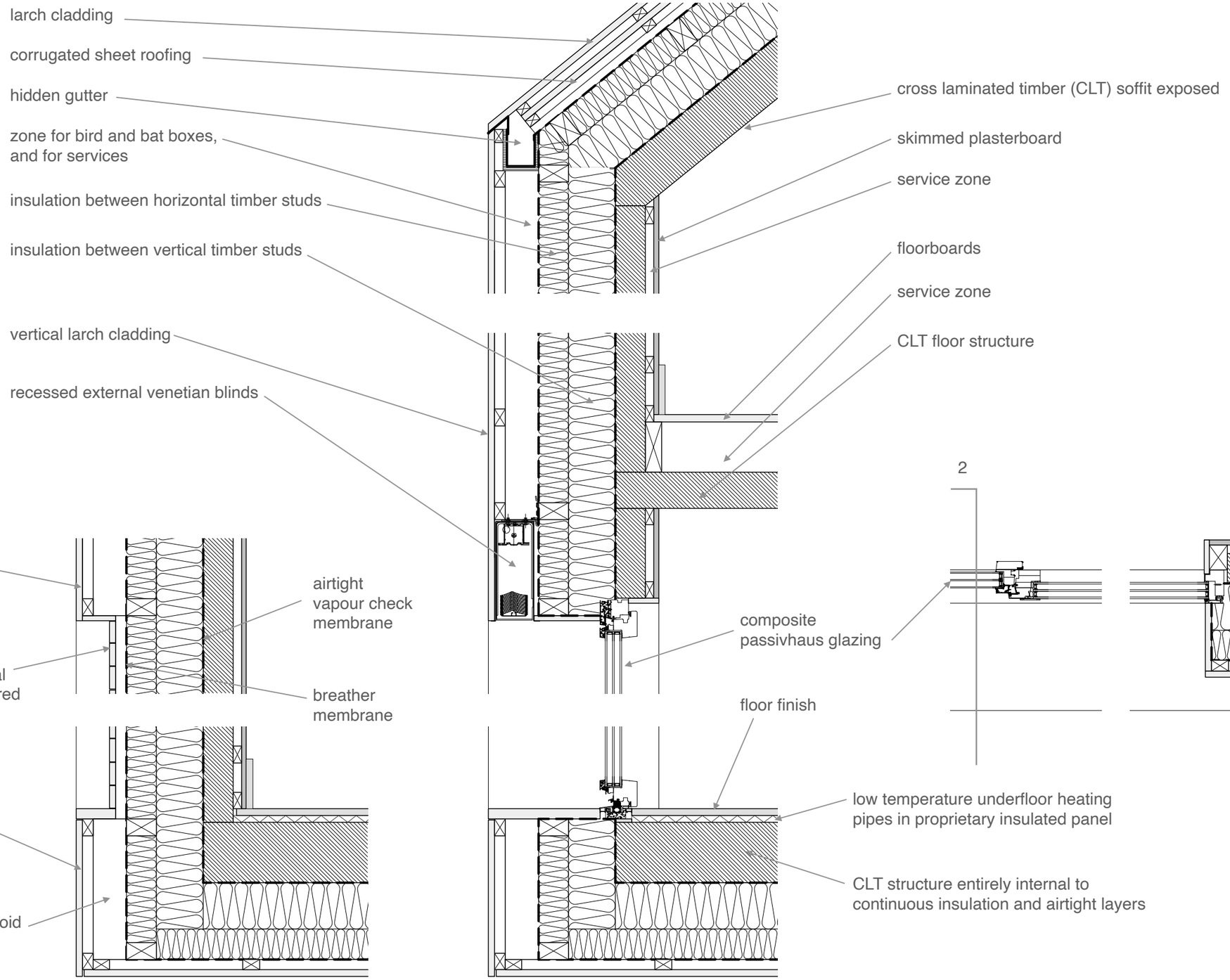
A further contrast is between the monochrome arrival courtyard (above) and the southern elevations of the wings (below), where the splashes of colour from the western red cedar cladding appear.



SECTION 1

SECTION 2

PLAN

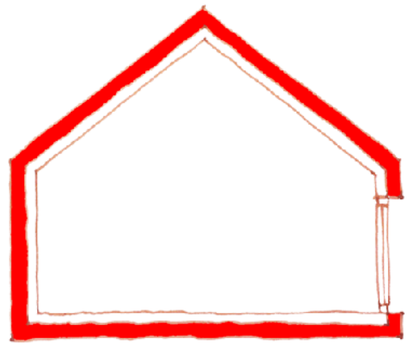
ENVIRONMENTAL STRATEGY

There are three main ways to make a building sustainable - 1) what it is built out of, 2) how it is designed, and 3) how its energy needs will be met.

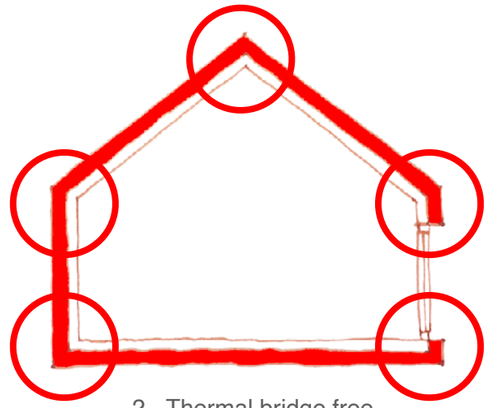
Regarding point 1), this house will be built from renewable, sustainable wood, for both the structure and the cladding, and it will also be insulated with breathable sustainable wood fibre insulation.

Before considering point 3), how the building's energy will be supplied, it is first sensible to look at point 2) and minimise the amount of energy that it will need. This will be done by:

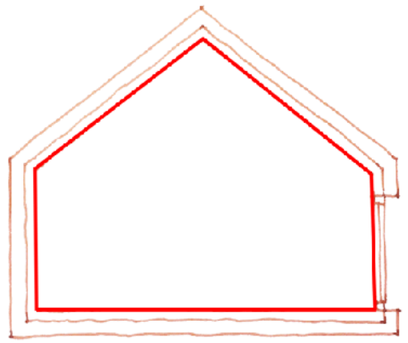
1. Super Insulation: to keep the heat in - U values of less than 0.15 W/m2K for the building envelope. This is like wearing a warm coat, or akin to comparing a thermos flask with a kettle - the kettle uses lots of energy to keep re-heating the water, whereas the flask keeps the water hot without using any energy.
2. Thermal Bridge-free Construction: heat loss through thermal bridges (breaks in the insulation) can be eliminated by carefully detailing every junction of the building.
3. Airtightness: a carefully detailed continuous airtight barrier will ensure that no heat is lost through air leakage. This building will have air leakage of no more than 0.6 air changes per hour, compared with the current Building Regulations requirement of 10.
4. Mechanical Ventilation with Heat Recovery (MVHR): This effectively provides fresh air without letting the heat out. MVHR works by extracting the stale air from the kitchen, bathroom, toilets and utility rooms and supplying fresh air to the 'living' rooms e.g. bedrooms, living rooms, studies etc. The extracted air is taken through a central heat exchanger and the heat from it recovered into the supply air. This works both ways, if the air temperature inside the building is colder than the outside air temperature then the coolth is maintained in the building.
5. Thermal mass: Insulating externally allows us to exploit the thermal mass of the CLT structure. This results in the internal temperature being stable throughout the day, keeping the house warm in winter and cool in the summer.
6. Triple Glazing: with lots of glazing to the south and minimal glazing to the north - Triple glazed, triple sealed argon filled timber framed & insulated aluminium clad Passivhaus windows & doors will be specified throughout, to minimise heat lost whilst maximising useful solar gain. (See more on solar gain and shading on next page).



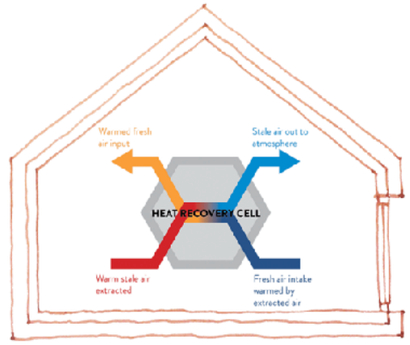
1 - Super insulation



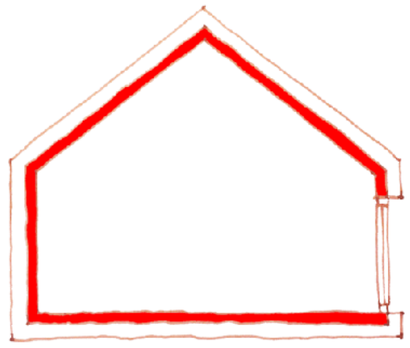
2 - Thermal bridge free



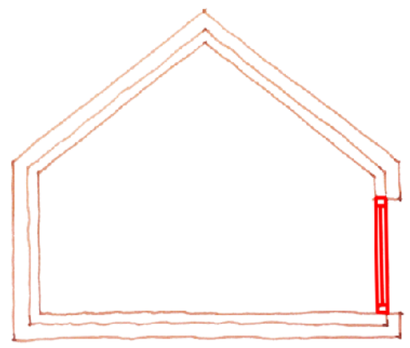
3 - Airtight construction



4 - MVHR



5 - Thermal mass



6 - Triple glazing

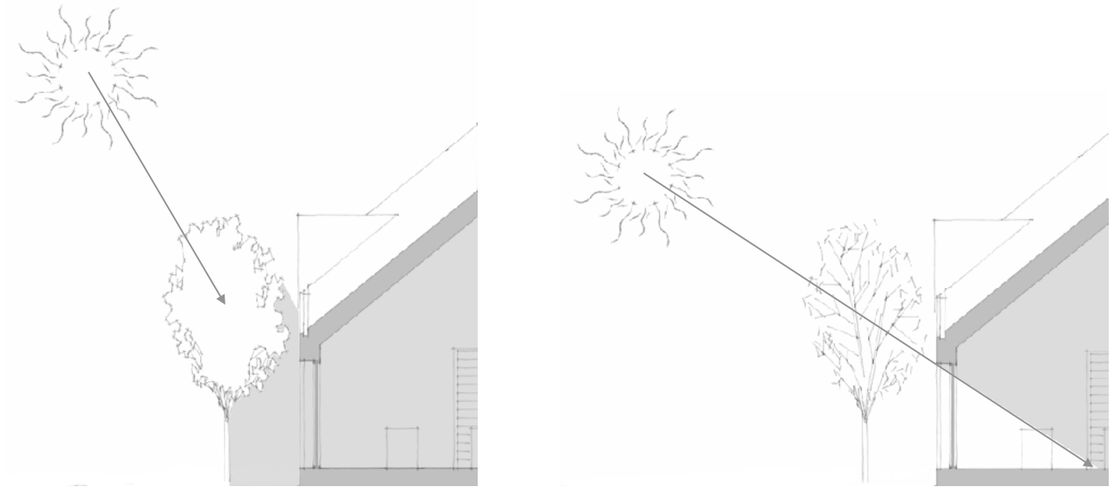
For passive solar design, it makes sense to minimise windows to the north, and maximise windows to the south, so as to benefit from the heat provided by the solar gain in winter. However… that solar gain could lead to problematic overheating in the summer.

Preventing overheating in the summer is a really important consideration, and this will be dealt with in three main ways:

1

New trees will be planted fairly close to the building.

Trees are really clever… in the summer, their leaves provide shade when it is needed to prevent overheating - and in the winter, when they have lost their leaves, they allow in all the beneficial solar gain.



summer winter

2

These trees will provide shade and prevent overheating for much of the building's glazing. However, for those windows that aren't shaded by trees, they will have automatically controlled external venetian blinds concealed in the window heads:

Above - blinds open; below - blinds (partially) closed

3

Lastly, in order to minimise the amount that the blinds will need to be used, the glass specification will be very carefully designed.

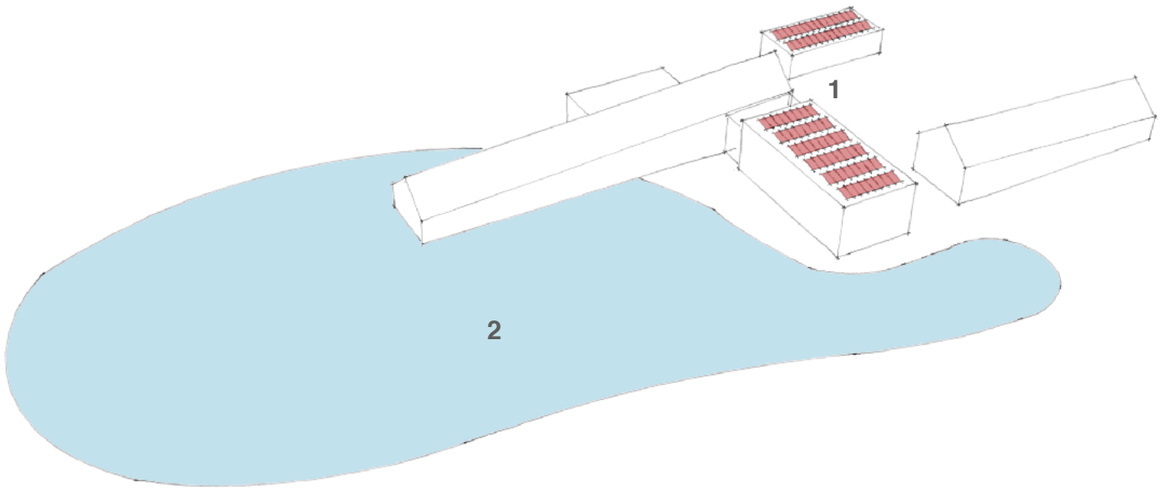
Generally, to make optimum use of the useful solar gains in winter, the glazing must have low installed U values (≤ 0.85 W/m2K) to reduce heat losses, and good solar transmittance (g-values ≥ 0.5). However, for maximum performance, the glazing specification should be fine-tuned on each façade, and should be a balance between the U-value (minimising heat loss) and the g-value (optimising solar heat gain).

In a cool-temperate climate such as the UK, the g-value would typically be 0.5 or higher. Glass with a g-value of 0.5 means that 50% of the solar heat is transmitted through the glass.

In this instance where we want to reduce overheating, a lower g-value will be used to allow less heat transmittance through the glass, and this will be calculated for each window during the detailed design stage.

Having minimised the requirements for energy in the design of the fabric and orientation of the building, the next step was to look at how this energy could be supplied in the most sustainable way.

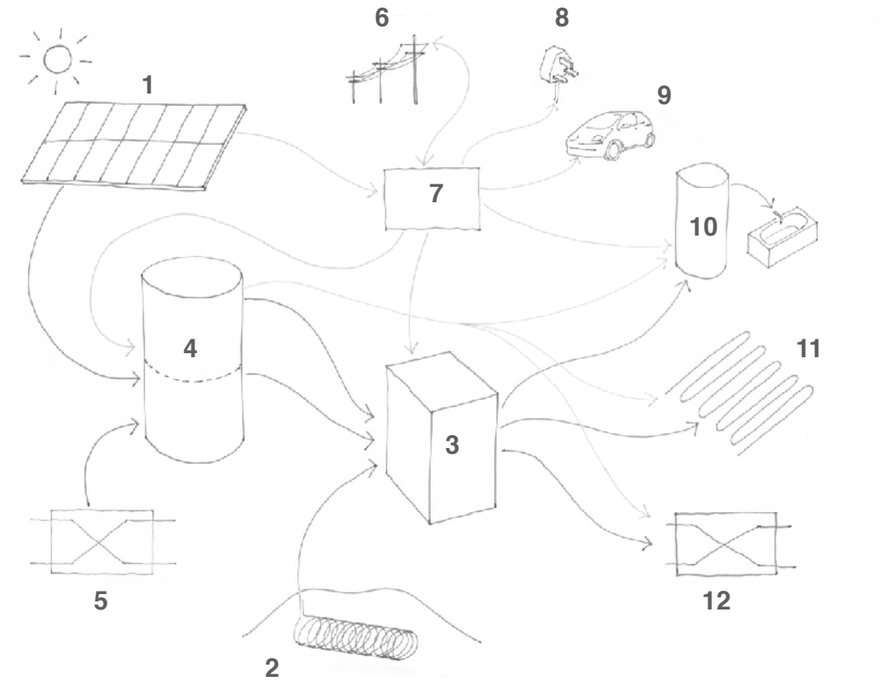
The two key ingredients here are extensive flat roofs for PV and PV-T panels (1) and the water body that the house projects out over. Having the building close to the water has meant that the benefits of this highly effective heat source can be maximised (2).



We have worked with specialists in this field, Energy Zone, to come up for an energy strategy for this project which optimises these resources to contribute to this project being zero carbon and representing the very highest standards of architecture.

A summary of the approach is illustrated on the right, but the detail is contained within a separate report which also forms part of this submission.

Although the proposed multi-source heat-pump (3) will be the first of its kind, and so by definition, innovative, the primary focus has been on optimising the whole site energy strategy, combining existing technologies in a new way to improve their efficiency. The result is a zero-carbon solution, which will actually produce more clean carbon-free energy per year than it will consume.



Energy generation:
1 - PV-T and PV panels
2 - Water-source “slinkies” in lake
3 - Multi-source heat-pump with desuperheater
4 - Source Energy Thermal Battery
5 - MVHR (heat recovered in summer to Thermal Battery)
6 - National Grid (acting like a battery to even out electrical supply and demand)
7 - Solar Edge battery & control system

Energy usage:
8 - small power
9 - electric vehicle charging
10 - hot water cylinders
11 - low temperature underfloor heating
12 - MVHR (mechanical ventilation with heat recovery)