Heat pumps and fuel poverty

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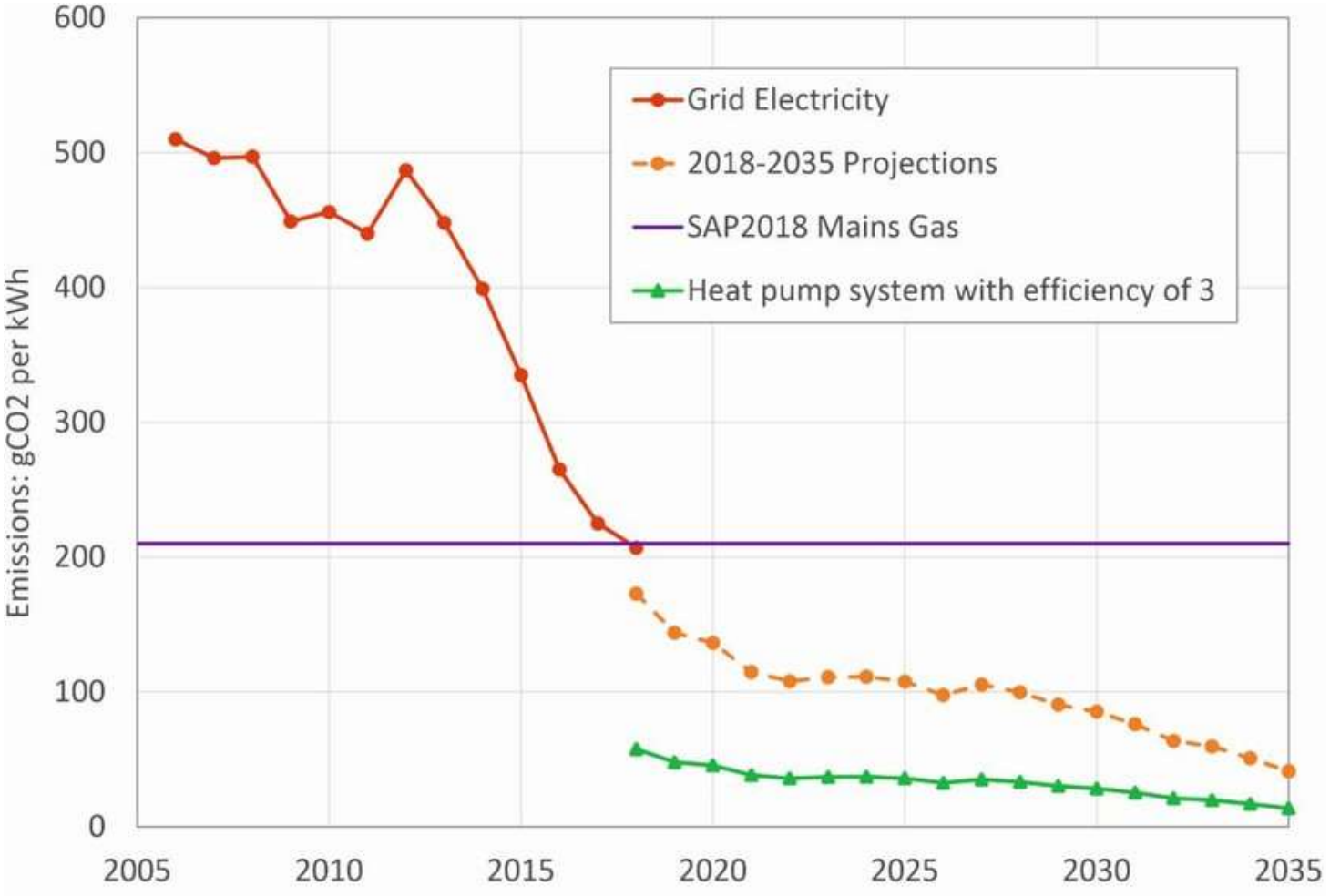
Watch for the physics ☺

Once upon a time....

It was all about fabric

Decarbonisation: grid electricity is now lower carbon than gas



Heat pumps will fix it?

Insulation impact: how much do UK houses really need?

Fabric ~~First~~ Fifth

Fabric first: is it still the right approach?

BRIEFING NOTE

Low income UK homes 'should be given free heat pumps' to meet climate targets – but hydrogen ruled out

Advisers say government should cover cost of replacing gas boilers with pumps in more than 2m hom

Andrew Ward, Customer Business, said: "I'm thrilled to see us reach the 3,000 milestone of newly installed heat pumps across England, Wales and Scotland, making more and more homes warmer and healthier, particularly for those who are more vulnerable.

Why wouldn’t we want good fabric?

Benefits of improved fabric

- Low heat demand, affordable warmth, resilience to cold snaps, power outages and financial calamities
- Good indoor air quality
- Freedom from damp and mould
- Peace and quiet

- However low carbon your heating system, it can't offer any of these

We want to tackle fuel poverty and poor indoor conditions.
We want low carbon too.
But the mechanisms have diverged

However low carbon your heat, if you can't afford any, nothing has been achieved.

How much do heat pumps cost to run?

A diversion into physics

What is SPF? (Seasonal performance factor)

$$\text{SPF} = \frac{\text{Useful heat provided to the home}}{\text{Energy used to power the system}}$$

Because heat pumps draw “free” heat from the environment this value should be greater than one.

A government-funded trial

December 17, 2021

Heat pumps suitable for all properties finds Electrification of Heat project

By Molly Lempriere

Written up by Energy Systems Catapult

Was not looking at a representative sample of UK households

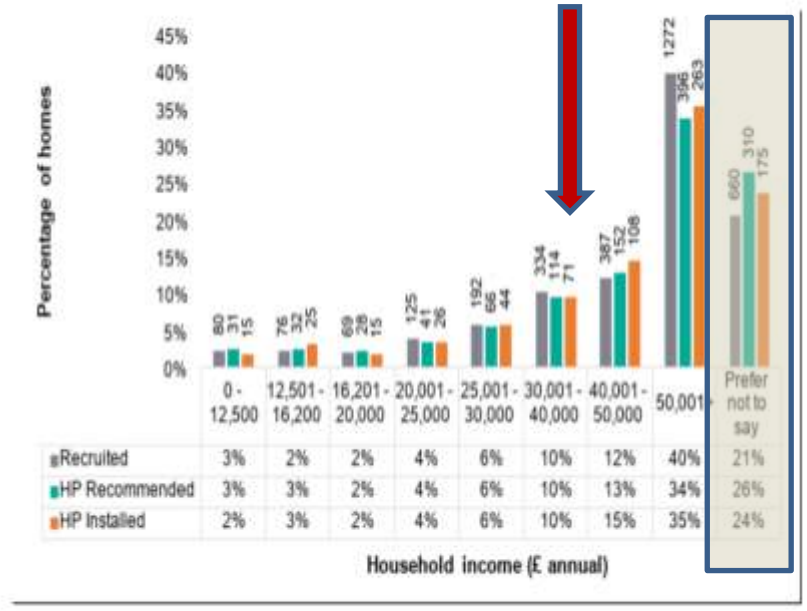


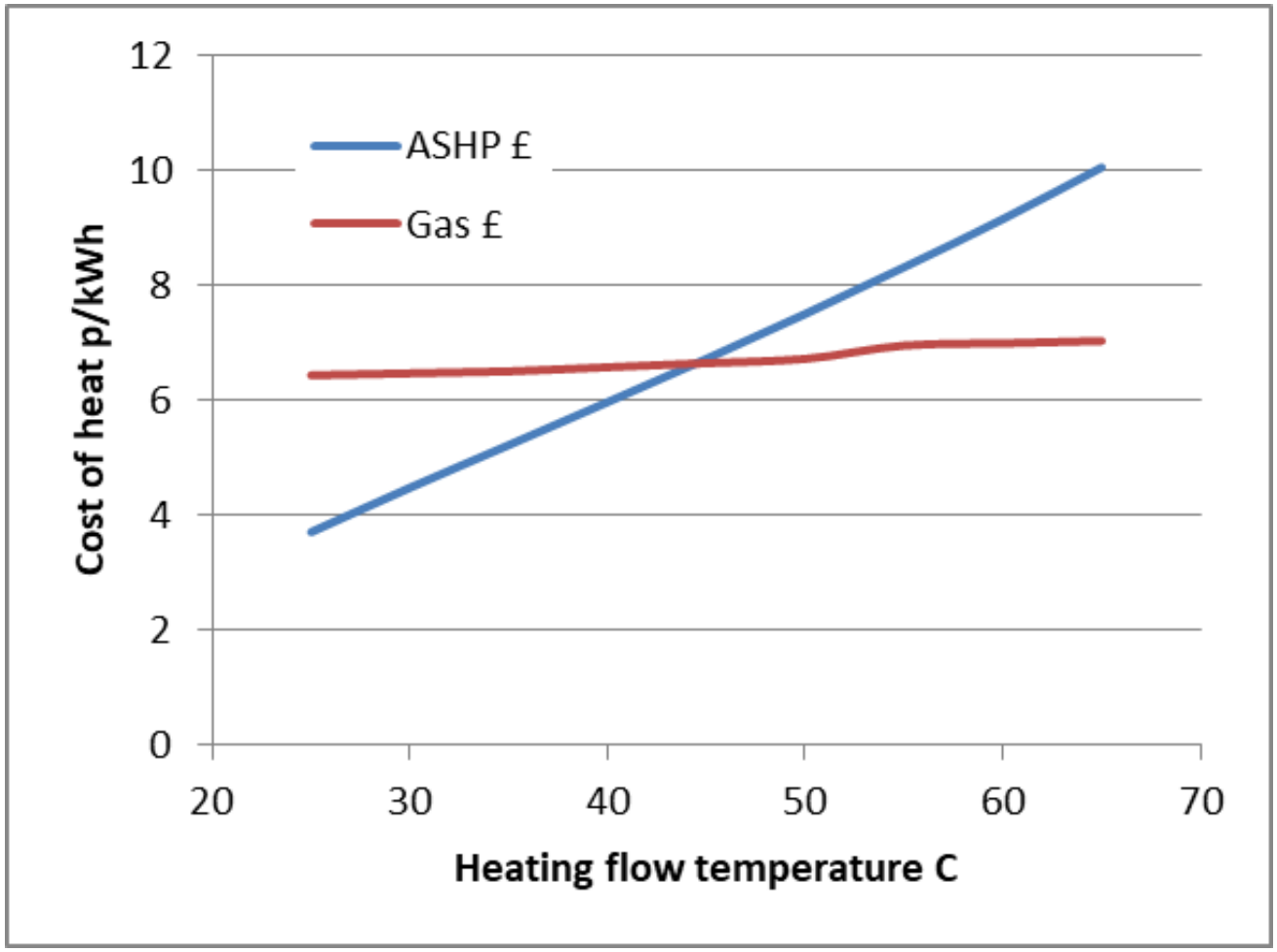
Figure 16 Homes involved in trial, broken down by reported household income; absolute numbers at each stage shown above bars

Arrow --> **£38,000**, approx. median household income at the time

What is SPF?

And what does it depend on?

Low flow temperature for high efficiency



For the price to compete with gas (at current price ratios) SPF needs to be about 3.3 - 3.5

Most heat pumps will need an average flow temperature of below 45 to achieve that.

What does flow temperature depend on?

+

To get plenty of heat into the building with a low heating flow temperature, you need BIG radiators (or under-floor heating) and to allow the heating to run for long hours

So what happened in that government trial?

- Many satisfied users but ...
- Median ASHP SPF = 2.80 – so not parity with gas costs (then or now)
- Wide scatter of results: some excellent but

  I in 4 below SPF 2.5
- Not everyone happy

Winter – coldest day (temps ~0°)

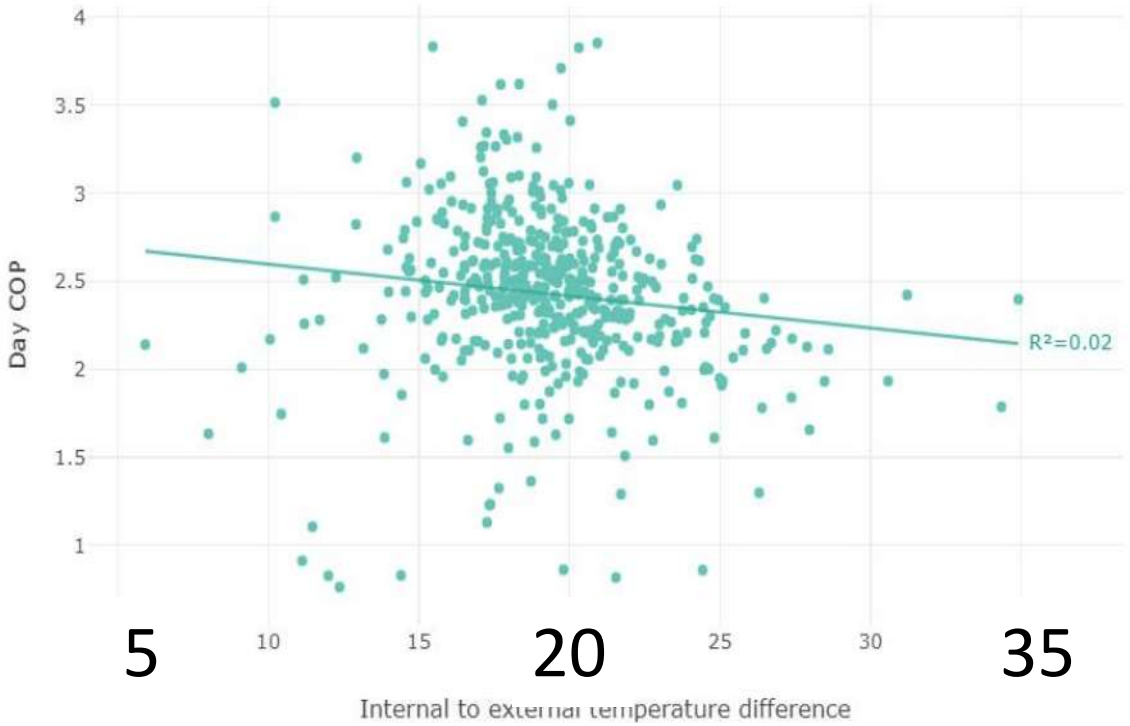


Figure 5.10: COP by difference between internal and external temperatures on the coldest day.

Cold inside

Warm inside

COP = amount of heat provided per unit of energy, on that day

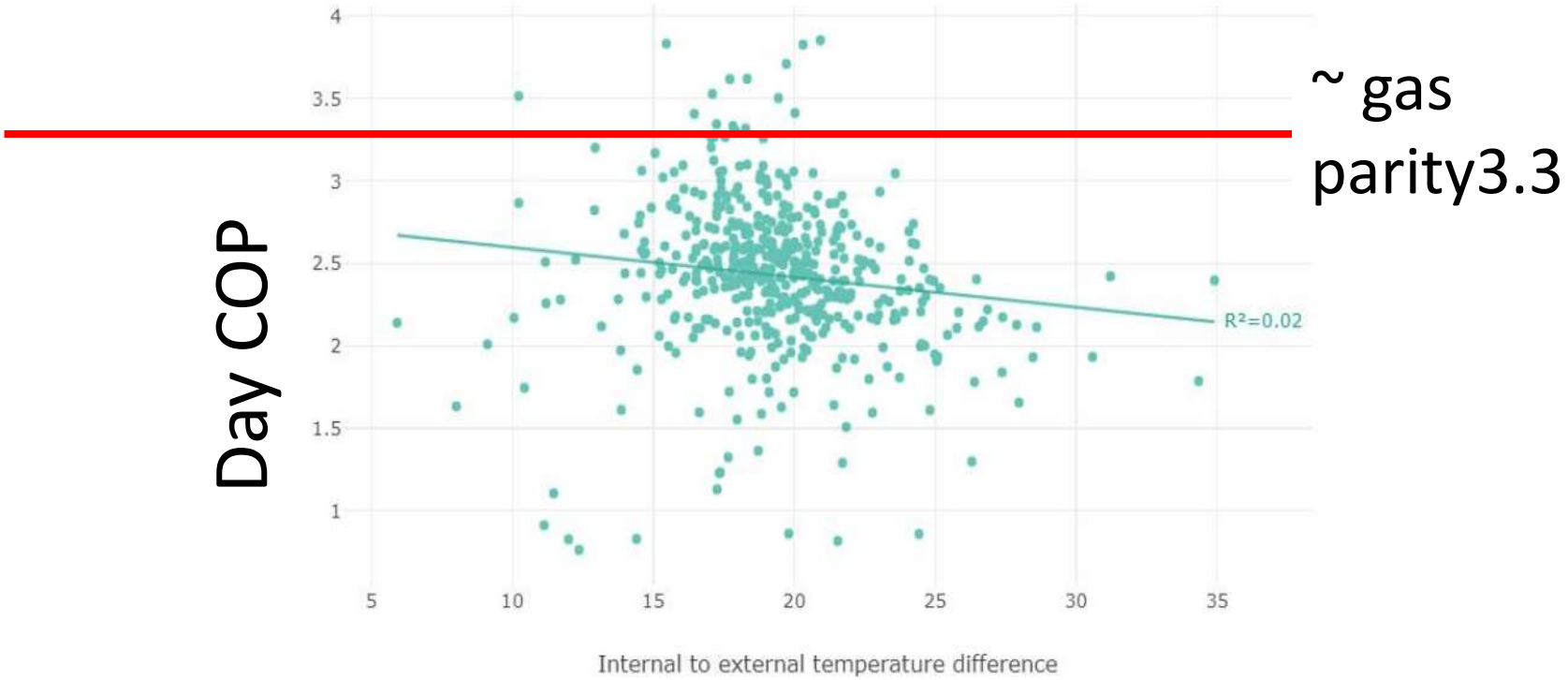


Figure 5.10: COP by difference between internal and external temperatures on the coldest day.

For most of the homes studied, heat was more expensive than gas at this time of year

...but also, many of the homes were not very warm

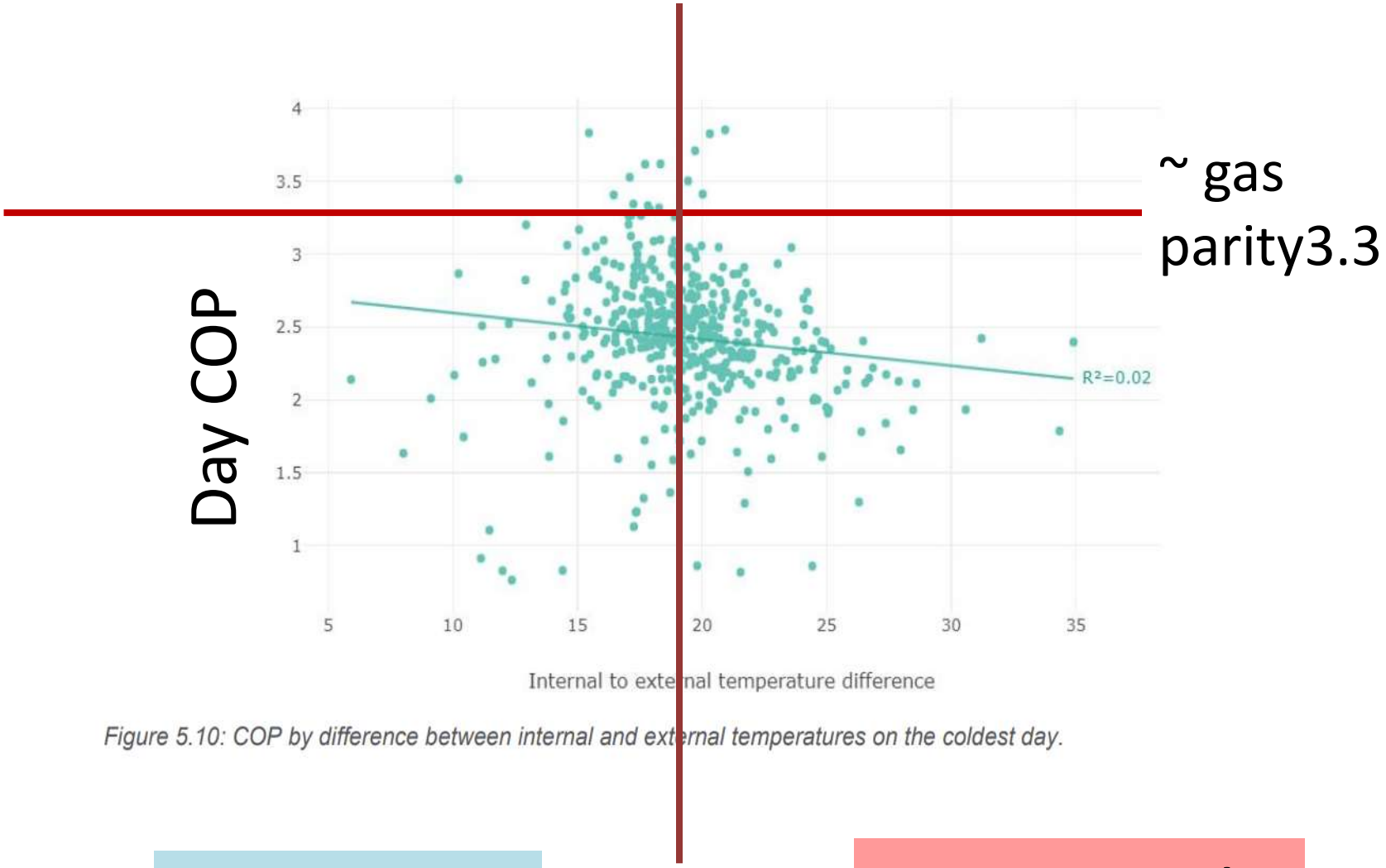


Figure 5.10: COP by difference between internal and external temperatures on the coldest day.

Cold inside

Warm inside

Homes where heat was expensive, or occupants were cold……

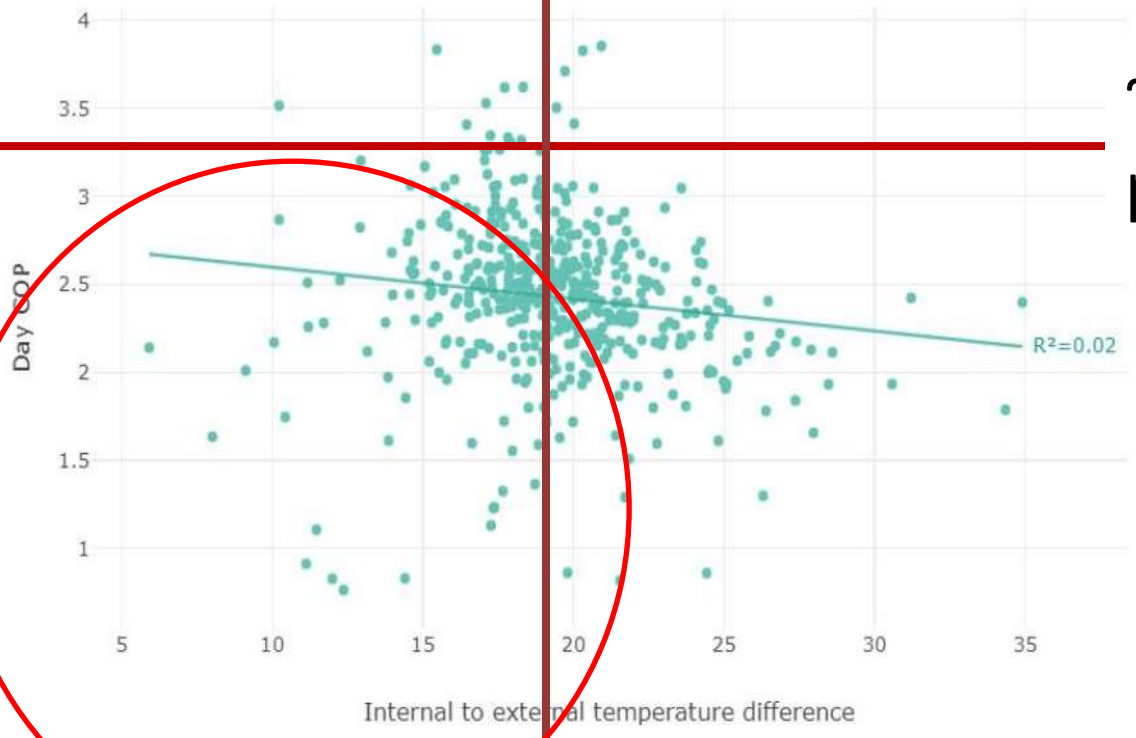


Figure 5.10: COP by difference between internal and external temperatures on the coldest day.

~ gas parity3.3

…or both

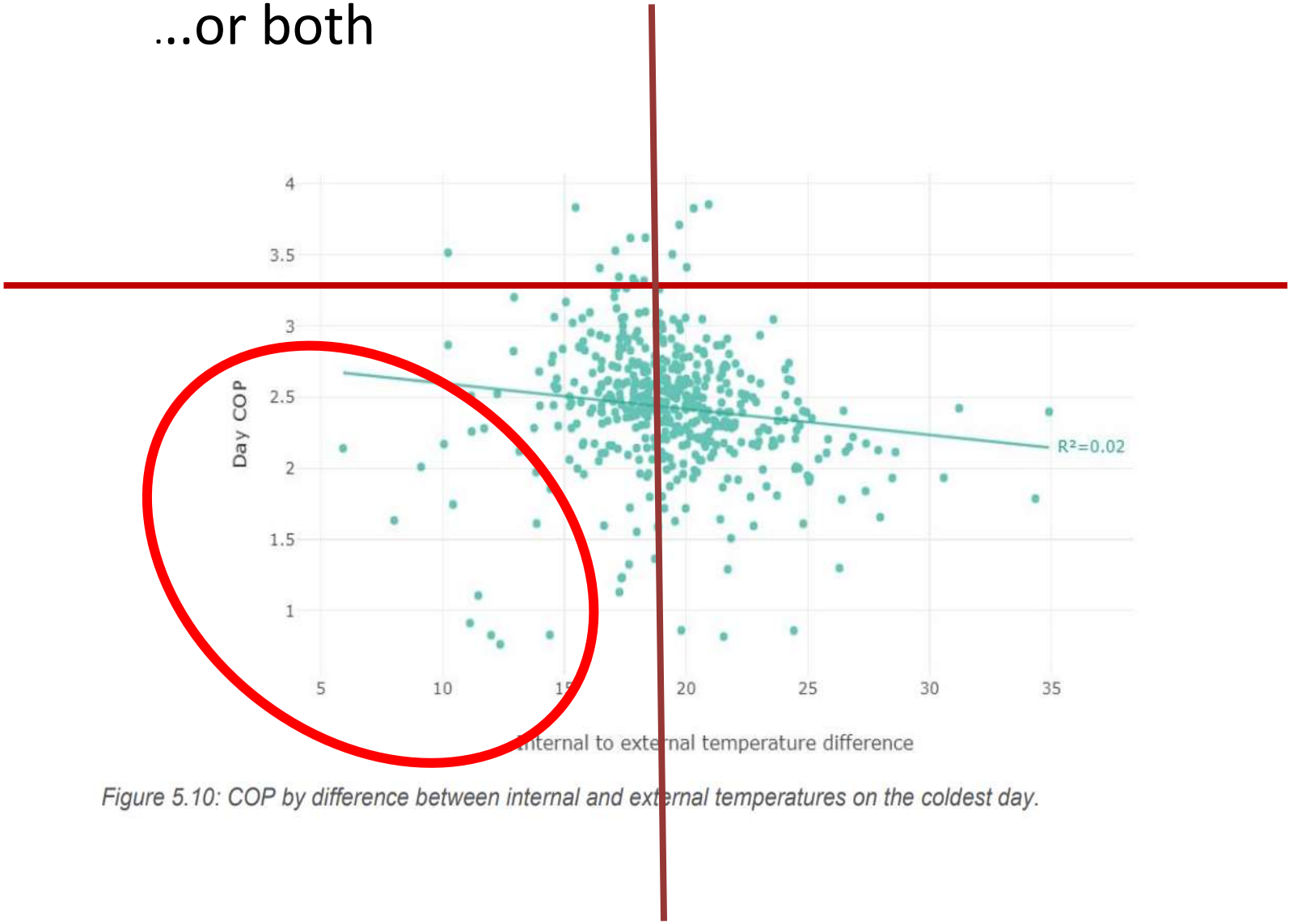
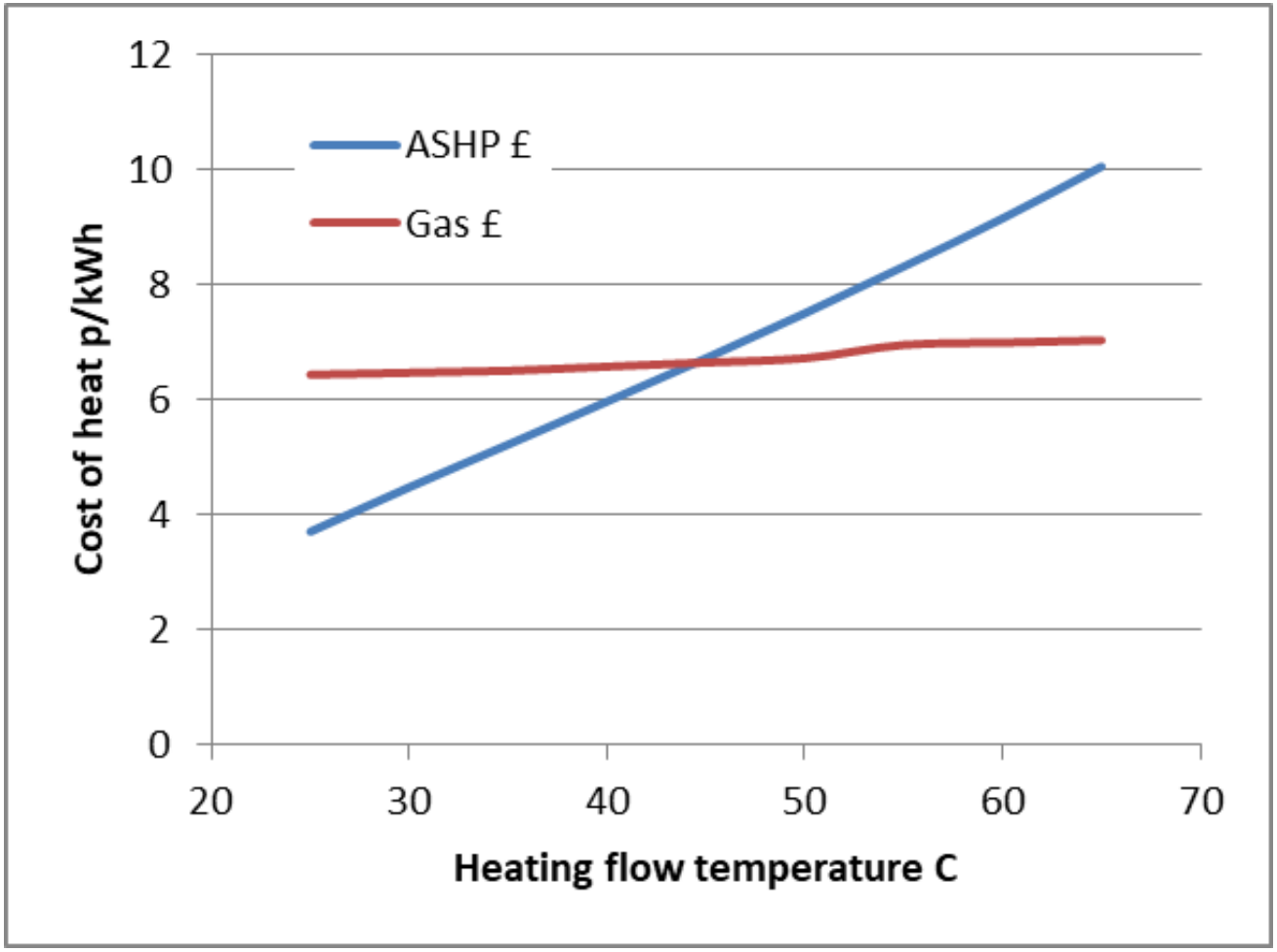


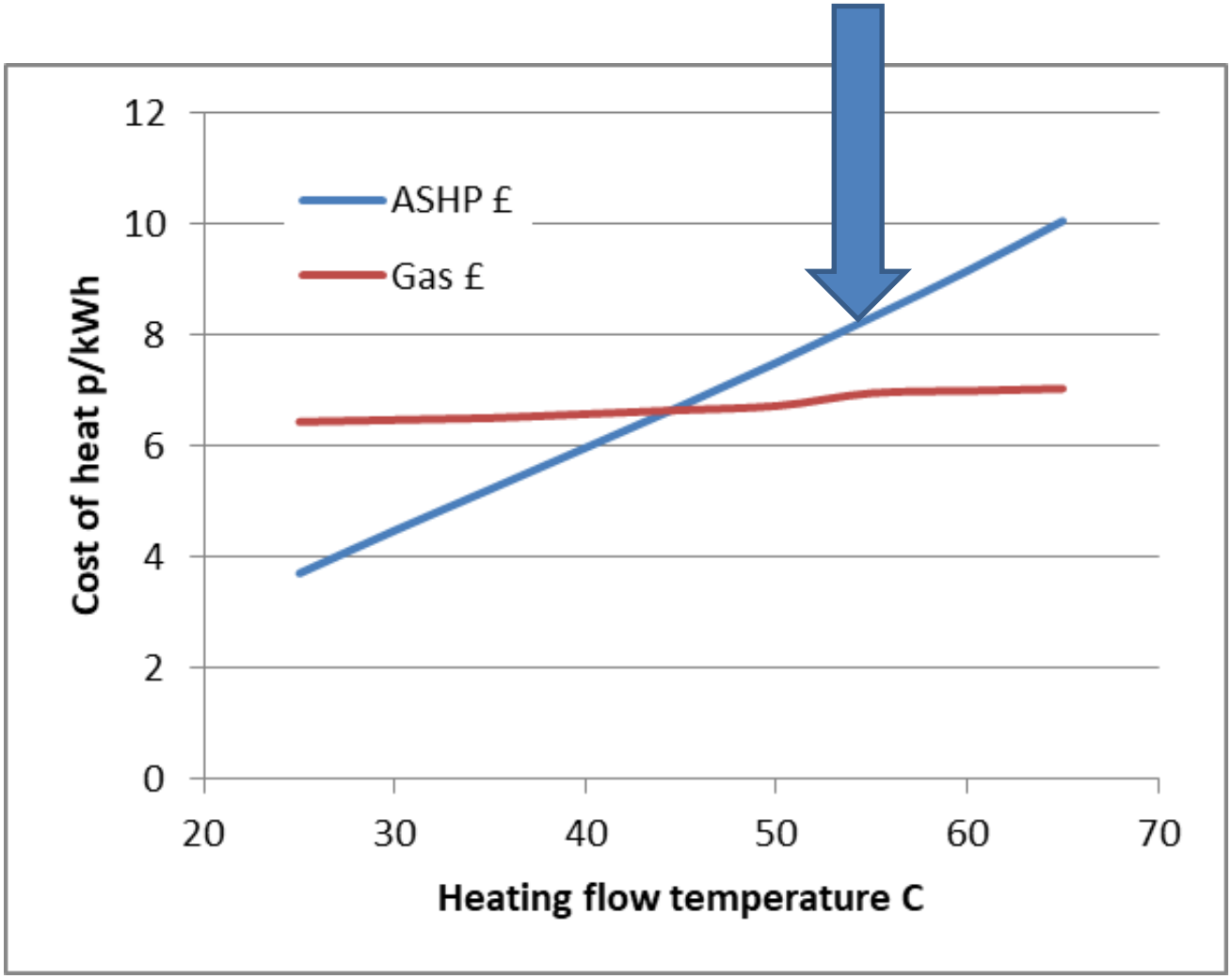
Figure 5.10: COP by difference between internal and external temperatures on the coldest day.

What’s going on?

Remember - low flow temperature for low cost



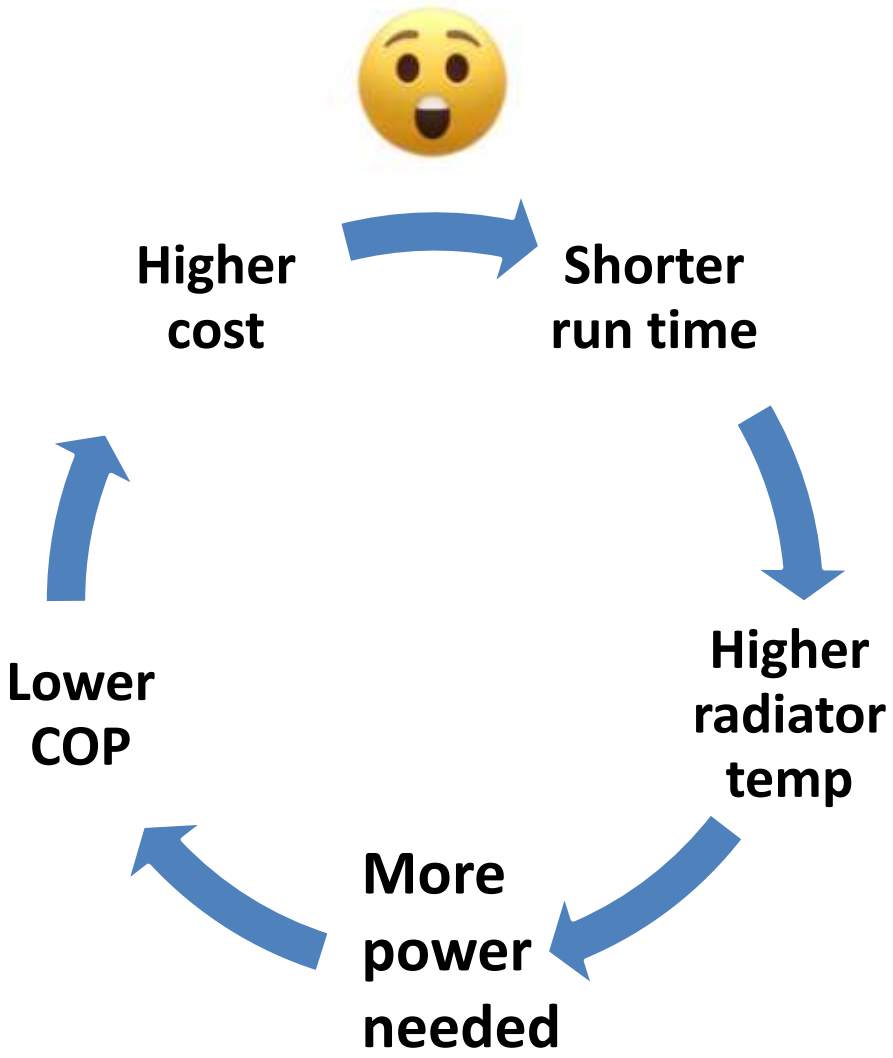
Government and too many installers' idea of 'low temperature'



And then…..people on low incomes are often used to managing costs by shortening heating hours. This *increases* HP temperature and reduces efficiency further!

This can end badly

Heat pump loop of doom



The doom loop in action ☹

- This scenario has played out in real life on more than one occasion, users ended up too frightened to use thier heating at all

What to do?

- Insulate! (and ventilate)
- Talk, support, check - then listen!
- Safety net  ?

Warm rent/heat guarantee?

Cost of 24/7 heat to 16,17,18..?

Savings?

- Occupant health and wellbeing (and earnings)
- Asset protected
- Call-outs reduced, fewer arrears, evictions and voids?
- Reputation of the decarbonisation programme (and its promoters) defended

Playing to heat pump strengths?

Cavity insulation, loft topup, draughtproofing, double glazing, Mech Vent - approx ≡ SHDF 90 kWh/m2.a target

'Heat guarantee'- estimated cost at different temperatures, HP then gas

24hr temp	16	17	18	
flow T	31	33	34	
kWh dem	8073	9200	10462	
kWh used	1734	2040	2304	
COP	4.66	4.51	4.54	
£/year	496	583	659	
per week (+hw)	10	11	13	
per week	**7**	**8**	**10**	
gas cost for same	**11**	**12**	**14**	

Thanks to Alan Clarke for modelling

Thank you

[Report available from Passivhaus Trust here]

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