

SEDA CONFERENCE
PROGRESSING RETROFIT
Glasgow, 15-16 September 2023

RETROFIT:
A SENSE OF PROPORTION

Bill Bordass

www.usablebuildings.co.uk

FABRIC FIRST can help many new buildings do without much space heating and cooling

My ambition:

*“a building with
no heating,
no cooling,
and no lighting
while the Sun is
above the horizon”*

MAX FORDHAM
1933-2022

***In 2019, he very
nearly did it >>>***

Max Fordham House verified as net zero carbon



THE HOME OF DESIGN & ARCHITECTURE

APRIL 25, 2022 / INDUSTRY NEWS

The UK's first net zero carbon residential home has been verified in line with the UKGBC's framework. A private house in Camden, built for pioneering engineer Max Fordham, has become the first residential building in the UK to be verified a completely net zero. *[Including offsets for residual embodied C].*

The RIBA award-winning house sets an example of how net zero homes can become a key part of the UK's housing solution. During his lifetime, Max Fordham made great efforts to change the way architects think about heating, power, and light, and constantly championing sustainable design.

But what about our legacy?

Louis Hellman cartoon on cover of RIBA Journal Energy issue Feb 1976

And we now have another half century of energy dependent buildings.

HOW WRONG CAN WE AFFORD TO BE?



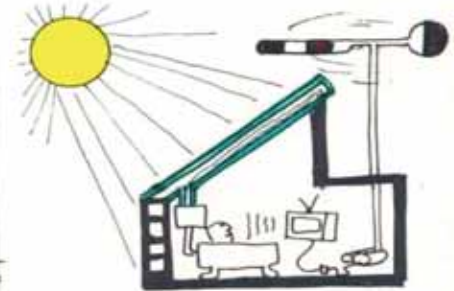
OLD BUILDINGS ARE HIGHLY FLEXIBLE IN USE, THEY CAN BE ADAPTED TO NEW FUNCTIONS CHEAPLY AND EASILY BY KNOCKING DOWN WALLS OR BY ADDING BATHROOMS OR STAIRCASES. IT HAS BEEN ESTIMATED THAT THE GREAT MAJORITY OF HUMAN ACTIVITIES CAN BE ACCOMMODATED IN A GEORGIAN TERRACE HOUSE.



WHAT WE NEED IS A COMBINATION OF THE OLD EMPIRICAL EXPERTISE AND NEW TECHNIQUES TO PROVIDE REASONABLE BUILDINGS WITH THE MINIMUM COST AND ENERGY CONSUMPTION.



FOR EXAMPLE THE QUALITY OF DAYLIGHT IS MORE IMPORTANT THAN THE QUANTITY. SMALL WINDOWS FOR VIEWOUT CAN BE USED WITH ARTIFICIAL LIGHTING FOR WORK ETC.



MODERN MATERIALS CAN BE USED TO EXPLOIT SOLAR ENERGY MORE EFFICIENTLY TO HEAT WATER OR ROOMS, PLUS IMPROVED WINDMILLS TO DRIVE GENERATORS.



IT IS CLEAR THAT THE HIGHER THE BUILDING THE GREATER THE TECHNOLOGY REQUIRED TO COUNTERACT THE PROBLEMS CREATED BY BUILDING HIGH.



ENVIRONMENTAL DESIGN IS NOT AN EXACT SCIENCE - WE CAN NEVER BE RIGHT, THE QUESTION IS...



HOW WRONG CAN WE AFFORD TO BE?

Hellman

Should we be resolving our problems,
or re-examining our premises?

*“We can't solve problems
by using the same kind of thinking
we used when we created them”*

Attributed to A EINSTEIN

*“We are suffering from an attempt
to know our way into the future
instead of live our way”*

W SHARPE

RETROFIT-RELATED RESEARCH:

Some personal lightbulb moments: 1

1970s Non-domestic energy surveys:

Lots of scope for simple, user-friendly measures.

1980s Historic buildings: *Importance of moisture.*

Non-domestic retrofit: *Emergence of performance gaps, unmanageable complication, lack of even simple monitoring.*

1990s Non-domestic POEs: *Deficiencies in building procurement, over-optimistic energy prediction, few tune-ups.*

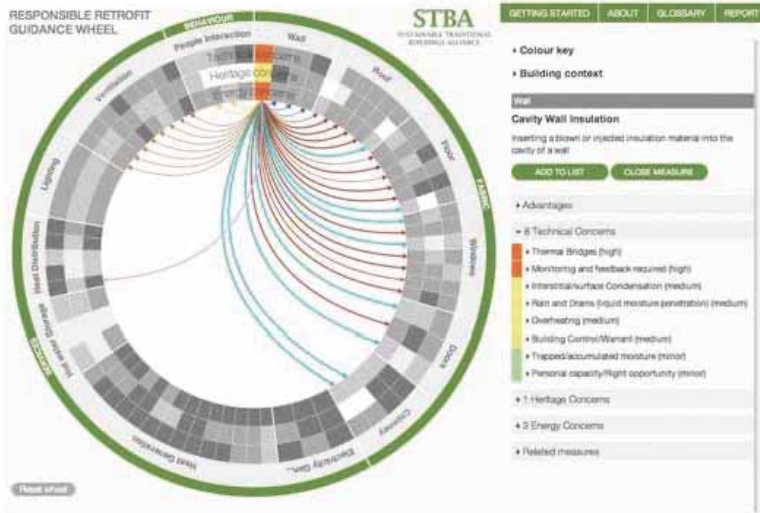
Singapore fabric first refit edict: could **increase** office energy.

2000s Traditional domestic retrofit:

Owner-occupiers often cut corners successfully. Social landlords couldn't, but their solutions risked being fragile.

2010s Domestic Green Deal: *Only an energy shopping list, so we helped to develop the STBA Guidance Wheel.*

Knowledge base for retrofit in 2012, *which led to the STBA Wheel for risk management*



SOME CONCLUSIONS

Industry and policy lack understanding of traditional building performance.

Lack of connection between research intelligence and guidance procedures.

Significant uncertainty in application of models and software.

Some methods used are inappropriate.

A systemic approach is necessary to avoid unintended consequences.

There are good opportunities, but some will need to be developed using a rather different basis and structure.

RETROFIT-RELATED RESEARCH:

Personal lightbulb moments: 2 - Recent

In particular from work on PAS 2038 and the Heritage group of the developing UK Net Zero Carbon Buildings Standard.

- BS PAS 2035 and 2038 concentrate on "Medium Term" retrofit plans. These are too expensive for many clients and can ignore many opportunities and constraints. *We need a better briefing process.*
- Owner-occupiers, Social landlords and Private landlords have very different perspectives. *So do rich and poor.*
- Most owner-occupiers will proceed incrementally.
- Planning authorities can be a big problem: *"Conservation Officer says no"*. Education required.
- Retrofit provides opportunities to reverse indignities inflicted on traditional buildings, *see for example the ACAN Guide**.
- Most designers and builders know little about traditional buildings.
- Local knowledge is vital. *Do things bottom-up not top-down.*

* ACAN Conservation Area Toolkit, Architects Climate Action Network (March 2023)

CHANGED
PRIORITIES
AHEAD



WOODZ ER

Priorities for existing buildings: FABRIC FIRST?

Essential to think about for new construction, *as the fabric tends to be the most difficult to change later.*

HOWEVER

- Most post-WW2 buildings were not well designed or built in terms of the fabric's environmental performance.

AND

- Existing buildings can be sensitive, both aesthetically, and in terms of technical performance. TAKE CARE!
- Interventions can be destructive, particularly those that add layers and increase vulnerabilities, e.g. to moisture-related problems, fire and recovery from floods.
- Fabric first means GOOD MAINTENANCE FIRST:
Too often this has not happened (viz the Green Deal).

Scope for massive improvement
if you use the multiplier effect. For example:

BE LEAN - Halve the demand

Review standards, reduce losses, avoid waste.

times

BE MEAN - Double the efficiency

*Buy efficient equipment, use it efficiently,
avoid system losses, tune it all up.*

times

BE GREEN - Halve the carbon in the supplies

With on-and off-site measures

equals

You're down to one-eighth of the CO₂

BUT YOU NEED TO TAKE ALL THE STEPS!

A spectrum of approaches to energy and carbon-saving retrofit

TYPE	COMMENT	TYPICAL COST (<i>per dwelling</i>)	SOME INGREDIENTS	NOTES
1. DEEP RETROFIT <i>LETI Exemplary</i>	The current mantra? e.g. EnerPHit	£ 100,000	Full suite of measures.	Nice work if you can get it, but rare.
2. GOOD PRACTICE <i>e.g. AECB</i>				
3. COST EFFECTIVE <i>LETI is working on this</i>				
4. "SOFT" RETROFIT <i>People first</i>				
5. BASIC ENERGY SAVING				

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5. BASIC ENERGY SAVING	Simple, <i>but too often still not done.</i>	£ 1,000 or less	Basic insulation, draughtproofing, equipment, control	Often absent from retrofit plans. <i>Advisers needed!</i>

So what can we now do quickly *to be healthy and comfortable enough while saving energy in a hurry?*



Comfort is socially and culturally determined:

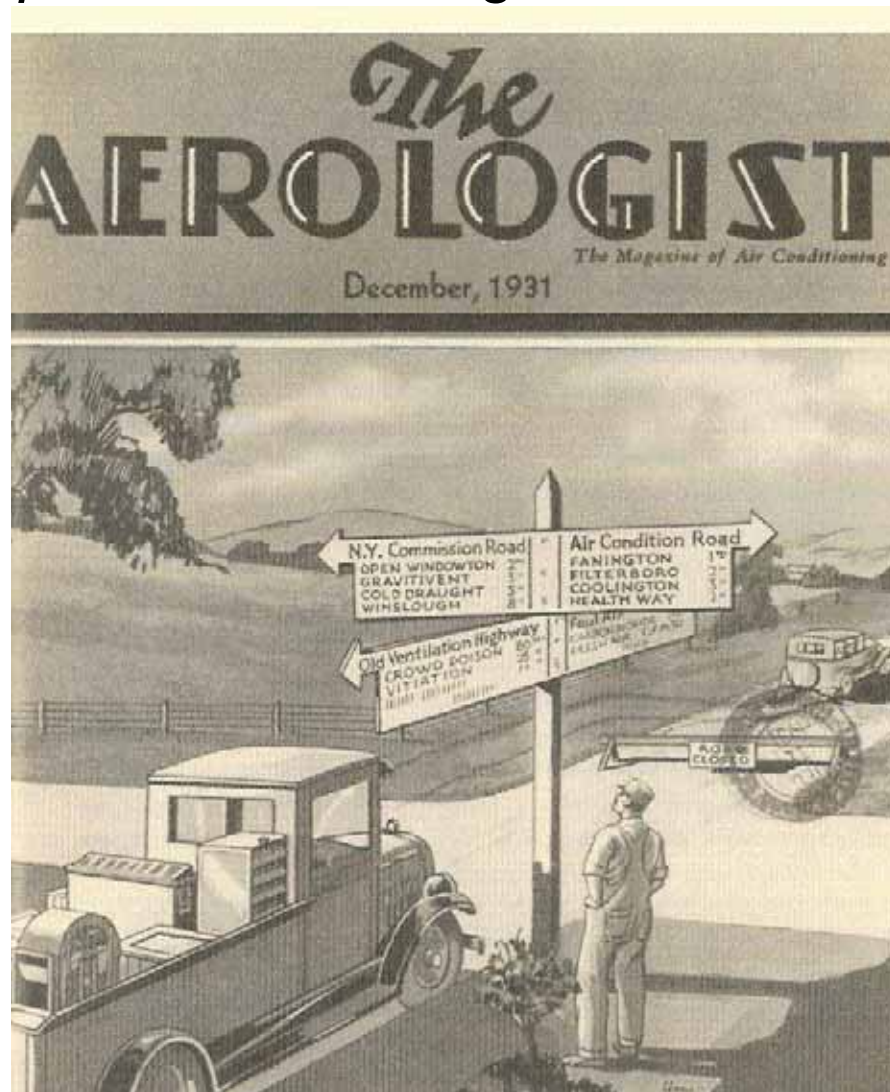
People's needs... have social histories of their own ... The [mistaken] distinction between technology ... and behaviour.

"Sociology ... repeatedly demonstrates the extent to which things ... 'script' what people do ...

"If current understandings of comfort underpin escalating energy demands, why persist with them?"

FRAMING COMFORT *in the 20th Century:*

Space conditioning was converted into a marketable commodity



"In 1922, the New York State Commission ... advocated natural ventilation ... The engineering community seriously opposed ...

... *"The Aeroalogist journal ... argued physicians were stepping outside their [professional] boundaries.*

"When natural climate was the ideal, mechanical systems were found wanting, but when quantitative standards ... became the measure, natural climate was found wanting. When no town could deliver an ideal climate, all towns became potential markets."

AND AFTER WORLD WAR 2:

Climate-responsive features of buildings (verandahs, shutters, shade roofs etc.) were simplified or eliminated, in order to make air conditioning more affordable.

Lobbying Rules OK?

Constitution of American Society of H&V Engineers 1895

Proclaiming the Truth

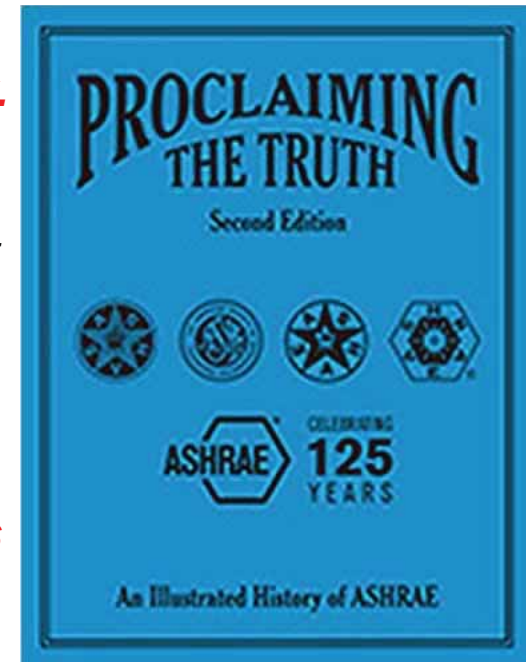


To establish a clearly defined minimum standard of heating and ventilation for all classes of buildings.

To favor legislation compelling ventilation of all public buildings in accordance with the standard of this society.

To encourage legislation favorable to improvement in the arts of heating and ventilation, and

to oppose legislation inimical to the business of the engineer.



ENERGY SUFFICIENCY: *Avoid unhealthy environments, allow escape from crises of discomfort*

MAIN METHODS:

1. Review appropriate standards *and promote adaptive comfort*
2. Control draughts, air movement and radiant heat gains and losses
3. Wear the right clothing and have suitable furniture etc.
4. Consider local and personal heating and cooling systems
5. Have accessible, responsive user-friendly controls
6. Improve thermoregulatory fitness where practicable
7. ADD thermal refuges, *both hot and cold, local and communal.*
8. *Plan to avoid health and moisture-related unintended consequences.*



"He gets so dramatic when I lower the thermostat."

These also save energy and carbon much more quickly and cheaply than heavy capital investment.

SOFT RETROFIT: Some possible implications for heating in traditional buildings

Possible advantages	Caveats
Fewer alterations required to fabric, reducing associated risks too.	Some improvements may nevertheless be appropriate, depending on context.
Lower internal air temperatures.	Sometimes they are too low already, <i>increasingly so with current price spike.</i>
Less necessary to limit air infiltration if air temperatures are lower.	Some draughtproofing may also be helpful, depending on context.
Could help to reduce condensation and moisture problems that can occur after draughtproofing etc.	Cooler buildings can be more prone to problems from any internally-generated moisture - needs removal at source.
Potentially much faster, cheaper energy savings than deep fabric retrofits.	New technology is often electric and used at peak times. Storage needed?
Local electric systems simpler and less intrusive to install than traditional HVAC	Additional, dispersed electric heating equipment might increase fire risks.
Local systems could be particularly useful in lightly-occupied buildings.	Less energy-saving potential in heavily- or densely- occupied buildings.

MOVING FORWARD: *Evolving Mindsets*

PAST <i>can persist, or revert</i>	PRESENT <i>C20-21</i>	FUTURE? <i>Later C21</i>
SUBJECT of a Chief, King, <i>Pope, Dictator, Putin ...</i>	CONSUMER <i>I spend, therefore I am</i>	CITIZEN + COMMUNITY <i>both local and wider scales</i>
PRIESTHOODS <i>+ Guilds Professions Unions</i>	MARKETS: <i>Invisible Hand,</i> <i>or Corporate Takeover?</i>	COLLABORATIVES <i>with diverse skills</i>

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BUILDINGS: BUILT TO LAST, Robust <i>With routine maintenance</i>	BUILT TO CONSUME <i>Demolish or retrofit old ones</i>	IMAGINATIVE RE-USE <i>Improving what we've got</i>
COMFORT: LOCAL PROVISION & <i>Thermoregulatory Fitness</i>	SPACE CONDITIONING <i>Commoditised comfort</i>	RESILIENCE, AVOIDING CRISES of DISCOMFORT plus Thermal Adaptation
ENERGY: CONSERVATION <i>Husbanding resources</i>	EFFICIENCY <i>But not necessarily saving</i>	SUFFICIENCY <i>Living within our means</i>

*“... we are living the end of what could have seemed an era of abundance
... of products of technologies that seemed always available ... of land
and materials including water”* - EMMANUEL MACRON, 23 Aug 2022

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RESEARCH: BASIC <i>And on-the-job learning</i>	ACADEMIC <i>Distanced from practice</i>	REAL-WORLD <i>Closely</i> <i>integrated with practice</i>

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		RESEARCH: REAL-WORLD <i>Closely integrated with practice</i>

“You don’t waste time with reactionaries; rather you work with active change agents and with the vast middle-ground of people who are open minded” - DONELLA MEADOWS *

So which mindset might this have come from? ***Current Story or Emerging Story?***

“The opportunity for widespread behaviour change has been considered, with a cautious approach to expectations that occupants will be able to reduce thermostats without improvements to building fabric –
one of the supporting arguments for the fabric first* retrofit programme.”

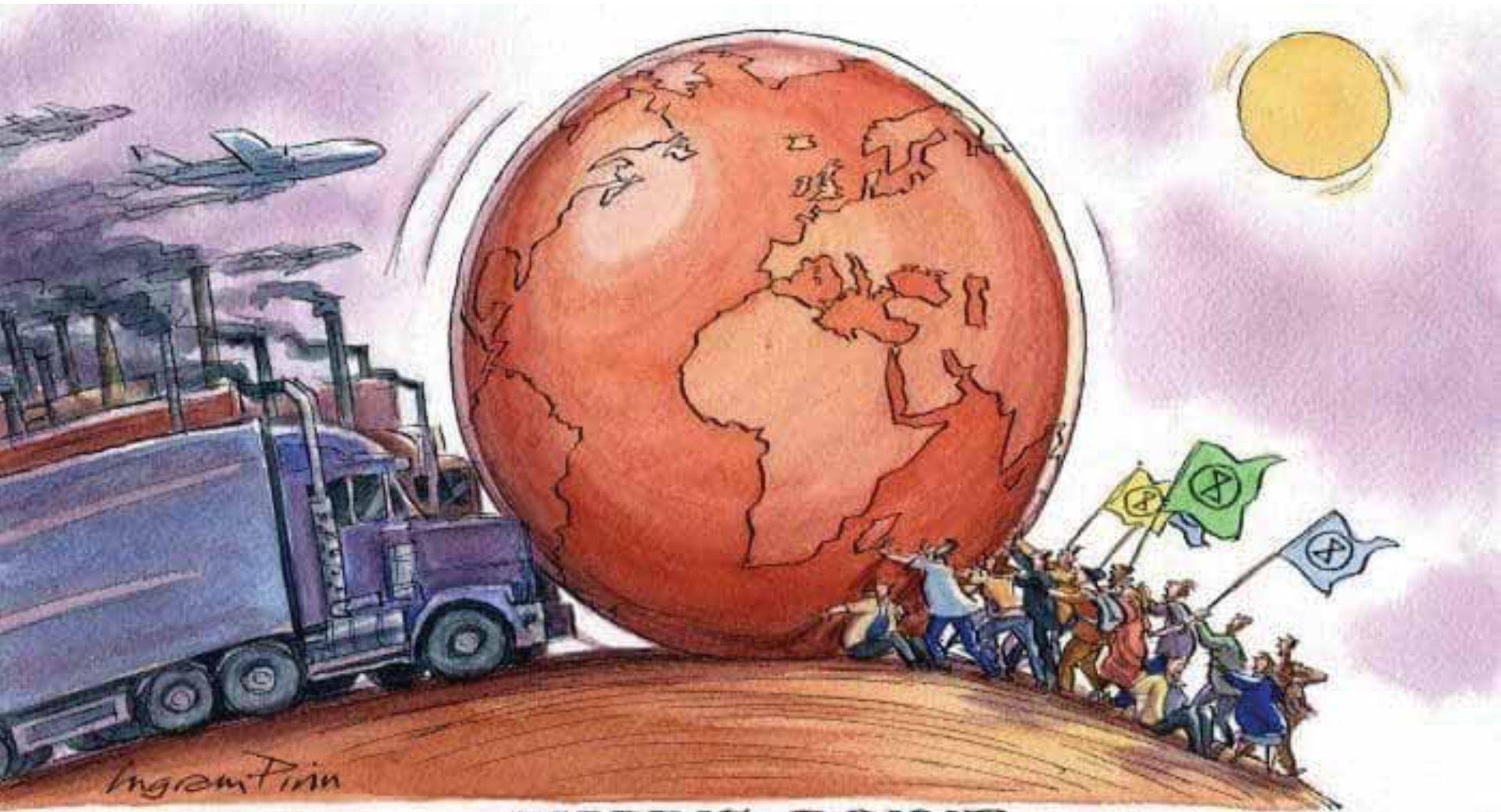


Net Zero Whole Life Carbon Roadmap

A Pathway to Net Zero for
the UK Built Environment

* NOTE: this UK Green Building Council report (2021, page 24) also regards Fabric First as a “no regrets” strategy.

Thank you



TIPPING POINT


www.usablebuildings.co.uk

SUPPLEMENTARY SLIDES


Referred to, but not shown on the day

BEYOND SPACE HEATING AND COOLING

Comfort and discomfort in context *on a simplified scale*

- 
- Acute medical problems (e.g. heat stress, frostbite)
 - **Discomfort** and stress (too much of a good thing)
 - Delight (exhilarating stress: theatre, beach, skiing)
 - Comfortably unbalanced (e.g. comfortably warm or cool)
 - **Neutral** (comfortable) – **Typical aspiration** (but sensory deprivation?)
 - Slightly uncomfortable *but tolerable* (boiled frog)

CRISIS OF DISCOMFORT (comes sooner if one lacks perceived control)

- 
- Irritably uncomfortable
 - Increasing discomfort, until ...
 - Acute medical problems (heat stroke, hypothermia)

People don't need heating or cooling

BUT heat gains and loss must not be so high that our physiology can't keep core body temperature under close control
AND take care to avoid chronic health issues, e.g. from damp and mould.



FRAMING: People respond to Stories

Stories can alter radically ... and then become taken for granted

OLDER STORIES	CURRENT STORIES	EMERGING STORIES ?
<i>can persist, or revert</i>	C20-21	Later C21

“If current understandings of comfort underpin escalating energy demands, why persist with them?” **Comfort is socially and culturally determined:**

People’s needs... have social histories of their own ... The [mistaken] distinction between technology ... and behaviour.

“Sociology ... repeatedly demonstrates the extent to which things ... ‘script’ what people do ...

“[while] dominant paradigms remain ... there are fewer references to non-technical barriers and more to sociotechnical change... practices not behaviours.”

e.g. Clothes like these could halve demand for space heating: Could they be made fashionable? >>>>



FRAMING COMFORT *in a Climate Emergency:* *How about seeking to **escape Crises of discomfort****

HOW?

Use perceived control & adaptive opportunity, e.g:

- Adjust a passive system (*windows, blinds etc*).
- Adjust M&E services (*central, local or personal*).
- Contact the manager (*but rapid response is vital*).
- Adjust posture, clothing, activity etc. (*+ lap dogs and hot water bottles*)
- Move about, go somewhere else, go outside (*possible at home, in some modern work environments, in Australia! ...*).
- Eat or drink (*hot or cold*), take a shower, feet in bucket ...



Loose control with adaptive opportunity can give greater occupant satisfaction with less energy dependency ...

BUT achieving consensus in shared spaces can be tricky.

* SOURCE: D Haigh, *User response in environmental control*, in D Hawkes & J Owers (ed), *The architecture of energy* (1981).

Where looser control works effectively *with occupants tending to report better conditions*

- **Design intent is made clear** to occupants; and where possible is made intuitively obvious, *or at worst only needs explaining once.*
- **Controls are clear** to users and managers, and give them good feedback on what to do and what is then happening.
- **Default states (e.g. to OFF) are restored** manually or automatically, to avoid unnecessary stress and/or energy waste. *People are good judges of what they need, but can't have too much of a good thing.*

AND IN MANAGED BUILDINGS:

- Facilities management is adequately resourced, respects users and responds rapidly and effectively to their needs.
- Organisations monitor performance in use, and make an effort to ensure that things are working and occupants are kept informed.

AVOIDING THERMAL DISCOMFORT

Beyond space heating and cooling

“Evening out fluctuations has become an egalitarian enterprise which it is heresy to question.” - MICHAEL YOUNG

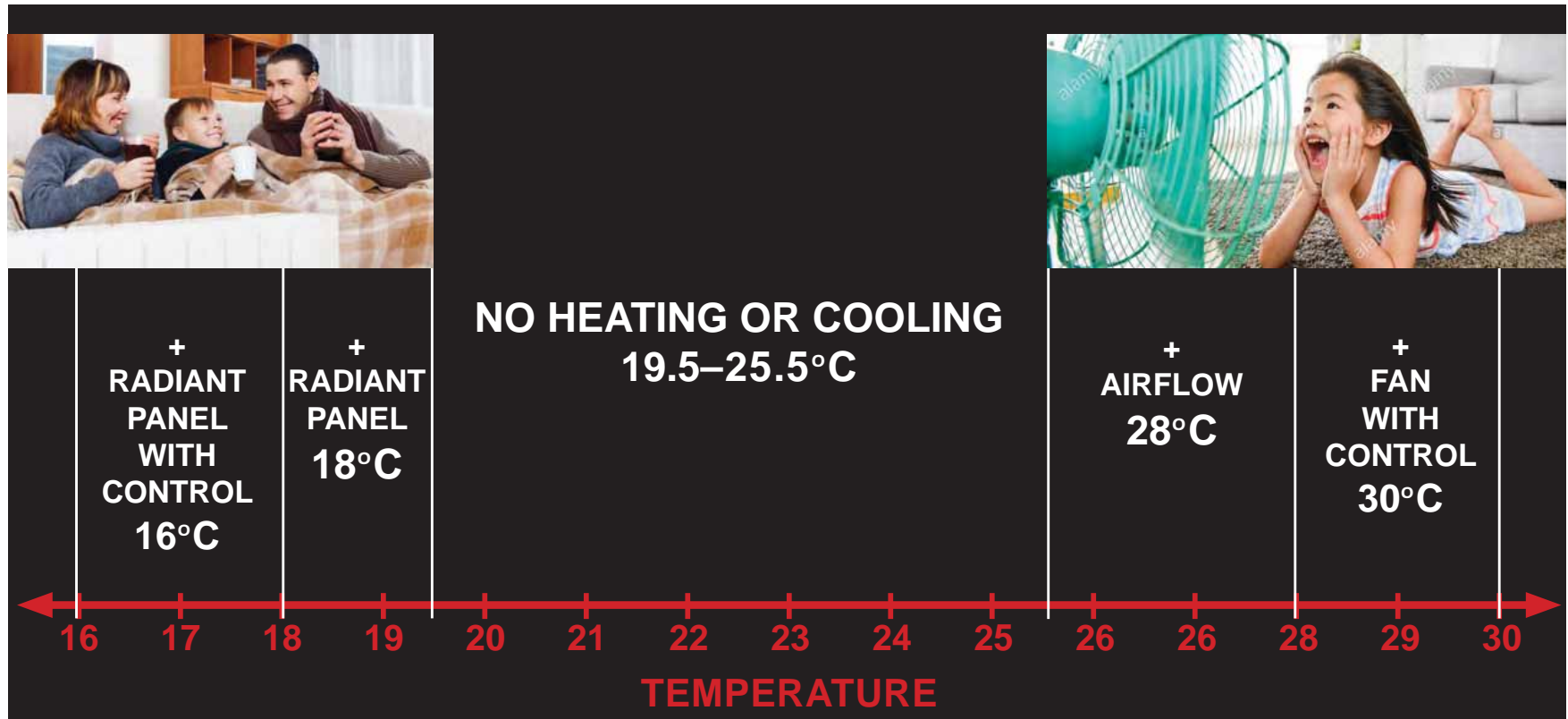
1. Challenge standards
2. Control draughts/breezes and radiant gains and losses
3. Effective clothing, *make it fashionable too.*
4. Local and personal heating *and appropriate furnishings*
5. Responsive, user-friendly controls, *default to off or safe*
6. Improve thermoregulatory fitness: *use it or lose it!*
7. Thermal refuges, *local and communal*

AND

8. Plan to avoid health-related unintended consequences.

1. STANDARDS: *Are they fit for today?*

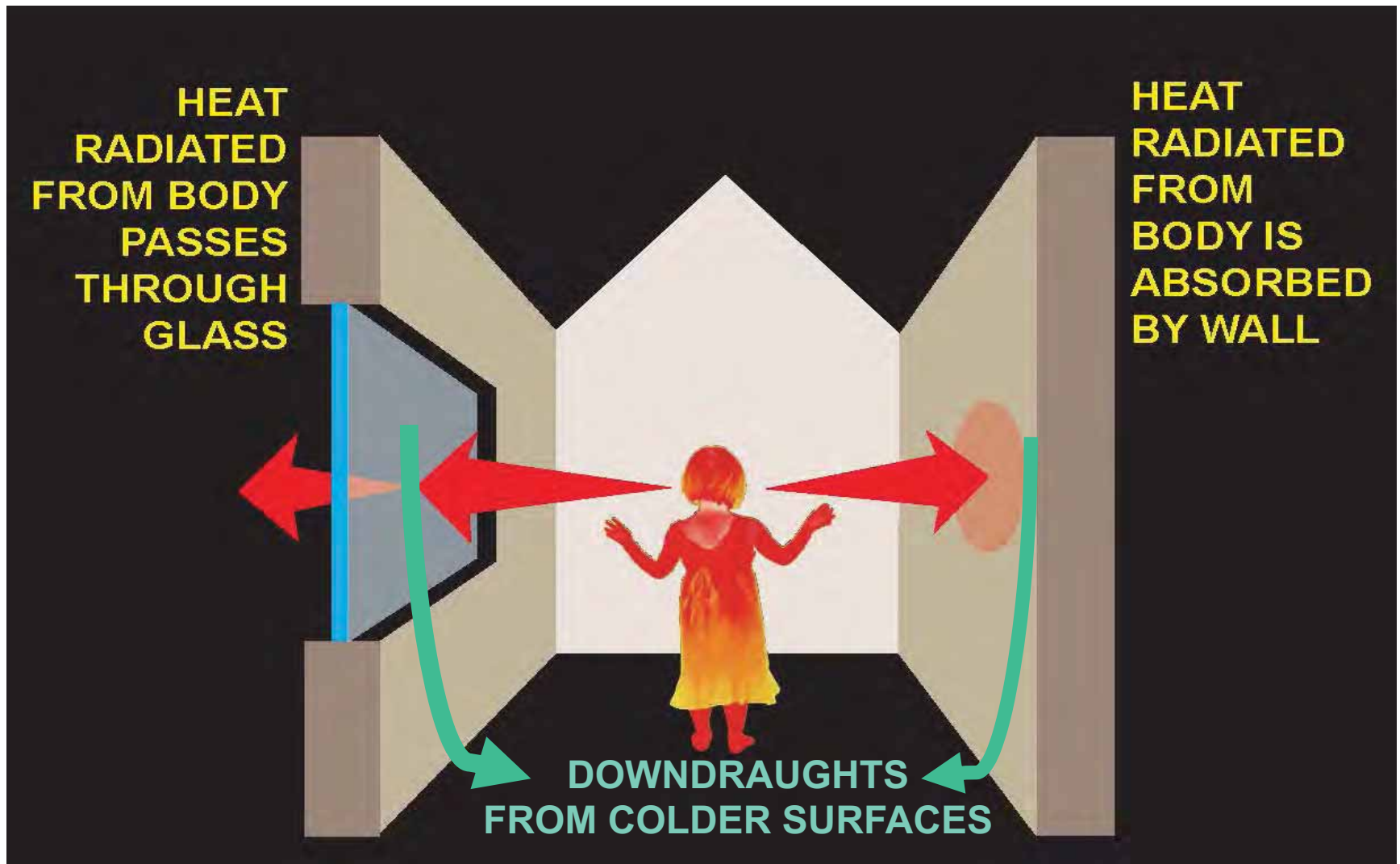
What do we really need to heat and cool spaces to?



What about UK's recommended minimum 18°C Health requirement?

In its Minimum Home Temperature Thresholds review (2014) Public Health England says it is a “*weak recommendation*” with little robust support, but *may be beneficial to the over-65s and those with pre-existing medical conditions.*

2. DRAUGHTS & RADIATION: *Effects of relatively cooler surfaces*



2. DRAUGHTS & “COLD” RADIATION: *Mediaeval hangings weren't just decorative*



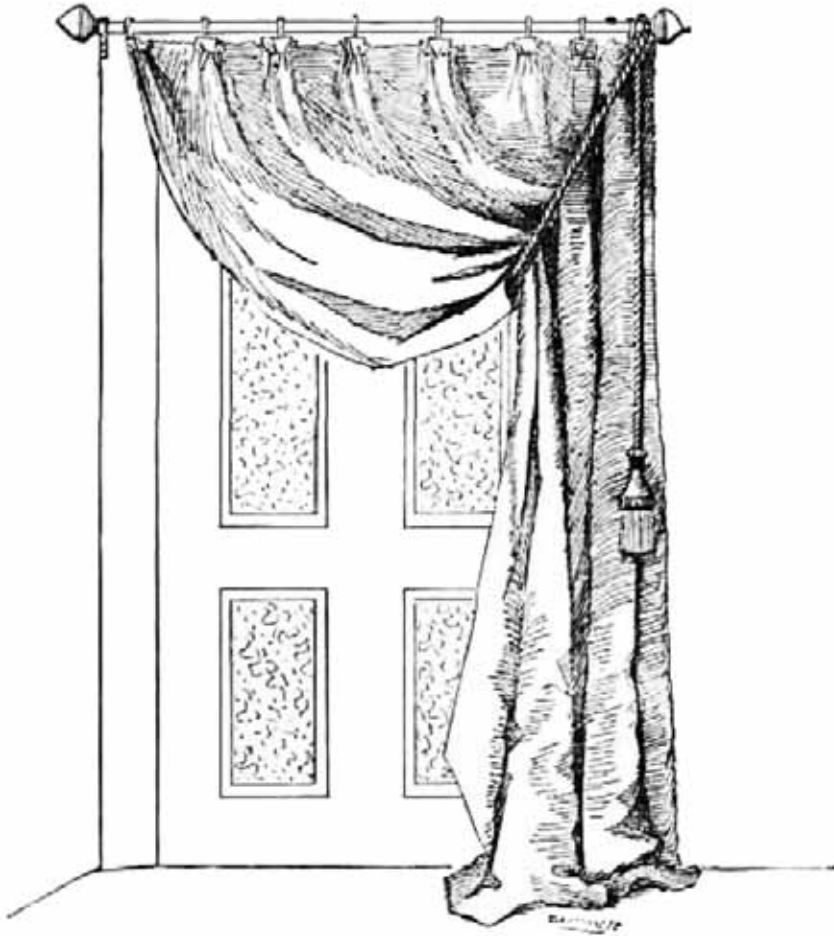
2. DRAUGHTS & “COLD” RADIATION: *Rich and poor could both have wall hangings*



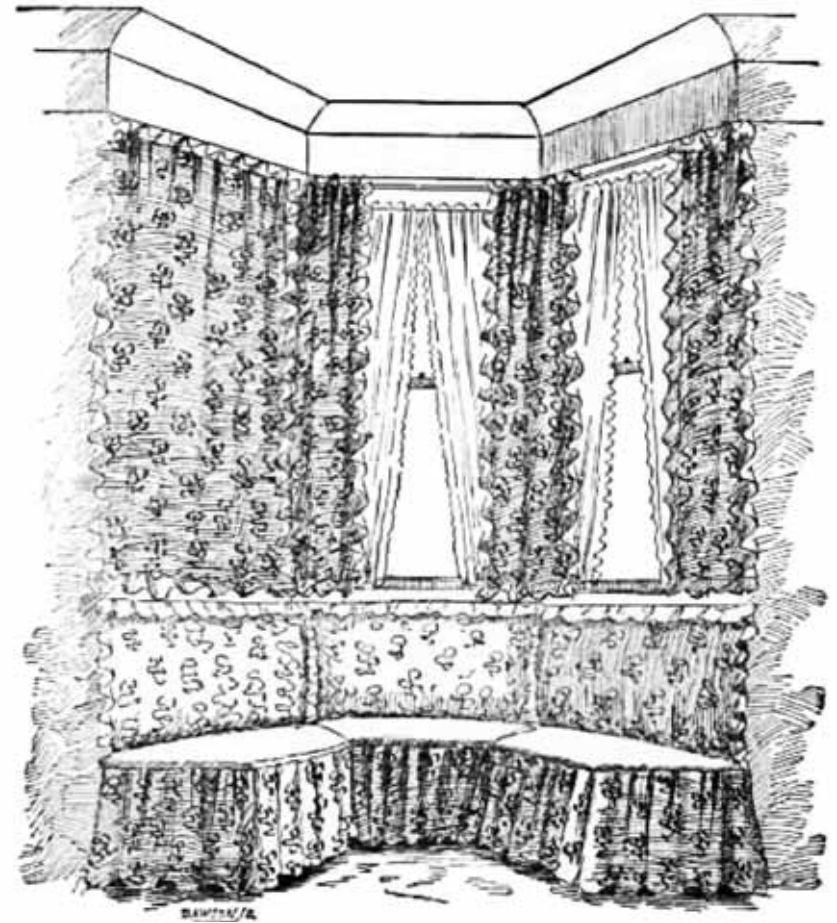
SOURCE: Robyn Pender, Historic England, *Lecture to the Rumford Club* (20 Feb 2020).

2. DRAUGHTS & “COLD” RADIATION:

Victorian soft furnishings were partly for thermal reasons



“This [cord] allows the curtain being dropped in one moment should more warmth be desired.”



“[the male architect]... too many windows ... and almost ruins us in blinds and curtains”

2. DRAUGHTS & RADIATION:

Simple ways of countering losses and gains



Traditional Orkney high-backed chair with drawers for whisky and a Bible.



Ad hoc external shading by old linen sheets during 2022 London heatwave kept peak internal temperatures below 27 C.

3. CLOTHING: Back to the Future *in a chateau*



Modern winter layers – awkward indoors and ultimately not warm enough



An Erasmus-style hat is comfortable and warm



Late medieval Burgundian coats – finally warm enough!

Cone-shaped mediaeval garments proved to be the warmest and most controllable

Heating one 40 m² room to 10-15°C with a log fire needed less than 5% of the fuel required to heat the whole building to the high teens using modern wood burning stoves.

SOURCE: J Parker, *Returning to old ways of staying warm*, (2016), www.traditioninaction.org/Cultural/C042_Warm.htm

4. LOCAL AND PERSONAL HEATING: *Experiments with 16-zone thermal manikin*

Indicative Watts to increase personal comfort by 1°C:

250	Local convector heater
100	Local radiant panel
35	Local foot warming mat
<10	Heated chair or cushion



Max heating power 14 W
Max cooling power 3.6 W

5. USER-FRIENDLY CONTROLS

“In a Machine for Living, I want to be in the driving seat” – OCCUPIER

“We sell dreams and install nightmares” – CONTROLS MANUFACTURER

THE RUNBACK TIMER:

The most neglected control?



perhaps no longer ... ?



PEOPLE ARE THE BEST JUDGES OF WHAT THEY WANT ... BUT
YOU CAN NEVER HAVE TOO MUCH OF A GOOD THING

5. USER-FRIENDLY ROOM CONTROLS

A few principles for both passive + active systems

- **Easy to reach**
from the point of need
- **Easy to use** and understand,
and preferably intuitively obvious
- **Acknowledge interventions**,
so you know things are going to happen
- **Default to off**, safe or standby,
so energy isn't wasted.

PLUS Rapid system response:

Widens thresholds of acceptability, by lessening any anxieties that conditions might continue to deteriorate. Conversely, slow or no response narrows thresholds for a “crisis of discomfort”.

BUT People are not good at anticipation:
advice, decision support, or backup (e.g. mixed mode) systems may be needed.



Controls for End Users

a guide for good design and implementation



by Bill Bordass, Adrian Leaman and Roderic Bunn

Compiled for the BCIA by



Funded by



6. THERMOREGULATORY FITNESS

*Improving one's personal thermal physiology**

- **Habituation** to uniform thermal environments
has reduced our thermoregulatory capacity to cope with temperatures outside the range of conditions we normally experience.
- **We CAN be more resilient**
Acclimatisation has been shown to improve the ability to regulate body temperature in young, middle-aged and overweight individuals.
- **This will require “temperature training”**
More thermal variation in everyday life will improve cardiovascular and metabolic health, save energy, and help us adapt to climate change.

BUT We will still need to protect ourselves
(and particularly vulnerable individuals) from the hazardous effects of thermal extremes and other health issues, especially those related to moisture management.

7. REFUGES

both local and communal



JAPANESE KOTATSU HEATED TABLE.
Also used in Middle East and WW1 trenches.
Traditionally charcoal. Often electric today.



PUBLIC REFUGE IN PORTLAND, OREGON
During the "heat dome" temperature extreme
in late June 2021.

RECAP: SOFT RETROFITS

Beyond space heating and cooling

“Evening out fluctuations has become an egalitarian enterprise which it is heresy to question.” - MICHAEL YOUNG

1. Challenge standards
2. Control draughts/breezes and radiant gains and losses
3. Effective clothing, *make it fashionable too.*
4. Local and personal heating *and appropriate furnishings*
5. Responsive, user-friendly controls, *default to off or safe*
6. Improve thermoregulatory fitness: *use it or lose it!*
7. Thermal refuges, *local and communal*

AND

8. *Plan to avoid health-related unintended consequences.*

THANK YOU DISCUSSION

