5x4

A tiny plot of land in East Melbourne's Hayes Lane measuring only 5m by 4m will be home to a project whose formidable scope belies its diminutive size, writes GHD's **Tai Hollingsbee**, M.AIRAH, a member of the design team.

A hidden back alley in East Melbourne will be home to an intriguing initiative. This project is named after the physical constraints imposed by the site: a plot measuring 5m by 4m. Nestled between existing buildings, a prefabricated residential dwelling to house two people will rise three stories from the plot.

> The design approach minimises the building's life-cycle energy demand through innovative systems, materials and construction techniques

It will be an example of how to build and live in a small space. It's an approach that is familiar in urban populations with high densities, such as Hong Kong, Tokyo, and interestingly, Warsaw, where architect Jakub Szczesny claims to have built the world's narrowest house, which is 122cm at its widest point.

Such an approach will inevitably be embraced in big cities throughout Australia. The space between buildings will become increasingly more valuable as a growing and aging population competes for land, housing and desirable inner-city living.

The 5x4 Hayes Lane Project is facilitating this conversation by demonstrating how one team can make it work.

The project's mission is to showcase how reducing our ecological footprint can be put into practice, not just in design and construction but also in the behaviour and lifestyle of the occupants.

BioRegional's One Planet Living approach has been integrated into the project to guide the design, construction and operation of the house. It involves a commitment from the design team and the building owner to enable the building occupants to monitor their total ecological impact and actively adapt their behaviour over time, to get within their share of one planet's worth of resources.

Highly ambitious and requiring significant adjustments in food habits and lifestyle, the vision is underpinned by successful projects in the UK, the US, and most recently WestWyck ecovillage in Melbourne.

DESIGN AND THINKING

Following an integrated design approach to architecture and engineering, the building envelope has been optimised to minimise winter heat losses and maximise beneficial summer night-time heat losses.

Responding to Melbourne's climate, the house can be well-sealed and insulated when needed, or opened up to ambient conditions for passive comfort control. The construction detailing has been developed to meet an air-infiltration

A dual-skin staircase acts as a climatic buffer from thermal gains, and allows diffuse light into the bedroom.

performance target of better than 1 ACH @ 50 Pa with a door blower test.

When the building is sealed, a whole-house, energy-recovery ventilation system provides outdoor air, with tempering during peak conditions.

> The project is a showcase of design thinking, a whole-of-life energy approach to building

A ground-coupled heat pump system provides heating, hot water and supplementary conditioning of the supply airstream when needed.

A 2.5kW roof-mounted and façade-integrated photovoltaic system, individually metered power points and an intelligent house-and-energy-management system represent an "advanced" application of commercial technology at a domestic scale. Yet it is other aspects of the approach that are a point of difference.

The thermal insulation integrated in the prefabricated panel system is an aerogel-based product that has extremely low thermal conductivity (typically a K-value of around 13.9W/mK at 23°C).

LESSONS LEARNT

1. Demonstrate international precedence in techniques or engineering approaches to quell a debate about innovation – talk physics and actual examples to inspire rationality in design.
2. You can make a bigger impact on your ecological footprint by adjusting your food habits than by putting PV on your roof at home.
3. When you huddle the team together at the start of project to define project aspirations, it creates a legacy that is enduring and facilitates achieving the aspirations.
4. An intelligent, prefabricated approach to high-performance design in housing is only possible by working collaboratively, across all disciplines and in detail, from the start of a project.

Originally developed by NASA, it enables the building envelope to achieve R-values of between 4–6 in unusually thin wall assemblies.

Coupled to this is the use of phase-change material to mimic the beneficial thermal effects of concrete walls, without the weight or thickness of concrete. The thermal-admittance properties of concrete and brickwork in the local climate helps modulate rapid internal temperature swings, and offers beneficial thermal-lag effects by reducing peak cooling and heating demands.

Thermally broken frames with high-performance double glazing has lower embodied carbon than a triple-glazed system over the life of the building.

By using phase-change material, we can replicate this effect, as it has a high heat-of-fusion property, similar to that of concrete and brick walls. The product used for this project has been "tuned" to useful temperatures for human comfort, melting at temperatures above 23°C – absorbing heat as the temperature rises and releasing it slowly as it melts.

This combination of high-performance thermal insulation and a phase-change material allows for a lightweight, thermally excellent wall construction that has similar thermal admittance to a concrete wall, without the weight, construction time and quality issues associated with traditional construction methods.

This forms part of the strategy to maximise the efficiencies offered by prefabrication – a lightweight panellised system that behaves like a heavyweight wall and can be assembled easily.

PROJECT AT A GLANCE

The equipment

Aerogel: Aerogels Australia

Heat-recovery ventilator: Zehnder Systems/air2energy

House automation: Zoo Automation

Geothermal system: Direct Energy

Lighting: Bright Green

The team

Architect + builder: ARKit

Building physics, ecological accountancy + building systems design: GHD

Client and project manager: Ralph Alphonso/Barley Store Productions

Embodied carbon + life-cycle analysis: University of Melbourne eTool

Structural engineer: Peter Felicetti

WHERE DO THE MATERIALS COME FROM?

A key component of the project is the quantification of predicted operational energy demand, as well as initial and recurrent embodied energy over a period of 100 years.

The design approach minimises the building's life-cycle energy demand through innovative systems, materials and construction techniques.

A range of potential construction materials were carefully analysed, and appropriate, low-embodied-energy content alternatives selected. Embodied energy was calculated using a comprehensive hybrid approach, taking into account energy savings – such as the prefabricated construction approach – in minimising transportation requirements, on-site inefficiencies, and increasing the speed and quality of construction.

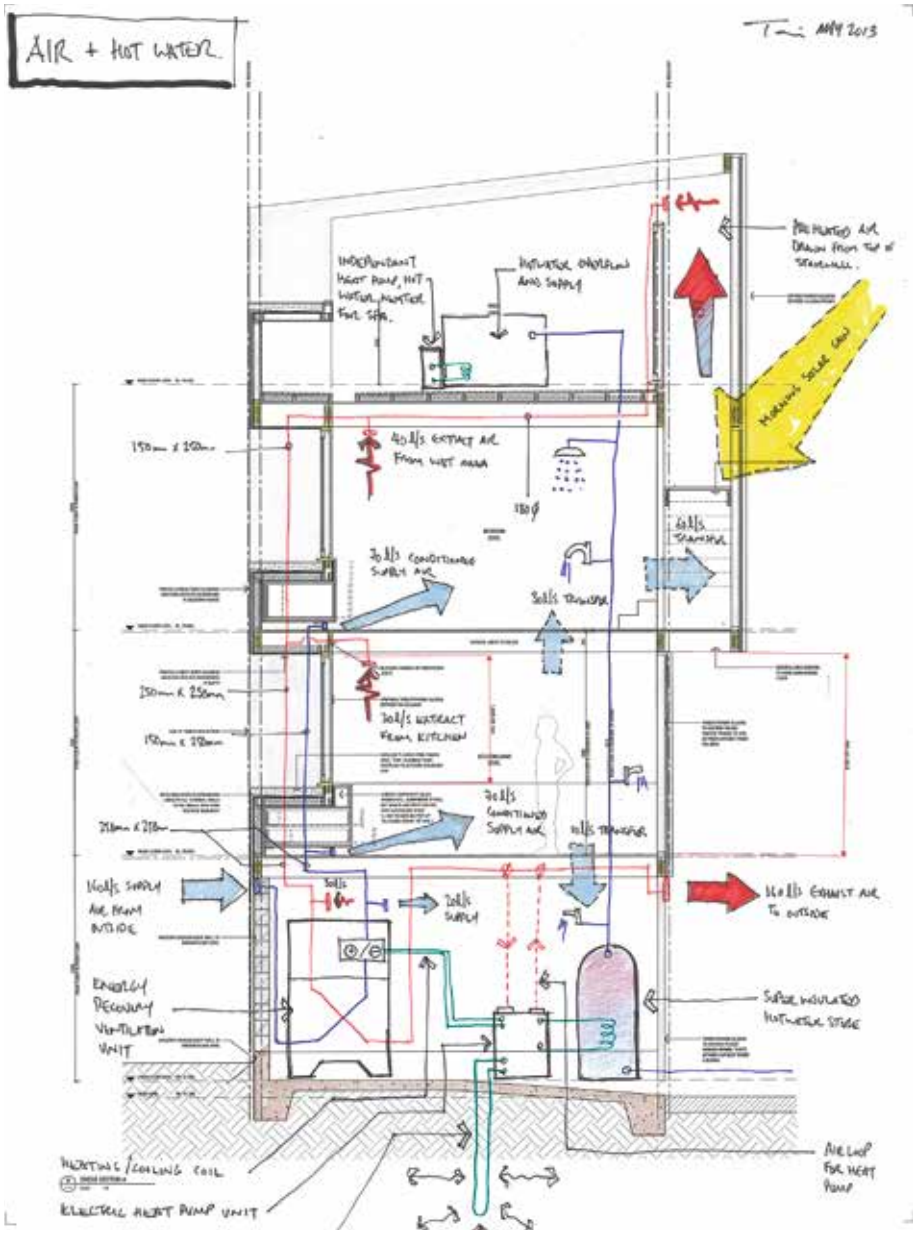
BEHAVIOUR VS ENGINEERING

The project is a showcase of design thinking, a whole-of-life energy approach to building, and a commitment to monitor and publicly share the occupants' total carbon-emission performance. In many respects, the technology and engineering is only the first and relatively simple step in enabling the occupants to start reducing their total ecological footprint.

Engineers, scientists and designers of the built environment have a comprehensive understanding of the calculations and equipment needed to minimise carbon emissions. The next step is harder: operating and behaving in a way that realises the intended performance.

Under the One Planet Living framework, the team has set up a behavioural adaptation program than encompasses the occupants and the neighbouring community, explaining the context for the project and engaging people in a live discussion about how we consume things in our daily lives. Through this program, we are hoping to make that vital second step much easier and more meaningful to people from different walks of life.

Tai Hollingsbee, M.AIRAH, is principal at GHD.



5x4's air and water strategy.

Would you like to know more?

For more info about the 5x4 project, go to www.fivexfour.com

For more info about One Planet Living, go to www.oneplanetliving.org