



How Not to Become an 'Axiom Human' – The Paradox of Energy Efficiency and Human Behaviour

Dr. Jill Zhao | BArch MSc PhD FHEA

Senior Lecturer in Architecture, School of Architecture and Environment, UWE

Axiom Human – Utopia or Dystopia?

- The paradox:

Humans actively develop technology in order to be passive.

- What are the roles of humans in a technology-dominated world?
- What does it mean under the context of climate change and energy crisis?

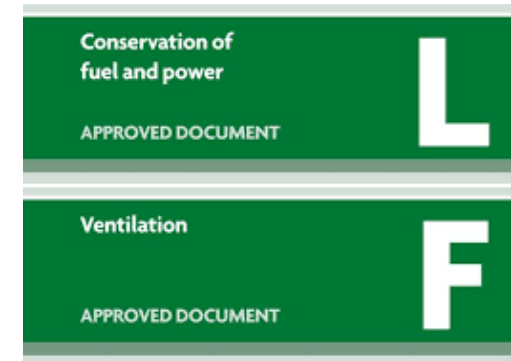
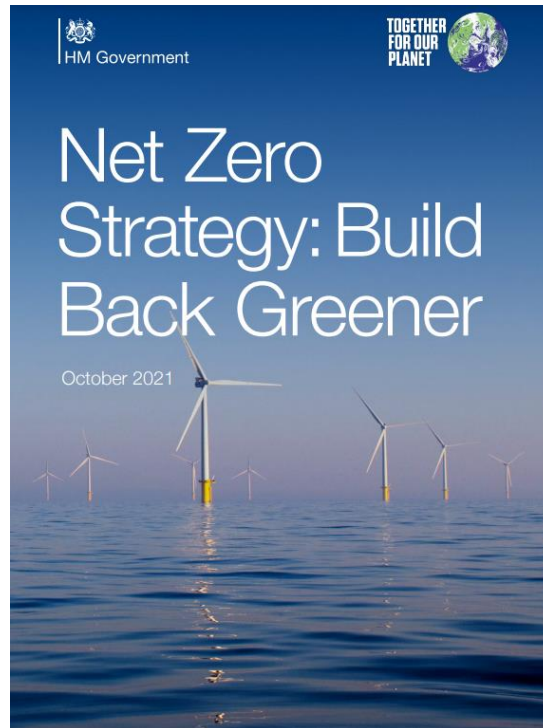
Overview

- Background and policy context
- Passivhaus
- Comfort, energy efficiency and behaviour
- Passivhaus = Passive people?

Background

- Buildings are the UK's second-largest source of emissions.
- Existing housing stock is in urgent need of an upgrade in both the quantity and quality to deliver carbon reduction.
- Designing and retrofitting low-carbon housing is key in achieving carbon emission goals.

Policy Context – techno-economic paradigm



Y Foel, Wales

99.52m treated floor area

The 2018-19 energy usage numbers are:
Space Heating: 9.84 kWh/(m².yr)

Average SSH since 2010: 12.54 kWh/(m².yr)

Passivhaus

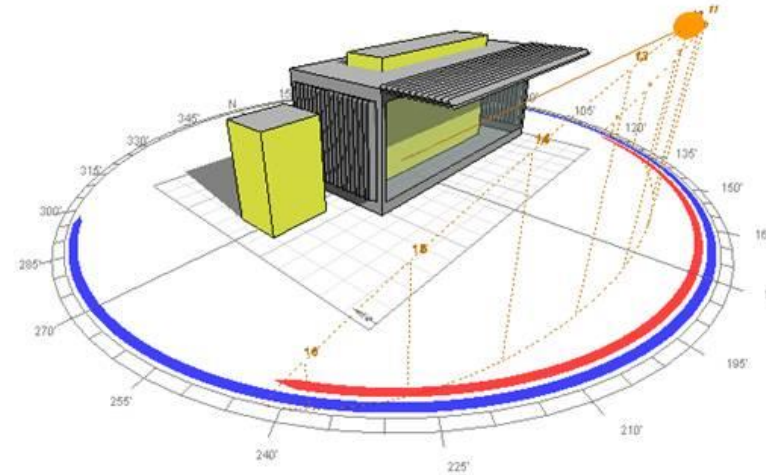
[ˈpasi:fhaus] noun
Passive House/Building





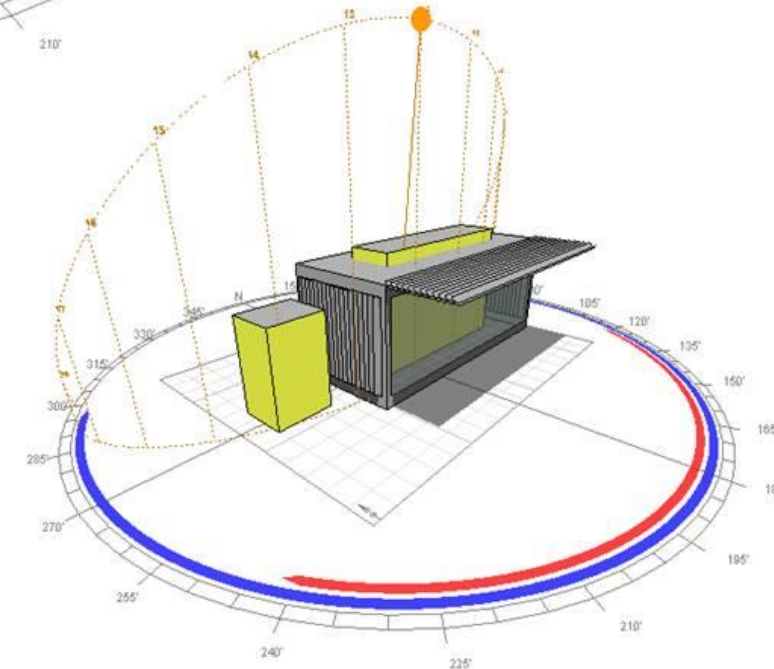
Orientation

± 20 degrees of true south



Winter
21.12 12:00 PM

Summer
21.6 12:00 PM



Form Factor

Compactness of a building

Form factor = A / TFA

Heat Escape Lessening Position

TFA = 200m²



Single storey
Insulated ceiling

3.7



Single storey
Insulated roof

4.1



Two Storey
Insulated ceiling

2.9

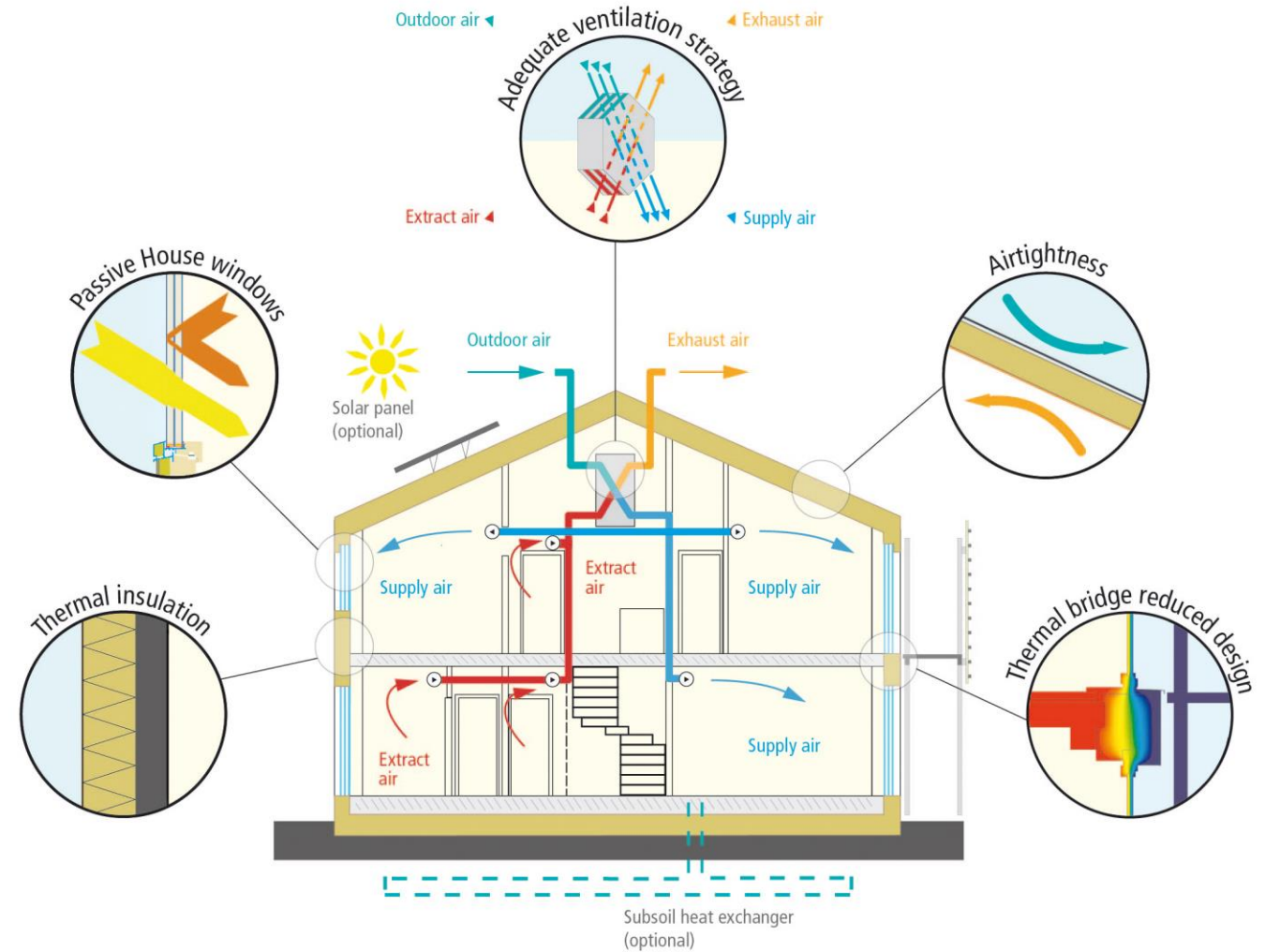


Single storey L
Insulated ceiling

3.9

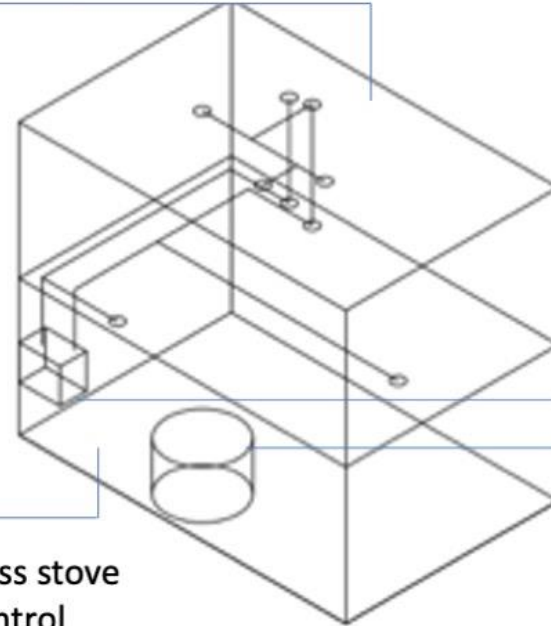
Envelope

Fabric First Approach





Solar thermal hot water system
and control



Thermal water tank
And control



Bio-mass stove
and control



MVHR and control



Questions

- Is it comfortable living inside a Passivhaus?
- How well does the technology work?
- Does Passivhaus need passive people?



10 Case studies

16 Households

8 detached, single family houses

8 multi family semi-detached or terraced houses

Floor area from 65 sq.m to 297 sq.m

Occupation date no more than 3 years

Questionnaire survey, interview, site visit, architectural analysis



- **Is it comfortable living inside a Passivhaus?**

...What do you mean by comfort ?

Adaptive Comfort

- Behavioural adaptation
- Psychological adaption
- Pysiological adaption



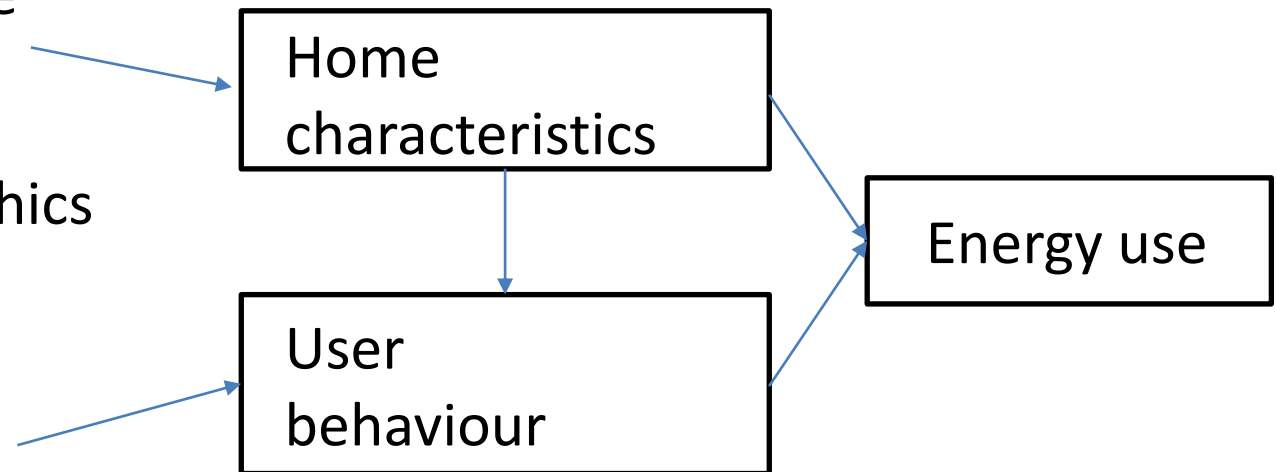
- **How well does the technology work?**

It only works well when the occupants are given sufficient support and information to learn and practice.

Energy Efficiency and Behaviour

- Size, type, insulation level, surface area
- Heating system and energy type
- Layout

- Social and economic demographics
- Occupancy pattern
- Knowledge
- Attitudes
- Value pattern



There is an assumption that occupants behaviour is too unpredictable, and most occupants are unwilling or unable to change their behaviour.



Control panel complexities



Differences in windows and blinds

- **Does Passivhaus need passive people?**

Absolutely not. Passivhaus needs active occupants, to learn about the control system, to actively practice comfort, to develop a new set of routines to use the house to its designed efficiency.

Conclusion

- Human behaviour is important to be considered in low-carbon design.
- Most occupants are willing and able to change behaviour and make low-carbon choices if given sufficient means.
- In order not to become the 'Axiom Human', behaviour change should be emphasised under the context of climate change and energy crisis.

Thank you! Questions?



Jill.zhao@uwe.ac.uk



@doctorpassive

Zhao, J., (2023), Implementing Net Zero Affordable Housing – towards a Human-Centred Approach, under review
Zhao, J., & Carter, K. (2020). [Do passive houses need passive people? Evaluating the active occupancy of Passivhaus homes in the United Kingdom](https://doi.org/10.1016/j.erss.2020.101448). *Energy Research and Social Science*, 64, 101448.
<https://doi.org/10.1016/j.erss.2020.101448>.

Reference

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