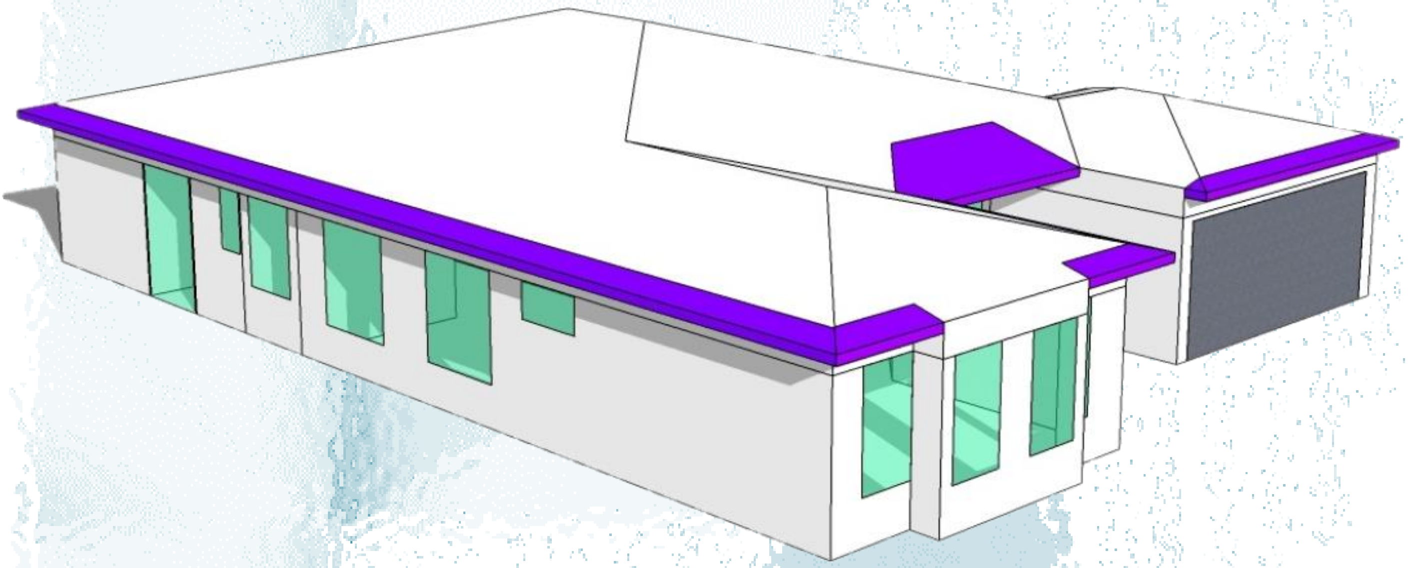
Solar-Smart PreCondition

Springfield, QLD 4300

CASE STUDY FOR TWO ALTERNATIVE SOLAR PV SIZES AND INCLUSION OF SOLAR SHARE FREE SCHEME



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Document Control

Revision	Date	Prepared	Approved	Status/Amendments
0	**03/07/2026**	**MA**	**AVK**	**3 Alternative Solar Scenarios Investigated – Final Report**

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1. Executive Summary

This case study assesses the energy, cost, and resilience benefits of using two alternative solar PV sizes and the inclusion of Solar Share free schemes for the revision 4 report, to precondition an NCC 2022-compliant detached house in Springfield, Queensland.

The strategy uses daytime solar generation to operate the 16 kW MEPS-compliant AC system during unoccupied periods, trying to reach a pre-conditioning set point of 18°C in summer and of 27°C in winter, thermally charging the house before occupants return. This shifts electricity demand away from occupied periods, reducing reliance on grid electricity while maintaining comfort and improving solar utilisation.

The three Scenarios were evaluated against their respective Reference Cases in this report:

- **Reference Cases:** exclusive to each scenario | same solar PV capacity & electricity plans | no preconditioning
- **Base Case:** 13.0 kWdc/10.0 kWac solar PV system | no free electricity from grid | with preconditioning
- **<u>Scenario 1:</u>** 6.6 kWdc/5.5 kWac solar PV system | no free electricity from grid | with preconditioning
- **<u>Scenario 2:</u>** 6.6 kWdc/5.5 kWac solar PV system | free electricity from 11 AM to 2 PM | with preconditioning
- **<u>Scenario 3:</u>** 8.0 kWdc/6.6 kWac solar PV system | no free electricity from grid | with preconditioning

All preconditioning scenarios outperform the Base Reference Case, even though the Base Reference Case uses a larger 13.0 kWdc / 10.0 kWac solar PV system. This confirms that simply increasing PV capacity is less effective than aligning air-conditioning operation with solar generation. The reference case exports more solar energy, but still relies heavily on the grid during occupied heating and cooling periods. The following tables present the results of this assessment, with reductions relative to the Reference case shown in parentheses.

Table 1: Summary of the results - Base Case

Base Case	13.0 kWdc/10.0 kWac solar PV system	Heating electricity from Grid (kWh)	Cooling electricity from Grid (kWh)	Total electricity from Grid (kWh)	Feed-in to Grid (kWh)
Reference	13.0 kWdc/10.0 kWac solar PV system | no free electricity from grid | No preconditioning	451	2664	4929	17846
Proposed	13.0 kWdc/10.0 kWac solar PV system | no free electricity from grid | with preconditioning	101	912	2724	11987
	Saving	78%	66%	45%	

Base Case	13.0 kWdc/10.0 kWac solar PV system	Heating electricity cost ($)	Cooling electricity cost ($)	Total services running cost - including non-AC loads ($)	Feed-in to Grid ($)	Net cost (feed-in revenue included) ($)
Reference	13.0 kWdc/10.0 kWac solar PV system | no free electricity from grid | No preconditioning	159	939	1737	178	**1559**
Proposed	13.0 kWdc/10.0 kWac solar PV system | no free electricity from grid | with preconditioning	36	321	960	120	**840**
	Saving	78%	66%	45%	-33%	46%

Table 2: Summary of the results - Scenario 1

Scenario 1	6.6 kWdc/5.5 kWac solar PV system	Heating electricity from Grid (kWh)	Cooling electricity from Grid (kWh)	Total electricity from Grid (kWh)	Feed-in to Grid (kWh)
Reference	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - no preconditioning	461	2949	5303	8225
Scenario 1	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - with preconditionin	155	1363	3416	3392
	Saving	66%	54%	36%	

Scenario 1	6.6 kWdc/5.5 kWac solar PV system	Heating electricity cost ($)	Cooling electricity cost ($)	Total services running cost - including non-AC loads ($)	Feed-in to Grid ($)	Net cost (feed-in revenue included) ($)
Reference	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - no preconditioning	162	1040	1869	82	**1787**
Scenario 1	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - with preconditionin	55	480	1204	34	**1170**
	Saving	66%	54%	36%	-59%	35%

Table 3: Summary of the results - Scenario 2

Scenario 2	6.6 kWdc/5.5 kWac solar PV system | free electricity from 11 AM to 2 PM	Heating electricity from Grid (kWh)	Cooling electricity from Grid (kWh)	Total electricity from Grid (kWh)	Feed-in to Grid (kWh)
Reference	6.6kWdc / 5.5kWac solar PV system - free grid electricity from 11 AM to 2 PM - no preconditioning	461	2948	5301	8657
Scenario 2	6.6kWdc / 5.5kWac solar PV system - free grid electricity from 11 AM to 2 PM - with preconditionir	128	1268	3276	5993
	Saving	**72%**	**57%**	**38%**	

Scenario 2	6.6 kWdc/5.5 kWac solar PV system | free electricity from 11 AM to 2 PM	Heating electricity cost ($)	Cooling electricity cost ($)	Total services running cost - including non-AC loads ($)	Feed-in to Grid ($)	**Net cost (feed-in revenue included) ($)**
Reference	6.6kWdc / 5.5kWac solar PV system - free grid electricity from 11 AM to 2 PM - no preconditioning	162	1039	1869	87	**1782**
Scenario 2	6.6kWdc / 5.5kWac solar PV system - free grid electricity from 11 AM to 2 PM - with preconditionir	45	447	1155	60	**1095**
	Saving	**72%**	**57%**	**38%**	**-31%**	**39%**

Table 4: Summary of the results - Scenario 3

Scenario 3	8.0 kWdc/6.6 kWac solar PV system	Heating electricity from Grid (kWh)	Cooling electricity from Grid (kWh)	Total electricity from Grid (kWh)	Feed-in to Grid (kWh)
Reference	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - no preconditioning	458	2865	5191	10392
Scenario 3	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - with preconditioning	132	1161	3127	5088
	Saving	**71%**	**59%**	**40%**	

Scenario 3	8.0 kWdc/6.6 kWac solar PV system	Heating electricity cost ($)	Cooling electricity cost ($)	Total services running cost - including non-AC loads ($)	Feed-in to Grid ($)	**Net cost (feed-in revenue included) ($)**
Reference	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - no preconditioning	161	1010	1830	104	**1726**
Scenario 3	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - with preconditioning	47	409	1102	51	**1051**
	Saving	**71%**	**59%**	**40%**	**-51%**	**39%**

Scenario 1 shows that even with a smaller 6.6 kWdc / 5.5 kWac PV system, preconditioning can reduce total grid electricity by **36%** and net annual electricity cost by **35%**. Scenario 2 shows that adding a free electricity period from 11 AM to 2 PM improves the result further, reducing total grid electricity by **38%** and net cost by **39%**. Scenario 3 provides the best overall result, with the 8.0 kWdc / 6.6 kWac PV system reducing total grid electricity by **40%** and net annual cost by **39%**.

The strongest benefit is observed in HVAC electricity use. Combined heating and cooling electricity from the grid reduces from **3,323 kWh/year** in the reference case to **1,293 kWh/year** in Scenario 3, representing an HVAC grid electricity reduction of approximately **61%**. Cooling provides the largest absolute saving because it is the dominant load in the dwelling and occurs when the solar PV generation is the highest.

The assessment demonstrates that solar-assisted preconditioning is an effective thermal load-shifting strategy for the proposed dwelling. By operating the air-conditioning system during daytime periods when solar PV generation or low-cost electricity is available, the building is used as a form of thermal storage. This reduces the need for heating and cooling during occupied periods when solar output is low and grid electricity use would otherwise be higher.

Important Note

The case study model features a concrete slab-on-ground floor construction. Because of preheating, precooling, and the extended hours during which the proposed case is conditioned compared to the reference case, the ground temperature aligns more closely with the indoor air temperature. This thermal interaction becomes a key source of energy savings: in winter, the ground releases heat into the building, while in summer it stores heat.

2. Introduction

2.1. Concept of Pre-conditioning

The proposed solution is based on the principle of thermal load shifting. In a conventional house, air-conditioning is usually operated when occupants are present and require comfort. This often means that heating or cooling demand occurs in the morning, evening, or night, when solar photovoltaic output is low or unavailable. As a result, the dwelling may rely heavily on grid electricity during the times when occupants are at home. In contrast, the preconditioning strategy intentionally operates the air-conditioning system during unoccupied daytime periods, when solar PV generation is available. During this period, the building is heated or cooled beyond the normal occupied set point. The objective is not to maintain that more extreme temperature permanently, but to store useful thermal energy within the building fabric, indoor air, furniture, internal surfaces, and other thermal mass.

In winter, preconditioning raises the indoor temperature above the normal occupied heating set point. For example, instead of allowing the house to sit near 20°C, the air-conditioning system heats the house to 27°C during solar-available hours. When occupants later return and the heating set point is reduced to 20°C, the house can remain comfortable for a longer period before additional heating is needed. Heat stored in internal surfaces and building materials is gradually released back into the indoor space, reducing the amount of heating required during occupied hours.

In summer, the process is reversed. The air-conditioning system cools the house below the normal occupied cooling set point of 23°C. By precooling the dwelling to 18°C while solar electricity is available, the building starts the occupied period from a cooler thermal condition. As outdoor heat gains enter the house through the roof, walls, windows, infiltration, and internal loads, the indoor temperature rises more slowly. This delays or reduces the need for air-conditioning operation during occupied hours.

In both seasons, the well-insulated house is being used as a form of distributed thermal storage. Instead of storing solar electricity in a battery, solar energy is stored indirectly as a change in the building's thermal state. The air-conditioning system converts solar electricity into heating or cooling at a time when solar power is abundant, and the building envelope then retains part of that heating or cooling for later use.

2.2. Mechanics of the Preconditioning Strategy

The mechanics of this solution depend on the interaction between four main components: solar PV generation, air-conditioning operation, building thermal mass, and thermostat control.

The solar PV system produces electricity during daylight hours. In a typical household without batteries, solar generation that exceeds the instantaneous household load may be exported to the grid, often at a lower financial value than the cost of importing electricity later. The preconditioning strategy increases useful self-consumption of solar electricity by scheduling air-conditioning operation when PV output is available.

The air-conditioning system acts as the controllable load. During unoccupied hours, the system is allowed to operate at more aggressive set points. In winter, higher set points increase the amount of heat added to the dwelling. In summer, lower set points increase the amount of heat removed from the dwelling. Because this operation occurs when the house is unoccupied, the temporary indoor temperature does not need to match normal comfort expectations, provided that the temperature remains within safe and reasonable limits and does not create condensation, moisture, or material risks.

The building fabric acts as the storage medium. Floors, walls, ceilings, internal linings, furniture, and enclosed air all absorb or release heat. A well-performing NCC 2022-compliant building envelope improves this process because insulation, glazing performance, and reduced unwanted heat transfer help the dwelling retain the preconditioned state for longer. A poorly insulated or leaky building would lose the stored heating or cooling more quickly, reducing the benefit of the strategy.

The thermostat schedule coordinates the entire process. During unoccupied solar periods, the set point is shifted away from the normal occupied condition. During occupancy, the thermostat is reset to the comfort set point: 20°C for heating and 23°C for cooling. The purpose is to reduce the intensity and duration of air-conditioning operation after occupants return. In effect, the system does not eliminate heating and cooling demand; it changes when that demand is met and how much of it is supplied by free onsite solar electricity.

2.3. Energy-Saving Mechanism

The energy-saving mechanism is based on reducing peak occupied HVAC demand. In the reference case, the air-conditioning system must respond to the building's thermal condition at the time occupants return. If the house is hot in summer or cold in winter, the system must operate intensively to restore comfort. This recovery load can be large because the indoor air, internal surfaces, and building materials all need to be brought back toward the comfort range.

With preconditioning, much of this recovery work is completed earlier in the day using solar electricity. The air-conditioning system still consumes energy during unoccupied hours, but that energy is supplied fully by the PV system. More importantly, the occupied-period HVAC demand is reduced because the dwelling is already closer to, or beyond, the required comfort condition.

The strategy also improves air-conditioning efficiency in some cases. Air-conditioning systems can perform more efficiently when they operate steadily rather than under sudden high-load recovery conditions. By spreading the thermal conditioning task over a longer period and aligning it with solar availability, the system may avoid sharp evening peaks. This can reduce compressor cycling, reduce high-load operation, and improve the overall match between energy supply and demand.

The cost-saving mechanism is different from, but related to, the energy-saving mechanism. Electricity cost depends not only on how much electricity is consumed, but also on when it is consumed and whether it is imported from the grid or supplied by onsite solar.

When solar PV electricity is available, the marginal cost of using that electricity onsite is very low. If the alternative is exporting surplus PV to the grid at a relatively low feed-in tariff and later buying electricity back at a higher retail tariff, it is usually more valuable to use solar electricity directly in the house. Preconditioning increases solar self-consumption by creating a useful daytime load.

2.4. Resilience Benefits

In addition to reducing electricity consumption and cost, the preconditioning strategy improves building resilience. In this context, resilience refers to the dwelling's ability to maintain acceptable indoor conditions during periods when active heating or cooling is reduced, unavailable, expensive, or constrained.

A preconditioned house has a thermal buffer. In winter, the house contains stored heat before the occupied period begins. In summer, the house contains stored cooling. This buffer means that the indoor temperature changes more slowly after the air-conditioning system is turned down, turned off, or reset to a less demanding occupied set point.

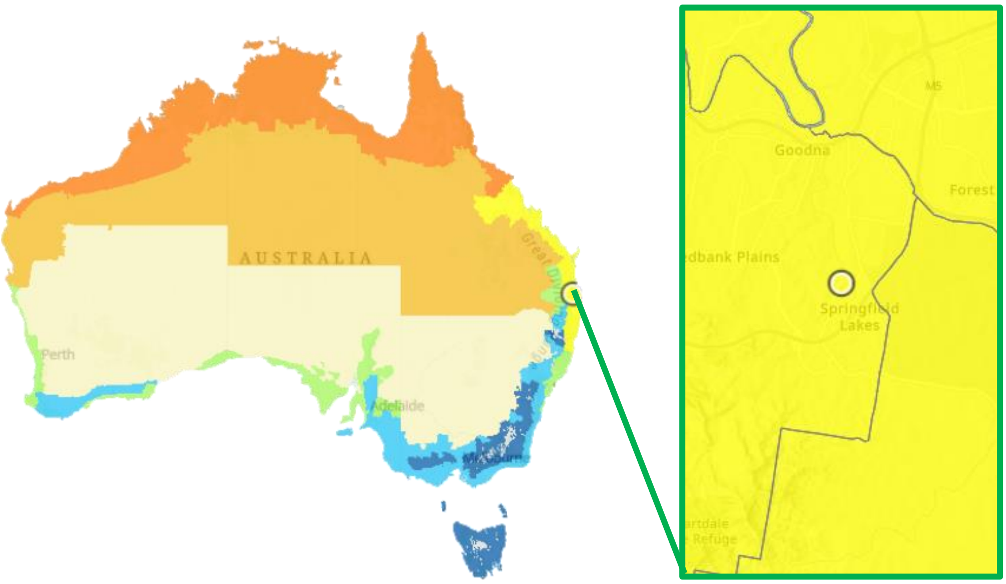
This is valuable during grid stress events, evening peak demand periods, outages, demand response events, or periods of high electricity price. A house that has been preheated or precooled can ride through these periods with less immediate need for active HVAC operation. Occupants may experience improved comfort stability because the indoor temperature does not change as rapidly.

The strategy also supports broader grid resilience. Residential air-conditioning can be a major contributor to peak electricity demand, especially during hot weather. If many homes shift part of their cooling demand to solar-rich daytime periods, evening peak demand may be reduced. This can lower stress on the electricity network and improve the integration of distributed solar generation.

3. Building Details

3.1. Site Context

The building is located within **Climate Zone 2,** Refer below for the ABCB's Climate Zone Map:



The simulation solution applies to the area shown in Figure 1.

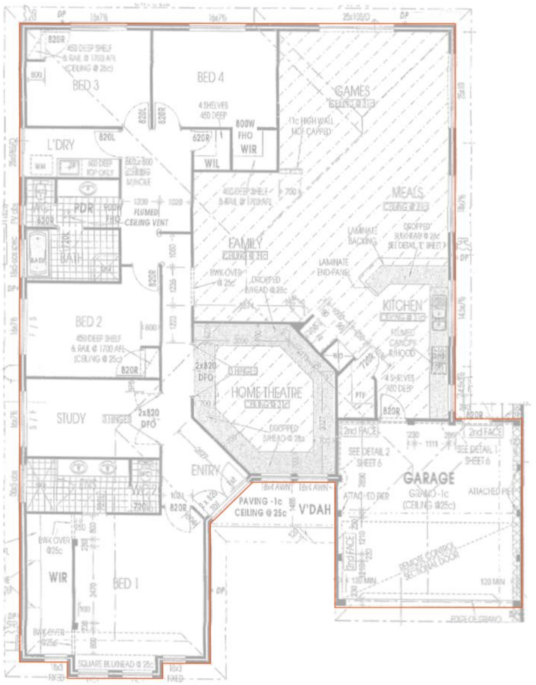


Figure 1: Proposed building plan view

Property Title:	Proposed Dwelling
Number of Stories:	1
Gross floor area (including Garage):	275 m2
Net Conditioned Floor Area:	198 m2 (excluding wall thicknesses)
Software Used in the Analysis:	DesignBuilder, V6

3.2. Building Function and NCC Classification

The following Building Classifications (as defined by NCC Vol. 1 Clause A3) have been identified for this development:

BCA Class	Type of classification	Inclusion
1a	**Residential dwelling**	✓
1b	Boarding house/guest house	X
2	Apartments	X
2	Common areas	X
3	Hotel, residential care building, . . .	X
4	Dwelling in a commercial building	X
5	Office	X
6	Shop, Restaurant/café	X
7a	Carpark	X
7b	Storage/warehouse	X
8	Laboratory/factory	X
9a	Ward area, Clinic	X
9b	Theatre/cinema, Conference facility	X
9b	School	X
9c	Aged-care facility	X
10a	**Garage**	✓

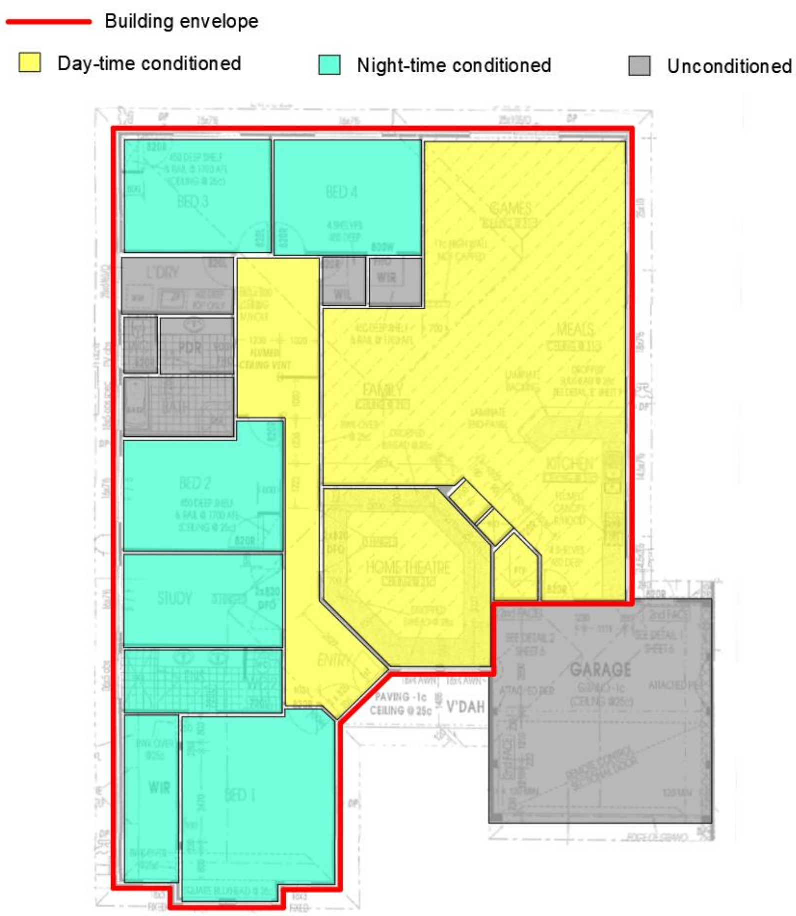


Figure 2: Types of spaces based on air conditioning status and the extent of the building envelope

3.3. Modelling Geometry

The following figures show the 3D modelling geometry as per the supplied architectural plans.

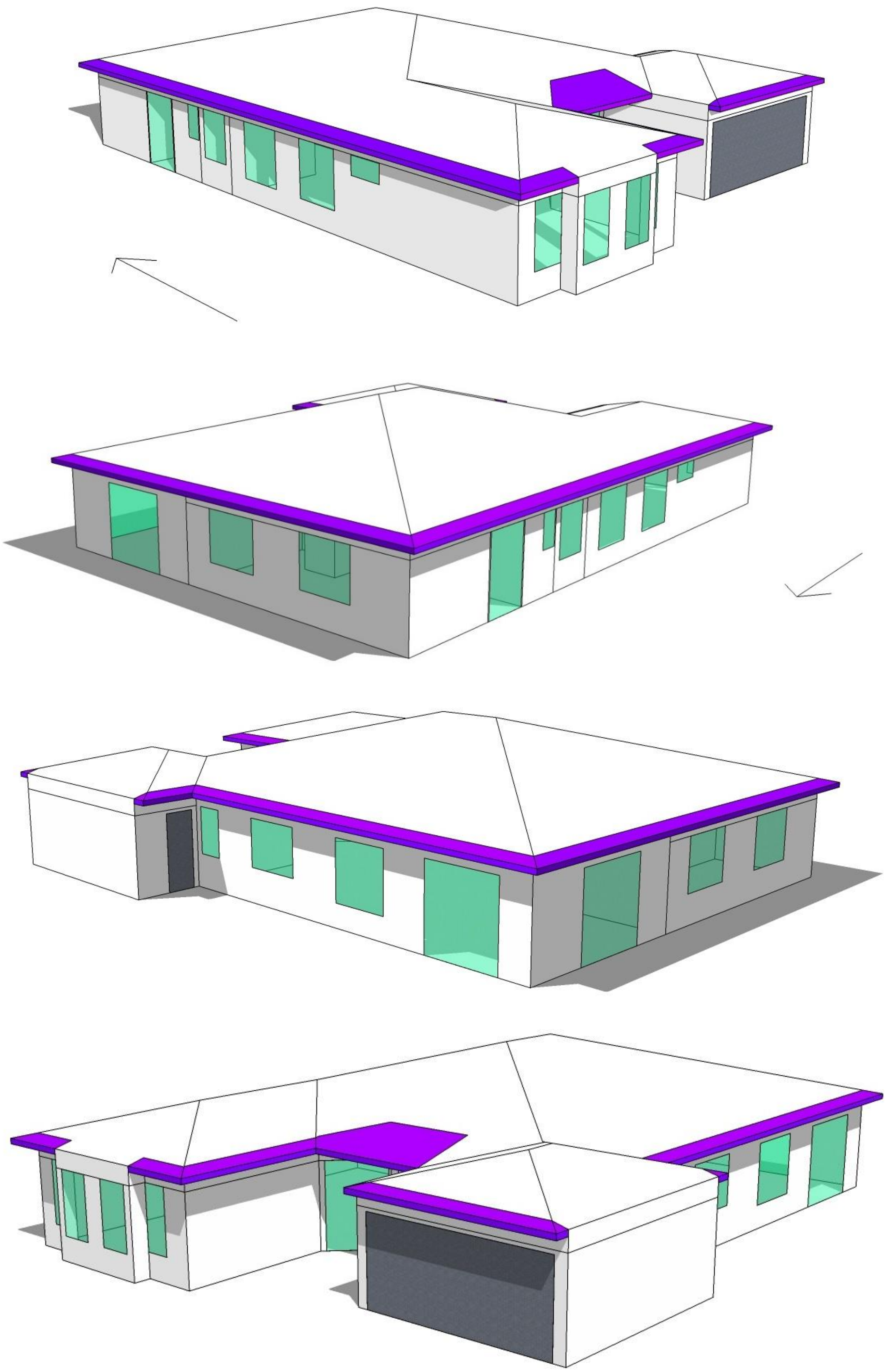
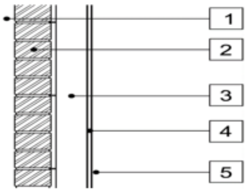


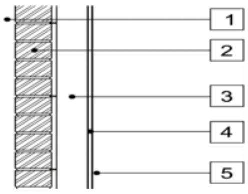
Figure 3: Proposed building geometry implemented in energy modelling

3.4. Building Thermal Performance

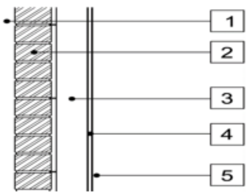
3.4.1. Walls



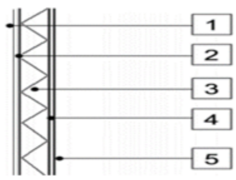
External brick veneer wall - excluding Garage and Living areas	Solar absorptance 0.7	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
1. Outdoor air film (7m/s)			0.03	
2. Brick		110	0.17	
3b. Bulk insulation		90		2.0
4. Gypsum plasterboard		10	0.06	
5. Indoor air film (still air)			0.12	
Total R-Value			**2.4**	



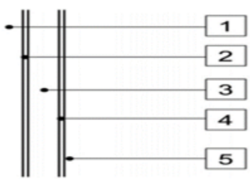
External brick veneer wall - Living areas	Solar absorptance 0.7	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
1. Outdoor air film (7m/s)			0.03	
2. Brick		110	0.17	
3b. Bulk insulation		90		2.5
4. Gypsum plasterboard		10	0.06	
5. Indoor air film (still air)			0.12	
Total R-Value			**2.9**	



External brick veneer wall - Garage	Solar absorptance 0.7	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
1. Outdoor air film (7m/s)			0.03	
2. Brick		110	0.17	
3c. Airspace (non-reflective / unventilated)		90	0.16	
4. Gypsum plasterboard		10	0.06	
5. Indoor air film (still air)			0.12	
Total R-Value			**0.5**	

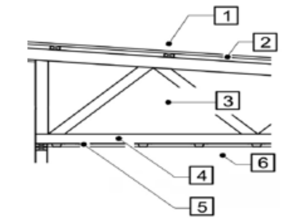


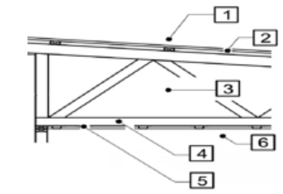
Common wall - Garage	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
1. Indoor air film (still air)	-	0.12	
2. Gypsum plasterboard	10	0.06	
3c. Bulk insulation	90		1.8
4. Gypsum plasterboard	10	0.06	
5. Indoor air film (still air)	-	0.12	
Total R-Value		**2.2**	



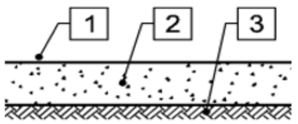
Internal stud walls	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
1. Indoor air film (still air)	-	0.12	
2. Gypsum plasterboard	10	0.06	
3. Air space (non-reflective / unventilated)	90	0.17	
4. Gypsum plasterboard	10	0.06	
5. Indoor air film (still air)	-	0.12	
Total R-Value		**0.5**	

3.4.2. Roof/ceiling Construction

Skillion metal roof with flat ceiling - excluding Garage	Solar absorptance 0.32	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
	1. Outdoor air film (7m/s)	-	0.03	
	2. Metal cladding	-	0	
	3. Air space (unventilated / non-reflective)	300	0.28	
	4. Bulk insulation	185		3.0
	5. Gypsum plasterboard	10	0.06	
	6. Indoor air film (still air)	-	0.16	
	Total R-Value	**3.5**		

Skillion metal roof with flat ceiling - Garage	Solar absorptance 0.32	Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
	1. Outdoor air film (7m/s)	-	0.03	
	2. Metal cladding	-	0	
	3,4. Air space (unventilated / non-reflective)	300	0.28	
	5. Gypsum plasterboard	10	0.06	
	6. Indoor air film (still air)	-	0.16	
	Total R-Value	**0.5**		

3.4.3. Floor

Concrete slab on ground - including Garage		Minimum thickness required (mm)	Inherent R-Value	Minimum Added R-Value
	1. Indoor air film (still air)	-	0.11	
	2. Concrete	100	0.07	
	3. Soil thermal resistance *	-	*	
	Total R-Value	**0.2**		
*** Soil thermal resistance is calculated in the modelling software for each time step**				

3.4.4. External Glazing

ABCB

Glazing

National Construction Code

Calculator

Help

1. Enter building name and description below - identifying the particular part(s) covered by this assessment.

Springfield, QLD

Floor construction	Area
Direct contact	215m²
Ground suspended	
Suspended upper floor(s)	
Area of dwelling	**215m²**
Area of glazing	*52.1m²* *(24% of floor area)*
Number of rows for table below	**20** *(as currently displayed)*

Number of storeys: One

Climate zone: 2

Constants: C_U 9.60; C_{SHGC} 0.0617

Allowances: $C_U / C_{SHGC\,W}$ **9.6**; $C_{SHGC\,S}$ x area **13.3**

Glazing elements, orientation sector, size and performance characteristics | Shading | Calculation data | Winter outcomes: Conduction / Solar gain - PASSED 99.2% | Summer outcomes: Solar heat gain - PASSED 100.0%

ID	Glazing element: Description (optional)	Orientation: Facing sector	Size: Height (m)	Size: Width (m)	Size: Area (m²)	Room type Bedroom / Utility? / Other	Level/ Floor type	Floor Covering	Frame colour	Openability	Performance: Total System U-Value (AFRC)	Performance: Total System SHGC (AFRC)	P&H or Device: P (m)	P&H or Device: H (m)	Adjustable vertical shading (external blind)	Exposure: P/H (not including device)	Exposure: Ew	Size: Area used (m²)	% of winter heat loss	% of winter heat gain	SHGC x E_s x Area	Element share % of allowance used
1	Home Theatre (AW1)	S	1.80	0.96		Other	Ground: Direct	Floating Timber	Medium	Awning	4.00	0.40	1.95	2.15		0.91	0.20	1.73	4%	1%	0.1	1% of 100%
2	Home Theatre (AW2)	S	1.80	0.96		Other	Ground: Direct	Floating Timber	Medium	Awning	4.00	0.40	1.95	2.15		0.91	0.20	1.73	4%	1%	0.1	1% of 100%
3	Entry Door (HD)	SE	2.50	1.70		Other	Ground: Direct	Polished Concrete	Medium	Highly Openable	4.00	0.40	1.50	2.85		0.53	0.30	4.25	10%	4%	0.6	5% of 100%
4	Bed 1 (FX1)	S	1.80	0.72		Bedroom	Ground: Direct	Carpet	Medium	Fixed	4.00	0.40	0.55	2.15		0.26	0.20	1.30	1%	1%	0.1	1% of 100%
5	Bed 1 (AW1)	S	1.80	0.96		Bedroom	Ground: Direct	Carpet	Medium	Awning	4.00	0.40					0.29	1.73	1%	1%	0.2	1% of 100%
6	Bed 1 (AW2)	S	1.80	0.96		Bedroom	Ground: Direct	Carpet	Medium	Awning	4.00	0.40					0.29	1.73	1%	1%	0.2	1% of 100%
7	WIR 1 (FX2)	S	1.80	0.72		Bedroom	Ground: Direct	Carpet	Medium	Fixed	4.00	0.40	0.55	2.15		0.26	0.20	1.30	1%	1%	0.1	1% of 100%
8	Ens 1 (FX)	W	0.60	1.20		Bedroom	Ground: Direct	Ceramic Tile	Medium	Fixed	4.00	0.40	0.55	0.95		0.58	0.49	0.72	1%	1%	0.1	1% of 100%
9	Study (SW)	W	1.80	1.80		Other	Ground: Direct	Carpet	Medium	Sliding	4.00	0.40	0.55	2.15		0.26	0.80	3.24	8%	7%	1.6	12% of 100%
10	Bed 2 (SW)	W	1.80	1.80		Bedroom	Ground: Direct	Carpet	Medium	Sliding	4.00	0.40	0.55	2.15		0.26	0.58	3.24	3%	5%	1.0	7% of 100%
11	Bath (FX)	W	1.50	1.20		Utility	Ground: Direct	Ceramic Tile	Medium	Fixed	4.00	0.40	0.55	1.95		0.28	0.56	1.80	2%	3%	0.5	4% of 100%
12	WC (FX)	W	1.10	0.60		Utility	Ground: Direct	Ceramic Tile	Medium	Fixed	4.00	0.40	0.55	1.40		0.39	0.51	0.66	1%	1%	0.2	1% of 100%
13	L'dry (SD)	W	2.50	1.56		Utility	Ground: Direct	Ceramic Tile	Medium	Sliding Door	4.00	0.40	0.55	2.85		0.19	0.61	3.90	4%	7%	1.3	9% of 100%
14	Bed 3 (SW)	N	1.60	1.80		Bedroom	Ground: Direct	Carpet	Medium	Sliding	4.00	0.40	0.50	1.95		0.26	0.83	2.88	3%	7%	0.3	2% of 100%
15	Bed 4 (SW)	N	1.60	1.80		Bedroom	Ground: Direct	Carpet	Medium	Sliding	4.00	0.40	0.50	1.95		0.26	0.83	2.88	3%	7%	0.3	2% of 100%
16	Games (SD)	N	2.50	2.40		Other	Ground: Direct	Floating Timber	Medium	Sliding Door	4.00	0.40	0.50	2.85		0.18	1.25	6.00	20%	21%	1.0	7% of 100%
17	Games (FX)	E	2.50	2.40		Other	Ground: Direct	Floating Timber	Medium	Fixed	4.00	0.40	0.50	2.85		0.18	0.87	6.00	15%	15%	2.8	21% of 100%
18	Meals (FX1)	E	1.80	1.80		Other	Ground: Direct	Floating Timber	Medium	Fixed	4.00	0.40	0.50	2.15		0.23	0.82	3.24	8%	8%	1.4	11% of 100%
19	Kitchen (FX1)	E	1.45	1.80		Other	Ground: Direct	Floating Timber	Medium	Fixed	4.00	0.40	0.50	1.80		0.28	0.78	2.61	6%	6%	1.1	8% of 100%
20	Kitchen (FX2)	E	1.45	0.84		Other	Ground: Direct	Floating Timber	Medium	Fixed	4.00	0.40	0.50	1.80		0.28	0.78	1.22	3%	3%	0.5	4% of 100%

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✓

If inputs are valid

4. Modelling Parameters

The following assumptions have been adopted for the purposes of this energy assessment.

General

1- The weatherfile used for the assessment is **AUS_QLD_RAAF.Amberley.945680_TMYx.2011-2025**

2- Peak electricity hour starts at 15:00 and ends at 21:00, having a rate of 35.25 c/kWh. All other hours are assumed off-peak having a rate of 35.25 c/kWh.

3- Solar feed-in to grid tariff is assumed 1 c/kWh.

Building Fabric

4- The size, glazing characteristics of all external windows and glazed doors incorporated into the model are summarised in the table below:

Level	Description	type	Orientaion	Height (m)	Width (m)
GF	Home Theatre (AW1)	Awning	S	1.8	0.96
	Home Theatre (AW2)	Awning	S	1.8	0.96
	Entry Door (HD)	Hinged Door	SE	2.5	1.7
	Bed 1 (FX1)	Fixed	S	1.8	0.72
	Bed 1 (AW1)	Awning	S	1.8	0.96
	Bed 1 (AW2)	Awning	S	1.8	0.96
	WIR 1 (FX2)	Fixed	S	1.8	0.72
	Ens 1 (FX)	Fixed	W	0.6	1.2
	Study (SW)	Sliding Window	W	1.8	1.8
	Bed 2 (SW)	Sliding Window	W	1.8	1.8
	Bath (FX)	Fixed	W	1.5	1.2
	WC (FX)	Fixed	W	1.1	0.6
	L'dry (SD)	Sliding door	W	2.5	1.56
	Bed 3 (SW)	Sliding Window	N	1.6	1.8
	Bed 4 (SW)	Sliding Window	N	1.6	1.8
	Games (SD)	Sliding door	N	2.5	2.4
	Games (FX)	Fixed	E	2.5	2.4
	Meals (FX1)	Fixed	E	1.8	1.8
	Kitchen (FX1)	Fixed	E	1.45	1.8
	Kitchen (FX2)	Fixed	E	1.45	0.84
	Garage door 1	Solid core	N	2.4	0.9
	Garage door 2	Solid core	S	2.4	5.4

Internal Condition

5- The occupancy schedules, equipment and lighting profiles, thermostat setpoints, and operational assumptions adopted in the simulation are summarised in the table below.

	Heating and cooling schedules												OCCUPANCY						Lighting, cooking and appliance schedules					
	LIVING - Habitable rooms other than bedrooms							Bedrooms					Weekday occupancy in habitable rooms other than bedrooms		Weekend occupancy in habitable rooms other than bedrooms		BEDROOM		Lighting		Cooking		Appliances	
Ending hour	NCC	REF Weekday	SET PNT C/H	PROP Weekday	SET PNT C/H	Weekend REF & PROP	SET PNT C/H	NCC	REF Weekday & weekend	SET PNT C/H	PROP Weekday & weekend	SET PNT C/H	NCC	REF & Prop	NCC	REF & Prop	NCC	REF & Prop	NCC	REF & PROP	NCC	REF & PROP	NCC	REF & PROP
1:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	45%	45%
2:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	40%	40%
3:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	40%	40%
4:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	40%	40%
5:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	40%	40%
6:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	40%	40%
7:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	30%	30%	30%	30%	50%	50%	10%	10%	5%	35.0%	50%	50%
8:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	30%	30%	30%	30%	50%	50%	10%	10%	10%	70.0%	70%	70%
9:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	100%	100%	30%	30%	50%	50%	5%	5%	10%	70.0%	55%	55%
10:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	100%	0%	100%	100%	0%	0%	0%	0%	15%	0%	50%	50%
11:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	100%	100%	0%	0%	0%	0%	15%	0%	50%	50%
12:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	100%	100%	0%	0%	0%	0%	15%	0%	50%	50%
13:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	100%	100%	0%	0%	0%	0%	20%	0%	50%	50%
14:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	50%	50%	0%	0%	0%	0%	20%	0%	50%	50%
15:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	50%	50%	0%	0%	0%	0%	20%	0%	50%	50%
16:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	50%	0%	50%	50%	0%	0%	0%	0%	20%	0%	50%	50%
17:00	ON	OFF	na	SOLAR Pre H/C	18/27	ON	23/20C	OFF	OFF	na	SOLAR Pre H/C	18/27	100%	0%	50%	50%	0%	0%	0%	0%	25%	0%	75%	75%
18:00	ON	ON	23/20C	ON	23/20	ON	23/20C	OFF	ON	23/20C	ON	23/20	100%	100%	50%	50%	0%	0%	20%	20%	40%	40%	95%	95%
19:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	100%	100%	100%	100%	50%	50%	30%	30%	80%	80%	80%	80%
20:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	100%	100%	100%	100%	50%	50%	35%	35%	80%	80%	70%	70%
21:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	100%	100%	100%	100%	50%	50%	30%	30%	40%	40%	70%	70%
22:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	30%	30%	100%	100%	100%	100%	25%	25%	20%	20%	65%	65%
23:00	ON	ON	23/20C	ON	23/20	ON	23/20C	ON	ON	23/20C	ON	23/20	30%	30%	30%	30%	100%	100%	15%	15%	10%	10%	55%	55%
0:00	OFF	OFF	na	OFF	na	OFF	na	ON	ON	na	ON	na	0%	0%	0%	0%	100%	100%	0%	0%	5%	5%	55%	55%

6- Internal heat gains from occupants, lighting, and appliances have been modelled in accordance with the requirements and default assumptions specified in NCC 2022 Volume Two, Part H6V2.

AC system

7- Space heating and cooling are provided by a reverse-cycle air-conditioning system with a total nominal capacity of 16 kW.

8- For modelling purposes, the system capacity is assumed to be evenly distributed between the building zones, with:
   a. 60% of the total capacity is allocated to living areas; and
   b. 40% of the total capacity is allocated to bedroom areas.

9- The air-conditioning system performance is assumed to remain constant throughout the year, with:
   a. Heating Coefficient of Performance (COP): 3.2
   b. Cooling Energy Efficiency Ratio (EER): 3.2.

Solar System

10- The following photovoltaic (PV) system has been incorporated into the energy models for this case study:

Parameter	*Modelling Parameters*		
	Base Case	*Scenarios 1 and 2*	*Scenario 3*
PV rated output at STC (We)	**325 W**	**330 W**	**400 W**
PV DC conversion efficiency [STC full-load]	**19.6%**	**17.0 %**	**19.9 %**
Total PV array area (m^2)	**66.4 (40 Modules)**	**38.8 (20 Modules)**	**40.2 (20 Modules)**
System integration	**2 Subarrays, each 2x10 modules**	**2 Subarrays, each 1x10 modules**	**2 Subarrays, each 2x5 modules**
Total Solar PV DC capacity	**13.0 kWdc**	**6.6 kWdc**	**8.0 kWdc**
Inverter rating	**10.0 kWac**	**5.5 kWac**	**6.6 kWac**
Inverter efficiency at full-load (CEC weighted)	**97.1 %**	**96.7 %**	**97.3 %**
Orientation	**North**		
Battery	**-**		
PV array inclination angle (°)	**15 degrees**		
Losses	**Soiling loss: 5% Module mismatch: 2% Diodes and connections: 0.5% DC wiring: 2% AC wiring: 1%**		
Annual Solar PV production	**20,241 kWh**	**10,246 kWh**	**12,524 kWh**

5. Results and Discussion

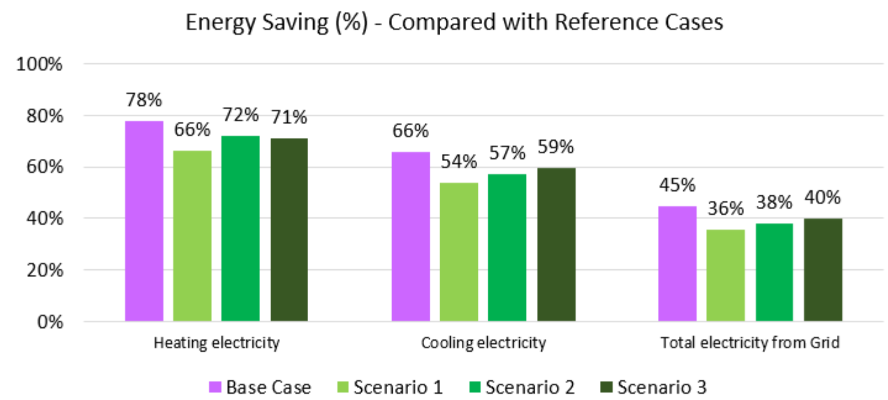
The following section compares the savings of each scenario with their corresponding Reference cases, with the same solar PV size and grid rates, but without the preconditioning control strategy.

5.1. Electricity Consumption

Electricity consumption for each scenario is shown in the following Figure:

Scenario	Description	Energy use (kWh) Heating electricity	Cooling electricity	Total electricity from Grid
Base Case	13.0kWdc / 10.0kWac solar PV system - no free grid electricity - with preconditioning	101	912	2724
Scenario 1	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - with preconditioning	155	1363	3416
Scenario 2	6.6kWdc / 5.5kWac solar PV system - free grid electricity @ 11 AM to 2 PM - with preconditioning	128	1268	3276
Scenario 3	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - with preconditioning	132	1161	3127

Compared with their corresponding Reference Cases, having the same solar PV size and electricity rates but without the preconditioning control strategy, the energy saving opportunities are shown below:



The results show that cooling is clearly the dominant load. It represents the largest portion of grid electricity consumption, so most of the practical benefit of preconditioning comes from reducing cooling electricity during occupied hours.

The results also show that the Base Case achieves the lowest absolute grid electricity consumption, with total grid electricity use of **2,724 kWh**. This is expected, as it includes the largest solar PV system, rated at **13.0 kWdc / 10.0 kWac**. However, when savings are assessed relative to each case's corresponding Reference Case, which has the same PV capacity but no preconditioning, the Base Case provides only an **additional 5% energy saving** compared with Scenario 1, despite having almost twice the PV capacity. This indicates that increasing PV capacity provides only a modest additional benefit, particularly for cooling in a hot climate such as Springfield, while the primary energy-saving benefit is driven by the preconditioning control strategy.

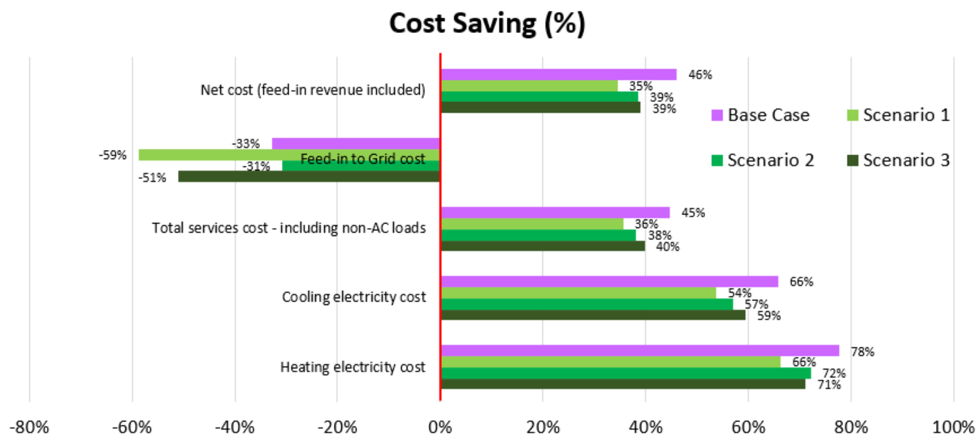
Scenario 2 reduces total grid electricity to **3,276 kWh**, which is a **38%** reduction compared with its corresponding Reference Case. Compared with Scenario 1, the free electricity period improves the result by reducing total grid electricity by a further **140 kWh per year**. This shows that the 11 AM to 2 PM free electricity window aligns well with the preconditioning period. However, the improvement is moderate rather than dramatic because the 6.6 kWdc PV system is already supplying part of the daytime preconditioning load.

5.2. Cost Saving

Cost-saving opportunities for each scenario are shown in the following Table:

		Running cost ($)				
Scenario	Description	Heating electricity cost	Cooling electricity cost	Total services cost - including non-AC loads	Feed-in to Grid revenue ($)	Net cost (feed-in revenue included)
Base Case	13.0kWdc / 10.0kWac solar PV system - no free grid electricity - with preconditioning	36	321	960	120	**840**
Scenario 1	6.6kWdc / 5.5kWac solar PV system - no free grid electricity - with preconditioning	55	480	1204	34	**1170**
Scenario 2	6.6kWdc / 5.5kWac solar PV system - free grid electricity @ 11 AM to 2 PM - with preconditioning	45	447	1155	60	**1095**
Scenario 3	8.0kWdc / 6.6kWac solar PV system - no free grid electricity - with preconditioning	47	409	1102	51	**1051**

Compared with their corresponding Reference Cases, with the same solar PV size and electricity rates but without the preconditioning control strategy, the cost saving opportunities are shown below:



The net cost saving for each scenario includes:

- Base Scenario vs Reference: **$719/year**
  This represents a **46%** reduction in net annual electricity cost. Compared with Scenario 1, which has almost half the solar PV capacity, the Base Case achieves an additional cost saving of **$330 per year** ($1,170 – $840). However, this additional saving should be considered in the context of the extra **6.4 kWdc / 4.5 kWac** of solar PV capacity installed in the Base Case, as the incremental financial benefit may not fully justify the additional system size.

- Scenario 1 vs Reference: **$617/year**
  This shows that by implementing the preconditioning control strategy and installing a moderate 6.6 kWdc/5.5 kWac solar PV, the household can achieve a **35%** reduction in net annual electricity cost.

- Scenario 2: **$687/year**
  This represents a **39%** reduction in net annual electricity cost. Compared with Scenario 1, Scenario 2 saves an additional **$75/year**. This confirms that the free grid electricity period provides additional value when it overlaps with the preconditioning operation. However, the improvement is not as large as the main preconditioning benefit itself.

- Scenario 3: **$675/year**
  Compared with the relative savings achieved in Scenario 2, the results show that when a free electricity rate is applied, the cost benefit of installing an **additional 1.4 kWdc / 1.1 kWac** of solar PV capacity is reduced. This indicates that the incremental financial value of increasing PV capacity diminishes when free grid electricity during unoccupied hours is available.

6. Conclusion

This case study demonstrates that using an alternative solar PV system scenario and a 16 kW AC system to precondition an NCC 2022-compliant house in Springfield, Queensland, can substantially reduce air-conditioning electricity consumption and operating cost. By preheating the dwelling in winter and precooling it in summer during unoccupied solar-available hours, the house effectively stores renewable energy as thermal energy within the building fabric and indoor environment.

The key findings of this energy assessment are summarised below:

- Solar-assisted thermal preconditioning is an effective demand-side management strategy for residential buildings. The combination of a high-performance building envelope, contact with the ground, rooftop photovoltaic (PV) generation, and intelligent HVAC control can deliver substantial reductions in energy consumption and operating costs.

- Solar-responsive preconditioning improves building resilience and energy self-sufficiency by increasing the utilisation of onsite renewable energy and reducing dependence on grid-supplied electricity.

- The preconditioning control strategy was effective across all scenarios, reducing total grid electricity consumption by approximately **40%** to **45%**. This demonstrates that solar-assisted preconditioning can significantly shift HVAC demand away from paid grid electricity during occupied periods.

- When no free grid electricity is available, the additional **1.4 kWdc / 1.1 kWac** of PV capacity provides a net benefit of **4%** reduction in electricity consumption. However, this benefit is significantly reduced to almost half when zero-cost grid electricity is available from 11 AM to 2 PM.

- Compared with Scenario 1, which has almost half the solar PV capacity, the Base Case achieves an additional cost saving of **$330 per year**. However, this additional saving should be considered in the context of the extra 6.4 kWdc / 4.5 kWac of solar PV capacity installed in the Base Case, as the incremental financial benefit may not fully justify the additional system size.

- In cooling-dominant regions such as Springfield, Queensland, aligning the preconditioning control strategy with periods of available solar generation can significantly reduce reliance on grid electricity and improve the operational resilience of the dwelling.

- The results indicate that the preconditioning control strategy is more influential than PV system size. The key benefit comes from using intelligent HVAC control to shift heating and cooling demand into periods when solar electricity is available, rather than exporting the generated electricity to the grid.

Regards,

Dr. Kevin (Amir) Kivi
Energy Consultant
HERA Membership Number: HERA10402
Energy Compliance Consultants Pty Ltd

6.1. Disclaimer & Legal Statement

1. Energy Compliance Consultants (Geoflow Australia Pty Ltd) will act in all professional matters as a faithful advisor to the client, whose interests will be regarded with all reasonable skill and care. Energy Compliance Consultants shall only be liable to the client for the consequences of a negligent act, omission or statement. Energy Compliance Consultants is not liable for errors in plans, specifications, documentation or other advice not prepared or designed by Energy Compliance Consultants. Notwithstanding anything to the contrary contained in this Agreement, the liability of Energy Compliance Consultants (Geoflow Australia Pty Ltd) under or in connection with this report whether in contract or in tort, in negligence, for breach of statutory duty or otherwise (other than in respect of personal injury or death) will not exceed the total fees paid to Energy Compliance Consultants in association with the project.

2. This energy model provides a calculated estimate of the building's energy performance. The estimate is based on a simplified computational model of the building that doesn't, and cannot, fully represent the multitude of variables of the building's operations, such as the number of people in a space and the time of use of space. The basis of these criteria is to enable the comparison of the estimated annual energy consumption of the Proposed Building with the NCC Reference Building, to determine if the Proposed Building is capable of being relatively energy efficient. The energy model results therefore only represent one interpretation of the potential performance of the building under NCC-prescribed people and equipment schedules. No guarantee or warranty of the building's potential performance can be based on limited energy modelling results. In no case should these methods be used to predict future utility bills. Also note that the system sizes (capacities) used in this report assessment are for relative feasibility assessment only and the final system size can only be confirmed during the design stage.

3. The thermal properties described in this report are only centred on meeting the minimum energy efficiency requirements stated in the NCC.

4. The mention of any company, product or process in this Report does not constitute or imply endorsement by Energy Compliance Consultants.

5. This report has been provided based on the information that has been made available to Energy Compliance Consultants. Any variation to the design or construction of the development will deem this energy compliance report void unless the variations are assessed by Energy Compliance Consultants. Energy Compliance Consultants is not responsible for any loss or damage arising directly or indirectly from the use of this energy compliance report in circumstances where there has been a variation to the design or construction of the development which has not been assessed by Energy Compliance Consultants.

6. Thermal comfort of the occupants has not been analysed in this assessment.

APPENDICES

7. Appendix A – Definitions

Building Fabric: means the basic building structural elements and components of a building including the roof, ceilings, walls and floors.

Climate Zone: means an area defined in for specific locations, having energy efficiency provisions based on a range of similar climatic characteristics.

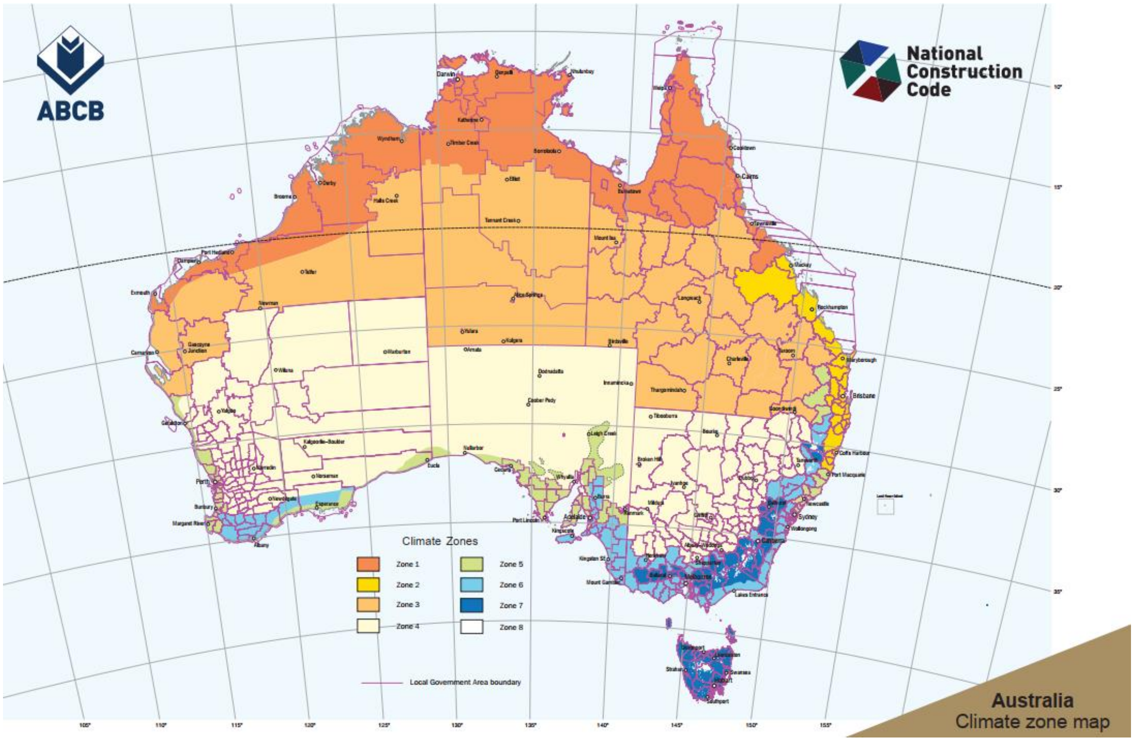


Figure 4: Australia climate zone map

Common Wall: means a wall that is common to adjoining buildings other than Class 1 buildings.

Conditioned space: for the purposes of Volume Two, means a space within a building that is heated or cooled by the building's domestic services, excluding a non-habitable room in which a heater with a capacity of not more than 1.2 kW or 4.3 MJ/hour is installed.

Cooling load: means the calculated amount of energy removed from the cooled spaces of the building annually by artificial means to maintain the desired temperatures in those spaces.

Deemed-to-Satisfy Provisions: means provisions which are deemed to satisfy the Performance Requirements.

Envelope: for the purpose of Part H6 in NCC Volume Two and Section 13 of the ABCB Housing Provisions, means the parts of a building's fabric that separate artificially heated or cooled spaces from—

a) the exterior of the building; or
b) Other spaces that are not artificially heated or cooled.

External wall: for the purposes of Volume Two, means an outer wall of a building that is not a separating wall.

Floor area: for the purposes of Volume Two, means in relation to a room, the area of the room measured within the finished surfaces of the walls, and includes the area occupied by any cupboard or other built-in furniture, fixture or fitting.

Glazing: for the purposes of Part H6 in NCC Volume Two and Part 13 in ABCB Housing Provisions, means a transparent or translucent element and its supporting frame located in the external fabric of the building, and includes a window other than a roof light.

Heating load: means the calculated amount of energy delivered to the heated spaces of the building annually by artificial means to maintain the desired temperatures in those spaces.

Performance Requirements: means a requirement that states the level of performance that a Performance Solution or Deemed-to-Satisfy Solution must meet.

R-Value: means the thermal resistance (m2.K/W) of a component calculated by dividing its thickness by its thermal conductivity.

Solar Heat Gain Coefficient (SHGC): means the fraction of incident irradiance on glazing or a roof light that adds heat to a building's space.

U-Value: means the thermal transmittance (W/m2.K) of the composite element allowing for the effect of any airspaces and associated surface resistances.

8. Appendix B – Assessor's Qualification

This energy report has been undertaken by Dr Kevin (Amir) Kivi, energy assessor from Energy Compliance Consultants. Kevin has 12 years of experience and has carried out numerous energy and ESD analyses for commercial and residential developments across Australia. In the following a summary of Kevin's qualifications is presented:

EDUCATION

- 2021-2023: Green Star Accredited Professional (GSAP)
- 2011- 2015: PhD in Geothermal energy systems, Infrastructural Engineering Department, University of Melbourne, Australia.
- 2016-2026: ABSA-accredited Energy Assessor
- 2016: Certificate 4 in NatHERS (6-star building energy assessment)
- 2013: Accredited Geothermal designer and installer from IGSHPA
- 2007- 2010: M.Sc. in Civil Engineering, Sharif University of Technology, Tehran, Iran.
- 2003- 2007: B.Sc. in Civil Engineering, IKIU, Iran.
- Certificate 4 in Building and Construction

ROLE

- ESD lead and responsible for energy modelling tasks at Energy Compliance Consultants - a Melbourne-based sustainable energy consultancy specializing in energy efficiency. The business provides a range of services that all require energy assessment, from ESD, JV3, Section J, energy rating, and design of geothermal, direct solar heating, and indoor farming energy solutions to sitting on the Advisory Panel to the Clean Energy Regulator.

SOFTWARE USED

- Energy Modelling: DesignBuilder, TRNSYS, TRNBuild, FirstRate5, Carrier HAP, LEAD, LBNL WINDOW
- Other: STORM, NREL System Advisor Model, AutoCAD, etc.

9. Appendix C – Simulation Software

The building has been modelled using DesignBuilder modelling software. With residential buildings, DesignBuilder complies with all the requirements in NCC Volume 2 Part H6 for residential buildings. For commercial buildings, it complies with the ABCB Protocol for Building Energy Analysis Software (Version 2006.1). Referring to Clause 3 of the ABCB protocol for building energy analysis software; DesignBuilder software:

- Is commercially available in Australia;
- Is based on a simulation program with hourly climate data files;
- Is capable of computing the annual energy consumption of a building under the Verification methods of the BCA/NCC;
- Is capable of geometrically describing the building in three dimensions including taking into account the surface azimuth, tilt angle and adjacent structures and features;
- Provides the results comparable to other similar software under ASHRAE Standard 140, Standard Method of Test for the Evaluation of Building Energy Analysis Computer programs using International Energy Agency BESTEST,
- Satisfies all the specific capabilities in Clause 4 of ABCB protocol for building energy analysis software.
- Has a calculation method that complies with ANSI/ASHRAE Standard 140 and is capable of assessing the heating load and cooling load by modelling:
  - (i) The building fabric; and
  - (ii) Glazing and shading; and
  - (iii) Air infiltration and ventilation; and
  - (iv) the function and use of the building including zoning, hours of occupation, hours of heating and cooling availability and internal heat gains; and
  - (v) Relevant built-environment and topographical features; and
  - (vi) The sensible heat component of the cooling load and heating load.
- Can employ climatic data in the calculation that is based on hourly recorded values and is representative of a typical year for the proposed location.

For more information about DesignBuilder ASHRAE Standard 140-2017 compliance, please refer to: https://designbuilder.co.uk/download/documents, info@designbuilder.com.au