RESHAPING BUILDING RETROFIT

BRIDGING THE GAP BETWEEN HOUSEHOLDERS AND RETROFIT PROGRAMMES IN AOTEAROA NEW ZEALAND

PHD CANDIDATE LUIS MEDRANO

20 February - Energy Centre Summer School 2024
WHO WE ARE

We investigate the complexities of built environments and their interfaces with natural ecosystems to expand knowledge, instrumentalities and find innovative and effective design approaches and solutions at all scales – from individual buildings to entire neighbourhoods, cities and regions.

OUR VISION

We co-create a more equitable, regenerative and healthier built environment for the future generations of Aotearoa New Zealand, through evidence-based research focused on strategic innovation in policy-making, planning and design to combat climate change, affirming equality, and enhancing urban well-being.
Sustainable, Resilient & Regenerative Approaches

- Creating a balance between people, nature and the built environment
- Responding to climate change at the different scales
- Improving the sustainability and resilience of cities and buildings
- Enhancing the health of ecosystems during and after urbanisation

Low-Carbon Solutions & Zero-Emission Economy

- New or upgraded low-carbon materials
- New recycling and re-use approaches
- Solutions to achieve net-positive homes and buildings
- Clean and affordable energy implementation
- Manufacturing and construction methods and processes to improve building quality

Urban Innovations

- Developing smart cities
- Using big data to inform planning and design
- Assessing the impacts of transportation on urban life
- Using better transport systems and data to help improving our cities

Urban Wellbeing, Spatial Justice & Community Development

- Improving fairness, well-being, and community growth
- Spatial quality and quality design in cities
- User-centred design and designing with communities
- Creating affordable and equitable cities
OVERVIEW

- The climate crisis and the role of buildings
- Building retrofit and retrofit programmes
- Performance gaps and POE
- The role of occupants in performance
- Research on the Otago Home Upgrade Programme
THE CLIMATE CRISIS...

- Climate change: weather extremes, natural disasters, food and water insecurity, rising sea levels, economic disruption – the crisis of our time.

- Today, the global average surface temperature is around 1.2 °C above pre-industrial levels, prompting heatwaves and other extreme weather events.

- IEA recently concluded, in its updated Net Zero Roadmap, that a pathway to limiting global warming to 1.5 °C is very difficult – but remains open.

The climate crisis... and the impact of buildings

- The operations of buildings account for 30% of global final energy consumption and close to 40% of total direct and indirect CO² emissions.

- Buildings sector energy use increased by around 1% in 2022.

- Strategies - Performance standards and building energy codes are increasing across countries.

- The use and efficiency of renewable building technologies are accelerating.

- Goal by 2030 - All new buildings and 20% of existing building stock zero-carbon-ready – Building retrofit rate.

WHAT IS BUILDING RETROFIT?
What is Building Retrofit?

**SHALLOW RETROFIT**

- Single measures / partial refurbishment
- Low risk and short payback
- Aotearoa
- E.g. heat pump & windows

**DEEP RETROFIT**

- Major and integral
- Energy use, IEQ and comfort
- Whole vs stand-alone
- Air-tightness, thermal bridging...

Image source: https://www.aucklandhomeshow.co.nz

Image source: https://www.greenbuildingadvisor.com/collection/deep-energy-retrofits
RETROFIT IN THE RESIDENTIAL SECTOR

- **Challenging** – cost, privacy, inconvenience, motivation.

- **Critical** – over 70% of the European residential buildings stock in 2050 already stands today

- **Householders’ role** in shaping the clean energy transition – challenging to fund clean energy technologies and retrofits

- Deep retrofits can cost 4-9 months of income for poorer households in China and the US – barrier resulting in limited retrofits

- **Governments’ role** ensuring change is accessible for vulnerable communities – financial incentives and subsidised retrofit programmes

Image source: https://www.safeguardeurope.com/applications/energy-saving-retrofit
Retrofit in the residential sector... Aotearoa New Zealand

- Homes in Aotearoa New Zealand are not meeting heating and energy needs of occupants – Energy hardship/fuel poverty, respiratory illnesses, leaky buildings.

- Up to 460,000 homes in the country require retrofitting.

- Benefits: reducing cost of heating, increased comfort, better health and mental well-being.

- Shallow retrofit programmes – a deep retrofit programme is needed in the country.
RETROFIT IN THE RESIDENTIAL SECTOR... AOTEAROA NEW ZEALAND
GAPS IN AOTEAROA NEW ZEALAND – WHAT NEEDS OUR ATTENTION?

- **Expand** energy efficiency programmes to benefit the wider stock of existing buildings, especially to promote **deep retrofits** that yield greater performance improvements.

- **Align** funding schemes, retrofit programmes, and government strategies with **emissions targets**.

- Continuous **monitoring and evaluation** of the outcomes.

- Understand the **needs of vulnerable households** at a closer level – **Post-Occupancy Evaluation** (POE).

**Post-Occupancy Evaluation (POE)**

- **Systematic assessment** of buildings’ performance once it is occupied
- **Quantitative** (physical variables) and **qualitative** (occupants’ **satisfaction**)
- Ability to **compare** estimates against actual performance
- Potential to assess energy-related behaviours and operation efficiency.
- Most projects **focus on quantitative** neglecting links with occupant-related parameters like driving factors and comfort.
Performance Gaps and Underlying Causes

Occupant behaviour
One of the main reasons for the EPG – increase in studies

Boundaries
A margin of error is inevitable (10%), but it can be up to 2.5x higher

Performance Gaps
Discrepancy between estimated and actual energy/thermal performance – Risk in tackling climate change challenges

Lack of POE
Lack of data to learn from previous experiences and improve our design
**Occipant-building interaction**

Technology ≠ building efficient
Behaviours ≠ performance gaps

Complex and hard
to predict

Conscious and
unconscious practices
from the interaction

Effective human
behaviours and efficient
building systems
So, what is happening today...?

What are the rules guiding their practice?
What is motivating their retrofit choices?
Do they have the tools they need?

What is the baseline thermal and energy performance?
What is the thermal and energy performance after the retrofit is completed?

Are measures aligned with their practices?
Are they easy to understand and operate?
Do occupants know how to use them and why?
WHAT IS THE IDEAL LOOP FOR RETROFITS?

Building performance → Monitoring and assessment → Handover and training → Construction → Budget and scope → Stakeholders' practices → Professionals from retrofit programmes → Householders → Buildings performance
Practice theory – beyond behaviours

Behaviours

Individuals as carriers of practice

Know-how
- Understanding, habits, routines
- Training?

Explicit rules
- Institutional and explicit rules
- Change rules?

Engagement
- Motivation, meanings, beliefs
- Target motivations?

Materials & Technologies
- Affordance, usability
- Promote or avoid?

Elements of practice

Professionals from Retrofit programmes
Householders

Future Cities Research Hub

Reshaping building retrofit | Luis Medrano Gomez
Te Paire School of Architecture and Planning
RESEARCH - THE OTAGO HOME UPGRADE PROGRAMME

Collaboration with Aukaha – the Otago Home Upgrade programme

Case Studies located in Dunedin
66 homes for data analysis
3 semi-structured interviews with professionals
9 semi-structured interviews with householders

Semi-structured interviews with retrofit programmes
Document review of case study reports
Statistical analysis of IEQ data
Semi-structured interviews householders
Focus Group With householders
Data triangulation and Best practice analysis

Elements of practice guiding programme
Pre-retrofit building survey
Pre- and Post-retrofit IEQ performance
Elements of practice guiding behaviours / householder needs
Co-develop improvement strategies aligned with householder needs
Recommendations to retrofit programme / definition of sociotechnical POE
CONCLUDING REMARKS

There is still a lot of room for growth in the residential retrofit practice in Aotearoa New Zealand. We have an old and inefficient existing building stock that is not performing well for our whānau. However, many talented people and institutions are working towards improving the quality of homes and the energy well-being in the country.

Let’s make sure that soon we have deep retrofit programmes responding to the householders’ needs and practices, with measurable performance objectives and continuous monitoring and assessment.
THANK YOU

luis.medrano@auckland.ac.nz