Resilient Domestic Retrofit: Producing Real World Performance

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The Performance Gap

A problem for new-build housing……

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FEATURES

A load of hot air

Are the guarantees offered for new-builds worth the paper they are printed on? Overoptimistic claims about energy use are misleading buyers

Sarah Lonsdale   Published: 22 November 2015

Comment (0)   Print

Mind the energy gap: Jo Donaldson with her daughter, Charlotte. The family's new home in Suffolk was insulated so badly that £1 coins could be fitted between the joins in the windows (Vicki Couchman)

The Performance Gap

A problem for new-build housing……

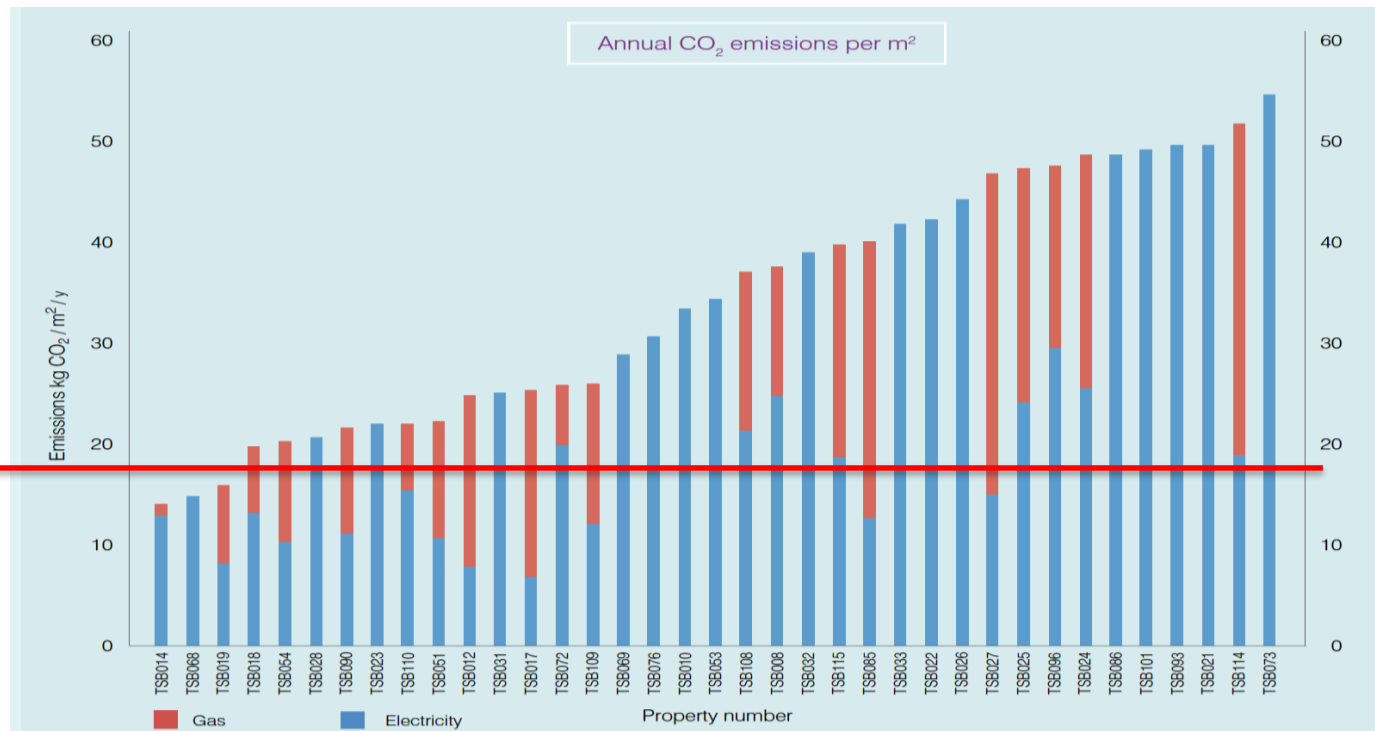….an even bigger problem in retrofit?

The Performance Gap

Where does it come from?:

- Modelling?
- Design?
- Construction quality?
- User behaviour?

Design Target:

From: 'Retrofit Revealed' (2012)

Report on TSB Retrofit for the Future Programme.

The Project

- Stretching design targets –

  - $17 kgCO_2/m^2$.year total carbon emissions

  - 60 kWh/m^2.year Space Heating Demand

- 9 homes scattered across Greater Manchester (8 'whole house')

- Various typologies and occupants

- 'Fabric First' approach

- Design integrated with energy modelling.

- Traditional contract with 'mainstream' contractor.

- Householders 'living in' during the works – not possible to strip back to brick.

- 'Modest' budgets of £20-40K per house.

The Performance Gap

How we tackled it:

- Full SAP (9.92), used carefully, including all energy use (not just regulated)

- Calibrated against actual bills (conscious of 'pre-bound' effect), and informed by householder questionnaire.

- Detailed pre-works surveys and some conservative assumptions about performance. Careful design, integrated with energy model.

- Quality control on site – though within limits of budget and acceptable disruption.
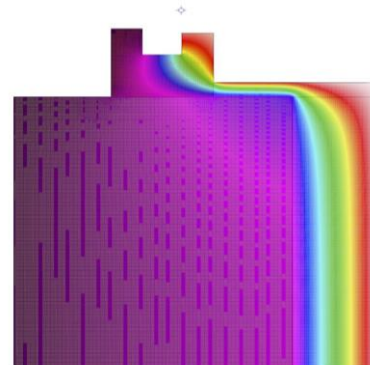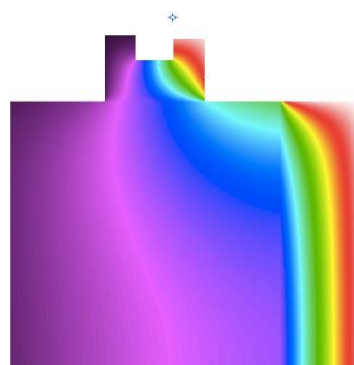
The Data

- Physical data and monitoring by householders, by Carbon Coop and by University of Salford.

- Householder views gathered through surveys by University of Salford, Carbon Coop and independent researchers.

- Difficulties of patchy physical data – esp before works.

- Difficulties of monitoring PV generation and use.

- What level of data is 'good enough' to inform future designs and modelling? To determine the

- Householders limits for being 'guinea pigs' (5 out of 8 consent to full analysis).
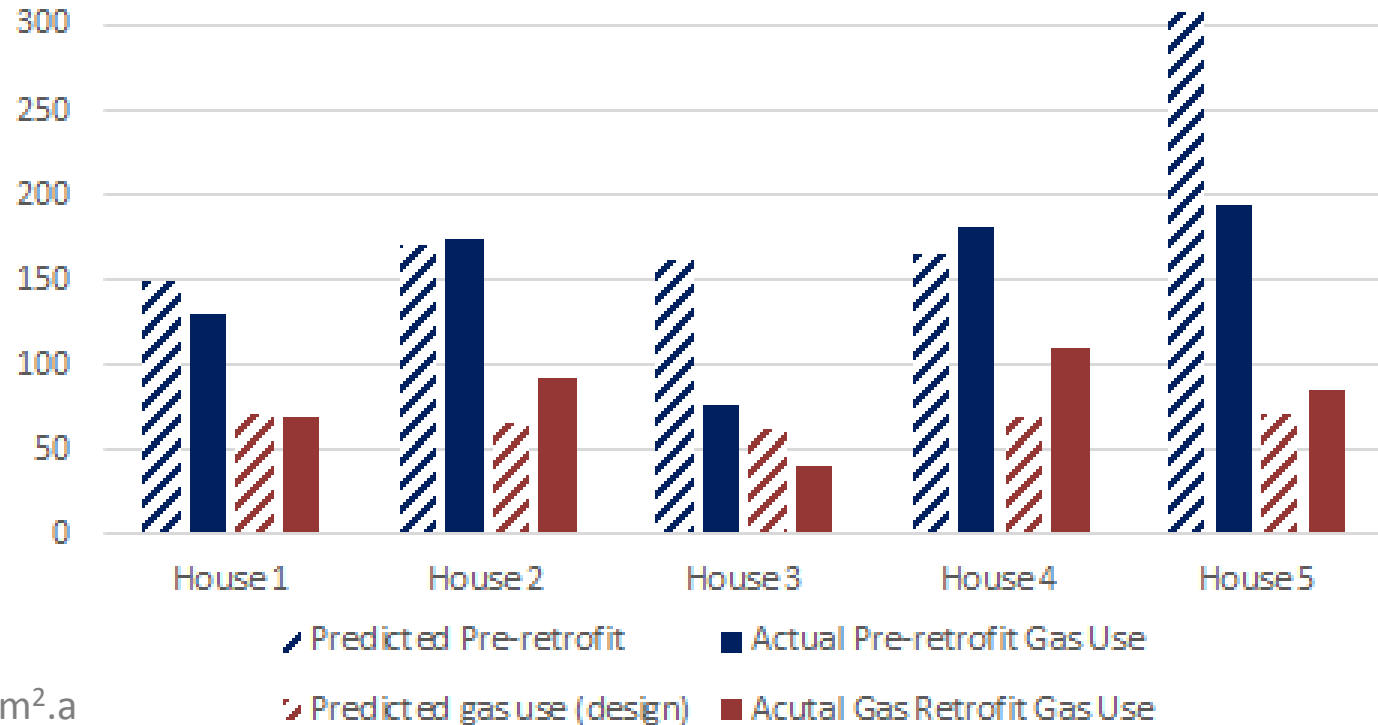
Available data	Salford University Data (days)		Householder data (days)
	Gas data (no reliable elec data)	Temperature RH & CO2 data	Gas / Electricity billing data
House 1	505	515	5170
House 2	0	313	2501
House 3	366	366	3099
House 4	273	203	1790
House 5	243	574	537

The Results

Air-permeability	Before (m3/m2.hr @ 50pa)			After (m3/m2.hr @ 50pa)		
	Modelled (SAP)	Actual (Test to EN13829)	% difference	Modelled (SAP)	Actual (Test to EN13829)	% difference
House 1	13.60	9.43	31% better	5.00	9.22	84% worse
House 2	16.00	n/a	n/a	5.00	8.88	77% worse
House 3	15.40	n/a	n/a	5.00	10.18	103% worse
House 4	21.6	14.55	32% better	5.00	13.55	171% worse
House 5	18.4	16.71	9% better	5.00	11.69	133% worse

The Results

Predicted versus Actual Gas Use kWh/m2.a

UK Average: 170kWh/m².a

'Before' Average: 151kWh/m².a

'After' Average: 79kWh/m².a

The Results

Predicted versus Actual SHD kWh/m2.a

Legend:
- Predicted Pre-retrofit
- Actual Pre-retrofit SHD
- Predicted SHD (design)
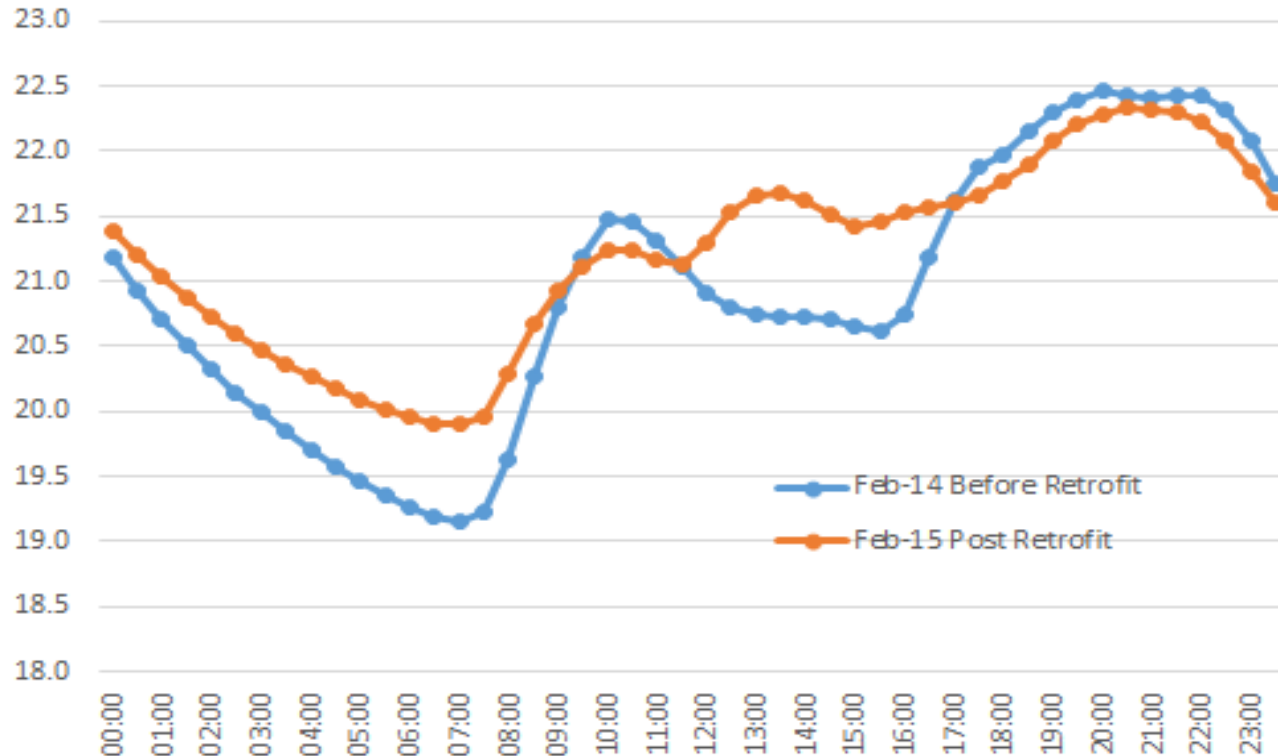- Acutal Gas Retrofit SHD
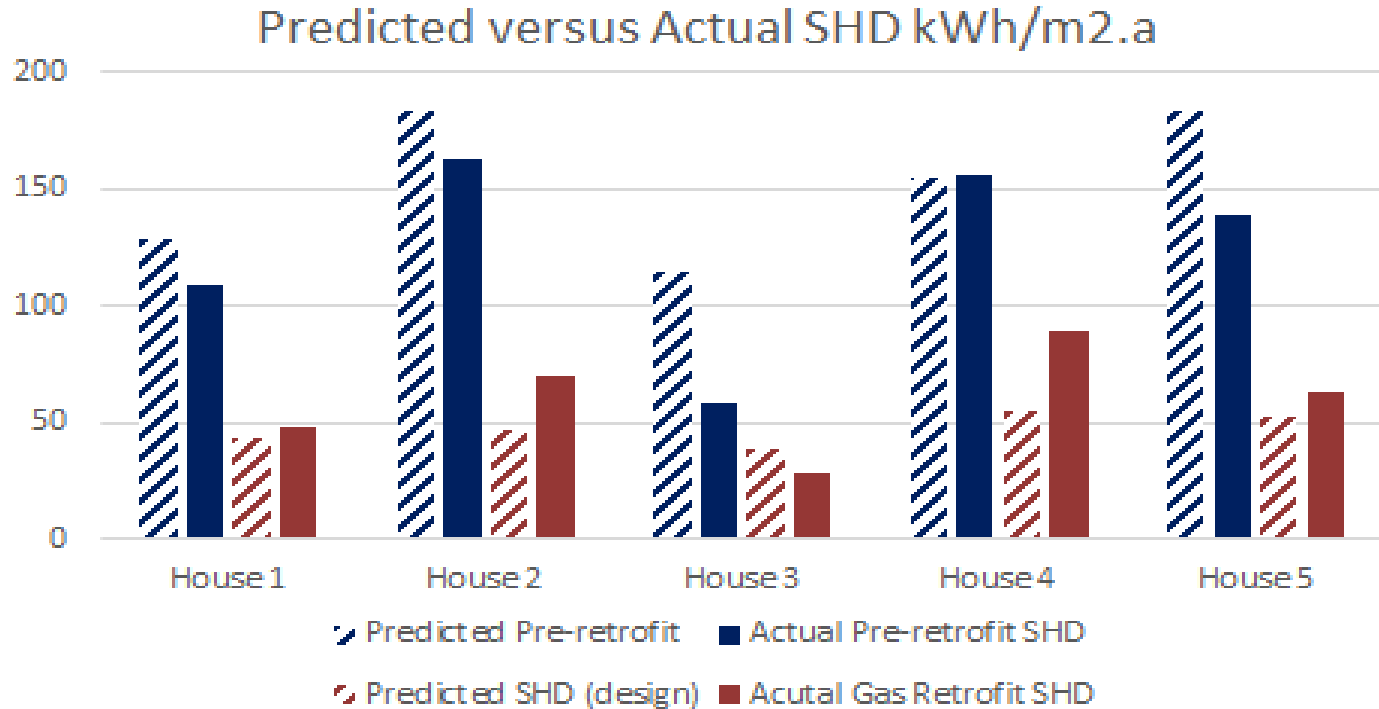
UK Average: 140kWh/m².a

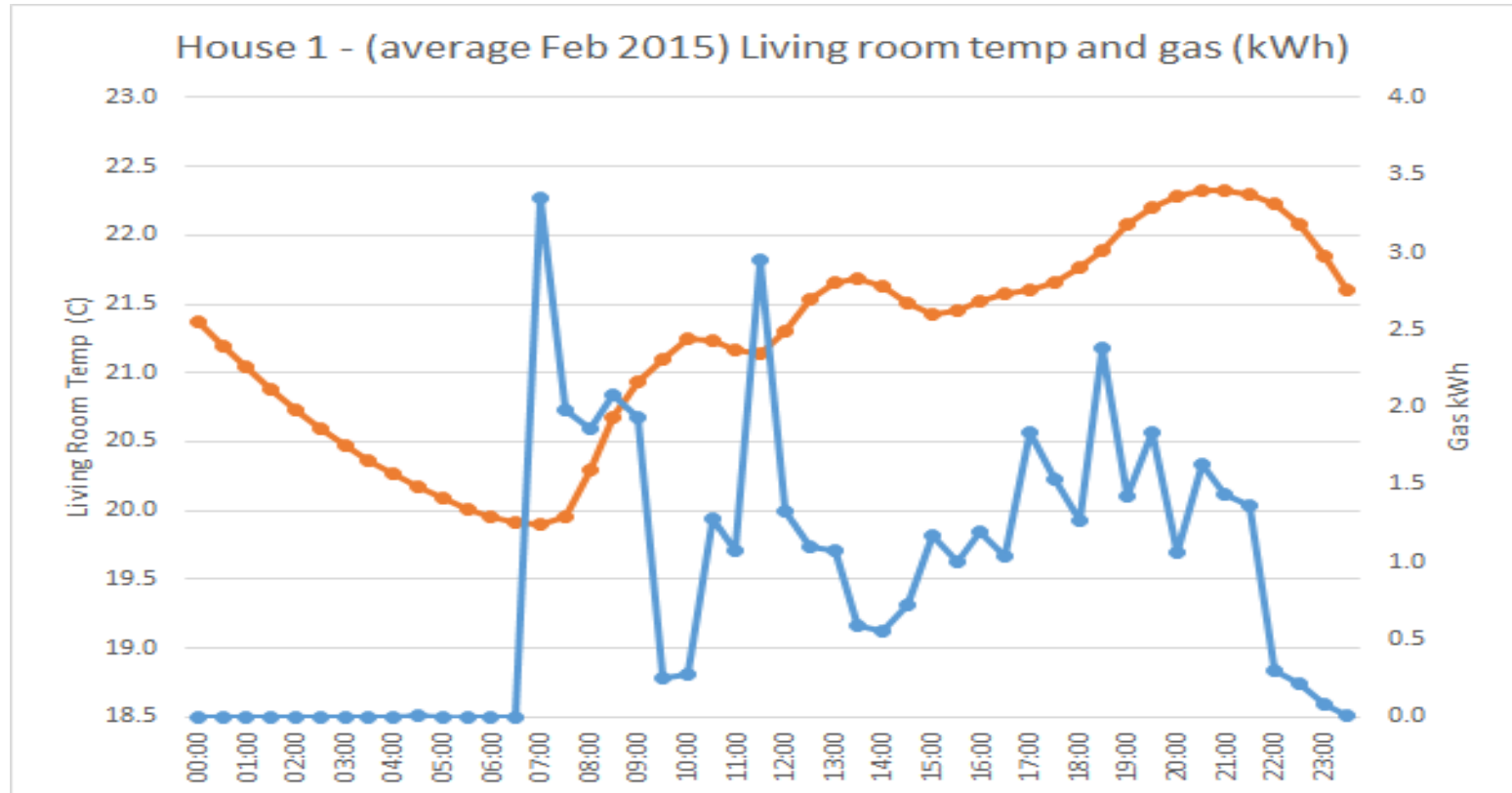'Before' Average: 125kWh/m².a

'After' Average: 60kWh/m².a

The Results

House 1:

Typical living room temperature
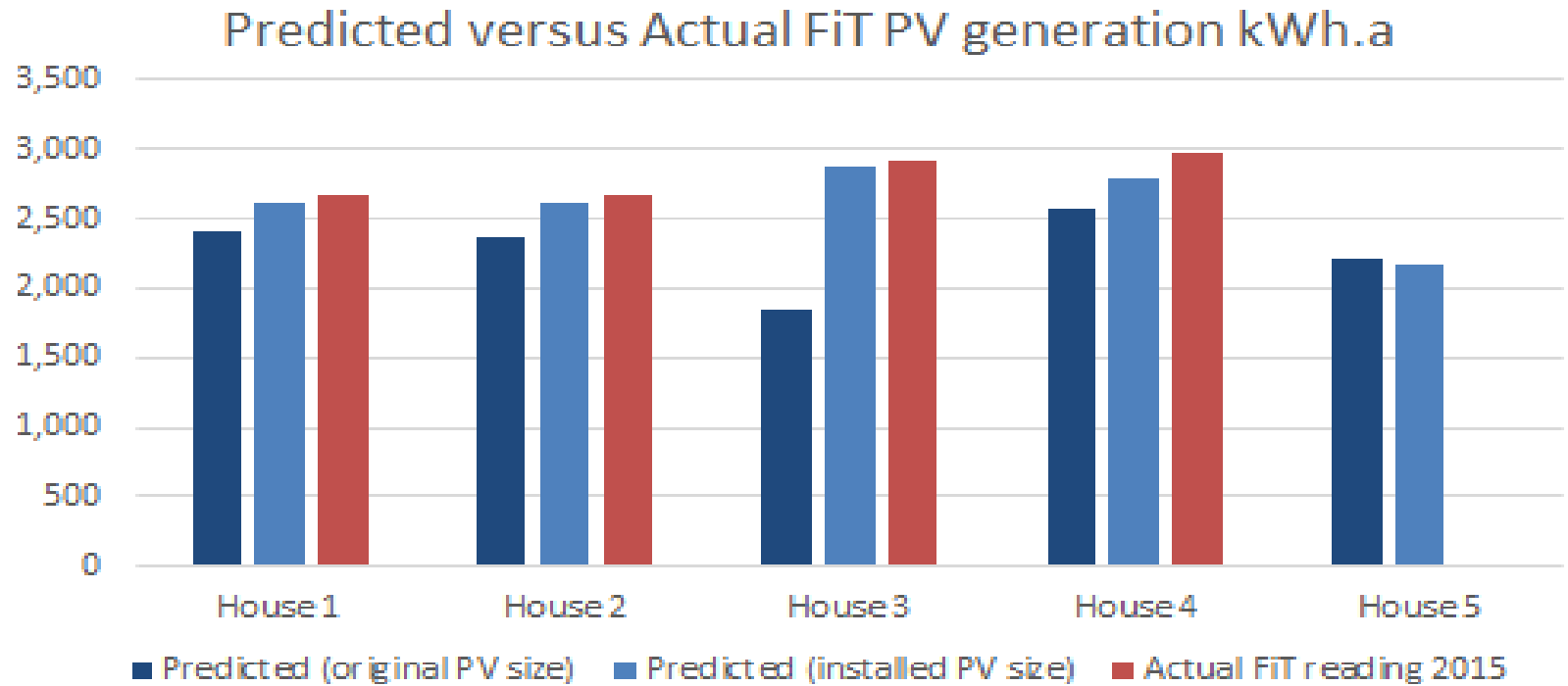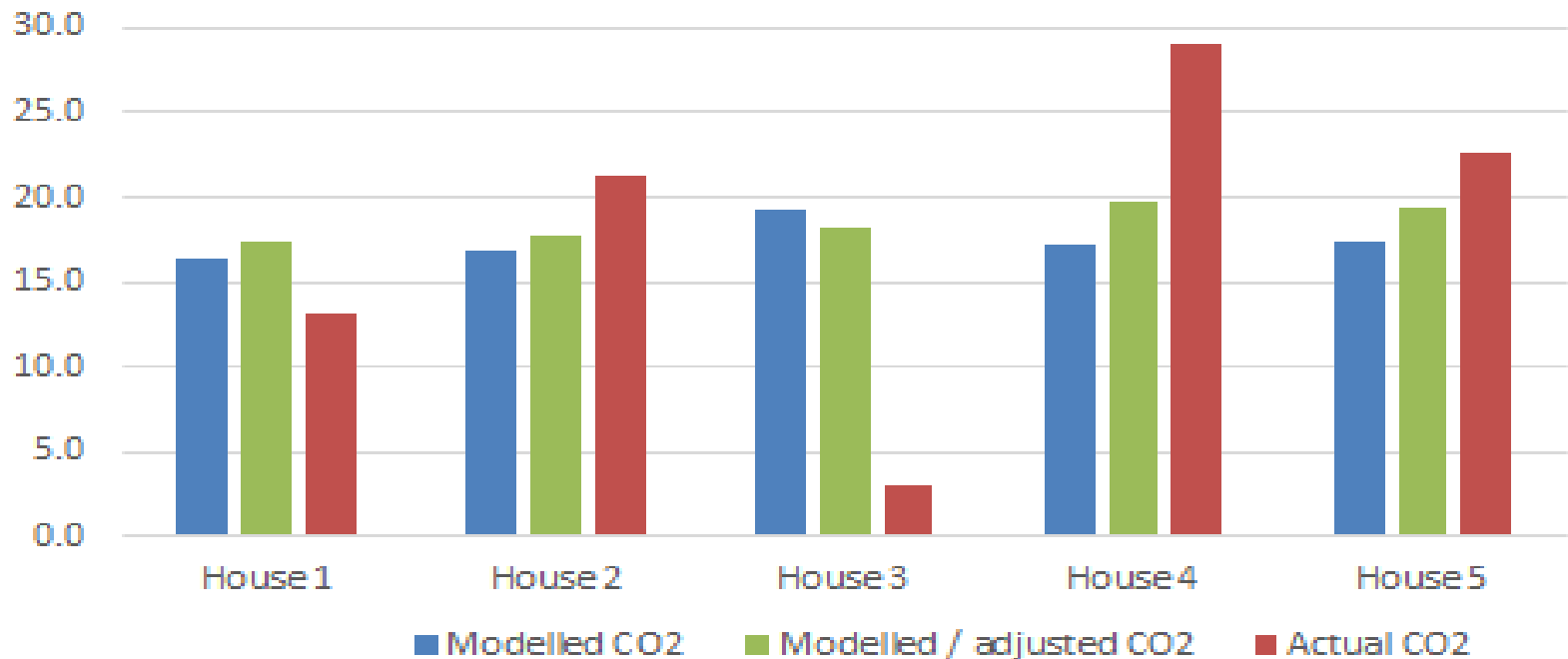
The Results

House 1 - (average Feb 2015) Living room temp and gas (kWh)

The Results

Predicted versus Billed Electricity Consumption kWh.a
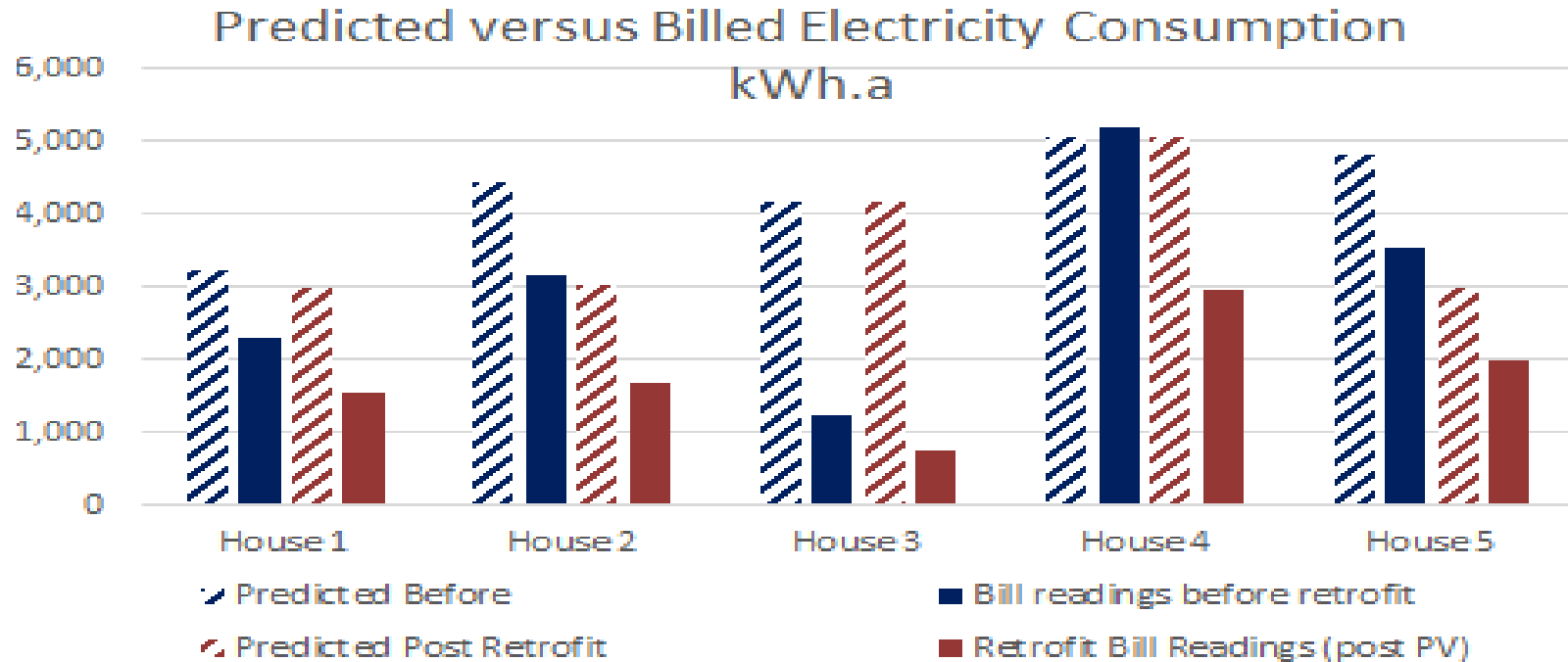
UK Average: 3885kWh , 'Before' Average: 3088kWh, 'After' Average: 1780kWh

The Results

Predicted versus Actual FiT PV generation kWh.a

■ Predicted (original PV size) ■ Predicted (installed PV size) ■ Actual FiT reading 2015

The Results

Post Retrofit CO2 emissions - kgCO2/m2.a

Householders' Views

- Varying tolerance for the disruption involved – not an easy process.

- BUT general perception it was 'worth it' – that homes are now easier to keep warm and more comfortable (see other research and case studies)

- Some possible under-heating (e.g. house 3), some higher temp preferences (e.g. house 4)

- Three householders in programme now on Carbon Coop board

- Others involved in open days and meetups to share learning and experience – staying involved and looking for further improvements (batteries, controls, monitoring….)
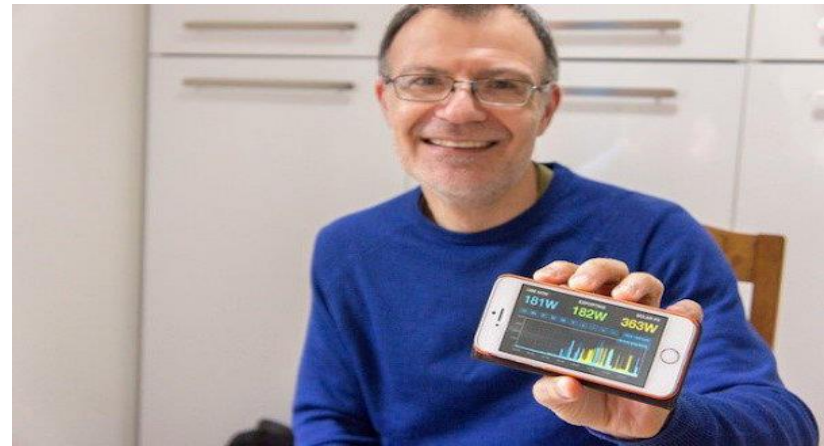
Conclusions

- SAP is not a perfect tool – but 'good enough'?

- Stretching, fabric-based targets help

- Designers can be over optimistic – and builders can under-perform (e.g. air-tightness).

- Getting close to expectations requires follow-through; design > construction > occupation.

- Assumptions about heating patterns, hot water use, electricity use all open to question and need development.

- All models are wrong, some are useful.

- What's possible within large-scale programmes? Speed and scale required.

- Future links with actual data…..?