# Our Challenge

**What is the role buildings can or must have in driving New Zealand to a low carbon economy and society?**

- **Climate Change: The Global Environmental Context**
- **Carbon Emissions and New Zealand's Built Environment**
- **New Zealand's Homes: New stand-alone single and double storey**

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We are at a critical junction in our global action to curb global warming climate change, and our economy's and society's transition to a zero-carbon future. Simultaneously, as an industry, we face the unique challenges of a housing quality and quantity crisis – where there are not enough houses, and many of the houses we have are substandard. However, these are problems and we are all here looking for solutions, and we need to start by asking ourselves, what role buildings must have to make a net zero low carbon future a reality.

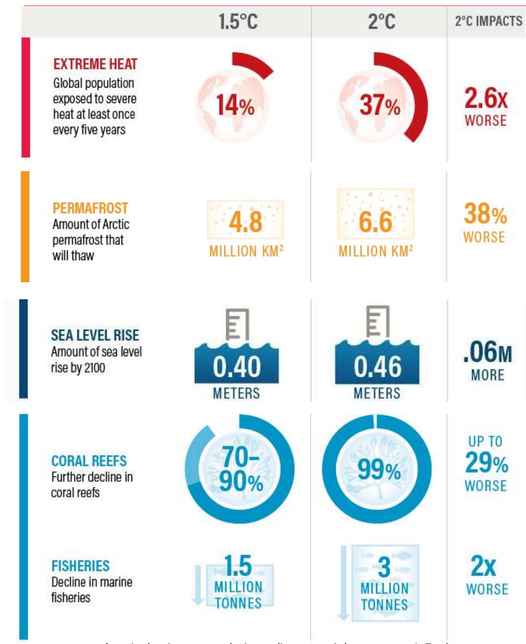
My name is Brian Berg, and I'm a Building Environmental Scientist at BRANZ.

Today I'm presenting on behalf of the team of research I work with investigating carbon mitigation and the environmental impact of buildings – specifically New Stand-alone single and double storey residential homes.

# The Global Environmental Context: Global Warming / Climate Change

The global environmental context – what does this mean and how does it translate to the new homes we are designing and constructing?

## Global Warming




www.skeptical-science.com/science/ipcc-special-report-on-1-5-c/

## New Zealand's Commitments:

**New Zealand signed and ratified The Paris Agreement:**

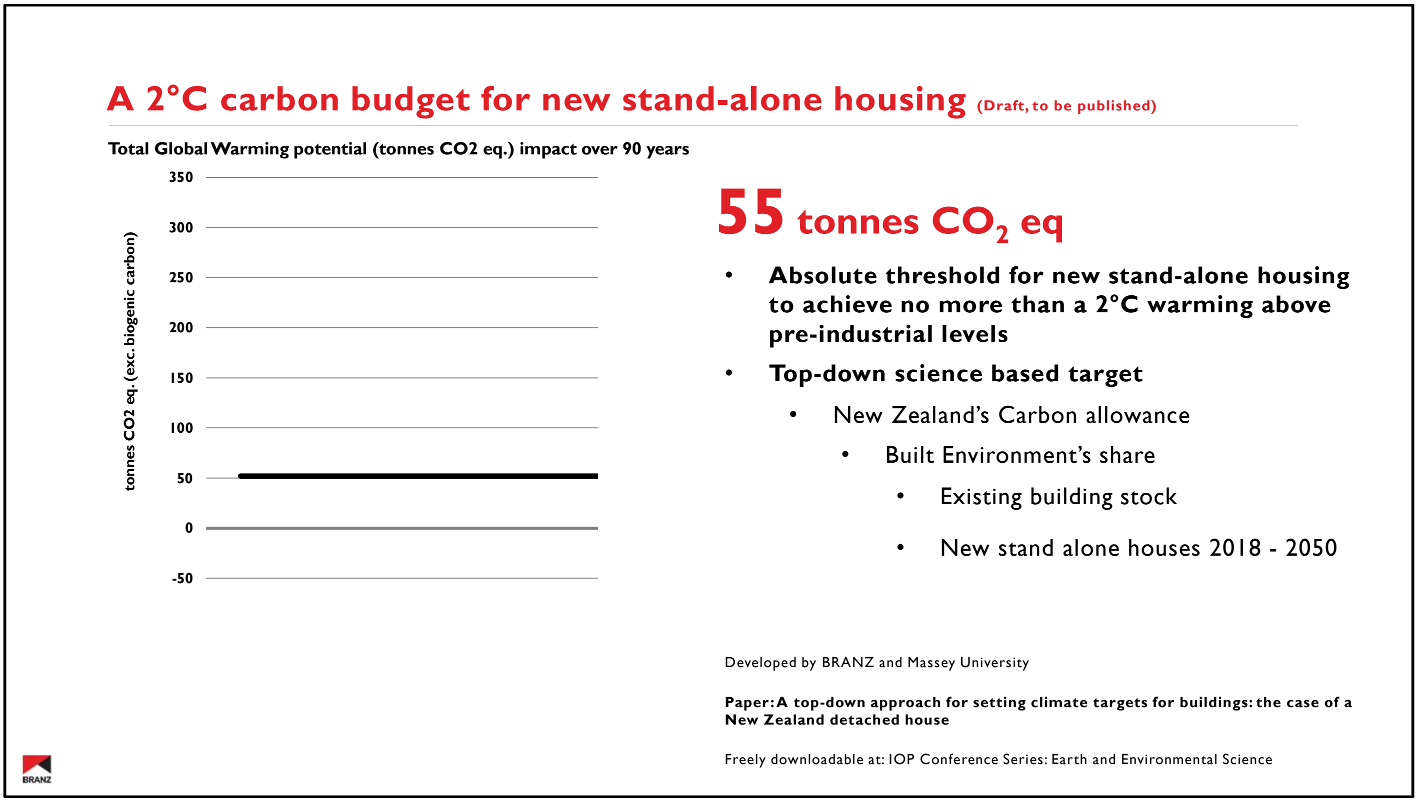
- **30% reduction** on our 2005 Greenhouse Gas (GHG) emissions by 2030.
- **Net-zero carbon** emissions between **2050** to 2100.

The starting point I want to emphasise is the difference between 1.5°C and 2°C anthropogenic or man made average global temperature rise. The environmental impact of global warming is not linear, and it will not be 25% easier to keep temperature increases below 2°C than 1.5°C. New Zealand has signed and ratified the Paris Agreement, and as a developed country we are expected to be a global leader and be net zero carbon closer to 2050 than 2100.

This is the ongoing global political debate and the climate science we read about in the newspaper – but its just re-describing the problem we already know, what about actions and solutions? Our government is currently developing the Zero-Carbon bill, and draft carbon budgets for sectors are being developed, however, these budgets are likely to be production based and aligned to the Ministry for Environments accounting methods.

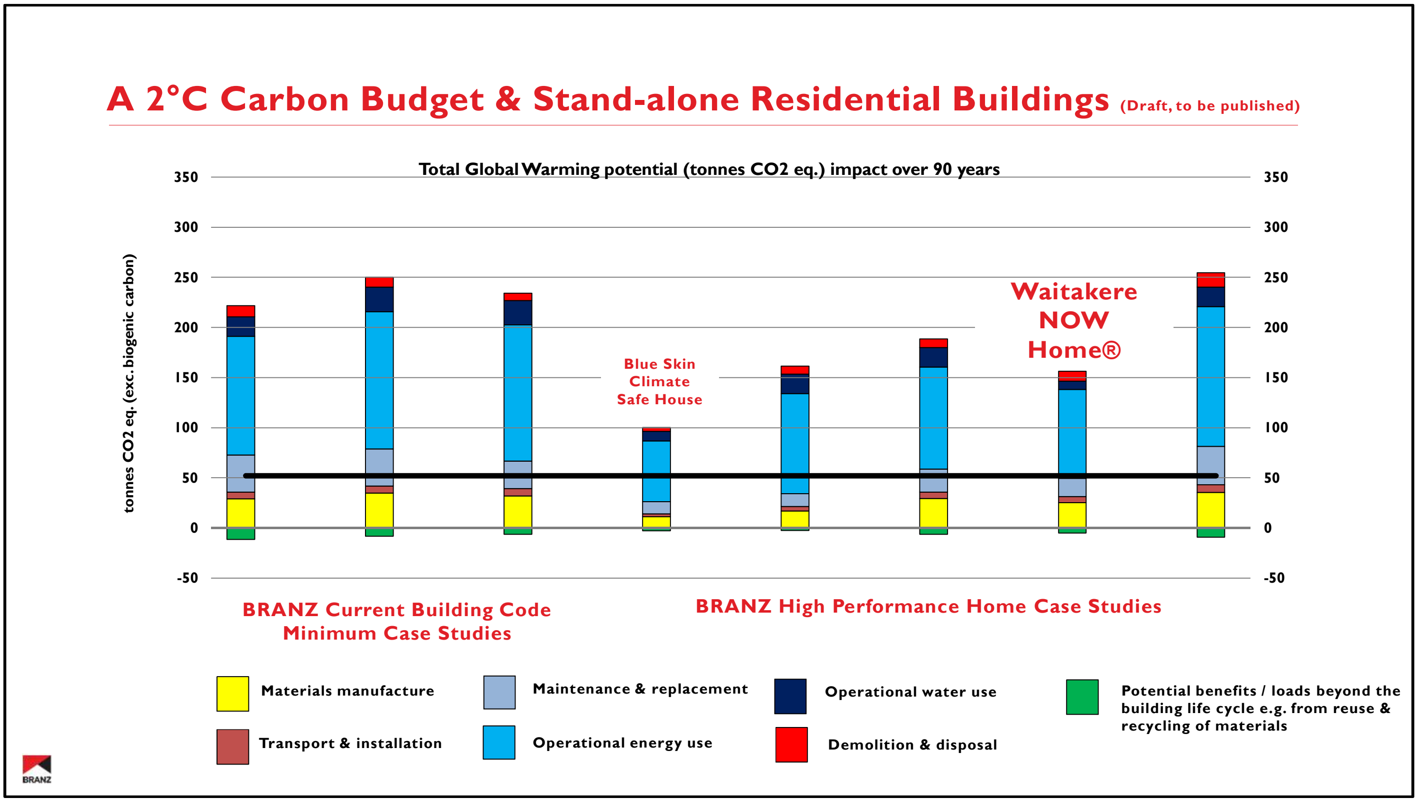
In these budgets the carbon emission's of buildings are unlikely to be disaggregated and therefore of little use for building designers at an individual level. Therefore we must ask:

- How do these global average temperature rises translate to the building's we are currently designing?
- How much Lifecyle carbon do our new stand-alone single and double storey homes produce?
- And as a building designer, what should I be doing?




BRANZ in collaboration with Massy University's Lifecycle Management Centre, has developed a 2°C Carbon Budget for Stand-alone residential houses. This is based on the amount of carbon each new home can release from now until 2050, after which time all buildings must be net-zero carbon. For the subject typology, stand-alone single and double storey residential housing, this translates to an absolute threshold of 55 tonnes per building, not per area or per person, or per year, but 55 tonnes per building.

This is a Top-down science based target, where we take the amount of carbon we can still release, allocate NZ its share based on our population, the built environment gets its share, our existing building's at their current energy efficiency quality levels have a locked in consumption that is prioritised so they get their proportion first, and then the remainder is divided by the number of new building's we need. This is linking climate change, with the quality concerns of our existing housing stock, and the quantity issues of our housing shortage.




Applied to the stand-alone housing typology the budget is 55 tonnes of carbon dioxide equivalent across all life cycle stages; including material manufacturing, transport and construction, operational energy and water, and demolition and disposal.
Let's see how some of our current Building Code minimum compliant new build stand-alone houses compare to the 2°C 55 tonne lifecycle carbon budget.

As you can see they are well above, and even the material impacts alone are more than 55 tonne budget. Overall, they are between 4-5 times, with the single largest life cycle stage being the operational energy of the grid electricity consumed over 90 years.

Now, comparing these case study results to some high performance energy efficient homes, you can see that the life cycle carbon has decreased, primarily due to reduced operational energy. This is great, however, even our high performance energy efficient homes, while being warm, dry and designed to be space heating energy efficient, are not low carbon homes as defined by the carbon budget.

# As an industry what can we do?

**Design carbon out of our buildings.**

# How?

**What BRANZ tools are available?**

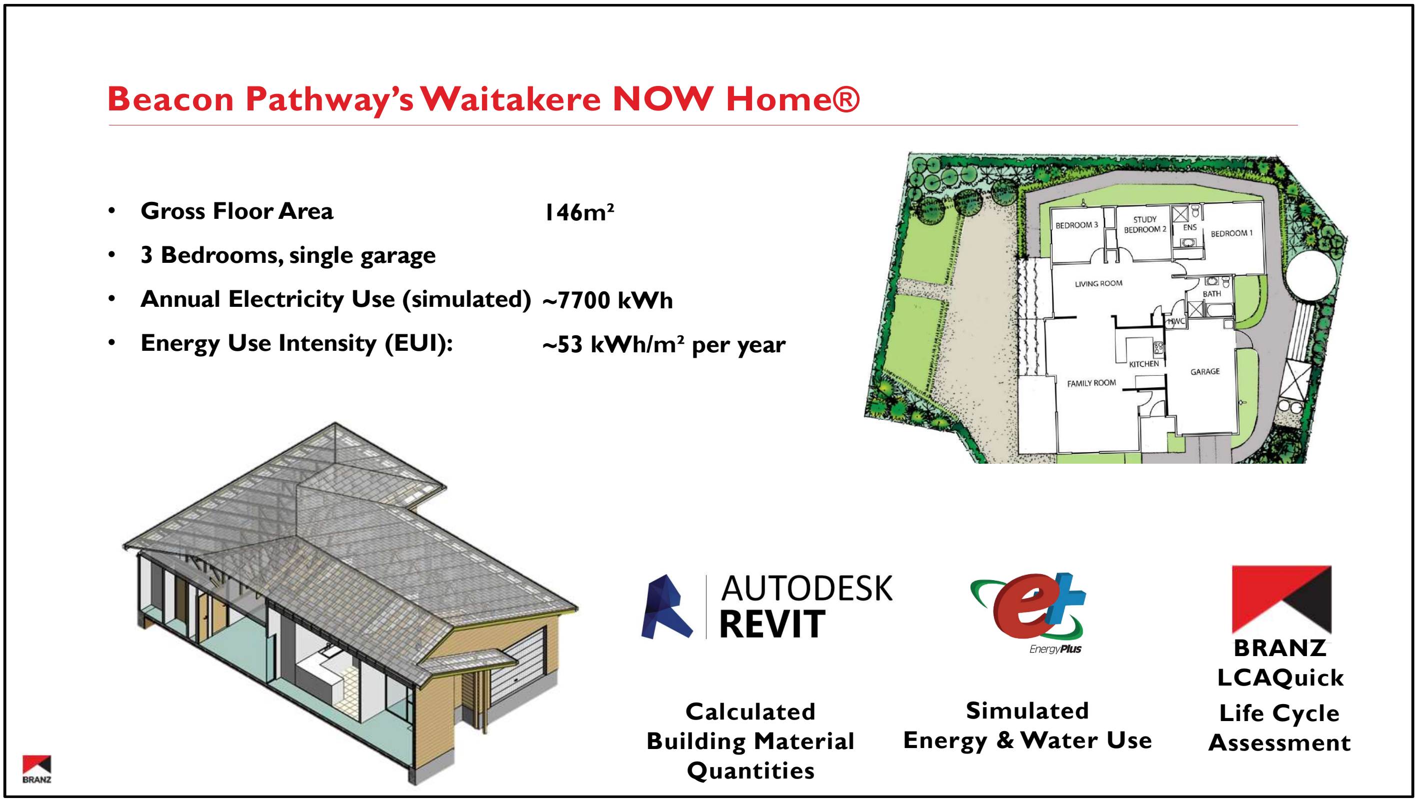
BRANZ CO2NSTRUCT

BRANZ LCAQuick

www.branz.co.nz/co2nstruct www.branz.co.nz/lcaquick

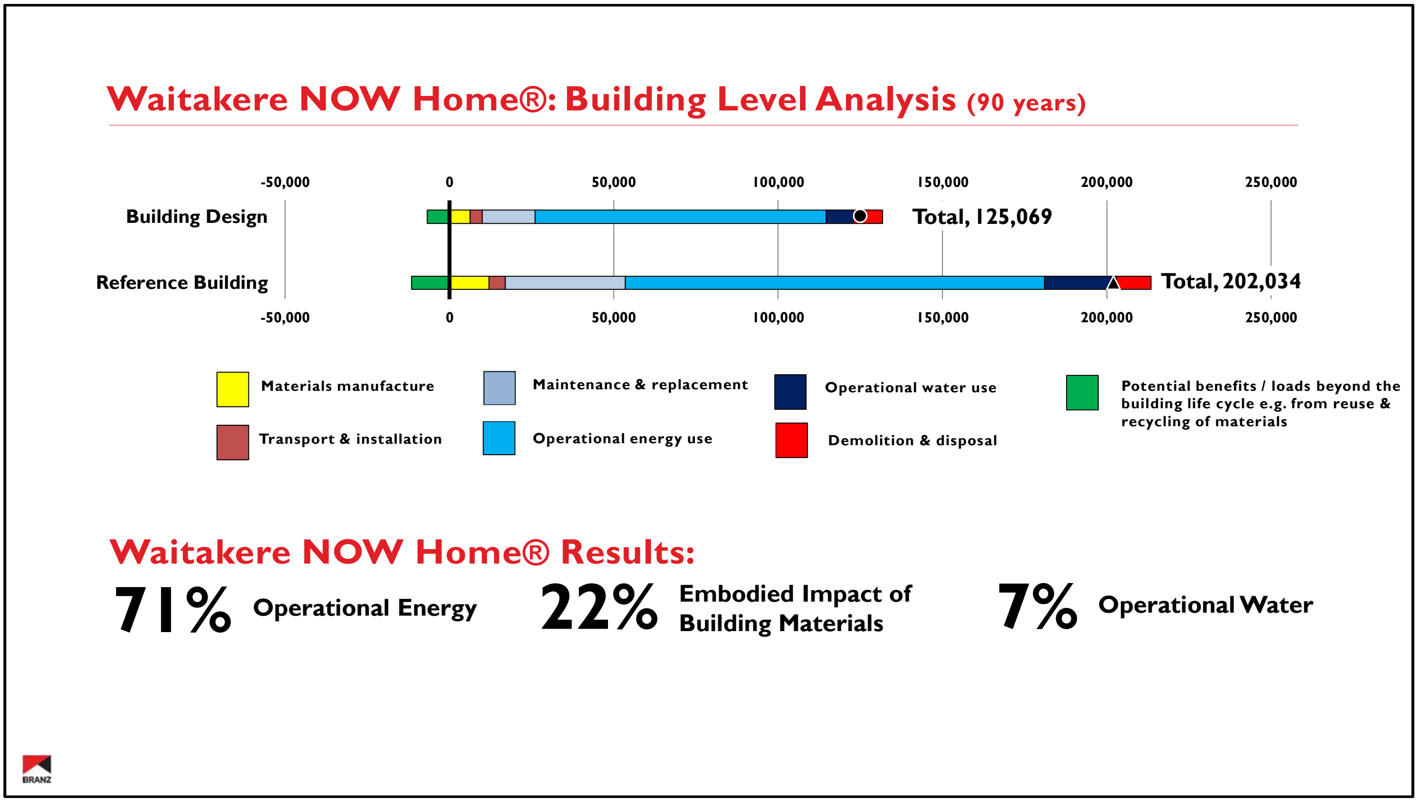
Therefore to deliver low carbon homes, we need to design carbon out of our buildings from the start, and tools that calculate the carbon impact of building's need to be used as early as possible. We need freely available tools that provide the information needed in many different formats so that the information is accessible and can applied easily.

However, tools do not design buildings, they only analyse them. It is up to industry experts such as yourselves to reduce the carbon emissions of buildings.
Let's look at how Beacon Pathway's Waitakere Now Home, one of the better case study houses we modelled, emits carbon.




The Waitakere Now Home was designed to be energy efficient, warm, dry, healthy and affordable. Being extensively studied by Beacon and BRANZ, this building was ideally suited to be a reference building modelled and embedded in LCAQuick – a NZ specific and freely available Whole Building LCA tool that can calculate the carbon impact of buildings.

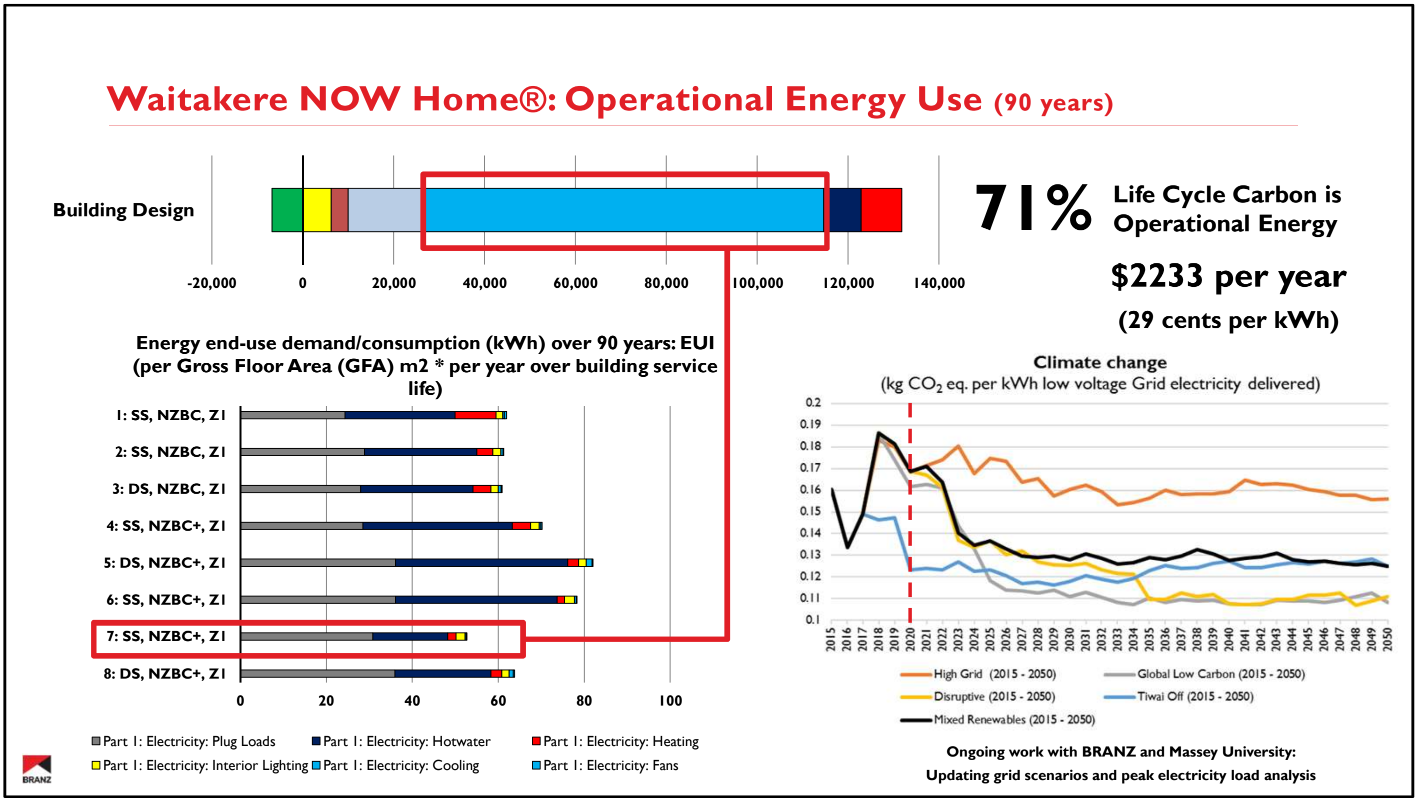
To do this LCA we calculated the building material quantities, in this case by constructing a Revit BIM model and using the scheduling tools to extract number of items, areas and volumes of each material. We simulated the energy consumption using building simulation tools and EECA's online hot water energy calculator, and we applied water consumption benchmarks based on measured data from real homes.




This graph is an example of the outputs from the BRANZ LCAQuick tool. It compares the Now Home, labelled as the Building Design, to one of the BRANZ Code Minimum reference buildings shown previously.

The different coloured bars represent the different lifecycle stages over the 90 year lifespan of both buildings. 90 years was the selected reference building service life, and is the time after which half the houses constructed in the same year no longer remain in our building stock.
As you can see, 71% of the carbon emitted by the Now Home is attributed to the electricity consumption whereas 21% is due to the manufacture, transport, construction, maintenance replacement, demolition and disposal of building materials.

You may be wondering, what the negative green bar represents. In LCA this is called module D, and it is the environmental benefit or load that occurs beyond the system boundary of the building. This is where the benefit expressed as a negative value, of activities such as material recycling, reuse or the exportation of excess onsite energy generation to the national electricity grid is captured. Therefore materials such as aluminium will have a manufacturing impact of a virgin product, and the recyclability will be represented in module D. This point will be illustrated clearly when we look specifically at the building materials in more detail.

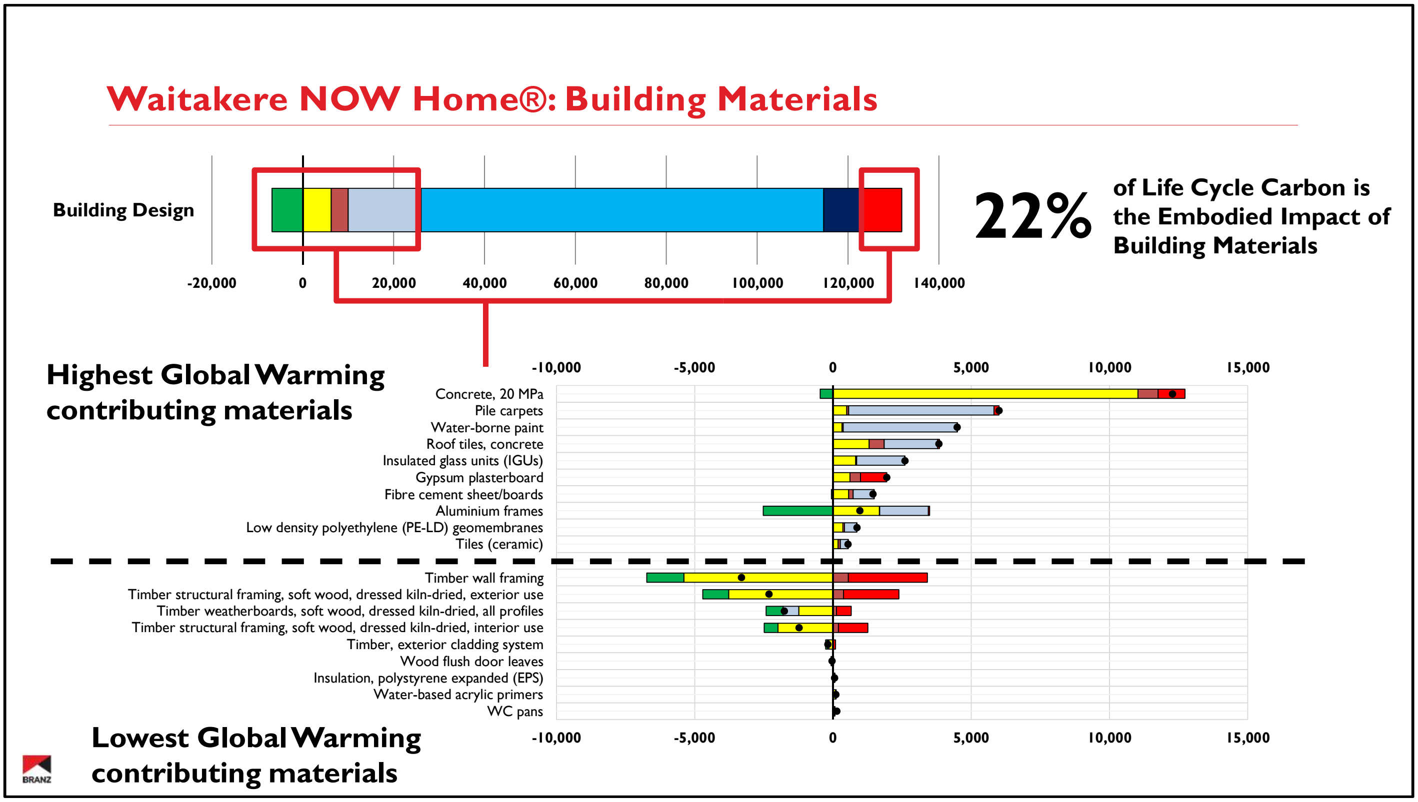



Looking at these building level results, the first step in iterative design is to identify the areas where carbon reductions can be made. The operational energy use is the single largest impact and is the logical starting point.

This lifecycle stage encompasses all energy fuel sources and end-uses, and in the case of the NOW home and the other BRANZ residential reference buildings, energy use is dominated by plug loads and hot water. This suggests that our current focus on heating energy efficiency, especially in Auckland, will not lead to low carbon home.

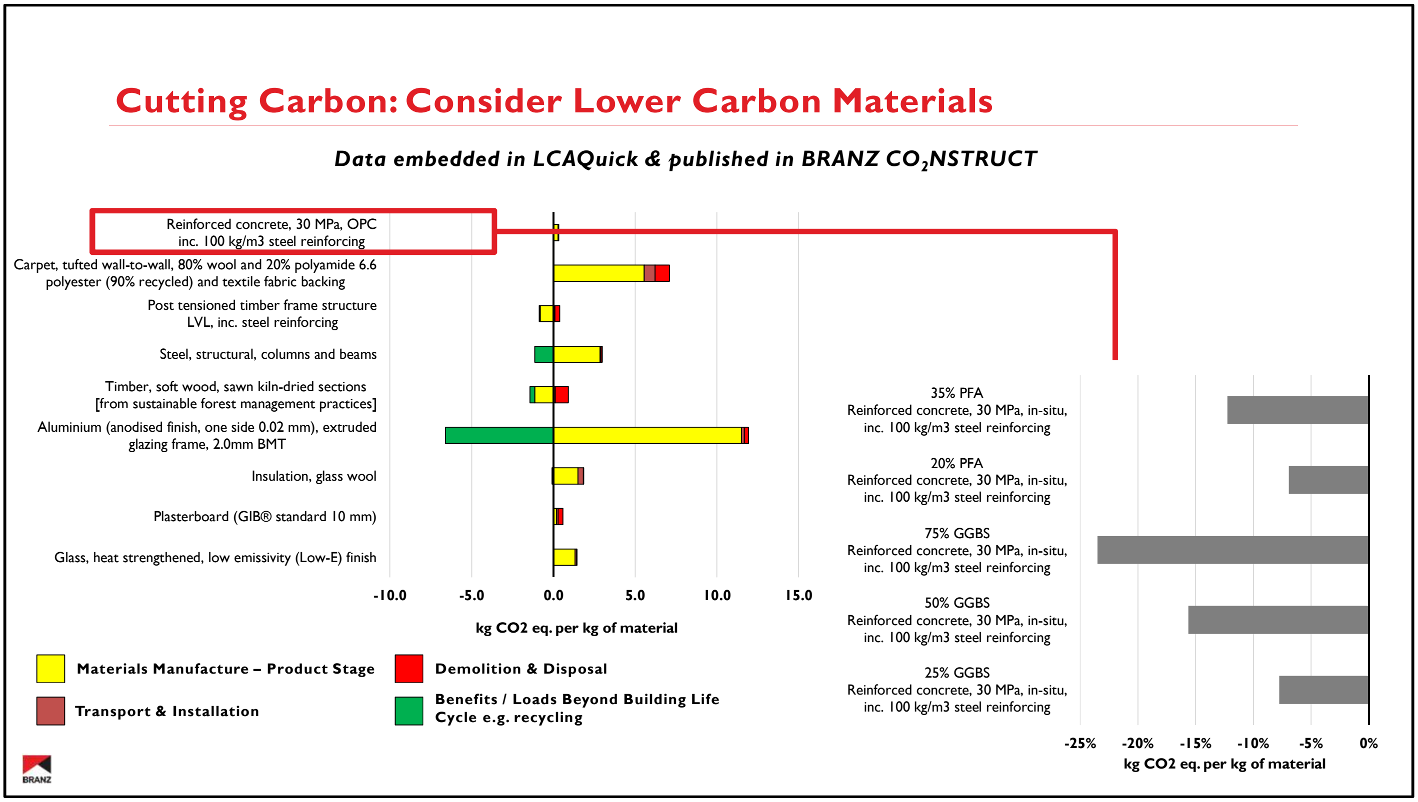
As designer's we are very good at designing low energy, efficient warm homes, e.g. the Now Home. The challenge now moves to, how do we reduce hot water energy and plug load electricity use and their upstream carbon impact. Part of the solution is decarbonising our electricity grid by increasing the contribution of renewable energy sources.

On our Carbon budget, this will have the dual impact of reducing the impact of our existing stock, therefore freeing up more carbon for our new buildings, and decreasing the impact of the energy use of those new buildings. Therefore bring both closer together.
However as you can see with these different grid mix scenarios, a renewable grid is not net-zero carbon and peak load issues surrounding the timing of electricity use must be considered. All these factors mean designing for energy efficiency for all energy end-uses is critical.




However, energy efficiency solutions cannot be implemented without considering the impact of the materials that actually form the building. For the NOW home 22% of the lifecycle carbon impact is associated with building materials and their impact is spread across the manufacturing, transport, construction, maintenance, replacement, demolition and disposal.

Concrete is the single largest material product life cycle stage contributor, whereas surprisingly carpet has the largest maintenance and replacement stage impact and shows the importance of lifecycle decision making. Other materials such as sustainably sourced timber with certified forest management documentation can help to offset higher carbon but critically important materials such as concrete, steel and aluminium. The negative yellow bar of timber illustrates the benefit of the carbon sequestered by the growing tree. This carbon is being sequestered in the building and once demolished, the timber goes to landfill and is essentially sealed away from the atmosphere – and being from sustainably managed forestry a replacement tree was already planted.




Material substitution for lower carbon alternatives such as cement replacement concrete is also an approach to fine tune or optimise a design. The graph on the left shows some examples of materials included in LCAQuick which is based on EPDs from both NZ & other countries and supplemented with modelling from Life Cycle Assessment software EcoInvent and New Zealand research.

For some materials, there are opportunities to reduce carbon emissions through the use of lower carbon alternatives. Cement production in concrete is a large GHG issue. Two common cement replacements, Ground granulated blast-furnace slag and Pulverised Fuel or Fly Ash, have a 7-24% CO2 reduction compared to ordinary Portland cement.
While the Embodied carbon intensity of materials can vary enormously, a holistic whole building whole of life approach considering the quantities of materials being used, as well as their impact on energy use and role within the building & lifecycle must be considered.

Several key points of emphasis include:

- The negative AI-A3 of timber sources from sustainable forests management practices illustrates the benefit of the carbon sequestered by the growing tree. This can be used to compensate for other carbon intensive materials such as concrete, steel and aluminium.

- Focussing on the metals, Aluminium and steel do have a large environmental benefit beyond their lifecycle. This is how their recyclability is accounted, with the number shown being the net result of all lifecycle stages.

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While the embodied carbon intensity of materials can vary enormously, a holistic whole building whole of life approach considering the quantities of materials being used, as well as their impact on energy use and role within the building & lifecycle must be considered.  This is to not inadvertently transfer the environmental impact from one stage of the life cycle to another, or from one indicator to another.

# Key Take Home Message

**A high performance home is not necessarily a low carbon home.**

**We must consider holistic lifecycle design:**

**Building Size**
**(efficient design)**

**Energy**
**(consumption/efficiency, fuel type, and time of use)**

**Materials**
**(building size, material type, maintenance, lifespan, waste, recycling, and reuse)**

**Water**
**(consumption/efficiency, water source, reuse/recycling)**

**Solutions and Tools for Industry to Act Now**
**(BRANZ LCAQuick, BRANZ $CO_2$NSTRUCT, EPDs, energy simulation)**