EDH–A3 Main

Criteria	Ratings	Pts
Introduction	**15 pts** **High Distinction** Exceptional understanding of the context/ scenario: ● Outstanding knowledge of zoning through illustrating and justifying the zoning of different areas in the building; ● An outstanding illustration of the current building environmental performance assessment using FR5 and BESS that complies with the standards. **12 pts** **Distinction** A clear understanding of the context / scenario: ● Demonstrated a clear understanding of building zoning in FirstRate5 with reasoning but with a few mistakes; ● Detailed Illustration of the current building environmental performance assessment using FR5 and BESS that complies with the standards.	/ 15 pts

FirstRate5: Improving from 7-star to 8-star rating	**20 pts** **High Distinction** *The importance and impact of selected strategies are very-well explained:* ● The current design specification is very well demonstrated with details; ● The rationales for the chosen approach are explained clearly with detailed text and creative graphics; ● The impact of the selected procedure on the energy star rating (before and after) is demonstrated with figures and texts. **16 pts** **Distinction** *The importance and impact of selected strategies are well explained:* ● The current design specification is well described; ● The rationales for the chosen approach are clear and complete; ● The effect of the selected procedure on the energy star rating (before and after) is demonstrated.	/ 20 pts

BESS with minimum overall 80% score	**20 pts** **High Distinction** *Exceptional illustration of the aim of selected sections and the functionality of the design responses:* ● The objective of selected approaches is very well explained that shows a lot of further research effort using a lot of reliable resources; ● The selected approach and the modifications in BESS are very well explained using text, creative graphics and bullet-points; ● The overall score for **each section** and the final BESS assessment result is demonstrated; ● The water tank size is calibrated and presented in detail and outstanding reasoning. **16 pts** **Distinction** *A clear illustration of the aim of selected sections and the functionality of the design responses:* ● The objective of the selected approach is well explained that shows research effort using some reliable resources; ● The selected approach and the modifications in BESS are well described, but some information is missed; ● The overall score for each section and the final BESS assessment result is demonstrated; ● The water tank size is calibrated and presented clearly with some reasoning.	/ 20 pts

HOT2000	**25 pts** **High Distinction** *Exceptional illustration of the building specifications and its active systems:* ● The selected approaches and the modifications in HOT2000 are very well explained using text, creative graphics and bullet-points; ● The functionality and applicability of the selected approaches or items are very well explained that show a lot of further research effort using a lot of reliable resources. **20 pts** **Distinction** *A clear illustration of the building specifications and its active systems:* ● The selected approaches and the modifications in HOT2000 are well described, but some information is missed; ● The functionality and applicability of the selected approaches or items are well explained that show research effort using some reliable resources.	/ 25 pts

PV Units	**10 pts** **High Distinction** *Exceptional conclusion and final design choice and recommendations toward zero-energy building:* ● Interpretations of data are accurate, and the annual energy consumption of the building is very well reported; ● The functionality and applicability of selected PV units and their installation approach are very well explained, which shows a lot of further research effort using a lot of reliable resources. **8 pts** **Distinction** *Perfect conclusion and final design choice and recommendations toward zero-energy building:* ● Presents some reasonable interpretations of data and the annual energy consumption of the building is well reported; ● The functionality and applicability of selected PV units and their installation approach are well explained that shows research effort using some reliable resources.	/ 10 pts

<table>
<tr>
<td>Quality of the presentation</td>
<td>10 pts
High Distinction
Exceptional presentation and format:

Appropriate use of vocabulary and detailed attention to punctuations;
Consistent font size/style. Pages numbered;
An appropriate length of paragraphs/ sentences;
All headings and subheadings are very well labelled and distinguished. All figures and tables captioned. Bullet-point clarity;
Relevant references (when applicable).

8 pts
Distinction
The report is coherently presented professionally with a clear and logical structure:

Detailed attention to punctuations;
Consistent font size/style. Pages numbered;
An appropriate length of paragraphs/ sentences;
All headings and subheadings are very well labelled and distinguished. All figures and tables captioned;
Relevant references (when applicable).

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Length

Max. 3,000 words (+/- 10% = 3300) excluding references, tables, and figure captions (you are encouraged to provide pictures, charts, tables and others to illustrate your strategies further).

Background

Many councils in Victoria now require an Environmentally Sustainable Design (ESD) report for new home developments, before granting a planning permit. The ESD report aims to identify and convey the critical sustainability opportunities embraced in the design and provide the Responsible Planning Authority with a clear identification of how the development achieves the Council's policy aims and objectives.

Requirements

So far, you have designed a new home in a subdivision housing development site in Melbourne based on the client's expectations. You have also achieved the Nationwide House Energy Rating Scheme (NatHERS) 7-star rating and a minimum 50% Built Environment Sustainability Scorecard (BESS) score for your design. However, **the client wants to live in a zero-energy house** and needs an **ESD report** as part of the planning process.

In this assignment, you should **provide an ESD report** for *"Zero Energy Sustainable House Delivery"* based on your newly designed house presented on the last teaching day. The ESD report should:

1. **Start with the detailed housing project information.** BESS should be used for identification of environmental sustainability measures with a minimum of overall **80% score.**
    a. ***Rainwater Tank:*** Provision is required in this project, and the water tank size should be estimated and presented in detail.
    b. ***FR5 and HOT2000:*** Evidential data of total domestic operational energy consumption should be provided using *both* FirstRate5 and HOT2000.

       FirstRate5 is used to achieve a **minimum of NatHERS 8-star rating** to make sure that the house design meets and surpasses the compliance.

    c. HOT2000 should also be used to estimate the total domestic energy consumption per annum to which both:

       Effective passive and active strategies (excluding renewable energy technologies) are applied.

       PVWatts Calculator should be used for estimation of solar PV power generation capacity to demonstrate the net-zero energy operation of your proposed house.

//

<u>Assignment 3–ESD Report</u>

Prompt the assignment:

Important: Develop ESD Report:

Showcase the journey (strategies, methods & techniques) to get from:

- *NatHERS: 7 to 8 star rating*
- *BESS Score / Rating: 50 - 80 points*

*Demonstrate **<u>net-zero energy operation</u>** of the proposed house.*

Note:

- Use your existing design of the building
- *Energy Outcomes: Focus on <u>zero energy outcomes / net-zero energy operation of the house ie. minimise energy demand.</u>*

  PV Panels are required: <u>H2000 (Whole Energy Simulation - a minimum amount of PV should be provided</u>. Ideally installed on the rooftop, but *not necessary:* Walls, garage (and its rooftop) and can be used as locations.

  Strongly recommended:

  Tool: PV Watt has limitations.

  Clarify: The **roof area** for practical considerations.

Roof Dimensions:

North (and NE):

- Roof (N): Area = **3898269.85** (+/- 0.001) square mm
- Roof (NE; Long): Area = **15160547.3** (+/- 0.01) square mm
- Roof (NE; Small): Area = **3365209.05** (+/- 0.001) square mm

//

South:

- Verandah (S): Area = **6995635.67** (+/- 0.001) square mm
- Roof (S): Area = **8775604.36** (+/- 0.001) square mm

//

East:

- Roof (E; Larger): Area = **16802309.7** (+/- 0.01) square mm
- Patio (E): Area = **8503570.22** (+/- 0.001) square mm

//

West:

- Roof (Largest): Area = **30111820.3 (+/- 0.01)** square mm

Total Area (m) = 93.613

Net Conditioned Floor Area (NCFA) = **81.9 m²**

Double Stud Wall = More Energy Efficient?

//

PV Profile - RETScreen

Workflow: H2K > RETScreen > PVWatts Calculator (?)

- Find Location > Paste Data > Energy > Power > Photovoltaic (PV) > Level 2:
  - Fixed; 33; poly-Si; (variable) kW;
  - Click Cart Icon: Kyocera (KD235GX-LFB);
    - Good for poly-crystalline (poly-Si(?))
  - BP or Mitsubishi Heavy Industries (from example);
  - Misc. losses: 15%
  - Adjusted slope angle accordingly - PV: Angle (25-33 degrees)
  - *Exported to grid:* kWh

Resources & References:

1. ***Handbook: NCC Volume Two - Energy Efficiency***

- Subclause 3.12.1.1(a) requires any mandatory insulation - form a consistent and continuous barrier other than at supporting members.
- Use the references to justify / layout the addressed requirements
- Using references; indicate how you addressed each and every part of the requirements.

pp41-Criteria to be modelled

//

2. ***Guide to NCC Volume One Amendment 1:***

- Section J (pp368): Energy efficiency

//

3. ***Passive House Australia:***

- *Glazing:* (SHGC) of 0.63 w/ U-value >3.4
- *Wall Insulation:* Ext generally R2.5

//

4. ***Combined Volume 2 and Housing Provisions:***

- Minimum R values

//

5. ***Outcomes Report - Energy Efficiency 2022 and Beyond:***

- Introduces the term ‘net-zero regulated energy’ (NZRE)
- 5.4 Reliance on specialist consultants and software:
    - Cost concerns
- Look into *‘Passive House Standard’*

//

6. ***NCC 2022 Update Whole-of-Home Component***

Describes methodology for modelling whole-of-home energy flows’ setting and achieving of these performance targets.

Introduction (pp11)

- The concept of ‘net-zero energy’
- Building shell / envelope(?) performance; appliance type and performance

Increasing proportion of PV generation used on site = improves economic returns for the householder / home owner that installs them.

3.1 Metrics (pp27):

3 types of metric numerator for performance assessments:

- Energy Consumption (MJ)
- Cost of Operation ($)
- Greenhouse gas emissions (Tonnes CO_2)

Review - 4 Sample Dwelling and Equipment Types Modelled

Photovoltaic 6.8 (pp52)

- Supports installation
- Table 19: Assumed Distribution of PVs by orientation - North (35%)
    - Most systems do not exceed 7kW

6.10.3 - Fuel costs (pp58)

- Electricity - Table 22: Electricity Tariffs by Jurisdiction (c/kWh incl. GST)

Review: Table 38 Thermal Bridging Factors for Class 1 Dwellings (pp80)

//

7. ***NCC 2022 Combined Vol II wth. Housing Provisions***

Part 4 Footings and slabs

Part 5.3 Cavity masonry ~~(pp78)~~ (pp390)

Part 5.3.3 External walls

Part 5.3.4 Internal walls

Part 5.7 Weather-proofing masonry (pp415)

Part 6.2.1 Subfloor ventilation (pp421)

- Explained on pp424

(1) Subfloor space must be provided with openings in *external walls* and internal subfloor walls in accordance with Table 6.2.1a for the climatic zones given in Figure 6.2.1a; and . . .

Table 6.2.1a: Climatic zones based on relative humidity:

Melbourne = **Zone C(?)** - 9am Relative Humidity (RH) > 70% and 3pm RH > 60%

- Minimum aggregate subfloor ventilation openings with ground sealed with impervious membrane (mm2/m of wall) = 3000 mm2/m

Table 6.2.1b Ground clearance

Part H6 Energy Efficiency - Class 1 and 10 Buildings (pp134)

Part 13 Energy Efficiency (pp679)

- *Where reflective insulation also acts as a vapour barrier or sarking . . . (pp644)*

(6) Where the ceiling insulation required by (1) to (5) has an R-Value—

(a) *greater than R3.0 and less than or equal to R4.5, it may be reduced to R3.0 within 450 mm of an external wall;*

or

(b) *greater than R4.5, it may be reduced to R3.0 within 450 mm of an external wall, provided all other required ceiling insulation is increased by R0.5.*

Table 13.2.6f:

Minimum R-Value of floor and subfloor wall insulation where the floor is over an enclosed

subfloor space: climate zone 6

(4)A concrete slab-on-ground with an in-slab or in-screed heating or cooling system, must have insulation with an R-

Value greater than or equal to 1.0, installed around the vertical edge of its perimeter.

Figure 13.2.6 Slab Edge Insulation (pp679)

Part 13.2 Building fabric (pp331)

Other resources - masonry:

https://roymech.org/Related/Construction/Masonry.html

- Cavity wall- defined as a wall constructed of two parallel single-leaf walls, tied together with wall ties or bed joint reinforcement. One or both leaves can be load-bearing. The cavity between the leaves can be filled, or partially-filled, with non-load bearing insulation material https://www.nationalmasonry.com.au/wp-content/uploads/National-Masonry-VIC-Brochure-MDG-Book-1-Structural-Fire-Acoustic-v24.pdf

- pp(7) R-Values for Typical Wall Construction

//

8. ***Ground Slab Insulation Guide***

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9. ***YourHome (.gov) and Australian Building Codes Board***

Getting Started:

- Define a sustainable home?

Design for climate: https://www.yourhome.gov.au/passive-design/design-climate

- Designs for Climate zone 4 (Hot dry summer, cool winter), Climate zone 5 (Warm temperate) and **Climate zone 6 (Mild temperate)** need to achieve a balance between reducing cooling needs in summer and reducing heating needs in winter.

Climate zone map:

- Melbourne, VIC = Climate zone 6 - mild temperate

https://www.abcb.gov.au/resources/climate-zone-map

Slab-on-ground:
Slab-on-ground is the most common type of slab.
There are 2 types: conventional slabs with deep excavated beams and waffle pod slabs, which sit near ground level and have a grid of expanded polystyrene foam pods as void formers creating a maze of beams in between. Conventional slabs can be insulated beneath the broad floor panels; waffle pods are insulated beneath. Both may benefit from slab edge insulation.

Earth coupling:
It is when concrete floors (sometimes walls) are in direct contact with the earth - concrete slab on grade (the bottom of the structure which is normally earth). CSOG systems in a properly shaded, well-oriented and with good insulation properties ‘draws up’ the stable deeper ground temperatures to the floor's surface, thus avoiding the reliance on active systems for thermal regulation.

//

10. Reused System House by Takumi Iwahara and Yoshiyuki Suzuki (2005)

Industrial Waste and the Construction Industry:

- About 400 million tons of industrial waste are generated annually in Japan, out of which about 20% is from the construction industry, 40% is recycled or properly disposed of, and 60% is illegally disposed of”
- Figure 2 (pp2) Ratio of waste generation according to industry:
    - Construction = 19%

Waffle Pod Slab Systems:

Composition and Design:

- Waffle pod slabs typically use moulded EPS (Expanded Polystyrene) pods, which are placed as a grid to form the foundation of a concrete slab.
- These pods create air pockets that act as insulation, reducing heat transfer through the slab.

Sustainable Engineering Ltd:
https://sustainableengineering.co.nz/entering-waffle-pod-slabs-into-phpp/

- Commonly, additional layers of insulation are added either on top of the concrete or below the ribs to further improve performance

TDS Custom Construction:

- CSOG with thickened perimeter, thermally isolated from the ground by eight inches of high-density expanded polystyrene (EPS) insulation (US R 38) = (R 6.7) or (R 6.6818)
    - *To convert Imperial R- values to Metric R-Values multiply by **0.1761***
    - International System of Units (SI) *R-values used in Australia conform to SI units while those in the US (based on measurements in Fahrenheit as opposed to Celsius) are approximately **5.71 times** those measured using SI.*
- The insulation layer turns up at the edges of the slab and connects with the above-grade wall insulation. This results in a continuous thermal building envelope bereft of thermal bridges.

Under-Slab Insulation:

- Incorporating XPS (Extruded Polystyrene) insulation under the slab can be effective, especially in reactive soil types. This approach minimises thermal bridging and enhances the overall insulation of the building (LAB Design).

- Waffle pod slabs are typically on-grade, composed of a concrete slab on top with concrete ribs and waffle pods beneath.
- Passive House projects often add another layer of insulation on top of the concrete or below the ribs to increase performance.

Ventilation:

https://velcdn.azureedge.net/-/media/marketing/au/downloads/factsheets/aust%20vs%20product%20sheet%202022%20web.pdf

Velum VCM Manually operated

- 5 Stars for Summer Ratings.

National Construction Code Resources:

The NCC is Australia's primary set of technical design and construction provisions for buildings. It is a performance-based code; setting minimum required levels for the health, safety, amenity, and sustainability of certain buildings.

1. **NCC Volume One:** primarily covers the design and construction of multi-residential, commercial, industrial and public assembly buildings and associated structures.
2. **NCC Volume Two:** contains technical design requirements for certain residential and non-habitable buildings and structures.
3. **NCC Volume Three:** covers the design, construction and maintenance of plumbing and drainage systems in new and existing buildings.

NCC Vol. 2:

Part 3.3.5 - Masonry units (pp137):

3.3.5.2 - Height of wall limitation:

- Masonry veneer walls must not be greater than 8.5m in height when measured above the adjacent finished ground level.

Figure 3.3.5.2 - Lintel installation (pp143):

- Lintels can carry a max. 110mm wall thickness

Part 3.4.1 - Subfloor Ventilation:

Climatic zone (see Figure 3.4.1)	**Minimum aggregate sub-floor ventilation openings with no membrane (mm^2/m of wall)**	**Minimum aggregate sub-floor ventilation openings with ground sealed with impervious membrane (mm^2/m of wall)**
A	2000	1000
B	4000	2000
C (Melbourne)	6000	3000

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NCC Vol. 1:

Section J - Energy efficiency (pp336)

PartJ1 - Building Fabric (pp358)

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A2 Presentation Slide Content:

1 to 2–Intro & Vision Statement:

Our collective vision is to design adaptable, efficient and comfortable living spaces; fostering environmental and social harmony in achieving sustainable development goals.

- A 5-step model is designed in line with a renovation of our client's property; based on our weighted evaluation.
- First: regenerative reuse; Second: prioritising passive design strategies;
- Third: Implementing energy efficient systems;
- Fourth, Improving the ecological profile and;
- Finally: we see education as imperative to sustainable resilience, and aim to inspire occupant behaviour to optimise operational energy and self-sufficiency.

Developed personas: Our clients are a middle income family with one school aged child. Their budget for the renovation is tight but they have strong connections to the community, and interests in suburban permaculture practices. They are keen to grow their own food on site and share excess with neighbours, so require green infrastructure to be designed. They are hoping to reuse as much of the existing property as possible and retrofit for lowered operational costs over time.

3–Initial Assessment:

Our initial BESS and FR5 assessment resulted in a 23% BESS score and an extremely low 1.6 FR5 rating. The lowest scoring categories are water, IEQ, and stormwater management, providing us a framework for our focus.

This assessment aids in determining the issues that we need to touch on such as the rating of existing fixtures, storm management, and passive strategies which will be further discussed in this presentation.

4–Existing Conditions:

Before delving into our design proposal, we'll give a quick overview of the existing conditions of our site. Our site is located in a middle ring suburb of Melbourne, in Brunswick, and is a common terrace house typology.

- The current layout doesn't optimise the Northern orientation, therefore, there is a lack of natural lighting and over reliance on artificial lighting.
- The current appliances also have poor energy ratings which will be completely replaced with higher rated and more efficient appliances.
- Ventilation is also lacking with no cross ventilation present and various partitions that detract the natural flow of fresh air. Therefore, resulting in high energy consumption and high utility costs.

Another weakness of the existing design is the insufficient area of permeability. Only 14% of the site incorporates permeable areas, which raises concerns about natural drainage and water runoff issues.

Spatial organisation is also an issue as service areas are scattered and inefficiently designed. The design is also limiting the functionality and comfort for users, and doesn't encourage sustainable practices.

Therefore, various innovative solutions will be proposed to design a more user friendly and sustainable design.

//

5–Proposed Renovations

This is our renovation proposal for 25 Lydia Street.

Our first concern with a vision of regenerative re-use and strict council codes, was preserving the heritage facade. The bedrooms were structurally sound and well arranged, so we aimed to retain at least 30% of the existing property. This also strategically reduces the embodied energy from construction and feeds into visibility and passive education for the occupants and the community.

Our design decision to omit windows on the Western boundary significantly reduced the thermal heat loss by tightening the building envelope and also reducing initial costs for our clients.

Services are grouped for optimal energy efficiency. A renovation of the rear area is recommended to capitalise on the north facing orientation and encourage sustainable practices by occupants.

The open living area is designed with floor to ceiling double glazed glass tri-fold doors that completely open up into the backyard, seamlessly merging the indoor and outdoor areas. Thus, not only prioritising energy efficiency but also enhancing the overall IEQ and well-being of the occupants.

We have also implemented a productive garden, share shelf and underground rainwater tank, which will be further discussed later in this presentation.

06–IEQ

Our design enhances the IEQ through:

- Ventilation; natural sunlight; acoustics and; a connection to nature.

To optimise acoustic comfort within the residence, we implemented zoning strategies. Designing spaces based on function and usage.

With the use of acoustic insulation and carpet the transition of sound is further minimised and the heat transfer is reduced, which contributes to the overall thermal comfort of the building.

A connection to the outdoors incorporating biophilic design principles also promotes the IEQ of our design. The inclusion of plants aims to enhance the air quality and reduce stress, creating a more comfortable environment for the occupants.

//

07–Passive Strategies

In our architectural approach, we strategically oriented the openings and primary living spaces to the north to harness solar control and increase shared use of this zone. The extension's roof features a Southern operable clerestory window, facilitating cross ventilation in the main living areas and effectively regulating temperatures. This north facing skillion roof facilitates the addition of PV panels mounted on 30 degree frames, should our clients wish to add them in the future. A box gutter between the original roof and addition collects rainwater to be funnelled into a slimline water tank.

Recognizing the impracticality of cross ventilation in bedrooms, and considering we couldn't add a window to bedroom 1 due to onlooking a neighbouring window, we integrated operable skylights for stack ventilation, ensuring a comfortable and healthy atmosphere.

Our design approach extends to innovative passive shading solutions, including a pergola with a native deciduous Wisteria vine, as you can see in the diagram. This not only mitigates excessive heat penetration during the summer but also contributes indoor heat retention in the winter, directed onto the concrete slab that has high thermal mass.

A main precedent for the backyard adaptable hub was Helvetia House by Austin Maynard Architects, which was designed in the same residential zone as our client's house. This area serves as a small-scale, visible urban food forest above and a multifunction storage area below. Future-proofing has been considered, with the potential for conversion into a carport or bike storage if desired by the occupants. We designed this space with parallel roller doors, which can be fully opened to the laneway, fostering social connection.

Important to our FR5 calculations, this area is not air-conditioned and falls outside the building envelope, meeting council regulations for a separate addition. Additionally, the garden space is classified as a rooftop area, further ensuring compliance with overlooking standards.

//

08–ResCode

The property falls under Neighbourhood Residential Zone 1 under the Moreland Planning Scheme and Merri-bek Local Planning Association.

A more detailed assessment of Res-Code regulations revealed strict heritage overlays, creating restrictions for the facade, and little wiggle room between neighbouring properties, which was the impetus behind retaining the East and Western walls as far back as possible so we do not have to indent the extension as you can see 23 Lydia St had to do to comply with Standard A11. Luckily, the weatherboard walls are structurally sound so we just retrofitted them with higher-performing insulation and aluminium wrap.

Lydia street has on-street council permit parking and 2 share cars located within 500m of the property. We aim to convince our clients to omit an on-site garage for these reasons and convert the backyard hub to bike storage in the future (but we didn't include these as they increased our BESS score well above 50%.)

We more than doubled the required permeable area, increased vegetated zones inspired by the native vegetation on site, and used materials that complied with the requirements of the zone. The window added on the Eastern bedroom complies with privacy and overlooking regulations through a calculation of total window areas on both number 25 and 23.

//

09–Energy Efficiency

Improving energy efficiency is a key component of sustainable development. It helps in resource conservation, saving costs, reducing greenhouse gas emissions, and protecting the environment.

Our main goal in energy assessment was to implement a passively run house through;

- Double glazed, well sealed windows;
- Cross ventilation and thermally sound material choices, to reduce reliance on grid energy.

We acknowledge that occupant comfort requires some active systems especially when aiming for a BESS score of only 50%, therefore we upgraded appliances to have better efficiency ratings and introduced electric reverse cycle air conditioners rather than gas.

//

10–Energy Consumption

Energy consumption refers to the total amount of energy used by individuals. It is typically measured in units like kilowatt-hours (kWh) or Megajoules.

High energy consumption, particularly from fossil fuels, contributes to the release of greenhouse gases, leading to climate change. The existing house consumed a total energy usage of 342MJ per square metre.

With the implementation of passive systems and reducing heat transfer through the building envelope, we have reduced the energy consumption by 5.9 times, with the proposed renovation energy consumption being 58 MJ per square metre.

Due to the climate in Melbourne as a temperate oceanic climate, summers are generally warm with an average high temperature ranging from 25 to 30 degrees Celsius and winters are cool with an average day temperature ranging from 10 to 15 degrees Celsius. Therefore, the heating energy usage is normally higher than the cooling usage.

//

11–Stormwater Management

In order to effectively manage the stormwater on site, the household water demands and the roof catchment size were calculated to determine the optimal tank size required.

With the WELS rated water appliances, we estimated a daily water usage of 935L. Along with a roof catchment size of 105m2 and Melbourne's annual rainfall of 649ml, we determined that a 3000L rainwater tank would be suitable for the purposes of toilet flushing, garden irrigation and laundry. Which accounts for 56% of the water usage in the household.

Other stormwater strategies include rain gardens and green roofs. Which were not implemented in our initial proposal but are key recommendations for further iterations, as these strategies not only slow down stormwater runoff but also improve the quality of stormwater.

//

12–Urban Ecology

We were inspired by the existing abundance of native plants on site, which encouraged us to have a focus on Urban Ecology.

Here we see the existing vegetation on site that has beneficial attributes as natural remedies done by Indigenous People in the past. By thinking this way, one can extend this further through food sustainability and quality on food, water and air.

Through retaining and expanding these permeable areas and utilising them for food production, it has improved our BESS score from 25% coming from the existing site condition to 50% for the improved condition.

Ideally, if we are going to maximise our BESS Score for Urban Ecology, it is advisable to consider incorporating Green Roof and Green Walls for its Architecture which will automatically make the Urban Ecology BESS Score into 100%.

Addition to this, productive gardens, communal Food Pantry, and QR Plants are the initial measures for harnessing the potential of urban ecology.

Firstly, having a productive garden can help decrease food waste and assure Food Sustainability. Not only this will help the occupants to develop a healthy eating habit but also assist reduction of Carbon Emissions through food transportation.

Secondly, the Communal Food Pantry is one of the most significant ideas that my team has developed. This initiative for sustainable housing can foster a sense of community and solidarity within the neighbourhood, at the same time, encourages a culture of giving and sharing which also promotes Social Sustainability.

Finally, the QR Plant Tag provides direct access to information about the plant types, plant care, and its beneficial attributes. These QR Plant Tags also provide access to local council workshops on Urban Ecology encouraging more people to be knowledgeable with Sustainability.

As aspiring environmental designers, these initiatives hold importance for us as they align with our proposal for Sustainable Education. Now, I would call Pip for a more comprehensive discussion on how to inspire occupant's behaviour for sustainable practices.

//

13–Inspiring Occupant Behaviour

We strongly believe that achieving long-term sustainability necessitates a holistic approach that extends beyond the architectural framework. Inspiring sustainable behaviours among occupants was a top consideration for us. So our design is not only environmentally conscious but we also hope it serves as a platform to educate and motivate both our clients and the broader community.

A key element in our educational initiative is visibility. We strategically incorporated;

- Permeable screens; repurposed existing materials in innovative ways; heightened biophilia and biodiversity; and introduced data visualisation technology.

These elements collectively incentivize efficient energy use and contribute to a reduction in operational energy.

The backyard hub was conceived as an adaptable zone, not just for the residents but also as a space that can be opened up for community engagement. It serves as a tangible example of the potential for sustainable living practices. We have designed a residential composting system and a worm farm to service this area, allowing occupants to responsibly manage food waste. To further extend our impact, we've implemented a share shelf, reaching out to the street and encouraging neighbours to adopt similar sustainable and regenerative practices in their own homes.

Our commitment to occupant education is embedded in many facets of the design, fostering a sense of responsibility and inspiring positive change both within our client's home and into the wider community.

//

14–Updated Assessment

The Updated design achieved a BESS score of 51% and a NatHERS rating of 7.3. While these numbers hit the assignment criteria, and significantly surpassed the original scores, we had to reduce and omit many strategies to stay under 51%.

With a bigger budget and a brief to improve the BESS score, we can recommend various future strategies.

In order for us to attain an accurate NatHERS Rating required particular technical methods to ensure an accurate simulation of the proposal.

As the outside areas were added and repurposed: such as the verandah and garage into an adaptable space for the client - it was important to consider how this would be simulated in FR5.

This involved familiarisation with technical aspects - establishing these outside areas as 'shading screens' within FR5. This accounts for the shading provided by the adjoining properties and related elements.

//

15–Outcomes & Recommendations

We analysed the outcomes from most to least effective strategies - and found that innovation, transport and water performed the lowest.

The most effective categories were: storm water, urban ecology and IEQ - largely due to the significantly increased permeability. Thus implementing a rainwater harvesting system and prioritising visibility to influence occupant behaviour is a direction to take. This is largely approached through optimising living spaces, application of passive strategies and much improved biophilia.

To further improve the design, we recommend:

- Clean energy generation through installing Solar or PV panels;

- A green roof under the solar panels to create a stable microclimate;

- Introducing bike storage in the adaptable backyard hub;

- Upgrading to a potable and non-potable water system;

- Introducing green walls along the Eastern and Western sides of the property and finally;

- Upgrading fixtures with higher WELS and MEPS ratings - for water and energy respectively.

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