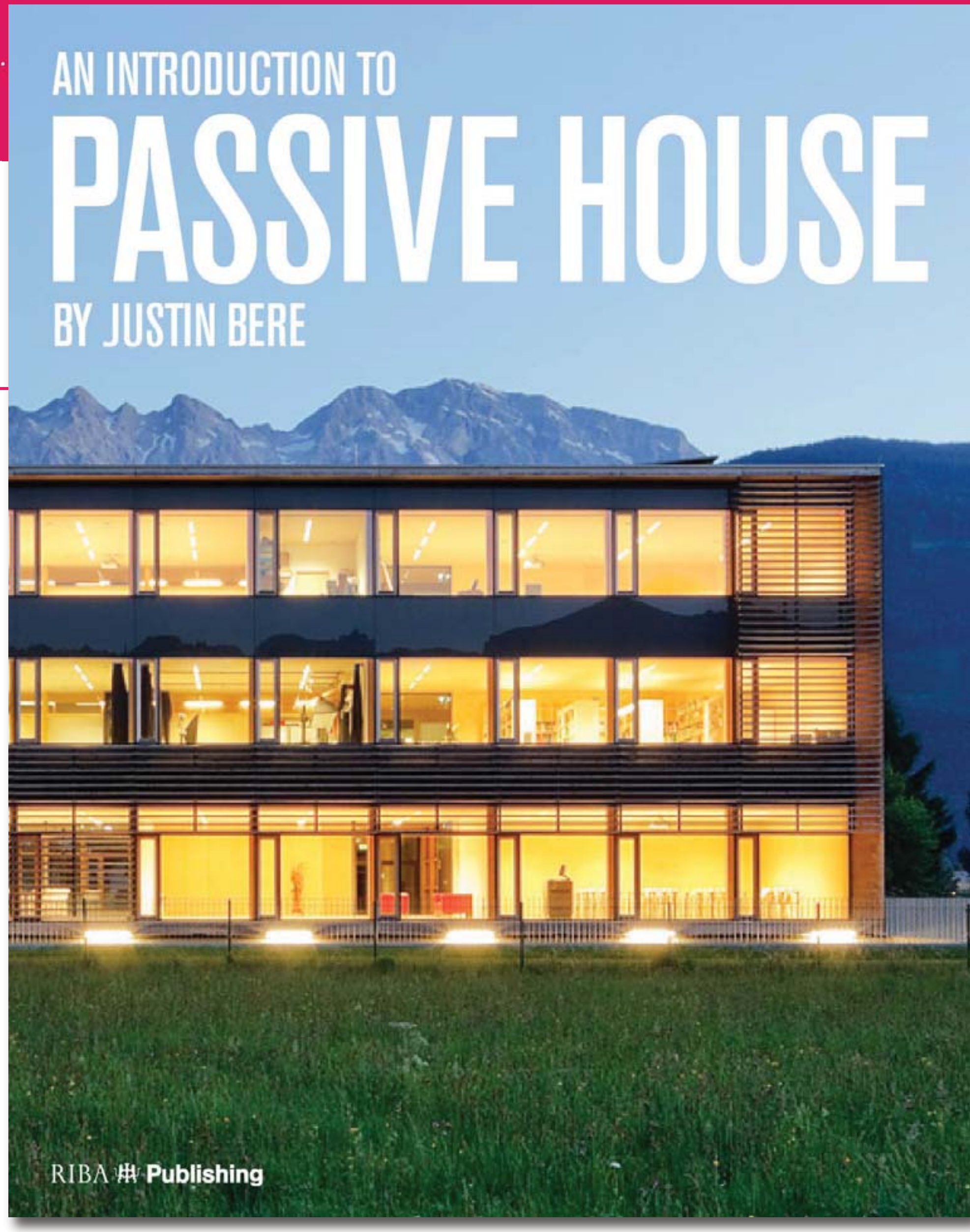

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