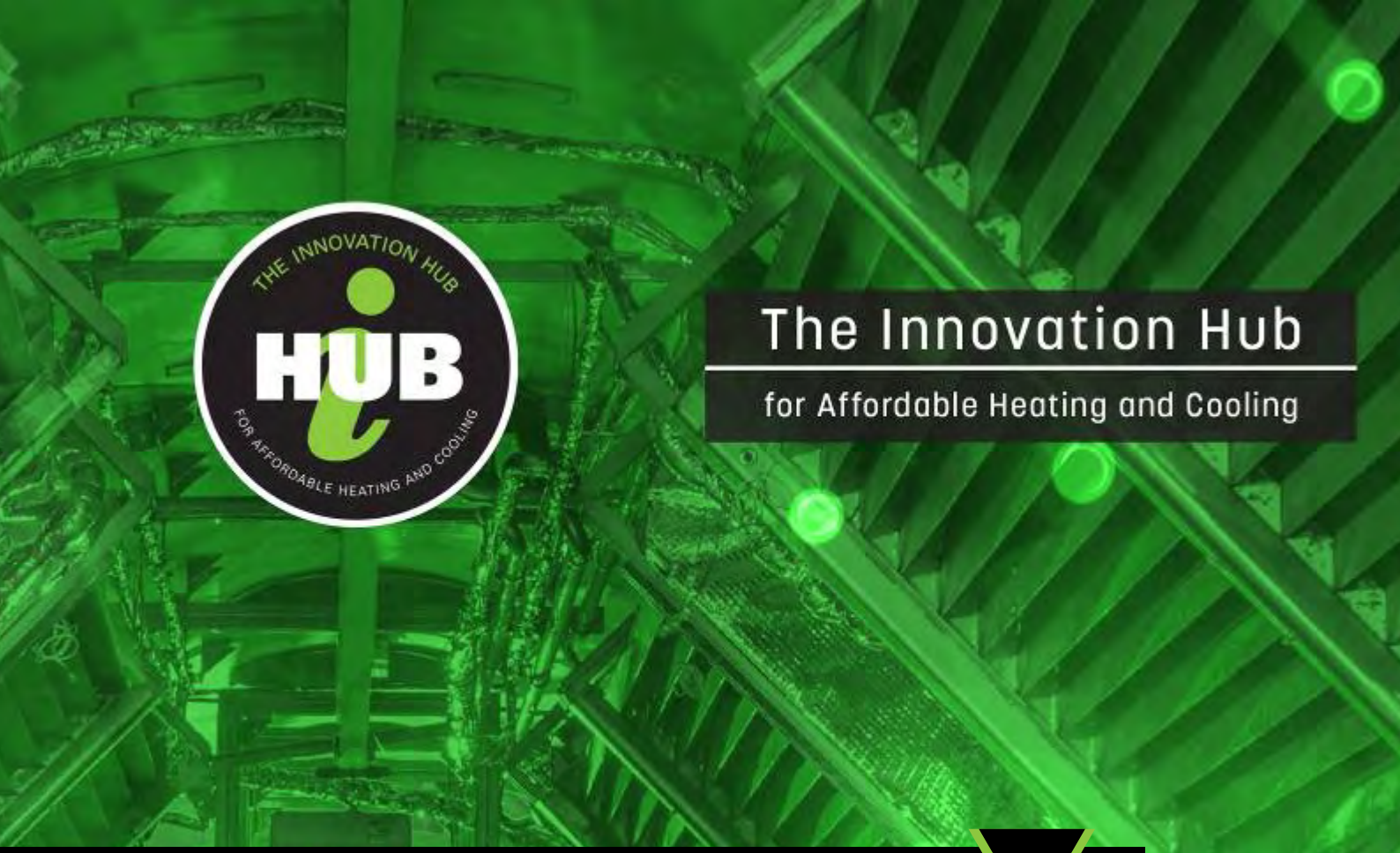

The Innovation Hub

for Affordable Heating and Cooling

Design Studio Outcomes Report (100% Milestone)

IDS-07 Aged Care

Project IDS07
19 November 2021

The University of Melbourne

About i-Hub

The Innovation Hub for Affordable Heating and Cooling (i-Hub) is an initiative led by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) in conjunction with CSIRO, Queensland University of Technology (QUT), the University of Melbourne and the University of Wollongong and supported by Australian Renewable Energy Agency (ARENA) to facilitate the heating, ventilation, air conditioning and refrigeration (HVAC&R) industry's transition to a low emissions future, stimulate jobs growth, and showcase HVAC&R innovation in buildings.

The objective of i-Hub is to support the broader HVAC&R industry with knowledge dissemination, skills-development and capacity-building. By facilitating a collaborative approach to innovation, i-Hub brings together leading universities, researchers, consultants, building owners and equipment manufacturers to create a connected research and development community in Australia.

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.
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i-Hub Design Studio Outcomes Report (100% Milestone)

The IDS-07 Aged Care Integrated Design Studio, investigates design innovation to reduce net energy consumption through the use of renewables and other energy technologies. Over a 14-week period, a group of architecture and engineering students work jointly with Engineering experts to develop an Aged Care facility. This type of facility is known to have high operational energy requirements.

Based on a project brief presented by the client, students explore novel approaches to develop an Aged Care residential facility within the wider Melbourne area. Particular focus is given to the intrinsic nature of the layout of such centres and their environmental affordances, by integrating novel technologies that provide synergies with various programmatic requirements, functional considerations, and overall aesthetics, thereby significantly reducing its carbon footprint.

Lead organisation	The University of Melbourne		
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1. SUMMARY

1.1 Purpose

This report summarises all findings taken from IDS-07 and marks the 100% completion milestone at the end of the project. Information inherent to this report will flow directly into the 'Lessons Learned' from IDS-07 and they will be further disseminated under the IDS Knowledge Sharing strategy associated to the program.

1.2 Executive summary

The IDS-07 Aged Care was initiated late February / early March 2021, after substantial stakeholder engagement with their client representatives back in Q4 of 2020. In contrast to the IDS run in Semesters 1&2 2020, it was clear from that start that this IDS would be run entirely in person at the Melbourne University campus. Based on prior experience, the IDS steering committee ensured participation of Engineering students from the start, who could now interact in person with their architecture counterparts throughout the duration of the semester.

Each of the 16 students (comprising 12 architecture and 4 engineering students) advanced their ideas in groups. Group work included research and design exploration exercises, and the development of design proposals. The group work continued through to end of semester, with the architecture and engineering students interacting with the student tutor twice a week, and with the industry consultants on at least a weekly basis during early semester with more frequent support provided toward end of semester. A dedicated 'Catalyst for Integrated Design' guideline underpins the collaborative effort and helps in the joint development of common goals toward 'Net Zero' design. The two weekly studio sessions were being held on Campus this semester, allowing the team of UoM academics to diligently observe and analyse the integrated design process as it unfolds.

Findings from this semester indicate that, in contrast to previous IDS iterations, the impact of COVID-19 was barely noticeable. Face-to-Face classroom teaching was the ideal setting of IDS-07 and individual projects by each group of students advanced well. Participation of industry consultants occurred in regular intervals throughout the semesters, as they joined the students at the University of Melbourne. Face to Face sessions in class provided the main interface for engagement, supplemented by online resources that allowed students to collaborate remotely, if needed. Observations of the integrated design effort point towards preliminary lessons learned, which include (but are not limited to):

- Important to establish a level playing field from which each participant benefits, characterised in this IDS by the replacement of professional specificity with mutual respect, and realised through integration in shared decision making and work efforts by working in groups.
- Clear articulation of common goals is a key priority, and in this IDS translating into clear assessment criteria and being upheld in an intelligible way through the integrated design development process.
- Maintaining focus on the common goal and how it translates at progressive design moments was achieved in this IDS by working in groups through to end of semester, with each group availing themselves of the hands-on guidance from the studio tutor and industry consultants to navigate the unfamiliar design process.
- Engineering students struggle with a 'brief under development', expect clearly defined problems instead; addressed in this IDS by actively involving the engineers in articulating the engineering component of a return brief from each group and then following this through with the same group as the design development process unfolded through to end of semester.
- This IDS demonstrated that collaboration between the engineers and architects is upheld when engineers are fully engaged in design decision making and particularly when the engineers articulate their requirements in the return brief.
- The group dynamic had a strong influence on design collaboration by enabling the team to build relationships and a team identity. The group structure enabled good collaboration but did not drive it. This was more attributed to the studio context.
- Integrated design happens over a limited time window, but design challenges can be complex for students to navigate; this IDS actively encouraged keeping options open for as long as possible while designers grappled with understanding the full complexity of the integrated design challenge.

- In the context of a fast-track studio process, the more information provided up front was seen as key to helping students focus on what they are being asked to do.
- Balancing individual contributions to design co-authorship proved a challenge in some groups, but the engineer in each group constantly brought up the topic of sustainability, generating helpful conversations, and providing good scope for the engineering modelling to influence the design with some real evidence of environmental principles being integrated into the architectural form.
- The engineering students were there right through and that was seen as crucial, generating multiple opportunities for regular interaction, and enabling team members to bond more easily.
- For students' first encounter with an integrated design challenge, the approach of immersing them into a strong contextual project space within which to develop ideas was perceived as a strong driver of collaborative and integrated outcomes.

Figure 1: The studio at work

2. PROJECT CONTEXT AND INCEPTION

2.1 Context to the Aged Care Integrated Design Studio

In the lead-up to University of Melbourne's start of semester, Prof Brendon McNiven from the Faculty of Architecture, Building and Planning, and Prof Lu Aye from the Melbourne School of Engineering engaged in intensive industry consultation to search for compelling case-studies to investigate new technologies under the Integrated Design Studio banner. This IDS project was run during Semester 1 2021, which spans over 13-15 weeks from early March until early June.

The Aged Care – Active Community project embodied a programmatic and functional specificity that promises a fertile testing ground for design exploration, particularly when considering Zero Carbon constraints. The brief and detailed program for the Aged Care Active Community remained under development through the first weeks of semester. The client looked for ideas related to the design of a low-rise 'Zero Carbon facility' - a new standard for Aged Care, and asked students to consider medium to high-rise opportunities.

In the weeks leading up to the start of semester, the Melbourne University team went on to gain University of Melbourne internal *Ethics Approval*, select the Design Studio tutor, establish the context for the IDS to integrate seamlessly with the existing curriculum, and chose the industry consultants to join in on the project.

2.2 Studio Inception

Several kick-up workshops took place at the start of Semester 1, to introduce all studio participants to the IDS principles, as well as providing a platform for stakeholders to get to know each other. Despite the COVID-19 context, luckily these workshops were able to be run face to face, following the University of Melbourne's 'Return to Campus' strategy. It was decided to split the initial workshops over 2 classes in early March (one in the first, and one in the second week). The workshop sessions included presentations from the IDS research team, University of Melbourne academics, the clients, and the participating consultants (Atelier 10).

Figures 2 & 3: Start-up workshop early March 2021. IDS team and Client introduction, week 1

Next to the benefits for information exchange, the initial kick-off workshops also fulfilled the essential task of introducing all key IDS participants to each other and facilitate social bonding, particularly between architecture and engineering students.

Figure 4: ESD Consultant Introduction, week 2

2.3 Client Engagement

This IDS worked with an open-minded client, whose aim is to redefine the design of an Aged Care facility as an active community with a more conscious approach towards Zero Carbon goals. The client welcomed the opportunity to test unprecedented and novel technologies, brought into context with innovative design ideas for an Aged Care facility that would enable an active and connected lifestyle with engagement to the local community and make senior living more procurable. The IDS-07 Aged Care project was joined by industry experts and consultants, with a proven track record in the design, delivery and operation of these bespoke assets. This mix between willingness to experiment, paired with a high degree of expertise in Aged Care design, is greatly benefitting the conversations and design approaches in the studio. The client remained involved intermittently through the semester, providing guidance and feedback, particularly at the mid-semester and end-of semester milestones.

2.4 Site Visit

A greenfield site in the Melbourne suburb of Ringwood was chosen by the client. The relative proximity and ease of freeway access afforded IDS participants a valuable opportunity to visit the site at any time through the semester. This ease of access appears to have assisted designers' sound understanding of the passive design opportunities and community context offered by the site, with some groups exploring multiple ways to develop the site as an active part of a locally engaged community.

Figure 5: Site Locality Plan.

3. DESIGN STUDIO PROGRESSION

3.1 Setup for Collaborative Design Integration

To provide guidance for the programming of Design Studio activities, and in particular their interface with the investigation on integrated design, the IDS management updated their detailed manual titled: *'Catalyst for Integrated Design'.* Released approximately 2 weeks before the studio's commencement, it combines aspects of design collaboration that cut across architecture and engineering disciplines, and it ties directly into the studio-teaching process. The manual first addresses overarching aspects of design integration to then delve into the specifics of environmental building performance, human comfort, and mechanical design systems. The manual ultimately assisted the studio tutor to coincide their activities for advancing design concepts with key milestones for addressing and integrating technologies throughout the semester.

General

Understand the **limitations of traditional**, non-integrated design (solutions).

- Facilitate an environment that prioritises working on **common goals** over **individual goals**
- Establish **trust** among participants (open/non-judgmental/sensitised/willing/etc)
- Allow every participant to understand what's **important to the others**.
- Explain the **process** each participant (group) typically goes through, in order to derive their desired **output**.
- Understand **why** we often see things **different**ly, and
- develop a **common language** that cuts across discipline silos (metaphors/analogies/co-experience)
- Call students '**designers**' **rather than architects** and **engineers**. Engineering should empower architecture and vice versa
- Set **common targets** and instill a sense of joint ownership … and
- introduce a sense of **shared responsibility** across group participants
- **Knowing in action/heuristics**: discuss and advance integrated design solutions on the fly…
- **start with** educated guesses/**rule of thumb**, **then verify** validity of assumptions for preferred solutions

Focus on Performative design

- Address **environmental** building **performance** systemically across Arch and Eng
- Establish joint environmental **targets** per relevant building type à apply end-use performance metrics
    - What are the mechanisms to address them in **early**-stage design?
    - What are the mechanisms to address them in the **advanced** design stages?
- Develop an iterative Arch/Eng process for **optimising performance** (Optioneering)
- Search for integrated design responses to human **comfort** and environmental **loads** à understand how various aspects of the Arch and Eng design are connected.
- Search for **synergies** via design **innovation rather than** relying only on **mechanical** solutions (passive over active) … as part of that…
- foster **multi-functional design** – design elements in an integrated design should be doing more than one thing at once (at least 3 things).
- **Define** the **characteristics** that represent the '**integratedness**' of a design solution. That's what the success of this project should (also) be measured against!

3.2 Schedule for Interdisciplinary Engagement

The studio tutor proposed a detailed IDS schedule in week two of the semester, based on his experience as design studio leader within a 13-15-week semester, as well as preparatory conversations held with the industry consultants, the Aged Care client (Active Community Group - Kris Chau and Hing-Wah Chau) and the academic participants. The schedule addressed the output requirements typically inherent to Masters-level design Studio teaching at the Melbourne School of Design, and the specific IDS output requirements for exploring novel technologies to support a Net Zero Carbon design goal. In particular, the schedule mapped out the intensity and duration of engagement between the architecture students, engineering students, the regular architectural and engineering design consultants and guest consultants.

3.3 Weekly interaction between Design Studio Participants

After the initial online kick-off workshops, the Aged Care IDS moved into the period of bi-weekly 3-hour design review sessions.

Figure 6: Mid-semester presentations

The Aged Care IDS took an adaptable approach to the studio interaction to assist engineering integration and more readily respond to students' progress towards an innovative 'Net Zero Carbon' outcome. The first half of the semester focused on demonstrating a range of integrated design strategies (climate responsive design, zero carbon brief, design performance) giving context to guide studio interaction and align with the group design challenges offered by the studio leader. The initial three weeks was marked by additional presentations by the Active Community Group client and the Sustainable Design Consultant together with presentations from the Aged Care consultant. This period was also used to showcase precedent projects that illustrated innovative approaches to sustainability. Students were asked to research Aged Care typology in both low-rise and high-rise forms and to start presenting first preliminary responses to the site and community context and the articulation/visualisation of various programmatic features, together with an extreme architectural or engineering design response to encourage them to think in different ways. This led activity into developing the brief with more specifics to assist design efforts, in particular of a social and environmental nature to complement the community connection of this Aged Care facility and the project's commitment to environmentally responsible design. Underpinning this phase was a focused effort by the Studio Leader to encourage integration of architecture and urbanism in the developing design responses.

In a 13-15-week design programme much of the front end is taken up with briefing and bringing design parties up to speed with each other's discipline (in general knowledge terms), the back end is conversely dominated by design development and documentation type activities. A first public presentation of preliminary design concepts occurred at the IDS mid-semester presentations in mid-April. Following the success of the group design presentations, the studio leader made the decision to continue working in groups to advance the designs through to end-of semester. The 7-week design development phase was occupied with detailed development, together with performance testing of designs in preparation for final presentations. Activities were staged to enable groups to refine their designs in response to the findings from the performance testing process, prior to final review in mid-June.

4. DESIGN STUDIO FINDINGS

4.1 Observations in Studio Sessions

4.1.1 Understanding Professional Specificity (and how to overcome it)

Striking a balance between architecture and engineering requires active curation. The Aged Care IDS took the approach of asking designers to work in four groups, each with 3 architects and 1 engineer and each responsible for key deliverables that would inform the concurrent development of individual design work. The group work proved very successful, and a decision was made to continue through to the end of semester as a group design effort.

Earlier IDSs had found that designers gained significant benefit from working in groups by creating common space for architects and engineers to work closely together on common tasks. This gives each discipline the opportunity to gain familiarity with different design thinking during early project phases whilst engaged in activities for common benefit. Observations showed interdisciplinary familiarity developed very well within most groups in this IDS.

Overall, it could be observed that face-to-face contact of students allowed for social bonding and the establishment of a proper 'group mentality' among architecture and engineering students. A sense of co-ownership was clearly detectable among all parties joining in on the same design effort. With both architects, as well as engineers presenting in the classroom, it also became more evident for each party, what the other party would bring to the table.

Figure 7: Joint architect-engineering student presentation

4.1.2 Aligning the Dialogue

Integrated design is the coming together of multiple disciplines to produce design solutions that meet 'whole of project' visions. Early observations in previous Integrated Design Studios (IDS's) show that not all designers are used to working in this way.

Current design paradigms often place engineering as following architecture in the design process. This encourages a consulting type approach to the engineering where engineers are asked to comment on preformed ideas. Design integration can occur in this model, however to a reduced potential with the initial ideation missing ideas founded in engineering aspects of the project.

Early studios found this consulting model difficult to break free from. Close attention was paid in this studio to create a mindset of 'design co-authorship' in all participants (engineers and architects alike).

Design Co-author mindset: This aspect of design is sensitive to the relationship between individual designers which can be complex. We feel it is an important point to have uncovered however believe it will take some iteration in adjustments of the studio mix and nature of the integrated design process being trialled. In this IDS the relationship between individual designers was observed to be a significant factor in shaping an integrated design response.

Earlier IDSs approach to bridging the discipline gap by encouraging the creation of good working relationships within small groups by both disciplines working together had been found to be a positive move towards alignment of thinking and design co-author mindset.
The adoption of design groups in this IDS proved successful with all groups evidencing collaborative behaviour. Observation of individual Aged Care IDS groups at work found most groups readily engaging within the group around common design challenges, particularly environmental and engineering aspects evidenced by use of a common language and displaying a sense of common ownership.

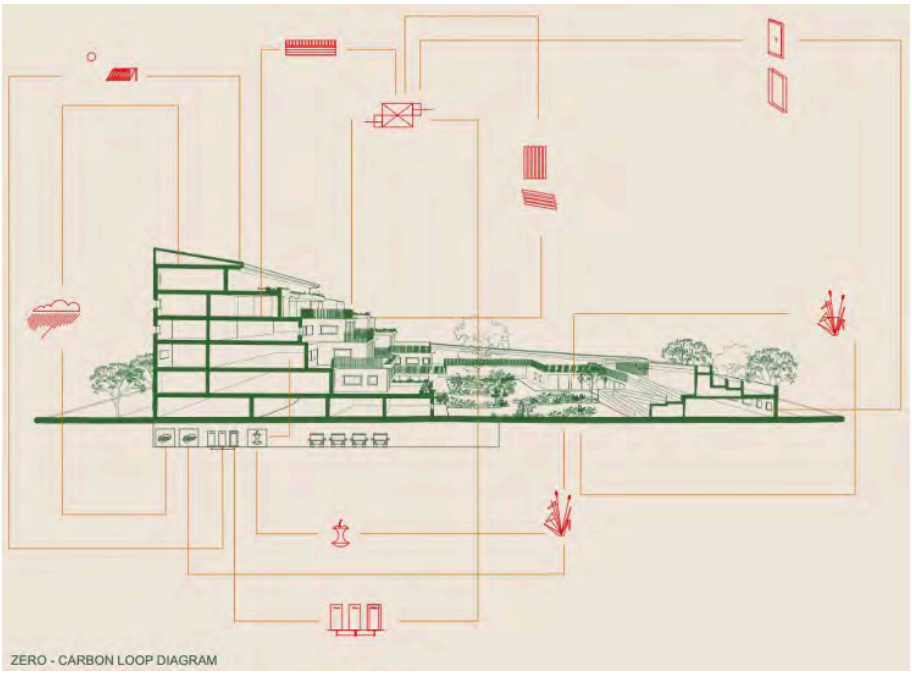


Figure 8: Zero Carbon Loop – mid-semester

Observation suggests that the Aged Care IDS approach of offering early opportunity for group-work around foundational aspects of projects – client, site context / analysis, brought high value in founding a productive cross-disciplinary working relationship. This cross-disciplinary work appeared to strengthen the groups' design responses and shared decision making; but not without challenges such as balancing individual contributions to design co-authorship. The decision in the Aged Care IDS to continue with group work through to the end-of semester was observed to be successful.

4.1.3 Integrated Design Process

The Aged Care IDS took the approach of demonstrating that good integrated design is a result of where the ideas are generated and presenting all aspects of the design challenge in an integrated way from the start. This included (but was not limited to) integrated design as the new normal, researching multi-function systems, and illustrations of environmental and energy focus leading to new design forms. The methodology for the integrated process was mapped out via the studio brief, which was designed to provoke different thinking and move away from the familiar. All students were encouraged to think, as designers, in terms of architecture/urbanism. The studio leader led them through the process of exploring different viewpoints before integrating them into a solution. The studio sessions were differentiated with the architectural consultant attending Mondays and the engineering consultants attending Thursday sessions. This gave a sense of structure and clarity for students although there may have been a missed opportunity for students to observe cross-disciplinary interaction between consultants.
The decision to work in groups was observed to offer multiple opportunities in the Aged Care IDS. The sharing of tasks and division of work effort in developing a group project context underpinned the collaboration between

participants and their analysis of key information. This played out so well that the decision to work in groups was continued through the whole semester.
The clients articulated their expectations from the IDS via conversation and presentation, without prescribing a specific approach or outcome. The adoption of the 'permanent vacation' concept as the goal for senior living in this facility encapsulates the benefits that a good design outcome can bring to the Aged Care and local communities.
The early introduction of the environmental consultant, Atelier 10 and the Aged Care consultant, Place Design Studio, together with the studio tutor, provided designers with sustained architectural, programmatic/functional and engineering support through the whole integrated design development journey.

Figure 9: Bridget, Claudio, Ian – mid-semester, Permanent Vacation

Early observation of group selections of reference/precedent projects illustrated a good grasp of the range of design opportunities in Aged Care. It was less clear whether the selected precedent projects exemplified integrated design approaches.
It was observed that the engineers were initially uncomfortable without clearly defined scenarios and clear outcomes. Some engineers expressed uncertainty about their skillset and ability to contribute to the group work efforts. It was encouraging to observe this early recognition of the challenge of working as co-authors as a key aspect of integrated design. End of semester comments from these engineers suggested it had been a very positive experience.

Figure 10: Georgia, Holly, Dom – final presentation, elevation

The design challenge of producing extreme 'solutions' afforded groups an opportunity to see the impact of optimising engineering aspects over the architecture and vice versa and this context coerced designers to think in different ways. The need for balance appeared to be readily taken on board along with an overall grasp of

the key design components for each extreme solution. It was notable that all participants engaged with some enthusiasm in the production of extreme architectural and engineering solutions, and many were able to carry forward their new grasp of key design components relevant to a third, more balanced design approach that was taken through to final review. It was interesting to observe how readily one or two of the groups seemed to navigate the design development pathway with relative ease.

Observations showed engineering students leaning more towards interrogation of project specifics, across engineering and programmatic information, whereas observations indicated architects' initial interrogations were around visual form making. This combination of perspectives appears to have underpinned, with the support of the studio, the evolution of their project through multiple design iterations. It was encouraging to observe the emergence of a shared perspective in one or two groups with designers interrogating each other's ideas. This appears to have further enabled groups to explore a wide range of design strategies without losing focus.

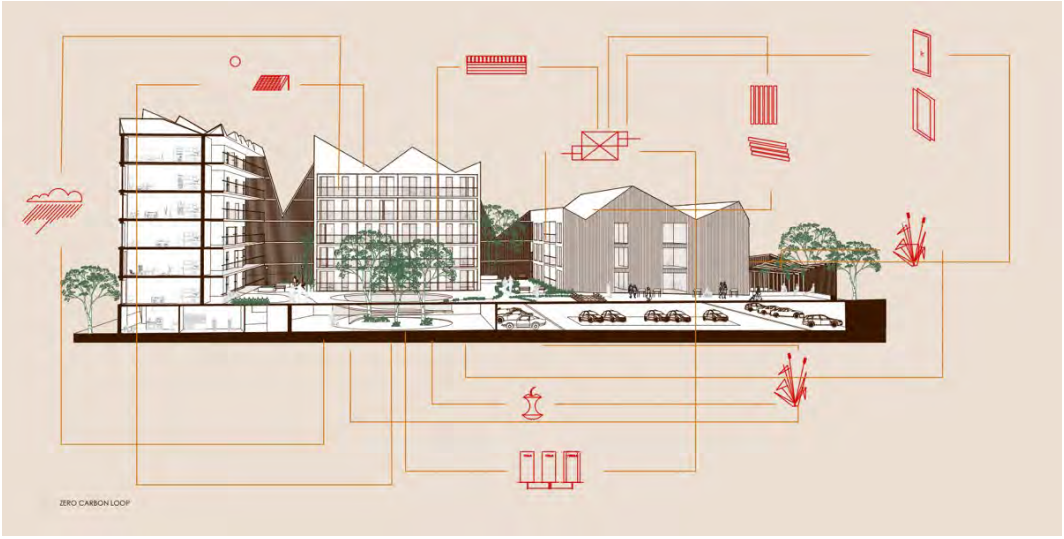


Figure 11: Carol, Skye, Morna – The Nest

The frequent design tutorials with the studio tutor and industry consultants offered fertile ground for multiple perspectives to be considered with each design iteration in some groups. In these same groups peer-to-peer critiquing was also observed and with the support of the studio appeared to give rise to more integrated development of designs that enabled key architectural and engineering priorities to be upheld through each iteration. It was observed however, that in at least one group students struggled to uphold some early project aspirations through design development, at the same time as they faced struggles to balance the workload.

Figure 12: Alexa, Sherry – courtyard stroll

As the semester progressed most designers were conversant with applicable engineering systems and able to juggle the balance between form and function and in general, most groups appeared to have a sound grasp of the principles they tried to uphold in their final design proposition. However, some still struggled with prioritising

the key aspects of the design that would define a unique outcome. The use of e-tools such as PHPP – Passive House Planning Package energy modelling software, introduced by the sustainability consultant enhanced and underpinned designers' understanding of how buildings interact with their environment at multiple levels and that all aspects must work together as an integrated design response. These activities allowed designers to better understand the relationship between good design and performance and inform their understanding of how buildings work together.
Earlier IDSs have evidenced varying degrees of uncertainty amongst designers when moving beyond the group environment to work individually, with a noticeable loss of project momentum. Observations in this studio indicated sustained project momentum for most groups despite challenges with balancing individual workloads and design contributions. In a fast-track studio environment in which collaborative integration is championed this is seen as a positive achievement.

4.1.4 Working toward Common Goals

One key element that is being addressed in this IDS, is a targeted articulation of common goals towards Net Zero carbon in the joint architect/engineer effort. Following on from the mid-semester reviews, a team from Atelier 10 continued to provide, once or twice a week, one-on-one engineering feedback in the form of environmental design tutorials with students able to participate either as individuals or groups. Designers were guided through the process of modelling and testing their design proposition for its performance against common 'Net Zero carbon' parameters. Students used the engineers' feedback from these tutorials to inform a refined version of their final design iteration, which optimised the performance of each of their designs to bring them closer to the 'Net Zero carbon' goal.

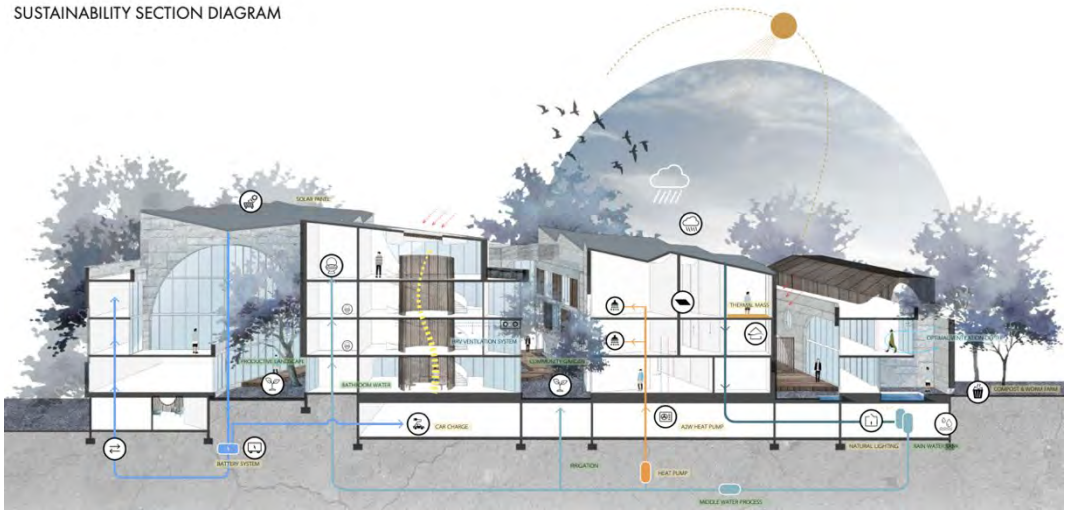


Figure 13: Alexa, Sherry – final presentation, sustainability section

4.2 Feedback from the participating industry consultants, the studio tutor, and the client

The feedback from the key contributors to IDS-07, was captured via online face-to-face interviews. Two industry consultants, the client representative and the studio tutor participated in these interviews. The interviewees were asked about the key drivers and barriers to achieving integrated design, their opinion on the studio and client briefs, the nature of their contribution and their general feedback on the overall performance of the AV integrated design studio, its usefulness, and areas for potential improvement. The interviewees' feedback is summarised below and highlights a range of aspects of the IDS that interviewees perceived had influenced design integration, team integration and design outcomes.

The Aged Care Active Community initial client brief was seen to be crucial and for this studio the brief was not well defined in its detail. During the second week of studio the client presented an overview of the requirements such as the aged care categories to be accommodated, the number of beds and staffing ratios, together with the standards set by the Australian Institute of Health and Welfare. In response, the architecture students, working in groups of 3, undertook some good research around this building typology and energy usage

and made their own return brief. Interviewees noted that the brief evolved further along the way via conversation and presentation as designers processed the design requirements and began to form design responses. The less well-defined client brief was not observed to hinder the desired integrated design work. In the context of a fast-track studio process however, the more information provided up front was seen as key to helping students focus on what they are being asked to do. The client offered that they could have assisted students by providing more information early to give clarity around this building typology and what this aged-care setting required and the practical considerations of that environment.

Design Inspiration for students appeared to come from a variety of sources including talks and precedent projects and to a great extent the consultant presentations. Interviewees observed that one group struggled with abstracting ideas from these sources and settled on a familiar architectural form. Another group had a mature understanding of the urban implications of architectural concepts, and this played out well in their attempts to do something quite different. This group also recognised the repeating pattern of accommodation within the briefed requirements and used this to anchor their explorations of form. Another group found a source of inspiration in an interpretation of Chinese Tsusho Garden methodology which they were ultimately able to make work. Interviewees noted some specific things in the brief, such as 'village like character' were picked up on, but engineering and sustainability aspects did not appear to inspire very strongly.

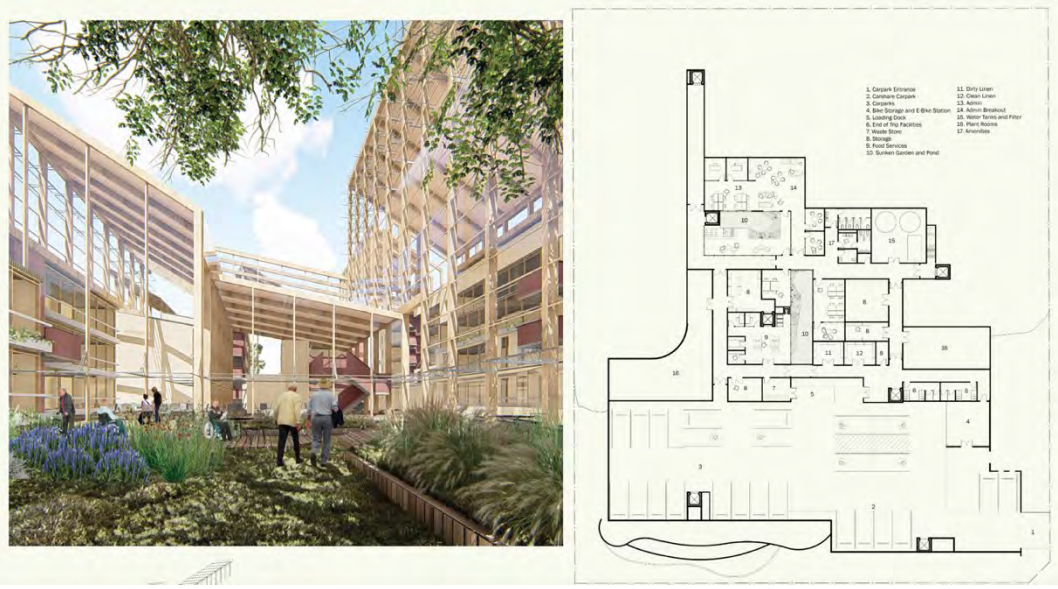


Figure 14: Modular housing and village accommodation – Bridget, Claudio, Ian

Design co-authorship was evidenced by a good overall integration of architecture and engineering principles. It was felt there was a good balance of that in this studio and they all learned that it was more about the process than the result. Balancing individual contributions to design co-authorship proved a challenge in some groups, depending on the relationship between students and individual circumstances. It was noted that the engineer in each group constantly brought up the topic of sustainability and generated helpful conversations, but the architects did not necessarily share the architectural conversations with the engineers. One participant observed that during his engagement with some groups the engineers offered insightful comments and that … "*engineering students seemed to embrace the opportunity to get involved in architecture, but I didn't see that same strong sense from the architecture students … who had more of a tendency to see the engineering as an add-on* …". (David Pryor, Industry consultant).

So, there were challenges and some stray notes where it was not quite working such as when students wanted to add engineering on a whim, which was discouraged, or literal takes on the use of technology without consideration of the impact on the spaces and what it would feel like using these spaces. It was suggested that some 'structuring' of design group activities to include an early planning session may help students get an early measure of each other a bit more and at least understand what each will bring to the table.

However, there were many opportunities for co-authorship with one interviewee noting that orientation was well responded to, and roof forms were significantly influenced by engineering input, such as the use of roof areas for photovoltaics and the strong use of timber that may have been encouraged by engineering feedback as to its sustainable qualities.

The architectural response to the initial engineering modelling was critical and the engineers provided good scope for the modelling to influence the design, such as solar carving where the building form evolves from the fall of sun/shadow. It was remarked on, that individual designers showed real evidence of environmental principles being integrated into the architectural form. The environmental consultant noted that *"… the exploration of what an extreme sort of engineering or technically performing solution might look like … and the exploration of form making, (*brought) *into play a more aesthetic or principles-based approach to the architectural design …* (with) *some real pointers in the form making explorations about which forms led to the best (*performing) *environmental solutions … that in turn led to some of the most distinctive outcomes presented in the final schemes that embraced some strong passive solutions … This was a powerful point in the process*."
As the studio leader expressed it: "*They all came to the table converted to sustainability and … it was a big challenge for these students to understand that they cannot reject good design in favour of sustainability... there's a lot of things architecture does beyond (sustainability) and there are lots of things we can still do with the palette of sustainability."* (Toby Reed, Studio Leader)
By the end of semester each scheme showed a good level of intelligence in the sort of environmental and engineering systems being integrated into the project and some 'powerful points' in the final presentations.

Figure 15: Georgia, Holly, Dom – southern aerial perspective

Inter-Disciplinary Collaboration was perceived to have played out in a very positive way and 'improved things', but not necessarily the aesthetics. Interviewees felt that the group dynamic had a strong influence on design collaboration through building relationships and a team identity. The observations were variously described in terms of friendship, group dynamic, synergy, equality, balance, motivation, power balance and insight. The team outputs were prescribed by the studio leader, but in terms of re-defining engineer/architect roles or an equal emphasis on design input, the team structure was not prescribed, although it could have been. In a collaborative environment, navigating how each discipline can integrate themselves in shared decision making and be useful in a common design output, will present challenges. All groups benefited from actively involved engineers whose contributions ranged from well researched sustainability and engineering systems information to active involvement in the process and presentations and, in some instance, design decisions. It made sense that every decision was thought through a few ways, rather than deciding just for the sake of it. The differentiation between each of the bi-weekly studio sessions (architecture/engineering focus) was seen by one participant as a clarifying influence for engineer/architect collaboration.
The group structure enabled good collaboration but did not drive it. This was attributed to the studio context, where "*the building design became the framework for the integration … providing a strong contextual space to organise the steps of the design process."* (Toby Reed, Studio Leader) providing students with an intelligible context within which to work. For students' first encounter with an integrated design challenge, this approach of immersing students into a strong contextual project space was perceived as a forceful driver of collaborative and integrated outcomes by the "… *exploration of what an extreme sort of engineering or technically performing solution might look like …"* (David Ritter) and the "*... bringing together of the extreme engineering and architectural ideas and using this as the point of integration* (David Pryor, industry consultant).
One interviewee observed that the degree of integration shown at the final presentation indicated that a lot more collaboration and integration had taken place that was not apparent in earlier presentations - a reminder that a great deal of the engineer/architect collaboration happens quite rapidly and, perhaps unconsciously, within a

collaborative group environment. The ability to rapidly process information and design challenges and the natural/unconscious cross-disciplinary engagement that evolves in a group environment are desirable goals for an integrated design process particularly when applied in industry.

The timing of the collaboration was seen by some participants as being crucial to the success of this studio, in that the engineering students were there right through and that was seen as crucial in generating multiple opportunities for regular interaction and enabling the team to bond together more easily.

"*The more time they spend together, the more time they can gel together the better … how do you make a group really understand each other, and gel with what they each have to do and how they can contribute to that?* (David Ritter, sustainability consultant).

The timing of the client's input was also perceived to be crucial, with a strong client preference for early engagement to clarify questions about the brief as early as possible and before design activity begins.

Figure 16: Integrate and adapt – Bridget, Claudio, Ian

Designers Struggled in several areas including the shared struggles of balancing individual workloads when working in groups and the struggle to be a bit more experimental and flexible and going that step further in some of their sustainability research. It was perceived that designers grew in confidence about what they were doing on a sustainable level however, they did not portray the same level of confidence in creating a building as a "piece of urbanism". It was noted that the areas of least confidence were in creating a community, where people want to hang around". (Toby Reed, Studio Leader) The studio leader noted that students are used to fulfilling one 'task' or outcome, not 2 or 3 at once, which raised the question of how to help students engage more rigorously with the more challenging integrated design environment.

Much of the architect/engineer barrier was understanding what each could bring to the party and, in David Ritter's words "… *you can't speed that up because that's their learning pathway … and, for a certain number of students this revealed a lack of clarity as to how one discipline and another discipline or one pathway of design development and another way of looking at design development could mesh together …"*

It was suggested that the studio could be structured more "… *so we don't just pigeonhole them into the roles they have in industry."* (David Ritter)

Design struggles were observed in the planning challenges of large-scale buildings with many rooms/spaces and complex circulation and access and other competing priorities. Students are also not used to working with constraints so attempts at doing good architecture were a bit excessive, or wasteful in materials and not sustainable; they didn't know how to make a good building with less rather than more. Finding the balance between design rigour and a less constrained approach was a challenge that they did not really take on board despite the additional resources available in their groups.

Other students did not expand their research into applications of sustainable systems beyond the familiar so, they missed opportunities for multiple use applications. Although mindful of passive design as a key driver of sustainable outcomes, with orientation of particular importance, some designers struggled with the design rigour to respond to, for example, elevational treatments for different orientations. Some designers did not really understand the environmental issues sufficiently well to create a design solution around it or were not engaged with the technical performance of the project or simply, as suggested above, were more challenged by thinking in an integrated way.

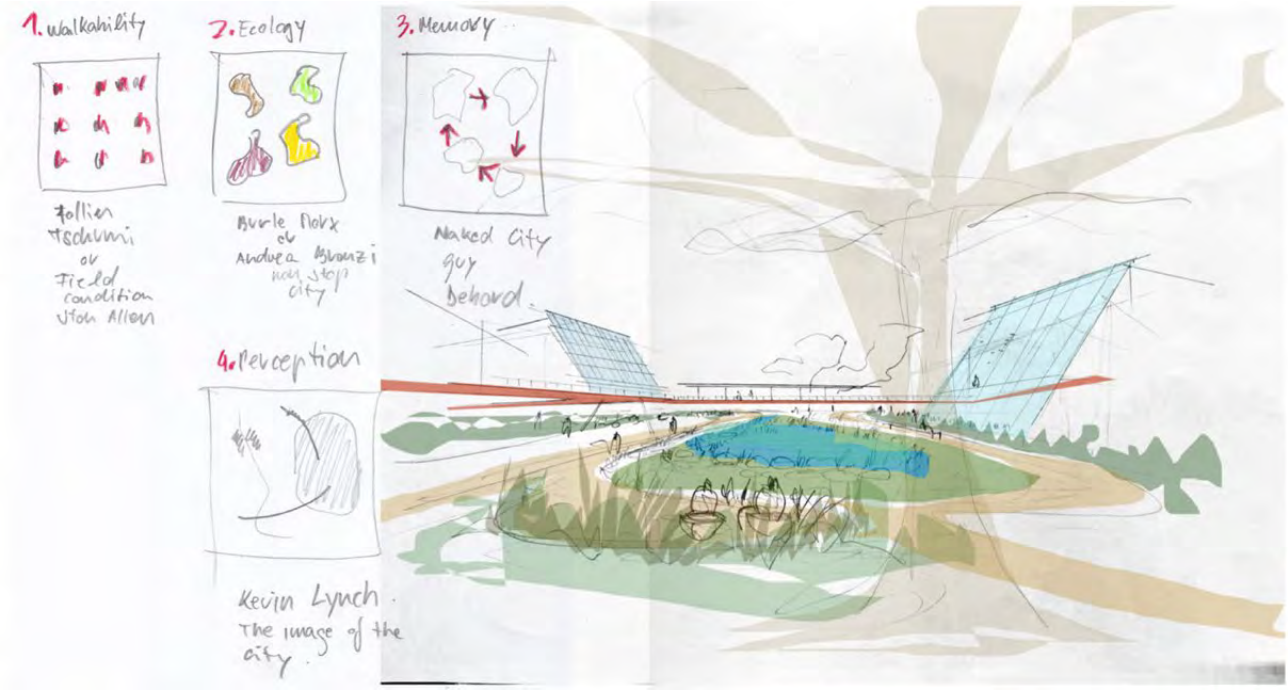


Figure 17: Claudio Torres, integrated thinking

Studio Guidance was purposefully structured to engage designers in what might be termed the design equivalent of 'method acting' where, as mentioned earlier, the building design provided a strong contextual stage to immerse designers in a space set within the limits of extreme architectural and extreme engineering solutions. Students were first asked to work in groups to explore these extremes, placing each group of students into the heart of what was possible for each discipline. They were then asked to take the best aspects of each extreme and, via a collaborative and balanced effort, bring them together as an integrated solution. The decision to work in groups within this studio structure was perceived by all participants in a very positive way.

As semester progressed the studio leader constantly reminded students to look at things from different viewpoints and not fall into the 'normal' lead/sub-consultant relationship; assisting students to clarify where they were at and how they perceived the project by countering different viewpoints and integrating those aspects that enabled optimal performance of their design proposal from functional/aesthetic and technical/engineering points of view. It was noted that sometimes they would look at things from too much of an engineering point of view and conversely sometimes too much of an architectural point of view; finding the balance was a challenge and some just 'muddled' their way through.

The constant presence of the industry consultants in the studio offered great value for students in gaining insight into the integrated design process, such as testing and refining of proposals. The 'penny dropped' for some of those encountering an unfamiliar design process simply by asking questions of the consultants. The consultants "*… engaged with those (students) who were more engaged … but if they are not asking the questions … there's not much we can do*." (David Ritter)

The Industry Consultants included an environmental engineering team and a guest architect with a specialist focus on aged care. Industry consultants collaborated with designers weekly or twice weekly in the classroom and interviewees were unanimous in their perception that students understanding of environmental issues and associated solutions improved as semester progressed and they felt most confident about what they were doing on a sustainable level.

The environmental engineering consultant team assisted students in the classroom with challenges and questions, providing support using the tools for testing building performance, trying to look at how their proposals performed from daylight, solar, and energy perspectives and offering advice and feedback on group proposals then refining those proposals. They challenged students to undertake an exercise looking at these aspects and produce a booklet illustrating the full out depth of those exercises. Dedicated one-on-one studio sessions assisted those more engaged with the technical side. Some students were delving more deeply than others into technical solutions and using the modelling tools and testing. Others sought information about specific sustainable design propositions at a somewhat more superficial level but still focused on the principles of good environmental design. For the consultant, the goal was to see the kind of pathway that was followed, see some effective application of analysis and testing, and see design inspiration.

Figure 18: Alexa, Sherry – aerial view, final presentation

Some engineering students initially felt overwhelmed by "*the challenge of working in an integrated team and being part of the research, the analysis, the testing of design proposals and, in a way, performing that role as a technical consultant*." (David Ritter) Impromptu feedback from students at the end of semester indicated that the guidance provided by the Atelier 10 team was very helpful.

The specialist architect engaged designers in discussions and tutorials around design principles relevant to ageing, based on what designers brought to the table, and clarifying thinking, highlighting weak points, helping to stimulate ideas, and assisting with the integration of sustainable features for this building typology. They were encouraged to think of design elements as capable of performing multiple functions, and thinking at a broader environmental scale, such as circular systems, positive activity, and asking critical questions such as "do we need that much parking?"

"… for example, (lifts) both consume energy and they're important in providing universal access … when the lift breaks down … provide attractive stairs, so that those who can use stairs … become more resilient and fitter and healthier as a result." (David Pryor, Specialist Architect)

Maximising Input was something interviewees felt can always be improved so they provide more help to students. Suggestions of what form this could take ranged from giving weekly mini-lectures, better examples of integrated design challenges and examples of how to see things from different points of view and being more 'assertive' about the timing and nature of input for student benefit. It was suggested that the architect/engineer consultants could occasionally interact in the classroom. However, as expressed by David Ritter:

"… it's a messy process and you've got to be prepared for students to be a bit scared, or their feathers ruffled a bit because they're outside their comfort zone. And you've got to be a little bit open minded about what results come out of the process. So, we try to set up a framework for them, which covers presentation, feeding them

some ideas, giving them some precedents, showing them some tools, and letting them practice with those tools, and giving them some feedback and allowing them to freely create with what you've given them … for those students who engage with that, it's a powerful learning experience. Whether they go this way or that way, … or get the wrong end of the stick here or there, you can't be over everything that's going on. But it's them being engaged with that process, which is the powerful learning experience.

Enablers and Barriers to Integrated Design exist in the studio just as they do in industry. Interviewees made various observations around this subject such as the need to find the right engineers to work with, which can be hard. The right engineer will collaborate by throwing multiple ideas into the mix and solutions arise from the collaborative dialogue. Many engineers resist collaboration as they are usually in separate firms, and their attitude of mind is to provide the input they are asked for, stick with BAU, and not take the initiative. There's risk associated with changing core business activities such as scopes of work, contract terms and fee structures. Landscape architects were noted as more ready to collaborate with traditional demarcation dissolved - each embraces the other's thinking more and more. Students are encouraged to think beyond their own scope. Tight timelines in industry are reflected in the studio environment. You only get short sharp moments to gel with one another and find a pattern of working together and you must go out of your way to make these things happen. This level of understanding and collaboration requires disciplines to go deeper and go beyond their typical scope and spend time in each other's territories.

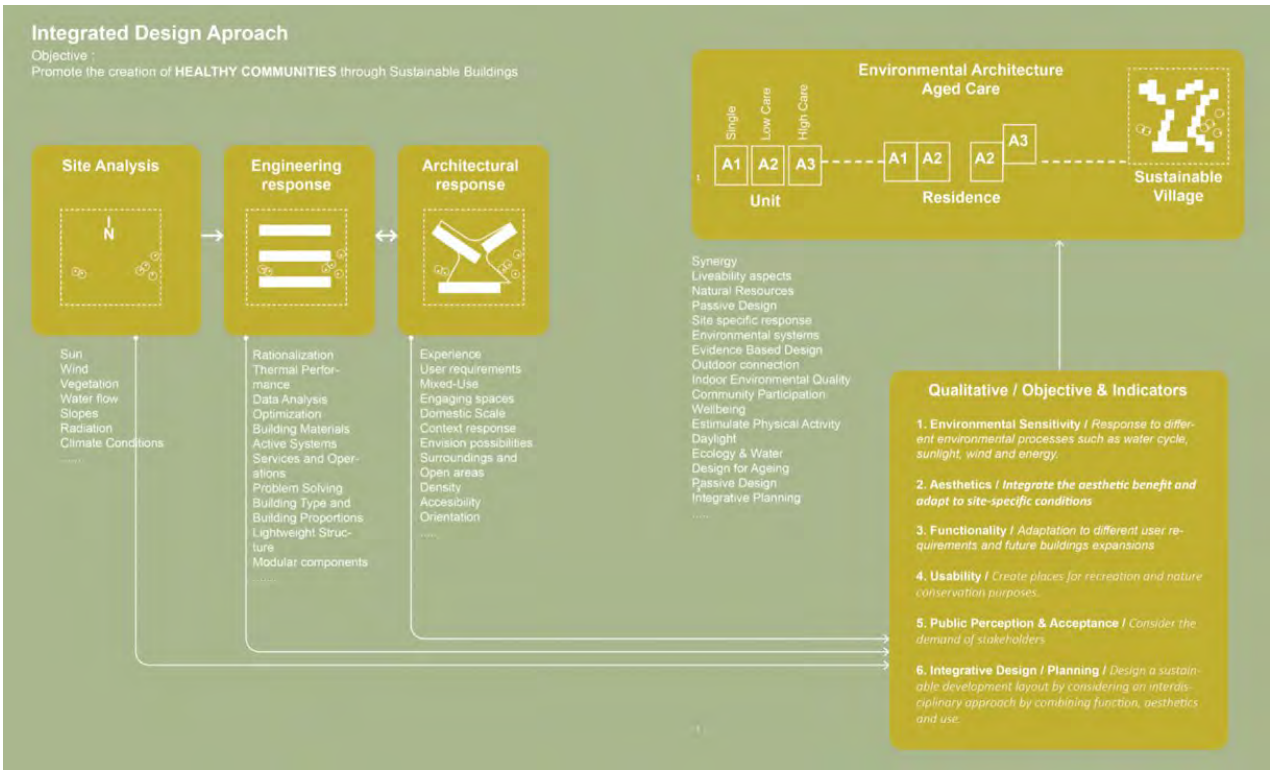


Figure 19: Bridget, Claudio, Ian – integrated design approach

Most clients see sustainable solutions as costing more; this focus on capital budget vs lifecycle costing is a barrier despite statistics that bear out for every $1 spent on good design you can save 10:100:1000 times in construction: maintenance: running costs.

One interviewee emphasised the importance of pushing the idea of co-creation and pushing the idea of "*generosity of spirit … adventurous spirit … to see how an integrated solution could be".* This studio illustrated how some engineering students saw a different way of working and communicating ideas and readily jumped into the architects' shoes, because they could see clear benefits whilst architects were able to appreciate how engineering systems could benefit their proposals.

Learning Outcomes for Students and Usefulness of Studios

Participants overall saw it as a "… *good, shared learning experience* …". Earlier noted impromptu feedback from students highlighted how initially overwhelming it was for them to take on a role in an integrated design

studio, where they would be part of the research, the analysis, and the testing of design propositions. It was clear that these students felt very supported and learned a lot from their interaction with the environmental engineering team and "loved" the experience. Interviewees felt that it was a great thing for students to be involved in. Students learned a lot more out of the process than the project that came out of it by being heavily encouraged/gently coerced to think in different ways – a seemingly essential goal for designers preparing to enter industry. In the context of the reference to method acting, the studio leader commented that "*… it's a good process for them to go through and perhaps the results will happen later – a delayed response.*"

Familiarising students with some of the disciplines who are players in the building game was seen as an opportunity to build realistic expectations for students' as they enter industry; and, if they could repeat this experience more than once, all the better. "*One distinguishing characteristic of architects is that they are good at integrating. So, if we don't produce graduates who are good at integrating inputs from various disciplines then we've really failed*." (David Pryor)

Some students had their eyes opened to what the design process is really like: "… *a kind of messy collaborative affair involving lots of technical consultants and designers* …" (David Ritter)

Group discussions between students and consultants indicated students were all on board with the key concepts and ideas and technical solutions that were fundamental to their design propositions. The client felt that "*It's definitely useful to be able to equip themselves with the capability to cope with the changing working environment outside …* (and) *to think outside the box and work together with the other disciplines."* (Hing-Wah Chau, Kris Chau).

"*They all would have learned, intuitively, a lot out of it … that would have been much greater than the actual project that they got out of it.*" (Toby Reed)

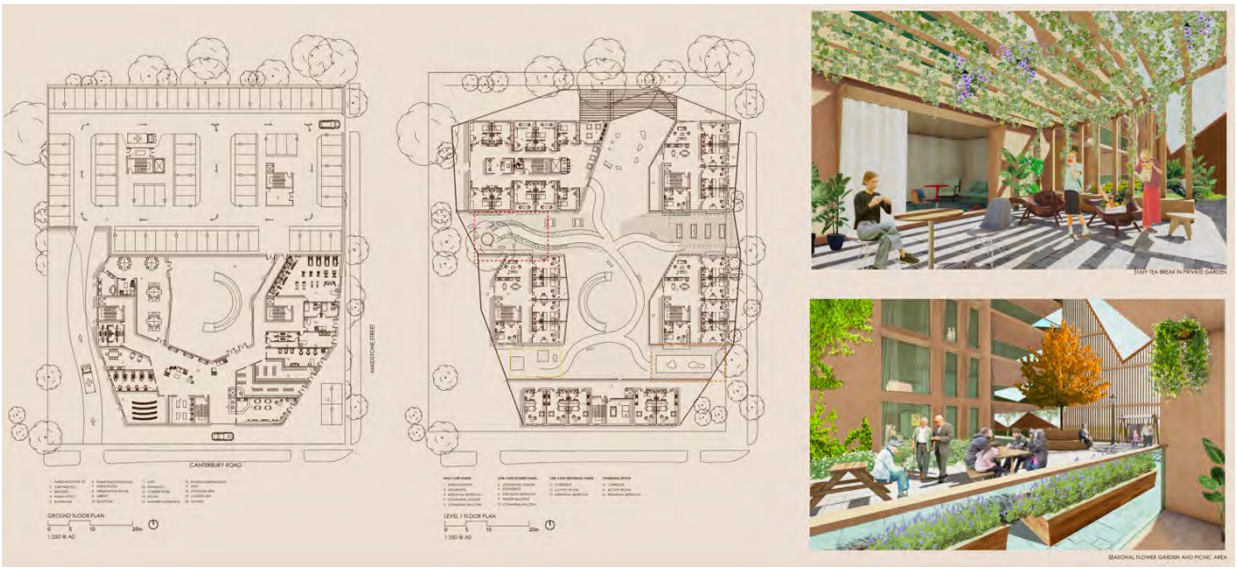


Figure 20: Carol, Skye, Morna – The Nest, plans and views

4.3 Feedback from the participating students

Students who attended this class were mostly new to Environmental Design, with most arguing they had no, or little-to no prior engagement with the topic before starting the IDS. Only about 20% had come across Environmental Design in other classes.

Students listed: *Time assigned to the dialogue between Architects & Engineers,* as the key design-drivers affecting successful environmental design to achieve renewables/zero carbon goals, followed *Level of existing expertise of individual contributors, and Imagination and creativity.*

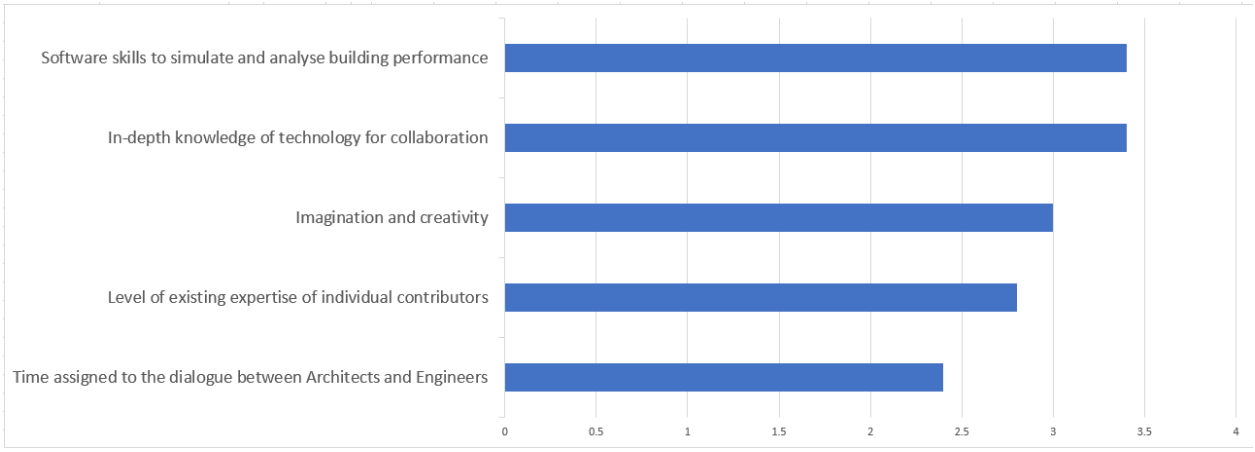


Figure 21: Key design-drivers affecting successful environmental design (with smaller numbers ranking higher)

Overall, the majority of participants felt that the client's brief supported them in achieving a balance between architectural and engineering design, yet 20% of participants were more critical about the brief, resulting in a median score of 3.5 (out of 5) in judging its quality. Asked about the impact the brief had, and the way it was written/communicated, most students seemed to appreciate it overall, yet would have preferred more clearly articulated (in writing) goals: *The brief reminded us of the 'real world' considerations of the design, and was driven largely by how affordable the running costs would be.* One voice was in particular critical suggesting: *The studio's brief was ambiguous because there was a different evaluation parameter for engineering and architecture students, respectively. That has an impact on the way that students distribute their workloads and time commitment during the workshops. Consequently, the brief was very problem-oriented, focusing on resolving a building facility rather than accentuating the focus on the integration across the design process.*

Prompted about the most critical decision-making points when balancing architect/engineer input for generating environmentally optimised design solutions, students listed: *defining the priorities of the design team at the conceptual strategy stage, balancing the inputs of different disciplines, considering Energy efficiency and ongoing management costs, and weighting off natural light vs thermal efficiency.*

The inspiration for Aged Care design. Overall, students listed *architectural precedents, Passive Design, health & wellbeing considerations, and ideas from conversation with the engineers,* as key factors. One student argued: *I found the Passive Haus precedents that combine performance & aesthetics immensely inspiring.*

According to the students, the engineers contribute to the authorship of design solutions primarily via *supplying background data and knowledge,* by offering *consultancy-type feedback, and by providing initial idea inspiration*.

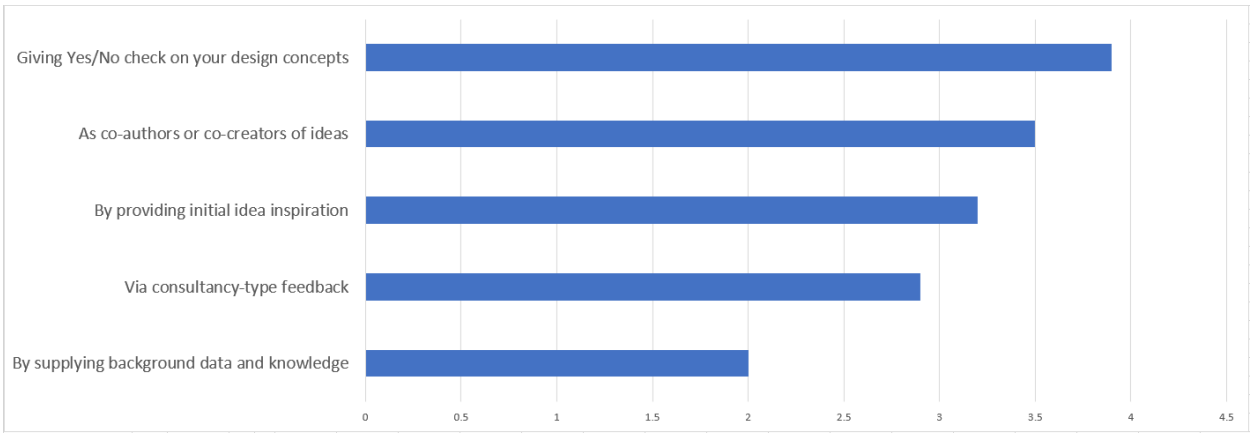


Figure 22: Reflection on input provided by the Engineering Consultants (with smaller numbers ranking higher)

Asked about the most useful guidance by the consultants, students referred to professional guidance such as: *information regarding the effectiveness of our solutions, introducing sustainable and Passive Haus principles* and in particular the use of computational tools to iterate Passive Haus solutions. One student explains: *Systematic environmental knowledge and software skills helped us to find the start points and to find proof to improve*.

With a median score of 4.7 (out of 5), nearly all students argued that the input by consultants strongly increased their 'level of understanding of' environmental issues and associated solutions.
Students acknowledged the benefits of via face-to-face meetings and the focused software tutorials for the Passive Haus plugin for Rhino Grasshopper. A critical voice commented: *It would have been valuable to introduce the tools much earlier in the class. We probably didn't need so many conceptual presentations since sustainability is pretty ubiquitous now. There could have been a consultant with specific mass timber design experience to help drive and refine that part of the design*.

For this iteration of the IDS, students appeared very satisfied with the collaboration between architecture and engineering students. They rated the quality of collaboration 1.8 points out of 5 (with 1 being best and 5 being worst), with all participants stating that they learned a lot from each other.

One student reported: *Our team gained a deep appreciation for each others' skills and contributions. We were able to prepare and share different tasks in order to collaborate on a final design.* Comments like these point towards the benefits of face-to-face collaboration for such studio contexts.

In IDS-07, students did not sense that they had to compromise aesthetics and functional design aspects when balancing architectural and engineering concerns (median score 2.3 - with 2.5 meaning '*neither-nor*'). Hence, in this IDS, we see little evidence that the performance focus impacted the design aesthetics of their project outcome. One student argued: *Personally, I think environmental comes first and aesthetic comes second. Although sometimes it is tricky to balance both, I think it is still manageable.* Another student says that conflicts could be avoided: *…because the architects would switch their thinking of what constitutes architecture to enable us to design the environmental systems to complement spaces. Also, the engineers worked with us to find a solution that worked for us.*

Despite the overall positive feedback about the IDS, students also reported several challenges when advancing their design-thinking with environmental/engineering constraints in mind, listing: '*Time-constraints on projects*', '*education in isolation'*, and their *'knowledge gaps'* as the main obstacles.

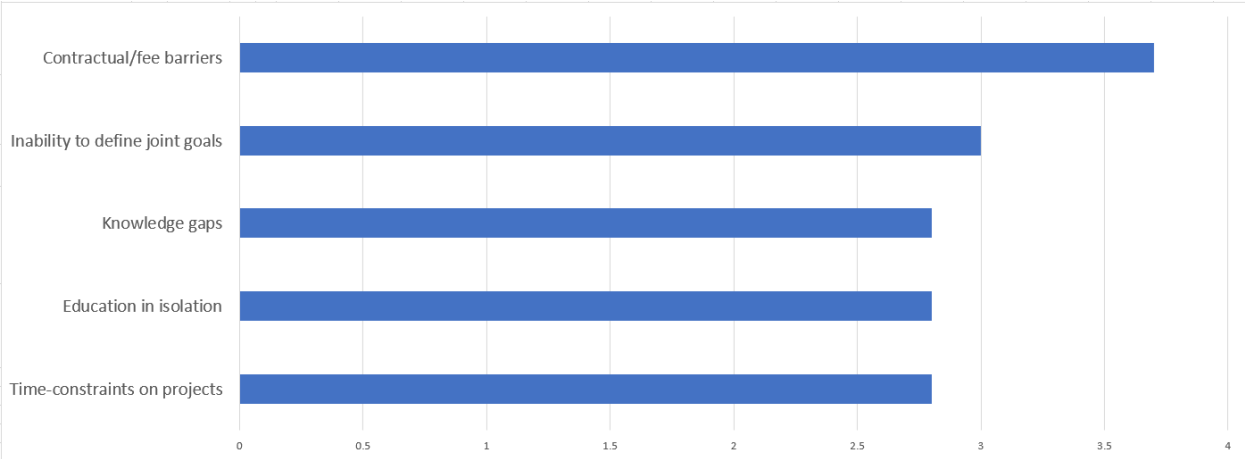


Figure 23: Challenges reported by the students. (with smaller numbers ranking higher)

Additional struggles reported by the students were expressed as follows:

- *As engineers' and architects' foundations of knowledge are quite different, it was hard to balance the principles of the design.*

- *Insufficient support in the design aspect - we were given a lot of information around the engineering aspect but relatively little guidance around the architecture.*
- *Finding appropriate engineering precedents especially for an aged care setting*
- *For an architect, it takes time to get used to engineer tools. It helps to have an expert on the team, but if the student personally has little experience using that tool, it is hard to understand the reasoning behind it.*

Overall, the introduction to Integrated Design as part of the studio was well received by students with one of them defining it as follows:

I think integrated design is a process more than a particular solution. This specific case is a nested process between architects and engineers, but this could also include planners, landscape architects, policymakers, etc. The integratedness of this process is given by the level of interaction and co-participation of the group members, also their different skills and profiles/backgrounds. Design integration can also be a way of synthesising the complexity of technological systems that require more than one function; in the end, we are studying and working towards carbon neutrality and reflecting how we can challenge new practices to address environmental sustainability in the built environment.

The question about the usefulness of integrated design processes as part of their university education, elicited a highly positive response, with 90% saying it was 'quite' or 'extremely' useful. Yet 10% highlighting that they were not convinced integrated design should be addressed in academia (median score: 4.5 out of 5).

5. STUDIO DESIGN OUTPUT - Select Examples

A select number of 2 student group projects (Group 1 and Group 4) have been taken further by the Engineering Consultants (Atelier Ten) in order to consolidate feedback and extract some key data. They also established an Energy Use Breakdown typical for an Aged Care facility of the size/typology investigated as part of this IDS:

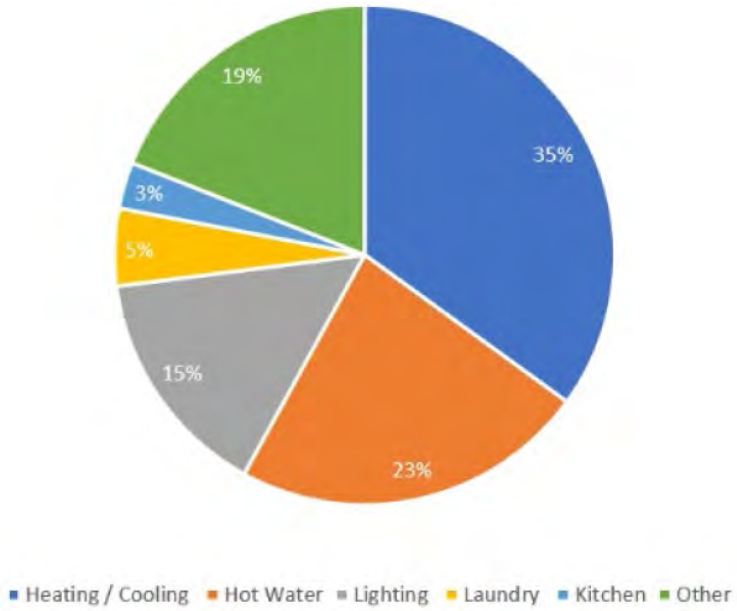


Figure 24: Energy Use Breakdown – Aged Care facility

The following two sections summarise information contained in Atelier Ten's consolidation/vetting document. The full 15-page document can be found as an appendix to this document.

The scope of the students' proposition has largely related to energy efficiency and carbon reduction, since the Zero carbon target had been introduced to them as a key part of their brief that they had to investigate. One notable aspect of the student work is the use of a software plugin PHPP (via Rhino/Grasshopper), that allows them to interrogate their 3D designs according to Passive Haus principles.

Within each IDS project, there were many common active and passive sustainability initiatives applied, however each student group achieved slightly different and innovative ways to incorporate this into their designs.

Within the work of these two groups, four key carbon reduction measures were identified:

- Low Carbon Construction Measures
- Key Passive Measures
- Key Systems Measures, and
- Renewable Energy Systems Measures

5.1 Passive Measures

Some of the initiatives introduced by the students were progressive or innovative and provided some new ways of thinking about and designing aged care facilities. Both groups tested their designs within the PHPP interface, developing performing façades and optimising glazing placement (Group 1), as well as using a hybrid concrete and CLT structure (Group 4). Key initiatives can be summarised as follows:

- Passive solar orientation

- Stack / cross ventilation
- Double/ triple glazed windows
- Stack / cross ventilation
- Thermal Breaks

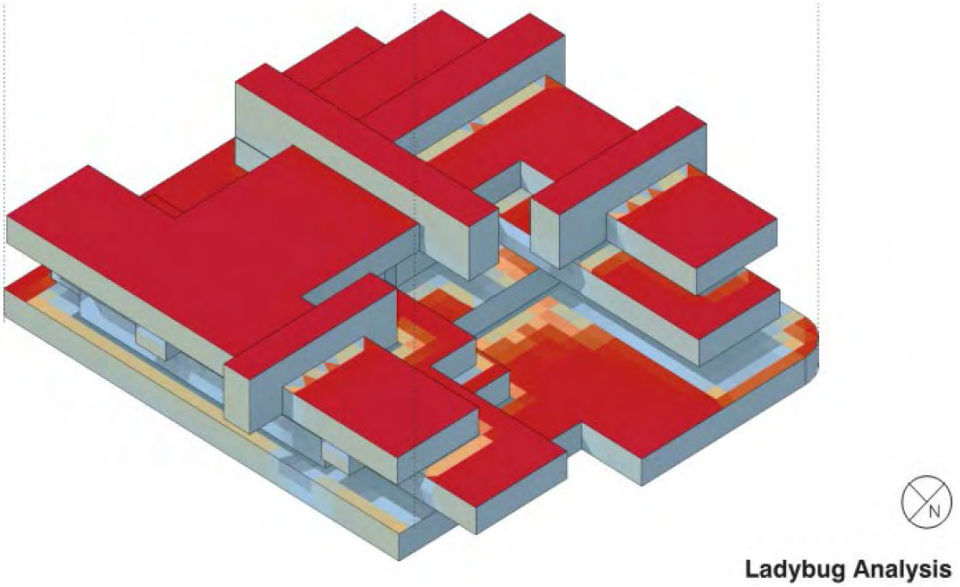


Figure 25: External solar radiation analysis undertaken by students in Group 1

5.2 Active Measures

Next to addressing passive measures, a number of active measures were proposed by the two groups in this studio. As an example, Group 1 undertook an electricity usage analysis in order to correctly size and orientate their photovoltaic system to the maximum benefit. Group 4 used a similar approach to determine the amount of electricity required for the facility and to understand from what sources they could draw this electricity. They ultimately implemented a 135 kWh battery system to offset their electricity usage across the yearly variations.

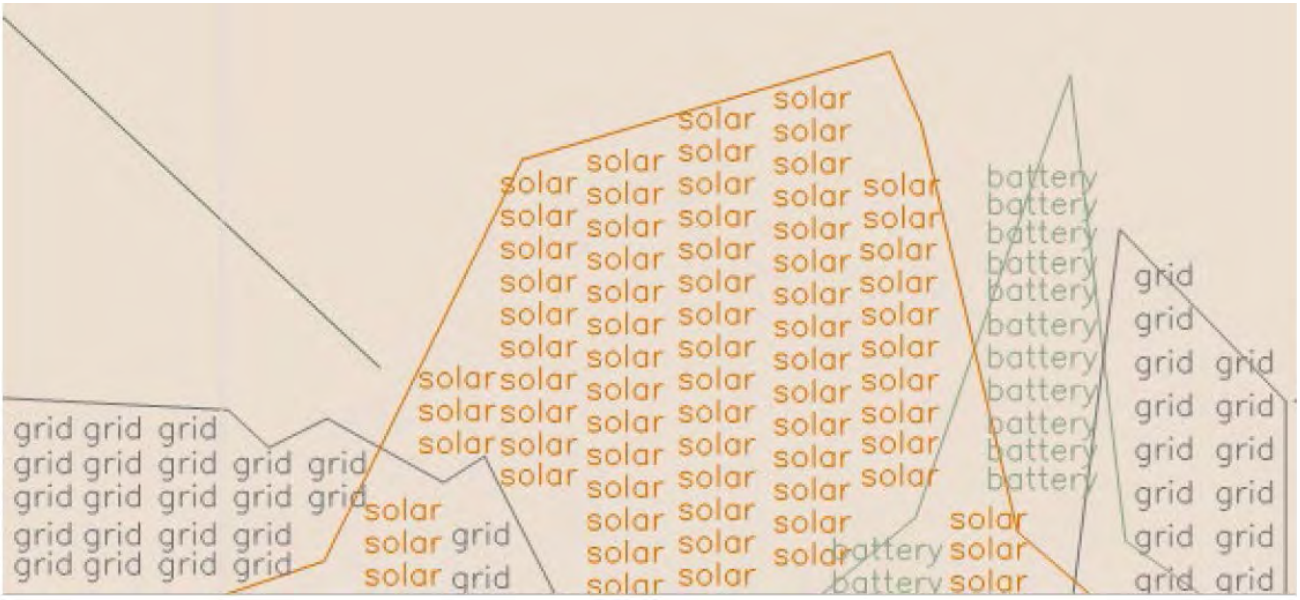


Figure 26: Mapping out annual energy use sources (Group 4)

Key initiatives can be summarised as follows:

- Photovoltaics
- Ground source heat pump
- Recycled water-cooling tower
- Underfloor heating
- Biodigester
- High efficiency LED lighting
- Battery Systems

Atelier 10 noted that: … *some groups took the step towards battery storage to further offset their energy usage, which can often lead to quickly declining benefits as the system scales up, both in terms of cost and impact on the environment. However, their proposed strategies in terms of sizing fell within the expected range of what could be considered appropriate for the scale of the development*.

6. SUMMARY OF CONSULTANT VETTING – Performance relative to BAU

Atelier Ten's benchmarking studies found that the schemes developed by students pushed the envelope of what defines a high-performance aged-care facility:

Students were able to show with the use of a high-performance façade, efficient use of fittings and photovoltaics, that energy savings of up to 60-70% (compared to Business as Usual – BAU) *could be achieved. This is especially significant considering the energy intensive typology which is inherent to aged-care homes.*

In analysing the possibilities presented by students in their design of a 3-4 storey aged-care facility, Atelier Ten assess that: *Whilst significant energy reductions were seen across the board when assessing the student proposals, reaching a truly net zero design was out of reach. This was acknowledged early on in the design studio as being an extremely difficult target to reach given the high energy demand and the 3-4 storey nature of the aged-care facilities proposed (resulting in a reduced roof area to floor area ratio) limiting the ability for rooftop solar to fully meet annual demand.*

Regarding the breakdown of carbon reduction measures, Atelier Ten highlight that their assessments of performance improvements are based on readily available, real-world technologies that *pave the way towards future feasibility of truly net-zero aged care facilities* with a strong focus on occupant health and well-being.

In more detail, the Atelier Ten BAU comparison *shows that up to 57% energy saving compared to business-as-usual could be achieved through a cumulative combination of high-performance passive design measures, optimisation of HVAC systems, and consideration of on-going operational energy management*.

Their benchmarking study suggests that the use of photovoltaic could reduce energy demands by another 14%, bringing to total to up to 71%. Atelier Ten note that due to the energy-intensive nature of the aged-care building typology*, it was unlikely that using a purely solar energy would be able to meet the demands required. As such, the figures of being able to provide roughly 45%-65% of the onsite energy through maximising PV array size and positioning, reflect a well-considered and accurate assessment of the limits of current technology*.

A detailed quantitative breakdown of Energy reduction measures can be found in Figure 27.

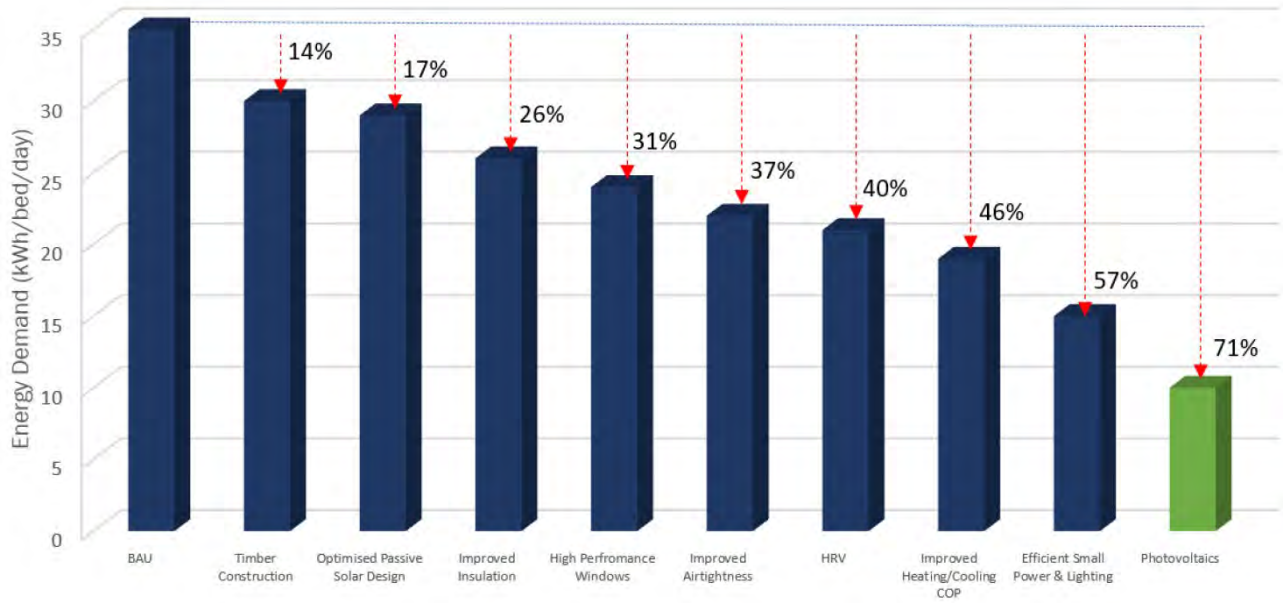


Figure 27: Atelier Ten: Aged Care Facility – Energy Reduction Strategies

7. CONCLUSIONS

7.1 Conclusions and Next Steps

In all, IDS-07 was a highly successful studio, both in terms of learning outcomes related to integrated design, as well as the investigation of new technologies for carbon reduction in aged-care facilities. It was the first IDS with an opportunity to be run entirely face-to-face, which allowed the studio to be investigated very closely in class.

Four group projects were developed to completion and explored a wide variety of technologies and innovations to achieve Net Zero carbon goals. Approaches to each design were very different across the groups, yet it was illuminating to observe that most proposals tried to push the boundaries whilst meeting the functional and operational needs of an active and connected Aged Care facility.

Observations around the benefits of working in groups, within a well-defined project context, emerged. Each project was unique, yet some of the issues faced for design integration cut across all: questions of shared design authorship and balancing input, the varying emphasis/benefits of the integrated effort across different ideation phases, the curation of an integrated workflow, and the definition of common goals. These emerged as key discussion points in the first half of semester. Mid-semester presentations of IDS projects occurred in mid-April, following which project participants advanced their designs up until mid-June.

Further discussion points, arising from observations through to the end of semester, gave greater insight to the challenges and opportunities of working in groups with the focus in the second half of semester turning to 'Net Zero' principles and their impact on design morphology/performance. The hands-on experience of testing the performance of their designs (e.g. via the PassiveHouse plugin to Rhino/Grasshopper as introduced by the Engineers Atelier Ten) gave students a heightened awareness of the full impact of their design decisions and they took advantage of the opportunity offered to refine their design to improve its performance before final submission.

Following the final project submission/presentation, the industry consultants engaged in a vetting process to extract the essence of the most innovative concepts to then add more articulation around those. Their work highlights the potential of up to 71% reduction in energy demand for this kind of building typology. In parallel, the UoM academics gathered feedback from all project participants about the effectiveness and quality of the integrated design process, to feed back this information into this 100% IDS-07 outcomes report.

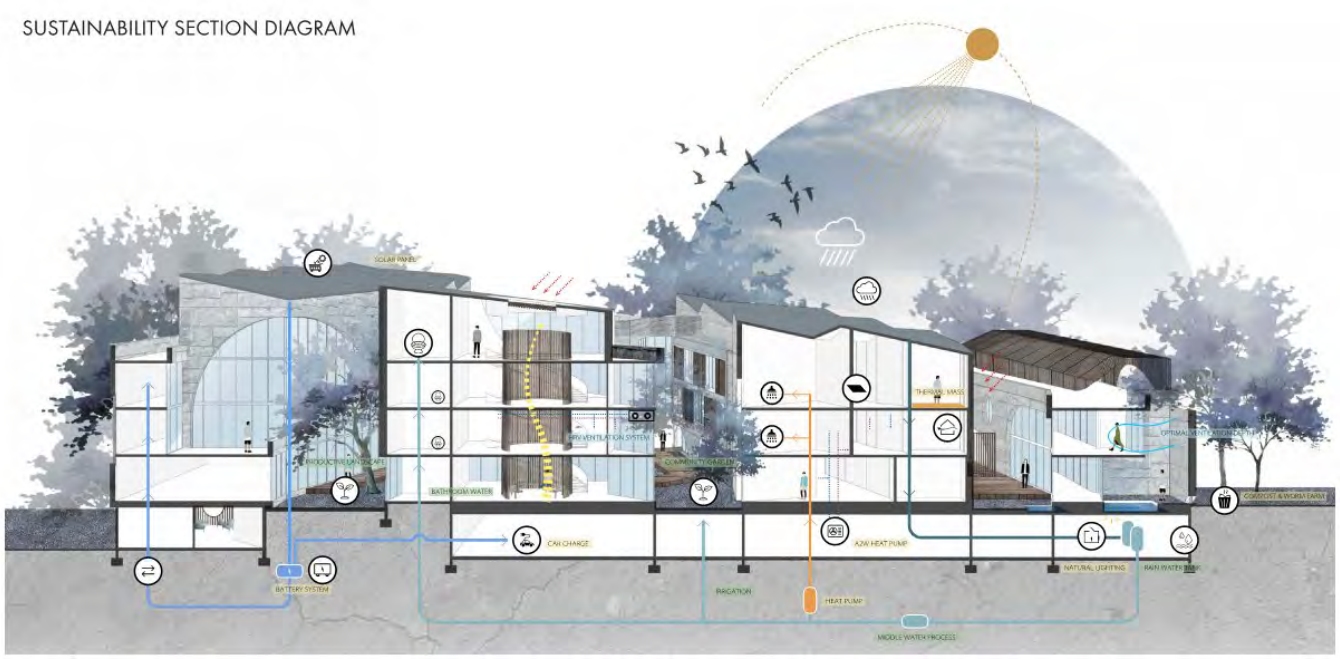
APPENDIX A – Engineering Consultant Vetting Report
APPENDIX B – Student Work

APPENDIX A

i-Hub IDS Student Proposals Vetting Report

Active Community Group - Aged Care Facility

Revision 01, 2021



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Revisions

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Contents

Executive summary

The student design work has been successful in demonstrating that the high performance, human-centric aged care facility can be achieved using passive design, energy efficient systems and on-site photovoltaic energy generation. The solutions presented by the student group are all readily available, known technologies which offer enhanced whole life cost performance over the life cycle of the project.

Readily Achievable Solutions

The body of student work has demonstrated that a set of sustainability measures can be applied to achieve a high performance, low-carbon outcome whilst providing a high quality of life for its occupants.

The technologies and systems proposed consider all aspects of the building and its occupant's interaction with it. Key strategies across all groups include:

- Optimised Passive Solar principles for winter heating and summer control
- High-performance building fabric through enhanced U-values of the building fabric
- Selection of low embodied carbon building materials such as CLT and recycled steel
- Large photovoltaic panel installations with on-site battery storage
- Biophilic integration for cooling and health purposes

Enhanced Life-Cycle Benefits

All of the above technologies have a beneficial economic payback over the life of the asset due to the energy and running cost savings making a sound business case for their implementation.

Enhanced Health Outcomes

The above solutions also offer health and wellness benefits that are a significant value-add to occupants of the aged care facility. Good daylight, access to sunlight, thermal comfort and well-designed ventilation systems are key indoor environmental amenity outcomes that benefit the health and well-being of elderly occupants. Whilst natural ventilation is applicable for a large part of the year on most sites, the use of heat recovery ventilation in winter is of particular note as a means of achieving healthy internal air quality and minimising energy use.

The student work also took the mobility, and activity of the aged populations which would be inhabiting the spaces into great consideration. Thoughtful design to incorporate biophilic landscapes integrated across the projects acts to further improve the comfort and well-being of guests.

1 Project Overview and Introduction

Active Community Group provided a brief that set out an ambition to address the challenges of a large aged-care facility with a high focus on community, constructing a 'permanent vacation' experience for its occupants. Simultaneously, the students were tasked with integrating a high-performance ethos into their designs, aiming for a zero-carbon operation in line with international Paris Agreement targets.

1.1 Project Overview

1.1.1 Emergency Response Station Brief

The students were provided with a briefing pack by Active Community group including the following information:

- Provide a retirement living village that includes both 55+ years old and 65+ years groups
- Design and delivery of 120+ beds for occupants, serving both high care (30) and low care (90) residents.
- Provide additional facilities that create a sense of home for the residents

The students were also provided with site context information for the studio design project. The greenfield site was located at 313 – 317 Canterbury Rd. Ringwood, at the intersection between an industrial complex and residential living. The proximity to the freeway afforded occupants and their respective family's easy access to the facility. It's low-lying environment and direct opposition of a golf course, opened up many opportunities for solar and natural ventilation access; however, opened the discussion of inclusion within the existing suburban landscape without dominating it.

1.2 Studio Introduction

1.2.1 Sustainable Design Brief

The sustainable design brief set for the students of this studio was to re-imagine a typical aged care facility with consideration of a broader set of briefing objectives:

- A net zero-carbon performance
- Passive design principles
- Low carbon construction and operation
- Sustainable Materials and Waste Management
- High levels of health and well-being for both the guests and the staff members

The 'real-world' challenges for the delivery of step-change innovation in line with the above ambition were principally determined to be the following factors that students were asked to consider in their research and design proposition:

- Cost
- Operational step-change and end-user buy-in
- Leadership
- Vigilance and accountability
- Integration with the typical needs and demands of a large age-care facility

1.2.2 Integrative Design Tools

As an experimental approach to this studio's teaching and learning experience, Atelier Ten decided to introduce 2no. performance analysis tools intended to enable the students to test their design proposals against net zero carbon objectives. The tools that were selected were:

- The Passive House Planning Package (PHPP). An excel spreadsheet energy model containing architectural building fabric and engineering systems intended for assessment of building design and construction energy performance in pursuit of the German Passivhaus standard.
- Ladybug Tools – Environmental plugin contained within the architectural modelling platform, Rhinoceros. Ladybug Tools hosts a variety of environmentally focused design tools which allow for a variety of real time analysis' to be undertaken such as: site studies, daylight analysis, energy usage and more.

Both tools were selected for their ease of access, and transparency in presenting the whole range of inputs and design variables that must be considered when undertaking a holistic energy and carbon performance assessment of any given design.

The PHPP tool is typically relevant to smaller residential analysis, being recognised as the industry best practice for high performance residential home design. However, it's ease of use within the familiar spreadsheet tool Microsoft excel lends itself to accessibility for all students and as an introduction to the key

aspects of high-performance building fabric design. Instead of modelling their entire buildings within the PHPP, students were encouraged to model smaller representative portions and extrapolate the information gained from these studies across their designs.

Similarly, 'Ladybug tools' was selected for usage due to its placement within a design ecosystem already familiar to the students who were already working with the Rhinoceros 3D design package. By further extending the functionality of currently used tools into the environmental design space, students could leverage the tool to quickly understand how design changes would manifest impacts in terms of their environmental performance. Key focuses within the Ladybug environment were given to daylight analysis, which was identified as a key factor in providing a healthy living environments for the elderly occupants.

The students were given a basic introduction and 3no. tutorial sessions covering the use of the tools with the expectation that they would use self-learning to develop their skills and understanding further.

It was hoped that by giving the students the capability to test their own architectural and engineering proposals it might provide a framework for learning through direct application, encourage collaboration between engineering and architectural students and encourage inter-disciplinary, integrative design thinking.

2 Studio Summary

2.1 Atelier Ten Input

1.1.1 Environmental Design and Engineering Systems Analysis Overlay

In addition to the architectural teaching program and engineering assignments that the students had been tasked with as part of their course, Atelier Ten provided an overlay of environmental design lectures and a series of tutorials to enable the students to carry out their own energy, daylight, and carbon performance analyses to test their design proposals against the ambitious zero carbon brief set for the project. The structure of this overlay was generally set out to support the fast-track design process within the 12-week design term as they quickly move in their thinking from masterplan to built form as follows:

- Introduction to the ambitious performance targets, precedents, and pathways to achieving them.
- Design exploration and testing of masterplan (form and massing) concept ideas against environmental engineering performance requirements
- Introduction to detailed operational energy and daylight analysis tools to allow refinement within the proposed built form.
- Tutoring and support to allow the students to freely produce their own outcomes using the learnt tools and techniques.

2.2 Submission Expectations

2.2.1 Expectations for Design Testing using Modelling Tools

A key aspect of the integrative design process that was presented to students was the use of energy and environmental performance modelling to inform design iteration. This is counter to the prevailing culture in industry where modelling and analysis tools tend to be primarily used for compliance checking after design has evolved.

It was expected that each student would carry out modelling analysis of their proposals using PHPP and Ladybug Tools, gain feedback from the exercise and run further iterative design development and testing in order to refine their design concepts towards meeting the ambitious brief targets.

2.2.2 Expectations for Final Submission

For the final submission, the students were provided with an A3 single page template for completion with the following contents:

- A short text description of the sustainability strategy for their project
- A sustainability strategy diagram (either a section or axonometric drawing) which explains the proposals
- A summary of how far possible it is to achieve net zero carbon in operations with onsite renewable energy generation
- Explanation of how students tested and iterated their designs based on environmental analysis

The format of the submission was kept deliberately succinct in order not to overburden the students with additional reporting requirements but provide a framework that challenged them to demonstrate integrated design working methods and successful refinement.

2.3 Working Methods

2.3.1 Encouragement for engineers and architecture students to collaborate

The studio was split into four groups, each allocated one engineering student. These groups worked collaboratively through the site analysis phase of the project and generally continued to collaborate as the studio program moved into individual project proposition.

At all stages of the process the architecture and engineering students were encouraged to collaborate. They were not necessarily encouraged to play the role of 'architect' and 'consultant' but rather work together as equals, exploring aspects of the design process that were of interest to them, rather than to be confined by preconceived roles. The key opportunities in this collaboration process were:

- Site analysis: with engineering students naturally supporting a summary of technical constraints and opportunities and architects contributing their understanding of urban planning and other softer constraints such as history, culture etc. An area of good crossover in their skillsets naturally seemed to be in the area of environmental design and sustainability.
- The process of modelling and testing design proposition to allow optimisation of form; the use of the PHPP tool provided an excellent framework for accessing this process for all students since it requires simple building geometry inputs as well as technical inputs related to engineering systems. It afforded all students the opportunity to be playing the role of both architect and engineer, whilst also encouraging them to have dialogue and assist each other with the data inputs.
- The process of modelling and iteration within the Ladybug Tools interface, which finds an interested intersection between the two fields of engineering and architecture. The tools, whilst existing within an architectural ecosystem, provide inherently engineering based processes and results which allows for frequent cross-over and collaborations within the different streams of students. The results encourage positive discussion within the groups and allows for constructive feedback with which to further improve designs.

- All students including the engineering students were encouraged to propose an architectural design concept and test its performance using the tools available or any other environmental design or energy modelling software that they were familiar with.

2.4 Programme

2.4.1 Atelier Ten teaching overlay

The following teaching overlay was added to the studio by Atelier Ten, with the intention of introducing some key concepts during the early part of the term and spending some time with the students in tutorial sessions to cover the key aspects of passive design integration.

Following the student presentation of their design concepts at mid-semester we focused on providing some tutorials to enable the students to run PHPP and Ladybug Tools modelling of their projects, with the final part of the term devoted to students having tutorial time where they could discuss their design iteration and emerging outputs.

Table 2.1: Teaching Schedule

WEEK	Atelier Ten Teaching Activity
WEEK 1	N/A
WEEK 2	Introduction to Integrated Design Presentation + Individual Environmental Design Tutorials
WEEK 3	Climate Responsive Design Presentation + Individual Environmental Design Tutorials
WEEK 4	Introduction to Zero Carbon brief + Individual Environmental Design Tutorials
WEEK 5	Introduction to Principles of High Performance Facades - Passive House + Individual Environmental Design Tutorials
NON-TEACHING WEEK	
WEEK 6	MID-SEMESTER REVIEWS
WEEK 7	PHPP Tutorial 1 / Ladybug Tools – Tutorial 1
WEEK 8	PHPP Tutorial 2 / Ladybug Tools – Tutorial 2
WEEK 9	Individual Environmental Design Tutorials
WEEK 10	Individual Environmental Design Tutorials
WEEK 11	Individual Environmental Design Tutorials
WEEK 12	Individual Environmental Design Tutorials
WEEK 13	FINAL REVIEWS

2.5 Student Outputs

2.5.1 Engagement with the Ambitious Brief

In general, it can be reported that all students enthusiastically engaged with the net zero carbon brief that was set for their design research and proposition. All of the architecture students engaged in dialogue and collaboration with their engineering colleagues and it was generally felt that the introduction of analysis tools that they could both access and utilise provided them with a common framework to discuss the design challenge set before them.

2.5.2 Uptake of Analysis Tools and Output

The outputs from the architecture and engineering students have been submitted for Atelier Ten review and vetting. These have been reviewed and summarised in the following pages.

- All of the four groups were successful in including a final panel summarising their projects sustainability strategy with accompanying graphics.
- Students were able to provide evidence of their calculation methodology and results to differing degrees, depending on their focus and success with each of the tools.
- All four of the groups were able to illustrate some evidence of iteration of design as a result of environmental analysis throughout the semester.

2.6 Student Outputs Summary

2.6.1 Scope of Student Proposition

The scope of the students' proposition has largely related to passive design, energy efficiency and renewable energy generation, since the zero carbon target had been introduced to them as a key part of their brief that they had to investigate. It should be noted that all students have also taken on the challenge of designing for lower embodied carbon, and with consideration of circular economy principles. A number of students were also interested in water sensitive urban design, water efficiency, urban food production, and health and wellness considerations as part of their sustainability strategy. The following table 2.1 summarises their work, including their success in using the modelling tools and presenting a project with realistic net zero carbon potential.

2.6.2 Scope of Vetting Exercise

For the purposes of this report, we have focused our vetting review of student proposals on the embodied carbon, passive design, energy efficiency and carbon reduction strategies as these are the aspects where the students have gone into some depth within their work. As the students this semester were not asked to provide detailed calculations or PHPP excel documents,

Key:

Achieved:

the vetting exercises have been undertaken at a high-level understanding of the projects and the strategies involved.

Insufficient Resolution:

Not submitted:

Table 2.1 Summary of Student Outputs

Group #	Low Carbon Construction Measures	Passive Design Measures	Energy Efficiency and Renewable Energy Technologies	Other Sustainability Initiatives	PHPP Analysis	Daylight Modelling	Net Zero Carbon Potential
Group 1	• CLT Timber structure – 8x8 grid • Gluelam beams • 100% timber cladding and interiors • Recycled Polyester batts • 30% fly ash concrete ground slab	• Passive solar orientation • Stack / cross ventilation • Double glazed windows	• Photovoltaics • Ground source heat pump • Recycled watercooling tower • Underfloor heating • Biodigester • High efficiency LED lighting	• Food growing • Recycled grey water • Mechanical ventilation heat recovery units • Rainwater harvesting	✓	✓	?
Group 2	• Timber Construction • Recycled materials	• Passive solar orientation • Stack / cross ventilation • High performance building fabric	• Ground source heat pump • Photovoltaics • Battery System	• Rainwater harvesting • Indigenous species green roof • Food growing • Native Planting • Non-toxic materials	✓	✓	?
Group 3	• CLT construction • Recycled brick • Prefabrication	• Stack / cross ventilation • Greenhouse design to improve comfort in winter • Good daylight • Thermal breaks • Double glazing	• Photovoltaics • Ground source heat pump • Hydronic slab heating	• Therapeutic landscapes • Rainwater harvesting • Recycled grey water • Community gardens • Biophilic cooling	✓	✓	?
Group 4	• Hybrid CLT Slab + Green Concrete Construction • Recycled Batts	• Passive solar orientation • Stack / cross ventilation • Thermal Breaks • Triple Glazing	• Ground source heat pump • Photovoltaics • Battery System	• Rainwater harvesting • Waste water recycling • Food harvesting • Biophilic Cooling • Organic waste recycling	✓	✓	?

3 Exemplar Project Feasibility

3.1 Introduction

3.1.1 Selection of Student Projects for Further Analysis

A selection of the best student projects has been selected for further vetting analysis of their proposals and the validity of their technical analysis and application. The vetting analysis covers the application of the following systems and is primarily related to the energy and carbon performance of the projects:

- Passive operation measures (e.g. design of natural ventilation or building fabric improvement)
- Active systems proposals including building services systems
- On-site renewable energy generation systems

These projects have been selected for the quality of their engineering design integration and the range of systems and technologies that are representative of the group as a whole.

It is clearly evident that there are common systems and technological approaches that have been applied across the body of student work that merit further investigation and these can be summarised as follows:

- Use of timber construction systems as a means of meeting embodied carbon reduction goals
- Passive principles for solar heating and summer control, natural ventilation and daylight are readily incorporated into this building typology, so what are the common rules that can be applied on any given site?
- High-performance Passive House principles and Construction Quality Assurance are proposed to meet ambitious operational carbon reduction targets.
- Innovative heat pump solutions are explored for enhanced energy performance
- Photovoltaic panels were consistently applied across projects for on-site renewable energy generation.

Table 3.1 Exemplar Student Proposal Measures

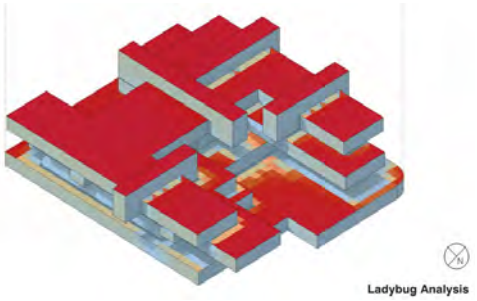
Student #	Low Carbon Construction Measures	Key Passive Measures	Key Systems Measures	Renewable Energy Systems Measures
Group 1	• CLT Timber structure – 8x8 grid • Gluelam beams • 100% timber cladding and interiors • Recycled Polyester batts • 30% fly ash concrete ground slab	• Passive solar orientation • Stack / cross ventilation • Double glazed windows	• Mechanical ventilation with heat recovery to support passive ventilation systems • Ground source heat pump • Recycled water cooling tower • Underfloor hydronic heating	• Photovoltaics • Biodigester
Group 4	• Hybrid CLT Slab + Green Concrete Construction • Recycled Batts	• Passive solar orientation • Stack / cross ventilation • Thermal Breaks • Triple Glazing • Biophilic Cooling	• Ground source heat pump	• Photovoltaics • Battery System

3.2 Exemplar Project Group 1

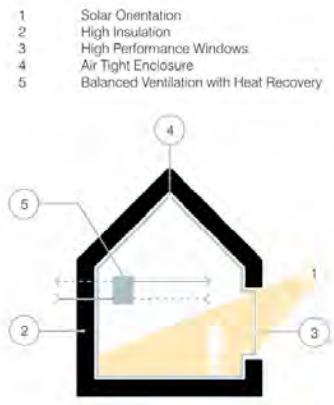
3.2.1 Passive Design Features:

Group 1 integrated a host of passive design features throughout their design. Through testing within the PHPP interface, a high performing façade was developed featuring a fully timber constructed façade and double-glazed windows. Glazing placement is restrained and selective towards providing maximum passive benefit with strong potential for natural ventilation.

3.2.2 Daylight Performance

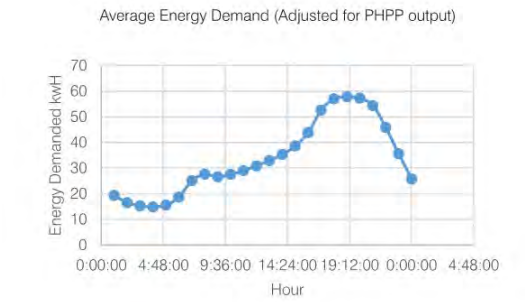


The above diagram illustrates an external solar radiation analysis undertaken by the students. The analysis illustrates the effective use of overshadowing within the development to protect the façade from overexposure within the building. Deep façade sections as shown below further exemplify the buildings passive solar performance by allowing low flying winter sun to penetrate deeply into the façade and protect from the harmful summer sun. This study also informed the placement of solar panels to maximise their effectiveness cost to performance ratio.

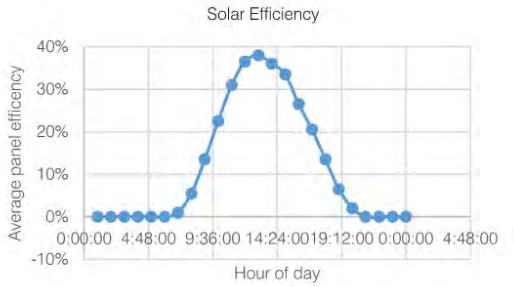


3.2.3 Building Energy Performance Results

In order to correctly size their photovoltaic system to the maximum benefit, the students successfully undertook and energy usage analysis using figures developed from their PHPP study. This demand is shown in the following figure.



The following figure illustrates the solar efficiency study also undertaken by the students to evaluate the hours at which their solar panels would be most efficient, based on learnings from their initial solar radiation study.



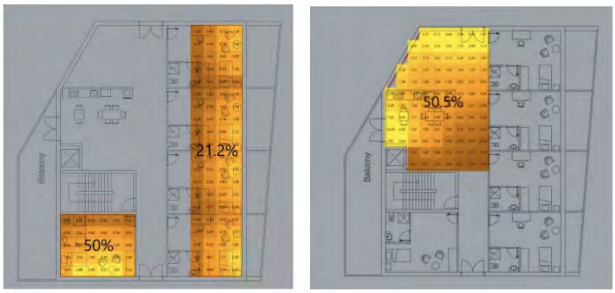
As a result, the students sized their photovoltaic array at 180kW, meeting 45% of their total energy usage annually. This was sized to ensure that the array was meeting 100% of the buildings demands when in full sun.

3.3 Exemplar Project Group 4

3.3.1 Passive Design Features:

Group 4 students similarly used the PHPP to develop a high-performance structure, using a hybrid concrete and CLT structure to frame their concept. Strategic form finding which maximised the solar benefit, was further enhanced with the use of vertical shading on the east and western façade to block harmful low-lying sun, and adjustable louvers on the northern façade to maximise performance depending on the seasonal position of the sun. Triple glazed windows were incorporated which students were able to show gave a 30% performance increase compared to single glazed units.

3.3.2 Daylight Performance



Group 4 was successfully able to undertake an internal daylight performance assessment as shown by the figures above. Through iteration they were able to maximise the placement of horizontal and vertical shading devices to ensure daylight was reaching deep enough into the floorplate to ensure residents were receiving ample daylight to the benefit of their well-being and reduction in energy usage.

3.3.3 Building Energy Performance Results

Group 4 students undertook a energy demand analysis using data they derived from the PHPP to understand heating and cooling loads across the year. These results are shown within the figures below.

Using this data the students were succesfully able to determine both the amount of energy required for the facility at different points throughout the year, and understand from what sources they could draw this energy. Their 160kW solar system was placed on angled, north orientated roof portions, maximising their potential production and was shown to be able to meet well above their summer energy requirements. As such they decided to implement a 135 kWh battery system to offset their energy usage in the following months. The figure below illustrates the sources of energy used throughout the year, and demonstrates their critical thinking in attempting to reduce power draw from the grid.

4 Benchmarking Study & Vetting

4.1 Benchmarking against Business-As-Usual

4.1.1 Atelier Ten Modelling of the Base Case

In order to enable the benchmarking exercise Atelier Ten undertook modelling analysis to establish a base case for the business-as-usual approach.

As Atelier Ten did not have access to in-depth details regarding the client's current energy usages of aged-cared facilities, figures and estimates were developed with reference to the literature researched by the student teams[1]. Estimates place current energy demands at between 14 and 32 kWh/bed/day for a Melbourne aged care facility. This would place the total energy load of a base-case facility forecasted for 120 beds at around 3000 kWh/day.

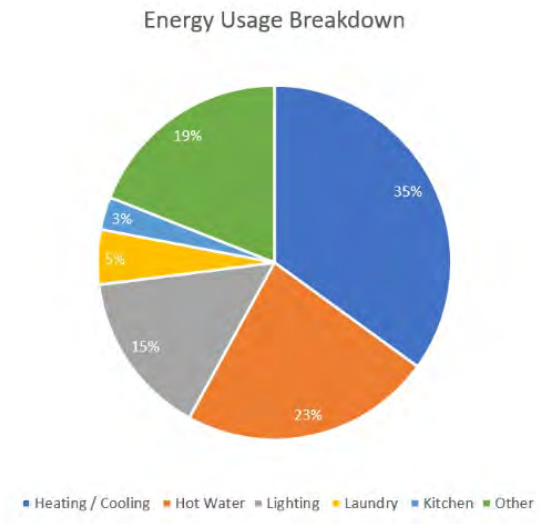
A representative model of this business-as-usual base case was built using PHPP to calculate an accurate operational energy consumption.

4.1.2 Student Strategies

Common themes were evident in the student's design propositions for solutions that meet the net zero carbon goal. These have been identified as follows:

- Optimised passive solar design through allocation of higher proportion of north facing, horizontal shaded glazing to better capture the winter suns heating energy
- CLT / Glulam construction to avoid the usage of high embodied carbon in typical steel construction and reduce thermal bridging
- Improved Insulation across walls, roof and under slab, to reduce energy flow
- High Performance Windows with improved U-values and reduced thermal breaks
- Enhanced airtightness in line with the Passive House standard, achieving 0.6 air changes per hour during a blower door test at 50Pa pressure
- The use of heat recovery ventilation for enhanced indoor air quality and significant reduction in heating energy demand
- High efficiency LED Lighting and small power units to reduce the total equipment energy load
- Photovoltaics placed in optimised arrays to maximise the potential for onsite renewable energy generation

4.1.3 Energy Usage Breakdown



4.1.4 Comparison with BAU

Atelier Ten created a model into which was input a representative level of energy usage for an aged care facility based on the literature studied and considering typical business as usual standards for elements such as building fabric, lighting, heating and cooling COP's, airtightness, and other building loads.

The most common student strategies were incorporated into this model to investigate the relevant impacts they might have on an aged care facility and study their effectiveness in light of the studio's ambitious zero-carbon targets.

In doing so a feasibility study was be undertaken to assess both total potential energy reduction and assess the validity of the propositions put forth by the students.

[1] Sustainability Design Strategy for Permanent Vacation, Jaixu Liu, 2021

4.1.5 Performance Relative to Business-as-Usual

The results of vetting process demonstrate that the students have been successful in selecting solutions that are on acredible pathway towards significant energy reductions as shown in the graph below of annual energy (electricity) consumption.

It can be seen that up to 57% energy saving compared to business-as-usual could be achieved through a cumulative combination of high-performance passive design measures, optimisation of HVAC systems, and consideration of on-going operational energy management.

This can be further reduced with photovoltaics, with which in Atelier Ten's benchmarking study was shown to reduce energy demands by another 14%. Students incorporated photovoltaic arrays of varying sizes, optimised to suit the form of their proposed design. As such an average size based from the student works and estimations based on typical aged care facility dimensions was used in the benchmarking study.

4.1.6 Path towards achieve Net Zero Carbon Performance

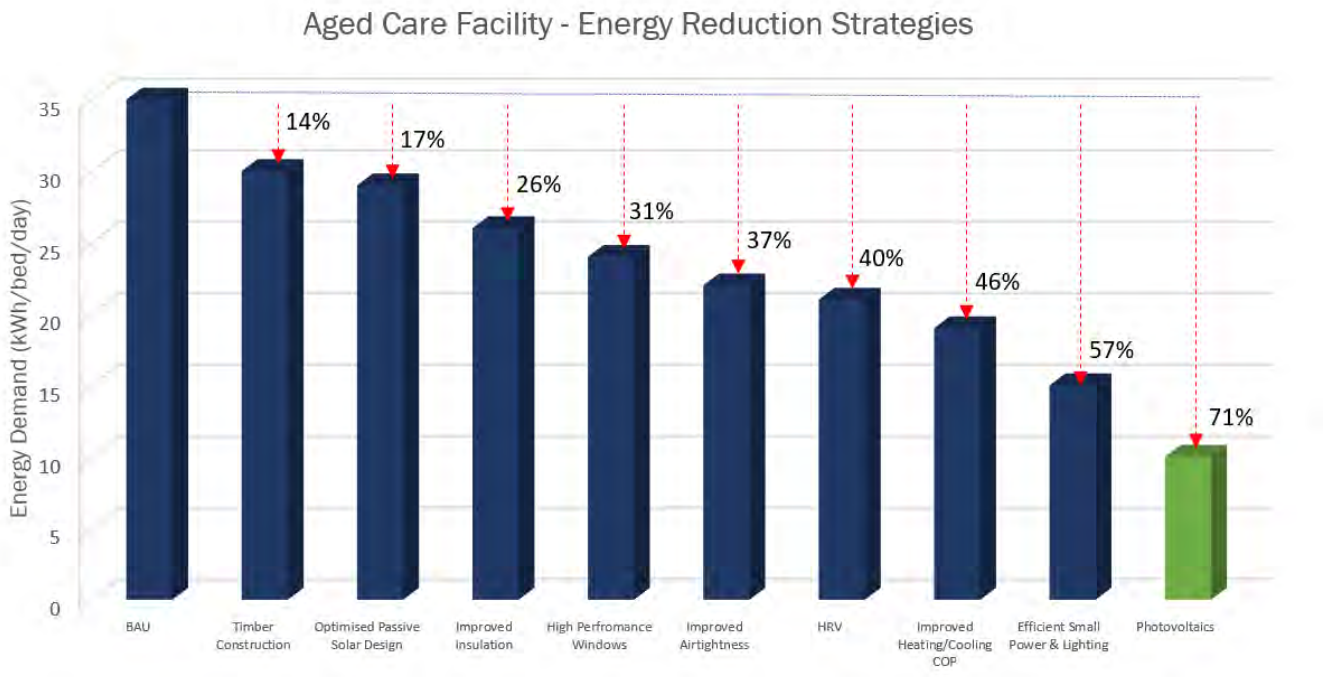
Whilst significant energy reductions were seen across the board when assessing the student proposals, reaching a truly net zero design was out of reach. This was acknowledged early on in the design studio as being an extremely difficult target to reach given the high energy demand and the 3-4 storey nature of the aged-care facilities proposed (resulting in a reduced roof area : floor area ratio) limiting the ability for rooftop solar to fully meet annual demand.

In light of this, the proposals as put forth by the students fall in line with the vetting exercise undertaken by Atelier Ten, as seen in the figure below.

These figures are based on current, readily available technologies that have been put forward by the students and as such, pave the way towards future feasibility of truly net-zero aged care facilities in the future, with higher performance fabric, less energy intensive equipment and more productive photovoltaics as they become available.

A summary of the primary measures put forward by the students and included within our vetting analysis are as follows:

1. Use of mass timber construction to minimise thermal bridging heat losses within the building fabric
2. Optimised passive solar orientation through experimentation with different block massing and orientation
3. Enhanced insulation thickness in wall construction and high-performance window system performance in line with Passive House performance standards
4. Improved air tightness measures to meet the Passive House requirement of 0.6 ach @ 50Pa
5. Heat Recovery Ventilation (HRV) to ensure continuous background fresh air change (to supplement natural ventilation capabilities)
6. Enhanced performance heating and colling systems including consideration of the higher COP that can be achievable through higher performance systems such as the proposed ground source heat pumps
7. An assumed energy efficiency achievable through small power and lighting specification and usage control
8. Lastly we considered the possibility of meeting the reduced building energy demand through on-site PV.



5 Discussion

5.1 Results Format

The required outcomes in relation to sustainability as put forth by Atelier Ten was quite broad in its scope, allowing students to experiment and produce results in ways which they found most useful or interesting to their particular needs and studies.

All students were able to provide a detailed diagram which outlined their chosen environmental strategies, which included in depth detail of how they were integrated into their designs. In all cases these descriptions provided a high-quality overview of a range of interesting sustainability strategies which were clearly well thought out and successfully integrated into the complicated schemes with which they were tasked.

However, these descriptions were often high level, and lacked the level of detail required for in-depth critique and assessment of their selected methodology.

Many students went into greater detail in their folio submissions, capturing screenshots of their processes and more detailed figures of results. However, these processes still lacked to provide important information such as the input numbers and sources from which these were gained.

As such, whilst all students clearly highlighted strategies which were evident in moving towards the zero-carbon loop objective of the studio, the evidence provided of how close to achieving this goal was often unclear.

5.2 Appropriateness of the Results

In assessing the proposed strategies and figures outlined by the students, all proposed readily achievable, real-world solutions which were appropriate to the aged-care typology.

A range of other proposals which were reviewed by Atelier Ten and are considered to be highly appropriate and implemented effectively for the scheme include:

- CLT and Glulam structure
- 30% fly ash concrete slabs
- Prefabrication of units
- Appropriate floor depths for passive natural ventilation (<20m)
- Double / Triple Glazing
- Ground source heat pumps
- Recycled water-cooling towers
- Hydronic underfloor heating
- Onsite food growth
- Organic material recycling

Some proposals which were peer reviewed by Atelier Ten and found to be not less appropriate in terms performance and cost include:

- Greenhouse style building for heat control
- Biodigesters

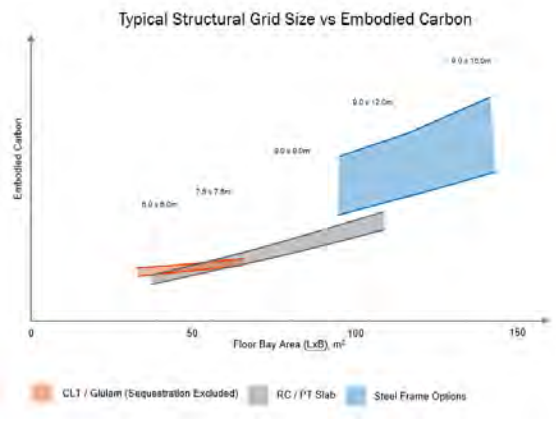
5.2.1 Photovoltaics and Battery Systems

Photovoltaics were implemented across the board in varying sizes and implementation. Many students undertook a solar radiation study prior to determining the size and positioning of their array's which exhumed a level of thoroughness and forethought often seen in industry. In all cases the scale of the photovoltaic array was appropriately sized to match the needs of the facility. Due to the energy intensive nature of the typology, it was unlikely that using a purely solar energy would be able to meet the demands required. As such, the figures of being able to provide roughly 45%-65% of the onsite energy through maximising array size and positioning, reflect a well-considered and accurate assessment of the limits of current technology.

Some groups took the step towards battery storage to further offset their energy usage, which can often lead to quickly declining benefits as the system scales up, both in terms of cost and impact on the environment. However their proposed strategies in terms of sizing fell within the expected range of what could be considered appropriate for the scale of the development.

5.2.2 Cross Laminated Timber

Most groups incorporated the use of CLT floor slabs across their developments, with a range of grid spacings. Commonly suggested grid sizing's include 8x8m and 6x12m.



As can be seen, at grid sizes larger than 6x6m, the benefit of CLT, without considering carbon sequestration, quickly falls in line with concrete structure. As such, whilst the student uptake of low-carbon construction methods was to be commended, further consideration of the results impacts in each of their proposals could be recommended for further studies.

5.3 Effectiveness of the teaching methods within the scope of the studio

Building on the learning of the previous studio, an updated catalogue of environmental analysis tools was introduced to the students over the course of the semester.

In previous semesters a web-based life-cycle analysis tool was used throughout the studio to assess the carbon impact of designs over the course of a 50-year life cycle. However, this was met with limited success due to the highly time-consuming and data intensive nature of the tool. As a result, this semester saw students tackle carbon-zero objectives on a higher level, focusing on strategies and their impacts rather than trying to accurately forecast the exact levels of carbons associated with their designs both during construction and in operation.

This move saw a much greater level of exploration and investigation from the students, who were no longer held back by challenging interfaces and high levels of data input. More time was spent on research and integration of their ideas into a cohesive design which suited the aged-care typology.

5.3.1 Ladybug Tools

Instead of the web based LCA software, Atelier Ten chose to introduce the students to the parametric analysis software, Ladybug Tools. This software was deemed appropriate for a number of reasons:

- Contained within a native architectural software which the students were familiar with, ensuring that they felt comfortable within it and avoided the need for extra software installation
- Ability to test models quickly and accurately without the need to export their models
- Wide range of analysis options including daylight, energy, ventilation, comfort and more.

The shift to this software saw a much greater student uptake and interaction with the tools presented. Students were introduced to a number of simple studies within the platform, focusing on site analysis and daylight performance within their schemes. However, it was clear that students were interested in the potential of the platform's ecosystem, with many expanding past the tools introduced to them by Atelier Ten.

Daylight was deemed to be especially relevant within the scope of the studio due to its intrinsic connection to health and well-being of occupants. Iterative daylight analysis saw the uptake of positive discussion regarding how design changes could be leveraged to positively benefit the indoor quality of spaces within student designs. As such, the introduction of the new platform within the student was seen as a success, and one which hopefully has opened the doors for students to continue using and developing such skills within their own personal practises beyond the scope of this studio.

5.3.2 Passive House Planning Package

The Passive House planning package, whilst typically more appropriate for smaller residential application, once again saw good uptake within the student body.

The platform gave students a simple and easy to understand method of assessing the external fabric of their building and the implications it had on their energy loads as a whole.

Students were successful in using the information gained within the PHPP to further develop other aspects of their building such as the sizing and requirements of the photovoltaic arrays designed.

6 Conclusions

The multidisciplinary process across the course of the semester saw students successfully investigate and incorporate a range of environmental solutions into their designs. Outcomes indicated that with a considered approach, existing technologies and materials could be harnessed to significantly reduce energy usage, alongside the embodied and operational carbon impacts of their proposals.

6.1 Path towards Net-Zero

6.1.1 Strategies Identified

Across the student body of work, a number of strategies and technologies were consistent in recommendation. Their prevalence across a wide variety of different design proposals indicates their suitability and achievability within the scope of a typical aged-care facility. Key systems which were common across the studio which held the greatest benefits include:

- Optimised Passive Solar principles for winter heating and summer control.
- High-performance building fabric through enhanced U-values of the building fabric
- Reduction in thermal bridging and airtightness construction quality Assurance
- Mechanical ventilation with heat recovery for energy saving benefit in addition to other indoor environmental quality and health benefits.
- Photovoltaic panels were consistently applied across projects for on-site renewable energy generation.
- Selection of materials which minimise the impact of embodied carbon across the development.

6.1.2 Student Outcomes

With such implementations, students put forth schemes which pushed the envelope of what defines a high-performance aged-care facility. Outcomes considered a swath of different factors in their interrogation of possible solutions, including cost, efficacy, carbon impact and the overall health of occupants.

Students were able to show with the use of a high-performance façade, efficient use of fittings and photovoltaics, that energy savings of up to 60-70% could be achieved. This is especially significant considering the energy intensive typology which is inherent to aged-care homes.

Many strategies were considered in the effort to reduce the carbon costs associated with the building, with all students taking on some form of timber or hybrid timber construction within their designs. Whilst significant gains were found, it was unclear within the students' findings whether or not the schemes could achieve the lofty targets of reaching carbon zero in operations. Though, as purported by the student body, the remaining energy which was to be drawn from the grid in the months which solar power could not meet the entirety of the demand, offsets and selecting green energy sources is a tangible pathway towards carbon neutrality in operations.

In addition to the clearly demonstrated carbon reduction benefits, significant improvement to the health and well-being of occupants is associated with some of the strategies put forth. Health and well-being are of the highest priority when considering the use-case of the development, ensuring that the elderly occupants have access the best indoor environment quality possible. Implementations such as considered daylight access, thermal comfort control, airtightness and well-designed ventilation systems can be leveraged to improve the quality of life within the facility.

6.2 Recommendations

6.2.1 Studio Success in Big-Picture Learning

The integrative approach across the course of the studio contributed to a potent learning experience for all involved. Many of the students were successfully able to achieve significant carbon, energy, and health improvements in their schemes over the course of the semester. This is a valuable exercise and one which they will hopefully continue to consider as they progress further into their design careers. With significant gains being shown in a scheme with such challenging energy demands as a default, it is hoped that the students can translate the learnings across to any other projects they tackle in the future, with similar or even greater reductions possible.

6.2.2 Learning Tools

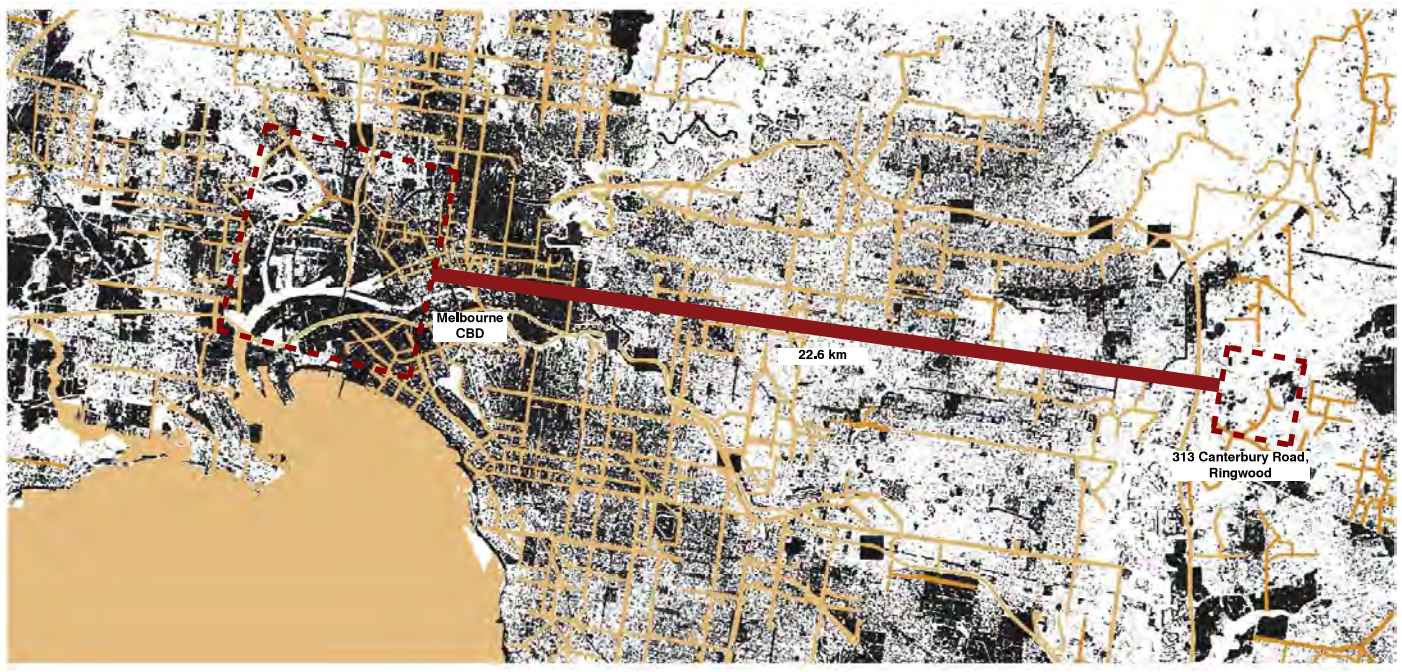
Students were found to be most likely to engage with and understand the impact of environmentally focused design decisions through the process of iteration. With the introduction of the Ladybug Tools platform to the students, tangible environmental impacts were able to be discovered within the student's design tool of choice. Significant uplift in comparison with previous semesters regarding the student's excitement and engagement were found as they developed their skills within this parametric software, which is easily translated into other aspects of their design skills. Further development of the base tools and strategies involved with the introduction of these tools are recommended for further studios, as it's relevance to the students' growth is recognised both within the studio and beyond.

APPENDIX B - Student Work

Group 1
Georgia Honan
Holly Mills
Domenica Cosentino
Vanessa Hope (Engineer)

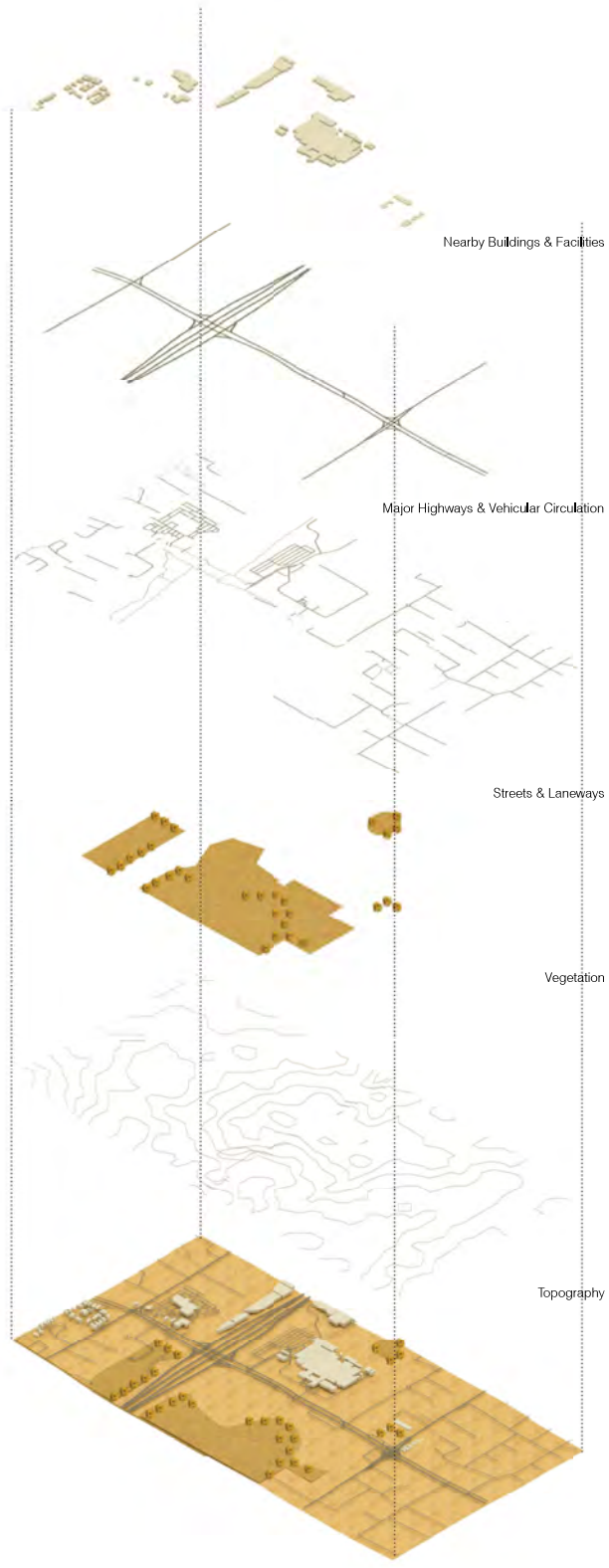
Southern Aerial Perspective

PERMANENT VACATION

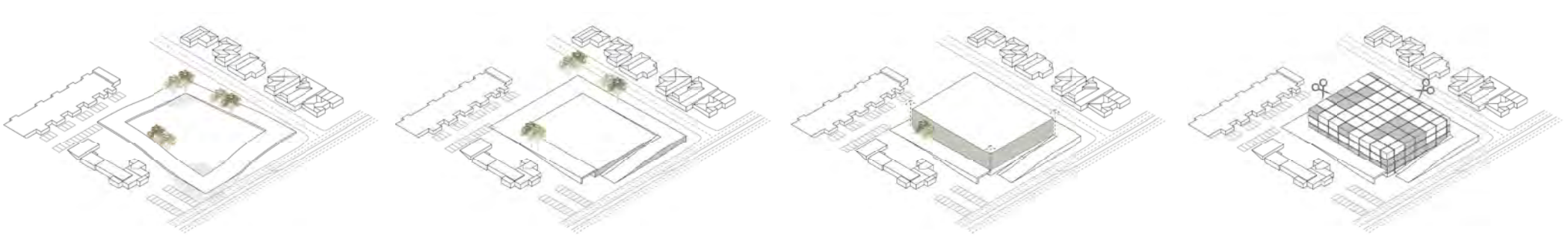


Locality Plan

313 Canterbury Road, Ringwood is located 22.6 km from Melbourne's CBD. We acknowledge that we are therefore designing in suburban culture, and the language of our design speaks to the surrounding context of family homes, golf courses, the Dandenong ranges and low rise buildings. Our design demonstrates sensitivity towards its contextual framing by not seeking to compete with existing structures but complement its surroundings and provide the community with an opportunity to interract with it.



Site Analysis

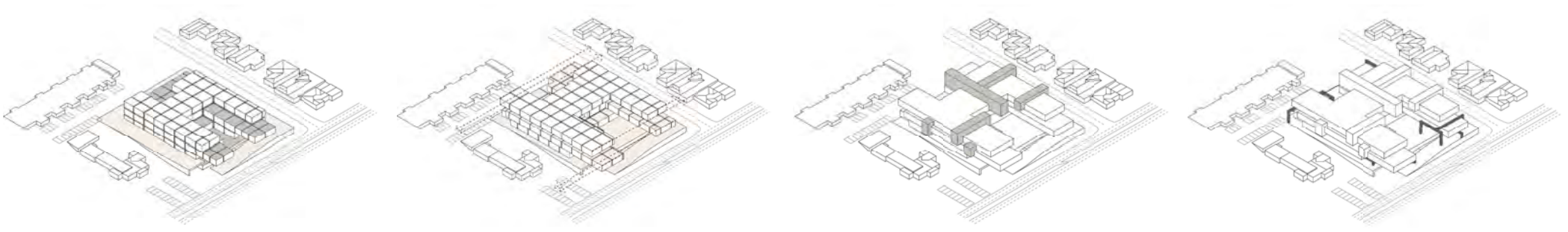


Start by peeling up the land from beneath the resident's feet to unground them and express phenomenon.

Continue the streetscape along this 'peel' and extrude volumes from it to serve as public retail spaces.

Extrude central volume 16 m (four levels) to create a low-rise facility.

Slice up volume into an 8 x 8 x 8 m grid (as derived from the load-bearing capacity of CLT).



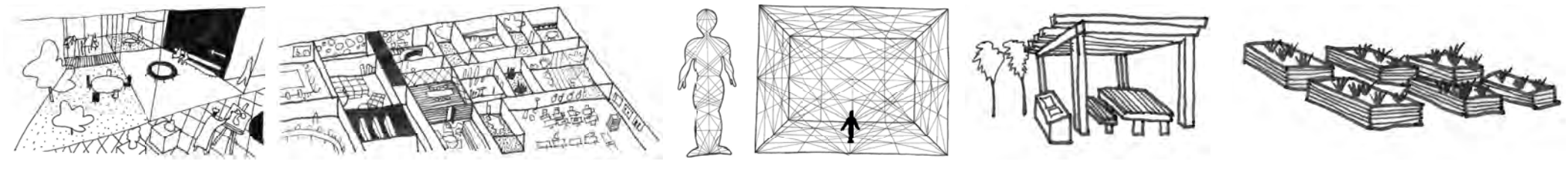
Delete modules to create internal courtyards to capture maximum natural daylight intake.

Slide each floor out from under each other to create cantilevers for passive shading and to create lots of laneways that lead to more green spaces.

Vertically extrude massings to create double height spaces, break up corridors and maximise daylight entry. Additionally, this provides cantilevers to shade the below external spaces.

Provide external columns that speak to the 8 x 8 m grid in an illogical manner to disrupt expectation.

Form - Finding

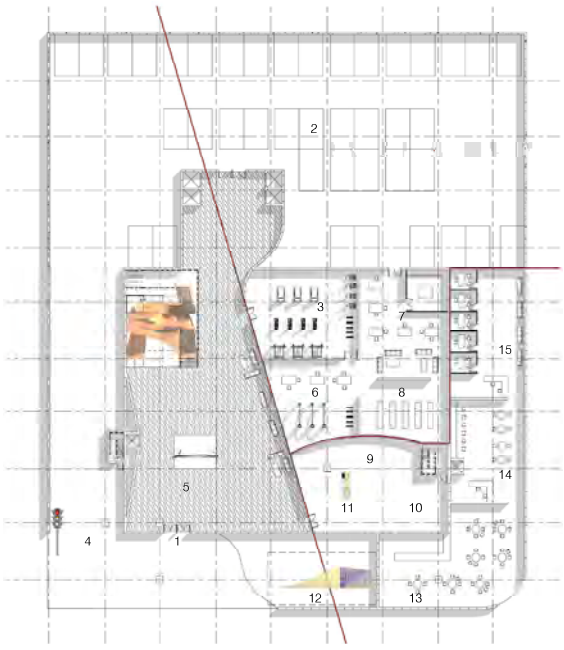


Kevin Lynch's 'The Image of the City' outlines the key aspects that are evident in each city and contribute to producing an urban utopia. Our aged care facility draws upon this concept by incorporating paths, edges, districts, landmarks and nodes to create a sense that people are transitioning between 'different worlds' within our building. Our plans have been divided up into different districts and been provided with a theme to give them a sense of personality.

We embraced the concept of phenomenology and believe that this has the power to reinstate one's sense of independence and connection to the world around them, which is particularly important when entering the final stages of human life. As phenomenology is often a very human-centric notion, we reversed this concept by placing the environment at the fore-front of our minds when designing spaces. Our design seeks to harness each resident's connection to the land and celebrate the humanistic experience by creating spaces that play on one's memory and forgetfulness, jogging consciousness.

Concept Diagrams

Studio 21, Final Review, Georgia Honan (831427), Dom Cosentino (1207120), Holly Mills (757497) & Vanessa Hope (834407)



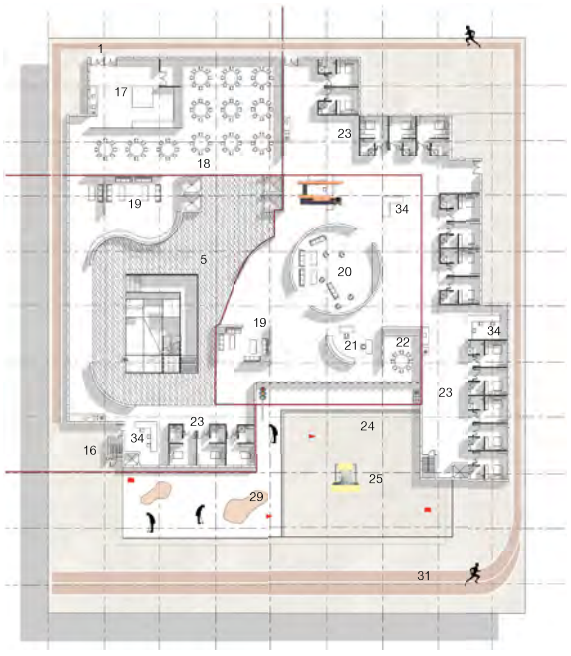
Ground Floor Plan

The ground floor welcomes public access on the South-East corner with a commercial retail area. Spaces 13, 14 and 15 are intended to be area that can be sublet by external business as a way of integrating our aged-care residents with their broader context.

When entering through the main entrance, the large foyer space directs the observers line of view towards a grand staircase that is designed in the language of phenomenology.

Being a carbon neutral building, we chose to celebrate the aspects that allow it to be so by exposing these to the public eye. For instance, a curtain wall encloses our plant room, revealing the behind the scenes functions of our facility. Additionally, cafe visitors can view into the rainwater tank and experience an aquarium-like atmosphere.

Car circulation is welcomed into the South side of the building and parks underground on the North side.



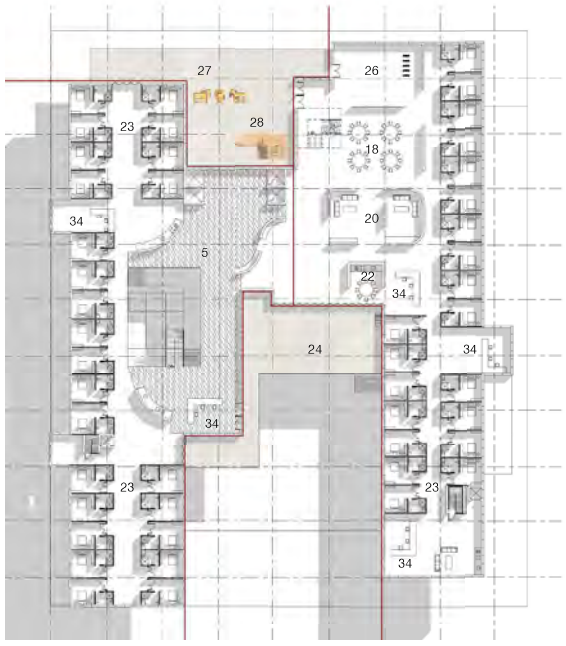
First Floor Plan

The First Floor is a celebration of green space through incorporation of a southern plaza to welcome residents home. This plaza collects residents and disperses them throughout the different worlds of the facility and provides a plethora of outdoor activities to pursue. For instance, mini golf, outdoor chess and a walking track.

Internal walls respond to an 8 x 8 m square column grid, which provides a framework for spaces to be broken up by program. We used a combination of curved and linear walls to break up the expected circulation, consequently jogging one's expectation of logical design. Specifically, the TV lounge is a circular plan, which juxtaposes the square like nature of television viewing.

Low care bedrooms are predominantly located towards the South and East of the building as to protect them against solar heat gain in the afternoons.

18 depicts a large dining space, where all residents can meet to enjoy a meal together.



Second Floor Plan

The majority of bedrooms are located between the second and third floor, with high-care residents being situated towards the North and West of the building to increase their solar intake and access to daylight throughout the day.

By separating the plans into seperate 'worlds' as shown by the red line, we have given each program its own personality. For instance, the Northern greenspace is a farmers village, where a chicken coop and kitchen garden are available for the residents use.

Long corridors are broken up by the insertion of vertical planes which provides double height spaces, as well as openings to communal lounges and nurses stations.

We have organised each bedroom into a cluster of six, where each cluster is provided with a nurses station and kitchenette.

Additionally, provision of bookable function spaces are located on each floor (22), giving residents the freedom to continue to invite over their loved ones for a BBQ or entertainment.

Third Floor Plan

The third floor continues the logic of the rest of the building, with inclusion of a large cinema lounge for the residents. We designed certain spaces of our facility in the image of the broader city to provide a sense of freedom and escape for our residents. By replicating the experience of going to the movies, people experience a phenomenological sensation as it plays on their memory and sense of freedom. In this way, it evokes a sense of confidence from residents as they feel connected to the broader world.

We have also included a bocce court for the residents leisure. The numerous green spaces break up the external activities available to people and provide constant accessibility to natural air, light and vistas.

1	Entrance	18	Dining Space
2	Carpark	19	Well-Being Hub
3	Gym	20	TV Lounge
4	Carpark Entrance	21	Research & Creative Space
5	Foyer	22	Bookable Function Space
6	Allied Health	23	Low-Care Residences
7	Staff Administration & Kitchen	24	Plaza
8	Medical Storage	25	Water Feature
9	Plant Room	26	Yoga Space
10	Biodigester	27	Outdoor Kitchen
11	Ground Source Heat Pump	28	Chicken Coop
12	Rainwater Tank	29	Miniature Golf Course
13	Cafe & Bakery	30	Bocce Course
14	Hair Salon	31	Running Track
15	Consultant Suites	32	High-Care Residences
16	Emergancy Exit	33	Cinema Lounge
17	Commercial Kitchen	34	Nurses Station

8m 16m N

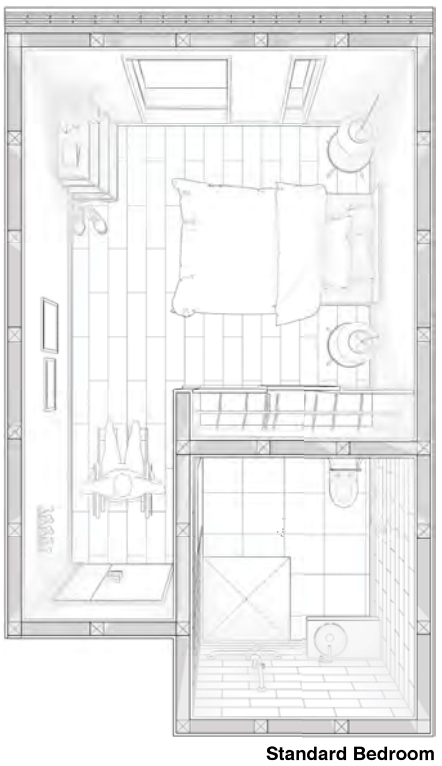
Our site is situated in a very residential area which prompted our careful consideration to our neighbouring homes. We did not aim to overpower the area with a high-rise facility, rather create a residential oasis in the image of the city that is contextually framed by natural resources, family living and generous circulation.

Unfolded Plan

Free circulation is provided by a path that zig-zags up through the four stories, with spaces designed along this path.
Although the vertical circulation is quite linear to provide a notion of way-finding for the residents, horizontal circulation is decentralised through designing junctions that confront people with choice of travel path.

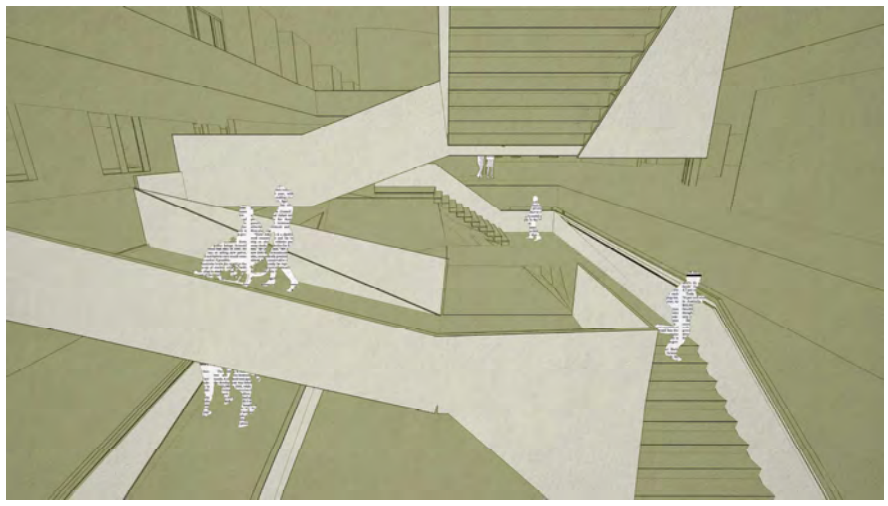
First Floor, North-East Perspective

Our 6000 x 4000 mm bedrooms provide a generous amount of space for residents to create a home out of. Each aspect of the bedroom has been designed with accessibility in mind, for instance full length windows providing people with the same vista, regardless of being wheelchair bound. Additionally, the entry to each bedroom has been recessed to allow resident's the opportunity to express their sense of home.



Standard Bedroom

Studio 21, Final Review, Georgia Honan (831427), Dom Cosentino (1207120), Holly Mills (757497) & Vanessa Hope (834407)



Central Staircase Perspective

Cinema Lounge Perspective

Bedroom Perspective

Nurses Station Perspective

Landmarks provide a point reference system for residents. The observer does not enter within them, they are instead a defined physical object. In this aged-care facility, landmarks have been 'sprinkled' throughout the spaces, much like confetti. These include: engineering systems such as our ground-source heat pump, biodigester, chicken coop, kitchen garden, grand staircase, front reception desk, nurses stations, rainwater tank and columns that prompt contemplation.

Nodes are the access points of our building. Our car entrance is located on the South-West of the site, welcomed by the peeling upwards of the land. There are several entrances to our dedicated public spaces to the South-East of the site, along with a main entrance into our ground floor foyer at the South. Additionally, there are opportunities to enter off the ground plane of the first floor, to the North of the site.

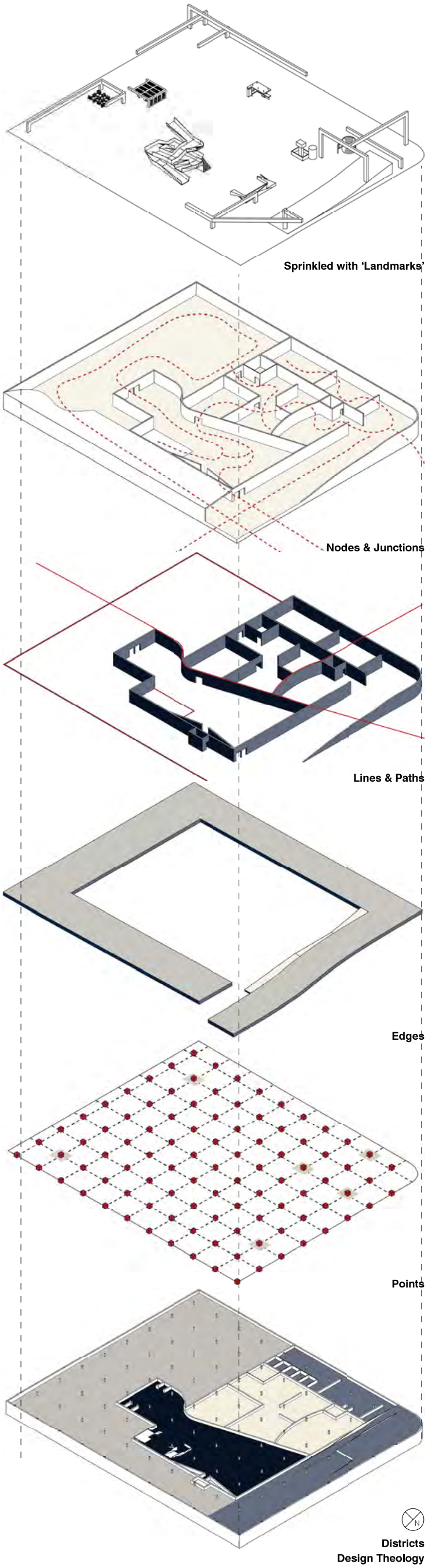
Our junctions serve to present people with a sense of choice and independence. Specifically, when standing at a junction in between four walls, the resident can choose multiple spaces and circulation paths to take, evoking a sense of freedom.

Paths are the channels that circulates the observer and separates the districts. Outlined in red here are the main paths and divisions between the different districts, to really give the resident a feel that they are living in the image of a city. The lines divide spaces and activities, helping us realise our concept of designing different 'worlds' within our facility. They are playful and dynamic, enlivening each residents inner childlike inhibitions.

These are typically linear elements that act as a protective barrier to the facility. We gently peeled up the land from under the visitors feet, ungrounding them and thereby expressing phenomena. This peel binds our city together in a single architectural gesture, protecting residents from wandering out of the site and containing commercial spaces underneath the height of the peel.

Due to the bearing capacity of our CLT material, our facility is designed on an 8 x 8 m grid. This grid furthermore provides the framework onto which walls are then placed. We created really playful walls and lines throughout our building to really push the limits of this grid system, and placed larger exterior columns that really forces the observer to contemplate what is and isn't logical.

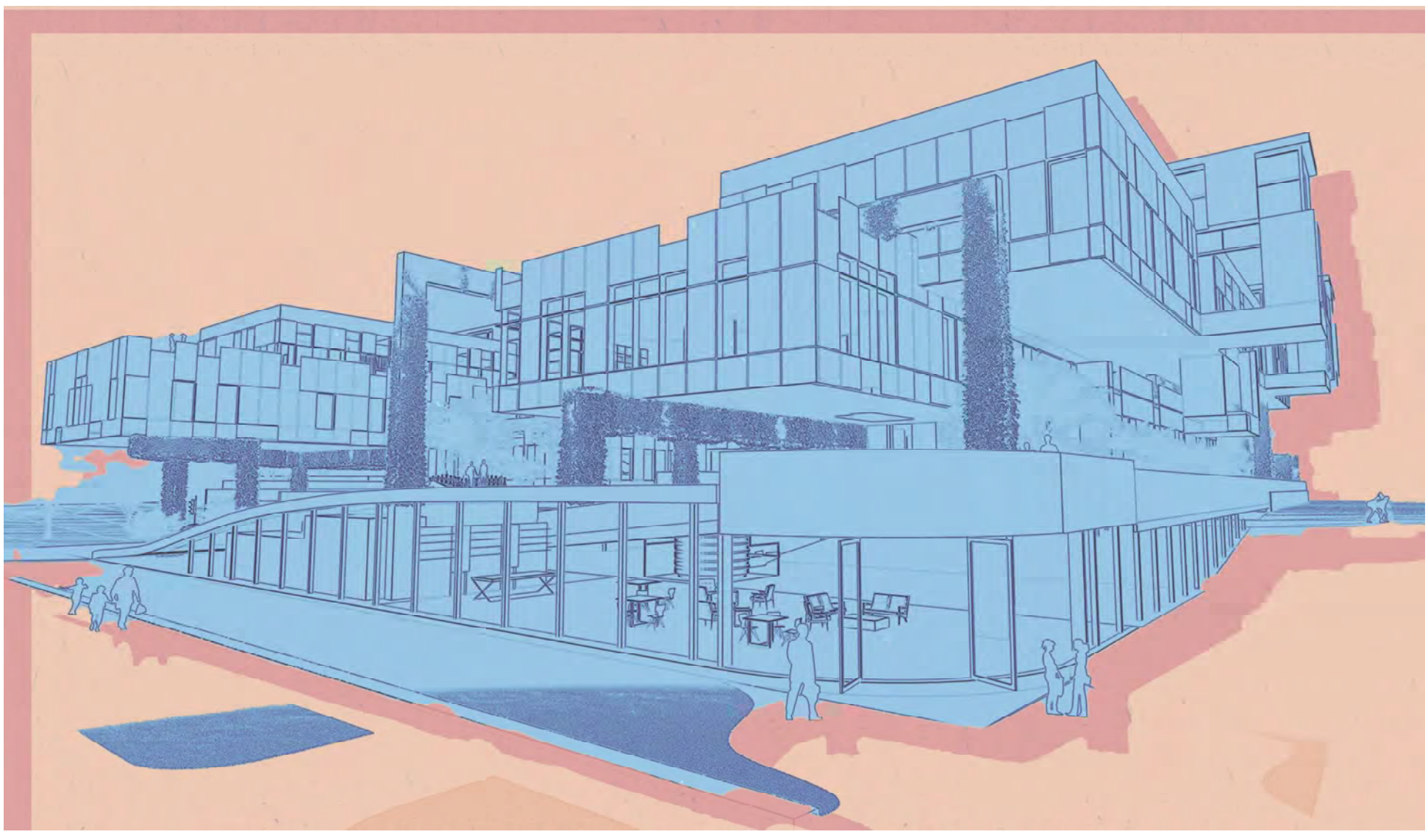
The most important aspect of our building, districts, section up our facility into separate 'worlds', enabling us to give each one a personality. This diagram illustrates car circulation, the main foyer, features that are typically perceived as 'back of house functions' and outdoor activity spaces. Residents feel most comfortable and at ease when they feel they are living in the image of a city, which is what we have designed here.



Kitchen Garden & Chicken Coop Perspective

Central Plaza Perspective

Reflective Space Perspective



South-East Perspective

This aged care facility explores the value of colour theory and how it psychologically affects residents. In other words, colours have been strategically implemented to play on emotion and orientate the observer. Specifically, blue and green colours evoke a sense of calm from residents, expecially those experiencing dementia or alzheimers. In contrast, warmer colours such as red and orange alert the resident when they are entering a zone they aren't supposed to, such as staff administration or back of house functions such as the commercial kitchen. Large vertical planes provide a reference to this colour theory and ultimately help orientate the resident when transitioning throughout spaces, for instance someone may live in blue but find themselves in green and therefore uses the colours to guide their way back home.

North Elevation

There are three different types of panels over the majority of the building's facade. By alternating these finishes, it provides continuous experiences of air and light to internal spaces and ensures constant views to the outside world. Opaque, white danpalon / diffused light panels are alternated with double glazed windows and external plywood cladding. The plywood reflects the structural material of the building and is broken up with two other types of cladding to soften the appearance of the facade and create a more transparent and welcoming internal environment.

East Elevation

The panels are arranged on the 8 x 8 m grid of the building so that the facade subsequently communicates this grid back to the observer. The panels extend above the height of the wall and conceal the face panel of the corrugated colorbond roof behind.

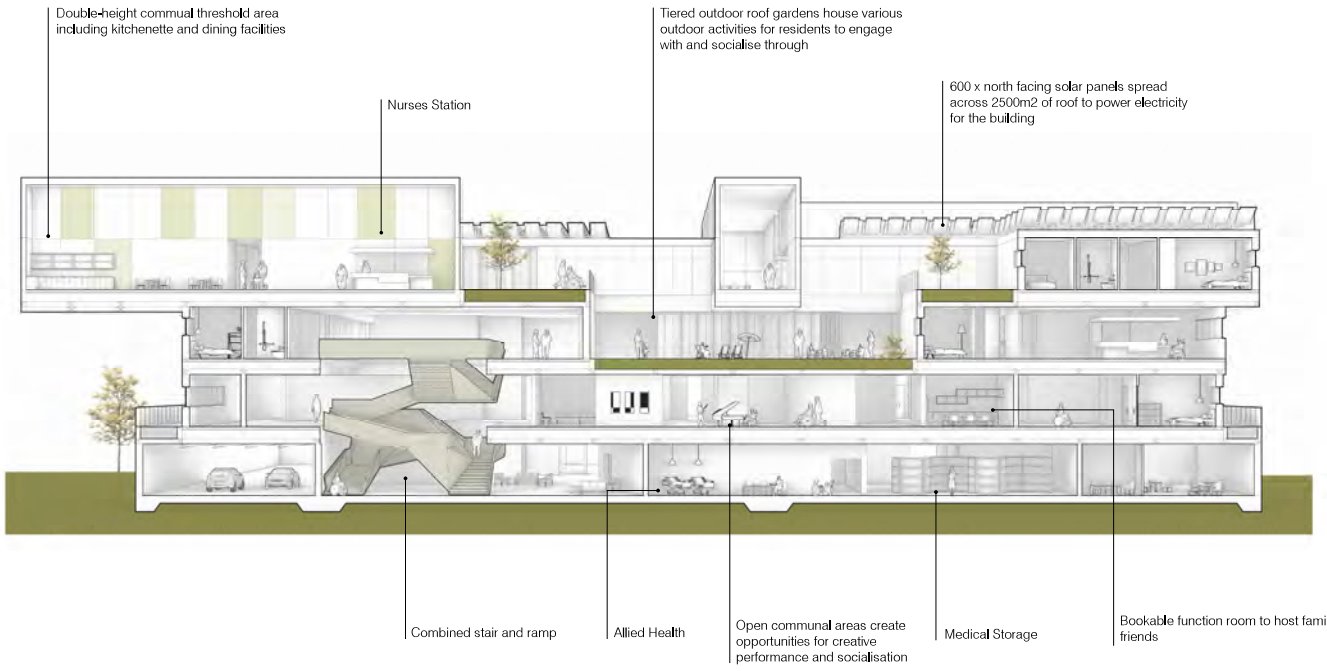
South Elevation

The vertical planes are composed of three cladding materials. The plywood and opaque white danpalon evident on the standard facade continues across the vertical planes but are broken up with the inclusion of coloured danpalon panels. Each vertical plane has a different colour that contributes to wayfinding techniques to aid residents in orientating themselved throughout the building. Additionally, they cast coloured light throughout the corridors within, evoking a sense of playfulness from the resident. Panels are made up of different sizes to also reflect this playfulness, however consistently respond to the 8 x 8 m grid.

West Elevation

Section A-A: Accessible and communal spaces are evenly distrubuted throughout the facility to facilitate an deinstitutionalised environment. Residents and visitors are greeted with the combined stair and ramp upon entry, serving as both a central circulatory node as well as an architectural gesture.The ground plane also houses allied health, medical store facilities and staff administration.

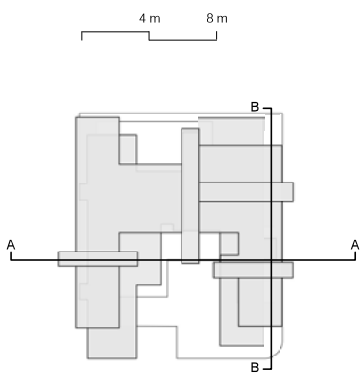
On the upper levels, corridors are widened as to redefine their program. Small piano concerts, galleries and other social activities may now take place here. Double height spaces and tiered roof gardens serve to disrupt the linearity of the building by creating threshold spaces and moments of repose and play.

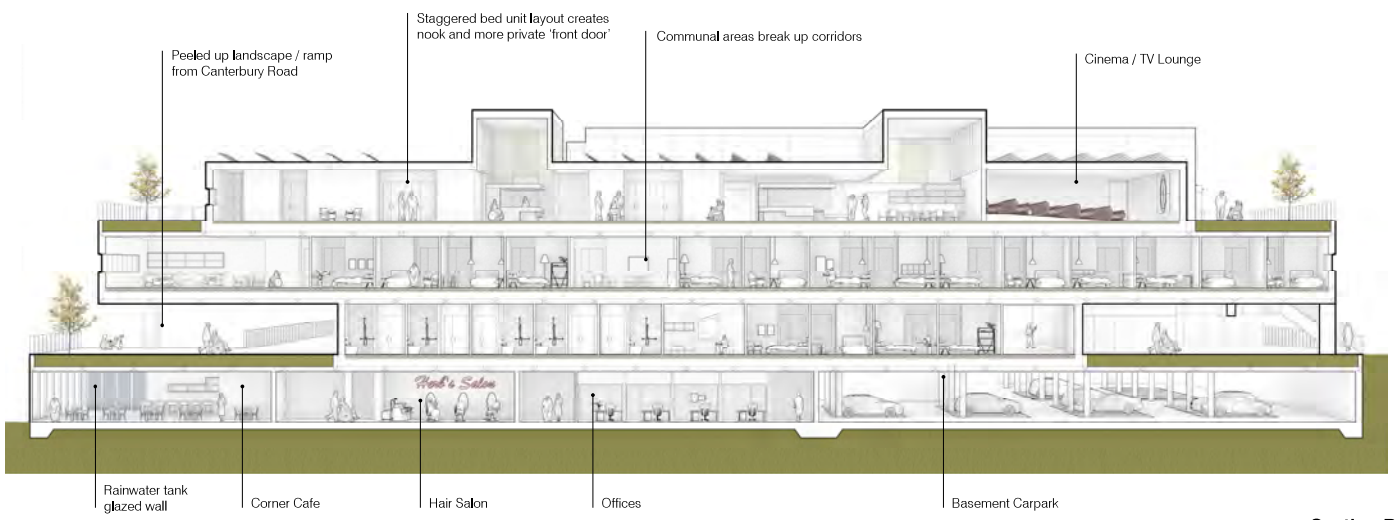


Section A - A

Section B-B: The ground plane along maidstone street serves to create an activated frontage via public program such as cafes and hair salons to establish a community dialogue with the surban character of the street.

Communal areas are used as a tool to break up long corridors and the incorporation of program such as cinemas and bocce courts contribute to the notion of the self-suffiencient city. Bed unit front doors are stepped in and mirrored in order to create a nook and private front door. The layout of the bed units also allows for personalisation and diversity to reflect the idiosyncrasies of each resident.

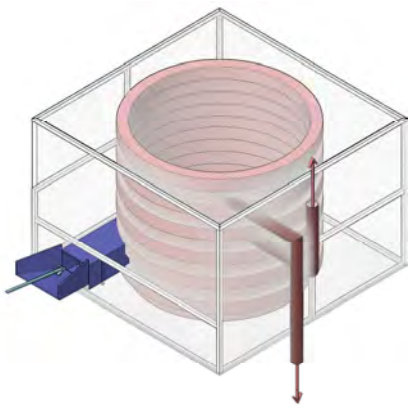




Section B - B

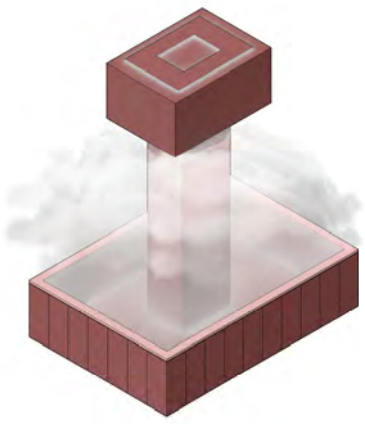
Biodigester

A small biodigester system could be utilized as a reverse carbon modernity initiative to create gas for cooking and other purposes. In aged care, the Victorian Government estimates a total of 0.2 kg of food waste per bed per day. This ultimately saves 24kg of food waste going to landfill per day.



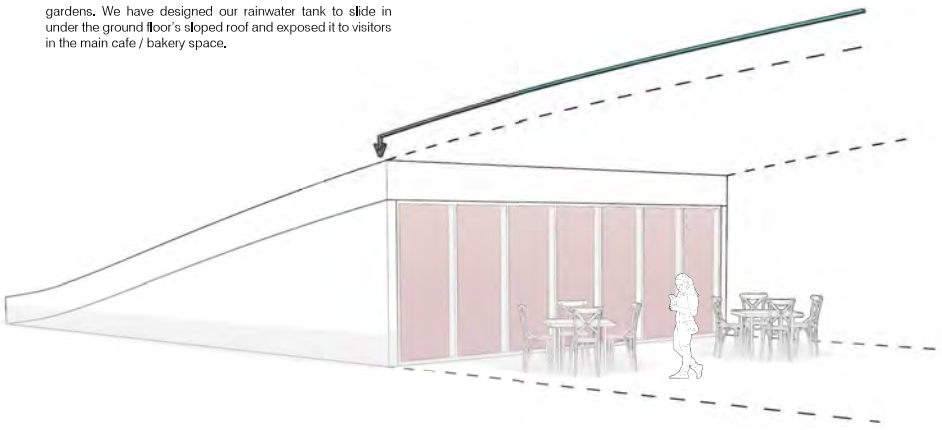
Water Tower

The feature collects water from our grey water sustem and mists it throughout selected outdoor areas to moderate outdoor temperatures. The grey water that is pumped is powered by the solar panels which generate plenty of heat in the warmer months.



Rainwater Tank

A rainwater tank exists within the basement which collects excess rain water from the roof. This is used to maintain the gardens. We have designed our rainwater tank to slide in under the ground floor's sloped roof and exposed it to visitors in the main cafe / bakery space.



Detail Section

1 m 2 m

Located on the roof are 600, 300W solar panels installed over 2500 square meters angled at 30 degrees. They are strategically located on the highest point of the residence to avoid the shadows cast by the vertical extrusions throughout the day. The solar panels power 45% of the buildings total electricity usage. Specifically, at the sun's peak, the solar panels will be powering 100% of the building.

Bedrooms are located along the perimeter of our form to increase their daylight intake throughout the day. The high-care residents have mainly been situated towards the North and West of the facility to optimise their solar heat gain throughout the day. Additionally, a plethora of cantilevers provide solar shading to their below areas for comfort.

Additionally, our double-glazed windows contribute to a high performance facade in that they provide residents with thermal and acoustic comfort. The number and positioning of windows has been optimised in terms of the passive house requirements and is reflected in the PHPP outputs. In order to ensure an effective thermal envelope, cross-laminated timber and wood-fibre insulation has been used on all external walls. CLT has low embodied energy as it is a recycable timber material with high structural integrity and insulative properties.

Our provision of windows is generous to allow for multiple opportunities to open and close them to provide natural ventilation to the residents. They are situated at different heights to allow for the hot air to rise and escape during the warmer months.

Our choice of efficient LED lighting is consistent throughout the facility, leading to individual power sources with an on / off switch. Additionally, these are powered by the solar panels during the day.

Our grey water is filtered and treated before being pumped through to a water feature in our external plaza, which provides residents with mist and temperature moderation during the warmer months.

Finally, each internal wall incorporated decoupled space conditioning to create a thermal break which disables the transfer of heat from one room to another.

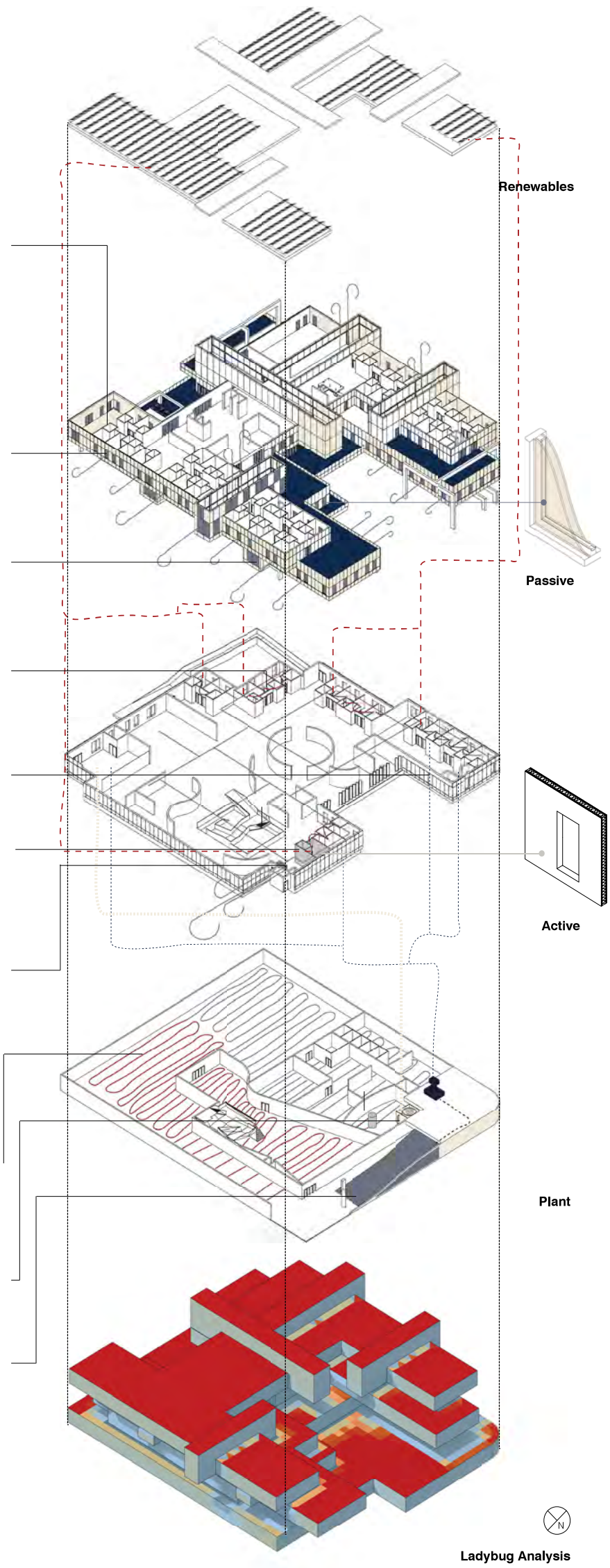
Each space within our facility is accompanied by mechanical heat recovery ventilation which removes hot air from internal rooms and replaces it with cool, fresh air from the exterior environment. This enables the heating and cooling demand within the building to remain low (as evident in the PHPP results). However, due to the nature of aged-care requirements, heating and cooling override options are available in each room whereby the resident can choose to turn it on ond off.

Located underneath our concrete slab are coils that form part of a ground-source heat pump. The heat pump has the capability to heat and cool spaces within our building and provide hot water to residents. This enables us to have a high efficiency HVAC system. The ground-source heat pump is able to produce four times the amount of energy than what is required to power it.

Moreover, our biodigester provides an additional source of energy by using food waste generated by the kitchen to produce bio-gas.

The rainwater tank is designed to slide under our 'peeling' form and reveal itself to observers inside the space. The grey water provided by the tank is then filtered and redistributed throughout the building.

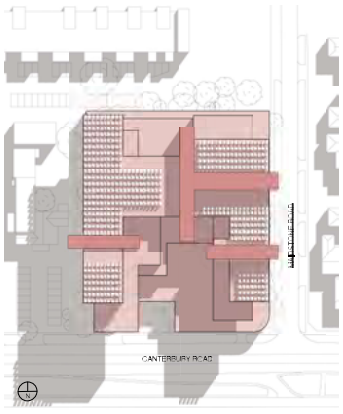
The following diagram demonstrates the solar radiation generated between 1-3pm during Summer. This informs our solar panels placement, namely not to place them on the South side of the vertical extrusions as they will be in the shade.



Ladybug Analysis

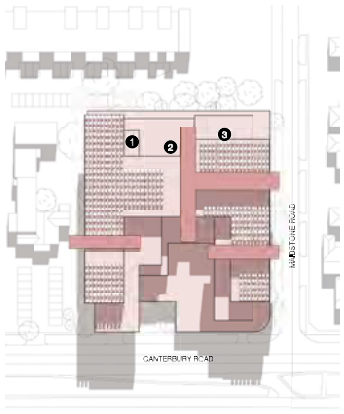
Reversing Carbon Modernity : The layers of Carbon Neutrality

Shadow Studies



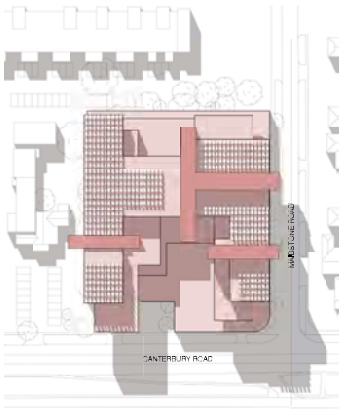
WINTER SOLISTICE 10AM

Morning winter sun reaches northern rooftop gardens whilst significantly shading southern lower gardens. Western facade is completely shaded.



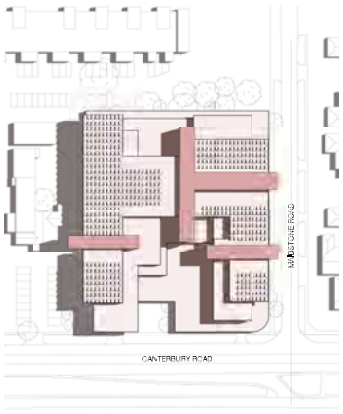
WINTER SOLISTICE 12PM

Northern courtyards are fully exposed to the sun, shading is provided by undercover activity areas such as the veggie garden (1),chicken coop (2) and undercover Bocce court (3). Southern courtyards and partially shaded creating a pleasant outdoor environment at midday in winter.



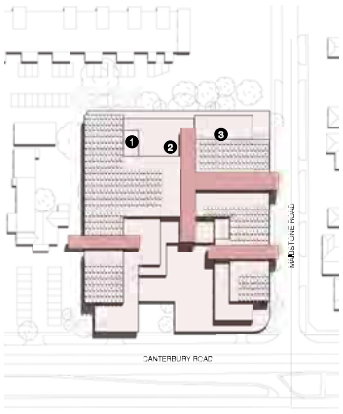
WINTER SOLISTICE 2PM

Increased shading to southern courtyards and rooftop gardens, increased sun exposure to western facade. Pleasant north western sun reaches norther roof gardens. Increase in shading to roof solar on southern roofs.



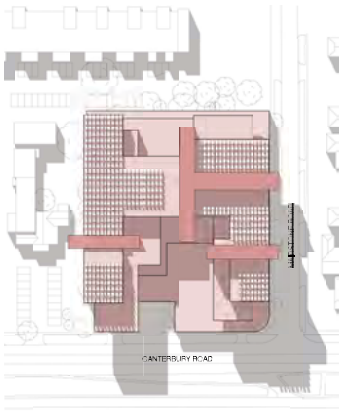
SUMMER SOLISTICE 10AM

Shading from hot summer sun in northern gardens is achieved via shadowing from double height spaces. Shading of southern outdoor spaces is achieved via cantilevered forms. Optimal sun exposure to PV.



SUMMER SOLISTICE 12PM

Harsh exposure to hot summer sun is mitigated by undercover areas such as the veggie garden (1),chicken coop (2) and undercover Bocce court (3). Southern outdoor areas are also shaded by cantilevered forms. Optimal sun exposure to PV.



SUMMER SOLISTICE 2PM

Shading provided by undercover activity areas in the northen outdoor areas. Optimal shading is provided in the southern outdoor areas by cantilevered forms and double height spaces.

Studio 21, Final Review, Georgia Honan (831427), Dom Cosentino (1207120), Holly Mills (757497) & Vanessa Hope (834407)

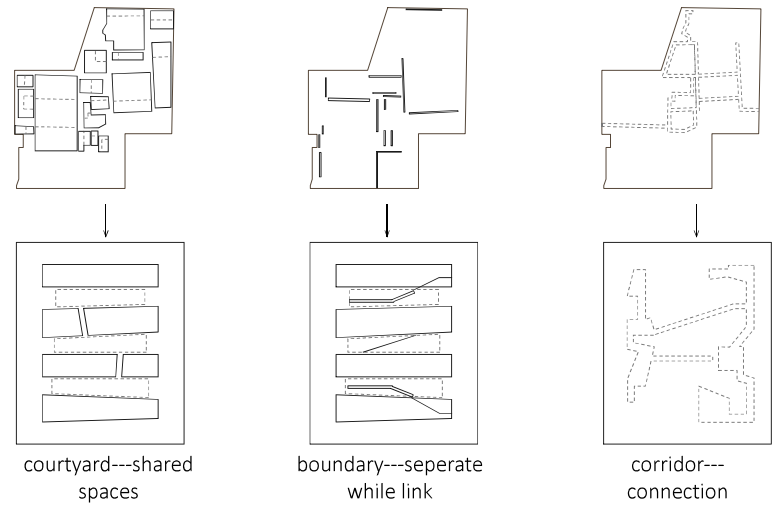
Group 2
Alexa (Leyuan)Yu
Sherry (Xueyin) Yan
Jiaxu Liu (Engineer)

Linger Garden Aged Care Facility Design

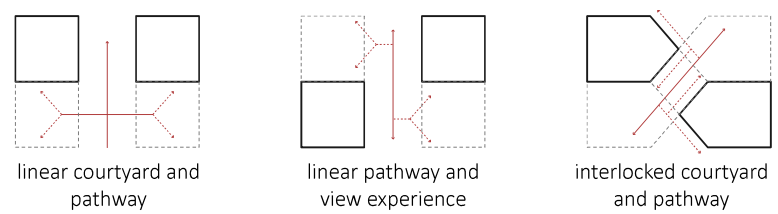
courtyard---shared spaces

CONCEPT COLLAGE

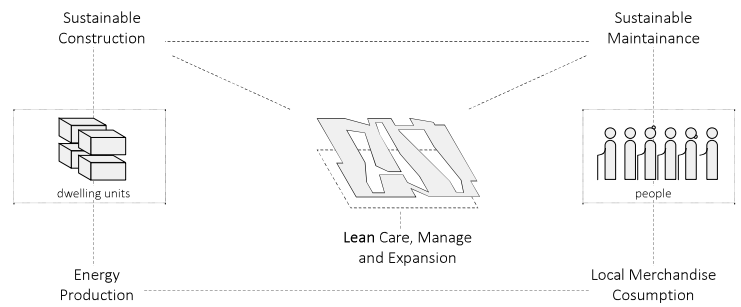
TANSFORMATION OF GARDEN ELEMENTS

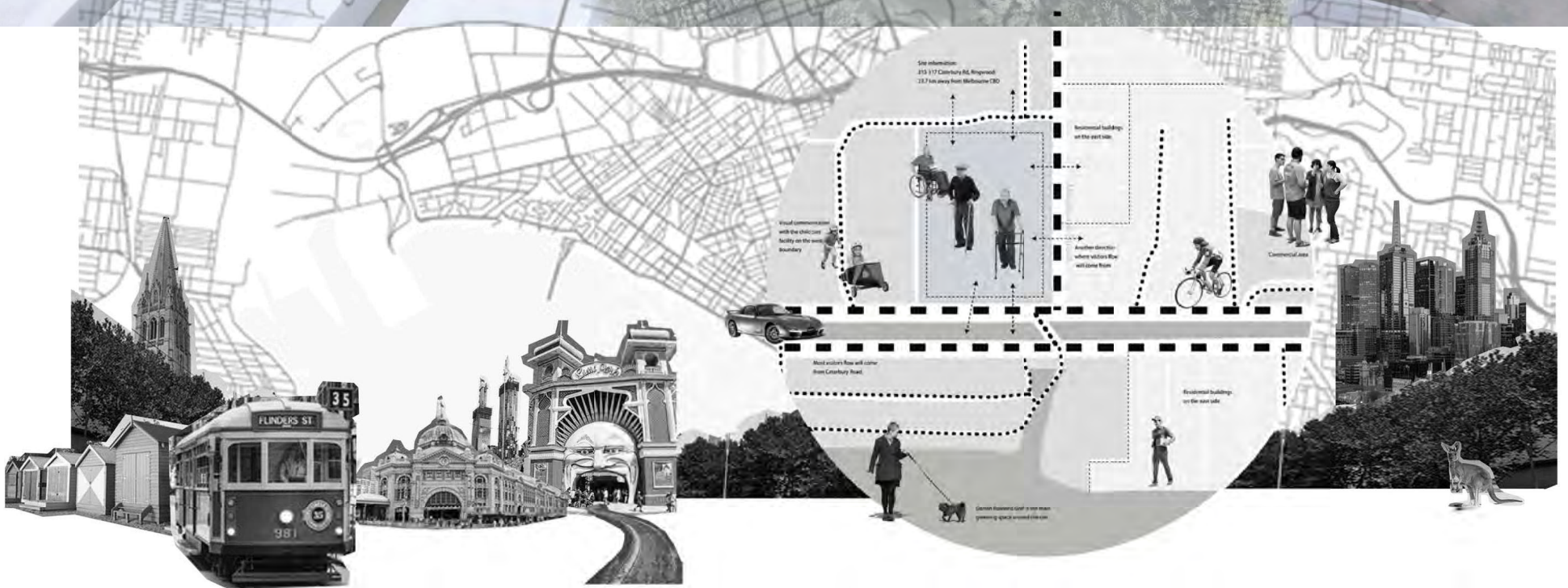


COURTYARD EVOLUTION



CARBON FORM MODEL

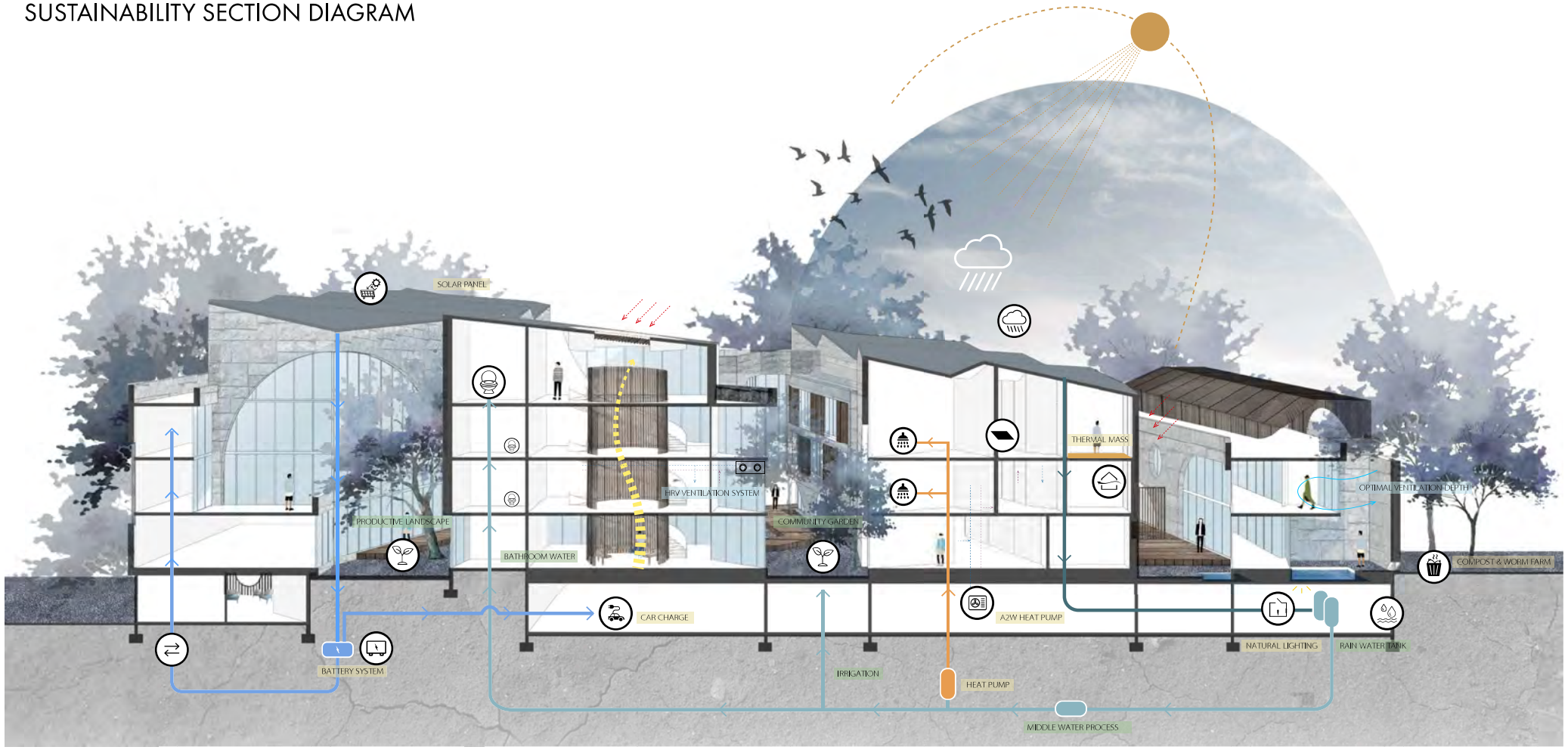




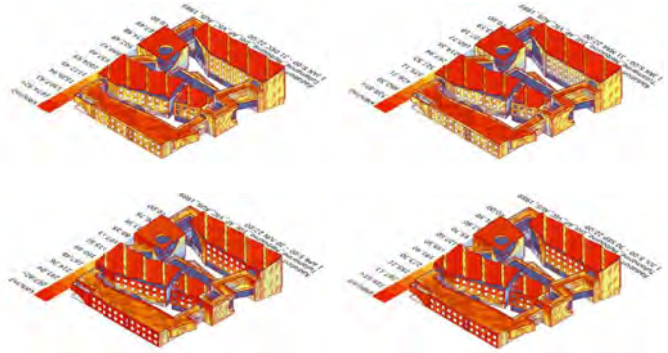
SITE CONTEXT

located in Ringwood, Greater melbourne region, our site is surrounded by very typical Melbourne mid-surbub houses and well-growed parks and golf field as green spaces.

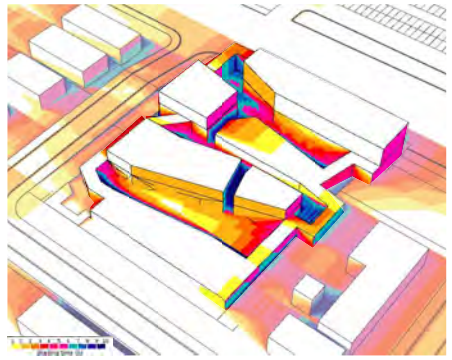
SUSTAINABILITY SECTION DIAGRAM



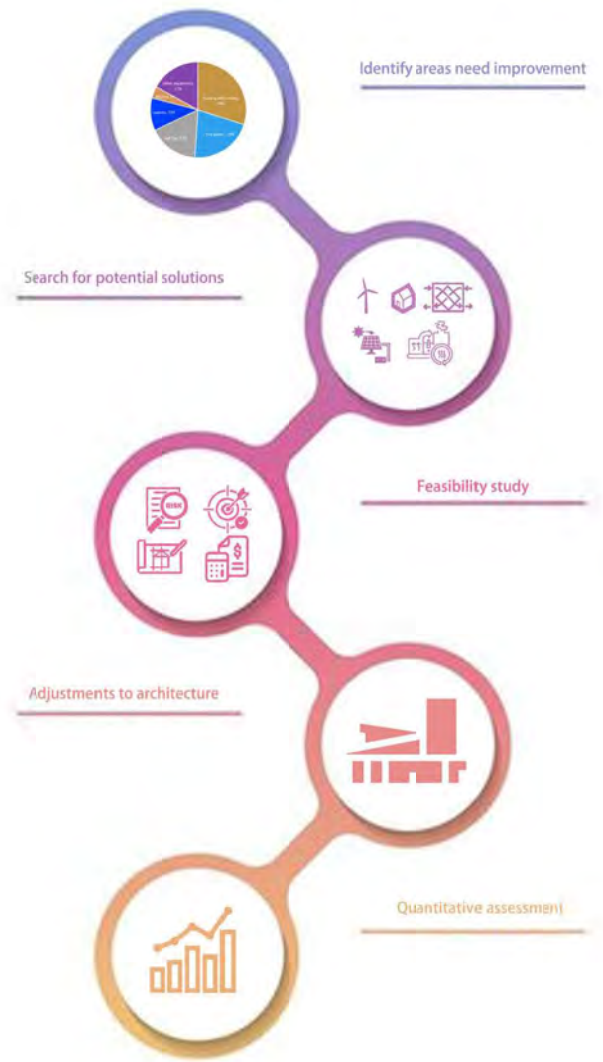
RADICAL ANALYSIS



SHADOW ANALYSIS



DECISION MAP



SUSTAINABILITY

HUMAN HEALTH TARGET: Mental, Physical, and Social.
At the core of the Freespace's enriched spaces is the aspiration to encourage "activated optimal human health".

Energy Efficiency and Comfort
High performance building fabric and passive design minimise heating and cooling demands while maximizing occupant comfort

Daylight, Solar Access and Mitigation
Courtyard depth and optimal orientation allow great solar access to apartments, whichis controlled by a combination of fixed and operable window shading devices to each facade.

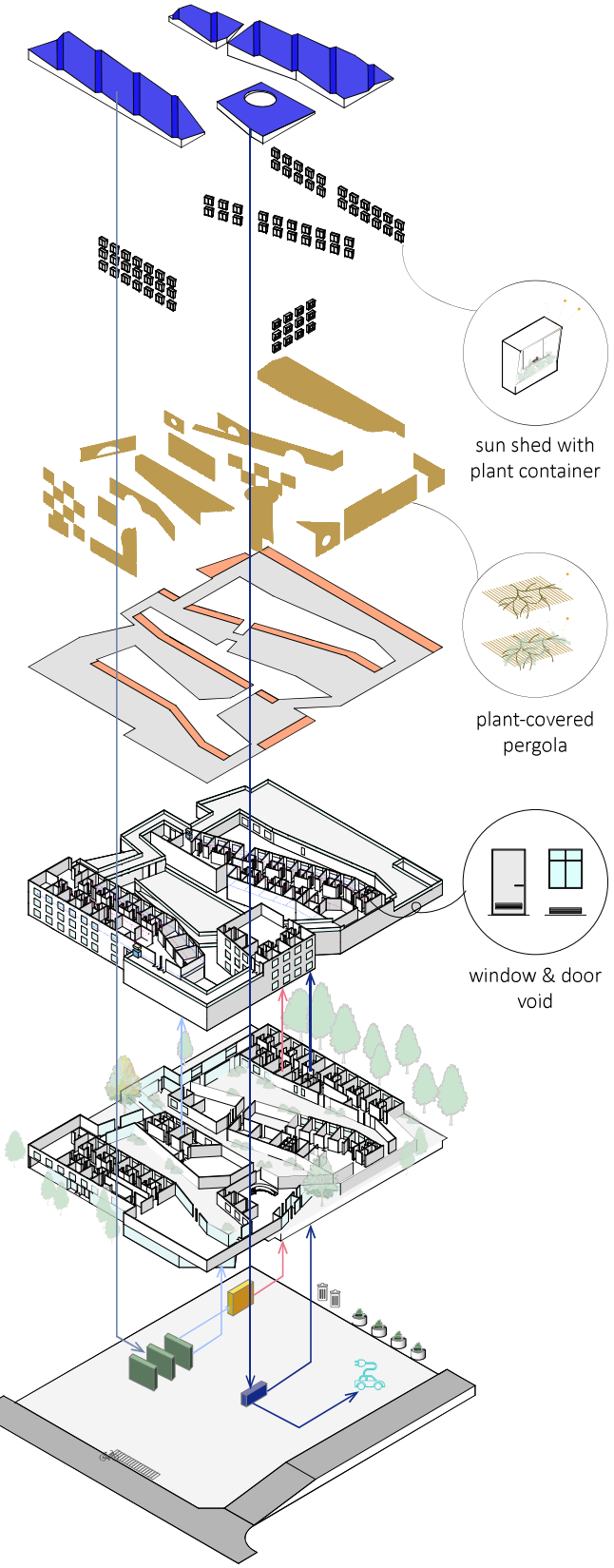
Ventilation
Well oriented apartments, shallow unit depth with glazing designed to enhance cross ventilation. HRVallows for ventilation from different pipes, providing indoor comfort with minimal energy consumption.

Water
Minimising use of mains water through collection and treatment of rainwater and stormwater for reuse in communal laundry and irrigation.

Waste
On site treatment of organic waste and service system designed to help people minimise waste generation.

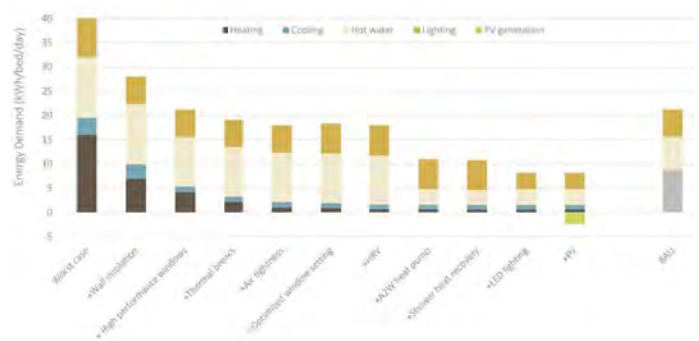
Landscape and Biodiversity
Native and productive gardens provide affordable landscape and could be used as raingarden.

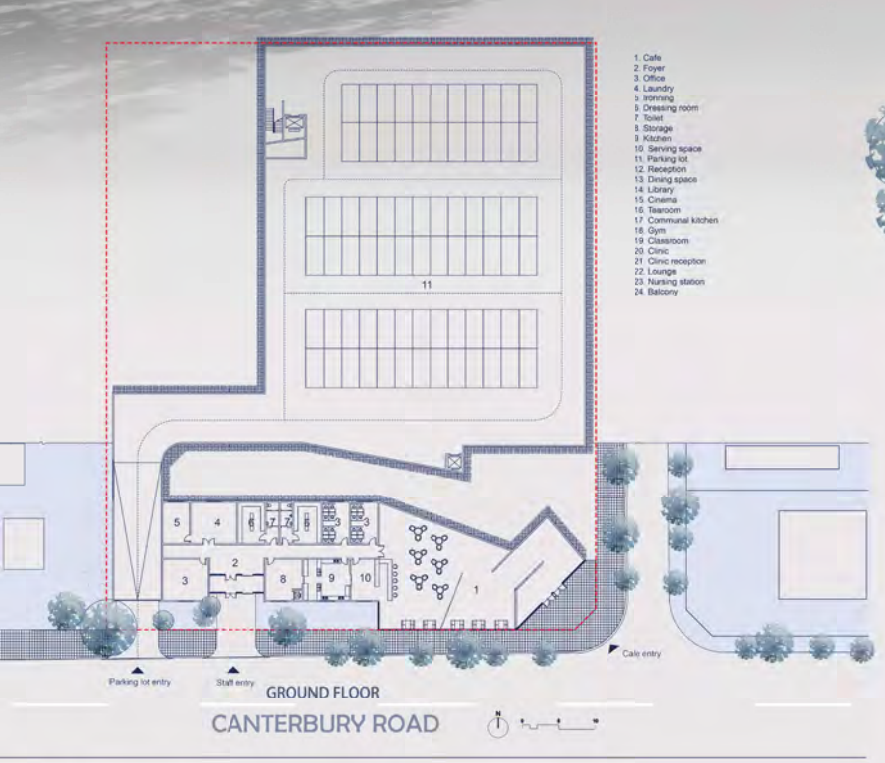
Materials and Construction
Recycled, non toxic and durable materials have been specified throughout. Mass timber construction technique reduces the buidlings carbon footprint.



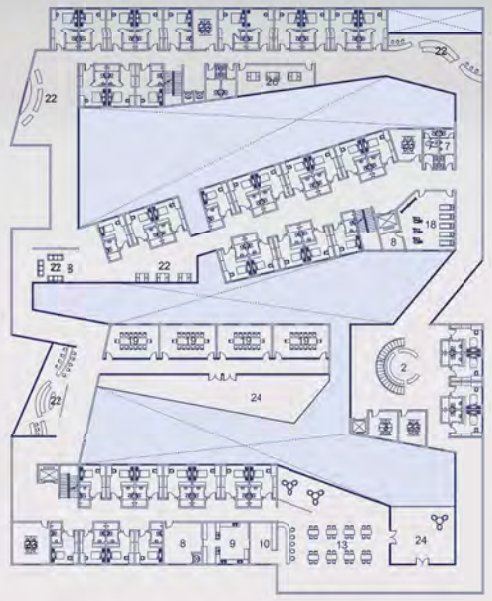
PHPP OUTCOME

energy comsumption has been significantly reduced after a number of strategies were taken.

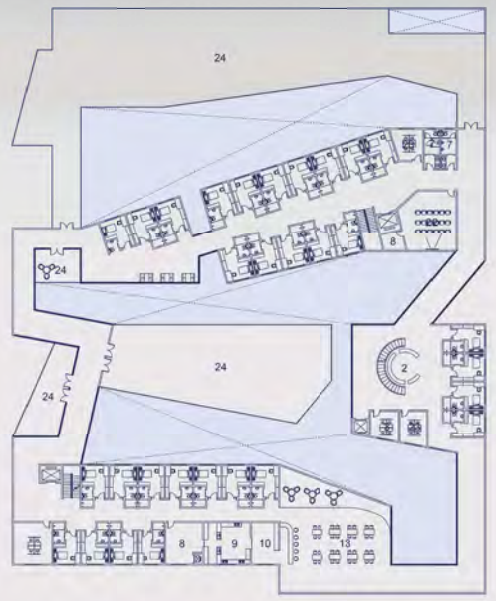




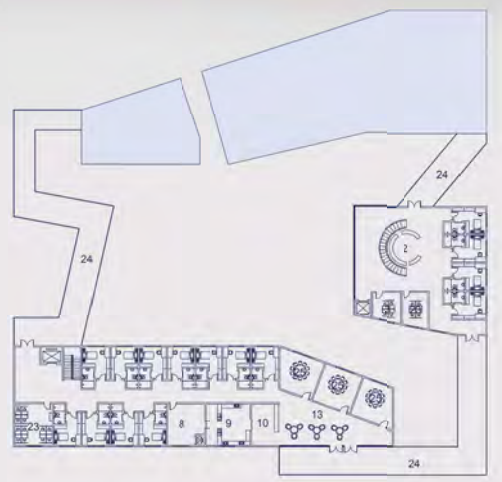
FIRST FLOOR



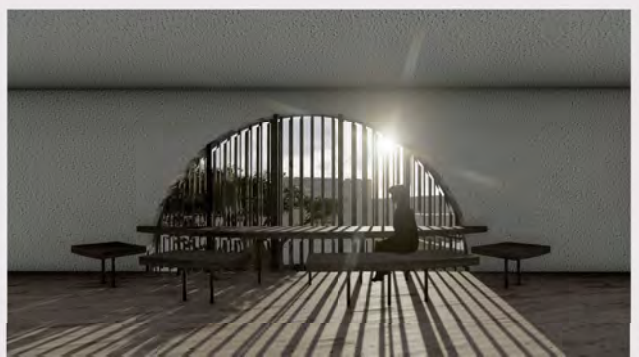
SECOND FLOOR

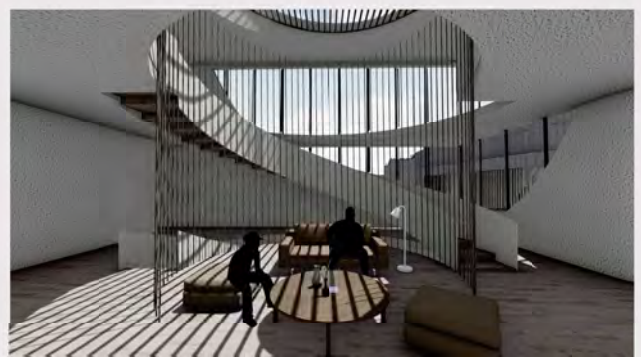


THIRD FLOOR

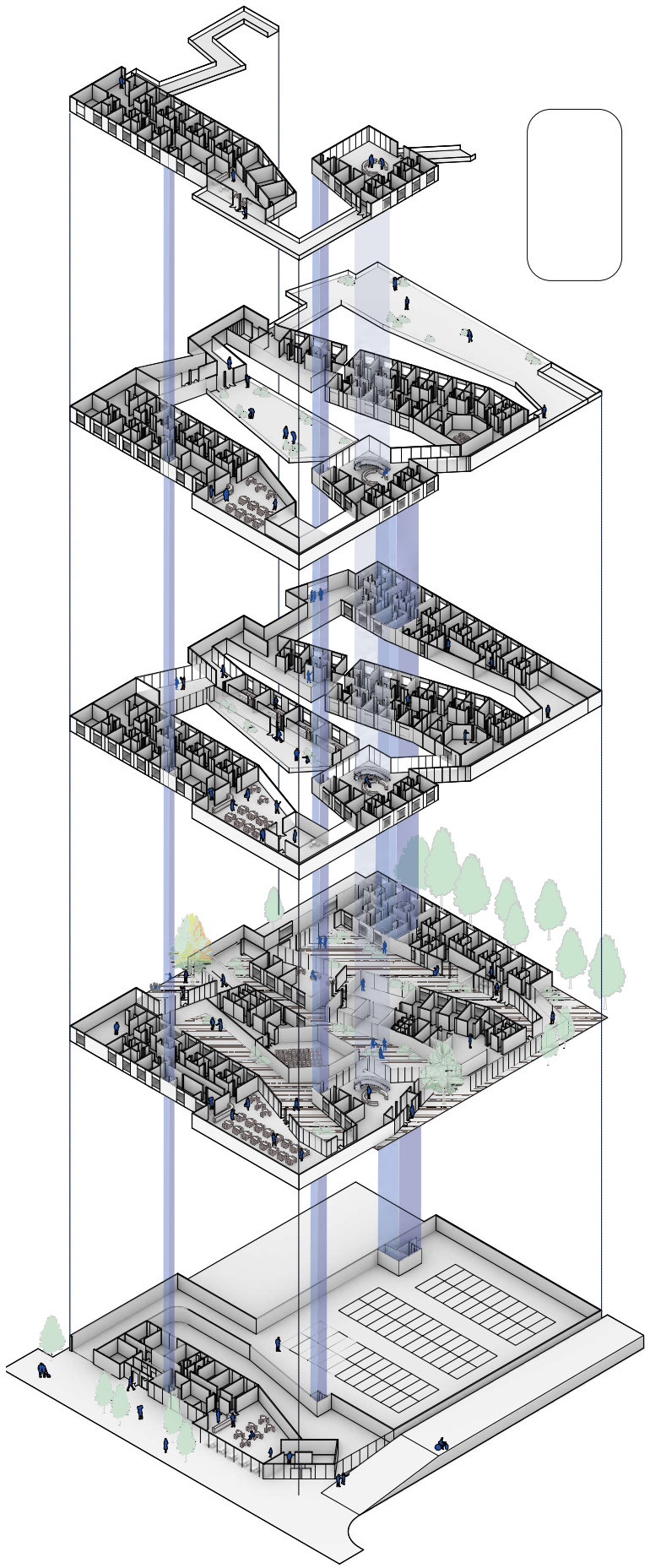


FOURTH FLOOR





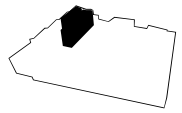
PERSPECTIVE EXPLOSION DIAGRAM



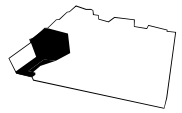
High-care Residence

Medical service &Physical therapy

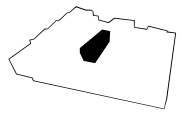
Midium-care Residence



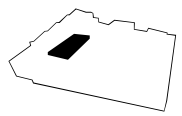
Low Care Residence



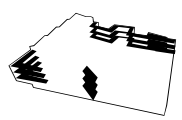
Dining Spaces



Entertainment Facilities



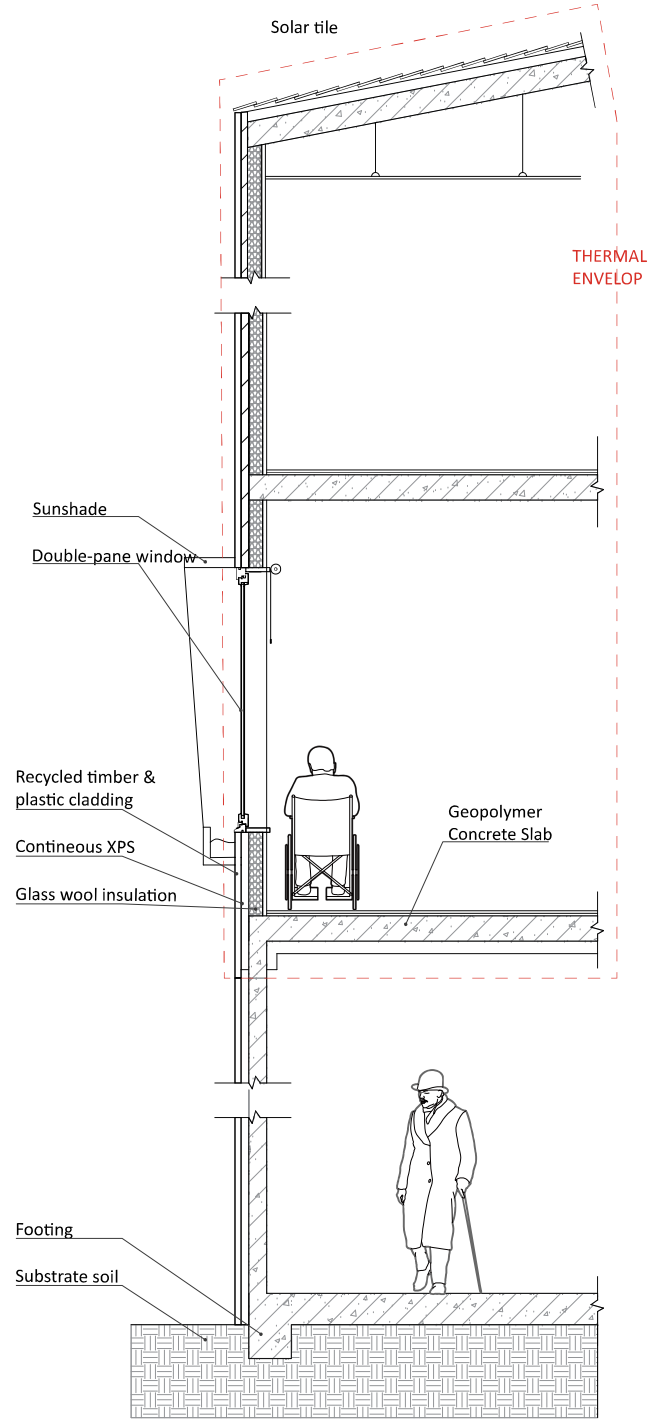
Service Functions



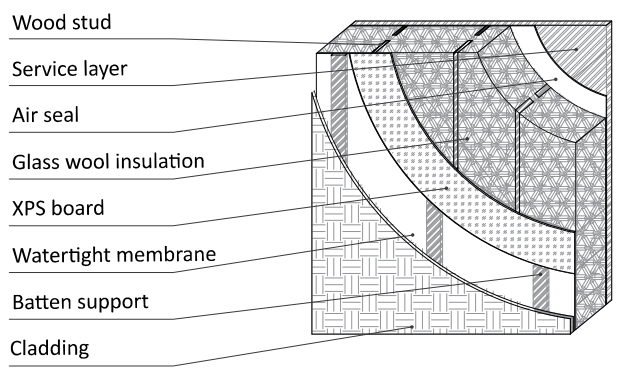
Corridor space

Terrace&courtyard

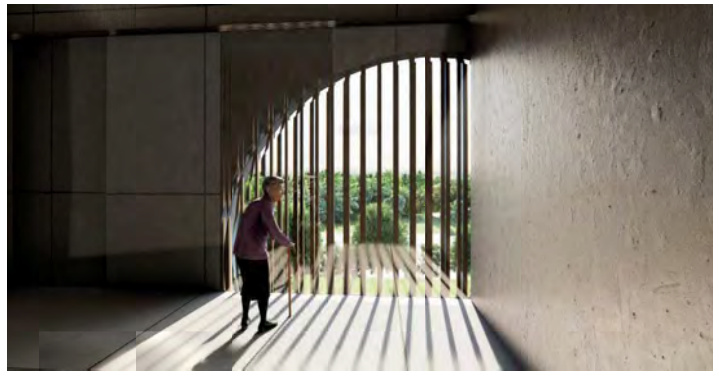
FACADE DETAIL



FACADE DETAIL

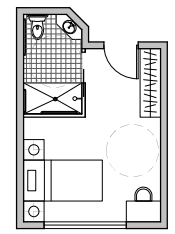


INDOOR RENDER

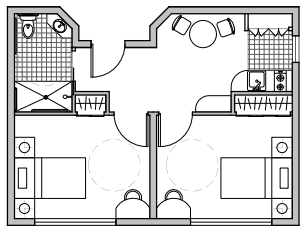


RESIDENCE UNITS

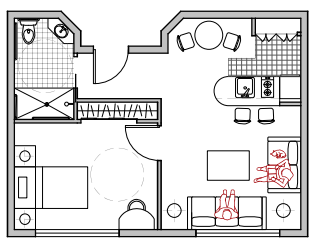
STUDIO UNITS (→)
Size: 23.8 sqm
Number: **75** beds
Client: High-care residents/ long term clients of all care level.
Features: buffer zone at the front door: encouraging residents to stay and communicate.



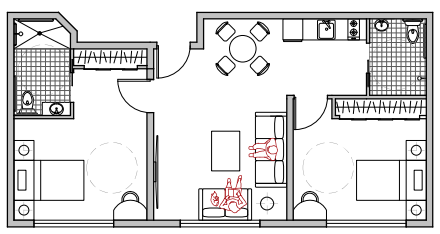
COMPANION SUITES
Size: 47.6 sqm
Number: **30** beds
Client: Couples/Close friends of all care levels
Feature: a. Equipped with simple kitchen area & a mini bar; b. abundant storage space



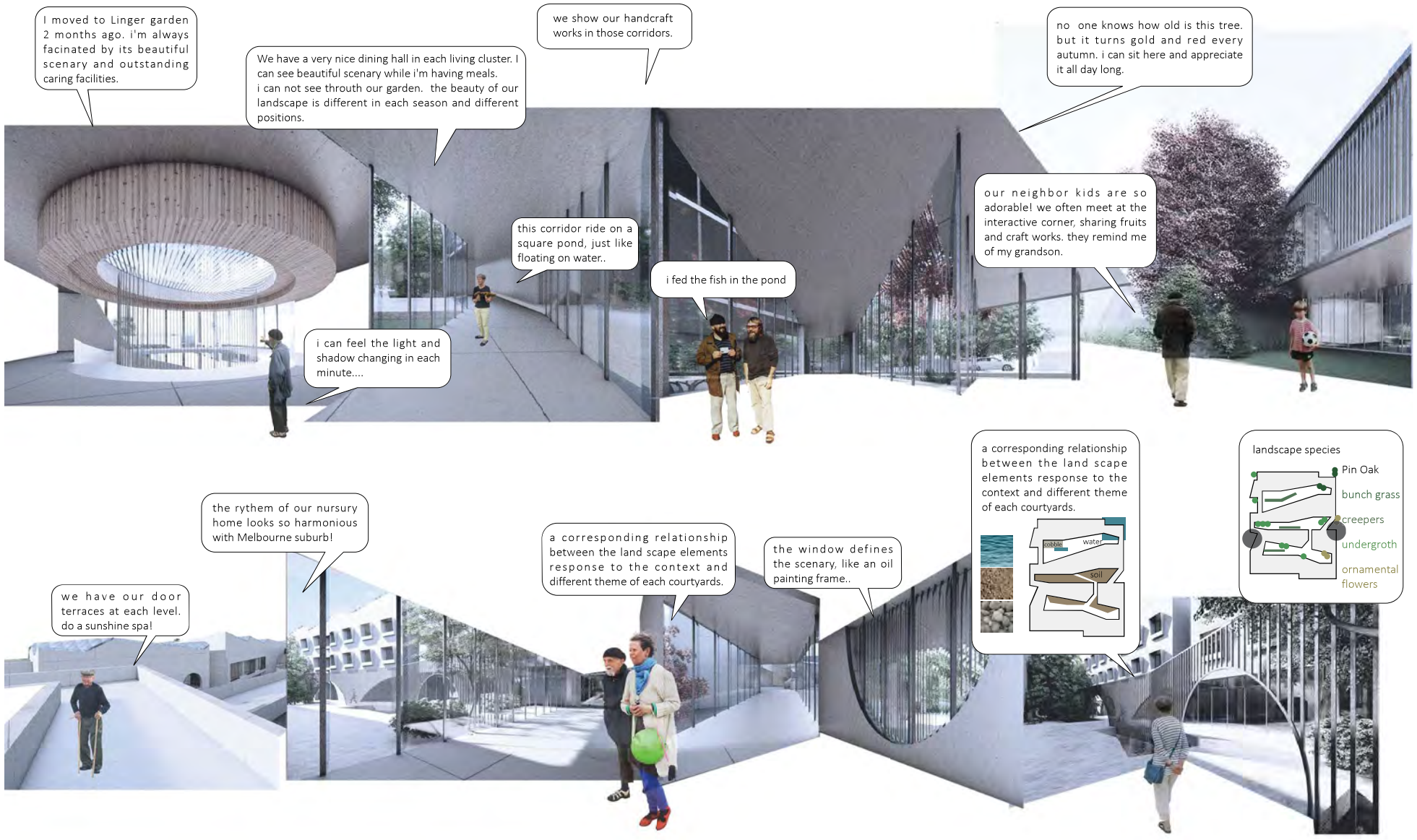
1BEDROOM SUITES
Size: 47.6 sqm
Number: **5** beds
Client: long term Couples/single client of medium to low care

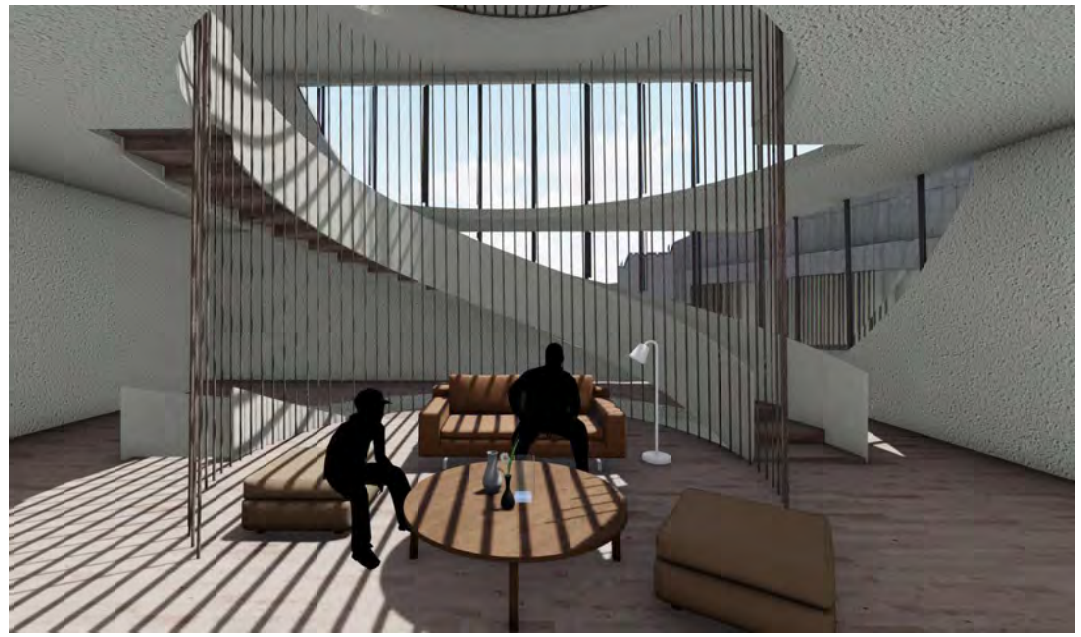


2BR SUITES (↓)
Size: 71.4 sqm
Number: **10** beds
Client: couple/close friends of low to medium care.



COURTYARD COLLAGE SCROLL





INHERITANCE OF ASIAN GARDEN SPACE

scenery frame

Inside-outside

linear space with linear scenery

buffer space

Group 3
Bridget McNab
Claudio Torres
Ian Danielle Alcazar
Jorge Riesco (Engineer

Integrate the aesthetic benefit and adapt to site-specific conditions and surrounding area.

A PERMANENT VACATION

Rethinking aged care

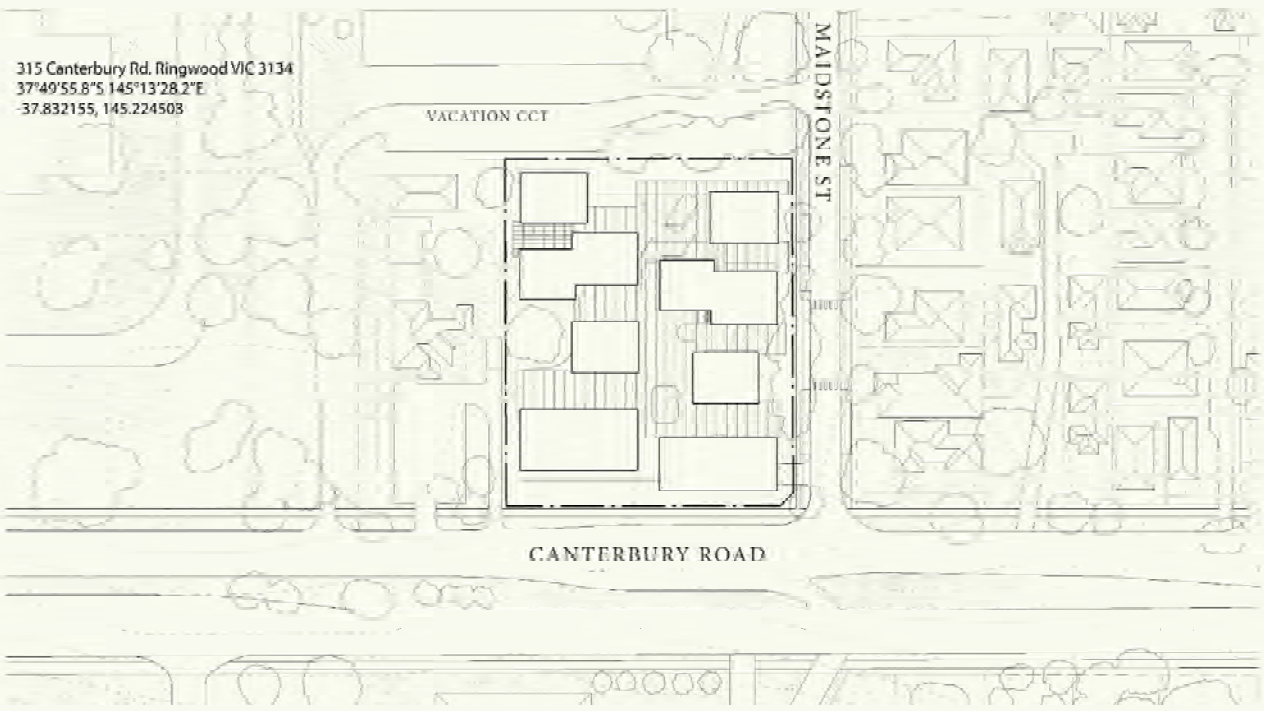
How do we rethink ageing? Moreover, how do we do it in the context of the pursuit for carbon zero? The project team aims to answer this question through the scheme to see both as a not separate entity to resolve, instead of challenges that both help each other for a better outcome. The design itself has been driven by constant analysis and iteration, evidence-based design and further guided by architectural literature.

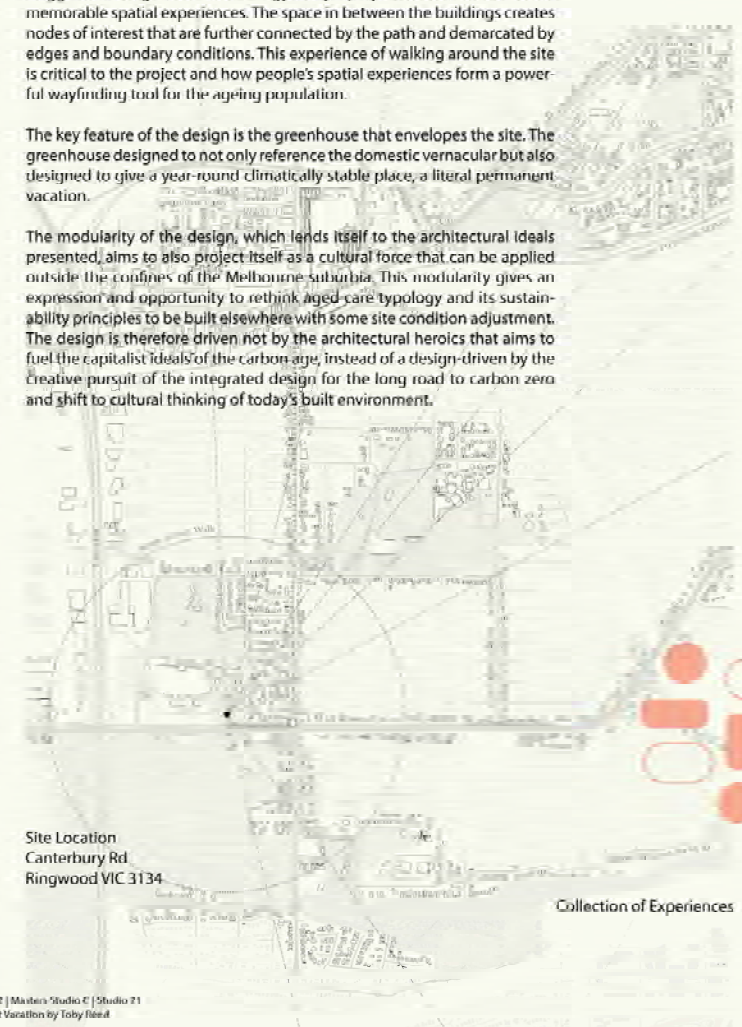
The arrangement of the building, driven by civic aspirations and the city grid, staggered through a series of energy analysis, is punctuated with different memorable spatial experiences. The space in between the buildings creates nodes of interest that are further connected by the path and demarcated by edges and boundary conditions. This experience of walking around the site is critical to the project and how people's spatial experiences form a powerful wayfinding tool for the ageing population.

The key feature of the design is the greenhouse that envelopes the site. The greenhouse designed to not only reference the domestic vernacular but also designed to give a year-round climatically stable place, a literal permanent vacation.

The modularity of the design, which lends itself to the architectural ideals presented, aims to also project itself as a cultural force that can be applied outside the confines of the Melbourne suburbia. This modularity gives an expression and opportunity to rethink aged-care typology and its sustainability principles to be built elsewhere with some site condition adjustment. The design is therefore driven not by the architectural heroics that aims to fuel the capitalist ideals of the carbon age, instead of a design-driven by the creative pursuit of the integrated design for the long road to carbon zero and shift to cultural thinking of today's built environment.

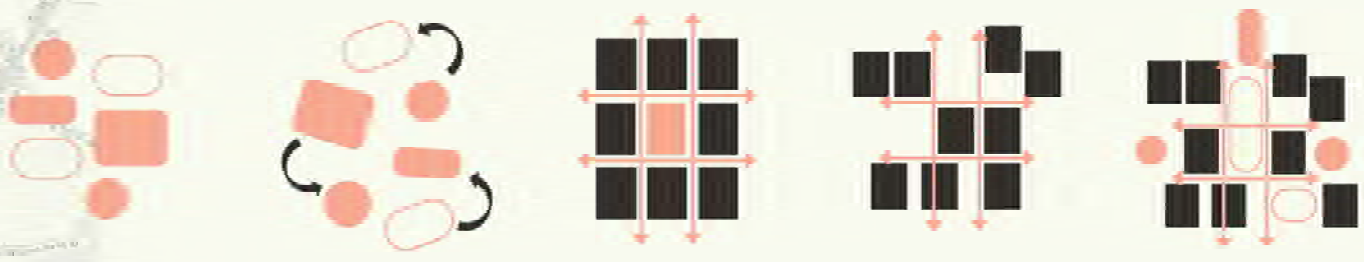
315 Canterbury Rd, Ringwood VIC 3134
37°49'55.8"S 145°13'28.2"E
-37.832155, 145.224503





Site Location
Canterbury Rd
Ringwood VIC 3134

Independent living for elderly



Collection of Experiences

Experience as attractors

The city grid and the plaza

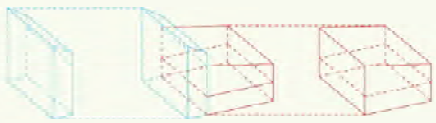
Stagger to climatically optimised

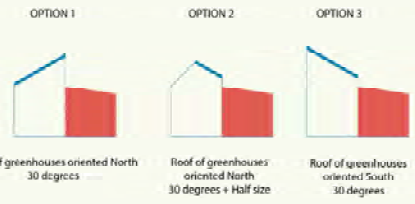
Introduce attractors

Bridget McNab | 1201277
Ian Alcazar | 608457
Jorge Rivero | 1148083
Claudio Torres | 1056113

Allow Form to Follow Energy

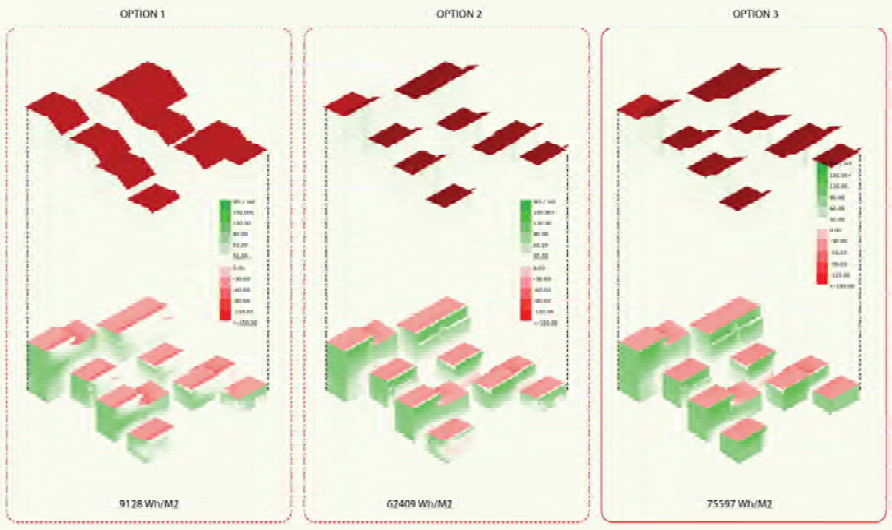
Greenhouses Climate control device /



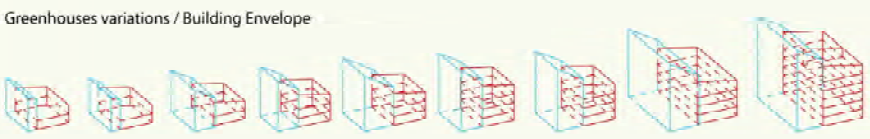


Massing solar benefit study / Building Envelope

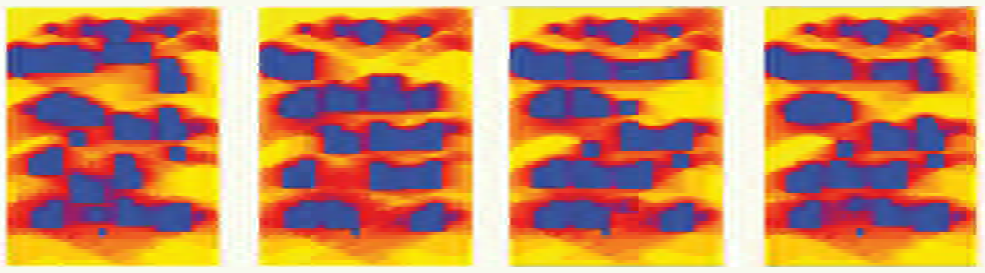
The study compares the total amount of helpful winter solar radiation (green) with the total amount of harfmul solar radiation (red) to determine a final "radiation benefit" value. The higher this value, the better performing the building massing is. (Mackey, 2017)

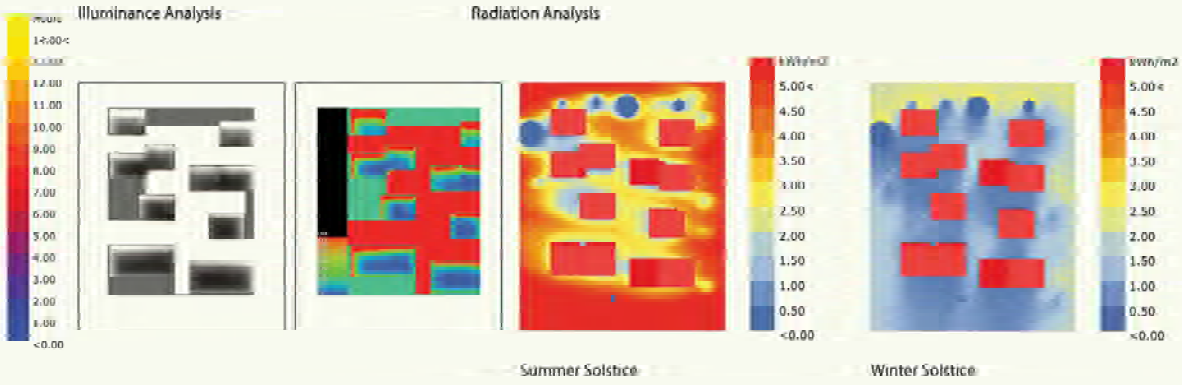


Greenhouses variations / Building Envelope



Sunlight hours Analysis / Outdoor spaces





Daylight performance

Daylight and Insolation allow more livable outdoor spaces for cold days.

Passive Design:

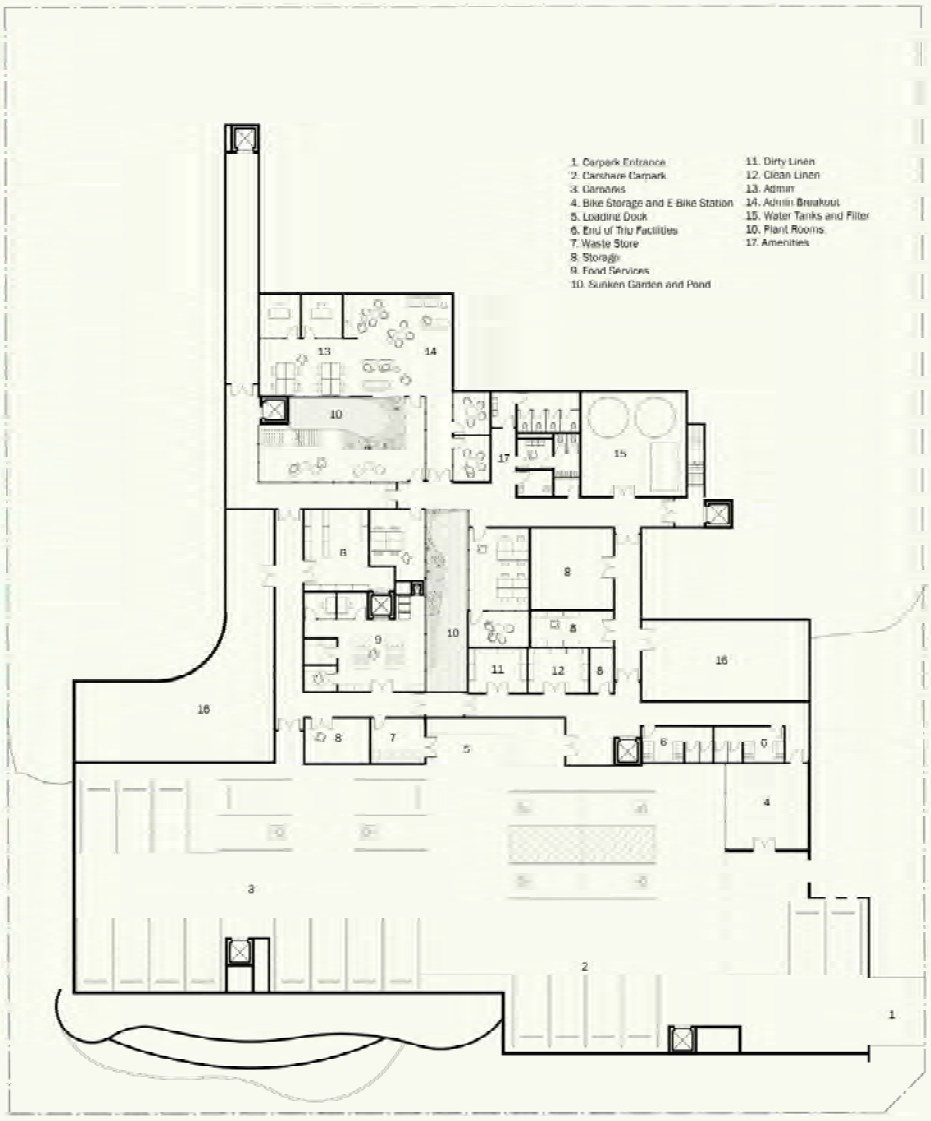
Summer: Greenhouse shading reduces solar gains, and openings allow natural ventilation.

Winter: Greenhouse effect and weather protection creates a more livable space outdoors and reduces heat losses from indoors.

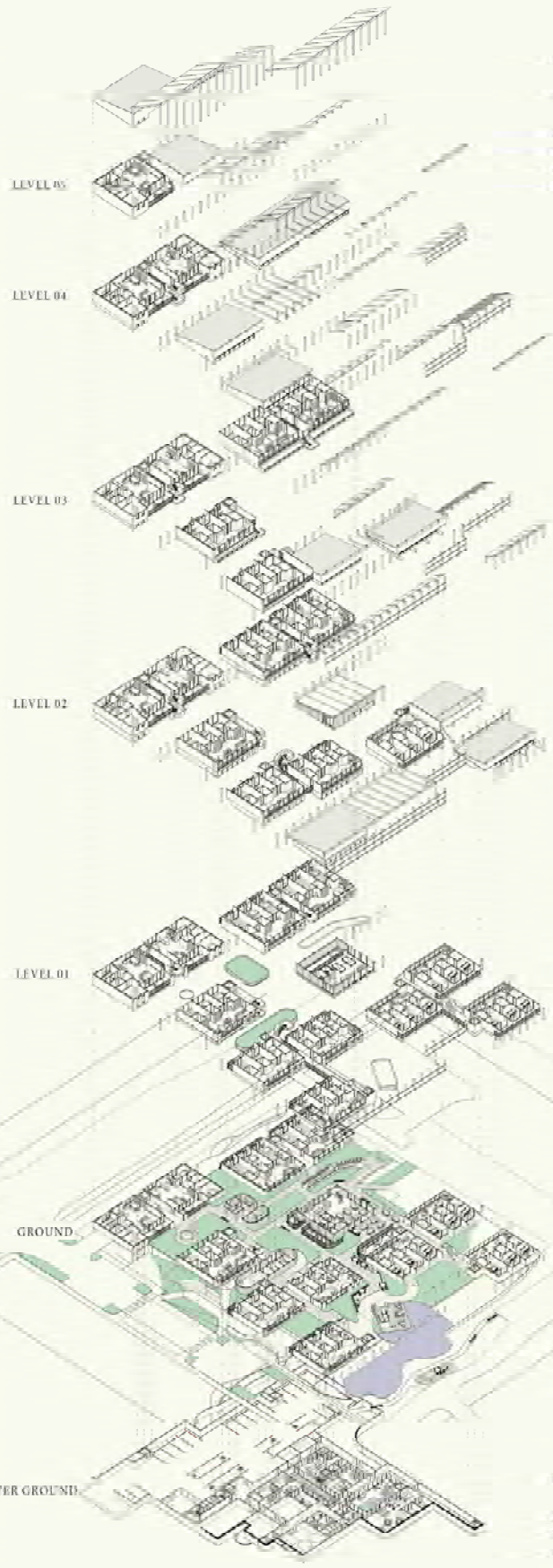
- 35.5 kW PV System supply more energy than HVAC consumption.

Bridget McNab | 12012777
Ian Alcazar | 698457
Jorge Rivero | 1148080
Yasmin Torres | 1056112

Modular housing and village acommodation



Lower Ground Plan



Ground Plan

The logistical machine

As part of the curated and staged resident experience, logistical support has been centralised in the lower ground. Through a series of horizontal and vertical circulation, the BOH enables the scheme to be connected and allows the resident to be supported

A Case for evidence-based design

Studies suggest that access to natural daylight increase productivity (Oseland, 2001) and reduces absenteeism (Thayer, 1995). Designing with nature and a well-designed workplace further reduces staff turnover (Commission for Architecture and Built Environment, 2006), making the residents develop long term connection with staff supporting them. The admin areas in the scheme is bathed with nature and light through a series of sunken garden and pond.

A Microcosm of the village and the city

Through creating a series of curated experiences and activities through nodes, with a staggered grid formation connected informed by sustainability aspiration and the civic grid, the design aims to build a community of people who actively engage with the landscape, people and the built environment

A case for evidence-based design

A study in older residents in Tokyo (Takano, 2002) revealed that walking in parks and tree-lined streetscapes were linked to +5 years life expectancy. The physical activity in nature and parks also reveals a reduced need for accessing healthcare (SLOV, 2018), a testament to improved overall mental health and physical wellbeing

1. Reception including Hot Desking Tenant
2. Second Entrance
3. Carpark and End of Trip Entrance (Entry at Lower Ground)
4. Flexible Amenity Building
5. Library
6. Community Garden
7. The Forest Pavilion
8. Amenities + Garden Store Room
9. Admin
11. Amphitheatre interface with Public
12. Community Pantry and BBQ
13. The Plaza
14. Cafe
15. The Pond
16. The Crescent
17. Active Lawn
18. Void to Lower Ground Pond
A. High Care
B. Garden Low Care
C. Deluxe Low Care
D. Active Low Care
E. Independent Living Apartment

ARPL5014Z | Masters Studio 2 | Studio 21
Permanent Vacation by Toby Reed

Bridget McNab | 1201277
Ilze Ah Yan | 6884457
Jorge Rivero | 1148085
Claudia Torres | 1066112

Adaptable Architecture

MODULES

Overarching Principles

The design further explored in great scrutiny on how the residents will live. The outcome of the Royal Commission to Aged Care revealed that the current policies and predominant models of care only further institutionalise the typology.

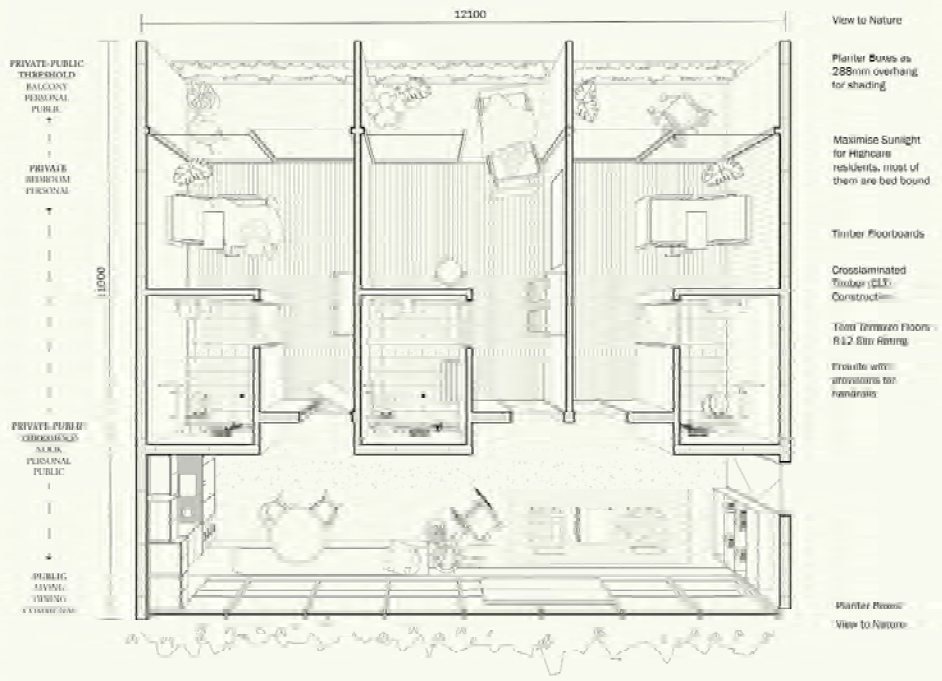
The scheme responds to this by developing modules that cluster residents on a domestic scale. The scheme explores the threshold and transition between spaces in the modules. Central to this is the nook residents can identify with them and balconies and operable fenestrations to encourage passive connection with the bustle of activities outside.

A. HIGH CARE MODULE
B. GARDEN LOW CARE MODULE
C. DELUXE LOW CARE MODULE
D. ACTIVE LOW CARE MODULE
E. INDEPENDENT LIVING

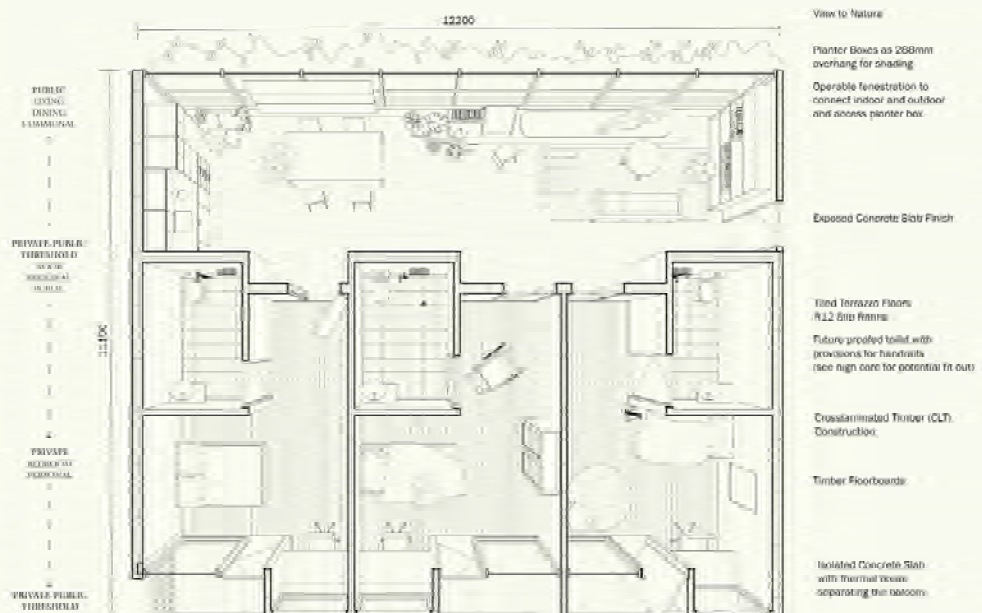
Create places for recreation and nature conservation purposes.

Therapeutic landscapes

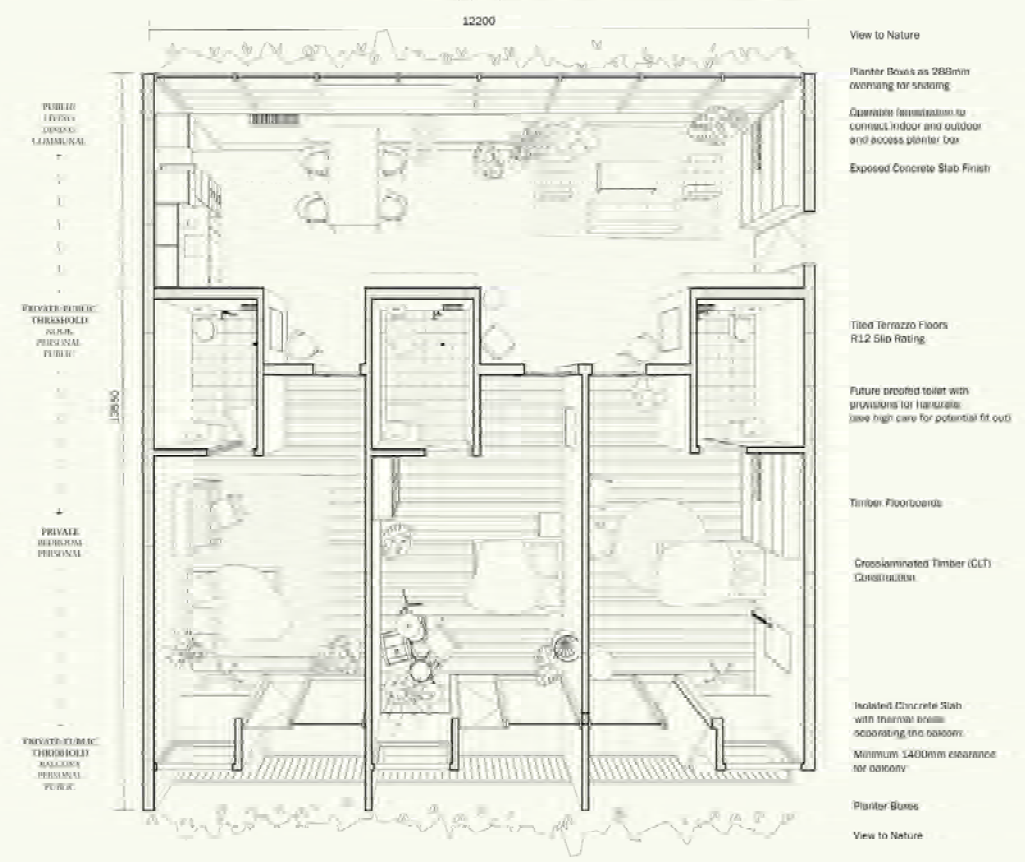
A. HIGH CARE MODULE OVERALL 126sqm / 39sqm Shared / 16.8sqm Bedroom / 6.3 sqm Ensuite /6.7sqm Balcony



B. GARDEN LOW CARE MODULE OVERALL 132sqm / 42sqm Shared / 17sqm Bedroom / 6.3 sqm Ensuite /8.55sqm Balcony



C. DELUXE LOW CARE MODULE OVERALL 162sqm / 54sqm Shared / 28.8sqm Bedroom / 6.2 sqm Ensuite /8.4sqm Balcony



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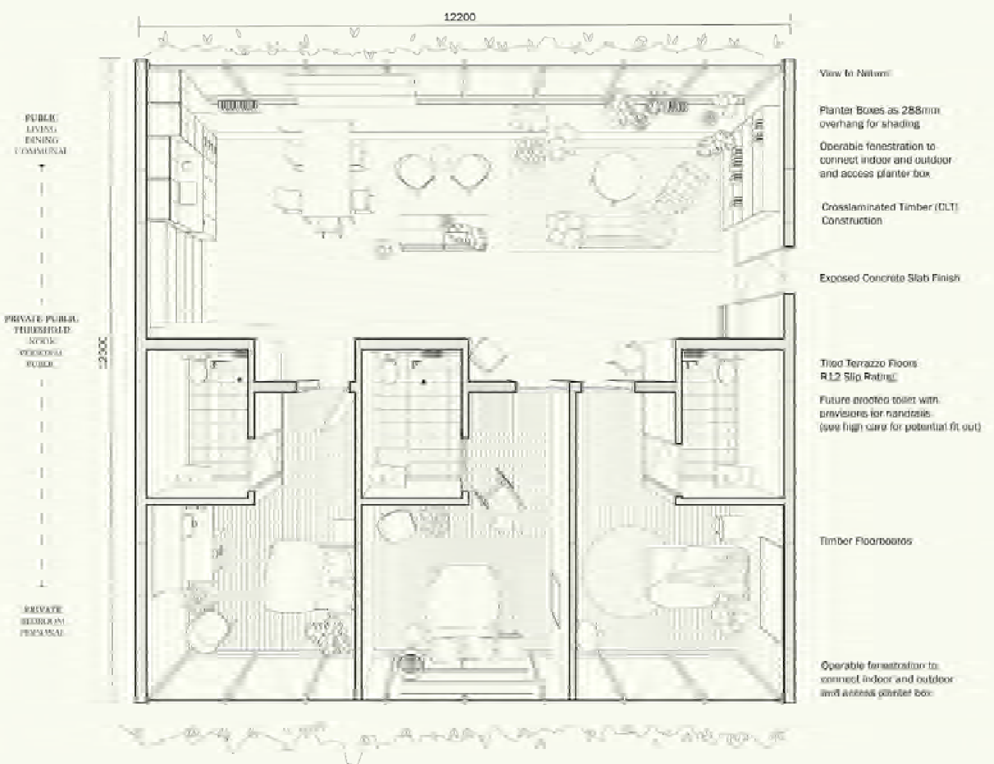
Ian Alcazar | 698457
Jorge Rivero | 1148085
Camilo Torres | 1066112

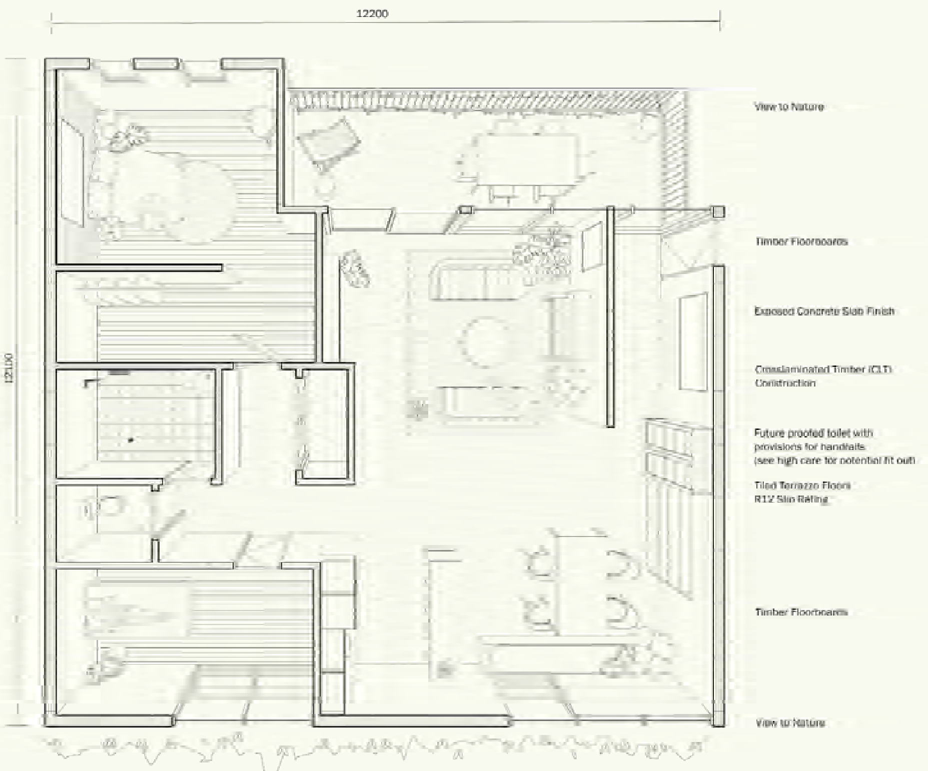
Integrative Planning

Design a sustainable layout by considering an interdisciplinary approach by combining function, aesthetics and use.

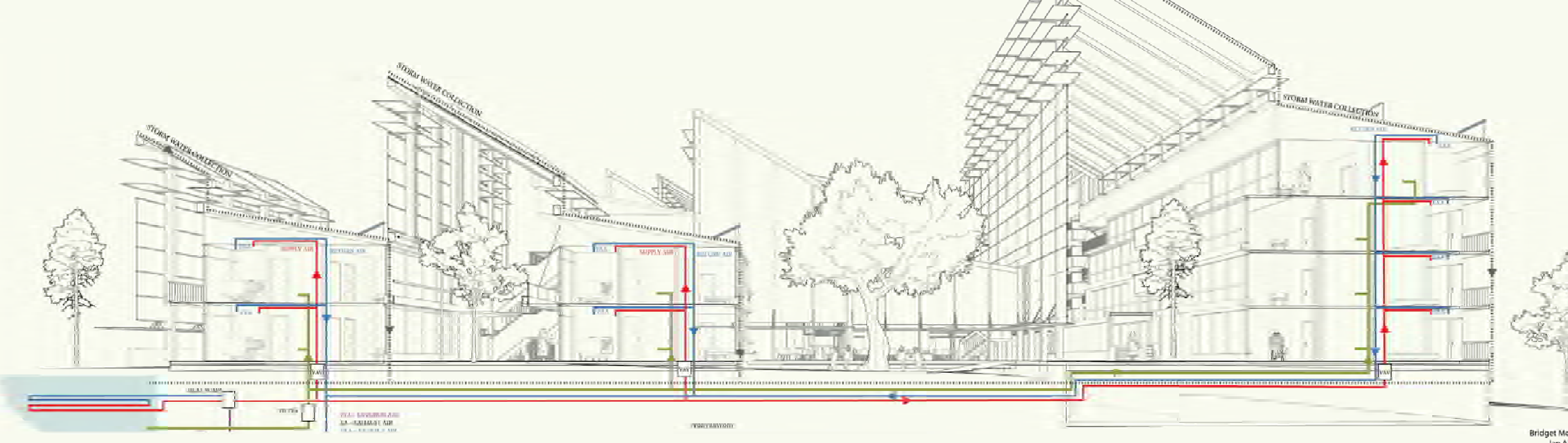
D. ACTIVE LOW CARE MODULE OVERALL 140sqm / 64sqm Shared / 18.3sqm Bedroom / 6.3 sqm Ensuite



E. INDEPENDENT LIVING OVERALL 140sqm / 80sqm Shared / 23.4sqm Bedroom / 13sqm Bedroom / 20sqm Balcony

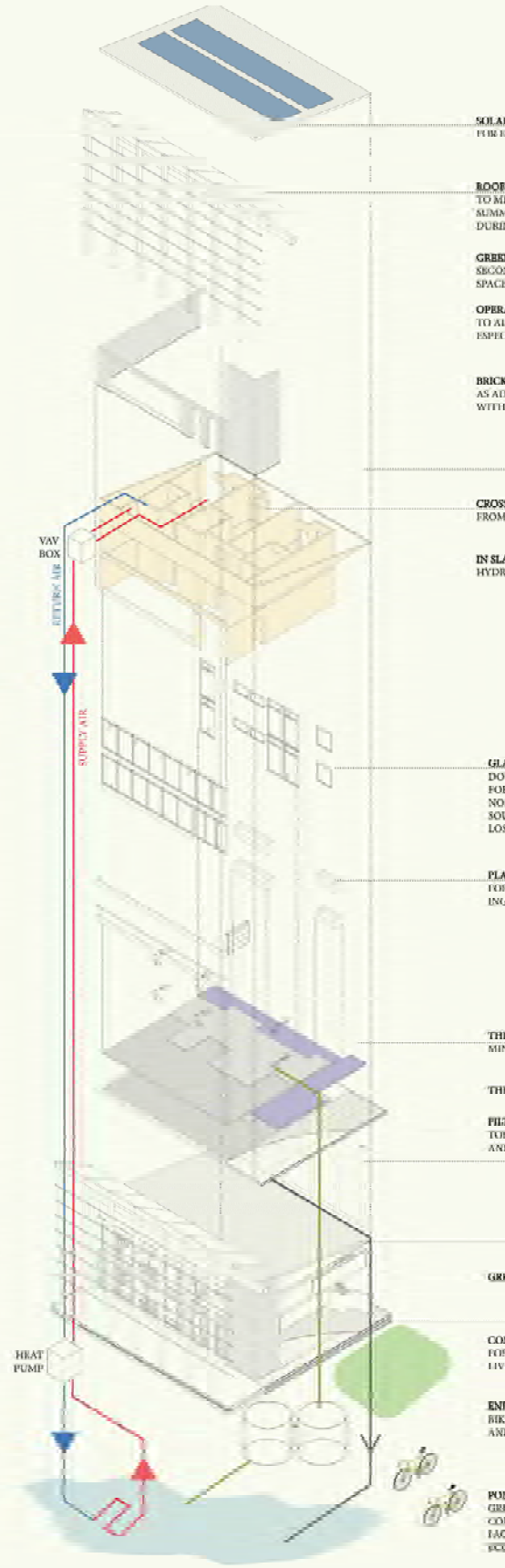


Sustainable Built Environment



Bridget McNab | 1201277
Ian Alcazar | 698457
Jorge Blasco | 1148080
Camilo Torres | 1066112

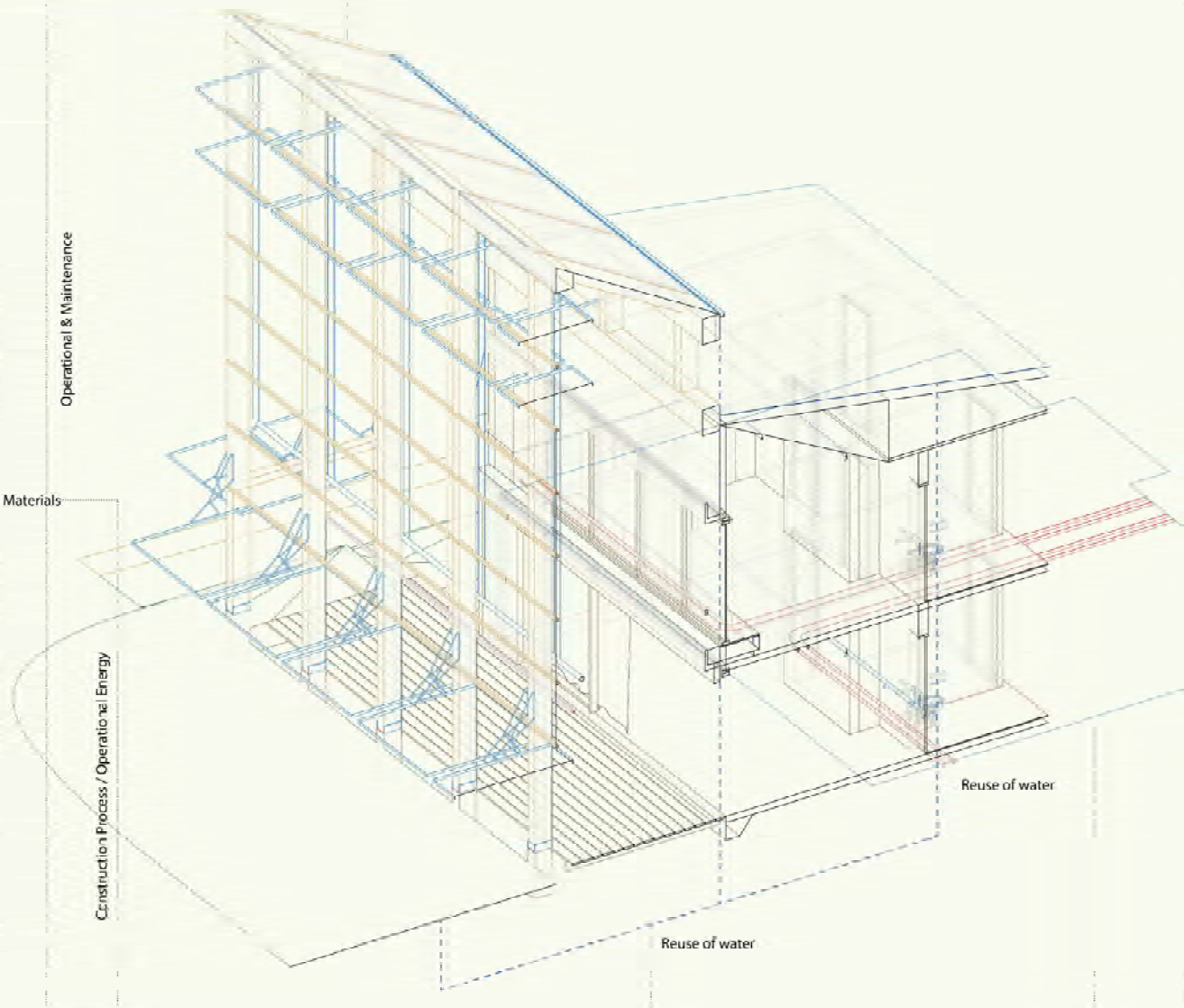
Design Embodied Energy



Operational & Maintenance

Materials

Construction Process / Operational Energy



Construction

How can heat loss be reduced in a greenhouse?

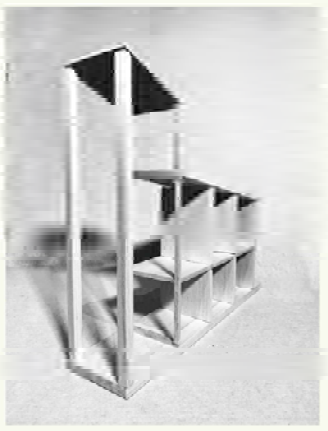
How much heat does a greenhouse lose at night?

How fast does a greenhouse lose heat?

How much energy is lost in the prefabrication process?

Passive House standard for envelope construction
Double– Triple glazed windows, R-35 walls , R-49 Roofs and reduced thermal bridging where possible

1/4 of the Built form
To be analysed in PHPP and energy modelling for further studies about Quantitive and Qualitative effects of timber construction

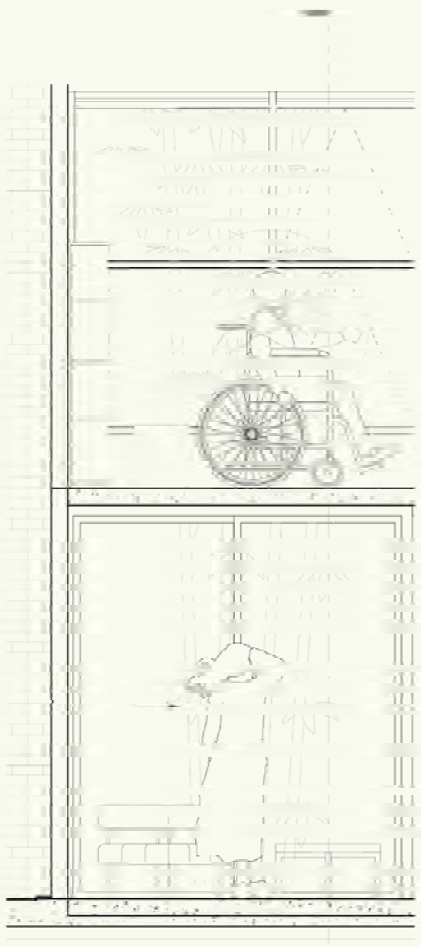


Recycle

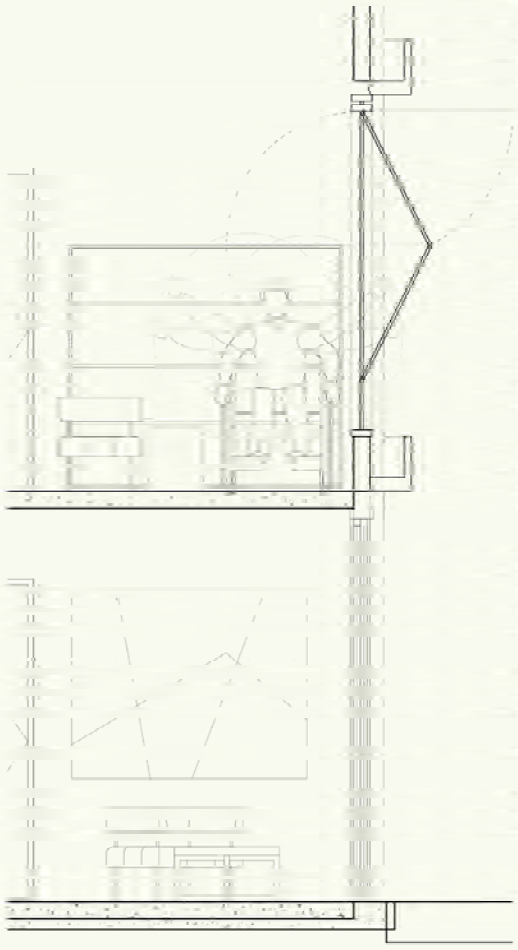
35.5 kW PV System annually supplies 50 MWh
Rainwater and greywater is collected.
The pond provides treated greywater storage. Additionally, behave as a heat storage for both the greenhouse and the heat pump.
Annual Freshwater Demand: 3050 m3
Annual Rainwater Collection: 1850 m3

Design for ageing

Section detail / South Facade



Section detail / North Facade



Feasibility

The integrated design team believes that the proposed scheme has tackled the problems posed by the studio, the pursuit for zero-carbon and the challenges posed by a delicate and demanding typology of seniors living. The scheme's adaptability and modularity further extend itself beyond the context of Ringwood, allowing the principles to be applied elsewhere.

The design made some assumptions about the future residents it will host:

- Most of the residents will be healthy and mobile and are looking to downsize and live in a place where they can age in place. The project team has made necessary provision to allow each aspect of the design to be universally accessible and account for the changing needs of each user.

- The design assumes the impact of how we design spaces in the post-pandemic world. The design caters itself to give less risk for the residents to contract illness from visitors through the open spaces facilitated by the large expanses of greenhouse that covers the activated ground plane.

It is also essential to consider that the design team has identified some gaps and further improvements to the design to enable itself to be genuinely carbon-zero and the best place to live for the ageing population:

- One of the project's ethos is designing with ageing, also specify the concept of ageing in place. The modularity of the scheme may be limited to the specific needs of a person, and there is less flexibility to cater for when developing the design further.

- The village concept and treating each building separately lends itself to distributed vertical transport. Although the design team expects the initial residents to be adequately serviced by these, the likelihood of the transportation being overwhelmed might be a concern when the residents have aged in place and are exhibiting chronic illness and impairments associated with ageing.

- The model of care and staffing requirement for each of the residents would need to be highly considered as there is less horizontal mobility between each of the buildings in the upper levels.

We then further recommend the following to address the concerns

- Extensive engagement with the client, the staff and the users to determine the best model of care will be facilitated through the arrangement of the building. This also extends to the design of the modules.

- Further consolidating the building arrangement to consolidate the vertical transport, bearing in mind the ethos of the village and city

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Claudio Torres | 1066112

Group 4
Carol (Tingxin) Wang
Skye (Qiyu) Tang
Morna Hu
Lucy Marsland (Engineer)

THE NEST

The Nest is a 120 bed retirement village and aged living facility within a new energy paradigm. Drawing on both a mountain range and a village, this dynamic design encourages residents to engage with the site, each other, and the wider community through a variety of communal and commercial spaces. The residential units are tailored to independent, low care and high care residents, and offer a peaceful and inviting retreat for their permanent vacation.

The project aims to challenge the concept of 'form follows energy' that drives carbon form by using formal and spatial organisations that reflect our focus on renewable and sustainable energy sources. The 'decarbonisation' of our design can be seen through the pitch of the roofs, the collection and use of rainwater and grey water, and the very dimensions of our building which are informed by our primary material, CLT. These interventions will ensure residents are comfortable all year round while minimising energy costs.

Not only are the principles of zero-carbon buildings embedded in the form, they will also be experienced by residents, staff and visitors as they navigate the site. While we acknowledge the necessity of cars, the circulation throughout the site is designed at a pedestrian scale. This is especially important on the ground floor and first floor where people can circulate freely and safely throughout the wide range of communal and commercial spaces.

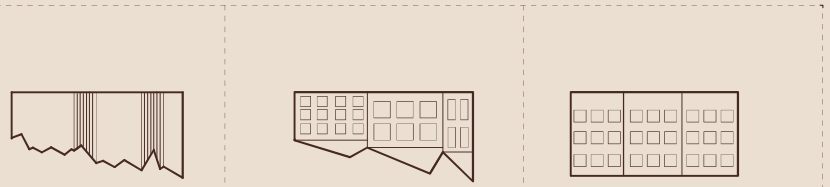
Connection to nature is an integral part of this project. The distinctive character of each garden not only create different experiential zones for the residents, but also serve as landmarks and can assist residents in wayfinding. These gardens are designed to work with the local environment and climate and native and low-maintenance plants have been used where possible. The raised vegetable garden gives residents the opportunity to grow their own produce.

Welcome to The Nest —

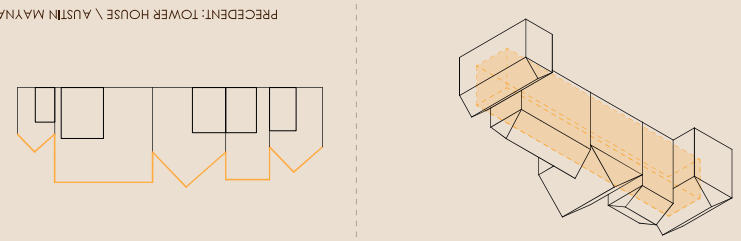
STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

PROCESS: CONTINUITY AND FACADE LANGUAGE

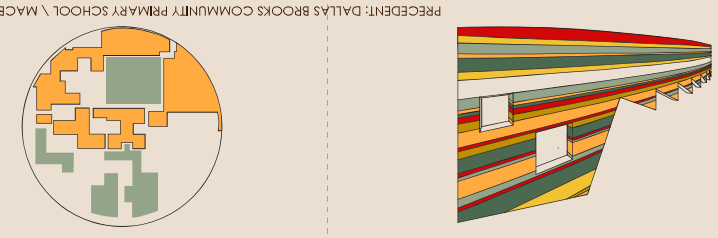


PRECEDENT: TOWER HOUSE \ AUSTIN MAYNARD ARCHITECTS

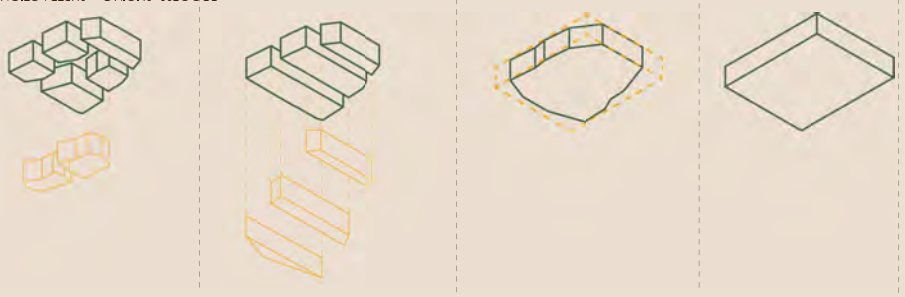


PROCESS: FACADE VS PLAN

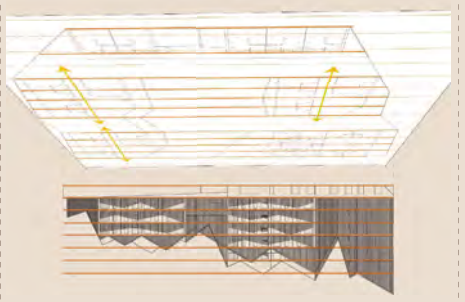
PRECEDENT: DALLAS BROOKS COMMUNITY PRIMARY SCHOOL \ MACGRIDE CHARLES RYAN



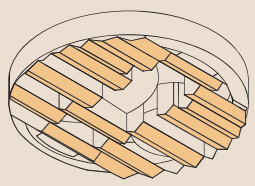
PROCESS: SLICING + SUBTRACTION



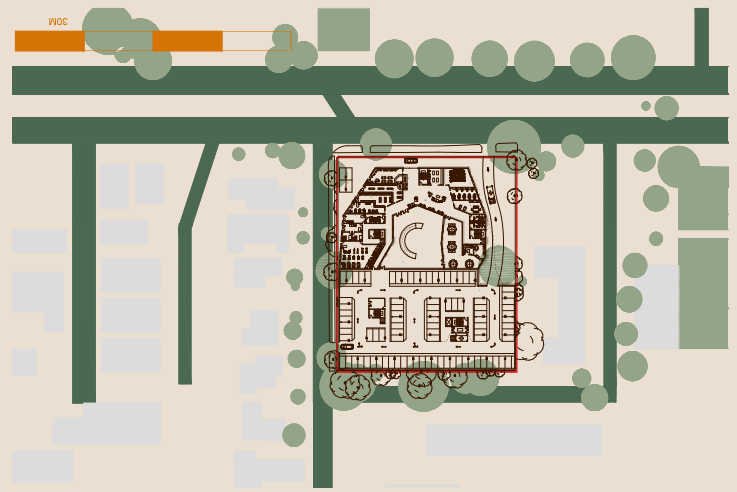
PROCESS: HORIZONTAL SLICING ACROSS FORM



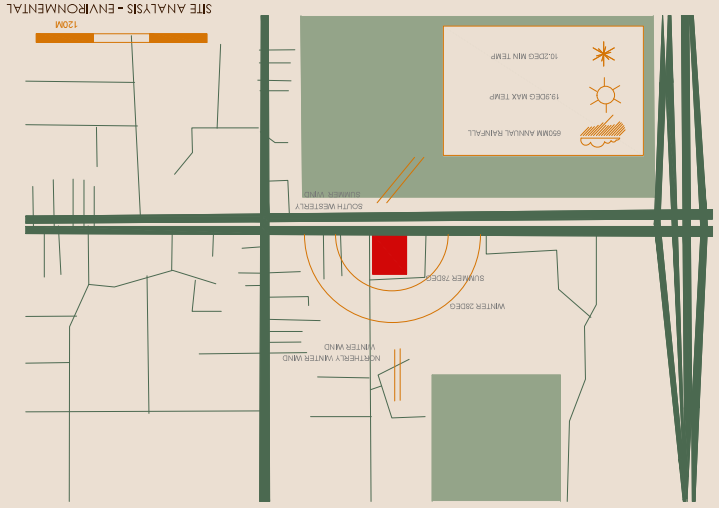
PRECEDENT: SKOLKOVO INSTITUTE \ HERZOG DE MEURON



SITE PLAN



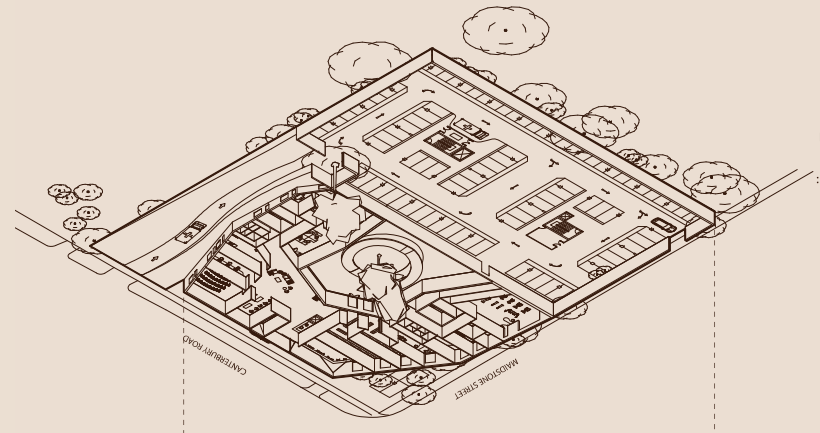
SITE ANALYSIS - ENVIRONMENTAL

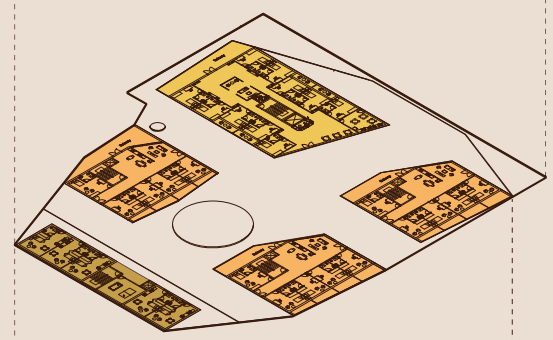


SITE ANALYSIS - SUBURBAN

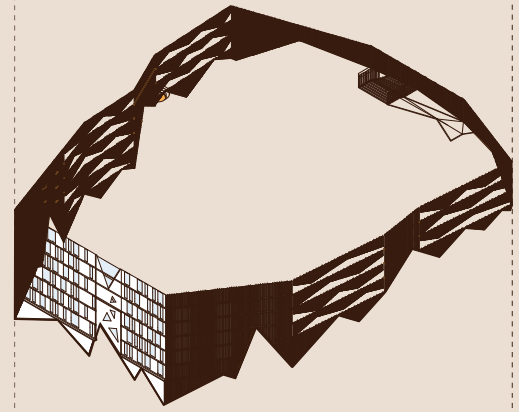
LOCALITY PLAN

BUILDING EXPLODED DIAGRAM

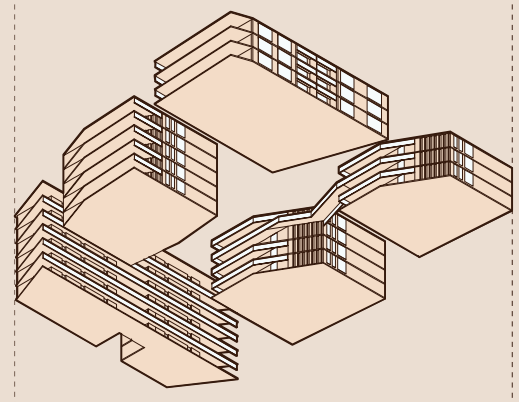




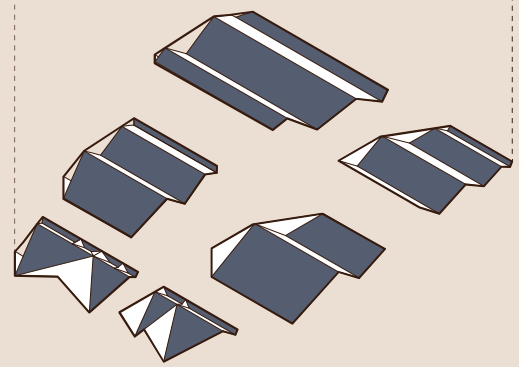
INDEPENDENT LIVING UNITS
LOW CARE CLUSTER
HIGH CARE CLUSTER



TIMBER SCREEN FACADE
TIMBER PERGOLA

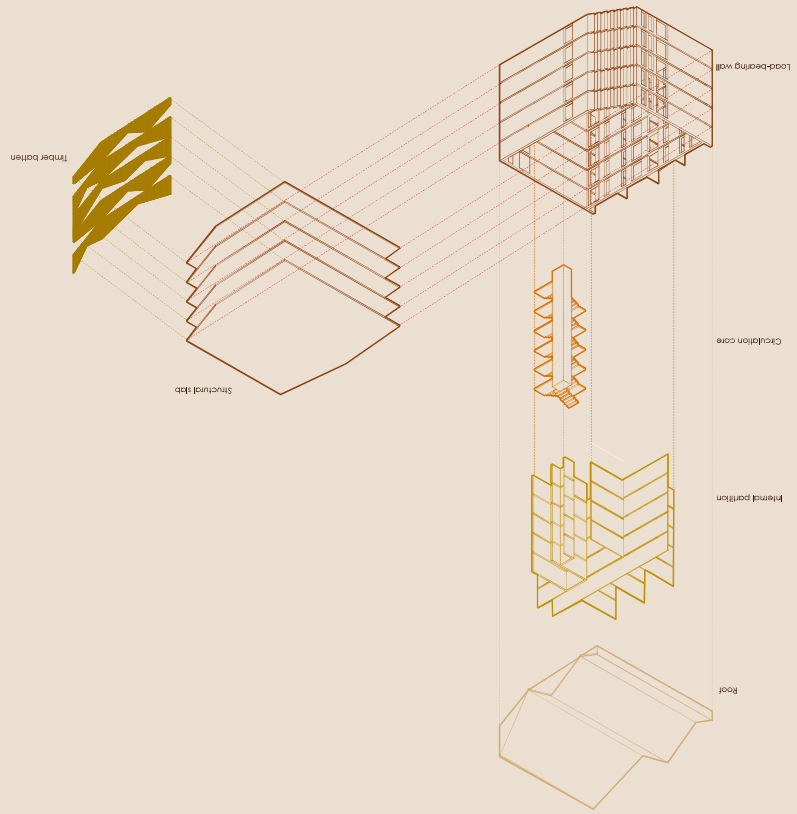


OPEN WARDS WITH BALCONIES

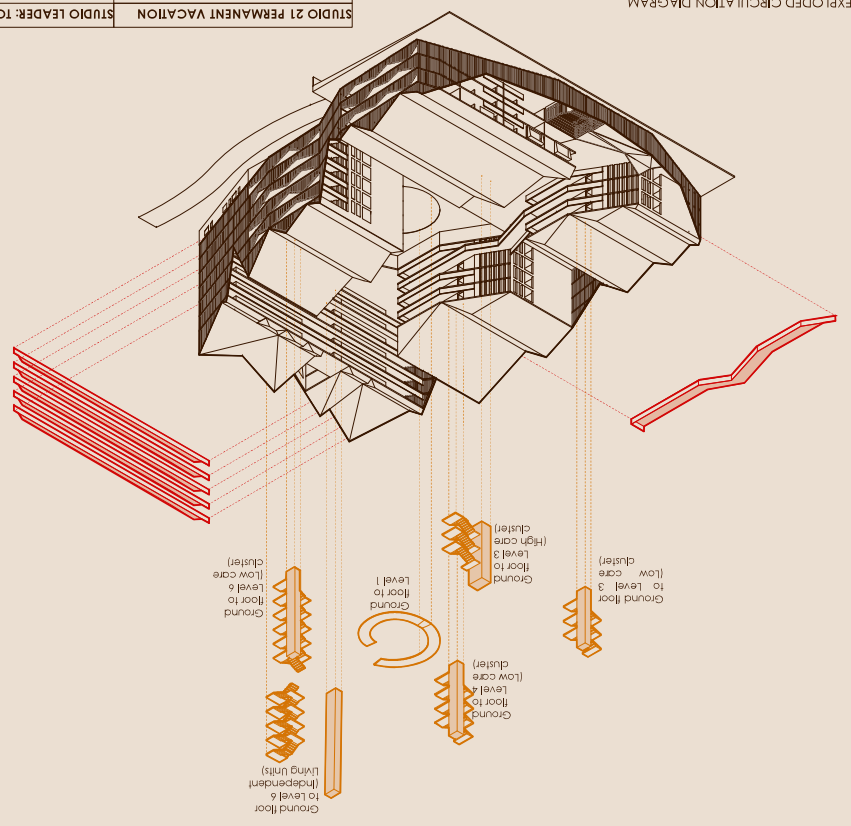


NORTH-FACIG ROOF WITH
SOLAR PANELS
SEMI-OPEN MECHANICAL AREA

EXPLODED STRUCTURAL DIAGRAM



EXPLODED CIRCULATION DIAGRAM

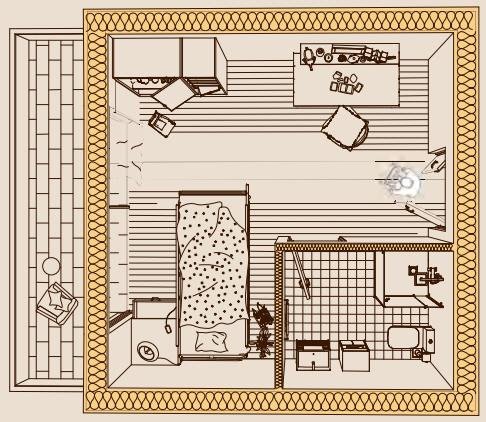


STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

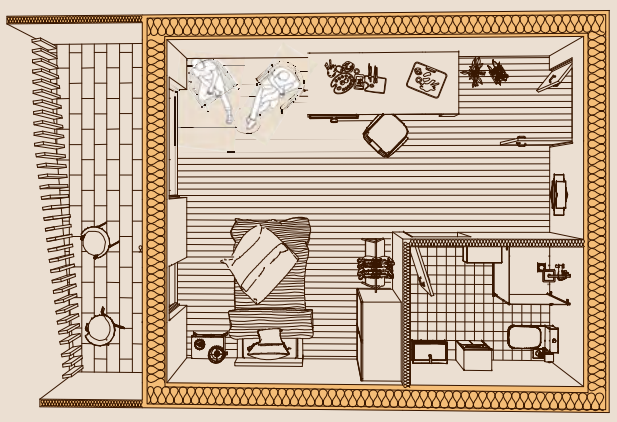
LOW CARE CLUSTER LIVING - BEDROOM

LOW CARE CLUSTER LIVING - LOUNGE ROOM

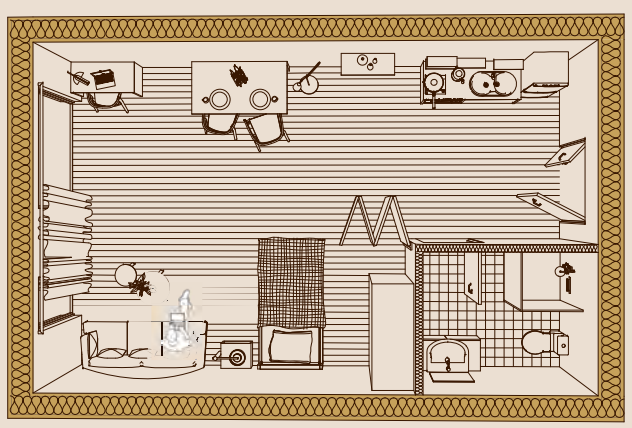
HIGH CARE UNIT 25m²

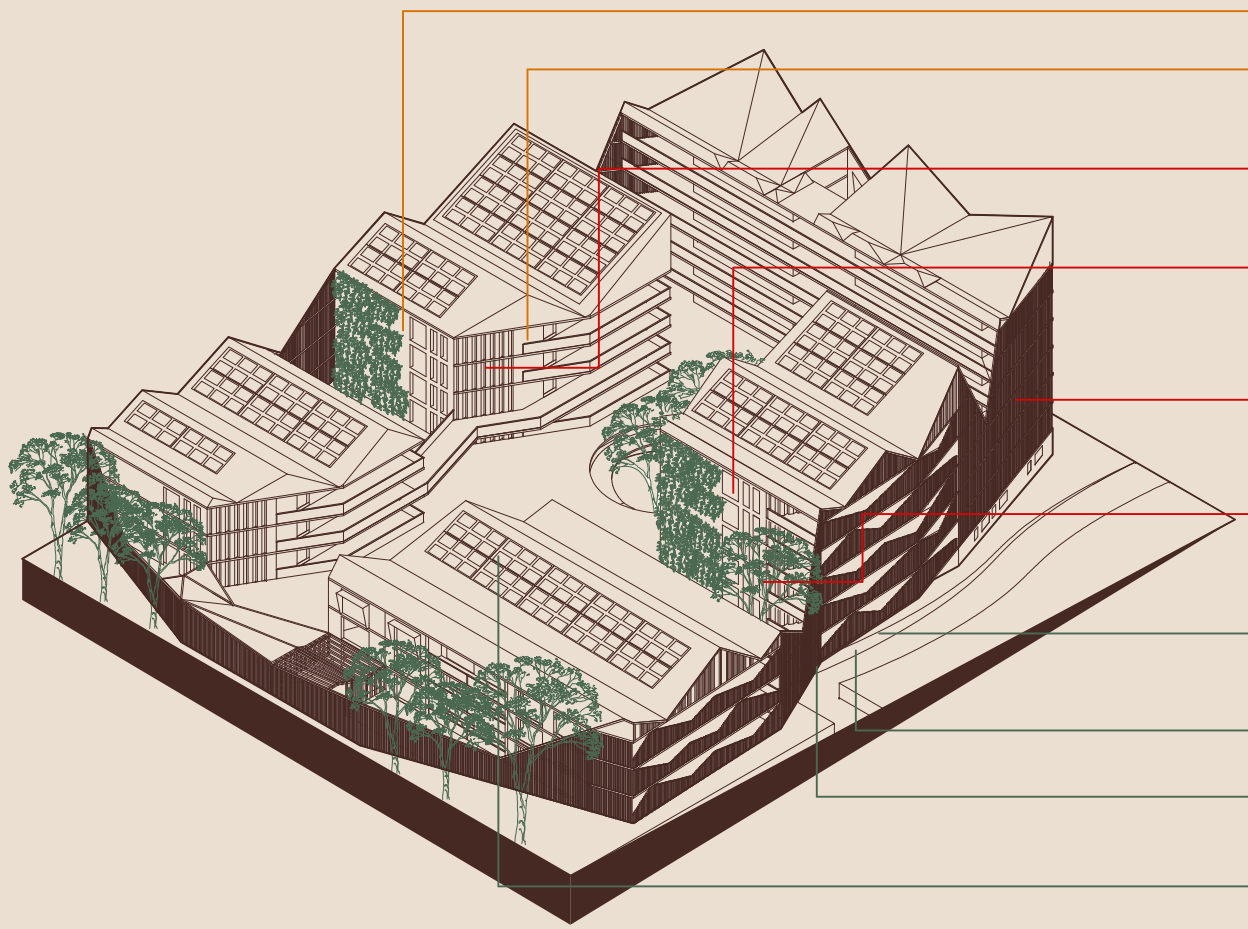


LOW CARE CLUSTER LIVING UNIT 30m²



LOW CARE INDEPENDENT LIVING UNIT 40m²





with recycled expanded foam

\ Hybrid slabs CLT + green concrete

\ South, east, west faces green concrete

\ Thermal breaks in slab between terrace and units

\ Vertical slated shading devices on east and west faces

\ Raked louvre shading devices on north face for seasonal sun angle variation

\ Glazing (north face dominated triple glazing and aluminium frames) reduces heat loss by 30% compared to single glazed,

\ Thermal mass concrete bench at north window in residential units for visitors

\ Biophilic cooling on terraces and ground level, native vegetation

\ Rainwater collection 50 000L off roofs + greywater filtered

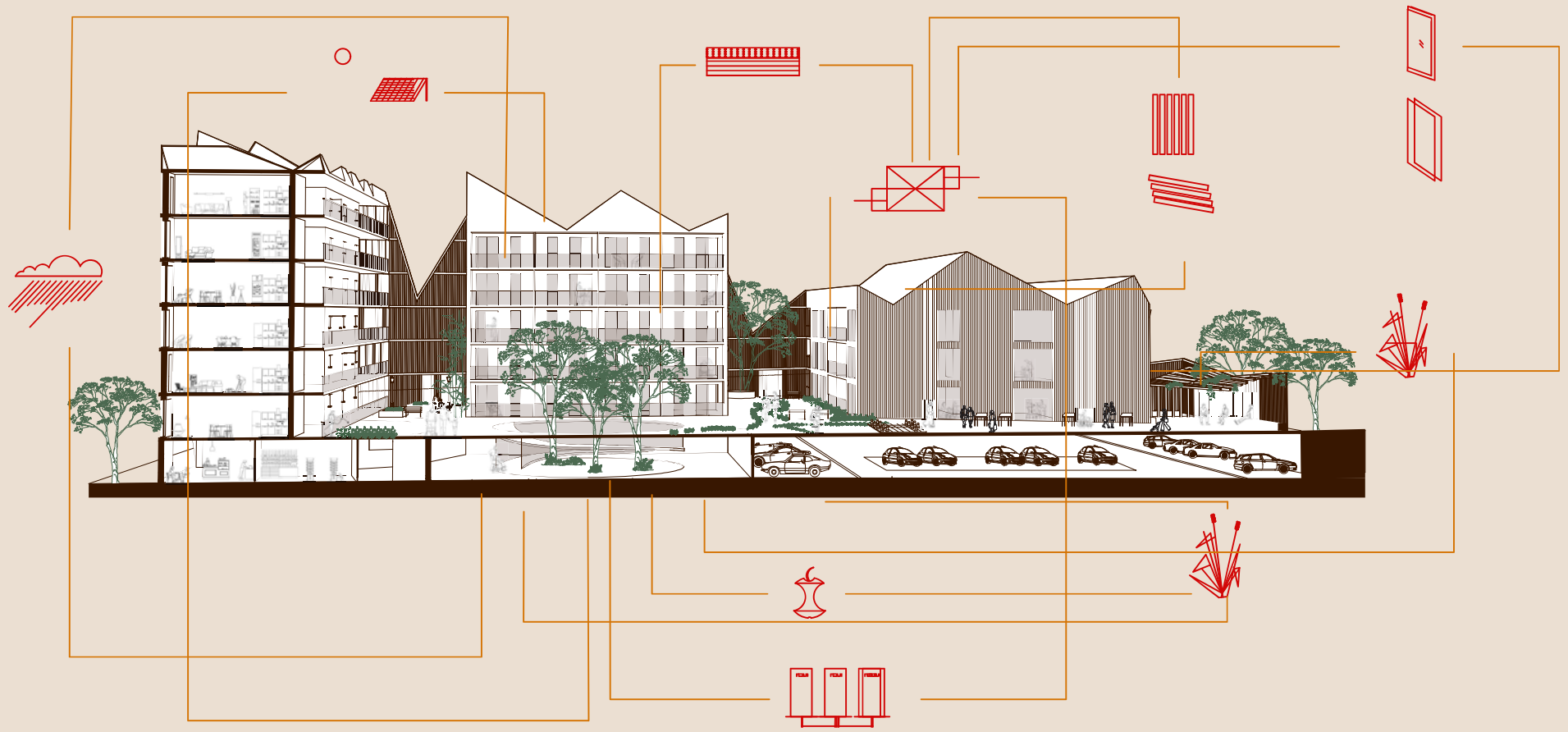
50 000L and irrigates vegetation

\ 10 PowerWall 135kWh system

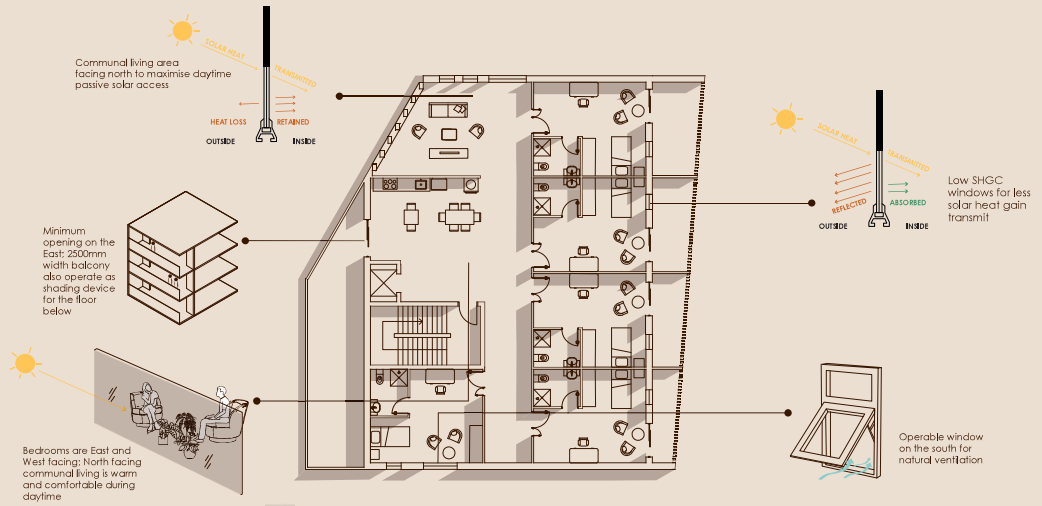
\ 1kg per person per day of organic waste processed and used to fertilize the on-site vegetation

\ 511 solar panels 160kW system

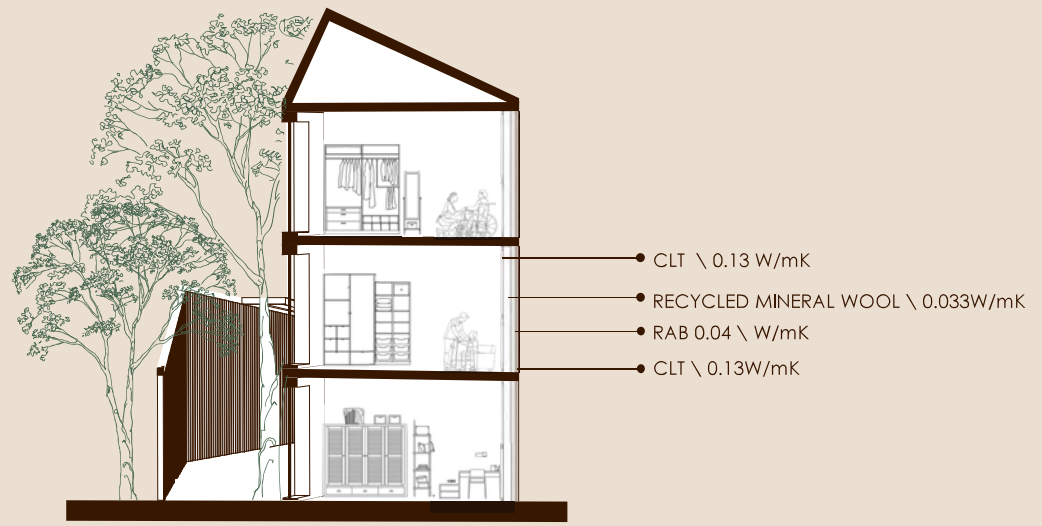
SUSTAINABILITY STRATEGY DIAGRAM



ZERO CARBON LOOP



LOW CARE CLUSTER LIVING FLOOR PLAN



HIGH CARE DETAILED SECTION

A NEW ENERGY PARADIGM

The design holds our sustainability strategy at the core of all decisions and iterations, tailored for the topology of an aged care community and the specific needs of the occupants. The aim of the sustainability strategy is to reduce the carbon emissions associated with operational energy demand toward zero. Further, the strategy moves beyond energy to facilitate a sustainable life cycle for the building and the community.

Solar panels power the community, the angled roofline provides optimized locations for the 600kW system. The energy generated is further utilized by a 135kW battery storage system, reducing the grid demand of the building by 61%.

The structural frame consists of CLT shear walls and slabs, glulam column/beam framing and a slag/fly ash/ recycled aggregate concrete service core. Mass timber products reduce loading, resulting in fewer and smaller structural elements, creating a spacious and light internal experience. CLT is used for the external cladding to showcase the material and inspire a sustainable lifestyle for the community. The replicability of the tiny towers allows pre-fabrication and end of life recycling.

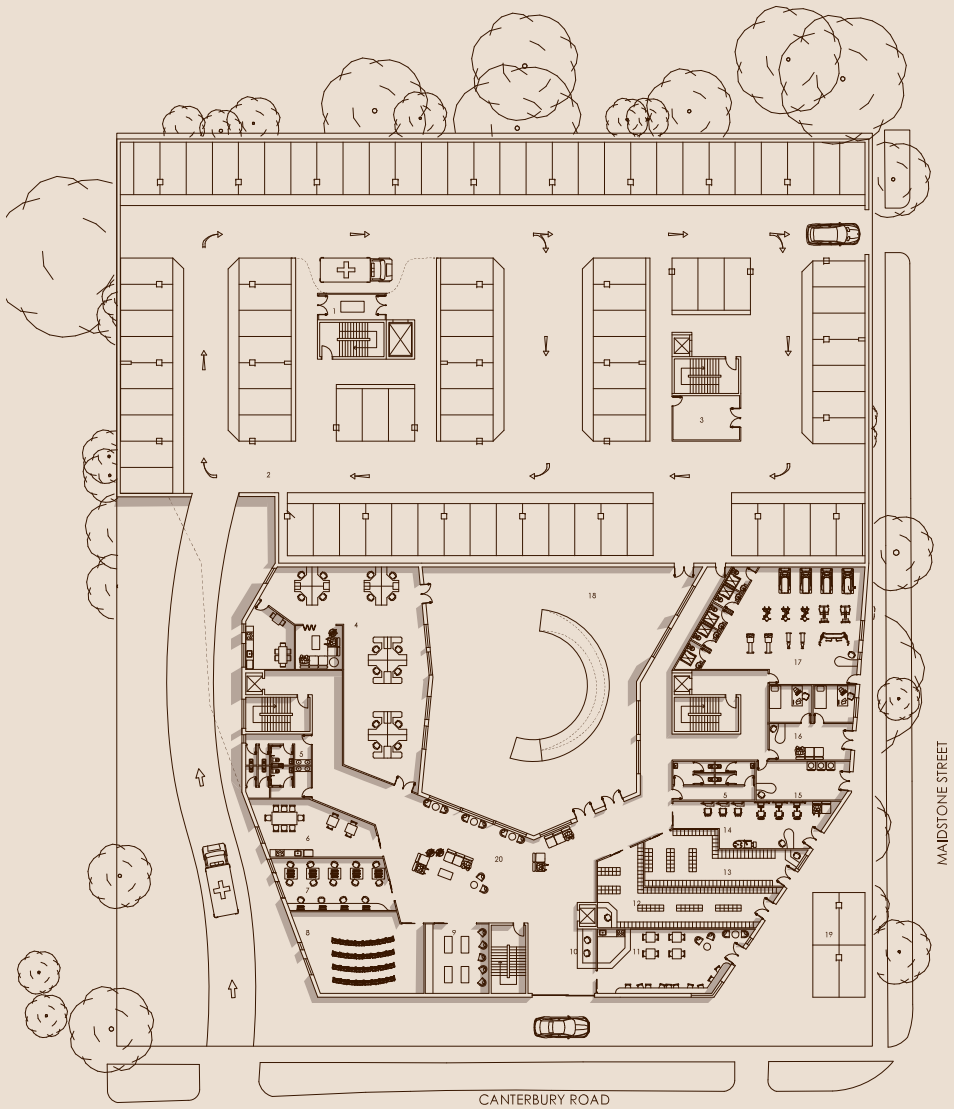
Recycled mineral wool and double-glazing fittings in the external envelope of CLT walls create a stable environment, maximising occupant thermal comfort throughout the year, reducing the heating demand for energy by 75%. Glazing location is informed by Passivehaus modelling and Daylight simulations to optimize the passive solar gains from the environment and provide natural ventilation, harnessing the summer southerly wind. Heat-exchange-ventilators are specified throughout to reduce heat loss and provide clean air at all times.

Large extruded shading to the north limits summer sunlight while allowing winter warmth. The east and west battens create diffuse lighting for the occupants, showcasing views of the city and mountain ranges while reducing glare.

A dual water collection system provides stable irrigation for the landscaping from rainwater, collected off the solar panels, and greywater is directed to on-site non-potable demand.

Landscaping preferences native varieties that are resilient and good carbon sinks. Organic waste is processed on-site with bio-digester for use in the landscaping and personal flower/ vegetable gardens. This enhances the sustainability by providing active and healthy hobbies for occupants.

STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

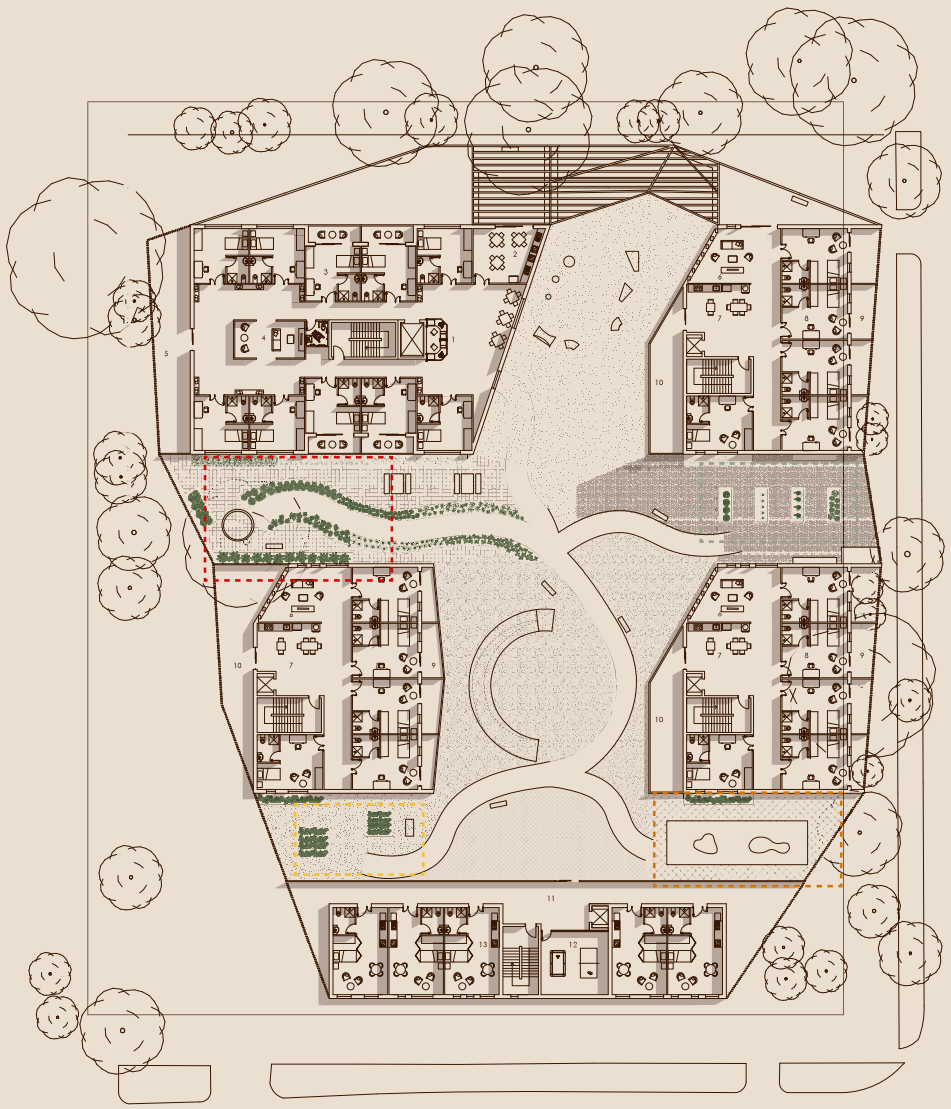


1 AMBULANCE PICK UP
2 CAR PARK (91)
3 RFS SHED
4 ADMIN OFFICE
5 BATHROOM
6 EVENT/FUNCTION ROOM
7 MEDIA ROOM
8 PRESENTATION ROOM
9 LIBRARY
10 RECEPTION
11 CAFE
12 PHARMACY
13 CORNER STORE
14 SOLON
15 LAUNDRY/ALTERATION
16 PHYSIO/CHIROPRACTOR
17 GYM
18 OUTDOOR AREA
19 LOADING BAY
20 LOUNGE

GROUND FLOOR PLAN

0 5 10 20m

1:250 @ A0



HIGH-CARE LIVING
1 NURSE SATATION
2 KITCHENETTE
3 INDIVIDUAL BEDROOM
4 COMMUNAL LOUNGE
5 COMMUNAL BALCONY

LOW-CARE CLUSTER LIVING
6 COMMUNAL LOUNGE
7 KITCHENETTE
8 INDIVIDUAL BEDROOM
9 PRIVATE BALCONY
10 COMMUNAL BALCONY

LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 ACTIVITY ROOM
13 INDIVIDUAL BEDROOM

COMMUNAL SPACE
14 CORRIDOR
15 ACTIVITY ROOM
16 INDIVIDUAL BEDROOM

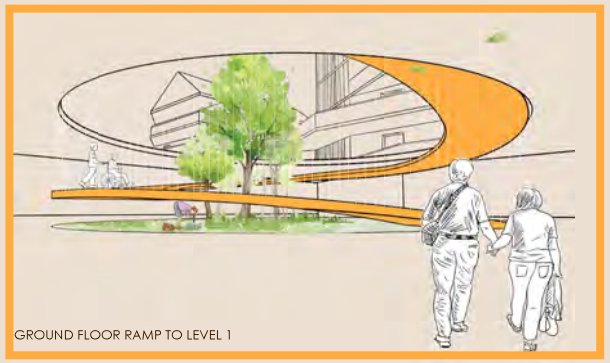
LEVEL 1 FLOOR PLAN

0 5 10 20m

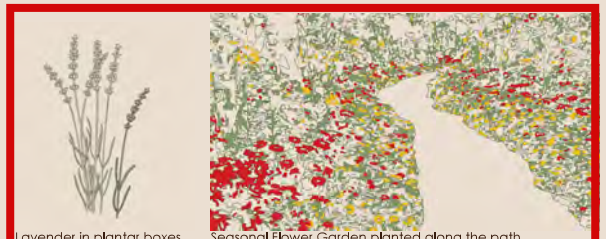
1:250 @ A0

STAFF TEA BREAK IN PRIVATE GARDEN

SEASONAL FLOWER GARDEN AND PICNIC AREA



GROUND FLOOR RAMP TO LEVEL 1



Lavender in plantar boxes to create distance between High Care windows/outdoor space and garden users while still allowing views out.

Seasonal Flower Garden planted along the path

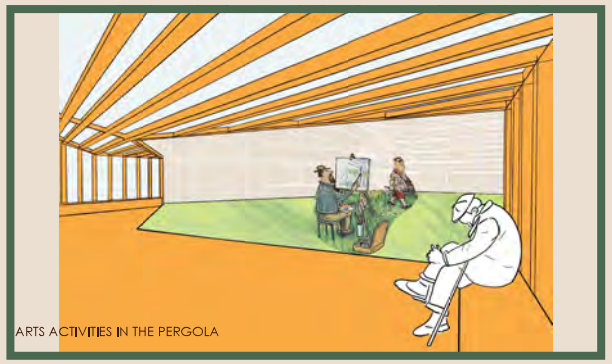
Spring: Daffodils, tulips and pansies

Summer: Roses and Hydrangeas or Irises

Autumn: Asters and Chrysanthemums

Vanilla Lily / Arthropodium milleflorum along the south window for privacy. Grows to 1m high in shallow soil. Native to Victoria, low maintenance, and edible

Vegetable Garden
Raised planter boxes for vegetable garden with wide lip for leaning on or resting tools on.
3000mm x 1000mm x 1000mm
Some plants to be trellised to allow for easier reach



ARTS ACTIVITIES IN THE PERGOLA

Nepalese bamboo for screening
Clumping bamboo- will not spread

Zen Garden
Features: moss, rock arrangement, gravel surface for raking.

Nepalese bamboo for screening
Clumping bamboo- will not spread

Chinese style Garden
Features: moss, potted plants, small water features, paved paths

VIEW FROM LEVEL 2 BALCONY TO CENTRAL GARDEN SPACE AND MUSICAL THERAPY GARDEN

STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

SECTION A

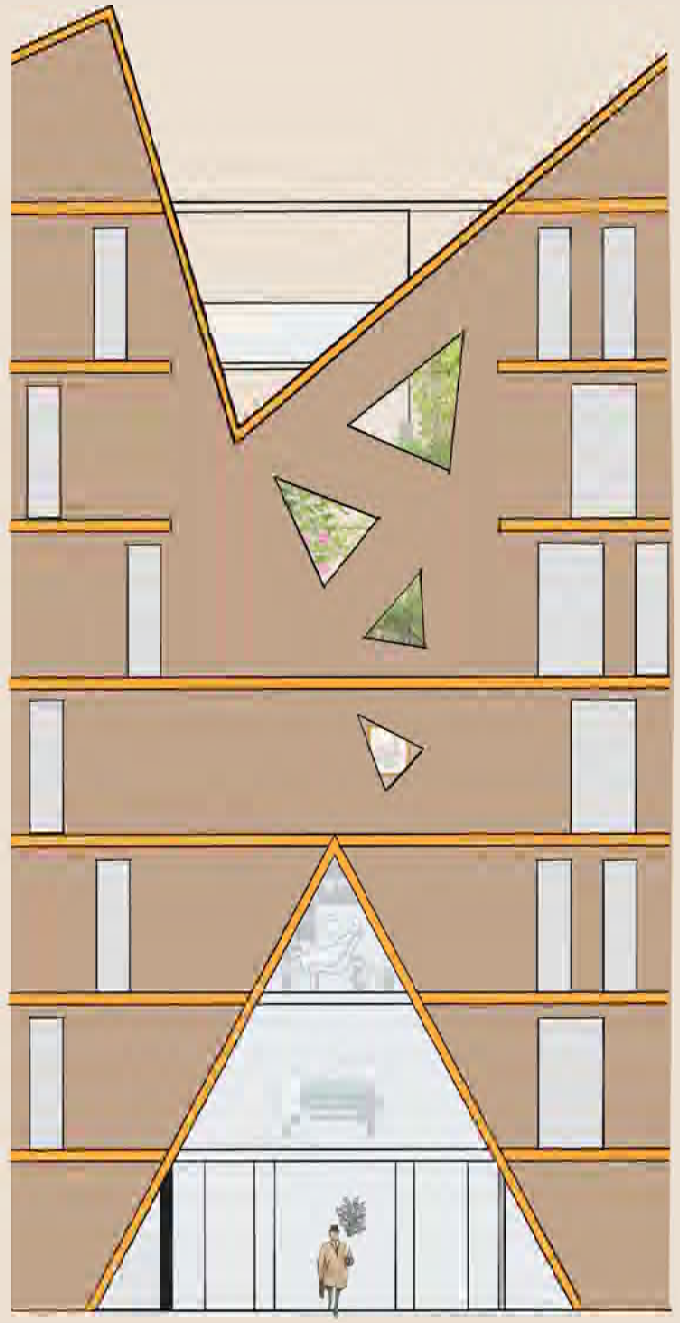
0 5 10m

1: 100 @ A0

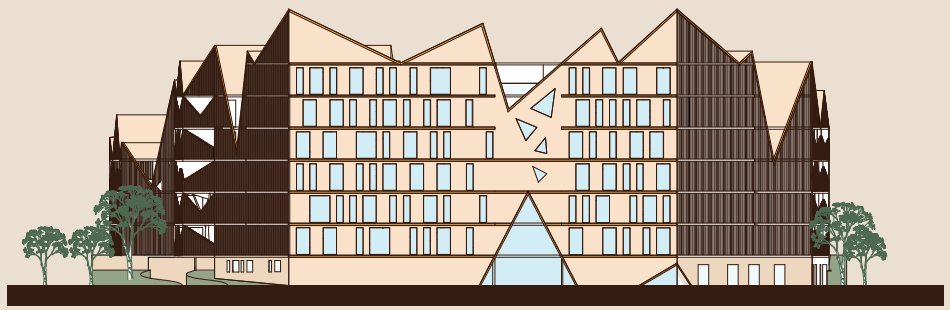
SECTION B

0 5 10m

1: 100 @ A0



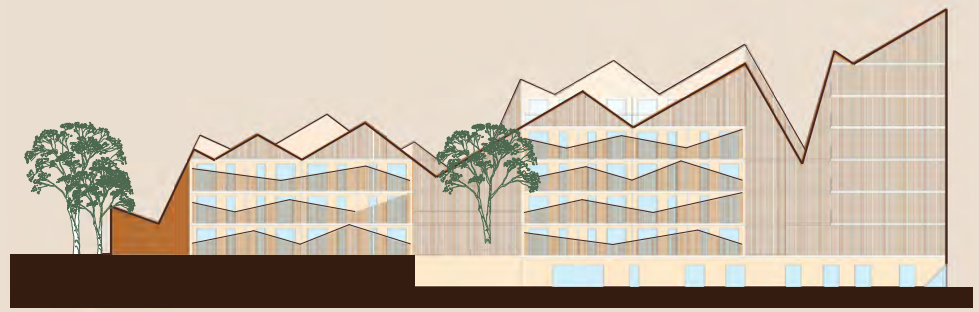
SOUTH FACADE ENTRENCE
NOT TO SCALE



EAST ELEVATION

0 5 10 20m

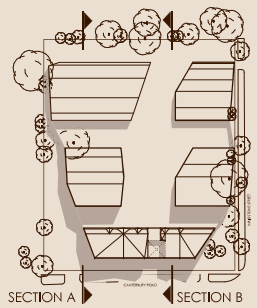
1:250 @ A0



EAST ELEVATION

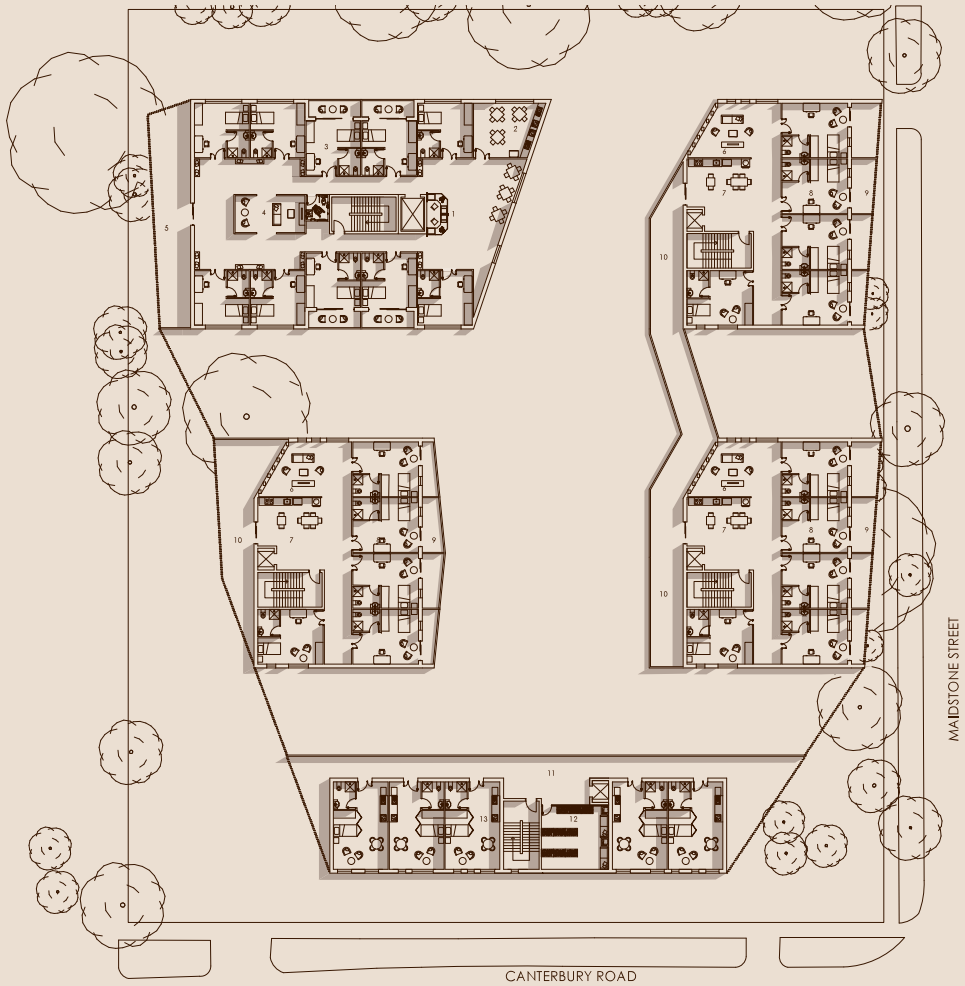
0 5 10 20m

1:250 @ A0



LEVEL 4 VERTICAL GARDEN

STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	

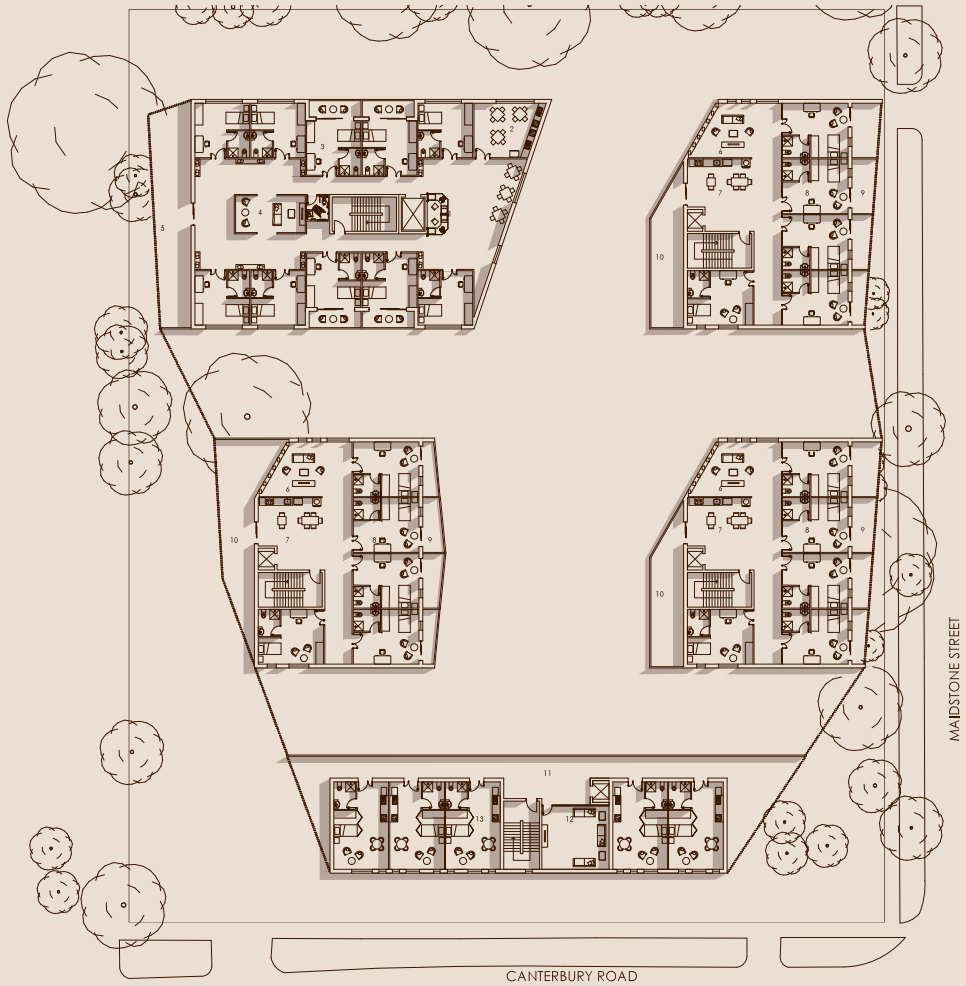


HIGH-CARE LIVING
1 NURSE SATATION
2 KITCHENETTE
3 INDIVIDUAL BEDROOM
4 COMMUNAL LOUNGE
5 COMMUNAL BALCONY

LOW-CARE CLUSTER LIVING
6 COMMUNAL LOUNGE
7 KITCHENETTE
8 INDIVIDUAL BEDROOM
9 PRIVATE BALCONY
10 COMMUNAL BALCONY

LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 READING ROOM
13 INDIVIDUAL BEDROOM

LEVEL 2 FLOOR PLAN
0 5 10 20m
1:250 @ A0

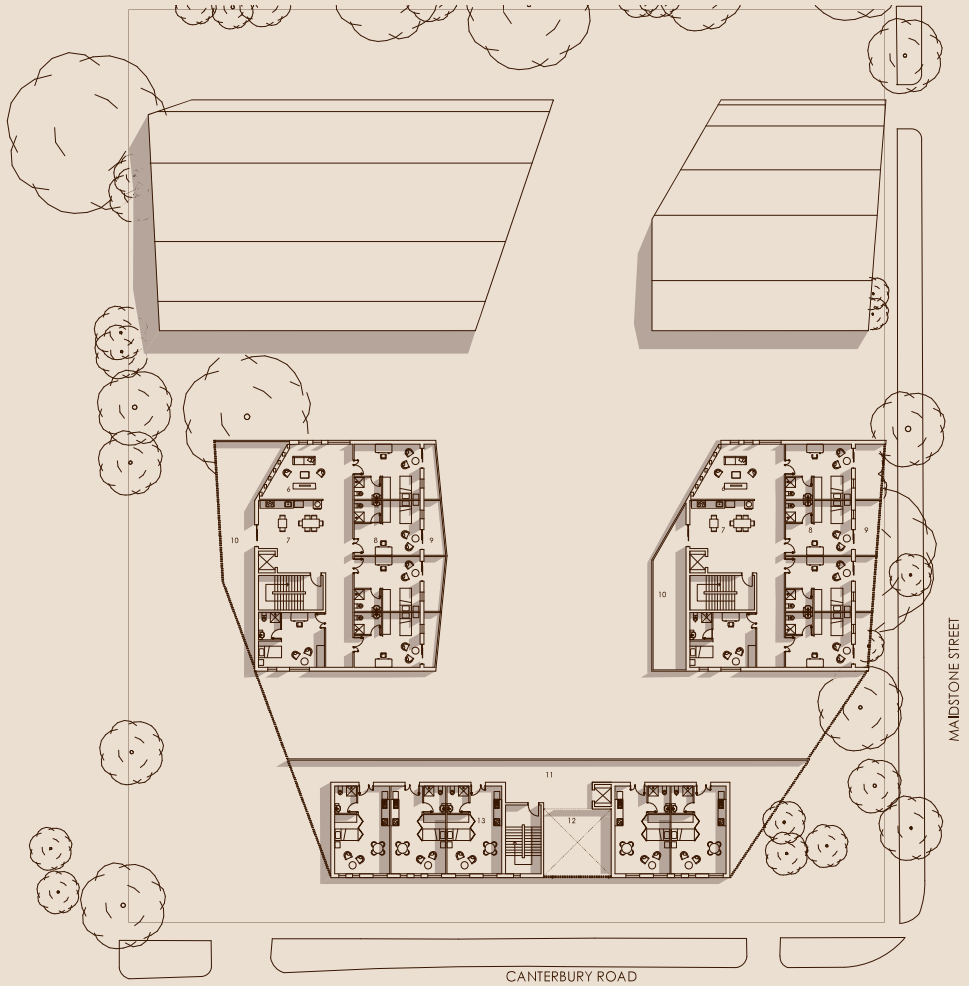


HIGH-CARE LIVING
1 NURSE SATATION
2 KITCHENETTE
3 INDIVIDUAL BEDROOM
4 COMMUNAL LOUNGE
5 COMMUNAL BALCONY

LOW-CARE CLUSTER LIVING
6 COMMUNAL LOUNGE
7 KITCHENETTE
8 INDIVIDUAL BEDROOM
9 PRIVATE BALCONY
10 COMMUNAL BALCONY

LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 MEDIA ROOM
13 INDIVIDUAL BEDROOM

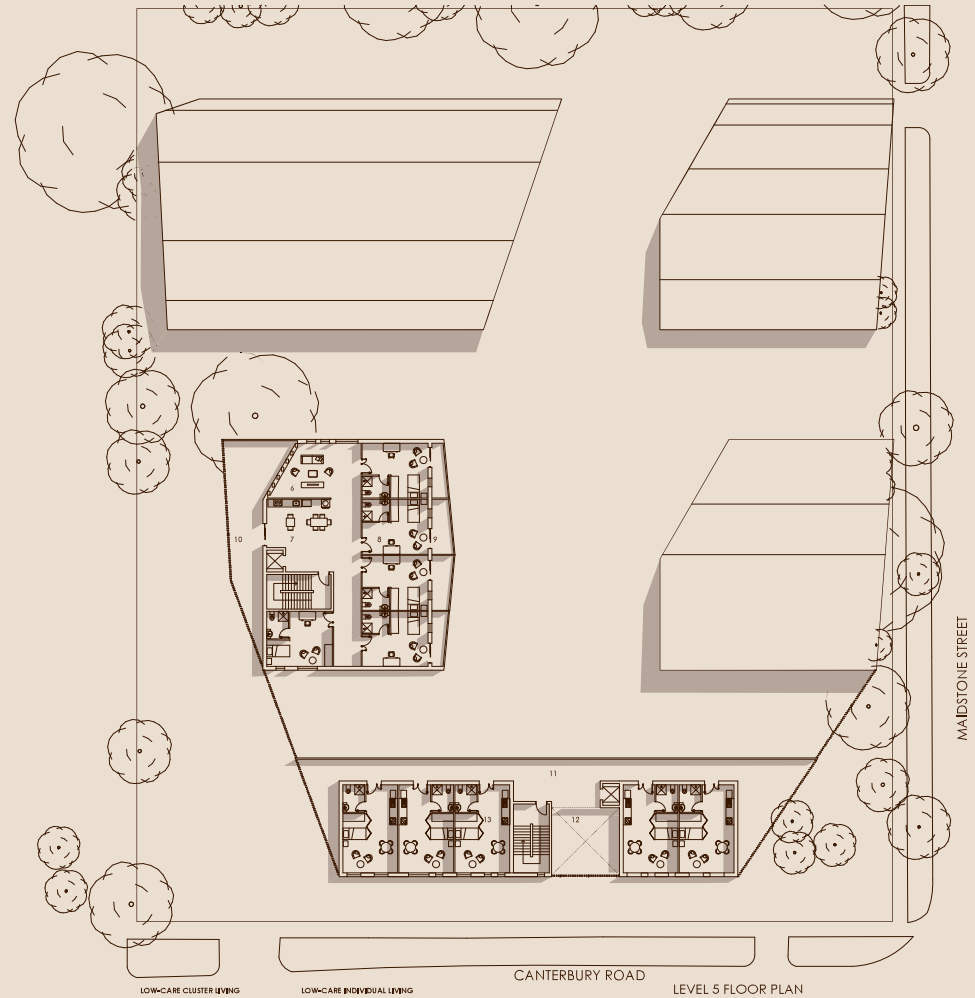
LEVEL 2 FLOOR PLAN
0 5 10 20m
1:250 @ A0



LOW-CARE CLUSTER LIVING
6 COMMUNAL LOUNGE
7 KITCHENETTE
8 INDIVIDUAL BEDROOM
9 PRIVATE BALCONY
10 COMMUNAL BALCONY

LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 VERTICAL GARDEN
13 INDIVIDUAL BEDROOM

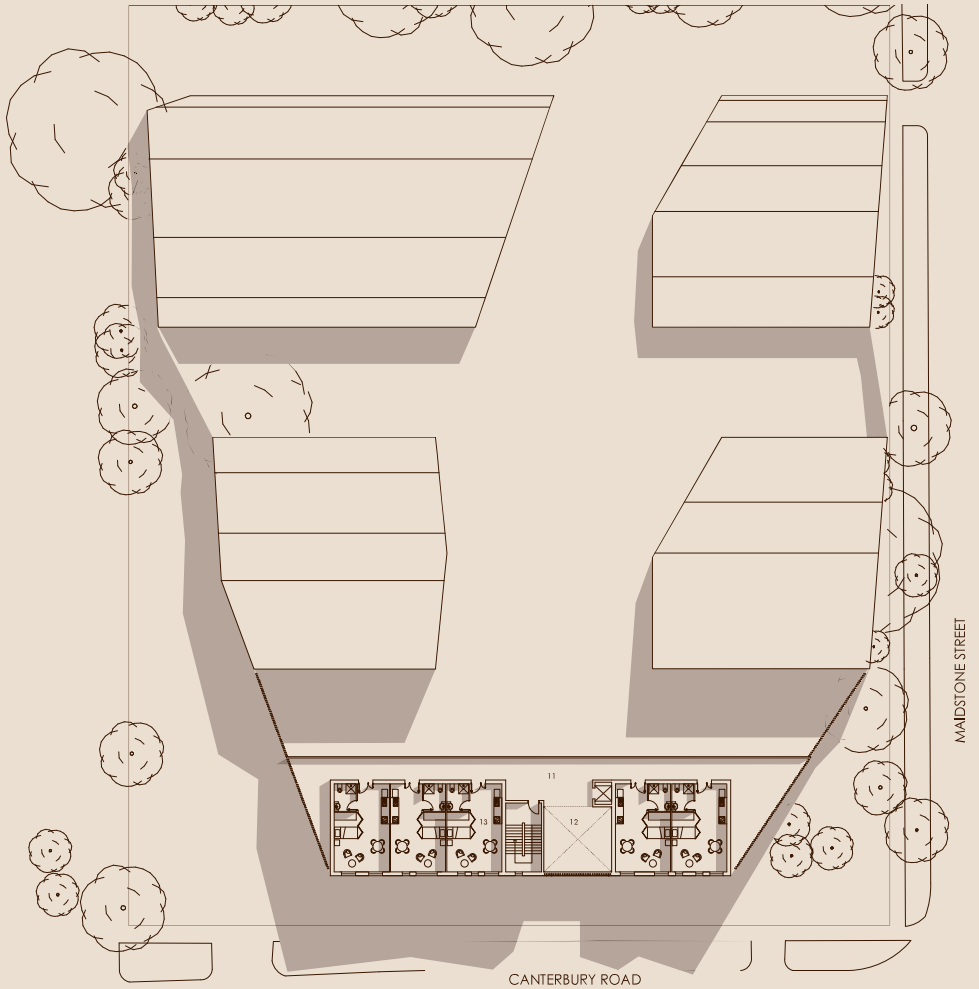
LEVEL 4 FLOOR PLAN
0 5 10 20m
1:250 @ A0



LOW-CARE CLUSTER LIVING
6 COMMUNAL LOUNGE
7 KITCHENETTE
8 INDIVIDUAL BEDROOM
9 PRIVATE BALCONY
10 COMMUNAL BALCONY

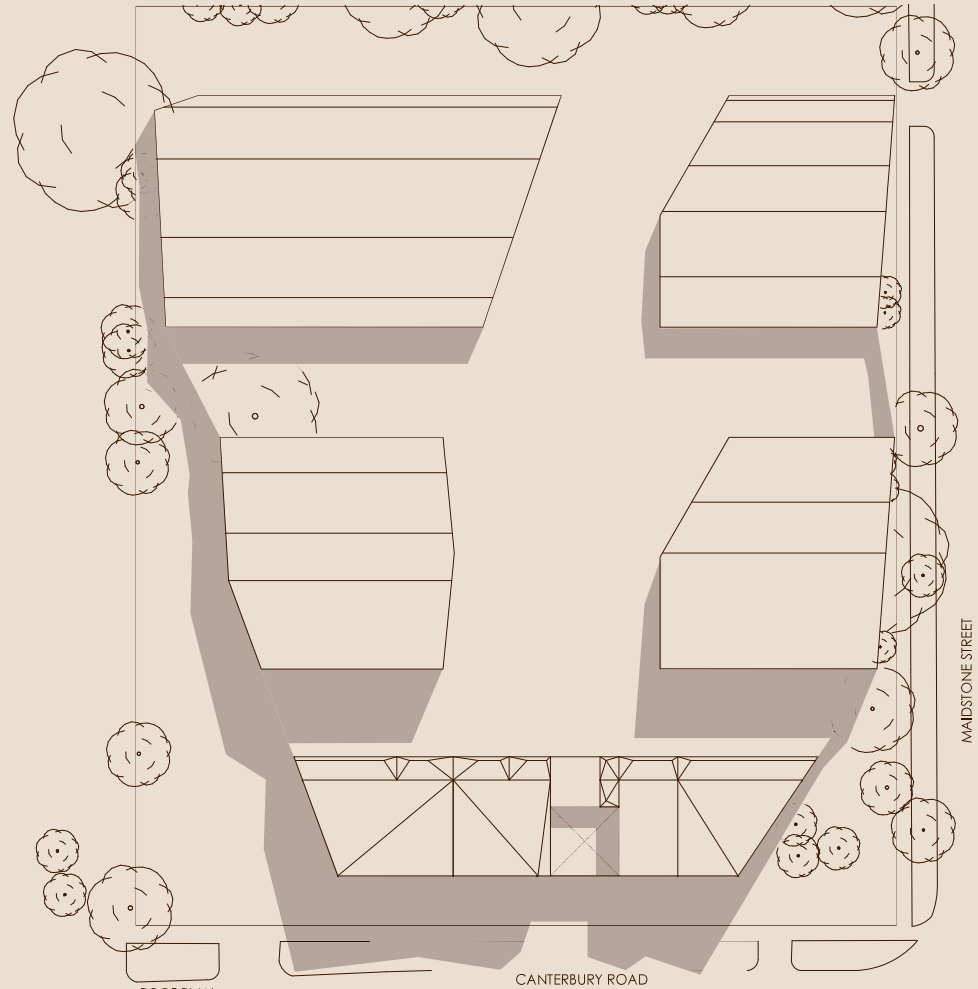
LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 VERTICAL GARDEN
13 INDIVIDUAL BEDROOM

LEVEL 5 FLOOR PLAN
0 5 10 20m
1:250 @ A0



LOW-CARE INDIVIDUAL LIVING
11 CORRIDOR
12 VERTICAL GARDEN
13 INDIVIDUAL BEDROOM

LEVEL 6 FLOOR PLAN
0 5 10 20m
1:250 @ A0



ROOF PLAN
0 5 10 20m
1:250 @ A0

STUDIO 21 PERMANENT VACATION	STUDIO LEADER: TOBY REED
SHEET: A01	
GROUP 4: LUCY MARSLAND, CAROL WANG, SKYE TANG, MORNA HU	