



NCH/1

Executive Summary
New Category of Home and
Warmframe™: Combined Learnings

FINAL

A report prepared by Beacon Pathway Incorporated for New Category of Home partners

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About This Report

Title

New Category of Home and Warmframe™: Combined Learnings

Authors

Verney Ryan, Cambrian Berry (Beacon Pathway Inc)

Reviewer

Vicki Cowan, Lois Easton, Nick Collins (Beacon Pathway Inc)

Abstract

This report provides the New Category of Home partners with synthesised learnings drawn largely from the construction of two dwellings built as a duplex in Hobsonville Point. It provides an overview of learnings from the off-site (factory) manufacturing process and the remaining on-site construction period, and highlights many of the key barriers and opportunities. It outlines recommendations to assist partners with the upscale of the Warmframe™ New Category of Home concepts for market delivery.

Reference

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1 Executive summary

The New Category of Home project seeks to develop a new way of delivering high performance homes to New Zealanders through technical innovation (Warmframe) and potentially a novel method of delivery of homes to the market (off-site construction). This report deals specifically with the demonstration learnings from the construction of two dwellings built as a duplex in Hobsonville Point to help inform commercialisation decisions.

The demonstration applied the prototype technical NCH innovation to:

- an existing duplex design (two joined dwellings)
- working with Universal Homes (exploring delivery to the volume home builder market)
- construction within the volume builder's programme at Hobsonville (working in a business as usual environment).

As the demonstration was trialling innovation (technical and systems) inside a commercial development it proved an extremely challenging project for all partners. But it revealed issues of the NCH innovation and business as usual, which are invaluable insights for potential commercialisation. In particular this report documents learning for these key questions:

- What is the best 'scale' of offsite construction? (demonstration trialled both 2D panels and 3D pods)
- What is the optimal level of offsite construction? (i.e. the balance between factory and site construction)
- How far down the value chain does the NCH process have to extend to ensure the best outcome?

1.1 Design learnings

Future projects should concentrate on a design-led approach which focuses on simplicity of design, lean manufacturing, and integration of partner products as part of an off-site manufactured offering. Rework and additional cost can be avoided with closer integration of the designer, builder, engineer and detailers at the start of the project to ensure greater clarity of design and more buildable solutions. Designing houses with off-site manufacture in mind at the start of the process is warranted, and there may be potential to explore four different house types with four different orientations that could be delivered at scale. As part of this approach the multi-proof building consent process could be investigated as it may save time and cost. Solutions and Producer Statements should be developed in partnership with cladding and fixing companies if required. Pre-engineered framing solutions for fixings, claddings, structure etc. with clear producer statements could aid the builder and the council building control officer when working with steel.

1.2 Learnings for off-site manufacture

A design-led solution with a focus on ease of prefabrication and an ergonomic factory set up could significantly increase efficiency of the factory build time. Factory set up can be relatively simple and cost effective with a good process to establish streamlined and efficient ergonomic construction processes. Further factory specifications are identified in the report. The framing component should be an integral part of the factory set up to deliver time and cost savings in terms of transport and in relation to any framing corrections required. Partners should explore further development of the wall panel system to include services such as plumbing, electrics with the potential for plug and play systems and internal finishing in the factory.

Productivity would have increased with a more consistent workforce. A properly trained workforce for the factory production line and overseeing by a licensed building practitioner with a factory manager in place would work well (ratio of 1-2 skilled to 6-10 unskilled).

1.3 Learnings for on-site finishing

Builders need strong support from an on-site framing specialist to resolve issues relating to steel frame. A detailed and accurate framing manual with clear illustrations and instructions would benefit the trades and subtrades. Sub-trades require training and simple solutions to make their job faster and easier in steel. When dealing with volume-home builders, it is important to establish and work with the same construction schedule so both parties are aware of critical deadlines and can minimise delays if issues arise.

1.4 What is the best 'scale' of offsite construction?

Findings from this demonstration indicate that 2D panels are more likely to be the successful scale of offsite construction for New Zealand homes. The evidence for this is summarised in the following table:

	For	Against
2D wall panels	<ul style="list-style-type: none"> ■ Easy to manage in factory space (storage, movement, construction) ■ Easy to manage on-site (moveable, re-positionable) ■ Easy to transport (low weight, stackable, space efficient, hi ab friendly) ■ Shows promise for market accepted system development with applied learnings ■ Potential for further integration of services (e.g. wiring, plug and play) ■ Potential for further partnerships (e.g. RAB board, cladding, lining) ■ Ease of ergonomic construction 	<ul style="list-style-type: none"> ■ Tricky if delivered in BAU environment: unfamiliar in a risk adverse culture. ■ Levelling has to be completed on-site ■ Insulation or internal finish exposed on-site to weather

	system (lay flat and construct in factory)	
3D volumetric pods	<ul style="list-style-type: none"> ■ More opportunity for greater level of offsite construction (plug and play type innovation to finished standard) ■ Reduces reliance on quality of site workers to assure quality outcomes ■ NZ has an established home moving industry (would need to formalise partnership so prioritised work) ■ Costs and quality more easily controlled over whole construction ■ Ability to ship to site finished, closed in and waterproofed 	<ul style="list-style-type: none"> ■ Hard and costly to transport and requires specialised contractors ■ Needs bigger cranes (limit some residential sites especially existing neighbourhoods) ■ Errors more costly in transport and delivery (greater insurance costs) ■ System alignment between factory and site must be 100% in detailing, design and delivery (harder to 'fix' slight variation). ■ Greater health & safety requirements during construction (than 2D) ■ Require more space in factory and more transport space for delivery ■ This demonstration didn't provide enough insight to consider pod connection to standard pre-laid concrete slab.

To ensure outcomes residential construction using NCH at 2D panel level requires clear documentation for construction (panels and fastenings well labelled, site instructions, cleared process with council for sign off).

1.5 What is the optimal level of offsite construction?

The optimal level of off-site construction depends on both factory and site construction factors, and the opportunities to overcome business as usual challenges revealed in this demonstration. The demonstration trialled this level of factory based construction: framing + insulation + windows, as well as a 3D delivery of upstairs modules (incorporating floor joists and roof trusses), and indicated these issues needed to be overcome:

- **Weather proofing** (wind and rain) for delivery and storage on-site
- **Site level sub-contractors and trades:** quality of work, familiarity of product, willingness to engage
- **The constraints of the NCH system and Warmframe™:** can and should be very accurate, but when it isn't 'fix-up' solutions on-site are difficult and can be costly (time and \$) and undermine performance (particularly insulation/thermal performance).
- **Technical fixes for a variety of 'market desired' cladding** and the Warmframe™ system (e.g. suitable fixings for vertical cedar).
- **Linkages between the design, detailing, engineering and product supply all driven by a standardised software solution.**
- **The requirement for clear documentation for construction** (panels and fastenings well labelled, site instructions, cleared process with council for sign off).

The demonstration proved that it is feasible and valuable to deliver 2D panels with framing + insulation + windows. The issues above indicate that a higher degree of offsite construction would assist outcomes. Options would be to include:

- Infrastructure for services (e.g. wiring, plumbing, plug and play adaptations) would overcome quality issues experienced on-site as well as resistance from tradespeople unfamiliar with steel.
- Developing a range of easy fastening and fixing details (wall to wall, corner detail, wall to floor, wall to truss).
- Cladding (need to consider protection during transportation and weatherproofing on-site).
- Lining (need to consider protection during transportation and weatherproofing on-site).

How far down the value chain does the NCH process have to extend to ensure the best outcome?

The demonstration has provided clear evidence that stopping the New Category of Home Warmframe™ system at point of delivery to site, and then expecting business as usual to take over final delivery undermines the final objective to take time and cost out of residential construction. In essence, delivering an innovative product to an unfamiliar work force, who have business as usual constraints, weakens the value proposition for New Category of Home's primary objectives. Therefore, Beacon concludes that the NCH system needs to cover the entire process from design to fit out, to ensure all outcomes can be optimised.

1.6 Key guiding principles for New Category of Home and Warmframe™

As part of delivering a comprehensive system Beacon proposes a set of key principles in order to achieve successful outcomes. These are provided here as a starting point and require further analysis, debate and fine tuning with partners to the New Category of Home project.

- 1) **Design-led:** A lean manufacturing design-led process that optimises NCH potential through reduced time, waste and cost whilst also meeting market demand in respect to quality, affordability and performance.
- 2) **Targets:** Meet specific and tangible targets for home performance based on Beacon's HSS High Standard of Sustainability® and Homestar™ (i.e. develop house designs that optimise the NCH potential and deliver market premium – e.g. Homestar™). Including targets relating to:
 - a) Waste – high rates of recycling of Warmframe™ componentry and a target of less than 200kg waste to landfill per home
 - b) Affordability - a factor of both cost and time to construct (suggest a target of \$1200 per m² and six week delivery time)
 - c) Safety - reducing construction accidents to zero
- 3) **Integration:** Integrate the appropriate trades and professions (such as architects, product manufacturers, steel framing detailers, engineers, council officials, builders, plumbers,

electricians, Gib stoppers, roofers etc.) so that challenges can be identified and resolved before they become problems.

- 4) **Communication:** Establish an integrated knowledge and communication system for all aspects from design to fit out including the ability to deliver information, designs, diagrams for detailers, engineers, products suppliers, factory construction, on-site construction, and council sign off.
- 5) **Factory set up** with a trained competent team and optimised systems.
- 6) **Dedicated delivery agent:** Provision of a dedicated manager responsible for ensuring seamless delivery from design to finished house and between factory and site. This person can also translate any shortcomings or lessons learned back into the design-led process.

