



# Enhancing Design Skills for Energy-Efficient Affordable Housing

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# Authors



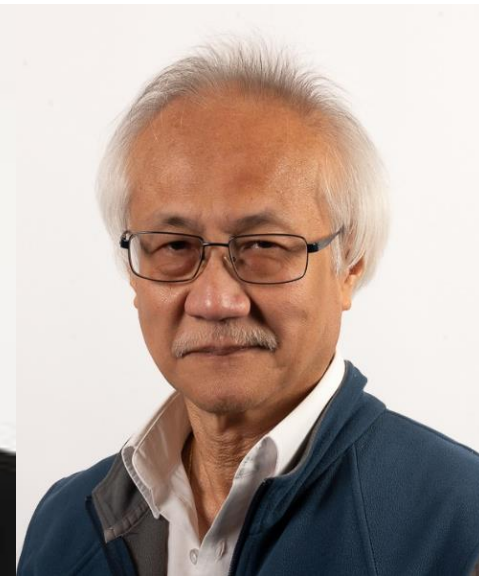
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# Can I afford to have comfort?



Empowering  
disadvantaged  
households  
to access  
affordable,  
clean energy



Working for an Australia free of poverty



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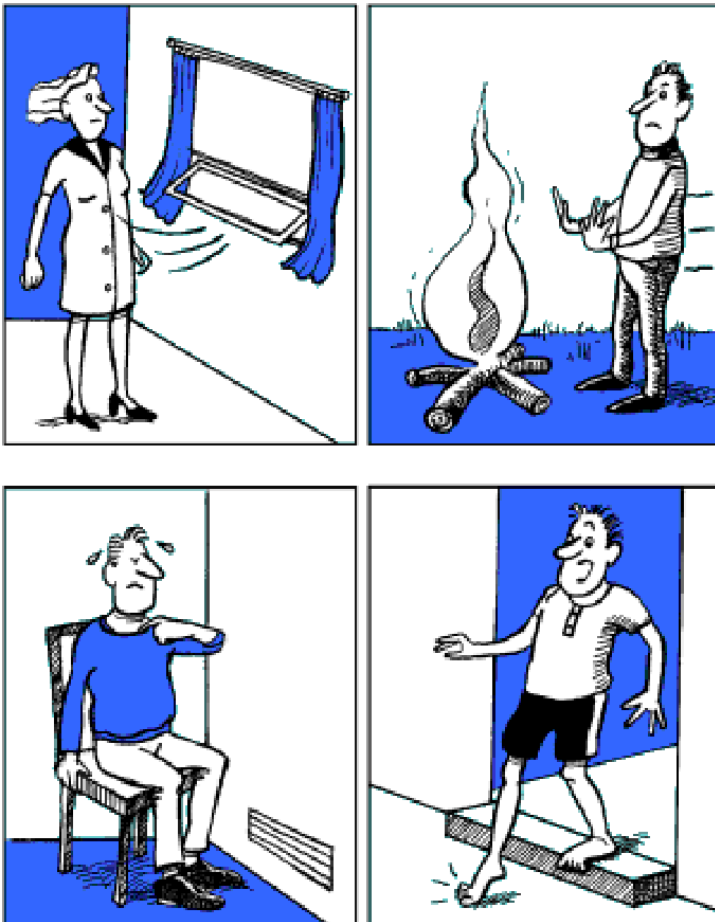
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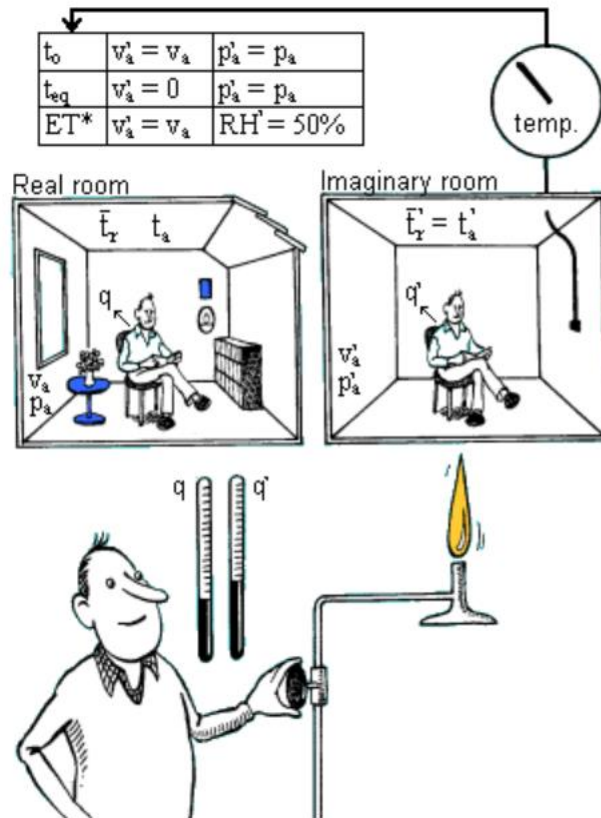
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# Perceptions of comfort

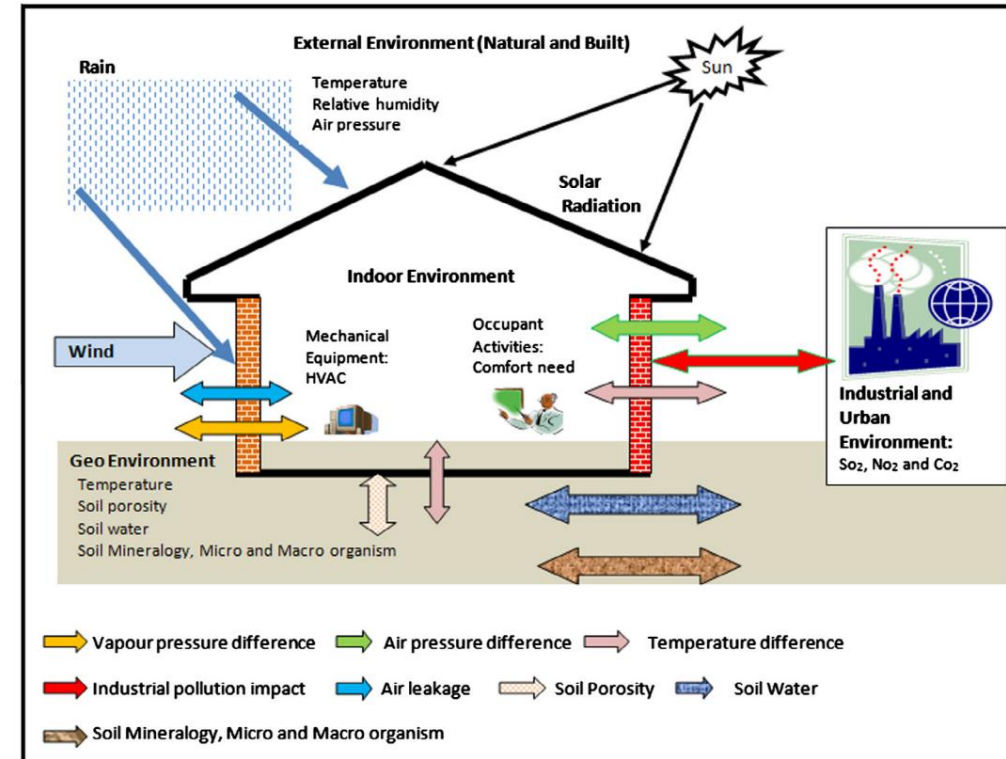


Innova AirTech Instruments (1997) Thermal Comfort, INNOVA

# Perceptions of comfort



Innova AirTech Instruments (1997) Thermal Comfort, INNOVA



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# Issues: Energy Efficiency (EE) in Affordable Housing

- **People living in affordable housing** - choose between maintaining thermal comfort and covering essential expenses like food and clothing (Jayalath *et al.*, 2024)
- **Occupant behaviour could significantly impact energy consumption**
- **Demographics of Affordable** housing tenants, particularly aging populations with fixed incomes, face mounting financial pressures as rents continue to rise
- **Other challenges:**
  - By aging buildings with outdated heating and cooling systems
  - Insufficient air tightness and inefficient appliances contribute to poor indoor air quality, healthy living conditions and high energy consumption (Haddad *et al.*, 2022)

# Availability of technical solutions

- Retrofitting
- Energy efficient technologies
- Passive strategies

## However, challenges exist

- *Education and Training*, addressing the effectiveness of measures to improve the thermal conditions of affordable housing and reduce occupiers' energy bills.

# Methods



- It starts with a **review of current approaches** by the literature on energy efficiency, focusing on occupiers' awareness and behaviour.
- Literature Review of **professional training and technical knowledge**, and the value of integrating both.
- An analysis of **current courses offered by private organisations and tertiary education institutes** was undertaken to identify current gaps and opportunities for improvement.



# Occupant Awareness of EE and Behaviour



- Studies by Haddad *et al.* (2022) and Daly *et al.* (2021) in Australia revealed that low-income households often face extreme indoor temperatures, with **numerous residents prioritising manageable energy bills over thermal comfort and health concerns.**
- Esmaeilimoakher *et al.* (2016) found that occupants often **adjust clothing levels instead of using heating or cooling systems**, suggesting a lack of awareness of energy-efficient practices.
- Chen *et al.* (2017) emphasised the role of **social-psychological factors** in influencing energy conservation behaviours in the U.S..
- Reaves *et al.* (2016) identified **knowledge and structural barriers** to energy-saving behaviours in Colorado.
- Aragon *et al.* (2022) and Gill *et al.* (2011) demonstrated that **occupant behaviour and fuel affordability** create significant variability in heat demand, which often deviates from national averages.
- Studies by Rouleau *et al.* (2018) and Gupta *et al.* (2018) further emphasise that even in energy-efficient buildings, such as those designed with the 'Passivhaus' approach, substantial differences in energy consumption are **attributed to how occupants use and manage building systems.**
- Simões and Leder (2022) highlighted that **behavioural factors, such as the number of occupants and their habits**, influence energy costs, which are exacerbated by rising energy prices.



# Passive Solutions

- **Passive design strategies**, such as improved insulation, thermal mass, and natural ventilation, offer cost-effective solutions to enhance thermal comfort in low-income housing, minimising reliance on active heating and cooling systems.
- Flamant *et al.* (2022) found that while passive strategies may increase embodied energy, they provide **long-term sustainability** through reduced energy consumption.
- Herrera-Limones *et al.* (2022) noted that these strategies **require occupant awareness** and understanding to maximise their effectiveness.

# Integrated Strategies for Improvement



- Passive house standards consist of five key design principles to delivers high performance and occupant comfort for the building's lifetime.
- Five design principles include
  - 1) increasing the performance of building **insulation**,
  - 2) reducing **thermal bridges**,
  - 3) creating **airtight** building envelopes,
  - 4) using energy-efficient space conditioning systems and
  - 5) Heat Recovery Ventilation (**HRV**) to provide improved indoor air quality.





# Professional courses

- The findings show that no specific undergraduate or graduate courses are offered with the certificate in passive design principles.
- Notably, fewer universities offer subjects related to passive design principles, moreover the concepts are taught as a part of a subject

No.	Subject	University	Level
1.	Advanced Architecture Technologies (DESST3519)	The University of Adelaide	Undergraduate
2.	Advanced Architecture Technologies (M) (ARCH7041)	The University of Adelaide	Graduate
3.	Advanced Building Design for Energy Efficiency and Sustainability (ENGG447)	University of Wollongong	Undergraduate
4.	Advanced Building Design for Energy Efficiency and Sustainability (ENGG947)	University of Wollongong	Graduate
5.	Building Energy Analysis (DESC9015)	The University of Sydney	Graduate
6.	Building Physics and Building Services (ENGG210)	University of Wollongong	Undergraduate
7.	Building Science: Performance and Sustainability (BLDG2120)	The University of Queensland	Undergraduate
8.	Building Services (BLDG2011)	University of New South Wales	Undergraduate
9	Building Services and Environment (CONMGNT7002)	The University of Adelaide	Graduate
10.	Design Integration Lab: Energy (BAEN2002)	The University of Sydney	Undergraduate
11.	Design Studio Gamma (ARCH20002)	The University of Melbourne	Undergraduate
12.	Environmental Design (ARCT2050)	The University of Western Australia	Undergraduate
13.	Environmental Systems (ABPL90086)	The University of Melbourne	Graduate
14.	Environmental Technologies (ABPL10007)	The University of Melbourne	Undergraduate
15.	Integrated Design Studio (CVEN90073)	The University of Melbourne	Graduate
16.	Integrated Design Studio (SUSD0007)	University of New South Wales	Graduate
17.	Interior Architecture Technics 4 (INTA2004)	University of New South Wales	Undergraduate
18.	Lighting, Acoustics and Advanced Environmental Control (11232)	University of Technology Sydney	Undergraduate
19.	Mechanical Design Fundamentals Studio 2 (41060)	University of Technology Sydney	Undergraduate
20.	Project Implementation and Documentation (ARCT4440)	The University of Western Australia	Graduate
21.	Sustainable Architectural Practice (DAAE3001)	The University of Sydney	Undergraduate
22.	Sustainable Buildings (ENEN90014)	The University of Melbourne	Graduate
23.	Thermal Design and Environmental Control (11225)	University of Technology Sydney	Undergraduate
24.	ZEMCH Sustainable Design Workshop (ABPL90394)	The University of Melbourne	Graduate



# Passive house designer/consultant providers and courses offered

Provider	Courses offered
<a href="#">Australian Passivhaus Association (APA)</a>	Certification as Passivhaus designer/consultant/tradesperson Comprehensive introduction Passivhaus certification DesignPH Software training On-demand short courses
<a href="#">Box Hill Institute</a>	Certification as Passive house tradespeople Certification as Passive House designers/consultants
<a href="#">PassiveHouse Professionals</a>	Passive house training for work teams, support for external quality certification and analysis based on Passivhaus standard
<a href="#">Smart Plus Academy</a>	Certification as Passive house tradesperson Certification as Passive House designer



# Conclusions

- Implementing effective energy efficiency practices in Affordable Housing requires a team-based approach that consists of **trade persons, community members, and occupants, supported by training, workshops, and awareness** programs offered by professional and government associations.
- Lack of **public education** (from kindergarten) and heightened requirement occupant awareness related to energy efficiency.
- **Limited tertiary education programs** were identified that can cater to changing practices, regulations and technical knowledge required for energy-efficient building construction and maintenance using passive design strategies.
- Targeted tertiary education programs can be **developed in conjunction with professional bodies and industry associations** to fill the gap between theoretical knowledge and practical competencies.
- The availability of **accredited training and certification programs** on passive design strategies requires due recognition of building codes and regulations.



# Q&A

# Thank you

