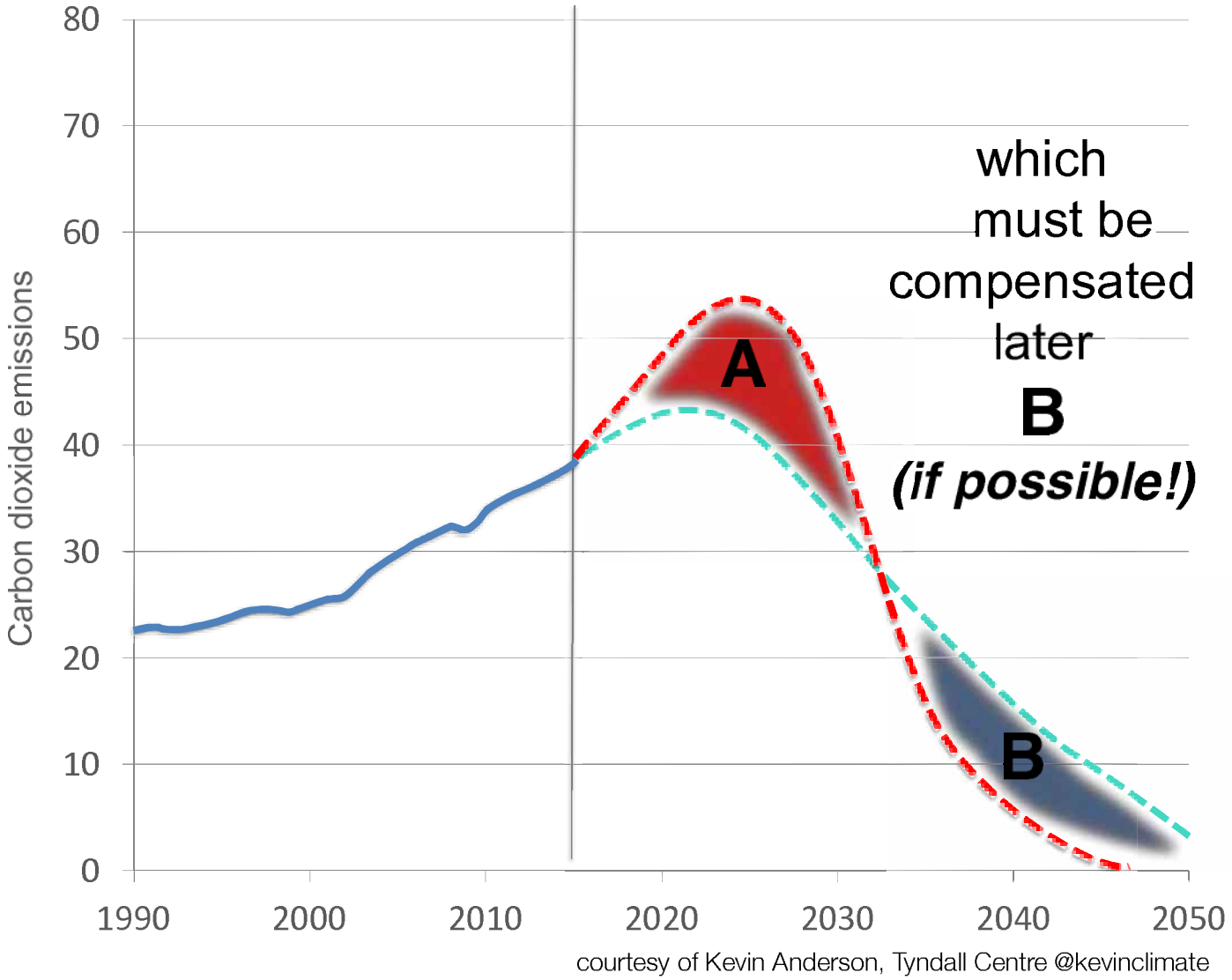
retrofit + decentralised energy = the game changer

- on target to pass the 2ºC target, with no brakes left

business as usual is not going to work

- in 2013 the UK had 9.5 $GtCO_2$ still left in the budget



There is a widespread view that 4°C is…

- Incompatible with an organised global community
- Beyond ‘adaptation’
- Devastating to eco-systems
- Highly unlikely to be stable (‘tipping points’)

… consequently …

4° C should be avoided at ‘all’ costs

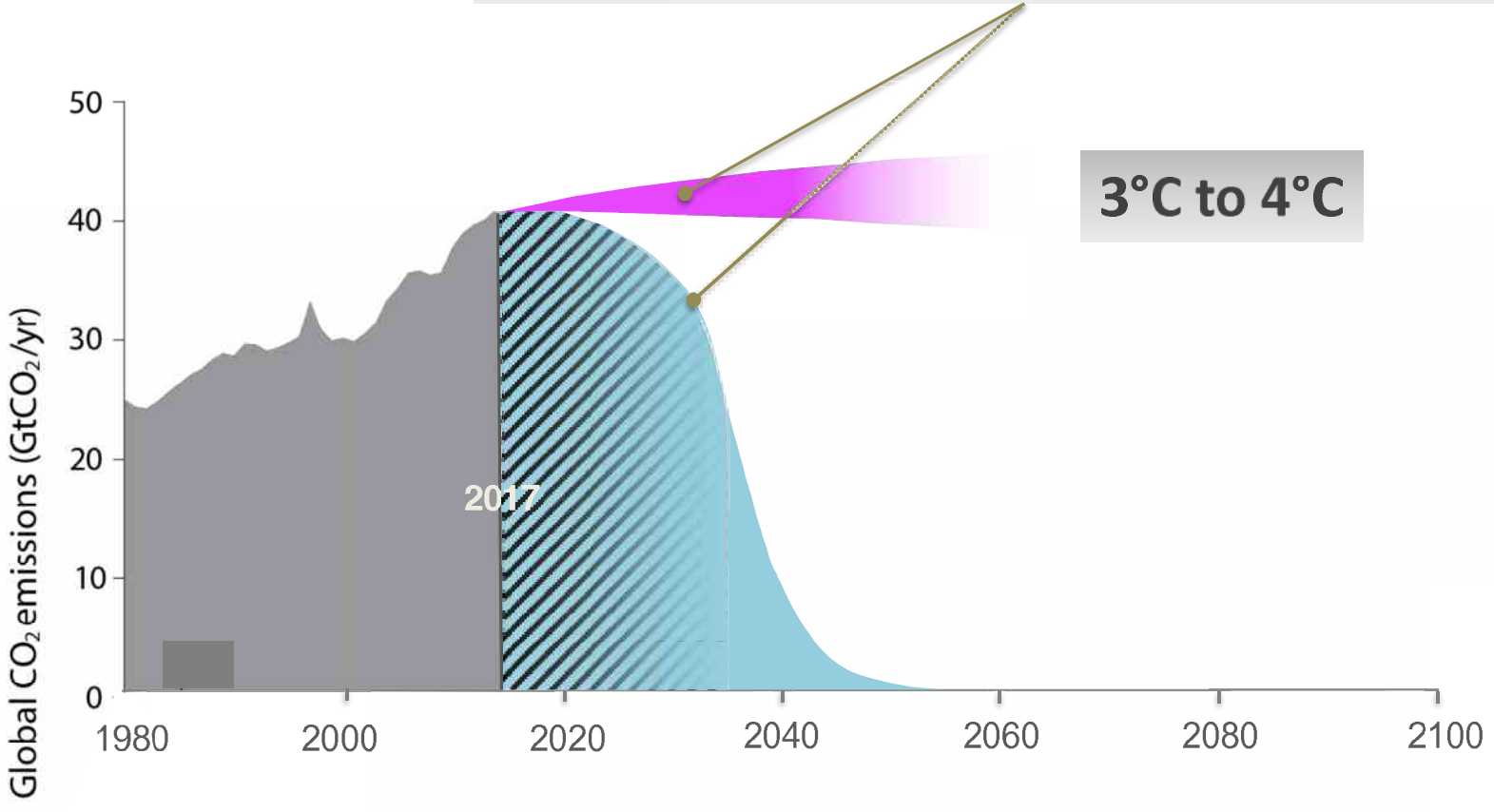
courtesy of Kevin Anderson, Tyndall Centre @kevinclimate

A "romantic illusion"?

"the alliance of technology and economics ends up side-lining anything unrelated to its immediate interests. ... whereas any genuine attempt to introduce change is viewed as a nuisance based on romantic illusions" - the Pope

To move rapidly from current to 2°C pathways, requires

Immediate & deep cuts in ENERGY DEMAND



courtesy of Kevin Anderson, Tyndall Centre @kevinclimate

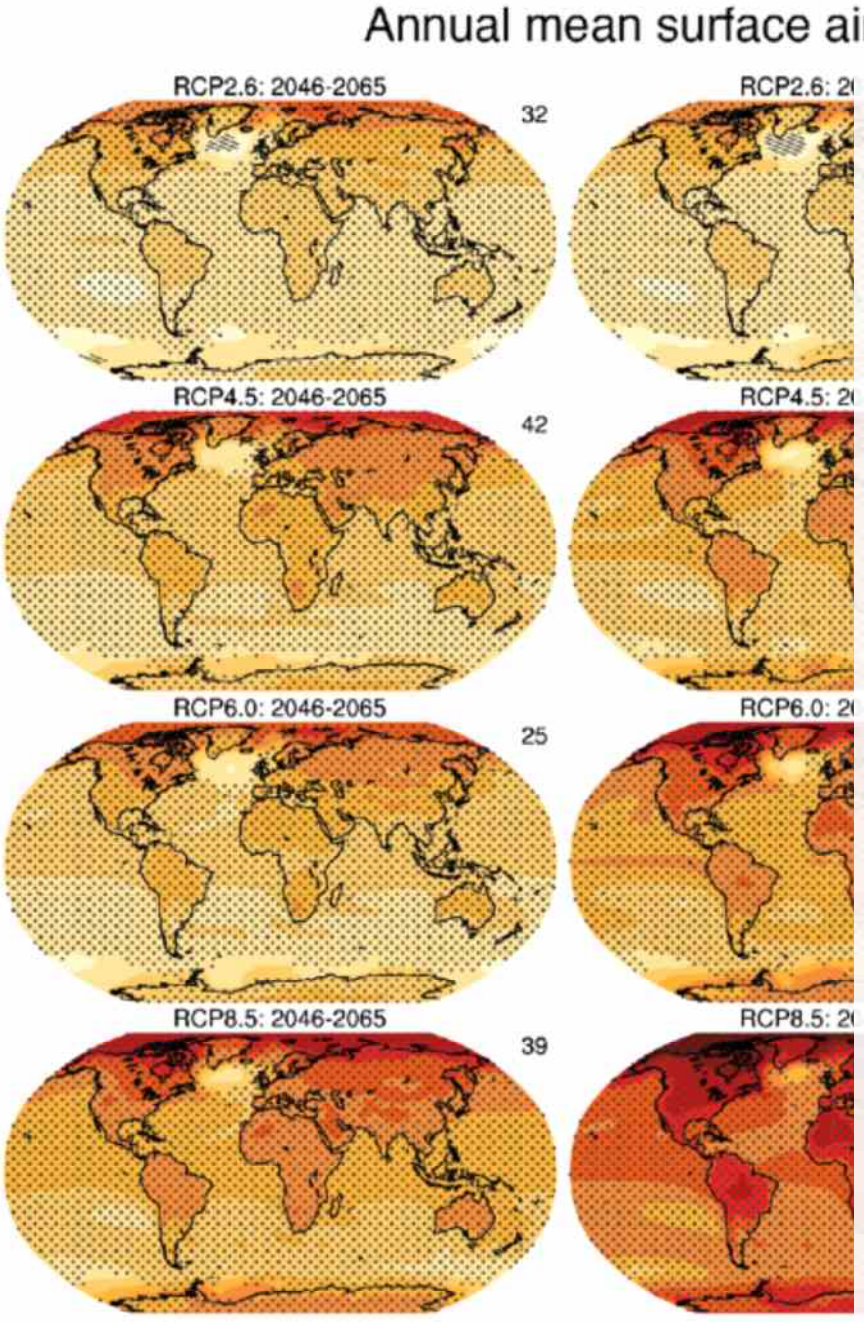
Headline mitigation message for the **UK**

To

- mitigate at **>13% p.a.** starting now
- ~75% reduction in CO_2 by **2025**
- **~fully** decarbonised energy by around **2035**

courtesy of Kevin Anderson, Tyndall Centre @kevinclimate

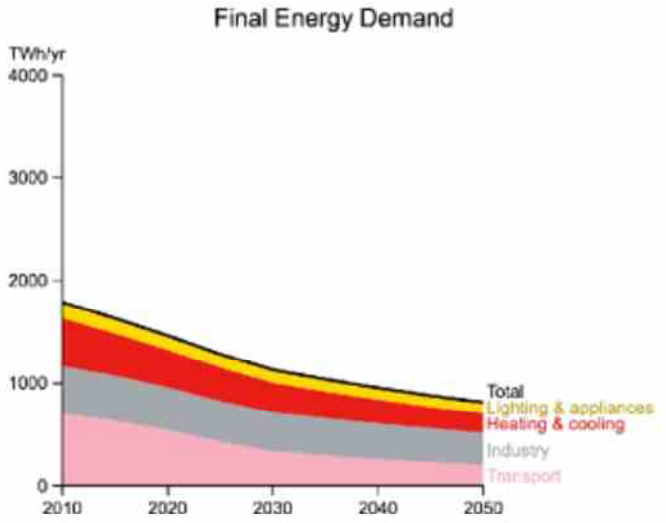
but there's so much more than that:

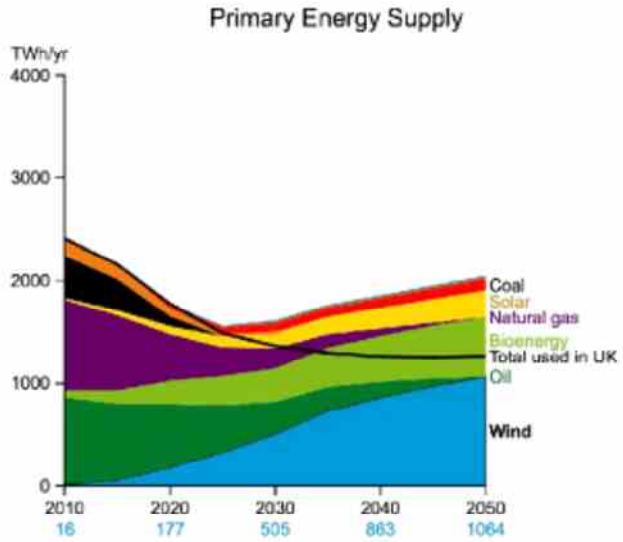


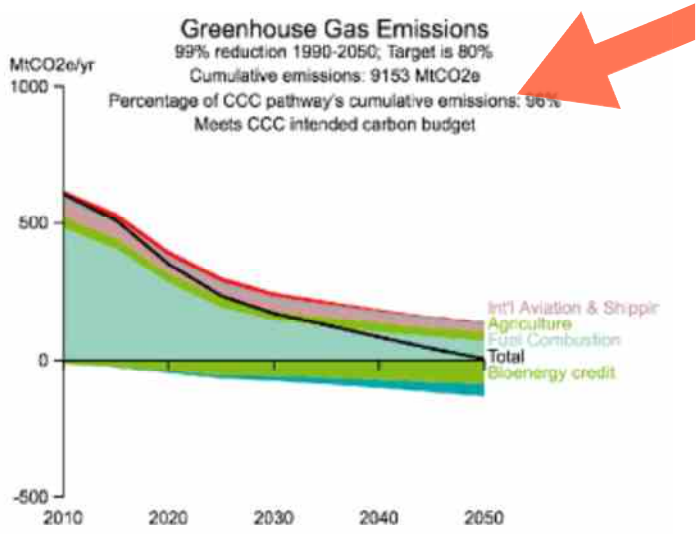
- keeping the lights on
- 60,000 stable blue & white collar jobs in installation alone
- regional 1st mover advantage leading to :
  - more inward investment
  - zero carbon business clusters
  - independent future income
  - fuel price control
  - possibility of poverty alleviation (not just in fuel)
  - comfort, health, regeneration

some numbers: DECC 2050 calculator #2

http://2050.hellings.webfactional.com



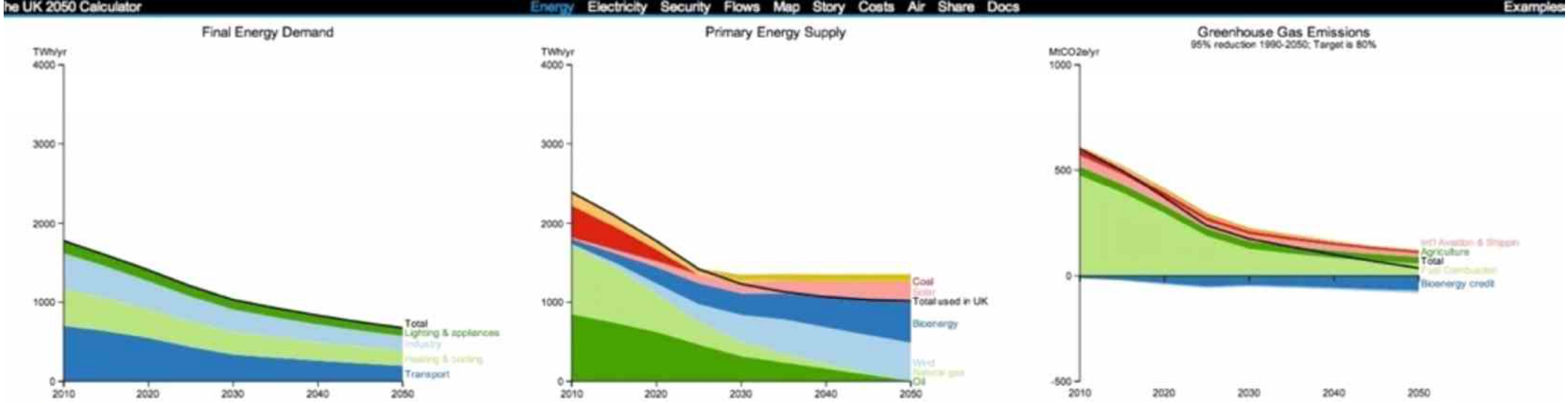




Domestic transport behaviour	?	1	2	3	4
Shift to zero emission transport	?	1	2	3	4
Choice of fuel cells or batteries	?	A	B	C	D
Domestic freight	?	1	2	3	4
International aviation	?	1	2	3	4
International shipping	?	1	2	3	4
Average temperature of homes	?	1	2	3	4
Home insulation	?	1	2	3	4
Home heating electrification	?	A	B	C	D
Home heating that isn't electric	?	A	B	C	D
Home lighting & appliances	?	1	2	3	4
Electrification of home cooking	?	A	B		
Growth in industry	?	A	B	C	
Energy intensity of industry	?	1	2	3	
Commercial demand for heating and cooling	?	1	2	3	4
Commercial heating electrification	?	A	B	C	D
Commercial heating that isn't electric	?	A	B	C	D
Commercial lighting & appliances	?	1	2	3	4
Electrification of commercial cooking	?	A	B		

Nuclear power stations	?	1	2	3	4
CCS power stations	?	1	2	3	4
CCS power station fuel mix	?	A	B	C	D
Offshore wind	?	1	2	3	4
Onshore wind	?	1	2	3	4
Wave	?	1	2	3	4
Tidal Stream	?	1	2	3	4
Tidal Range	?	1	2	3	4
Biomass power stations	?	1	2	3	4
Solar panels for electricity	?	1	2	3	4
Solar panels for hot water	?	1	2	3	4
Geothermal electricity	?	1	2	3	4
Hydroelectric power stations	?	1	2	3	4
Small-scale wind	?	1	2	3	4
Electricity imports	?	1	2	3	4
Land dedicated to bioenergy	?	1	2	3	4
Livestock and their management	?	1	2	3	4
Volume of waste and recycling	?	A	B	C	D
Marine algae	?	1	2	3	4
Type of fuels from biomass	?	A	B	C	D
Bioenergy imports	?	1	2	3	4

Geosequestration	?	1	2	3	4
Storage, demand shifting & interconnection	?	1	2	3	4



Nuclear power stations
CCS power stations
CCS power station fuel mix
Offshore wind
Onshore wind
Wave
Tidal Stream
Tidal Range
Biomass power stations
Solar panels for electricity
Solar panels for hot water
Geothermal electricity
Hydroelectric power stations
Small-scale wind
Electricity imports
Land dedicated to bioenergy
Livestock and their management
Volume of waste and recycling
Marine algae
Type of fuels from biomass
Bioenergy imports

headlines:

- **Nukes are too slow,**
- **we can do this without CCS,**
  (which is good as it doesn't exist)
- **we need all kinds of renewables**
- **but we need to make use of our land and eat less meat**

?	1	2	3	4
?	1	2	3	4
?	A	B	C	D
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
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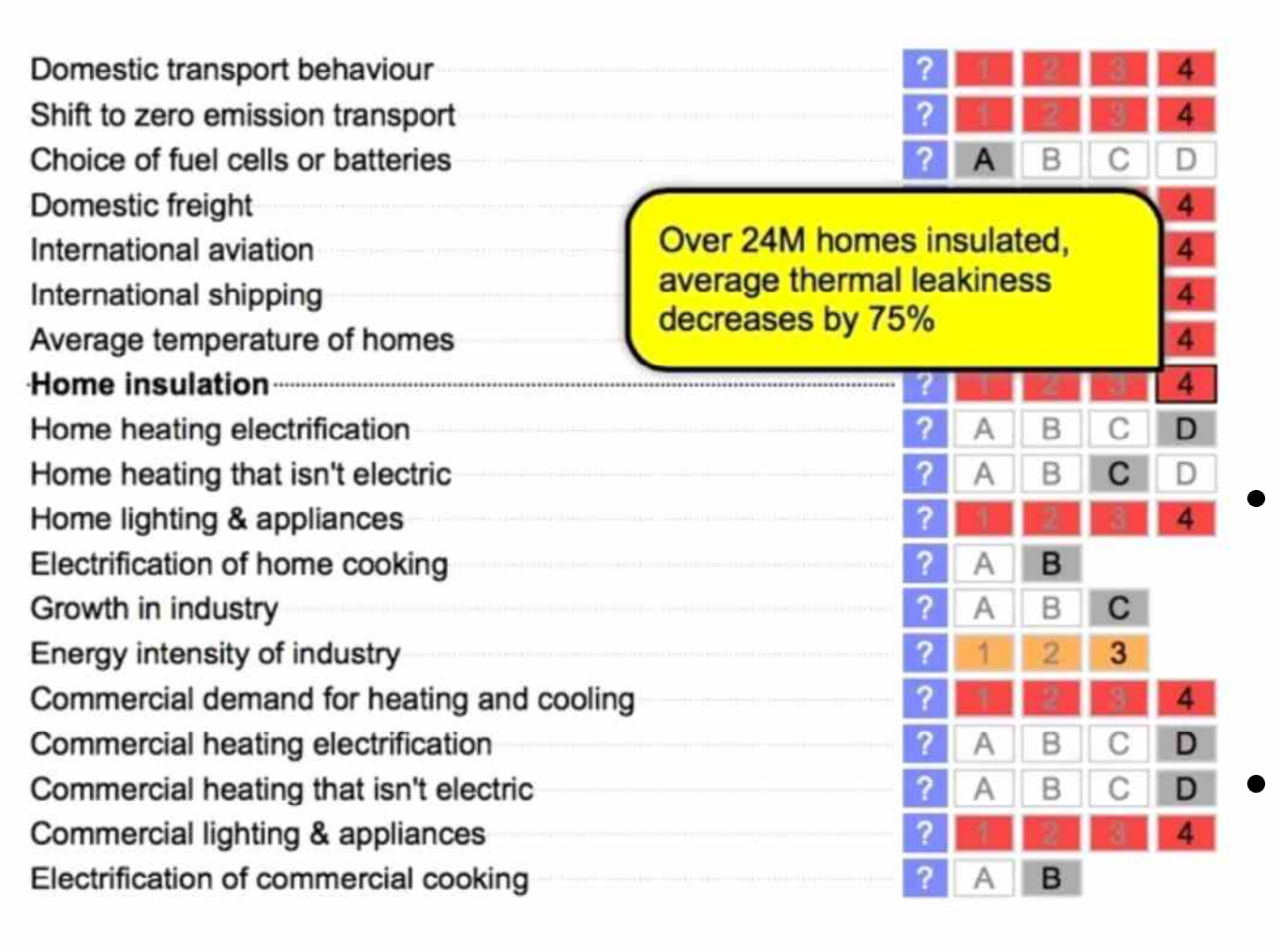
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
?	1	2	3	4
?	A	B	C	D
?	1	2	3	4
?	A	B	C	D
?	1	2	3	4

some numbers: DECC 2050 calculator #2

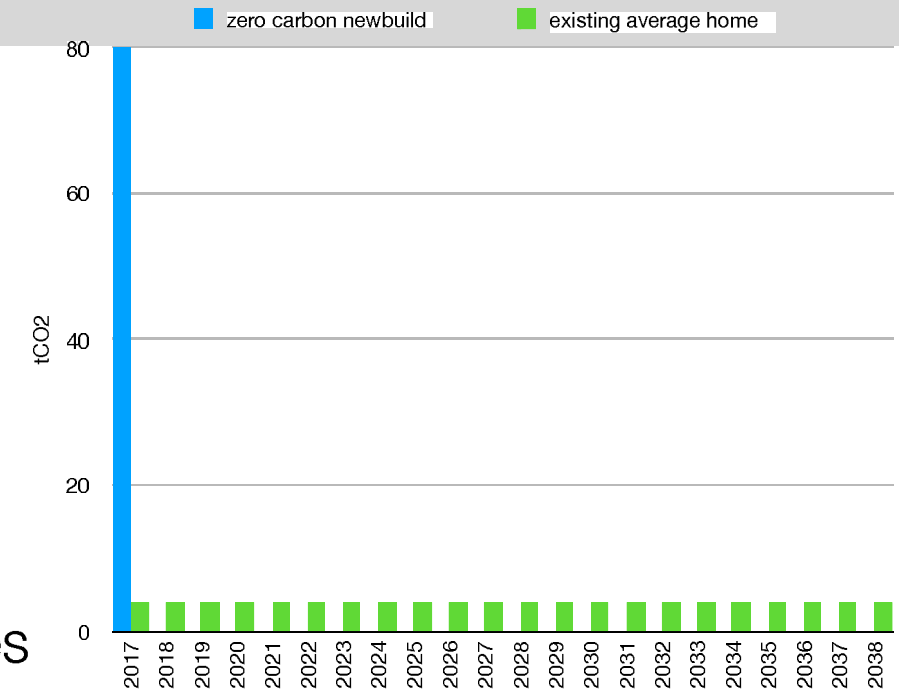


- back in 2013, DECC insisted 50% would be fine
- UKGBC now calling for ‘deep retrofit’

http://2050.hellings.webfactional.com

UK housing stock

- now:
  - 4.1tCO_2/home pA
- by 2038
  - 95% of today's homes will still be standing at current build rates



- each new home currently consumes 50-80tCO_2 to build.

A new 'zero carbon home' may have no net impact on a carbon budget to 2038 compared to an average house!

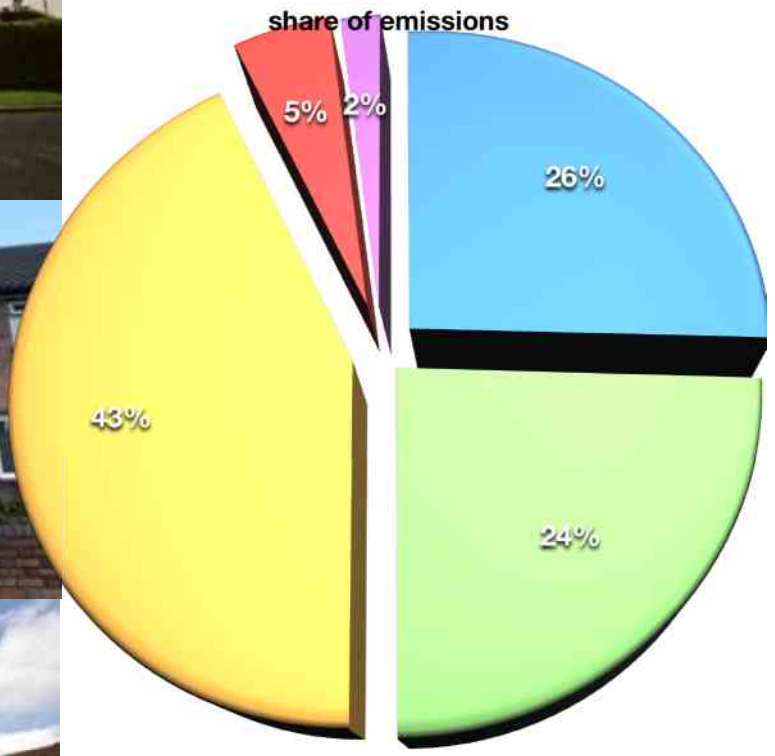
- we have to make better use of our existing buildings,
- new build footprints must massively be reduced or it is a distraction








- where we live
- moving us + stuff around
- business
- public buildings + services
- agriculture + forestry



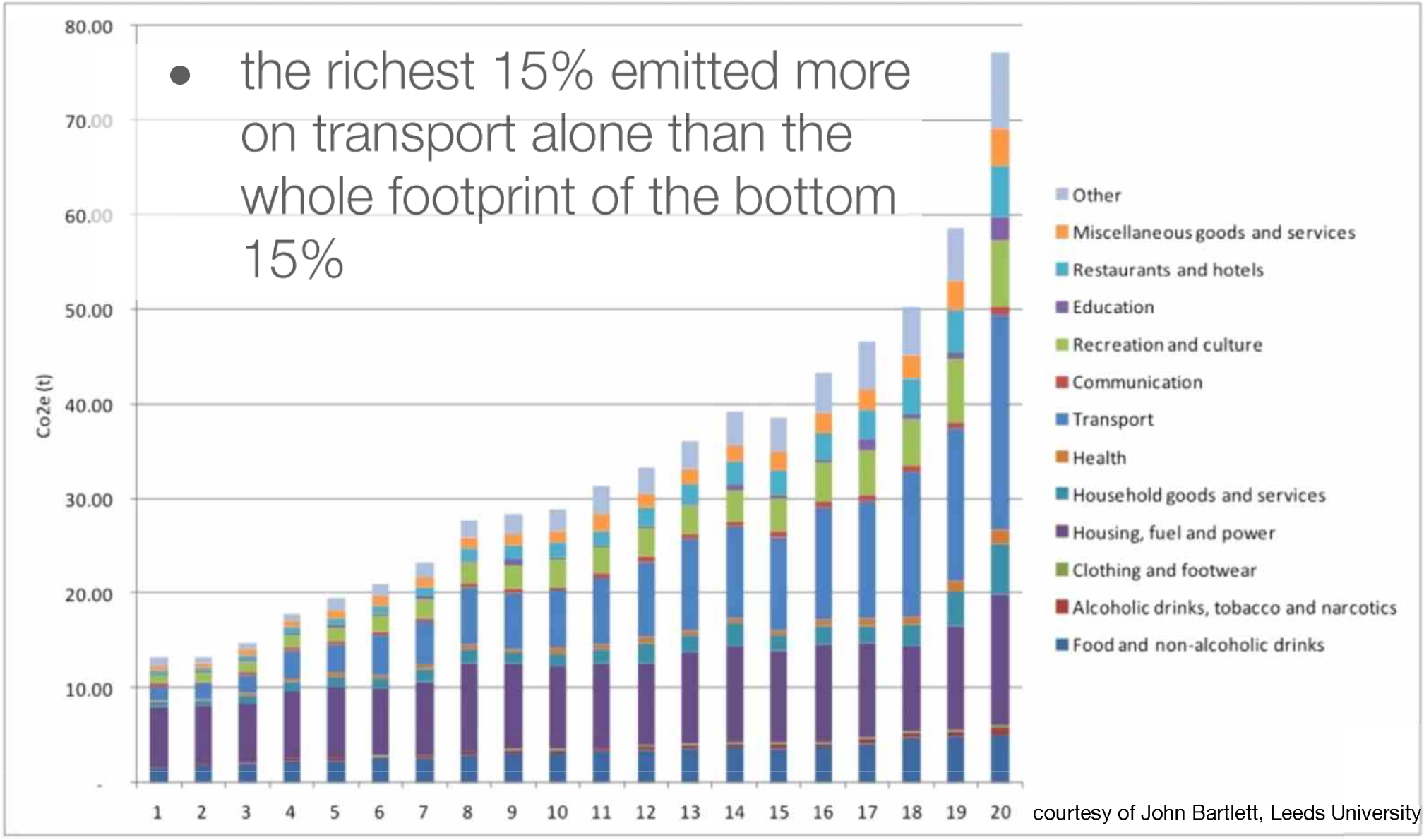
we can make our homes part of a zero carbon energy system

where can you be most effective?

Carbon Emissions by income

UNIVERSITY OF LEEDS

- the richest 15% emitted more on transport alone than the whole footprint of the bottom 15%



courtesy of John Bartlett, Leeds University

what is a retrofit?

building retrofit

it ought to be about regeneration, renewal, reuse.

building retrofit

many of our houses are in a very poor state

but once you've replaced the rotten
floor you can do more interesting things

timber from Heaton Park, recycled steel from Wigan

building retrofit

EWI

external wall insulation

0.2 W/m².K

walls

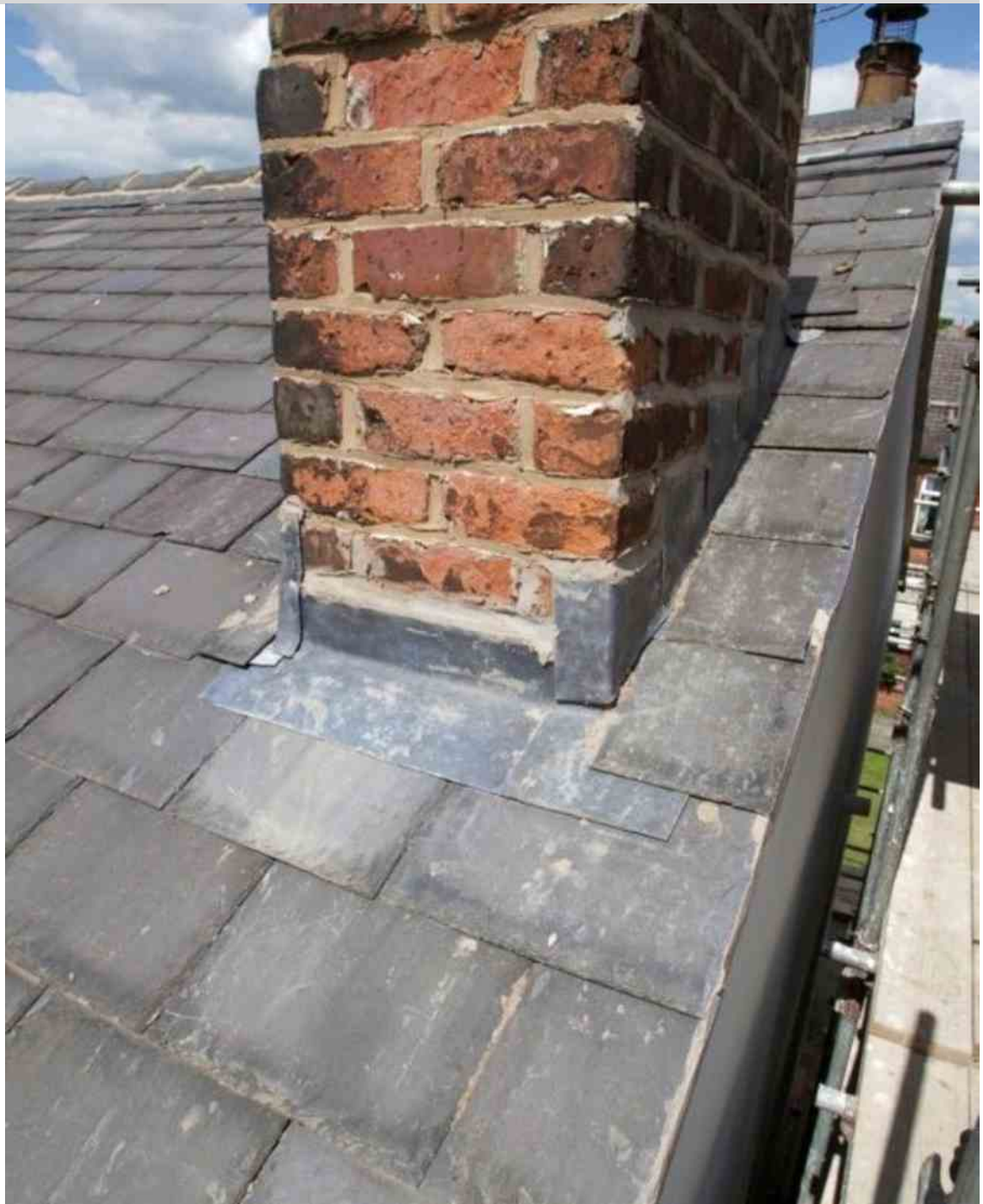
- applied insulation before rendering
- it can’t just stop at the DPC

building
retrofit

we can do a
lot more with
external wall
insulation


it coul e
under here, &
it's a better
alternative to
brick slips

verges



case study:

case study: eaves + EWI

building retrofit

IWI

internal wall insulation
0.3 W/m².K

building retrofit

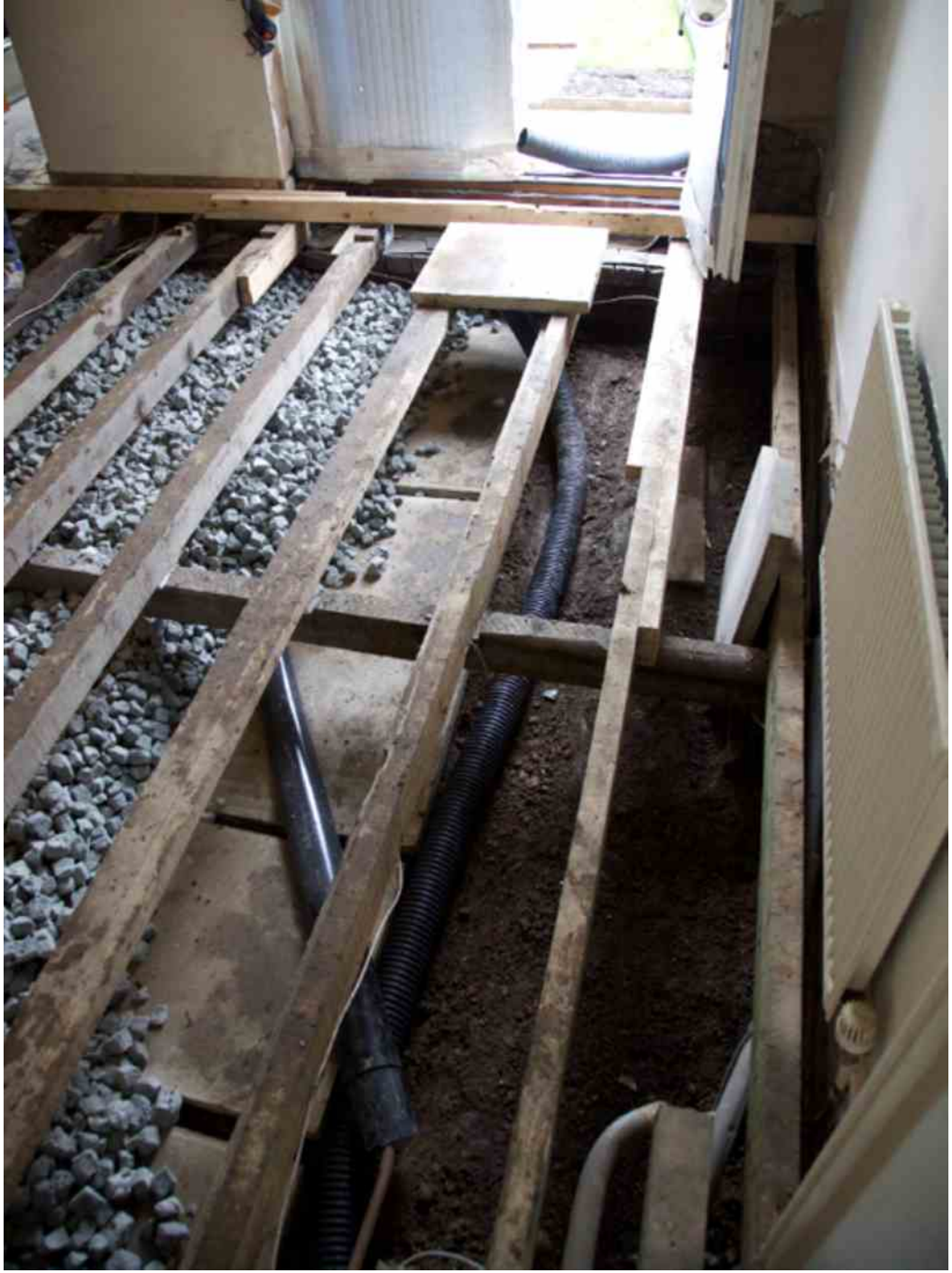
roof

0.1 W/m².K for loft
0.15-0.2 W/m².K for room in roof

building retrofit

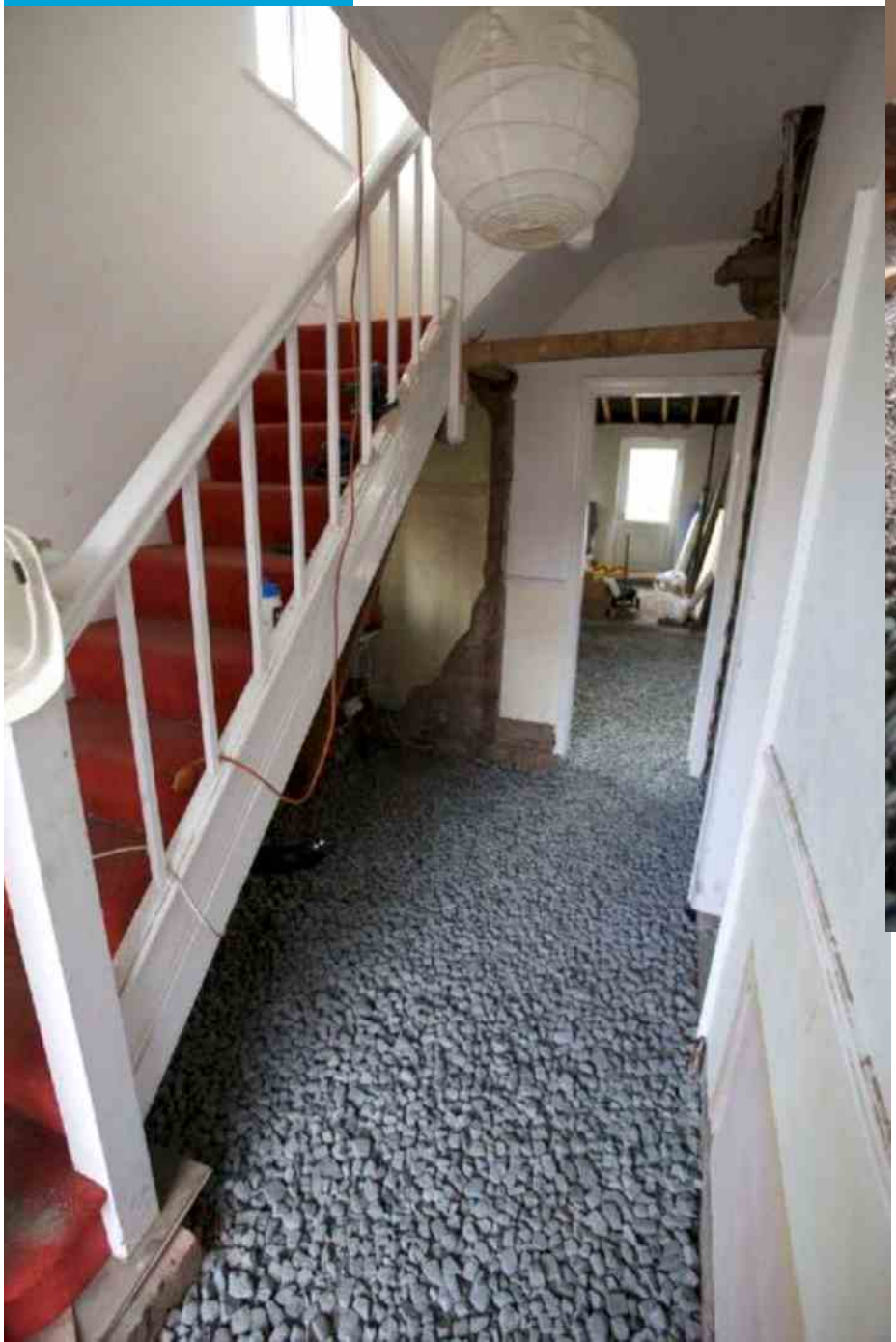
floors

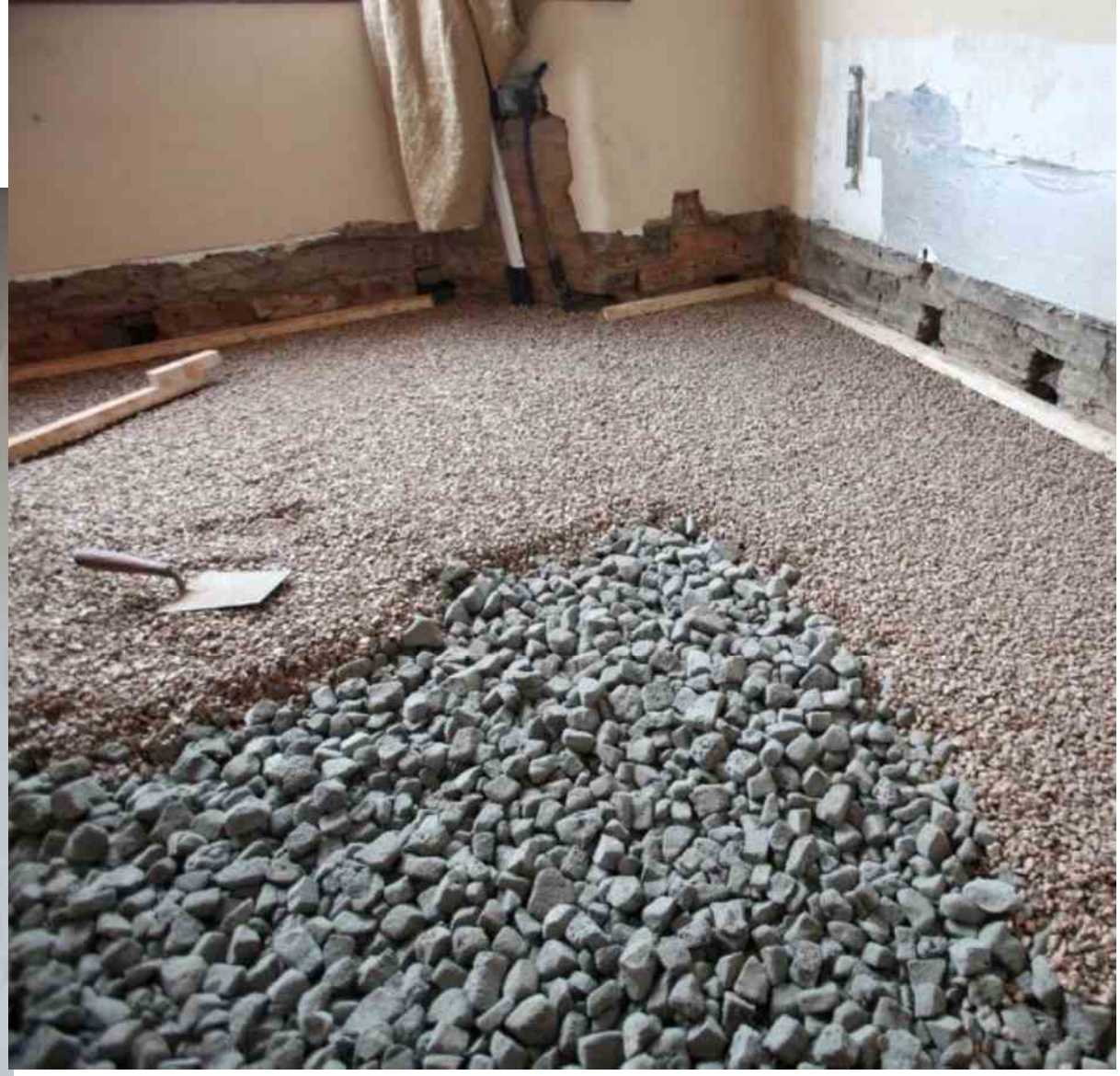
0.15 W/m².K fully insulated
0.4 W/m².K perimeter insulation



some are so damp they need draining

building
retrofit





replacing suspended floor
starting with
recycled glass pumice
insulation

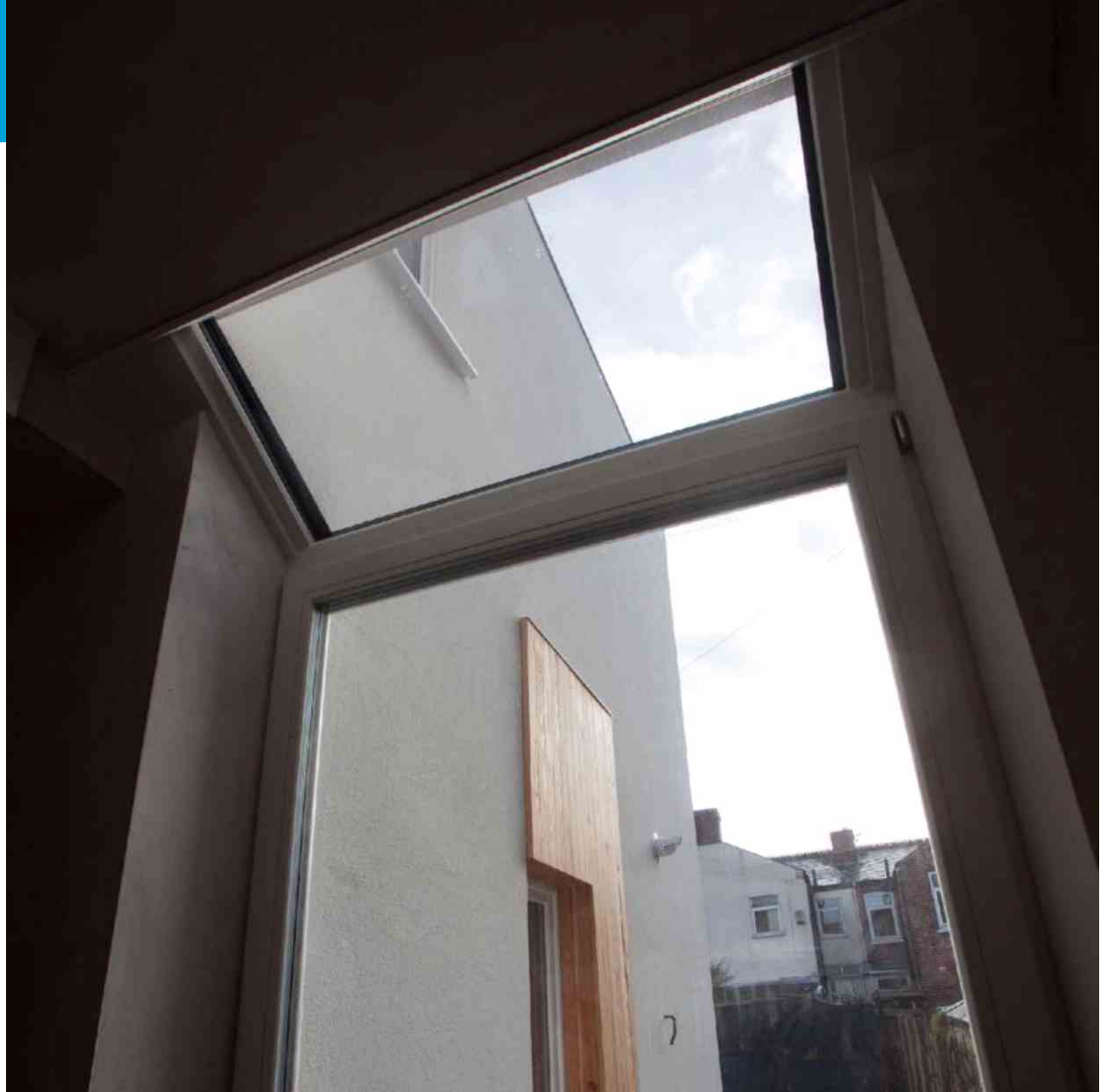
dry ground bearing floor
with underfloor heating

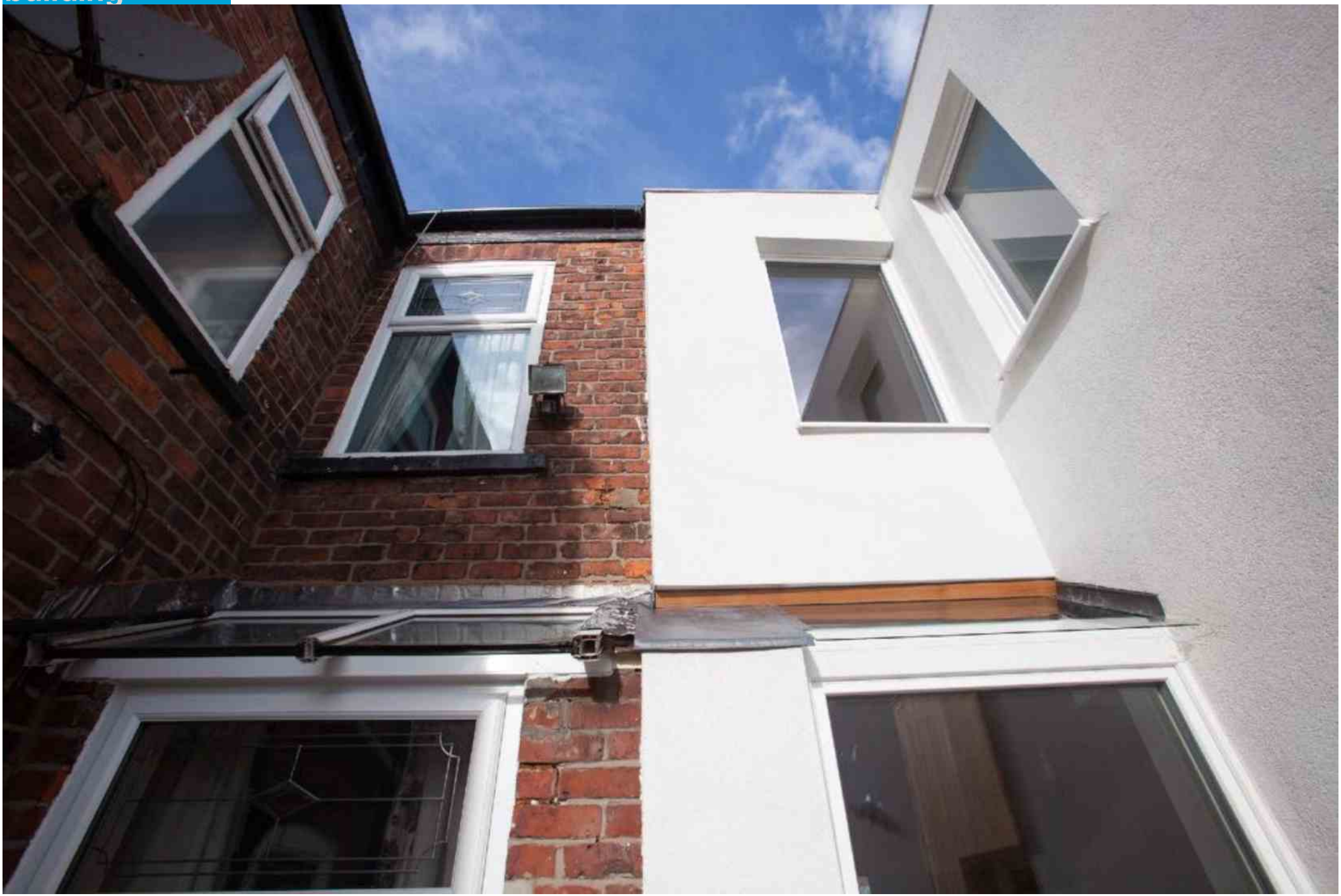
building retrofit

windows & doors

0.85 W/m².K windows
1.0 W/m².K doors

new windows set into insulation on boxes

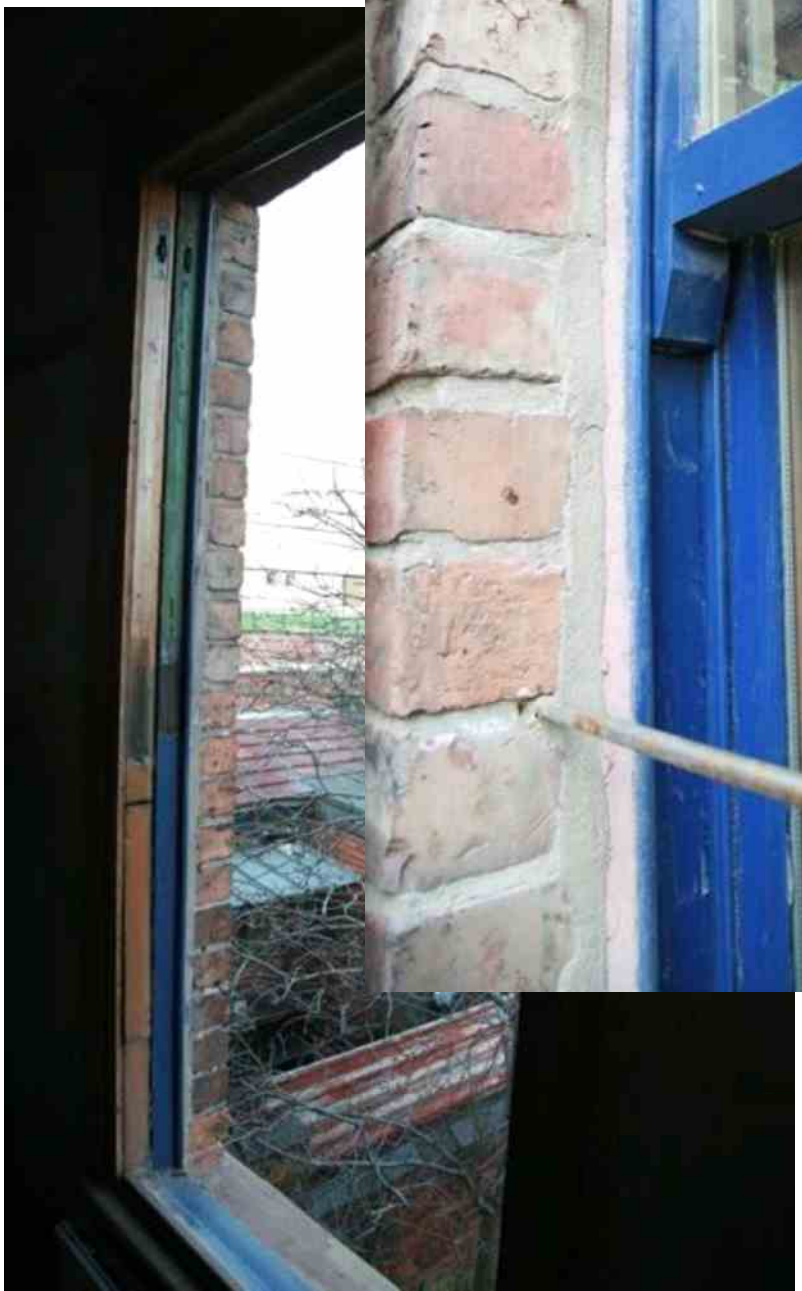





wood fibre
EWI +
retained sash

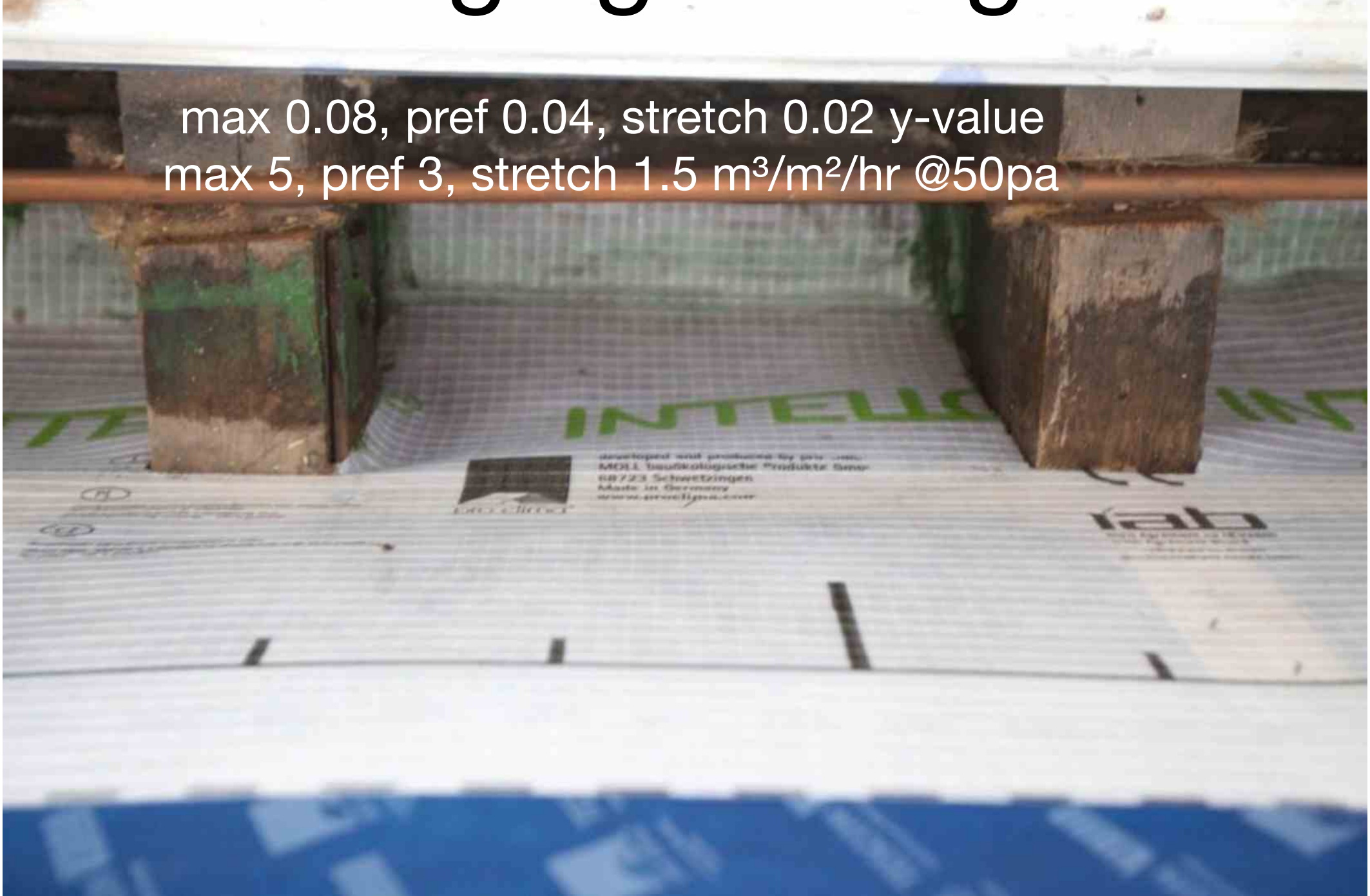

locally made
stainless steel
reveal to reduce
apparent depth

building
retrofit



retained windows

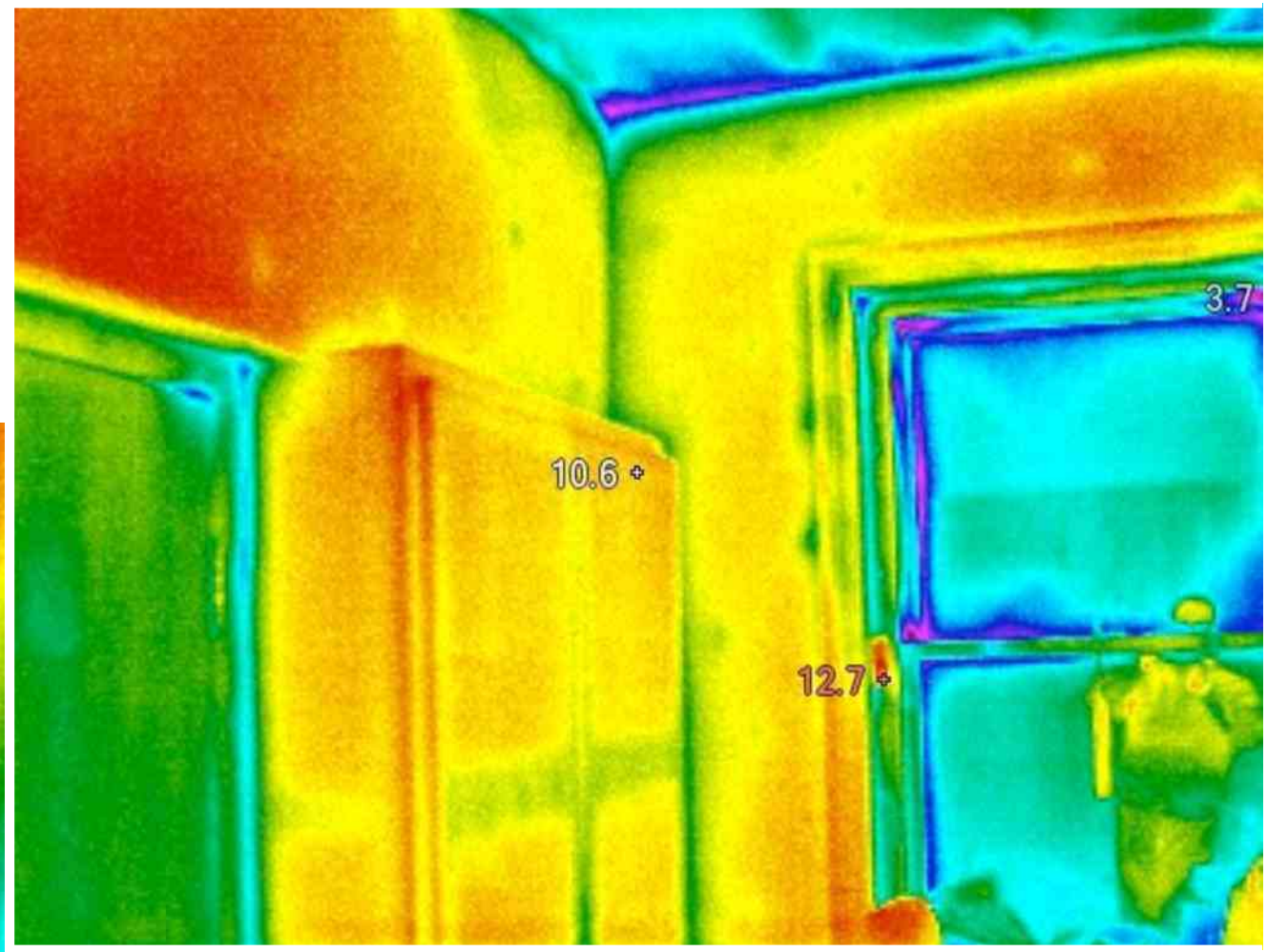
cold bridging & airtightness

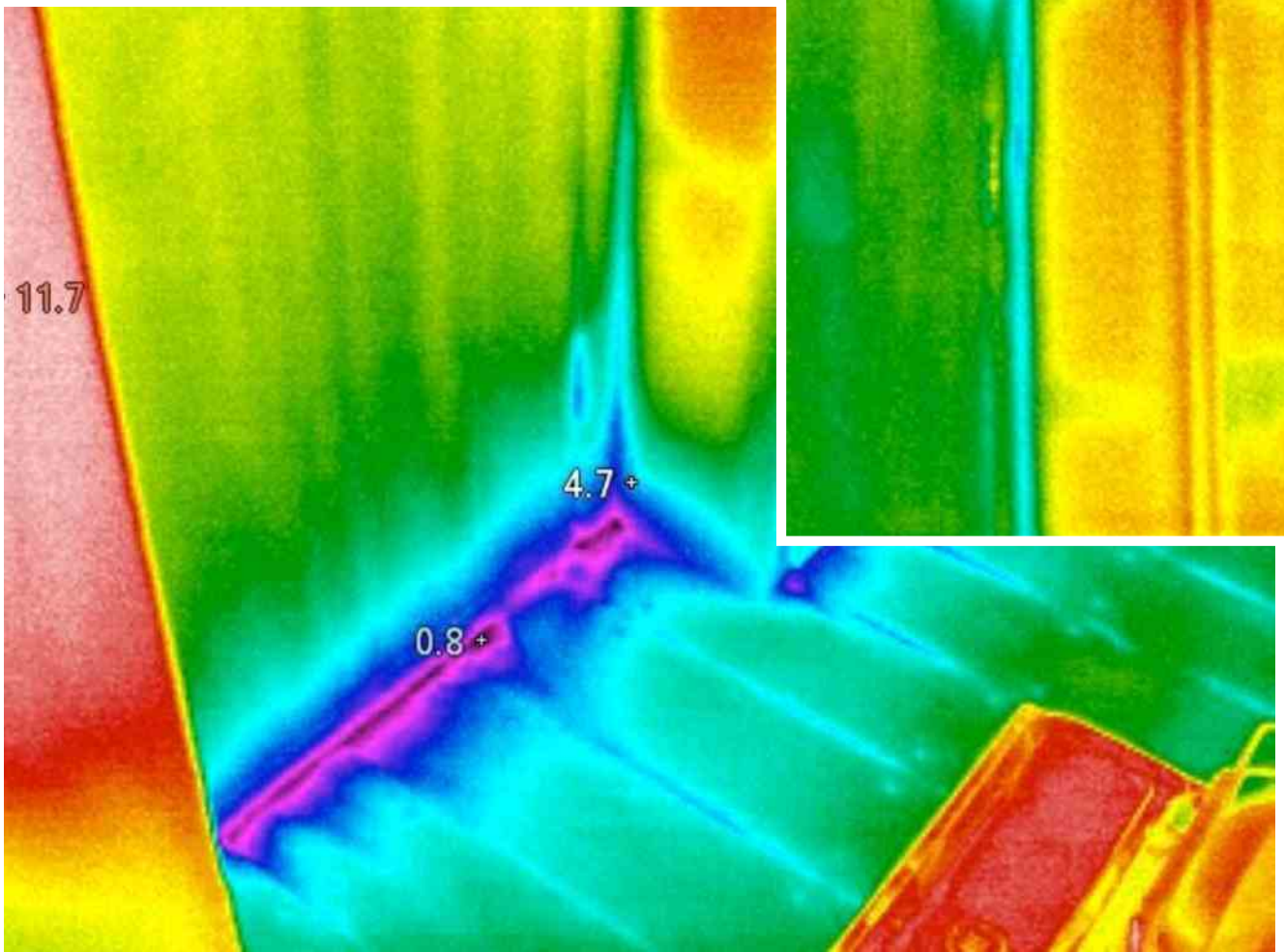



the bit between
the floor &
ceiling

air-tightness #1

- leaks under the door
- around the eaves
- (but the insulated cupboard works)





headlines - cold bridging

psi (Ψ) doesn't even feature in rdSAP yet it can save another 15%*

things like:

- eaves
- edges of all floors
- window reveals
- chimneys
- services are not very big areas or lengths
- porches, conservatories, balconies
- party walls and garden walls

* example property after retrofit measures to FEE at 40W/m2

building retrofit

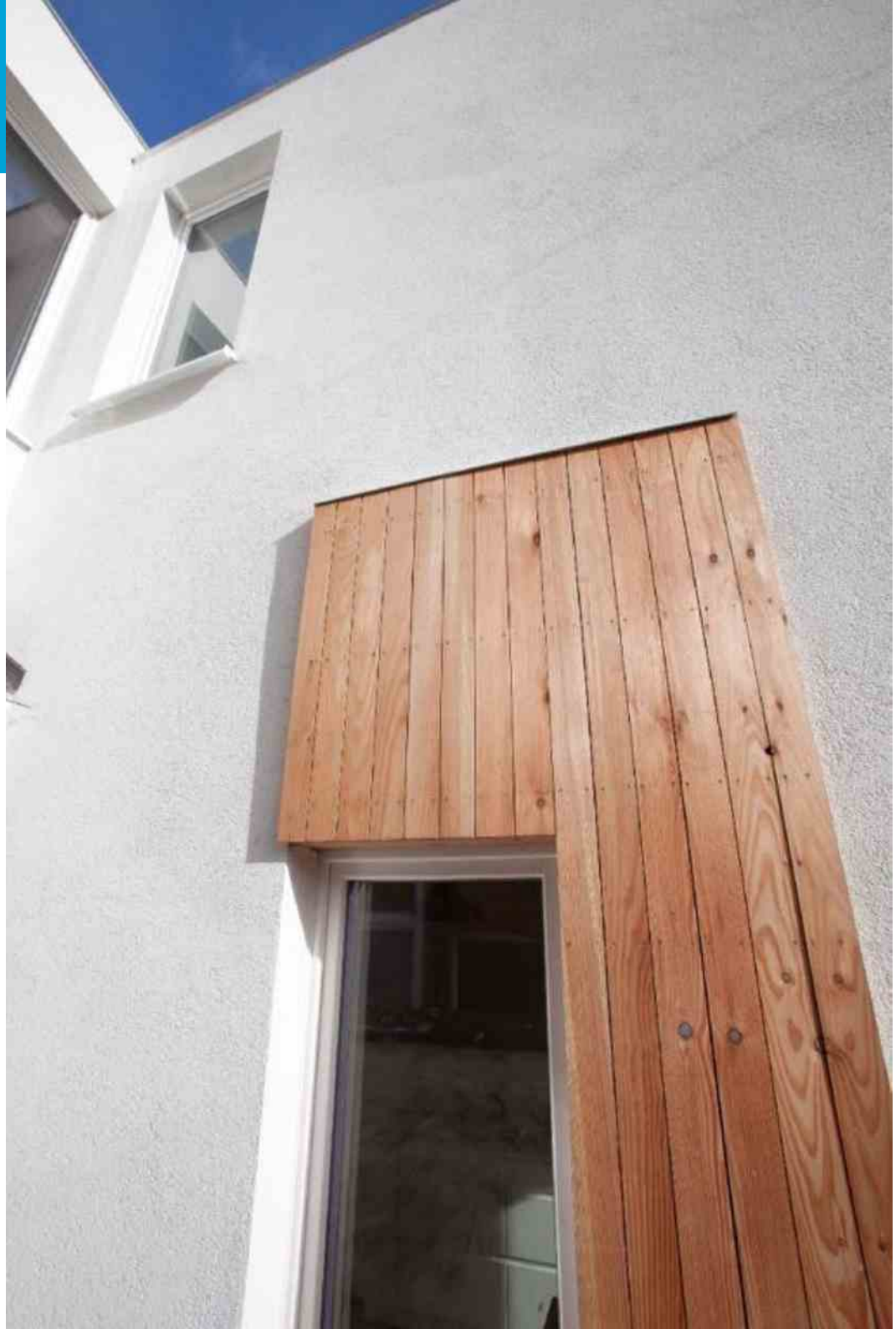
moisture handling

we need vapour permeable materials and ones that can handle moisture better

building retrofit

services

- perimeter insulation down to foundations
- drainage has to be moved, above and below ground



soil stack embedded in the EWI then insulated then clad with locally grown larch

building retrofit

ventilation

use the chimneys

building retrofit

passive stack ventilation

retrofitted MVHR

building
retrofit

more than housing

not just housing

an energy efficiency retrofit can be a trigger for making it look better too

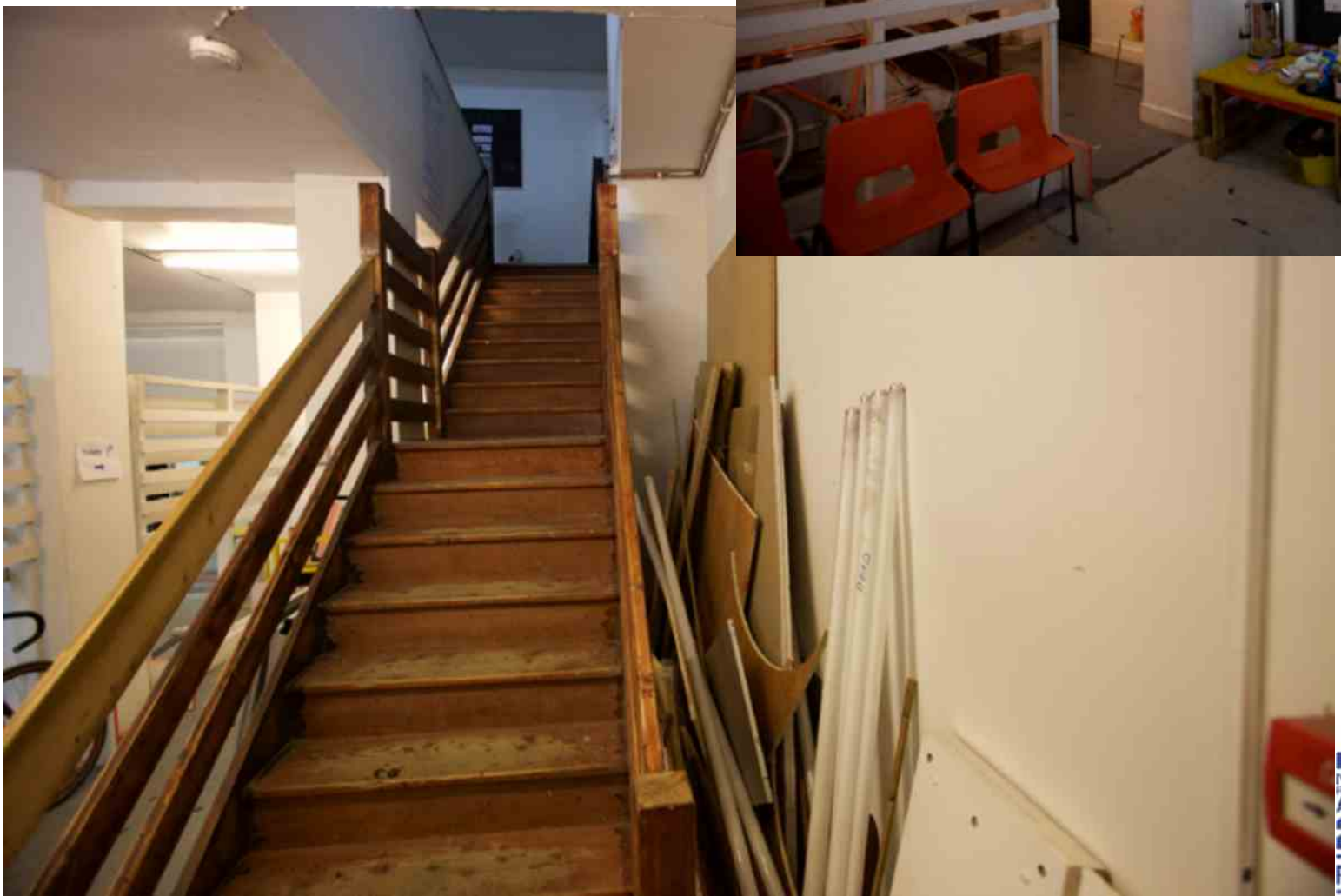
not just housing


let's do workspace fit outs properly
13kWh/m²/A space heating,

regeneration - madlab

NORTH WEST REGIONAL CONSTRUCTION AWARDS 2017 FINALIST

not just housing



an energy efficiency retrofit can be a trigger for making it safer & look better too

NORTH WEST REGIONAL CONSTRUCTION AWARDS 2017 FINALIST

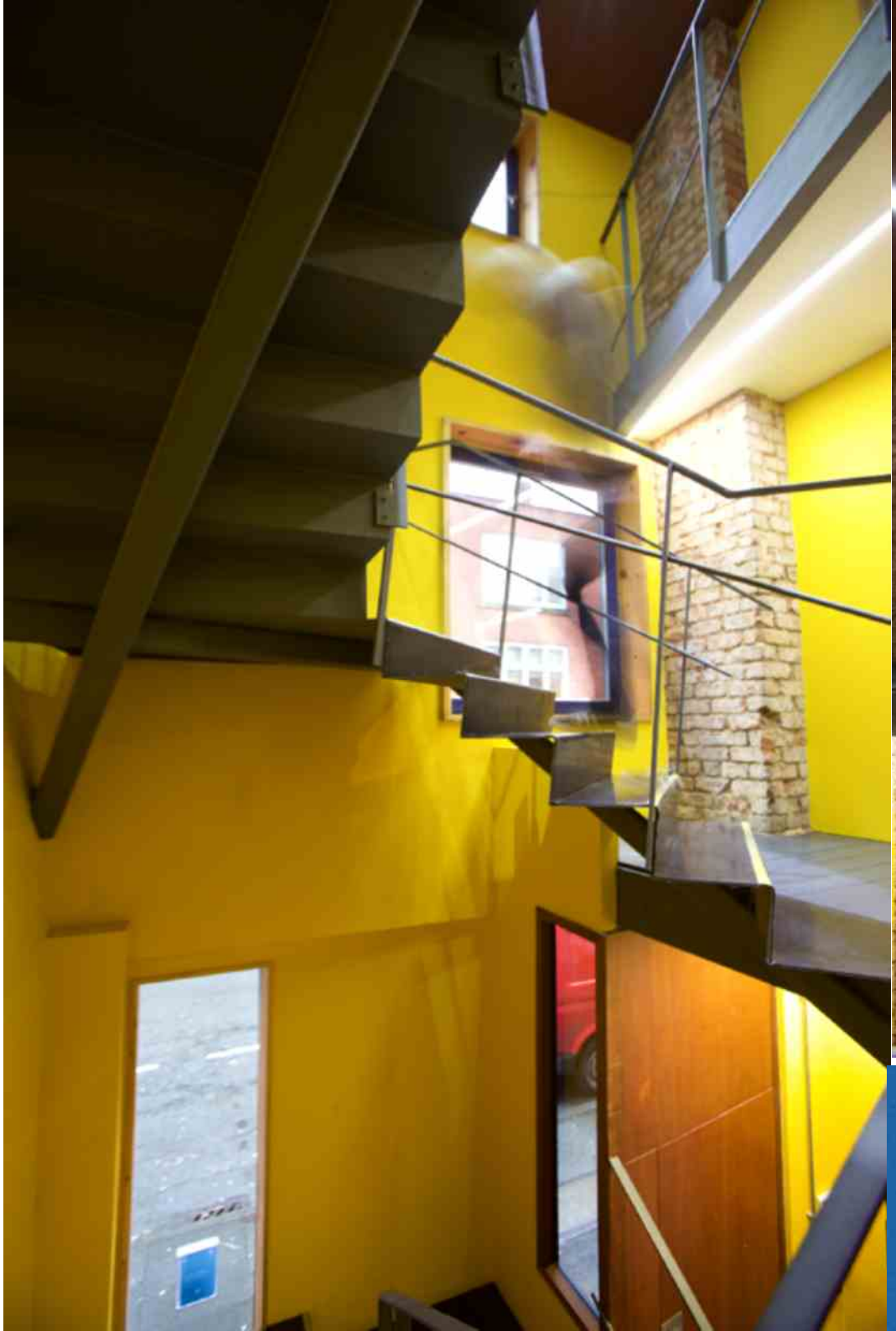
not just housing

and you thought houses were badly maintained!

NORTH WEST REGIONAL CONSTRUCTION AWARDS ★ 2017 FINALIST

MAD LAB

60% emissions & bill reductions

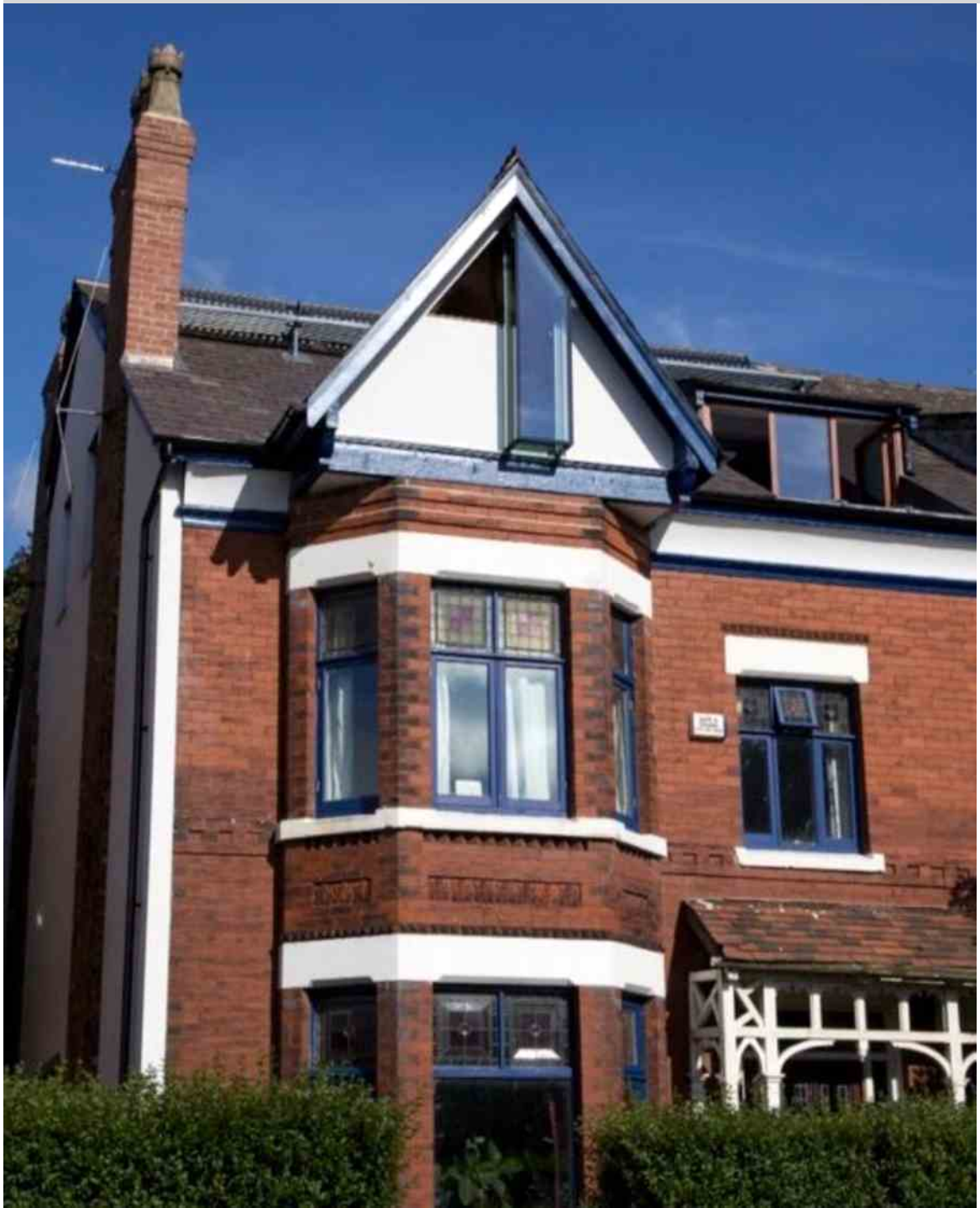


NORTH WEST REGIONAL CONSTRUCTION AWARDS ★ 2017 FINALIST

MAD LAB

regenerated & improved

making a start on homes



we took a 215m² house,
made it warm,
reduced gas use to 0,
electricity by 30%
CO_2 by 84%

cost: £44,000 in 2009

proof it works:

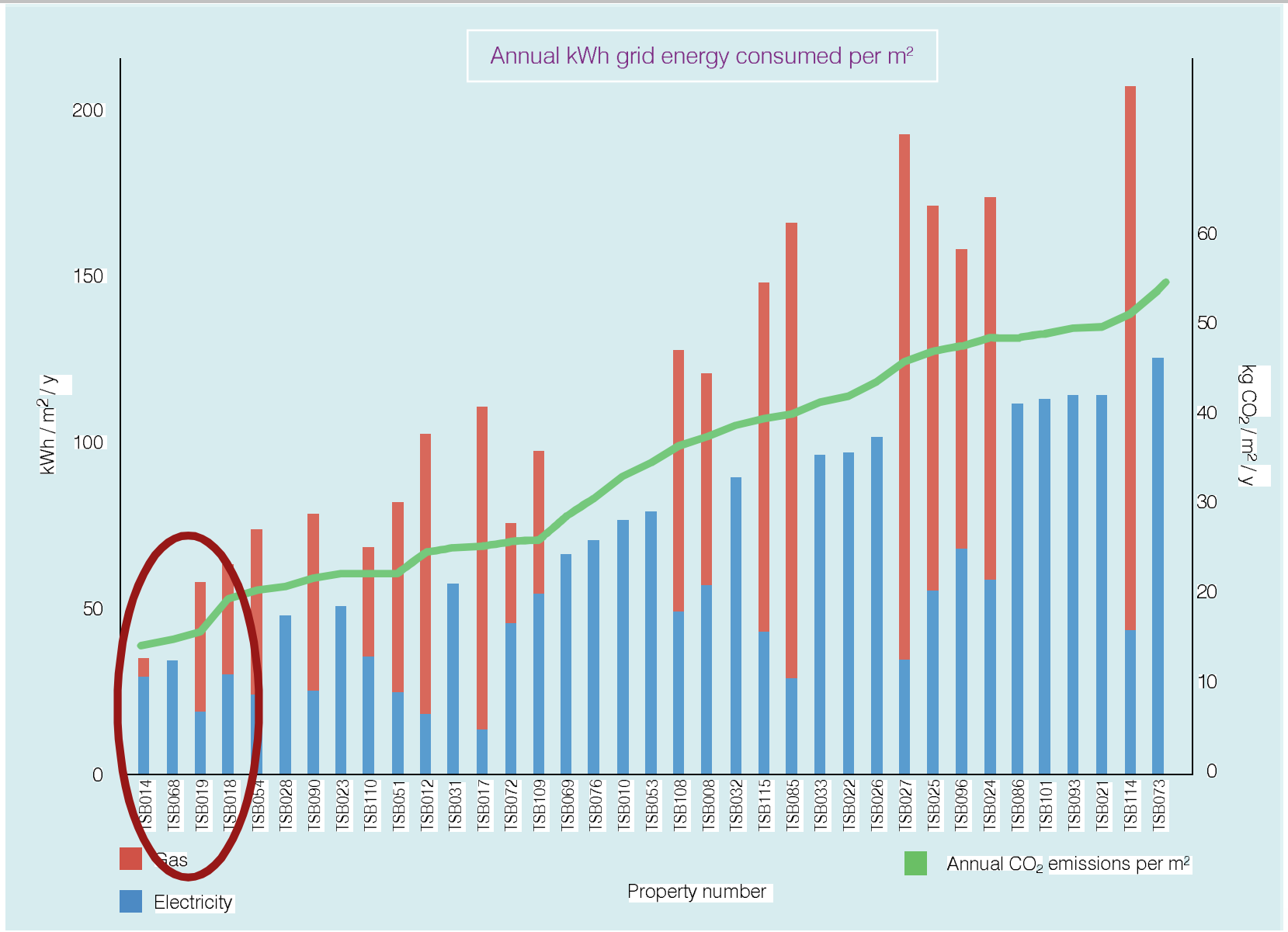
rotherham	walls, roof, doors	electrical	floor insulation	windows	ventilation	heating	solar kit	appliances
237	external wall insulation, loft build up + insulated doors	low flow taps, showers + wc's smart meters, real time display in house. CFL's.	internal floor insulation	new hardwood triple glazed windows	Passive vent	gas	photo-voltaic	A++
239					MVHR	gas	solar thermal	A++
241					Passive vent underfloor pre-heat	biomass	solar thermal	A++
251			external floor insulation	replace glazing only if not external beaded	existing natural	gas	photo-voltaic	existing retained
253					Passive vent	biomass	solar thermal	A++
255					MVHR	gas	photo-voltaic	A++

Retrofit for the Future 2011

17kgs CO_2/per square metre/year

120kWh/m^2/A

proof it works:



TSB Retrofit Revealed Report 2013

refurb rethink retrofit awards 2011 highly commended

sustain MAGAZINE AWARDS 2011 WINNER

Demo Homes: Green Deal Go Early

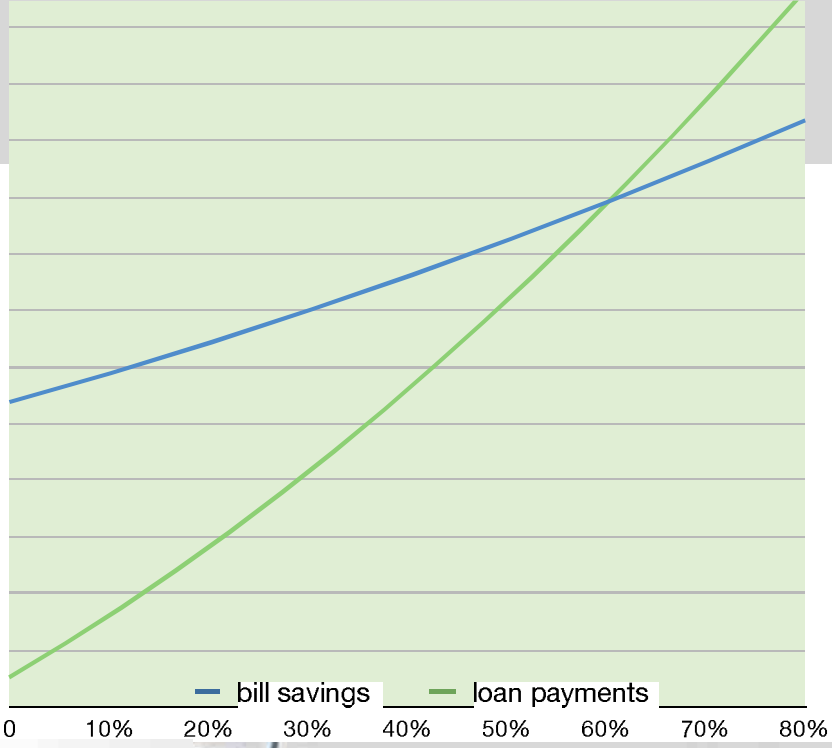
actual pay as you save:

- 8 houses
- to a '2050 target (17kgs $CO_2/m^2/A$ + 120kWh/m^2/A)
- using interest free loans
- costs between £50k & £22k
- some householders £7pw better off through to £10 worse off

CarbonCo-op

Procure PLUS

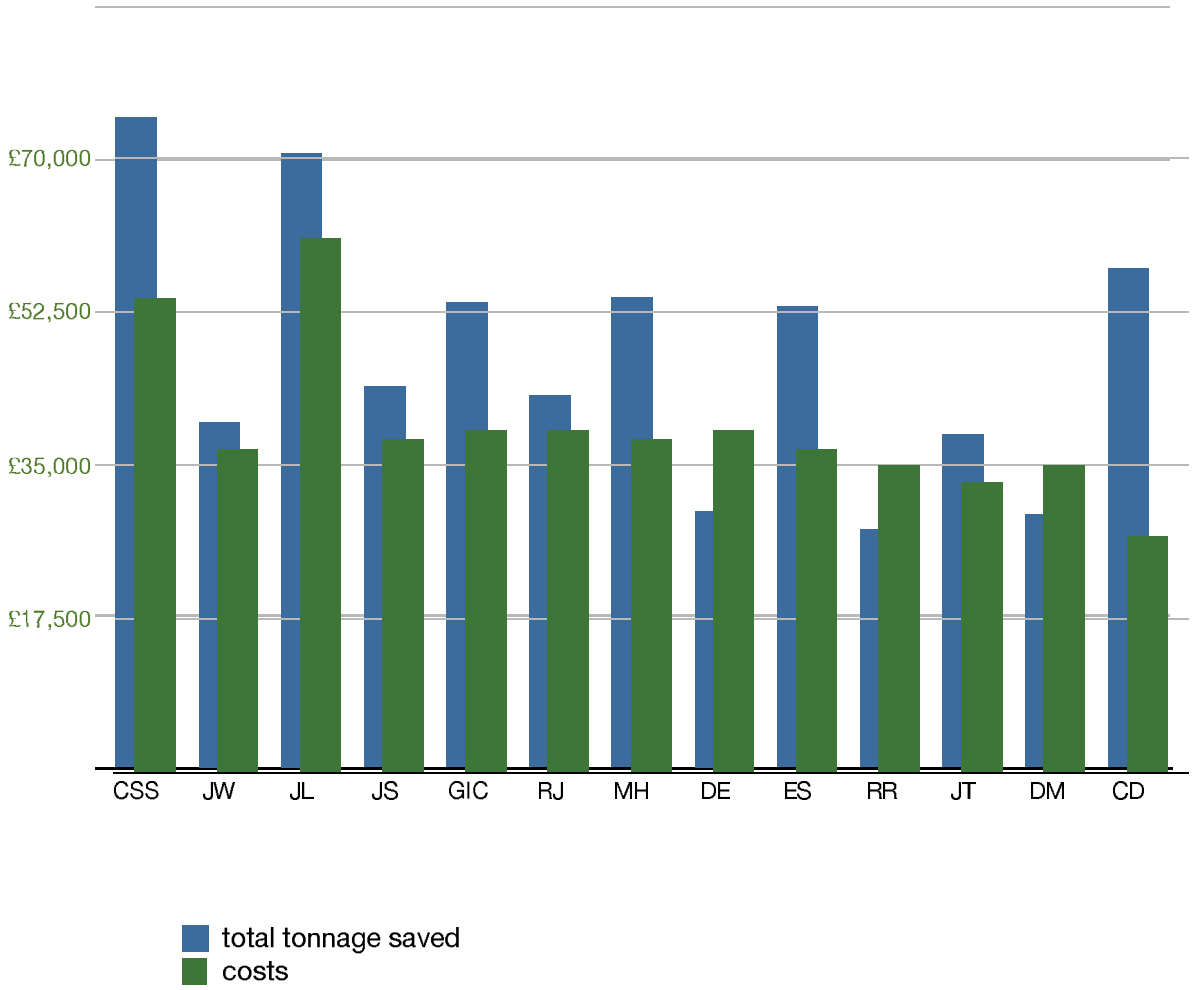
JACKSON JACKSON
PUBLIC SECTOR AND COMMERCIAL CONTRACT WORK SPECIALISTS



80-90% reductions in energy demand from homes is feasible for pioneers now

Current pilot retrofit average stats:

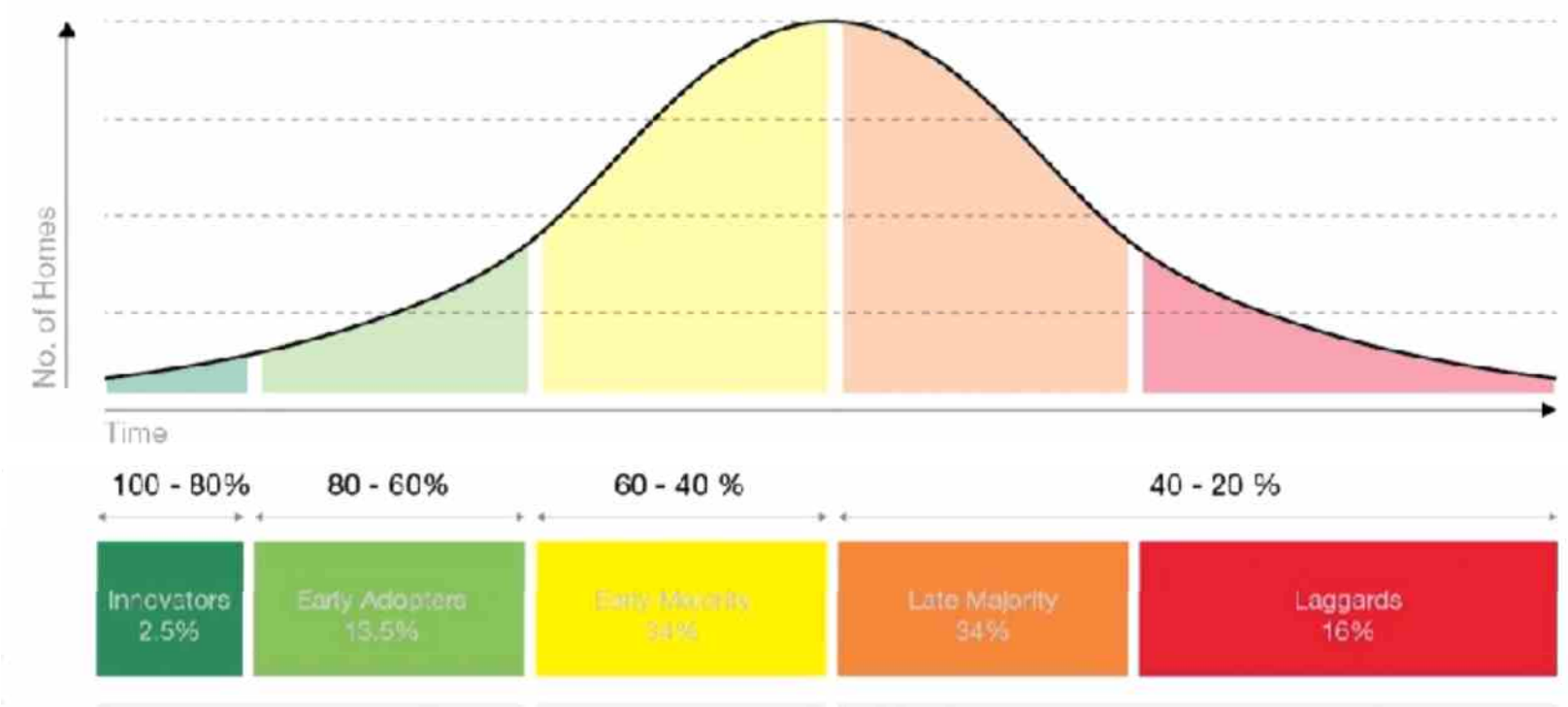
- emissions: 16.7kg $CO_2/m^2.A$
- tonnes saved 5.4t CO_2/A
- cost: £45,000
- ECO 'assistance': £4,000
- nearly meeting golden rule - but this *may* not be the important issue



CarbonCo-op

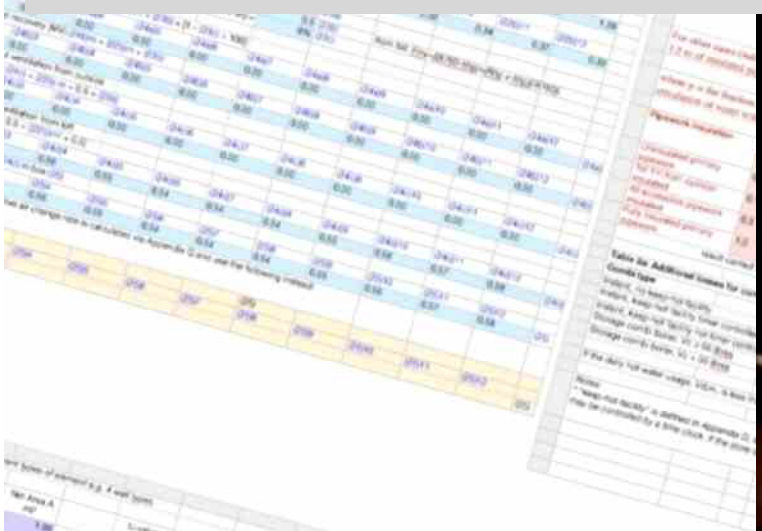
take-up with owners requires new approaches

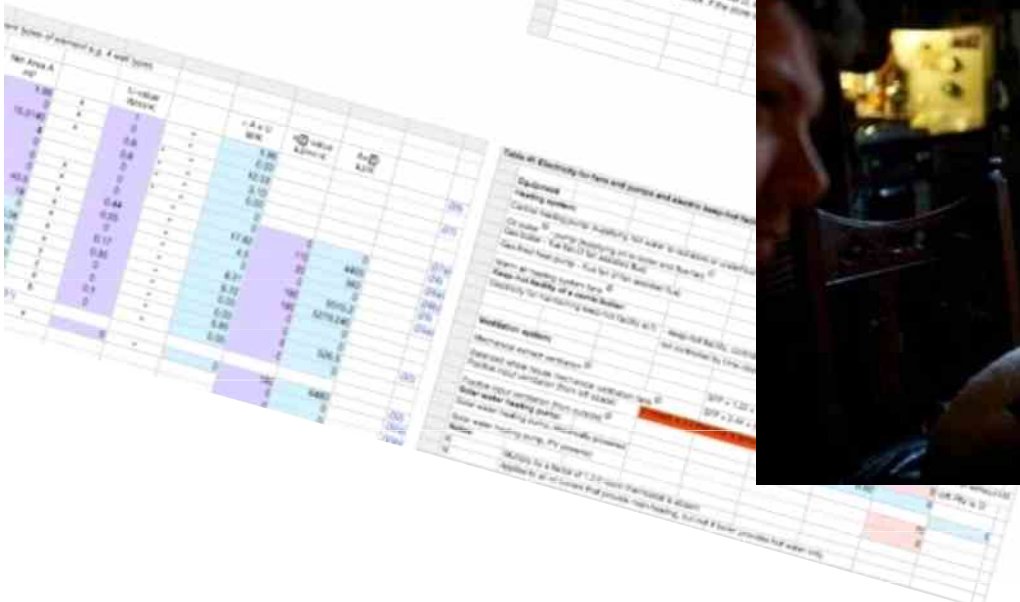
- learn from history: retrofit 1:10 homes and it'll become socially embedded
- learn from past experience



- trust
- care
- choice
- segment the market

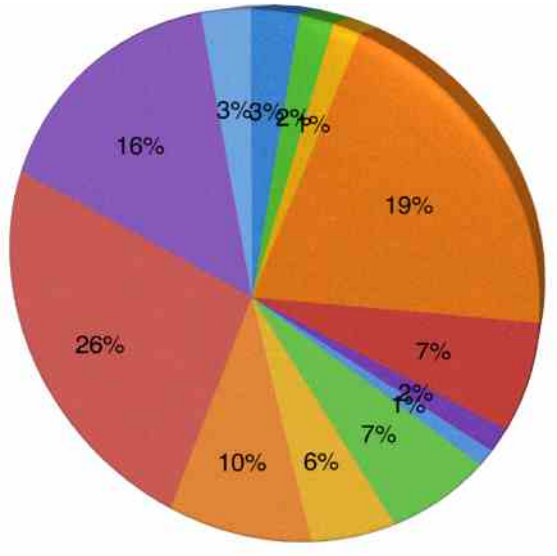
Proper reliable methods of **assessment** and **calculation** of measures to be developed/adopted, including the cost to install measures and their impact on running costs of being warm and healthy in the home.





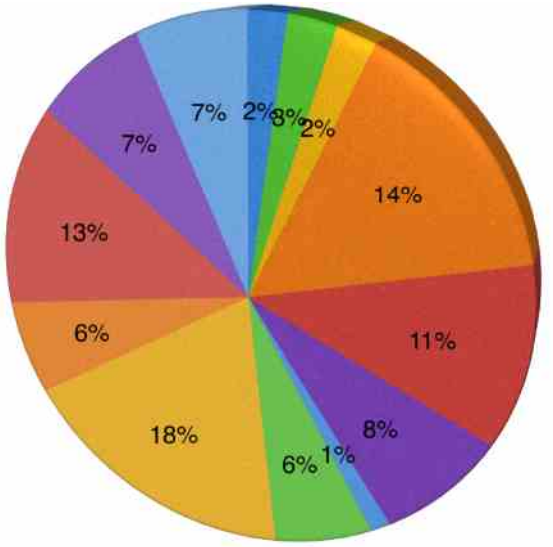
performance gap: whole house assessment method

before FEE:116W/m²



- Front door
- Kitchen door
- Single glazed window
- Obscured Double glazing
- Solid kitchen floor
- Side wall
- Main roof
- Back door
- Double Glazing
- Patterned single glazing
- Suspended ground floor
- Front wall
- Rear wall

after FEE: 37W/m²



- work out more accurately where the energy is going
- include all cold bridging & airtightness
- but it's just Full SAP not rdSAP
- and it works: Go Early houses average emissions 16kg $CO_2/m^2/A$, target was 17

MEASURES with costs

The table below outlines the potential measure which could be implemented to achieve the 80% carbon reduction target. Costs are provided for budget guidance only, based on best available information from a quantity surveyor. They are not formal quotes, and actual costs may vary.

BC	measure	benefits	notes	amount	price	total
appliances etc	appliances A++ - dishwasher, washing machine, fridge, freezer	Up to 30% reductions in electricity use in appliance can be achieved, if all appliances are very energy efficient	Dishwaher £425.00 Washing Machine £275.00 Fridge (undercounter) £305.00 Freezer (undercounter £335.00			£1,340
	low energy lighting - replace all GLS or bayonet bulbs with CFL's and all low energy spotlights and downlighters with LED equivalents	This reduces both power use and maintenance	CFLs	11.0	1.50	£17
			LEDs	8.0	9.50	£76
controls	masterswitches - remote controlled sockets either bypass or replacement sockets	This allows for all the appliances in a room to be turned off at the mains when turing off the lights	Sockets for things like TiVo boxes can be left off the circuit. This does not need to be hardwired there are products such as intermediate plug/sockets that power to be switched off to several remotely	3.0	55.00	£165
	better heating controls such as programmable thermostats, gate valves to create differently programmed heating zones	This allows heating to be confined to areas of the house in use, minimising heating of unoccupied area	The effect of zones will have less effect as the heating needs of the house are reduced however it can be an early measure. Products need to be chosen that allow for easy manual override	6.0	175.00	£1,050
	energy monitor		http://www.efergy.com/index.php/default/products-uk-1/e2v2-wirelesssmonitor-uk.html	1.0	55.00	£55
	basic measures					
	draught proofing - adding draught seals and extra rebate front door	Much heat is lost through draughts	Chimneys can be sealed to if not needed for the design ventilation arrangements, if external these should be filled with granular inert closed pore insulation	94.2	3.50	£330
	sealing timber ground floor	Much heat is lost through draughts	This can be done with mastic on top prior to re-sanding or can be done with air seal membrane and tape while fitting insulation beneath.	32.0	6.00	£192
	increase loft insulation to an overall depth of 400mm of high recycled content glass wool to achieve U-value of 0.1W/m^{2}K^{-1}	Cost effective reduction in heat loss while allowing vapour permeability	If used for storage and the rafters are inadequate then build up the rafters to enable decking on top of insulation. If adequate then some of the glass wool can be replaced with layer of extruded polystyrene to create deck.	4.0	7.50	£30
servicing	high efficiency woodburner	flexible focal point heating that reduces CO_2		1.0	935.00	£935
	replace boiler with modern A rated	Even a 10% rise in efficiency has a considerable effect on overall energy performance	The boiler will also need to be sized to suit the much reduced heat losses depending on what the final level of thermal performance is post-retrofit.	1.0	875.00	£875
	design in a passive stack ventilation system making use of existing openings	Improve and stabilise internal air quality while minimising energy use.	Making use of warm air rising to vents in the roof or up existing chimneys, with replacement fresh air being allowed in in a controlled way through humidity controlled vents in windows or up form below the ground floor.	1.0	1,000.00	£1,000
				2.0	90.00	£180

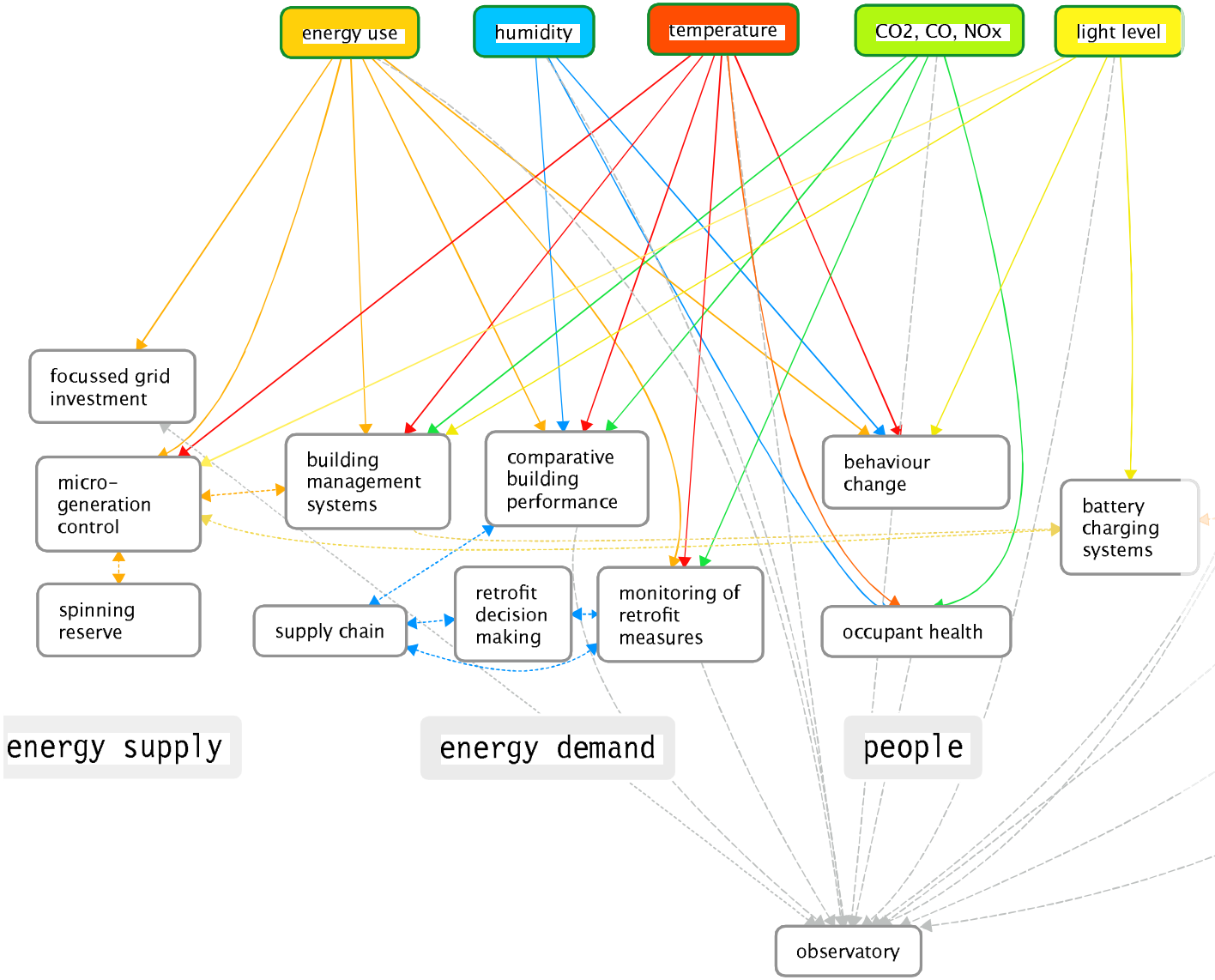
2

much better **data**

Pre- and post-works much lower cost, **monitoring**, on all properties as part of a project to develop, prove then disseminate best practice as well as identify problems.

- with so many variations measures require monitoring
- low cost computing components to monitor & respond

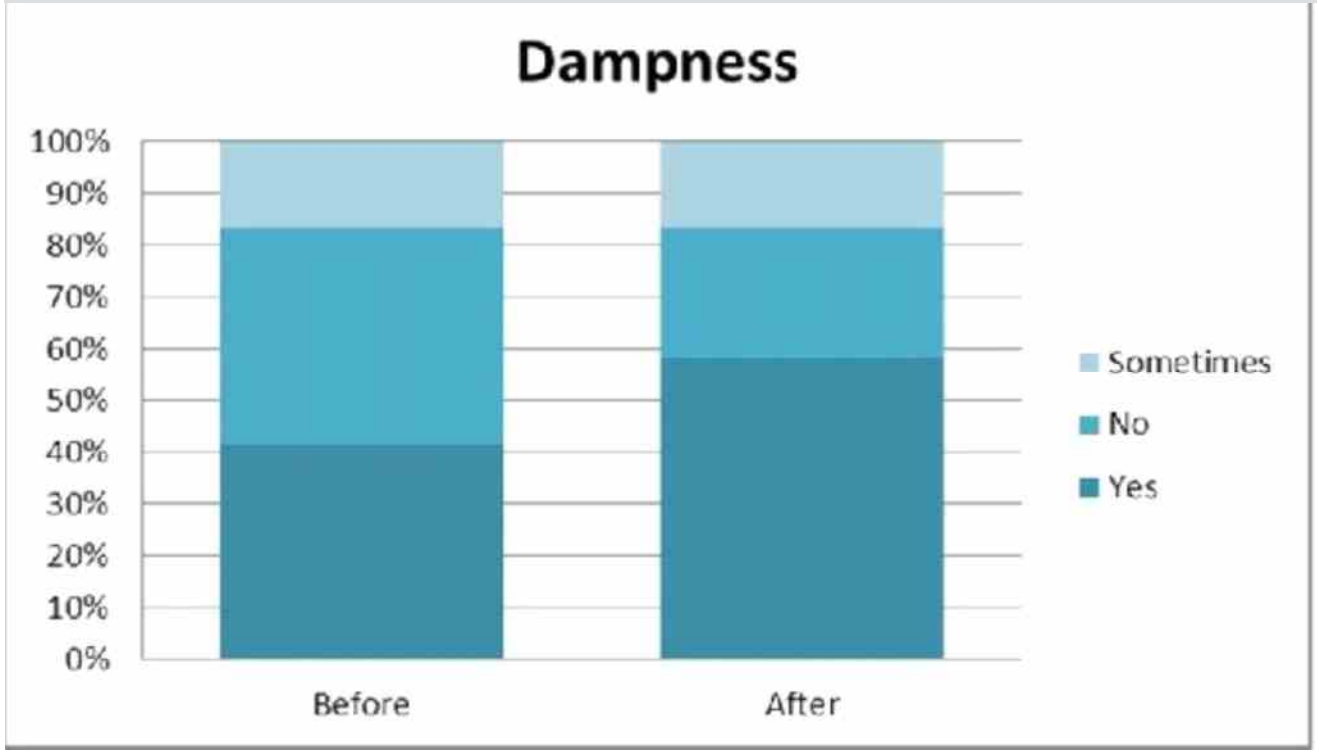
change how innovation is stimulated, disseminated & rewarded...



- we desperately need to know what is working
- to give us representative samples of data
- from which to draw realistic conclusions
- to improve effectiveness

3

Proper science and risk based **specification**, not simply lowest cost based methods of material selection, and how they are put together to reduce underperformance, defects and health effects.

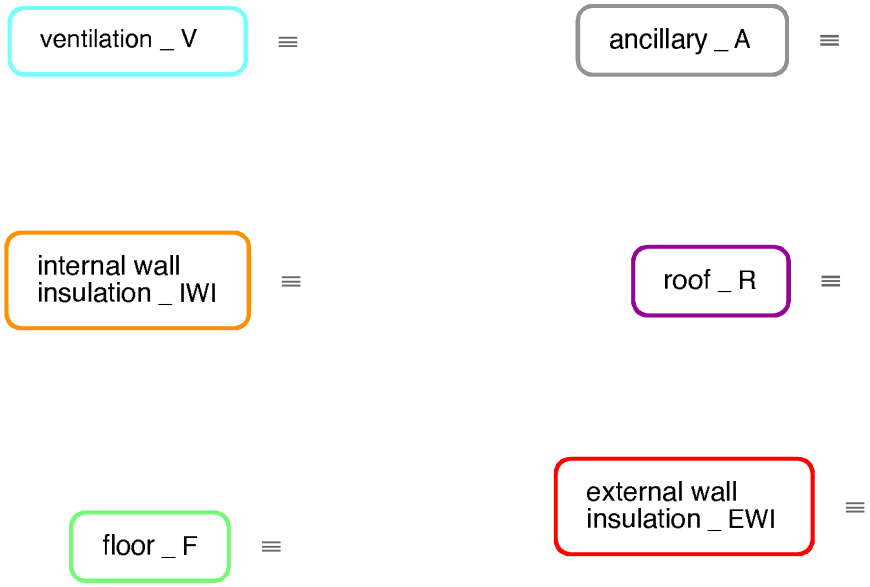


we cannot afford mass failure

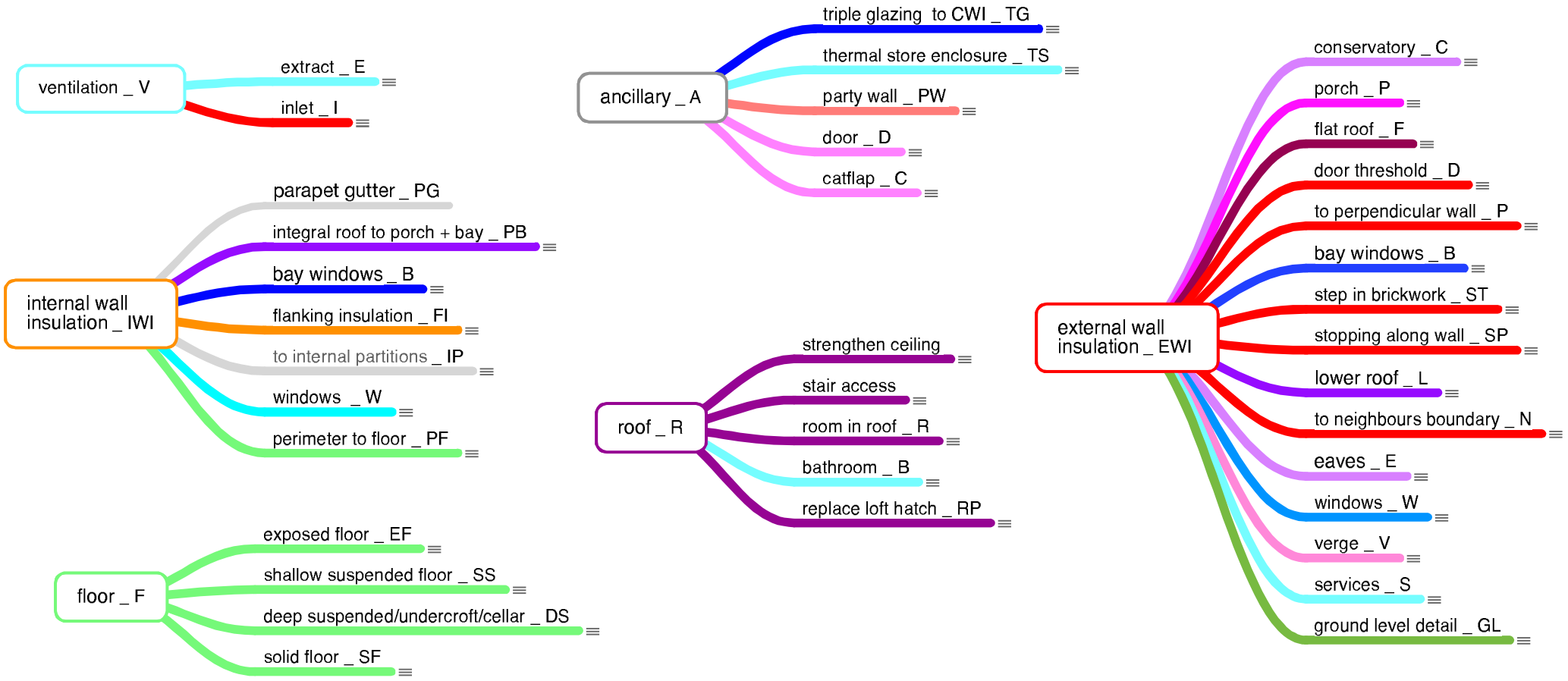
BRE study for DECC

(Image source: BRE)

- basic building retrofit elements...



- subdivided into areas where they join other elements...

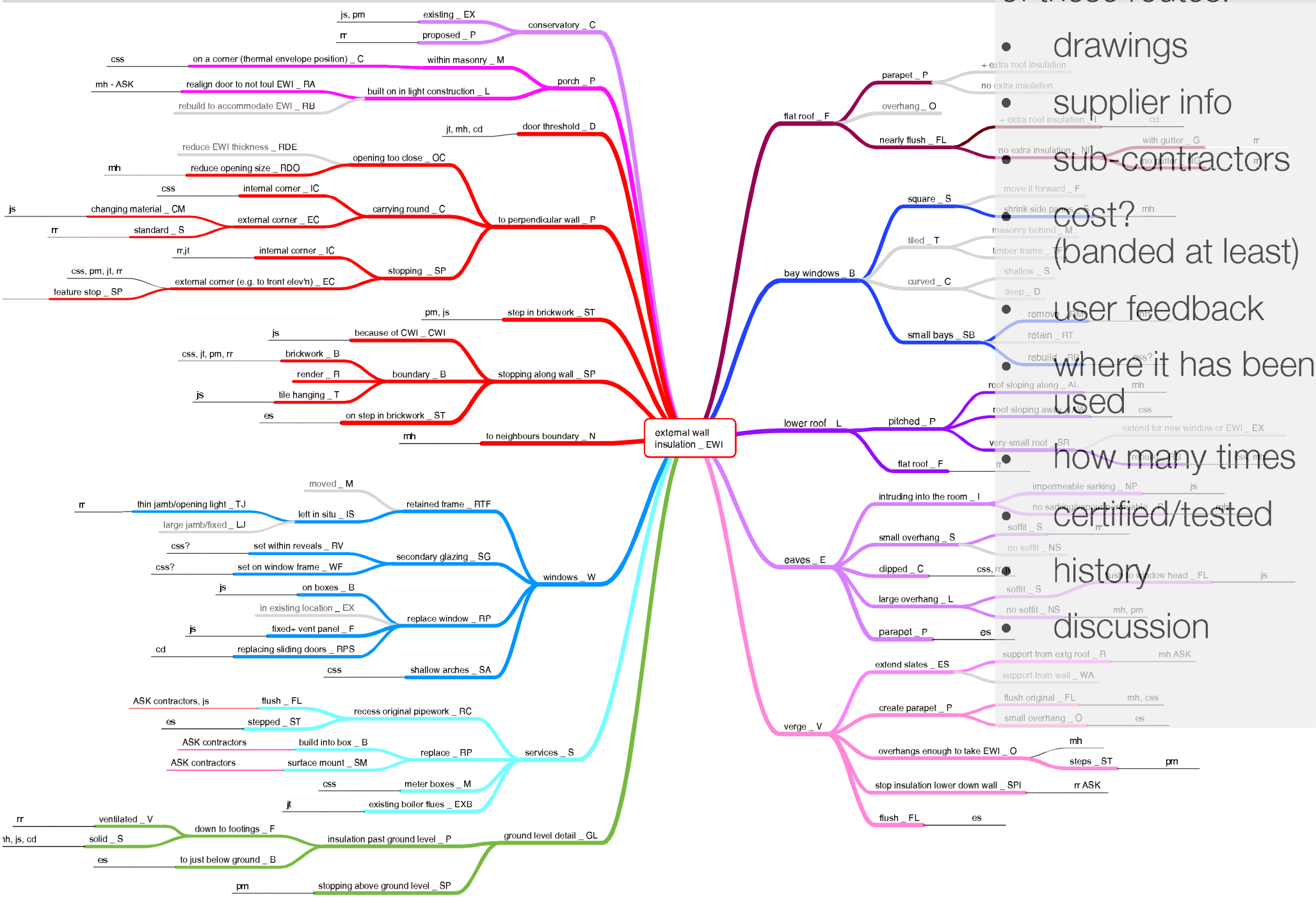


and details

http://retrofit.support

a lot of information can be stored on the ends of these routes:

- drawings
- supplier info
- sub-contractors
- cost? (banded at least)
- user feedback
- where it has been used
- how many times
- certified/tested
- history
- discussion



EWI to clipped eaves with room in roof (insulation to rafters)

Original Author: Admin

Organisation: Retrofit Pattern Book

Overview Revisions

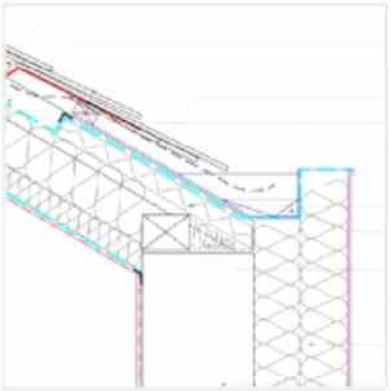
Detail summary

A detail for external wall insulation to deal with a potential cold bridge at eaves where new insulation to rafters meets external wall insulation. To be used where there is an existing room-in-roof or loft/roof insulation to be applied to existing rafters.

Where there is a limited overhang at the existing eaves, an integral gutter is required to enable water run-off. The EWI is used to form a verge, which is then capped with a Stainless steel gutter.

Target values:

Target Roof U-Value: 0.18 W/m²K Target Wall U-Value: 0.18 W/m²K



Other details in the same category:

EWI to clipped eaves with hidde

Go >

Risk factors

Technical description

Section detail. EWI to existing wall. Up to eaves, clipped, with new/ existing loft insulation join to EWI. Loft insulation to rafters where existing room in roof

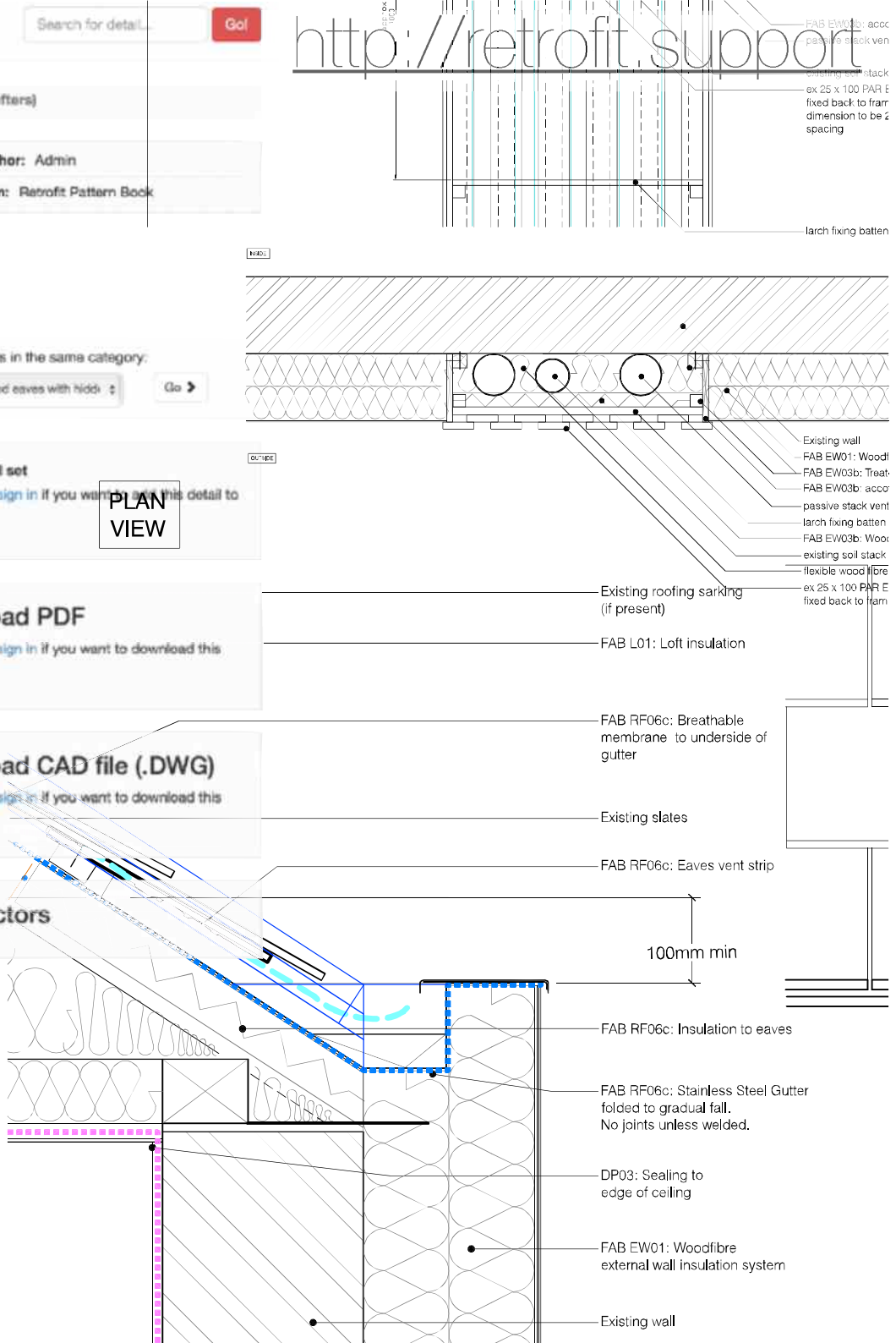
Suggested Installation Sequence:

Preparation of roof and loft space: Remove any existing loose material and prepare in accordance with manufacturer's requirements.

Any alterations to cabling, existing ventilation, drainage and other fixtures, affected by the work to be agreed with contract administrator prior to work being undertaken. Prior to start on site inspect the form and condition of the roof internally and externally, especially any structural timbers; institute repairs and/ or additional works necessary to make the substrate suitable to receive insulation.

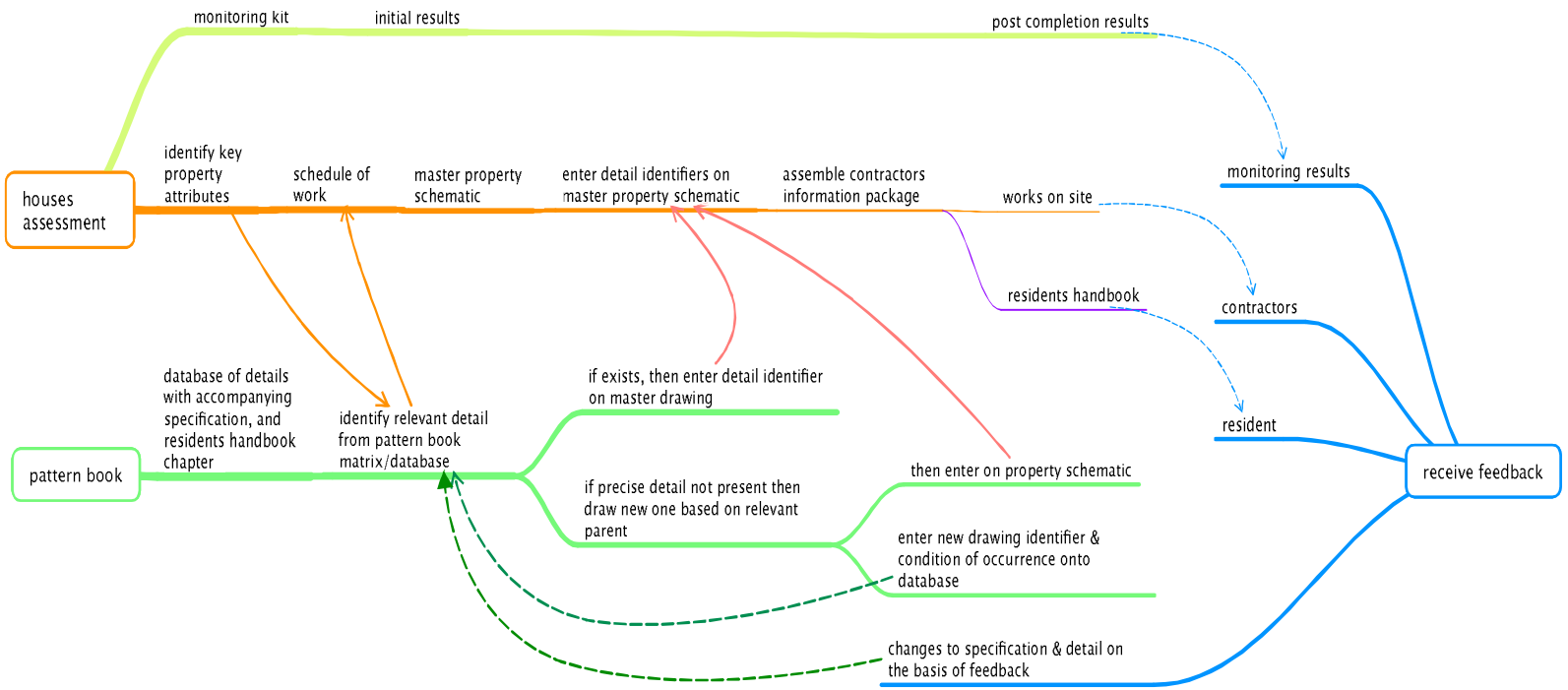
Installation:

1. Carefully remove minimum 750mm of tiles or slates, putting to one side for reuse. Note positions of existing roofing battens.
2. Remove roofing battens to at least 600mm up the roof from the existing eaves. Roll existing membrane back but do not cut.
3. Insert rigid insulation (RF06)between rafters, allowing at least 125mm from the edge of insulation board to the next batten position up the roof.
4. Fix external wall insulation (EW01)- cut to fit to eaves insulation and cut back to form gutter parapet.
5. Install breathable membrane/ roof underlay (RF06c) approx 500mm up roof slope from front edge of EWI. Pin in place to rafters with galvanised clouts at upper edge. Dress over EWI outer layer so as not to protrude beyond the front face.
6. Insert stainless steel gutter system over the top of the breather membrane/ roof underlay and EWI as shown on drawing. Fix in place with self drilling fixings to every third rafter at inner upper edge.



4

Development of **IT systems & interoperable software** to both allow mass customisation, more streamlined design, site management and cost control.

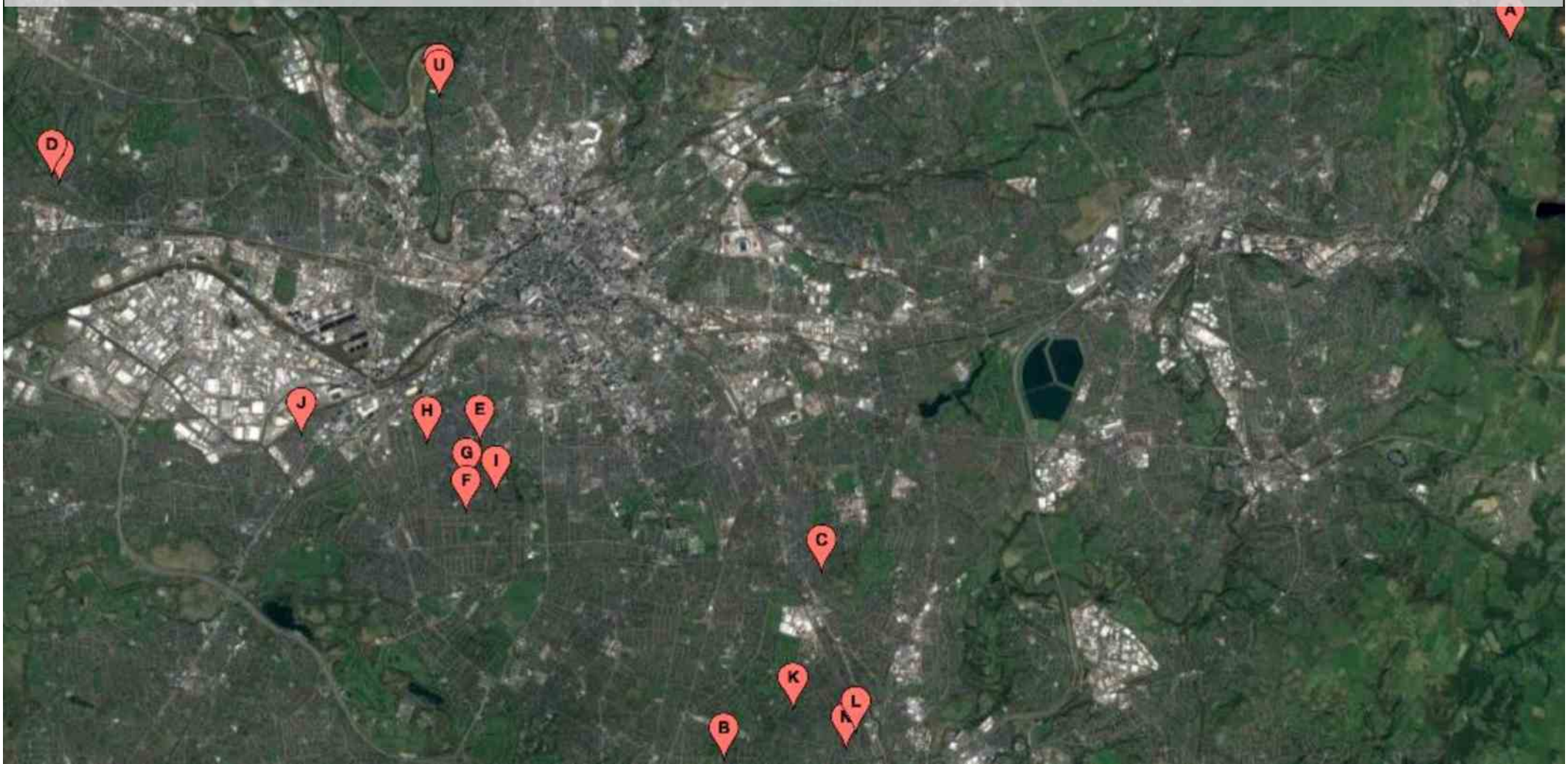


NORTH WEST REGIONAL CONSTRUCTION AWARDS ★ 2017 WINNER

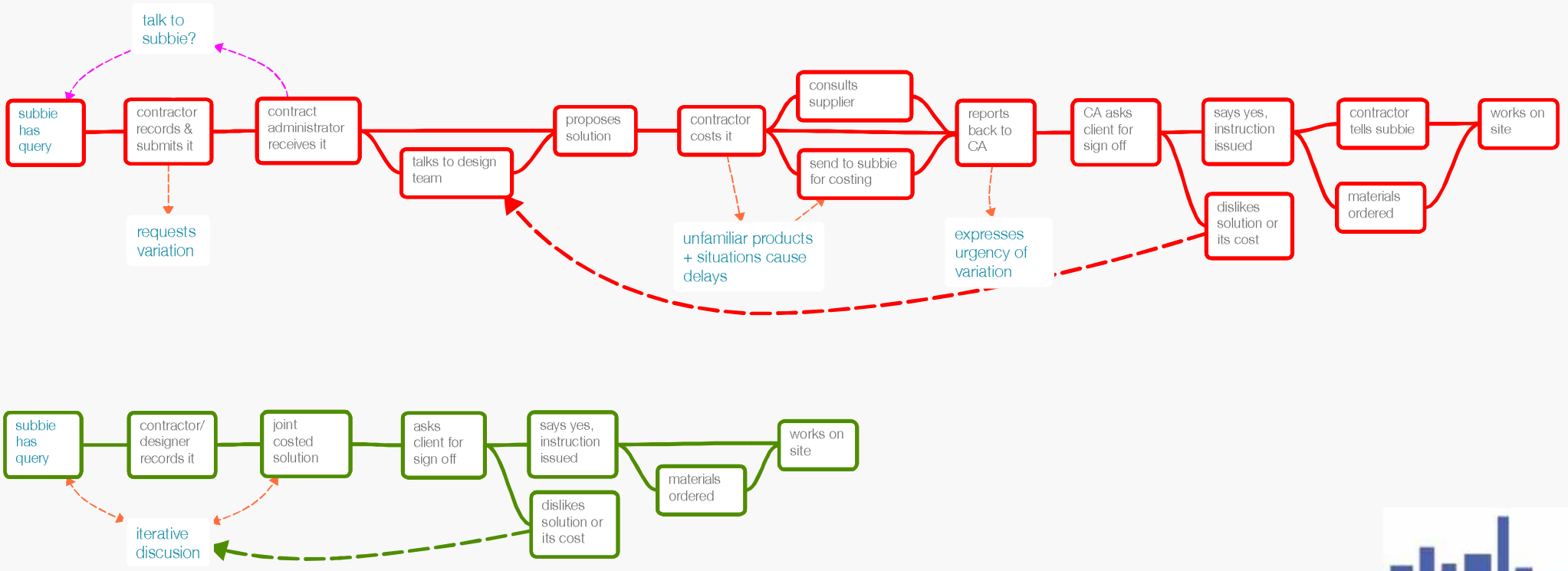
enhancements to learning what works, turnround, efficiency & costs

5

Developing **capacity**: Competitions or rolling competitive funds to develop designer/contractor teams capable of delivering deep retrofits that they would be prepared to then both warranty AND roll out at scale after further R&D.



6 Better **contract models** and delivery structures including **energy performance guarantees.**



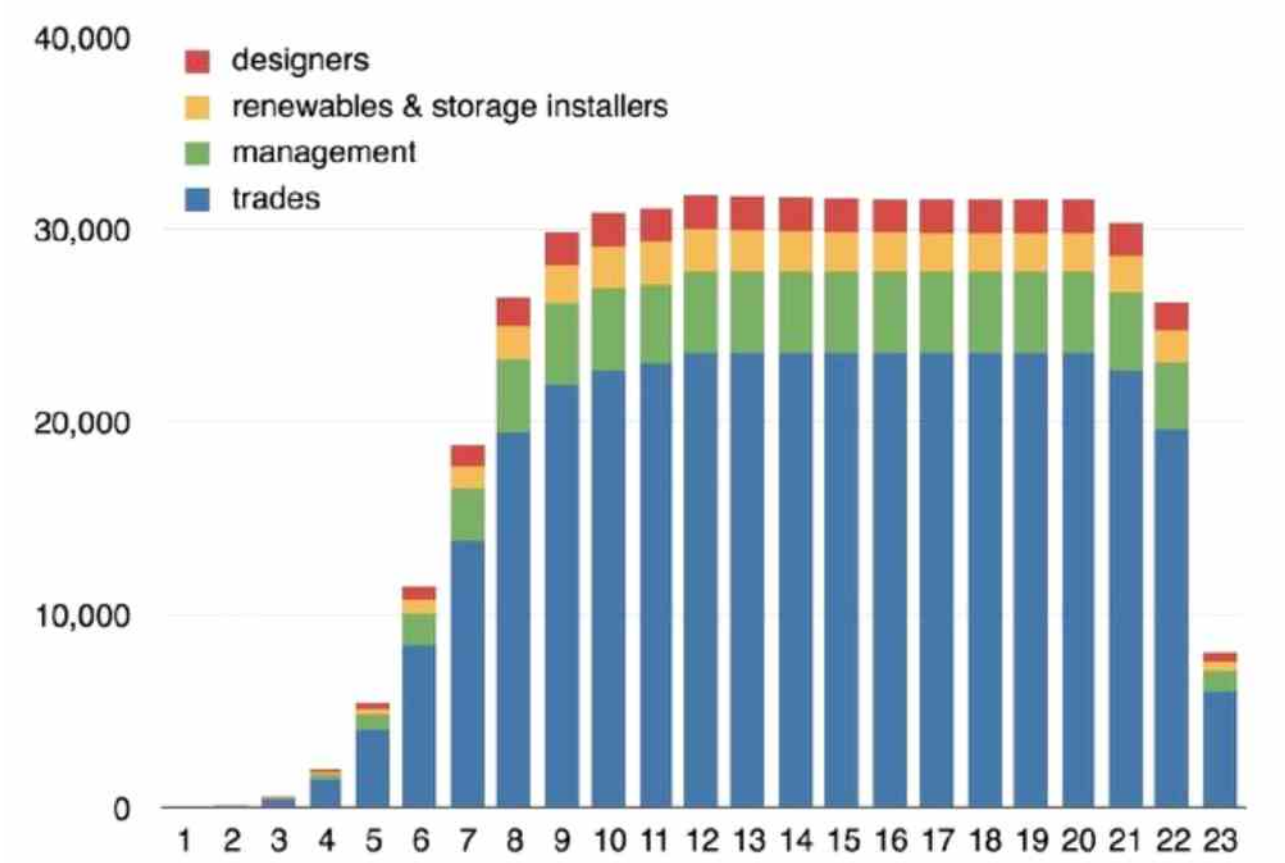
- the current models are not fit for purpose
- involve trades in the process
- on-site access to project docs -Refurbify + Retrofitworks
- enabling problems to be spotted and sorted more effectively

NORTH WEST REGIONAL CONSTRUCTION AWARDS ★ 2017 WINNER

closely examine new thinking: energiesprong - netherlands

the most important bit: 30 year performance guarantee

7 **Workforce development**: There are not enough people with the relevant skills. Training needs to be developed, and be scalable to respond.



potentially 50-60,000 new jobs in GM where are they going to come from?

building
retrofit

then we have to do something about industry custom & practice


we’re squandering a once in a century opportunity

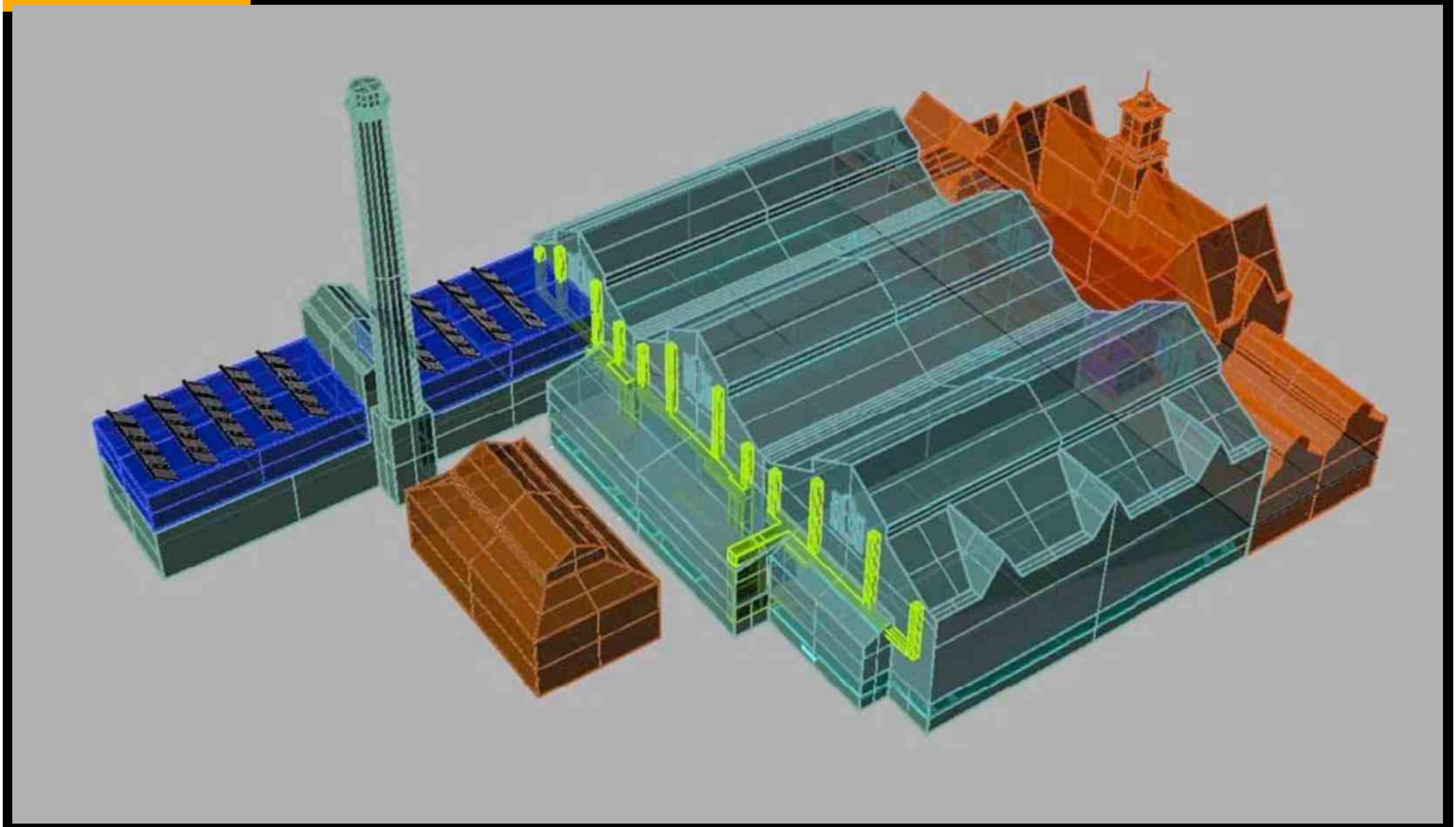
8 **renewable energy** and **storage** rollout to develop additional income to help develop demand reduction

- most houses can accommodate PV,
- average so far 3.28kW.
- 4kW of PV on 90% of our homes produces a regional generation capacity of 4GW
- equal to about the non-heat electrical needs of a UK household now.
- before demand reduction

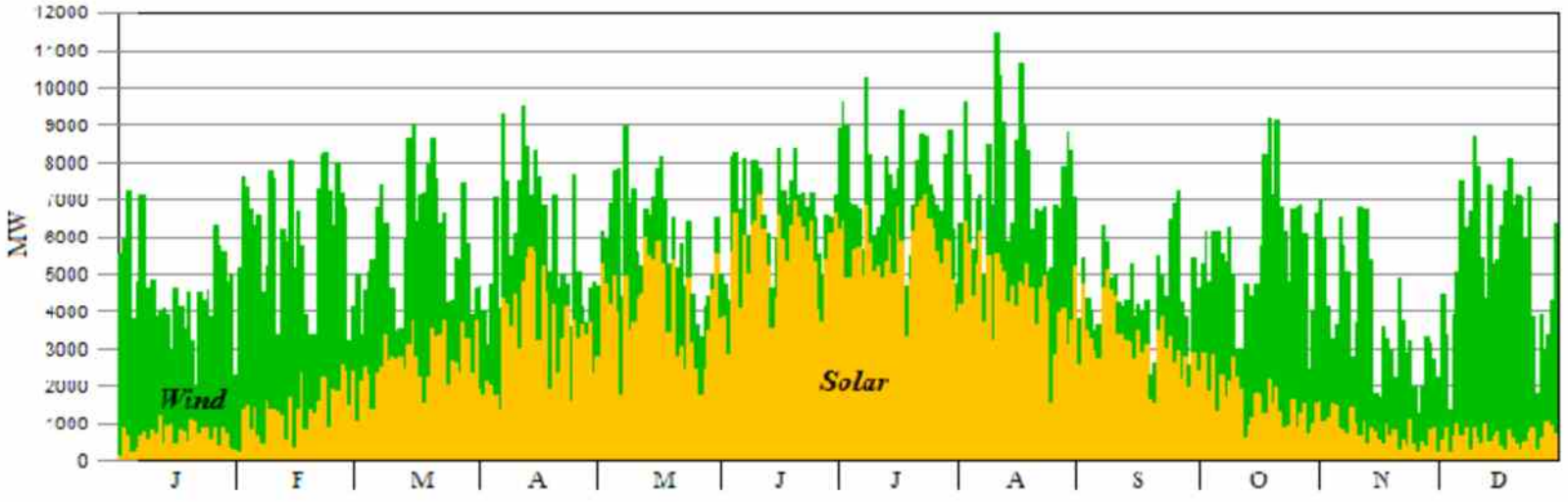

buildings as energy centres


buildings as energy centres

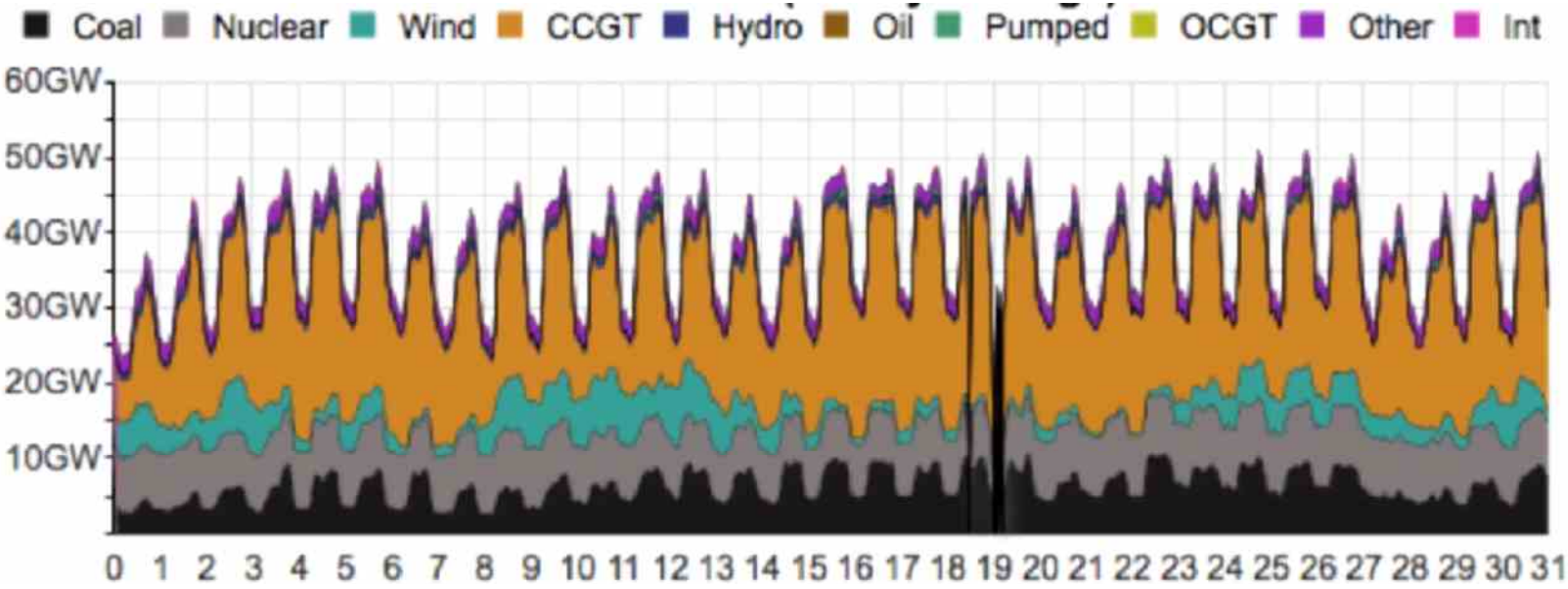
buildings as power centres



the new component is energy storage



annual renewable energy variations



daily energy supply variations

the new component is storage

1. **demand shifting**

Time of Day tariff costs 5p/kWh instead of 14p/kWh
assume average UK bill at 3,800kWh then if sufficient battery to provide whole day then annual saving > 3800 x (14-5)= **£342**

2. **supply shifting**

assume a 4kW PV installation generating 3,200kWh/A, additional saving = 3200 x 5= + **£160**

3. **aggregated sales to grid**

Short Term Operating Reserve - up to **£350**
or Frequency Response up to **£300**

4. **Demand Side Management**

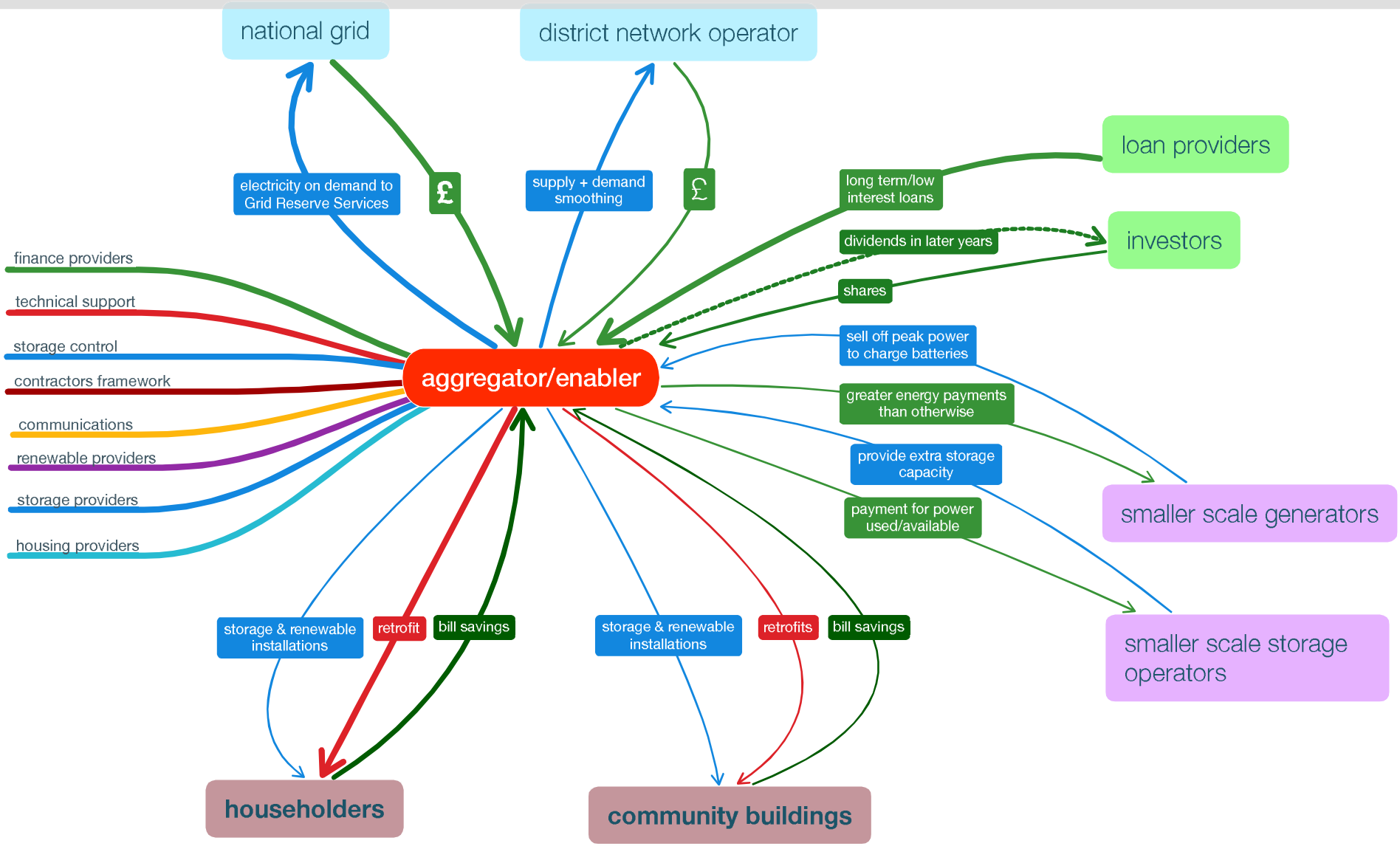
(possibly) DUoS Red band avoidance **£60**

Our early models funded early retrofit with Feed-In Tariff,

energy storage income is not subsidy,

it is the energy market

9 **Aggregation models:** to take the individual batteries' energy & package it for sale to energy suppliers & the grid



e: charlie@red.coop
w: www.red.coop

10

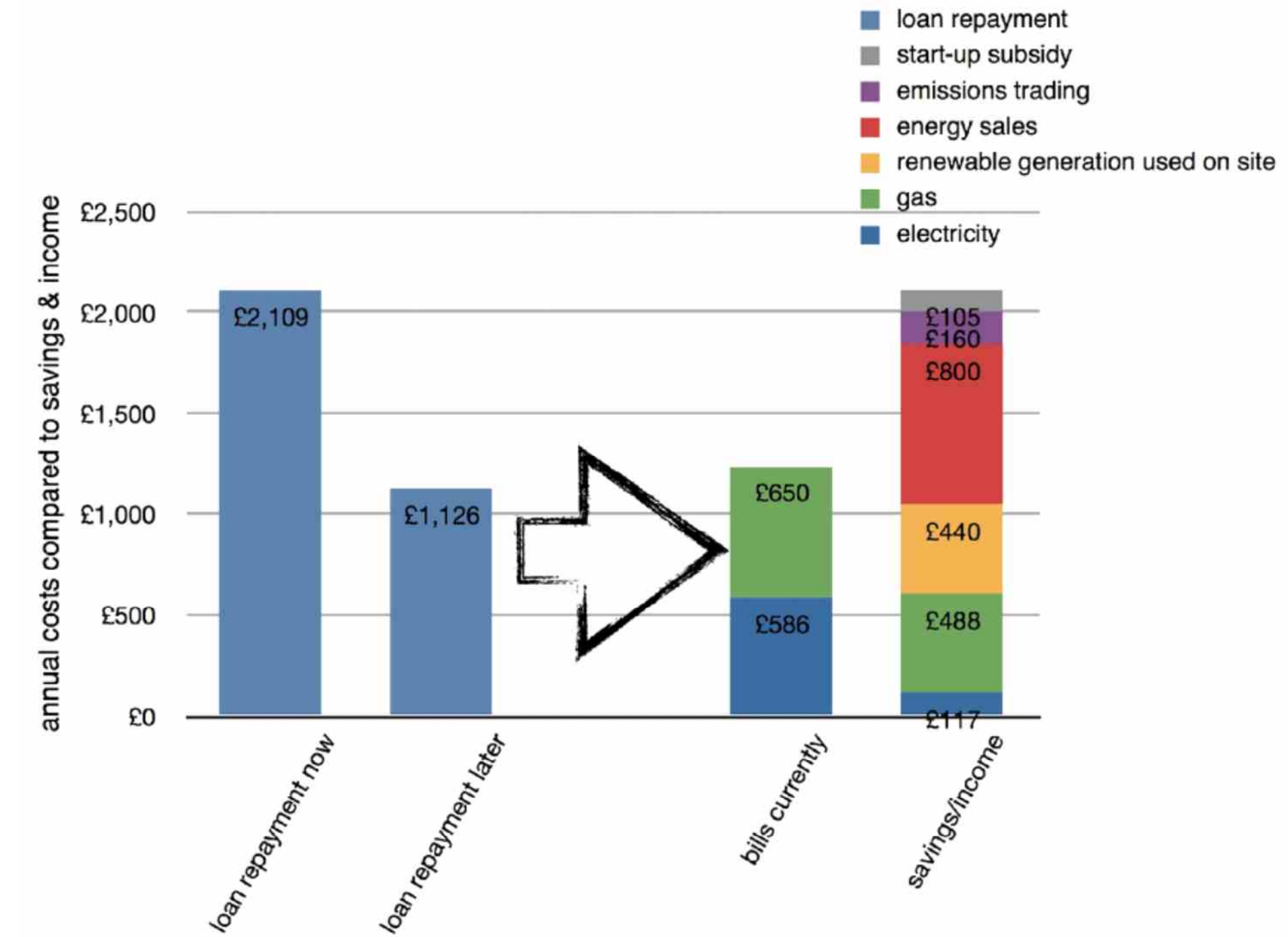
Financial vehicle:

- to take in large scale low cost finance from multiple sources, distribute to fund householders works,
- make policy led decisions on offering equity loans to less well-off householders,
- hold, redeploy or share out surpluses from different elements of the programme.

red cooperative ltd
3 corkland rd
manchester
m21 8up

t: 07976 793 795
e: charlie@red.coop
w: www.red.coop

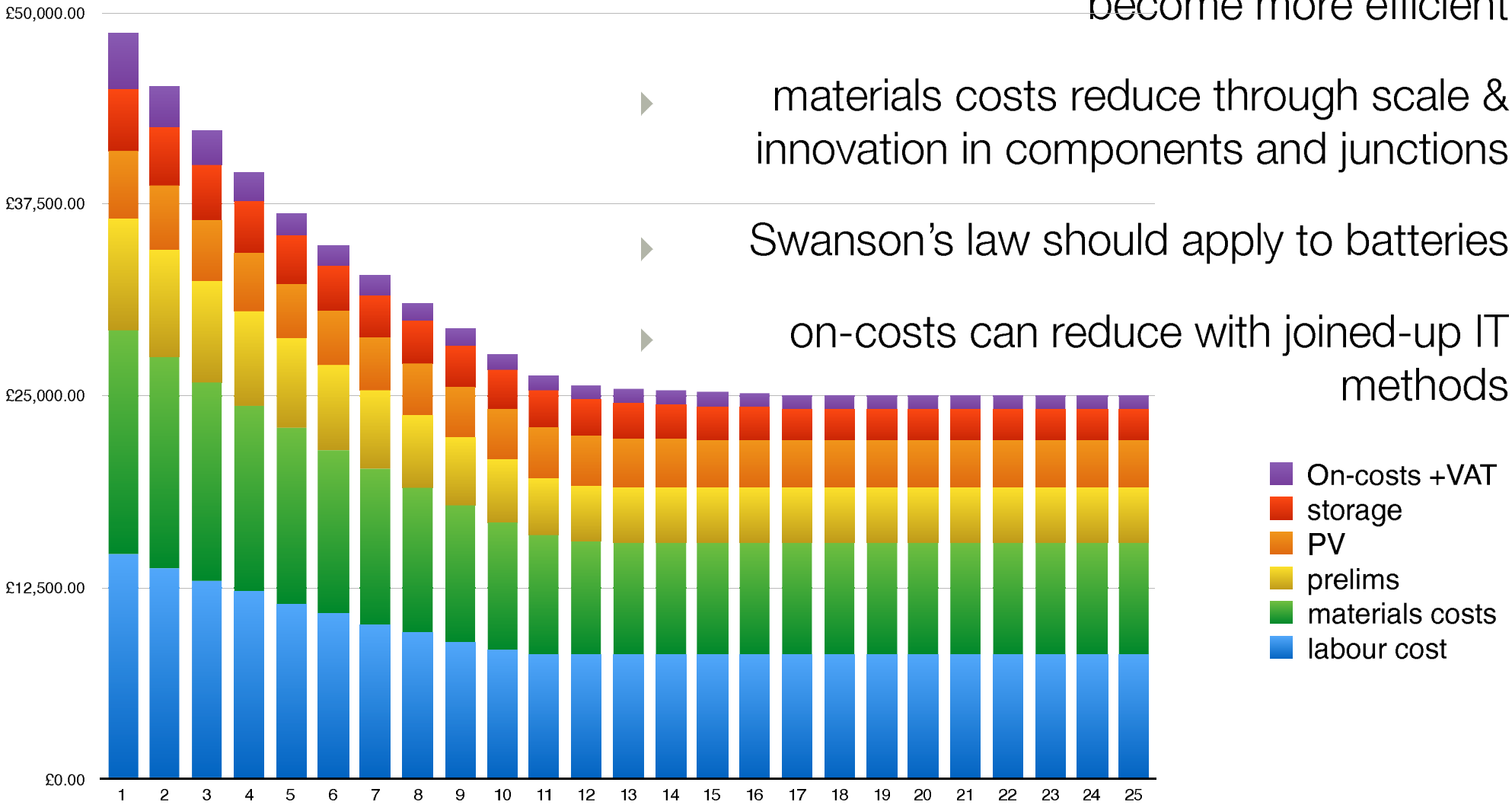
paying for it



scale should reduce costs, if prepared for

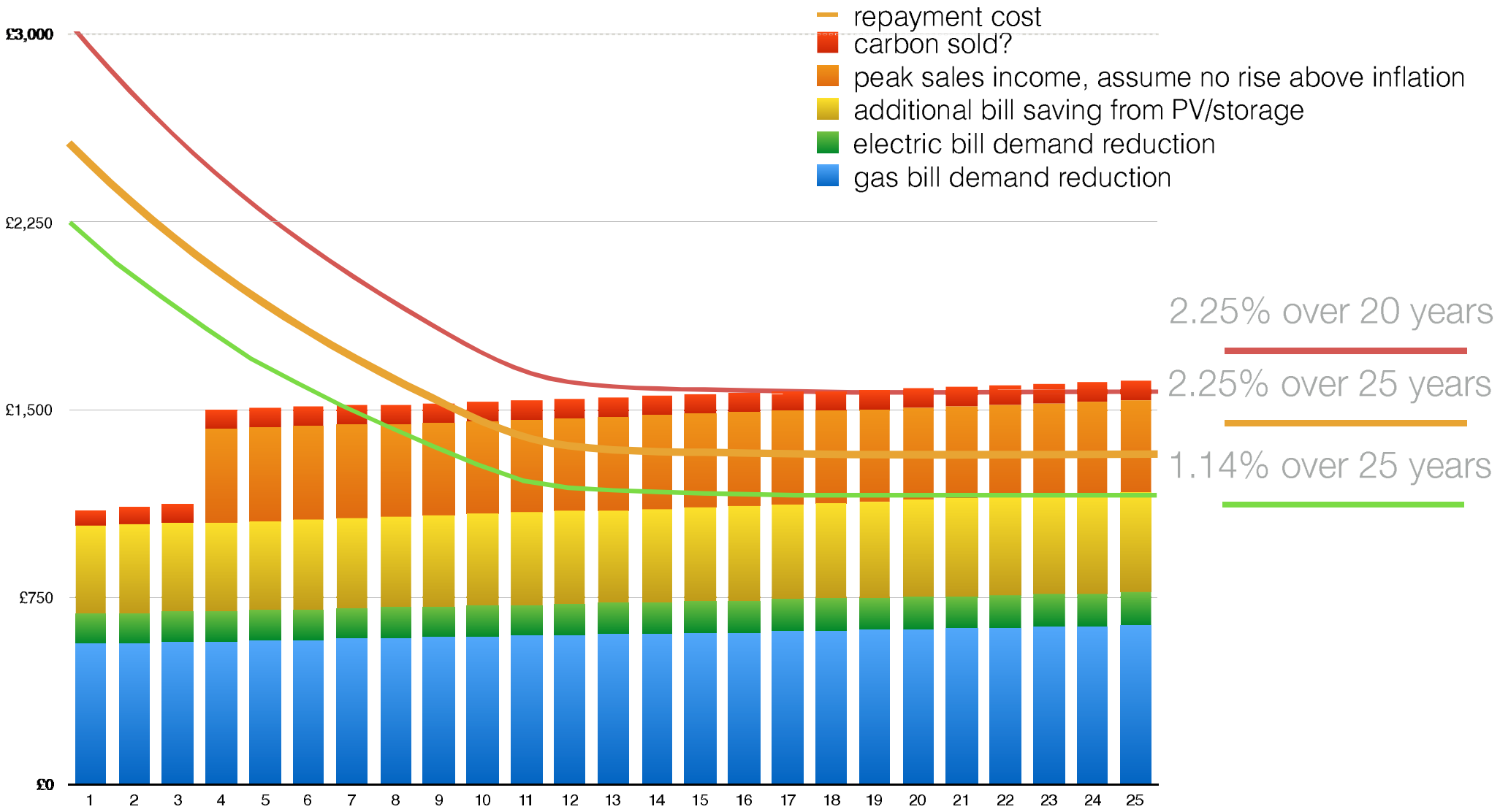
supply & demand can push prices up if bottlenecks are not addressed early but…

- labour costs should reduce as methods become more efficient
- materials costs reduce through scale & innovation in components and junctions
- Swanson's law should apply to batteries
- on-costs can reduce with joined-up IT methods



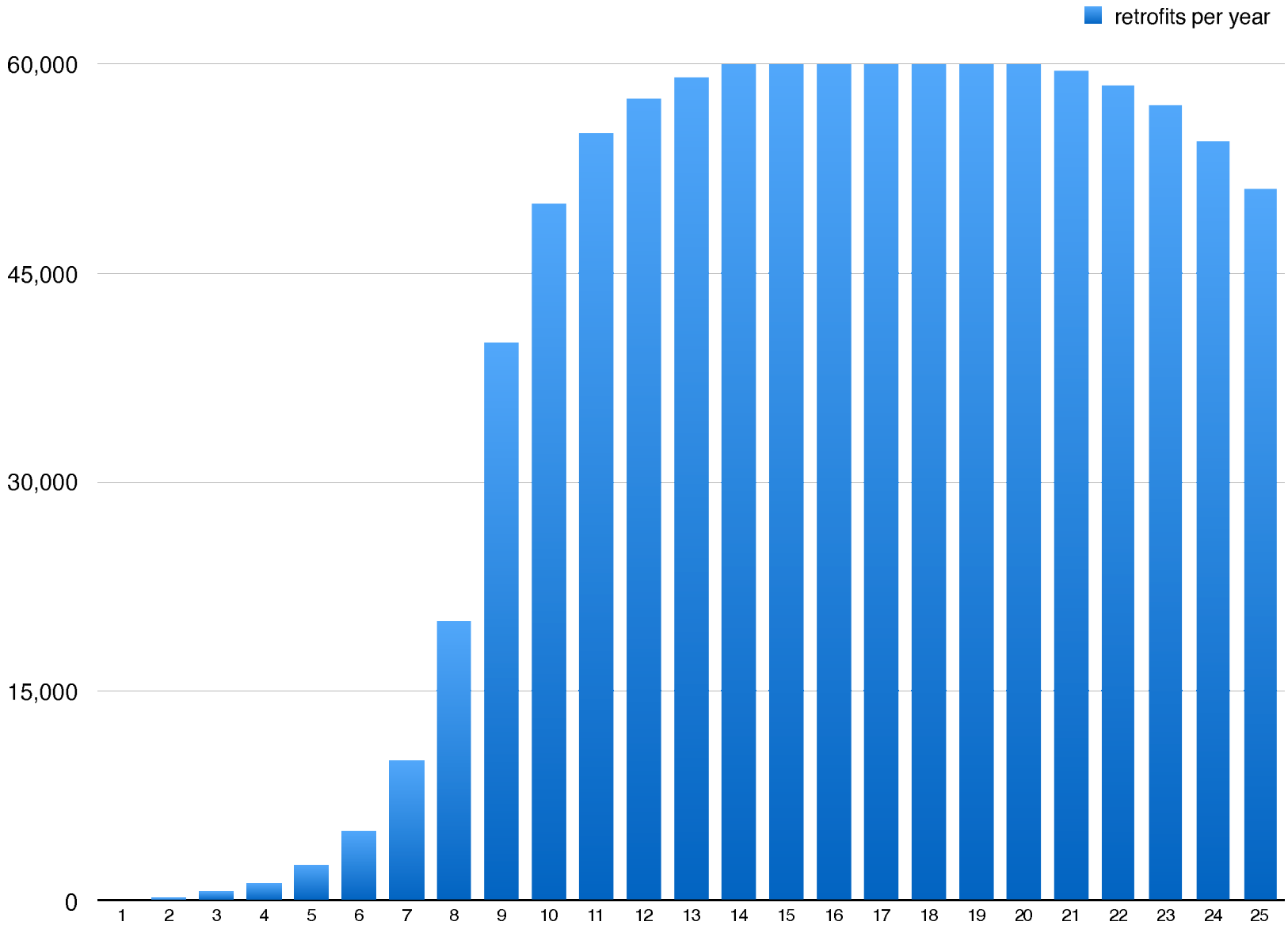
repayments & how they can be covered

- various sources cover declining repayments as efficiencies and scale grow
- cost of finance is key



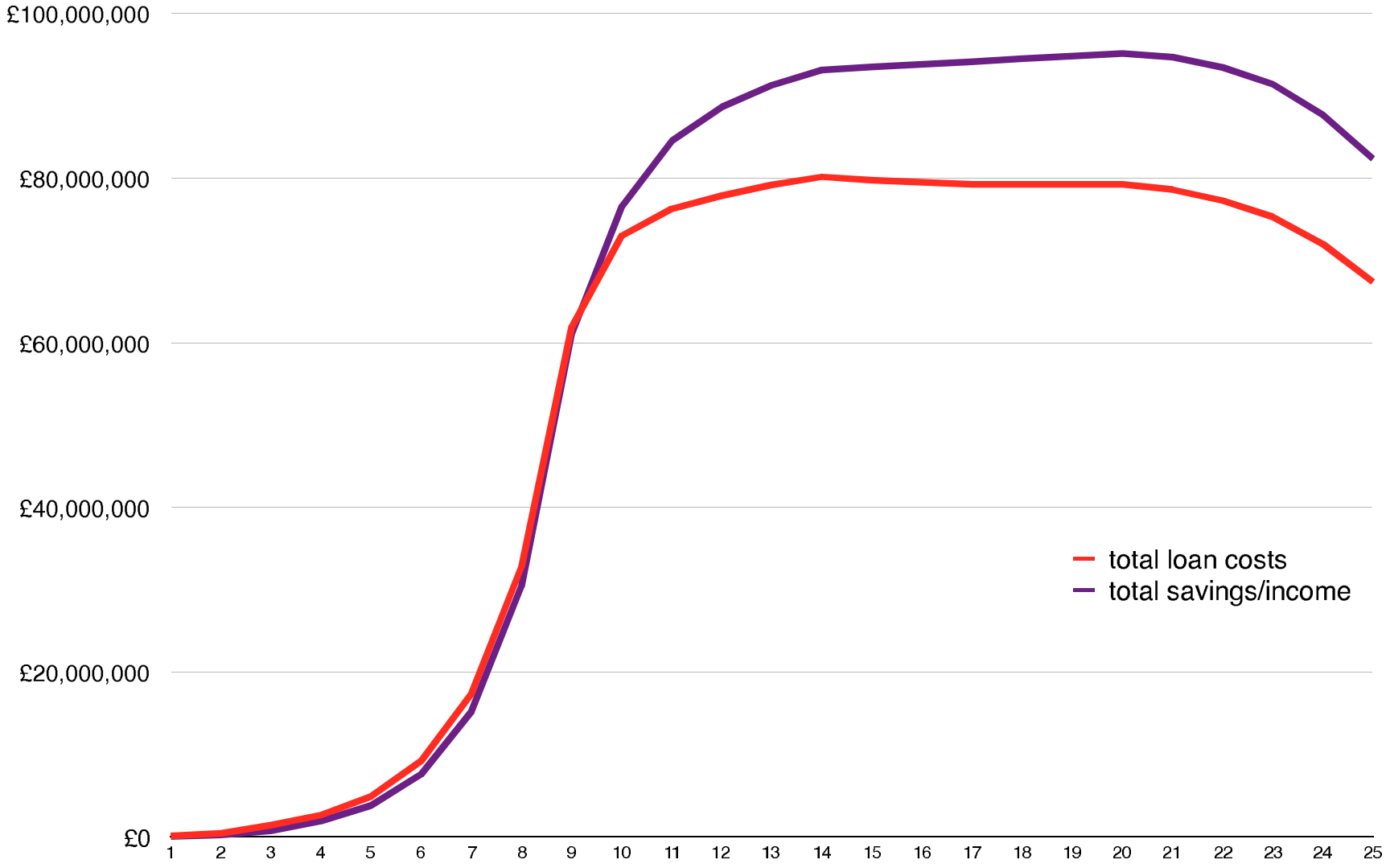
slow start retrofit programme

- rehearse + perfect, disseminate



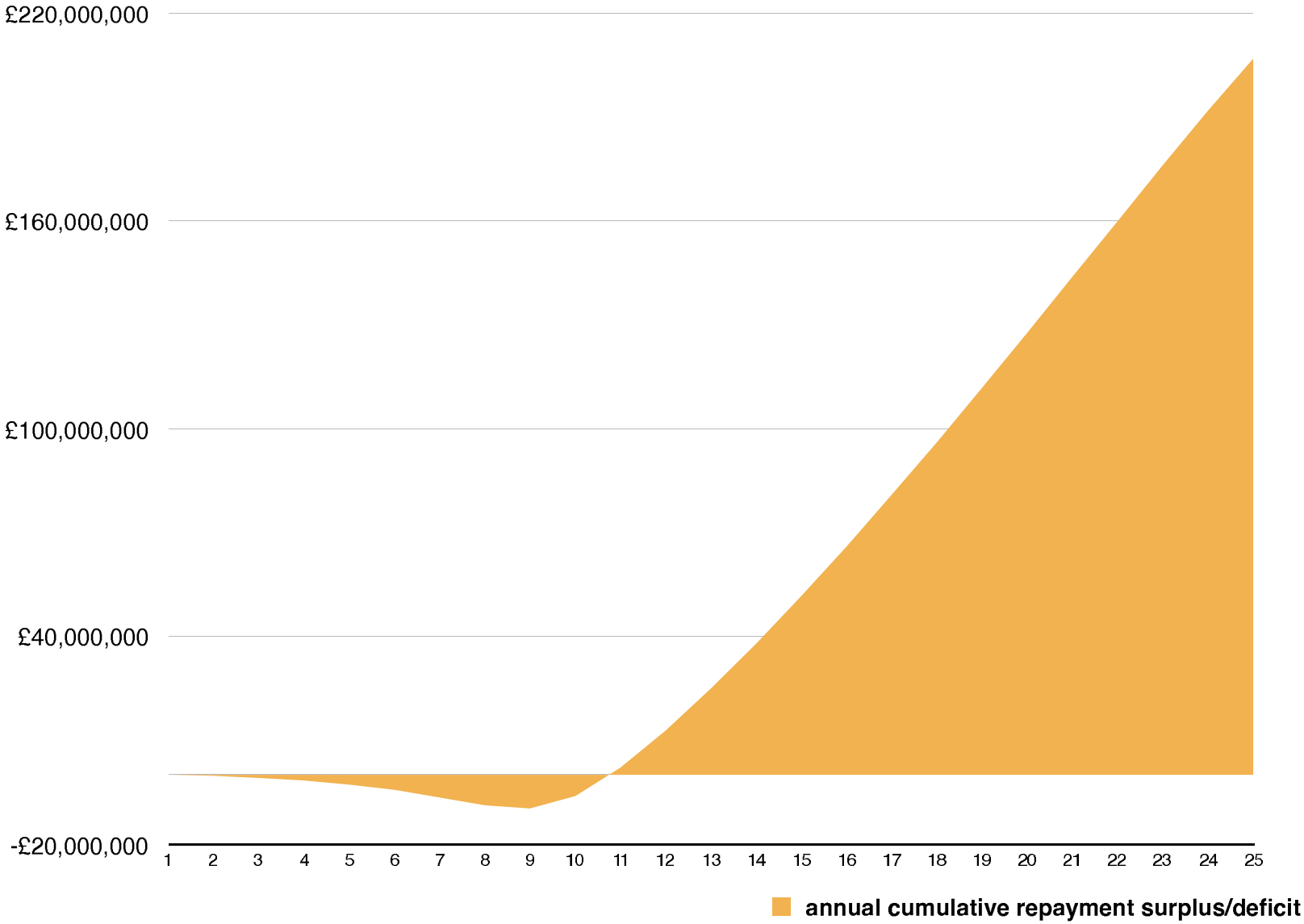
total cumulative energy 'income' vs total loan costs

- on 1 million homes
- early years small deficit, repaid later



cumulative repayment balance

- the early deficits are small compared to later surplus

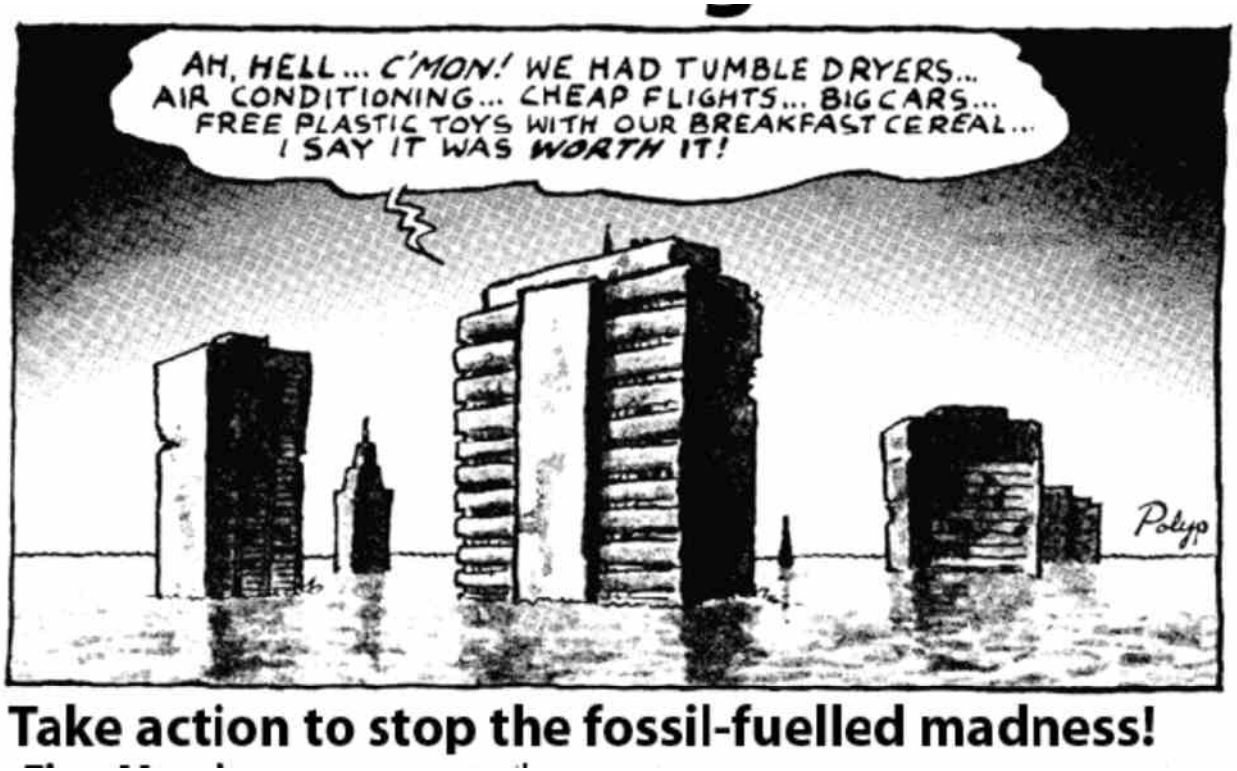


finance - a GM Green Bond, PWLB, Institutions?

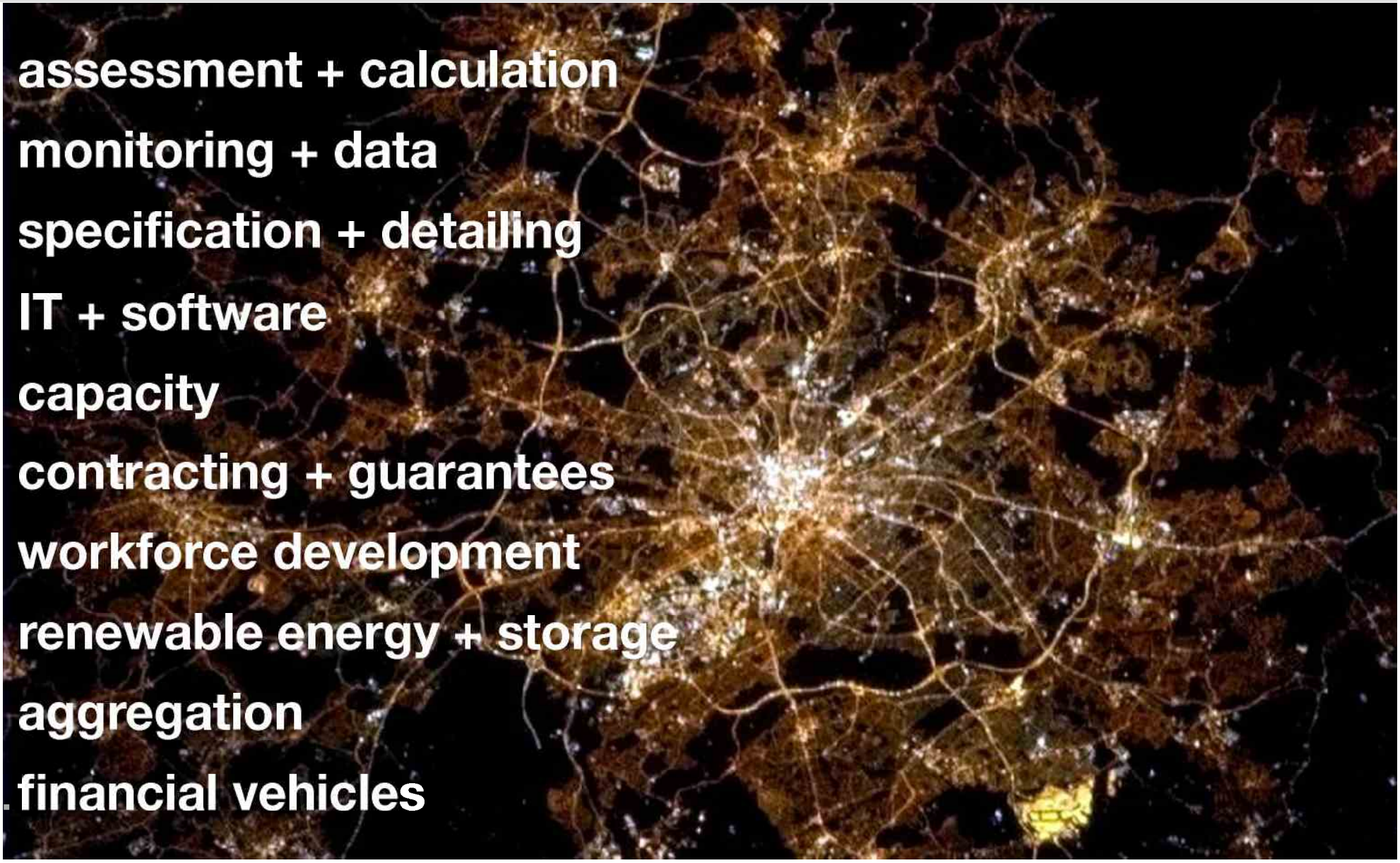
- savers get 1%, 1.5% if lucky
- FTSE All Share performance since 2007 only 4.9%
- US bonds during the 1st world war only paid 3.5%.
- will PWLB become popular again post-Brexit?
- insurers have much to lose from Climate Change, what do they think?
- could crowdfunding help to kick start?
- upscaled community finance could shorten loops, so your money could help your community

we need the profits to stay in the zero carbon project

- demand aggregation for bulk sales needs a competent & trusted intermediary
- RP's + LA's are more trusted than for profit companies
- a Manchester bond could offer differential rates for both investors borrowers to influence direction
- Differential Council Tax bands by EPC could influence decisions



the 10 point plan



red cooperative ltd
3 corkland rd
manchester
m21 8up

t: 07976 793 795
e: charlie@red.coop
w: www.red.coop