green star™

green building council australia

GREEN STAR MULTI UNIT RESIDENTIAL ENERGY CALCULATOR GUIDE

EXECUTIVE SUMMARY

The Green Star – Multi Unit Residential Energy Calculator has been developed to predict the performance of multi-unit residential buildings based on the total greenhouse gas emissions per person. The calculator compares the predicted greenhouse gas emissions to a set benchmark. Points are then awarded for a percentage reduction in greenhouse gas emissions compared to the benchmark.

To use the calculator, the predicted energy consumption of the building is calculated. Important components such as heating and cooling loads can be determined by using the NatHERS score or by computer modeling. For NSW buildings, the BASIX score can be used as an option to score Green Star points in lieu of the calculator.

The predicted ancillary load energy consumption, such as that from lighting, mechanical ventilation and lifts, must also be calculated. This guide includes details on how to calculate these loads in such a way that they can be fairly compared to the set benchmark.

Finally, this guide includes information on how to enter the simulation outputs and the ancillary load calculations into the Green Star – Multi Unit Residential Energy Calculator. The calculator compares the performance of the facility relative to the benchmarks. The Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology report provides further information on how these benchmarks were determined.

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1. INTRODUCTION

The Green Building Council of Australia (GBCA) has developed a suite of rating tools to assess the environmental performance of buildings in Australia. As part of the Green Star – Multi Unit Residential rating tool, the Green Star – Multi Unit Residential Energy Calculator assesses the environmental performance of residential buildings with multiple dwellings by measuring their environmental impact.

Part of this assessment of environmental performance includes determining the predicted energy consumption of the multi-unit residential building. The Green Star – Multi Unit Residential Energy Calculator has been developed to compare this to a benchmark. More information on how the benchmarks were set can be found in the Green Star – Multi Unit Residential Calculator Benchmarking Methodology report.

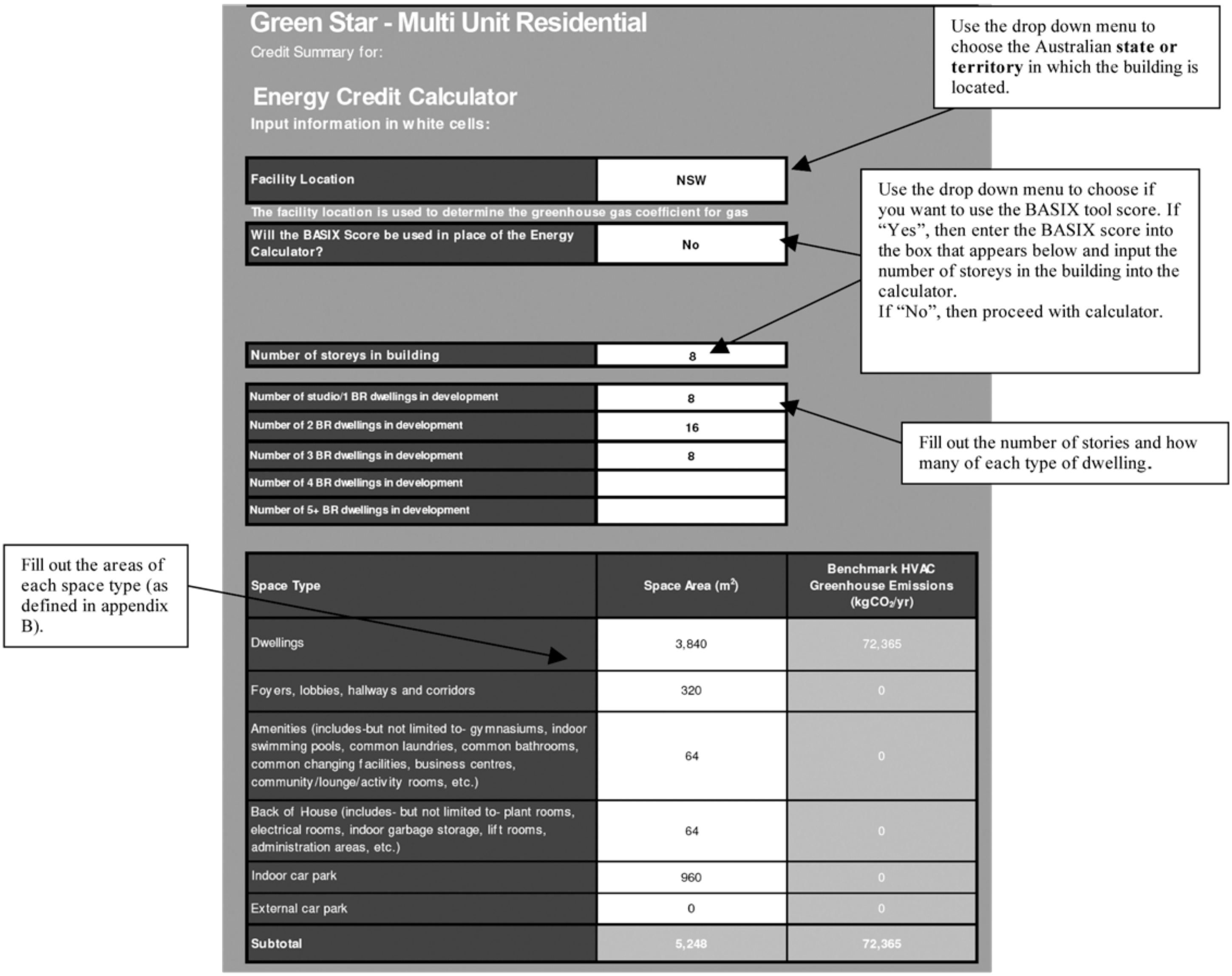
The building can be simulated using computer modelling software in order to determine the predicted energy consumption of its Heating, Ventilation and Cooling (HVAC) system. In place of this, NatHERS second generation heating and cooling loads can be used for dwellings. In addition, the predicted energy consumption of the ancillary loads in the building must be calculated.

The BASIX tool score for NSW buildings can be input into the Green Star – Multi Unit Residential Energy Calculator as a substitute to filling out the rest of the calculator to determine the Green Star points awarded.

This report has been written as a guide to the required Green Star – Multi Unit Residential, and how they should be entered into the Energy Calculator for comparison.

2. GUIDELINES FOR SIMULATION OUTPUTS

Figure 1 shows how to enter the simulation outputs into the Green Star – Multi Unit Residential Energy Calculator. Information should be entered into the white cells.



Green Star - Multi Unit Residential

Credit Summary for:

Energy Credit Calculator

Input information in white cells:

Facility Location	NSW

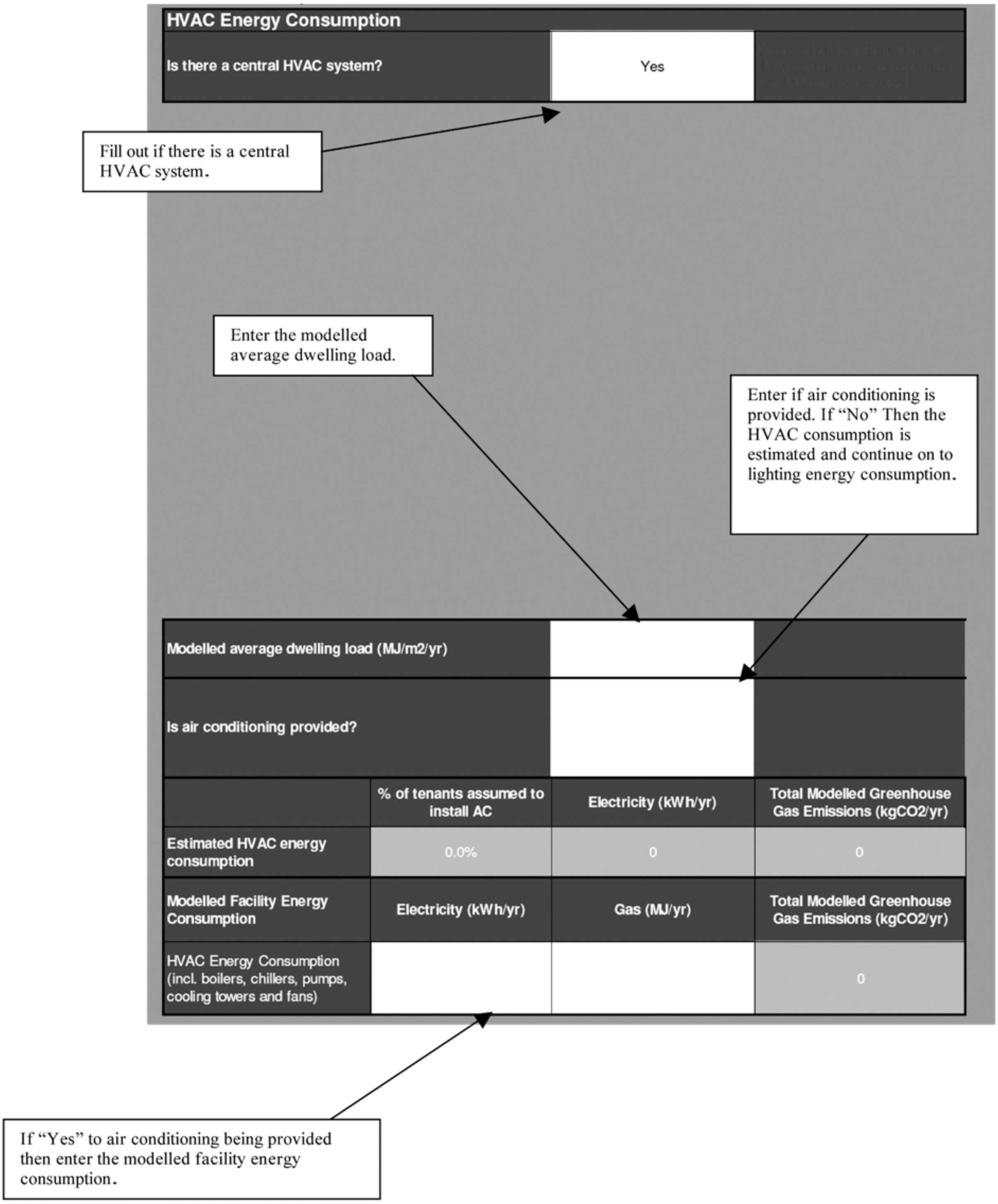
The facility location is used to determine the greenhouse gas coefficient for gas

Will the BASIX Score be used in place of the Energy Calculator?	No
Number of storeys in building	8
Number of studio/1 BR dwellings in development	8
Number of 2 BR dwellings in development	16
Number of 3 BR dwellings in development	8
Number of 4 BR dwellings in development	
Number of 5+ BR dwellings in development	

Space Type	Space Area (m²)	Benchmark HVAC Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	3,840	72,365
Foyers, lobbies, hallways and corridors	320	0
Amenities (includes-but not limited to- gymnasiums, indoor swimming pools, common laundries, common bathrooms, common changing facilities, business centres, community/lounge/activity rooms, etc.)	64	0
Back of House (includes- but not limited to- plant rooms, electrical rooms, indoor garbage storage, lift rooms, administration areas, etc.)	64	0
Indoor car park	960	0
External car park	0	0
Subtotal	5,248	72,365

Continue to HVAC Energy Consumption >

Figure 2: If there is a central HVAC system:



Continue to HVAC Energy Consumption >

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Figure 3: Screen shot of the Energy Calculator

Lighting Energy Consumption			
Space type	Total Calculated Energy Consumption (kWh/yr)	Calculated Greenhouse Gas Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	31,059	29,195	30,171
Foyers, lobbies, hallways and corridors	2,803	2,635	2,723
Amenities	2,243	2,108	2,179
Back of House	1,121	1,054	1,089
Car park	12,614	11,857	12,253
External lighting	0	0	0
Lighting Subtotal	49,840	46,850	48,415

Enter the lighting energy consumption as calculated using section 4 of this guide.

Extras	Total Calculated Energy Consumption	Modelled Greenhouse Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwelling Exhaust Systems	5,840	5,490	5,673
Back of House & Amenities Mechanical Ventilation	0	0	0
Car Park Ventilation	40,640	38,202	39,477
Lifts	32,850	30,879	31,910
Escalators and Travelators	0	0	0
Domestic Hot Water (GAS) (enter value as MJ/yr)	292,202	18,669	17,392
Domestic Hot Water (ELECTRIC) (Enter value as kWh/yr)		0	0
Pool	0	0	0
Sauna	0	0	0
Spa	0	0	0
Subtotal	371,532	93,239	94,452

Enter all the energy consumption by "extras" (using section 4). Note that Domestic hot water can be serviced by electricity, gas or both by entering the respective amounts energy consumed.

Energy Generation	Total Calculated Energy Generation (kWh/yr)	Total Greenhouse Emissions Avoided ($kgCO_2/yr$)
Renewable Energy (incl. photovoltaics, geothermal and wind, but not solar hot water)	0	0
Onsite Generation (incl. electricity from a co-generation system)	0	0

Enter the energy generation from renewable energy (except for solar hot water) and onsite generation (such as co-generation).

Total Benchmark Emissions ($kgCO_2/yr$)	215,232
Total Benchmark Emissions ($kgCO_2/pers$)	2,242
Actual Facility Emissions ($kgCO_2/yr$)	152,854
Actual Facility Emissions ($kgCO_2/pers/yr$	1,592
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility ($kgCO_2/yr$))	29.0%

Shows the percentage reduction in emissions of the building compared with the benchmark.

Shows the points awarded for the design.

Figure 4: If there is no central HVAC system
(air conditioning is only provided individually to dwellings):

Enter if NatHERS methodology is being used.
If "Yes enter NatHERS score.
If "NO" the average building load must be modelled as per section 3.

HVAC Energy Consumption			
Is there a central HVAC system?		No	
Will NatHERS second generation (Five Star, AccuRate, FirstRate 5, BERS Professional) heating and cooling loads be used?		Yes	
Enter the average load of the building dwellings (MJ/m2/yr)		35	
Is air conditioning provided?		Yes	
Percent of dwellings with air conditioning		100.0%	
Coefficient of Performance (COP) of AC system		3.3	
	% of tenants with AC	Electricity (kWh/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
NatHERS dwelling HVAC energy consumption	100.0%	13,580	12,765
Modelled Non-Dwelling Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
HVAC Energy Consumption (incl. boilers, chillers, pumps, cooling towers and fans)	0	0	0

If "Yes" to NatHERS methodology being used enter the NatHERS score in the average load of building dwellings in MJ/m²/yr (defined in section 3).

Enter if AC is provided. If "No" proceed to enter the Modelled non-dwelling energy consumption.

IF "YES" Enter the Co-efficient of Performance (COP) and percentage of dwellings using air-conditioning.

IF "No" to NatHERS methodology being used, enter the modelled average load of building dwellings in MJ/m²/yr in accordance with section 3.

Enter if air conditioning is provided. If "No" Then the HVAC consumption is estimated and continue on to lighting energy consumption.

Modelled average dwelling load (MJ/m2/yr)			
Is air conditioning provided?			
	% of tenants assumed to install AC	Electricity (kWh/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
Estimated HVAC energy consumption	0.0%	0	0
Modelled Facility Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
HVAC Energy Consumption (incl. boilers, chillers, pumps, cooling towers and fans)			0

If "Yes" to air conditioning being provided then enter the modelled facility HVAC energy consumption.

Continue to Lighting Energy Consumption

3. GUIDELINES FOR SIMULATION INPUT PARAMETERS

This section outlines the parametres used to simulate the HVAC energy consumption of a residential building. These are standard criteria that must be adhered to in ordered to comply with the Green Star energy credit requirements. The outputs from this simulation will then be entered in the calculator, as outlined in Section 2. Each typical dwelling must be assessed, as well as any common area which contains HVAC.
The average dwelling load is based on an area weighted average of typical dwellings.

If the BASIX tool is used, then only the BASIX score needs to be entered to be awarded the points and no other sections of the calculator need to be filled out. Second Generation NatHERS heating and cooling loads can be used as an alternative to the modelled heating and cooling loads for dwellings.

3.1 NatHERS Methodology

Table 1: NatHERS parameters table

Modelling Parameter	Requirements	Documentation
NatHERS	• Demonstrate the average heating and cooling loads.	Verification Documents: • NatHERS Certificate.
HVAC Performance	• Demonstrate the co-efficient performance of HVAC system. Give a brief description of the system.	Verification Documents: • Relevant pages of the HVAC Specification.

3.2 General HVAC modelling parameters

Table 2: Building envelope parameters

Simulation Package	• Passed the BESTEST validation test; or • The European Union draft standard EN13791 July 2000; or • Be certified in accordance with ANSI/ASHRAE Standard 140-2001. Please contact the Green Building Council of Australia if none of the above options can be complied with.	Energy Report: • Simulation brief for assessor (see Appendix A).
Weather Data	• A Test Reference Year (TRY) if the building location is within 50km of a TRY location; or • In the absence of local TRY weather data, an actual year of recorded weather data from a location within 50km of the building location; or • In the absence of TRY or actual weather data within 50km, interpolated data based upon 3 points within 250km of the building location. Please contact the Green Building Council of Australia if none of the above options can be complied with.	Energy Report: • Type of data (TRY / year / interpolated). • Weather station location.
Over shadowing	• Demonstrate that overshadowing from the surrounding environment has been taken into account in the model.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how overshadowing from the external environment has been represented in the model.

[1] The International Energy Agency, working with the U.S. National Renewable Energy Lab, has created a benchmark for building energy simulation programs. This benchmark is entitled "BESTEST – International Energy Agency Building Energy Simulation Test and Diagnostic Method".

Table 2: Building envelope parameters (continued)

Building Form	• Demonstrate that the simulation model is an accurate representation of the building's shape; • Demonstrate that all floors in the building are modelled; and • Show that there are limited simplifications to the building form.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how the building's physical shape has been represented in the model. • Details of any simplifications in the model and their effect.
Insulation	• Demonstrate that insulation in the walls, ceiling and floors has been accurately represented.	Verification Documents: • Relevant architectural drawings. • Materials schedule. Energy Report: • Details on how the insulation has been represented in the model.
Glazing	• Demonstrate that glazing is modelled using the following parameters: - Visible light transmission; - Solar transmission; - Internal and external solar reflectance; and - Emissivity.	Verification Documents: • Relevant pages from the glazing or façade specification. Energy Report: • Details of how glazing has been modelled.
Windows and Spandrel	• Demonstrate that the sizes of windows and spandrel are accurately represented.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of the window and spandel sizes that have been used in the model.
Shading	• Demonstrate that all shading of windows and external building fabric has been accurately represented.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how window shading and external building fabric are represented in the model.
Orientation	• Demonstrate that the building orientation has been included in the model.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how the orientation has been represented in the model.
Infiltration	• Demonstrate that infiltration has been modelled to reflect façade design specification. Typical default values are 0.5 air changes per hour for perimeter zones and zero air changes per hour for central zones.	Verification Documents: • Relevant architectural drawings. • Relevant pages from the façade specification that show infiltration or façade sealing characteristics. Energy Report: • Details of how infiltration has been modelled.

3.2 HVAC Internal Loads

Table 3: Internal loads parameters

Modelling Parameter	Requirements	Documentation
Lighting	• Demonstrate that lighting is calculated based on space type. • Demonstrate that the appropriate HVAC Model Operational Profile (see Appendix C) has been used in the HVAC Model.	Verification Documents: • Area schedule. • Reflected ceiling plans with base building lighting design. • Relevant pages from electrical specification showing occupancy sensors (if any), time clock (if any), lights and light fittings. Energy Report: • Details of space type areas using the definitions in Appendix B. • Details of how the lighting power densities have been modelled. • Details of how the operational profiles for the building have been modelled.
Equipment	• Demonstrate that all equipment loads is calculated based on space type. • Demonstrate that the equipment loads are modelled using the operational profiles as prescribed in Appendix C.	Verification Documents: • Area schedule. Energy Report: • Details of space type areas using the definitions in Appendix B. • Details of how the equipment load densities have been calculated. • Details of how the operational profiles have been modelled.
Occupancy	• Demonstrate that all occupancies are calculated based bedroom quantities. • Demonstrate that the occupancy profile used is that prescribed for each space type in Appendices C.	Verification Documents: • Bedroom schedule. Energy Report: • Details of space type areas using the definitions in Appendix B. • Details on how the occupancy loads have been modelled. • Details on the profiles used for occupancy.

Table 4: A/C pumping parameters

Modelling Parameter	Requirements	Documentation
Chilled water	• If central chiller water is supplied, demonstrate that chilled water pumping is calculated using the building cooling load, the static pressure of the chilled water pumps (typically 250kPa) and the flow rate in L/s.	Verification Documents: • Relevant pages from the hydraulic and mechanical specifications showing chilled water pump data – static pressure and flow rate in L/s. Energy Report: • Calculation of chilled water pumping.
Heating hot water	• If central heating hot water is supplied, demonstrate that the hot water pumping is calculated using the building heating load, the static pressure of the hot water pumps (typically 250kPa) and the flow rate in L/s.	Verification Documents: • Relevant pages from the hydraulic and mechanical specifications showing hot water pump data – static pressure and flow rate in L/s. Energy Report: • Calculation of hot water pumping.

3.4 HVAC System Simulations

Table 5: HVAC system simulation

Modelling Parameter	Requirements	Documentation
HVAC System design	• Demonstrate that the HVAC system modelled represents the system design for each part of the building.	Verification Documents: • Relevant pages from mechanical specification and mechanical drawings which accurately and thoroughly describe the basic HVAC system design. Energy Report: • Details of how the HVAC system has been represented in the model.
Zoning	• Demonstrate that all air conditioning zones represented in the thermal model accurately reflect system performance and zonal solar diversity.	Energy Report: • Details of how the air conditioning zones have been represented in the model, and how these zones accurately represent the mechanical design drawings and specification.
Chiller plant and/or AC units	• Demonstrate that the chiller plant size and for AC units are accurately reflected in the model. • Demonstrate that the actual efficiency curves of the installed equipment are used in the model. • Water cooled equipment: Demonstrate that data is specified under conditions that reflect the intended condenser water temperature controls. • Air cooled equipment: Demonstrate that the COP profiles have been accurately modelled with regard to loading and ambient conditions	Verification Documents: • Relevant pages from the mechanical specification showing the chiller plant size and any condenser water operation. • Documentation from chiller supplier giving part load curves (and condenser water temperatures where applicable). Energy Report: • Details of how the chiller plant size has been represented in the model. • Details of how the actual efficiency curves have been used in the model. • Details of how the chiller data is relevant to the intended condenser water temperature controls.
Boiler plant	• If there is a boiler plant, demonstrate that the boiler plant size, thermal efficiency and distribution efficiency are accurately reflected in the model.	Verification Documents: • Relevant pages from the mechanical specification which show details of the boiler plant size, thermal efficiency and distribution efficiency. Energy Report: • Details of how the boiler has been modelled.
Supply Air and Relief Fans	• Demonstrate that fan performance curves are accurately represented in the model. • Demonstrate that index run pressure drops are accurately represented to include the total static inclusive of filters, coils and diffusers.	Verification Documents: • Pages from the mechanical specification showing fan performance curves and fan size. Energy Report: • Details of how the index run pressure drops have been calculated. • Details of how these have been modelled.
Cooling Tower and Condenser Water Pumping	• If there are cooling towers, demonstrate that allowance for energy consumption from cooling tower and condenser water pumping has been made, based upon the annual cooling load of the building.	Energy Report: • Details of how the cooling tower and condenser water pumping have been modelled.

3.5 HVAC Controls

Table 6: HVAC Controls parameters

Modelling Parameter	Requirements	Documentation
Outside Air	• Demonstrate that outdoor air flows have been modelled as documented in the mechanical design drawings and specifications, and in compliance with the appropriate standards.	Verification Documents: • Relevant pages from mechanical specification giving details on the correct minimum outside air flow. Energy Report: • Detail of how outside air flow has been represented in the system.
Economy Cycle	• Demonstrate that economy cycles have been modelled to reflect system specification noting any enthalpy/temperature cut-off and control point.	Verification Documents: • Relevant pages from mechanical specification giving details on the economy cycle of the system. Energy Report: • Details of how the economy cycle has been modelled.
Primary duct temperature control	• Constant Volume Systems: Demonstrate that modelling has allowed supply air temperatures to vary to meet loads in the space. • Variable Volume Systems: Demonstrate that modelling has allowed supply air volumes to vary to meet loads in the space. • Demonstrate that set points have been rescheduled as specified. Note that simplifications may be made to consider average zone temperature in lieu of high/low select.	Verification Documents: • Relevant pages from mechanical specification giving details of the design temperature and HVAC cooling and heating set points. Energy Report: • Detail of how design temperatures and set points have been modelled.
Airflow Control	• Demonstrate that control logic describing the operation of the dampers to control outside and re-circulated airflow is inherent in the model and accurately reflects the airflow characteristics of the system.	Verification Documents: • Relevant pages from the mechanical specification giving details of the operation of the dampers to control outside and re-circulated air. Energy Report: • Details of how these have been represented in the model.
Minimum turndown	• Demonstrate, where relevant, that the minimum turndown airflow of each air supply is accurately reflected in the model.	Verification Documents: • Relevant pages from the mechanical specification giving details of the minimum turndown airflow of each air supply. Energy Report: • Details of how the minimum turndown is modelled for each air supply.
Chiller staging	• Demonstrate that for systems that employ multiple chillers with a chiller staging strategy, the correct controls are modelled to reflect the actual relationship between the chillers.	Verification Documents: • Relevant pages from the mechanical specification giving details of the chiller staging strategy. Energy Report: • Details of how chiller staging has been modelled.
Temperature control bands	• Demonstrate that the temperature control bands of the system accurately reflect the thermal model.	Verification Documents: • Relevant pages from the mechanical specification giving details of the design specification for the thermal model. Energy Report: • Details of how the temperature control bands have been modelled.

4. OTHER SERVICES

In addition to the building's air conditioning system, the following items must also be accounted for in the energy consumption assessment:

- Lighting;
- Mechanical exhaust;
- Lifts, escalators and travelators;
- Domestic hot water supply; and
- Pool, spa and sauna.

These items will be entered separately into the calculator. Domestic water pumping can be ignored. Any other normal or extraordinary energy item that would reasonably be considered significant in an energy model must also be included and the calculation or simulation methodology must be adequately adjusted. This shall include, but not be limited to, groundwater or water recycling treatment plants.

Table 7: Other services parameters

Modelling Parameter	Requirements	Documentation
Lighting	• Demonstrate that lighting is calculated based on floor area. • Demonstrate that the appropriate Lighting Energy Consumption Profile in Appendix D has been used. The lighting profile can be adjusted if the following are installed: • Occupancy sensors: Lighting must follow the appropriate lighting profile whenever the appropriate occupancy profile is greater than 0. • Time Clocks: If lighting operates on a time clock then common area lighting must follow the appropriate lighting profile when specified as "on" by the electrical specification. This must operate for no less time than described for the previous point. • Daylight dimming: Details on this system must be provided.	Verification Documents: • Area schedule. • Reflected ceiling plans with base building lighting design. • Relevant pages from electrical specification showing occupancy sensors (if any), time clock (if any), lights and light fittings. Energy Report: • Details of space type areas using the definitions in Appendix B. • Details of how the lighting power densities have been modelled. • Details of how the operational profiles for the building have been modelled. • Details of the lighting control systems and how they have been modelled.
Mechanical exhaust systems	• Demonstrate that the energy requirements for mechanical exhaust systems (such as those installed for toilets, kitchens and any other purpose specific systems such as car parks and amenities exhausts). Each exhaust system is calculated as operating for 0.5 hr/ day.	Verification Documents: • Relevant pages from the mechanical specification showing details of mechanical exhaust systems. Energy Report: • Details of how the energy requirements for mechanical exhaust systems are calculated.
Lift loads	• Lift loads are to be calculated using the method outlined in Appendix D.	Verification Documents: • Area schedule. • Specification of lift systems. Energy Report: • Details of how the lift energy requirement is calculated in accordance with Appendix D.
Escalator and travelator loads	• Escalator and travelator loads are to be calculated using the method outlined in Appendix D.	Verification Documents: • Area schedule. • Specification of escalator and travelator systems. Energy Report: • Details of how the escalator and travelator energy requirement is calculated.
Domestic hot water loads	• Domestic hot water loads (to showers and wash hand basins) are to be calculated using the method outlined in Appendix D. • Note that any other hot water supply (such as for laundries) is not to be included. • Note that the contribution from any solar hot water source is to be calculated and subtracted from the hot water energy consumption.	Verification Documents: • Area schedule. • Specification of domestic hot water systems. • Specification of solar hot water systems. Energy Report: Details of how the domestic hot water heating energy requirement is calculated in accordance with Appendix D.
Pools, Spa and Sauna's	• Demonstrate the energy requirements for pools, spas and sauna's	Verification Documents: • Specification of pool volume, heating system and cover. • Specification of spa volume, heating system and cover. • Specification of sauna volume, heating system and ventilation system. Energy Report: • Details of how the energy requirements for the pool, spa and sauna were calculated.

5. CASE STUDY

5.1 Two Storey Building

This case study illustrates how a two storey building can achieve one point. This building has two studio/1 bedroom apartments, and two 2 bedroom apartments giving a total of four dwellings in the building. These apartments 80m² and 120m² respectively as set by the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology Report). Foyers are 20m² per apartment and one car space per apartment is provided also as per the benchmark.

Firstly, the space type areas are calculated using the definitions in Appendix B.

Table 8: Two Storey Space Areas

Space Type	Space Area (m²)
Foyers, lobbies, hallways and corridors	400
Amenities	40
Back of House	0
Indoor car park	0
External car park	0
Dwellings	120

Next, the HVAC consumption of electricity and gas is calculated using Section 3 of this guide. NatHERS second generation heating and cooling loads were used in place of a central HVAC system with 100% of all dwellings having air-conditioning. There was no modelled non-dwelling HVAC energy consumption in this case study.

Table 9: Two Storey HVAC NatHERS inputs

Average load of building dwellings MJ/m²/yr	35
Coefficient of Performance (COP) of AC system	3.3

All lighting and extras energy consumption were calculated as specified in section 4 and also to meet the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology Report).

Table 10: Two Storey Lighting Energy Consumption

Space Type	Total Calculated Lighting Energy Consumption (kWh/yr)
Dwellings	3,236
Foyers, lobbies, hallways and corridors	350
Amenities	0
Back of House	0
Car park	0
External lighting	1,577

Table 11: Two Storey Extras Energy Consumption

Extras	Total Calculated Energy Consumption (kWh/yr)
Dwellings Exhaust Systems	730
Amenities, Back of House & Mechanical Ventilation	0
Car park Ventilation	0
Lifts	0
Domestic Hot Water GAS MJ/yr	30,441

Figure 5: Two storey residential calculator snap shot (right).

Green Star - Multi-unit Residential

Credit Summary for:

Energy Credit Calculator

Input information in white cells:

Facility Location	NSW
Will the BASIX Score be used in place of the Energy Calculator?	No
Number of storeys in building	2
Number of studio/1 BR dwellings in development	2
Number of 2 BR dwellings in development	2
Number of 3 BR dwellings in development	
Number of 4 BR dwellings in development	
Number of 5+ BR dwellings in development	

Space Type	Space Area (m^2)	Benchmark HVAC Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	400	8,769
Foyers, lobbies, hallways and corridors	40	0
Amenities (includes-but not limited to-gymnasiums, indoor swimming pools, common laundries, common bathrooms, common changing facilities, business centres, community/lounge/activity rooms, etc.)		0
Back of House (includes- but not limited to- plant rooms, electrical rooms, indoor garbage storage, lift rooms, administration areas, etc.)		0
Indoor car park		0
External car park	120	0
Subtotal	580	8,769

HVAC Energy Consumption

Is there a central HVAC system?	No
Will NatHERS second generation (Five Star, AccuRate, FirstRate 5, BERS Professional) heating and cooling loads be used?	Yes
Enter the average load of the building dwellings (MJ/m2/yr)	35
Is air conditioning provided?	Yes
Percent of dwellings with air conditioning	100.0%
Coefficient of Performance (COP) of AC system	3.3

	% of tenants with AC	Electricity (kWh/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
NatHERS dwelling HVAC energy consumption	100.0%	1,415	1,511

Modelled Non-Dwelling Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
HVAC Energy Consumption (incl. boilers, chillers, pumps, cooling towers and fans)			0

Lighting Energy Consumption

Space type	Total Calculated Energy Consumption (kWh/yr)	Calculated Greenhouse Gas Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	3,236	3,456	3,656
Foyers, lobbies, hallways and corridors	350	374	396
Amenities		0	0
Back of House		0	0
Car park		0	0
External lighting	1,577	1,684	1,782
Lighting Subtotal	5,163	5,514	5,833

Extras	Total Calculated Energy Consumption	Modelled Greenhouse Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwelling Exhaust Systems	730	780	825
Back of House & Amenities Mechanical Ventilation		0	0
Car Park Ventilation		0	0
Lifts		0	0
Escalators and Travelators		0	0
Domestic Hot Water (GAS) (enter value as MJ/yr)	30,441	2,170	1,988
Domestic Hot Water (ELECTRIC) (Enter value as kWh/yr)		0	0
Pool		0	0
Sauna		0	0
Spa		0	0
Subtotal	31,171	2,950	2,813

Energy Generation	Total Calculated Energy Generation (kWh/yr)	Total Greenhouse Emissions Avoided ($kgCO_2/yr$)
Renewable Energy (incl. photovoltaics, geothermal and wind, but not solar hot water)	0	0
Onsite Generation (incl. electricity from a co-generation system)	0	0

Total Benchmark Emissions ($kgCO_2/yr$)	17,415
Total Benchmark Emissions ($kgCO_2/pers$)	1,741
Actual Facility Emissions ($kgCO_2/yr$)	9,975
Actual Facility Emissions ($kgCO_2$/pers/yr	998
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility ($kgCO_2/yr$))	42.7%

No energy generation was used in this case study. The results of this case study were as follows:

Table 12: Two Storey Case Study Results

Total Benchmark Emissions (kgCO2/yr)	17,415
Total Benchmark Emissions (kgCO2/pers)	1,741
Actual Facility Emissions (kgCO2/yr)	9,975
Actual Facility Emissions (kgCO2/pers/yr)	998
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	42.7%
Number of Points Achieved	**1**

For an equivalent building, a BASIX score of 40% is required to achieve a comparative Green Star point.

This information is entered into the calculator as detailed in Figure 5.

5.2 Four Storey Building

This case study illustrates how a four storey building can achieve one point. This building has four studio/1 bedroom dwellings and four 2 bedroom dwellings and four 3 bedroom dwelling giving a total of 12 dwellings. These dwellings have an area of 80m², 120m², 160m² respectively as defined by the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology Report). Foyers, lobbies, hallways and corridors have been set at 10m² per dwelling as per the benchmark. However, only five car spaces are provided.

Firstly, the space type areas are calculated using the definitions in Appendix B.

Table 13: Four Storey Space Areas

Space Type	Space Area (m²)
Dwellings	1,440
Foyers, lobbies, hallways and corridors	120
Amenities	0
Back of House	30
Indoor car park	150
External car park	0

Next, the HVAC consumption of electricity and gas is calculated using Section 3 of this guide. NatHERS second generation heating and cooling loads were used in place of a central HVAC system with 100% of all dwellings having air-conditioning. There was no modelled non-dwelling HVAC energy consumption in this case study.

Table 14: Four Storey NatHERS inputs

Average load of building dwellings MJ/m²/yr	35
Coefficient of Performance (COP) of AC system	3.3

All lighting and extras energy consumption were calculated as specified in Section 4 to meet the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology report)

Table 15: Four Storey Lighting Energy Consumption

Space Type	Total Calculated Lighting Energy Consumption (kWh/yr)
Dwellings	11,647
Foyers, lobbies, hallways and corridors	1,051
Amenities	0
Back of House	526
Car park	1,971
External lighting	0

No energy generation was used in this case study. The results of this case study were as follows:

Table 17: Four Storey Case Study Results

Extras	Total Calculated Energy Consumption (kWh/yr)
Total Benchmark Emissions (kgCO2/yr)	74,229
Total Benchmark Emissions (kgCO2/pers)	2,062
Actual Facility Emissions (kgCO2/yr)	47,305
Actual Facility Emissions (kgCO2/pers/yr)	1,314
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	36.3%
Number of Points Achieved	**1**

For an equivalent building a BASIX score of 33% is required to achieve a comparative Green Star point.

This information is entered into the calculator as detailed in Figure 6.

Figure 6: Four storey residential calculator snap shot (right)

Green Star - Multi-unit Residential

Credit Summary for:

Energy Credit Calculator

Input information in white cells:

Facility Location	NSW
Will the BASIX Score be used in place of the Energy Calculator?	No

Number of storeys in building	4
Number of studio/1 BR dwellings in development	4
Number of 2 BR dwellings in development	4
Number of 3 BR dwellings in development	4
Number of 4 BR dwellings in development	
Number of 5+ BR dwellings in development	

Space Type	Space Area (m^2)	Benchmark HVAC Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	1,440	31,588
Foyers, lobbies, hallways and corridors	120	0
Amenities (includes but not limited to gymnasiums, indoor swimming pools, common laundries, common bathrooms, common charging facilities, business centres, community/lounge/activity rooms, etc.)		0
Back of House (includes but not limited to plant rooms, electrical rooms, indoor garbage storage, lift rooms, administration areas, etc.)	30	0
Indoor car park	150	0
External car park		0
Subtotal	1,740	31,588

HVAC Energy Consumption			
Is there a central HVAC system?		No	
Will NatHERS second generation (FiveStar, AccuRate, FirstRate 5, BERS Professional) heating and cooling loads be used?		Yes	
Enter the average load of the building dwellings (MJ/m2/yr)		35	
Is air conditioning provided?		Yes	
Percent of dwellings with air conditioning		100.0%	
Coefficient of Performance (COP) of AC system		3.3	
	% of tenants with AC	Electricity (kWh/yr)	Total Modelled Greenhouse Gas Emissions ($kgCO_2/yr$)
NatHERS dwelling HVAC energy consumption	100.0%	5,038	549
Modelled Non-Dwelling Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions ($kgCO_2/yr$)
HVAC Energy Consumption (incl. boilers, chillers, pumps, cooling towers and fans)			0

Lighting Energy Consumption

Space type	Total Calculated Energy Consumption (kWh/yr)	Calculated Greenhouse Gas Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwellings	11,647	12,439	13,161
Foyers, lobbies, hallways and corridors	1,051	1,122	1,188
Amenities		0	0
Back of House	526	562	0
Car park	1,971	2,105	2,227
External lighting		0	0
Lighting Subtotal	15,195	16,228	16,576

Extras	Total Calculated Energy Consumption	Modelled Greenhouse Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Dwelling Exhaust Systems	2,127	2,272	2,475
Back of House & Amenities Mechanical Ventilation		0	0
Car Park Ventilation	6,350	6,782	7,175
Lifts	8,213	8,771	9,280
Escalators and Travelators		0	0
Domestic Hot Water (GAS) (enter value as MJ/yr)	109,576	7,813	7,155
Domestic Hot Water (ELECTRIC) (Enter value as kWh/yr)		0	0
Pool		0	0
Sauna		0	0
Spa		0	0
Subtotal	126,266	25,638	26,085

Energy Generation	Total Calculated Energy Generation (kWh/yr)	Total Greenhouse Emissions Avoided ($kgCO_2/yr$)
Renewable Energy (incl. photovoltaics, geothermal and wind, but not solar hot water)	0	0
Onsite Generation (incl. electricity from a co-generation system)	0	0

Total Benchmark Emissions ($kgCO_2/yr$)	74,229
Total Benchmark Emissions ($kgCO_2/pers$)	2,062
Actual Facility Emissions ($kgCO_2/yr$)	47,305
Actual Facility Emissions ($kgCO_2/pers/yr$)	1,314
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility ($kgCO_2/yr$))	36.3%

Number of Points Achieved	1

5.3 Eight Storey Building

This case study illustrates how an eight storey building can achieve one point. This building has eight studio/1 bedroom, sixteen 2 bedroom and eight 3 bedroom dwellings giving a total of 32 dwellings in the building. Dwelling areas have been defined according to the number and type of dwellings as per the benchmark. All other space areas have been defined as per the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology Report).

Firstly, the space type areas are calculated using the definitions in Appendix B.

Table 18: Eight Storey Space Areas

Space Type	Space Area (m²)
Dwellings	3,840
Foyers, lobbies, hallways and corridors	320
Amenities	64
Back of House	64
Indoor car park	960
External car park	0

Next, the HVAC consumption of electricity and gas is calculated using Section 3 of this guide. NatHERS second generation heating and cooling loads were used in place of a central HVAC system with 100% of all dwellings having air-conditioning. There was no modelled non-dwelling HVAC energy consumption in this case study.

Table 19: Eight Storey NatHERS inputs

Average load of building dwellings MJ/m²/yr	35
Coefficient of Performance (COP) of AC system	3.3

All lighting and extras energy consumption were calculated as specified in Section 4 to meet the benchmark (see Green Star – Multi Unit Residential Energy Calculator Benchmarking Methodology)

Table 20: Eight Storey Lighting Energy Consumption

Space Type	Total Calculated Lighting Energy Consumption (kWh/yr)
Dwellings	31,059
Foyers, lobbies, hallways and corridors	2,803
Amenities	2,243
Back of House	1,121
Car park	16,614
External lighting	0

Table 21: Eight Storey Extras Energy Consumption

Extras	Total Calculated Energy Consumption (kWh/yr)
Dwellings Exhaust Systems	5,840
Amenities, Back of House & Mechanical Ventilation	0
Car park Ventilation	40,640
Lifts	32,850
Domestic Hot Water GAS MJ/yr	292,202

No energy generation was used in this case study.
The results of this case study were as follows:

Table 22: Eight Storey Case Study Results

Total Benchmark Emissions (kgCO2/yr)	249,224
Total Benchmark Emissions (kgCO2/pers)	2,596
Actual Facility Emissions (kgCO2/yr)	177,563
Actual Facility Emissions (kgCO2/pers/yr)	1,850
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	28.7%
Number of Points Achieved	**1**

For an equivalent building, a BASIX score of 30% is required to achieve a comparative Green Star point

This information is entered into the calculator as detailed in Figure 7.

Green Star - Multi-unit Residential

Credit Summary for:

Energy Credit Calculator

Input information in white cells:

Facility Location	NSW
Will the BASIX Score be used in place of the Energy Calculator?	No
Number of storeys in building	8
Number of studio/1 BR dwellings in development	8
Number of 2 BR dwellings in development	16
Number of 3 BR dwellings in development	8
Number of 4 BR dwellings in development	
Number of 5+ BR dwellings in development	

Space Type	Space Area (m²)	Benchmark HVAC Greenhouse Emissions (kgCO2/yr)
Dwellings	3,840	84,180
Foyers, lobbies, hallways and corridors	320	0
Amenities (includes but not limited to gymnasiums, indoor swimming pools, common laundries, common bathrooms, common changing facilities, business centres, community lounge/activity rooms, etc.)	64	0
Back of House (includes but not limited to plant rooms, electrical rooms, indoor garbage storage, lift rooms, administration areas, etc.)	64	0
Indoor car park	960	0
External car park		0
Subtotal	6,248	84,180

HVAC Energy Consumption			
Is there a central HVAC system?		No	
Will NatHERS second generation (Five Star, AccuRate, FirstRate 5, BERS Professional) heating and cooling loads be used?		Yes	
Enter the average load of the building dwellings (MJ/m2/yr)		35	
Is air conditioning provided?		Yes	
Percent of dwellings with air conditioning		100.0%	
Coefficient of Performance (COP) of AC system		3.3	
	% of tenants with AC	Electricity (kWh/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
NatHERS dwelling HVAC energy consumption	100.0%	13,580	14,503
Modelled Non-Dwelling Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
HVAC Energy Consumption (incl. boilers, chillers, pumps, cooling towers and fans)			0

Lighting Energy Consumption

Space type	Total Calculated Energy Consumption (kWh/yr)	Calculated Greenhouse Gas Emissions (kgCO2/yr)	Benchmark Greenhouse Emissions (kgCO2/yr)
Dwellings	31,059	33,171	35,097
Foyers, lobbies, hallways and corridors	2,803	2,994	3,167
Amenities	2,243	2,396	2,535
Back of House	1,121	1,197	1,267
Car park	16,614	17,744	14,254
External lighting		0	0
Lighting Subtotal	53,840	57,501	56,319

Extras	Total Calculated Energy Consumption	Modelled Greenhouse Emissions (kgCO2/yr)	Benchmark Greenhouse Emissions (kgCO2/yr)
Dwelling Exhaust Systems	5,840	6,237	6,599
Back of House & Amenities Mechanical Ventilation		0	0
Car Park Ventilation	40,640	43,404	45,923
Lifts	32,850	35,084	37,121
Escalators and Travelators		0	0
Domestic Hot Water (GAS) (enter value as MJ/yr)	292,202	20,834	19,081
Domestic Hot Water (ELECTRIC) (Enter value as kWh/yr)		0	0
Pool		0	0
Sauna		0	0
Spa		0	0
Subtotal	371,532	105,558	108,724

Energy Generation	Total Calculated Energy Generation (kWh/yr)	Total Greenhouse Emissions Avoided (kgCO2/yr)
Renewable Energy (incl. photovoltaics, geothermal and wind, but not solar hot water)	0	0
Onsite Generation (incl. electricity from a co-generation system)	0	0

Total Benchmark Emissions (kgCO2/yr)	249,224
Total Benchmark Emissions (kgCO2/pers)	2,596
Actual Facility Emissions (kgCO2/yr)	177,563
Actual Facility Emissions (kgCO2/pers/yr	1,850
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	28.7%
Number of Points Achieved	1

Figure 7: Eight storey residential calculator screen shot (right)

APPENDIX A
SIMULATION BRIEF FOR ASSESSORS

In order to assess the validity of the final results, it is critical that the assessor and the simulator understand the limitations of the simulation package which has been used. The simulator must provide the assessor with a briefing of the simulation package and model used which shows that the following requirements have been met:

- The simulation package has passed external validation standards such as BESTEST;
- The model analyses building performance on an hourly basis for a full year;
- The model accurately represents:

  - The proposed HVAC system;

  - The HVAC controls which are to be used;

  - Glazing on the building – whether the model represents glazing as only a U-value and shading coefficient;

  - The performance curves and sizes for plant items;

  - The day lighting effects and the operation of daylight controls; and

- All other aspects of the building have been modelled correctly, with no significant compromises made.

If these requirements are not met, then the reasons for this will need to be adequately justified.

2. The International Energy Agency, working with the U.S. National Renewable Energy Lab, has created a benchmark for building energy simulation programs. This benchmark is entitled "BESTEST – International Energy Agency Building Energy Simulation Test and Diagnostic Method".

APPENDIX B
SPACE TYPE DEFINITIONS

The following list provides for each space type used within the Green Star – Multi Unit Residential Energy Calculator.

- Dwellings – These spaces include areas for private individual residential use only i.e. the apartments themselves.
- Foyers, lobbies, hallways and corridors – These spaces include the foyers, lobbies, hallways and corridors within the residential building not part of private dwellings.
- Amenities – to include but not limited to , gymnasiums, indoor swimming pools, common laundries, common bathrooms, common changing facilities, business centres, community/lounge/activity rooms etc.
- Back of House – to include, but not limited to, plant rooms, electrical rooms, indoor garbage storage, lift rooms, administration area, etc.
- Car Parks – These spaces include areas specifically designated for car parking.

APPENDIX C
HVAC INTERNAL LOADS AND PROFILES

Living Spaces

The profile on this page is used to benchmark the model living space. The people load is determined by the total number of people assumed to be living in a 2 bedroom apartment. The benchmark occupancy for a 2 bedroom apartment is 3 people.

Figure 8: Living space profile

Living spaces including kitchens							
Time	Equipment (W)	Equip latent (W)	Lighting (W)	People Sensible (W)	People Latent (W)	Htg setpoint (°C)	Clg setpoint (°C)
midnight-1am	100	0	0	0	0	off	off
1am-2am	100	0	0	0	0	off	off
2am-3am	100	0	0	0	0	off	off
3am-4am	100	0	0	0	0	off	off
4am-5am	100	0	0	0	0	off	off
5am-6am	100	0	0	0	0	off	off
6am-7am	100	0	0	0	0	off	off
7am-8am	400	200	180	210	150	20	26.5
8am-9am	100	0	180	210	150	20	26.5
9am-10am	100	0	0	105	75	20	26.5
10am-11am	100	0	0	105	75	20	26.5
11am-noon	100	0	0	105	75	20	26.5
noon-1pm	100	0	0	105	75	20	26.5
1pm-2pm	100	0	0	105	75	20	26.5
2pm-3pm	100	0	0	105	75	20	26.5
3pm-4pm	100	0	0	105	75	20	26.5
4pm-5pm	100	0	0	105	75	20	26.5
5pm-6pm	100	0	300	210	150	20	26.5
6pm-7pm	1100	600	300	210	150	20	26.5
7pm-8pm	250	0	300	210	150	20	26.5
8pm-9pm	250	0	300	210	150	20	26.5
9pm-10pm	250	0	300	210	150	20	26.5
10pm-11pm	100	0	0	0	0	20	26.5
11pm-midnight	100	0	0	0	0	20	26.5

Bedrooms

The following profile is used for the first bedroom.
The people load accounts for 2 people in the first bedroom.

Figure 9: First Bedroom profile

First Bedroom					
Time	Lighting (W)	People Sensible (W)	People Latent (W)	Htg setpoint (°C)	Clg setpoint (°C)
midnight-1am	0	100	50	15	26.5
1am-2am	0	100	50	15	26.5
2am-3am	0	100	50	15	26.5
3am-4am	0	100	50	15	26.5
4am-5am	0	100	50	15	26.5
5am-6am	0	100	50	15	26.5
6am-7am	0	100	50	15	26.5
7am-8am	0	0	0	18	26.5
8am-9am	0	0	0	18	26.5
9am-10am	0	0	0	off	off
10am-11am	0	0	0	off	off
11am-noon	0	0	0	off	off
noon-1pm	0	0	0	off	off
1pm-2pm	0	0	0	off	off
2pm-3pm	0	0	0	off	off
3pm-4pm	0	0	0	off	off
4pm-5pm	0	0	0	18	26.5
5pm-6pm	0	0	0	18	26.5
6pm-7pm	0	0	0	18	26.5
7pm-8pm	100	0	0	18	26.5
8pm-9pm	100	0	0	18	26.5
9pm-10pm	100	0	0	18	26.5
10pm-11pm	100	100	50	18	26.5
11pm-midnight	0	100	50	18	26.5

This profile is to be used for each additional bedroom. The people load accounts for 1 person in each additional bedroom.

Figure 10: Additional bedrooms profile

Additional Bedrooms					
Time	Lighting (W)	People Sensible (W)	People Latent (W)	Htg setpoint (°C)	Clg setpoint (°C)
midnight-1am	0	50	25	15	26.5
1am-2am	0	50	25	15	26.5
2am-3am	0	50	25	15	26.5
3am-4am	0	50	25	15	26.5
4am-5am	0	50	25	15	26.5
5am-6am	0	50	25	15	26.5
6am-7am	0	50	25	15	26.5
7am-8am	0	0	0	18	26.5
8am-9am	0	0	0	18	26.5
9am-10am	0	0	0	off	off
10am-11am	0	0	0	off	off
11am-noon	0	0	0	off	off
noon-1pm	0	0	0	off	off
1pm-2pm	0	0	0	off	off
2pm-3pm	0	0	0	off	off
3pm-4pm	0	0	0	off	off
4pm-5pm	0	0	0	18	26.5
5pm-6pm	0	0	0	18	26.5
6pm-7pm	0	0	0	18	26.5
7pm-8pm	100	0	0	18	26.5
8pm-9pm	100	0	0	18	26.5
9pm-10pm	100	0	0	18	26.5
10pm-11pm	100	50	25	18	26.5
11pm-midnight	0	50	25	18	26.5

Aperture Schedules

If there are openable windows, the windows in the building are modelled as being open when the indoor space is above 20° C and are shut when indoor temperature exceeds 26.5° C. The air conditioning system is modelled as off when the windows are open and on when natural ventilation cannot maintain indoor temperatures (according to schedules and set points listed in the previous section).

APPENDIX D: OTHER ENERGY CONSUMPTION

1. Lighting Energy Consumption

1a. Lighting energy consumption for dwelling spaces

Lighting schedule for dwelling spaces.

Table 24:

Time	Artificial Lighting (%) Living Spaces	Artificial Lighting (%) Bedrooms
0000-0700	0	0
0700-0900	60	0
0900-1700	0	0
1700-1900	100	0
1900-2200	100	100
2200-2300	0	100
2200-2400	0	0

Protocol for calculating lighting energy use in dwelling spaces:

1. Calculate the lighting power of each space.
2. Calculate the daily energy use using the lighting schedules above adding together the energy lighting uses for living areas, the first bedrooms and any additional bedrooms within the entire building.
3. Multiply the total daily energy use by 365 days per year.

Example (olive sections to be filled in)

This example has two studio/1 bedroom dwellings, two 2 bedroom dwellings and two 3 bedroom dwellings giving a total of 6 living spaces and 12 bedrooms.

Table 25: Example for lighting energy use in dwellings

Living space daily energy kwh	Bedroom daily energy kwh	Operational days/year kwh	Yearly energy required kwh
12.96	4.8	365	6,482

1b. Lighting energy use in non-dwelling spaces

Table 26: Lighting schedule for non dwelling spaces

Space Type	Operational Hours/day	Operational Days/year
Foyers, hallways, corridors	8	365
Amenities	12	365
Back of House	8	365
Indoor car park	12	365
External Lighting	12	365

Protocol for calculating lighting energy use in non dwelling spaces:

1. Calculate the lighting density of the space type (as defined in appendix B).

2. Determine the operational hours of you space as per the lighting schedule in table 25.

3. Calculate the yearly energy usage.

Example (olive sections to be filled in)

Table 27: Example for lighting energy use in non-dwelling spaces

Lighting density W/m²	Operational hours/day	Operational days/year	Space area M²	Yearly energy required Kwh
3	8	365	60	525.6

2. Ventilation Energy Consumption

2a. Protocol for calculating ventilation energy use in dwellings, back of house and amenities:

1. Determine the ventilation power rating and number of exhaust systems in use in the building

2. Calculate the yearly energy requirement by multiplying the ventilation power rating by the number of exhaust systems by the operational hours per day, then by the operational days per year. Operational hours per day are:

   i) 0.5 Hours/day for dwellings (i.e. kitchen and bathroom exhausts).

   ii) For back of house and amenities evidence must be provided showing average hours of operation per day.

Example (limestone green sections to be filled in)

Table 28: Example for ventilation energy use in dwellings, back of house and amenities

Space type	Ventialtion power rating W	Number of exhaust systems	Operational hours/day	Operational days/year	Yearly energy required Kwh
Dwellings	500	32	0.5	365	2,920
Boh & amenties	500	10	5	365	9,125

2b. Ventilation energy consumption in car parks

Table 29: Car Park Ventilation Schedule

Space Type	Operational Hours/day	Operational Days/year
0	0%	100%
1	0%	100%
2	0%	100%
3	0%	100%
4	0%	100%
5	5%	100%
6	10%	100%
7	60%	100%
8	100%	100%
9	100%	100%
10	50%	100%
11	40%	100%
12	40%	100%
13	40%	100%
14	40%	100%
15	50%	100%
16	100%	100%
17	100%	100%
18	75%	100%
19	50%	100%
20	20%	100%
21	0%	100%
22	0%	100%
23	0%	100%
24	0%	100%

Protocol for calculating energy use in car parks:

1. Determine the ventilation power rating of the car park exhaust system.

2. Determine the operational hours per day as per the appropriate car park ventilation schedule in Table 28.

3. Calculate the yearly energy requirements in kWh by multiplying the ventilation power rating by the number of exhaust systems, by the operational hours per day.

Example (fill in the limestone green sections):

Table 30: Example on ventilation yearly energy required in carparks

Ventialtion power rating W	Number of exhaust systems	Operational hours/day	Operational days/year	Yearly energy required Kwh
3	8	365	60	525.6

3. Lift, Escalator and Travelator Energy Use

3a. Calculating Lift Energy Use

Protocol for calculating lift energy use:

1. Determine the lift power ratings from supplier specifications.

2. Assume each person uses the lift 3 times per day every day, each trip takes 1 minute which gives the usage factor of 0.05 (hrs/person/day).

3. Calculate the Yearly Energy Usage. This can be done by multiplying the lift power rating by the number of lifts, then by the number of people, then by the usage factor and finally by 365 days a year. This is the figure to be entered into the Green Star – Multi Unit Residential Energy Calculator.

Example (limestone green sections to be filled in)

Table 31: Example of how to calculate lift energy consumption

Lift power rating (kw)	Number of lifts	Number of people	Usage factor (hrs/day)	Days per year	Yearly energy usage (Kwh/year)
25	1	32	0.05	365	14,600

3b. Calculating Escalator and Travelator Energy Use

Protocol for calculating escalator and travelator energy use:

1. Determine the escalator or travelator power rating from supplier specifications.

2. Determine the Usage Factor based on the presence of an escalator or travelator sensor. These sensors detect movement and start the escalator or travelator moving if someone is walking towards it. The usage factor is:

   i) 0.05 (hrs/pers/day) if there is sensor assuming each person uses the lift 3 times per day every day, each trip takes 1 minute which gives the usage factor; and

   ii) 1 (hrs/pers/day) with no sensor.

3. Calculate the Yearly Energy Usage. This can be done by multiplying the power rating by the number of escalators or travelators, then by the usage factor and finally by 365 days per year. This is the figure to be entered into the Green Star – Multi Unit Residential Energy Calculator.

Example (limestone green sections to be filled in)

Table 32: Example of how to calculate escalator or travelator energy consumption

Escalator travelator power rating	Number of escalators	Number of people	Number of people	Days per year	Yearly energy usage (Kwh/year)
8kW (with sensor)	2	32	0.05	365	9344

4. Domestic Hot Water Energy Consumption

4a. Domestic gas hot water energy consumption

Protocol for calculating energy use:

1. Calculate the Daily Domestic Hot Water Requirements (L/person/day). A building that uses 4 Star taps and 3 Star showers will require 95 L/day/person of water. Typically, hot water accounts for half of this, therefore 47.5 L/day/person of hot water is required.

2. Calculate the Daily Domestic Hot Water Energy Requirements by determining how much primary energy input is required to heat this amount of water to 60°C per day using:

Q	= 0.001 x	M		Cp		ΔT
Energy (MJ/pers/day)		Mass of water (L/pers/day)	x	Specific Heat of water (J/g°C)	x	Change in Temperature (°C)

3. Multiply the Daily Domestic Hot Water Energy Requirement by 365 days to calculate the Yearly Hot Water Energy Requirement.

Example steps 1-3 (limestone green section to be filled in)

Table 33: Example to how to calculate hot water energy consumption

Mass of water L/pers/day	Number of people	Change in temperature (°c)	Specific heat capacity Cp	Daily energy required to heat hot water (mj/day)	Yearly energy required to heat hot water (mj/year)
47.5	32	(60-18) = 42	4.18	267	97401

Therefore the value put into the Green Star Calculator for gas instantaneous 97,401MJ/yr.

If a gas storage hot water system is being used then the heating losses must be taken into account.

4. Determine the declared heating loss from the manufacturers specification in MJ/day.

5. Calculate the yearly heating loss by multiplying the declared heating loss by the number of systems, by the operational days per year to get it in MJ/year.

Example steps 4-5 (fill in limestone green sections)

Table 34: Example for yearly heating losses in gas storage hot water systems

Declared heating loss Mj /day	Number of hot water gas storage systems	Operational days/year	Yearly heating loss Mj
7.02	16	365	40,997

6. Add the yearly required energy to heat the water to the yearly heating loss to determine the yearly energy required to deliver hot water to residents.

Example step 5 (fill in limestone green sections)

Table 35: Example for yearly energy required to deliver hot water to residents with gas storage systems

Yearly heating loss Mj	Yearly energy requirement to heat water Mj	Yearly energy required to deliver hot water to residents Mj
40967	97401	138,398

Therefore the value put into the Green Star calculator if an gas storage hot water system is 138,398MJ/yr.

4b. Domestic electric storage hot water energy consumption

Protocol for determining the electric hot water energy consumption:

1. Calculate the Daily Domestic Hot Water Requirements (L/person/day). A building that uses 4 Star taps and 3 Star showers will require 95 L/day/person of water. Typically, hot water accounts for half of this, therefore 47.5 L/day/person of hot water is required.

2. Calculate the Daily Domestic Hot Water Energy Requirements by determining how much primary energy input is required to heat this amount of water to 60°C per day using this equation:

Q		= 0.001 x	M		Cp		ΔT	÷	3.6
Energy (kWh/pers/day)	=		Mass of water (L/pers/day)	x	Specific Heat of water (J/g°C)	x	Change in Temperature (°C)		

3. Multiply the Daily Domestic Hot Water Energy Requirement by 365 days to calculate the Yearly Hot Water Energy Requirement.

Example steps 1-3 (limestone green section to be filled in)

Table 36: Example to how to calculate hot water energy consumption

Mass of water L/pers/day	Number of people	Change in temperature (°c)	Specific heat capacity Cp	Daily energy required to heat hot water (mj/day)	Yearly energy required to heat hot water (mj/year)
47.5	32	(60-18) = 42	4.18	74	27,056

Therefore the value put into the Green Star Calculator for electric instantaneous 27,056kWh/yr.

If an electric storage hot water system is being used then the heating losses must be taken into account.

4. Determine the declared heating loss from the manufacturers specification in kWh/day.

5. Calculate the yearly heating loss by multiplying the declared heating loss by the number of systems, by the operational days per year to get it in kWh/year.

Example steps 1-3 (limestone green section to be filled in)

Table 37: Example for yearly heating losses in electric storage hot water systems

Declared heating loss Kwh /day	Number of hot water gas storage systems	Operational days/year	Yearly heating loss Kwh
1.95	16	365	11,388

6. Add the yearly required energy to heat the water to the yearly heating loss to determine the yearly energy required to deliver hot water to residents.

Example step 5 (fill in yellow sections)

Table 38: Example for yearly energy required to deliver hot water to residents with electric storage systems

Yearly heating loss Kwh	Yearly energy requirement to heat water Kwh	Yearly energy required to deliver hot water to residents Kwh
11388	27,056	38,444

Therefore the value put into the Green Star calculator if an electric storage hot water system is 38,444kWh/yr.