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Sustainability and Heritage

City of Darebin Council

HIP V. HYPE

WHO WE ARE

HIP V. HYPE Sustainability provides advice that is commercially grounded, yet ambitious. We pursue exceptional outcomes that are socially, economically and environmentally sustainable and enable action across government, institutions and organisations.

We seek to partner with those who are willing to think strategically to achieve better. We lead, collaborate and support others to deliver impact and build Better Cities and Regions, Better Buildings, and Better Businesses.

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HIP V. HYPE

Glossary

COP

Co-efficient of Performance - the efficiency ratio of the amount of heating or cooling energy produced against the amount of energy consumed by the system.

HSPF

Heat Seasonal Performance Factor - heating efficiency rating for heat pumps - the ratio of heat output over the heating season to the electricity used by the system

TCSPF

Total Cooling Season Performance Factor - cooling efficiency rating for heat pumps - the ratio of cooling output over the cooling season to the electricity used by the system

NatHERS

The Nationwide House Energy Rating Scheme (NatHERS) - Used to measure a home's energy efficiency to generate a star rating.

FirstRate5
Interactive tool with a graphic user interface that enables designers and thermal performance assessors to generate energy ratings in accordance with NatHERS.

R Value

The capacity of an insulation material to resist heat flow - used to measure thermal performance of insulation and other building materials

U-Value

The rate of transfer of heat through a material - used to assess the thermal performance of glazing system.

SHGC

Solar Heat Gain Co-efficient - Measurement of how much solar radiation passes through a glazing system.

Executive Summary

HIP V. HYPE has been engaged by the City of Darebin Council to investigate how the design and adaptation of homes within a heritage overlay can achieve a high thermal efficiency with net zero outcomes.

SUMMARY OF RESULTS

The analysis within this report has demonstrated addressing the impacts of climate change and producing high performing homes that are within a heritage overlay is achievable when renovating the property.

Within the context of the proposed Thornbury Estate Heritage Precinct, two typical Californian Bungalow designs were thermally modelled both pre and post a hypothetical renovation (one minor and one major). The aim was to determine whether a 7 Star NatHERS rating and a net-zero operational energy could be achieved while being consistent with the heritage significance of the local area.

Through careful design in regards to orientation, choice of technology and retention of key façade features, environmental and heritage outcomes can be achieved through:

1. Improving the building's thermal envelope- through reducing penetrations, significantly increasing insulation, and improving the thermal performance of glazing;

2. Removing all natural gas appliances- and replacing them with highly efficient electrified alternatives- such as heat pump hot water systems, induction cooktops and reverse cycle air conditioning;

3. Installing onsite solar PV- to reduce the consumption of electricity from the grid; and

4. Purchasing 100% GreenPower- for any residual electricity consumed from the grid.

Davison Collaborative. Photo by Tess Kelly.

Introduction

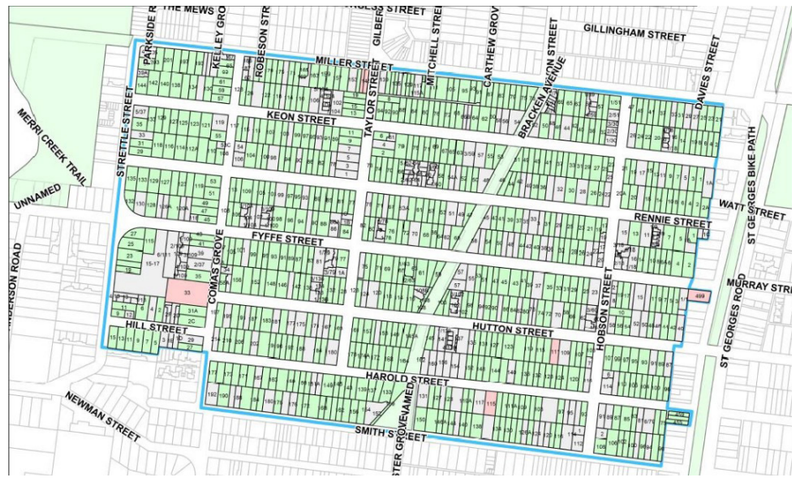
HIP V. HYPE (HV.H) have been engaged by City of Darebin Council to investigate and consider how the design and adaptation of residential homes in a heritage overlay can achieve net zero emissions and a 7+ Star NatHERS rating.

PROJECT DESCRIPTION

HV.H will conduct NatHERS modelling simulations utilising two typical Californian bungalow-type layouts in a north/south orientation to compile a list of thermal performance initiatives and upgrades required to bring the NatHERS rating to a 7-star minimum.

A 7-Star layout will be investigated further to determine what is required to achieve an operational net-zero outcome, utilising the Sustainability Victoria Whole-of-Home tool.

The findings from the investigations will form the recommendations HV.H have for the potential heritage overlay and it's impact on sustainability.



The Thornbury Park Estate - Darebin Planning Scheme

Project Context - General & Scope

City of Darebin is committed to both protecting local heritage and addressing the climate emergency. Through the engagement of HV.H, a thorough understanding of the relationship between the two in the context of heritage overlays and residential homes will occur.

GENERAL CONTEXT

City of Darebin is committed to both protecting local heritage and addressing the climate emergency.

The proposed heritage amendment (Planning Scheme Amendment C191dare) seeks to apply one of the largest heritage precincts for City of Darebin, and to support this proposal, council seeks to address the concerns raised around the perceived conflict with preserving heritage and in supporting high sustainability outcomes for new developments.

The area proposed for the heritage overlay, known as the Thornbury Park Estate, consists of a 'high percentage of intact historic building stock that is distributed consistently across it, with some interspersed non-contributory places'[1]. The majority of dwellings within this area consist of 'detached, timber clad bungalow types which are set back from the street with a garden identified by law, shrubs and other plantings'[1]. As such, it has been recommended to be considered for a heritage overlay.

Council declared a climate emergency in 2017, adopting their Climate Emergency Plan 2017-2022. Council implemented their new four year plan in 2021, which has highlighted the need to achieve zero gas emissions for Darebin by 2030.

There is a strong commitment to both Heritage preservation and addressing the climate emergency, therefore Council are interested in the connections, implications and impacts of the two in the context of residential homes.

The report will inform Council's submission to the planning panel for this amendment to recognise that high sustainability outcomes (including net zero emissions) can be achieved whilst meeting heritage overlay requirements.

SCOPE OF WORK

City of Darebin is seeking an investigation and report that considers how the design and adaptation of residential homes in an heritage overlay can achieve net-zero emissions and high thermal efficiency outcomes.

The report will investigate how the council can achieve both objectives of protecting the cultural heritage of significant neighbourhoods and addressing the declared climate emergency, within the context of residential homes.

High sustainable outcomes for the residential dwellings impacted by the heritage overlay will be defined as:

- 7+ star NatHERS rating (high thermal efficiency outcome)
- Net-Zero rating with the Sustainability Victoria Whole-of-Home Pilot tool (net-zero emissions outcome)

As such, the analysis will be based on achieving the above outcomes.

References/ Footnotes

1. Thornbury Park Estate Precinct, RBA Architects + Conservation Consultants, 26/11/21

Project Context - Climate Emergency

THE CLIMATE EMERGENCY

Recognising that the previous 16 years were some of the hottest on record, City of Darebin formally declared their commitment to undertake ambitious action to combat the climate emergency in 2017. The Climate Emergency Plan defined the following overarching goals:

- To provide maximum protection for the community of Darebin and for people, civilisation and species globally, especially the most vulnerable.
- To restore a safe climate at emergency speed by eliminating greenhouse gas emissions and enabling drawdown of excess carbon dioxide in the air.
- To encourage research to find safe ways to protect people, species and civilisation from near-term dangerous temperatures, while zero emission and carbon dioxide drawdown strategies are being enacted.
- To enable our community to be resilient in the face of any unavoidable dangerous climate impacts.
- To engage, empower and mobilise governments, communities and organisations to take action on and achieve these goals with certainty and at emergency speed.

An update of City of Darebin's Climate Emergency Plan is currently being completed. In particular, the commitment to set out the best pathway to achieve zero greenhouse gas emissions for Darebin by 2030 will be included.

There is no Planet B. Photo by Kim Landy.

Project Context - Heritage Overlay

The proposed heritage overlay impacts approximately 1,100 homes, with three levels of significance. The heritage overlay and impact is explained in this section.

HERITAGE OVERLAY

Through the proposed Planning Scheme Amendment C191dare, City of Darebin is seeking to apply a heritage overlay in the Thornbury Park Estate Precinct. The Thornbury Park Estate is an area bound by Strettle Street to the West, Miller Street to the North, Smith Street to the South and St Georges Road to the East, within the suburb of Thornbury. This area contains numerous developments dating back to the 1920's and 1930's, which have been considered as culturally significant.

Currently, there is an interim heritage overlay, which is due to expire on the 29th of April, 2023. This has been put in place to allow the permanent heritage overlay to be considered.

Broadly, the proposed heritage overlay will classify residential dwellings into three categories, defining their heritage significance:

Contributory

Contributes to the significance of the heritage precinct, but would not be significant on their own.

Non Contributory

Does not contribute to the significance of a heritage precinct.

Significant

A Significant place is a single heritage place that has cultural heritage significance which may be independent of its context. These places may also contribute to the significance of a heritage precinct. Significant places within a heritage precinct will not usually have a separate Statement of Significance.

The majority of dwellings within the heritage overlay are currently proposed to be 'Contributory'.

CATEGORY IMPACTS

Significant and Contributory

Dwellings deemed significant and contributory will generally need to consider the following if pursuing alterations:

- Respect of the contributory elements of the heritage buildings
- Retention of significant parts of heritage values
- No adverse impact of the significance, character and appearance of the heritage place

Non-Contributory

Dwellings deemed to be non-contributory will generally need to consider the following

- Respect of nearby contributory and significant buildings in the heritage precinct
- No adverse impact of the character and appearance of surrounding precinct
- Ensuring that the near-by contributory and significant buildings retain their prominence and aren't dominated by new works.

Project Context - The Californian Bungalow

The inter-war Californian bungalow is the predominant building type that is under consideration for heritage overlay in the Thornbury Estate. Research was completed to understand the typical construction, materiality and layout of the building type.

HISTORY

The Californian bungalow became widespread among Australian suburbs during the early 20th century, particularly in the inter-war period. They were considered economical and easy to construct during their time, contributing to their wide popularity and density in certain suburbs.

TYPICAL CONSTRUCTION

The typical Californian bungalow consists of a lightweight, single story timber construction with weatherboard external cladding, but can also incorporate partial brick construction. Stained glass double hung windows, front verandahs, statement front doors and gabled roofs are also typically incorporated into the design. Typical layouts do follow a pattern of a centralised hallway, with individual bedrooms and living rooms either side. Often, a lightweight kitchen, laundry or bathroom was attached to the rear of the structure.

TYPOLOGY EXAMPLE

Utilising a combination of street view, Google maps and real estate listings, research was conducted to create the ‘Typical Californian bungalow’. Some typical examples found in the affected area are shown in the images to the right.

103 Hutton Street - Realestate.com.au

6 Fyfe Street - Realestate.com.au

13 Rennie Street - Realestate.com.au

Project Context - Project Site Visits

As part of the research into this analysis, two projects that had either been required to retain significance under heritage, or had chosen to retain aspects were reviewed.

PROJECT 1

Description

A inner-north Californian bungalow under a heritage overlay, with a modernised renovation and upgrade to thermal performance.

Details

HV.H toured the home with the owner to gain an understanding of the requirements, difficulties and outcomes of targeting a high thermal performance outcome for a bungalow type home impacted by heritage overlay.

The home had significant work completed to improve the thermal efficiency of the fabric, including re-insulating the external walls and ceilings, upgrade of glazing systems to timber framed double glazed units, and considerable work to obtain a high level of airtightness.

The main complication that were identified with achieving a high thermal performance outcome was the retention of the existing front windows, which included stained-glass aspects considered significant by the heritage consultant. Several options of like-for-like replacements were put forward and rejected. The outcome was to incorporate a secondary, double glazed window system inside the stained-glass units in order to attain both a high thermal performance and meet heritage requirements.

The project was completed to a high thermal performance, achieving both a high NatHERS rating, and being extremely well sealed.

PROJECT 2

Description

A south-eastern suburbs Californian bungalow renovated with intention of retaining the facade style.

Details

HV.H were given a presentation on a home built by a staff member on a Californian bungalow renovated to be modernised, but also retain the style of the original design. The scope called for the front facade to be retained as much as possible and was driven by the client rather than a heritage overlay. Items such as glazing, wall and roof insulation were upgraded.

The project was successfully completed, however several key complications were noted, including:

- Rotting of timber structure, requiring rework
- Sourcing of windows to retain heritage look
- Condition of external cladding
- Structural integrity of footings

While typical of any renovation, these items were highlighted as causing additional costs.

Modelling Methodology

The proposed analysis is based around NatHERS modelling and Whole-of-Home Pilot tool - the basis and methodology is presented here.

MODELLING METHODOLOGY

The scope of this analysis has been defined as the following:

Investigation of:

- 7+ Star NatHERS rating
- Net-Zero operational outcome

7+ Star NatHERS Rating

To investigate the viability of a heritage overlay impacted dwelling achieving a 7+ star NatHERS rating, The modelling software FirstRate5 V5.3.2a has been used.

To form the basis of modelling, a range of inter-war Californian bungalow dwellings were reviewed. Two general layouts were created to form case study one and two for further analysis. The two typologies are assessed under as is conditions, that is existing and unrenovated which form a baseline rating for comparison.

For further analysis, the typologies were modified into a theoretical renovation, with one typology receiving a 'Minor Renovation' and the other typology receiving a 'Major Renovation', on the assumption that the alteration to an existing home will include a modernised renovation.

The renovated typologies are analysed with various thermal performance initiatives implemented to achieve a 7+ star NatHERS rating, while keeping with heritage overlay requirements.

NatHERS Overview

The Nationwide House Energy Rating Scheme (NatHERS) measures a home's energy efficiency to generate a star rating. It was first introduced in 1993.[1]

The higher the star rating, the less energy needed to heat and cool the home to keep it comfortable.[1]

NatHERS Assessors currently use the house plans and building specifications of a home to input data into a NatHERS accredited software tool. NatHERS tools estimate the amount of heat that needs to be added or removed to keep that home comfortable. The NatHERS tools then generate a NatHERS star rating out of 10 and a Certificate. This star rating measures the home's thermal performance, based on its structure, design and materials.[1]

Net-Zero Operational Outcome

To investigate the requirements of the impacted dwellings to achieve a net zero operational outcome, the Sustainability Victoria Pilot Whole-of-Home tool has been utilised. This tool uses the thermal modelling outcome of the FirstRate5 software and, along with input assumptions on operational usage, models the predicted annual energy usage of the home. By also incorporating solar PV analysis, the tool can determine whether a dwelling achieves an operational net-zero outcome in energy usage.

A renovated typology, achieving 7-stars, has been used to determine the solar PV, appliance and services specifications required to achieve a net-zero operational outcome in energy consumption.

The net-zero operational outcome in energy consumption will be defined as net energy consumed annually versus net energy produced annually. That is, a home will achieve net-zero energy if it produces as much energy as it consumes annually. It will still draw from the grid as needed, but feed back to the grid when generating excess energy.

This is a clear distinction from an off-grid scenario, where a home generates, stores and consumes enough energy to be sustainable off-grid.

References/ Footnotes

1. 'What is NatHERS?' - https://www.nathers.gov.au/

Case Study One: Minor Renovation

Case Study One: Minor Renovation

Case study one: Single storey, weatherboard exterior, double hung single-glazed windows

EXISTING FLOOR PLAN

As a baseline, case one illustrates how existing bungalows might perform prior to renovation works. This includes:

- South facing orientation
- Floor area 108m2
- Three bedroom, one bath
- No insulation in walls
- Single glazed double hung windows
- Weatherboard exterior

RENOVATED FLOOR PLAN

Case study one (minor renovation): Single storey, wall insulation added to external walls, timber framed, double glazed, thermally broken windows

This assessment defines a minor renovation as upgrades to the bathroom and open plan kitchen, dining and living/lounge areas. These features are considered minor with works focusing on the back extension and a small laundry addition to the bathroom. Front bedrooms are retained with no ensuites.

- South facing orientation
- Floor area increased to 141m2
- Three bedroom, renovated bath and laundry
- Open plan kitchen, dining and living lounge area
- Insulation added to all external walls
- Timber-framed double glazed windows
- North windows retained

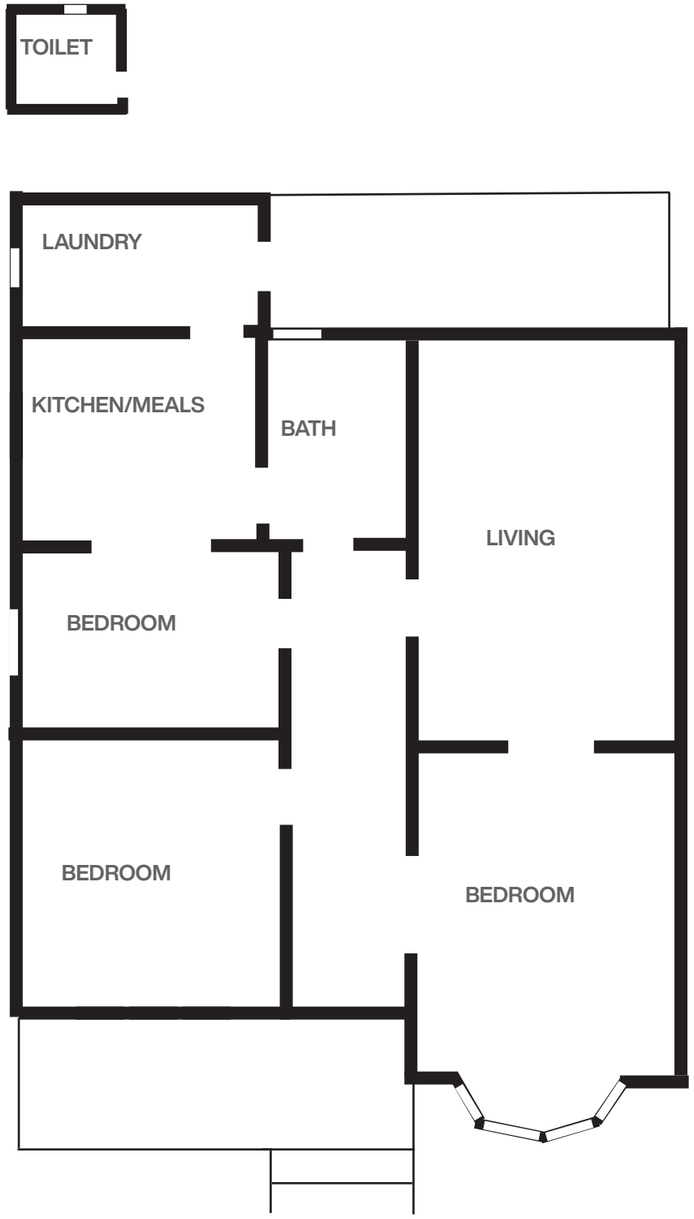
Case Study One: Minor Renovation

MODELLING ASSUMPTIONS

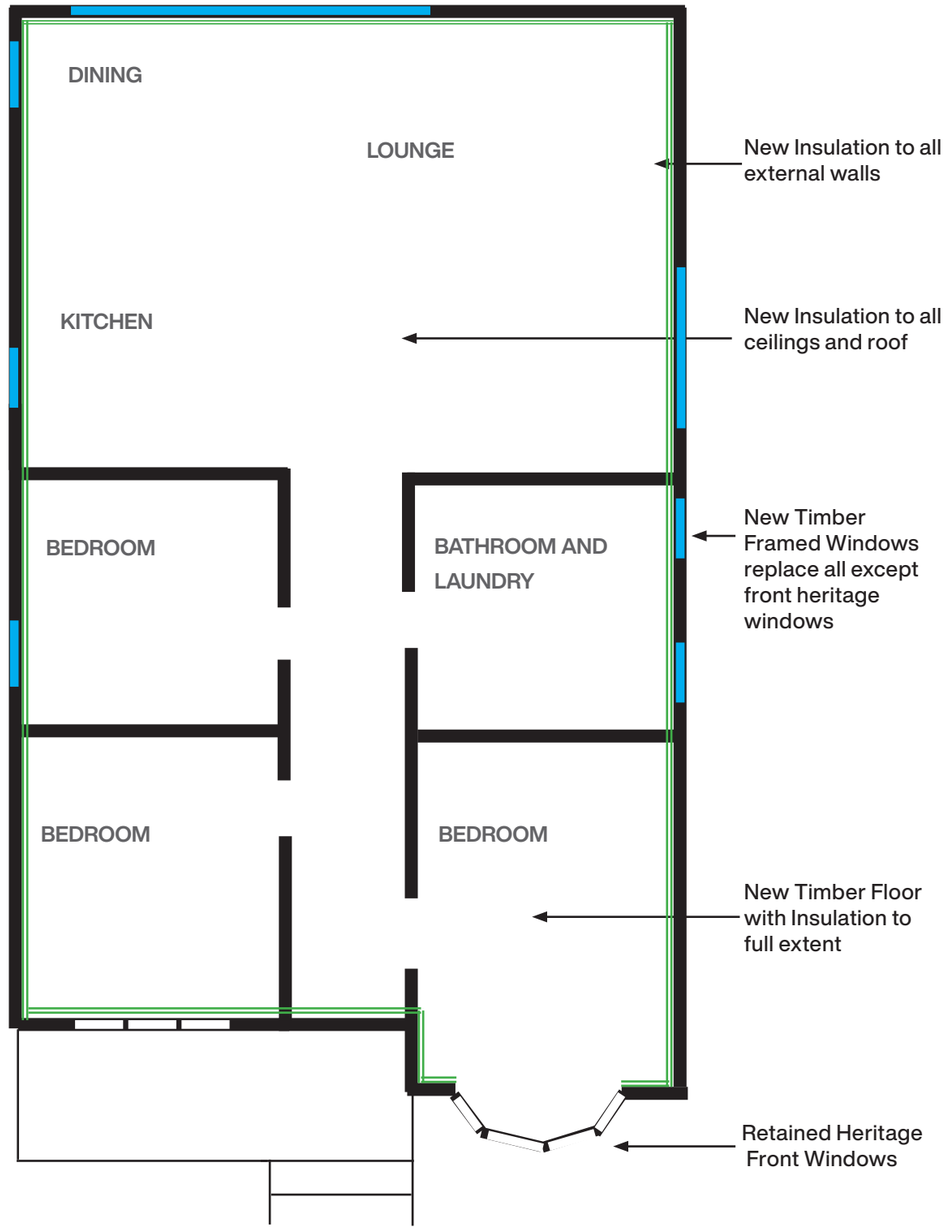
The modelling assumptions below outline how existing dwellings can achieve thermal comfort, lower operational costs and reduced carbon footprint. Column one baseline rating is representative of energy performance of current Californian bungalows which have not undergone renovation works. Column two reflects the necessary upgrades required to achieve best practice.

ITEM	ASSUMPTION VALUES	
	BEFORE	AFTER
EXTERNAL WALLS	Weatherboard + no insulation	Weatherboard + R2.7 insulation
INTERNAL WALLS	Internal plasterboard stud wall, uninsulated	As is - uninsulated
ROOF AND EXPOSED CEILING	Sloped roof with attic space, uninsulated	R5.0 ceiling + R1.8 roof insulation
SUB FLOOR TYPE	Timber floor + no insulation, open ventilation	Timber floor + R2.5 insulation, enclosed ventilation
GLAZING PERFORMANCE	Existing timber double hung single glazed windows U value: 5.0 SHGC: 0.63	Front facing double hung windows retained New windows: Timber framed + thermally broken U value: 1.8 SHGC: 0.3
LIGHTING	n/a	Recessed LED downlights, uncovered and sealed
EXHAUST FANS	n/a	Energy efficient exhaust fans, sealed
DOORS	n/a	Sealed and weather-stripped
STAR RATING	1.2 Star	7.1 Star

Case Study One: Minor Renovation



Case Study 1: Before Renovation



Case Study 2: After Renovation

Case Study One: Minor Renovation

DESIGN INTERVENTIONS IMPACT ON NATHERS RATING

The overall rating is a result of all interventions added accumulatively to exceed best practice standards of 7.1 Star. The table shows how each design intervention works in conjunction with one another to incrementally affect the overall rating. From this assessment, insulation to the ceiling, roof and external walls have the highest impact, leading to the following outcomes:

- 25% - 35% reduction in winter heat losses and summer heat gains
- 40% reduction in cost of heating and cooling
- Reduction in GHG emissions

DESIGN INTERVENTIONS	IMPACT OF DESIGN INTERVENTIONS	IMPROVEMENT OVER BASELINE
	STAR RATING	
Baseline	1.2	
+ Add R5.0 Ceiling + R1.8 Roof Insulation	3.3	+2.1
+ New walls and existing walls :Weatherboard External Walls + R2.7 Insulation	5.4	+2.2
+ Timber Flooring + R2.5 Insulation	6.4	+1.0
+ Glazing Upgrade to Timber Framed Thermally Broken (U value: 1.8 SHGC: 0.3) Existing front dwelling facade: Double hung windows retained	6.9	+0.5
+ Sub-floor Ventilation: Enclosed	7.1	+0.2
Total Result	7.1 Star	

Case Study One: Net-Zero Analysis

Building on the 7-star analysis presented within this report, a Net-Zero analysis has been undertaken to identify further sustainability specifications required to achieve an annual, net zero energy outcome for the typical Californian bungalow.

NET ZERO ANALYSIS

Utilising the 7-star, renovated Case One typology - a net zero analysis was completed using Sustainability Victoria's Whole-of-Home tool. To achieve an annual net-zero energy outcome, the following specifications were required:

ITEM	SPECIFICATION REQUIREMENT	
	BEFORE	AFTER
HEATING/COOLING	No cooling systems Gas fueled heater in main living room electric element heaters in bedrooms	Refrigerative split systems sized to peak heating cooling loads appropriately and achieving min. 4.20 HSPF/6.8 TCSPF, at 6kW Heating and 5kW Cooling capacity. Systems have been bundled into 'Primary' and 'Secondary' zones: Primary: Main living zones Secondary: Bedroom zones
HOT WATER	Gas storage system	High efficiency heat pump system, min. COP=6.0 @ 32 degrees ambient - 315L Tank
LIGHTING	Incandescent light globes (8-10Wm/2)	LED type, general assumption of 4W/m2
COOKTOP/OVEN	Gas cooktop and oven	Induction cooktop, electric oven
PV SOLAR SYSTEM	No PV system - No GreenPower Purchase	Min. 3.5kWp PV system for north orientation (best ideal scenario) Min. 4.8kWp PV system for south orientation (worst case scenario)

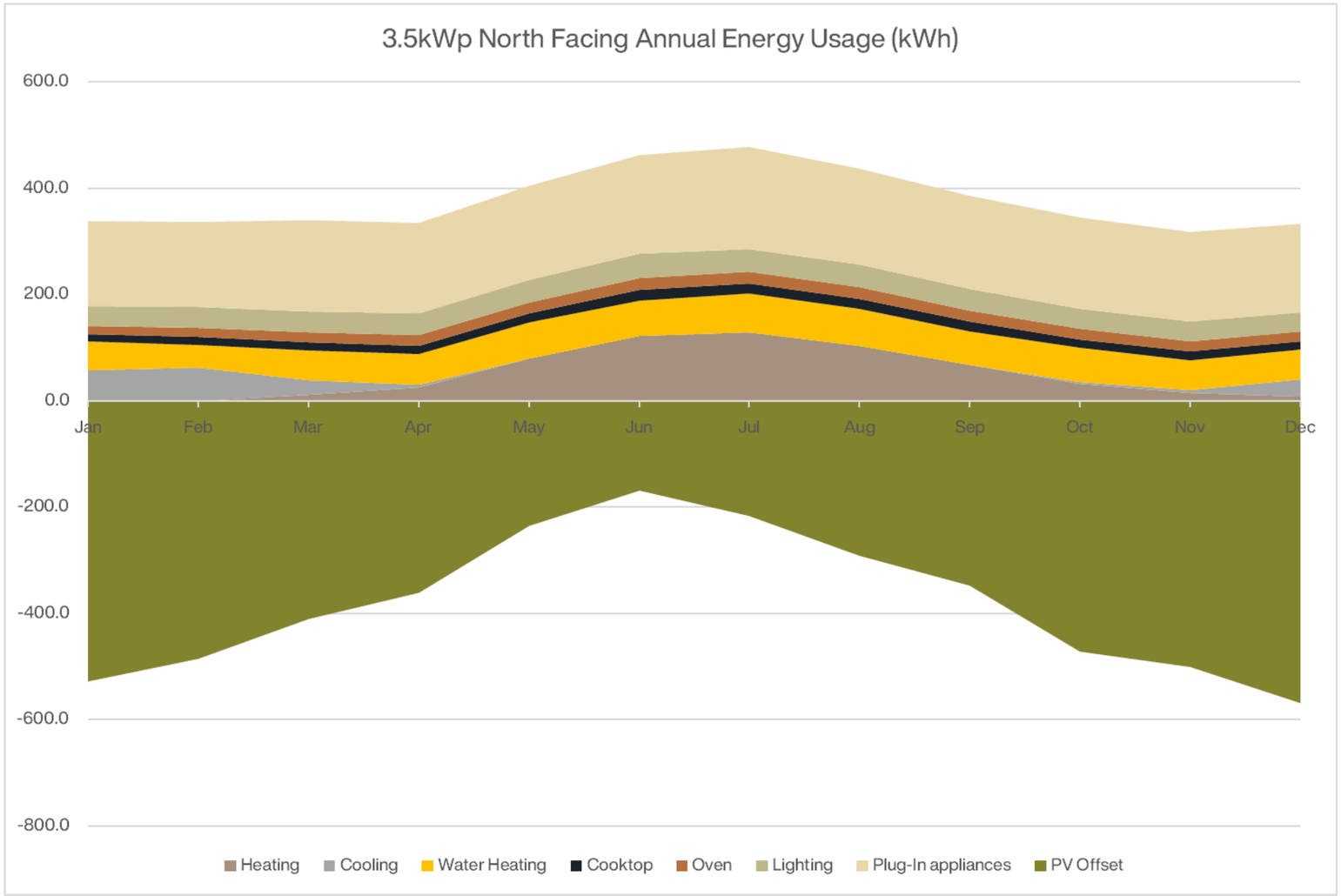
Utilising the above parameters, the following energy usage figures for each operational usage has been modelled:

ENERGY USAGE (kWh)									
ANNUAL TOTALS	PV OFFSET	HEATING	COOLING	WATER HEATING	COOKTOP	OVEN	LIGHTING	PLUG-IN APPLIANCES	ANNUAL BALANCE
3.5KW NORTH FACING	4588.9	591.9	190.0	731.9	197.2	236.9	482.8	2080.6	-77.5
4.8KWP SOUTH FACING	4627.8	591.9	190.0	731.9	197.2	236.9	482.8	2080.6	-116.4

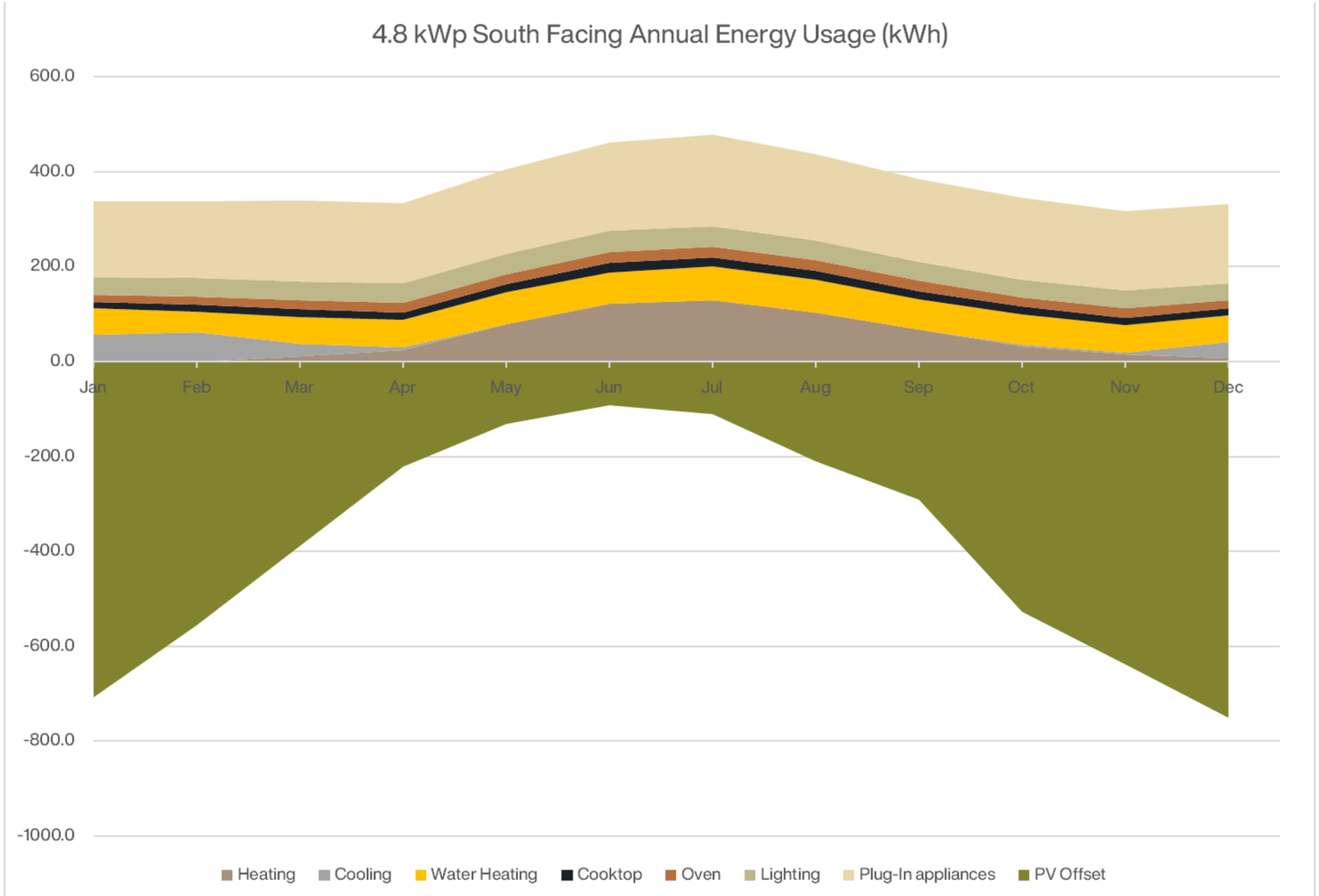
South facing properties that do not have adequate north facing roof space for a PV system will require additional PV panels to reach an

Case Study One: Net-Zero Analysis

The above data is presented in the following graph.



Case Study One: Net-Zero Analysis



Case Study Two: Major Renovation

Case Study Two: Major Renovation

Case study two: Single storey, weatherboard exterior, double hung single glazed windows

EXISTING FLOOR PLAN

Case two explores a similar floor plan however is slightly larger in size.

- North facing orientation
- 134m2 floor area
- Four bedroom, one bath, one laundry,
- Separate living and kitchen areas
- No insulation in walls
- Single glazed double hung windows

RENOVATED FLOOR PLAN

Case study two (major renovation): Double storey, weatherboard exterior upgrade, all new and existing walls with added insulation, double glazed windows

In addition to the open plan kitchen, dining and lounge areas seen in case one, major renovation includes an additional story, two bedroom with ensuites, family/retreat space and separate laundry.

- North facing orientation
- Floor area increased to 178m2
- Four bedroom on ground floor, master bedroom and retreat/family room on floor above
- Open plan kitchen, dining and living lounge area
- Insulation added to all new and existing walls
- Timber-framed double glazed windows

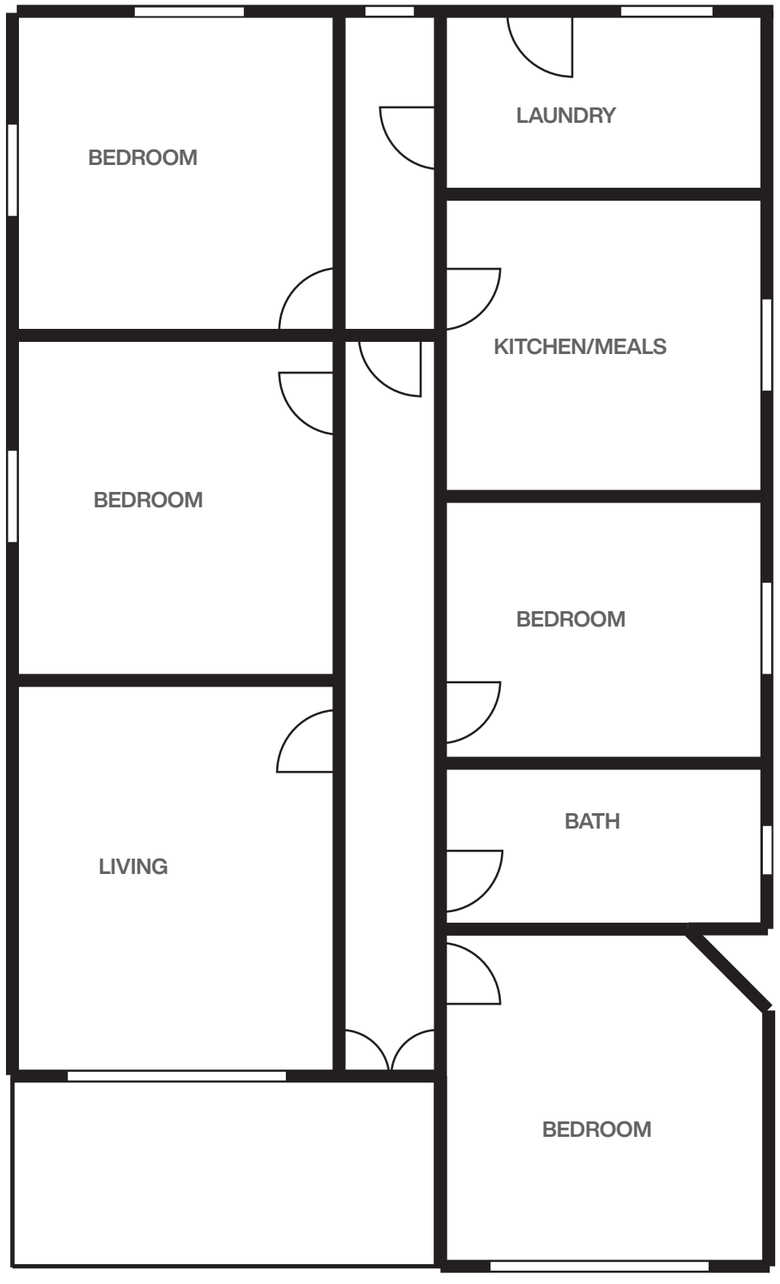
Case Study Two: Major Renovation

MODELLING ASSUMPTIONS

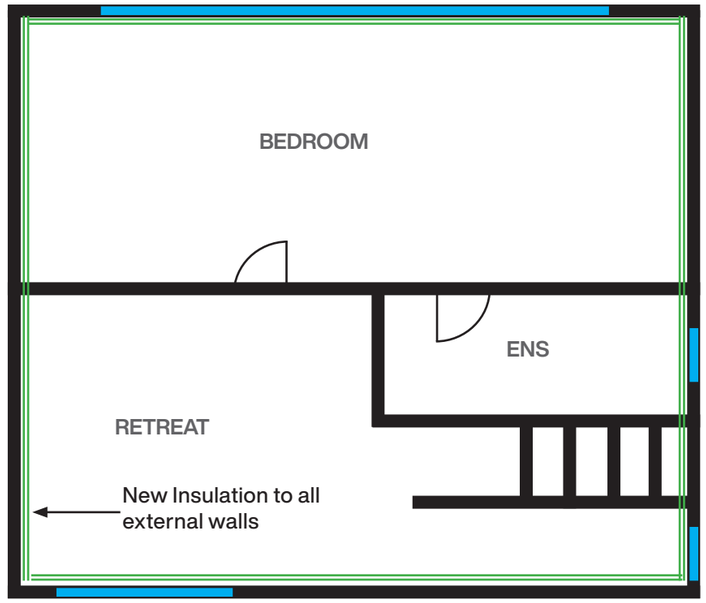
The modelling assumptions below outline how existing dwellings can achieve thermal comfort, lower operational costs and reduced carbon footprint. Column one baseline rating is representative of energy performance of current Californian bungalows which have not undergone renovation works. Column two relects the necessary upgrades required to achieve best practice.

ITEM	ASSUMPTION VALUES	
	BEFORE	AFTER
EXTERNAL WALLS	Weatherboard + no insulation	Weatherboard + R3.0 insulation
INTERNAL WALLS	Internal plasterboard stud wall, uninsulated	Lightweight wall construction, uninsulated
ROOF AND EXPOSED CEILING	Sloped roof with attic space, uninsulated	R5.0 ceiling + R1.8 roof insulation
SUB FLOOR TYPE	Timber floor, uninsulated Open ventilation	Ground level: timber floor + R2.5 insulation Enclosed ventilation Level 1: timber floor, uninsulated
GLAZING PERFORMANCE	Existing timber double hung single glazed windows U value: 5.0 SHGC: 0.63	Ground floor front facing double hung windows retained New windows: Timber framed + thermally broken U value: 1.8 SHGC: 0.3
LIGHTING	n/a	Recessed LED downlights, uncovered and sealed
EXHAUST FANS	n/a	Energy efficient exhaust fans, sealed
DOORS	n/a	Sealed and weather-stripped
STAR RATING	1.2 Star	7.2 Star

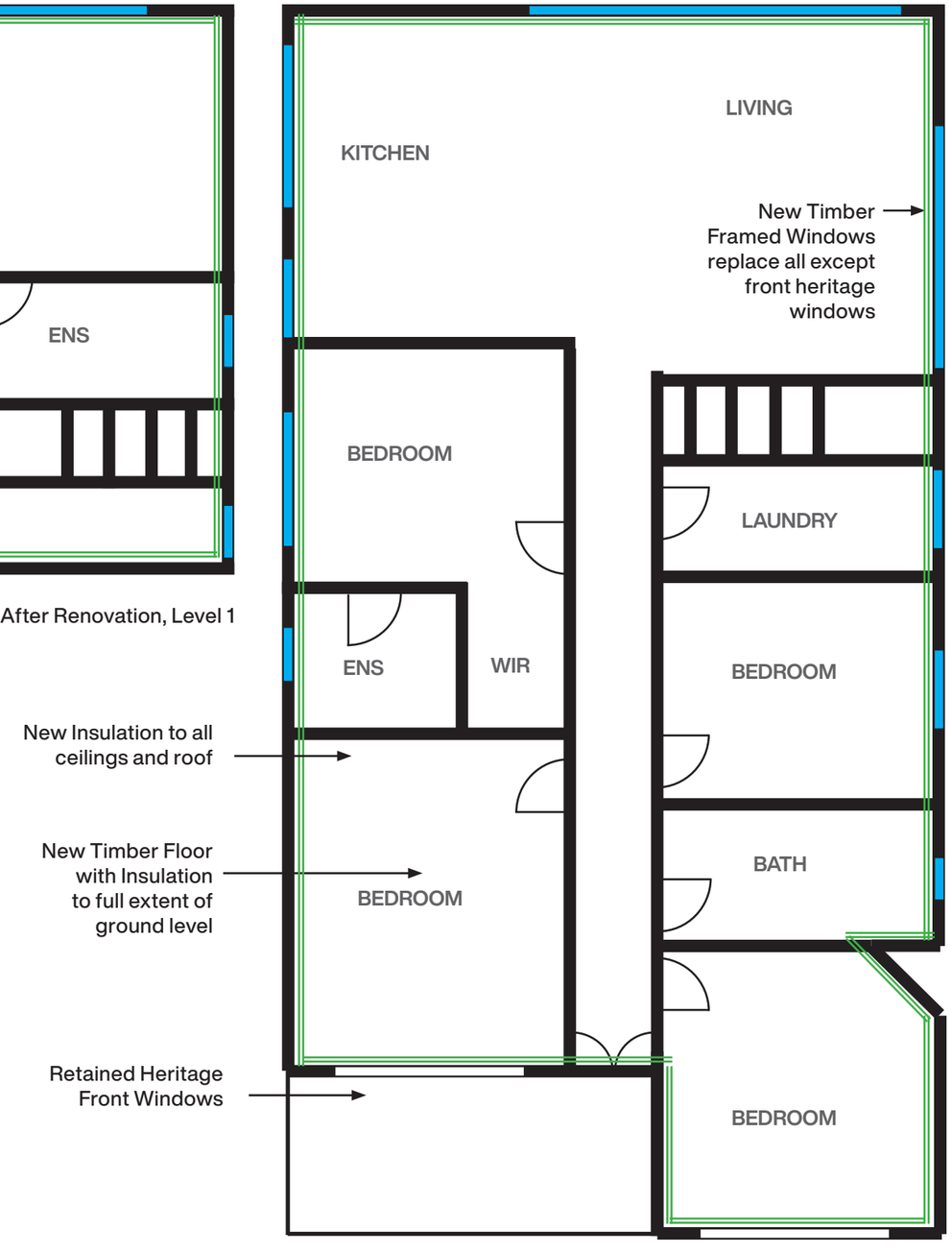
Case Study Two: Major Renovation



Case Study 1: Before Renovation



Case Study 2: After Renovation, Level 1



Case Study 2: After Renovation, Ground

Case Study Two: Major Renovation

BUILDING FABRIC RELATED INTERVENTIONS

Similarly, the following design interventions have been applied to case study two to determine how this may affect a larger north facing floorplan. Differing from case study one, the table below indicates dwelling larger in size will require more insulating, seeing an increase from R2.7 up to R3.0. Wall, roof and floor insulation have again proven to be the most impactful when it comes to heat loss/gain mitigation.

DESIGN INTERVENTIONS	IMPACT OF DESIGN INTERVENTIONS	IMPROVEMENT OVER BASELINE
	STAR RATING	
Baseline	1.2	
+ Add R5.0 Ceiling + R1.8 Roof Insulation G and L1	2.7	+1.5
+ New walls and existing walls : Weatherboard External Walls + R3.0 Insulation	5.1	+2.4
+ Timber Flooring + R2.5 Insulation	6.3	+1.2
+ Glazing Upgrade to Timber Framed Thermally Broken (U value: 1.8 SHGC: 0.3) Existing front dwelling facade: Double hung windows retained	7.1	+0.8
+ Sub-floor Ventilation: Enclosed	7.1	+0.1
Total Result	7.2 Star	

Orientation Analysis

Orientation Analysis

Understanding a building's orientation is important to achieving energy efficiency. How a building is positioned in relation to the sun's path in different seasons can help inform designs to either utilise natural daylight and wind or protect from their effects. To assess the relationship between orientation and energy efficiency, case one and two are modelled to north, east, south and west orientations.

ORIENTATION OUTCOMES

From the tabulated results below, north and east present as optimal orientations for case study one and north for case study two. Both case studies show no significant difference between the orientations, with north orientation proving only slightly more favourable.

CASE STUDY ONE MINOR RENOVATION				
ORIENTATION	HEATING LOAD	COOLING LOAD	TOTAL LOAD	STAR RATING
NORTH	52.3	24.0	76.3	7.2
EAST	50.1	26.3	76.3	7.2
SOUTH	54.4	26.7	81.1	7.1
WEST	53.2	27.9	80.0	7.1

CASE STUDY TWO MAJOR RENOVATION				
ORIENTATION	HEATING LOAD	COOLING LOAD	TOTAL LOAD	STAR RATING
NORTH	53.4	23.6	77.1	7.2
EAST	53.3	27.7	80.9	7.1
SOUTH	54.9	26.3	81.2	7.1
WEST	52.4	26.9	79.3	7.1

Discussion

The analysis has demonstrated that a 7-star and net-zero outcome for a heritage-impacted Californian bungalow is possible.

ACHIEVING A 7-STAR RATING

Through creating a general floor layout based on a typical Californian bungalow found within the Thornbury Estate, an analysis has been completed and a possible pathway to a 7 star outcome has been identified. The following performance requirements are needed to upgrade an existing bungalow to a 7 star rating:

- R2.7 insulation in all external walls, including retained walls
- R2.5 underfloor insulation to all floors, including retained floors
- R5.0, plus R1.2 sarking insulation to roof and ceiling, including retained ceilings and roofs
- Timber framed double glazing windows (U=1.3, SHGC=0.3) to new extensions, retaining the existing windows where of significant heritage.

It has been assumed within this modelling that the average home owner will look to modernise part of their home with an open plan living/additional bedroom renovation. As such, the modelling has focused on Californian bungalow type homes that have the retained structure thermally upgraded, and a new addition to modernise the layout.

When considering renovations and additions, the following design principles have been included:

- Orientation of living areas to the North (as seen in case study one)
- Minimisation of glazing to the West
- Focusing glazing to the North to take advantage of passive heating

Given the limitation of changes available under the heritage overlay, it is important to maximise passive principles on additions.

ACHIEVING A NET-ZERO OUTCOME

Utilising the typology of case study one with a minor renovation, at 7.1 stars, the following design initiatives will allow the home to achieve a annual, net-zero energy usage:

- High efficiency split system air-conditioning to living and bedrooms (modelled at 4.20 HSPF, 6.80 TCSPF and appropriately sized to peak heating/cooling loads)
- High efficiency heat pump system for hot water (COP of 6.0 @ 32 degree ambient condition)
- Induction cooktop and electric oven
- 3.5kWp North facing PV solar system, or:
- 4.8kW South facing PV solar system

The above specification essentially removes all gas connected services, creating an all electric home.

Given there is a wide array of PV system sizes and orientations that any one home can have, the best and worse case scenario has been presented in this analysis. The expectation is that the average 7-star renovated home can offset their electrical usage with a system ranging from 3.5 to 4.8kW.

GreenPower Energy Purchasing

The final step in achieving a net-zero carbon home is purchasing renewable energy from the grid when needed. Many suppliers offer a renewable energy product with GreenPower awarding those with an accreditation.

A wide range of energy suppliers offering a 100% GreenPower product can be found at GreenPowers website: https://www.greenpower.gov.au/

Discussion

HERITAGE OVERLAY CONSIDERATION

From review of the proposed heritage overlay amendment, it is understood that for the majority of homes (as considered contributory), the restrictions imposed will be relating to the visual preservation of the front facade. As such, the modelling presented has assumed the following is generally acceptable under the heritage overlay rules:

- Retention of front windows
- Removal and replacement of front cladding with visually similar product (i.e. replacement of existing timber weatherboards with new equivalent)
- Removal and replacement of existing floor
- Lifting and relaying roof tiles to installing sarking and insulation to existing roof and ceiling
- Retention of existing timber framework, particularly of front facade.

The thermal performance modelling has been based on the above points, and it is believed that all thermal performance initiatives presented are possible while adhering to heritage overlay requirements.

To achieve an annual net zero energy operational outcome, external plant space for heat pumps, inverters etc. will be required. These can be discreetly installed to avoid visual impact from the street.

AIR TIGHTNESS

An important aspect of thermal efficiency that is not considered within NatHERS star ratings is the air tightness of the homes.

Airtightness refers to the ability of a home to be sealed from unintentional introduction of outdoor air into a building. This unintended air movement results in lower cooling/heating efficiencies, as more mechanical conditioning is required to heat or cool the home. Air leaks can cause 15-25% of winter heat loss in buildings.[1]

An important note to make regarding Californian bungalows and older homes in general are prone to high air leakage through compared to newer buildings. Tolerance levels of joins and years of use can contribute to mismatch alignments and cause the airtightness of homes to decrease.

To combat leakage in the building envelope, the following outcomes should be considered before renovation works:

ITEM	CONSIDERATIONS
BUILDING ENVELOPE	– continuous air barrier wrap in wall – draught proof vapour membranes in cavities or under cladding
WINDOWS AND DOORS	– adhesive weather strips to seal windows – draught-proofing strips on hinged doors
FLOORS	– seal gaps due to misalignment in timber floors – seal edge of floors to prevent air penetration from sub floor vents
JUNCTIONS AND GAPS	– air sealing tape around switches, powerpoints, windows, architraves and pushing bulk insulation into frame
VENTS, SKYLIGHTS, HATCHES AND PENETRATIONS	– avoid/replace open-vented downlights that penetrate ceiling insulation – duct exhaust fans/rangehoods to outside and install non-return baffles. – insulate and fit air seals to all sides of manholes and roof spaces
AIR LEAKAGE FROM HEATING AND COOLING	– avoid unflued gas heaters, open fireplaces – ducted air conditioner penetrations through ceilings and floors should be sealed.

INDUSTRY FEEDBACK

To gain a broader understanding of the industry opinion and standing, feedback was sought from several industry bodies:

Sustainability Victoria

Comment was sought from a relevant member of the Sustainability Victoria team. Generally, they were supportive of considering the impact of Heritage Overlays and the sustainability of homes into the future, but had acknowledged that conflict may occur with regards to retention of heritage significance and the upgrade of the thermal performance of the building fabric

Green Building Council of Australia (GBCA)

Response to request not received in time.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Response to request not received in time.

Analysis Outcomes

The 7-star analysis of the typical Californian Bungalow found in the Thornbury Estate has identified a potential pathway that can be followed by the homeowner to achieve a 7 star NatHERs and annual net-zero operational outcome.

7-STAR OUTCOMES

The analysis presented within this report has demonstrated that theoretically, a Californian bungalow type dwelling can achieve a 7-star outcome when renovated with an addition to modernise layouts.

However, the required works are significant and exceed what is considered a typical specification for thermal performance of a new home.

NET-ZERO OUTCOMES

The analysis has also demonstrated that an annual operational energy can be achieved with an 7-star rated home. In particular, a typical home will need to install:

- Electric Heat Pump system
- Solar PV System

This equipment will require an external footprint for installation, depending on heritage considerations location of services will need to be carefully considered within individual designs.

We respectfully acknowledge that every project enabled or assisted by HIP V. HYPE in Australia exists on traditional aboriginal lands which have been sustained for thousands of years.

We honour their ongoing connection to these lands, and seek to respectfully acknowledge the traditional custodians in our work.

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For additional information, questions unturned, collaboration opportunities and project enquiries please get in touch.

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