By Steve McNeil, BRANZ Senior Building Physicist

What really is a warm roof?

Warm roofs are becoming popular – not just for commercial buildings but for residential houses too. What's the science behind them and how should they be installed? BRANZ found answers by retrofitting an existing residential house.

Recently, BRANZ retrofitted its ventilation test building with a warm roof – see *Roofing rethink: warm roofs, healthy Kiwis* in *Build* 202. The project sought a practical and straightforward way of retrofitting residential dwellings so they could benefit from the warm roof methodology alongside new-build homes.

Regardless of whether it's a new or retrofitted roof, planning is important. It's necessary to understand what a warm roof is and the different ways of building them to see if the method can be used in your project.

What defines a warm roof?

Most of the answer is in the name. A key thing to note is that warm roofs really mean warm structures because the insulation is located outside of the trusses or rafters, not fitted between them. With this change, the whole dynamic of the roof space changes – see Figure 1 for a comparison of temperatures in a cold and warm roof.

Warm roofs have several benefits over conventional roof constructions. The benefits have been covered in detail in *Build* 161, *Don't be cool about warm roofs* and Build 202, *Roof space moisture – it's complicated.*

BRANZ research puts retrofit warm roofs to the test

In summary, warm roofs include:

- significantly reduced risk of moisture accumulation
- enhanced thermal performance
- reduced overheating risk
- improved efficiency of ventilation systems (inculding heat recovery units) or ducted heat pumps
- less temperature extremes for services such as plumbing
- potentially much longer lifespan for the cladding.

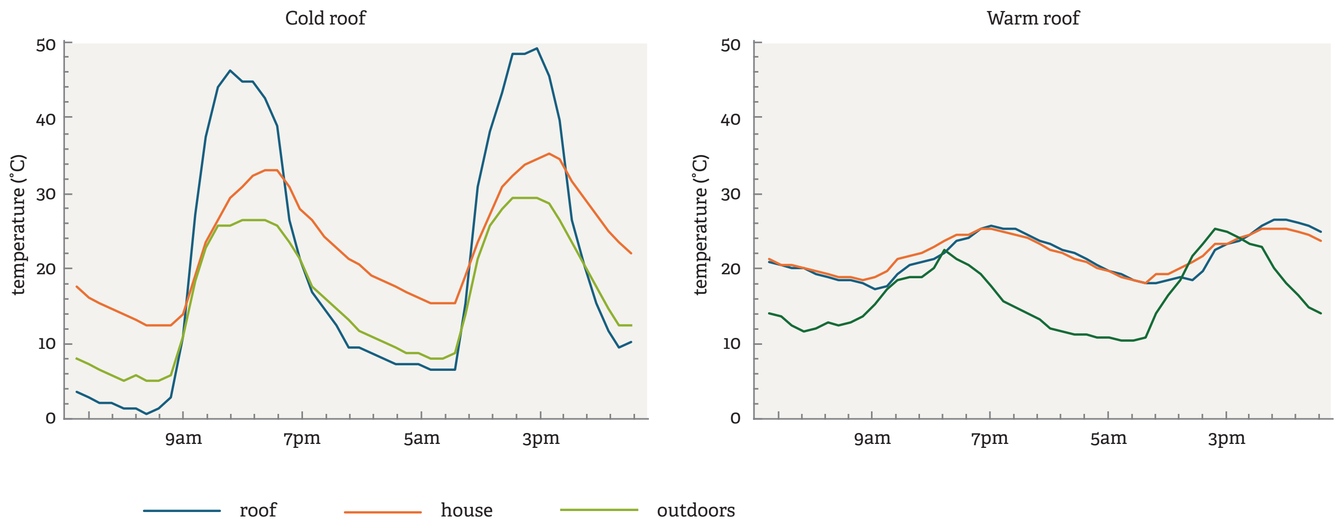

Figure 1: Temperatures in mid-autumn – pre-retrofit cold roof (left) and post-retrofit warm roof (right).

Air and vapour control

It is important that a good air barrier is fitted directly below the insulation layer as the roof space is now entirely within the thermal envelope. There's no need to provide additional passive vents in a warm roof – just treat it the same as the building below. A simple solution would be to incorporate a roof space extract vent into the mechanical ventilation system.

The great thing is that most warm roof systems available here come with good air control as a standard feature. However, make sure the trusses/rafters are blocked at the junction with the top plate and appropriately sealed. It's also a good time to add some additional insulation outside this blocking before closing up the roof. The top of the blocking should be cut to match the roof slope, which will maximise the surface area and make sealing the joint easier.

Vapour control is also something to consider, with a vapour barrier needed for membrane-clad systems to prevent internal moisture collecting under the external membrane and in the insulation itself.

Different options

There are several ways to accomplish warm roof construction and plenty of proprietary systems on the market. These typically fall into three categories:

- Metal-skinned panels – easiest on simple forms and available in long spans.
- Membrane systems – great for low-pitched and large roofs.
- Built assembly with a ventilated conventional roof above (Figure 2) – a good option for retrofits, smaller buildings or those with complicated roof forms.

While hybrid options exist – where some additional insulation is installed either on the ceiling or directly below the bottom deck of a warm roof – they do require specific design and hygrothermal (WUFI) modelling.

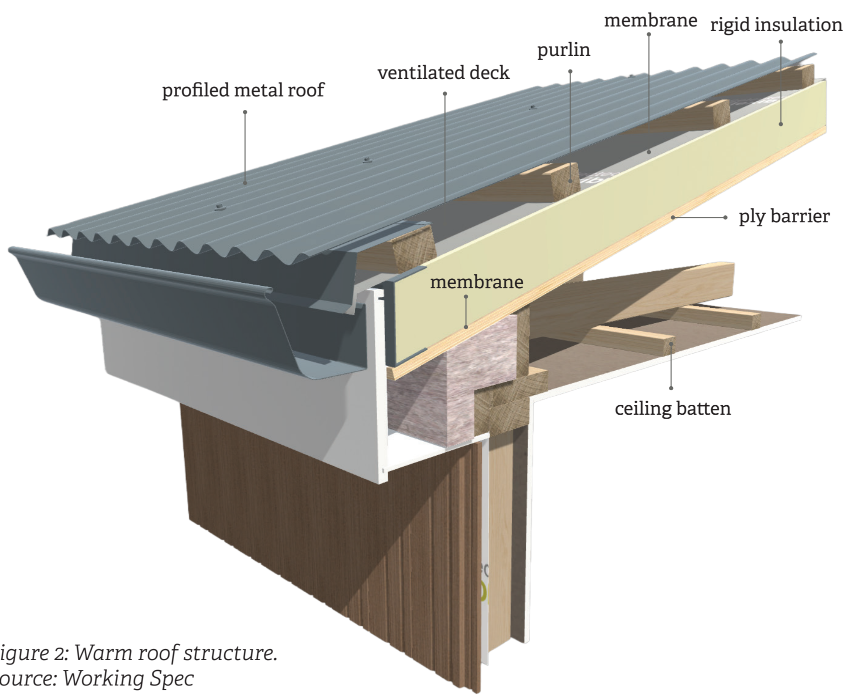

Figure 2: Warm roof structure.
Source: Working Spec

The key challenge is that there will usually be discontinuities in vapour permeability and thermal resistance where the materials in the construction change, and poorly chosen combinations can be a significant risk factor for accumulation of internal moisture in the structure.

Hybrid assemblies also pose questions around where the air barrier lies. The skill of the hygrothermal modeller is critical here to ensure any risks are understood and good sensitivity analysis is important. For context with these challenges, there are well-documented failures of hybrid assemblies in the UK, which is why a straight warm roof is the preferred approach.

Each layer has a role

The good thing is that, in a warm roof, the roles of the different layers of the assembly are clear. This removes several of the compromises that exist with traditional construction. There is no longer an expectation that the roof deck has to deal with moisture loads from the inside of the dwelling.

If using a membrane assembly or something like the BRANZ retrofit roof, detail the lower membrane to fall outside the wall cladding. There are a couple of options here. In the case of the BRANZ retrofit, the lower membrane was lapped over the existing fascia and a second fascia was added on a packer to provide a drainage path.

This detail gives the building owners some warning when the roof cladding eventually needs replacing and ensures everything possible is being done to comply with the performance requirement E2.3.5. As the entire sub-roof is effectively an anti-ponding board, it makes sense to use it.

Winter results from the ventilated deck

An obvious question is how the performance of the ventilated deck stacks up compared to traditional cold roofing (which has the same cladding). Measurements in early August 2024 give an idea of how good this assembly is at shedding moisture accumulated due to long-wave overcooling. Figure 3 shows the absolute humidity of the outside air (actual water content per m^3 of air) and the cavity below the roofing on both the north and south faces of the building.

The spikes in air moisture content are the condensate evaporating, with the absolute humidity below the roof deck matching the exterior conditions by 10am on the north side and by around lunchtime on the south side.

The key takeaway is that the lower surface of the roofing stays damp for a much shorter period than traditional roofing in the same circumstances, which should contribute to a longer service life.

What's next?

Summertime data is currently being analysed. Early indications are that there are significant benefits in terms of reducing the risk of overheating. The ventilation building will then undergo a deep retrofit as part of a new BRANZ Levy-funded project: *Framework for reducing the impact of future climate change on building performance.*

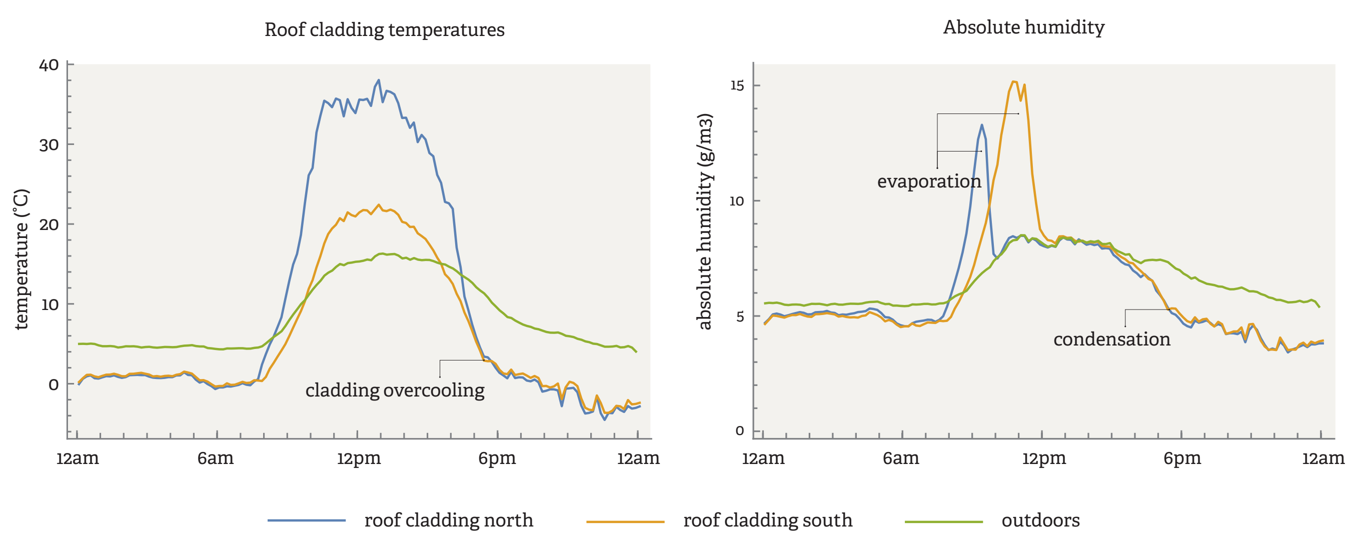

Figure 3: Early August roof cladding temperatures (left) and absolute humidity (right).