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THE UNIVERSITY OF MELBOURNE

Faculty of
Engineering and
Information Technology

Advanced HVAC and Decarbonisation Research

Lu Aye, Renewable Energy and Energy Efficiency Group

26 August 2024, CMU

Acknowledgements

"We recognise the importance of our relationship to the traditional owners of the land. I pay my respects to the traditional custodians of the land and extend that respect to other indigenous people."

Special Thanks to:

CMU, Supporting a Visiting Professor Grant

A/Prof. Dr Chatchawan Chaichana, Inviting and hosting

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Dr Sanparwat Vithayasai, Caring local hospitality

The University of Melbourne

Established 1853

One of the world's 50 finest universities, #1 in Australia

160 years of academic leadership

Faculty of Engineering and Information Technology

At a glance

- 470+ PhD qualified researchers and teachers
- 10,000+ students, 4,400+ Masters by Coursework, 1,000+ graduate research students
- Dual accreditation – Engineers Australia and EUR-ACE
- Cutting-edge interdisciplinary research and work with a range of partners from academia, government and industry

Faculty of Engineering and Information Technology

At a glance

- Biomedical Engineering
- Chemical Engineering
- Electrical Engineering
- Infrastructure Engineering
- Mechanical Engineering
- Computing and Information Systems

Department of Infrastructure Engineering

Civil, Environmental and Geomatics Engineering Disciplines

- Structures, Structural Materials and Built Environment
- Geotechnical Engineering
- Transport Engineering
- Project Management
- Ocean Engineering
- Environmental Hydrology and Water Resources
- Geomatics Engineering

Heat Pump Applications, PhD Theses

Beyond Conventional Space Cooling: A Structured Approach to Assessment of Thermally Activated Radiant Cooling Panels with Phase Change Materials

Seyedmostafa Mousavi, Behzad Rismanchi (ed.), Lu Aye (ed.)

Published : 2023

Multi-objective optimisation for multi-residential building retrofit: A method and an application

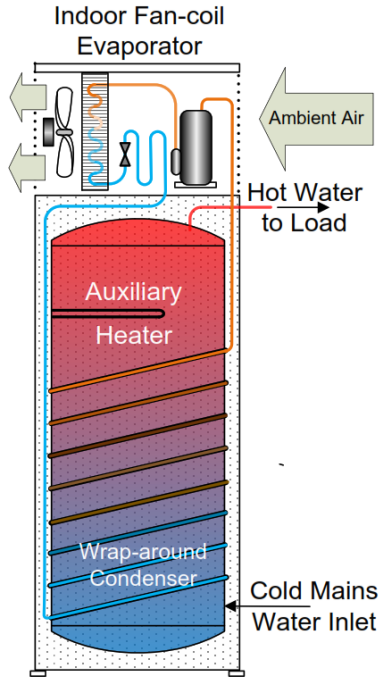
Maria Panagiotidou, Lu Aye (ed.), Behzad Rismanchi (ed.)

Published : 2020

Multi-objective optimisation of a prefabricated house in Australian climate zones

Sareh Naji, Lu Aye (ed.), Masayoshi Noguchi (ed.)

Published : 2020



Compact Heat Pump Water Heater (Harrison 2017)

Direct geothermal energy: reducing the poultry industries' carbon footprint

Yu Zhou, Guillermo Narsilio (ed.), Lu Aye (ed.), Asal Bidarmaghz (ed.)

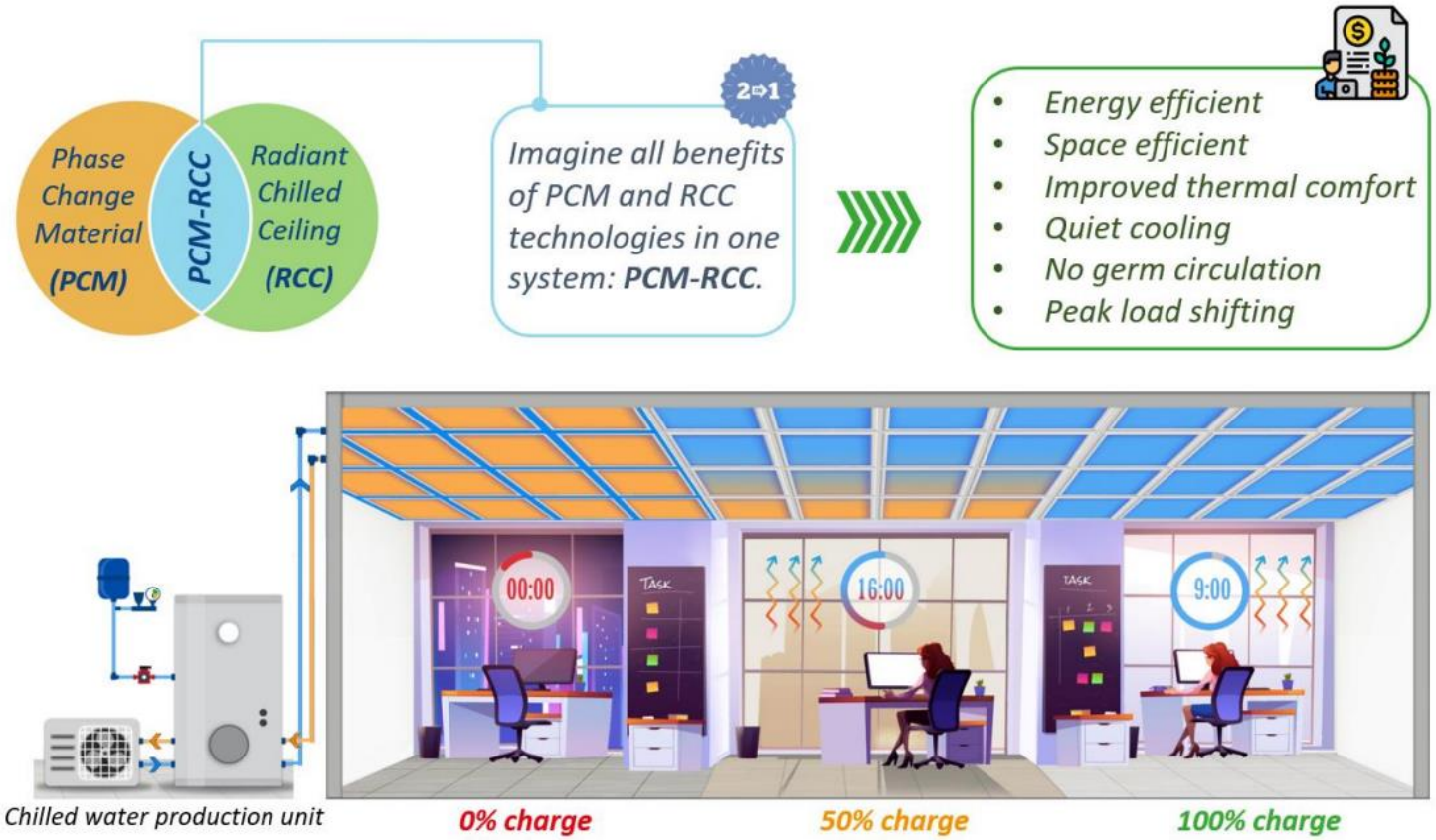
Published : 2019

Optimisations of a seasonal solar thermal energy storage system for space heating in cold climate

Sheikh Khaleduzzaman Shah, Lu Aye (ed.), Behzad Rismanchi (ed.)

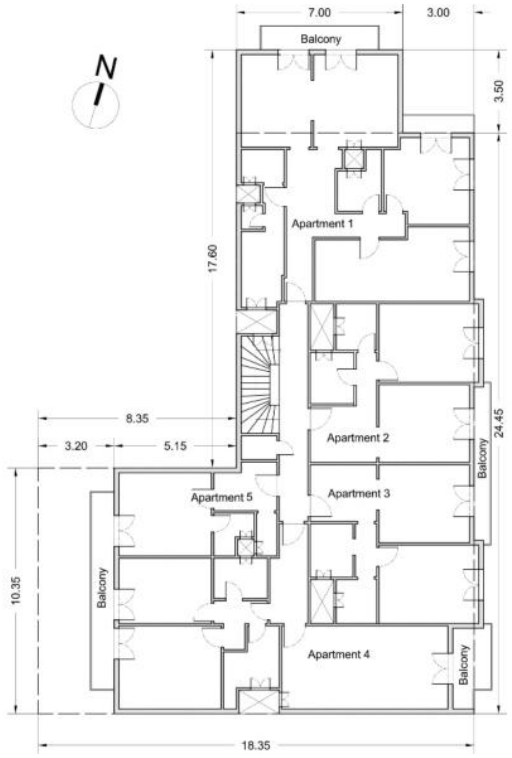
Published : 2019

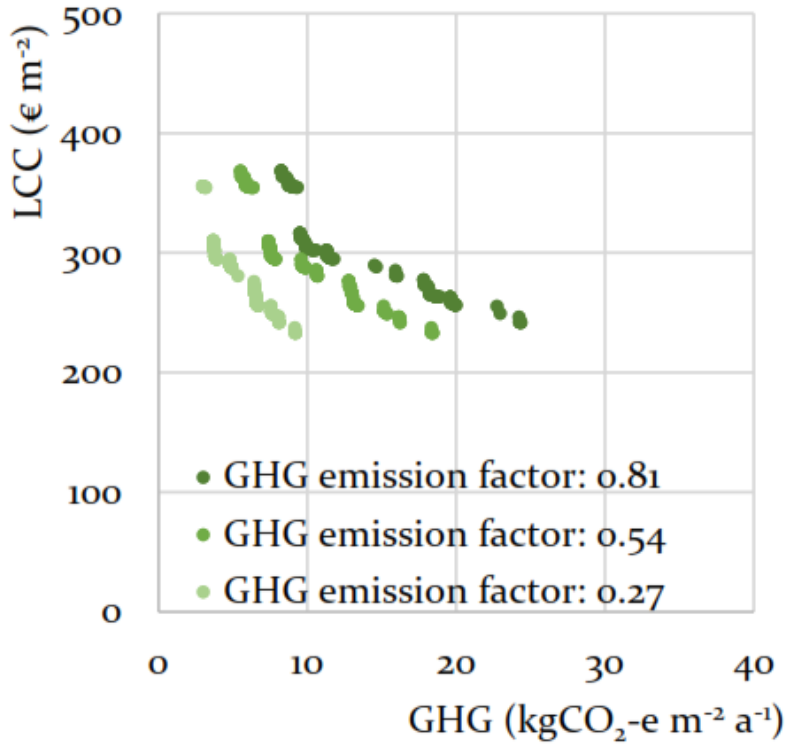
PCM embedded radiant chilled ceiling (PCM-RCC)



Aim: To develop an advanced control strategy to enhance the operational efficiency of a newly developed PCM-RCC system.

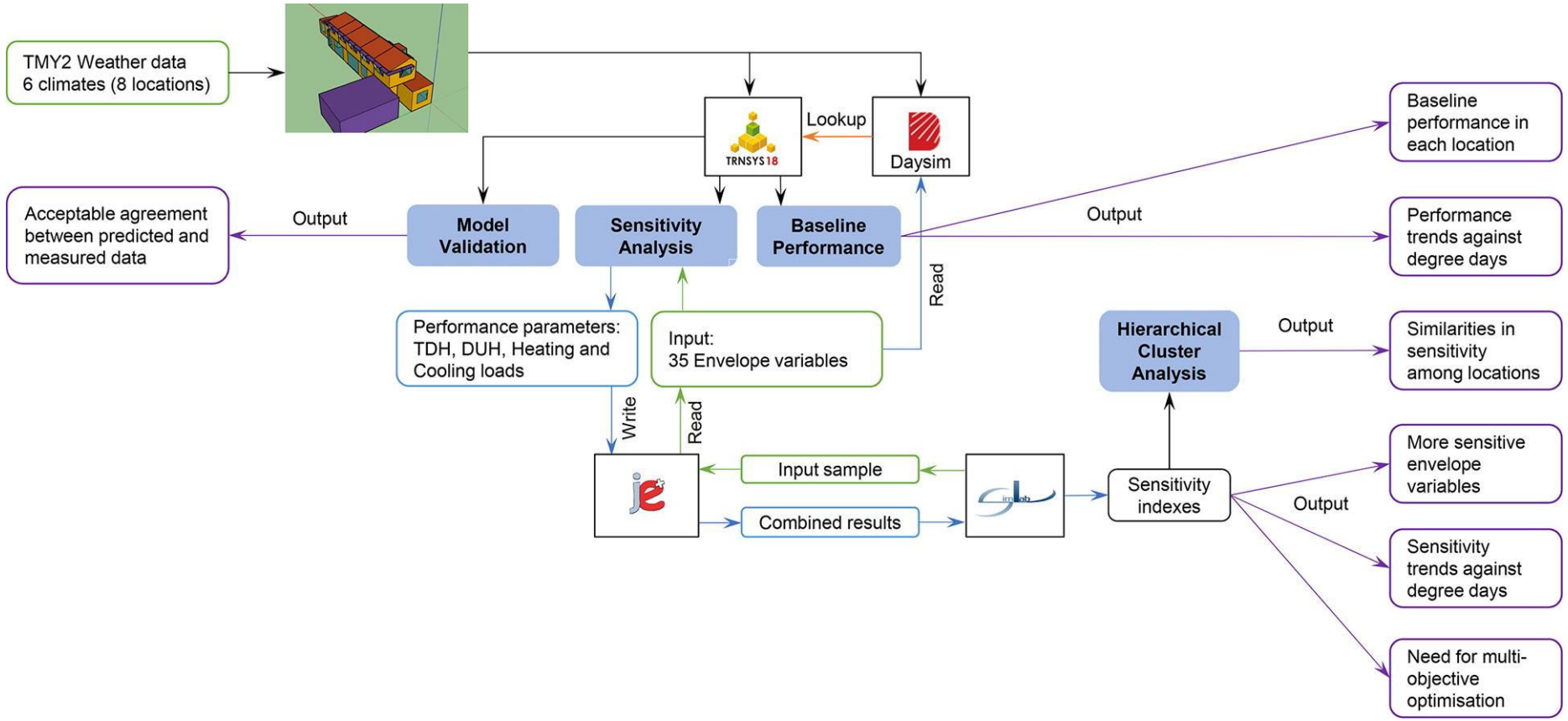
Effects of grid's GHG emission factor on Pareto optimality





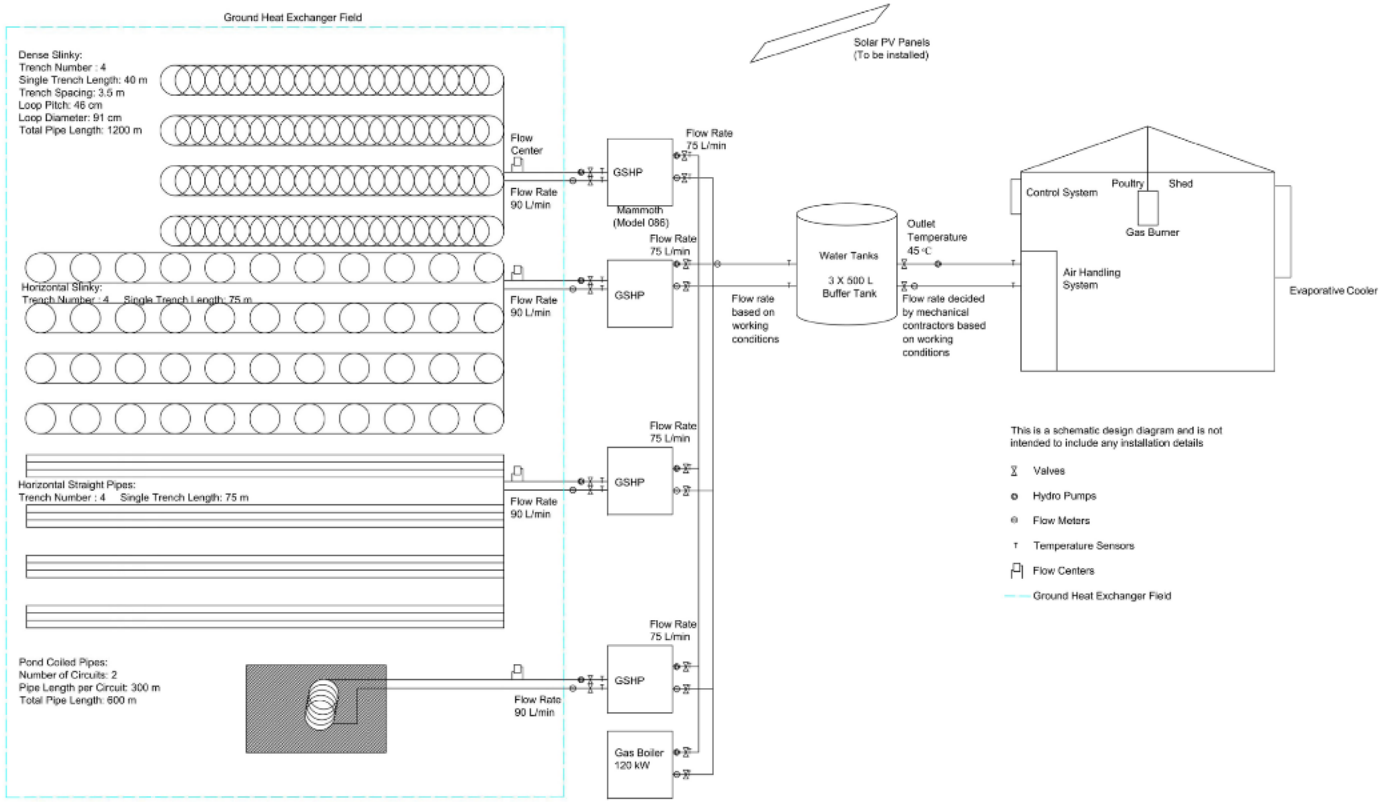
Aim: To develop a method to support the residential building retrofit dec ision making (minimum operational GHG emissions and retrofit LCC.

Sensitivity analysis on energy performance, thermal and visual discomfort of a prefabricated house



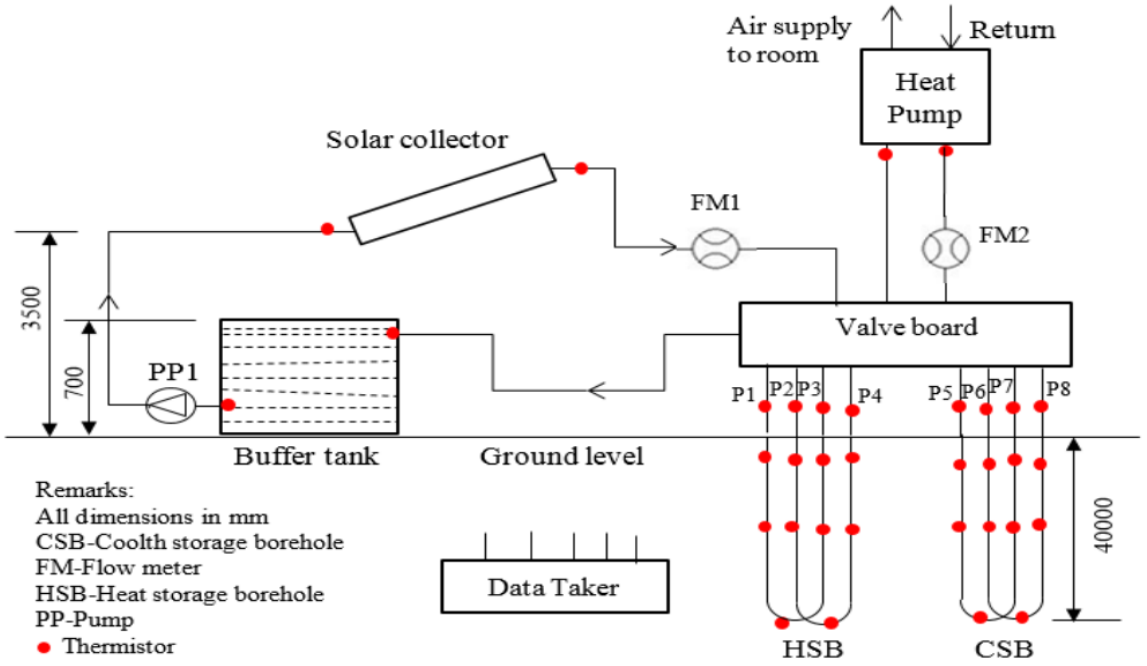
Aim: To optimise the envelope components of a prefabricated house to minimise Thermal discomfort hour (TDH), Daylight unsatisfied hour (DUH) and LCC.

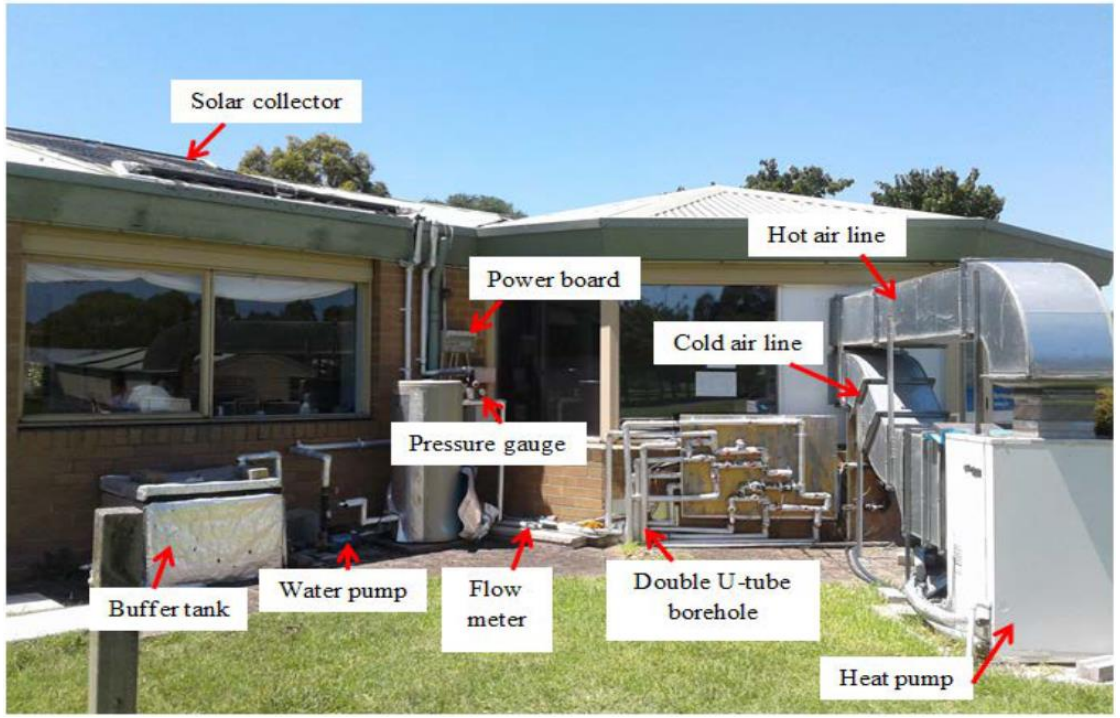
Hybrid ground source heat pump system



Aim: To develop hybrid GSHP system with horizontal ground heat exchangers (GHEs) suitable for the poultry sheds.

Seasonal solar thermal energy storage system for space heating in cold climate





Aim: To minimise life cycle cost and greenhouse gas emissions for residential space heating in cold climate locations.

Transition to Decarbonisation, PhD Theses

Multi-Scale Life Cycle Energy Assessment of Australian Residential Buildings

Shengping Li, Behzad Rismanchi (ed.), Lu Aye (ed.)

Published : 2022

Energy Policy Analysis Towards Clean Energy Transitions in Mexico

Omar Castrejon Campos, Lu Aye (ed.), Kin Hui (ed.), Paulo Vaz-Serra (ed.)

Published : 2022

Towards Resilient Net-Zero Emission Communities: A Multi-dimensional Approach for Energy Master Planning

Saeid Charani Shandiz, Behzad Rismanchi (ed.), Lu Aye (ed.), Greg Foliente (ed.)

Published : 2022

Cost-effective Self-cleaning Floating Solar Thermal Desalination System for Potable Water Production in Remote Areas

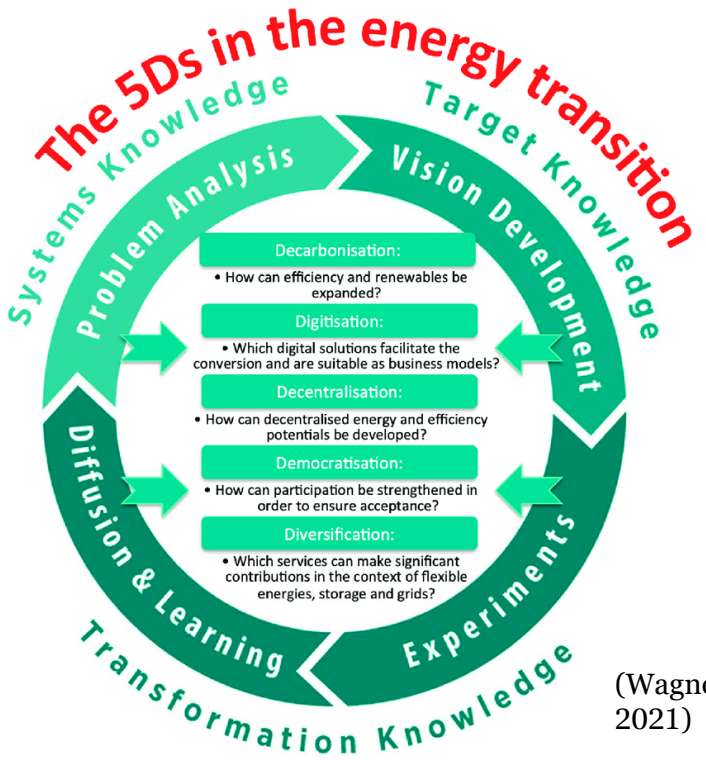
Milad Mohsenzadeh, Lu Aye (ed.), Philip Christopher (ed.)

Published : 2022

Sustainability Transitions Modelling and Assessment of Socio-technical Energy Systems: An Australian Case

Angela María Rojas Arévalo, Lu Aye (ed.), Fjalar de Haan (ed.), Seona Candy (ed.), Greg Foliente (ed.)

Published : 2022



(Wagner & Götz 2021)

Samples of articles published

Building and Environment
Volume 242, 15 August 2023, 110567

Efficient HVAC system identification using Koopman operator and machine learning for thermal comfort optimisation

Nourehan Wahba, Behzad Rismanchi, Ye Pu, Lu Aye

Renewable Energy
Volume 201, Part 1, December 2022, Pages 462-485

Validations of a double U-tube borehole model and a seasonal solar thermal energy storage system model

Sheikh Khaleduzzaman Shah, Lu Aye, Behzad Rismanchi

Energy and Buildings
Volume 252, 1 December 2021, 111385

Optimisation of multi-residential building retrofit, cost-optimal and net-zero emission targets

Maria Panagiotidou, Lu Aye, Behzad Rismanchi

Energy Technology
Generation, Conversion, Storage, Distribution

Research Article

Alternative Heating and Cooling Systems for the Retrofit of Medium-Rise Residential Buildings in Greece

Maria Panagiotidou, Lu Aye, Behzad Rismanchi

Construction and Building Materials
Volume 254, 10 September 2020, 119221

Multi-scale analysis on thermal properties of cement-based materials containing micro-encapsulated phase change materials

Amitha Jayalath, Lu Aye, Tuan Ngo, Priyan Mendis

Build Simul (2023) 16: 813–829
https://doi.org/10.1007/s12273-023-0985-5

Development and validation of a transient simulation model of a full-scale PCM embedded radiant chilled ceiling

Seyedmostafa Mousavi[1], Behzad Rismanchi[1] (✉), Stefan Brey[2], Lu Aye[1]

1. Renewable Energy and Energy Efficiency Group, Department of Infrastructure Engineering, Faculty of Engineering and Information Technology (FEIT), The University of Melbourne, VIC 3010, Australia
2. InvAus Pty Ltd., Melbourne, VIC 3000, Australia

Cover Article

Household energy supply decarbonisation

Question: What technologies provide the least-cost supply of all household energy services under increasingly tight emission constraints?

Question: What are the implications?

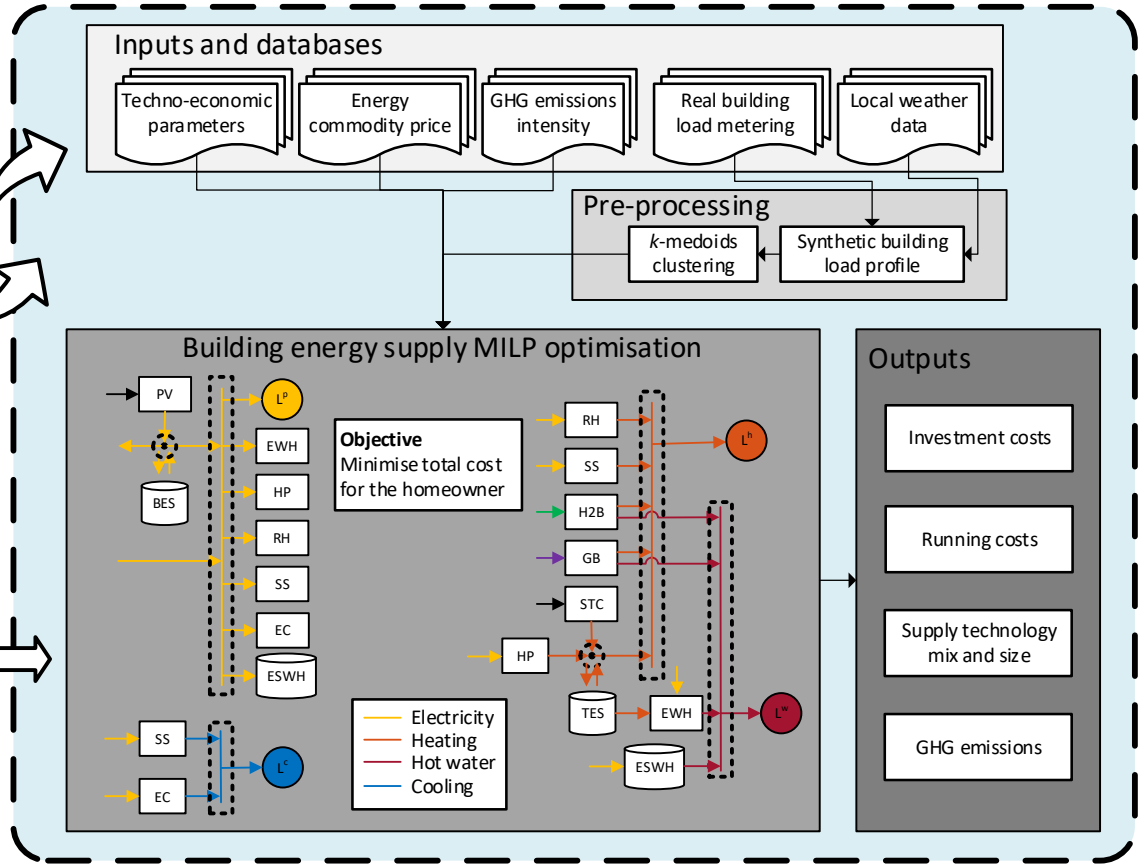
Answer investigated for different:

- Building types
- Climates
- Energy prices
- Grid emissions intensity

Validated **building dynamic model** and **real-life** energy consumption **measurements**

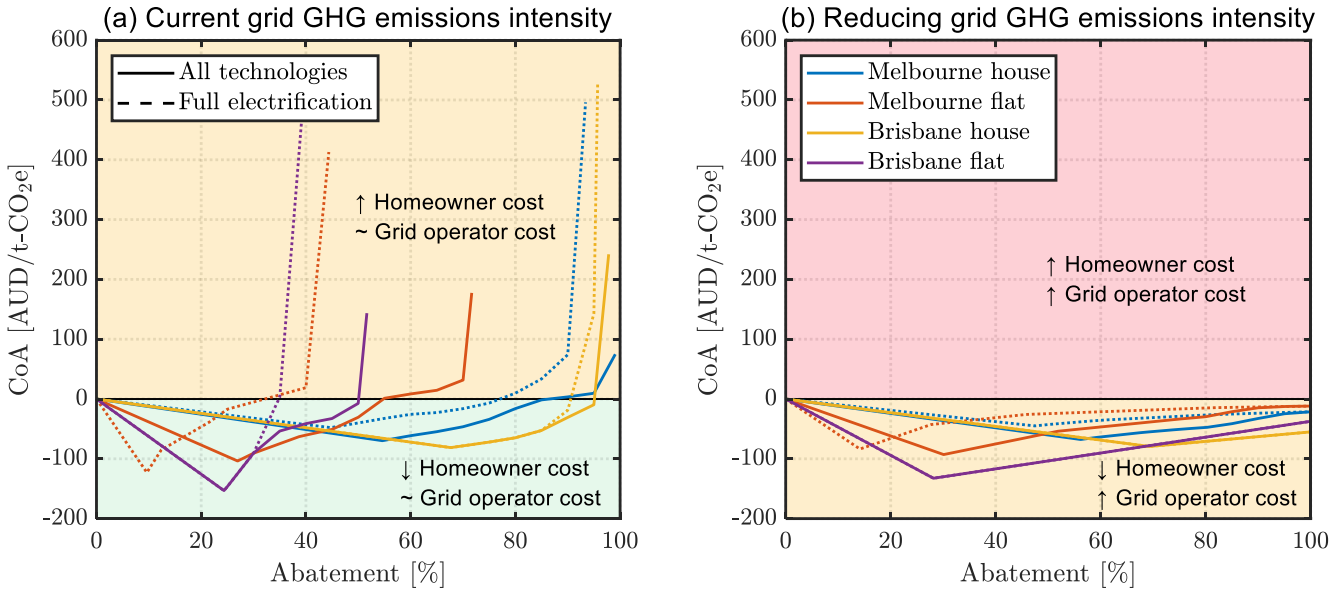
Scenarios & sensitivities

- Buildings and climates
- GHG emissions abatement
- Energy prices



PV: rooftop solar; EWH: electric water heater; ESWH: electric storage water heater; HP: heat pump; RH: resistive heater; SS: split system; EC: evaporative cooler; H2B: hydrogen boiler; GB: gas boiler; STC: solar thermal collector; BES: battery energy storage; TES: thermal energy storage; L: load

Findings



(Vecchi, A., Davis, D., Brear, M., & Aye, L. (2024). Least-cost solutions to household energy supply decarbonisation in temperate and sub-tropical climates. Journal of Cleaner Production, 448. https://doi.org/10.1016/j.jclepro.2024.141465)

- Different **climates** and **building types**, have **different GHG emission reduction** and **cost saving** potential
- **Significant** (30-80%) GHG emissions **abatement** prospective **without significant** rise in system and household **costs**, and irrespective of grid emissions intensity

Many thanks!

To have much learning

To be skilled and knowledgeable

To be restrained by a moral code

To have beautiful speech

This is the highest blessing

(Maṅgala Sutta, Sutta Nipāta 2.4)

Contact: lua@unimelb.edu.au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The End.