More Space, Less Energy

Extending and Upgrading a 1940s Semi

Starting point

Retrofit, yes, but what & how?

Extending & upgrading

Works carried out: insulation, airtightness

Results!

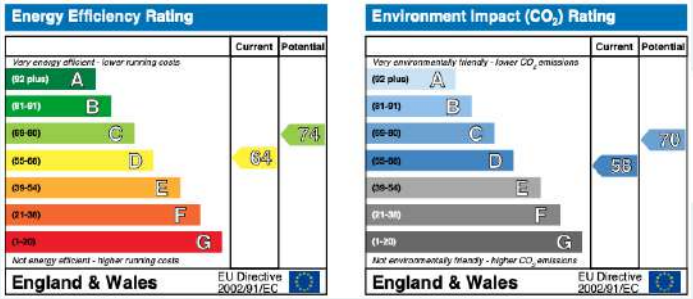
Saw the house during an outing

in need of some updating

I wasn't looking for a doer “retrofit” upper

Quickly realised it would be a long term project

Starting point



Very much British standard 1940s semi

EPC band D

- 50mm cavity walls, filled with mineral wool
- Double glazing UPVC windows & doors
- Suspended timber floor in living room
- Screed-on-soil floor in kitchen, landings
- Uninsulated sloping ceilings on 1st floor
- 100mm mineral wool loft insulation
- Back boiler: 55-65% efficient (SEDBUK)
- open flue, many double brick vents
- hot water cylinder with 20mm spray-on foam

Initial improvements

Picking the low hanging fruit: low £, immediate effect

- Hot water cylinder jacket(s)
- Better CH controls: thermostat, Nest
- OWL electricity consumption monitor & display

Planted an orchard (2011):

- Solar PV: 2.88 kWp array

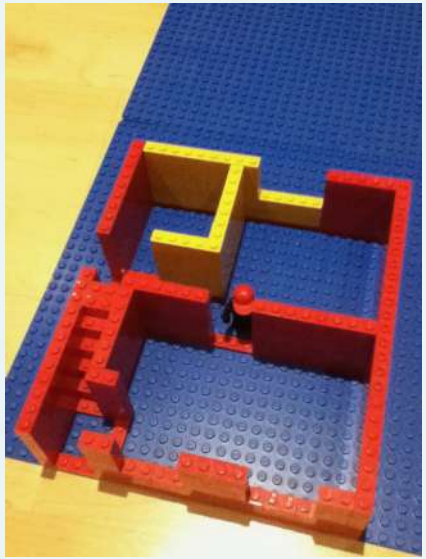
Picked some harvest:

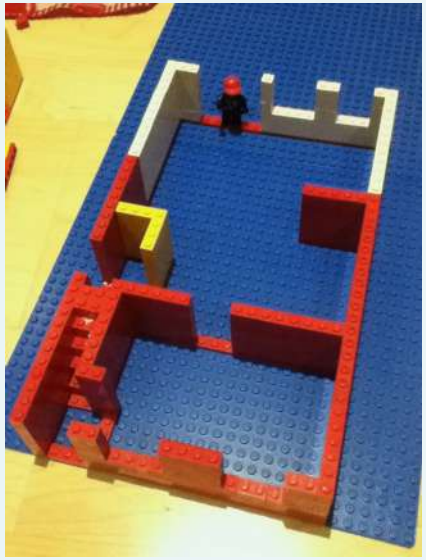
- Solar Immersion Diverter
- Heat bank for mains pressure hot water
- “Free” hot water for 7 months/year

Extension + Retrofit

Opportunity to build extension

- Should not increase energy use
- Starting point for whole-house upgrade
- Have to build it to the highest standard (or not at all?)



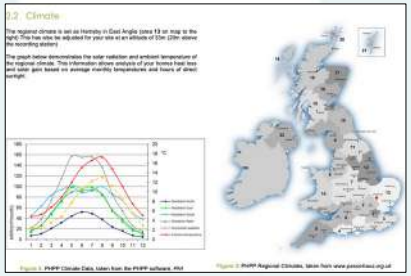


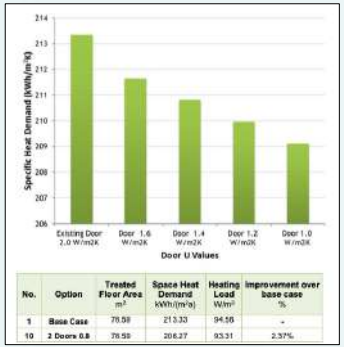
Three main aspects of work:

- Insulation
- Airtightness & ventilation
- Heating & Hot Water

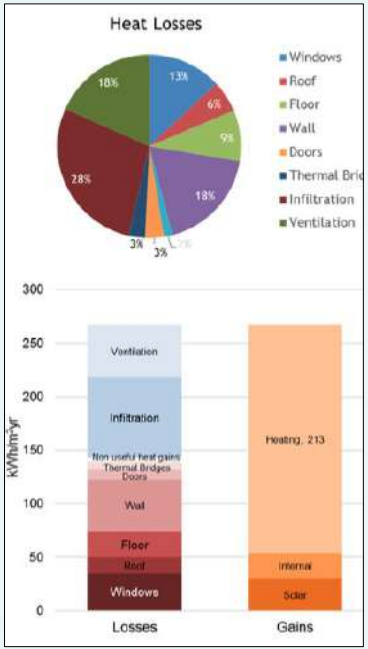
Retrofit: yes. But what and how?

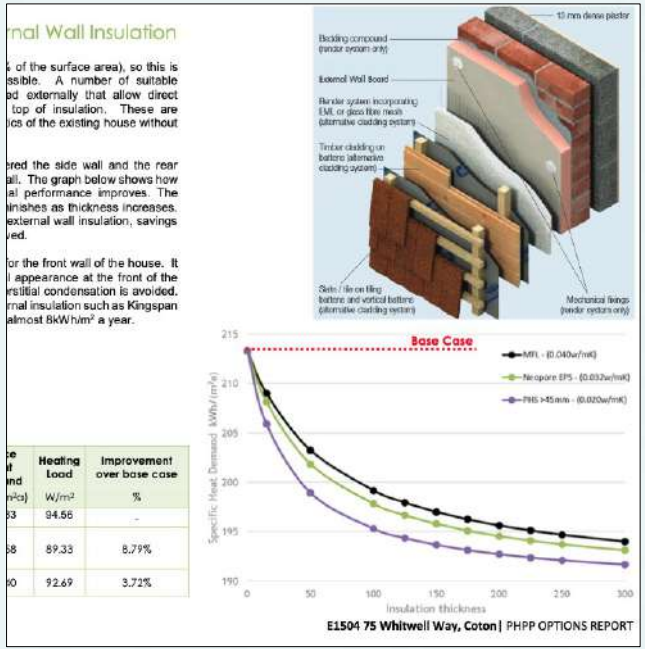
Architect* to design extension, and come up with **whole house plan** using PHPP software





No.	Option	Treated Floor Area m²	Space Heat Demand kWh/(m²a)	Heating Load W/m²	Improvement over base case %
1	Base Case	78.59	213.33	94.56	-
10	2 Doors 0.8	78.59	208.27	93.31	2.37%





	Heating Load W/m²	Improvement over base case %
	94.56	-
	89.33	8.79%
	92.69	3.72%

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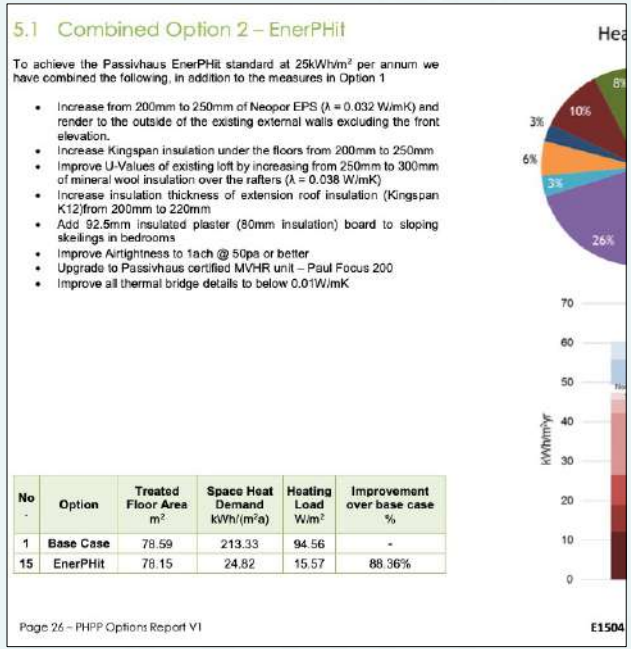

No.	Option	Treated Floor Area m²	Space Heat Demand kWh/(m²a)	Heating Load W/m²	Improvement over base case %
1	Base Case	78.59	213.33	94.56	-
15	EnerPHit	78.15	24.82	15.57	88.36%

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Highly recommended for those serious about retrofitting to high standards!

* Alan Budden / Eco Design Consultants, Milton Keynes

Insulation, Insulation, Insulation

Floors: 300mm, U ≤ 0.11 W/m^{2}K

Walls: 200mm, U ≤ 0.14

Ceiling/Roof: 220mm, U ≤ 0.11

Break for Q & A

Airtightness

Our home was estimated to lose **50%** of heat through infiltration + ventilation

But:

We need ventilation to keep indoor climate healthy

Our ventilation was passive: Brick vents, chimney stack

Wind speed governs ventilation rate

Better is: controlled ventilation

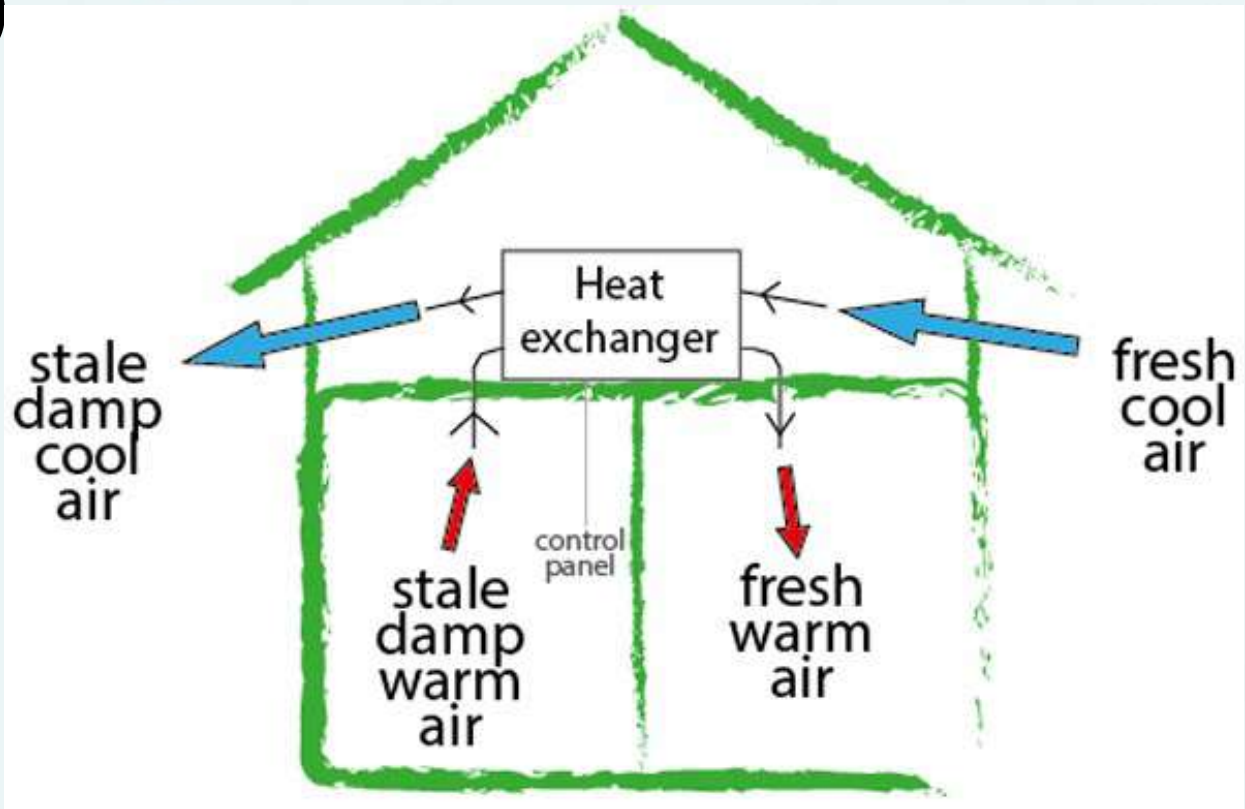
Many unintended ventilation (holes) need plugging as they cause cold spots->condensation->mould

This is something you can start doing today!

Airtightness

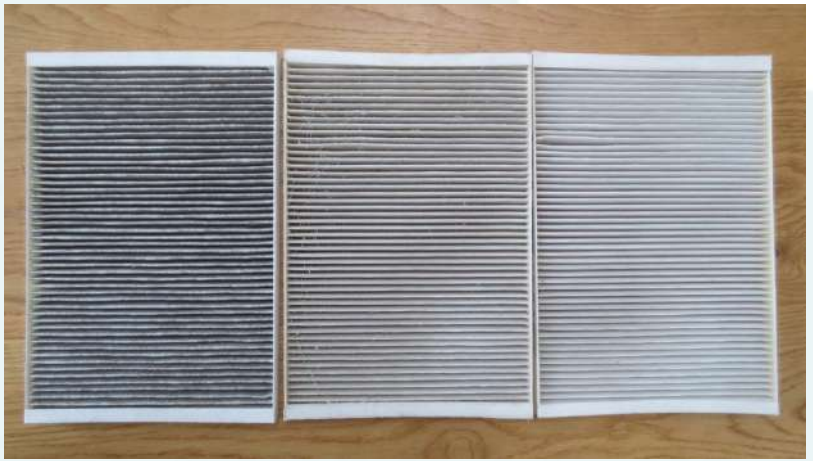
More airtightness → less uncontrolled ventilation → requires controlled ventilation

Mechanical Ventilation with Heat Recovery (MVHR)



Picture: great-home.co.uk

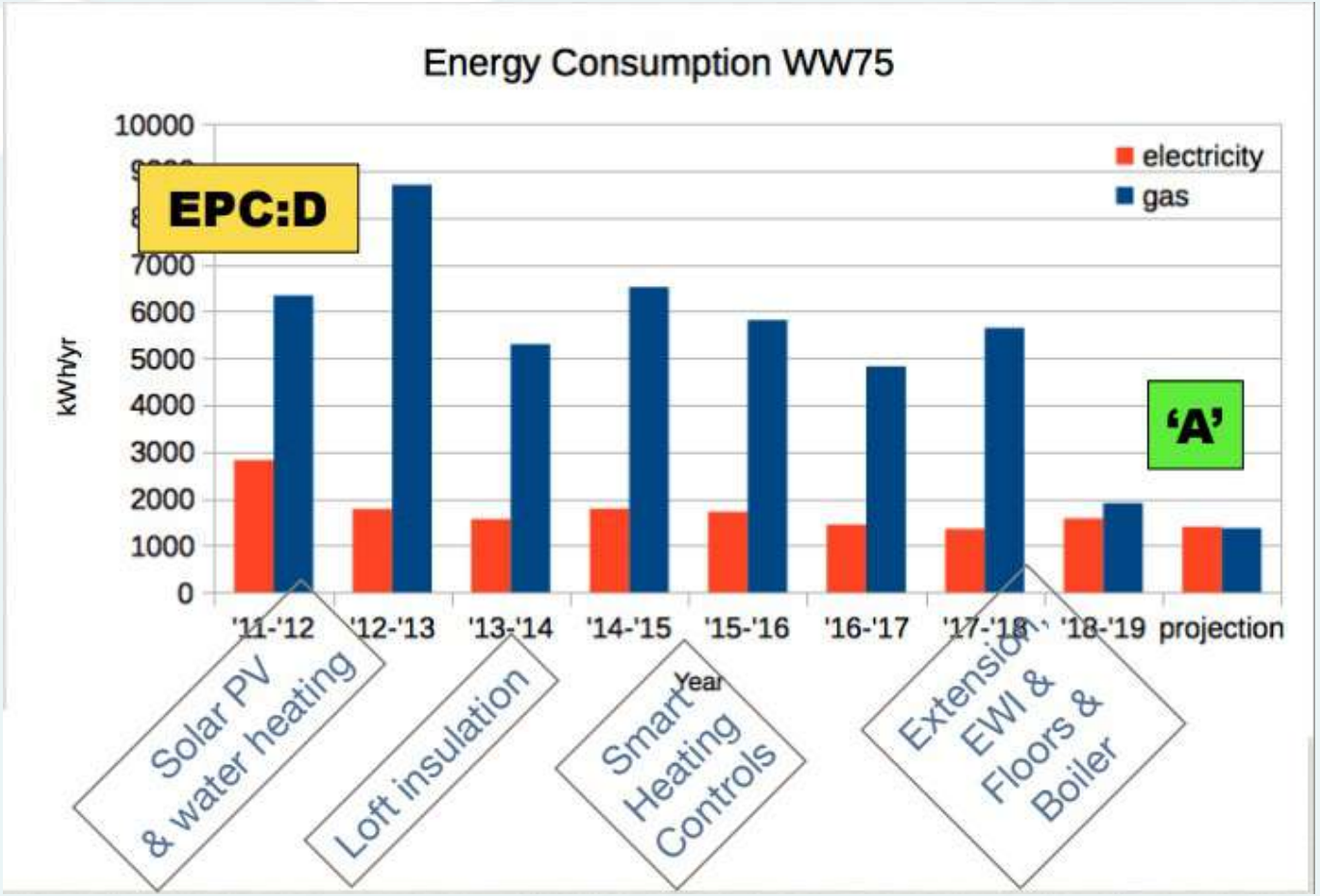
MVHR Retrofit



Video

Results!

Results in numbers



Small measures

=

Worth doing

but

Big measures

=

Big changes

Results in experiences

House at very even temperature throughout

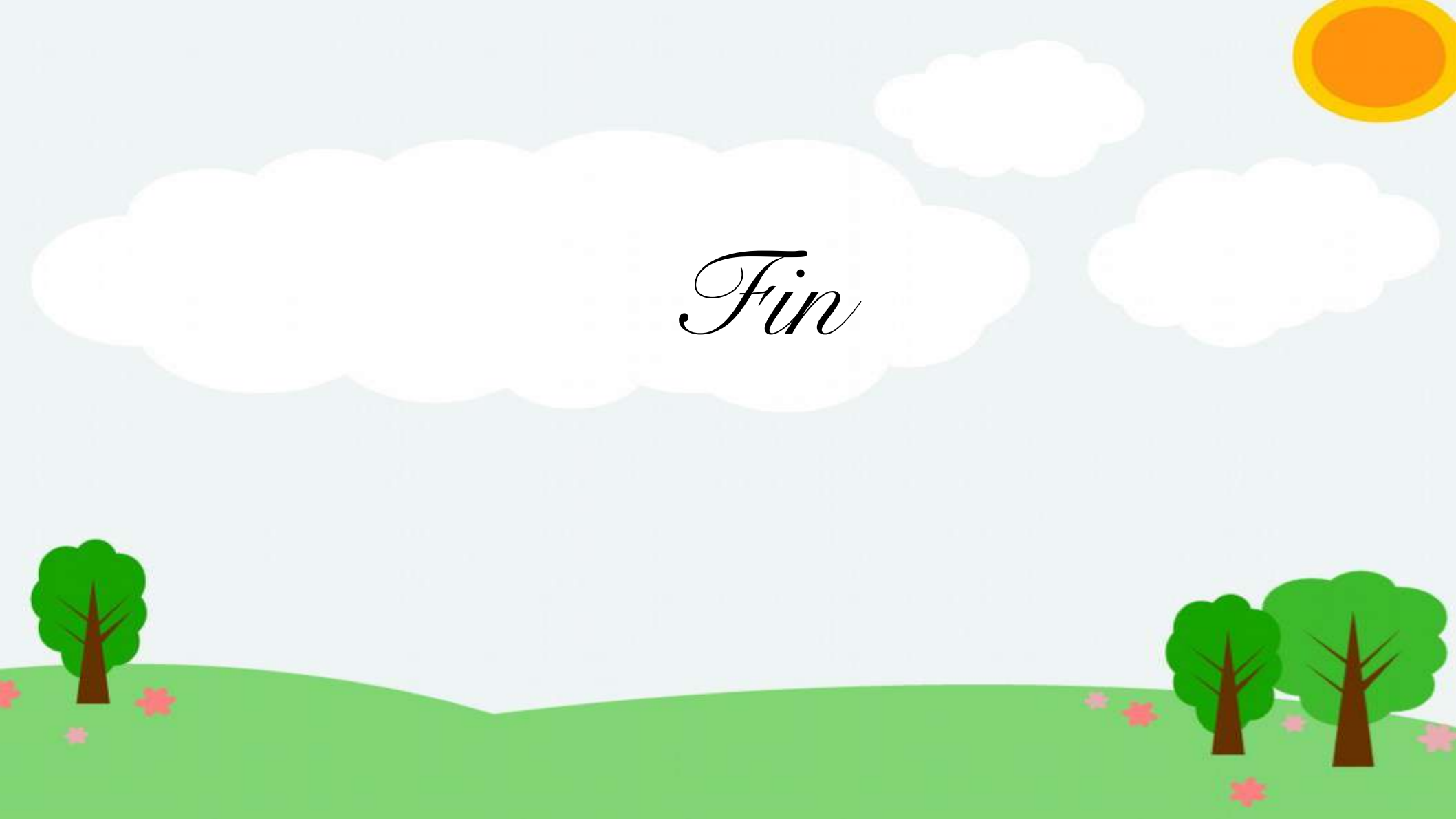
Keeps warm in winter, stays cool in summer - even in a heatwave

No more need to huddle in the living room, keeping all doors shut in winter

Much healthier indoor climate

No more condensation on the windows in winter

Very silent, serene internal atmosphere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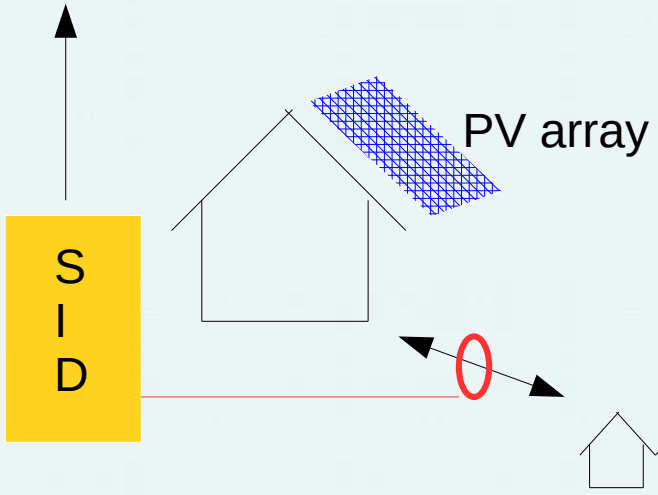
Backup

Solar Immersion Diverter

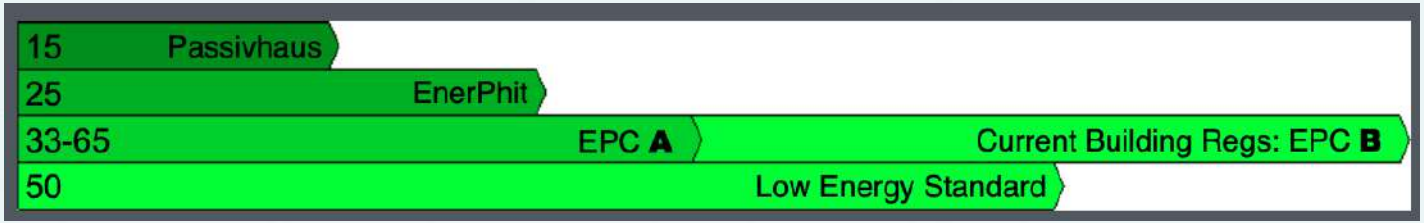


- Measures electricity flow (every second)
  - Solar PV
  - House consumption
- Excess energy is diverted into the immersion heater
  - Needs device to pulse immersion heater
- Commercial offerings available:
  - EMMA, iBoost, etc
  - Or...DIY: potentially more efficient

Retrofit: before you begin

What to do? Which standard to go for?

- Current Building Regulations are well understood, still far away from zero carbon. Achievable in post 1930s homes.
- Current BR result in EPC B
- Only ~0.1% of houses sold has EPC A
- Low Energy Homes standard (AECB Silver) puts retrofits ahead of new builds!
- EnerPHit is a very high standard, has excellent documentation available but not easy to achieve. Very difficult in older homes.



Whole-house plan

Architect* to design extension, and come up with whole house plan using PHPP

PassivHaus Planning Package is software to simulate house:

- Takes into account size, shape, materials, orientation, local climate
- Allows tinkering with insulation thickness, window, door sizing & orientation to avoid high heating requirements AND summer overheating
- Architect offer options report detailing measures to achieve Low Energy, EnerPHit

I cannot recommend this highly enough for those getting serious about retrofit!

* Alan Budden / Eco Design Consultants, Milton Keynes

Insulation

Floor insulation

Floors: 280/300mm

$U \leq 0.11 W/m^2K$

Details / cold bridges

Floor perimeter

This you will do only once, hopefully, so better do it well

Insulation: Walls

Walls: 200mm

$U \leq 0.14 W/m^2K$

Details / cold bridges

Window reveals

EWI to footings

Extension:
200mm full-fill cavities
XPS below DPC
Mineral wool above

EWI:
200mm EPS

Ceiling/roof: 220mm

$U \leq 0.12 W/m^2K$

Insulation: ceiling & roof

Warm roof: 110mm celotex over rafters
+110 between

Cold roof: 50mm between rafters, 110 under
Below: sloping ceiling

Airtightness testing

Inspired by another Eco Homes Host: Rob L, who lent me his test kit: car radiator fan

Modified & expanded it for my own use

Take out glass panel from UPVC window

Replace with cut-to-size wood panel

Tubing for diff. Pressure meter

Switch on and start going around the house looking for leaks

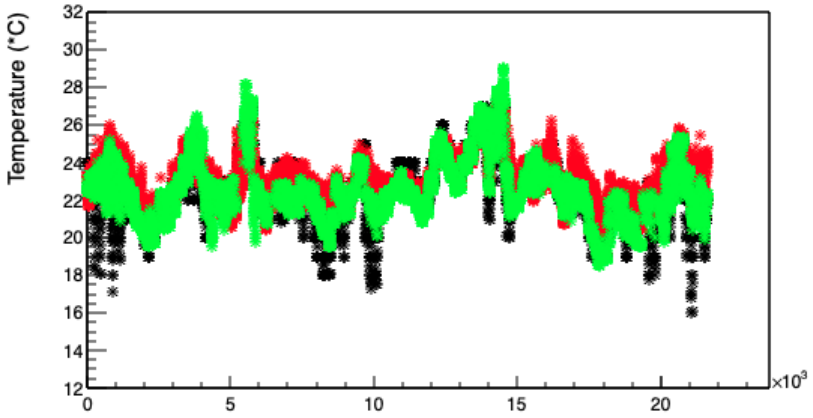
Use adjustable power supply and determine air flow rate at 50 Pa to get leak rate in Air CHanges per hour (ACH)

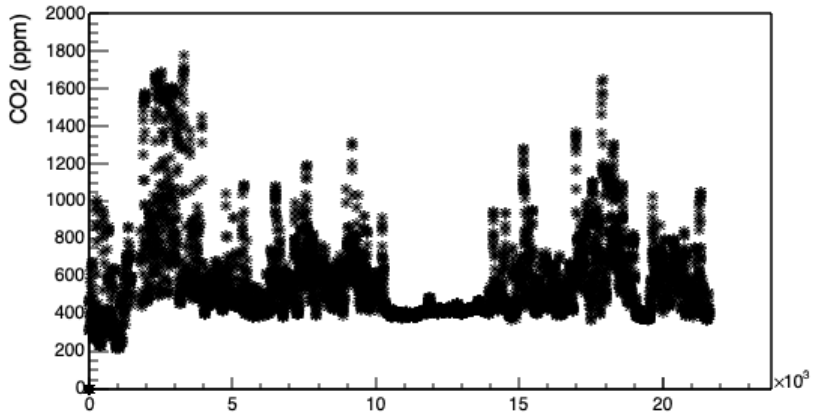
Environmental Monitoring

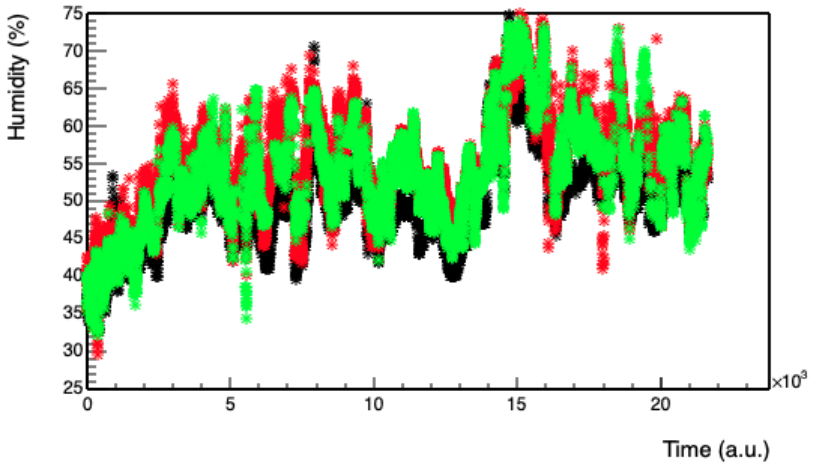
Distributed sensors for Temperature, Humidity and CO2 level

Wireless transmission to central node with display and memory card

You can't manage what you can't measure!







Thermal Imaging Training

Cambridge Carbon Footprint

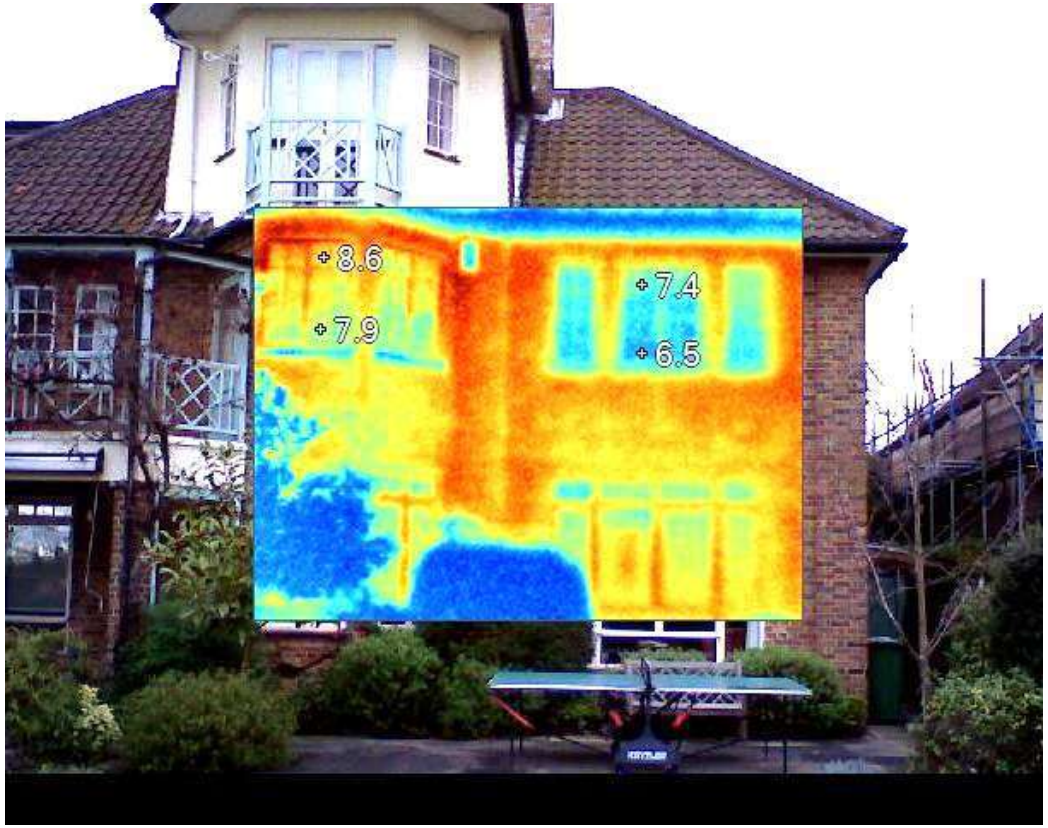
Get trained at one of these & borrow a camera:

Tue 3rd Nov, 7:30-9:00 pm

Wed 2nd Dec, 6:00-7:30 pm

Thu 14th Jan, 7:30-9:00 pm

Tue 23rd Feb, 6:00-7:30 pm



More Online Tours & Talks

openecohomes.org/autumnseason

Please write feedback in Chat: - What did you enjoy?

- Suggestions for improvement?

Donations welcome: cambridgecarbonfootprint.org/donate