



Breach House

Sustainability Statement

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1. Introduction

SCOPE + PURPOSE

This document describes how Breach House responds to key environmental challenges and considerations, from resource use to carbon balance. The document covers some of the processes and key environmental analysis which has been undertaken through the design phase for Breach House. The report highlights anticipated environmental performance metrics for the proposal.

CONTEXT: CLIMATE CRISIS

“The alarm bells are deafening, and the evidence is irrefutable: greenhouse gas emissions from fossil fuel burning and deforestation are choking our planet and putting billions of people at immediate risk”
- António Guterres, UN Secretary-General

The concept of the ‘greenhouse effect’ dates back to the work of Victorian scientists. In the 1960s and 70s many governmental and corporate organisations began detailed research on the greenhouse effect and its climatic implications. This research coalesced in 1988 with the formation of the Intergovernmental Panel on Climate Change (IPCC) and subsequently the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Today, climate science is vast and sophisticated discipline which has reached a remarkable and alarming consensus regarding our present course.

Climate change is the most significant, all-encompassing and pressing issue facing humanity today. Over the next few decades its impacts, already felt in many places, will accelerate, leaving no aspect of our societies, economies and lives untouched.

IMPACTS

“Increasing temperatures, rising sea-levels and modified rainfall patterns will change the climate-related risks to people and the built environment.”
- UK Climate Change Committee (CCC)

The many reports of the IPCC make clear the causal link between a warming climate and extreme weather events. A plethora of scientific literature now exists, documenting the ways in which climate change will destabilise the dependable climatic rhythms of the Holocene. We are moving into a situation where there is no ‘normal’, with the climate behaving in a less and less predictable way.

Overheating in buildings is becoming an increasing problem, especially given that our current building stock is designed for a different climate than the one we are moving into. According to the CCC there are currently around 2000 heat-related deaths per year. This figure is expected to increase by 250% by 2050.

The frequency of flood events in the UK is expected to increase. This is relevant to our context in particular with regards to the village of Shenton which is prone to flooding. Leicestershire County Council conducted an investigation into 2012 flooding of that village, concluding: *“The Sence Brook breached its banks in multiple locations within the village. The highway gullies and the ‘public sewer’ were not able to cope with the quantity of water running off the surrounding agricultural fields and in some areas natural flow paths conveyed the water down the highway and into the village.”*

The summer of 2022 has also illustrated our vulnerability to droughts and water scarcity which will likely also be an increasing issue to be addressed.

CLIMATE EMERGENCY DECLARATIONS + TARGETS

The severity of this situation was formally recognised by the UK Parliament in May 2019, when it became the first national legislature to declare a ‘climate emergency’. The UK has a legally binding target to achieve carbon neutrality by 2050. More recently (4th December 2020) a further announcement was made by the government in which the new plan aims for at least 68% reduction in greenhouse gas emissions by the end of the decade (2030), compared to 1990 levels.

Hinckley & Bosworth Borough Council also declared a climate emergency in July 2019, setting an ambitious target for the council to become carbon neutral by 2030 and the wider borough by 2050.

Within the construction sector we have also seen various initiatives emerge in response to this including Architects Declare. Launched by a coalition of high-profile practices in 2019, AD UK now has over 1200 signatory practices. As signatories to architects declare, Studio Bark seek to pursue the declaration pledges through our work. In addition, members of Studio Bark have been involved in the launching of the Architects Climate Action Network (ACAN).

TAKING STOCK

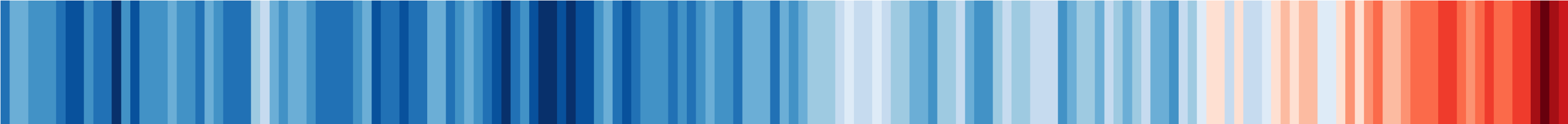
According to the UK Green Building Council the built environment accounts for around 42% of the UK’s carbon emissions. The impact of construction itself in terms of embodied carbon is reckoned to be around 10% of the total UK emissions. According to the Committee on Climate Change (the governments climate advisory group: *“substantial gaps and weaknesses remain in the Governments set of policies for decarbonisation of manufacturing and construction.”*

DESIGN RESPONSE

Throughout this issue the twin aspects of mitigation and adaptation are always present.

Our first priority needs to be mitigation, to stop adding to this problem and find a way to draw carbon down out of the atmosphere. In this spirit, we will be quantifying the carbon balance for the project, to ensure that construction impacts are offset through onsite afforestation and that the carbon balance of the scheme as a whole, over the medium and longer term is contributing positively to efforts to tackle the climate crisis.

In parallel to this we need to design in a way that acknowledges inevitable changes which are already in the pipeline. This includes looking at how buildings can adapt to hotter, less stable weather conditions and the stresses that this will put upon our infrastructure. For these reasons we are seeking to model the performance of this house under future climate scenarios and look at future-proofing strategies. The notion of resilience will also be embedded into our proposal through an off-grid strategy for energy and water, reducing stresses on existing infrastructure and resources and enabling the house to withstand future shocks and instabilities within those wider systems.



CLIMATE AND ECOLOGICAL EMERGENCY

The UK's climate is changing, and it is getting hotter, with predictions from 2019 that London's climate will feel like Barcelona. This has been shown in stark ways over recent summers, with temperature records and droughts.

Climate change

London's climate will feel like Barcelona by 2050, study says

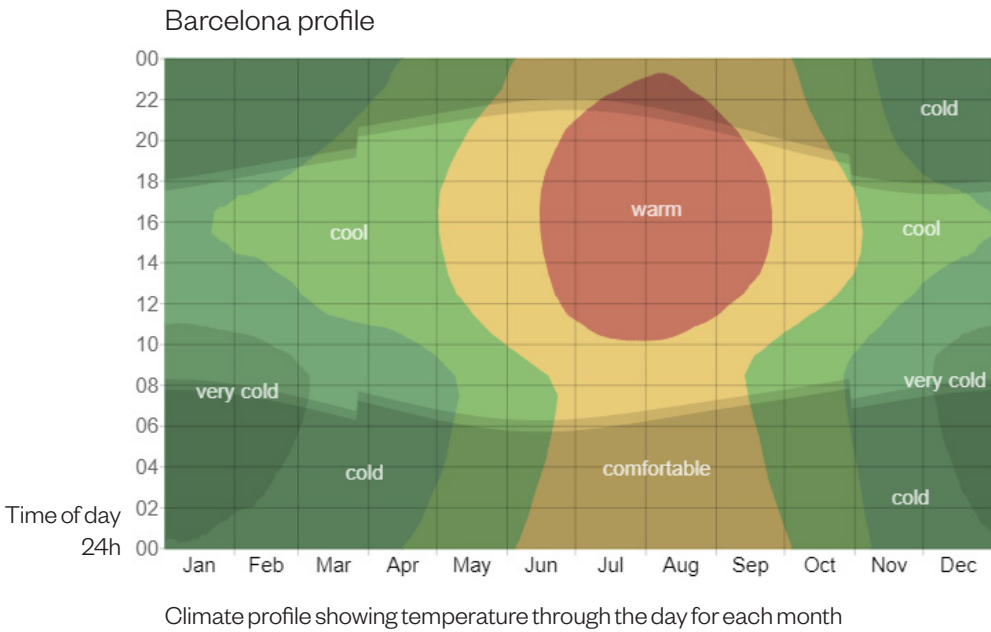
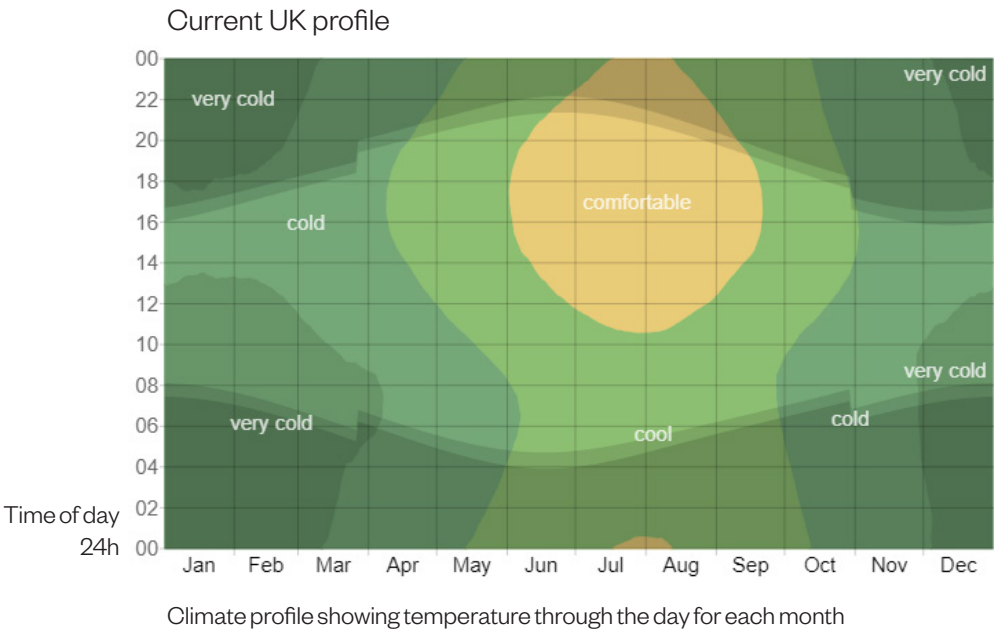
Cities in Northern latitudes forecast seeing biggest shifts in extreme temperatures

Leslie Hook JULY 10 2019

Heatwave: Fires blaze after UK passes 40C for first time

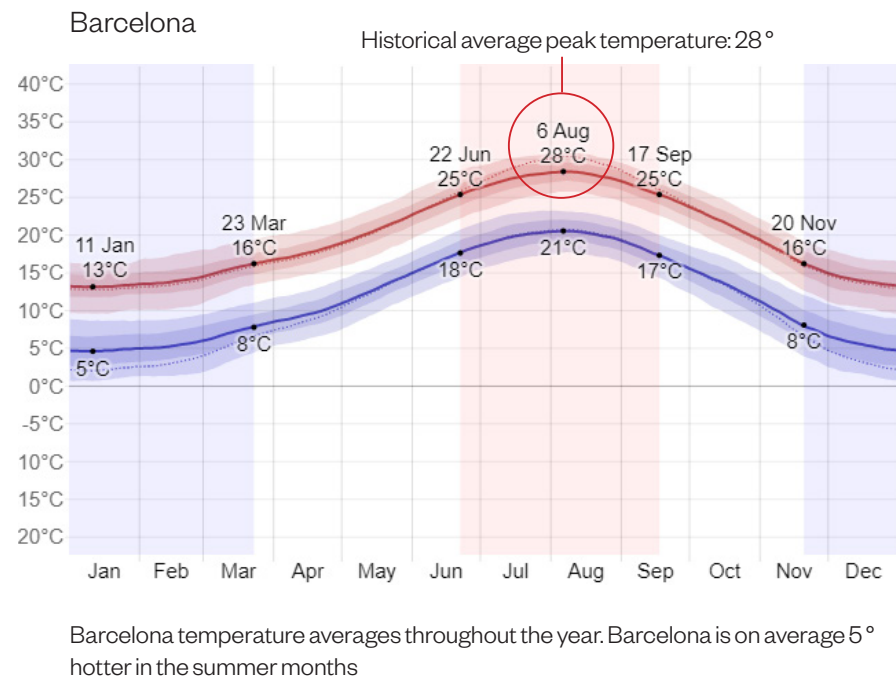
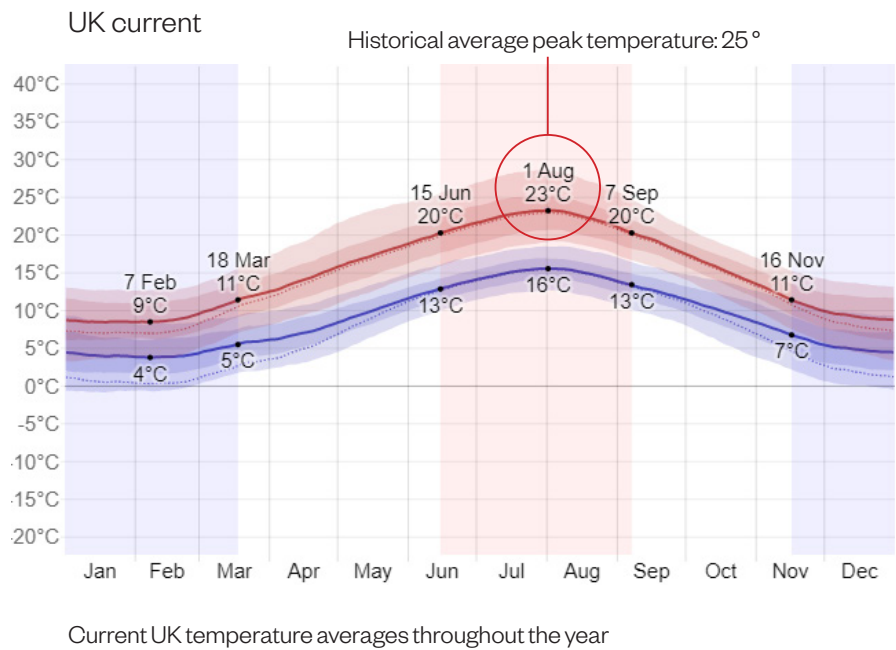
By Jasmine Andersson & Doug Faulkner
BBC News

19 July · Comments



CLIMATE RESILIENT HOUSING

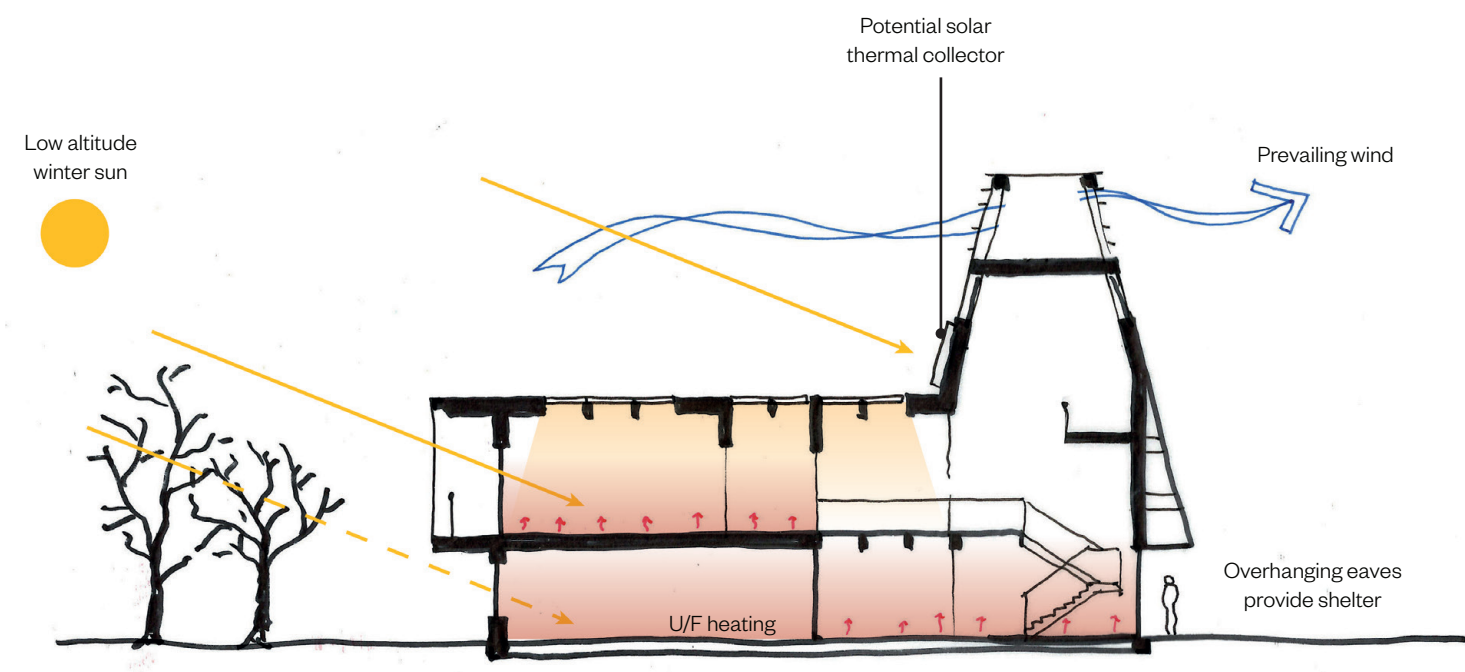
It is now more important than ever to design low embodied and operational carbon designs that are resilient to a changing UK climate. We can look to hotter countries to better understand how to design for this. At present our new buildings are being designed for a historic climate which is rapidly changing. Part of the agenda with this project, and part of what we believe makes a building 'outstanding' is to meaningfully respond to both global and local context. In this sense the house will seek to grapple with the question of how UK homes can respond to the increasing risk of overheating without resorting to active air conditioning, which brings its own problems in terms of embodied carbon, energy consumption and moving heat around.



2. Environmental Design

OVERVIEW + PURPOSE

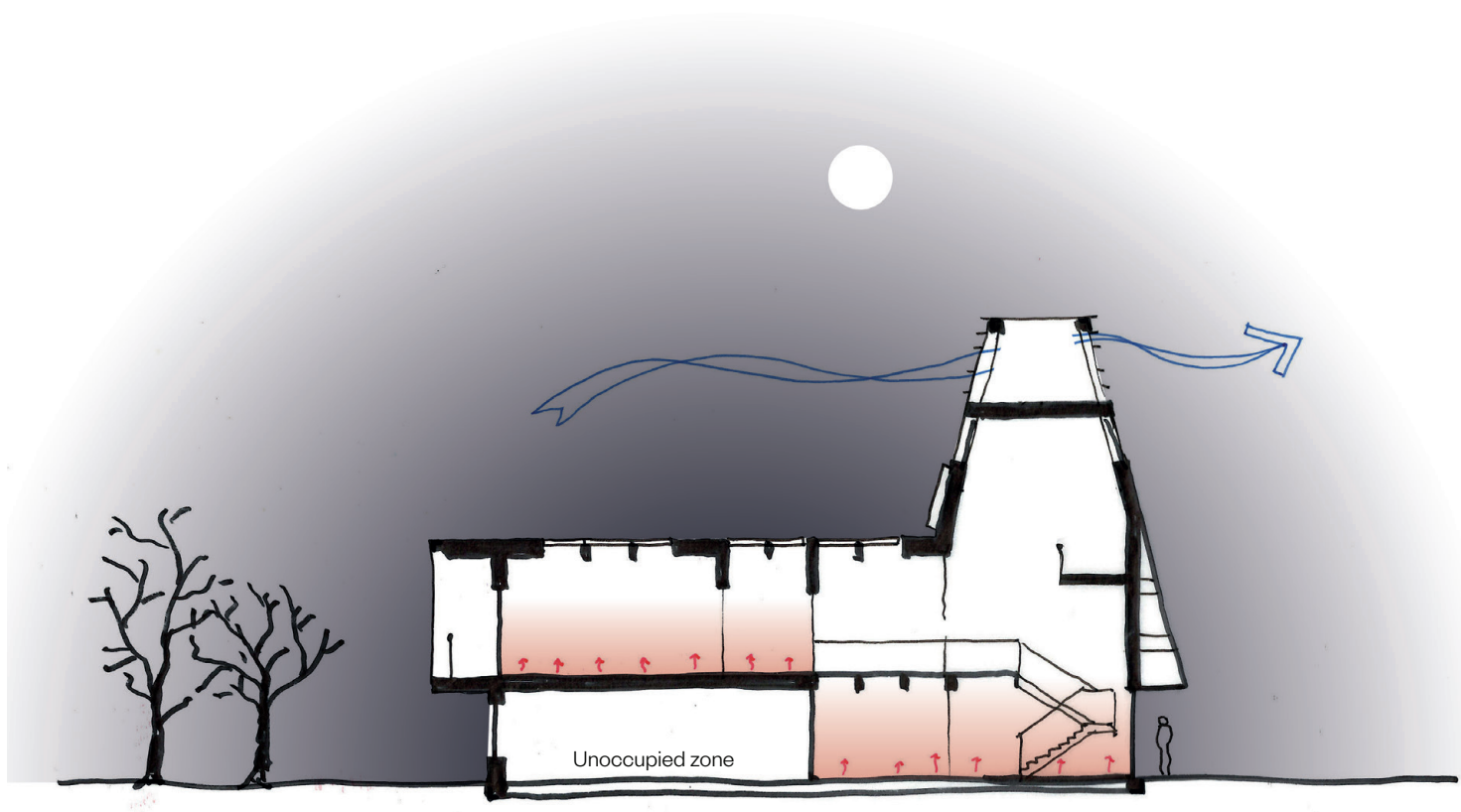
The purpose of developing environmental strategies is to ensure good comfort levels for occupants, while keeping energy use/demand to a minimum. The strategies illustrated in the sections below, are based on a fabric first approach while seeking to maximise opportunities offered by the environmental and climatic context. Seasonal and diurnal strategies have played a key role in shaping the form, orientation and architectural design of the proposal.



WINTER DAY

The form is arranged to enable low altitude winter sun to ingress, enabling the building to benefit from passive solar gains and reducing heat load. As a general principle, larger areas of glazing are found on the southern elevations while glazing on the north is used more sparingly. Underfloor heating runs at a lower operational temperature than conventional central heating and has a psychological benefit. In addition, given the large volumes of the interior space, this approach focusses on heating the zone which is occupied by humans. The heating system can run from a heat pump enabling the heating strategy to be low carbon and work with the off-grid philosophy of the project.

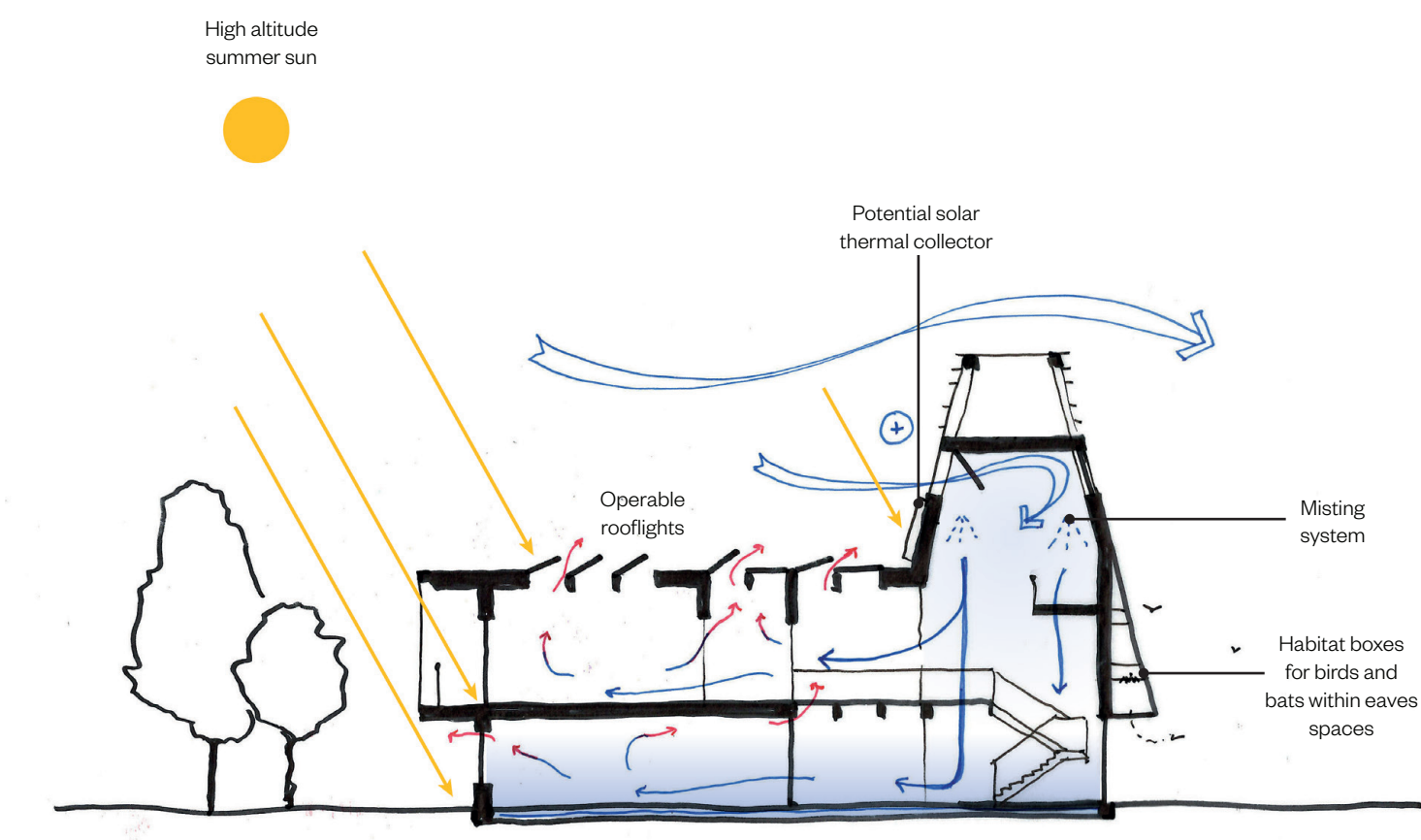
Rooflights ensure good levels of daylighting to interior spaces even on overcast winter days. Overhanging eaves provide shelter from the elements to exterior spaces immediately adjacent to the building.



WINTER NIGHT

At night, heating can be cut to the zones which are not occupied, further reducing the energy spend via timers or a management system. An MVHR system will operate in the winter months to reduce ventilation heat losses.

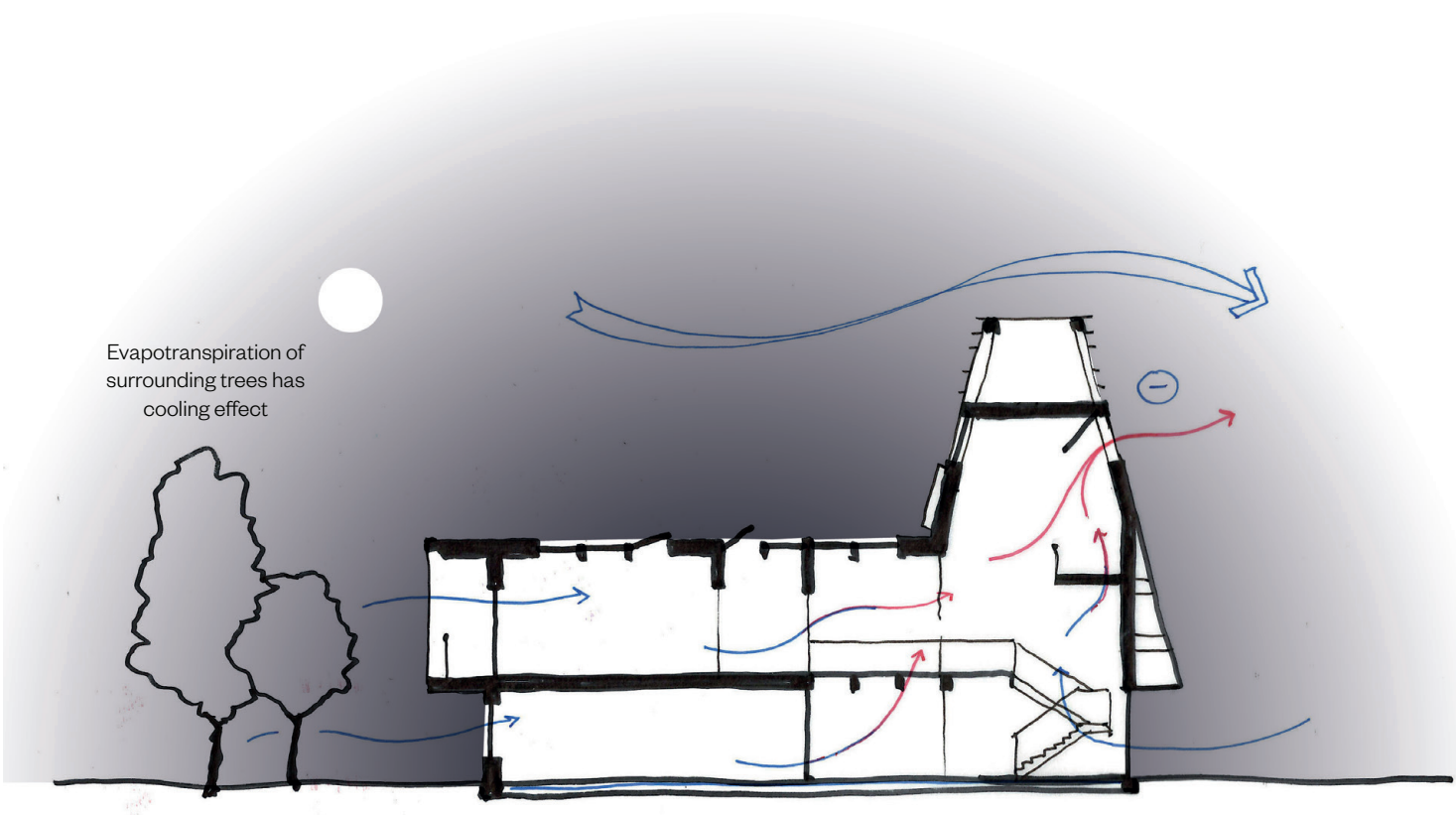
In the winter months there will be a lot less energy generated by PV panels but the micro hydro should be more constant or possibly ramp up in the winter.



SUMMER DAY

As described earlier in this document, increasingly hot summers and the potential for overheating are increasing a concern in the UK in the context of climate change. The strategy for hot summer days is based around the use of PDEC (passive downdraught evaporative cooling) which has been explored through dynamic thermal modelling. The tower element acts as a ‘wind scoop’. This means that whichever orientation is facing into the wind can open in order to benefit from positive wind-pressure. On still days, there will be a ‘suction effect’ created as the cooling air within the tower drops into the lower areas of the building, drawing air from outside into the top of the tower.

Other measures include large overhanging eaves and the master bedroom balcony which shade windows from high altitude summer sun and help to guard against excessive solar ingress. Integral blinds within rooflights or high-level shutters help to perform a similar function for rooflights.



SUMMER NIGHT

Temperatures typically drop at night - known as the ‘diurnal temperature swing’. At night cool air can be brought into the building at lower levels, rising through the building via buoyancy-driven or ‘stack’ effect and cooling the building down in the process. ‘Spent’ hot air exits via an outlet near the top of the tower. The orientation of the outlet can vary according to wind direction, and when open on the leeward side will enable airflow to benefit from negative pressure created by the prevailing wind. This night purge strategy would work particularly well with heavy thermal mass, ie stone or concrete floors.

Cold water can also be run through the underfloor pipe system both day and night to provide further cooling effects.

HONEYBEE MODELLING

Dynamic thermal modelling was undertaken by Morphi, using ‘Honeybee’. This toolset runs on the Grasshopper platform within Rhino. The toolset links to other environmental softwares such as Therm, EnergyPlus and Open Studio, in order to run energy simulations. As such the software is an ecosystem of functionality calling upon open-source industry standard protocols and formats. The diagram on this page maps the interrelation between ladybug, butterfly and honeybee (which run within rhino/ grasshopper) and external softwares which these toolsets call upon in order to run specific calculations.

Energy modelling was undertaken in order to make performance predications regarding the thermal behaviour of the building in its given climatic context and in relation to different scenarios. In this instance we have used this process to test the potential application of passive downdraught evaporative cooling (PDEC) within our proposal - specifically to look at whether this could be an effective way to ensure internal thermal comfort on very hot days, both now and in the context of the hotter climate of the future.

PASSIVE DOWNDRAUGHT EVAPORATIVE COOLING

PDEC is a type of passive cooling often used in hotter climates. It exploits the difference between the ‘dry bulb temperature’ shown by thermometers, and the wet bulb temperature (ie the lowest temperature to which air can be cooled by the evaporation of water into the air at a constant pressure). Using misting systems at the top of a tower or stack element it is possible to create a downdraught flow of cool air flowing into the occupied spaces below.

ASSUMPTIONS + SET-UP

The results of thermal modelling are impacted by the kinds of baseline assumptions used in the model including occupancy and usage patterns. In this case some of the key parameters are listed here. The purpose of this study is primarily ‘relative’, ie assessing the impact on thermal comfort of a particular strategy versus a baseline case without. Set-up parameters become more significant in a sense if you are attempting to reach some kind of absolute determination, for example, to predict the annual space heating demand of a building.

- Fabric parameters were based on LETI recommended U-Values and target airtightness etc.
- The evaporative cooling tower is modelled to activate at 20°C on the days when required.
- The glazing is modelled to open at 24°C
- The peak hottest day in the Birmingham weather file was used as the test case: 22 July

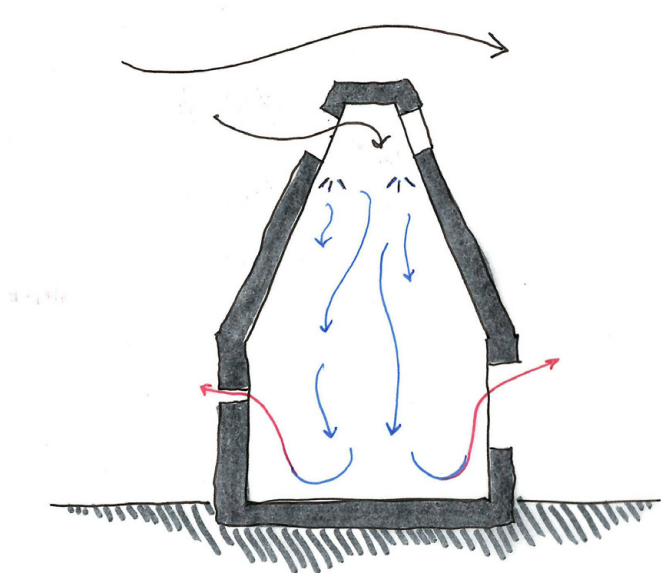
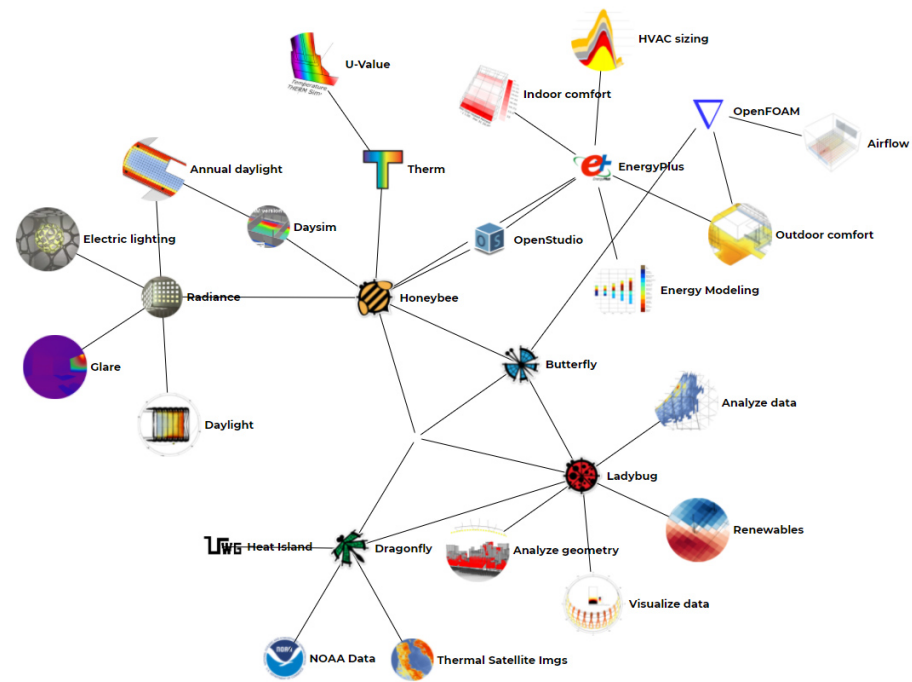
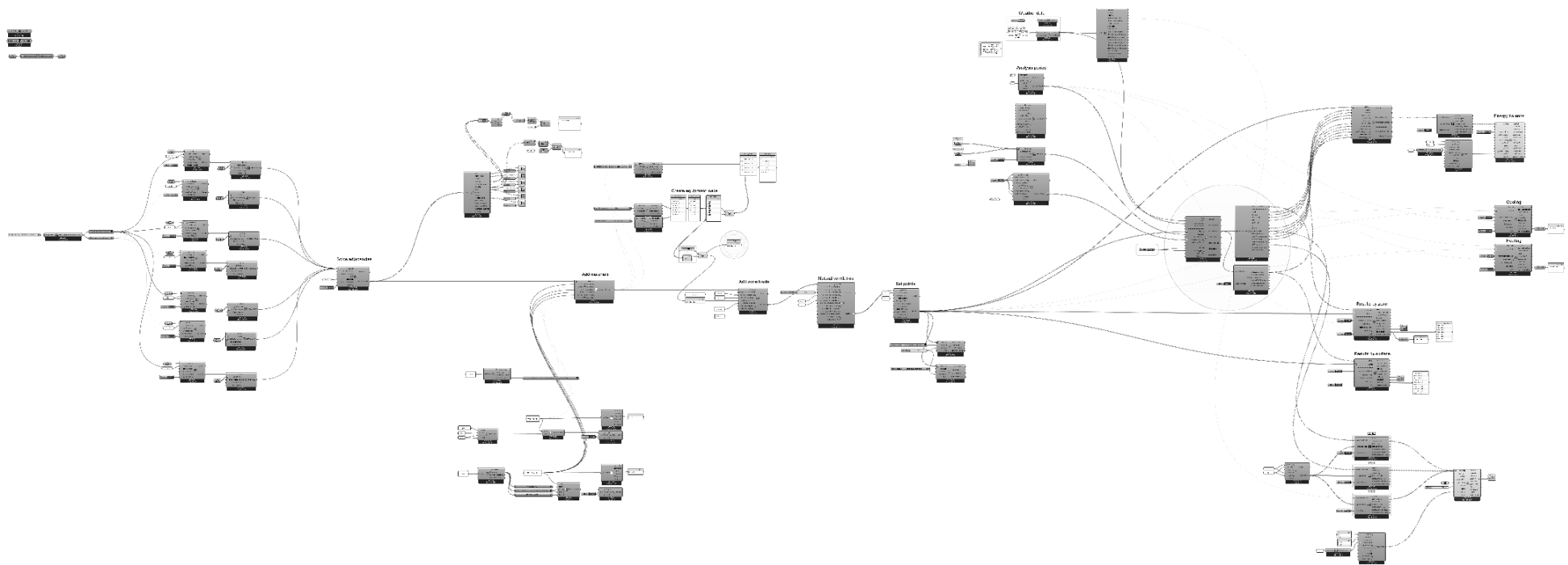


Diagram showing the principle of Passive Downdraught Evaporative Cooling (PDEC)



Relationship between platform (rhino/grasshopper), honeybee (plug-in) and other external softwares and protocols.



Example of honeybee grasshopper definition

RESULTS + DISCUSSION

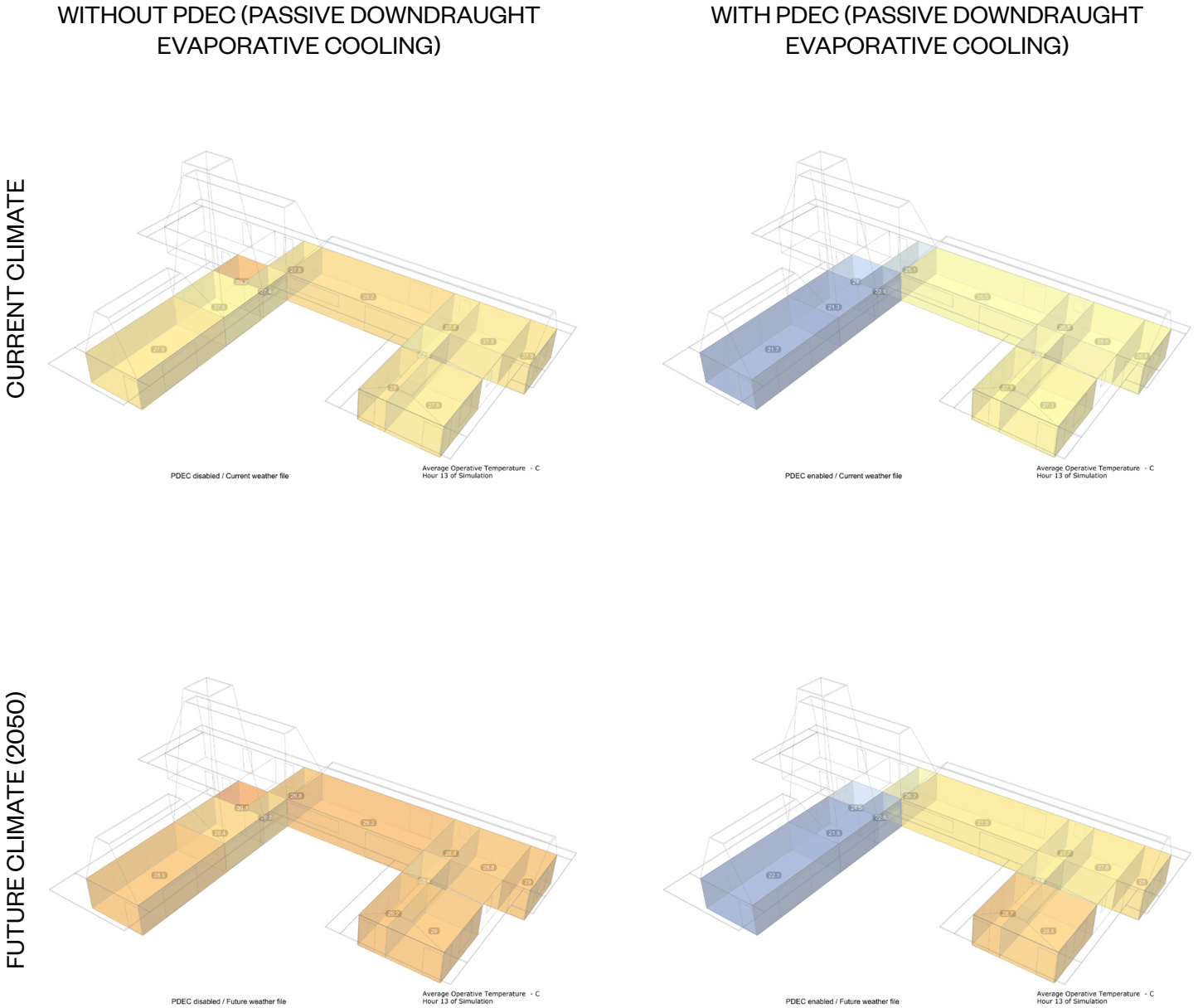
Overall the results of the study are very promising and indicate that evaporative cooling could be a highly effective approach to maintaining thermal comfort on very hot days.

Results from this modelling show that, evaporative cooling can keep interior temperatures within human comfort ranges, under both current and future climatic scenarios. For example at midday on the hottest day in the images show under current climate scenario, the games room interior temperature would be around 28C - above normal human comfort ranges. Evaporative cooling could lower this by up to 6 degrees down to around 22C which is well within target ranges.

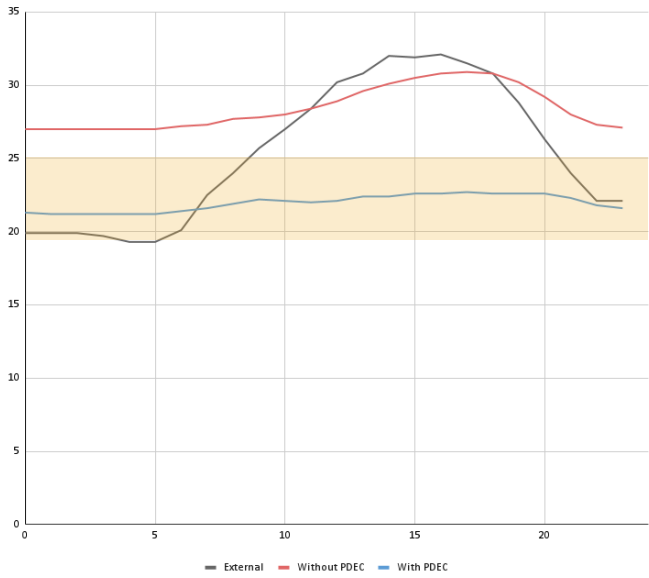
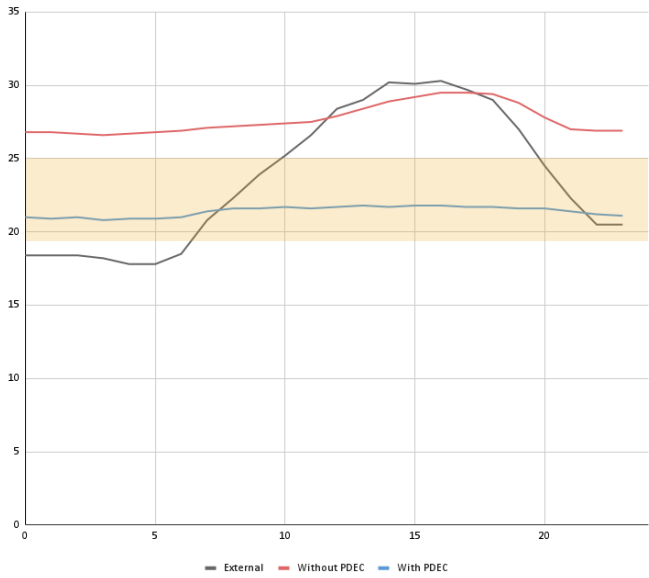
One observation from the study is that the cooling effect is most impactful upon the zones immediately around the tower. Zones further from the tower are less impacted and some of these still reach uncomfortably hot temperatures. The findings of this study have fed into the further development and refinement of the design: the tower is now situated as a central connecting element with good adjacencies to main living spaces. This should ensure that all connecting spaces experience the benefits of cooling and ventilation when needed.

The current model allows for a tower height of 6m. The tower should be at least 5m (anything less impacts the performance) and anything beyond 10m does not have an impact in the performance.

For full results of thermal simulation see appendix A.

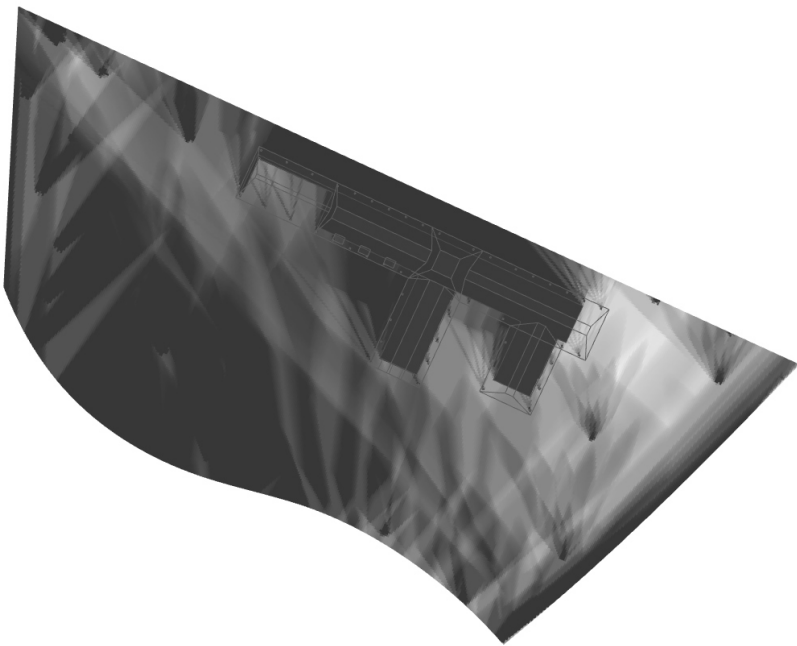
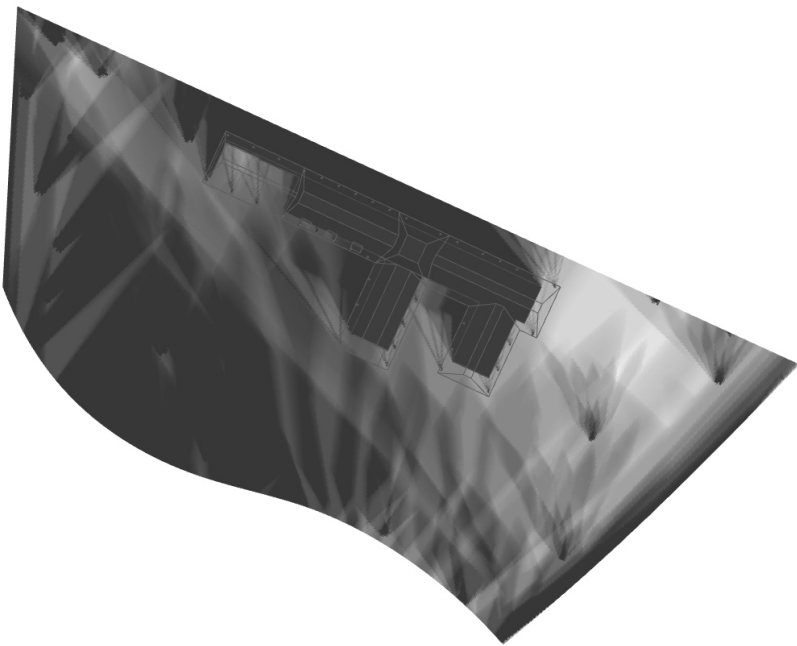
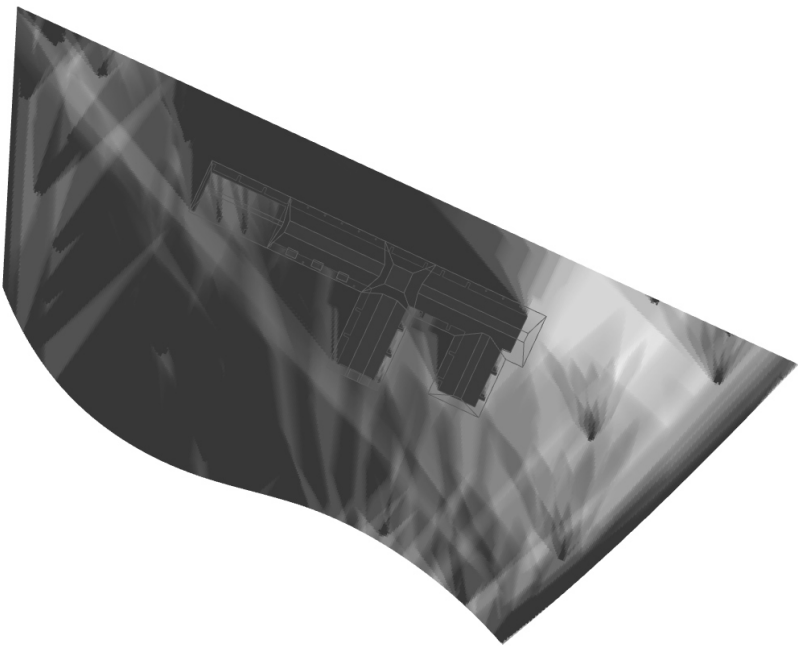


Results from thermal simulation showing resultant zone temperatures at midday on the hottest day under current and future climate scenarios, assessing the resulting impact of PDEC strategy upon internal temperatures.

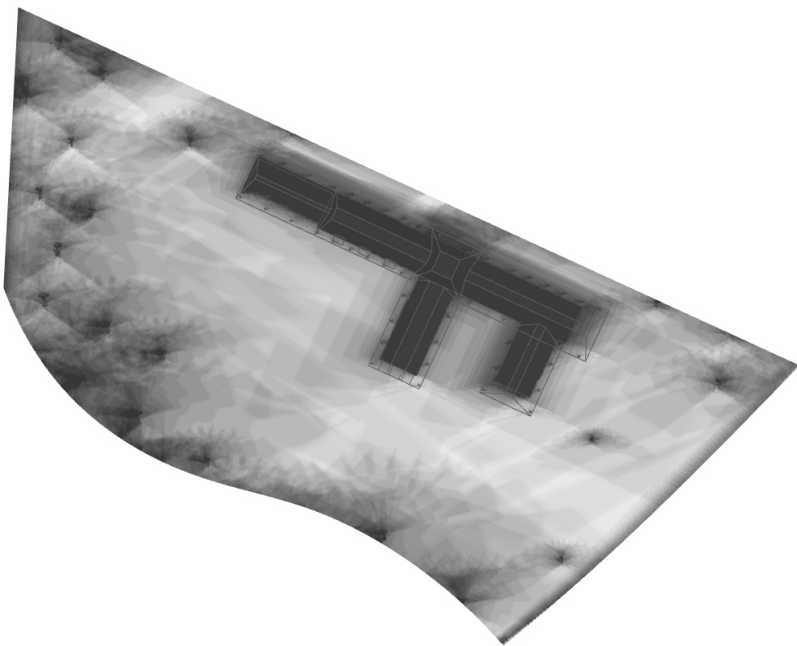
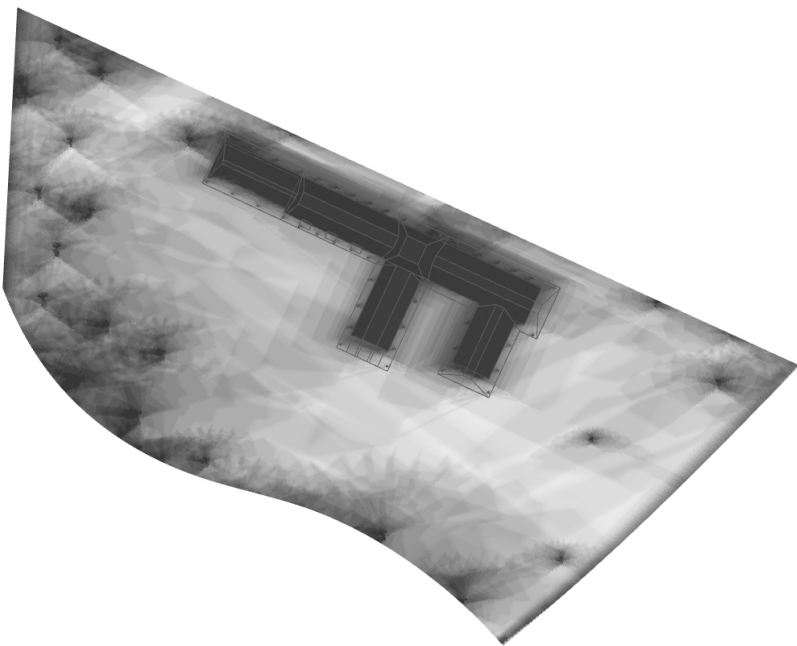
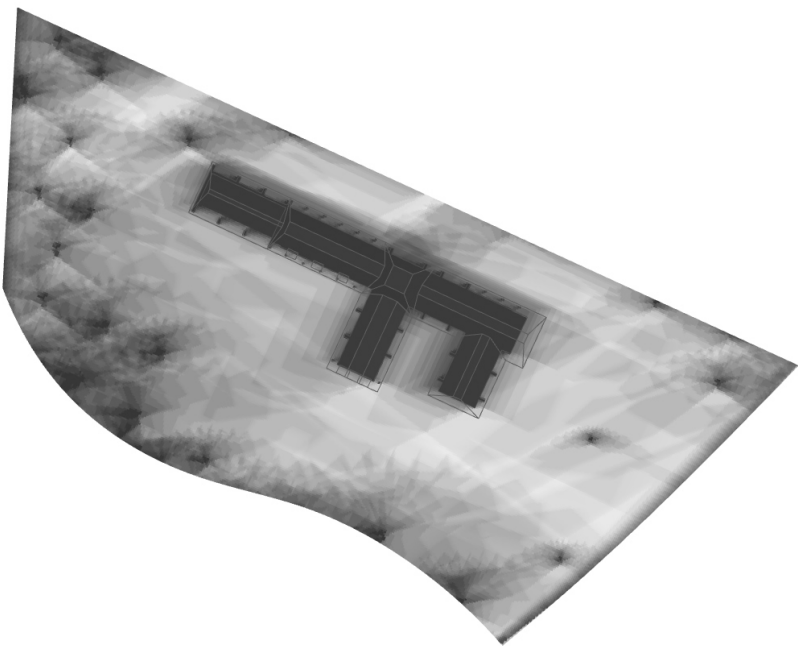


Graphs for current and future climate scenarios showing external temperature, and internal temperature for games room (1) without PDEC (red) and (2) with PDEC (blue). Human thermal comfort range shown in light yellow band.

WINTER SOLSTICE



SUMMER SOLSTICE



A - STAGE 2 PRE-PLANNING DESIGN

Above configuration shows the massing configuration from stage 2. Generally in winter, the copse provides quite a bit of shading on the site, though the portion of garden to the east of the house receives most direct light. The house creates a fair amount of self shading, but the more shaded parts are the carport and bedroom wing, with the primary living spaces receiving more sunlight in winter.

B - PUSHED NORTHWARDS

The two images above show the impact of pushing the building slight further north away from the shadow of the copse. This allows the building to benefit from greater solar gain in the winter.

C - ENLARGED COURTYARD (FINAL DESIGN)

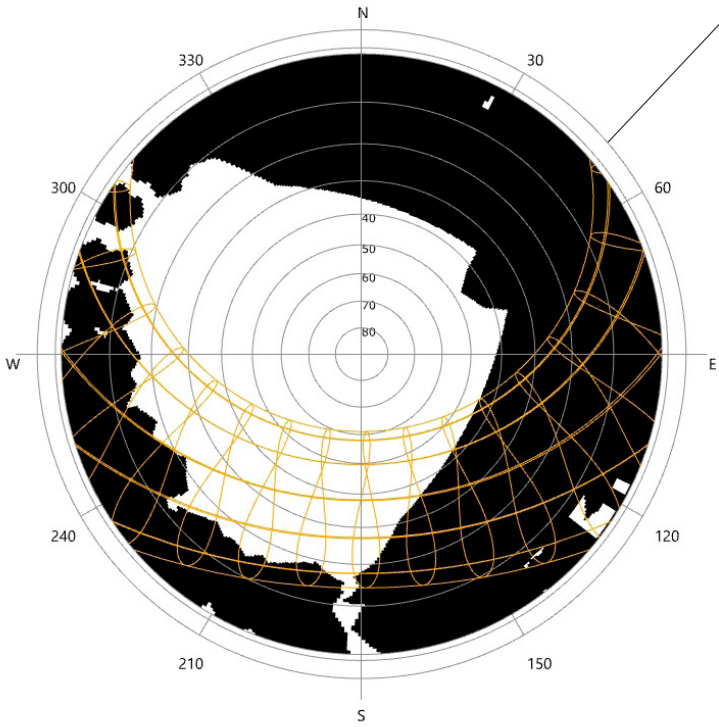
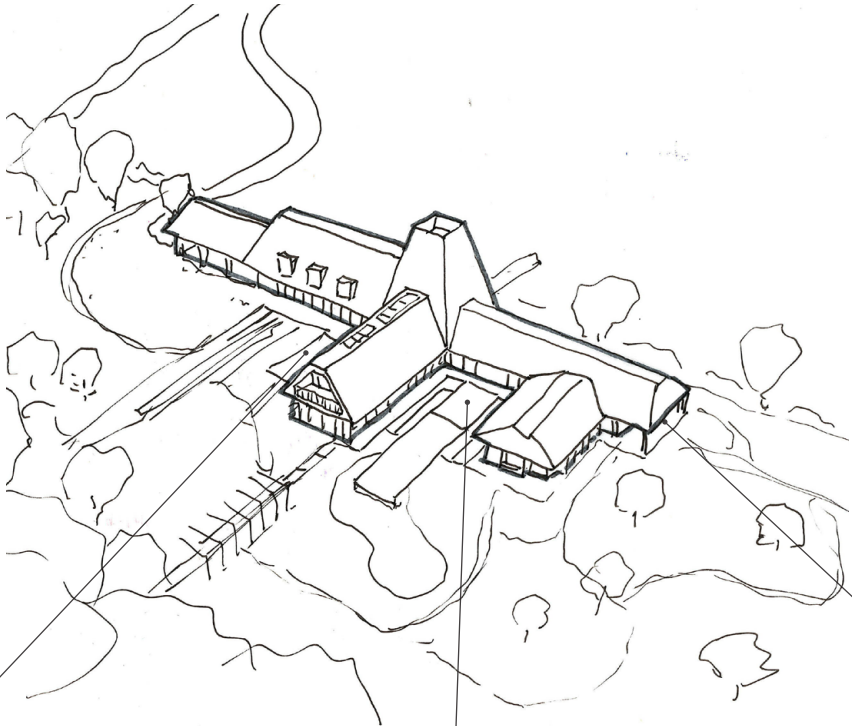
A slightly enlarged courtyard allows this exterior space to receive more sunlight in the winter period. In summer the courtyard offers a moderate amount of shade which will change throughout the diurnal cycle.



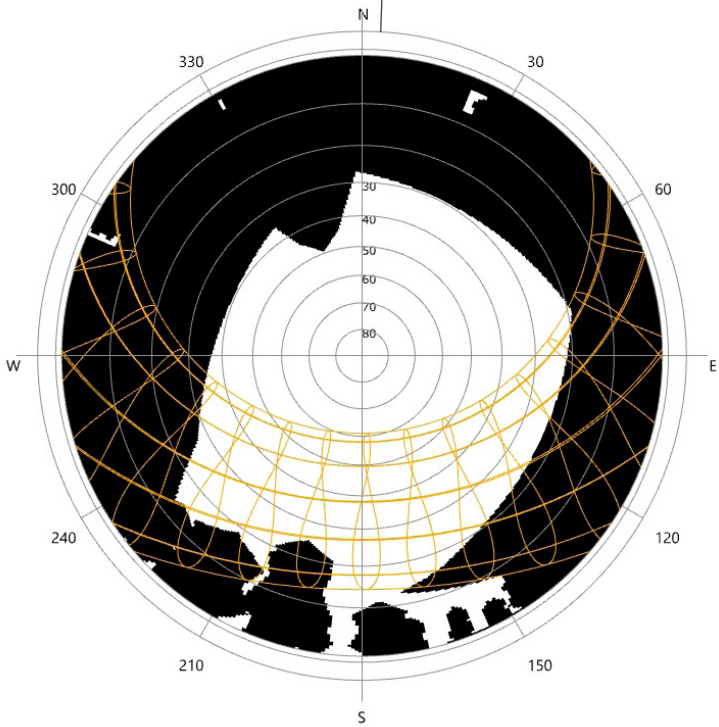
SUNPATH ANALYSIS

Sunpath analysis has been used to interrogate comfort of key exterior spaces, comprised of three main external terrace areas. The study looks at which times of day/month you would get direct sun in these locations (at a height of 1m). The sunpath plots the solar azimuth and altitude of the sun across the span of a year. A shadow mask is overlaid on this illustrating how buildings and trees will cast shade.

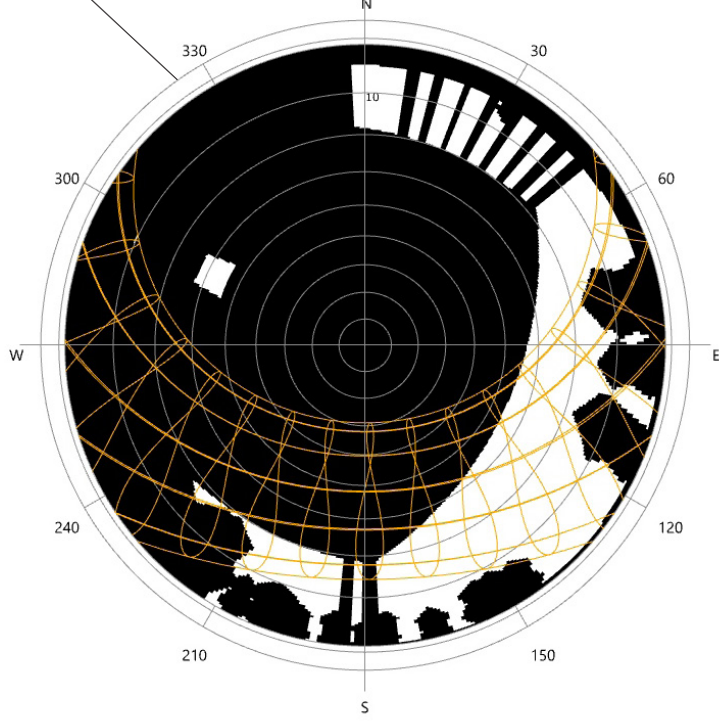
Consideration needs to be given to the use patterns of occupants; for example these exterior spaces are more likely to be used spring-early autumn. Analysis illustrates the three key spaces receive sun pretty reliably at three times of day, either morning, midday or evening throughout the year - of course subject to conditions (which may often be overcast in this climate). The approach here has been to provide a range of conditions, so occupants can migrate around the building and find the place which is most comfortable for a given time of day/year and in respect of prevailing conditions. In addition to the studied spaces, there are a range of other external environments in the domestic garden, wider landscape, or for example the tower look-out.



Entrance terrace - afternoon / evening sun



Courtyard - late morning - mid afternoon sun



Breakfast terrace - morning sun

SOLAR INSOLATION STUDY

A solar insolation study examines the quantity of solar radiation falling on a surface for a given time period based on location and context. For this study we have looked at a 3 month winter period (broadly the heating season) and a 3 month summer period (cooling season). The two time periods have opposite needs in terms of energy efficiency and maintenance of user comfort. In winter a high degree of solar gain via windows is desirable as it contributes to passive heating of the building, reducing operational energy demand. In summer the opposite is the case; generally it is preferable to exude solar gain from ingressing into the building in order to keep internal conditions cool and comfortable and reduce any residual cooling demand.

WINTER CASE

The higher solar gain areas (indicated by warmer colours) illustrate optimal places for larger areas of glazing in order to harvest solar gain.

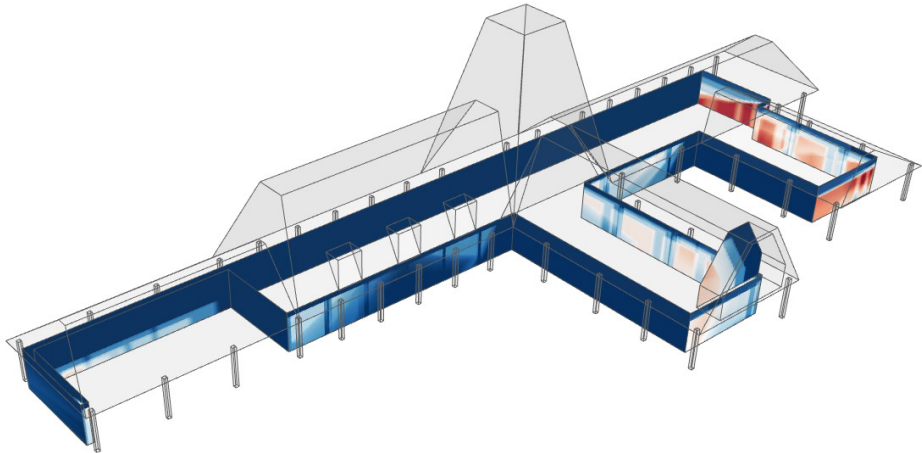
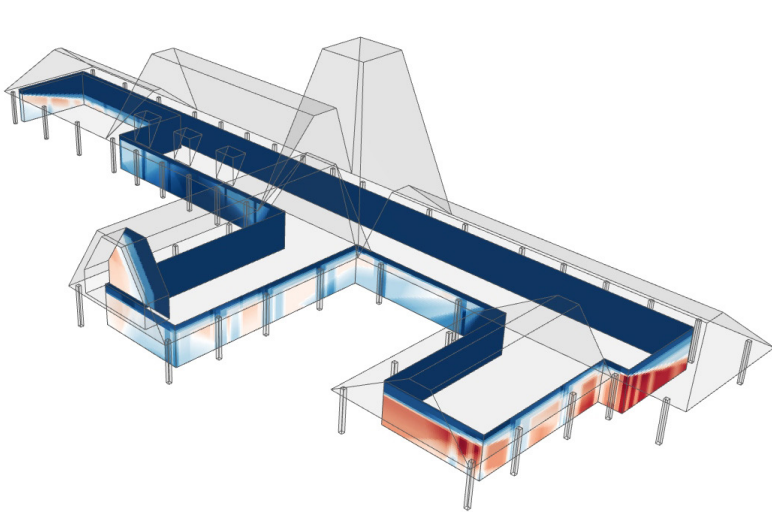
SUMMER CASE

The lower solar gain areas (indicated by colder colours) illustrate optimal places for glazing which can allow good daylighting and connection with the outdoors while avoiding excessive solar gain.

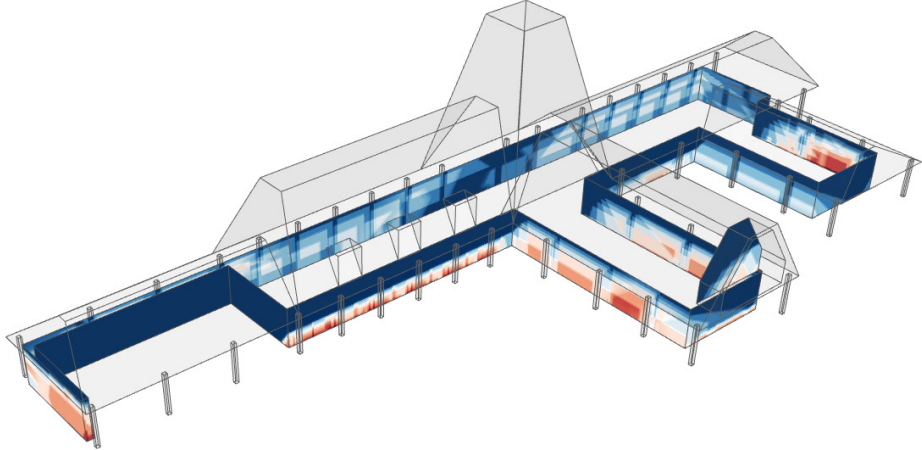
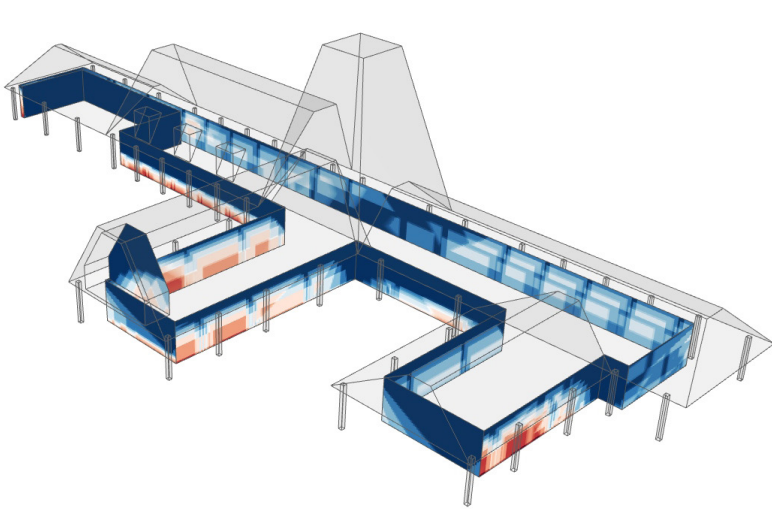
CONCLUSION

This study has formed part of an integrated design process, which as sought to synthesise many considerations into a unified design proposal. The study has been an important factor in the configuration and placement of glazing - while this has also needed to respond to a range of other factors such as the functional and amenity needs of spaces. Undertaking of these quantified studies in tandem with integration of a range of best practice principles has enabled refinement of the design in ways which move us towards greater energy efficiency, building performance and occupant comfort.

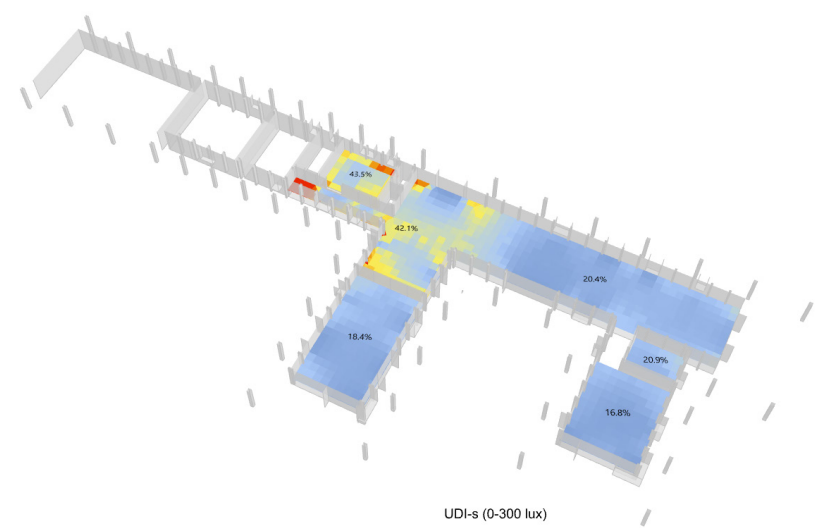
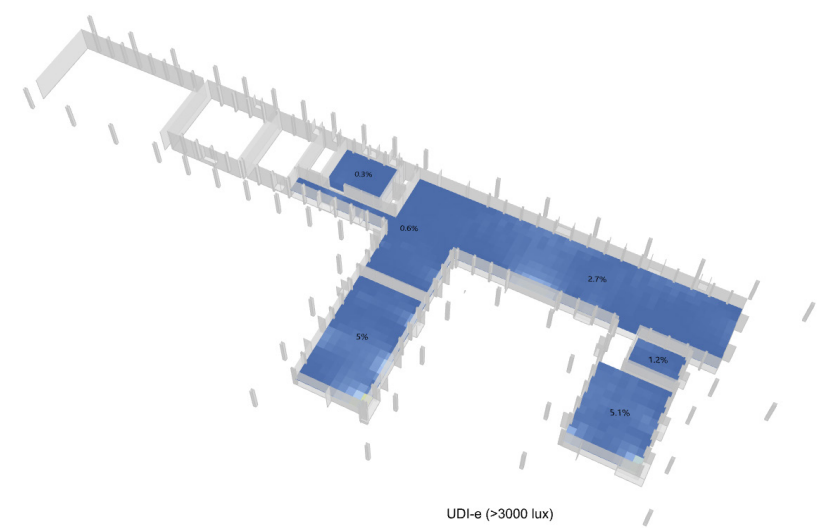
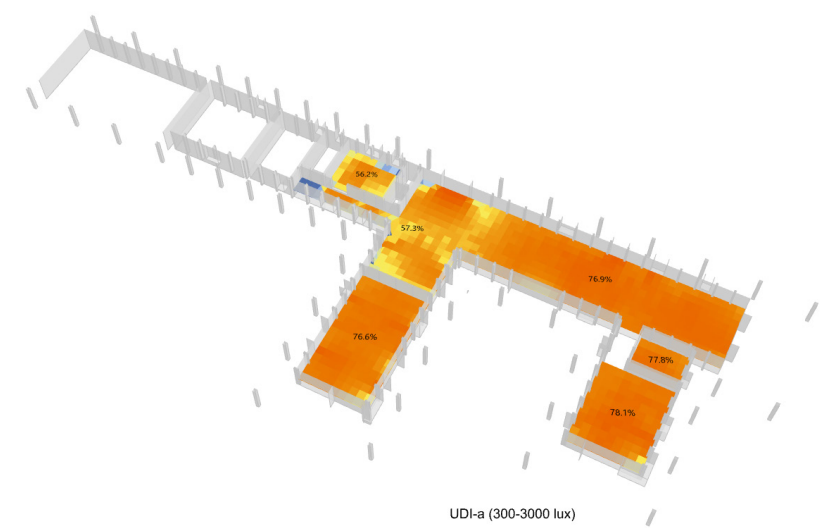
WINTER SOLSTICE:



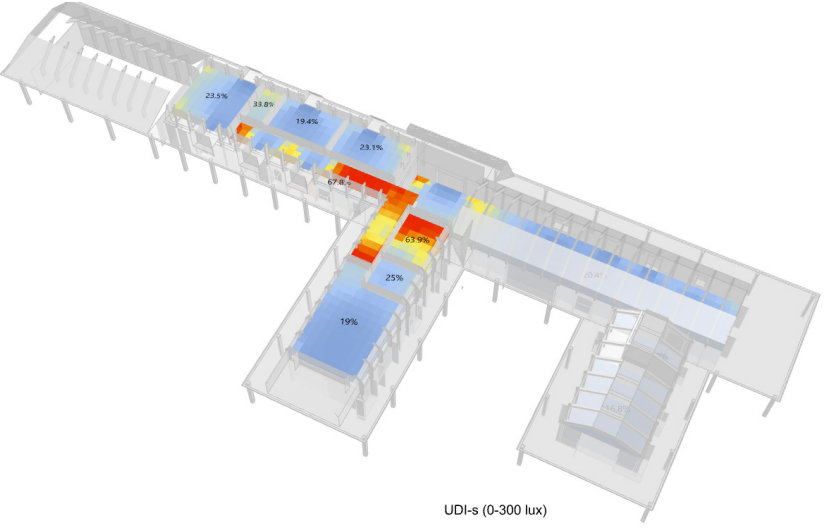
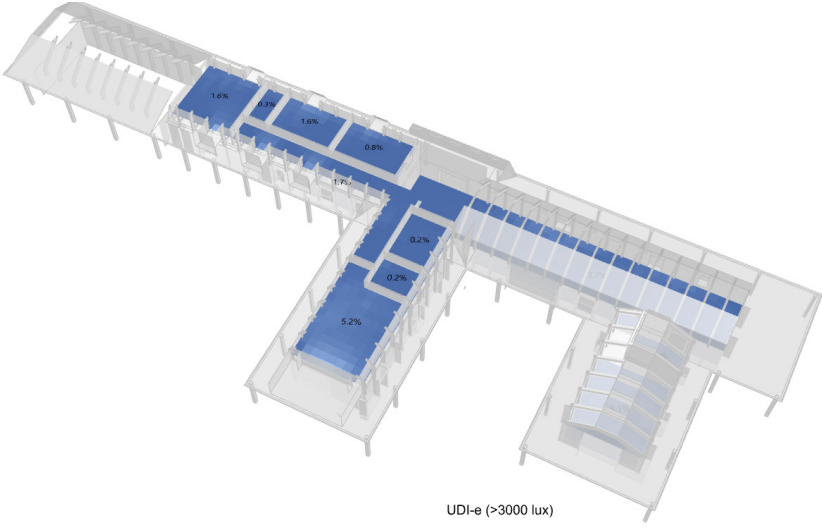
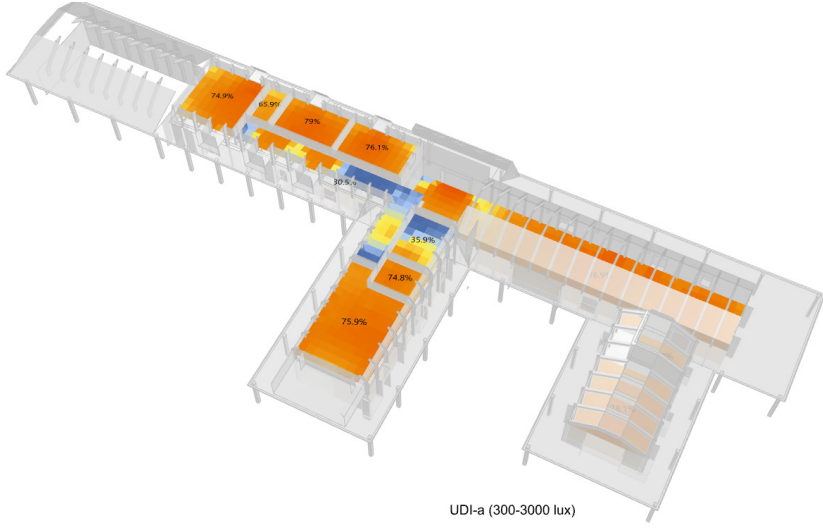
SUMMER SOLSTICE:



GROUND FLOOR



FIRST FLOOR



UDI - A

Daylight analysis was undertaken in order to assess the daylight performance of the house and ensure good natural lighting of interior spaces.

A UDI-a value of around 80% should generally ensure good natural daylighting. In our case there are some circulation and ancillary spaces which are a bit below this but the primary spaces perform adequately.

UDI - E

UDI-e looks at the risk of glare and spaces being over-lit. The results suggest that there isn't a risk.

UDI - S

UDI-s indicates under-lit areas. In this case some of the circulation spaces are potentially under-lit. However this is also part of the 'spatial drama' of the proposal, moving from darker areas to more well-lit main spaces. Ancillary and circulation spaces are not areas in which occupants will dwell for significant periods of time.

3. Operational Energy + MEP

RENEWABLE ENERGY + SERVICES

An energy and services strategy has been developed for the proposal in tandem with specialist engineers. Energy is generated via PV panels and a micro hydro turbine (see appendix E for micro hydro generation calculation). A battery and inverter/demand management system will provide storage for day to day needs.

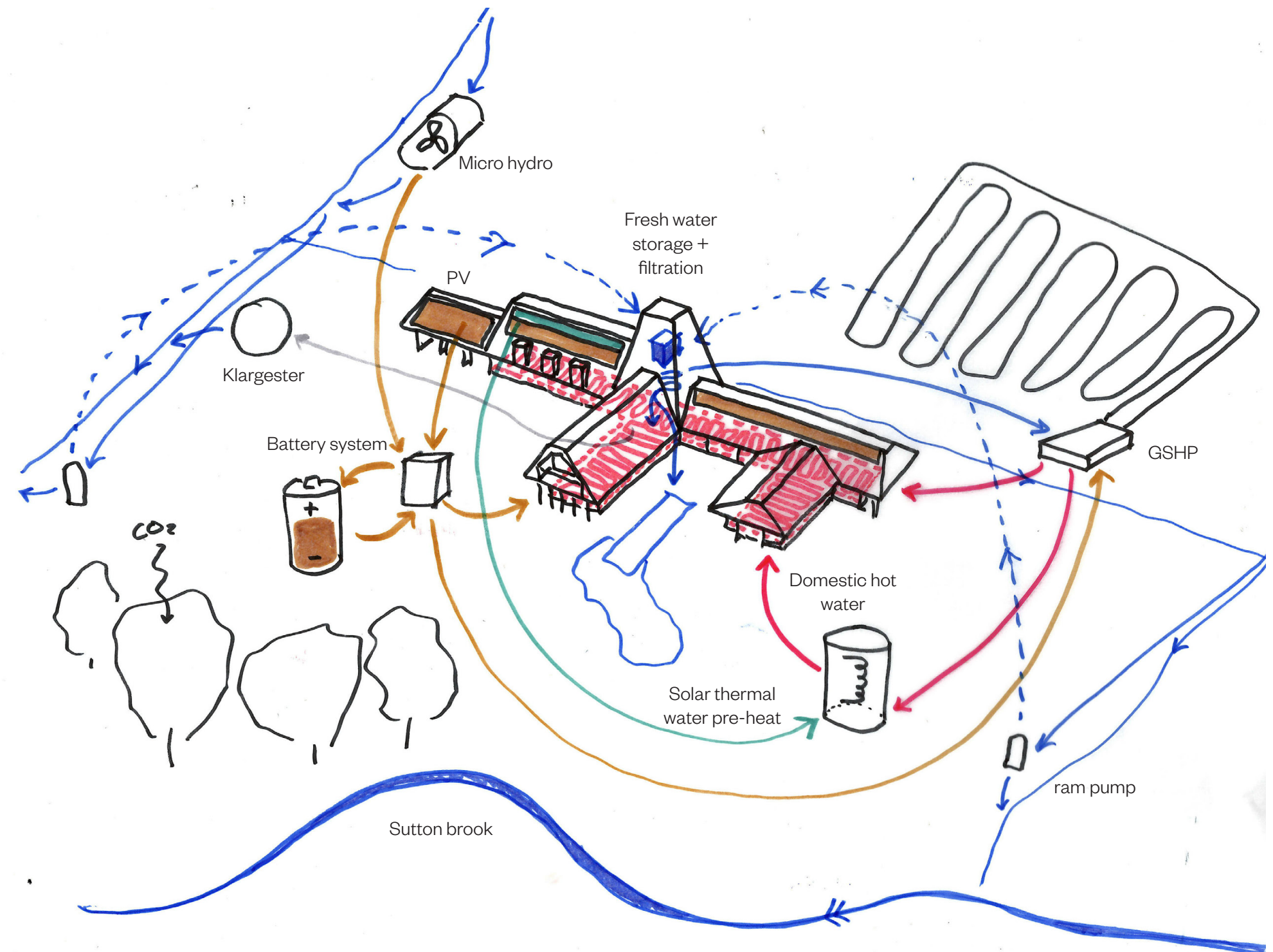
Space heating is provided primarily via a ground source heat pump and underfloor heating. Wood burners provide top-up space heating in the depths of mid winter. Ground source heat pump is used, making use of the relatively stable ground temperature, as a highly efficient heating and cooling system.

Heat is distributed via underfloor heating that requires a lower operating temperature than typical radiators, owing to a larger surface area. This also means comfort levels can be achieved at lower temperatures. This system can also be used for room cooling in the summer using the same principles in reverse.

Mechanical ventilation with heat recovery (MVHR) reduces heat loss through ventilation and improves indoor air quality. This is used in the winter as a more energy efficient alternative to natural ventilation.

Water is extracted from surrounding ditches using a modern version of a water ram pump. This water is stored at height in the tower and filtered for domestic use. Domestic hot water is created through a blend of contributions involving solar thermal panels. Excess freshwater is fed into the landscape water features before finding its way back to the water course.

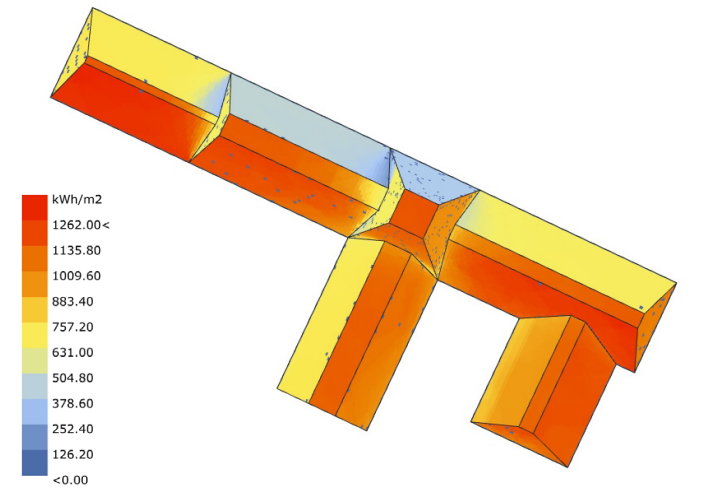
Waste water from the house is filtered using a klargester biodisc system.



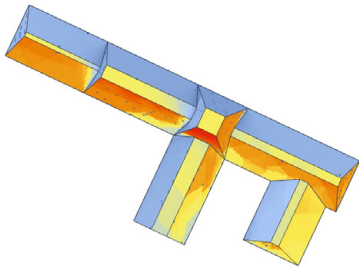
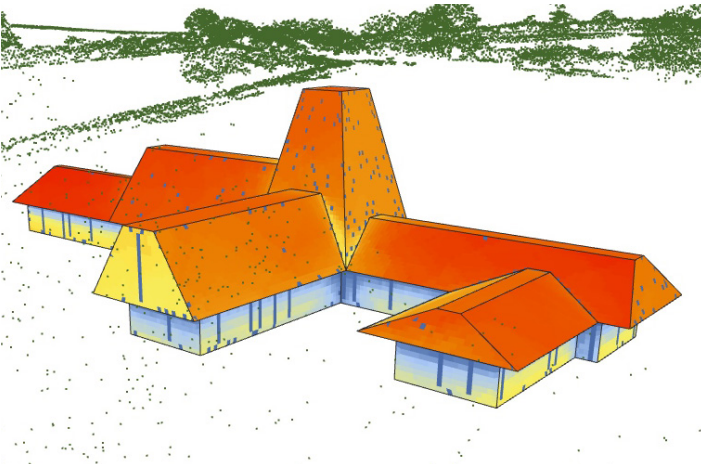
ASSESSING PV POTENTIAL

This solar insolation radiation study was carried out using honeybee in order to assess the potential for harvesting solar energy from different surfaces of the building. The images to the right show a cumulative total for each month while the two images below show the combine total radiation falling on each surface in one year.

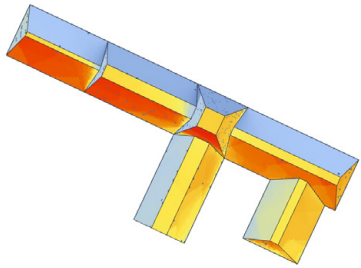
From this study it appears that the south facing roof areas of the garage and bedroom wing could be quite optimal. The south facing face of the tower also receives a high incidence of solar radiation.



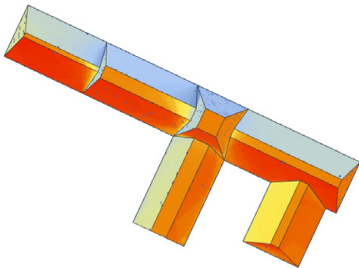
Annual combined



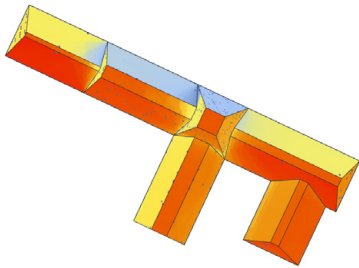
Jan



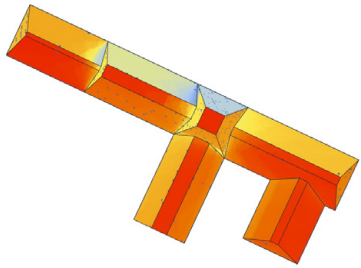
Feb



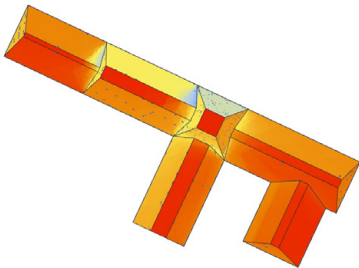
Mar



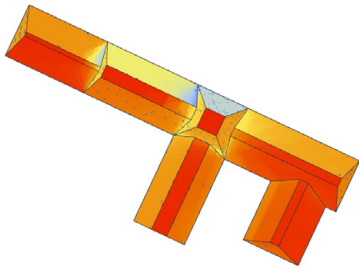
Apr



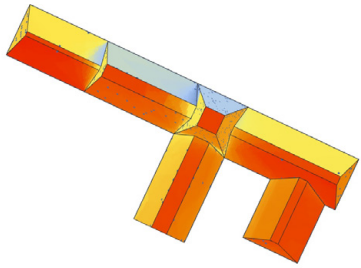
May



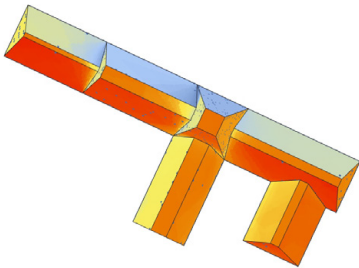
Jun



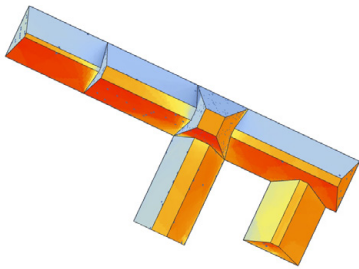
Jul



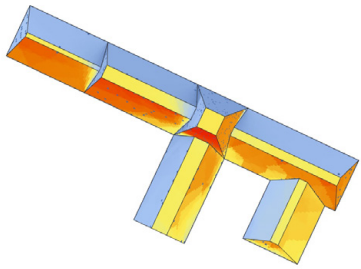
Aug



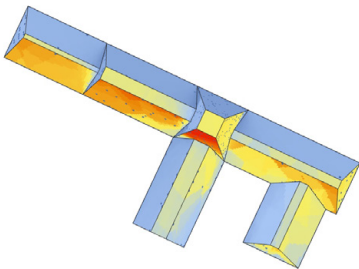
Sep



Oct



Nov



Dec

ENERGY EFFICIENCY - DEMAND

Environmental engineers Max Fordham have been engaged to undertake a detailed energy study for Breach House. Please refer to their report which accompanies this application for a full description of energy performance.

The architectural design process has been guided by the principles of a 'fabric first approach'. Max Fordham's report details the fabric performance criteria for the proposal.

Overall energy demand has also been calculated across a typical year in order to understand the energy needs of the building. The proposal meets the industry best practice targets for low energy building defined by LETI (Low Energy Transformation Initiative). Calculations predict the building will consume approximately 15 MWh of energy per year.

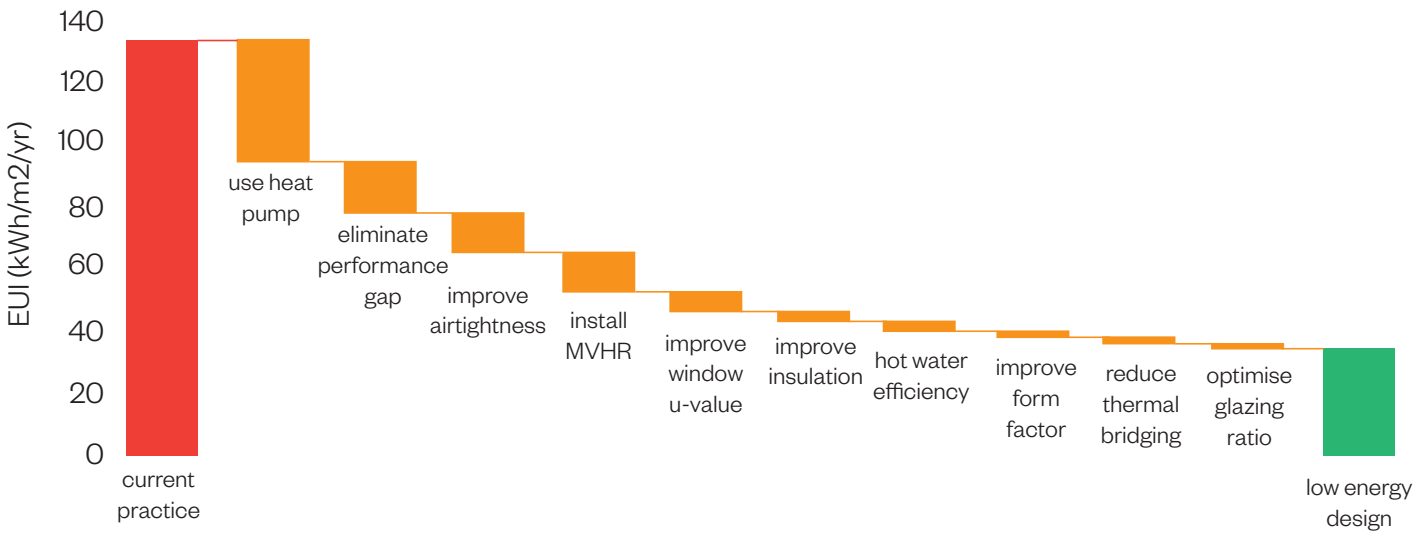
RENEWABLE ENERGY - SUPPLY

The scheme has been designed so as to meet the energy demands of the house on site. This is achieved through solar thermal, solar PV panels and a micro hydro generation system. The PV will generate around 18.9 MWh/year while hyrdo generates around 3.5 MWh/year. PV generation is very seasonal while micro hyro generation is more consistent across the year. Max Fordham have looked at the balance of supply and demand across the seasons of the year and the graph showing this is reproduced here. Wood burners which can be supplied from fallen branches, prunings and excess timber produced by the woodlands on site, are proposed as a strategy to top-up the anticipated winter demand for space heating.

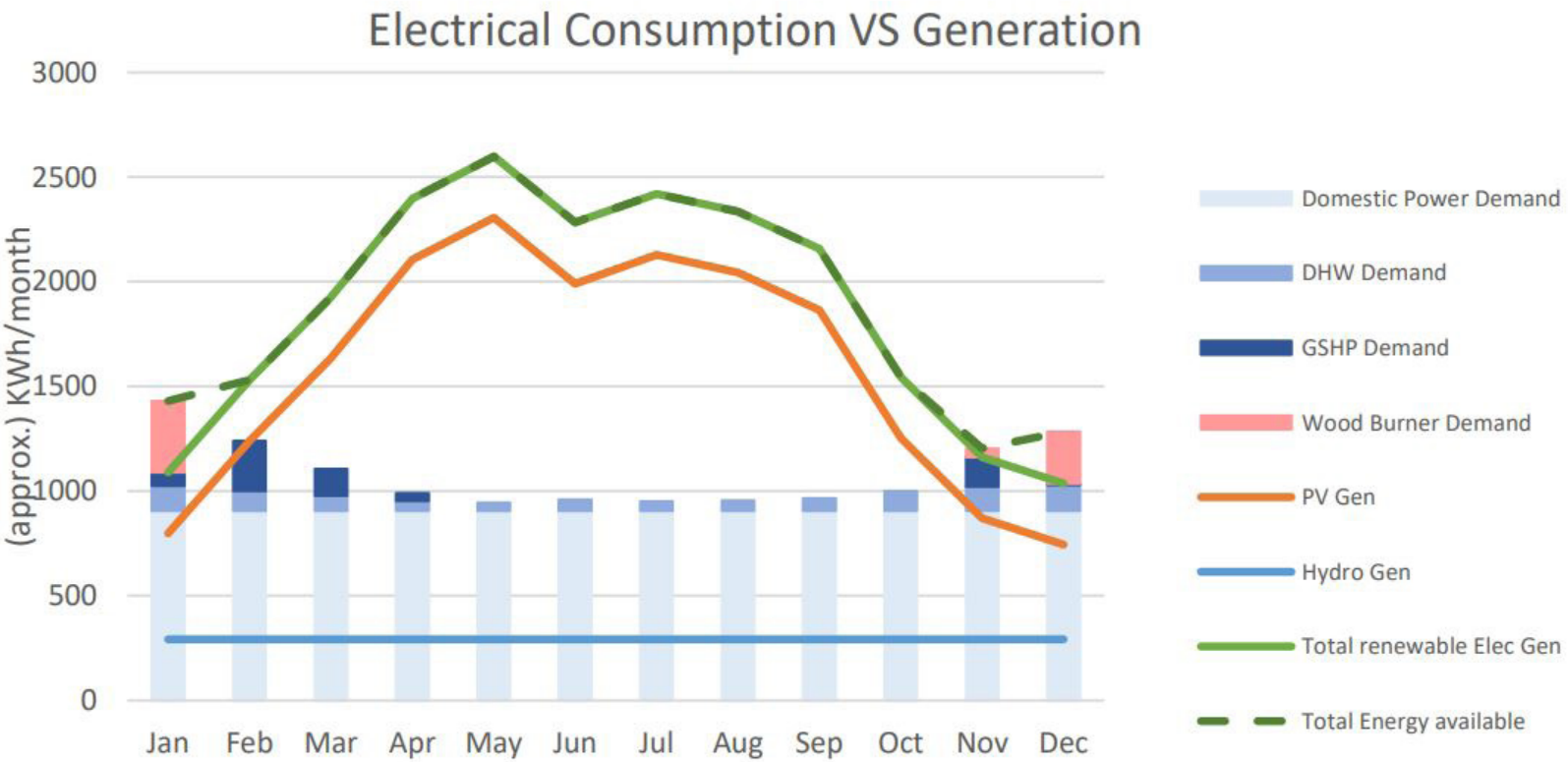
OPERATIONAL ENERGY

The quantity of energy produced on site significantly exceeds the buildings demand. The house has the capability to run off-grid, with careful energy management by the occupants. If the proposal is connected to the grid it will export zero carbon renewable energy to the grid, offering a wider benefit.

Based on this, operational carbon is assumed to be zero; however if connected to the grid, energy produced on site would displace carbon intensive energy generated elsewhere within the national grid.



Adapted Diagram from LETI, opportunities to reduce energy consumption in new residential development



Graph from Max Fordham energy report

4. Whole Life Carbon

WHAT IS WHOLE LIFE CARBON?

Whole Life Carbon = Embodied Carbon + Operational Carbon

The built environment is responsible 42% of carbon emissions in the UK. For homes, this is made up of ‘embodied carbon’ and ‘operational carbon’. However, it is often only the operational carbon which is considered when people talk about ‘zero carbon’ buildings.

Operational Carbon is the carbon used in the day to day running of a house, from heating and lighting, to cooking and using appliances.

Embodied Carbon is the carbon required to produce materials and components, transport them to site and construct the building. It also includes replacement of materials during the building’s life and the carbon impact of demolishing or deconstruction.

To ensure that Breach House can meet ‘Whole Life Zero Carbon’ steps need to be made to reduce the building’s carbon footprint in both its construction and operation.

STUDIO BARK AND ZERO CARBON DESIGN

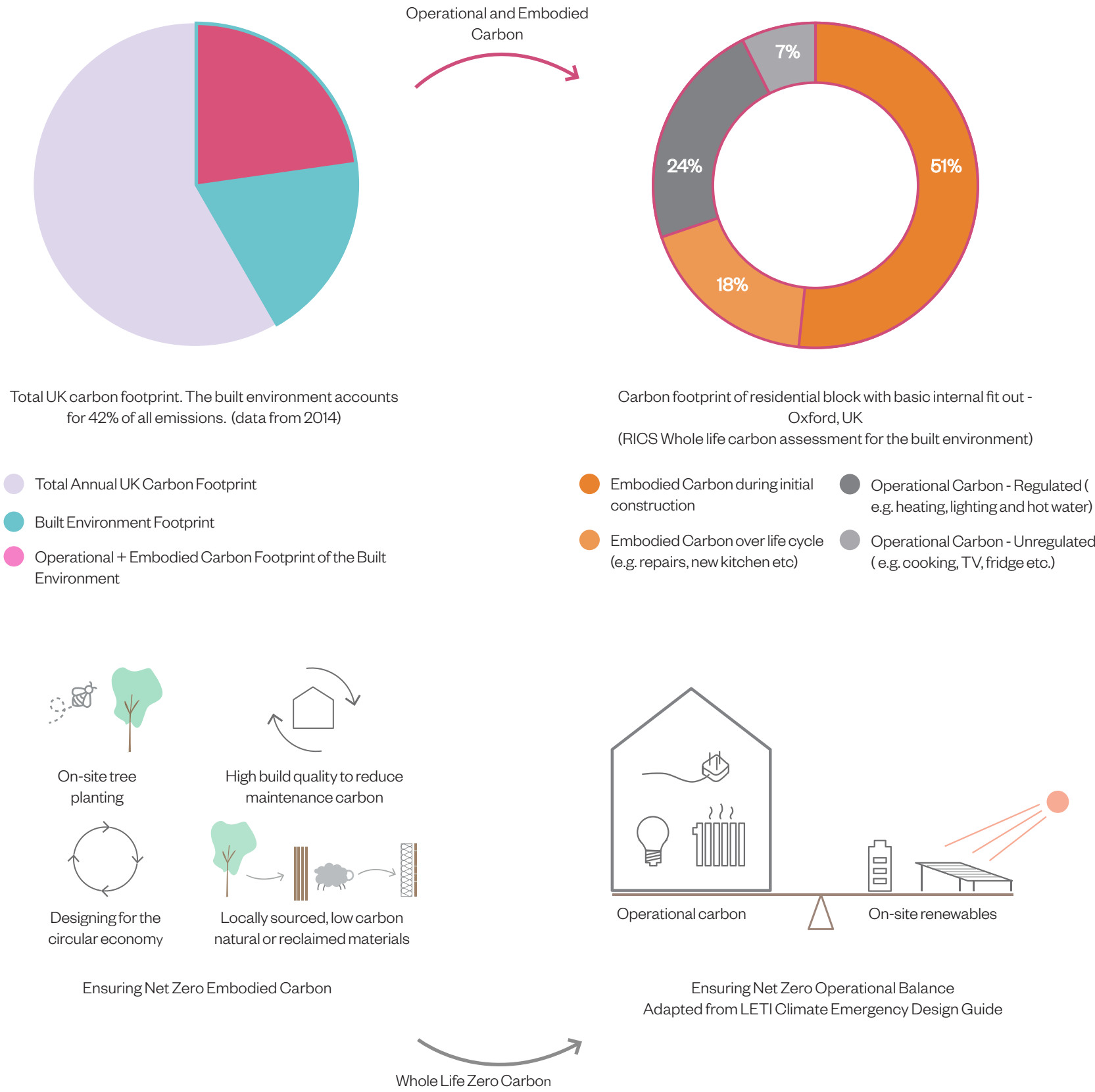
Studio Bark seeks to create high quality, sensitive design to raise awareness and inspire change.

In order to keep within the earth’s resources, we must change the way we build. We believe that this can be achieved through experimentation, innovation, analysis and contextual understanding of each unique site.

‘The manner in which we produce, operate and renew our built environment continues to curtail biodiversity, pollute ecosystems and encourage unsustainable lifestyles.’ - Architects Climate Action Network

We propose that Breach House should be Whole Life Zero Carbon (at 60 years) meaning that the building will not have caused harm to the planet and will go on to be ‘climate positive, i.e. continue to generate electricity and the building materials and associated new planting will continue to sequester carbon.

To ensure Whole Life Zero Carbon remains feasible, our initial design decisions are grounded in best practice ‘fabric first’ principles ensuring key decisions such as orientation, form, location and glazing set the proposed design on the right tracks. Furthermore, we have interrogated the entire material specification to choose solutions which have the least ‘whole life’ impact on our environment.



RICS FRAMEWORK

The framework for appraising the environmental impacts of the built environment is provided by EN 15978: 2011, part of the EN 15643 family of standards for the sustainability assessment of buildings. The standard is quite open to interpretation, and so the RICS developed a modular framework to provide a unified approach to undertaking whole life carbon assessments for buildings and infrastructure.

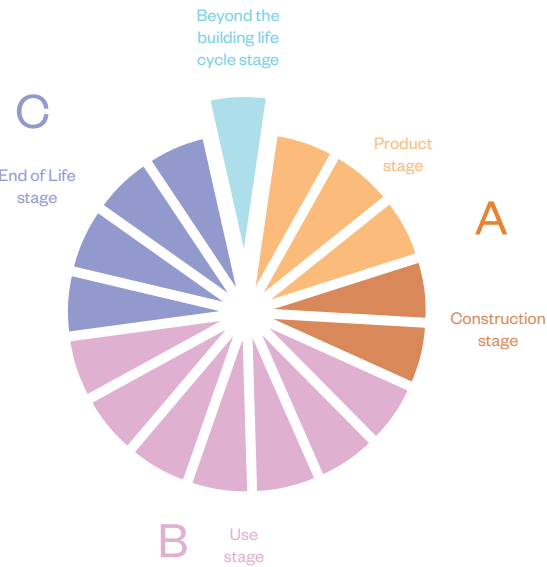
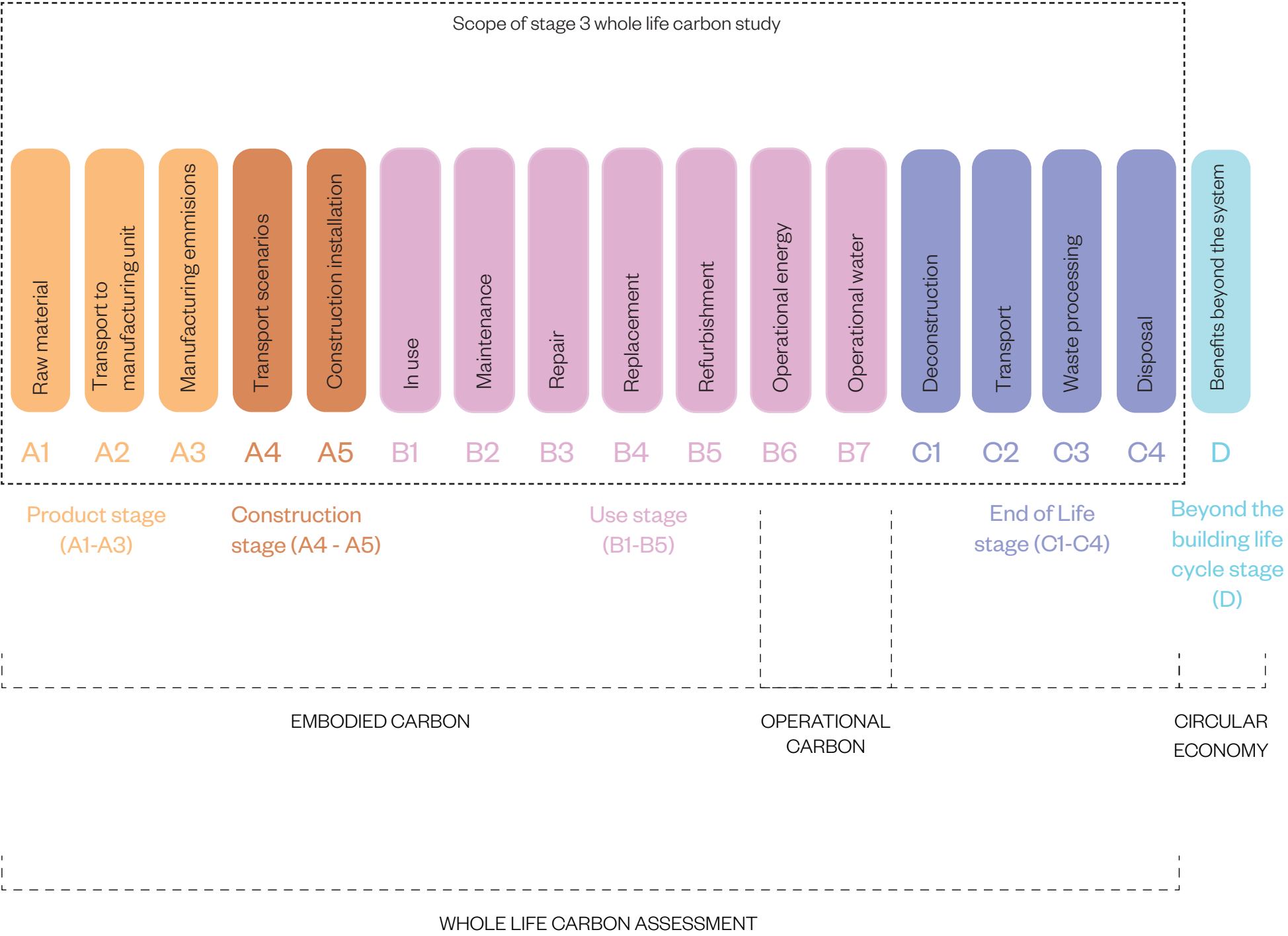
The diagram here has been adapted from ‘RICS Whole life carbon assessment for the built environment by iStructE’ and details the project life cycle and carbon categories through stages: A product (and materials), construction process, B in use and C end of life.

STAGE 3 WLC ASSESSMENT

The purpose of this whole life carbon study is to make an assessment of the anticipated carbon impact of the scheme over its whole life-cycle including modules:

- A - Upfront carbon (product + construction stages)
- B - In-use stage
- C - End of life stage

For an example calculation spreadsheet, see appendix D.



STUDY APPROACH

The approach of this study has been to define a number of scenarios, beginning with “O” a ‘business as usual’ type case using conventional construction approaches. Through a series of incremental steps we have then looked at modifying the proposed construction methods and material choices to target lower embodied carbon results. This study has enabled us to understand the distribution of carbon within the project, in terms of element type and over time (ie over the building lifecycle).

SCOPE, PARAMETERS AND ASSUMPTIONS

As the building is designed to operate off-grid for energy and water, we have assumed that carbon impact from operational energy and operational water is 0. If at a future point the scheme is connected to the grid, it will be a net energy exporter, meaning that it will deliver significantly more zero-carbon energy to the grid than it imports. In this sense our assumption is conservative, as any future connection is likely to reduce the whole life carbon impact of the scheme in numerical terms.

Notable exclusions:

- Built-in furniture and fit-out
- Existing barn renovation is exluded. While it is a part of the application, it is also a separate building. Given that it does not include interior space, inclusion of this would skew the results.

SCENARIOS

	O - BAU	1	2	3	4	5	6
Foundations	Reinforced concrete slab	Low carbon concrete strip	Low carbon concrete strip	Low carbon concrete strip	Low carbon concrete strip	No concrete, alt foundation approach (limecrete slab)	No concrete, alt foundation approach (limecrete slab)
Insulations	Petrochemical / plastic	Rockwool / glasswool	Rockwool / glasswool	Natural / woodfibre	Natural / woodfibre	Natural / woodfibre	Natural straw insulations
External finishes	Timber cladding New brick and tile	Timber cladding New brick and tile	Timber cladding Reclaimed brick and tile	Timber cladding Reclaimed brick and tile	Timber cladding Reclaimed brick and tile	Timber cladding Reclaimed brick and tile	Timber cladding Reclaimed brick and tile
Internal finishes	Conventional plaster	Conventional plaster	Conventional plaster	Conventional plaster	Clay plaster	Olay plaster	Clay plaster
MEP / service level	Heavily serviced	Standard service level	Standard service level	Standard service level	Standard service level	Standard service level	Standard service level
Total embodied carbon over lifecycle:	558,520 kgCO2e	393,060 kgCO2e	368,839 kgCO2e	341,885 kgCO2e	339,763 kgCO2e	317,744 kgCO2e	281,816 kgCO2e

METHODOLOGY

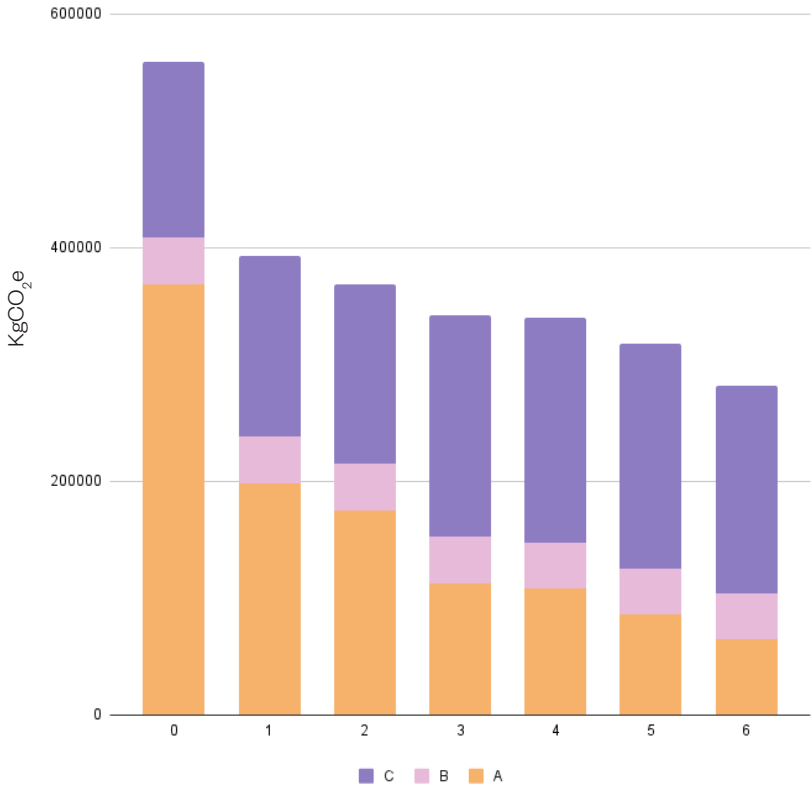
The form and size of the building, number and location of windows etc has all been fixed prior to the carrying out of this study. The areas of materials, walls, floors, roofs etc were extracted from the digital model. These in combination with proposed element build-ups allow us to establish an estimated bill of quantities for each scenario.

This quantity data is fed into a bespoke spreadsheet tool created by Studio Bark, in order to undertake the calculation, in line with RICS guidance. All data regarding embodied carbon factors has come from the ICE database, from product specific EPDs or where data is not available, assumptions are based upon RICS and IStructE guidance.

For a sample of the calculation spreadsheet, see appendix D.

RESULTS

The table below shows some of the key differences between each of the tested scenarios, and the resulting total embodied carbon over the lifecycle. The graph on the right shows the total embodied carbon for each case and is broken down according to the three modules: A (upfront carbon), B (in-use stage) and C (end of life stage).



TARGETS AND BENCHMARKING

Both RIBA and LETI have produced whole life carbon targets and benchmarks which can help to guide and assess the performance of designs and proposals. These are normalised by floor area, ie expressed in terms of amount of carbon (kgCO₂e) per unit of GIA (m²), as a way of achieving comparison between different buildings. These benchmarks are graphed alongside the results from our whole life carbon study here.

DISCUSSION

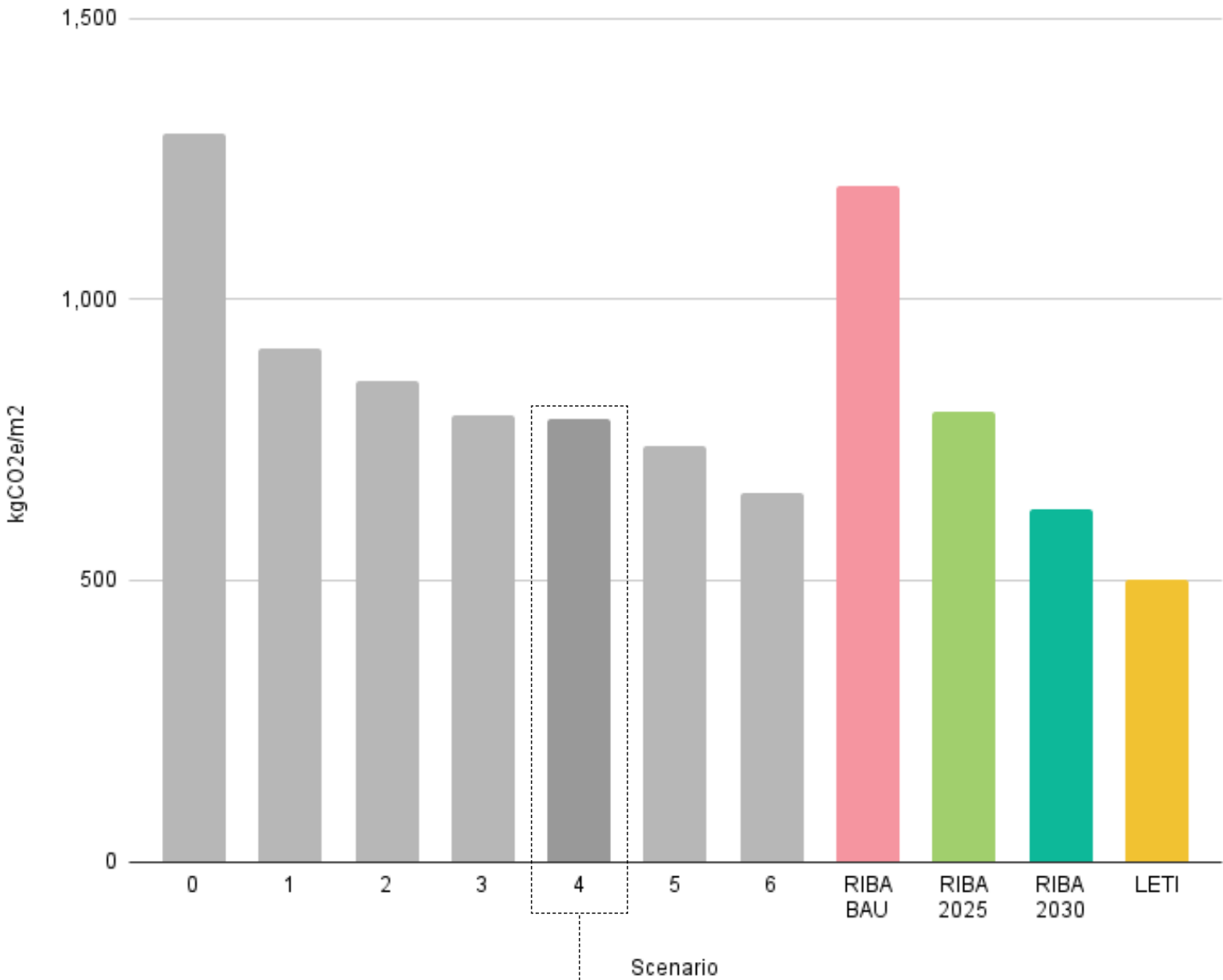
The results illustrate clearly the importance of material specification and sourcing choices in terms of carbon impact. In our case, the same building, built using different materials (foundations, insulations etc) can result in very different levels of whole life carbon impact.

Option 0 “business as usual” is based on carbon-intensive, conventional building practices of the kind that we need to move away from. This produces a carbon impact that is similar to business as usual ranges indicated by the RIBA.

Options 1 - 6 illustrate an incremental pathway with various changes (described on the previous table) in order to reduce embodied carbon over the lifecycle. In many cases this involves swapping higher-carbon synthetic materials for more natural, bio-based products and using reclaimed materials where practical. This has the effect of dramatically reducing upfront carbon (module A) as carbon is sequestered biogenically within the building. Much of this biogenic carbon is released at the end of the building’s life (module C), and so this part of the picture becomes more significant. The results indicate that with carbon-conscious material and specification choices the building can achieve the RIBA 2025 targets and at a stretch (scenario 6), get pretty close to the RIBA 2030 target.

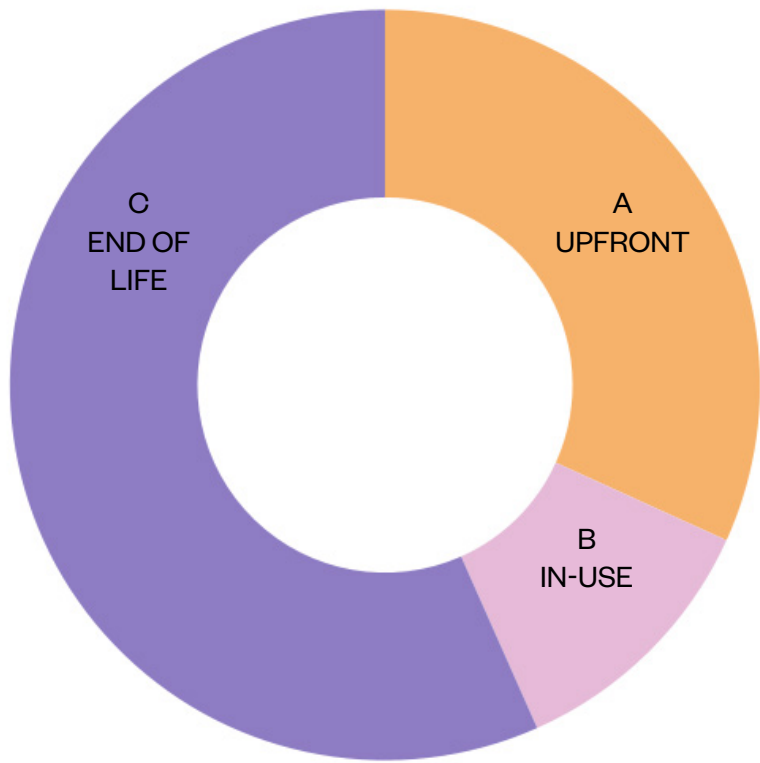
Many specification choices such as foundations are not known for sure at this stage. In reality there needs to be a balance of considerations, as specification choices will in part be guided by cost in the later project stages, and may be challenging to control at planning stage. That said, the low carbon options are not always more expensive and it should be possible to make many carbon savings over and above scenario 0 without damaging the viability of the project. We will therefore take scenario 4 as representative of our approach and target at this point in time - a good low-carbon result in whole life terms, whilst realistic in terms of post-planning realities.

Graph showing whole life carbon of 7 calculated scenarios against industry best practice benchmarks



Scenario 4 is taken forward from this study as the proposed approach, balancing considerations of carbon against other factors around cost and buildability

Graph showing distribution of carbon through 3 stages for scenario 4



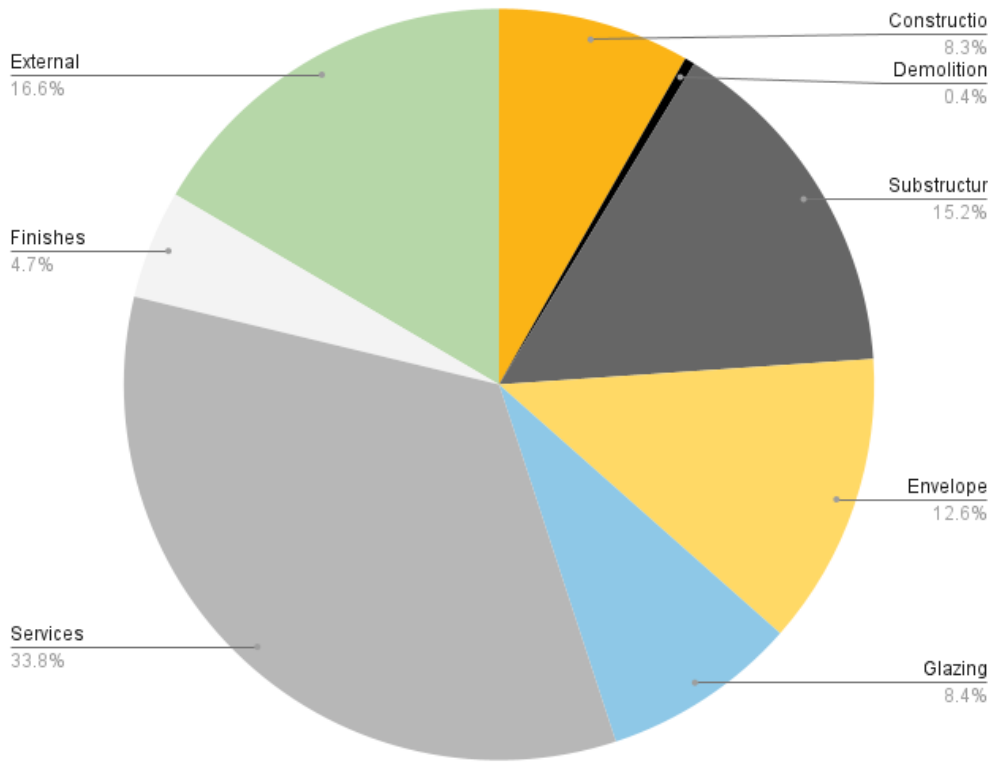
DISTRIBUTION THROUGH LIFE CYCLE

As a timber frame, timber clad building with a proposed approach using natural bio-based insulations, there is a high degree of biogenic material within the building. That is to say, many of the materials used, such as timber, have sequestered carbon from the atmosphere as they grew. This is known as 'biogenic carbon'.

As part of the whole life approach, this biogenic carbon is assumed to be 'sucked in' to the building system in the product stage (A) as negative carbon which is accounted against the other upfront impacts (processing, transport etc). This suppresses the impact of module A in terms of the calculation. However it is also assumed that much of this biogenic carbon is released back into the atmosphere at the end of the buildings life (C), as a significant proportion of the bio materials may go to incineration or landfill.

The graph above shows that this results in module C being most significant, due to the re-release of all this previously stored biogenic carbon. The best way to address that would be to introduce more measures for circularity, so that materials are more likely to be re-used at the end of the buildings life. However, we should also caution against over reliance on this to achieve a low whole life carbon result, as the ultimate fate of the building is a future unknowable. We should be careful not to assume high degrees of material reuse when this is so beyond the control of anyone currently involved in the project.

Graph showing distribution of carbon by element type for scenario 4



DISTRIBUTION BY ELEMENT TYPE

The chart above shows the distribution of embodied carbon over the whole lifecycle broken down by element type.

The foundations / substructure is still quite a significant amount of the remaining carbon impact. This could be reduced via a no-concrete approach. However ground conditions are unknown and so it isn't possible to determine if that is a viable approach at this point in time.

The envelope has been reduced to a fairly low amount, though glazing remains a significant proportion overall.

MEP and services represent a very significant amount. However, that is to be expected given on-site energy generation and integrated renewable technologies within the project.

External works are also quite a significant amount, however this is not surprising given that the amount of drive and landscaping etc is quite significant. This could be reduced by eliminating concrete and steel. However in reality some is probably needed in order to achieve the design intent.

NET ZERO CARBON

LETI (the London Energy Transformation Initiative) are a cross industry collaboration of experts, and have proposed the following working definition for a zero carbon building: *“A ‘Net Zero (whole life) carbon’ Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset’s life cycle (modules A1-5, B1-7, C1-4) are minimised, meet local carbon, energy and water targets, and with residual ‘offsets’ equals zero.”*

ON-SITE OFFSETTING

To achieve a zero carbon scheme we propose an on-site offsetting strategy, which relies on the carbon drawdown effect of trees. We have worked with Studio 31 to scope out the approximate requirement, based upon available data for carbon sequestration. The numerical workings behind this calculation can be seen in appendix D.

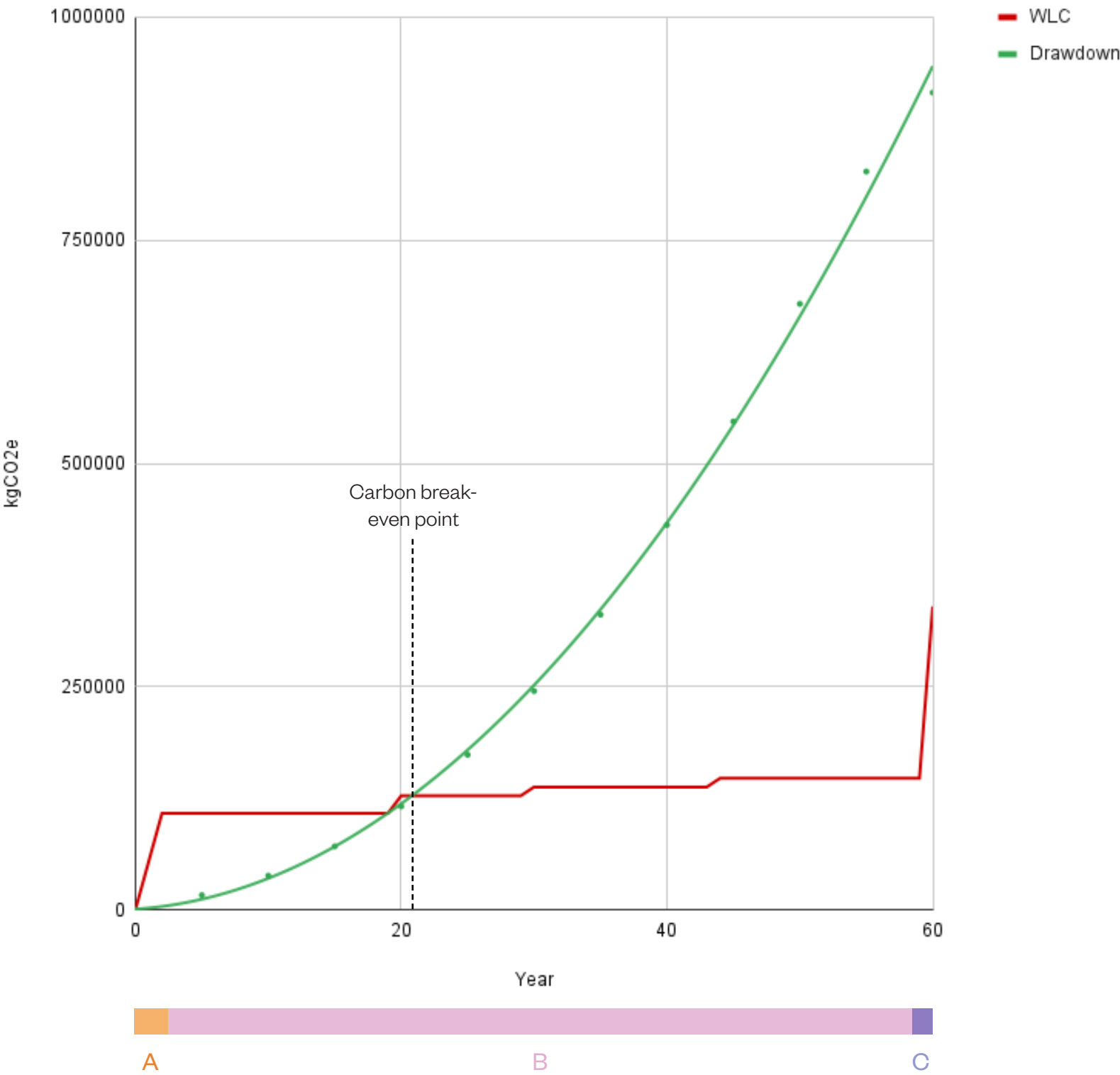
The target for this project is to achieve carbon ‘break-even’ within 25 years, ie by circa 2050 - the date set by national government to achieve net zero (a target shared by Hinckley + Bosworth Borough Council). Looking at our graph which maps whole life carbon impact against the carbon sequestered on-site, this should be easily achieved.

To achieve this we propose the following tree planting as a minimum:

	Slow	Moderate	Fast
	Oak, hornbeam, beech	hawthorn, maple, silver birch, fruit trees	horse chestnut, sycamore, willow, alder, poplar, linden
Age			
1+	15	15	60
5+	40	30	30

DRAWDOWN - CARBON NEGATIVE

After the break-even point, the landscaping will continue to sequester carbon from the atmosphere. Over a 60 year period, we anticipate that the planted trees will have sequestered almost three times as much carbon as was released by the construction, operation and end of life scenarios of the house, within the same time period. Therefore we propose that this scheme, taken in its entirety, is ‘carbon negative’ and will have a beneficial impact as a carbon sink, in helping to address the climate emergency.



Carbon Balance - This graph to show whole life carbon impact of house construction (assuming different levels of benchmarking) against carbon sequestration by landscaping over a 60 year period.

5. Conclusion

SUSTAINABILITY STATEMENT

Breach House is the result of an extensive and iterative design process. This has included multiple studies of environmental performance considerations, from micro climate and shading, to energy demand and embodied carbon. The result is a unique and rigorously environmental building which can be described as ‘energy positive, carbon negative’.

The operational energy demand of the building has been reduced, through environmental design strategies and a fabric-first approach, to meet the LETI target of 35 kWh/m2/yr. Fossil fuel energy has been completely eliminated from the scheme. Energy demand will be met via on-site renewables and more energy is generated on-site over the course of a year than is consumed. The scheme makes a net positive energy contribution and if connected to the grid will export zero carbon renewable energy. The house is capable of running ‘off grid’ if required.

Embodied carbon across the lifecycle of the building has been reduced and minimised through selection of low carbon and natural materials. The residual carbon impact of the development is counterbalanced by landscaping proposals to enrich ecology and accelerate carbon drawdown on site. Calculations undertaken here suggest that the landscape enhancements will sequester around 3 times as much carbon as is released in the construction and operation of the building over its lifetime.

In its own way, Breach House contributes towards meeting Hinckley + Bosworth Borough Council’s target for achieving net zero in the wider borough by 2050. In addition the scheme demonstrates an approach to development in rural areas which is grounded in environmental principles and seeks to respond to the key challenges of our time.