

# Building services design

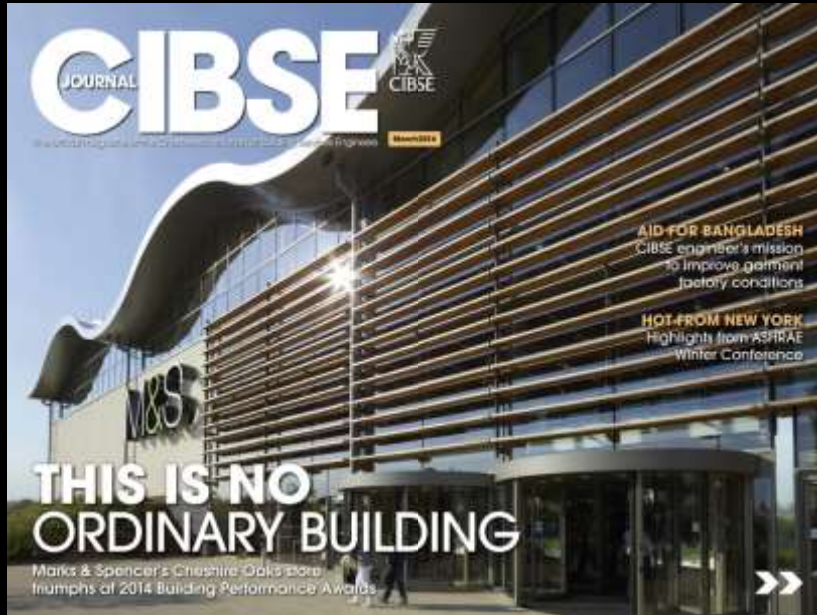
UK Passivhaus Conference 2015

Alan Clarke

@AR\_Clarke



# Building services



# Services engineers love all this:

- Plant rooms
- Valves
- Pumps
- Ducts
- Building Management Systems
- The more the better!

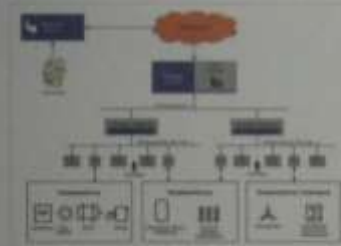
# Eco-plant room – for passivhaus

- Biomass
- Solar
- District heat
- BMS



# Vorsprung durch Technik

## Klimagerechte Regelung und Gebäudeleittechnik



Mit dem Energiemanagementsystem der Firma Klimakon lassen sich einzelne Gebäudeteile bedarfsgerecht heizen und kühlen.

Das Klimakon-Energieregelungssystem ist speziell für große Niedrigenergiegebäude ausgelegt. Die neue modular aufgebaute Steuerung berücksichtigt die technische Ausstattung des Gebäudes auf Basis einer permanenten Energiebedarfsprognose und optimiert die Einstellung der Systeme zur Energiegewinnung (Solar, BHKW, Spitzenlastkessel), -speicherung (Erdspeicher, Puffertank) und -verteilung (Wand-/Deckenabsorber).

Über eine Online-Kopplung zur lokalen Wettervorhersage registriert die Klimakon die aktuellen Klimaverläufe. Dadurch werden Überlappungen beim Heizen/Kühlen verhindert und der optimale Speichereinsatz ermittelt. Speziell in der Übergangszeit spart das erheblich Energie. Über die Energiebedarfsrechnung werden zudem die inneren Energieeinträge des Gebäudes mit berücksichtigt.

Per Monitoring überwacht die Klimakon die Funktion der Regelungstechnik, erkennt und korrigiert Fehler, optimiert die Regler und erstellt eine Energiebilanz.



# CIBSE Journal Dec 2014



However, a new web-based platform that extracts and analyses data from building management systems (BMS) has identified 47 opportunities to save energy at King's College London – which have, so far, resulted in annual savings of £390,000.

The primary aim is to find low-hanging fruit by identifying the 'energy insanities' that are still happening in commercial buildings.

We promise dreams...

...and build nightmares

Is there an alternative?



# Houses: easy



# Temperature control

- In a passivhaus dwelling:
  - We use 1 radiator,
  - control heat source according to room temperature
- It works well, cheap, reliable
- What about bedrooms?



- Heat loss from say 150W
- Heated via floors & walls?
- Heat transfer through open door
  - 1 degree difference: 200W
  - 2 degree difference: 600W
- Heat distribution is passive, no room controls  
no pipes, no extra radiators

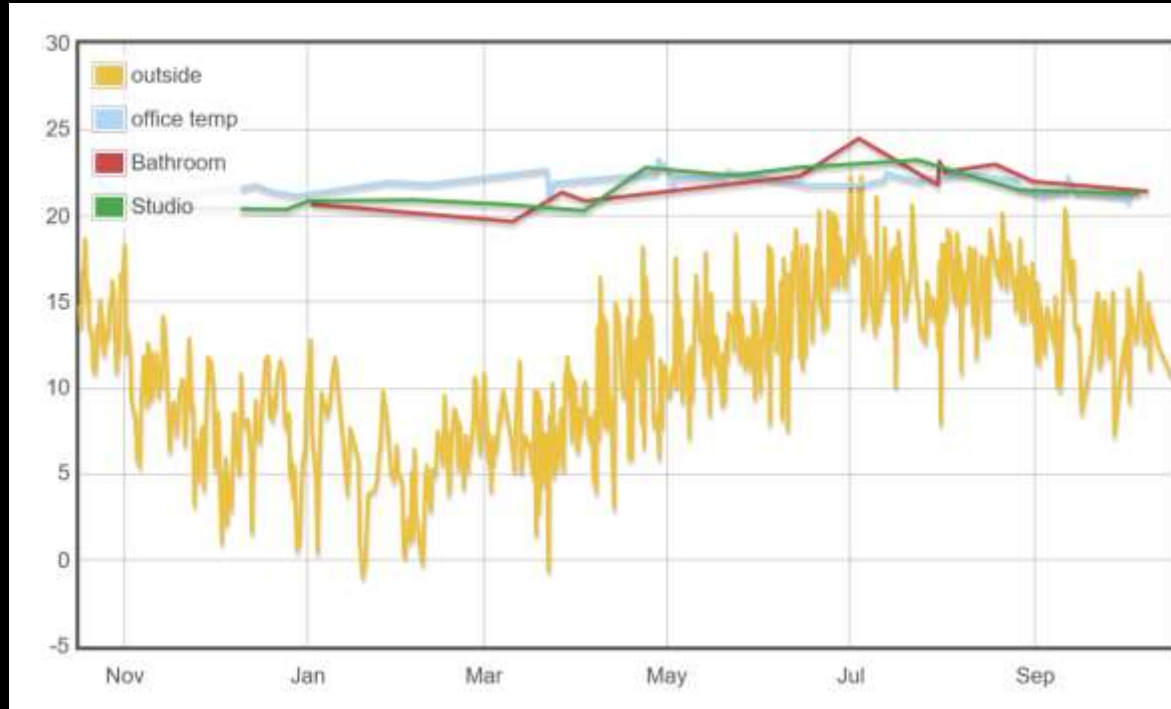


# Or, underfloor heating



- Pipe in thick RC slab
- Very slow response
- Passivhaus with big windows
- Control nightmare!

# Results



# The maths behind floor heating...

- $\text{Power} = 10\text{W/m}^2 \times (\text{room temp} - \text{floor temp})$
- So floor needs to be 1-2 degrees above desired temperature: simple to control this
- Then if room is cold, heat output is increased, and if room hot, then heat output reduces
- Magic: underfloor heating with instant response

# Simple heating: why it works

Heat loads in PH are very low

Natural heat flow in the building hasn't reduced

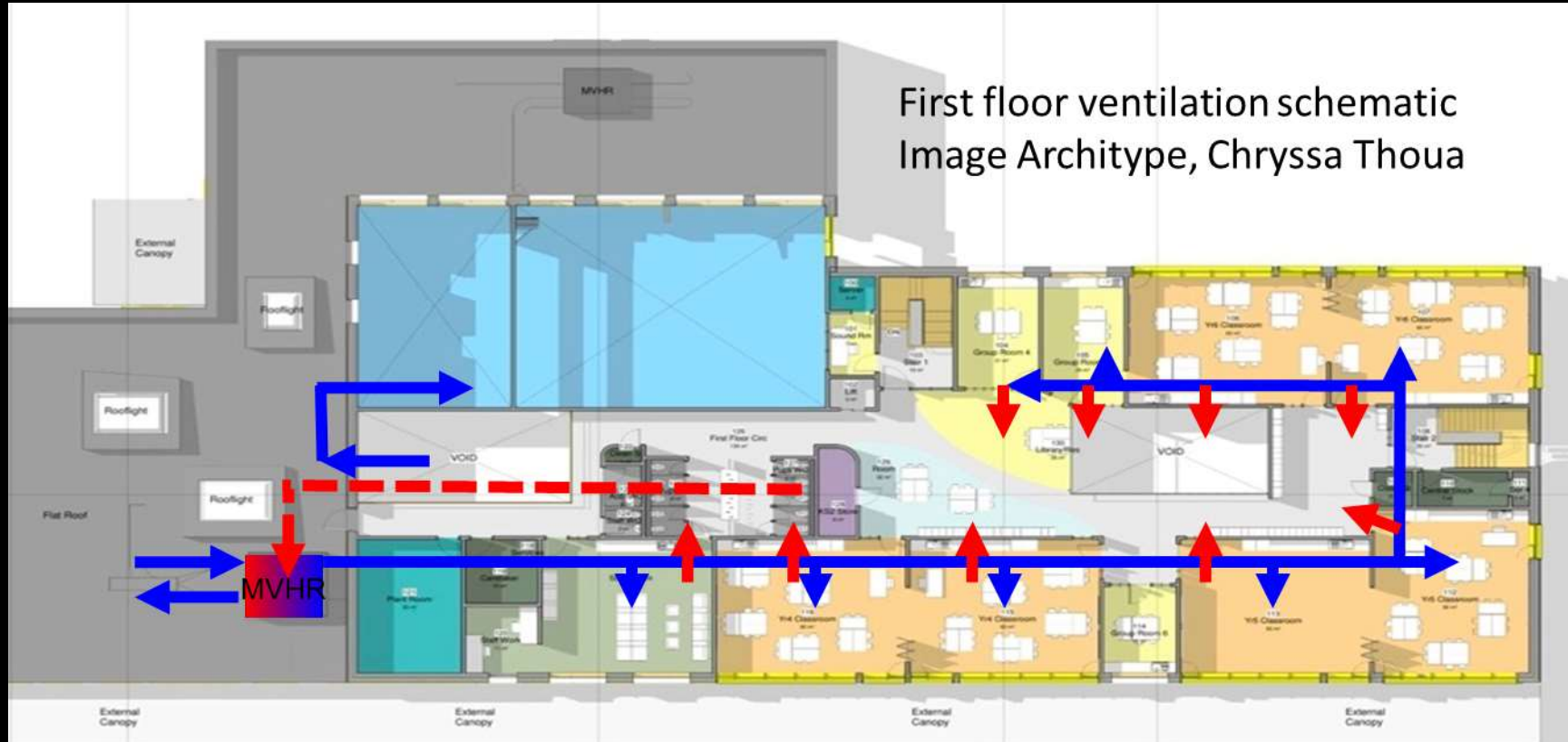
Can just add heat gently and let it balance out

# How about bigger buildings?





# Schools ventilation



# Cascade approach

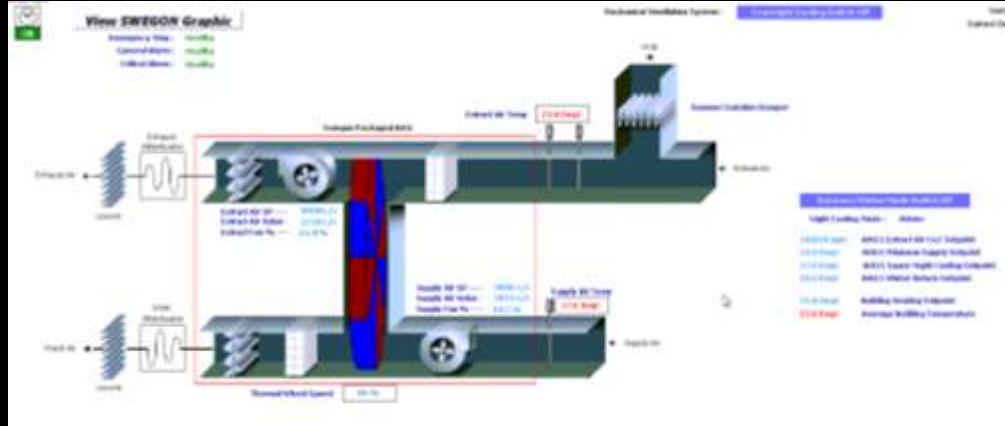
- Simple, minimal control, works well
- Summer mode:
  - Open windows
  - Turn the nasty mechanical ventilation off
  - How do we do ventilate toilets?

# #1



- Separate fan for toilets in summer
- Snag – dampers leak in winter – imbalance?
- Pay for, and control extra fan, dampers, etc

# #2



- AHU for WC extract only: isolate rest of school
- Damper shut for first winter: BMS “logic error”
- Result: low extract air flow, poor heat recovery, cold supply temperatures

# #3



- Actually everyone likes the MVHR in summer
  - No need to know when to open windows
  - Air quality is better
- No special dampers, no extra fans, no BMS, the ventilation just works, all year round

# Hereford Archive



# Archive repository

For storing historic documents, maps etc.

Need to be coolish, fairly dry...

This should be easy

- Temperature controlled to 13-20° C through year, just so long as it changes slowly
- No windows, virtually no ventilation required

# Just an insulated concrete box





# Nothing happening in there

Extremely high thermal mass relative to heat loss – very stable conditions.

Should be around average temperature for the season.

So will need a little bit of heating in the winter, not much.

What could possibly go wrong?

# The repository heating system



- Adjoining each strong room
- Air handling unit with (big) heater
- Rather over sized in our view!

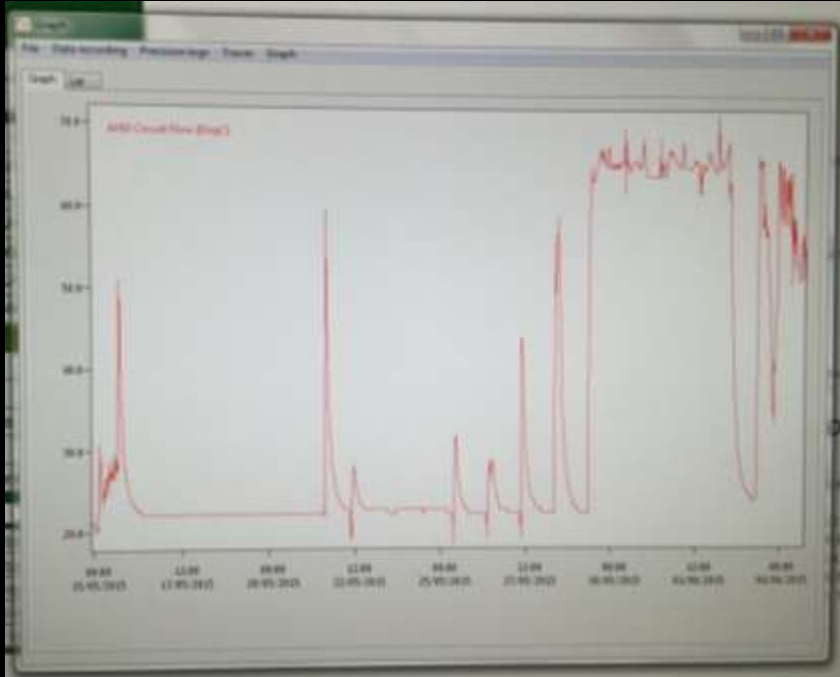
# Heating control

- Special high accuracy temperature sensors
- Two per room
- (to maintain exactly 13-20° C!!!)
- Switch the fan and heater on if below 14° C
- The sensors seem to be prone to large variation in reading, we don't really know why

# At first stores just a bit too warm

- Heating pipes always hot
  - Old-school constant-flow controls
  - Close the bypasses
- Dehumidifier is connected in back to front
  - Gets fixed
- Lights left on
  - Don't rely on auto controls – turn everything off

# Then...

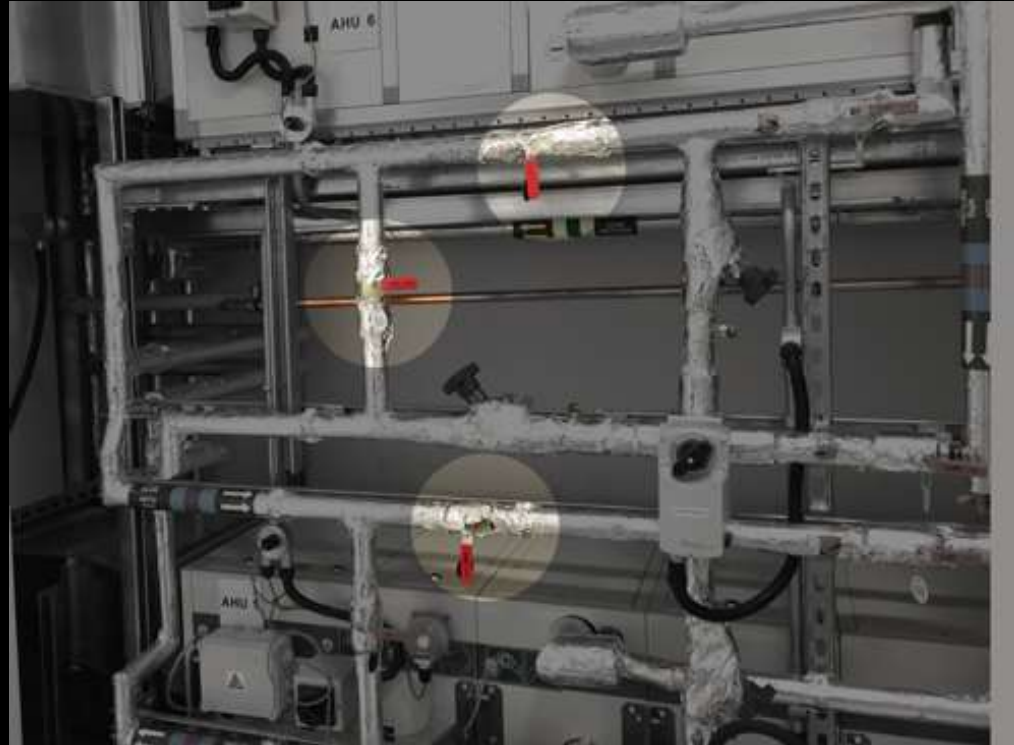


- End of May
- Stores at 16° C
- Suddenly the heating is on in middle floor
- Temperatures rising, staff worried.

...the BMS had stepped in

- Sensors had been indicating too high, false alarm when actual temperature measured
- So sensors were “recalibrated”
- Then the BMS thought the repository was *too cold* and turned the heating on!

# Solution



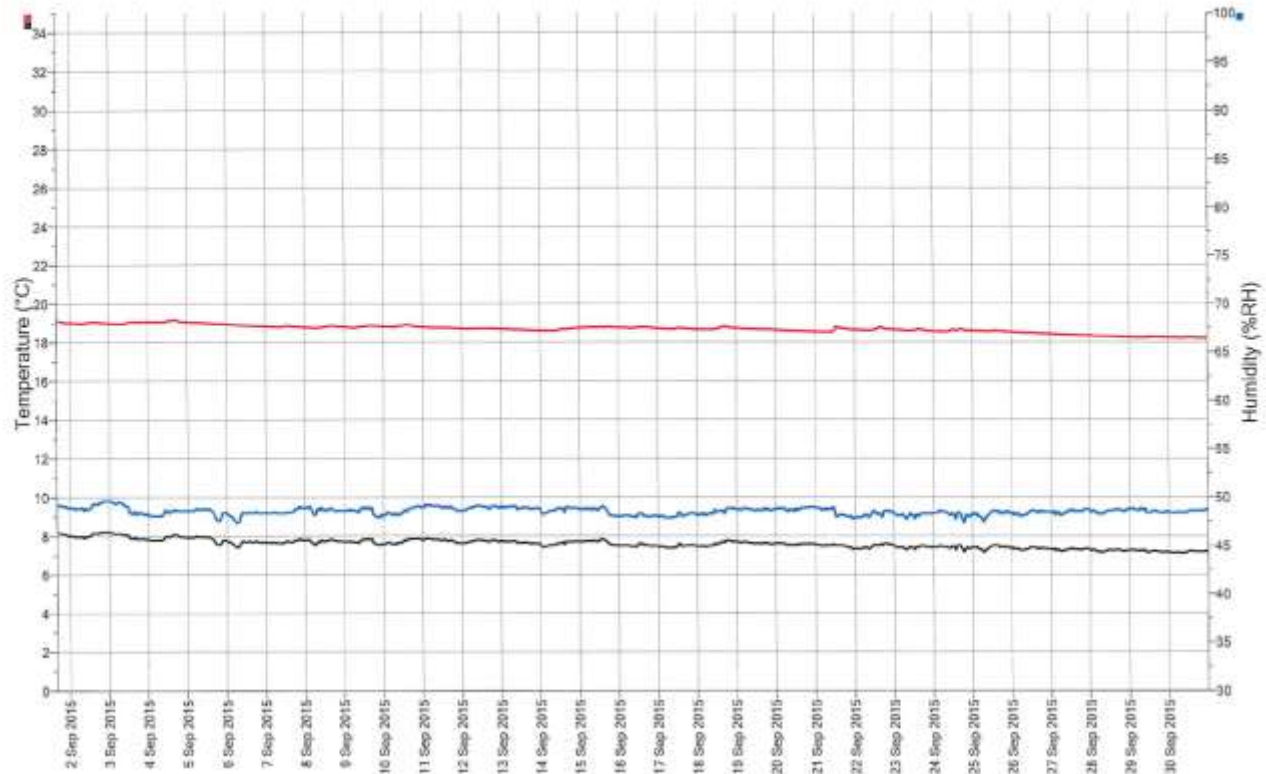


# Now

- All hot water valves in repository shut
- Archive staff download their own temperature log every month
- If too cold they will turn heating back on for following month!

### Middle Floor left

■ 391943 Temperature Middle Floor left ■ 391943 Humidity Middle Floor left ■ 391943 Dew Point Middle Floor left



# Why it works

- “Passive” building fabric
  - Thermally isolated
  - Airtight
  - Thermal and moisture buffering
- No heating
- Very low ventilation rate

# Are we just unlucky?

We used to think “what might go wrong?”

Now it's

“what will happen when this does go wrong?”

# Conclusions

- Make the services simpler
- Get rid of stuff
- If it needs a BMS it's too complicated:  
    Get rid of more stuff
- Heating: just control on room temperature
- Ventilation: run when people are there

Thank you



training@peterwarm.co.uk

01752 542 546



## AECB Passivhaus Designer Course

**Venue:** Centre for Efficient and Renewable Energy Buildings (CLREB) at London South Bank University.

**Week 1:** 2<sup>nd</sup> -5<sup>th</sup> Nov.

**Week 2:** 16<sup>th</sup> -20<sup>th</sup> Nov.

**Exam:** 4<sup>th</sup> Dec.

**Who are the trainers?** This course is taught by leaders in the UK Passivhaus development. They are the experts who are at the heart of any successful designing/ building Passivhaus in UK.



[www.aecb.net/carbonlite](http://www.aecb.net/carbonlite)