Simple Design Solutions

Nick Grant
Elemental Solutions

Value Engineering!

"It has been said an engineer is a man who can do for five shillings what any fool can do for a pound...."

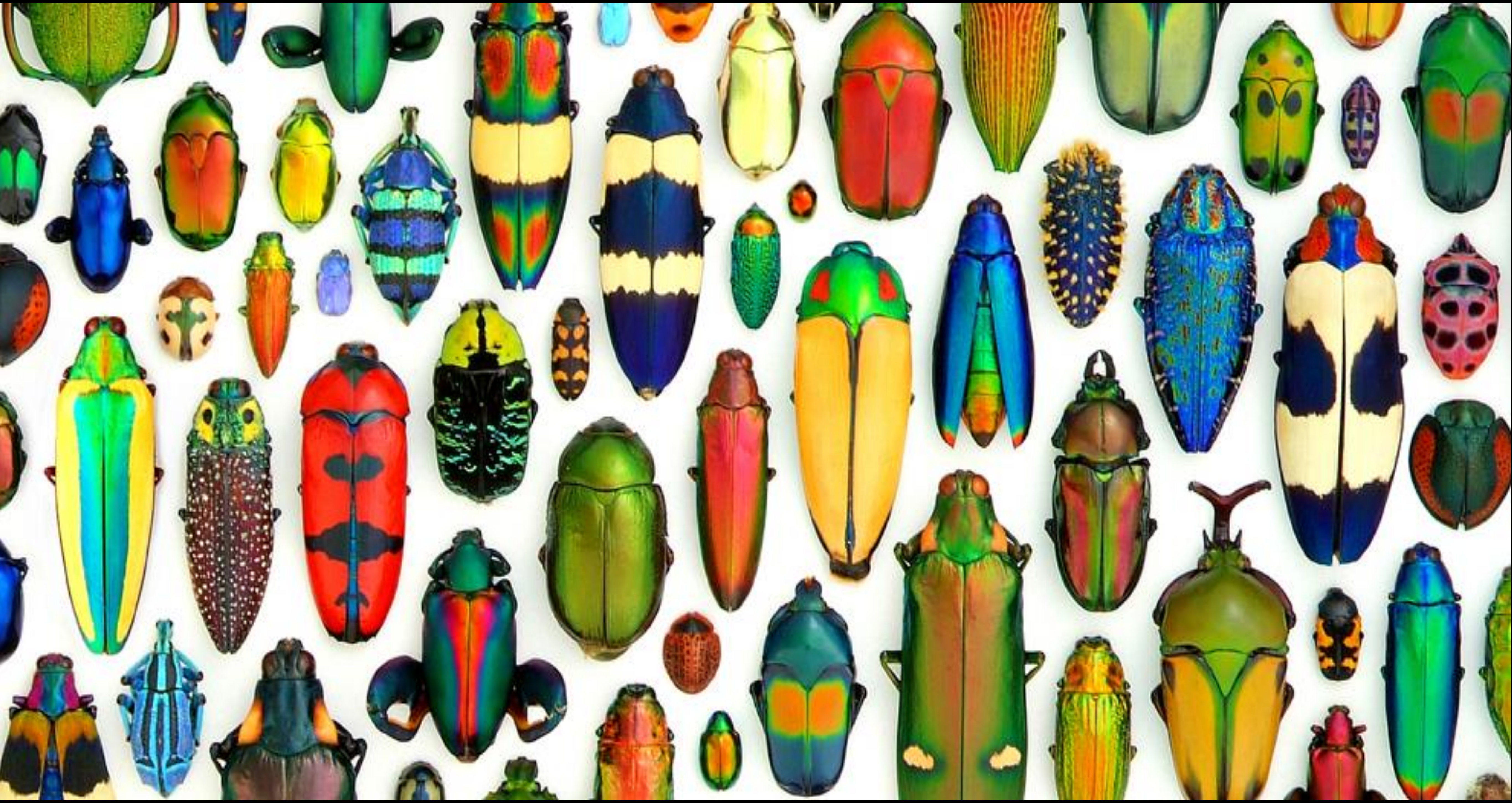
Nevil Shute, quoting anonymous epigram

Value Engineering!

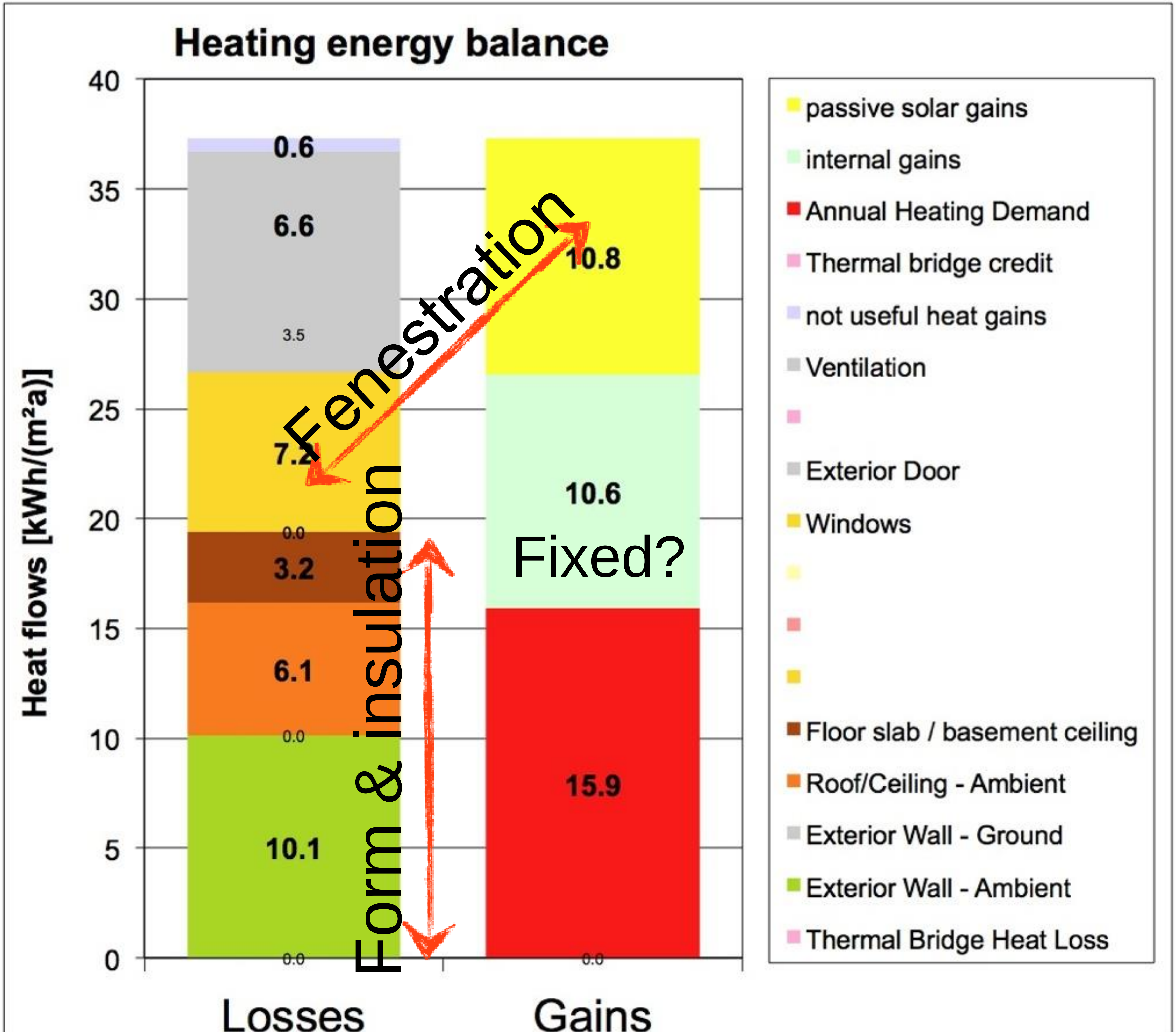
“My job is not done until we have got rid of all the architectural delight....”


Value Engineered
(3.5 billion year design time)

Nature all looks a bit Darwinian



‘An inordinate fondness for beetles’ (300,000 species of beetle)
– JBS Haldane


Heating energy balance
Heat flows [kWh/(m²a)]
40
35
30
25
20
15
10
5
0
0.6
6.6
3.5
7.2
0.0
3.2
6.1
0.0
10.1
0.0
10.8
10.6
15.9
0.0
Fenestration
Form & insulation
Fixed?
Losses
Gains
passive solar gains
internal gains
Annual Heating Demand
Thermal bridge credit
not useful heat gains
Ventilation
Exterior Door
Windows
Floor slab / basement ceiling
Roof/Ceiling - Ambient
Exterior Wall - Ground
Exterior Wall - Ambient
Thermal Bridge Heat Loss

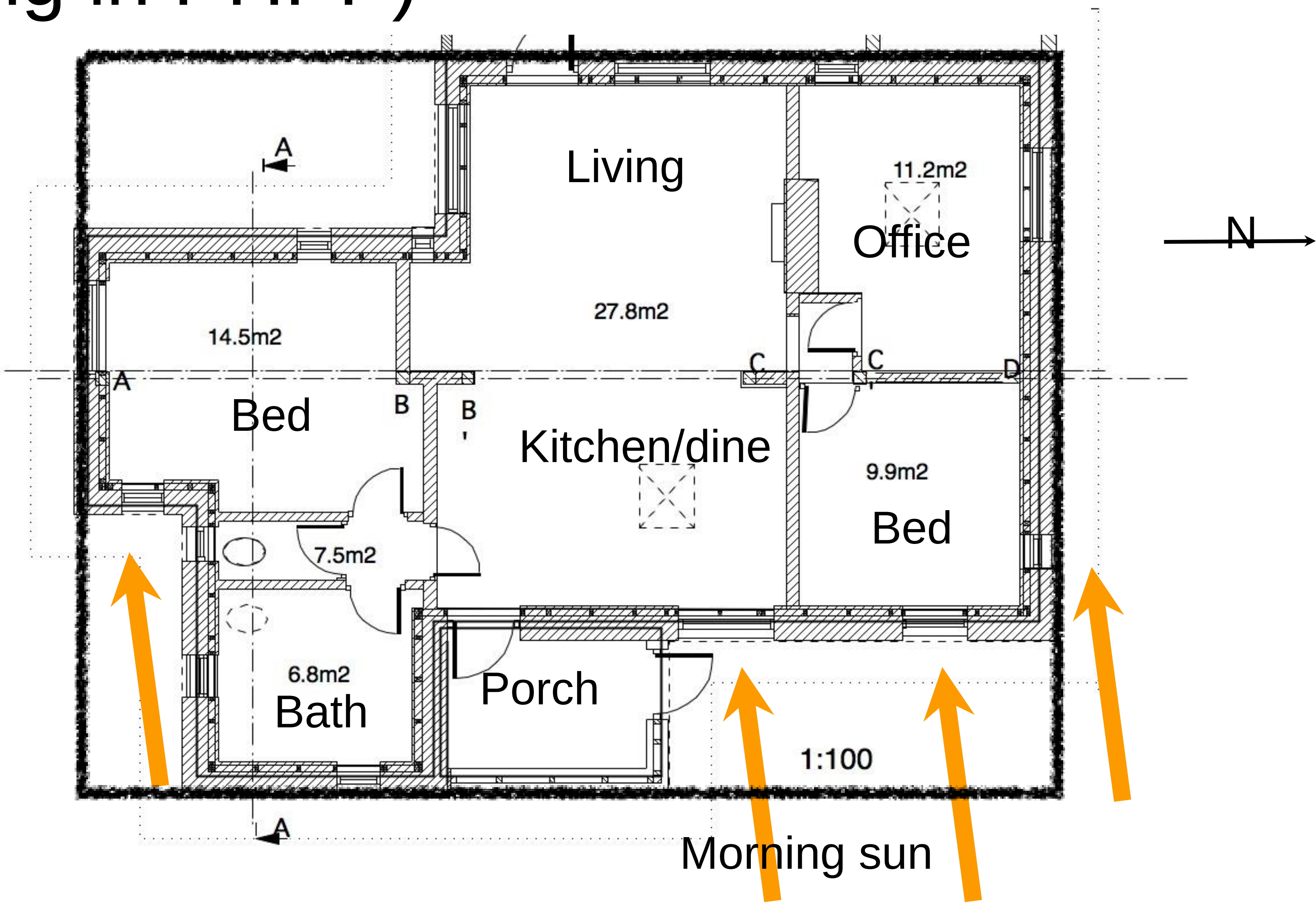
Form

- Heat loss area/TFA
    - <3 is good target
- Orientation and shading by building
    - L & H shapes are problematic
- Structure inside – easy airtightness
    - Think skeleton and skin

Do what I say not what I did!

- A/TFA = 5
- Shape shades windows (reveal shading in PHPP)

same wall area!



Reduce HL Area

- e.g. 100mm wall height = 0.1 x 32m perim x 0.15 U x 70 kKh/a = 34 kWh/a

  if 90m^2 TFA = 0.4 kWh/m^2.a

- Flatter roof pitch or cold roof

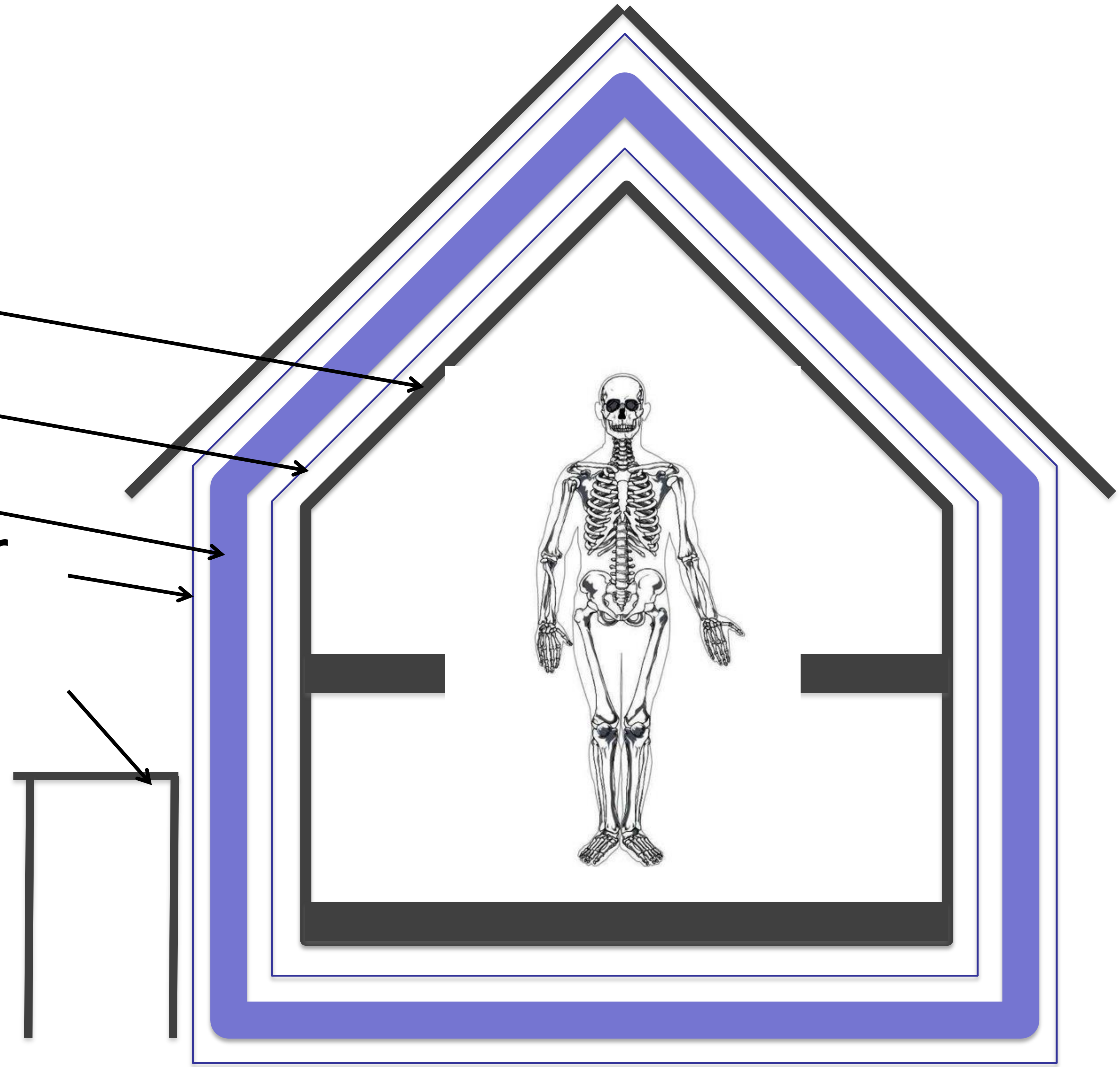
- Lower lambda insulation = thinner walls+roof

Maximise TFA

- Space under stairs
- Optimise stair width
- Avoid plant room label on domestic
- Beware double height spaces
- Design out ‘circulation’ for non dom buildings.

As in nature:

structure
air barrier
insulation
wind and weather
external structure
no penetrations
they leak!



Superficial simplicity is expensive

http://www.archdaily.com
Photo © Eibe Sönnecken

Fenestration

- Orientation
  - South net gain, E&W summer comfort issues.
- Quantity
  - For views and daylight not heat and symmetry.
- Format
  - Size, shape, height, fixed and opening elements.

Passive Solar;
What does free heat cost/kWh?

Passive House verification

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building:

Annual heating demand: 14 kWh/(m²a)

Heating degree hours: 67.0

Climate: Wales (Sennybridge)

Window area orientation	Global radiation (cardinal points)	Shading	Dirt	Non-perpendicular incident radiation	Glazing fraction	g-Value	Reduction factor for solar radiation	Window area	Window U-Value	Glazing area	Average global radiation	Transmission losses	Heat gains solar radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)	kWh/a	kWh/a
North	105	0.70	0.95	0.85	0.569	0.53	0.32	18.90	0.83	10.8	106	1050	341
East	234	1.00	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	234	0	0
South	432	0.89	0.95	0.85	0.675	0.53	0.49	36.23	0.77	24.5	428	1863	4000
West	248	1.00	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	248	0	0
Horizontal	360	1.00	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	360	0	0
		Total or Average Value for All Windows.				0.53	0.43	55.13	0.79	35.2		2913	4341
								[illegible]%	glazed fraction				

$$\frac{\text{Gains 4000 kWh/a - losses 1863 kWh/a}}{\text{Window area } 36\text{m}^2} = 59 \text{ kWh/m}^2\text{.a}$$

- About £6 'saved' per m² window per year @ 80p/kWh*
- Gets worse the more glass you add! (utilisation factor, solar shading, additional mass - all cost)
- BUT, free if you needed the window area anyway.
- *(3% discount rate, 20 year life, £400/m² window cost, 100% utilisation – YMMV)

Glass to floor

- Larger overhang to shade
- May need external blinds
- Structure more challenging
- Difficult cill detail
- Dirt from splash
- Loss of wall space

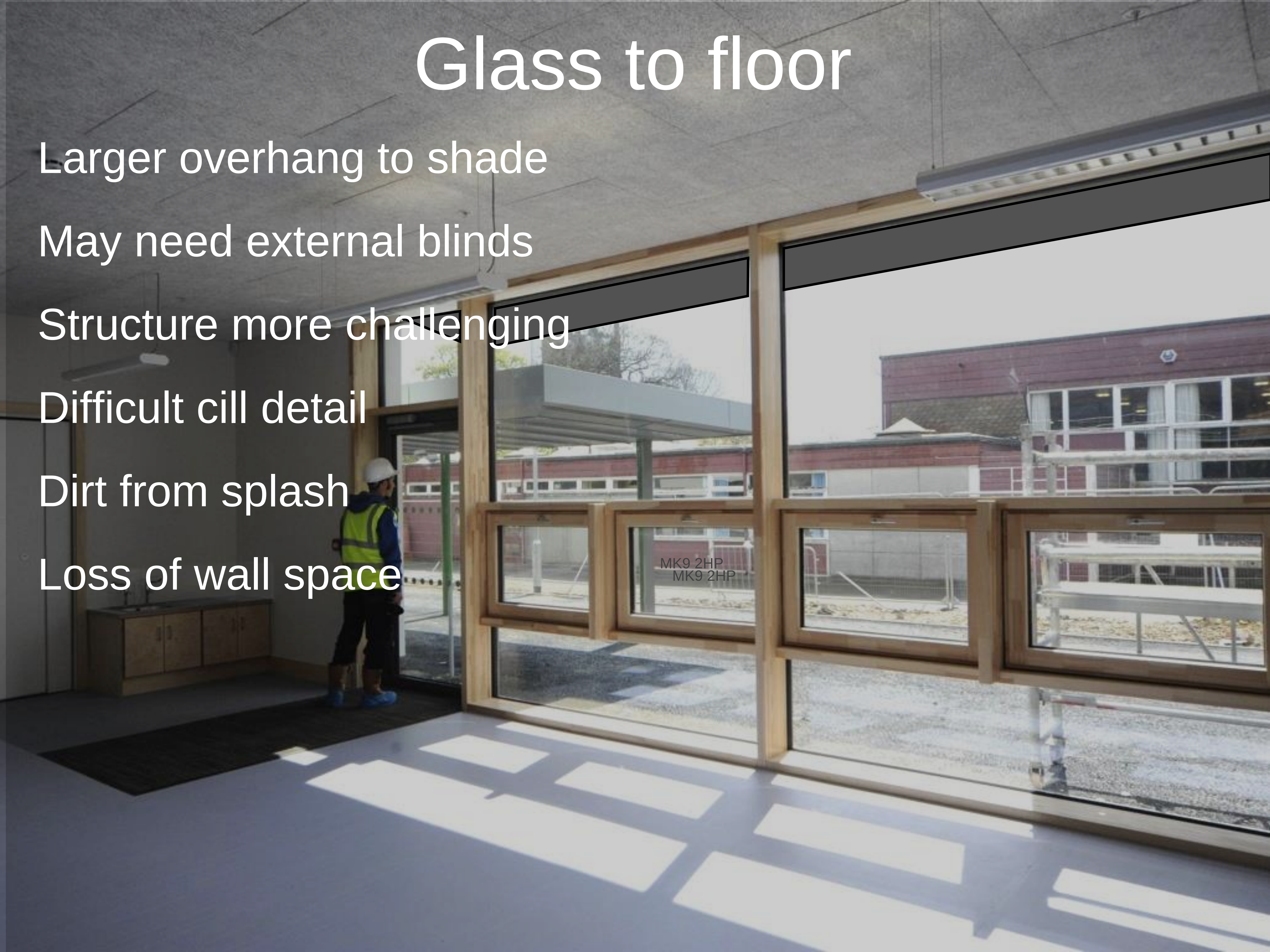


Photo Lisa Pasquale

Design out mechanical shading in UK climate

Windows - performance

For UK Building Regulations, the performance of these two windows can be considered the same:

But with Passivhaus, you have to calculate them individually

Poor Installation;

Traditional mullions

U_{window}=1.8 W/m²K

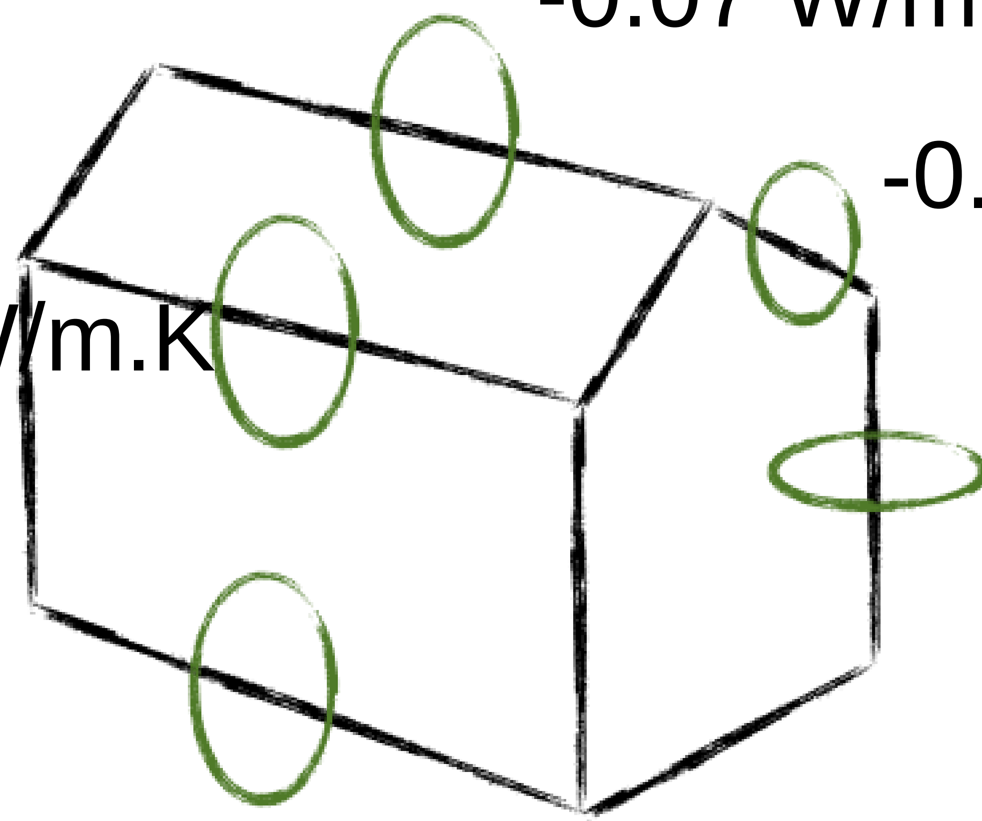
Installation free of thermal bridges;

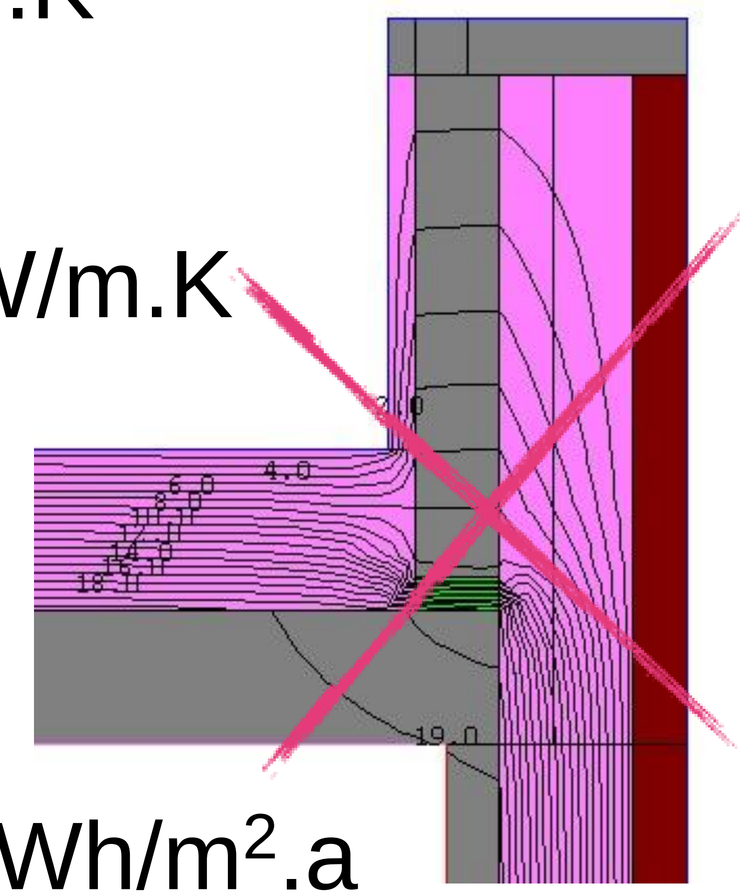
Simplified design

U_{window}=0.8 W/m²K

How could you optimise the window performance through design?

Thermal Bridges

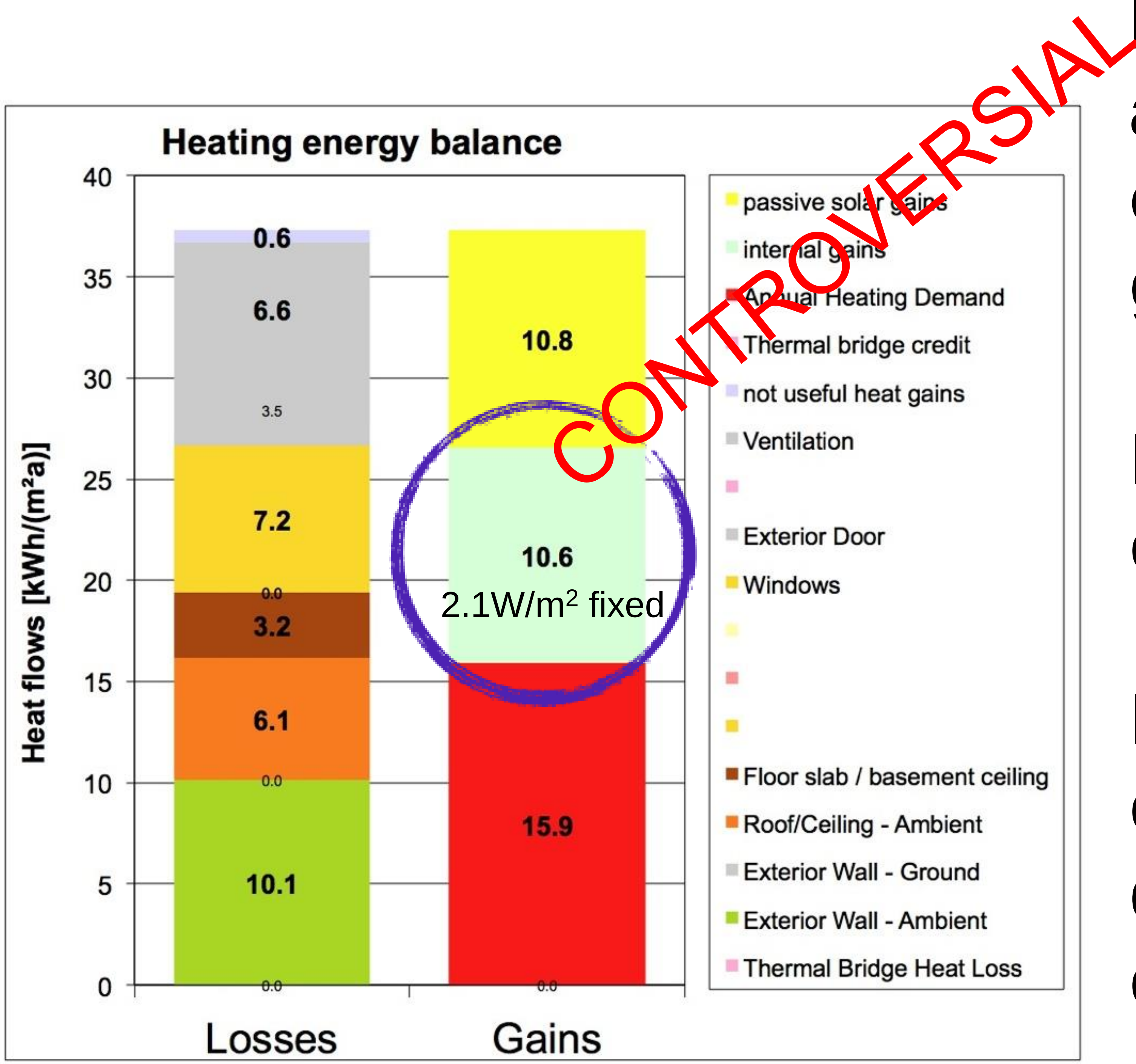




Thermal bridge free details save about 2-3 kWh/m^2.a

Expensive to calculate for one-off so develop standard details

Internal Heat Gains



Low but realistic IHG assumptions are key to closing performance gap.

Not all ‘free heat’ is free, e.g. IT, lighting etc.

BUT under or overestimating IHGs has design & value consequences

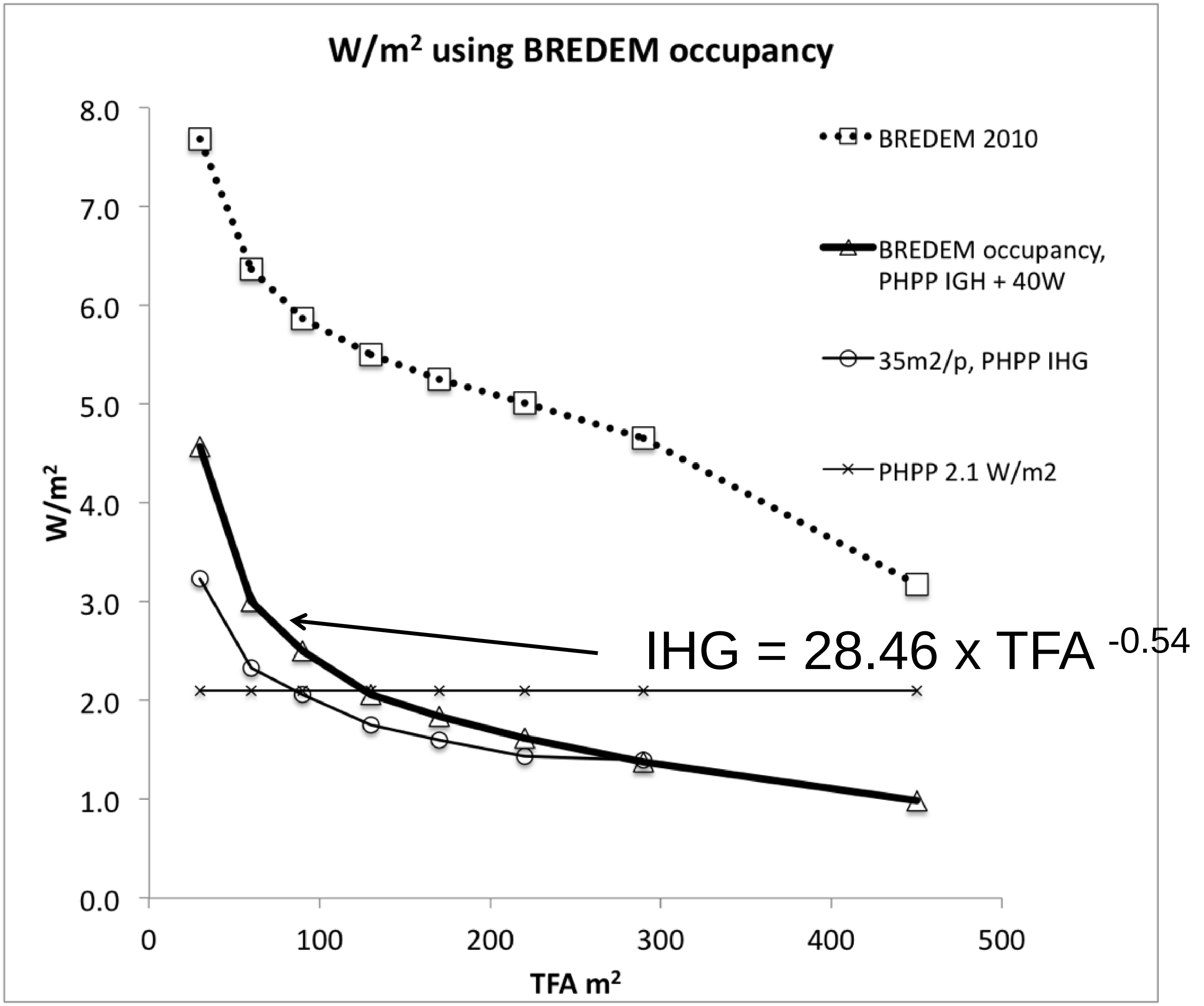
School	Children	TFA m^2	m^2/child
Bushbury Hill (UK)	240	1707	7.1
Oakmeadow (UK)	450	2205	4.9
Montgomery (UK)	446	2367	5.3
Swillington (UK)	240	1344	5.6
Wilkinson (UK)	459	2500	5.4
LH Hannover (D)	300	3507	11.7
Gronau (D)	336	2953	8.8
Reidberg (D)	500	5540	11.1

Average for UK examples[1]	5.7 m^2/child
Average for German examples	10.5 m^2/child

$+1.3\ W/m^2$

$= +\ 5.8\ kWh/(m^2.a)$

Domestic IHG



“All models are wrong, some are useful”
George Box

Are we there yet?

We can always add complexity and cost but simplicity and value has an end point.

However we have a long way to go.